CHANGES IN BATHYMETRY FOR LAKE KATHERINE AND WOOD LAKE, RICHLAND COUNTY, SOUTH CAROLINA, 1989-93

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
foot (ft)	0.3048	meter
acre	4,047	square meter
cubic foot (ft^3)	0.02832	cubic meter
acre-foot (acre-ft)	1,233	cubic meter
cubic foot (ft^3)	0.03704	cubic yard
cubic foot (ft^3)	0.00002296	acre-foot

Sea level: 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 the United States and Canada, formerly called Sea Level Datum of 1929.

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ABSTRACT

Bathymetric surveys of Lake Katherine and Wood Lake, small residential lakes in Columbia, South Carolina, were made in 1989 and 1993. During this period the combined volume of the lakes decreased by 519,000 cubic feet (11.9 acre-feet). Most of the decrease in volume occurred in the northern part of Lake Katherine where deltaic sediment deposits at the mouth of Gills Creek increased in thickness during the 4-year period. The sediment was derived from a combination of sources in the Gills Creek Basin upstream from the lakes. Construction of a highway and a housing development in the Basin were significant factors in the sedimentation.

INTRODUCTION

All lakes, whether natural or artificial, tend to collect sediment and eventually fill in. Human activities can increase the rate of sediment inflow into lakes. In managing lakes for benefits such as recreation and aesthetics, it is often important to determine the rate of infilling by sediment.

Lake Katherine, located in the southeastern part of Columbia, S.C. (figs. 1 and 2), is a 151-acre residential lake on Gills Creek. Wood Lake is an 18-acre lake just north of Lake Katherine. Lake Katherine and Wood Lake are separated by a small dam under the Woodlake Drive bridge, so that water levels can fluctuate independently in the two lakes. Wood Lake is connected to Gills Creek by a single narrow channel.

Construction of the Southeastern Beltway in the Gills Creek Basin during 1989-93 presented the potential for increasing the rate of sediment inflow to the lakes. Accordingly, the South Carolina Department of Transportation (SCDOT) requested that the U.S. Geological Survey (USGS) make bathymetric surveys of the lakes prior to and following the highway construction. This report presents the maps prepared during each survey, a map showing changes in lake bathymetry, and a computation of the change in lake volume from 1989 to 1993. These results will help to build a national data base pertaining to lake sedimentation rates.

METHOD OF STUDY

The first bathymetric survey was made in June 1989 when Lake Katherine was at its full-pool elevation of 146 ft above sea level. The second survey was made on February 4, 1993, when Lake Katherine was drawn down 3.7 ft below full-pool elevation. The surveys were made by measuring water depth with a recording depth sounder from a small boat while making traverses across the lakes. Boat position was determined using a combination of reference landmarks on topographic maps and an automatic microwave positioning system. In water that was too shallow to navigate, depths were determined by wading and by observation of wading birds. During the 1993 survey, when the northern third of Lake Katherine was too shallow for navigation, aerial photographs were taken to aid in drawing depth contours for the shallow water.

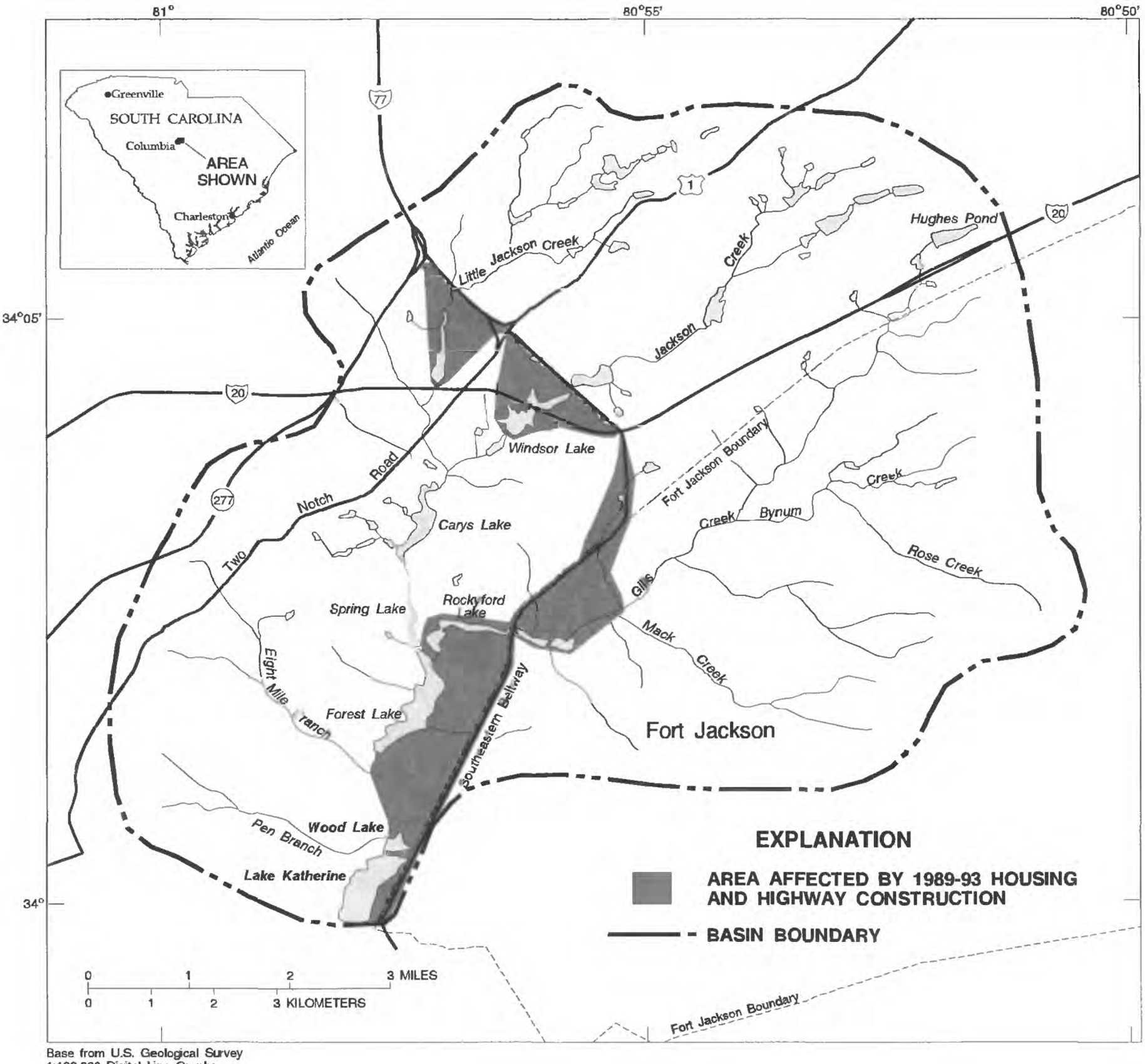


Figure 1.--Lake Katherine watershed.

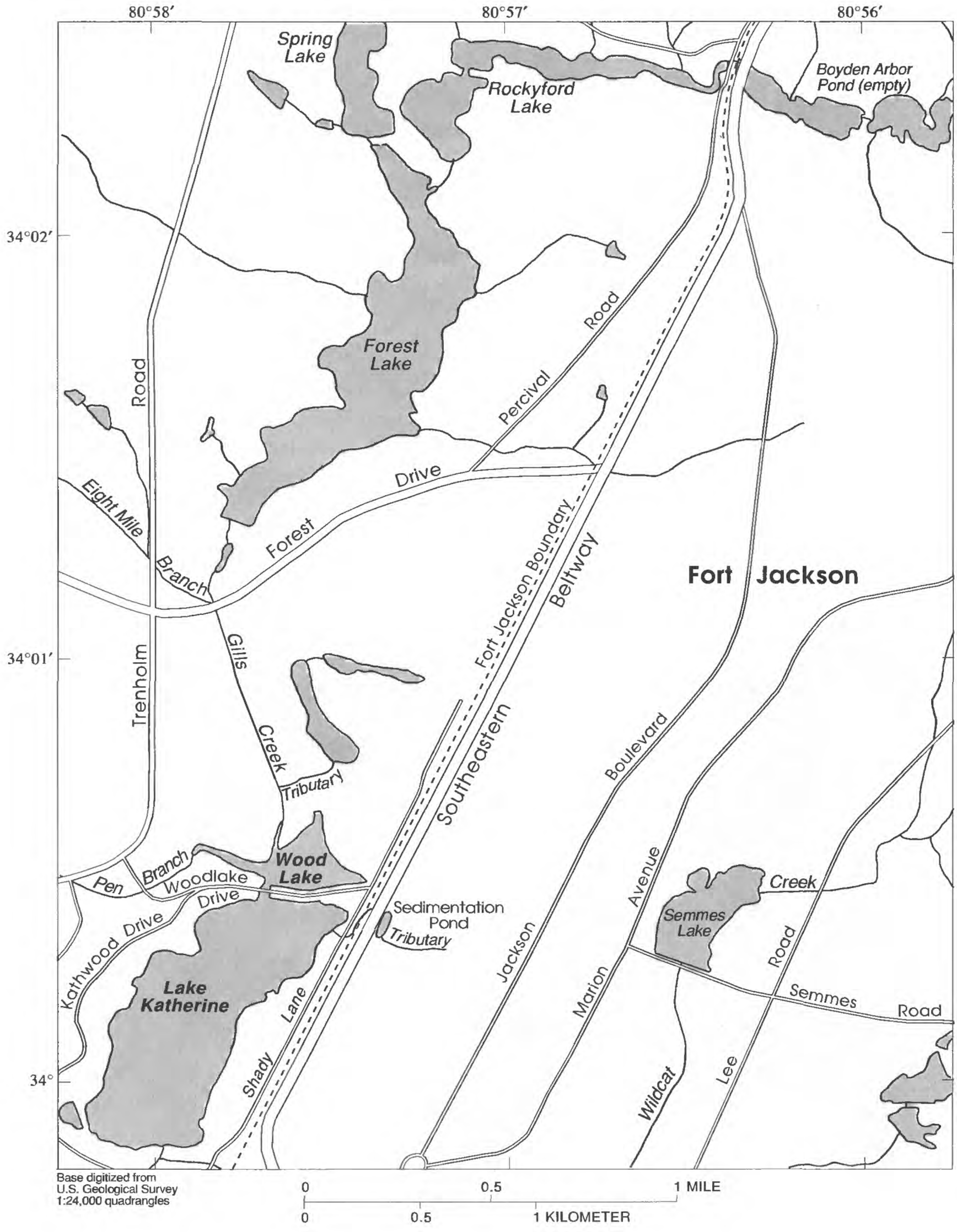


Figure 2.--Location of study area.

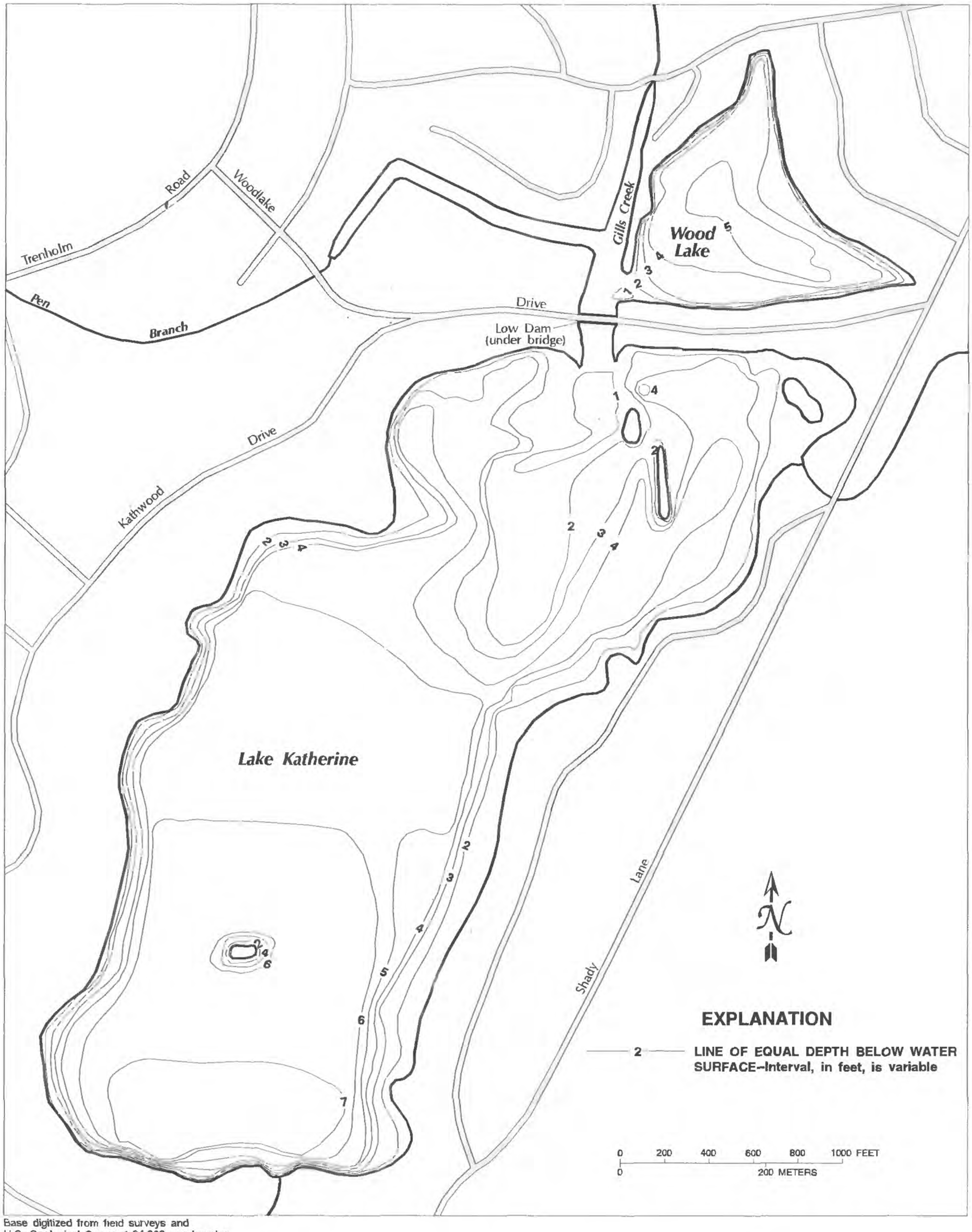
Water levels were noted at the outlet of each lake. The water level at the outlet of Lake Katherine in 1993 was 3.7 ft below the 1989 level. In order to reference the 1989 and 1993 depths to a common datum, the 1993 depths were adjusted by adding the difference in lake levels.

The shallow northern part of Lake Katherine in 1993 had a sloping water surface, as evidenced by the current in the inlet stream as it meandered through the exposed delta (fig. 3). As a result, the lake surface could not be approximated by a flat plane from the lake inlet to the outlet. Therefore, a second determination of water-level difference was made at the lake inlet by comparing the water surface in 1993 to the full-pool elevation, as evidenced by vegetation differences and a wash line of fine debris. The water-level difference at the inlet was 2.8 ft. In drawing the 1993 contour map, the water-level difference adjustment was prorated from 2.8 ft at the lake inlet to 3.7 ft near the middle of the lake. From there to the lake outlet a flat water surface was assumed, because no flow was observed.

Wood Lake had approximately the same water level in 1993 and 1989. No depth adjustment was required to draw contours.

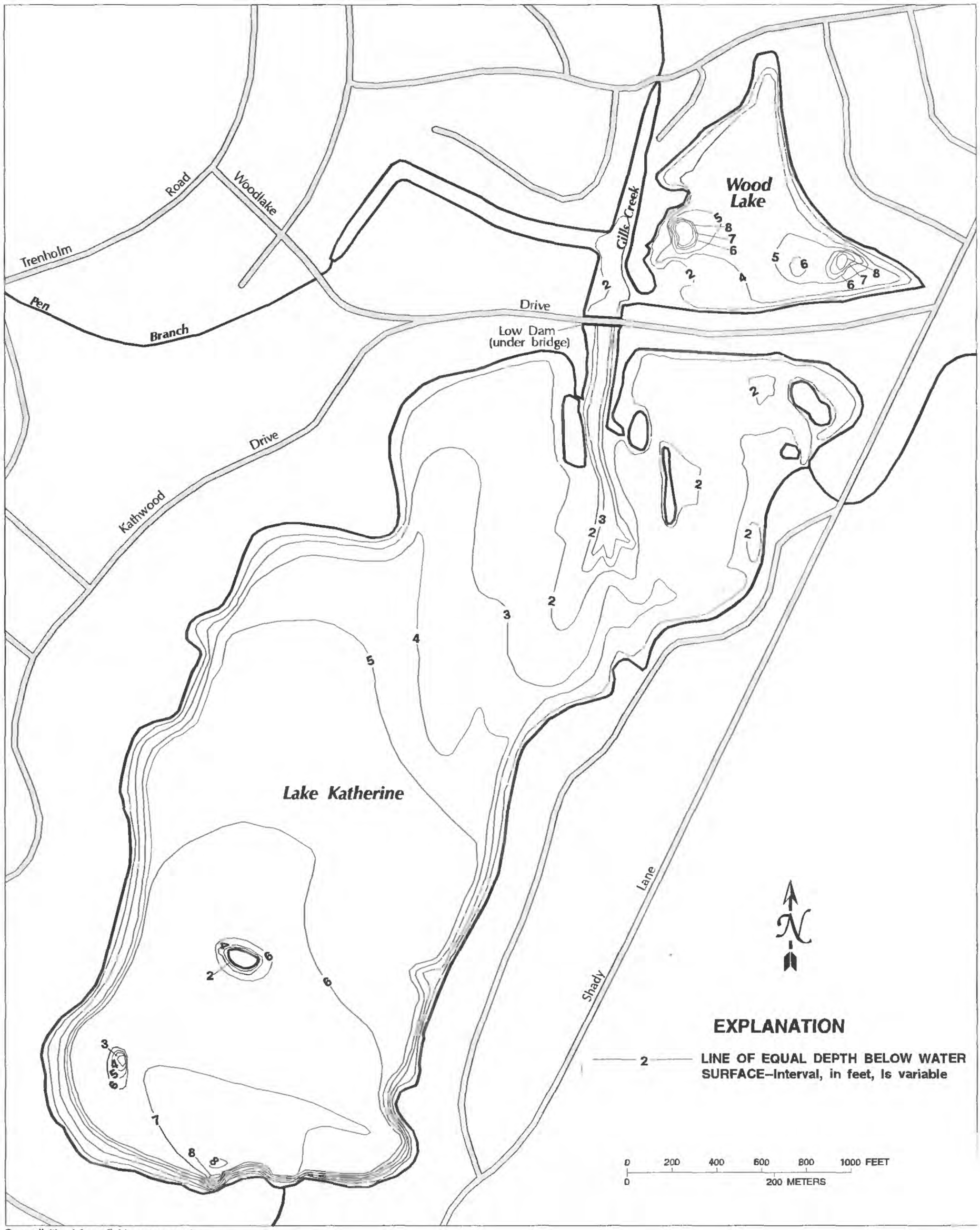
The contour maps from the two successive surveys were digitized (figs. 4 and 5), and the digitized maps were compared using a geographic information system. A third map (fig. 6) was prepared showing changes in bathymetry in both lakes. Lake volumes were computed using a geographic information system volume-computation program, and the difference in volumes was determined.

Figure 3.--Deltas in Lake Katherine, February 1993.



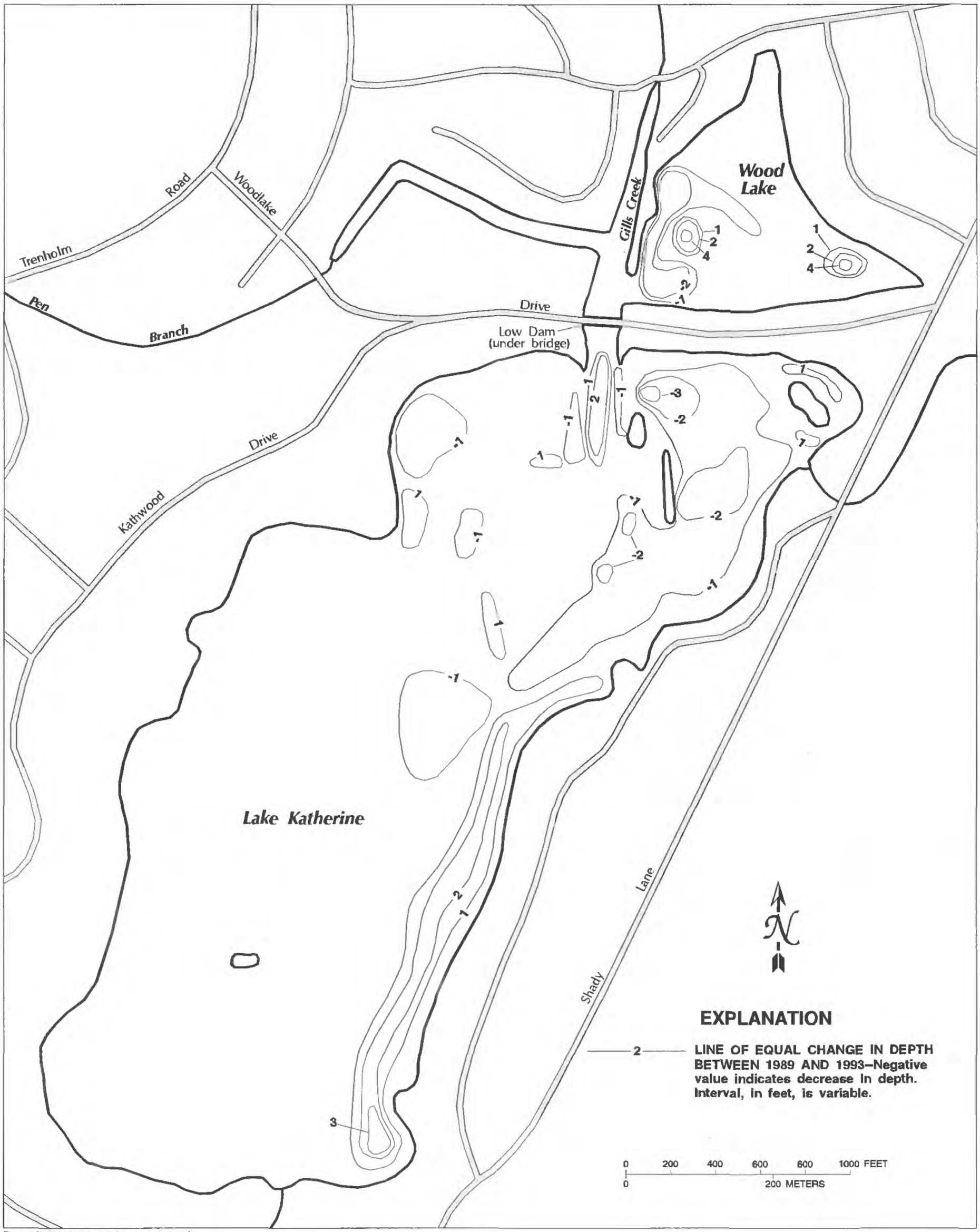
Base digitized from field surveys and
U.S. Geological Survey 1:24,000 quadrangles

Figure 4.--Bathymetry of Lake Katherine and Wood Lake, June 1989.



Base digitized from field surveys and
U.S. Geological Survey 1:24,000 quadrangles

Figure 5.--Bathymetry of Lake Katherine and Wood Lake, February 1993.



Base digitized from field surveys and
U.S. Geological Survey 1:24,000 quadrangles

Figure 6.--Changes in bathymetry of Lake Katherine and Wood Lake, 1989-93.

CHANGES IN BATHYMETRY FOR LAKE KATHERINE AND WOOD LAKE

Comparison of the bathymetric maps resulting from surveys in 1989 and 1993 discloses some changes that have occurred in water depths in Lake Katherine and Wood Lake. In addition, examination of the patterns of sediment deposition provides some insight as to possible sources of sediment.

Changes in Lake Depths and Volumes

Examination of the bathymetric maps prepared in 1989 and 1993 (figs. 4 and 5, respectively) and the map showing changes (fig. 6) indicates that there was little change in water depth in the southern part of Lake Katherine. In the northern part of the lake, however, an influx of sediment created a more significant delta than was apparent in 1989, resulting in shallower water depths. The greatest change was just over 3 ft in a limited area near the inlet. Most of the bathymetry changes ranged from 0 to 1 ft. A narrow band along the southeastern shore had greater depths in 1993 than in 1989.

In Wood Lake little change in bathymetry was detected. Some changes occurred along the western shore of Wood Lake where a deepening of 1 to 2 feet was observed (fig. 6). These changes could have been due to modifications to the shoreline. Deepening of up to 4 ft in two spots, one near the western shore and one near the eastern corner of the Wood Lake, is shown in figure 6. The deep spots detected by the transects of the 1993 survey were probably present in 1989, but were missed because they occurred between survey transects at that time.

The combined volume of the two lakes decreased by 519,000 ft^3 (11.9 acre-ft) or 1.7 percent during 1989-93, as indicated in the following table.

	Volume at full-pool elevation (cubic feet)		
	1989	1993	Volume decrease
Lake Katherine	27,340,000	26,902,000	438,000
Wood Lake	2,723,000	2,642,000	81,000
Total	30,063,000	29,544,000	519,000

Possible Sources Of Sediment

During this study, a few observations were made to determine possible sources of the sediment that entered the lakes during the period between the bathymetric surveys. The presence of a characteristic delta composed of loose, unvegetated sediments is evidence for a recent significant inflow of sediment. The location and orientation of this delta show that the primary avenue for transport of this sediment into Lake Katherine was Gills Creek (fig. 3).

A much smaller delta, visible in figure 3, has formed at the mouth of a small tributary that flows from Fort Jackson under the new Southeastern Beltway and into the northeastern corner of Lake Katherine. This tributary is impounded by a large sedimentation pond just upstream of the Southeastern Beltway (fig. 2). A sediment fence across the stream downstream of the beltway has retained some of the sediment that passed through the pond. No other significant tributaries, except Gills Creek, flow from the highway construction area directly into Lake Katherine.

Inspections were made of Gills Creek upstream from Lake Katherine on February 8, 1993 and April 25, 1993. Three tributaries enter Gills Creek between Lake Katherine and the Forest Lake Dam, two from the west and one from the east (fig. 2). Pen Branch joins Gills Creek from the west just north of Woodlake Drive. Eightmile Branch joins Gills Creek from the west farther upstream, just north of Forest Drive. Both of these tributaries had some deposits of sand and silt in the lower parts of their channels, but both streams are significantly smaller than Gills Creek. An even smaller unnamed tributary joins Gills Creek from the east between the two western tributaries. This tributary drains a small basin that includes some of the highway construction area near the Forest Drive entrance to Fort Jackson, as well as a new housing development. This tributary contains numerous sediment deposits and a delta at its confluence with Gills Creek.

On the days of the inspection, Gills Creek was slightly but noticeably more turbid than the tributaries, even though there are no other tributaries to Gills Creek downstream from the Forest Lake Dam. The water passing through the dam on February 8 had the same slightly brownish color as Gills Creek farther downstream, indicating that at the slightly elevated flow condition of February 8 silt could pass through the dam from Forest Lake to Gills Creek. The significance of this is that the dam on Boyden Arbor Pond, on Gills Creek above Forest Lake and Rockyford Lake (fig. 2), was removed rather suddenly. The resulting high flow in all likelihood carried a large amount of sediment from Boyden Arbor Pond downstream into Rockyford Lake. During an inspection of Rockyford Lake on October 2, 1992, a delta was observed with up to 4 ft of relatively fresh sediment, grading to thinner deposits of soft sediment farther down that lake. No significant delta was observed where the outlet of Rockyford Lake flows into Forest Lake during an inspection on November 9, 1993. It is possible that some silt and perhaps some sand were subsequently washed downstream through Forest Lake and Gills Creek, and into Lake Katherine.

Evidence of this spate of sediment-laden water was noticed on the eastern bank of Gills Creek just downstream from Forest Drive on April 25, 1993, in the form of sandy overbank deposits. These deposits, in relatively low parts of the flat flood plain about 3 ft above the normal creek level, were composed of sorted sand. They had an elongated lenticular form, about 1 ft thick, extending some 20 ft from the bank. The deposits are upstream of Pen Branch and the eastern tributary. The presence of the deposits suggests that a previous flood in Gills Creek carried a significant load of sediment and left these deposits in the relatively calm water of the inundated flood plain.

In summary, available evidence suggests that the sediment that entered Lake Katherine and Wood Lake during 1989-93 was derived from a mixture of sources in the Gills Creek Basin. The predominant source of the sediment was the part of the basin in which highway and housing construction activities occurred. This inflowing sediment changed the bathymetry of Lake Katherine by enlarging the delta where Gills Creek enters the lake. The infilling of sediment decreased the combined volume of Lake Katherine and Wood Lake by 519,000 ft^3, or 1.7 percent.