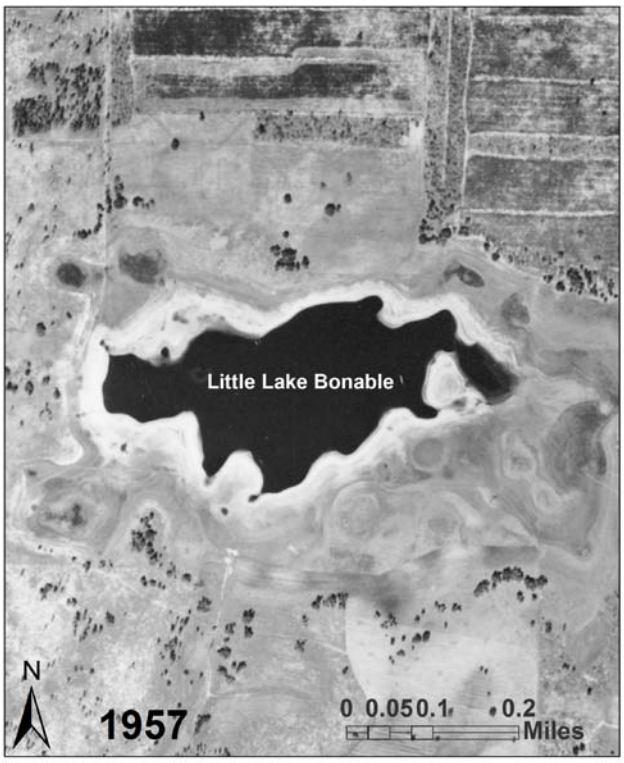
Minimum and Guidance Levels for Little Lake Bonable in Marion County, Florida



February 22, 2013

Resource Evaluation Section
Water Resources Bureau

Southwest Florida
Water Management District

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Cover Page: Aerial view of Little Lake Bonable with source imagery collected in 1957 by the United States Department of Agriculture, Soil Conservation Service. The 2011 imagery was collected on January 7th by the District through its aerial imagery acquisition program.

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Minimum and Guidance Levels for Little Lake Bonable

Section 373.042, Florida Statutes (F.S.) directs the Department of Environmental Protection or the water management districts to establish minimum flows and levels for lakes, wetlands, rivers and aquifers. Section 373.042(1)(a), F.S., states that the minimum flow for a given watercourse "shall be the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area". Section 373.042(1)(b), F.S., defines the minimum level of an aquifer or surface water body as "the level of groundwater in the aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources of the area". Minimum flows and levels are established and used by the Southwest Florida Water Management District (SWFWMD) for water resource planning, as one of the criteria used for evaluating water use permit applications, and for the design, construction and use of surface water management systems.

Development of minimum flows and levels are key components in supporting resource protection, recovery and regulatory compliance by establishing standards below which significant harm will occur in specific water bodies. Section 373.0421, F.S., requires the development of a recovery or prevention strategy for water bodies if the " existing flow or level in a water body is below, or is projected to fall within 20 years below, the applicable minimum flow or level." Section 373.0421 (2), F.S., requires that recovery or prevention strategies be developed to: "(a) achieve recovery to the established minimum flow or level as soon as practicable; or (b) prevent the existing flow or level from falling below the established minimum flow or level." Periodic re-evaluation and, as necessary, revision of established minimum flows and levels are required by Section 373.0421(3), F.S.

Minimum flows and levels are to be established based upon the best available information with consideration given to "…changes and structural alterations to watersheds, surface waters and aquifers, and the effects such changes or alterations have had, and the constraints such changes or alterations have placed on the hydrology of the affected watershed, surface water, or aquifer…", with the caveat that these considerations shall not allow significant harm caused by withdrawals (Section 373.0421, F.S.). The Florida Water Resources Implementation Rule (Rule 62-40.473, Florida Administrative Code (F.A.C.), provides additional guidance for the establishment of minimum flows and levels, requiring that "consideration shall be given to the protection of water resources, natural seasonal fluctuations in water flows, and environmental values associated with coastal, estuarine, aquatic and wetland ecology, including: a) recreation in and on the water; b) fish and wildlife habitats and the passage of fish; c) estuarine resources; d) transfer of detrital material; e) maintenance of freshwater storage and supply; f) aesthetic and scenic attributes; g) filtration and absorption of nutrients and other pollutants; h) sediment loads; i) water quality; and j) navigation." The Water Resource Implementation Rule also indicates that "minimum flows and levels should be expressed as multiple flows or levels defining a minimum hydrologic regime, to the extent practical and necessary to establish the limit beyond

which further withdrawals would be significantly harmful to the water resources or the ecology of the area".

The Southwest Florida Water Management District has developed specific methodologies for establishing minimum flows or levels for lakes, wetlands, rivers and aquifers, subjected the methodologies to independent, scientific peer-review, and incorporated the methods into Chapter 40D-8, F.A.C. For lakes, methodologies have been developed for establishing Minimum Levels for systems with fringing cypress-dominated wetlands greater than 0.5 acre in size, and for those without fringing cypress wetlands. Lakes with fringing cypress wetlands where water levels currently rise to an elevation expected to fully maintain the integrity of the wetlands are classified as Category 1 Lakes. Lakes with fringing cypress wetlands that have been structurally altered such that lake water levels do not rise to levels expected to fully maintain the integrity of the wetlands are classified as Category 2 Lakes. Lakes without at least 0.5 acre of fringing cypress wetlands are classified as Category 3 Lakes. Rule 40D-8.624, F.A.C., provides for the establishment of Guidance Levels, which serve as advisory information for the District, lakeshore residents and local governments, or to aid in the management or control of adjustable water level structures. Information regarding the development of adopted methods for establishing Minimum and Guidance lake levels is provided in Southwest Florida Water Management District (1999a, b), Leeper *et al.* (2001) and Leeper (2006). Peer-review findings regarding the lake level methods are available in Bedient *et al.* (1999), Dierberg and Wagner (2001) and Wagner and Dierberg (2006).

Two Minimum Levels and two Guidance Levels have typically been established for lakes, and upon adoption by the District Governing Board, incorporated into Rule 40D-8.624, F.A.C. The levels, which are expressed as elevations in feet above the National Geodetic Vertical Datum of 1929 (NGVD), are described below.

- The **High Guidance Level** is provided as an advisory guideline for construction of lakeshore development, water dependent structures, and operation of water management structures. The High Guidance Level is the elevation that a lake's water levels are expected to equal or exceed ten percent of the time on a long-term basis.

- The **High Minimum Lake Level** is the elevation that a lake's water levels are required to equal or exceed ten percent of the time on a long-term basis.

- The **Minimum Lake Level** is the elevation that a lake's water levels are required to equal or exceed fifty percent of the time on a long-term basis.

- The **Low Guidance Level** is provided as an advisory guideline for water dependent structures, information for lakeshore residents and operation of water management structures. The Low Guidance Level is the elevation that a lake's water levels are expected to equal or exceed ninety percent of the time on a long-term basis.

In accordance with Chapter 40D-8, F.A.C., Minimum and Guidance Levels were developed for Little Lake Bonable (Table 1), a Category 3 lake located in Marion County, Florida. The levels were established using best available information, including field data that were obtained specifically for the purpose of minimum levels development. The data and analyses used for development of the levels are described in the remainder of this report. Following a public input process, District staff recommended and the Governing Board approved incorporation of the proposed levels into District Rule, Chapter 40D-8, subsection 40D-8.624, F.A.C., at their October 30, 2012 meeting. Public input included a public workshop held on September 27, 2012 in Dunnellon Florida. Upon approval by the District Governing Board, staff prepared an amendment to subsection 40D-8.624, F.A.C. that establishes Minimum and Guidance levels for Little Lake Bonable based on current methodologies, replacing the previously adopted management levels established in 1993 (see Table 2). The rule amendment was submitted to the Joint Administrative Procedures Committee and notice was provided to the Governor's Office of Fiscal Accountability and Regulatory Reform (OFARR). The rule amendment and adoption of Minimum and Guidance levels (See Table 1) became effective on February 21, 2013.

All elevation data values shown within this report on graphs, bathymetric maps, and within tables are expressed as elevations in feet above the National Geodetic Vertical Datum of 1929 (NGVD 29). In some circumstances notations are made for data that was collected as North American Vertical Datum of 1988 (NAVD 88) (also as feet) and converted to NGVD 29. All datum conversions were derived using Corpscon 6.0, a computer software program developed by the United States Army Corps of Engineers.

Table 1. Minimum and Guidance Levels for Little Lake Bonable

Minimum and Guidance Levels	Elevation in Feet
	NGVD 29
High Guidance Level	58.6
High Minimum Lake Level	57.8
Minimum Lake Level	52.2
Low Guidance Level	45.9

Data and Analyses Supporting Development of Minimum and Guidance Levels for Little Lake Bonable

Lake Setting and Description

Little Lake Bonable is located northwest of Dunnellon in western Marion County and eastern Levy County (Section 30, Township 15 South, R18 East) (Figure 1). The "Gazetteer of Florida Lakes" (Shafer *et al.* 1986) lists the lake area of Little Lake Bonable at 157 acres.

The lake is part of the Sand Slough watershed (approximately 32.3 square miles), which drains to Waccasassa River basin. The lake is located within the Northern Brooksville Ridge lakes region that was identified and mapped as part of the Florida Department of Environmental Protection's Lake Bioassessment / Regionalization Initiative (Griffith *et al.* 1997). Romie (2000) described Little Lake Bonable as a colored, soft water, eutrophic lake.

The eastern and north surrounding area of the lake is in the Rainbow Lake Estates, a low density sub-division of Dunnellon. The lake is bounded on the western edge by low density residential and agriculture land use (Figure 2). At high levels the lake discharges into a forested wetland strand through a manmade drainage ditch located on central southern shore.

Topographic maps (Figures 3 and 4) of the basin generated in support of minimum levels development indicate that Little Lake Bonable is shallow with both gradual shoreline slopes and bottom slopes. There are no deep depressions within the lake bottom (Figure 4). The maximum depth is 14 feet during time periods of high stage such as shown in Figure 4. At a high stage elevation of 58 NGVD the average depth is 7.7 ft and at a median stage of 53.0 NGVD the average depth is 4.7ft. The shallow nature of the lake supports growth of emergent wetland plants including *Panicum dichotomiflorum* and *Panicum hemitomon* that are considered valuable habitat for fish and numerous species of birds.

There are no surface water withdrawals from the lake currently permitted by the District. Additionally, there are no significant withdrawals within the immediate vicinity of the lakes with only five permitted groundwater withdrawals within a two mile radius of the lake (Figure 5). Within 3 miles of the lake there are nine permitted groundwater withdrawals with the average monthly water use ranging between 0.10 and 0.36 million gallons per day (mgd) for years 2000 through 2006 (SWFWMD 2011). Lake stage has been monitored on a monthly basis starting in 1992 (Figure 2).

Figure 1. General location of Little Lake Bonable in Marion County, Florida.

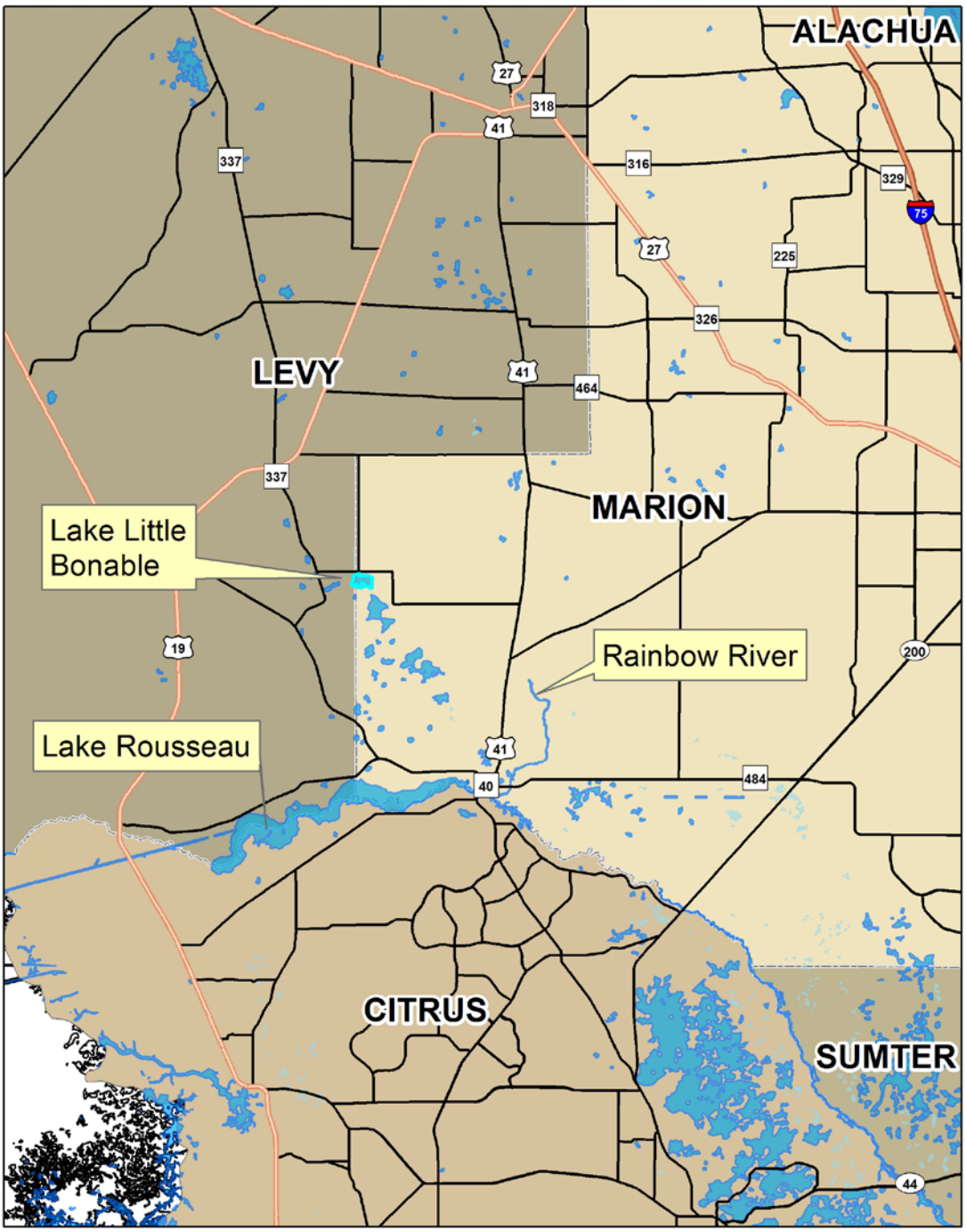
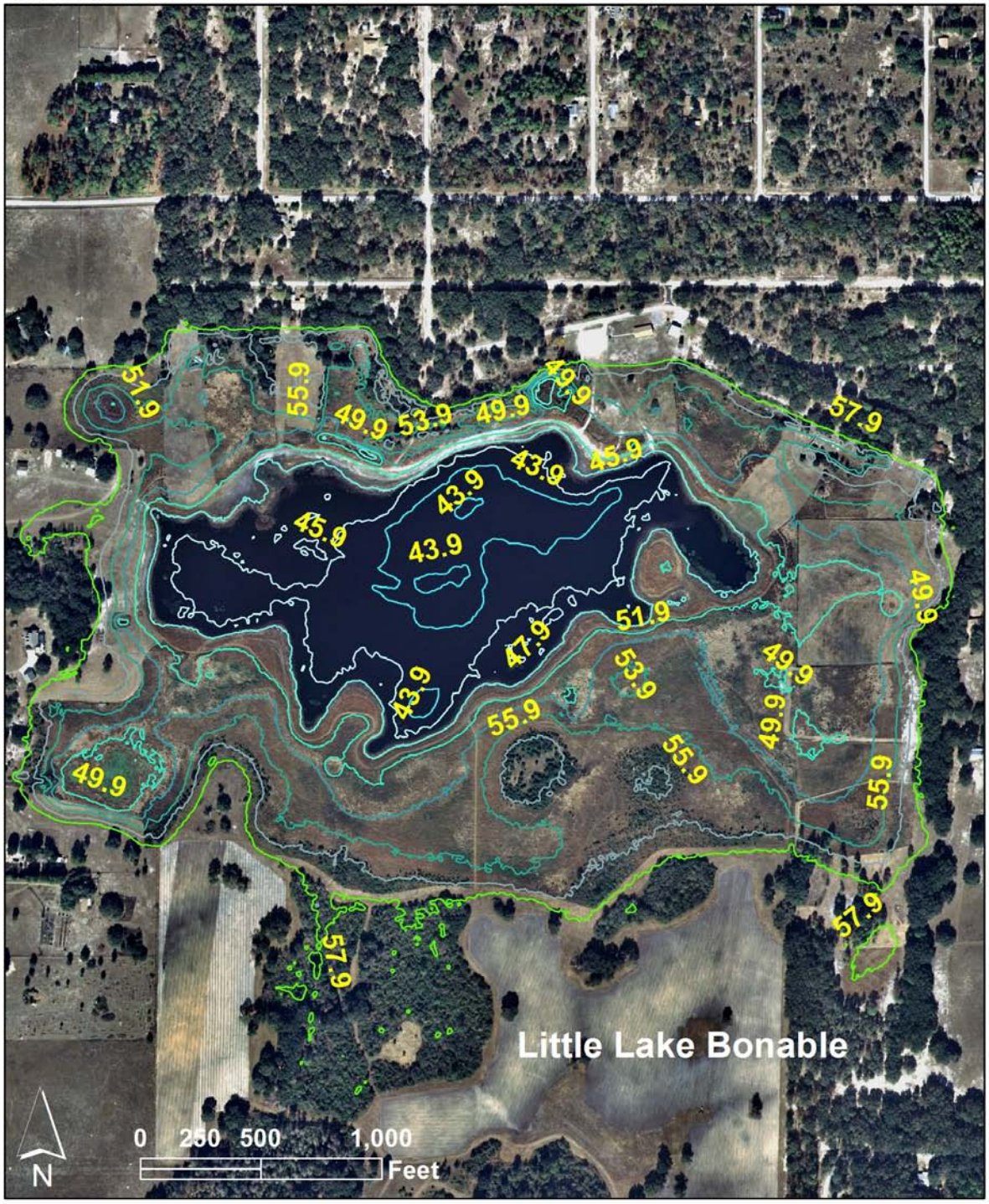


Figure 2. Location of the lake water level gage at Little Lake Bonable

- Approximate location of water level gage (WMIS ID 23377) on Lake Little Bonable Map was prepared using natural color imagery collected on January 7, 2011.

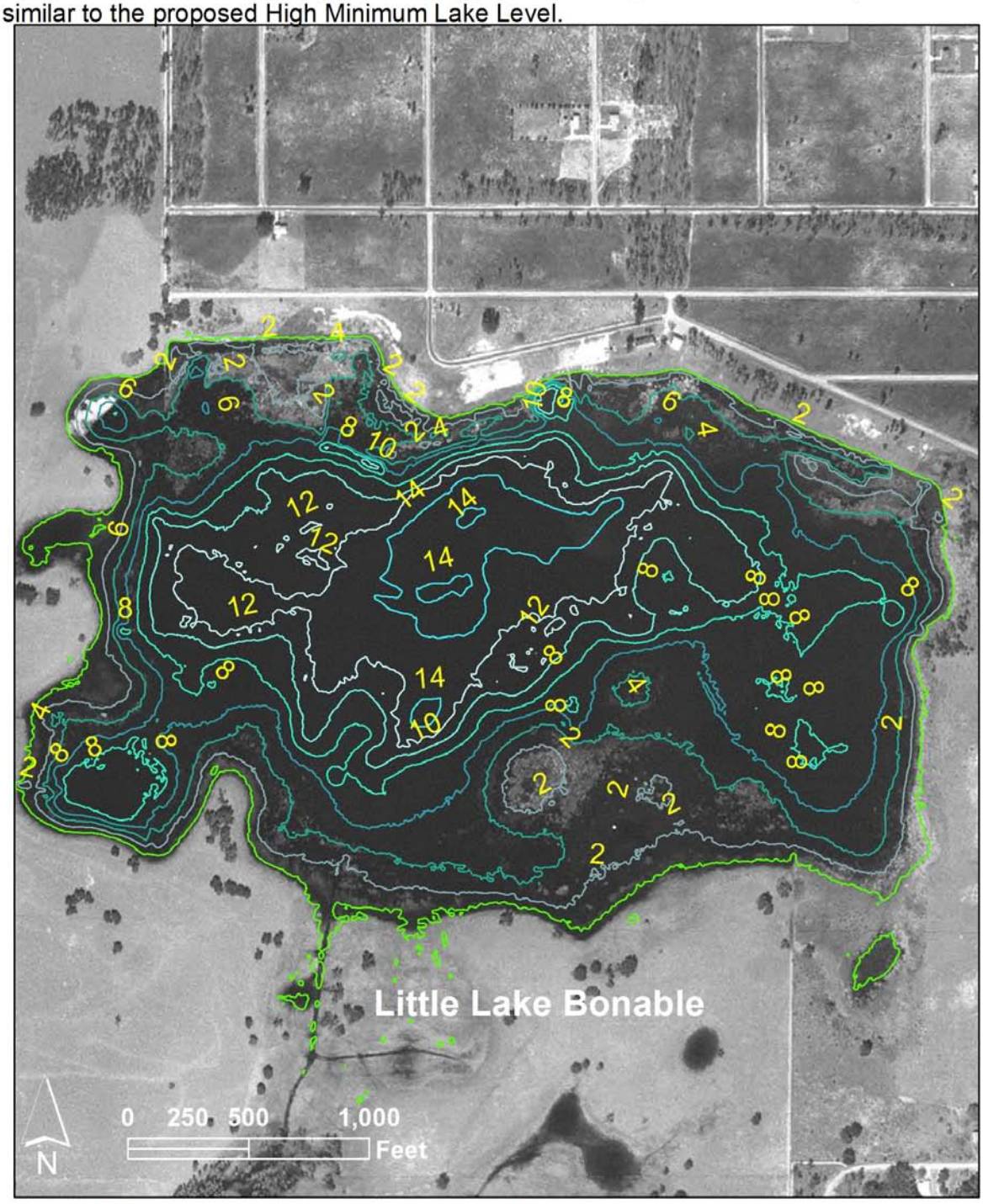
0 125 250 500 750 1,000
Feet

Figure 3. Two-foot contour lines within Little Lake Bonable. Values shown are elevations in feet as NGVD 29.



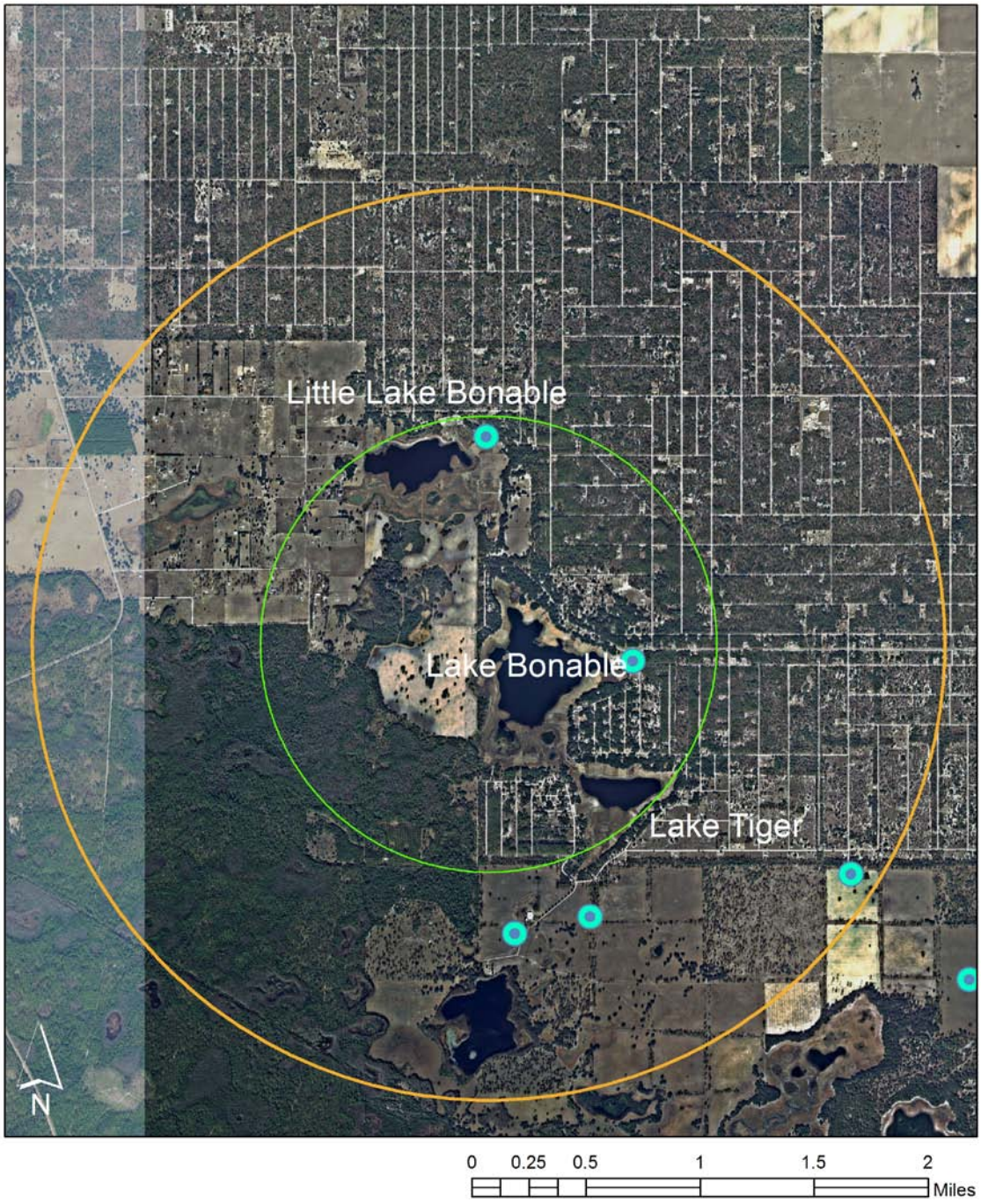
Approximate bottom elevation contours (as NGVD 29) within Little Lake Bonable, Marion County. Contours were prepared using bottom depth data and LiDAR surface elevation data. Bottom depths were collected by D.C. Johnsons & Associates in June 2006 (File No, 2004-003A02). The background imagery is natural color imagery collected on Jan 07, 2011.

Figure 4. Bathymetric map of Little Lake Bonable showing approximate bottom depths in feet with the lake basin nearly full at an approximate stage of 57.9 NGVD 29, an elevation similar to the proposed High Minimum Lake Level.



Two foot depth contours within Little Lake Bonable, Marion County. Contours were prepared using bottom depth data and LiDAR surface elevation data. Bottom depths were collected by D.C. Johnsons & Associates in June 2006 (File No, 2004-003A02). Backgorund imagery was collected in March 1970 by the Florida Dept. of Transportation.

Figure 5. Permitted groundwater withdrawals within a one mile and two mile radius of Lakes Little Bonable, Bonable, and Tiger.



Currently Adopted Guidance Levels

The Southwest Florida Water Management District has a long history of water resource protection through the establishment of lake management levels. With the development of the Lake Levels Program in the mid-1970s, the District began an initiative for establishing lake management levels based on hydrologic, biological, physical and cultural aspects of lake ecosystems. By 1996, management levels for nearly 400 lakes had been established.

Based on work conducted in the 1970s (see SWFWMD 1996), the District Governing Board adopted management levels (currently referred to as Guidance Levels) for Little Lake Bonable in January 1993 (Table 2). A Maximum Desirable Level of 57.50 NGVD was also developed, but was not adopted by the Governing Board. The adopted Guidance Levels and Maximum Desirable Level were developed using a methodology that differs from the current District approach for establishing Minimum and Guidance Levels. The levels do not, therefore, necessarily correspond with levels developed using current methods. Minimum and Guidance Levels developed using current methods will replace existing Guidance Levels upon adoption by the District Governing Board into Chapter 40D-8, F.A.C. One of the management levels, a Ten Year Flood Guidance Level of 59.80 NGVD, was removed from Chapter 40D-8 in 2007, when the District Governing Board determined that flood-stage elevations should not be included in the District's Water Levels and Rates of Flow rules

Annually since 1991, a list of stressed lakes has been developed to support the District's consumptive water use permitting program. As described in the District's Consumptive Use of Water Rule (Chapter 40D-2, F.A.C.), "a stressed condition for a lake is defined to be chronic fluctuation below the normal range of lake level fluctuations". For lakes with adopted Guidance Levels, chronic fluctuation below the Low Level is considered a stressed condition. For lakes without adopted levels, evaluation of stressed condition is conducted on a case-by-case basis. As a result of the prolonged drought, Little Lake Bonable has been listed as stressed over multiple recent years, including 2009, 2010, and 2011 (Gant *et al.* 2009, Gant *et al.* 2010, Gant *et al.* 2011).

Table 2. Previously adopted Guidance Levels for Little Lake Bonable as listed in Table 8-3 of subsection 40D-8.624, F.A.C.

Guidance Levels	Elevation in Feet NGVD 29
Ten Year Flood Guidance Level	59.80
High Level	58.00
Low Level	55.50
Extreme Low Level	53.50

Summary Data Used for Development of Minimum and Guidance Levels

Minimum and Guidance Levels for Little Lake Bonable were developed using the methodology for Category 3 Lakes described in Rule 40D-8.624, F.A.C. The recommended levels and additional information are listed in Table 3, along with lake surface areas for each level or feature/standard elevation. Detailed descriptions of the development and use of these data are provided in the subsequent sections of this report.

Table 3. Minimum and Guidance Levels, lake stage exceedance percentiles, and control point elevations, significant change standards, and associated surface areas for Little Lake Bonable.

Levels	Elevation in Feet NGVD 29	Lake Area (acres)
Lake Stage Percentiles		
Period of Record (POR) P10 (1992 to 2012)	54.1	134.2
Period of Record (POR) P50 (1992 to 2012)	49.4	64.8
Period of Record (POR) P90 (1992 to 2012)	46.1	37.9
Historic P10 (1946 to 2012)	58.6	188.9
Historic P50 (1946 to 2012)	53.0	118.4
Historic P90 (1946 to 2012)	46.0	37.1
Control Point		
Control Point	59.0	NA
Significant Change Standards		
Wetland Offset Elevation	52.2	103.5
Species Richness Standard	52.1	101.8
Aesthetics Standard	45.9	36.1
Lake Mixing Standard	45.2	28.1
Recreation/Ski Standard	NA	NA
Dock-Use Standard	NA	NA
Basin Connectivity Standard	NA	NA
Minimum and Guidance Levels		
High Guidance Level	**58.6**	188.9
High Minimum Lake Level	**57.8**	177.2
Minimum Lake Level	**52.2**	103.5
Low Guidance Level	**45.9**	36.1

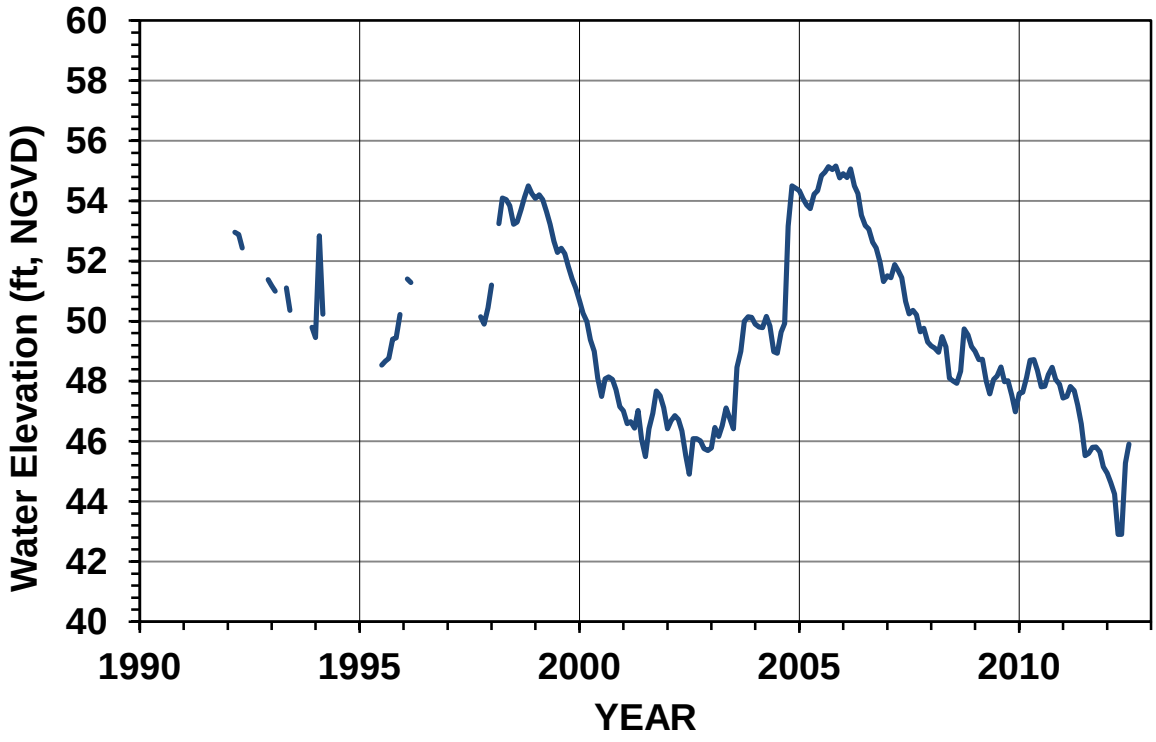
NA = not appropriate;

Lake Stage Data and Exceedance Percentiles

Lake stage data, *i.e.,* surface water elevations for Little Lake Bonable relative to NGVD 29 were obtained from the District's Water Management Information System (WMIS) data base (Site Identification Number 23377). There is a twenty year period of record for lake stage data on Little Lake Bonable (WMIS ID 23377) with the period of record (POR) extending from February 1992 through present day (Figure 7, see Figure 2 for the location of the SWFWMD lake water level gage).

Lake stage data has been recorded for Little Lake Bonable on a monthly basis and recorded in the District's WMIS data base. A graph of the data is shown in Figure 7. The highest surface water elevation for the lake recorded for Little Lake Bonable was 55.16 NGVD 29 occurring in October 2005 after the 2004 series of hurricane that brought above average rainfall to central Florida. Similar high stages were recorded in October 1998 during the well known "El Niño" event. The lowest surface water elevation of 42.9 NGVD 29 occurred recently during both March and April of 2012. A low stage of 44.9 NGVD 29 also occurred approximately ten years prior, during June 2002. Based on the most recent level of 45.9 NGVD recorded on August 24, 2012, the lake stage has increased by 3 feet from its POR low as the result of heavy rainfall that occurred during Tropical Storm Debby.

Figure 7. Monthly surface water elevations (NGVD 29) through June 2012 for Little Lake Bonable, SWFWMD WMIS site ID 23377.



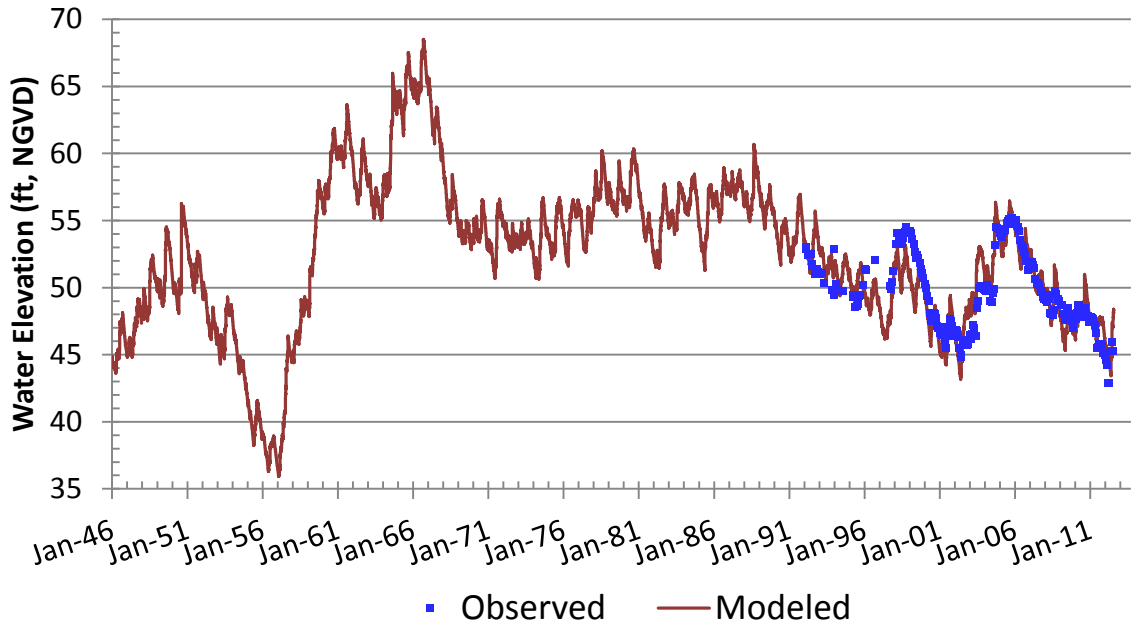
For the purpose of Minimum Levels determination, lake stage data are classified as "Historic" for periods when there were no measurable impacts due to water withdrawals, and impacts due to structural alterations were similar to existing conditions. In the context of Minimum Levels development, "structural alterations" means man's physical alteration of the control point, or highest stable point along the outlet conveyance system of a lake, to the degree that water level fluctuations are affected. Lake stage data are classified as "Current" for periods when there were measurable, stable impacts due to water withdrawals, and impacts due to structural alterations were stable. A hydrologic analysis (SWFWMD 2011, draft report) completed for Little Lake Bonable indicated that the lake was determined to be have no measureable impacts due to regional groundwater withdrawals. The results of the analysis indicated that lake stage data for the period of record (1992 to 2012) for Little Lake Bonable could be classified as Historic (Figure 9).

Although the period of record of lake stage data (1992 to 2012) for Little Lake Bonable could be classified as the Historic data, it was determined that a longer period of data would better characterize historic water level fluctuation within the basin. A longer period was developed by using a predictive lake stage model, referred to as the "Rainfall Line of Organic Correlation" model (LOC)(Ellison et al. 2011). The method relates local rain gage data to historic lake stage data to produce a regression model that predicts lake stage based on past rainfall amounts. The procedure uses a linear inverse time weighted rainfall sums to establish the relationship. Models produced with this method are extended back in time to 1946, to produce a 60-year non-impacted lake stage record that serves as the basis for establishing historic lake-stage exceedance percentiles. A sixty year period was considered sufficient for incorporating the range of lake stage fluctuations that would be expected based on long-term climatic cycles that have been shown to be associated with changes in regional hydrology (Enfield et al. 2001, Basso and Schultz 2003).

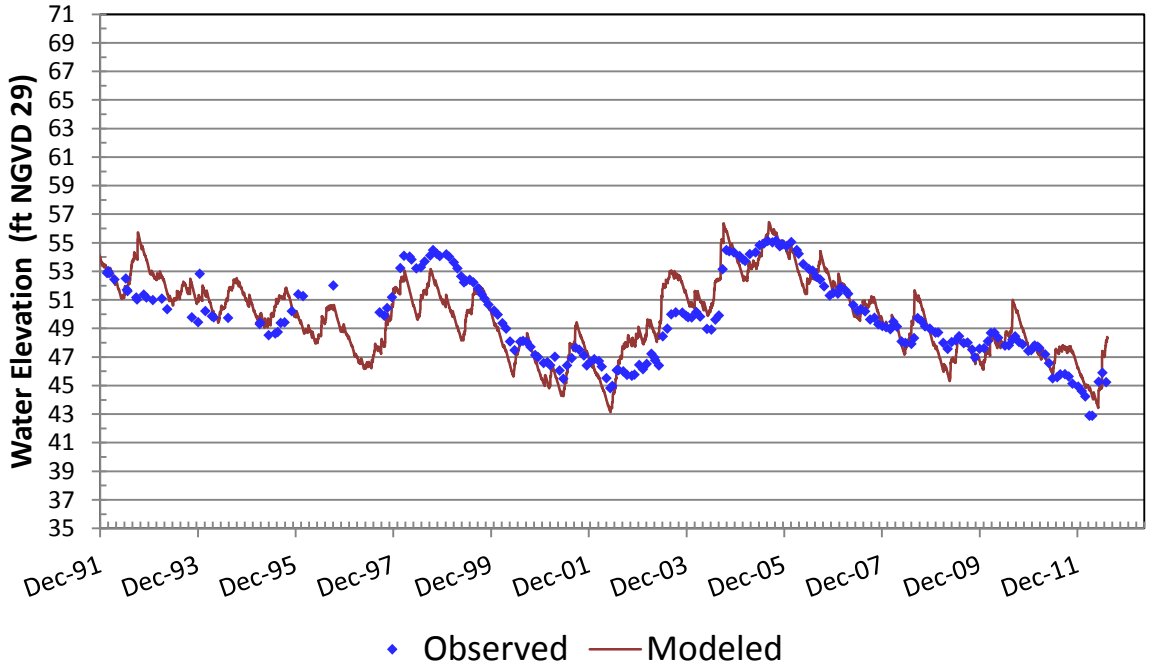
To produce the model a composite rainfall data set was developed for the time period of 1946 to 2012 using data from five rainfall data collection sites. The rain gage sites included the following: Cedar Key, Dunnellon Tower, Inglis Lock, Inglis 3E NWS, Lebanon Tower, Rainbow Springs, Romeo, and Usher (WMIS Site ID's 26292, 22997, 22959, 22958, 26291, 23323, 22977, 26387). The resulting lake level rainfall model had a correlation coefficient of determination (r^2) equal to 0.700 based on use of a five-year linear decay series of daily rainfall values. The model was then applied to predict the lake stage for the long term Historic time period of the 1946 to 2012 (Figure 9a). A visual comparison of the modeled lake stage to the observed lake stage during the period of record (1992-2012) is shown in Figure 9b, and generally shows good agreement between the modeled and observed lake stage.

Figure 9: **a**. Modeled long term **Historic** lake stage (as daily, see red line) from 1946 to 2012 and observed lake stage (as daily, see blue points) from 1992 to 2012 for Little Lake Bonable. **b.** Modeled daily lake stage and observed (as daily) for period of record (1992 to 2012).

9a.



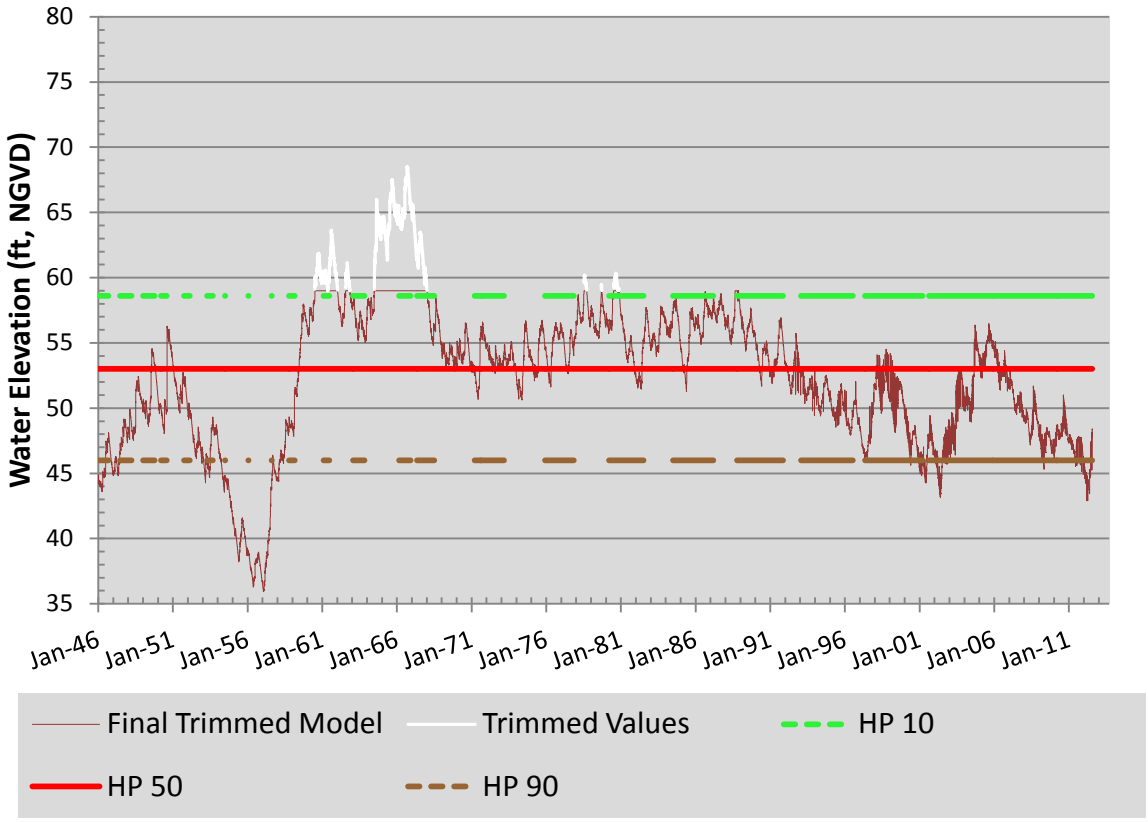
9b.



The modeled long term Historic lake stage (1946 to 2012) was then combined with the measured or period of lake stage (1992 to 2012) to provide a final composite long term Historic lake stage (Figure 10). Because the model predicts levels in excess of the outfall ditch control point elevation, the model results were trimmed at the control elevation (59.0 NGVD 29). The trimmed modeled values are shown in white on Figure 10. This composite data long term Historic data trimmed at 59.0 NGVD was the final data set used to calculate the **Historic P10, P50, and P90** lake stage exceedance percentile elevations.

The **Historic P10** elevation, the elevation the lake water surface equaled or exceeded ten percent of the time during the historic period, was **58.6 NGVD 29.** The **Historic P50** elevation, the elevation the lake water surface equaled or exceeded fifty percent of the time during the historic period, was **53.0 NGVD 29.** The **Historic P90** elevation, the elevation the lake water surface equaled or exceeded 90 percent of the time during the historic period, was **46.0 NGVD 29.**

Figure 10. Modeled long term Historic lake stage and measured lake stage (both as daily) used to calculate the Historic P10, P50, and P90 lake stage exceedance percentile elevations for Little Lake Bonable from January 1946 through July 2012. The long term Historic P10, P50, and P90 are depicted as horizontal solid and dotted lines. The white line represents trimmed modeled lake stage using the control point as the trim elevation (59.0 NGVD 29).



Normal Pool Elevation, Control Point Elevation and Structural Alteration Status

The **Normal Pool** elevation, a reference elevation used for development of minimum lake and wetland levels, is established based on the elevation of Hydrologic Indicators of sustained inundation. For development of Minimum Lake Levels, the Normal pool elevation is considered an approximation of the Historic P10. Because Hydrologic Indicators of Normal Pool were not observed at Little Lake Bonable, establishment of the Normal Pool elevation was not possible.

The **Control Point** elevation is the elevation of the highest stable point along the outlet profile of a surface water conveyance system (*e.g.,* weir, ditch, culvert, or pipe) that is the principal control of water level fluctuations in the lake. The outfall for Little Lake Bonable is located within a man-made drainage ditch located on the south side of the lake (Figure 2). Water discharges from the lake into a wetland strand system located down gradient of the lake. The wetland slough continues to expand down gradient to the west, where it eventually becomes connected to the expansive cypress strands within the Goethe State Forest. Based on a review of historical imagery the drainage ditch appears to have been constructed between 1957 and 1963. Based on a profile flowline of the outlet ditch completed by professional surveyors during the topographic assessment of the watershed (Xynides 2010), the control point occurs at a constructed road crossing located approximately 3500 feet downstream of the lake. An 18 inch PVC pipe provides conveyance of flow under the road. The invert of the pipe was found to be 59.07 NGVD.

Structural Alteration Status is determined to support development of Minimum and Guidance Levels. Because of known modifications to the natural outlet of Little Lake Bonable, the lake is considered to be Structurally Altered.

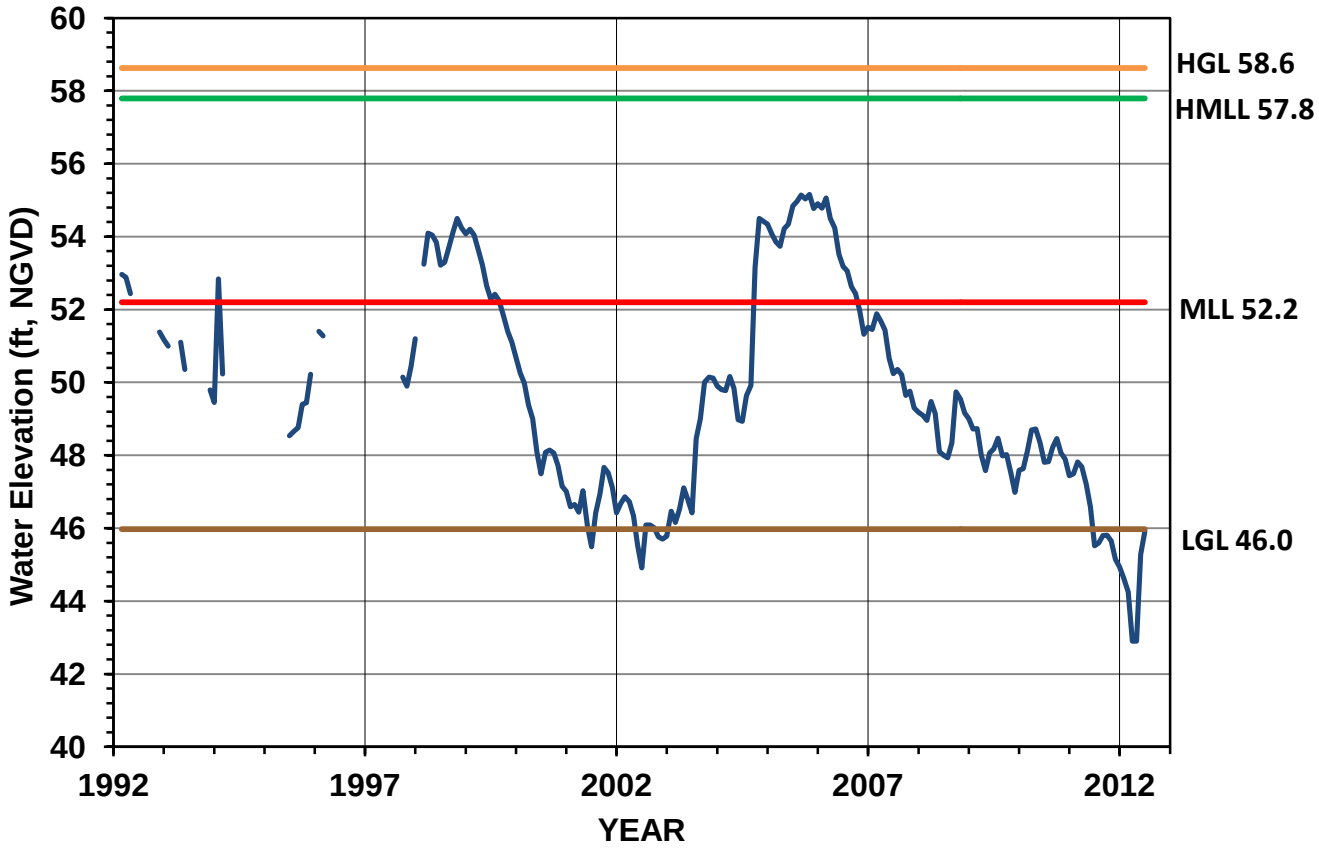
Guidance Levels

The **High Guidance Level** is provided as an advisory guideline for construction of lake-shore development, water dependent structures, and operation of water management structures. The High Guidance Level is the expected Historic P10 of the lake and is established using historic lake stage data if it is available, or is estimated using the Current P10, the control point, and the normal pool elevation. Based on the availability of the modeled long term Historic data record for Little Lake Bonable, the High Guidance Level was established at **58.3 NGVD 29** (Figure 11).

The **Low Guidance Level** is provided as an advisory guideline for water dependent structures, information for lake shore residents, and operation of water management structures. The Low Guidance Level is the elevation that a lake's water levels are expected to equal or exceed ninety percent of the time (P90) on a long-term basis. The level is established using Historic or Current lake stage data, and in some cases, the Reference Lake Water Regime (RLWR) statistics. Based on the availability of the

long term modeled Historic data set for Little Lake Bonable, the Low Guidance Level for both lakes was established at **46.0 NGVD 29** (Figure 11, Table 3).

Figure 11. Mean monthly lake stage for the period of record and Minimum and Guidance Levels for Little Lake Bonable, in feet above NGVD 29. Levels include the High Guidance Level (HGL), High Minimum Lake Level (HMLL), Minimum Lake Level (MLL), and the Low Guidance Level (LGL).



Lake Classification

Lakes are classified as Category 1, 2, or 3 for the purpose of Minimum Levels development. Those with fringing cypress wetlands greater than 0.5 acres in size where water levels currently rise to an elevation expected to fully maintain the integrity of the wetlands (*i.e.*, the Historic P50 is equal to or higher than an elevation 1.8 feet below the Normal Pool elevation) are classified as Category 1 Lakes. Lakes with fringing cypress wetlands greater than 0.5 acres in size that have been structurally altered such that the Historic P50 elevation is more than 1.8 feet below the Normal Pool elevation are classified as Category 2 Lakes. Lakes without fringing cypress wetlands or with cypress wetlands less than 0.5 acres in size are classified as Category 3 Lakes. Because Little Lake Bonable does not have fringing cypress wetlands, it is classified as a **Category 3 Lake.**

Significant Change Standards and Other Information for Consideration

Lake-specific significant change standards and other available information are developed for establishing minimum levels for Category 3 Lakes. The standards are used to identify thresholds for preventing significant harm to cultural and natural system values associated with lakes in accordance with guidance provided in the Florida Water Resources Implementation Rule (Rule 62-40.473, F.A.C.). Other information taken into consideration includes potential changes in the coverage of herbaceous wetland vegetation and aquatic plants.

Six significant change standards are developed for Category 3 Lakes, including a Recreation/Ski Standard, a Species Richness Standard, a Lake Mixing Standard, an Aesthetics Standard, a Dock-Use Standard, and a Basin Connectivity Standard. A Wetland Offset Elevation is also developed and used along with the significant change standards to identify desired median lake stage elevations that if achieved, are intended to preserve various natural system and human-use lake values.

The **Recreation/Ski Standard** is developed to identify the lowest elevation within the lake basin that will contain an area suitable for safe water skiing. The standard is based on the lowest elevation (the Ski Elevation) within the basin that can contain a five-foot deep ski corridor delineated as a circular area with a radius of 418 ft, or a rectangular ski area 200 ft in width and 2,000 ft in length, and use of Historic lake stage data or region-specific reference lake water regime statistics. The Recreation/Ski Standard was established at 59**.**1 ft NGVD, based on the sum of the elevation at which the lake could contain an area suitable for safe skiing (47.0 + 5 ft or 51.0 NGVD) and the difference between the Historic P50 and Historic P90 (7.1 ft). Based on a review of the long term composite Historic water level record for Little Lake Bonable, the Recreation /Ski Standard elevation of 59.1 falls above the Historic P10 and associated High Guidance Level. The Recreation /Ski Standard occurs at this high stage due to the shallow nature of the lake basin. The basin must be nearly completely full before it is considered safe for skiing activities. The Recreation /Ski Standard is not appropriate in this case.

The **Species Richness Standard** is developed to prevent a decline in the number of bird species that may be expected to occur at or utilize a lake. Based on an empirical relationship between lake surface area and the number of birds expected to occur at Florida lakes, the standard is established at the lowest elevation associated with less than a 15 percent reduction in lake surface area relative to the lake area at the Historic P50 elevation (see Figure 12, for a plot of lake surface area versus lake stage). For Little Lake Bonable, the Species Richness Standard was established at 52.1 NGVD 29. The Species Richness Standard was equaled or exceeded 55.4 percent of the time, based on the long term composite Historic water level record. The standard elevation therefore corresponds to the Historic P55.4.

The **Aesthetics Standard** is developed to protect aesthetic values associated with the inundation of lake basins. The standard is intended to protect aesthetic values associated with the median lake stage from becoming degraded below the values associated with the lake when it is staged at the Low Guidance Level. The Aesthetic Standard was established at the Low Guidance Level, which for Little Lake Bonable is 45.9 NGVD 29. Because the Low Guidance Level was established at the Historic P90 elevation, water levels equaled or exceeded the Aesthetics Standard ninety percent of the time during the composite Historic long term period (1946 to present, Figure 9b).

The **Lake Mixing Standard** is developed to prevent significant changes in patterns of wind-driven mixing of the lake water column and sediment resuspension. The standard is established at the highest elevation at or below the Historic P50 elevation where the dynamic ratio (see Bachmann *et al.* 2000) shifts from a value of <0.8 to a value >0.8, or from a value >0.8 to a value of <0.8. A shift in the dynamic ratio occurs at an elevation of 51.0 (Figure 12), indicating the elevation at which the lake depth and bottom slope becomes susceptible to resuspension of bottom sediments. The Mixing Standard elevation established at 45.2 NGVD 29 was equaled or exceeded 92.0 percent of the time, based on the term composite Historic water level record. The standard elevation therefore corresponds to the Historic P92.0.

The **Dock-Use Standard** and **Basin Connectivity Standard** were not applicable to Little Lake Bonable. The Dock-Use Standard is developed to provide for sufficient water depth at the end of existing docks to permit mooring of boats and prevent adverse impacts to bottom-dwelling plants and animals caused by boat operation. Because there are no docks on Little Lake Bonable, a Dock-Use standard was not developed. The Basin Connectivity Standard is developed to protect surface water connections between lake basins or among sub-basins within lake basins to allow for movement of aquatic biota, such as fish, and support recreational uses. A review of the historical imagery (see Figures 15 and 16) indicated that the lake remains one basin over various stages and time periods. Because lake-basin depth measurements indicate that Little Lake Bonable does not contain separate sub-basins, the Basin Connectivity Standard was not considered applicable for the lake.

Information on herbaceous wetlands is taken into consideration when determining the elevation at which changes in lake stage would result in substantial changes in potential

wetland area within the lake basin (*i.e*., basin area with a water depth of four or less feet). Similarly, changes in lake stage associated with changes in lake area available for colonization by rooted submersed or floating-leaved macrophytes are also evaluated, based on water transparency values (*i.e*., basin area with a water depth of 5.2 feet or less feet). Review of changes in potential herbaceous wetland area or area available for submersed aquatic plant colonization in relation to change in lake stage did not indicate that of use of any of the significant change standards would be inappropriate for establishment of the Minimum Lake Level (Figure 13). No loss of wetland area would occur at the elevations associated with these standards; however, due to the shallow nature of the lake basin, there is potential for 100% of the basin to become vegetated resulting in the loss recreational use of the lake and open water needed for fish habitat. Due to these changes the use of these standards for establishment of the Minimum Lake Level is not recommended.

Based on a review (Hancock 2006) of the development of minimum level methods for cypress-dominated wetlands, it was determined that up to an 0.8 foot decrease (or Wetland Offset) in the Historic P50 elevation would not likely be associated with significant changes in the herbaceous wetlands occurring within lake basins. Because herbaceous wetlands are common within the Little Lake Bonable basin, the **Wetland Offset** was determined by subtracting 0.8 feet from the Historic P50 elevation. A Wetland Offset elevation of 52.2 NGVD was therefore established for Little Lake Bonable and was equaled or exceeded 54.7 percent of the time, based on the Historic, composite water level record. The standard elevation therefore corresponds to the Historic P54.7. Review of changes in potential wetland area in relation to change in lake stage indicated there would not be a substantial increase or decrease in potential wetland area within the lake basin at the Wetland Offset Elevation (50.4% of the lake basin) relative to the potential wetland area at the Historic P50 elevation (49.4% of the lake basin).

Minimum Levels

Minimum Lake Levels are developed using specific lake-category significant change standards and other available information or unique factors, including: substantial changes in the coverage of herbaceous wetland vegetation and aquatic macrophytes; elevations associated with residential dwellings, roads or other structures; frequent submergence of dock platforms; faunal surveys; aerial photographs; typical uses of lakes (*e.g.,* recreation, aesthetics, navigation, and irrigation); surrounding land-uses; socio-economic effects; and public health, safety and welfare matters. Minimum Levels development is also contingent upon lake classification*, i.e.,* whether a lake is classified as a Category 1, 2 or 3 lake. Table 7 provides an overall summary of the environmental and structural elevations that were considered for the development of significant change standards for Lakes Bonable and Tiger, as well as the change standards calculations applied from the District's methodology outlined in Rule 40D-8.624, F.A.C.

The **Minimum Lake Level (MLL)** is the elevation that a lake's water levels are required to equal or exceed fifty percent of the time on a long-term basis. For Category 3 Lakes, the Minimum Lake Level is typically established at the elevation corresponding to the most conservative significant change standard, *i.e*., the standard with the highest elevation, except where that elevation is above the Historic P50 elevation, in which case, the Minimum Lake Level is established at the Historic P50 elevation. Because all appropriate significant change standards were below the Historic P50 elevation, the Minimum Level for Little Lake Bonable could be established at 52.1 NGVD 29, the elevation corresponding to the Species Richness Standard. The Minimum Lake Level was, however, established at the Wetland Offset elevation, 52.3 NGVD 29. (Figures 11,14, 15, and 16). The Minimum Lake Level was equaled or exceeded 54.7 percent of the time, based on the Historic, composite water level record and corresponds to the Historic P54.7. This level is expected to afford protection to the natural system and human-use values associated with the identified significant change standards and also provide protection for wetlands occurring within the basin.

The **High Minimum Lake Level** (HMLL) is the elevation that a lake's water levels are required to equal or exceed ten percent of the time on a long-term basis. For Category 3 lakes, the High Minimum Lake Level is developed using the Minimum Lake Level, Historic data or reference lake water regime statistics. If Historic Data are available, the High Minimum Lake Level is established at an elevation corresponding to the Minimum Lake Level plus the difference between the Historic P10 and Historic P50. If Historic data are not available, the High Minimum Lake Level is set at an elevation corresponding to the Minimum Lake Level plus the region-specific RLWR50. Based on the availability of long term composite Historic data for Little Lake Bonable, the High Minimum Lake Level was established at 57.8 NGVD 29 (Figures 11,14, 15, and 16) by adding the difference between the Historic P50 and Historic P10 (5.6 feet) to the Minimum Lake Level. The High Minimum Lake Level at 57.8 NGVD 29 was equaled or exceeded 12.7 percent of the time, based on the term modeled Historic water level record, and corresponds to the Historic P12.7.

The Minimum and Guidance levels for Little Lake Bonable are shown in Figure 11 along with monthly mean water surface elevations based on period of record water level measurements. Staging of the lake at Minimum levels (Figure 14, 15, and 16) would not be expected to flood any man-made features within the immediate lake basin. The High Minimum Lake Level (62.8 NGVD 29) is approximately 3.1 feet lower than the lowest residential floor slab (65.9 NGVD 29) within the lake basin (Table 6). The High Minimum Lake Level is also approximately 4.4 ft lower than the lowest spot on the paved roads (67.18 NGVD 29) encircling the lake.

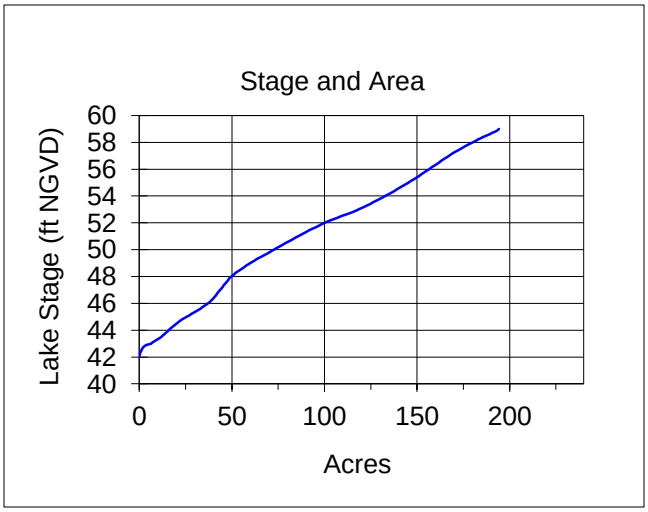
Table 6. Elevations of lake basin features in the immediate Little Lake Bonable basin (Xynides 2010).

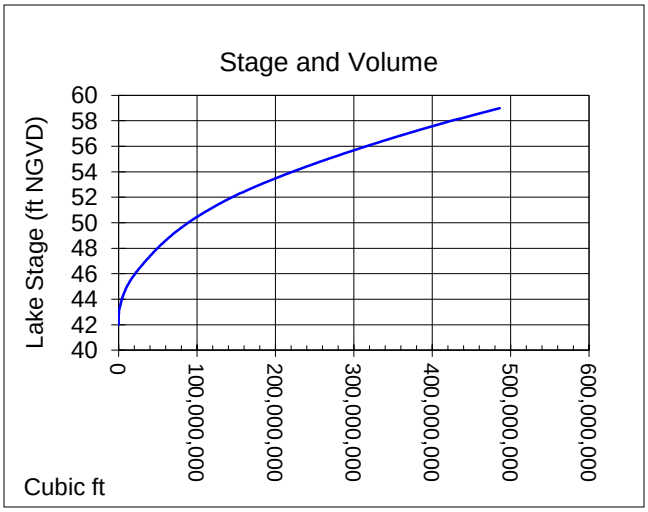
Lake Basin Features	Elevation in Feet NGVD 29
Lowest roadway elevation	**59.27**
Low floor slab – residential	**62.63**
Control Point – outfall ditch	**59.07**

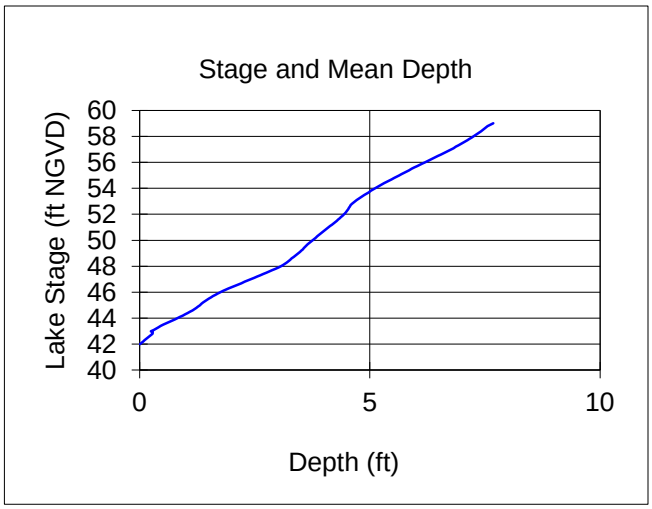
Compliance Evaluation

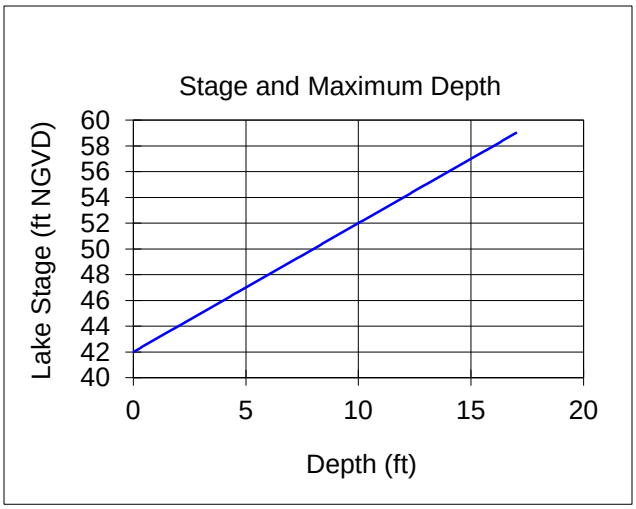
The Minimum Lake Level and High Minimum Lake Level were evaluated for comparison using same predictive model (Rainfall Line of Organic Correlation) that was used to develop the long term Historic Exceedance percentiles (Ellison 2012). The model is used to evaluate whether the predicted lake stage and observed lake stage fits within the prediction intervals established with the model's calibration window or time period. Little Lake Bonable was determined to be in compliance for both the Minimum Low Level and High Minimum Level using rainfall data through July 2012. A recovery strategy is not required for Little Lake Bonable.

Figure 12. Surface area, maximum depth, mean depth, volume, dynamic ratio (basin slope) in feet above NGVD 29 for Little Lake Bonable.









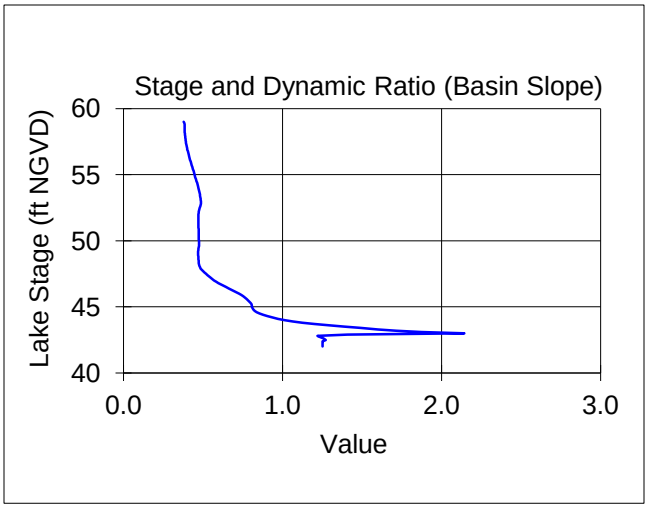
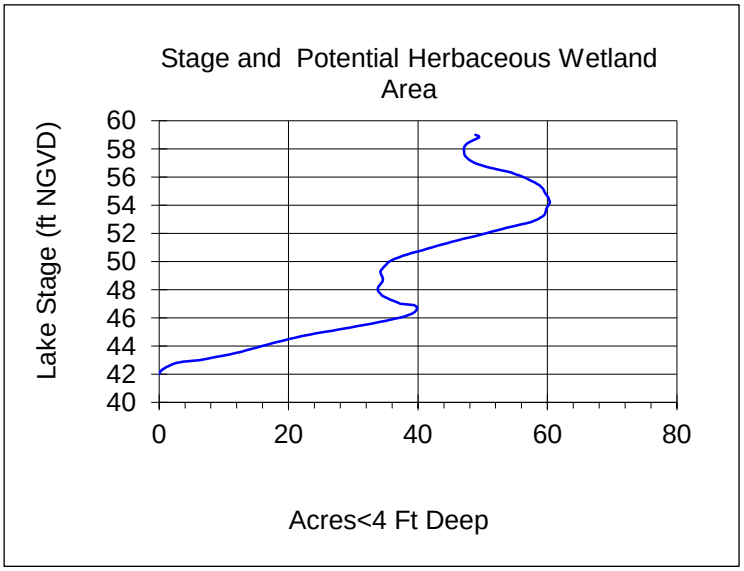


Figure 13. Potential herbaceous wetland area and area available for submersed macrophyte colonization in Little Lake Bonable as a function of lake stage (water surface elevation).



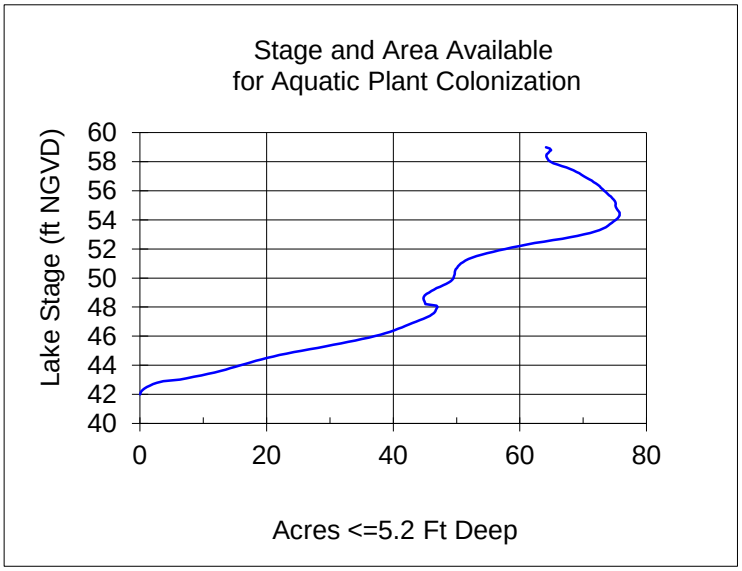
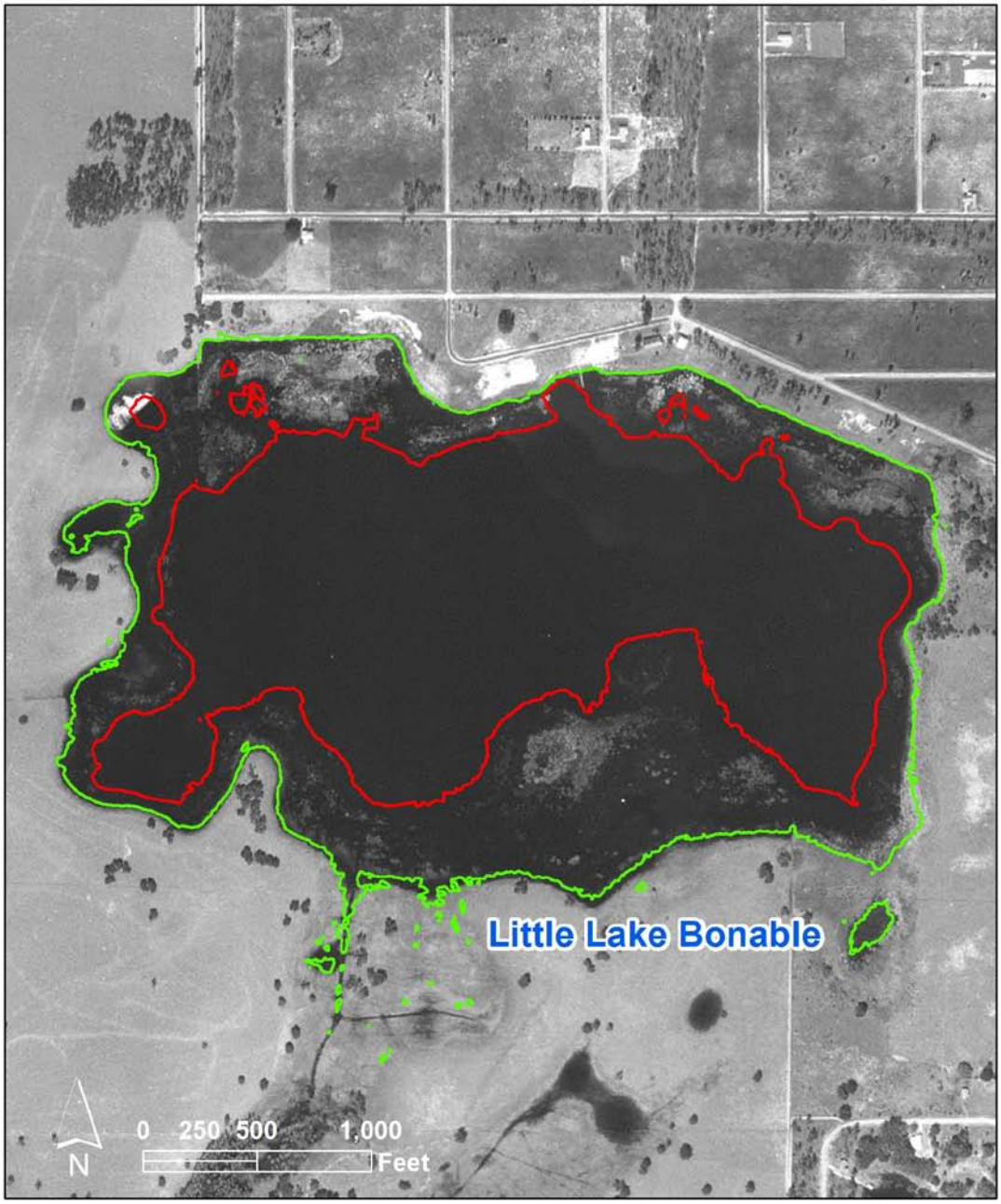


Figure 14. Approximate location of the Minimum Lake Level (MLL), Low Guidance Level (LGL), High Minimum Lake Level (HMLL), and High Guidance Level (HGL) for Little Lake Bonable in Marion County, during recent conditions shown within the 2011 aerial imagery. Based on gage readings the estimated lake stage was 47.49 NGVD 29 on the date of the imagery.

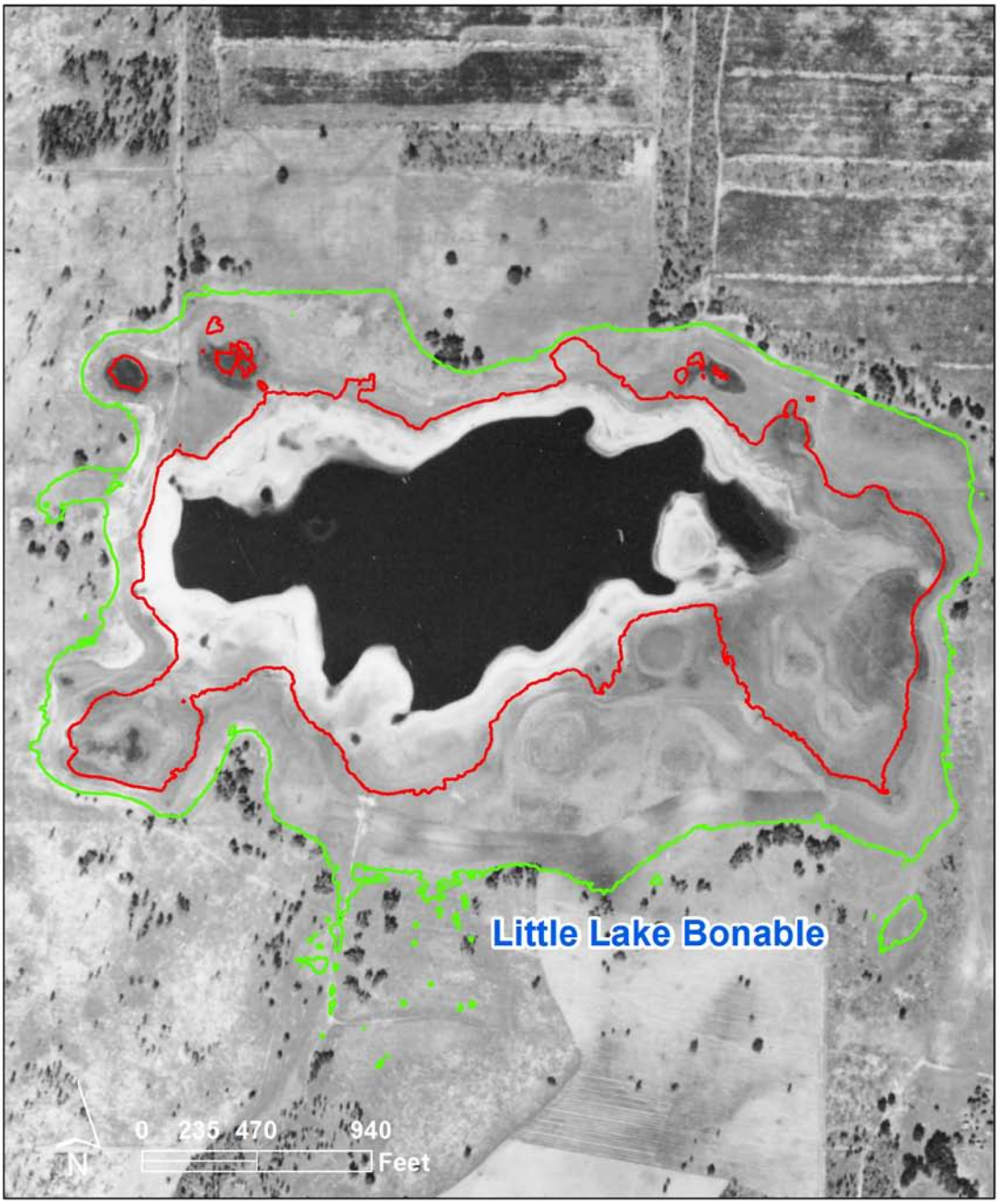
The two colored contour lines depict the approximate level or stage of the lake that corresponds to the Minimum Low Level in red (52.2 NGVD) and the High Minimum Level in green (57.8 NGVD). Contours were prepared using a combination of LiDAR data and bathymetric data collected with both underwater sonar and as surveyed spot elevations. Bathymetric data was collected by D.C. Johnsons & Associates in June 2006 (File No, 2004-003A02). The background imagery is natural color imagery collected on Jan 07, 2011. The lake stage data recorded on Jan 12, 2011 was 47.49 NGVD.

Figure 15. Approximate location of the Minimum Lake Level (MLL), Low Guidance Level (LGL), High Minimum Lake Level (HMLL), and High Guidance Level (HGL) for Little Lake Bonable as associated with conditions observed in January 1970.



The two colored contour lines depict the approximate stage of the lake that corresponds to the Minimum Low Level shown in red (52.2 NGVD), and the High Minimum Level shown in green (57.8 NGVD). Contours were prepared using a combination of LiDAR data and bathymetric data collected with both underwater sonar and as spot elevations. Bathymetric data was collected by D.C. Johnsons & Associates in June 2006 (File No, 2004-003A02). The background imagery was collected on January 25, 1970 by the Florida Department of Transportation.

Figure 16. Approximate location of the Minimum Lake Level (MLL), Low Guidance Level (LGL), High Minimum Lake Level (HMLL), and High Guidance Level (HGL) for Little Lake Bonable as associated with conditions observed in February 1957.



The two colored contour lines depict the approximate stage of the lake that corresponds to the Minimum Low Level shown in red (52.2 NGVD), and the High Minimum Level shown in green (57.8 NGVD). Contours were prepared using a combination of LiDAR data and bathymetric data collected with both underwater sonar and as spot elevations. Bathymetric data was collected by D.C. Johnsons & Associates in June 2006 (File No, 2004-003A02). The background imagery was collected on February 2, 1957 by the U.S. Department of Agriculture (University of Florida, 2011).

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