Lake Murray
Bathymetric Mapping Report

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Introduction

Lake Murray, located in Carter and Love Counties, is eight miles south of Ardmore and has a surface area of 5,728 acres (OWRB, 1990). The dam structure, built in 1929 to impound the Anadarche River, was created with the intention of forming a lake for water recreation. Today the lake is operated by the Oklahoma Department of Tourism and Recreation, and is one of the states most popular lakes due to its clear waters and good fishing.

The purpose of this study was to create a bathymetric map of Lake Murray. Information obtained from the development of this map may be used to determine the reliable yield of the lake by calculating current volume, create a database for future determination of sedimentation, and be used by lake managers in assessing shoreline exposure during lake level fluctuations.

Hydrographic Surveying Technology

<u>Equipment Used in Mapping:</u>

- Coastal Oceanographics, Inc. Hypack Software
- Raytheon Fathometer with 10 degree transducer (±0.1% feet accuracy)
- Trimble Global Positioning System (GPS) (sub meter accuracy)
- Rocky Ruggedized Field Notebook Computer

<u>Global Positioning Systems (GPS)</u>

GPS is a relatively new technology that uses a network of satellites, maintained in precise orbits around the earth to determine exact locations on the earth's surface. GPS receivers continuously monitor the broadcasts from the satellites to determine the position of the receiver. During OWRB's surveys approximately five to seven satellites are locked at one time to ensure the greatest level of accuracy.

Historic Survey Procedures

Originally, reservoir surveys were conducted with a rope stretched across the reservoir along pre-determined range lines. A small boat would manually pole the depth at selected intervals along the rope. Over time, aircraft cable replaced the rope and electronic depth sounders replaced the pole. The boat was hooked the to the cable, and depths were again recorded and selected intervals. This method, used mainly by the Soil Conservation Service, worked well for small reservoirs.

Larger bodies of water required more involved means to accomplish the survey, mainly due to increased size. Cables could not be stretched across the body of water, so surveying instruments were utilized to determine the path of the boat. Monuments were set for the end points of each line so the same lines could be used on subsequent surveys. Prior to a survey, each end point had to be located (and sometimes reestablished) in the field and vegetation cleared so that line of sight could be maintained. One surveyor monitored the path of the boat and issued commands via radio to insure that it remained online while a second surveyor determined depth measurement locations by turning angles. Since it took a major effort to determine each of the points along the line, the depth readings were spaced quite a distance apart. Another major cost was the land surveying required prior to the reservoir survey to locate the range line monuments and clear vegetation.

More recently, aerial photography has been used prior to construction; to generate elevation contours from which to calculate the volume of the reservoir. Fairly accurate results could be obtained, although the vertical accuracy of the aerial topography was generally one-half of the contour interval or ± five feet for a ten-foot contour interval. This method could be quite costly and was only applicable in areas that were not inundated (TWDB, 1998).

Latest Survey Procedures (Bathymetric Mapping)

The GPS equipment, survey vessel, software, and depth sounder together, provide an efficient hydrographic survey system. As the boat travels across the lake surface, the depth sounder gathers approximately one reading every 300 ms* or 0.3 seconds from the lake bottom. The depth readings are stored on the survey vessel's on-board computer along with the corrected positional data generated from the boat's GPS receiver. The daily data files collected are downloaded from the computer and brought to the office for editing after the survey is completed. During editing, data "noise" is removed or corrected, and average depths are converted to elevation readings based on the daily-recorded lake elevation on the day the survey was performed. Accurate estimates of the lake volume can be quickly determined by building a 3-D model of the reservoir from the collected data. The level of accuracy of the new technology allows for better determinations of lake volumes.

The Bathymetric surveys consist of Four successive procedures. These include setup, field surveying, post-processing of the collected data, and exportation of data into GIS format. In the first procedure, Hypack software from Coastal Oceanographic is used to create virtual track lines that are laid across a digital rendering of the reservoir with GPS (XY) coordinates. These virtual track lines are spaced according to the accuracy that is required for each project (typically 300 feet*). Closely spaced virtual lines will result in the collection of considerable amounts of data. The next step in the surveying process is the field survey.

Field Surveying consists of the data collection. The fathometer is calibrated on-site to compensate for the salinity/temperature of lake. Virtual lines are followed across the lake until the entire navigable surface area of the reservoir has been covered. Hypack software coordinates the GPS (XY) point and a depth reading (Z), collected every 300 ms while navigating each virtual line. The raw data is collected in Oklahoma South State Plane Coordinate System. In this mode the XYZ coordinates are collected in feet (units selected by surveyor). Hypack software is used to display the map of the reservoir, the virtual lines and store all data points. After the field surveying has been completed the mapping process continues in the office where post-processing takes place.

This next procedure involves reviewing the data for accuracy and completeness using the Hypack Single Beam Editing program. This editing program displays each virtual line and the profile of the data collected for that line. Collected points on each line that are inaccurate are integrated with adjacent accurate points; this process reduces the "noise" in data collection. Fluctuations in lake levels are also adjusted in the raw data during this process. This is done by recording the lakes level on the days that the surveying took place and then adjusting the raw depth (Z) values. Once the raw data has been corrected it is saved and exported as an *.XYZ file. The XYZ data file is then imported into Excel where it is saved as a *.XLS which can then be brought into ArcView 3.2x. In ArcView 3.2x the data is then rendered into a map, such as a contour map, or some other form of graphical representation to satisfy the needs of the project. Volume calculations can then be made and compared to original volumes and/or projected volumes to determine current reliable yield.

*Transects separated by 300 feet are more stringent than other surveys performed by the Texas Water Development Board and Corp of Engineers. The OWRB is investigating point coverage and levels of accuracy to determine if these transect distances could be increased. The point collection rate of 300 ms is determined by the instrumentation defaults. New equipment may alter this collection rate.

Results

Historic information for original depths, surface areas, lake elevations, and volumes for Lake Murray have been difficult to obtain. Therefore, original "data" referenced for this report was taken from the Oklahoma Water Atlas printed in 1990 by the Oklahoma Water Resources Board. Based on this information, Lake Murray has a surface area of 5,728 acres with a storage of 153,250 ac-ft. The 2001 Survey surface area, digitized off a 1:6000 Digital Ortho Photo, was 5,877 acres with a volume of 161,642 ac-ft. The maximum depth of Lake Murray was found to be 102.8 ft, with an average depth of 27.54 ft. The current 2001 survey is likely more accurate survey than the original lake volume calculations when the lake was constructed. Therefore it is hard to calculate the true change in lake capacity. The ratio of surface area to volume (26.7:27.7) between the Oklahoma Water Atlas figures and current information shows that there was no significant change in storage of Lake Murray. Since the lake was constructed in 1929 there has been vast improvements in measurement technology, it is very likely that the original volume calculation of 153,250 ac-ft was an under estimation of the true lake volume. The new volume calculation of 161,642 will serve as a more accurate number for future comparisons.

Map of Lake Murray

The following figure contains the contour map for Lake Murray. This map gives contours appropriate to the lake bottom morphometry. Maximum and minimum depths are given in feet below the normal pool elevation. Surface area is for normal pool elevation. The areas covered by each depth contour are given in the map keys. Current lake volume in acre-feet is also listed in the key. Although over 200,000 data points were collected in the survey, after these points were edited and sorted to have one point for every 10 feet of distance the number of survey points was reduced to 83,026. These points were then used to interpolate a lake bottom surface grid comprised of 20-foot by 20-foot cells. Each cell has a single depth value. These cells were used to compute the lake volume, maximum and average depths.

References:

Oklahoma Water Resources Board. 1990 Oklahoma Water Atlas. Publication 135.

Texas Water Development Board. 1998. Benbrook Lake Hydrographic Survey Report. Prepared for: U.S. Army Corps of Engineers, Fort Worth District.