Volumetric and Sedimentation Survey of LAKE BRIDGEPORT

October - December 2010

Texas Water Development Board

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Tarrant Regional Water District

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Executive summary

In October, 2010, the Texas Water Development Board entered into agreement with Tarrant Regional Water District, to perform a volumetric and sedimentation survey of Lake Bridgeport. Surveying was performed using a multi-frequency (200 kHz, 50 kHz, and 24 kHz), sub-bottom profiling depth sounder. In addition, sediment core samples were collected in select locations and correlated with the multi-frequency depth sounder signal returns to estimate sediment accumulation thicknesses and sedimentation rates.

Bridgeport Dam and Lake Bridgeport are located on the West Fork Trinity River in Wise County, four miles west of Bridgeport, Texas. The conservation pool elevation of Lake Bridgeport is 836.0 feet above mean sea level (NGVD29). TWDB collected bathymetric data for Lake Bridgeport between October 12, 2010, and December 19, 2010. The daily average water surface elevations during that time ranged between 833.04 and 834.76 feet above mean sea level (NGVD29).

The 2010 TWDB volumetric survey indicates that Lake Bridgeport has a total reservoir capacity of 361,875 acre-feet and encompasses 11,712 acres at conservation pool elevation (836.0 feet above mean sea level, NGVD29). Previous capacity estimates include multiple surveys conducted by Freese and Nichols in 1959, 1968, and 1988, indicating Lake Bridgeport's total capacity was 386,420, 386,559, and 374,836 acre-feet, respectively. A TWDB volumetric survey conducted in 2000 was re-evaluated using current processing procedures that resulted in an updated capacity estimate of 369,594 acre-feet.

Based on two methods for estimating sedimentation rates, TWDB estimates that Lake Bridgeport loses between 321 and 772 acre-feet per year of capacity due to sedimentation. Sediment accumulation is greatest in the deeper areas of the main body of the lake and in the cove south of Steele Island. Sediment is also greater in the submerged channel of the West Fork Trinity River. TWDB recommends that a similar methodology be used to resurvey Lake Bridgeport in 10 years or after a major flood event.

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Note: References to brand names throughout this report do not imply endorsement by the Texas Water Development Board

Introduction

The Hydrographic Survey Program of the Texas Water Development Board (TWDB) was authorized by the 72nd Texas State Legislature in 1991. The Texas Water Code authorizes TWDB to perform surveys to determine reservoir storage capacity, sedimentation levels, rates of sedimentation, and projected water supply availability.

In October, 2010, TWDB entered into agreement with Tarrant Regional Water District, to perform a volumetric and sedimentation survey of Lake Bridgeport (TWDB, 2010). This report describes the methods used to conduct the volumetric and sedimentation survey, including data collection and processing techniques. This report serves as the final contract deliverable from TWDB to the Tarrant Regional Water District and contains as deliverables: (1) an elevation-area-capacity table of the lake acceptable to the Texas Commission on Environmental Quality [Appendix A, B], (2) a bottom contour map [Figure 5], (3) a shaded relief plot of the lake bottom [Figure 3], and (4) an estimate of sediment accumulation and location [Figure 10].

Lake Bridgeport general information

Bridgeport Dam and Lake Bridgeport are located on the West Fork Trinity River (Trinity River Basin) in Wise and Jack Counties, four miles west of Bridgeport, Texas (Figure 1). Bridgeport Dam and Lake Bridgeport are owned and operated by the Tarrant Regional Water District. Lake Bridgeport was built primarily for water supply and flood control (TWDB, 2001). Construction on Bridgeport Dam began on January 23, 1930, and was completed on December 15, 1931. Deliberate impoundment began on April 1, 1932 (TWDB, 1973). Additional pertinent data about Bridgeport Dam and Lake Bridgeport can be found in Table 1.

Tarrant Regional Water District also owns and operates Eagle Mountain Lake, Cedar Creek Reservoir, and Richland-Chambers Reservoir. Tarrant Regional Water District is one of the largest raw water suppliers in Texas, serving over 1.7 million people in eleven counties (TRWD, 2012). The cities of Fort Worth, Arlington, and Mansfield, and the Trinity River Authority are a few of the more than 30 wholesale customers Tarrant Regional Water District serves. In addition to providing water, Tarrant Regional Water District is responsible for providing flood control and protection along the West and Clear Forks of the Trinity River within Tarrant County (TRWD, 2012).

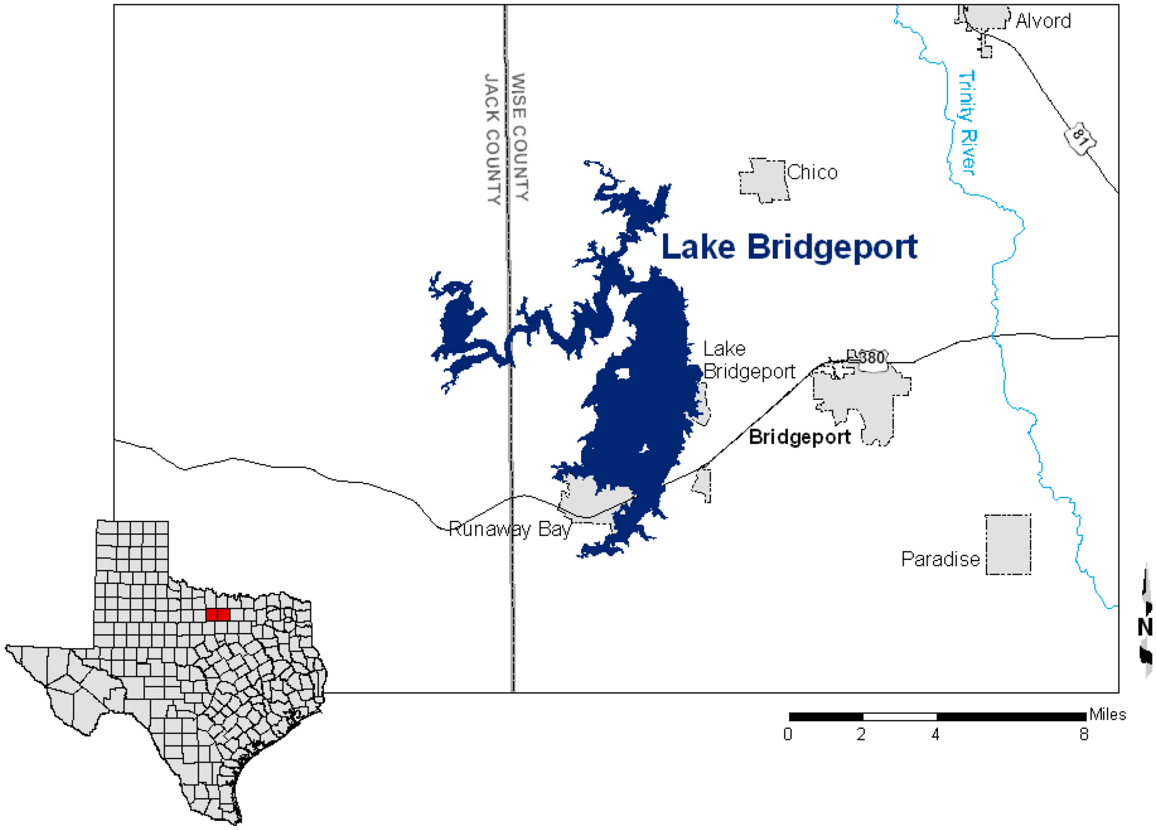


Figure 1. **Location map –Lake Bridgeport**

Water rights for Lake Bridgeport have been appropriated to Tarrant Regional Water District through Certificate of Adjudication and amendment Nos.08-3808, 08-3808A, and 08-3808B. The complete certificates are on file in the Information Resources Division of the Texas Commission on Environmental Quality.

Table 1. Pertinent data for Bridgeport Dam and Lake Bridgeport

Owner				
Tarrant Regional Water District				
Engineer (Design)				
Hawley, Freese and Nichols (original)				
Freese, Nichols and Endress (1971 enlargement)				
Location of dam				
On the West Fork Trinity River in Wise County, 4 miles west of Bridgeport, Texas				
Drainage area				
1,111 square miles				
Dam				
Type	Earthfill			
Length	2,040 feet			
Maximum height	130 feet			
Top width	16 feet			
Top elevation	874.0 feet above mean sea level			
Spillway (emergency)				
Location	Left of the dam			
Type	Natural ground			
Length	700 feet			
Elevation	866.0 feet above mean sea level			
Spillway (new service)				
Location	3,000 feet ± to left of dam			
Type	Excavated channel from lake to concrete ogee section			
Crest length	90 feet			
Control	8 vertical gates			
Crest elevation	820.0 feet above mean sea level			
Top of gate elevation	842.0 feet above mean sea level			
Discharge	To excavated channel			
Modified original outlet works				
Type	Pipes installed in conduits used to pass water during original construction			
Size	18- and 48-inch steel cylinder concrete pipes			
Control	Valves operated from top of tower			
Invert of pipe	752.0 feet above mean sea level			
Outlet works (new)				
Location	Part of service spillway wall			
Type	60-inch steel pipe with entrance elbow			
Invert of elbow	810.0 feet above mean sea level			
Control	Slide gate at discharge			
Discharge	To spillway discharge basin at elevation 810.0 feet above mean sea level			
Reservoir data (Based on 2010 TWDB survey)				
Feature		**Elevation (feet NGVD29[a])**	**Capacity (acre-feet)**	**Area (acres)**
Top of dam		874.0	N/A	N/A
Crest of service spillway		836.0	361,875	11,712
Invert of elbow (outlet works)		810.0	123,492	6,662
Invert of 48-inch valves		751.4	0	0
Usable conservation storage space		-	361,875	

Source: (TWDB, 1973)

[a] NGVD29 = National Geodetic Vertical Datum 1929

Volumetric and sedimentation survey of Lake Bridgeport

Datum

The vertical datum used during this survey is the National Geodetic Vertical Datum 1929 (NGVD29). This datum is also utilized by the United States Geological Survey (USGS) for the reservoir elevation gage *USGS 08043000 Bridgeport Res abv Bridgeport, TX* (USGS, 2011). Elevations herein are reported in feet above mean sea level relative to the NGVD29 datum. Volume and area calculations in this report are referenced to water levels provided by the USGS gage. The horizontal datum used for this report is North American Datum 1983 (NAD83), and the horizontal coordinate system is State Plane Texas North Central Zone (feet).

TWDB bathymetric and sedimentation data collection

TWDB collected bathymetric data for Lake Bridgeport between October 12, 2010, and December 19, 2010. The daily average water surface elevations during that time ranged between 833.04 and 834.76 feet above mean sea level (NGVD29). For data collection, TWDB used a Specialty Devices, Inc. (SDI), single-beam, multi-frequency (200 kHz, 50 kHz, and 24 kHz) sub-bottom profiling depth sounder integrated with differential global positioning system (DGPS) equipment. Data collection occurred while navigating along pre-planned survey lines oriented perpendicular to the assumed location of the original river channels and spaced approximately 500 feet apart. Many of the survey lines were also surveyed by TWDB during the 2000 survey. The depth sounder was calibrated daily using a velocity profiler to measure the speed of sound in the water column and a weighted tape or stadia rod for depth reading verification. Figure 2 shows where data collection occurred during the 2010 TWDB survey.

All sounding data was collected and reviewed before sediment core sampling sites were selected. Sediment core samples are collected at regularly spaced intervals within the lake, or at locations where interpretation of the acoustic display would be difficult without site-specific sediment core data. Following analysis of the sounding data, TWDB selected seven locations to collect sediment core samples (Figure 2). The sediment core samples were collected on October 11-12, 2011, with a custom-coring boat and SDI VibraCore system.

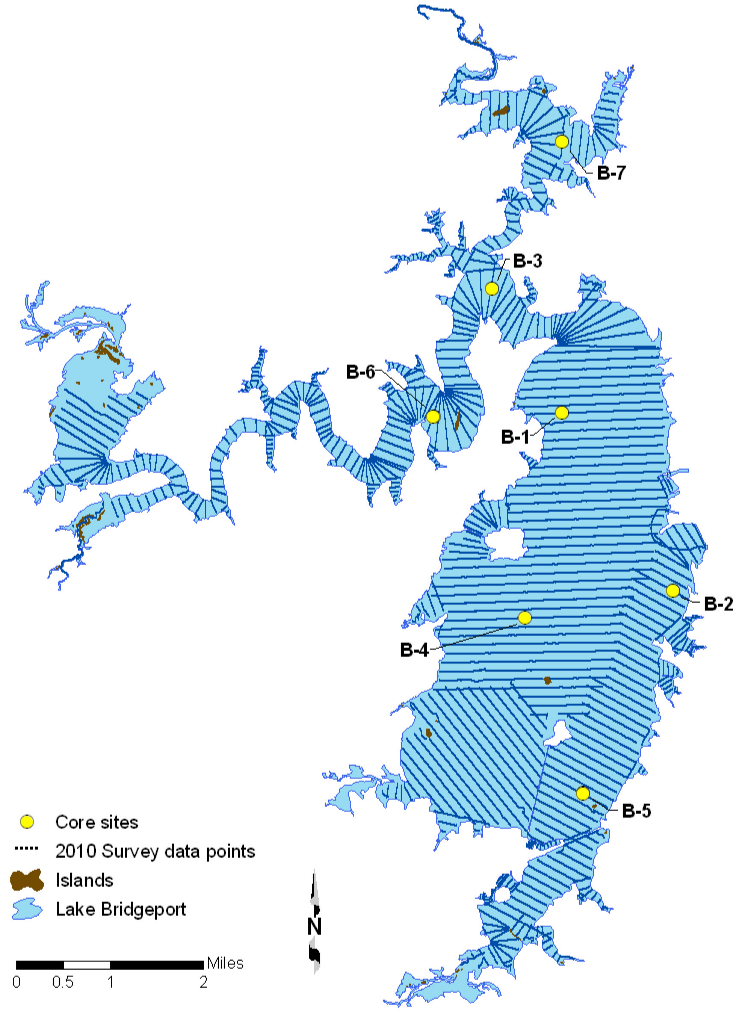


Figure 2. **Data collected during 2010 TWDB Lake Bridgeport survey**

Sediment cores are collected in 3-inch diameter aluminum tubes. Analysis of the acoustic data collected during the bathymetric survey assists in determining the depth of penetration to which the tube must be driven during sediment sampling. The goal is to collect a sediment core sample extending from the current lake bottom, through the accumulated sediment, and to the pre-impoundment surface. After retrieving the sample, a stadia rod is inserted into the top of the tube to assist in locating the top of the sediment in the tube. This identifies the location of the layer corresponding to the current reservoir surface. The aluminum tube is cut to this level, capped, and transported back to TWDB headquarters for further analysis. During this time, some settling of the upper layer can occur.

Data processing

Model boundaries

The reservoir boundary was digitized from aerial photographs, also known as digital orthophoto quarter-quadrangle images (DOQQs), obtained from the Texas Natural Resources Information System (TNIRIS, 2009) using Environmental Systems Research Institute's ArcGIS 9.3.1 software. The quarter-quadrangles that cover Lake Bridgeport are Bridgeport West (NW, SW), Wizard Wells (NW, NE, SE), Crafton (SW, SE), and Chico (SW). The DOQQs were photographed on July 18, 2010, and July 30, 2010, while the daily average water surface elevation measured 836.45 and 836.08 feet above mean sea level, respectively. According to the associated metadata, the 2010 DOQQS have a resolution of 1.0-meters and a horizontal accuracy within + / - 6 meters to absolute ground control (USDA, 2011, TNRIS, 2010). For this analysis, the boundary digitized at the land-water interface in the 2010 photographs is assumed to be a good approximation of the lake boundary at conservation pool elevation. Therefore, the delineated boundary was given an elevation of 836.0 feet above mean sea level to facilitate calculating the area-capacity tables up to the conservation pool elevation.

Triangulated Irregular Network model

Following completion of data collection, the raw data was edited using DepthPic. DepthPic is used to display, interpret, and edit the multi-frequency data and to manually identify the current reservoir-bottom surface and the reservoir-bottom surface at the time of initial impoundment (i.e. pre-impoundment surface). An in-house TWDB software package, HydroTools, is used to identify the current reservoir–bottom surface, pre-impoundment surface, and sediment thickness at each sounding location; remove data anomalies; and output the data into a single file (McEwen, 2011a). The water surface elevation at the time of each sounding is used to convert each sounding depth to a corresponding reservoir-bottom elevation. This survey point dataset is then preconditioned by inserting a uniform grid of artificial survey points between the actual survey lines. Bathymetric elevations at these artificial points are determined using an anisotropic spatial interpolation algorithm described in the spatial interpolation of reservoir bathymetry section below. This technique creates a high resolution, uniform grid of interpolated bathymetric elevation points throughout a majority of the lake (McEwen et al., 2011). Finally, the point file resulting from spatial interpolation is used in conjunction with sounding and boundary data to create volumetric and sediment Triangulated Irregular Network (TIN) models utilizing the 3D Analyst Extension of ArcGIS. The 3D Analyst algorithm uses Delaunay's criteria for triangulation to create a grid composed of triangles from non-uniformly spaced points, including the boundary vertices (ESRI, 1995).

Area, Volume, and Contour Calculations

Using ArcInfo software and the volumetric TIN model, volumes and areas were calculated for the entire reservoir at 0.1 feet intervals, from elevation 761.3 to 836.0 feet. The elevation-capacity table and elevation-area table, updated for 2010, are presented in Appendices A and B, respectively. The area-capacity curves are presented in Appendix C.

The volumetric TIN model was converted to a raster representation using a cell size of 2 feet by 2 feet. The raster data was then used to produce an elevation relief map (Figure 3), representing the topography of the reservoir bottom, a depth range map (Figure 4), showing shaded depth ranges for Lake Bridgeport, and a 5-foot contour map (Figure 5 - attached).

Spatial interpolation of reservoir bathymetry

Isotropic spatial interpolation techniques such as the Delaunay triangulation used by the 3D Analyst extension of ArcGIS are, in many instances, unable to suitably interpolate bathymetries between survey lines common to lake surveys. Reservoirs and stream channels are anisotropic morphological features where bathymetry at any particular location is similar more to upstream and downstream locations than to transverse locations. Interpolation schemes that do not consider this anisotropy lead to the creation of several types of artifacts in the final representation of the reservoir bottom surface and hence to errors in volume. These include: artificially-curved contour lines extending into the reservoir where the reservoir walls are steep or the reservoir is relatively narrow; intermittent representation of submerged stream channel connectivity; oscillations of contour lines in between survey lines. These artifacts reduce the accuracy of the resulting volumetric and sediment TIN models in areas between actual survey data.

To improve the accuracy of bathymetric representation between survey lines, TWDB developed various anisotropic spatial interpolation techniques. Generally, the directionality of interpolation at different locations of a reservoir can be determined from

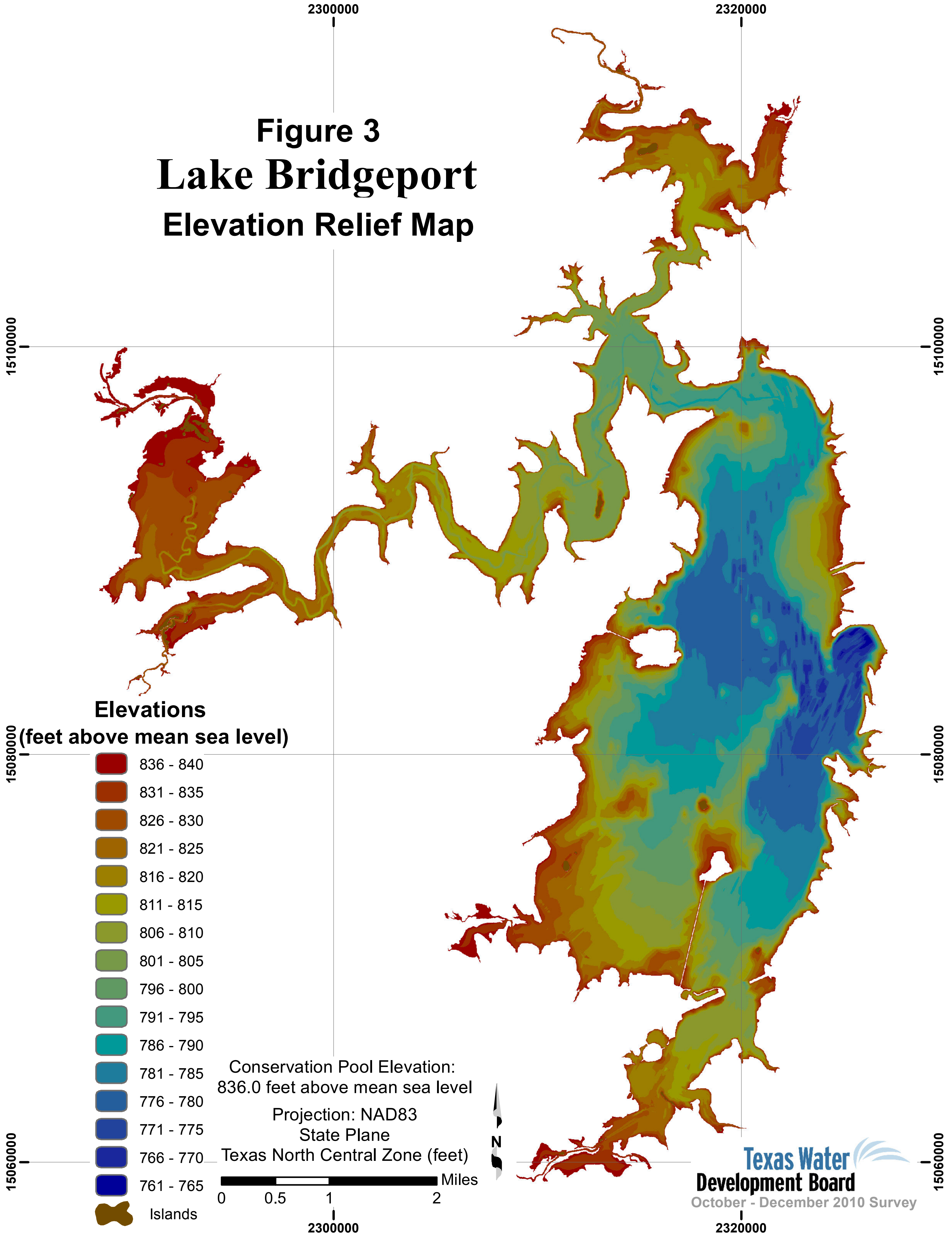
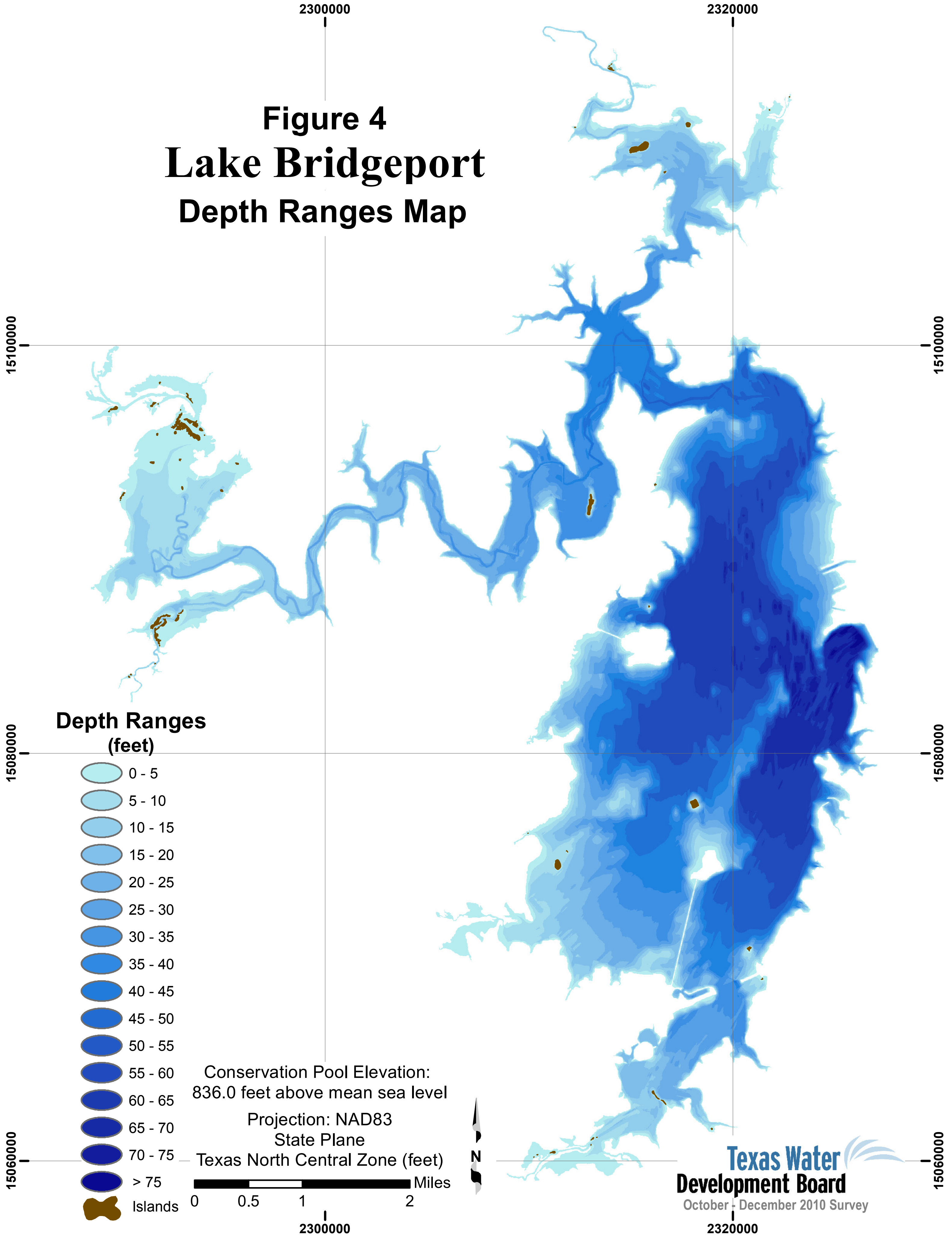


Figure 3
Lake Bridgeport
Elevation Relief Map

Figure 4
Lake Bridgeport
Depth Ranges Map



external data sources. A basic assumption is that the reservoir profile in the vicinity of a particular location has upstream and downstream similarity. No known external data sources were available for Lake Bridgeport.

Using the survey data, polygons are created to partition the lake into segments with centerlines defining directionality of interpolation within each segment. These interpolation definition files are independent of survey data and can be applied to past and future data of the same reservoir. Using the interpolation definition files and survey data the current lake-bottom elevation, pre-impoundment elevation and sediment thickness are calculated for each point in the high resolution uniform grid of artificial survey points. The reservoir boundary, artificial survey points grid and survey data points are used to create volumetric and sediment TIN models representing the reservoir bathymetry and sediment accumulation throughout the reservoir. Specific details of this interpolation technique can be found in the HydroTools manual (McEwen et al, 2011a) and in McEwen et al, 2011b.

In areas inaccessible to survey data collection such as small coves and shallow upstream areas of the reservoir, linear extrapolation is used for volumetric and sediment accumulation estimations. The linear extrapolation follows a linear definition file linking the survey points file to the lake boundary file (McEwen et al, 2011a). Figure 6 illustrates typical results from application of the anisotropic interpolation and line extrapolation techniques to Lake Bridgeport. The bathymetry shown in Figure 6C was used in computing reservoir capacity and area tables (Appendix A, B).

In Figure 6B, deeper channels indicated by surveyed cross sections are not continuously represented in areas between survey cross sections. This is an artifact of the TIN generation routine, rather than an accurate representation of the physical bathymetric surface. Inclusion of interpolation points, represented in Figure 6C, in creation of the volumetric TIN model directs Delaunay triangulation to better represent the lake bathymetry between survey cross-sections.

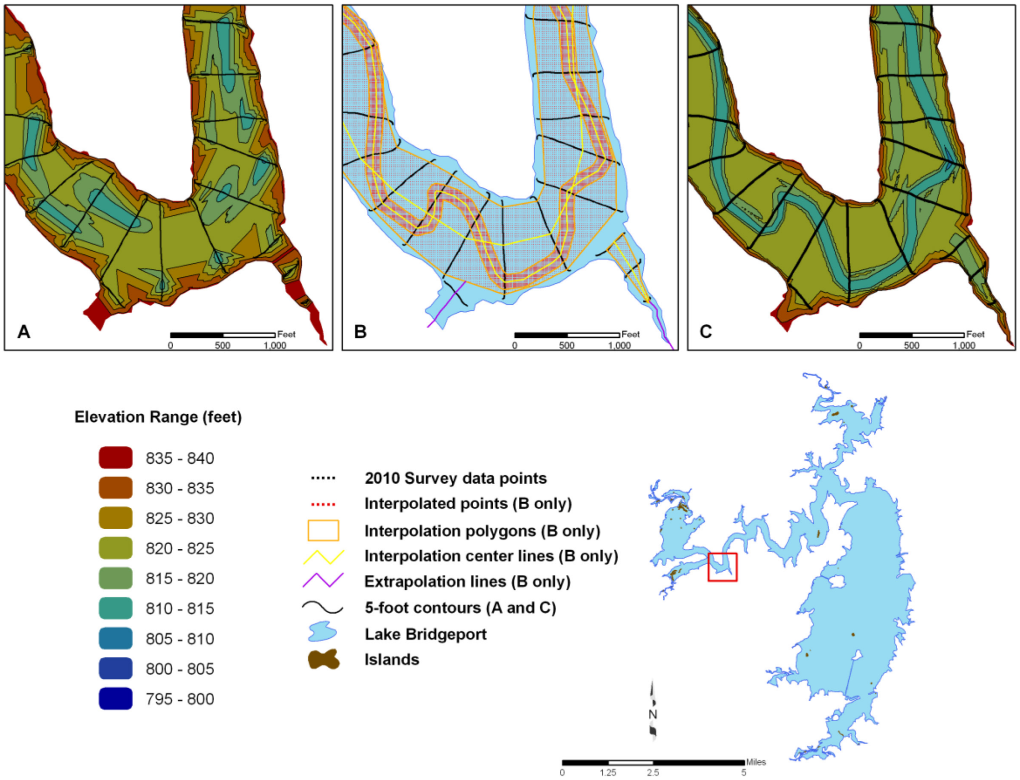


Figure 6. **Anisotropic spatial interpolation and line extrapolation of Lake Bridgeport sounding data – A) bathymetric contours without interpolated points, B) sounding points (black) and interpolated points (red), C) bathymetric contours with the interpolated points**

Analysis of sediment data from Lake Bridgeport

Sedimentation in Lake Bridgeport was determined by analyzing all three depth sounder frequencies in the DepthPic software. The 200 kHz signal was used to determine the current bathymetric surface of the lake, while the 50 kHz and 24 kHz frequencies were used to determine the reservoir bathymetric surface at the time of initial impoundment (i.e. pre-impoundment surface). Sediment core samples collected in the lake were used to assist in identifying the location of the pre-impoundment surface in the acoustic signals. The difference between the current surface and the pre-impoundment surface yields a sediment thickness value at each sounding location.

Analysis of the sediment core samples was conducted at TWDB headquarters in Austin. Each sample was split longitudinally and analyzed to identify the location of the pre-impoundment surface. The pre-impoundment surface is identified within the sediment core sample by one of the following methods: (1) a visual examination of the sediment core for terrestrial materials, such as leaf litter, tree bark, twigs, intact roots, etc., concentrations of which tend to occur on or just below the pre-impoundment surface, (2) changes in texture from well sorted, relatively fine-grained sediment to poorly sorted mixtures of coarse and fine-grained materials, and (3) variations in the physical properties of the sediment, particularly sediment water content and penetration resistance with depth (Van Metre et al, 2004). The total sample length, sediment thickness and the pre-impoundment thickness were recorded. Physical characteristics of the sediment core, including color, texture, relative water content, and presence of organic materials, were also recorded (Table 2).

Table 2. Sediment core sampling analysis data – Lake Bridgeport

Core	Easting[a] (ft)	Northing[a] (ft)	Total core sample/ post-impoundment sediment	Sediment core description	Munsell soil color
B-1	2165221.05	7134829.80	65”/52”	0-40” high water content, loose sediment, gelatinous silt texture	5y 4/1
				40-52” lower water content, more dense that layer above (compaction), silt texture	5y 4/2
				52-65” terrestrial matter/ organics at 60”, dense compact soil with large peds, low soil moisture, silty loam	5y 3/1
B-2	2171525.90	7124817.20	66.5”/62”	0-62” high water content, loose silt, soil color change from 38-44”	5y 4/1 and 2.5y 4/2
				62-66.5” low water content, silty clay loam, dense soil structure with peds	2.5y 3/1
B-3	2161290.49	7141867.40	33”/24”	0-16” high water content, loose silt	5y 4/1 (80%) 5y 2.5/1 (20%)
				16-24” high water content, silt	5y 4/2
				24-33” lower water content, organics present, increased dense soil structure with peds, clay soil	2.5y 3/2
B-4	2163126.88	7123281.30	38”/26”	0-20” high water content, loose gelatinous silt soil	5y 4/1
				20-26” saturated sediment	5y 4/2
				26-32” lower soil moisture, dense soil structure, organics at 34”	2.5y 4/1
				32-38” very dense compact soil with peds and organics present	5y 3/2
B-5	2166437.63	7113382.88	42”/26”	0-26” high water content, loose gelatinous silt	5y 4/1
				26-31.5” saturated sediment, some organics present	5y 4/2
				31.5-42” silty clay soil with soil structure and peds, low soil moisture	10yr 4/2
B-6	2157995.46	7134642.42	36”/23.5”	0-23.5” high water content, loose gelatinous silt	5y 4/1
				23.5-36” saturated silty clay soil, dense soil structure	10yr 4/2
B-7	2165266.04	7150145.84	35”/21”	0-21” very high water content, loose gelatinous silt	5y 4/1 (70%) 5y 2.5/1 (30%)
				21-27” dense soil structure, decreasing soil moisture, silty clay, organics and peds present below 21”	2.5y 4/1
				27-35” clay loam soil, dense soil with small peds, organics present	2.5y 4/2

[a] Coordinates are based on NAD83 State Plane Texas North Central System (feet)

A photograph of sediment core B-2 is shown in Figure 7 and is representative of the sediment cores sampled from Lake Bridgeport. The 200 kHz frequency measures the top layer as the current bottom surface of the reservoir.

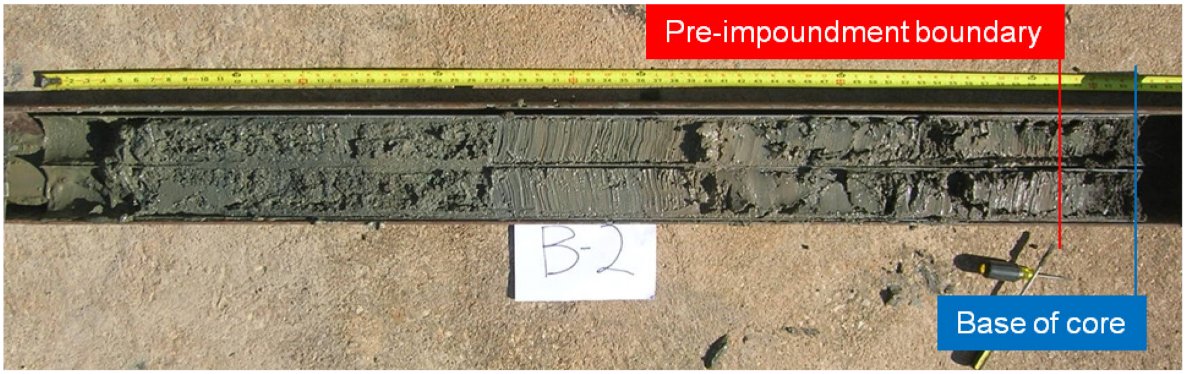


Figure 7. Sediment Core B-2 from Lake Bridgeport

Sediment core sample B-2 consisted of 66.5 inches of total sediment corresponding to the length of the aluminum sampling tube. The upper sediment layer (horizon), 0–62.0 inches, consisted of loose silt soil with high water content, and measured 5y 4/1 on the Munsell soil color chart. A change in color measuring 2.5y 4/2 occurred from 38.0-44.0 inches. The second horizon, beginning at 62.0 inches and extending to 66.5 inches below the surface, consisted of dense structured silty clay loam soil with peds with a 2.5y 3/1 Munsell soil color, and low water content. The base of the sample is denoted by the blue line in Figure 7.

The pre-impoundment boundary (red line in Figure 7) was evident within this sediment core sample at 62.0 inches and identified by the change in soil color, texture, moisture, porosity and structure. Identification of the pre-impoundment surface for the remaining sediment cores followed a similar procedure.

Figures 8 and 9 illustrate how measurements from sediment core samples are used with sonar data to help identify the interface between the post- and pre-impoundment layers in the acoustic signal. Within DepthPic, the current surface is automatically determined based on signal returns from the 200 kHz transducer and verified by TWDB staff, while the pre-impoundment surface must be determined visually. The pre-impoundment surface is first identified along cross-sections for which sediment core samples have been collected. The sediment core sample is represented in each figure as colored boxes. The yellow box represents post-impoundment sediment, and the blue box represents the pre-impoundment sediment.

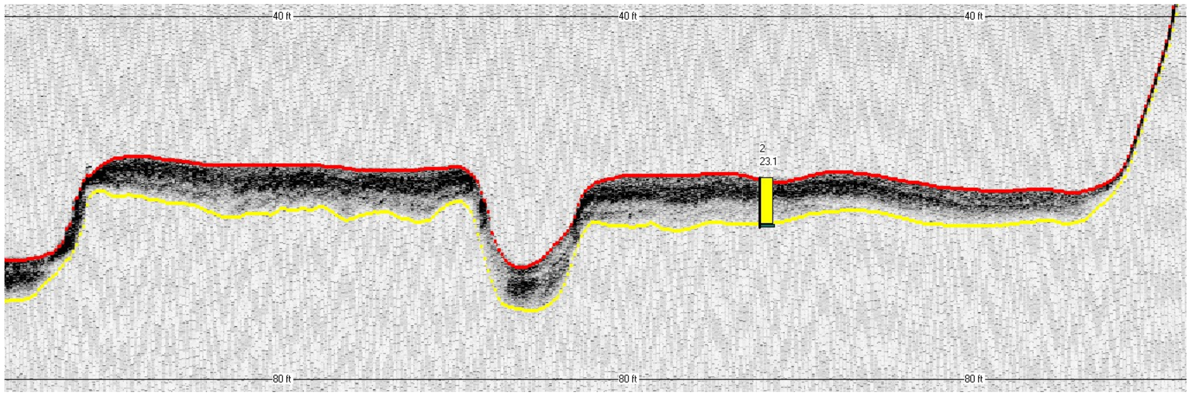


Figure 8. **Cross-section of data collected during 2010 survey, displayed in DepthPic (200 kHz frequency), correlated with sediment core sample B-2 and showing the current surface in red and pre-impoundment surface in yellow**

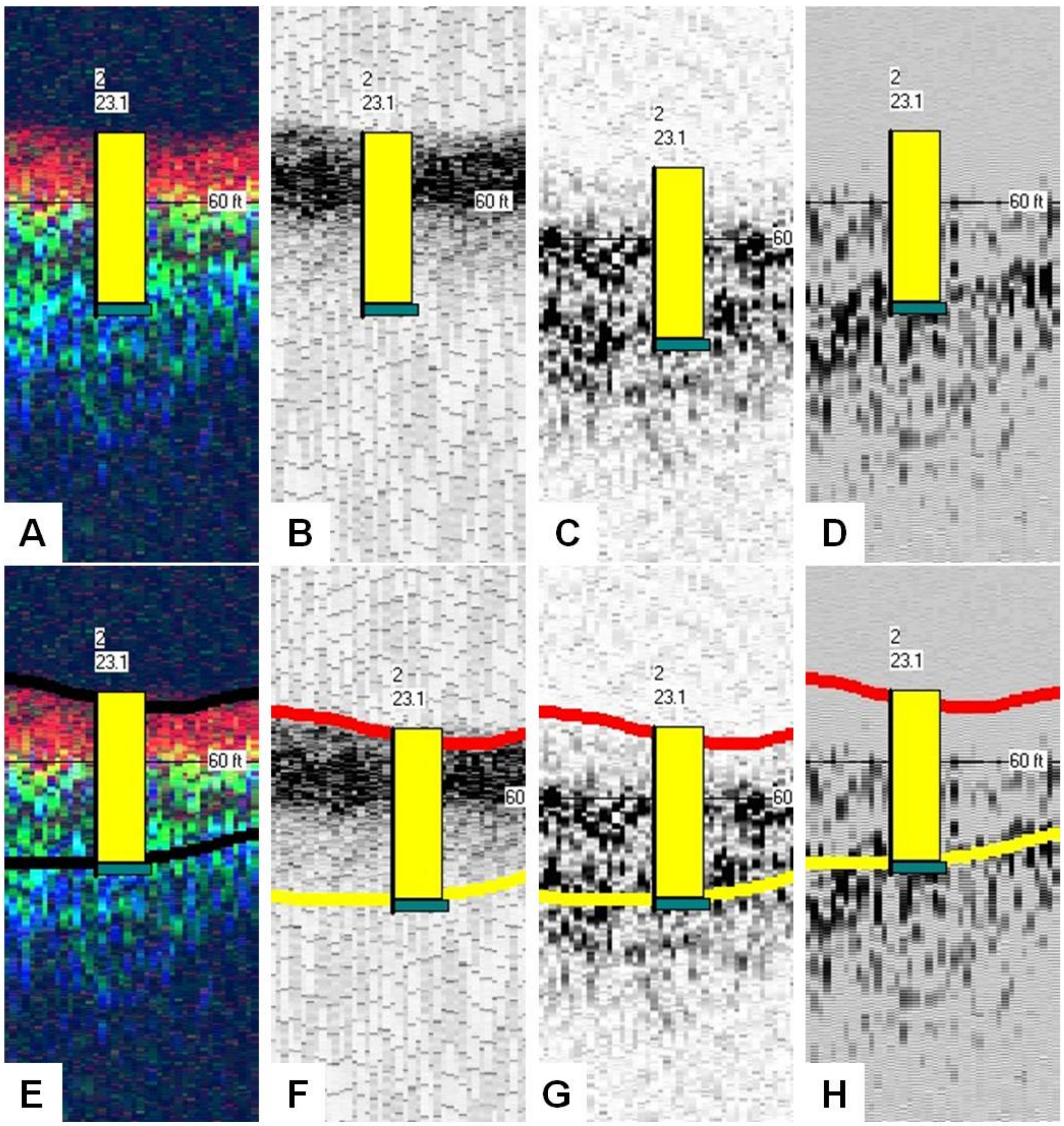


Figure 9. **Comparison of sediment core B-2 with acoustic signal returns A,E) combined acoustic signal returns, B,F) 200 kHz frequency, C,G) 50 kHz frequency, D,H) 24 kHz frequency**

Figure 9 shows the acoustic signals for all frequencies combined (A, E), 200 kHz (B, F), 50 kHz (C, G), and 24 kHz (D, H). In figure 9A-D, the bathymetric surfaces are not shown. In figure 9E, the current bathymetric surface is represented as the top black line and in Figures 9 F-H as the top red line. The pre-impoundment surface is identified by comparing boundaries observed in the 200 kHz, 50 kHz and 24 kHz signals to the location of the pre-impoundment surface of the sediment core sample. In this example, the boundary in the 200 kHz signal matched the pre-impoundment interface of the sediment core sample, therefore the 200 kHz signal was used to locate the pre-impoundment layer. The pre-impoundment surface was manually drawn and is represented by the bottom black line in Figure 9E, and by the yellow line in Figures 9F-H. The pre-impoundment surface identified along cross-sections where sediment core samples were collected is used as a guide for identifying the pre-impoundment surface along cross-sections where sediment core samples were not collected.

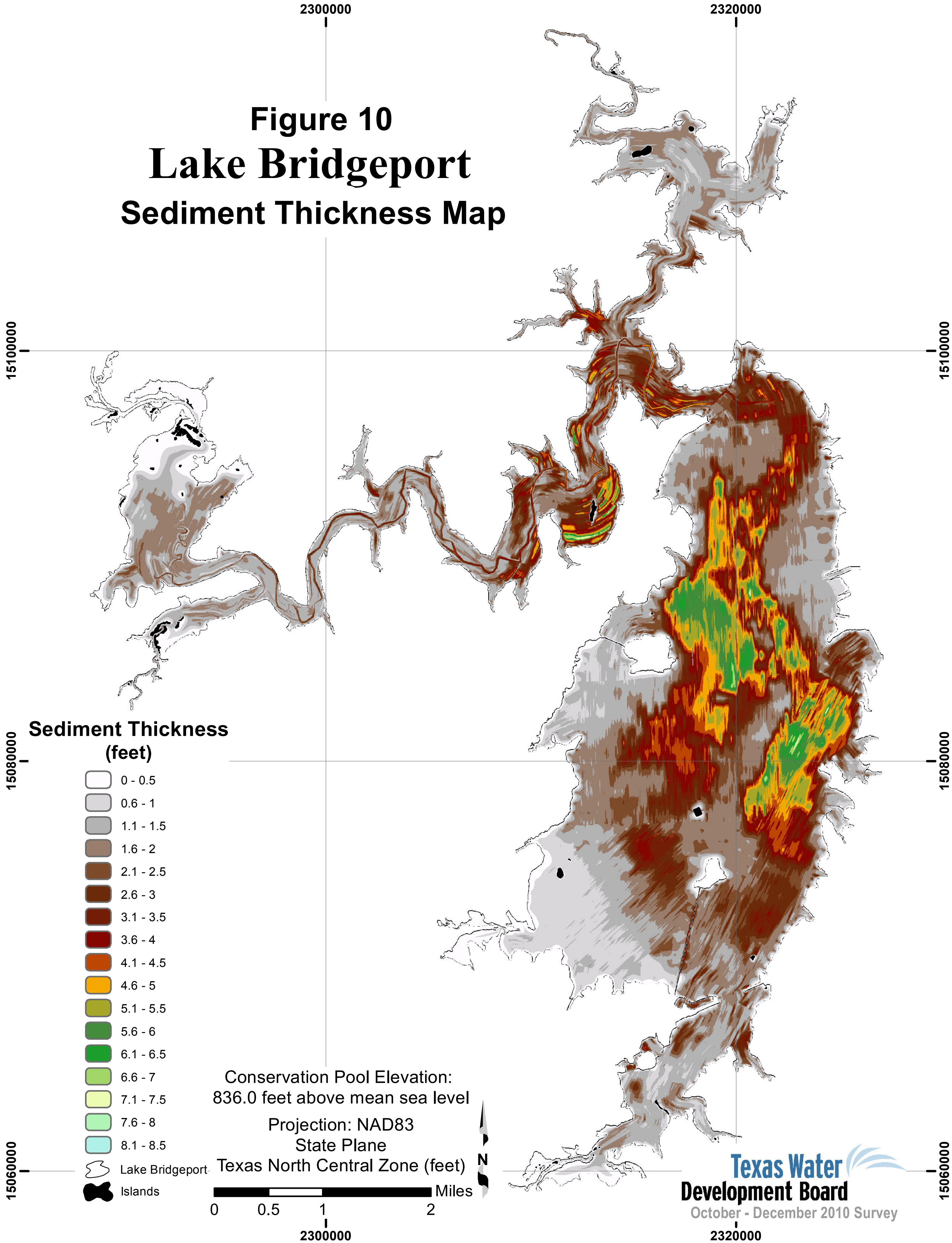
After manually digitizing the pre-impoundment surface from all cross-sections, a sediment thickness TIN model is created following standard GIS techniques (Furnans, 2007). Sediment thicknesses were interpolated between surveyed cross-sections using HydroTools with the same interpolation definition file used for bathymetric interpolation. For the purposes of the TIN model creation, TWDB assumed sediment thickness at the lake boundary was zero feet (defined as the 836.0 foot NGVD29 elevation contour). The sediment thickness TIN model was converted to a raster representation using a cell size of 5 feet by 5 feet and used to produce a sediment thickness map of Lake Bridgeport (Figure 10).

Survey results

Volumetric survey

The results of the 2010 TWDB volumetric survey indicate Lake Bridgeport has a total reservoir capacity of 361,875 acre-feet and encompasses 11,712 acres at conservation pool elevation (836.0 feet above mean sea level, NGVD29). Previous capacity estimates include multiple surveys conducted by Freese and Nichols in 1959, 1968, and 1988, and a re-analysis of the 2000 TWDB volumetric survey data using current processing procedures (Table 3). Differences in past and present survey methodologies make direct comparison of volumetric surveys difficult and potentially unreliable.

Figure 10
Lake Bridgeport
Sediment Thickness Map



To properly compare results from TWDB surveys of Lake Bridgeport, TWDB applied the 2012 data processing techniques to the survey data collected in 2000. Specifically, TWDB applied anisotropic spatial interpolation to the 2000 survey dataset using the same interpolation definition file as was used for the 2010 survey. A revised volumetric TIN model was created using the original 2000 survey boundary. The 2000 survey boundary was created from DOQQs photographed on February 2, 1995, while the daily average water surface elevation of Lake Bridgeport measured 836.04 feet. According to the associated metadata, the 1995 DOQQs have a resolution of 1-meter, with a horizontal positional accuracy that meets the National Map Accuracy Standards (NMAS) for 1:12,000-scale products. Revision of the 2000 survey using current TWDB data processing methods resulted in a 3,358 acre-feet (0.92%) increase in reservoir capacity.

Table 3. **Current and previous survey capacity and surface area data**

Survey	Surface area (acres)	Capacity (acre-feet)
Freese and Nichols 1959 [a]	13,000	386,420
Freese and Nichols 1968 [b]	12,941	386,559
Freese and Nichols 1988 [b]	12,900	374,836
TWDB 2000	11,954	366,236
TWDB 2000 revised	11,952	369,594
TWDB 2010	11,712	361,875

[a] Source: (TWDB, 1973)
[b] Source: (TWDB, 2001)

Sedimentation survey

Based on two methods for estimating sedimentation rates, the 2010 TWDB sedimentation survey estimates Lake Bridgeport loses between 321 and 772 acre-feet per year of capacity due to sedimentation (Table 4). Sediment accumulation is greatest in the deeper areas of the main body of the lake and in the cove south of Steele Island. Sediment is also greater in the submerged channel of the West Fork Trinity River.

In principle, comparing lake volumes from multiple lake surveys allows for calculation of capacity loss rates. If all lost capacity is due to sediment accumulation, then comparisons of lake volumetric surveys would yield sediment accumulation rates. In practice, however, the differences in methodologies used in each lake survey may yield greater differences in computed lake volumes than the true volume differences. In addition, because volumetric surveys are not exact, small losses or gains in sediment may be masked by the imprecision of the computed volumes. For this reason, TWDB prefers to estimate sediment accumulation rates through sedimentation surveys, which directly measure the sediment layer thicknesses throughout the reservoir. The sediment accumulation rates derived from such surveys reflect the average rate of sediment accrual since the time of impoundment.

For informational purposes only, a capacity loss rate, i.e. sedimentation rate, was calculated for the difference between the current volumetric survey and the 1959 estimate; the current volumetric survey and the 1968 estimate; the current volumetric survey and the 1988 estimate; the current capacity estimation and the 2010 pre-impoundment capacity estimation; as well as the current volumetric capacity estimation and the revised 2000 volumetric capacity estimation (Table 4). Based on the 2010 estimated sediment volume, Lake Bridgeport lost an average of approximately 321 acre-feet of capacity per year from 1932 to 2010. The comparison of the current volumetric survey to the 2000 revised volumetric survey suggests the current rate of sedimentation in Lake Bridgeport is approximately 772 acre-feet per year. Comparison of capacity estimates of Lake Bridgeport derived using differing methodologies are provided in Table 4 for sedimentation rate calculation.

Table 4. Capacity loss comparisons for Lake Bridgeport

Survey	Volume comparisons @ CPE (acre-feet)				Pre-impoundment (acre-feet)
Freese and Nichols 1959[a]	386,420	<>	<>	<>	<>
Freese and Nichols 1968[b]	<>	386,559	<>	<>	<>
Freese and Nichols 1988[b]	<>	<>	374,836	<>	<>
TWDB pre-impoundment estimate based on 2010 survey	<>	<>	<>	<>	386,894[c]
2000 TWDB volumetric survey (revised)	<>	<>	<>	369,594	<>
2010 volumetric survey	361,875	361,875	361,875	361,875	361,875
Volume difference (acre-feet)	24,545 (6.35%)	24,684 (6.39%)	12,961 (3.5%)	7,719 (2.1%)	25,019 (6.47%)
Number of years	51	42	22	10	78
Capacity loss rate (acre-feet/year)	481	588	589	772	321

[a] Source: (TWDB, 1973), note: Bridgeport Dam was completed on December 15, 1931, and deliberate impoundment began on April 1, 1932.
[b] Source: (TWDB, 2001)
[c] 2010 TWDB surveyed capacity of 361,875 acre-feet plus 2010 TWDB surveyed sediment volume of 25,019 acre-feet.

Recommendations

To improve estimates of sediment accumulation rates, TWDB recommends resurveying Lake Bridgeport in approximately 10 years or after a major flood event. To further improve estimates of sediment accumulation, TWDB recommends another sedimentation survey. A re-survey would allow a more accurate quantification of the average sediment accumulation rate for Lake Bridgeport.

TWDB contact information

More information about the Hydrographic Survey Program can be found at:

http://www.twdb.texas.gov/assistance/lakesurveys/volumetricindex.asp

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Appendix A

Lake Bridgeport

RESERVOIR CAPACITY TABLE

TEXAS WATER DEVELOPMENT BOARD — October - December 2010 Survey

CAPACITY IN ACRE-FEET — Conservation Pool Elevation 836.0 feet NGVD29

ELEVATION INCREMENT IS ONE TENTH FOOT

ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
761	0	0	0	0	0	0	0	0	0	0
762	0	0	0	1	1	1	1	2	2	2
763	2	3	3	4	4	4	5	5	6	6
764	7	7	8	8	9	9	10	11	11	12
765	13	13	14	15	16	17	18	18	19	20
766	22	23	24	25	27	28	29	31	33	35
767	36	38	40	43	45	47	50	52	55	58
768	61	64	67	70	73	77	80	84	88	92
769	96	100	104	109	114	118	123	129	134	139
770	145	151	157	163	169	176	182	189	196	204
771	211	219	227	235	243	252	261	270	279	289
772	299	309	320	330	341	353	365	377	389	402
773	415	428	442	457	471	486	502	518	534	551
774	569	588	607	627	647	669	691	715	739	765
775	791	820	850	882	915	950	988	1,027	1,067	1,110
776	1,154	1,200	1,247	1,295	1,345	1,397	1,450	1,505	1,561	1,619
777	1,678	1,739	1,802	1,866	1,932	2,000	2,070	2,143	2,218	2,296
778	2,377	2,461	2,549	2,639	2,733	2,829	2,929	3,031	3,136	3,244
779	3,354	3,467	3,583	3,700	3,820	3,942	4,065	4,191	4,319	4,449
780	4,581	4,715	4,851	4,990	5,130	5,273	5,417	5,564	5,713	5,863
781	6,016	6,170	6,326	6,483	6,643	6,804	6,966	7,131	7,298	7,467
782	7,638	7,811	7,986	8,164	8,346	8,529	8,715	8,903	9,093	9,285
783	9,478	9,673	9,870	10,069	10,269	10,471	10,675	10,881	11,089	11,299
784	11,509	11,722	11,936	12,152	12,371	12,591	12,812	13,036	13,262	13,489
785	13,719	13,950	14,182	14,417	14,653	14,891	15,130	15,372	15,615	15,860
786	16,107	16,355	16,605	16,856	17,109	17,364	17,621	17,879	18,139	18,400
787	18,663	18,928	19,195	19,463	19,733	20,004	20,278	20,553	20,830	21,108
788	21,388	21,669	21,952	22,236	22,522	22,810	23,098	23,389	23,681	23,974
789	24,269	24,565	24,863	25,162	25,463	25,765	26,069	26,375	26,682	26,991
790	27,302	27,614	27,928	28,243	28,560	28,879	29,200	29,523	29,846	30,172
791	30,499	30,828	31,159	31,491	31,825	32,160	32,497	32,835	33,175	33,517
792	33,861	34,207	34,554	34,903	35,254	35,607	35,961	36,317	36,675	37,035
793	37,396	37,758	38,122	38,487	38,854	39,223	39,592	39,963	40,336	40,710
794	41,085	41,462	41,840	42,219	42,601	42,983	43,366	43,752	44,138	44,526
795	44,915	45,305	45,697	46,091	46,486	46,882	47,281	47,681	48,082	48,485
796	48,889	49,295	49,703	50,111	50,522	50,933	51,346	51,760	52,176	52,594
797	53,013	53,434	53,856	54,281	54,707	55,134	55,564	55,995	56,429	56,865
798	57,302	57,741	58,183	58,626	59,071	59,518	59,966	60,417	60,869	61,323
799	61,779	62,237	62,697	63,159	63,622	64,087	64,553	65,021	65,491	65,962
800	66,435	66,909	67,386	67,864	68,344	68,826	69,310	69,795	70,282	70,771
801	71,261	71,753	72,247	72,742	73,240	73,739	74,240	74,743	75,249	75,758
802	76,269	76,781	77,297	77,814	78,333	78,855	79,378	79,904	80,431	80,961
803	81,492	82,026	82,561	83,098	83,638	84,179	84,722	85,267	85,812	86,360
804	86,909	87,459	88,012	88,566	89,122	89,680	90,239	90,801	91,364	91,930
805	92,497	93,066	93,638	94,211	94,786	95,364	95,944	96,526	97,110	97,696
806	98,285	98,875	99,467	100,062	100,659	101,258	101,859	102,463	103,068	103,677
807	104,287	104,899	105,515	106,132	106,751	107,373	107,996	108,621	109,248	109,877
808	110,508	111,141	111,775	112,411	113,049	113,689	114,330	114,973	115,618	116,265
809	116,913	117,563	118,215	118,868	119,524	120,181	120,840	121,500	122,162	122,826

Appendix A (Continued)

Lake Bridgeport

RESERVOIR CAPACITY TABLE

TEXAS WATER DEVELOPMENT BOARD — October - December 2010 Survey

CAPACITY IN ACRE-FEET — Conservation Pool Elevation 836.0 feet NGVD29

ELEVATION INCREMENT IS ONE TENTH FOOT

ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
810	123,492	124,159	124,828	125,498	126,171	126,845	127,520	128,198	128,877	129,559
811	130,241	130,926	131,613	132,301	132,991	133,682	134,375	135,070	135,767	136,465
812	137,165	137,867	138,570	139,275	139,983	140,691	141,402	142,115	142,829	143,545
813	144,263	144,982	145,704	146,426	147,152	147,878	148,607	149,337	150,069	150,804
814	151,539	152,277	153,017	153,758	154,501	155,246	155,993	156,742	157,492	158,245
815	159,000	159,756	160,515	161,275	162,038	162,802	163,569	164,337	165,108	165,881
816	166,656	167,434	168,213	168,995	169,778	170,564	171,351	172,140	172,931	173,725
817	174,520	175,317	176,116	176,917	177,720	178,525	179,332	180,142	180,954	181,768
818	182,584	183,402	184,223	185,045	185,870	186,696	187,525	188,355	189,188	190,023
819	190,859	191,697	192,538	193,380	194,225	195,071	195,919	196,770	197,622	198,477
820	199,333	200,192	201,053	201,915	202,780	203,646	204,514	205,384	206,256	207,130
821	208,006	208,884	209,765	210,647	211,532	212,419	213,308	214,200	215,093	215,989
822	216,886	217,786	218,688	219,592	220,498	221,405	222,314	223,226	224,139	225,054
823	225,971	226,890	227,811	228,733	229,659	230,586	231,515	232,446	233,379	234,314
824	235,251	236,189	237,130	238,072	239,016	239,962	240,910	241,860	242,811	243,765
825	244,720	245,677	246,637	247,598	248,561	249,526	250,493	251,462	252,433	253,407
826	254,383	255,361	256,342	257,324	258,310	259,296	260,285	261,277	262,270	263,267
827	264,264	265,264	266,267	267,272	268,279	269,288	270,300	271,314	272,329	273,348
828	274,369	275,392	276,418	277,446	278,477	279,509	280,544	281,582	282,621	283,662
829	284,705	285,749	286,796	287,845	288,895	289,947	291,001	292,057	293,114	294,173
830	295,234	296,296	297,360	298,425	299,492	300,560	301,630	302,701	303,774	304,849
831	305,924	307,001	308,080	309,160	310,243	311,326	312,410	313,497	314,584	315,674
832	316,765	317,857	318,952	320,047	321,145	322,244	323,344	324,447	325,550	326,656
833	327,763	328,872	329,983	331,095	332,209	333,325	334,442	335,562	336,683	337,807
834	338,932	340,058	341,188	342,318	343,451	344,586	345,722	346,862	348,002	349,146
835	350,291	351,438	352,589	353,741	354,896	356,052	357,211	358,374	359,538	360,705
836	361,875									

Appendix B

Lake Bridgeport

RESERVOIR AREA TABLE

TEXAS WATER DEVELOPMENT BOARD
AREA IN ACRES
ELEVATION INCREMENT IS ONE TENTH FOOT

October - December 2010 Survey
Conservation Pool Elevation 836.0 feet NGVD29

ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
761	0	0	0	0	0	0	0	0	0	1
762	1	1	2	2	2	2	2	3	3	3
763	3	3	4	4	4	4	4	4	5	5
764	5	5	5	6	6	6	6	7	7	7
765	7	7	8	8	8	9	9	10	10	11
766	11	12	12	13	14	15	15	16	17	18
767	19	20	21	22	23	24	25	26	27	28
768	30	31	32	33	34	35	36	37	39	40
769	42	43	44	46	48	49	51	53	54	56
770	57	59	60	62	64	66	68	70	72	74
771	76	78	80	83	85	87	90	92	95	98
772	101	103	106	109	112	116	119	122	126	129
773	133	137	141	145	149	153	158	162	167	173
774	181	188	195	203	211	220	229	238	250	263
775	275	292	309	326	344	363	380	400	417	433
776	447	465	479	493	507	523	538	554	570	587
777	603	620	635	652	670	690	711	736	766	797
778	825	853	891	920	953	981	1,008	1,037	1,065	1,092
779	1,117	1,142	1,165	1,187	1,207	1,227	1,247	1,269	1,289	1,310
780	1,330	1,351	1,372	1,394	1,414	1,435	1,457	1,477	1,497	1,515
781	1,533	1,551	1,569	1,586	1,602	1,618	1,637	1,656	1,677	1,699
782	1,721	1,744	1,767	1,797	1,826	1,848	1,871	1,890	1,908	1,924
783	1,942	1,959	1,977	1,995	2,013	2,031	2,050	2,068	2,086	2,102
784	2,118	2,134	2,152	2,170	2,190	2,210	2,229	2,247	2,265	2,283
785	2,302	2,320	2,337	2,353	2,370	2,387	2,405	2,424	2,441	2,457
786	2,473	2,490	2,507	2,523	2,540	2,557	2,574	2,590	2,607	2,623
787	2,639	2,656	2,673	2,691	2,708	2,727	2,744	2,759	2,775	2,790
788	2,805	2,820	2,835	2,851	2,866	2,882	2,896	2,911	2,926	2,940
789	2,955	2,970	2,984	3,000	3,017	3,034	3,050	3,065	3,081	3,096
790	3,112	3,129	3,146	3,164	3,181	3,199	3,216	3,232	3,248	3,264
791	3,281	3,298	3,313	3,329	3,345	3,361	3,376	3,392	3,410	3,429
792	3,448	3,465	3,482	3,500	3,517	3,535	3,553	3,571	3,588	3,603
793	3,617	3,632	3,647	3,661	3,675	3,690	3,704	3,718	3,732	3,746
794	3,760	3,774	3,788	3,803	3,817	3,831	3,844	3,857	3,870	3,884
795	3,897	3,912	3,928	3,943	3,959	3,975	3,991	4,007	4,021	4,036
796	4,051	4,066	4,080	4,094	4,108	4,122	4,137	4,152	4,168	4,185
797	4,200	4,215	4,233	4,251	4,268	4,287	4,306	4,326	4,345	4,364
798	4,384	4,404	4,422	4,440	4,461	4,478	4,495	4,514	4,532	4,550
799	4,570	4,589	4,607	4,624	4,640	4,656	4,672	4,688	4,704	4,720
800	4,736	4,755	4,772	4,793	4,811	4,828	4,846	4,862	4,879	4,894
801	4,911	4,928	4,945	4,965	4,983	5,001	5,021	5,046	5,073	5,096
802	5,118	5,140	5,161	5,183	5,205	5,225	5,246	5,265	5,284	5,304
803	5,325	5,344	5,364	5,384	5,403	5,420	5,437	5,452	5,467	5,482
804	5,498	5,516	5,533	5,550	5,568	5,587	5,607	5,625	5,642	5,662
805	5,682	5,702	5,723	5,744	5,766	5,788	5,809	5,830	5,852	5,873
806	5,894	5,914	5,935	5,956	5,979	6,001	6,024	6,046	6,069	6,092
807	6,115	6,139	6,161	6,183	6,204	6,224	6,243	6,262	6,281	6,299
808	6,317	6,335	6,353	6,370	6,388	6,405	6,422	6,439	6,457	6,475
809	6,493	6,511	6,528	6,545	6,562	6,580	6,597	6,613	6,629	6,645

Appendix B (Continued)

Lake Bridgeport

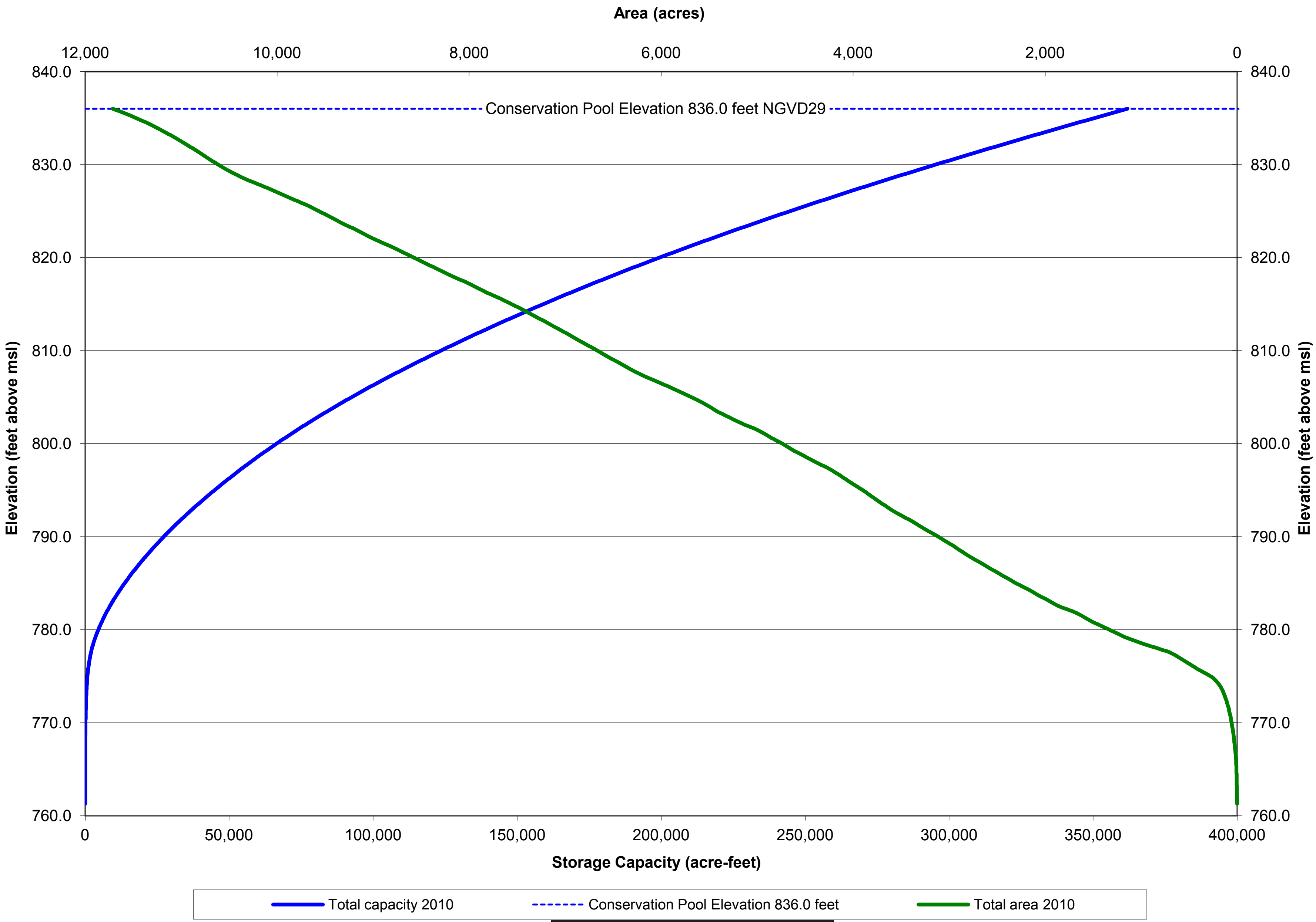
RESERVOIR AREA TABLE

TEXAS WATER DEVELOPMENT BOARD | October - December 2010 Survey

AREA IN ACRES | Conservation Pool Elevation 836.0 feet NGVD29

ELEVATION INCREMENT IS ONE TENTH FOOT

ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
810	6,662	6,680	6,698	6,715	6,732	6,750	6,768	6,785	6,802	6,819
811	6,837	6,855	6,873	6,891	6,907	6,924	6,940	6,957	6,974	6,992
812	7,009	7,026	7,043	7,061	7,079	7,098	7,117	7,135	7,152	7,168
813	7,186	7,203	7,221	7,240	7,258	7,277	7,295	7,314	7,332	7,350
814	7,367	7,386	7,405	7,423	7,441	7,459	7,479	7,498	7,516	7,535
815	7,555	7,575	7,595	7,616	7,636	7,655	7,674	7,697	7,719	7,742
816	7,764	7,785	7,805	7,825	7,844	7,864	7,883	7,904	7,923	7,942
817	7,961	7,980	8,000	8,020	8,040	8,062	8,084	8,107	8,129	8,152
818	8,173	8,194	8,215	8,235	8,254	8,275	8,296	8,316	8,335	8,355
819	8,374	8,394	8,415	8,435	8,455	8,475	8,495	8,514	8,534	8,555
820	8,575	8,596	8,616	8,635	8,654	8,672	8,691	8,710	8,731	8,751
821	8,771	8,792	8,813	8,835	8,859	8,881	8,904	8,926	8,946	8,966
822	8,987	9,008	9,028	9,048	9,066	9,085	9,104	9,122	9,141	9,160
823	9,179	9,198	9,218	9,239	9,259	9,282	9,302	9,321	9,340	9,358
824	9,376	9,394	9,413	9,432	9,451	9,470	9,488	9,507	9,526	9,545
825	9,564	9,584	9,603	9,621	9,640	9,660	9,679	9,701	9,725	9,750
826	9,771	9,794	9,815	9,837	9,859	9,881	9,903	9,925	9,948	9,970
827	9,992	10,014	10,036	10,059	10,082	10,104	10,126	10,148	10,171	10,196
828	10,221	10,245	10,270	10,295	10,317	10,340	10,363	10,383	10,402	10,420
829	10,438	10,456	10,475	10,494	10,512	10,530	10,548	10,566	10,582	10,598
830	10,613	10,630	10,645	10,660	10,676	10,691	10,706	10,721	10,736	10,751
831	10,766	10,780	10,795	10,810	10,825	10,840	10,855	10,871	10,886	10,902
832	10,918	10,933	10,949	10,965	10,981	10,997	11,014	11,030	11,047	11,064
833	11,081	11,098	11,115	11,132	11,150	11,168	11,186	11,204	11,222	11,241
834	11,260	11,279	11,298	11,318	11,338	11,358	11,379	11,400	11,421	11,443
835	11,465	11,487	11,510	11,533	11,557	11,581	11,606	11,631	11,657	11,684
836	11,712									



Lake Bridgeport
October - December 2010 Survey
Prepared by: TWDB

Appendix C: Area and Capacity Curves

Figure 5

Projection: NAD83
State Plane
Texas North Central Zone (feet)

Lake Bridgeport

Islands

N

CONTOURS
(feet above mean sea level)

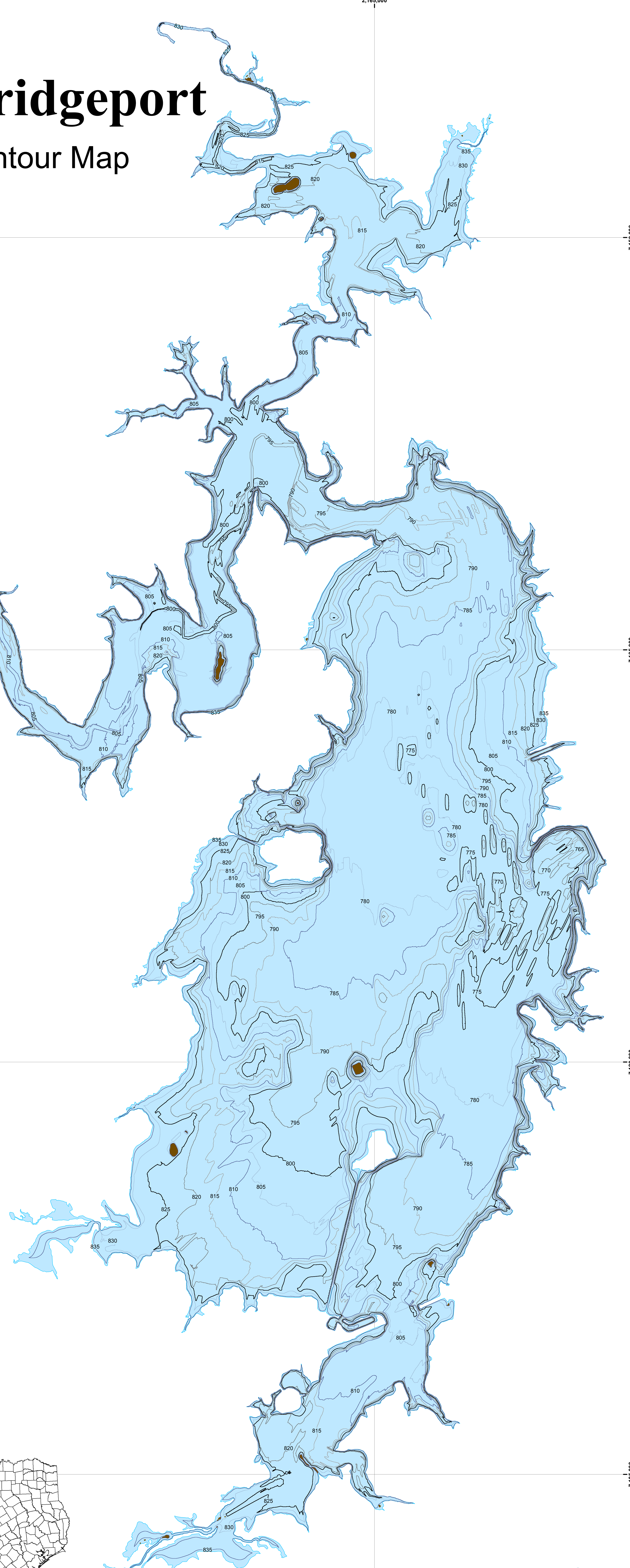
835
830
825
820
815
810
805
800
795
790
785
780
775
770
765

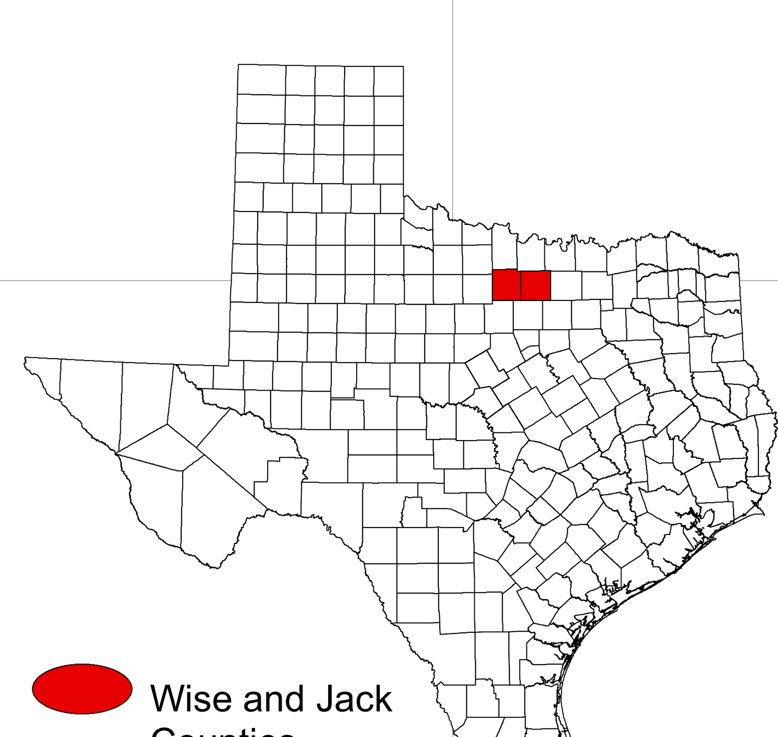
Conservation Pool Elevation:
836.0 feet above mean sea level

This map is the product of a survey conducted by the Texas Water Development Board's Hydrographic Survey Program to determine the capacity of Lake Bridgeport. The Texas Water Development Board makes no representations nor assumes any liability.

Lake Bridgeport

5' - Contour Map





Wise and Jack Counties

0 0.5 1 2 Miles

Texas Water Development Board

October - December 2010 Survey