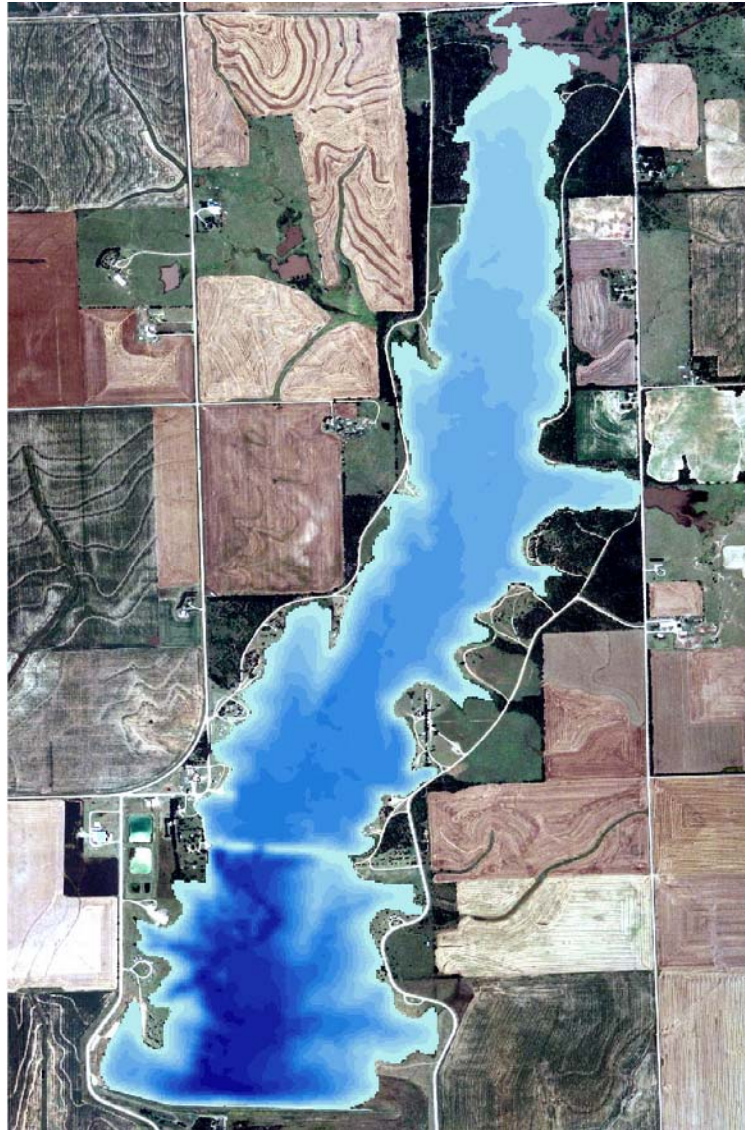


Bathymetric Survey of Wellington City Lake, Sumner County, Kansas



Kansas Biological Survey
*Applied Science and Technology for
Reservoir Assessment (ASTRA) Program*
Report 2008-08 (March 2009)

Revised Area-Elevation-Capacity Tables and Figures, January 2010



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SUMMARY

During November 2007, the Kansas Biological Survey (KBS) performed a bathymetric survey of Wellington City Lake in Sumner County, Kansas. The survey was carried out using acoustic echosounding apparatus linked to a global positioning system. Both Old Wellington Lake and the contiguous New Wellington Lake were surveyed. Area-elevation-volume tables were constructed for the entire lake and separately for the older northern part of the lake and the newer southern part of the lake. No sediment sampling was performed on this lake.

Summary Data:

Bathymetric Survey:		
Date of survey:		November 15, 2007
Water elevation on date of survey:		1209.25
Reservoir Statistics:		
Entire Impoundment		
Elevation on survey date		1209.25 ft.
Area on survey date (acres):		615 ^a
Volume on survey date (acre-feet):		5958 ^a
Maximum depth (feet):		26.3
North Impoundment (Old Wellington City Lake)		
Year constructed:		1935
Area on survey date (acres):		402
Volume on survey date (acre-feet):		3032
Maximum depth (feet):		14.9
South Impoundment (New Wellington City Lake)		
Year constructed:		1993
Area on survey date (acres):		212
Volume on survey date (acre-feet):		2925
Maximum depth (feet):		26.3

^a Total area and volume for the entire impoundment do not precisely equal the sums of area and volume of the north and south impoundment due to rounding.

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LAKE HISTORY AND PERTINENT INFORMATION

(This section summarized from the National Dam Inventory and the Kansas Department of Wildlife and Parks website descriptions)

<http://crunch.tec.army.mil.nidpublic.webpages.nid.cfm>

<http://www.kdwp.state.ks.us/news/Fishing/Where-to-Fish-in-Kansas/Fishing-Locations-Public-Waters/Region-4/Wellington-City-Lake>



Figure 1. Wellington Lake, Sumner County, Kansas (Photo: KBS).

Location: 5 miles west of Wellington, Kansas on US Hwy 160 in Sumner County on Hargis Creek.

Purpose: Drinking water, flood control and storm water management.

History of Construction: The original Wellington City Lake Dam was constructed in 1935 on East Prairie Creek in Sumner County. It is owned by the City of Wellington. The Wellington Lake Dam Project in 1993 increased the Lake's surface area by 50%.

Structure and Spillway Type: The project consists of an earthfill embankment and a total dam length of 4,150 feet, including an uncontrolled spillway, 400 feet wide.

Sumner County, Kansas

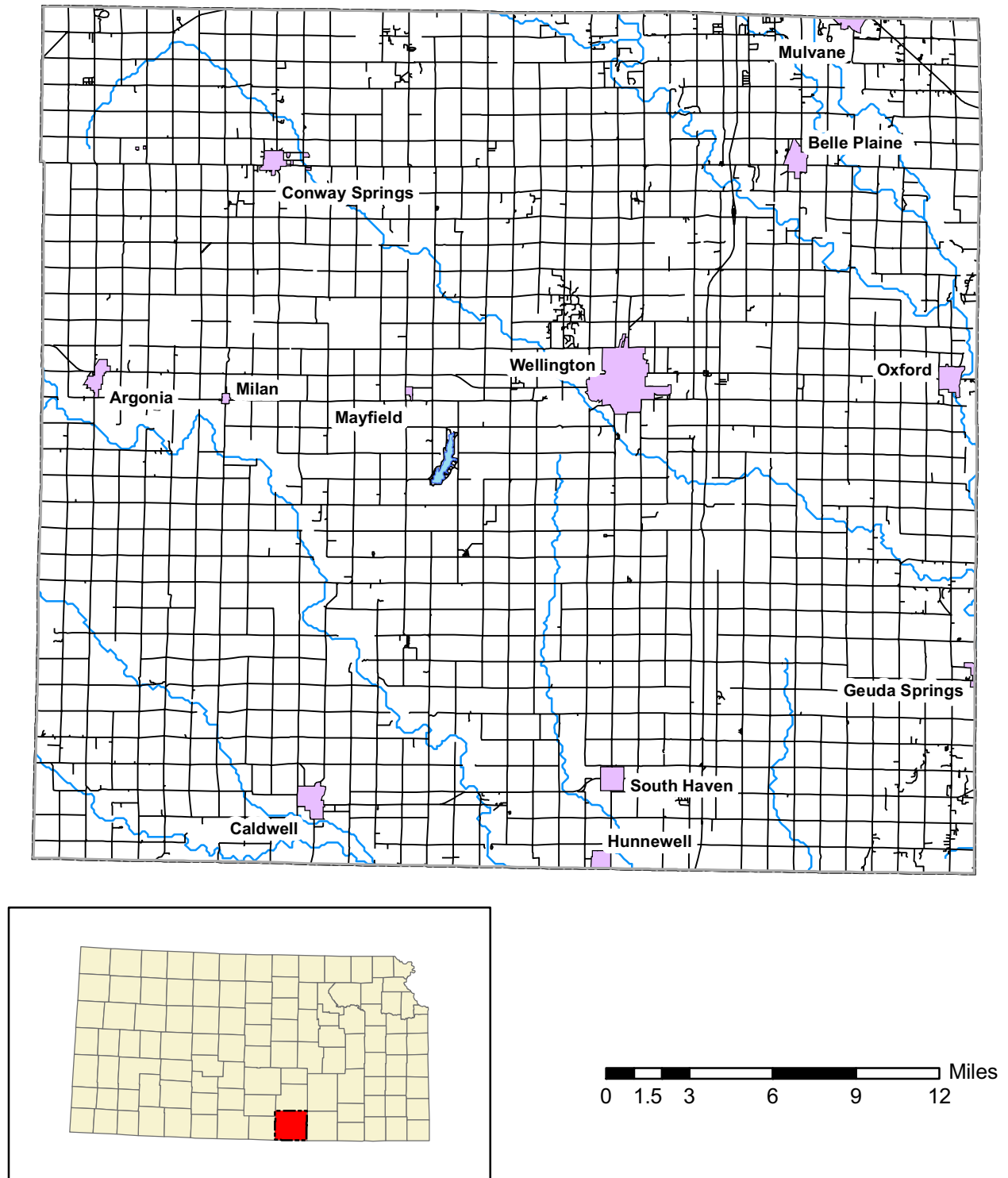


Figure 2. Location of Wellington City Lake in Sumner County, Kansas

Reservoir Bathymetric (Depth) Surveying Procedures

KBS operates a Biosonics DT-X acoustic echosounding system (www.biosonicsinc.com) with a 200 kHz split-beam transducer and a 38-kHz single-beam transducer. In addition to providing basic information on reservoir depth profiles, the Biosonics system also permits the assessment of bottom sediment composition. Latitude-longitude information is provided by a JRC global positioning system (GPS) that interfaces with the Biosonics system. ESRI's ArcGIS is used for on-lake navigation and positioning, with GPS data feeds provided by the Biosonics unit through a serial cable. Power is provided to the echosounding unit, command/navigation computer, and auxiliary monitor by means of a inverter and battery backup device that in turn draw power from the 12-volt boat battery.

Pre-survey preparation:

Geospatial reference data: Prior to conducting the survey, geospatial data of the target lake is acquired, including georeferenced National Agricultural Imagery Project (NAIP) photography. The lake boundary is digitized as a polygon shapefile from the FSA NAIP georeferenced aerial photography obtained online from the Data Access and Service Center (DASC) at the Kansas Geological Survey. Prior to the lake survey, a series of transect lines are created as a shapefile in ArcGIS for guiding the boat during the survey. Transect lines are spaced more closely (25-50 meters separation) on smaller state/local lakes, while a spacing of 100-150 meters is used for federal reservoirs.

Survey procedures:

Calibration (Temperature and ball check): After boat launch and initialization of the Biosonics system and command computer, system parameters are set in the Biosonics Visual Acquisition software. The temperature of the lake at 1-2 meters is taken with a research-grade metric electronic thermometer. This temperature, in degrees Celsius, is input to the Biosonics Visual Acquisition software to calculate the speed of sound in water at the given temperature at the given depth. Start range, end range, ping duration, and ping interval are also set at this time. A ball check is performed using a tungsten-carbide sphere supplied by Biosonics for this purpose. The ball is lowered to a known distance (1.0 meter) below the transducer faces. The position of the ball in the water column (distance from the transducer face to the ball) is clearly visible on the echogram. The echogram distance is compared to the known distance to assure that parameters are properly set and the system is operating correctly.

On-lake survey procedures: Using the GPS Extension of ArcGIS, the GPS data feed from the GPS receiver via the Biosonics echosounder, and the pre-planned transect pattern, the location of the boat on the lake in real-time is shown on the command/navigation computer screen. To assist the boat operator in navigation, an auxiliary LCD monitor is connected to the computer and placed within the easy view of the boat operator. Transducer face depth on all dates is 0.5 meters below the water surface. The transect pattern is maintained except when modified by obstructions in the lake (e.g., partially submerged trees) or shallow water and mudflats. Data are automatically logged in new files every half-hour (approximately 9000-ping files) by the Biosonics system.

Wellington Lake Elevation Benchmark:

Elevation of the water surface on the day of the bathymetric survey was taken from the gauge on the water intake tower located midlake at the western end of the former dam. The gauge is marked in feet above sea level, with minor markings at 3-inch intervals. From this gauge we determined that the water level was 1209.25 feet on November 15, 2007. This value is assumed to be NGVD29.



Figure 3a. Water surface elevation gauge on intake tower, Wellington Lake, November 15, 2007.



Figure 3b. Closeup: Water surface elevation gauge on intake tower, Wellington Lake, November 15, 2007. Water elevation is 1209.25 feet.

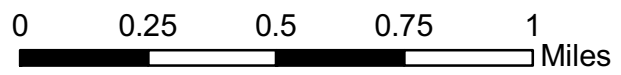
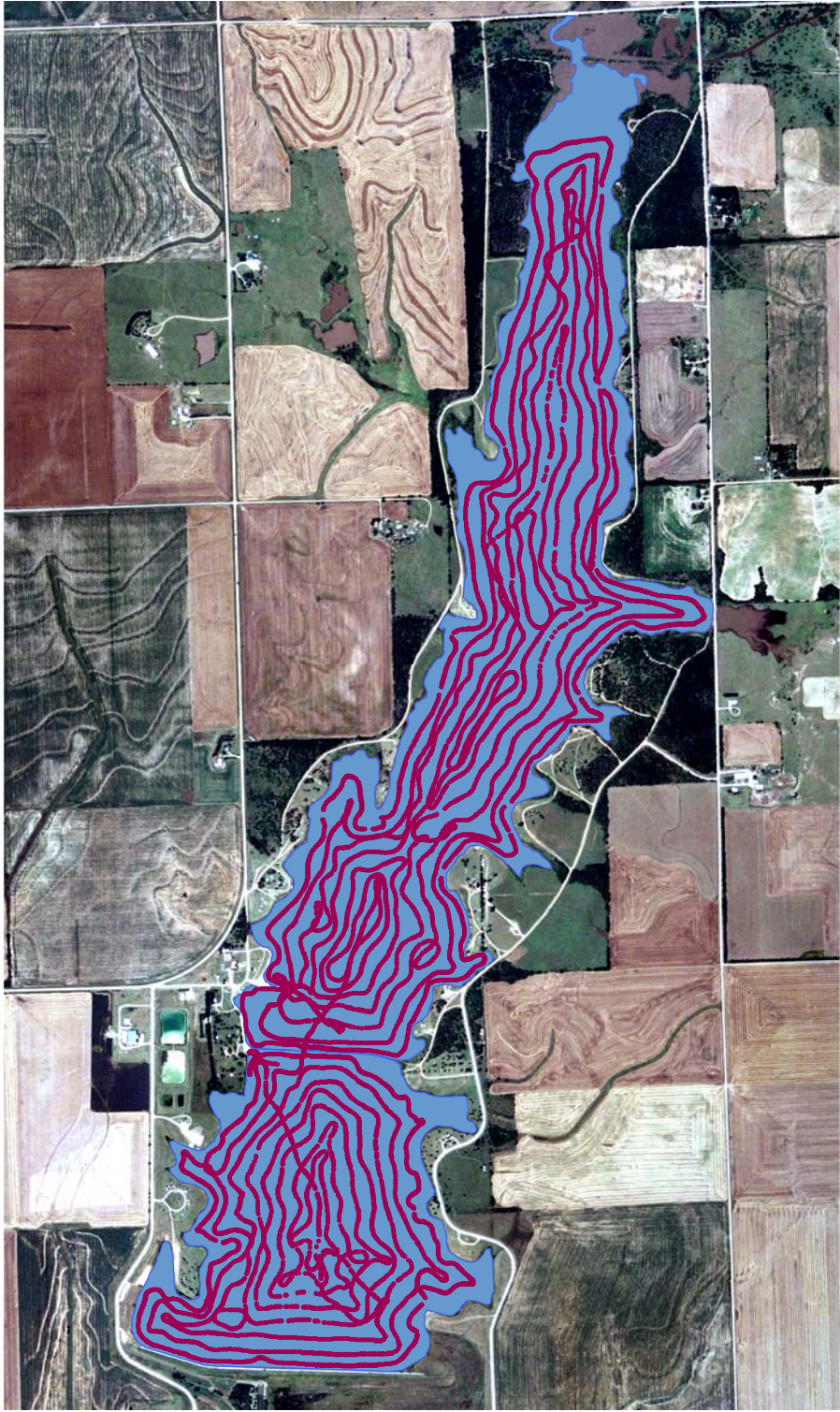


Figure 4. Bathymetric Survey Transects

Post-processing (*Visual Bottom Typer*)

The Biosonics DT-X system produces data files in a proprietary DT4 file format containing acoustic and GPS data. To extract the bottom position from the acoustic data, each DT4 file is processed through the Biosonics Visual Bottom Typer (VBT) software. The processing algorithm is described as follows:

“The BioSonics, Inc. bottom tracker is an “end_up” algorithm, in that it begins searching for the bottom echo portion of a ping from the last sample toward the first sample. The bottom tracker tracks the bottom echo by isolating the region(s) where the data exceeds a peak threshold for N consecutive samples, then drops below a surface threshold for M samples. Once a bottom echo has been identified, a bottom sampling window is used to find the next echo. The bottom echo is first isolated by user_defined threshold values that indicate (1) the lowest energy to include in the bottom echo (bottom detection threshold) and (2) the lowest energy to start looking for a bottom peak (peak threshold). The bottom detection threshold allows the user to filter out noise caused by a low data acquisition threshold. The peak threshold prevents the algorithm from identifying the small energy echoes (due to fish, sediment or plant life) as a bottom echo.” (Biosonics Visual Bottom Typer User’s Manual, Version 1.10, p. 70).

Data is output as a comma-delimited (*.csv) text file. A set number of qualifying pings are averaged to produce a single report (for example, the output for ping 31 {when pings per report is 20} is the average of all values for pings 12-31). Standard analysis procedure for all 2008 and later data is to use the average of 7 pings to produce one output value.

All raw *.csv files are merged into one master *.csv file using the shareware program File Append and Split Tool (FAST) by Boxer Software (Ver. 1.0, 2006).

Post-processing (*Excel*)

The master *.csv file created by the FAST utility is imported into Microsoft Excel. Excess header lines are deleted (each input CSV file has its own header), and the header file is edited to change the column headers “#Ping” to “Ping” and “E1’ “ to “E11”, characters that are not ingestable by ArcGIS. Entries with depth values of zero (0) are deleted, as are any entries with depth values less than the start range of the data acquisition parameter (typically 0.49 meters or less) (indicating areas where the water was too shallow to record a depth reading).

In Excel, depth adjustments are made. A new field – Adj_Depth – is created. The value for AdjDepth is calculated as $AdjDepth = Depth + (Transducer\ Face\ Depth)$, where the Transducer Face Depth represents the depth of the transducer face below water level in meters (Typically, this value is 0.5 meters). Four values are computed in Excel: DepthM, DepthFt, ElevM and ElevFt, where:

$$\text{DepthM} = \text{Adj_Depth}$$
$$\text{DepthFt} = \text{Adj_Depth} * 3.28084$$

These water depths are RELATIVE water depths that can vary from day-to-day based on the elevation of the water surface. In order to normalize all depth measurements to an absolute reference, water depths must be subtracted from an established value for the elevation of the water surface at the time of the bathymetric survey. Determination of water surface elevation has been described in an earlier section on establishment of lake levels.

To set depths relative to lake elevation, another field is added to the attribute table of the point shapefile, ElevM. The value for this attribute is then computed as $\text{Depth_ElevM} = (\text{Elevation of the Water Surface in meters above sea level}) - \text{Adj_Depth}$. Elevation of the water surface in feet above sea level is also computed by converting ElevM to elevation in feet ($\text{ElevM} * 3.28084$).

Particularly for multi-day surveys, ADJ_DEPTH, Depth_M, and Depth_Ft should **NOT** be used for further analysis or interpolation. If water depth is desired, it should be produced by subtracting Elev_M or Elev_Ft from the reference elevation used for interpolation purposes (for federal reservoirs, the elevation of the water surface on the day that the aerial photography from which the lake perimeter polygon was digitized).

Post-processing (ArcGIS):

Ingest to ArcGIS is accomplished by using the Tools – Add XY Data option. The projection information is specified at this time (WGS84). Point files are displayed as Event files, and are then exported as a shapefile (filename convention: ALLPOINTS_WGS84.shp). The pointfile is then reprojected to the UTM coordinate system of the appropriate zone (14 or 15) (filename convention ALLPOINTS_UTM.shp).

Raster interpolation of the point data is performed using the same input data and the Topo to Raster option within the 3D Extension of ArcGIS. The elevation of the reservoir on the date of aerial photography used to create the perimeter/shoreline shapefile was used as the water surface elevation in all interpolations from point data to raster data.

Contour line files are derived from the raster interpolation files using the ArcGIS command under 3D Analyst – Raster Surface – Contour.

Area-elevation-volume tables are derived using an ArcGIS extension custom written for and available from the ASTRA Program. Summarized, the extension calculates the area and volume of the reservoir at 1/10-foot elevation increments from the raster data for a series of water surfaces beginning at the lowest elevation recorded and progressing upward in 1/10-foot elevation increments to the reference water surface. Cumulative volume is also computed in acre-feet.

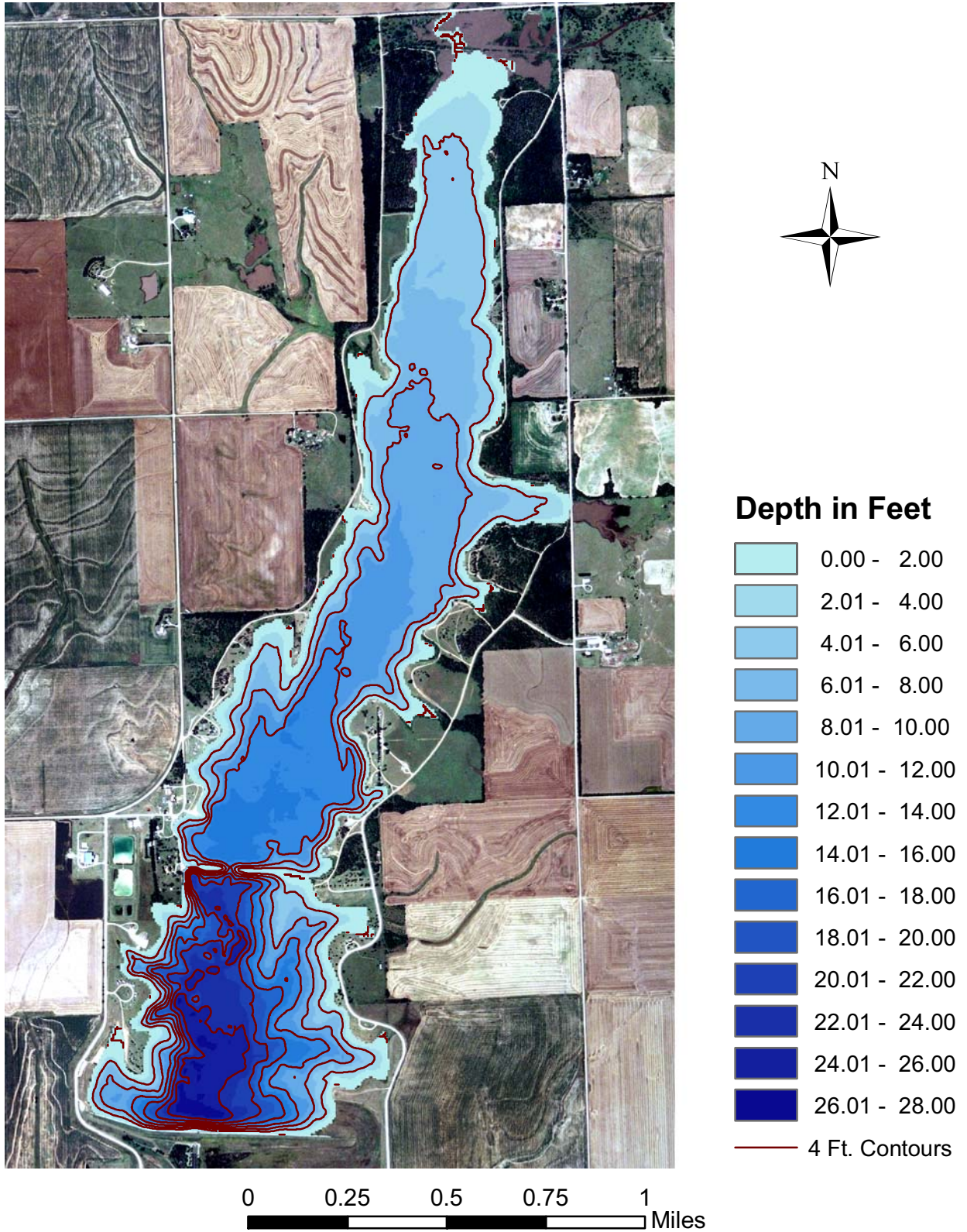


Figure 5. Water depth based on November 2007 bathymetric survey. Depths are based on a pool elevation of 1209.25 feet.

Table 1

**Entire Reservoir (North and South impoundments combined)
Cumulative area in acres by tenth foot elevation increments**

<u>Elevation</u> <u>(ft NGVD)</u>	<u>0.00</u>	<u>0.10</u>	<u>0.20</u>	<u>0.30</u>	<u>0.40</u>	<u>0.50</u>	<u>0.60</u>	<u>0.70</u>	<u>0.80</u>	<u>0.90</u>
1182	0	0	0	0	1	1	1	1	2	2
1183	3	3	4	5	6	7	8	10	11	11
1184	12	13	14	15	16	17	18	19	20	21
1185	22	23	24	25	27	28	29	30	31	32
1186	33	35	36	37	38	39	41	42	43	44
1187	44	45	46	47	48	50	51	52	53	54
1188	55	56	57	57	58	59	60	60	61	62
1189	63	63	64	65	65	66	67	67	68	68
1190	69	70	70	71	72	72	73	74	74	75
1191	76	76	77	77	78	79	79	80	80	81
1192	81	82	83	83	84	85	85	86	86	87
1193	88	88	89	89	90	91	91	92	92	93
1194	94	94	95	96	97	99	100	102	106	110
1195	113	117	121	125	130	134	139	145	150	155
1196	159	162	165	168	171	173	175	177	179	180
1197	182	184	186	189	192	195	198	201	204	208
1198	211	214	217	221	224	227	230	233	235	238
1199	240	243	246	249	252	256	260	263	268	271
1200	276	280	285	290	295	298	302	307	311	316
1201	321	325	330	334	339	342	346	349	353	357
1202	360	364	368	372	377	381	386	392	396	401
1203	405	410	414	419	423	428	433	439	444	448
1204	454	458	463	468	472	476	480	484	488	492
1205	496	500	504	509	512	516	520	524	527	530
1206	533	535	538	541	543	546	548	550	553	555
1207	558	560	562	565	567	570	572	575	577	580
1208	582	585	587	590	593	595	598	600	603	606
1209	609	612	615							

Table 2

**Entire Reservoir (North and South impoundments combined)
Cumulative volume in acre-feet by tenth foot elevation increments**

<u>Elevation (ft NGVD)</u>	<u>0.00</u>	<u>0.10</u>	<u>0.20</u>	<u>0.30</u>	<u>0.40</u>	<u>0.50</u>	<u>0.60</u>	<u>0.70</u>	<u>0.80</u>	<u>0.90</u>
1182	0	0	0	0	0	0	0	0	0	1
1183	1	1	1	2	2	3	4	5	6	7
1184	8	9	11	12	14	15	17	19	21	23
1185	25	27	29	32	35	37	40	43	46	49
1186	53	56	59	63	67	71	75	79	83	87
1187	92	96	101	105	110	115	120	125	131	136
1188	141	147	152	158	164	170	176	182	188	194
1189	200	206	213	219	226	232	239	246	252	259
1190	266	273	280	287	294	301	309	316	323	331
1191	338	346	354	361	369	377	385	393	401	409
1192	417	425	433	442	450	459	467	476	484	493
1193	502	510	519	528	537	546	555	564	574	583
1194	592	602	611	621	630	640	650	660	671	681
1195	693	704	716	728	741	754	768	782	797	812
1196	828	844	860	877	894	911	928	946	964	982
1197	1000	1018	1037	1056	1075	1094	1114	1134	1154	1175
1198	1195	1217	1238	1260	1282	1305	1328	1351	1374	1398
1199	1422	1446	1471	1495	1521	1546	1572	1598	1624	1651
1200	1679	1707	1735	1763	1793	1822	1852	1883	1914	1945
1201	1977	2009	2042	2075	2109	2143	2178	2212	2248	2283
1202	2319	2355	2392	2429	2466	2504	2543	2582	2621	2661
1203	2701	2742	2783	2825	2867	2909	2953	2996	3040	3085
1204	3130	3176	3222	3268	3315	3363	3411	3459	3508	3557
1205	3606	3656	3706	3757	3808	3859	3911	3963	4016	4069
1206	4122	4175	4229	4283	4337	4392	4446	4501	4557	4612
1207	4668	4724	4780	4836	4893	4950	5007	5064	5122	5180
1208	5238	5297	5356	5415	5474	5533	5593	5653	5714	5774
1209	5835	5897	5958							

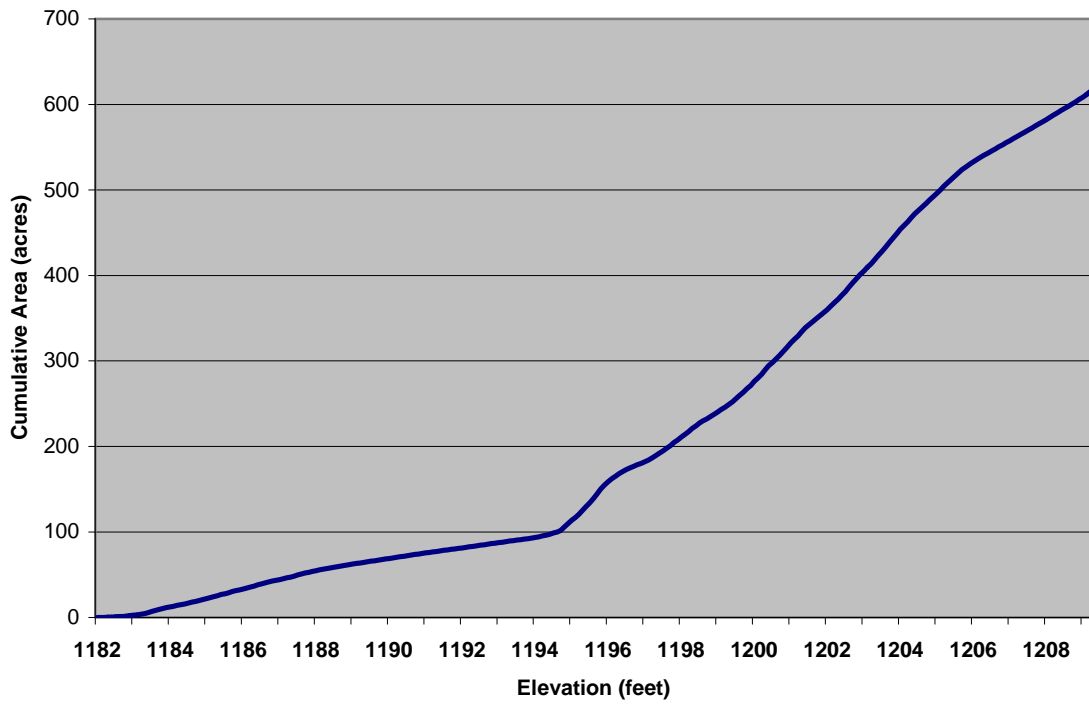


Figure 6. Cumulative area-elevation curve – entire reservoir.

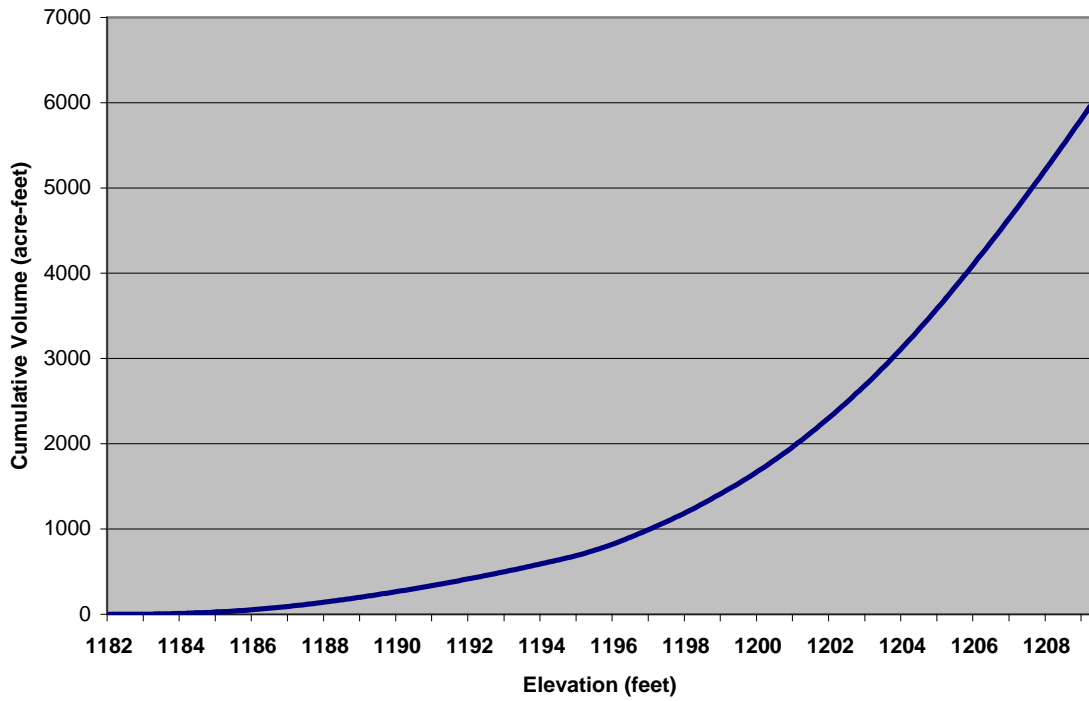


Figure 7. Cumulative volume-elevation curve – entire reservoir.

Table 3

**North Impoundment ONLY (Old Wellington City Lake)
Cumulative area in acres by tenth foot elevation increments**

<u>Elevation (ft NGVD)</u>	<u>0.00</u>	<u>0.10</u>	<u>0.20</u>	<u>0.30</u>	<u>0.40</u>	<u>0.50</u>	<u>0.60</u>	<u>0.70</u>	<u>0.80</u>	<u>0.90</u>
1193										
1194				1	1	2	2	4	7	10
1195	13	16	19	22	26	30	34	39	44	48
1196	51	54	56	58	60	61	63	64	65	66
1197	67	68	70	72	74	76	78	80	83	85
1198	88	90	93	95	97	100	102	103	105	107
1199	108	110	112	114	117	120	123	126	129	132
1200	135	138	142	147	151	154	157	161	164	168
1201	172	175	179	183	186	189	192	194	197	200
1202	203	206	209	212	216	220	224	228	232	236
1203	239	243	246	250	254	258	262	267	271	275
1204	280	283	287	291	294	298	301	304	308	311
1205	314	317	321	324	327	330	334	336	339	341
1206	343	345	347	349	351	353	355	356	358	360
1207	362	363	365	367	369	370	372	374	376	377
1208	379	381	383	385	387	389	390	392	394	396
1209	398	400	402							

Table 4

**North Impoundment ONLY (Old Wellington City Lake)
Cumulative volume in acre-feet by tenth foot elevation increments**

<u>Elevation (ft NGVD)</u>	<u>0.00</u>	<u>0.10</u>	<u>0.20</u>	<u>0.30</u>	<u>0.40</u>	<u>0.50</u>	<u>0.60</u>	<u>0.70</u>	<u>0.80</u>	<u>0.90</u>
1194	0	0	0	0	0	0	1	1	1	2
1195	3	5	6	8	11	14	17	21	25	29
1196	34	39	45	51	57	63	69	75	82	88
1197	95	101	108	115	123	130	138	146	154	162
1198	171	180	189	198	208	218	228	238	249	259
1199	270	281	292	303	315	327	339	351	364	377
1200	390	404	418	433	447	463	478	494	510	527
1201	544	561	579	597	615	634	653	672	692	712
1202	732	752	773	794	816	837	860	882	905	929
1203	952	977	1001	1026	1051	1077	1103	1129	1156	1183
1204	1211	1239	1268	1297	1326	1356	1386	1416	1446	1477
1205	1509	1540	1572	1604	1637	1670	1703	1736	1770	1804
1206	1838	1873	1908	1942	1977	2013	2048	2084	2119	2155
1207	2191	2228	2264	2301	2337	2374	2412	2449	2486	2524
1208	2562	2600	2638	2677	2716	2754	2794	2833	2872	2912
1209	2952	2992	3032							

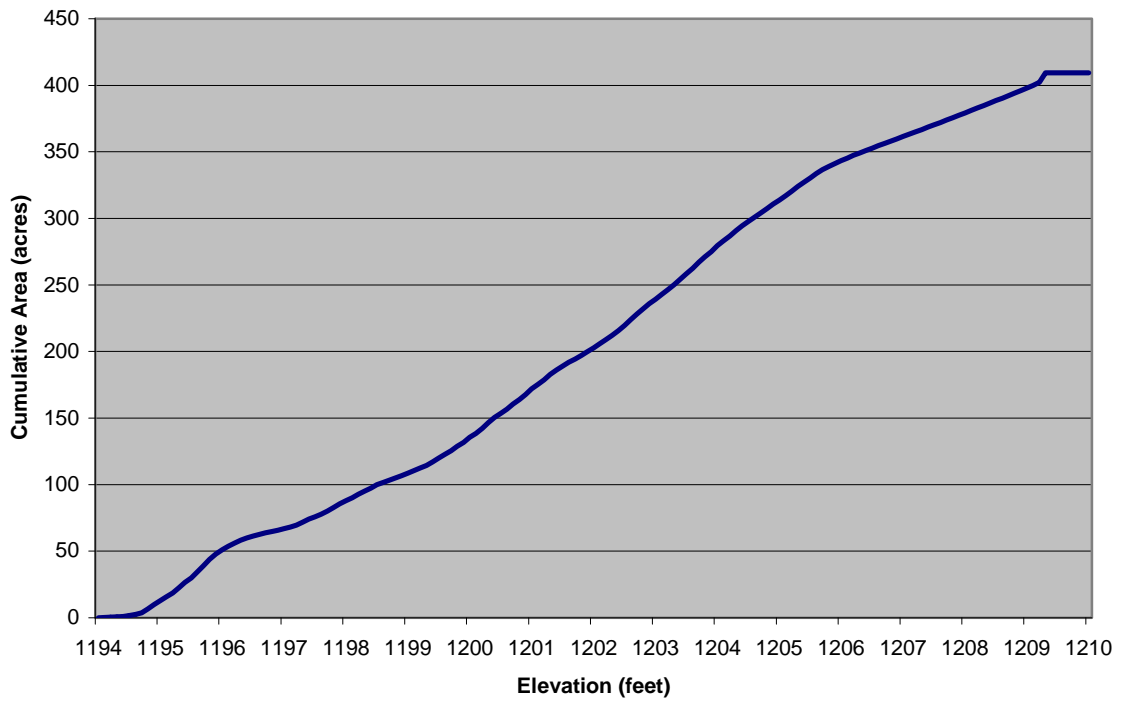


Figure 8. Cumulative area-elevation curve for north impoundment ONLY

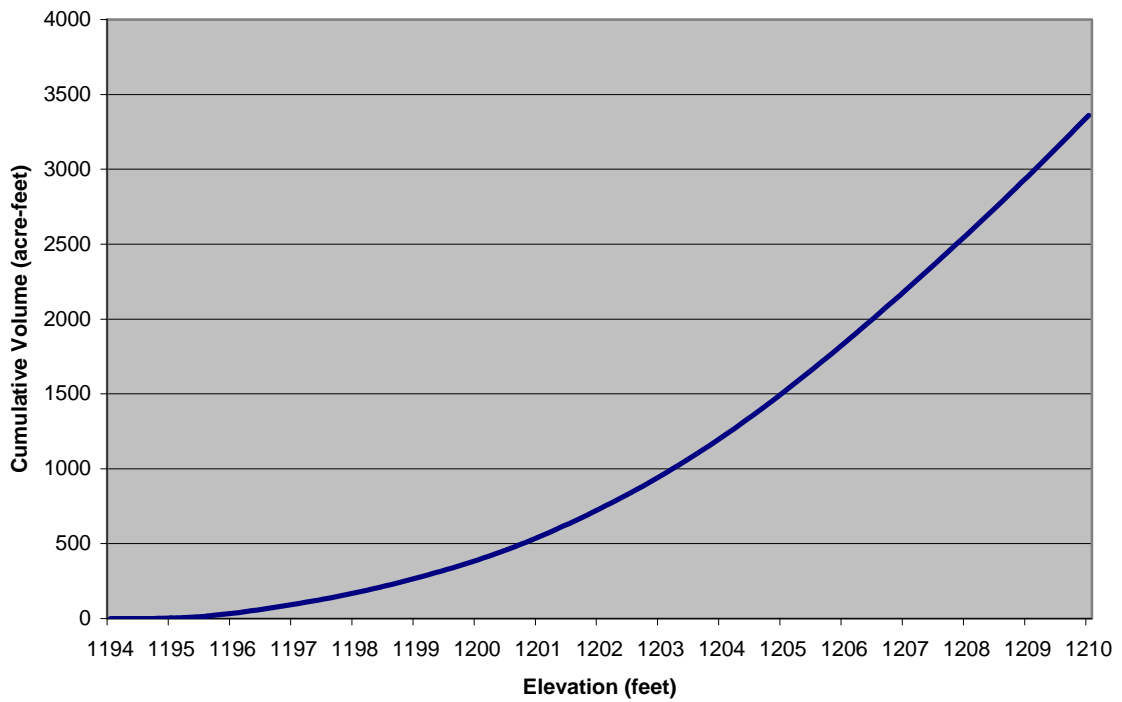


Figure 9. Cumulative volume-elevation curve for north impoundment ONLY

Table 5

**South Impoundment ONLY (New Wellington City Lake)
Cumulative area in acres by tenth foot elevation increments**

<u>Elevation (ft NGVD)</u>	<u>0.00</u>	<u>0.10</u>	<u>0.20</u>	<u>0.30</u>	<u>0.40</u>	<u>0.50</u>	<u>0.60</u>	<u>0.70</u>	<u>0.80</u>	<u>0.90</u>
1182					1	1	1	1	2	2
1183	3	3	4	5	6	7	8	10	11	11
1184	12	13	14	15	16	17	18	19	20	21
1185	22	23	24	25	27	28	29	30	31	32
1186	33	35	36	37	38	39	41	42	43	44
1187	44	45	46	47	48	50	51	52	53	54
1188	55	56	57	57	58	59	60	60	61	62
1189	63	63	64	65	65	66	67	67	68	68
1190	69	70	70	71	72	72	73	74	74	75
1191	76	76	77	77	78	79	79	80	80	81
1192	81	82	83	83	84	85	85	86	86	87
1193	88	88	89	89	90	91	91	92	92	93
1194	94	94	95	96	96	97	98	99	99	100
1195	101	101	102	103	103	104	105	106	106	107
1196	108	109	109	110	111	112	112	113	114	115
1197	115	116	117	118	118	119	120	121	122	122
1198	123	124	125	126	127	128	128	129	130	131
1199	132	133	134	134	135	136	137	138	139	140
1200	141	142	142	143	144	145	146	147	148	148
1201	149	150	151	152	153	154	154	155	156	157
1202	158	158	159	160	161	162	163	163	164	165
1203	166	167	168	168	169	170	171	172	173	174
1204	175	175	176	177	178	179	179	180	181	182
1205	182	183	184	184	185	186	187	187	188	189
1206	189	190	190	191	192	192	193	194	194	195
1207	196	196	197	198	198	199	200	200	201	202
1208	202	203	204	205	206	206	207	208	209	209
1209	210	211	212							

Table 2

**South Impoundment ONLY (New Wellington City Lake)
Cumulative volume in acre-feet by tenth foot elevation increments**

<u>Elevation (ft NGVD)</u>	<u>0.00</u>	<u>0.10</u>	<u>0.20</u>	<u>0.30</u>	<u>0.40</u>	<u>0.50</u>	<u>0.60</u>	<u>0.70</u>	<u>0.80</u>	<u>0.90</u>
1182										1
1183	1	1	1	2	2	3	4	5	6	7
1184	8	9	11	12	14	15	17	19	21	23
1185	25	27	29	32	35	37	40	43	46	49
1186	53	56	59	63	67	71	75	79	83	87
1187	92	96	101	105	110	115	120	125	131	136
1188	141	147	152	158	164	170	176	182	188	194
1189	200	206	213	219	226	232	239	246	252	259
1190	266	273	280	287	294	301	309	316	323	331
1191	338	346	354	361	369	377	385	393	401	409
1192	417	425	433	442	450	459	467	476	484	493
1193	502	510	519	528	537	546	555	564	574	583
1194	592	602	611	621	630	640	650	659	669	679
1195	689	699	710	720	730	741	751	762	772	783
1196	794	804	815	826	837	848	860	871	882	894
1197	905	917	929	940	952	964	976	988	1000	1012
1198	1025	1037	1049	1062	1075	1087	1100	1113	1126	1139
1199	1152	1165	1179	1192	1206	1219	1233	1247	1260	1274
1200	1288	1303	1317	1331	1345	1360	1374	1389	1404	1419
1201	1434	1449	1464	1479	1494	1509	1525	1540	1556	1571
1202	1587	1603	1619	1635	1651	1667	1683	1700	1716	1733
1203	1749	1766	1782	1799	1816	1833	1850	1867	1885	1902
1204	1919	1937	1955	1972	1990	2008	2026	2044	2062	2080
1205	2098	2116	2135	2153	2172	2190	2209	2228	2246	2265
1206	2284	2303	2322	2341	2360	2380	2399	2418	2438	2457
1207	2477	2496	2516	2536	2556	2575	2595	2615	2635	2656
1208	2676	2696	2717	2737	2758	2778	2799	2820	2841	2862
1209	2883	2904	2925							

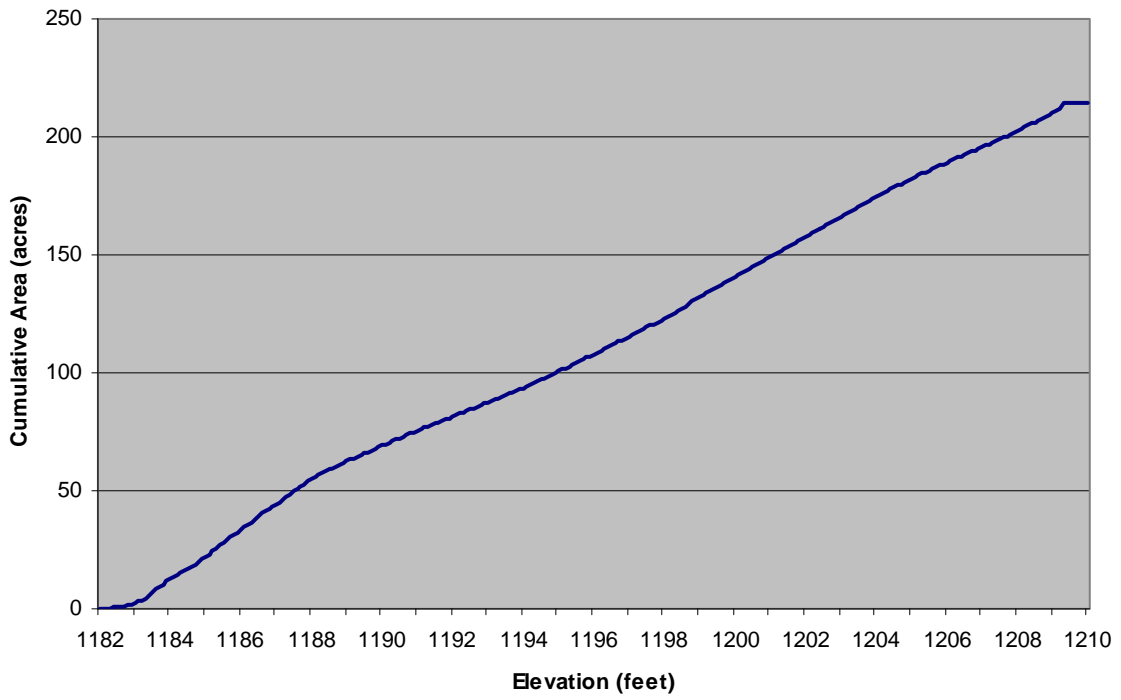


Figure 10. Cumulative area-elevation curve for south impoundment ONLY.

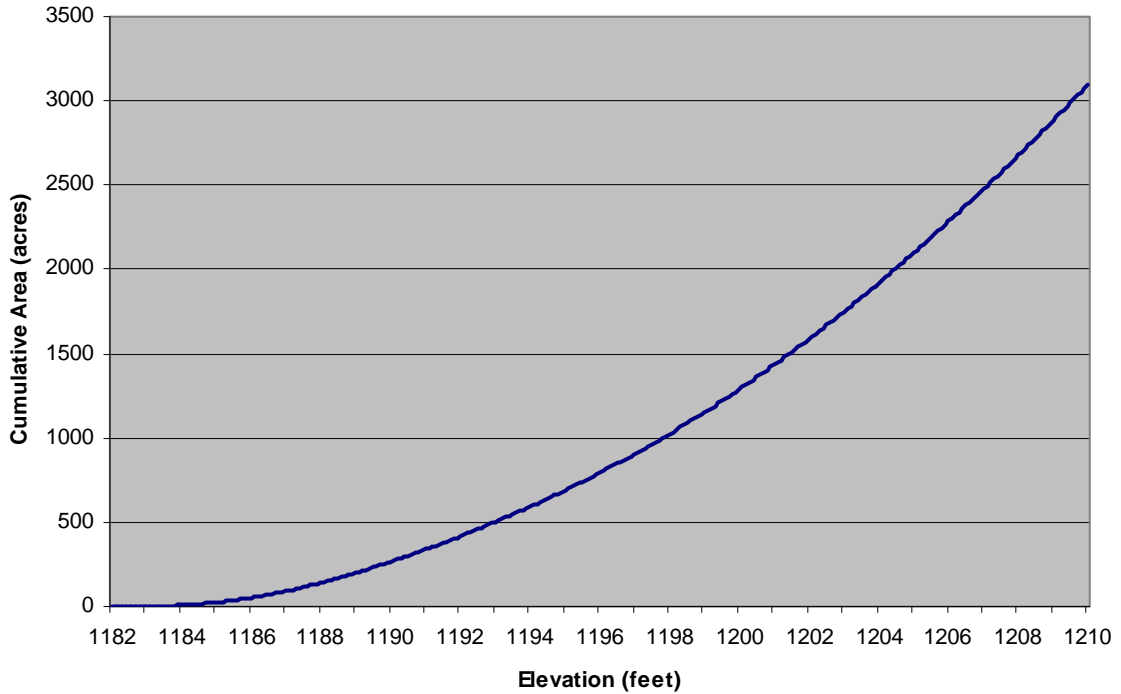


Figure 11. Cumulative volume-elevation curve for south impoundment ONLY