Case No. 1:16-cv-1534-JEB

CHEYENNE RIVER SIOUX TRIBE

EXHIBIT 2

Case No. 1:16-cv-1534-JEB

**IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF COLUMBIA**

STANDING ROCK SIOUX TRIBE, **Plaintiff,** **and** **CHEYENNE RIVER SIOUX TRIBE,** **Intervenor-Plaintiff,** **v.** **U.S. ARMY CORPS OF ENGINEERS,** **Defendant – Cross-Defendant.** **and** **DAKOTA ACCESS, LLP,** **Intervenor-Defendant – Cross-Claimant.**	**Case No. 1:16-cv-1534-JEB**

DECLARATION OF NICOLE E. DUCHENEAUX SUPPORT OF CHEYENNE RIVER SIOUX TRIBE'S MOTION FOR SUMMARY JUDGEMENT

I, Nicole E. Ducheneaux, declare as follows:

1. I am counsel of record for Intervenor-Plaintiff Cheyenne River Sioux Tribe. I have been admitted to practice before this Court.
2. A true and correct copy of the Missouri River Mainstem Reservoir System Master Water Control Manual for the Missouri River Basin revised in March 2006, excerpts of the manual are attached hereto as **Attachment A.**

3. A true and correct copy of the September 14, 2006 Department of Defense Instruction Number 4710.02 Subject: DoD Interactions with Federally-Recognized Tribes is attached hereto as **Attachment B.**

4. A true and correct copy of the November 1, 2012 Memorandum for Commanders, Directors and Chiefs of Separate Officers, U.S. Army Corps of Engineers Tribal Consultation Policy is attached hereto as **Attachment C.**

5. A true and correct copy of an excerpt of the August 24, 2017 Hearing Transcript is attached hereto as **Attachment D.**

6. A true and correct copy of an excerpt of the September 16, 2016 Transcript is attached hereto as **Attachment E.**

I swear under the penalty of perjury that the foregoing is true and accurate to the best of my knowledge.

February 22, 2017

Nicole E. Ducheneaux

Case No. 1:16-cv-1534-JEB

CHEYENNE RIVER SIOUX TRIBE

ATTACHMENT A

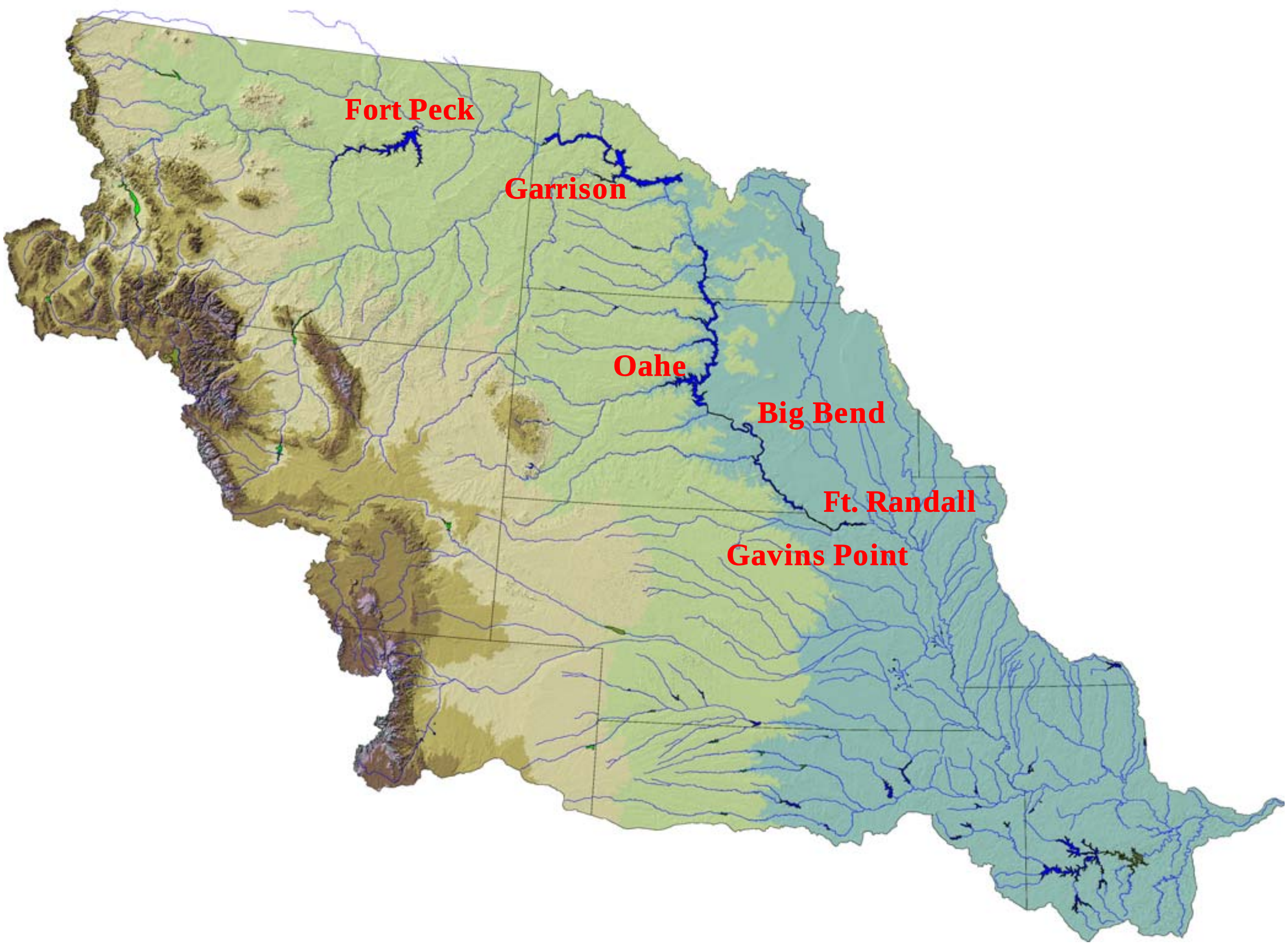
US Army Corps of Engineers

Northwestern Division

Missouri River Mainstem Reservoir System

Master Water Control Manual

Missouri River Basin



Reservoir Control Center
U. S. Army Corps of Engineers
Northwestern Division - Missouri River Basin
Omaha, Nebraska

Revised March 2006

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, NORTHWESTERN DIVISION
PO BOX 2870
PORTLAND OR 97208-2870

REPLY TO
ATTENTION OF

March 1, 2006

In 2003, the United States Fish and Wildlife Service (USFWS) issued an Amended Biological Opinion (2003 Amended BiOp) on the United States Army Corps of Engineers' (Corps') Missouri River System operations. Among other actions, the 2003 Amended BiOp called for bimodal spring pulse releases from Gavins Point Dam for the benefit of the listed pallid sturgeon. Working with the USFWS, Tribes, states, and other basin stakeholders, the Corps has developed technical criteria for the bimodal spring pulse releases which, under the terms of the 2003 Amended BiOp, are to be implemented by March 2006. By my approval of the attached Memorandum of Decision, the Corps is including these technical criteria in Revision 1 to the Missouri River Mainstem Reservoir System Master Water Control Manual (Master Manual). In addition to the spring rise technical criteria in Chapter 7 and Appendix I, Revision 1 also includes an update of Appendix A.

Public participation in the soon-to-be-established Missouri River Recovery Implementation Committee will be critical to efforts to recover these protected species. The Corps is dedicated to this effort and is committed to serve the Nation and its citizens in protecting one of our National Treasures, the Missouri River. We are also committed to working with all basin interests, including Tribes, states, and interested public and private groups, to assure that the implementation of the water control plan, as presented in this Master Manual, as well as any future changes, are coordinated with the basin. The Corps looks forward to our participation in this regional partnership in carrying out our stewardship responsibilities to the Nation and the region in the regulation of the Missouri River Mainstem System.

Sincerely,

/ Signed /

Gregg F. Martin
Brigadier General, US Army
Division Commander

Record of Decision
Master Water Control Manual

MEMORANDUM OF DECISION

MISSOURI RIVER MASTER WATER CONTROL MANUAL, REVISON 1, INCORPORATION OF TECHNICAL CRITERIA FOR BIMODAL SPRING PULSE RELEASES FROM GAVINS POINT DAM

In 2003 the United States Fish and Wildlife Service (USFWS) issued an Amended Biological Opinion (Amended BiOp) on the United States Army Corps of Engineers' (Corps') Missouri River Mainstem Reservoir System operations. Among other actions, the Amended BiOp called for bimodal spring pulse releases from Gavins Point Dam for the benefit of the endangered pallid sturgeon. Under the terms of the Amended BiOp, a plan for the bimodal spring pulse releases is to be implemented by March 2006.

Bimodal spring pulse releases from Gavins Point Dam were controversial throughout the Missouri River Master Water Control Manual (Master Manual) Review and Update National Environmental Policy Act (NEPA) process. Although the NEPA documents developed during that process addressed several alternatives that included spring pulse releases, the Record of Decision (ROD) for the revisions to the Master Manual dated March 19, 2004 did not include any flow changes for the pallid sturgeon. The ROD did present the Corps' commitment to identify a spring pulse plan that complied with the provisions of the Amended BiOp by 2006.

Subsequent to the issuance of the March 19, 2004 ROD, the Corps, in coordination with the USFWS and with the assistance of the United States Institute for Environmental Conflict Resolution, coordinated with basin Tribal representatives, States, and stakeholders in an attempt to develop a basin consensus for bimodal spring pulse release criteria meeting the requirements of the Amended BiOp. While this process was not successful in developing a basin consensus, it did assist the Corps in developing spring pulse release technical criteria for inclusion in the Master Manual. Recognizing the unique government-to-government relationship between American Indian Tribes and the United States, and in light of the Corps' Trust responsibilities and commitments pursuant to the March 2004 "Programmatic Agreement for the Operation and Management of the Missouri River Mainstem System for Compliance with the National Historic Preservation Act", additional consultation/meetings were held with Tribal representatives and members regarding the spring pulse release technical criteria to address Tribal issues.

An Environmental Assessment (EA) was prepared (attachment) that addresses the purpose and need for the bimodal spring pulse releases from Gavins Point Dam. The EA compares the environmental impacts of the bimodal spring pulse releases plan, as defined by the technical criteria, with the range of impacts of alternative spring pulse proposals that were addressed in prior environmental analyses conducted by the Corps. These prior analyses were presented in the Final Environmental Impact Statement, Missouri River Master Manual Water Control Manual, Review and Update (FEIS). The EA has concluded that the impacts associated with the bimodal spring pulse releases technical criteria are within the range of impacts identified for spring pulse alternatives analyzed in the earlier Master Manual Review and Update NEPA process, or less than the impacts identified by those alternatives. The EA also discussed a No Action Alternative whereby spring pulse criteria would not be adopted, but concluded that the Corps would not be in compliance with the Endangered Species Act if the No Action Alternative were adopted.

The USFWS has informed the Corps that the technical criteria for bimodal spring pulse releases from Gavins Point Dam, if implemented in conjunction with a comprehensive adaptive management strategy, will meet the intended purposes outlined in the 2003 Amended BiOp for 2006 and beyond. The technical criteria include sufficient safeguards to minimize impacts to authorized project purposes, basin Tribes, and both upstream and downstream river uses while providing potential benefits to the endangered pallid sturgeon. The bimodal spring pulse releases, as described in the technical criteria, would not be implemented in extreme drought conditions, thereby protecting upstream reservoir uses. The technical criteria do not modify existing downstream flow limits, thereby providing the same level of protection to downstream rivers users, who are concerned about interior drainage and groundwater issues, as are currently provided.

The Corps is committed to monitoring both the physical and biological impacts of the bimodal spring pulse releases, including the response of the pallid sturgeon to the pulses, further evaluation of interior drainage and groundwater concerns, and potential impacts to cultural resources. Within an overall adaptive management strategy, results of monitoring will be used to inform future modifications to the criteria. If future changes to the technical criteria are necessary, they will be the subject of Tribal and public review.

I find that the bimodal spring pulse release criteria, as described in the EA and included in Appendix I of the revised Master Manual, is consistent with all environmental statutes and the Corps' Trust and Treaty responsibilities to Missouri River Basin Tribes; provides for the Congressionally authorized uses of the Mainstem Reservoir System; and is not contrary to the public interest. I, therefore, approve these revisions to the Master Manual.

Date: 28 February 2006

/ Signed /
Gregg F. Martin
Brigadier General, U.S. Army
Division Engineer

MISSOURI RIVER BASIN
MAINSTEM RESERVOIR SYSTEM
MASTER WATER CONTROL MANUAL

In 7 Volumes — Volume 1

MASTER MANUAL

TABLE OF CONTENTS

VIII – WATER MANAGEMENT ORGANIZATION

APPENDICES

TABLES

PLATES

ABBREVIATIONS

AOP	-	annual operating plan
ARPA	-	Archaeological Resources Protection Act
ac.ft.	-	acre-feet
AF	-	acre-feet
B	-	Billion
BIA	-	Bureau of Indian Affairs
BiOp	-	November 2000 U.S. Fish and Wildlife Service Biological Opinion
BSNP	-	Missouri River Bank Stabilization and Navigation Project
cfs	-	cubic feet per second
COOP	-	Continuity of Operations Plan
CO-OP)	-	cooperative stream-gaging program
Corps	-	Corps of Engineers
COE	-	Corps of Engineers
con't	-	continued
CRREL	-	Corps' Cold Regions Research and Engineering Laboratory
CSU/DSU	-	Channel Service Unit/Data Service Unit
CY	-	calendar year (January 1 to December 31)
CWCP	-	current water control plan
CWMS	-	Corps' Water Management System
DCP	-	Data Collection Platform
DOMSAT	-	DOMestic SATellite
DRGS	-	Direct Readout Ground Station
DRM	-	Daily Routing Model
DSS	-	HEC-Data Storage System
EIS	-	Environmental Impact Statement
elev	-	elevation
EPA	-	Environmental Protection Agency
EMWIN	-	Emergency Managers Weather Information Network
ERDC	-	Corps' Engineering Research and Development Center
EOC	-	Emergency Operations Center
ESA	-	Endangered Species Act
F	-	Fahrenheit
FEIS	-	Missouri River Master Water Control Manual Final Environmental Impact Statement
FEMA	-	Federal Emergency Management Agency
FIS	-	Flood Insurance Study
FPC	-	Federal Power Commission
ft	-	feet
FUI	-	Forecasted Ungaged Inflow
GIS	-	Geographic Information System
GOES	-	Geostationary Orbiting Environmental Satellite
GSA	-	General Service Administration
GWh	-	gigawatt hour
HEC	-	Corps' Hydrologic Engineering Center

HMS	-	Corps' Hydrologic Modeling System
Holdouts	-	Natural, or unregulated, flows
HQUSACE	-	Headquarters, U.S. Army Corps of Engineers
IMPLAN	-	Impact Analysis for Planning
I-O	-	input-output
IWIN	-	Interactive Weather Information Network
IWR	-	Institute for Water Resources
KAF	-	1,000 acre-feet
Kcfs	-	1,000 cubic feet per second
kW	-	kilowatt
kWh	-	kilowatt hour
LAN	-	Local Area Network
LRGS	-	Local Readout Ground Stations
LRS	-	Long-Range Study
M	-	million
Master Manual Master	-	Missouri River Water Control Manual
Master Manual Study	-	Missouri River Master Water Control Manual Review and Update Study
MAF	-	million acre-feet
MAPP	-	Mid-continent Area Power Pool
MBRFC	-	National Weather Service Missouri Basin River Forecast Center
MPE	-	Multi-sensor Precipitation Estimates
MRBA	-	Missouri River Basin Association
MRBC	-	Missouri River Basin Commission
MBIAC	-	Missouri River Basin Inter-Agency Committee
MBSA	-	Missouri Basin States Association
MBSC	-	Missouri Basin Survey Commission
MRBWMD	-	Missouri River Basin Water Management Division
MRD	-	Corps' Missouri River Division
MRADS	-	Missouri River Automatic Data System
MRNRC	-	Missouri River Natural Resources Committee
MOU	-	Memorandum of Understanding
mph	-	miles per hour
msl	-	mean sea level
MVD	-	Corps' Mississippi Valley Division
NWK	-	Corps' Kansas City District
NOW	-	Corps' Omaha District
MVP	-	Corps' St. Paul District
MVR	-	Corps' Rock Island District
MVS	-	Corps' St. Louis District
MW	-	megawatt
MWh	-	megawatt hour
NAGPRA	-	Native American Graves Protection and Repatriation Act
NHPA	-	National Historic Preservation Act
NPDES	-	National Pollutant Discharge Elimination System
NOAA	-	National Oceanic and Atmospheric Administration

NOC	-	Network Operations Center
NOHRSC	-	National Operational Hydrologic Remote Sensing Center
NRCS	-	Natural Resource Conservation Service
NRMS	-	Natural Resource Management System
NWCC	-	National Water and Climate Center
NWD	-	Corps' Northwestern Division
NWS	-	National Weather Service
P.L.	-	Public Law
plover	-	piping plover
pp	-	powerplant
ppm	-	parts per million
POP	-	Points of Presence
PPCS	-	Power Plant Control System
QPF	-	Quantitative Precipitation Forecasts
RAS	-	River Analysis System
RCC	-	Reservoir Control Center
RDEIS	-	Revised Draft Environmental Impact Statement
RM	-	river mile
Service	-	U.S. Fish and Wildlife Service
SNOTEL	-	SNOw TELemetry
Southwestern	-	Southwestern Power Administration
SSARR	-	Streamflow Synthesis and Reservoir Regulation
Sq. Mi.	-	square miles
SWE	-	Snow Water Equivalency
System	-	Missouri River Mainstem Reservoir System
T&E	-	threatened and endangered species
tern	-	interior least tern
TLR	-	transmission loading relief
tw	-	tailwater
UMRS FFS	-	Upper Mississippi River System Flow Frequency Study
UNET	-	Unsteady Flow Through a Full Network
UPS	-	Uninterrupted Power Supplies
UTP	-	Unshielded Twisted Pair
USBR	-	Bureau of Reclamation
USGS	-	United States Geological Survey
Western	-	Western Area Power Administration
WAPA	-	Western Area Power Administration
WSCC	-	Western Systems Coordinating Council
WSFO	-	National Weather Service Weather Forecast Offices
yr	-	year

MISSOURI RIVER BASIN
MAINSTEM RESERVOIR SYSTEM
MASTER WATER CONTROL MANUAL

I – INTRODUCTION

1-01. **Authorization.** This manual has been prepared as directed in the U.S. Army Corps of Engineers' Water Management Regulation, ER 1110-2-240, which prescribes the policies and procedures to be followed by the U.S. Army Corps of Engineers (Corps) in carrying out water management activities, including establishment and the updating of water control plans for Corps and non-Corps projects, as required by Federal laws and directives. This manual is prepared as a Master Water Control Manual (Master Manual) as discussed in that regulation. This manual is also prepared in accordance with pertinent sections of the Corps' Engineering Manual, EM 1110-2-3600, entitled "Management of Water Control Systems." This Master Manual is prepared under the format and recommendations described in the Corps' Water Management Regulation, ER 1110-2-8156, dated August 31, 1995 and entitled "Preparation of Water Control Manuals." Revisions to this manual are processed in accordance with ER 1110-2-240. Deviations from this manual are processed in accordance with ER 1110-2-1400.

1-02. **Purpose and Scope.** Master Manuals for river basins that include more than one Corps District are prepared by, or under direct supervision of, Division Commanders. The system of six dams on the Missouri River affects not only the States within the Missouri River basin in which the six dams and their reservoirs are located, but also the downstream reaches of the Missouri River to its mouth near St. Louis, Missouri. The States are located within the Corps' Omaha and Kansas City Districts; therefore, the Missouri River Basin Water Management Division (MRBWMD), Programs Directorate, of the Corps' Northwestern Division (NWD) located in Omaha, Nebraska has prepared this Master Manual. A subset of the MRBWMD, known as the Reservoir Control Center (RCC), is responsible for the day-to-day regulation of the Missouri River Mainstem Reservoir System (System). Section 9 of the 1944 Flood Control Act authorized the System to be operated for the purposes of flood control, navigation, irrigation, power, water supply, water quality control, recreation, and fish and wildlife. In addition, operation of the System must also comply with other applicable Federal statutory and regulatory requirements. Furthermore, to achieve the multi-purpose benefits for which they were authorized and constructed, the six System reservoirs must be operated as a hydraulically and electrically integrated system. A Master Manual is required because the System consists of the integrated operation of multiple projects, each having its own Water Control Manual. The Master Manual serves as a guide to the RCC in meeting the operational objectives of the System when regulating the six System reservoirs. This Master Manual also includes the integrated operation of both System and tributary reservoir water control plans so that an effective plan for flood control and conservation operations exists within the basin. The sheer size of the System dwarfs all other tributary reservoir projects within the Missouri River basin; therefore, this plan must serve to integrate all those operations to remain effective in meeting the overall operational objectives of the System.

1-02.1. The total set of Water Control Manuals for the System numbers seven, one for each of the individual projects and this Master Manual. The Water Control Manual for the entire System is in seven volumes as follows:

Volume	Project
1	**Master Manual**
2	**Fort Peck Dam & Reservoir (Fort Peck Lake)**
3	**Garrison Dam & Reservoir (Lake Sakakawea)**
4	**Oahe Dam & Reservoir (Lake Oahe)**
5	**Big Bend Dam & Reservoir (Lake Sharpe)**
6	**Fort Randall Dam & Reservoir (Lake Francis Case)**
7	**Gavins Point Dam & Reservoir (Lewis and Clark Lake)**

1-02.2. The individual project Water Control Manuals serve as supplements to this Master Manual and present aspects of project usage not common to the System as a whole, including added detail on the incremental drainage areas regarding hydrology, hydrologic networks, forecasting, streamflow, and runoff. Also site-specific maps and regulation considerations for each individual project are discussed in greater detail than in this Master Manual.

1-02.3. This Master Manual describes the water control plan for the System. The plan consists of the water control criteria for the management of the System for the full spectrum of anticipated runoff conditions that could be expected to occur. According to ER 1110-2-240, "Throughout the life of the project, it is necessary to define the water control criteria in precise terms at a particular time, in order to assure carrying out the intended functional commitments in accordance with the authorizing documents." Annual water management plans (Annual Operating Plans, or AOP's) are prepared each year, based on the water control criteria contained in the Master Manual, in order to detail reservoir regulation of the System for the current operating year. Because the System is so large, it can respond to extreme conditions of longer than one-year duration. The AOP document also provides an outlook for planning purposes in future years.

1-02.4. ER 1110-2-240 also specifies, "…necessary actions will be taken to keep approved water control plans up-to-date." The regulation further states, "For this purpose, plans will be subject to continuing and progressive study by personnel in field offices of the Corps of Engineers." Revision of this Master Manual may be necessary in the future because of the possible changing emphasis on the level of service to various authorized or new project purposes or with new knowledge that is gained from additional actual operating experience. The emphasis will remain, however, on maintaining the inherent flexibility that exists and is required for effective operation of the System. New information on the needs of the project purposes, such as the requirements for endangered species enhancement, may also require revision of the water control plan and, subsequently, the Master Manual. Furthermore, other factors within the basin, such as a significant reduction in the availability of water (changes in depletions of water within and downstream from the System), may also require a revision of the water control plan included in this Master Manual.

1-02.5. Chapter 3 of the Engineering Manual for Management of Water Control Systems (EM 1110-2-3600) outlines the various steps and technical considerations necessary to develop water control plans. This chapter states, "Usually, management of water control systems by the Corps involves input from other agencies of the Federal government, as well as state and local authorities, public utilities, irrigation districts, fish and wildlife interests, and other groups that are involved in environmental and public use functions of project regulation." ER 1110-2-240 also addresses public input when it states, "Water control plans will be developed in concert with all basin interests which are or could be impacted by or have an influence on project regulation." The NWD fully complied with these regulations and the Water Resources Development Act of 1990 as this Master Manual was reviewed and updated with a new water control plan. Basin interests can anticipate continued public involvement in the water control management process and any significant water control plan or Master Manual revisions in the future will be processed in accordance with ER 1110-2-240. Minor revisions to this or any of the previously mentioned individual project manuals will be the responsibility of the RCC and do not require coordination throughout the basin. In addition, changed circumstances or unforeseen conditions may necessitate short-term deviations from the current water control plans (CWCP). Such deviations are reviewed and approved by the Commander, Northwestern Division in accordance with ER 1110-2-1400.

1-03. **Related Manuals and Reports.** The Master Manual was first published in December 1960. Selected pages were revised in November 1973, and a revised water control manual was published in 1975. Regulation criteria for flood control were revised, and the Master Manual was republished in 1979. The Master Manual has been reprinted several times since with no additional changes using the 1979 date. The first Master Manual and its subsequent versions were developed in consultation with State governments within the Missouri River basin and Federal agencies having related authorities and responsibilities. This Master Manual represents the first major revision of the drought conservation regulation portion of the water control plan for the System.

1-03.1. Public concern over the drought conservation plan presented in the 1979 version of the Master Manual surfaced early in the 1987 to 1993 drought. This was the first major drought to occur in the basin since the System was originally filled and became fully operational in 1967. The NWD initiated an update of the water control plan in 1989 because of this concern. The update to the existing water control plan was considered a major revision that required extensive coordination with basin interests. As part of the subsequent review and update process for the Master Manual, an Environmental Impact Statement (EIS) under the auspices of the National Environmental Policy Act was prepared. Numerous supporting technical reports and five versions of the EIS (preliminary draft (May 1993), draft (July 1994), preliminary revised draft (August 1998), revised draft (August 2000), and final (March 2004)) were prepared. The basis for the selection of the water control plan included in this Master Manual is outlined in the Final EIS and the subsequent Record of Decision. There have been extensive coordination activities conducted by the NWD during the 14-year process of updating this Master Manual. This Master Manual represents the culmination of those coordination efforts.

1-03.2. The operation of the Corps' integrated dam and reservoir projects, such as the System, is guided by information presented in master water control manuals. To achieve the maximum became operational in 1951, completing construction of the first powerplant. Construction of a second powerplant began in the late 1950's and the two units of this plant became operational in 1961. The Permanent Pool Zone (inactive storage) of the reservoir was initially filled (elevation 2150) in April 1942 and the Carryover Multiple Use Zone (elevation 2234) first filled in 1947, 5 years later. Drought conditions during the late 1950's, combined with withdrawals to provide water for the initial fill of other System projects, resulted in a drawdown of the reservoir level to elevation 2167.4 in early 1956, followed by a generally slow increase in pool elevation. The Carryover Multiple Use Zone was finally refilled in July 1964. Generally, it has remained filled from that time with the exception of the droughts of 1987 to 1993 and 1999 to date. Exclusive flood control storage space was first used in 1969, and then again in 1970, 1975, 1976, 1979, 1996, and 1997. In 1975, a maximum reservoir level of 2251.6 ft msl, 1.6 feet above the top of the Exclusive Flood Control Zone, occurred.

2-03.2. **Construction of Garrison Dam – Lake Sakakawea.** Garrison Dam is located in central North Dakota on the Missouri River at RM 1390, about 75 river miles northwest of Bismarck, North Dakota and 11 miles south of the town of Garrison, North Dakota. Construction of the project was initiated in 1946, closure was made in April 1953, and the navigation and flood control functions of the project were placed in operation in 1955. Garrison Dam is currently the fifth largest earthen dam in the world. The first power unit of the project went on the line in January 1956, followed by the second and third units in March and August of the same year. Power units 4 and 5 were placed in operation in October 1960. Lake Sakakawea first reached its minimum operating level in late 1955. Due to the drought conditions it was not until 10 years later, in 1965, that the Carryover Multiple Use Zone was first filled. Generally, it remained filled from that time through 2002, except for the two drought periods to date. Exclusive flood control storage space was used in 1969, 1975, 1995 and 1997. During 1975, all flood control space was filled and the maximum reservoir level was 0.8 foot above the top of the Exclusive Flood Control Zone, elevation 1854.8 ft msl. Lake Sakakawea is the largest Corps reservoir. When full, the reservoir is 178 miles long and up to 6 miles wide. The reservoir contains almost a third of the total storage capacity of the System, nearly 24 MAF, which is enough water to cover the State of North Dakota to a depth of 6 inches.

2-03.3. **Construction of Oahe Dam – Lake Oahe.** The Oahe Dam is located on the Missouri River at RM 1072, 6 miles northwest of Pierre, South Dakota. Construction of Oahe Dam was initiated in September 1948. Closure of the dam was completed in 1958, and deliberate accumulation of storage was begun in late 1961, just before the first power unit came on line in April 1962. The last of the seven power units became operational in July 1966. Permanent Pool storage space in Lake Oahe was first filled in 1962 and the Carryover Multiple Use Zone was filled in 1967. Generally, the Carryover Multiple Use Zone remained filled from that time through 2002, except for seasonal drawdowns in the interest of increased winter power generation and the two drought periods to date. The Exclusive Flood Control Zone in Lake Oahe was used in 1975, 1984, 1986, 1995, 1996, 1997, and 1999. The maximum of record elevation was experienced on June 25, 1995, at 1618.71 feet mean sea level (msl), when the Oahe pool occupied 1.7 feet of the 3-foot Exclusive Flood Control Zone. Lake Oahe is the second largest Corps reservoir, with just over 23 MAF of storage capability. When full, the reservoir is 231 miles long, with 2,250 miles of shoreline.

2-03.4. **Construction of Big Bend Dam - Lake Sharp.** Big Bend Dam is located on the Missouri River at RM 987, near Fort Thompson, South Dakota and about 20 miles upstream from Chamberlain, South Dakota. Lake Sharpe extends 80 miles upstream to the vicinity of the Oahe Dam. The project is basically a run-of-the-river power development with regulation of flows limited almost entirely to daily and weekly power pondage operations. Construction began in 1959, with closure in July 1963. The first power unit was placed on line in October 1964, and the last of the eight units began operation during July 1966. Since full operation began, the reservoir has been held very near the normal operating level of elevation 1420. A maximum level at elevation 1422.1, 0.1 foot into the Exclusive Flood Control Zone, occurred in June 1991.

2-03.5. **Construction of Fort Randall Dam – Lake Francis Case.** Fort Randall Dam is located on the Missouri River at RM 880, about 6 miles south of Lake Andes, South Dakota. Lake Frances Case extends to Big Bend Dam. Construction of the project was initiated in August 1946, closure was made in July 1952, initial power generation began in March 1954, and the project reached an essentially complete status in January 1956, when the eighth and final unit of the 320,000-kilowatt installation came into service. The reservoir filling was initiated in January 1953 and reached the minimum operating pool elevation of 1320 feet msl on November 24, 1953. The maximum reservoir level experienced to date was in July 1997, when an elevation of 1372.2 occurred, 2.6 feet below the top of the Exclusive Flood Control Zone. The maximum mean daily release of 67,500 cubic feet per second (cfs) was experienced in November 1997.

2-03.6. **Construction of Gavins Point Dam – Lewis and Clark Lake.** Gavins Point Dam is located on the Missouri River at RM 811 on the Nebraska-South Dakota border, 4 miles west of Yankton, South Dakota. Lewis and Clark Lake extends 37 miles to the vicinity of Niobrara, Nebraska. Construction was initiated in 1952, and closure was made in July 1955, with initial power generation beginning in September 1956. The third and final unit of the 100,000-kilowatt installation came into service in January 1957.

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IV – MISSOURI RIVER BASIN FEDERAL PROJECTS AND RIVER REACH DESCRIPTIONS

4-01. **Missouri River Basin - Mainstem System Reservoirs.** The Missouri River Mainstem Reservoir System (System) is comprised of six reservoirs that were constructed by the Corps of Engineers. These six Corps reservoirs contain about 73.4 million acre-feet of storage capacity, which constitutes over 52 percent of the total storage in the basin's 17,200-plus reservoirs. The System is the largest reservoir system in the United States. It contains 71 percent of the installed capacity in the basin's Federal hydroelectric power system, provides almost all of the reservoir support for downstream flow support on the Missouri River, and contributes greatly to flood protection for over 2 million acres of land in the floodplain of the Missouri River. At normal pool levels, these reservoirs provide an aggregate water surface area of 1 million acres for recreation and fish and wildlife enhancement.

4-02. **Authorized Purposes of the Mainstem Reservoir System.** The six System dams are regulated as a hydrologically and electrically integrated system for the Congressionally authorized purposes of flood control, navigation, hydropower, water supply, water quality, irrigation, recreation, and fish and wildlife. The 1944 Flood Control Act authorized construction of the System dams, with the exception of Fort Peck Dam, which was authorized by the Rivers and Harbors Act of 1935. The Fort Peck Power Act of 1938 authorized the construction of hydropower facilities at Fort Peck Dam. The 1944 Flood Control Act also recognized that all of the authorized purposes for the other System projects should apply to Fort Peck as well as making this project a part of the System. The Endangered Species Act of 1973 (Public Law 93-205, as amended in Public Laws 95-632, 96-159 and 97-304) states that the policy of Congress is for all Federal departments and agencies to seek to conserve endangered and threatened species and to utilize their authorities in furtherance of the purposes of the Act. This Act is discussed in greater detail in Chapter 2, Paragraph 2-01.14.6 of this Master Manual. The System has endangered species and has, therefore, operated for the continued existence of these species in coordination with the Service. This Missouri River Mainstem System Master Water Control Manual presents the guidelines and operational objectives for regulating the System for the Congressionally authorized purposes, with recognition that other incidental benefits are also achieved.

4-03. **System Project Locations.** The Corps has six multiple purpose dams located on the main stem of the Missouri River. Extending from the upper reaches of Fort Peck Lake in northeastern Montana to Gavins Point Dam in southeastern South Dakota and northeastern Nebraska, the reservoirs control runoff from 279,480 square miles of the upper Missouri River basin. A map of the Missouri River basin with the main stem and tributary projects is shown on Plate III-23. A Summary of Engineering Data containing pertinent project information is shown on Plates II-1 and II-2.

4-03.1.1. Fort Peck Dam is located at river mile (RM) 1771.5 in McCone and Valley Counties, Montana, 17 miles southeast of Glasgow and 9 miles south of Nashua. The western boundary of the 57,500 square mile drainage area is the Continental Divide.

4-03.1.2. The next downstream project is Garrison Dam at RM 1389.9 in Mercer and McLean Counties, North Dakota. Garrison Dam is 75 river miles northwest of Bismarck, the state capital, and 11 miles south of the town of Garrison, North Dakota. The primary tributary, the Yellowstone River, enters the Missouri River at RM 1582, about 14 miles above the headwaters of Lake Sakakawea.

4-03.1.3. Oahe Dam is located at RM 1072.3 in Stanley and Hughes Counties, South Dakota, 6 miles northwest of Pierre, the capital. The Cheyenne River, draining southwestern South Dakota and northeastern Wyoming, is the largest tributary. Other major tributaries include the Moreau, Grand, Cannonball, Heart, and Knife Rivers.

4-03.1.4. Big Bend Dam, at RM 987.4, is near Fort Thompson, South Dakota and about 20 miles upstream from Chamberlain, South Dakota in Buffalo and Lyman Counties. The primary tributary is the Bad River, which enters the Missouri River at Fort Pierre, South Dakota in the upper end of Lake Sharpe.

4-03.1.5. Fort Randall Dam, also in South Dakota, is located in Charles Mix and Gregory Counties at RM 880.0, about 6 miles south of Lake Andes, South Dakota. The major tributary, the White River, enters Lake Francis Case at RM 955.

4-03.1.6. The last dam, Gavins Point Dam, is on the South Dakota-Nebraska state line at RM 811.1, 4 miles west of Yankton, South Dakota. The right abutment and powerhouse are located on the Nebraska side in Cedar County. The left abutment is in Yankton County, South Dakota. The Niobrara River, a right bank tributary, enters the Missouri River about 8 miles above the headwaters of Lewis and Clark Lake.

4-04. **System Project Physical Components.** The following paragraphs describe the embankments, spillways, outlet works, hydroelectric powerplants, and water supply facilities for each of the System projects. Plates II-3 through II-81 contain maps of each project, including details of embankments, spillway, outlet works and powerplant facilities, area-capacity tables, tailwater rating curves, spillway and outlet works discharge rating curves, and powerplant characteristics.

4-04.1. **Fort Peck Dam – Fort Peck Lake.** The following paragraphs describe the physical features of the System project, Fort Peck Dam – Fort Peck Lake.

4-04.1.1. **Fort Peck Embankment.** Fort Peck Dam is 4 miles long and was constructed almost entirely by hydraulic fill methods. The final topping out of the embankment and a section at the end of a 2-mile-long dike are rolled-earth construction. The embankment contains more than 122 million cubic yards of dredged fill material, making Fort Peck Dam one of the largest hydraulic fill dams in the world. Maximum height of the embankment is 250.5 feet msl, and the maximum base width is 3,500 feet. The crest elevation of the embankment is at 2280.5 feet msl, and the crest width is 50 feet. Rock riprap protects the upstream face of the embankment above elevation 2162 feet msl. A continuous sheet pile cutoff wall in an impervious core provides seepage control. Relief wells are placed along the downstream toe to reduce hydrostatic pressure in the shale foundation.

4-04.1.2. **Fort Peck Spillway.** The Fort Peck spillway is a massive concrete and steel structure located in a natural saddle of the reservoir rim, about 3 miles east of the dam. It consists of a partially lined approach channel; a gated control structure, including a training wall section; a lined discharge channel; and an unlined earth discharge channel that enters the Missouri River about 9 river miles below the dam. Seventeen concrete gate piers are set on a curved line support and provide mountings for 16 vertical lift spillway gates. The piers also support a steel service bridge, a reinforced concrete highway bridge and piers, machinery platforms, and service walkways. The spillway gates, each 25 feet high and 40 feet wide, are electrically operated and can be individually controlled from the service bridge. The spillway crest elevation is 2225 feet msl. Discharge capacity at the maximum operating pool elevation of 2250 feet msl is 230,000 cfs.

4-04.1.3. The concrete-lined discharge channel is about 5,000 feet long and varies in width from 800 feet at the end of the spillway gate structure to 120 feet at the downstream end. A reinforced concrete cutoff structure is located at the downstream end of the discharge channel. This structure extends about 70 feet below the channel floor and has wide wing walls to control erosion on the adjacent shale banks. The spillway does not have an energy dissipation structure. Spillway releases have enlarged and deepened a natural stilling basin that has formed immediately downstream from the cutoff structure. Foundation rebound has caused differential movement of the gate structure, spillway channel, sidewalls, and roadway retaining walls. Foundation rebound at the downstream section of the spillway chute has resulted in deformation of the channel floor. There is a concern that any future sustained spillway releases may erode around the west wing wall or uplift the floor slabs and threaten the downstream end of the spillway channel.

4-04.1.4. **Fort Peck Outlet Works and Power Tunnels.** Four concrete diversion tunnels, varying in length from 5,700 to 7,200 feet, extend through the east abutment. A submerged intake structure equipped with removable steel trash racks is located at the upstream end of the tunnels. The intake floor of the tunnel portals is at elevation 2030 feet msl. Emergency and main control shafts are located near the axis of the dam. Each tunnel has two 48-ton vertical lift tractor type emergency gates 11 feet wide and 24 feet high. Tunnels 1 and 2 have steel liners downstream from the control shafts to supply flows to Powerplants 1 and 2, respectively. Flow through these tunnels is controlled in Powerhouse 1, which contains Powerplant 1, and the main control shafts, having no regulating gates, serve as auxiliary surge tanks. Tunnels 3 and 4 were designed for emergency flood releases. Two cylindrical gates are installed in each of the main control shafts of Tunnels 3 and 4 for flow control. The upper main control gates are at elevation 2165 feet msl and the lower gates are at elevation 2085 feet msl. Total discharge capacity of both Tunnels 3 and 4 at elevation 2250 feet msl is 45,000 cfs. The flood control tunnels have not been used in some years. Because of experience gained during past release periods, the flood control tunnels should not be operated at individual tunnel release rates above 5,000 cfs without an updated evaluation from the Corps' Omaha District of the effects from such an operation. Past occurrences of cavitation, violent surging, loud noises, gate icing, and gate vibration have resulted in a reluctance to use these structures as a primary solution to project releases greater than powerplant capacity. Since 1975, supplemental releases above powerplant capacity have been made over the spillway. The Omaha District requested authority within the Major Rehabilitation program for replacement of the Fort Peck flood control gates; however, authorization to implement the recommendations in the study was not approved. The tunnels discharge into a concrete reinforced stilling basin consisting of retaining walls, training walls, outlet portals, base slab, and baffle piers.

4-04.1.5. **Fort Peck Powerplants.** Powerplant 1 is located on the left bank of the discharge channel approximately 260 feet downstream from the Tunnel 1 portal in Powerhouse 1. The original Powerplant 1 penstock system was determined to be unsafe in a March 1988 Omaha District reconnaissance report. Replacement of the original penstock, trifurcation, unit penstocks, and butterfly valves was completed in 1992. The turbines are vertical–shaft, Francis-type turbines with plate steel scroll cases. Discharge capacity at rated head is 8,800 cfs. Units 1 and 3 have a nameplate rating of 43.5 megawatts (MW) and the smaller Unit 2 is rated at 18.25 MW. All three units were rewound in 1978, but the Unit 3 stator experienced a major failure in February 2002 and will be rewound. An enclosed surge tank section houses three interconnected 40-foot diameter surge tanks. New, more restrictive orifices were installed in the 8-foot diameter surge tank risers during the penstock replacement to prevent surge tank overtopping. The control room for both powerplants is located in Powerhouse 1.

4-04.1.5.1. Powerplant 2 has two identical turbine generator units located approximately 350 feet downstream from the Tunnel 2 portal. Two penstocks extend from a wye branch at the outlet end of the tunnel. An enclosed surge tank structure houses two interconnected surge tanks. Vertical–shaft, Francis turbines are connected to generators having nameplate ratings of 40 MW each. Units 4 and 5 became operational in 1961, and no rewinds have been required. The discharge capacity of Powerplant 2 is 7,200 cfs.

4-04.1.5.2. Each powerplant has a separate switchyard with a tie line for power interchange between the powerplants. Generation from Powerplant 1 is transmitted to either the east or west grid. Units 1 and 3 are important to the Western Area Power Administration for load control on the west grid. Powerplant 2 supplies energy to the east grid only.

4-04.1.6. **Fort Peck Water Supply Facilities.** Water supply for the town of Fort Peck is obtained from a 10-inch raw water line that taps into the Unit 3 penstock. A water filtration treatment plant is located near the town site.

4-04.2. **Garrison Dam – Lake Sakakawea.** The following paragraphs describe the physical features of the System project, Garrison Dam – Lake Sakakawea.

4-04.2.1. **Garrison Embankment.** Garrison Dam is a rolled earth fill embankment, 11,300 feet long at the crest, rising 210 feet above the old riverbed to a crest elevation of 1875 feet msl. The maximum dam base width is 3,400 feet and the crest width is 60 feet. The upstream portion of the embankment is composed of impervious material and the downstream portion is semi-pervious with a pervious drainage blanket over the old streambed. Seepage control is accomplished by a combination of the upstream pervious blanket, steel sheet piling cutoff walls, impervious filled cutoff trenches, grout curtains at the abutments, and a toe drain in the downstream section of the embankment. Relief wells located about 175 feet downstream from the toe of the dam reduce hydrostatic pressure in the foundation. The upstream face of the dam is protected from wave action by riprap placed above elevation 1800 feet msl. A gravel blanket extends from the bottom of the riprap to elevation 1770 feet msl.

4-04.2.2. **Garrison Spillway.** The 1,336-foot-wide Garrison spillway is sited along the left abutment and is separated from the main embankment by about 800 feet of natural ground. It is a conventional concrete chute type with crest gates at the upper end and consists of the approach channel, control gate structure, lined chute, stilling basin, and unlined discharge channel. The spillway crest, at elevation 1825, consists of an ogee weir divided into 28 bays. Each bay contains a tainter gate 40 feet wide by 29 feet high. The gates are electrically operated and can be individually controlled from the service bridge. The concrete lined discharge chute extends 2,600 feet downstream from the crest structure to the stilling basin. The stilling basin is 800 feet wide and 200 feet long with a floor elevation of 1620 feet msl. Baffles located in the lower end of the stilling basin are 10 feet high and 8 feet wide, spaced on 10-foot centers. Discharge capacity at maximum operating pool (elevation 1854 feet msl) is 660,000 cfs. An unlined pilot channel will erode and guide flows to the Missouri River channel in the event spillway releases are required.

4-04.2.3. **Garrison Outlet Works and Power Tunnels.** The outlet works and power tunnels include an approach channel, an intake structure, eight concrete lined tunnels (three for flood control and five to supply the power units), a stilling basin at the downstream end of the flood control tunnels, and a discharge channel. A large reinforced concrete intake structure contains gate-controlled inlets to the eight tunnels through the dam. Each flood control tunnel has an 18-foot wide by 24.5-foot high tainter gate for flow regulation. Two 12-foot wide by 26-foot high vertical lift gates are located near the upstream end of the five power tunnels. Emergency gates are provided for closure ahead of each of the regulating gates. Tunnels 1 through 5 are concrete with a 29-foot inside diameter and serve as conduits for 24-foot diameter 1,829-foot long steel penstocks to the power units. Tunnels 6, 7, and 8 are for flood control and discharge into a stilling basin. Stop log slots are located in the upper end of the stilling basin for dewatering. Tunnel 6 has an inside diameter of 26 feet and Tunnels 7 and 8 have inside diameters of 22 feet. The combined discharge capacity of Tunnels 6 through 8 is 98,000 cfs at elevation 1854 feet msl. A discharge channel extends nearly 4,000 feet from the downstream edge of the tailrace to the Missouri River channel.

4-04.2.4. **Garrison Powerplant.** In addition to the five penstocks described above, the powerplant has two surge tanks per unit, each 65 feet in diameter and nearly 140 feet high. The powerhouse contains five generators, turbines, control room, and related equipment. The five units have a 41,000-cfs discharge capacity at 150 feet of rated head. A major rehabilitation of the Garrison powerplants was approved, and construction began in 2000 to install more efficient stainless-steel turbine runners. The main unit transformers are located on the transformer deck on the downstream side of the powerhouse and supply power to the switchyard by a high-voltage, oil-filled, pipe cable system. The Garrison switchyard is located southeast of the powerhouse between the outlet works discharge channel and the downstream slope of the dam. The estimated cost of the powerplant major rehabilitation is $55 million. An additional $20 to 30 million may be spent on switchyard rehabilitation. Nameplate rating of Units 1, 2 and 3 will increase from 109.25 MW to 126 MW and Units 4 and 5 will remain at 109.25 MW unless further modifications are made. Maximum efficiency of the turbines' efficiency is expected to be near 95 percent.

4-04.2.5. **Garrison Water Supply Facilities.** A 12-inch water line supplies the town of Riverdale and the Corps' maintenance facility. The Garrison National Fish Hatchery is located downstream from Garrison Dam and receives water from a 16-inch line extending from the Units 4 and 5 penstocks.

4-04.3. **Oahe Dam – Lake Oahe.** The following paragraphs describe the physical features of the System project, Oahe Dam – Lake Oahe.

4-04.3.1. **Oahe Embankment.** Oahe Dam is a compacted earthen embankment flanked by massive shale berms, both upstream and downstream. Outlet works tunnels are located in the right abutment and power tunnels in the left abutment. The total embankment length excluding the spillway is 9,300 feet, maximum dam height is 245 feet, maximum dam base width is 3,500 feet, dam crest width is 60 feet and top of dam elevation is 1660 feet msl. The total dam fill volume is approximately 92 million cubic yards. The right abutment and central valley portions of the embankment are composed of both impervious materials placed in the upstream third of the embankment and more pervious materials placed in the downstream remaining section of the embankment. The left abutment portion is composed of mostly impervious materials. An impervious blanket was placed in the upstream berm and a 5,270-foot-long steel sheet pile wall was constructed 350 feet upstream of the axis of the embankment to control under seepage. The upstream embankment slope is provided rock protection that extends to the crest. A system of 34 relief wells is used in conjunction with a sheet pile cutoff wall to control hydrostatic seepage in the embankment foundations.

4-04.3.2. **Oahe Spillway.** The Oahe spillway is located about 1 mile from the right abutment of the dam. An unlined approach channel was excavated in shale to elevation 1590 feet msl for a distance of approximately 1,200 feet upstream from the spillway gate structure. The spillway structure has a flat weir with a crest elevation of 1596.5 feet msl. Eight tainter gates, each 50 feet wide by 23.5 feet high, provide control. A depressed basin extends 100 feet downstream from the weir and a paved apron extends another 210 feet downstream from the end sill of the basin. The spillway has never been used, and provision for a conventional spillway chute and stilling basin has been deferred. An unlined discharge channel extends approximately 2 miles downstream from the spillway structure. Spillway operating criteria have been established to reduce unpaved discharge channel erosion rates and are published in the Oahe Project - Missouri River Mainstem System Reservoir Regulation Manual. The discharge capacity of the spillway is 80,000 cfs at maximum operating pool.

4-04.3.3. **Oahe Outlet Works.** The outlet works consist of an approach channel, six tunnels with intake structures and control shafts, a stilling basin, and a discharge channel. The approach channel and outlet tunnels were used for diversion of Missouri River flows during construction of the embankment. The intakes are individual, submerged reinforced structures located at the upstream end of the tunnels. They are staggered in plan and elevation. Intake 1 is set the furthest upstream and has the lowest invert elevation (1425 feet msl). Each succeeding intake is approximately 70 feet farther downstream with the invert elevation raised in 6-foot increments. The six flood control tunnels are parallel to each other, with a centerline spacing of 85 feet and lengths varying from 3,500 to 3,660 feet. The control shafts are located near the axis of the dam and house the control and emergency gates and other equipment necessary for flow control. The six control gates include a 13-foot by 22-foot vertical lift cable suspended tractor type gate installed in each of Tunnels 1 to 4 and a 13-foot by 22-foot hydraulic lift, wheeled-type gate installed in Tunnels 5 and 6 for fine regulation. A single 13-foot by 22-foot vertical lift tractor type emergency gate is provided for use in any of the six tunnels. The combined discharge capacity of the six tunnels is 111,000 cfs at elevation 1620 feet msl. The stilling basin downstream from the tunnel portals consists of training piers, drop sections, retaining walls, weir baffles, and end sill. An ogee weir divides the stilling basin into a double stage type with a primary basin and a secondary basin. Two rows of concrete baffles, 6 feet high, are located in the secondary basin, with the tops of the baffles at the same elevation as the end sill. A discharge channel approximately 9,000 feet long returns flow to the Missouri River.

4-04.3.4. **Oahe Powerplant.** The powerplant intake structure, located near the left abutment, has seven intake towers spaced 90 feet on centers. Each tower contains a cylinder gate, 10 feet high and 30 feet in diameter, to control the water passing through eight openings into a 30-foot diameter shaft that connects with a tunnel at the bottom. Bulkhead platforms are provided on the outside of the towers at elevation 1620 feet msl for installing bulkheads. The seven power tunnels extend from the downstream edge of the intake structure to the upstream face of the surge tank base structures. They vary in length from 3,280 to 4,000 feet and are curved in plan. The downstream portions of the tunnels are steel lined, extending from the terminus of the concrete lined section near the axis of the dam to the downstream edge of the tunnel entry structure. Seven 24-foot inside diameter steel penstocks extend 294 feet from the embedded liner to the spiral case. Two, 70-foot diameter by 145-foot high surge tanks are provided for each penstock. The seven hydraulic turbines are vertical-shaft, single–runner, Francis–type turbines, with welded-steel scroll cases and elbow-type draft tubes. The powerhouse discharge capacity at rated head is 54,000 cfs. The generators were rewound from May 1984 through December 1986 and have a nameplate rating of 112.29 MW at a 0.95 power factor. They have been designed to operate at 115 percent of nameplate. Transformer banks are installed in vaults on the draft tube deck. The switchyard, located on the right tailrace, contains an autotransformer section, 115 kV bays, and 230 kV bays. The tailrace is paved with reinforced concrete anchored to the foundation. The tailrace discharge channel is 508 feet wide and extends 1,200 feet downstream from the lower end of the tailrace paving.

4-04.3.5. **Oahe Water Supply Facilities.** A pumping station was constructed for the USBR Oahe Diversion but not used since that project was deauthorized. The intake for the Mni Wiconi pipeline is located about 4 miles downstream from the dam at Channel Block 6 and does not affect Oahe releases.

4-04.4. **Big Bend Dam – Lake Sharpe.** The following paragraphs describe the physical features of the System project, Big Bend Dam – Lake Sharpe.

4-04.4.1. **Big Bend Embankment.** Big Bend Dam is a rolled earth fill embankment with the powerhouse at the right abutment and the spillway at the left abutment. The total embankment length, including the spillway, is 10,570 feet. Maximum dam height is 95 feet, top elevation is 1440 feet msl, maximum dam base width including berms is 1,200 feet and the top of dam width is 50 feet. The embankment makes a gentle S-curve across the valley and is composed of approximately 17 million cubic yards of fill material. The embankment is built on dredged pervious fill with a top elevation near 1357 feet msl. A central impervious core along the entire length of the dam extends from the pervious fill to 5 feet below the top of the dam to control seepage through the embankment. An impervious blanket ties into the central impervious core and extends 425 to 540 feet through the major portion of the embankment. A pervious drain section is located on the downstream side of the impervious core.

4-04.4.2. **Big Bend Spillway.** The Big Bend spillway structure is 376 feet wide and is sited at the left end of the embankment section. The spillway structure consists of an ogee weir with a crest elevation 10 feet above the bottom of the approach channel, eight 40-foot wide by 38-foot high tainter gates, a highway bridge, equipment platforms, and service walkways. The gates operate individually and may be opened or closed in 1-foot increments. A concrete chute extends from the spillway weir to the stilling basin, which is 194 feet long, including the end sill. The end sill is stepped in 5-foot increments from elevation 1320 to 1330 feet msl. Two rows of concrete baffles having a top elevation of 1332 feet msl are provided in the stilling basin. The discharge capacity is 268,000 cfs at elevation 1423 feet msl.

4-04.4.3. **Big Bend Outlet Works.** There are no conventional outlet works structures at the Big Bend project. Releases must be made through the powerplant or the spillway.

4-04.4.4. **Big Bend Powerplant.** The right bank Big Bend powerhouse has a curved approach channel to the intake structure containing separate intakes for each of the eight turbines. Unit intakes are divided into three water passages by intermediate piers. Each water passage contains two sets of gate slots, one for the service gate and one for the bulkhead gate. Three tractor-type, vertical-lift, service gates are provided for each of the unit intakes. An emergency bulkhead-type gate is provided for use in any of the upstream bulkhead gate slots. The powerhouse is constructed integrally with the intake structure. Eight vertical-shaft, fixed–blade, propeller-type turbines with concrete semi-spiral cases and concrete elbow-type draft tubes are installed in the powerhouse. Their combined discharge capacity is 103,000 cfs at a rated head of 67 feet. Generators 1, 2, and 3 were rewound in 1990 and 1991 and have a nameplate rating of 67.276 MW. Units 5 through 8 have the original windings and have a nameplate rating of 58.5 MW. Each pair of generators is connected to one of the four main power transformers located on the draft tube deck. The high voltage switching facilities are also located on the draft tube deck. The reinforced concrete tailrace is 675 feet wide and 140 feet long. The tailrace discharge channel extends 4,350 feet downstream from the downstream end of the tailrace paving.

4-04.4.5. **Big Bend Water Supply Facilities.** There are no water supply facilities provided from the Big Bend powerhouse.

4-04.5. **Fort Randall Dam – Lake Francis Case.** The following paragraphs describe the physical features of the System project, Fort Randall Dam – Lake Francis Case.

4-04.5.1. **Fort Randall Embankment.** Fort Randall Dam is a rolled earth fill embankment with a 165-foot maximum height and a 10,700-foot length, including the spillway section. The top of dam elevation is 1395 feet msl; fill volume, including berms, is approximately 50 million cubic yards; maximum dam base width is 4,300 feet; and the top of dam width is 60 feet. Rock-fill riprap protection is provided for the upstream earth fill slopes above elevation 1310 feet msl. The embankment section primarily consists of a central impervious earth fill section and dumped chalk fill outer berm sections. An upstream impervious fill blanket adjacent to the central impervious section reduces uplift pressures beneath the embankment by lengthening the seepage path. Seepage through and beneath the valley embankment section is controlled primarily by the massive embankment and berm sections and by pressure relief wells along the downstream toe of the compacted embankment. There is no dam cutoff for seepage control.

4-04.5.2. **Fort Randall Spillway.** The spillway is a conventional chute-type spillway located near the left abutment of the dam. A large ravine upstream from the dam, supplemented by a relatively small amount of unlined excavation, forms the approach channel. The spillway structure has an ogee crest weir having a crest elevation of 1346 feet msl, concrete piers, 21 40-foot wide by 29-foot high tainter gates, a roadway, service bridge, and machinery platforms. The gates operate individually and can be opened or closed in 1-foot increments. A 1,000-foot-wide paved chute connects the spillway weir to the stilling basin. The stilling basin has an end sill stepped at 5-foot increments from elevation 1198 to 1218 feet msl. The spillway discharge channel is paved for 75 feet downstream from the end sill of the stilling basin. Discharge capacity at the maximum operating pool elevation, 1375 feet msl, is 508,000 cfs.

4-04.5.3. **Fort Randall Outlet Works and Power Tunnels.** The outlet works are located near the left abutment, approximately 800 feet riverward of the spillway structure, and include eight tunnels for powerplant releases and four tunnels for supplemental releases. The reinforced concrete intake structure consists of twelve towers spaced on 70-foot centers and rising about 180 feet above the chalk foundation. Each tower has two 11-foot by 23-foot service gates and two emergency gates to control flow into the tunnels. A 49-foot transition connects the two 11-foot by 23-foot conduits in each tower with the 22-foot diameter tunnels. Access to the intake structure is via a service bridge connecting the gantry deck to the highway on the main embankment. Tunnels 1 through 8 are used for power discharges and Tunnels 9 through 12 are for releases supplemental to the powerplant. A fine regulating gate was provided near the lower end of Tunnel 10 but failed during an extended period of high releases in 1975 and was not replaced. Prior to gate vibration studies in 1998 and 1999, the cable-suspended service gates were operated in a fully open position when supplemental releases were required during the fall drawdown of Lake Francis Case. The study determined that the gates could be safely operated at partial gate openings, and this was done for the first time in the fall of 1999 with Tunnel 11. The eight power tunnels and former regulating Tunnel 10 are 22 feet in diameter for the first 215 feet downstream from the transition section connecting the intake structure with the tunnels. The remainder of each of these tunnels is 28 feet in diameter. Steel penstocks 22 feet in diameter are installed in the downstream portion of the power tunnels and Tunnel 10. Flood control Tunnels 9, 11, and 12 are 22 feet in diameter throughout their entire length. The stilling basin extends approximately 730 feet downstream from the tunnel portals and consists of a retaining wall on the landward side, a training wall separating the stilling basin and tailrace, and a series of baffle piers between these two walls. An ogee weir divides the stilling basin into an upstream primary basin and a downstream secondary basin. The ogee weir crest is at elevation 1244 feet, or approximately 25 feet above the primary floor basin. It extends 400 feet across the full width of the basin. Three concrete training piers extend approximately 200 feet downstream from the tunnel portals and function to separate flows from the four flood control tunnels. Two rows of baffle piers are placed across the width of the secondary basin, with the piers in each row staggered with respect to those in the other row. An end sill and cutoff wall are located at the downstream end of the basin. The discharge capacity of the flood control tunnels is 128,000 cfs.

4-04.5.4. **Fort Randall Powerplant.** Eight 59-foot in diameter by 100-foot high surge tanks are located upstream from the powerhouse and are connected in pairs to the penstocks serving each of Units 1, 3, 5, and 7. The penstocks without surge tanks are connected to turbines with slow-acting governors and the penstocks with surge tanks are connected to turbines with fast-acting governors. Eight vertical-shaft, single-runner Francis-type hydraulic turbines with steel spiral casings are installed in the powerhouse. The discharge capacity of the turbines is 44,500 cfs at a rated head of 112 feet. The generators, operational since 1954 to 1956, have a nameplate rating of 40 MW and have not been rewound. The tailrace is approximately 560 feet wide and extends 500 feet downstream from the powerhouse. The sidewall on the right bank is the switchyard retaining wall and the sidewall on the left is the boundary wall between the tailrace and stilling basin. An outdoor switchyard contains the main transformers, switchgear, main high voltage busses, circuit breakers, transformers, disconnects, lightning arresters, and instrument transformers. The Omaha District submitted a Major Rehabilitation Report in March 2002 that recommended replacement of the turbine runner and generator rotor, upgrade of the generators to 59 MW, and replacement of other powerhouse and switchyard equipment. The estimated cost of the selected plan is $137 million.

4-04.5.5. **Fort Randall Water Supply Facilities.** There are no water supply facilities provided from the Fort Randall powerhouse.

4-04.6. **Gavins Point Dam – Lewis and Clark Lake.** The following paragraphs describe the physical features of the System project, Gavins Point Dam – Lewis and Clark Lake.

4-04.6.1. **Gavins Point Embankment.** Gavins Point Dam is a rolled earth fill embankment 8,700 feet in length, including the spillway. The powerhouse is located at the right abutment and the spillway is located on the riverward side of the powerhouse, separated by an unexcavated portion, Chalk Island. The embankment contains approximately 7 million cubic yards of fill material obtained from the spillway, powerhouse, and downstream-channel excavations. The embankment crest is at elevation 1234 feet msl, maximum height above the streambed is 74 feet, and average height above the valley floor is 60 feet. A core and a blanket, extending 300 feet upstream from the core, were constructed from impervious material. Downstream relief wells and the level of Lake Yankton, located immediately downstream from the dam, control hydrostatic pressures.

4-04.6.2. **Gavins Point Spillway.** The Gavins Point spillway is a chute-type spillway consisting of a short approach channel, a gated-ogee crest structure, a concrete-paved chute, a stilling basin, and a discharge channel. The relatively short approach channel has concrete approach walls at each end of the spillway. The spillway crest structure has a 560-foot long concrete weir and 13 concrete piers. The weir has an ogee crest at elevation 1180 feet msl, 25 feet above the approach channel floor. Fourteen 40-foot long and 30-foot high tainter gates control flow over the crest. A concrete chute 664 feet wide and 216 feet long connects the weir to the stilling basin. The stilling basin has two rows of baffles, each 12 feet wide and 8 feet high. A stepped end sill provides a transition between the stilling basin floor and the upstream end of the discharge channel. Gavins Point has no outlet works, and all releases in excess of powerplant capacity are made through the spillway. The spillway can discharge 345,000 cfs at a maximum operating pool of 1210 feet msl.

4-04.6.3. **Gavins Point Powerplant.** A curved approach channel guides flows a relatively short distance to the powerhouse intake. Concrete abutment walls are located at each side of the intake. The intake structure has three separate intakes for each of the three power units. Five welded steel trash rack sections are provided at each intake opening. Emergency and service gate slots are provided at each passage. Nine tractor-type, vertical-lift service gates operate in the downstream gate slots. The powerhouse, containing the main structure and the service bay, is integrally constructed with the intake. Three vertical-shaft, single–runner, adjustable-blade Kaplan-type hydraulic turbines with concrete semi-spiral cases and concrete elbow-type draft tubes are installed in the powerhouse. Powerplant discharge capacity is 36,000 cfs at 48 feet of rated head. The generators were rewound from 1987 through 1989 and have a nameplate capacity of 44.1 MW. The tailrace channel conveys flow from the draft tube outlets to the spillway discharge channel. A concrete slab extends 99 feet downstream from the draft tube outlets. The transformer yard is located outside the powerhouse adjacent to the erection bay. The switchyard is located above and south of the transformer yard and contains transformer switching bays, a bus tie bay, and four outgoing line bays.

4-04.6.4. **Gavins Point Water Supply Facilities.** There are no water supply facilities provided from the Gavins Point powerhouse.

4-05. **Missouri River Channel and Floodway Characteristics.** The System, intervening river reaches and lower river reaches extend from Fort Peck in eastern Montana downstream to the confluence with the Mississippi River at St. Louis, as shown on Plate III-1. Plate IV-1 presents the usual time of travel of within-bank, open-water flows for the Missouri River and its major tributaries. It should be noted that these are general approximations that may be affected by many factors. For purposes of scheduling System releases, approximate open water travel times from Gavins Point Dam are 1.5 days to Sioux City, 3 days to Omaha, 3.5 days to Nebraska City, 5.5 days to Kansas City, and 10 days to the mouth of the Missouri River.

4-05.1. The maximum flow that may be passed through a specific river reach without damage, or the channel capacity, varies throughout the length of the Missouri River and is dependent upon channel dimensions, the degree of encroachment upon the floodplain, and improvements such as levees and channel modifications. Channel capacities at specific locations also vary from season to season, especially in the middle and upper reaches. In these two reaches, a decrease in channel capacity due to the formation of an ice cover is common through the winter and early spring months. Generally, the capacity of the Missouri River channel usually increases progressively downstream, although instances do occur where this trend is reversed. Between and below the System dams are reaches of the Missouri River that range in length from 811 miles for the lower Missouri River below Gavins Point Dam to 0 miles between Big Bend Dam and Lake Francis Case. Descriptions of each of these reaches follow.

4-05.2. **Missouri River Reach - Fort Peck Dam to Lake Sakakawea.** The Missouri River from Fort Peck Dam flows in an easterly direction for about 204 miles in an unchannelized river before entering the headwaters of Lake Sakakawea near Williston, North Dakota. Major tributaries include the Milk, Poplar, and Yellowstone Rivers. The Yellowstone River enters the Missouri River just upstream of the Lake Sakakawea delta and influences only a short segment of the Fort Peck reach.

4-05.2.1. Channel characteristics of this river reach include many sandbars, islands, and side channels. Abandoned channels and several oxbow lakes remain in the floodplain. Upstream of Brockton, Montana (RM 1660), the floodplain is about 4 miles wide and is bordered by rolling grasslands, dry-land crops, and rangelands. Downstream from this point, the floodplain narrows to a 1-mile-wide valley surrounded by badlands. Most of the floodplain consists of croplands, pastures, and hayfields in private ownership or in the Fort Peck Reservation. The total reach contains 100,600 acres of agricultural land subject to flooding.

4-05.2.2. **Damage Levels.** Flood damages begin with open water flows of 30,000 cfs. For flows ranging from 50,000 cfs in the upper portion to 70,000 cfs in the lower portion of the reach, damages are relatively minor and limited mainly to pasture and other unimproved lands. Historical regulation has shown that stages at Wolf Point and Culbertson up to 11 feet and 13 feet, respectively, do not cause significant flood damages. During the winter season, the ice-covered channel capacity through this Missouri River reach is limited to 10,000 cfs at the time of ice formation, increasing to over 15,000 cfs after the ice cover has stabilized.

4-05.2.3. **Channel Degradation.** Since the closure of Fort Peck Dam on June 24,1937 most of the channel degradation occurred from date of closure through 1966. Since that time, some degradation has continued in the upper and center portions of the reach. Degradation below the dam (RM 1771.5) occurs at differing rates downstream to about RM 1650. Below RM 1650, no significant degradation has occurred since 1966.

4-05.2.4. **Channel Width.** There has been very little increased channel width due to streambank erosion, except in isolated stretches between RM 1612 and RM 1746. Streambank erosion rates for the 204-mile reach averaged about 97 acres per year from 1975 to 1983. Sediment is being deposited beginning at the mouth of the Yellowstone River and ending in Lake Sakakawea, where a delta has formed because of a reduction in flood flows and the backwater effect of Lake Sakakawea. The associated increase in the elevation of the Missouri and Yellowstone River channels in this area has led to higher river water levels, localized flooding, and higher water tables.

4-05.3. **Missouri River Reach - Garrison Dam to Oahe.** Below Garrison Dam, the Missouri River flows 87 miles in a south-southeasterly direction, passing the cities of Bismarck and Mandan, North Dakota before entering Lake Oahe. Significant tributaries include the Knife

River near Stanton, North Dakota, and the Heart River just upstream of the Lake Oahe delta and downstream of Mandan.

4-05.3.1. **Channel Characteristics.** Within the Missouri River floodplain in the Garrison Dam to Oahe reach, terraces form a complex of different low-lying landforms, many at an elevation within 3 feet above the river. The river is restricted to one main channel in this reach with very few side channels, old channels, or oxbow lakes. The floodplain in this reach contains 34,600 acres of agricultural land subject to flooding. Main damage centers in this reach are the cities of Bismarck and Mandan. Historical regulation has shown that limiting stages at Bismarck to 13 feet does not result in significant flood damages. At the time Garrison Dam was constructed, a 13-foot stage at Bismarck represented an open water channel capacity of about 90,000 cfs; however, in 1997 after 42 years of reservoir operation, the channel had deteriorated to the extent that open water flows of about 50,000 cfs resulted in a stage of 13 feet. During 1997, releases of 59,000 cfs were made from Garrison Dam, resulting in a stage at Bismarck of 14 feet. Some erosion and minor flood damage from water ponding in the yards of homes occurred as a result of this release. A substantial amount of floodplain development at low levels has occurred in the Bismarck and Mandan metropolitan areas. Recent winter operational experience has shown that flows of 20,000 cfs during ice formation and over 28,000 cfs once the ice-cover stabilizes result in a Bismarck stage near 13 feet. This is a reduction from the original Garrison powerplant capacity of 35,000 cfs due to aggradation in the upper end of Lake Oahe.

4-05.3.2. **Channel Degradation.** Degradation of the riverbed below Garrison Dam (RM 1390) occurs primarily in the initial 35-mile stretch below the dam. Channel degradation was greatest before the beginning of power generation in 1956 and began to level off in about 1983. The channel below the dam degraded about 5 feet between 1950 and 1975. Further significant degradation is unlikely to occur, except during high-flow periods. Channel bed grain size has increased over the years in the 25 miles below Garrison Dam, indicating a gradual armoring of the channel bed. The riverbed 25 to 50 miles below the dam continues to degrade, but the rate of degradation became slower after 1975. Since 1960, erosion of the streambed in this part of the reach totals about 4 feet.

4-05.3.3. **Channel Width.** The channel widths for the initial 20 miles below Garrison Dam have remained fairly constant. Only near the mouth of the Knife River (RM 1378) is the channel width decreasing. This decrease is due to a buildup of Knife River deposits resulting from a reduction in flood flow currents. Farther downstream, the channel is widening. Streambank erosion rates were 48 acres per year from 1978 to 1982 for the 87-mile reach and have declined steadily since.

4-05.3.4. **Bank Erosion.** Bank erosion continues in the reach, however, the rate of bank erosion has declined since dam closure in 1953. This is likely due to the reduction in high spring and early summer flows. Before 1953, bank erosion averaged 200 to 250 acres per year. Since 1953, the loss has been about 60 acres per year. A study of the rates of erosion during the 1990's showed the rates to be highly variable, ranging from 35.1 to 86.5 acres per year. The Corps constructed some bank protection in this reach in the 1980's, which has successfully limited the erosion in most sub reaches.

4-05.3.5. **Damage Levels**. This reach has 34,500 acres of cropland subjected to flood damage. The Missouri River area most subject to flooding in this reach, however, is the urban area near Bismarck. Expensive homes constructed in the bottomlands located along the Missouri River are subject to flooding during the winter freeze-in period as well as during significant System inflow events that require releases greater than 60,000 cfs from Garrison Dam. The floodplain construction in the Bismarck area during the past 25 years represents an area of considerable concern that has become more susceptible to future flood control storage evacuation. Damage in this reach will be very high when higher project releases, that are required to evacuate flood storage, occur. Also, this area of Bismarck is subject to potential damage if an ice jam occurs just downstream that backs water into these housing developments. The 2-day water travel time from Garrison Dam to this vicinity prevents any significant control by Garrison Dam during ice jam events.

4-05.4. **Missouri River Reach - Oahe Dam to Lake Sharpe.** This short reach extends from Oahe Dam (RM 1072) 5 miles downstream to Lake Sharpe (RM 1067), near the city of Pierre, South Dakota.

4-05.4.1. **Channel Characteristics**. This reach is relatively straight, confined to one channel, and dam with no large tributary flows dominating the reach. The Bad River enters near the downstream end of this reach. A large amount of sediment enters the river from this tributary. An EPA-funded Section 319 project in the Bad River basin has reduced this sediment load in recent years.

4-05.4.2. **Damage Levels.** Flooding in the Pierre-Fort Pierre area, especially at street intersections in the Stoeser Addition of Pierre, has been a recurring problem since 1979. Prior to the installation of an emergency gate, high Oahe Dam releases, coupled with the formation of river ice in the LaFrambois Island area, caused water to back up into a storm sewer outlet, flooding street intersections. Public Law 105-277, as amended by Public Law 106-224, authorized and funded for the Fort Pierre and Pierre areas, the design and modification of infrastructure changes, acquisition of the most flood-prone properties, and flood-proofing of other properties. When this project is completed, the Corps anticipates that the Oahe powerplant capacity will continue to be limited but to a lesser extent during the cold winter periods. Release restrictions have been implemented in previous years to prevent flooding. Peak hourly releases, as well as daily energy generation, will be constrained to prevent urban flooding in the Pierre and Fort Pierre areas if severe ice problems develop downstream of Oahe Dam. This potential reduction has been coordinated with the Western Area Power Administration (Western). The urban areas of Pierre and Fort Pierre are subject to high potential damages high if extremely high releases are required from Oahe Dam for flood storage evacuation.

4-05.5. **Missouri River Reach - Fort Randall Dam to Lewis and Clark Lake.** The Missouri River below Fort Randall Dam (RM 880) flows in a southeasterly direction for approximately 44 miles in an unchannelized river to Lewis and Clark Lake. The major tributary in this reach is the Niobrara River, a right bank tributary that enters the Missouri River at RM 843.5. In this reach, the Missouri River meanders in a wide channel with the flow restricted to generally one main channel. Only a few side channels and backwaters are present, except at the lower end of the reach in the Lewis and Clark Lake delta. The 39-mile reach of Missouri River from Fort Randall Dam (RM 880) to Running Water, South Dakota has been designated a National Recreational River under the National Wild and Scenic Rivers Act.

4-05.5.1. **Channel Characteristics.** The tailwater area of Fort Randall Dam, from RM 880 to 860, has experienced up to 6 feet of riverbed degradation and channel widening from 1953 to 1997. The rate of erosion has decreased over this period. Streambank erosion since closure of the dam in 1953 has averaged about 35 acres per year. This compares to a pre-dam rate of 135 acres per year. The Missouri River has coarser bed material above RM 870 than below, indicating some armoring of the channel below the dam. Downstream from the tailwater area, less erosion of the bed and streambank occurs.

4-05.5.2. **Damage Levels.** Since Gavins Point reservoir first filled, a delta has formed at the mouth of the Niobrara River (RM 843.5) to near Springfield, South Dakota. This delta formation has restricted reservoir access at Springfield and caused problems for the city's water intake. While this reach of the Missouri River was capable of passing flows in excess of 150,000 cfs prior to construction of the System, Fort Randall open water releases of 35,000 cfs now result in flood problems. High releases, coupled with diminished channel capacity, caused lowland flooding in this reach during the period from 1995 to 1997. The resulting swampy wetland conditions were very beneficial to migratory waterfowl and other wetland habitat users. In addition, the record high releases in 1997 caused a notable, although as of yet unquantified, increase in the channel capacity in this reach of the Missouri River. It appears quite probable that the channel capacity in the reach has been reduced since 1997. The reach contains approximately 2,200 acres of agricultural land and 62 residential buildings subject to flooding. Corn and soybeans are the primary crops grown. With the severely restricted channel capacity in this reach, inundation of some of the bottomlands adjacent to the channel will likely be necessary in most years that above-normal System inflows must be evacuated.

4-05.6. **Missouri River Reach - Gavins Point Dam to Sioux City.** The Missouri River between Gavins Point Dam (RM 811.1) and Sioux City (732.3) flows in an east-southeasterly direction and is comprised of three sub reaches, the Missouri River National Recreational River, Kensler's Bend, and Missouri River Navigation Channel reaches.

4-05.6.1. **Missouri River National Recreation River Reach.** The 59-mile reach of river downstream of Gavins Point Dam starting at RM 811 down to Ponca, Nebraska (RM 752) is designated as a Missouri River National Recreational River. The National Recreational River reach below Gavins Point Dam has not been channelized by the construction of dikes and revetments. This portion of the river is a meandering channel with many chutes, backwater marshes, sandbars, islands, and variable current velocities. Snags and deep pools are also common. Although this portion of the river includes some bank stabilization structures, the river remains fairly wide. Bank erosion rates since closure of Gavins Point Dam in 1956 have averaged 132 acres per year between Gavins Point and Ponca State Park, compared to a pre-dam rate of 202 acres per year. The rate of erosion had been declining since 1975 and then dramatically increased during the high flow years of 1995 through 1997.

4-05.6.2. **Kensler's Bend Reach.** The Kensler's Bend reach extends from Ponca, Nebraska (RM 752) to above Sioux City, Iowa, (RM 735). The Missouri River banks have been stabilized with dikes and revetments under the Kensler's Bend Project.

4-05.6.3. **Missouri River Navigation Channel Reach.** The reach from the downstream end of the Kensler's Bend Project (RM 735) to Sioux City (RM 732.3) is part of the Missouri River Navigation and Bank Stabilization Project. The channelized reach extends to the mouth of the Missouri River near St. Louis, Missouri.

4-05.6.4. **Channel Characteristics.** The tributaries in the Gavins Point to Sioux City reach are the James River (RM 800.8), Vermillion River (RM 772), and Big Sioux River (RM 734). All are left bank tributaries. Prior to construction of the System, the open water channel capacity through this reach of the Missouri River was well in excess of 100,000 cfs. There is evidence of channel deterioration due largely to floodplain encroachment in backwater areas and along old river meander chutes. This is offset by channel degradation. Extensive bed degradation has occurred in this Missouri River reach because river sediment is captured above Gavins Point Dam. Another factor is the substantial Missouri River channel shortening that occurred as part of the downstream Missouri River Bank Stabilization and Navigation Project. Gradual armoring of the riverbed has reduced the rate of channel degradation. Since 1965, approximately 10 feet of stage reduction has occurred for a discharge of 30,000 cfs.

4-05.6.5. **Damage Levels.** The regulation of the System provides a great amount of flood protection to this Missouri River reach because of the close proximity of this reach to the downstream end of the System. In 1997, flows of 70,000 cfs in this reach caused no significant damage because of the channel degradation that has occurred in this reach. The maximum flow with a stabilized ice cover at which there would be no flood damage is believed to be near 30,000 cfs. The reach contains approximately 1,900 acres of agricultural land and approximately 4,000 residential and nonresidential buildings subject to flooding.

4-05.7. **Missouri River Reach - Sioux City, Iowa to Omaha.** The approximately 116-mile reach between Sioux City (RM 732.3) and Omaha, Nebraska (RM 615.9) is part of the upper Missouri River Navigation and Bank Stabilization Project. Major tributaries in this reach include the Floyd River (RM 731.1) and the Little Sioux River (RM 669.2).

4-05.7.1. **Channel Characteristics.** The Missouri River flows in a south-southeasterly direction through this channelized reach. Open water channel capacities in this reach prior to construction of the System were in excess of 100,000 cfs. During recent years, there has been considerable encroachment on the channel area. Fixed boat docks have been constructed in numerous locations through this reach and low areas are now being cropped. Much of this development is on or adjacent to river stabilization structures and takes advantage of sand deposition encouraged by this stabilization. The extensive degradation (about 10 feet since 1965) noted previously at Sioux City is non-existent at Omaha.

4-05.7.2. **Damage Levels.** Flows of 65,000 cfs in 1975 and 70,000 cfs in 1997 resulted in inundation of some of the cropped land and interrupted access to some marinas constructed along the banks. Some agricultural lands experience interior drainage problems at the higher flow levels as well. Winter flows of up to 30,000 cfs with a stable ice-cover appear possible without flooding. During river freeze-in and ice break-up periods, which can occur at any time during the winter season, flows in excess of 25,000 cfs could result in lowland inundation. Based on the 1996 land survey, the reach contains about 415,000 acres of agricultural land and about 18,500 residential and non-residential buildings subject to flooding.

4-05.8. **Missouri River Reach - Omaha to Kansas City.** The Missouri River reach from Omaha (RM 615.9) to Kansas City, Missouri (RM 366.1) flows in a south-southeasterly direction for approximately 250 miles. Major tributaries in this reach include the Platte River (RM 494.8), Nishnabotna River (RM 542), and Kansas River (RM 367.5). Deterioration of the channel and flood capacity has occurred throughout this reach. Recent experience indicates that mid-summer flows exceeding 90,000 cfs will result in river levels above flood stage at Nebraska City, Rulo, and St. Joseph. Complaints are received from adjacent landowners concerning water logging of cultivated fields with stages at 2 feet below flood stage. During the winter months, stages in this reach have gone as much as 5 feet above flood stage due to ice jams even though Gavins Point Dam releases were limited to 20,000 cfs and there was little incremental inflow occurring below Gavins Point Dam. This reach contains about 360,000 acres of agricultural land and about 2,650 residential and commercial buildings subject to flooding.

4-05.9. **Missouri River Reach - Kansas City to Mouth of Missouri River.** From Kansas City (RM 366.1), the Missouri River flows 366 miles in an easterly direction to its confluence with the Mississippi River (RM 0). Major tributaries in this reach include the Grand (RM 250), Chariton (RM 238.9), Osage (RM 130), and Gasconade (RM 104.5) Rivers. Open-water flows of about 150,000 cfs will cause only relatively minor agricultural damages in this reach. In the vicinity of Kansas City, the channel is experiencing both a deterioration of the flood conveyance capacity in the overbank area and, simultaneously, increased channel capacity through channel degradation. This channel degradation has adversely impacted water intakes in this reach during low winter stages. In recent years, the established flood stage on the Missouri River at Waverly, Missouri, has been exceeded when flows were greater than 115,000 cfs. This lowest reach of the Missouri River has historically experienced a deterioration of the flood conveyance capacity. The reach contains about 472,000 acres of agricultural land and about 4,800 residential and commercial buildings subject to flooding. Ice jams can cause flooding with flows of less than 30,000 cfs on this reach of the Missouri River.

4-05.10. **System Flood Damage Levels.** The three primary resources directly affected by the System's ability to control floods are agricultural resources, nonagricultural resources and navigation.

4-05.10.1. **Agricultural Resources.** Approximately 1.4 million acres of agricultural land is subject to flooding along the Missouri River. Ninety percent of these acres are located downstream of Gavins Point Dam. Corn is the primary crop cultivated, followed by soybeans and wheat. In total, approximately 42,800 acres of Tribal lands are also subject to flooding. Most of the Tribal lands are on the Fort Peck Reservation. Grassland is not included in the above acreage figures.

4-05.10.2. **Nonagricultural Resources.** Nonagricultural resources include residential and nonresidential structures located in areas along the Missouri River that are subject to flooding. There are 30,395 residential buildings worth approximately $1.9 billion located within identified flood hazard areas. There are 5,345 nonresidential buildings subject to flooding, with a total value of approximately $15.7 billion (Corps, 1998e). Residential development is characterized according to 10 general classes of residential buildings. Farmsteads are included in the residential building category. For nonresidential structures, over 100 building categories were used for the initial classification. The value of each structure is based upon the size, condition, and construction type and includes the value of the building's contents. This development has been growing much faster in recent years than in the past as the floodplain is being developed and expensive structures are being constructed. Development on Tribal lands adjacent to the Missouri River floodplain includes about 475 buildings worth an estimated $62 million. Approximately 96 percent of this estimated value is located on the Fort Peck Reservation.

4-05.11. **Navigation.** Flood flows greater than a 25-year flood event have the potential to adversely affect navigation on the Missouri River. Navigation losses result from interrupted service. The duration of the interruption depends on the length of river affected and the magnitude of the flood. Losses are based on daily barge and towboat costs and the average daily tonnage moved during the month that a flood occurs.

4-05.12. **System Flood Damages Prevented Report.** The RCC provides the Omaha and Kansas City District's planning sections the basic hydrologic data to determine the damages prevented of both actual and without dams (natural) conditions by the System. The districts then apply the hydrologic data using stage-discharge-damage curves for the various reaches of the System. The computed damages prevented are then provided to the RCC and higher authority on an annual basis. The flood control effects of the Missouri River levee system are included in the determination, and the System fair-shares the benefits with the levee system. Fair-sharing occurs unless the levee system would have been overtopped by the natural events. In the case of levee overtopping, the System gets the full credit for damages prevented for the river reach for that flood event. Tributary reservoir effects are accounted for, and, if the tributary projects have authorized flood control storage, they receive credit for damages prevented. If they do not have authorized flood control, the benefits are assigned to the System, because, on all events to date, the System could have contained the flood runoff without releasing additional damaging flows. The estimated accumulated flood damages prevented by the System is $24.8 billion from 1938 to 2001, or $393.7 million annually.

4-05.13. **System Stage-Discharge-Damage Curves.** Rating and damage curves, relating stages at particular locations with open-river discharges and with damages through an adjacent reach along the Missouri River, are shown on Plates IV-2 through IV-13. Damage curves have been developed for both existing and natural (without levees) conditions. This was done to determine the effect of protective levees that have been built in many reaches of the Missouri River below Sioux City. Levees currently in place provide protection, as indicated by the existing curves. The curves denoted as "natural" indicate the damages that would result at any particular stage with complete levee failure or overtopping through the affected reach.

4-06. **System Related Control Facilities.** The following facilities were designed and do work in concert with the System to provide an improved Missouri River basin water management condition. The following subparagraphs are devoted to describing the projects other than the System that affect, or influence, water management in the Missouri River basin.

4-06.1. **Missouri River Basin - Tributary Reservoirs.** The facilities that have the greatest affect on the System are the tributary reservoirs. A significant number of tributary reservoirs have been constructed in the Missouri River basin, many as a result of the 1944 Flood Control Act and others for general water resource development purposes. The cumulative effect provided by these tributary reservoirs on the System is significant. In 2002, the 529,350-square mile Missouri River basin contained about 3,100 multiple-purpose reservoirs and over 14,100 single-purpose reservoirs, either completed or under construction. In the aggregate, these reservoirs provide a total of over 141 MAF of storage capacity. The investment cost for this storage capacity exceeds $15 billion. Almost 99 percent of the total storage capacity serves multiple-purpose functions. Purposes served by individual multiple-purpose reservoirs may include any combination of the purposes of flood control, municipal and industrial water supply, water quality control, irrigation, navigation, hydroelectric power, fish and wildlife enhancement, and recreation. In contrast, the function of most single-purpose reservoirs is either flood control or water supply. Pertinent data from reservoirs in the basin, including all of the reservoirs in which the Corps has an operational responsibility, are listed in Table IV-1and IV-2. Locations of the major reservoirs, as well as the locations of other water resource developments discussed subsequently herein, are shown on Plate III-23. The tributary reservoirs are divided into two groups for purposes of discussion; those above the System are called Upstream Tributary Reservoirs and those below the System are called Downstream Tributary Reservoirs.

4-06.1.1. **Missouri River Basin – Upstream Tributary Reservoirs.** Although it is relatively simple to approximate the effects of a single tributary reservoir upon specific streamflow occurrences, provided flow and storage data are available, such a process becomes exceedingly complex with the large number of such reservoirs existing in the Missouri River basin. The approximation process becomes further complicated with recognition of the many small projects in existence for which no hydrologic data are available. Individually, these small projects have insignificant effects on Missouri River flows; however, when considered in the aggregate, this effect may be very significant. Certain general conclusions, as given below, may be deduced relative to the effect on streamflow of these projects. Many of these projects are not regulated specifically for flood control; however, their releases are integral to total System regulation.

4-06.1.1.1. On an annual or other long-term basis, the existence of tributary reservoir storage will result in a decrease in Missouri River streamflow. In addition to the consumptive use of water from the projects, nearly all are located in regions where the volume of evaporation from the reservoir will exceed the volume of precipitation that may fall directly on the pool. During any flood season, the existence of upstream tributary storage will almost certainly reduce System flood volumes to some extent, the amount being dependent on antecedent conditions. Although specific flood control storage may not be allocated, these reservoirs are located in regions where flows are of a distinct seasonal nature. Reservoir regulation to achieve the purposes that the reservoirs serve results in storing water during periods of excess flows. The stored water is then used later during periods of low runoff. This stored water will reduce flood volumes and peak inflows into the System and augment the amount of water in System storage during low-inflow periods into the System later in the season.

4-06.1.1.2. Normally, the natural crest flows on the Missouri River will also be reduced by the existence of tributary reservoir storage, provided significant runoff contributing to the crest flow originates above the tributary projects. Reasons for this are those given above, plus the effects of the tributary reservoirs in smoothing and delaying sharp crests even if there were no appreciable vacant storage space remaining at the time of the crest. It is realized that, in certain instances, a reservoir project can increase the size of the crest below the project over that which would have occurred naturally. This is due to the reservoir decreasing the travel time of the crest flow or by delaying a portion of the runoff from a sub-area that is later contributing to a major upstream crest on the Missouri River when releases from the tributary reservoir are made. With a single tributary reservoir, or only a few projects, such an increase in crests flows might occasionally be expected. With the large number of projects tributary to the Missouri River, it is not likely that their aggregate effect would increase Missouri River crest flows.

4-06.1.1.3. The Corps of Engineers is responsible for flood control regulation of all Federal reservoirs with allocated flood control space. Many of these reservoirs will be regulated, insofar as practical, to prevent local flood damages along both the tributary streams and on the Missouri River downstream from the reservoirs. Regulation of the tributary reservoirs will be coordinated with regulation of the System at times of large flood flows or large quantities of water in System storage. Table IV-1 provides pertinent data of larger reservoirs above Gavins Point Dam. One reservoir, Canyon Ferry is located on the Missouri River above the System while all others are tributary reservoirs regulated by either the Corps or USBR.

4-06.1.2. **Missouri River Basin – Downstream Tributary Reservoirs.** There are no reservoirs located on the main stem of the Missouri River below the System. Many tributary reservoirs provide some control of the flows to the Missouri River and, at times, have a significant effect on Missouri River levels and regulation of the System. Chapter VII provides some insight on how the lower basin tributary reservoirs effect System regulation. One difference is that three reservoir projects located downstream of the System are used at times to support navigation on the Missouri River. These three reservoir projects are located in the Kansas River basin: the Milford, Tuttle Creek, and Perry projects. Table IV-2 provides a list of the larger tributary reservoirs located below the System.

4-06.2. **Missouri River Basin – Upstream Tributary Levee Projects.** In addition to levee protection along the Missouri River, the comprehensive plan for basin development included many protection projects for localities in the upstream reaches of the Missouri River or on tributary streams. Some of the projects are designed to provide protection in combination with flood control reservoirs constructed upstream from the affected locality. Description of each of these projects is beyond the scope of this manual, and reference is made to individual System project water control manuals or tributary reservoir water control manuals for descriptions of these projects.

4-06.3. **Missouri River Basin - Downstream Levee Structures.** The drainage area above Gavins Point Dam is 279,480 square miles, 52 percent of the basin total of 529,350 square miles. The ability to control the movement of water in the lower Missouri River decreases the farther downstream from Gavins Point Dam a particular location is. Sioux City has 88 percent of the drainage area controlled by the System while Omaha has 86 percent. Values continue to drop to 68, 66, 57, 55, and 53 percent for Nebraska City, St. Joseph, Kansas City, Boonville, and Hermann, respectively. The production of food is the major industry in the large agricultural region that makes up the Missouri River basin. More than 1.5 million acres of the most productive farm land within the basin, the associated livestock, equipment, farm buildings, and other improvements, and numerous rural communities are located on the floodplain of the Missouri River between Sioux City and the river's mouth.

4-06.3.1. **Missouri River Basin – Downstream Federal Agricultural Levee Projects**. Federal levee construction in accordance with the 1941 and 1944 Flood Control Acts was started in 1947. The levees are designed to function as a team with System and tributary reservoirs. Neither the reservoirs alone nor the levees alone provide the desired degree of protection, but operating to supplement each other, they provide protection against floods equal to any of past record. The whole system of Federal levees is constructed in individual units. Older levees were built of semi-compacted earth fill with a top width of 10 feet, side slopes of 1 on 3, and a freeboard of 2 to 3 feet above the water surface of the design flood. New construction of the levees remains similar, but the design is based on risk analysis at a 90 percent confidence level. Landside berms or seepage wells are provided where foundation conditions require such measures. Drainage structures extend through the levees to provide adequate internal drainage.

4-06.3.2. At the end of 2001, 29 Federal units were either constructed or under construction. With the exception of two units between Kansas City and Boonville, Missouri, all Federal levees now constructed are in the reach located between Omaha and Kansas City. While additional units appear economically feasible, they presently are in an inactive status. Design discharges of these Federal levees range from 250,000 cfs at Omaha, 295,000 cfs at Nebraska City, 325,000 cfs at St. Joseph, 425,000 cfs at Kansas City, and up to 620,000 cfs at Hermann, Missouri, near the mouth of the Missouri River. Detailed locations of these levees and their protected areas, are shown in the Project Maps, as published and revised annually by the Corps' Omaha and Kansas City District offices.

4-06.3.3. **Missouri River Basin - Downstream Federal Urban Levee Projects**. Levee projects for the protection of large urban areas along the Missouri River have been constructed at Omaha; Council Bluffs, Iowa; and Kansas City. The Kansas City project was authorized by the 1936 Flood Control Act and modified and extended by the Acts of 1944 and 1954. The authorizations for the Omaha and Council Bluffs projects were included in the 1944 Flood Control Act. These projects are designed to operate in conjunction with the System and tributary reservoirs to prevent flooding of these localities from the most severe flood events of record. Design discharge of the Omaha-Council Bluffs project is 250,000 cfs, while levees in the Kansas City area are designed for Missouri River flows of 540,000 cfs. In addition to the large projects, a short levee constructed by the Corps under Section 212 protects the town of New Haven, Missouri from Missouri River floods.

Table IV-1
Large Reservoir Projects in the Upper Missouri River Basin– Pertinent Data

Project Name	Location (City, State)	Drainage Area (sq. mi).	Regulated By
Gavins Point Dam	Yankton, SD	16,000	COE
Fort Randall Dam	Pickstown, SD	14,150	COE
Big Bend Dam	Fort Thompson, SD	5,840	COE
Oahe Dam	Pierre, SD	62,090	COE
Garrison Dam	Riverdale, ND	123,900	COE
Fort Peck Dam	Fort Peck, MT	57,500	COE
Clark Canyon (1)	Dillon, MT	2,320	USBR
Canyon Ferry (1)	Helena, MT	13,580	USBR
Gibson	Augusta, MT	575	USBR
Tiber (1)	Chester, MT	4,920	USBR
Fresno	Havre, MT	3,776	USBR
Bull Hook	Havre, MT	54	COE
Buffalo Bill	Cody, WY	1,500	USBR
Boysen (1)	Thermopolis, WY	7,710	USBR
Yellowtail (1)	St. Xavier, MT	10,420	USBR
Dickinson	Dickinson, ND	400	USBR
Heart Butte (1)	Glen Ullin, ND	3,400	USBR
Bowman Haley	Scranton, ND	446	COE
Shadehill	Lemmon, SD	3,070	USBR
Belle Fourche	Belle Fourche, SD	205	USBR
Deerfield	Rapid City, SD	95	USBR
Pactola (1)	Rapid City, SD	214	USBR
Coldbrook	Hot Springs, SD	71	COE
Cottonwood Springs	Hot Springs, SD	26	COE
Angostura	Hot Springs, SD	9,100	USBR

(1) USBR Section 7 project

Table IV-2
Reservoir Projects Located in the Lower Missouri River Basin

Project Name	Location (City, State)	Drainage Area (Sq. Mi.)	Regulated By
Milford Lake	Junction City, KS	3,620	COE
Wilson Reservoir	Russell, KS	1,917	COE
Glen Elder Dam	Beloit, KS	5,076	USBR
Kirwin Dam	Kirwin, KS	1,409	USBR
Webster Dam	Stockton, KS	1,150	USBR
Cedar Bluff Dam	Ellis, KS	5,365	USBR
Bonny Dam	Hale, CO	1,435	USBR
Enders Dam	Imperial, NE	951	USBR
Trenton Dam	Trenton, NE	8,624	USBR
Kanopolis Reservoir	Lindsborg, KS	2,330	COE
Tuttle Creek Reservoir	Manhattan, KS	9,556	COE
Harlan County Dam	Republican City, NE	20,751	COE
Medicine Creek Dam	Cambridge, NE	642	USBR
Perry Reservoir	Topeka, KS	1,117	COE
Clinton Reservoir	Lawrence, KS	367	COE
Smithville Reservoir	Platte City, MO	213	COE
Longview Lake	Lee's Summit, MO	50.3	COE
Blue Springs Lake	Lee's Summit, MO	32.8	COE
Pomona Reservoir	Osage City, MO	322	COE
Melvern Reservoir	Osage City, MO	349	COE
Hillsdale Lake	Paola, KS	144	COE
Stockton Lake	Stockton, MO	1,160	COE
Pomme De Terre Lake	Hermitage, MO	611	COE
Harry S Truman Reservoir	Warsaw, MO	11,500	COE
Lake of the Ozarks	Lake Ozark, MO		Non Federal
Lovewell	Lovewell, KS	358	USBR
Longbranch Lake	Macon, MO	109	COE
Rathbun Lake	Rathbun, IA	549	COE
Red Willow Dam	McCook, NE	310	USBR
Norton	Norton, KS	688	USBR
Keyhole	Moorcraft, WY	1,900	USBR
Jamestown Dam	Jamestown, ND	1,300	USBR
Pipestem Dam	Jamestown, ND	400	COE
Chatfield Dam	Denver, CO	3,018	COE
Bear Creek Dam	Denver, CO	261	COE
Cherry Creek Dam	Denver, CO	386	COE
Glendo Dam	Glendo, WY	14,330	USBR
Pathfinder Dam	Alcova, WY	14,600	USBR
Seminoe Reservoir	Sinclair, WY	7,210	USBR

4-06.3.4. **Missouri River Basin - Downstream Private Levee Projects.** In addition, railroads, highways, bridges, and municipal developments within the floodplain increase the necessity for adequate flood protection in the non-urban Missouri River bottom areas. Local interests have built many miles of levees, comprising over 500 non-Federal levee units through this reach of the river. These are listed in appropriate Flood Emergency Plans; however, most of these levees are inadequate to withstand major floods. Still, they provide protection during the majority of events.

4-06.4. **Missouri River Basin – Missouri River Streambank Stabilization.** The following paragraphs discuss the programs implemented to stabilize the banks of the Missouri River. Streambank erosion is a continuing problem along most of the main stem and many tributaries in the Missouri River basin. Most bank protection projects now in existence are comparatively small and many have been of an emergency nature. This is particularly true for tributary streams and the upper two-thirds of the Missouri River. Numerous bank protection projects have been installed below the Garrison, Fort Randall, and Gavins Point Dams and additional revetments will probably be required in future years below all of the projects due to increased river front development. These projects are very small compared to the most significant bank-erosion control achievements in the basin, the Missouri River Navigation and Bank Stabilization Project from Sioux City, Iowa (RM 735) to the mouth and the Kensler's Bend Project between Ponca State Park, Nebraska (RM 753) and Sioux City. Prior to stabilization, the Missouri River banks were subject to serious erosion. Development along the Missouri River was very limited because of this bank erosion in combination with serious flooding. Prior to System regulation, high bank erosion and high bank accretions would be comparable over time; however, since the reservoirs act as a sediment trap, this is no longer the case. In the Missouri River below the System, the flow of the river during moderate and low flow periods is confined to one designed alignment, stabilized by permanent rock dikes and bank revetments. Although some natural side channels exist and some historic side channels have been recently restored to provide fish and wildlife habitat, the lower one-third of the main stem of the Missouri River remains highly channelized.

4-06.4.1. **Missouri River Basin – Upstream Bank Stabilization**. There are numerous bank stabilization projects located in and above the System that provide bank stabilization along the Missouri River and its tributaries. These projects are not addressed in detail in this Master Manual but the larger projects are discussed in the individual System projects' and tributary projects' water control manuals.

4-06.4.2. **Missouri River Basin – Downstream Bank Stabilization.** This reach of the river has been modified over its entire length by an intricate system of dikes and revetments designed to provide a continuous navigation channel without the use of locks and dams. Authorized channel dimensions are achieved through supplementary releases from the large upstream reservoirs and occasional dredging and maintenance. In addition, when certain conditions warrant, supplemental flows are provided from specific tributary reservoirs to support Missouri River navigation to conserve System storage. The Missouri River reach from Gavins Point Dam to St. Louis includes numerous authorized projects that provide bank stabilization and a navigation channel. In addition to the primary authorization to maintain a 9-foot-deep by 300-foot-wide navigation channel from Sioux City to the mouth, there are authorizations to stabilize the riverbanks. This project is referred to as the Missouri River Bank Stabilization and Navigation project and extends from just above Sioux City to the mouth of the Missouri River, a distance of 735 river miles.

4-06.4. 2.1. The Missouri River Bank Stabilization and Navigation Project (BSNP) was designed to prevent bank erosion and channel meandering and to provide reliable Missouri River navigation. This project, authorized by Congress in the Rivers and Harbors Act of 1945, provides for a 9-foot-deep channel with a minimum width of 300 feet from near Sioux City to the mouth of the river near St. Louis, a distance of 735 miles. Construction of the navigation works was declared complete in September 1981, although corrective work will be required as the Missouri River continues to form its channel in response to changing flow conditions. The navigation project is not accomplished by using locks, as is the case on most of the inland waterway systems, but by using river structures placed to confine and control the channel. The use of these structures produces velocities high enough to prevent the accumulation of sediment in the channel and permits an open condition for the entire length of the project with no dredging required under normal water supply conditions. The Missouri River, as previous discussed, therefore, has higher velocities than other inland navigation systems that can present challenges to navigating the river.

4-06.4.2.2. Commercial navigation in the Missouri River is confined to the main stem of the Missouri River between Sioux City and the mouth of the Missouri River near St. Louis. The Missouri River Navigation and Stabilization Project, discussed in the preceding paragraph, is designed to secure a permanent, continuous, open-river navigation channel with a 9-foot depth and a width of not less than 300 feet under full navigation service conditions. Maintenance of these dimensions requires releases from the System, as well as some infrequent dredging activities, particularly during periods of sub-normal water supply. This navigation project is an important link with the Mississippi River waterway system. Low-cost transportation, particularly for bulk commodities, is available at many localities in the Missouri River valley. Cities and commercial interests have provided facilities along the banks of the river for both handling and managing navigation traffic.

4-06.4.3. **Bank Stabilization on Tribal Cultural Resource and Archeological Sites.** In addition to the above-mentioned bank stabilization efforts there is an ongoing effort to stabilize portions of the System to protect Tribal cultural resource and archaeological sites. The Corps, through the Corps' Operation and Maintenance appropriations, continues to make progress in Missouri River bank stabilization efforts for the protection of archaeological sites. Table IV -3 details those efforts during the past few years. The Corps consults with American Indian Tribes, Tribal Historic Preservation Offices, and State Historic Preservation Offices to determine priority sites where bank stabilization efforts should be focused. Site-stabilization work is contingent upon available funds. Additional sites will be protected as funding becomes available.

4-06.5. **Missouri River Basin – National Recreational River Designations.** Two sections of the Missouri River have been declared National Recreational River reaches. They are described in the following paragraphs.

4-06.5.1. **Missouri River Basin - National Recreational River.** The 36 miles of river from Fort Randall Dam (RM 880) to the Lewis and Clark Lake delta (RM 844) is designated a National Recreational River under the National Wild and Scenic Rivers Act. The banks along this reach tend to restrict flow to one main channel. There are only a few side channels and backwaters, except at the lower end in the Lewis and Clark Lake delta. The Missouri River bank line that borders the Yankton Reservation is located adjacent to this reach, from RM 880 downstream to RM 845. The Fort Randall reach receives no significant inflow from tributaries other than the Niobrara River.

4-06.5.2. **Missouri River Basin - Downstream National Recreational River.** The 59-mile stretch of river between Gavins Point Dam (RM 811) and Ponca (RM 752) is designated a National Recreational River under the National Wild and Scenic Rivers Act. It is also the only river segment downstream of Gavins Point Dam that has not been channelized by dikes and revetments. A wide, braided channel and numerous islands, chutes, and backwaters favor a variety of wetlands. The Gavins Point reach resembles the original undeveloped Missouri River more than any other reach, and compared to the other reaches, displays the greatest density of wetlands, approximately 90 acres per mile. Wetland acreage, however, has undoubtedly declined in the years following the designation as a result of channel degradation. Major tributaries in the Gavins Point reach are the James and Vermillion Rivers.

4-06.6. **Missouri River Basin - Federal and State Fish Hatcheries.** Two existing Federal fish hatcheries and one fish hatchery currently being constructed are located on or adjacent to System projects. The following paragraphs describe these facilities. Appendix C of the Final Environmental Impact Statement for the water control plan discusses fish propagation activities of both Federal and State fish hatcheries for native and endangered species with regard to the Missouri River and the System. That discussion will not be repeated in this Master Manual.

4-06.6.1. **Fort Peck Dam National Fish Hatchery.** This is a Federal fish hatchery that is currently being constructed adjacent to Fort Peck Dam. When completed, it will be operated as a National Fish Hatchery.

4-06.6.2. **Garrison Dam National Fish Hatchery.** This hatchery was originally established in 1957 to provide fish for recreational fishing in the new reservoirs created by Federal water development projects in the Midwest. The Service operates this hatchery. Today, the hatchery continues to provide management and production of many freshwater fishes for the System, National Wildlife Refuges, American Indian waters, and programs of the State of North Dakota. As many of the native fishes struggle with the changes in the Missouri River aquatic ecosystems, the hatchery's role has changed to include maintaining migratory fishes, such as the paddlefish, and restoring endangered species, such as the pallid sturgeon. To meet the high fish production demands, Garrison Dam National Fish Hatchery encompasses 209 acres of land and has a total of 64 rearing ponds.

Table IV-3
Bank Stabilization Efforts for the Protection of Archaeological Sites

Name	Fiscal Year	Expenditures ($thousands)
Havens	1987	20
Havens	1988	77
Fort Randall Historical Site	1988	24
Whistling Elk	1988	77
Cemetery Relocation	1988	20
Crow Creek	1989	78
Travis 11	1990	25
Fort Rice Dam	1993	7
Forest City/Cheyenne River	1993	23
Stoney Point	1993	6
Fort Rice Dam	1994	20
Old Scout Cemetery (BIA)	1995	48
Iron Shooter	1996	22
South Iron Nation (Vegetative)	1996	68 [a/]
Heavens Arch	1998	50
Fort Yates	1998	118
Rorgo/Walth Bay	1998	74
Stoney Point (con’t)	1998	54
Iron Shooter (con’t)	1998	45
South Iron Nation (con’t)	1998	38
Molstad	1999	51
Vanderbuilt	1999	112
Rorgo/Walth Bay (con’t)	1999	2
Fort Yates (con’t)	1999	6
Havens Arch	1999	49
South Iron Nation (con’t)	1999	111
Stoney Point (con’t)	1999	84
Mobridge Village	2000	97
Molstad (con’t)	2000	56
Vanderbuilt (con’t)	2000	168
South Iron Nation (con’t)	2000	222
Leavenworth	2001	310
Jake White Bull	2001	195
Fort Rice	2001	653
Leavenworth (con’t)	2002	207
Jake White Bull (con’t)	2002	15
Fort Rice (con’t)	2002	132
White Swan/St. Philips	2002	24
White Swan/St. Philips (con’t)	2003	196
Crow Flies High	2003	607
Nishu Point	2003	104
Protection of Fort Randall Chapel	2003	280
Cattle Oiler	2004	250 [b/]
Short Creek	2004	250 [b/]
North Cannonball	2004	900 [b/]
Terrace Complex	2004	400 [b/]

a/ Estimated value of volunteer service.
b/ Planned expenditures for fiscal year

4-06.6.3. **Gavins Point National Fish Hatchery and Aquarium.** The Gavins Point National Fish Hatchery and Aquarium is located just downstream of Gavins Point Dam on the South Dakota side of the Missouri River. The hatchery that began operations in 1961, raises 12 to 16 species of sport fish, and has produced more than 5 billion fish for stocking or release in Midwestern waters. The hatchery raises the endangered pallid sturgeon and the paddlefish, both of which are native to the Missouri River. The hatchery has 36 rearing ponds that cover 40 acres. The Service also operates this fish hatchery.

4-06.7. **System Public Recreation Facilities.** Recreation at System projects consists of both water-based and land-based activities. Water-based recreation includes boating, fishing, water skiing, jet skiing, and swimming. Land-based recreation includes hunting, camping, picnicking, sightseeing, hiking, and wildlife photography. Visitors participate in these activities at recreation areas that range from undeveloped lake access points to highly developed and extensively used campground areas. The six System projects have a total of 179 public recreation areas. The number of recreation areas by System projects includes 22 at Fort Peck, 35 at Garrison, 51 at Oahe, 24 at Big Bend, 24 at Fort Randall, and 23 at Gavins Point. In 2002, most of the South Dakota Federal recreation areas were transferred in fee title to the State of South Dakota or to the Bureau of Indian Affairs (BIA), which holds the areas in trust for the Lower Brule Sioux Tribe and the Cheyenne River Sioux Tribe, under Title VI of Public Law (P.L.) 105-53, Water Resources Development Act of 1999 as amended by P.L. 106-541, Water Resources Development Act of 2000. The 65 recreation areas transferred in fee title, along with the nine recreation areas leased in perpetuity, will be managed for the restoration of terrestrial wildlife habitat loss that occurred as a result of the flooding of lands related to the construction of the Oahe, Big Bend, Fort Randall, and Gavins Point projects. Table IV-4 presents the Natural Resource Management System reporting area recreation sites, marinas, camping sites and swimming areas for each System project.

Table IV-4
Missouri River System Recreation

Reservoir	NRMS Recreation Areas*	Marinas	Camping Sites	Swimming Areas
Fort Peck Lake	26	3	231	3
Lake Sakakawea	45	9	1,111	4
Lake Oahe	52	4	995	5
Lake Sharpe	31	1	371	7
Lake Francis Case	31	3	578	6
Lewis and Clark Lake	28	2	1,022	7
Total	**213**	**22**	**4,308**	**32**

* The Natural Resource Management System (NRMS) reporting areas include sites where visitor use occurs and may include visitor centers, powerplant exhibit areas, cabin sites, fishing access areas, campgrounds, multiple-use areas, and day-use facilities. These areas are located both upstream and immediately downstream of the dam within the project boundary. The 179 total sites referred to in the above paragraph are just public recreation areas on the respective System projects.

4-06.8. **Missouri River Basin - Irrigation Facilities.** Irrigation is the largest single use of water in the Missouri River basin. As of 1965, about 7.4 million acres of irrigated land, including 6.9 million acres of cropland and 0.5 million acres of pasture, required an annual farm delivery in excess of 14 million acre-feet of water. Of this total, about 5.8 million acres are served by group irrigation systems. These systems have an aggregate reservoir storage capacity of nearly 9 million acre-feet and about 42,000 miles of group-delivery canals. About 45 percent of the storage capacity for group irrigation systems is in reservoirs constructed by irrigation districts, water companies, or the States, with Federal projects accounting for the remainder. About 70 percent of the irrigated area is served by surface water, and about 30 percent is served by groundwater. In years of deficient water supply, a significant portion of the area normally irrigated cannot be furnished the water required.

4-06.8.1. Since 1965, an estimated additional 4 million acres have been placed under irrigation in the Missouri River basin, predominantly from groundwater sources and by private enterprise. Only about one-fifth of the potentially irrigable lands in the basin are irrigated. Consequently, a continuing growth can be expected in the future. Over 6 million additional acres in the basin are estimated to be irrigated eventually. One of the major components of the Pick-Sloan Plan was the Federally funded Oahe (Oahe Diversion) and Garrison (Garrison Diversion) irrigation projects. While the facilities have been constructed to pump this water from Oahe and Garrison System projects, the actual irrigation of lands has not occurred. The Oahe Diversion project has been de-authorized, and the Garrison Diversion project has been significantly scaled back over the past 20 years. No acres are currently irrigated with the Garrison Diversion project.

4-07. **System Real Estate Acquisition.** Construction of the System required the acquisition of approximately 1.7 million acres in fee, public domain transfers, and easements. The individual System projects' Water Control Manuals contain additional details regarding real estate acquisition and relocations for that specific project. The following paragraphs contain a brief description of the acquisitions for the System, the largest reservoir system in the United States.

4-07.1. **Fort Peck Real Estate Acquisition.** Approximately 590,085 acres, with 167,705 acquired in fee and 422,069 from public domain and 311 acres in easement, were acquired for the Fort Peck – Fort Peck Lake System project. Land acquisition was based on a guide taking elevation of 2250 feet msl (top of the Exclusive Flood Control Zone) from the dam to RM 1863 (approximately 3 miles below the Musselshell River). Land was acquired to a guide taking elevation of 2270 from RM 1863 to 1932 because of the flatness of the terrain and the problem with winter ice-jam flooding in this reach.

4-07.2. **Garrison Real Estate Acquisition.** Almost one-half million acres of real estate in fee and just less than 3,000 acres in easement were acquired for the Garrison Dam – Lake Sakakawea System project. Land acquisition was based on a guide taking line of elevation 1855 feet msl (1 foot higher than the top of the Exclusive Flood Control Zone) of a major portion of the reservoir area. In the upper end of Lake Sakakawea, the high potential for aggradation and backwater effects was recognized; therefore, land was acquired to an elevation of 1860 feet msl.

4-07.3. **Oahe Real Estate Acquisition.** Over 400,000 acres of real estate in fee and 2,417 acres in easement were acquired for the Oahe Dam – Lake Oahe System project. Land acquisition was based on a guide taking line of elevation 1620 feet msl (top of the Exclusive Flood Control Zone) with allowances for wave heights, set-up, wave run-up, erosion, and bank caving. In the upper end of the Lake Oahe, aggradation and backwater effects were recognized; therefore, land was acquired to an elevation of 1630 feet msl.

4-07.4. **Big Bend Real Estate Acquisition.** Approximately 44,870 acres in fee and 160 acres in easements were acquired for the Big Bend Dam – Lake Sharpe System project. Land acquisition was based on a guide taking line at elevation 1423 (top of the Exclusive Flood Control Zone) with allowances for wave heights, set-up, wave run-up, erosion, and bank caving, or a 300-foot setback from the 1423 feet msl contour, whichever was the greater. Flowage easements were acquired on four tracts of land having a total area of less than 10 acres.

4-07.5. **Fort Randall Real Estate Acquisition.** Approximately 114,163 acres in fee and 649 acres in easements were acquired for the Fort Randall Dam – Lake Francis Case System project, including 514 acres of flowage easements at 15 locations. In addition, Public Land Order transferred 173 acres from the public domain. Of the total originally acquired for Fort Randall, approximately 15,000 acres were later included as necessary real estate for the Big Bend Dam – Lake Sharpe System project. A guide taking line of elevation 1375 feet msl (top of the Exclusive Flood Control Zone) was the basis of the acquisition over most of the reservoir area.

4-07.6. **Gavins Point Real Estate Acquisition.** Approximately 34,474 acres in fee and 212 acres in easements were acquired for the Gavins Point Dam – Lewis and Clark Lake System project. No public domain land was involved at this project. The guide-taking line for the main body of the reservoir was to elevation 1210 feet msl (top of the Exclusive Flood Control Zone) with a provision for wave heights, erosion, bank caving, reservoir set-up, and wave run-up. Provision was also made for raising the elevation of the taking line in upper reaches of the reservoir to allow for sedimentation and backwater effects.

V - DATA COLLECTION AND COMMUNICATION NETWORKS

5-01. **Hydrometeorologic Stations.** This section describes the data collection methods and locations to meet the Corps' mission of managing the Nation's water resources in the Missouri River basin.

5-01.1. **Data Collection System.** Effective reservoir regulation of the System requires accurate real-time data relating to existing and anticipated hydrologic and meteorological conditions within the Missouri River basin. Due to the wide seasonal and area1 variations of hydrologic events within this very large basin, it is necessary to integrate a large volume of basic data pertinent to runoff and water supply in order that the System can be regulated to meet the operational objectives for which the System was originally designed. The RCC has created and maintained the Missouri River Automatic Data System (MRADS) since 1978 to serve that purpose. MRADS, in combination with the new Corps' Water Management System (CWMS), lays the foundation for the automation and integration of data and watershed runoff model simulation for all Corps water management activities in the Missouri River basin.

5-01.1.1. Data is collected at Corps sites through a variety of sources and integrated into one verified and validated centrally located database. The basis for automated data collection is the satellite Data Collection Platform (DCP). The DCP is a computer microprocessor physically located at the gage site. A DCP has the capability to interrogate sensors at regular intervals to obtain real-time information (e.g., river stages, reservoir elevations, water and air temperatures, precipitation), save the information, perform simple analyses of this information, and then transmit this information to a fixed geostationary satellite. Since all of the data is transmitted by satellite, the past problem of loss of communications during significant runoff or storm events has been eliminated. The RCC has operated and maintained a Direct Readout Ground Station (DRGS) since 1983. The DRGS collects DCP-transmitted, real-time data directly from the west Geostationary Orbiting Environmental Satellite (GOES) System operated by the National Oceanic and Atmospheric Administration (NOAA). The Corps' Omaha and Kansas City Districts also collect specific data using a different transmission component of the NOAA system – the DOMestic SATellite (DOMSAT). The DOMSATs at the two District offices are also referred to as Local Readout Ground Stations (LRGS). An Oracle database, maintained by the RCC, is used to store, validate, and integrate all data. The data is also available to the two District water control offices. Each of the three water management offices in the Corps' Missouri River basin area of the Northwestern Division (NWD) has an independent, current copy of the database available on a local computer system to provide a high degree of reliability. Data that are updated or revised at any of the three offices are quickly replicated at each of the other sites' databases. This system has proven invaluable during many critical events in providing water managers and other decision-makers with dependable, reliable, and accurate real-time data to assist in making significant water management decisions. Other components of the system include the Corps' communication network for inter-office communications and the highly reliable and redundant UNIX computer systems connected with both battery-powered Uninterrupted Power Supplies (UPS) and diesel-powered emergency generating facilities to assure continual operation. Preparation and implementation of a Continuity of Operations Plan

(COOP) for this system is critical to providing for redundancy and future reliability to assure success of critical data collection and modeling efforts. Plate V-1 shows the interconnection of the offices and the GOES data collection system.

5-01.2. **Data Collected.** The following paragraphs describe the data collected by the Corps to meet its water resources mission.

5-01.2.1. **Precipitation.** Historically, a relatively large number of precipitation stations were required for adequate coverage in the Missouri River basin. This precipitation station network was established and is maintained largely by the National Weather Service (NWS). The Corps had historically hired observers to report significant precipitation. Beginning in the late 1960's, this practice was phased out, and the Corps contracted with the NWS to provide precipitation data through its cooperative programs. Both the Omaha and Kansas City Districts had previously participated in this effort by providing funds to the NWS under the FC-50 and FC-33 NWS programs, respectively. In recent years, the Kansas City District has dropped their support of the FC-33 program. The Omaha District continues to fund the FC-50 program for precipitation data support. Currently, the only direct district involvement in collecting precipitation data is conducted at Corps project weather stations, and by providing automated precipitation equipment to the U.S. Geological Survey (USGS) to install and maintain at the DCP gaging sites. The introduction of automated precipitation gages at real-time DCP stations has nearly eliminated the need for observer precipitation stations in the basin. Also, data on the spatial distribution of precipitation is now provided, to a great extent, by the NWS through its Multi-sensor Precipitation Estimates (MPE). The MPE provides a 4-square-kilometer pixel format for almost all areas of the basin and are used as the primary data source for watershed modeling in the basin. The hourly MPE files are automatically retrieved from the NWS on a near real-time basis and stored on a Water Management Office's UNIX workstation. The primary purpose of the DCP real-time precipitation network is for validation of the MPE data, and for use as primary data during that portion of the runoff season when MPE data are not considered accurate. In addition, the NWS maintains a network of observed precipitation stations to provide additional point-rainfall data to validate MPE data.

5-01.2.1.1. **Station Locations.** Individual water control manuals contain maps of key hydrologic and meteorologic stations for that portion of the Missouri River basin most pertinent to regulation of the specific project under consideration. Plate V-2 shows weather stations for which meteorologic data are available more often than once daily. Data gathered through this basic network is augmented by numerous additional reports from the NWS and Corps' Districts at times of significant precipitation within the basin.

5-01.2.2. **Snow.** Nearly three-fourths of the total annual streamflow that enters the System results from the melting of the winter's snow accumulation over the northern plains area during the spring (March-April) and from the high mountain area (in combination with rainfall runoff) during the late spring and early summer (May-July) season. Flooding in the upper basin is nearly always associated with these events when the accumulation of snow is significant. Snowmelt also contributes to flood flows that occur throughout the lower basin. Measurement of the snow depth and water content of the snow cover, in combination with quantitative as well as qualitative assessments of other related data, provide insight into the potential magnitude of the flood events. This, in turn, enables System regulation to be adjusted accordingly so that flood control, as well as the other authorized project purposes, may be accomplished according to the operational objectives stated in this manual.

5-01.2.2.1. **Plains Snow.** Plains-area winter ground surveys that determine the water content of the plains snow blanket have been conducted in the Missouri River basin by Omaha District personnel during years of high plains snowmelt runoff potential since 1948. Uniform measuring and observation criteria have been established so that data from year to year will be comparable. Data pertinent to estimating runoff potential are observed at specific locations and include water content of the snow cover, snow depth, amount of ice layer present on the ground surface, a qualitative estimate of surface ground saturation, amount of drifting, and the condition of the ground surface with regard to frost penetration. In addition to the Corps' network, the NWS has a program for obtaining and reporting snow water content at selected stations in the basin and by conducting airborne gamma radiation surveys along predetermined flight lines in the upper basin. The National Operational Hydrologic Remote Sensing Center (NOHRSC) provides remotely sensored and modeled hydrology products that are used by staff to determine the expected volume of runoff from snowmelt. Sharing of these data is accomplished through the NWS Missouri Basin River Forecast Center (MBRFC) and through various NWS websites. Generally, once these data have been collected, a water equivalent map for the basin can be created. These maps have recently been digitized and sub-basin areas developed so that a history of significant plains snowmelt events is available by river basins. By comparing similar historic snow accumulations, a general estimate of the expected runoff can be developed for each tributary watershed. This technique has resulted in improved plains snowmelt runoff forecasting. As an ongoing research and development effort with the Corps' Cold Regions Research and Environmental Laboratory (CRREL), a new set of runoff models are being developed to forecast snowmelt runoff from plains areas within the Missouri River basin. This modeling system will consist of daily satellite-collected Snow Water Equivalency (SWE) data that will be integrated into a computer model utilizing a grid-cell approach. Forecasted snowmelt runoff is then routed and accumulated on a grid-cell basis. This will provide both more accurate and timely plains snowmelt forecasts that are based on daily SWE measurements rather than on data historically collected once or twice a season. Plate III-16 shows the mean annual snowfall in the basin.

5-01.2.2.1.1. **Plains Snow Surveys.** Each District office has the responsibility to stay informed of the flood potential within its drainage area at all times. Plains snow surveys within both Districts' boundaries can be made at their discretion, with inter-District coordination by the RCC. Basin-wide surveys conducted by the Districts over their established network are implemented by orders from the RCC. A partial index to the runoff potentials, upon which the implementation order is based, is obtained from available District surveys. In addition, precipitation and snow-depth reports are received throughout the winter season from various NWS stations and Corps projects. Imp1ementation orders to the District offices include the dates, area1 coverage, and minimum observation criteria for the surveys. Accomplishment of the surveys is a District responsibility. A basin-wide survey will normally be made from mid-February to early-March during those years that a moderate to heavy plains snow cover is reported. More than one survey may be implemented in any season if conditions so warrant. Reports of plains snow survey observations are forwarded by the District offices to the RCC and to the NWS MBRFC through established communication channels. Analyses of data as they affect local flood conditions and tributary reservoirs are conducted by the appropriate District water control office. The RCC evaluates the data for regulation of the System. In the event of a basin-wide survey, the RCC is responsible for combining the District reports with snow data that may be available from other sources to make a composite basin-wide analysis of the runoff potential. The RCC disseminates results of these analyses to the Districts. The analyses summary output is usually in the form of Geographic Information System (GIS) pixel layers that graphically represent the SWE over the affected areas. This information can also be used as input into watershed runoff models to represent the volume of flow expected from snowmelt. Over a period of years, these manually-measured plains snow surveys are expected to be phased out in favor of a new NOAA satellite-based system that will provide continual monitoring of plains snow accumulation. The RCC is working cooperatively in the research and development efforts on this new system and plans to incorporate the new system into its watershed runoff modeling efforts (CWMS) when it becomes available.

5-01.2.2.2. **Mountain Snow.** Manually measured snow surveys in the mountainous areas above the Fort Peck and Garrison projects date back to 1934; however, the network has changed considerably since that date. Of the snow courses most pertinent to System regulation, 60 are located in the drainage area above Fort Peck (45 are SNOw TELemetry (SNOTEL) automated sites) and 80 are located in the Yellowstone River basin (45 are SNOTEL automated sites).

5-01.2.2.2.1. **Manually Measured Snow Courses.** Surveys are conducted through the cooperative efforts of many Federal and State agencies and private entities. The Natural Resources Conservation Service (NRCS) of the Department of Agriculture has the primary responsibility for coordinating mountain snow surveys in the western United States. Manually measured mountain snow surveys are normally conducted near the first of each month during the period January to June along specified courses. The frequency of sampling varies from course to course. Most courses are measured near the first of March and the first of April when the snow cover is near the maximum. Only a few courses are sampled each month through the entire January-June period. Observations consist of measuring snow depth and water content in inches and noting qualitative data regarding ground conditions. The NRCS has phased out many of the manually measured snow courses over the years due to the high costs of conducting such data collection. The SNOTEL network primarily consists of real-time data collection from snow pillows, with just a few key locations manually measured for quality control and field verification.

5-01.2.2.2.2. **Automated SNOTEL Stations.** Automated SNOTEL pillows have been installed at various mountain locations in the Missouri River basin by the NRCS. These snow pillows, which measure the density of the snow on them, are linked to a telemetry network that is implemented and maintained by the NRCS. Snow water content and other meteorologic information are relayed to a center via meteor-burst technology. The data is subsequently verified and crosschecked with manually measured data by NRCS personnel. The SNOTEL and snow course data are entered into a NRCS database. The data are available via the NRCS web sites and the NRCS database, both of which can be accessed by the RCC. This network of data is used to provide information to determine the amount of SWE in the mountain snowpack in the Missouri River basin. Once the SWE is known, various techniques are used to determine the expected volume of runoff that will be produced. Over the years, real-time SNOTEL stations have replaced the manually measured stations and snow courses to the extent that the RCC exclusively uses real-time SNOTEL data in the Corps' Missouri River basin runoff forecast. A more detailed description of the NRCS and the SNOTEL system is available in Chapter 6, Paragraph 6-01.2.3 of this manual.

5-01.2.3. **River Stages and Discharges.** When the dams were first closed in the 1950's, river stage data were collected weekly by U.S. mail. In the early 1960s, the Corps contracted directly with individual observers. The Corps then collected the hydrologic data by telephoning these observers daily. This data collection effort was necessary to effectively regulate the System and tributary reservoirs.

5-01.2.3.1. **USGS Cooperative Program.** Over a period of years beginning in the late 1960's, the Corps began to contract out this data collection and maintenance effort to the USGS and NWS through cooperative stream gaging and precipitation network programs. The USGS, in cooperation with other Federal and State agencies, currently maintains a network of real-time DCP stream gaging stations throughout the Missouri River basin. The USGS is responsible for the supervision and maintenance of the real-time DCP gaging stations and the collection and distribution of streamflow data. In addition, the USGS maintains a systematic measurement program at the stations in order that the stage-discharge relationship for each station is current. Through cooperative arrangements with the USGS, discharge measurements at key Missouri River locations are made at a greater frequency than is normally considered adequate for historic streamflow records. Such a procedure is necessary to maintain the most current stage-discharge relationships at these stations. Current Missouri River rating curves are required to ensure that System regulation, whether geared to flood control or other authorized purposes, may proceed as efficiently as possible. Results of discharge measurements at important stations are furnished to the RCC and NWS as soon as available. The measurement results are also placed on the RCC website for District and public dissemination. Upon special request, the appropriate District arranges and furnishes discharge data for stations not included in the basic network. In addition to the stations maintained by the USGS, other Federal and State agencies, including the Corps, NWS, U.S. Bureau of Reclamation (USBR), and private entities collect stage and, occasionally, discharge data at certain locations. These additional data, if deemed useful or pertinent to System regulation, can usually be obtained from these parties by establishing appropriate data retrieval means.

5-01.2.3.2. **Non-DCP Data.** The RCC obtains most of the daily precipitation and stage data it needs for real-time System regulation directly from satellite DCPs using the GOES system, as previously discussed. The NWS, however, also distributes most of the hourly stage information used for regulation of the System over its data networks and web sites. Arrangements for the NWS reporting of stage data pertinent to System regulation are made through the NWS MBRFC in Prairie Hill, Missouri. Most of this information is available to the public via either the web or through private vendors who redistribute the information. The RCC has used both the web and private vendors for many years to provide timely graphic and text weather data for regulation of the System and for in-house briefing purposes. Maps and text are updated automatically as products are prepared and transferred on a scheduled basis. Plate V-3 shows locations of these important streamflow stations and key reservoir reporting stations within the Missouri River basin. More detailed station maps pertinent to the regulation of the individual reservoirs are presented in the individual project water control manuals. In addition to the basic network, considerable amounts of additional stream data are received, often on a seasonal or emergency basis, directly from the MBRFC. Listings and locations of these stations are presented in individual project water control manuals and in appropriate disaster manuals for flood emergency operations.

5-01.2.4. **Reservoir Data.** Reservoir data are obtained and transmitted to RCC by the Power Plant Control System (PPCS). The PPCS is explained in greater detail in Paragraph 5-04.

5-01.2.5. **Evaporation Data.** Evaporation data are particularly significant on the very large System. The average annual water loss due to evaporation at Fort Peck Lake since the System became fully operational (1967 to 2002) is 692,000 acre-feet; Lake Sakakawea is 903,000 acre-feet; Lake Oahe is 932,000 acre-feet; Lake Sharpe is 183,000 acre-feet; Lake Francis Case is 253,000 acre-feet; and Lewis and Clark Lake is 92,000 acre-feet. A standard Class "A" evaporation pan is in operation at each Mainstem reservoir. Daily manual observations of evaporation depth, pan wind movement, and pan temperature are made from April through October. Observations are not made during the other months because the pan water freezes. Based on the observed pan readings, a reservoir evaporation coefficient is computed and used to determine the daily loss of storage due to evaporation. The evaporation rate in inches per day is manually entered into the PPCS at each project. Additional data pertinent to evaporation measurement are collected from instruments co-located in the weather yard near the evaporation pan; daily minimum and maximum air and pan temperature and hourly precipitation, wind speed, and wind direction. The RCC is working cooperatively with the CRREL to automate the data collection and calculation of the daily evaporation at the System projects.

5-01.2.6. **Air Temperature Data.** Air temperature is an important meteorological parameter used in the regulation of the System. Snowmelt and ice formation can be anticipated by observing air temperature readings. Air temperature, along with wind speed, wind direction, and precipitation, are recorded hourly at each project using automated weather equipment. The data are supplied to the RCC via the PPCS network. In addition to the data collected at the projects, regional air temperature data are obtained hourly from the NWS via satellite that is displayed via a computer-based weather display system leased from Meteorlogix Company. Data is also available on various public Internet sites. Air temperature and wind velocity data is critical for accurate prediction of river ice formation. Regulation of the System to ensure adequate water supply and to prevent flooding is based on forecasts of river ice formation. Air temperature data is also important during the summer months when river water temperatures can exceed established water quality standards under low-flow conditions on the Missouri River.

5-01.2.7. **Tailwater Temperature Data.** The river water temperatures just downstream of the System dams usually vary from the mean air temperatures due to the large amount of water in storage in most of the System reservoirs. While this tailwater temperature is an important water quality parameter, it is of most concern to the regulation process as an index to surface water temperature, an important element in the development of evaporation estimates. Tailwater temperature is also an important element in predicting downstream water temperatures and for estimating formation and movement of the ice cover below the projects. Automated tailwater temperature measurements are made on an hourly basis at each of the Mainstem reservoir projects via the PPCS and are retrieved by the RCC. These data are an important element of the daily reports furnished by the RCC.

5-01.2.8. **River Reconnaissance Data Collection.** While the conditions expected to result from regulation of the reservoirs can be estimated or modeled through empirical means developed from past experience, verification requires accurate field observations. Project personnel make numerous reconnaissance trips to portions of the Missouri River that are affected by project releases and of the reservoirs to obtain information pertinent to System regulation. During the winter season, observations of ice conditions in the Missouri River are sometimes requested at critical locations. In recent years, video cameras have been located in remote areas with limited access. The cameras provide valuable river condition information through Internet access over the World Wide Web. Effects of unusual release rates or reservoir levels are also documented by field observations. Bank erosion below projects is also a matter of concern. The reconnaissance trips consist primarily of visual observations and verbal reports to the District office and the RCC. The trips are supplemented with photographic imagery when conditions warrant. When particularly unusual events occur, aerial photography or video imagery may be also scheduled. Normally, the District office coordinates and contracts for the acquisition of the aerial photography or video imagery. If aerial photography or video imagery is conducted to observe ice cover, the photography or video is shared with the local NWS Weather Forecast Offices (WFO) so that all Federal agencies can use the results.

5-01.3. **Responsibilities for Data Collection, Analysis, and Dissemination.** The Districts are responsible for making appropriate arrangements to ensure adequate hydrologic coverage within their respective boundaries. In addition to the requirements for regulating the System, these data are essential for the Districts to accomplish their water resources mission of tributary reservoir regulation, discharge forecasting, and emergency operations on both the main stem and tributaries. Pertinent data collected by the Districts are immediately forwarded to the RCC through established communication channels. In addition to data received from the Districts, the RCC has weather and climatic products transmitted directly to the office over a satellite link by Meteorlogix Company. The RCC also maintains direct contact, either by telephone or email, with the NWS, NRCS, USGS, USBR, Western Area Power Administration (WAPA), U.S. Fish and Wildlife Service (Service), U.S. Coast Guard, and many other agencies and individuals who provide hydrologic and other data integral to the regulation of the System reservoirs. In some cases, arrangements are made with these agencies to receive data considered necessary for efficient regulation of the System and for staff supervision of the regulation of tributary reservoir projects.

5-01.3.1. All received data are directly stored in a raw unverified format to both the MRADS and CWMS databases that can be accessed by all water management staff. Automated computer programs are run on an hourly basis to complete a first-run check of the raw data. In addition, water management staff manually verify the data accuracy several times each day. These verified data are used to make scheduling decisions regarding release rates from the System and tributary reservoirs. Both MRADS and CWMS systems allow for the graphical representation of all pertinent data. The graphical representation of river flow hydrographs allows water management staff to quickly determine if the data are accurate and establish basin streamflow patterns. These data are then integrated into various runoff scenarios so that multiple reservoir simulations can be run to determine the best reservoir regulation to schedule to meet the operational objectives stated in this manual. Data can be displayed on individual water control management computers and are posted to a website for public dissemination. The database and graphics are continually updated to provide the water management staff and public with the most up-to-date information.

5-01.3.2. **RCC Briefings.** Weekly briefings, or more often, should conditions warrant, are held in the RCC for key personnel. During these briefings, pertinent basin hydrologic and meteorological information is discussed and short-term and long-term System regulation decisions are made. In addition, other meetings or telephone conferences are scheduled as necessary to keep decision-makers abreast of significant or changing conditions related to water management.

5-01.3.3. **Off-Duty Hours.** RCC water control managers also have the capability to view data and run hydrologic runoff models from their homes via high-speed Internet connections. This allows the water management staff to effectively manage the System during anytime of the day or night, including holidays and weekends.

5.02. **Water Quality Stations.** Several water quality monitoring programs have been established for the System and the Missouri River. The Corps conducts water quality monitoring on selected stream reaches and reservoirs to prepare annual and technical reports. The USGS also conducts water quality monitoring at selected locations in the Missouri River basin as shown on Table V-1. The Corps and the USGS maintain 49 active monitoring locations on the System and the lower river. The Corps maintains 25 of the sites and the USGS operates 24. The States perform water quality monitoring, but the locations, status, and sampling frequency are not readily available. There is no comprehensive, integrated monitoring and reporting program for the entire Missouri River basin between the Federal agencies and the individual States.

5-03. **Sediment Stations.** The Omaha and Kansas City Districts operate 13 suspended-sediment sampling stations. Seven of these stations are located on the Missouri River at Landusky, Montana; Sioux City, Iowa; Omaha, Nebraska; Nebraska City, Nebraska; St. Joseph, Missouri; Kansas City, Missouri; and Hermann, Missouri. The remaining six stations are tributary stations at the Musselshell River at Mosby, Montana; Yellowstone River at Sidney, Montana; Bad River at Ft. Pierre, South Dakota; White River at Oacoma, South Dakota; Osage River above Schell City, Missouri; and the South Grand River near Clinton, Missouri. All sampling is conducted by, or in cooperation with, the USGS. Table V-2 presents a summary of the sediment sampling stations within the Missouri River basin.

5-04. **System Hydrologic Data Collection.** The following paragraphs describe the retrieval of hydrologic data for regulation of the System.

5-04.1. **System Reservoir Data.** Each of the System projects report data via the PPCS. Data is retrieved on an hourly basis and written to the MRADS and CWMS databases. Hourly data retrieved from the PPCS are air temperature, elevation, hydropower generation, tailwater elevation, spillway flow, turbine flow, and wind direction and speed. In addition, daily values retrieved once per day from the PPCS include total energy, average head (difference between the reservoir elevation and the tailwater elevation), pan evaporation depth, pan wind movement, average spillway flow, average turbine flow, minimum and maximum air and pan temperatures, precipitation, and turbine-flow water temperature at the tailrace. RCC staff can also access the

Table V-1

Water Quality Monitoring Stations in the Missouri River Basin

Agency	Location	Type
COE-OMAHA	Fort Peck Lake at Hell Creek	Ambient Lake
COE-OMAHA	Fort Peck Lake near Dam	Ambient Lake
COE-OMAHA	Fort Peck Lake Releases	Ambient Stream
COE-OMAHA	Lake Audubon at Snake Creek	Ambient Lake
COE-OMAHA	Lake Audubon Deepwater near Dam	Ambient Lake
COE-OMAHA	Lake Francis Case near Dam	Ambient Lake
COE-OMAHA	Lake Francis Case near Elm Creek	Ambient Lake
COE-OMAHA	Lake Francis Case Releases	Ambient Stream
COE-OMAHA	Lake Oahe near Dam	Ambient Lake
COE-OMAHA	Lake Oahe near Pollock, South Dakota	Ambient Lake
COE-OMAHA	Lake Oahe Releases	Ambient Lake
112WRD-USGS	Lake Sakakawea above Little Missouri River, ND	Ambient Lake
112WRD-USGS	Lake Sakakawea above Van Hook Arm, ND	Ambient Lake
112WRD-USGS	Lake Sakakawea at Beaver Creek Bay, ND	Ambient Lake
COE-OMAHA	Lake Sakakawea at Garrison Dam	Ambient Lake
112WRD-USGS	Lake Sakakawea at Douglas Creek Bay, ND	Ambient Lake
112WRD-USGS	Lake Sakakawea at Lewis and Clark Bay, ND	Ambient Lake
COE-OMAHA	Lake Sakakawea at Newtown, ND	Ambient Stream
112WRD-USGS	Lake Sakakawea at Riverdale, ND	Ambient Lake
112WRD-USGS	Lake Sakakawea at White Earth Bay, ND	Ambient Lake
112WRD-USGS	Lake Sakakawea near New Town, ND	Ambient Lake
COE-OMAHA	Lake Sharpe Releases	Ambient Stream
COE-OMAHA	Lake Sharpe near Dam	Ambient Lake
COE-OMAHA	Lewis and Clarke Lake near Dam	Ambient Lake
COE-OMAHA	Lewis and Clarke Lake near Springfield	Ambient Stream
COE-OMAHA	Lewis and Clarke Lake Releases	Ambient Stream
112WRD-USGS	Missouri River at Pierre, SD	Ambient Stream
112WRD-USGS	Missouri River at Yankton, SD	Ambient Stream
112WRD-USGS	Missouri River at Bismarck, ND	Ambient Stream
112WRD-USGS	Missouri River at Fort Benton, MT	Ambient Stream
112WRD-USGS	Missouri River at Garrison Dam, ND	Ambient Stream
112WRD-USGS	Missouri River near Williston, ND	Ambient Stream
112WRD-USGS	Missouri River at Toston, MT	Ambient Stream
112WRD-USGS	Missouri River at Virgelle, MT	Ambient Stream

Agency	Location	Type
112WRD-USGS	Missouri River below Fort Peck Dam, MT	Ambient Stream
112WRD-USGS	Missouri River blw Hauser Lake near Helena, MT	Ambient Stream
112WRD-USGS	Missouri River blw Holter Dam, Mt	Ambient Stream
112WRD-USGS	Missouri River near Culberston, MT	Ambient Stream
112WRD-USGS	Missouri River near Great Falls, MT	Ambient Stream
112WRD-USGS	Missouri River near Landusky, MT	Ambient Stream
112WRD-USGS	Missouri River near Ulm, MT	Ambient Stream
112WRD-USGS	Missouri River near Wolf Point, MT	Ambient Stream
COE-OMAHA	Monitor at Big Bend Power House	Ambient Lake
COE-OMAHA	Monitor at Fort Randall Power House	Ambient Lake
COE-OMAHA	Monitor at Garrison Power House	Ambient Lake
COE-OMAHA	Monitor at Gavins Point Power House	Ambient Lake
COE-OMAHA	Monitor at Oahe Power House	Ambient Lake
COE-OMAHA	Monitor at Fort Peck Power House	Ambient Lake
COE-OMAHA	Power House outfall at Pierre, SD	Ambient Lake
11NPSWRD-USGS	Yankton Raw Water Intake at Meridian Bridge	Ambient Stream

COE-OMAHA: Corps of Engineers – Omaha District Monitoring Sites
112WRD: USGS Monitoring Sites
11NPSWD: USGS Monitoring Sites

Source: EPA, 2001 and Corps, 2000

PPCS system directly to observe current, instantaneous project operational and daily historic data. This system is very useful to monitor project releases and schedule changes during critical periods and allows confirmation that project release changes have been made in accordance with RCC orders. Similar reports from tributary reservoirs that may affect System regulation are furnished daily by the District offices. Other Federal, State, and local agencies, primarily the USBR, who are responsible for regulation of non-Corps reservoir projects, furnish reports to the RCC when their operations affect System regulation. Monthly reports, which include tabulations of inflow, releases, pool elevations, storage, evaporation losses, and other pertinent factors, are prepared by the RCC for each of the System projects. Similar reports are furnished by the Districts for each of the Corps and USBR tributary reservoirs in which the Corps has an interest. These reports are entered into the MRADS system as soon as practicable following the end of each month. The reports, sometimes referred to as MRD Form 0168, are all available to the public via the RCC's web page. A sample of such a report is shown on Plate V-4.

5-04.2. **System Databases.** MRADS and CWMS are the primary databases used to facilitate System regulation.

Table V-2
Sediment Sampling Stations in the Missouri River Basin

Water Resources Regions & Streams	Location	Drainage Area (Sq. Mi.)	Period of Record	Sample Equipment and Type	Sample Frequency	Station/Purpose
Missouri River	Nr. Landusky, Montana	40,987 (1) 18,221 (2)	Oct 1968 to Date	D43 1-3/1di Str 1	G-S	Fort Peck Lake O&M
Musselshell River	Mosby, Montana	7,846 (1) 7,846 (2)	Oct 1981 to Date	D43 1/1di Str1	G-S	Fort Peck Lake O&M
Yellowstone River	Sidney, Montana	69,103 (1) 46,448 (2)	Jun. 1937 to Date	P46 1-3/1di D43 1-3/1di BMH60 1-3	G-S	Lake Sakakawea O&M
Bad River	Ft. Pierre S. Dakota	3,107 (1) 3,107 (2)	May 1947 to date	D43 1/1di D49 1/1di Str 1	G-S	Lake Sharpe O&M
White River	Nr. Oacoma, South Dakota	10,200 (1) 10,200 (2)	May 1939-May1942 Mar 1944-Sep 1976 Oct1979 to Date	D43 1/1di		Lake Francis Case O&M
Missouri River [1]	Sioux City, Iowa	314,600 (1)	Oct 1954 to date		G	
Missouri River [1]	Omaha, Nebraska	322,800 (1)	April 1939 to date		G	
Missouri River [1]	Nebraska City, Nebraska	410,000 (1)	May 1951 to date		G	
Missouri River [1]	St. Joseph, Missouri	424,300 (1)	Jun 1948 to date	P61A 1-5/1di 5-5to7P BM54.5	M	Navigation Monitoring
Missouri River [1]	Kansas City, Missouri	489,200 (1)	May 1948 to date	P61A 1-5/1di 5-5to7P BM54.5	M	Navigation Monitoring
Missouri River [1]	Hermann, Missouri	528,200 (1)	Aug 1948 to date	P61A 1-5/1di 5-5to7P BM54.5	M	Navigation Monitoring
Osage River	Abv Shell City, Missouri	5,410 (1)	Feb 1991 to date	D-76 1/1di	D	Inflow to Truman Lake
South Grand River	Nr Clinton, Missouri	1,270 (1)	Apr 1991 to date	D-76 1/1di	D	Inflow to Truman Lake

Note: Stations are operated and records published by the USGS

Sampling Equipment
D43 D49 P46 — Suspended Samplers
Str — Straub Bed Sampler
BMH60 BM — Bed Sampler

Sample Types
1-3/di — One to three verticls/one depth
1/1di — One vertical/one depth integrated

Sampling Frequency
G - Samples depending on discharge
S - Surface Samples
M - Monthly
D - Daily

Drainage Area
(1) Total Drainage Area
(2) Net Sediment Contributing Drainage

1 –Sediment sampling was suspended at the Sioux City gage in FY 2001 due to funding constraints. Data will be collected on a rotating schedule at the Omaha, Nebraska City, and Sioux City gages.

5-04.2.1. **Missouri River Automated Data System.** MRADS is a computer-operated, on-line, centralized database that has been in operation since 1978 for storing and disseminating Missouri River basin real-time water management data. Several times each day, the current river and project water management data are entered into MRADS via computers in the RCC and District water management offices. These data are maintained in an Oracle database with approximately 365 days of current data immediately available. Each month, the most recent month's data are added to an historic data file that is available on-line to enable quick access. Once the most recent month's data are added, the oldest month of data is removed from the file, making space available to store the current month's data. The MRADS data are archived on a regularly scheduled basis and a copy of the file is stored offsite for protection. This ensures continuity of operation in case the primary file is destroyed. Also, the RCC keeps the master copy of the centralized water management database and each District maintains a copy of this database locally to provide greater reliability if network capability is lost or degraded. The Districts make frequent updates to both the local and master databases, especially during flood events, to ensure that all water management staff is using the same data. MRADS also includes static data such as reservoir elevation-storage tables, project storage allocations, river station stage-discharge tables, river routing coefficients, and river station miles. As its development continues, CWMS will replace a portion of the existing MRADS system. The RCC anticipates that CWMS will be incorporated over the next few years into day-to-day operations.

5-04.2.2. **Corps Water Management System.** CWMS is a client-server system recently developed by the Corps' Hydrologic Engineering Center (HEC). CWMS utilizes the Sun Solaris platform on the server side and the Sun Solaris and Windows 2000 platforms on the client side. CWMS involves the retrieval and storage of time-series data into an Oracle database, data verification and transformation of the data, the development and use of an array of hydrologic models to determine streamflow, reservoir operations and downstream impacts from project releases (stage and damage), the visual display of edited and transformed data and model results, and dissemination of data to web applications. In its full-functioning mode, the three water control offices will synchronize their CWMS Oracle databases. Any change made to a database in any of the three offices will immediately be "replicated" to the other two databases. The CWMS Oracle databases will not only include the various time-series data retrieved from DCP and non-DCP stations, but will also include complimentary data such as images, descriptions, and paired data (e.g., stage-discharge, elevation-storage and stage-damage tables). The development of CWMS in the RCC and District water management offices has been ongoing since the late 1990's. Because the database is such an integral part of the regulation of the System, the RCC is proceeding very cautiously in its development and ultimate implementation of CWMS as its primary database management system.

5-05. **Communications Network.** The following paragraphs describe the communication network infrastructure between the three Corps offices responsible for regulating the System and tributary reservoirs in the Missouri River basin.

5-05.1. **Physical Description.** The global network of the Corps consists of private, dedicated, leased lines between every Division and District office worldwide. These lines are procured through a minimum of two General Service Administration (GSA) approved telephone vendors, and each office has a minimum of two connections, one for each vendor. The individual links consist of either dedicated point-to-point circuits or dedicated point-to-frame relay cloud Points of Presence (POPs). The primary protocol of the entire Corps network is Ethernet. Plate V-5 shows the physical communications network of the Missouri River basin. Plate V-1 shows the data acquisition and network interconnections.

5-05.2. **Reliability.** The reliability of the Corps' network is considered a command priority and, as such, supports a dedicated 24/7/365 (24 hours per day, 7 days per week, 365 days per year) Network Operations Center (NOC). The NOC, physically located in Portland, Oregon, maintains operational status of the network. This team coordinates with all local telephone vendors as outages occur and informs local information technology staff of problems and solutions. The NOC has full control of all routers, firewalls, Channel Service Unit/Data Service Unit (CSU/DSU), and any other communication equipment that is required to connect the local office to the Corps' backbone network. This approach mitigates the risk of any office being cut off from the global network for command and control purposes. The use of multiple telephone companies supplying the network connections minimizes the risk of a one cable cut causing an outage for any office. This dual redundancy, plus the use of satellite data acquisition, makes for a very reliable water control network infrastructure.

5-05.3. **Local Operations.** The local office network operations begin at the demarcation point of the global network. This is usually the firewall output port of the global network. From this point, all network control is designed and maintained locally to meet the needs and mission requirements of each office. For the water management mission, the network is treated as a separate entity. This ensures that a local network outage, planned or unplanned, does not disrupt daily regulation of the System by the RCC or by the District offices, who regulate the tributary reservoirs in the Missouri River basin. Each Corps office is designed to exist without the other network resources. This is accomplished with the segmenting of the RCC computers and staff to use dedicated Ethernet equipment rather than to be consolidated into the general office Local Area Network (LAN). The RCC can, therefore, operate independently of the general office network. This design allows data acquisition and review to take place within the finite network of the water management LAN.

5-05.4. **Emergency Power.** The RCC is a critical component of the emergency operations plans of each District. The RCC has to be able to function in cases of flooding or other disasters, which typically are followed by the loss of commercial electricity. Because the RCC LAN is identified as separate from the office network backbone, this critical equipment is connected to both UPS and either dedicated or rapidly deployed emergency power generation equipment. A diesel-powered generator is physically located at the RCC, and is tested on a regular basis. Commercial fuel companies or Army fuel depot units, in the case of extended electrical outages, can be used to fuel the generator. The division office location has the generator and automatic transfer switch in operation 24/7/365 to maintain one command and control point in the basin for all water management needs. The District offices have large truck-mounted generation equipment that can be rapidly deployed and placed into service should an extended power outage occur.

5-05.5. **Typical Equipment.** Because the Corps' network is based on the Ethernet protocol, many different devices are used to implement the physical layer interconnection between device and network. The typical RCC LAN consists of 10/100/1000 megabit Unshielded Twisted Pair (UTP) cabling to each device. The cabling is connected to Ethernet switches to provide device-to-device communication. The switches are connected to the corporate firewall appliances, which are then connected to the physical phone network by routers and a telephonic specialized device called a CSU/DSU. The CSU/DSU is the demarcation point of the network. From this point forward the network is treated the same as standard telephone circuits by the telephone vendors who are providing the dedicated service to the Corps.

5-06. **Communication with Projects.** The following paragraphs describe the communication between the RCC and the System projects.

5-06.1. **Regulating Office with Project Office.** The RCC is the regulating office of the System. Communication between the RCC and System project offices is normally through daily reservoir and power production orders. Daily reservoir regulation and power production orders are sent by email from the RCC to the System project offices. These orders usually specify the daily average individual System project releases to be made. Scheduled power generation and maximum allowable tolerances or limits are also included in the order. Maximum hourly generation is also included, recognizing current head conditions and number of available units. Any additional release requirements, such as minimums, steady releases, or release patterns for threatened and endangered species operations, are also outlined in the order. In some cases, when no changes in releases are likely to occur at a particular project, orders may be sent to cover a period of several days. Normally, project orders are sent on Friday to cover the weekend period of project regulation, but the weekend worker will change these if deemed appropriate. In the event of loss of network communications, orders can be given via telephone.

5-06.1.1. **Standing Orders.** Standing orders are regulation orders that provide general and continuing guidance to the System projects above and beyond that contained in the daily regulation orders. For example, standing orders may specify minimum permissible generation for varying durations of time from 1 to 12 hours, maximum release fluctuations, and similar regulating limitations. When appropriate, standing orders are referenced in the daily regulation orders to avoid repeating this guidance in each order.

5-06.1.2. **Critical Regulation Periods.** During critical reservoir regulation periods and to assure timely response, significant coordination is often conducted by telephone between the project office and the RCC. This direct contact assures that issues are completely coordinated and concerns by both offices are presented and considered before release decisions are made final by the RCC. The Chief of the RCC is generally available by cell phone as are several of the Project Operations Managers. The RCC weekend worker also carries a cell phone and has the responsibility of notifying the appropriate RCC staff so that proper coordination has occurred before significant changes are made to project releases.

5-06.2. **Between the Project Office and Others.** The Mainstem project office is generally responsible for local notification and for maintaining lists of those individuals who require notification under various project regulation changes. In addition, the project office is responsible for notifying the public using project recreation areas, campsites, and other facilities that could be affected by various project release changes. A more complete discussion of project notification procedures is located in the individual project manual and the specific Mainstem Operation and Maintenance Manual, Appendix E, Contingency Plan for Emergencies for each project.

5-07. **Project Reporting Instructions.** Hourly and daily hydrologic data from the System projects are automatically transferred from the PPCS computer at each project to the RCC MRADS and CWMS databases. In the event the automatic data collection and transfer is not working, projects are required to fax or email hourly and daily project powerplant data to the RCC. RCC staff will manually input the information into the database. Monthly summaries are faxed or emailed from the individual System project offices to the RCC and are used to verify daily data.

5-07.1. Project personnel are responsible for requesting any scheduled System hydropower unit outages in excess of 2 hours. The RCC, following coordination with Western and any other affected entities, approves the request. Out-of-service times are reported back to the RCC upon completion of outages. Forced outages are also reported with an estimated return time, if possible. Any forced or scheduled outages causing the project to miss scheduled water release targets must be immediately reported to the RCC. The Mainstem project staff has been advised to contact the RCC when any unusual occurrence happens at the specific project that may affect project operations. This includes any confusion over project release schedules that have been coordinated between Western and the RCC. It is imperative that the System projects release the amount of water ordered by the RCC within the authorized tolerances.

5-08. **Warnings.** The Operation and Maintenance Manual, Appendix E, Contingency Plan for Emergencies, contains information regarding responsibilities, authority, and notification lists in the event that any warnings need to be issued. In the case of an emergency, initial in-house notification is to the District Emergency Operations Center (EOC). The EOC will, in turn, notify the District Engineer, appropriate Division Chiefs in the District, the Public Affairs Office, the NWD EOC, and the appropriate State Civil Defense Directors. Appendix E contains State Civil Defense phone numbers, maps of immediate downstream notification areas, flood inundation maps, and other pertinent information.

5-08.1. Additionally, the RCC and System project staff keep tabulations of water intakes, marinas, and other river users that could be affected by discharge changes and/or changes in river conditions. Each District's Operations Division is responsible for maintaining a contact list of navigation interests. The RCC works closely with the NWS MBRFC staff, which has the responsibility for issuing flood forecasts and warnings to the public. The Corps provides System regulation information directly to the NWS, to allow it to fulfill its responsibility to notify the public of current and expected future river conditions. In addition, the Corps consults with the U.S. Coast Guard when the Missouri River must be closed for navigation for public safety and to preserve the integrity of the flood protection structures located adjacent to the Missouri River. The final responsibility for closing the river for any purpose rests with the U.S. Coast Guard.

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VI - HYDROLOGIC FORECASTS

6-01. **General.** The Corps has developed techniques and maintains staff at the RCC and at the Omaha and Kansas City Districts to conduct forecasting in support of the regulation of the System. Daily forecasting of river flow and stage is a challenging task due to the large size (529,000 square miles) of the Missouri River basin, along with the basin's hydrologic variability in climate. The Corps has developed runoff simulation and streamflow prediction models for only those areas of the Missouri River basin that have the most significant impact on the Corps' System regulation responsibilities. The System has the largest amount of storage of any reservoir system in North America. The regulation of the multipurpose System, therefore, requires the scheduling of releases and storages on the basis of both observed and forecasted hydrologic events throughout the basin. Releases to provide downstream flow support are based on providing flow levels at designated downstream locations. The accumulation and evacuation of storage for the authorized purpose of flood control is accomplished in a manner that will prevent, insofar as possible, flows exceeding those which will cause flood damage downstream. Flood risk must be considered at all times. During both normal and below-normal runoff conditions, releases through the powerplants are scheduled, to the extent reasonably possible, at the times and rates that will maximize revenue returned to the Federal Government. The release level and schedules are very dependent on current and anticipated hydro1ogic events. The most efficient use of water is always a goal, especially during the course of a hydrologic cycle when below-normal streamflow is occurring. Reliable forecasts of reservoir inflow and other hydrologic events that influence streamflow are critical to the efficient regulation of the System.

6-01.1. **Role of the Corps' Hydrologic Forecasting.** The System was designed for a long-term conservation regulation spanning many successive drought years. The flood control and drought conservation System regulation requires accurate, continual short-range and long-range runoff, streamflow, and river-stage forecasting. The runoff forecasts are used as input in System computer model simulations so that project release determinations can be optimized to achieve the regulation objectives stated in this manual. The RCC continuously monitors the weather conditions occurring throughout the Missouri River basin and the forecasts issued by the NWS. Whenever possible, the NWS weather and hydrologic forecasts are used. The RCC develops forecasts that are to meet the regulation objectives of regulating the System and tributary reservoirs. The RCC prepares long-range runoff forecasts based on estimates of rainfall and snowmelt runoff in the basin. In addition to long-range runoff forecasting, the RCC performs short-term streamflow and river-stage forecasting to assist in scheduling System and individual project releases.

6-01.2. **Role of Other Agencies in Hydrologic Forecasting.** Several other Federal agencies have hydrologic forecasting responsibilities in the Missouri River basin. These agencies include the National Weather Service (NWS), the U.S. Bureau of Reclamation (USBR) and the Natural Resource Conservation Service (NRCS). In addition there are other Federal, State, and local agencies involved in drought and emergency operations that are, at times, providing information that is of particular interest in regulating the System.

6-01.2.1. **Role of the NWS.** The NWS is responsible for all preparation and public dissemination of forecasts relating to precipitation, temperatures, and other meteorological elements related to weather and weather-related forecasting in the Missouri River basin. The

RCC uses the NWS as the sole source of information for weather forecasts. The meteorological forecasting provided by the NWS is considered critical to the Corps' water resources management mission. The use of precipitation forecasts and subsequent runoff directly relates to project release decisions. Equally important at certain times are temperature forecasts related to snowmelt and ice-jam formation. The NWS has a Weather Service Forecast Office (WSFO) at several locations in the Missouri River basin that can be contacted directly by RCC for weather-related information required to regulate the System. Currently the NWS has WSFOs at the following locations with web links that issue or disseminate local weather forecasts:

Montana	**North Dakota**	**South Dakota**	**Nebraska**	**Colorado**	**Iowa**	**Missouri**	**Kansas**
Great Falls	Bismarck	Aberdeen	Hastings	Denver/Boulder		Kansas City	Goodland
Glasgow		Rapid City	North Platte		Des Moines	Springfield	Topeka
Billings		Sioux Falls	Omaha	Grand Junction		St. Louis	Wichita
Missoula							

6-01.2.1.1. In addition, the NWS is the Federal agency responsible for the preparation and issuance of streamflow and river-stage forecasts for public dissemination. Because project regulation affects streamflows and vice versa, a close liaison is maintained between the Corps and the NWS. The Missouri Basin River Forecast Center (MBRFC), located at Prairie Hill, Missouri, prepares forecasts for specified locations along the streams throughout the Missouri River basin. The MBRFC is also responsible for the supervision and coordination of streamflow and river-stage forecasting services provided by the NWS WSFOs located throughout the Missouri River basin. The MBRFC routinely prepares and distributes 5-day streamflow and river-stage forecasts at key gaging stations along the Missouri River from Sioux City, Iowa, to the mouth. The MBRFC also provides the Corps' District offices with flow forecasts for selected locations upon request. On a weekly basis, the MBRFC prepares a monthly forecast of river stages for the Missouri River. While both the Corps and the NWS prepare short-range streamflow and river stage forecasts, they do so for different purposes. National Weather Service forecasts include runoff from potential future precipitation to ensure that people in flood prone areas get the maximum warning possible of potential flooding. In some cases, if potential precipitation does not occur, the NWS forecast may over estimate streamflow and river stage. The RCC forecasts only use runoff that is already being registered at the numerous stream gages in the basin, coupled with an estimate of the ungaged runoff in the numerous river reaches covered by the forecast. The RCC forecast may underestimate streamflow and river stage, if potential precipitation does actually occur. Use of both forecasts can provide a reasonable range of future streamflow and river stage. Since the NWS is responsible for public dissemination of weather-related forecasts, the Corps forecast is not made available to the public, but can be obtained by specific request.

6-01.2.1.2. The RCC obtains most of the NWS information it uses through either the NWS public network access now called Interactive Weather Information Network (IWIN) or by using LRGS data connections directly to the MBRFC. This approach has greatly improved the exchange of information via a standard format between the two agencies. In addition, this approach has resulted in a reduction in time spent on data collection exchanges between the two agencies. When questions arise concerning the validity of data or forecasts, a telephone call between respective forecasters normally resolves the issues. Inter-agency coordination meetings are conducted between offices as necessary. Other NWS systems can be used for obtaining

NWS products such as the Emergency Managers Weather Information Network (EMWIN) designated for use by State and Federal emergency managers.

6-01.2.1.3. The information provided by the MBRFC and the NWS WSFOs are used to the maximum extent possible for regulation of both System and tributary Corps reservoirs. These services are particularly useful when significant flood conditions are occurring or are imminent within the basin. The 24- and 48-hour Quantitative Precipitation Forecasts (QPFs) and severe storm forecasts are invaluable in providing guidance for System release determinations. During periods of significant basin flooding, the frequency of contacts between the RCC and MBRFC staff are increased to allow a complete interchange of available data upon which the most reliable forecasts and subsequent project regulation can be based. River-stage forecasts disseminated to the public are a NWS responsibility. The RCC conducts its own forecasting, when necessary, for System and tributary reservoir project release determinations. All Corps forecasts are not available to the general public but are shared with the NWS by allowing MBRFC staff to access these forecasts on the Corps' RCC website or by passing the information files directly to the NWS. The NWS also makes its internal forecasts available to the RCC as well as the Corps' District offices.

6-01.2.1.4. The MBRFC also issues long-term forecasts called Spring Snowmelt Outlooks. These forecasts are generally issued in February and March, with additional forecasts provided as conditions warrant. Numerical outlooks include two crest forecasts. The first crest forecast is based on a normal melt of existing snow cover. The second crest forecast is based on a normal melt of the snow cover plus normal precipitation through the melt period. Data used in preparing the Snowmelt Outlook include precipitation, snow depth, snow water content, soil moisture, ground frost, river stages and flows, and reservoir elevations. The data is disseminated by the MBRFC on Thursdays for inclusion by the WSFOs into their official public releases on Fridays.

6-01.2.2. **Role of the USBR.** Several offices in the Great Plains Region of the USBR make long-range volume hydrologic forecasts of runoff that are used for the regulation of their tributary reservoir projects in the upper Missouri River basin. The USBR offices in Billings, Montana; Casper, Wyoming; and Loveland, Colorado compute seasonal runoff forecasts for the basins in their respective states for the areas east of the Continental Divide in the Missouri River basin. The USBR uses snow water equivalent (SWE) and precipitation data collected by the NRCS and NWS. The USBR forecast models, which are based on multiple linear regressions, are developed in a similar manner to the NRCS and Corps models. The USBR models purposefully use different stations than those used by the NRCS and the Corps. The USBR generally uses average April through June precipitation in its models. Similar to the NRCS procedure, a forecaster has the option to subjectively alter the anticipated spring precipitation totals if conditions warrant adjusting for unusually wet or dry spring precipitation. The USBR compares and averages the monthly forecasts from its models with those from the NRCS and the Corps to develop a composite runoff forecast. The composite runoff forecast is then factored to minimum (80 percent), most probable (100 percent), and maximum (120 percent) confidence limits for seasonal project regulation forecasts. Similar to the NRCS, the USBR issues runoff forecast reports at the beginning of each month from January through June. Each State office computes a January 1, February 1, March 1, and April 1 forecast report that indicates most probable April through July inflows for all their major tributary basins east of the Continental

Divide. The May 1 and June 1 forecast reports indicate the same for the May through July and June and July time periods, respectively. If a tributary basin, such as the Wind/Bighorn River basins in Wyoming and Montana, crosses state lines, the two offices coordinate their forecast results before developing the seasonal project regulation forecasts. The USBR does not publish its seasonal runoff forecasts for public dissemination; however, they pass their results internally to the Corps and the NRCS via email or phone. These forecasts are furnished to the Corps District offices and the RCC. These forecasts are used by the District and RCC water managers in the regulation of tributary reservoir projects and in the integration of water supply forecasts for the Missouri River basin. The procedure of exchanging these runoff forecasts, beginning in January and extending through June of each year, has been long established in the Missouri River basin, dating back to the 1960's. The USBR is also the Federal agency responsible for providing the Corps with depletion estimates for the System that are used in long-term model simulations and to adjust current calendar year projections.

6-01.2.3. **Role of the NRCS.** The National Water and Climate Center (NWCC) NRCS office in Portland, Oregon is responsible for determining the seasonal and monthly runoff forecasts for the western United States, including the upper Missouri River basin. The NRCS field offices in Bozeman, Montana; Casper, Wyoming; and Denver, Colorado are responsible for the installation, maintenance, monitoring, and data collection of snow courses and SNOw TELemtry (SNOTEL) sites in the Missouri River basin as discussed in Chapter 5. Data for the Missouri River basin are collected at a master computer center in Portland and edited at the Bozeman and Denver offices. These offices, along with the Casper office, are also responsible for distributing the monthly forecasts and dealing directly with water users and interests. All snow courses and SNOTEL data are available on the World Wide Web. To access these data, any search engine can be used to search for "NRCS SNOTEL" or http://www.wcc.nrcs.usda.gov/, which is the Internet link to the NWCC home page. The NWCC NRCS hydrologists are responsible for issuing the seasonal and monthly forecasts, in cooperation with the NWS. The forecasts are computed at the first of each month from January through June. Updated forecasts are available at any time upon request. For the January 1, February 1, March 1, and April 1 forecasts, the NWCC hydrologists issue April through July and April through September inflows for all major tributary basins in the upper Missouri River watershed. On May 1, May through July and May through September seasonal streamflow forecasts are issued. On June 1, June through July and June through September seasonal streamflow forecasts are issued. The NRCS/NWS forecasts are available on the World Wide Web via the NWCC home page or by using any search engine to search for "NRCS Water Supply Outlook Report." The SWE and precipitation are the primary parameters used in the forecast models. To determine the pre-snowfall priming of the basin, otherwise referred to as antecedent soil moisture conditions, one of three methods may be used by the NRCS as a forecasting index. Soil moisture values are the best indicator of basin antecedent soil moisture conditions. If soil moisture values are not available for a basin, summer and early fall streamflow records from July through October are used. If neither soil moisture or streamflow records are available, summer and fall precipitation records are used. Generally, the NRCS uses data recorded as historic in their forecasts. For example, the April 1 forecast consists only of data observed and collected up to April 1. Occasionally, an NRCS hydrologist will observe that a certain spring period has the potential for unusually wet or dry conditions. In this case, the forecaster may subjectively adjust the forecast parameters to account for the unusual conditions. The NRCS forecast model results are developed using, as principal components, regression analysis. This type of analysis allows for the use of all closely located stations with closely related parameter values to be weighted and used in the forecast. The statistical regression models may be linear or nonlinear, depending on the relationship of the index parameters with the resulting streamflow. Preferably, the models are based on at least 30years of snow, precipitation and streamflow data, using the most current data available. Through streamflow analysis and historical observations, the NRCS hydrologists have found that, for basins that are primarily snowmelt driven, seasonal runoff volumes are most highly related with the yearly peak SWE recorded at the various SNOTEL sites and snow courses. For most basins in the upper Missouri River basin, the peak snowpack is observed about mid-April of each year. The NRCS, in addition to collecting and disseminating mountain snow survey data, issues forecasts of runoff volumes. The resulting publications are furnished directly to the RCC and the Omaha District water management office.

6-02. **Flood Forecasts.** As previously discussed, the NWS has the primary responsibility to issue flood forecasts to the public. The RCC uses these forecasts as much as possible for regulating the System. The Corps also provides a link to the NWS website so that the RCC and the public can obtain this vital information in a timely fashion.

6-02.1. When hydrologic conditions exist so that all or portions of the Missouri River basin are considered to be flooding, existing Corps streamflow and short and long-range forecasting runoff models, which are described later in this chapter, are run on a more frequent as-needed basis. This information is available to the entire Corps by providing these forecasts on the RCC internal website. The Missouri River basin is so large that the travel times are relatively long; however, many sub-basins respond quickly. Geographic diversity within such a large basin must be accounted for in any Missouri River basin-wide modeling approach. Travel time from the lowermost System project to the mouth is 10 days, as shown on Plate IV-1. Very high-runoff-producing areas exist along the Missouri River in the Big Sioux, Little Sioux, Platte, Kansas, Grand, and Ozark River basins. Those basins have much shorter travel times than the Missouri River and require continuous modeling to provide effective downstream flood control. The RCC remains cognizant of the issue of being able to quickly run forecasts during times of flooding or for other purposes. The RCC has integrated timeliness into each forecast simulation model so that the existing suite of models can perform effectively and efficiently both during normal and extreme time-constraint conditions. The currently used real-time streamflow model can be easily run in 30 minutes to provide the necessary information to determine System release scheduling. Most other models associated with runoff or streamflow forecasting for real-time regulation can perform in this same 30-minute timeframe. This short timeframe is significant. With such a large, multi-purpose System, many simulations must be run and evaluated to find the best approach to regulating the System under a range of forecasted hydrologic conditions. As greater detail is integrated into future streamflow and project simulation models to improve regulation, time of forecasting will become a more significant issue. The modeling approach is to divide the model area into smaller sub-basin areas. Only the sub-basins of the model that have significant real-time hydrologic change will be run to facilitate a quick model response time for improved decision-making. The entire basin is likely to be run in an automated fashion at certain time periods during the day to identify basins that need further evaluation. The timeliness of simulation models is tied in with RCC Continuity of Operations (COOP) plan for the water resources mission in NWD and with other prudent efforts to manage manpower and regulate the System effectively.

6-02.2. During the winter when ice jamming on the Missouri River is believed to exist, the Corps uses data from reconnaissance flights to determine the nature and extent of the ice jam to inform release decisions. This information is shared with other Federal agencies and the public through reports and photographs available on the RCC website. Data from plains snow surveys are used to anticipate high runoff and the potential for flooding in the basin. The plains snow surveys supplement existing data and are used by the RCC to improve the regulation of the System and by the Corps' Districts for emergency operations and effective tributary reservoir regulation.

6-02.3. The individual Mainstem projects have two zones designated for flood control storage, the Annual Flood Control and Multiple Use Zone and the Exclusive Flood Control Zone. The Annual Flood Control and Multiple Use-Zone is the range of elevations in which projects normally operate under a wide range of runoff conditions. The zone designated as Exclusive Flood Control Zone is vacated most of the time and encroached upon only during significant runoff events. When individual project or System storage is great enough to occupy this zone or the Corps' simulation models forecast the projects to rise to an elevation to enter this zone, the projects are considered to be in a flood control state. When the System is in a flood control state this results in an increased frequency of forecasts and an examination of additional alternatives to return the System to a normal condition. The flood control purpose is considered foremost in this situation because of the health and human safety issues, as well as the goal of minimizing loss of property. The RCC has had a great deal of experience in performing this type of System regulation.

6-02.3.1. Several Corps reports have been published that reflect past System regulation during historically significant System flood evacuation situations (e.g., 1975, 1978 and 1997) that can be referred to for guidance. Plate VI-1 is used for guidance by the RCC in determining the service level and subsequent System release for flood storage evacuation periods. Experience demonstrates that the sooner a significant flood event can be recognized and the appropriate pre-release of flows scheduled, an improvement in overall flood control can be achieved. This situation applies mostly to the accumulation of significant mountain or plains snowpack that normally melts well after the peaking date, allowing a considerable amount of time for pre-evacuation to resolve the problem early. System storage that has accumulated from significant rainfall events must be evacuated following the event and as downstream conditions permit to provide effective flood control. While each individual System project has flood control capability, the upper three projects contain 88 percent of the total storage and are most effective in providing flood control. Also critical is the quick response in scheduling System release changes. This makes the small amount of flood control storage available in Fort Randall important as it is used to absorb these changes for a short period of time. Thus, the System has an effective regulation plan to optimize downstream flood control, which is one of the authorized project purposes. Flood Control carries the highest priority during significant runoff events that pose a threat to human health and safety and, as indicated by Plate VI-2, has provided many benefits to the Nation. Still, the area below the System is not a flood free zone. The fact that a large part of the basin is not controlled by any reservoirs results in diminished flood control effectiveness especially in the farther downstream areas.

6-02.4. **Stage - Discharge Analyses.** Because most raw stream data are received in the form of stage information, transformation of these data as discharges is required for use in the forecasting models. Current rating curves are automatically obtained directly from the U.S. Geological Survey (USGS). Verification or adjustments are made as often as discharge measurements are received from the USGS. It is frequently necessary to reconcile initial estimates of discharges for streamflow stations along the Missouri River on the basis of comparison with flows at adjacent stations and reports from tributary stations. It should be noted that, while stage information is important, the System is regulated based, primarily, on discharge or flow with downstream flow targets for both flood control and other multi-purpose regulation. The determination of the correct discharge is, therefore, critical to consistent System regulation for the Missouri River.

6-02.4 1. Stage data are also required in the evaluation of System regulation effects on downstream flows. With the construction of the System, the occurrences of extreme flows (both large and small) have been reduced, particularly with large flood flows at locations that are now immediately below dams in the System. As a consequence, there is frequently no data available to define the current relationship between discharges that would have occurred without System regulation and corresponding stages. This problem is addressed in detail in the Corps' former Missouri River Division (MRD) Technical Study S-73, referred to in Paragraph 8-20. This report recommends the assumption that although the stage-discharge relationship may have changed considerably since streamflow data in the required range were last observed, the slope of the rating curve through the currently undefined portions of the curve can be expected to be similar to slopes that occurred in previous years when records were available. Simplified procedures for estimating incremental stages on the basis of incremental discharges in the extreme ranges of discharge are also presented in the report.

6-02.4.2. The effect of ice cover at downstream locations is another complicating stage-discharge factor experienced in the evaluation of System regulation impacts. Construction of the System projects has altered the formation of ice at locations that are now immediately downstream from those projects. The presence, or absence, of an ice cover has a material effect on the stage-discharge relationship. Technical Study S-73 also addresses this matter and presents suggested procedures for the consideration of these effects.

6-03. **Conservation Forecasts.** Most of the time the System is regulated for normal or below-normal runoff conditions; therefore, the majority of the forecasting and runoff modeling simulation is for conservation regulation decisions. The following paragraphs discuss the forecasting and associated System modeling simulations that the Corps has developed and performs on a routine basis to meet its water resources management mission. The Corps has integrated short- and long-range forecasting as well as and flood and drought System regulation into all real-time simulation models. The System is the largest reservoir system in North

America and, as such, requires significant forecasting and modeling simulation efforts to achieve the operational objectives stated in this Master Manual. The data collection system discussed in the previous chapter allows for the rapid collection and assimilation of large amounts of real-time data for input into these models. The automated input of verified hydrologic data into the forecasting and simulation models is significant in allowing a greater amount of time for the RCC staff to focus on alternative regulation to achieve maximum benefits for the System.

6-03.1. **Short-Range Water Supply Forecasts.** Due to the meteorological variability of conditions in the Missouri River basin and the critical need to adjust runoff based on precipitation that has occurred at unexpected rates, short-range water-supply forecasts are frequently developed. The need of these forecasts varies, based on reservoir status and time-of-year considerations. Spring fish spawn and plains and mountain snowmelt periods often require more frequent than once monthly water-supply forecasts as does the System regulation for endangered and threatened bird species during nesting season. Large deviations in precipitation, both above and below the System, often create a need to make a mid-month or more frequent adjustment in System regulation. These forecasts generally serve the purpose of improved intra-System regulation and provide more accurate reservoir elevation and project release criteria than would be available by waiting for monthly forecasts. These forecasts are normally provided as input to the Three-Week Forecast Simulation Model, which is discussed later in this chapter. The techniques used for short-range water supply forecasting are based primarily on current basin conditions integrated with forecasted runoff, which is based on engineering judgment and experience regarding the specific basin runoff responses. The techniques used are a refinement of the previously mentioned long-range water-supply forecasting techniques. This refinement could be expected to include a greater in-depth analysis of the effects of temperature variability on expected plains and mountain snowmelt runoff and basin-wide hydrologic conditions with regard to precipitation and associated runoff. The shorter time period also allows for an adjustment for the current month of runoff because weekly runoff volumes are determined and can be integrated into the current month's forecasted runoff as a refinement. The integration of NWS Quantitative Precipitation Forecasts (QPFs) into the current Corps' Hydrologic Modeling System (HMS) streamflow forecasting model is an example of an often utilized short-range forecasting technique to determine the proper System release to meet the flood control objectives stated in this manual.

6-03.2. **Short-Range Streamflow Forecasts.** Day-to-day scheduling of releases necessary for regulation of the System on an integrated basis requires the Corps to develop daily forecasts of flows at key locations throughout the basin. These forecasts are based on observed and anticipated precipitation, temperature, temperature-snowmelt relationships, rainfall-runoff relationships, observed streamflow in the main stem of the Missouri River and tributaries, antecedent precipitation, and other factors that often may be subject to only qualitative analysis.

6-03.2.1. **District Forecasts.** The Corps' Omaha and Kansas City District water management offices also have a forecast capability and responsibility for aiding in the regulation of the System. This includes the forecasting of expected crest flows from tributary streams during periods of flood runoff. Most of these forecasts also serve the Districts in their regulation of tributary reservoir projects or in their flood emergency activities. On a routine daily basis, through the Missouri River navigation season, the Kansas City District furnishes the RCC a 14-day flow forecast for the mouth of the Kansas River on a daily basis. The Kansas City District also forecasts 14-day flows from the Osage River basin during periods of high streamflow.

6-03.2.2. **Forecasted Ungaged Inflow (FUI) Streamflow Forecasting.** The scheduling of releases from the System throughout the open-water season (generally late March through mid-December) is based on maintaining prescribed flows at downstream control points on the Missouri River referred to as "target locations" at: Sioux City, Iowa; Omaha, Nebraska; Nebraska City, Nebraska; and Kansas City, Missouri. The proper scheduling of System releases require the development of accurate forecasts of the inflows originating between Gavins Point Dam, the lowermost System dam, and the downstream target locations. Because the RCC is responsible for release scheduling from the System, it also develops forecasts of reach inflow and forecasts of flow at the target locations as a basis for release scheduling. These forecasts are developed daily for the next 14 days in the future and are compared to daily forecasts developed by the MBRFC. If significant differences in forecasts occur, an attempt is made to reconcile the differences prior to release scheduling. The ultimate forecast and scheduling responsibility for the System is, however, with the RCC.

6-03.2.2.1. The reach inflow forecasts were originally based on hand computations. These computations involved a procedure of recording observed flows at gaging locations, routing these flows to a target location, and subtracting those combined flows from the actual flow at that target location to get an "ungaged" inflow for the river reach between target locations. This procedure is carried out for five previous days of actual data and then a 14-day forecast is made of both future tributary flows at known gaging points and for the ungaged inflow into the reach. These forecasts are combined to make a 14-day Missouri River forecast that includes anticipated System releases to meet downstream target location flows. The procedure came to be known as the Forecasting Unregulated Inflow (FUI) and, subsequently, the simulation model came to be known as the FUI model. The FUI model remains an integral part of the System real-time regulation. A typical example of the output for the tributary ungaged and combined flows and resultant stages for the combined flows is shown as Plates VI-3 to VI-6. The FUI model has been modified several times over the course of its life. It uses equations developed in the North Pacific Division Streamflow Synthesis and Reservoir Regulation (SSARR) model study that is documented in MRD-RCC Technical Study O-78 Computer Program for FUI. The FUI model allows a great deal of flexibility for the forecaster to input his experience into the final Missouri River forecast. The results computed by the FUI model are adjusted utilizing the judgment and experience of the forecaster who runs the model. The FUI model only takes into account water that has reached a gaging point used in the forecast. This limitation can be significant in determining the release schedule. A significant rain that has not reached a gaging location due to water travel time to that location is not automatically included in the FUI forecast. Rainfall can only be integrated into the forecast if the forecaster has the experience to include it by adding additional flow to that location to reflect the expected additional runoff. Also, the modeling of plains snowmelt can only be accounted for as it shows up at the gaging stations used in the model. The Corps has successfully used the FUI model for over 30 years as the primary modeling tool for determining System releases. The forecasters have used their experience plus near-real-time gaging and weather information on hydrologic basin conditions as they have made FUI forecast runs. National Oceanic and Atmospheric Administration (NOAA) Multi-sensor

Precipitation Estimates (MPE) radar data and other real-time weather data are available to use as input to the daily FUI forecasts. A detailed forecast for the reach from Gavins Point Dam to the mouth of the Missouri River can be run in a 20 to 30-minute time period. This relatively short time period allows for the updating and running of additional forecasts as river and weather changes become available.

6-03.2.3. **Hydrologic Modeling System (HMS) Streamflow Forecasting.** Future streamflow modeling efforts for the System are being developed using the Corps' HMS. This is the latest modeling tool available from the Corps' HEC, and it will significantly improve two aspects of modeling of the System. First, the HMS model will use more gaging stations and, most importantly, MPE radar reflectivity data in a real-time mode. This will allow the Corps staff to use MPE radar data as input to the HMS model in real-time, which will result in a streamflow prediction model that uses distributed precipitation with a much faster watershed response time than FUI. This reduced response time is considered significant in operating for both flood control and other multi-purpose regulation using the downstream target approach. In the near term, the RCC envisions that a two-step approach will be implemented to predict streamflow. First, the MPE data will be integrated using the HMS, and then the FUI model would be used to route flows downstream. This is necessary until the new models can be correctly calibrated and verified and experience can be gained in their use. Eventually, the whole lower Missouri River basin will be modeled using the HMS model to predict runoff. It is also thought that a significant portion of the Missouri River will be modeled in using the HEC River Analysis System (RAS) routing model to allow prediction of water surface profiles for the Missouri River urban areas below Gavins Point Dam. This would also allow development of flood inundation data for forecasted damage and damage-reduction information associated with flood control regulation. This information will also be used to evaluate the effects on habitat for riverine fish and endangered and threatened species along portions of the Missouri River. During drought periods, releases are set to the absolute minimum that will meet downstream targets to conserve as much water as possible in the System. The streamflow forecasting models discussed above, the FUI and HMS models, have been developed and tailored to support regulation to meet the regulation objectives for the System.

6-03.2.3.1. The rainfall distribution data provided in the MPE radar data is much more reliable for both intensity and coverage compared to rainfall data obtained from single point sources as was the case in the past. The improved capability to predict watershed response is enhanced by use of the MPE radar data. The MPE radar data is collected continuously by the NWS and summed in hourly rainfall totals by local NWS radars for the entire Missouri River basin. This information is corrected and/or adjusted using observer and remote-sensing rain gages, sometimes referred to as ground-truthing, by NWS staff and provided directly to the Corps. Use of the MPE radar data has significantly improved the RCC's capability to develop reliable real-time forecasting models.

6-03.3. **Short-Range System Simulation Models.** The following paragraphs discuss the short-range system simulation models. In general, the short-range models are used both to update the long-range System models and to make daily and weekly release changes to the System. These adjustments to the release schedule generally are required to improve the storage balance between Mainstem projects or to more quickly respond to better meet the fish and wildlife enhancement operational objective with regard to fish spawning or threatened and endangered species' nesting.

6-03.3.1. **Three-Week Forecast System Model Simulation.** The Three-Week Forecast is developed using a short-range System regulation model of the same name. The model uses daily input data that is updated by the RCC on Wednesday of each week or more frequently if needed. The Three-Week Forecast presents forecasted inflows, outflows, reservoir pool elevations, and hydropower generation for a 3 to 5-week period for each of the System projects. The study serves as a guide for short-term System modifications and is used to make regulation adjustments within the range normally determined by the long-term monthly studies.

6-03.3.1.1. The power generation estimate from the Three-Week Simulation for the System is provided to Western for use in its planning and marketing. Property owners, fishermen, recreation enthusiasts, and developers use the daily pool and release forecasts from the Three-Week Forecast for a variety of purposes. Summarized data from this forecast, along with a weekly narrative on System regulation, are furnished to the System projects each week. An updated version of the Three-Week Forecast, complete with graphs and narrative, is available to the public on the RCC website.

6-03.3.1.2. The Three-Week Forecast Simulation Model is also a useful tool for comparing various regulation scenarios for specific interest requests or other requested regulation changes of short duration. Alternative current and future conditions can be simulated and individual alternative simulations can be saved and recalled at a later date for graphical or tabular comparison.

6-03.3.2. **Unsteady Flow Through a Full Network (UNET) of Open Channels Model Simulation.** The UNET model is a one-dimensional unsteady flow computer model that simulates flow in a complex network of open channels. Fluctuations of downstream river stages with varying project releases are simulated with UNET by routing flows though river reach cross sections below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams for the purpose of determining the optimum System regulation for endangered and threatened species. The other two System projects, Oahe and Big Bend, have very short river reaches below their dams to model and are signficiantly affected by downstream reservoir levels.

6-03.3.2.1. Project releases define upstream UNET boundary conditions while downstream boundary conditions are historic or forecasted reservoir elevations at the downstream Corps project (excluding Gavins Point). A stage hydrograph below the Sioux City gage serves as the downstream boundary for the Gavins Point UNET simulation model. Tributary hydrographs are input at the cross section nearest the confluence of the Missouri River and each applicable tributary. Model calibration was focused on duplicating historic water surface profiles surveyed over a wide range of steady-state releases. Input and output files are developed in an HEC-Data Storage System (DSS) format, with displays data in both a tabular and graphical format.

6-03.3.2.2. The UNET simulation models were developed for, and are used to, analyze System project release peaking patterns. The UNET models for the individual projects are used to determine the effects that these release patterns have on downstream Missouri River levels and the effects these stage changes have on interior least tern and piping plover nesting habitat below the Mainstem projects. The UNET modeling has also been invaluable for forecasting stage fluctuations at critical downstream locations during periods of high tributary flow to avoid flooding nests and chicks. The UNET simulation model is run to inform the decision-making process as releases are increased to compensate for receding tributary flows. In addition, the UNET simulation model is occasionally used for estimating stages for contractors and other specific interests at downstream locations for various project release simulations.

6-04. **Long-Range Forecasts.** Long-range forecasting has always been one of the tools that are necessary to accomplish the Corps' water management mission in the Missouri River basin. The System was constructed to serve the Congressionally authorized project purposes during an extended period of drought, like the 12-year drought of the 1930's and early 1940's. The techniques used today were developed years ago but have been updated as improvements have occurred in computing capability and long-range forecasting techniques. In addition, many more years of System regulation experience have occurred since the System filled and became fully operational in 1967, and this experience has improved the capability to develop reliable long-range forecasts. The following paragraphs describe the current long-range forecasts that are developed by the RCC to inform decisions on System regulation.

6-04.1. **Long-Range Runoff Forecasting.** Normally a significant volume of inflow into the System originates as snow. Two factors enhance the ability to conduct reliable long-range forecasts for the System. First, a considerably long period occurs between the time that the majority of the snow falls and the time it melts to produce runoff. Second, a greater percentage of the snowmelt produces runoff that eventually flows into the Missouri River because relatively little runoff is likely to infiltrate into the ground, which is generally frozen in the winter and early spring months. The accuracy of long-range forecasts is somewhat limited by abnormal hydrologic events. Generally, numerous and complex variables influence the volume of streamflow from a drainage area during any specific time period. This makes long-range forecasting difficult and decreases the accuracy. As has been the case since the System first filled in 1967, a continuous effort to improve long-range runoff forecasting will be pursued as computational capabilities and forecasting techniques continue to improve.

6-04.1.1. **Calendar Year Runoff Forecast.** The long-range runoff forecast is presented as the Calendar Year Runoff Forecast. This forecast is developed shortly after the beginning of each calendar year and is updated at the beginning of each month to show the actual runoff for historic months of that year and the updated forecast for the remaining months of the year. This forecast presents monthly inflows MAF from five incremental drainage areas, as defined by the individual System projects, plus the incremental drainage area between Gavins Point Dam and Sioux City. Due to their close proximity, the Big Bend and Fort Randall drainage areas are combined. Plate VI-7 provides an example of the Calendar Year Runoff Forecast report format. Summations are provided for the total Missouri River reach above Gavins Point Dam and for the total Missouri River reach above Sioux City. This runoff forecast is adjusted as data becomes available to a common level of basin development, which has been selected as 1949. The 1949 development year is the most recent year that is not affected, to a great extent, by water resource development in the Missouri River basin. By adjusting runoffs to this common level of development, a consistent historical runoff data set has been created by river reach. The historic runoff data set is used to determine the effects of regulation changes by the various System simulation models. This data set can be adjusted for use in various studies to another level of basin development by applying correction factors to get to the level of development desired.

6-04.1.1.1. Procedures for the development of the CalendarYear Runoff Forecast were originally detailed in the MRD-RCC Technical Study MH-73, "Missouri River Main Stem Reservoir System, Long Range Runoff Forecasts," dated March 1973. This technical study was updated in December 1979 to reflect the two very large runoff seasons of 1975 and 1978 as MRD-RCC Technical Report D-79. These studies were updated in 1996 to reflect the addition of 17 years of additional snow data and the additional 17 years of long-term forecasting experience. This study is referred to as MRD-RCC Technical Study D-96. This study now serves as the basis for the Calendar Year Runoff Forecast, although the previous studies have also been integrated into the latest study. This long-range forecast forms the principal basis of the "Water Supply Outlook," which is developed monthly by the RCC from January through June and furnished via the World Wide Web to the Chief of Engineers and other interested parties. It is also used for the projections of System long-term forecast updates that are made monthly and extend through the remainder of the current calendar year plus through February of the following year.

6-04.1.1.2. More reliable seasonal forecast procedures would be very valuable in meeting the need for advance planning related to System regulation. At the present time, numerous forecasts are made for runoff anticipated from the snow that has accumulated in the mountainous areas of the basin by several agencies. Snow accumulated over the plains area is frequently a major contributor to System inflows. To date, few reliable procedures for making quantitative volume runoff forecasts for plains snowmelt are available. The RCC is working with the Corps' CRREL, which is located in Hanover, New Hampshire, to improve existing plains snowmelt techniques and to lay the framework for the integration of future satellite remote sensing capabilities. Grid-cell-based accumulation and runoff models for plains snowmelt have been developed for the Missouri River basin that drains into the System. Future NOAA satellite-based remote sensing capability will provide a daily measure of SWE for the entire Missouri River basin. Improved plains snowmelt-runoff estimation procedures are being actively pursued. The Districts develop seasonal flow forecasts for tributary areas as an aid to tributary reservoir regulation and as a basis for the overall basin-wide evaluation of runoff potential for emergency operations.

6-04.1.2. **Annual Operating Plan (AOP) and 5-Year Extension Runoff Forecasts.** In addition to the Calendar Year Runoff Forecast, the Corps has developed a statistical technique to compute an estimate of future basin runoff using the historic annual runoff data set. This estimate allows the RCC staff to complete simulations for periods longer than just the current year. The historic annual runoff data set consists of the observed runoff for each drainage area by month beginning in 1898 through the present. This data set is then organized into a set of runoff volumes that are based on actual specific years reflected in the historical data and referred to as Upper Decile, Upper Quartile, Median, Lower Quartile and Lower Decile. To accomplish this, the years are organized from highest to lowest according to their total annual runoff volumes above Sioux City using the runoff adjusted to the 1949 level of depletions. Median runoff is developed by selecting the volume of runoff associated with an actual historic year that has 50 percent of the years having higher annual runoff volumes and 50 percent of the years having lower runoff volumes. The Upper Decile volume is selected by finding the specific year in the historic data set that is exceeded in only 10 percent of the years. Lower Decile volume is selected by finding the specific year that is represented in the historic data set that represents only 10 percent of the years having a lower volume. The same process is repeated for Upper Quartile (25 percent greater) and Lower Quartile (25 percent lower) volumes. Each of these five annual volumes is then analyzed to determine the most appropriate monthly runoff distribution by reach. This involves examining the monthly historical runoffs that have occurred in the basin and adjusting the volumes for each of these five years to get their expected monthly distributions. This technique is described in RCC Technical Report entitled, "Runoff Volumes for Annual Operating Plan Study O-98." These runoff scenarios are then used for System model simulations that, in some cases, extend as many as five additional years into the future. This allows the Corps to include data in the AOP that allows the public to look at System simulations that reflect 80 percent (between Upper and Lower Decile) of the historic runoff volumes. This provides information for planning purposes on a range of future reservoir levels and release rates. The AOP forecasts also include forecasts of water supply that will be available for the period from August 1 to March 1 of the following year. During this period of time, flows are more predictable; therefore, they can be forecast with reasonable reliability. A basic forecast of monthly inflows is made for each of the System reservoir reaches above Sioux City, which is paired with the Median forecast. Following March 1, inflows depend on many factors that cannot be forecasted at the time of preparation of the AOP. Therefore, for the AOP studies for future regulation beyond March 1 of the following year use a wide range of potential water supply scenarios, based on a statistical analysis of reach inflows during the period of record beginning in 1898. For the Upper Decile and Quartile forecasts, 120 percent of the basic forecast for August 1 through March 1 is used. Similarly, 80 percent of the basic forecast is used for the Lower Decile and Quartile forecasts. The AOP studies for future regulation, therefore, use a wide range of potential water supply.

6-04.1.3. **Long-Range System Model Simulation - Monthly Study.** The Long-Range System (LRS) regulation simulation model is routinely run on the first of each month, and if significant changes occur during the current month, it may be run more frequently. Gavins Point releases to support navigation flows are determined by March 15 and July 1 System storage checks. Depending on water supply, winter releases are set by either a September 1 storage check, a minimum rate based on experience to avoid low stages downstream, or at rates as high as 24,000 cfs if evacuation of excess water in System storage continues through the winter. Intra-System releases from the other five projects are simulated to determine optimum movement of storage through the System reservoirs to satisfy authorized purposes.

6-04.1.3.1. The USBR provides streamflow depletion forecasts by river reach (excluding Big Bend) above Sioux City by August 1 of each year for use in the AOP studies described in Paragraph 6-04.1.4 in this Master Manual. These same depletion estimates are used in the LRS monthly regulation model. New Calendar Year Runoff Forecasts are prepared on the first of each month and are input to the model. Depletions are either subtracted or added to the inflows, depending on whether water is removed or returned. Reservoir evaporation is computed and subtracted from the inflows. There is no routing of project releases due to the monthly time step.

6-04.1.3.2. Western uses forecasted monthly hydropower generation for marketing purposes. The LRS model monthly forecasts are also used as a guide in scheduling unit maintenance and inspection outages and for long-term outages required for major rehabilitation of the power facilities. Property owners, fishermen, recreationists, and developers use reservoir level and project release forecasts for a variety of purposes. An abbreviated version of the monthly study is available to the public on the RCC website.

6-04.1.4. **LRS Model Simulation - AOP Study.** An AOP Study for regulation of the System has been prepared by the RCC each year since System regulation began in 1953. The AOP presents estimates of future inflows under several water supply conditions, plans for future System regulation, and expected results. The results of the AOP studies form the basis for the planned regulation of the System projects from August 1 of the current year until March 1st – two years into the future. The AOP serves as a basis for advanced coordination with the Federal and State agencies, the American Indian Tribes, the general public, and specific interests that are concerned with the regulation of the System. The AOP and monthly studies use the same computer model to simulate long-term System regulation. The AOP studies conducted to determine the expected results are based on a wide range of forecasted runoff conditions that have been previously discussed in Paragraph 6-04.2. of this manual. Expected reservoir releases, storages, elevations, evaporation, and power generation and capability are determined for each month for each water supply condition. Studies are made for the Median, Upper Decile, Upper Quartile, Median, Lower Quartile, and Lower Decile water supply forecasts. Selection of the monthly and annual runoff values considered appropriate for each of these water supply conditions is discussed in more detail in MRD-RCC Technical Report A-75. Expected System reservoir releases, storages, elevations, evaporation, and power generation and capability are determined for each month for each water supply condition. The studies for the year ahead are illustrative of possible System regulation that could occur rather than predictive of regulation actually anticipated.

6-04.1.4.1. Annual Operating Plan studies are prepared on August 1, based on August 1 initial conditions (starting storages, runoff forecast, and depletions) and the five runoff scenarios. These studies are finalized after input is received from the Missouri River Natural Resources Committee (MRNRC) and from State agencies and the public who attend the fall AOP Public Meetings or who provide written comments. When possible, the studies are revised to reflect these recommendations and are published in the final AOP. Five-year extensions to the Median, Lower Quartile and Lower Decile simulations are published in the final AOP. Western uses the energy forecasts shown in the extensions as a guide in making long-term energy commitments. Lower Quartile and Lower Decile extensions indicate the effects of continued below-normal runoff on project releases and pool elevations. Regulation of the System is also reviewed as part of the AOP for the calendar year and presented in a separate report entitled, "Mainstem Reservoirs Summary of Actual Operations." Subjects covered in this review are actual water supply available; System regulation, including individual System project releases and storages; special regulation; and summary of the regulation results in terms of effects on Congressionally authorized purposes. This report also contains the System endangered and threatened species regulation and results.

6-04.1.5. **Special, Unscheduled Regulation Studies.** Special purpose studies are often made in response to inquiries from higher authority, from Congress, and from other Federal and State agencies. Additionally, throughout the year as forecasts of future runoff become available or are revised, studies are made to serve as a supplement to, and updating of, the AOP. Generally, these additional AOP-type studies are made on a monthly basis if inflow conditions depart significantly from previous studies.

6-04.1.6. **Daily Routing Model (DRM) Simulations - Master Manual Update.** The DRM was developed during the 1990's as part of the Master Manual Review and Update Study to simulate and evaluate alternative System regulation for all authorized purposes under a widely varying long-term hydrologic record. Prior to that time, the monthly version of the DRM, or the Long Range Study model, was used to review proposed changes in System regulation. The DRM uses daily input data that provides a greater level of precision that is necessary to evaluate the effects of different proposed System regulation alternatives with regard to flood control, interior drainage, groundwater, riverine fish requirements (spawning cue and shallow water habitat) on the downstream from the System, and power (capacity and energy generation) at risk in the basin.

6-04.1.6.1. The DRM is a water accounting model that consists of 20 nodes, including the six System dams and 14 gaging stations. In the DRM, each of the six System reservoirs was modeled, whereas the LRS model assumed constant elevations at the two smaller reservoirs, Lake Sharpe and Lewis and Clark Lake. The DRM provides output at four locations (nodes) along river reaches between System projects: Wolf Point and Culbertson, Montana, and Williston and Bismarck, North Dakota; and ten locations along river reaches below the System: Sioux City, Iowa; Omaha, Nebraska City and Rulo, Nebraska; St. Joseph, Kansas City, Waverly, Boonville, and Hermann, Missouri on the Missouri River and St. Louis, Missouri on the Mississippi River.

6-04.1.6.2. The historic data set used for the DRM was developed from the RCC MRADS Oracle database, USGS gaging records, and from the LRS model database for depletions and reservoir evaporations prior to 1967. Daily records are available for the six System dams since their respective dates of closure, and daily flow data is available for the majority of gaging stations since 1930. Prior to 1930, there is general lack of daily records in the basin. Representative daily data was constructed to cover the period from 1898 to 1929 because of the significance and statistical importance of the drought of the 1930's in System regulation. As a result, there are 100 years of data used in the historic data set, which extends from 1898 through 1997. The data are organized in yearly files that contain daily data for each of the dams and gage locations.

6-04.1.6.3. The DRM uses two sets of input data and a number of smaller data files. The first set of input data consists of historic reach inflows and streamflow depletions. There is also an option to include forecasted monthly runoff. The second data set contains various constants and variable parameters that define regulation decisions and operational limits for a particular simulation. These include downstream flow targets, reservoir characteristics, regulation levels, regulation guide curves, power generation criteria, navigation guide criteria, and fish and wildlife criteria, including endangered and threatened species.

6-04.1.6.4. The DRM provides options for creating a number of output files showing various parameters for each node in the model and for the System, using either daily or monthly data for the period of study. The DRM also has associated graphics programs developed to view daily or monthly data for a variety of parameters and time periods to evaluate the effects of proposed alternatives. The DRM model can be used as a real-time regulation model. As with all models, the DRM will eventually be modified or replaced by an improved regulation-modeling tool.

6-04.1.7. **Natural, or Unregulated Flows (Holdouts).** Analyses are conducted to reconstitute flows without the System for the purpose of determining reservoir regulation effects of System and tributary reservoirs regulation. These effects are computed using a program called Mainstem and Tributary Reservoir unregulated flows, or holdouts. A simple lag-average procedure is used for the routing of reservoir effects downstream to selected Missouri River main stem locations at which reconstituted, or natural, flows are desired. Coefficients considered to be applicable, based on examination of flood events, are presented in MRD Technical Study S-73, "Upper Missouri River, Unregulated Flow Development." The reach locations are chosen based on length of river, taking into account streamflow attenuation, and are basically the same as those presented in the stage-damage curve reduction discussion in Paragraph 4-05.13 and Plates IV-2 through IV-13. The natural flows are used to compute annual flood damages prevented and to explain stage reductions resulting from regulation of the System to the public and other interested parties. There has been interest in recent years to make this a real-time tool, and this will be possible when the CWMS software is implemented.

6-04.1.8. **System Water-Quality Modeling.** The RCC, cooperating with the Omaha District Water Control and Water Quality Section, is developing a CE-QUAL-W2 water quality model for the larger System reservoirs. CE-QUAL-W2 is a two-dimensional, unsteady flow hydrodynamic and water-quality model developed and supported by the Corps' Engineering Research and Development Center (ERDC) located in Vicksburg, Mississippi. This model has been widely applied to stratified surface water systems such as lakes, reservoirs, rivers, and estuaries. This water quality model computes water levels, horizontal and vertical velocities, temperatures, and 21 other water quality parameters such as dissolved oxygen, nutrients, organic matter, algae, pH, carbonate cycle, bacteria, and dissolved and suspended solids. The preliminary results of using a CE-QUAL-W2 model as an additional reservoir regulation tool to evaluate water quality considerations has been promising. The model has shown that it could facilitate evaluating the effects on water quality of changes in reservoir regulation and other adaptive management actions. The following are observations noted, based on preliminary CE-QUAL_W2 model results. This model can quickly demonstrate or clarify how, by changing regulation of projects' storage levels, release rates, and timing, the reservoir and downstream river water quality parameters vary. Certain real-time water quality conditions can be predicted at System projects, using real-time flows and meteorological conditions. The model can also forecast future water quality conditions based on projected future reservoir regulation scenarios using either synthetic or historic inflows and meteorological data. Finally, the model can be used simulate water quality conditions due to System regulation changes due to changes in runoff scenarios or structural changes such as intake modifications. The aspects of System regulation evaluated could include distribution of storage volumes between several reservoirs and drawing water from different elevations in the reservoir. The CE-QUAL-W2 model could then be used to measure the impact on water quality in the reservoirs by evaluating alternative types of regulation. This model could also aid in water quality data collection by identifying expected critical or sensitive water quality situations in advance that would require more extensive water quality monitoring. The model could be useful in focusing data collection on that part of the reservoir for those water quality parameters that would provide the desired information. This is especially significant on the upper three System reservoirs that are so large.

6-05. **Drought Forecast Simulation.** Over the regulation history of the System, various products have been used to detect the extent and severity of basin drought conditions. Since the System was developed to deal with consecutive years of long-term drought, no specific drought forecast has been developed. The System was designed, and the new water control plan was selected, to serve authorized purposes during a 12-year drought such as that experienced during the 1930's. The consideration of drought for short and long-term forecasting and System regulation is part of the normal forecasting process used by the RCC. Currently, a product called the Drought Monitor, which has replaced the Palmer Index as a drought reference, is used to generally determine the extent and severity of drought in the Missouri River basin. The runoff forecasts developed for both short and long-range time periods reflect drought conditions when appropriate. The normal banding of runoff to address 80 percent of the expected runoff conditions covers significant drought and provides a reliable tool to assess the effects of drought and the anticipated System regulation. The period of record contains four significant droughts, including the two droughts contained in the record since the System first filled in 1967. This provides a good data set to guide real-time regulation during significant drought periods. As various new techniques become available and improvements are made to existing drought indicators, they will be integrated into the System runoff forecasts. Improved forecasting and the development of simulation tools will be an ongoing process in which better techniques will become available and used in all forecasting areas. The primary data source used to demonstrate System regulation during drought is the Corps' statistical runoff volumes representing Lower Quartile and Lower Decile runoffs. This data set is used as input for the System LRS simulation model to show long-term effects of System regulation under very low basin runoff. This is particularly true for AOP period simulations using the LRS model that includes the 5-year extensions of Lower Quartile and Lower Decile runoffs.

VII – CURRENT WATER CONTROL PLAN FOR THE SYSTEM

7-01. **System Water Control Plan.** In enacting the 1944 Flood Control Act, Congress adopted the recommendations contained in the underlying Pick-Sloan documents. These documents identified flood control, navigation, irrigation, hydropower, water supply, water quality, recreation, and fish and wildlife as project purposes and also provided for the protection of beneficial consumptive uses in the upper basin. Congress did not assign a priority to these purposes. Instead, it was contemplated that the Corps, in consultation with affected interests and other agencies, would balance these functions in order to obtain the optimum development and utilization of the water resources of the Missouri River basin to best serve the needs of the people. The Missouri River Master Water Control Manual Review and Update Study (Master Manual Study) was conducted without bias toward any project purpose. Therefore, no priority was assumed for any economic use or environmental resource in the conduct of that study. The result of the Master Manual Study has been the identification of the current Missouri River Mainstem Reservoir System Water Control Plan (CWCP) that is described in detail in this chapter. This chapter sets forth the detailed provisions of the selected water control plan for the System. In the event of any inconsistencies between the provisions of this Chapter VII and any other provisions of this Master Manual, this Chapter VII shall take precedence.

7-01.1. The CWCP presented in this Master Manual was developed with four objectives in mind: first, to serve the contemporary needs of the basin and the Nation; second, to serve the Congressionally authorized project purposes; third to comply with other applicable statutory and regulatory requirements including environmental laws such as the Endangered Species Act (ESA); and fourth, to fulfill the Corps' responsibilities to Federally recognized Tribes. The application of the water control plan presented in this Master Manual is designed to meet certain operational objectives during drought, flood and normal runoff periods. Many assumptions were necessary in order to effectively analyze the effects of the application of this water control plan. If these assumptions are no longer valid in the future due to changed conditions or unforeseen circumstances, the Corps will adjust the water control plan presented in this Master Manual in an attempt to continue to meet the intended operational objectives. The following paragraphs describe how the water control plan will meet the operational objectives of this Master Manual for each of the Congressionally authorized project purposes. The CWCP described in this chapter meets the objective of serving all of the Congressionally authorized project purposes of the System while considering the other short and long-term factors affecting the regulation of the System. Optimizing service to all of the Congressionally authorized purposes may be impossible at times because of conflicts between the individual authorized purposes. Therefore, optimization of benefits to individual project purposes will be pursued to the extent reasonably possible.

7-01.2. **Regulation Objectives.** As an introduction to a discussion on regulation objectives of the CWCP, the need to conform to certain basic water-in-storage provisions and basic principles of reservoir regulation of the System should be recognized, except in unusual circumstances. The Permanent Pool Zones of the System reservoirs are intended to remain permanently filled with water. This will ensure the maintenance of minimum power heads, minimum irrigation diversion levels, and minimum reservoir elevations for the water supply, recreation, and fish and wildlife purposes. Similarly, the Exclusive Flood Control Zones at the projects are provided for the regulation of the largest of floods. They will be reserved exclusively for this purpose and generally be empty. The two other storage zones that are intermediate to the Permanent Pool and the Exclusive Flood Control Zones provide active storage for project purposes. These storage zones are called the Annual Flood Control and Multiple Use and the Carryover Multiple Use Zones. These also provide storage space for the control of moderate floods and, when combined with the upper Exclusive Flood Control Zone, provide control of major floods.

7-02. **System Regulation Summary.** System regulation is, in many ways, a repetitive annual cycle. The melting of plains and mountain snow produces most of the year's runoff into the System, and spring and summer rains supplement that runoff. After reaching a peak, usually during July, the amount of water stored in the System declines until late in the winter when the cycle begins anew. A similar pattern may be found in rates of releases from the System, with the higher levels of flow from mid-March to late November, followed by low rates of winter discharge from late November until mid-March, after which the cycle repeats. The Water Control Calendar of Events, shown on Plate VII-1, presents the time sequence of many of these cyclic events.

7-02.1. Variations in runoff into the System necessitates the varied regulation plans to accommodate the multipurpose regulation objectives. The two primary high-risk flood seasons are the plains snowmelt and rainfall season extending from late February through April and the mountain snowmelt and rainfall period extending from May through July. Also, the winter ice-jam flood period extends from mid-December through February. The highest average power generation period extends from mid-April to mid-October, with high peaking loads during the winter heating season (mid-December to mid-February) and the summer air conditioning season (mid-June to mid-August). The power needs during the winter are supplied primarily with Fort Peck Dam and Garrison Dam releases and the peaking capacity of Oahe and Big Bend. During the spring and summer period, releases are normally geared to navigation and flood control requirements, and primary power loads are supplied using the four lower dams. During the fall when power needs diminish, Fort Randall is normally drawn down to permit generation during the winter period when Oahe and Big Bend peaking-power releases refill the reservoir. The major maintenance periods for the System hydropower facilities extend from March through mid-May and September through November, which normally are the lower demand and off-peak energy periods. The exception is Gavins Point, where maintenance is performed after the end of the navigation season because all three power units are normally required to provide for navigation and other downstream flow support needs. The normal 8-month navigation season extends from April 1 through December 1, during which time System releases are increased to meet downstream target flows in combination with downstream tributary inflows. Winter releases after the close of the navigation season are much lower and vary depending on the need to conserve or evacuate System storage volumes, downstream ice conditions permitting. Minimum release restrictions and pool fluctuations for fish spawning management generally occur from April 1 through July. Endangered species nesting occurs from early May through mid-August. Other factors may vary widely from year to year, such as the amount of water-in-storage and the magnitude and distribution of inflow received during the coming year. All of these factors will affect the timing and magnitude of project releases. The gain or loss in the water stored at each reservoir must also be considered in scheduling the amount of water transferred between reservoirs to achieve the desired storage levels and to generate power.

These items are continually reviewed as they occur and are appraised with respect to the expected range of regulation. The following paragraphs discuss the regulation of the individual System dams to accomplish the System reservoir regulation objectives.

7-02.2. **Fort Peck – Fort Peck Lake.** Fort Peck's primary water management functions are (1) to capture the mountain and the plains snowmelt and localized rainfall runoffs from the large drainage area above Fort Peck Dam, which are then metered out at controlled release rates to meet the System's authorized purposes while reducing flood damages in the Fort Peck Dam to Lake Sakakawea reach; (2) to serve as a secondary storage location for water accumulated in the System from reduced System releases due to major downstream flood control regulation, thus helping to alleviate large reservoir level increases in Garrison, Oahe, and Fort Randall; and (3) to provide the extra water needed to meet all of the System's Congressionally authorized project purposes that draft storage during low-water years.

7-02.3. **Garrison Dam – Lake Sakakawea.** Garrison, the largest Corps storage reservoir, is another key player in the regulation of the System. Its primary water management functions are (1) to capture the snowmelt runoff and localized rainfall runoffs from the large drainage area between Fort Peck and Garrison Dams that are then metered out at controlled release rates to meet System requirements, while reducing flood damages in the Garrison Dam to Lake Oahe reach, particularly the urban Bismarck area; (2) to serve as a secondary storage location for water accumulated in the System from reduced System releases due to major downstream flood control regulation, thus helping to alleviate large reservoir level increases in Oahe and Fort Randall; and (3) to provide the extra water needed to meet all of the System's Congressionally authorized project purposes that draft storage during low-water years.

7-02.4. **Oahe Dam – Lake Oahe.** Oahe's primary water management functions are (1) to capture plains snowmelt and localized rainfall runoffs from the large drainage area between Garrison and Oahe Dams that are then metered out at controlled release rates to meet System requirements, while reducing flood damages in the Oahe Dam to Big Bend reach, especially in the urban Pierre and Fort Pierre areas; (2) to serve as a primary storage location for water accumulated in the System from reduced System releases due to major downstream flood control regulation, thus helping to alleviate large reservoir level increases in Big Bend, Fort Randall, and Gavins Point; and (3) to provide the extra water needed to meet project purposes that draft storage during low-water years, particularly downstream water supply and navigation. In addition, hourly and daily releases from Big Bend and Oahe Dams fluctuate widely to meet varying power loads. Over the long term, their release rates are geared to back up navigation releases from Fort Randall and Gavins Point Dams in addition to providing storage space to permit a smooth transition in the scheduled annual fall drawdown of Fort Randall. Big Bend, with less than 2 MAF of storage, is primarily used for hydropower production, so releases from Oahe are generally passed directly through Big Bend.

7-02.5. **Fort Randall – Lake Francis Case.** Fort Randall's primary functions are (1) to capture plains snowmelt and localized rainfall runoffs in the drainage area from Big Bend Dam to Fort Randall Dam that are then metered out at controlled release rates to meet System requirements, while reducing flood damages in the Fort Randall reach, where several areas have homes and cabins in close proximity to the river; (2) to serve as a primary storage location, along with Oahe, for water accumulated in the System when System releases are reduced due to major downstream flood control regulation, thus helping to alleviate large pool increases in the very small Gavins Point project; (3) to provide a location to store the water necessary to provide increased winter energy to the basin by allowing an annual fall drawdown of the reservoir to occur with a winter reservoir refilling that is unique to Fort Randall; and (4) to provide the extra water needed to meet all of the System's Congressionally authorized project purposes, particularly navigation and downstream water supply, that draft storage during low-water years.

7-02.6. **Gavins Point Dam – Lewis and Clark Lake.** Gavins Point Dam, the most downstream of the System dams, is primarily used as a re-regulating dam to level out the release fluctuations from the upper System dams to better serve System requirements. With a total reservoir storage volume of only 500,000 acre-feet, it provides very little flood control and is generally maintained in a narrow reservoir elevation band between 1205 and 1207 feet msl. Due to the limited storage, releases from Gavins Point Dam must be backed up with corresponding release changes out of the upper projects. Gavins Point is the key location in the initiation of release reductions for downstream flood control. Even though it has only a small amount of storage space for flood control, this volume is usually adequate to perform downstream flood control by coordinating Gavins Point Dam release reductions with Fort Randall's. Releases greater than the powerplant capacity are passed through the spillway

7-03. **System Regulation Techniques.** The following discussion provides basic information related to the CWCP presented in this Master Manual. The concepts discussed are the division of the individual System reservoirs into regulation zones; the provision of a level of service to meet the Congressionally authorized purposes and the associated flow targets to achieve that level of service; System water-in-storage checks; and seasonal release considerations, which include regulation during the winter and regulation for endangered species. The process of implementing this CWCP is based on selecting the appropriate System regulation criteria described in this chapter for the appropriate time of year and System water in storage (storage) or water supply (System water in storage plus anticipated runoff for the remainder of the year) condition. Normal and Conservation System regulation involves a check on the amount of System water in storage on March 15 to determine if a navigation season will be provided that year, and if so, the service level to provide for the first part of the navigation season (Table VII-2). Downstream target flows at four designated locations are used to guide System releases (Table VII-1). The System water-in-storage is checked again on July 1 to determine the service level for the remainder of the navigation season (Table VII-2) and the ending date or length of the navigation season (Table VII-3). Finally the System storage is checked on September 15 (Table VII-4) to determine the System winter release rate. The above sequence is altered slightly if the System water supply is above normal or if the System is performing a major flood control action. In that case, the service level is determined as often as required (Plate VI-1) based on actual System storage and forecasted water supply so that the System release rate can be scheduled to minimize downstream flood risk and reduce flood damages. The navigation season is extended for 10 days in higher runoff years to facilitate evacuation of flood control storage space before the next flood season. Navigation Service Level is defined as "full" or "minimum." Full Service (see Table VII-7) is provided in near-normal runoff years to provide for evacuation of flood control storage before the next flood season, while serving navigation to the full capability of the authorized 9-foot downstream channel (8.5 foot draft). Minimum Service (see

Table VII-8) is usually provided in drought times to provide a minimum level of navigation service (7.5 feet of draft) while conserving water in the System in case of an extended drought. Consideration is also given to using System Replacement Flood Control Storage in cooperation with the U.S. Bureau of Reclamation (USBR), which will be discussed in greater detail later in this chapter. Also, within the framework of the overall goals stated above, there are seasonal decisions to optimize the benefits obtained for the various authorized purposes, such as fish spawning, endangered species nesting and releases during river ice formation periods.

7-03.1. **System Regulation Zones.** The storage capacity of the System has been developed to provide beneficial service to the Congressionally authorized purposes. Regulation of a particular project for one authorized purpose may be compatible, to a varying degree, with regulation for most of the other authorized purposes. For another authorized purpose, this regulation may be detrimental. For example, the vacating of storage capacity after a flood event to assure control of possible future flood events is compatible with providing releases for power, navigation, and water supply; however, it is incompatible with the objective of providing stored reserves for continuation of these purposes during a subsequent drought period. These factors made it advisable to divide the storage in individual System reservoirs into regulation zones to obtain the maximum possible service to all of the purposes consistent with the physical and authorizing limitations of the System. Totaling the storage capacity in the respective zones of the individual projects provides the total System storage capacity available in each regulation zone for use in System regulation. These values are not fixed but vary slightly over time according to changes in reservoir capacity from sediment collection in the reservoirs and shoreline erosion. For example, when the System was first considered filled in 1967, the total storage capacity was 75.2 MAF, and at this time, total storage capacity is 73.4 MAF. This change in storage capacity has been reflected in the System storage zones by adjusting the elevations of the various storage zones within the individual projects to reflect the correct amount of storage according to the change that has occurred. In some cases, the elevations have not changed but the actual System storage number has been adjusted for that zone. The regulation zones, and the guidance criteria for regulation in these zones considered necessary to achieve the multipurpose benefits and operational objectives for which the reservoirs were authorized, are described in the following paragraphs.

7-03.1.1. **Exclusive Flood Control Zone.** Flood control is the only authorized purpose that requires empty space in the reservoirs to achieve the objective. A top zone in each System reservoir is reserved for use to meet the flood control requirements. The storage space therein is used only for detention of extreme or unpredictable flood flows and is evacuated as rapidly as soon as downstream conditions permit, while still serving the overall flood control objective of protecting life and property. Considerations to achieve the flood control objective include a release limitation for each of the projects, status of storage in the other projects and the level of System or the Gavins Point Dam release being maintained, as designated by criteria discussed later in this chapter. The Exclusive Flood Control Zone represents 4.7 MAF (the upper 6 percent) of the total System storage volume, and this zone, from 73.4 MAF down to 68.7 MAF, is normally empty. The large four reservoirs, Fort Peck Lake, Lake Sakakawea, Lake Oahe, and Lake Francis Case, contain 98 percent of the total storage reserved for the Exclusive Flood Control Zone.

7-03.1.2. **Annual Flood Control and Multiple Use Zone.** An upper "normal operating zone" is reserved annually for the capture and retention of normal and flood runoff and for annual multiple-purpose regulation of this impounded water. The System storage capacity in this zone represents 11.6 MAF (16 percent) of the total System storage volume, and it extends from 68.7 MAF down to 57.1 MAF. This storage zone, located immediately below the Exclusive Flood Control Zone, will normally be evacuated to the base of this zone by about March 1 to provide adequate storage capacity for capturing runoff during the next flood season. Exceptions may occur. For example, if System Replacement Storage were requested in conjunction with regulation of the USBR reservoirs in the upper Missouri River basin. On an annual basis, water will be impounded in this zone as required to achieve the System flood control purpose and also stored in the interest of general water conservation to serve all the other Congressionally authorized System purposes. The evacuation of water from the Annual Flood Control and Multiple Use Zone is scheduled to maximize service to the authorized purposes that depend on the release of water from the System. Scheduling releases from this zone is limited by the flood control objective in that the evacuation must be completed by the beginning of the next flood season. This is normally accomplished as long as the evacuation is possible without contributing to serious downstream flooding. Evacuation is, therefore, accomplished mainly during the summer and fall because Missouri River ice formation and the potential for flooding from higher release rates limit System release rates during the December through March period.

7-03.1.3. **Carryover Multiple Use Zone.** A second lower intermediate zone provides a storage reserve for irrigation, navigation, power production, water supply, recreation, and fish and wildlife. The water stored in this zone at the three larger reservoirs (Fort Peck, Garrison, and Oahe) will maintain downstream flows through a succession of well-below-normal runoff years into the System. Serving the authorized purposes during an extended drought is an important regulation objective of the System and the primary reason the upper three System reservoirs are so large compared to other Federal water resource projects. The System storage capacity in this the largest storage zone, represents 39.0 MAF (53 percent) of the total System storage volume and extends from a volume of 57.1 MAF down to 18.1 MAF. The Carryover Multiple Use Zone is often referred to as the "bank account" for water in the System because of its role in providing assistance to the basin during critical dry periods. Water stored in the Carryover Multiple Use Zone will be used to meet project purposes in the event that the storage in the Annual Flood Control and Multiple Use Zone is exhausted. Only Fort Peck, Garrison, Oahe, and Fort Randall have this storage as a designated storage zone. The three larger projects of Fort Peck, Garrison, and Oahe serve the Missouri River basin during drought periods, and water from this zone is called upon to meet operational objectives stated in this plan. The storage space assigned to this zone in Fort Randall serves a different purpose. A portion of the Fort Randall space is normally evacuated each year during the fall season to provide recapture space for upstream winter power releases. The recapture results in complete refill of the space during the winter months. Deliberate, long-term drawdown into the Fort Randall Carryover Multiple Use Zone is not contemplated. During drought periods, the three smaller System projects (Fort Randall, Big Bend, and Gavins Point) are maintained at the same elevation they would be at if runoff conditions were normal. While a minor amount of space in Big Bend and Gavins Point was initially provided in this zone, deliberate drawdown into this zone is generally not contemplated.

7-03.1.4. **Permanent Pool Zone.** A bottom inactive zone, called the Permanent Pool Zone, provides for a minimum power head and for future sediment storage capacity. It also serves as a minimum pool for recreation, fish and wildlife, and as an assured minimum level for water access from the reservoir. A drawdown into this zone is generally not scheduled except in unusual conditions. The System storage capacity in this the lowermost storage zone represents 18.1 MAF (25 percent) of the total System storage volume (extends from 18.1 MAF down to 0 MAF). To date, this zone has been increased by the addition of storage originally in the Carryover Multiple Use Zones of Big Bend and Gavins Point. The regulation of System in the Permanent Pool Zone has been changed slightly due to the changes in the storage used in the Carryover Multiple Use Zone. The likelihood of using water stored in the Permanent Pool Zone has been reduced in the CWCP.

7-03.1.5. **Current System Storage Zone Allocations.** As of this time, the System has been regulated as an integrated system for 50 years. During this 50-year period, many regulation techniques have been evaluated. System regulation procedures have been modified to provide a plan for sustaining and balancing all of the Congressionally authorized project purposes. A basic method of evaluating proposed changes in System reservoir regulation has been the long-range System regulation study, as described in Chapter VI of this Master Manual. Numerous long-range studies have been made since 1964, and long-range study criteria have been modified so that release restrictions imposed by the flood control purpose are reflected in the studies. These many long-range studies have been supplemented by detailed examination of particularly severe flood events, which are described in detail in Appendix A of this Master Manual. The Master Manual Study included over 500 long-range studies, exceeding the total number of studies conducted prior to that time.

7-03.1.5.1. Long-term studies have also been made to investigate the effects of continued water resource development in the Missouri River basin. In general, these studies indicate that the flood control zone elevations currently used will continue being applicable well into the future. The loss of storage in the flood control zones of the System reservoirs due to sedimentation will be balanced by the reductions of flood runoff resulting from continuing water resource development, land treatment, and depletions that includes future appropriation of tribal water rights. Studies will continue to be made to determine the effects of such changes in Missouri River basin water resource development and in associated System regulation techniques. A major purpose of these studies will be the re-evaluation of System and individual System project storage zone allocations. If deemed necessary, appropriate action toward modification of System project storage zones will be initiated.

7-03.1.5.2. The current storage allocations and associated elevations in each of the zones of individual System projects, as well as for the System as a whole, is shown on Plates II-1 and II-2. Storages given in this table reflect the January 2004 elevation-storage relationships. Minor modifications from previous allocation tables are discussed below.

7-03.1.5.2.1. **Fort Peck.** The elevation of the top of the Permanent Pool Zone, or the bottom of the Carryover Multiple Use Zone, has not changed for Fort Peck; however, this updated water control plan has changed the regulation of the System during drought, or water conservation, periods. This change will result in the reservoir being approximately 22 feet higher during a drought like the 1930's; therefore, the likelihood that Fort Peck will drop to the top of its Permanent Pool Zone during its project life is reduced under this changed plan.

7-03.1.5.2.2. **Garrison.** The elevation of the top of the Permanent Pool Zone, or the bottom of the Carryover Multiple Use Zone has not changed for Garrison but it should be recognized that this updated water control plan has changed the regulation of the System during drought or water conservation periods. This change will result in the reservoir being approximately18 feet higher during a drought like the 1930's, therefore the likelihood that Garrison will drop to the top of its Permanent Pool Zone during its project life is reduced under this changed plan.

7-03.1.5.2.3. **Oahe.** The elevation of the top of the Permanent Pool Zone or the bottom of the Carryover Multiple Use Zone has not changed for Oahe but it should be recognized that this updated water control plan has changed the regulation of the System during drought or water conservation periods. This change will result in the pool being approximately 21 feet higher during a drought like the 1930's, therefore the likelihood that Oahe will drop to the top of its Permanent Pool Zone during its project life is reduced under this changed plan.

7-03.1.5.2.4. **Big Bend.** The elevation of the top of the Permanent Pool Zone or the bottom of the Carryover Multiple Use Zone has not changed for Big Bend. The Annual Flood Control and Multiple Use Zone extends between elevations 1420 and 1422 feet msl and is used for power scheduling purposes with the Exclusive Flood Control Zone extending between elevations 1422 and 1423 feet msl. The Annual Flood Control and Multiple Use Zone in Big Bend is not provided for seasonal regulation of flood inflows like the other major upstream projects, but the zone is used for day-to-day and week-to-week power operations. A settlement agreement approved in an order of dismissal by the United States District Court, District of South Dakota, in the case of Lower Brule Sioux Tribe et al. v. Rumsfeld, et al. (Civil No. 02-3014 (D.S.D.) provides that the Corps will consult with the Lower Brule Tribe and the Crow Creek Sioux Tribe during any review and revision of the Missouri River Master Water Control Manual. This agreement also provides that the Corps will coordinate the regulation of the Big Bend Project and the water level of Lake Sharp with the two Tribes to include the following: the Corps will normally strive to maintain a level at Lake Sharpe between elevation 1419 feet msl and 1421.5 feet msl; when the level of Lake Sharp drops below elevation 1419 feet msl or exceeds elevation 1421.5 feet msl, the RCC will provide notice to such persons as the Tribes shall designate in writing; when it is anticipated that the water level will drop below 1418 feet msl or rise above 1422 feet msl, or in the event the water level falls below 1418 feet msl or rises above 1422 feet msl, the Commander, Northwestern Division, or his designee, shall immediately contact the Chairpersons of the Tribes or their designees to notify them of the situation and discuss proposed actions to remedy the situation.

7-03.1.5.2.5. **Fort Randall.** The Carryover Multiple Use Zone in this project is used to recapture upstream winter power releases rather than for the maintenance of a storage reserve for long-term droughts, as is provided in the three major upstream System projects. On all reservoir regulation simulations analyzed for the Master Manual Study, Fort Randall was not drawn down below an elevation of 1337.5 feet msl. This lower limit has been a regulation objective since it was first instituted in 1972. Additional details of this change are available in an RCC report entitled, "Modification of Operation of Lake Francis Case, South Dakota." The water stored in the Fort Randall Carryover Multiple Use Zone from 1320 to 1337.5 feet msl may be used and withdrawn during a drought that is more severe than the drought of the 1930's. This storage volume remains as part of the Carryover Multiple Use Zone for this purpose.

7-03.1.5.2.6. **Gavins Point.** The Permanent Pool Zone at Gavins Point extends from 1160 to 1204.5 feet msl. The Annual Flood Control and Multiple Use Zone from 1204.5 to 1208 feet msl is the zone the project normally is regulated. The Exclusive Flood Control Zone from 1208 to 1210 is kept vacated except during flood control events. Gavins Point reservoir is normally regulated near 1206.0 feet msl in the spring and early summer with variations day to day due to rainfall runoff. The reservoir level is then increased to elevation 1207.5 feet msl following the nesting season for lake recreation enhancement.

7-03.2. **System Service Level.** To facilitate appropriate application of System multipurpose regulation criteria, a numeric "service level" has been adopted since the System was first filled in 1967. Quantitatively, this service level approximates the water volume necessary to achieve a normal 8-month navigation season with average downstream tributary flow contributions. For the "full-service" level, the numeric service level value is 35,000 cfs. For the "minimum-service" level, the numeric service level value is 29,000 cfs. This service level is used for selection of appropriate flow target values at previously established downstream control locations on the Missouri River. There are four flow target locations selected below Gavins Point to assure that the Missouri River has adequate water available for the entire downstream reach to achieve regulation objectives. Because of the fluvial nature of the bed of the Missouri River, flow targets are used rather than river stage targets at the control point locations. The discharge approach has resulted in a consistency in regulation over time as aggradation and degradation previously discussed has occurred at some of the System control point locations, which has changed river stage values for the same flow. The specific technical criteria for the relationship between service level and control point target discharge are as shown in Table VII-1. The service level determination has a range much greater than the minimum and full service discussed so far. The application of the service level concept is also used in the evacuation of flood runoff accumulated in the System by establishing service levels much greater than 35,000 cfs, as shown on Plate VI-1. The specific use of the service levels technique for System flood control evacuation is fully discussed in this chapter in Paragraph 7-04.13.4.

Table VII-1
Relation of Target Discharges to Service Level

Control Point Location	Flow Target Discharge Deviation from Service Level
Sioux City	-4,000 cfs
Omaha	-4,000 cfs
Nebraska City	+2,000 cfs
Kansas City	+6,000 cfs

7-03.2.1. **Service Level for Conservation and Normal System regulation.** A full-service level of 35,000 cfs results in target discharges of 31,000 cfs at Sioux City and Omaha, 37,000 cfs at Nebraska City and 41,000 cfs at Kansas City. Similarly, a "minimum service" level of 29,000 cfs results in target values of 6,000 cfs less than the full-service levels at the four System control points identified above. Selection of the appropriate service level to be maintained is based on the actual volume of water-in-storage in the System. The use of actual water-in-storage means that forecasting is not relied upon when the volume of water in System storage is below normal.

7-03.2.1.1. **Service Level System Water-in-Storage Checks.** The System water-in-storage checks occur on constant key dates (March 15 and July 1) of each year. The volumes selected have been derived from long-range model simulations that allow the System to function to meet authorized purposes during significant multi-year drought periods. The specific technical criteria for System service level are as shown in Table VII-2. Straight-line interpolation defines intermediate service levels between full and minimum service. These service level determinations are for conservation and normal System regulation. During years when flood evacuation is required, the service level will be calculated monthly to facilitate a smooth transition in System release rather than a stepped approach at the above-mentioned March 15 and July 1 dates. Further details related to System regulation during flood events are provided later in this chapter.

Table VII-2
Relation of Service Level to the Volume of Water in System Storage

Date	Service Level (cfs)	Water in System Storage (MAF)
March 15	35,000 cfs (full-service)	54.5 or more
March 15	29,000 cfs (minimum-service)	49.0 to 31
March 15	no service	31.0 or less
July 1	35,000 cfs (full-service)	57.0 or more
July 1	29,000 cfs (minimum-service)	50.5 or less

7-03.3. **Non-navigation Years.** As shown in Table VII-2, the CWCP presented in this revised and updated Master Manual calls for suspension of navigation service if System water-in-storage is at or below 31 MAF on March 15 of any year. It should be noted that the occurrence of System storage at or below 31 MAF would most likely coincide with a national drought emergency. If any of the reservoir regulation studies performed for the development of the AOP indicate that System storage will be at or below 31 MAF by the upcoming March 15, the Corps of Engineers will notify the Secretary of the Army. Approval from the Secretary of the Army will be required prior to suspension of Missouri River navigation for the second of two consecutive years. The Corps will ensure that basin stakeholders are promptly informed of the notification to the Secretary of the Army and of the Secretary's decision regarding suspension of navigation.

7-03.4. **Season Length Determination.** The water-in-storage check for navigation season length is taken on July 1 of each year. Assuming System water-in-storage is above 31 MAF on March 15, a navigation season will be supported. If System water-in-storage is at or above 51.5 MAF, a full 8-month navigation season would be provided, unless the season is extended to evacuate System flood control storage. However, if System water-in-storage falls below 51.5 MAF on any July 1, a shortened navigation season would be provided to conserve water stored in the System to extend availability of water-in-storage in the case of an extended drought. The specific technical criteria for season length are shown in Table VII-3. Straight-line interpolation between 51.5 and 46.8 MAF of water-in-storage on July 1 provides the closure date for a season length between 8 and 7 months. If System water-in-storage on July 1 is between 46.8 and 41.0 MAF, a 7-month navigation season is provided. A straight-line interpolation is again used between 41.0 and 36.5 MAF, providing season lengths between 7 and 6 months. For System water-in-storage on July 1 below 36.5 MAF, a 6-month season is provided.

Table VII-3
Relation of System Storage to Season Length

Date	System Storage (MAF)	Season Closure Date at Mouth of the Missouri River
March 15	31.0 or less	no season
July 1	51.5 or more	December 1 – 8-month season
July 1	46.8 through 41.0	November 1 – 7-month season
July 1	36.5 or less	October 1 – 6-month season

7-03.4.1. **Season Opening and Closing Dates**. Navigation on the Missouri River is limited to the normal ice-free season, with a full-length flow support season of 8 months. Successful commercial navigation on the Missouri River from Sioux City to the mouth is dependent upon low-flow supplementation from the System, with occasional assistance from tributary reservoirs authorized to support Missouri River navigation. Navigation is limited to the ice-free season and, based on historical records of ice formation on the Missouri River together with experience gained in System regulation to date, the opening and closing dates of a normal 8-month navigation season have been scheduled as follows:

	Opening Date	Closing Date
Sioux City	March 23	November 22
Omaha	March 25	November 24
Kansas City	March 28	November 27
Mouth	April 1	December 1

In some years, ice conditions will undoubtedly delay the opening of the season and in others may force an early end to the season.

7-03.4.2. Fall extensions of the season beyond the normal 8-month length will normally be scheduled (ice conditions permitting) in years with above-normal water supply and when such extensions will not result in a drawdown into the System's Carryover Multiple Use Zone. Based on experience to date, these season extensions will normally be limited to 10 days beyond the normal closure date, resulting in a season closing on December 11 at the mouth of the Missouri River. In addition to enhancing navigation and water supply, the 10-day extension of the navigation season also enhances hydropower production by transferring an additional block of power from the normal navigation season to the more critical (for power purposes) winter season.

7-03.5. **System Seasonal Considerations.** For a portion of some years, deviations may be made from the above stated specific technical criteria to achieve the operational objectives of the CWCP or to comply with other statutory or regulatory obligations such as the ESA. In such circumstances, the AOP will explain the deviation from the specific technical criteria and the rationale for that deviation related to the operational objectives of the CWCP or applicable statutory and regulatory requirements. Other seasonal considerations and the corresponding reservoir regulation are further discussed elsewhere, as appropriate, in this Master Manual.

7-03.5.1. **System Winter Release Determination.** Another seasonal consideration is regulation in the wintertime period, which extends from December through February, to support the Congressionally authorized project purposes of hydropower production and downstream water supply and water quality. The specific technical criteria for Gavins Point Dam winter release rate is shown in Table VII-4. The System water-in-storage check for System winter release is taken on September 1 of each year.

Table VII-4
Relation of System Winter Release Level to System Storage

September 1 System Storage in MAF	Average Winter Release from Gavins Point in cfs
58.0 or more	17,000 cfs
55.0 or less	12,000 cfs

7-03.5.2. A modification to the winter release rate from Gavins Point Dam generally occurs when the evacuation of System flood control storage cannot be accomplished by providing a full-service navigation season with a 10-day extension of the navigation season. With an excess annual water supply, the winter season Gavins Point release will be scheduled at a rate of up to 25,000 cfs to continue to evacuate the remaining excess water in System flood control storage. When extremely high runoff has not been previously evacuated due to downstream flood control regulation, consideration will be given to scheduling winter releases in the 25,000 to 30,000 cfs range to accomplish the flood control objective of evacuating the Annual Carryover and Multiple Use Zone prior to the beginning of the next flood season.

7-03.6. **Integration of Downstream Requirements.** Gavins Point Dam releases are regulated to provide service to all multiple-use purposes, while at the same time recognizing the important flood control function of the System. In years of excess water supply, Gavins Point Dam releases in excess of full-service requirements may be necessary to evacuate flood control storage space. In recognition that these higher-than-normal releases can have an adverse effect on downstream floods, should unexpected rainfall occur, the higher releases should be made, to the extent possible, when floods from downstream tributaries are less likely. Also, the magnitude of these releases during the open-water season can be reduced somewhat by scheduling winter releases at a higher rate than would be the case with a normal water supply. While this may have the effect of slightly increasing the flood risk during the winter months, it reduces the flood risk during the open-water season when the flood potential is greatest. In addition, it may also increase the service provided to the power and navigation purposes by extending the navigation season length and increasing the amount of winter energy generation. Also, flood storage evacuation releases somewhat above full-service requirements during the open-water season usually have a beneficial effect upon navigation and hydropower production.

7-03.6.1. With a normal or less-than-normal water supply, navigation and hydropower releases during the open-water season are made taking into account the existing System water-in-storage and less-than-full-service flows may be provided when water-in-storage is low. Under such conditions, winter power releases may also be reduced. Table VII-4 shows that, for a normal System water-in-storage, a winter release from Gavins Point would be approximately 17,000 cfs. This release equates to fully serving the winter System hydropower production purpose and meeting all downstream water supply requirements. If, due to a depletion in System water-in-storage reserves down to the levels identified in Table VII-3, navigation season lengths need to be reduced to less than 8 months, winter releases from Gavins Point may be reduced to the minimum necessary for water intake or water quality requirements. The minimum System release considered applicable at this time is 9,000 cfs during the non-summer open-water season (March-April and September-November), 18,000 cfs during the summer open-water season (May-August) and 12,000 cfs during the winter period (December-February).

7-03.7. **System Conservation or Drought Reservoir Regulation Considerations**. As this manual was being revised, the System was experiencing its second extended drought since the System became fully operational in 1967. In fact, the amount of water in System storage was at the lowest level since it first filled. All authorized purposes, except for flood control, are affected negatively during extended drought. The impacts range from minor to very severe. Those most severely affected are recreation in the upper three large System reservoirs and below the System; navigation; intake access on the upper three large System reservoirs and in the river reaches between the reservoirs and downstream; cold water reservoir fishery species; reservoir and river water quality including thermal powerplants; irrigation; and hydropower production.

7-04. **System Regulation for Flood Control**. The regulation of the System for flood control is provided in the following paragraphs.

7-04.1. **Objectives of Flood Control Regulation.** The System is regulated, insofar as is practical, to prevent flows originating above or within the System from contributing to damaging flows through the downstream reaches of the Missouri River. Regulation of individual System projects is integrated to successfully meet this regulation objective. In addition, each individual System project is regulated to prevent, insofar as practicable, project releases from contributing to damaging flows through the downstream reaches in which that particular project affords a significant degree of control.

7-04.2. **Method of Flood Control Regulation.** In general, the developed method of regulation of the System as described in subsequent paragraphs may be classified as Method C, as defined in EM 1110-2-3600. This represents a combination of the maximum beneficial use of the available reservoir storage space during each flood event with regulation procedures based on the control of floods of approximate reservoir design magnitude. Specific procedures for the accomplishment of flood control regulation and examples are given in the succeeding paragraphs.

7-04.3. **Mainstem System Storage Space Available for Flood Control.** During any specific major flood event, all available storage space within the System will be used to the maximum extent practicable for flood control. This control will be provided in combination with other beneficial water uses for which the System was authorized. Approximately 16.3 MAF of System storage space are allocated for flood control purposes, of which 4.7 MAF are for this purpose exclusively; the remainder combines flood control with other authorized purposes. Most of the System flood control storage space is located in the Fort Peck (Fort Peck Lake), Garrison (Lake Sakakawea), Oahe (Lake Oahe), and Fort Randall (Lake Francis Case) projects. The flood storage in the Big Bend and Gavins Point projects is relatively minor in magnitude. In addition to allocated flood control storage space, surcharge space is available in each of the System reservoirs, primarily to ensure the safety of the project, but the use of that space will provide downstream flood reductions during extreme flood events. The Carryover Multiple Use Zone storage space, when evacuated, will also serve to benefit the flood control; however, deliberate evacuation of this zone to serve flood control will not be normally scheduled. As discussed in Appendix A of this manual, determination of the current flood control storage allocation of the System is based, to a large degree, on the vacated space required to control the 1881 flood. The 1881 flood is discussed in greater detail in Appendix A of this manual. The System flood control storage allocation has been examined and confirmed as adequate by numerous long-range regulation studies and the study for this Master Manual update.

7-04.4. **Amount of Tributary Reservoir Space Available for Flood Control.** The availability of upstream tributary reservoir flood control storage space was not recognized in the early flood studies. Early long-range System regulation studies also did not consider tributary reservoirs regulated specifically for flood control along the main stem of the Missouri River. Tributary reservoir storage space upstream from the System, if regulated for that purpose, can be effective in reducing flood crests in the lower Missouri River. Certain Missouri River basin tributary reservoirs, therefore, have a portion of their available storage space allocated to flood control use on a “replacement” basis. Replacement storage is defined as tributary reservoir storage space that is regulated in close coordination with the System and, as a consequence, can replace a portion of the System’s Annual Flood Control and Multiple Use Zone space. Replacement storage effectively allows for an increase in the amount of Carryover Multiple Use Zone storage that can be retained in the System projects. This greater amount of Carryover Multiple Use Zone storage results in increased multiple-use benefits while continuing the same degree of downstream flood protection that the System was designed to achieve. Past long-range regulation studies have incorporated this replacement storage concept and have demonstrated the resulting increased multiple-purpose benefits and continued flood control effectiveness of the expanded system of reservoirs. The use of replacement storage was last integrated into the System regulation in the 1980’s. Basin hydrologic conditions determine if use of tributary replacement storage is warranted. Future requests for the use of tributary replacement storage are not anticipated.

7-04.4.1. **Replacement System Flood Control Storage Space.** Replacement flood control storage has been provided in three projects in the upstream basin: Clark Canyon, Canyon Ferry, and Tiber. These projects are all USBR projects controlling drainage areas upstream of Fort Peck. The Corps’ NWD Commander is responsible for the flood control regulation of these projects under Section 7 of the 1944 Flood Control Act. The NWD Commander has delegated the flood control regulation of these USBR projects to the Corps’ Omaha District Commander.

The drainage areas of these three projects all have relatively high runoff yields that produce significant volumes of the flood season runoff above the System. It is expected that, in years of large runoff that could conceivably tax the flood control abilities of the System, the replacement storage space in these projects would be used for the control of flooding on the Missouri River. The three USBR projects have the use of replacement System Flood Control Storage outlined in their respective tributary water control manuals. Each manual details the procedures for the Corps to follow in computing the amount of replacement storage available for each runoff season. When replacement storage for any or all of the projects is used, the actual regulation of the System proceeds as if this upstream tributary replacement storage space was a part of the System's Annual Flood Control and Multiple Use Zone. When replacement storage is used, the total System storage, or storage in a particular System project, could enter the flood season on March 1 above the base of the Annual Flood Control and Multiple Use Zone. This storage may appear to exceed the amount suggested by flood control objective criteria stated in this manual. Because the vacated space in the upstream reservoirs is being used as tributary replacement storage, what is initially seen as excess flood control storage in the System is actually consistent with criteria outlined in this manual. If replacement storage is used, the affected USBR tributary project(s) is credited with extra flood control benefits for a portion of System damages prevented on the Missouri River. The RCC is responsible for requesting, in writing, that the Omaha District water control office initiate the process to use tributary replacement storage to benefit the System. The Omaha District in turn notifies the USBR that tributary replacement storage is being requested by the RCC. The USBR must then assure that the space is evacuated in the tributary project prior to flood season in accordance with the procedures written in the tributary manuals. The volume of replacement storage space available in the USBR tributary projects, as stated in the tributary project water control manuals, is shown in Table VII-5.

Table VII-5
System Replacement Flood Control Storage

Tributary Project		System Replacement Storage
Tiber		569,468 acre-feet
Clark Canyon		106,911 acre-feet
Canyon Ferry		450,000 acre-feet
	Total	1,126,379 acre-feet

7-04.4.2. **Other Tributary Reservoir Flood Control Storage Space.** In addition to the aforementioned USBR tributary projects that have assigned replacement flood control storage space, there are many other tributary reservoirs upstream from the System. Many of these tributary reservoirs have no Congressionally authorized flood control space or have flood control space assigned only for the purpose of local flood control in the immediate downstream river reach. At times, these reservoirs are drawn well below their normal full level prior to the flood season. Efficient Missouri River basin water resources management requires that the status of storage in all significant tributary reservoirs be considered and integrated into the overall regulation of the System, to the extent practical, while maintaining the overall flood control capability originally designed into the System.

7-04.5. **System Project Regulation Features.** Releases from individual System projects can be made through their respective powerplants, outlet works, and spillways. The powerplants will be used to the fullest extent possible to achieve the maximum benefit. During normal operating conditions, the greatest portion of project releases is made through the powerplants. When releases greater than the powerplant capacity or power demand are necessary, the outlet works and spillways will be used. The spillway, in combination with surcharge storage provided, ensures the safety of the dam in the case of extreme floods. Capacities of flow regulating devices at the System projects are indicated on rating curves represented on Plates II-5 through II-9 for Fort Peck, Plates II-20 through II-23 for Garrison, Plates II-34 through II-37 for Oahe, Plates II-47 through II-49 for Big Bend, Plates II-59 through II-62 for Fort Randall, and Plates II-72 through II-74 for Gavins Point. Additional information can be found in the individual System project water control manuals.

7-04.6. **System Flood Control Regulation.** Flood control regulation of the System projects, as per the objectives stated in Paragraph 7-04.1, is based on careful consideration of the following factors: river channel capacities downstream from individual System projects; observed and forecasted tributary flows to those portions of the Missouri River through which the System and individual System reservoirs afford a positive degree of flood control; observed and forecasted inflows into the System and the individual System reservoirs; amount of vacated individual System projects and total System storage space for controlling current and forecasted runoff; flood-producing potential of the drainage area both above and below the System and its relationship to individual System projects within the System; release requirements from the System and also from the individual System projects for purposes other than flood control; and available tributary reservoir flood control storage space above the System. The desired March 1 System water-in-storage is 57.1 MAF, equivalent to having each individual System reservoir at the base of its Annual Flood Control and Multiple Use Zone. When median or greater runoff occurs with System storage at 57.1 MAF or above on March 1, System releases are adjusted by computing the appropriate service level to draft storage to 57.1 MAF by March 1 of the following year. The three large reservoirs can either be balanced or unbalanced in terms of the amount of water in the Carryover Multiple Use Zone remaining on March 1 by specifying target storages; however the overall system goal is to have the system evacuated to the base of the Annual Flood Control and Multiple Use Zone (57.1 MAF) by March 1 each season to fully serve the flood control purpose.

7-04.6.1. **Use of Annual Flood Control Storage.** The flood control storage space in the System is normally evacuated prior to the start of the next flood season, which starts in March or early April. The Annual Flood Control and Multiple Use Zone will be allowed to fill or partially fill through the flood season, with the rate and amount of fill largely determined by actual and anticipated hydrologic conditions. Optimum System regulation requires the filling of a portion of this zone during the flood-runoff season to fully meet the regulation objectives of this CWCP. This is accomplished provided that inflows exceed the releases required to meet all authorized purposes.

7-04.6.2. **Use of Exclusive and Surcharge Flood Control Storage.** The Exclusive Flood Control Zone space provided in the System is reserved entirely for the control of floods and is not to be encroached on except for that specific purpose. Surcharge storage space is provided in addition to flood control space to assure project integrity and will be used only in the case of extreme floods.

7-04.7**. Individual System Project Flood Control Regulation.** Seasonal regulation of the storage within the individual System projects of the System will, to a degree, parallel that for the System, which is described in previous sections. The individual System projects have two zones designated for flood control, the Annual Flood Control and Multiple Use and the Exclusive Flood Control Zones. The Annual Flood Control and Multiple Use Zone is the zone where the projects normally operate under a wide range of runoff conditions. The zone designated as Exclusive Flood Control Zone is vacated most of the time and encroached upon only during significant runoff events. When the amount of water in an individual project or System storage is great enough to occupy this zone or the Corps' simulation models forecast the projects to rise into this zone, the projects are considered to be in a flood control state. Downstream runoff and streamflow conditions can also cause the System to be considered in a flood control state. The flood control state results in an increased frequency of forecasts and an examination of additional alternatives to return the System to a normal condition. During a flood control state, the flood control purpose is considered foremost in making release determinations.

7-04.7.1. **Fort Peck and Garrison Flood Control Considerations.** The winter season is the time period when the firm power demand from the System is the greatest. To enhance winter energy generation, winter releases from the upstream Fort Peck and Garrison reservoirs are often maintained at the maximum level possible that is consistent with downstream channel capacity. During the winter, channel capacity is reduced because of threat of flooding during river ice formation or when an established Missouri River ice cover raises Missouri River stages. Because of the somewhat unpredictable behavior of a downstream ice cover, the exact potential volume of winter releases from these upstream projects cannot be estimated accurately. Pre-winter System reservoir storage levels are scheduled on the basis that the established winter release rate will be made most of the time through these upstream powerplants. If channel conditions during the winter are such that the established winter release rate assumed in pre-winter scheduling is not possible, a release deviation will be implemented. The changed release rate may result in some imbalance in the amount of water-in-storage in individual System reservoirs by the following spring. This storage imbalance will favor the downstream flood control purpose, with additional evacuated storage space located in the largest downstream System project, Oahe. This is not a matter of great concern because open-water channel capacities below Fort Peck and Garrison are sufficient to allow a relatively fast restoration of System storage balance following the ice breakup if attaining a balance in the amount of water-in-storage at the large upper three reservoirs is still a goal at that time of the season.

7-04.7.2. **Fort Randall Flood Control Considerations.** The early spring flood potential is defined by the amount of accumulation of plains snow and the ground conditions in the incremental areas above and between the System reservoirs. Manipulation of the Fort Randall reservoir level prior to the flood season is based on the spring flood potential. In years when the early-spring flood potential between Oahe and Fort Randall is high because of plains snow accumulation or the flooding potential below Fort Randall is high, the Fort Randall reservoir level may be held below its base of the Annual Flood Control and Multiple Use Zone prior to the onset of spring runoff. This reservoir level manipulation is achieved by reducing late winter power releases from the Oahe and Big Bend projects. The additional vacated storage space in

Fort Randall allows for the capture of flood flows with a less severe disruption of power releases from upstream projects through the spring runoff period. During normal runoff situations, the reservoir will be maintained at the base of flood control, 1350 feet msl. During those years that the flood potential below Oahe is low, it may be desirable to raise Fort Randall reservoir level above the base of the Annual Flood Control and Multiple Use Zone prior to March 1. This allows for an increased amount of energy to be generated during the high demand winter period. Additionally, the higher reservoir level provides a reserve of additional water that may be used to satisfy short-term demands for increased System releases during the following navigation season for downstream flow support. Experience has indicated that a Fort Randall reservoir level of about 1355 feet msl, 5 feet above the base of the Annual Flood Control and Multiple Use Zone, is satisfactory for meeting the short-term downstream flow support demands. Experience has also indicated that maintaining a minimum pool elevation of 1353.0 feet msl will meet the recreational and irrigation purposes during the April to September timeframe. Consequently, any deliberate fill of the Fort Randall reservoir, based on low flood potential prior to March 1, will normally be limited to an elevation of 1355.0 feet msl.

7-04.7.3. **Gavins Point Flood Control Considerations.** Consideration of the early spring flood potential in the drainage area between Fort Randall Dam and Gavins Point Dam is similar to that outlined in Paragraph 7-04.7.2 for the area between the Oahe and Fort Randall projects. Because it is possible to manipulate the Gavins Point reservoir level in a relatively short period of time, the reservoir level at the start of the flood season will be somewhat dependent on this spring flood potential. When the spring flood potential between Fort Randall Dam and Gavins Point Dam is high, the Gavins Point reservoir level will be drawn down well below the base of Annual Flood Control and Multiple Use Zone immediately prior to the start of the snowmelt period and allowed to refill from the snowmelt runoff. The limit of this drawdown will be dependent on the potential for flooding based on the forecasted runoff in the Fort Randall Dam to Gavins Point Dam reach. When the runoff potential between Fort Randall and Gavins Point Dam is very low, as evidenced by the lack of a plains snow cover or by a lack of antecedent rainfall over the incremental drainage area, complete evacuation of the Annual Flood Control and Multiple Use Zone may not be necessary. Continued surveillance of the runoff potential in this incremental area is required. If the runoff potential increases during the March through July flood season, appropriate measures will be taken to lower the level of the Gavins Point reservoir to near the base of the Annual Flood Control and Multiple Use Zone, which is 1204.5 feet msl; however, consideration of the state of tern and plover nesting must be made prior to lowering the reservoir. The potential effects on the recreational use of the Gavins Point project will be a consideration in any decision made to reduce the elevation of Gavins Point to capture additional runoff. In this area, there is continued pressure from recreation specific interests to maintain Gavins Point reservoir levels at the highest practical level consistent with the flood runoff potential. Additionally, keeping the Gavins Point reservoir level high, along with a corresponding storage decrease in upstream reservoirs, increases System power production because the small size of Gavins Point provides a greater amount of power per unit of storage than any of the other System projects. Because releases from this downstream project are normally greater than from other System projects, the additional head is more effective for increased energy production than a corresponding head increase at another System project. The Gavins Point reservoir level following the March through July flood season and the completion of tern and plover nesting season will normally be maintained at 1207.5 feet msl to enhance both recreation and power. The base of the Exclusive Flood Control Zone is 1208.0 feet msl. Manipulation of the Gavins

Point and Fort Randall reservoir levels, as described in this and the preceding sections, has no effect on the overall availability of evacuated flood control storage space in the System prior to early spring floods. This is because desired reservoir levels are realized by scheduling releases from upstream projects. Downstream System release rates are also not affected by any System reservoir level manipulations discussed in the subparagraphs of 7-04.7.

7-04.8**. System Flood Control Regulation Criteria.** In order to conduct System flood control regulation in an optimum manner, while at the same time providing the maximum possible service to the other multiple-use purposes of the System, storage space allocated for flood control in the downstream System reservoirs of Big Bend, Fort Randall, and Gavins Point should be maintained as near to the base of their Annual Flood Control and Multiple Use Zones as possible, which is consistent with the discussion in Paragraph 7-04.7. The basis for this type of System regulation is explained in the following subparagraphs.

7-04.8.1. Vacant space in the three smaller downstream System projects provides an additional measure of flood control for the large urban damage centers below the System than the same amount of vacated space in the upper three, larger System projects.

7-04.8.2. When the levels of the Big Bend and Fort Randall reservoirs are near the base of their respective Annual Flood Control and Multiple Use Zones, tailwater levels at the immediately upstream Oahe and Big Bend projects will provide maximum power heads. This will result in improved hydropower production.

7-04.8.3. In the case of heavy runoff originating below the System, vacant Annual Flood Control and Multiple Use Zone space in the downstream three smaller System projects helps both flood control and power generation. These smaller projects then have the space to store the upstream project releases necessary to maintain the optimum System power generation from the upstream three larger System projects, while releases can be reduced from the smaller downstream projects to provide the maximum practical flood reductions.

7-04.8.4. Flood control releases from the System will be made in such a manner as to satisfy the following general requirement. When allocated flood control storage space in Fort Randall is available to capture existing or forecasted flood events, maximum System releases will normally be limited to a rate that will not contribute to flows that exceed 120,000 cfs at Sioux City, Iowa. If insufficient storage is available in Fort Randall reservoir for controlling the existing or forecasted runoff, System releases will be increased as necessary to ensure project safety while at the same time providing significant downstream flood reductions.

7-04.9. **System Regulation Considerations During Winter Ice Season.** The maximum flow that may be passed without damage varies through the length of the Missouri River and is dependent on channel dimensions, the degree of encroachment onto the floodplain, and improvements such as levees and channel modifications. Capacities at specific locations also vary from season to season, especially in the middle and upper river reaches, where a decrease in capacity due to the formation of an ice cover is common through the winter and early spring months. Like with most streams, the capacity of the Missouri River channel usually increases progressively downstream, although instances occur where this trend is reversed.

7-04.9.1. Above Sioux City, the Missouri River and its tributaries can be expected to freeze over each year. An intermittent ice cover will also usually form on the Missouri River as far downstream as St. Joseph. In the downstream reaches of the river below St. Joseph, an ice cover may occasionally form as a result of severe and extended cold temperatures. The time of formation and breakup of the ice cover varies widely from year to year, but an ice cover may be expected over some reaches from early December to about mid-March. RCC Technical Report No. SS-N-71, "Missouri River Freeze and Breakup," November 1971, presents detailed historical data on this subject.

7-04.9.2. An ice cover greatly decreases the river conveyance at any given stage and, consequently, the channel capacities are significantly reduced. The formation and breakup of the ice cover through any reach or series of reaches often causes ice jams. Substantial volumes of water are stored temporarily by these ice jams or by a solid ice cover due to flow restriction by the ice. This phenomenon has a marked effect upon streamflow and river stages. Downstream flows and accompanying stages may be markedly reduced at the onset of the jam, while stages just upstream or in the upstream portions of ice-covered sections of the river may rise to damaging levels. The volume of ice in any particular reach of the river that may contribute to jamming is a function of the thickness of ice, the width of the river, and the length of the reach. With low stages, the river width, and the ice volume within the reach are reduced from what they would have been with higher stages. Most of the maximum stages of record in the upper Missouri River resulted from ice jams and occurred prior to regulation provided by the System. The System projects tend to act as a trap to flowing ice and reduce the possibility of severe ice jam formation in downstream areas, both during the period of ice formation and ice breakup.

7-04.9.3. In the downstream portions of the Missouri River, ice jamming or ice bridging is likely to occur during periods of extremely cold weather. Large cakes of ice form and float downstream to a restricted reach where they lodge. The resulting blockages are fed by additional floating ice. Usually, such blockages in the downstream reaches are temporary in nature and continue until such time that temperatures moderate. On several occasions, blockages have formed in the Nebraska City to St. Joseph reach of the Missouri River and have caused stages to exceed established flood stage, in spite of low releases from Gavins Point. In recent years, the Missouri River normally freezes first below Gavins Point Dam in the Ponca area above Sioux City; below Decatur, Nebraska; below Fort Calhoun, Nebraska; below the Platte River confluence with the Missouri River and near Leavenworth, Kansas. During severely cold Midwest winters, over 400 miles of the Missouri River have been covered by ice below Gavins Point Dam. Generally, the long travel times to most locations prevent the Corps from making significant changes in Gavins Point releases to correct stage fluctuations from ice jam events below the System.

7-04.9.4. Ice cover forming on the Missouri River below Fort Peck, Garrison, and Oahe Dams has a marked effect on the winter regulation of these projects. At the time the ice cover first forms below Fort Peck and Garrison Dams, the downstream channel capacities are at a minimum. As the river ice cover stabilizes, flows are normally slowly increased followed by a progressive increase in the channel capacity that continues until just prior to the end of the winter season. It is often possible to increase releases while maintaining relatively constant downstream stages. This phenomenon is discussed in more detail in two RCC Technical Reports, "Freezing of the Missouri River Below Garrison Dam," February 1973, and "Freezing of the Missouri River Below Fort Peck Dam," July 1973.

7-04.9.5. Ice cover forming on the Missouri River below the Oahe Dam also has a marked effect upon the winter regulation of this project. As discussed previously, Federal funds are currently being used to acquire the properties most susceptible to ice-affected flooding in Pierre and Fort Pierre, South Dakota.

7-04.9.6. **System Winter Season Flood Control Releases.** Due to restricted channel capacities under ice conditions, releases from specific projects during the winter river ice-cover period will be limited at all six System projects.

7-04.9.6.1. **Fort Peck.** At the time when active downstream river ice formation is anticipated or occurring in the reach between Fort Peck Dam and the mouth of the Yellowstone River, mean daily releases from Fort Peck are limited to a maximum of 10,000 cfs unless higher releases are needed for flood control evacuation. After a river ice-cover has formed, releases will be limited to prevent Missouri River stages from exceeding 11 feet at Wolf Point or 13 feet at Culbertson unless higher release rates are required for flood control evacuation. Experience indicates that, after the downstream ice cover has formed and stabilized, mean daily releases can be increased up to 15,000 cfs, which is the Fort Peck powerplant capacity. However, increases in releases from the normal freeze-in level to the maximum winter ice-covered level should normally be made in gradual increments. Additionally, tributary runoff between Fort Peck and the downstream Wolf Point and Culbertson gages due to plains snowmelt prior to the time the river becomes ice-free are a consideration in release scheduling.

7-04.9.6.2. **Garrison.** Garrison releases are normally not scheduled above 20,000 cfs in December to prevent the river at the Bismarck gage from exceeding a 13-foot stage during the winter freeze-in period. Releases have been reduced to as low as 16,000 cfs in past years as the head of ice advanced upstream from the upper end of Lake Oahe. This action is taken to prevent flooding of housing developments adjacent to the river in Bismarck and Mandan, North Dakota. Releases can be safely increased without increasing the river stage after an ice cover is established. After the river ice cover has stabilized in the downstream Missouri River reach around Bismarck, releases from Garrison can be gradually increased without increasing the river stage. Experience has shown that approximately 1 month after the initial freeze-in at Bismarck, releases approaching 27,000 cfs are possible. Tributary runoff between Garrison Dam and Bismarck prior to the time the Missouri River becomes ice-free must be considered in scheduling Garrison releases. The 27,000 cfs winter release rate is a reduction from the original Garrison powerplant capacity winter release rate of 35,000 cfs. This reduction is attributed to aggradation in the upper end of Oahe, which has caused a reduction in channel capacity.

7-04.9.6.3. **Oahe.** Experience has indicated that the normal powerplant peaking at Oahe maintains the 7-mile reach between Oahe Dam and the head of Lake Sharpe largely in an ice-free condition under all but the most severe weather conditions. Therefore, the channel capacity available requires no restrictions on winter discharges through the Oahe powerplant except during the most severely cold conditions. Several times since 1979, minimum and maximum restrictions have been placed on Oahe generation when extremely cold weather results in ice formation and high stages in the Pierre and Fort Pierre area. The formation of this ice cover at times has resulted in street flooding. The Bad River delta, which has raised the water surface for both open-water and ice-affected flows, exacerbates this problem. As a result, powerplant release restrictions have been imposed during critically cold periods. The previously discussed Corps project will reduce flood damage potential, which will allow for some reduction in these restrictions.

7-04.9.6.4. **Big Bend.** Big Bend discharges directly into Lake Francis Case, consequently, no restrictions on winter releases are necessary.

7-04.9.6.5. **Fort Randall.** Although the ice-covered Missouri River channel between Fort Randall Dam and the head of Lewis and Clark Lake could sustain higher discharges without resulting in damages, the average winter season release from Fort Randall is normally limited to about 15,000 cfs. This release restriction is due to the restricted ice-covered channel capacity below Gavins Point Dam combined with the small amount of storage space available in Gavins Point reservoir to re-regulate flows in this downstream project. Additionally, System regulation associated with an average winter release of 15,000 cfs from Fort Randall represents full winter service to the power function of the System. Winter release rates when the channel is ice covered may be increased gradually to average 25,000 cfs or slightly more when it is deemed necessary to evacuate accumulated flood storage.

7-04.9.6.6. **Gavins Point.** In the reach of the Missouri River from Gavins Point Dam to Kansas City, Missouri, ice jams can and have caused flood damage. This reach is particularly vulnerable due to intermittent freeze-ups and breakups of Missouri River ice cover throughout the winter. This reach of the river valley is also highly developed relative to the rest of the basin; therefore, there is a high flood damage potential related to serious ice jams. There has been ice-jam-related flooding during extremely cold winters when much of the Missouri River below the System is ice covered. The long travel time to this reach of the river makes river-icing problems particularly difficult, if not impossible, to resolve with System release changes. Normally, any attempt to modify the result of the river icing this far downstream, results in a risk to upstream ice cover and potential flooding. Experience has demonstrated that the icing situation normally resolves itself before the System release change arrives at the problem location. The travel times during open-water periods are 5 to 10 days to this reach, and, when ice cover is present, these times are extended considerably. Additional degradation of the Missouri River in the Sioux City vicinity has permitted the maximum Gavins Point winter release rate to be increased from 20,000 cfs up to 30,000 cfs. Open-water stages corresponding to a release of 30,000 cfs today are essentially the same as they were previously with a 20,000 cfs release. At times, reductions below the 25,000 cfs level may be necessary due to the formation of severe ice blockages in the Gavins Point to Sioux City reach.

7-04.9.6.6.1. During periods of extended drought, recent experience indicates an average winter release of 12,000 cfs with increases up to 18,000 cfs during river ice formation periods is required to meet winter water supply needs downstream of Gavins Point Dam extending as far as the Kansas City metropolitan area. When the System was first filled, the downstream reach of concern during the winter was much shorter, mostly confined to the Missouri River reach from Gavins Point Dam to Omaha, Nebraska. Additional years of degradation have, however, resulted in moving the most affected area downstream to at least Kansas City. It should be noted that most of these winter water supply problems are related to intake access problems that need to be corrected by the intake owners; however, a large number of problem areas may be an indication that it is more than just an access problem. The Corps updates a Missouri River Stage Trends Report each year that discusses the degradation and aggradation that is occurring on the Missouri River. The report shows graphically the effects of degradation or aggradation during the past several years for specific Missouri River locations at various levels of flow. Some intake owners have used this report in planning for adequate water supply access.

7-04.10. **System Flood Control Considerations During the Open-Water Season.** Maximum releases during the open-water season are based on downstream channel capacities at all times that flood control storage space is available to control existing or forecasted inflows.

7-04.10.1. **Use of Upper Three Reservoirs.** To the extent reasonably possible, the available flood control storage space available in the three upper System reservoirs, Fort Peck, Garrison, and Oahe, will be used for the control of floods in preference to the flood control storage space available in the three lower System reservoirs. The allocated flood control space in the downstream Big Bend, Fort Randall, and Gavins Point projects will be used to the degree necessary to re-regulate upstream System reservoir releases and to control runoff originating below the Oahe Dam drainage area.

7.04.10.2. **Balancing Available Flood Control Space.** To the extent reasonably possible, a balance of the vacant storage space (in terms of percent of allocated space) within both the Annual Flood Control and Multiple Use Zones and Exclusive Flood Control Zones will be maintained between the three larger upper; Fort Peck, Garrison, and Oahe projects when the flood control storage in the System is taxed or expected to be taxed by forecasted inflows. When flood control storage zones are more than able to contain forecasted inflows, departures from storage balance criteria will be permitted in the interest of enhancing other Congressionally authorized purposes. It should be recognized that, in the event of extreme deviations in expected runoff at individual System projects, some time will be required to achieve a storage balance in the upper three reservoirs without causing downstream damaging flows.

7-04.10.3. **System Flood Control Evacuation Priority.** Evacuation of System flood control storage immediately following the capture of flood runoff will be accomplished, insofar as practical, on the basis of established priorities in the order as follows:

1st Surcharge Storage from all of the System reservoirs.

2nd Exclusive Flood Control Storage Zones in the three lower reservoirs (Big Bend, Fort Randall and Gavins Point).

3rd Exclusive Flood Control Storage Zones in the three upper larger reservoirs (Fort Peck, Garrison, and Oahe).

4th Annual Flood Control and Multiple Use Zone in Gavins Point and in Fort Randall above elevation 1360.0 feet msl. Evacuation of Fort Randall storage below elevation 1360.0 feet msl is greatly influenced by power loads and the required power generation at Oahe and Big Bend

5th Annual Flood Control and Multiple Use Zones in the three upper projects (Fort Peck, Garrison, and Oahe). In general, evacuation of at least the upper portions of the Annual Flood Control and Multiple Use Zones in the three upper reservoirs should be conducted in such a manner as to maintain a balance of available allocated space within all three of the large reservoirs. Due to the restricted channel capacity below Fort Peck, it may be necessary, depending on conditions, to distort this balance to assure the evacuation of that System project.

6th Evacuation of the Annual Flood Control and Multiple Use Zone storage space will be made in a manner that, to the extent reasonably possible, will assure complete evacuation of this space prior to the beginning of the next flood runoff season while achieving the maximum beneficial conservation use of the stored water based on the operational objectives stated in this manual. The serious hazard of downstream flood damages in the case of late fall or winter ice conditions may make complete evacuation of Annual Flood Control and Multiple Use Zone prior to the next flood season inadvisable. In certain extreme high water years, there being a lesser risk associated with leaving some water in the Annual Flood Control and Multiple Use Zones as opposed to continuing the evacuation and, possibly, contributing to downstream flood damages during the late fall and winter months. Even in these high water years, a major portion of the Annual Flood Control and Multiple Use Zone will be evacuated prior to the next runoff season.

7-04.11. **Scheduling of System Releases.** The flood control purpose of the System continues to be a major consideration in scheduling System releases, irrespective of the amount of water contained in the System or the character of inflows to the System. Multipurpose regulation techniques described in this Master Manual are consistent with the flood control objectives. During the winter months, multipurpose releases are restricted due to the possibility of ice formation and consequent severe loss of channel capacity. Downstream flow support releases during the open-water season are based on maintaining specified target flows at downstream control points. This type of multipurpose regulation serves flood control and the other downstream purposes most of the time.

7-04.11.1. There are times, however, when the service provided to other purposes must be modified in the interest of the flood control objective. During winter months, severe ice jams can form on the Missouri River below Gavins Point Dam, even with the restrictions to System releases that are imposed during the winter season. Because this is the non-crop season, flood damages associated with the resultant high Missouri River stages are, fortunately, usually much less than would occur if similar stages were experienced during the summer season. Particularly severe ice jamming could result in flooding of property susceptible to flood damage; therefore, when severe ice jamming is occurring at downstream locations, a reduction in System releases may be warranted. While past experience indicates that those release reductions will have very little effect on stages associated with the jams, action by the Corps will indicate awareness of the problem and the desire to alleviate the adverse conditions. Such release reductions will usually be only temporary, extending, at the most, for a week or two. The overall level of service to other System purposes can usually be maintained by increasing releases after the river ice cover stabilizes. At other times, it is prudent to increase System releases prior to the onset of expected river ice buildup or even during a significant ice jam. Experience during recent years indicates that increasing System releases speeds the recovery of the Missouri River to more normal stages and assures that the downstream water intakes are operational sooner or affected less by the icing condition. The Corps will evaluate each ice-jam situation on a case-by-case basis and make a determination regarding the appropriate release.

7-04.12. **System Service Level.** Because the ability to evacuate System storage is severely restricted during the winter months, the necessary increases in System release rates for storage evacuation purposes above the rates necessary for navigation and other authorized purposes will largely be made during the navigation season. The methodology to determine releases to evacuate flood storage and reduced System releases during periods of downstream flood events is an extension of the "service level" and "target flow" concepts described in Paragraphs 7-03.2 through 7-03.2.1.1 of this chapter. Basic to use of the "service level" concept is a definition of the minimum and maximum service levels that can be maintained while meeting the other regulation objectives.

7-04.12.1. **Flood Control Considerations for the System Minimum Service Level.** As discussed earlier in this chapter, the minimum open-water level that will sustain the navigation purpose throughout the Missouri River navigation project is the 29,000 cfs service level. Target flows for this service level are 25,000 (29,000 - 4,000) cfs at Sioux City, Iowa and Omaha, Nebraska, 31,000 (29,000 + 2,000) cfs at Nebraska City, Nebraska and 35,000 (29,000 + 6,000) cfs at Kansas City, Missouri. Making release reductions below this service level for flood control purposes could have serious adverse effects on navigation, downstream recreation, and water supply. Adverse effects on power production are also quite probable with sharply reduced System releases. Release reductions to below the minimum navigation service level should, therefore, be made only when it is reasonably assured that the reductions will be of significant benefit from the flood control standpoint. Reductions below the minimum service level will not be made without consideration of the effects on other project purposes.

7-04.12.2. **Flood Control Considerations for the System Full-Service Level.** The full-service level of downstream open-water flows is 35,000 cfs. This is the flow necessary to meet the navigation channel requirements along with all other Congressionally authorized project purposes, such as water supply and recreation, served below the System. Missouri River target flows for this service level are 31,000 cfs at Sioux City and Omaha, 37,000 cfs at Nebraska City and 41,000 cfs at Kansas City. Navigation and some other authorized purposes are enhanced to some extent by flows in excess of those provided by this full-service level. Powerplant capacities of the downstream powerplants are also generally sufficient to use System release rates somewhat in excess of those necessary for full-service flows. Any enhancement to navigation and power production would be negligible for service levels increased beyond the 45,000 cfs service level. System releases above 45,000 cfs may, however, be necessary for flood storage evacuation purposes.

7-04.12.2.1. During the winter season, a 5,000 cfs or higher release level from Fort Randall Dam can be sustained during all past hydrologic conditions since 1898 with the present level of water resource development. Reductions below this level will not be made. The full-service winter level corresponds to a 15,000 cfs average winter release from Fort Randall Dam. Past experience has indicated that the winter release level can be increased to 25,000 cfs from Gavins Point Dam with only a modest increase in the potential for downstream ice-jam flooding. This increased potential is held to a minimum by selective release scheduling through the winter season, based on temperature forecasts and observations of current or forecasted ice conditions. In high runoff years when complete evacuation of the accumulated flood control storage during an extended navigation season would result in release rates that are substantially above normal, consideration will be given to scheduling winter System releases in the 25,000 to 30,000 cfs range to provide the most effective overall System flood control regulation.

7-04.13. **System Service Level Selection for Flood Control Evacuation.** Selection of the appropriate service level for flood storage evacuation purposes in excess of the full-service level is dependent on anticipated runoff from the Missouri River drainage area above the System; depletions to this runoff that can be expected to occur prior to the time this runoff appears as inflows to the System reservoirs; current storage conditions in the System and in the major tributary reservoirs located above the System; and evaporation from the System reservoirs. Plate VI-1 was developed to determine the service level at any time during the year. This plate relates the annual water supply and time of year to the appropriate System service level. If a significant growth in depletions occurs, appropriate revisions should be made to Plate VI-1. The revisions would be necessary because the water supply necessary to maintain the indicated service level is based on depletions expected. Determination of water supply is made based on a combination of (a) forecasted runoff above Gavins Point Dam from the current date through December, (b) current amount of water in System storage, and (c) the tributary reservoir storage deficiency.

7-04.13.1. **Forecasted Runoff.** The forecasted runoff for the remainder of the current calendar year is developed by procedures described in Paragraph 6-04.1.1 of this Master Manual, with specific forecast techniques described in detail in MRD-RCC Technical Study MH-73.

7-04.13.2. **Tributary Storage Deficiency.** The current tributary water-in-storage deficiency is developed by first accumulating the current reservoir water-in-storage in each of the 10 tributary USBR reservoirs listed in Table VII-6. All of these reservoirs are located above the System. These reservoirs, when filled to levels that can be expected during years of excess runoff, have a storage capacity of over 6 MAF. For the purpose of determining an appropriate System service level, a 5.5 MAF level of tributary reservoir storage was selected as the base level for computation of an acceptable water-in-storage level condition by March 1 of the next year. If there is currently more water than 5.5 MAF, the difference is subtracted from the water supply value computed for use in Plate VI-1, and vice versa, as a second step in the computation.

Table VII-6
USBR Projects Used for Calculating Tributary Storage Deficiency for the Water Supply Computation

Lima	Tiber
Clark Canyon	Bull Lake
Hebgen	Boysen
Canyon Ferry	Buffalo Bill
Gibson	Yellowtail

7-04.13.3. **Future Adjustments to Service Level.** It can be expected that future adjustments to Plate VI-1 may be required. Several factors and past history indicate that changes in tributary reservoir storage and in System storage due to sedimentation and other factors may require some adjustment when they become significant. Also significant Missouri River basin depletion changes may require adjustment. A significant change in release patterns for any reason may require the information provided on Plate VI-1 to be adjusted since it assumes a steady flow will be provided throughout the remainder of the period.

7-04.13.4. **Determining the Service Level for Flood Control Evacuation.** Plate VI-1 presents water supply (System water-in-storage plus anticipated runoff into the System for the remainder of the year) evacuation curves. Releases based on the curves can be expected to result in the evacuation of the System to the base of the Annual Flood Control and Multiple Use Zone, provided scheduled winter releases can also be maintained, by the following March 1. Determination of the appropriate service level is accomplished by computing the current tributary reservoir water-in-storage excess or deficiency and adding or subtracting it from the current actual System water-in-storage. The resulting water-in-storage is then added to the forecasted remaining calendar year runoff into the System to obtain the current water supply value. The water supply value, which is computed as described above, is then used to enter Plate VI-1. By following the water supply value horizontally to the current date, the appropriate service level on which System releases should be based is determined. Forecasted runoff is an essential (Plate VI-7 shows an example of the calendar year forecast) component to determining the service level. Because forecasts of future runoff (which may not materialize) are basic to the use of this plate, and because the potential for downstream tributary flood runoff is greater during the spring and early summer months, the service level provided should not be increased above the 35,000 cfs, full-service level prior to July 1 unless an indicated service level of 40,000 cfs or greater is identified by using Plate VI-1. This limitation provides a factor of safety in favor of the flood control purpose. For service level determinations below full-service, release rates are computed based on actual water-in-storage checks discussed in this chapter and on Plate VI-1. The March 1 date indicators on the curves are consistent with the service level definitions defined in this chapter.

7-04.14. **System Expanded Full-Service Level.** The 35,000 cfs service level is considered to be the full-service level for meeting all authorized purposes of the System. The initial increase above this full-service level has been designated as the "expanded full-service level" and consists of extending the navigation season 10 days beyond its normal closing data of December 1 at the mouth of the Missouri River. Additionally, as a storage evacuation measure, winter releases averaging 20,000 cfs will be scheduled from Gavins Point Dam. While a primary purpose of this expanded full-service is for the evacuation of storage space in the System, it also benefits the other authorized purposes. An additional 10 days of navigation service also results in the transfer of a substantial block of power from the normal fall navigation season, when power is relatively abundant, to the winter season. In some years, ice conditions may preclude this extension, and, if such occurs, it may be necessary to carry a minor amount of excess water over to the succeeding flood season. In recognition of ice problems that may occur, releases during the 10-day extension of the navigation season will be made at the full-service level unless storage evacuation requirements are such that higher releases are deemed necessary. The announcement of this expanded service should be made as soon as it is determined to allow the downstream users to take full advantage of the 10 days of higher flows.

7-04.15. **System Reservoir System – Missouri River Flood Target Flows.** Normally, the difference between the selected service level and target flows at control points below the System will be the same for evacuation of flood storage as for normal navigation or downstream flow support releases. This results in Missouri River flow targets located at Sioux City and Omaha of 4,000 cfs less than the current service level, at Nebraska City of 2,000 cfs greater than the current service level, and at Kansas City of 6,000 cfs greater than the current service level. Similar to navigation or downstream flow support targets, storage evacuation targets are for minimum flows at the controlling flow target location. For example, with a 40,000 cfs service level, a target flow of 42,000 cfs at Nebraska City might be controlling with Sioux City, Omaha, and Kansas City forecasted flows in excess of their respective targets of 36,000, 36,000, and 46,000 cfs, respectively. When target flows at the non-controlling locations approach critical levels from a flood damage standpoint, the service level-target flow concept is modified to emphasize System regulation for downstream flood control instead of navigation support or System storage evacuation.

7-04.16. **Missouri River Flood Target Flows – Full-Service Provided.** As a flood control measure, the normal relationship between service levels and target flow levels may be modified when large amounts of tributary inflow are forecasted between Gavins Point Dam and the downstream flow target control points. Criteria for these modifications are presented in Table VII-7. For example, if the current service level were 40,000 cfs, System releases would be reduced consistent with the full-service level if it were deemed necessary to maintain flows at or below 46,000 cfs at Omaha, 52,000 cfs at Nebraska City, or 76,000 cfs at Kansas City. These target flows may be modified by up to 5,000 cfs after consideration is given to antecedent, current, and projected hydrometeorological conditions. Modification of target flows to the full-service levels provides a safety margin for the inability to accurately forecast downstream tributary runoff and from unexpected rainfall. There are, however, conditions during large runoff years similar to 1997, when the above criteria must be replaced with a System regulation approach that will result in the best flood control for the lower river. Repeated reductions in System releases early in the runoff season will likely result in the need to make higher System releases to evacuate accumulated floodwater later in the season. The progressive increase in System releases must be evaluated against the approach of taking some small flood risk over a longer period of time and providing a slightly higher System release initially.

Table VII-7
Criteria for Modifying Target Flows – Full Service

Target flows will be reduced to those consistent with the full-service level of 35,000 cfs when one or more of the anticipated downstream flows exceed the current service level flow values by more than:	
6,000 cfs at Omaha	(target flow plus 10,000 cfs)
12,000 cfs at Nebraska City	(target flow plus 10,000 cfs)
36,000 cfs at Kansas City	(target flow plus 30,000 cfs)

7-04.17. **Missouri River Flood Target Flows – Minimum Service Provided.** As an additional flood control measure for the lower Missouri River, the normal relationship between minimum service levels and target flow levels will be modified when large amounts of tributary runoff are forecasted or occurring between Gavins Point Dam and the downstream flow target control points. Selected criteria for these modifications are noted in Table VII-8. These target flows may also be modified by up to 5,000 cfs after consideration is given to antecedent, current, and projected hydrometeorological conditions. Modification of target flows to the minimum service levels provides even a greater safety margin (than to the full-service level) for the inability to accurately forecast downstream tributary runoff and from unexpected rainfall. There are, however, conditions during large runoff years similar to 1997, when the above criteria must sometimes be replaced with a System reservoir regulation approach that will result in the best flood control for the downstream reach for the entire flood runoff season. Repeated reductions in System releases early in the runoff season will result in the need, later in the season, to make higher System releases to evacuate accumulated floodwater. The progressive increase in System releases must be evaluated against the approach of taking some small flood risk over a longer period of time. This System flood control approach is accomplished by providing a slightly higher System release initially or earlier in the flood runoff season and, therefore, lower flows are provided later in the year. This flood control reservoir regulation approach is at times the preferred option when it is known the flood runoff season will be extended because of the large volume of runoff expected.

Table VII-8
Criteria for Modifying Target Flows – Minimum Service

Target flows will be reduced to those consistent with the minimum service level of 29,000 cfs in order that one or more of the anticipated resultant downstream flows exceed the current service level flow value by more than:	
11,000 cfs at Omaha	(target flow plus 15,000 cfs)
22,000 cfs at Nebraska City	(target flow plus 20,000 cfs)
66,000 cfs at Kansas City	(target flow plus 60,000 cfs)

7-04.18. **Coordination of System and Tributary Reservoir Flood Control Releases.** At Kansas City, the farthest downstream control point used for scheduling System releases, control of streamflow is also provided by tributary reservoirs located in the Kansas River basin. Flood control regulation criteria and techniques applicable to the Kansas River basin reservoir projects when this competition does not exist are described in the Kansas River Basin Master Manual and in the project manuals for individual Kansas River basin reservoirs. At times, however, competition will exist between the two reservoir systems for use of the available Missouri River channel capacity at Kansas City and downstream. When storage evacuation is required from the Kansas basin reservoirs, coordinated regulation of the two systems of reservoirs will proceed as follows.

7-04.18.1. If the System water supply is such that a service level of 35,000 cfs or less is applicable, Kansas River basin reservoirs will have priority for the Missouri River channel capacity below Kansas City. Target flows on the Missouri River upstream from Kansas City will be reduced up to the minimum service level (if required) so that System releases do not contribute to forecasted Kansas City flows in excess of the current System service level flow value plus 66,000 cfs.

7-04.18.2. Releases from Kansas River basin reservoirs with accumulated flood control storage in Phase II or higher will have priority over System releases for the available channel capacity, irrespective of the current System service level. System releases will be scheduled as described in Paragraphs 7-04.16 or 7-04.17 after consideration is made of the effects of Phase II and Phase III releases from Kansas River basin reservoirs on Kansas City target flows.

7-04.18.3. If System storage evacuation requires a service level greater than the 35,000 cfs level, the System release requirements will have priority over releases from Kansas River basin reservoirs with accumulated flood control storage in the Phase I zone. Releases from the Phase I zone of Kansas basin reservoirs will be scheduled on the basis of System releases made in accordance with criteria given in Paragraphs 7-04.16 or 7-04.17.

7-04.18.4. During the period of flood storage evacuation from the Kansas River basin reservoirs, close coordination between the Corps' Kansas City District water control office and the RCC is required for the development of release schedules. This coordination consists of the following actions.

7-04.18.4.1. The Kansas City District water control office will develop release schedules for their tributary reservoirs with storage levels in Phase II or higher and furnish the resultant forecasted flows of the Kansas River at Desoto, Kansas to the RCC in a timely fashion so that it can be integrated into the RCC's daily Missouri River streamflow forecast. Based on the above, the RCC will schedule releases from the System and furnish this schedule to the Kansas City District in the form of the RCC's Missouri River streamflow forecast. The Kansas City District will then take advantage of any remaining Missouri River channel capacity available at Kansas City and downstream Missouri River locations to schedule releases from reservoirs in the Phase I zone.

7-04.19. **Lower Missouri River Flood Flows.** Because the water travel time to Missouri River locations below Kansas City is over 6 days from Gavins Point Dam, the Kansas City flow target location is the most downstream location for which System releases will normally be scheduled based on a forecast. Experience has shown that predicted hydrologic conditions that could produce large rainfalls are only mildly accurate for periods 3 to 6 days in advance and are not accurate for periods more than 6 days in advance. If System release reductions will not result in missing flow targets and hydrologic forecasts indicate that System release reductions will result in flood damage reductions below Kansas City, a reduction in System releases will be scheduled. This should not be attempted if it will significantly impact System or tributary reservoir flood storage evacuation. Due to the long-range forecasts required and the current state-of-the-art forecasting technology, such System release reductions for this purpose will seldom be necessary except during severe, prolonged downstream flooding periods. Requests for coordinated flood storage evacuation from the System due to flooding on the Mississippi River have occurred in the past. This regulation has been requested even though there are no flood control targets below Kansas City or on the Mississippi River. These requests are rare and difficult to achieve because of the travel time involved. If System regulation changes can be accomplished without significant adverse affects, they should be attempted. There have been times when the RCC has also been requested to coordinate tributary reservoir releases from Corps' projects located in the

Kansas City District to minimize flood crests on the Mississippi River. These actions have proven beneficial to preventing or reducing flood damages on the Mississippi River.

7-04.20. **Individual System Project Reservoir Regulation Techniques.** Volumes 2 through 7 of the Mainstem Reservoir Regulation Manual series present the details necessary for integrating regulation of the individual System reservoirs with System regulation described in this volume. Paragraph 1-02.1.in this manual presents an explanation of the Mainstem Reservoir Regulation Manual series. While regulation of many of the tributary reservoirs in the Missouri River basin is independent of System regulation, integrated regulation will, at times, be required. Paragraph 7-04.18 describes the coordination necessary in regulating Kansas River basin reservoirs. Individual System project manuals describe coordinated regulation with those tributary reservoirs that are most closely related with each individual System project, particularly those tributary reservoirs that have System replacement flood control storage, as described in Paragraph 7-04.4.1.of this manual.

7-04.20.1. During extreme floods approaching the magnitude of the greatest floods of historical record, it is quite probable that surcharge regulation will be required of one or more of the System projects. If such an event were to occur, System regulation would be conducted largely on a reservoir-by-reservoir basis and would be based on techniques described in the individual project manuals. System releases would be as defined by the Gavins Point procedures. In the event of a prolonged communications failure between the RCC and individual projects, System release rates would be scheduled according to the emergency procedures outlined in the individual System project manuals.

7-04.21. **Responsibility for Application of System Reservoir Regulation Techniques.** Due to the necessity for integrated regulation to secure the maximum degree of beneficial use from all System storage, the RCC will be responsible for, and will direct, the regulation of all the System reservoirs in accordance with the relationship between the RCC and District offices outlined in Chapter VIII of this manual. Such direction will normally be in the form of regulation orders to the System projects that specify releases to be maintained, the permissible fluctuations in this release rate, and the period through which the order will be applicable. The respective District offices provide personnel for operation and maintenance of the projects and are responsible for the physical manipulations necessary to carry out the directives.

7-04.22**. Responsibility for System Dam Safety and Emergency Regulation.** Although regulation procedures for the System and individual System reservoirs are normally developed in the RCC, it is the responsibility of the District to maintain adequate provisions for maintaining the integrity of the System dams at all times. The RCC will be informed, and a specific method of System or individual reservoir regulation may be recommended by the District at any time it is believed that any part of a project’s dam structure may be endangered by existing or anticipated conditions. In addition, the RCC will be advised when local flood conditions are such that improved conditions may result by specific methods of System reservoir regulation. The RCC will consider this information and field recommendations in conjunction with other known existing conditions in the basin prior to issuing System project regulation instructions. If Corps staff believes that the integrity of a dam is endangered and communications with the RCC are not possible, the project office and/or the District office may modify instructions (regulation orders) to ensure the safety of the structure. When communication with the RCC is impossible and the project/s are under emergency conditions, the District or project is entirely responsible for application of emergency regulation techniques. Paragraph 7-16 of this chapter contains a more detailed discussion regarding System emergency regulation procedures.

7-04.23. **Responsibility for Flood Control Reservoir Regulation Coordination in Missouri River Basin.** Normally, tributary reservoir regulation is a function of the Districts with pertinent reservoir regulation information furnished to the RCC. When tributary reservoir regulation affects Missouri River flood flows or navigation on the Missouri River, tributary reservoir regulation will, however, become a direct concern of the RCC. During such periods, the RCC will issue pertinent tributary reservoir regulating instructions so that flood damages may be held to a minimum through integrated regulation of all flood control reservoirs in the Missouri River basin. The appropriate District, with only nominal Division supervision, will direct tributary reservoir regulation during periods of tributary floods not extending to the Missouri River. The provisions of Paragraph 7-04.22 of this manual regarding safety of the project and conflicts between local and general flood protection will also apply to tributary reservoirs during periods when they are regulated as directed by the RCC. The Corps' Guidance Memorandum entitled, "Reservoir Control Center (RCC)", dated March 1972, serves as the document that details the role and responsibilities of the RCC in managing and regulating the System, including the coordination responsibilities for the regulation of tributary reservoirs during major flood control events.

7-04.24. **Reporting of System Flood Control Operations.** Status reports regarding System flood control operations are prepared by the RCC and provided to key Division and District offices on an immediate basis. The reports are normally distributed by email and/or posted to the internal Corps website. The Power Plant Control System (PPCS) allows RCC staff access to all System projects to obtain real-time System data such as instantaneous releases from each power unit, spillway releases, outlet tunnel flows, and reservoir elevations. This information is transmitted automatically to the RCC database on an hourly basis. Once these data are received in the RCC, reservoir storages and inflows are calculated. Even with all the project data available to the RCC, it is sometimes necessary and prudent for RCC staff to speak directly to the project staff to assess any potential problems with the project, its major features, or any matter that could affect future project release decisions. During severe flood periods, daily summaries of hydrologic conditions and reservoir regulation will be furnished to Office of the Chief of Engineers by the District Engineer. Various types of information relative to floods are required in the flood control operations status reports including reservoir name, reservoir elevation, forecasted maximum elevation and associated date, current and forecasted rates of inflow and outflow in cfs, percent of flood control storage used to date, and any other specific information pertinent to the flood situation. Coordination is required with the RCC prior to the Districts furnishing this information relating to the System to the Chief of Engineers.

7-04.25. **Monthly System and Tributary Reservoir Reports.** Each month, the RCC prepares a reservoir summary report, also referred to as an MRD 0168 Report, for each System project, indicating daily reservoir elevation, storage, inflow, release, and estimated evaporation. The appropriate District office prepares the same report for each of the Corps' tributary reservoirs and all USBR tributary reservoir projects having flood control as an authorized purpose. The District reports are either provided to the RCC electronically or the data to create the report is available in the RCC database.

7-04.26. **Historical Examples of System Regulation During Major Floods.** Although Fort Peck was placed in operation in 1937, additional projects on the System were not operable prior to the 1950's and early 1960's. Limited System regulation was initiated in 1953, following the closure of the Fort Randall embankment in 1952 and Garrison in 1953. Gavins Point was closed in 1955, Oahe in 1958, and Big Bend in 1963. Although this completed the embankment closures on the System, regulation of the System was somewhat limited in the early years of regulation by project construction and the completion of real estate activities. In July 1966, installation of all of the present power units was completed, and the following summer the System reservoirs reached their base of the Annual Flood Control and Multiple Use Zones for the first time. Only since that time, have the individual System reservoirs, therefore, been regulated as a completely integrated System. Appendix A contains the historical examples of flood since the system was completed in 1967.

7-04.26.1. **System Storage Accumulation.** Initial fill of the System was accompanied during a period of below-normal runoff from the Missouri River drainage area above the System. Runoff was well below normal during each year of the 8-year period, extending from 1954 through 1961. The cumulative effect of these low-runoff years resulted in the second most severe drought period for the Missouri River basin since 1898. Runoff above the System averaged somewhat above normal from 1962 through the mid-1980's with well-above-normal amounts occurring in some years. The 6-year drought extending from 1987 through 1992, represented a particularly challenging System regulation period. The 1990's represent the highest runoff decade of the past century. As of the writing of this manual (March 2004), the System has been experiencing drought conditions since 2000. Plate VII-2 illustrates month-by-month accumulation of water in the System and its distribution in the individual System reservoirs. As shown on Plate VII-2, the Carryover Multiple Use Zone was first filled in 1967. Since 1967, the volume of water in System storage has generally remained within the Annual Flood Control and Multiple Use Zone that extends from 57.1 MAF to 68.7 MAF. The typical annual variation of the amount of water in System storage shown on Plate VII-2 reflects the normal accumulation of water-in-storage during the March through July flood season and normal evacuation of accumulated water to regain this space during the remainder of the year.

7-04.26.2. **System Regulation Effects on Streamflow.** The accumulation and evacuation of water in System storage has had a major effect on streamflow below the System. Plate VII-3 presents hydrographs of mean monthly flows at Yankton, South Dakota, which is immediately below Gavins Point Dam, since the System has been fully operational. The flows at Sioux City consist primarily of Gavins Point Dam releases. Unregulated flows are determined at various sites for the purpose of calculating flood damages prevented. Unregulated daily flows are determined by representing the regulated flows adjusted for upstream reservoir effects. The upstream reservoir effects include storage of runoff, evaporation from the reservoir surface, and precipitation directly on the reservoirs. The reservoir effects used in the development of unregulated flows include those from major tributary reservoirs and the System projects. The major portion of the reservoir effects results from regulation provided by the System. Unregulated flow development was on a mean daily basis, and only the mean monthly flows are shown on Plate VII-3.

7-04.26.3. The 1967, 1972, 1975, 1978, 1993, and 1997 hydrographs illustrate the effects of System regulation on substantial flood inflows. Plates VII-4 through VII-9 also illustrate characteristic patterns of releases from the System. Data to produce similar hydrographs that indicate System regulated versus unregulated flows are stored on the RCC database. The data are available for all years of regulation since 1950 and for other locations within and below the System. Complete write-ups for each year are on file as separate reports in the RCC.

7-04.27. **Regulation During Extreme Floods and During Emergencies.** The following paragraphs briefly describe the System flood control regulation procedures for extreme floods and during emergencies.

7-04.27.1. **System Regulation During Extreme Floods.** During extremely large foods that may use all of the flood control storage zone capacity provided in any of the individual System projects, regulation will primarily be based on conditions affecting that particular project rather than the System as a whole. Examples of regulation during this type of flood are, consequently, not included in this manual. Individual System project water control manuals address this subject with the Gavins Point manual providing the best example of System releases that could be expected to occur during such events. The effects from individual project regulation will be integrated into a System model to balance the effects throughout the System and afford greater flood control downstream than that provided by any one project. Paragraph 7-04.10.3 of this Master Manual describes the flood storage evacuation priority order for the System and individual projects. The System daily and long-range study simulation models discussed in Chapter VI include this evacuation priority as a normal regulation procedure. Further model refinement is provided by manually adjusting individual project and System releases to achieve the desired result.

7-04.28. **Emergency Procedures.** Regulation criteria in the event of a communications failure with the RCC are detailed in individual project manuals and their associated instructions to project personnel for such events. Examples of their application are contained in individual System project water control manuals.

7-04.29**. System Flood Control Storage Analysis.** This manual presents a new CWCP primarily making changes to the drought conservation measures used for System regulation. Normal and flood control System reservoir regulation procedures have not been changed, but they have been updated to reflect current conditions. The amount of System flood control storage space required has been analyzed in depth for the Master Manual Study. Results indicate that very little additional flood control benefit could be obtained from additional flood control storage space in the System. In general, much of the basin lies below the System. That fact has prevented, and will continue to prevent, the System from controlling all flooding along the Missouri River. Normally, enough vacant space exists in the System prior to the runoff season to control the significant floods that occur above the System, as demonstrated by the 200-percent-of-normal event that occurred in 1997. This storage normally provides the additional space needed to provide for an extensive reduction in System releases to control downstream flooding. The decade of the 1990's provided four of the top seven basin runoffs that occurred in the 106-year Missouri River basin historic runoff record (1898-2003). Regulation of these runoffs has refined the System flood control techniques described in this chapter and provided many examples of successful System flood control regulation. Study and refinement of System flood regulation techniques will continue along with research and development to improve the long-range forecasting of expected runoff in the Missouri River basin.

7-05. **Multipurpose Regulation Plans.** In the course of the planning, design, construction, and regulation of the System, many long-range regulation studies have been made to establish and demonstrate the capabilities of the System to meet the many project purposes and to establish criteria for planning, design and regulation purposes. Other shorter-term studies, on a continuing basis, lead to AOPs, 5-year projections, and many other special purpose plans. These studies provide a sufficient volume of predetermined vacant storage capacity at each of the System reservoirs at the beginning of the flood season; therefore, they recognize the flood control purpose. The daily routing model (DRM), which uses a daily time-step, serves as a useful tool in the examination of detailed flood control regulation criteria and the other project purposes.

7-05.1. **Long-Range Regulation Studies.** Long-range regulation studies of the System encompassing the hydrologic period from 1898 to the time of the study have been referred to previously in this manual, particularly in Chapter VI, Hydrologic Forecasts, Paragraph 6-04. Long-Range Forecasts, where some of the limitations of these studies were discussed. Major studies have been published and distributed to interested Corps offices, USBR, Western, and others**.** The RCC has a list of the major studies performed in the past and pertinent data as to the basic conditions assumed in their performance. Future studies by the RCC will be needed to evaluate proposed Adaptive Management actions and other regulation considerations as the System matures under this updated water control plan.

7-05.2. **Service to System Authorized Purposes.** The long-range regulation studies demonstrate the service (e.g., flows, reservoir levels, and power generation values) that the System is expected to provide for the basic purposes under various scenarios with differing levels of basin development and conditions of water supply. They also serve to examine variations in regulation criteria and in this manner keep criteria consistent with changing emphasis upon specific purposes through the years. The latest studies reflect current conditions (or near-term anticipated future conditions) and the service to purposes provided by the System under current criteria included in the Master Manual.

7-06. **Emergency Regulation Procedures (Standing Instructions to Dam Tender).** The Standing Instructions to the dam tender that would be used in the event that communication is lost with the RCC are contained in the individual System project water control manuals and are not repeated in this document. Those instructions are to be used only in the event of a significant communication failure over an extended period of time that results from a catastrophic event. The RCC uses real-time simulation modeling to effectively regulate the System and this cannot be replicated in the instructions to the dam tenders. These orders serve only as a temporary way of bridging the time period between not having orders and until RCC staff can run their models and issue new orders. The RCC normally schedules each of the System projects for more than 1 day into the future, many as long as the next week. It is unlikely, even in a significant communications failure, that the System projects would not have Power Production and Reservoir Regulation orders with which to regulate the project.

7-07. **Flood Control Purpose System Regulation.** The discussion of the planning and subsequent regulation for the flood control purpose of the System constitutes a major portion of this Master Manual. The planning of the sizing of the individual Mainstem project flood control zones is described above and in Appendix A. The reservoir regulation of the System for flood control is detailed in the paragraphs above. Storage of large runoffs in the System for multiple purpose use later by releasing during low-flow periods is consistent with the Congressionally authorized flood control purpose. Similarly, storage of water for the control of floods is also compatible, to a great extent, with multiple purpose regulation of the System. The flood control purpose of the System will be given the highest System priority during periods of significant runoff when loss of life and property could occur. Regulation efforts will be made to minimize these losses. The flood damage prevention provided by the System has been greater than originally envisioned because of the protection provided to the critical urban areas in the basin during the 1993 and 1997 flood events. Plate VI-2 identifies the flood damages prevented to date by the System. The $24.8 billion in accumulative damages prevented by the System exceeds the cost of building the entire System in today's dollars. Several specific years (1993, 1995, 1996, 1997, and 1999) have resulted in more than 60 percent of the total damages prevented, primarily due the protection of downstream urban areas located below the System. The unpredictability of these major flood events means that, to fulfill the flood control operational objective of the System, the Exclusive Flood Zone should be kept empty except during major flood events. This unpredictability also means that the System should normally be at the base of the Annual Flood Control and Multiple Use Zone (57.1 MAF) prior to the beginning of the flood season. The use of Plate VI-1 as a guide in determining the service level for evacuation of water captured in the Exclusive Flood Control and the Annual Flood Control and Multiple Use Zones and for normal and conservation regulation is discussed in Chapter VI and above. This plan was developed with the intent of fully meeting the Congressionally authorized flood control purpose.

7-07.1. **Flood Control Regulation Problems Associated with Stage–Discharge Variation and Channel Capacity Deterioration.** The following paragraphs discuss the problems associated with System regulation during flooding with regard to variation in the stage-discharge relationship on a seasonal basis and channel degradation.

7-07.1.1. **Seasonal Variations in the Stage-Discharge Relationships.** The Missouri River is an alluvial stream with a movable sand bed; consequently, marked variations in the relationship between stages and corresponding discharges occur. While some of these variations may be more or less permanent in nature due to changes in channel regimen, there is a seasonal shift in this relationship, particularly in the reach extending from Sioux City to Kansas City. Investigation indicates that this shift is related to water temperature and consequent bed form configuration. In essence, the typical seasonal shift results in higher stages during the mid-summer months than during the early spring and fall months for similar rates of flow. Stage variations of approximately 1 foot may occur as a result of these seasonal rating curve shifts. Gavins Point Dam releases are made to meet a downstream level of service (target flows) at Sioux City, Omaha, Nebraska City, and Kansas City. Evaluation of these service level requirements is based on the stage-discharge relationship at the above USGS gaging station locations. Accurate determination of flow based on observed stage at the gaging stations is difficult during the spring and fall water temperature rating curve shift period, requiring more frequent Missouri River discharge measurements and database corrections.

7-07.1.2. **River Channel Deterioration.** Evidence exists of a permanent shift in the stage-discharge relationship at numerous locations along the Missouri. This shift generally is in the direction of reduced channel capacity for higher flows and has been very significant at some locations. For example, below Fort Randall Dam and just upstream from the mouth of the Niobrara River, land areas adjacent to the river channel are now being inundated with flows less than 50,000 cfs that were dry with flows of over 150,000 cfs prior to the time that System reservoir regulation began. By the mid 1970's, the bankfull capacity was reduced to 60,000 cfs, and further reductions continued to 44,000 cfs in 1985 and 35,000 cfs in 1994. The high releases in 1997 resulted in an improvement in channel capacity when some deposits were scoured from the channel. Many similar instances could be cited, although generally not as extreme as the above example. The effects of these channel changes have been to reduce capacity and can be partly attributed to the control by the System of flood flows and their scouring. Some deterioration in channel capacity at some locations may have, however, resulted from bank stabilization measures that have been constructed for navigation or streambank erosion control purposes.

7-07.1.2.1. Conversely, in some Missouri River reaches, evidence exists of significant degradation, or lowering, of the Missouri River channel. As expected, degradation has occurred downstream of the System powerplants. In these cases, degradation has been considered beneficial, as increased power heads result that allow a greater amount of power production. On the Missouri River below the System, particularly in the Missouri River reach from Gavins Point Dam to Omaha, river stages have decreased markedly since System regulation first began in 1954. This degradation has had adverse effects on; recreation facilities, water intakes, well fields, navigation docks, tributary channel stability, and wetland habitat. The degradation has had a positive effect on flood control, as channel capacity has improved and areas that were once subject to flooding are now high and dry during significant release increases. For example, the flood control situation has been significantly improved for moderate floods in both the Dakota Dunes area near Sioux City and the Kansas City urban area because of additional channel degradation during the 1990's.

7-07.1.3. **Flood Control Regulation Problems Associated with Interior Drainage and Groundwater.** Also of concern is the effect of higher System releases during prolonged flood evacuation periods on interior drainage and groundwater tables in the reach of the Missouri River below the System. Higher Missouri River levels below the System make the draining of runoff that falls on cropland difficult, if not impossible, especially because the levee system constructed generally depends on draining into the Missouri River. Higher Missouri River levels also result in higher groundwater levels that make planting and harvesting crops difficult or impossible for farmland located just adjacent to the Missouri River. This is especially true in the aggradation reach just below the confluence of the Platte River with the Missouri River in Nebraska. Consideration is given to the effects of interior drainage and high groundwater levels in any prolonged flood control System regulation event.

7-07.1.3.1. Development of flood damageable property in flood-prone areas has been general and extensive throughout the entire reach of the Missouri River, especially in the areas downstream of the System projects. When higher-than-normal releases are required from System projects, flooding of floodplain lands and developments can, and should be, expected. The capture and metering of flood flows during the remainder of the year can also result in higher releases during late summer and fall. This period is normally not a high-runoff period, but, for those low-lying areas immediately adjacent to the Missouri River, poor drainage conditions are a continual concern.

7-07.2. **Other Flood Control Regulation Challenges.** The regulation of the System during years when the annual runoff is approximately equal to or greater than 30 MAF has occurred many times since the System became operational in 1967. The most significant flood runoff years are 1975, 1978, 1984, 1986, 1993, 1995, 1996, 1997 and 1999, all of which are documented in detail in the flood history of Appendix A. The 1975, 1978, and 1997 years stand apart from the others in the severity of the events. Most of the concerns arose from high pool elevations and passing the large volumes of water through the existing outlet works and into limited downstream channels to evacuate flood storage. The following should be recognized in a typical flood control situation.

7-07.2.1. System releases will be reduced to a minimum level to protect and minimize the loss of life and property downstream in all river reaches during significant flood events. The releases are never reduced to zero, because this would have significant negative impacts for just a small improvement in downstream flood control. Over reaction in the form of reducing releases to extremely low levels early in the runoff season may result in significantly less capability to control flooding, should a significant flood event or a succession of lesser flood events occur later. The System has a finite amount of storage available for flood control, and it should be used judiciously.

7-07.2.2. All reasonable attempts will be made to evacuate all of the water that is captured or retained in the System above the base of the Annual Flood Control and Multiple Use Zone prior to the following March 1. Most of this volume will be evacuated by December 1, prior to the onset of winter release restrictions due to expected limited winter releases because of river icing.

7-07.2.3. The System does not guarantee a flood-free zone in the Missouri River reaches between the System reservoirs and below the System. Downstream flooding will occur even if releases are reduced to minimums from the System dams because enough uncontrolled area exists downstream from several of the dams to cause major flooding if significant rainfall occurs. The potential extent and amount of damage caused by this runoff varies. Lack of floodplain zoning to discourage development in flood-prone areas will result in higher flood damage in the future even with the flood protection provided by the System.

7-07.2.4. If a flood occurs below the System, the damages are likely to be greater than if the same volume of flood occurs in reaches within the System because the major urban centers that exist below the System have a greater potential for very high flood damages. Two Missouri River reaches within the system below Garrison and Oahe, also have large cities on the floodplain, and the potential flood damage in these reaches is also very significant.

7-07.2.5. During past major flood events, a concern has developed that the upper three System reservoirs rise too high into their Annual Flood Control and Multiple Use and Exclusive Flood Control Zones. In 1975, a large rainfall event occurred in eastern Montana, and Fort Peck reached a maximum elevation that was 1.6 feet above its maximum operating level, or 1.6 feet into the surcharge zone provided for the control of extraordinary floods. Only Federal lands acquired for project purposes were inundated. Also in 1975, Garrison’s maximum level reached elevation 1854.8 feet msl, or 0.8 foot into the surcharge zone but below the 1855-foot msl guide taking line for land acquisition. The majority of the concerns relating to high reservoir levels were received from the headwaters' area of the Garrison project. Lands affected were Federally-purchased lands affected by the backwater effects of both high reservoir levels and large inflow rates. These were lands leased to private individuals, subject to flooding if required for project regulation. Concerns were also voiced over flooding on the Missouri River near the mouth of the Yellowstone, upstream of the taking line; however, this land was flooded by high river flows, rather than by Lake Sakakawea. During the large plains and mountain snowmelt flood of 1997, Garrison again exceeded the maximum normal operating level following a large, local rainfall event after it had successfully captured snowmelt runoff. Oahe has been in its Exclusive Flood Control Zone several times during the 1990's, prompting concerns about high, prolonged reservoir levels at this System project. The RCC recognizes that encroachment has occurred into the surcharge zone of some System projects. This, however, has not reduced the effectiveness of these projects to control flood inflows. All studies to date have indicated that there is no long-term problem associated with having the large System projects in their Exclusive Flood Control Zones. This zone is designed to store water during major flood events and the maximum project benefits cannot be obtained unless this zone is used, when appropriate. Releases from System projects with water in their Exclusive Flood Control Zones should be increased to the maximum practical in order to use downstream channel capacity so that the Exclusive Flood Control and the Surcharge Zones are vacated as soon as possible to allow storage space for subsequent runoff, should it occur.

7-07.2.6. A question has arisen in recent years whether or not project releases should be increased to higher levels earlier in the season to lower maximum release rates and reservoir levels. This is a common practice for snowmelt-type flood events; however, this approach does not apply to rainfall events that cannot be predicted. With snowmelt events, the actual conditions during the melt heavily influence the amount of runoff volume produced. Unfortunately, the temperatures and associated rainfall during snowmelt, the most significant variables, cannot be reliably predicted. This results in a wide range of potential runoff volume for the same amount of accumulated snow. Releasing at higher-than-normal rates early in the season that cannot be supported by runoff forecasting techniques is inconsistent with all System purposes other than flood control. All of the other authorized purposes depend upon the accumulation of water in the System rather than the availability of vacant storage space. Unnecessary drawdown of water in the System would not achieve the regulation objective of optimizing service to all authorized purposes.

7-07.2.7. Bank erosion along the unstabilized portion of the Missouri River channel has been a past concern. Data available to the Corps indicate that average erosion rates through the unprotected areas since full System regulation began in 1967 are less than during pre-project conditions, although this improvement is small in some Missouri River reaches.

7-07.3. **Missouri River Open-Water Channel Capacities.** A brief summary of present open-water channel capacities for specific Missouri River reaches is given below. Discussion of ice-affected channel capacities is presented in 7.04-9.

7-07.3.1. **Fort Peck Dam to the Mouth of the Yellowstone River.** Damages in this reach begin with open-water flows of 30,000 cfs; however, with flows ranging from 50,000 cfs in the upper portion to 70,000 cfs in the lower portion of the reach, damages are relatively minor and limited mainly to pasture and other unimproved lands.

7-07.3.2. **Garrison Dam to Lake Oahe.** The main damage center in this reach is Bismarck. If Bismarck stages are not allowed to rise significantly above 13 feet, few flood damages are observed. Flood stage at the Bismarck gage is 16 feet. At the time Garrison Dam was constructed, this represented an open-water channel capacity of about 90,000 cfs; however, in 1975, after 20 years of reservoir regulation, the channel had deteriorated to the extent that open-water flows of about 50,000 cfs resulted in a stage of 13 feet. This is due in part to the Oahe delta affect just downstream of Bismarck. A substantial amount of floodplain development has occurred at low levels in the Bismarck/Mandan vicinity.

7-07.3.3. **Big Bend Dam to Lake Francis Case.** During the 1991 fall drawdown of Fort Randall, it was observed that the White River delta, which extends across Lake Francis Case, was having a damming effect that created different lake elevations upstream and downstream of the delta. In recent times, the upper reservoir elevation has been as much as 6 feet higher than that for the reservoir downstream from the delta. The Corps has published a revised elevation capacity table for Lake Francis Case reflecting the effect of this sedimentation near elevation 1347 feet msl and below.

7-07.3.4. **Fort Randall Dam to Lewis and Clark Lake.** Since System regulation began, a delta has formed at the mouth of the Niobrara River, a stream that enters the Missouri River just upstream from Lewis and Clark Lake. Prior to System regulation, large flood flows periodically removed the delta material; however, these large floods are now eliminated by upstream System control. While this reach of the Missouri River was capable of passing flows in excess of 150,000 cfs prior to construction of the System projects, Fort Randall Dam open-water releases of 40,000 to 50,000 cfs now result in flood problems to adjacent property owners.

7-07.3.5. **Gavins Point Dam to Sioux City.** Prior to construction of the System, the open-water channel capacity through this reach of the Missouri River was well in excess of 100,000 cfs. There is evidence of channel deterioration due largely to encroachment in backwater areas and along old river meander chutes; however, this is partially offset by channel degradation. In 1997, sustained flows of 70,000 cfs in this reach caused some damage. The channel capacity has increased in this reach since 1995 by the additional degradation of approximately 3 feet in this reach, based on the estimated stage change at flows near 100,000 cfs.

7-07.3.6. **Sioux City to Omaha.** Open-water channel capacity in this reach prior to construction of the System was in excess of 100,000 cfs. During recent years, there has been considerable encroachment on the channel area. Fixed boat docks have been constructed in numerous locations through this reach, and low areas are now being farmed. Much of this development is on or adjacent to river stabilization structures and takes advantage of sediment deposition encouraged by this stabilization. Adversely affecting the channel and floodplain developmental encroachment is the channel degradation in this reach. Degradation, while increasing the channel flood capacity, has adversely impacted marinas, water intakes, and tributary channel stability.

7-07.3.7. **Omaha to St. Joseph.** Deterioration of the channel capacity has occurred through this reach. Recent experience indicates that mid-summer flows exceeding 90,000 cfs will result in river levels above flood stage at Nebraska City and Rulo, Nebraska and St. Joseph, Missouri. Damage due to high groundwater and interior drainage behind levees in cultivated fields begins at stages 2 or more feet below flood stage.

7-07.3.8. **St. Joseph to the Mouth of Missouri River Near St. Louis.** Open-water flows of about 150,000 cfs will cause only relatively minor agricultural damages in this reach; however, the established flood stage at Waverly, Missouri, has been exceeded when flows were greater than 115,000 cfs during recent years.

7-08. **Recreation Purpose System Regulation.** Historic System regulation to serve the recreation purpose is detailed in Appendix B of this Master Manual. Numerous adjustments of both a temporary and a relatively permanent nature have been made to the regulation of individual System projects to enhance recreational activities. For example, a limitation is placed on power peaking during particular periods in order that downstream boating or fishing tournaments may be facilitated. Recreational use of the System has increased through the years, with the visitor-hour attendance approaching or slightly exceeding 60 million visitor hours during the past 7 years.

7-08.1. Reservoir levels in the upper three, larger System reservoirs during drought were a main focus of the Master Manual Study that was the basis for the selection of the CWCP presented in this document. Application of the specific technical criteria for the CWCP discussed previously in this chapter would improve benefits provided to lake recreation as compared to the former water control plan.

7-08.2. The three smaller System projects are not affected to any significant degree by extended drought because their levels are basically unaffected by changes in the annual water supply and total System storage. Only if a drought were more severe than that experienced in the 1930's, would the elevation in Lake Francis Case be reduced to levels lower than the normal annual cycle.

7-09. **Water Quality Purpose System Regulation.** Historic System regulation to serve the water quality purpose is detailed in Appendix C of this Master Manual. Water quality characteristics that are of greatest concern in the basin are chemical constituents, which affect human health, plant and animal life, and the various uses of water by man (irrigation, domestic, and industrial uses); temperatures, which affect fisheries and the aquatic environment; biological organisms, which affect human health; and taste, odor, and floating materials, which affect the water's potability and the aesthetic quality of the environment. The level of dissolved solids concentrations has been a concern historically. Biologic quality and dissolved-oxygen quality have not been considered problems within the basin until recent years. As a result, there has not been a long-term watershed approach in obtaining area-wide data, but it is known that problems exist below several of the major cities and below industrialized areas on some of the smaller tributary streams. High ambient air temperatures, solar radiation, water depth, and thermal discharges from point sources can also affect thermal water quality conditions. Low releases could impact the operation of downstream powerplants.

7-09.1. **System Downstream Release Requirements for Water Quality.** Generally, System project release levels necessary to meet the downstream water supply purposes exceed the minimum release levels necessary to meet minimum downstream water quality requirements. Tentative flow requirements for satisfactory water quality were first established by the U.S. Public Health Service and presented in the 1951 Missouri Basin Inter-Agency Committee Report on Adequacy of Flows in the Missouri River. These requirements were used in System regulation until revisions were made in 1969 by the Federal Water Pollution Control Administration. The Missouri River minimum daily flow requirements for water quality that are given in Table VII-9 were initially established by the Federal Water Pollution Control Administration in 1969. They were reaffirmed by the Environmental Protection Agency in 1974 after consideration of (1) the current status of PL 92-500 programs for managing both point and non-point waste sources discharging into the river, and (2) the satisfactory adherence to the dissolved-oxygen concentration of 5.0 parts per million (ppm). The minimum daily flow requirements listed in Table VII-9 will be used for System regulation purposes. The intent of this CWCP is to fully meet applicable water quality requirements and to continue to monitor the reservoirs and releases from the System to assure that this occurs.

Table VII-9
Minimum Daily Flow Requirements Below the System
for Adequate Dissolved Oxygen
(cfs)

Urban Area	December January February	March April	May	June July August September	October November
Sioux City	1,800	1,350	1,800	3,000	1,350
Omaha	4,500	3,375	4,500	7,500	3,375
Kansas City	5,400	4,050	5,400	9,000	4,050

7-09.2. **Other Water Quality Considerations.** The System and its regulation have significantly improved water quality in the river reaches between the reservoirs and downstream of the System, compared to the water quality in the Missouri River before the System was constructed. Downstream flow support from the System for the authorized purposes other than water quality more than meets the minimum flow requirements for Missouri River water quality. Water quality, therefore, has more than enough flow during all periods of the year in all of the Missouri River reaches with the CWCP. Water quality in the System reservoirs has been deteriorating for some time, essentially since the reservoirs were first filled. The dissolved-oxygen levels in the lower levels of the System reservoirs do not provide water quality conditions conducive to support some types of fish. The number of algae blooms has increased during the life of the System. Water quality has deteriorated in some arms of the large reservoirs for short periods so that the water in these locations is not potable, but these situations have been rare. In general, the water quality in the System reservoirs is considered good and is expected to remain so. Low flows in the reaches downstream from Garrison and Gavins Point Dams directly affect the ability of thermal powerplants in these two reaches to meet National Pollutant

Discharge Elimination System (NPDES) permit standards for discharging cooling water back into the Missouri River. Low reservoir levels and river stages may increase the sediment content in water supplies.

7-10. **Fish and Wildlife Purpose System Regulation.** Historic System regulation to serve the fish and wildlife purpose is detailed in Appendix D of this Master Manual. Declining water levels of the reservoirs are a concern to many project users interested in the reservoir fishery; however, some fluctuation in the reservoir levels is unavoidable if the reservoirs are to serve all of the authorized purposes. A continuing objective in the regulation of the System is to minimize the departures in reservoir levels from normal, full multipurpose levels to the maximum practical extent consistent with regulation for other authorized project purposes. The partial elimination of the annual drawdown of Lake Francis Case, which was previously discussed, is a good example of limiting reservoir level fluctuations while continuing to meet authorized purposes.

7-10.1. The maintenance of relatively uniform release rates during certain times of the year is also an environmental objective to benefit certain riverine species during their spawning period. Minimum releases are also required from some of the projects for downstream fisheries. System regulation has reduced high flows and supplementing low flows that still naturally occur on the Missouri River, which allows requests by State game and fish agencies to be met. Relatively constant releases, however, are not desirable for all fish species. Some fluctuations in release rates continue to be unavoidable if all of the authorized System project purposes are to be served. Additionally, access to the river may be more difficult at times, fishing success may be affected, the sediment load in the river may be increased, and use of fixed boat docks may be inconvenienced. To the extent practical, considering release requirements for other authorized purposes, release fluctuations are being minimized.

7-10.2. **Minimum System Releases for Fish and Wildlife.** Establishment of minimum releases and steady-to-rising pools during the spring months have been recognized since the 1950's as beneficial for successful fish spawning and hatching. An ad-hoc committee of the American Fisheries Society first made recommendations to the former Missouri River Division Reservoir Control Center in 1972 regarding regulation activities beneficial for the fishery. This committee was replaced with the MRNRC, which was established in 1987 to provide the Corps with a coordinated recommendation for fishery enhancement. The MRNRC is comprised of representatives from fish and game agencies from the seven states bordering the Missouri River.

7-10.2.1. **Fort Peck Minimum Release.** Minimum hourly releases, particularly during fish spawning, have been requested from Fort Peck, Garrison and Fort Randall Dams for many years. These requests are implemented if other project purposes are not affected. A year-round instantaneous minimum release of 3,000 cfs was established at Fort Peck in 1992 for the trout fishery located in the dredge cuts immediately below Fort Peck Dam. This minimum was raised to 4,000 cfs in 1995 and has been in place since, except in the spring of 1997 when releases were lowered to 3,000 cfs as part of a System flood control operation to reduce inflows to a rapidly rising Lake Sakakawea.

7-10.2.2. **Garrison Minimum Release.** Garrison Dam minimum releases are established by standing orders that call for a minimum generation over a specified number of hours depending on a range of daily average project releases. In most years, the minimum hourly generation resulting from release patterns for least terns and piping plovers is higher than the minimum specified in the standing orders. The minimum daily average Garrison Dam release is 9,000 cfs to avoid excessively low stages at downstream water intakes.

7-10.2.3. **Oahe Minimum Release.** A 3,000 cfs minimum Oahe Dam release during daylight hours is normally established in early April to enhance downstream fishing and boating use during the recreation season.

7-10.2.4. **Fort Randall Minimum Release.** Minimum releases from Fort Randall Dam are imposed for fish spawning below the project in years when daily average releases are sufficiently high. The most recent MRNRC recommendation is a minimum of 9,000 cfs from April through June.

7-10.2.5. **Gavins Point Minimum Release.** The minimums under the CWCP for other purposes exceed current fishery minimum requirements.

7-10.3. **Modified System Regulation for Threatened and Endangered Species.** Releases from all projects except Oahe and Big Bend have been modified to accommodate endangered interior least tern and threatened piping plover nesting since 1986. Daily hydropower peaking patterns are developed prior to nest initiation in early to mid-May and are provided to Western. Fort Peck and Garrison peaking is limited to 4 of 5 units for no more than 6 hours each day. Fort Randall peaking is limited to 7 of 8 units for no more than 6 hours per day. Deviations from this CWCP to address ESA requirements will normally be provided in the AOP.

7-10.3.1. **Gavins Point Cycling.** During the early years of operating for endangered species, a technique of increasing project releases every third day by 8,000 to 10,000 cfs was used to encourage terns and plovers to build their nests high so that these nests would not be inundated later when increases were required to meet the regulation objectives of the System. This pattern of increasing releases every third day was referred to as “cycling.” Cycling has not been used in recent years because of the potential harm to native fish and the risk of stranding chicks. Every third day “cycling” of Gavins Point Dam releases during release reductions for downstream flood control has continued to be used to keep birds nesting at sufficiently high elevations to maintain room for release increases when downstream flooding has subsided. The variation in releases is normally limited to 8,000 cfs to minimize adverse affects on downstream river users and fish.

7-10.3.2. **Gavins Point Steady Release.** Another technique, called “steady release,” is to increase the Gavins Point Dam release by early to mid-May when the terns and plovers begin to initiate nesting activities to the amount expected to be needed in August when downstream tributary flows are typically lower. This uses an additional amount of water stored in the System but usually preserves the ability to support downstream flow objectives and meet endangered species objectives as well. This type of release from Gavins Point Dam has been successfully used many times since system regulation for threatened and endangered species nesting began.

7-10.3.3. **Gavins Point Flow-to-Target Release.** Prior to the System regulating for endangered species, a "flow-to-target" approach was taken where releases from the System were increased as needed to provide downstream flow support. While this approach preserved the most habitat during the initial nesting phase, it normally resulted in the inundation of nests as downstream tributary flows fell off and Gavins Point Dam releases were increased to meet downstream target flows.

7-10.3.4. **Gavins Point Steady Release – Flow to Target.** During the 2003 nesting season, a new procedure, called "steady release – flow to target" was used to set the Gavins Point Dam release. This procedure combined features of the original "flow-to-target" method with the "steady release" plan. It called for an initial steady release high enough to inundate low-lying habitat that would likely be subject to inundation later in the season. As downstream tributary flows declined through the summer, releases could be increased as needed, within the limits of the Incidental Take Statement provided by the Service in its Supplemental BiOp prepared for the 2003 AOP, to meet downstream flow support for navigation and other authorized purposes.

7-11. **Water Supply and Irrigation Purpose System Regulation.** Historic System regulation to serve the water supply and irrigation purpose as well as intake locations are detailed in Appendix E of this Master Manual. Tribal intakes are presented as well in Appendix E. Numerous water intakes are located along the Missouri River, both within and below the System. These intakes are primarily for the purposes of municipal water supplies, nuclear and thermal powerplant cooling, and irrigation supplies withdrawn directly from the Missouri River. Historically, water access problems have been associated with several of these intakes; however, the problems have been primarily a matter of sandbars or sediment deposition at the intake restricting access to the river rather than insufficient water supply. Other water supply problems can occur during the winter months due to ice jamming on the river. Floating or frazil ice can also block the water intake facilities directly, which can reduce flow to unacceptable rates.

7-11.1. **System Water Supply Considerations.** The minimum daily flow requirements established for water supply are designed to prevent operational problems at municipal and thermal powerplant intakes at numerous locations along the Missouri River below the System. The lower Missouri River is significant with regard to water supply because 94 percent of the population served and 75 percent of the thermal power generating capacity using the Missouri River for once-through cooling are located below the System. Problems that have been experienced within the System are related primarily to intake elevations or river access rather than inadequate water supply. Evaluations are continuing by appropriate State agencies in coordination with water plant operators to determine the minimum stage and flow requirements at each intake location for satisfactory hydraulic operation. During drought, downstream water supply and water quality (thermal effects) will be a major consideration if the service level is dropped below minimum service from April through November to further conserve water in the System (navigation purpose not served). The minimum required summer release below minimum service rates to fully meet the water supply and water quality needs has not been established because this release has not been tested. In 2003, a 21,000 cfs release for only a few days resulted in downstream water supply problems. It is not known if these facilities could be modified to function at lower levels. An 18,000 cfs release rate was modeled during the development of this CWCP as a potential minimum Gavins Point Dam release rate in the summer months, which may result in some adverse impacts to power generation to comply with the water quality requirements for temperature. Lower releases of 9,000 cfs are included in the non-summer, open-water-season months, and these releases may not be adequate to meet water supply needs below the System on the Missouri River without modifications to some intakes, particularly those in the degradation reaches at Sioux City and Kansas City.

7-11.2. **Water Supply.** The growth in the use of the Missouri River for water supply as an authorized purpose has, like recreation, exceeded all original expectations. The RCC recognizes the importance to regulate the System in a manner to provide sufficient streamflow in intervening reaches between the System reservoirs and in the lower Missouri River reach from Gavins Point Dam to the mouth near St. Louis, Missouri, to sustain public water supplies of the numerous communities along the banks of the Missouri River. More than 1,600 intakes and intake facilities have been identified on the reservoirs and in the river reaches (Table E-1). Of these, 302 intakes and intake facilities are identified for American Indian Tribes. Appendix E and Section 2-10 discuss water supply intakes using the Missouri River. These intakes are primarily for municipal, industrial, and individual water supplies; fossil and nuclear-fueled powerplant cooling; and irrigation withdrawals directly from the Missouri River. In recent years, problems have been associated with several of these intakes; however, the problems have been a matter of intake access to the water rather than insufficient water to supply or meet requirements. The lower river reach is very reliant on the river for water supply because 94 percent of the population served, as shown in Table E-1, is located downstream of the System. In addition, 75 percent of the generation by thermal powerplants using the Missouri River, as shown in Table E-2, is located below the System. The following paragraphs discuss water supply for the reaches between the System projects and below the System. The purpose of this plan is to fully meet these water supply requirements to the extent reasonably possible. The Corps will continue to obtain the necessary data and make adjustments to the System to assure that this occurs; however, the intake access associated with obtaining Missouri River water is the responsibility of the entity choosing to use this source of water for its supply. Intake access problems are the responsibility of the intake owner, and the Corps will not guarantee access only that the supply of water in the Missouri River is adequate to meet this project purpose.

7-11.3. **Minimum System Release Requirements for Water Supply and Irrigation – Open-Water Season.**

7-11.3.1. **Fort Peck.** Historic regulating experience indicates that a minimum daily average release of 3,000 cfs from Fort Peck Dam is satisfactory for municipal water supply. During the spring and fall, instantaneous releases of no less than 4,000 cfs are normally scheduled for a downstream fishery. The irrigation demands below Fort Peck Dam during the irrigation season currently call for a flow of 6,000 cfs as a minimum; however, the formation of sandbars has at times restricted flows to some intakes in this reach. The Fort Peck Dam minimum release rate is, therefore, greater than the minimum water supply release requirement for this reach.

7-11.3.2. **Garrison.** At Garrison Dam, a minimum average daily release of at least 9,000 cfs during both the open-water and ice-cover seasons is desirable to provide sufficient river depths for satisfactory operation of municipal, irrigation, and powerplant water intakes in North Dakota.

In this reach of the river, fluctuations in release levels at times require the resetting of irrigation pumping facilities to achieve access to available water or to prevent inundation of pumps.

7-11.3.3. **Oahe and Big Bend.** No restriction on minimum releases from Oahe and Big Bend is necessary for adequate service to water intakes because the headwaters of downstream reservoirs may extend to near the upstream dam sites. Minimum flows from Oahe of at least 3,000 cfs are normally made during the daylight hours during the recreation season.

7-11.3.4. **Fort Randall.** Mean daily releases of 1,000 cfs are considered to be adequate to meet all of the water supply requirements below Fort Randall Dam except for the city of Pickstown, South Dakota. This city has, in the past, needed a minimum of 12,000 cfs for 12 hours every third day to fill its water supply storage tanks. The city has recently connected to a rural water supply system that should eliminate this requirement in the future.

7-11.3.5. **Below Gavins Point.** When the water-in-storage in the System is at normal or higher levels, releases for the navigation and power production purposes and to evacuate flood control storage during the navigation season and winter period will normally be at levels that are deemed to be sufficient for the downstream water supply needs. During extended droughts, Gavins Point Dam releases are reduced. Some intakes require more than 9,000 cfs (minimum release required in the early 1990's) during the open-water season for effective operation. These intakes should be modified as soon as possible to ensure that they can remain operational as the Corps continues to pursue lowering the Gavins Point Dam release in the non-navigation months during drought periods to this rate. A winter Gavins Point Dam minimum release rate of 12,000 cfs has been established as the guide in meeting downstream water supply requirements during this period. Intakes typically have higher requirements during the winter period because of the effects of river ice in reducing the capacity of their intakes. If Gavins Point Dam release rates are reduced below 12,000 cfs for water conservation, continued surveillance of these intakes will be required, and, if appropriate, additional releases may be required to assure adequate water levels for uninterrupted intake operation. During the critical and more difficult winter period, release rates may be adjusted according to river icing conditions to assure that the water supply service is provided downstream. During drought years when System storage is low enough to reduce or eliminate the navigation season, a Gavins Point Dam release of 18,000 cfs has been established as meeting the summer water supply requirement. Intake owners should modify their intakes as soon as possible if a summer Gavins Point Dam release rate of 18,000 cfs will not be adequate to meet their needs.

7-11.4. **Irrigation Purpose System Regulation.** Federally-developed irrigation projects served directly from the System were envisioned and the pumping plants to support these irrigation projects from Garrison and Oahe were constructed. The Federal irrigation projects have not been constructed. The Oahe Diversion project was deauthorized, and the Garrison Diversion project has been significantly scaled back. No acres are currently irrigated with the Garrison Diversion project. Current plans for water resource development in the Missouri River basin do not include significant Federal irrigation development from the System. Releases from the reservoirs are used by numerous private irrigators and by Federally-financed projects. Private irrigation directly from the reservoirs is also continuing to develop. While the minimum releases established for water quality or for satisfactory operation of Missouri River water supply intakes are usually ample to meet the needs of irrigators, low reservoir levels and low river stages, with their associated exposure of sandbars and drying up of secondary channels, make access to the available supply difficult or inconvenient to obtain. Instances of such occurrences are discussed in the individual System project water control manuals. The System will continue to regulate for this Congressionally authorized project purpose and adjust releases to meet needs. As previously discussed, access is the major problem for all types of intakes along the Missouri River and on the System reservoirs. Generally speaking, access to Missouri River water for irrigation is the responsibility of the entity owning the intake.

7-12. **Hydropower Purpose System Regulation.** Historic System regulation to serve the hydropower purpose is detailed in Appendix F of this Master Manual. Since completion of the power installations at the System projects, most System project releases have been made through the respective powerplants. When release requirements were exceptionally high due to flood control storage evacuation, spillway releases were necessary at Gavins Point Dam. Some spills have also been required at Fort Peck, Garrison and Fort Randall Dams for this purpose; however, in most years releases from all projects are made through the powerplants at all times. The six System 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 MWh of energy per year, which is marketed by Western. Power generation at the six System dams generally must follow the seasonal pattern of water movement through the System; however, adjustments are made, when possible, to provide maximum power production during the summer and winter when demand and value of this authorized purpose is highest. Hydropower is the only Congressionally authorized purpose of the System that actually returns money to the Federal Treasury

7-12.1. Realization of the maximum power potential provided by the water passing through the dams of the System requires that hydropower operations be carefully integrated into regulation of the overall System. This requires consideration of many factors, including generating capacity at each plant, marketability and current market price of generated power, necessary peaking capability, anticipated long-range storage balance requirements, regional power emergencies, and others. Regulation of the System projects is scheduled to develop the maximum power benefits to the extent reasonably possible. .

7-12.2. **Hydropower Modifications for Transmission Loading Relief.** Pursuant to the Federal Energy Regulatory Commission's open access transmission law, Western was requested to reduce generation on the System hydropower system during the spring and summer of 1997 to preserve transmission capability. This "transmission loading relief" (TLR) is accomplished on a very short notice at any time of the day and is performed by reducing the load at one or more System hydropower plants for an unforeseen duration, although usually for just a few hours. TLR was normally accomplished at Oahe in 1997 but also occurred at Fort Randall and Garrison. The relief involved shedding anywhere from a few MW to a few hundred MW with an accompanying reduction in System project release. Corps project personnel were then pressed into service to initiate supplemental releases through outlet works other than the powerplants to compensate for the reduced powerplant releases. During 1997, the volume of runoff was twice that in a normal year, and even a few hours of reduced releases could have become critical. Evacuation of the record runoff in 1997 caused releases to exceed powerplant capacity at all projects except Big Bend. TLR has been frequently provided by the System powerplants, particularly Oahe, since 1997. Lower runoff associated with the current drought has resulted in reduced generation since the record high set in 1997, and TLR requirements have eased due to lighter loading of the generating units. When high runoff years return, TLR is expected to be a consideration in regulation of the System.

7-12.3. **Hydropower Considerations – Annual Fort Randall Drawdown.** A disparity exists between summer power generation, when releases from four of the six System projects are relatively high to provide Missouri River downstream flow support, and winter generation, when System releases to the lower river must be restricted due to the limited ice-covered channel capacity. The effect of this disparity may be eased by another aspect of System regulation, the draft and refill of a portion of the Fort Randall Carryover Multiple Use Zone storage space. During this regulation, Oahe and Big Bend releases are reduced several weeks before the end of the navigation season. This leaves the water in Fort Randall as the primary source for downstream release requirements for the remainder of the fall season, a process that results in evacuation of a portion of its Carryover Multiple Use Zone storage space. This vacated storage space is then refilled with Oahe and Big Bend releases following the navigation season through the winter period. Whereas, the volume of winter releases from Oahe and Big Bend, in the absence of this recapture, would be about equal to those from Fort Randall, the refill of the evacuated Fort Randall space allows winter releases from these upstream projects to substantially exceed those from Fort Randall Dam.

7-12.3.1. During the period of initial fill and the regulation of the System in years prior to 1971, as much as 2 MAF of storage below the base of the Annual Flood Control Multiple Use Zone were drawn out of Fort Randall. The recapture of the evacuated storage space allowed Oahe and Big Bend releases to exceed Fort Randall releases by an average of 8,000 cfs for the winter. This regulation resulted in substantially more winter energy generation, exceeding 300,000 MWhs, when Oahe was at its normal level. Offsetting this gain in System generation, the generating capability at Fort Randall Dam was reduced by 60 to 70 MW in early December because of the lower reservoir level; however, this negatively impacted other System authorized purposes. A lowered Lake Francis Case has an adverse effect on recreation in and around the reservoir area while the exposed reservoir floor becomes undesirable in an esthetic sense. Mud flats in the reservoir headwaters spawned blowing dust storms near Chamberlain, and boat ramps were out of the water. The effects of this drawdown on the surrounding environment became an increasing concern, particularly when this drawdown proceeded below elevation 1340 feet msl. Studies conducted in 1971 and 1972 resulted in a compromise being accepted that limited the drawdown of Fort Randall to elevation 1337.5 feet msl in most years. The drawdown to this level was also delayed as late as possible in the year so that any negative impacts were felt for the shortest possible period of time. This drawdown was also scheduled to coincide with the period during which there is a marked decline in the recreational usage of the reservoir. Fort Randall, at a reservoir level of elevation 1337.5 feet msl, makes available about 900 MAF of storage space below the base of the Annual Flood Control and Multiple Use Zone for recapture of winter power releases from Oahe and Big Bend Dams. During droughts greater than that of the 1930's, when System storage reserves and System releases are reduced, an additional drawdown of Fort Randall to as low as 1320 feet msl may be scheduled to permit Oahe and Big Bend Dam releases to be maintained near a 15,000 cfs rate during the winter period.

7-12.4. **Other Hydropower Considerations – Annual Oahe Drawdown.** While not as significant (in terms of pool level fluctuation) as the Fort Randall recapture, a similar recapture can occur at Oahe. This recapture is coordinated with upstream Fort Peck and Garrison Dam releases. Oahe recapture may also significantly increase the amount of winter energy generation. During the 4-month winter period, Garrison Dam releases normally are scheduled to be at least 1 MAF more than Oahe releases. The recapture of these upstream releases results in a rise of up to 5 feet or more in Lake Oahe elevation during the winter months.

7-12.5. **System Hydropower Coordination.** Daily, real-time regulation of the System for hydropower purposes is closely coordinated with Western and with regulation of the System for non-hydropower purposes. Detailed advance planning is essential so that releases from each of the System projects for any of the other authorized project purposes may be used to the fullest extent practicable for optimum power production. Daily schedules of power production for each System powerplant are prepared and furnished to Western. Western, in turn, makes such daily changes in the power marketing arrangements as are necessary. Power production orders, which include the scheduled daily generation as well as limits of powerplant loading, are issued directly by the RCC to individual System powerplants. Within the limits of the daily schedules, Western controls the actual hourly loadings of the plants, subject to the limitations imposed by load limits in the power production orders and discharge limits imposed by concurrent reservoir regulation orders schedule by the RCC.

7-12.5.1. The Big Bend and Oahe powerplants are used primarily to follow daily load patterns. In the summer cooling season, Big Bend and Oahe generation is patterned to meet peak electricity demands, which generally occur around 6 p.m. In the winter heating season, their generation is patterned to meet morning and evening peak demands. The Fort Randall, Garrison, and Fort Peck powerplants are also used for peaking, but to a lesser degree. The relative role of each powerplant in meeting required peaking patterns varies with relative water supply available to each powerplant and other regulation factors. The peaking patterns vary through time, primarily in response to such factors as the demand for power and the average release rate through the System. At individual dams, daily power releases are normally adjusted for other project purposes, taking into account; flood control, water conservation, environmental objectives, physical and seasonal constraints, and other factors.

7-13. **Navigation Purpose System Regulation.** Historic System regulation to serve the navigation purpose is detailed in Appendix G of this Master Manual. Service was provided to navigation on the lower Missouri River during the years that Fort Peck was regulated as an individual project. With the construction and filling of additional System projects, this service was expanded. Full-length (8-month) seasons were first initiated in 1962 and have continued except in years when flow reductions were required during extended droughts. Navigation service flows have been provided since June 1967. Navigation on the Missouri River occurs from Sioux City to the mouth near St. Louis. Commercial traffic has ranged from as high as 3.3 million tons in 1978 but has declined in recent years to less than 2 million tons. In 1999, total commercial traffic moved by barge reached a record peak of 9.25 million tons. Commercial tonnage, not including sand, gravel, and waterway materials, accounted for 1.58 million tons. The Missouri River Bank Stabilization and Navigation Project is authorized to provide a 9-foot-deep by a minimum of 300-foot-wide navigation channel. Downstream flow support is provided to meet many of the Congressionally authorized purposes, which includes navigation. 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 System, according to the criteria presented in Table VII-2.

7-13.1. **Navigation and Other Downstream Support Considerations.** Frequent groundings are often experienced during the early portion of the navigation season. These are believed to be due to a combination of cold water temperatures and the requirement for the channel dimensions to adjust from the lower winter flows to the higher navigation and downstream support flows. To alleviate this situation, when appropriate, based on water supply, downstream flow support releases at the beginning of the season may be scheduled for a short period at a level of up to 5,000 cfs higher than the service level requires, to provide channel conditioning provided System storage levels at the time are adequate.

7-13.1.1. Day-by-day regulation of the System to support navigation requires forecasts of inflow to various reaches of the Missouri River below the System. From these forecasts and current flow targets, the control point (either Sioux City, Omaha, Nebraska City, or Kansas City) is determined daily. Anticipated traffic or the absence of traffic at the control points will also have a bearing on the control point selection. For this reason, the RCC will continuously monitor traffic movement on the Missouri River. After selection of the control point, releases from the System are adjusted so that, in combination with the anticipated inflows between the System and the control point, they will meet the target flow at the control point.

7-13.2. **System Downstream Flow Support.** The System releases required to meet the minimum and full-service targets vary by month in response to downstream tributary flow, as shown on Table VII-10. These values will be updated as additional data are accumulated and when a significant change in these values occurs. A reanalysis of the average monthly Gavins Point Dam releases needed to meet navigation service requirements was completed in 1999. As part of this study, the relationship between annual runoff upstream of Sioux City and the average Gavins Point Dam release required for the navigation season was analyzed. That study showed that generally more water was needed downstream to support navigation during years with below-normal upper basin runoff than during years with higher upper basin runoff. Regulation studies performed since 1999, therefore, use two levels of System release requirements, one for Median, Upper Quartile, and Upper Decile runoff scenarios and another for Lower Quartile and Lower Decile scenarios. An examination of the data presented in Table VII-10 reflects that, early in the season, the flow target is at Sioux City with adequate downstream tributary flows to meet flow targets. Normally, as the runoff season progresses, downstream tributary flows recede or cease during the summer, and the flow target moves from Sioux City to Nebraska City and eventually Kansas City. This requires higher flow support as the season progresses through the summer. Often the target moves upstream during the fall, when higher downstream tributary flows return. This seasonal tributary flow pattern is reflected in the Gavins Point Dam release data presented below. These releases are the average monthly values during the period studied for the various runoff conditions and do not reflect the maximum and minimums required during that month to meet flow targets. Actual regulation, therefore, requires daily adjustments to fully serve the Congressionally authorized project purpose of navigation. Studies conducted for the ESA consultation in the spring of 2003 concluded that 30,000 cfs would be needed to provide a

90 percent assurance of meeting minimum service flow targets in July and August. That study used all runoff data from the period of analysis (1898 through 1997).

Table VII-10
Gavins Point Releases Needed to Meet
Downstream Target Flows for Indicated Service Level
1950 to 1996 Data
(Discharges in 1,000 cfs)

Median, Upper Quartile, Upper Decile Runoff

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Full-Service	26.7	28.0	27.9	31.6	33.2	32.6	32.0	31.1
Minimum-Service	20.7	22.0	21.9	25.6	27.2	26.6	26.0	25.1

Lower Quartile, Lower Decile Runoff

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Full-Service	29.8	31.3	31.2	34.3	34.0	33.5	33.1	31.2
Minimum-Service	23.8	25.3	25.2	28.3	28.0	27.5	27.1	25.2

7-13.3. **Navigation Service Disruptions.** The level of service to navigation can be affected by release restrictions at Gavins Point Dam for the tern and plover nesting season. Release restrictions were first implemented in 1986 to preserve nesting habitat and not inundate nests or birds that could not yet fly. At times during the release restriction period, navigation target flows could not be met because tributary flows are declining in July and August and flows cannot be augmented by increased releases from Gavins Point Dam beyond the maximum release established prior to tern and plover nesting. Generally, release restrictions to protect the birds are lifted in mid-August when the young birds are able to fly and leave the area. Beginning in 1995, releases from Gavins Point Dam were adjusted in early May, when the terns and plovers began to initiate nesting. The release rate was based on an assessment of flows needed to support navigation in July and August. The resulting release prevented the inundation of nests and chicks by not requiring increased downstream support later in the summer.

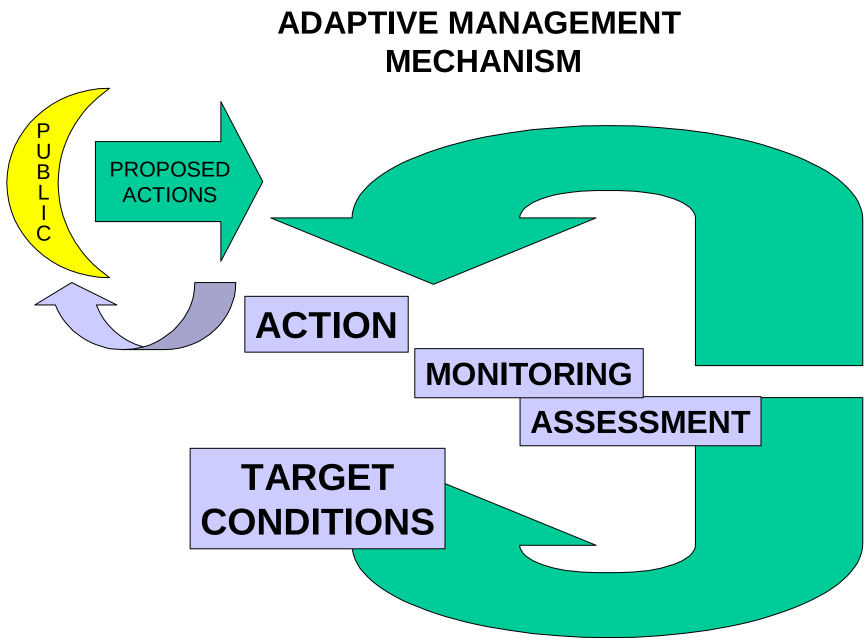
7-13.3.1. High lower Missouri River flows can also disrupt navigation. The river is generally closed to navigation when stages become so high that towboat prop wash and the wake from the tows can damage the Missouri River levees. In the flood of 1993, the Missouri River was closed for navigation for 7 weeks by high flows between Kansas City and St. Louis. The U.S. Coast Guard has the responsibility of officially closing the Missouri River. The Corps and the Coast Guard coordinate this closing and reopening so that significant impacts can be minimized both to the levee system and to the navigation industry. During both the 1987-93 drought and the current drought, navigators experienced hardships and lost revenues due to both reduced Gavins Point Dam releases and shortened navigation seasons, including disruptions caused by court-ordered actions and threatened and endangered species operations. Table G-3 provides the season lengths and tonnage on the Missouri River since the System filled in 1967.

Guard coordinate this closing and reopening so that significant impacts can be minimized both to the levee system and to the navigation industry. During both the 1987-93 drought and the current drought, navigators experienced hardships and lost revenues due to both reduced Gavins Point Dam releases and shortened navigation seasons, including disruptions caused by court-ordered actions and threatened and endangered species operations. Table G-3 provides the season lengths and tonnage on the Missouri River since the System filled in 1967.

7-14. **Adaptive Management.** The Corps has implemented some System regulation changes via an Adaptive Management process for many years. The Corps, in implementing the CWCP described in this manual, will continue the use of the Adaptive Management process. Adaptive Management is not a new concept; but rather, commonly used throughout the world to help shape resource management decisions, policies, and approaches. The process involves recognition that all is not known about the impacts, both positive and negative, of changes in System regulation. It also recognizes the likelihood that physical conditions may change in the future, and allows flexibility to meet the challenges of those changed conditions. For example, the database of information on the complete life cycles and behaviors of the threatened and endangered species or their requisite habitat needs throughout their life cycles grows constantly. Adaptive Management is an overall strategy for dealing with change and scientific uncertainty. It promotes an environment that allows testing of hypotheses and pursuit of promising change based on sound scientific data and analyses followed by critical monitoring and evaluation.

7-14.1. The Corps recognizes that changes in the operation of the System may impact many river uses and is committed to ensuring that the public is actively involved and well informed of potential changes in System regulation and has the opportunity to comment on those proposed changes prior to any decision on implementation. The adaptive management process will be used to implement changes designed to improve the benefits provided by the System, including benefits to the threatened and endangered species. Decisions regarding actions proposed through the adaptive management process will meet the Corps' treaty and trust responsibilities to the Tribes and conform to all of the applicable requirements of Federal laws including the National Environmental Policy Act, Endangered Species Act and the Flood Control Act of 1944. Adaptive management measures implemented as part of the water control plan are described and explained in Appendix I.

7-14.2. **Adaptive Management Process Diagram.** A conceptual diagram of an Adaptive Management strategy is provided below.



7-15. **Drought Contingency Plan.** Regulation of the System during drought was a significant consideration in the development of this CWCP. The System is the largest reservoir system in the United States serving all authorized project purposes during an extended drought like the 1930's was part of the original objectives of the System. This resulted in the construction of the System with an enormous amount of water normally retained in System storage in anticipation of the onset of extended drought. For this reason, the three upper reservoirs are extremely large compared to other Corps reservoirs, which makes the System so unique. The System was designed to use this stored water during extended drought periods to meet a diminished level of service to all Congressionally authorized purposes except flood control. As such, no separate Drought Contingency Plan is needed or required for the System, as it is included as part of the CWCP presented in this Master Manual.

7-16. **Flood Emergency Action Plans.** The Omaha District is responsible for the development of Flood Emergency Action Plans for the System. The Omaha District has developed a Contingency Plan for Emergencies for each of the System dams, and these plans are presented as Appendix E of the Operations and Maintenance Manuals for each System project. The action plans were all developed for individual projects and were last updated in 1984. These action plans are available to the RCC and project staff for use should a catastrophic failure be imminent or occur. These action plans are contained in large documents and, as such, are not provided as part of this Master Manual. In addition, the Omaha District has conducted full Emergency Dam Safety Exercises involving all of the larger System dams with expected emergency management partners. The RCC was a participant in these exercises and provided modeling support for System regulation during the exercises. The Fort Peck Dam Safety Exercise was conducted in July 1985, and it simulated an earthquake-related event that involved Federal, State, and local participation. The Garrison Dam Safety Exercise was conducted in August 1987, and it was a flood-related event that involved Federal, State, and local participation. The Oahe Dam Safety Exercise was conducted in September 1992, and it was also a flood-related event with Federal, State, and local participation. These full-scale Dam Safety Exercises have also been augmented by tabletop exercises to train and prepare the staff for emergency situations.

7-17. **Other Considerations.** Other considerations than just serving the authorized System purposes must be served from the System, as needed. Adjustments are made to System regulation at times for downstream construction and to aid in recovering bodies from drowning accidents. Recently, adjustments in reservoir levels or dam release rates to help reintur cultural artifacts and human remains at Tribal burial sites have occurred. Special regulation to determine the effectiveness of moving accumulated sediment below the System projects has also occurred.

7-18. **Deviations from the CWCP.** The deviations from the operational objectives presented in this Master Manual or the following year's AOP final plan are discussed during the AOP process. All significant deviations from this CWCP will be coordinated and approved by the Northwestern Division Commander, who may also coordinate with higher authority. All deviations of significance are modeled and presented to the public through the normal coordination procedures involving public press releases and World Wide Web dissemination. Minor deviations are accomplished by the RCC through coordination directly with the affected parties.

7-19. **Rate of Change in Release.** Releases from the System are generally scheduled on a mean daily basis. A gradual change is important when releases are being decreased and downstream conditions are very wet, resulting in saturated riverbank conditions. The RCC staff is aware that a significant reduction in System releases over a short period can result in some bank sloughing, and release changes are scheduled accordingly when a slower rate of change does not significantly impact downstream flood risk. Overall, the effect of System regulation on streambank erosion has been reduced by the regulation of the System because higher peak-runoff flows into the System are captured and metered out more slowly. Increasing System project releases can be changed more significantly than reductions because streambank erosion due to sloughing is not an issue. Many years of regulation experience have also indicated that a simple transition of releases is normally desirable, when possible.

7-19.1. Two sets of criteria are used that are related to the rate of release change for the System dams. The rate of release change criteria is adjusted from that for a normal situation if a flood control regulation objective is initiated to protect life and property in downstream areas or to respond if an emergency exists either at the project or in the project vicinity that requires rapid release changes. Table VII-11 lists the normal and flood control daily rate of release change criteria for each System project. If a situation presents itself that has not been contemplated or a change greater than that described below is required to meet the operational objectives of this plan, the appropriate change will be made. A rate of release change guideline at Oahe and Big Bend does not apply because the tailwaters empty into either a very short river reach or the downstream reservoir, respectively. Also Oahe and Big Bend experience daily changes of releases in the range of full powerplant capacity as required for System hydropower generation to meet this authorized project purpose.

Table VII-11
Mainstem Project
Maximum Daily Rate of Release Change

Mainstem Project	Normal Increase cfs	Normal Decrease cfs	Flood Control Increase cfs	Flood Control Decrease cfs
Fort Peck	6,000	3,000	9,000	12,000
Garrison	6,000	3,000	9,000	12,000
Oahe	N.A.	N.A.	N.A.	N.A.
Big Bend	N.A.	N.A.	N.A.	N.A.
Fort Randall	10,000	6,000	12,000	17,000
Gavins Point	8,000	4,000	10,000	15,000

7-19.2. While Table VII-11 shows the maximum daily decrease is 4,000 cfs per day at Gavins Point Dam during a normal situation, this assumes no change in tributary flows downstream. If tributary flows in the reach just downstream of a System project are increasing or decreasing, the actual project release increase or decrease can be based on the combination of tributary flow change and release change to provide the same result downstream. For example, if reach increase of tributary flows of 5,000 cfs were forecasted or experienced at gaging locations in the reach just below Gavins Point Dam and the System were in a normal situation, Gavins Point Dam releases could be reduced by 9,000 cfs per day (5,000 cfs more than the 4,000 cfs shown in Table VII-11) to obtain the same downstream result on the Missouri River as would occur with no tributary flow changes and a release change of 4,000 cfs.

7-20. **Mainstem System Physical Constraints.** The physical constraints of the System are relatively minor with a few exceptions. These constraints are discussed in the following paragraphs.

7-20.1. **Fort Peck – Emergency Flood Tunnels.** The three largest System projects have flood control tunnels that served as outlets when the project embankments were constructed. The flood control tunnels at Fort Peck Dam consist of two 24’ 8” diameter concrete-lined tunnels. The regulation of flow through these tunnels is provided by the operation of a cylinder gate in the tunnels, which also have upstream emergency gates. The use of the flood control tunnels has revealed many operational problems and resulted in high maintenance costs. The operational problems consist of entrained air, cavitation, gate vibration, violent surging, loud noises, and gate icing. The flood tunnels are considered unreliable for the prolonged discharge of water from Fort Peck Dam. The emergency gates consist of cable-suspended, tractor gates, which have never been tested under full flow emergency gate closure conditions. A high probability exists that the emergency gates would not close under full flow conditions, and considerable risk would be associated with any attempt to close these gates under design conditions.

7-20.2. **Fort Peck – Emergency Spillway.** The emergency spillway consists of a gated, overflow weir, with a net crest length of 640 feet; a 5,000-foot-long, trapezoidal-shaped, concrete-lined chute; and a 70-foot deep, downstream cutoff wall. The spillway was not provided with an energy dissipation structure. Concerns over the use of the emergency spillway under higher flows consist of the potential for uplifting of the concrete slabs on the spillway and enlargement of the downstream scour hole and its impact on the integrity of the adjacent cutoff wall.

7-20.3. **Fort Peck – Spillway Vertical Lift Gates.** Recent engineering analyses have shown that there should not be any continuous overtopping of the vertical lift gates at Fort Peck Dam other than the wind-induced effects of run-up and setup. A System constraint task item was established following the 1997 flood to evaluate this concern, but the studies have yet to be completed.

7-20.4. **Garrison – Floodplain Development.** The primary regulation constraint for releases from Garrison Dam is an increased water surface at Bismarck and Mandan due to aggradation in the upper reaches of Lake Oahe. The past two decades have resulted in a considerable amount of residential development along both sides of the Missouri River floodplain in the Bismarck, North Dakota area. Flows at and above flood stage will result in a considerable amount of flood damage. The natural Missouri River flows prior to the construction of Garrison Dam were high enough, and the flooding frequent enough, to discourage such floodplain development. When high releases from Garrison are required for flood storage evacuation, local interests will likely express their desires to keep flows through Bismarck below flood stage to reduce the amount of damage in the floodplain near Bismarck. A Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) for the Bismarck area has been completed, but the report has not yet been finalized. The Federal Government does not hold the authority to control local floodplain development.

7-20.5. **Garrison – Spillway Tainter Gates.** Recent engineering analyses have shown that there should not be any continuous overtopping of the tainter gates at Garrison Dam other than wind-induced effects of run-up and setup. This has been an issue when the reservoir nears the top of the Exclusive Flood Control Zone, as it has two times in the past. A System constraint task item was established following the 1997 flood to evaluate this concern, but the studies have yet to be completed.

7-20.6. **Garrison – Spillway Slab.** Use of the Garrison Dam spillway is a concern because of the associated spillway structure uplift pressures. An engineering analysis was completed in 1999 that indicates satisfactory factors of safety are achieved up to a reservoir elevation of 1859 feet msl. Due to the limited amount of data for analysis, a cautious approach should, however, be taken when spillway releases are required. Instrumentation has been installed, and evaluation under higher pools is required to complete the analysis.

7-20.7. **Oahe – Spillway.** The Oahe spillway empties into a downstream earth channel, therefore, when used, it will incur significant downstream erosion and flood damages. There will be some local resistance to using this project feature whenever it is first used.

7-20.8. **Oahe – Spillway Tainter Gates.** Recent engineering analyses have shown that there should not be any continuous overtopping of the tainter gates at Oahe Dam other than wind-induced effects of run-up and setup. A System constraint task item was established in 1998 to evaluate this concern, but the studies have yet to be completed.

7-20.9. **Oahe – High Pool Levels.** There has been considerable concern in recent years regarding the use of the Oahe Exclusive Flood Control Zone for controlling major floods (reservoir level above 1617 feet msl). A Board of Consultants was convened to evaluate the Oahe embankment stability for maximum design pool levels. The primary conclusion of the Board was that "*The dam has sufficient global resistance to operate without restriction to the maximum surcharge pool of elevation 1645 feet. The required safety is provided by the reserve resistance of the potential break-out zone and the three-dimensional restraints.*"

7-20.10. **Oahe – Winter Release Rates.** Winter release rates in past years during river ice formation have resulted in minor street flooding in the cities of Pierre and Fort Pierre, South Dakota. This flooding has prompted the application of a restriction on releases from Oahe Dam during a period when river ice formation is occurring, which usually coincides with high demands for hydropower production. A project is currently underway to provide a solution to this problem via a combination of purchasing and/or flood proofing homes and/or the purchase of flooding easements for the affected property in Pierre and Fort Pierre floodplains. The completion of this project will allow for more flexibility for winter regulation of Oahe. Completing this Federal project will take several more years.

7-20.11. **Big Bend – Spillway.** The Big Bend project has never used the spillway, however, this is not considered an operational constraint during periods of large flood evacuations. The powerplant can normally pass the expected flows, but a powerplant failure for more than a short period of time could disrupt the transfer of water downstream requiring supplemental spillway flows.

7-20.12. **Fort Randall – Low Pool Levels.** The fall drawdown and winter refill at Fort Randall permits increased energy generation from the System during the winter. Complaints during the late 1960's about the fall regulation of Fort Randall reduced the amount of the normal fall drawdown from 1320 to 1337.5 feet msl. This change in regulation in the early 1970's has reduced overall power benefits. During a very severe drought, Fort Randall reservoir can be drawn down to 1320 feet msl to augment water provided by the upper three, larger System reservoirs.

7-20.13. **Fort Randall – Flood Tunnel Fine Regulating Gate.** The fine regulating gate at Fort Randall was destroyed in 1975 and has never been replaced. Two gates in Flood Tunnel No. 11 have been modified to dampen gate vibrations and can be used to make fine regulating releases, either individually or in combination with each other.

7-20.14. **Fort Randall – Reduced Channel Capacity.** There has been significant loss of channel capacity in the downstream Fort Randall river reach, such that releases to evacuate accumulated flood storage in 1997 caused flooding to some property located adjacent to the Missouri River. The Niobrara River has been depositing sediments at its mouth (near the upper end of Lewis and Clark Lake), which is causing a loss of conveyance capacity in the river channel in this reach. Restricted downstream channel capacity because of aggradation remains a concern. Also some cabins and residences have encroached onto the floodplain in this reach and were, in some cases, flooded by the 1997 flood evacuation releases.

7-20.15. **Gavins Point – Spillway Tainter Gates.** Steady winter releases from Gavins Point Dam are required to meet minimum downstream flow support targets. The spillway is used to ensure steady releases in the case of a planned or forced hydropower unit outage. In the case of a forced hydropower unit outage, spillway releases are initiated immediately to ensure that a reduction in flows below target levels does not occur downstream. In the winter, lower than planned downstream flows could cause disruption of established downstream river ice cover by a sudden reduction in flows, which could result in an ice jam. Winter operation of the spillway tainter gates has been hindered by ice formation along the tainter gate seals and the backside of the gates from water spraying over the spillway and freezing. Sidewall heater plates have been installed to alleviate the gate seal problem. These have not been tested to date during a significantly cold winter to determine effectiveness of this solution.

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VIII – WATER MANAGEMENT ORGANIZATION

8-01. **Responsibilities and Organization.** This Chapter describes the personnel and coordinating necessary to manage the System. The Corps has the long- and short-term direct responsibility for regulating the System. The System has been regulated as a hydraulically and electrically integrated system since 1953 when Fort Randall Dam (the second Mainstem dam constructed) was closed to begin storing water. As each System dam was completed and filled, System regulation procedures were followed and regulation of the new project was immediately integrated into regulation of the System. The System became "full," or filled to the top of all six projects' Carryover Multiple Use Zones in 1967, following a significant 8-year drought (1954 through 1961) in the Missouri River basin. The year 1967 is, therefore, considered the official beginning of System regulation. The following paragraphs describe the responsibilities for the regulation of the System.

8-01.1. **Corps of Engineers.** The Northwestern Division's (NWD) Missouri River Basin Water Management Division (MRBWMD) of the Programs Directorate, located in Omaha, Nebraska, is comprised of a 20-person staff of hydraulic engineers, biologists, information management specialists, program analysts, hydrologic technicians, and support staff. The MRBWMD is comprised of three teams: Reservoir Regulation, Power Production, and the Master Manual Review and Update. The Reservoir Control Center (RCC) is a subset of MRBWM that includes the Reservoir Regulation and Power Production Teams. The Corps' Guidance Memorandum entitled, "Reservoir Control Center", dated March 1972, serves as the document that details the role and responsibilities of the RCC in managing and regulating the System. The RCC was founded in 1954 and was the first RCC established in the Corps. The organization chart for the MRBWMD in the NWD is provided on Plate VIII-1.

8-01.1.1. The Corps constructed the System projects during the period from 1933 to 1966 and is the sole owner and regulator of the six dams that comprise the System. The Chief of Engineers for the Corps has delegated the regulation of this System to the NWD Commander, who provides oversight of the MRBWMD's day-to-day regulation of the System. The RCC, under the supervision of the Deputy Director, Programs Directorate – Missouri River/Chief, MRBWMD (a dual-hatted position), has the direct responsibility of regulating the System and issues daily release and hydropower production orders to accomplish this mission. The operation and maintenance of the System dams and associated structures are the responsibility of the Omaha District of NWD. The Omaha District has staff physically located at the System projects to make the actual gate changes stated on the System project orders developed and sent by the RCC. The System is the largest reservoir system in the United States, based on the amount of water in storage. The Corps has the responsibility to coordinate the regulation of this System, both within and outside of the Missouri River basin. The RCC prepares long- and short-term runoff and streamflow forecasts that are integrated into model simulations to effectively regulate the System, as described in Chapter 6 of this Master Manual. Each individual System project water control manual contains instructions to the dam tender in case of loss of communication for an extended period of time during a significant or catastrophic event. The RCC staff maintains communication with each other and Corps staff at the System projects via cell phones and computers that are available from work, their homes, and while they are on travel status. Maintaining these communication devices ensures that staff can be reached at any hour of any day of the year. Also, there is at least one staff person that physically reports to the RCC, for at least part of the each day of the year. Detailed calling lists are provided to the System projects and Omaha District Emergency Operations staff in case there is a need to contact RCC staff during normal off-duty hours.

8-01.1.2. The two teams within the RCC have the responsibility for regulating the System. The Reservoir Regulation Team in the RCC has the responsibility of running the daily Missouri River streamflow forecast to determine releases (often called the System release) from the lower-most System dam (Gavins Point Dam). This team also forecasts all runoff volumes for both long- and short-range model simulations. Because runoff forecasting is a critical component in the decision process to determine the most effective flood control release rate, the Reservoir Regulation Team has the responsibility of making all individual System project release determinations during significant System flood control operations. The Reservoir Regulation Team also directs and approves the deviation requests from the Omaha and Kansas City Districts for Corps tributary reservoirs and U.S. Bureau of Reclamation (USBR) tributary projects that have Corps-regulated flood control zones. The Power Production Team has the responsibility of intra-System regulation and threatened and endangered species (T&E) coordination relating to System regulation. Intra-System regulation oversight by this team is conducted to respond to widely varying Missouri River basin runoff to meet the operational objectives stated in this Master Manual. It also performs all hydropower related activities.

8-01.1.3. The Master Manual Review and Update Team was formed to oversee the studies and documentation required for the review of the Mainstem System Master Manual that led to this update of the Master Manual. This team also provides program management for, and oversight of, the non-flow Missouri River and tributaries related actions necessary to comply with the Endangered Species Act (ESA). This team has the responsibility to ensure that the overall adaptive management process for both the flow and non-flow ESA-related actions are established and proceed in an effective and efficient manner.

8-01.1.4. **Adaptive Management.** The Corps has conducted System water management within an adaptive management framework for many years. This Master Manual documents the Corps' vision for the future adaptive management process. This process will allow for the review of System water management by Federal and State agencies, basin Tribes, and the public and allow for their input into the implementation of, and changes to, the CWCP. Additional details regarding adaptive management are presented in Appendix I of this Master Manual.

8-02. **System Coordination.** The RCC strives to keep everyone interested in the short- and long-term regulation of the System informed as to the amount of water stored in the System, the outlook for future runoff, and the short- and long-term plans for System water management. As the largest storage reservoir system in the United States with the potential for a wide array of positive and negative impacts, the regulation of this System generates a high level of interest within and outside of the basin. The Annual Operating Plan (AOP) process, developed by the RCC, provides an important tool for the Corps to interact with, inform, and coordinate with the public on a semi-annual basis. Other interests have a need to keep informed of changes and project status of the System on an almost continual basis. Successful regulation of the System to meet the regulation objectives stated in this Master Manual is dependant on a group of well-informed stakeholders and partners providing continual dialog on the effects of actual and proposed System regulation. The following paragraphs detail how this coordination is accomplished.

8-02.1. **Local Press and Corps Bulletins.** The RCC provides monthly and other special press releases concerning the regulation of the System. The NWD Public Affairs Office is responsible for issuing the official RCC press releases.

8-02.2. **RCC Website.** The RCC maintains a public website at the following address: www.nwd-mr.usace.army.mil/rcc. This site contains information concerning System regulation. It includes forecasted reservoir levels and dam releases as well as historic data in both tabular and graphic formats. The website contains user-friendly, clickable maps to observe graphical streamflow and System project data. The National Weather Service (NWS) has the responsibility for issuing streamflow forecasts. While the RCC performs streamflow forecasting at select locations, these results are not available for public dissemination. The NWS forecasts are available as a link from the RCC website. The website contains special news releases regarding closure of the river for navigation during to extremely large flood events, deviations from proposed regulation plans, water control plan information meetings, T&E nesting operations, and other significant items that occur on an unscheduled basis. In addition, the Corps produces numerous reports on a daily basis that provide continual updates of the System's status and regulation changes. These reports are available to the public by either World Wide Web access or email.

8-02.3. **AOP Public Meetings.** The Corps follows a public process as part of the AOP preparation and implementation process for regulating the System. This process involves the development and publishing of a Draft AOP in the fall of each year. The draft AOP forecasts the regulation of the System for various runoff scenarios for the remainder of the current year, plus the following calendar year. Numerous copies of the Draft AOP are mailed to all interested stakeholders in late September. Public meetings are held at three or four sites within the basin, normally in October, to accept comments from the public and provide a forum for discussion on the Draft AOP. Written comments on the Draft AOP are also considered for a period of generally 30 days after the public meeting dates. After considering the comments from the public meetings and any written comments provided during the comment period, appropriate changes are made to the Draft AOP to produce a Final AOP, which is normally made available around the first of the calendar year. In the spring, the Corps again conducts public meetings to provide information on the current hydrologic conditions in the basin and the expected effects of System regulation for the remainder of the year given the most-likely forecast and other possible runoff scenarios. Once again, comments are obtained for fine-tuning the System regulation for the spring and summer. The RCC follows the Final AOP as closely as possible for the remaining year, and the process begins again in August for the next AOP. It should be stated that not all circumstances are covered in the AOP. Even with this public process, flexibility to deviate from the Final AOP is prudent. This flexibility allows the Corps to regulate the System for maximum benefit in an area of the continent where extreme climate changes can and frequently occur.

8-02.4. **National Weather Service Coordination.** The NWS is the official Federal agency responsible for issuing streamflow forecasts to the public. The Corps uses these forecasts in its regulation of the System. The NWS office interface for the RCC is the NWS Missouri River Basin Forecast (MBRFC), located in Prairie Hill, Missouri. The MBRFC has the forecasting responsibility for the entire Missouri River basin. The Corps and NWS share real-time data, U.S. Geological Survey (USGS) measurements and flood information, and forecasts for streamflow and runoff. The RCC provides the MBRFC with System regulation data on a daily basis. The MBRFC integrates the Corps' forecasted System project releases with its short- and long-range streamflow forecasts for the Missouri River. The normal method of data exchange is through web-displayed products or by direct telephone contact, when required. The Corps receives MBRFC forecasts and Multi-sensor Precipitation Estimates (MPE) rainfall radar imagery, as described in Chapter 5, Paragraph 5-01.2.1 for integration into the RCC real-time forecasting models. During years of significant plains snowmelt, additional coordination between the Corps and MBRFC is necessary to assure a proper data exchange between the two agencies for the forecasting of plains snowmelt. In addition, whenever the Corps conducts special reconnaissance surveys of ice conditions on the Missouri River, the obtained information is readily shared with the MBRFC.

8-02.5. **U.S. Geological Survey Coordination.** The USGS is the primary source of data and hydrologic support to the Corps. The USGS obtains streamflow measurement data that it supplies to the RCC in a real-time mode. This prompt delivery of data allows the RCC to meet its mission of managing the Nation's water resources. This effort is conducted through a cooperative stream-gaging program (CO-OP). This CO-OP program covers the 1) maintenance of Data Collection Platform (DCP) stations, 2) measurement of streamflow at select locations, and 3) sediment and water quality sampling at select locations. The RCC has review responsibility for this program but has delegated the implementation of the program to the Corps' Omaha and Kansas City District Water Management staffs. The Districts negotiate separate programs with each State and manage these programs throughout the year. The USGS also conducts specific data collection efforts to support the Corps. For example, it acquired the specific data needed for impacts modeling of ground water and fish and wildlife effects of alternative water control plans leading to the selection of the CWCP presented in this Master Manual.

8-02.6. **Western Area Power Administration Coordination.** Long-term (monthly) and short-term (weekly) regulation forecasts of energy generation and capability are coordinated with Western Area Power Administration (Western). These forecasts serve an important role in determining when surplus energy is available during high-water years, otherwise referred to as surplus sales, and when firm energy commitments cannot be met during low-water years, otherwise referred to as energy purchases. These forecasts are also used to reflect unanticipated adjustments in project releases, such as flood control regulation and lawsuits that can dramatically alter energy generation schedules. Scheduled and forced outages of the generating units are closely coordinated with Western. Coordination and letters of support from Western are required during the planning and execution of major rehabilitation of the System powerplants.

8-02.7. **U. S. Fish and Wildlife Service Coordination.** The U.S. Fish and Wildlife Service (Service) is the primary Federal agency in charge of administering the Endangered Species Act of 1973 as it relates to protected species in the Missouri River basin. The RCC and Service coordinate extensively on regulation of the System during the nesting season for the endangered interior least tern and threatened piping plover and on other issues relating to the implementation of the Service's "Biological Opinion the Operation of the Missouri River Main Stem Reservoir System, Operation and Maintenance of the Missouri River Banks Stabilization and Navigation Project, and operation of the Kansas River System", dated November 30, 2000 and its December 16, 2003 Amendment to that Biological Opinion. Additional interagency coordination will continue and expand as the adaptive management process evolves.

8-03. **Interagency Agreements.** No permanent Interagency Agreements are in effect with regard to the regulation of the System. A considerable amount of coordination has been conducted between the RCC and the Federal agencies that have missions that are affected by the System. In 2003, the RCC participated in a Memorandum of Understanding (MOU) with the Southwestern Power Administration (Southwestern) with regard to hydropower generation on the Corps' tributary projects in the Kansas City District. The RCC also had an agreement with the USBR from Boise, Idaho, as recently as 1999, for mutual satellite data collection and backup. This MOU was not renewed because each agency had developed Continuity of Operation Plans (COOP) using other sources for data system redundancy. The RCC has an existing agreement with the Great Plains Region of the USBR for the use of System Replacement Flood Control Storage. The agreement concerns the USBR Clark Canyon, Canyon Ferry, and Tiber projects. These three USBR tributary projects contain authorized Flood Control Storage Zones that are regulated by the Omaha District when water is stored in this zone. The RCC has not exercised the option of using this storage since the drought of the 1980's; however, the water control plans for the System and the individual USBR projects describe this storage and how it would be used to enhance overall basin benefits.

8-04. **Commissions, River Authorities, Compacts, and Committees.** The Missouri Basin Survey Commission (MBSC), in a report to President Truman per Executive Order 10318 dated 1953, recommended that a five-member Missouri River Basin Commission be established by Presidential appointment to oversee the water resource development in the Missouri River basin. This commission never came to fruition; however, several committees, some dating from that period, have provided significant guidance to the primary Federal agencies in developing Missouri River basin water resources and in regulating those resource projects in the Missouri River basin. The following paragraphs discuss the roles of those committees in providing information for consideration in regulation of the System.

8-04.1. **Committee History.** This section describes the major committees in the Missouri River basin previously or presently coordinating water resource planning and System regulation guidance to the Corps.

8-04.1.1. **Missouri River States Committee.** On May 21, 1943, eight basin states formed the Missouri River States Committee (MRSC) for the purpose of lobbying and working collaboratively for water resource development in the Missouri River basin. The MRSC worked with the Corps and the USBR to finalize the Pick-Sloan Plan for the Missouri River basin that led to the construction of the final five dams in the System and made the Fort Peck project a part of the System.

8-04.1.2. **Missouri River Basin Inter-Agency Committee.** In March 1945, the Missouri River Basin Inter-Agency Committee (MBIAC) was formed by the Federal Interagency River Basin Committee to facilitate progress on the Pick-Sloan Plan and the Missouri River navigation project. The group consisted of the Corps, USBR, Department of Agriculture, and the Federal Power Commission (FPC). In addition, the MRSC was invited to provide four representatives. The Corps hosted the first meeting on July 19, 1945 in Omaha. The Committee facilitated the sharing of data and information and provided a format for problem solving in the basin. A revised charter was adopted in 1954 to provide improved facilities and procedures for coordination of the policies, programs, and activities of the various Federal departments and the States in water and related land resources investigation, planning, construction, operation, and maintenance. MBIAC had no authority for making policy for water resource development in the Missouri River basin. The MBIAC functioned until June 14, 1972, when its members joined the Missouri River Basin Commission.

8-04.1.3. **Missouri Basin Survey Commission.** On January 3, 1952, President Truman appointed an 11-member Missouri Basin Survey Committee (MBSC) to determine the land and water resources in the Missouri River basin. It also was to provide guidance on the best way to develop the Missouri River basin resources. The MBSC provided a report in 1953 that promoted the formation of a Missouri Valley Authority to regulate and oversee basin water resource development and coordinate the reservoir regulation of the newly constructed projects. As mentioned in the leading paragraph above, this never occurred.

8-04.1.4. **Missouri River Coordinating Committee.** The Missouri River Coordinating Committee was established at the request of the Corps' Missouri River Division Commander in 1953. The Governors appointed representatives to the Committee, usually the State Engineer or the head of the State's water resources agency. In addition, representatives of the nine affected Federal agencies served in an advisory capacity to represent all interests in their State and basin or for their Federal agency. This Committee served to guide the development of the System and collectively suggested changes to the System from 1953 through 1981. In 1981, it was disbanded because it fell under the purview of the Federal Advisory Committee Act. The overall coordination concept was changed because the Committee had become somewhat less effective and some felt that its members did not always represent all of the interests within their respective State or Federal agency. The process adopted at that time to replace the Missouri River Coordinating Committee was the bi-annual AOP public meeting process discussed in Paragraph 8-02.3.

8-04.1.5. **Missouri River Basin Commission.** In March 1972, President Richard Nixon approved a Missouri River Basin Commission (MRBC). Transfer from the MBIAC to the MRBC was completed formally at a joint meeting on June 14, 1972. The thrust of the MRBC in the early years was the completion of several Missouri River basin water resources studies. At the request of the Governors, this group developed a computerized water accounting system for the Missouri River basin in 1979. This group was disbanded in 1981 as a program that had been created under the Water Resources Act of 1965 and transferred its assets to the Missouri Basin States Association.

8-04.1.6. **Missouri Basin States Association.** Another significant committee was the Missouri Basin States Association (MBSA) that was formed in October 1981, following termination of the MRBC. The Governors of the Missouri River basin States formed the MBSA to provide regional coordination of water resource management. The MBSA was governed by a board of directors composed of one member for each of the ten basin States. The Governors generally appointed senior water resource officials to this position. The affected Federal agencies and other interested persons attended the meetings as observers. The primary goal when the MBSA was first formed was to complete some of the Missouri River basin water resources studies. An office was established in Omaha and was funded through a group effort of the members. The MBSA office in Omaha closed on April 1, 1988.

8-04.1.7. **Missouri River Natural Resources Committee.** The Missouri River Natural Resources Committee (MRNRC) was established in 1988 at the request of the Corps' Missouri River Division Commander to consolidate the recommendations from the State biologists and fishery experts. The intent was to better guide the Corps in meeting the operational objectives of the fish and wildlife enhancement purpose. The MRNRC continues to be active in providing guidance and recommendations to the RCC on fishery resource issues.

8-04.1.8. **Missouri River Basin Association.** In 1993, the MBSA changed its name to the Missouri River Basin Association (MRBA) reflecting the inclusion of the basin Tribes in its membership. The MRBA also expanded its role as providing a single location for resolving water resource issues occurring in the basin. Basin coordination and cooperation on water resource issues were the primary goal of the MRBA, which is active today.

8-04.1.9. **Missouri River Basin Interagency Roundtable.** This group was organized in 2001 to promote interagency cooperation among the Federal agencies within the Missouri River basin. The mission is to foster effective communication and coordination among Federal agencies, and, when possible and where appropriate, to communicate to other basin interests with a single Federal voice. The cooperating agencies include, but are not limited to the Corps, National Park Service, U. S. Geological Survey, U. S. Fish and Wildlife Service, U. S. Bureau of Reclamation, Bureau of Indian Affairs, Environmental Protection Agency, Western Area Power Administration, U.S. Forest Service, and the Natural Resources Conservation Service.

8-05. **Non-Federal Hydropower.** All hydropower facilities located either at or in association with the System are Federally owned and operated. No non-Federal hydropower facilities are currently located either at the System projects or on System project lands.

8-06. **Reports.** The RCC prepares several reports to serve as summaries of activities and to communicate to others the current status and proposed regulation of the System. Most reports are available on the RCC website – www.nwd-mr.usace.army.mil/rcc. This website is used for public dissemination of water resource information related to regulation of the System. In addition to the reports shown in Table VIII-1, the RCC prepares technical reports on an as-required basis to provide information and additional guidance in regulation of the System. The RCC prepared post flood reports on System operations for the 1975, 1978, and 1997 flood events. Also, a detailed post-flood report was prepared by the Omaha District as part of the Great Flood of 1993 entitled, "Post-Flood Report, Mississippi River Basin and Tributaries Flooding, 1993." The Omaha and Kansas City Districts' portions of the report are Appendix D and E, respectively. The RCC provided all pertinent information to the Omaha District concerning System regulation for inclusion in this report.

Table VIII-1
Reservoir Control Center Reports

Frequency of Report/Type of Report	Reporting Requirement*
Hourly	
Hourly plots of gages with DCP transmissions in basin – 15 days provided	
Daily	
Daily Bulletin	
Weekly Bulletin	
Monthly Bulletin	
Yearly Bulletin	
Reservoir Summary Bulletins	
Flood Report	
Ice Report (Seasonal December-April)	
Power Production Orders	
Missouri River Streamflow Forecast – 14 days	
Mainstem Release and Energy Schedule	
Weekly	
Reach Runoff Report	
LRS Three-Week Model Simulation	
Weekly Mountain Snowpack Report	
Monthly	
Basin Calendar-Year Runoff	
Monthly Mountain Snow Report (Seasonal)	
Runoff Outlook	(ER Requirement)
Long-Range Monthly Model Simulation	
Project 0168 Monthly Summaries	(ER Requirement)
Monthly Press Release	
Monthly Project and System Energy Summary	
Yearly	
Draft Annual Operating Plan	
Final Annual Operating Plan	
Annual Summary of Actual Operations	
Division Annual Report	(ER requirement, includes District Reservoirs)
Flood Damages Prevented	(ER requirement - RCC provides holdouts and districts provide estimated damages prevented)
Stage Trends Report	
Annual Sediment Report	(ER requirement)
Annual Water Quality Report	(ER requirement)
Cooperative Stream Gage Program	(ER requirement)

- Reports required per Corps Engineering Regulation (ER).

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Appendix E – Water Supply And Irrigation

E-01. **Introduction.** System regulation has assured a relatively uniform supply of water for downstream municipalities and industrial uses. The Corps provides more than adequate flow in the river to meet the requirements of all who choose to utilize the Missouri River for their water supply. At times, releases from individual System projects have been adjusted to assure continued satisfactory functioning of water intakes on a short-term basis. The Missouri River and its System reservoirs are a source of water for municipal water supply; irrigation; cooling water; and commercial, industrial, and domestic uses. Approximately 1,600 water intakes of widely varying size are located within the System and the lower Missouri River. Access to water is a key concern because low water levels increase the cost of getting water from both the reservoirs and Missouri River. Water supply is a purpose that has grown more than originally envisioned. The regulation of the System in such a predictable manner has resulted in a dependency from many river communities for using the Missouri River as a source for domestic as well as industrial water supply. Releases have been of a uniformly good quality. There have been times when intake access becomes a problem, primarily during release reductions for flood control or because of reduced releases during extended drought. Generally, these access problems have been accommodated. The Missouri River below the System has the greater dependency on the Missouri River for its municipal water supply and thermal powerplant intakes, as indicated in Tables E-1 and E-2.

E-01.1. **Missouri River Basin – Missouri River Water Basin Intakes and Water Supply.** Water is withdrawn from the Missouri River and its System reservoirs for cooling purposes in the production of electricity; municipal water supply; and commercial, industrial, irrigation, domestic, and public uses. More than 1,600 intakes and intake facilities have been identified on the System reservoirs and river reaches (Table E-3). Of these, 302 intakes and intake facilities are identified for American Indian Tribes.

E-01.1.1. **Missouri River Basin – Upstream Water Supply Intakes.** Water supply intakes have been constructed on the System projects and river reaches downstream from several of these projects. The major population centers served are Bismarck, North Dakota and Pierre, South Dakota. The dominant category of intake type for the upstream water supply intakes is irrigation, as shown in Table E-3.

E-01.1.1.1. **Fort Peck Lake.** As shown on Table E-3, 109 water supply intakes and intake facilities are located on Fort Peck Lake. These include 1 municipal water supply facility, 5 irrigation intakes, 101 domestic intakes, and 2 public intakes. The municipal water supply facility serves a population of approximately 580 persons. Cabin owners own the majority of the domestic intakes, which are generally used in lawn watering, car washing, and fire protection. Domestic intakes along this reach are not generally used to provide drinking water, which is obtained in neighboring towns.

Table E-1
Municipal Water Supply by River Reach

Reach/Lake	Population Served	Share of Total (%)
Fort Peck Lake	580	<1
Fort Peck	28,020 (200)	1
Lake Sakakawea	21,950 (2,562)	1
Garrison	69,960	2
Lake Oahe	48,050 (11,550)	1
Oahe	0	0
Lake Sharpe	2,390 (600)	<1
Big Bend	0	0
Lake Francis Case	12,100	<1
Fort Randall	0	0
Lewis and Clark Lake	4,380	<1
Gavins Point	15,000	<1
Sioux City	88,800	3
Omaha	530,000	17
Nebraska City	0	0
St. Joseph	418,000	14
Kansas City	845,500	27
Boonville	46,740	1
Hermann	940,000	31
Total	**3,071,470 (14,912)**	**100**
Served Above Gavins Point	187,430 (14,912)	6
Served Below Gavins Point	2,884,040 (0)	94

Source: Corps, 1994 DEIS
( ) Denotes Tribal Reservation population served by municipal intakes.

Table E-2
Thermal Powerplants Using Missouri River for Cooling Water

Reach/Lake	Powerplant Gross Capacity (MW)	Share of Total (%)
Fort Peck Lake	0	0
Fort Peck	0	0
Lake Sakakawea	879	6
Garrison	3,147	21
Lake Oahe	0	0
Lake Sharpe	0	0
Lake Francis Case	0	0
Lewis and Clark Lake	0	0
Gavins Point	0	0
Sioux City	1,560	10
Omaha	2,028	13
Nebraska City	1,424	9
St. Joseph	1,026	7
Kansas City	1,309	9
Boonville	0	0
Hermann	3,711	25
Total	**15,084**	**100**
Above Gavins Point	4,026	27
Below Gavins Point	11,058	73

Source: Corps, 1994 DEIS

Table E-3
Missouri River Water Supply Intakes

Reach	River Mile	Intake by Type: Power	Municipal	Industrial	Irrigation	Domestic	Public	Total Intakes
Fort Peck Lake	1,771.6		1		5	101	2	109
Fort Peck	1,547.1		5 (1)	4	283 (94)	162 (14)	1	455 (109)
Lake Sakakawea	1,389.9	1	10 (5)	6 (1)	44 (10)	228 (63)	11	300 (79)
Garrison	1,317.4	6	3	6	77	28	3	123
Lake Oahe	1,072.3		8 (3)	2	179 (12)	21 (6)	8 (2)	218 (23)
Oahe	1,072.2							0
Lake Sharpe	987.4		3 (2)		91 (71)	19 (4)	2	115 (77)
Big Bend	987.3							0
Lake Francis Case	841.8		6		72	4	3	85
Fort Randall	836.1				100*(4)			100* (4)
Lewis and Clark Lake	811.1		2		27 (5)	6	2 (2)	37 (7)
Gavins Point	734.2		1		33	7	1	42
Sioux City	648.0	2	2	1	42 (3)		2	49 (3)
Omaha	597.2	3	2	1	8	2	5	21
Nebraska City	497.4	2			22	1		25
St. Joseph	374.0	3	4				2	9
Kansas City	249.9	5	4				1	10
Boonville	129.9		3				1	4
Hermann	0.0	3	3					6
Total		**25**	**57 (11)**	**20 (1)**	**891 (199)**	**579 (87)**	**44 (4)**	**1,616 (302)**
Above Gavins Point		7	38 (11)	18 (1)	786 (196)	569 (87)	32 (4)	
Below Gavins Point		18	19	2	105 (3)	10	12	

Source: Corps 1994
( ) Denotes intakes located on Reservation land.
* Source: Fort Randall Project Manager 2002

E-01.1.1.2. **Fort Peck Dam to Lake Sakakawea.** As shown on Table E-3, 455 water supply intakes and intake facilities are located on the Missouri River in this reach from Wolf Point to Williston. These include 5 municipal water supply facilities, 4 industrial intakes, 283 irrigation intakes, 162 domestic intakes, and 1 public intake. The municipal water supply facilities serve a population of approximately 28,020 persons, 80 percent of whom live in the Williston area. Of the 455 water supply intakes and intake facilities, there are 109 water supply intakes and intake facilities located on the Missouri River serving the Fort Peck Reservation. These include 1 municipal water supply facility, 94 irrigation intakes, and 14 domestic intakes. The municipal water supply facilities serve a population of approximately 200 persons.

E-01.1.1.3. **Lake Sakakawea.** As shown on Table E-3, 300 water supply intakes and intake facilities draw water from Lake Sakakawea. These include 1 powerplant, 10 municipal water supply facilities, 6 industrial intakes, 44 irrigation intakes, 228 domestic intakes, and 11 public intakes. The powerplant has a gross generating capacity of 879 megawatts (MW). The municipal water supply facilities serve a population of approximately 21,950 persons. Of the 300 water supply intakes and intake facilities, there are 79 water supply intakes and intake facilities that serve the Fort Berthold Reservation. These include 5 municipal water supply facilities, 1 industrial intake, 10 irrigation intakes, and 63 domestic intakes. The municipal water supply facilities serve a population of approximately 2,562 persons.

E-01.1.1.4. **Garrison Dam to Lake Oahe.** As shown on Table E-3, 123 water supply intakes are located on the Missouri River from Garrison Dam to the upper end of Lake Oahe. These include 6 powerplant intakes, 3 municipal water supply facilities, 6 industrial intakes, 77 irrigation intakes, 28 domestic intakes, and 3 public intakes. The 3 powerplants served by the 6 intakes have a gross generating capacity of 3,147 MW. The municipal water supply facilities serve a population of approximately 70,000 persons.

E-01.1.1.5. **Lake Oahe.** As shown on Table E-3, there are 218 water supply intakes are located on Lake Oahe. These include 8 municipal intakes, 2 industrial intakes, 179 irrigation intakes, 21 domestic intakes, and 8 public intakes. The municipal water supply facilities serve a population of approximately 48,050 persons. Of the 218 water supply intakes, 14 water supply intakes serve the Standing Rock Reservation. These include 2 municipal intakes, 9 irrigation intakes, 1 domestic intake, and 2 public intakes. The Reservation's municipal water supply facilities serve a population of approximately 1,550 persons. Likewise, 9 water supply intakes service the Cheyenne River Reservation. These include 1 municipal intake, 3 irrigation intakes, and 5 domestic intakes. The Reservation's municipal water supply facilities serve a population of approximately 10,000 persons.

E-01.1.1.6. **Lake Sharpe.** As shown on Table E-3, 115 water supply intakes are located on Lake Sharpe. These include 3 municipal intake facilities, 91 irrigation intakes, 19 domestic intakes, and 2 public intakes. The municipal water supply facilities serve a population of approximately 2,390 persons. Of the 115 water supply intakes, there are 22 water supply intakes serving the Lower Brule Reservation. These include a single municipal intake facility, 20 irrigation intakes, and 1 domestic intake. The municipal water supply facility serves a population of approximately 300 persons. Additionally, there are 55 water supply intakes serving the Crow Creek Reservation. These include a municipal intake facility, 51 irrigation intakes, and 3 domestic intakes. The municipal water supply facility serves a population of approximately 300 persons.

E-01.1.1.7. **Lake Francis Case From Fort Randall Dam to Lewis and Clark Lake.** As shown on Table E-3, 85 water supply intakes are located on Lake Francis Case. These include 6 municipal water supply facilities, 72 irrigation intakes, 4 domestic intakes, and 3 public intakes. The municipal water supply facilities serve a population of approximately 12,100 persons. Of the 100 irrigation intakes located on the river reach downstream of Fort Randall Dam, four are located on the Yankton Reservation.

E-01.1.1.8. **Lewis and Clark Lake.** As shown on Table E-3, 37 water supply intakes are located on Lewis and Clark Lake. These include 2 municipal water supply facilities, 27 irrigation intakes, 6 domestic intakes, and 2 public intakes. The municipal water supply facilities serve a population of approximately 4,380 persons. Of the 37 water supply intakes located on Lewis and Clark Lake, 7 are serving the Santee Reservation. These include 5 irrigation intakes and 2 public intakes.

E-01.1.2. **Missouri River Basin – Downstream Water Supply Intakes.** The lower river has 166 water supply intakes that depend on the Missouri River as their source of water.

E-01.1.2.1. **Gavins Point Reach.** As shown on Table E-3, 42 water supply intakes are located on the Missouri River below Gavins Point Dam to Sioux City, Iowa. These include 1 municipal water supply facility, 33 irrigation intakes, 7 domestic intakes, and 1 public intake. The municipal water supply facility serves a population of approximately 15,000 persons.

E-01.1.2.2. **Sioux City Reach.** As shown on Table E-3, 49 water supply intakes are located on the Missouri River in the Sioux City to Blair, Nebraska reach. These include 2 powerplant intakes, 2 municipal water supply facilities, 1 industrial intake, 42 irrigation intakes, and 2 public intakes. The two powerplants have a gross generating capacity of 1,535 MW. The municipal water supply facilities serve a population of approximately 88,800 persons. Of the 49 water supply intakes located on the Missouri River in the Sioux City reach, 1 irrigation intake is located on the Winnebago Reservation and 2 irrigation intakes are located on the Omaha Reservation.

E-01.1.2.3. **Omaha Reach.** As shown on Table E–3, 21 water supply intakes are located on the Missouri River in the Blair to Bellevue, Nebraska reach. These include 3 powerplant (one nuclear) intakes, 2 municipal water supply facilities, 1 industrial intake, 8 irrigation intakes, 2 domestic intakes, and 5 public intakes. The three powerplants have a gross generating capacity of 1,975 MW. The municipal water supply facilities serve a population of approximately 530,000 persons.

E-01.1.2.4. **Nebraska City Reach.** As shown on Table E-3, between Bellevue and Rulo, Nebraska, 25 water supply intakes are located on the Missouri River. These include 2 powerplant (one nuclear) intakes, 22 irrigation intakes, and 1 domestic intake. The two powerplants have a gross generating capacity of 1,424 MW.

E-01.1.2.5. **St. Joseph Reach.** As shown on Table E-3, 9 water supply intakes are located on the Missouri River between Rulo and Kansas City, Missouri. These include 3 powerplant intakes, 4 municipal water supply facilities, and 2 public intakes. The 3 powerplants have a gross generating capacity of 1,026 MW. The municipal water supply facilities serve a population of approximately 418,000 persons. None of 9 water supply intakes located on the St. Joseph reach of the Missouri River are on the Iowa and the Sac and Fox Reservation.

E-01.1.2.6. **Kansas City Reach.** As shown on Table E-3, 10 water supply intakes are located on the Missouri River between Kansas City and the Grand River confluence with the Missouri River. These include 5 powerplant intakes, 4 municipal water supply facilities, and 1 public intake. The 5 powerplants have a gross generating capacity of 1,309 MW. The municipal water supply facilities serve a population of approximately 845,500 persons.

E-01.1.2.6. **Boonville Reach.** As shown on Table E-3, 4 water supply intakes are located on the Missouri River between the Grand River and Osage River confluences. These include 3 municipal water supply intakes and 1 public intake. The municipal water supply intakes serve a population of approximately 46,740 persons.

E-01.1.2.7. **Hermann Reach.** As shown on Table E-3, 6 water supply intakes are located on the Missouri River between the Osage River and St. Louis. These include 3 powerplant (one nuclear) intakes and 3 municipal water supply facilities. The 3 powerplants have a gross generating capacity of 3,711 MW. The municipal water supply facilities serve a population of approximately 940,000 persons.

E-02. **Historic Municipal and Domestic Water Supply Considerations.** Missouri River water is used for municipal water supply uses. Municipal water supply use is for Tribal and public supply of water to Reservations, residents of cities and towns, and rural water districts or associations. Approximately 3 million people are served by municipal water supply facilities that withdraw water from the System and the Missouri River below the System. Tribal, public, and private water supply facilities provide treated water to households and commercial and industrial establishments. Most of the smaller municipal water supply facilities are located on the reservoirs and upper river reaches and serve about 190,000 persons. The largest municipal water supply facilities are located on the Missouri River reach below the System and serve the major urban areas of the lower basin located near the Missouri River. The municipal water supply facilities located below Gavins Point Dam serve nearly 2.9 million persons. The larger downstream municipal intakes on the Missouri River were in place well before the construction of the System. Many were in place before the turn of the century, when the cities were first established. Some of the smaller municipal or rural water supply intakes are situated at a relatively high elevation in the System reservoirs. The Corps makes every effort to accommodate serving all water intakes when it is possible to do so without impacting the other project purposes. The water supply purpose is fully served by the System because the quantity of water available has been, and is expected to continue to be, sufficient to meet the needs

E-02.1. The water supply problem that sometimes occurs is usually related to an intake access problem that is further discussed in Paragraph E-05. When these problems do occur the cost of obtaining water increases. In addition to the cost of extending intakes, costs may be incurred due to additional strain on equipment, increased sedimentation problems, and the necessity for more frequent and thorough cleaning of intake screens. Other costs include increased pumping costs, costs for additional personnel, and increases in water treatment costs to eliminate taste and odor problems that could occur from heavier algae growth at lower reservoir and river levels. Most municipalities located on the Missouri River or System reservoirs have no alternative sources of water. Some have wells that serve as short-term backup systems only. Even by instituting strict conservation measures, most facilities have only about 1 to 2 days of water supply available in storage. To increase the amount of water available, some municipalities have had to drill new wells as an alternative water source or to increase pumping capacity at existing wells.

E-02.2. Of the approximately 1,800 communities with public water service, the great majority (over 1,500) obtain their water supply from groundwater sources alone, about 200 communities use surface water sources exclusively, and 50 communities use combined surface and groundwater sources. In terms of the population served from public systems, almost 54 percent is served exclusively from surface water sources and about 35 percent is served exclusively from groundwater sources. The major cities of Omaha, Kansas City, and St. Louis, Missouri depend on the Missouri River as a major source for water supply, as do several other smaller cities along the Missouri River.

E-02.3. Currently, the gross annual withdrawal of water for municipal, rural domestic, and industrial purposes in the Missouri River basin is 2.8 million acre-feet. About 13 percent of the gross demand, equivalent to about 350,000 acre-feet annually, is consumptive use. About 21 percent of the gross demand is obtained from groundwater, 21 percent from surface water, and 58 percent from re-use of return flows from upstream systems.

E-03. **Historic Industrial Water Supply Considerations.** Many industrial water users in the Missouri River basin have water supply systems separate from the local municipal water supply systems and use both groundwater and surface water resources. Thermal-electric power generation represents the largest industrial use, with a current estimated withdrawal of over 1.7 MAF annually. Activities associated with the extraction and primary processing of ores and fuels are estimated to require almost 100,000 acre-feet each year, while other industries in the basin use about 400,000 acre-feet annually. Livestock production is an important part of the agricultural industry within the basin, accounting for about 70 percent of the average annual agricultural income. The estimated current use for livestock production is about 400,000 acre-feet annually, exclusive of evaporation from ponds constructed specifically for livestock watering purposes. Total industrial use in the basin now totals about 4 MAF annually, of which less than 1 MAF is consumptive (not returned to the tributary or main stem).

E-04. **Missouri River Basin – Irrigation Considerations.** Large Federally developed irrigation projects have not been served directly from the System reservoirs. Significant increased use of the System for irrigation water supply is not presently contemplated unless developed in association with Tribal water rights. However, approximately 100 irrigation pipeline easements have been granted to private irrigators to permit them to obtain water from the System reservoirs to serve about 40,000 acres. Numerous irrigation intakes are also located downstream from individual reservoirs and at certain times of the year their requirements have been a reservoir regulation consideration. The amount of such irrigation made possible by System regulation is not known; however, it is believed that a large amount would not have been practicable without the stabilizing influences upon river flows exerted by the regulation of the System. Table E -3 indicates almost 900 irrigation intakes either in the System reservoirs or on the Missouri with irrigation as the primary use. Historically, intake access is the major System regulation problem with serving this purpose.

E-05. **Missouri River Basin – Intake Access Problems.** Access to the water rather than the quantity of water available is the primary concern of intake operators along the Missouri River. In periods of average or above-average rainfall, few problems are experienced because river stages and reservoir levels are sufficiently high for all intakes along the Missouri River. During below-average rainfall, or drought periods, low reservoir levels and low Missouri River stages have resulted in water access problems at some intakes, causing intake owners extreme difficulties related to pumping the water. Low flows and low reservoir levels also alter sediment deposition and sandbar formation, which may further restrict the flow of water to the intakes. During the winter, ice formation can further complicate water availability, particularly in the Missouri River reaches below the System. During floods, reservoir releases are minimized, which may cause local water access problems downstream. Changes in river flows and reservoir levels affect the cost of operating intake facilities. Low water levels may increase day-to-day operating costs, or, in extreme cases, lead to capital costs for intake modification, location of an alternative water source, or even shutdowns. Low reservoir levels and below-normal reservoir releases during the recent drought forced many intake owners to modify operations and intake structures. The intent of this plan is to fully meet the authorized project purposes of water supply and providing for all irrigation requirements. The Corps will continue to make adjustments to the System to implement this purpose. However the intake access associated with obtaining Missouri River water is the responsibility of the entity choosing to use this source of water for their supply. Therefore intake access problems are the responsibility of the intake owner and the Corps will not guarantee access, only that the supply of water in the Missouri River is adequate to meet this purpose. The Corps does not assure a water supply based on a certain river stage or reservoir level, only that the quantity of water required will be available at that location. Again, accessing it is the user’s responsibility.

E-06. **Missouri River – Tribal Water Rights.** Certain Missouri River basin American Indian Tribes are entitled to water rights in streams running through and along their Reservations under the Winters Doctrine. This doctrine refers to the 1908 U.S. Supreme Court decision in the case of *Winters v. U.S.* (207 U.S. 564 1908). These reserved water rights are not forfeited by non-use. The basin's Native American Indian Tribes are in various stages of exercising their water rights. Currently, Tribal Reservation-reserved water rights have not been quantified in an appropriate legal forum or by compact, except in four instances. These are the rights embodied in the Compacts between Montana and the Tribes of the Fort Peck Reservation (awaiting Congressional approval), between Montana and the Tribes of Rocky Boys Reservation, between Montana and the Tribes of the Northern Cheyenne Reservation, and the Wyoming settlement within the Wind River Reservation. The current standard for quantification of reserved water rights where Reservations were intended for agricultural purposes is the measure of practicable irrigable acreage. There may be other standards for quantifying Tribal water rights (e.g., where a Reservation was intended to maintain viable fisheries). The standard for quantification of Tribal water rights is still evolving, however, and is not under the legal authority of the Corps. The following paragraphs discuss current and ongoing Tribal water right considerations but additional discussion is available in the Tribal Appendices of the RDEIS and FEIS.

E-06.1. The Fort Peck Compact proposal now awaiting Congressional approval would entitle the Assiniboine and Sioux Tribes of the Fort Peck Reservation to an annual diversion of 1 MAF with an annual consumptive use of 0.55 MAF. A Wyoming Supreme Court decision held that the United States, as trustee for the Shoshone and Arapahoe Tribes, was entitled to annually divert approximately 0.48 MAF of water. A divided United States Supreme Court affirmed the Wyoming Supreme Court decision without opinion.

E-06.2. The Northern Cheyenne Indian Reserved Water Rights Settlement Act (P.L. 102-374), was passed by Congress and signed by the President. This Compact allows the annual use or disposition by the Tribe of 0.03 MAF of stored water in Big Horn Reservoir in Montana per year, as measured at the outlet works of the dam or at the diversion point from the reservoir, for any purpose. The Standing Rock Sioux Tribe has indicated in correspondence to the Corps that it believes its water rights should be quantified at 1.2 MAF per year.

E-06.3. Native American reserved water rights are rights to divert water from a stream for beneficial use. When a Tribe exercises its water rights, these consumptive uses will then be incorporated as an existing depletion. Unless specifically provided for by law, these rights do not entail an allocation of storage. Accordingly, water must actually be diverted to have an impact on the operation of the System. Further modifications to System operation, in accordance with pertinent legal requirements, will be considered as Tribal water rights are exercised in accordance with applicable law.

E-06.4. Based on the survey performed by the Mni Sose Intertribal Water Rights Coalition (February 1994), the Winnebago Reservation has indicated that the System and levees "affected wetlands along the river, caused erosion, affected fishing and navigation, and caused willows to dry due to cranes." Prior to the construction of the dams and levees, the river was used for "navigation, fish, food and transportation, and willows along bank used to build wigwams, feeds, and baskets." Currently, the Tribal water sources identified in the survey are the Missouri River for agricultural uses and the aquifer/groundwater (Ogalala) for domestic uses. The Winnebago Tribe identified in the survey future water uses as "fisheries, recreation, and irrigation." Similar to the sentiments of the Santee Sioux Tribe, the Winnebago Tribe indicated in the survey that the water levels fluctuate too much and are too low. The Tribe identified "solid waste, water quality/groundwater contamination, and underground storage tanks" as its top three environmental challenges.

E-06.5. The Mni Sose Intertribal Water Rights Coalition survey indicated that, for the Omaha Reservation, the Missouri River represented "campsites, watering of livestock, fishing, watering gardens, recreation, drinking water, and trading with non-Indians" prior to the construction of the dams and levees. Construction of the dams and levees "dried Lawless Lake and Betsey Bottom Lake where cultural activities took place," caused "loss of individual allotments and Tribal lands," and moved the river, thus affecting the Tribe's sole sources of water. "Tribal ceremonies and religious activities ceased or changed," according to the survey.

E-06.6. Future water use concerns identified by the Omaha Tribe are water quality and quantity and Tribal water code by priority rights. Unlike the Winnebago Tribe, the Omaha Tribe feels that the water levels are about right and that the Reservation does benefit from the current flood control measures. Even so, the survey indicated that the Tribe feels that it would suffer a financial impact as a result of the loss of financial revenue from the alternatives previously evaluated in the RDEIS. The Omaha Tribe currently uses the Tribal Rural System (aquifer/wells system) for its water source. Additionally, the Tribe's top three environmental challenges were identified as "landfill closure, Tribal utility system, and water rights." Current land uses on the Omaha Reservation are identified as primarily agricultural, forestry, grazing, recreation, tourism, and residential, with minor amounts of commercial uses.

E-06.7. For Iowa Tribal members on the Iowa Reservation, the Missouri River was a source of "fish and fresh water" prior to the construction of the dams and levees. The survey completed by the Iowa Tribe indicated that the "fish population has declined dramatically" to "almost nonexistent" since construction of the dams and levees. Additionally, the Tribe feels that "dams and levees have caused flooding by trying to control and confine the river." The survey indicated that Tribal members feel that there is too much water level fluctuation and that the Corps should minimize the amount of fluctuation. Currently, the Tribe relies on well water as a Tribal water source and identifies recreation and irrigation as future water uses. "Solid waste, water pollution, and erosion" were identified as the top three environmental challenges facing the Iowa Tribe. Current land uses are identified as agricultural, grazing, and forestry.

E-06.8. The survey of the Sac and Fox Reservations indicated that, prior to the construction of the dams and levees, the Missouri River was a source for “navigation, hunting, and fishing.” The construction of the dams “destroyed fish and wildlife habitat,” “decreased navigation,” and “lowered creeks, affecting fishing.” The survey did not indicate any future water uses or environmental challenges for the Sac and Fox Reservation. The current identified land use on the Sac and Fox Reservation was identified primarily as agricultural.

E-07. **Missouri River Basin Depletions.** Dependence on the System as a source for water supply is continually increasing. Increases in use of the water can result in decreases in the amount of water that is available for use by those downstream from the new users. The Bureau of Reclamation (USBR) prepares estimates of the depletions of river flow for the Missouri River. The USBR also makes estimates of future levels of depletion based on projections of increased water uses along the System. The Corps uses the USBR projections and actual depletions in their forecasting and planning for System regulation.

Case No. 1:16-cv-1534-JEB

CHEYENNE RIVER SIOUX TRIBE

ATTACHMENT B

Case No. 1:16-cv-1534-JEB

Department of Defense
INSTRUCTION

NUMBER 4710.02
September 14, 2006

USD(AT&L)

SUBJECT: DoD Interactions with Federally-Recognized Tribes

References: (a) DoD Directive 5134.01, "Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L))," December 9, 2005
(b) DoD Directive 4715.1E, "Environment, Safety, and Occupational Health (ESOH)," March 19, 2005
(c) DoD Instruction 4715.3, "Environmental Conservation Program," May 3, 1996
(d) Secretary of Defense Policy on "Department of Defense American Indian and Alaska Native Policy," October 20, 1998[1]
(e) through (s), see Enclosure 1

1. PURPOSE

This Instruction implements DoD policy, assigns responsibilities, and provides procedures for DoD interactions with federally-recognized tribes (hereafter referred to as "tribes") in accordance with References (a) through (d), Executive Order (E.O.) 13175[2] (Reference (e)), and the Presidential Memorandum on "Government-to-Government Relationship with Tribal Governments"[3] (Reference (f)).

2. APPLICABILITY AND SCOPE

This Instruction applies to:

2.1. The Office of the Secretary of Defense (OSD), the Military Departments, the Chairman of the Joint Chiefs of Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities in the Department of Defense (hereafter referred to collectively as the "DoD Components").

2.2. All DoD operations, activities, and installations that require interactions with tribes.

[1] Copies may be obtained via the internet at https://www.denix.osd.mil/denix/Public/Native/Outreach/policy.html
[2] Copies may be obtained via the internet at http://www.epa.gov/fedrgstr/eo/eo13175.htm
[3] Copies may be obtained via the internet at http://www.whitehouse.gov/news/releases/2004/09/20040923-4.html

3. DEFINITIONS

3.1. Indian. A member of a tribe, as defined in subparagraph 3.5.

3.2. Indian Lands. Any lands the title to which is either held in trust by the United States for the benefit of any Indian tribe or Indian, or held by an Indian tribe or Indian subject to restrictions by the United States against alienation (Reference (d) and 32 Code of Federal Regulations (CFR) part 229 (Reference (g)).

3.3. Protected Tribal Resources. Those natural resources and properties of traditional or customary religious or cultural importance, either on or off Indian lands, retained by or reserved by or for Indian tribes through treaties, statutes, judicial decisions, or executive orders, including tribal trust resources (Reference (d)).

3.4. Tribal Rights. Those rights legally accruing to a tribe or tribes by virtue of inherent sovereign authority, un-extinguished aboriginal title, treaty, statute, judicial decision, Executive Order, or agreement, and that give rise to legally enforceable remedies (Reference (d)).

3.5. Tribe. A federally-recognized Indian or Alaska Native tribe, band, nation, pueblo, village, or community that the Secretary of the Interior acknowledges to exist as an Indian tribe pursuant to the most current Department of Interior list of tribes published in the Federal Register (Reference (c), Reference (d), and Section 1996a of 42 United States Code (U.S.C.) (Reference (h)).

4. POLICY

It is DoD policy to:

4.1. Meet its responsibilities to tribes as derived from Federal trust doctrine, treaties, and agreements between the United States Government and tribal governments, and to comply with Federal statutes, regulations, Presidential Memorandums, and Executive Orders governing DoD interactions with tribes.

4.2. Build stable and enduring government-to-government relations with federally-recognized tribal governments in a manner that sustains the DoD mission and minimizes effects on protected tribal resources in accordance with References (c) through (f) and 32 CFR part 22 (Reference (i)).

4.3. Fully integrate, down to staff officers and civilian officials at the installation level, the principles and practices of meaningful consultation and communication with tribes in accordance with References (a) through (f).

4.4. Take into consideration the significance that tribes ascribe to protected tribal resources on protected lands in accordance with References (c), (g), and (h); 36 CFR part 800 (Reference (j)); 43 CFR part 10 (Reference (k)); Sections 470, 470.1, and 470.a through 470.w of title 16 U.S.C. (Reference (l)); and E.O. 13007[4] (Reference (m)).

[4] Copies may be obtained via the internet at http://web.em.doe.gov/public/tribal/eo13007.html

5. RESPONSIBILITIES

5.1. The Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) shall oversee DoD interactions with tribes.

5.2. The Deputy Under Secretary of Defense for Installations and Environment (DUSD(I&E)), under the USD(AT&L), shall:

5.2.1. Develop additional policy and guidance, as needed, in accordance with Reference (a).

5.2.2. Designate responsibilities and provide procedures for DoD interactions with tribes.

5.2.3. Enhance the DoD Components' understanding of tribal issues and concerns through education and training programs and outreach activities.

5.2.4. Assist the DoD Components in identifying requirements of Presidential Memorandums, Executive Orders, statutes, and regulations governing DoD interactions with tribes.

5.2.5. As requested, assist the DoD Components with consultation and government-to-government relations with tribes to implement the following:

5.2.5.1. Support and services for eligible organizations and activities outside the Department of Defense in accordance with DoD Directive 1100.20 (Reference (n)).

5.2.5.2. The DoD Office of Small Business Programs in accordance with DoD Directive 4205.1 (Reference (o)).

5.2.6. Oversee DoD Component implementation of this Instruction, compliance with the guidance for consulting with tribes set forth in Enclosure 2, and compliance with the measures of merit set forth in Enclosure 3.

5.2.7. Coordinate with other Federal Agencies and tribal organizations, as appropriate, on tribal issues of regional and national scope.

5.3. The Heads of the DoD Components shall:

5.3.1. Integrate the requirements of Presidential Memorandums, Executive Orders, statutes, and regulations regarding DoD interactions with tribes into their mission requirements.

5.3.2. Plan, program, and budget for statutory and regulatory requirements applicable to interactions with tribes consistent with DoD guidance and fiscal policies, and within available resources.

5.3.3. Develop and implement programs to monitor, achieve, and maintain compliance with this Instruction, including compliance by installations and their tenant activities.

5.3.4. Consult with federally-recognized tribal governments on a government-to-government basis on matters that may have the potential to significantly affect protected tribal resources, tribal rights, or Indian lands in accordance with Reference (d), Enclosure 2, and the measures of merit in Enclosure 3.

5.3.5. To the extent permitted by legal authority, provide information on opportunities for tribes to compete for requests for proposals or other potential contracting, sub-contracting, and grant or cooperative agreement instruments; for surplus equipment and property; and for education, training, or employment, as appropriate.

5.3.6. Promptly notify the DUSD(I&E) of tribal issues that have the potential to be elevated to OSD for resolution.

5.3.7. Assign tribal liaison responsibilities to staff at the Headquarters level to coordinate tribal issues with the Office of the DUSD(I&E).

6. PROCEDURES

6.1. The DoD Components shall consult with tribes whenever proposing an action that may have the potential to significantly affect protected tribal resources, tribal rights, or Indian lands.

6.2. The DoD Components shall consult with tribes in accordance with the requirements specified in References (c) through (h).

6.3. Consultation required by paragraphs 6.1. and 6.2. shall apply to proposed actions that may have the potential to significantly affect tribes, including, but not limited to: land-disturbing activities, construction, training, over-flights, management of properties of traditional religious and cultural importance, protection of sacred sites from vandalism and other damage, access to sacred sites, access to treaty-reserved resources, disposition of cultural items in accordance with Reference (k), and land use decisions.

6.4. The DoD Components shall afford tribes that have a cultural or historical affiliation with the lands encompassed by the installation an opportunity to consult on the development of the Integrated Cultural Resources Management Plan (ICRMP), and, where tribal treaty rights or other rights to natural resources potentially may be affected, Integrated Natural Resources Management Plans (INRMPs).

6.5. In consultation with tribes identified in paragraph 6.4., the DoD Components shall incorporate in applicable documentation, including ICRMPs and INRMPs, a standard process for consultation whenever issues arise between the tribe and the Component.

6.6. The DoD Components shall involve tribal governments early in the planning process for proposed actions that may have the potential to affect protected tribal rights, land, or resources, and shall endeavor to complete consultations prior to implementation of the proposed action. Early involvement means that a tribal government is given an opportunity to comment on a proposed action in time for the tribal government to provide meaningful comments that may affect the decision. Installations should take advantage of the processes set forth in 40 CFR parts 1500-1508 (Reference (p)) and E.O. 12898[5] (Reference (q)) to involve tribes in early planning.

6.7. The DoD Components are encouraged to use agreements such as Comprehensive Agreements, Memorandums of Agreement, or Memorandums of Understanding between the Department of Defense and tribal governments, as appropriate, on issues of common interest to each party. The primary goal of formalized agreements with tribal governments is to foster relationships that facilitate military training and readiness while addressing issues of importance to tribes.

6.8. When contacting tribes, the consultation shall be initiated by the installation commander. Follow-on consultation shall be at a level agreed to by the installation commander and tribal government leadership.

6.9. Base commanders at installations that have on-going consultation and coordination with tribes shall assign a staff member to serve as a tribal liaison.

6.10. Installation personnel who conduct activities that may have the potential to affect protected tribal rights, land, or resources shall participate in training courses and workshops to raise their awareness of tribal culture and to learn about local tribal issues, especially access, use, and privacy issues, that may be affected by military operations such as low-level flights and access to sacred sites.

7. <u>EFFECTIVE DATE</u>

This Instruction is effective immediately.

Kenneth J. Krieg
Under Secretary of Defense
for Acquisition, Technology, and Logistics

Enclosures – 3
E1. References, continued
E2. Guidance for Consultation with Tribes
E3. Compliance Measures of Merit

[5] Copies may be obtained via the internet at www.epa.gov/civilrights/eo12898.htm

E1. ENCLOSURE 1

REFERENCES, continued

(e) Executive Order 13175, "Consultation and Coordination with Indian Tribal Governments," November 6, 2000
(f) Presidential Memorandum on "Government-to-Government Relationship with Tribal Governments," September 23, 1994
(g) Title 32, Code of Federal Regulations, Part 229, "Protection of Archeological Resources: Uniform Regulations," current edition
(h) Section 1996a of title 42, United States Code, American Indian Religious Freedom Act
(i) Title 32, Code of Federal Regulations, Part 22, "DoD Grants and Agreements: Award and Administration," current edition
(j) Title 36, Code of Federal Regulations, Part 800, "Protection of Historic Properties," current edition
(k) Title 43, Code of Federal Regulations, Part 10, "Native American Graves Protection and Repatriation Regulations," current edition
(l) Sections 470, 470.1, and 470.a through 470.w of title 16, United States Code, Conservation
(m) Executive Order 13007, "Indian Sacred Sites," May 24, 1996
(n) DoD Directive 1100.20, "Support and Services for Eligible Organizations and Activities Outside the Department of Defense," April 12, 2004
(o) DoD Directive 4205.1, "Department of Defense Small Business and Small Disadvantaged Business Utilization Programs," September 11, 1996
(p) Title 40, Code of Federal Regulations, Parts 1500-1508, "Council on Environmental Quality," current edition
(q) Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," February 11, 1994
(r) DoD Directive 5400.07, "DoD Freedom of Information Act Program," October 28, 2005
(s) Federal Register, Volume 48, Page 44716, "Secretary of the Interior's Professional Qualification Standards," September 29, 1983

E2. ENCLOSURE 2

GUIDANCE FOR CONSULTATION WITH TRIBES

Consultation is always a dialog, with information and opinion respectfully exchanged in both directions. The following guidance is designed to facilitate the consultation process and to make it more productive.

E2.1. The DoD Components should identify official points-of-contact prior to initiating consultation with all tribes (or lineal descendants in the case of Reference (k) actions) that may have an interest in the matter under consultation. As tribal boundaries have shifted and tribes have migrated, tribes that seem far removed geographically may have a traditional interest in assets and actions at specific, present-day installations.

E2.2. Commanders and commanding officers play a prominent role in government-to-government consultation. Commander/commanding officer presence and signature is appropriate at significant milestones such as formal initiation of consultation, notification of final DoD decisions about proposed actions under consultation, and completion of any agreement document that may result from consultation.

E2.3. Commanders and commanding officers may delegate follow-up consultation functions. Designated DoD staff at the local or regional level may negotiate details and engage in routine consultation with tribal government staff or other tribal representatives delegated by tribal authorities.

E2.4. Consultation should take place at a time and in a location convenient for tribal representatives. DoD staff may find it necessary to negotiate the time and place for consultation, recognizing that many tribes do not have an operating budget that will pay for tribal representatives' transportation and per diem, and that tribal representatives may have existing work, community, and family commitments.

E2.5. DoD staff should consider several factors in scheduling consultation. Consultation may require multiple meetings over a period of months, or may be dependent upon culturally specific circumstances such as religious ceremonies conducted only at certain times of the year, availability of information sources, or certain natural resources cycles. DoD Components should start early and allow plenty of time. If there is an urgent need for expeditious consultation, the component must make this fact known to tribal contacts and negotiate an expedited timetable.

E2.6. Participating members of a particular culture are in the best position to provide the most up-to-date and accurate information about that culture; therefore culturally specific information obtained from a member of a particular culture is to be respected as expert testimony.

E2.7. In participating in consultation, DoD staff should take into consideration and respect tribal protocols, such as the following:

E2.7.1. Tribal representatives may want to open a meeting with a traditional ceremony, although DoD representatives are under no obligation to participate.

E2.7.2. The installation may need to schedule meetings well in advance to enable the tribe to decide upon appropriate attendees such as tribal elders, traditional religious leaders, and translators.

E2.7.3. Tribal representatives may be reluctant to discuss culturally sensitive information outside of the tribe or at certain times of the year, or they may need to clear information with traditional religious leaders or tribal council members prior to making commitments.

E2.7.4. Tribal governments differ from each other in their organizational structures and corporate cultures. DoD representatives should be mindful that these differences may affect formal titles and forms of address (such as “Chief,” “Governor,” and/or “Chairman”) and other forms of protocol. Tribal representatives may be female or male, elected or not elected, political or spiritual leaders, and exhibit other variations from tribe to tribe.

E2.8. Each tribe should be consulted separately, unless affected tribes choose to act collectively.

E2.9. Without including culturally sensitive information, document the consultation in writing and place it in the administrative record. Although consent, approval, or formal agreement from tribal governments is not required to conclude the consultation process and to proceed with a project on Federal land, the record must show that the Department of Defense has given careful consideration to all the available evidence and points of view before making the final decision.

E2.10. The Department of Defense recognizes that a tribe may wish to keep confidential some of the information it may provide during consultation. Tribes should be assured that the Department of Defense will make every reasonable effort, consistent with the law, to withhold from public disclosure any specific information that a tribe identifies as confidential, especially information related to sacred sites and other traditional cultural properties. Nonetheless, tribes should also understand that the Department of Defense is required to provide public access to its records under the Freedom of Information Act (Reference (r)), except to the extent that any such records are protected from disclosure by a statutory exemption or exclusion. Consequently, tribes should be encouraged to seek the advice of their own legal counsel before providing sensitive information to the Department of Defense.

E2.11. The final decision should be placed into the administrative record and circulated to all consulting parties. It should explain the reasoning as well as the data compiled, but exclude any direct reference to culturally sensitive information provided by tribes and to information sensitive to the DoD mission.

E3. ENCLOSURE 3

COMPLIANCE MEASURES OF MERIT

E3.1. Policy Implementation

E3.1.1. The Office of the DUSD(I&E) shall assess the number of installations that have incorporated a process for consultation with tribes either as part of an ICRMP and/or an INRMP, or as an independent process in which tribal interests have been identified.

E3.1.2. A process for consultation is required only when tribes have a cultural or historical affiliation with the lands encompassed by the installation for an ICRMP, and where tribal treaty rights or other rights to natural resources potentially may be affected, for an INRMP.

E3.2. Native American Graves Protection and Repatriation Act (NAGPRA) (Reference (k))

The Office of the DUSD(I&E) shall assess the number of installations:

E3.2.1. With possession or control of any archaeological, historic, or ethnographic collections, including items held by a DoD contractor for the installation.

E3.2.2. With possession or control of items in paragraph E3.2.1., where these items have been professionally evaluated for the presence of "cultural items" as defined in Section 2 of Reference (m). "Professionally evaluated" means the items have been examined and a finding made by a person who has professional training to make an authoritative determination. At a minimum, the person making the determination shall meet the requirements of 48 FR 44716 (Reference (s)).

E3.2.3. With professionally evaluated items that meet the definition of cultural items.

E3.2.4. Retaining possession or control of NAGPRA cultural items that do not fall within the following categories:

E3.2.4.1. The cultural affiliation cannot be determined.

E3.2.4.2. Consultation is ongoing.

E3.2.1.3. No tribes have expressed an interest in the items for repatriation purposes.

E3.2.1.4. Repatriation is pending Federal Register Notice.

Case No. 1:16-cv-1534-JEB

CHEYENNE RIVER SIOUX TRIBE

ATTACHMENT C

Case No. 1:16-cv-1534-JEB

Case No. 1:16-cv-1534-JEB

EXHIBIT 60

Case No. 1:16-cv-1534-JEB

US ARMY CORPS OF ENGINEERS

TRIBAL CONSULTATION POLICY

AND RELATED DOCUMENTS

USACE TRIBAL NATIONS COMMUNITY OF PRACTICE

2013

CONTENTS

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

REPLY TO
ATTENTION OF

NOV 1 2012

CECG

MEMORANDUM FOR Commanders, Directors and Chiefs of Separate Offices, US Army Corps of Engineers

SUBJECT: Tribal Consultation Policy

1. This memorandum affirms and formalizes current tribal consultation procedures for the U. S. Army Corps of Engineers (USACE).

2. The interaction between the federal government and federally recognized Indian Tribes (including Alaska Natives) has its origins in the U. S. Constitution and has been upheld and defined through Treaties, U.S. Supreme Court cases, various statutes and regulations, presidential documents and policies, including the Department of Defense American Indian and Alaska Native Policy, and the USACE Tribal Policy Principles, recently reissued on 10 May 2010.

3. The Policy provides an outline of our responsibilities to federally recognized Tribes as well as a framework for consulting with them. It is purposefully general in nature because each of the 565 federally recognized American Indian and Alaska Native Tribes are distinct and separate governments, requiring a consultation process that may be completely unique to them.

4. USACE recognizes the sovereign status of Tribal governments and our obligation for pre-decisional government-to-government consultation. USACE also recognizes the unique role Tribes play as partners in water resources projects and seeks to develop relationships with all Tribes who may need our assistance in their capacity building and self-determination.

5. USACE has an excellent tribal program coordinated by a tribal liaison at Headquarters and a point of contact or liaison in each District and Division office. These experts are ready to support you and answer any questions you have regarding tribal policies.

6. An accountable process to interact with Tribes is mandated in Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments*, 06 Nov 2000, and Presidential Memorandum, *Tribal Consultation*, 05 Nov 2009. Please ensure that your staff is aware of and abides by our Consultation Policy to ensure effective and mutually beneficial relationships with tribal partners.

7. My point of contact on this issue is Dr. Georgeie Reynolds, (202) 761-5855.

Encl

THOMAS P. BOSTICK
Lieutenant General, U. S. Army
Commanding

October 4, 2012

U.S. Army Corps of Engineers
Tribal Consultation Policy

1. References.

a. U.S. Constitution, Articles I, Section 8; Article VI.

b. National Historic Preservation Act.

c. American Indian Religious Freedom Act.

d. Archaeological Resources Protection Act.

e. Native American Graves Protection and Repatriation Act.

f. Religious Freedom Restoration Act.

g. Executive Order 13007, *Indian Sacred Sites*, 24 May 1996.

h. Department of Defense American Indian and Alaska Native Policy, 20 Oct 1998.

i. Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments*, 06 Nov 2000.

j. Engineer Regulation 1105-2-100, *Planners Guidance Notebook*, 22 Apr 2000.

k. Department of Defense Instruction Number 4710.02: DoD Interactions with Federally Recognized Tribes, 14 Sep 2006.

l. Army Regulation 200-1, *Environmental Protection and Enhancement*, 13 Dec 2007.

m. Engineer Regulation 1130-2-540, *Project Operations – Environmental Stewardship Operations and Maintenance Guidelines and Procedures*, 11 Aug 2008.

n. Presidential Memorandum, *Tribal Consultation*, 5 Nov 2009.

o. USACE *Tribal Policy Principles*, 18 Feb 1998 and 10 May 2010.

p. Announcement of Presidential support for the *United Nations Declaration on the Rights of Indigenous Peoples*, Public Papers of the President, December 16, 2010.

2. Purpose. On November 5, 2009, President Barack Obama issued a Memorandum to the heads of all federally agencies entitled *Tribal Consultation* (74 Fed Reg 57881) reaffirming Executive

Order 13175, *Consultation and Coordination with Indian Tribal Governments* (65 Fed Reg 67249) signed by President William J. Clinton on November 6, 2000. E.O. 13175 requires all federal agencies to formulate "an accountable process to ensure meaningful and timely input by tribal officials in the development of regulatory policies that have tribal implications." This document affirms the U.S. Army Corps of Engineers'(USACE) commitment to engage in consultation with federally recognized Tribes.

3. Background. There are responsibilities to Tribes resulting from the Federal Trust Doctrine, as well as from Treaties, statutes, regulations, Executive Orders and agreements between the United States government and tribal governments. Department of Defense *American Indian and Alaska Native Policy*, Department of Defense Instruction number 4710.02: *DoD Interactions with Federally Recognized Tribes,* and US Army Corps of Engineers *Tribal Policy Principles* (Attachment 1) provide guidance.

For the purposes of this policy, the following definitions are applied:

a. Tribe: Indian Tribes as defined in E.O. 13175, "an Indian or Alaska Native tribe, band, nation, pueblo, village, or community that the Secretary of the Interior acknowledges to exist as an Indian tribe pursuant to the Federally Recognized Indian Tribe List Act of 1994, 25 USC 479a."

b. Consultation: Open, timely, meaningful, collaborative and effective deliberative communication process that emphasizes trust, respect and shared responsibility. To the extent practicable and permitted by law, consultation works toward mutual consensus and begins at the earliest planning stages, before decisions are made and actions are taken; an active and respectful dialogue concerning actions taken by the USACE that may significantly affect tribal resources, tribal rights (including treaty rights) or Indian lands.

4. Applicability. This regulation applies to all HQUSACE elements, Major Subordinate Commands, District Commands, the Institute for Water Resources, the Humphreys Engineering Center Support Activity, and the Engineer Research and Development Center.

5. General Policy. The Tribal Policy Principles.

a. All federally recognized Tribes are sovereign governments and will be treated with respect.

(1) Sovereignty is the foundation of tribal governments.

(2) Tribes are responsible for their own governance and management.

b. The Trust responsibility will be honored and fulfilled.

(1) The federal government has a unique legal and political relationship with Tribal governments that recognizes self-government and self-determination.

(2) USACE is committed to supporting projects and programs beneficial to Tribes through partnership with them.

(3) USACE will ensure that it addresses Tribal concerns regarding protected tribal resources, tribal rights (including treaty rights) and Indian lands.

(4) USACE will protect and allow access to protected tribal resources under USACE jurisdiction to the extent practicable, and will work to develop and implement access policies as needed.

(5) USACE will share information that is not otherwise controlled or classified information.

c. USACE will maintain a government-to-government relationship with Tribes.

(1) Tribes have a unique and distinctive political and legal relationship with the United States.

(2) A Tribe may have access to the Chief of Engineers, the Assistant Secretary of the Army (Civil Works), and other high level individuals if the need arises.

(3) While most interaction will be staff to staff, decision making will be leader to leader (the head of the Tribe and the district commander), with the assistance of the local subject matter expert (typically, the Tribal Liaison).

d. Consultation will be an integral, invaluable process of USACE planning and implementation.

(1) When appropriate, potentially affected Tribes, as determined by the Corps, including Tribes whose aboriginal territories extend to the lands where an activity would occur, will be contacted by letter, telephone or e-mail sufficiently early to allow a timely review of the proposed action. If contacted Tribes notify USACE that other Tribes are potentially affected, USACE has the responsibility to notify those Tribes as well.

(2) Any activity that has the potential to significantly affect protected tribal resources, tribal rights (including treaty rights) and Indian lands-individual projects, programs, permit applications, real estate actions, promulgation of regulations and policies-regardless of land status, will be reviewed at the district level by an individual who effectively interacts with Tribes, usually the Tribal Liaison.

(3) Consultation will be conducted at the district or division level under the guidance of an individual who effectively interacts with Tribes, usually the Tribal Liaison, unless there is a request for HQUSACE (and/or OASA(CW) in the case of Civil Works) input, or if HQUSACE determines input is necessary.

(4) Commands will ensure that all Tribes with an interest in a particular activity that has the potential to significantly affect protected tribal resources, tribal rights (including treaty rights) and Indian lands are contacted and their comments taken into consideration.

(5) Consultation procedures for individual projects or programs may be developed at the local level to meet the needs of particular Tribe(s).

(6) In recognition of the varied organizations and customs of different Tribes, written protocols for consultation procedures may be considered and implemented at the local level with a specific Tribe.

(7) A dispute resolution process will be developed during the consultation process, including a provision to elevate the consultation to higher USACE and/or Tribal levels.

(8) Requests for consultation by a Tribe to USACE will be honored.

e. USACE will support Tribal self-determination, self reliance and capacity building by:

(1) Partnering with Tribes on studies, projects, programs and permitting procedures will be supported and promoted to the extent permitted by law and policy.

(2) To the extent permitted by law and policy, provide information on opportunities to compete for requests for proposals or other potential contracts with USACE.

(3) Sharing appropriate information on USACE programs, policies and procedures, and public documents.

(4) Utilizing Tribal knowledge for planning purposes and to inform operational activities.

(5) Supporting Tribal efforts to lease and operate water resource projects and lands, where appropriate.

(6) Identifying and implementing, within existing authority, other capacity-building opportunities as they occur.

f. Protection of natural and cultural resources.

(1) USACE recognizes the importance of strict compliance with the Native American Graves Protection and Repatriation Act (NAGPRA), the National Historic Preservation Act (NHPA) and other statutes concerning cultural and natural resources.

(2) USACE acknowledges that compliance with the above statutes may not comprise the full range of consultation, nor of cultural property and resource protection.

(3) To the extent allowed by law, USACE will protect the location of historic properties, properties of religious and cultural significance, and archaeological resources, in consultation with and when requested by the affected Tribe(s).[1]

6. Responsibilities of Commanders and other USACE officials interacting with federally recognized Tribes.

a. Build relationships with Tribes soon after each change of command by face-to-face interaction at the local headquarters or at tribal offices when at all possible.

b. Identify and remove procedural impediments to working with Tribes whenever possible.

c. Share appropriate Corps procedures, regulations and organizational information with Tribes.

d. Maintain open lines of communication through consultation with Tribes during the decision making process for those matters that have the potential to significantly affect protected tribal resources, tribal rights (including treaty rights) and Indian lands.

e. Provide Tribes with points of contact on project-related issues, and issues in general.

f. Encourage partnerships on projects with Tribes wherever possible.

g. Encourage collaborative partnerships by other federal and state agencies with Tribes to further their goals and projects.

7. Education. To develop a proactive well-informed workforce, in-house training, workshops, and an annual meeting of USACE tribal liaisons have been developed and should be attended by Corps employees who interact with Tribes-liaisons, project managers, program managers, real estate professionals, regulators, leaders, contracting specialists, etc.

8. Accountability. To assess the effectiveness of USACE Tribal consultation, professionals who interact with Tribes will keep records of consultation meetings and other tribal interactions. These records will be accessible and can be made available for purposes of reporting to OMB through DoD as per the reporting requirement in the Presidential Proclamation of 5 Nov 2009. The report will be synthesized at HQUSACE and transmitted to DoD (OSD) on a yearly basis. A copy of this report will be distributed to federally recognized Tribes upon request.

9. Implementation. USACE will incorporate the six Tribal policy principles, including pre-decisional consultation, into its planning, management, budgetary, operational, and legislative

[1] USACE will make every reasonable effort, consistent with law, to withhold this information. However, USACE is required to provide public access to its records under the Freedom of Information Act and can only withhold those records protected from disclosure under a statutory exemption or exclusion. Tribes are encouraged to seek legal advice before providing sensitive information to USACE.

initiatives, management accountability system and ongoing policy and regulation development processes.

10. General Provision: This policy does not establish new requirements, but reaffirms procedures and policies already in place, clarifies responsibilities and establishes clear measures of implementation success. [2]

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[2] This policy is not intended to, and does not grant, expand, create, or diminish any legally enforceable rights, benefits, or trust responsibilities, substantive or procedural, not otherwise granted or created under existing law. Nor shall this policy be construed to alter, repeal, interpret, or modify tribal sovereignty, any treaty rights, or other rights of any Indian Tribe, or to preempt, modify or limit the exercise of any such right.

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
WASHINGTON, D.C. 20314-1000

CECW

10 MAY 2010

MEMORANDUM FOR COMMANDERS, DIRECTORS, AND CHIEFS OF SEPARATE OFFICES, HQ USACE

SUBJECT: Sovereignty and Government-to-Government Relations with American Indian and Alaska Native Tribal Governments: USACE Tribal Policy Principles

1. This memorandum affirms the continuing applicability of the six USACE Tribal Policy Principles, issued by the Chief of Engineers on 18 Feb 1998, and embodied in Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments,* 06 Nov 2000, and in President Obama's Presidential Memorandum of 05 Nov 2009.

2. The U.S. Army Corps of Engineers continues to recognize the sovereign status of American Indian and Alaska Native Tribal Governments, and our obligation for consultation on a government-to-government basis. We remain committed to fulfilling our Nation's trust responsibility to Tribes in accordance with the Constitution, Treaties, executive orders, statutes, and the Supreme Court decisions that gave rise to and define that responsibility.

3. The Corps also recognizes the central role of Tribes in protecting and managing their own resources, and remains committed to working in partnership with Tribes on projects that build Tribal capacity and foster development.

4. To facilitate the implementation of our Tribal Policy Principles, the Corps has created a Tribal Nations Program and Community of Practice under the direction of a Tribal Liaison at Headquarters, with a Tribal Point of Contact in each Corps District and Division office.

5. Fulfilling the Tribal trust responsibility is required by law. Please ensure that your staff is aware of and abides by our Tribal Policy to ensure effective and mutually beneficial relationships with our Tribal partners. It is good for the Nation, the Tribes and the Corps.

6. My point of contact on this issue is Dr. Georgeie Reynolds, (202) 761-5855.

Encl

R. L. VAN ANTWERP
Lieutenant General, US Army
Commanding

U.S. ARMY CORPS OF ENGINEERS
TRIBAL POLICY PRINCIPLES

TRIBAL SOVEREIGNTY -The U.S. Army Corps of Engineers recognizes that Tribal governments are sovereign entities, with rights to set their own priorities, develop and manage Tribal and trust resources, and be involved in Federal decisions or activities which have the potential to affect these rights. Tribes retain inherent powers of self-government.

TRUST RESPONSIBILITY - The U.S. Army Corps of Engineers will work to meet trust obligations, protect trust resources, and obtain Tribal views of trust and treaty responsibilities or actions related to the Corps, in accordance with provisions of treaties, laws and Executive Orders as well as principles lodged in the Constitution of the United States.

GOVERNMENT-TO-GOVERNMENT RELATIONS - The U.S. Army Corps of Engineers will ensure that Tribal Chairs/Leaders meet with Corps Commanders/Leaders and recognize that, as governments, Tribes have the right to be treated with appropriate respect and dignity, in accordance with principles of self-determination.

PRE-DECISIONAL AND HONEST CONSULTATION - The U.S. Army Corps of Engineers will reach out, through designated points of contact, to involve Tribes in collaborative processes designed to ensure information exchange, consideration of disparate viewpoints before and during decision making, and utilize fair and impartial dispute resolution mechanisms.

SELF RELIANCE, CAPACITY BUILDING, AND GROWTH - The U.S. Army Corps of Engineers will search for ways to involve Tribes in programs, projects and other activities that build economic capacity and foster abilities to manage Tribal resources while preserving cultural identities.

NATURAL AND CULTURAL RESOURCES - The U.S. Army Corps of Engineers will act to fulfill obligations to preserve and protect trust resources, comply with the Native American Graves Protection and Repatriation Act, and ensure reasonable access to sacred sites in accordance with published and easily accessible guidance.

Case 1:16-cv-01534-JEB Document 14-3 Filed 08/22/16 Page 10 of 26

SECRETARY OF THE ARMY
WASHINGTON

24 OCT 2012

MEMORANDUM FOR Principal Official of Headquarters, Department of the Army

SUBJECT: American Indian and Alaska Native Policy

1. References:

a. Department of Defense American Indian and Alaska Native Policy, 20 October 1998.

b. Department of Defense Instruction 4710.02, DoD Interactions with Federally Recognized Tribes, 14 September 2006.

2. Purpose. This memorandum establishes Department of the Army policy for interaction with Federally-recognized American Indian and Alaska Native Tribes (Federally-recognized Tribes), in accordance with references 1.a. and 1.b.

3. Policy. The Department of the Army will:

a. Meet its responsibilities to Federally-recognized Tribes as derived from the federal trust doctrine, treaties, and agreements and comply with federal statutes and regulations, presidential memoranda and executive orders governing interactions with Federally-recognized Tribes.

b. Build stable and enduring government-to-government relations with Federally-recognized Tribes in a manner that sustains the Army mission and minimizes effects on protected tribal resources. The Army will communicate with Federally-recognized Tribes on a government-to-government basis in recognition of their sovereignty.

c. Recognize, respect and take into consideration the significance that Federally-recognized Tribes ascribe to protected tribal resources when undertaking Army mission activities and when managing Army lands.

d. Fully integrate the principles of meaningful consultation and communication with Federally-recognized Tribes at all organizational levels including staff officers and civilian officials. The Army will consider the unique qualities of individual Federally-recognized Tribes when applying these principles.

4. This policy recognizes the importance of understanding and addressing the concerns of Federally-recognized Tribes prior to reaching decisions on matters that may have the potential to significantly affect tribal rights, tribal lands or protected tribal resources.

12101354

SUBJECT: American Indian and Alaska Native Policy

5. Definition of Key Terms:

a. Tribal rights: Those rights legally accruing to a Federally-recognized Tribe or tribes by virtue of inherent sovereign authority, unextinguished aboriginal title, treaties, statutes, judicial decisions, executive orders or agreement and that give rise to legally enforceable remedies.

b. Tribal lands: Any lands title to which is: either held in trust by the United States for the benefit of any Federally-recognized Indian tribe or individual or held by any Federally-recognized Indian tribe or individual subject to restrictions by the United States against alienation.

c. Protected tribal resources: Those natural resources and properties of traditional or customary religious or cultural importance, either on or off Tribal lands, retained by, or reserved by or for, Federally-recognized Tribes through treaties, statutes, judicial decisions or executive orders.

6. This policy is not intended to, and does not grant, expand, create or diminish any legally enforceable rights, benefits or trust responsibilities, substantive or procedural not otherwise granted or created under existing law. This policy shall not be construed to alter, amend, repeal, interpret or modify tribal sovereignty, any treaty rights or other rights of any Indian tribes or to preempt, modify or limit the exercise of any such right.

John M. McHugh

PREAMBLE

These principles establish the Department of Defense's (DoD) American Indian and Alaska Native Policy for interacting and working with federally-recognized American Indian and Alaska Native governments (hereinafter referred to as "tribes"[1])(a). These principles are based on tribal input, federal policy, treaties, and federal statutes. The DoD policy supports tribal self-governance and government-to-government relations between the federal government and tribes. Although these principles are intended to provide general guidance to DoD Components on issues affecting tribes[2] (b), DoD personnel must consider the unique qualities of individual tribes when applying these principles, particularly at the installation level. These principles recognize the importance of increasing understanding and addressing tribal concerns, past, present, and future. These concerns should be addressed prior to reaching decisions on matters that may have the potential to significantly affect (c&d) protected tribal resources, tribal rights, or Indian lands[3] (e).

[1] As defined by most current Department of Interior/Bureau of Indian Affairs list of tribal entities published in Federal Register pursuant to Section 104 of the Federally Recognized Indian Tribe List Act.

[2] This policy is not intended to, and does not, grant, expand, create, or diminish any legally enforceable rights, benefits, or trust responsibilities, substantive or procedural, not otherwise granted or created under existing law. Nor shall this policy be construed to alter, amend, repeal, interpret, or modify tribal sovereignty, any treaty rights, or other rights of any Indian tribes, or to preempt, modify, or limit the exercise of any such rights.

[3] Definition of Key Terms:

- Protected Tribal Resources: Those natural resources and properties of traditional or customary religious or cultural importance, either on or off Indian lands, retained by, or reserved by or for, Indian tribes through treaties, statutes, judicial decisions, or executive orders, including tribal trust resources.
- Tribal Rights: Those rights legally accruing to a tribe or tribes by virtue of inherent sovereign authority, unextinguished aboriginal title, treaty, statute, judicial decisions, executive order or agreement, and that give rise to legally enforceable remedies.
- Indian Lands (f): Any lands title to which is either: 1) held in trust by the United States for the benefit of any Indian tribe or individual; or 2) held by any Indian tribe or individual subject to restrictions by the United States against alienation.

(a) This policy governs Department interactions with federally recognized tribes only; it does not govern interaction with unrecognized tribes, state-recognized tribes, Alaska Native corporations, or Native Hawaiian Organizations. [In Alaska, as a practical matter, the Department may be required to consult with Alaska Native corporations simply because these corporate entities own and manage much of the land in Alaska. In addition, all Federal agencies must consult with Alaska Native corporations "on the same basis as Indian tribes under Executive Order No. 13175." See section 161 of Public Law 108-199 (188 Stat. 452), as amended by section 518 of Public Law 108-447 (118 Stat. 3267)]. DoD interactions with Native Hawaiian Organizations are governed by Department of Defense Instruction 4710.03, "Consultation With Native Hawaiian Organizations," issued on October 25, 2011. A copy of the Instruction is available at www.denix.osd.mil/na/hawaii.

(b) This policy neither enlarges nor diminishes the Department's legal obligations with respect to federally recognized tribes, nor does the policy provide an independent cause of action upon which the Department may be sued.

(c) The phrase "may have the potential to significantly affect," which appears throughout the policy, establishes the general threshold or "trigger" for consultation to be used unless a statute or other legal obligation specifically establishes a lower threshold for consultation. It is expected that DoD personnel will informally contact interested tribes whenever there is any real possibility that tribal interests may be affected by proposed DoD actions, but that continued, more formal consultation will be necessary only when it appears, from initial discussions with a tribe, that tribal interests will be significantly affected by the proposed action. In other words, the policy anticipates a two-step process designed first, to overcome the fact that, as non-Indians, we may not always recognize the effect our actions may have on tribal interests unless we ask; and second, to permit DoD to proceed without the need for further consultation unless potentially significant consequences are identified during this initial discussion. [Note: The word "significantly" is used in this policy in its ordinary dictionary sense; i.e., as a synonym for "material" or "important." It should not be interpreted in the NEPA or Council on Environmental Quality NEPA Regulations sense, as that would set a higher threshold for consultation than is intended.]

(d) There is no obligation to consult with tribes absent a proposal that "may have the potential to significantly affect" tribal interests. In other words, the obligation to consult with tribes under this policy is event- or proposal-driven. Nonetheless, as a matter of discretion, general consultation may be desirable where an installation expects to have frequent interaction with a tribe and wishes to establish a stand-by protocol for consultation absent the pressures associated with a particular proposal.

(e) The phrase "protected tribal resources, tribal rights, or Indian lands," which appears throughout the policy, works in conjunction with the "may have the potential to significantly affect" trigger to determine when DoD must consult with tribes. Generally speaking, DoD must consult with tribes only when its proposed actions may have the potential to significantly affect Indian lands, treaty rights, or other tribal interests protected by statute, regulation, or executive order. [Note: Some statutes may establish a lower threshold for consultation than the default threshold established in this policy (see, e.g., 16 U.S.C. 470a(d)(6)(B)); in such cases, the Department must consult with tribes in accordance with the statutory requirements.] [Note also, that individual rural residents of Alaska, including both Natives and non-Natives, generally have a right to engage in nonwasteful subsistence uses of fish, wildlife, and other wild, renewable resources on public lands in Alaska. While this right is not a tribal right per se, installations nonetheless may find it both convenient and beneficial to consult with the appropriate Alaska Native entity whenever a proposed DoD action may have the potential to adversely affect the subsistence activities of several members of the same village or tribe.]

(f) With respect to Alaska, the term "Indian Lands" does not include lands held by Alaska Native Corporations or lands conveyed in fee to an Indian Reorganization Act entity or traditional village council; the term may include village-owned townsite lands (depending on the particular status of the village itself and upon a fact-specific inquiry into whether the area at issue qualifies as a dependent Indian community), and individual Native townsite lots and Native allotments (so long as these properties remain in either restricted fee or trust allotment form).

I. TRUST RESPONSIBILITIES

DoD will meet its responsibilities to tribes. These responsibilities are derived from:

- Federal trust doctrine (g) (i.e., the trust obligation of the United States government to the tribes);
- Treaties, Executive Orders, Agreements, Statutes, and other obligations between the United States government and tribes, to include:

1. Federal statutes (e.g., Native American Graves Protection and Repatriation Act, American Indian Religious Freedom Act, National Environmental Policy Act, National Historic Preservation Act, Alaska National Interest Lands Conservation Act, Alaskan Native Claims Settlement Act, and Archeological Resources Protection Act); and

2. Other federal policies (e.g., Executive Order 12898, “Environmental Justice”; Executive Order 13007, “Indian Sacred Sites”; Executive Order 13021 “Tribal Colleges and Universities”; “Executive Memorandum: Government to Government Relations with Native American Tribal Governments,” dated 29 April 1994; and Executive Order 13084, “Consultation and Coordination with Indian Tribal Governments”).

DoD will annually review the status of relations with tribes to ensure that DoD is:

- Fulfilling its federal responsibilities; and
- Addressing tribal concerns related to protected tribal resources, tribal rights, or Indian lands.

(g) Under the federal trust doctrine, the United States--and individual agencies of the federal government--owe a fiduciary duty to Indian tribes. The nature of that duty depends on the underlying substantive laws (i.e., treaties, statutes, agreements) creating the duty. Where agency actions may affect Indian lands or off-reservation treaty rights, the trust duty includes a substantive duty to protect these lands and treaty rights "to the fullest extent possible." Otherwise, unless the law imposes a specific duty on the federal government with respect to Indians, the trust responsibility may be discharged by the agency's compliance with general statutes and regulations not specifically aimed at protecting Indian tribes.

II. GOVERNMENT TO GOVERNMENT RELATIONS

Build stable and enduring relationships with tribes by:

- Communicating with tribes on a government-to-government basis (h) in recognition of their sovereignty;
- Requiring meaningful communication addressing tribal concerns between tribes and military installations at both the tribal leadership-to-installation commander and the tribal staff-to-installation staff levels (i);
- Establishing a senior level tribal liaison in the Office of the Secretary of Defense (j) and other appropriate points of contact within DoD to ensure that tribal inquiries are channeled to appropriate officials within DoD and responded to in a timely manner;
- Providing, to the extent permitted by DoD authorities and procedures, information concerning opportunities available to tribes to: 1) compete for contracts, subcontracts, and grants, and participate in cooperative agreements; 2) benefit from education and training; 3) obtain employment; and 4) obtain surplus equipment and property;
- Assessing, through consultation, the effect of proposed DoD actions that may have the potential to significantly affect protected tribal resources, tribal rights, and Indian lands before decisions are made (k);
- Taking appropriate steps to remove any procedural or regulatory impediments to DoD working directly and effectively with tribes on activities that may have the potential to significantly affect protected tribal resources, tribal rights, and Indian lands; and
- Working with other federal agencies, in consultation with tribes, to minimize duplicative requests (l) for information from tribes.

(h) Indian tribes have been called "domestic dependent nations"--i.e., nations within a nation. As such, consultation with tribes on a "government-to-government basis" requires a high degree of formality. Unless--or until--a tribal-specific protocol for consultation has been developed, formal contact with a tribe should be made by the installation commander, and should be directed to the tribe's senior elected official, usually referred to as the tribal chair, governor, or president.

(i) Although communication with tribes on a government-to-government basis demands attention--at least initially--at a relatively senior level of command, the goal should be to develop mutually acceptable protocols or procedures that will allow most day-to-day liaison and work with interested tribes to be accomplished on a staff-to-staff basis. Senior commanders and tribal leaders should be kept apprised of this day-to-day interaction, but--once these protocols are in place--need act personally and directly only when requested to do so by the other party.

(j) Although the Deputy Under Secretary of Defense for Environmental Security will provide tribes with a senior-level liaison to ensure tribal inquires are promptly addressed, DoD officials at all levels of command should strive to make it easier for tribes to receive timely answers to the questions they may have concerning DoD activities that may affect them. One way to accomplish this at the installation level could be to designate and announce a principal point-of-contact for the receipt of tribal inquiries.

(k) The single most important element of consultation is to initiate the dialogue with potentially affected tribes before decisions affecting tribal interests are made. Meaningful consultation demands that the information obtained from tribes be given particular, though not necessarily dispositive, consideration; this can happen only if tribal input is solicited early enough in the planning process that it may actually influence the decision to be made. Consultation is worth very little if decisions have already been made.

(l) Keep in mind that many tribes have relatively few enrolled members and only a limited staff to respond to your requests. This being the case, coordinate your requests for information with other federal agencies whenever doing so may reduce the administrative burden on the affected tribe.

III. CONSULTATION

Fully integrate (down to staff officers at the installation level) the principle and practice of meaningful consultation and communication with tribes by:

- Recognizing that there exists a unique and distinctive political relationship between the United States and the tribes that mandates that, whenever DoD actions may have the potential to significantly affect protected tribal resources, tribal rights, or Indian lands, DoD must provide affected tribes an opportunity to participate in the decision-making process that will ensure these tribal interests are given due consideration in a manner consistent with tribal sovereign authority (m);
- Consulting consistent with government-to-government relations and in accordance with protocols mutually agreed to (n) by the particular tribe and DoD, including necessary dispute resolution processes;
- Providing timely notice to, and consulting with, tribal governments prior to taking any actions that may have the potential to significantly affect protected tribal resources, tribal rights, or Indian lands;
- Consulting in good faith throughout the decision-making process (o); and
- Developing and maintaining effective communication, coordination, and cooperation with tribes, especially at the tribal leadership-to-installation commander level and the tribal staff-to-installation staff levels.

(m) What constitutes "due consideration...consistent with tribal sovereignty" depends, in part, on the underlying law that dictates that consultation take place. "Consultation" can vary from simple notice of a pending action to negotiation to obtain the tribe's formal consent to a proposed action (the absence of which may be enough to stop that action from proceeding). The attached table summarizes the specific legal obligations owed tribes under the trust doctrine and various statutes. In general, two principles should be kept in mind. One, tribes are not just another interested party; where tribal interests may be significantly affected, tribes must be regarded as separate from the general public for the purposes of consultation. Second, in most cases, consultation should include an invitation to potentially affected tribes to provide information to DoD concerning actions that may significantly affect tribal interests; that information should be given special consideration. In some instances, e.g., where Indian lands or treaty rights may be significantly and adversely affected, tribal rights may take precedence and dictate that DoD protect these rights to the fullest extent possible.

(n) The are over 570 federally recognized Indian tribes, each with its own distinctive cultural identity. Just as is true with foreign nations, a "one-size-fits-all" prescription for consultation with Indian tribes is neither appropriate nor possible. Instead, installations should expect to have to negotiate a mutually agreeable protocol with each separate tribe with which it must consult. While certain elements can be expected to be a part of any such protocol, installations should be mindful of the fact that tribes all have different ways of controlling property, harvesting natural resources, revering the environment, and even conducting consultations.

(o) Keep it in mind that the consultation trigger contemplates a two-step process. Consultation need continue throughout the decision-making process only for those proposals that have the potential to significantly affect tribal interests.

IV. NATURAL AND CULTURAL RESOURCES PROTECTION

Recognize and respect the significance tribes ascribe to certain natural resources and properties of traditional or customary religious or cultural importance by:

- Undertaking DoD actions and managing DoD lands consistent with the conservation of protected tribal resources and in recognition of Indian treaty rights to fish, hunt, and gather resources at both on- and off-reservation locations (p);
- Enhancing, to the extent permitted by law, tribal capabilities to effectively protect and manage natural and cultural tribal trust resources (q) whenever DoD acts to carry out a program that may have the potential to significantly affect those tribal trust resources;
- Accommodating, to the extent practicable and consistent with military training, security, and readiness requirements, tribal member access to sacred and off-reservation treaty fishing, hunting, and gathering sites located on military installations; and
- Developing tribal specific protocols to protect (r), to the maximum extent practicable and consistent with the Freedom of Information Act, Privacy Act, National Historic Preservation Act, and Archeological Resources Protection Act, tribal information regarding protected tribal resources that has been disclosed to, or collected by, the DoD.

WILLIAM S. COHEN
SECRETARY OF DEFENSE
October 20, 1998

(p) Fulfillment of the trust responsibility demands that federal agencies protect the lands and habitats that support the resources upon which the meaningful exercise of tribal hunting, fishing, and gathering rights depend. This includes actions on non-Indian-owned lands (including DoD installations) that may affect Indian lands or off-reservation treaty rights (such as reserved rights to hunt, fish, or gather on treaty-ceded lands or "usual and accustomed" grounds and stations). In addition, in Alaska, DoD must endeavor to protect the continued viability of all wild, renewable resources in order to minimize, to the extent possible, the adverse effects of its actions on rural residents who depend upon subsistence uses of such renewable resources.

(q) Where a proposed DoD action may have the potential to significantly affect tribal trust resources (i.e., Indian lands or treaty rights to certain resources) or DoD has been given express statutory authority (e.g., §8050 of the Department of Defense Appropriations Act of FY 1999), DoD may have limited authority to help develop and enhance the affected tribe's capacity to better manage these resources. This, however, is an area fraught with fiscal law pitfalls; consequently, installations are advised to consult with legal counsel before committing to expend appropriated funds for this purpose.

(r) Presently, legal authority to protect tribal information concerning sacred sites is very limited. Section 9 of the Archeological Resources Protection Act (16 U.S.C. § 470hh) and Section 304 of the National Historic Preservation Act (16 U.S.C. § 470w-3) may provide some protection from a request for such information, but may not be enough to guarantee confidentiality in the face of a Freedom of Information Act request for disclosure--especially the NHPA provision. A written consultation agreement with a tribe may be appropriate in some circumstances and permit an installation to withhold disclosure under FOIA Exemption 5, but even this tactic may prove to be ineffective. As a consequence, installations should be careful not to overstate their ability to keep sensitive tribal information confidential.

Federal Register
Vol. 74, No. 215
Monday, November 9, 2009

Presidential Documents

Title 3—

The President

Memorandum of November 5, 2009

Tribal Consultation

Memorandum for the Heads of Executive Departments And Agencies

The United States has a unique legal and political relationship with Indian tribal governments, established through and confirmed by the Constitution of the United States, treaties, statutes, executive orders, and judicial decisions. In recognition of that special relationship, pursuant to Executive Order 13175 of November 6, 2000, executive departments and agencies (agencies) are charged with engaging in regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications, and are responsible for strengthening the government-to-government relationship between the United States and Indian tribes.

History has shown that failure to include the voices of tribal officials in formulating policy affecting their communities has all too often led to undesirable and, at times, devastating and tragic results. By contrast, meaningful dialogue between Federal officials and tribal officials has greatly improved Federal policy toward Indian tribes. Consultation is a critical ingredient of a sound and productive Federal-tribal relationship.

My Administration is committed to regular and meaningful consultation and collaboration with tribal officials in policy decisions that have tribal implications including, as an initial step, through complete and consistent implementation of Executive Order 13175. Accordingly, I hereby direct each agency head to submit to the Director of the Office of Management and Budget (OMB), within 90 days after the date of this memorandum, a detailed plan of actions the agency will take to implement the policies and directives of Executive Order 13175. This plan shall be developed after consultation by the agency with Indian tribes and tribal officials as defined in Executive Order 13175. I also direct each agency head to submit to the Director of the OMB, within 270 days after the date of this memorandum, and annually thereafter, a progress report on the status of each action included in its plan together with any proposed updates to its plan.

Each agency's plan and subsequent reports shall designate an appropriate official to coordinate implementation of the plan and preparation of progress reports required by this memorandum. The Assistant to the President for Domestic Policy and the Director of the OMB shall review agency plans and subsequent reports for consistency with the policies and directives of Executive Order 13175.

In addition, the Director of the OMB, in coordination with the Assistant to the President for Domestic Policy, shall submit to me, within 1 year from the date of this memorandum, a report on the implementation of Executive Order 13175 across the executive branch based on the review of agency plans and progress reports. Recommendations for improving the plans and making the tribal consultation process more effective, if any, should be included in this report.

The terms ''Indian tribe,'' ''tribal officials,'' and ''policies that have tribal implications'' as used in this memorandum are as defined in Executive Order 13175.

The Director of the OMB is hereby authorized and directed to publish this memorandum in the *Federal Register*.

This memorandum is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person. Executive departments and agencies shall carry out the provisions of this memorandum to the extent permitted by law and consistent with their statutory and regulatory authorities and their enforcement mechanisms.

THE WHITE HOUSE,
Washington, November 5, 2009.

[FR Doc. E9–27142
Filed 11–6–09; 11:15 am]
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Federal Register

Vol. 65, No. 218

Thursday, November 9, 2000

Presidential Documents

Title 3—

The President

Executive Order 13175 of November 6, 2000

Consultation and Coordination With Indian Tribal Governments

By the authority vested in me as President by the Constitution and the laws of the United States of America, and in order to establish regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications, to strengthen the United States government-to-government relationships with Indian tribes, and to reduce the imposition of unfunded mandates upon Indian tribes; it is hereby ordered as follows:

Section 1. *Definitions.* For purposes of this order:

(a) ''Policies that have tribal implications'' refers to regulations, legislative comments or proposed legislation, and other policy statements or actions that have substantial direct effects on one or more Indian tribes, on the relationship between the Federal Government and Indian tribes, or on the distribution of power and responsibilities between the Federal Government and Indian tribes.

(b) ''Indian tribe'' means an Indian or Alaska Native tribe, band, nation, pueblo, village, or community that the Secretary of the Interior acknowledges to exist as an Indian tribe pursuant to the Federally Recognized Indian Tribe List Act of 1994, 25 U.S.C. 479a.

(c) ''Agency'' means any authority of the United States that is an ''agency'' under 44 U.S.C. 3502(1), other than those considered to be independent regulatory agencies, as defined in 44 U.S.C. 3502(5).

(d) ''Tribal officials'' means elected or duly appointed officials of Indian tribal governments or authorized intertribal organizations.

Sec. 2. *Fundamental Principles.* In formulating or implementing policies that have tribal implications, agencies shall be guided by the following fundamental principles:

(a) The United States has a unique legal relationship with Indian tribal governments as set forth in the Constitution of the United States, treaties, statutes, Executive Orders, and court decisions. Since the formation of the Union, the United States has recognized Indian tribes as domestic dependent nations under its protection. The Federal Government has enacted numerous statutes and promulgated numerous regulations that establish and define a trust relationship with Indian tribes.

(b) Our Nation, under the law of the United States, in accordance with treaties, statutes, Executive Orders, and judicial decisions, has recognized the right of Indian tribes to self-government. As domestic dependent nations, Indian tribes exercise inherent sovereign powers over their members and territory. The United States continues to work with Indian tribes on a government-to-government basis to address issues concerning Indian tribal self-government, tribal trust resources, and Indian tribal treaty and other rights.

(c) The United States recognizes the right of Indian tribes to self-government and supports tribal sovereignty and self-determination.

Sec. 3. *Policymaking Criteria.* In addition to adhering to the fundamental principles set forth in section 2, agencies shall adhere, to the extent permitted by law, to the following criteria when formulating and implementing policies that have tribal implications:

(a) Agencies shall respect Indian tribal self-government and sovereignty, honor tribal treaty and other rights, and strive to meet the responsibilities that arise from the unique legal relationship between the Federal Government and Indian tribal governments.

(b) With respect to Federal statutes and regulations administered by Indian tribal governments, the Federal Government shall grant Indian tribal governments the maximum administrative discretion possible.

(c) When undertaking to formulate and implement policies that have tribal implications, agencies shall:

(1) encourage Indian tribes to develop their own policies to achieve program objectives;

(2) where possible, defer to Indian tribes to establish standards; and

(3) in determining whether to establish Federal standards, consult with tribal officials as to the need for Federal standards and any alternatives that would limit the scope of Federal standards or otherwise preserve the prerogatives and authority of Indian tribes.

Sec. 4. *Special Requirements for Legislative Proposals.* Agencies shall not submit to the Congress legislation that would be inconsistent with the policymaking criteria in Section 3.

Sec. 5. *Consultation.* (a) Each agency shall have an accountable process to ensure meaningful and timely input by tribal officials in the development of regulatory policies that have tribal implications. Within 30 days after the effective date of this order, the head of each agency shall designate an official with principal responsibility for the agency's implementation of this order. Within 60 days of the effective date of this order, the designated official shall submit to the Office of Management and Budget (OMB) a description of the agency's consultation process.

(b) To the extent practicable and permitted by law, no agency shall promulgate any regulation that has tribal implications, that imposes substantial direct compliance costs on Indian tribal governments, and that is not required by statute, unless:

(1) funds necessary to pay the direct costs incurred by the Indian tribal government or the tribe in complying with the regulation are provided by the Federal Government; or

(2) the agency, prior to the formal promulgation of the regulation,

(A) consulted with tribal officials early in the process of developing the proposed regulation;

(B) in a separately identified portion of the preamble to the regulation as it is to be issued in the **Federal Register**, provides to the Director of OMB a tribal summary impact statement, which consists of a description of the extent of the agency's prior consultation with tribal officials, a summary of the nature of their concerns and the agency's position supporting the need to issue the regulation, and a statement of the extent to which the concerns of tribal officials have been met; and

(C) makes available to the Director of OMB any written communications submitted to the agency by tribal officials.

(c) To the extent practicable and permitted by law, no agency shall promulgate any regulation that has tribal implications and that preempts tribal law unless the agency, prior to the formal promulgation of the regulation,

(1) consulted with tribal officials early in the process of developing the proposed regulation;

(2) in a separately identified portion of the preamble to the regulation as it is to be issued in the **Federal Register**, provides to the Director of OMB a tribal summary impact statement, which consists of a description of the extent of the agency's prior consultation with tribal officials, a summary of the nature of their concerns and the agency's position supporting the

need to issue the regulation, and a statement of the extent to which the concerns of tribal officials have been met; and

(3) makes available to the Director of OMB any written communications submitted to the agency by tribal officials.

(d) On issues relating to tribal self-government, tribal trust resources, or Indian tribal treaty and other rights, each agency should explore and, where appropriate, use consensual mechanisms for developing regulations, including negotiated rulemaking.

Sec. 6. *Increasing Flexibility for Indian Tribal Waivers.*

(a) Agencies shall review the processes under which Indian tribes apply for waivers of statutory and regulatory requirements and take appropriate steps to streamline those processes.

(b) Each agency shall, to the extent practicable and permitted by law, consider any application by an Indian tribe for a waiver of statutory or regulatory requirements in connection with any program administered by the agency with a general view toward increasing opportunities for utilizing flexible policy approaches at the Indian tribal level in cases in which the proposed waiver is consistent with the applicable Federal policy objectives and is otherwise appropriate.

(c) Each agency shall, to the extent practicable and permitted by law, render a decision upon a complete application for a waiver within 120 days of receipt of such application by the agency, or as otherwise provided by law or regulation. If the application for waiver is not granted, the agency shall provide the applicant with timely written notice of the decision and the reasons therefor.

(d) This section applies only to statutory or regulatory requirements that are discretionary and subject to waiver by the agency.

Sec. 7. *Accountability.*

(a) In transmitting any draft final regulation that has tribal implications to OMB pursuant to Executive Order 12866 of September 30, 1993, each agency shall include a certification from the official designated to ensure compliance with this order stating that the requirements of this order have been met in a meaningful and timely manner.

(b) In transmitting proposed legislation that has tribal implications to OMB, each agency shall include a certification from the official designated to ensure compliance with this order that all relevant requirements of this order have been met.

(c) Within 180 days after the effective date of this order the Director of OMB and the Assistant to the President for Intergovernmental Affairs shall confer with tribal officials to ensure that this order is being properly and effectively implemented.

Sec. 8. *Independent Agencies.* Independent regulatory agencies are encouraged to comply with the provisions of this order.

Sec. 9. *General Provisions.* (a) This order shall supplement but not supersede the requirements contained in Executive Order 12866 (Regulatory Planning and Review), Executive Order 12988 (Civil Justice Reform), OMB Circular A–19, and the Executive Memorandum of April 29, 1994, on Government-to-Government Relations with Native American Tribal Governments.

(b) This order shall complement the consultation and waiver provisions in sections 6 and 7 of Executive Order 13132 (Federalism).

(c) Executive Order 13084 (Consultation and Coordination with Indian Tribal Governments) is revoked at the time this order takes effect.

(d) This order shall be effective 60 days after the date of this order.

Sec. 10. *Judicial Review.* This order is intended only to improve the internal management of the executive branch, and is not intended to create any right, benefit, or trust responsibility, substantive or procedural, enforceable at law by a party against the United States, its agencies, or any person.

THE WHITE HOUSE,
November 6, 2000.

[FR Doc. 00–29003
Filed 11–8–00; 8:45 am]
Billing code 3195–01–P

Case No. 1:16-cv-1534-JEB

CHEYENNE RIVER SIOUX TRIBE

ATTACHMENT D

Case No. 1:16-cv-1534-JEB

UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF COLUMBIA

----------------------------X

STANDING ROCK SIOUX TRIBE,

Plaintiff

v. Civil Action 16-1534.

U.S. ARMY CORPS OF ENGINEERS,

Defendant

-----------------------------X

Washington, D.C
Wednesday, August 24, 2016
2:00 P.M.

TRANSCRIPT OF HEARING ON PRELIMINARY INJUNCTION
BEFORE THE HONORABLE JAMES E. BOASBERG
UNITED STATES DISTRICT JUDGE

APPEARANCES:

For the Plaintiff: Jan Hasselman, Esq.
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THE COURT: Don't you still need an easement for the Lake Oahe crossing?

MR. LEONE: My understanding, Your Honor, is that the easement has been issued; that the notification -- the requisite notification has been provided to Congress. There is a 14 day notice period.

THE COURT: All right.

MR. MARINELLI: Your Honor, my understanding as of this morning is that the easement is still at the Pentagon and it is still under consideration.

THE COURT: I'm just trying to get a sense of what is the earliest you could begin construction at the Lake Oahe site.

MR. LEONE: Your Honor, as soon as we get the easement and the waiting period is either waived or satisfied, we would be ready to begin construction. We've got a little bit of access road construction yet to do, a few days worth.

But I'm glad you've asked this question because this is really a critical point for this company. We didn't seek to postpone this hearing, although we could have I supposed because it is really urgent to us to get a decision here. That the gating issue here for our delivery date of January 1st is the Oahe bore.

As I understand it, and you'll see this in the affidavits, it's a 90 to 120 day process to complete that bore and put the pipeline in place. It needs to really be ready for testing by about the first week in December so that deliveries can begin on January 1. You can tell from the calendar already that even a two week injunction or a one week injunction or a three week injunction poses a critical path, threat to this project.

Now I have been under the impression until just three minutes ago that the easements had been issued and we were in the 14 days waiting period. So this is news to me.

THE COURT: So what this means, am I correct to infer that, if there is a 14 day waiting period then construction cannot begin for at least 14 days from today?

MR. LEONE: I think the actual bore under the river has to await the easement. But the construction of the drill pads and the access roads can take place and we would commence doing that immediately -- well, we will continue to do that.

THE COURT: Okay. I'll give you another minute or two if there are any last points that you want to raise.

MR. LEONE: Your Honor, I had a whole plan that was 13 minutes long. It just seems wrong to try to start it with one minute left.

But I will say that, I think this is probably the most important point that my client would like me to

Case No. 1:16-cv-1534-JEB

CHEYENNE RIVER SIOUX TRIBE

ATTACHMENT E

Case No. 1:16-cv-1534-JEB

UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF COLUMBIA

STANDING ROCK SIOUX TRIBE, et al.,	)	(Corrected transcript)
	)	Civil No. 16-01534
Plaintiffs	)	
v.	)	
	)	Washington, D.C.
UNITED STATES ARMY CORPS OF ENGINEERS, et al.,	)	
	)	Friday, September 16, 2016
	)	2:05 p.m.
Defendants.		

TRANSCRIPT OF STATUS CONFERENCE
BEFORE THE HONORABLE JAMES E. BOASBERG
UNITED STATES DISTRICT JUDGE

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agency action or any change whatsoever in the agency's position.

THE COURT: In other words, when the press release says, "The Army will not authorize constructing the pipeline under Lake Oahe," is what you're saying that you're not withdrawing the permit, it is just that you're not granting the easement, or both?

MR. THORP: It is really neither, Your Honor. There has been no suspension or revocation of any authorization, verification, or permit that's already been granted, none whatsoever.

THE COURT: They still have the permit to go ahead and construct?

MR. THORP: That's correct.

THE COURT: What is blocking them?

MR. THORP: With respect to the easement, that has never been granted, and it is still under consideration. That also has not changed.

THE COURT: When you say you won't authorize it, that means you won't issue the easement?

MR. THORP: No. If you read the statement, what we are really saying is that remains under consideration.

THE COURT: But you're not authorizing it now?

MR. THORP: Right. That was not a final agency action, Your Honor. What we were saying is that it won't be authorized today or tomorrow, it will be authorized once the Corps completes its review --

THE COURT: When you say "authorized," I want this to be clear. You tell me to read this literally, but it doesn't mention the easement or the permit, and I'm sure Dakota Access would like to know, I'm sure the plaintiff would like to know, I'm sure the public would like to know what you do mean by that.

Does it mean at the moment you're not granting the easement, or you're saying there is something beyond the easement?

MR. THORP: No. It is at the moment. The easement has only been under consideration and has not been granted. That easement issue, actually, is not before the Court right now, nor was it ever.

THE COURT: When you say you won't authorize, it means that for now you're not granting the easement?

MR. THORP: What it means is the easement application remains under consideration.

THE COURT: Everyone knows the easement consideration is under consideration. You're saying you're not going to authorize until it can determine whether it will need to reconsider any of its previous decisions. Again, you're talking about the easement and not the permit?

MR. THORP: Right. The easement remains under