Volumetric Survey of Bryan Utilities Lake

February 2016 Survey

Texas Water Development Board

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Prepared for:

Bryan Texas Utilities

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Executive summary

In January 2016, the Texas Water Development Board entered into agreement with Bryan Texas Utilities to perform a volumetric survey of Bryan Utilities Lake. Surveying was performed using a multi-frequency (208 kHz, 50 kHz, and 24 kHz), sub-bottom profiling depth sounder, although only the 208 kHz frequency was analyzed for this report.

Bryan Utilities Lake Dam and Bryan Utilities Lake are located on unnamed tributaries of Thompsons Creek and the Little Brazos River in Brazos County, five miles northwest of Bryan, Texas. The conservation pool elevation of Bryan Utilities Lake is 355.5 feet above mean sea level (NGVD29). TWDB collected bathymetric data for Bryan Utilities Lake on February 9-10, 2016. The daily average water surface elevation during the survey measured 349.8 feet.

The 2016 TWDB volumetric survey indicates that Bryan Utilities Lake has a total reservoir capacity of 14,163 acre-feet and encompasses 818 acres at conservation pool elevation (355.5 feet above mean sea level, NGVD29). Previous capacity estimates include the original design capacity of 15,227 acre-feet encompassing 829 acres.

TWDB recommends that a similar methodology be used to resurvey Bryan Utilities Lake in 10 years or after a major flood event. To further improve estimates of capacity loss, TWDB recommends a volumetric and sedimentation survey. Sedimentation surveys include additional analysis of the multi-frequency data for post-impoundment sediment by correlation with sediment core samples and a map identifying the spatial distribution of sediment throughout the reservoir.

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

Introduction

The Hydrographic Survey Program of the Texas Water Development Board (TWDB) was authorized by the 72nd Texas State Legislature in 1991. Section 15.804 of the Texas Water Code authorizes TWDB to perform surveys to determine reservoir storage capacity, sedimentation levels, rates of sedimentation, and projected water supply availability.

In January 2016, the Texas Water Development Board entered into agreement with Bryan Texas Utilities, to perform a volumetric survey of Bryan Utilities Lake (TWDB, 2016). This report describes the methods used to conduct the volumetric survey, including data collection and processing techniques. This report serves as the final contract deliverable from TWDB to Bryan Texas Utilities, and contains as 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 [Appendix A, B].

Bryan Utilities Lake general information

Bryan Utilities Lake Dam and Bryan Utilities Lake, also known as Lake Bryan, are located on unnamed tributaries of Thompsons Creek and the Little Brazos River in Brazos County, approximately five miles northwest of Bryan, Texas, in the Brazos River Basin (Figure 1). Construction of the dam was completed in 1975 (Freese and Nichols, 2010). Bryan Utilities Lake is owned by the City of Bryan (SJB&A, 1976) and operated by Bryan Texas Utilities (Freese and Nichols, 2010). Bryan Texas Utilities is a municipally owned electric utility, wholly-owned by the City of Bryan (BTU, 2016). Bryan Utilities Lake is primarily an industrial water supply reservoir used for cooling purposes at the Roland C. Dansby Power Plant and for recreational purposes (Freese and Nichols, 2010). The lake's water level is maintained via groundwater from a Bryan Texas Utilities owned well (TPWD, 2014). Additional pertinent data about Bryan Utilities Lake Dam and Bryan Utilities Lake can be found in Table 1.

Water rights for Bryan Utilities Lake have been appropriated to the City of Bryan, through Certificate of Adjudication No. 12-5268. The complete certificate is on file in the Information Resources Division of the Texas Commission on Environmental Quality.

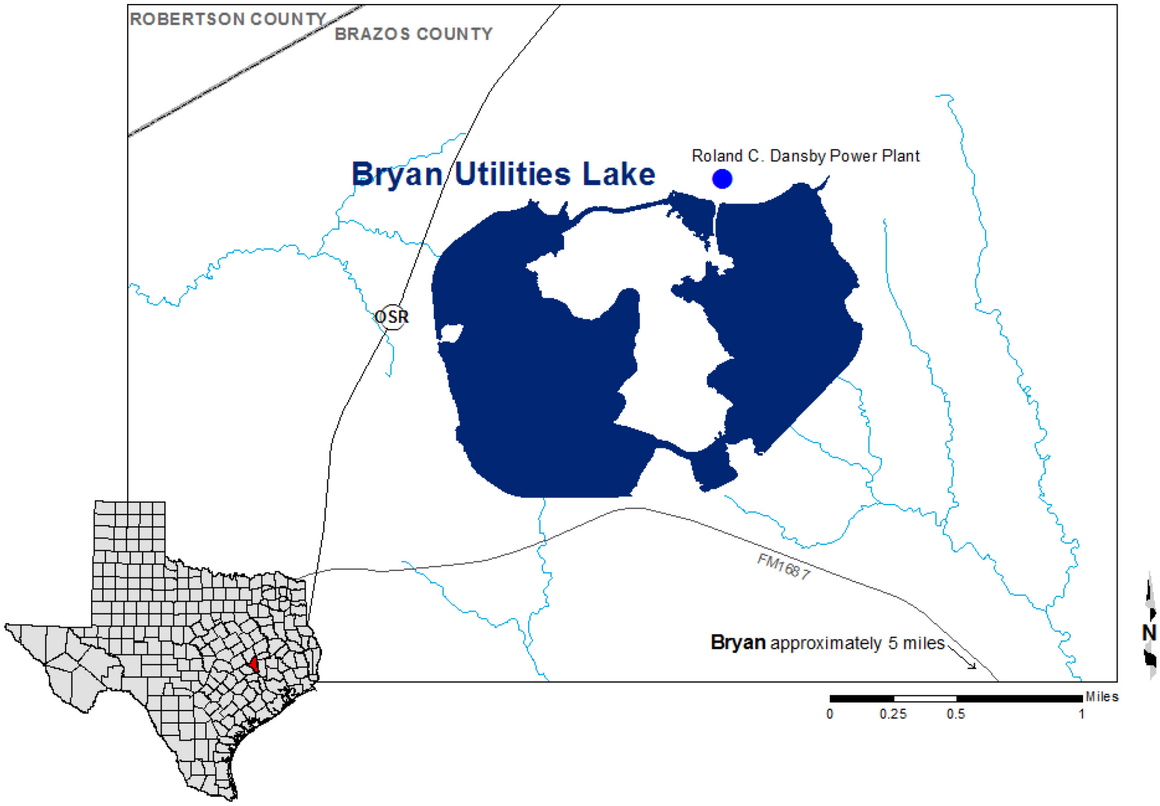


Figure 1. Location of Bryan Utilities Lake

Table 1. Pertinent data for Bryan Utilities Lake Dam and Bryan Utilities Lake

Owner				
City of Bryan, Texas				
Engineer (Design)				
Spencer J. Buchanan & Associates				
Location of dam				
On unnamed tributaries of the Brazos River, 5 miles northwest of Bryan, Texas				
Drainage area				
0 square miles				
Dam				
Type	Earthfill			
Length	17,500 feet			
Maximum height	59 feet			
Top width	20 feet			
Top elevation	362.5 feet above mean sea level			
Spillway (service)				
Type	Drop inlet			
Size	12 feet by 12 feet			
Location	East embankment section near the center			
Crest elevation	355.5 feet above mean sea level			
Conduit size	4.5 foot square transitioning to 5.5 foot square			
Conduit length	250 feet			
Service outlet				
Type	Sluice gate			
Location	On side of drop inlet service spillway			
Gate size	3 feet by 3 feet			
Gate elevation	322.5 feet above mean sea level			
Reservoir data (Based on 2016 TWDB survey)				
Feature		**Elevation (feet** NGVD29[a]**)**	**Capacity (acre-feet)**	**Area (acres)**
Top of dam		362.5	20,516	998
Conservation pool		355.5	14,163	818
Service outlet gate		322.5	87	47

Source: (Freese and Nichols, 2010, SJB&A, 1976)
[a] NGVD29 = National Geodetic Vertical Datum 1929

Volumetric survey of Bryan Utilities Lake

Datum

The vertical datum used during this survey is unknown. It is assumed to be equivalent to the National Geodetic Vertical Datum 1929 (NGVD29). Volume and area calculations in this report are referenced to water levels provided by Bryan Texas Utilities. The horizontal datum used for this report is North American Datum 1983 (NAD83), and the horizontal coordinate system is State Plane Texas Central Zone (feet).

TWDB bathymetric data collection

TWDB collected bathymetric data for Bryan Utilities Lake on February 9-10, 2016. The daily average water surface elevations during the survey measured 349.8 feet (W. Williams, personal communication, March 1, 2016). For data collection, 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. Data was collected along pre-planned survey lines oriented perpendicular to the assumed location of the original river channels and spaced approximately 250 feet apart. The depth sounder was calibrated daily using a velocity profiler to measure the speed of sound in the water column and a weighted tape or stadia rod for depth reading verification. Figure 2 shows where data collection occurred during the 2016 TWDB survey.

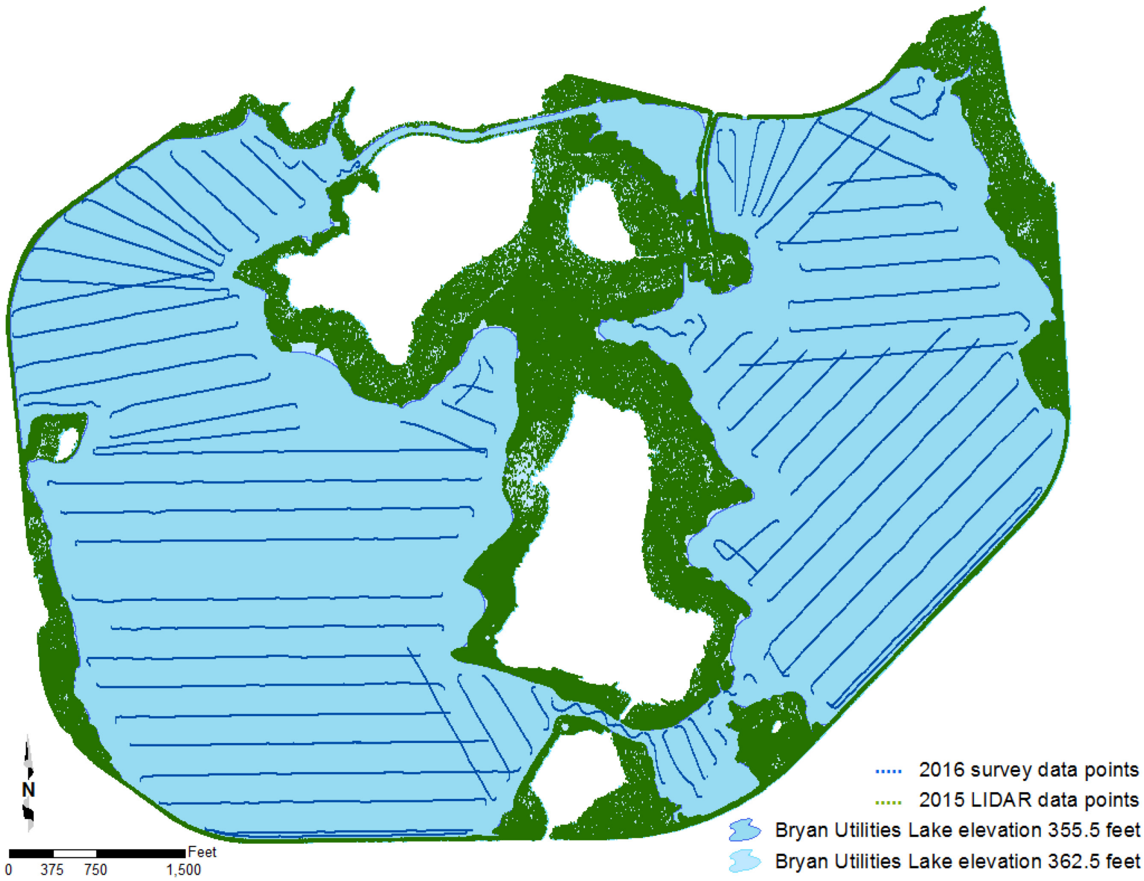


Figure 2. Data collected during 2016 TWDB Bryan Utilities Lake survey

Data processing

Model boundary

The reservoir's model boundary was generated from Light Detection and Ranging (LIDAR) Data available from the Texas Natural Resource Information System (TNRIS, 2016a). The LIDAR data was collected on February 9-10, 2015, while the reservoir was full at elevation 355.5 feet or very close to it. According to the associated metadata, the LIDAR data has a vertical accuracy of ±12.2 centimeters and a horizontal accuracy of 1 meter. To generate the boundary, LIDAR data with a classification equal to 2, or ground, was imported into an Environmental Systems Research Institute's ArcGIS file geodatabase from .las files. A topographical model of the data was generated and converted to a raster using a cell size of 0.5 meters by 0.5 meters. The horizontal datum of the LIDAR data is Universal Transverse Mercator (UTM) North American Datum 1983 (NAD83) Zone 14 and the vertical datum is North American Vertical Datum 1988 (NAVD88), meters. Therefore, a contour of 110.525 meters NAVD88, equivalent to 362.5 feet NGVD29, was extracted from the raster. 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 VERTCON software (NGS, 2016) to single reference point in the vicinity of the survey, *Latitude 30º43'12.129"N, Longitude 96º27'37.168"W NAD83.* Horizontal coordinate transformations to NAD83 State Plane Texas Central Zone (feet) coordinates were done using the ArcGIS Project tool. Additional editing of the 362.5-foot contour was necessary to close the contour across the top of the dam and remove other artifacts.

LIDAR data points

To model the reservoir between conservation pool elevation and top of dam elevation, or model boundary elevation, the .las files were converted to text files with x, y, and z values. To reduce computational burden, the LIDAR data was filtered to include only every 3rd point before clipping to include only data points within the reservoir boundary (Figure 2). The LIDAR data points have an average spacing of 0.5 meters; therefore, using a thinned point dataset did not significantly affect the modeled topography of the coverage area. No interpolation of the data in the areas of LIDAR coverage was necessary. After the points were clipped to within the boundary, the shapefile was projected to NAD83 State Plane Texas Central Zone (feet). New attribute fields were added to first convert the elevations from meters NAVD88 to meters NGVD29 by subtracting the VERTCON conversion offset of 0.035 meters, then to feet NGVD29 for compatibility with the bathymetric survey data.

Triangulated Irregular Network model

Following completion of data collection, the 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 bottom surface. For processing outside of DepthPic©, an in-house software package, HydroTools, 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 are 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 bathymetries 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, 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. Using the survey data, polygons are created to partition the reservoir into segments with centerlines defining directionality of interpolation within each segment. 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 the 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. The linear interpolation follows a linear definition file 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. It is not always possible to remove all flat triangles, and linear interpolation is only applied where adding bathymetry is deemed reasonable.

Figure 3 illustrates typical results from application of the anisotropic interpolation and linear interpolation techniques to Bryan Utilities Lake. 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, represented in Figure 3B, in creation of the TIN model directs Delaunay triangulation to better represent the lake bathymetry between survey cross-sections. The bathymetry shown in Figure 3C was used in computing reservoir capacity and area tables (Appendix A, B).

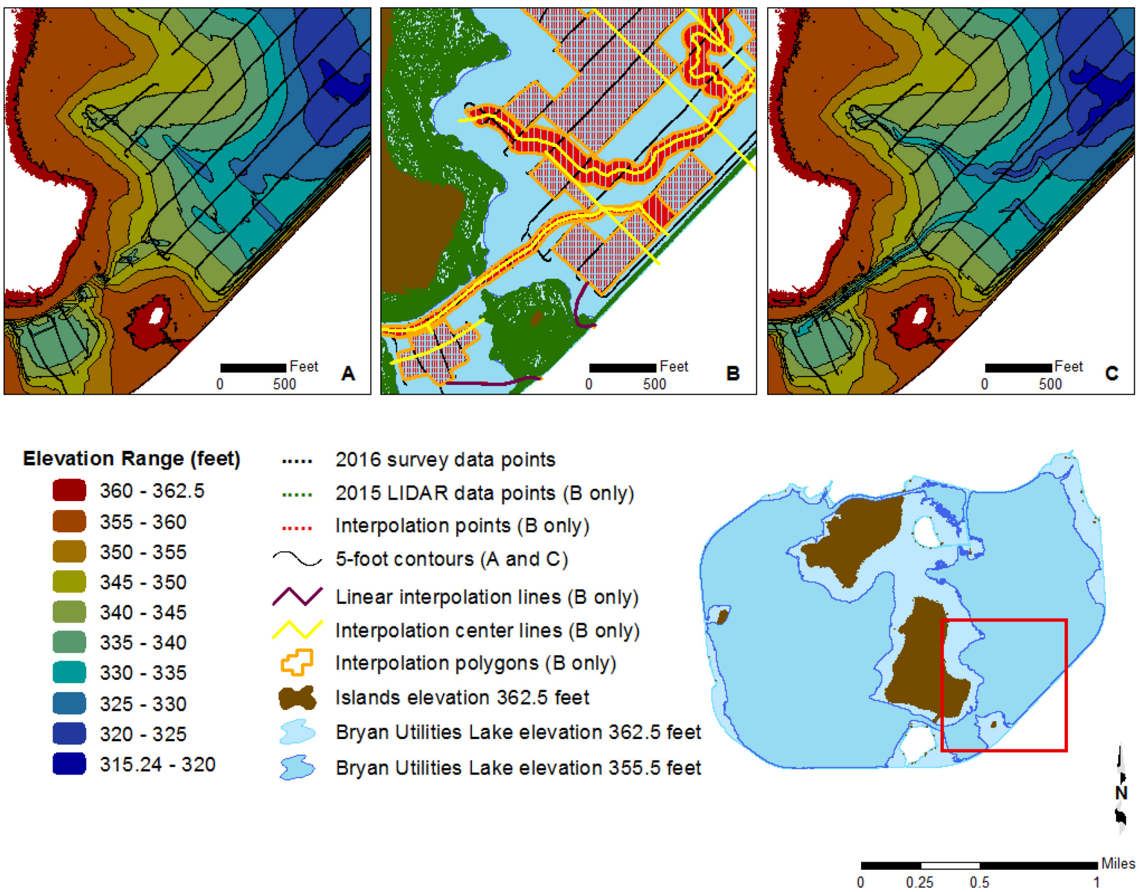


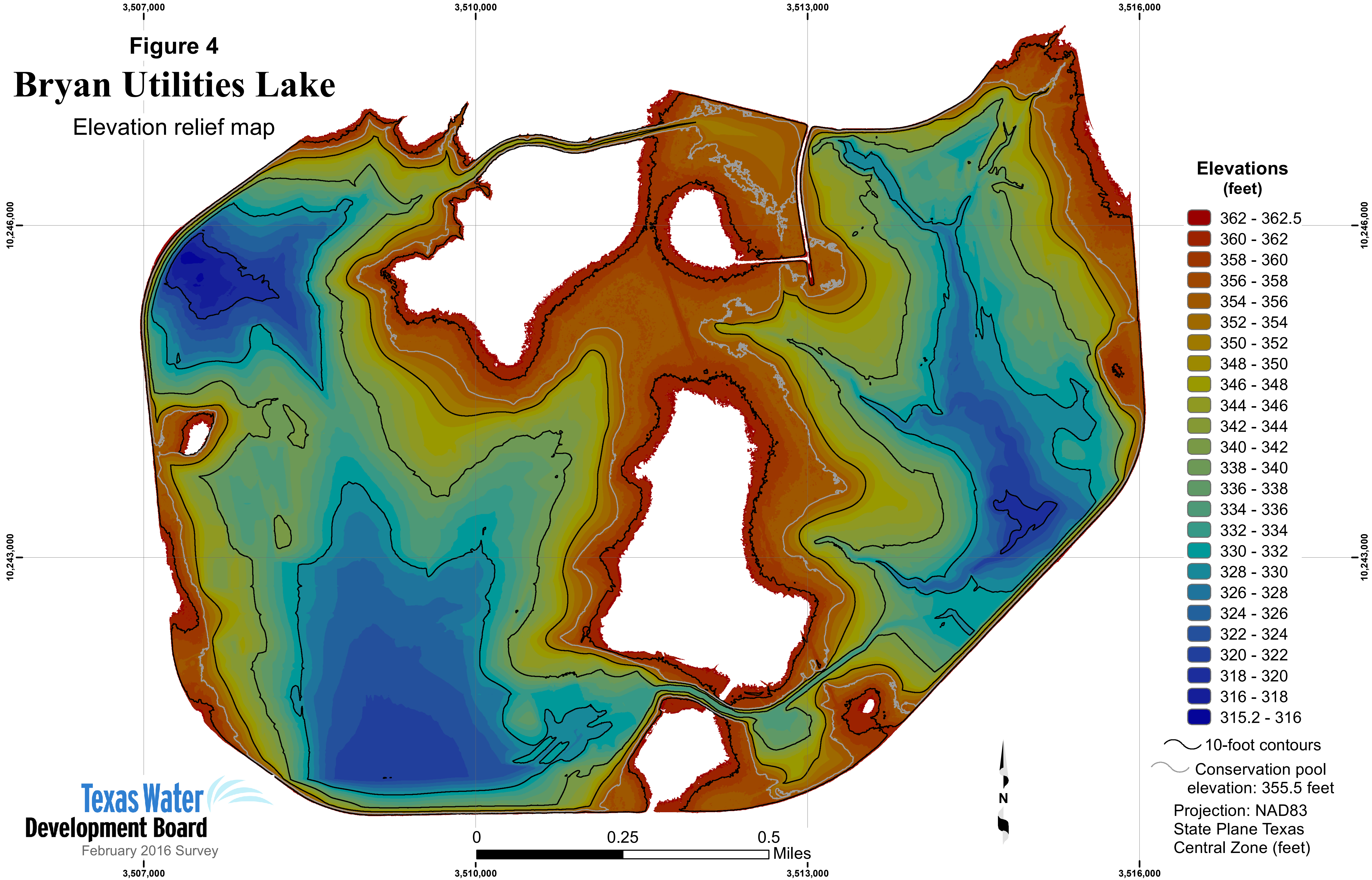
Figure 3. Anisotropic spatial interpolation and linear interpolation of Bryan Utilities Lake sounding data - A) bathymetric contours without interpolated points, B) sounding points (black) and interpolated points (red), C) bathymetric contours with the interpolated points

Area, volume, and contour calculation

Using ArcInfo software and the TIN model, volumes and areas were calculated for the entire reservoir at 0.1 feet intervals, from 315.2 to 362.5 feet. While linear interpolation was used in some areas to estimate the topography in areas that were inaccessible by boat or too shallow for the instruments to work properly, development of anomalous "flat triangles", that is triangles whose three 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 conservation pool elevation 355.5 feet. To eliminate the effects of the flat triangles on area and volume calculations, areas between elevations 346.6 feet and 356.4 feet were linearly interpolated between the computed values, and volumes above elevation 346.6 feet were calculated based on the corrected areas. The validity of interpolation to the areas was tested by comparing the interpolated area at elevation 355.0 feet to the area of the survey boundary digitized from aerial photographs obtained from the Texas Natural Resources Information System (TNRIS, 2016a) collected on January 27, 2015. Bryan Texas Utilities did not have a water surface elevation measurement for that day, however, on January 21, 2015; the water surface elevation measured 355.0 feet (W. Williams, personal communication, March 1, 2016). According to metadata associated with the 2015 photographs, the photographs have a resolution of six inches (TNRIS, 2016b). The interpolated area and the area of the survey boundary polygon digitized at elevation 355.0 feet were equivalent. The elevation-capacity table and elevation-area table, updated for 2016, 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 1 foot by 1 foot. The raster data was then used to produce: an elevation relief map (Figure 4), representing the topography of the reservoir bottom; a depth range map (Figure 5), showing shaded depth ranges for Bryan Utilities Lake; and a 5-foot contour map (Figure 6).

Figure 4
Bryan Utilities Lake
Elevation relief map



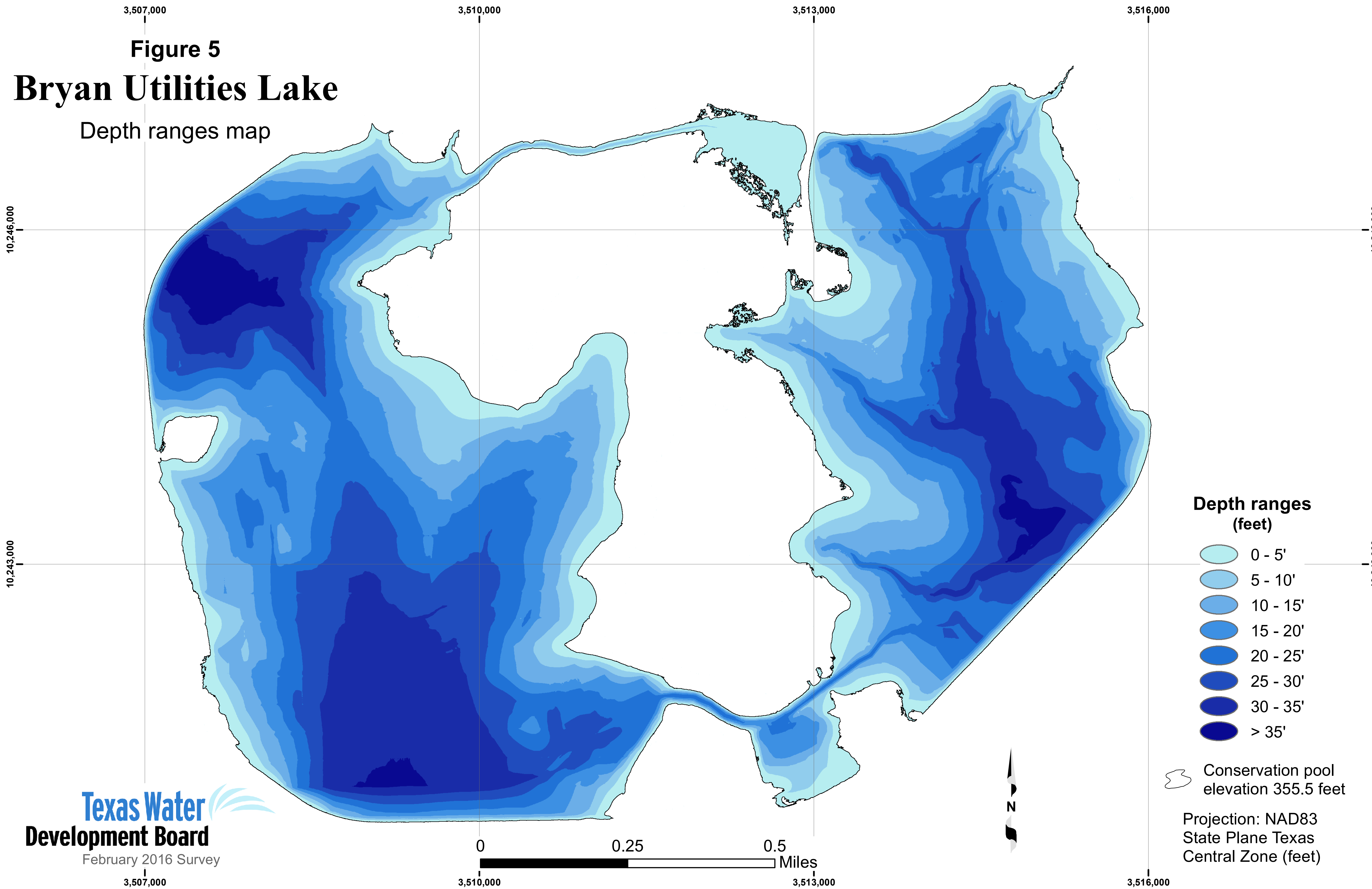
Projection: NAD83
State Plane Texas
Central Zone (feet)

Texas Water Development Board
February 2016 Survey

Figure 5

Bryan Utilities Lake

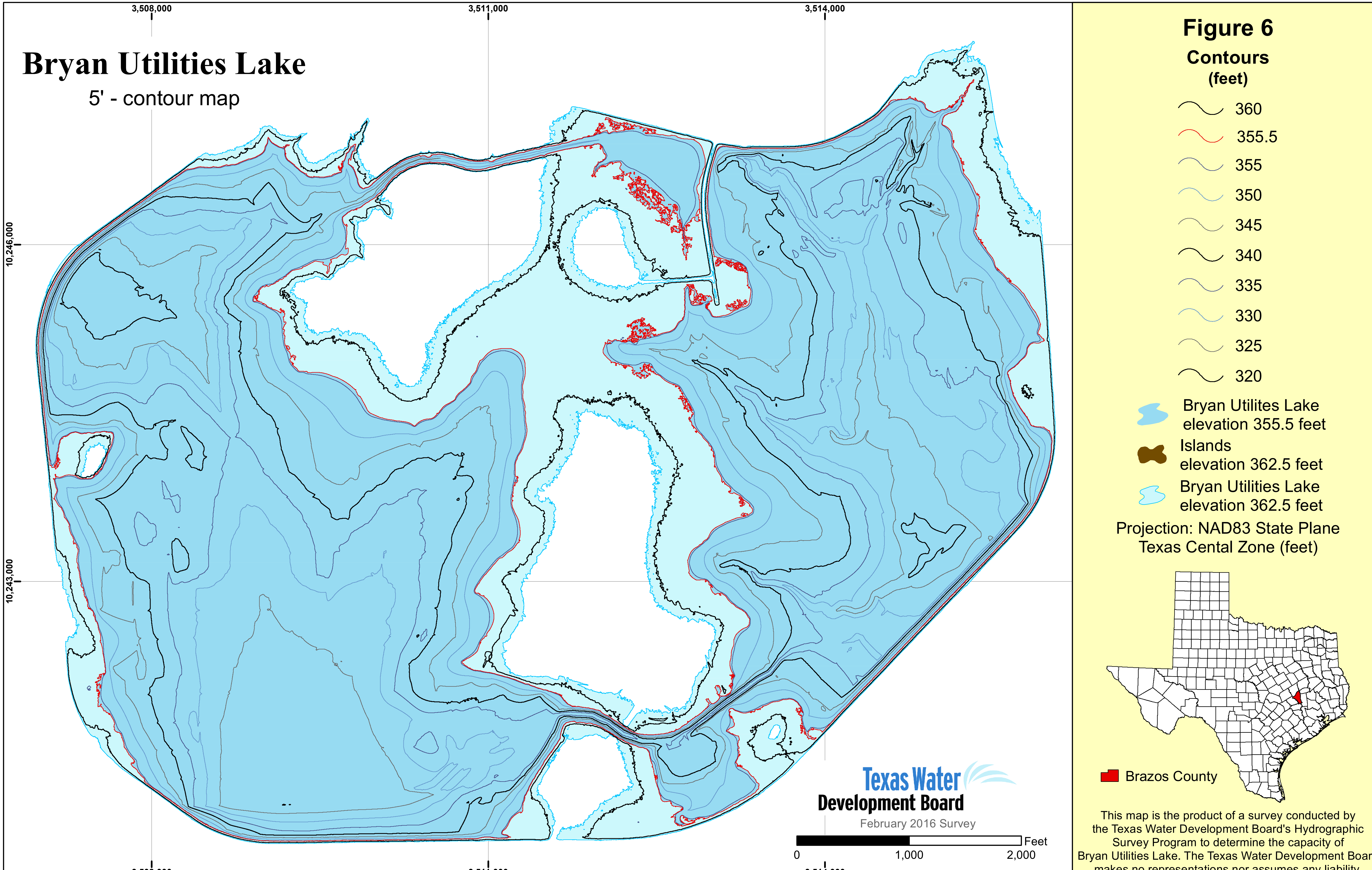
Depth ranges map



Projection: NAD83
State Plane Texas
Central Zone (feet)

Texas Water Development Board

February 2016 Survey



Bryan Utilities Lake
5' - contour map
3,508,000
3,511,000
3,514,000
10,246,000
10,243,000
Figure 6
Contours
(feet)
360
355.5
355
350
345
340
335
330
325
320
Bryan Utilites Lake
elevation 355.5 feet
Islands
elevation 362.5 feet
Bryan Utilities Lake
elevation 362.5 feet
Projection: NAD83 State Plane
Texas Cental Zone (feet)
Brazos County
Texas Water
Development Board
February 2016 Survey
0
1,000
2,000
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
Bryan Utilities Lake. The Texas Water Development Board
makes no representations nor assumes any liability.

Survey results

Volumetric survey

The results of the 2016 TWDB volumetric survey indicate Bryan Utilities Lake has a total reservoir capacity of 14,163 acre-feet and encompasses 818 acres at conservation pool elevation (355.5 feet above mean sea level, NGVD29). The original design estimate for Bryan Utilities Lake indicates a total reservoir capacity of 15,227 acre-feet encompassing 829 acres (Freese and Nichols, 2010). Because of differences in past and present survey methodologies, direct comparison of volumetric surveys to estimate loss of capacity is difficult and can be unreliable.

Recommendations

To improve estimates of sediment accumulation rates, TWDB recommends resurveying Bryan Utilities Lake in approximately 10 years or after a major flood event. To further improve estimates of capacity loss, TWDB recommends a volumetric and sedimentation survey. Sedimentation surveys include additional analysis of the multi-frequency data for post-impoundment sediment by correlation with sediment core samples and a map identifying the spatial distribution of sediment throughout the reservoir.

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:

Jason J. Kemp
Manager, Hydrographic Survey Program
Phone: (512) 463-2456
Email: Jason.Kemp@twdb.texas.gov

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TWDB (Texas Water Development Board), 2016, Contract No. 1648011953 with Bryan Texas Utilities.

Appendix A

Bryan Utilities Lake

RESERVOIR CAPACITY TABLE

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

February 2106 Survey
Conservation Pool Elevation 355.5 feet NGVD29
Top of Dam elevation 362.5 feet

ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
315	0	0	0	0	0	0	0	0	0	0
316	0	0	0	0	0	1	1	1	1	1
317	2	2	2	2	3	3	3	4	4	4
318	5	5	6	6	7	7	8	8	9	9
319	10	11	11	12	13	14	14	15	16	17
320	19	20	21	22	24	25	27	29	31	33
321	35	38	40	43	46	49	52	55	58	62
322	66	70	74	78	82	87	92	97	102	107
323	112	118	124	130	136	142	149	155	162	169
324	176	184	191	199	207	215	224	232	241	250
325	260	269	279	289	299	309	320	331	342	353
326	364	376	388	400	412	424	437	449	462	475
327	488	502	515	529	543	558	572	587	602	617
328	632	648	664	679	695	712	728	745	762	779
329	796	813	831	849	867	886	904	924	943	962
330	982	1,002	1,023	1,044	1,064	1,086	1,107	1,129	1,151	1,173
331	1,195	1,218	1,241	1,265	1,288	1,312	1,337	1,361	1,386	1,411
332	1,436	1,462	1,487	1,513	1,540	1,566	1,593	1,619	1,646	1,674
333	1,701	1,729	1,757	1,785	1,814	1,842	1,871	1,900	1,930	1,959
334	1,989	2,019	2,050	2,080	2,111	2,142	2,174	2,205	2,237	2,269
335	2,302	2,335	2,368	2,401	2,435	2,469	2,503	2,538	2,573	2,608
336	2,643	2,679	2,715	2,752	2,789	2,826	2,863	2,900	2,938	2,976
337	3,015	3,053	3,092	3,131	3,171	3,210	3,250	3,290	3,331	3,371
338	3,412	3,453	3,495	3,536	3,578	3,620	3,662	3,705	3,748	3,791
339	3,834	3,878	3,922	3,966	4,010	4,055	4,099	4,144	4,190	4,235
340	4,281	4,327	4,373	4,419	4,466	4,513	4,560	4,608	4,655	4,703
341	4,751	4,800	4,848	4,897	4,946	4,996	5,045	5,095	5,145	5,195
342	5,246	5,296	5,347	5,398	5,450	5,501	5,553	5,605	5,657	5,710
343	5,763	5,816	5,869	5,922	5,976	6,030	6,084	6,138	6,193	6,248
344	6,303	6,358	6,414	6,469	6,525	6,582	6,638	6,695	6,751	6,808
345	6,866	6,923	6,981	7,039	7,097	7,156	7,214	7,273	7,332	7,392
346	7,451	7,511	7,571	7,631	7,691	7,752	7,813	7,874	7,935	7,996
347	8,058	8,120	8,182	8,245	8,307	8,370	8,433	8,497	8,560	8,624
348	8,688	8,752	8,817	8,882	8,947	9,012	9,077	9,143	9,209	9,275
349	9,341	9,408	9,475	9,542	9,609	9,677	9,745	9,813	9,881	9,950
350	10,018	10,087	10,157	10,226	10,296	10,366	10,436	10,506	10,577	10,648
351	10,719	10,790	10,862	10,934	11,006	11,078	11,151	11,223	11,296	11,370
352	11,443	11,517	11,591	11,665	11,739	11,814	11,889	11,964	12,039	12,115
353	12,191	12,267	12,343	12,420	12,496	12,573	12,651	12,728	12,806	12,884
354	12,962	13,040	13,119	13,198	13,277	13,356	13,436	13,516	13,596	13,676
355	13,757	13,837	13,918	14,000	14,081	14,163	14,245	14,327	14,409	14,492
356	14,575	14,658	14,741	14,825	14,909	14,993	15,077	15,162	15,247	15,332
357	15,417	15,503	15,589	15,675	15,761	15,848	15,935	16,022	16,109	16,197
358	16,284	16,373	16,461	16,550	16,639	16,728	16,817	16,907	16,997	17,087
359	17,178	17,269	17,360	17,451	17,543	17,635	17,727	17,819	17,912	18,005
360	18,099	18,192	18,286	18,380	18,475	18,569	18,664	18,760	18,855	18,951
361	19,047	19,143	19,240	19,336	19,433	19,531	19,628	19,726	19,824	19,922
362	20,020	20,119	20,218	20,317	20,416	20,516				

Appendix B

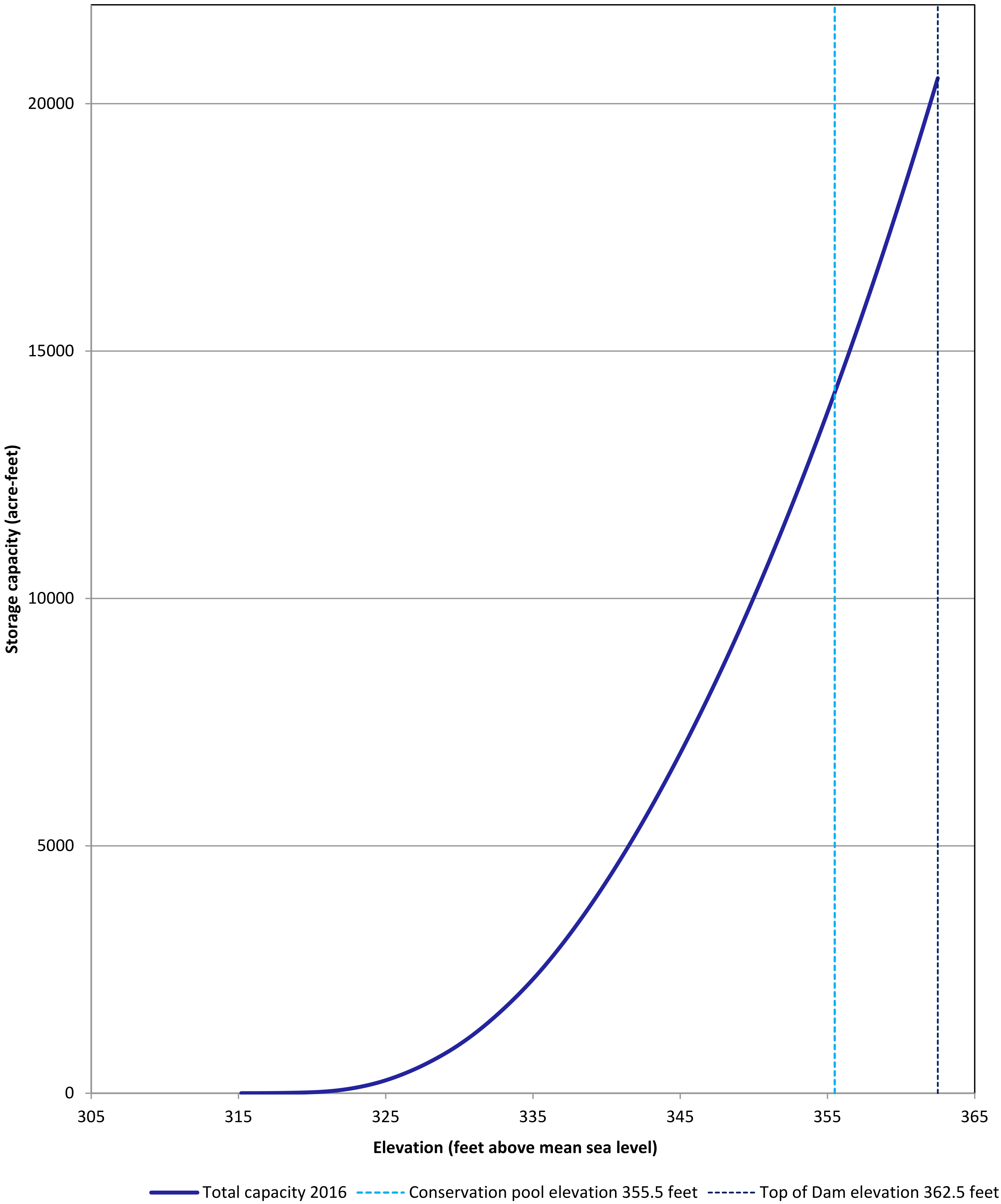
Bryan Utilities Lake

RESERVOIR AREA TABLE

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

February 2016 Survey
Conservation Pool Elevation 355.5 feet NGVD29
Top of Dam elevation 362.5 feet

ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
315	0	0	0	0	0	0	0	0	0	0
316	1	1	1	1	1	1	2	2	2	2
317	2	2	3	3	3	3	3	4	4	4
318	4	5	5	5	5	5	6	6	6	6
319	6	6	7	7	8	8	9	10	10	11
320	11	12	13	14	15	17	18	19	21	22
321	23	25	26	27	29	30	32	33	35	36
322	38	40	42	43	45	47	48	50	52	53
323	55	57	58	60	62	64	65	67	69	71
324	73	75	77	79	81	83	86	88	90	92
325	94	96	99	101	103	105	107	109	111	113
326	115	117	119	120	122	124	126	127	129	131
327	133	136	138	140	142	144	146	148	150	152
328	154	156	158	160	162	164	166	167	169	171
329	173	175	178	180	183	186	189	192	195	197
330	200	203	205	208	211	213	216	218	221	224
331	227	229	232	235	238	241	244	246	249	251
332	254	256	258	261	263	265	267	269	272	274
333	276	279	281	283	286	288	290	293	295	297
334	300	302	305	307	310	313	315	318	321	323
335	326	329	332	336	339	342	345	348	351	354
336	357	360	363	366	369	371	374	377	380	382
337	385	387	390	393	395	398	400	403	405	407
338	410	412	415	417	420	422	425	427	430	432
339	434	437	439	442	444	446	449	451	454	456
340	459	461	463	466	468	471	473	475	478	480
341	483	485	487	489	492	494	496	499	501	503
342	506	508	510	512	515	517	519	522	524	526
343	529	531	533	536	538	540	543	545	547	549
344	552	554	556	558	560	563	565	567	569	572
345	574	576	578	581	583	586	588	590	592	595
346	597	599	601	603	605	607	609	611	613	616
347	618	620	623	625	628	630	632	635	637	639
348	642	644	646	649	651	653	656	658	661	663
349	665	668	670	672	675	677	679	682	684	686
350	689	691	693	696	698	701	703	705	708	710
351	712	715	717	719	722	724	726	729	731	733
352	736	738	741	743	745	748	750	752	755	757
353	759	762	764	766	769	771	774	776	778	781
354	783	785	788	790	792	795	797	799	802	804
355	806	809	811	814	816	818	821	823	825	828
356	830	832	835	837	839	842	845	848	850	853
357	855	857	860	862	865	867	870	872	875	877
358	880	882	885	888	891	893	896	899	902	904
359	907	910	913	915	918	921	924	926	929	932
360	935	937	940	943	946	948	951	954	956	959
361	961	964	966	969	971	974	976	978	981	983
362	986	988	990	993	995	998				



Bryan Utilities Lake
February 2016 Survey
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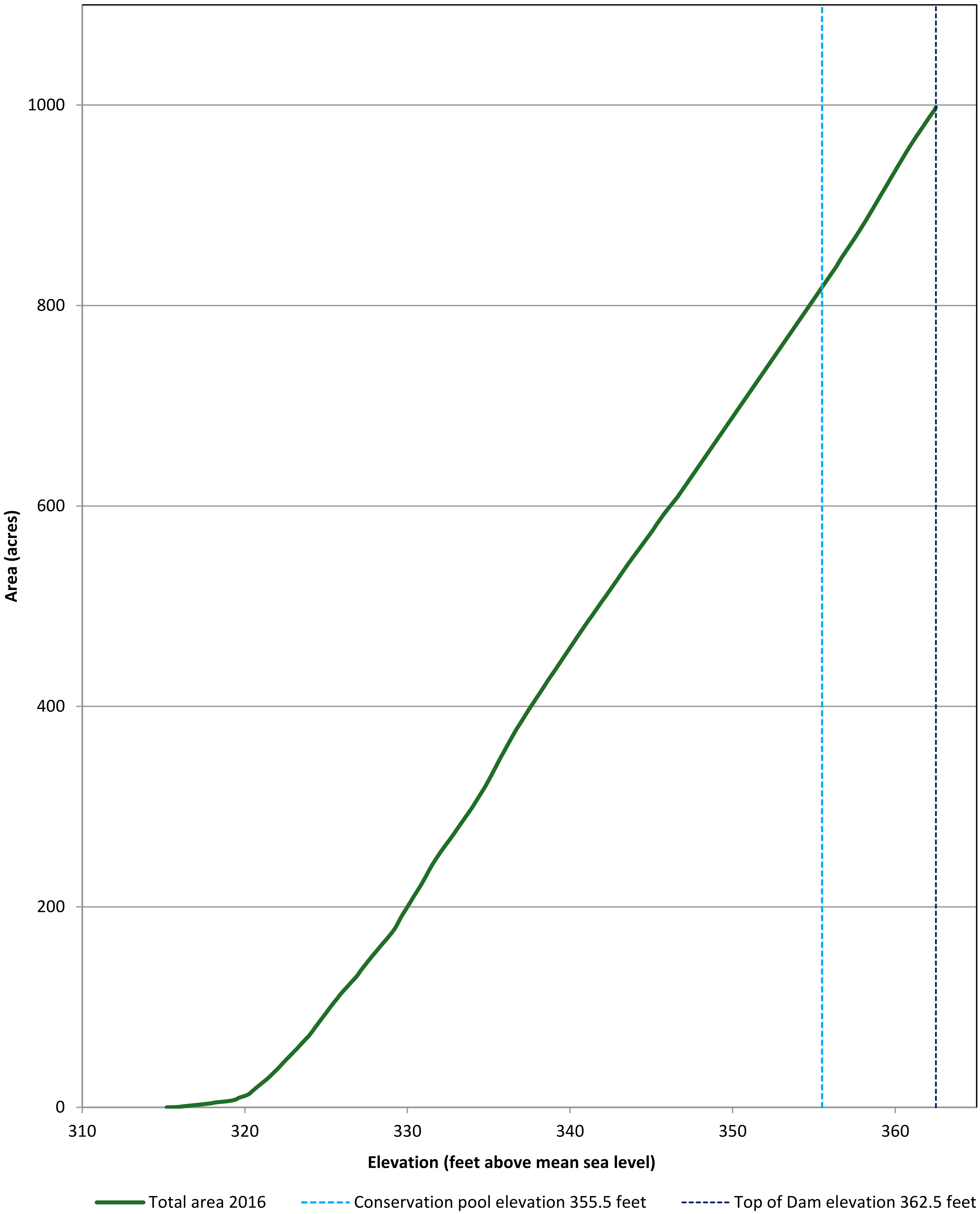
Appendix C: Capacity curve



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Appendix D: Area curve