Minimum and Guidance Levels for

Lake Okahumpka

in Sumter County, Florida

Draft – September 2006

Ecologic Evaluation Section

Resource Conservation and Development Department

Southwest Florida
Water Management District

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State law (Section 373.042, Florida Statutes; hereafter F.S.) directs the Department of Environmental Protection or the water management districts to establish minimum flows and levels (MFLs) for lakes, wetlands, rivers and aquifers. As currently defined by statute, the minimum level of an aquifer or surface water body is "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". Adoption of a minimum water level does not necessarily protect a water body from significant harm, however, protection, recovery or regulatory compliance can be gauged once a standard has been established.

Minimum flows and levels are to be established based upon the best available information and shall be developed with consideration of "…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.). Additional guidance for the establishment of minimum flows and levels is provided in the Florida Water Resources Implementation Rule (Chapter 62-40.473, Florida Administrative Code; hereafter F.A.C.), which requires 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; j) and navigation."

To address this legislative mandate within its jurisdictional boundaries, the Southwest Florida Water Management District (District or SWFWMD) has developed specific methodologies for establishing minimum flows or levels for lakes, wetlands, rivers and aquifers, and adopted them into the Water Levels and Rates of Flow Rule (Chapter 40D-8, F.A.C.). For lakes, methodologies have been developed for establishing Minimum Levels for systems with fringing cypress wetlands 0.5 acres or greater in size and for those without fringing cypress wetlands 0.5 acres or greater in size. 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 former levels are classified as Category 2 Lakes. Lakes without fringing cypress wetlands are classified as Category 3 Lakes. Chapter 40D-8, F.A.C. also provides for the establishment of Guidance Levels, which serve as advisory information for the District, lake shore residents and local governments, or to aid in the management or control of adjustable water level structures. Typically two Minimum

Levels and three Guidance Levels are established for lakes, and upon adoption by the District Governing Board, are incorporated into Chapter 40D-8, 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 **Ten Year Flood Guidance Level** is provided as an advisory guideline for lake shore development. It is the level of flooding expected on a frequency of not less than the ten year recurring interval, or on a frequency of not greater than a ten percent probability of occurrence in any given year.

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 elevation that a lake's water levels are expected to equal or exceed ten percent of the time (P10) 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 (P10) 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 (P50) on a long-term basis.

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.

In accordance with Chapter 40D-8, F.A.C., proposed Minimum and Guidance Levels were developed for Lake Okahumpka (Table 1), a Category 1 Lake located in Sumter County, Florida. The levels were established using best available information, including field data that were obtained specifically for the purpose of Minimum Levels development. Data and analyses used for development of the proposed Minimum and Guidance Levels are described in the remainder of this report.

Table 1. Proposed Minimum and Guidance Levels for Lake Okahumpka.

Minimum and Guidance Levels	Elevation (feet above NGVD)
Ten Year Flood Guidance Level	59.9
High Guidance Level	58.1
High Minimum Lake Level	58.1
Minimum Lake Level	56.7
Low Guidance Level	55.0

Data and Analyses Supporting Proposed Minimum and Guidance Levels for Lake Okahumpka

Lake Setting and Description

Lake Okahumpka is located in Sumter County, Florida (Sections 15, 16, 21, 22, 27, and 28, Township 19 South, Range 23 East), in the Withlacoochee River Basin of the Southwest Florida Water Management District (Figure 1). White (1970) classified the area of west-central Florida containing Lake Okahumpka as the Western Valley and Central Valley physiographic regions. Brooks (1981) characterized the area surrounding the lake as the Tsala Apopka Basin subdivision of the Ocala Uplift physiographic district and described the subdivision as an erosional valley in a limestone terrain with thin surficial sands. As part of the Florida Department of Environmental Protection's Lake Bioassessment/Regionalization Initiative, the area has been identified as the Central Valley region, and described as an area with large, shallow, and euthrophic lakes (although lake size and type are variable) that have abundant macrophytes or are green with algae (Griffith *et al.* 1997).

The lake is located in the Lake Okahumpka Outlet drainage basin in the Withlacoochee River watershed. According to the United States Geological Survey (Foose 1981), the drainage area for Lake Okahumpka is 49 square miles. Surface water inflow to the lake occurs from areas to the east, north, and west of the lake. The lake discharges to the south through the District's Okahumpka water control structure (Figure 2). Although there are permitted ground water withdrawals within the surrounding lake area, there are no surface water withdrawals from the lake currently permitted by the District. A public boat ramp at Lake Okahumpka Park, located on the north shore of the lake, provides access to the lake.

The United States Geological Survey 1:24,000 Leesburg West (1966) and Wildwood (1967) quadrangle maps indicate an elevation of 57 feet above NGVD for Lake Okahumpka. The "Gazetteer of Florida Lakes" (Florida Board of Conservation 1969, Shafer *et al.* 1986) lists the lake area as 670 acres at this elevation. A topographic map of the lake basin generated in support of Minimum Levels development (Figure 3) indicates that the lake extends over 623 acres at an elevation of 57 feet above NGVD.

Residential development, pastureland and expansive wetland systems dominate the landscape within the surrounding lake region. Large wetland areas along the shoreline as well as much of the forested uplands to the west of the lake remain in relatively natural condition. Dominant plant species observed along the shoreline and within the lake basin include, red maple (*Acer rubrum*), cypress (*Taxodium sp.*), willow (*Salix caroliniana*), primrose willow (*Ludwigia spp.*), cattail (*Typha sp.*), sawgrass (*Cladium jamaicense*), bulrush (*Scirpus cubensis*), pickerelweed (*Pontederia cordata*), arrowhead (*Sagittaria lancifolia*), hydrilla (*Hydrilla verticillata*), fragrant water lily (*Nymphaea odorata*), Illinois pondweed (*Potamogeton illinoesis*), floating hearts (*Nymphoides spp.*), water hyacinth (*Eichhornia crassipes*), and water lettuce (*Pistia stratiotes*).

Figure 1. Location of Lake Okahumpka in Sumter County, Florida.

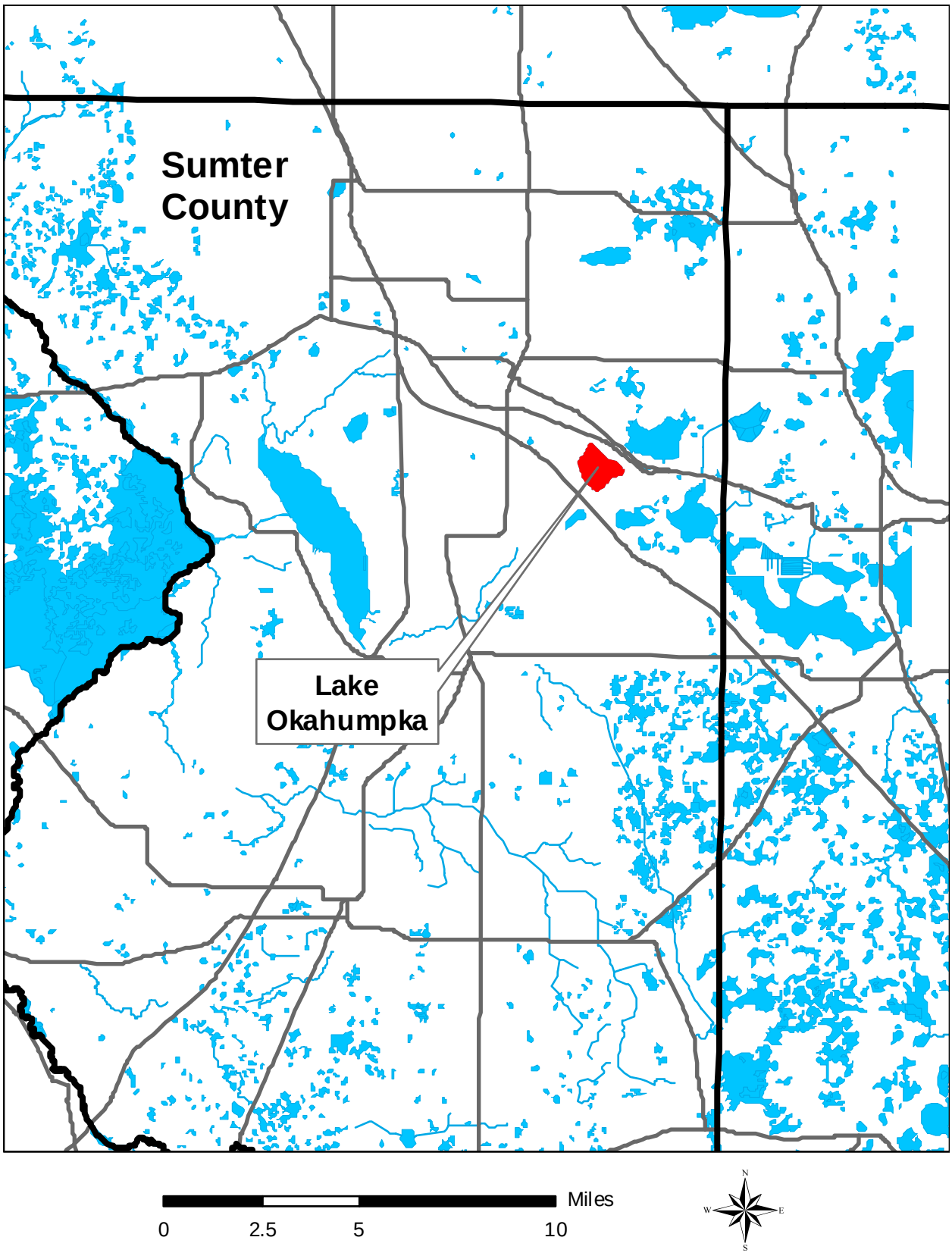
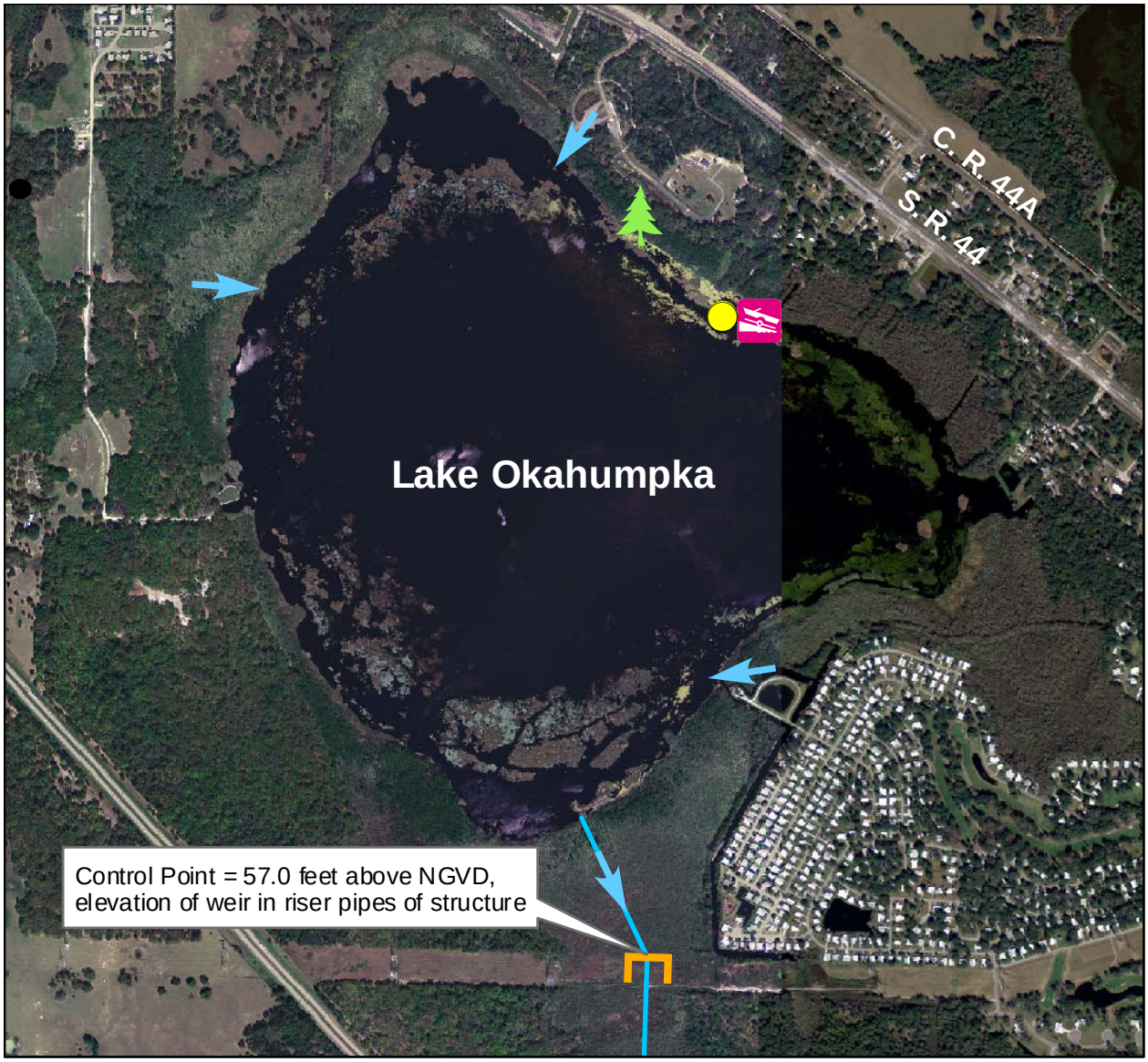


Figure 2. Location of the lake water level gauge, public boat ramp, hydrologic indicators, inlets, outlet, outlet conveyance system, water control structure, and control point for Lake Okahumpka.



Legend

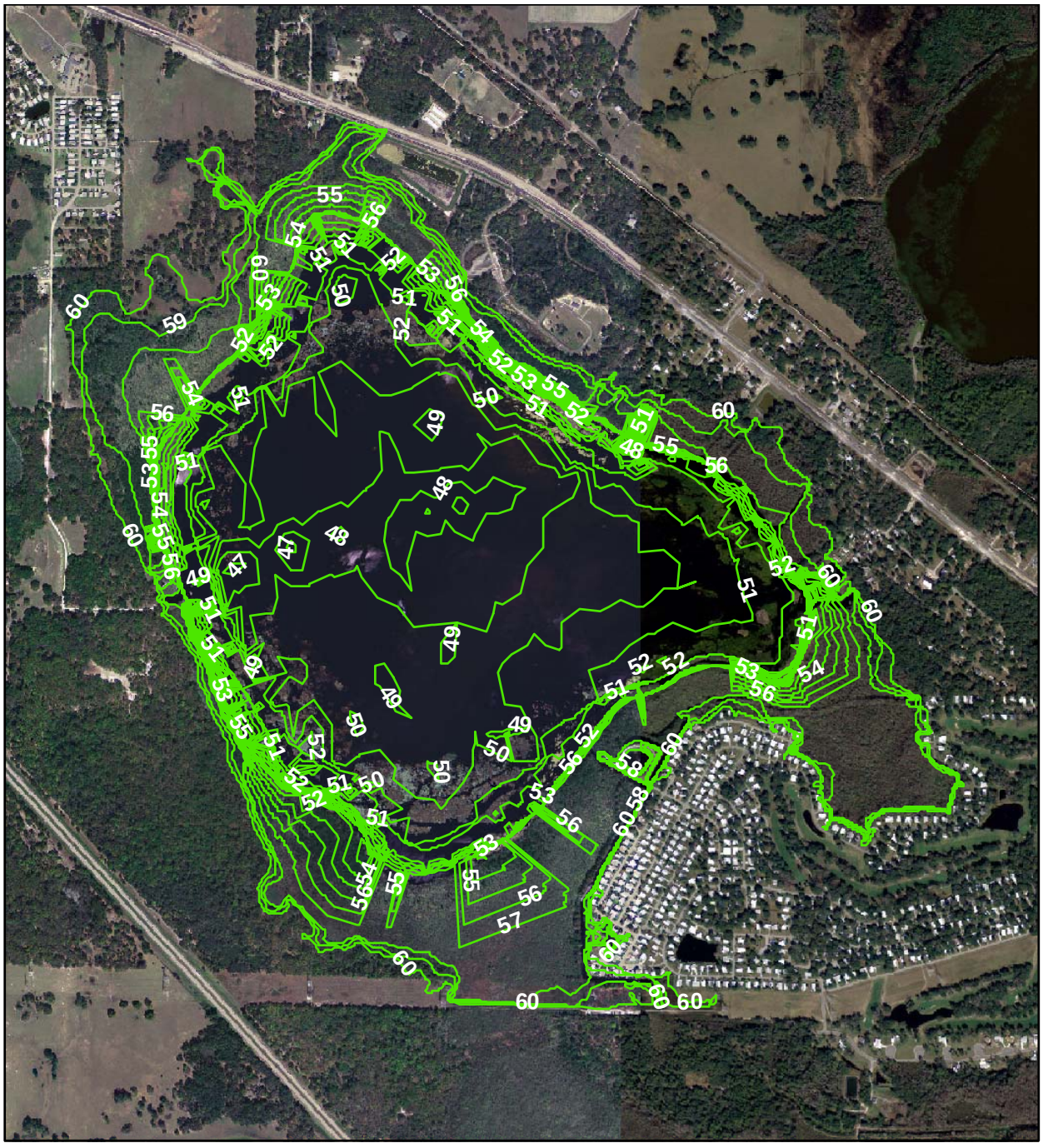
- Lake Level Gauge
- Boat Ramp
- Hydrologic Indicators
- Inlets/Outlet
- Structure

Feet

0 1,000 2,000 4,000

Map prepared using 2004 true color digital ortho photography.

Figure 3. One-foot contours within the Lake Okahumpka basin. Values shown are elevations in feet above the National Geodetic Vertical Datum of 1929.



Map prepared using 2004 true color digital ortho photography, elevation data from 1984 SWFWMD aerial photography with contours maps (Secs. 15, 16, 21, 22, 27, and 28, Twp. 19 S, Rge. 23 E), and elevation data collected by D.C. Johnson and Associates, Inc.

Feet

0 1,000 2,000 4,000

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 Lake Okahumpka in November 1983. These levels have been incorporated into Chapter 40D-8, F.A.C. (Table 2). A Maximum Desirable Level of 58.25 feet above NGVD was also developed, but was not adopted. 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.

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. Lake Okahumpka is not included on the current or historical Stressed Lakes Lists (Gant *et al.* 1999, 2006).

Table 2. Adopted Guidance Levels and associated surface areas for Lake Okahumpka.

Management Levels	Elevation (feet above NGVD)	Lake Area (acres)
Ten Year Flood Guidance Level	59.90	883
High Level	58.75	819
Low Level	56.25	601
Extreme Low Level	54.00	536

Development of Minimum and Guidance Levels

Proposed Minimum and Guidance Levels for Lake Okahumpka were developed using the methodology for Category 1 Lakes described in Chapter 40D-8, F.A.C. and best available information in accordance with Section 373.042, F.S. Additional information gathered in 2004 and 2005 through field evaluations and survey work was also used. The levels and additional information are listed in Table 3, along with surface areas for each elevation. Detailed descriptions of the development and use of these data are provided in the remainder of this report.

Table 3. Proposed Minimum and Guidance Levels, Historic P50, lake stage percentiles, normal pool and control point elevations, and significant change standards for Lake Okahumpka.

Levels	Elevation (feet above NGVD)	Lake Area (acres)
Lake Stage Percentiles		
Historic P10	58.1	779
Historic P50	57.0	623
Historic P90	55.0	562
Other Levels		
Normal Pool	58.5	802
Control Point	57.0	623
Guidance Levels and Historic P50		
Ten Year Flood Guidance Level	59.9	883
High Guidance Level	58.1	779
Historic P50	57.0	623
Low Guidance Level	55.0	562
Significant Change Standards		
*Dock-Use Standard	60.0	895
*Recreation/Ski Standard	56.0	591
*Aesthetics Standard	55.0	562
*Species Richness Standard	53.8	531
*Basin Connectivity Standard	NA	NA
*Lake Mixing Standard	NA	NA
Minimum Levels		
High Minimum Lake Level	58.1	779
Minimum Lake Level	56.7	613

NA = not available/not appropriate

* = Category 3 Lake Significant Change Standards developed for comparison purposes only

Lake Stage Data and Percentiles

Lake stage data, *i.e.,* surface water elevations for Lake Okahumpka (District Universal Identification Number STA 405 406) are available from the District's Water Management Data Base from October 1977 through the present date (Figure 4, see Figure 2 for current location of the SWFWMD lake water level gauge). The highest surface water elevation for Lake Okahumpka recorded in the Water Management Data Base, 59.00 feet above NGVD, occurred on July 10, 1982. The low of record, 52.97 feet above NGVD, occurred on June 18, 2001.

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.

Based on water-use estimates and analysis of lake water levels and regional ground water fluctuations, available lake stage data for Lake Okahumpka were classified as Historic data. These data, however, were considered insufficient for calculating Historic lake stage exceedance percentiles, because the record only extends over a 29-year period. Historic lake stage exceedance percentiles were, instead, developed using a composite sixty-year record of monthly mean lake surface elevations based on available stage records that were supplemented with modeled estimates. The 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, Kelly 2004).

Modeled monthly mean lake stage values for the composite data set were estimated using a linear fitting procedure known as the line or organic correlation (see Helsel and Hirsch 1992). The procedure was used to describe the relationship between available lake stage data for Lake Okahumpka and lake stage data for Lake Eustis in Lake County. The line of organic correlation equation developed for the two data sets was utilized to estimate water surface elevation values for Lake Okahumpka for the period from January 1946 through December 2005 (SWFWMD draft report, 2006). A Historic, composite data set of monthly mean water surface elevations for Lake Okahumpka was then developed using available lake stage records from October 1977 through December 2005, and modeled water surface elevations for the remainder of the sixty-year period (Figure 5). The composite record includes several periods when estimated water surface elevations exceed the values that have been measured since 1977. The highest value included in the composite data set, 60.6 feet above NGVD, was estimated for April 1960.

Composite Historic data from January 1946 through December 2005 were used to calculate **the Historic P10, P50, and P90** lake stage 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 **58.1 feet above NGVD**. The Historic P50 elevation, the elevation the lake water surface equaled or exceeded fifty percent of the time during the historic period, was **57.0 feet above NGVD**. The Historic P90 elevation, the elevation the lake water surface equaled or exceeded 90 percent of the time during the historic period, was **55.0 feet above NGVD**.

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, including biological and physical features. Based on the median elevation of buttress inflection points for 20 cypress trees located along the north shoreline of Lake Okahumpka, the Normal Pool elevation for the lake basin was established at **58.5 feet above NGVD** (Figure 2 and Table 4).

Table 4. Summary statistics used for development of the Normal Pool elevation for Lake Okahumpka.

Statistics	Elevations (feet above NGVD)
Mean (Standard Deviation)	58.5 (0.11)
Median	58.5
Minimum	58.3
Maximum	58.8

The **Control Point** elevation is the elevation of the highest stable point along the outlet profile of a surface water conveyance system (*e.g.,* structure, ditch, culvert, or pipe) that is the principal control of water level fluctuation in the lake. For Lake Okahumpka, the Control Point was established at **57.0 feet above NGVD,** the elevation of the top of the weir in the two riser pipes of the water control structure located on the north side of the Florida Power and Light powerline easement (Figure 2).

Structual Alteration Status is determined to support development of Minimum and Guidance Levels. Because the Control Point elevation for the lake is below the Normal Pool elevation, **Lake Okahumpka is considered to be Structurally Altered**.

Proposed Guidance Levels and the Historic P50

The **Ten Year Flood Guidance Level** is provided as an advisory guideline for lake shore development. It is the level of flooding expected on a frequency of not less than the ten year recurring interval, or on a frequency of not greater than a ten percent

probability of occurrence in any given year. The Ten Year Flood Guidance Level for Lake Okahumpka was established at **59.9 feet above NGVD** using the methodology for closed basin lakes described in current District Rules (Chapter 40D-8, Florida Administrative Code). For the analysis, flood frequency elevations were based on a probability analysis of simulated annual peak stages for an 87-year period, from 1893 through 1979 (FEMA 1981). Simulated peak lake stages for this period were derived from available rainfall and evaporation records. Based on available lake stage data, the Ten Year Flood Guidance Level has not been exceeded.

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. Because Historic data are available, the High Guidance Level was established at **58.1 feet above NGVD**, the Historic P10 elevation.

The **Historic P50** elevation is the elevation that a lake's water levels are expected to equal or exceed fifty percent of the time on a long-term basis. The level is derived to support development of minimum lake levels, and is established using Historic or Current data and, in some cases, reference lake water regime statistics. Reference lake water regime (RLWR) statistics are used to describe expected water level fluctuations for lakes that lack adequate Historic or Current data and are derived using lake stage data for typical, regional lakes that exhibit little or no impacts from water withdrawals. The statistics include the RLWR50, RLWR5090, and RLWR90, which are, respectively, median differences between the P10 and P50, P50 and P90, and P10 and P90 percentiles. Because Historic data are available for Lake Okahumpka, the Historic P50 was established at **57.0 feet above NGVD**.

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. Because Historic data are available, the Low Guidance Level was established at **55.0 feet above NGVD**, the Historic P90 elevation.

Lake Categories

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. Based on the occurrence of lake-fringing cypress, and because the Historic P50 (57.0

feet above NGVD) is higher than the elevation 1.8 feet below the Normal Pool (58.5 feet above NGVD), Lake Okahumpka is classified as a **Category 1 Lake**.

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 (Chapter 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, including a Species Richness Standard, an Aesthetics Standard, a Lake Mixing Standard, a Recreation/Ski Standard, a Dock-Use Standard, and a Basin Connectivity Standard. Potential changes in the coverage of herbaceous wetland vegetation and aquatic plants associated with use of standards for development of Minimum Levels for Category 3 Lakes is also taken into consideration. Although Lake Okahumpka is a Category 1 Lake, Category 3 Lake significant change standards were developed for comparative purposes but were not used for Minimum Levels development (Table 3).

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. The standard is based on the elevation of lake sediments at the end of existing docks, a two-foot water depth requirement for boat mooring, and use of Historic lake stage data or region-specific reference lake water regime statistics. Because Historic data are available, the Dock-Use Standard would be established at **60.0 feet above NGVD** by adding 2 feet and the difference between the Historic P50 and Historic P90 (2.0 feet), to the elevation of sediments at the end of 90 percent of the 29 docks (56.0 feet above NGVD) (Table 5).

Table 5. Summary statistics for elevations associated with docks in Lake Okahumpka. Percentiles (P10 and P90) represent elevations exceeded by 10 and 90 percent of the docks.

Statistics	Elevation of Sediments at Waterward End of Docks (feet above NGVD)	Elevation of Dock Platform (feet above NGVD)
N	29	27
Mean (SD)	54.7 (1.5)	59.3 (0.8)
P10	56.0	60.4
P90	53.5	58.6
Maximum	57.0	60.9
Minimum	49.8	57.7

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 feet, or a rectangular area 200 feet in width and 2,000 feet in length, and use of Historic lake stage data or region-specific reference lake water regime statistics. Because Historic data are available, the Recreation/Ski Standard would be established at **56.0 feet above NGVD** based on the sum of the ski elevation (54.0 feet above NGVD), and the difference between the Historic P50 and Historic P90 (2.0 feet).

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 would be established at the Low Guidance Level, which is **55.0 feet above NGVD**.

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. For Lake Okahumpka, the Species Richness Standard would be established at **53.8 feet above NGVD**.

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. The standard is based on the elevation of lake sediments at a critical high spot between lake basins or lake sub-basins, a water depth requirement for movement of aquatic biota or powerboats and other watercraft, and use of Historic lake stage data or region-specific reference lake water regime statistics. Because lake basin depth measurements indicate Lake Okahumpka does not contain sub-basins, **the Basin Connectivity Standard is not applicable.**

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 <0.8. Because the dynamic ratio does not shift across the 0.8 threshold, **the Lake Mixing Standard is not applicable** (Figure 6).

Herbaceous Wetland Information is taken into consideration to determine the elevation at which change in lake stage would result in substantial change in potential area of herbaceous wetland vegetation within the lake basin (*i.e*., basin area with a water depth less than or equal to four feet) relative to the potential herbaceous wetland

area at the Historic P50 elevation. 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 Minimum Lake Level (20% of the lake basin) relative to the potential wetland area at the Historic P50 elevation (18% of the lake basin) (Figure 6).

Submersed Aquatic Plant Information is taken into consideration to determine the elevation at which change in lake stage would result in substantial change in potential area of submersed aquatic plants within the lake basin relative to the potential aquatic plant area at the Historic P50 elevation. Because colonization of aquatic plants is dependent on sufficient light penetration, but data on the depth of light penetration into the lake water column is insufficient, it is not possible to determine the depth and potential area of submersed aquatic plants for Lake Okahumpka.

Proposed Minimum Levels

The method used for establishing Minimum Levels for a lake is dependent on its lake category. For Category 1 Lakes, the High Minimum Lake Level and Minimum Lake Level are established 0.4 feet and 1.8 feet below the Normal Pool elevation, respectively. For Category 2 Lakes, the High Minimum Lake Level is established at the High Guidance Level, and the Minimum Lake Level at the Historic P50 elevation. For Category 3 Lakes, the High Minimum Lake Level is established using Historic data or region-specific reference lake water regime statistics, and the Minimum Lake Level using lake-specific significant change standards or the Historic P50 elevation. Other available information taken into consideration in the establishment of Minimum Levels for all three lake categories includes: 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.

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 Minimum Lake Level for Category 1 Lakes is established 1.8 feet below the Normal Pool elevation. For Lake Okahumpka, the Minimum Lake Level was established at **56.7 feet above NGVD** (Figures 5 and 7).

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 High Minimum Lake Level for Category 1 lakes is established 0.4 feet below the Normal Pool elevation. For Lake Okahumpka, the High Minimum Lake Level was established at **58.1 feet above NGVD** (Figures 5 and 7).

Comparison of the High Minimum Lake Level with Lake Basin Features

The elevations of various man-made features within the immediate Lake Okahumpka basin were determined to evaluate the potential for flooding when the lake surface is at the proposed High Minimum Lake Level. Based on review of available one-foot contour interval aerial maps for the region and field survey data collected in April 2005, the proposed High Minimum Lake Level is 2.4 feet below the floor of the lowest residential home along the southeast lakeshore, 2.2 feet below the garage floor of the home, 1.3 feet below the lowest spot of a road along the southeast lakeshore in the Continental Country Club, 1.3 feet below the top of the public boat ramp at the north end of the lake, and 2.0 feet above the bottom of the public boat ramp (Table 8).

Table 8. Elevations of selected features in the Lake Okahumpka basin.

Lake Basin Features	Elevation (feet above NGVD)
House finished floor	60.51
Garage finished floor	60.34
Road	59.42
Top of public boat ramp	59.35
Bottom of public boat ramp	56.10

Figure 4. Surface water elevations for Lake Okahumpka from the District's Water Management Data Base from October 1977 through December 2005.

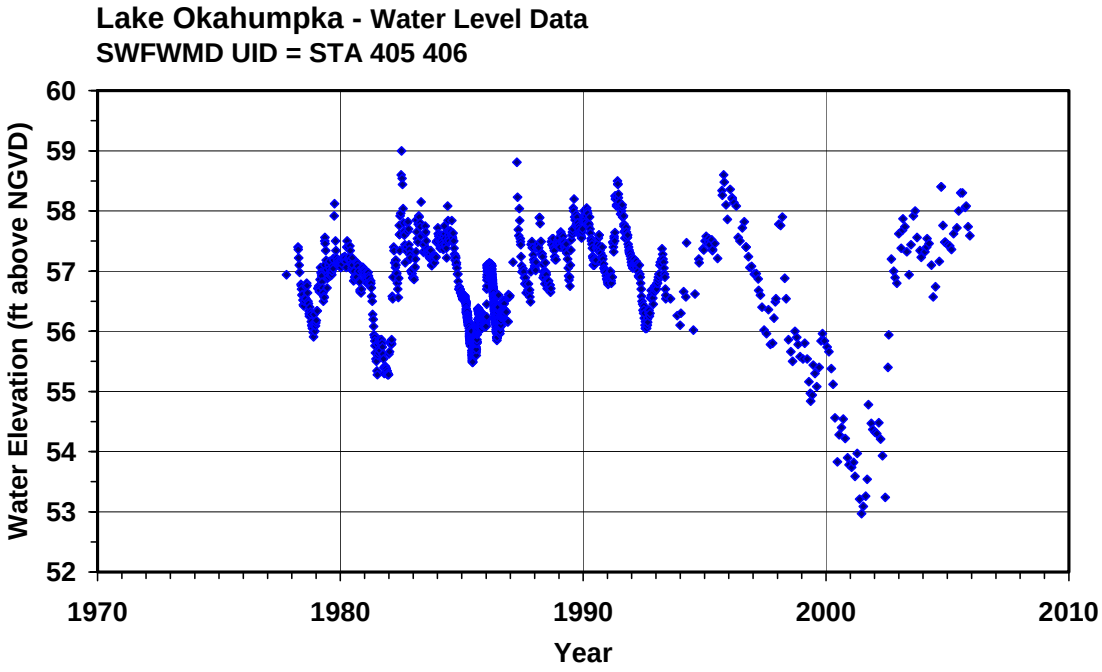


Figure 5. Composite monthly-means surface water elevations (modeled data - light blue, lake data - dark blue) for Lake Okahumpka from January 1946 through December 2005, and Guidance and Minimum Levels. Levels include the Ten-Year Flood Guidance Level (10-YR), High Guidance Level (HGL), Low Guidance Level (LGL), High Minimum Lake Level (HMLL), and Minimum Lake Level (MLL).

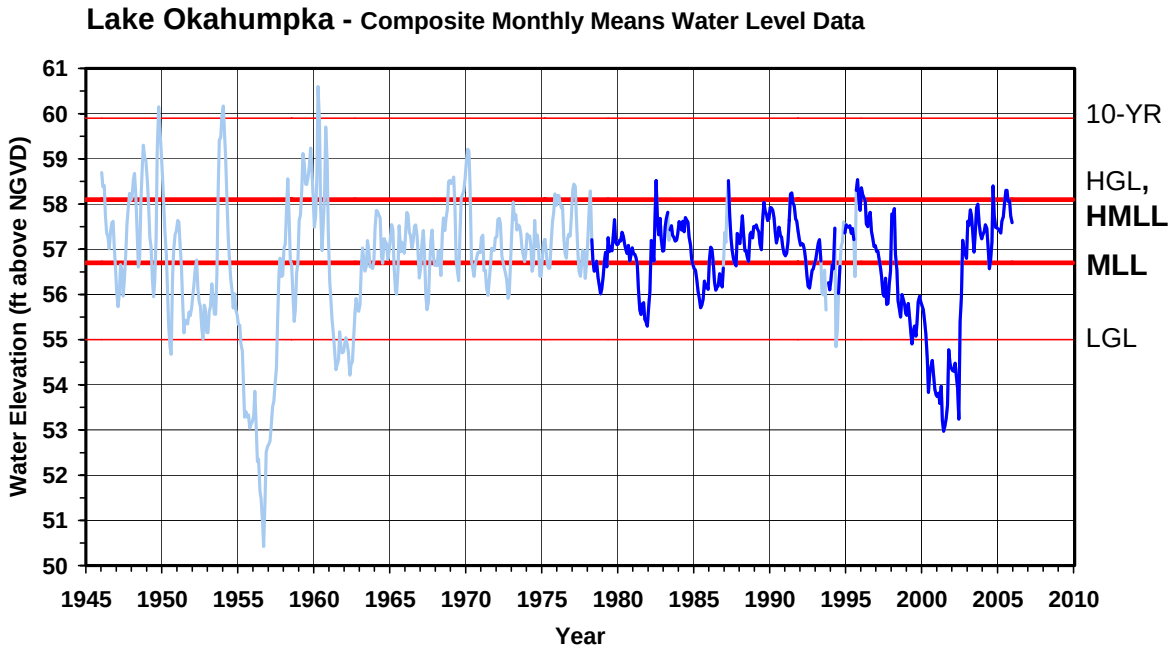


Figure 6. Surface area, maximum depth, mean depth, volume, dynamic ratio (basin slope), and potential herbaceous wetland area versus lake stage for Lake Okahumpka.

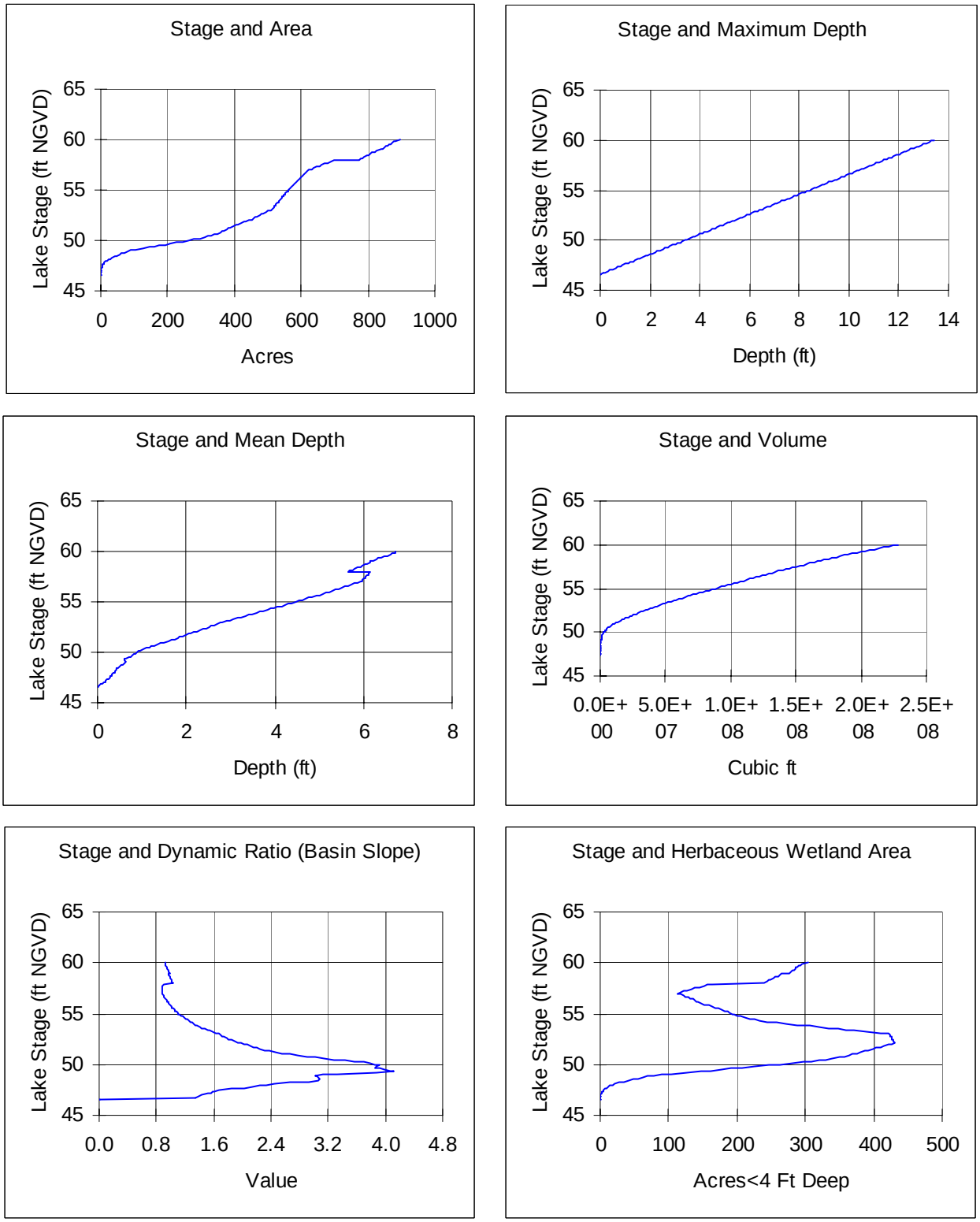
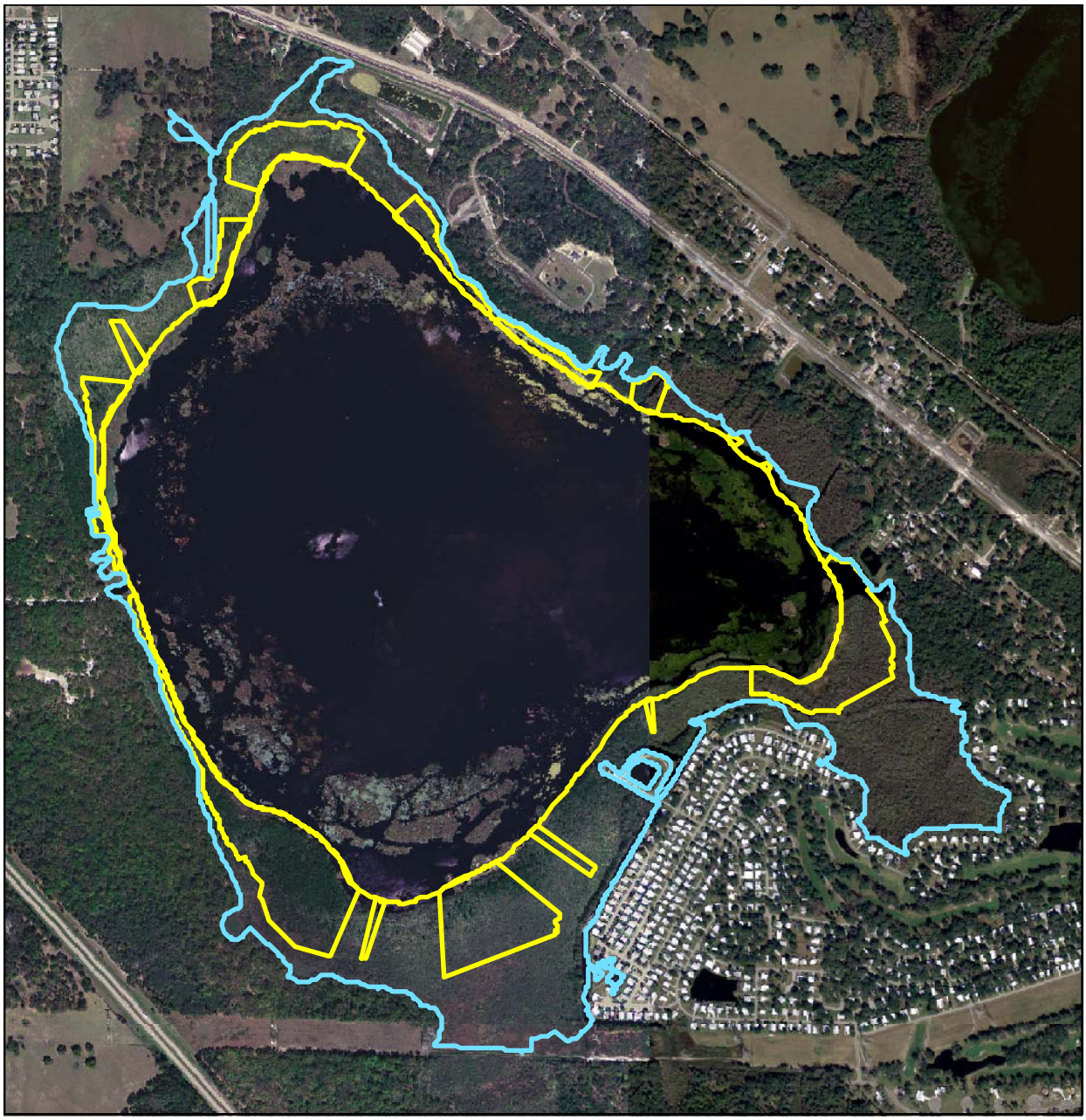


Figure 7. Approximate location of the proposed Minimum Lake Level (MLL) and High Minimum Lake Level (HMLL) for Lake Okahumpka.



Legend

Okahumpka Minimum Levels

- 56.7 feet above NGVD = MLL
- 58.1 feet above NGVD = HMLL

Map prepared using 2004 true color digital ortho photography, elevation data from 1984 SWFWMD aerial photography with contours maps (Secs. 15, 16, 21, 22, 27, and 28, Twp. 19 S, Rge. 23 E), and elevation data collected by D.C. Johnson and Associates, Inc.

Feet

0 1,000 2,000 4,000

Documents Cited and Reviewed for Development of Proposed Minimum and Guidance Levels

Arnold, D. 2005. Memorandum – FY 2005 MFL Lakes 10-yr Flood Elevations. Southwest Florida Water Management District, Brooksville Florida.

Bachmann, R. W., Hoyer, M. V., and Canfield, D. E., Jr. 2000. The potential for wave disturbance in shallow Florida lakes. Lake and Reservoir Management 16: 281-291.

Basso, R. and Schultz, R. 2003. Long-term variation in rainfall and its effect on Peace River flow in west-central Florida. Southwest Florida Water Management District, Brooksville, Florida.

Brooks, H. K. 1981. Physiographic divisions of Florida: map and guide. Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida.

Dierberg, F. E. and Wagner, K. J. 2001. A review of "A multiple-parameter approach for establishing minimum levels for Category 3 Lakes of the Southwest Florida Water Management District" June 2001 draft by D. Leeper, M. Kelly, A. Munson, and R. Gant. Prepared for the Southwest Florida Water Management District, Brooksville, Florida.

Enfield, D. B., Mestas-Nunez, A. M., and Trimble, P. J. 2001. The Atlantic multi-decadal oscillation and its relation to rainfall and river flow in the continental U. S. Geophysical Research Letters 28: 2077-2080.

Federal Emergency Management Agency. 1981. Flood Insurance Study, Sumter County, Florida Unincorporated Areas. Community Number 1200296.

Florida Board of Conservation. 1969. Florida lakes, part III: gazetteer. Division of Water Resources, Tallahassee, Florida.

Foose, D. W. 1981. Drainage areas of selected surface-water sites in Florida. Open-file report 81-482. United States Geological Survey, Tallahassee, Florida.

Gant, R., Hood, J. and Toole, D. 1999. Memorandum to Mario Cabana, John Parker, Brian Starford and Scott Laidlaw, regarding the Historical List of Stressed Lakes.

Gant, R., Hood, J. and Toole, D. 2006. Memorandum to Ralph Kerr, John Parker, Michael Balser and Scott Laidlaw, regarding the 2006 Stressed Lakes List. Southwest Florida Water Management District, Brooksville, Florida.

Griffith, G., Canfield, D., Jr., Horsburgh, C., Omernik, and J. Azevedo, S. 1997. Lake regions of Florida (map). United States Environmental Protection Agency, University of Florida Institute of Food and Agricultural Sciences, Florida Lakewatch, Florida

Department of Environmental Protection, and the Florida Lake Management Society, Gainesville and Tallahassee, Florida.

Helsel, D. R. and Hirsch, R. M. 1992. Statistical methods in water resources. Studies in Environmental Science 45. Elsevier. New York, New York.

Kelly, M. 2004. Florida river flow patterns and the Atlantic Multidecadal Oscillation. Southwest Florida Water Management District, Brooksville, Florida.

Leeper, D. 2000. Memorandum – Proposed structure at the outfall of Lake Okahumpka. Southwest Florida Water Management District, Brooksville, Florida.

Leeper, D., Kelly, M., Munson, A. and Gant, R. 2001. A multiple-parameter approach for establishing minimum levels for Category 3 Lakes of the Southwest Florida Water Management District, June14, 2001 draft. Southwest Florida Water Management District, Brooksville, Florida.

Romie, K. 2000. Water chemistry of lakes in the Southwest Florida Water Management District. Brooksville, Florida.

Shafer, M. D., Dickinson, R. E., Heaney, J. P., and Huber, W. C. 1986. Gazetteer of Florida lakes. Publication no. 96, Water Resources Research Center, University of Florida, Gainesville, Florida.

Simonds, E. P., and E. R. German. 1980. Hydrology of the Lake Deaton and Lake Okahumpka area, northeast Sumter County, Florida. Water-Resources Investigations Open-file Report 80-733, United States Geological Survey, Tallahassee, Florida.

Southwest Florida Water Management District. 1984. Withlacoochee River Basin, Wildwood, aerial photography with contours. Sheet Nos. 16-19-23, 21-19-23, 22-19-23, 27-19-23, and 28-19-23. Brooksville, Florida. Prepared by Photogrammetric Services, Reynoldsville, Ohio.

Southwest Florida Water Management District. 1992. Flood-stage frequency relations for selected lakes within the Southwest Florida Water Management District, Brooksville, Florida.

Southwest Florida Water Management District. 1996. Lake Levels Program lake data sheets/1977-1996, Withlacoochee River Basin – 19. Brooksville, Florida.

Southwest Florida Water Management District. 1999. Establishment of minimum levels for Category 1 and Category 2 lakes, in Northern Tampa Bay minimum flows and levels white papers: white papers supporting the establishment of minimum flows and levels for isolated cypress wetlands, Category 1 and 2 lakes, seawater intrusion, environmental aquifer levels, and Tampa Bypass Canal; peer-review final draft, March 19, 1999. Brooksville, Florida.

Southwest Florida Water Management District. 2005. Surveyor's Report, Lake Level Data for the Establishment of Minimum Flows and Levels – Lake Okahumpka – Sumter County, work order #05062. Brooksville, Florida.

United States Geological Survey. 1966. Leesburg West Quadrangle, Florida, 7.5 minute series (topographic) map, N2845-W8152.5/7.5, AMS 4641 IV SW-Series V847. Department of Interior, Washington, D.C.

United States Geological Survey. 1967. Wildwood Quadrangle, Florida, 7.5 minute series (topographic) map, N2845-W8200/7.5, AMS 4541 I SE-Series V847. Department of Interior, Washington, D.C.

White, W. A. 1970. The geomorphology of the Florida peninsula. Geological Bulletin, No. 51. Bureau of Geology, Florida Department of Natural Resources, Tallahassee, Florida.

Xynides, C. H. 2004. Surveyor's report – bathymetry for various lakes. File No. 2004-003A02 BG00001. D. C. Johnson and Associates, Inc., San Antonio, Florida.