US Army Corps
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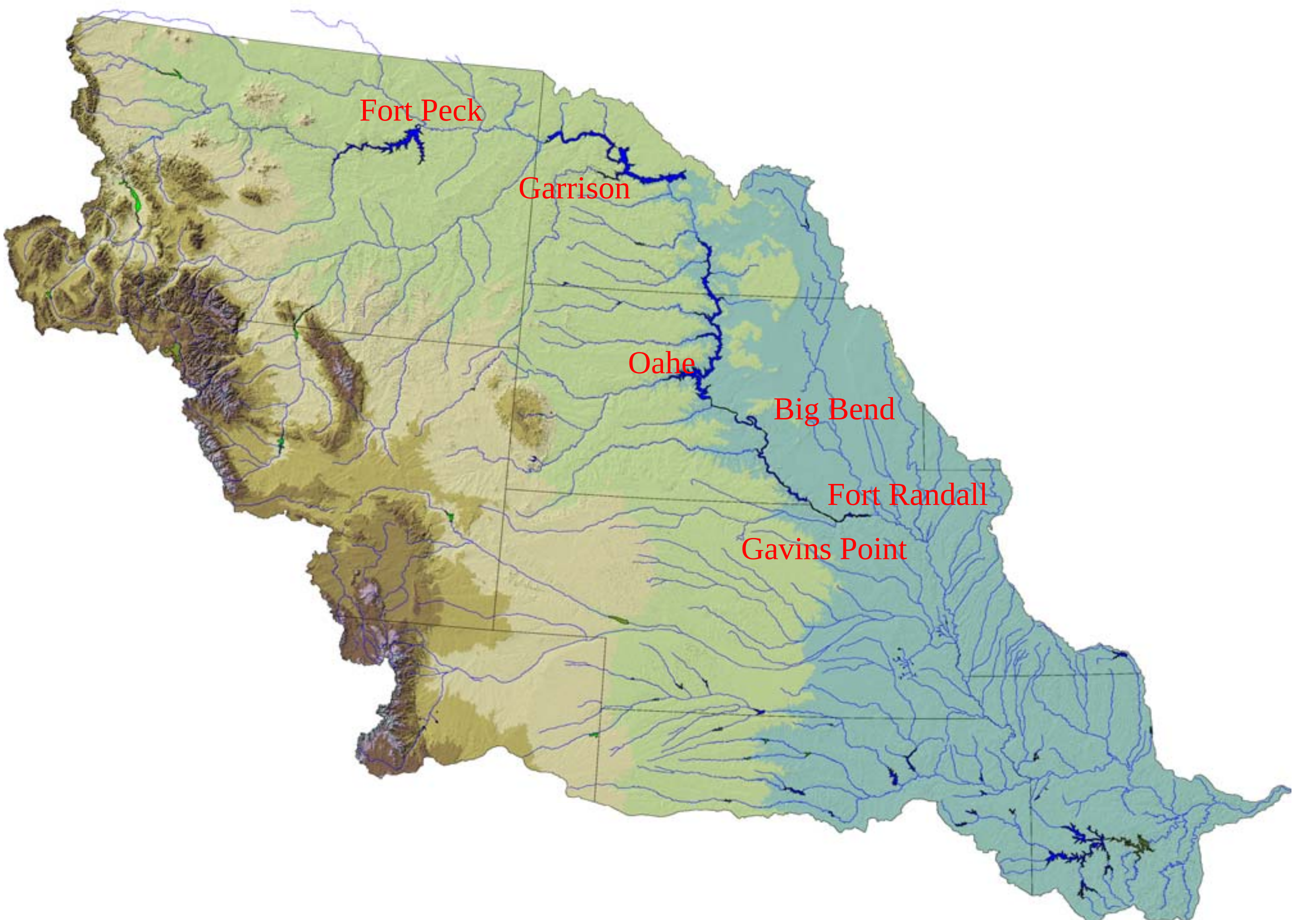
Reservoir Control Center

Northwestern Division

Missouri River Mainstem Reservoir System

Summary of Actual 2012 Regulation

Missouri River Basin



U.S. Army Corps of Engineers
Northwestern Division
Missouri River Basin Water Management Division
Omaha, Nebraska

June 2013

Missouri River Mainstem Reservoir System

Summary of Actual 2012 Regulation

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LIST OF ABBREVIATIONS AND ACRONYMS

AOP	annual operating plan
AF	acre-feet
cfs	cubic feet per second
CPC	National Oceanic and Atmospheric Administration Climate Prediction Center
CPFLP	coldwater permanent fish life propagation
CY	calendar year (January 1 to December 31)
DMS	Data Management System
C	degrees Celsius
F	degrees Fahrenheit
EA	Environmental Assessment
ENSO	El Nino Southern Oscillation
EOM	End of Month
FTT	Flow to Target
ft	feet
ft msl	feet above mean sea level
kW	kilowatt
kWh	kilowatt hour
M	million
MAF	million acre-feet
Master Manual	Master Water Control Manual
MGD	million gallons per day
μg/l	micrograms per liter
mg/l	milligrams per liter
MRNRC	Missouri River Natural Resources Committee
MRBWM	Missouri River Basin Water Management
msl	mean sea level
MV	motor vessel
MVD	Corps' Mississippi Valley Division
MW	megawatt
MWh	megawatt hour
M&I	municipal and industrial
NDEQ	Nebraska Department of Environmental Quality
NOAA-NWS	National Oceanic and Atmospheric Administration – National Weather Service
NOHRSC	National Operational and Hydrologic Remote Sensing Center
NRCS-SNOTEL	Natural Resources Conservation Service SNOwpack TELemtry
NWD	Corps' Northwestern Division
NWK	Corps' Kansas City District
NWO	Corps' Omaha District

LIST OF ABBREVIATIONS AND ACRONYMS (cont'd)

OPPD	Omaha Public Power District
PA	2004 Programmatic Agreement
plover	piping plover
P-S MBP	Pick-Sloan Missouri Basin Program
RM	river mile
SHPO	State Historic Preservation Officer
SR	Steady Release
SWE	snow water equivalent
System	Missouri River Mainstem Reservoir System
tern	interior least tern
THPO	Tribal Historic Preservation Officer
TMDL	Total Maximum Daily Load
T&E	Threatened and Endangered
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
VERS	Visitation Estimation Reporting System
WCSC	Waterborne Commerce Statistics Center
Western	Western Area Power Administration
WPFLP	warmwater permanent fish life propagation

DEFINITION OF TERMS

Acre-foot (AF, ac-ft) is the quantity of water required to cover 1 acre to a depth of 1 foot and is equivalent to 43,560 cubic feet or 325,850 gallons.

Cubic foot per second (cfs) is the rate of discharge representing a volume of 1 cubic foot passing a given point during 1 second and is equivalent to approximately 7.48 gallons per second or 448.8 gallons per minute. The volume of water represented by a flow of 1 cubic foot per second for 24 hours is equivalent to 86,400 cubic feet, approximately 1.983 acre-feet, or 646,272 gallons. Conversely, 1.5 cfs for 24 hours is approximately 1 million gallons; therefore, 1.5 cfs is approximately 1 million gallons per day (MGD).

Discharge is the volume of water (or more broadly, volume of fluid plus suspended sediment) that passes a given point within a given period of time.

Drainage area of a stream at a specific location is that area, measured in a horizontal plane, enclosed by a topographic divide from which direct surface runoff from precipitation normally drains by gravity into the river above the specified point. Figures of drainage area given herein include all closed basins, or noncontributing areas, within the area unless otherwise noted.

Drainage basin is a part of the surface of the earth that is occupied by drainage system, which consists of a surface stream or body of impounded surface water together with all tributary surface streams and bodies of impounded water.

Drought is three or more consecutive years of below-average calendar year runoff into the Missouri River above Sioux City, IA.

Gaging station is a particular site on a stream, canal, lake, or reservoir where systematic observations of hydrologic data are obtained.

Runoff in inches shows the depth to which the drainage area would be covered if all the runoff for a given time period were uniformly distributed on it.

Streamflow is the discharge that occurs in a natural channel. Although the term "discharge" can be applied to the flow of a canal, the word "streamflow" uniquely describes the discharge in a surface stream course. The term "streamflow" is more general than "runoff" as streamflow may be applied to discharge whether or not it is affected by diversion or regulation.

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Missouri River Mainstem Reservoir System

Summary of Actual 2012 Regulation

I. FOREWORD

This document contains a summary of the actual regulation of the Missouri River Mainstem Reservoir System (System) for the 2012 Calendar Year (CY). Two other reports related to System regulation are also available, the ***System Description and Regulation*** and ***Final 2011-2012 Annual Operating Plan.*** All three reports can be obtained by contacting the Missouri River Basin Water Management Division (MRBWM), Northwestern Division, U.S. Army Corps of Engineers at 1616 Capitol Avenue, Suite 365, Omaha, Nebraska 68102-4909, phone (402) 996-3841. The reports are also available on the MRBWM website at www.nwd-mr.usace.army.mil/rcc/.

A basin map is presented on ***Plate 1*** and the pertinent data for the System are shown on ***Plate 2.***

II. REVIEW OF REGULATION

A. General

This report summarizes the System regulation as it pertains to all eight Congressionally-authorized purposes. During 2012 the System was regulated in accordance with the Master Water Control Manual (Master Manual) and the applicable provisions of the Final 2011-2012 Annual Operating Plan (AOP), which was made available for review and comment by representatives of State and Federal agencies, Tribes, the general public and specific interest groups. A summary of the significant events during 2012 follows.

B. Precipitation and Water Supply Available

Plains snowpack, mountain snowpack and general weather conditions during the 2012 calendar year are discussed in the following sections. The reference period for average conditions for plains and mountain snowpack, precipitation and temperature is 1971-2000.

1. Plains Snowpack

Plains snowpack is monitored and modeled by the NOAA National Operational Hydrologic Remote Sensing Center (NOHRSC). The NOHRSC measures snow water equivalent (SWE) and soil moisture using gamma radiation remote sensing. The NOHRSC uses that data, along with field measurements of snow depth, SWE and soil conditions, to develop a national snow analysis for the contiguous U.S.

At the beginning of 2012 nearly the entire Missouri River Basin, with the exception of central and eastern North Dakota, was devoid of any plains snowpack. National Weather Service (NWS) records indicated Bismarck, ND had no snow on the ground while the eastern half of the state was covered by about 2 inches of snow depth. During the month of January snowfall was generally below normal in most areas, though some notable snowfall accumulations included: 15.6 inches in Billings, MT; 9.0 inches in Huron, SD; and 8.2 inches in Sioux Falls, SD. Much of this snow occurred as a result of two large winter storms occurring January 19-20 and January 22-23 in Montana, North Dakota, South Dakota, northeast Nebraska and northwest Iowa. Snowfall accumulation depths resulting from these storms ranged from 4 to 10 inches; however, very warm temperatures in late January quickly melted much of this new snowpack. At the end of January very light snowpack covered eastern South Dakota and northern and eastern North Dakota.

During February precipitation was above normal in most regions of the plains including parts of eastern Montana and Wyoming, eastern South Dakota, Nebraska and western Iowa, yielding greater than average snowfall in these areas. Snowfall accumulations at major recording stations included: 11.6 inches at Omaha, NE; 16.4 inches at Huron, SD; 9.5 inches at Pierre, SD; and 9.3 inches at Sioux City, IA. The first significant winter storm on February 3-5 produced heavy snowfall ranging from 8 to 12 inches in northeast Colorado, Nebraska and southwest Iowa. Kansas and Missouri received 1 to 1.5 inches of rain. Plains snowpack following this storm contained 0.5 to 1.5 inches of snow water equivalent (SWE) over northeast Colorado, Nebraska and southwest Iowa; however, no plains snowpack existed in Montana, North Dakota and South Dakota. A series of moderately heavy snowfall events brought some additional snow to northeast Montana, North Dakota, South Dakota, northeast Nebraska and western Iowa February 21-24 followed by some additional snow in eastern South Dakota February 27-28. Accumulations depths from the February 21-24 and February 27-28 storms ranged from 2 to 12 inches near Huron, SD. Following this late February snow the plains snowpack was at its maximum extent just prior to the spring snowmelt season. The plains SWE on March 1 is shown in ***Figure 1***.

Average daily temperature departures ranging from 6 to 12 degrees Fahrenheit (F) above normal during the month of March quickly melted the plains snowpack in the upper Missouri River Basin by March 12. Very little snowfall occurred during the remainder of March and in April with the exception of some additional snowfall accumulations in western Montana. Great Falls, MT received 10.5 inches of snow in March and 7.2 inches of snow in April.

As shown on ***Table 1***, seasonal snowfall totals in 2012 were well below normal in all areas of the upper Missouri River Basin. Snowfall departures in Billings and Great Falls, MT were 19.1

and 19.2 inches below normal, respectively, while Glasgow received 4.9 inches below normal. Williston and Bismarck, ND received 35.6 and 36.5 inches of snow below normal, respectively. Departures in South Dakota were 21.1 inches below normal in Aberdeen, 11.6 inches below normal in Watertown and 24.7 inches below normal in Sioux Falls. Sioux City, IA received 13.1 inches of snow below normal, while Omaha, NE received 6.7 inches below normal. In comparison, snowfall departures during 2011 were 7.8 inches above normal in Omaha, NE; 9.9 inches above normal in Sioux City, IA; 40.7 inches above normal in Aberdeen, SD; 35.3 inches above normal in Bismarck, ND; and 78.0 inches above normal in Glasgow, MT.

Table 1
Missouri River Basin - Plains Snowfall (inches)

Location	2011 Total	2012 Total	Seasonal Average
Billings, MT	71.9	38.6	57.7
Glasgow, MT	108.6	25.7	30.6
Great Falls, MT	107.6	40.0	59.2
Bismarck, ND	85.4	13.6	50.1
Williston, ND	107.2	7.5	43.1
Aberdeen, SD	79.3	17.5	38.6
Sioux Falls, SD	45.6	15.9	40.6
Watertown, SD	79.4	19.6	31.2
Sioux City, IA	41.3	18.3	31.4
Omaha, NE	34.9	20.4	27.1

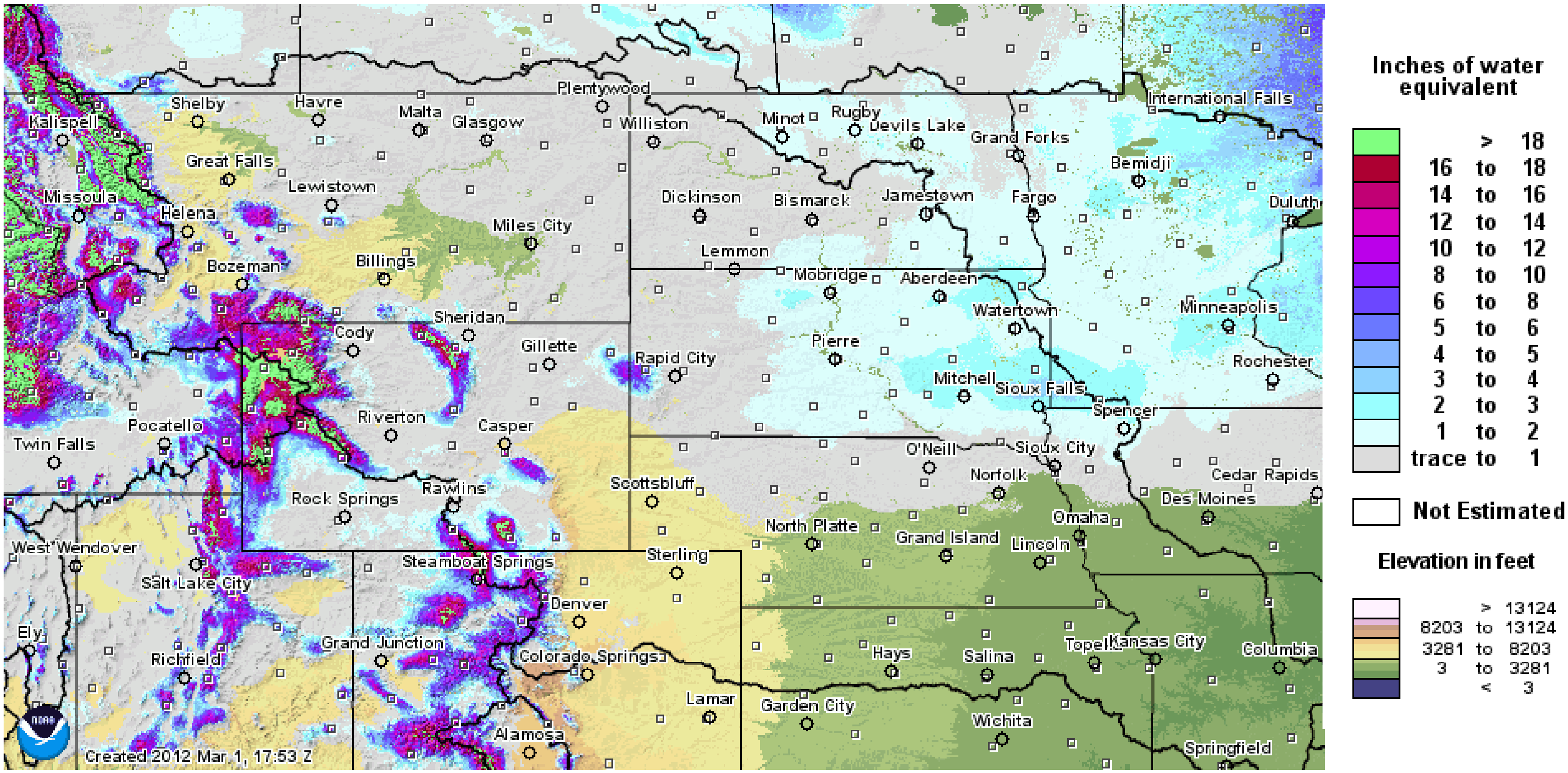


Figure 1. March 1, 2012 plains snow water equivalent (inches) modeled by NOAA NOHRSC.

2. Mountain Snowpack

Mountain snowpack is monitored by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service's (NRCS) network of SNOwpack TELemetry (SNOTEL) stations. For purposes of monitoring the mountain snowpack and forecasting spring and summer runoff from the Rocky Mountains, average mountain snowpack expressed as inches of SWE is computed from the SNOTEL stations in the reservoir reaches above Fort Peck and from Fort Peck to Garrison. The 2011-2012 mountain snowpack accumulation and melt pattern for each of the two reaches is illustrated in ***Figure 2***. Mountain SWE is discussed in the following paragraphs as a percent of the 1971-2000 average SWE occurring on the first day of each month.

a. Accumulation and Melt

During the fall of 2011 weak to moderate La Niña conditions in the central Pacific Ocean were influencing the weather in the Pacific Northwest and the northern region of the Rocky Mountains in the Missouri River Basin. La Niña conditions usually cause greater-than-average mountain snow accumulations and lower-than-normal winter temperatures. Often during the second consecutive year of La Niña conditions, as was the case in 2011-2012, the probability of greater-than-average snow accumulation is lower than during the first year of La Niña conditions. By the second week of October 2011, low levels of snowpack were present in the Fort Peck and Garrison reservoir reaches. SWE accumulation as a percent of normal for the two reaches is summarized in ***Table 2***.

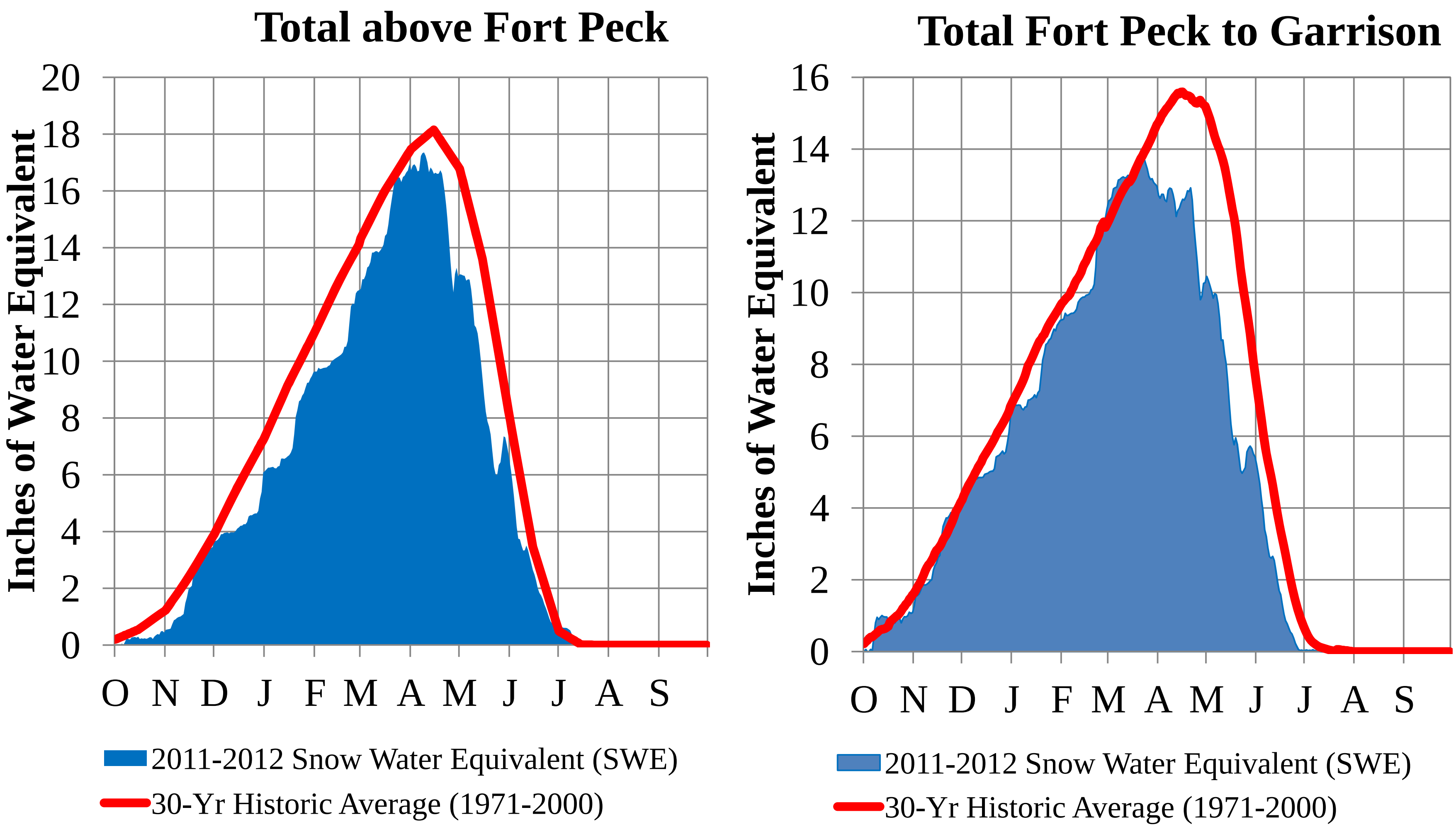
Table 2
Mountain Snow Water Equivalent Accumulation

Date	Above Fort Peck (percent of normal)	Fort Peck to Garrison (percent of normal)
November 1	44	78
December 1	89	103
January 1	79	97
February 1	85	95
March 1	90	105
April 1	97	86
May 1	80	69
June 1	87	70
July 1	107	5

b. Summary

Over the course of the winter season the mountain snowpack began accumulating at a below average rate; however, accumulations increased by December to near normal snowpack levels overall. During the months of January, February and March, accumulations generally occurred at lower-than-normal rates. The peak accumulation above Fort Peck occurred on April 9 at 97 percent of the normal April 15 peak accumulation, while the peak accumulation in the Fort Peck to Garrison reach occurred on March 22 at 88 percent of the normal April 15 peak accumulation. The 2011-2012 mountain snow accumulation and melt for the reaches above Fort Peck and Fort Peck to Garrison is illustrated in ***Figure 2***.

Missouri River Basin – Mountain Snowpack



The mountain snowpack in the reach above Fort Peck peaked at 97% of the normal peak accumulation on April 9. The mountain snowpack in the reach between Fort Peck and Garrison peaked at 88% of the normal peak accumulation on March 22. The Missouri River basin mountain snowpack normally peaks near April 15.

Figure 2. Missouri River Basin mountain snowpack water content 2011-2012.

3. Weather Conditions

Dry and warm weather conditions were dominant factors influencing the upper Missouri River Basin during 2012. These conditions were a continuation of drier-than-normal and warmer-than-normal conditions that began to develop during July 2011. The winter of 2011-2012 was technically a La Niña year. For the Missouri River Basin, a typical La Niña year results in colder-than-normal winter temperatures accompanied by greater snowfall accumulations in the plains and mountains. However, the weather that actually occurred was quite opposite to a typical La Niña year. During the winter the basin observed warmer-than-normal temperatures during the winter as well as lower-than-normal snowfall accumulations. This warmer and drier pattern continued throughout the entire calendar year. For 2012 precipitation was well below normal throughout all of the Missouri River Basin. Precipitation rankings by state as shown in ***Figure 3*** indicate that precipitation was below normal in Montana (23rd driest), North Dakota (18th driest) and in South Dakota (13th driest) in 118 years of record. Precipitation was much below normal in Colorado (4th driest), Kansas and Missouri (7th driest) and Iowa (11th driest), while Wyoming and Nebraska experienced their driest years in 118 years of record. Annual temperatures were much above normal over the entire Missouri River Basin. Temperature rankings by state in ***Figure 4*** indicate that temperatures were much above normal in Montana (3rd warmest), North Dakota, Colorado and Iowa (2nd warmest). Wyoming, South Dakota, Nebraska and Missouri experienced their warmest years in 118 years of record.

Figure 5 depicts percent of normal precipitation for the 3-month periods of January through March, April through June, July through September and October through December 2012 in the central U.S. In general, precipitation was below normal for all 3-month periods. The prevailing features during each of the 3-month periods were the large areas that received less than 50 percent of normal precipitation. Low precipitation accumulations affected the Rocky Mountains and the plains centered over South Dakota, Nebraska and Kansas over the entire year. However, not the entire basin saw below normal precipitation during 2012. Areas in central Montana, southeast South Dakota, Kansas and Missouri received above normal precipitation during the January through March period. During the April-May period, northern Montana and a narrow region winding through North Dakota and South Dakota received above normal precipitation. Also, during the October through December period, precipitation was much greater than normal throughout northern Montana and much of North Dakota.

Figure 6 depicts much warmer-than-normal temperatures that persisted during 2012 throughout the entire Missouri River Basin. January through March temperatures ranged from 2 to 6 degrees F above normal from Montana to Wyoming, Colorado, western Nebraska and western Kansas. East of a line from northeast Montana through central Kansas, temperature departures ranged from 6 to 10 degrees F above normal. April through June departures ranged from 2 to 6 degrees F above normal throughout much of the basin, while in the July through September period departures ranged from 2 to 5 degrees F above normal. During the October through December period temperature departures ranged from 2 to 4 degrees F above normal in the Rocky Mountains; however, departures ranged from 3 degrees F below normal in northern Montana and North Dakota to 3 degrees F above normal from southern South Dakota to Missouri.

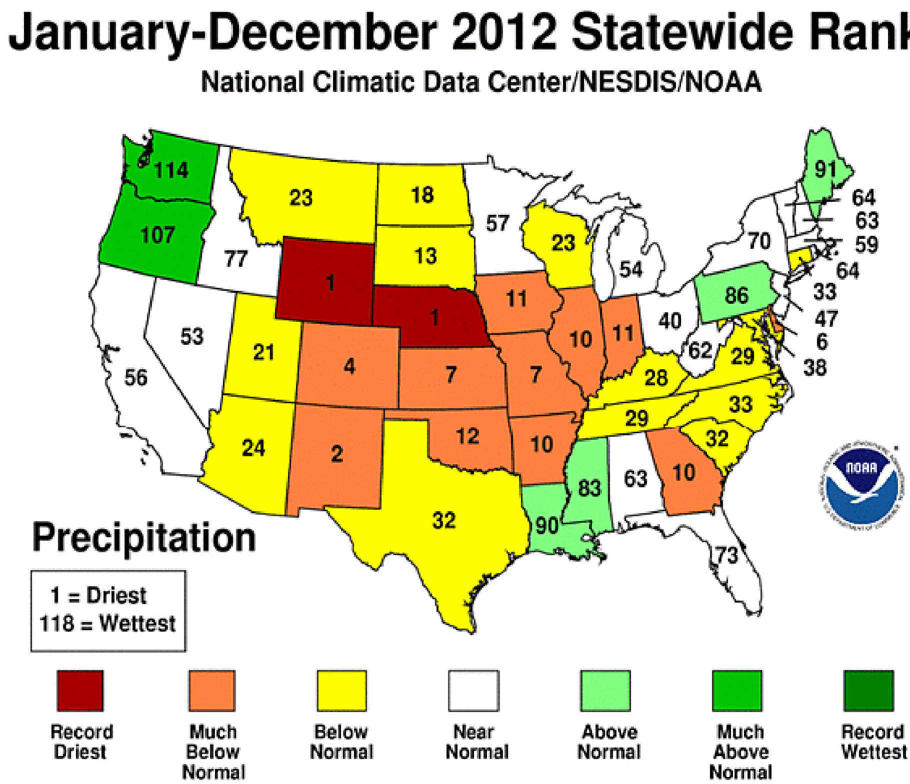


Figure 3. January-December 2012 statewide precipitation ranks. Source: NOAA NCDC

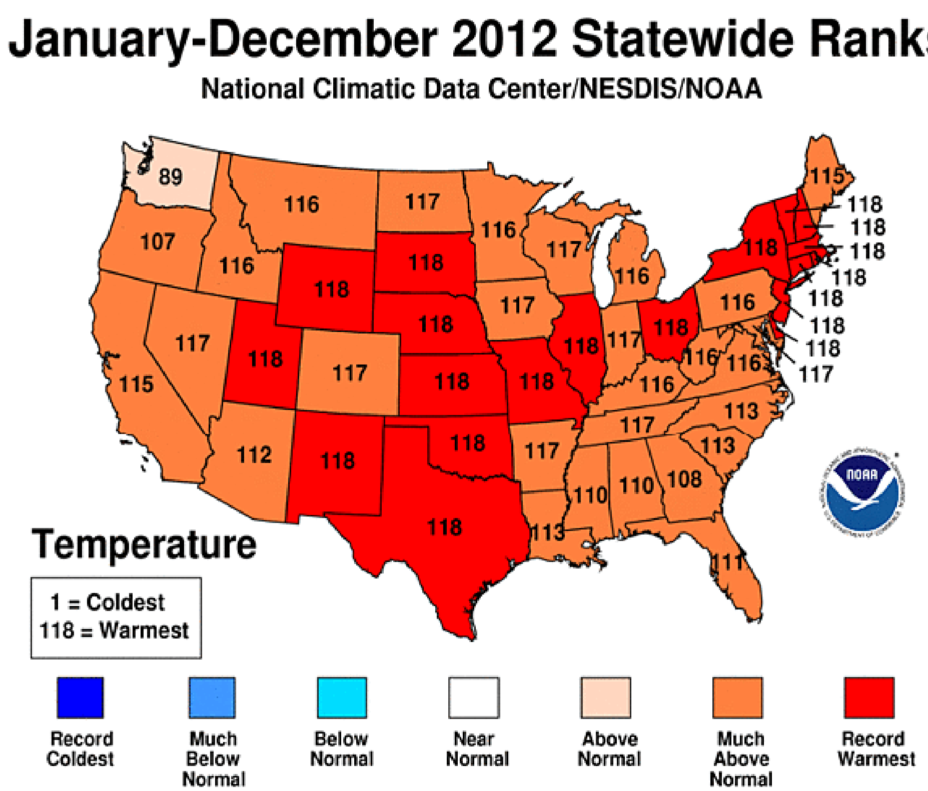


Figure 4. January-December 2012 statewide temperature ranks. Source: NOAA NCDC

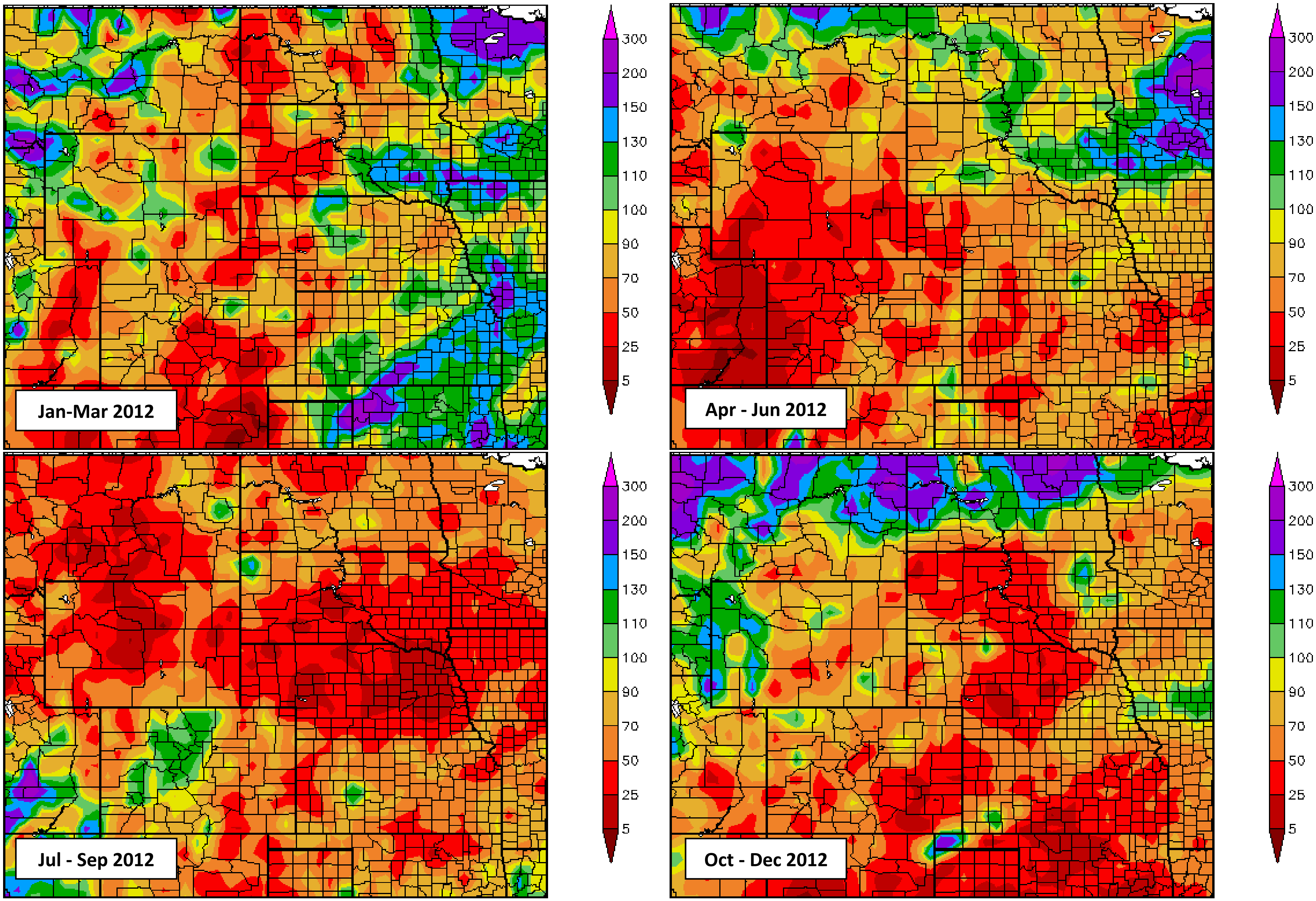


Figure 5. Percent of normal precipitation maps for the 2012 3-month periods: Jan-Mar, Apr-Jun, Jul-Sep and Oct-Dec. Reformatted from the High Plains Regional Climate Center Climate Summary Maps.

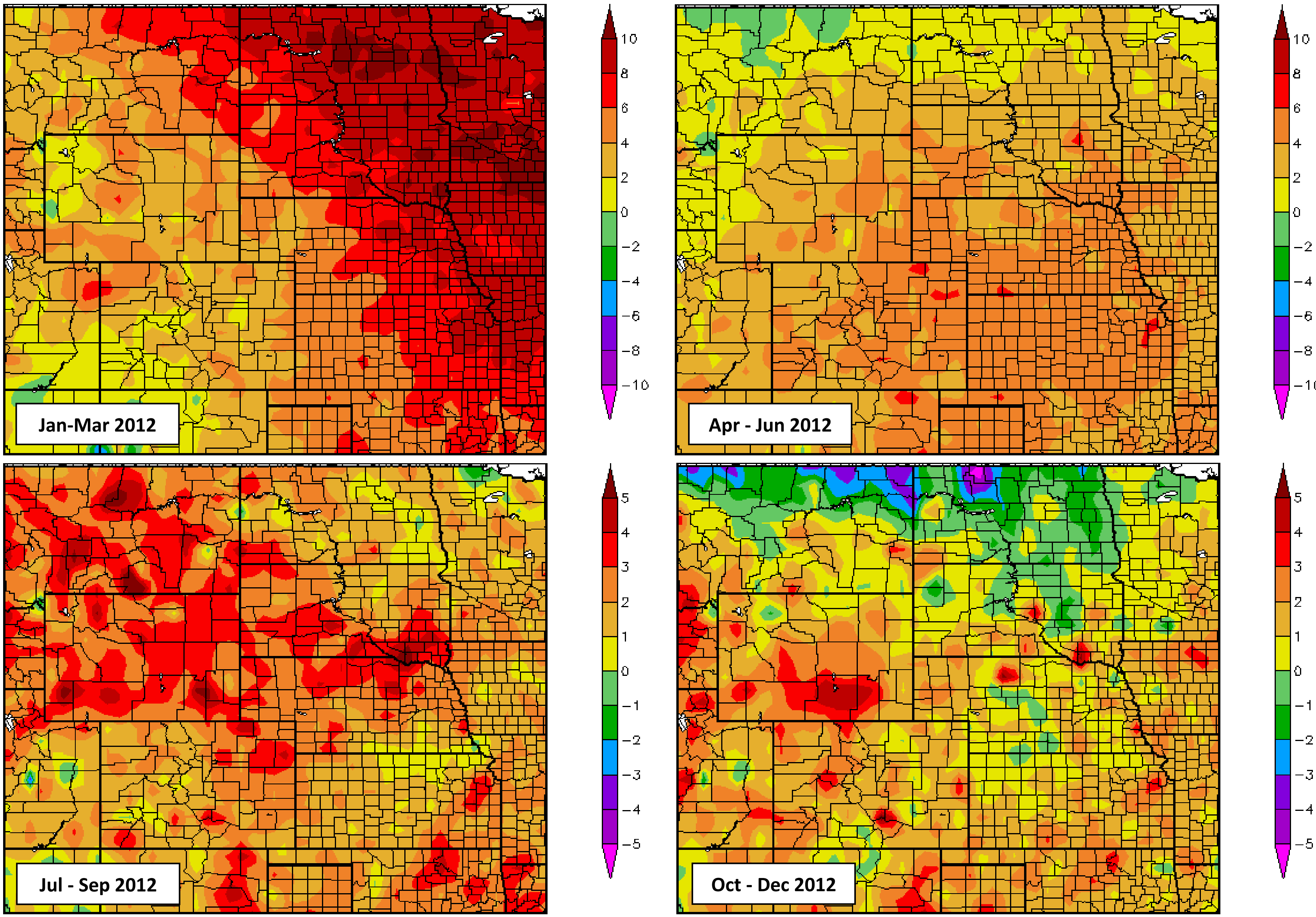


Figure 6. Departure from normal temperature (degrees F) for the 2012 3-month periods: Jan-Mar, Apr-Jun, Jul-Sep and Oct-Dec. Reformatted from the High Plains Regional Climate Center Climate Summary Maps.

Figure 7 depicts drought magnitudes in January, April, July and October 2012 as defined by the National Drought Mitigation Center. On January 3 abnormally dry conditions covered North Dakota, parts of South Dakota and Nebraska. Moderate to severe drought conditions had begun to develop in eastern South Dakota, eastern Nebraska and northwest Iowa. By April 3 the abnormally dry conditions expanded into eastern Montana and eastern Wyoming and were covering most of South Dakota and some of western Nebraska. In addition, moderate drought conditions had developed in western North Dakota and western South Dakota. Very warm and dry conditions continued to impact the upper Missouri River Basin through June. By July 3 drought conditions had intensified in areas already impacted by drought and expanded westward into the Rocky Mountains. The July 3 map shows intensification to moderate and severe drought conditions in southern Montana, Wyoming, western South Dakota and western Nebraska. Some precipitation relief occurred between April and June improving the drought classifications in northeast Montana and northwest North Dakota. The July through September period was much warmer and much drier than normal, resulting in further intensification to extreme and exceptional drought conditions across Wyoming, South Dakota and Nebraska and western Iowa by October 2. Moderate to severe drought conditions also expanded across Montana and North Dakota. During the October through December period, precipitation was above normal and temperatures were below normal in northern Montana and North Dakota, providing some additional improvement to drought conditions in those areas; however, the extreme and severe drought conditions in Wyoming, South Dakota, Nebraska and Iowa did not change.

a. January – March

January through March weather was drier and warmer than normal in the upper Missouri River Basin. As shown in ***Figure 5***, precipitation was generally below normal, especially in eastern Montana, Wyoming, North Dakota, western South Dakota and Nebraska. Some areas received less than 50 percent of normal precipitation during the 3-month period. Temperature departures, shown in ***Figure 6***, ranged from 2 degrees F above normal in the Rocky Mountains to 8 degrees F above normal in the plains. The warmest regions experienced departures of 10 degrees F above normal in central and eastern North Dakota and eastern South Dakota.

Very few significant snowfall events occurred during the January through March period in the mountains and plains. From February 3-5, a plains snowfall event moved from northeast Colorado, across Nebraska into southwest Iowa producing 1 to 1.5 inches of SWE and an average snowfall depth of 10 inches. Additional precipitation during February added to monthly precipitation totals in excess of 200 percent of normal precipitation in much of Nebraska, eastern South Dakota and western Iowa. February precipitation in the plains, which was less than 50 percent of normal in Nebraska and Iowa, sharply contrasted with January precipitation. The drier-than-normal and warmer-than-normal patterns continued into March with most of the upper basin receiving less than 50 percent of normal precipitation and temperature departures ranging from 3 to 6 degrees F above normal in the mountains and 12 to 15 degrees F above normal in the plains.

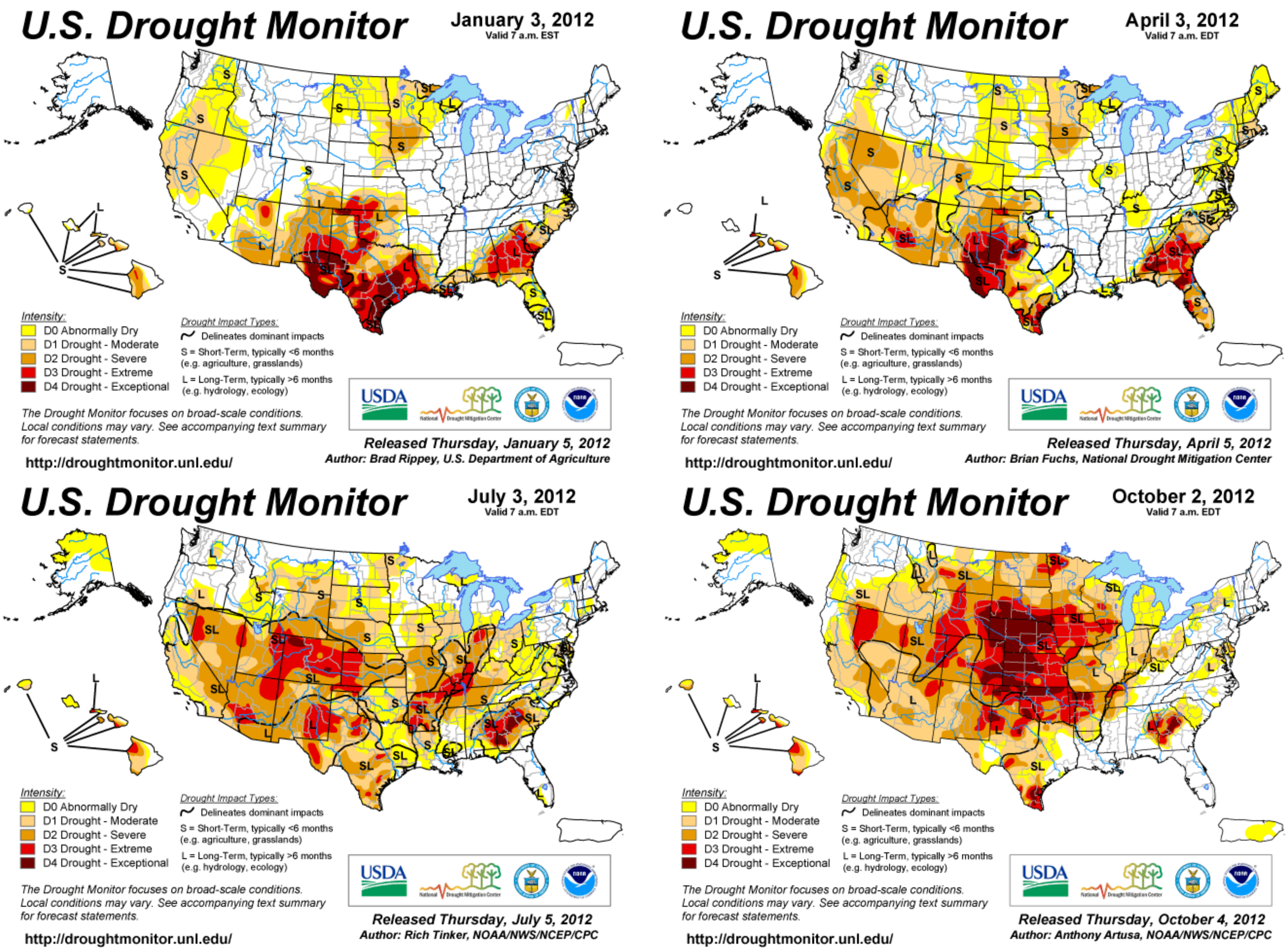


Figure 7. The National Drought Mitigation Center’s drought maps for early January, April, July and October 2012.

b. April - June

April through June weather was also drier and warmer than normal in nearly all of the Missouri River Basin. Precipitation departures as shown on ***Figure 5*** were particularly dry in the Rocky Mountains and the plains west of the Missouri River. Precipitation was less than 70 percent of normal in these areas, and it was less than 50 percent of normal in much of Wyoming, Colorado and western Nebraska. Temperature departures as shown on ***Figure 6*** generally were 2 to 6 degrees F above normal, and the greatest departures were 4 to 6 degrees F above normal in South Dakota, eastern Wyoming, Colorado, Kansas and Nebraska. Departures in Montana and North Dakota ranged from normal to 4 degrees F above normal.

April precipitation over the Missouri River Basin was above normal in most regions with the exception of the Rocky Mountains in Wyoming and Colorado. April precipitation was highlighted by a stormy period from April 12-16. During this time period, moderate to heavy rainfall occurred over South Dakota, eastern Nebraska, western Iowa and Missouri. Rainfall amounts ranged from 2 to 2.5 inches in eastern South Dakota, 2 to 3.5 inches in eastern Nebraska and western Iowa and 2 to 3.5 inches in Missouri. Near the end of April a large system produced widespread rainfall amounts of 1 to 2 inches across Montana, North Dakota, South Dakota and Nebraska. In central Missouri thunderstorms on April 29-30 produced 2.5 to 4 inches of rainfall. Temperatures during April were 4 to 6 degrees F above normal.

During May precipitation accumulations were well below normal in the Missouri River Basin, especially in the lower basin, which received less than 50 percent of normal precipitation during the month. The upper basin generally received from 70 to 90 percent of normal precipitation. The regions that received above normal precipitation included northeast Montana, eastern South Dakota and northwest Iowa where precipitation ranged from 100 to 200 percent of normal. Some significant May precipitation totals included 3.1 inches at Glasgow, MT; 4.6 inches at Sioux Falls, SD; and 6.2 inches at Sioux City, IA. May temperature departures were normal to 4 degrees F below normal in Montana, normal across the Dakotas and 4 to 6 degrees F above normal in the lower basin.

June precipitation accumulations were generally below normal throughout the Missouri River Basin. The Rocky Mountains extending from southwest Montana to Colorado received the least precipitation with accumulations ranging from 10 to 50 percent of normal. In the plains, accumulations ranged from 25 to 75 percent of normal with the exception of isolated areas that received normal precipitation. The heaviest rainfall event occurred June 14-15 in southeast Nebraska and northern Kansas producing amounts ranging from 1.5 to 3 inches. Temperatures in June were 4 to 8 degrees F above normal in eastern Wyoming, Colorado, western South Dakota, western Nebraska and western Kansas. In all other areas, temperature departures were normal to 4 degrees F above normal.

g. July – September

The warmer-than-normal and drier-than-normal weather pattern continued during July through September. Precipitation departures were less than 50 percent of normal in large portions of Montana, Wyoming, South Dakota, Nebraska and Iowa as shown on ***Figure 5***. Temperature departures as shown on ***Figure 6*** were 2 to 5 degrees F above normal over much of the same region, while in the remainder of the Missouri River Basin temperatures ranged from normal to 2 degrees F above normal.

Precipitation was below normal during July for most of the basin; however, several areas including northeast Colorado, southeast Wyoming, northwest South Dakota and eastern Montana received above normal precipitation. Precipitation in the lower basin was generally less than 50 percent of normal. There were no significant rainfall events that affected the Missouri River Basin in July. Average monthly temperatures were 4 to 8 degrees F above normal.

Rainfall in August was less than 50 percent of normal throughout a majority of the Missouri River Basin with the greatest departures occurring in the Rocky Mountains and the lower basin. Only localized areas received above normal August precipitation due to scattered thunderstorms. A particularly heavy rainfall event occurred on August 24-25, producing 3 to 5 inches of rain in a small portion of northwest Missouri, southwest Iowa and southeast Nebraska including 4.9 inches at Falls City, NE. Temperatures during August were normal to 3 degrees F below normal in some portions of the lower basin, North Dakota and South Dakota; while in much of Montana, Wyoming, Colorado and western Nebraska, temperatures were 1 to 4 degrees F above normal.

In September most of the upper Missouri River Basin received less than 25 percent of normal precipitation with large areas receiving less than 10 percent of normal precipitation. In the lower basin, precipitation was generally less than 50 percent of normal, with the exception being Missouri, which was impacted by precipitation from the remnants of Hurricane Isaac from August 31-September 1. Over the 2-day period, Isaac produced 4 to 6 inches of rainfall over western Missouri. Some significant rainfall amounts include 4.9 inches in Kansas City, MO and 5.6 inches in Lee’s Summit, MO. Temperatures during September were near normal in the lower basin. In the upper basin west of the Missouri River, temperatures were 2 to 6 degrees F above normal.

j. October - December

During October precipitation was generally less than 75 percent of normal throughout the Missouri River Basin. Several areas received less than 50 percent of normal precipitation including South Dakota, central Wyoming, Nebraska northeast Kansas and western Missouri. In contrast, rainfall was much more persistent in northern Montana, northern North Dakota and southwest Iowa, which received greater than 150 percent of normal precipitation. Temperatures were normal to 4 degrees F below normal throughout the Missouri River Basin.

November precipitation was less than 50 percent of normal throughout much of Wyoming, South Dakota, Nebraska, Iowa, Colorado and Kansas. The wetter-than-normal precipitation pattern continued in Montana, northern North Dakota and the Rocky Mountains in Wyoming producing November precipitation accumulations in excess of 150 percent of normal in many areas. The above normal precipitation gave the mountain snowpack a substantial increase to levels that were normal by the end of November. With the exception of normal to 4 degrees F below normal temperatures in northern Montana and Wyoming, temperatures in much of the Missouri River Basin were warmer than normal. Average monthly temperature departures in southern Montana, Wyoming, South Dakota, Nebraska, Iowa and Kansas were 2 to 6 degrees F above normal.

December precipitation, as a percent of normal, showed improvement when compared to November. While the Rocky Mountains in Montana and Wyoming were slightly above normal, the remainder of Montana and Wyoming received less than 75 percent of normal precipitation. Monthly precipitation as a percent of normal in South Dakota, Nebraska and Iowa varied locally; however, there were several areas in these states that received greater than 200 percent of normal precipitation as a result of three winter storms, which occurred December 7-9, December 15-16 and December 20. Each of these storms produced similar amounts of precipitation, which contributed to December accumulations of 1 to 2.5 inches of precipitation in eastern South Dakota, 1 to 1.5 inches of precipitation in southern and eastern Nebraska and about 1 inch in western Iowa. Average monthly temperatures in Montana and North Dakota were normal to 2 degrees F below normal, while in the remainder of the basin temperatures were normal to 4 degrees F above normal.

4. Calendar Year Runoff

The final unregulated runoff volume for the period January through December 2012 for the upper basin above Sioux City, IA is 19.5 MAF, 77 percent of normal runoff, based on the historical period of 1898-2011 as shown in ***Table 3*** and ***Figure 8***. Total runoff in the lower basin from Sioux City, IA to Hermann, MO, was 22.2 MAF, 51 percent of normal runoff. Of the nine reaches in the entire Missouri River Basin outlined in ***Table 4***, runoff in one reach, Fort Randall to Gavins Point, was above normal. ***Figure 9*** indicates the monthly variation of runoff in the basin above Sioux City, IA.

Table 3 lists the runoff for the upper basin by month and reach and is the adjusted compilation of the runoff into the System. As the year progresses, this table is filled in with observed monthly runoff data for those months that have occurred and with forecast runoff data for the remaining months in the year. This runoff estimate forms a basis for intrasystem balancing of storage accumulated in the System and is updated by MRBWM on the first of each month to forecast the runoff for the remainder of the year. The monthly accumulation of actual runoff is shown under the "Accumulated Summation above Sioux City" column. As the season progresses, more of the observed runoff is accumulated and the estimate of annual runoff becomes more reliable. The majority of the annual runoff has usually occurred by the end of July and the remainder of the year can be estimated with a greater degree of accuracy.

Table 3
Missouri River Basin
2012 Runoff above Sioux City, IA

Reach Above	Fort Peck	Garrison	Oahe	Fort Randall	Gavins Point	Sioux City	Summation above Gavins Point	Summation above Sioux City	Accumulated Summation above Sioux City
				Values in 1000 Acre Feet					
	(Actual)								
JAN 2012	332	248	-71	131	78	236	718	954	954
NORMAL	312	262	12	27	100	49	713	762	762
DEPARTURE	20	-14	-83	104	-22	187	5	192	192
% OF NORM	106%	95%	-592%	485%	78%	482%	101%	125%	125%
FEB 2012	455	539	184	127	188	187	1,493	1,680	2,634
NORMAL	360	353	94	53	132	100	992	1,092	1,854
DEPARTURE	95	186	90	74	56	87	501	588	780
% OF NORM	126%	153%	196%	240%	142%	187%	151%	154%	142%
MAR 2012	523	839	266	106	177	333	1,911	2,244	4,878
NORMAL	597	999	590	218	212	327	2,616	2,943	4,797
DEPARTURE	-74	-160	-324	-112	-35	6	-705	-699	81
% OF NORM	88%	84%	45%	49%	83%	102%	73%	76%	102%
APR 2012	605	554	108	73	183	236	1,523	1,759	6,637
NORMAL	643	1,084	514	145	181	388	2,567	2,955	7,752
DEPARTURE	-38	-530	-406	-72	2	-152	-1,044	-1,196	-1,115
% OF NORM	94%	51%	21%	50%	101%	61%	59%	60%	86%
MAY 2012	961	980	193	91	189	627	2,414	3,041	9,678
NORMAL	1,087	1,264	320	147	185	319	3,003	3,322	11,074
DEPARTURE	-126	-284	-127	-56	4	308	-589	-281	-1,396
% OF NORM	88%	78%	60%	62%	102%	197%	80%	92%	87%
JUN 2012	1,193	2,112	199	-1	156	301	3,659	3,960	13,638
NORMAL	1,643	2,712	439	162	185	315	5,141	5,456	16,530
DEPARTURE	-450	-600	-240	-163	-29	-14	-1,482	-1,496	-2,892
% OF NORM	73%	78%	45%	-1%	84%	96%	71%	73%	83%
JUL 2012	611	1,340	145	-63	158	98	2,191	2,289	15,927
NORMAL	835	1,823	185	59	139	244	3,041	3,285	19,815
DEPARTURE	-224	-483	-40	-122	19	-146	-850	-996	-3,888
% OF NORM	73%	74%	78%	-107%	114%	40%	72%	70%	80%
AUG 2012	316	428	48	-5	137	78	924	1,002	16,929
NORMAL	356	612	70	41	116	148	1,195	1,343	21,158
DEPARTURE	-40	-184	-22	-46	21	-70	-271	-341	-4,229
% OF NORM	89%	70%	69%	-12%	118%	53%	77%	75%	80%
SEP 2012	147	111	-24	65	87	-3	386	383	17,312
NORMAL	332	451	110	37	111	108	1,041	1,149	22,307
DEPARTURE	-185	-340	-134	28	-24	-111	-655	-766	-4,995
% OF NORM	44%	25%	-22%	176%	78%	-3%	37%	33%	78%
OCT 2012	205	429	-47	-51	119	-17	655	638	17,950
NORMAL	382	525	64	5	120	89	1,096	1,185	23,492
DEPARTURE	-177	-96	-111	-56	-1	-106	-441	-547	-5,542
% OF NORM	54%	82%	-73%	--	99%	-19%	60%	54%	76%
NOV 2012	356	344	70	-63	188	-27	895	868	18,818
NORMAL	382	394	66	5	118	81	965	1,046	24,538
DEPARTURE	-26	-50	4	-68	70	-108	-70	-178	-5,720
% OF NORM	93%	87%	106%	--	159%	-33%	93%	83%	77%
DEC 2012	297	199	58	-8	131	50	677	727	19,545
NORMAL	328	249	1	12	100	57	690	747	25,285
DEPARTURE	-31	-50	57	-20	31	-7	-13	-20	-5,740
% OF NORM	91%	80%	--	-67%	131%	88%	98%	97%	77%
				Calendar Year Totals					
	6,001	8,123	1,129	402	1,791	2,099	17,446	19,545	
NORMAL	7,257	10,728	2,465	911	1,699	2,225	23,060	25,285	
DEPARTURE	-1,256	-2,605	-1,336	-509	92	-126	-5,614	-5,740	
% OF NORM	83%	76%	46%	44%	105%	94%	76%	77%	

Table 4
Missouri River Basin 2012 Runoff for Selected Reaches (kAF)

Reach	1898-2011 Average Runoff Volume	2012 Runoff Volume	Percent of Average Runoff
Above Fort Peck	7,257	6,001	83
Fort Peck to Garrison	10,728	8,123	76
Garrison to Oahe	2,465	1,129	46
Oahe to Fort Randall	911	402	44
Fort Randall to Gavins Point	1,699	1,791	105
Gavins Point to Sioux City	2,225	2,099	94
TOTAL ABOVE SIOUX CITY	**25,285**	**19,545**	**77**
	1967-2012 Average Runoff	**2012 Runoff Volume**	**Percent of Average Runoff**
Sioux City, IA to Nebraska City, NE*	7,700	5,120	66
Nebraska City, NE to Kansas City, MO*	11,800	5,530	47
Kansas City, MO to Hermann, MO*	24,000	11,570	48
TOTAL BELOW SIOUX CITY*	**43,500**	**22,230**	**51**

** Runoff in the reaches from Sioux City, IA to Hermann, MO is not adjusted to 1949 depletion levels. Annual monthly averages are taken from the USGS Water Data Reports for the period 1967-2012.*

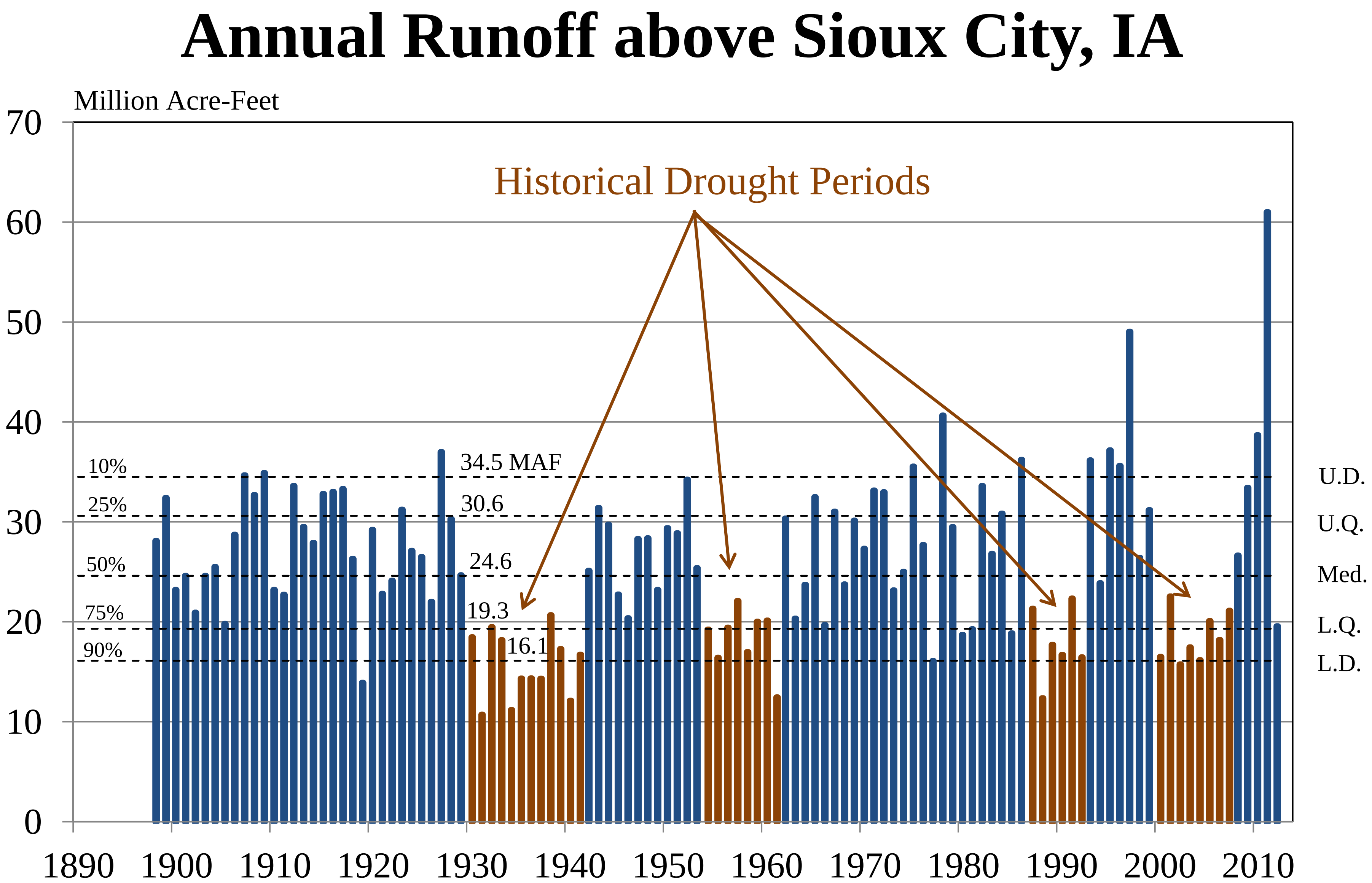


Figure 8. Missouri River annual runoff above Sioux City, IA.

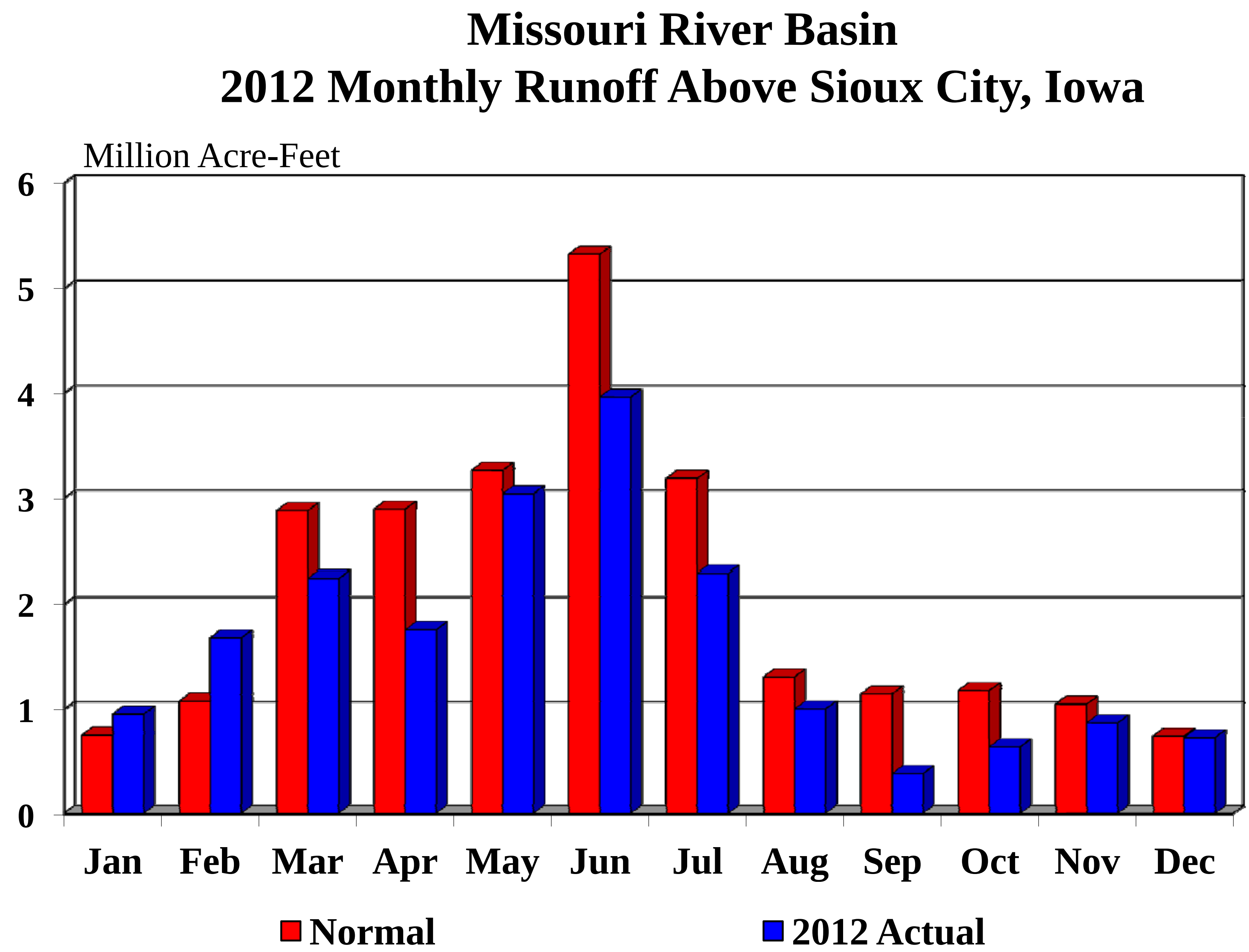


Figure 9. Missouri River Basin 2012 monthly runoff above Sioux City, IA.

C. System Regulation

1. Basin Conditions and System Storage

Runoff above Sioux City in 2012 was 19.5 MAF, 77 percent of normal. This followed 2011, which had produced 61.0 MAF, the highest runoff on record and nearly 2.5 times the normal runoff.

a. Conditions in January and February

During the previous three winters the upper basin experienced significant plains snow. The winter of 2012 was very mild throughout the entire upper basin and very little plains snow was observed. During the first few months of 2012, temperatures were warmer than normal and wet soil conditions did result in above normal runoff early in the year. Runoff during January and February was 125 percent and 154 percent of normal, respectively.

The March 1 plains snow coverage as shown on ***Figure 1*** indicated little to no snow in the plains areas of Montana, Wyoming, North Dakota and western South Dakota. In eastern and central South Dakota, the plains snow depth ranged from 4 to 20 inches, which was significantly less than the previous three years. The mountain SWE in the reach above Fort Peck and the Fort Peck to Garrison reach was 94 percent and 105 percent, respectively. The March 1 annual inflow forecast was 26.1 MAF, 105 percent of normal. All of the stored floodwaters from 2011 had been evacuated from the System by December 21, 2011 when System storage reached 56.8 MAF, the base of the Annual Flood Control and Multiple Use Zone. As part of the flexible and aggressive approach taken following the 2011 flood, conditions allowed for higher-than-normal winter releases and creation of additional flood control storage space. System storage was at 56.1 MAF on January 26, creating an additional 0.7 MAF of flood control space in addition to the designated 16.3 MAF annual flood control and exclusive flood control storage space. By March 1 runoff from early plains snowpack had entered the reservoirs and system storage had increased to 56.5 MAF, 0.3 MAF below the base of the Annual Flood Control and Multiple Use Zone.

b. Conditions in March

The warmer-than-normal temperatures continued through March. During March the basin began to see the initial indications of the 2012 drought. March precipitation was significantly less than normal and temperatures were warmer than normal. This resulted in the soil conditions quickly moving from “wet” to “normal” throughout the upper basin. The result was 78 percent of normal runoff in March. The mountain SWE in the reach above Fort Peck and the Fort Peck to Garrison reach were below normal at 97 percent and 94 percent, respectively. The April 1 annual inflow forecast was 23.4 MAF, 94 percent of normal. System storage on April 1 was 56.9 MAF, which is 0.1 MAF above the base of the Annual Flood Control and Multiple Use Zone.

c. Conditions in April

The warmer-than-normal temperatures continued through April. Precipitation in the upper basin during April was generally normal with above normal precipitation in northern Montana and eastern South Dakota. Even with the normal to above normal precipitation, the lack of plains snow and drying soil conditions resulted in 61 percent of normal of runoff in April. The mountain SWE in the reach above Fort Peck peaked on April 9 at 97 percent of normal as shown on ***Figure 2***. The mountain SWE in the Fort Peck to Garrison reach peaked on March 22 at 88 percent of normal. The May 1 annual inflow forecast was 21.6 MAF, 87 percent of normal. System storage on May 1 was 56.7 MAF, 0.1 MAF below the base of the Annual Flood Control and Multiple Use Zone.

d. Conditions in May through July

Well above normal temperatures continued during the late spring and early summer. While there were areas of northern Montana that observed above normal precipitation, the large majority of the upper basin received below normal precipitation. With May's very warm temperatures, the mountain snowpack melted significantly during the month and resulted in near normal May runoff, 93 percent of normal. However, the warmer-than-normal temperatures, faster-than-normal mountain snowpack melt and drier-than-normal precipitation led to much less-than-normal runoff in June and July, 79 percent and 68 percent, respectively. System storage on July 1 was 57.6 MAF, 0.8 MAF into the Annual Flood Control and Multiple Use Zone. Most significantly, the July 1 System storage check resulted in providing full service navigation flow support for a full 8-month season. The August 1 annual inflow forecast was 21.0 MAF, 85 percent of normal.

e. Conditions in August through December

Well above normal temperatures continued during the late summer and fall throughout the entire Missouri River Basin. The basin also endured below normal precipitation during this period. Because of dry conditions in the lower basin, which led to very low tributary inflow into the Missouri River, Gavins Point releases were higher than normal during the fall in order to meet the Kansas City full service navigation flow target of 41,000 cfs. The higher-than-normal System releases, coupled with below normal runoff in the upper basin, resulted in System storage decreasing at a very rapid rate. During the 4-month period of August 1 to November 30, System storage decreased from 56.4 MAF to 48.9 MAF. The September 1 System storage check of 54.3 MAF resulted in prescribed minimum winter releases of 12,000 cfs from Gavins during the 2012-2013 winter season.

2. Fort Peck

a. General

Fort Peck, the third largest Corps storage reservoir, serves all authorized purposes. Fort Peck's primary functions are: (1) to capture the snowmelt runoff and localized rainfall runoff from the large drainage area above Fort Peck, which are metered out at controlled release rates to meet the authorized purposes while reducing flood damages in the Fort Peck to Garrison 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 pool increases in Garrison, Oahe and Fort Randall; and (3) to provide the water needed to meet all authorized purposes that draft storage during low-water years.

Table 5 lists the monthly inflows and releases and the end-of-month (EOM) pool elevations for Fort Peck for 2011 and 2012 as well as the average monthly inflow and releases and EOM pool elevations since the System first filled in 1967.

Table 5
Fort Peck – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2012	2011	1967-2012	2012	2011	1967-2012	2012	2011	1967-2012
January	7,100	9,100	7,200	11,800	8,900	10,600	2234.8	2235.3	2227.4
February	9,000	12,000	8,700	10,800	9,800	10,900	2234.3	2235.8	2226.8
March	9,500	17,900	11,800	6,800	7,400	7,900	2234.9	2238.7	2227.9
April	10,100	15,400	10,300	6,900	7,100	7,300	2235.7	2240.9	2228.7
May	12,700	46,100*	15,700	9,100	14,700	9,100	2236.6	2248.9*	2230.4
June	14,000	61,200*	19,700	10,000	52,600*	10,600	2237.4	2250.7*	2232.9
July	7,300	26,700	12,400	11,100	41,500*	10,600	2235.9	2246.6	2232.9
August	5,700	10,800	7,900	10,900	26,600*	10,200	2233.8	2241.9	2231.8
September	5,600	10,100	7,800	10,500	23,000*	9,100	2231.8	2237.9	2230.9
October	5,600	10,200	7,400	10,100	9,200	8,000	2230.0	2237.7	2230.3
November	6,200	9,400	7,200	10,400	10,100	8,400	2228.4	2237.2	2229.6
December	4,800	8,800	6,600	11,100	11,100	9,500	2226.0	2236.2	2228.5

*monthly maximum of record

b. Winter Season 2011-2012

The Fort Peck pool level was at elevation 2237.2 ft msl on December 1, 2011, 1.7 feet higher than the previous year's elevation of 2235.5 ft msl. Releases from Fort Peck were above normal for December 2011 as well as January and February 2012. The Fort Peck pool level was at elevation 2236.2 ft msl on January 1, 2.2 feet above the base of the Annual Flood Control and Multiple Use Zone and 0.8 foot higher than the previous year. The 2012 annual minimum reservoir level occurred on December 31 at 2226.0 ft msl, 9.2 feet lower than the 2011 annual minimum, which was 2235.2 ft msl on February 12.

c. Winter River and Ice Conditions Below Fort Peck

No special release reductions were required to prevent ice-jam flooding downstream of Fort Peck. The average monthly discharge for December 2011 and January 2012 were above normal at 11,100 and 11,800 cfs, respectively. February releases of 10,800 cfs were near the normal monthly average. Ice-cover formation on the Missouri River downstream of Fort Peck occurred January 18-23 and resulted in the Missouri River stage rising over 6 feet in the Wolf Point, MT area. The stage at Wolf Point peaked at 8.3 feet on January 23, well below the flood stage of 23 feet. A majority of the ice cover near Wolf Point melted in early February and then re-formed later in the month. The highest winter stage at Wolf Point of 10.6 feet occurred on February 14. The Missouri River at Culbertson, MT peaked on January 26 at a stage of 9.3 feet, well below the flood stage of 19 feet. No reports of ice-affected flooding on the Missouri River below Fort Peck were recorded during the 2011-2012 winter season. Fort Peck Reservoir froze over on January 20 and was free of ice on March 20.

d. Spring Open Water Season 2012

Inflows into Fort Peck were near normal for April before dropping off in May and June. Releases from Fort Peck were also near their historic monthly normal for that same period. In May and June, monthly inflows to the reservoir were 12,700 cfs (81 percent of normal) and 14,000 cfs (71 percent of normal), respectively. Fort Peck releases were normal at 9,100 cfs in May and were near normal at 10,000 cfs in June. Fort Peck Reservoir rose 2.7 feet from its April 1 elevation of 2234.9 ft msl to its peak elevation for the year of 2237.6 ft msl in late June.

e. Summer Open Water Season 2012

Average monthly release rates from Fort Peck were near normal (109 percent of the 3-month normal) during the summer with 11,100, 10,900 and 10,500 cfs in July, August and September, respectively. Inflows during that same 3-month period were below normal (68 percent) with 7,300, 5,700 and 5,600 cfs, respectively. After peaking in late June, the reservoir level held steady before starting its gradual decline through the remainder of the year. Over a 3-month period the reservoir level steadily dropped 5.6 feet from 2237.4 ft msl (July 1) to 2231.8 ft msl (September 30).

f. Fall Open Water Season 2012

Releases during the fall were above normal with 10,100 cfs in October (126 percent of normal) and 10,400 cfs in November (124 percent of normal) and 11,100 cfs in December (117 percent of normal). The high releases were continued in an effort to balance system storage. Inflows for October, November and December were below normal, ranging from 73 percent to 86 percent of normal. The combination of below normal inflow and above normal releases resulted in the pool elevation declining 5.8 feet over a 3-month period from 2231.8 ft msl (October 1) to 2226.0 ft msl (December 31).

g. Summary

The highest Fort Peck Reservoir level during 2012 occurred on July 1 at 2237.6 ft msl, 3.6 feet into the Annual Flood Control and Multiple Use Zone. The lowest reservoir level during 2012 occurred on December 31 at 2226.0 ft msl. The average annual inflow of 8,100 cfs during 2012 was 79 percent of normal (1967-2012). The average annual release of 10,000 cfs during 2012 was 108 percent of normal (1967-2012).

3. Garrison

a. General

Garrison, the largest Corps storage reservoir, is another key component in the regulation of the System. Its primary functions are: (1) to capture the snowmelt runoff and localized rainfall runoff from the large drainage area between the Fort Peck and Garrisons, which are metered out at controlled release rates to meet the authorized purposes while reducing flood damages in the Garrison to Oahe reach, particularly in 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 pool increases in Oahe and Fort Randall; and (3) to provide water needed to meet all authorized purposes that draft storage during low-water years.

Table 6 lists the monthly inflows and releases in cfs and the EOM pool elevation in ft msl for Garrison for 2011 and 2012 as well as the average monthly inflows and releases and EOM pool elevations since the System first filled in 1967.

Table 6
Garrison – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation(ft msl)		
	2012	2011	1967-2012	2012	2011	1967-2012	2012	2011	1967-2012
January	16,500	14,800	15,200	21,300	23,600	22,500	1838.2	1840.0	1831.9
February	21,700	18,000	18,500	22,600	25,800	23,700	1838.0	1838.5	1830.9
March	20,500	32,500	26,600	20,500	21,800	19,200	1837.9	1840.5	1832.4
April	16,300	53,700	22,800	26,600	14,900	18,700	1835.8	1847.6*	1833.0
May	25,400	88,200*	29,500	26,200	50,700*	21,500	1835.6	1853.3*	1834.5
June	36,800	144,600*	47,600	25,400	136,600*	25,100	1837.7	1854.5*	1838.7
July	23,300	111,700*	33,700	24,300	127,700*	26,100	1837.3	1851.6	1839.8
August	15,500	51,900*	18,700	24,600	91,100*	25,200	1834.8	1844.5	1838.0
September	14,700	37,300*	16,900	21,800	43,400	21,000	1832.8	1842.8	1836.8
October	17,400	22,700	17,300	19,700	25,800	19,100	1831.6	1841.9	1836.1
November	19,000	20,300	16,000	22,100	28,400	20,000	1830.3	1840.0	1834.9
December	14,600	18,800	13,800	17,400	20,400	20,000	1829.5	1839.5	1833.4

*monthly maximum of record

b. Winter Season 2011-2012

The Garrison Reservoir level was at elevation 1839.9 ft msl on December 1, 2011, 2.5 feet lower than the previous year's elevation of 1842.4 ft msl. This elevation was 2.4 feet above the base of the Annual Flood Control and Multiple Use Zone. Releases from Garrison were above normal for December 2011. January and February releases were below normal. The reservoir level declined throughout the winter season and ended February at 1838.0 ft msl, 0.5 foot above the base of the Annual Flood Control and Multiple Use Zone. The annual minimum elevation of

1829.5 ft msl was reached on December 31, 2012. Garrison Reservoir froze over on January 18 and was free of ice on March 27.

c. Winter River and Ice Conditions Below Garrison

The Missouri River in the Bismarck, ND area rose over 6 feet on January 13-14 during river ice-cover formation. This type of rise in stage during the river ice formation is normal. The river ice-cover conditions were generally continuous from January 13 through February 17, at which time the river ice broke up due to warm temperatures. The winter ice-affected Missouri River peak stage at Bismarck was 12.1 feet on January 24. This was 2.4 feet below the Bismarck flood stage of 14.5 feet and 0.9 feet below the Corps' winter freeze-in maximum stage target of 13 feet.

d. Spring Open Water Season 2012

After starting the year with above normal runoff above Garrison, inflows dropped off in March and remained below normal for the rest of the spring. Releases from Garrison were kept at above normal levels during the spring in order to maintain a steady-to-rising pool level in Oahe during the critical fish spawning period. The less-than-normal inflows and above normal releases resulted in Garrison pool levels decreasing 2.3 feet over a 2-month period, from 1837.9 ft msl (April 1) to 1835.6 ft msl (May 31). During June melting mountain snowpack increased inflows and resulted in a pool rise of 1.8 feet to 1837.4 ft msl (June 30). Inflows for April were 71 percent of normal, for May were 86 percent of normal, and for June were 77 percent of normal, all well below normal. Releases were 142 percent of normal in April, 122 percent of normal in May and 101 percent of normal in June.

e. Summer Open Water Season 2012

Inflows into Garrison Reservoir were below normal for the 3-month period of July through August: July (23,300 cfs; 69 percent of normal); August (15,500 cfs; 83 percent of normal) and September (14,700 cfs; 87 percent of normal). Releases during this 3-month period were near normal. The pool rose to 1838.0 ft msl July 8, 0.5 foot into the Annual Flood Control and Multiple Use Zone. This was less than the annual peak elevation of 1839.3 ft msl that occurred on January 1. Following the July 8 seasonal crest, the Garrison pool declined and entered the Carryover Multiple Use Zone on July 27 and continued to decline to 1832.8 ft msl (September 30), 5.2 feet below the July 8 crest.

f. Fall Open Water Season 2012

Fall releases were normal over the October through December period. Inflows over this same period were above normal, averaging 108 percent of normal. Releases were reduced to about 16,000 cfs starting in mid-December in anticipation of the December freeze-in downstream of Garrison between Washburn and Bismarck, ND. The river froze over at Bismarck on December 25 at a stage of just over 9 feet. After the ice cover stabilized, releases from Garrison were increased 1,000 cfs every three days starting December 30 with the intent of reaching the planned winter release of 23,000 cfs. Garrison releases at the end of the year were

17,000 cfs. The end-of-year Garrison elevation was 1829.5 ft msl, 8.0 feet below the base of the Annual Flood Control and Multiple Use Zone.

g. Lake Audubon / Snake Creek Embankment

During the 2000-2007 drought, a 43-foot maximum water level difference between Lake Audubon and Garrison Reservoir was put in place. This restriction required a pool restriction for Lake Audubon as a result of an under-seepage evaluation of the Lake Audubon embankment by the Corps' Omaha District. Since that time relief wells have been installed and under-seepage issues should not be a factor in future operations of the Lake Audubon. In the event the pool difference approaches the 43-foot maximum that was in place in 2007, the Omaha District's Geotechnical Branch will be consulted as to whether or not the 43-foot maximum is still a consideration. Since Garrison Reservoir has returned to more normal elevations following the 8-year drought, this water level difference restriction has not been in effect. Lake Audubon was drawn down to the normal winter level of 1845.0 ft msl in the fall.

h. Summary

The Garrison pool elevation peaked at 1839.3 ft msl on January 1, 2012, 1.8 feet above the base of the Annual Flood Control and Multiple Use Zone and 15.3 feet lower than the 2011 peak. The lowest Garrison Reservoir level during 2012 occurred on December 31 at 1829.5 ft msl or 8.0 feet lower than the base of the Annual Flood Control and Multiple Use Zone. The average annual inflow of 20,100 cfs was 88 percent of normal (1967-2012). The average annual release of 22,700 cfs was 104 percent of normal (1967-2012).

4. Oahe and Big Bend

a. General

Oahe, the second largest Corps storage reservoir, serves all authorized purposes. Oahe's primary functions are: (1) to capture snowmelt and localized rainfall runoff from the large drainage area between the Garrison and Oahe, which are metered out at controlled release rates to meet the authorized purposes, while reducing flood damages in the Oahe 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 water needed to meet all authorized 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 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 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 total storage, is primarily used for hydropower production, so releases from Oahe are generally passed directly through Big Bend.

Table 7 lists the monthly inflows and releases and the EOM pool elevations for Oahe for 2011 and 2012 as well as the average monthly inflows and releases and EOM pool elevations since the System first filled in 1967.

Table 7
Oahe – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2012	2011	1967-2012	2012	2011	1967-2012	2012	2011	1967-2012
January	20,200	24,800	23,000	26,700	22,500	20,900	1605.2	1605.4	1598.8
February	25,200	30,500	27,100	22,400	17,700	18,300	1605.6	1607.7	1600.5
March	23,500	50,400	31,300	22,300	13,900	18,100	1605.7	1614.4	1603.1
April	27,900	41,400	27,200	24,800	26,000	20,900	1606.4	1617.5	1604.2
May	28,400	65,100*	28,000	24,200	52,600*	22,200	1607.1	1618.8*	1605.1
June	26,900	147,500*	30,700	29,400	142,500*	27,400	1606.5	1619.6*	1605.3
July	24,100	133,600*	28,700	35,000	144,200*	31,600	1603.9	1617.5	1604.3
August	23,800	95,300*	26,500	38,100	117,100*	34,200	1600.5	1613.3	1602.3
September	21,400	46,800	22,500	36,800	67,300*	29,800	1596.8	1609.0	1600.4
October	19,500	28,700	20,500	27,200	27,800	24,000	1594.7	1609.0	1599.2
November	23,300	29,500	21,400	26,100	36,300	22,700	1593.3	1607.4	1598.7
December	17,500	22,300	20,300	14,700	23,800	20,900	1593.5	1606.8	1598.3

*monthly maximum of record

A settlement agreement was approved in an order of dismissal by the United States District Court, District of South Dakota on August 8, 2003, in the case of Lower Brule Sioux Tribe et al. v. Rumsfeld, et al. (Civil No. 02-3014 (D.S.D.)). The agreement 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 Big Bend and the water level of the Big Bend Reservoir with the two Tribes to include the following: the Corps will normally strive to maintain a Big Bend Reservoir level between elevation 1419.0 ft msl and 1421.5 ft msl and, when the level of Big Bend Reservoir drops below elevation 1419.0 ft msl or exceeds elevation 1421.5 ft msl, the Chief of MRBWM will provide notice to such persons as the Tribes shall designate in writing. When it is anticipated that the water level will drop below 1418.0 ft msl or rise above 1422.0 ft msl or, in the event the water level falls below 1418.0 ft msl or rises above 1422.0 ft msl, the Commander, NWD, 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. During 2012 the Big Bend Reservoir level varied in the narrow range between elevations 1419.2 ft msl to 1421.5 ft msl. As per the settlement agreement, no additional coordination was necessary.

Table 8 lists the monthly inflows and releases in cfs and the EOM pool elevations in ft msl for Big Bend for 2011 and 2012 as well as the average monthly inflows and releases and EOM pool elevations since the System first filled in 1967.

Table 8
Big Bend – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2012	2012	1967-2012	2012	2011	1967-2012	2012	2011	1967-2012
January	25,500	20,600	20,600	25,200	19,700	20,500	1420.6	1421.2	1420.5
February	21,000	17,400	18,300	21,000	17,600	18,300	1420.5	1420.7	1420.4
March	21,100	17,100	18,900	21,100	17,200	18,800	1420.4	1420.5	1420.4
April	23,700	25,200	21,200	23,000	24,900	20,900	1420.8	1420.7	1420.5
May	22,900	49,200**	22,400	23,600	50,400**	22,300	1419.8	1419.0	1420.4
June	27,200	143,000**	27,600	26,400	142,100**	27,300	1420.3	1419.8	1420.3
July	32,100	141,600**	30,900	31,900	141,600**	30,500	1420.1	1419.5*	1420.3
August	35,400	113,500**	33,500	34,700	113,100**	33,000	1420.1	1419.3	1420.2
September	34,000	63,600**	29,300	32,800	62,800**	28,900	1420.9	1419.6	1420.3
October	25,100	25,800	23,800	25,200	24,700	23,300	1420.4	1420.4	1420.5
November	24,300	34,600	24,000	24,300	34,200	22,400	1420.1	1420.6	1420.4
December	13,500	22,500	20,700	12,900	22,700	20,500	1420.8	1420.4	1420.5

*monthly minimum of record **monthly maximum of record

b. Winter Season 2011-2012

No ice-induced flooding problems were experienced downstream of the two projects during the winter of 2011-2012 due to the warmer temperatures and much above average releases. In addition, it was not necessary to implement the one-unit-minimum release from Oahe. The one unit minimum, which is approximately 7,000 cfs, ensures that water is always flowing in the river downstream of the Oahe in order to lessen river ice-forming. Oahe Reservoir did not freeze over during the 2011-2012 winter season.

Big Bend was regulated in the winter season to follow power-peaking requirements and thus hourly releases varied widely. The daily average release during the winter season varied between 0 and 45,000 cfs. Big Bend Reservoir froze over on January 19 and was free of ice on March 16.

c. Spring Open Water Season 2012

The lack of plains snowpack combined with much below normal precipitation resulted in less-than-normal March incremental inflow into Oahe. Thus, most of the inflows into Oahe were a result of Garrison releases. In April and May, more than 90 percent of the Oahe inflows were a result of Garrison releases. March average monthly inflows of 23,500 cfs were below normal (75 percent of normal) while near normal inflows of 27,900 cfs and 28,400 cfs were observed during April and May, respectively. During this same time period, releases were above normal: 22,300 cfs in March (123 percent of normal), 24,800 cfs in April (119 percent of normal) and 24,200 cfs in May (109 percent of normal). Oahe releases were higher than normal from March through May in order to provide navigation flow support. The Oahe Reservoir level rose 1.4 feet during the critical fish spawning period from 1605.7 ft msl (April 1) to 1607.1 ft msl (May 31).

d. Summer Open Water Season 2012

With below normal inflows and above normal releases continuing from June through September, the Oahe pool level peaked at 1607.1 ft msl on June 6, 0.4 foot below the base of the Annual Flood Control and Multiple Use Zone. The above normal releases continued in support of navigation and reflected the lack of tributary runoff in the lower basin below Gavins Point. June releases were 29,400 cfs (107 percent of normal), July releases were 35,000 cfs (111 percent of normal), August releases were 38,100 cfs (111 percent of normal) and September releases were 36,800 cfs (123 percent of normal). The reservoir pool steadily declined from its peak in early June through the end of September, ending the month at 1596.8 ft msl, 10.3 feet lower than at its peak.

e. Fall Open Water Season 2012

Fall releases from Oahe continued to be above normal to support navigation through late November when releases to support navigation ended. Releases for October (27,200 cfs, 113 percent of normal) and November (26,100 cfs, 115 percent of normal) were above normal while December was below normal. Releases dropped off in late November in conjunction with the reduction in System releases. At the end of 2012 the Oahe pool elevation was 1593.5 ft msl, 14.0 feet below the base of the Annual Flood Control and Multiple Use Zone.

f. Summary

The highest Oahe Reservoir level of 1607.5 ft msl during 2012 occurred on May 10. The 2012 minimum pool elevation of 1593.3 ft msl occurred on November 30. The average annual inflow to Oahe of 23,500 cfs was 92 percent of normal (1967-2012). The average annual release from Oahe of 27,300 cfs was 112 percent of normal (1967-2012). During the year the Oahe Reservoir rose to the base of the Annual Flood Control and Multiple Use Zone. Big Bend was generally operated within its normal regulating range of 1420.0 ft msl to 1421.0 ft msl.

5. Fort Randall

a. General

Fort Randall, the fourth largest System reservoir, serves all authorized purposes. Fort Randall's primary functions are: (1) to capture snow and localized rainfall runoffs in the drainage area between the Big Bend and Fort Randall, which are metered out at controlled release rates to meet the authorized purposes 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 the upstream projects 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 hydropower energy 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 water needed to meet all authorized purposes, particularly navigation and downstream water supply, that draft storage during low-water years.

Table 9 lists the Fort Randall monthly inflows and releases in cfs and the EOM pool elevation in ft msl for 2011 and 2012 as well as the average monthly inflows and releases and EOM pool elevations since the System was first filled in 1967.

Table 9
Fort Randall – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2012	2011	1967-2012	2012	2011	1967-2012	2012	2011	1967-2012
January	28,600	23,000	22,000	20,100	17,300	15,200	1346.1	1345.8	1347.1
February	24,700	22,300	20,200	18,700	15,800	13,400	1350.7	1350.6	1352.0
March	24,400	25,100	21,700	21,100	15,100	15,600	1353.0	1357.8	1356.3
April	25,900	29,700	23,600	23,400	27,700	21,300	1354.5	1359.8	1357.7
May	26,600	58,500*	25,200	25,400	57,000*	25,400	1355.2	1359.9	1357.4
June	28,500	157,000*	30,300	29,800	134,600*	29,100	1354.0	1373.9*	1357.9
July	33,600	149,600*	32,000	32,400	156,000*	33,300	1354.5	1369.3*	1356.7
August	37,700	121,100*	34,500	36,500	133,000*	35,600	1354.7	1361.2	1355.4
September	37,000	68,900*	30,000	37,600	80,000*	34,900	1353.6	1352.9	1351.1
October	26,600	27,000	23,400	36,100	39,300	32,400	1345.4	1341.9	1343.2
November	25,300	36,200	22,300	30,600	38,800	28,800	1340.2	1339.2	1336.8
December	14,100	25,600	21,600	14,200	26,400	17,300	1340.0	1338.3	1341.0

*monthly maximum of record

b. Winter Season 2011-2012

Fort Randall releases were reduced from approximately 41,000 cfs in early December 2011 to 21,000 cfs by mid-December. For the remainder of the winter Fort Randall average daily releases ranged from 15,900 to 21,900 cfs. Fort Randall Reservoir froze over on January 14 and was free of ice on March 12.

c. Spring Open Water Season 2012

The Fort Randall pool was increased 4.5 feet from 1350.7 ft msl (March 1) to its typical spring and summer pool of 1355.2 ft msl (May 31). Releases were adjusted as needed to back up System releases from Gavins Point and to maintain the Gavins Point pool in the desired range. The average March release of 21,100 cfs was 135 percent of normal and the average April release of 23,400 cfs was 110 percent of normal. These releases corresponded with above normal inflows of 24,400 cfs in March (112 percent of normal) and 25,900 cfs in April (110 percent of normal). During May Fort Randall inflows were near normal at 26,600 cfs (106 percent of normal) while the releases of 25,400 cfs were normal. Fort Randall Reservoir reached its annual peak elevation of 1356.6 ft msl on May 10.

d. Summer Open Water Season 2012

During June and July inflows and releases were near normal. During August and September, as tributary inflows downstream of Gavins Point diminished due to drought conditions, Fort Randall releases were increased to back up System releases in order to provide navigation flow support. Inflows were 28,500 cfs in June (94 percent of normal), 33,600 cfs in July (105 percent of normal), 37,700 cfs in August (109 percent of normal) and 37,000 cfs in September (123 percent of normal). Releases from Fort Randall were 29,800 cfs in June (102 percent of normal), 32,400 cfs in July (97 percent of normal), 36,500 cfs in August (103 percent of normal) and 37,600 cfs in September (108 percent of normal).

A daily peaking pattern was established at Fort Randall during the nesting season to provide flexibility to regulate over a range of releases while minimizing impacts to birds nesting below the project. Peaking started on June 22 and ceased on August 16. Initially, peaking was limited to 330 MW for a continuous 8-hour time frame. On June 29, due to Western Area Power Administration (Western) experiencing transmission restriction issues that made it difficult to sustain a continuous 8-hour peak, peaking was changed to 350 MW for a continuous 6-hour time frame. This peaking pattern was kept in place until August 16 at which time all restrictions were lifted.

e. Fall Open Water Season 2012

Normal regulation of Fort Randall includes the lowering of the pool level at the end of the navigation season to 1337.5 ft msl, 17.5 feet below the normal summer level (1355.0 ft msl), to make room for capture of the winter powerplant releases from the upper reservoirs. During a full navigation season, the pool is maintained above 1353.0 ft msl through the Labor Day weekend before starting the lowering of the pool. Both inflows and releases were above normal for

October and November because of the continuation of the dry conditions downstream of Gavins Point required higher releases to meet downstream navigation targets. On September 1, the pool level was 1354.7 ft msl. The lowering of Fort Randall was started after Labor Day and reached its fall season low of 1338.0 ft msl on November 21.

f. Summary

The highest Fort Randall Reservoir level during 2012 occurred on May 10 at 1356.6 ft msl. The lowest reservoir level during 2012 was 1337.6 ft msl on January 2. The lowest reservoir level after the 2012 navigation support season occurred on November 21 at 1338.0 ft msl. The average annual inflow to Fort Randall of 27,800 cfs was 109 percent of normal (1967-2012) and the average annual release of 27,200 cfs was 108 percent of normal (1967-2012).

6. Gavins Point

a. General

Gavins Point, the most downstream of the System projects, is primarily used for flow re-regulating to smooth out the release fluctuations of the upper projects to better serve downstream purposes. With a total storage of 450,000 acre-feet (AF), it provides only a small amount of flood control storage and is generally maintained in a narrow reservoir elevation band between 1205.0 and 1208.0 ft msl. Due to the limited storage, releases from Gavins Point must be backed up with releases out of the upper reservoirs. 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 significant downstream flood control by coordinating Gavins Point release reductions with the upstream projects. Releases greater than the powerplant capacity, normally near 35,000 cfs, are passed through the spillway.

Table 10 lists the Gavins Point monthly inflows and releases in cfs and the EOM pool elevation in ft msl for 2011 and 2012 as well as the average monthly inflows and releases and EOM pool elevations since the System was first filled in 1967.

Table 10
Gavins Point – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2012	2011	1967-2012	2012	2011	1967-2012	2012	2011	1967-2012
January	21,800	18,400	17,400	21,900	18,500	17,100	1207.2	1207.2	1207.5
February	21,800	20,000	16,600	22,000	20,700	17,400	1206.5	1205.5	1205.7
March	23,600	21,500	19,700	23,900	21,000	19,700	1205.9	1206.5	1205.6
April	26,700	30,000	25,200	26,200	30,300	25,000	1206.6	1205.7	1205.8
May	27,900	57,000	29,000	28,000	56,300	28,800	1206.1	1206.5	1206.0
June	32,000	139,200*	32,400	31,700	139,000*	32,200	1206.3	1206.3	1206.2
July	34,300	159,800*	35,500	34,000	159,700*	35,100	1206.3	1205.8	1206.7
August	38,100	136,900*	37,400	37,800	136,200*	36,900	1206.4	1206.6	1207.3
September	38,800	82,500*	36,900	38,200	81,900*	36,600	1207.0	1207.3	1207.6
October	38,400	40,500	34,700	37,600	40,100	34,500	1208.0	1207.3	1207.8
November	34,400	40,200	31,100	34,200	40,100	31,100	1207.6	1207.0	1207.6
December	16,400	28,000	19,400	16,300	27,700	19,500	1207.7	1207.8	1207.4

*monthly maximum of record

b. Winter Season 2011-2012

The Gavins Point average daily release was reduced from 40,000 cfs in early December 2011 to approximately 22,000 cfs by mid-December. The Gavins Point average daily release was above the normal winter release rate in December 2011, January and February. Winter releases varied from 21,500 cfs to 22,100 cfs in January and from 21,800 cfs to 22,100 cfs in February. Gavins Point Reservoir froze over on January 13 and was free of ice on March 10.

c. Spring Open Water Season 2012

The March spring pulse from Gavins Point was not conducted in 2012. The 2011 flood event was unprecedented in both magnitude and duration along much of the Missouri River resulting in significant damage to the projects, levees and other infrastructure. During 2012 the Corps was still in the process of inspection, repair and restoration of this important infrastructure and all repairs were not completed prior to the start of the 2012 runoff season. The river experienced a natural rise of near historic proportions in 2011, therefore it was determined that the efforts of the Missouri River Recovery Program (MRRP) should be focused on capturing the impact of the historic flood event rather than monitoring and analyzing a much smaller managed spring pulse in 2012. Finally, based on discussions with the U.S. Fish and Wildlife Service (USFWS) regarding the aforementioned factors and the ongoing review of the Gavins Point bimodal spring pulse by the Independent Science Advisory Panel (ISAP), the future direction of the bimodal spring pulse from Gavins Point has not yet been determined.

Flow support for the 2012 navigation season began on March 23 at Sioux City, IA; March 25 at Omaha, NE; March 26 at Nebraska City, NE; March 28 at Kansas City, MO; and April 1 at the mouth of the Missouri River near St. Louis, MO. Based on the March 15 System storage check of 56.8 MAF, full navigation flow support was provided for the first half of the navigation season.

No cycling of Gavins Point releases were made in 2012. Cycling of releases has been conducted in previous years in early May to encourage the threatened and endangered (T&E) birds to nest on the higher elevation areas of downstream sandbars in the reach. This allows for future increases to support navigation. Cycling of releases has also been conducted in previous years as a drought conservation measure as well as a flood risk management measure. Starting in mid-May, Gavins Point releases of 28,000 cfs and above were needed to maintain the flow at the downstream navigation targets and therefore, the cycling was not necessary.

d. Summer Open Water Season 2012

Based on the July 1 System storage check of 57.6 MAF, full navigation flow support for a full length (8-month) season was provided. Persistent hot and dry conditions began impacting the lower basin by the start of the summer. In order to meet the Kansas City full service navigation flow target of 41,000 cfs, Gavins releases were increased to 35,000 cfs by the end of July and were as high as 38,500 cfs by mid-August.

From mid-July to early August supplemental flow support was provided by Tuttle Creek, Perry and Milford, NWK Kansas River projects, to minimize take of threatened and endangered species nesting below the mainstem dams. Additional information about this operation is provided in Section II.F.5 of this report.

e. Fall Open Water Season 2012

Based on the September 1 System storage of 54.3 MAF, minimum winter releases of 12,000 cfs from Gavins were dictated per rule curves outlined in the Master Manual. During September and October an extensive outreach effort with the downstream intake owners was conducted to verify critical river stages as they relate to keeping intakes operational. Based on feedback from intake owners, it was decided that MRBWM would reduce to winter releases more slowly than normal to determine if the Gavins Point minimum winter release of 12,000 cfs could be achieved while still keeping downstream intakes operational. Continued drought conditions in the lower basin reduced incremental inflows downstream of Gavins Point to extremely low levels. After reducing Gavins Point releases to 14,000 cfs, intake owners from Yankton, SD, Blair and Omaha, NE, Council Bluffs, IA and Kansas City, MO all indicated that further reductions would severely impact their respective intake operations. Thus, minimum winter releases from Gavins Point for the 2012-2013 winter season were 14,000 cfs.

f. Summary

The highest Gavins Point Reservoir level in 2012 was 1208.3 ft msl, reached on December 18. The lowest reservoir level during 2012 occurred on January 22, at 1204.6 ft msl. The 2012 average annual inflow to Gavins Point of 29,500 cfs was 105 percent of average (1967-2012). The 2012 average annual release from Gavins Point of 29,300 cfs was 105 percent of average (1967-2012).

D. <u>Non-Routine Regulation and Other Items Pertaining to System Regulation</u>

Numerous regulation activities are performed each year that, although at one time may have been considered unique, are now considered routine. These include release restrictions from a particular project for a period of time to permit hydrographic surveys, to facilitate limited construction within or adjacent to the downstream channel and to pattern releases to facilitate measurements of downstream discharges and water surface profiles. Events that occurred in connection with regulation activities during 2012 that may be considered unusual, or recently have come to the attention of MRBWM, are discussed in the following paragraphs.

1. Lawsuits

There were no lawsuits that impacted regulation of the System in 2012.

2. Fort Peck Spillway Assessment and Flow Test

During the week of September 3, 2012 a flow test was conducted using the Fort Peck spillway. The test was performed to determine whether a sub-drain system that relieves potential pressure beneath the spillway was functioning properly. The test included spillway releases ranging from 3,000 cfs to 30,000 cfs at periodic intervals over a 5-day period. During the test, powerplant releases were reduced to 3,000 cfs to lessen the downstream impacts. Hourly powerplant and spillway release are shown on ***Plate 3***.

The flow test was originally scheduled for June 2012, but stakeholder input noted that negative impacts to agricultural production and other activities along the river made a September test preferable. During the test period, stages at Wolf Point, MT increased as much as 3 feet and Culbertson, MT increased nearly 2 feet as shown on ***Plate 3***.

3. Gavins Point Spillway Assessment and Zero Release

Following the flood of 2011, preliminary assessments of Gavins Point indicated minor damage sustained to a number of areas on the spillway slab and the need for subsurface investigations into the foundation conditions underlying the slab. In order to properly evaluate the actual damage, Gavins Point releases were reduced to zero to dewater the uppermost portion of the spillway slab on May 9, 2012. In the early morning, releases from Gavins Point were reduced from 25,000 cfs to zero in increments of approximately 9,000 cfs per hour. Flows remained at zero for eight hours and were then stepped up over four hours to 28,000 cfs. The spillway assessment included the use of ground penetrating radar and other investigative methods. Hourly Gavins Point releases are shown on ***Plate 4***.

The Sioux City stage dropped approximately 2.7 feet as a result of the reduction in flows. The stage reduction lessened downstream with Omaha dropping 1.7 feet and Nebraska City dropping 1.0 foot. The Missouri River stage reductions were lessened due to increased tributary flows from the James, Vermillion and Big Sioux rivers near the time of the assessment, as shown on ***Plate 4***.

E. Reservoir Elevations and Storage

Reservoir elevations and storage contents of the System reservoirs at the end of July 2012 are presented in ***Table 11*** and the same information for the end of December 2012 is presented in ***Table 12***. The 12-month-change columns for the end of July indicate significant decreases in the elevations and respective storages in the Fort Peck, Garrison and Oahe reservoirs, with all three of the large storage reservoirs at or near the base of their respective Annual Flood Control and Multiple Use Zones. By the end of December, all three were well below their bases of Annual Flood Control and Multiple Use Zone.

Figure 10A and ***Figure 10B*** show the end-of-July pool elevations for Fort Peck, Garrison and Oahe plus total System end-of-July storage for 2011 and 2012. Individual tables with the historic maximum, average and minimum pool elevations for each reservoir are also shown. During the 2000-2007 drought, all three reservoirs experienced their historical minimum record pool levels: Garrison in 2005, Oahe in 2006 and Fort Peck in 2007. During 2011 Fort Peck, Oahe and Fort Randall experienced their historical maximum pool levels in addition to the System experiencing its maximum storage of 72.8 MAF.

Table 11
Reservoir Levels and Storages – July 31, 2012

Project	Reservoir Elevation		Reservoir Storage in 1,000 AF		
	Elevation (ft msl)	12-Month Change (ft)	Total	Above Min. Level*	12-Month Change
Fort Peck	2235.9	-10.7	15,191	11,103	-2,443
Garrison	1837.3	-14.3	18,018	13,308	-4,902
Oahe	1603.9	-13.6	17,766	12,393	-4,471
Big Bend	1420.1	+0.6	1,629	8	+38
Fort Randall	1354.5	-14.8	3,486	1,969	-1,364
Gavins Point	1206.3	+0.5	350	43	+11

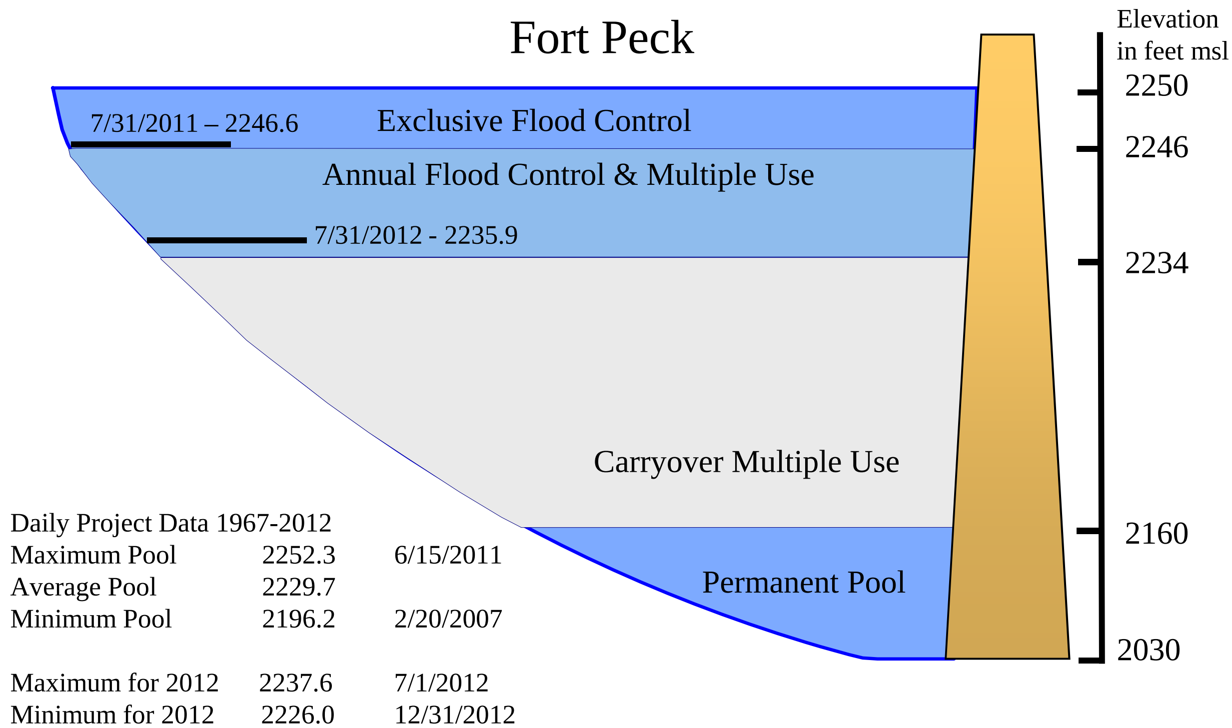
*Net usable storage above minimum reservoir levels established for power, recreation, irrigation diversions and other purposes.

Table 12
Reservoir Levels and Storages – December 31, 2012

Project	Reservoir Elevation		Reservoir Storage in 1,000 AF		
	Elevation (ft msl)	12-Month Change (ft)	Total	Above Min. Level*	12-Month Change
Fort Peck	2226.0	-10.2	13,192	9,104	-2,063
Garrison	1829.5	-10.0	15,762	10,782	-2,876
Oahe	1593.5	-13.3	14,907	9,534	-3,608
Big Bend	1420.8	+0.4	1,666	45	+30
Fort Randall	1340.0	+1.7	2,440	923	+117
Gavins Point	1207.7	-0.1	384	77	-1

*Net usable storage above minimum reservoir levels established for power, recreation, irrigation diversions and other purposes.

Missouri River System Reservoirs
End-of-July Pool Elevations and Total System Storage



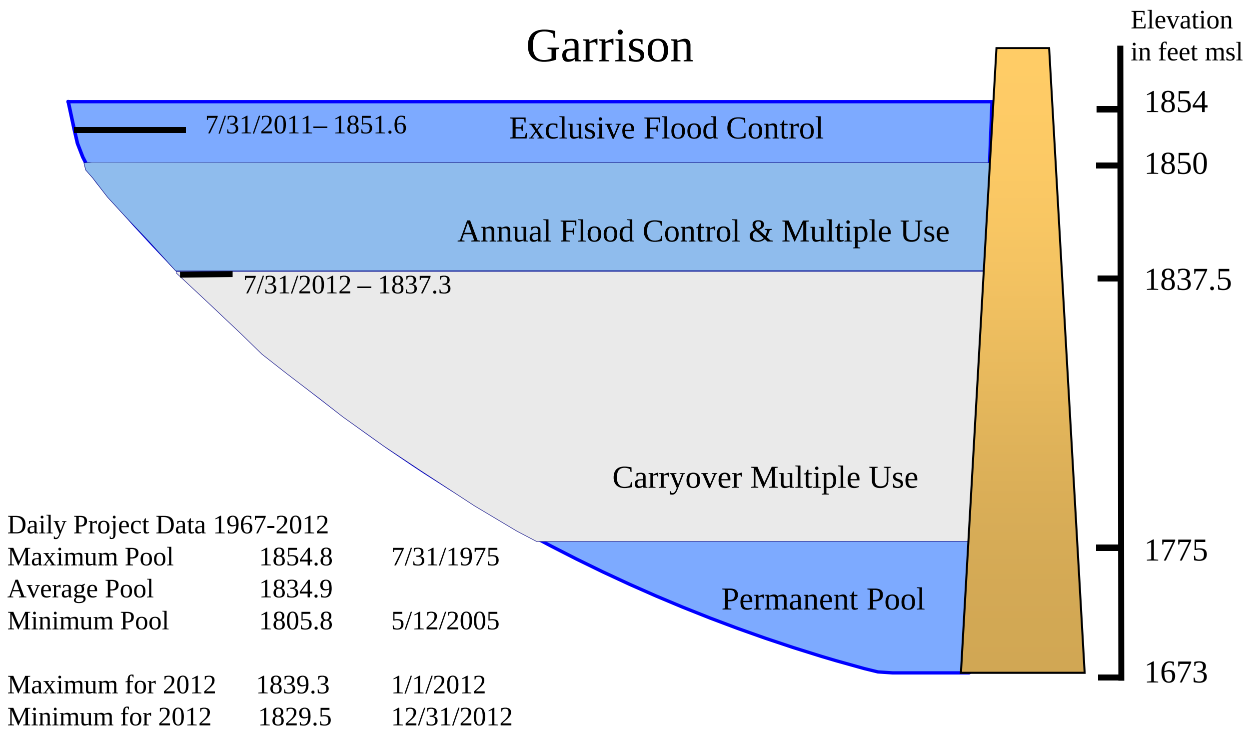
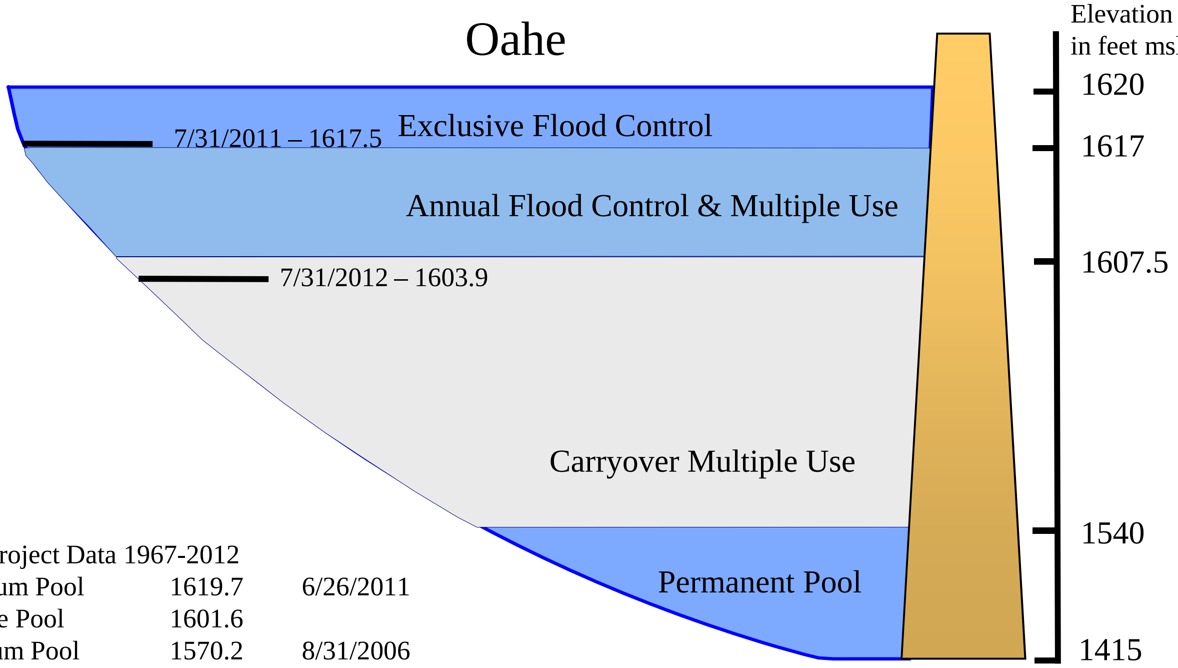


Figure 10A. End of July pool elevations for Fort Peck and Garrison.

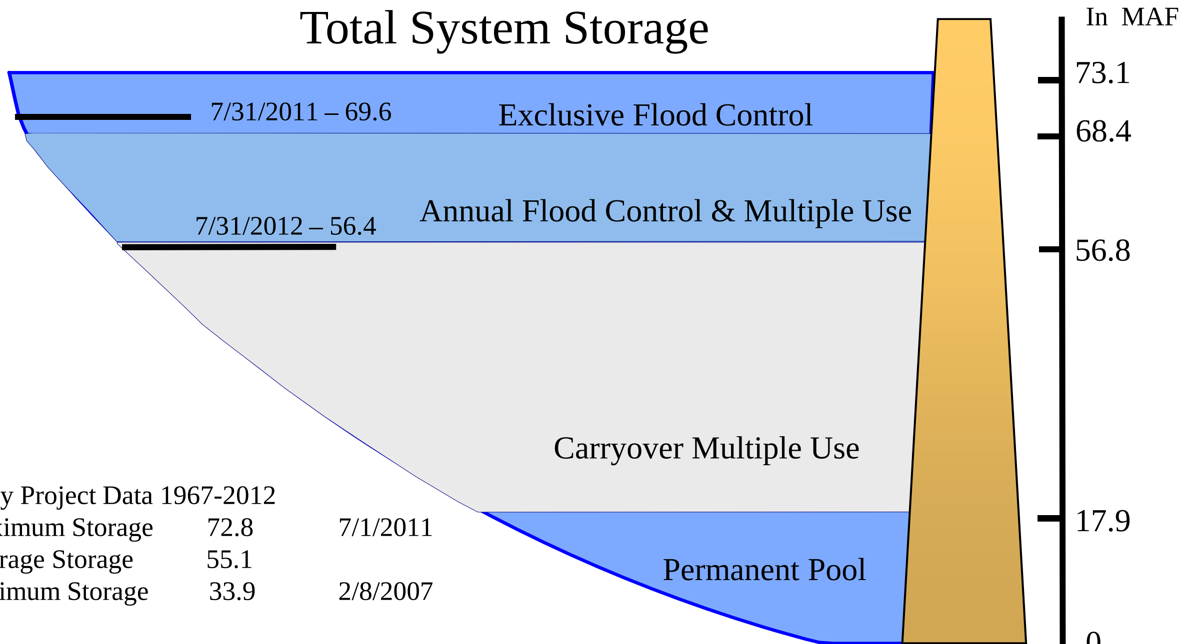
Missouri River System Reservoirs
End-of-July Pool Elevations and Total System Storage

Oahe



Daily Project Data 1967-2012		
Maximum Pool	1619.7	6/26/2011
Average Pool	1601.6	
Minimum Pool	1570.2	8/31/2006
Maximum for 2012	1607.5	5/10/2012
Minimum for 2012	1593.3	11/30/2012

Total System Storage



Daily Project Data 1967-2012		
Maximum Storage	72.8	7/1/2011
Average Storage	55.1	
Minimum Storage	33.9	2/8/2007
Maximum for 2012	57.6	6/30/2012
Minimum for 2012	48.4	12/31/2012

Figure 10B. End of July pool elevation for Oahe and Total System Storage.

F. <u>Summary of Results</u>

1. Flood Control

Following the record runoff and record releases in 2011 and as outlined in the 2011-2012 Annual Operating Plan (AOP), a more flexible posture was taken as water was evacuated during the fall of 2011 and early winter of 2012. If it appeared that 2012 would be another high runoff year, the Corps agreed to aggressively release water during the winter and spring as weather permitted and repair work allowed. This "flexible and aggressive" strategy was implemented during the winter and created 0.7 MAF of additional flood control storage space. As the 2012 runoff season unfolded it became evident that the basin was being impacted by an absence of runoff, rather than an excess of runoff.

The estimated total flood damages prevented by all the Corps controlled reservoir projects in the basin during 2012 were estimated to exceed $58.1 million ($54.3 million Omaha District; $3.8 million Kansas City District). As shown in ***Figure 11A***, the estimated total flood damages prevented by the System alone during 2012 were $48.5 million ($46.8 million Omaha District; $1.7 million Kansas City District). The un-indexed flood damages prevented by the System since its construction now total $32.7 billion, the bulk of which were prevented during the 7-year period from 1993 to 1999 and the 4-year period of 2008 and 2011 (see ***Figure 11B***). ***Figure 11A*** indicates the flood damages prevented indexed to 2012. For comparison purposes, the ***Figure 11A*** and ***Figure 11B*** include the construction cost of the dams.

Figure 12 shows the 2012 regulated (actual experienced) and unregulated (with no System reservoirs and tributary reservoirs upstream from them) Missouri River flows at Omaha, NE; Nebraska City, NE and Kansas City, MO.

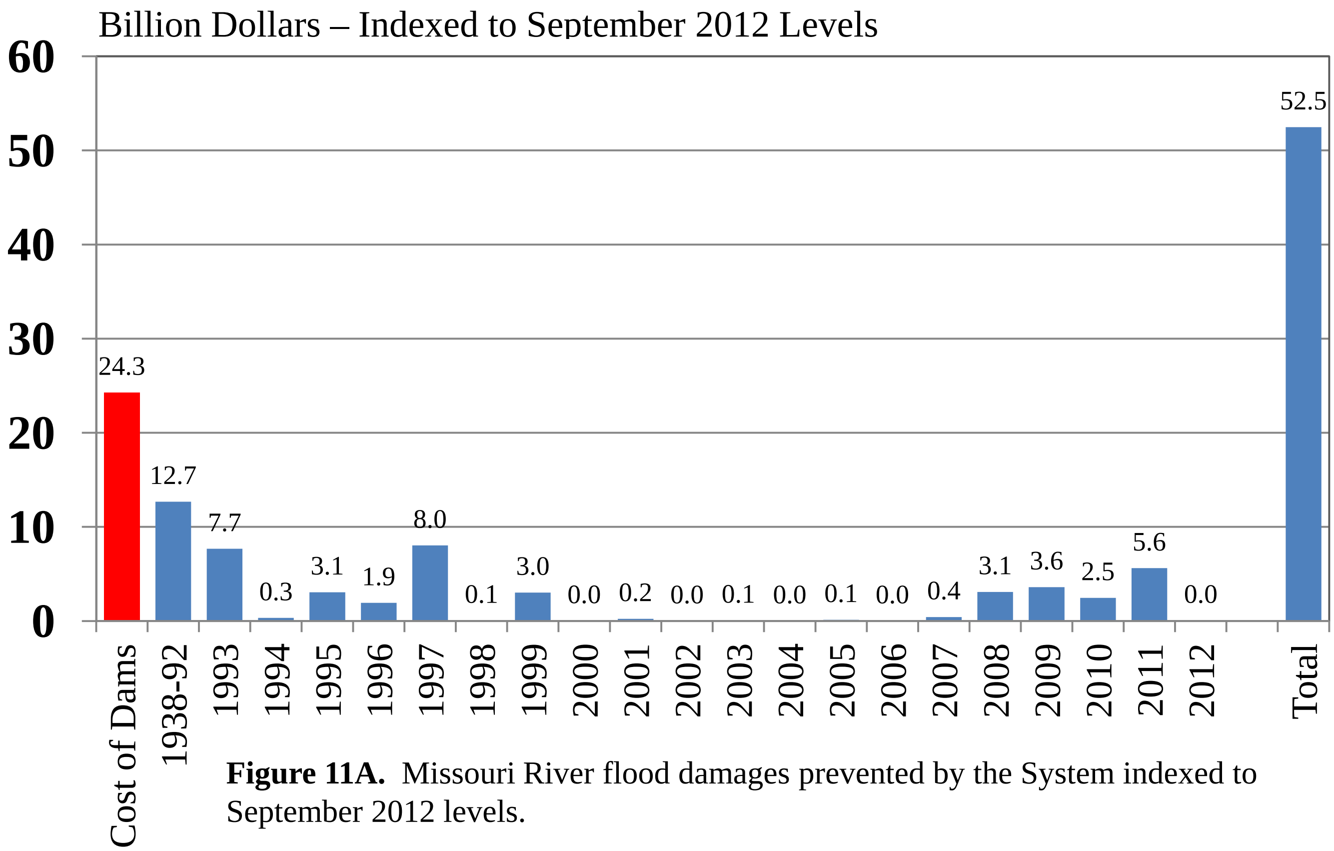


Figure 11A. Missouri River flood damages prevented by the System indexed to September 2012 levels.

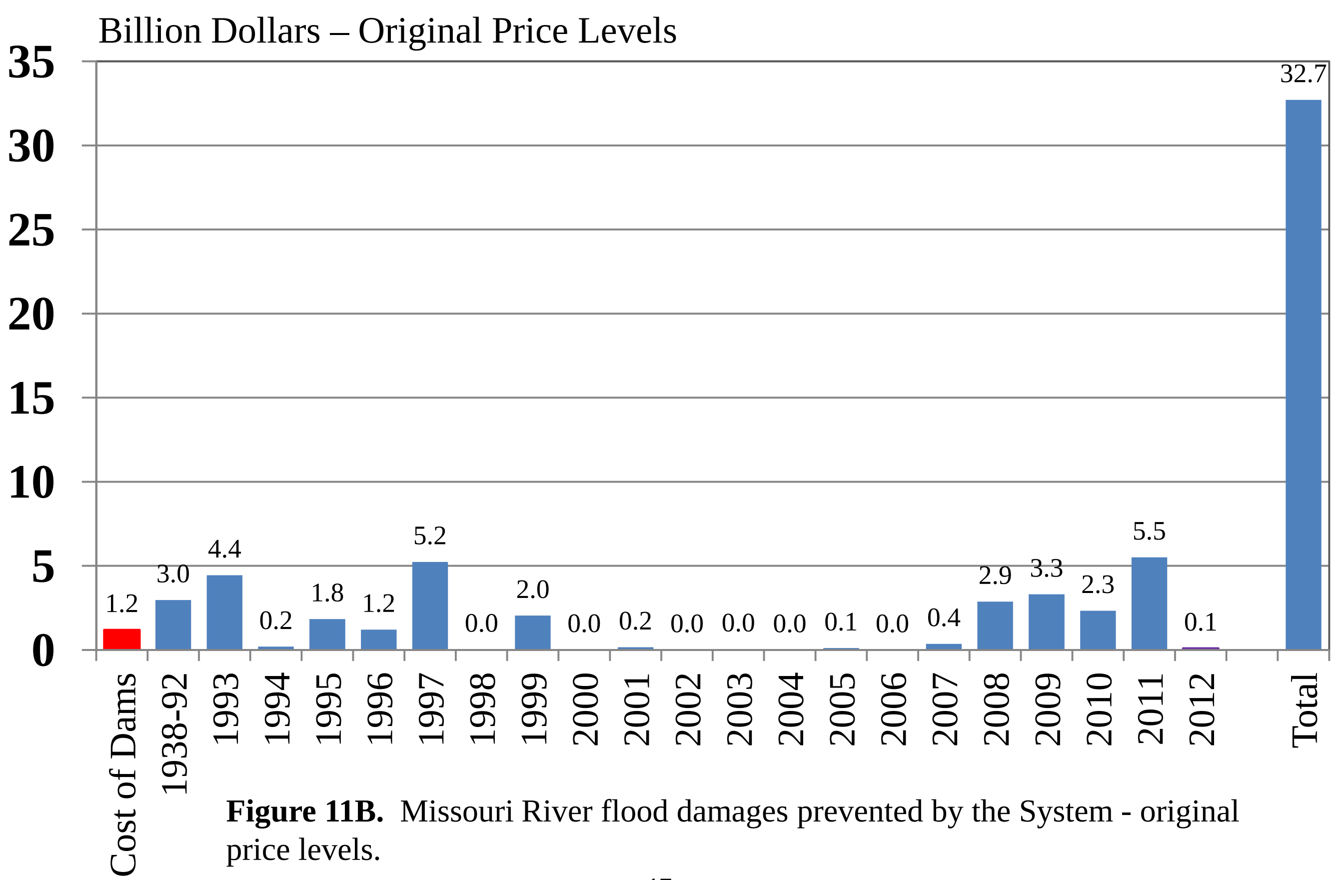


Figure 11B. Missouri River flood damages prevented by the System - original price levels.

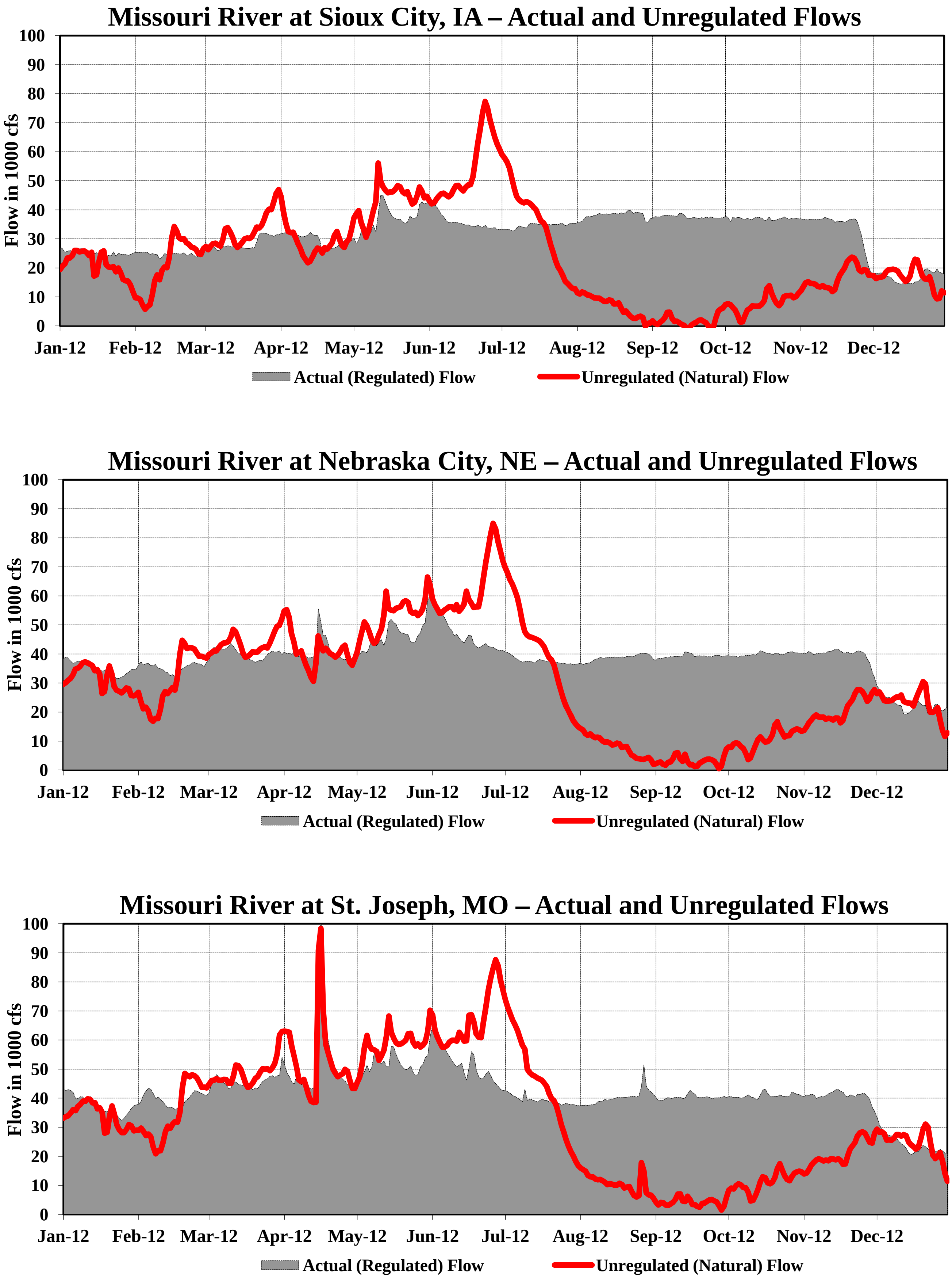


Figure 12. Actual and unregulated flows – Sioux City, IA, Nebraska City, NE and St. Joseph, MO.

2. Irrigation

Federally developed irrigation projects are not being served directly from the System reservoirs. The reservoirs, however, are being utilized by numerous private irrigators as well as Federally financed projects that take water from the Missouri River. About 900 private irrigators pump directly from the reservoirs or river reaches.

3. Water Supply

Problems at municipal and industrial (M&I) intakes located in the river reaches and System reservoirs are related primarily to intake or river access problems rather than inadequate water supply. Intake owners today are generally better prepared to handle periods of low water with adjustments to intakes or regulation procedures. Some of these adjustments involve using warm water to keep ice formation from building up on intake screens, installing new pumps, lowering intakes, installing sediment redirection vanes and ice deflectors, obtaining, or arranging to obtain, alternate sources of water, and cleaning screens more thoroughly and frequently. While these remedial actions are expensive to install and operate, they significantly improved the ability of the intakes to operate at lower river stages and reservoir levels.

Due to the historic releases in 2011, stretches of the Missouri River experienced significant channel degradation. The September 1 storage check called for minimum winter System releases of 12,000 cfs. After significant coordination with the intake owners and operators, it was determined that winter releases for 2012 would be set at 14,000 cfs rather than 12,000 cfs. All intake owners and operators were advised to take necessary action during 2013 so that their intakes are operational in subsequent years for the minimum release rate of 12,000 cfs.

4. Water Quality Control

a. Overview

During 2012 Omaha District conducted long-term, fixed-station ambient water quality monitoring at the System reservoirs and on the lower Missouri River. Water quality conditions of the water discharged through each of the System dams was continuously monitored. An intensive water quality survey of the lower Missouri River was continued and conducted jointly with the Kansas City District and extended from Gavins Point Dam to the river's mouth at St. Louis, Missouri. More detailed water quality monitoring information is available via the Omaha District water quality annual reports.

The Omaha District has identified eight priority water quality issues that have relevance to the System projects. These identified priority issues are:

1. Determine how regulation of the System affects water quality in the impounded reservoir and downstream river reaches. Utilize the CE-QUAL-W2 hydrodynamic and water quality model to facilitate this effort.
2. Evaluate how eutrophication is progressing in the System reservoirs, especially regarding the expansion of anoxic conditions in the hypolimnion during summer stratification.
3. Determine how flow regimes, especially the release of water from System projects, affects water quality in the Missouri River.
4. Determine how current water quality conditions in the Missouri River (e.g. water temperature, turbidity) may be affecting pallid sturgeon populations in the Missouri River.
5. Provide water quality information to support Corps reservoir regulation elements for effective surface water quality and aquatic habitat management.
6. Provide water quality information and technical support to the Tribes and States in the development of their Section 303(d) lists and development and implementation of total maximum daily loads (TMDLs) at Omaha District tributary projects.
7. Identify existing and potential surface water quality problems at Omaha District projects and develop and implement appropriate solutions.
8. Evaluate surface water quality conditions and trends at Omaha District projects.

Table 11 provides a summary of water quality issues and concerns at each of the System projects based on Omaha District monitoring and a review of current State integrated water quality reports.

b. Occurrence of "Two-Story" Fisheries at System Reservoirs

The Fort Peck, Garrison, and Oahe reservoirs maintain "two-story" fisheries that are comprised of warmwater and coldwater species. The ability of the reservoirs to maintain "two-story" fisheries is due to their thermal stratification in the summer that allows coldwater habitat to be maintained in the deeper, colder region of the reservoir (i.e. hypolimnion). Warmwater species inhabit the warmer, shallower areas of the reservoirs (i.e. epilimnion), while coldwater species inhabit the colder, deeper areas of the reservoirs. Coldwater fish species also provide forage that is used extensively by both the coldwater and warmwater fish species. These

Table 13
Water Quality Issues and Concerns

Project	TMDL Considerations*				Fish Consumption Advisories		Other Potential Water Quality Concerns
	On 303(d) List	Impaired Uses	Pollutant/Stressor	TMDL Completed	Advisory in Effect	Identified Contamination	
Fort Peck • Fort Peck Lake	Yes (MT)	Drinking Water Supply Recreation	Lead Mercury Aquatic Plants - Native	No NA**	Yes	Mercury	---
• Missouri River, Fort Peck Dam to the Milk River	Yes (MT)	Aquatic Life Cold Water Fishery	Water Temperature Degraded riparian vegetation Other flow regime alterations	No NA**	No	---	---
• Missouri River, Milk River to the Poplar River	Yes (MT)	Aquatic Life Warm Water Fishery	Water Temperature Degraded riparian vegetation Other flow regime alterations	No NA**	No	---	---
• Missouri River, Poplar River to North Dakota	Yes (MT)	Aquatic Life Warm Water Fishery	Water Temperature Other flow regime alterations	No NA**	No	---	---
Garrison • Lake Sakakawea	Yes (ND)***	Fish Consumption	Methyl-Mercury	No	Yes	Mercury	Coldwater fishery during drought conditions Hypolimnetic dissolved oxygen levels
• Missouri River, Garrison Dam to Lake Oahe	No	---	---	---	Yes	Mercury	Low dissolved oxygen in Garrison Dam tailwaters (associated with late summer hypolimnetic lake withdrawals)
Oahe • Lake Oahe	No	---	---	---	Yes	Mercury	Fish consumption advisory issued by the Cheyenne River Sioux Tribe for Lake Oahe within their tribal lands.
Big Bend • Lake Sharpe	Yes	Coldwater Permanent Fish Life	Temperature	No	No	---	TMDL completed for sediment. A nonpoint source management project is being implemented in the Bad River watershed.
Fort Randall • Lake Francis Case	No	---	---	---	No	---	Low dissolved oxygen in Fort Randall Dam tailwaters (associated with late summer hypolimnetic reservoir withdrawals)
• Missouri River, Fort Randall Dam to Lewis and Clark Lake	No	---	---	---	No	---	---
Gavins Point • Lewis and Clark Lake	Yes	Aquatic Life	Nutrients (Total Phosphorus and Total Nitrogen)	No	No	---	Sedimentation Emergent aquatic vegetation
• Missouri River, Gavins Point Dam to the Big Sioux River	No	---	---	---	No	---	Reduced suspended sediment and turbidity impacts to pallid sturgeon. Assimilative capacity and flow reduction
• Missouri River, Big Sioux River to Platte River	Yes (NE)	Aquatic Life	Cancer Risk and Hazard Index Compounds (Primarily PCBs and Dieldrin)	No	Yes	Dieldrin PCBs	Reduced suspended sediment and turbidity impacts to pallid sturgeon. Assimilative capacity and flow reduction
• Missouri River, Boyer River to Council Bluffs water supply intake	Yes (IA)	Drinking Water	Arsenic	No	No	---	---
• Missouri River, Platte River (NE) to Kansas	Yes (NE)	Recreation Aquatic Life	*E. coli* Cancer Risk and Hazard Index Compounds (Primarily PCBs and Dieldrin)	Yes (*E. coli*)	Yes	Dieldrin PCBs	Reduced suspended sediment and turbidity impacts to pallid sturgeon. Assimilative capacity and flow reduction

* Information taken from published state Total Maximum Daily Load (TMDL) 303(d) reports and listings as of January 1, 2011.
** Impairment identified in Montana's integrated report, but not on 303(d) list for development of a TMDL.
*** Was delisted in 2010 for impairment to Fish and other Aquatic Biota (water temperature and low dissolved oxygen) when Lake Sakakawea pool elevations recovered from drought conditions.

coldwater forage species include the rainbow smelt (*Osmerus mordax*) in Oahe and Garrison and lake cisco (*Coregonus artedi*) in Fort Peck. Maintaining healthy populations of these coldwater forage fish is important to maintaining both the coldwater and warmwater recreational fisheries in the three reservoirs.

c. Bottom Withdrawal Reservoirs

Bottom withdrawal reservoirs have outlet structures located near the deepest part of the reservoir. During the summer thermal stratification period, bottom withdrawal releases cold water from the deep portion of the reservoir that may be hypoxic during periods of stratification. Hypoxic conditions in the hypolimnion can result in the release of water with low dissolved oxygen and high levels of nutrients. Bottom outlets can cause density interflows or underflows through the reservoir and generally provide little or no direct control over the quality of the water released through the bottom withdrawal. Garrison and Fort Randall are bottom withdrawal reservoirs with both their power and flood tunnels drawing water from the bottom of the impounded reservoirs. Fort Peck Reservoir has a near-bottom withdrawal (i.e. 60 feet above the reservoir bottom) for the power and flood tunnels. The power tunnels at Oahe draw water at a mid-depth (i.e. 114 feet above the reservoir bottom); however, the flood tunnels draw water from the bottom of the reservoir. The Big Bend and Gavins Point powerplants both draw water from the bottom of the reservoir, however these are shallower, run-of-the-river reservoirs and water drawn into the powerplants is usually fairly well-mixed through the reservoir water column.

d. Fort Peck Reservoir

Fort Peck is not assigned a coldwater fishery use by the State of Montana in their water quality standards. However, the reservoir supports a stocked put-grow-take salmon fishery and a naturally reproducing lake trout and lake cisco fishery; all are considered coldwater species. Since a coldwater fishery is currently supported in Fort Peck, it is seemingly an existing use and is to be protected pursuant to the Federal Clean Water Act and anti-degradation policy provisions (40 CFR 131.3).

Dissolved oxygen concentrations below Montana's 5 mg/l 7-day mean minimum water quality standard were monitored at the Fort Peck powerplant for the first time in 2012. A Special Water Quality Study was conducted in 2012 to evaluate the situation. When monitored on September 25, the area immediately downstream of the dam to just beyond the energy dissipation structures was below 5 mg/l dissolved oxygen, while the area from just downstream of the energy dissipation structures through the dredge cuts area was just above 5 mg/l. The situation will continued to be evaluated to determine if corrective measures to meet Montana water quality standards may be needed.

e. Garrison Reservoir

The State of North Dakota's water quality standards protect Garrison for Coldwater Permanent Fish Life Propagation (CPFLP) use (i.e. coldwater fishery). As such, a water temperature criterion of ≤ 57 degrees F (or 15 degrees C), a dissolved oxygen criterion of ≥ 5 mg/l and a minimum volume of 500,000 AF meeting those criteria have been promulgated by North Dakota to protect the coldwater fishery of Garrison.

Water temperature and dissolved oxygen depth profiles that were measured during water quality monitoring conducted at Garrison over the 10-year period 2003 through 2012 were used to estimate the volume of water in the reservoir that meets the coldwater habitat conditions defined by the State of North Dakota. ***Plate 3*** and ***Plate 4*** show estimated reservoir and coldwater habitat volumes, by year, for 2003 through 2012. Water quality monitoring in 2012 indicates that North Dakota's 500,000-AF minimum water quality standards criterion for coldwater habitat was seemingly not met.

Dissolved oxygen concentrations below North Dakota's 5 mg/l water quality standard have been monitored in late summer at the Garrison powerplant. To date, there is no evidence of current or past fish kills in Garrison tailwaters. A Special Water Quality Study of the situation is being considered, and the situation will continue to be evaluated to determine if corrective measures to meet North Dakota's water quality standards may be needed.

f. Oahe Reservoir

South Dakota's water quality standards protect Oahe for CPFLP use. As such, a water temperature criterion of ≤ 65 degrees F (or 18.3 degrees C) and a dissolved oxygen criterion of ≥ 6 mg/l have been promulgated by South Dakota to protect the coldwater fishery of Oahe.

The occurrence of coldwater fishery habitat (i.e. water temperature ≤ 18.3 degrees C and dissolved oxygen ≥ 6 mg/l) in Oahe was estimated from water quality monitoring conducted over the 8-year period 2005 through 2012. ***Plate 5*** shows estimated summer reservoir and coldwater habitat volumes, by year, for 2005 through 2012. At least 1 MAF of coldwater fishery habitat was present in Oahe for all years except 2011. The record releases made from Oahe during 2011 significantly reduced residence time of the water in storage. The lowered residence time was a function of the high releases "flushing" the water through the reservoir and appears to have resulted in greater dissolved oxygen degradation in the hypolimnion as hypoxic water was drawn from the upstream reaches of the reservoir downstream to the dam. This situation was exacerbated by the extensive use of the bottom-withdrawal flood tunnels, which tended to pull water along the bottom of the reservoir.

g. Big Bend Reservoir

The State of South Dakota classifies Big Bend for CPFLP use and currently lists the designated coldwater fishery as impaired due to warm water temperatures. However, during the next triennial water quality standards review, South Dakota may pursue reclassification of Big Bend from a coldwater fishery to a warmwater fishery based on a use attainability assessment of "natural conditions" (personal communication with South Dakota Department of Environment and Natural Resources). Natural summer water temperatures of the Oahe powerplant discharge, especially during lower pool levels, did not meet the temperature requirements for a coldwater fishery use and allow for the support of coldwater fishery habitat in Big Bend during the summer.

h. Fort Randall Reservoir

Hypoxic water is passed through Fort Randall during power production in the summer and dissolved oxygen levels in Fort Randall tailwaters fall below South Dakota’s water quality standards’ minimum dissolved oxygen criterion of 6 mg/l. The low dissolved oxygen levels in the tailwaters are not seemingly impairing the designated Warmwater Permanent Fish Life Propagation (WPFLP) beneficial use as regions of refugia exist in the impacted area, and there is no evidence of current or past summer fish kills in the tailwaters attributable to hypoxic conditions. If warranted, dissolved oxygen conditions in Fort Randall tailwaters, during periods of hypoxic dam releases, could be mitigated by spilling surface water with higher dissolved oxygen concentrations down the spillway. The situation will continued to be evaluated to determine if corrective measures to meet South Dakota’s water quality standards may be needed.

5. Navigation

a. Barge Traffic

The first towboats using the Missouri River in 2012 were the Motor Vessel (*MV) Jamie Leigh*, with an assistant towboat *MV Halle Kate.* Both vessels are owned by Jefferson City River Terminal, which is located at Jefferson City, MO at river mile (RM) 143. The vessels left the terminal on January 31 with two empty barges headed to a Mississippi River cement terminal near St. Louis, MO. On February 1 the vessels returned to the Missouri River with two loaded cement barges destined for Jefferson City, MO. On March 31 the *MV Mary Lynn*, pushing six barges loaded with fertilizer and operated by Hermann Sand and Gravel, was the first towboat to arrive at the AgriServices Terminal, Brunswick, MO (RM 256). On April 15 the *MV Mary Lynn*, pushing three fertilizer-loaded barges, made a second trip passing Kansas City, MO (RM 367) and arrived at Nebraska City, NE (RM 462).

There were three special "high value" product barge moves during 2012: two moves involved powerplant equipment barges and the other move involved three barges loaded with prefabricated bridge steel. The *MV Claude*, owned by McDonough Marine, brought one barge hauling four transformers to the Ameren Calloway plant and arrived on August 15, off-loading at RM 115. The *MV Mary Lynn* transported one barge of four transformers for Nebraska Public Power District's (NPPD) Cooper Nuclear Power Plant. The barge was delivered on June 15 and off-loaded at Brownville, NE (RM 535). The *MV Mary Lynn* brought up two barges of prefabricated bridge steel, arriving at RM 596 on November 20. The *MV Atlas*, owned by Gateway Dredging and Contracting, in tow with the *MV Kathryn Ann*, owned by Hermann Sand and Gravel, brought the third steel barge to RM 471.5 where they met the *MV Mary Lynn*. The *MV Mary Lynn* and *MV Atlas* then proceeded upstream to RM 596 and delivered the third barge arriving on November 23. The estimated total value on the barges for all of these deliveries was $50 million.

Per the March 15 and July 1 storage checks, the reservoir system had adequate storage to provide for full service navigation flow support with a full 8-month season. The four downstream navigation flow targets were met or exceeded flow support all season. However, downstream of Kansas City, the last target location, the tributary basins that provide incremental flow to the river were in extreme drought conditions. The river channel was designed to provide the 9-foot by 300-foot authorized channel with the help of normal tributary inflows. Due to the dry conditions in the lower basin, extreme low water conditions plagued the downstream 200 miles of the navigation channel all season. The result was multiple groundings, stoppages and delays at several river mile locations: RM 178, 60, 41, 35 and 23. At RM 178 a Missouri River Recovery Program (MRRP) side channel chute sill was damaged during the 2011 flood. Early in the navigation season several tows were delayed at this location due to channel shoaling. With the support of the Corps' NWK Napoleon field office reconnaissance and sill repairs, the channel conditions improved. At RM 41, groundings occurred throughout the month of August. From August 29 to September 17 the Corps field office conducted emergency dredging at this location to assist commercial navigation. On a totally voluntary basis and using their permit, Gateway Dredging Company did conduct sand and gravel mining operations at RM 41 for their own purposes.

The *MV Jamie Leigh* was the last towboat to use the river during the calendar year. On December 3, after flow support for navigation had ceased, the vessel entered the river with four loads of cement destined for Jefferson City, MO. The *MV Jamie Leigh* was temporarily grounded and stopped from proceeding at RM 34.5 by a channel shoal. The company decided to tie up at RM 28 in a standby status and wait for more favorable channel conditions to finish the trip. There were no tows with a Sioux City, IA (RM 735); Blair, NE (RM 648); or Omaha, NE (RM 616) destination during 2012. The farthest upstream move was to move the bridge steel to RM 596.

b. Tonnage

Table 14 shows the Missouri River tonnage data for 2008 – 2011 compiled by the Waterborne Commerce Statistics Center (WCSC). The 2011 total of 3,832 thousand tons includes 3,548 thousand tons for sand and gravel, 77 thousand tons for waterways materials and 230 thousand tons for long-haul commercial tonnage. In 2011 the total commercial tonnage decreased by almost a million tons compared to 2010. The 2011 long-haul tonnage of 230 thousand tons decreased by 150 thousand tons from 2010. As outlined in the Summary of Actual 2011 Regulation, the Missouri River Flood of 2011 impacted the total tonnage and the long haul tonnage as portions of the river were closed for several months to all vessel traffic by the Coast Guard to protect levee integrity. The largest total tonnage year was 2001 at 9,730 thousand tons. The largest long-haul commercial tonnage, excluding sand, gravel and waterway material, occurred in 1977 at 3,340 thousand tons. ***Figure 13A*** shows total navigation tonnage on the Missouri River. Total tonnage for 2011 is final; the total 2012 tonnage is estimated. ***Figure 13B*** shows the long-haul commercial navigation tonnage not including sand, gravel and waterway materials. The Missouri River long-haul commercial tonnage in 2011 is final. The long-haul commercial tonnage in 2012 is currently estimated to total about 350 thousand tons, based on carrier interviews, towboat activity and barge counts from the Corps' daily boat reports. ***Figure 14A*** shows the navigation tonnage value of the commodities since 1960, using 2013 present-worth computations. ***Figure 14B*** shows the navigation tonnage value of long-haul commercial commodities since 1960. The ***Figures 13A***, ***13B***, ***14A*** and ***14B*** tonnages and tonnage values for 2012 are estimates and will change once final WCSC tabulations are available.

Navigation season target flows for past years are given in ***Table 15***. ***Table 16*** shows the scheduled lengths of past System-supported navigation seasons, with total tonnage and ton-miles for each year.

c. Kansas River Projects

From mid-July to early August supplemental flow support was provided by three of the NWK Kansas River projects: Tuttle Creek, Perry and Milford, as noted in ***Table 17***. Storage in each of these three projects is authorized to be used to supplement Missouri River navigation either: (1) as a drought conservation measure to minimize impact on the mainstem reservoirs or (2) as a measure to minimize take of endangered species nesting below the mainstem dams. According to the agreement with the State of Kansas, the Corps can use 3 feet of storage (from

Table 14
Missouri River Tonnage by Commodity (1000 Tons)

Commodity Classification Group	2008	2009	2010	2011
Farm Products	0	18	35	21
Corn	0	4	13	6
Wheat	0	0	0	0
Soybeans	0	14	23	15
Misc Farm Product	0	0	0	0
Nonmetallic Minerals	5415	4666	4388	3588
Sand/Gravel	5415	4649	4346	3548
Misc Nonmetallic	0	17	42	39
Food and Kindred	16	32	36	0
Pulp and Paper	0	0	0	0
Chemicals	5	26	72	49
Fertilizer	4	24	70	49
Other Chemicals	1	2	1	0
Petroleum (including coke)	87	120	118	44
Stone/Clay/Glass	55	57	76	77
Primary Metals	0	0	0	0
Waterway Materials	81	117	105	53
Other	12	0	0	0
Total Commercial	5671	5036	4831	3832
Total Long-Haul Commercial	175	270	380	230

the base of flood control zone) out of each reservoir prior to October 1 and an additional 3 feet thereafter. During 2012, the Kansas River project storage was used to meet navigation targets solely as a measure to minimize take. Several low elevation nests below Gavin Point would have been inundated with additional releases that were needed to meet the Kansas City navigation target. By mid-August the eggs had hatched, the chicks were able to move themselves to higher ground and all downstream navigation targets were met with releases from the mainstem projects. The pool drawdown from Milford, Tuttle Creek and Perry was 2.9, 2.9 and 2.6 feet, respectively.

Figure 15 presents discharge data at Sioux City, IA; Nebraska City, NE; and Kansas City, MO, three of the four navigation target locations for 2012. The navigation target at Sioux City was missed during a portion of April, however, there was no commercial navigation occurring in that reach at that time. ***Figure 16*** presents the same information as ***Figure 15*** but focuses on a smaller flow range during the 8-month navigation season to better depict the Kansas River project flow support as well as the lack of incremental runoff at each of these locations from July to November.

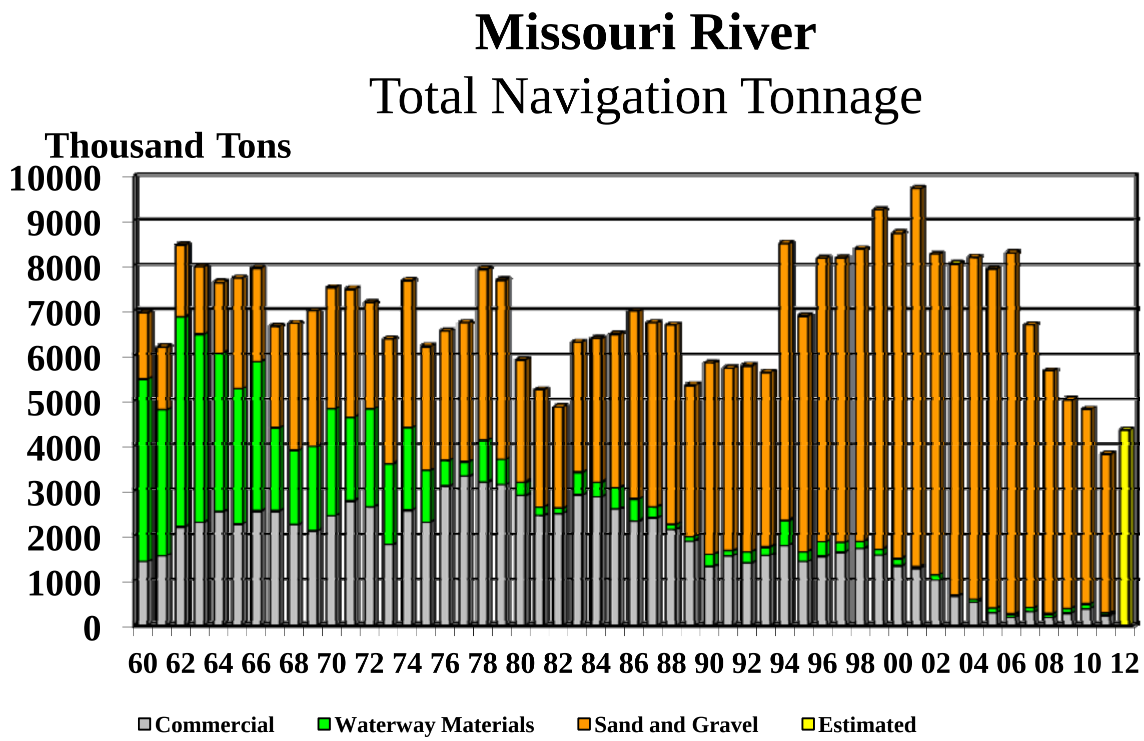


Figure 13A. Missouri River total navigation tonnage from 1960 to 2012 (estimated)

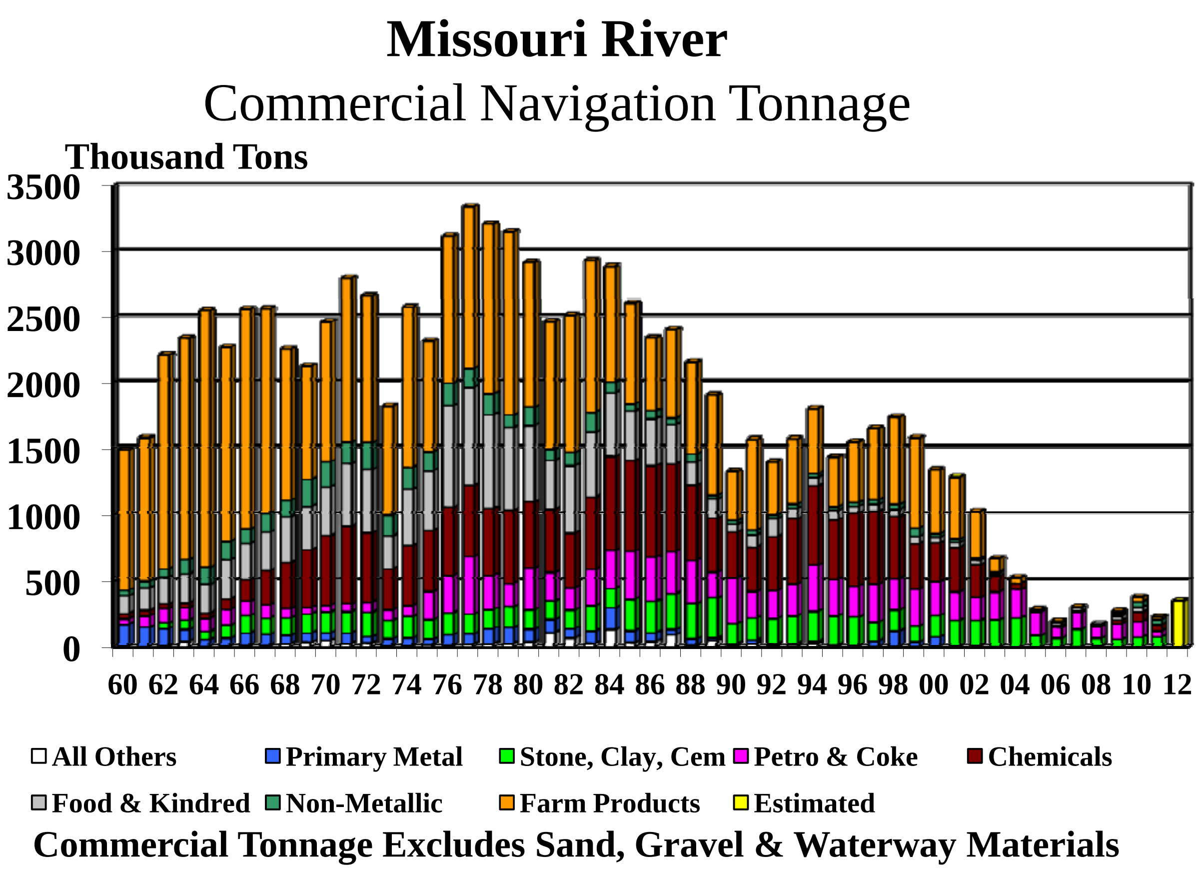


Figure 13B. Missouri River commercial navigation tonnage from 1960 to 2012 (estimated)

Missouri River

Total Navigation Tonnage Value - 2013 Present Worth

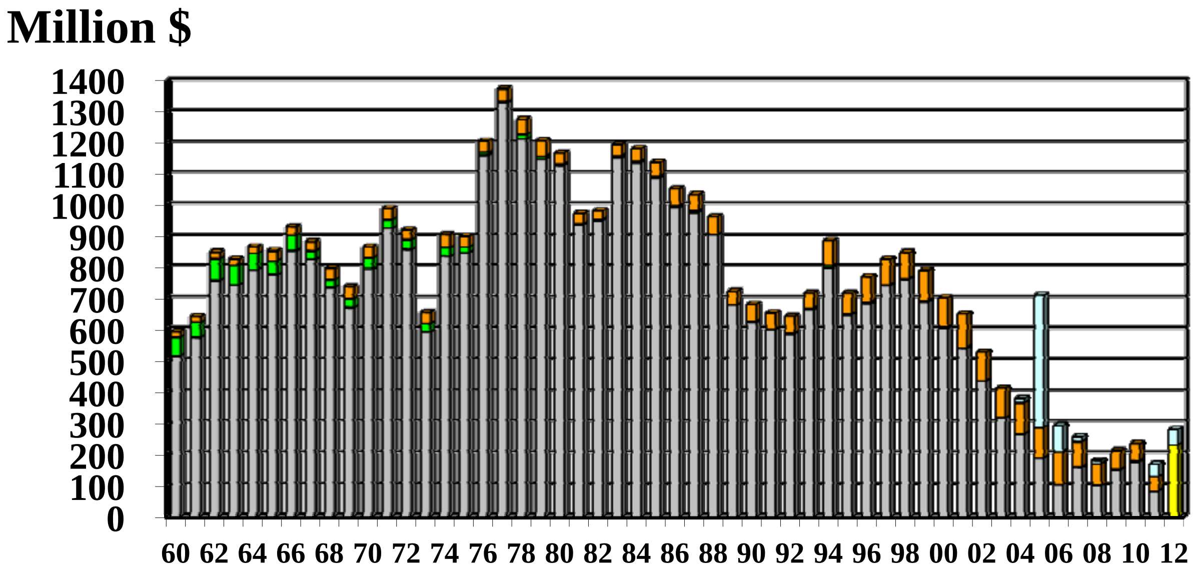
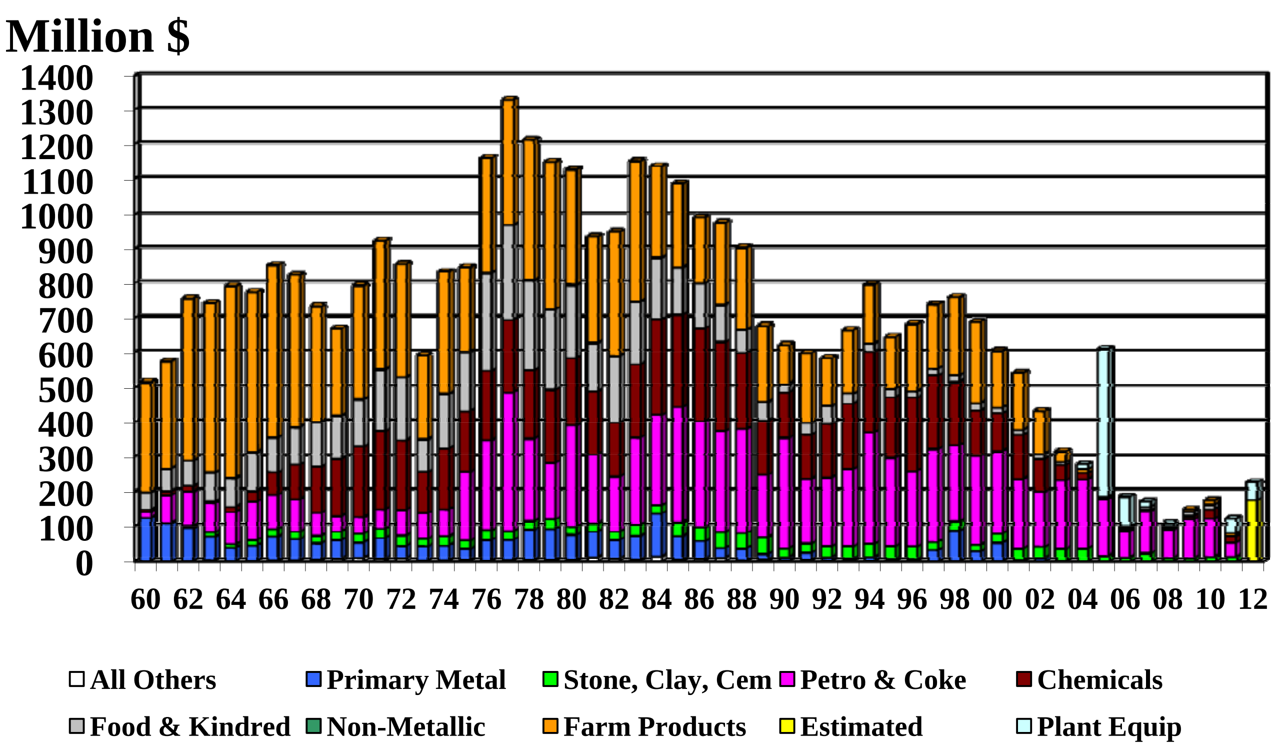


Figure 14A. Total navigation tonnage value using 2013 present worth computations

Missouri River

Commercial Navigation Tonnage Value - 2013 Present Worth



Commercial Value Excludes Sand, Gravel and Waterway Materials

Figure 14B. Commercial navigation tonnage value using 2013 present worth computations

Table 15
Navigation Season Target Flows
(1000 cfs)

Year	Months	Sioux City	Omaha	Nebraska City	Kansas City
1967	Apr-Jun	28	28	34	38
	Jul-Nov	31	31	37	41
1968	Apr-Nov	31	31	37	41
1969	Apr-Jun(1)	35-40	35-40	41-46	45-50
	Jul(1)	36	36	42	46
	Aug-Sep(1)	50-55	50-55	55-60	55-60
	Oct-Nov(1)	40-45	40-45	45-50	50-55
1970	Apr-May	31	31	37	41
	May-Sep(1)	36	36	42	46
	Oct-Nov(1)	40	40	46	50
1971	Apr-May(1)	36	36	42	46
	May-Nov(1)	45-50	45-50	50-55	55-60
1972	Apr-Nov(1)	40-50	40-50	45-55	50-60
1973-74	Apr-Nov	31	31	37	41
1975	Apr	31	31	37	41
	May-Nov(1)	35-60	35-60	41-66	45-70
1976	Apr-Jul(1)	34-38	34-38	40-44	44-48
	Aug-Dec(1)	31-34	31-34	37-40	41-44
1977	Apr-Nov	31	31	37	41
1978	Apr	31	31	37	41
	May-Jul(1)	35-46	35-46	41-52	45-56
	Aug-Nov(1)	46-51	46-51	52-57	56-61
1979	Apr-Jul(1)	36-42	36-42	42-48	46-52
	Aug-Nov(1)	31-36	31-36	37-42	41-46
1980	Apr-Nov	31	31	37	41
1981	Apr-Nov(2)	31	31	37	41
1982	Apr-Sep	31	31	37	41
	Oct	31-36	31-36	37-42	41-46
	Nov-Dec(1)	36-46	36-46	42-52	46-56
1983	Apr-Jun	31	31	37	41
	Jul	31-36	31-36	37-42	41-46
	Aug-Nov(1)	36	36	42	46
1984	Apr-Jun	31	31	37	41
	Jul-Dec(1)	31-44	31-44	37-50	41-54
1985	Apr-Dec	31	31	37	41
1986	Apr(1)	36-41	36-41	42-47	46-51
	May-Dec(1)	41-46	41-46	47-52	51-56
1987	Apr-Nov	31	31	37	41
1988	Apr-Nov(2)	31	31	37	41
1989	Apr-Aug(3)	28	28	34	38
	Sep-Oct(3)	28	28	34	35
1990-93	Apr-Oct(4)	25	25	31	35
1994	Apr-Dec	31	31	37	41
1995	Apr-May	31	31	37	41
	Jun-Dec(1)	46-56	46-56	52-62	56-66
1996	Apr(1)	41	41	47	51
	May(1)	41-51	41-51	47-57	51-61
	Jun-Dec(1)	56	56	62	66
1997	Apr-Dec(5)	*	*	*	*
1998	Apr-Dec(5)	31	31	37	41
1999	Apr-Dec(1)	31-43	31-43	37-49	41-53
2000	Apr-Jun	31	31	37	41
	Jul-Dec(3)	29.5	29.5	35.5	39.5
2001	Apr-Dec(3)	28	28	34	38
2002	Apr-Jun(3)	27	27	33	37
	Jul-Dec(3)	25	25	31	35
2003	Apr-Nov(4)	25	25	31	35
2004-08	Apr-Oct(6)	25	25	31	35
2009	Apr-Nov(7)	25/31	25/31	31/37	35/41
2010	Apr-Dec(1)	31-43	31-43	37-49	41-53
2011	Apr(1)	31-41	31-41	37-47	41-51
	mid-Apr(1)	41-46	41-46	47-52	51-56
	May(1)	46-56	46-56	52-62	56-66
	mid-May(5)	*	*	*	*
2012	Apr-Dec	31	31	37	41

(1) Downstream flow targets above full-service navigation level as a flood control storage evacuation measure.
(2) Full service flows provided for shortened season.
(3) Navigation targets below full service as a water conservation measure.
(4) Navigation targets at minimum service as a water conservation measure.
(5) Releases determined by flood control storage evacuation critiera and not adjusted to meet specific navigation targets.
(6) Minimum service targets at Sioux City and Omaha not met during periods when there was no navigation in those reaches.
(7) Minimum service targets at Sioux City were not met during periods when there was no navigation in those reaches.

Table 16
Missouri River Navigation
Tonnage and Season Length

Year	Reservoir System Supported Length of Season (Months)	Commercial (Tons) (1)	Total Traffic (Tons) (2)	Total Traffic (1,000 Ton-Miles) (2)
1967 (3)	8	2,562,657	6,659,219	1,179,235
1968	8 (4)	2,254,489	6,724,562	1,047,935
1969	8 (4)	2,123,152	7,001,107	1,053,856
1970	8 (5)	2,462,935	7,519,251	1,190,232
1971	8 (4)	2,791,929	7,483,708	1,329,899
1972	8 (4)	2,665,579	7,182,841	1,280,385
1973	8	1,817,471	6,370,838	844,406
1974	8	2,576,018	7,673,084	1,227,525
1975	8 (4)	2,317,321	6,208,426	1,105,811
1976	8 (4)	3,111,376	6,552,949	1,535,912
1977	8	3,335,780	6,734,850	1,596,284
1978	8 (4)	3,202,822	7,929,184	1,528,614
1979	8 (4)	3,145,902	7,684,738	1,518,549
1980	8	2,909,279	5,914,775	1,335,309
1981	7 1/4 (6)	2,466,619	5,251,952	1,130,787
1982	8 (4)	2,513,166	4,880,527	1,131,249
1983	8 (4)	2,925,384	6,301,465	1,300,000
1984	8 (4)	2,878,720	6,386,205	1,338,939
1985	8 (4) (7)	2,606,461	6,471,418	1,201,854
1986	8 (4) (7)	2,343,899	6,990,778	1,044,299
1987	8	2,405,212	6,735,968	1,057,526
1988	7 1/2	2,156,387	6,680,878	949,356
1989	6 3/4	1,906,508	5,352,282	796,799
1990	6 3/4	1,329,000	5,841,000	552,509
1991	6 3/4	1,563,000	5,729,000	537,498
1992	6 3/4	1,403,000	5,783,000	593,790
1993	8 (8)	1,570,000	5,631,000	615,541
1994	8	1,800,000	8,501,000	774,491
1995	8 (4)	1,439,000	6,884,000	604,171
1996	8 (4)	1,547,000	8,165,000	680,872
1997	8 (4)	1,651,000	8,172,000	725,268
1998	8 (4)	1,735,000	8,379,000	777,727
1999	8 (4)	1,576,000	9,252,000	699,744
2000	8	1,344,000	8,733,000	628,575
2001	8	1,288,000	9,732,000	566,150
2002	8 (9)	1,009,000	8,266,000	409,980
2003	8 (10)	667,000	8,050,000	256,788
2004	6 1/2 (11)	525,498	8,192,219	181,995
2005	6 1/2 (11)	284,641	7,935,747	129,882
2006	6 1/2 (11)	195,290	8,295,226	84,483
2007	6 3/4 (11)	302,769	6,684,625	119,177
2008	7 (11)	174,800	5,670,968	86,203
2009	8	269,563	5,035,744	114,865
2010	8(4)	379,492	4,829,714	132,747
2011	8(4)	230,439(12)	3,831,925(12)	62,253(12)
2012	8	350,000(13)	4,350,000(13)	100,000(13)

(1) Includes commercial tonnage except for sand and gravel or waterway materials. Tonnage compiled by Waterborne Commerce Statistics Center (WCSC).

(2) Includes commodities; sand, gravel, and crushed rock; and waterway improvement materials. Tonnage by WCSC.

(3) Mainstem Reservoir System first reached normal operating storage level in 1967.

(4) 10-day extension of season provided.

(5) 10-day extension and 10-day early opening provided.

(6) Full service flows for shortened season in preference to reduced service.

(7) 10-day extension provided for 1985 season in trade for 10-day delayed support of 1986 season.

(8) Lower Missouri River closed: 57 days in 1993, 20 days in 1995, and 18 days in 1999.

(9) To protect endangered shore birds below Gavins Point Dam, the Corps did not support navigation from July 3 to August 14, 2002. Average days towing industry off the river was 23 days.

(10) 6-day shortening of season to follow CWCP. From Aug 11 to Sep 1 Corps did not support navigation flows to comply with lawsuit to follow 2000 Biological Opinion. Navigation industry left the river during this period.

(11) Season shortening; 47-days, 2004; 48-days, 2005; 44-days, 2006; 35-days, 2007; 30-days, 2008

(12) Preliminary

(13) Estimated using boat report barge counts.

Table 17
Navigation Flow Support – Kansas River Projects

Date*	Increase (cfs)	De Soto target flow (cfs)	Decrease (cfs)	De Soto target flow (cfs)
July 12	500	1500		
July 14	500	2000		
July 23	1000	3000		
July 30	500	3500		
July 31 – August 3			2100	n/a
August 5			400	1000

*Indicates when releases from projects arrived at De Soto, KS. Travel times from Milford, Tuttle Creek and Perry to De Soto are approximately 4-6, 3-5 and 1-1.5 days, respectively. The range indicates when the release starts arriving and when it becomes fully effective. Travel time from De Soto to the Missouri River at Kansas City target location is approximately 1 day.

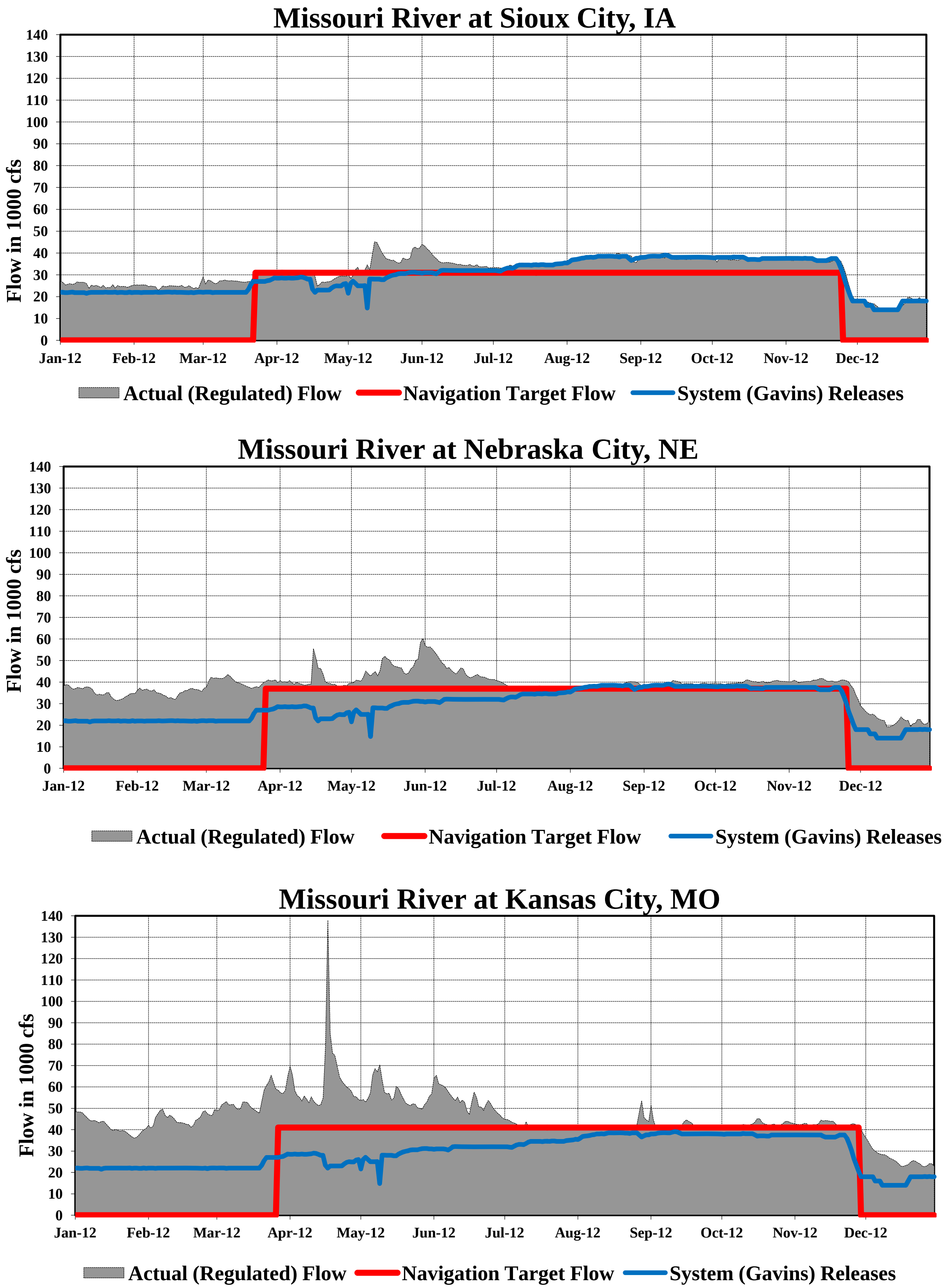


Figure 15. Actual flow, System releases and navigation target flows – Sioux City, IA; Nebraska City, NE and Kansas City, MO.

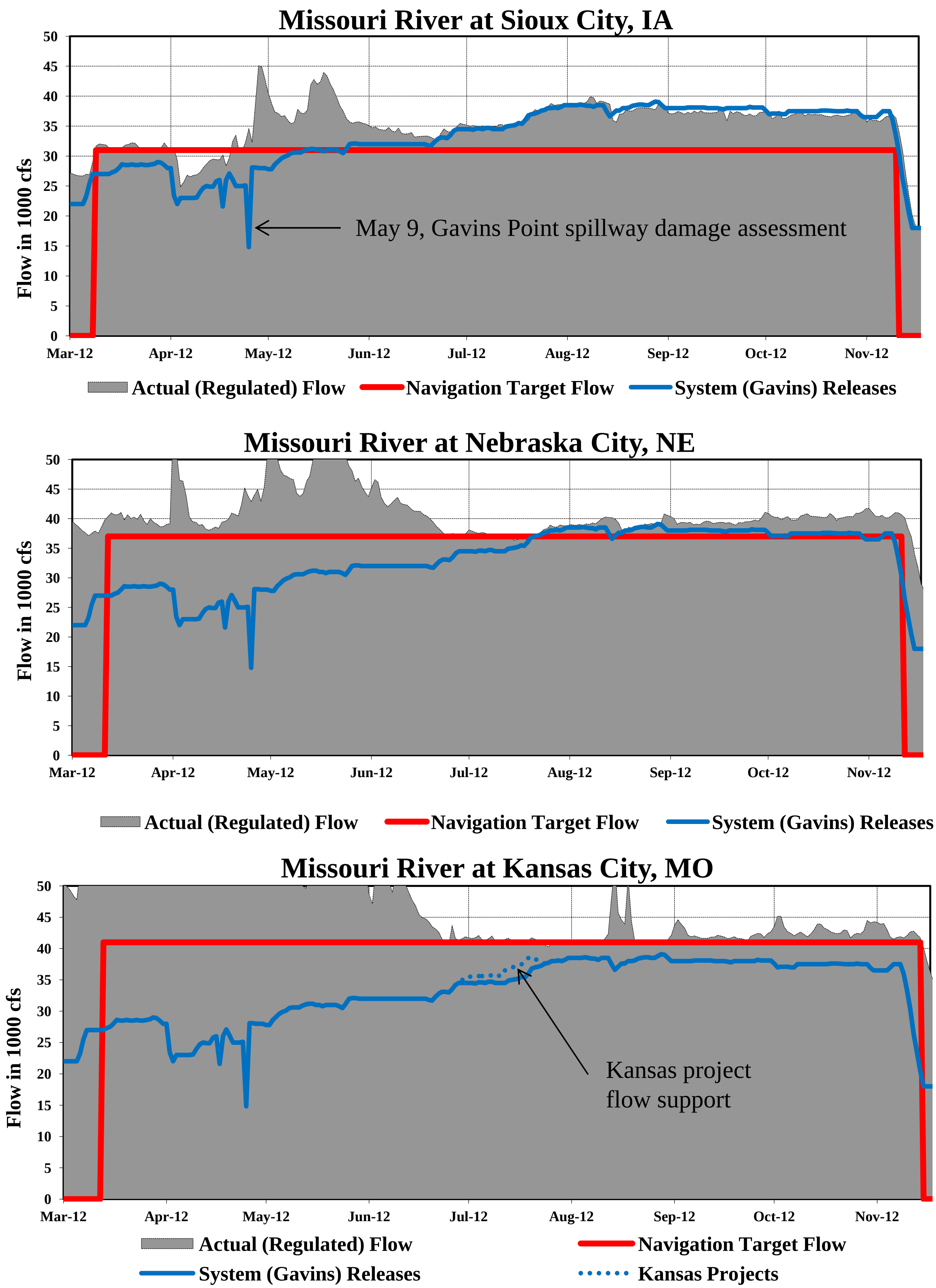


Figure 16. Actual flow, System releases and navigation target flows – Sioux City, IA; Nebraska City, NE and Kansas City, MO.

6. Hydropower Generation

The hydropower energy generated by the System is transmitted over a Federal transmission system that traverses 7,886 circuit miles. During 2012, service was provided to over 360 wholesale customers. Customers receiving service include 200 municipalities, 3 Federal agencies, 30 state agencies, 27 USBR projects, 5 irrigation districts, 36 rural electric cooperatives, 7 public utility districts, 12 private utilities, 25 Native American Services and 20 power marketers. Additional benefits were provided by the interconnections to the Southwestern Power Administration (SWPA) and Bonneville Power Administration (BPA) and other areas of the Western Area Power Administration (Western).

Per the Omaha Public Power District (OPPD) statistics, the average OPPD customer uses approximately 11,750 kilowatt hours (kWh) of energy annually. Based upon the total System generation of 10.4 billion kWh, the energy generated in 2012 by this portion of the Federal power system could have supplied all of the yearly needs of about 885,000 residential OPPD customers. In addition to the clean, renewable energy transmitted to the Midwest area, System hydropower provides an added measure of stability to the regional power system with the ability to meet full load in 5 seconds or less. Large coal-fired and nuclear units are reinforced by idle hydropower units, typically in 30 seconds. Outside utilities benefit through reserve sharing by calling on the hydropower capability within several minutes of a known problem. In addition, hydropower generation can be integrated with wind generation to provide balance to the regional power system. This balance is achieved by using hydropower to rapidly respond to the increased power system variation and forecast errors caused by wind. Currently, there is approximately 806 MW of wind generation capability in Western's balancing area.

The excellent reliability of System hydropower is indicated by having to maintain a 7 percent reserve, while thermal power must maintain a 12 percent reserve. Although the Federal hydropower that serves the Missouri River region accounts for only 9 percent of the region's energy, it is large enough to fill gaps and provide a positive benefit to the integrated system.

Hydropower generation in 2012 was 10.4 billion kWh, which was 111 percent of average since the System first filled in 1967. The 2012 generation was 0.7 billion kWh less than the 2011 generation of 11.1 billion kWh and 5.5 billion kWh more than the record low of 4.9 billion kWh, set in 2008. Generation was above average in 2012, largely due to the increased releases from the System projects to support navigation flows. Releases to support navigation were higher than normal due to tributary flows downstream of Gavins Point being much lower than normal due to the ongoing drought. Western purchased about 2.2 billion kWh between January 1 and December 31 at a cost of $80.1 million to supplement System hydropower production.

System generation with individual project distribution for each calendar year in million megawatt hours (MWh) since 1954 is shown on ***Figure 17***. The total generation from the Federal system (peak capacity and energy sales) for 2012 is shown in ***Table 18***. The tabulations in ***Table 19*** and ***Table 20*** summarize the total gross generation and power regulation for the Eastern Division, Pick-Sloan Missouri Basin Program (P-S MBP) marketing area system for the past operating year. Actual settlement figures at the end of the billing periods differ somewhat from the calendar month figures shown.

Table 18
Gross Federal Power System Generation – January 2012 through December 2012

	Energy Generation 1000 kWh	**Peak Hour kW**	**Generation Date**
Corps Powerplants – Mainstem			
Fort Peck	1,163,830	194,000	Jun 18
Garrison	2,491,152	412,000	Feb 18
Oahe	2,908,388	679,000	Jun 20
Big Bend	1,114,849	422,000	Sep 12
Fort Randall	1,962,380	353,000	Aug 31
Gavins Point	752,990	115,000	Jun 2
Corps Subtotal	**10,393,589**	**2,079,000**	Aug 3
USBR Powerplants			
Canyon Ferry	324,864	53,000	January
Yellowtail*	291,230	74,500	January
USBR Subtotal	**616,094**	**128,000**	
Federal System Total	**11,009,683**	**2,207,000**	

* Includes only half of total Yellowtail generation, which is marketed by the Eastern Division, P-S MBP.

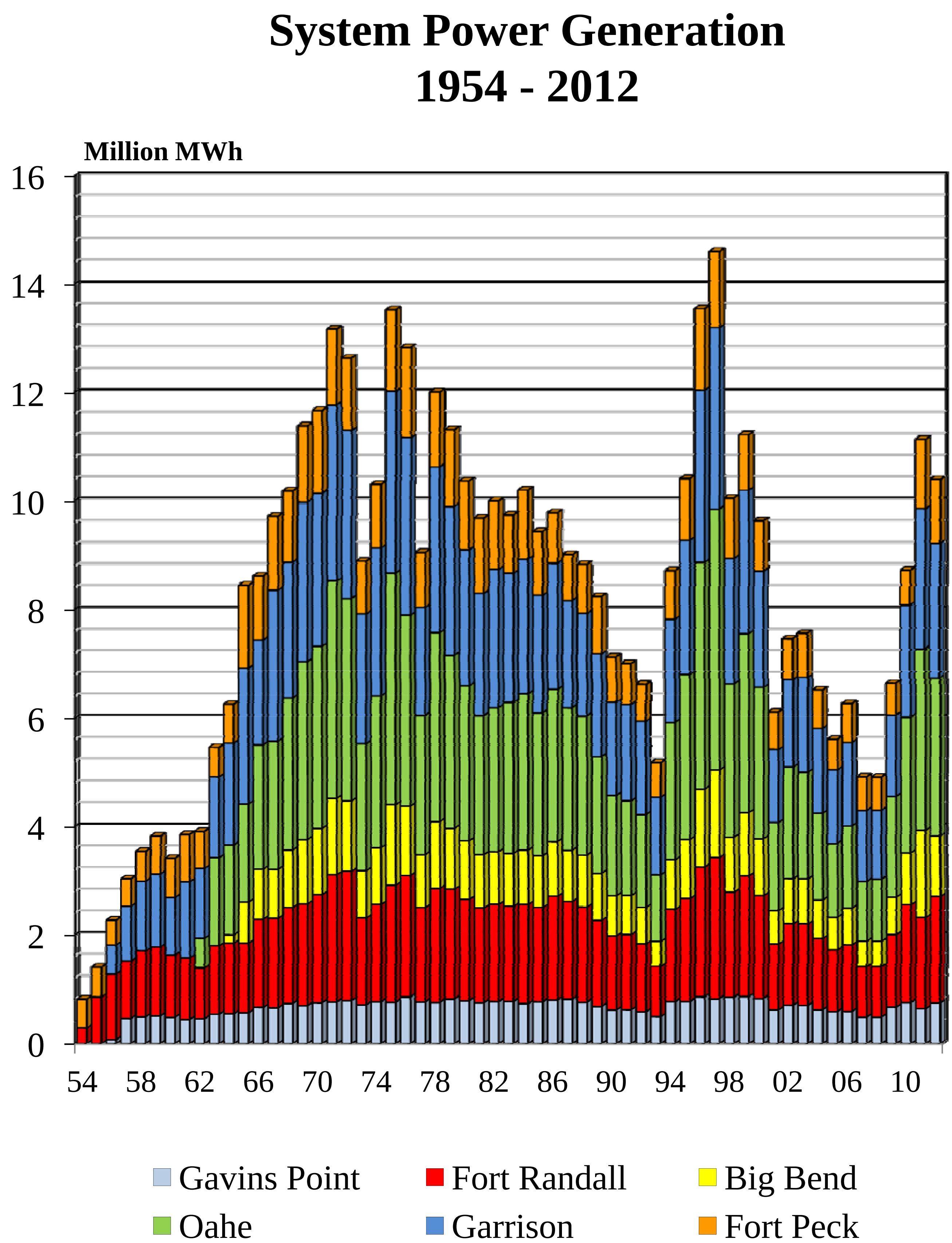


Figure 17. System power generation by project from 1954 to 2012.

Table 19
Historical Generation and Load Data – Peaks
Eastern Division, Pick-Sloan Missouri Basin Program*
Data at Plant (1000 kW)
January 1, 2012 through December 31, 2012

Period	Corps of Engineers Hourly Generation (Gross)**	(plus)	USBR Hourly Generation (Gross)**	(equals)	Federal Hour Generation (Gross)**	(plus)	Interchange and Purchases Received**	(equals)	Peak Total System Load	Peak Date	Peak Hour
January	1,732		110		1,842		1,842		1,892	Jan 26	1900
February	1,604		109		1,713		1,713		2,223	Feb 27	800
March	1,510		109		1,619		1,619		1,669	Mar 28	800
April	1,806		126		1,932		1,932		1,977	Apr 10	800
May	1,598		82		1,680		1,680		1,730	May 31	1300
June	2,018		73		2,091		2,091		2,191	Jun 18	1800
July	2,036		72		2,108		2,108		2,262	Jul 30	1600
August	2,079		71		2,150		2,150		2,252	Aug 03	1600
September	1,928		64		1,992		1,992		2,042	Sep 03	1500
October	1,763		65		1,828		1,828		1,878	Oct 04	2000
November	1,741		61		1,802		1,802		1,852	Nov 23	1800
December	1,956		75		2,031		2,031		2,497	Dec 25	1900

* This tabulation summarizes the total gross generation and power operations for the Eastern Division marketing area system shown on Table 18.
** During hour of peak total system load.

Table 20
Historical Generation and Load Data – Total
Eastern Division, Pick-Sloan Missouri Basin Program*
Data at Plant (1000 kWh)
January 1, 2012 through December 31, 2012

Period	Corps of Engineers Generation (Gross)	(plus)	USBR Generation (Gross)	(equals)	Federal Generation (Gross)	(plus)	Scheduled Interchange and Purchases Received	(equals)	Total System Load
January	843,790		70,078		913,868		22,741		936,609
February	729,959		67,298		797,257		75,808		873,065
March	738,252		61,895		800,147		41,025		841,172
April	821,571		55,101		876,672		4,742		881,414
May	844,874		49,487		894,361		9,456		903,817
June	950,007		45,046		995,053		43,081		1,038,134
July	1,062,093		47,397		1,109,490		106,028		1,215,518
August	1,105,582		44,647		1,150,229		13,408		1,163,637
September	997,830		39,953		1,037,783		4,657		1,042,440
October	894,320		34,736		929,056		4,046		933,102
November	836,398		38,033		874,431		25,991		900,422
December	568,923		43,039		611,962		375,066		987,028

*Powerplants from Table 18.

7. Recreation

The System reservoirs provide outstanding opportunities for boating, fishing, swimming, camping and other outdoor recreation pursuits. Tourism related to the reservoirs is a major economic factor in all of the states adjoining the System. However, when the reservoirs are drawn down due to extended drought periods, as they were in some recent years, recreation may be adversely affected primarily due to access issues. Most of the recreational impacts of drought are experienced at Fort Peck, Garrison and Oahe, the upper three reservoirs. Due to the manner in which they are regulated, the lower three reservoirs are not significantly impacted by drought. In 2012, reservoirs levels during the first half of the year were near normal. However, as drought conditions continued into the late summer, reservoirs levels began to drop, which impacted recreation sites at some reservoirs.

Access areas at the upper three reservoirs include Corps-owned as well as Tribal, state and privately-owned facilities. In 2002, many of the Federal recreation areas and boat ramps in South Dakota were turned over in fee title to the State of South Dakota and the Bureau of Indian Affairs through the Title VI process. Since the land transfer, both the Federal treasury and the Corps have provided money to the South Dakota Game Fish and Parks, Cheyenne River Sioux Tribe and Lower Brule Sioux Tribe for operations and stewardship of the Title VI lands they received. Congress is also capitalizing a trust fund to cover these costs in the future.

At the time this report was being prepared, visitation data was only available for the January through September period of 2012. For this period, public use at the System reservoirs totaled 45,153,500 visitor hours, an 8 percent increase from 2011. The annual visitation data will be updated when the October through December period is available. Visitor attendance figures at the System reservoirs from 2008 through 2012 are shown in ***Table 21***. ***Figure 17*** displays recreation-related visitor hours at each of the six System projects for the years 1954 through 2012. Although the drought had an impact on visitation during the years from 2000-2007, much of the reduction shown in ***Figure 17*** is attributed to the data collection changes associated with the South Dakota Title VI land transfer mentioned previously. Since the land transfer occurred, the Corps has not collected visitation data consistent with previous years at the recreation sites in South Dakota. The 2012 visitation in South Dakota presented in ***Table 22*** and ***Figure 17*** reflects water-related use on the reservoirs but not the visitation at the campgrounds that were turned over to South Dakota and the Tribes.

The reporting method was changed from recreation days to visitor hours in 1987. All Corps projects, including the System projects, are now reporting visitation using the Visitation Estimation Reporting System (VERS).

In the 2011, a number of recreation areas were unusable due to the high reservoir levels and record project releases. In that year, the number of visitors increased but overall visitor hours declined due to the closure of areas such as campgrounds that tend to be used for longer periods. The 8 percent increase in visitor hours for 2012 is attributed to the availability of many of those same recreation areas.

Table 21
Visitation at System Reservoirs (Visitor Hours)

Mainstem Project	2009	2010	2011	2012*	Percent Change 2011-2012*
Fort Peck	5,820,400	6,173,900	6,455,300	6,666,900	+3
Garrison	13,773,900	15,698,700	14,190,300	15,233,400	+7
Oahe	9,322,300	9,503,100	6,964,900	10,863,700	+56
Big Bend	3,210,200	3,346,500	2,528,100	2,651,700	+5
Fort Randall	1,030,900	1,067,000	1,108,500	860,300	-22
Gavins Point	8,880,300	9,410,000	10,737,500	8,877,500	-17
System Total	**42,038,100**	**45,199,200**	**41,984,600**	**45,153,500**	**+8**

*2012 visitor hours are for January to September only.

System Visitation
1954 - 2012

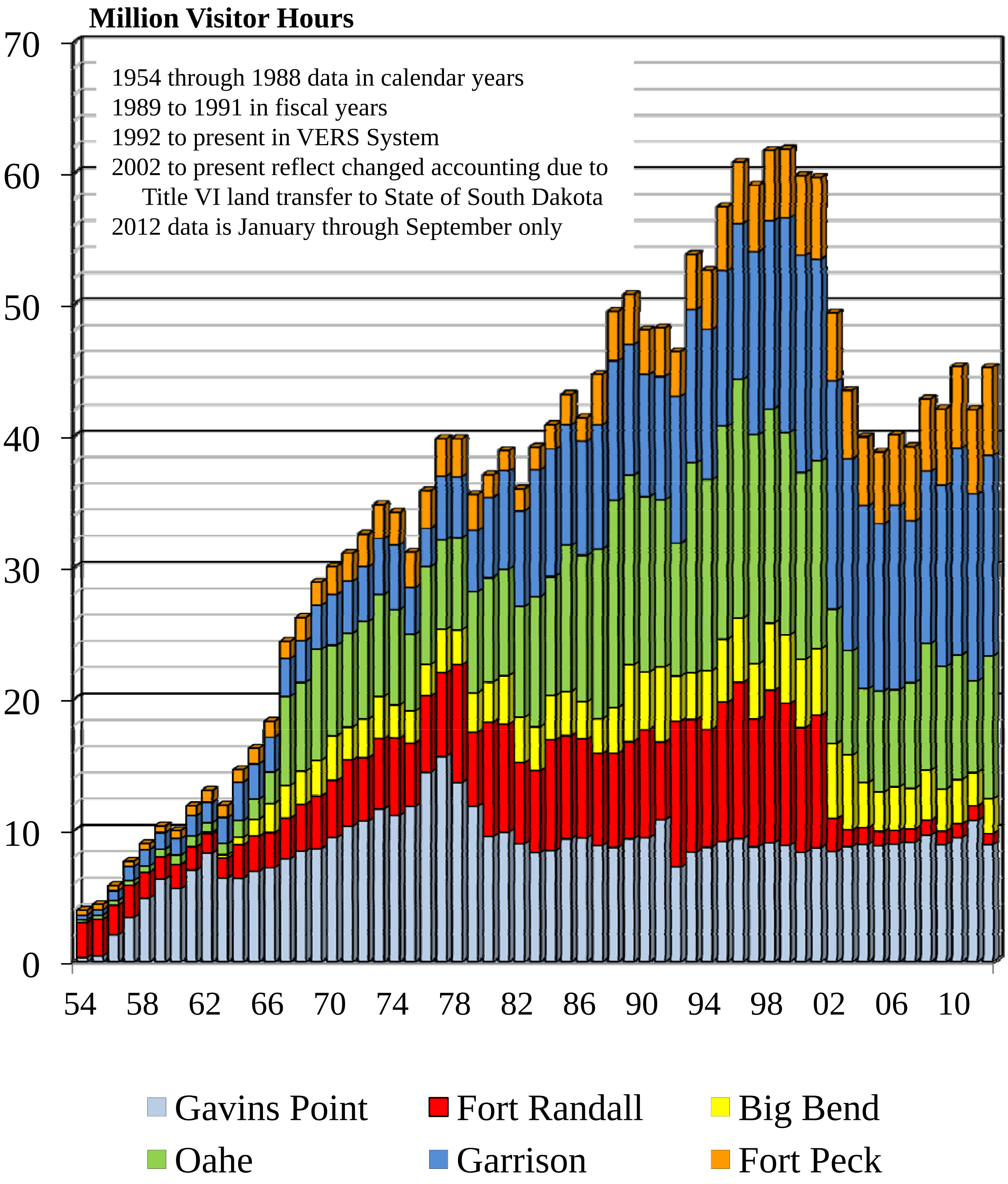


Figure 18. System visitation by project from 1954 to 2012.

8. Fish and Wildlife

a. Fish Management

Rainbow smelt are the primary forage species in both Garrison and Oahe reservoirs. Successful rainbow smelt reproduction is dependent on many factors including stable reservoir levels during the smelt spawning period, generally in April and early May. Most eggs are laid in water less than 1 foot deep and are subject to desiccation through wave action and slight drops in water level.

With the return of the drought and lower reservoir levels in 2012, forage fish production was again a major concern in the upper three large reservoirs. Coupled with the high entrainment experienced during the flood of 2011 and the lower reservoir levels in 2012, forage fish production was more dire in Oahe than in Garrison. Gizzard shad have been stocked in both reservoirs to supplement the rainbow smelt forage base.

b. Threatened and Endangered Species

(1) Pallid Sturgeon

The bimodal spring pulse from Gavins Point was not conducted in 2012, as detailed in section II.C.6.c. of this report.

(2) Piping Plovers and Least Terns

Since 1986 the System has been regulated for the threatened piping plover (plover) and endangered least tern (tern), when they were federally listed. The terns and plovers nest on sparsely vegetated sandbars, islands and shoreline of the Missouri River and the reservoirs. Real-time telemetered streamgaging stations have been installed along the Missouri River to monitor river stages and flows during the nesting season. These gages provide a check, as well as a stage history, throughout the season to help relate the effects of regulation and natural events at intervals along the river. The gage data must be supplemented with observations of nesting activities and conditions to provide the information that is needed for regulation of the reservoirs. A dynamic flow routing model has been developed to predict river stages along the river reaches downstream from the Fort Peck, Garrison, Fort Randall, and Gavins Points for different combinations of daily and hourly power peaking; however, the cross-sectional data needs to be updated following the 2011 Flood.

Beginning in 1999, Omaha District created a computerized threatened and endangered (T&E) species Data Management System (DMS). Report data, which is updated daily, includes nest records, census and productivity data, site descriptions, field journals and field observations. This database is a valuable tool in aiding regulation decisions benefiting the terns and plovers in years when the reservoirs are regulated to protect nesting terns and plovers.

Although the Corps prevented inundation of nests where possible and created habitat following the listing, fledging ratios continued to be lower than predicted by the USFWS 1990 Biological Opinion until 1998, when fledge ratios exceeded the goal for both species. Predation, habitat degradation, severe weather, nest inundation, record runoff and other factors contributed to the low fledging rates. The record fledging that occurred for both species between 1998 and 2005 is primarily attributed to the large amount of habitat created by the high runoff years of 1995, 1996 and 1997 and the declining reservoir levels during the 2000-2007 drought. The creation of additional habitat has also allowed greater flexibility in the release levels at Fort Randall and Gavins Point, the lower two System projects.

During 2012 the majority of terns and plovers were found on the Gavins Point Reservoir constructed habitat. The record runoff above the System during 2011 created an abundance of high elevation nesting habitat throughout the System. This habitat allowed for the production of a large number of T&E fledged birds during 2012. A detailed description of the factors affecting tern and plover nesting, fledge ratios and habitat conditions and creation activities can be found in the Missouri River Recovery Program 2012 Annual Report (*www.moriverrecovery.org*).

The population distribution and productivity for terns and plovers for 1986 through 2012 are shown in ***Table 22*** and ***Table 23***, respectively. Productivity estimates for these birds on the Missouri River do not include terns and plovers raised in captivity from 1995 to 2002. Adult bird totals listed in ***Table 22*** and ***Table 23*** are considered breeders even though they may not have had nesting success. The term "fledglings/pair" refers to the number of young birds produced per breeding pair. The fledge ratio is an estimate, as the fate of every single fledgling is impossible to ascertain.

Table 22
Missouri River System
Interior Least Tern Survey Data

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Fort Peck Lake																											
Adults	-	4	3	4	6	10	0	7	9	2	0	0	4	0	0	0	0	2	0	0	2	2	0	0	0	0	0
Fledglings/Pair	-	-	0	3.00	-	0.40	{}	0	0.44	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	
Fort Peck to Lake Sakakawea																											
Adults	-	-	18	48	92	66	110	31	58	95	128	162	25	40	13	39	34	38	48	34	36	77	22	46	26	0	0
Fledglings/Pair	-	-	0.33	0	0.17+	0.55+	0.25+	0.45+	1.41+	0.99+	0.33	0.53	.1.52	1.70	0.15	0.97	0.59	0.63	0.50	2.18	1.17	1.38	1.45	0.87	1.00	0.00	0.00
Lake Sakakawea																											
Adults	-	-	7	15	6*	8	29+	17	35	7	27	2	23	9	10	34	21	25	16	26	48	53	14	15	11	3	14
Fledglings/Pair	-	-	0	0	-	-	0.83+	0.12+	0	0	0.15	0	1.04	0.67	0.20	0.76	0.86	0.56	0.88	0.31	0.71	0.72	2.57	1.07	0.00	0.00	0.29
Garrison to Lake Oahe																											
Adults	171	175	142	121	174	195	198	145	217	284	105	41	141	105	105	125	126	144	142	157	139	123	73	108	134	0	105
Fledglings/Pair	-	-	0.93	0.43	0.44+	0.58	0.48	0.28	0.54	0.91	0.08	0.39	1.52	1.50	1.03	1.26	1.83	1.28	1.13	0.73	0.81	1.06	1.34	0.48	1.36	0.00	0.99
Lake Oahe/Lake Sharpe																											
Adults	16*	21*	82	97	100	143	124	125	160	84	74	101	110	57	85	94	106	70	73	131	128	186	111	71	48	39	100
Fledglings/Pair	0.75	1.62	0	0	-	-	0.42	0	0.06	0	0.24	0.16	1.29	0.88	1.01	1.34	1.32	1.20	1.26	0.87	1.14	0.48	0.58	0.96	0.17	1.33	1.06
Ft. Randall to Niobrara																											
Adults	25	60	0	4	26	32	13	38	43	10	2	0	64	124	72	71	84	50	71	76	55	74	58	23	10	0	87
Fledglings/Pair	0.48	0.43	0	0	0.31+	0.63	0.46	0	0	0	0	0	0.94	1.03	1.26	0.14	0.71	0.92	0.37	0.47	0.69	0.30	1.14	0.43	0.00	0.00	1.10
Lake Lewis and Clark																											
Adults	0	0	45	29	63	55	29	76	44	16	28	60	120	76	44	58	46	46	13	4	0	85	225	214	272	231	211
Fledglings/Pair	-	-	0.13	0.62	0.35+	0	1.59	0.97	0	0	0	1.57	2.33	0.21	0.38	1.17	1.04	0.39	0.00	0.00	0.00	1.58	0.67	0.76	1.01	0.15	1.43
Gavins Point to Ponca																											
Adults	181	232	252	210	167	193	187	272	211	93	82	115	148	161	149	232	314	366	359	476	383	410	278	211	159	0	209
Fledglings/Pair	0.26	0.46	0.49	0.55	0.46+	0.26	0.21	0.83	0.48	0.49	0.27	0.90	2.27	2.41	1.72	1.09	1.32	0.75	1.04	1.34	0.63	0.59	1.14	1.00	1.17	0	1.2
Total Adults	393	492	549	528	634	702	690	711	777	591	446	481	635	572	551	653	731	741	722	904	802**	1,010	781	696	650	273	726
Fledglings/Pair	0.26	0.46	0.59	0.54	0.38	0.41	0.42	0.50	0.41	0.67	0.21	0.66	1.73	1.42	1.22	1.04	1.27	0.87	0.95	1.09	0.80**	0.75	0.98	0.80	1.02	0.32	1.19

5-Year Running Average Interior Least Tern Fledge Ratio Goal = 0.94

- Data not collected
* Partial Survey Results
{} No Birds Found
+ Subsampling of Selected Nesting Areas
** Includes adults and fledglings from Lake Francis Case

Notes: The data do not include least terns and piping plovers raised in captivity from 1995 to 2002. The data represent only wild fledged birds.
From 1990 to 2003 the 10-Year Least Tern Fledge Ratio was 0.70 (1990 and 2000 Biological Opinions).
From 2004 to current 5-Year running average goal is 0.94 (2003 Amended Biological Opinion)
Data in this table may differ from previous reports. As information becomes available, this table is updated.

Table 23
Missouri River System
Piping Plover Survey Data

		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Fort Peck Lake																												
	Adults	16	10	20	12	22	25	26	30	4	5	0	0	4	2	0	4	2	17	9	26	20	16	9	12	3	2	0
	Fledglings/Pair	-	-	1.70	1.50	3.18	1.20	1.00	0.60	1.50	1.20	0	0	0	2.00	0	1	2	0.35	2.22	1.08	1.2	0.5	0.22	0.33	0	0	0
Fort Peck to Lake Sakakawea																												
	Adults	-	-	5	11	17	13	0	4	9	20	24	23	4	5	4	3	2	6	0	2	5	0	0	0	0	0	0
	Fledglings/Pair	-	-	0	0.18	0	0	{}	0+	0	3.50	1.00	0.87	1.00	0	0	1.33	0	2.67	0	4	0.4	0	0	0	0	0	0
Lake Sakakawea																												
	Adults	-	-	143	57	132	150	108	8	45	24	70	3	119	83	277	424	469	528	738	746	430	399	363	85	38	24	200
	Fledglings/Pair	-	-	0	0	-	-	1.50	8.5+	1.24	0	0.57	0.67	1.24	1.25	1.61	1.25	1.65	1.06	1.5	0.89	0.61	0.7	0.68	0.21	0.89	1.67	1.4
Garrison to Lake Oahe																												
	Adults	139	160	113	84	71	124	77	127	119	261	45	6	74	139	99	149	119	149	164	220	175	222	218	275	287	0	98
	Fledglings/Pair	-	-	0.97	0.26	1.04+	1.13+	1.06+	0.54+	0.87	0.87	0.09	0	1.84	0.88	1.41	1.53	2.03	1.66	1.16	0.8	0.77	0.97	1.37	0.94	0.84	0	1
Lake Oahe/Lake Sharpe																												
	Adults	4*	4*	55	140	88	87	143	66+	85	30	21	31	98	46	141	184	203	301	372	364	331	273	281	158	44	20	125
	Fledglings/Pair	-	2.50*	0	0	-	-	0.97+	0.33	0.09	0.93	0.29	1.29	1.06	0.30	1.45	1.41	2.16	1.84	1.41	1.21	0.99	0.62	0.9	0.47	0.1	0.4	1.76
Ft. Randall to Niobrara																												
	Adults	11	16	0	0	12	25	8	12	17	0	3	0	33	51	62	38	35	37	42	42	37	21	26	16	6	0	43
	Fledglings/Pair	0.18	0.13	0	0	0.67*	0.48	0.75	0	0	0	0	0	1.27	1.02	0.87	0.74	1.03	1.46	0.71	0.81	0.38	0	1	1	0	0	1.81
Lake Lewis and Clark																												
	Adults	0	0	31	18	30	33	6	32	12	4	6	32	84	67	28	34	44	14	0	24	4	20	57	122	152	134	179
	Fledglings/Pair	-	-	0.06	0.56	0.67+	0	0	0.06	0.33	0	0	1.25	2.45	0.30	0.5	0.71	1.68	1.57	0	0.17	0.5	1.8	1.37	1.8	1.25	0.22	1.35
Gavins Point to Ponca																												
	Adults	172	177	212	122	148	166	112	109	62	63	22	22	49	141	186	218	260	286	262	340	309	300	320	238	74	2	137
	Fledglings/Pair	0.05	1.13	0.62	0.21	0.39+	0.35	0.34	1.06	0.61	0.16	0	0	2.20	1.60	2.17	1.85	2.29	1.9	1.87	1.97	0.78	0.39	1.39	1.09	1.86	0	1.82
Total Adults		342	367	579	444	521	623	480	388	353	407	191	117	465	534	797	1054	1134	1338	1587	1764	1311	1251	1274	906	604	182	782
Fledglings/Pair		0.06	1.08	0.73	0.32	0.76	0.62	0.94	0.76	0.61	0.84	0.39	0.87	1.61	1.01	1.58	1.41	1.91	1.5	1.49	1.15	0.78	0.66	1.06	0.94	1.01	0.43	1.49

10-Year Running Average Piping Plover Fledge Ratio Goal = 1.22

- Data not collected
* Partial Survey Results
{} No Birds Found
\+ Subsampling of Selected Nesting Areas

Notes: The data do not include least terns and piping plovers raised in captivity from 1995 to 2002. The data represent only wild fledged birds.
From 1990 to 2000 the 15-Year Piping Plover Fledge Ratio Goal was 1.44 (1990 Biological Opinion).
From 2001 to 2003 the goal was 1.13 (2000 Biological Opinion)
From 2004 to current the 10-year running average goal is 1.22 (2003 Amended Biological Opinion)
Data in this table may differ from previous reports. As information becomes available, this table is updated.

9. Cultural Resources

As acknowledged in the 2004 Programmatic Agreement (PA) for the operation and management of the System, wave action and the fluctuation of reservoirs levels results in erosion along the banks of the reservoirs. During drought conditions, cultural resource sites are exposed as the pool levels decline. With higher-than-normal reservoir levels in 2011, a number of sites were still affected, and assessment of those sites continued into 2012. The Corps will continue to work with the Tribes utilizing 36 CFR Part 800 and the PA to address the exposure of sites. The objective of a programmatic agreement is to deal "…with the potential adverse effects of complex projects or multiple undertakings…" The objective of the PA was to collaboratively develop a preservation program that would avoid, minimize and/or mitigate the adverse effects of the System regulation. All Tribes, whether signatory to the PA or not, may request government-to-government consultation on the regulation of the System and the resulting effect on historic and cultural properties and other resources.

The planned preservation program is outlined by multiple stipulations in the PA. One of the stipulations, or program components, is the 5-year plan. This plan outlines how the Corps will accomplish its responsibilities under the PA and National Historic Preservation Act. The "Final Five Year Plan, dated February 2012" is currently being implemented (see website *http://www.nwo.usace.army.mil/Missions/CivilWorks/CulturalResources.aspx*).

The plan includes inventory, testing and evaluation, mitigation and other specific activities that will allow the Corps to avoid, minimize and/or mitigate the adverse effects to cultural sites on the Corps' lands within the System.

Under the terms of Stipulation 18 of the PA the Corps has agreed to consult/meet with the affected Tribes and Tribal Historic Preservation Officers (THPO's), State Historic Preservation Officers (SHPO's), the Advisory Council on Historic Preservation (ACHP) and other parties on the draft AOP. The purpose of this consultation/meeting is to determine whether operational changes are likely to cause changes to the nature, location or severity of adverse effects to historic properties or to the types of historic properties affected and whether amendments to the Corps' Cultural Resources Management Plans and Final Five Year Plan are warranted in order to better address such effects to historic properties. A letter, dated September 5, 2012, was sent to the Missouri River basin Tribes offering consultation on the 2012-2013 AOP. To date, one tribe requested consultation; and two Tribes participated in the fall AOP public meetings in October and November 2012. No Tribe provided written input on the draft AOP.

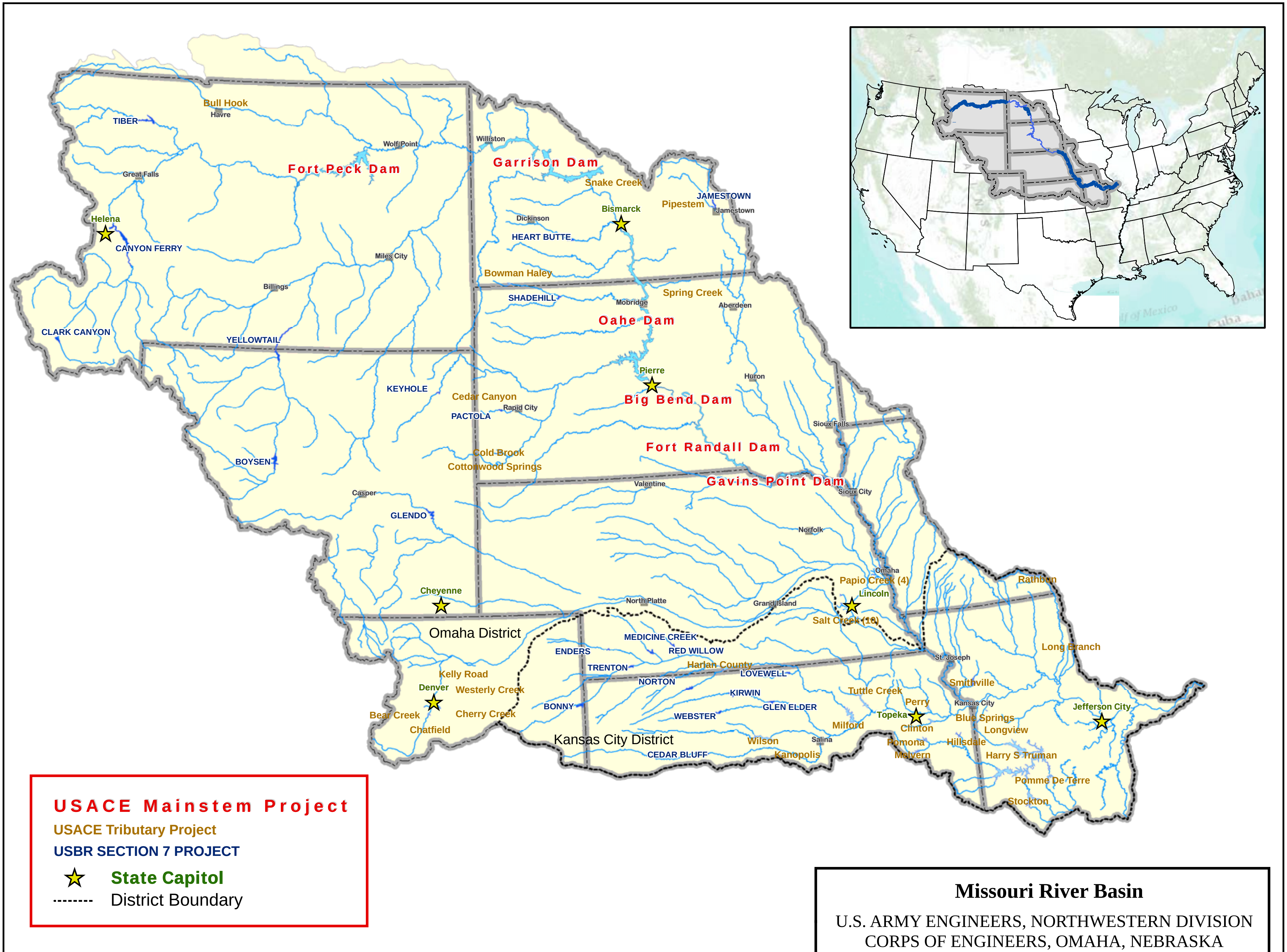


PLATE 1. Missouri River Basin Map.

Item No.	Summary of Engineering Data -- Missouri River Mainstem System Subject	Fort Peck Dam - Fort Peck Lake	Garrison Dam - Lake Sakakawea	Oahe Dam - Lake Oahe
1	Location of Dam	Near Glasgow, Montana	Near Garrison, ND	Near Pierre, SD
2	River Mile - 1960 Mileage	Mile 1771.5	Mile 1389.9	Mile 1072.3
3	Total & incremental drainage areas in square miles	57,500	181,400 (2) 123,900	243,490 (1) 62,090
4	Approximate length of full reservoir (in valley miles)	134, ending near Zortman, MT	178, ending near Trenton, ND	231, ending near Bismarck, ND
5	Shoreline in miles (3)	1520 (elevation 2234)	1340 (elevation 1837.5)	2250 (elevation 1607.5)
6	Average total & incremental inflow in cfs	10,200	25,600 15,400	28,900 3,300
7	Max. discharge of record near damsite in cfs	137,000 (June 1953)	348,000 (April 1952)	440,000 (April 1952)
8	Construction started - calendar yr.	1933	1946	1948
9	In operation (4) calendar yr.	1940	1955	1962
	<u>Dam and Embankment</u>			
10	Top of dam, elevation in feet msl	2280.5	1875	1660
11	Length of dam in feet	21,026 (excluding spillway)	11,300 (including spillway)	9,300 (excluding spillway)
12	Damming height in feet (5)	220	180	200
13	Maximum height in feet (5)	250.5	210	245
14	Max. base width, total & w/o berms in feet	3500, 2700	3400, 2050	3500, 1500
15	Abutment formations (under dam & embankment)	Bearpaw shale and glacial fill	Fort Union clay shale	Pierre shale
16	Type of fill	Hydraulic & rolled earth fill	Rolled earth filled	Rolled earth fill & shale berms
17	Fill quantity, cubic yards	125,628,000	66,500,000	55,000,000 & 37,000,000
18	Volume of concrete, cubic yards	1,200,000	1,500,000	1,045,000
19	Date of closure	24 June 1937	15 April 1953	3 August 1958
	<u>Spillway Data</u>			
20	Location	Right bank - remote	Left bank - adjacent	Right bank - remote
21	Crest elevation in feet msl	2225	1825	1596.5
22	Width (including piers) in feet	820 gated	1336 gated	456 gated
23	No., size and type of gates	16 - 40' x 25' vertical lift gates	28 - 40' x 29' Tainter	8 - 50' x 23.5' Tainter
24	Design discharge capacity, cfs	275,000 at elev 2253.3	827,000 at elev 1858.5	304,000 at elev 1644.4
25	Discharge capacity at maximum operating pool in cfs	230,000	660,000	80,000
	<u>Reservoir Data (6)</u>			
26	Max. operating pool elev. & area	2250 msl 241,000 acres	1854 msl 380,000 acres	1620 msl 374,000 acres
27	Max. normal op. pool elev. & area	2246 msl 234,000 acres	1850 msl 364,000 acres	1617 msl 360,000 acres
28	Base flood control elev & area	2234 msl 210,000 acres	1837.5 msl 307,000 acres	1607.5 msl 312,000 acres
29	Min. operating pool elev. & area	2160 msl 89,000 acres	1775 msl 128,000 acres	1540 msl 117,000 acres
	<u>Storage allocation & capacity</u>			
30	Exclusive flood control	2250-2246 971,000 a.f.	1854-1850 1,489,000 a.f.	1620-1617 1,102,000 a.f.
31	Flood control & multiple use	2246-2234 2,704,000 a.f.	1850-1837.5 4,222,000 a.f.	1617-1607.5 3,201,000 a.f.
32	Carryover multiple use	2234-2160 10,700,000 a.f.	1837.5-1775 13,130,000 a.f.	1607.5-1540 13,461,000 a.f.
33	Permanent	2160-2030 4,088,000 a.f.	1775-1673 4,980,000 a.f.	1540-1415 5,373,000 a.f.
34	Gross	2250-2030 18,463,000 a.f.	1854-1673 23,821,000 a.f.	1620-1415 23,137,000 a.f.
35	Reservoir filling initiated	November 1937	December 1953	August 1958
36	Initially reached min. operating pool	27 May 1942	7 August 1955	3 April 1962
37	Estimated annual sediment inflow	17,700 a.f. 1030 yrs.	25,900 a.f. 920 yrs.	19,800 a.f. 1170 yrs.
	<u>Outlet Works Data</u>			
38	Location	Right bank	Right Bank	Right Bank
39	Number and size of conduits	2 - 24' 8" diameter (nos. 3 & 4)	1 - 26' dia. and 2 - 22' dia.	6 - 19.75' dia. upstream, 18.25' dia. downstream
40	Length of conduits in feet (8)	No. 3 - 6,615, No. 4 - 7,240	1529	3496 to 3659
41	No., size, and type of service gates	1 - 28' dia. cylindrical gate 6 ports, 7.6' x 8.5' high (net opening) in each control shaft	1 - 18' x 24.5' Tainter gate per conduit for fine regulation	1 - 13' x 22' per conduit, vertical lift, 4 cable suspension and 2 hydraulic suspension (fine regulation)
42	Entrance invert elevation (msl)	2095	1672	1425
43	Avg. discharge capacity per conduit & total	Elev. 2250 22,500 cfs - 45,000 cfs	Elev. 1854 30,400 cfs - 98,000 cfs	Elev. 1620 18,500 cfs - 111,000 cfs
44	Present tailwater elevation (ft msl)	2032-2036 5,000 - 35,000 cfs	1670-1680 15,000- 60,000 cfs	1423-1428 20,000-55,000 cfs
	<u>Power Facilities and Data</u>			
45	Avg. gross head available in feet (14)	194	161	174
46	Number and size of conduits	No. 1-24'8" dia., No. 2-22'4" dia.	5 - 29' dia., 25' penstocks	7 - 24' dia., imbedded penstocks
47	Length of conduits in feet (8)	No. 1 - 5,653, No. 2 - 6,355	1829	From 3,280 to 4,005
48	Surge tanks	PH#1: 3-40' dia., PH#2: 2-65' dia.	65' dia. - 2 per penstock	70' dia., 2 per penstock
49	No., type and speed of turbines	5 Francis, PH#1-2: 128.5 rpm, 1-164 rpm , PH#2-2: 128.6 rpm	5 Francis, 90 rpm	7 Francis, 100 rpm
50	Discharge cap. at rated head in cfs	PH#1, units 1&3 170', 2-140' 8,800 cfs, PH#2-4&5 170'-7,200 cfs	150' 41,000 cfs	185' 54,000 cfs
51	Generator nameplate rating in kW	1&3: 43,500; 2: 18,250; 4&5: 40,000	3 - 121,600, 2 - 109,250	112,290
52	Plant capacity in kW	185,250	583,300	786,030
53	Dependable capacity in kW (9)	181,000	388,000	534,000
54	Avg. annual energy, million kWh (12)	1,048	2,253	2,635
55	Initial generation, first and last unit	July 1943 - June 1961	January 1956 - October 1960	April 1962 - June 1963
56	Estimated cost September 1999 completed project (13)	$158,428,000	$305,274,000	$346,521,000

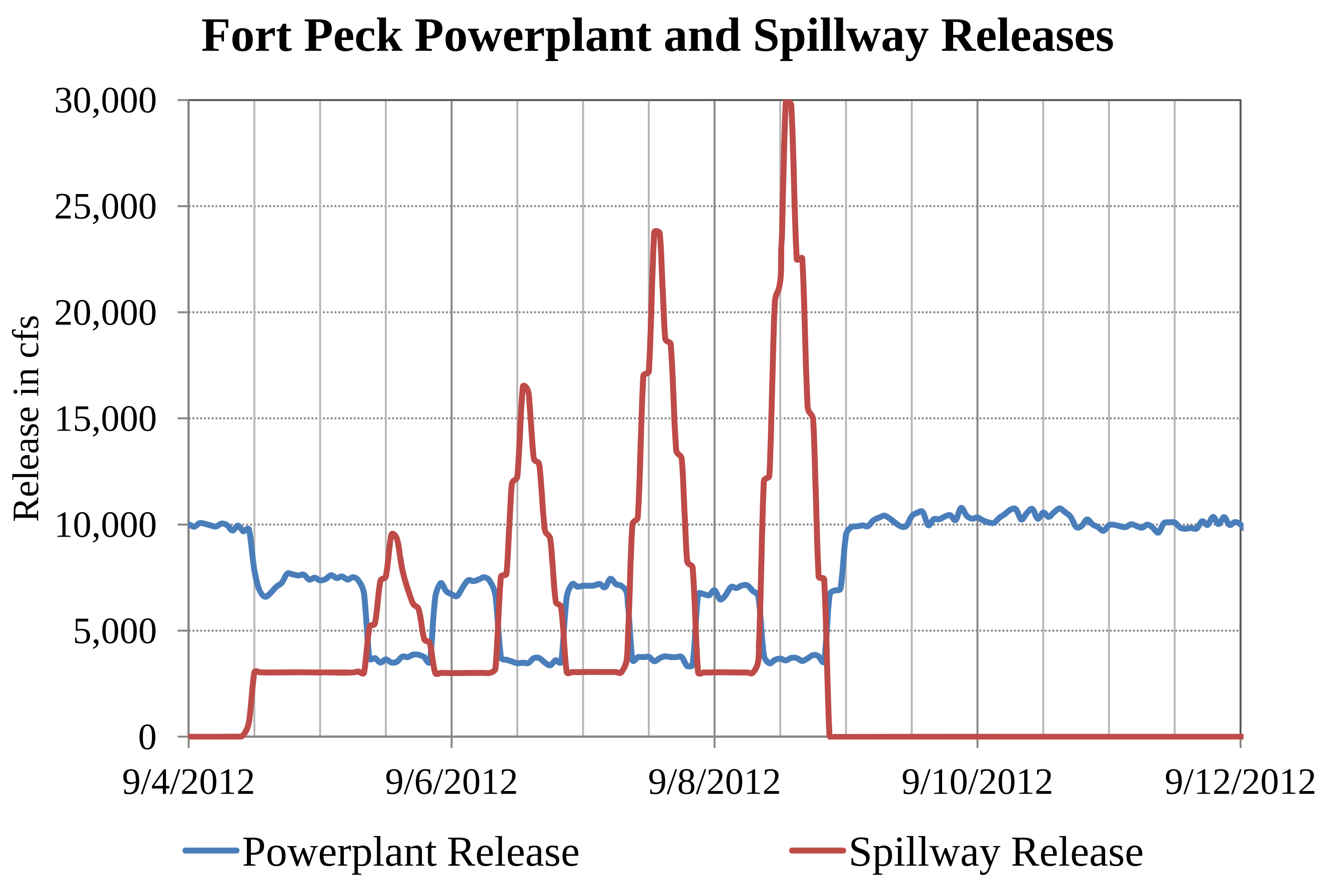
Summary of Engineering Data -- Missouri River Mainstem System

Big Bend Dam - Lake Sharpe	Fort Randall Dam - Lake Francis Case	Gavins Point Dam - Lewis & Clark Lake	Total	Item No.
21 miles upstream Chamberlain, SD	Near Lake Andes, SD	Near Yankton, SD		1
Mile 987.4	Mile 880.0	Mile 811.1		2
249,330 (1) 5,840	263,480 (1) 14,150	279,480 (1) 16,000		3
80, ending near Pierre, SD	107, ending at Big Bend Dam	25, ending near Niobrara, NE	755 miles	4
200 (elevation 1420)	540 (elevation 1350)	90 (elevation 1204.5)	5,940 miles	5
28,900	30,000 1,100	32,000 2,000		6
440,000 (April 1952)	447,000 (April 1952)	480,000 (April 1952)		7
1959	1946	1952		8
1964	1953	1955		9
1440	1395	1234		10
10,570 (including spillway)	10,700 (including spillway)	8,700 (including spillway)	71,596	11
78	140	45	863 feet	12
95	165	74		13
1200, 700	4300, 1250	850, 450		14
Pierre shale & Niobrara chalk	Niobrara chalk	Niobrara chalk & Carlile shale		15
Rolled earth, shale, chalk fill	Rolled earth fill & chalk berms	Rolled earth & chalk fill		16
17,000,000	28,000,000 & 22,000,000	7,000,000	358,128,000 cu. yds	17
540,000	961,000	308,000	5,554,000 cu. yds.	18
24 July 1963	20 July 1952	31 July 1955		19
Left bank - adjacent	Left bank - adjacent	Right bank - adjacent		20
1385	1346	1180		21
376 gated	1000 gated	664 gated		22
8 - 40' x 38' Tainter	21 - 40' x 29' Tainter	14 - 40' x 30' Tainter		23
390,000 at elev 1433.6	633,000 at elev 1379.8	584,000 at elev 1221.4		24
270,000	508,000	345,000		25
1423 msl 61,000 acres	1375 msl 102,000 acres	1210 msl 30,000 acres	1,188,000 acres	26
1422 msl 60,000 acres	1365 msl 95,000 acres	1208 msl 27,000 acres	1,140,000 acres	27
1420 msl 57,000 acres	1350 msl 77,000 acres	1204.5 msl 23,000 acres	986,000 acres	28
1415 msl 51,000 acres	1320 msl 38,000 acres	1204.5 msl 23,000 acres	446,000 acres	29
1423-1422 60,000 a.f.	1375-1365 985,000 a.f.	1210-1208 57,000 a.f.	4,664,000 a.f.	30
1422-1420 117,000 a.f.	1365-1350 1,309,000 a.f.	1208-1204.5 86,000 a.f.	11,639,000 a.f.	31
	1350-1320 1,607,000 a.f.		38,898,000 a.f.	32
1420-1345 1,621,000 a.f.	1320-1240 1,517,000 a.f.	1204.5-1160 307,000 a.f.	17,886,000 a.f.	33
1423-1345 1,798,000 a.f.	1375-1240 5,418,000 a.f.	1210-1160 450,000 a.f.	73,087,000 a.f.	34
November 1963	January 1953	August 1955		35
25 March 1964	24 November 1953	22 December 1955		36
5,300 a.f. 430 yrs.	18,400 a.f. 250 yrs.	2,600 a.f. 180 yrs.	89,700 a.f.	37
	Left Bank			38
None (7)	4 - 22' diameter	None (7)		39
	1013			40
	2 - 11' x 23' per conduit, vertical lift, cable suspension			41
1385 (11)	1229	1180 (11)		42
	Elev 1375 32,000 cfs - 128,000 cfs			43
1351-1355(10) 25,000-100,000 cfs	1228-1239 5,000-60,000 cfs	1155-1163 15,000-60,000 cfs		44
70	117	48	764 feet	45
None: direct intake	8 - 28' dia., 22' penstocks	None: direct intake		46
	1,074		55,083	47
None	59' dia, 2 per alternate penstock	None		48
8 Fixed blade, 81.8 rpm	8 Francis, 85.7 rpm	3 Kaplan, 75 rpm	36 units	49
67' 103,000 cfs	112' 44,500 cfs	48' 36,000 cfs		50
3 - 67,276, 5 - 58,500	40,000	44,100		51
494,320	320,000	132,300	2,501,200 kw	52
497,000	293,000	74,000	1,967,000 kw	53
983	1,728	726	9,372 million kWh	54
October 1964 - July 1966	March 1954 - January 1956	September 1956 - January 1957	July 1943 - July 1966	55
$107,498,000	$199,066,000	$49,617,000	$1,166,404,000	56

Remarks

(1) Includes 4,280 square miles of non-contributing areas.
(2) Includes 1,350 square miles of non-contributing areas.
(3) With pool at base of flood control.
(4) Storage first available for regulation of flows.
(5) Damming height is height from low water to maximum operating pool. Maximum height is from average streambed to top of dam.
(6) Based on latest available storage data.
(7) River regulation is attained by flows over low-crested spillway and through turbines.
(8) Length from upstream face of outlet or to spiral case.
(9) Based on 8th year (1961) of drought drawdown (From study 8-83-1985).
(10) Affected by level of Lake Francis case. Applicable to pool at elevation 1350.
(11) Spillway crest.
(12) 1967-2011 Average
(13) Source: Annual Report on Civil Works Activities of the Corps of Engineers. Extract Report Fiscal Year 1999.
(14) Based on Study 8-83-1985

Corps of Engineers, U.S. Army
Compiled by
Northwestern Division
Missouri River Region
August 2012



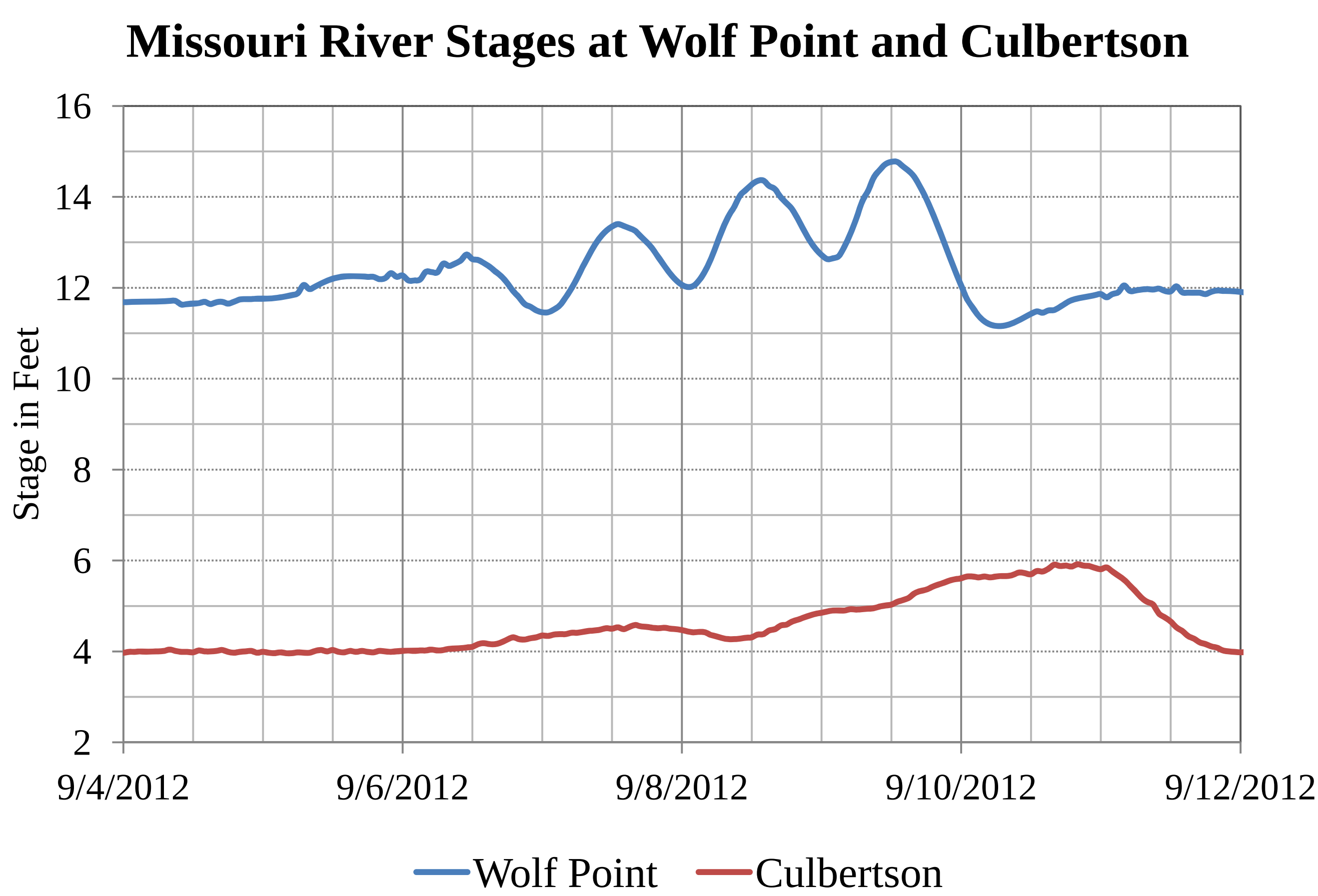
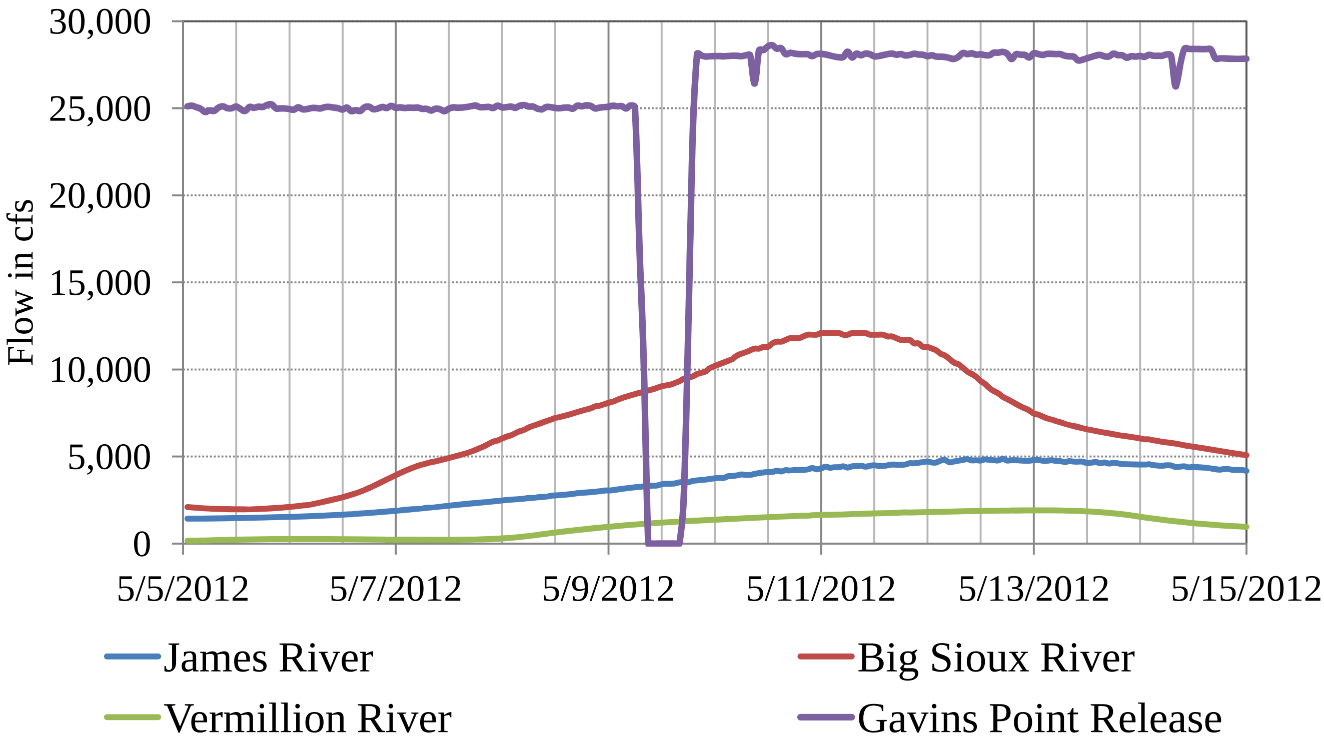


Plate 3. Fort Peck Spillway Assessment – Downstream Flows and Stages

Gavins Point Release and James, Big Sioux and Vermillion River Flows



Missouri River Stages at Yankton, Sioux City and Omaha

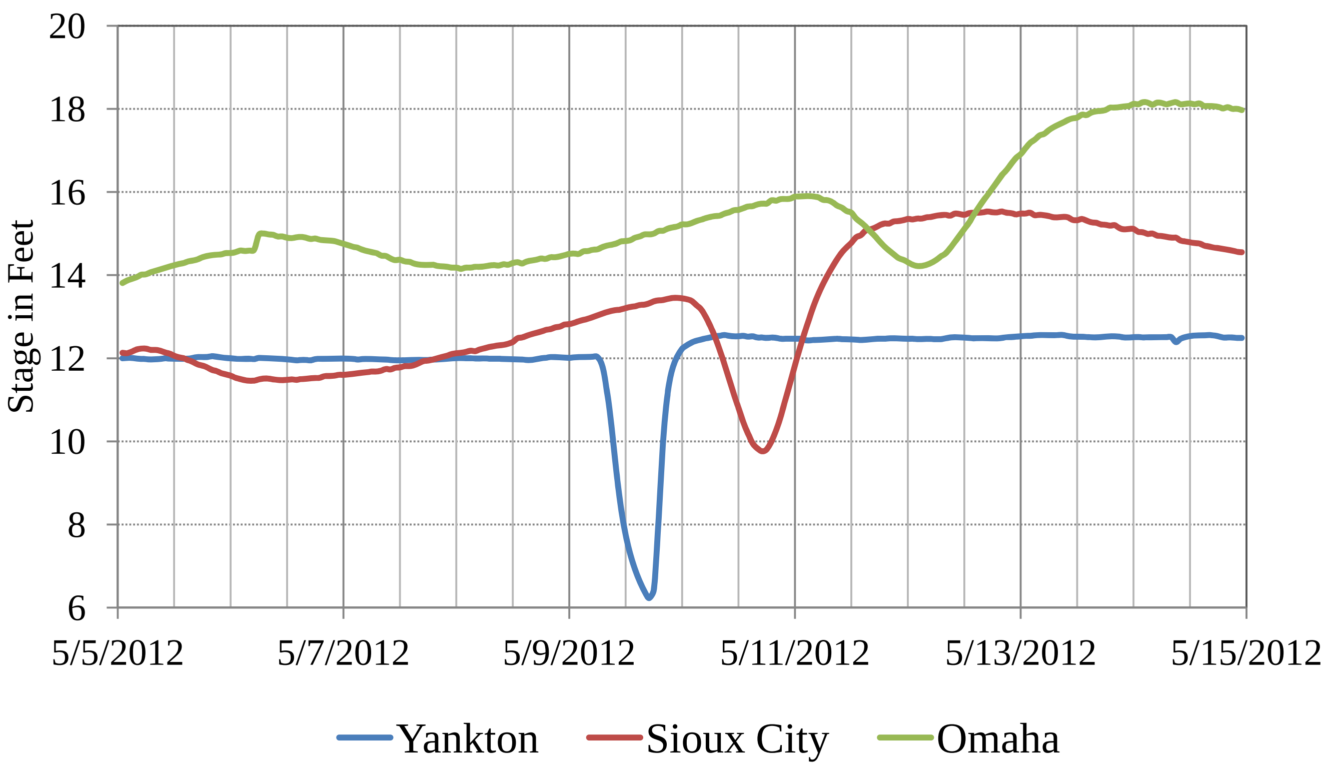


Plate 4. Gavins Point Spillway Slab Assessment – Downstream Flows and Stages

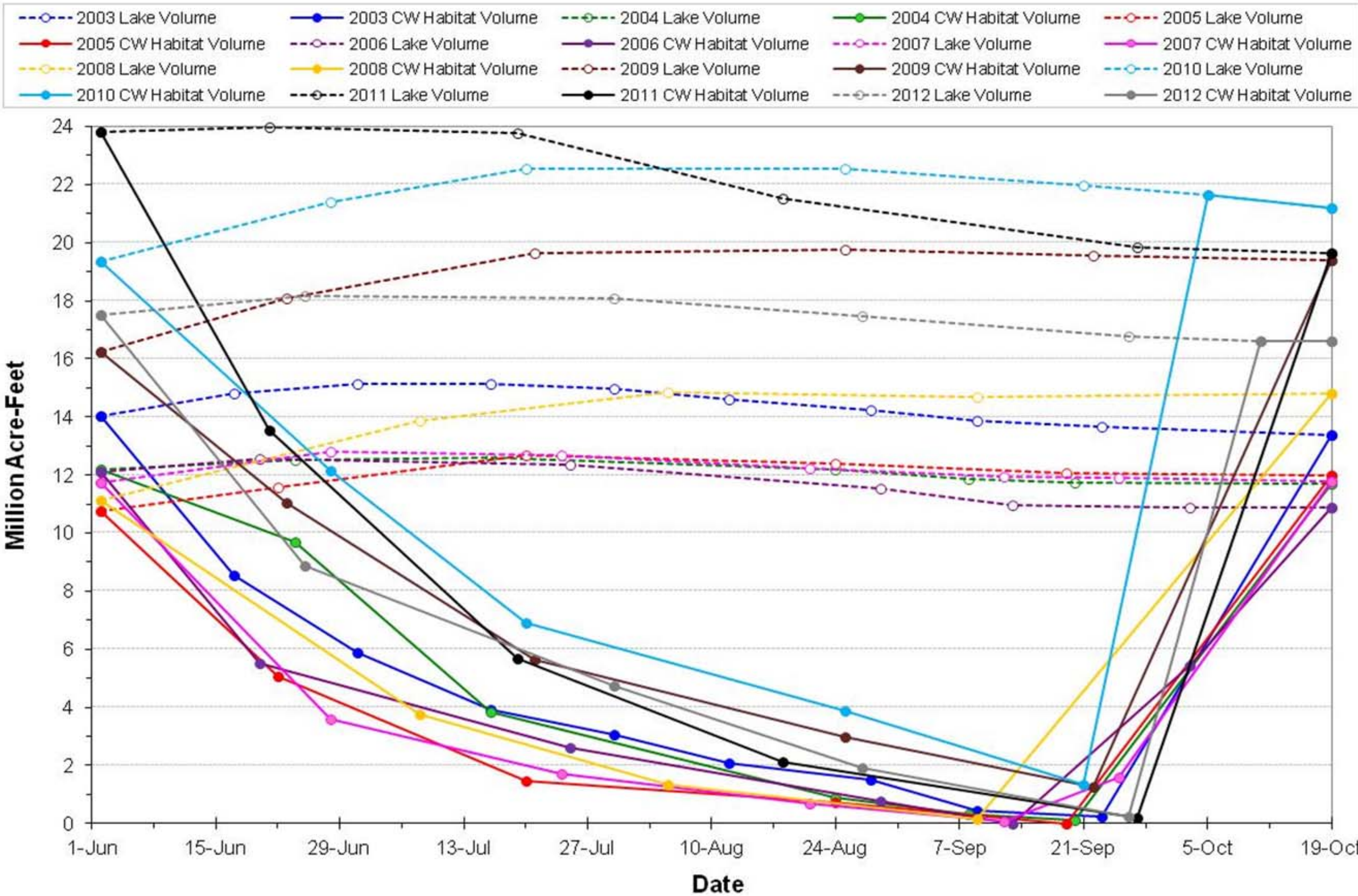


Plate 5. Garrison Reservoir - estimated reservoir and coldwater habitat 2003 through 2012.

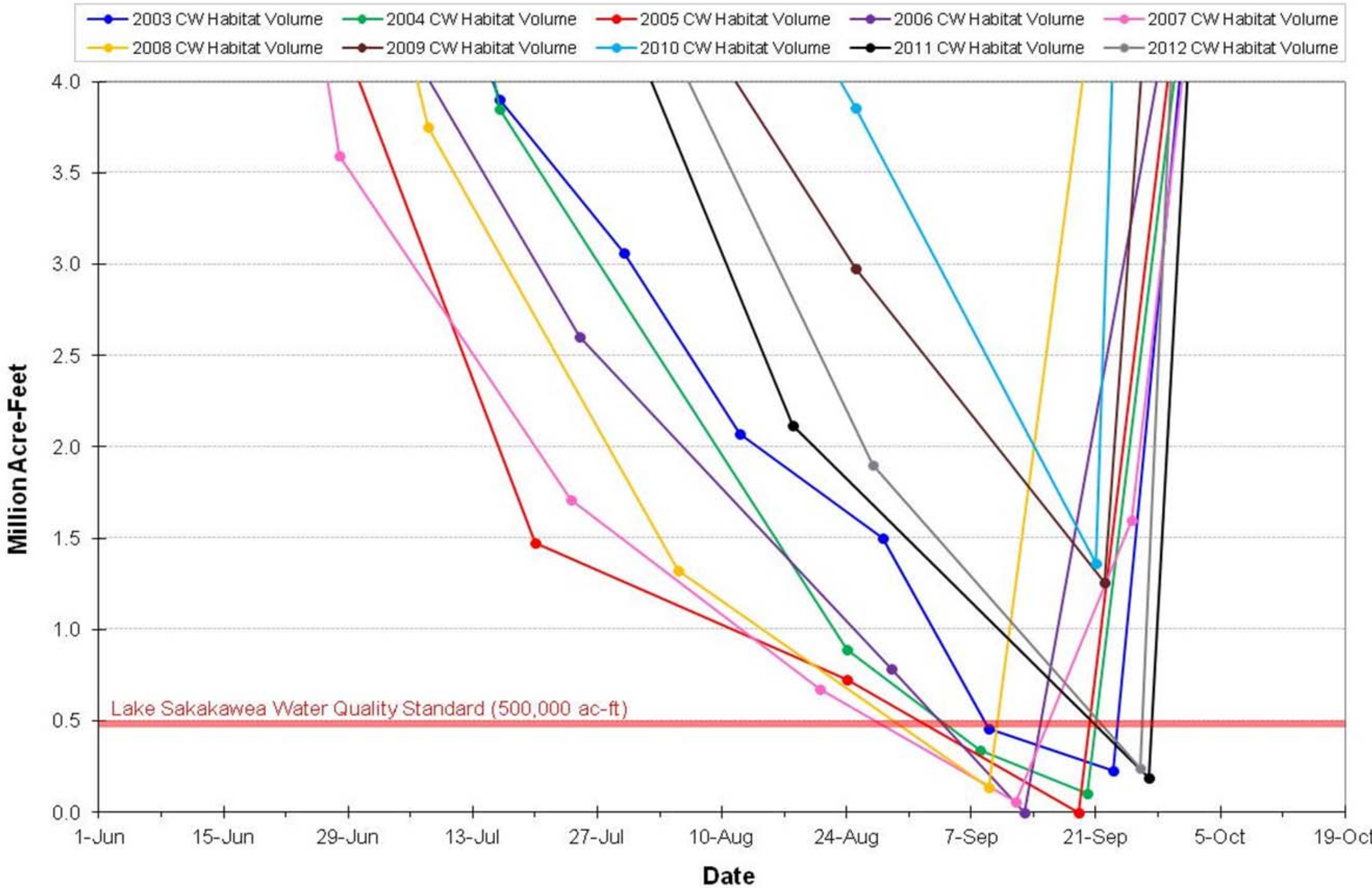


Plate 6. Garrison Reservoir - estimated reservoir and coldwater habitat 2003 through 2012 (exploded view).

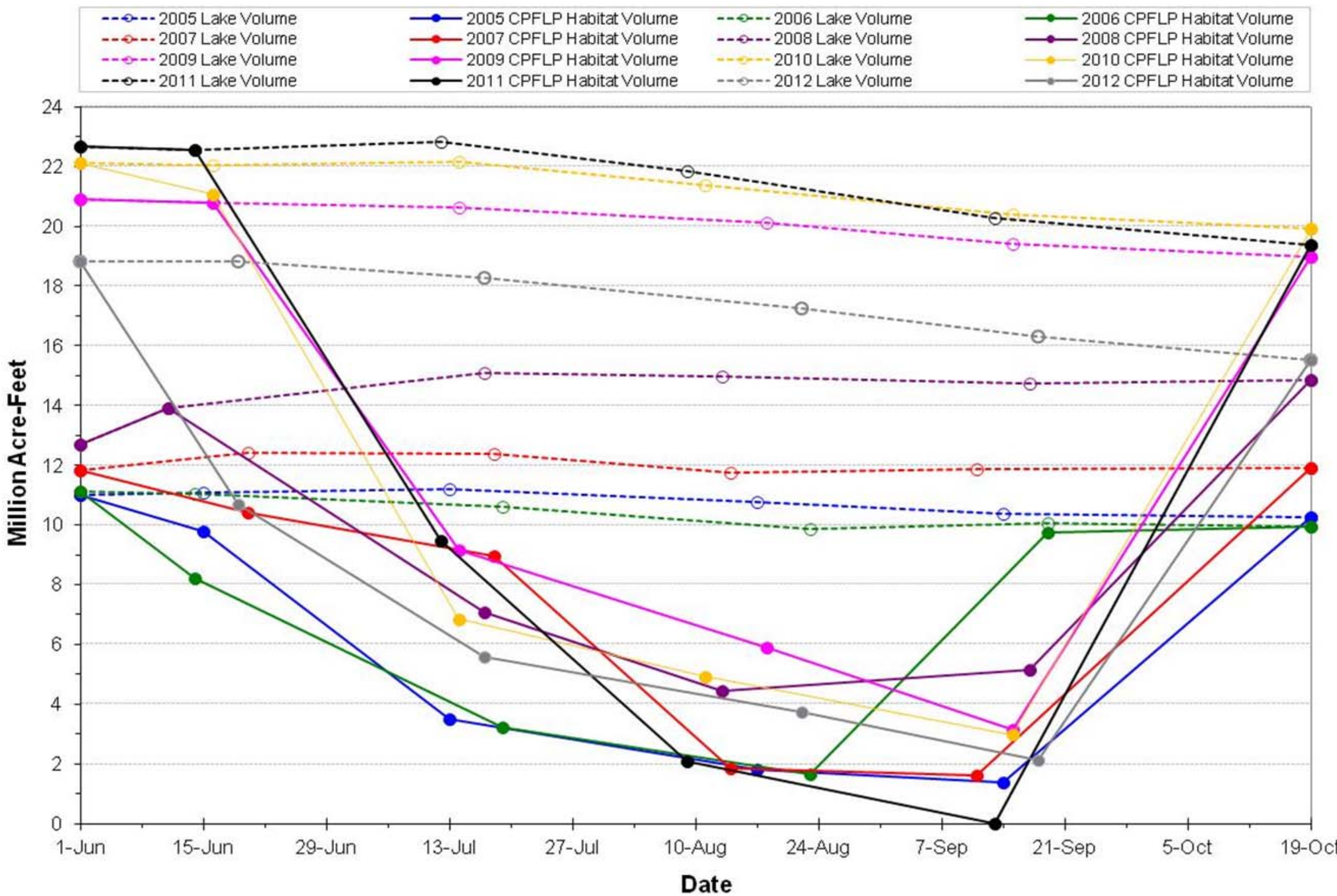


Plate 7. Oahe Reservoir - estimated reservoir and coldwater habitat 2005 through 2012.