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SCIENTIFIC INVESTIGATIONS MAP 3213
Bathymetric Contours of Breckenridge Reservoir, Quantico, Virginia
Wicklein, S.M., Lotspeich, R.R., and Banks, R.B., III, 2012

Abstract

Breckenridge Reservoir, built in 1938, is fed by Chopawamsic Creek and South Branch Chopawamsic Creek. The Reservoir is a main source of drinking water for the U.S. Marine Corps (USMC) Base in Quantico, Virginia. The U.S. Geological Survey (USGS), in cooperation with the USMC, conducted a bathymetric survey of Breckenridge Reservoir in March 2009. The survey was conducted to provide the USMC Natural Resources and Environmental Affairs (NREA) with information regarding reservoir storage capacity and general bathymetric properties. The bathymetric survey can provide a baseline for future work on sediment loads and deposition rates for the reservoir.

Bathymetric data were collected using a boat-mounted Wide Area Augmentation System (WAAS) differential global positioning system (DGPS), echo depth-sounding equipment, and computer software. Data were exported into a geographic information system (GIS) for mapping and calculating area and volume. Reservoir storage volume at the time of the survey was about 22,500,000 cubic feet (517 acre-feet) with a surface area of about 1,820,000 square feet (41.9 acres).

Introduction

Bathymetric mapping can provide useful information for water-quality and water-supply managers to address a variety of issues regarding lakes and reservoirs. Since 1983, the USGS Virginia Water Science Center has collected streamflow, water-quality, and suspended sediment information for a number of streams on the USMC Base Quantico as well as another manmade reservoir, Lunga Reservoir. This bathymetric survey in this report was conducted along with a water-quality assessment to provide the NREA with information regarding the general condition of Breckenridge Reservoir (Lotspeich, 2012).

The bathymetric contours also can provide a baseline for future work on sediment loads and deposition rates for the reservoir. Understanding sedimentation rates in reservoirs provides insight into the role(s) of reservoirs on watershed sediment-transport processes, so that systems of watershed structures can be designed efficiently to provide floodwater retention and other uses of the stored water (USGS, 2009).

Breckenridge Reservoir was constructed in 1938 and is located in northeast Virginia, 5.4 miles northwest of Quantico in Prince William County, Virginia. The reservoir straddles the border between Prince William and Stafford Counties. Breckenridge Reservoir is primarily used for drinking-water supply on the USMC Base Quantico, but recreational activities, mainly fishing, do occur at times. The reservoir is fed by two streams, Chopawamsic Creek and South Branch Chopawamsic Creek, that drain areas located on the base located west of the reservoir. Breckenridge Reservoir discharges over a fixed spillway at the dam at the southern end of the reservoir into Chopawamsic Creek, which is a tributary of the Potomac River (fig. 1).

Methods

Bathymetric data were collected on March 30–31, 2009, using a boat-mounted DGPS and echo depth-sounding equipment. The DGPS allowed for accuracies of less than 10 feet (ft; about 3 meters) in the horizontal direction (Garmin Ltd., 2005). The echo sounder emits pulses of sound that are reflected off the lake bottom and received by a transducer. Depths are computed by measuring the time it takes for a sound pulse to travel down and reflect back, which is a function of the speed of sound in water and bed-sediment type (Garmin Ltd., 2005). The accuracy of the depth sounder was quantified by the repeatability of depth measurements, as described in the Quality Assurance section. Shallow areas of the reservoir (less than 2.0 ft) were manually measured using a graduated survey pole marked in 0.5-ft increments due to depth limitations of the sounding equipment. Data were collected along lateral transects throughout the reservoir and longitudinally along the reservoir perimeter as well as through the middle of the reservoir. Individual data points were collected at 5-second intervals while traversing the reservoir (fig. 2). The depth data were later converted to elevation during postprocessing by subtracting the depths at each location from the reference-surface elevation of the reservoir.

The reference-surface elevation was determined by calculating the elevation difference between the water-surface elevation and a reference point on shore that was surveyed using DGPS equipment. A submersible pressure transducer was deployed at the reference point. Water levels were recorded hourly throughout the survey, downloaded, and corrected for changes in atmospheric pressure, then converted to elevations above North American Vertical Datum of 1988 (NAVD 88).

The corrected water-level elevations were averaged to compute a mean water-surface elevation of 135.5 ft (NAVD 88) for the period of time when the survey was conducted. Bathymetric data were filtered to eliminate any erroneous data points and then exported to GIS software where a three-dimensional surface model of the reservoir-bottom elevations was generated. The three-dimensional surface was contoured using the Inverse Distance Weighted method, and the resulting 2-ft contours were adjusted manually where needed to correct for interpretive errors (fig. 3). Reservoir storage volumes (fig. 4A) and surface areas (fig. 4B) were then computed for a range of reservoir water-surface elevations.

Quality Assurance

A depth check on the echo sounder was performed once at the beginning of the survey to ensure that the echo sounder was calibrated correctly. The check was performed by lowering a 0.01-ft graduated steel tape with a sounding weight on the end to the bottom of the reservoir directly below the echo sounder, then comparing the measured depth to the echo sounder reading. The offset of the transducer, or the draft of the transducer below the water surface, was adjusted to generate the same depth as the measured depth within about 0.1 ft. The precision (repeatability) of the sounding data collected with the echo sounder was evaluated to estimate the accuracy of the contours (Wilson and Richards, 2006). The primary dataset, which consisted of over 4,000 data points collected on March 30–31, 2009 (fig. 2), was compared to a smaller dataset of 233 data points that were collected on February 24, 2009. Points from each survey that were collected within 1.5 ft of each other were considered coincidental and were paired for comparison. This process produced 32 coincidental pairs of points. The standard deviation of the depth measurement for the data point pairs was 1.2 ft. The horizontal precision was evaluated by comparing surveyed data points to a georeferenced reservoir boundary. Less than 0.5 percent of surveyed data points plotted beyond the georeferenced reservoir boundary.

Bathymetric Contours

The average water-surface elevation of Breckenridge Reservoir on March 30–31, 2009, was 135.5 ft (NAVD 88). The depth of water in the reservoir increases toward the dam (fig. 3). The deepest part of the reservoir is just above the dam with an elevation of 96.8 ft (NAVD 88), or 38.7 ft deep. The average elevation of the reservoir bottom is 121.1 ft (NAVD 88), or 14.4 ft deep. The slope of the reservoir bottom is greatest between the mouth of South Branch Chopawamsic Creek and the dam, and the slope of the banks increases where the reservoir narrows along this reach. The total surface area of Breckenridge Reservoir was computed to be approximately 1,820,000 square feet (41.9 acres) and the total water volume was about 22,500,000 cubic feet (517 acre-feet) at the time of the survey.

References

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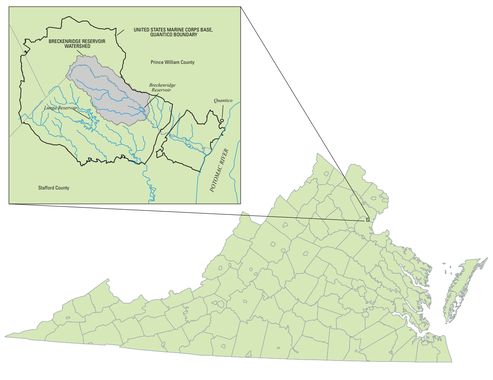

Figure 1. Map showing location of Breckenridge Reservoir, Virginia.

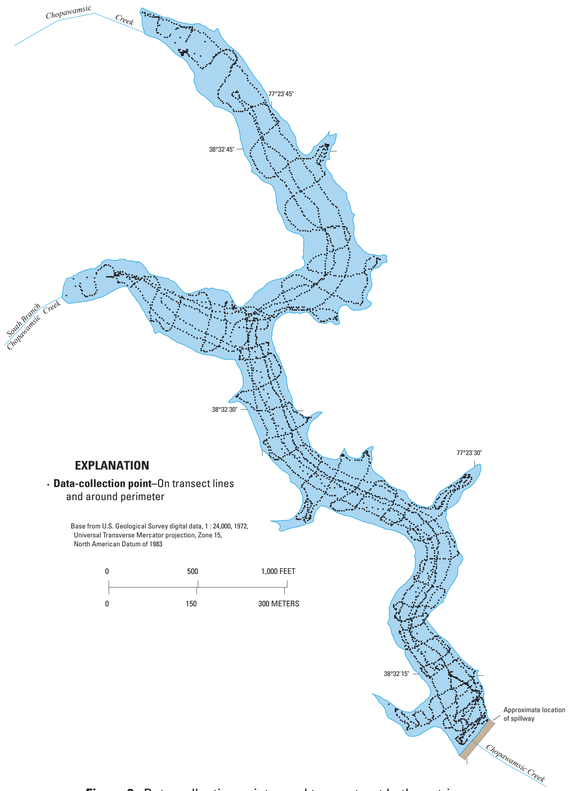

Figure 2. Data-collection points used to construct bathymetric contours of Breckenridge Reservoir, Virginia, 2009.

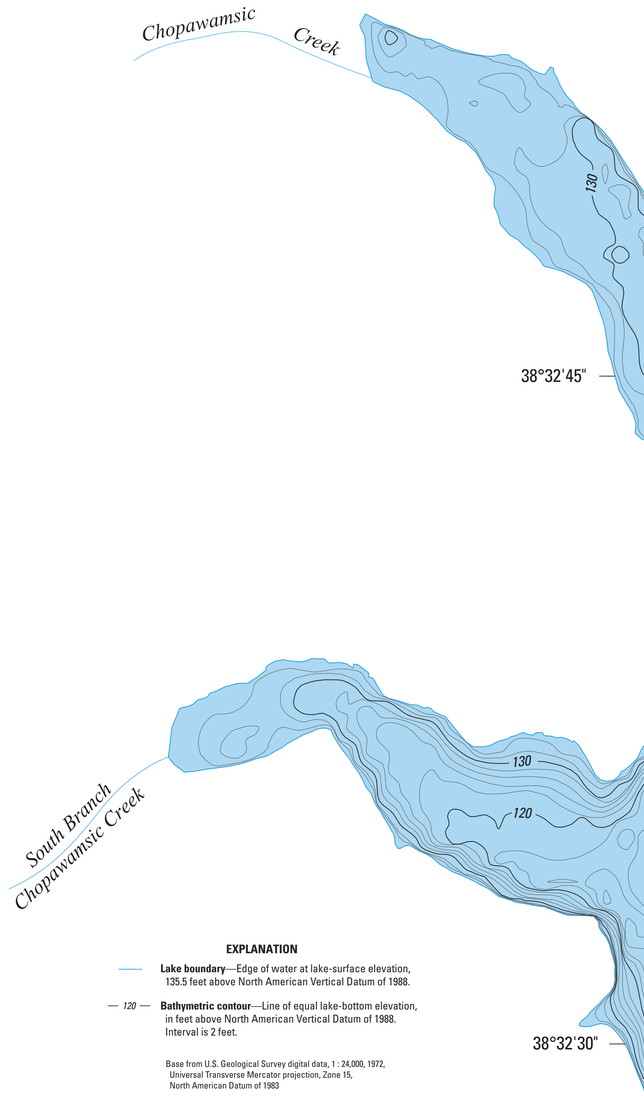

Figure 3. Bathymetric contours of Breckenridge Reservoir, Virginia, March 2009 (not for navigational use).

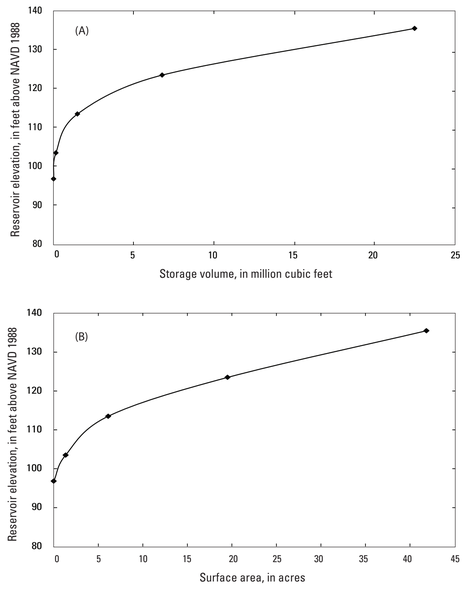

Figure 4. Storage volume (A) and surface area (B) curves for Breckenridge Reservoir, Virginia.

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By
S.M. Wicklein, R.R. Lotspeich, and R.B. Banks III

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