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Bathymetric Survey and Storage Capacity of Upper Lake Mary near Flagstaff, Arizona

Open-File Report 2008–1098

U.S. Department of the Interior
U.S. Geological Survey

Inside front cover

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By Nancy J. Hornewer and Marilyn E. Flynn

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FRONT COVER
U.S. Geological Survey personnel setting up surveying equipment by Upper Lake Mary, Arizona.

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	4,047	square meter (m^2)
acre	0.004047	square kilometer (km^2)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
million gallons (Mgal)	3,785	cubic meter (m^3)
acre-foot (acre-ft)	1,233	cubic meter (m^3)

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:
°C=(°F-32)/1.8
Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).
Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).
Elevation, as used in this report, refers to distance above the vertical datum.

Abbreviations Used In This Report

DGPS	Differentially corrected global positioning system
GPS	Global positioning system
LMWTP	Lake Mary Water Treatment Plant
NAD 83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988
NGS	National Geodetic Survey
NGVD 29	National Geodetic Vertical Datum of 1929
NSSDA	National Standard for Spatial Data Accuracy
OPUS	On-line Positioning User Service
RTK GPS	Real-time kinematic differentially corrected global positioning system
TGO	Trimble Geomatics Office software
TIN	Triangulated irregular network
USGS	U.S. Geological Survey

Bathymetric Survey and Storage Capacity of Upper Lake Mary near Flagstaff, Arizona

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Abstract

Upper Lake Mary is a preferred drinking-water source for the City of Flagstaff, Arizona. Therefore, storage capacity and sedimentation issues in Upper Lake Mary are of interest to the City. The U.S. Geological Survey, in cooperation with the City of Flagstaff, collected bathymetric and land-survey data in Upper Lake Mary during late August through October 2006. Water-depth data were collected using a single-beam, high-definition fathometer. Position data were collected using real-time differential global position system receivers. Data were processed using commercial software and imported into geographic information system software to produce contour maps of lakebed elevations and for the computation of area and storage-capacity information.

At full pool (spillway elevation of 6,828.5 feet above mean sea level), Upper Lake Mary has a storage capacity of 16,300 acre-feet, a surface area of 939 acres, a mean depth of 17.4 feet, and a depth near the dam of 39 feet. It is 5.6 miles long and varies in width from 308 feet near the central, narrow portion of the lake to 2,630 feet in the upper portion. Comparisons between this survey and a previous survey conducted in the 1950s indicate no apparent decrease in reservoir area or storage capacity between the two surveys.

Introduction

A combination of ground water from well fields throughout the Flagstaff area and surface water from Upper Lake Mary are used to supply drinking water to the City of Flagstaff, Arizona. Upper Lake Mary is a preferred source because it is one of the most economical water supplies for the City (City of Flagstaff Utilities Department, 2004). Over time, the storage capacity of a lake can decrease because of sediment accumulation. It is therefore important to periodically resurvey a lake to update area and storage-capacity information so managers are better able to oversee the resource.

The U.S. Geological Survey (USGS), in cooperation with the City of Flagstaff, collected bathymetric and land-survey data in Upper Lake Mary during late August through October 2006. Water-depth data were collected using a single-beam, high-definition fathometer. Position data were collected using real-time differentially corrected global position system (DGPS) receivers. Data were processed using commercial software and imported into geographic information system software to produce contour maps of lakebed elevations and for the computation of area and storage-capacity information.

Purpose and Scope

This report describes the methods used to collect bathymetric and land-survey data and discusses data-processing techniques that were used to produce the bathymetric-surface model, contour map of lakebed elevations, and an elevation-area and elevation-storage capacity (hereinafter referred to as area and storage capacity) table for Upper Lake Mary. The units used in this report are those used by the City of Flagstaff.

Acknowledgments

Jack Rathjen and Troy Truman from the Lake Mary Water Treatment Plant (LMWTP) provided information regarding the history of Lake Mary, as well as area and storage-capacity information from an earlier survey. Ron Doba and Randy Pellatz from the City of Flagstaff provided information regarding the dam structure and settlement-monument survey data. Jim Duncker from the USGS Illinois Water Science Center provided assistance and guidance with the collection of the bathymetric data. Gary Wilson and Joseph Richards from the USGS Missouri Water Science Center provided much assistance with data postprocessing and interpretation. Emmet McGuire and many other personnel from the USGS Arizona Water Science Center helped with this data-collection effort.

Description of Study Area

Upper Lake Mary is located approximately 10 miles (mi) southeast of Flagstaff in the Plateau Uplands hydrologic province region of north-central Arizona (fig. 1). It lies in a graben formed by two high-angle faults that run parallel along the north and south shores for the entire length of the lake (Blee, 1987). To the north, the Anderson Mesa Fault has an average displacement of about 250 feet (ft). To the south, the Lake Mary Fault has an average displacement of about 100 ft. Because of the faulting, the bedrock that underlies the lake is highly fractured to a depth of several hundred feet (Blee, 1987).

Flagstaff is located in a semiarid area and receives an average of 22.91 inches (in.) of precipitation per year, which includes 109.8 in. of snowfall per year. The Flagstaff area has an average annual temperature of 45.9°F with large diurnal changes (National Oceanic and Atmospheric Administration, 2006).

Upper Lake Mary is an artificial lake formed by an earthen dam constructed in 1941 by the City of Flagstaff. In 1951 the City raised the crest of the dam approximately 10 ft to the current elevation of 6,835.5 ft above mean sea level and improved the spillway, (Pellatz, 2006). The spillway is a concrete channel with sidewalls (Blee, 1987).

The drainage area for Upper Lake Mary is approximately 51 square miles (mi^2; City of Flagstaff Utilities Department, 2004). Inflow to the lake largely comes from spring snowmelt; however, there are small contributions from rainfall and from ephemeral streams, such as Babbit Spring and Newman Canyon. Water losses from the lake include evaporation, leakage, water-supply withdrawals, and spillage (Blee, 1987).

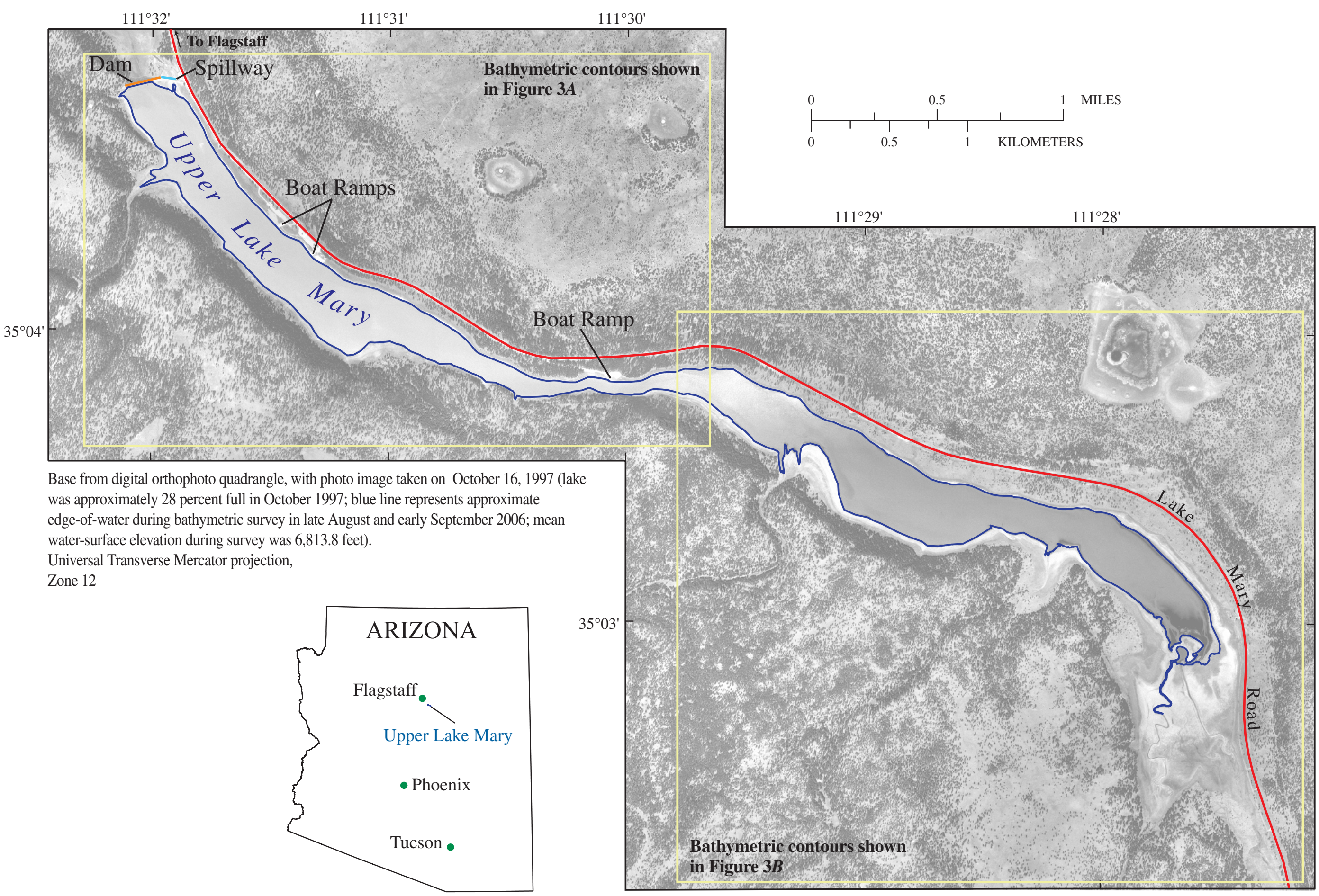

Figure 1. Location of Upper Lake Mary study area near Flagstaff, Arizona.

Methods

Data Collection

During the time of data collection, late August through October 2006, Upper Lake Mary decreased from approximately 30 percent capacity to 25 percent capacity or from 14.8 ft to 16.3 ft below the spillway elevation (Lake Mary Water Treatment Plant, written commun., 2007). A combination of bathymetric data and land-survey data up to the spillway elevation (or slightly above spillway elevation) were required to produce accurate area and storage-capacity information because the lake was below the spillway elevation.

Elevation data collected during this investigation are referenced to the City of Flagstaff monument 27, located on the spillway. This investigation used an elevation of 6,828.548 ft referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29), measured by the City of Flagstaff, as the base elevation for monument 27 (Pellatz, 2006). Note that during this investigation, three data files collected over periods of 3.5 hours, 5.7 hours, and 5.6 hours were downloaded from the base station positioned on monument 27. The files were processed using the Geoid-2003 model option of the On-line Positioning User Service (OPUS; National Geodetic Survey, 2006) at the National Geodetic Survey (NGS) to obtain an elevation referenced to the North American Vertical Datum of 1988 (NAVD 88). The average OPUS solution for monument 27 was 6,831.508 ft. This information allows an elevation referenced to NGVD 29 to be converted to an elevation referenced to NAVD 88.

Bathymetric, lake-survey, and land-survey data were collected at Upper Lake Mary to determine area and storage capacity relations (fig. 2). Bathymetric data were collected from a boat over all navigable areas of the lake by using a survey-grade, single-beam fathometer for water-depth data, and DGPS was used to collect corresponding position data. Lake-survey data were collected from non-navigable areas of the lake—areas that were either too shallow or had dense areas of submerged vegetation—by using real-time kinematic DGPS receivers (hereafter referred to as RTK GPS) for position and elevation data. Land-survey data were collected from the water's edge to a location on land slightly above the spillway elevation by using RTK GPS for position and elevation data.

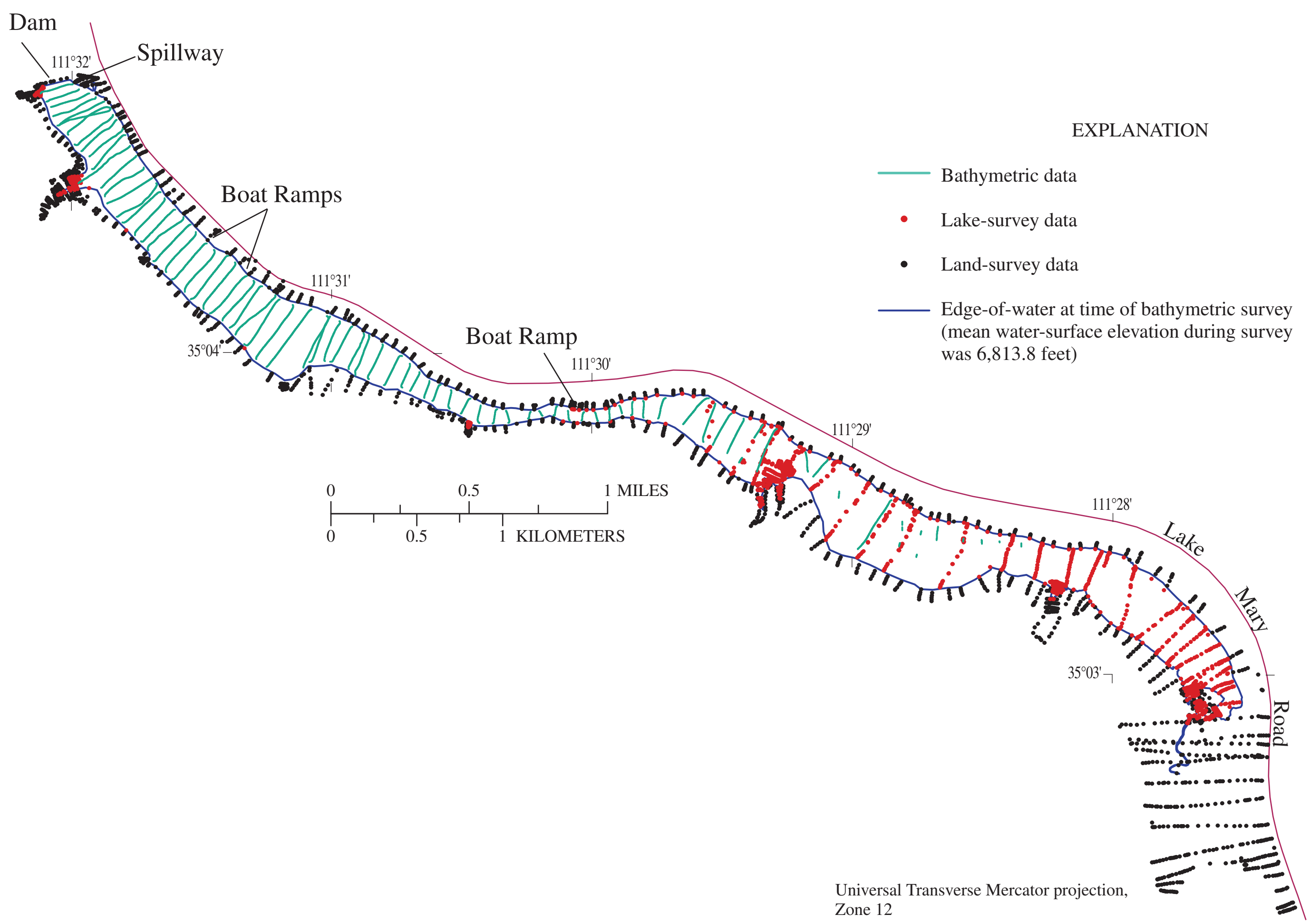

Figure 2. Map showing locations of three data-collection methods used at Upper Lake Mary: bathymetric data, lake-survey data, and land-survey data.

Bathymetric data were collected from navigable areas of Upper Lake Mary. Water-depth data were collected using a Reson, Incorporated, model 210 single-beam fathometer, or echosounder, and a 200-kilohertz transducer with a 2.7-degree beam width. Manufacturer specifications state an accuracy of +/-0.4 in. (Reson Incorporated, 2002); however, actual accuracy may be less because of wave action introducing tilt, roll, and pitch errors. The lake was relatively calm during the bathymetric data-collection effort, and therefore errors introduced because of boat instability are assumed to be small.

The transducer was mounted to a bracket on the boat with the transducer face at a depth of 0.2 ft to 1.0 ft below the water surface. Distance from the water surface to the face of the transducer was manually measured daily and added to the echosounder depth to obtain the total depth (lake bottom to water surface). Before the bathymetric data were collected each day, water depth was manually measured at a location and used to calibrate the echosounder. The water-surface elevation for each day was determined by measuring the elevation difference between a reference point with a known elevation and the water surface, and then subtracting that difference from the reference point elevation. This allowed for the conversion of depths measured by the echosounder to elevation data.

Horizontal-position data (latitude and longitude) were collected concurrently and combined with water-depth data. The position data were collected using a Trimble AG132 DGPS receiver. Differentially corrected data collected with a DGPS receiver improve the global positioning system (GPS) data accuracy by correcting for errors such as those introduced through atmospheric delays and satellite-clock errors. The manufacturer states an accuracy of less than +/-3.28 ft for the AG132 DGPS receiver (Trimble Navigation Limited, 2000). The antenna for the DPGS receiver was mounted at a fixed location above the transducer. Position data from the DGPS receiver were combined with depth data from the echosounder as they were being collected in the field by using Hypack Max, a hydrographic surveying software package developed by Hypack, Incorporated.

Bathymetric data were collected along transects that were spaced approximately 180 ft apart and were oriented perpendicular to the longitudinal axis of the lake (fig. 2). The boat slowly moved along each transect at velocities less than 3 miles per hour while collecting data in order to maximize the number of depth measurements made. The upper end of the lake was shallow, with areas of dense, submerged vegetation. Distances between transects were greater in this area because of boat-navigation difficulties, or because data collected along a transect were too noisy, because of submerged vegetation, to be useable and therefore were eliminated.

Raw bathymetric data were processed using Hypack Max to eliminate points that were outliers (a point that was much higher or lower than nearby points, points that showed zero depth, vegetation-affected points from which the bottom could not be determined, or points that may have been affected by boat roll/pitch errors). The resulting data were exported from Hypack Max as an x, y, z (latitude, longitude, elevation) file and then imported into a geographic information system database for postprocessing.

The second type of data collected was lake-survey data. These data were collected from areas in the lake that either were too shallow to safely navigate the boat or where there was dense, submerged vegetation, causing noisy and therefore unusable echosounder data (fig. 2). Lake-survey position and elevation data were collected using the following RTK GPS systems: the Trimble RTK R8 GNSS, the Trimble 5700, and the Trimble R7. These systems, for kinematic surveys, have a horizontal accuracy of +/-0.4 in. and a vertical accuracy of +/-0.8 in. (Trimble Navigation Limited, 2006).

Lake-survey data were collected either by wading across the lake or by using a boat for those areas with deeper water that had dense, submerged vegetation. In areas of the lake that were shallow enough to wade, measurements were taken along transects, with more frequent measurements taken in areas with rapidly changing slopes. In water too deep to wade, measurements were collected from a boat by slowly moving across the lake and stopping frequently to take RTK GPS measurements. Again, more frequent measurements were made in areas of rapidly changing slopes. These areas were determined by manually checking the lake bottom with a pole for slope changes as the boat traversed a transect.

Raw position and elevation data were processed using a standard surveying software package called Trimble Geomatics Office (TGO) made by Trimble Navigation Limited. Data were corrected with reference to the local geoid and quality assured for outliers. The corrected data were exported from TGO as an x, y, z (latitude, longitude, elevation) file and then imported into the geographic information system database for postprocessing.

The final type of data collected was land-survey data. Position and elevation data were collected using the same RTK GPS systems described above for lake-survey data. Data were collected from the water's edge and at several points along a transect moving away from the lake, until an elevation slightly above spillway elevation was reached (fig. 2). These transects were spaced approximately 220 ft apart, with larger intervals in the upper part of the lake. In some cases, it was not possible to reach the spillway elevation along a transect because trees interfered with the RTK GPS signal reception. In those instances, the spillway elevation was estimated using nearby data. Raw position and elevation data were processed as described in the lake-survey section.

Data Postprocessing

The bathymetric, lake-survey, and land-survey elevation and position data were imported into the ArcGIS 9.1 software package (Environmental Systems Research Institute, 2007a) in x, y, z format for additional processing. The data were first inspected in a 3-D environment to aid in identifying and deleting any outliers not apparent during the initial processing of the data. The data were then processed into a preliminary triangulated irregular network (TIN) surface model. A TIN is a network of adjacent, nonoverlapping triangles generated from irregularly spaced points that have x, y coordinates and z values. The triangles are created so that all points are connected using their two nearest neighbors to form the triangles and the resulting triangulation satisfies the Delaunay triangle criterion (Environmental Systems Research Institute, 2005). This triangulated network forms a continuous faceted surface, where each triangle describes the behavior of a portion of the surface.

Preliminary elevation contours were generated from the initial TIN surface model by using the TIN contouring function. The contours were inspected for the accurate surface representation of linear features such as stream channels, steep slopes, and the tops of the dam and spillway. The surface model (and consequently the contours) may not accurately represent these features because the distance between transects can be large enough that the feature is not interpolated appropriately between transects. Adding linear enforcement data to the surface model forces a more accurate representation of linear features. To add linear-enforcement data for stream channels and other linear features identified in the 3-D environment, lines were drawn to connect the linear features between transects. The nodes at the ends of the lines, where lines intersect with data points on a transect, were attributed with the surveyed elevations of the data points. Additional vertices were added along the lines, and the elevations for these vertices were interpolated using the known elevations of the end nodes. The line vertices were then converted to points.

A secondary TIN was generated using the edited elevation data and the linear-enforcement point data representing the stream channels and the tops of the dam and the spillway. From this TIN, a secondary set of contours was generated using the TIN contouring function. Because of the strictly numerical interpretation of the data, the contour lines in some areas appeared jagged. The contouring function interpolates straight lines across each triangle to produce an exact linear interpretation of the surface. Although this interpretation is numerically correct, it does not match the cartographic interpretation (smooth contour lines typically shown on maps) of the data. To more closely match the cartographic interpretation, the contours were edited manually by reshaping contour lines using the edited elevation data as a guide.

The necessity for reshaping the contours using the edited elevation data as a guide indicated that the nonuniform change in slope along the north shore of the lake was not accurately represented in the secondary TIN surface model. Therefore, linear-enforcement data in the form of constant elevation breaklines based on the edited contours were used to linearly enforce the slope and shape of the north shore of the lake in the secondary TIN. The final bathymetric TIN surface model was generated using the edited elevation data, the linear enforcement point data representing the stream channels and the tops of the dam and spillway, and the north-shore breaklines.

Area and storage capacity were calculated for specific water-surface elevations using the final TIN surface model with the ArcGIS 3D Analyst extension (Environmental Systems Research Institute, 2007b). Each triangle in the TIN was examined to determine its contribution to the area and volume at the given elevation.

Results

At full pool (spillway elevation of 6,828.5 ft), Upper Lake Mary has a storage capacity of 16,300 acre-ft, a surface area of 939 acres, a mean depth of 17.4 ft, and a depth near the dam of 39 ft. It is 5.6 mi long and varies in width from 308 ft near the central, narrow portion of the lake to 2,630 ft in the upper portion.

The edited contour map created in ArcGIS is shown in figure 3. Although vertical accuracy using the National Standard for Spatial Data Accuracy (NSSDA) method was not checked for this contour map, the survey was completed using processing methods that usually obtain a vertical accuracy of approximately 2.78 ft at the 95-percent confidence level for lakes of this size (Wilson and Richards, 2006). Figure 3 represents lakebed elevations when the lake is at full pool or at the spillway elevation of 6,828.5 ft. The blue shading is the approximate edge-of-water (mean water-surface elevation of 6,813.8 ft) at the time of the bathymetric survey. The contours are at 5-ft intervals. At this resolution, it is possible to see an old channel of Walnut Creek meandering through the lake. The locations of aerators that were installed in the lake to keep the lake well mixed also are shown in figure 3.

Table 1 shows area and storage-capacity information calculated from the final TIN surface model using ArcGIS for Upper Lake Mary, starting from near the lake bottom to 1.1 ft above full-pool capacity, allowing for backwater conditions. Although vertical accuracy using the NSSDA method was not checked for this bathymetric surface, the survey was completed using processing methods that usually obtain a vertical accuracy of approximately 1.62 ft at the 95-percent confidence level (Wilson and Richards, 2006). Table 1 was generated at 0.1-ft increments in order to match the area and storage-capacity table currently in use at the Lake Mary Water Treatment Plant (LMWTP). The table also relates lake elevation data to a relative datum used by personnel at the LMWTP.

Upper Lake Mary was last surveyed in the early 1950s (J. Rathjen, Utilities Department—Water Production, City of Flagstaff, oral commun., 2007). Results from that survey showed a full-pool storage capacity of 15,620 acre-ft at the spillway elevation, a maximum surface area of 876 acres, a mean depth of 17.9 ft, and a depth near the dam of 40 ft. The lake was determined to be 5.5 mi long and 300 to 2,000 ft wide (Blee, 1987). Table 2 compares results from the two surveys.

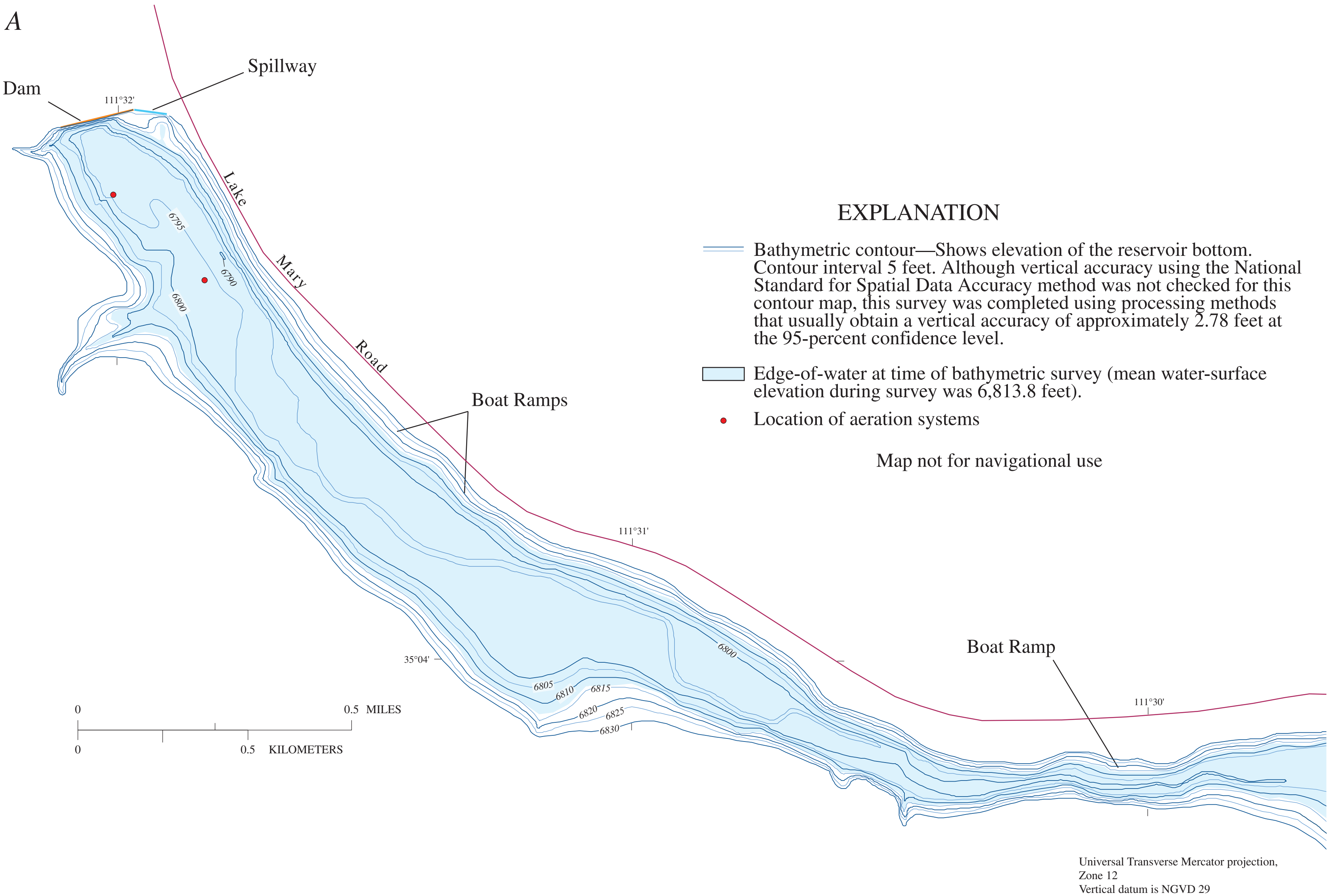

Figure 3. Contour map showing lakebed elevations up to the spillway elevation for Upper Lake Mary. *A*, West (lower) part. *B*, East (upper) part.

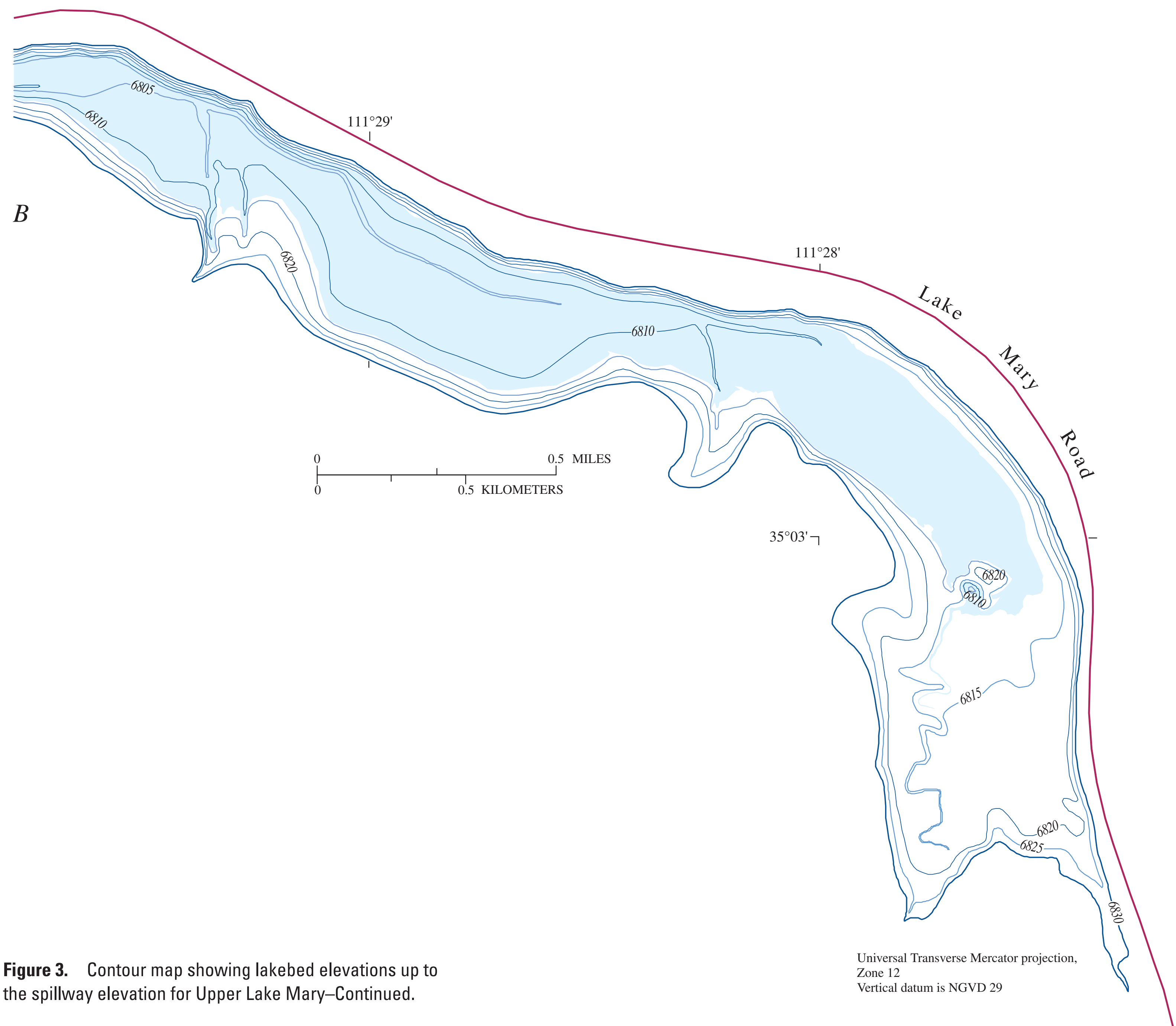

Figure 3. Contour map showing lakebed elevations up to the spillway elevation for Upper Lake Mary—Continued.

Table 1. Elevation-area and elevation-storage capacity information for Upper Lake Mary

[This is an operational table that will be used by personnel at the Lake Mary Water Treatment Plant (LMWTP); the beginning and ending elevations are the same as those currently in use by personnel at the LMWTP; the base elevation used for this study was monument 27 located on the spillway with an elevation of 6,828.548 feet as documented by the City of Flagstaff; the spillway elevation used by the LMWTP is 6,828.5 feet, which corresponds to full capacity for Upper Lake Mary; elevation is referenced to the National Geodetic Vertical Datum of 1929; personnel at the LMWTP use a relative datum for measurements, which also is shown on this table; although vertical accuracy using the National Standard for Spatial Data Accuracy method was not checked for the bathymetric surface from which this table was generated, this survey was completed using processing methods that usually obtain a vertical accuracy of approximately 1.62 feet at the 95-percent confidence level]

Water-surface elevation (feet)	Surface area (acres)	Volume (acre-feet)	Volume (million gallons)	Relative datum - measured up from lake bottom (feet)	Relative datum - measured down from tower (feet)	Percent capacity (percent)
6,790.0	0.009	0.001	0.000	0.0	39.6	0.0
6,790.1	0.013	0.002	0.001	0.1	39.5	0.0
6,790.2	0.019	0.004	0.001	0.2	39.4	0.0
6,790.3	0.027	0.006	0.002	0.3	39.3	0.0
6,790.4	0.037	0.009	0.003	0.4	39.2	0.0
6,790.5	0.052	0.013	0.004	0.5	39.1	0.0
6,790.6	0.076	0.020	0.006	0.6	39.0	0.0
6,790.7	0.118	0.029	0.009	0.7	38.9	0.0
6,790.8	0.192	0.044	0.014	0.8	38.8	0.0
6,790.9	0.304	0.069	0.022	0.9	38.7	0.0
6,791.0	0.454	0.106	0.035	1.0	38.6	0.0
6,791.1	0.639	0.161	0.052	1.1	38.5	0.0
6,791.2	0.868	0.236	0.077	1.2	38.4	0.0
6,791.3	1.10	0.334	0.109	1.3	38.3	0.0
6,791.4	1.34	0.456	0.149	1.4	38.2	0.0
6,791.5	1.61	0.604	0.197	1.5	38.1	0.0
6,791.6	1.92	0.779	0.254	1.6	38.0	0.0
6,791.7	2.28	0.988	0.322	1.7	37.9	0.0
6,791.8	2.70	1.24	0.403	1.8	37.8	0.0
6,791.9	3.19	1.53	0.499	1.9	37.7	0.0
6,792.0	3.75	1.88	0.612	2.0	37.6	0.0
6,792.1	4.38	2.28	0.744	2.1	37.5	0.0
6,792.2	5.15	2.76	0.898	2.2	37.4	0.0
6,792.3	5.88	3.31	1.08	2.3	37.3	0.0
6,792.4	6.62	3.93	1.28	2.4	37.2	0.0
6,792.5	7.36	4.63	1.51	2.5	37.1	0.0
6,792.6	8.10	5.41	1.76	2.6	37.0	0.0
6,792.7	8.90	6.26	2.04	2.7	36.9	0.0
6,792.8	9.89	7.20	2.35	2.8	36.8	0.0
6,792.9	11.0	8.24	2.68	2.9	36.7	0.1
6,793.0	12.1	9.39	3.06	3.0	36.6	0.1
6,793.1	13.3	10.7	3.47	3.1	36.5	0.1
6,793.2	14.8	12.1	3.93	3.2	36.4	0.1
6,793.3	16.1	13.6	4.43	3.3	36.3	0.1
6,793.4	17.5	15.3	4.98	3.4	36.2	0.1
6,793.5	18.8	17.1	5.57	3.5	36.1	0.1

Table 1. Elevation-area and elevation-storage capacity information for Upper Lake Mary—Continued

Water-surface elevation (feet)	Surface area (acres)	Volume (acre-feet)	Volume (million gallons)	Relative datum - measured up from lake bottom (feet)	Relative datum - measured down from tower (feet)	Percent capacity (percent)
6,793.6	20.1	19.0	6.21	3.6	36.0	0.1
6,793.7	21.4	21.1	6.88	3.7	35.9	0.1
6,793.8	22.7	23.3	7.60	3.8	35.8	0.1
6,793.9	24.0	25.7	8.36	3.9	35.7	0.2
6,794.0	25.3	28.1	9.17	4.0	35.6	0.2
6,794.1	26.6	30.7	10.0	4.1	35.5	0.2
6,794.2	27.9	33.4	10.9	4.2	35.4	0.2
6,794.3	29.4	36.3	11.8	4.3	35.3	0.2
6,794.4	31.0	39.3	12.8	4.4	35.2	0.2
6,794.5	32.7	42.5	13.9	4.5	35.1	0.3
6,794.6	34.6	45.9	14.9	4.6	35.0	0.3
6,794.7	36.7	49.4	16.1	4.7	34.9	0.3
6,794.8	39.0	53.2	17.3	4.8	34.8	0.3
6,794.9	41.5	57.2	18.6	4.9	34.7	0.4
6,795.0	44.2	61.5	20.0	5.0	34.6	0.4
6,795.1	46.9	66.1	21.5	5.1	34.5	0.4
6,795.2	49.6	70.9	23.1	5.2	34.4	0.4
6,795.3	52.4	76.0	24.8	5.3	34.3	0.5
6,795.4	55.3	81.4	26.5	5.4	34.2	0.5
6,795.5	58.0	87.0	28.4	5.5	34.1	0.5
6,795.6	60.6	93.0	30.3	5.6	34.0	0.6
6,795.7	63.4	99.2	32.3	5.7	33.9	0.6
6,795.8	66.3	106	34.4	5.8	33.8	0.7
6,795.9	69.2	112	36.6	5.9	33.7	0.7
6,796.0	71.9	120	38.9	6.0	33.6	0.7
6,796.1	74.4	127	41.3	6.1	33.5	0.8
6,796.2	76.7	134	43.8	6.2	33.4	0.8
6,796.3	78.9	142	46.3	6.3	33.3	0.9
6,796.4	81.2	150	48.9	6.4	33.2	0.9
6,796.5	83.6	158	51.6	6.5	33.1	1.0
6,796.6	86.4	167	54.4	6.6	33.0	1.0
6,796.7	89.3	176	57.3	6.7	32.9	1.1
6,796.8	92.3	185	60.2	6.8	32.8	1.1
6,796.9	95.0	194	63.2	6.9	32.7	1.2
6,797.0	97.8	204	66.4	7.0	32.6	1.3
6,797.1	101	214	69.6	7.1	32.5	1.3
6,797.2	103	224	73.0	7.2	32.4	1.4
6,797.3	106	234	76.4	7.3	32.3	1.4
6,797.4	109	245	79.9	7.4	32.2	1.5
6,797.5	111	256	83.5	7.5	32.1	1.6
6,797.6	114	267	87.1	7.6	32.0	1.6

Table 1. Elevation-area and elevation-storage capacity information for Upper Lake Mary—Continued

Water-surface elevation (feet)	Surface area (acres)	Volume (acre-feet)	Volume (million gallons)	Relative datum - measured up from lake bottom (feet)	Relative datum - measured down from tower (feet)	Percent capacity (percent)
6,797.7	117	279	90.9	7.7	31.9	1.7
6,797.8	119	291	94.8	7.8	31.8	1.8
6,797.9	121	303	98.7	7.9	31.7	1.9
6,798.0	123	315	103	8.0	31.6	1.9
6,798.1	125	327	107	8.1	31.5	2.0
6,798.2	128	340	111	8.2	31.4	2.1
6,798.3	130	353	115	8.3	31.3	2.2
6,798.4	132	366	119	8.4	31.2	2.2
6,798.5	134	379	124	8.5	31.1	2.3
6,798.6	136	393	128	8.6	31.0	2.4
6,798.7	138	407	132	8.7	30.9	2.5
6,798.8	140	420	137	8.8	30.8	2.6
6,798.9	141	434	142	8.9	30.7	2.7
6,799.0	143	449	146	9.0	30.6	2.8
6,799.1	144	463	151	9.1	30.5	2.8
6,799.2	146	478	156	9.2	30.4	2.9
6,799.3	147	492	160	9.3	30.3	3.0
6,799.4	148	507	165	9.4	30.2	3.1
6,799.5	150	522	170	9.5	30.1	3.2
6,799.6	151	537	175	9.6	30.0	3.3
6,799.7	153	552	180	9.7	29.9	3.4
6,799.8	154	567	185	9.8	29.8	3.5
6,799.9	155	583	190	9.9	29.7	3.6
6,800.0	156	598	195	10.0	29.6	3.7
6,800.1	157	614	200	10.1	29.5	3.8
6,800.2	158	630	205	10.2	29.4	3.9
6,800.3	159	646	210	10.3	29.3	4.0
6,800.4	160	662	216	10.4	29.2	4.1
6,800.5	161	678	221	10.5	29.1	4.2
6,800.6	162	694	226	10.6	29.0	4.3
6,800.7	163	710	231	10.7	28.9	4.4
6,800.8	164	727	237	10.8	28.8	4.5
6,800.9	165	743	242	10.9	28.7	4.6
6,801.0	166	760	248	11.0	28.6	4.7
6,801.1	167	777	253	11.1	28.5	4.8
6,801.2	168	793	259	11.2	28.4	4.9
6,801.3	169	810	264	11.3	28.3	5.0
6,801.4	171	827	270	11.4	28.2	5.1
6,801.5	172	844	275	11.5	28.1	5.2
6,801.6	173	862	281	11.6	28.0	5.3
6,801.7	174	879	286	11.7	27.9	5.4

Table 1. Elevation-area and elevation-storage capacity information for Upper Lake Mary—Continued

Water-surface elevation (feet)	Surface area (acres)	Volume (acre-feet)	Volume (million gallons)	Relative datum - measured up from lake bottom (feet)	Relative datum - measured down from tower (feet)	Percent capacity (percent)
6,801.8	176	896	292	11.8	27.8	5.5
6,801.9	177	914	298	11.9	27.7	5.6
6,802.0	178	932	304	12.0	27.6	5.7
6,802.1	179	950	309	12.1	27.5	5.8
6,802.2	180	968	315	12.2	27.4	5.9
6,802.3	181	986	321	12.3	27.3	6.0
6,802.4	182	1,000	327	12.4	27.2	6.1
6,802.5	183	1,020	333	12.5	27.1	6.3
6,802.6	184	1,040	339	12.6	27.0	6.4
6,802.7	185	1,060	345	12.7	26.9	6.5
6,802.8	187	1,080	351	12.8	26.8	6.6
6,802.9	188	1,100	357	12.9	26.7	6.7
6,803.0	189	1,120	363	13.0	26.6	6.9
6,803.1	190	1,130	370	13.1	26.5	6.9
6,803.2	191	1,150	376	13.2	26.4	7.1
6,803.3	192	1,170	382	13.3	26.3	7.2
6,803.4	193	1,190	388	13.4	26.2	7.3
6,803.5	195	1,210	395	13.5	26.1	7.4
6,803.6	196	1,230	401	13.6	26.0	7.5
6,803.7	197	1,250	407	13.7	25.9	7.7
6,803.8	198	1,270	414	13.8	25.8	7.8
6,803.9	199	1,290	420	13.9	25.7	7.9
6,804.0	201	1,310	427	14.0	25.6	8.0
6,804.1	202	1,330	433	14.1	25.5	8.2
6,804.2	203	1,350	440	14.2	25.4	8.3
6,804.3	205	1,370	447	14.3	25.3	8.4
6,804.4	206	1,390	453	14.4	25.2	8.5
6,804.5	207	1,410	460	14.5	25.1	8.7
6,804.6	209	1,430	467	14.6	25.0	8.8
6,804.7	210	1,450	474	14.7	24.9	8.9
6,804.8	212	1,470	481	14.8	24.8	9.0
6,804.9	214	1,500	487	14.9	24.7	9.2
6,805.0	215	1,520	494	15.0	24.6	9.3
6,805.1	217	1,540	502	15.1	24.5	9.4
6,805.2	219	1,560	509	15.2	24.4	9.6
6,805.3	221	1,580	516	15.3	24.3	9.7
6,805.4	222	1,600	523	15.4	24.2	9.8
6,805.5	224	1,630	530	15.5	24.1	10.0
6,805.6	226	1,650	538	15.6	24.0	10.1
6,805.7	228	1,670	545	15.7	23.9	10.2
6,805.8	230	1,700	552	15.8	23.8	10.4

Table 1. Elevation-area and elevation-storage capacity information for Upper Lake Mary—Continued

Water-surface elevation (feet)	Surface area (acres)	Volume (acre-feet)	Volume (million gallons)	Relative datum - measured up from lake bottom (feet)	Relative datum - measured down from tower (feet)	Percent capacity (percent)
6,805.9	232	1,720	560	15.9	23.7	10.6
6,806.0	234	1,740	568	16.0	23.6	10.7
6,806.1	236	1,770	575	16.1	23.5	10.9
6,806.2	239	1,790	583	16.2	23.4	11.0
6,806.3	241	1,810	591	16.3	23.3	11.1
6,806.4	243	1,840	599	16.4	23.2	11.3
6,806.5	246	1,860	607	16.5	23.1	11.4
6,806.6	248	1,890	615	16.6	23.0	11.6
6,806.7	251	1,910	623	16.7	22.9	11.7
6,806.8	253	1,940	631	16.8	22.8	11.9
6,806.9	256	1,960	639	16.9	22.7	12.0
6,807.0	259	1,990	648	17.0	22.6	12.2
6,807.1	262	2,010	656	17.1	22.5	12.3
6,807.2	264	2,040	665	17.2	22.4	12.5
6,807.3	267	2,070	673	17.3	22.3	12.7
6,807.4	270	2,090	682	17.4	22.2	12.8
6,807.5	273	2,120	691	17.5	22.1	13.0
6,807.6	277	2,150	700	17.6	22.0	13.2
6,807.7	280	2,180	709	17.7	21.9	13.4
6,807.8	284	2,200	718	17.8	21.8	13.5
6,807.9	289	2,230	728	17.9	21.7	13.7
6,808.0	294	2,260	737	18.0	21.6	13.9
6,808.1	299	2,290	747	18.1	21.5	14.0
6,808.2	303	2,320	757	18.2	21.4	14.2
6,808.3	307	2,350	767	18.3	21.3	14.4
6,808.4	312	2,380	777	18.4	21.2	14.6
6,808.5	316	2,410	787	18.5	21.1	14.8
6,808.6	320	2,450	797	18.6	21.0	15.0
6,808.7	323	2,480	808	18.7	20.9	15.2
6,808.8	327	2,510	818	18.8	20.8	15.4
6,808.9	331	2,540	829	18.9	20.7	15.6
6,809.0	334	2,580	840	19.0	20.6	15.8
6,809.1	337	2,610	851	19.1	20.5	16.0
6,809.2	341	2,640	862	19.2	20.4	16.2
6,809.3	344	2,680	873	19.3	20.3	16.4
6,809.4	347	2,710	884	19.4	20.2	16.6
6,809.5	350	2,750	896	19.5	20.1	16.9
6,809.6	354	2,780	907	19.6	20.0	17.1
6,809.7	357	2,820	919	19.7	19.9	17.3
6,809.8	360	2,860	930	19.8	19.8	17.5
6,809.9	363	2,890	942	19.9	19.7	17.7

Table 1. Elevation-area and elevation-storage capacity information for Upper Lake Mary—Continued

Water-surface elevation (feet)	Surface area (acres)	Volume (acre-feet)	Volume (million gallons)	Relative datum - measured up from lake bottom (feet)	Relative datum - measured down from tower (feet)	Percent capacity (percent)
6,810.0	366	2,930	954	20.0	19.6	18.0
6,810.1	370	2,960	966	20.1	19.5	18.2
6,810.2	373	3,000	978	20.2	19.4	18.4
6,810.3	376	3,040	990	20.3	19.3	18.7
6,810.4	379	3,080	1,000	20.4	19.2	18.9
6,810.5	383	3,110	1,020	20.5	19.1	19.1
6,810.6	387	3,150	1,030	20.6	19.0	19.3
6,810.7	391	3,190	1,040	20.7	18.9	19.6
6,810.8	396	3,230	1,050	20.8	18.8	19.8
6,810.9	401	3,270	1,070	20.9	18.7	20.1
6,811.0	405	3,310	1,080	21.0	18.6	20.3
6,811.1	410	3,350	1,090	21.1	18.5	20.6
6,811.2	415	3,390	1,110	21.2	18.4	20.8
6,811.3	419	3,440	1,120	21.3	18.3	21.1
6,811.4	424	3,480	1,130	21.4	18.2	21.3
6,811.5	428	3,520	1,150	21.5	18.1	21.6
6,811.6	433	3,560	1,160	21.6	18.0	21.8
6,811.7	438	3,610	1,180	21.7	17.9	22.1
6,811.8	444	3,650	1,190	21.8	17.8	22.4
6,811.9	450	3,700	1,200	21.9	17.7	22.7
6,812.0	456	3,740	1,220	22.0	17.6	22.9
6,812.1	462	3,790	1,230	22.1	17.5	23.3
6,812.2	468	3,830	1,250	22.2	17.4	23.5
6,812.3	475	3,880	1,260	22.3	17.3	23.8
6,812.4	481	3,930	1,280	22.4	17.2	24.1
6,812.5	488	3,980	1,300	22.5	17.1	24.4
6,812.6	494	4,030	1,310	22.6	17.0	24.7
6,812.7	500	4,080	1,330	22.7	16.9	25.0
6,812.8	505	4,130	1,340	22.8	16.8	25.3
6,812.9	511	4,180	1,360	22.9	16.7	25.6
6,813.0	517	4,230	1,380	23.0	16.6	26.0
6,813.1	523	4,280	1,390	23.1	16.5	26.3
6,813.2	529	4,330	1,410	23.2	16.4	26.6
6,813.3	534	4,390	1,430	23.3	16.3	26.9
6,813.4	538	4,440	1,450	23.4	16.2	27.2
6,813.5	543	4,490	1,460	23.5	16.1	27.5
6,813.6	547	4,550	1,480	23.6	16.0	27.9
6,813.7	552	4,600	1,500	23.7	15.9	28.2
6,813.8	558	4,660	1,520	23.8	15.8	28.6
6,813.9	568	4,710	1,540	23.9	15.7	28.9
6,814.0	573	4,770	1,550	24.0	15.6	29.3

Table 1. Elevation-area and elevation-storage capacity information for Upper Lake Mary—Continued

Water-surface elevation (feet)	Surface area (acres)	Volume (acre-feet)	Volume (million gallons)	Relative datum - measured up from lake bottom (feet)	Relative datum - measured down from tower (feet)	Percent capacity (percent)
6,814.1	579	4,830	1,570	24.1	15.5	29.6
6,814.2	584	4,890	1,590	24.2	15.4	30.0
6,814.3	589	4,950	1,610	24.3	15.3	30.4
6,814.4	594	5,010	1,630	24.4	15.2	30.7
6,814.5	599	5,060	1,650	24.5	15.1	31.0
6,814.6	604	5,130	1,670	24.6	15.0	31.5
6,814.7	609	5,190	1,690	24.7	14.9	31.8
6,814.8	614	5,250	1,710	24.8	14.8	32.2
6,814.9	619	5,310	1,730	24.9	14.7	32.6
6,815.0	624	5,370	1,750	25.0	14.6	32.9
6,815.1	628	5,430	1,770	25.1	14.5	33.3
6,815.2	631	5,500	1,790	25.2	14.4	33.7
6,815.3	635	5,560	1,810	25.3	14.3	34.1
6,815.4	639	5,620	1,830	25.4	14.2	34.5
6,815.5	642	5,690	1,850	25.5	14.1	34.9
6,815.6	646	5,750	1,870	25.6	14.0	35.3
6,815.7	650	5,820	1,900	25.7	13.9	35.7
6,815.8	653	5,880	1,920	25.8	13.8	36.1
6,815.9	657	5,950	1,940	25.9	13.7	36.5
6,816.0	661	6,010	1,960	26.0	13.6	36.9
6,816.1	665	6,080	1,980	26.1	13.5	37.3
6,816.2	669	6,150	2,000	26.2	13.4	37.7
6,816.3	673	6,210	2,020	26.3	13.3	38.1
6,816.4	677	6,280	2,050	26.4	13.2	38.5
6,816.5	681	6,350	2,070	26.5	13.1	39.0
6,816.6	685	6,420	2,090	26.6	13.0	39.4
6,816.7	689	6,490	2,110	26.7	12.9	39.8
6,816.8	694	6,560	2,140	26.8	12.8	40.2
6,816.9	698	6,620	2,160	26.9	12.7	40.6
6,817.0	703	6,690	2,180	27.0	12.6	41.0
6,817.1	707	6,770	2,200	27.1	12.5	41.5
6,817.2	711	6,840	2,230	27.2	12.4	42.0
6,817.3	715	6,910	2,250	27.3	12.3	42.4
6,817.4	720	6,980	2,270	27.4	12.2	42.8
6,817.5	724	7,050	2,300	27.5	12.1	43.3
6,817.6	727	7,120	2,320	27.6	12.0	43.7
6,817.7	730	7,200	2,350	27.7	11.9	44.2
6,817.8	733	7,270	2,370	27.8	11.8	44.6
6,817.9	736	7,340	2,390	27.9	11.7	45.0
6,818.0	739	7,420	2,420	28.0	11.6	45.5
6,818.1	741	7,490	2,440	28.1	11.5	46.0

Table 1. Elevation-area and elevation-storage capacity information for Upper Lake Mary—Continued

Water-surface elevation (feet)	Surface area (acres)	Volume (acre-feet)	Volume (million gallons)	Relative datum - measured up from lake bottom (feet)	Relative datum - measured down from tower (feet)	Percent capacity (percent)
6,818.2	744	7,570	2,470	28.2	11.4	46.4
6,818.3	747	7,640	2,490	28.3	11.3	46.9
6,818.4	749	7,710	2,510	28.4	11.2	47.3
6,818.5	752	7,790	2,540	28.5	11.1	47.8
6,818.6	754	7,870	2,560	28.6	11.0	48.3
6,818.7	757	7,940	2,590	28.7	10.9	48.7
6,818.8	759	8,020	2,610	28.8	10.8	49.2
6,818.9	762	8,090	2,640	28.9	10.7	49.6
6,819.0	764	8,170	2,660	29.0	10.6	50.1
6,819.1	767	8,250	2,690	29.1	10.5	50.6
6,819.2	770	8,320	2,710	29.2	10.4	51.0
6,819.3	772	8,400	2,740	29.3	10.3	51.5
6,819.4	775	8,480	2,760	29.4	10.2	52.0
6,819.5	778	8,550	2,790	29.5	10.1	52.5
6,819.6	780	8,630	2,810	29.6	10.0	52.9
6,819.7	783	8,710	2,840	29.7	9.9	53.4
6,819.8	785	8,790	2,860	29.8	9.8	53.9
6,819.9	787	8,870	2,890	29.9	9.7	54.4
6,820.0	790	8,950	2,920	30.0	9.6	54.9
6,820.1	793	9,030	2,940	30.1	9.5	55.4
6,820.2	795	9,100	2,970	30.2	9.4	55.8
6,820.3	797	9,180	2,990	30.3	9.3	56.3
6,820.4	799	9,260	3,020	30.4	9.2	56.8
6,820.5	801	9,340	3,040	30.5	9.1	57.3
6,820.6	803	9,420	3,070	30.6	9.0	57.8
6,820.7	805	9,500	3,100	30.7	8.9	58.3
6,820.8	807	9,590	3,120	30.8	8.8	58.8
6,820.9	809	9,670	3,150	30.9	8.7	59.3
6,821.0	811	9,750	3,180	31.0	8.6	59.8
6,821.1	812	9,830	3,200	31.1	8.5	60.3
6,821.2	814	9,910	3,230	31.2	8.4	60.8
6,821.3	816	9,990	3,260	31.3	8.3	61.3
6,821.4	818	10,100	3,280	31.4	8.2	62.0
6,821.5	820	10,200	3,310	31.5	8.1	62.6
6,821.6	822	10,200	3,340	31.6	8.0	62.6
6,821.7	824	10,300	3,360	31.7	7.9	63.2
6,821.8	826	10,400	3,390	31.8	7.8	63.8
6,821.9	827	10,500	3,420	31.9	7.7	64.4
6,822.0	829	10,600	3,440	32.0	7.6	65.0
6,822.1	831	10,600	3,470	32.1	7.5	65.0
6,822.2	833	10,700	3,500	32.2	7.4	65.6

Table 1. Elevation-area and elevation-storage capacity information for Upper Lake Mary—Continued

Water-surface elevation (feet)	Surface area (acres)	Volume (acre-feet)	Volume (million gallons)	Relative datum - measured up from lake bottom (feet)	Relative datum - measured down from tower (feet)	Percent capacity (percent)
6,822.3	835	10,800	3,520	32.3	7.3	66.3
6,822.4	836	10,900	3,550	32.4	7.2	66.9
6,822.5	838	11,000	3,580	32.5	7.1	67.5
6,822.6	840	11,100	3,610	32.6	7.0	68.1
6,822.7	842	11,200	3,630	32.7	6.9	68.7
6,822.8	844	11,200	3,660	32.8	6.8	68.7
6,822.9	845	11,300	3,690	32.9	6.7	69.3
6,823.0	847	11,400	3,720	33.0	6.6	69.9
6,823.1	849	11,500	3,740	33.1	6.5	70.6
6,823.2	851	11,600	3,770	33.2	6.4	71.2
6,823.3	853	11,700	3,800	33.3	6.3	71.8
6,823.4	854	11,700	3,830	33.4	6.2	71.8
6,823.5	856	11,800	3,860	33.5	6.1	72.4
6,823.6	858	11,900	3,880	33.6	6.0	73.0
6,823.7	860	12,000	3,910	33.7	5.9	73.6
6,823.8	861	12,100	3,940	33.8	5.8	74.2
6,823.9	863	12,200	3,970	33.9	5.7	74.8
6,824.0	865	12,300	4,000	34.0	5.6	75.5
6,824.1	866	12,300	4,020	34.1	5.5	75.5
6,824.2	868	12,400	4,050	34.2	5.4	76.1
6,824.3	870	12,500	4,080	34.3	5.3	76.7
6,824.4	872	12,600	4,110	34.4	5.2	77.3
6,824.5	873	12,700	4,140	34.5	5.1	77.9
6,824.6	875	12,800	4,170	34.6	5.0	78.5
6,824.7	877	12,900	4,190	34.7	4.9	79.1
6,824.8	879	13,000	4,220	34.8	4.8	79.8
6,824.9	880	13,000	4,250	34.9	4.7	79.8
6,825.0	882	13,100	4,280	35.0	4.6	80.4
6,825.1	884	13,200	4,310	35.1	4.5	81.0
6,825.2	886	13,300	4,340	35.2	4.4	81.6
6,825.3	887	13,400	4,370	35.3	4.3	82.2
6,825.4	889	13,500	4,400	35.4	4.2	82.8
6,825.5	891	13,600	4,420	35.5	4.1	83.4
6,825.6	892	13,700	4,450	35.6	4.0	84.0
6,825.7	894	13,800	4,480	35.7	3.9	84.7
6,825.8	896	13,800	4,510	35.8	3.8	84.7
6,825.9	897	13,900	4,540	35.9	3.7	85.3
6,826.0	899	14,000	4,570	36.0	3.6	85.9
6,826.1	901	14,100	4,600	36.1	3.5	86.5
6,826.2	902	14,200	4,630	36.2	3.4	87.1
6,826.3	904	14,300	4,660	36.3	3.3	87.7

Table 1. Elevation-area and elevation-storage capacity information for Upper Lake Mary—Continued

Water-surface elevation (feet)	Surface area (acres)	Volume (acre-feet)	Volume (million gallons)	Relative datum - measured up from lake bottom (feet)	Relative datum - measured down from tower (feet)	Percent capacity (percent)
6,826.4	906	14,400	4,690	36.4	3.2	88.3
6,826.5	907	14,500	4,720	36.5	3.1	89.0
6,826.6	909	14,600	4,750	36.6	3.0	89.6
6,826.7	910	14,700	4,780	36.7	2.9	90.2
6,826.8	912	14,700	4,810	36.8	2.8	90.2
6,826.9	914	14,800	4,840	36.9	2.7	90.8
6,827.0	915	14,900	4,870	37.0	2.6	91.4
6,827.1	917	15,000	4,900	37.1	2.5	92.0
6,827.2	919	15,100	4,930	37.2	2.4	92.6
6,827.3	920	15,200	4,960	37.3	2.3	93.3
6,827.4	922	15,300	4,990	37.4	2.2	93.9
6,827.5	923	15,400	5,020	37.5	2.1	94.5
6,827.6	925	15,500	5,050	37.6	2.0	95.1
6,827.7	927	15,600	5,080	37.7	1.9	95.7
6,827.8	928	15,700	5,110	37.8	1.8	96.3
6,827.9	930	15,800	5,140	37.9	1.7	96.9
6,828.0	931	15,900	5,170	38.0	1.6	97.5
6,828.1	933	15,900	5,200	38.1	1.5	97.5
6,828.2	935	16,000	5,230	38.2	1.4	98.2
6,828.3	936	16,100	5,260	38.3	1.3	98.8
6,828.4	938	16,200	5,290	38.4	1.2	99.4
6,828.5	939	16,300	5,320	38.5	1.1	100.0
6,828.6	941	16,400	5,350	38.6	1.0	100.6
6,828.7	943	16,500	5,380	38.7	0.9	101.2
6,828.8	944	16,600	5,410	38.8	0.8	101.8
6,828.9	946	16,700	5,440	38.9	0.7	102.5
6,829.0	948	16,800	5,470	39.0	0.6	103.1
6,829.1	949	16,900	5,500	39.1	0.5	103.7
6,829.2	951	17,000	5,530	39.2	0.4	104.3
6,829.3	953	17,100	5,570	39.3	0.3	104.9
6,829.4	954	17,200	5,600	39.4	0.2	105.5
6,829.5	956	17,300	5,630	39.5	0.1	106.1
6,829.6	958	17,400	5,660	39.6	0.0	106.7

Table 2. Comparison of summary lake statistics between surveys for Upper Lake Mary

[1950s survey results summarized in Blee, 1987; 2006 survey results, this paper. Values based on full-pool capacity at spillway elevation of 6,828.5 feet above mean sea level referenced to National Geodetic Vertical Datum of 1929]

Lake Statistic	1950s Survey (a)	2006 Survey (b)	Percent Change [((b-a)/a)x100]
Storage capacity (acre-feet)	15,620	16,300	4.4
Surface area (acres)	876	939	7.2
Mean depth (feet)	17.9	17.4	-2.8
Depth near dam (feet)	40	39	-2.5
Lake length (miles)	5.5	5.6	1.8
Lake width range (feet)	300 - 2,000	308 - 2,630	2.7 - 31.5

The small differences in storage capacity (4.4 percent), surface area (7.2 percent), mean depth (-2.8 percent), and depth near the dam (-2.5 percent) between the last survey and this one indicate that lake geometry has remained fairly stable over this period. The large difference in lake width (31.5 percent) is probably because measurements were taken at different locations in the lake for the earlier survey (it is not known where the measurements were made) and this survey. The reservoir capacity calculated from this recent survey is 4.4 percent larger than the capacity reported from the earlier survey. This apparent difference in storage capacity is probably a result of differences in surveying methods and the development and use of more accurate surveying equipment, as well as better processing capabilities in terms of both software algorithms and computing technology since the earlier survey was conducted. Decreases in area and storage capacity as a result of sedimentation in Upper Lake Mary are not apparent in comparisons between the two surveys. In conclusion, the area and storage capacity of Upper Lake Mary has remained fairly stable over time.

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