THE RECORD FLOOD OF 1993

by

JOHN DREW AND CHARLES DuCHARME

1993

OPEN FILE REPORT SERIES

OFR-93-95-WR

Missouri
Department of
Natural Resources

Geological Survey and Resource Assessment Division
P.O. Box 250, Rolla, MO 65402-0250
PHONE (573) 368-2125 FAX (573) 368-2481
E-MAIL gsradpubs@dnr.state.mo.us

Integrity and excellence in all we do

THE RECORD FLOOD OF 1993

by

John Drew

and

Charles DuCharme

1993

OFR-93-95-WR

OPEN FILE REPORT SERIES

MISSOURI DEPARTMENT OF NATURAL RESOURCES

Division of Geology and Land Survey

FORWARD

This publication responds to both public and private needs for information about the 1993 flood in the Missouri and Mississippi River basins. The report draws upon information specific to Missouri published by a variety of government agencies who are collecting and disseminating flood related data. Referencing such diverse information enables us to make historic flood comparisons. For example, the 1993 flood heights are compared with those published in National Flood Insurance Program Studies.

Some points to consider when reading this publication:

1. The data collected during the 1993 flood is preliminary; therefore some of the information presented in this report may be revised as the values are finalized.

2. Because of the magnitude of the 1993 flood event, the published statistics will need to be revisited to include the 1993 event. I expect the larger flood events will be of greater frequency due to the magnitude of the 1993 and 1980 Midwestern floods.

3. I question the validity of the statistical procedures related to the 1993 event. The adjustment procedures which account for significant changes in runoff and channel hydraulics are inadequate. The commonly used statistics are weak in predicting events of large frequency intervals. Climate is changing over time and is cyclic or evolving. Climate changes may influence increased variability for both floods and drought. Combinations of these three concerns may be linked to having the recorded high in August 1993 and low flows in the 1988-1989 drought.

Steve McIntosh, Director
Water Resources Program

LIST OF CHARTS

THE RECORD FLOOD OF 1993

Much of Missouri was subjected to major flooding through the Spring and Summer of 1993. The flood severity was such that as of August 19th, 77 counties and the City of St. Louis were included in a Presidential Disaster Declaration for individual assistance. Chart 1, lists those places declared for individual assistance.[1] This assistance provides relief to private citizens affected by the flood.

This flooding was the result of abnormally high precipitation occurring over a large geographic area during a several month period. At its mouth, the Missouri River has a drainage area of approximately 529,000 square miles.[2] The Mississippi River at St. Louis has a contributing drainage area of about 697,000 square miles.[3] On several occasions, rainfall amounts in many areas of the Missouri and Upper Mississippi River basins were commonly five to seven inches over a 24 hour period.[2] Some locations experienced 24 hour precipitation exceeding 10 inches.[4]

Flood levels on the Missouri River would have been higher without the storage capacity of the reservoirs located in the basin. Missouri River main stem reservoirs gained 5.3 million acre feet of water in storage during July.[5] One acre-foot equals 43,560 cubic feet. After experiencing drought the last six years, the high precipitation sent the lower four of the six main stem reservoirs into flood stage.[6] The main stem reservoirs ended August with 57.2 million acre-feet of water in storage, 12.4 million acre-feet higher than the previous August.[7]

The U.S. Army Corps of Engineers reported that at the end of July, 8.7 million acre-feet of water were contained in flood control pools of reservoirs located in their Kansas City District.[6] Truman Reservoir crested on August 3, 1993, at an elevation of 735.20, with 79 percent of the flood control pool filled.[7]

In Missouri, Worth County reported 29 inches of precipitation during July.[8] This amount is seven times the long term average and 18 inches greater than the previous record for the county, a record set in July, 1958.[9] During June and July, of 1993, Worth County reported almost 40 inches of precipitation.[6] They reported 51.52 inches of precipitation from January to July of this year; 17 inches more than their average annual precipitation. Even with no further precipitation during 1993 the total annual precipitation record set in 1973 would be exceeded by almost five inches. Chart 2, shows July 1993 precipitation totals for each county in the State.

The National Weather Service reported that 33 river stage records were broken in 1993. St. Joseph set a new record stage at 32.69 feet on July 25, 1993, almost six feet above the previous record set in April 1952.[9] Chart 3 lists those records.

The U.S. Geological Survey measured streamflow at many stations during the flood including several very near the crest. From the preliminary discharge

measurements and calculated frequency discharges listed in National Flood Insurance Program (Flood Insurance Studies), it appears that the frequency of the event on both the Missouri and Mississippi Rivers near the top of the state compares to about a 500-year event (0.2% chance of occurrence in any given year). Nearer St. Louis it appears that these rivers crested closer to a 100-year event (1% chance of occurrence in any given year).[10,11-31]

The flow of the Mississippi River at St. Louis exceeded one million cubic feet per second. Chart 4 lists some of the discharge measurements made by the U.S. Geological Survey. It also lists 100-year and 500-year frequency discharges at several locations.

Velocity measurements are taken in computing streamflow. Based on preliminary data, the U.S. Geological Survey measured a maximum velocity of 19 feet per second (13 miles per hour) on the Missouri River at St. Charles. Preliminary data from a measurement of the Mississippi River at Chester, Illinois, shows a maximum velocity of 16 feet per second (11 miles per hour). Preliminary data for the Missouri River at Boonville shows a maximum velocity of 10.6 feet per second (7.2 miles per hour), and a maximum velocity of 7.6 feet per second (5.2 miles per hour) in the overbank area.[32,33]

All of these velocities are point measurements, measured on days near the river crests. When more data become available many additional velocity measurements (across the entire cross section) will probably be lower than these maximums. But as proven by some of the destruction, velocities were high enough to cause severe damage including widespread scour and transport of large sand deposits on some sections of the Missouri River floodplain.

Along the Missouri and Mississippi Rivers there are primary gaging stations that measure water level (stage) at specific locations along the river. At these stations the U.S. Geological Survey has rating tables which relate stage to flow. At a few other locations along the two rivers, stage is recorded (usually daily) but no rating tables have been developed to relate stage to flow. Stage is measured relative to a base datum. Zero stage is often the bottom of the river, but because rivers change elevation over time, this is not always true.

Chart 5 displays river stage information for several locations along the Mississippi and Missouri rivers.

Flood stage is the approximate elevation that flooding begins. For this report river stage has been converted to feet above flood stage. Since stage is based on a somewhat arbitrary reference point (base datum), feet above flood stage is possibly more meaningful.

On the Mississippi River, St. Louis had the highest reported stage of any stations in Missouri. It crested at 49.3 feet. However, it was 20 feet above flood stage while Chester Illinois across the Mississippi River from St. Marys, Missouri, reported a lower stage, 48.14 feet, but was 23 feet above flood stage. At Melvin Price Lock and Dam near Alton, Illinois, the stage reached 42.72 feet and was 22 feet above flood stage.

On the Missouri River, Kansas City reached the highest stage at 48.8 feet but was not quite as high above flood stage as the Missouri River at Gasconade, Missouri (261 miles down stream), which was 18 feet above flood stage. Chart 6 displays this information for several locations along the Mississippi and Missouri Rivers.

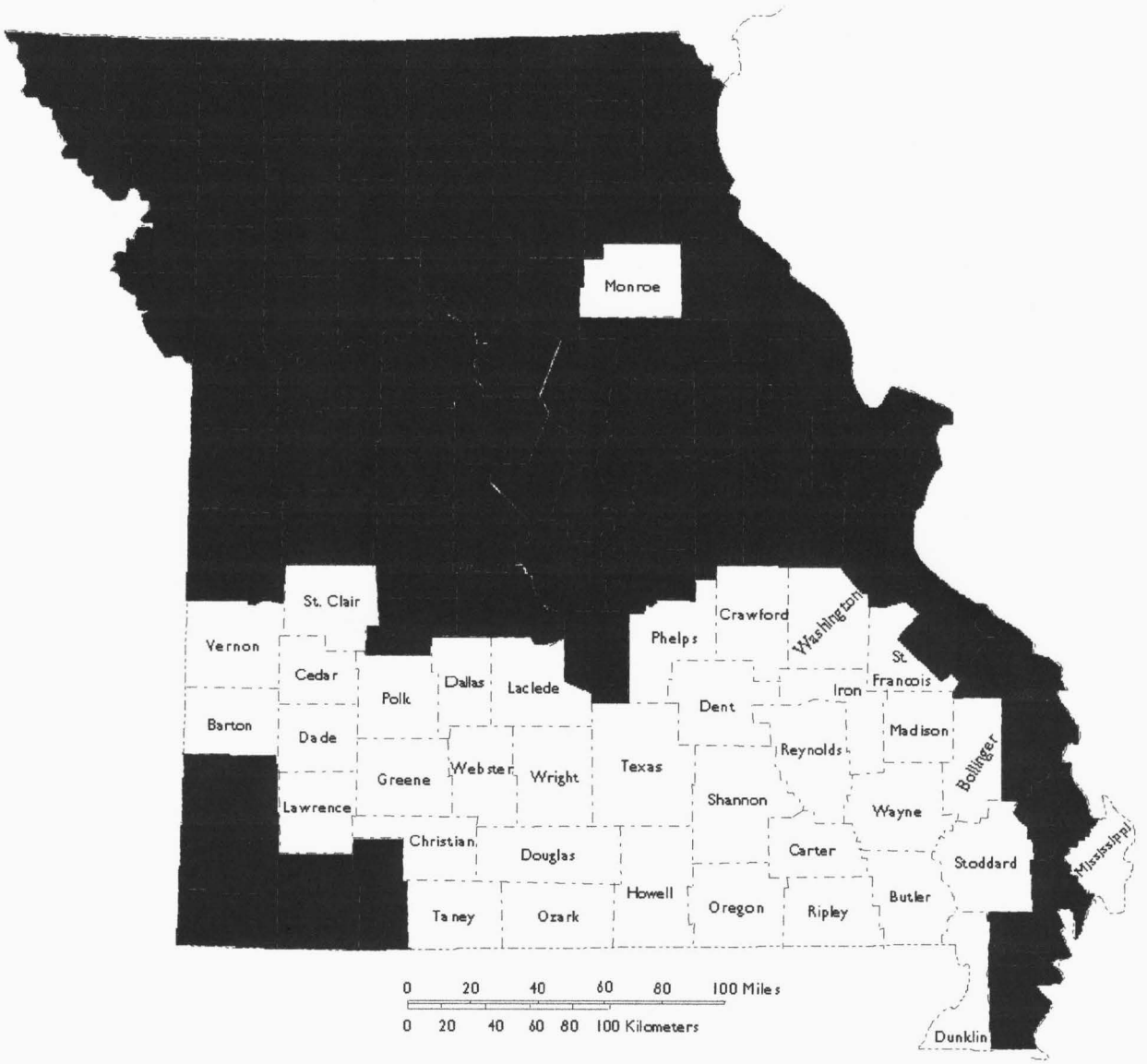
The National Flood Insurance Program (NFIP) uses the 100-year or Base Flood Elevation to regulate development in Special Flood Hazard Areas. For this report stage recordings were converted to elevation (m.s.l.). This allows a comparison of flood heights during this flood with the predicted frequency flood heights* used by the Federal Emergency Management Agency and the National Flood Insurance Program. As displayed on the attached graphs, the Missouri River was below the 100-year flood elevation for much of July. Very little damage to structures built to NFIP construction standards would be expected when flooding is below the Base Flood Elevation. Chart 7 displays daily instantaneous stages for many locations along the Mississippi and Missouri Rivers.

In Missouri, almost all of the Special Flood Hazard Areas along the Missouri and Mississippi River are regulated by local government. These communities follow federal standards to regulate new development and substantially improved structures located in the identified Special Flood Hazard Areas. These regulations include building standards to help protect the safety and financial well being of our citizens. Also, a Regulatory Floodway has been established to prevent encroachment in the floodplain that would increase flood heights of the 100-year flood beyond a set limit (normally one foot). The National Flood Insurance Program does not address encroachment that raises flood heights of other frequency floods (for example the 10-year or 500-year frequency floods).

* frequency flood heights were computed by inputting estimated frequency discharges into water surface profile models (usually HEC 2 computer model).

Chart 1
Counties and Cities Included in Federal Disaster Declaration
(Individual Assistance)

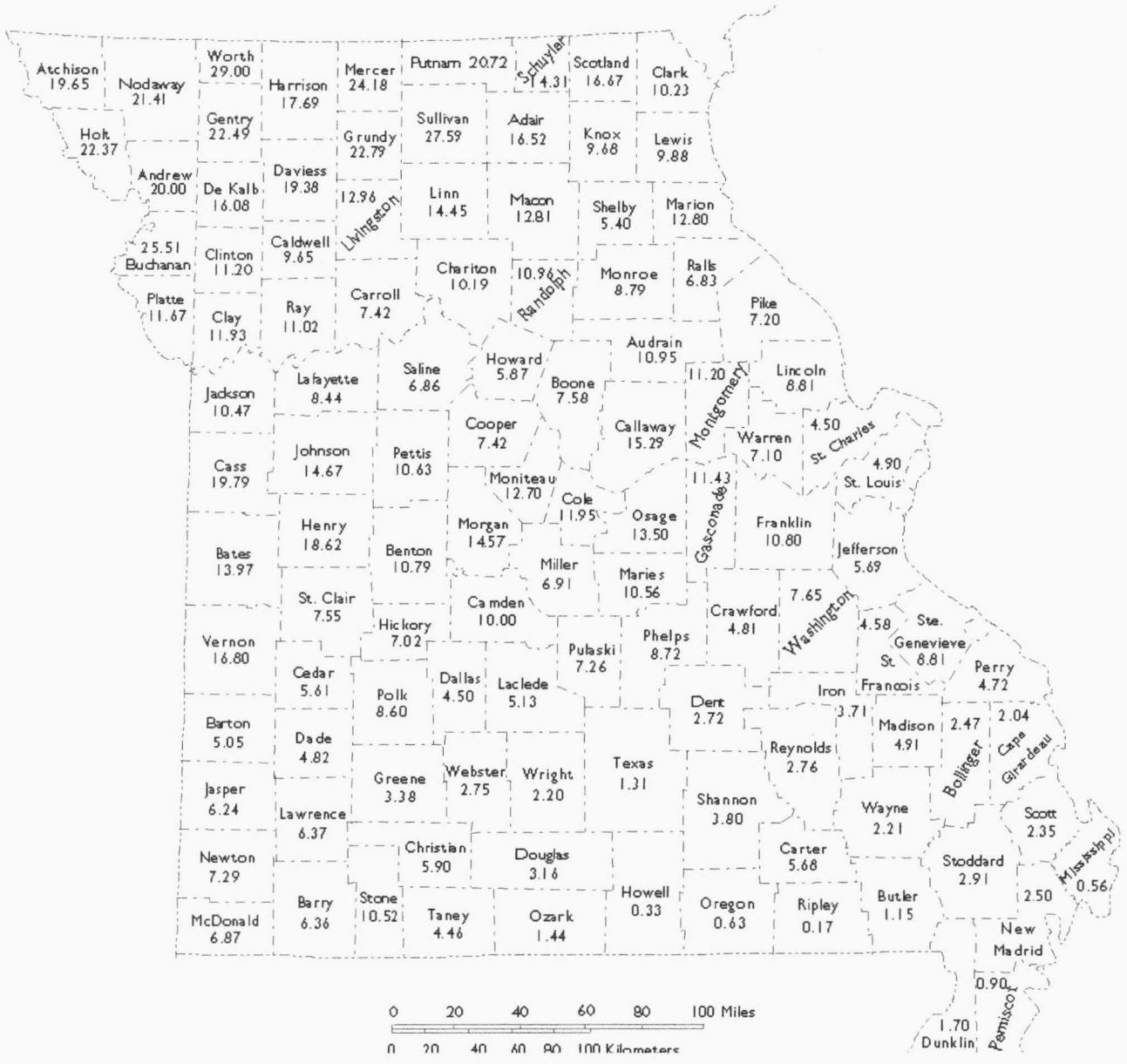
Adair	Carroll	Grundy	Lincoln	Newton	St. Charles
Andrew	Cass	Harrison	Linn	Nodaway	St. Louis
Atchison	Chariton	Henry	Livingston	Osage	St. Louis City
Audrain	Clark	Hickory	Macon	Pemiscot	St. Genevieve
Barry	Clay	Holt	Maries	Perry	Saline
Bates	Clinton	Howard	Marion	Pettis	Schuyler
Benton	Cole	Jackson	McDonald	Pike	Scotland
Boone	Cooper	Jasper	Mercer	Platte	Scott
Buchanan	Daviess	Jefferson	Miller	Pulaski	Shelby
Caldwell	DeKalb	Johnson	Moniteau	Putnam	Stone
Callaway	Franklin	Knox	Montgomery	Ralls	Sullivan
Camden	Gasconade	Lafayette	Morgan	Randolph	Warren
Cape Girardeau	Gentry	Lewis	New Madrid	Ray	Worth



8/19/93

Chart 2

Precipitation for the Month of July 1993



Average precipitation for the month of July 1993: 9.48 inches.

Precipitation information provided by ASCS County Offices.

Chart 3
Preliminary Record River Stages

Location	New record stage/date		Previous record stage/date	
MISSOURI RIVER				
St. Joseph	32.69	07/25	26.8	04/22/52
Atchison	30.7	07/15	29.5	04/22/52
Kansas City	48.8	07/27	46.2	07/14/51
Napoleon	27.6	07/27	26.8	07/15/51
Waverly	31.1	07/28	29.2	06/23/84
Miami	32.6	07/30	29.0	07/16/51
Glasgow	39.5	07/30	36.7	07/18/51
Boonville	37.1	07/30	32.8	07/17/51
Jefferson City	38.3	07/31	34.2	07/18/51
Gasconade	39.6	07/31	38.6	10/05/86
Hermann	36.3	07/31	35.8	10/05/86
St. Charles	39.6	08/02	37.5	10/07/86
MISSISSIPPI RIVER				
Gregory Landing	26.4	07/07	24.58	04/24/73
Quincy	32.2	07/13	28.9	04/25/73
Hannibal	31.8	07/15	28.59	04/25/73
Louisiana	28.3	07/29	27.05	04/24/73
Clarksville	37.7	07/29	36.76	04/24/73
Winfield	39.6	08/01	36.93	04/27/73
Grafton	38.15	08/01	33.12	04/28/73
Mel Price (Alton, IL)	42.72	08/01	36.6	04/29/73
St. Louis	49.43	08/01	43.2	04/28/73
Chester	48.14	08/01	43.3	04/30/73
Cape Girardeau	46.9	08/03	45.55	05/01/73

Information from the National Weather Service, St. Louis, Missouri—08/04/93

(Chart 3 continued)

Location	New record stage/date		Previous record stage/date	
GRAND RIVER				
Pattonsburg	37.6	07/24	34.3	06/05/47
Gallatin	42.0	07/24	42.0	07/08/09
Chillicothe	39.0	07/25	34.7	05/06/91
Sumner	42.1	07/10	39.5	06/07/47
Brunswick	34.5	07/29	26.3	06/12/84
PLATTE RIVER				
Agency	35.9	07/25	35.1	07/20/65
Sharps Station	36.4	07/26	34.6	06/12/84
LAMINE RIVER				
Clifton City	36	07.09	35.3	1903
MARMATON RIVER				
Nevada	47.2	07/24	46.0	10/04/86
MOREAU RIVER				
Jefferson City	29	07/08	29.0*	10/04/86

Information from the National Weather Service, St. Louis, Missouri—08/04/93

*According to the USGS this record is 39.05 on 10/03/86.

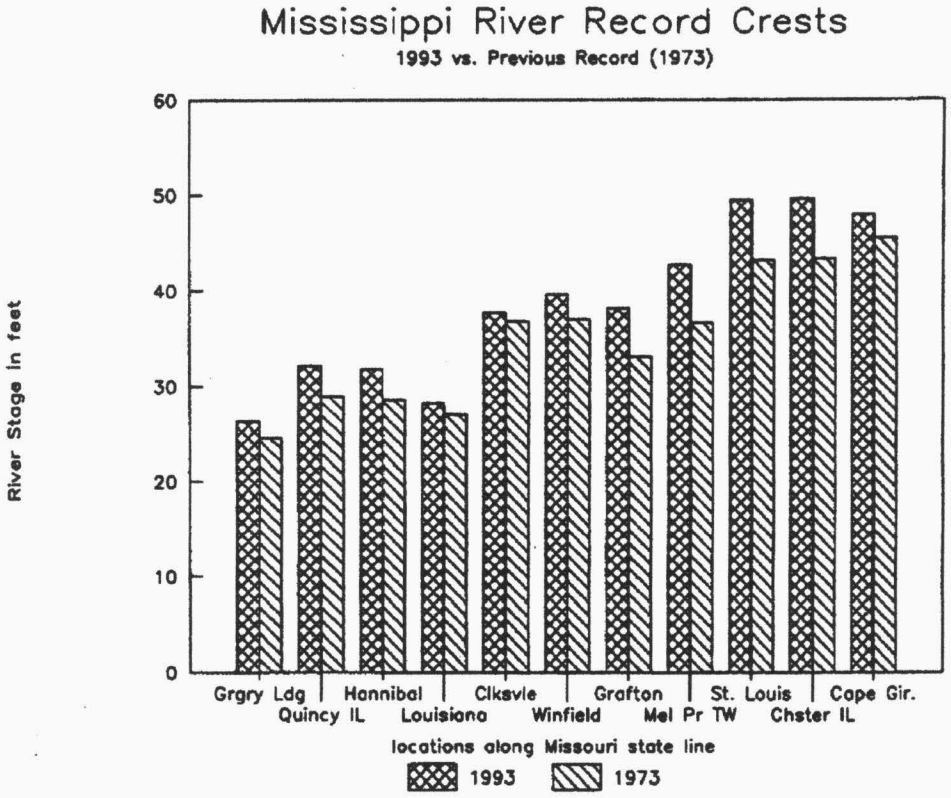
Chart 4
Missouri and Mississippi River
Significant Discharges

Calculated discharges with 100 and 500 year frequency recurrences were taken from NFIP Flood Insurance Studies at respective locations. 1993 measured discharges were made by the U.S. Geological Survey.

Note: 1993 measured discharges are preliminary.

Location	100 Year dicharge	500 Year discharge	1993 meas. discharge	date measured
MISSOURI RIVER				
St. Joseph	270000	333000	400000	07/26/93
Kansas City, Mo.	434000	549000	541000	07/27/93
Sibley	434000	549000		
Napoleon	439000	554000		
Miami	445000	560000		
Glasgow	528000	670000		
Boonville	550000	700000	717000	07/29/93
Jefferson City	550000	700000		
Gasconade	610000	800000		
Hermann	620000	820000	748000	07/31/93
St. Charles	620000	820000	693000	08/01/93
MISSISSIPPI RIVER				
Hannibal	377000	444000		
Louisiana	410000	500000	493000	07/29/93
Dam 24, Clarksville	410000	500000		
Dam 25, Winfield	410000	500000		
Grafton	510000	620000		
Melvin Price TW	510000	620000		
St. Louis	1020000	1250000	1030000	07/31/93
Chester, Il.	1090000	1380000	944000	08/05/93
Cape Girardeau	1140000	1400000		
New Madrid	1880000 (80 yr)	2360000 (Project Design)		
Caruthersville	1960000	N/A		

Chart 5
Record River Stages,
Comparison with Previous Record



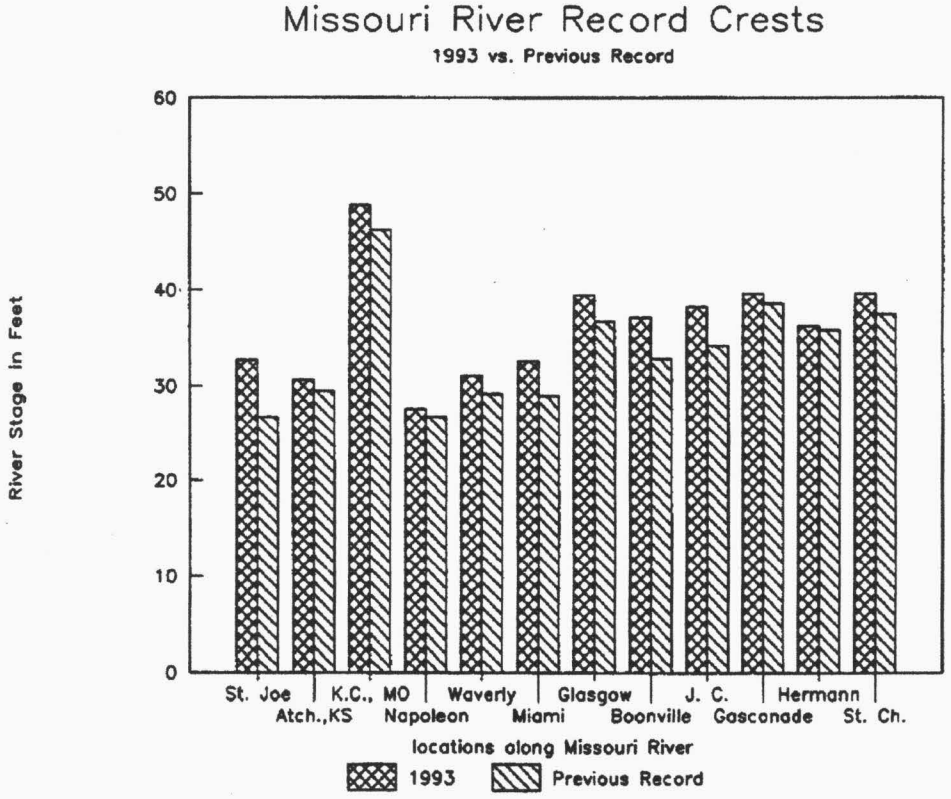
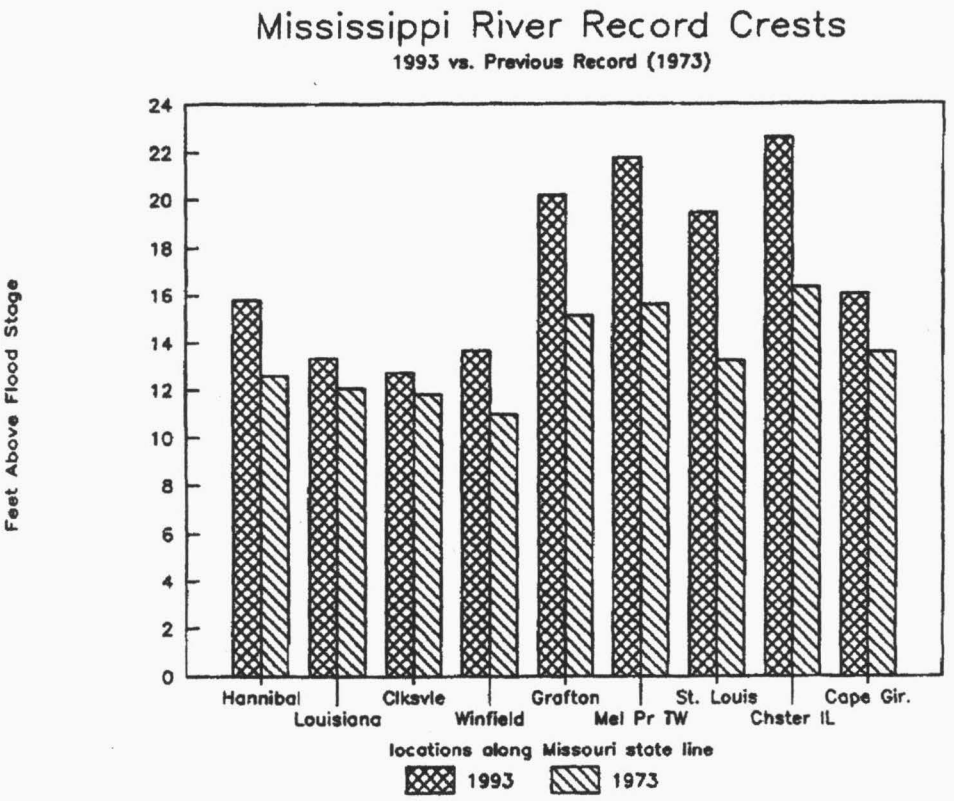


Chart 6
River Crests, Feet above Flood Stage



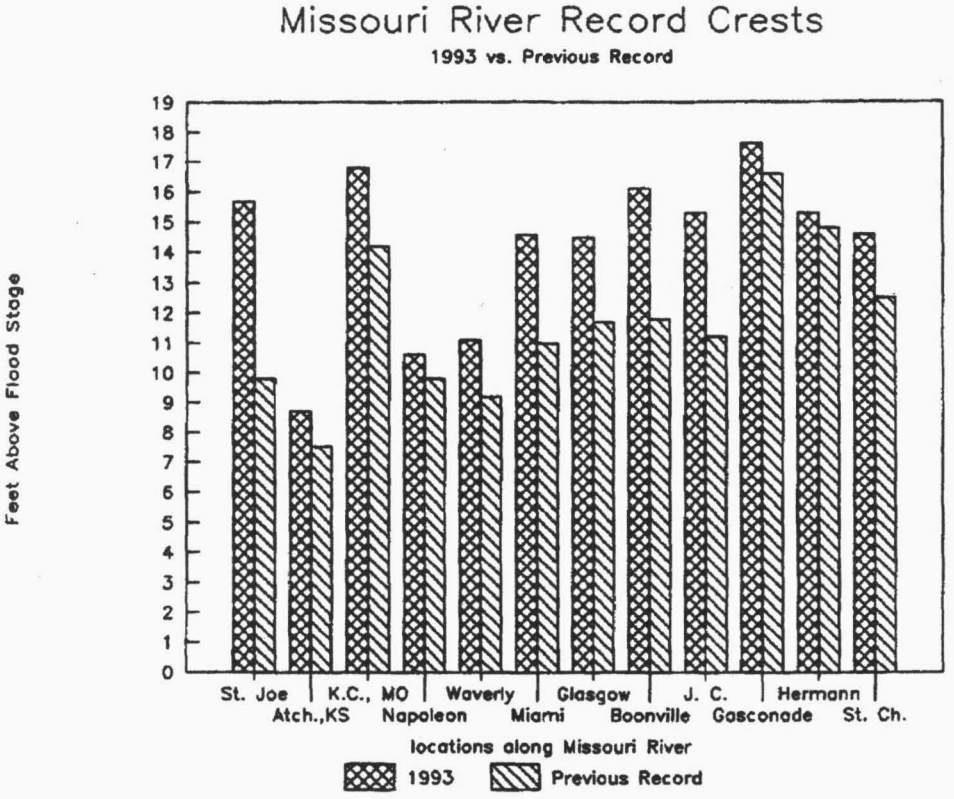
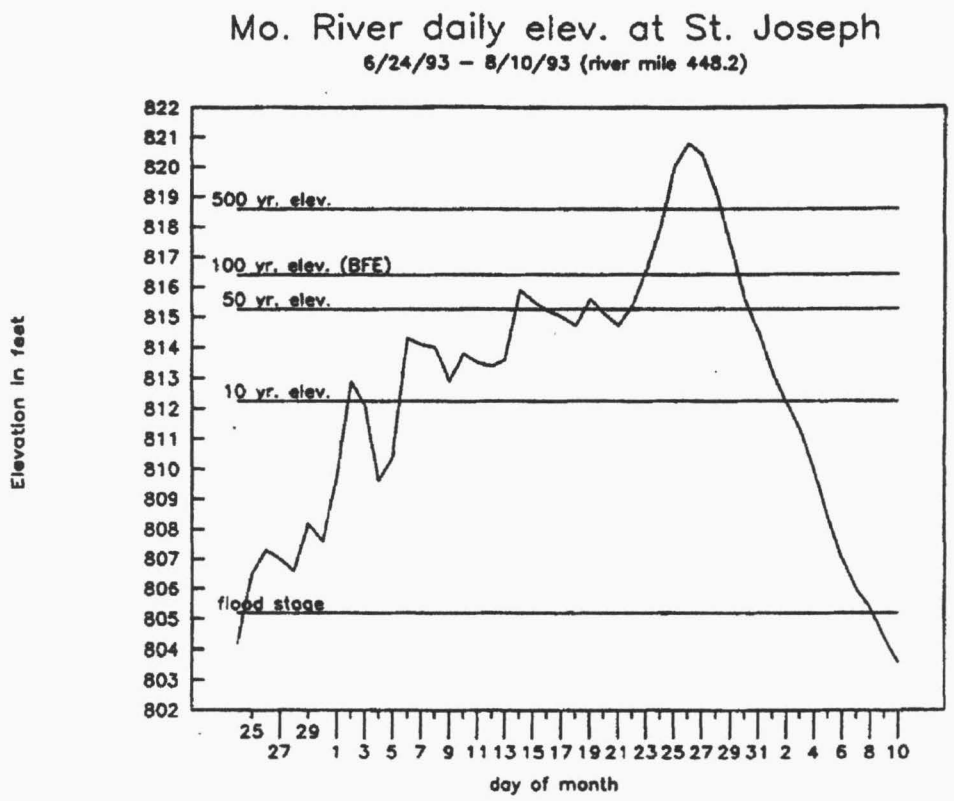
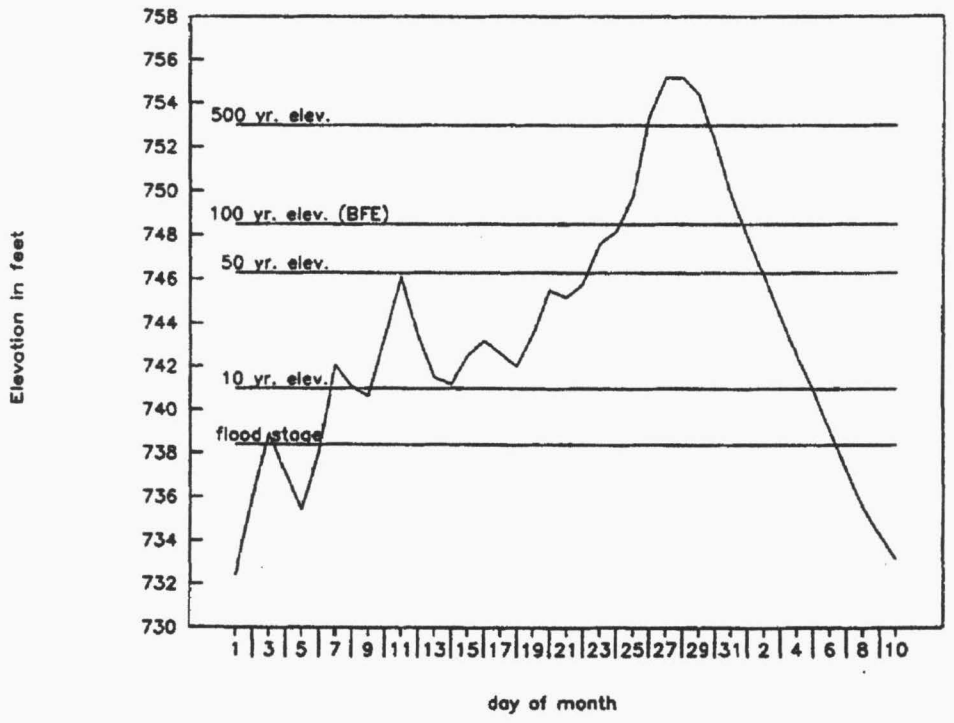
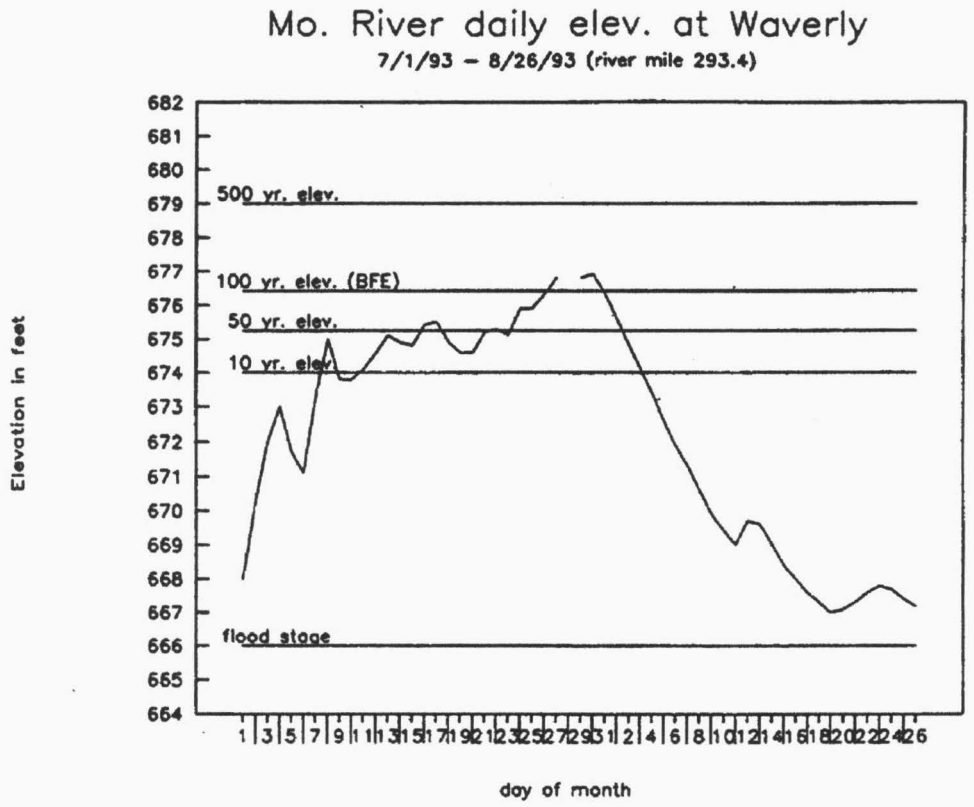


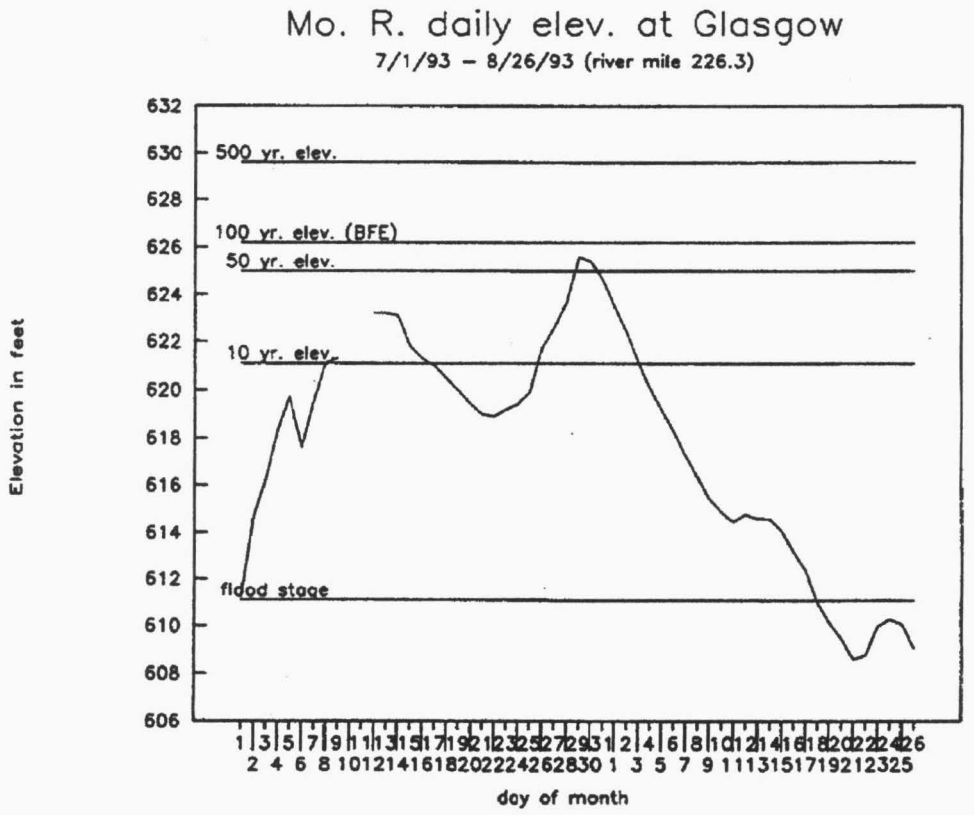
Chart 7
Daily River Elevation



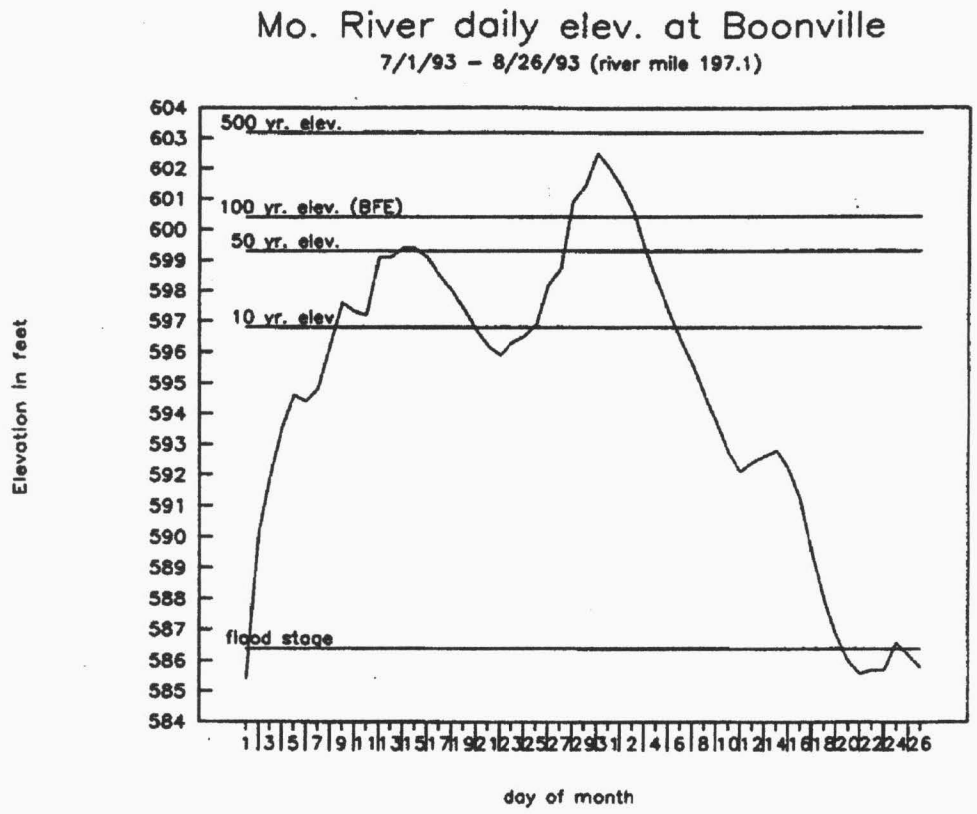


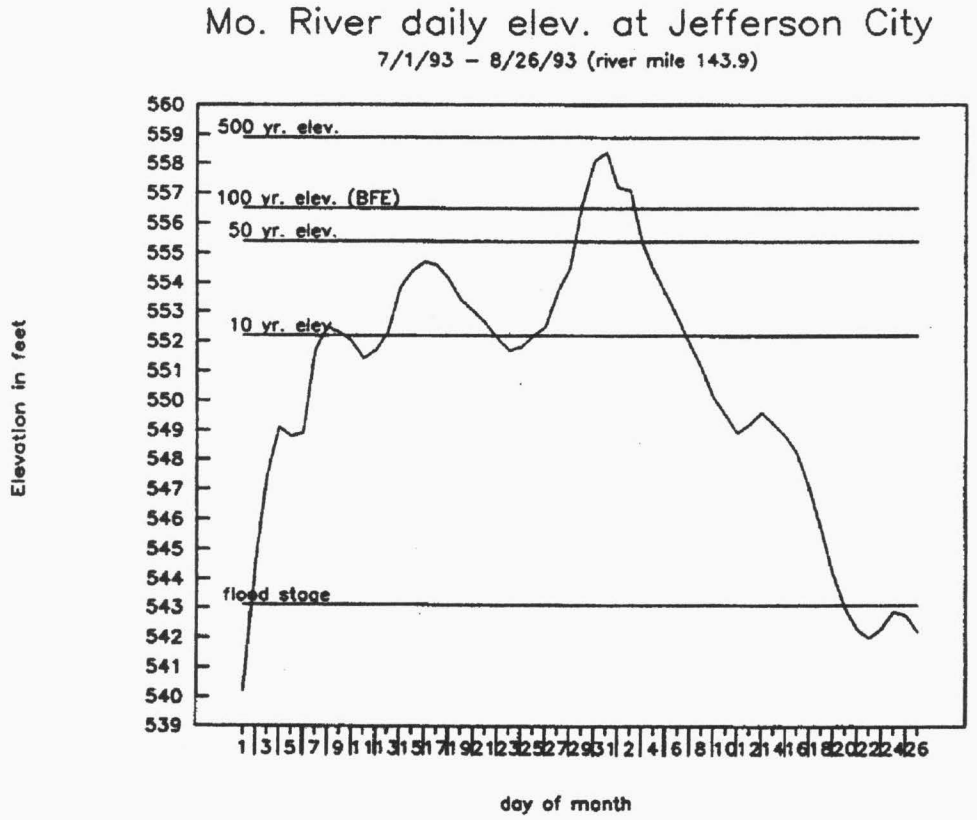
(Chart 7 continued)



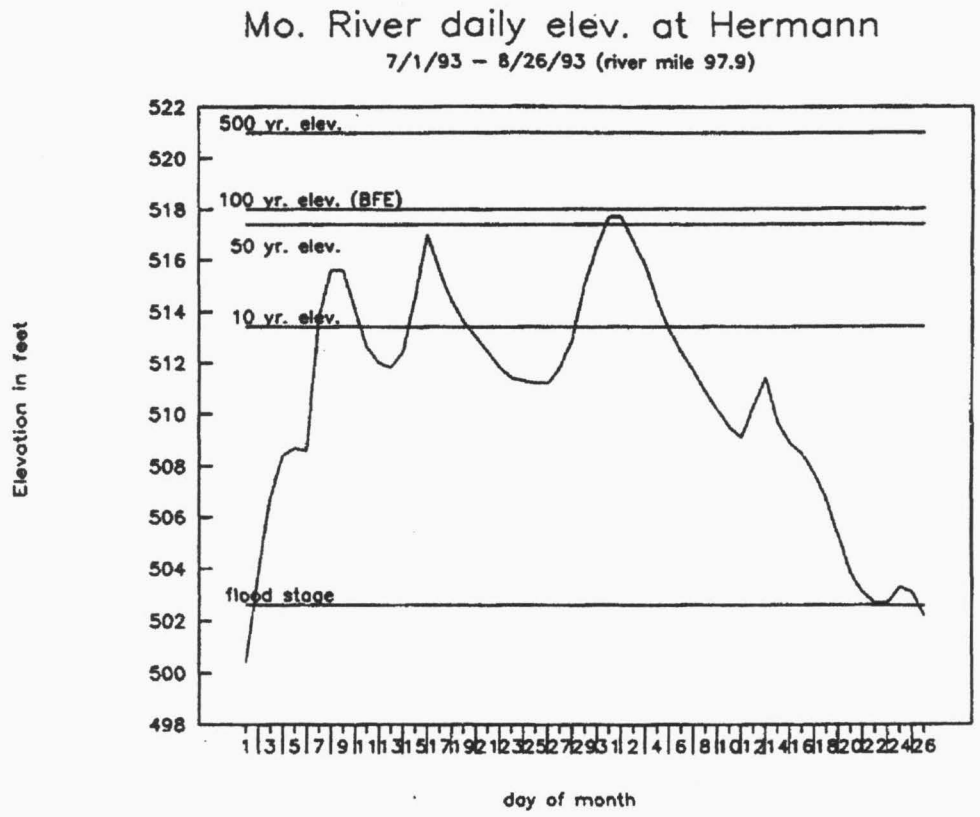


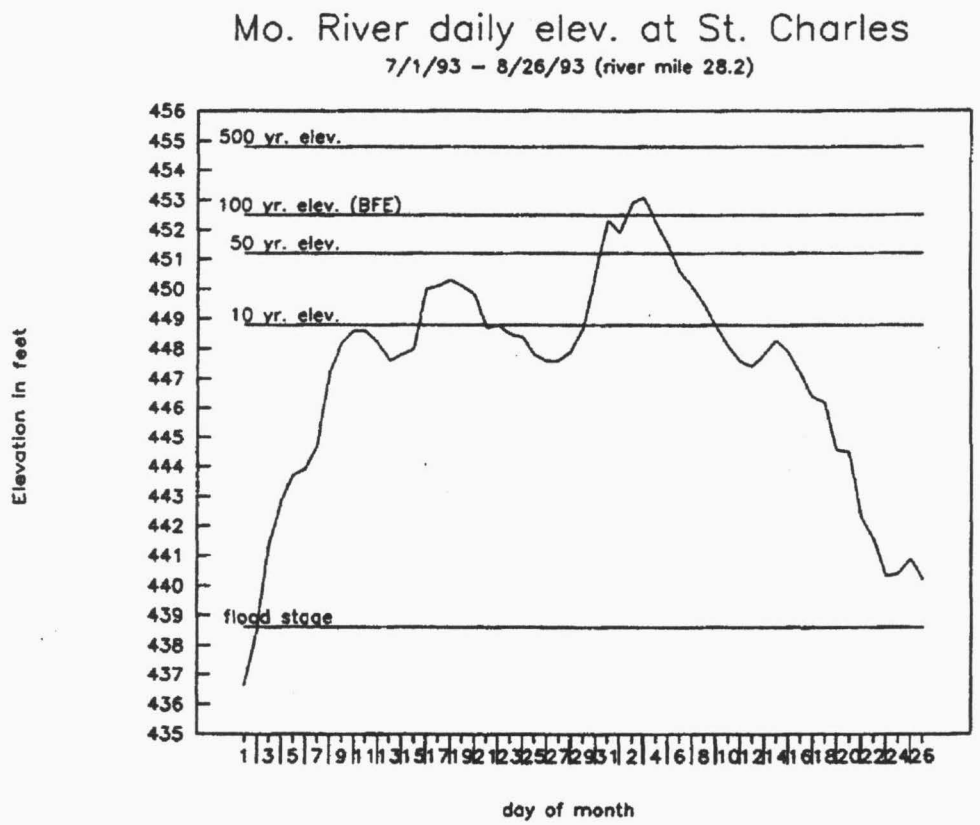
(Chart 7 continued)



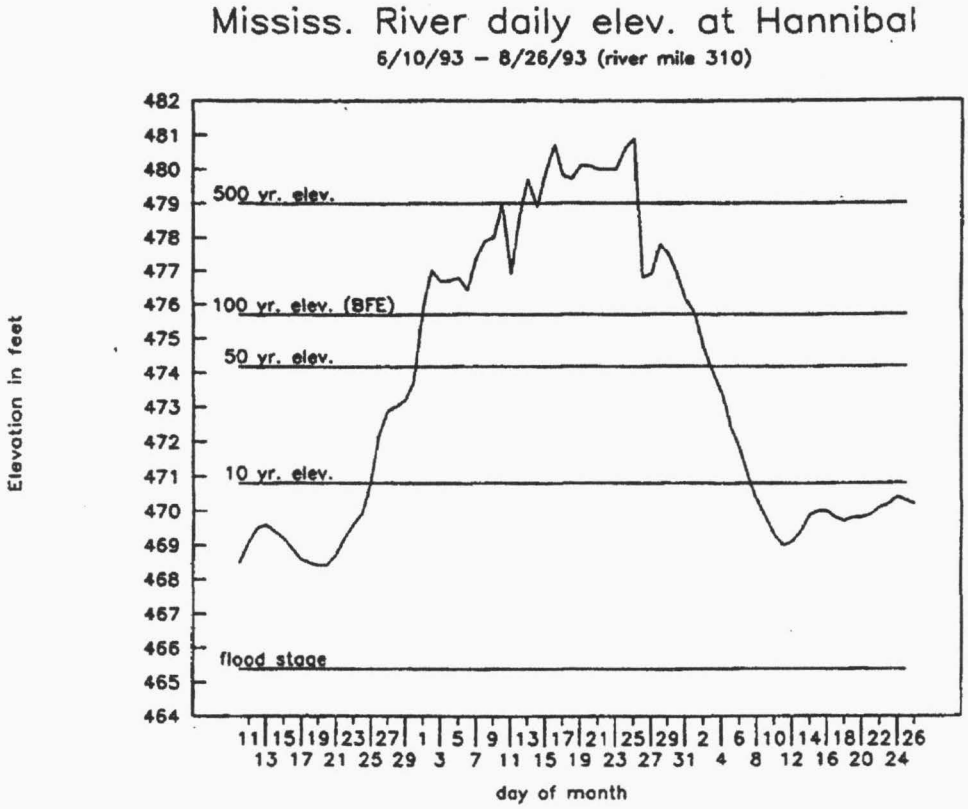


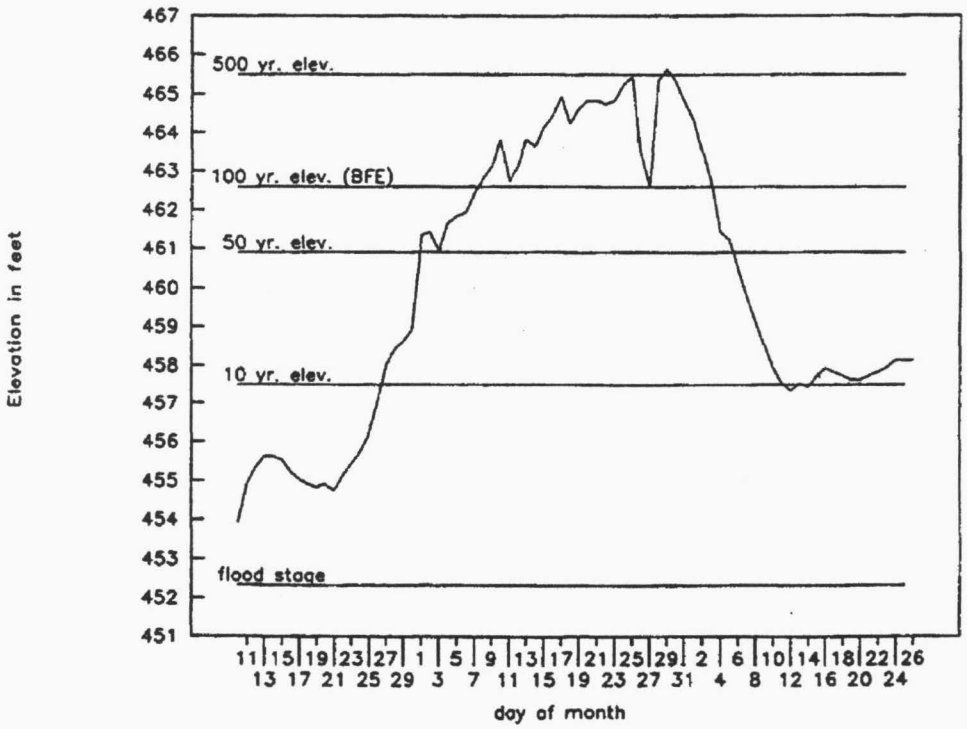
(Chart 7 continued)



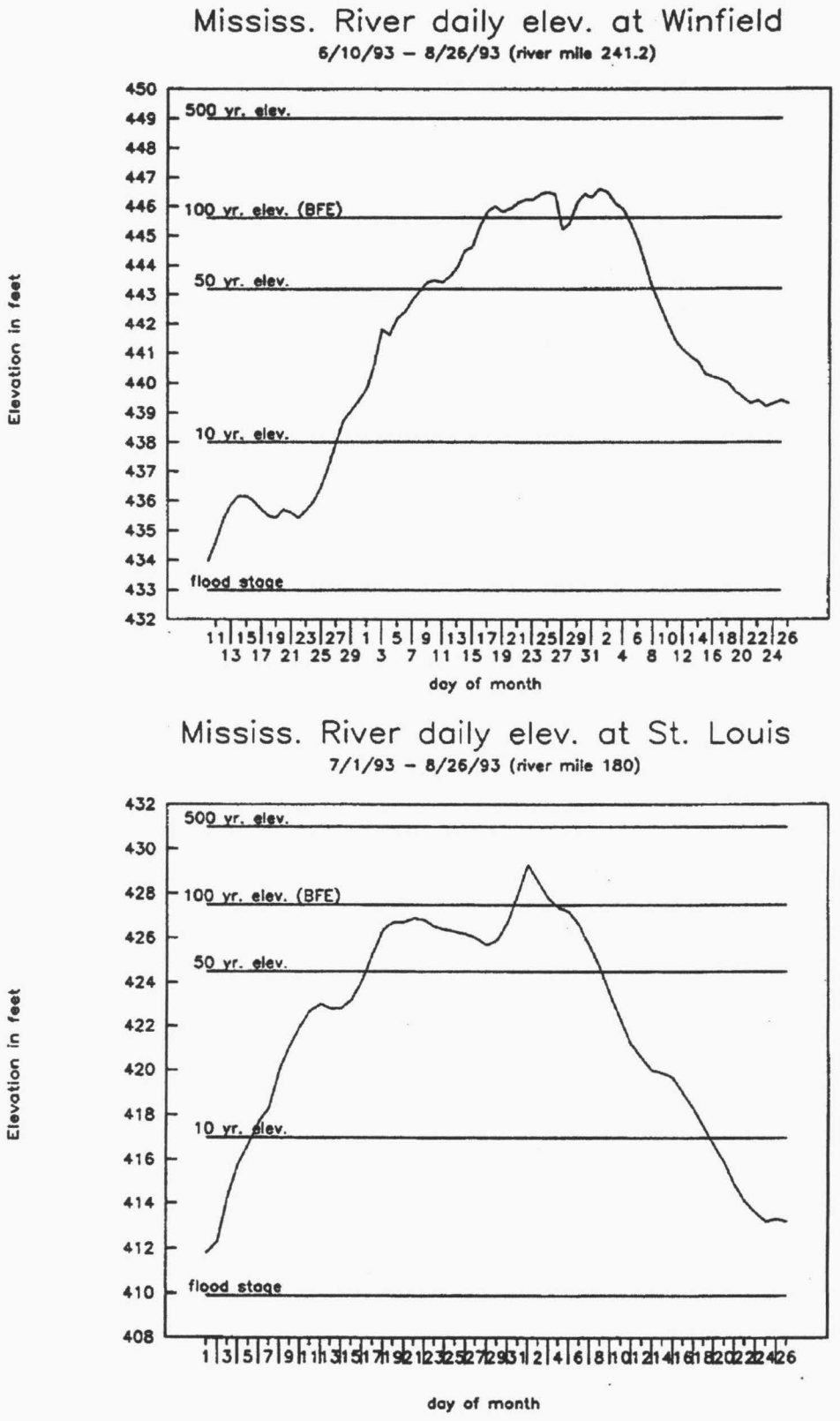


(Chart 7 continued)

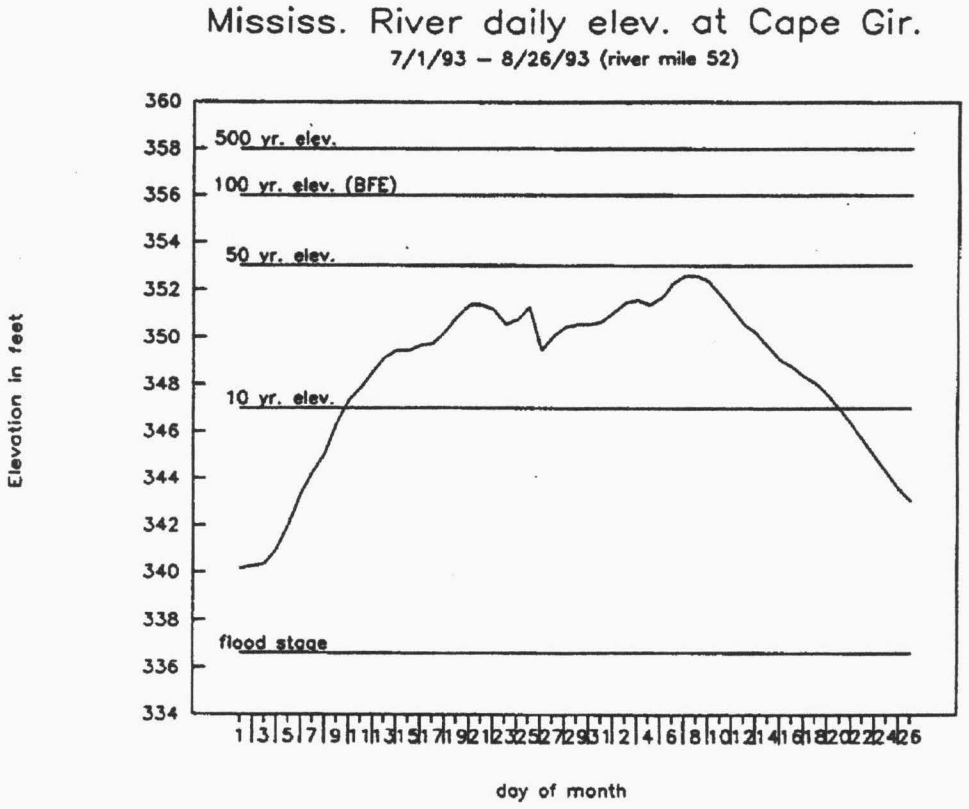




(Chart 7 continued)



(Chart 7 continued)



REFERENCES

1. State Emergency Management Agency, August 19, 1993

2. 1992-1993 Annual Operating Plan, U.S. Army Corps of Engineers, December 1992

3. Water Data Report MO-89-1, U.S. Geological Survey

4. Monthly Report of River and Flood Conditions, Jack Burns, U.S. Weather Service, August 20, 1993

5. News Release, U.S. Army Corps of Engineers, August 16, 1993

6. Missouri River Main Stem Reservoir System Operational Summary for Week Ending 13. August. 1993. and Three-Week Forecast, U.S. Army Corps of Engineers, August 13, 1993

7. Missouri River Main Stem Reservoir System Operational Summary for Week Ending 13. August. 1993. and Three-Week Forecast, U.S. Army Corps of Engineers, September 3, 1993

8. Missouri Crop and Weather Report, Missouri Agricultural Statistics Service, August 2, 1993

9. NCDC Summary of the Day - Central, Hydrosphere Inc., 1992

10. Provisional Data, U.S. Geological Survey, August 13, 1993

11. Flood Insurance Study. City of St. Joseph. Missouri, Federal Emergency Management Agency, September 19, 1984

12. Flood Insurance Study. City of Kansas City. Missouri, Federal Emergency Management Agency, September 14, 1990

13. Flood Insurance Study. Village of Sibley. Missouri, Federal Emergency Management Agency, November 15, 1984

14. Flood Insurance Study. Lafayette County. Missouri, Federal Emergency Management Agency, September 4, 1986

15. Flood Insurance Study. City of Miami. Missouri, Federal Emergency Management Agency, June 4, 1984

16. Flood Insurance Study. City of Glasgow. Missouri, Federal Emergency Management Agency, February 2, 1982

17. Flood Insurance Study, City of Boonville, Missouri, Federal Emergency Management Agency, April 16, 1984

18. Flood Insurance Study, City of Jefferson City, Missouri, Federal Emergency Management Agency, October 1979

19. Flood Insurance Study, City of Gasconade, Missouri, Federal Emergency Management Agency, June 18, 1984

20. Flood Insurance Study, Warren County, Missouri, Federal Emergency Management Agency, October 3, 1984

21. Flood Insurance Study, St. Charles County, Missouri and Incorporated Areas, Federal Emergency Management Agency, December 15, 1992

22. Flood Insurance Study, City of Hannibal, Missouri, Federal Emergency Management Agency, September 1, 1981

23. Flood Insurance Study, City of Louisiana, Missouri, Federal Emergency Management Agency, June 1977

24. Flood Insurance Study, City of Clarksville, Missouri, Federal Emergency Management Agency, undated

25. Flood Insurance Study, Lincoln County, Missouri, Federal Emergency Management Agency, April 2, 1993

26. Flood Insurance Study, City of Winfield, Missouri, Federal Emergency Management Agency, May 17, 1982

27. Flood Insurance Study, City of St. Louis, Missouri, Federal Emergency Management Agency, March 15, 1993

28. Flood Insurance Study, City of St. Genevieve, Missouri, Federal Emergency Management Agency, September 1977

29. Flood Insurance Study, Cape Girardeau County, Missouri, Federal Emergency Management Agency, August 15, 1989

30. Flood Insurance Study, City of New Madrid, Missouri, Federal Emergency Management Agency, December 15, 1978

31. Flood Insurance Study, City of Caruthersville, Missouri, Federal Emergency Management Agency, July 16, 1980

32. Personal contact with George Gray, U.S. Geological Survey, September 2, 1993

33. Personal contact with Leon Reed, U.S. Geological Survey, September 2, 1993