# Minimum and Guidance Levels for

# Horse Lake

## in Hillsborough County, Florida


**Draft – September 2004**

**Ecologic Evaluation Section**

**Resource Conservation and Development Department**

Southwest Florida
Water Management District

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# Proposed Minimum and Guidance Levels for Horse Lake

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, Florida Statues). 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 and levels for lakes, wetlands, rivers and aquifers, and adopted them into it 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-dominated wetlands 0.5 acres or greater in size (Category 1 or 2 lakes), and for those without fringing cypress wetlands 0.5 acres or greater in size (Category 3 lakes). 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 0.5 acres or greater in size 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 (P90) 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 Horse Lake (Table 1), a Category 3 lake located in Hillsborough 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 Horse Lake.**

| Minimum and Guidance Levels | Elevation (feet above NGVD) |
|---|---|
| Ten Year Flood Guidance Level | 48.9 |
| High Guidance Level | 46.9 |
| High Minimum Lake Level | 45.8 |
| Minimum Lake Level | 44.8 |
| Low Guidance Level | 44.8 |

NA = not available/not appropriate

# Data and Analyses Supporting Proposed Minimum and Guidance Levels for Horse Lake

## Lake Setting and Description

Horse Lake is located in Hillsborough County, Florida (Section 26, Township 27S, Range 17E), in the Northwest Hillsborough River Basin of the Southwest Florida Water Management District (Figure 1). White (1970) classified the area of west-central Florida containing Horse Lake as the Northern Gulf Coastal Lowlands physiographic region. Brooks (1981) characterized the area surrounding the lake as the Land-O-Lakes physiographic subdivision and described the subdivision as a plain with elevations between 50 and 80 feet with many small lakes, despite the fact the silty sand overlying the limestone is moderately thick. As part of the Florida Department of Environmental Protection's Lake Bioassessment/Regionalization Initiative, the area has been identified as the Keystone Lakes region, and described as a small area of well-drained, sandy uplands, with slightly acidic, low nutrient, mostly clear water lakes (Griffith *et al.* 1997).

The lake is located in the Horse Lake drainage basin in the Brooker Creek watershed. Surface water inflow to the lake occurs as overland flow from the lake's small drainage basin. Horse Lake has the potential to discharge to Lake Raleigh, located to the southwest, via a culvert under Gunn Highway and a ditch excavated from Gunn Highway to Lake Raleigh (Figure 2). However, due to chronically low lake levels, Horse Lake is effectively a closed-basin system. In early 1998, during the 1997/1998 El Niño event, and again in late 2002 through mid 2003, Horse Lake was augmented with surface water from Lake Pretty as a temporary flood control measure for the Lake Pretty basin. During these wet periods, the District pumped water from Lake Pretty to Horse Lake, and from Horse Lake to Lake Raleigh. Tampa Bay Water then pumped water from Lake Raleigh to Lake Rogers. The District and Tampa Bay Water have an on-going cooperative funding project (Rocky Creek Lake Enhancement Project – B027) to construct a diversion system to allow for the transfer of surface water from Rocky Creek/Lake Pretty into lakes Horse, Raleigh, Rogers, and nearby wetlands during wet periods. There are a number of permitted ground water withdrawals within the surrounding area, including those associated with the Cosme-Odessa Wellfield located just to the west of Horse Lake. There are no surface water withdrawals from the lake currently permitted by the District.

The 1956 (photorevised 1987) United States Geological Survey 1:24,000 Citrus Park quadrangle map indicates an elevation of 42 ft above NGVD for Horse Lake. The "Gazetteer of Florida Lakes" (Florida Board of Conservation 1969, Shafer *et al.* 1986) lists the lake area as 28 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 19 acres at an elevation of 42 ft above NGVD.

Uplands surrounding Horse Lake consist of low to medium density development and citrus. Much of the shoreline has been altered or cleared in association with residential

development and to create pasture. Wetland and aquatic vegetation observed along the shoreline and within the lake basin include, cypress (*Taxodium sp.*), melaleuca (*Melaleuca quinquenervia*) primrose willow (*Ludwigia sp.*), torpedo grass (*Panicum repens*), cattail (*Typha sp.*), pennywort (*Hydrocotyle umbellata*), bladderwort (*Utricularia sp.*), and spatterdock (*Nuphar luteum*).

**Figure 1. Location of Horse Lake in Hillsborough County, Florida.**

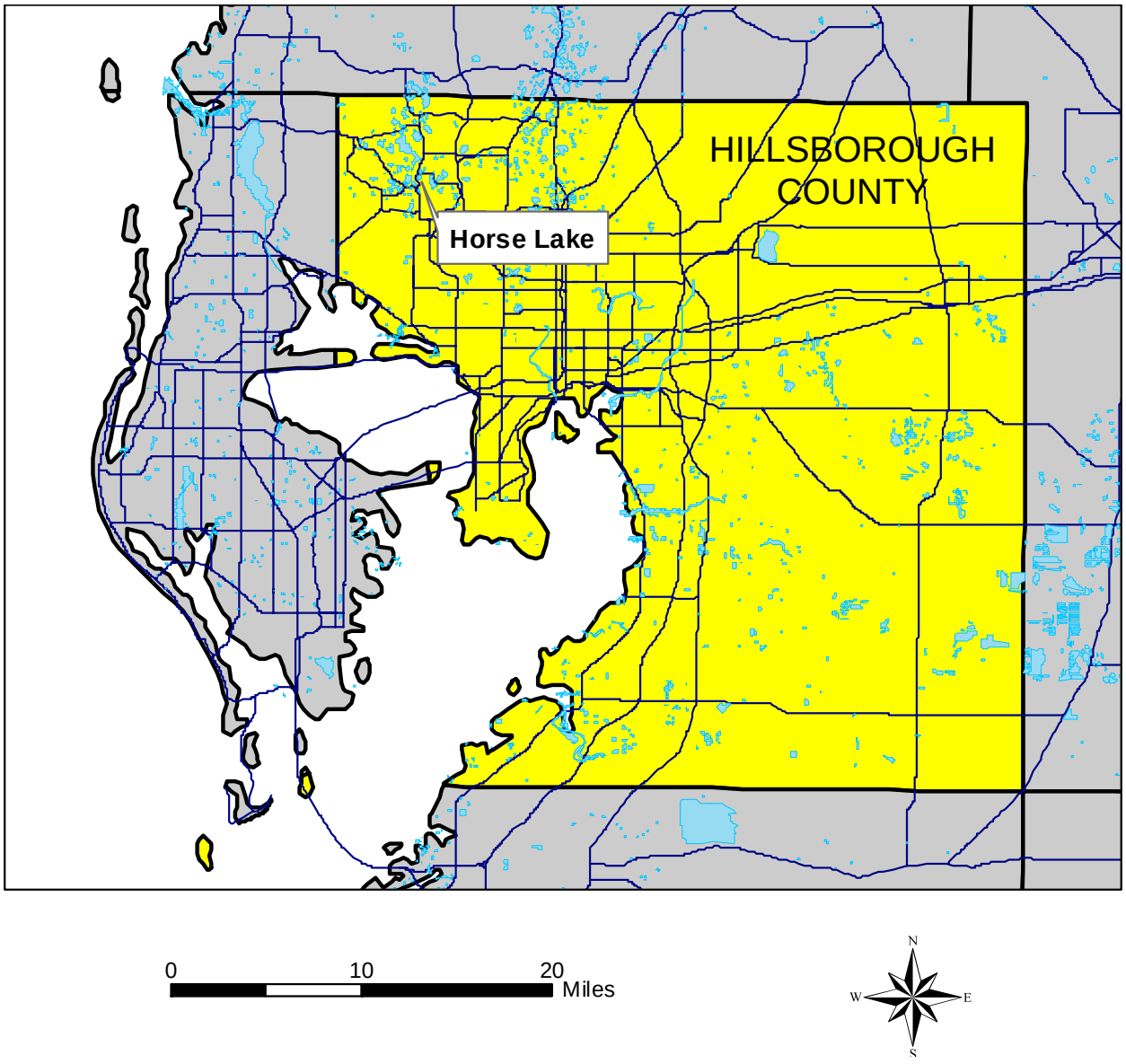


**Figure 2. Location of lake water level gauge, hydrologic indicators, outlet, control point, and outlet conveyance system for Horse Lake.**

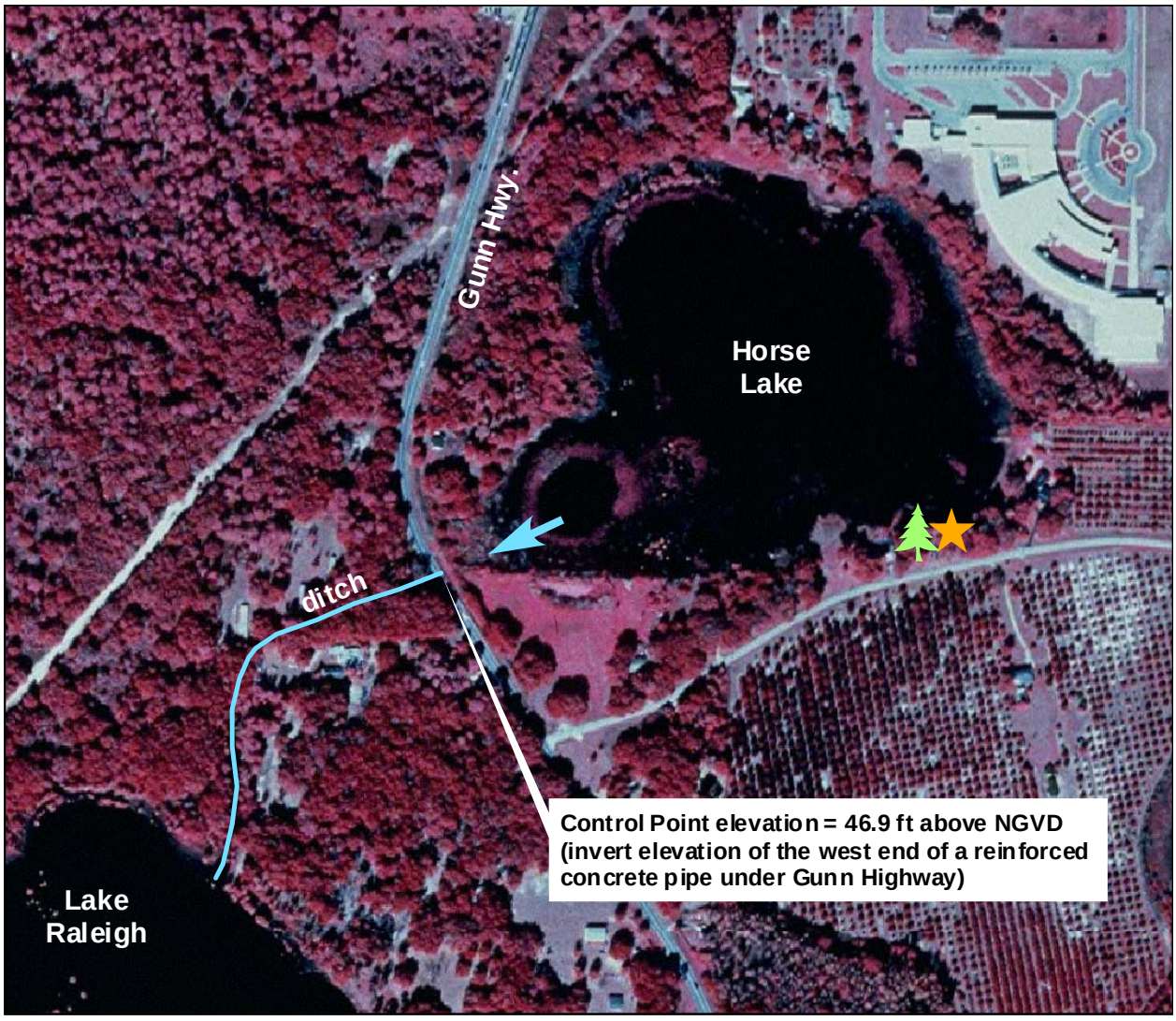
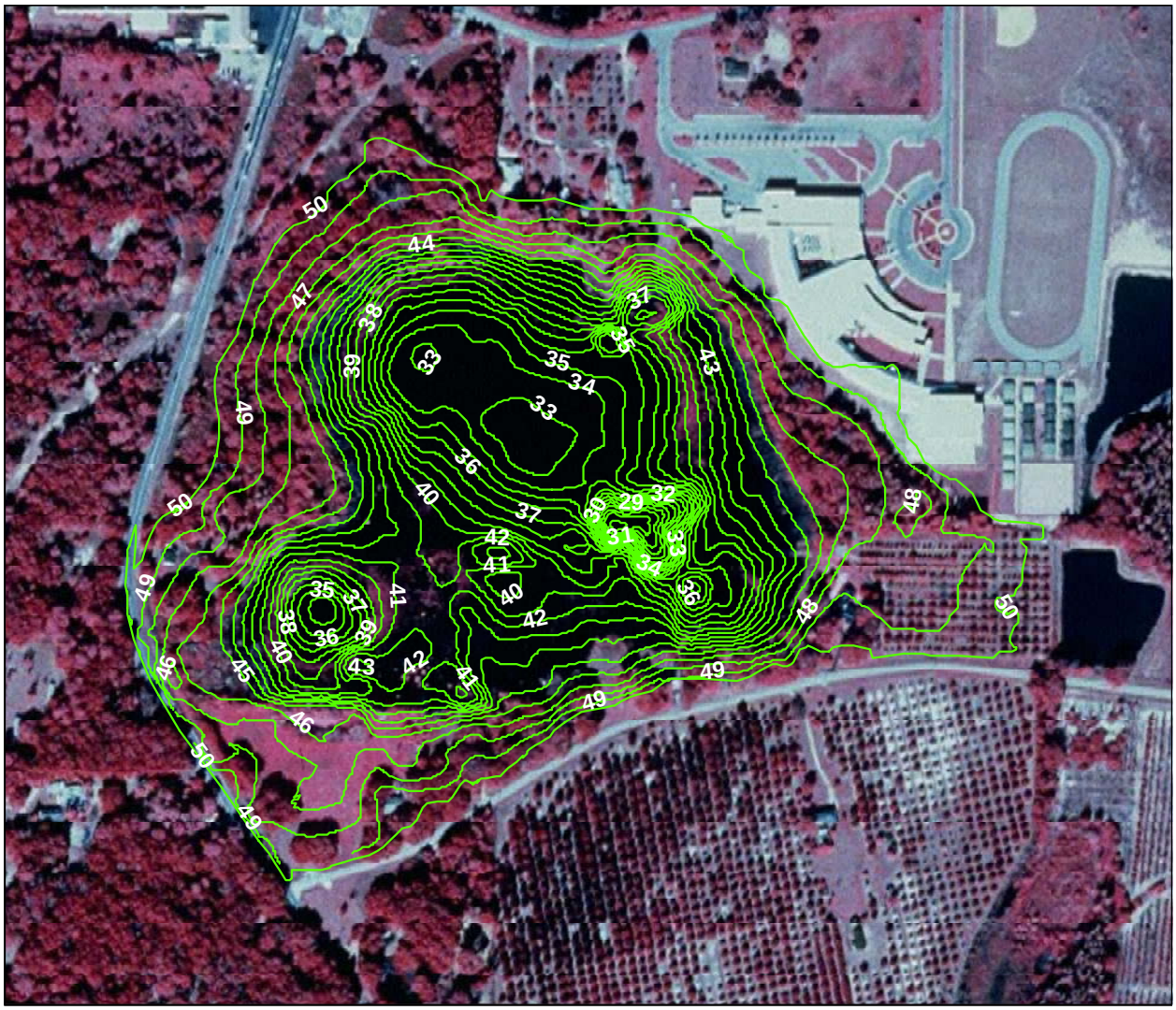


**Figure 3. One foot contours within the Horse Lake basin. Values shown are elevations in feet above the National Geodetic Vertical Datum of 1929.**




Map prepared March 2, 2004 using 1999 USGS digital orthophotography, elevation data from 1989 SWFWMD aerial photography with contours maps (Sheet No. 26-27-17), and elevation data collected on February 17, 2004 by SWFWMD staff.

## Currently Adopted Lake Guidance Levels

The 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 1996a), the District Governing Board adopted Guidance Levels for Horse Lake in May 1986 (Table 2). A Maximum Desirable Level of 46.00 ft 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 methodologies. Minimum and Guidance Levels established during minimum levels development shall replace current Guidance Levels shown in Table 2 upon adoption by the District's 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 Chapter 40D-2, F.A.C., Consumptive Use of Water, "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, determination of stressed condition is determined on a case-by-case basis. Horse Lake is included on the current Stressed Lakes List (Gant *et al.* 2004), and has been classified as a stressed lake since 1991.

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

| Management Levels | Elevation (feet above NGVD) | Lake Area (acres) |
|---|---|---|
| Ten Year Flood Guidance Level | 48.40 | 42 |
| High Level | 46.50 | 31 |
| Low Level | 44.00 | 24 |
| Extreme Low Level | 42.00 | 19 |

## Development of Minimum and Guidance Levels

Proposed Minimum and Guidance Levels for Horse Lake were developed using the methodology for Category 3 lakes described in Chapter 40D-8, F.A.C. and best available information in accordance with Section 373.042, F.S. Additional information gathered through field evaluations were 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 Horse Lake.**

| Levels | Elevation (feet above NGVD) | Lake Area (acres) |
|---|---|---|
| **Lake Stage Percentiles** | | |
| Current P10 | 45.50 | 27 |
| Current P50 | 42.94 | 22 |
| Current P90 | 38.81 | 11 |
| **Other Levels** | | |
| Normal Pool | 50.4 | NA |
| Control Point | 46.9 | 33 |
| **Guidance Levels and Historic P50** | | |
| Ten Year Flood Guidance Level | 48.9 | 44 |
| High Guidance Level | 46.9 | 33 |
| Historic P50 | 45.9 | 28 |
| Low Guidance Level | 44.8 | 26 |
| **Significant Change Standards** | | |
| Aesthetics Standard | 44.8 | 26 |
| Basin Connectivity Standard | 44.4 | 25 |
| Species Richness Standard | 44.1 | 26 |
| Dock-Use Standard | NA | NA |
| Recreation/Ski Standard | NA | NA |
| Lake Mixing Standard | NA | NA |
| **Minimum Levels** | | |
| High Minimum Lake Level | 45.8 | 28 |
| Minimum Lake Level | 44.8 | 26 |

NA = not available/not appropriate

## Lake Stage Data and Percentiles

Lake stage data, *i.e.,* surface water elevations for Horse Lake (District Universal ID Number STA 421 422) were obtained from the District's Water Management Data Base. The period of record for the data extends from May 1930 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 Horse Lake recorded in the Water Management Data Base, 50.00 ft above NGVD, occurred on August 1, 1959. The low of record, 36.33 ft above NGVD, occurred on June 14, 2002. Based on available lake stage data, monthly mean lake surface elevations were calculated and graphed (Figure 5). The data record for Horse Lake is not continuous, *i.e.*, there are some months during the period of record when lake surface elevations were not recorded.

For the purpose of minimum levels determination, lake stage data are categorized 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. Lake stage data are categorized as "Current" for periods when there were measurable, stable impacts due to water withdrawals, and impacts due to structural alterations were stable. Historic lake stage data are not available for Horse Lake because the lake occurs within an area where there are measurable impacts due to groundwater withdrawals (SWFWMD 1999). Lake stage data from January 1964 through the present date are classified as Current data for lakes affected by the wellfields within this region.

Current data collected through December 2003 were used to calculate **the Current P10, P50, and P90** lake stage percentile elevations. The Current P10 elevation, the elevation the lake water surface equalled or exceeded ten percent of the time during the current period, was **45.50 ft above NGVD**. The Current P50 elevation, the elevation the lake water surface equalled or exceeded fifty percent of the time during the current period, was **42.94 ft above NGVD**. The Current P90 elevation, the elevation the lake water surface equalled or exceeded 90 percent of the time during the current period, was **38.81 ft above NGVD**.

## Normal Pool and Control Point Elevations

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 eight cypress trees located along the southeast shoreline of Horse Lake, the Normal Pool elevation for the lake basin was established at **50.4 ft above NGVD** (Figure 2 and Table 4). The Normal Pool elevation is 4.9 ft higher than the Current P10 elevation.

**Table 4. Summary data used for development of the Normal Pool elevation for Horse Lake.**

| Normal Pool Statistics | Elevations Based on 8 Cypress Buttresses (feet above NGVD) |
|---|---|
| Mean (Standard Deviation) | 50.3 (0.3) |
| Median | 50.4 |
| Minimum | 49.6 |
| Maximum | 50.7 |

The **Control Point** elevation is 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 Horse Lake, the Control Point was established at **46.9 ft above NGVD,** the invert elevation of the west end of a culvert under Gunn Highway (Figure 2). Because the Control Point elevation is below the Normal Pool elevation, **Horse Lake 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 Horse Lake was established at **48.9 ft above NGVD** using the methodology for open basin lakes described in current District Rules (Chapter 40D-8, Florida Administrative Code). For the analysis, the long-term gauging record for Horse Lake was used to assess flooding potential. Flood frequency elevation estimates were based on probability analysis of annual peak stages recorded between 1930 and 2003. Various frequency distributions and probability plots were compared to establish the best estimate of flood frequency elevations. Based on available lake stage data, the Ten Year Flood Guidance Level has not been exceeded since 1959.

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 not available and Horse Lake is Structurally Altered, the High Guidance Level was established at **46.9 ft above NGVD**, the higher of the Current P10 (45.50 ft above NGVD) and the Control Point (46.9 ft above NGVD) elevations.

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. It 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. The statistics include the RLWR50,

RLWR5090, and RLWR90 and are derived using lake stage data for typical, regional lakes that exhibit little or no impacts from water withdrawals. Because Historic data are not available for Horse Lake, and the difference between the Current P10 and the Current P50 (2.56 ft) is greater than the Northern Tampa Bay area RLWR50 (1.0 ft, SWFWMD 1999), the Historic P50 was established at **45.9 ft above NGVD** by subtracting the Northern Tampa Bay area RLWR50 from the High Guidance Level (46.9 ft 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 not available, and the difference between the Current P10 and the Current P90 (6.69 ft) is greater than the Northern Tampa Bay area RLWR90 (2.1 ft, SWFWMD 1999), the Low Guidance Level was established at **44.8 ft above NGVD** by subtracting the Northern Tampa Bay area RLWR90 from the High Guidance Level (46.9 ft above NGVD).

## Lake Categorization

Lakes are classified as Category 1, 2, or 3 for the purpose of Minimum Levels development. Those with fringing cypress wetlands greater that 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 ft 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 ft 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 Horse Lake 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. The standards are used to identifiy 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.

For Category 3 lakes, 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. Since Horse Lake is a Category 3 lake, the applicable significant change standards were developed (Table 3) and evaluated with respect to potential changes in plant cover.

The **Aesthetics Standard** is developed to protect aesthetic values associated with the inundation of lake basins. The standard is intended to limit potential change in aesthetic values associated with the median lake stage from diminishing 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 is **44.8 ft 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, clearance values 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 Historic data are not available, the Basin Connectivity Standard was established at **44.4 ft above NGVD**, based on the sum of the critical high spot elevation (41.3 ft NGVD), the clearance value for powerboats and movement of biota (2 ft), and the Northern Tampa Bay area RLWR5090 (1.1 ft, SWFWMD 1999).

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 Horse Lake, the Species Richness Standard was established at **44.1 ft above NGVD**.

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 clearance value for boat mooring, and use of Historic lake stage data or region-specific reference lake water regime statistics. Because only one dock platform is located on Horse Lake, use of this standard for Minimum Levels development is **not appropriate**.

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 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. Because the Recreation/Ski Standard elevation is several feet above the shoreline of the lake basin, use of this standard for Minimum Levels development is **not appropriate**.

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, use of this standard for Minimum Levels development is **not appropriate** (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 wetland area within the lake basin (*i.e*., basin area with a water depth less than or equal to four feet). Review of changes in potential herbaceous wetland area in relation to change in lake stage did not indicate that there would be a significant increase or decrease in the area of herbaceous wetland vegetation associated with use of the applicable significant change standards (Figure 6).

**Submersed Aquatic Macrophyte Information** is taken into consideration to determine the elevation at which change in lake stage would result in substantial change in the area available for colonization by submersed aquatic plants. Because of limited Secchi depth data, it was not possible to determine the depth of macrophyte colonization for Horse Lake.

## Proposed Minimum Levels

The High Minimum Lake Level and the Minimum Lake Level are developed using lake-specific significant change standards, lake categorization, and other available information 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.

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 3 Lakes is established at the elevation corresponding to the most conservative, *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. For Horse Lake, the Minimum Lake Level was established at the Aesthetics standard, **44.8 ft above NGVD**, the most conservative of the appropriate standards (Table 3, Figures 5 and 7). The water level equaled or exceeded fifty percent of the time (P50) has been below the Minimum Lake Level for Horse Lake over the last five long-term (10-year) periods (Table 5).

**Table 5. Comparisons between the Minimum Lake Level for Horse Lake and water surface elevations equaled or exceeded fifty percent of the time (P50) over the last five 10-year periods.**

| 10-year Period | | | MLL Equaled or Exceeded ? | Feet P50 is above(+) or below (-) MLL |
|---|---|---|---|---|
| January 1994 | through | December 2003 | No | -2.2 |
| January 1993 | through | December 2002 | No | -3.2 |
| January 1992 | through | December 2001 | No | -3.2 |
| January 1991 | through | December 2000 | No | -4.1 |
| January 1990 | through | December 1999 | No | -4.3 |

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. Because Horse Lake is a Category 3 lake and historic data are not available, the High Minimum Lake Level was established at **45.8 ft above NGVD**, an elevation corresponding to the Minimum Lake Level elevation plus the Northern Tampa Bay RLWR50 (1.0) (Table 3, Figures 5 and 7). The water level equaled or exceeded ten percent of the time (P10) has been below the High Minimum Lake Level for Horse Lake over the last five long-term (10-year) periods (Table 6).

**Table 6. Comparisons between the High Minimum Lake Level for Horse Lake and water surface elevations equaled or exceeded ten percent of the time (P10) over the last five 10-year periods.**

| 10-year Period | | | HMLL Equaled or Exceeded ? | Feet P10 is above (+) or below (-) HMLL |
|---|---|---|---|---|
| January 1994 | through | December 2003 | No | -0.6 |
| January 1993 | through | December 2002 | No | -1.5 |
| January 1992 | through | December 2001 | No | -1.5 |
| January 1991 | through | December 2000 | No | -1.5 |
| January 1990 | through | December 1999 | No | -1.5 |

## Comparison of the High Minimum Lake Level with Lake Basin Features

The elevations of various man-made features within the immediate Horse Lake 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 February 2002, the

proposed High Minimum Lake Level is 3.8 ft below the slab of the lowest residential dwelling along the lakeshore, 1.8 ft below a well located at the rear of a residential dwelling, and 4.2 ft below the lowest spot in the roads that encircle the lake (Table 7).

**Table 7. Elevations of lake basin features surrounding Horse Lake.**

| Lake Basin Features | Elevation (feet above NGVD) |
|---|---|
| Low Floor Slab (house) | 49.56 |
| Low Other (well) | 47.57 |
| Low Road (Gunn Hwy.) | 49.95 |

**Figure 4. Surface water elevations through December 2003 for Horse Lake.**

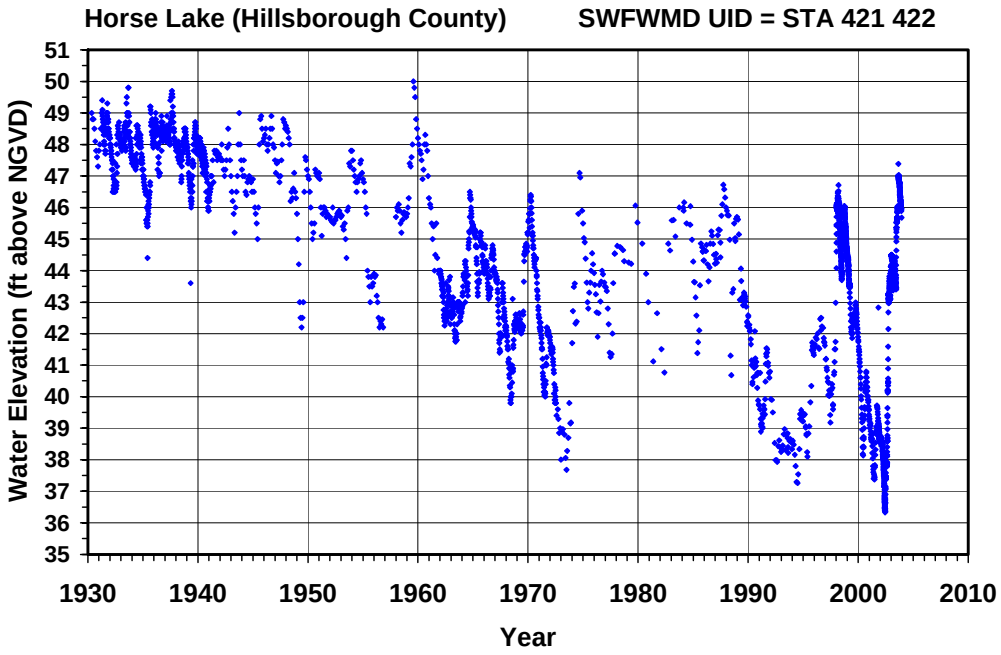



**Figure 5. Mean monthly surface water elevations through December 2003, and proposed Guidance and Minimum Levels for Horse Lake. Proposed levels include the Ten-Year Flood Guidance Level (10-YR), High Guidance Level (HGL), Low Guidance Level (LGL), High Minimum Lake Level (HMLL), and Minimum Lake Level (MLL).**

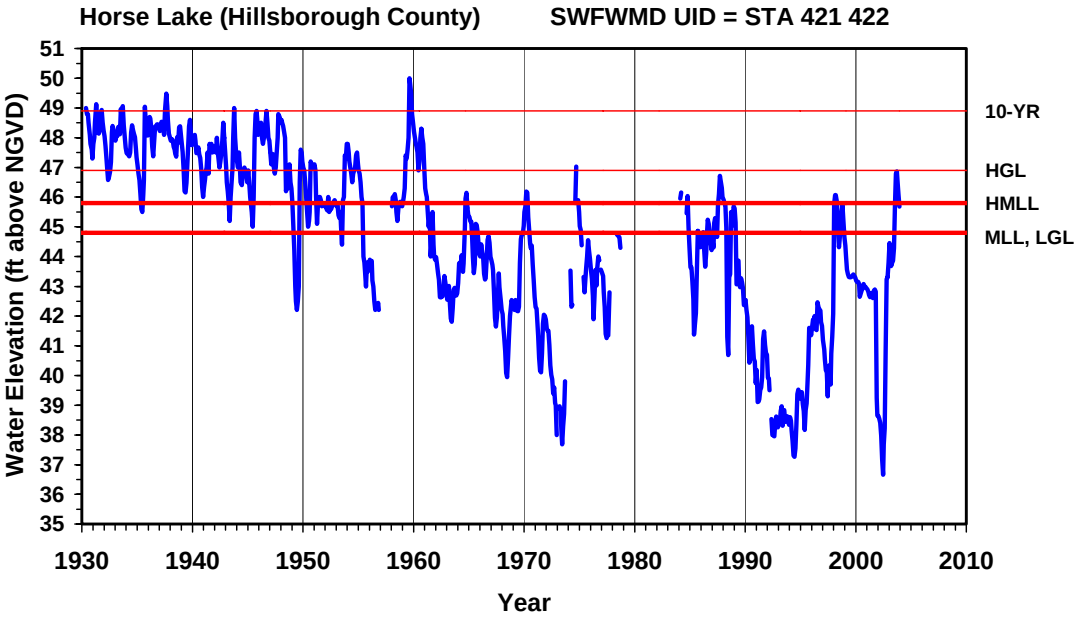
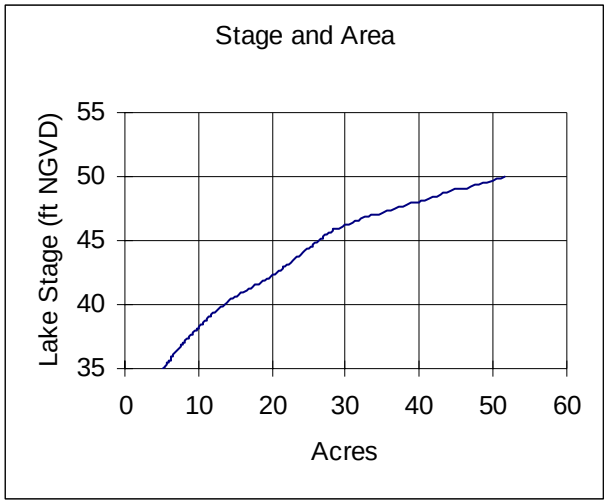
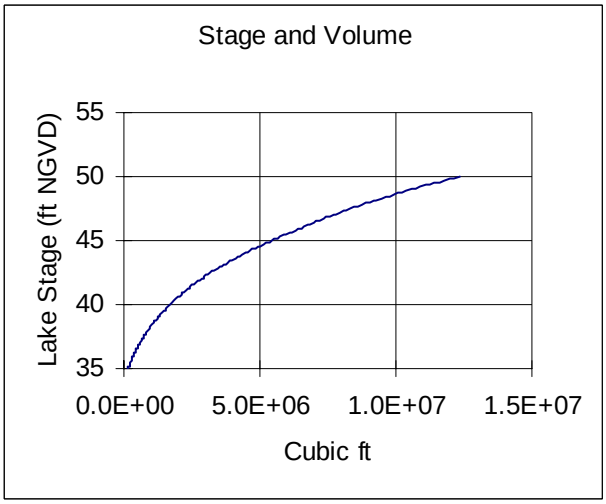
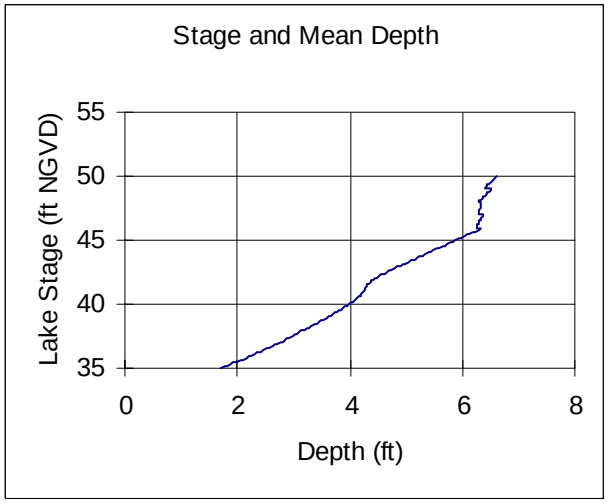
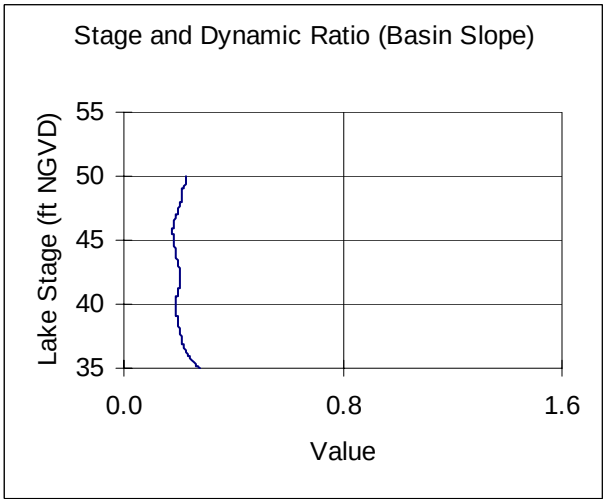


**Figure 6. Surface area, volume, mean depth, dynamic ratio (basin slope), and potential herbaceous wetland area versus lake stage for Horse Lake.**



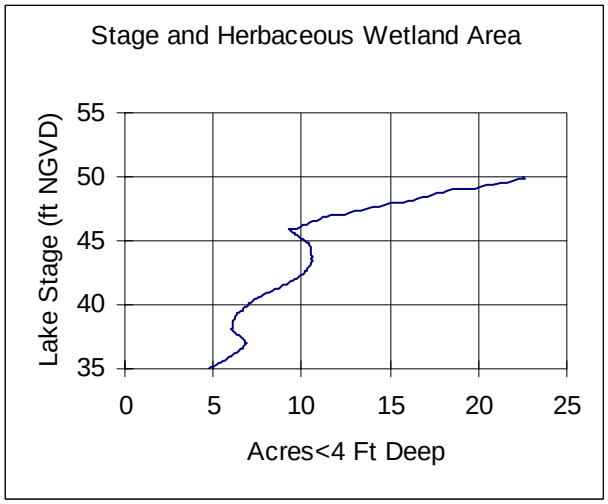



**Figure 7. Approximate location of the proposed Minimum Lake Level (MLL) and High Minimum Lake Level (HMLL) for Horse Lake.**


## Legend

**Horse Minimum Levels**

44.8 ft above NGVD = MLL

45.8 ft above NGVD = HMLL

N
W
E
S

Map prepared March 4, 2004 using 1999 USGS digital orthophotography, elevation data from 1989 SWFWMD aerial photography with contours maps (Sheet No. 26-27-17), and elevation data collected on February 17, 2004 by SWFWMD staff.

0 100 200 400
Feet

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