Volumetric and Sedimentation Survey of JIM CHAPMAN LAKE

January – July 2022

Texas Water Development Board

August 2023

Texas Water Development Board

Prepared for:

North Texas Municipal Water District

This report was prepared by staff of the Surface Water Division:

Mindy Conyers, Manager
Nathan Leber
Holly Holmquist
Khan Iqbal
Josh Duty
Dane McCollum

Published and distributed by the

Texas Water Development Board

P.O. Box 13231, 1700 N. Congress Ave.
Austin, TX 78711-3231, www.twdb.texas.gov
Phone (512) 463-7847, Fax (512) 475-2053

Executive summary

In May 2022, the Texas Water Development Board (TWDB) entered into an agreement with the North Texas Municipal Water District (NTMWD) to perform a volumetric and sedimentation survey of Jim Chapman Lake (Delta and Hopkins counties, Texas). Surveying was performed using a multi-frequency (200 kHz, 50 kHz, and 12 kHz), sub-bottom profiling depth sounder. Sediment core samples were collected and correlated with sub-bottom acoustic profiles to estimate sediment accumulation thicknesses and sedimentation rates.

Cooper Dam, impounding Jim Chapman Lake, also known as Cooper Lake, is located on the South Sulphur River, in Delta and Hopkins counties, approximately four miles southeast of Cooper, Texas. The conservation pool elevation of Jim Chapman Lake is 440.0 feet NGVD29. The TWDB collected bathymetric data for Jim Chapman Lake between January 26 and July 26, 2022, while daily average water surface elevations ranged between 436.05 and 437.07 feet NGVD29. Additional bathymetric data was collected on April 10 and 11, 2023, while the daily average water surface elevation measured 440.35 and 440.33 feet, respectively.

The 2022 TWDB volumetric survey indicates Jim Chapman Lake has a total reservoir capacity of 294,498 acre-feet and encompasses 17,998 acres at conservation pool elevation (440.0 feet NGVD29). Previous capacity estimates include the original design estimate of 310,813 acre-feet and an estimate of 299,857 acre-feet re-calculated using data from TWDB's 2008 report. Because of differences in past and present survey methodologies and technological improvements, direct comparison of volumetric surveys to others to estimate loss of area and capacity can be unreliable. Information from past surveys is presented here for informational purposes only.

The 2022 TWDB sedimentation survey measured 16,652 acre-feet of sediment below conservation pool elevation (440.0 feet NGVD29). The sedimentation survey indicates sediment accumulation is greatest near the dam and in the submerged river channels. The TWDB recommends that a similar methodology be used to resurvey Jim Chapman Lake in 10 years or after a major high flow event.

Table of Contents

Introduction **1**
Jim Chapman Lake general information **1**
Volumetric and sedimentation survey of Jim Chapman Lake **4**
  Datum 4
  TWDB bathymetric and sedimentation data collection 4
Data processing **6**
  Model boundary 6
  LIDAR data points 7
  Triangulated Irregular Network model 7
  Spatial interpolation of reservoir bathymetry 8
  Area, volume, and contour calculation 10
  Analysis of sediment data from Jim Chapman Lake 14
Survey results **24**
  Volumetric survey 24
  Sedimentation survey 24
Sediment range lines **27**
Recommendations **27**
TWDB contact information **27**
References **28**

List of Tables

Table 1: Pertinent data for Cooper Dam and Jim Chapman Lake
Table 2: Sediment core analysis data
Table 3: Previous and current survey estimates
Table 4: Average annual capacity loss comparisons

List of Figures

Figure 1: Location map
Figure 2: 2022 TWDB sounding data and sediment coring locations
Figure 3: Anisotropic spatial interpolation
Figure 4: Elevation relief map
Figure 5: Depth range map
Figure 6: 5-foot contour map
Figure 7: Sediment core sample JC-15
Figure 8: Comparison of sediment core JC-15 with acoustic signal returns
Figure 9: Sediment thickness map
Figure 10: Plot of current and previous capacity estimates

Appendices

Appendix A: Jim Chapman Lake 2005 / 2007 re-calculated elevation-capacity table
Appendix B: Jim Chapman Lake 2005 / 2007 re-calculated elevation-area table
Appendix C: Jim Chapman Lake 2005 / 2007 re-calculated capacity curve
Appendix D: Jim Chapman Lake 2005 / 2007 re-calculated area curve
Appendix E: Jim Chapman Lake 2022 bathymetric elevation-capacity table
Appendix F: Jim Chapman Lake 2022 bathymetric elevation-area table
Appendix G: Jim Chapman Lake 2022 bathymetric capacity curve
Appendix H: Jim Chapman Lake 2022 bathymetric area curve
Appendix I: Jim Chapman Lake 2022 bathymetric and topographic elevation-capacity table
Appendix J: Jim Chapman Lake 2022 bathymetric and topographic elevation-area table

Appendix K: Jim Chapman Lake 2022 bathymetric and topographic capacity curve
Appendix L: Jim Chapman Lake 2022 bathymetric and topographic area curve
Appendix M: Sediment range lines

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. Texas Water Code Section 15.804 authorizes the TWDB to perform surveys to determine reservoir storage capacity, sedimentation levels, rates of sedimentation, and projected water supply availability.

In May 2022, the TWDB entered into an agreement with the North Texas Municipal Water District (NTMWD), to perform a volumetric and sedimentation survey of Jim Chapman Lake (Delta and Hopkins counties, Texas) (Texas Water Development Board, 2022). This report provides an overview of the survey methods, analysis techniques, and associated results. Also included are the following contract deliverables: (1) an elevation-area-capacity table of the reservoir acceptable to the Texas Commission on Environmental Quality (Appendices A and B), (2) a bottom contour map (Figure 6), (3) a shaded relief plot of the reservoir bottom (Figure 4), and (4) an estimate of sediment accumulation and location (Figure 9).

Jim Chapman Lake general information

Cooper Dam, impounding Jim Chapman Lake, also known as Cooper Lake, is located on the South Sulphur River, in Delta and Hopkins counties, approximately four miles southeast of Cooper, Texas (Figure 1). Jim Chapman Lake is owned and operated by the U.S. Army Corps of Engineers, Fort Worth District. Construction of Cooper Dam and Jim Chapman Lake began in August 1987. The dam was completed, and deliberate impoundment of water began on September 28, 1991 (U.S. Army Corps of Engineers, 2023a). The reservoir was built primarily for water supply purposes and is also used for flood control purposes (U.S. Army Corps of Engineers, 2023b). Additional pertinent data about Cooper Dam and Jim Chapman Lake can be found in Table 1.

Water rights for Jim Chapman Lake have been appropriated as follows: to the NTMWD through Certificate of Adjudication No. 03-4798; to the Sulphur River Municipal Water District through Certificate of Adjudication No. 03-4797 and Amendment to Certificate of Adjudication Nos. 03-4797A and 03-4797B; and to the City of Irving through Certificate of Adjudication No. 03-4799 and Amendment to Certificate of Adjudication Nos. 03-4799A, 03-4799B, 03-4799C, and 03-4799D (Texas Commission on Environmental Quality, 2023). The complete certificates are on file at the Texas Commission on Environmental Quality (TCEQ).

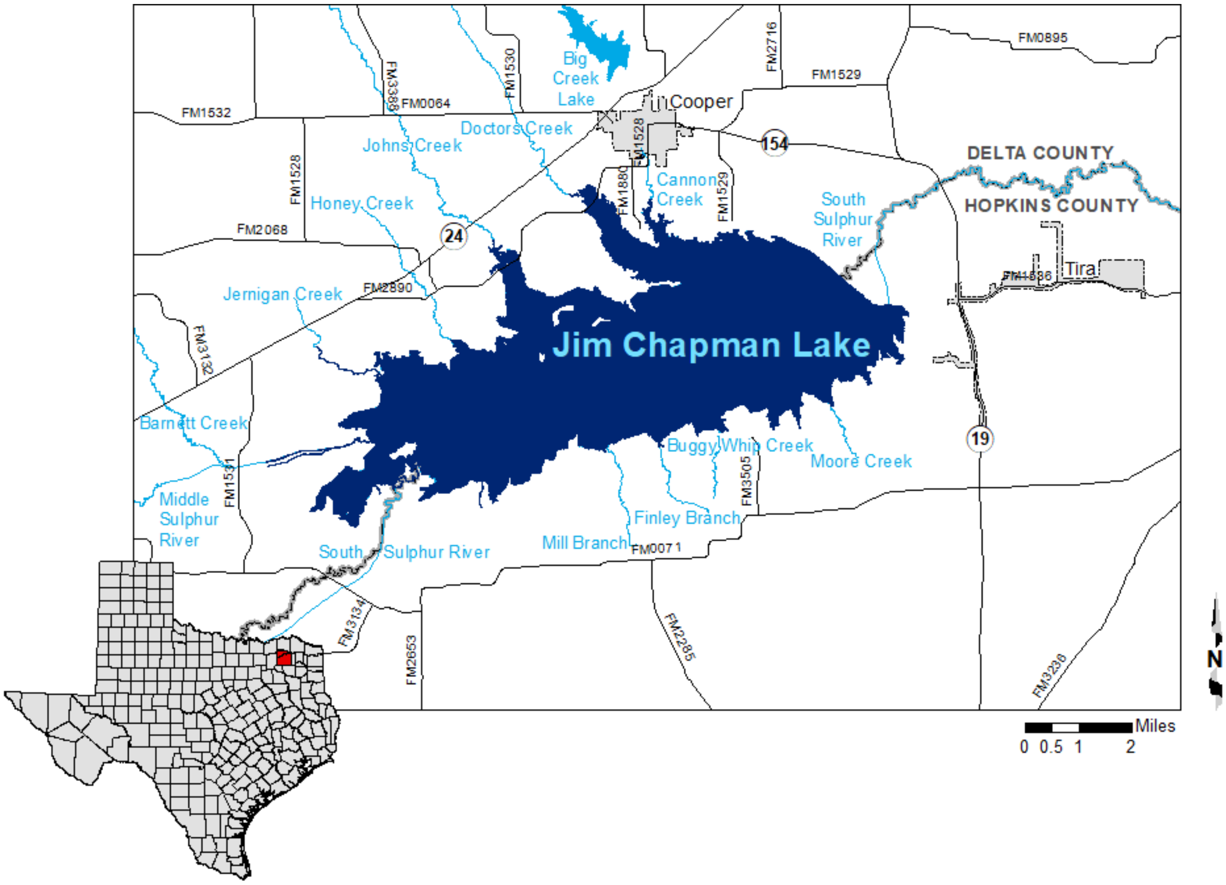


Figure 1. **Location map.**

Table 1. Pertinent Data for Cooper Dam and Jim Chapman Lake

Owner(s)			
U.S. Army Corps of Engineers			
Location			
In Delta and Hopkins counties, River Mile 23.2 on the South Sulphur River, Red River Basin, about 4 miles southeast of Cooper, Texas			
Drainage area			
Total drainage area	479 square miles		
Dam			
Type	Rolled earth fill		
Total length (including spillway)	28,072 feet		
Maximum height	79.5 feet		
Top width	30.0 feet		
Spillway			
Crest elevation	446.2 feet NGVD29		
Width	700.0 feet		
Length	207.0 feet		
Type	Ogee weir		
Control	None		
Outlet Works			
Type	One gate controlled conduit		
Dimensions	10.5 feet diameter		
Invert elevation	394.0 feet NGVD29		
Control	4.75 feet by 10.5 feet service gates		
Reservoir data (Based on 2022 TWDB survey)			
Feature	**Elevation (feet above mean sea level[a])**	**Capacity (acre-feet)**	**Area (acres)**
Top of dam	464.5	956,229	37,630
Probable maximum flood design water surface	463.5	919,052	36,725
Maximum design water surface	459.5	779,768	32,938
Top of flood control pool	446.2	417,056	21,506
Top of conservation pool	440.0	294,498	17,998
Sediment storage	415.5	35,775	4,802
Conservation storage capacity[b]	—	258,723	—

Source: U.S. Army Corps of Engineers, 2023a

a. Mean sea level indicates a reference to USGS National Geodetic Vertical Datum 1929 (NGVD29).

b. Usable conservation storage equals total capacity at conservation pool elevation minus dead pool capacity. Dead pool refers to water that cannot be drained by gravity through the dam outlet works.

Volumetric and sedimentation survey of Jim Chapman Lake

Datum

The vertical datum used during this survey is the National Geodetic Vertical Datum 1929 (NGVD29). This datum is utilized by the United States Geological Survey (USGS) for the reservoir elevation gage *USGS 07342495 Jim L. Chapman Lk nr Cooper, TX* (U.S. Geological Survey, 2022). Elevations herein are reported in feet relative to the NGVD29 datum. Volume and area calculations in this report are referenced to water levels reported 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

The TWDB collected bathymetric data for Jim Chapman Lake between January 26 and July 26, 2022, while daily average water surface elevations ranged between 436.05 and 437.07 feet NGVD29. Additional bathymetric data was collected on April 10-11, 2023, while the daily average water surface elevation measured 440.35 and 440.33 feet NGVD29, respectively. For simplicity, references to data collection are stated as '2022' throughout this report. For data collection, the TWDB used a Specialty Devices, Inc. (SDI), single-beam, multi-frequency (200 kHz, 50 kHz, and 12 kHz) sub-bottom profiling depth sounder integrated with differential global positioning system (DGPS) equipment. Data were collected 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 same survey lines also were used by the TWDB for the *Volumetric Survey of Jim Chapman Lake* (Texas Water Development Board, 2008). 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. Each speed of sound profile, or velocity cast, is saved for further data processing. Figure 2 shows the data collection locations for the 2022 TWDB survey.

All sounding data were collected and reviewed before sediment core sampling sites were selected. Sediment core samples are collected throughout the reservoir to assist with interpretation of the sub-bottom acoustic profiles. After analyzing the sounding data, the TWDB selected 21 locations to collect sediment core samples (Figure 2). Sediment cores were collected on October 18 and 19, 2022, with a custom-coring boat and an SDI VibeCore system.

Sediment cores are collected in 3-inch diameter aluminum tubes. A sediment core extends from the current reservoir-bottom surface, through the accumulated sediment, and into the pre-impoundment surface. After the sample is retrieved, the core tube is cut to the level of the sediment core. The tube is capped, labeled, and transported to TWDB headquarters for further analysis.

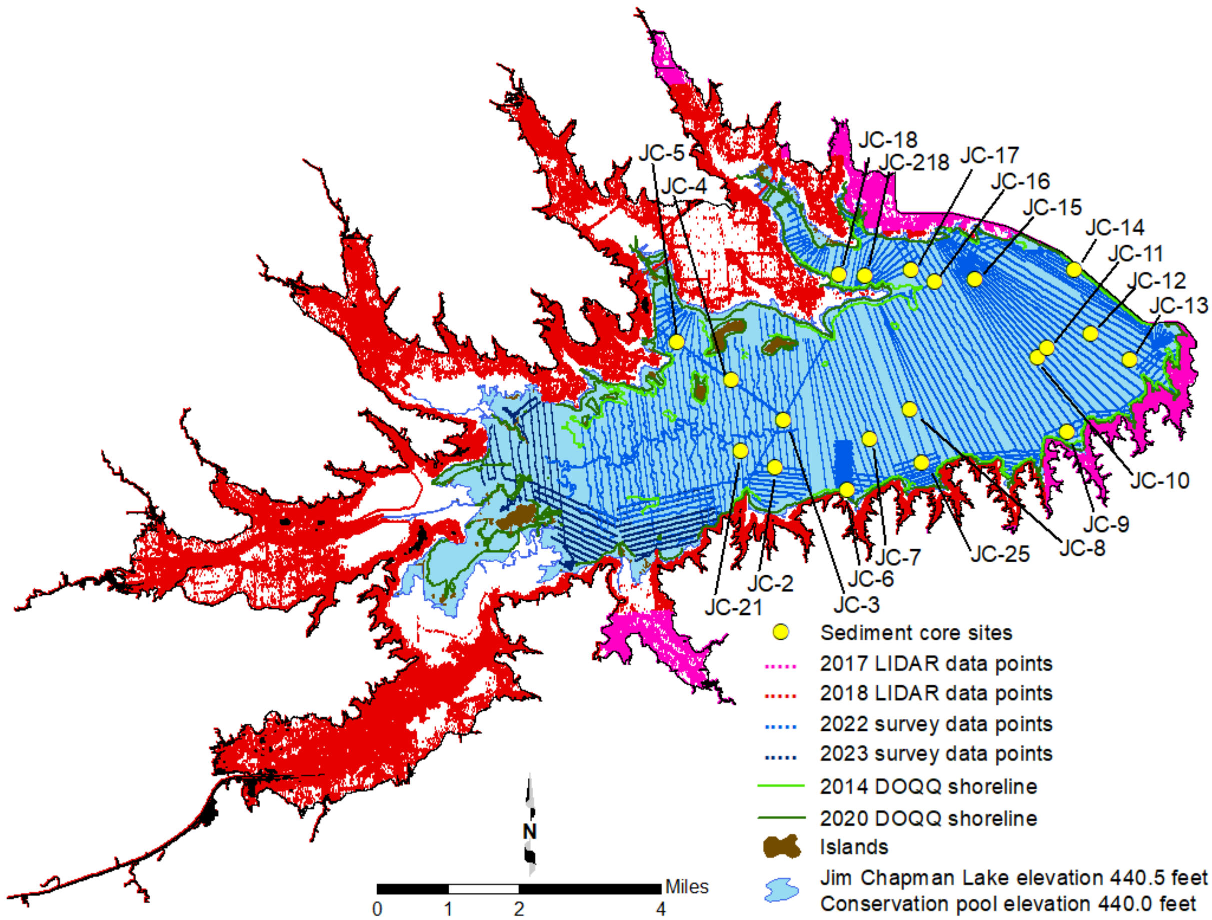


Figure 2. **2022 TWDB sounding data (*blue dots*), 2023 TWDB sounding data (*dark blue dots*), sediment coring locations (*yellow circles*), 2017 LIDAR data for topographic model (*pink dots*), and 2018 LIDAR data for topographic model (*red dots*), 2014 DOQQ shoreline (*light green lines*), and 2020 DOQQ shoreline (*dark green lines*).**

Data processing

Model boundary

The bathymetric model boundary of the reservoir was digitized from aerial photographs, also known as digital orthophoto quarter-quadrangle images (DOQQs), acquired by the National Agriculture Imagery Program (NAIP) and obtained from the Texas Natural Resources Information System (TNRIS) using Environmental Systems Research Institute's ArcGIS software (Texas Natural Resources Information System, 2014; Texas Natural Resources Information System, 2018; Texas Natural Resources Information System, 2020). DOQQs photographed on November 15, 2018, while the daily average water surface elevation measured 440.46 feet, were used to digitize a model boundary at the land-water interface. For modeling purposes, the boundary was assigned an elevation of 440.5 feet. Additional boundary information was obtained from aerial photographs taken on July 12, 2014, and November 1, 2020, while the daily average water surface elevation measured 431.72 feet (NGVD29), and 436.46 feet (NGVD29), respectively, and added to the lake model as a hard line. The 2014 shoreline was verified against the 2022 survey data for accuracy and relevance.

The topographic model boundary of the reservoir was generated with Light Detection and Ranging (LIDAR) data available from the Texas Natural Resource Information System (TNRIS). Multiple LIDAR datasets were needed for complete coverage of Jim Chapman Lake acquired at different times. These data were collected on February 27, 2018, March 3, 2018, and March 7, 2018, while the daily average water surface elevation of the reservoir measured 446.88 feet, 448.18 feet, and 446.95 feet; and between December 29, 2016, and February 7, 2017, while the daily average water surface elevation of the reservoir measured between 436.27 and 436.40 feet. The LIDAR data files (.las) were imported into an LAS Dataset and the dataset was converted to a raster using a cell size of 1.0 meters by 1.0 meters. The horizontal datum of the LIDAR data is North American Datum 1983 (NAD83; meters) and the projection is Universal Transverse Mercator (UTM) Zone 15. The vertical datum is North American Vertical Datum 1988 (NAVD88; meters). A contour representing the top of the dam elevation of 141.5896 meters NAVD88, equivalent to 464.5 feet NGVD29, was extracted from the raster. The vertical datum transformation offset of 0.01 meters was used to convert from meters NAVD88 to meters NGVD29 before converting to feet NGVD29. The vertical datum transformation offset for the conversion from NAVD88 to NGVD29 was determined by applying the National Oceanic and Atmospheric Administration National Geodetic Survey's North American Data Conversion

(NADCON) software (National Geodetic Survey, 2022a) and Coordinate Conversion and Transformation Tool (NCAT) (National Geodetic Survey, 2022b) to a single reference point in the vicinity of the survey: the reservoir elevation gage *USGS 07342495 Jim L. Chapman Lk nr Cooper, TX Latitude 33º20'00" N, Longitude 95º37'30" W NAD27.* The topographic model contour was edited to close the contour across the dam and remove other artifacts. Horizontal coordinate transformations to NAD83 State Plane Texas North Central Zone (feet) coordinates were applied using the ArcGIS Project tool.

LIDAR data points

To utilize the LIDAR data in the reservoir topographic model, the LIDAR data files (.las) were converted to a multipoint feature class in an Environmental Systems Research Institute's ArcGIS file geodatabase filtered to include only data classified as ground points. A topographical model of the data was generated. The ArcGIS tool Terrain to Points was used to extract points from the Terrain, or topographical model, of the reservoir. The Terrain was created using the z-tolerance Pyramid Type. Points were extracted from the terrain at the z-tolerance level of 0.25 meters. New attribute fields were added to convert the elevations from meters NAVD88 to meters NGVD29, then feet NGVD29 for compatibility with the bathymetric survey data. The feature class was then projected to NAD83 State Plane Texas North Central Zone (feet).

Triangulated Irregular Network model

Following completion of data collection, the raw data files collected by the TWDB were edited to remove data anomalies. The current bottom surface of the reservoir is automatically determined by the data acquisition software. Hydropick software, developed by TWDB staff, was used to display, interpret, and edit the multi-frequency data by manually removing data anomalies in the current bottom surface and to manually edit the pre-impoundment surfaces. The speed of sound profiles, also known as velocity casts, were used to further refine the measured depths. For each location where velocity casts are collected, the harmonic mean sound speed of all the casts is calculated. From this, depths collected using one average speed of sound are corrected with an overall optimum speed of sound for each specific depth (Specialty Devices, Inc., 2018).

All data were exported into a single file, including the current reservoir bottom surface, pre-impoundment surface, and sediment thickness at each sounding location. The water surface elevation at the time of each sounding was used to convert each sounding depth to a corresponding reservoir-bottom elevation. This survey point dataset was then preconditioned by inserting a uniform grid of artificial survey points between the actual survey lines. Bathymetric elevations at these artificial points were determined using an anisotropic spatial interpolation algorithm described in the next section. This technique creates a high resolution, uniform grid of interpolated bathymetric elevation points throughout a majority of the reservoir (McEwen *et al.* 2011a). The resulting point file was 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 (Environmental Systems Research Institute, 1995).

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 bathymetry between survey lines common to reservoir surveys. Reservoirs and stream channels are anisotropic morphological features where bathymetry at any particular location is more similar 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 artifacts may 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, and 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, the TWDB developed various anisotropic spatial interpolation techniques. Generally, the directionality of interpolation at different locations of a reservoir can be determined from external data sources. A basic assumption is that the reservoir profile in the vicinity of a particular location has upstream and downstream similarity. In addition, the sinuosity and directionality of submerged stream channels can be determined by directly examining the survey data, or more robustly by examining scanned USGS 7.5-minute quadrangle maps (DRGs), hypsography files (the vector format of USGS 7.5-minute quadrangle map contours), and historical aerial photographs, when available. Using the survey data, polygons are created to partition the reservoir into segments with centerlines defining the directionality of interpolation within each segment. Using the interpolation definition files and survey data, the current reservoir-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 reservoir bathymetry and sediment accumulation throughout the reservoir. Specific details of this interpolation technique can be found in the HydroTools manual (McEwen and others, 2011a) and in McEwen and others (2011b).

In areas inaccessible to survey data collection, such as small coves and shallow upstream areas of the reservoir, linear interpolation is used for volumetric and sediment accumulation estimations (McEwen and others, 2011a). Although LIDAR was utilized, linear interpolation was necessary to accurately model features in the areas between survey data and LIDAR data. Linear interpolation results in improved elevation-capacity and elevation-area calculations.

Figure 3 illustrates typical results from application of the anisotropic interpolation as applied to Jim Chapman Lake. In Figure 3A, deeper channels and steep slopes 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 in creation of the volumetric TIN model, represented in Figure 3B, directs Delaunay triangulation to better represent the reservoir bathymetry between survey cross-sections. The bathymetry shown in Figure 3C was used in computing reservoir elevation-capacity (Appendix E, I) and elevation-area (Appendix F, J) tables.

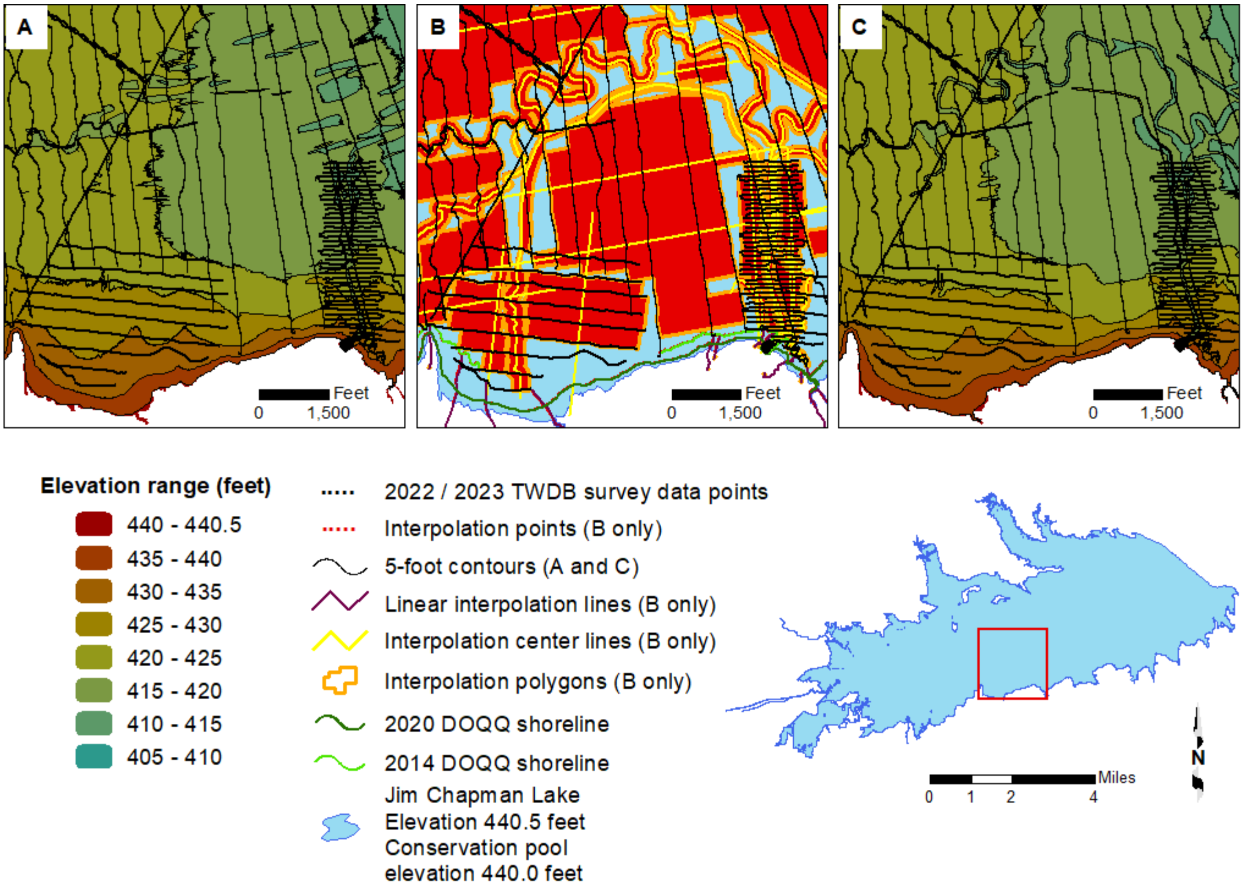


Figure 3. **Anisotropic spatial interpolation as applied to Jim Chapman Lake sounding data; A) bathymetric contours without interpolated points, B) sounding points (*black*) and interpolated points (*red*), C) bathymetric contours with interpolated points.**

Although spatial interpolation using Self-Similar Interpolation was originally applied to TWDB's previous survey of Jim Chapman (Texas Water Development Board, 2008), in 2017, the TWDB updated those results to account for flat triangles created in the TIN model at each elevation a model contour was input. Areas were adjusted using a cubic spline method and capacities were calculated based on the corrected areas (Texas Water Development Board, 2016). The re-calculated elevation-capacity table and elevation-area table are presented in Appendices A and B, respectively. The re-calculated capacity curve is presented in Appendix C, and the re-calculated area curve is presented in Appendix D.

Area, volume, and contour calculation

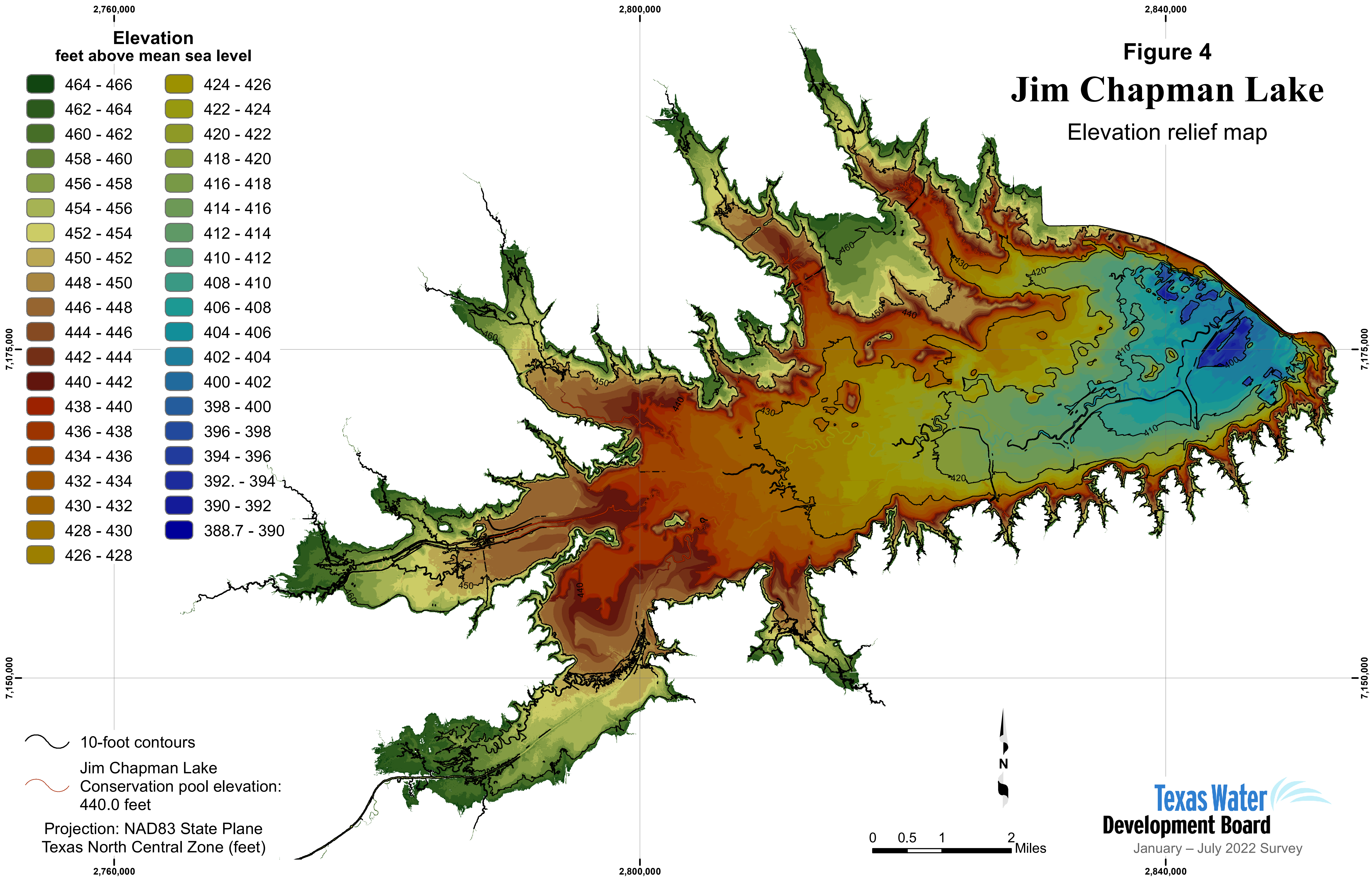
Volumes and areas were computed for the entire reservoir at 0.1-foot intervals, from 388.6 to 440.5 feet for the bathymetric TIN model, and from 388.6 to 464.5 feet for the bathymetric and topographic TIN model. While linear interpolation was used to estimate the topography in areas without data, flat triangles led to anomalous area and volume calculations at the boundary elevations of 436.46 and 440.50 feet. Therefore, areas between 436.3 feet and 440.50 feet were linearly interpolated between the computed values, and volumes above 436.3 feet were calculated based on the corrected areas. The bathymetric elevation-capacity table and bathymetric elevation-area table, based on the 2022 survey and analysis, are presented in Appendices E and F, respectively. The bathymetric capacity curve is presented in Appendix G, and the bathymetric area curve is presented in Appendix H. The topographic elevation-capacity table and topographic elevation-area table developed from the 2022 survey and analysis are presented in Appendices I and J, respectively. The topographic capacity curve is presented in Appendix K, and the topographic area curve is presented in Appendix L.

The bathymetric volumetric TIN model was converted to a raster representation using a cell size of 2 feet by 2 feet. The raster data then were used to produce three figures: (1) an elevation relief map representing the topography of the reservoir bottom (Figure 4); (2) a depth range map showing depth ranges for Jim Chapman Lake (Figure 5); and (3) a 5-foot contour map (Figure 6).

Figure 4

Jim Chapman Lake

Elevation relief map



Texas Water Development Board

January – July 2022 Survey

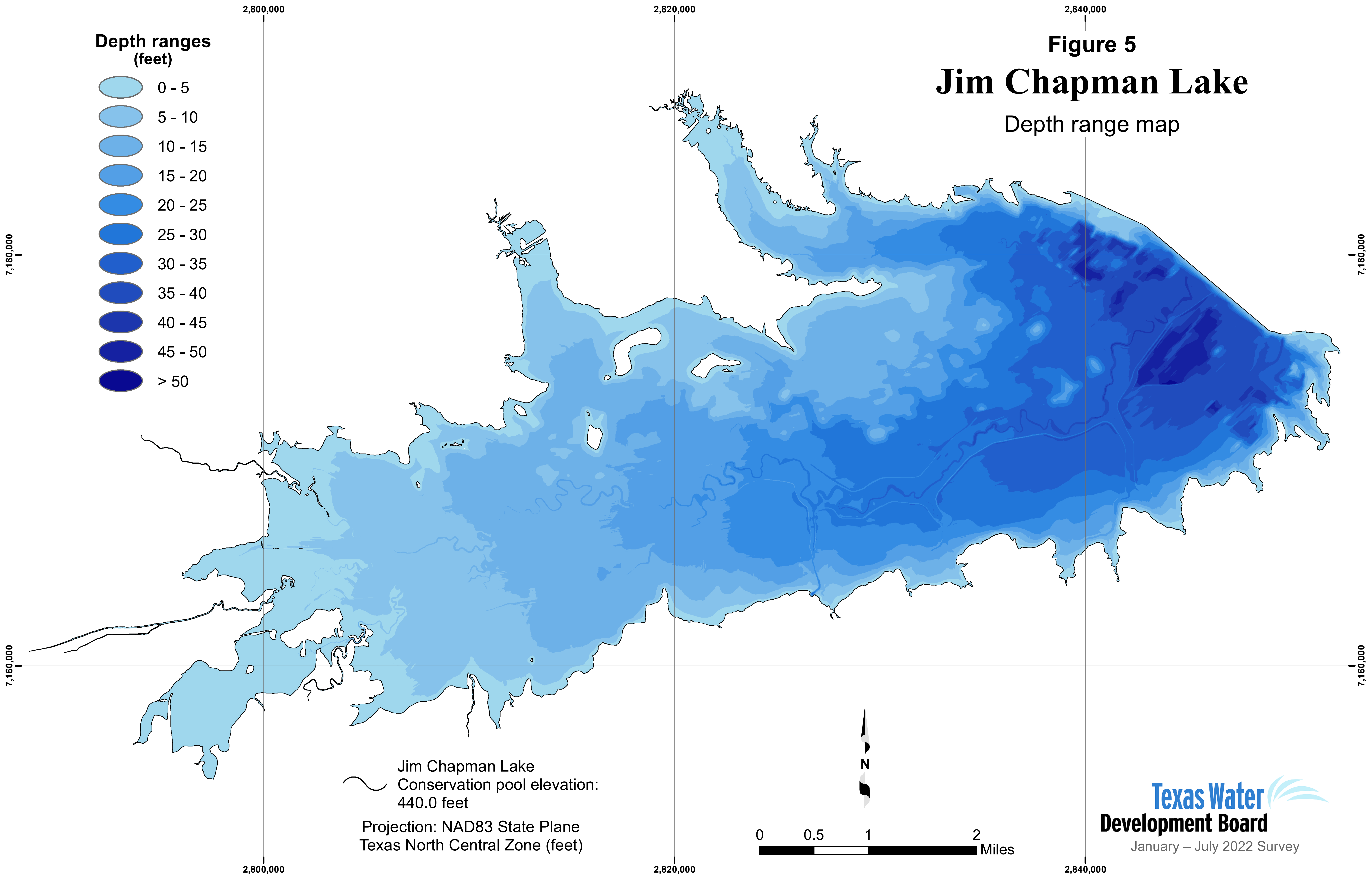


Figure 5
Jim Chapman Lake
Depth range map
Depth ranges (feet)
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
> 50
2,800,000
2,820,000
2,840,000
7,180,000
7,160,000
Jim Chapman Lake
Conservation pool elevation:
440.0 feet
Projection: NAD83 State Plane
Texas North Central Zone (feet)
N
0
0.5
1
2
Miles
Texas Water
Development Board
January – July 2022 Survey

Analysis of sediment data from Jim Chapman Lake

Sedimentation in Jim Chapman Lake was determined by analyzing the acoustic signal returns of all three depth sounder frequencies using customized software called Hydropick. While the 200 kHz signal is used to determine the current bathymetric surface, the 200 kHz, 50 kHz, and 12 kHz are analyzed to determine the reservoir bathymetric surface at the time of initial impoundment, *i.e.*, pre-impoundment surface. Sediment core samples collected in the reservoir are correlated with the acoustic signals in each frequency to assist in identifying the pre-impoundment surface. The difference between the current surface bathymetry and the pre-impoundment surface bathymetry yields a sediment thickness value at each sounding location.

Sediment cores were analyzed at TWDB headquarters in Austin. Each core was split longitudinally and analyzed to identify the location of the pre-impoundment surface. The pre-impoundment surface was identified within the sediment core using 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) recording changes in texture from well sorted, relatively fine-grained sediment to poorly sorted mixtures of coarse and fine-grained materials; and, (3) identifying variations in the physical properties of the sediment, particularly sediment water content and penetration resistance with depth (Van Metre and others, 2004). Total sediment core length, post impoundment sediment thickness, and pre-impoundment thickness were recorded. Physical characteristics of the sediment core, such as Munsell soil color, texture, relative water content, and presence of organic materials are presented in Table 2.

Table 2. Sediment core sample analysis data.

Sediment core sample	Easting[a] (feet)	Northing[a] (feet)	Total core sample / post-impoundment sediment length (inches)	Sediment core description[b]		Munsell soil color
JC-1	2812058.59	7165271.99	N/A	N/A	No recovery, submerged obstructions, non-navigable area	N/A
JC-2	2821696.15	7165508.39	5.5 / 2.5	post-impoundment	0.0–2.5" high water content, silty clay, smooth, soupy, uniform consistency and texture throughout	2.5Y 3/1 very dark gray
				pre-impoundment	2.5–5.5" low water content, clay, malleable, dense, similar to playdough, uniform consistency and texture throughout	2.5Y 3/1 very dark gray
JC-3	2822298.23	7169046.09	3.5 / N/A	post-impoundment	0.0–3.5" low water content, silty clay, loosely packed, easily crumbles, large hard bits of clay mixed throughout, malleable, organic material present throughout (fibrous roots and small stems)	2.5Y 3/1 very dark gray
JC-4	2818451.99	7172015.69	19.0 / 15.0	post-impoundment	0.0–1.0" very high water content, fine silt, soupy, smooth	2.5Y 3/1 very dark gray
					1.0−15.0" high water content, silty clay, pudding like, very smooth, fine bits of clay present at bottom of layer	3.5Y 3/1 very dark gray
				pre-impoundment	15.0–19.0" low water content, clay, top of layer loosely packed, malleable, density increases with depth, organic material present (fibrous roots)	2.5Y 2.5/1 black
JC-5	2814327.71	7174793.23	15.0 / 13.0	post-impoundment	0.0–13.0" high water content, silty clay, small bits of clay, pudding like, uniform consistency and texture throughout	2.5Y 3/1 very dark gray
				pre-impoundment	13.0–15.0" low water content, clay, malleable, dense, organic material present throughout (fibrous roots)	2.5Y 2.5/1 black
JC-6	2827059.79	7163852.50	84.0 / 75.0	post-impoundment	0.0–2.0" very high water content, fine silt, soupy, smooth	2.5Y 3/1 very dark gray
					2.0–75.0" high to moderate water content, water content decreases with depth, silty clay, smooth, sticky, pudding to peanut butter like consistency with increases in depth, density increases with depth, organic material sparsely present with no consistency (fibrous roots)	2.5Y 3/1 very dark gray
				pre-impoundment	75.0–84.0" low water content, silty clay, dense, uniform texture throughout, organic material present (fibrous roots and detritus)	5Y 4/2 olive gray

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

b. Sediment core samples are measured in inches with zero representing the current bottom surface.

Table 2 (continued). Sediment core sample analysis data.

Sediment core sample	Easting[a] (feet)	Northing[a] (feet)	Total core sample / post-impoundment sediment length (inches)	Sediment core description[b]		Munsell soil color
JC-7	2828747.42	7167639.44	120.0 / N/A	post-impoundment	0.0–120.0" high to moderate water content, water content decreases with depth, silty clay, smooth, sticky, pudding to peanut butter like consistency with increases in depth, density increases with depth, uniform texture throughout	2.5Y 3/1 very dark gray
JC-8	2831727.65	7169774.75	13.0 / 9.0	post-impoundment	0.0–9.0" high water content, silty clay, smooth, soupy at top of layer, peanut butter like, small bits of clay throughout, uniform texture throughout, larger bits of clay near bottom of layer	5Y 3/2 dark olive gray
				pre-impoundment	9.0–13.0" low water content, clay, malleable, top of layer loose with bit of clay, density increases with depth	10YR 3/1 very dark gray
JC-9	2843448.96	7168091.52	35.0 / 28.0	post-impoundment	0.0–3.0" high water content, silt, soupy, smooth	2.5Y 3/1 very dark gray
					3.0–15.0" moderate water content, silty clay, peanut butter like, bits of clay sporadically mixed in, clay bits add to density, organic material present	2.5Y 3/1 very dark gray
					15.0–17.0" moderate water content, silty clay mixed with a layer of organic material, organic material present (detritus, small woody debris, and fibrous roots)	2.5Y 3/1 very dark gray
					17.0–28.0" moderate water content, silty clay, smooth, peanut butter like, more dense than previous layer, uniform consistency and texture throughout	2.5Y 3/1 very dark gray
				pre-impoundment	28.0–35.0" moderate to low water content, water content decreases with depth, silty clay, malleable, playdough consistency, organic material present throughout (woody debris at top of layer, dendritic and fibrous roots throughout)	2.5Y 2.5/1 black
JC-10	2841193.86	7173678.33	120.0 / N/A	post-impoundment	0.0–120.0" moderate water content, silty clay, smooth, peanut butter like consistency, density increases with depth, uniform consistency and texture throughout, streaks of black coloration, organic material present (sparse charcoal deposits and vegetation)	2.5Y 3/1 very dark gray 2.5Y 2.5/1 black

a. Coordinates are based on NAD83 State Plane Texas North Central System (feet).
b. Sediment core samples are measured in inches with zero representing the current bottom surface.

Table 2 (continued). Sediment core sample analysis data.

Sediment core sample	Easting[a] (feet)	Northing[a] (feet)	Total core sample / post-impoundment sediment length (inches)	Sediment core description[b]		Munsell soil color
JC-11	2841931.46	7174387.05	23.0 / 13.0	post-impoundment	0.0−13.0” high to moderate water content, water content decreases with depth, silty clay, smooth with small bits of clay near the bottom of the layer, pudding like, uniform consistency and texture throughout	2.5Y 3/1 very dark gray
				pre-impoundment	13.0–23.0” moderate to low water content, water content decreases with depth, silty clay, malleable, density increases with depth, organic material present (fibrous roots and stems, woody debris at 21 inches)	2.5Y 2.5/1 black
JC-12	2845187.71	7175439.30	103.0 / 99.0	post-impoundment	0.0–6.0” very high water content, silty clay, soupy, smooth	2.5Y 3/1 very dark gray
					6.0–99.0” high to low water content, water content decreases with depth, silty clay, smooth, sticky, pudding to peanut butter like consistency with increases in depth, density increases with depth, black streaks found at 61, 78, and 93 inches	2.5Y 4/1 dark gray
				pre-impoundment	99.0–103.0” low water content, clay, malleable, dense	2.5Y 4/1 dark gray
JC-13	2848072.24	7173540.31	53.0 / 44.0	post-impoundment	0.0–3.0” very high water content, silt, soupy, smooth	5Y 3/2 dark olive gray
					3.0−25.0” high to moderate water content, water content decreases with depth, silty clay, smooth, pudding like, uniform consistency and texture throughout	5Y 3/1 very dark gray
					25.0–34.0” moderate water content, silty clay with various sized bits of clay throughout, pudding like, uniform consistency and texture throughout	5Y 3/1 very dark gray
					34.0−44.0” moderate water content, silty clay with various sized bits of clay throughout, larger quantity of clay bits then previous layer, more dense then previous layer, pudding like	5Y 3/1 very dark gray
				pre-impoundment	44.0–53.0” moderate to low water content, water content decreases with depth, silty clay, dense, malleable, hold shape, organic material present (fibrous roots and rocks)	5Y 4/2 olive gray

a. Coordinates are based on NAD83 State Plane Texas North Central System (feet).
b. Sediment core samples are measured in inches with zero representing the current bottom surface.

Table 2 (continued). Sediment core sample analysis data.

Sediment core sample	Easting[a] (feet)	Northing[a] (feet)	Total core sample / post-impoundment sediment length (inches)	Sediment core description[b]		Munsell soil color
JC-14	2843969.95	7180182.90	54.0 / 53.0	post-impoundment	0.0–1.0” very high, silt, soupy smooth	2.5Y 3/1 very dark gray
					1.0–3.0” high water content, silty clay, pudding like, uniform consistency and texture throughout	2.5Y 3/1 very dark gray
					3.0−39.0” high to moderate water content, water content decreases with depth, silty clay, very dense, more dense then previous layer, peanut butter like, uniform consistency and texture throughout, organic material present (macroinvertebrates)	2.5Y 3/1 very dark gray
					39.0−53.0” low water content, sandy clay, malleable, dense, uniform consistency and texture throughout	2.5Y 4/1 dark gray
				pre-impoundment	53.0–54.0” low water content, clay, malleable, playdough consistency	2.5Y 2.5/1 black
JC-15	2836598.96	7179492.66	30.0 / 25.0	post-impoundment	0.0−25.0” high to moderate water content, water content decreases with depth, silty clay, smooth, pudding to peanut butter like consistency with increases in depth, density increases with depth, uniform texture	2.5Y 3/1 very dark gray
				pre-impoundment	25.0−30.0” moderate to low water content, water content decreases with depth, clay, malleable, density increases with depth, organic material present throughout (fibrous roots)	2.5Y 2.5/1 black
JC-16	2833553.01	7179282.14	17.0 / 9.0	post-impoundment	0.0–9.0” moderate to low water content, water content decreases with depth, silty sand, fine grain sand, uniform consistency and texture throughout, density increases with depth, organic material present (1 inch piece of woody debris)	10YR 4/2 dark grayish brown
				pre-impoundment	9.0–17.0” low water content, sandy clay, malleable, dense, uniform consistency and texture throughout, organic material present throughout (fibrous roots)	2.5Y 2.5/1 black
JC-17	2831804.53	7180236.99	33.0 / 28.0	post-impoundment	0.0–2.0” high water content, silt, soupy, smooth	2.5Y 3/1 very dark gray

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

b. Sediment core samples are measured in inches with zero representing the current bottom surface.

Table 2 (continued). Sediment core sample analysis data.

Sediment core sample	Easting[a] (feet)	Northing[a] (feet)	Total core sample / post-impoundment sediment length (inches)	Sediment core description[b]		Munsell soil color
JC-17 (continued)	2831804.53	7180236.99	33.0 / 28.0	post-impoundment	2.0–28.0" high to moderate water content, water content decreases with depth, silty clay, smooth, pudding to peanut butter like consistency with increases in depth, density increases with depth, uniform texture throughout	2.5Y 3/1 very dark gray
				pre-impoundment	28.0−33.0" moderate to low water content, water content decreases with depth, clay, loosely packed at top, small granular bits of clay, density increases with depth, organic material present (woody debris)	2.5Y 2.5/1 black
JC-18	2826458.45	7179838.31	31.0 / N/A	post-impoundment	0.0−5.0" high water content, silty clay, smooth, pudding like, uniform consistency and texture throughout	2.5Y 3/1 very dark gray
					5.0−27.0" moderate water content, silty clay, more dense than previous layer, density increases with depth, small bits of clay at top of layer, bits of clay increase in size with depth, peanut butter like	2.5Y 3/1 very dark gray
					27.0−31.0" moderate water content, silty clay, loosely packed at top with small bits of clay, more dense than previous layer, gelatinous, uniform consistency and texture throughout	2.5Y 3/1 very dark gray
JC-21	2819111.61	7166699.73	21.0 / 27.0	post-impoundment	0.0–2.0" very high water content, fine silt, soupy, smooth	2.5Y 3/1 very dark gray
					2.0–14.0" high water content, silty clay, pudding like, uniform consistency and texture throughout, bits of clay near bottom of layer, organic material present (vegetation at 9 inches)	2.5y 2.5/1 black
					14.0−21.0" moderate water content, silty clay, pudding like, uniform consistency and texture throughout, density increases with depth	2.5Y 3/2 dark grayish brown
				pre-impoundment	21.0−27.0" low water content, clay, loosely packed at top, density increases with depth, malleable, holds shape, organic material present throughout (fibrous roots)	2.5Y 2.5/1 black
JC-25	2832615.32	7165821.89	15.0 / 6.0	post-impoundment	0.0–1.0" very high water content, fine silt, soupy, smooth	2.5Y 4/1 dark gray

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

b. Sediment core samples are measured in inches with zero representing the current bottom surface.

Table 2 (continued). Sediment core sample analysis data.

Sediment core sample	Easting[a] (feet)	Northing[a] (feet)	Total core sample / post-impoundment sediment length (inches)	Sediment core description[b]		Munsell soil color
JC-25 (continued)	2832615.32	7165821.89	15.0 / 6.0	post-impoundment	1.0–6.0" high water content, silty clay, pudding like, uniform consistency and texture throughout	2.5Y 3/1 very dark gray
				pre-impoundment	6.0−15.0" moderate to low water content, water content decreases with depth, clay, dense malleable, organic material present throughout(fibrous roots)	2.5Y 4/1 dark gray
JC-218	2828337.52	7179745.80	14.0 / 12.0	post-impoundment	0.0−12.0" high water content, silty clay, smooth, pudding like, small bits of clay, uniform consistency and texture throughout, organic material present throughout (sparse leaf litter, small twigs, and a 4-inch chunk of woody debris)	2.5Y 4/1 dark gray
				pre-impoundment	12.0−14.0" moderate water content, clay, loosely packed, peanut butter like, bits of clay throughout, organic material present (fibrous roots, twigs, and vegetation)	2.5Y 3/1 very dark gray

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

b. Sediment core samples are measured in inches with zero representing the current bottom surface.

A photograph of sediment core JC-15 (for location, refer to Figure 2) is shown in Figure 7. The base, or deepest part of the sample is denoted by the blue line. The pre-impoundment boundary (yellow line closest to the base) was evident within this sediment core sample at 25 inches and identified by the change in color, texture, moisture, porosity, and structure. Identification of the pre-impoundment surface for each sediment core followed a similar procedure.

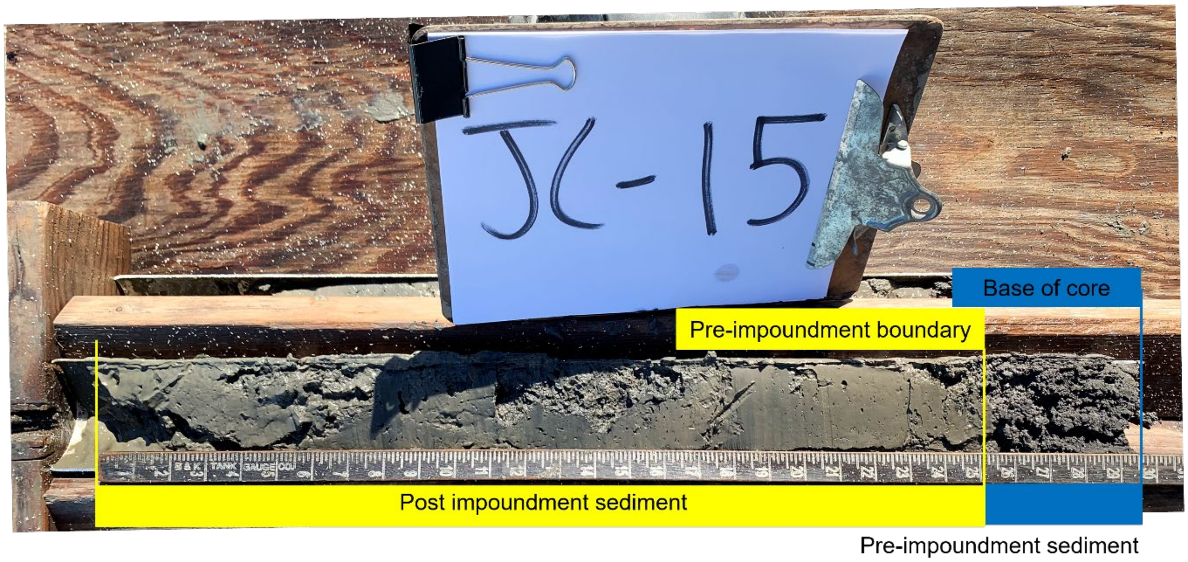


Figure 7. Sediment core JC-15. Post-impoundment sediment layers occur in the top 25 inches of this sediment core (identified by the yellow box). Pre-impoundment sediment layers were identified and are defined by the blue box.

Figure 8 illustrates the relationships between acoustic signal returns and the depositional layering seen in sediment cores. In this example, sediment core JC-15 is shown correlated with each frequency: 200 kHz, 50 kHz, and 12 kHz. The current bathymetric surface is determined based on signal returns from the 200 kHz transducer as represented by the top red line in Figure 8. The pre-impoundment surface is identified by comparing boundaries observed in the 200 kHz, 50 kHz, and 12 kHz signals to the location of the pre-impoundment surface of the sediment core sample. Many layers of sediment may be identified during analysis based on changes in observed characteristics such as water content, organic matter content, and sediment particle size, and each layer is classified as either post-impoundment or pre-impoundment. Yellow boxes represent post-impoundment sediments identified in the sediment core. Blue boxes indicate pre-impoundment sediments.

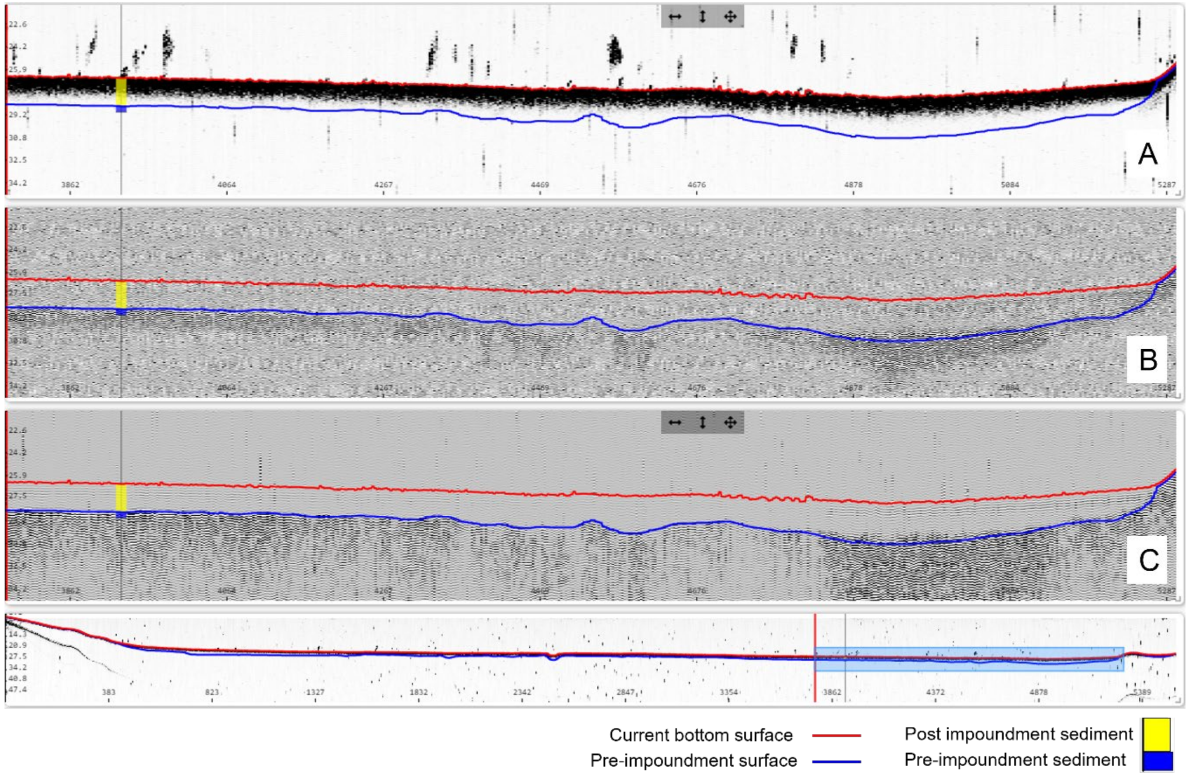


Figure 8. **Sediment core sample JC-15 compared with acoustic signal returns. A) 200 kHz frequency, B) 50 kHz frequency, and C) 12 kHz frequency.**

The pre-impoundment boundary in sediment core JC-15 most closely aligned with the different layers picked up by the 12 kHz acoustic returns (Figure 8). The pre-impoundment surface is first identified along cross-sections for which sediment core samples were collected. This information then is used as a guide for identifying the pre-impoundment surface along cross-sections where sediment core samples were not collected.

After the pre-impoundment surface for all cross-sections is identified, a pre-impoundment TIN model and a sediment thickness TIN model are created. Pre-impoundment elevations and sediment thicknesses are interpolated between surveyed cross-sections using HydroTools with the same interpolation definition file used for bathymetric interpolation. For the purposes of TIN model creation, the TWDB assumes the sediment thickness at the reservoir boundary is 0 feet (defined as the 440.5-foot elevation contour). The sediment thickness TIN model was converted to a raster representation using a cell size of 5 feet by 5 feet and was used to produce a sediment thickness map (Figure 9). Elevation-capacity and elevation-area tables were computed from the pre-impoundment TIN model for the purpose of calculating the total volume of accumulated sediment.

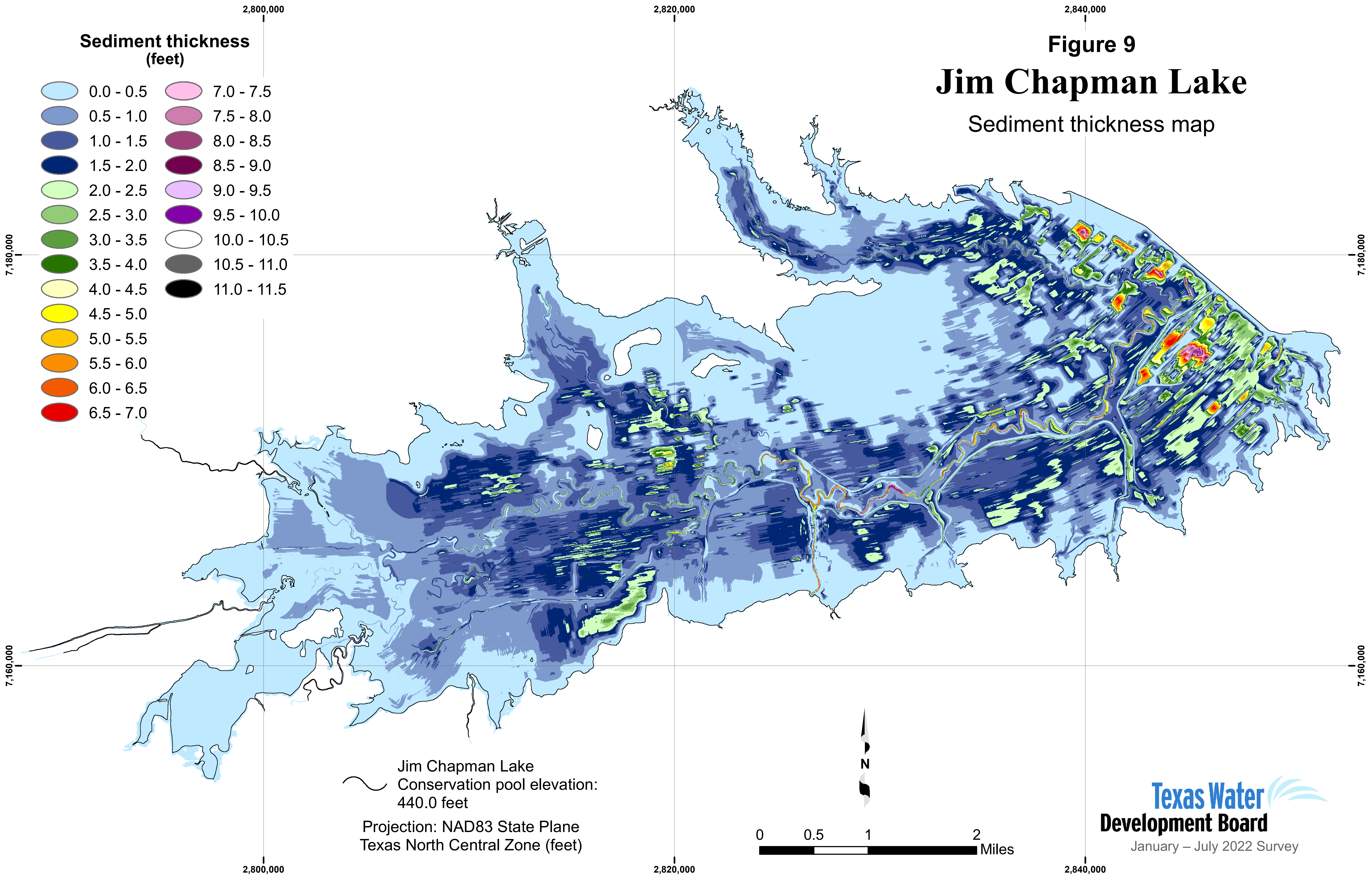


Figure 9
Jim Chapman Lake
Sediment thickness map
Sediment thickness
(feet)
0.0 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
2.5 - 3.0
3.0 - 3.5
3.5 - 4.0
4.0 - 4.5
4.5 - 5.0
5.0 - 5.5
5.5 - 6.0
6.0 - 6.5
6.5 - 7.0
7.0 - 7.5
7.5 - 8.0
8.0 - 8.5
8.5 - 9.0
9.0 - 9.5
9.5 - 10.0
10.0 - 10.5
10.5 - 11.0
11.0 - 11.5
2,800,000
2,820,000
2,840,000
7,180,000
7,160,000
Jim Chapman Lake
Conservation pool elevation:
440.0 feet
Projection: NAD83 State Plane
Texas North Central Zone (feet)
N
0
0.5
1
2
Miles
Texas Water
Development Board
January – July 2022 Survey

Survey results

Volumetric survey

The 2022 TWDB volumetric survey indicates that Jim Chapman Lake has a total reservoir capacity of 294,498 acre-feet and encompasses 17,998 acres at conservation pool elevation (440.0 feet NGVD29). Previous capacity estimates of Jim Chapman Lake include the original design estimate of 310,813 acre-feet (U.S. Army Corps of Engineers, 1987) and an estimate of 299,857 acre-feet re-calculated using data from TWDB's 2008 report (Texas Water Development Board, 2008). Current area and capacity estimates are compared to previous area and capacity estimates at different elevations in Table 3. Because of differences in past and present survey methodologies and technological improvements, direct comparison of volumetric surveys to others to estimate loss of area and capacity can be unreliable.

Table 3. Previous and current survey estimates.

Survey	Surface Area (acres)	Total Capacity (acre-feet)	Conservation Pool Elevation[a]	Source
U.S. Army Corps of Engineers original design	19,305	310,813	440.0	U.S. Army Corps of Engineers, 1987
TWDB 2005 / 2007	17,958	298,930	440.0	Texas Water Development Board, 2008
TWDB 2005 / 2007 re-calculated	17,958	299,857	440.0	Texas Water Development Board, 2016
TWDB 2022	17,998	294,498	440.0	

[a.] Feet above mean sea level, National Geodetic Vertical Datum 1929 (NGVD29).

Sedimentation survey

The 2022 TWDB sedimentation survey measured 16,652 acre-feet of sediment below conservation pool elevation (440.0 feet NGVD29). The sedimentation survey indicates sediment accumulation is greatest near the dam and in the submerged river channels. Comparison of capacity estimates of Jim Chapman Lake derived using differing methodologies are provided in Table 4 for sedimentation rate calculation.

Jim Chapman Lake is prone to periods of high inflow as well as periods of drought as seen in the water surface elevation records (Texas Water Development Board, 2023). The fluctuation in water levels makes it difficult to identify the pre-impoundment layer in the acoustic returns and can lead to an under or overestimate of sediment in these areas. Low water levels lead to the desiccation of any exposed sediment. For example, from 25

November 2005 to 20 March 2006; 15 June 2006 to 21 January 2007; 3 August 2013 to 8 May 2014; and 5 September 2014 to 25 February 2015 the water surface elevation of the reservoir measured at or below elevation 430.0 feet, falling below elevation 423.0 feet from October 24 to December 30, 2006. Upon inundation and re-saturation, exposed sediment will not return to its original high level of water content (Dunbar and Allen, 2003). Drying of sediment in exposed areas create hard surfaces that cannot be penetrated with gravity coring techniques, and compressive stresses on the sediments may also increase sediment density, inhibiting the measurement of the original, pre-impoundment surface. Density stratification in the sediment layers can also scatter and attenuate acoustic return signals of the multi-frequency depth sounder (U.S. Army Corps of Engineers, 2013).

The 2022 TWDB sedimentation survey indicates Jim Chapman Lake has lost capacity at an average of 537 acre-feet per year since impoundment due to sedimentation below conservation pool elevation (440.0 feet NGVD29) (Table 4). Any changes to the hydrologic system that contribute runoff to the reservoir, including changes in vegetative cover, land use, or frequency and intensity of rainfall events, can impact the local rate of sedimentation. Because methodological and technological changes from one survey to the next yield inconsistencies in capacity loss rates, long term capacity calculations, computed by plotting all capacity estimates and calculating a linear regression line, reduces the effect of individual survey error. As illustrated in Figure 10, long-term trends indicate Jim Chapman Lake loses capacity at an average of 548 acre-feet per year since impoundment due to sedimentation below conservation pool elevation (440.0 feet NGVD29).

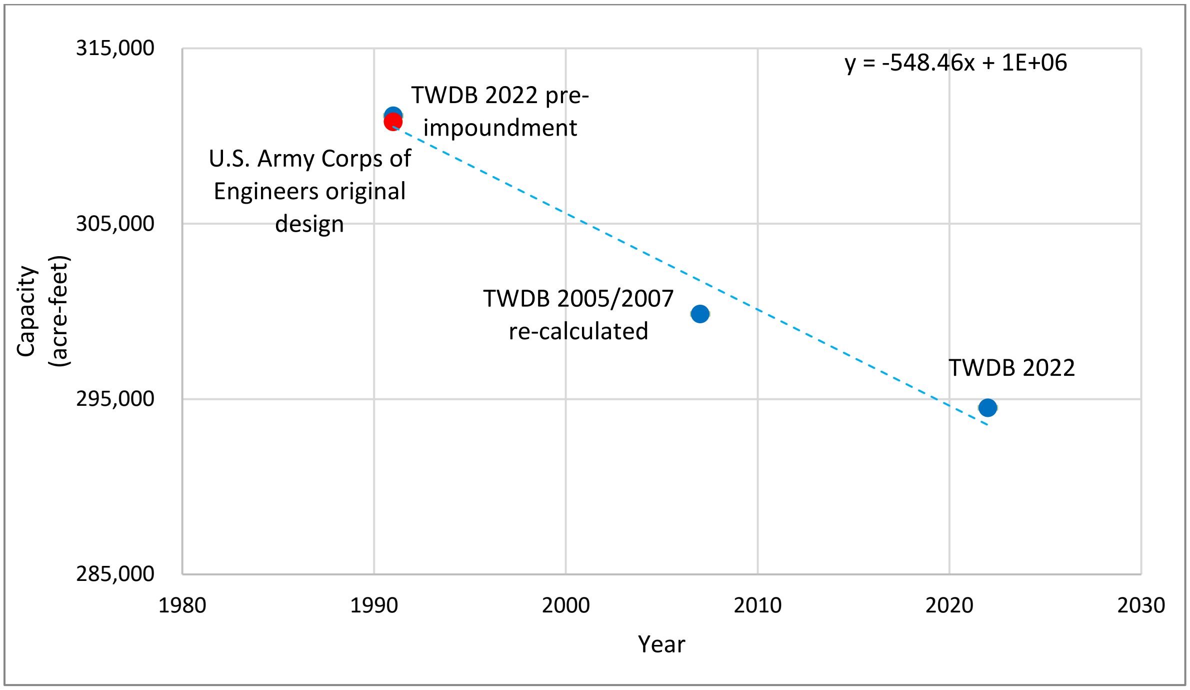


Figure 10. **Plot of current and previous capacity estimates (acre-feet). Capacity estimates for each TWDB survey plotted as blue dots and other surveys as red dots. The blue trend line illustrates the total average loss of capacity through 2022.**

Table 4. Average annual capacity loss comparisons.

Survey comparisons	U.S. Army Corps of Engineers original design[b] versus TWDB 2022	TWDB 2005 / 2007[c] versus TWDB 2022	TWDB 2022 pre-impoundment estimate Versus TWDB 2022
Total capacity (acre-feet) at top of conservation pool elevation 440.0 feet[a]	310,813	<>	<>
	<>	299,857	<>
	<>	<>	311,150
	294,498	294,498	294,498
Volume difference (acre-feet)	16,315	5,359	16,652
Percent change	5.25	1.79	5.35
Number of years[d]	31	15	31
Capacity loss rate (acre-feet/year)	526	357	537
Capacity loss rate (acre-feet/square mile of drainage area of 479 square miles /year)	1.1	0.75	1.1

a. Feet above mean sea level, National Geodetic Vertical Datum 1929 (NGVD29).
b. U.S. Army Corps of Engineers, 1987
c. Texas Water Development Board, 2016
d. Source: U.S. Army Corps of Engineers, 2023a; Cooper Dam was completed, and deliberate impoundment began on September 28, 1991.

Sediment range lines

Sediment range lines for Jim Chapman Lake were established to measure sediment accumulation over time. The TWDB digitized the location of three range lines from the A.I.D Associates, Inc., Lake Map of Cooper Lake, 3rd Edition maps (A.I.D Associates, Inc. 2003). A cross-sectional comparison of the three sediment range lines comparing the previous volumetric surface with the current volumetric surface is presented in Appendix M. Appendix M includes a map depicting the locations of the sediment range lines and a list of the endpoint coordinates for each line (Table M1). Some differences between the TWDB cross-sections may be a result of data availability, spatial interpolation, and the interpolation routine of the TIN Model.

Recommendations

The TWDB recommends a detailed analysis of sediment deposits in the areas where exposure of the lake bottom may have led to identification of a false pre-impoundment using augured-coring techniques, as well as a repeat volumetric and sedimentation survey in 10 years or after a major high flow event to further improve estimates of sediment accumulation rates.

TWDB contact information

For more information about the TWDB Hydrographic Survey Program, visit www.twdb.texas.gov/surfacewater/surveys. Any questions regarding the TWDB Hydrographic Survey Program or this report may be addressed to: Hydrosurvey@twdb.texas.gov.

References

A.I.D Associates, Inc. 2003, Lake Map of Cooper Lake, 3rd Edition, Dallas, Texas

Dunbar, J.A. and Allen, P.M., 2003, Sediment Thickness from Coring and Acoustics within Lakes Aquilla, Granger, Limestone, and Proctor: Brazos River Watershed, TX: Baylor University, Department of Geology.

Environmental Systems Research Institute, 1995, ARC/INFO Surface Modeling and Display, TIN Users Guide: ESRI, California.

McEwen, T., Brock, N., Kemp, J., Pothina, D. and Weyant, H., 2011a, HydroTools User's Manual: Texas Water Development Board.

McEwen, T., Pothina, D. and Negusse, S., 2011b, Improving efficiency and repeatability of lake volume estimates using Python: Proceedings of the 10th Python for Scientific Computing Conference.

National Geodetic Survey, 2022a, NADCON computations, accessed August 3, 2022, http://www.ngs.noaa.gov/cgi-bin/nadcon.prl.

National Geodetic Survey, 2022b, NGS Coordinate Conversion and Transformation Tool, accessed August 3, 2022, https://geodesy.noaa.gov/NCAT/.

Specialty Devices, Inc., 2018, SDI DepthPic post-processing software instruction manual: Wylie, Texas, Specialty Devices, Inc., p. 45.

Texas Commission on Environmental Quality, 2023, Texas Water Rights Viewer, accessed March 13, 2023, at https://tceq.maps.arcgis.com/apps/webappviewer/index.html?id=44adc80d90b749cb85cf39e04027dbdc.

Texas Natural Resources Information System, 2014, TNRIS DataHub, Texas NAIP Imagery, accessed March 14, 2023, at https://data.tnris.org/collection?c=e7d2ccee-5288-4257-85bc-e4a2babf91ee#5.26/31.311/-100.094.

Texas Natural Resources Information System, 2018, TNRIS DataHub, Texas NAIP Imagery, accessed March 14, 2023, at https://data.tnris.org/collection?c=f1d66250-4021-47df-9fe9-9fca286b0f50#5.3/31.459/-100.094.

Texas Natural Resources Information System, 2020, TNRIS DataHub, Texas NAIP Imagery, accessed March 14, 2023, at https://data.tnris.org/collection?c=aa5183ca-a1bd-4b5f-9b63-4ba48d01b83d#5.25/31.234/-100.42.

Texas Water Development Board, 2008, Volumetric Survey of Jim Chapman Lake, accessed October 31, 2022, at https://www.twdb.texas.gov/hydro_survey/JimChapman/2007-07/.

Texas Water Development Board, 2016, Application of New Procedures to Re-Assess Reservoir Capacity, accessed June 16, 2021, at http://www.twdb.texas.gov/hydro_survey/Re-assessment/ReassessOldSurveys_Draft4Comment.pdf.

Texas Water Development Board, 2022, Contract No. 2248012618 with the North Texas Municipal Water District.

Texas Water Development Board, 2023, Water Data for Texas, accessed June 9, 2023, at https://www.waterdatafortexas.org/reservoirs/individual/jim-chapman.csv.

U.S. Army Corps of Engineers, 1987, Cooper Lake Master Plan, Design Memorandum No. 10, accessed August 19, 2022, at https://www.swf.usace.army.mil/Portals/47/docs/Lakes/JimChapman/MasterPlan/2-Cooper_Master_Plan_DM_10_1987.pdf?ver=7cS_BvSSCMG4scREY9xgeQ%3d%3d.

U.S. Army Corps of Engineers, 2013, Engineering and Design, Hydrographic Surveying - Engineer Manual, EM 1100-2-1003 (30 Nov 13): U.S. Army Corps of Engineers, Appendix P.

U.S. Army Corps of Engineers, 2023a, Pertinent Data – Cooper Dam and Jim Chapman Lake, accessed March 13, 2023, at https://www.swf-wc.usace.army.mil/pertdata/sclt2.pdf.

U.S. Army Corps of Engineers, 2023b, History of Jim Chapman Lake/ Cooper Dam, accessed March 13, 2023, at https://www.swf-wc.usace.army.mil/cooper/Information/History.shtml.

U.S. Geological Survey, 2022, U.S. Geological Survey National Water Information System: Web Interface, USGS 07342495 Jim L. Chapman Lk nr Cooper, TX, accessed August 29, 2022, at https://waterdata.usgs.gov/nwis/dv?referred_module=sw&site_no=07342495.

Van Metre, P.C., Wilson, J.T., Fuller, C.C., Callender, E., and Mahler, B.J., 2004, Collection, analysis, and age-dating of sediment cores from 56 U.S. lakes and reservoirs sampled by the U.S. Geological Survey, 1992-2001: U.S. Geological Survey Scientific Investigations Report 2004-5184, 180 p

Appendix A

Jim Chapman Lake

RESERVOIR CAPACITY TABLE

TEXAS WATER DEVELOPMENT BOARD | 2005 / 2007 Survey re-calculated May 2017[a,b]
CAPACITY IN ACRE-FEET | Conservation Pool Elevation 440.0 feet NGVD29
ELEVATION INCREMENT IS ONE TENTH FOOT

ELEVATION (FEET NGVD29)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
393	0	0	0	0	0	0	0	0	0	0
394	0	0	0	0	0	0	0	0	0	0
395	0	0	0	0	0	0	0	0	0	0
396	0	0	0	0	0	0	0	0	1	1
397	1	1	1	1	1	1	1	1	1	1
398	1	1	1	1	2	2	2	2	2	2
399	2	2	3	3	3	3	3	4	4	5
400	5	6	16	35	59	87	120	156	196	239
401	286	335	386	441	499	559	622	688	756	827
402	901	976	1,055	1,135	1,219	1,305	1,394	1,485	1,578	1,673
403	1,771	1,871	1,974	2,079	2,186	2,296	2,409	2,523	2,641	2,760
404	2,882	3,007	3,133	3,263	3,395	3,529	3,667	3,806	3,949	4,094
405	4,241	4,392	4,546	4,703	4,864	5,028	5,195	5,365	5,539	5,716
406	5,896	6,079	6,265	6,454	6,647	6,844	7,044	7,248	7,455	7,664
407	7,877	8,093	8,313	8,536	8,762	8,992	9,225	9,461	9,701	9,943
408	10,189	10,437	10,689	10,945	11,203	11,464	11,729	11,996	12,267	12,541
409	12,818	13,100	13,385	13,673	13,967	14,264	14,565	14,870	15,178	15,491
410	15,808	16,129	16,455	16,785	17,119	17,457	17,798	18,143	18,492	18,844
411	19,199	19,558	19,921	20,287	20,656	21,029	21,406	21,786	22,170	22,557
412	22,947	23,341	23,738	24,139	24,543	24,950	25,361	25,774	26,190	26,610
413	27,032	27,458	27,887	28,319	28,753	29,191	29,632	30,076	30,523	30,973
414	31,426	31,883	32,342	32,805	33,270	33,738	34,210	34,685	35,163	35,645
415	36,130	36,618	37,109	37,602	38,099	38,598	39,099	39,604	40,111	40,622
416	41,136	41,653	42,173	42,696	43,222	43,752	44,284	44,820	45,359	45,900
417	46,445	46,992	47,542	48,095	48,651	49,210	49,772	50,337	50,905	51,476
418	52,051	52,628	53,209	53,793	54,380	54,970	55,562	56,158	56,756	57,358
419	57,962	58,569	59,180	59,792	60,408	61,027	61,648	62,273	62,900	63,531
420	64,164	64,801	65,441	66,083	66,729	67,378	68,030	68,685	69,343	70,004
421	70,668	71,335	72,005	72,678	73,354	74,033	74,716	75,401	76,090	76,782
422	77,478	78,177	78,880	79,586	80,295	81,009	81,727	82,449	83,176	83,907
423	84,643	85,383	86,127	86,876	87,631	88,390	89,154	89,923	90,696	91,475
424	92,257	93,045	93,837	94,635	95,437	96,245	97,058	97,876	98,700	99,530
425	100,366	101,208	102,056	102,910	103,771	104,639	105,513	106,392	107,278	108,169
426	109,066	109,969	110,879	111,797	112,723	113,655	114,595	115,541	116,495	117,456
427	118,434	119,408	120,388	121,374	122,366	123,366	124,373	125,387	126,410	127,440
428	128,478	129,523	130,575	131,633	132,698	133,769	134,847	135,931	137,022	138,120
429	139,225	140,338	141,457	142,581	143,712	144,849	145,991	147,138	148,292	149,451
430	150,616	151,786	152,963	154,145	155,333	156,526	157,726	158,931	160,142	161,358
431	162,581	163,810	165,045	166,286	167,534	168,789	170,050	171,317	172,591	173,871
432	175,157	176,450	177,750	179,055	180,367	181,686	183,011	184,342	185,681	187,029
433	188,386	189,752	191,126	192,510	193,902	195,303	196,713	198,132	199,559	200,996
434	202,441	203,895	205,355	206,821	208,293	209,770	211,253	212,741	214,236	215,736
435	217,242	218,754	220,271	221,794	223,323	224,858	226,398	227,944	229,496	231,054
436	232,617	234,186	235,761	237,342	238,928	240,520	242,118	243,721	245,330	246,945
437	248,566	250,193	251,825	253,463	255,106	256,756	258,411	260,072	261,739	263,411
438	265,089	266,773	268,463	270,158	271,859	273,566	275,279	276,997	278,721	280,451
439	282,186	283,928	285,675	287,427	289,186	290,950	292,720	294,496	296,277	298,064
440	299,857									

Note: Capacities between elevations 426.0 and 427.0 feet and 429.5 and 440.0 feet calculated from interpolated areas

[a]Texas Water Development Board, 2008, Volumetric Survey of Jim Chapman Lake, accessed October 31, 2022, at https://www.twdb.texas.gov/hydro_survey/JimChapman/2007-07/.

[b]Texas Water Development Board, 2016, Application of New Procedures to Re-Assess Reservoir Capacity, accessed June 16, 2021, at http://www.twdb.texas.gov/hydro_survey/Re-assessment/ReassessOldSurveys_Draft4Comment.pdf.

Appendix B

Jim Chapman Lake

RESERVOIR AREA TABLE

TEXAS WATER DEVELOPMENT BOARD — 2005 / 2007 Survey re-calculated May 2017[a,b]

AREA IN ACRES — Conservation Pool Elevation 440.0 feet NGVD29

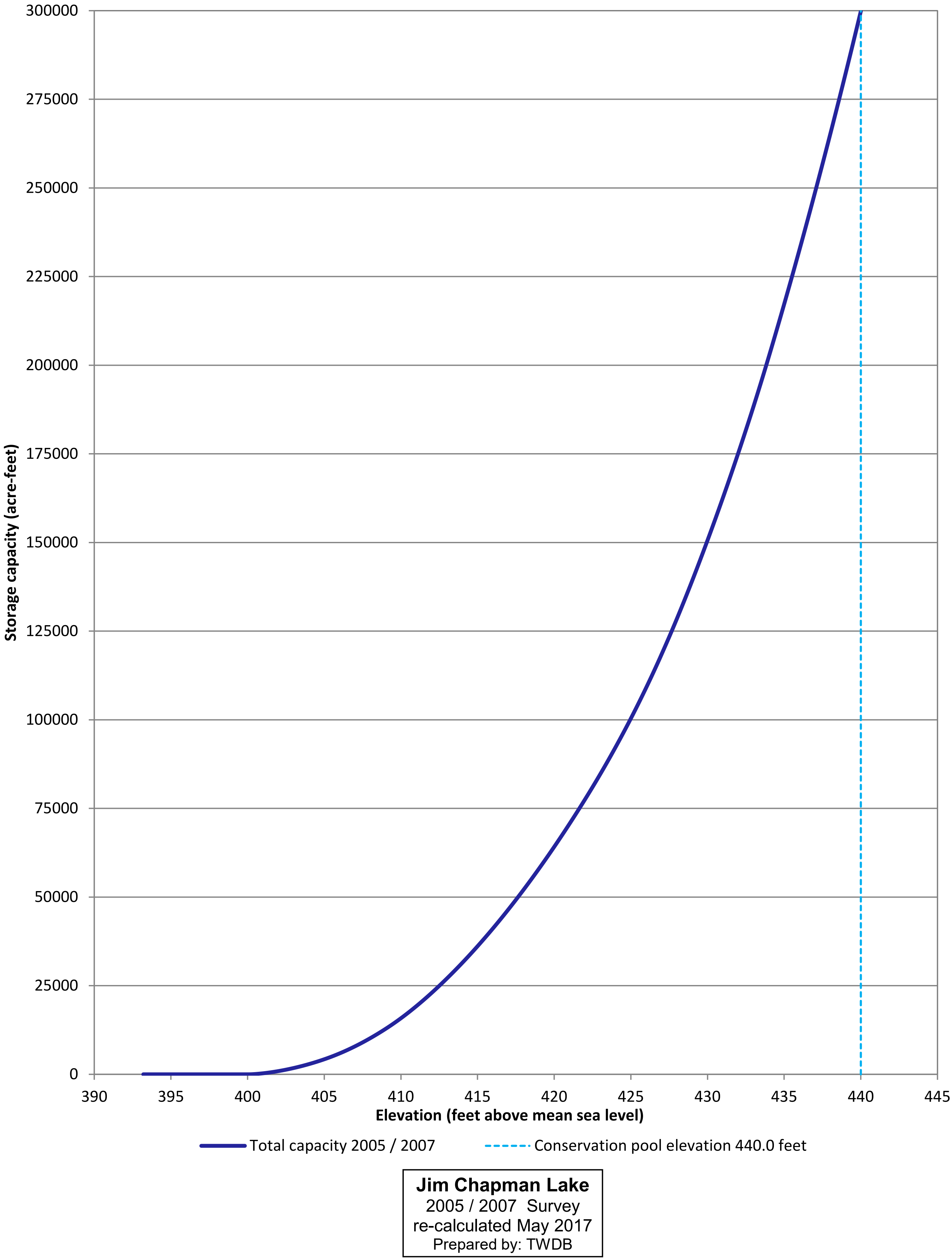
ELEVATION INCREMENT IS ONE TENTH FOOT

ELEVATION (FEET NGVD29)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
393	0	0	0	0	0	0	0	0	0	0
394	0	0	0	0	0	0	0	0	0	0
395	0	0	0	0	0	0	0	0	0	0
396	0	0	0	0	0	0	0	0	0	0
397	0	0	0	1	1	1	1	1	1	1
398	1	1	1	1	1	1	1	1	1	1
399	1	2	2	2	2	2	3	4	5	6
400	8	51	153	218	264	306	345	382	416	448
401	477	504	532	560	591	619	646	671	696	721
402	746	771	796	821	847	874	898	921	945	967
403	990	1,013	1,038	1,062	1,087	1,112	1,136	1,160	1,184	1,208
404	1,232	1,255	1,280	1,307	1,335	1,360	1,384	1,409	1,436	1,464
405	1,492	1,523	1,556	1,590	1,622	1,653	1,688	1,721	1,753	1,784
406	1,814	1,845	1,878	1,914	1,950	1,984	2,019	2,051	2,082	2,114
407	2,145	2,177	2,211	2,247	2,282	2,314	2,347	2,379	2,410	2,440
408	2,471	2,503	2,536	2,568	2,598	2,629	2,661	2,692	2,723	2,756
409	2,792	2,830	2,869	2,911	2,952	2,992	3,029	3,067	3,105	3,146
410	3,190	3,237	3,279	3,320	3,360	3,398	3,433	3,468	3,503	3,538
411	3,573	3,607	3,642	3,677	3,712	3,749	3,786	3,820	3,853	3,886
412	3,921	3,955	3,990	4,023	4,056	4,088	4,118	4,148	4,179	4,211
413	4,242	4,272	4,302	4,332	4,363	4,393	4,423	4,453	4,484	4,518
414	4,549	4,581	4,610	4,639	4,669	4,700	4,733	4,766	4,799	4,833
415	4,865	4,895	4,923	4,950	4,976	5,002	5,030	5,060	5,092	5,124
416	5,154	5,185	5,216	5,246	5,277	5,309	5,342	5,373	5,402	5,430
417	5,459	5,488	5,517	5,545	5,573	5,603	5,634	5,665	5,698	5,729
418	5,760	5,791	5,822	5,854	5,885	5,913	5,941	5,969	6,000	6,029
419	6,058	6,087	6,115	6,143	6,172	6,201	6,231	6,260	6,290	6,320
420	6,349	6,381	6,413	6,444	6,474	6,505	6,535	6,566	6,596	6,626
421	6,655	6,683	6,713	6,744	6,775	6,808	6,841	6,873	6,905	6,940
422	6,973	7,008	7,043	7,079	7,118	7,158	7,200	7,244	7,288	7,332
423	7,377	7,423	7,470	7,517	7,564	7,618	7,667	7,713	7,758	7,804
424	7,851	7,900	7,950	8,000	8,050	8,103	8,157	8,212	8,269	8,329
425	8,387	8,449	8,514	8,577	8,643	8,706	8,767	8,826	8,883	8,938
426	8,996	9,069	9,143	9,217	9,289	9,360	9,431	9,501	9,572	9,643
427	9,714	9,773	9,831	9,890	9,956	10,029	10,108	10,188	10,265	10,341
428	10,412	10,486	10,553	10,616	10,678	10,742	10,809	10,877	10,947	11,017
429	11,087	11,156	11,220	11,280	11,337	11,390	11,448	11,505	11,563	11,620
430	11,678	11,735	11,793	11,850	11,908	11,965	12,022	12,080	12,137	12,195
431	12,256	12,320	12,384	12,448	12,512	12,576	12,641	12,705	12,769	12,833
432	12,897	12,961	13,025	13,090	13,154	13,218	13,282	13,346	13,435	13,523
433	13,612	13,701	13,789	13,878	13,967	14,055	14,144	14,233	14,321	14,410
434	14,498	14,571	14,629	14,686	14,744	14,801	14,858	14,916	14,973	15,031
435	15,088	15,145	15,203	15,260	15,318	15,375	15,432	15,490	15,547	15,605
436	15,662	15,719	15,777	15,834	15,892	15,949	16,006	16,064	16,121	16,179
437	16,236	16,293	16,351	16,408	16,466	16,523	16,580	16,638	16,695	16,753
438	16,810	16,867	16,925	16,982	17,040	17,097	17,154	17,212	17,269	17,327
439	17,384	17,441	17,499	17,556	17,614	17,671	17,728	17,786	17,843	17,901
440	17,958									

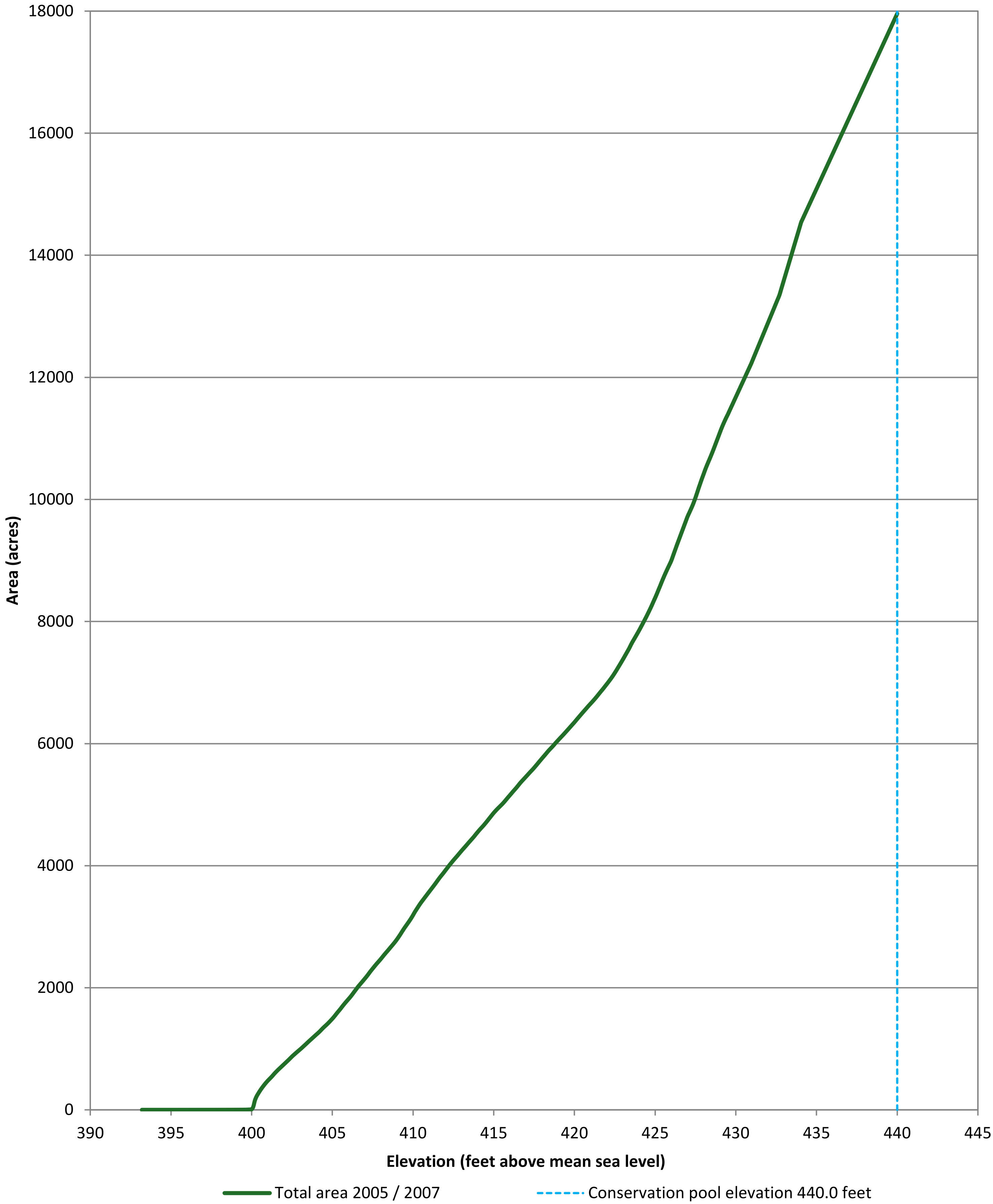
Note: Areas between elevations 426.0 and 426.35 feet, 426.35 and 427.0 feet, 429.5 and 430.95 feet, 430.95 and 432.70 feet, 432.70 and 434.05 feet, and 434.05 and 440.0 feet adjusted using cubic spline interpolation. Values used for cubic spline interpolation equal to average of computed values at 0.1-foot increments.

[a]Texas Water Development Board, 2008, Volumetric Survey of Jim Chapman Lake, accessed October 31, 2022, at https://www.twdb.texas.gov/hydro_survey/JimChapman/2007-07/.

[b]Texas Water Development Board, 2016, Application of New Procedures to Re-Assess Reservoir Capacity, accessed June 16, 2021, at http://www.twdb.texas.gov/hydro_survey/Re-assessment/ReassessOldSurveys_Draft4Comment.pdf.



Appendix C: 2005 / 2007 re-calculated capacity curve



Jim Chapman Lake
2005 / 2007 Survey
re-calculated May 2017
Prepared by: TWDB

Appendix D: 2005 / 2007 re-calculated area curve

Appendix E

Jim Chapman Lake

RESERVOIR BATHYMETRIC CAPACITY TABLE

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

January - July 2022 Survey
Conservation Pool Elevation 440.0 feet NGVD29

ELEVATION (FEET NGVD29)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
388	0	0	0	0	0	0	0	0	0	0
389	0	0	0	0	0	0	1	1	1	1
390	1	1	2	2	2	2	3	3	4	5
391	7	8	10	12	14	17	20	23	26	30
392	34	38	43	49	55	61	68	75	83	91
393	99	107	116	125	135	144	154	164	175	186
394	197	209	221	233	246	259	273	286	300	315
395	330	345	361	376	393	409	426	443	460	478
396	496	514	533	552	571	590	610	630	651	672
397	693	714	736	758	781	803	827	850	874	899
398	924	949	975	1,002	1,028	1,056	1,083	1,111	1,140	1,169
399	1,199	1,229	1,260	1,291	1,322	1,354	1,387	1,419	1,453	1,487
400	1,521	1,556	1,591	1,627	1,664	1,701	1,739	1,777	1,816	1,855
401	1,895	1,936	1,978	2,020	2,063	2,108	2,153	2,200	2,248	2,297
402	2,348	2,401	2,456	2,513	2,573	2,635	2,699	2,767	2,837	2,909
403	2,983	3,060	3,139	3,221	3,306	3,393	3,483	3,574	3,668	3,764
404	3,861	3,960	4,061	4,164	4,269	4,376	4,486	4,598	4,713	4,830
405	4,949	5,071	5,195	5,321	5,450	5,581	5,714	5,851	5,990	6,132
406	6,276	6,422	6,572	6,724	6,879	7,037	7,199	7,364	7,533	7,705
407	7,880	8,058	8,241	8,427	8,616	8,809	9,006	9,205	9,408	9,614
408	9,824	10,037	10,253	10,473	10,696	10,922	11,151	11,384	11,621	11,861
409	12,105	12,353	12,603	12,857	13,114	13,374	13,637	13,904	14,173	14,446
410	14,721	15,000	15,282	15,568	15,858	16,153	16,451	16,754	17,061	17,372
411	17,688	18,009	18,335	18,665	19,000	19,339	19,683	20,031	20,383	20,738
412	21,097	21,459	21,825	22,194	22,567	22,943	23,323	23,706	24,092	24,481
413	24,873	25,269	25,668	26,070	26,476	26,884	27,296	27,711	28,130	28,551
414	28,976	29,404	29,835	30,270	30,708	31,150	31,596	32,045	32,498	32,955
415	33,416	33,881	34,349	34,821	35,296	35,775	36,256	36,741	37,229	37,720
416	38,214	38,711	39,212	39,717	40,225	40,736	41,251	41,768	42,289	42,814
417	43,341	43,872	44,406	44,943	45,483	46,026	46,572	47,120	47,671	48,225
418	48,782	49,341	49,903	50,469	51,037	51,609	52,183	52,761	53,342	53,926
419	54,513	55,103	55,696	56,293	56,892	57,494	58,099	58,707	59,318	59,932
420	60,549	61,169	61,791	62,417	63,045	63,676	64,311	64,948	65,589	66,233
421	66,880	67,530	68,184	68,841	69,501	70,165	70,832	71,503	72,178	72,855
422	73,536	74,221	74,910	75,602	76,298	76,998	77,701	78,408	79,119	79,834
423	80,553	81,277	82,007	82,740	83,479	84,223	84,971	85,724	86,483	87,246
424	88,015	88,788	89,566	90,349	91,137	91,929	92,726	93,529	94,337	95,152
425	95,973	96,800	97,633	98,472	99,317	100,168	101,025	101,889	102,760	103,637
426	104,520	105,408	106,302	107,201	108,107	109,018	109,935	110,859	111,788	112,723
427	113,664	114,612	115,565	116,527	117,496	118,473	119,457	120,449	121,449	122,457
428	123,474	124,498	125,532	126,574	127,624	128,683	129,748	130,822	131,903	132,992
429	134,088	135,191	136,301	137,418	138,540	139,670	140,805	141,948	143,097	144,253
430	145,414	146,582	147,756	148,936	150,122	151,315	152,514	153,719	154,930	156,147
431	157,371	158,600	159,837	161,079	162,329	163,584	164,846	166,114	167,392	168,676
432	169,968	171,265	172,569	173,881	175,199	176,524	177,856	179,194	180,538	181,889
433	183,246	184,612	185,984	187,364	188,750	190,143	191,542	192,948	194,360	195,778
434	197,202	198,632	200,069	201,512	202,962	204,419	205,882	207,353	208,831	210,315
435	211,806	213,304	214,809	216,322	217,842	219,369	220,904	222,446	223,994	225,550
436	227,113	228,683	230,259	231,843	233,433	235,028	236,630	238,237	239,850	241,468
437	243,092	244,723	246,358	248,000	249,647	251,300	252,959	254,624	256,294	257,970
438	259,652	261,340	263,033	264,732	266,437	268,148	269,864	271,586	273,314	275,048
439	276,787	278,532	280,283	282,040	283,802	285,571	287,344	289,124	290,910	292,701
440	294,498	296,300	298,109	299,923	301,743	303,568				

Note: Capacities above elevation 436.3 feet calculated from interpolated areas

Appendix F

Jim Chapman Lake

RESERVOIR BATHYMETRIC AREA TABLE

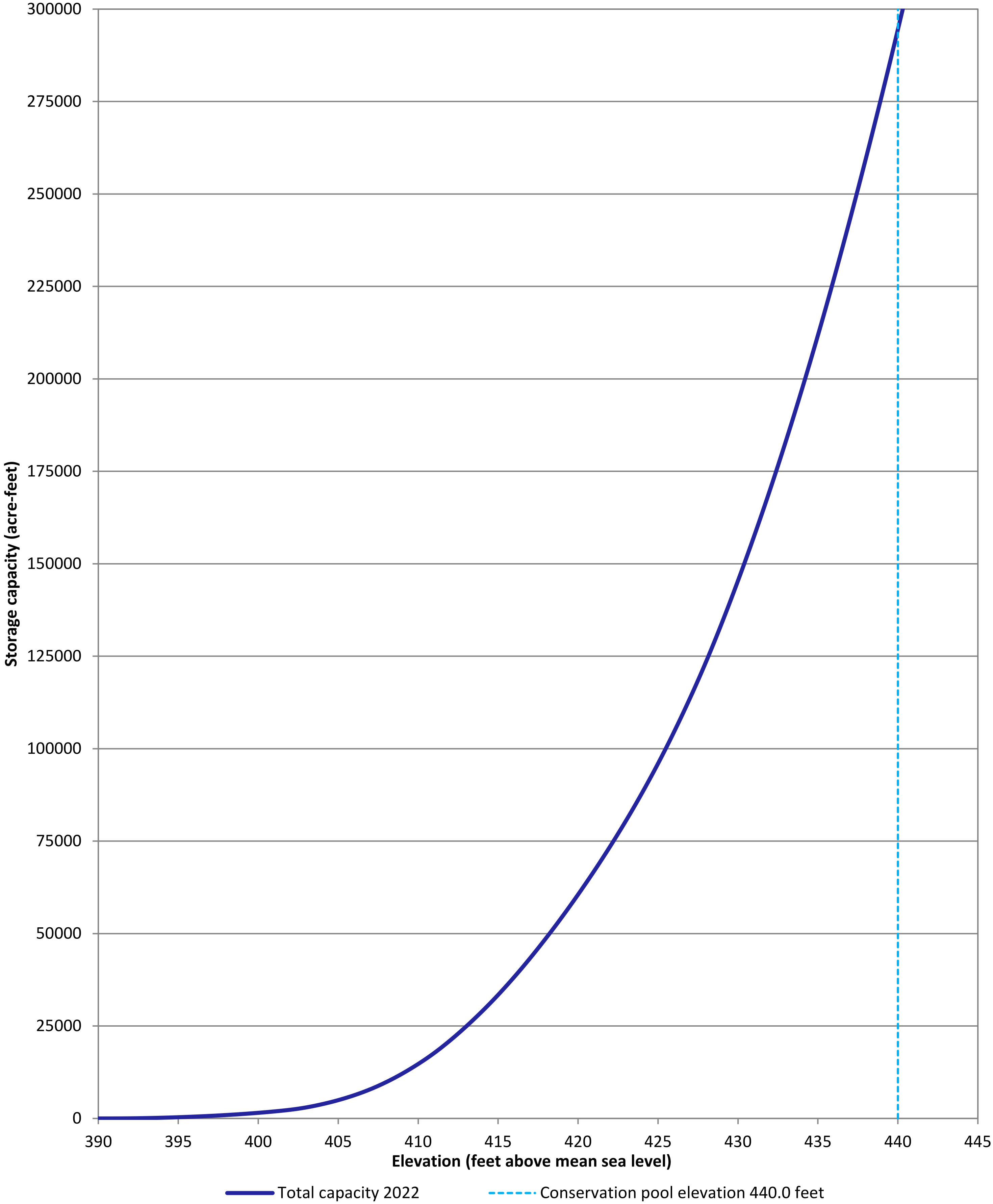
TEXAS WATER DEVELOPMENT BOARD — January - July 2022 Survey

AREA IN ACRES — Conservation Pool Elevation 440.0 feet NGVD29

ELEVATION INCREMENT IS ONE TENTH FOOT

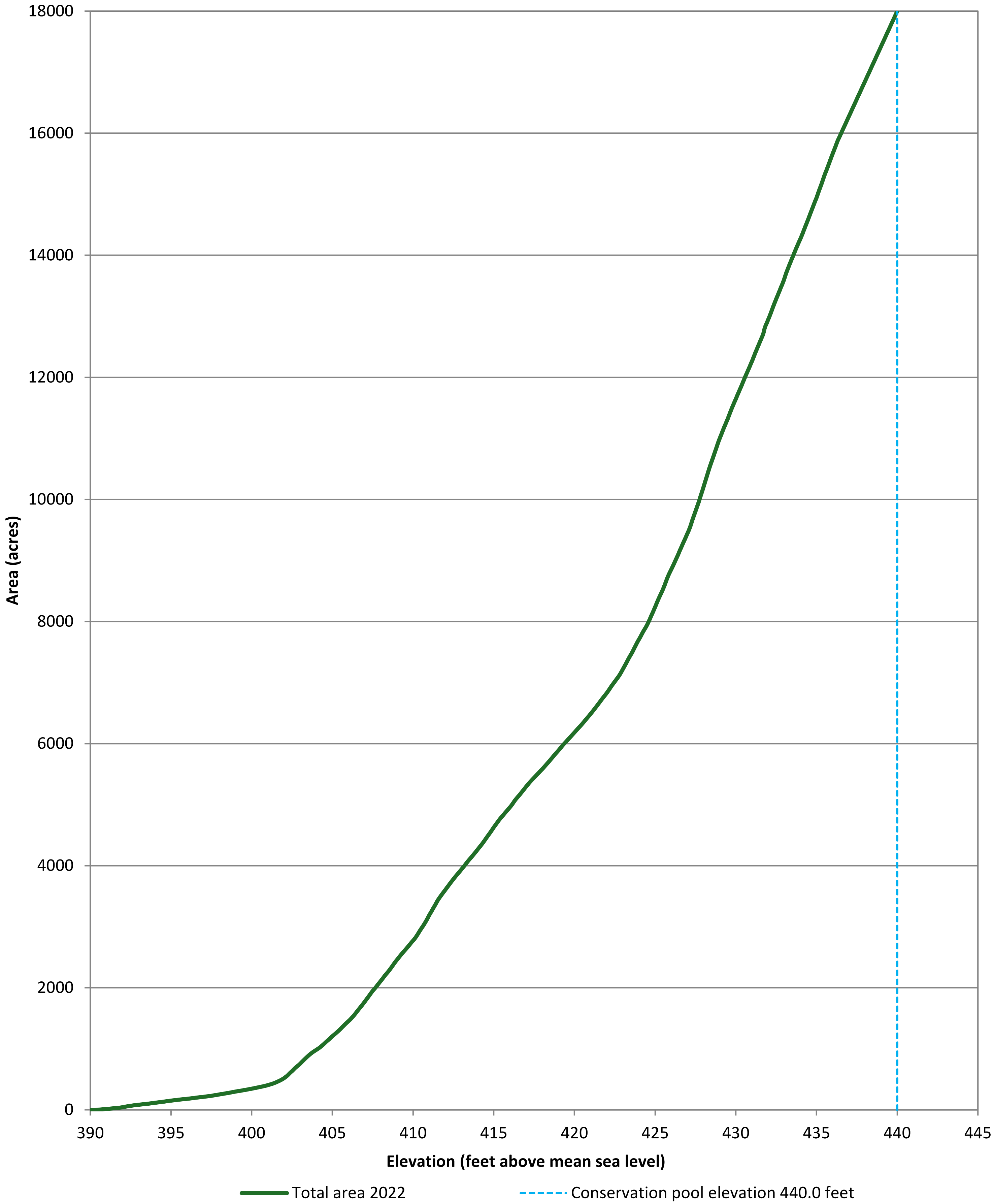
ELEVATION (FEET NGVD29)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
388	0	0	0	0	0	0	0	0	0	0
389	0	1	1	1	1	1	1	2	2	2
390	2	2	2	2	3	3	4	7	9	13
391	15	17	19	22	24	27	29	32	35	38
392	42	48	53	57	62	66	70	74	77	80
393	83	86	89	92	95	98	101	105	108	112
394	115	119	122	125	129	132	136	140	143	147
395	151	154	157	160	163	167	170	173	175	178
396	181	184	187	190	194	197	200	204	207	210
397	213	216	219	223	226	230	234	239	243	248
398	252	257	261	266	270	275	279	284	289	295
399	299	304	308	312	317	322	326	331	336	341
400	346	351	357	362	368	373	379	385	391	397
401	405	412	420	429	439	450	461	473	486	501
402	518	537	558	584	611	634	660	687	709	730
403	755	782	808	834	859	883	907	928	947	965
404	982	999	1,017	1,039	1,061	1,085	1,110	1,134	1,157	1,182
405	1,206	1,229	1,251	1,275	1,298	1,324	1,352	1,378	1,404	1,429
406	1,453	1,478	1,507	1,536	1,568	1,602	1,635	1,668	1,701	1,735
407	1,769	1,806	1,841	1,877	1,914	1,949	1,979	2,011	2,046	2,078
408	2,112	2,145	2,180	2,215	2,245	2,277	2,312	2,348	2,386	2,423
409	2,456	2,489	2,523	2,555	2,586	2,616	2,646	2,677	2,709	2,742
410	2,772	2,803	2,840	2,881	2,925	2,966	3,005	3,046	3,090	3,137
411	3,188	3,233	3,279	3,324	3,371	3,418	3,460	3,497	3,534	3,569
412	3,604	3,640	3,675	3,711	3,746	3,780	3,813	3,845	3,876	3,907
413	3,940	3,972	4,005	4,039	4,073	4,104	4,135	4,166	4,198	4,230
414	4,264	4,297	4,330	4,364	4,401	4,438	4,476	4,513	4,549	4,588
415	4,627	4,663	4,700	4,737	4,771	4,802	4,832	4,865	4,894	4,926
416	4,956	4,989	5,026	5,065	5,098	5,129	5,160	5,193	5,226	5,259
417	5,293	5,324	5,357	5,386	5,414	5,441	5,469	5,497	5,524	5,554
418	5,580	5,610	5,639	5,669	5,699	5,731	5,762	5,794	5,825	5,855
419	5,885	5,916	5,948	5,979	6,008	6,036	6,066	6,095	6,124	6,153
420	6,182	6,211	6,241	6,270	6,299	6,328	6,360	6,392	6,423	6,454
421	6,487	6,519	6,552	6,587	6,621	6,656	6,691	6,727	6,761	6,794
422	6,828	6,865	6,904	6,944	6,980	7,016	7,052	7,087	7,126	7,170
423	7,219	7,267	7,314	7,364	7,414	7,460	7,505	7,559	7,610	7,662
424	7,708	7,755	7,806	7,852	7,896	7,944	7,999	8,057	8,117	8,176
425	8,238	8,302	8,365	8,422	8,478	8,538	8,604	8,676	8,742	8,800
426	8,853	8,909	8,966	9,024	9,082	9,144	9,205	9,264	9,322	9,381
427	9,442	9,502	9,573	9,656	9,731	9,806	9,881	9,956	10,041	10,122
428	10,205	10,291	10,377	10,463	10,545	10,621	10,695	10,773	10,849	10,928
429	10,999	11,064	11,133	11,197	11,259	11,322	11,392	11,460	11,525	11,586
430	11,646	11,710	11,771	11,831	11,894	11,958	12,021	12,081	12,140	12,203
431	12,264	12,330	12,397	12,460	12,523	12,586	12,648	12,714	12,816	12,879
432	12,944	13,008	13,077	13,149	13,217	13,283	13,347	13,411	13,478	13,540
433	13,611	13,693	13,763	13,830	13,896	13,959	14,024	14,088	14,150	14,211
434	14,270	14,332	14,400	14,468	14,534	14,601	14,672	14,740	14,808	14,877
435	14,942	15,018	15,091	15,162	15,239	15,315	15,382	15,451	15,523	15,594
436	15,664	15,731	15,799	15,870	15,927	15,985	16,042	16,100	16,157	16,215
437	16,272	16,330	16,387	16,445	16,502	16,560	16,617	16,675	16,732	16,790
438	16,847	16,905	16,962	17,020	17,078	17,135	17,193	17,250	17,308	17,365
439	17,423	17,480	17,538	17,595	17,653	17,710	17,768	17,825	17,883	17,940
440	17,998	18,055	18,113	18,170	18,228	18,286				

Note: Areas between elevations 436.3 and 440.5 feet linearly interpolated



Jim Chapman Lake
January - July 2022
Survey
Prepared by: TWDB

Appendix G: 2022 bathymetric capacity curve



Jim Chapman Lake
January - July 2022
Survey
Prepared by: TWDB

Appendix H: 2022 bathymetric area curve

Appendix I

Jim Chapman Lake

RESERVOIR BATHYMETRIC AND TOPOGRAPHIC CAPACITY TABLE

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

January - July 2022 Survey
Conservation Pool Elevation 440.0 feet NGVD29
Top of dam elevation 464.5 feet NGVD29

ELEVATION (FEET NGVD29)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
388	0	0	0	0	0	0	0	0	0	0
389	0	0	0	0	0	0	1	1	1	1
390	1	1	2	2	2	2	3	3	4	5
391	7	8	10	12	14	17	20	23	26	30
392	34	38	43	49	55	61	68	75	83	91
393	99	107	116	125	135	144	154	164	175	186
394	197	209	221	233	246	259	273	286	300	315
395	330	345	361	376	393	409	426	443	460	478
396	496	514	533	552	571	590	610	630	651	672
397	693	714	736	758	781	803	827	850	874	899
398	924	949	975	1,002	1,028	1,056	1,083	1,111	1,140	1,169
399	1,199	1,229	1,260	1,291	1,322	1,354	1,387	1,419	1,453	1,487
400	1,521	1,556	1,591	1,627	1,664	1,701	1,739	1,777	1,816	1,855
401	1,895	1,936	1,978	2,020	2,063	2,108	2,153	2,200	2,248	2,297
402	2,348	2,401	2,456	2,513	2,573	2,635	2,699	2,767	2,837	2,909
403	2,983	3,060	3,139	3,221	3,306	3,393	3,483	3,574	3,668	3,764
404	3,861	3,960	4,061	4,164	4,269	4,376	4,486	4,598	4,713	4,830
405	4,949	5,071	5,195	5,321	5,450	5,581	5,714	5,851	5,990	6,132
406	6,276	6,422	6,572	6,724	6,879	7,037	7,199	7,364	7,533	7,705
407	7,880	8,058	8,241	8,427	8,616	8,809	9,006	9,205	9,408	9,614
408	9,824	10,037	10,253	10,473	10,696	10,922	11,151	11,384	11,621	11,861
409	12,105	12,353	12,603	12,857	13,114	13,374	13,637	13,904	14,173	14,446
410	14,721	15,000	15,282	15,568	15,858	16,153	16,451	16,754	17,061	17,372
411	17,688	18,009	18,335	18,665	19,000	19,339	19,683	20,031	20,383	20,738
412	21,097	21,459	21,825	22,194	22,567	22,943	23,323	23,706	24,092	24,481
413	24,873	25,269	25,668	26,070	26,476	26,884	27,296	27,711	28,130	28,551
414	28,976	29,404	29,835	30,270	30,708	31,150	31,596	32,045	32,498	32,955
415	33,416	33,881	34,349	34,821	35,296	35,775	36,256	36,741	37,229	37,720
416	38,214	38,711	39,212	39,717	40,225	40,736	41,251	41,768	42,289	42,814
417	43,341	43,872	44,406	44,943	45,483	46,026	46,572	47,120	47,671	48,225
418	48,782	49,341	49,903	50,469	51,037	51,609	52,183	52,761	53,342	53,926
419	54,513	55,103	55,696	56,293	56,892	57,494	58,099	58,707	59,318	59,932
420	60,549	61,169	61,791	62,417	63,045	63,676	64,311	64,948	65,589	66,233
421	66,880	67,530	68,184	68,841	69,501	70,165	70,832	71,503	72,178	72,855
422	73,536	74,221	74,910	75,602	76,298	76,998	77,701	78,408	79,119	79,834
423	80,553	81,277	82,007	82,740	83,479	84,223	84,971	85,724	86,483	87,246
424	88,015	88,788	89,566	90,349	91,137	91,929	92,726	93,529	94,337	95,152
425	95,973	96,800	97,633	98,472	99,317	100,168	101,025	101,889	102,760	103,637
426	104,520	105,408	106,302	107,201	108,107	109,018	109,935	110,859	111,788	112,723
427	113,664	114,612	115,565	116,527	117,496	118,473	119,457	120,449	121,449	122,457
428	123,474	124,498	125,532	126,574	127,624	128,683	129,748	130,822	131,903	132,992
429	134,088	135,191	136,301	137,418	138,540	139,670	140,805	141,948	143,097	144,253
430	145,414	146,582	147,756	148,936	150,122	151,315	152,514	153,719	154,930	156,147
431	157,371	158,600	159,837	161,079	162,329	163,584	164,846	166,114	167,392	168,676
432	169,968	171,265	172,569	173,881	175,199	176,524	177,856	179,194	180,538	181,889
433	183,246	184,612	185,984	187,364	188,750	190,143	191,542	192,948	194,360	195,778
434	197,202	198,632	200,069	201,512	202,962	204,419	205,882	207,353	208,831	210,315
435	211,806	213,304	214,809	216,322	217,842	219,369	220,904	222,446	223,994	225,550
436	227,113	228,683	230,259	231,843	233,433	235,028	236,630	238,237	239,849	241,468
437	243,092	244,723	246,358	248,000	249,647	251,300	252,959	254,624	256,294	257,970
438	259,652	261,340	263,033	264,732	266,437	268,148	269,864	271,586	273,314	275,048
439	276,787	278,532	280,283	282,040	283,802	285,571	287,344	289,124	290,909	292,701
440	294,498	296,300	298,109	299,923	301,743	303,568	305,400	307,237	309,081	310,930

Appendix I

Jim Chapman Lake

RESERVOIR BATHYMETRIC AND TOPOGRAPHIC CAPACITY TABLE (continued)

TEXAS WATER DEVELOPMENT BOARD — January - July 2022 Survey
CAPACITY IN ACRE-FEET — Conservation Pool Elevation 440.0 feet NGVD29
ELEVATION INCREMENT IS ONE TENTH FOOT — Top of dam elevation 464.5 feet NGVD29

ELEVATION (FEET NGVD29)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
441	312,786	314,647	316,514	318,388	320,267	322,152	324,043	325,940	327,843	329,752
442	331,667	333,588	335,515	337,448	339,387	341,331	343,282	345,239	347,201	349,170
443	351,144	353,124	355,109	357,099	359,093	361,093	363,097	365,107	367,121	369,140
444	371,165	373,194	375,228	377,267	379,312	381,362	383,417	385,477	387,543	389,614
445	391,690	393,772	395,860	397,953	400,052	402,156	404,267	406,383	408,505	410,633
446	412,768	414,909	417,056	419,210	421,371	423,539	425,715	427,898	430,092	432,298
447	434,522	436,762	439,018	441,287	443,570	445,864	448,170	450,488	452,815	455,152
448	457,497	459,851	462,216	464,591	466,975	469,369	471,771	474,180	476,597	479,021
449	481,452	483,889	486,333	488,784	491,241	493,704	496,174	498,650	501,133	503,623
450	506,119	508,622	511,132	513,649	516,172	518,702	521,240	523,785	526,338	528,900
451	531,470	534,048	536,634	539,228	541,830	544,440	547,057	549,682	552,314	554,953
452	557,600	560,253	562,914	565,583	568,258	570,941	573,632	576,329	579,035	581,747
453	584,468	587,195	589,931	592,675	595,426	598,185	600,951	603,725	606,507	609,296
454	612,093	614,897	617,711	620,536	623,373	626,221	629,078	631,943	634,818	637,701
455	640,592	643,492	646,401	649,317	652,243	655,177	658,120	661,071	664,031	666,999
456	669,977	672,963	675,959	678,963	681,976	684,999	688,030	691,069	694,118	697,175
457	700,241	703,316	706,399	709,491	712,592	715,702	718,820	721,946	725,081	728,225
458	731,377	734,538	737,708	740,888	744,077	747,276	750,484	753,702	756,928	760,164
459	763,409	766,663	769,926	773,198	776,478	779,768	783,066	786,373	789,689	793,014
460	796,349	799,693	803,046	806,408	809,779	813,160	816,550	819,949	823,357	826,776
461	830,203	833,641	837,088	840,545	844,012	847,489	850,977	854,474	857,981	861,498
462	865,025	868,561	872,107	875,662	879,226	882,799	886,382	889,975	893,576	897,187
463	900,807	904,437	908,077	911,725	915,384	919,052	922,729	926,415	930,111	933,815
464	937,529	941,251	944,982	948,722	952,471	956,229				

Note: Capacities above elevation 436.3 feet calculated from interpolated areas

Appendix J

Jim Chapman Lake

RESERVOIR BATHYMETRIC AND TOPOGRAPHIC AREA TABLE

TEXAS WATER DEVELOPMENT BOARD — January - July 2022 Survey

AREA IN ACRES — Conservation Pool Elevation 440.0 feet NGVD29

ELEVATION INCREMENT IS ONE TENTH FOOT — Top of dam elevation 464.5 feet NGVD29

ELEVATION (FEET NGVD29)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
388	0	0	0	0	0	0	0	0	0	0
389	0	1	1	1	1	1	1	2	2	2
390	2	2	2	2	3	3	4	7	9	13
391	15	17	19	22	24	27	29	32	35	38
392	42	48	53	57	62	66	70	74	77	80
393	83	86	89	92	95	98	101	105	108	112
394	115	119	122	125	129	132	136	140	143	147
395	151	154	157	160	163	167	170	173	175	178
396	181	184	187	190	194	197	200	204	207	210
397	213	216	219	223	226	230	234	239	243	248
398	252	257	261	266	270	275	279	284	289	295
399	299	304	308	312	317	322	326	331	336	341
400	346	351	357	362	368	373	379	385	391	397
401	405	412	420	429	439	450	461	473	486	501
402	518	537	558	584	611	634	660	687	709	730
403	755	782	808	834	859	883	907	928	947	965
404	982	999	1,017	1,039	1,061	1,085	1,110	1,134	1,157	1,182
405	1,206	1,229	1,251	1,275	1,298	1,324	1,352	1,378	1,404	1,429
406	1,453	1,478	1,507	1,536	1,568	1,602	1,635	1,668	1,701	1,735
407	1,769	1,806	1,841	1,877	1,914	1,949	1,979	2,011	2,046	2,078
408	2,112	2,145	2,180	2,215	2,245	2,277	2,312	2,348	2,386	2,423
409	2,456	2,489	2,523	2,555	2,586	2,616	2,646	2,677	2,709	2,742
410	2,772	2,803	2,840	2,881	2,925	2,966	3,005	3,046	3,090	3,137
411	3,188	3,233	3,279	3,324	3,371	3,418	3,460	3,497	3,534	3,569
412	3,604	3,640	3,675	3,711	3,746	3,780	3,813	3,845	3,876	3,907
413	3,940	3,972	4,005	4,039	4,073	4,104	4,135	4,166	4,198	4,230
414	4,264	4,297	4,330	4,364	4,401	4,438	4,476	4,513	4,549	4,588
415	4,627	4,663	4,700	4,737	4,771	4,802	4,832	4,865	4,894	4,926
416	4,956	4,989	5,026	5,065	5,098	5,129	5,160	5,193	5,226	5,259
417	5,293	5,324	5,357	5,386	5,414	5,441	5,469	5,497	5,524	5,554
418	5,580	5,610	5,639	5,669	5,699	5,731	5,762	5,794	5,825	5,855
419	5,885	5,916	5,948	5,979	6,008	6,036	6,066	6,095	6,124	6,153
420	6,182	6,211	6,241	6,270	6,299	6,328	6,360	6,392	6,423	6,454
421	6,487	6,519	6,552	6,587	6,621	6,656	6,691	6,727	6,761	6,794
422	6,828	6,865	6,904	6,944	6,980	7,016	7,052	7,087	7,126	7,170
423	7,219	7,267	7,314	7,364	7,414	7,460	7,505	7,559	7,610	7,662
424	7,708	7,755	7,806	7,852	7,896	7,944	7,999	8,057	8,117	8,176
425	8,238	8,302	8,365	8,422	8,478	8,538	8,604	8,676	8,742	8,800
426	8,853	8,909	8,966	9,024	9,082	9,144	9,205	9,264	9,322	9,381
427	9,442	9,502	9,573	9,656	9,731	9,806	9,881	9,956	10,041	10,122
428	10,205	10,291	10,377	10,463	10,545	10,621	10,695	10,773	10,849	10,928
429	10,999	11,064	11,133	11,197	11,259	11,322	11,392	11,460	11,525	11,586
430	11,646	11,710	11,771	11,831	11,894	11,958	12,021	12,081	12,140	12,203
431	12,264	12,330	12,397	12,460	12,523	12,586	12,648	12,714	12,816	12,879
432	12,944	13,008	13,077	13,149	13,217	13,283	13,347	13,411	13,478	13,540
433	13,611	13,693	13,763	13,830	13,896	13,959	14,024	14,088	14,150	14,211
434	14,270	14,332	14,400	14,468	14,534	14,601	14,672	14,740	14,808	14,877
435	14,941	15,018	15,091	15,161	15,239	15,315	15,382	15,451	15,523	15,594
436	15,664	15,731	15,799	15,870	15,927	15,985	16,042	16,100	16,157	16,215
437	16,272	16,330	16,387	16,445	16,502	16,560	16,617	16,675	16,732	16,790
438	16,847	16,905	16,962	17,020	17,078	17,135	17,193	17,250	17,308	17,365
439	17,423	17,480	17,538	17,595	17,653	17,710	17,768	17,825	17,883	17,940
440	17,998	18,055	18,113	18,170	18,228	18,286	18,345	18,405	18,464	18,524

Appendix J

Jim Chapman Lake

RESERVOIR BATHYMETRIC AND TOPOGRAPHIC AREA TABLE (continued)

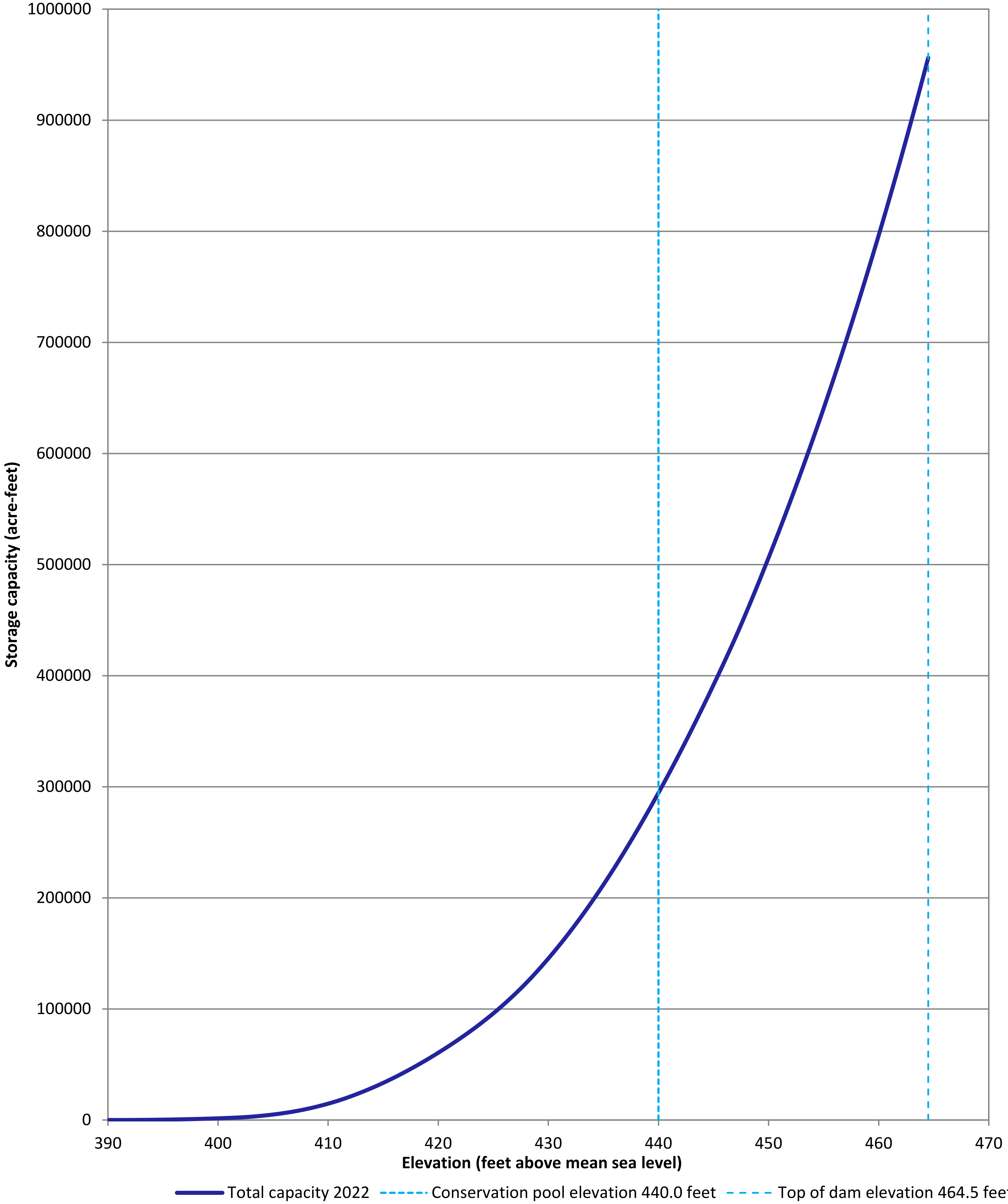
TEXAS WATER DEVELOPMENT BOARD — January - July 2022 Survey

AREA IN ACRES — Conservation Pool Elevation 440.0 feet NGVD29

ELEVATION INCREMENT IS ONE TENTH FOOT — Top of dam elevation 464.5 feet NGVD29

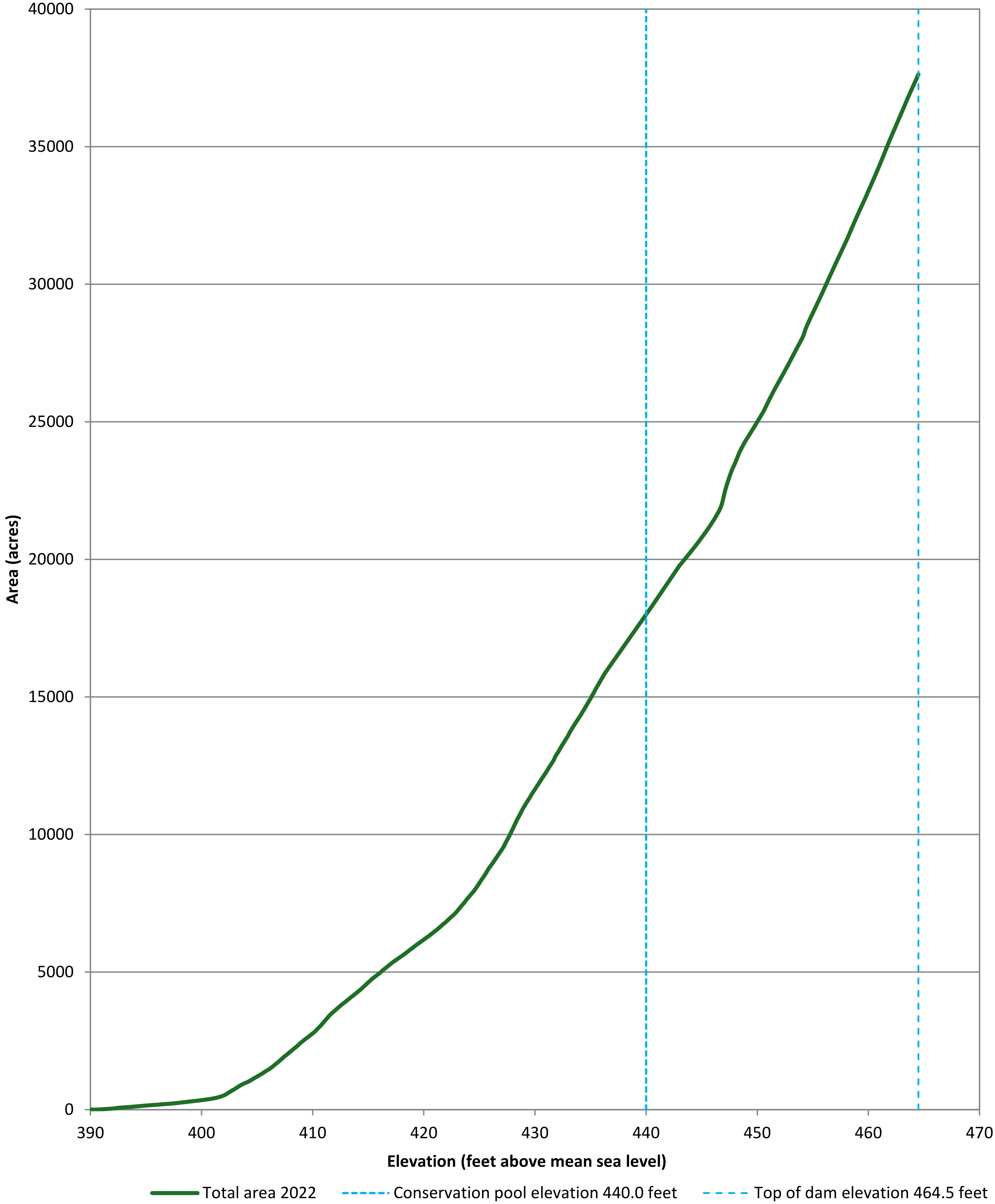
ELEVATION (FEET NGVD29)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
441	18,583	18,643	18,703	18,762	18,822	18,881	18,941	19,001	19,060	19,120
442	19,179	19,239	19,299	19,358	19,418	19,477	19,537	19,597	19,656	19,716
443	19,775	19,824	19,872	19,921	19,970	20,020	20,069	20,119	20,168	20,218
444	20,268	20,317	20,368	20,419	20,471	20,523	20,576	20,630	20,684	20,738
445	20,793	20,848	20,904	20,959	21,016	21,074	21,133	21,192	21,252	21,314
446	21,376	21,440	21,506	21,574	21,645	21,718	21,795	21,882	21,995	22,146
447	22,319	22,483	22,631	22,761	22,884	23,002	23,120	23,228	23,321	23,407
448	23,498	23,594	23,697	23,799	23,891	23,976	24,056	24,132	24,205	24,275
449	24,343	24,408	24,472	24,536	24,601	24,666	24,731	24,796	24,862	24,929
450	24,997	25,065	25,133	25,200	25,268	25,337	25,410	25,491	25,577	25,660
451	25,741	25,822	25,902	25,981	26,058	26,134	26,209	26,283	26,358	26,430
452	26,502	26,573	26,646	26,719	26,792	26,867	26,941	27,015	27,089	27,165
453	27,241	27,318	27,395	27,474	27,552	27,628	27,703	27,778	27,852	27,928
454	28,006	28,087	28,189	28,318	28,426	28,522	28,613	28,701	28,787	28,871
455	28,957	29,043	29,127	29,213	29,298	29,383	29,469	29,555	29,642	29,730
456	29,820	29,910	29,999	30,088	30,178	30,266	30,353	30,440	30,528	30,618
457	30,706	30,790	30,878	30,964	31,051	31,137	31,223	31,309	31,394	31,478
458	31,565	31,657	31,750	31,844	31,939	32,035	32,129	32,222	32,311	32,403
459	32,493	32,584	32,675	32,763	32,850	32,938	33,026	33,115	33,206	33,301
460	33,395	33,484	33,575	33,667	33,759	33,852	33,945	34,038	34,134	34,229
461	34,325	34,425	34,523	34,621	34,720	34,821	34,922	35,023	35,122	35,220
462	35,315	35,409	35,503	35,596	35,688	35,783	35,876	35,969	36,062	36,156
463	36,251	36,346	36,441	36,536	36,632	36,725	36,818	36,910	37,001	37,091
464	37,179	37,267	37,356	37,444	37,534	37,630				

Note: Areas between elevations 436.3 and 440.5 feet, and 440.5 and 443.0 feet linearly interpolated



Jim Chapman Lake
January - July 2022
Survey
Prepared by: TWDB

Appendix K: 2022 bathymetric and topographic capacity curve



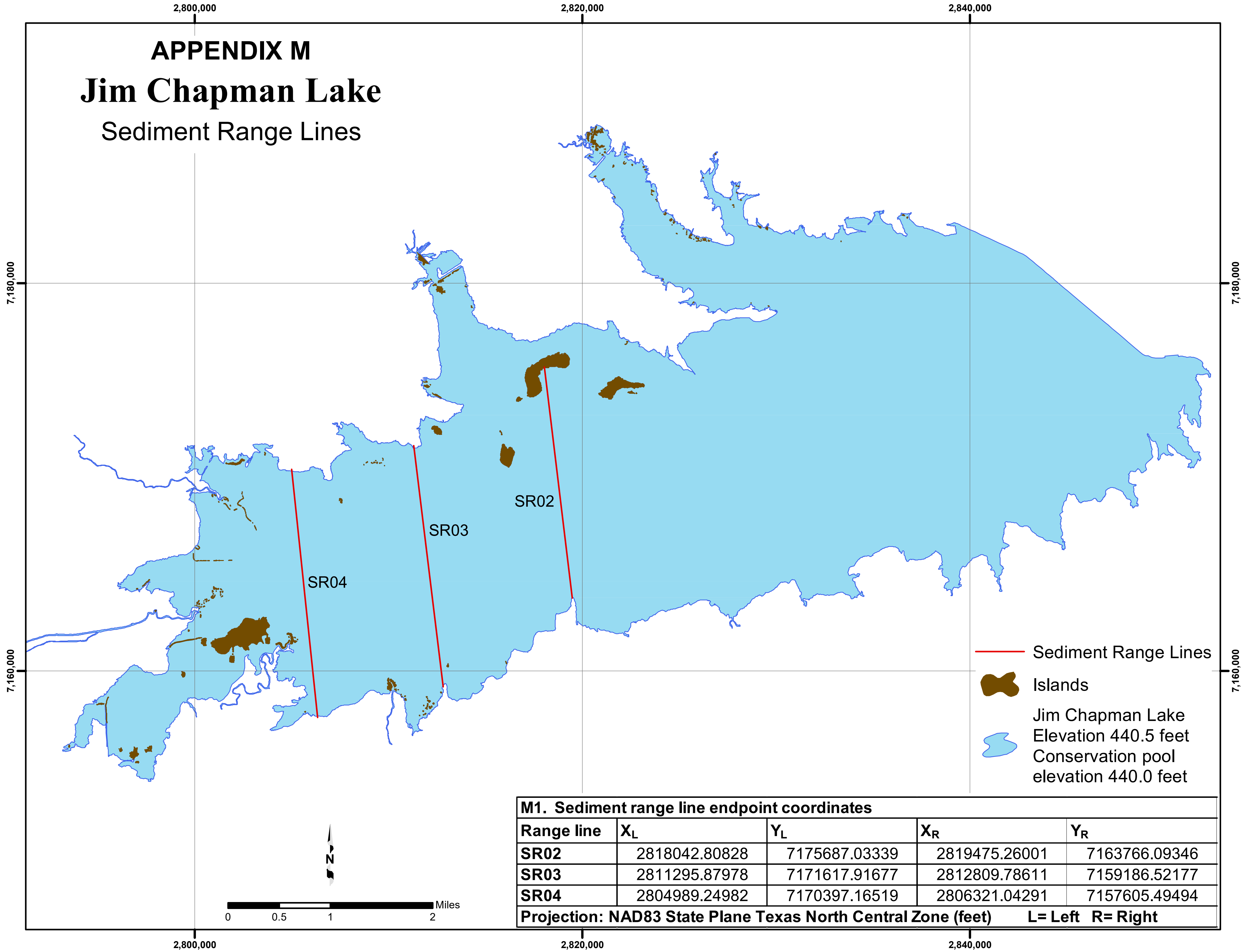
Jim Chapman Lake
January - July 2022
Survey
Prepared by: TWDB

Appendix L: 2022 bathymetric and topographic area curve

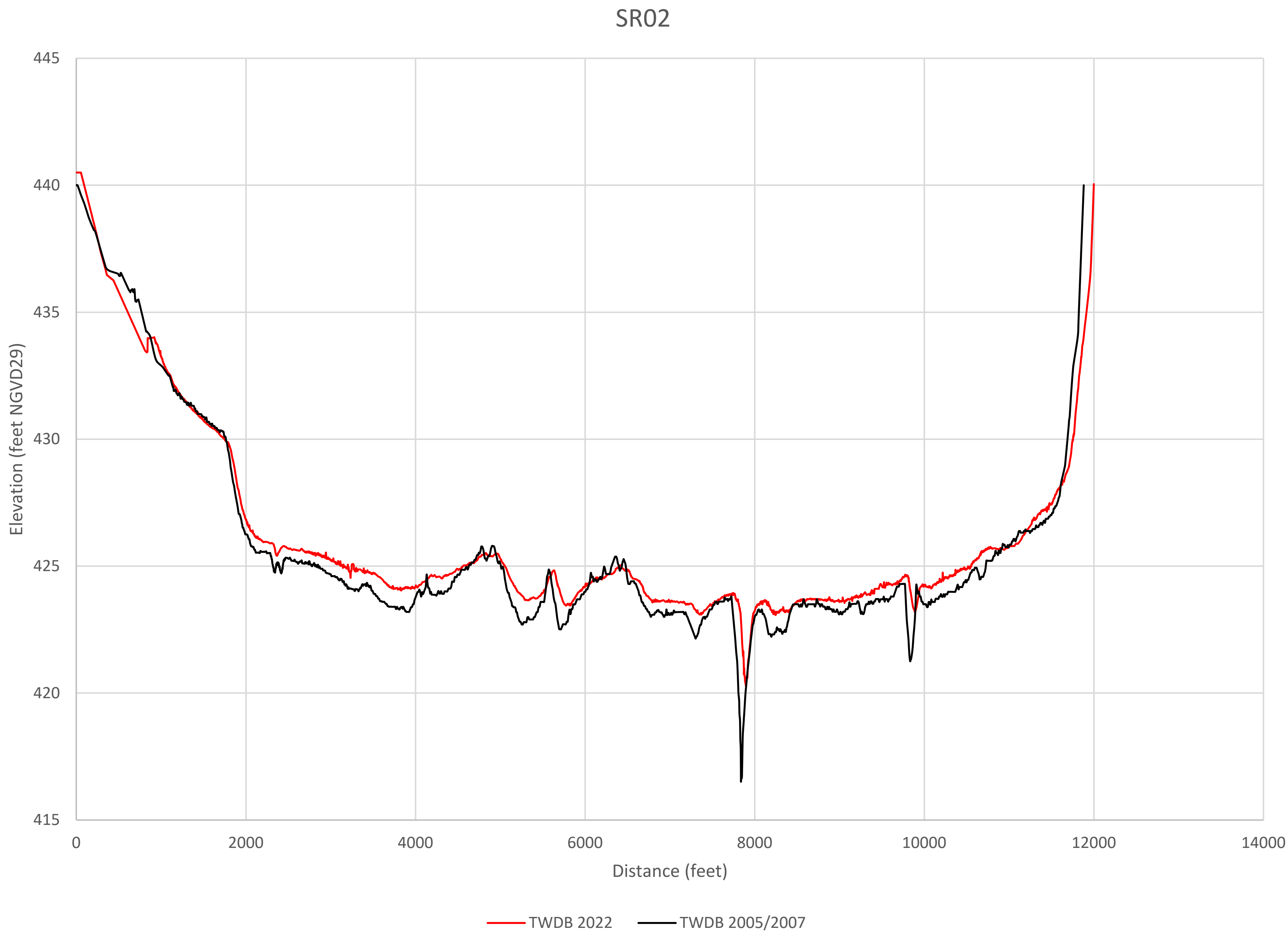
APPENDIX M

Jim Chapman Lake

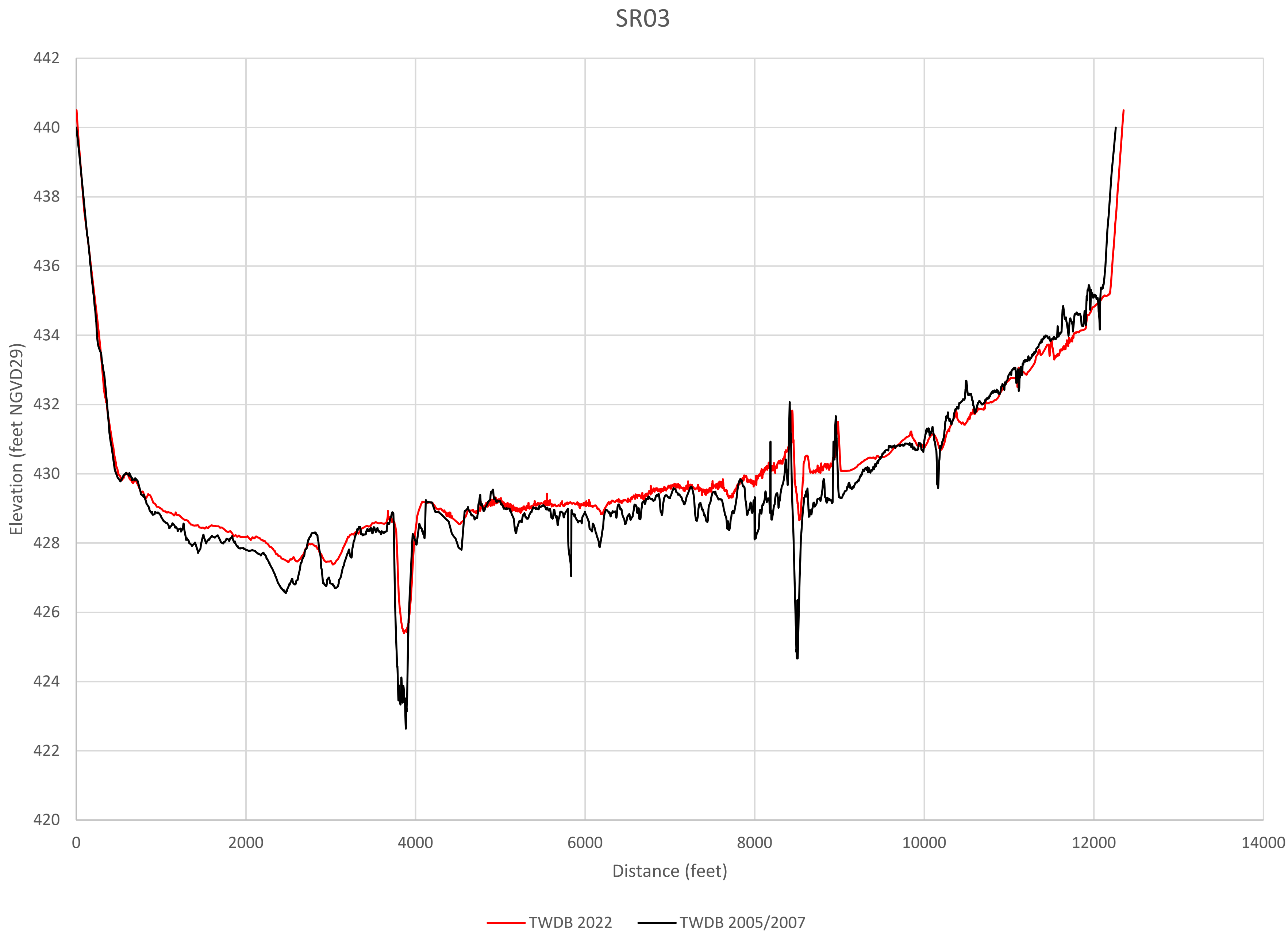
Sediment Range Lines



M1. Sediment range line endpoint coordinates				
Range line	**X_L**	**Y_L**	**X_R**	**Y_R**
SR02	2818042.80828	7175687.03339	2819475.26001	7163766.09346
SR03	2811295.87978	7171617.91677	2812809.78611	7159186.52177
SR04	2804989.24982	7170397.16519	2806321.04291	7157605.49494
Projection: NAD83 State Plane Texas North Central Zone (feet) L= Left R= Right				



SR02
445
440
435
430
425
420
415
Elevation (feet NGVD29)
0
2000
4000
6000
8000
10000
12000
14000
Distance (feet)
TWDB 2022
TWDB 2005/2007



SR03
442
440
438
436
434
432
430
428
426
424
422
420
Elevation (feet NGVD29)
0
2000
4000
6000
8000
10000
12000
14000
Distance (feet)
TWDB 2022
TWDB 2005/2007

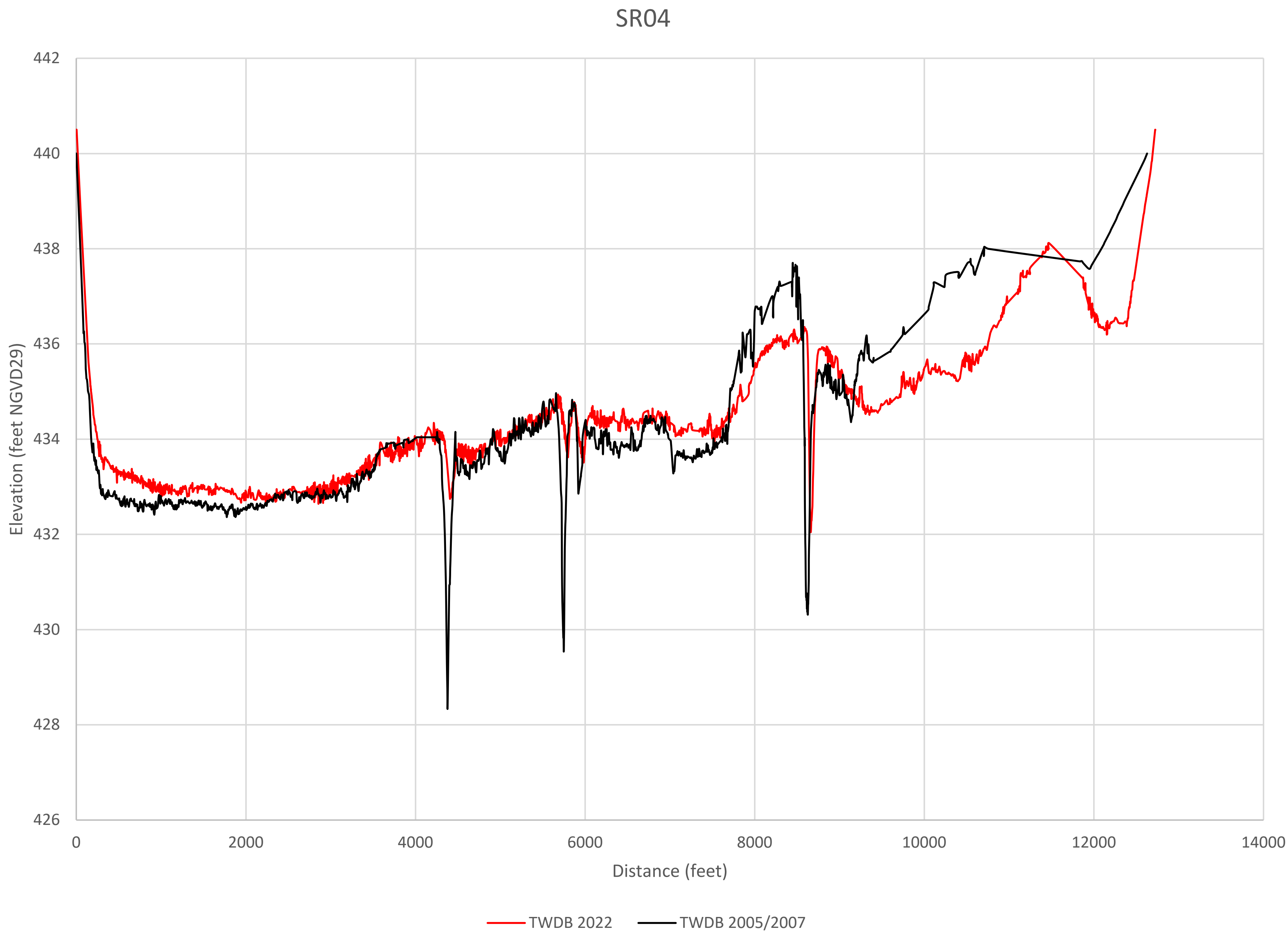

SR04
442
440
438
436
434
432
430
428
426
Elevation (feet NGVD29)
0
2000
4000
6000
8000
10000
12000
14000
Distance (feet)
TWDB 2022
TWDB 2005/2007

Figure 6

Contours

feet above mean sea level

440
435
430
425
420
415
410
405
400
395
390

Jim Chapman Lake: elevation 440.5 feet

Conservation pool elevation: 440.0 feet

Islands

Projection: NAD83
State Plane Texas
North 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 Jim Chapman Lake. The Texas Water Development Board makes no representations nor assumes any liability.