Volumetric Survey of Lake Corpus Christi

February 2016 Survey

Texas Water Development Board

October 2016

Texas Water Development Board

Prepared for:

City of Corpus Christi

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Executive summary

In August 2015, the Texas Water Development Board (TWDB) entered into agreement with the City of Corpus Christi, Texas to perform a volumetric survey of Lake Corpus Christi (San Patricio and Jim Wells counties). Surveying was performed using a multi-frequency (208 kHz, 50 kHz, and 24 kHz), sub-bottom profiling depth sounder, although only data collected at the 208 kHz frequency was analyzed for this report.

Wesley E. Seale Dam and Lake Corpus Christi are located on the Nueces River in San Patricio and Jim Wells counties, approximately four miles southwest of the City of Mathis, Texas. The conservation pool elevation of Lake Corpus Christi is 94.0 feet (NGVD29). The TWDB collected bathymetric data for Lake Corpus Christi between August 11, 2015, and February 12, 2016. Daily average water surface elevations during the survey ranged between 90.99 and 93.15 feet (NGVD29).

The 2016 TWDB volumetric survey indicates that Lake Corpus Christi has a total reservoir capacity of 256,813 acre-feet and encompasses 20,427 acres at conservation pool elevation (94.0 feet above mean sea level, NGVD29). Several previous capacity estimates for Lake Corpus Christi have been developed, most notably a 1957 survey estimate of 302,100 acre-feet, a 1972 survey estimate by McCaughan & Etheridge of 272,352 acre-feet, a 1987 U.S. Geological Survey survey estimate of 266,832 acre-feet, a 1991 re-calculation of the 1987 U.S. Geological Survey survey by HDR, Inc. estimating 241,241 acre-feet, and a 2002 TWDB survey that was re-evaluated resulting in an updated capacity estimate of 262,564 acre-feet.

The TWDB recommends a volumetric and sedimentation survey of Lake Corpus Christi within a 10 year time-frame or after a major flood event to assess changes in lake capacity and to further improve estimates of sediment accumulation rates.

Table of Contents

List of Tables

List of Figures

Appendices

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 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 August 2015, the TWDB entered into an agreement with the City of Corpus Christi to perform a volumetric survey of Lake Corpus Christi (TWDB 2015). The results of this agreement, described herein, include an overview of the data collection and processing techniques used to conduct the volumetric survey and the following final contract deliverables: (1) a shaded relief plot of the reservoir bottom (Figure 4), (2) a bottom contour map (Figure 6), and (3) an elevation-area-capacity table of the reservoir acceptable to the Texas Commission on Environmental Quality (Appendices A and B).

Lake Corpus Christi general information

Wesley E. Seale Dam and Lake Corpus Christi are located on the Nueces River in San Patricio and Jim Wells counties, approximately four miles southwest of Mathis, Texas (Figure 1). The reservoir also inundates part of Live Oak County. Wesley E. Seale Dam and Lake Corpus Christi are owned and operated by the City of Corpus Christi (COCC 2013). Construction of Wesley E. Seale Dam began on November 19, 1955. Dam completion and impoundment of water began on April 26, 1958 (TWDB 1967). Additional information about the reservoir can be found in the 2012 TWDB survey report (TWDB 2013).

Water rights for Lake Corpus Christi have been appropriated to the City of Corpus Christi through Certificate of Adjudication No. 21-2464. The complete certificate is on file in the Information Resources Division of the Texas Commission on Environmental Quality.

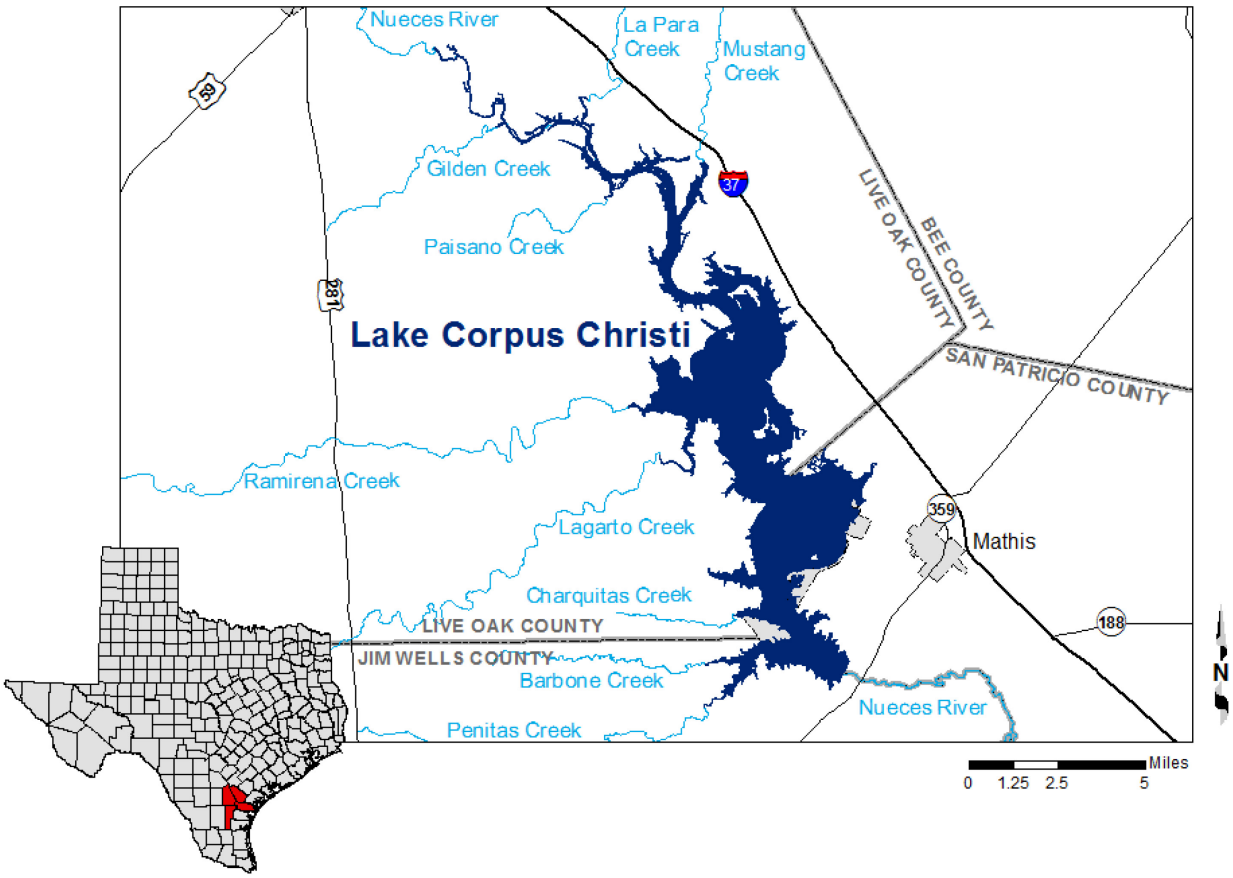

Figure 1. Location map of Lake Corpus Christi.

Table 1. Pertinent data for Wesley E. Seale Dam and Lake Corpus Christi.

Owner
City of Corpus Christi, Texas

Design Engineer
Ambursen Engineering Company (dam and original gates)
Forrest and Cotton, Inc. (modification of gates, completed September 4, 1966)

General contractor for the dam
H.B. Zachry Co.

Location of dam
On the Neuces River in San Patricio and Jim Wells counties, approximately 4 miles southwest of Mathis, Texas

Drainage area
16,656 square miles

Dam

Type	Earthfill and concrete
Length (including gates)	5,980 feet
Height	75 feet
Top width	varies 15 to 51 feet

Spillway (north or emergency)

Type	Concrete section
Control (screw type hoists, and portable engines)	33 gates, each 37.5 by 8.75 feet
Spillway crest elevation	88.0 feet above mean sea level
Top of gates elevation	94.3 feet above mean sea level

Spillway (south or service)

Type	Concrete section
Control (screw type hoists, and electric motors)	27 gates, each 37.5 by 8.75 feet
Spillway crest elevation	88.0 feet above mean sea level
Top of gates elevation	94.0 feet above mean sea level

Outlet works

Type	3 openings, each 2.5 by 4 feet
Control	48-inch cylinder valve
Invert elevation	55.5 feet above mean sea level

Water flows in river channel to treating plant.

Reservoir data (Based on 2015 TWDB survey)

Feature	**Elevation (feet** NGVD29[a]**)**	**Capacity (acre-feet)**	**Area (acres)**
Top of dam	109.3	N/A	N/A
Top of north spillway gates	94.3	N/A	N/A
Top of south spillway gates/ conservation pool elevation	94.0	256,813	20,427
Spillway crest	88.0	149,792	15,473
Invert low flow outlet	55.5	278	42
Usable conservation storage space[b]	-	256,535	-

Source: (TWDB 1967, TWDB 1971, COCC 2001)

[a] NGVD29 = National Geodetic Vertical Datum 1929

[b] Usable conservation storage space equals total capacity at conservation pool elevation minus dead pool capacity. Dead pool refers to water that cannot be drained by gravity through a dam's outlet works.

Volumetric survey of Lake Corpus Christi

Datum

The vertical datum used during this survey is the National Geodetic Vertical Datum 1929 (NGVD29). This datum also is utilized by the United States Geological Survey (USGS) for the reservoir elevation gage *USGS 08210500 Lk Corpus Christi nr Mathis, TX* (USGS 2016). Elevations herein are reported in feet 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 data collection

TWDB collected bathymetric data for Lake Corpus Christi between August 11, 2015, and February 16, 2016. Daily average water surface elevations during the survey ranged between 90.99 and 93.15 feet above mean sea level (NGVD29). For data collection, the TWDB used a Specialty Devices, Inc. (SDI), single-beam, multi-frequency (208 kHz, 50 kHz, and 24 kHz) sub-bottom profiling depth sounder integrated with differential global positioning system (DGPS) equipment and an SDI motion reference unit to account for heave. Data was 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 during the 2002 and 2012 surveys. The depth sounder was calibrated daily using a velocity profiler to measure the speed of sound in the water column and a weighted tape or stadia rod for depth reading verification. Figure 2 shows the data collection locations for the 2016 TWDB survey of Lake Corpus Christi.

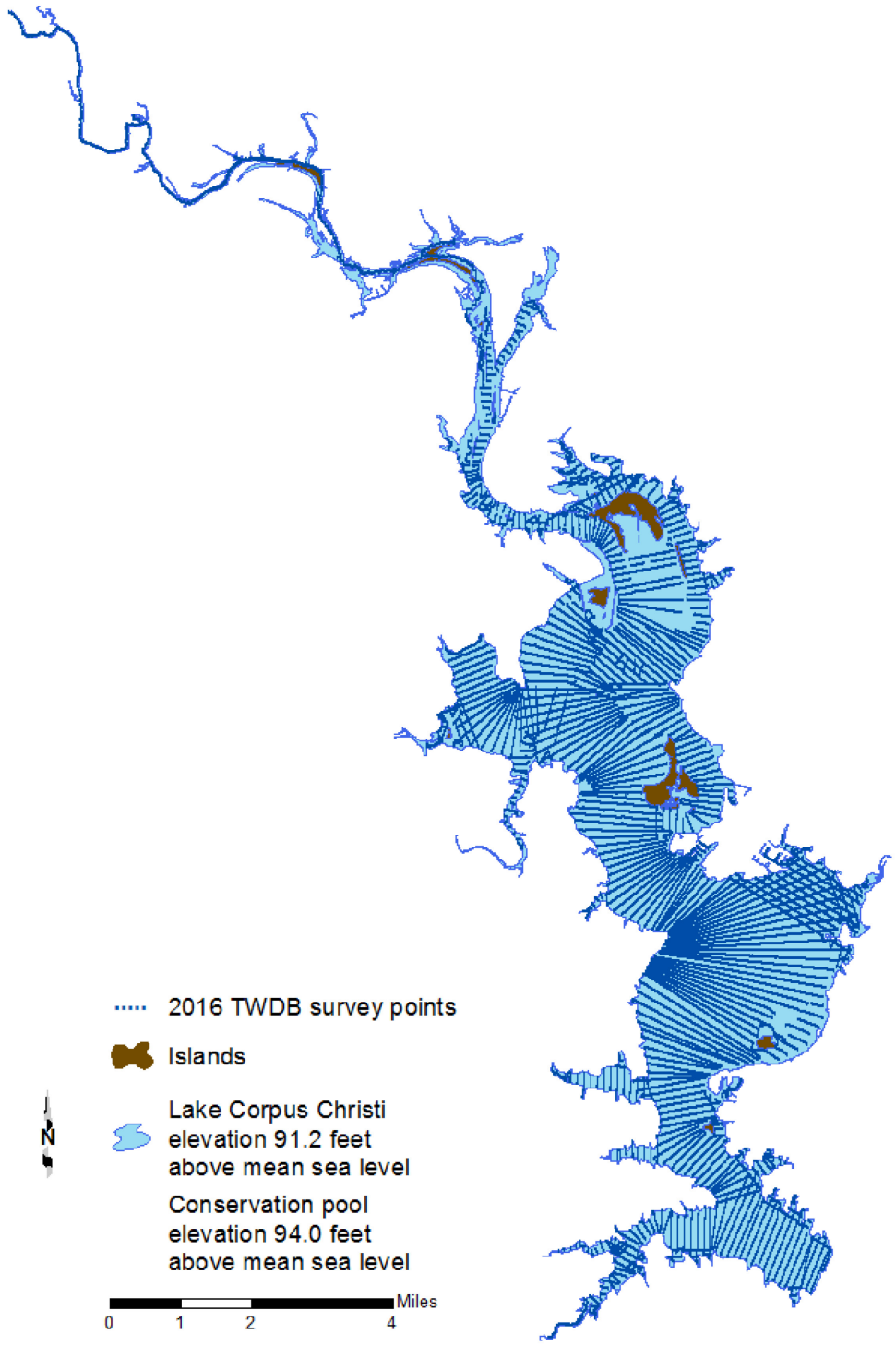

Figure 2. 2016 TWDB Lake Corpus Christi survey data (*blue dots*).

Data processing

Model boundary

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 2016a) using Environmental Systems Research Institute's ArcGIS software. The quarter-quadrangles that cover Lake Corpus Christi are Sandia (NE, SE), Mathis (NW, SW), Tynan (SW), Dinero (NE, NW, SE, SW), Mulos Hills (SW, SE), and George West (SE). The DOQQs Dinero (NW, SW), Mulos Hills (SW), and Goerge West (SE) were photographed on January 18, 2016, while the remaining DOQQs were photographed on January 29, 2016. Daily average water surface elevations measured 91.39 and 91.17 feet, respectively. The DOQQs have a resolution or ground sample distance of 0.5 meters and a horizontal accuracy within ± 2.45 meters at 95 percent confidence level, according to the associated metadata (TNRIS 2016b). For modeling and analysis purposes, the boundary was digitized at the land-water interface in the 2016 photographs and assigned an elevation of 91.2 feet, the average elevation of the water surface in all the photographs.

Triangulated Irregular Network model

Following completion of data collection, raw data files were edited to remove data anomalies. DepthPic© software, developed by SDI, Inc., was used to display, interpret, and edit the multi-frequency data by manually removing data anomalies in the current reservoir-bottom surface. For processing outside of DepthPic©, HydroTools, a software package developed by TWDB staff, was used to identify the current reservoir-bottom surface, and to output 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. 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). Finally, the point file resulting from spatial interpolation was used in conjunction with sounding and boundary data to create volumetric Triangulated Irregular Network (TIN)

models utilizing the 3D Analyst Extension of ArcGIS. The 3D Analyst algorithm uses Delaunay's criteria for triangulation to create a grid composed of triangles from non-uniformly spaced points, including the boundary vertices (ESRI 1995).

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 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 TIN model 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 survey data or more robustly by examining scanned USGS 7.5 minute quadrangle maps (known as digital raster graphics or DRGs) and hypsography files (the vector format of USGS 7.5 minute quadrangle map contours) when available. DOQQs photographed on May 22, 2012, while the daily average water surface elevation of the lake measured 83.13 feet, were especially useful for determining sinuosity and directionality of the stream channels for the 2016 TIN model of this reservoir. Polygons are created to partition the reservoir into segments with centerlines defining directionality of interpolation within each segment using the survey data. For surveys with similar spatial coverage, these interpolation definition files are, in principle, independent of the survey data and could be applied to past and future survey data of the same reservoir. In practice, however, minor

revisions of the interpolation definition files may be needed to account for differences in spatial coverage and boundary conditions between surveys. Using the interpolation definition files and survey data, the current reservoir-bottom elevation, when applicable, is 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 the TIN model representing reservoir bathymetry. Specific details of this interpolation technique can be found in the HydroTools manual (McEwen *et al.* 2011a) and in McEwen *et al.* 2011b.

In areas inaccessible to survey data collection such as small coves and shallow upstream areas of the reservoir, linear interpolation is used for volumetric estimations. Linear interpolation follows a line linking the survey points file to the lake boundary file (McEwen *et al.* 2011a). Without interpolated data, the TIN model builds flat triangles. A flat triangle is defined as a triangle where all three vertices are equal in elevation, generally the elevation of the reservoir boundary. Reducing flat triangles by applying linear interpolation improves the elevation-capacity and elevation-area calculations, although it is not always possible to remove all flat triangles.

Figure 3 illustrates typical results from application of the anisotropic interpolation and linear interpolation techniques to Lake Corpus Christi. In Figure 3A, deeper channels indicated by surveyed cross sections are not continuously represented in areas between survey cross-sections. This is an artifact of the TIN generation routine rather than an accurate representation of the physical bathymetric surface. Inclusion of interpolation points in creation of the 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 A) and elevation-area (Appendix B) tables.

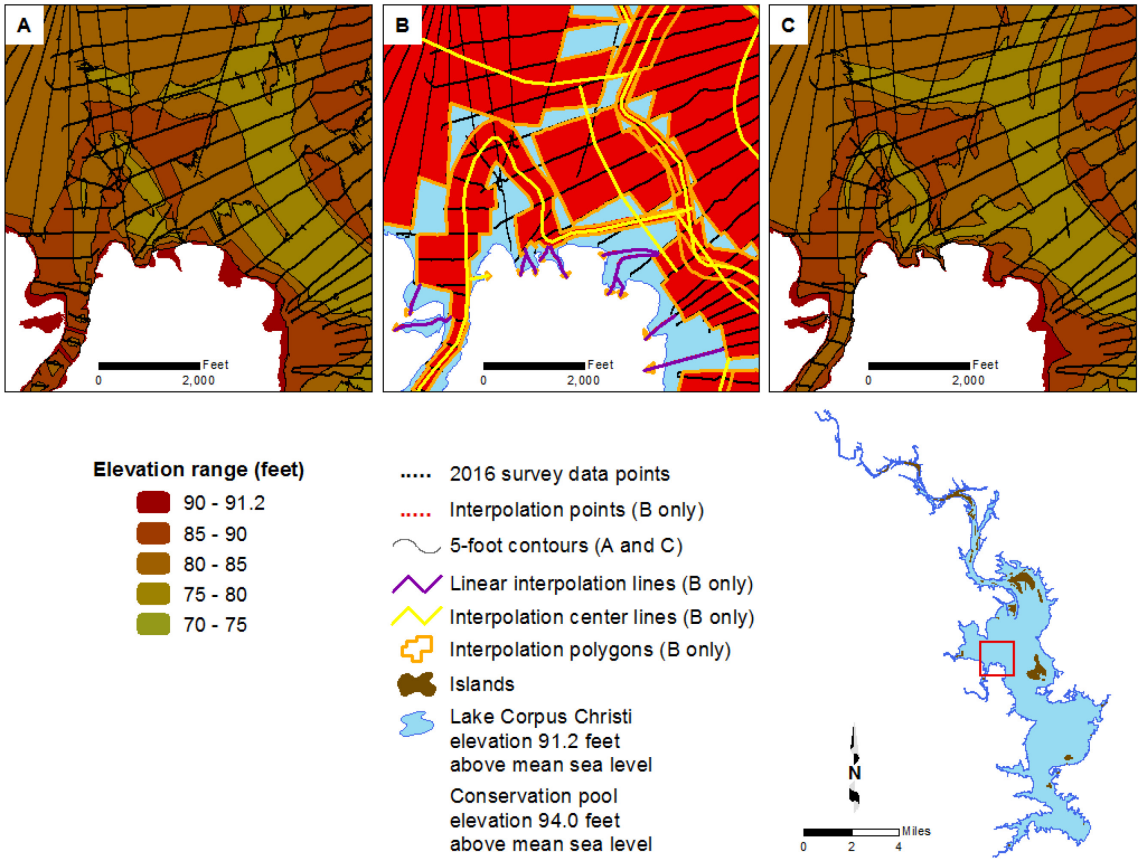

Figure 3. **Anisotropic spatial interpolation and linear interpolation of Lake Corpus Christi sounding data; A) bathymetric contours without interpolated points, B) sounding points (*black*) and interpolated points (*red*), C) bathymetric contours with interpolated points.**

Area, volume, and contour calculation

Using ArcInfo software and the TIN model, volumes and areas were calculated for the entire reservoir at 0.1-foot intervals from 38.0 to 91.2 feet. While linear interpolation was used to estimate topography in areas that were inaccessible by boat or too shallow for the instruments to work properly, development of anomalous flat triangles (triangles whose vertices all have the same elevation) in the TIN model are unavoidable. The flat triangles in turn lead to anomalous calculations of surface area and volume near the model boundary elevation 91.2 feet. To eliminate the effects of the flat triangles on area and volume calculations, areas between elevations 88.5 feet and 91.2 feet were linearly interpolated between the computed values, and volumes above elevation 88.5 feet were calculated based on the corrected areas. Areas above elevation 91.2 feet were linearly extrapolated and capacities were calculated from the extrapolated areas. The elevation-capacity table and elevation-area table, based on the 2016 survey and analysis, are presented in Appendices A and B, respectively. The capacity curve is presented in Appendix C, and the area curve is presented in Appendix D.

The TIN model was converted to a raster representation using a cell size of two feet by two feet. The raster data was then 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 shaded depth ranges for Lake Corpus Christi (Figure 5); and, (3) a five-foot contour map (Figure 6).

2,280,000 2,300,000 2,320,000

13,280,000 13,260,000 13,240,000 13,220,000 13,200,000

Figure 4

Lake Corpus Christi

Elevation relief map

Elevations
(feet above mean sea level)

- 90 - 91.2
- 88 - 90
- 86 - 88
- 84 - 86
- 82 - 84
- 80 - 82
- 78 - 80
- 76 - 78
- 74 - 76
- 72 - 74
- 70 - 72
- 68 - 70
- 66 - 68
- 64 - 66
- 62 - 64
- 60 - 62
- 58 - 60
- 56 - 58
- 54 - 56
- 52 - 54
- 50 - 52
- 48 - 50
- 46 - 48
- 44 - 46
- 42 - 44
- 40 - 42
- 38 - 40

10-foot contours

Conservation pool
elevation: 94.0 feet
above mean sea level

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

Texas Water Development Board

February 2016 Survey

N

0 1 2 4 Miles

Figure 5

Lake Corpus Christi

Depth range map

2,280,000
2,300,000
2,320,000
13,280,000
13,260,000
13,240,000
13,220,000
13,200,000

Depth ranges

(feet below conservation pool)

- 2.8 - 5'
- 5 - 10'
- 10 - 15'
- 15 - 20'
- 20 - 25'
- 25 - 30'
- 30 - 35'
- 35 - 40'
- 40 - 45'
- 45 - 50'
- 50 - 55'
- > 55'
- Islands

Conservation pool elevation: 94.0 feet above mean sea level

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

Texas Water Development Board

February 2016 Survey

N

0 1 2 4 Miles

Survey results

Volumetric survey

The results of the 2016 TWDB volumetric survey indicate Lake Corpus Christi has a total reservoir capacity of 256,813 acre-feet and encompasses 20,427 acres at conservation pool elevation (94.0 feet above mean sea level, NGVD29). Lake Corpus Christi has been surveyed several times since impoundment, and many area and capacity tables have been generated in an effort to understand sedimentation within the reservoir (Table 2). Additional information about each survey can be found in the 2012 TWDB survey report (TWDB 2013). Although the TWDB surveyed Lake Corpus Christi in 2012, field conditions prevented a complete survey of the entire reservoir. In 2012, water surface elevations of the reservoir during the survey measured between 81.57 and 82.82 feet (TWDB 2013). At elevation 82.8 feet, less than half the total reservoir surface area is submerged, according to both the 2002 and 2016 TWDB surveys. Therefore, the results of the 2012 TWDB survey were combined with results of the 2002 TWDB survey to generate complete elevation-area-capacity tables. Additionally, the capacity estimate at conservation pool elevation is not compared here, because it is not representative of the lake at a specific time. Because of differences in survey methodologies, any direct comparison of changes in capacity based on this volumetric survey is difficult and may be unreliable.

The 2002 TWDB survey originally estimated capacity to be 257,260 acre-feet at conservation pool elevation (94.0 feet; TWDB 2002), but in 2013, the data was re-evaluated using the then current procedures for applying anisotropic spatial interpolation, yielding a revised capacity estimate of 262,337 acre-feet (TWDB 2013). In 2016, the 2002 TWDB survey estimate was further revised to correct for flat triangles in the TIN model that were not removed with linear interpolation. Areas between 92.5 and 94.1 feet were linearly interpolated between the computed values, and volumes above 92.5 feet were calculated based on the corrected areas. This 2016 revision of the 2002 surface area estimate resulted in an additional 279 acres at conservation pool elevation (94.0 feet), or a 1.5 percent increase in surface area. Based on this corrected area estimate for the 2002 survey data, capacity is now estimated to be 262,564 acre-feet at conservation pool elevation, an increase of 227 acre-feet, or 0.09 percent. Compared to the area and capacity estimates originally published in 2002, this represents a 2.6 percent increase in area and a 2.1 percent increase in capacity at a conservation pool elevation of 94.0 feet.

The total capacity estimates of Lake Corpus Christi found in Table 2 are plotted in Figure 7 to illustrate how each estimate compares to the other. Further comparison of the capacity estimates derived using differing methodologies are provided in Table 3 for sedimentation rate calculation. Comparison of the current 2016 TWDB capacity estimate with the revised 2002 TWDB capacity estimate indicates Lake Corpus Christi is losing an average of 411 acre-feet of capacity per year.

Table 2. Current and previous survey capacity and surface area estimates for Lake Corpus Christi.

Survey	Surface area (acres)	Total capacity (acre-feet)	Source
U.S. Soil Conservation Service 1948	19,860	292,758	McCaughan & Etheridge 1973
Reagan & McCaughan 1957	22,050	302,100	TWDB 1967, McCaughan & Etheridge 1973
1957 re-calculated	22,050	297,776	McCaughan & Etheridge 1973
McCaughan & Etheridge 1972	19,336	272,352	McCaughan & Etheridge 1973
USGS 1987	18,883	266,832	West *et al.* 1987
USGS 1987 re-calculated by HDR Inc. 1991	19,251	241,241	COCC 1991, HDR 2002
TWDB 2002	18,286	257,260	TWDB 2002
TWDB 2002 re-calculated	18,487	262,337	TWDB 2013
TWDB 2002 re-calculated[a]	18,766	262,564	TWDB 2016
TWDB 2016	20,427	256,813	TWDB 2016

[a] Note: These values have been revised since being re-calculated in 2013 (TWDB 2013) to correct for flat triangles generated by the TIN model.

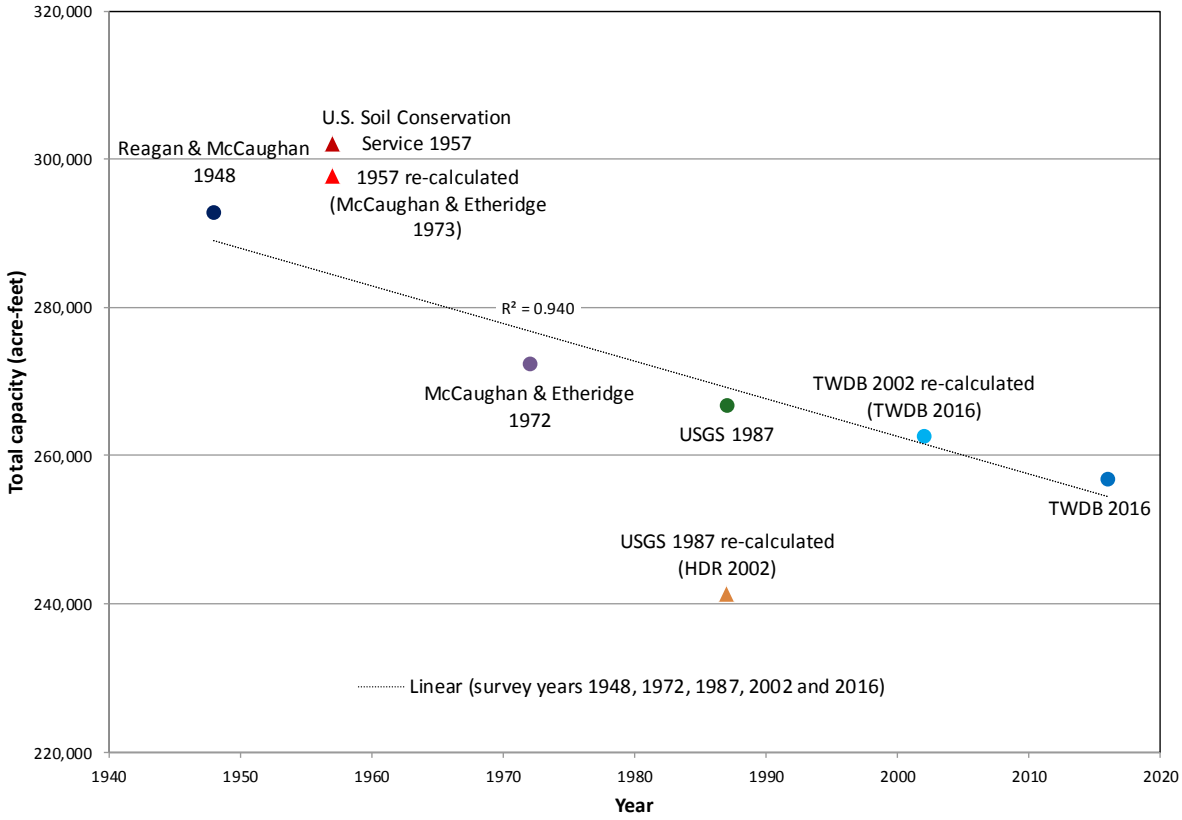

Figure 7. Comparison of total capacity estimates for Lake Corpus Christi.

Table 3. Capacity loss comparisons for Lake Corpus Christi.

Survey	Volume comparisons at conservation pool elevation 94.0 feet (acre-feet)				
1948	292,758	◇	◇	◇	◇
1957 re-calculated by McCaughan & Etheridge	◇	297,776	◇	◇	◇
McCaughan & Etheridge 1972	◇	◇	272,352	◇	◇
USGS 1987	◇	◇	◇	266,832	◇
TWDB 2002 re-calculated[a]	◇	◇	◇	◇	262,564
2016 volumetric survey	256,813	256,813	256,813	256,813	256,813
Volume difference (acre-feet)	35,945 (12.3%)	40,963 (13.8%)	15,539 (5.7%)	10,019 (3.8%)	5,751 (2.2%)
Number of years	68	59	44	29	14
Capacity loss rate (acre-feet/year)	529	694	353	345	411

[a] Note: This value has been revised, as described herein, since being re-calculated in 2013 (TWDB 2013) to correct for flat triangles generated by the TIN model.

Recommendations

The TWDB recommends a volumetric and sedimentation survey of Lake Corpus Christi within a 10 year time-frame or after a major flood event to assess changes in lake capacity and to further improve estimates of sediment accumulation rates.

TWDB contact information

More information about the Hydrographic Survey Program can be found at:
http://www.twdb.texas.gov/surfacewater/surveys/index.asp
Any questions regarding the TWDB Hydrographic Survey Program may be addressed to:
Hydrosurvey@twdb.texas.gov

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Appendix A

Lake Corpus Christi

RESERVOIR CAPACITY TABLE

TEXAS WATER DEVELOPMENT BOARD — February 2016 Survey

CAPACITY IN ACRE-FEET — Conservation Pool Elevation 94.0 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
38	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	1	1
40	1	1	1	1	1	1	1	1	2	2
41	2	2	2	2	3	3	3	3	3	4
42	4	4	5	5	5	6	6	6	7	7
43	7	8	8	9	9	10	10	11	11	12
44	12	13	13	14	14	15	16	16	17	18
45	18	19	20	20	21	22	23	23	24	25
46	26	27	28	29	30	31	32	33	34	36
47	37	38	40	41	42	44	45	47	48	50
48	52	53	55	57	59	61	63	65	68	70
49	72	74	77	79	81	84	86	89	91	94
50	96	99	101	104	106	109	112	114	117	120
51	123	126	128	131	134	137	140	143	146	149
52	152	155	158	162	165	168	171	174	178	181
53	184	188	191	195	198	201	205	208	212	216
54	219	223	226	230	234	238	241	245	249	253
55	257	261	265	269	273	278	282	286	290	295
56	299	304	308	313	318	322	327	332	337	342
57	347	352	357	362	368	373	378	384	389	395
58	400	406	412	418	424	430	436	443	450	457
59	464	472	480	488	497	506	515	525	535	545
60	555	565	576	587	599	611	623	636	649	662
61	676	691	706	722	739	757	775	794	814	835
62	857	881	905	931	957	985	1,014	1,045	1,077	1,113
63	1,151	1,194	1,240	1,289	1,340	1,393	1,448	1,506	1,565	1,625
64	1,687	1,750	1,814	1,880	1,947	2,015	2,085	2,156	2,229	2,305
65	2,382	2,462	2,543	2,626	2,712	2,799	2,889	2,980	3,073	3,168
66	3,265	3,364	3,464	3,567	3,671	3,777	3,886	3,997	4,111	4,226
67	4,345	4,466	4,589	4,715	4,842	4,970	5,101	5,233	5,367	5,502
68	5,639	5,778	5,919	6,062	6,206	6,352	6,500	6,649	6,800	6,951
69	7,104	7,258	7,413	7,569	7,727	7,885	8,046	8,208	8,372	8,538
70	8,705	8,874	9,045	9,219	9,394	9,571	9,751	9,934	10,118	10,305
71	10,495	10,686	10,881	11,078	11,279	11,483	11,691	11,902	12,117	12,336
72	12,558	12,784	13,014	13,247	13,485	13,729	13,980	14,239	14,509	14,789
73	15,081	15,382	15,691	16,009	16,336	16,672	17,019	17,377	17,745	18,125
74	18,513	18,910	19,316	19,730	20,154	20,588	21,031	21,484	21,945	22,415
75	22,894	23,380	23,873	24,372	24,876	25,387	25,904	26,426	26,954	27,488
76	28,028	28,575	29,127	29,685	30,248	30,818	31,393	31,975	32,563	33,158
77	33,760	34,367	34,981	35,601	36,228	36,860	37,498	38,142	38,793	39,451
78	40,117	40,791	41,473	42,163	42,861	43,565	44,276	44,993	45,717	46,447
79	47,184	47,928	48,678	49,435	50,198	50,968	51,745	52,528	53,319	54,116
80	54,921	55,733	56,554	57,384	58,224	59,074	59,935	60,805	61,685	62,575
81	63,475	64,385	65,305	66,234	67,172	68,120	69,076	70,041	71,015	71,997
82	72,988	73,988	74,997	76,014	77,041	78,077	79,123	80,178	81,243	82,318
83	83,402	84,496	85,599	86,711	87,832	88,962	90,102	91,252	92,413	93,583
84	94,764	95,955	97,156	98,368	99,589	100,820	102,061	103,311	104,571	105,840
85	107,119	108,408	109,706	111,014	112,332	113,658	114,994	116,340	117,695	119,060
86	120,434	121,819	123,214	124,618	126,031	127,453	128,884	130,325	131,774	133,231
87	134,697	136,173	137,656	139,147	140,645	142,151	143,664	145,184	146,713	148,249
88	149,792	151,343	152,902	154,468	156,042	157,623	159,221	160,826	162,440	164,063
89	165,693	167,332	168,980	170,635	172,299	173,971	175,652	177,341	179,038	180,744
90	182,457	184,180	185,910	187,649	189,396	191,152	192,915	194,688	196,468	198,257
91	200,054	201,859	203,673	205,495	207,326	209,164	211,011	212,867	214,730	216,603
92	218,483	220,372	222,269	224,174	226,088	228,010	229,940	231,879	233,825	235,781
93	237,744	239,716	241,697	243,685	245,682	247,687	249,701	251,723	253,753	255,791
94	256,813									

Note: Capacities above elevation 88.5 feet calculated from interpolated and extrapolated areas

Appendix B

Lake Corpus Christi

RESERVOIR AREA TABLE

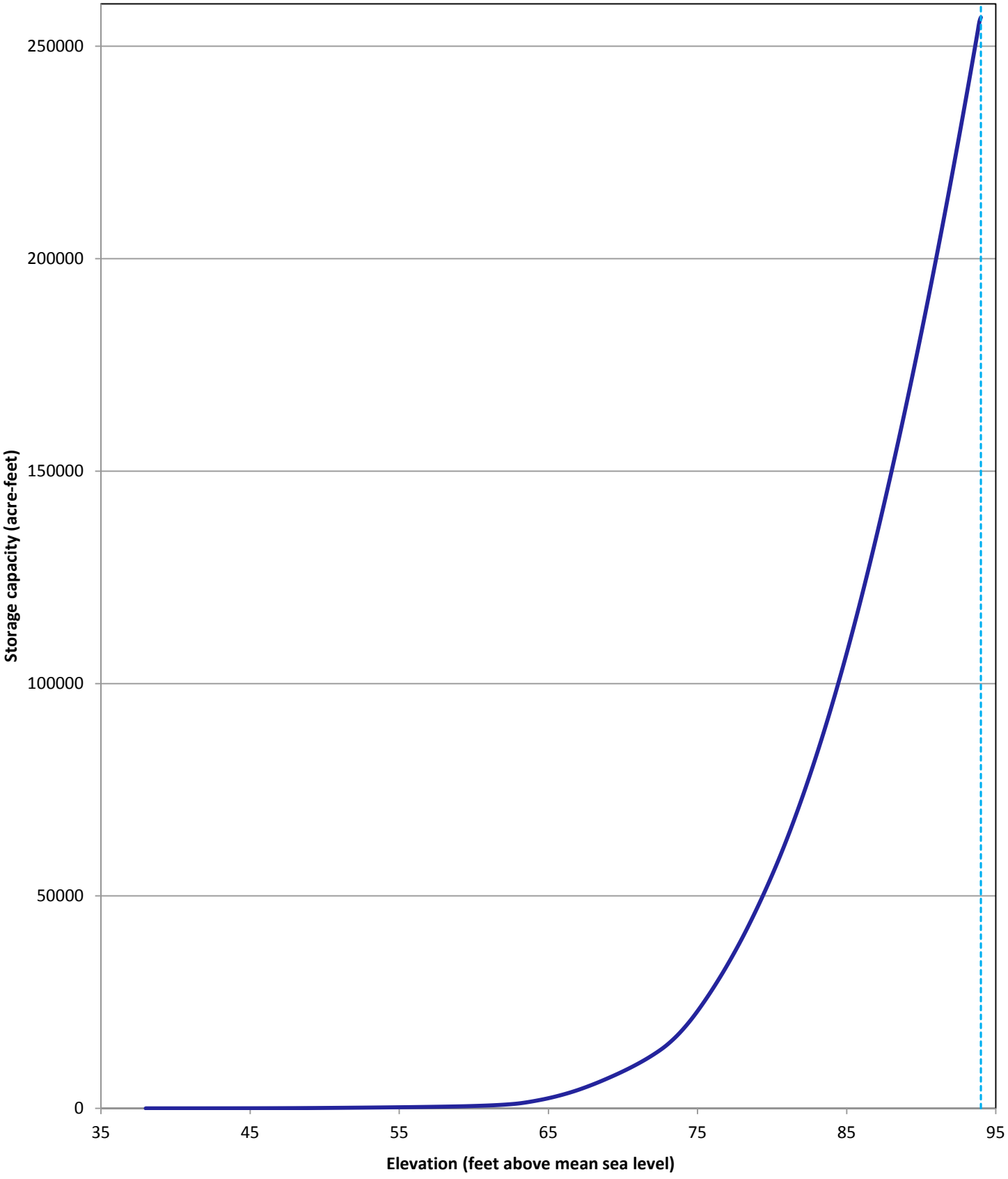
TEXAS WATER DEVELOPMENT BOARD — February 2016 Survey

AREA IN ACRES — Conservation Pool Elevation 94.0 feet NGVD29

ELEVATION INCREMENT IS ONE TENTH FOOT

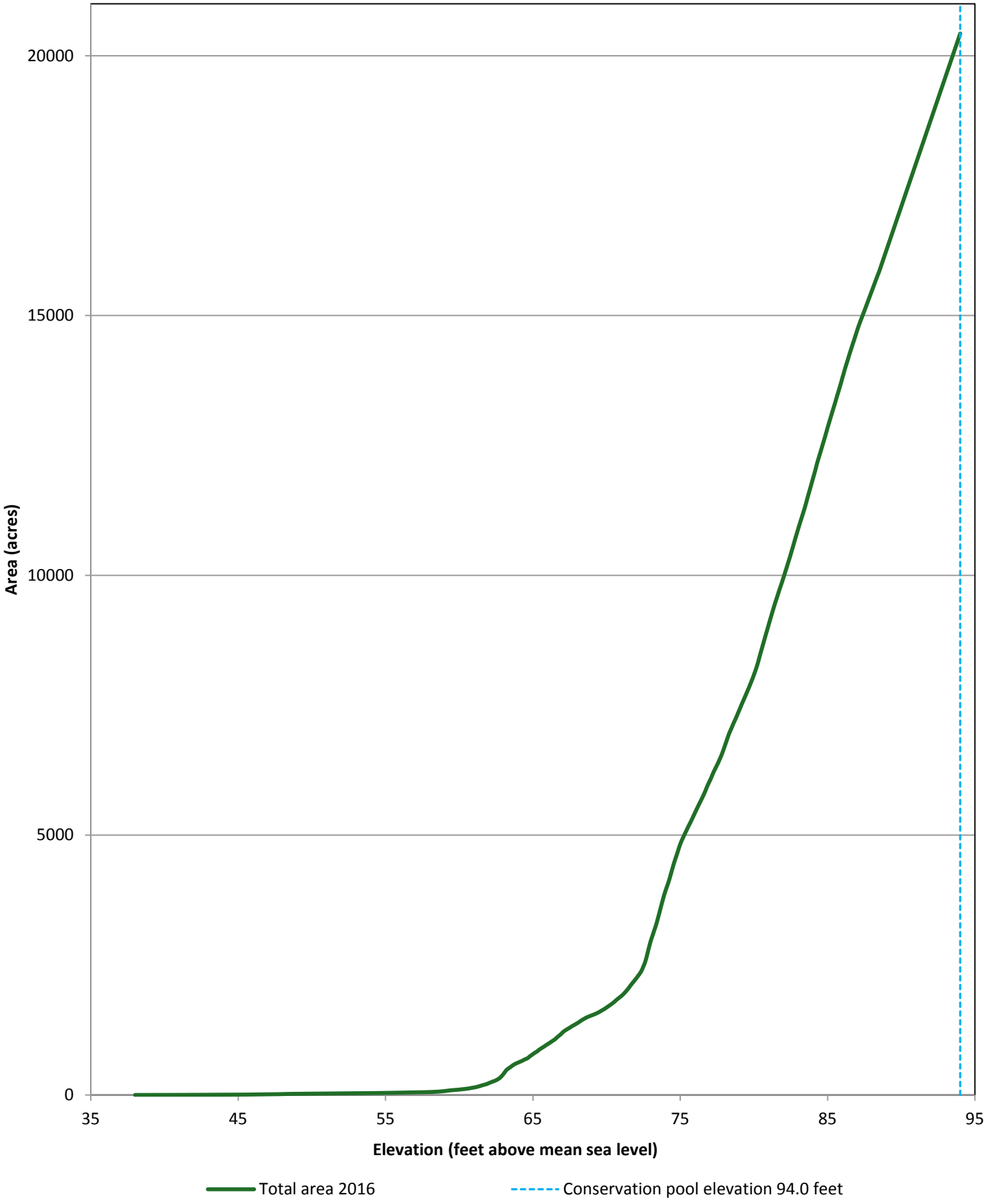
ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
38	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	1	1	1	1	1	1
40	1	1	1	1	1	1	1	1	1	1
41	2	2	2	2	2	2	2	2	3	3
42	3	3	3	3	3	3	3	3	4	4
43	4	4	4	5	5	5	5	5	5	5
44	6	6	6	6	6	6	6	6	6	7
45	7	7	7	7	7	8	8	8	8	9
46	9	9	10	10	11	11	11	12	12	13
47	13	13	14	14	14	15	15	15	16	16
48	17	18	19	20	20	21	21	21	22	22
49	22	23	23	23	24	24	24	25	25	25
50	25	26	26	26	26	27	27	27	28	28
51	28	28	29	29	29	29	30	30	30	31
52	31	31	31	32	32	32	33	33	33	33
53	33	34	34	34	34	35	35	35	36	36
54	36	36	37	37	37	38	38	39	39	39
55	40	40	41	41	42	42	43	43	44	45
56	45	45	46	46	47	48	48	49	49	50
57	50	51	51	52	52	53	54	54	55	56
58	57	58	59	60	62	63	65	67	69	72
59	75	78	82	86	89	92	94	97	99	101
60	104	107	110	113	116	120	124	128	134	139
61	144	149	155	164	171	180	189	197	205	214
62	227	239	250	260	270	283	299	316	339	369
63	403	442	478	502	521	542	563	583	598	611
64	624	636	648	662	678	689	702	720	746	765
65	786	806	823	842	865	885	904	921	941	960
66	978	995	1,015	1,034	1,053	1,072	1,098	1,124	1,147	1,170
67	1,199	1,223	1,244	1,261	1,278	1,295	1,314	1,331	1,346	1,363
68	1,380	1,398	1,417	1,436	1,454	1,470	1,485	1,499	1,510	1,522
69	1,533	1,544	1,556	1,568	1,582	1,597	1,614	1,631	1,646	1,664
70	1,683	1,703	1,723	1,742	1,764	1,786	1,811	1,836	1,859	1,882
71	1,904	1,930	1,958	1,989	2,024	2,058	2,097	2,134	2,169	2,204
72	2,239	2,278	2,316	2,356	2,407	2,475	2,544	2,639	2,753	2,863
73	2,966	3,051	3,138	3,221	3,312	3,417	3,523	3,632	3,739	3,841
74	3,929	4,013	4,094	4,188	4,289	4,388	4,484	4,569	4,654	4,745
75	4,826	4,897	4,958	5,019	5,078	5,138	5,195	5,252	5,310	5,371
76	5,431	5,492	5,550	5,608	5,665	5,724	5,784	5,848	5,920	5,984
77	6,043	6,104	6,174	6,236	6,293	6,351	6,410	6,475	6,541	6,618
78	6,698	6,778	6,862	6,943	7,010	7,075	7,144	7,205	7,267	7,335
79	7,402	7,470	7,538	7,602	7,667	7,733	7,800	7,867	7,938	8,009
80	8,087	8,165	8,251	8,348	8,453	8,554	8,652	8,753	8,853	8,949
81	9,049	9,147	9,243	9,339	9,433	9,521	9,606	9,696	9,780	9,864
82	9,953	10,041	10,131	10,222	10,313	10,407	10,504	10,602	10,701	10,795
83	10,892	10,985	11,074	11,164	11,254	11,350	11,455	11,556	11,655	11,756
84	11,858	11,956	12,063	12,170	12,265	12,357	12,453	12,548	12,642	12,741
85	12,842	12,938	13,032	13,127	13,220	13,312	13,411	13,504	13,599	13,695
86	13,796	13,896	13,994	14,085	14,177	14,270	14,357	14,446	14,531	14,619
87	14,708	14,794	14,871	14,947	15,020	15,094	15,168	15,245	15,321	15,398
88	15,473	15,549	15,625	15,701	15,776	15,848	15,932	16,015	16,098	16,181
89	16,265	16,348	16,431	16,514	16,598	16,681	16,764	16,847	16,931	17,014
90	17,097	17,180	17,264	17,347	17,430	17,513	17,597	17,680	17,763	17,846
91	17,930	18,013	18,096	18,179	18,263	18,346	18,429	18,512	18,596	18,679
92	18,762	18,845	18,928	19,012	19,095	19,178	19,261	19,345	19,428	19,511
93	19,594	19,678	19,761	19,844	19,927	20,011	20,094	20,177	20,260	20,344
94	20,427									

Note: Areas between elevations 88.5 and 91.2 feet linearly interpolated, areas above 91.2 feet linearly extrapolated



Lake Corpus Christi
February 2016 Survey
Prepared by: TWDB

Appendix C: Capacity curve



Lake Corpus Christi
February 2016 Survey
Prepared by: TWDB

Appendix D: Area curve

Figure 6

Lake Corpus Christi

5' - contour map

CONTOURS
(feet above mean sea level)

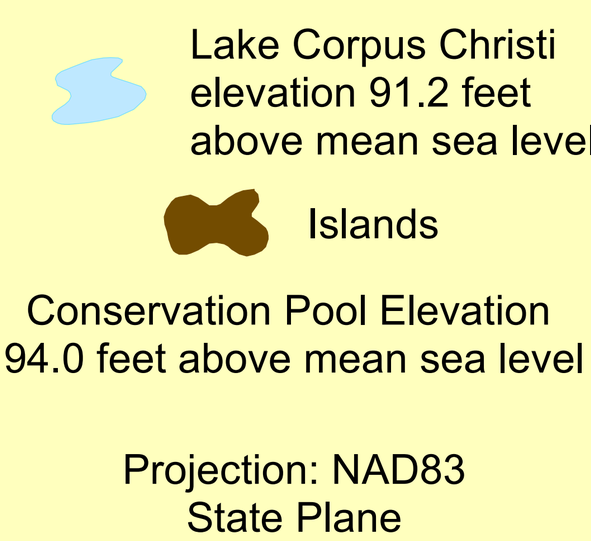
- 90
- 85
- 80
- 75
- 70
- 65
- 60
- 55
- 50
- 45
- 40

Lake Corpus Christi elevation 91.2 feet above mean sea level

Islands

Conservation Pool Elevation 94.0 feet above mean sea level

Projection: NAD83
State Plane
Texas South Central Zone



San Patricio, Jim Wells, and Live Oak Counties

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

N

Texas Water Development Board

February 2016 survey

2,300,000 2,325,000 13,275,000 13,250,000 13,225,000 13,200,000

0 1 2 4 Miles