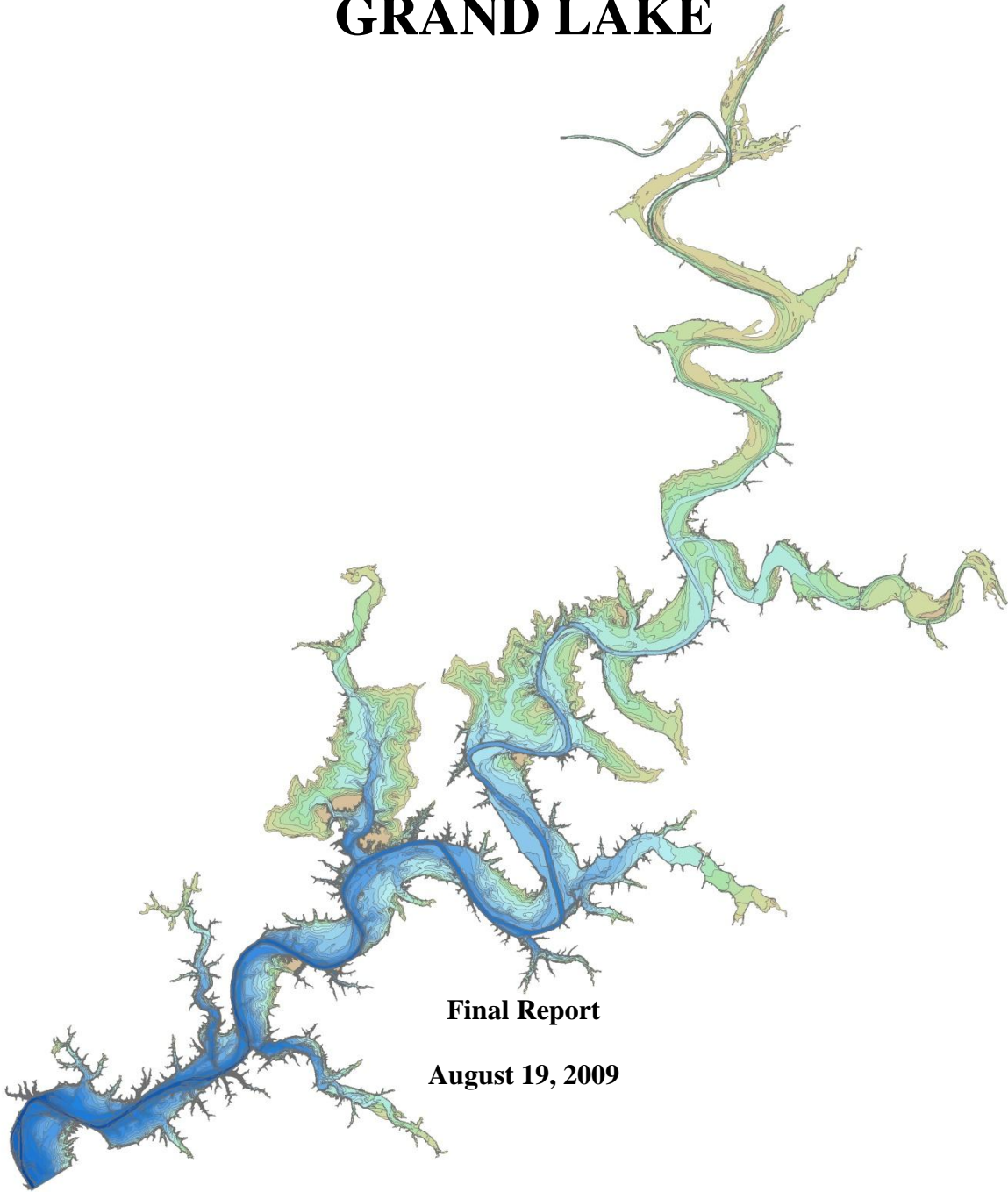# HYDROGRAPHIC SURVEY of GRAND LAKE

Final Report

August 19, 2009

Prepared by:

State of Oklahoma

OWRB

WATER RESOURCES BOARD
the water agency

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

GRAND LAKE
HYDROGRAPHIC SURVEY REPORT

INTRODUCTION

The Oklahoma Water Resources Board (OWRB) conducted a hydrographic survey of Grand Lake beginning in April of 2008 and ending in January of 2009. The purpose of this survey was to produce a new elevation-area-capacity table for Grand Lake that would aid in a dependable yield determination conducted by the United States Army Corps of Engineers (USACE).

LAKE BACKGROUND

Grand Lake is located on Grand River, which is formed by the junction of the Neosho and Spring Rivers, ten miles southeast of Miami, OK (**Figure 1**). It was created in 1940 with the completion of the Pensacola Dam. The lake is located in Ottawa, Delaware, Mayes, and Craig counties. Grand Lake's original purposes were hydropower and flood control.
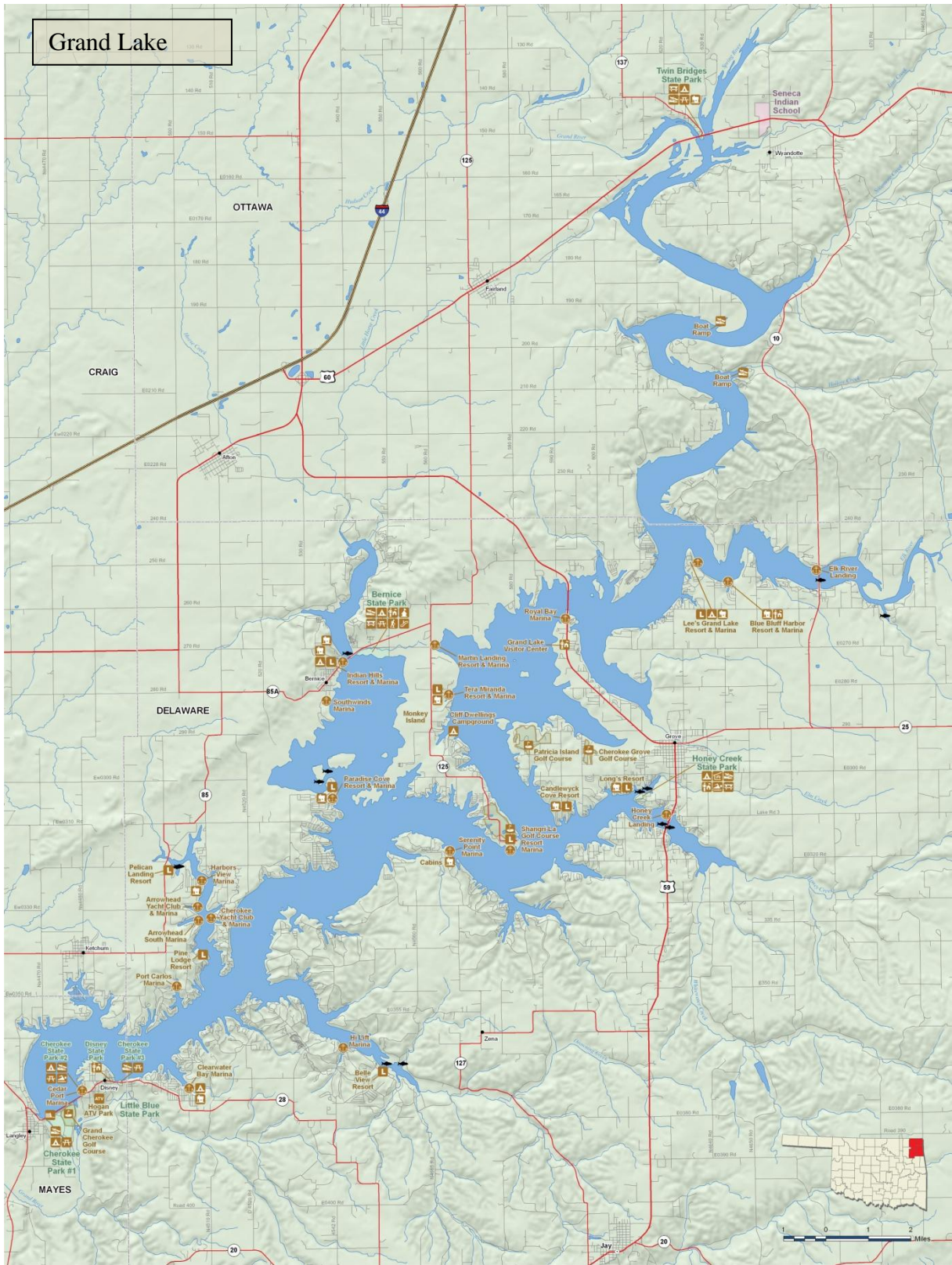
Figure 1: Location map for Grand Lake.

HYDROGRAPHIC SURVEYING PROCEDURES

The process of surveying a reservoir uses a combination of Geographic Positioning System (GPS) and acoustic depth sounding technologies that are incorporated into a hydrographic survey vessel. As the survey vessel travels across the lake's surface, the echosounder gathers multiple depth readings every second. The depth readings are stored on the survey vessel's on-board computer along with the positional data generated from the vessel's GPS receiver. The collected data files are downloaded daily 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 level elevation on the day the survey was performed. Accurate estimates of area-capacity can then be determined for the lake by building a 3-D model of the reservoir from the corrected data. The process of completing a hydrographic survey includes four steps: pre-survey planning, field survey, data processing, and GIS application.

Pre-survey Planning
Boundary File
The boundary file for Grand was on-screen digitized from the 2006 color digital orthoimagery quarter quadrangle (DOQQ) mosaic of Mayes, Delaware, and Ottawa counties in Oklahoma. The screen scale was set to 1:1,500. The digitized line is to represent the shoreline as closely as possible. Due to the photography being a summer photo, it was difficult to determine the actual shoreline when there are trees and other vegetation hanging over the lake. The 1995 DOQQs of the lakes were used as back ground reference. The reservoir boundaries were digitized in North American Datum (NAD) 1983 State Plane Coordinates (Oklahoma North-350<u>1</u>).

Set-up
HYPACK software from Hypack, Inc. was used to assign geodetic parameters, import background files, and create virtual track lines (transects). The geodetic parameters assigned were State Plane NAD 83 Zone OK-350<u>1</u> Oklahoma North with distance units and depth as US Survey Feet. The survey transects were spaced according to the accuracy required for the project. The survey transects within the digitized reservoir boundary were at 300 ft increments and ran perpendicular to the original stream channels and tributaries. Approximately 1,680 virtual transects were created for the Grand Lake.

Field Survey
Lake Elevation Acquisition
The lake elevation for Grand Lake was retrieved from the USACE website (http://www.swt-wc.usace.army.mil/PENS.lakepage.html). The USACE post hourly lake elevation to this website.

Method
The procedures followed by the OWRB during the hydrographic survey adhere to U.S. Army Corps of Engineers (USACE) standards (USACE, 2002). The quality control and quality assurance procedures for equipment calibration and operation, field survey, data processing, and accuracy standards are presented in the following sections.

Technology
The Hydro-survey vessel is an 18-ft aluminum Silverstreak hull with cabin, powered by a single 115-Horsepower Mercury outboard motor. Equipment used to conduct the survey included: a ruggedized notebook computer; Syqwest Bathy 1500 Echo Sounder, with a depth resolution of 0.1 ft; Trimble Navigation, Inc. Pro XR GPS receiver with differential global positioning system (DGPS) correction; and an Odom Hydrographics, Inc, DIGIBAR-Pro Profiling Sound Velocimeter. The software used was HYPACK.

Survey
A two-man survey crew was used during the project. Data collection for Grand Lake occurred in the spring, fall, and winter of 2008 as well as the first two months of 2009. The survey crew followed the parallel transects created during the pre-survey planning while collecting depth soundings and positional data. Data was also collected along a path parallel to the shoreline at a distance that was determined by the depth of the water and the draft of the boat – generally, two to three feet deep. Areas with depths less than this were avoided.

Quality Control/Quality Assurance
While on board the Hydro-survey vessel, the Syqwest Bathy 1500 Echo Sounder was calibrated using A DIGIBAR-Pro Profiling Sound Velocimeter, by Odom Hydrographics. The sound velocimeter measures the speed of sound at incremental depths throughout the water column. The factors that influence the speed of sound—depth, temperature, and salinity—are all taken into account. Deploying the unit involved lowering the probe, which measures the speed of sound, into the water to the calibration depth mark to allow for acclimation and calibration of the depth sensor. The unit was then gradually lowered at a controlled speed to a depth just above the lake bottom, and then was raised to the surface. The unit collected sound velocity measurements in feet/seconds (ft/sec) at 1 ft increments on both the deployment and retrieval phases. The data was then reviewed for any erroneous readings, which were then edited out of the sample. The sound velocity corrections were then applied to the raw depth readings.

A quality assurance cross-line check was performed on intersecting transect lines and channel track lines to assess the estimated accuracy of the survey measurements. The overall accuracy of an observed bottom elevation or depth reading is dependent on random and systematic errors that are present in the measurement process. Depth measurements contain both random errors and systematic bias. Biases are often referred to as systematic errors and are often due to observational errors. Examples of bias include a bar check calibration error, tidal errors, or incorrect squat corrections. Bias, however, does not affect the repeatability, or precision, of results. The precision of depth readings is affected by random errors. These are errors present in the measurement system that cannot be easily reduced by further calibration. Examples of random error include uneven bottom topography, bottom vegetation, positioning error, extreme listing of survey vessel, and speed of sound variation in the water column. An assessment of the accuracy of an individual depth or bottom elevation must fully consider all the error components contained in the observations that were used to determine that measurement. Therefore, the ultimate accuracy must be estimated (thus the use of the term "estimated accuracy") using statistical estimating measures (USACE, 2002).

The depth accuracy estimate is determined by comparing depth readings taken at the intersection of two lines and computing the difference. This is done on multiple intersections. The mean difference of all intersection points is used to calculate the mean difference (MD). The mean difference represents the bias present in the survey. The standard deviation (SD), representing the random error in the survey, is also calculated. The mean difference and the standard deviation are then used to calculate the Root Mean Square (RMS) error. The RMS error estimate is used to compare relative accuracies of estimates that differ substantially in bias and precision (USACE, 2002). According the USACE standards, the RMS at the 95% confidence level should not exceed a tolerance of $\pm$ 2.0 ft for this type of survey. This simply means that on average, 19 of every 20 observed depths will fall within the specified accuracy tolerance.

HYPACK Cross Statistics program was used to assess vertical accuracy and confidence measures of acoustically recorded depths. The program computes the sounding difference between intersecting lines of single beam data. The program provides a report that shows the standard deviation and mean difference. A total of 111 cross-sections points at Grand Lake were used to compute error estimates. A mean difference of 0.5 ft and a standard deviation of 0.43 ft were computed from intersections. The following formulas were used to determine the depth accuracy at the 95% confidence level.

$$RMS = \sqrt{\sigma^2{}_{Random\ error} + \sigma^2{}_{Bias}}$$

where:

Random error = Standard deviation
Bias = Mean difference
RMS = root mean square error (68% confidence level)

and:

$$RMS\ (95\%)\ depth\ accuracy\ = 1.96 \times RMS\ (68\%)$$

An RMS of $\pm$ 1.3 ft with a 95% confidence level is less than the USACE's minimum performance standard of $\pm$ 2.0 ft for this type of survey. A mean difference, or bias, of 0.5 ft is equal to the USACE's standard maximum allowable bias of $\pm$ 0.5 ft for this type of survey.

The GPS system is an advanced high performance geographic data-acquisition tool that uses DGPS to provide sub-meter positional accuracy on a second-by-second basis. Potential errors are reduced with differential GPS because additional data from a reference GPS receiver at a known position are used to correct positions obtained during the survey. Before the survey, Trimble's Pathfinder Controller software was used to configure the GPS receiver. To maximize the accuracy of the horizontal positioning, the horizontal mask setting was set to 15 degrees and the Position Dilution of Precision (PDOP) limit was set to 6. The position interval was set to 1 second and the Signal to Noise Ratio (SNR) mask was set to 4. The United States Coast Guard reference station used in the survey is located near Sallisaw,

Oklahoma. The reference beacon system transmitted corrected signals in real time, so no post-processing corrections of position data were needed.

A latency test was performed to determine the fixed delay time between the GPS and single beam echo sounder. The timing delay was determined by running reciprocal survey lines over a channel bank. The raw data files were downloaded into HYPACK, LATENCY TEST program. The program varies the time delay to determine the "best fit" setting. A position latency of 0.1 seconds was produced and adjustments were applied to the raw data in the EDIT program.

Data Processing
The collected data was transferred from the field computer onto an OWRB desktop computer. After downloading the data, each raw data file was reviewed using the EDIT program within HYPACK. The EDIT program allowed the user to assign transducer offsets, latency corrections, tide corrections, display the raw data profile, and review/edit all raw depth information. Raw data files are checked for gross inaccuracies that occur during data collection.

Offset correction values of 3.2 ft. starboard, 6.6 ft. forward, and -1.1 ft. vertical were applied to all raw data along with a latency correction factor of 0.1 seconds. The speed of sound corrections were applied during editing of raw data.

A correction file was produced using the HYPACK TIDES program to account for the variance in lake elevation at the time of data collection. Within the EDIT program, the corrected depths were subtracted from the elevation reading to convert the depth in feet to an elevation.

After editing the data for errors and correcting the spatial attributes (offsets and tide corrections), a data reduction scheme was needed. To accomplish this, the corrected data was resampled spatially at a 10 ft interval using the Sounding Selection program in HYPACK. The resultant data was saved and exported out as a xyz.txt file. The HYPACK raw and corrected data files for Grand Lake are located on the DVD entitled *Grand HYPACK/GIS Metadata.*

GIS Application
Geographic Information System (GIS) software was used to process the edited XYZ data collected from the survey. The GIS software used was ArcGIS Desktop and ArcMap, version 9.2, from Environmental System Research Institute (ESRI). All of the GIS datasets created are in Oklahoma State Plane North Coordinate System referenced to the North American Datum 1983. Horizontal and vertical units are in feet. The edited data points in XYZ text file format were converted into ArcMap point coverage format. The point coverage contains the X and Y horizontal coordinates and the elevation and depth values associated with each collected point.

Volumetric and area calculations were derived using a Triangulated Irregular Network (TIN) surface model. The TIN model was created in ArcMap, using the collected survey data points and the lake boundary inputs. The TIN consists of connected data points that form a network

of triangles representing the bottom surface of the lake. The lake volume was calculated by slicing the TIN horizontally into planes 0.1 ft thick. The cumulative volume and area of each slice are shown in **APPENDIX A: Area-Capacity Data.**

Contours, depth ranges, and the shaded relief map were derived from a constructed digital elevation model grid. This grid was created using the ArcMap Topo to Raster Tool and had a spatial resolution of five feet. A low pass 3x3 filter was run to lightly smooth the grid to improve contour generation. The contours were created at a 5-ft interval using the ArcMap Contour Tool. The contour lines were edited to allow for polygon topology and to improve accuracy and general smoothness of the lines. The contours were then converted to a polygon coverage and attributed to show 5-ft depth ranges across the lake. The bathymetric maps of the lakes are shown with 5-ft contour intervals in

Grand Lake
Area-Capacity by Elevation
2008/2009 Survey
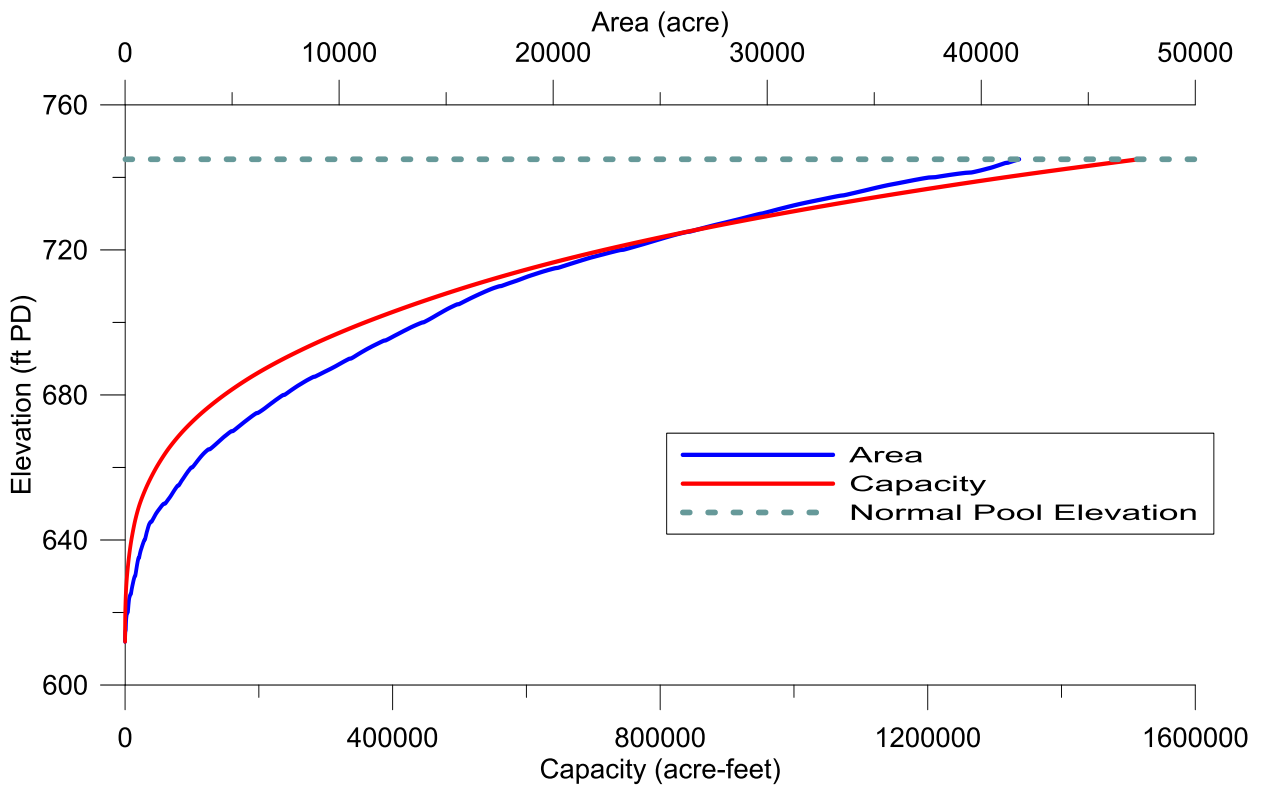
APPENDIX B: Grand Lake Maps.

All geographic datasets derived from the survey contain Federal Geographic Data Committee (FGDC) compliant metadata documentation. The metadata describes the procedures and commands used to create the datasets. The GIS metadata file for both lakes is located on the DVD entitled *Grand HYPACK/GIS Metadata.*

RESULTS

Results from the 2008/2009 OWRB survey indicate that Grand Lake encompasses 41,779.01 acres and contains a cumulative capacity of 1,515,415.52 ac-ft at the normal pool elevation (745 ft Pensacola Datum (PD)). The average depth for Grand Lake was 36.3ft.

SUMMARY and COMPARISON

Table 1 is comparison of area and volume changes of Grand Lake at the normal pool elevation. Based on the design specifications, Grand Lake had an area of 46,500 acres and cumulative volume of 1,672,000 acre-feet of water at normal pool elevation (745 ft PD). The surface area of the lake has had a decrease of 4,721 acres or approximately 10.1%. The 2008/2009 survey shows that Grand Lake had a decrease in capacity of 9.3% or approximately 156,588 acre-feet. Caution should be used, however, when directly comparing between the design specifications and the 2008/2009 survey conducted by the OWRB because different methods were used to collect the data and extrapolate capacity and area figures. It is the recommendation of the OWRB that another survey using the same method used in the 2008/2009 survey be conducted in 10-15 years. By using the new survey figures as a baseline, a future survey would allow an accurate sedimentation rate to be obtained.

Table 1: Area and Volume Comparisons of Grand Lake at normal pool (745 ft PD).

Feature	Survey Year

	1940 Design Specifications	2008/2009
Area (acres)	46,500	41,779
Cumulative Volume (acre-feet)	1,672,000	1,515,415
Mean depth (ft)	36.0	36.3
Maximum Depth (ft)		133

REFERENCES

U.S. Army Corps of Engineers (USACE). 2002.   Engineering and Design - Hydrographic Surveying, Publication EM 1110-2-1003, 3rd version.

Oklahoma Water Resources Board (OWRB). 2008. <u>Oklahoma Water Atlas</u>.

APPENDIX A: Area-Capacity Data

Table A. 1: Grand Lake Capacity/Area by 0.1-ft Increments.

Elevation (ft PD)		0.06	0.16	0.26	0.36	0.46	0.56	0.66	0.76	0.86	0.96
GRAND LAKE AREA-CAPACITY TABLE OKLAHOMA WATER RESOURCES BOARD 2008/2009 Survey Capacity in acre-feet by tenth foot elevation increments Area in acres by tenth foot elevation increments											
611	Area										0.0000
	Capacity										0.0000
612	Area	0.0003	0.0149	0.0405	0.0819	0.1359	0.2026	0.2912	0.4399	0.6588	0.8749
	Capacity	0.0000	0.0006	0.0033	0.0093	0.0201	0.0369	0.0613	0.0970	0.1520	0.2284
613	Area	1.151	1.533	1.934	2.358	2.832	3.351	3.937	4.584	5.276	6.018
	Capacity	0.3290	0.4620	0.6357	0.8499	1.109	1.418	1.782	2.207	2.700	3.265
614	Area	6.810	7.649	8.534	9.474	10.48	11.54	12.68	13.97	15.46	17.15
	Capacity	3.905	4.628	5.437	6.337	7.334	8.435	9.646	10.98	12.45	14.08
615	Area	30.83	31.42	31.96	32.47	32.97	33.47	33.97	34.47	34.98	35.49
	Capacity	16.62	19.73	22.90	26.12	29.39	32.72	36.09	39.51	42.98	46.51
616	Area	36.01	36.53	37.08	37.63	38.19	38.78	39.40	40.05	40.71	41.40
	Capacity	50.08	53.71	57.39	61.12	64.92	68.77	72.67	76.65	80.69	84.79
617	Area	42.11	42.85	43.61	44.41	45.26	46.15	47.07	48.03	49.04	50.13
	Capacity	88.97	93.22	97.54	101.9	106.4	111.0	115.7	120.4	125.3	130.2
618	Area	51.29	52.53	53.83	55.21	56.68	58.24	59.89	61.66	63.54	65.55
	Capacity	135.3	140.5	145.8	151.3	156.9	162.6	168.5	174.6	180.8	187.3
619	Area	67.65	69.87	72.20	74.64	77.22	80.00	83.06	86.31	89.84	93.97
	Capacity	194.0	200.8	207.9	215.3	222.9	230.7	238.9	247.4	256.2	265.3
620	Area	129.4	131.4	133.1	134.7	136.3	137.7	139.1	140.5	141.9	143.3
	Capacity	276.9	289.9	303.1	316.5	330.1	343.8	357.6	371.6	385.7	400.0
621	Area	144.6	146.0	147.4	148.7	150.1	151.4	152.8	154.2	155.6	157.0
	Capacity	414.4	428.9	443.6	458.4	473.3	488.4	503.6	519.0	534.5	550.1
622	Area	158.4	159.9	161.5	163.2	164.9	166.5	168.1	169.8	171.5	173.2
	Capacity	565.9	581.8	597.9	614.1	630.5	647.1	663.8	680.7	697.8	715.0
623	Area	175.1	176.9	178.8	180.6	182.5	184.4	186.5	188.7	191.3	194.3
	Capacity	732.4	750.0	767.8	785.8	803.9	822.3	840.8	859.6	878.6	897.9
624	Area	198.3	202.5	207.1	212.0	217.0	222.2	227.6	233.5	240.2	248.8
	Capacity	917.5	937.5	958.0	978.9	1,000	1,022	1,045	1,068	1,092	1,116
625	Area	271.7	275.2	278.3	281.2	283.9	286.5	289.0	291.5	294.0	296.6
	Capacity	1,142	1,170	1,197	1,225	1,254	1,282	1,311	1,340	1,369	1,399
626	Area	299.4	302.3	305.2	307.9	310.8	314.1	317.6	321.2	324.4	327.6
	Capacity	1,429	1,459	1,489	1,520	1,551	1,582	1,613	1,645	1,678	1,710
627	Area	330.7	333.9	337.3	341.0	344.6	348.2	351.9	355.6	359.4	363.2
	Capacity	1,743	1,776	1,810	1,844	1,878	1,913	1,948	1,983	2,019	2,055
628	Area	366.9	370.4	374.0	377.6	381.2	385.0	388.8	392.7	396.6	400.8
	Capacity	2,092	2,128	2,166	2,203	2,241	2,280	2,318	2,357	2,397	2,437
629	Area	405.0	409.3	413.7	418.2	422.8	427.5	432.7	438.3	444.7	452.4
	Capacity	2,477	2,518	2,559	2,600	2,643	2,685	2,728	2,772	2,816	2,861
630	Area	474.7	478.1	481.3	484.3	487.2	490.2	493.2	496.0	498.8	501.6
	Capacity	2,907	2,955	3,003	3,051	3,100	3,149	3,198	3,247	3,297	3,347
631	Area	504.3	507.0	509.7	512.4	515.0	517.7	520.3	523.0	525.6	528.2
	Capacity	3,397	3,448	3,499	3,550	3,601	3,653	3,705	3,757	3,809	3,862

Table A. 2: Grand Lake Capacity/Area by 0.1-ft Increments (cont).

GRAND LAKE AREA-CAPACITY TABLE
OKLAHOMA WATER RESOURCES BOARD
2008/2009 Survey
Capacity in acre-feet by tenth foot elevation increments
Area in acres by tenth foot elevation increments

Elevation (ft PD)		0.06	0.16	0.26	0.36	0.46	0.56	0.66	0.76	0.86	0.96
632	Area	530.8	533.5	536.1	538.8	541.5	544.2	547.0	549.7	552.5	555.3
	Capacity	3,915	3,968	4,022	4,075	4,129	4,184	4,238	4,293	4,348	4,404
633	Area	558.1	561.0	563.9	566.9	569.9	572.9	576.0	579.2	582.4	585.6
	Capacity	4,459	4,515	4,572	4,628	4,685	4,742	4,800	4,857	4,915	4,974
634	Area	588.9	592.3	595.8	599.2	602.8	606.4	610.1	613.8	617.8	621.9
	Capacity	5,033	5,092	5,151	5,211	5,271	5,331	5,392	5,453	5,515	5,577
635	Area	654.9	658.1	661.2	664.3	667.5	670.8	674.2	677.7	681.3	685.0
	Capacity	5,641	5,707	5,773	5,839	5,906	5,973	6,040	6,107	6,175	6,244
636	Area	688.7	692.4	696.2	700.0	704.1	708.4	712.7	716.8	721.0	725.6
	Capacity	6,312	6,381	6,451	6,521	6,591	6,662	6,733	6,804	6,876	6,948
637	Area	730.3	734.9	739.8	745.3	751.2	757.1	763.0	768.5	773.8	779.1
	Capacity	7,021	7,094	7,168	7,242	7,317	7,393	7,469	7,545	7,622	7,700
638	Area	784.4	789.6	794.9	800.3	805.8	811.4	817.0	822.7	828.7	834.6
	Capacity	7,778	7,857	7,936	8,016	8,096	8,177	8,259	8,341	8,423	8,506
639	Area	840.6	846.6	852.6	858.7	864.9	871.2	877.5	884.1	890.9	898.3
	Capacity	8,590	8,674	8,759	8,845	8,931	9,018	9,105	9,194	9,282	9,372
640	Area	926.7	931.2	935.7	940.1	944.5	948.8	952.9	957.0	961.1	965.1
	Capacity	9,463	9,556	9,650	9,743	9,838	9,932	10,027	10,123	10,219	10,315
641	Area	969.1	973.2	977.1	981.1	985.1	989.1	993.1	997.1	1,001	1,005
	Capacity	10,411.9	10,509.0	10,606.6	10,704.5	10,802.8	10,901.5	11,000.6	11,100.2	11,200.1	11,300.4
642	Area	1,009.3	1,013.5	1,018.0	1,022.9	1,028.3	1,033.6	1,038.5	1,043.2	1,047.8	1,052.5
	Capacity	11,401.2	11,502.3	11,603.9	11,705.9	11,808.5	11,911.6	12,015.2	12,119.4	12,223.9	12,329.0
643	Area	1,057.1	1,061.8	1,066.5	1,071.3	1,076.2	1,081.2	1,086.3	1,091.5	1,096.9	1,102.4
	Capacity	12,434.4	12,540.4	12,646.8	12,753.7	12,861.1	12,969.0	13,077.3	13,186.3	13,295.7	13,405.7
644	Area	1,108.2	1,114.4	1,121.1	1,128.6	1,137.1	1,146.7	1,157.4	1,167.4	1,177.8	1,188.9
	Capacity	13,516.2	13,627.3	13,739.2	13,851.6	13,965.0	14,079.1	14,194.3	14,310.6	14,427.9	14,546.2
645	Area	1,239.0	1,249.4	1,259.3	1,268.9	1,278.3	1,287.4	1,296.5	1,305.7	1,314.9	1,324.2
	Capacity	14,668.0	14,792.4	14,917.9	15,044.3	15,171.8	15,300.0	15,429.2	15,559.4	15,690.4	15,822.4
646	Area	1,333.6	1,342.7	1,351.9	1,361.1	1,370.4	1,379.5	1,388.5	1,397.4	1,406.6	1,415.9
	Capacity	15,955.3	16,089.1	16,223.9	16,359.5	16,496.2	16,633.7	16,772.0	16,911.4	17,051.6	17,192.8
647	Area	1,425.4	1,435.3	1,445.7	1,456.5	1,467.4	1,479.0	1,490.5	1,501.9	1,513.3	1,525.6
	Capacity	17,334.8	17,477.9	17,622.0	17,767.1	17,913.3	18,060.6	18,209.1	18,358.8	18,509.5	18,661.5
648	Area	1,538.3	1,550.9	1,564.1	1,576.9	1,589.5	1,602.2	1,615.0	1,627.9	1,640.6	1,653.2
	Capacity	18,814.7	18,969.1	19,125.0	19,282.0	19,440.4	19,600.0	19,760.8	19,923.0	20,086.4	20,251.2
649	Area	1,665.8	1,678.5	1,691.4	1,704.5	1,718.0	1,732.1	1,747.0	1,763.4	1,781.8	1,804.1
	Capacity	20,417.1	20,584.3	20,752.9	20,922.7	21,093.9	21,266.4	21,440.3	21,615.9	21,793.1	21,972.5
650	Area	1,874.5	1,890.0	1,903.7	1,916.6	1,929.0	1,941.1	1,953.0	1,964.9	1,976.9	1,989.3
	Capacity	22,157.0	22,345.2	22,535.0	22,726.0	22,918.4	23,111.9	23,306.5	23,502.5	23,699.6	23,898.0
651	Area	2,002.0	2,014.3	2,027.2	2,040.2	2,052.9	2,065.5	2,078.0	2,090.2	2,102.3	2,113.9
	Capacity	24,097.6	24,298.4	24,500.5	24,703.9	24,908.6	25,114.5	25,321.7	25,530.2	25,739.8	25,950.7
652	Area	2,125.1	2,136.1	2,147.3	2,158.2	2,169.0	2,179.7	2,190.4	2,201.0	2,211.5	2,222.0
	Capacity	26,162.7	26,375.7	26,590.0	26,805.2	27,021.7	27,239.1	27,457.6	27,677.3	27,897.9	28,119.7

Table A. 3: Grand Lake Capacity/Area by 0.1-ft Increments (cont).

GRAND LAKE AREA-CAPACITY TABLE											
OKLAHOMA WATER RESOURCES BOARD											
2008/2009 Survey											
Capacity in acre-feet by tenth foot elevation increments											
Area in acres by tenth foot elevation increments											
Elevation (ft PD)		0.06	0.16	0.26	0.36	0.46	0.56	0.66	0.76	0.86	0.96
653	Area	2,232	2,243	2,253	2,264	2,275	2,286	2,297	2,308	2,319	2,330
	Capacity	28,342	28,566	28,791	29,017	29,244	29,472	29,701	29,931	30,163	30,395
654	Area	2,342	2,353	2,365	2,377	2,389	2,402	2,414	2,428	2,441	2,456
	Capacity	30,629	30,864	31,100	31,337	31,575	31,815	32,055	32,298	32,541	32,786
655	Area	2,508	2,520	2,531	2,542	2,553	2,563	2,574	2,584	2,594	2,604
	Capacity	33,035	33,286	33,539	33,792	34,047	34,303	34,560	34,818	35,077	35,337
656	Area	2,614	2,625	2,635	2,646	2,657	2,669	2,681	2,693	2,705	2,716
	Capacity	35,598	35,860	36,123	36,387	36,652	36,918	37,186	37,455	37,725	37,996
657	Area	2,728	2,739	2,751	2,762	2,773	2,784	2,796	2,807	2,818	2,830
	Capacity	38,268	38,541	38,816	39,092	39,369	39,646	39,925	40,206	40,487	40,769
658	Area	2,841	2,853	2,865	2,876	2,888	2,900	2,912	2,923	2,935	2,947
	Capacity	41,053	41,337	41,623	41,910	42,199	42,488	42,779	43,071	43,364	43,658
659	Area	2,964	2,977	2,989	3,002	3,015	3,028	3,042	3,056	3,071	3,087
	Capacity	43,953	44,250	44,549	44,848	45,149	45,452	45,755	46,060	46,366	46,674
660	Area	3,147	3,163	3,177	3,191	3,205	3,219	3,232	3,245	3,259	3,272
	Capacity	46,987	47,302	47,619	47,938	48,258	48,579	48,901	49,225	49,551	49,877
661	Area	3,285	3,298	3,311	3,324	3,337	3,349	3,362	3,375	3,388	3,402
	Capacity	50,205	50,534	50,865	51,196	51,530	51,864	52,199	52,537	52,875	53,214
662	Area	3,415	3,428	3,442	3,456	3,470	3,483	3,497	3,510	3,524	3,538
	Capacity	53,555	53,897	54,241	54,586	54,932	55,280	55,629	55,979	56,331	56,684
663	Area	3,553	3,568	3,582	3,597	3,612	3,627	3,643	3,659	3,676	3,692
	Capacity	57,039	57,395	57,752	58,111	58,472	58,834	59,197	59,563	59,929	60,298
664	Area	3,710	3,727	3,745	3,763	3,782	3,801	3,821	3,842	3,863	3,886
	Capacity	60,668	61,040	61,414	61,789	62,167	62,546	62,927	63,310	63,695	64,083
665	Area	3,969	3,991	4,012	4,033	4,054	4,074	4,094	4,113	4,133	4,152
	Capacity	64,476	64,874	65,275	65,677	66,081	66,488	66,896	67,307	67,719	68,133
666	Area	4,172	4,191	4,210	4,229	4,248	4,267	4,286	4,305	4,323	4,342
	Capacity	68,550	68,968	69,388	69,810	70,234	70,660	71,087	71,517	71,948	72,382
667	Area	4,361	4,380	4,398	4,417	4,436	4,454	4,473	4,492	4,511	4,529
	Capacity	72,817	73,254	73,693	74,134	74,577	75,021	75,467	75,916	76,366	76,818
668	Area	4,548	4,567	4,586	4,605	4,625	4,646	4,668	4,690	4,712	4,733
	Capacity	77,272	77,728	78,186	78,645	79,107	79,570	80,036	80,504	80,974	81,447
669	Area	4,754	4,775	4,795	4,816	4,838	4,860	4,882	4,906	4,931	4,958
	Capacity	81,921	82,397	82,876	83,356	83,839	84,324	84,811	85,301	85,793	86,287
670	Area	5,044	5,068	5,091	5,114	5,136	5,157	5,178	5,199	5,220	5,241
	Capacity	86,788	87,294	87,802	88,312	88,825	89,340	89,856	90,375	90,896	91,420
671	Area	5,261	5,282	5,303	5,324	5,345	5,367	5,388	5,409	5,429	5,451
	Capacity	91,945	92,472	93,001	93,533	94,066	94,602	95,140	95,680	96,221	96,766
672	Area	5,472	5,493	5,514	5,535	5,556	5,577	5,599	5,621	5,643	5,665
	Capacity	97,312	97,860	98,411	98,963	99,518	100,074	100,633	101,194	101,757	102,323
673	Area	5,688	5,710	5,731	5,753	5,776	5,798	5,820	5,842	5,865	5,887
	Capacity	102,891	103,461	104,033	104,607	105,184	105,762	106,343	106,927	107,512	108,100

Table A. 4: Grand Lake Capacity/Area by 0.1-ft Increments (cont).

GRAND LAKE AREA-CAPACITY TABLE
OKLAHOMA WATER RESOURCES BOARD
2008/2009 Survey
Capacity in acre-feet by tenth foot elevation increments
Area in acres by tenth foot elevation increments

Elevation (ft PD)		0.06	0.16	0.26	0.36	0.46	0.56	0.66	0.76	0.86	0.96
674	Area	5,909	5,932	5,955	5,979	6,002	6,027	6,051	6,076	6,103	6,131
	Capacity	108,690	109,282	109,876	110,473	111,072	111,674	112,277	112,884	113,493	114,105
675	Area	6,210	6,240	6,267	6,294	6,320	6,346	6,371	6,397	6,421	6,445
	Capacity	114,722	115,345	115,971	116,599	117,230	117,863	118,499	119,137	119,778	120,422
676	Area	6,469	6,492	6,516	6,538	6,560	6,582	6,604	6,626	6,648	6,670
	Capacity	121,067	121,715	122,366	123,019	123,674	124,331	124,990	125,652	126,316	126,982
677	Area	6,692	6,714	6,737	6,759	6,781	6,803	6,825	6,848	6,871	6,895
	Capacity	127,650	128,320	128,993	129,668	130,345	131,024	131,705	132,389	133,075	133,764
678	Area	6,918	6,940	6,963	6,985	7,007	7,030	7,054	7,078	7,102	7,126
	Capacity	134,455	135,148	135,843	136,540	137,240	137,942	138,646	139,353	140,062	140,774
679	Area	7,150	7,175	7,199	7,223	7,247	7,272	7,296	7,322	7,350	7,381
	Capacity	141,488	142,204	142,923	143,644	144,368	145,094	145,822	146,553	147,287	148,024
680	Area	7,461	7,487	7,511	7,535	7,560	7,584	7,607	7,631	7,654	7,678
	Capacity	148,766	149,514	150,264	151,016	151,771	152,528	153,288	154,050	154,814	155,581
681	Area	7,702	7,726	7,750	7,775	7,799	7,824	7,849	7,874	7,899	7,924
	Capacity	156,350	157,121	157,896	158,672	159,451	160,232	161,015	161,802	162,591	163,382
682	Area	7,949	7,975	8,000	8,026	8,051	8,078	8,106	8,134	8,162	8,190
	Capacity	164,176	164,972	165,771	166,572	167,376	168,183	168,992	169,804	170,619	171,437
683	Area	8,218	8,247	8,275	8,302	8,330	8,358	8,386	8,415	8,443	8,473
	Capacity	172,257	173,081	173,907	174,736	175,568	176,402	177,239	178,080	178,923	179,769
684	Area	8,502	8,533	8,565	8,597	8,629	8,661	8,693	8,725	8,759	8,796
	Capacity	180,617	181,469	182,324	183,183	184,044	184,909	185,776	186,648	187,522	188,400
685	Area	8,877	8,912	8,946	8,980	9,014	9,049	9,082	9,115	9,148	9,181
	Capacity	189,284	190,173	191,067	191,963	192,863	193,766	194,673	195,583	196,496	197,413
686	Area	9,215	9,249	9,282	9,316	9,350	9,384	9,419	9,453	9,487	9,522
	Capacity	198,333	199,256	200,183	201,113	202,046	202,983	203,923	204,867	205,814	206,765
687	Area	9,556	9,590	9,623	9,656	9,688	9,720	9,753	9,786	9,817	9,847
	Capacity	207,719	208,676	209,637	210,601	211,569	212,539	213,513	214,490	215,470	216,454
688	Area	9,878	9,907	9,938	9,968	9,998	10,028	10,058	10,088	10,118	10,148
	Capacity	217,440	218,429	219,422	220,417	221,416	222,417	223,421	224,429	225,439	226,453
689	Area	10,178	10,209	10,240	10,272	10,303	10,335	10,367	10,400	10,433	10,469
	Capacity	227,469	228,488	229,511	230,537	231,566	232,598	233,633	234,672	235,713	236,759
690	Area	10,558	10,592	10,624	10,654	10,683	10,710	10,737	10,764	10,790	10,817
	Capacity	237,811	238,868	239,929	240,993	242,061	243,130	244,202	245,278	246,356	247,437
691	Area	10,844	10,871	10,899	10,927	10,955	10,984	11,012	11,040	11,069	11,098
	Capacity	248,519	249,605	250,694	251,785	252,880	253,977	255,077	256,180	257,285	258,394
692	Area	11,129	11,158	11,187	11,216	11,246	11,276	11,307	11,338	11,369	11,400
	Capacity	259,505	260,620	261,737	262,857	263,981	265,107	266,236	267,369	268,504	269,643
693	Area	11,438	11,467	11,497	11,529	11,563	11,596	11,630	11,664	11,699	11,733
	Capacity	270,785	271,930	273,079	274,230	275,385	276,543	277,704	278,870	280,038	281,210
694	Area	11,768	11,803	11,837	11,871	11,905	11,940	11,975	12,011	12,049	12,088
	Capacity	282,385	283,563	284,746	285,931	287,120	288,312	289,508	290,708	291,911	293,118

Table A. 5: Grand Lake Capacity/Area by 0.1-ft Increments (cont).

GRAND LAKE AREA-CAPACITY TABLE
OKLAHOMA WATER RESOURCES BOARD
2008/2009 Survey
Capacity in acre-feet by tenth foot elevation increments
Area in acres by tenth foot elevation increments

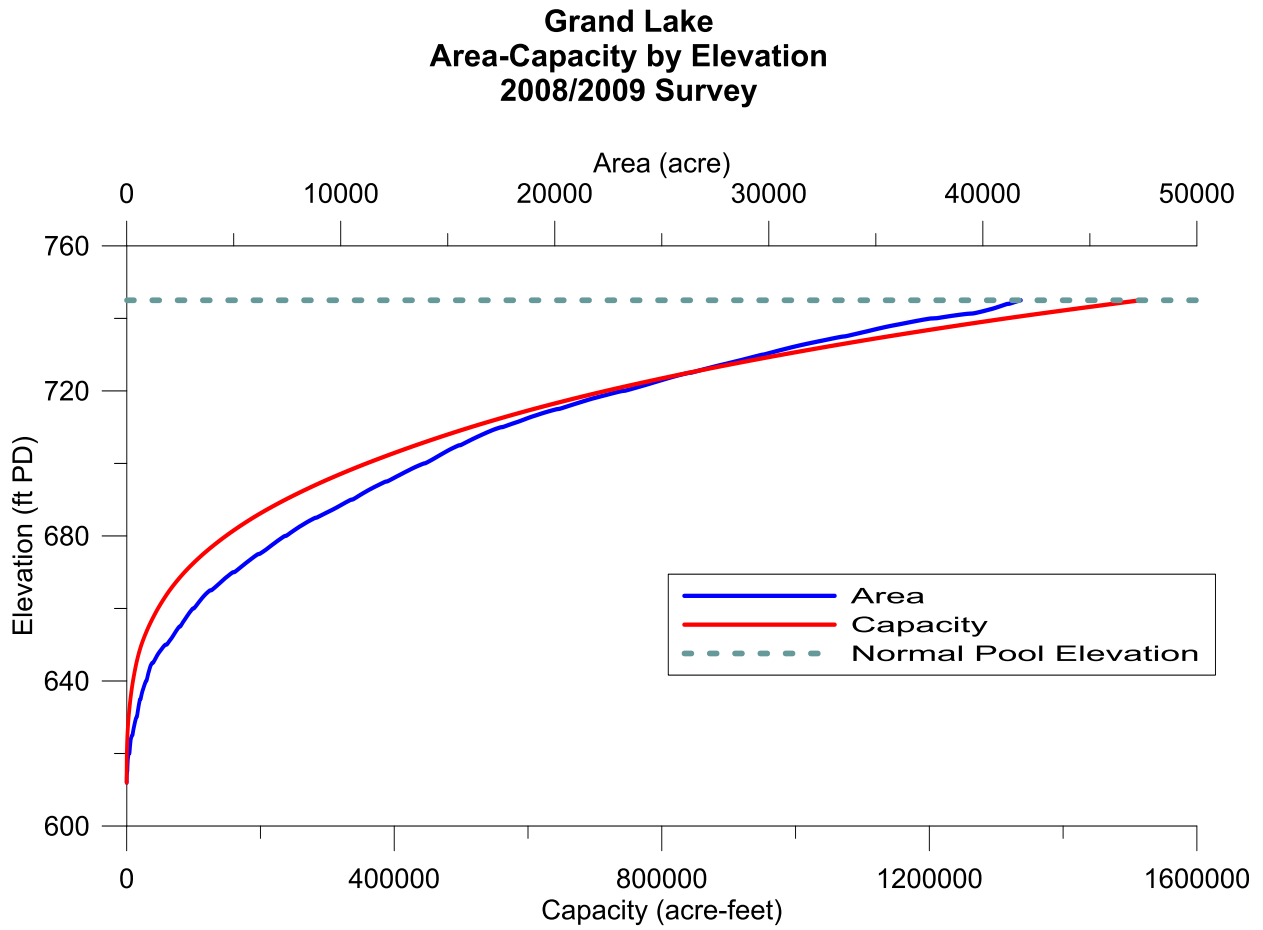| Elevation (ft PD)		0.06	0.16	0.26	0.36	0.46	0.56	0.66	0.76	0.86	0.96
695	Area	12,179	12,216	12,251	12,284	12,318	12,350	12,382	12,414	12,446	12,477
	Capacity	294,332	295,552	296,775	298,002	299,233	300,466	301,703	302,943	304,186	305,433
696	Area	12,509	12,540	12,571	12,603	12,636	12,669	12,702	12,736	12,768	12,800
	Capacity	306,682	307,934	309,190	310,449	311,711	312,977	314,245	315,517	316,792	318,071
697	Area	12,832	12,864	12,897	12,929	12,962	12,994	13,027	13,060	13,094	13,129
	Capacity	319,353	320,638	321,926	323,217	324,513	325,810	327,111	328,416	329,724	331,036
698	Area	13,162	13,196	13,229	13,262	13,295	13,328	13,362	13,398	13,435	13,472
	Capacity	332,350	333,668	334,990	336,314	337,642	338,974	340,308	341,647	342,988	344,334
699	Area	13,509	13,547	13,585	13,624	13,665	13,705	13,746	13,786	13,828	13,872
	Capacity	345,683	347,036	348,393	349,753	351,118	352,487	353,859	355,236	356,617	358,003
700	Area	13,958	13,993	14,026	14,058	14,090	14,122	14,153	14,185	14,216	14,247
	Capacity	359,395	360,792	362,194	363,598	365,006	366,416	367,830	369,247	370,667	372,091
701	Area	14,277	14,307	14,336	14,366	14,395	14,424	14,453	14,482	14,510	14,539
	Capacity	373,517	374,946	376,379	377,814	379,253	380,694	382,137	383,585	385,034	386,487
702	Area	14,568	14,597	14,627	14,656	14,686	14,715	14,746	14,776	14,805	14,834
	Capacity	387,942	389,401	390,862	392,326	393,794	395,264	396,737	398,214	399,693	401,176
703	Area	14,864	14,894	14,924	14,954	14,985	15,015	15,046	15,078	15,110	15,144
	Capacity	402,660	404,148	405,640	407,133	408,631	410,131	411,634	413,141	414,650	416,163
704	Area	15,177	15,212	15,246	15,282	15,319	15,355	15,390	15,427	15,465	15,506
	Capacity	417,679	419,199	420,722	422,249	423,779	425,313	426,850	428,392	429,936	431,485
705	Area	15,607	15,642	15,675	15,709	15,742	15,775	15,808	15,841	15,874	15,908
	Capacity	433,042	434,604	436,171	437,740	439,313	440,889	442,467	444,051	445,636	447,226
706	Area	15,941	15,974	16,008	16,042	16,076	16,110	16,144	16,179	16,214	16,249
	Capacity	448,819	450,414	452,014	453,616	455,223	456,832	458,445	460,062	461,681	463,305
707	Area	16,285	16,320	16,357	16,393	16,429	16,466	16,502	16,539	16,576	16,614
	Capacity	464,932	466,562	468,196	469,834	471,476	473,120	474,768	476,421	478,077	479,737
708	Area	16,652	16,690	16,727	16,765	16,803	16,841	16,880	16,920	16,960	17,000
	Capacity	481,400	483,067	484,739	486,413	488,093	489,775	491,461	493,151	494,845	496,544
709	Area	17,041	17,082	17,125	17,168	17,214	17,262	17,312	17,365	17,419	17,477
	Capacity	498,246	499,952	501,663	503,378	505,098	506,821	508,550	510,284	512,023	513,769
710	Area	17,589	17,637	17,683	17,730	17,777	17,823	17,871	17,918	17,966	18,016
	Capacity	515,523	517,284	519,051	520,821	522,598	524,377	526,162	527,952	529,746	531,546
711	Area	18,066	18,117	18,168	18,219	18,270	18,319	18,365	18,410	18,456	18,502
	Capacity	533,350	535,159	536,974	538,794	540,619	542,448	544,282	546,122	547,965	549,814
712	Area	18,546	18,591	18,635	18,679	18,723	18,769	18,815	18,864	18,914	18,966
	Capacity	551,666	553,523	555,385	557,250	559,121	560,996	562,875	564,760	566,649	568,543
713	Area	19,018	19,069	19,121	19,173	19,225	19,277	19,328	19,380	19,433	19,487
	Capacity	570,442	572,347	574,257	576,171	578,092	580,017	581,947	583,884	585,824	587,771
714	Area	19,542	19,600	19,660	19,718	19,776	19,836	19,898	19,962	20,029	20,098
	Capacity	589,722	591,679	593,643	595,612	597,587	599,568	601,554	603,548	605,548	607,555
715	Area	20,228	20,283	20,337	20,390	20,442	20,495	20,547	20,600	20,652	20,705
	Capacity	609,572	611,597	613,629	615,665	617,708	619,755	621,807	623,865	625,927	627,996

Table A. 6: Grand Lake Capacity/Area by 0.1-ft Increments (cont).

GRAND LAKE AREA-CAPACITY TABLE
OKLAHOMA WATER RESOURCES BOARD
2008/2009 Survey
Capacity in acre-feet by tenth foot elevation increments
Area in acres by tenth foot elevation increments

Elevation (ft PD)		0.06	0.16	0.26	0.36	0.46	0.56	0.66	0.76	0.86	0.96
716	Area	20,757	20,810	20,864	20,918	20,972	21,025	21,079	21,132	21,186	21,240
	Capacity	630,069	632,147	634,232	636,321	638,416	640,516	642,621	644,733	646,848	648,971
717	Area	21,295	21,350	21,405	21,460	21,516	21,572	21,628	21,686	21,744	21,805
	Capacity	651,097	653,229	655,368	657,511	659,661	661,815	663,975	666,142	668,313	670,492
718	Area	21,869	21,934	21,998	22,062	22,127	22,192	22,257	22,323	22,388	22,452
	Capacity	672,675	674,865	677,063	679,265	681,476	683,692	685,914	688,144	690,379	692,623
719	Area	22,516	22,580	22,645	22,711	22,777	22,844	22,912	22,982	23,055	23,133
	Capacity	694,871	697,125	699,388	701,655	703,931	706,212	708,499	710,795	713,097	715,407
720	Area	23,288	23,353	23,416	23,478	23,540	23,600	23,659	23,719	23,778	23,836
	Capacity	717,729	720,061	722,400	724,745	727,097	729,454	731,816	734,187	736,561	738,943
721	Area	23,895	23,955	24,015	24,074	24,133	24,192	24,250	24,307	24,364	24,421
	Capacity	741,329	743,721	746,121	748,525	750,937	753,353	755,775	758,204	760,637	763,078
722	Area	24,477	24,533	24,589	24,645	24,701	24,757	24,813	24,870	24,927	24,984
	Capacity	765,522	767,972	770,430	772,891	775,360	777,832	780,311	782,796	785,286	787,782
723	Area	25,041	25,098	25,155	25,212	25,270	25,328	25,387	25,447	25,507	25,567
	Capacity	790,283	792,790	795,304	797,822	800,347	802,877	805,413	807,955	810,503	813,058
724	Area	25,629	25,691	25,755	25,820	25,885	25,954	26,025	26,098	26,173	26,252
	Capacity	815,617	818,183	820,757	823,335	825,922	828,513	831,112	833,720	836,333	838,955
725	Area	26,397	26,461	26,524	26,586	26,649	26,711	26,774	26,838	26,901	26,966
	Capacity	841,588	844,231	846,882	849,537	852,200	854,868	857,541	860,224	862,910	865,605
726	Area	27,030	27,096	27,162	27,227	27,292	27,357	27,423	27,490	27,558	27,627
	Capacity	868,304	871,010	873,725	876,444	879,171	881,903	884,642	887,389	890,141	892,902
727	Area	27,698	27,769	27,841	27,912	27,986	28,056	28,123	28,192	28,264	28,332
	Capacity	895,668	898,441	901,222	904,010	906,806	909,608	912,417	915,234	918,056	920,888
728	Area	28,399	28,470	28,542	28,611	28,680	28,747	28,813	28,879	28,945	29,010
	Capacity	923,724	926,567	929,419	932,276	935,142	938,013	940,891	943,777	946,668	949,567
729	Area	29,074	29,139	29,205	29,271	29,336	29,402	29,468	29,535	29,605	29,678
	Capacity	952,471	955,382	958,300	961,224	964,155	967,092	970,035	972,987	975,944	978,909
730	Area	29,787	29,852	29,916	29,979	30,043	30,107	30,171	30,234	30,297	30,360
	Capacity	981,883	984,864	987,854	990,848	993,851	996,858	999,872	1,002,894	1,005,920	1,008,954
731	Area	30,424	30,488	30,553	30,620	30,688	30,756	30,823	30,889	30,956	31,024
	Capacity	1,011,993	1,015,038	1,018,092	1,021,150	1,024,217	1,027,289	1,030,368	1,033,455	1,036,547	1,039,647
732	Area	31,093	31,163	31,234	31,305	31,378	31,451	31,526	31,602	31,679	31,757
	Capacity	1,042,753	1,045,865	1,048,987	1,052,113	1,055,249	1,058,390	1,061,539	1,064,697	1,067,860	1,071,034
733	Area	31,836	31,916	31,998	32,079	32,161	32,242	32,324	32,407	32,491	32,574
	Capacity	1,074,213	1,077,400	1,080,598	1,083,801	1,087,015	1,090,234	1,093,462	1,096,701	1,099,945	1,103,200
734	Area	32,656	32,736	32,817	32,900	32,983	33,066	33,152	33,241	33,332	33,429
	Capacity	1,106,461	1,109,730	1,113,010	1,116,295	1,119,591	1,122,893	1,126,204	1,129,525	1,132,853	1,136,193
735	Area	33,583	33,661	33,737	33,810	33,882	33,954	34,028	34,102	34,175	34,246
	Capacity	1,139,544	1,142,906	1,146,277	1,149,654	1,153,041	1,156,432	1,159,831	1,163,239	1,166,653	1,170,075
736	Area	34,319	34,391	34,465	34,539	34,611	34,682	34,752	34,821	34,891	34,961
	Capacity	1,173,503	1,176,938	1,180,383	1,183,833	1,187,292	1,190,756	1,194,228	1,197,708	1,201,193	1,204,688

Table A. 7: Grand Lake Capacity/Area by 0.1-ft Increments (cont).

Elevation (ft PD)		0.06	0.16	0.26	0.36	0.46	0.56	0.66	0.76	0.86	0.96
737	Area	35,032	35,104	35,178	35,253	35,328	35,403	35,479	35,558	35,639	35,725
	Capacity	1,208,187	1,211,693	1,215,209	1,218,730	1,222,261	1,225,797	1,229,341	1,232,895	1,236,454	1,240,024
738	Area	35,814	35,904	35,996	36,084	36,173	36,260	36,347	36,433	36,519	36,604
	Capacity	1,243,601	1,247,186	1,250,783	1,254,387	1,258,001	1,261,623	1,265,253	1,268,893	1,272,541	1,276,199
739	Area	36,690	36,776	36,865	36,957	37,049	37,141	37,234	37,331	37,436	37,549
	Capacity	1,279,863	1,283,536	1,287,220	1,290,910	1,294,613	1,298,322	1,302,040	1,305,770	1,309,508	1,313,259
740	Area	37,857	37,962	38,067	38,175	38,283	38,390	38,503	38,621	38,743	38,868
	Capacity	1,317,031	1,320,822	1,324,625	1,328,437	1,332,262	1,336,095	1,339,939	1,343,797	1,347,665	1,351,547
741	Area	38,997	39,130	39,270	39,542	39,630	39,709	39,784	39,857	39,927	39,995
	Capacity	1,355,440	1,359,346	1,363,268	1,367,207	1,371,168	1,375,135	1,379,109	1,383,093	1,387,082	1,391,080
742	Area	40,062	40,128	40,191	40,255	40,319	40,388	40,450	40,509	40,563	40,615
	Capacity	1,395,082	1,399,091	1,403,109	1,407,131	1,411,162	1,415,197	1,419,238	1,423,288	1,427,342	1,431,403
743	Area	40,667	40,718	40,769	40,819	40,870	40,920	40,970	41,021	41,071	41,121
	Capacity	1,435,466	1,439,535	1,443,612	1,447,691	1,451,777	1,455,866	1,459,960	1,464,062	1,468,166	1,472,278
744	Area	41,254	41,308	41,361	41,414	41,466	41,518	41,571	41,623	41,676	41,728
	Capacity	1,476,397	1,480,524	1,484,660	1,488,798	1,492,944	1,497,093	1,501,247	1,505,409	1,509,573	1,513,746
745	Area	41,779									
	Capacity	1,515,415									

Table title (header):
GRAND LAKE AREA-CAPACITY TABLE
OKLAHOMA WATER RESOURCES BOARD
2008/2009 Survey
Capacity in acre-feet by tenth foot elevation increments
Area in acres by tenth foot elevation increments

Figure A. 1. Area-Capacity Curve for Grand Lake

Grand Lake
Area-Capacity by Elevation
2008/2009 Survey
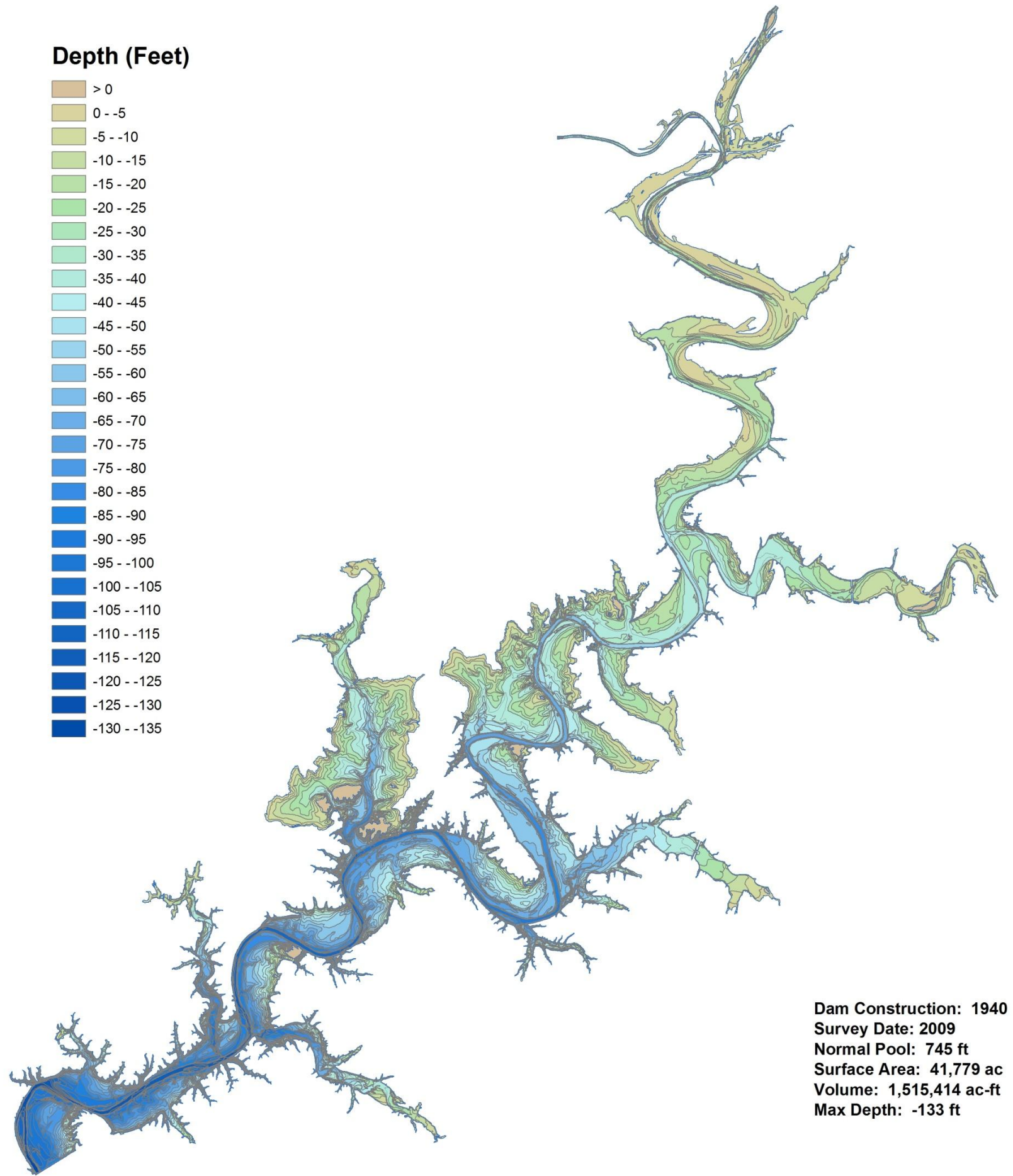
APPENDIX B: Grand Lake Maps

Figure B. 1: Grand Lake Bathymetric Map with 5-foot Contour Intervals.

Grand Lake 'O' the Cherokees
5-Foot Depth Contours

CAUTION - The intention of this map is to give a generalized overview
of the lake depths. There may be shallow underwater hazards such as rocks,
shoals, and vegetation that do not appear on this map.
THIS MAP SHOULD NOT BE USED FOR NAVIGATION PURPOSES.

OWRB
State of Oklahoma
WATER RESOURCES BOARD
the water agency

Depth (Feet)

- > 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -25
- -25 - -30
- -30 - -35
- -35 - -40
- -40 - -45
- -45 - -50
- -50 - -55
- -55 - -60
- -60 - -65
- -65 - -70
- -70 - -75
- -75 - -80
- -80 - -85
- -85 - -90
- -90 - -95
- -95 - -100
- -100 - -105
- -105 - -110
- -110 - -115
- -115 - -120
- -120 - -125
- -125 - -130
- -130 - -135

Dam Construction: 1940
Survey Date: 2009
Normal Pool: 745 ft
Surface Area: 41,779 ac
Volume: 1,515,414 ac-ft
Max Depth: -133 ft

1:140,000

0   2.5   5   10   15

Miles

N
W   E
S

Figure B. 2: Grand Lake Shaded Relief Bathymetric Map.

Grand Lake 'O' the Cherokees
Shaded Relief

CAUTION - The intention of this map is to give a generalized overview
of the lake depths. There may be shallow underwater hazards such as rocks,
shoals, and vegetation that do not appear on this map.
THIS MAP SHOULD NOT BE USED FOR NAVIGATION PURPOSES.

Depth (Feet)
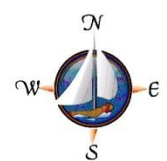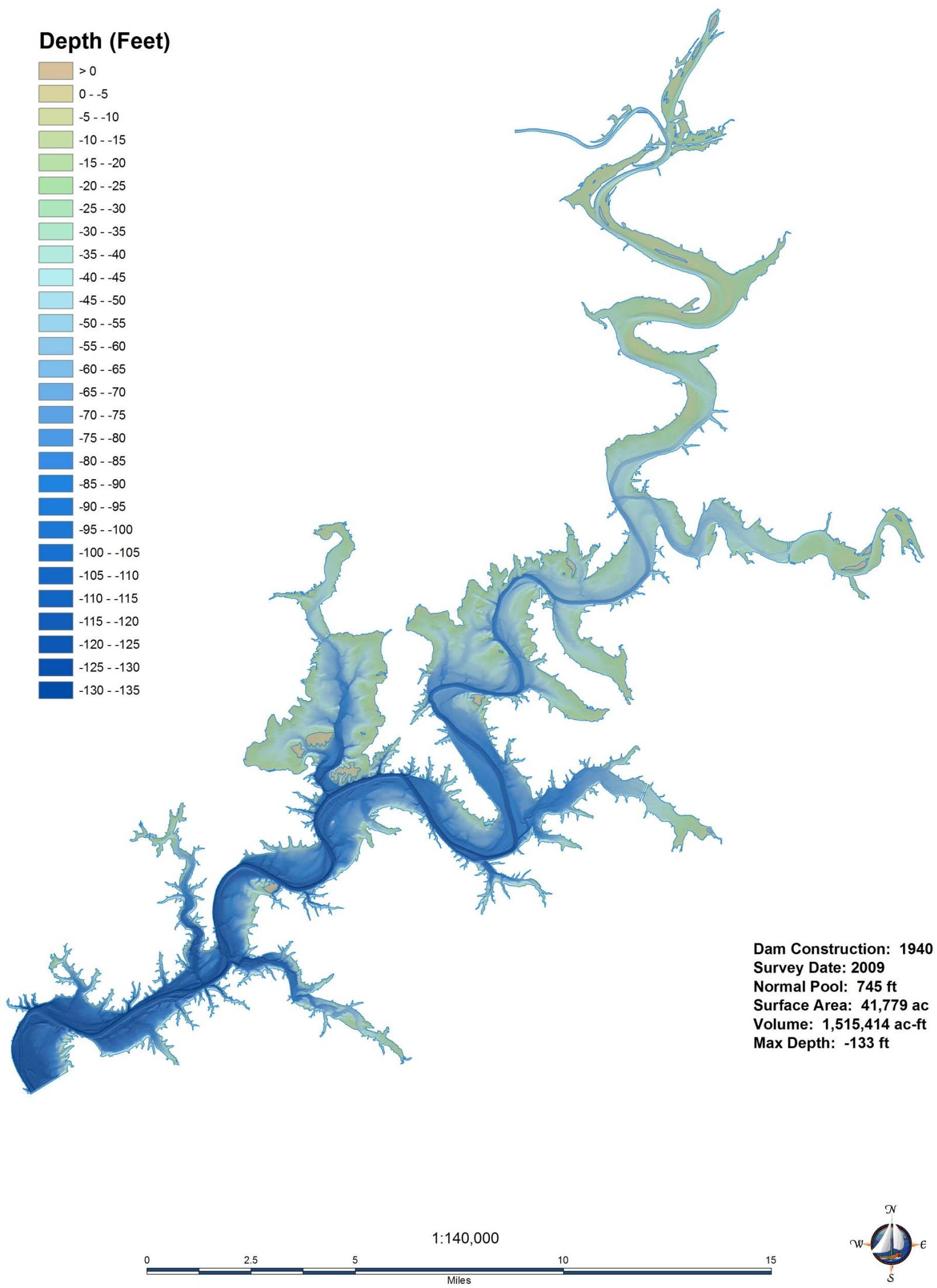
	> 0
	0 - -5
	-5 - -10
	-10 - -15
	-15 - -20
	-20 - -25
	-25 - -30
	-30 - -35
	-35 - -40
	-40 - -45
	-45 - -50
	-50 - -55
	-55 - -60
	-60 - -65
	-65 - -70
	-70 - -75
	-75 - -80
	-80 - -85
	-85 - -90
	-90 - -95
	-95 - -100
	-100 - -105
	-105 - -110
	-110 - -115
	-115 - -120
	-120 - -125
	-125 - -130
	-130 - -135

Dam Construction: 1940
Survey Date: 2009
Normal Pool: 745 ft
Surface Area: 41,779 ac
Volume: 1,515,414 ac-ft
Max Depth: -133 ft

1:140,000

0   2.5   5   10   15
Miles

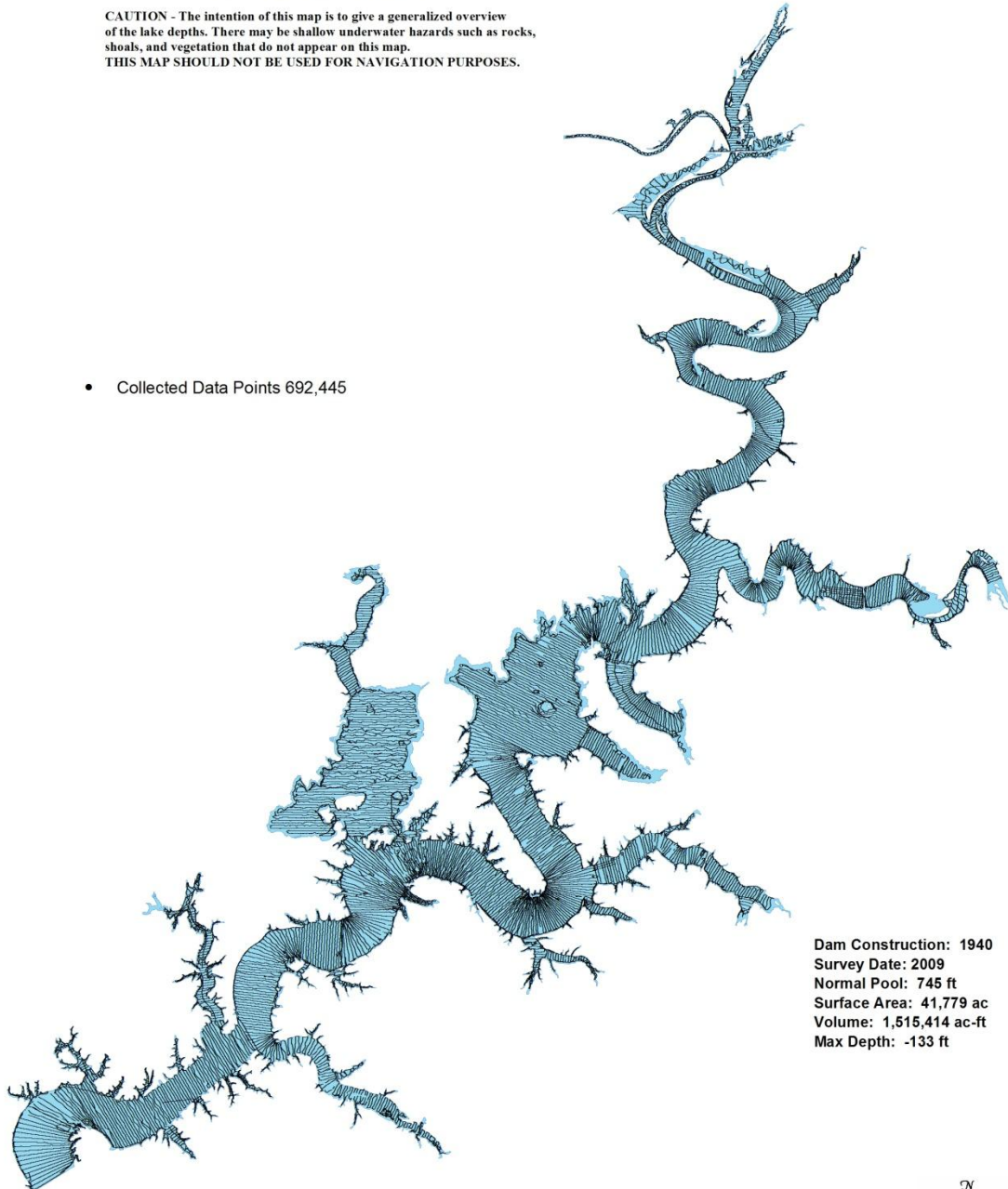**Figure B. 3: Grand Lake Collected Data Points.**

Grand Lake 'O' the Cherokees
Collected Data Points

CAUTION - The intention of this map is to give a generalized overview
of the lake depths. There may be shallow underwater hazards such as rocks,
shoals, and vegetation that do not appear on this map.
THIS MAP SHOULD NOT BE USED FOR NAVIGATION PURPOSES.

• Collected Data Points 692,445

Dam Construction: 1940
Survey Date: 2009
Normal Pool: 745 ft
Surface Area: 41,779 ac
Volume: 1,515,414 ac-ft
Max Depth: -133 ft

1:190,000

0   5   10
Miles