III. HYDROLOGY

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The drainage basin of the Mississippi River comprises approximately that portion of the United States lying between the Allegheny and the Rocky Mountains, except the Great Lakes and Hudson Bay drainages, with a total area of about 1,240,000 square miles. This covers about two-fifths of the total area of the United States proper. Water from part or all of 31 states, comprising the Mississippi River drainage basin, passes through the Mississippi River into the Gulf of Mexico (Figure 3.1). For convenience in this study, the entire drainage area has been divided into eight sub-areas as follows;

Region No.	Drainage Area	Drainage Area Sq. Mile
I	Upper Missouri	458,000
II	Lower Missouri	62,000
III	Upper Arkansas-Red	153,000
IV	Lower Arkansas-Red-White	117,000
V	Upper Mississippi	182,000
VI	Lower Mississippi	64,000
VII	Ohio	145,000
VIII	Tennessee-Cumberland	59,000

Figure 3.1 and the sub-basin areas were extracted from "Water Atlas of the United States" (Geraghty, et.al., 1973).

The purpose of this section of the LMVD (T-1) contract is to collect and display data that may be utilized in the design and operation of various control structures that will enhance navigation and flood protection on the Mississippi River.

The data needed to complete this section of the study consists of rainfall, mean-daily discharge and mean-daily stage.

The period of record for this section was chosen to be 1930, or the

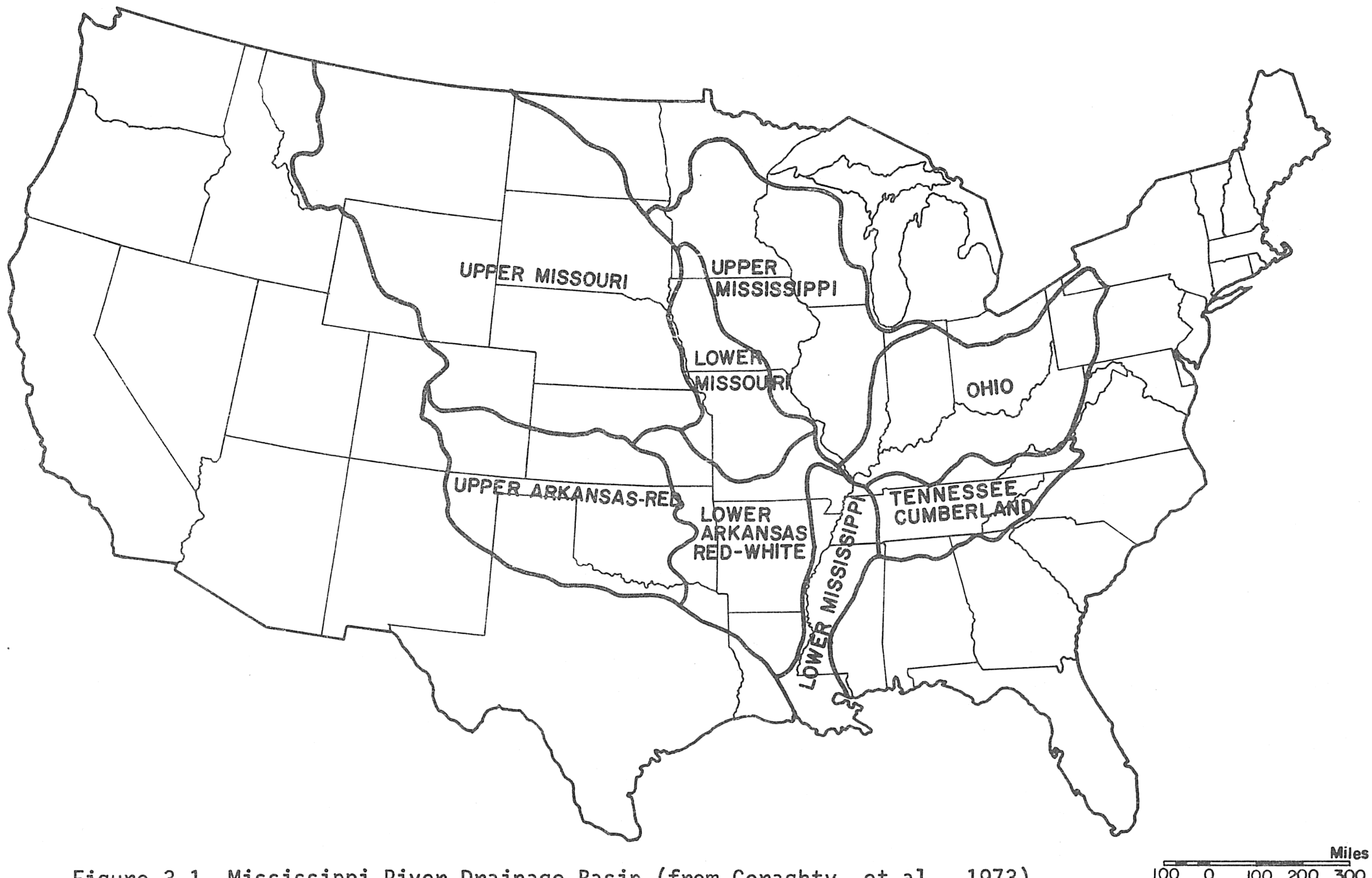

Figure 3.1 Mississippi River Drainage Basin (from Geraghty, et al., 1973)

first date measurements were made (if after 1930), through the latest published date. This period was selected because the discharge data were thought to be more reliable and consistent. Prior to this time span, measuring equipment and techniques used to determine discharge varied; thus, the mean-daily discharge, mean-daily stage and rainfall data recorded prior to the 1930's were not included.

Rainfall data for the 31 states that make up the Mississippi River Basin were obtained from the National Weather Service for the period of record. These data were utilized in determining the following (*-work required under the contract):

1. The average annual precipitation for each of the eight regions that make up the Mississippi River drainage basin.

2. The average annual rainfall for:

   a. The Missouri River Basin (Reg. 1 and 2)
   b. The Ohio River Basin (Reg. 7 and 8)
   c. The Atchafalaya River Basin (Reg. 3 and 4)
   d. The Mississippi River Basin above St. Louis (Reg. 1, 2, and 5)
   e. The Mississippi River Basin above Memphis (Reg. 1, 2, 5, 7, and 8)
   f. The Mississippi River Basin above New Orleans (Reg. 1, 2, 5, 6, 7, and 8)

3. The average annual precipitation data for each of the eight regions were plotted on extreme value distribution paper, utilizing the Weibull plot position formula.

4. Data from steps 1 and 2 were plotted as a time series.

5* The data from step 2 are presented graphically, along with runoff, as a time series.†

The mean-daily stage and mean-daily discharge data needed to complete this section of the potamology study were obtained for the period of record from the United States Corps of Engineers and the United States Geological Survey, Water Resources Division. Mean-daily stage and mean-discharge data were collected for eighteen locations on the Mississippi

River and its major tributaries. Locations on the Mississippi River were Keokuk, Iowa; Alton, Illinois; St. Louis, Missouri; Chester, Illinois; Thebes, Missouri; Memphis, Tennessee; Vicksburg, Mississippi; Helena, Arkansas; Arkansas City, Arkansas; and Red River Landing, Louisiana. Locations on the major tributaries were Meredosia, Illinois on the Illinois River; Hermann, Missouri on the Missouri River; Metropolis, Illinois on the Ohio River; Paducah, Kentucky on the Tennessee River; Little Rock, Arkansas on the Arkansas River; Clarendon, Arkansas on the White River; Alexandria, Louisiana on the Red River; and Simmesport, Louisiana on the Atchafalaya River. Data collected for each of the above-mentioned stations are displayed in the following forms (*-work required under the contract).

1* For each location, the United States Geological Survey, Water Resource Division eight-digit station number, bankfull stage and drainage area (square miles).

2* The average mean-daily stage and average mean-daily discharge for each year.

3* The average mean-daily stage and average mean-daily discharge for the low-water season (July-November) for each year.

4* The annual volume (inches over drainage basin) of runoff.

5* The number and listing of days per year that the mean-daily stage exceeded bankfull.

6* Percent of time per year mean-daily stage exceeded bankfull.

7* A histogram of mean-daily stage and mean-daily discharge showing the number of times per year that the stage and discharge were within predetermined intervals.

8* The volume (inches over drainage basin) of runoff for each month per year.

9* The average monthly volume of runoff for the period of record.

10* The percent of runoff for each month per year.

11* The average monthly percent runoff for the period of record.

12* The long-term yearly average

a. mean-daily stage (feet)
b. mean-daily flow (1000 cfs)
c. runoff (inches)
d. low-water season mean-daily stage and mean-daily discharge
e. high-water season mean-daily stage and mean-daily discharge

13* The deviation of the yearly averages of items 12, a, b, c, d and e from the long-term averages.

14. A complete listing of recorded mean-daily stages and mean-daily discharges.

15. The yearly minimum and maximum mean-daily stages.

16. The yearly minimum and maximum mean-daily discharges.

17. The long-term average mean-daily stage for each day of a calendar year.

18. The long-term average mean-daily discharge for each day of a calendar year.

19. The average mean-daily stage and average mean-daily discharge for the high-water season (December-June) for each year.

20. The deviation of the monthly average mean-daily stage and monthly average mean-daily discharge from the long-term yearly average for each year.

21. The long-term monthly, average mean-daily stage and mean-daily discharge.

22. The monthly average mean-daily stage and monthly average mean-daily discharge for each year.

23. The deviation of the mean-daily stage and mean-daily discharge

for each month of each year from the long-term mean-daily stage and mean-daily discharge for each month.

24. The mean-daily stage and mean-daily discharge data have been analyzed to determine

    a. the 1, 7, 14, 30, 60, 90 and 120 consecutive day minimums.
    b. the 1, 7, 14, 30, 60, 90, 120, 150 and 180 consecutive maximums

25. Data from 24a and 24b above have been plotted on extreme value distribution paper, utilizing the Weibull plot position formula.††

Data as presented in this section are amenable to making many hydrologic studies and comparisons. The following is a brief list of some of the studies that could and possibly should be undertaken:

A. Using the average annual precipitation data presented, one could study and predict the probability of the joint occurrence of various events. A study of this nature would be worthwhile in the design of flood protection structures and floodplain management.

B. The annual precipitation data, coupled with other pertinent data, could be utilized in studying the wet and dry cycle, thus assisting in developing information that could be utilized in reservoir regulation and operation.

C. Rainfall and runoff data could be utilized in studying the ever-changing land use management practices and possibly the study of the changing sediment (wash) load carried by the Mississippi River and its tributaries.

D. The data presented herein should be coupled with data from Morphology and Geology sections and a study conducted to understand more fully energy dissipaters as to type, location, development, etc.

E. The long-term average mean-daily discharge and mean-daily stage for day of the year would be useful in developing:

a. The long-term average mean-daily discharge hydrograph
b. The long-term average mean-daily stage hydrograph
c. The long-term average mean-daily stage-discharge relationship (rating curve)

The major stumbling block which all encounter who study the response of a river to changes made by man is that of sufficient and adequate data and its acquisition. Therefore, the first two recommendations which this or any other study team could make are:

1. That a comparison of the various types of measuring equipment and techniques used in determining discharge throughout the years in which measurements have been made should be undertaken. Such a study would result in the development of relationships between the various techniques and equipment used to measure discharge. These relationships could then be utilized in adjusting discharge data to the technique and equipment presently used.

2. That a central computerized data bank should be established. This data bank should contain all measured data that have been or will be collected on the Mississippi River and should have the retrieval capability that would make it useful to all.

Note: †A listing of the computer programs used in processing the data can be found in Appendix 3.1. The computer printout of the results obtained from the various calculations made with the rainfall data can be found in Appendix 3.2.

††The computer printout of the results obtained from the various calculations made with the mean-daily discharge and mean-daily stage can be found in Appendix 3.3 which contains four volumes. Tributary data are found in volumes 1 and 2. Volume 3 contains those stations upstream from Memphis. Volume 4 contains Memphis and those stations downstream.