Volumetric and Sedimentation Survey of LAKE TEXANA

January – March 2010 Survey

Prepared by:

The Texas Water Development Board

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Lavaca-Navidad River Authority

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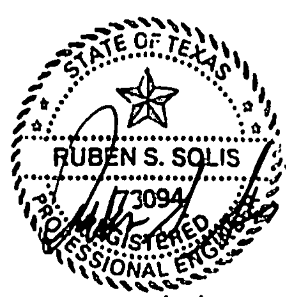

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Executive summary

In September 2009, the Texas Water Development Board entered into agreement with the U.S. Army Corps of Engineers, Fort Worth District, to perform a volumetric and sedimentation survey of Lake Texana. The U.S. Army Corps of Engineers, Fort Worth District, provided 50% of the funding for this survey through their Planning Assistance to States Program, while the Lavaca-Navidad River Authority of Texas provided the remaining 50%. 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.

Palmetto Bend Dam and Lake Texana are located on the Navidad River (Lavaca River Basin) in Jackson County, 7 miles southeast of Edna, Texas, approximately 5 miles upstream of the confluence with the Lavaca River. The conservation pool elevation of Lake Texana is 44.0 feet above mean sea level (NGVD29). TWDB collected bathymetric data for Lake Texana between January 12 and March 4, 2010 while the daily average water surface elevations ranged between 43.89 feet and 44.06 feet above mean sea level.

The 2010 TWDB volumetric survey indicates Lake Texana has a total reservoir capacity of 159,845 acre-feet and encompasses 9,676 acres at conservation pool elevation (44.0 feet above mean sea level, NGVD29). Previous capacity estimates include an original design estimate of 165,918 acre-feet at the time of impoundment in 1980, an estimate by the Bureau of Reclamation in 1991 of 163,506 acre-feet, and a re-analysis of the 2000 TWDB volumetric survey data using current processing procedures that resulted in an updated capacity estimate of 162,416 acre-feet.

The 2010 TWDB sedimentation survey indicates Lake Texana has accumulated 11,462 acre-feet of sediment since impoundment in 1980. Based on this measured sediment volume, Lake Texana lost an average of approximately 382 acre-feet of capacity per year from 1980-2010. Sediment accumulation is greater in the lower half of the lake. The thickest sediment accumulations were found within the submerged river channels. TWDB recommends that a similar methodology be used to resurvey Lake Texana 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 September 2009, TWDB entered into agreement with U.S. Army Corps of Engineers, Fort Worth District, to perform a volumetric and sedimentation survey of Lake Texana. The U.S. Army Corps of Engineers, Fort Worth District, provided 50% of the funding for this survey through their Planning Assistance to States Program, while the Lavaca-Navidad River Authority of Texas provided the remaining 50% (TWDB, 2009). 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 U.S. Army Corps of Engineers, Fort Worth District and contains as deliverables: (1) an elevation-area-capacity table for Lake Texana acceptable to the Texas Commission on Environmental Quality [Appendix A, B], (2) a lake 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 11].

Lake Texana general information

Palmetto Bend Dam and Lake Texana are located on the Navidad River (Lavaca River Basin) in Jackson County, 7 miles southeast of Edna, Texas, approximately 5 miles upstream of the confluence with the Lavaca River. Lake Texana was built primarily for water conservation and supply and is operated by the Lavaca-Navidad River Authority The Texas Legislature created the Lavaca-Navidad River Authority in 1941 (LNRA, 1996). As a conservation and reclamation district, the Lavaca-Navidad River Authority is responsible for controlling, storing, preserving, and distributing, for useful purposes, the waters of the rivers and streams within Jackson County (LNRA, 1996).

The Lavaca-Navidad River Authority secured funding for the construction of Palmetto Bend Dam and Lake Texana through a three-way contract between the Lavaca-Navidad River Authority, TWDB, and Department of the Interior Bureau of Reclamation (LNRA, 1996). Construction on Palmetto Bend Dam and Lake Texana began in 1976. Deliberate impoundment of water began in May, 1980. Conservation pool elevation was reached in May, 1982 (LNRA, 1996). Additional pertinent data about Palmetto Bend Dam and Lake Texana can be found in Table 1.

Water rights for Lake Texana have been appropriated to the Lavaca-Navidad River Authority and TWDB through Certificate of Adjudication and amendment Nos. 16-2095, 16-2095A, 16-2095B, and16-2095C. The complete certificates are on file in the Records Division of the Texas Commission on Environmental Quality.

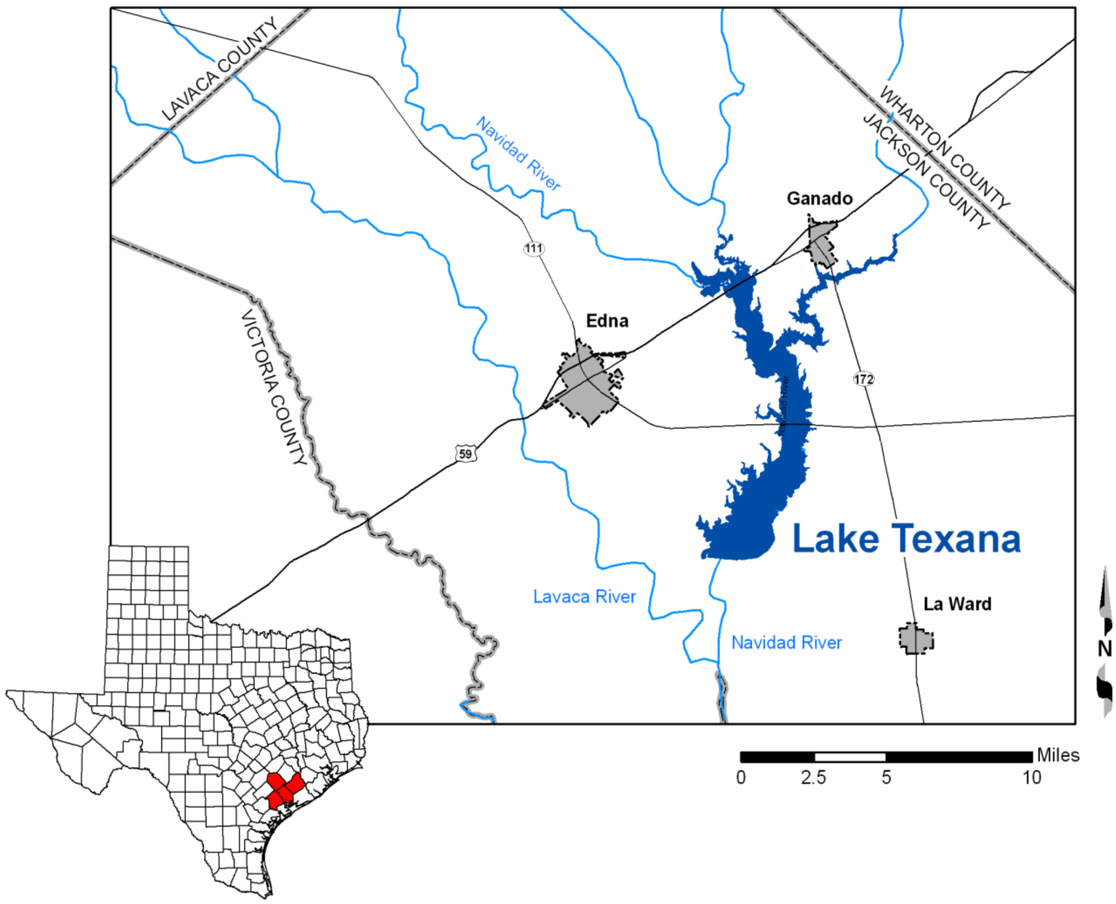


Figure 1. **Location map – Lake Texana**

Table 1.	**Pertinent data for Palmetto Bend Dam and Lake Texana**		
Owner			
Lavaca-Navidad River Authority, Texas Water Development Board, Department of the Interior Bureau of Reclamation			
Engineer (Design)			
Department of the Interior, Bureau of Reclamation			
Location of Dam			
On the Navidad River (Lavaca River Basin) in Jackson County, 7 miles southeast of Edna, Texas, approximately 5 miles upstream of the confluence with the Lavaca River.			
Drainage Area			
1,404 square miles			
Dam			
Type	Rolled-earthfill embankment		
Length	approximately 1 mile		
Maximum Height	58 feet		
Crest elevation	55.0 feet above mean sea level		
Top Width	42 feet wide		
Service spillway			
Control	12 bays with 22.5-feet by 35-feet wide radial gates		
Length	464 feet		
Maximum release	190,000 cubic feet of water per second		
Outlet works			
Intake for municipal and industrial purposes	Dual level structure consisting of 2 gates, each 48-inch by 60-inch		
Intake for downstream releases	multi-level structure with one 8 by 8-feet gate and two 4 by 4-feet gates		
Invert elevation	4.0 feet above mean sea level		
Maximum release	1,800 cubic feet of water per second		
Reservoir data (based on 2010 TWDB survey)			
Feature	**Elevation (feet NGVD29[a])**	**Capacity (acre-feet)**	**Area (acres)**
Top of dam	58.0	N/A	N/A
Emergency spillway/ Conservation pool elevation	44.0	159,845	9,676
Dead pool elevation	15.0	7,122	1,739
Invert elevation	4.0	279	72

Source: (TWDB, 2000)

[a] NGVD29 = National Geodetic Vertical Datum 1929

Volumetric and sedimentation survey of Lake Texana

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 08164525 Lk Texana nr Edna, TX* (USGS, 2010). 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 South Central Zone (feet).

TWDB bathymetric and sedimentation data collection

TWDB collected bathymetric data for Lake Texana between January 12 and March 4, 2010. The daily average water surface elevations during that time ranged between 43.89 and 44.06 feet above mean sea level (NGVD29). For data collection, TWDB used a Specialty Devices, Inc., 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 range 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. During the 2010 survey, team members collected nearly 244,000 data points over cross-sections totaling approximately 160 miles in length. Figure 2 shows where data collection occurred during the 2010 TWDB survey.

All sounding data was collected and reviewed before sediment core sample sites were selected and sediment cores were collected. Sediment core samples are normally 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 where sounding data had been previously collected (Figure 2) to collect sediment core samples. The samples were collected on October 20, 2010, with a custom-coring boat and SDI VibraCore system.

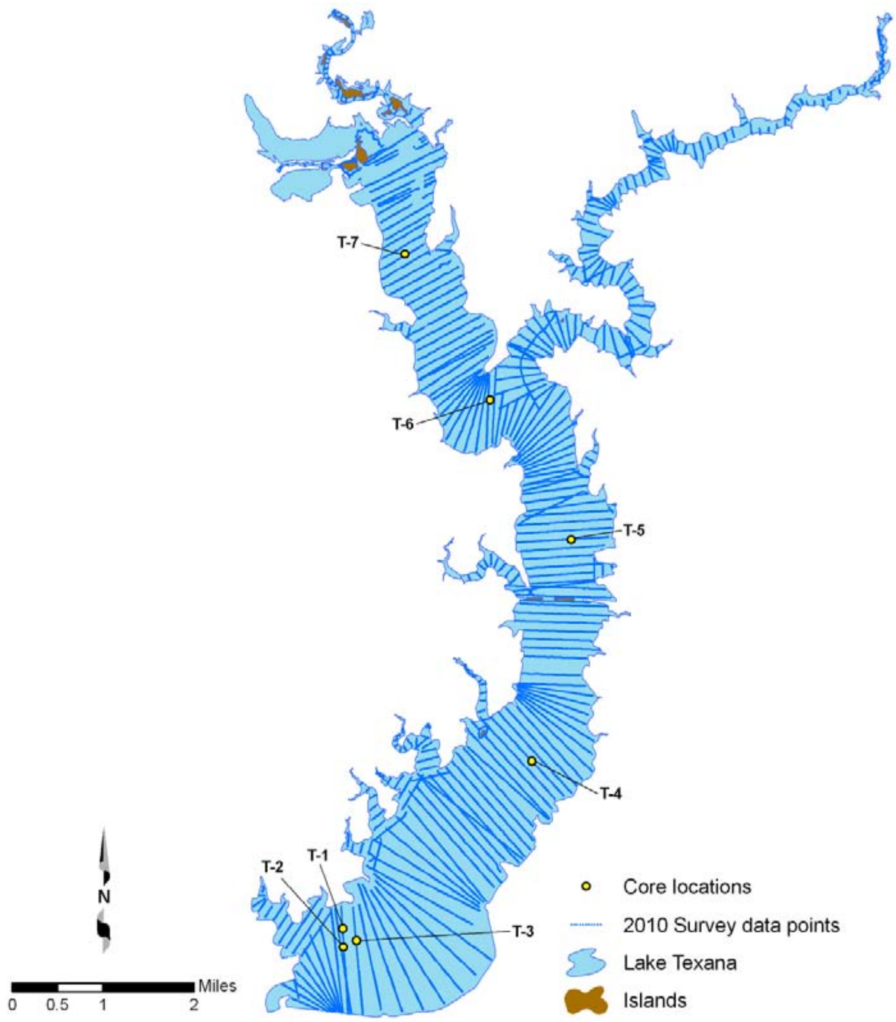


Figure 2. Locations of survey lines and sediment core sample sites during the 2010 TWDB survey

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 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 (TNRIS, 2009), using Environmental Systems Research Institute's ArcGIS 9.3.1 software. The quarter-quadrangles that cover Lake Texana are Manson (NW, NE, SW, SE), Ganado (SW, SE), and Louise (SW). The DOQQs were photographed on July 19 and August 13, 2004, while the daily average water surface elevation measured 43.98 and 43.86 feet above mean sea level, respectively. The 2004 DOQQS have a resolution, or ground sample distance, of 1-meters. Horizontal accuracy of the 2004 photos was required to match existing orthorectified imagery within 5-meters (USDA, 2011). For this analysis, the boundary digitized at the land-water interface in the 2004 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 44.0 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 and an internal TWDB computer program to remove data anomalies. DepthPic is used to display, interpret, and edit the multi-frequency data and to manually identify the reservoir-bottom surface at the time of initial impoundment (i.e. pre-impoundment surface). The internal TWDB computer program calculates the current reservoir-bottom surface, pre-impoundment surface and sediment thickness at each sounding location; removes data anomalies; and outputs the data into a single file. The water surface elevation at the time of each sounding was used to convert each sounding depth to a corresponding reservoir-bottom elevation. Using the self-similar interpolation technique (described below), TWDB created additional mass interpolated bathymetric elevation data between surveyed cross sections. To approximate reservoir bathymetry in shallow, un-surveyed regions, TWDB used the line extrapolation technique (described below) (Furnans, 2006). The point files resulting from both the data interpolation and extrapolation were used in conjunction with the sounding and boundary data to create a Triangulated Irregular Network (TIN) model 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 TIN model, reservoir volumes and areas were calculated at 0.1 feet intervals, from elevation -18.84 to 44.0 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 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 Texana, and a 5-foot contour map (Figure 5 - attached).

Self-similar interpolation

The 3D Analyst extension of ArcGIS utilizes the Delaunay method for triangulation. A limitation of the Delaunay method for triangulation when creating TIN models results in artificially-curved contour lines extending into the reservoir near the boundary of the reservoir between surveyed cross sections. These curved contours are likely a poor representation of the true reservoir bathymetry in these areas. Also, if the surveyed cross sections are not perpendicular to the centerline of the submerged river channel (the location of which is often unknown until after the survey), the TIN model is not likely to represent the true channel bathymetry well.

To ameliorate these problems, a self-similar interpolation routine developed by TWDB was used to interpolate the bathymetry between many survey lines. The self-similar interpolation technique increases the density of points input into the TIN model, and directs the TIN interpolation to better represent the reservoir topography between cross sections (Furnans, 2006). In the case of Lake Texana, application of self-similar interpolation improved representation of lake morphology near the banks and submerged river channels (Figure 6). In areas where obvious geomorphic features indicate a high-probability of cross-sectional shape changes (e.g. incoming tributaries, significant widening/narrowing of channel, etc.), the assumptions used in applying self-similar interpolation are not likely to be valid. Therefore, interpolation was not used in areas of Lake Texana where a high

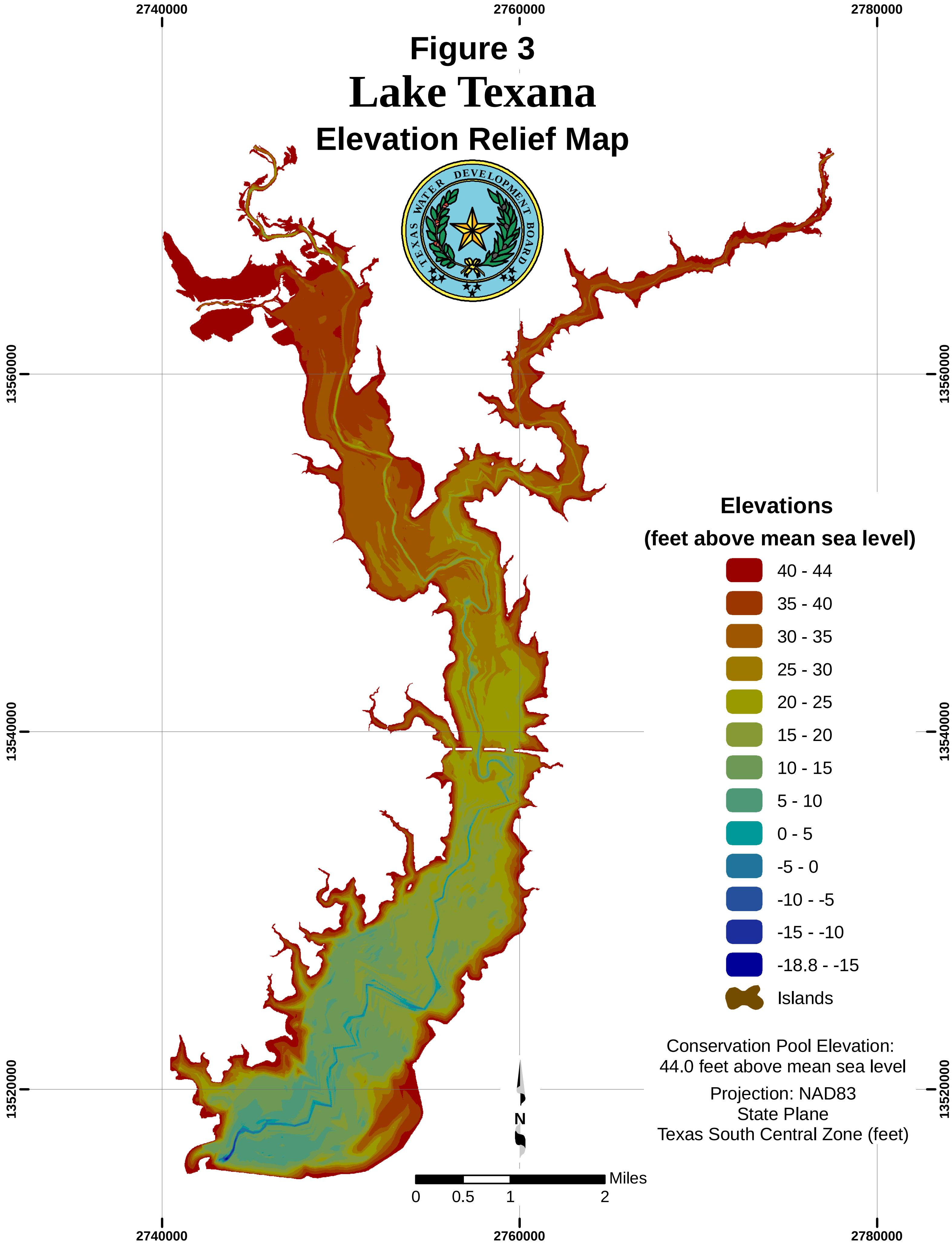
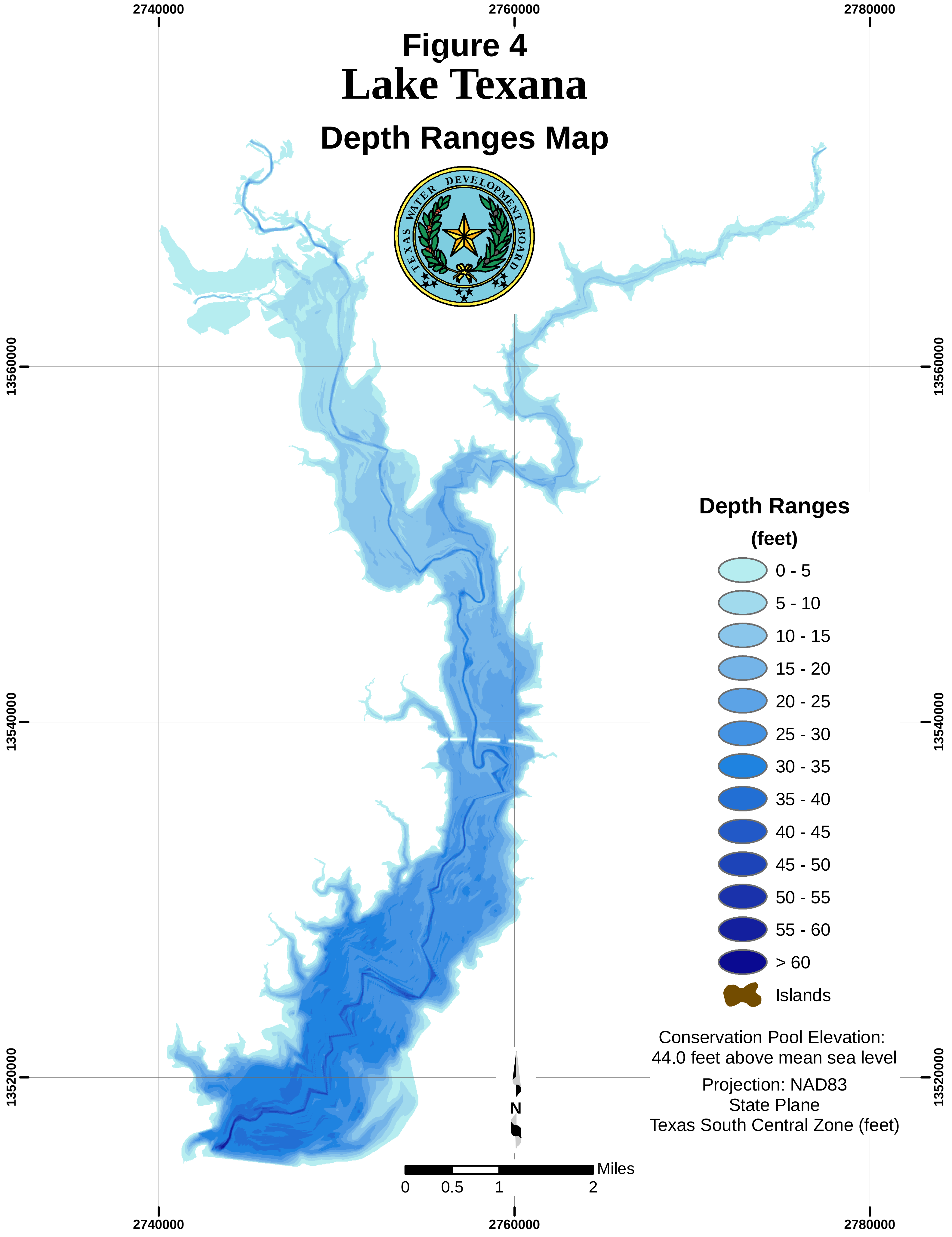


Figure 3
Lake Texana
Elevation Relief Map
TEXAS WATER DEVELOPMENT BOARD
2740000
2760000
2780000
13560000
13540000
13520000
Elevations
(feet above mean sea level)
40 - 44
35 - 40
30 - 35
25 - 30
20 - 25
15 - 20
10 - 15
5 - 10
0 - 5
-5 - 0
-10 - -5
-15 - -10
-18.8 - -15
Islands
Conservation Pool Elevation:
44.0 feet above mean sea level
Projection: NAD83
State Plane
Texas South Central Zone (feet)
N
Miles
0
0.5
1
2

Figure 4
Lake Texana
Depth Ranges Map



probability of change between cross-sections exists. Interpolation points and channel delineations used in self-similar interpolation are based on scanned USGS 7.5 minute quadrangle maps known as Digital Raster Graphics and the vector format of USGS 7.5 minute quadrangle map contours, when available (USGS, 2007). Figure 6 illustrates typical results from the self-similar interpolation routine for Lake Texana and the bathymetry shown in Figure 6C was used in computing reservoir capacity and area tables (Appendix A, B).

In Figure 6A the deeper channels indicated by the surveyed cross sections are not continuously represented in the 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 6B, in creation of the TIN model directs the Delaunay method for triangulation to better represent the lake bathymetry between survey cross-sections.

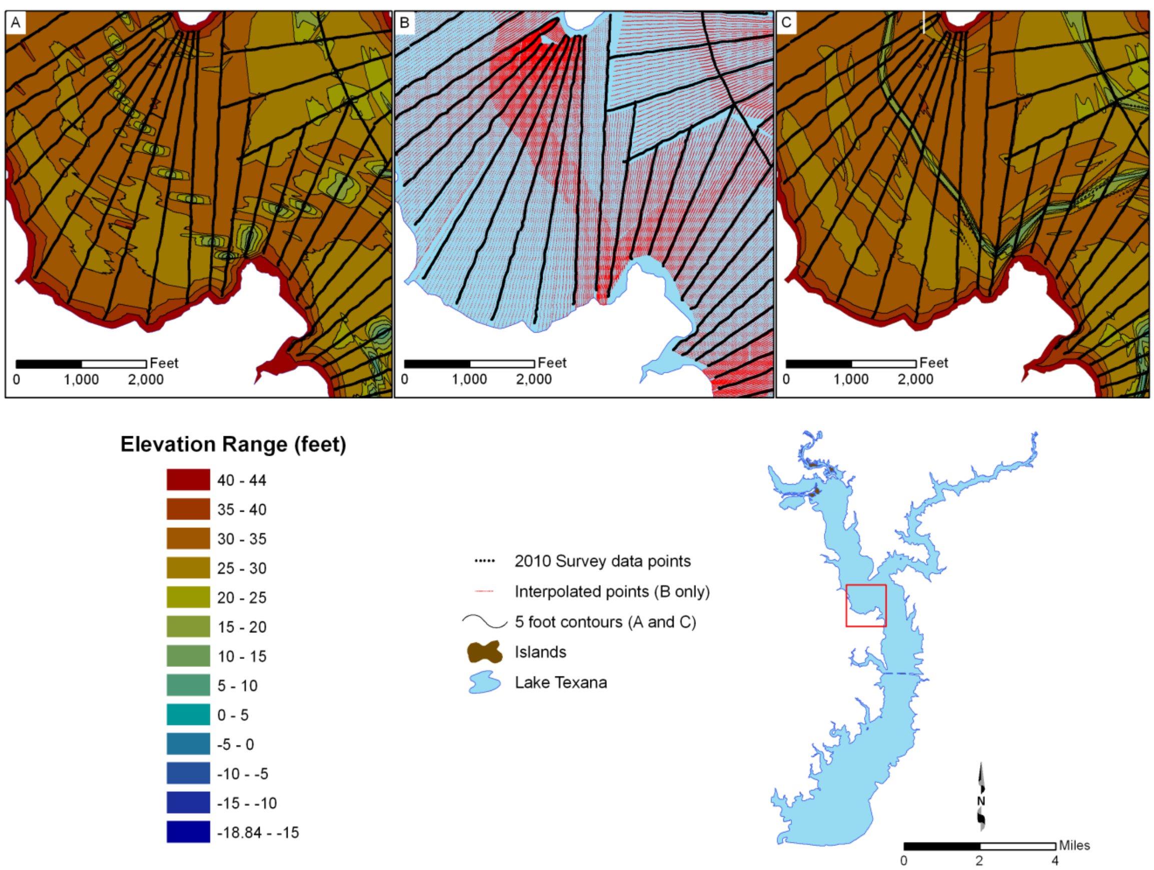


Figure 6. **Application of the self-similar interpolation technique to Lake Texana sounding data – A) bathymetric contours without interpolated points, B) sounding points (black) and interpolated points (red), C) bathymetric contours with the interpolated points**

Line extrapolation

To estimate the bathymetry within the small coves and other un-surveyed portions of Lake Texana, TWDB applied a line extrapolation technique similar to the interpolation discussed above. TWDB uses line extrapolation to project bathymetries in small coves where water depths are too shallow to allow boat passage. Line extrapolation requires the user to define (1) a center line approximately bisecting the small cove, (2) the elevation at the beginning of the center line, (3) the number of cross sections along the center line, and (4) the number of points between the center line and the cove boundary. The starting elevation of the center line is estimated based on the nearest surveyed depth.

Line extrapolation assumes a V-shaped profile for cross-sections within the extrapolation area, with the deepest section of the profile located along the center line. Elevations along the center line are linearly interpolated based on the distance along the line from the start (nearest the reservoir interior) to the end (where the center line crosses the reservoir boundary). The elevations at points along each extrapolated cross-section are linearly interpolated from an elevation on the center line (at the intersection with the cross-section) and the elevation at the extrapolation area boundary. Figure 7 illustrates line extrapolation as applied to Lake Texana.

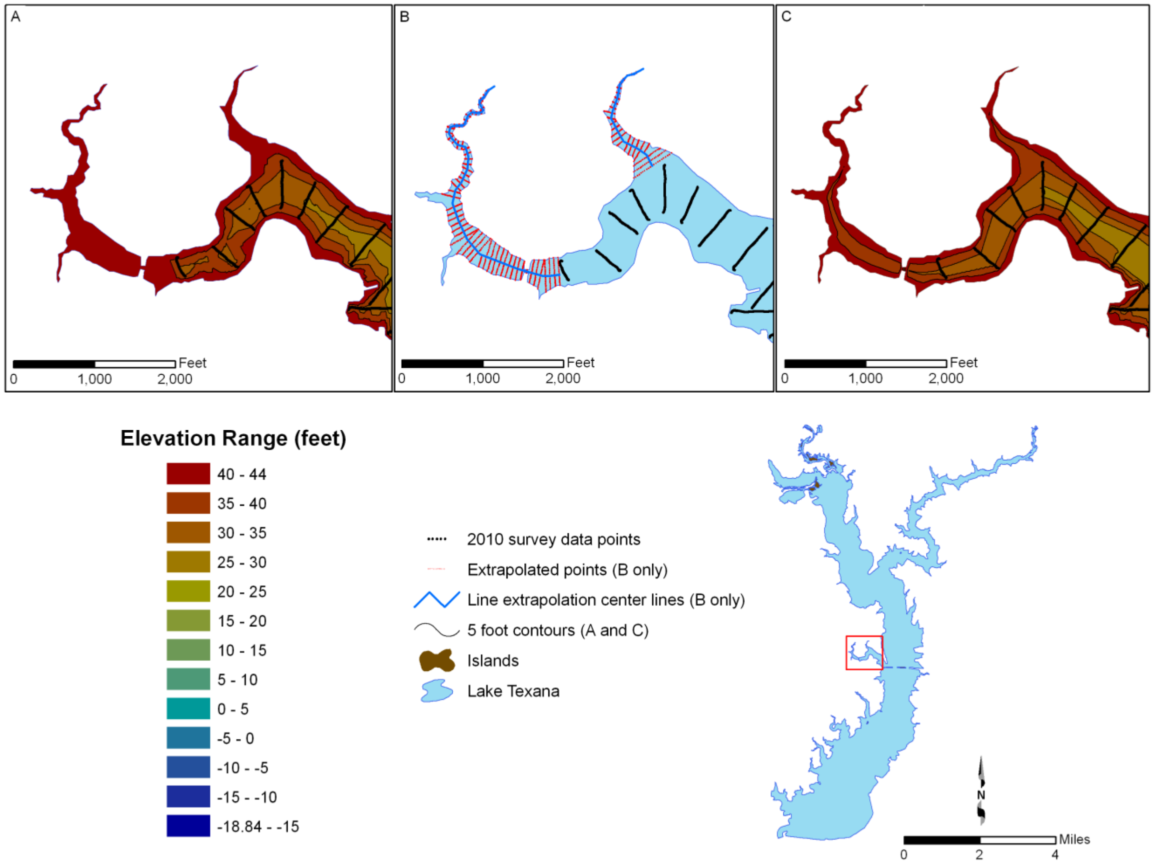


Figure 7. **Application of the line extrapolation technique to Lake Texana sounding data – A) bathymetric contours without extrapolated points, B) Sounding points (black), and extrapolated points to 44.0 feet (red), with reservoir boundary shown at elevation 44.0 feet, and C) bathymetric contours with extrapolated points**

As shown in Figure 7, the reservoir boundary at 44.0 feet was used as the outer boundary for the extrapolation technique. In Figure 7A the bathymetric contours do not extend into the un-surveyed area and "flat" triangles are formed connecting the nodes of the reservoir boundary. This is an artifact of the TIN generation routine when data points are too far apart or are absent from portions of the reservoir.

The inherent assumption of line extrapolation is a V-shaped cross section is a reasonable approximation of the unknown cross-section within the extrapolated area. The use of a V-shaped extrapolated cross-section likely provides a conservative estimate of the water volume in un-surveyed areas, as most surveyed cross-sections within Lake Texana had shapes more similar to U-profiles than to V-profiles. The V-profiles are thus conservative due to a greater implied volume of water for a U-profile when compared to a V-profile. Further information on line extrapolation is provided in the HydroEdit User's Manual (Furnans, 2006).

Analysis of sediment data from Lake Texana

Sedimentation in Lake Texana 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 signals were both analyzed to determine which best represented 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 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 sample by one of the following methods: (1) a visual examination of the sediment core for organic 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 Texana

Core	Easting[a] (ft)	Northing[a] (ft)	Total sediment/ post-impoundment sediment	Core description	Munsell soil color
T-1	2745730.43	13520030.82	33"/21"	0-21" dark colored silty loam, high water content, little to no soil structure	2.5Y 4/1
				21-33" lower water content, dense clay soil structure, organics present	5Y 2.5/1
T-2	2745752.61	13518949.72	20"/15"	0-15" grey colored silty loam, high water content, little to no soil structure	2.5Y 4/1
				15-20" lower water content, dense clay soil structure, organics present at 16-17"	5Y 2.5/1
T-3	2746517.69	13519335.37	25"/18"	0-18" grey colored silty loam, high water content, no soil structure	2.5Y 4/1
				18-25" dense clay loam soil, lower water content, organic/roots present	5Y 2.5/1
T-4	2745730.46	13520024.74	27"/18"	0-18" grey colored silty loam, high water content, no soil structure	2.5Y 4/1
				18-27" dense clay loam soil, lower water content, well defined soil structure	5Y 2.5/1
T-5	2758984.66	13542364.15	24"/18"	0-18" grey colored silty loam, high water content, little to no soil structure	2.5Y 4/1
				18-24" dense clay loam soil, lower water content, well defined soil structure	5Y 2.5/1
T-6	2754265.49	13550400.73	22"/16"	0-16" grey colored silty loam, high water content, no soil structure	2.5Y 4/1
				16-22" dense clay loam soil, lower water content, well defined soil structure	5Y 2.5/1
T-7	2749316.53	13558758.44	31.5"/16"	0-16" grey colored silty loam, high water content, no soil structure	2.5Y 4/1
				16-31.5" dense clay loam soil, lower water content, well defined soil structure	5Y 3/1

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

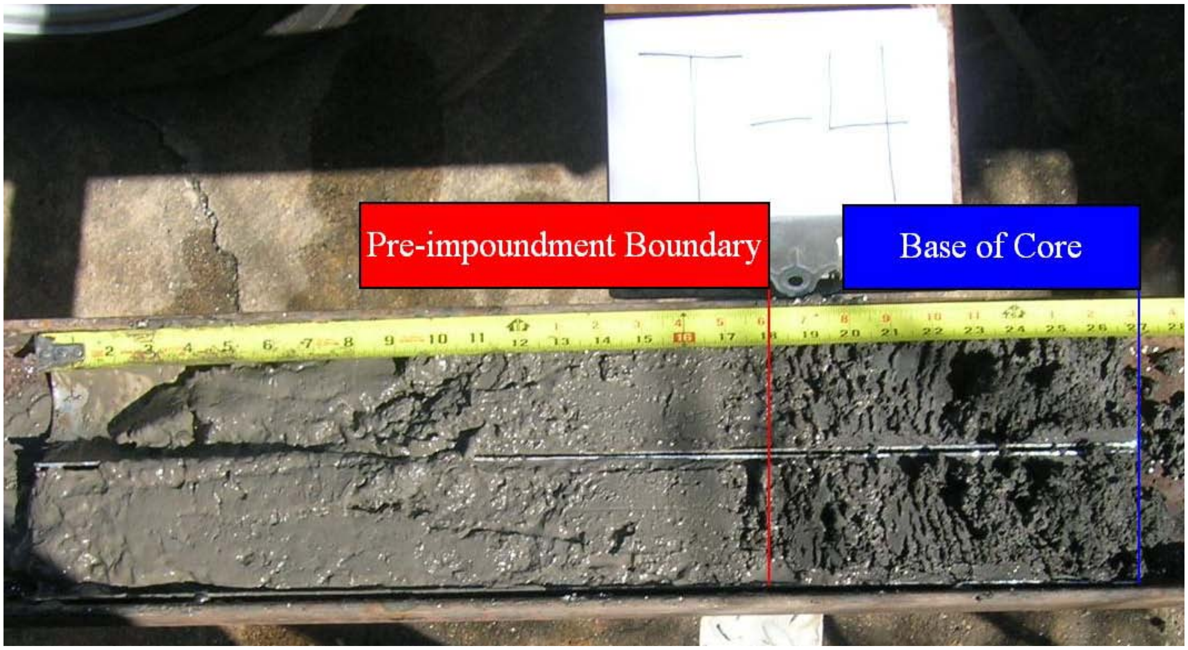


Figure 8. **Sediment core sample T-4 from Lake Texana**

Photographs of sediment core sample T-4 are shown in Figure 8 and are representative of the sediment cores sampled from Lake Texana. The 200 kHz frequency measures the top layer as the current bottom surface of the reservoir. Sediment core sample T-4 consisted of 27 inches of total sediment corresponding to the length of the aluminum sampling tube. The upper sediment layer (horizon) , 0 – 18 inches, had high water content, no soil structure, consisted of fine silty loam soil, and was a 2.5Y 4/1 color on the Munsell soil color chart. The second horizon, beginning at 18 inches and extending to 27 inches below the surface, consisted of a 5 Y 2.5/1 Munsell soil color, clay loam, lower water content, and well defined, dense soil structure. The base of the sample is denoted by the blue line in Figure 8.

The pre-impoundment boundary (red line in Figure 8) was evident within this sediment core sample at 18 inches and is 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 9 and 10 illustrate how the sediment thickness identified from a sediment core sample is used with the sounding data to help identify the post-impoundment sediment interface in the acoustic signal. Within DepthPic, the current surface is automatically determined based on the 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.

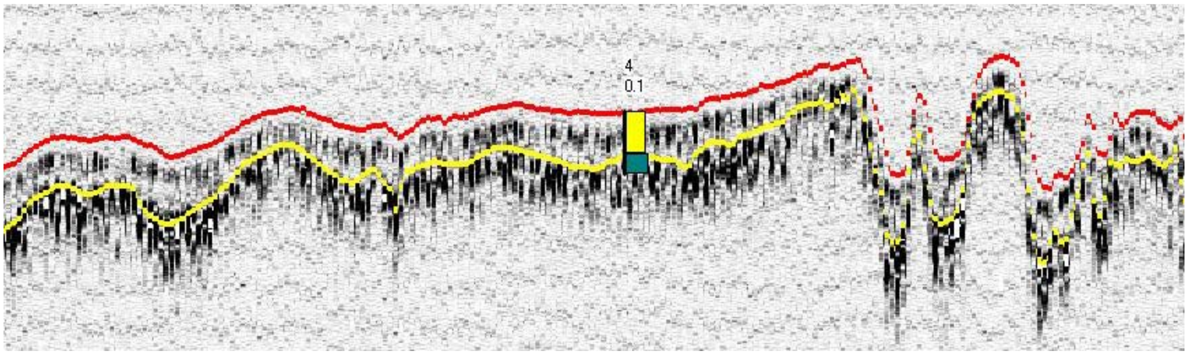


Figure 9. **Cross-section of data collected during 2010 survey, displayed in DepthPic (50 kHz frequency), correlated with sediment core sample T-4 and showing the current surface in red and pre-impoundment surface in yellow**

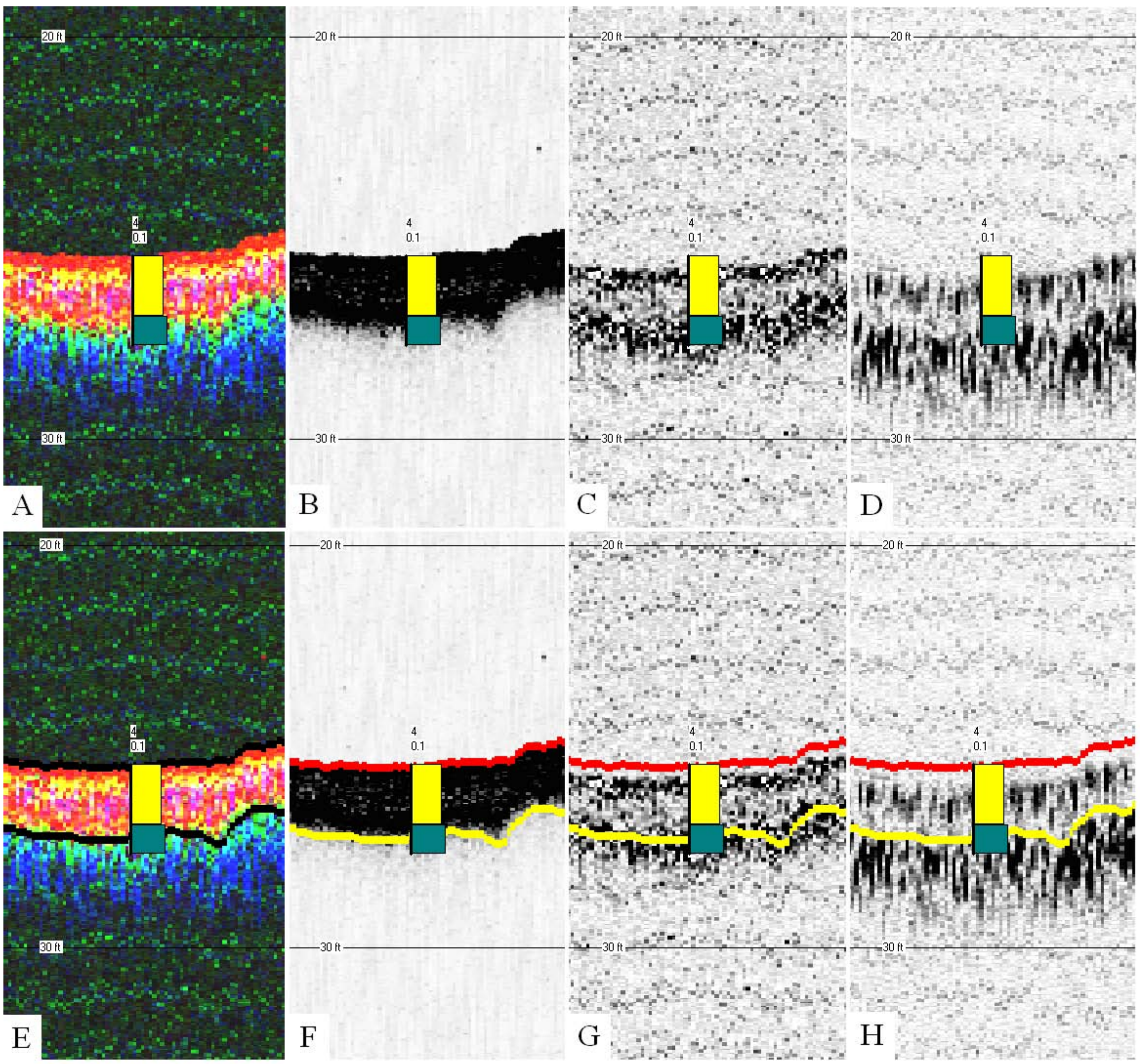


Figure 10. **Comparison of sediment core T-4 with acoustic signal returns A,E) combined acoustic signal returns, B,F) 200 kHz frequency, C,G) 50 kHz frequency, D,H) 24 kHz frequency**

Figure 10 shows the acoustic signals for all frequencies combined (A, E), 200 kHz (B, F), 50 kHz (C, G), and 24 kHz (D, H). The sediment core sample is represented in each figure as colored boxes. The yellow box represents post-impoundment sediment, and is 18 inches in length based on analysis of Sample T-4 (Figure 8, Table 2).The green box represents the pre-impoundment sediment with a well defined soil structure. In figure 10A-D, the bathymetric surfaces are not shown. In figure 10E, the current bathymetric surface is represented as the top black line and in Figures 10 F-H as the top red line. The numbers above the sediment core sample in Figures 9 and 10 represent the sediment core number (top) and the perpendicular distance from the cross-section in feet (bottom).The pre-impoundment surface is visually identified by comparing boundaries observed in the 50 kHz and 24 kHz signals to the location of the pre-impoundment surface based on the sediment core sample (designated by the location of the interface between the yellow and green boxes). In this example, the boundary in the 50 kHz signal most closely matched the pre-impoundment interface based on the core sample, so the 50 kHz signal was used to locate the pre-impoundment surface. The pre-impoundment surface was manually drawn in and is represented by the bottom black line in Figure 10E, and by the red line in Figures 10F-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.

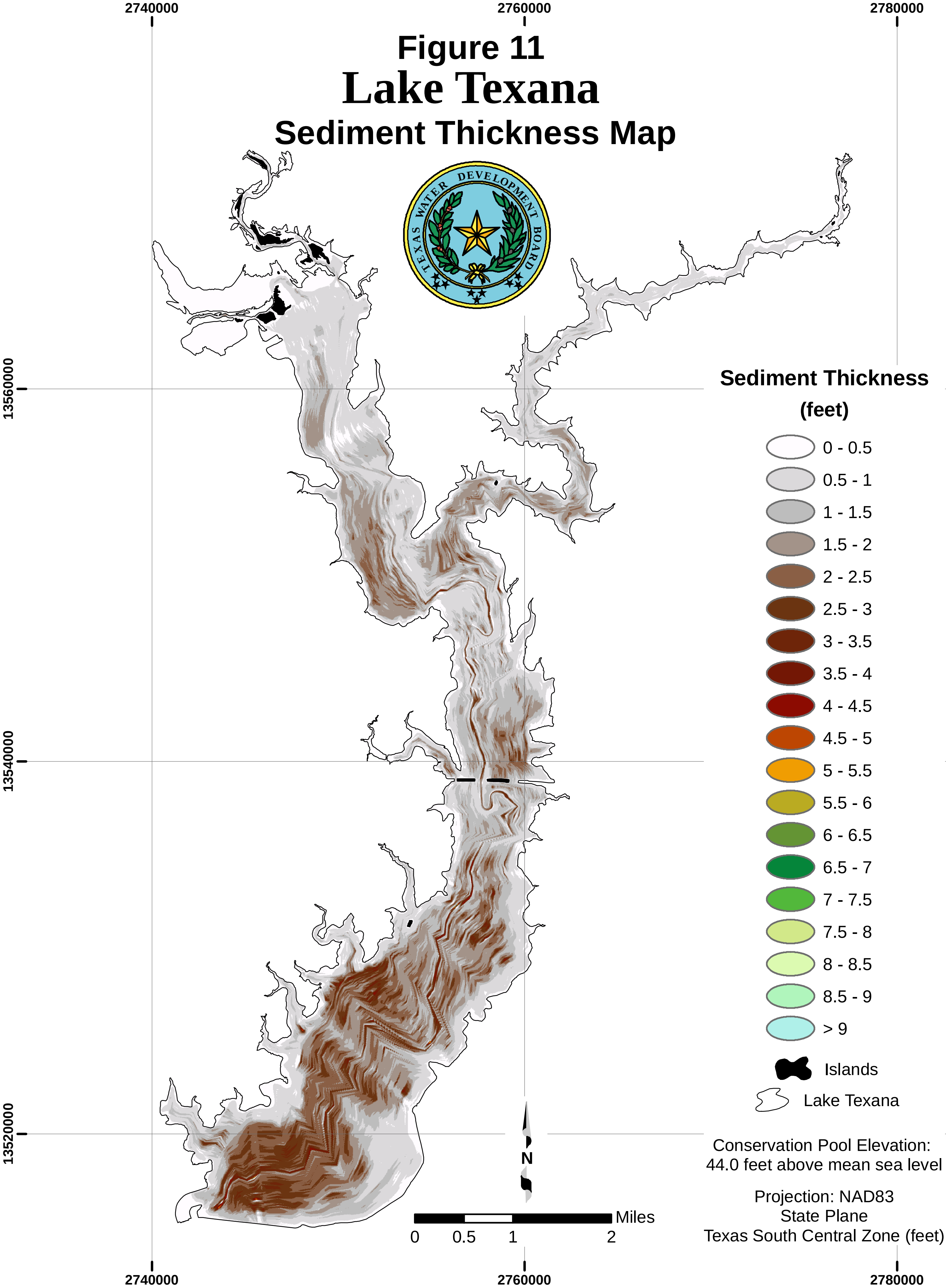
After manually digitizing the pre-impoundment surface from all cross-sections, a sediment thickness TIN model is created following standard GIS techniques (Furnans, 2007). Sediment thicknesses were interpolated between surveyed cross-sections using the TWDB self-similar interpolation technique (Furnans, 2006). For the purposes of the TIN model creation, TWDB assumed sediment thickness at the model boundary was zero feet (defined as the 44.0-foot elevation contour). This 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 (Figure 11) representing sediment accumulation throughout Lake Texana

Survey results

Volumetric survey

The results of the 2010 TWDB volumetric survey indicate Lake Texana has a total reservoir capacity of 159,845 acre-feet and encompasses 9,676 acres at

Figure 11
Lake Texana
Sediment Thickness Map



conservation pool elevation (44.0 feet above mean sea level, NGVD29). The Bureau of Reclamation in 1980 estimated that Lake Texana had a total capacity of 165,918 acre-feet and encompassed 9,934 acres at conservation pool elevation (Blanton and Ferrari, 1992). In 1991, the Bureau of Reclamation performed a sedimentation survey which indicated that Lake Texana had a total reservoir capacity of 163,506 acre-feet and encompassed 10,134 acres at conservation pool elevation (Blanton and Ferrari, 1992). Differences in past and present survey methodologies make direct comparison of volumetric surveys difficult and potentially unreliable.

To properly compare results from TWDB surveys of Lake Texana, TWDB applied the 2010 data processing techniques, specifically the self-similar interpolation and line extrapolation techniques, to the survey data and boundary from the 2000 survey. Revision of the 2000 survey using current TWDB data processing methods resulted in a 1,331 acre-feet (0.83%) increase in reservoir capacity (Table 3).

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

Survey	Surface area (acres)	Capacity (acre-feet)
USBR 1980[a]	9,934	165,918
USBR 1991[a]	10,134	163,506
TWDB 2000	9,727	161,085
TWDB 2000 revised	9,488	162,416
TWDB 2010	9,676	159,845

[a]Blanton and Ferrari, 1992

Sedimentation survey

The 2010 TWDB sedimentation survey indicates Lake Texana has accumulated 11,462 acre-feet of sediment since impoundment in 1980. Sediment accumulation is dispersed throughout the lake, though the majority of sediment is in the lower half of the lake. The thickest sediment deposits are in the submerged river channels.

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 original design estimate; the sediment survey results; 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 Texana lost an average of approximately 382 acre-feet of capacity per year from 1980 to 2010. Comparison 3 in Table 4 compares the current volumetric survey to the 2000 revised volumetric survey. This comparison suggests the current rate of sedimentation in Lake Texana is approximately 257 acre-feet per year. Comparison of capacity estimates of Lake Texana derived using differing methodologies are provided in Table 4 for sedimentation rate calculation.

Table 4. Capacity loss comparisons for Lake Texana

Survey	Volume comparisons @ CPE (acre-ft)		Pre-impoundment (acre-ft)
	Comparison #1	**Comparison #2**	**Comparison #3**
Original design estimate[a]	165,918	<>	<>
TWDB pre-impoundment based on 2010 estimated sediment volume	<>	171,307[b]	<>
2000 TWDB volumetric survey (revised)	<>	<>	162,416
2010 volumetric survey	159,845	159,845	159,845
Volume difference (acre-feet)	6,073 (3.7%)	11,462 (6.7%)	2,571 (1.6%)
Number of years	30	30	10
Capacity loss rate (acre-feet/year)	202	382	257

[a] Source: (Blanton and Ferrari, 1992), note: original design estimate based on 1980 survey and deliberate impoundment began in October, 1980.
[b] 2010 TWDB surveyed capacity of 159,845 acre-feet plus 2010 TWDB surveyed sediment volume of 11,462 acre-feet

Sediment Range Lines

Sediment range lines for Lake Texana were established by the Bureau of Reclamation and originally surveyed between 1977 and 1980 (Ochs, 1982, Blanton and Ferrari, 1992). A repeat survey was completed by the Bureau of Reclamation in 1991. TWDB collected data along 20 of the original range lines during the 2000 volumetric survey. For this current survey, TWDB re-surveyed those same 20 sediment range lines.

For informational purposes, cross-sectional plots comparing sediment ranges lines from the 1980, 1991, revised 2000, and current and pre-impoundment surfaces of the 2010 surveys are supplied in Appendix D. The end-point coordinates for each line and a location map are also presented in Appendix D.

The cross-sections from TWDB surveys were extracted from ArcGIS TIN models of the lake bathymetry by taking a depth reading at 5-feet intervals along each range line. The cross-sections from the 2000 survey were extracted from the revised TIN model, although self-similar interpolation was not applied in the river channels around sediment range lines 9, 10, 26, or 53, in the revised 2000 or 2010 TIN models.

Recommendations

To improve estimates of sediment accumulation rates, TWDB recommends resurveying Lake Texana 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 Texana.

TWDB contact information

More information about the Hydrographic Survey Program can be found at:
http://www.twdb.state.tx.us/assistance/lakesurveys/volumetricindex.asp
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Appendix A

Lake Texana

RESERVOIR CAPACITY TABLE

TEXAS WATER DEVELOPMENT BOARD
CAPACITY IN ACRE-FEET
ELEVATION INCREMENT IS ONE TENTH FOOT

January - March 2010 Survey
Conservation Pool Elevation 44.0 feet NGVD29

ELEVATION in Feet	-0.9	-0.8	-0.7	-0.6	-0.5	-0.4	-0.3	-0.2	-0.1	0.0
-18	0	0	0	0	0	0	0	0	0	0
-17	0	0	0	0	0	0	0	0	0	0
-16	0	0	0	0	0	0	0	0	0	0
-15	0	0	0	0	0	0	0	0	0	0
-14	0	0	0	0	1	1	1	1	1	1
-13	1	1	1	1	1	1	2	2	2	2
-12	2	2	2	3	3	3	3	3	3	4
-11	4	4	4	4	4	5	5	5	5	5
-10	6	6	6	6	7	7	7	7	8	8
-9	8	8	9	9	9	10	10	10	10	11
-8	11	11	12	12	12	13	13	13	14	14
-7	14	15	15	15	16	16	17	17	17	18
-6	18	19	19	19	20	20	21	21	22	22
-5	22	23	23	24	24	25	25	26	26	27
-4	27	28	29	29	30	30	31	32	32	33
-3	33	34	35	36	36	37	38	39	40	41
-2	42	43	44	45	46	47	48	50	51	52
-1	54	55	57	58	60	62	63	65	67	69
0	71	73	75	77	79	82	84	87	89	92

ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	92	95	98	100	103	107	110	113	116	120
1	123	127	130	134	138	142	146	150	154	159
2	163	168	172	177	182	187	192	198	203	209
3	214	220	226	232	238	245	251	258	265	272
4	279	286	294	301	309	317	325	334	342	351
5	360	369	378	387	397	407	417	427	438	449
6	460	471	482	494	506	519	532	545	559	573
7	588	603	619	635	652	670	688	707	727	747
8	769	791	815	839	865	892	920	950	981	1,013
9	1,047	1,083	1,121	1,160	1,201	1,244	1,289	1,336	1,384	1,435
10	1,487	1,541	1,598	1,656	1,716	1,779	1,844	1,911	1,981	2,053
11	2,129	2,207	2,288	2,371	2,456	2,544	2,634	2,727	2,821	2,919
12	3,019	3,121	3,225	3,332	3,441	3,552	3,666	3,782	3,901	4,022
13	4,145	4,271	4,400	4,531	4,664	4,799	4,936	5,076	5,218	5,363
14	5,510	5,660	5,812	5,967	6,124	6,284	6,447	6,612	6,780	6,950
15	7,122	7,297	7,475	7,655	7,838	8,023	8,210	8,400	8,592	8,787
16	8,984	9,184	9,387	9,592	9,800	10,010	10,223	10,438	10,657	10,877
17	11,100	11,326	11,554	11,785	12,018	12,253	12,491	12,731	12,973	13,218
18	13,466	13,716	13,968	14,223	14,481	14,740	15,003	15,267	15,534	15,803
19	16,074	16,348	16,623	16,901	17,181	17,464	17,749	18,035	18,325	18,616
20	18,910	19,205	19,503	19,803	20,104	20,408	20,714	21,022	21,332	21,644
21	21,957	22,273	22,591	22,910	23,232	23,556	23,883	24,211	24,541	24,874
22	25,208	25,544	25,882	26,222	26,563	26,906	27,251	27,598	27,947	28,298
23	28,651	29,006	29,364	29,723	30,084	30,447	30,812	31,179	31,549	31,920
24	32,294	32,669	33,047	33,428	33,810	34,195	34,583	34,972	35,364	35,758
25	36,154	36,552	36,953	37,356	37,762	38,170	38,580	38,994	39,409	39,828
26	40,248	40,672	41,097	41,525	41,956	42,389	42,825	43,262	43,703	44,145
27	44,590	45,036	45,486	45,937	46,390	46,845	47,303	47,763	48,224	48,688
28	49,153	49,621	50,090	50,562	51,035	51,510	51,988	52,467	52,949	53,433
29	53,919	54,408	54,898	55,392	55,887	56,385	56,885	57,388	57,893	58,401
30	58,911	59,423	59,939	60,457	60,978	61,502	62,028	62,558	63,090	63,625
31	64,162	64,702	65,245	65,790	66,338	66,889	67,442	67,998	68,556	69,118
32	69,682	70,249	70,818	71,390	71,965	72,542	73,122	73,705	74,291	74,879
33	75,470	76,064	76,661	77,260	77,862	78,466	79,073	79,684	80,297	80,914
34	81,534	82,159	82,786	83,418	84,052	84,691	85,333	85,978	86,627	87,280
35	87,935	88,594	89,256	89,922	90,592	91,265	91,942	92,622	93,306	93,993

Appendix A (Continued)

Lake Texana

RESERVOIR CAPACITY TABLE

TEXAS WATER DEVELOPMENT BOARD

CAPACITY IN ACRE-FEET

ELEVATION INCREMENT IS ONE TENTH FOOT

January - March 2010 Survey

Conservation Pool Elevation 44.0 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
36	94,684	95,378	96,075	96,775	97,479	98,186	98,897	99,611	100,328	101,048
37	101,772	102,499	103,229	103,962	104,698	105,437	106,179	106,925	107,673	108,425
38	109,180	109,938	110,700	111,465	112,234	113,006	113,782	114,562	115,345	116,132
39	116,923	117,719	118,518	119,320	120,126	120,935	121,747	122,562	123,380	124,200
40	125,023	125,848	126,677	127,507	128,340	129,175	130,012	130,852	131,694	132,538
41	133,384	134,232	135,083	135,935	136,790	137,648	138,507	139,369	140,233	141,099
42	141,968	142,839	143,712	144,588	145,466	146,346	147,228	148,113	149,001	149,890
43	150,783	151,677	152,574	153,474	154,376	155,281	156,188	157,098	158,011	158,926
44	159,845									

Appendix B

Lake Texana

RESERVOIR AREA TABLE

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

January - March 2010 Survey
Conservation Pool Elevation 44.0 feet NGVD29

ELEVATION in Feet	-0.9	-0.8	-0.7	-0.6	-0.5	-0.4	-0.3	-0.2	-0.1	0.0
-18	0	0	0	0	0	0	0	0	0	0
-17	0	0	0	0	0	0	0	0	0	0
-16	0	0	0	0	0	0	0	0	0	0
-15	0	0	0	0	0	0	0	0	0	0
-14	0	0	0	0	1	1	1	1	1	1
-13	1	1	1	1	1	1	1	1	1	1
-12	1	1	1	1	2	2	2	2	2	2
-11	2	2	2	2	2	2	2	2	2	2
-10	2	2	2	2	2	2	2	3	3	3
-9	3	3	3	3	3	3	3	3	3	3
-8	3	3	3	3	3	3	3	3	3	4
-7	4	4	4	4	4	4	4	4	4	4
-6	4	4	4	4	4	4	4	4	4	5
-5	5	5	5	5	5	5	5	5	5	5
-4	5	6	6	6	6	6	6	6	7	7
-3	7	7	7	8	8	8	9	9	9	10
-2	10	10	11	11	12	12	12	13	13	14
-1	14	15	15	16	16	17	17	18	19	19
0	20	21	22	22	23	24	25	26	26	27

ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	27	28	29	29	30	31	32	33	34	34
1	35	36	37	38	39	40	41	42	43	44
2	45	46	47	49	50	51	52	54	55	56
3	57	59	60	62	63	65	66	68	69	71
4	72	74	75	77	79	80	82	84	86	88
5	89	91	93	96	98	100	102	104	107	109
6	111	114	117	120	124	127	131	135	140	144
7	149	155	160	166	173	180	187	194	202	210
8	219	229	240	251	263	276	289	303	318	334
9	351	368	385	402	419	438	457	476	495	514
10	533	553	573	593	614	636	661	686	713	741
11	769	794	819	844	866	889	912	936	961	985
12	1,010	1,033	1,056	1,079	1,102	1,125	1,149	1,173	1,198	1,223
13	1,248	1,273	1,296	1,319	1,341	1,363	1,386	1,409	1,434	1,459
14	1,485	1,510	1,536	1,562	1,588	1,613	1,638	1,663	1,688	1,713
15	1,739	1,765	1,789	1,813	1,838	1,861	1,885	1,910	1,935	1,961
16	1,987	2,013	2,038	2,064	2,090	2,116	2,143	2,169	2,194	2,219
17	2,244	2,269	2,294	2,319	2,342	2,365	2,388	2,412	2,437	2,462
18	2,487	2,512	2,537	2,562	2,585	2,609	2,633	2,657	2,680	2,702
19	2,723	2,745	2,768	2,790	2,813	2,836	2,858	2,881	2,903	2,925
20	2,946	2,967	2,987	3,007	3,028	3,049	3,069	3,089	3,108	3,128
21	3,147	3,166	3,187	3,208	3,230	3,252	3,273	3,293	3,314	3,333
22	3,352	3,370	3,388	3,406	3,423	3,442	3,461	3,480	3,499	3,519
23	3,540	3,562	3,582	3,601	3,620	3,640	3,662	3,683	3,704	3,726
24	3,747	3,769	3,792	3,815	3,838	3,860	3,883	3,905	3,928	3,950
25	3,972	3,996	4,020	4,045	4,069	4,093	4,118	4,144	4,170	4,196
26	4,220	4,245	4,269	4,294	4,318	4,342	4,367	4,391	4,413	4,435
27	4,457	4,479	4,501	4,522	4,544	4,565	4,586	4,606	4,626	4,646
28	4,665	4,684	4,704	4,724	4,744	4,764	4,785	4,806	4,828	4,850
29	4,873	4,896	4,920	4,943	4,966	4,990	5,014	5,040	5,064	5,089
30	5,114	5,139	5,168	5,196	5,225	5,252	5,280	5,308	5,335	5,361
31	5,387	5,414	5,440	5,467	5,492	5,518	5,545	5,572	5,600	5,627
32	5,655	5,681	5,707	5,733	5,760	5,787	5,815	5,844	5,871	5,898
33	5,925	5,952	5,978	6,004	6,031	6,058	6,088	6,120	6,152	6,186
34	6,222	6,259	6,295	6,331	6,366	6,401	6,438	6,473	6,507	6,539
35	6,572	6,605	6,641	6,677	6,713	6,752	6,788	6,822	6,855	6,888

Appendix B (Continued)

Lake Texana

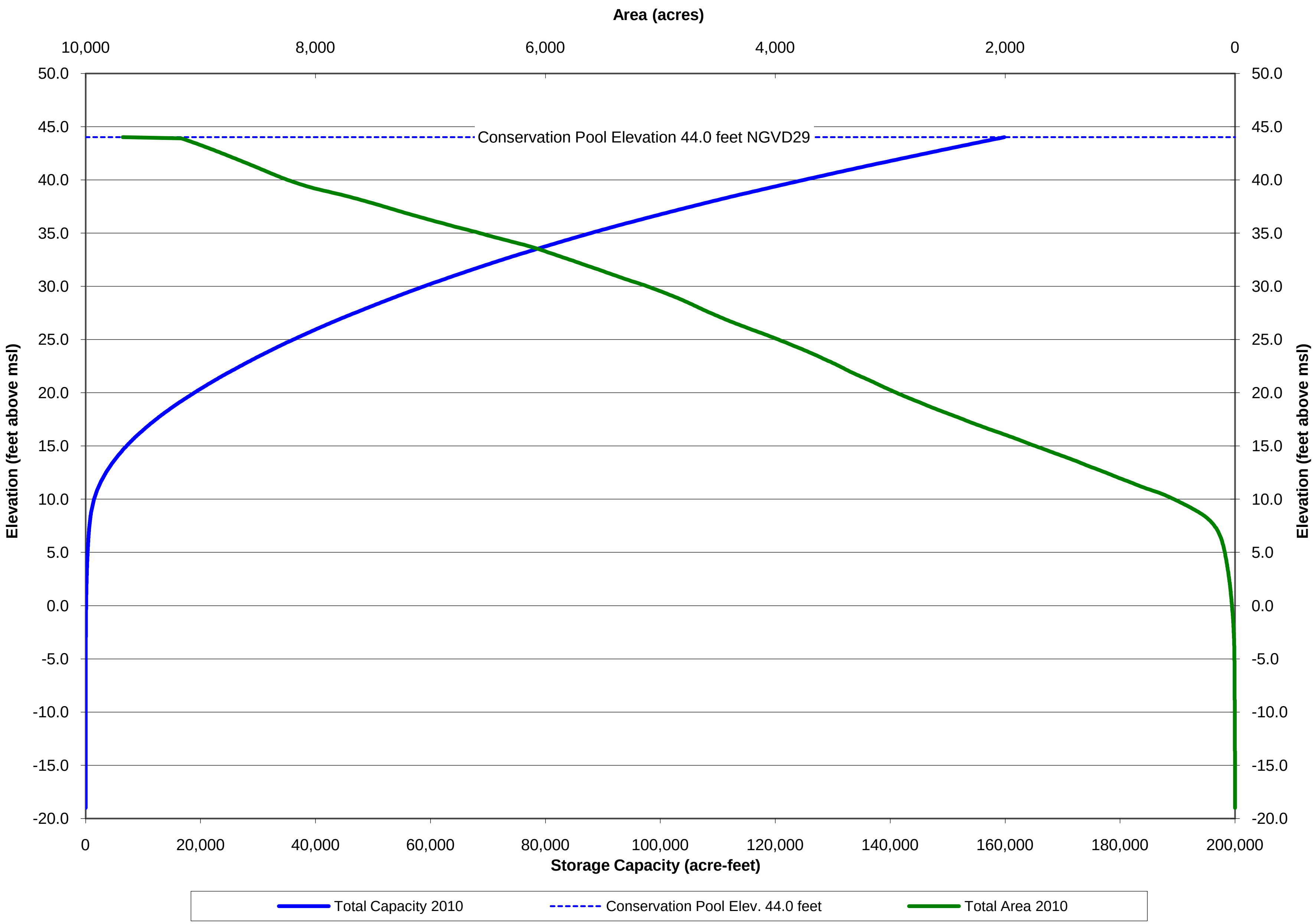
RESERVOIR AREA TABLE

TEXAS WATER DEVELOPMENT BOARD | January - March 2010 Survey

AREA IN ACRES | Conservation Pool Elevation 44.0 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
36	6,922	6,955	6,989	7,022	7,055	7,088	7,121	7,155	7,188	7,221
37	7,252	7,283	7,314	7,345	7,376	7,407	7,438	7,470	7,501	7,534
38	7,567	7,601	7,635	7,670	7,705	7,741	7,777	7,814	7,852	7,890
39	7,932	7,972	8,008	8,042	8,075	8,106	8,135	8,162	8,190	8,217
40	8,243	8,268	8,293	8,317	8,340	8,362	8,384	8,406	8,428	8,450
41	8,472	8,495	8,517	8,539	8,562	8,584	8,607	8,629	8,652	8,675
42	8,698	8,721	8,744	8,767	8,790	8,814	8,838	8,862	8,886	8,910
43	8,934	8,959	8,984	9,009	9,034	9,060	9,086	9,113	9,140	9,169
44	9,676									



Lake Texana
January - March 2010 Survey
Prepared by: TWDB

Appendix C: Area and Capacity Curves

Appendix D

Lake Texana

Sediment range lines

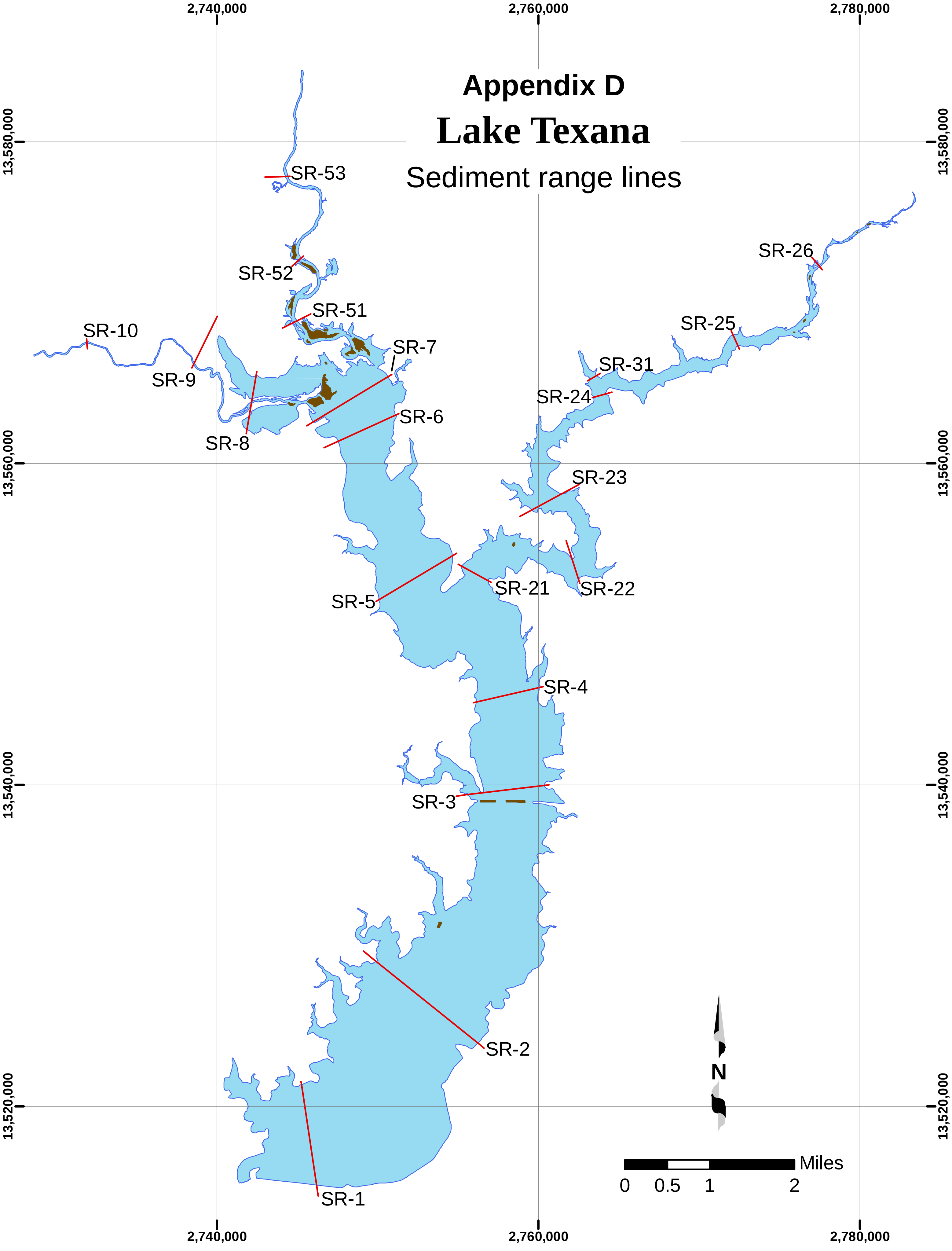


Table D1. Sediment range line endpoint coordinates

Sediment range line	X	Y
SR-1-L	2,746,313.92	13,514,435.18
SR-1-L P.O.T	2,746,215.83	13,515,082.88
SR-1-R P.O.T	2,745,252.75	13,521,442.80
SR-1-R	2,745,237.75	13,521,541.71
SR-2-L	2,756,631.34	13,523,626.73
SR-2-L P.O.T	2,756,320.40	13,523,876.71
SR-2-R P.O.T	2,749,723.29	13,529,180.47
SR-2-R	2,749,129.56	13,529,657.81
SR-3-L	2,760,656.65	13,540,007.38
SR-3-L P.O.T	2,760,458.11	13,539,983.35
SR-3-R P.O.T	2,756,566.20	13,539,512.05
SR-3-R P.O.T	2,755,538.26	13,539,387.58
SR-3-R	2,754,899.48	13,539,310.22
SR-4-L	2,760,296.60	13,546,121.14
SR-4-R P.O.T	2,756,074.48	13,545,141.72
SR-4-R	2,755,967.33	13,545,116.88
SR-5-L	2,754,929.59	13,554,412.12
SR-5-R	2,749,901.01	13,551,404.16
SR-6-L	2,751,328.63	13,563,091.82
SR-6-R	2,746,662.02	13,560,976.93
SR-7-L	2,750,876.06	13,565,538.61
SR-7-L P.O.T	2,750,704.93	13,565,435.12
SR-7-R P.O.T	2,745,794.53	13,562,465.29
SR-7-R	2,745,599.97	13,562,347.62
SR-8-L	2,742,485.33	13,565,724.00
SR-8-R	2,741,823.70	13,561,843.13
SR-9-L	2,740,030.49	13,569,150.34
SR-9-R	2,738,450.12	13,565,948.85

Source: (Ochs, 1982, Blanton and Ferrari, 1992)

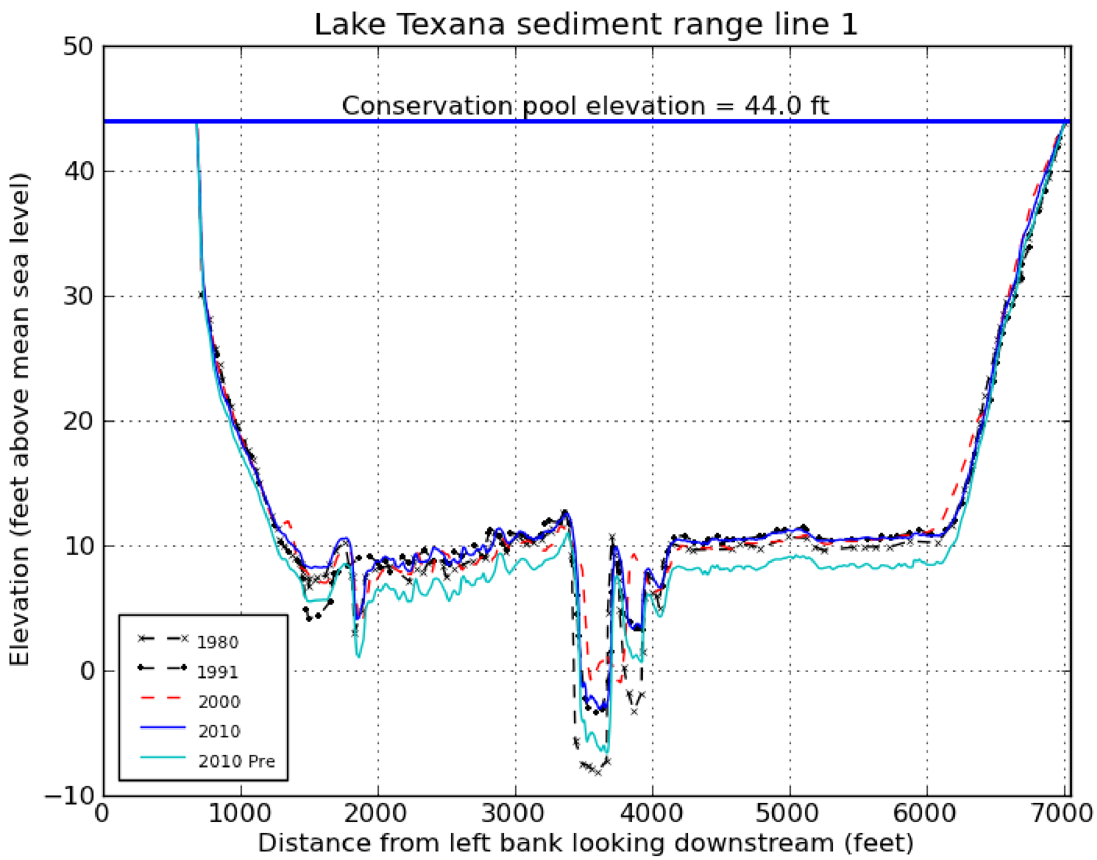
Coordinates reported in NAD83 State Plane Texas South Central Zone (feet)

Table D1. Sediment range line endpoint coordinates (cont.)

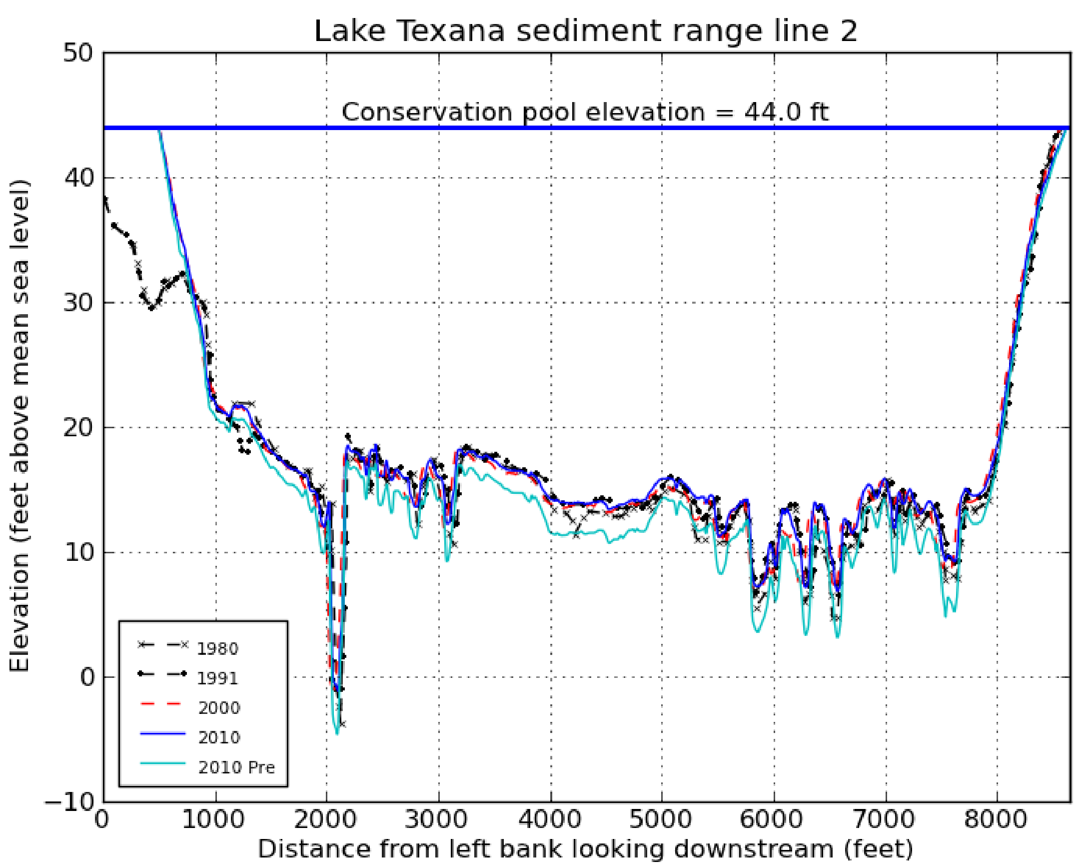
Sediment range line	X	Y
SR-10-L	2,731,896.73	13,567,731.41
SR-10-R P.O.T	2,731,933.43	13,567,330.41
SR-10-R	2,731,951.27	13,567,135.39
SR-21-L	2,757,060.22	13,552,613.16
SR-21-L P.O.T	2,756,972.24	13,552,661.34
SR-21-R	2,755,014.69	13,553,728.23
SR-22-L	2,762,581.46	13,552,537.66
SR-22-R P.O.T	2,761,998.20	13,554,365.98
SR-22-R	2,761,732.54	13,555,198.71
SR-23-L	2,762,526.36	13,558,687.96
SR-23-R P.O.T	2,759,461.73	13,557,029.63
SR-23-R	2,758,832.11	13,556,691.93
SR-24-L	2,764,571.34	13,564,438.34
SR-24-R	2,763,365.68	13,564,081.40
SR-25-L	2,772,501.47	13,567,105.08
SR-25-R	2,772,006.79	13,568,258.48
SR-26-L	2,777,668.45	13,572,051.95
SR-26-R	2,777,015.20	13,572,829.01
SR-31-L	2,763,861.99	13,565,598.46
SR-31-L	2,763,766.05	13,565,542.65
SR-31-R	2,763,079.55	13,565,142.02
SR-51-L	2,745,838.08	13,569,289.73
SR-51-R	2,744,096.06	13,568,436.11
SR-52-L	2,745,393.66	13,572,909.27
SR-52-R	2,744,669.10	13,572,268.89
SR-53-L	2,744,553.85	13,577,859.16
SR-53-R P.O.T	2,743,411.37	13,577,821.61
SR-53-R	2,742,999.88	13,577,808.09

Source: (Ochs, 1982, Blanton and Ferrari, 1992)

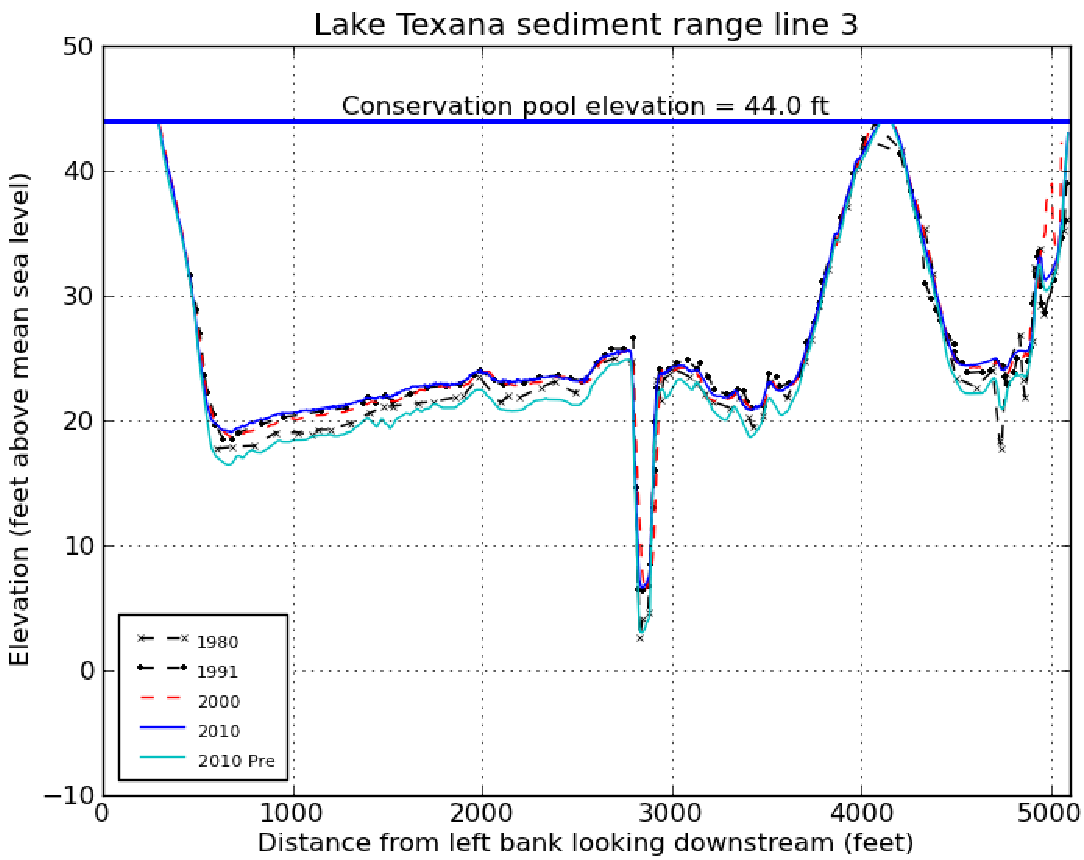
Coordinates reported in NAD83 State Plane Texas South Central Zone (feet)



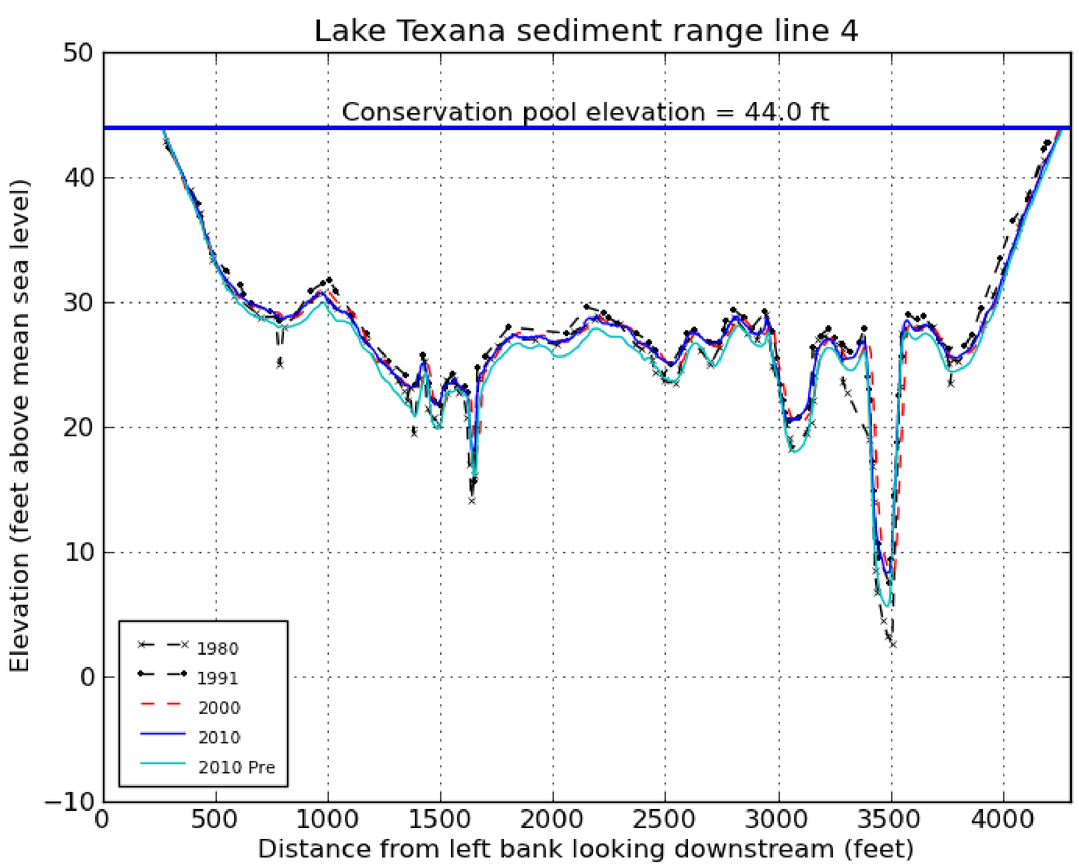
Lake Texana sediment range line 1
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
1980
1991
2000
2010
2010 Pre



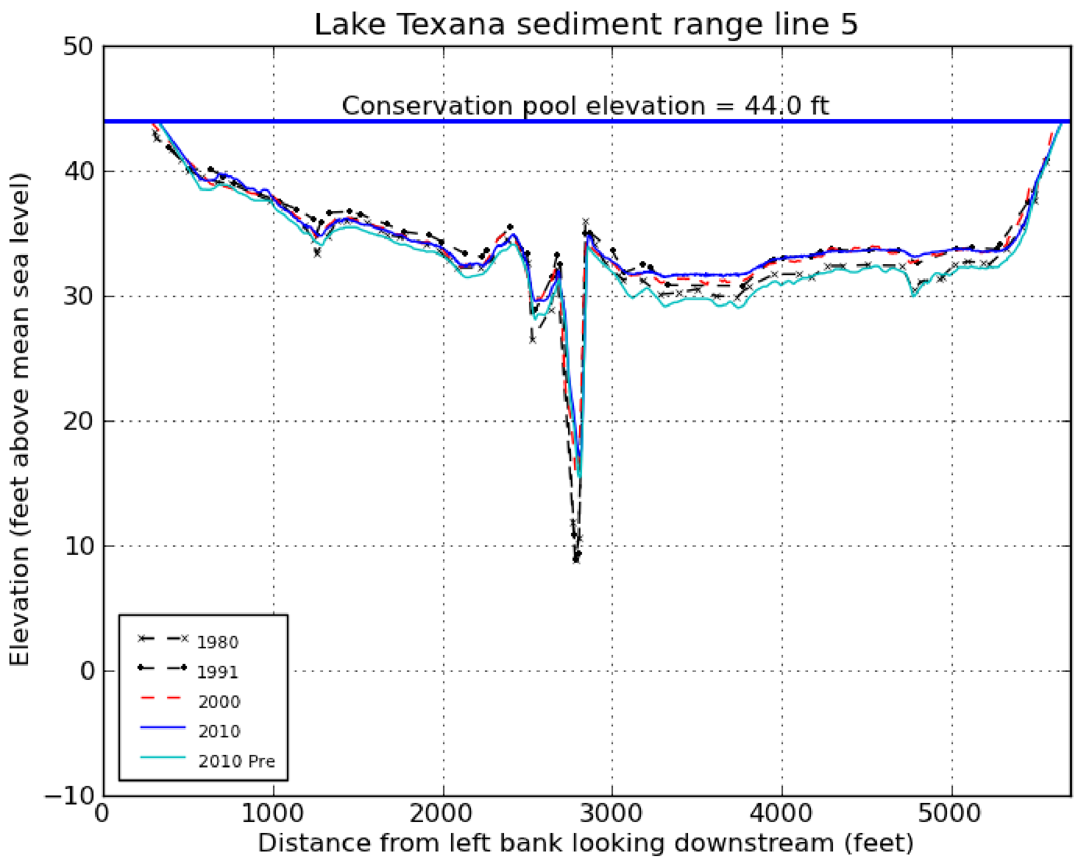
Lake Texana sediment range line 2
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
1980
1991
2000
2010
2010 Pre



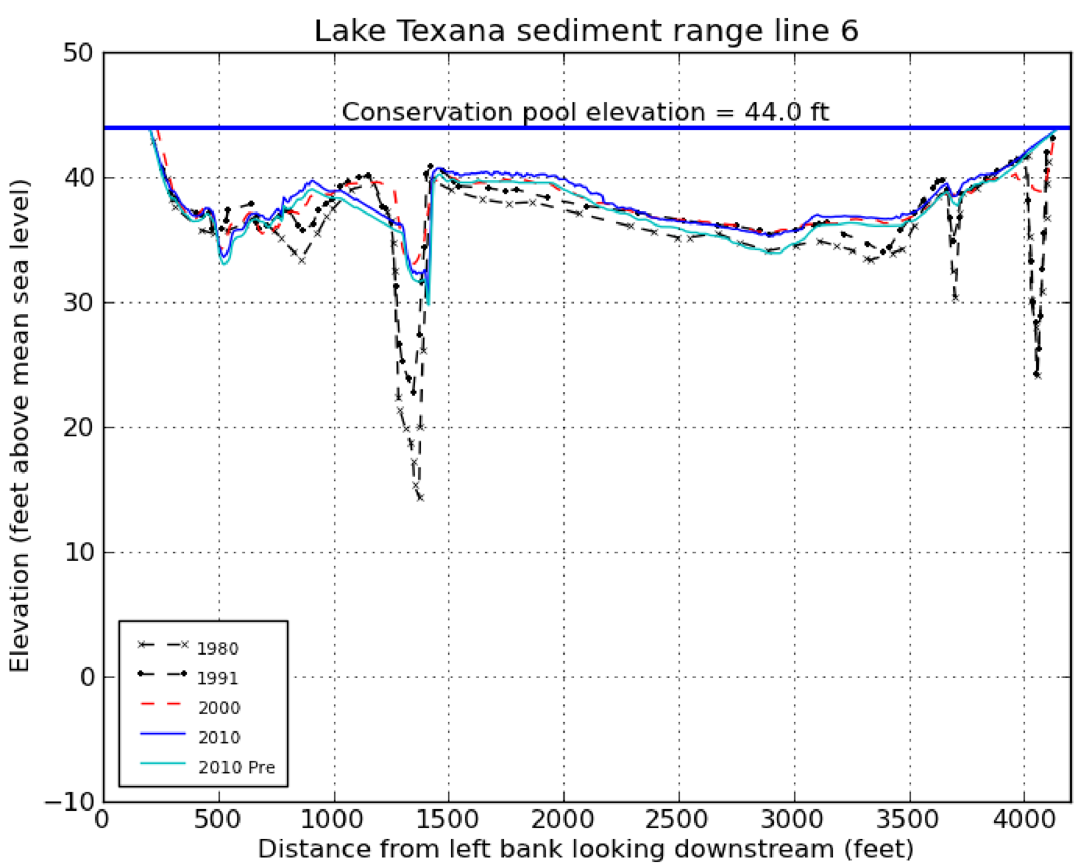
Lake Texana sediment range line 3
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
50
40
30
20
10
0
−10
0
1000
2000
3000
4000
5000
1980
1991
2000
2010
2010 Pre



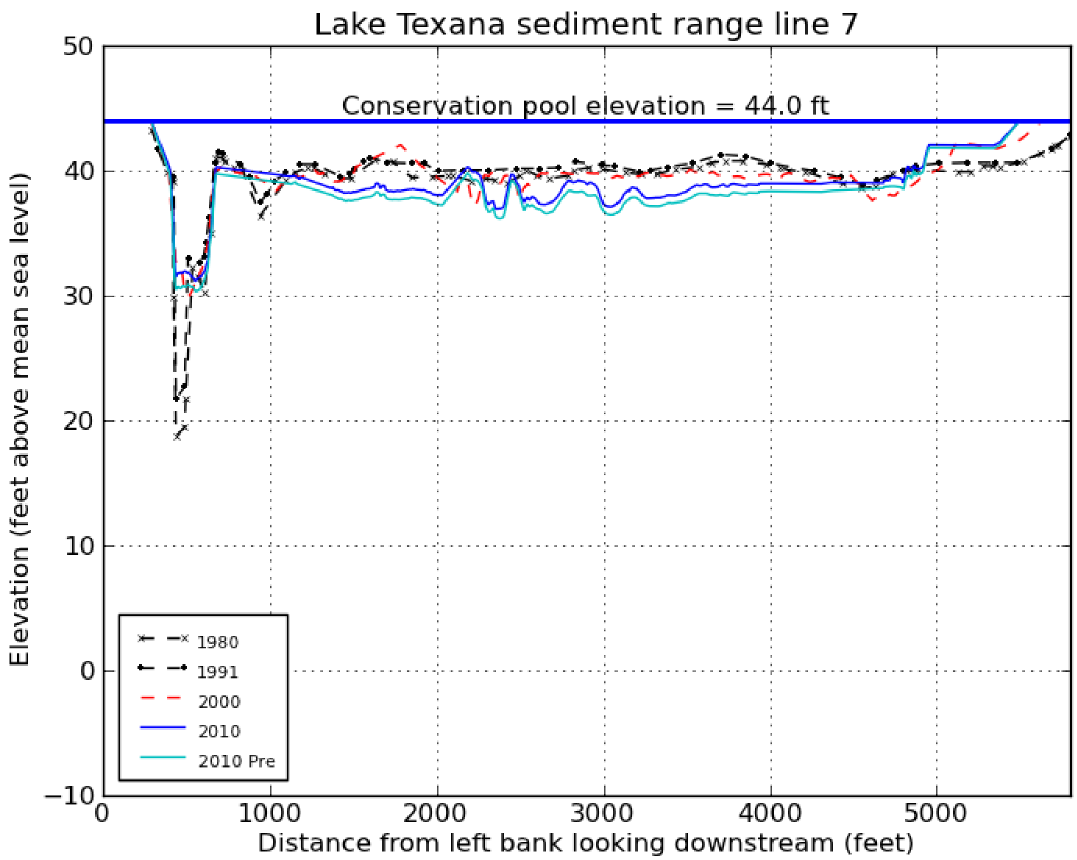
Lake Texana sediment range line 4
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
50
40
30
20
10
0
−10
0
500
1000
1500
2000
2500
3000
3500
4000
1980
1991
2000
2010
2010 Pre

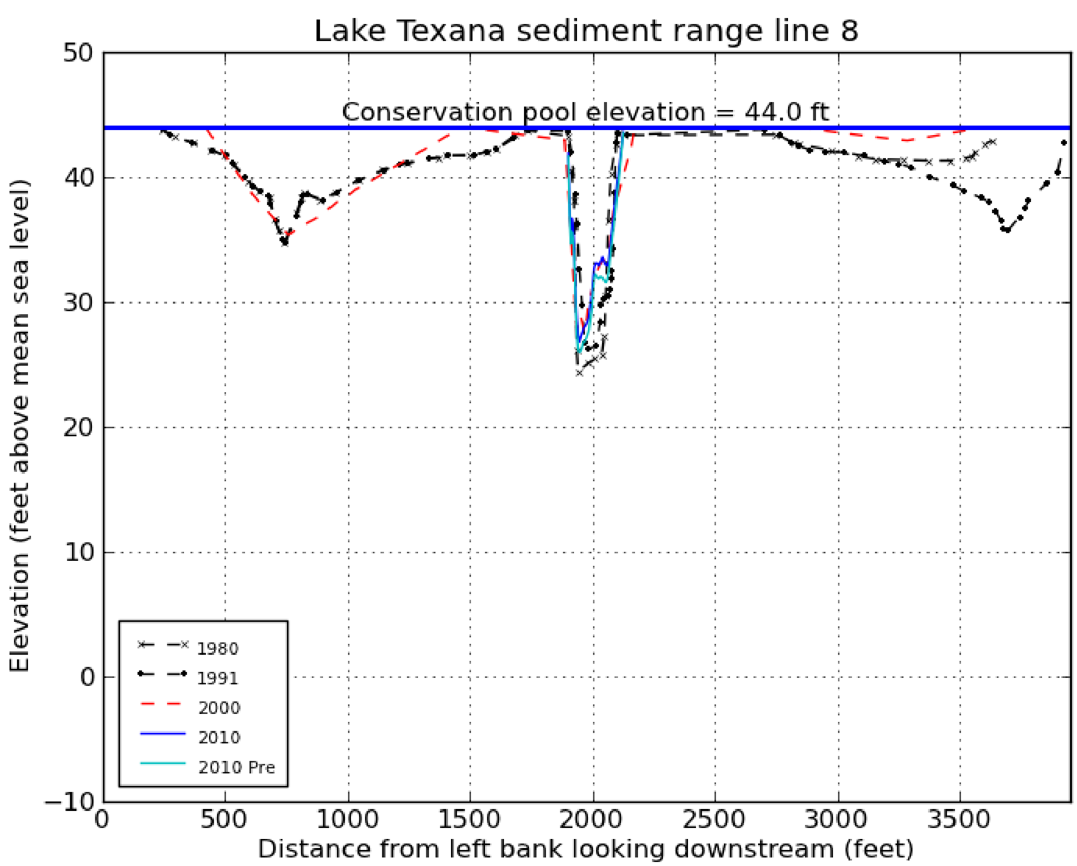


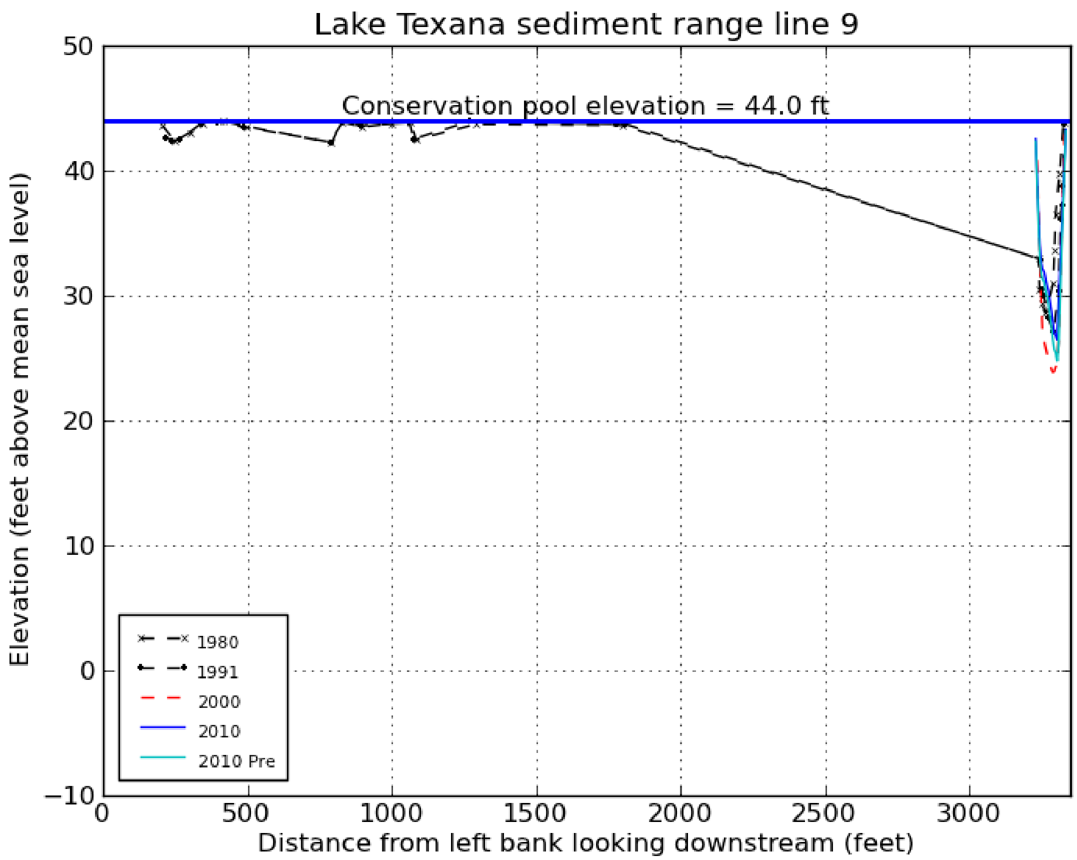
Lake Texana sediment range line 5
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
1980
1991
2000
2010
2010 Pre

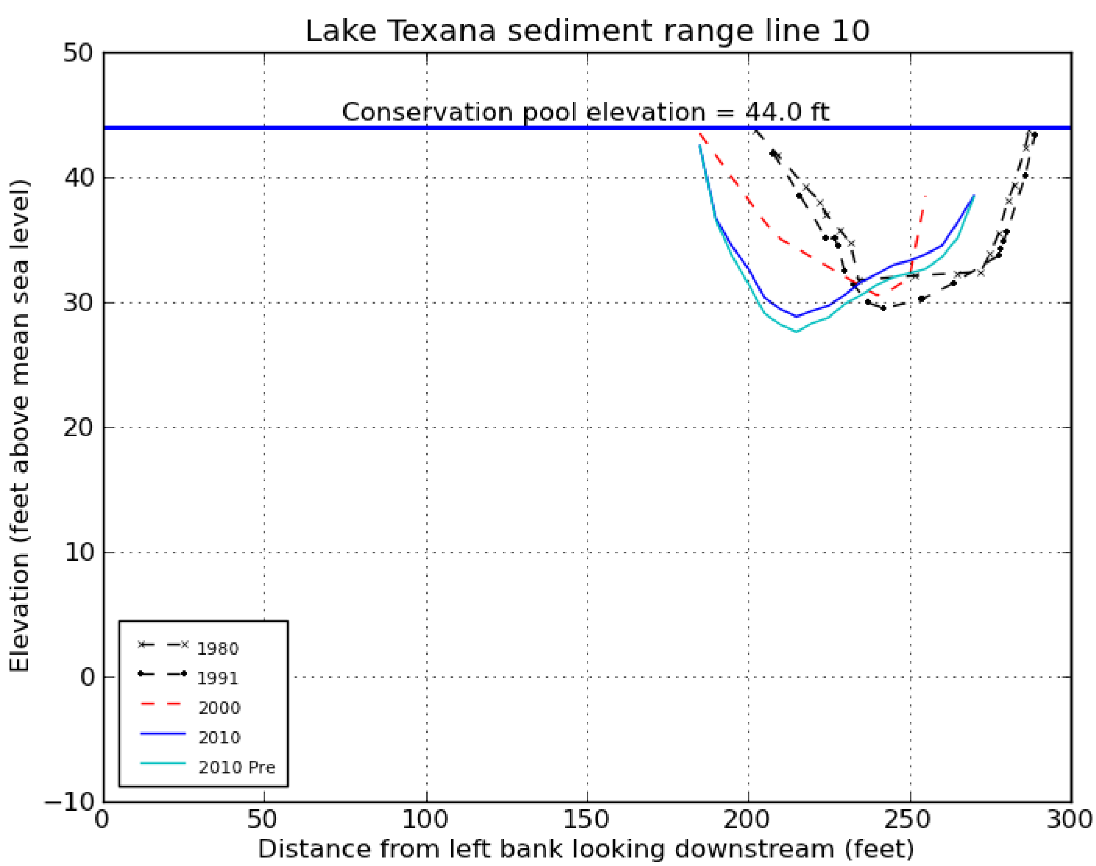


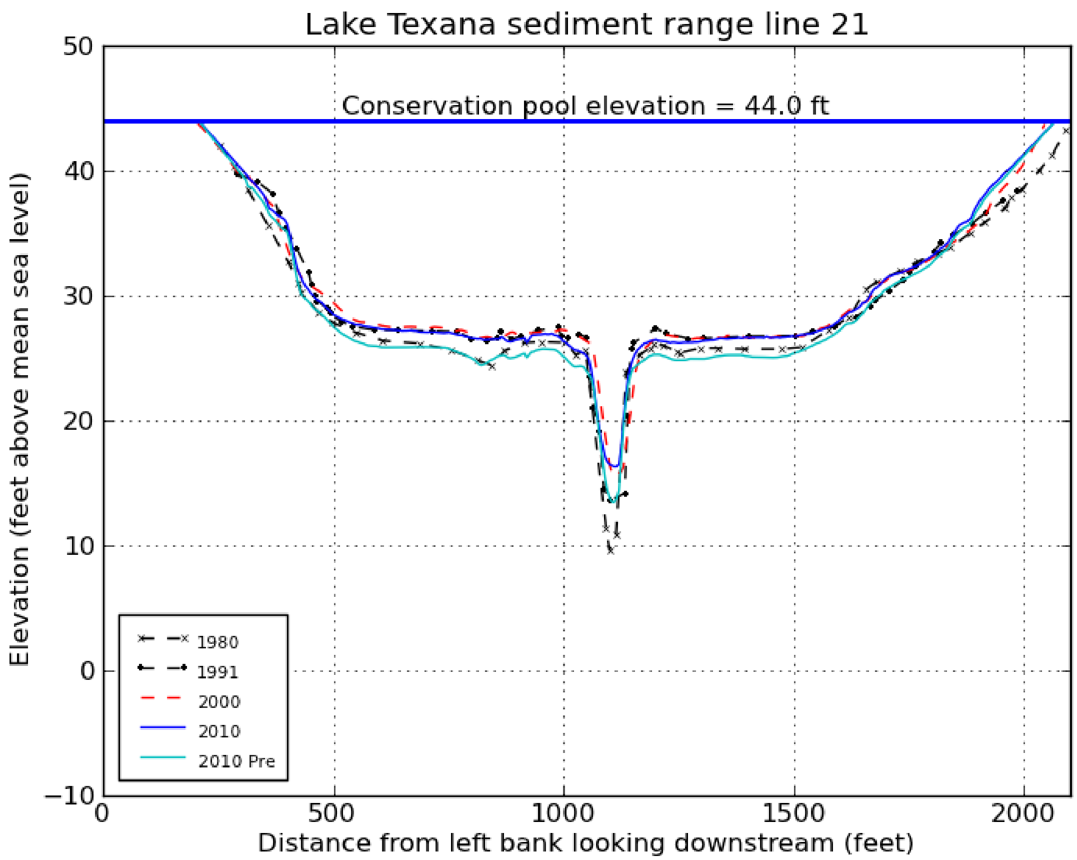
Lake Texana sediment range line 6
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
1980
1991
2000
2010
2010 Pre

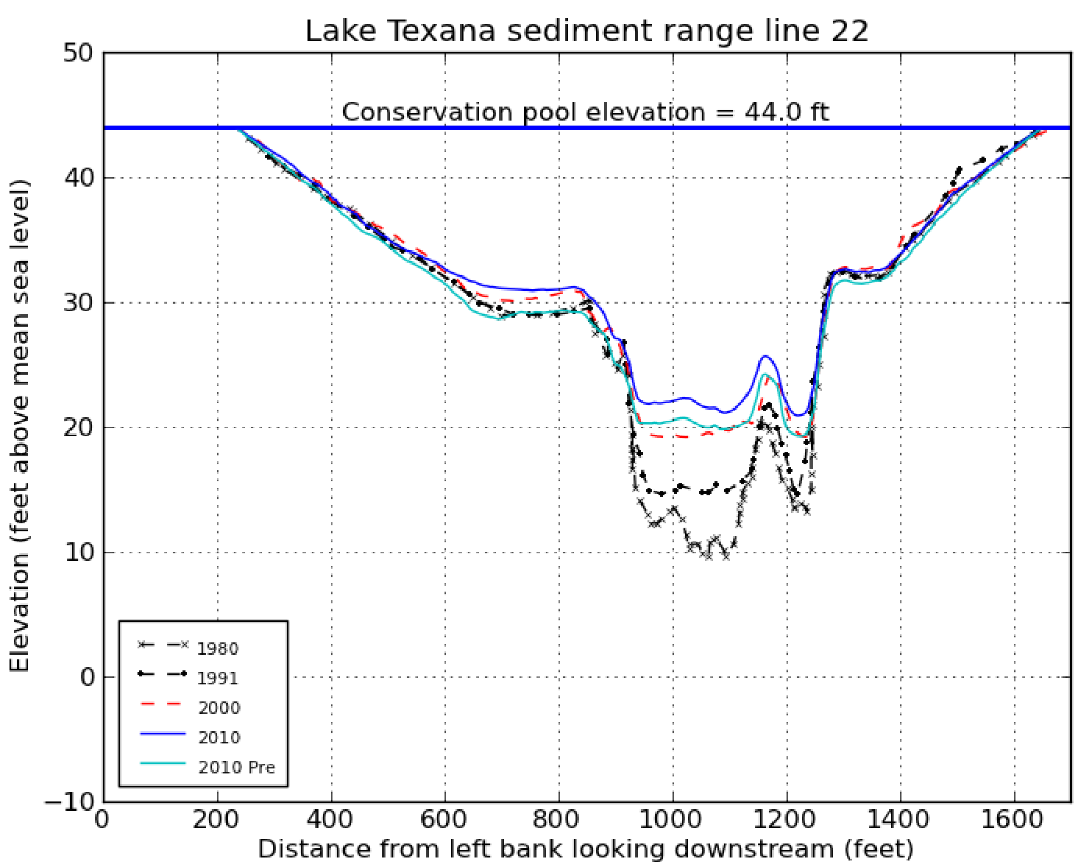

Lake Texana sediment range line 7
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
1980
1991
2000
2010
2010 Pre
50
40
30
20
10
0
−10
0
1000
2000
3000
4000
5000

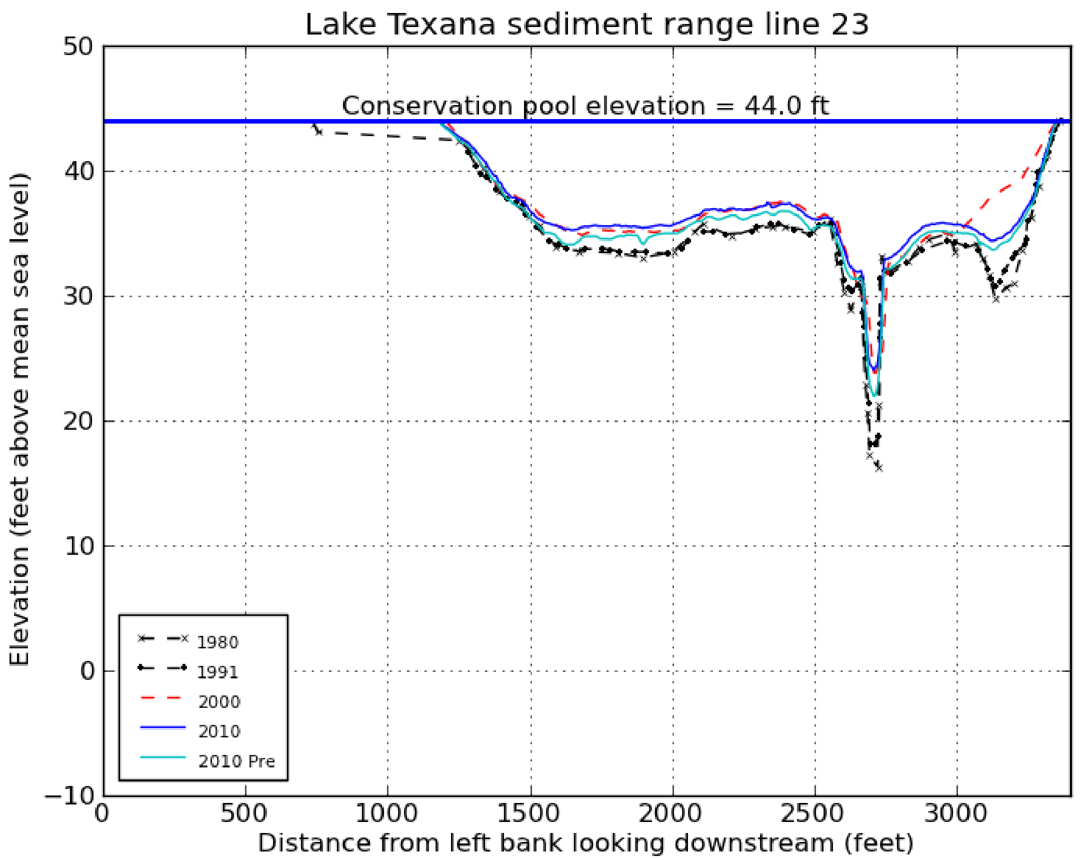

Lake Texana sediment range line 8
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
1980
1991
2000
2010
2010 Pre
50
40
30
20
10
0
−10
0
500
1000
1500
2000
2500
3000
3500


Lake Texana sediment range line 9
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
1980
1991
2000
2010
2010 Pre
50
40
30
20
10
0
−10
0
500
1000
1500
2000
2500
3000

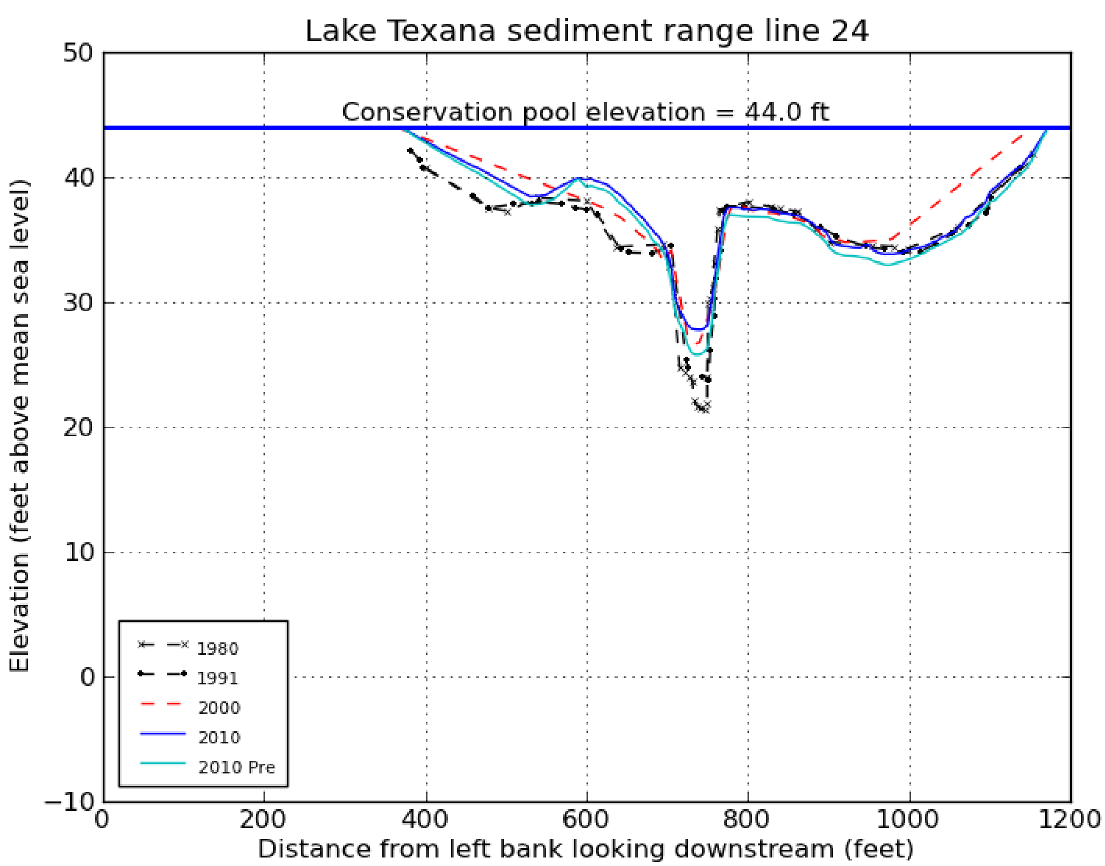

Lake Texana sediment range line 10
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
1980
1991
2000
2010
2010 Pre
50
40
30
20
10
0
−10
0
50
100
150
200
250
300


Lake Texana sediment range line 21
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
1980
1991
2000
2010
2010 Pre

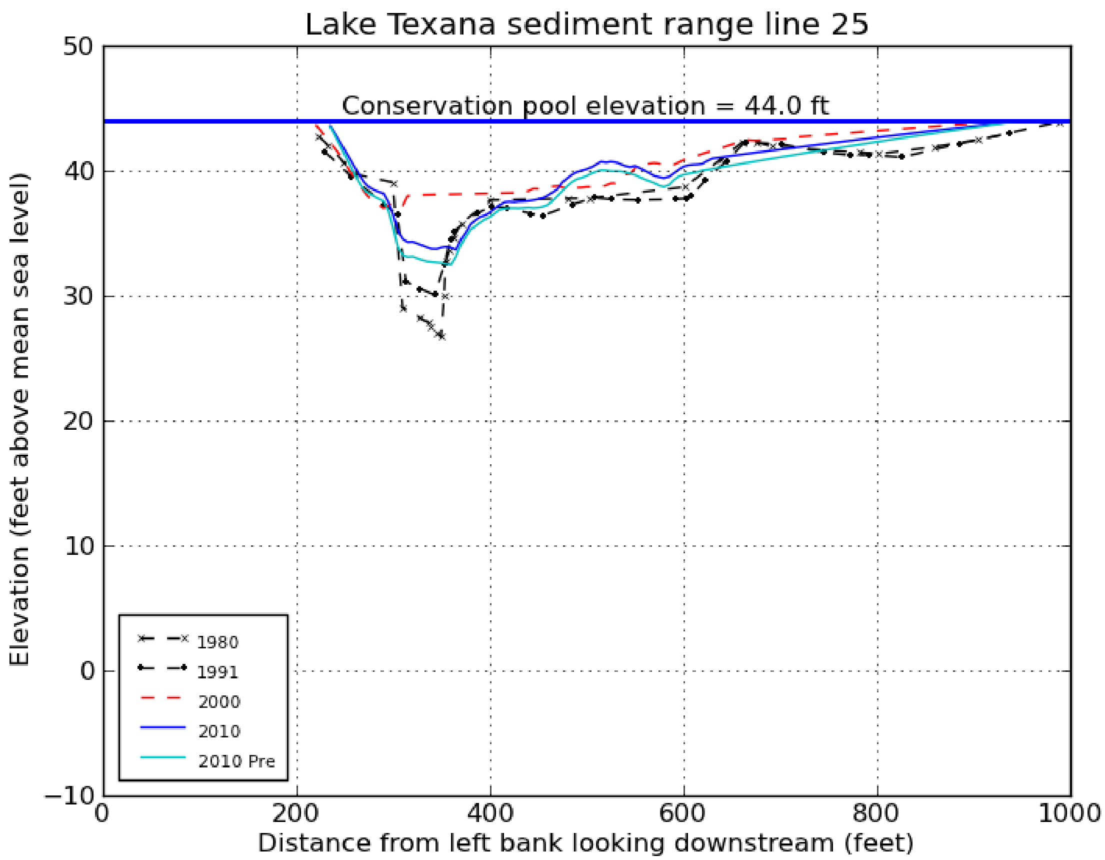

Lake Texana sediment range line 22
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
1980
1991
2000
2010
2010 Pre

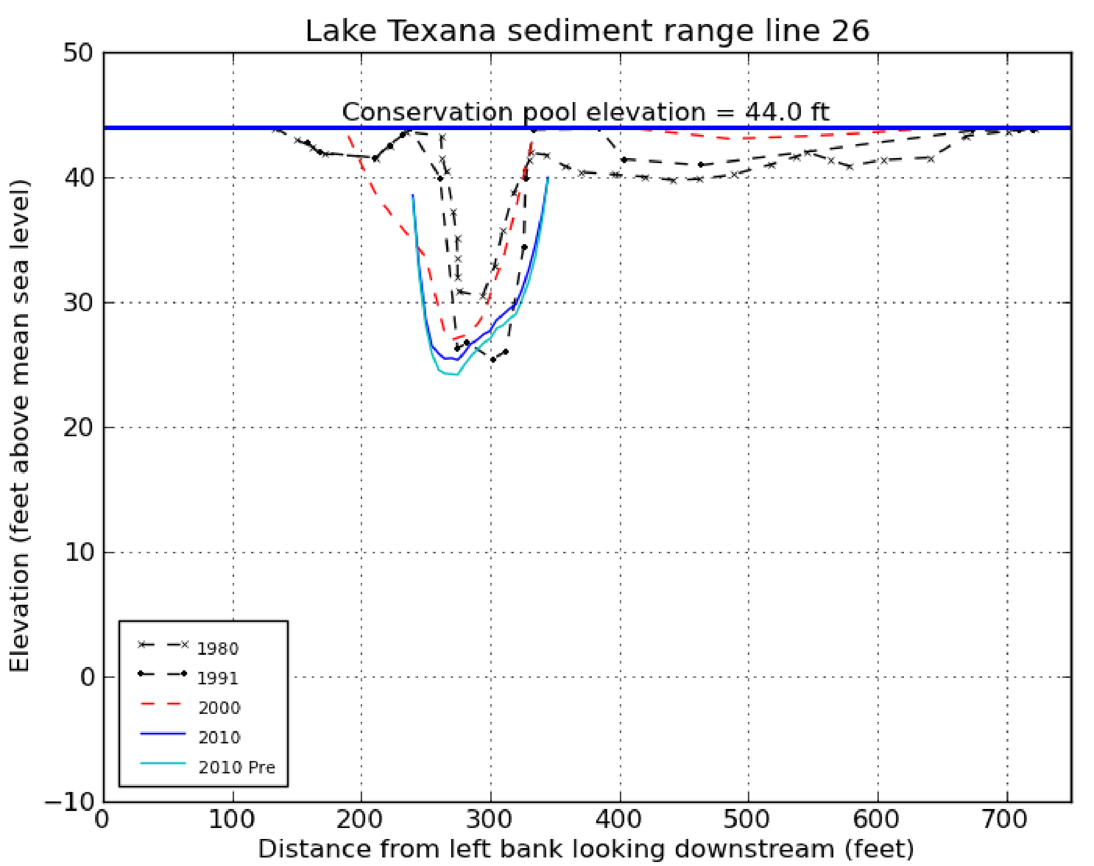


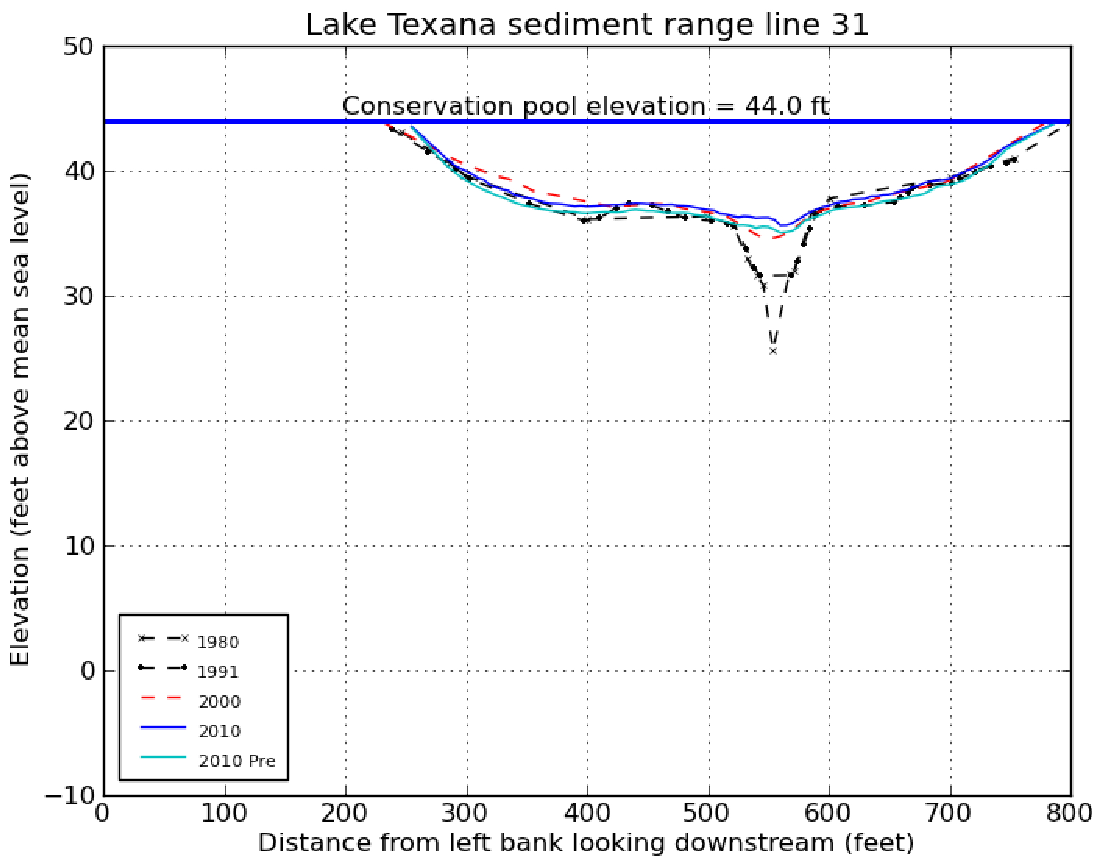
Lake Texana sediment range line 23
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
50
40
30
20
10
0
−10
0
500
1000
1500
2000
2500
3000
1980
1991
2000
2010
2010 Pre



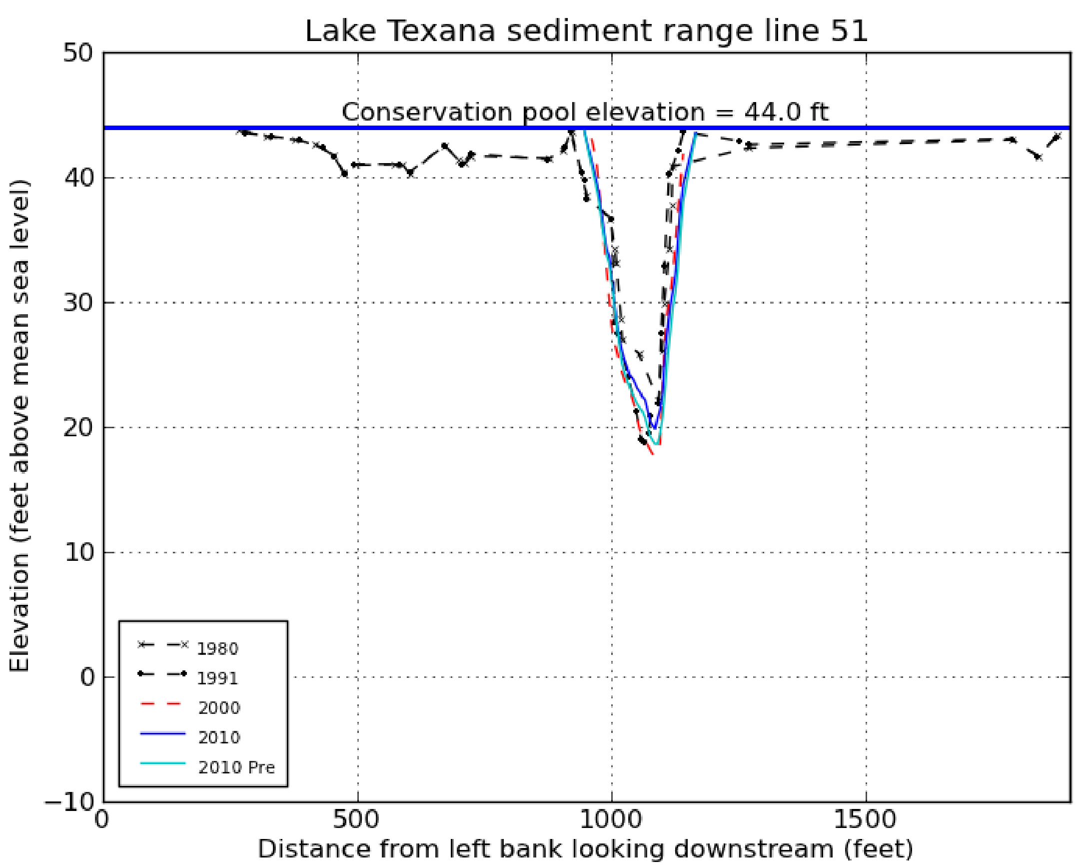
Lake Texana sediment range line 24
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
50
40
30
20
10
0
−10
0
200
400
600
800
1000
1200
1980
1991
2000
2010
2010 Pre


Lake Texana sediment range line 25
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
1980
1991
2000
2010
2010 Pre
50
40
30
20
10
0
−10
0
200
400
600
800
1000

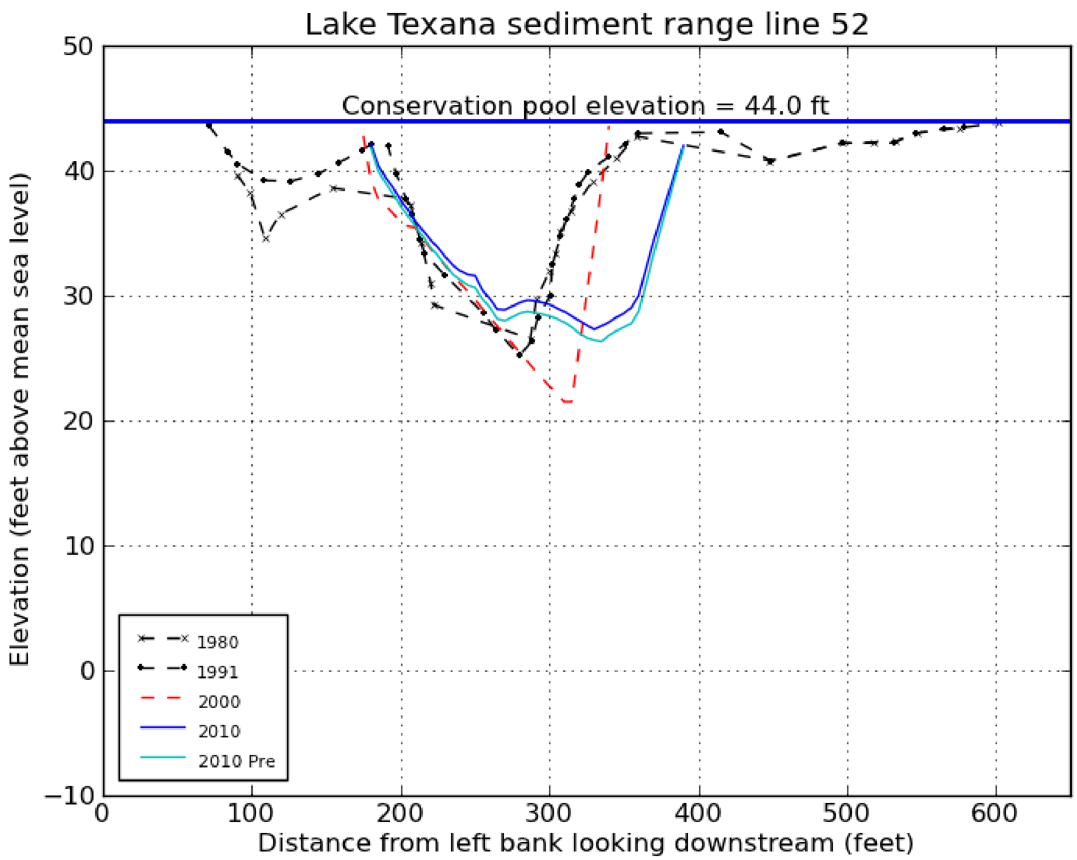

Lake Texana sediment range line 26
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
1980
1991
2000
2010
2010 Pre
50
40
30
20
10
0
−10
0
100
200
300
400
500
600
700

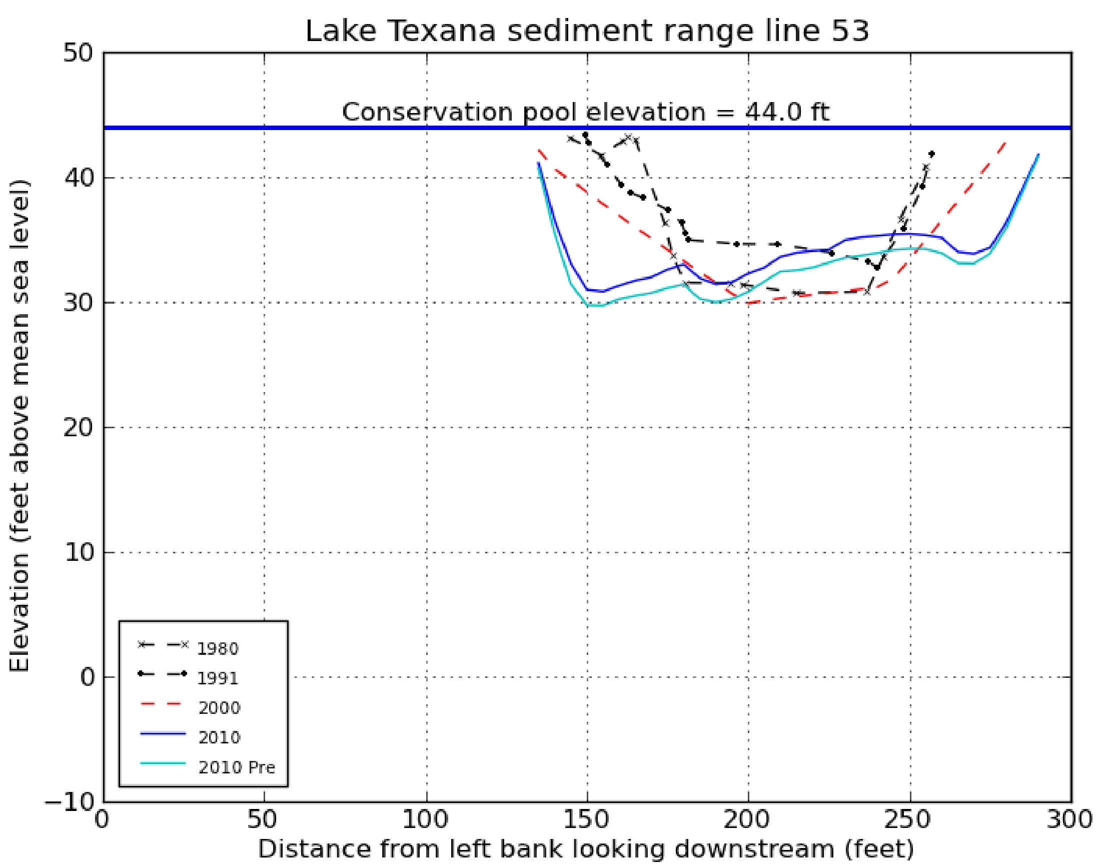


Lake Texana sediment range line 31
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
1980
1991
2000
2010
2010 Pre



Lake Texana sediment range line 51
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
1980
1991
2000
2010
2010 Pre


Lake Texana sediment range line 52
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
1980
1991
2000
2010
2010 Pre
50
40
30
20
10
0
−10
0
100
200
300
400
500
600


Lake Texana sediment range line 53
Conservation pool elevation = 44.0 ft
Elevation (feet above mean sea level)
Distance from left bank looking downstream (feet)
1980
1991
2000
2010
2010 Pre
50
40
30
20
10
0
−10
0
50
100
150
200
250
300

Appendix E

Introduction

During TWDB's hydrographic survey of Lake Texana from January 12 through March 4, 2010, the lake elevation varied from 43.89 to 44.06 feet above msl. An elevation-capacity table was developed using this survey data up to elevation 44.0 feet above msl, the normal or conservation pool elevation. At this elevation, the storage capacity is 159,845 acre-feet. Per request from the Lavaca-Navidad River Authority of Texas, TWDB extended the elevation-capacity table to estimate the reservoir capacity corresponding to the flood pool elevation of 46.6 feet above mean sea level. TWDB estimated the flood pool capacity by creating a Triangulated Irregular Network (TIN) model using Texas Natural Resources Information System (TNRIS) Light Detection and Ranging (LiDAR) data for the area surrounding Lake Texana.

Methodology

TIN model calculation

To supplement the TWDB survey data and create a TIN model extending above the 44.0 feet boundary elevation, Texas Natural Resources Information System (TNRIS) Light Detection and Ranging (LiDAR) data was used for the area surrounding Lake Texana (TNRIS, 2006). The LiDAR elevation data is available in the form of *.las* files. These files were converted to multi-point shapefiles using ArcGIS and had 1.4-meter default horizontal grid spacing. The ground or bare earth data classification, classification number 2, was used to extract only LiDAR points pertaining to ground elevation measurements. TWDB used ArcGIS to generate 0.5-foot contours from the bare earth LiDAR data for elevations above the current bathymetric survey boundary from 44.0 to 48.0 feet. With the additional contour data above 44.0 feet, a TIN model was created for Lake Texana using standard GIS techniques. For instances where the current bathymetric survey boundary conflicted with the contours, the 2010 TWDB survey boundary was used. The elevation-volume calculations for this new TIN model were conducted according to the procedures outlined in the Area, Volume and Contour Calculations section on page 7 of this report. The elevation/volume calculations below 44.0 feet rely on the TWDB survey and interpolation data and are those found in Appendix A. Volume calculation between 44.0 feet and 46.6 feet are based on the extended TIN model that is based on the TNRIS LiDAR data.

Results

TIN model calculation

The results of the TIN model volumetric calculation provide an approximate volume of 188,700 acre-feet at the flood pool elevation of 46.6 feet above mean sea level.

References

TNRIS (Texas Natural Resources Information Systems), 2006, Jackson County Light Detection And Ranging (LiDAR) data provided from TNRIS upon request, LiDAR data collected between April 9 and May 13, 2006.

Figure 5

TEXAS WATER DEVELOPMENT BOARD

CONTOURS

(feet above mean sea level)

40

35

30

25

20

15

10

5

0

-5

-10

-15

Islands

Lake Texana

Conservation Pool Elevation:
44.0 feet above mean sea level

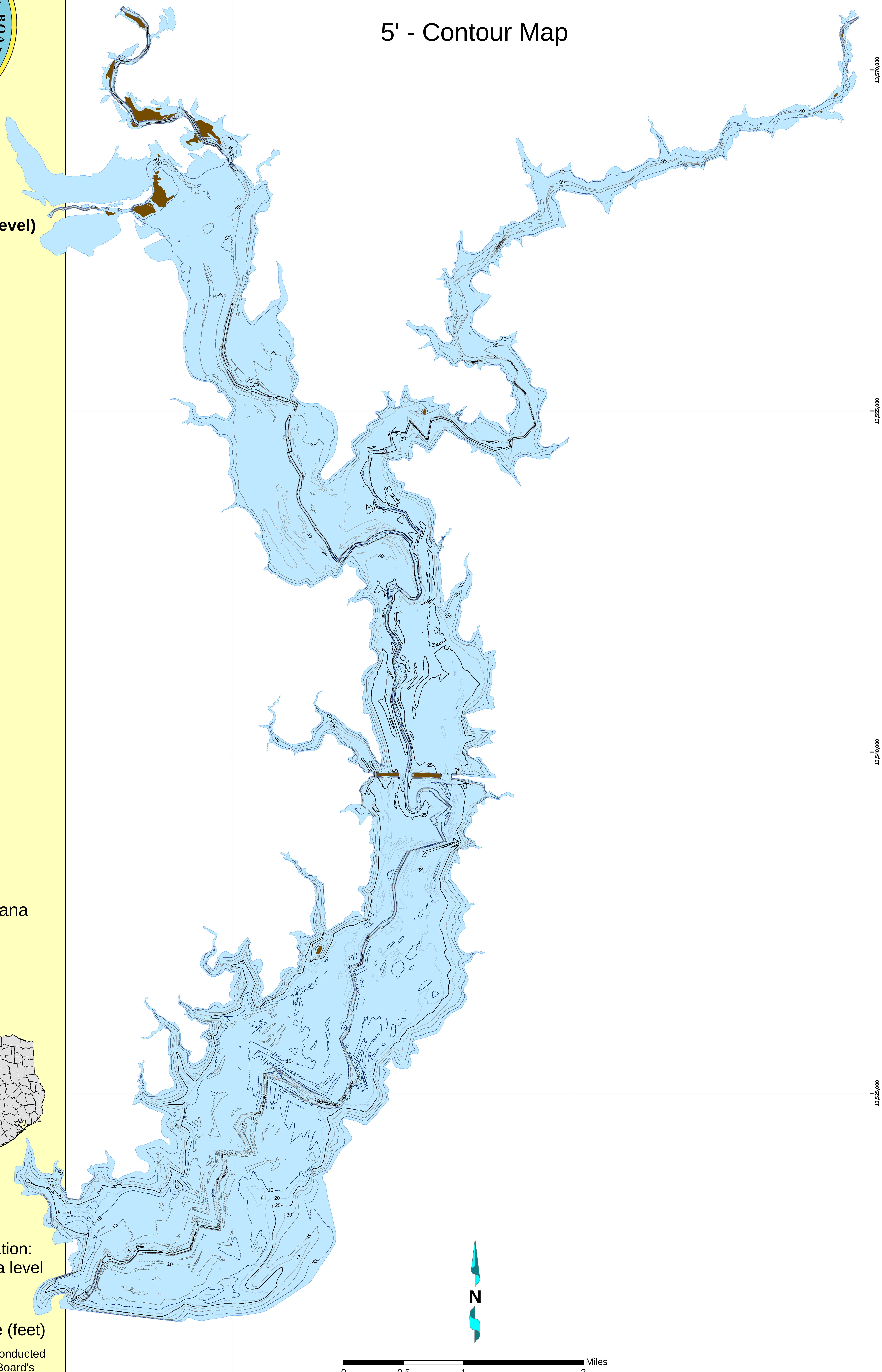
Projection: NAD83
State Plane
Texas South Central Zone (feet)

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 Texana. The Texas Water Development Board makes no representations nor assumes any liability.

2,750,000 2,765,000

Lake Texana

5' - Contour Map



Prepared by: TEXAS WATER DEVELOPMENT BOARD January - March 2010 Survey

2,750,000 2,765,000