

INTRODUCTION

Cross Lake is located in northwestern Louisiana. The lake was formed by constructing a dam on Cross Bayou in 1926 to provide an adequate source of drinking water for the residents of the City of Shreveport. At present (2001), the lake is the primary source of public water supply for the city. According to 1999 population statistics, the City of Shreveport had an estimated population of 196,667 (Northeast Louisiana University, Uniform Resource Locator accessed October 12, 2000). In 1995, 30.36 million gallons per day of water were withdrawn from the lake (Lovell and Johnson, 1996, p. 110) for public supply (Darren Fortenberry, City of Shreveport, oral commun., 2000). Furthermore, the lake is used for flood control, and it is a popular recreational area for the city and the surrounding area.

The City of Shreveport is responsible for the management of Cross Lake. An understanding of current hydrologic conditions of the lake is essential to the management and protection of this valuable resource. The quantity and quality of water in the lake are important concerns to those who use this water body for municipal and recreational purposes. Current and accurate information is fundamental to planners and managers for evaluating the lake. In April 1996, the U.S. Geological Survey (USGS), in cooperation with the City of Shreveport, Department of Operational Services, began a two-phase study to (1) conduct a bathymetric survey of Cross Lake and (2) determine the quality of water in the lake. The bathymetric survey defined the morphology of Cross Lake to provide basic information on the physical characteristics of the lake and to aid in the interpretation of the water-quality data. The results of the two-phase study will be documented in two reports.

The purpose of this report is to present the results of the bathymetric survey of Cross Lake. Data collected for the construction of the bathymetric map included water-surface elevation, latitude, longitude, and water depth. Hydrographic surveying software was used for combining differential global positioning system (DGPS) information with digital survey fathometer data to accurately map the lake bottom. Data were referenced to sea level by subtracting the water depth from the water-surface elevation that existed during the data collection, thus ensuring proper referencing of the data between collections. The bathymetric map was produced using geographic information systems, and contours were reviewed and edited for accuracy and consistency.

Description of Study Area

The study area includes the extent of Cross Lake (fig. 1) and is located in the northern part of the City of Shreveport in central Caddo Parish. The City of Shreveport had a total annual rainfall of 44 inches and a mean annual temperature of 66°F (degrees Fahrenheit) in 1995. The average total annual rainfall for the previous five years (1990-94) was 62 inches at Shreveport (Craig Ross, National Weather Service, oral commun., 2001). The total annual rainfall during the study was below the average total annual amount. The elongated lake is oriented east to west and is approximately 9 mi (miles) in length. The lake covers approximately 13.4 mi² (square miles). Much of the lake's shoreline is urbanized, particularly along the eastern and southern areas. The area mainly west of the lake is mostly forested land. The watershed area that contributes runoff to the lake is 253 mi² (Sloss, 1971, p. 30). The lake receives inflow from eight major tributaries in this watershed, including supplemental flow through a pipeline from nearby Twelvemile Bayou. These tributaries are Paw Paw Bayou, Cross Bayou, Shettleworth Bayou, Logan Bayou, Piney Bayou, Page Bayou, Bickham Bayou, and the pipeline from Twelvemile Bayou. Most of the inflow enters at the western end of the lake. The three largest tributaries (and their drainage areas) are Paw Paw Bayou (82.02 mi²), Cross Bayou (62.43 mi²), and Shettleworth Bayou (19.54 mi²) (Sloss, 1971, p. 30). The lake has two discharge points (Cross Lake spillway and a city water treatment plant intake), located at the eastern end of the lake.

Acknowledgments

The author extends appreciation to Robert "Bo" Williams, former Mayor of the City of Shreveport, and Mike Strong and Wes Wyche of the Department of Operational Services, City of Shreveport, for their cooperation and assistance provided during this study. Additionally, special thanks are given to the personnel of the Cross Lake Patrol and the Amis Water Treatment Plant for the direction provided and the use of their facilities, and to employees of the USGS office in Ruston, Louisiana, for their assistance in collection and analysis of data.

WATER-SURFACE ELEVATION

The lake's level is controlled by the spillway structure which is 189 feet in length and has a crest elevation of 171.19 feet above sea level. A permanent continuous stage recorder equipped with a data

collection platform and a staff gage were installed on the lake to monitor water-surface elevation during the study. The recorded daily mean water-surface elevation ranged from 169.04 to 170.03 feet above sea level with a mean of 169.71 feet above sea level during the bathymetric survey. The mean water-surface elevation of the lake was 170.27 feet above sea level during the years 1984-86, 1989-90, and 1992-95 (Darren Fortenberry, City of Shreveport, written commun., 1999), which indicates that the water-surface elevation during the study was slightly below its annual average.

BATHYMETRY

Bathymetric data for Cross Lake were collected during April 15-17 and 22, May 7 and 13, and June 14, 1996. More than 300,000 data points of latitude, longitude, and depth were recorded to accurately and comprehensively describe the bathymetry. Using hydrographic software, transects were established for the lake prior to data collection; 56 north to south, 4 east to west, and various other transects, from which bathymetric data were collected, were distributed across the lake.

Bathymetric data were collected using a DGPS linked through a computer to a digital fathometer. Specifically, the equipment included a Trimble Pathfinder ProXL DGPS unit, a Raytheon survey fathometer, equipped with an Odom digital interface, a portable computer, and HYPACK hydrographic software. The DGPS measured spatial position in state plane coordinates with routine accuracy of 5 feet. State plane coordinates were then converted to latitude and longitude and projected into universal transverse mercator units using ArcInfo. The digital fathometer measured the depth with routine accuracy of 0.1 foot; the fathometer was calibrated at the start of each survey day to maintain that accuracy. The hydrographic software was used for survey planning, survey execution, and storage and editing of data. Data were exported to ArcInfo for drawing elevation contours (fig. 1) and subsequent reviewing and editing of results.

Surface area and volume spatial analyses also were performed using ArcInfo. The water-surface area of Cross Lake was 8,576 acres, and the water volume was 65,807 acre-feet at a water-surface elevation of 171 feet above sea level. The depth-surface area and depth-volume relations are shown in figure 2. The average depth of the lake was 7.7 feet, with a depth of 7.7 feet or greater over more than 57 percent of the lake-surface area. The greatest depths were located mainly in the eastern parts of the lake. The shoreline

development index, defined as the ratio of the shoreline length to the circumference of a circle of area equal to that of the lake, is 5.4 for Cross Lake. This indicates that Cross Lake's morphology is very elliptical. Additional information about the lake is included in table 1.

Table 1. Physical description of Cross Lake

Latitude	32° 30' 30"
Longitude	93° 50' 00"
Lake-surface area	13.4 mi ²
Watershed area	253 mi ²
Shoreline length	70.4 mi
Maximum depth	18.3 feet
Average depth	7.7 feet
Watershed area to lake surface area ratio	19
Shoreline development index	5.4
Lake volume	65,807 acre-feet
Number of major tributaries	8
Number of major discharge points	2

SELECTED REFERENCES

- Ensminger, P.A., 1999, Bathymetric survey and physical and chemical-related properties of Caddo Lake, Louisiana and Texas, August and September 1998: U.S. Geological Survey Water-Resources Investigations Report 99-4217, 1 sheet.
- Lovell, J.K., and Johnson, P.M., 1996, Water use in Louisiana, 1995: Louisiana Department of Transportation and Development Water Resources Special Report no. 11, 110 p.
- Northeast Louisiana University, Center for Business and Economic Research, Louisiana parishes and municipalities July 1, 1999, population estimates published in January 2000: accessed October 12, 2000, at URL <http://leap.ulm.edu/POPHS/pop1999.txt>
- Sloss, Raymond, 1971, Drainage area of Louisiana Streams: Louisiana Department of Public Works Basic Records Report no. 6, 117 p.

In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

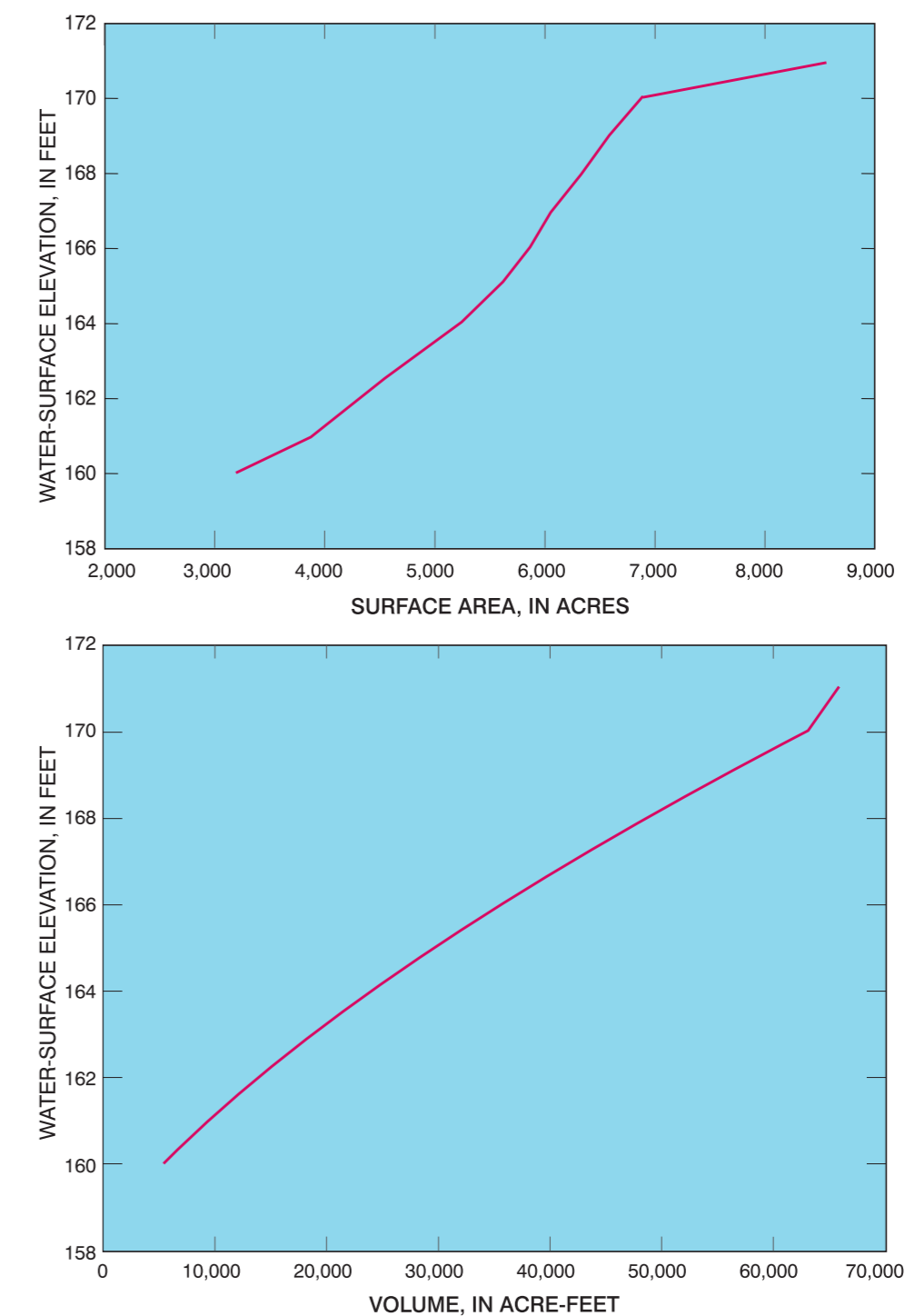


Figure 2. Depth-surface area and depth-volume relations of Cross Lake, April through June 1996.

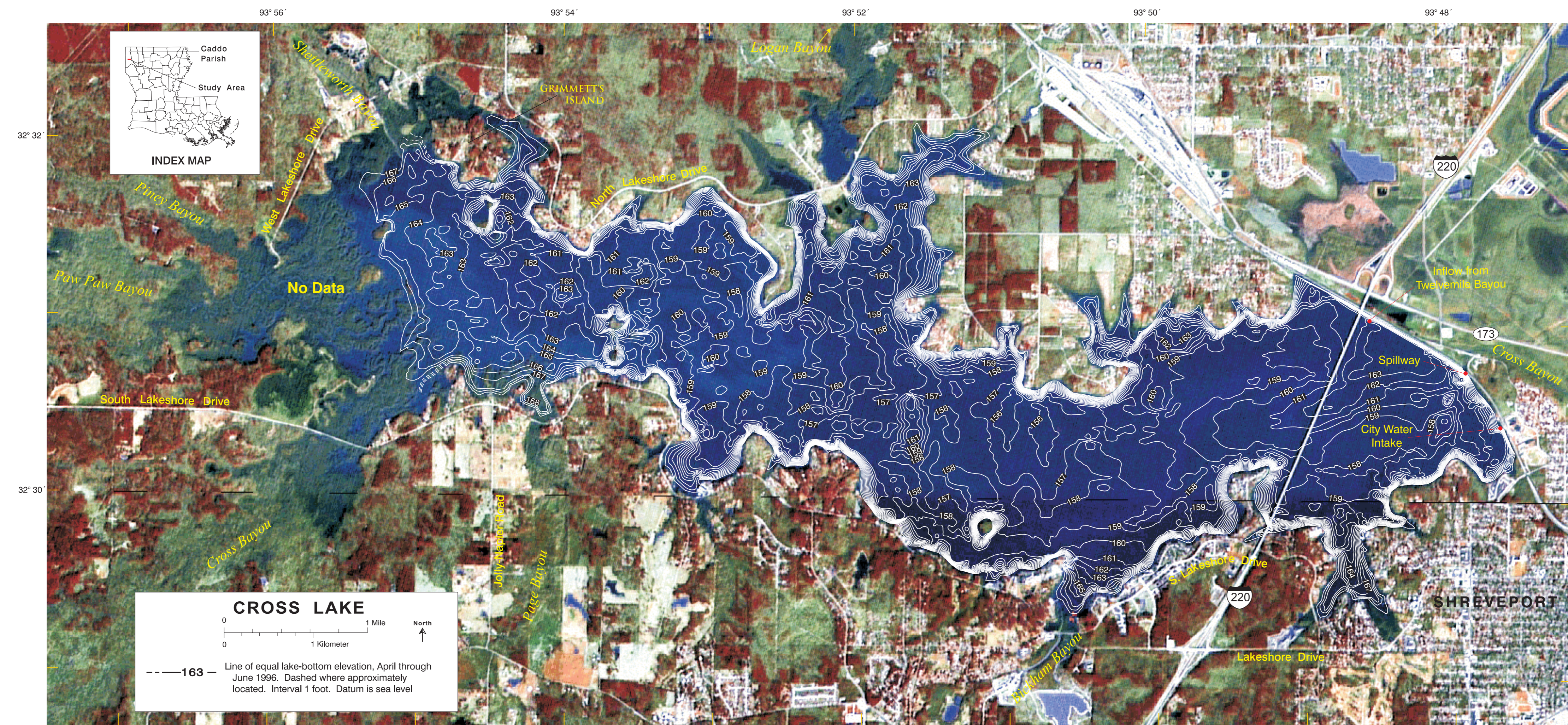


Figure 1. Bathymetry of Cross Lake, Caddo Parish, Louisiana, April through June 1996.

**Bathymetric Survey of Cross Lake, Caddo Parish, Louisiana,
April through June 1996**

By Benton D. McGee



For additional information, contact:
District Chief
U.S. Geological Survey
3535 S. Sherwood Forest Blvd., Suite 120
Baton Rouge, Louisiana 70816
E-mail: dc_la@usgs.gov
Telephone: (225) 389-0281
Fax: (225) 389-0706

Copies of this report can be purchased from:
U.S. Geological Survey
Branch of Information Services
Box 25286
Denver, Colorado 80225
E-mail: infoservices@usgs.gov
Fax: (303) 202-4188
Telephone (toll free): 1-888-ASK-USGS