A Multiple-Parameter Approach for Establishing Minimum Levels for Category 3 Lakes of the Southwest Florida Water Management District

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Terms, Abbreviations, Acronyms and Definitions

Category 1 Lakes	Lakes with lake-fringing cypress swamp(s) greater than 0.5 acres in size where Structural Alterations have not prevented te Historic P50 from equaling or rising above an elevation that is 1.8 feet below the normal pool of the cypress swamp(s).
Category 2 Lakes	Lakes with lake-fringing cypress swamp(s) greater than 0.5 acres in size where Structural Alterations have prevented the Historic P50 from equaling or rising above an elevation that is 1.8 feet below normal pool and the lake fringing cypress swamp(s) remain viable and perform functions beneficial to the lake in spite of the Structural Alterations.
Category 3 Lakes	Lakes without lake-fringing cypress swamp(s) greater than 0.5 acres in size.
Control Point Elevation	The elevation of the highest stable point along the outlet profile of a surface water conveyance system that principally controls lake water level fluctuations.
Current	A recent Long-term period during which Structural Alterations and hydrologic stressed are stable.
District	Southwest Florida Water Management District (SWFWMD).
Extreme Low Level	A Guidance Level, formerly referred to as the Extreme Low Management Level. Established for lakes with management levels adopted prior to implementation of the new lake minimum flows and levels methodologies.
F.A.C.	Florida Administrative Code.
FDEP	Florida Department of Environmental Protection.
F.S.	Florida Statutes.
Guidance Levels	Water levels, determined by the District using the best available information and expressed in feet relative to the National Geodetic Vertical Datum (of 1929) , or in feet

relative to the North American Vertical Datum (of 1988), uses as an advisory information for the District, lake shore residents and local governments, or to aid in the management or control of adjustable structures.

HGL High Guidance Level.

High Guidance Level The expected Historic P10 elevation. Provided as an advisory guideline for the construction of lake shore development, water dependent structures, and operation of water management structures.

High Level A Guidance Level, formerly referred to as the Minimum Flood Level. Established for lakes with management levels adopted prior to implementation of the new lake minimum flows and levels methodologies.

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

Historic A Long-term period when there are no measurable impacts due to withdrawals and Structural Alterations are similar to current conditions.

Historic P50 The expected Historic P50 elevation; *i.e.*, the elevation of the water surface of a lake or wetland that is expected to be equaled or exceeded fifty percent of the time based on a Long-term period when there are or were no measurable impacts due to withdrawals and Structural Alterations are similar to current conditions.

HMLL High Minimum Lake Level.

Hydrologic Indicators Biological and physical features which are representative or indicative of previous water levels as listed in Section 373.4211(20), Florida Statutes.

Long-term An evaluation period utilized to establish minimum flows and levels, to determine compliance with established minimum flows and levels and to assess withdrawal impacts on established minimum flows and levels that represents a period which spans the range of hydrologic conditions which can be expected to occur based upon historical records, ranging from high water levels to low water levels. In the context of a predictive model simulation, a Long-term simulation will be insensitive to temporal fluctuations in withdrawal rates and hydrologic conditions, so as to simulate steady-state, average conditions. In the context of an average water level, the average will be based upon the historic expected range and frequency of levels. Relative to minimum flow establishment and minimum level establishment and compliance, where there are six years of more of competent data, a minimum of a six year evaluation period will be used; but the available data and reasonable scientific judgement will dictate whether a longer period is used. Where there are less than six years of competent data, the period used will be dictated by the available data and a determination, based on reasonable scientific judgement, that the period is sufficiently representative of Long-term conditions.

LFS — Low Floor Slab. The elevation of the lowest floor slab of a residential dwelling in the immediate lake basin.

LGL — Low Guidance Level.

Low Guidance Level — The expected Historic P90. Provided as an advisory guideline for construction of water dependent structures, information for lakeshore residents, and operation of water management structures.

Low Level — A Guidance Level, formerly referred to as the Low Management Level. Established for lakes with management levels adopted prior to implementation of the new lake minimum flows and levels methodologies.

MFL — Minimum Flows and Levels.

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

MLL — Minimum Lake Level.

NGVD — National Geodetic Vertical Datum.

Normal Pool Elevation — An elevation approximating the P10 elevation which is determined based on hydrologic indicators of sustained inundation.

Not Structurally Altered	Refers to a lake where the control point elevation equals or exceeds the Normal Pool elevation or the lake has no outlet.
P10	The percentile ranking represented by the elevation of the water surface of a lake or wetland that is equaled or exceeded ten percent of the time as determined from a Long-term stage frequency analysis.
P50	The percentile ranking represented by the elevation of the water surface of a lake or wetland that is equaled or exceeded fifty percent of the time as determined from a Long-term stage frequency analysis.
P90	The percentile ranking represented by the elevation of the water surface of a lake or wetland that is equaled or exceeded ninety percent of the time as determined from a Long-term stage frequency analysis.
Reference Lakes	Lakes from a defined area which are not measurably impacted by water withdrawals. Reference lakes may be used to develop reference lake statistics, including the RLWR50, RLWR90, and the RLWR5090.
RLWR50	Reference Lake Water Regime 50. The median difference between the P10 and P50 elevations for reference lakes with historic data with similar hydrogeologic conditions as the lake of concern.
RLWR5090	Reference Lake Water Regime 5090. The median difference between the P50 and P90 elevations for reference lakes with historic data with similar hydrogeologic conditions as the lake of concern.
RLWR90	Reference Lake Water Regime 90. The median difference between the P10 and P90 lake stage elevations for reference lakes with historic data with similar hydrogeologic conditions as the lake of concern.
SFWMD	South Florida Water Management District.
SJRWMD	St. Johns River Water Management District.

Structurally Altered	A lake or wetland where the control point has been physically altered by man such that water levels are affected. *Refers to a lake where the control point elevation is below the Normal Pool elevation.*
Structural Alteration	Man's physical alteration of the control point of a lake or wetland that affects water levels.
SWFWMD	Southwest Florida Water Management District.
Ten-Year Flood Guidance Level	The level (elevation) of flooding expected on a frequency of not less than the ten year recurring probability of occurrence in any given year. Provided as an advisory guideline for lake shore development.
USGS	United States Geological Survey

Section 1

Introduction to the Establishment of Minimum Water Levels for Lakes of the Southwest Florida Water Management District

Lake Levels Program: 1970s-1996

The Southwest Florida Water Management District (the District or SWFWMD) has a long history of water resource protection through the establishment and implementation of lake management levels. With the adoption of lake levels for Lake Tarpon in 1972 and the development of the Lake Levels Program in the mid-1970s, the District began an initiative which by 1996, had resulted in the establishment of management levels for nearly four hundred lakes (Gant 1996). In the early years of this initiative, techniques and methods were developed for establishing lake levels based on hydrologic, biological, physical and cultural aspects of lake ecosystems. In 1978, four management levels based on application of these methods were adopted by the District Governing Board into Chapter 40D-8, Florida Administrative Code (hereafter F.A.C.). These levels were operationally defined as follows:

> Ten Year Flood Warning Level - An advisory level which approximates the level of flooding expected at a recurrence frequency of not more than once every ten years.
>
> Minimum Flood Level - A seasonal high water level expected to be equaled or exceeded approximately 5-10% of the time, and to which a surface water body may rise without interference, except as approved by the Governing Board.
>
> Low Management Level - A seasonal low level expected to be equaled 80-90% of the time, and a level below which further water withdrawals would be considered significantly harmful to the water resources of the area. Also used as a guide for operation of lake control structures and water use permitting.
>
> Extreme Low Management Level - A drought year low level expected to be exceeded 90-95% of the time. Used for operation of lake control structures and water use permitting.

Implementation of the Lake Levels Program through the mid-1990s was viewed by the District as an appropriate means to address the legislative requirement (Section 373.042, Florida Statutes, hereafter F.S.) that minimum levels were to be established for protection of water resources (in this case, lakes) of the state.

Lake Levels Program: 1996-1999

A Legislative Mandate Leads to New Methods for Establishing Minimum Water Levels for Lakes with Fringing Cypress Wetlands

Identification of severe water resource problems in the Northern Tampa Bay area in the mid-1990s (*e.g.*, see SWFWMD 1996) precipitated renewed interest by the Florida Legislature concerning the establishment of minimum flows and levels (MFLs). In 1996, the Legislature directed the Department of Environmental Protection (FDEP) or the governing boards of the state's five water management districts to develop minimum flows and levels for the freshwater resources of the state (Section 373.042, F.S., see Appendix A). 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". Thus, the purpose for establishing minimum levels is to ensure that water bodies are not lowered by withdrawals below a level which would cause significant harm. Mere adoption of a minimum water level, of course, does not protect a water body from significant harm; however, protection, recovery or regulatory compliance can be gauged once a standard has been established.

According to state law, minimum flows and levels are to be established based upon the best available information (Section 373.042, F.S), 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., see Appendix A). State law also acknowledges that certain water bodies no longer serve their historical hydrological functions and that "recovery of these water bodies to historical hydrological conditions may not be economically or technically feasible, and that such recovery effort could cause adverse environmental or hydrological impacts. Accordingly, the Florida Department of Environmental Protection or the Water Management Districts "may determine that setting a minimum flow or level for such a water body based on its historical condition is not appropriate" (Section 373.0421, F.S.). Additional exclusions pertaining to the establishment of minimum flows and levels include some discretion regarding establishment of minimum flows or levels for surface water bodies less than twenty-five acres in area and surface water bodies constructed prior to the requirement for a permit, or pursuant to an exemption, a permit or a reclamation plan which regulates the size, depth, or function of the surface water body.

State Water Policy (Chapter 62-40.473, F.A.C., see Appendix B) 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 or levels, and environmental values associated with coastal, estuarine, aquatic and wetlands 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."

As an initial priority in the 1996 minimum flows and levels legislation, the District was charged with establishing minimum flows and levels for certain water bodies (lakes, wetlands and aquifers) in Hillsborough, Pasco and Pinellas Counties by October 1, 1997. In response to this mandate, a Technical Advisory Committee comprised of District staff, representatives of local governments and interested citizens was convened to help develop minimum flows and levels methodologies. Separate subcommittees were formed to develop specific methodologies for aquifers, lakes, and wetlands.

As a result of work performed by the Lake Level Subcommittee and modified according to input from the public, the District Governing Board adopted a methodology for establishing minimum lake levels, and minimum levels for fifteen lakes (Chapter 40D-8, F.A.C.) based on the new methodology on October 28, 1998. The adopted methodology addresses the establishment of minimum levels for a subset of lakes within the District – those with fringing wetlands dominated by cypress (*Taxodium* spp.). According to the new methodology (SWFWMD 1999a, Chapter 40D-8, F.A.C.), 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 formerly attained are classified as Category 2 Lakes, and lakes without fringing cypress wetland are classified as Category 3 Lakes. Minimum levels are established based on these lake classifications; however, methodologies have not yet been adopted for Category 3 Lakes.

The recently adopted methodology for developing minimum levels for cypress-wetland fringed lakes addresses the legislative requirement for preventing significant harm associated with water withdrawals through the establishment of minimum levels and also provides for the establishment of Guidance Levels, which serve as guidelines for other water management activities. Currently, Chapter 40D-8 also provides for the classification of formerly adopted management levels as Guidance Levels. Minimum Levels and Guidance Levels are operationally defined as follows:

Minimum Levels - The Long-term level of a surface water, water table, or potentiometric surface at which further withdrawals would be significantly harmful to the water resources of the area and which may provide for the protection of nonconsumptive uses (*e.g.* , recreational, aesthetic, and navigation). Such level shall be expressed as an elevation, in feet relative to the National Geodetic Vertical Datum (1929) or in feet relative to the North American Vertical Datum (1988) and includes Minimum Wetland Levels, High Minimum Lake Levels, Minimum Lake Levels, and Salt Water Intrusion Minimum Aquifer Levels.

Guidance Levels - Levels, determined by the District using the best available information and expressed in feet relative to the National Geodetic Vertical Datum (of 1929), or in feet relative to the North American Vertical Datum (of 1988), used as advisory information for the District, lake shore residents and local governments, or to aid in the management or control of adjustable structures. Guidance Levels include the Ten Year Flood Guidance Level, the High Guidance Level, the Low Guidance Level, the High Level, the Low Level, and the Extreme Low Level

Specific Minimum and Guidance levels include the following:

High Minimum Lake Level - A Minimum Level, which corresponds to the elevation that the lake water level must equal or exceed ten percent of the time on a long-term basis. For evaluation of hydrologic data for the purpose of establishing minimum levels, "long-term" means a period that spans the range of hydrologic conditions which can be expected to occur, based upon historical records. Typically, a period of six or more years is considered sufficient establishment of long-term conditions; however, shorter periods may be considered to be representative of long-term conditions, based on reasonable scientific judgement.

Minimum Lake Level - A Minimum Level, which corresponds to the elevation that the lake water level must equal or exceed fifty percent of the time on a long-term basis.

High Guidance Level - A Guidance Level, provided as an advisory guideline for the construction of lake shore development, water dependent structures, and operation of water management structures. Lake water levels are expected to equal or exceed this level ten percent of the time on a long-term basis.

Low Guidance Level - A Guidance Level provided as an advisory guideline for water dependent structures, as information for lake shore residents and for operation of water management structures. Lake water levels are expected to equal or exceed this level ninety percent of the time on a long-term basis.

Ten Year Flood Guidance Level - A Guidance Level, formerly referred to as the Ten Year Flood Warning Level. An advisory level which approximates the level of flooding expected at a recurrence frequency of not more than once every ten years.

High Level - A Guidance Level, formerly referred to as the Minimum Flood Level. Established for lakes with management levels adopted prior to implementation of the current lake minimum flows and levels methodologies.

Low Level - A Guidance Level, formerly referred to as the Low Management Level. Established for lakes with management levels adopted prior to implementation of the current lake minimum flows and levels methodologies.

Extreme Low Level - A Guidance Level, formerly referred to as the Extreme Low Management Level. Established for lakes with management levels adopted prior to implementation of the current lake minimum flows and levels methodologies.

Significant Harm and Significant Change

Harm can be defined as "physical injury or damage" and can be evaluated relatively easily when applied to individual plants or animals, but becomes difficult to define or evaluate when applied to ecological assemblages or ecosystems. This became apparent during development of minimum flows and levels methodologies in 1997 and 1998, when scientists from various subcommittees of the Technical Advisory Committee frequently noted that "harm" as applied to whole water bodies or systems, is not a scientific concept, but rather a value judgement requiring a decision based on policy. For example, some committee members suggested that the replacement of lake or wetland plant species by invading upland species during periods of extended low water levels simply represents succession, or the change in ecological community type, rather than harm, because the resulting plant assemblages provide abundant, albeit different ecological goods and services than those provided by the previously existing wetland assemblage (Knight and Bays 1997). Although this example seems somewhat extreme, in that most persons would equate the transformation of a wetland to upland habitat as being harmful to the wetland, it illustrates the ease with which one can identify harm at the individual or species level (some individuals and wetland species would be displaced under the scenario described), but the difficulty associated with reaching scientific consensus regarding the determination of harm at the ecosystem level.

Although scientists may disagree on what constitutes significant "harm" at the ecosystem level, they can often agree on what qualifies as significant change. For example, while it might be debated how acceptable conversion of a wetland to an upland, or an old growth forest to a pine plantation is, most would agree that such conversions represent significant change. Scientists can therefore be expected to help determine when significant change has occurred or may be expected to occur. They may also acknowledge when they believe significant harm has occurred; however, determination of significant harm for District purposes ultimately relies on policy determined by the Governing Board.

Most Lake Level Subcommittee members agreed that a lake would be significantly changed if the hydrologic connection to its fringing wetland was diminished or severed or if the wetland itself was significantly changed. For example, it was noted that certain organisms (*e.g.*, some fish species) make use of wetland habitat during certain stages of their life cycle, that detrital material from wetland leaf fall is important to energy flow through wetland-lake systems, and that tannic substances contributed from wetlands affect water color, clarity and chemistry; all of which affect the biologic assemblages which populate a lake. Because these environmental values are among those specifically listed in State Water Policy for consideration when establishing minimum flows and levels (Section 62-40.473, F.A.C.), and the District has identified, as policy, the need to strive for management of water resources to achieve no net loss of wetlands (SWFWMD 2000), wetlands protection was (and is) viewed as a reasonable approach for establishing minimum water levels for lakes.

The Lake Level Subcommittee therefore adopted a "wetlands protection perspective" for establishing minimum levels for lakes with fringing cypress wetlands (SWFWMD 1999a). The method is based on significant change standards for isolated cypress wetlands that were established using correlative analyses of wetland health ratings and hydologic data (water level elevations). The standards were originally developed by the Wetland Subcommittee to identify wetlands that have been "significantly altered" as a result of reduced hydroperiods (SWFWMD 1999b). The Governing Board deemed the subcommittee's finding of "significantly altered" to be equivalent to "significantly harmed", and thus the standards and associated methods provide a means for evaluating significant harm to lakes with fringing cypress wetlands. Use of these standards for establishing minimum lake levels assures that lake-fringing cypress wetlands will remain in place and continue to provide ecological goods and services necessary for maintaining lake ecosystem integrity.

Lake Levels Program: 1999 to the present

Development of Methods for Establishing Minimum Levels for Lakes without Fringing Cypress Wetlands

In the spring of 1999, District assembled a guidance committee to identify appropriate methods for establishing minimum levels for lakes without fringing cypress wetlands (Category 3 Lakes). The committee, comprised of District staff and other scientists with extensive knowledge of Florida lake ecosystems reviewed literature and data pertaining to potential environmental impacts associated with long-term lake stage reductions.

In fall and winter of 2000/2001, the District hosted several technical workshops on potential approaches for establishing minimum levels for lakes without fringing cypress wetlands. Technical staff representing members of the Northern Tamp Bay Phase II Local Technical Peer Review Group and various governmental and non-governmental organizations from the Southern Water Use Caution Area were afforded the opportunity to provide input on minimum levels establishment and methodologies.

This report provides an up-to-date summary of the status of minimum levels development for District lakes. Current methodologies used for establishing minimum levels for lakes with fringing cypress wetlands are described in detail, as are the basic concepts supporting the development of a comprehensive, multiple-parameter approach for establishing minimum levels for lakes without fringing cypress wetlands. *Implementation of the current and proposed approaches is illustrated through the* development of provisional minimum and guidance levels for several lakes in the Northern Tampa Bay area. It is the author's hope that this report will lead the reader to consider and develop additional approaches for protection of our valuable lakes through the establishment of minimum levels.

Section 2

Establishing Minimum Water Levels for Lakes: Basic Considerations

Introduction

Knowledge of the elevation to which water levels have historically risen within a lake basin, and the potential impacts which may be expected with long-term lake stage reductions are fundamental to the development of minimum levels. These topics are briefly reviewed in this section to provide a framework for understanding the basic considerations required for minimum levels development.

High-Water Levels

The identification of lake high-water levels is of value for a wide variety of cultural and regulatory endeavors. High-water elevations are used for delineation of sovereign water bodies from uplands, for determination of water needs for maintenance of natural systems integrity, and for the establishment of boundaries governing human use of lakes and their surrounding uplands. An understanding of the approaches used to identify high-water levels is fundamental to the development of minimum lake levels.

Delineation or demarcation of the boundary between sovereign navigable water bodies and adjacent uplands has long been an integral part of the surveys of public lands of the United States. Water bodies delineated for this purpose are said to be meandered. Only a few, generally large lakes have been meandered in Florida (Kenner 1961). Guidelines for "meandering" water bodies have been included in public land survey program instructions in this country as far back as early nineteenth century (Cole 1997). The most recent national instructions for the survey of public lands (Bureau of Land Management 1973) provide for a process intended to identify the high-water mark, or alternatively, the ordinary high water line produced on the land by the adjacent water body.

In Florida, the ordinary high water line is used by the Division of State Lands of the Florida Department of Environmental Protection for resolution of disputes over state ownership of sovereign submerged lands. The ordinary high water line has been defined in state case law as "the line between a riparian owner and the public...determined by examining the bed and banks, and ascertaining where the presence and action of the water as so common and usual, and so long continued in all ordinary years as to mark upon the soil of the bed a character distinct from that of the banks, in respect to vegetation as well as respects the nature of the soil itself. High-water mark means what the language imports–a water mark." (Tilden v. Smith, Fla., 113 So. 708, 1927; as cited in Cole 1997). The ordinary high water line is similarly defined for regulatory purposes in Florida as the "point on the slope or bank [of a water body] where the surface water from the water body ceases to exert a dominant influence on the character of the surrounding vegetation and soils" (Gilbert *et al.* 1995). Guidelines for determination of the ordinary high water line are included in Chapter 373, F.S. and Chapter 62-340, F.A.C. The State has not, however, codified specific procedures for this purpose.

Botanical, physical and cultural features or data are often used for the identification of the ordinary high water line. Data on lake stage, erosional features of lake shores (beach ridges and scarps), the presence of stain lines, soil characteristics, and the zonation of terrestrial and aquatic or wetland vegetation have been accepted by federal and state courts involved in ordinary high water line determination (Cole 1997). These features also factor into recommended approaches for determining lake high-water elevations for regulatory and other purposes (Kenner 1961, Bishop 1967, Knochenmus 1967, Davis 1973, Dooris and Courser 1976, Patton 1980, Hull *et al.* 1989, Wisconsin Department of Natural Resources 1996, SWFWMD 1999a).

Since the inception of the Lake Levels Program in the 1970s, the evaluation of high-water indicators has been an integral component of the District's adoption of lake management levels. For example, in their review of District methods used for establishing regulatory lake levels, Dooris and Courser (1976) describe a water level, currently referred to as the High Level (a Guidance Level) in the Minimum Flows and Levels Rule adopted in October 1998, as approximating an elevation "historically equaled or exceeded about 5-10% of the period of record as determined from a stage duration curve". They note that this regulatory level typically corresponds to an elevation just below the fringe of wax myrtle (*Myrica cerifera*) and saw palmetto (*Serenoa repens*) shrubs, and a point approximately two-thirds up the buttress of mature cypress (*Taxodium* spp.) trees (Figure 2-1). They also note that cultural features and impacts were often considered when establishing this "high-water" lake management level.

More recently, the District has developed guidelines for establishing high-water levels approximating the P10 elevation. In 1997, the Lake Levels subcommittee developed a draft lake levels methodology manual (SWFWMD 1997) which includes detailed instructions for the identification of the annual high water level. The manual advocates the use of biological, physical and hydrological information for establishing the approximate P10 elevation representative of conditions pre-dating anthropogenic alterations to a lake's hydrologic regime. Biological indicators useful for establishing high-water elevations are identified, including the distribution of saw palmetto, cypress, longleaf pine (*Pinus palustris*), live oak (*Quercus virginiana*) and cultivated crops intolerant of inundation. Useful physical features or data, including the elevation of the toe of the highest landward scarp (see Bishop1967, Knochenmus 1967), historic aerial photography, topographic maps and other documents are also listed. The recently developed methods for establishing minimum levels for lakes with fringing cypress wetlands also incorporate guidelines for identifying a regulatory high-water elevation

Figure 2-1. Vegetation in lake basins may provide some indication of high lake levels. Panel A shows the saw palmetto (*Serenoa repens*) line at Big Fish Lake in Pasco County, Florida. Panel B shows buttressed trunks of cypress (*Taxodium* sp.) trees at Worrell (Bass) Lake in Pasco County, Florida.

A

B

approximating the Historic P10 elevation, based on analysis of stage data and determination of the normal pool elevation (see Section 3 for additional information on the normal pool elevation).

Lake Water Level Fluctuation and the Effects of Prolonged Low Water Levels

Water level fluctuation, whether natural or human-induced can have beneficial effects on lake ecosystems. Prolonged reduction in water level may, however, negatively impact environmental and cultural values. Substantial declines in water levels at numerous District lakes in recent decades (Barcelo *et al.* 1990, SWFWMD 1996) suggest that impacts associated with low water may be quite common in our area.

The potential for adverse environmental effects associated with low water levels coupled with the directive that minimum flows and levels are to be established to prevent significant harm to the State's water resources necessitates thorough consideration of the expected effects of low water levels on Florida lakes. Documented and potential ecological effects associated with low lake water levels are therefore briefly summarized in this sub-section. Effects of low water levels on morphometric, physical, chemical and biological aspects of lakes are considered. Results from research conducted on Florida lake or wetland systems are emphasized, as these data provide the best indication of expected effects of low water levels for lakes within the District.

Effects on Lake Morphometry

- ***Absolute lake depth is decreased, and in most cases, mean depth is reduced.***
  Reductions in lake water level will result in reduced water depths throughout the basin. In all but the rare case where a lake contains one or more relatively small deep basins surrounded by extensive shallow shelves, and the water level drops below the shallow shelves to a point where only the deep basins are inundated, water level reductions will also result in a decrease in the mean water depth. Because most Florida lakes are shallow (Kenner 1964, Schiffer 1998) and occur in basins with relatively uniform and gradual slopes, water level fluctuations do not typically result in major changes in the relative proportion of "deep" and "shallow" regions.

  Water depth influences a wide range of physical, chemical, and biological characteristics of lake systems. Among these characteristics, the penetration of light of sufficient quantity and quality to support photosynthetic activity is of primary importance to lake metabolism. Other important factors related to lake depth include the heat content of the water column and sediments, the stratification or mixing of the water column, the extent of coverage of the lake surface by aquatic macrophytes, and the production and transformation of oxygen, nutrients, and other molecules of importance for biological systems.

Recreational and aesthetic qualities of lake systems may also be compromised by low water levels. Prolonged periods of low water may limit recreational activities including boating and water skiing, and may be considered unnatural or undesirable. Potential economic effects associated with reduced lake levels include losses to local and regional economies based on loss of recreational spending, and impacts to valuation of real estate.

- ***Lake surface area, volume of the underlying water column, and the area of bottom substrates are reduced.***
  The lake surface, underlying water column and bottom substrates provide habitat for a diverse array of aquatic and semi-aquatic species. Each of these regions also provide unique sites where chemical and biological transformations of nutrients, organic matter and other materials can occur. Changes in the total extent of any of these surfaces as a result of water level reductions will reduce total abundances of associated organisms and reduce the magnitude of chemical and biological processes associated with these areas. Impacts would be expected to occur in both offshore (limnetic) and inshore (littoral) regions.

  Reductions in lake surface area may also diminish recreational, aesthetic and economic values associated with lake systems.

- ***Connectivity with other surface water features (lakes, streams, wetlands) is reduced.***
  Low water levels may limit the transport of organisms and materials among lake systems or among sub-basins within individual lake basins. In addition, movement of recreational lake users may be hindered by low water levels.

Effects on Physical Characteristics and Chemical Constituents

- ***Solar radiation may penetrate through a greater proportion of the water column.***
  Increase in the area where solar radiation penetrates through the water column to bottom substrates may influence the heat content of the lake system, and increase photosynthetic activity, leading to problems with overabundant algae or aquatic macrophytes.

- ***The lake thermal regime may be altered.***
  Water temperature fluctuations in shallow lakes are typically greater and occur more rapidly than in deep-water systems. Variation in the thermal characteristics of a lake may directly affect chemical and biological processes in the water column and the sediments by altering chemical reaction rates and influencing the behavior and growth rates of lake biota. Thermal variation may indirectly alter lake conditions by influencing water column stratification and the chemical and biological systems and processes associated with stratified (or non-stratified) conditions.

- ***Mixing of the water column may increase.***
  Decreased water depth may be associated with increased mixing of the water column and resuspension of lake sediments.

  Studies conducted in Florida indicate that:

  - Shallow Florida lakes are highly susceptible to mixing of the water column by wind. For example, wind speeds as low as 5-20 miles per hour were sufficient to cause complete mixing of the water column at Lake Kissimmee (Dye *et al.* 1980).

  - Shallow Florida lakes are susceptible to increased mixing and resuspension of sediments by power boating activity, and this activity is associated with increased water column turbidity and phosphorus concentrations (Yousef *et al.* 1980).

- ***Concentrations of nutrients and other chemical constituents in the water column or sediments may change.***
  Change in water level is expected to affect lake water-column and sediment chemistry, although the complexity of biological, chemical and physical processes influencing chemical dynamics in lake systems limit the predictability of expected effects.

  Studies of the water and sediment chemistry of Florida lakes during periods of low water have shown that:

  - During recent years, annual total phosphorus concentrations in Lake Okeechobee are significantly correlated with water level (Canfield and Hoyer 1988) and monthly-average wind velocity (Maceina and Soballe 1990). The causative mechanism(s) responsible for these relationship remain uncertain despite considerable investigation (reviewed by Havens 1997).

  - Concentrations of total phosphorus, total nitrogen and non-volatile suspended solids increased in Lake Okeechobee during an extended drought when lake water level was decreased by more than three feet (Phlips *et al.* 1995a, b).

  - Following an experimental drawdown of Lake Carlton in the Oklawaha Chain of lakes, turbidity levels and concentrations of phosphorus and nitrogen during the refill period exceeded pre- and post-drawdown levels (Johnson *et al.* 1981).

  - During a water level drawdown of Lake Griffin, nitrogen and phosphorus concentrations exceeded pre-drawdown levels (Florida Game and Freshwater Fish Commission 1986).

- During a water level drawdown of Lake Tohopekaliga, concentrations of most chemical constituents in the water column increased (reviewed by Holcomb *et al.* 1975).

- Physical or chemical changes occur in Florida lake sediments exposed to air following water level reductions. Changes include consolidation of muck-type sediments and oxidation of organic matter (McKinney and Coleman 1981, Wegener and Williams 1974, Fox *et al.* 1977, Johnson *et al.* 1981).

Effects on Bacteria, Algae, and Protozoans

- ***Abundances and composition of single-celled lake organisms may be altered.***
  Increases in the relative depth of light penetration, changes in the thermal regime and altered nutrient levels associated with reduced water levels would be expected to influence growth, abundance and composition of assemblages of bacteria, algae and protozoans.

  Few studies have examined the effects of low water level on microbial assemblages in Florida lakes, although it has been shown that:

  - Concentrations of chlorophyll-a decreased in Lake Okeechobee during an extended drought when lake water level dropped by more than three feet (Phlips 1995a, b).

  - No major changes in chlorophyll a could be associated with low water levels during an extended water level drawdown of Lake Tohopekaliga (Wegener and Holcomb 1972, as summarized by Holcomb *et al.* 1975). An increase in the diversity of green and blue-green algae (cyanobacteria) was evident during the refill period following the water level drawdown.

Effects on Aquatic and Terrestrial Vegetation

Lakes typically exhibit distinct zonation of plant assemblages based on water depth (Wetzel 1983). The extent and composition of hydrophytes, *i.e.*, plants that grow in water or in substrates that are periodically anaerobic, due to the presence of water, are commonly used indicators for the delineation of wetlands (Tiner 1991). Thus, low water levels in Florida lakes would be expected to be associated with changes in aquatic and semi-aquatic vegetation.

- ***Upland vegetation may invade exposed former lake or wetland areas.***
  - In the northern Tampa Bay region, upland vegetation has invaded hydrologically stressed isolated cypress wetlands where the water table has declined one or more feet (reviewed by Rochow 1998). Similar patterns of

colonization would be expected to occur in other lake fringing wetlands as a result of extended periods of hydrologic isolation.

- During an experimental water level drawdown of Lake Carlton in the Oklawaha Chain of lakes, many terrestrial species germinated on exposed sand and organic sediments (Johnson *et al.* 1981).

- ***Lake-fringing swamp forest vegetation may be damaged.***
  In isolated cypress wetlands of the northern Tampa Bay regions, abnormally high numbers of fallen trees have been observed at sites where the water table has declined one or more feet (reviewed by Rochow 1998; SWFWMD 1999b). Similar effects may be evident in hydrologically stressed lake-fringing wetlands.

- ***The extent (coverage) of the littoral zone vegetation may increase or decrease, and the composition of the assemblage may change.***
  Water level drawdown is a commonly used technique for managing aquatic macrophyte populations in reservoirs and lakes where water levels can be manipulated (reviewed by Leslie 1988, Greening and Doyon 1990, Cooke *et al.* 1993). The effects of water level drawdown, and low lake water levels in general, on littoral zone vegetation are influenced by several factors, including basin morphometry and the magnitude, duration and seasonality of the water level reduction.

  Studies of changes in vegetation associated with the low water levels during water level drawdown at Florida lakes have demonstrated that:

  - The coverage of littoral zone vegetation expanded during an extended reduction in water level in Lake Tohopekaliga (Holcomb and Wegener 1971). Shifts in relative abundance and distribution following the water level drawdown were in concordance with plant distribution and composition data collected at the lake in 1956, during a natural low-water period (Sincock and Powell 1957).

  - Major changes in the composition of the aquatic vegetation occurred at shallow sites in Lake Oklawaha (Rodman Reservoir) during a five-month water level drawdown (Hestand and Carter 1974, 1975).

Effects on Invertebrates

- ***Invertebrate abundance, biomass, assemblage composition or taxa (species) richness may change.***
  Aquatic invertebrates are typically common and abundant members of lake communities due to their relatively high rates of growth and reproduction (in warm conditions) and because many species have highly developed colonization traits (Pennak 1989). These traits impart great resilience to invertebrate

assemblages, but impacts associated with water level variation are evident in some assemblages.

For example, invertebrates in re-flooded littoral areas of reservoirs following water level drawdowns may take months to recover to levels comparable to those in continuously flooded areas (Kaster and Jacobi 1978), Hale and Bayne 1980). Post-disturbance rates of recovery may, however, be more rapid in Florida lakes (*e.g.*, see Fuller and Cowell 1985), due to the effect of warm water on invertebrate growth and reproduction.

Effects of low water level on aquatic invertebrate assemblages in Florida lakes may include changes in total numbers or biomass, changes in densities per unit area or volume, or changes in assemblage composition and species richness. These changes may occur as a result of reduction in habitat quantity or quality, including loss of, or shifts in the composition of littoral vegetation and food resources, or changes in sediment characteristics.

Studies of Florida lake invertebrate assemblages that provide information relevant to the evaluation of the effects of low lake water levels have demonstrated that:

- Zooplankton abundance is inversely correlated with lake stage at Lake Okeechobee, based on data collected from 1988-1992, a period which included a drought that resulted in the lowering of water level by more than three feet (Crisman *et al.* 1995, Beaver and Havens 1996). The relationship between water level and abundance is much stronger for rotifers than for microcrustaceans. During the period of low water levels, zooplankton densities were greatest at the open water/littoral transition zone.

- During a water level drawdown of Lake Tohopekaliga, limnetic benthic macroinvertebrate densities did not vary from pre-drawdown levels, although littoral benthic and epiphytic (plant-associated) macroinvertebrate abundances were low, due to loss of vegetation in the littoral zone (Wegener *et al.* 1974).

Effects on Fish

- ***Fish abundance, biomass, assemblage composition or species richness may change.***
  Low water levels in Florida lakes may be expected to influence fish abundance, biomass or assemblage composition as a result of decreased total lake area, change in littoral zone vegetation composition of coverage, or reduced connectivity with fringing forested wetlands.

  Across a broad range of lake sizes, lake surface area is generally directly proportional to total fish abundance and biomass. This relationship is based on simple geometry; greater lake surface area means more potential fish habitat is available. Fish abundance or biomass per unit area is, however, often inversely related to lake area because larger lakes tend to have a smaller proportion shallow, vegetated areas, which are important breeding, foraging or refuge areas for many fish species.

Of relevance to an evaluation of low lake water levels, studies of Florida fish assemblages indicate that:

- Small forage fish typically dominate marsh and swamp fish assemblages in South Florida (Carlson and Duever 1978, and papers cited therein).

- Fish biomass in Florida lakes is typically greater in littoral versus limnetic regions (Williams *et al.* 1985).

- Species richness of fish assemblages is positively correlated with lake surface area (Keller and Crisman 1990, Bachmann, *et al.* 1996).

- Limnetic (offshore) fish biomass remained stable during a reduction in water level lasting nearly six months at Lake Tohopekaliga (Wegener and Williams 1974). This was surprising, because limnetic fish biomass was expected to increase as fish moved from dewatered, inshore littoral regions during the drawdown. Littoral fish biomass was not determined during spring 1971, when water level was lowest, but was comparable to pre-drawdown levels by fall of that year.

Effects on Other Vertebrates

- ***Abundances, biomass or species richness of other lake-associated vertebrates may decline as a result of low water levels.***
  Studies or reviews of lake-associated vertebrates in Florida that are relevant to the issue of low lake water levels indicate that:

  - Bird abundance, biomass and species richness are correlated with lake surface area (Hoyer and Canfield 1990, 1994).

  - Lake-fringing cypress wetlands may provide refuge for amphibians and reptiles (Wharton *et al.* 1976).

Section 3

Establishing Minimum Water Levels for Lakes with Fringing Cypress Wetlands

Introduction

The pioneering work of the District Lake Levels Program staff in the 1970s and 1980s guided the recent development of standards for establishing minimum levels for lakes with fringing cypress wetlands (Category 1 and 2 Lakes). Similarly, the ground-breaking effort involving cypress wetland fringed lakes (SWFWMD 1999a) may guide development of methods for establishing minimum levels for lakes that lack cypress-dominated wetlands. Key factors and methods used to establish minimum levels for lakes with fringing cypress wetlands are reviewed in this section to provide an appreciation for how these concepts and techniques may be used to develop an approach for establishing minimum levels for other lake types.

Applicability of the Method for Establishing Minimum Lake Levels

The initial determination of whether minimum levels can be established for a lake using the recently developed methods for lakes with cypress fringing wetlands involves evaluation of the size of the cypress wetland associated with the lake. For application of the methodology, a cypress-dominated wetland of at least one half acre in size must be contiguous with the lake. This wetland-size criterion is rooted in current District policy (SWFWMD 2000) and procedures (SWFMWD 2001a) regarding the permitting of construction and operation of surface water management systems. The Governing Board has proclaimed that through District permitting activities, a goal of no net loss of wetlands and other surface water functions is to be achieved. Regulated activities, including the need for mitigation, are not, however, typically required for impacts to isolated wetlands of less than one half acre in size (SWFWMD 2001a). This procedural permitting criterion was adopted for use in the establishment of minimum lake levels as a means to prevent lakes from being classified as having fringing cypress wetlands when only a few trees, possibly remnants of former wetlands, remain along the lakeshore.

Lake Water Level Fluctuations and Hydrologic Data

Lake water levels in Florida are dynamic (Hughes 1974). Water level fluctuations are associated with changes in the ratio of water input and output (*i.e.*, the water budget). Natural processes influencing lake water budgets include seasonal weather patterns, long-term climatic trends, and catastrophic events, such as sinkhole formation or closure. Human activities influencing lake water budgets include structural alterations (*e.g.*, installation of road culverts and dams, modification of inflow or outflow channels), operations at inflow or outflow points (*e.g.*, pooling and release of water from a dam), and consumptive use of surface or ground water.

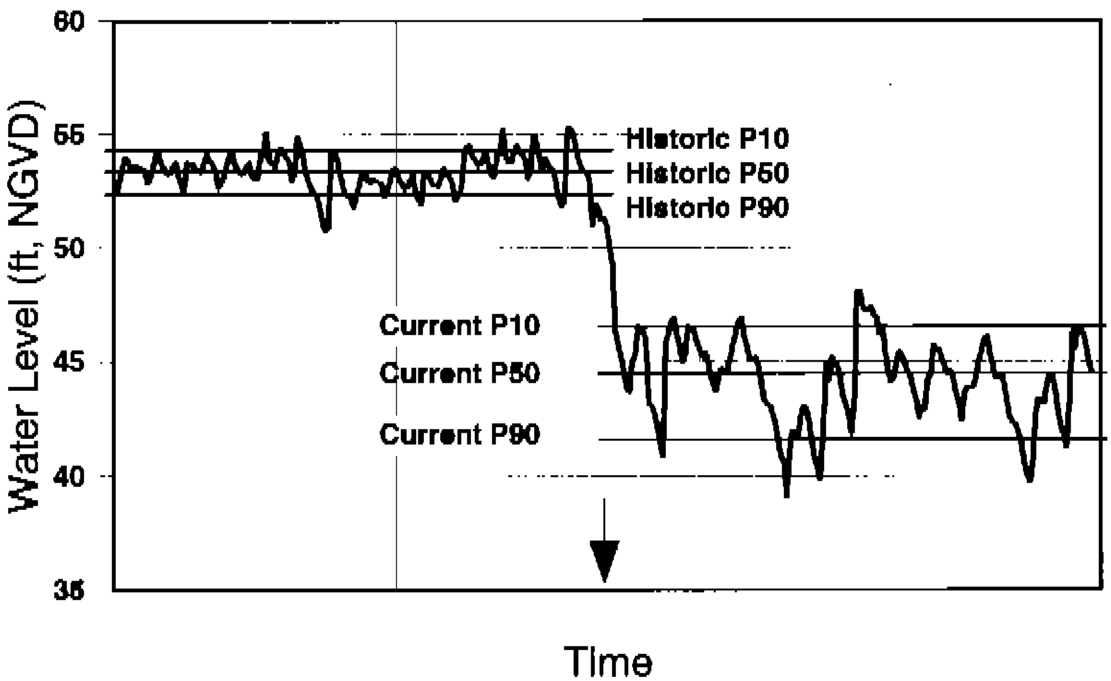
The determination of lake water level fluctuations pre-dating anthropogenic modifications or withdrawals is an important step in the establishment of minimum lake levels. The identification of structural alterations that currently influence lake water level fluctuations is also important because legislation requiring establishment of minimum flows and levels allows for impacts resulting from existing structural alterations, but not for those associated with water withdrawals.

Hydrologic data on water level elevations are available for many District lakes. These data, referred to as stage data or lake-stage data, are useful for evaluating patterns in water level fluctuations and establishing minimum levels. The period of record of stage data varies considerably from lake to lake, however, and may include periods when water level elevation has been impacted by structural alteration or by water withdrawals. District staff have developed methods for identifying impacts to lake stage resulting from structural alterations or regional well field withdrawals based on review of lake hydrographs and reports of drainage modifications, field reconnaissance of lake structures, and numerical simulation of the spatial extent of aquifer drawdown in areas surrounding known withdrawal sites. 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. Classification of hydrologic data as Historic or Current is also typically predicated on the data having been collected for a period of at least six years.

Historic lake data can be used to estimate the range of water level fluctuation likely to occur in a lake that is not influenced by water withdrawals, but which may be influenced by structural alteration. This range of fluctuation is statistically defined by determining the lake stage elevations that have been exceeded ten, fifty and ninety percent of the time during a specified period of record. These statistics are determined using mean monthly water levels and the elevations associated with these statistics are referred to as the Historic P10, Historic P50 and Historic P90.

Current data can be used to estimate lake stage fluctuations for periods when water withdrawals have been measurable, and structural alterations may have been in place. Current P10, Current P50 and Current P90 values are calculated in a manner similar to that used for determining Historic lake stage fluctuation statistics. The concepts of Historic versus Current hydrologic data, and exeedence percentiles are illustrated in Figure 3-1.

Figure 3-1. Hydrograph of a hypothetical lake for periods pre-dating (Historic) and post-dating (Current) the onset of water withdrawals. Water level elevation, in feet relative to the National Geodetic Vertical Datum (NGVD) is indicated by the thin, solid, line. Initiation of water withdrawals, which in this example coincides with a reduction in water levels, is indicated by the arrow along the x-axis. See text for explanation of the Historic and Current percentile (P10, P50, P90) statistic.



The Reference Lake Water Regime

The establishment of minimum lake levels requires information on the water level fluctuation of a lake as influenced by current structural alteration but in the absence of groundwater withdrawals (*i.e.*, Historic data). Unfortunately such information is generally lacking for most lakes within the District, and must be inferred on the basis of best available information. In cases were adequate Historic data do not exist for a lake, a surrogate fluctuation range statistic is developed using a group of typical lakes within a specified region that have experienced little or no impacts from water withdrawals. Lakes used to develop this inferential statistic are referred to as reference lakes.

Using stage data from reference lakes, an estimate of the range of water level fluctuation likely to occur in a particular region is developed. This range of fluctuation is statistically defined by two variables, the Reference Lake Water Regime 50 (RLWR50) and the Reference Lake Water Regime 90 (RLWR90). The RLWR50 represents the median difference between the reference lake P10 and P50 values, and the RLWR90 represents the median difference between the reference lake P10 and P90. Based on analysis of twenty-two reference lakes in the northern Tampa Bay area, it has been determined that appropriate RLWR50 and RLWR90 values for this region are 1.0 and 2.1 feet, respectively (SWFWMD 1999a).

In the absence of Historic lake stage data, the RLWR50 and RLWR90 are used to estimate the Historic P50 and P90 values. To accomplish this, the Historic P10 must be determined. Fortunately, in the absence of true Historic water level fluctuation data, the Historic P10 can often be established with reasonable assurance using hydrologic indicators of "normal pool."

Normal Pool and Significant Change Standards

The "normal pool", a concept adopted from the approach used for establishing isolated cypress wetland minimum levels, essentially corresponds to the P10. Hydrologic Indicators of normal pool include biological and physical features that become established as a result of recent or long-term water levels. Five Hydrologic Indicators of normal pool elevation in isolated cypress-dominated wetlands have been identified (SWFWMD 1999b). Some indicators, such as the buttress height of large cypress trees (see Figure 2-1 in the previous section of this report) can be used as indicators of long-term normal pool, since they persist in place for an extended period of time, while others (*e.g.*, adventitious rooting on St. John's Wort, *Hypericum fasiculatum*) tend to track more recent water levels. Identification of the normal pool elevation may therefore be used to determine the Historic P10, or the P10 elevation pre-dating structural modification(s) that currently prevent water from rising to former levels.

The significant change standards for establishing minimum levels for lakes with fringing cypress wetlands are based on variation in water level below the normal pool elevation. Research on isolated cypress wetlands indicates that these wetlands may be significantly harmed if the median (P50) water level elevation, which is often below the soil surface, is more than 1.8 feet below normal pool elevation (SWFWMD 1999b). Significant harm may also be expected to occur if the water level elevation exceeded only ten percent of the time, *i.e.*, the P10 elevation, is more than 0.4 feet below the normal pool elevation.

Evaluating Structural Alteration of Lake Outlets

When establishing minimum levels for lakes with fringing cypress wetlands, structural alterations that affect the lake control point are also considered. A lake control point elevation is the elevation of the highest stable point along the outlet profile of a surface water conveyance system (*e.g.*, ditch, culvert, or pipe) that is the principal control of water level fluctuation in the lake. For lakes with fringing cypress wetlands, the control point and normal pool elevations are compared to determine if the lake has been structurally altered. If the control point elevation of the lake is below the normal pool elevation then the lake is judged to be structurally altered. If the control point elevation is above the normal pool elevation or the lake has no outlet, then the lake is not considered to be structurally altered.

Establishing Minimum and Guidance Levels for Category 1 and 2 Lakes

The establishment of Minimum and Guidance Levels for cypress-wetland fringed lakes is preceded by the compilation of lake stage data, calculation of stage-duration percentile statistics, characterization of the data as Historic or Current, the determination of normal pool and control point elevations, and the development of a region-specific reference lake water regime. Minimum levels, the High Guidance Level and the Low Guidance Level are established based on a series of dichotomous choices concerning the type of stage data available and the relative elevations of the suite of descriptive stage-duration statistics (see Figures 13-16 in SWFWMD 1999a). The Ten-Year Flood Guidance Level is determined using hydrologic data, and numerical or simulation models (Chapter 40D-8, F.A.C).

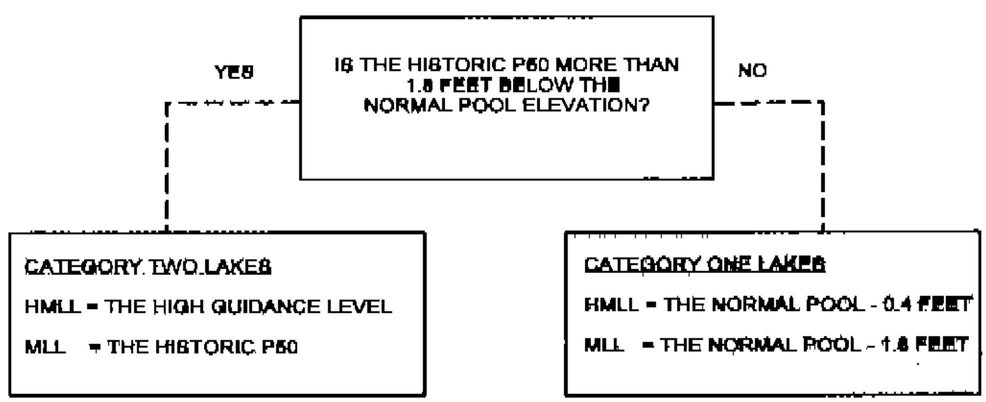
The High Guidance Level (HGL) is established as an advisory guideline for local governments and lakeshore residents to aid in the proper siting of lakeshore development and water-related facilities, including docks and seawalls. The High Guidance Level may also be used by the District for operation of water control structures. The High Guidance Level corresponds to the expected Historic P10 and is calculated using Historic data if available, or estimated using the Current P10, the control point elevation and the normal pool elevation. If only Current data are available and the lake is structurally altered, the High Guidance Level is established as the higher of the control point elevation or the Current P10. If only Current data are available and the lake is not structurally altered, the High Guidance Level is established as the higher of the normal pool elevation or the Current P10. If Historic or Current data are unavailable, and the lake has been structurally altered, the High Guidance Level is established at the control point elevation. If Historic and Current data are unavailable and the lake has not been structurally altered, the High Guidance Level is established at the normal pool elevation.

The Low Guidance Level (LGL) is established as an advisory guideline for local governments and lakeshore residents to aid in the proper siting of lakeshore facilities, including docks and seawalls and to inform lake users of expected low water levels. The Low Guidance Level may also be used by the District for operation of water control structures. The Low Guidance Level corresponds to the expected Historic P90 and is calculated using Historic data if available, or estimated using the Current P10 and P90, the High Guidance Level, and the RLWR90 for the region. If only Current data are available, and the difference between the Current P10 and the Current P90 is greater than or equal to the RLRW90, the Low Guidance Level is established at an elevation corresponding to the High Guidance Level minus the RLWR90. If only Current data are available, and the difference between the Current P10 and Current P90 is less than the RLWR90, the Low Guidance Level is established at an elevation corresponding to the High Guidance Level minus the difference between the Current P10 and Current P90. If Historic or Current data are unavailable, the Low Guidance Level is established at an elevation corresponding to the High Guidance Level minus the RLWR90.

The Historic P50 is established using Historic data, if available, or Current data, the High Guidance Level and the RLWR50 for the area. If only Current data are available and the difference between the Current P10 and Current P50 is greater than or equal to the RLWR50, the Historic P50 is established at an elevation corresponding to the High Guidance Level minus the RLWR50. If only Current data are available, and the difference between the Current P10 and the Current P50 is greater than or equal to the RLWR50, the Historic P50 is established at an elevation corresponding to the High Guidance Level minus the difference between the Current P10 and the Current P50. If Historic or Current data are unavailable, the Historic P50 is established at an elevation corresponding to the High Guidance Level minus the RLWR50.

The High Minimum Lake Level (HMLL) and Minimum Lake Level (MLL) are established using the High Guidance Level, the Historic P50, the normal pool elevation, and significant change standards developed for isolated cypress wetlands (Figure 2-3). These minimum levels represent elevations that lake water levels must equal or exceed ten and fifty percent of the time on a long-term basis. To determine the minimum levels, the Historic P50 is compared to the elevation of the significant change standard elevation for lakes with fringing cypress wetlands (the normal pool elevation minus 1.8 feet). If the Historic P50 is higher than the significant change standard elevation, the lake is classified as a Category 1 Lake. The High Minimum Lake Level for Category 1 Lakes is established at an elevation corresponding to the normal pool elevation minus 0.4 feet, and the Minimum Lake Level is established at an elevation corresponding to the normal pool elevation minus 1.8 feet. If the Historic P50 is lower than the significant change standard elevation, the lake is Classified as a Category 2 Lake. The High Minimum Lake Level for Category 2 Lakes is established at the High Guidance Level and the Minimum Lake Level is established at the Historic P50.

Figure 3-2. Derivation of the High Minimum Lake Level (HMLL) and Minimum Lake Level (MLL) for lakes contiguous with cypress-dominated wetlands of 0.5 or more acres in size.



The Ten Year Flood Guidance Level is established as an advisory guideline for lake shore development. The Ten Year Flood Guidance Level incorporates 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 is established using methods that correspond to the hydrology and type of conveyance system of the lake being evaluated.

The Ten Year Flood Guidance Level for "open basin lakes", which are lakes that have a surface water conveyance system that by itself, or in series with other lakes, connects to or is part of an ordered surface water conveyance system is established using numerical single storm event models. Rainfall depths are taken from Part D of the District's Environmental Resource Permitting Information Manual described and incorporated by reference in Rule 40D-4.091, F.A.C. Runoff volumes are computed using conventional methods such as the National Resources Conservation Service (NRCS) curve number method, or with standard infiltration formulas (*e.g.*, Horton's Equation, Green-Ampt Equation). Runoff distributions are computed using conventional methods including the NRCS method or other unit hydrograph methods, or the kinematic wave overland flow method. Modeling programs that account for tailwater and compute backflow (dynamic models) are preferred for the hydraulic routing.

The Ten Year Flood Guidance Level for "closed basin lakes", which are lakes that do not connect to, or are not part of an ordered surface water conveyance system is derived using a frequency analysis of lake stage readings, or lake stages predicted by a physically based numerical "continuous simulation model," or an empirical simulation model derived by regression methods. Reasonable scientific judgment is used to classify a lake as a closed basin lake where hydrology or hydraulic characteristics (*e.g.*, intermittent or periodic discharge) are associated with a lake such that the lake does not clearly meet the definition of a closed basin lake nor open basin lake. Selection of the method used to derive the Ten Year Flood Guidance Level for closed basin lakes is based on reasonable scientific judgement. Simulation periods for either numerical or empirical models are based on thirty or more years of contiguous rainfall record. A composite of more than one rainfall station in the region in which the subject lake is located is acceptable. Calibration of the simulation model shall be based on as many of the following indicators as possible: stage records and Hydrologic Indicators of water levels. If stage records or Hydrologic Indicators do not exist or the record does not contain peak elevation readings, then eye-witness accounts of peak stages are considered. Model simulations to determine the Ten Year Flood Guidance Level exclude effects of water withdrawals.

Section 4

Standards for a Multiple-Parameter Approach to Establishing Minimum Levels for Category 3 Lakes

Current Approaches and Recommendations For Establishing Minimum Levels for Florida Lakes

As outlined previously, numerous changes in lake structure and function may be expected with long-term lake stage reductions. These changes range from seasonal, cyclic shifts in biological communities and their associated functions, to potential degradation of ecological and cultural values following long-term water level reduction. Many, if not most of these changes occur in a continuous manner, *i.e.*, small changes in elevation are associated with small changes in the attributes or values, and few exhibit break-points or thresholds, which if crossed would result in the occurrence of marked or notable differences. The continuum of changing lake attributes and values associated with water level change makes it difficult to identify or develop science-based significant change standards for use in the establishment of minimum water levels.

The approach used by the District to develop minimum levels for lakes with fringing cypress wetlands serves as a good example of the development and use of significant change standards based on the coupling of quantitative hydrologic data and qualitative assessments of wetland integrity. This approach involves identification of elevations associated with significant change standards which must be exceeded for specified time intervals to prevent significant harm to cypress-dominated wetlands contiguous with lakes. An independent review of the methodology found the approach developed by the District to be "scientifically reasonable and defensible" (Bedient *et al.* 1999). District staff anticipate that the standards used for evaluating potential degradation of lake fringing wetlands dominated by cypress trees will be complemented by review of numerous other factors as a multiple-parameter approach is implemented for establishing minimum levels for District lakes.

Other water management districts of the State are currently developing and implementing programs for establishing minimum lake levels. In all cases, minimum levels are established based on review of multiple lake characteristics or parameters. For example, the South Florida Water Management District (SFWMD 2000) has proposed minimum levels for Lake Okeechobee based on relationships between lake water level and a variety of environmental and cultural factors, including water supply needs for consumptive use, and maintenance of flow in downstream basins or canals for prevention of salt-water intrusion, navigation and recreational needs, and changes in littoral zone vegetation. The St. Johns River Water Management District has developed minimum levels for approximately eighty lakes based principally on inundation depth requirements for wetland vegetation and hydric soils persistence, analyses of lake stage data, and hyrdologic modeling (*e.g.*, Neubauer 1997, Hall and Borah1998).

The utility and relative costs associated with detecting changes in lake characteristics resulting from water level reduction were recently summarized by Biological Research Associates (1996, 1997, 1999). Review of several factors, including: (1) reduction in lake volume; (2) reduction in lake area; (3) reduction in substrate (habitat) availability, in terms of reduction in sediment area and area available on submerged objects, including plants; (4) alteration of connectivity with other water bodies; (5) alteration of the vegetation cover in the littoral zone; (6) alteration of plant species composition in the littoral zone; and (7) changes in associated wetlands was indicated to be of relatively high value for detecting and quantifying ecological impacts resulting from water level reductions.

The independent panel charged with review of the minimum levels methods for cypress wetland fringed lakes identified the need for development of additional indicators of lake condition for development of minimum levels. For this purpose, they noted that "the three most logical choices that occurred to the Panel and were reiterated by the recent Biological Research Associates (1999) submission involve lake volume, lake area, and littoral plant assemblages." (Bedient *et al.* 1999). The following text, excerpted from the Panel's report, summarizes their recommendations concerning the utility of these factors for developing minimum levels.

> Lake volume and area will decline as a function of decreasing depth and the morphometry of the lake. Some assumption of general lake shape (truncated inverted cone) would allow a calculation of approximate loss of volume or area with decreasing depth, but more detailed morphometric information would not be difficult to collect for adopted lakes. The more difficult aspect of this approach is deciding at what level of lost volume or area there is significant harm to the lake. Any detailed, quantitative estimate will require further study, so the District is not to be faulted for failing to apply this approach on purely scientific grounds.
>
> However, it would reasonable to make an initial policy decision about approximate levels of loss that would be tolerated until a more scientific study could be completed. Losses such as 10 percent of the volume or area for up to 90 percent of the time would be consistent with the RLWR approach. Setting a maximum loss for the other end of the distribution is more difficult. Surely the lakes cannot sustain a 90 percent loss for up to 10 percent of the time; values more on the order of 75 percent for up to 10 percent of the time seem more appropriate. However, this is largely a policy decision based on reasonable scientific constraints, and should be adjusted over time as information becomes available through concerted studies or routine monitoring of adopted lakes.
>
> The use of the littoral plant community is a possible surrogate for fringing cypress wetlands, as some form of littoral vegetation would be expected in almost all lakes whether or not there are cypress trees present. The impact of water level decline on littoral vegetation has been studied extensively (Cooke et al., 1993), and vegetation community analysis is not an especially difficult or expensive task. Aerial photographs or digital image analysis techniques would be advantageous in this regard, if the scale is appropriate. Field investigations could focus on test plots that could be monitored on a standard time scale, much like water-level gauges.
>
> Setting the level of acceptable impact will require a combination of local study and policy decision, but it seems appropriate to suggest that any water level decline that eliminates aquatic species from the littoral community would be unacceptable. Replacement of aquatic species with terrestrial forms would be a clear indication of unacceptable alteration of the water level regime. Lesser degrees of loss could be assessed on the basis of areal coverage, community richness, or community diversity. As many factors other than water level affect the littoral zone plant assemblage (e.g., herbicide application, disease, herbivory), the relationship of water level to the aquatic plant community is unlikely to be as reliable as for cypress trees, but this approach has potential.

Implementation of this improvement could come in phases. Initial adoption of target lake volume and area values would require considerable discussion but limited field effort. Establishing quantitative relationships between in-lake features and water levels will be a major and protracted effort, much like the development of wetland health indicators.

Bedient *et al.* (1999)

Legislative Guidance for a Multiple-Parameter Approach to Minimum Levels Establishment

Before considering the rationale for developing new standards for a multiple-parameter approach to the establishment of minimum levels for Category 3 Lakes, it may be useful to review the guidance on this subject contained in State law and policy. Minimum Levels, defined as the "level of surface water at which further withdrawals would be significantly harmful to the water resources of the area", are to be established using the best available information (Section 373.042, F.S.). When appropriate, minimum levels may be established to reflect seasonal variation, and to protect nonconsumptive uses. Minimum levels are also to be established based on 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..." (Section 373.0421, F.S.). Legislation guiding the establishment of minimum levels acknowledges that certain water bodies no longer serve their historical hydrologic functions, and that establishment of a minimum levels for these waterbodies based on historical conditions is not technically or economically feasible. In addition, the establishment of minimum levels for water bodies less than twenty-five acres in size and for constructed water bodies (*i.e.*, reservoirs) is not required unless such areas have significant value or are an essential element of the water resources of the area.

State Water Policy (Chapter 62-40.473, F.A.C.) provides additional guidelines for the establishment of minimum levels pursuant to Section 373.042, F.S., stating that "consideration shall be given to the protection of water resources, natural seasonal fluctuations in water flows or levels, and environmental values associated with coastal, estuarine, aquatic and wetlands ecology, including:

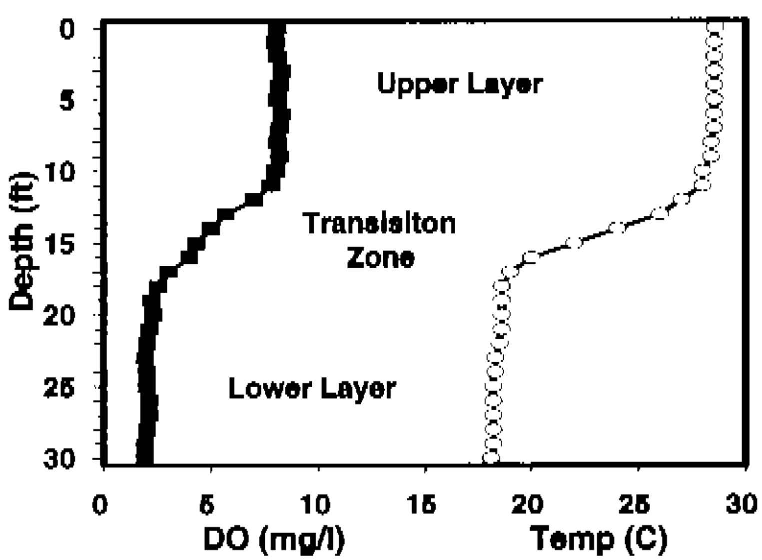
(a) Recreation in and on the water;
(b) Fish and wildlife habitats and the passage of fish;
(c) Estuarine resources;
(d) Transfer of detrital material;
(e) Maintenance of freshwater storage and supply;
(f) Aesthetic and scenic attributes;
(g) Filtration and absorption of nutrients and other pollutants;
(h) Sediment loads;
(i) Water quality; and
(j) Navigation."

The District is committed to developing minimum lake levels which address the concerns and guidance provided by State lawmakers. Recommendations regarding the use or consideration of variety factors for a multiple-parameter approach to the establishment of minimum lake levels for Category 3 Lakes are outlined in the following sub-sections. Where appropriate, limitations regarding the scientific basis for the proposed approaches are identified. Acceptance of any of these recommendations will require evaluation of the best available data in terms of compliance with current District policies and rules, and substantial deliberation by the Governing Board concerning the scope of changes that may be considered to constitute significant harm to the water resources of the area.

Evaluation of Changes in Lake Mixing and Susceptibility to Sediment Resuspension

Water depth and lake surface area are important determinants of a lake's energy budget. As light and wind-induced turbulence penetrate the water column of a lake, transfer of energy to the lake water may result in a process termed thermal stratification. Thermal stratification essentially involves the partitioning of the water column into two distinct layers of water separated by a transition zone (Figure 4-1) This process strongly influences the dynamics and state of physical, chemical and biological processes occurring within lake basins.

Figure 4-1. Water column profiles of temperature (Temp, open circles) and dissolved oxygen concentration (DO, filled squares) for a stratified lake. Thermal stratification results in the partitioning of the water column into two distinct layers, separated by a transition zone. As shown here for dissolved oxygen concentration, many chemical and biological parameters are affected by thermal stratification.



Based on typical lake basin morphology, very few lakes in the District are expected to develop stable thermal stratification. For those that do, however, any decrease in depth sufficient to disrupt the stratified state would be expected to cause major changes in ecosystem properties, including impacts to fish and wildlife habitat and water quality. The evaluation of potential changes in lake mixing patterns may, therefore, be useful for establishing minimum lake levels in accordance with the guidelines provided by State Water Policy.

As lake depth decreases, the potential for wind action to mix the entire water column and resuspend bottom sediments increases. Resuspension of sediments may affect water column transparency and productivity, leading to a multitude of ecological changes. For example, a reduction in transparency reduces the depth to which light penetrates the lake water column, which in turn may affect the composition and abundance of submersed aquatic macrophytes likely to occur, thereby affecting the abundance of organisms that utilize macrophyte habitat. Productivity of aquatic organisms, including the phytoplankton, may be increased as a result of resuspension of nutrients sequestered in bottom sediments. Increased productivity may have positive effects, such as increases in fishing potential, but may also be associated with negative consequences, including oxygen deficits and in extreme cases, fish kills.

Resuspension of bottom sediments occurs when wind-generated currents extend to the lake bottom. A decrease in mean lake depth associated with decreased water levels is typically associated with an increase in the extent of bottom substrates susceptible to resuspension. The fetch, or distance over which the wind blows across a lake, is also important in this process; decreases in fetch (resulting from a decrease in surface area) can, in part, counter the effects of decreasing mean depth.

Lakes with areas of depth sufficient to be protected from wind-driven sediment resuspension may be classified as "deep" lakes. Those which are of a depth such that the entire basin is subject to sediment resuspension may be classified as "shallow" lakes. In a recent study of thirty-six Florida lakes, Bachmann *et al.* (2000) identified an index which could be used to segregate lakes according to the extent of the basin susceptible to wind-driven sediment disturbance. This index, the "dynamic ratio", is simply the square root of the lake surface area in square kilometers divided by the mean depth in meters (Håkanson 1982). Among the lakes studied by Bachmann *et al.*, those with a dynamic ratio of about 0.8 or greater were found to be entirely subject (for some of the time) to wind-driven mixing of the water column and subsequent sediment disturbance. Lakes with a dynamic ratio of less than 0.8 exhibited a significant, positive relationship between the dynamic ratio and the percentage of lake basin subject to disturbance for some of the time.

The transformation of a deep lake to a shallow lake, which could occur as a result of reduced water levels, has been suggested to be of sufficient ecological importance to be useful as a significant change criterion for minimum levels establishment. Although the concept is valid, mixing in small, deep lakes (comparatively speaking), which are common in most regions of the District, are not substantially affected by changes in mean lake depth on the order of a few feet. Large, shallow lakes are more susceptible to major shifts in the extent of lake bed where wind-induced sediment resuspension can occur. Nonetheless, a significant change standard could be defined as the elevation within a lake basin, at which lesser water levels would result in the transformation of a deep lake to a shallow lake or a shallow lake to a deep lake.

Consideration of dynamic ratio values for several lakes within the Northern Tampa Bay region serves to illustrate that the index may not prove useful for the establishment of minimum levels. Bathymetric data for 14 lake systems in the region were recently collected and processed using a GPS/GIS and sonar-based system as described in Leeper (2001). Dynamic ratio values were estimated for various lake stages according to the approach outlined in Bachmann, *et al.* (2000). Changes in lake stage through the range bounded by Current P10 and P90 elevations were not associated with shifts in index values of a magnitude which would lead to reclassification of any of the lake systems as a deep or shallow lake (Table 4-1). That is, within the range of lake stages from the P10 to the P90 elevation, none of the lakes exhibited a shift in lake-mixing index across the 0.8 threshold.

An alternative use of the dynamic ratio for minimum levels establishment would involve development of a standard based on change in the percentage of lake basin subject to wind-driven suspension for some of the time. For example, an acceptable percentage of lake basin subject to disturbance could be established (*e.g.*, 50%), and used as a standard for evaluating potential change in the dynamic ratio as a function of change in water level. Alternatively, a defined change (*e.g.*, 20%) in the extent of basin susceptible to wind-driven disturbance, relative to an identified state value could be considered sufficient to constitute a significant change in basin characteristic, and therefore be used to develop a significant change standard.

District staff recommend that possible shifts in patterns of thermal stratification and the extent of area susceptible to sediment resuspension be reviewed for development of minimum lake levels. These factors are not, however, expected to become important considerations for most lakes. In general, substantial changes in lake mean depth would be required before most District lakes would exhibit major change in the extent of lake bed affected by wind-induced turbulence. Review of potential shifts in lake thermal stratification patterns and mixing could be incorporated into a multiple-parameter approach to minimum levels establishment through consideration of changes of this nature on a case-by-case basis.

Table 4-1. Range of dynamic ratio values (an index of lake mixing; see text) for lake stages between the Current P10 and Current P90 elevations for fourteen Northern Tampa Bay lake systems.

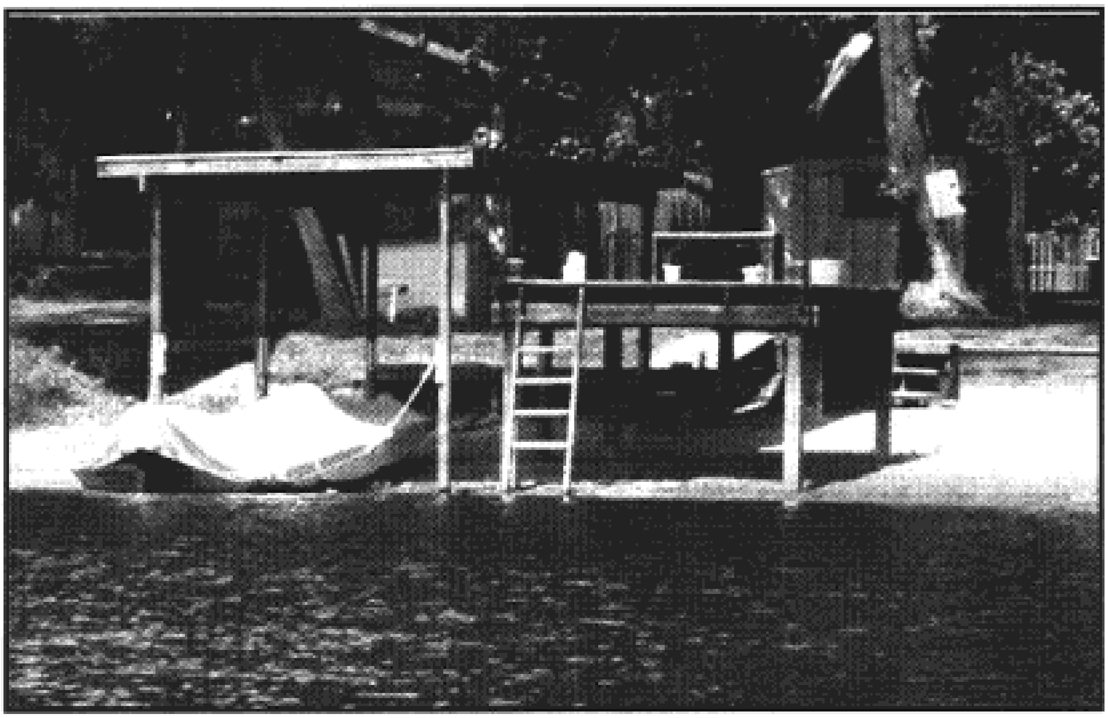
Lake System	Range in Lake Elevation (Current P10 to Current P90) Ft, NGVD	Dynamic Ratio Values (Minimum to Maximum)
Big Fish	75.9 - 67.6	1.0 - 2.5
Calm	49.2 - 45.1	0.2 - 0.3
Church/Echo	35.6 - 30.8	0.2 - 0.3
Crenshaw	55.5 - 50.7	0.1 - 0.2
Cypress	48.7 - 44.3	0.1 - 0.1
Fairy	33.42 - 30.7	0.2 - 0.2
Halfmoon*	44.0 - 39.57*	0.1 - 0.1
Helen/Ellen/Barbara	53.4 - 49.8	0.1 - 0.1
Hobbs	60.38 - 65.61	0.2 - 0.2
Raleigh	40.4 - 30.7	0.1 - 0.1
Rogers	37.9 - 30.0	0.2 - 0.3
Round	54.1 - 53.2	0.1 - 0.1
Saddleback	54.6 - 52.4	0.2 - 0.3
Starvation	52.0 - 45.7	0.3 - 0.3

* Data are for lake stages approximating the P10-P90 interval pre-dating installation of a water control structure at Halfmoon Lake in spring 1998.

Evaluation of Changes in Water Depth Associated with Docks

Change in lake water levels may have important consequences for human safety, navigation or recreational use of lakes, affecting activities such as the mooring and launching of boats and other watercraft (Figure 4-2). In addition, boating activity in water of insufficient depth may adversely affect lake water quality and impact benthic and littoral flora and fauna. Review of potential effects associated with low water levels and elevations associated with docks may therefore be considered consistent with State Water Policy guidelines for minimum levels development.

Figure 4-2. Water level is too low for proper mooring of this boat at Halfmoon Lake in Hillsborough County, Florida.



Regulations governing the installation of docks, piers, and other similar structures have been developed at numerous jurisdictional levels (see reviews by Czerwinski and McPherson 1995 and Yingling 1997). In Florida, compliance with FDEP rules may be required if the proposed dock or pier is located within an Aquatic Preserve (FDEP 1999, 2000). Within the District, additional requirements specified in District Rules and county ordinances or codes must also be met.

A minimum water depth requirement is typically included in regulations concerning dock construction and installation. This requirement is usually intended to prevent degradation of water quality or habitat destruction which may occur when watercraft come into contact with or disturb lake sediments or benthic biota. For example, District

Rules governing Environmental Resource Permits (Chapter 40D-400 F.A.C.) require "a minimum depth of two feet below the mean low water level in tidal waters or two feet below the mean annual low water level in non-tidal waters" for installation, alteration or maintenance of boat ramps and associated accessory docks", and similarly require a two-foot depth for all areas designed for boat mooring and navigational access for single-family piers (SWFWMD 2001b). For Class II Waters, which are waters approved for shellfish harvesting, permits for private, single-family boat docks may be issued if (among other factors) the mooring area "is located in water sufficiently deep to prevent bottom scour by boat propellers" (SWFWMD 2001a).

Local codes and ordinances may also require specific water depths at dock areas designed for boat mooring or loading. In Hillsborough County, the Environmental Protection Commission requires that a dock proposed for use with a boat "must be located so that a minimum of two feet of depth exists under the slip area during Ordinary Low or Mean Low Water conditions. This condition is meant to minimize the potential for any prop-dredging of the substrate during periods of lowered lake level" (Hillsborough County EPC 2001). Similarly, in Pinellas County, docks in tidal and non-tidal waters are required to have at least 18 inches of water depth at mean low tide, or as measured at the ordinary low water elevation, respectively, and shall have a continuous channel with a minimum of 18 inches of water depth to allow access to open water (Pinellas County Code 1996). At Lake Tarpon, the largest lake in Pinellas County, the minimum depth requirement is increased to 30 inches at the docking slip. In Hernando County, approval of dock installation is contingent upon assurance that "a minimum of one (1) foot clearance is provided between the deepest draft of the vessel and the bottom at mean low water" and that "a water depth of minus three feet (-3) mean low water must be provided for mooring a vessel at a dock" (Hernando County 2001). In Charlotte County "docking facilities in natural surface waters shall be designed to prevent or minimize impacts to grassbeds and other biologically productive bottom habitats" and "dock length shall be sufficient to provide for a minimum water depth of minus three (-3) feet (mean low water) at all slips and mooring sites, unless it is demonstrated that a lesser depth will not result in impacts to sensitive bottom communities" (Charlotte County 2000).

It may be reasonable to develop a significant change standard for establishing minimum levels for lakes where boats are utilized, based on a minimum water depth requirement at the end of existing docks. An assumption of this approach would be that the water depth requirement, which is usually associated with the mean annual or ordinary low water level in non-tidal systems, may be associated with the Low Guidance Level, an elevation lake water levels are expected to exceed approximately ninety percent of the time. This approach would involve measurement of the elevation of sediments at the end of existing docks, and use of reference lake water regime statistics and a two-foot depth requirement based on existing regulations governing dock construction.

Because not all docks on any given lake will have been constructed in accordance with current permitting requirements (*i.e.*, in compliance with the typical two foot low-water depth requirement), use of percentile statistics for derivation of an elevation representative of sediment elevations at the end of existing docks may be appropriate. For example, use of the tenth-percentile sediment elevation value (*i.e.*, the elevation exceeded by ten percent of the sediment elevations at the end of existing docks) could be used to establish an elevation value for dock-end sediments which would be representative of most of the existing docks, and eliminate the influence of the few, exceptionally high elevation values for docks which may have been installed for purposes other than boat usage. Once the tenth-percentile elevation of sediments at the end of existing docks (the "Dock-End Sediment Elevation") is determined, a significant change standard for use in establishing minimum levels for the lake could be established at an elevation equal to the Dock-End Sediment Elevation plus 2 feet plus the value of the Reference Lake Water Regime 5090 (RLWR5090) for the region. Use of a RLWR5090 statistic, which would represent the expected difference between the P50 and the P90 elevations (see Section 5), would be necessary and appropriate for development of a significant change standard used to establish the Minimum Lake Level, a level expected to be exceeded fifty percent of the time on a long-term basis.

It is recommended that for use in identifying potential minimum levels, a significant change standard based on water depth requirements for dock use (*i.e.*, a "Dock-Use Standard") should be compared to the Historic P50 elevation, because docks at some lake systems may be built in areas where standard requirements, including duration of inundation to specified depths would not be expected, based on existing structural alterations. For example, consider a lake with a Historic P50 elevation which is lower than the proposed Dock-Use Standard. At this lake, water depths at the end of docks would be expected to be less than the standard elevation more than fifty percent of the time. Use of the Dock-Use Standard for establishment of the Minimum Lake Level, which is the approximate median elevation for the lake system would not be appropriate. Alternatively, for a lake where the Historic P50 elevation is higher than the proposed Dock-Use Standard, the elevation associated with the standard could be considered along with other standards in a multiple-parameter approach to minimum levels development. If used for establishment of minimum levels, the Dock-Use Standard would be used to identify the Minimum Lake Level. The High Minimum Lake Level would be established using the Minimum Lake Level and Historic data or the RLWR50 for the region.

District staff recommend the use of a significant change standard based on inundation of sediments at the end of docks, *i.e.*, a Dock-Use Standard, for development of minimum levels for lakes where boats are utilized. Development of a Dock-Use Standard, based on the tenth percentile value of sediment elevations at the end of existing docks is recommended to ensure that the standard reflects a water depth at most docks that is sufficient for mooring of boats most of the time. The Dock-Use Standard could be reviewed along with other information regarding dock-use and location as part of a multiple-parameter approach to minimum levels development.

Evaluation of Changes in Basin Connectivity

In some lake basins, change in water level may influence basin connectivity. As used here, basin connectivity is defined as the existence, extent, or temporal occurrence of continuous surface-water connections between lake basins or among sub-basins within lake basins. Reductions in basin connectivity may limit navigation of watercraft throughout a lake system and thereby directly affect recreational and aesthetic values. Connectivity, or lack of connectivity between basins may also affect movement of aquatic biota, such as fish, among lake ecosystem segments. Because reduced water levels may significantly influence basin connectivity (*e.g.*, see Figure 4-3), review of basin connectivity for development of minimum lake levels is considered reasonable and in accordance with State Water Policy.

A significant change standard for establishing minimum lake levels could be developed based on minimum water depth requirements for basin connectivity. One approach would be to base the standard on the elevation of aquatic sediments at high-spots in areas of connection between lake basins or among sub-basins within individual lake basins. Such areas could be channels connecting basins, or ridges separating sub-basins within the larger lake basin. For lakes with multiple areas of connectivity, a critical high-spot elevation would be identified. The critical high-spot elevation could be selected based on relative elevation, *e.g.*, it could be the highest of the high-spots, or it could be selected based upon its perceived importance to the lake system.

For systems where motorized boating may be expected to occur, a significant change standard could be developed based on the rationale advanced for minimum depth requirements for boat mooring in association with docks and piers, as outlined in the previous sub-section of this report. This "Basin Connectivity Standard" could be established by adding two feet plus the RLWR5090 value to the critical high-spot elevation. Use of this standard would be intended to prevent or minimize boat-related damage to benthic substrates and associated biota in areas of connectivity, while providing for continued recreation and navigation within the basin, and for passage of fish and other wildlife.

For lakes where power boating is not an issue, development of a Basin Connectivity Standard could be based on providing for passage on non-motorized watercraft, fish and other wildlife. Data available for development of such a standard are limited. Based on a direct-mail survey of several canoe/kayak liveries and outfitters in Florida, Yingling (1997) reports that minimum depths of 1 to 1.5 feet are necessary to keep a fully loaded boat afloat and avoid boat drags and portages. Anecdotal information, included in Mosley (1982) indicates that critical minimum depths of 0.6 to1.2 ft are required for passage of canoes and jetskis over riffle areas in braided New Zealand streams. Thompson (1972), as cited in Mosley (1982) reports minimum depth requirements of 0.4, 0.6, and 0.8 ft for passage of three classes of salmonid fishes in flowing water systems. Based on Thompson's report, the SJRWMD currently uses a minimum depth value of 0.5 ft when fish passage is incorporated into establishment of minimum flows (*e.g.*, see Hupalo *et al.* 1994). For preventing damage to eelgrass and

Figure 4-3. Differences in basin connectivity as a result of varying water level within the Lake Starvation basin, Hillsborough County, Florida. Panel A is from a composite photographic map of the region in 1938. Panel B is based on composite digital orthopotographs produced in 1995, and shows the lake separated into two distinct basins at a lower water level. Note that the scale differs among the panels.

A

B

other vegetation in flowing water systems, the SJRWMD uses a 1.7 ft water depth requirement for establishment of minimum flows and levels (Hupalo *et al.* 1994). Considering the range of depth values from these varied sources, use of a 1 ft water depth requirement for passage of non-motorized watercraft, fish and wildlife may be appropriate for development of a significant change standard for minimum levels establishment. The significant change standard could be established by adding one foot plus the region-specific RLWR5090 value to the critical high-spot elevation.

It is recommended that Basin Connectivity Standards be used in a relative manner. That is, the standard elevations should be compared to the Historic P50 elevation, since connectivity between some lakes or among sub-basins within some lakes may naturally be non-existent more than half of the time. For example, consider a lake with a Historic P50 elevation which is lower than the proposed Basin Connectivity Standard. Connectivity in this system historically would be expected to be lacking more than fifty percent of the time. Use of the connectivity standard for establishment of minimum levels, including the Minimum Lake Level, which is the approximate median elevation for the lake system would not be appropriate. For a lake where the Historic P50 elevation is higher than the proposed Basin-Connectivity Standard, the elevation associated with the standard could be considered along with other standards in a multiple parameter approach to minimum levels development. If used for development of minimum levels, the Basin-Connectivity Standard would correspond to the Minimum Lake Level. The High Minimum Level would be established using the Minimum Lake Level and Historic data or the RLWR50 value for the region.

District staff recommend the use of significant change standards based on maintenance of basin connectivity for development of minimum levels for Category 3 Lakes. Basin Connectivity Standards could be reviewed along with other relevant information as part of a multiple-parameter approach to minimum levels development.

It is expected that such standards would be useful for development of minimum levels for relatively few District lakes, as connections between lake basins or sub-basins tend to occur at relatively high or low elevations. For example, canals between numerous District lakes have been dug to increase inter-basin connectivity. However, the elevation of many of these canals is such that a Basin-Connectivity Standard based on the elevation of high spots within the canals would typically exceed the Historic P50 elevation. In addition, standards based on natural high spots between sub-basins within most lake basins are expected to occur at relatively low elevations, a factor which would lead to the standards being superceded by other, more conservative standards.

Evaluation of Changes in Species Richness

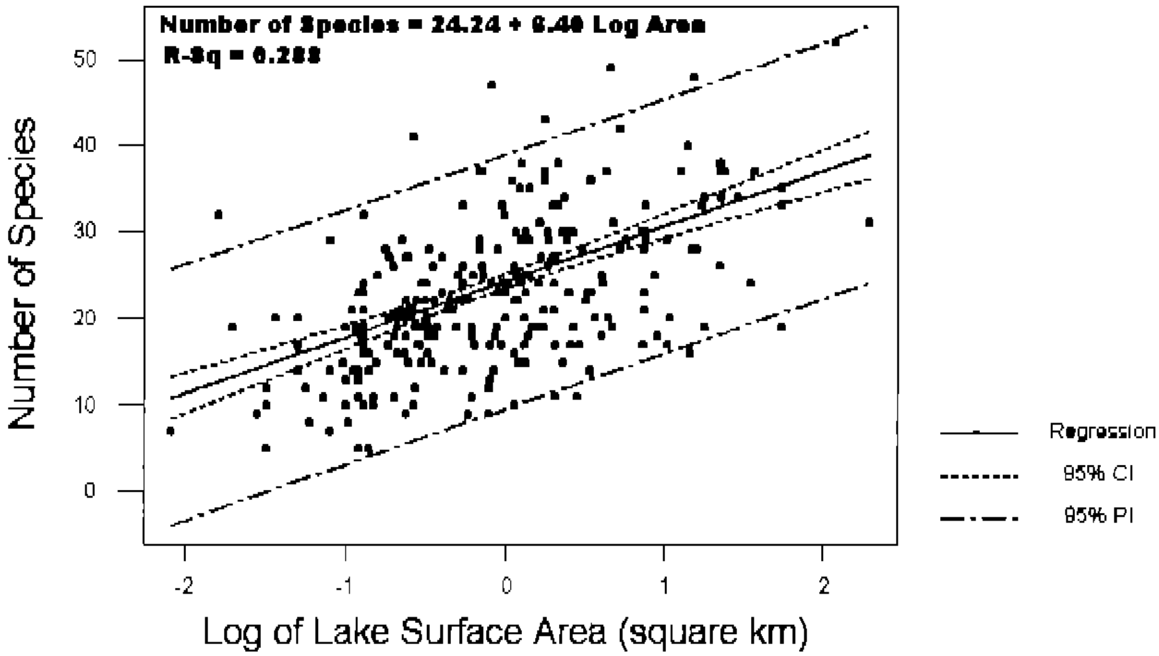
Species richness, *i.e.*, the number of species, of any given taxonomic group in any region is influenced by a wide range of factors, including geographic circumstances, climate, productivity, disturbance, and habitat complexity and availability. Characterization of species richness is frequently used for evaluating the integrity of biological communities and their response to stress (Ricklefs and Schluter 1993). In lake ecosystems, species richness of such divergent groups as crustaceans, fish, and birds has been empirically associated or correlated with lake size (*e.g.*, Fryer 1985, Dodson 1992, Keller and Conlon 1994, Allen *et al.* 1999). Reduction in lake size, a potential environmental stress, may therefore be expected to be associated with reduced species richness at lake ecosystems.

District staff contend that the loss of a species from a lake's biological community would constitute a significant change to the lake ecosystem. Given the existence of relationships between lake area and species richness, it may be reasonable to develop significant change standards based on limiting lake area reductions so as to prevent a reduction in species richness. Specifically, significant change standards may be developed based on available information for aquatic macrophyte, fish and bird assemblages in Florida lakes.

The number of aquatic macrophyte species occurring in a lake or wetland system may be influenced by changes in system size, a direct effect of lowered water levels. Based on unpublished data from 215 Florida lakes, researchers at the University of Florida have identified a weak, but statistically significant relationship between lake surface area and the number of aquatic and semi-aquatic plant species (species richness) occurring within the lakes (Figure 4-4). Data for this analysis included information on plant assemblages collected as described in Canfield and Hoyer (1992) and lake area values obtained primarily from Shafer *et al.* (1986).

Larger lakes tend to have more macrophyte species, while smaller lakes have fewer, according to the linear relationship: $N = 24.24 + 6.40 \log A$, where N is the expected number of species, and A is the lake surface area, in square kilometers (r^2 for the linear equation = 0.29). Although this relationship technically describes differences in macrophyte species richness among lakes of varying size, the relationship can provide some indication of the potential for change in plant species richness associated with long-term change in lake area for individual lakes. On average, a 30% decrease in lake size is predicted to be associated with the loss of an aquatic macrophyte species from the lake assemblage.

Figure 4-4. Relationship between the number of macrophyte species per lake and the logarithm of lake surface area for 215 Florida lakes (unpublished data from the University of Florida). Best-fit regression equation shown as a solid line. Ninety-five percent confidence (CI) and prediction (PI) intervals shown as a dotted and dash-dotted lines, respectively.



Using this relationship, a significant change standard for establishing minimum levels could be developed based on preventing a reduction in macrophyte species richness. Lake area at the Historic P50 could be identified and serve as a baseline condition for identifying the number of macrophyte species expected to occur at the lake. The elevation associated with a predicted decrease in macrophyte species richness (*i.e.*, a 30% decrease in lake surface area), relative to the baseline condition could serve as a significant change standard for comparison with other standards in a multiple-parameter approach to the establishment of minimum levels.

Species richness of fish assemblages has also been shown to be positively related to lake area (*e.g.*, Barbour and Brown 1974, Minns 1989, Allen *et al.* 1999). In Florida, lake surface area accounts for a substantial proportion of the variance in the fish species richness among lakes (Keller and Crisman 1990, Bachmann *et al.* 1996). Based on a survey of sixty-five Florida lakes, Bachmann *et al.* (1996) found the number of fish species (N) is related to lake surface area (A) in square kilometers according to the equation: $N = 19.5 + 7.02 \log A$, where log is the base 10 logarithm. Assuming that this equation, which accounted for 70% of the variance in the fish species richness among the studied lakes (r^2=0.70), can be transferred to individual lakes, it is predicted that fish species richness is reduced by one species each time lake area is decreased 28%.

This empirically-derived fish species-area relationship could be used to develop a significant change standard for establishing minimum levels based on preventing a decrease in fish species richness. The similarity between change in lake area and change in fish and macrophyte species richness suggests that a significant change standard developed to prevent more than a thirty percent change in lake area would likely be protective of the diversity of both these groups.

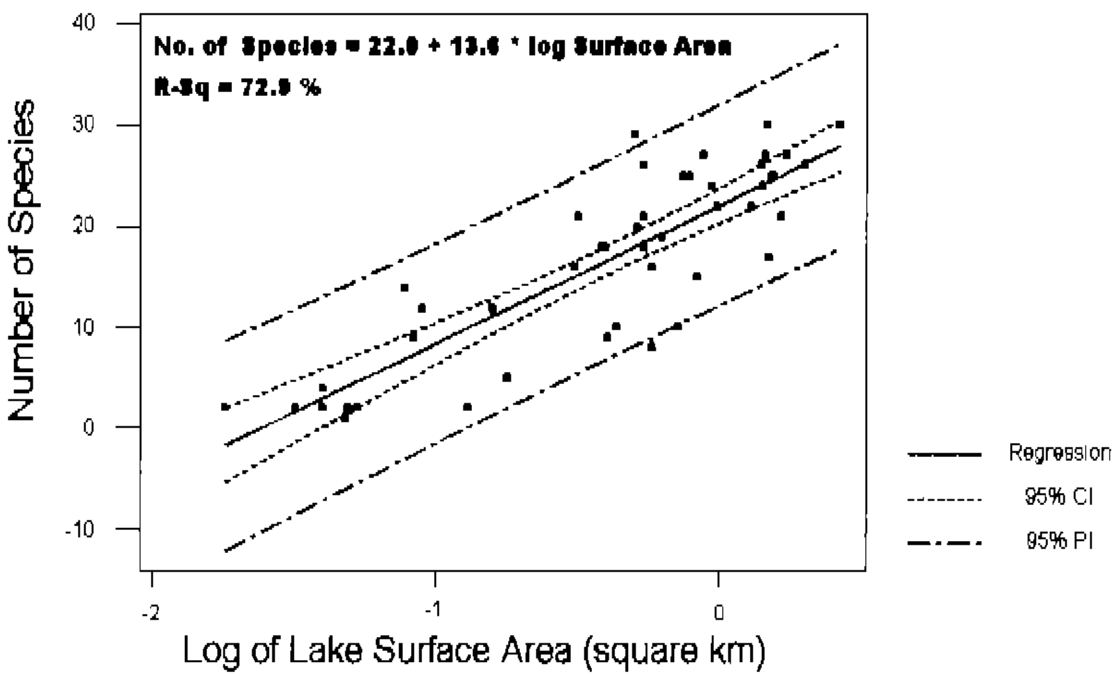
Much of the pioneering work on species-area relationships was based on the study of bird assemblages (*e.g.*, MacArthur and Wilson 1967; see review by Wiens 1989). Since publication of this seminal work, numerous studies have identified a significant relationship between lake or wetland area and bird species richness (Sillen and Solbeck 1977, Nilsson and Nilsson 1978, Brown and Dinsmore 1986, Elmberg *et al.* 1994, Suter 1994, Allen *et al.* 1999, Paszkowski and Tonn, 2000a, 2000b, Fairbairn and Dinsmore 2001). In Florida, lake surface area has been shown to account for much of the variation in the number of bird species encountered in field surveys (Hoyer and Canfield 1990, Canfield and Hoyer 1992). In a recent study, Hoyer and Canfield (1994) found that lake surface area was positively correlated ($r=0.86$) with the number of bird species found on or foraging from aquatic habitats at 46 Florida lakes (Figure 4-5). This relationship may be more a function of the extent of shallow area available for wading rather than actual lake size because most species encountered were wading birds. Even without identification of preferred bird habitat in terms of water depth, the number of bird species to be found at a Florida lake is likely to decrease with lake decreasing surface area.

Assuming that Hoyer and Canfield's results are applicable to changes in area within an individual lake, the number of bird species (N) expected to occur at a lake may be predicted according to the regression equation: $N = 22.0 + 13.6 \log A$, where A is the lake surface area in square kilometers, and log is the base ten logarithm (Bachmann and Hoyer 1999). Based on this relationship, the number of bird species predicted to occur at a lake may be expected to decrease by one as lake area is decreased by 15%.

Using this relationship, a significant change standard for establishing minimum levels based on preventing a decrease in bird species richness could be developed. Lake area at the Historic P50 could be identified and serve as a baseline condition. The elevation associated with a predicted decrease in bird species richness (*i.e.*, a 15% decrease in lake surface area), relative to the baseline condition could serve as significant change standard for comparison with other standards in a multi-parameter approach to the establishment of minimum levels. If used for minimum levels development, the standard elevation would be used to establish the Minimum Lake Level. The High Minimum Lake Level would be established using the standard elevation and Historic data or the region-specific RLWR50 statistic.

It should be noted that among the species-richness based standards discussed here, the standard associated with preventing a reduction in bird species richness is the most conservative. That is, the standard would be expected to occur at a relatively high elevation as compared to the standards for maintaining macrophyte and fish species richness. This is because of the differences in lake area decreases associated with loss of species from the respective groups; a 15% decrease in lake area is associated with a decrease in bird species richness, while an approximate 30% decrease in area is associated with a decrease in macrophyte and fish species richness. It may therefore be assumed that use of a relatively conservative standard based on maintaining bird species richness would be protective of macrophyte and fish species richness as well as other groups for which empirical relationships between diversity and lake area have not been established.

Figure 4-5. Relationship between the number of bird species per lake and the logarithm of lake surface area for 46 Florida lakes (adapted from Hoyer and Canfield 1994). Best-fit regression equation shown as a solid line. Ninety-five percent confidence (CI) and prediction (PI) intervals shown as a dotted and dash-dotted lines, respectively.



District staff recommend use of a significant change standard based on maintaining species richness of lake communities as part of a multiple-parameter approach to establishing minimum levels for Category 3 Lakes. A quantitative "Species Richness Standard", based on the relationship between bird species richness and lake area for Florida lakes, could be developed, and along with other relevant information associated with biological diversity, be reviewed for development of minimum lake levels. This approach is well grounded in current ecological theory, and is consistent with State Water policy guidelines regarding the protection of fish and wildlife habitats.

Evaluation of Changes in the Coverage of Herbaceous Wetland Vegetation

The methodology developed for setting minimum levels for lakes with fringing cypress wetlands is predicated on the assumption that these lakes are significantly harmed if their associated wetlands are significantly harmed. Implicit in the acceptance and use of this approach is that in terms of water level reductions, the most sensitive or the first significantly harmed component of these systems are their associated wetlands. Application of the recently adopted minimum level methodology is expected to protect fringing cypress wetlands associated with lake systems and thereby preserve many, if not most, of the environmental values identified in State Water Policy for consideration when establishing minimum flows and levels.

Whether forested or herbaceous, wetlands develop at specific elevations within lake basins in response to a pattern of inundation referred to as a hydrologic regime, or hydroperiod. The hydrologic regime may be characterized in terms of its frequency, duration, maximum depth or elevation, and seasonality. Life history responses of tree species adapted to wetland hyrdologic regimes are sufficiently different from those of most common herbaceous wetland plant species to permit an important distinction; forested wetlands require significantly greater periods of time for migration up or downslope in response to alteration of the hydrologic regime. While common wetland tree species, such as cypress (*Taxodium* spp.) or blackgum (*Nyssa sylvatica*) may require years or decades for successful colonization of new favored-habitat created as a result of water level change, herbaceous wetland plants such as cattail (*Typha* spp.) and maidencane (*Panicum hemitomum*), with generation times (the time-lapse between successive generations) on the order of months and the capacity for rapid vegetative growth can rapidly colonize regions of the basin favorable to their growth.

The varying capacity of wetland plant species to respond to trends in lake water levels adds complexity to the use of wetlands protection as a means for establishing minimum lake levels. The relatively slow growth and long-term persistence of cypress trees supports their use as indicators of historic water levels and also factors into approaches for protection of cypress dominated wetlands through minimum levels establishment (*e.g.,* the use of cypress growth from for the identification of normal pool). In contrast, the ability of herbaceous wetland vegetation to more rapidly colonize favorable habitat in response to altered hydology limits the usefulness of this group for indication of historic water levels, and hinders the development of significant change standards based on water level deviation from some norm. However, because coverage of non-forested wetland vegetation can rapidly change in response to trends in water levels, delineation of lake regions which provide favorable habitat for herbaceous wetland development and the evaluation of changes in this area as a function of water level change could aid the development of minimum levels.

To characterize the potential distribution of wetland vegetation in lakes without fringing cypress wetlands, data on the maximum depth of occurrence of various emergent and floating-leaved aquatic macrophytes, collected through implementation of the District's Lake Levels Program during the past twenty-five years was reviewed. Data from 295 lakes were compiled to establish maximum and mean maximum depths of occurrence for emergent and floating-leaved taxa observed in ten or more lakes. Mean-maximum depth values were weighted according to the number of lakes where populations of the plants were encountered, and averaged to establish the weighted-mean maximum water depth of occurrence for common emergent and floating aquatic macrophytes in District lakes.

Most of the common emergent and floating-leaved aquatic macrophytes were observed in water exceeding six feet in depth, however the mean depth of occurrence in the lakes surveyed was typically less than five feet (Table 4-2). The weighted-mean maximum depth for the eight common taxa was 3.9 feet. Interestingly, lake area of up to 4 feet in depth has been identified as being suitable for establishing and maintaining desirable aquatic and wetland plants in Florida lakes (Butts *et al.* 1997). Regions of District lakes with water depths of up to approximately four feet may therefore be characterized as potential herbaceous wetland habitat.

Based on this relationship between herbaceous wetland vegetation (emergent and floating-leaved macrophytes) and water depth, potential changes in the areal extent or coverage of herbaceous wetland habitat under various water level scenarios may be evaluated using bathymetric data or maps. For example, plots of potential herbaceous wetland area versus lake stage could be used to identify basin elevations at which water level changes would be associated with substantial change in wetland area. This information could be used to identify potential problems associated with development of minimum levels based on any of the significant change standards used in the multiple-parameter approach to minimum levels establishment. Assuming that change in potential wetland area can be considered a surrogate for potential change in wetland function, review of this information would support development of minimum levels which would not be expected to adversely impact wetland functions, such as provision of cover, forage and breeding area for wetland-dependent wildlife, detritus production, *etc.*

District staff recommend that potential changes in the coverage of herbaceous wetland vegetation be reviewed for development of minimum lake levels for Category 3 Lakes. Incorporation of potential shifts in herbaceous wetland coverage into a multiple-parameter approach to minimum levels establishment could be considered on a case-by-case basis when establishing minimum lake levels.

Table 4-2. Maximum, mean maximum and weighted-mean depth of occurrence for submersed and floating-leaved aquatic macrophytes observed in ten or more lakes in the District. Plant taxa are categorized by growth form (E = emergent, F = floating-leaved). Weighted-mean depth was derived by weighting taxon-specific mean maximum depth values according to the number of lakes where the taxa occurred.

Taxon	Common Name	Growth Form	Number of Lakes	Maximum Depth (feet)	Mean Maximum Depth (feet)
Panicum spp.	Panic Grass	E	246	7.9	4.0
Typha spp.	Cattail	E	202	8.0	4.4
Pontederia cordata	Pickerelweed	E	76	5.5	2.8
Scirpus spp.	Bullrush	E	67	7.3	3.3
Cladium sp.	Sawgrass	E	14	7.9	3.0
Nuphar luteum	Spatterdock	F	34	7.9	4.3
Nymphaea spp.	Water Lilly	F	13	6.0	4.0
Hydrocotyle spp.	Pennywort	F	10	5.9	4.2
				Weighted- Mean Depth (feet)	**3.9**

Evaluation of Changes in the Coverage of Aquatic Macrophytes

Excessive growth of aquatic macrophytes (macroscopic aquatic plants) can adversely affect environmental, recreational and aesthetic characteristics of Florida lakes. Habitat degradation and the hindering of navigation which is associated with excessive growth of hydrilla (*Hydrilla verticillata*) and water hyacinth (*Eichhornia crassipes*) serve as all too familiar examples of this problem within the District. Conversely, moderate aquatic macrophyte coverage is considered a desirable management goal for maintaining healthy lake fisheries, and water quality improvement (Canfield and Hoyer 1992). Whether considered a nuisance or beneficial, aquatic macrophytes are important components of lake ecosystems, and consideration of aquatic macrophyte coverage in lake basins may be useful for establishing minimum levels.

In lakes from Florida and other parts of the world, the maximum depth of colonization by submersed aquatic macrophytes is statistically related to water transparency (Canfield *et al.* 1985). Based on data from 26 Florida lakes, the maximum depth of colonization (MDC) in meters is related to the Secchi disc depth (SD) in meters according to the linear equation: log MDC = 0.422 log SD, where log equals the logarithm of the variable to the base ten (Canfield *et al.* 1985). This empirically derived relationship could be used to estimate the maximum depth of colonization for lakes where minimum levels are to be established. The colonization depth values could be used to estimate areal coverage of aquatic macrophytes for various water level elevations using available bathymetric data. Thus, the potential extent of aquatic macrophyte beds, including those dominated by nuisance species may be evaluated for minimum levels determination.

District staff recommend that potential changes in the coverage of submersed aquatic macrophytes be reviewed for development of minimum levels for Category 3 Lakes. Incorporation of potential shifts in submersed aquatic macrophyte coverage into a multiple-parameter approach to minimum levels establishment could be achieved through consideration of changes of this nature on a case-by-case basis when establishing minimum lake levels.

Evaluation of Changes in Cultural (Aesthetic and Recreational) Values

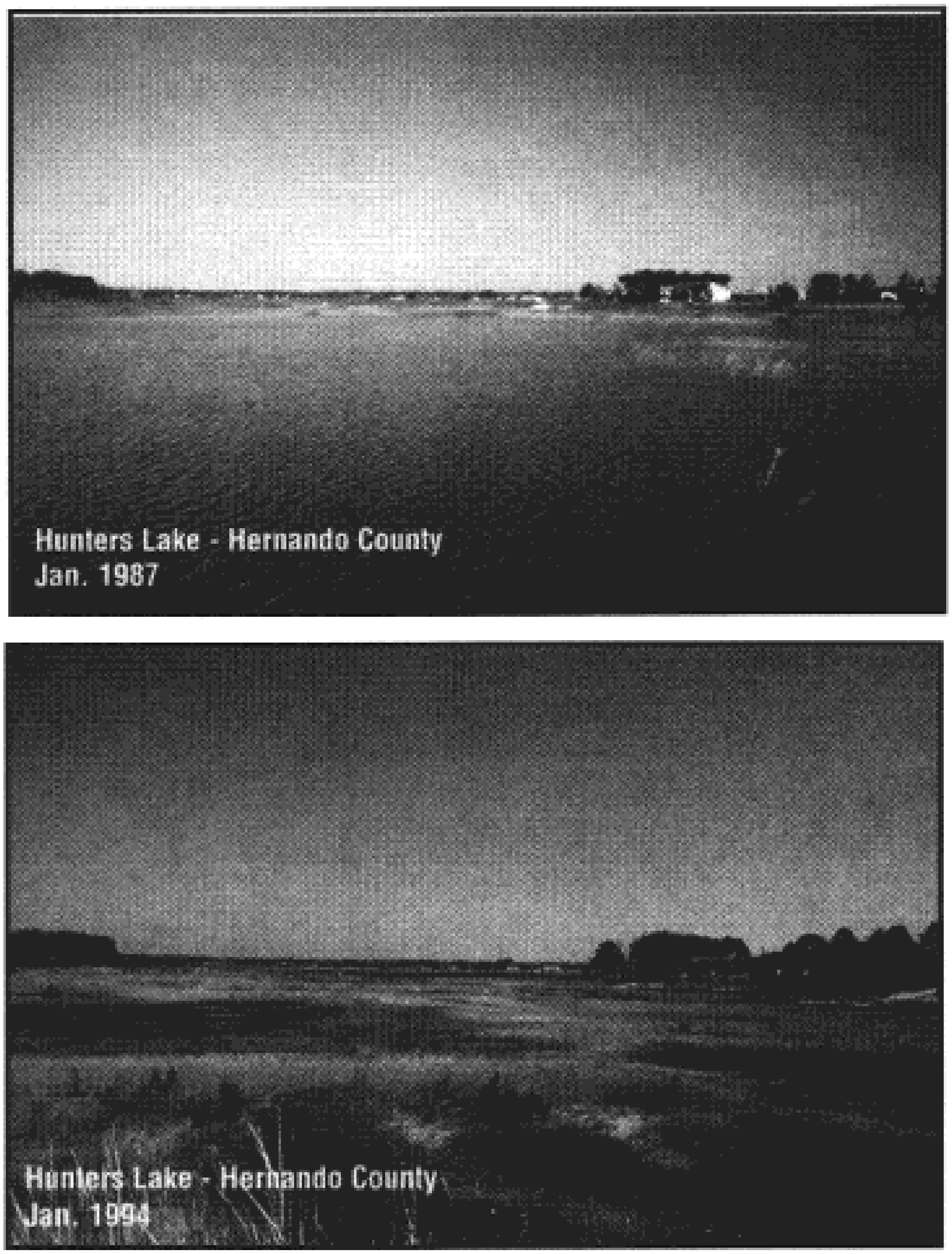
State Water Policy requires that consideration be given to cultural values and activities, including recreation, aesthetic and scenic attributes, when establishing minimum flows and levels. These factors may prove difficult to incorporate into significant change standards for development of minimum levels, but may nonetheless, be of great concern to those interested in lake use and conservation (Figure 4-6).

Significant change standards relevant to aesthetic values and change in lake level or area could be developed for minimum level establishment. One approach would be to acknowledge, *a priori,* that the Minimum Level should not be established at an elevation below the Low Guidance Level. This significant change standard may be considered reasonable and consistent with the typical lake user's perspective and understanding of lake hydrology in Florida. Most lake users are to some degree familiar with natural fluctuation in lake water levels, and most would likely acknowledge that lake water level and surface area less than that associated with a datum such as the Low Guidance Level, may be expected to occur for relatively short periods of time. Recall that the Low Guidance Level (and the Low Level) are provided as advisory guidelines for lakeshore residents and others to identify lake water levels which are expected to be exceeded ninety percent of the time. Water levels less than the Low Guidance Level may therefore be expected for approximately ten percent of the time. Establishment of the Minimum Lake Level, a level which may be expected to be exceeded half the time, at an elevation lower than the Low Guidance Level would therefore likely be unacceptable to most lake users; most would not want to see their lake reduced for fifty percent of the time to a state at which it currently exists at for less than ten percent of the time. The Low Guidance Level could serve as an aesthetics-based significant change standard for establishment of minimum levels. If used for development of the Minimum Lake Level, this aesthetics standard and Historic data or the RLWR50 values for the region could be used to develop the High Minimum Lake Level.

Figure 4-6. Long-term variation in water level and lake surface area, such as shown here at Hunters Lake in Hernando County, Florida may be associated with change in aesthetic and recreational values. Photographs were made from approximately the same vantage point in January 1987 (Panel A) and January 1994 (Panel B).

A

B



District staff recommend use of an aesthetics-based significant change standard for development of minimum levels for Category 3 Lakes. An Aesthetic Standard, as described above, would identify the Low Guidance Level as the lower limit for establishment of the Minimum Lake Level. This standard, along with other information related to aesthetics and scenic attributes could be reviewed as part of a multiple-parameter approach to the development of minimum levels.

Consideration of the extent of lake area suitable for certain recreational activities, including boating and swimming, may be a reasonable means to develop a recreation-based significant change standard for developing minimum levels. Yingling (1997) summarized literature pertaining to recreational use of water resources and noted that a minimum depth of three to four feet at the toe of boat launching ramps is recommended for boat launching (National Water Safety Congress 1988, Wilson 1996, Bowman 1997; all as cited in Yingling 1997). In a review of the effects of motorized boats on lake ecosystems, Wagner (1991) noted that watercraft with outboard engines are generally operated in depths of three or more feet while those with inboard engines are typically operated in depths of at least five feet. The United States Coast Guard Office of Boating Safety (2001) recommends a minimum depth of five to six feet of water free of obstacles for safe waterskiing. Recommendations or standards for preferred or safe swimming depths are not available for natural systems; however, Florida Health and Rehabilitative Service Department rules require depths of three feet for the shallow end and four feet for the deep end of swimming pools (Chapter 64E-9, F.A.C. FDOH 2001). Based on these recommendations regarding safe-boating and swimming, lake areas exceeding three to six feet in depth may be considered suitable for most recreational activities.

Certain recreational activities such as water skiing are dependent on open water, free of emergent, floating or near surface submerged vegetation. A decrease in the open water area of a lake may therefore be viewed as a decrease in recreation potential. The United States Coast Guard Office of Boating Safety (2001) recommends that "ski corridors" of at least 200 by 2,000 feet (~9 acres, assuming the corridors are rectangular in shape, or ~13 acres assuming the corridors can be delineated by a circular area) should be maintained to reduce interference with other skiers and reduce the need for excessive maneuvering. In Minnesota, boat density limits on metropolitan lakes are advanced by requiring one car/trailer parking space per 20 acres of lake surface area (Minnesota DNR 2000). For lakes where skiing and power boating are permitted, it has been suggested that 25 acres of water per boat is considered desirable and that no less that 10 acres is considered necessary for safe skiing and power boating (Wagner 1991). Collectively, this information suggests that approximately 10-25 acres of open water is necessary for safe boating/skiing on lakes.

The United States Coast Guard recommendation concerning ski corridor depth and size could be used to develop a significant change standard based on potential loss of area suitable for safe water skiing. Bathymetric data sets and maps could be reviewed to determine the critical minimum elevation at which the basin would contain a lake large and deep enough to support an area for safe skiing. This area, or ski corridor, could be defined as a circular area with a diameter of 418 ft and a depth of at least five feet. This area would contain a 2,000 ft ski/boat path and a 100 ft buffer for the ski path, in accordance with Coast Guard recommendations.

Development and use of a significant change standard based on maintaining a safe ski corridor should be contingent upon the lake basin containing a ski corridor for a specified amount of time. For example, it may be reasonable to consider use of a skiing-based standard only for those lakes which contain areas suitable for skiing most of the time. Comparison of the critical minimum elevation (as described in the preceding paragraph) with the Low Guidance Level would provide some indication of the temporal availability of ski corridors at individual lakes. Use of a significant change standard based on safe skiing would not be appropriate for lakes with a critical minimum elevation that is higher than the Low Guidance Level, as these lakes would not be considered to have historically supported skiing for ninety percent of the time. Use of a significant change standard based on safe-skiing for lakes with a critical minimum elevation lower than the Low Guidance would be appropriate. The standard would identify the elevation at which the lake would no longer support safe skiing for ninety percent of the time. This "Recreation/Ski Standard" could be developed using the critical minimum elevation and Historic data or the appropriate RLWR5090 statistic. If used for development of minimum levels, the standard would be used to identify the Minimum Lake Level. The High Minimum Lake Level would be established using the standard and Historic data or the appropriate RLWR50 statistic.

District staff recommend that a significant change standard, based on loss of the availability of a safe ski corridor be incorporated into a multiple-parameter approach to minimum levels establishment for Category 3 Lakes. This Recreation/Ski Standard would only be applicable for lakes where areas suitable for safe skiing would be available for ninety or more percent of the time.

Section 5

Proposed Methods for Establishing Minimum Levels for Category 3 Lakes

Overview

The recently developed methods for establishing minimum levels for lakes with fringing cypress wetlands (SWFWMD 1999a) are recommended, with some modification, for establishing minimum levels for Category 3 Lakes within the District. Proposed changes include:

(1) development of region-specific Reference Lake Water Regime 5090 (RLWR5090) statistics;
(2) acquisition of lake-basin bathymetric data, if possible;
(3) establishment of the Category 3 Lakes Normal Pool elevation;
(4) use of a variety of models and assumptions for development of the Ten Year Flood Guidance Level;
(5) development of a several significant change standards and additional information for a multiple-parameter approach to minimum levels establishment for Category 3 lakes; and
(6) development of decision rules for identifying the appropriate standard or other information for establishment of the Minimum Lake Level and the High Minimum Lake Level.

Since much of the proposed approach to minimum levels development is fundamentally similar to that outlined for use on lakes with fringing cypress wetlands, detailed discussion of recommended methods in this section is generally restricted to those aspects which were not described in the review of the cypress wetlands methodology presented in Section 3 of this manuscript. Some redundancy is unavoidable, however, to ensure a comprehensive presentation of the proposed methods.

Hydrologic Data Compilation and Classification

For the purpose of minimum levels determination for Category 3 Lakes, lake-stage data may be 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 may be categorized as "Current" for periods when there were measurable, stable impacts due to water withdrawals, and impacts due to structural alterations have remained stable. The availability of at least six years of data would typically be a prerequisite for classification of lake-stage data as Historic or Current.

As outlined in Section 3 of this report, statistics corresponding to water level elevations equaled or exceeded ten, fifty and ninety percent of the time for a specified period of record may be calculated for both Current and Historic lake stage data. These statistics, based on monthly mean values, are referred to as the Current or Historic P10, P50 and P90, respectively.

Development of Reference Lake Water Regime Statistics

The development and use of reference lake water regime statistics (RLWR50, RLWR90) described in Section 3 are recommended for establishment of minimum levels for Category 3 lakes. The development and use of an additional statistic, the Reference Lake Water Regime 5090 (RLWR5090), is also recommended. This statistic would be derived in a manner similar to that used for development of the RLWR50 and RLWR90. The RLWR5090 statistic would represent the median difference between the reference lake P50 and P90 values.

These statistics provide a means to establish water level elevations and fluctuation ranges for lakes lacking hydrologic data, and those with hydrologic regimes impacted by water withdrawals. It is anticipated that reference lake water regime statistics will be developed for several regions within the District. The availability of hydrologic data for lakes in the region of interest from periods pre-dating impacts from water withdrawals (*i.e.*, the availability of Historic data) is required for development of the reference lake water regime statistics.

For the Northern Tampa Bay Region, data from 22 lakes met this criterion, and were used to develop reference Lake Water Regime statistics for the region (RLWR50 = 1.0 ft, RLWR90 = 2.1 ft) (SWFWMD 1999a). These data are listed in Table 5-1 along with the RLWR5090 value (1.1 ft), based on the median difference between the P50 and P90 statistics.

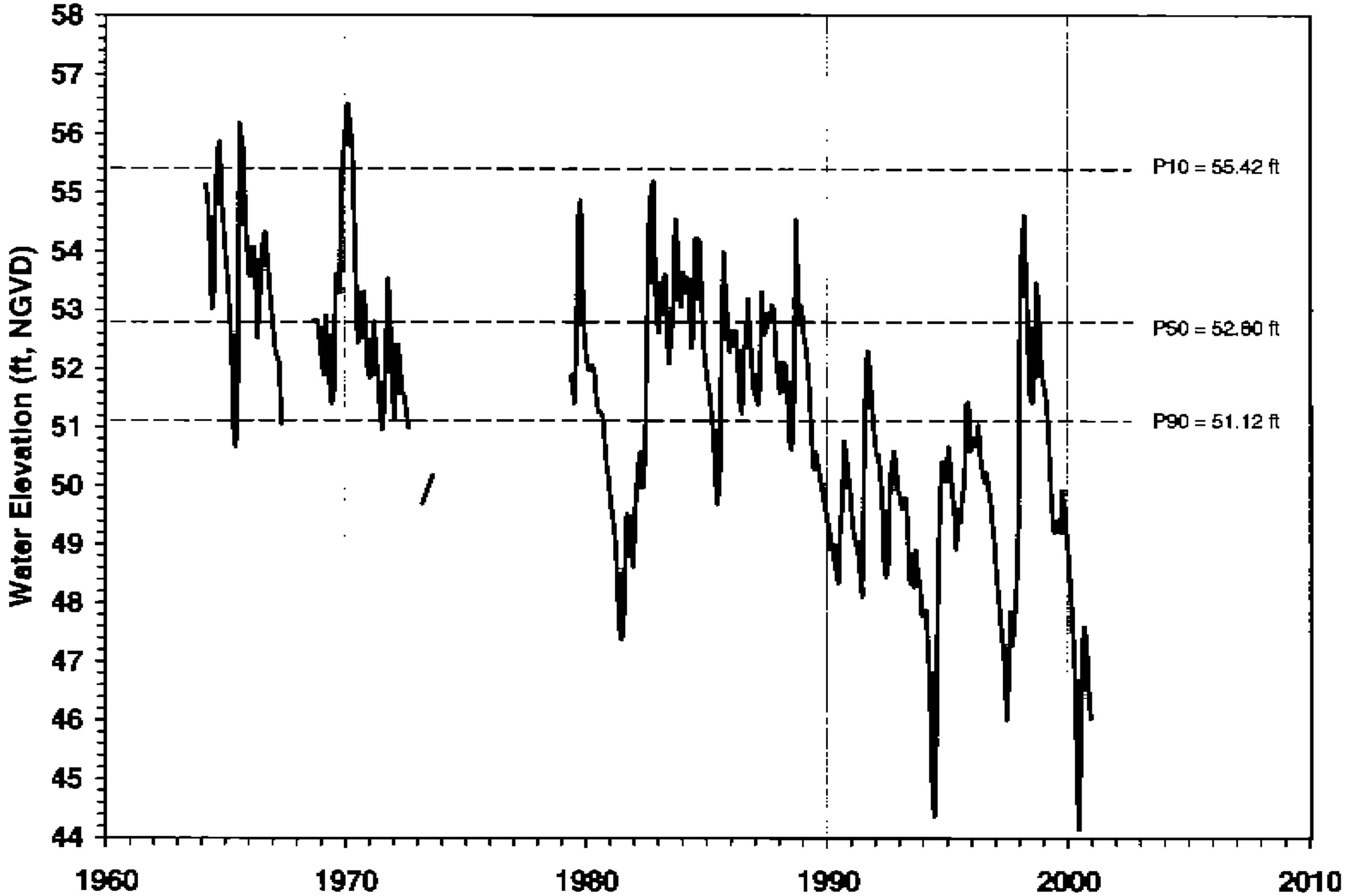
The development of reference lake water regime statistics for lakes located in the Central Hernando County and Central Pasco County region, north of the Tampa Bay region, is limited by the availability of Historic hydrologic data. Of the lakes in this region with available hydrologic data, only Crews Lake in Pasco County was found to have data from a period pre-dating the influence of large, regional well fields. Elevations corresponding to the tenth, fiftieth and ninetieth percentile lake stages (P10, P50, and P90) were calculated for Crews Lake using data collected from March 1964 through February 1980. This period pre-dates water withdrawals from the Cross Bar Ranch Wellfield, which began in 1980 (CCI Environmental Services, Inc. and Terra Environmental Services, Inc. 1998).

Lake stage percentiles were used to establish RLWR50, RLWR90 and RLWR5090 values for the Central Hernando County and Eastern Pasco County region, using the approach developed for the Northern Tampa Bay region reference lake water regime statistics (see Section 3 of this report, and also SWFMWD 1999a). Percentile values along with lake stage data from the period of record used for calculation of the statistics are shown in Figure 5-1. The RLWR50 (2.6 ft) was calculated as the difference *between the P10 and P50 values for Crews Lake, the RLWR90 (4.3 ft) was calculated* as the difference between the P10 and P90 values, and the RLWR5090 (1.7 ft), was calculated as the difference between the P50 and P90 values. The magnitude of the reference lake water regime statistics for the Central Hernando and North-Central Pasco Counties region, relative to the Northern Tampa Bay region statistics reflects the greater range in water level fluctuation typically observed for lakes in this area.

Table 5-1. Summary of hydrologic statistics for 22 reference lakes in the northern Tampa Bay area. Period of record (POR) reflects periods when historic data were available. Percentile values (P10, P50 and P90) are in units of feet, NGVD.

Lake	POR	P10	P50	P90	Difference Between P10 & P50 (ft)	Difference Between P10 & P90 (ft)	Difference Between P50 & P90 (ft)
Bell	1977-97	71.6	70.5	69.5	1.1	2.1	1.0
Big Lake	1986-97	68.8	67.6	66.7	1.2	2.1	0.9
Bird	1978-97	66.8	65.4	64.4	1.4	2.4	1.0
Cooper	1946-56	61.6	61.0	60.2	0.6	1.4	0.8
Cow (East)	1976-97	78.0	77.6	76.8	0.4	1.2	0.8
Curve	1976-97	76.6	75.4	74.0	1.2	2.6	1.4
Ellen	1946-56	40.6	39.9	38.9	0.7	1.7	1.0
Geneva (Mud)	1981-97	49.8	49.2	48.2	0.6	1.6	1.0
Gooseneck	1978-97	72.8	70.4	68.4	2.4	4.4	2.0
Hanna	1946-55	61.7	61.2	59.9	0.5	1.8	1.3
Hobbs	1947-62	67.0	65.9	63.8	1.1	3.2	2.1
King	1970-97	72.6	71.7	70.4	0.9	2.2	1.3
Minniola	1981-97	49.8	49.3	48.2	0.5	1.6	1.1
Moon	1965-97	39.9	38.6	36.6	1.3	3.3	2.0
Padgett	1965-97	70.5	69.6	68.6	0.9	1.9	1.0
Parker (Ann)	1969-97	48.0	46.8	45.6	1.2	2.4	1.2
Platt	1946-56	49.8	48.9	47.8	0.9	2.0	1.1
Saxon	1983-97	70.5	69.6	68.5	0.9	2.0	1.1
Seminole	1969-97	48.2	46.9	45.9	1.3	2.3	1.0
Stemper	1946-62	61.5	61.0	59.4	0.5	2.1	1.6
Tampa	1978-97	64.3	62.8	60.9	1.5	3.4	1.9
Thomas	1968-97	74.6	73.6	72.4	1.0	2.2	1.2
			Mean		**1.0**	**2.3**	**1.3**
			Median		**1.0**	**2.1**	**1.1**

Figure 5-1. Lake stage at Crews Lake and the water level elevations equaled or exceeded ten (P10), fifty (P50), and ninety (P90) percent of the time during the period of record from March 1964 through February 1980.



Acquisition of Bathymetric Data

The development and proposed use of several significant change standards for establishing minimum levels for Category 3 Lakes are based upon the ability to accurately predict change in lake area as a function of change in water level. For this purpose District staff recommend the use of existing maps or data, or the development of these data using standard surveying equipment and approaches (*e.g.*, see Leeper 2001).

Determination of the Category 3 Lake Normal Pool Elevation

Identification of an elevation approximating the lake stage which has historically been equaled or exceeded approximately ten percent of the time is an integral component of minimum levels establishment. As discussed previously, numerous approaches and sources of data may be used to approximate this elevation for lakes, regardless of whether the lakes have been impacted by water withdrawals or structural alterations. Based on approaches currently used by the District for Category 1 and 2 lakes, other water management districts and state agencies, and the recommendations of the Lake Levels Subcommittee, it is proposed that the elevation historically equaled or exceeded ten percent of the time for Category 3 lakes may include:

(1) the Normal Pool elevation as defined in current District rules (F.A.C., Chapter 40D-8), and approximated by: (a) the lower limit of epiphytic mosses and liverworts intolerant of sustained inundation; (b) the upper limit of the root crown on fetterbush *(Lyonia lucida)* growing on tree tussocks; (c) the upper limit of adventitious roots on St. John's Wort (*Hypericum fasiculatum*) and other species which exhibit ths morphologic response to sustained inundation; and (d) other indicators which can be demonstrated to represent a similar period of sustained inundation.
(2) the elevation associated with the inflection point on the buttress of cypress trees (*Taxodium* spp.);
(3) the elevation of soil on the lakeward side of the rooted base of the lowest extent of lake-fringing saw palmetto (*Serenoa repens*) shrubs;
(4) the elevation of soil on the lakeward side of the base of the lowest extent of lake-fringing, mature longleaf pine (*Pinus palustris*) trees;
(5) the elevation of soil on the lakeward side of the base of the lowest extent of lake fringing, mature live oak (Quercus virginiana) trees;
(6) the elevation of the toe of the highest landward scarp line (see Bishop 1967, Knochenmus 1967);
(7) the elevation of stratified beach deposits (see Bishop 1967, Knochenmus 1967);
(8) the elevation of soil on the lakeward side of the base of cultivated groves or stands of perennial woody species (*e.g.,* citrus or pine trees) intolerant of inundation;
(9) analysis of historical aerial photography, topographic maps, survey records, site plans or other information;

(10) the elevation of hydologic indicators listed in numbers 1 through 8 above for lakes which are connected via surface water canals or passages; and
(11) other indicators which can be demonstrated to represent a similar period of sustained inundation.

District staff recommend that for the purpose of establishing minimum lake levels for Category 3 lakes, the elevation derived from interpretation and analyses of data described above be termed the "Category 3 Lake Normal Pool Elevation".

Establishing Guidance Levels and the Historic P50

It is proposed that the Ten Year Flood Guidance Level, High Guidance Level, Low Guidance Level, and Historic P50 for Category 3 Lakes should be established in a manner similar to that used for Category 1 and 2 Lakes. Establishment of these levels is contingent upon the compilation of lake stage data, classification of lake stage data as Historic or Current, calculation of stage-duration percentile statistics, the development of a region-specific reference lake water regime, the determination of the Normal Pool or Category 3 Lake Normal Pool, and control point elevations, lake classification based on structural alteration and conveyance system configuration and numerical and simulation modeling.

The Ten Year Flood Guidance Level is established as an advisory guideline for lake shore development. The Ten Year Flood Guidance Level incorporates 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 is established using methods that correspond to the hydrology and type of conveyance system of the lake being evaluated.

The Ten Year Flood Guidance Level for "open-basin lakes", which are lakes that have a surface water conveyance system that by itself, or in series with other lakes, connects to or is part of an ordered surface water conveyance system is derived through a frequency analysis of lake stage readings (statistical method) or using numerical single storm event models.

If lake stage records of sufficient quality and quantity are available, the Ten Year Flood Guidance Level for open-basin lakes will be established using statistics derived from frequency analysis of the stage record (statistical method). Annual peak stages will be ranked and fit to a distribution or plotted to estimate the ten-year peak stage. As a general rule, at least thirty years of hydrologic data from a period when structural alterations have been stable are required for establishment of the Ten Year Flood Guidance Level using the statistical method.

Storm event modeling of open-basin lakes will be utilized when sufficient stage data for use of the statistical method are not available.. Rainfall depths are taken from sources such as the National Weather Service Technical Paper 49, and Part D of the District's Environmental Resource Permitting Information Manual described and incorporated by reference in Rule 40D-4.091, F.A.C. Runoff volumes are computed using conventional methods such as the Natural Resources Conservation Service (NRCS) curve number method, or with standard infiltration formulas (*e.g.*, Horton's Equation, Green-Ampt Equation). Runoff distributions are computed using conventional methods including the NRCS method or other unit hydrograph methods, or the kinematic wave overland flow method. Modeling programs that account for tailwater and compute backflow (dynamic models) are preferred for the hydraulic routing.

The Ten Year Flood Guidance Level for "closed-basin lakes", which are lakes that do not connect to, or are not part of an ordered surface water conveyance system is derived through a frequency analysis of lake stage readings (statistical method), or simulated lake stages predicted by a numerical simulation model (continuous simulation modeling), or an empirical simulation model derived by regression methods (empirical modeling). Reasonable scientific judgment is used to classify a lake as a closed-basin lake where hydrology or hydraulic characteristics (*e.g.*, intermittent or periodic discharge) are associated with a lake such that the lake does not clearly meet the definition of a closed basin lake nor open basin lake. Selection of the method used to derive the Ten Year Flood Guidance Level for closed-basin lakes is based on reasonable scientific judgement.

If lake stage records of sufficient quality and quantity are available, the Ten Year Flood Guidance Level for closed-basin lakes will be established using statistics derived from frequency analysis of the stage record (statistical method). Annual peak stages will be ranked and fit to a distribution or plotted to estimate the ten-year peak stage. As a general rule, at least thirty years of hydrologic data from a period when structural alterations have been stable are required for establishment of the Ten Year Flood Guidance Level using the statistical method.

Numerical or empirical modeling of closed-basin lakes will be utilized when sufficient stage data for use of the statistical method is not available. Simulation periods for either numerical or empirical models will be based on thirty or more years of continuous rainfall record. A composite of more than one rainfall station in the region in which the subject lake is located is acceptable. Calibration of the simulation model shall be based on as many of the following indicators as possible: stage records and Hydrologic Indicators of water levels. If stage records or Hydrologic Indicators do not exist or the record does not contain peak elevation readings, then eye-witness accounts of peak stages may be considered. Model simulations to determine the Ten Year Flood Guidance Level will exclude effects of water withdrawals.

The High Guidance Level (HGL) is established as an advisory guideline for local governments and lakeshore residents to aid in the proper siting of lakeshore development and water-related facilities, including docks and seawalls. The High Guidance Level may also be used by the District for operation of water control structures.

The High Guidance Level corresponds to the expected Historic P10 elevation and is calculated for Category 3 Lakes using Historic data if available, or estimated using the Current P10 elevation, the control point elevation and the Category 3 Lake Normal Pool elevation (Figure 5-2). If only Current data are available and the lake has been structurally altered, the High Guidance Level is established as the higher or the Current P10 or the control point elevation. Structurally Altered lakes are those where structural alteration has resulted in a lake control point which is lower than the Category 3 Lake Normal Pool elevation. If Current data are unavailable, and the lake has not been structurally altered, the High Guidance Level is established as the higher of Current P10 or the Category 3 Lake Normal Pool elevation. Lakes classified as Not Structurally Altered are those without outlets, or those where structural alteration has not resulted in a control point elevation lower than the Category 3 Lake Normal Pool elevation. If Historic or Current data are not available, the High Guidance Level is established at the control point elevation for Structurally Altered lakes and the Category 3 Lake Normal Pool elevation for lakes which are Not Structurally Altered.

The Low Guidance Level (LGL) is established as an advisory guideline for local governments and lakeshore residents to aid in the proper siting of lakeshore facilities, including docks and seawalls and to inform lake users of expected low water levels. The Low Guidance Level may also be used by the District for operation of water control structures.

The Low Guidance Level corresponds to the expected Historic P90 and is calculated using Historic data if available, or estimated using the Current P10 and P90, the High Guidance Level, and the RLWR90 for the region (Figure 5-3). If only Current data are available, and the difference between the Current P10 and the Current P90 is less than the RLRW90, the Low Guidance Level is established at an elevation corresponding to the High Guidance Level minus the difference between the Current P10 and the Current P90. If only Current data are available, and the difference between the Current P10 and Current P90 is greater than or equal to the RLWR90, the Low Guidance Level is established at an elevation corresponding to the High Guidance Level minus the RLWR90. If Historic or Current data are unavailable, the Low Guidance Level is established at an elevation corresponding to the High Guidance Level minus the RLWR90.

The Historic P50 elevation is established using historic data (Historic P50), if available or current data (Current P50), the High Guidance Level and the RLWR50 for the region (Figure 5-4). If only Current data are available and the difference between the Current P10 and Current P50 is less than the RLWR50, the Historic P50 is established at an elevation corresponding to the High Guidance Level minus the difference between the Current P10 and the Current P50. If only Current data are available, and the difference between the Current P10 and the Current P50 is greater than or equal to the RLWR50, the Historic P50 is established at an elevation corresponding to the High Guidance Level minus the RLWR50. If Historic or Current data are unavailable, the Historic P50 is established at an elevation corresponding to the High Guidance Level minus the RLWR50.

Developing Significant Change Standards and Information for Consideration for Category 3 Lakes

District Staff agree that the best approach for developing minimum levels for Category 3 Lakes is one that involves review of multiple lake characteristics or parameters. The derivation and potential use of several significant change standards for this purpose are described in detail in Sections 3 and 4 of this report. In this sub-section, step-by-step instructions are provided for developing standards and reviewing other information which may be relevant to minimum levels establishment for Category 3 lakes. Each step in the recommended approach involves the collection and evaluation of lake-specific data, or selection of appropriate descriptions of lake characteristics. The instructions are designed for review of information in eight categories, and for some categories, the development and evaluation of significant change standards. Collectively, these instructions provide the framework for a multiple-parameter approach for establishing minimum lake levels for Category 3 Lakes.

Lake Mixing and Stratification Information for Consideration

Step 1 Using bathymetric data/maps, establish dynamic ratio values for various lake stages.

If, over the range in elevation from the High Guidance Level to the Low Guidance Level, the dynamic ratio shifts from a value <0.8 to a value >0.8 or from a value >0.8 to a value <0.8, consideration of change in water level and change in sediment disturbance pattern may be warranted . . . . Proceed to Step 2

If, over the range in elevation from the High Guidance Level to the Low Guidance Level, the dynamic ratio does not shift from a value <0.8 to a value >0.8 or from a value >0.8 to a value <0.8, consideration of change in water level and change in sediment disturbance pattern may not be warranted . . . . Proceed to Step 2

Step 2 Develop depth profiles of water column temperature, dissolved oxygen, *etc.* during summer months.

If stable patterns of thermal stratification are evident, consideration of

potential changes in water column mixing associated with water level change is warranted
. . . . Proceed to Step 2

If stable patterns of thermal stratification are not evident, consideration of potential changes in water column mixing associated with water level change is not warranted . . . . Proceed to Step 3

Step 3 Review all relevant information pertaining to water column mixing and stratification for development of minimum levels.

Dock-Use Standard and Information for Consideration

Step 1 Conduct a site visit to determine whether boats or other watercraft are used on the lake.

If boats or other watercraft are used on the lake, development of a Dock-Use Standard is appropriate . . . . Proceed to Step 2

If boats or other watercraft are not used on the lake, development of a Dock-Use Standard is not appropriate . . . . Proceed to Step 6

Step 2 Determine the elevation of sediments at the end of all existing docks . . . . Proceed to Step 3

Step 3 Establish the Dock-End Sediment elevation at the elevation exceeded by ten percent of the sediment elevation values for existing docks
. . . . Proceed to Step 4

Step 4 Derive the Dock-Use Standard by adding 2 feet and the appropriate region-specific RLWR5090 value (in feet) to the Dock-End Sediment elevation . . . . Proceed to step 5.

Step 5 Compare the Dock-Use Standard to the Historic P50 elevation.

If the Dock-Use Standard is less than the Historic P50 elevation, use of the standard may be appropriate for minimum levels development
. . . . Proceed to Step 6

If the Dock-Use Standard is greater than the Historic P50 elevation, use of the standard is not appropriate . . . . Proceed to Step 6

Step 6 Review all relevant information pertaining to dock use and elevations (including the Dock-Use Standard, if appropriate) for development of minimum levels.

Basin Connectivity Standard and Information for Consideration

Step 1 Conduct a site visit and review relevant information (*e.g.*, bathymetric data) to determine whether basin morphology is such that hydrologic connections exist between the lake and other lakes or whether the basin may separate into sub-basins at some relatively low water level.

If hydrologic connections between lake basins or among sub-basins within the lake basin may be expected at some water levels, development of a Basin Connectivity Standard may be appropriate . . . Proceed to Step 2

If hydrologic connections between lake basins or among sub-basins within the lake basin are not expected at most water levels, development of a Basin Connectivity Standard is not appropriate . . . . . Proceed to Step 8

Step 2 Determine high-spot elevations for areas of connectivity between lake basins or between sub-basins within a lake basin. Identify the highest elevation (or other appropriate high-spot elevation) as the critical high-spot elevation.
. . . . Proceed to Step 3

Step 3 Conduct a site visit to determine whether power boats are used on the lake.

Power boats are used on the lake . . . . Proceed to Step 4

Power boats are not used on the lake . . . . Proceed to Step 6

Step 4 Derive a Basin Connectivity Standard for use on a lake where power boats are used by adding 2 feet and the appropriate region-specific RLWR5090 value (in feet) to the critical high spot elevation
. . . . Proceed to Step 5

Step 5 Compare the Basin Connectivity Standard to the Historic P50.

If the Basin Connectivity Standard is less than the Historic P50, use of the standard for minimum levels development may be appropriate
. . . . Proceed to step 8

If the Basin Connectivity Standard is greater than the Historic P50, use of this standard is not appropriate . . . . Proceed to step 6

Step 6 Derive a Basin Connectivity Standard for lakes where power boats are not used by adding 1 foot and the appropriate region-specific RLWR5090 value (in feet) to the critical high spot elevation . . . . . . Proceed to step 7

Step 7 Compare the Basin Connectivity Standard to the Historic P50.

If the Basin Connectivity Standard is less than the Historic P50, use of the standard for Minimum Levels development may be appropriate. . . . . Proceed to step 8

If the Basin Connectivity Standard is greater than the Historic P50, use of the standard for Minimum Levels development is not appropriate. . . . . Proceed to step 8

Step 8 Review relevant information pertaining to inter- and intra-basin hydrologic connections (including the Basin Connectivity Standard, if appropriate) for development of minimum levels.

Species Richness Standard and Information for Consideration

Step 1 Using bathymetric data, establish the total lake surface area associated with the Historic P50 elevation . . . . Proceed to Step 2

Step 2 Establish the Species Richness Standard at an elevation corresponding to a 15% decrease in the total lake area as measured from the Historic P50 elevation . . . . Proceed to Step 3

Step 3 Review all relevant information pertaining to biological diversity within the lake basin (including the Species Richness Standard) for development of minimum levels.

Herbaceous Wetland Information for Consideration

Step 1 Establish the potential herbaceous wetland area (*i.e.*, lake area with a water depth less than or equal to 4 feet) associated with the Historic P50 elevation . . . . Proceed to step 2

Step 2 Plot potential herbaceous wetland area (absolute in acres, or relative to the area at the Historic P50 elevation) versus lake stage to identify possible changes in lake stage associated with substantial changes in potential wetland area. Identify basin elevations where change in lake stage would result in substantial change in potential wetland area. Consider relationship between these elevations, the Historic P50 elevation and the use of significant change standards for minimum levels development . . . . Proceed to Step 3

Step 3 Review all relevant information pertaining to herbaceous wetlands in the lake basin (*e.g.*, elevation of connections between the lake basin and contiguous wetland areas) for development of minimum levels.

Submersed Aquatic Macrophyte Information for Consideration

Step 1 Establish the maximum depth of colonization by submersed aquatic macropytes using a representative, lake-specific Secchi Disk depth value and the empirical relationship reported in Canfield *et al. (1985)* . . . . Proceed to step 2.

Step 2 Using bathymetric data, estimate the lake area suitable for colonization by submersed aquatic macrophytes for various lake stages by calculating the stage-specific lake areas of depth equal to or greater than the maximum depth of colonization. . . . . Proceed to step 3

Step 3 Determine the change in area which could be colonized by submersed aquatic macrophytes (relative to the Historic P50 elevation) for the various significant change standards (Cypress Wetland Standard, Dock-Use Standard, *etc.*). Consider substantial changes suggestive of potential problems with use of the respective standards for minimum levels development. Evaluate use of standards accordingly . Proceed to step 4

Step 4 Plot area which may be colonized by submersed aquatic macrophytes (absolute in acres, or relative to area at Historic P50 elevation) versus lake stage to identify changes in lake stage that may be associated with substantial changes in potential colonized area. Identify basin elevations where change in lake stage would result in substantial change in area potentially colonized by plants. Consider the relationship between these elevations, the Historic P50 elevation, and the use of significant change standards for minimum levels development . . . . Proceed to Step 5

Step 5 Review all relevant information pertaining to aquatic macrophyte coverage in the lake basin (*e.g.*, coverage which may hinder navigation) for development of minimum levels.

Aesthetics Standard and Information for Consideration

Step 1 Establish the Aesthetics Standard at the Low Guidance Level . . . . Proceed to Step 2

Step 2 Review all relevant information pertaining to aesthetics within the lake basin (including the Aesthetics Standard) for development of minimum levels.

Recreation/Ski Standard and Information for Consideration

Step 1 Using bathymetric data, determine whether the lake basin can contain a ski corridor delineated as a circular area with a radius of 418 feet.

If the basin can contain such an area, development of a Recreation/Ski Standard may be appropriate . . . . Proceed to Step 2

If the basin cannot contain such an area, development of a Recreation/Ski Standard is not appropriate . . . . Proceed to Step 6

Step 2 Identify the critical minimum elevation at which the lake basin could contain a ski corridor by adding five feet to the elevation at which the basin could contain a circular ski corridor with a radius of 418 feet . . . . Proceed to Step 3.

Step 3 Compare the critical minimum elevation to the Low Guidance Level.

If the critical minimum elevation is greater than the Low Guidance Level, development of a Recreation/Ski Standard is appropriate . . . . Proceed to Step 4

If the critical minimum elevation is less than the Low Guidance Level, development of a Recreation/Ski Standard is not appropriate . . . . Proceed to Step 5

Step 4 Establish the Recreation/Ski Standard at an elevation corresponding to the critical minimum elevation plus the appropriate RLWR5090 value . . . . Proceed to Step 5

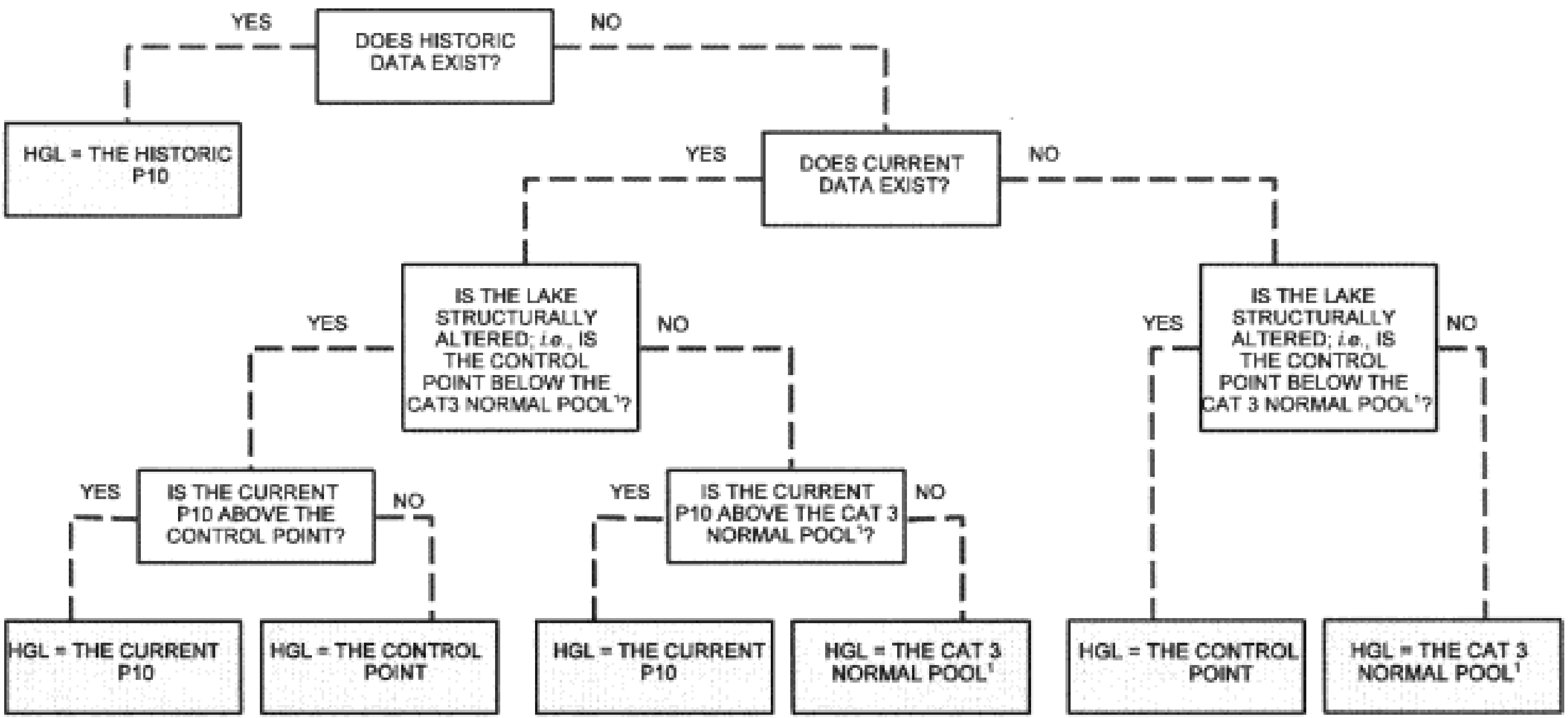
Step 5 Review all relevant information pertaining to skiing and other recreational activities within the lake basin (including the Recreation/Ski Standard) for development of minimum levels.

Establishing Minimum Levels for Category 3 Lakes Using a Multiple-Parameter Approach

Following development of lake-specific significant change standards and compilation of other relevant information, minimum levels for Category 3 lakes may be established. District staff recommend that the Minimum Lake Level be established at the elevation corresponding to the most conservative, *i.e.*, the highest, significant change standard, with consideration given to other relevant information. Information considered relevant to this process could include the Low Floor Slab elevation, substantial changes in the coverage of herbaceous wetland vegetation or submersed aquatic macrophytes, or frequent submergence of dock platforms.

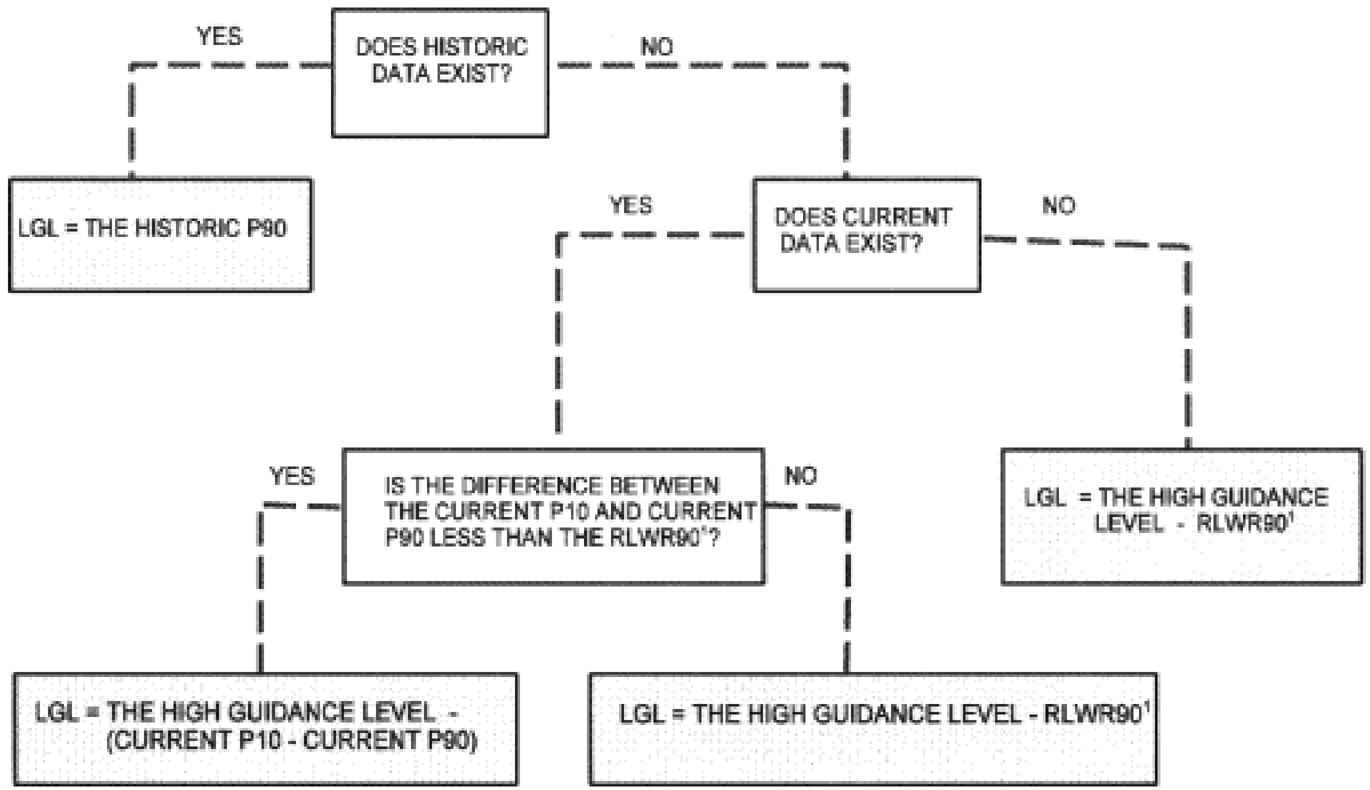
Once the Minimum Lake Level is identified, the High Minimum Lake Level may be established, using the region-specific reference lake water regime statistics, or Historic hydrologic data. If Historic data are available, the High Minimum Lake Level may be established at the elevation corresponding to the Minimum Lake Level plus the difference between the Historic P10 and the Historic P50. If Historic data are not available, the High Minimum Lake Level may be established at the elevation corresponding to the Minimum Lake Level plus the region-specific RLWR50 value.

Figure 5-2. Derivation of the High Guidance Level (HGL) for Category 3 Lakes.



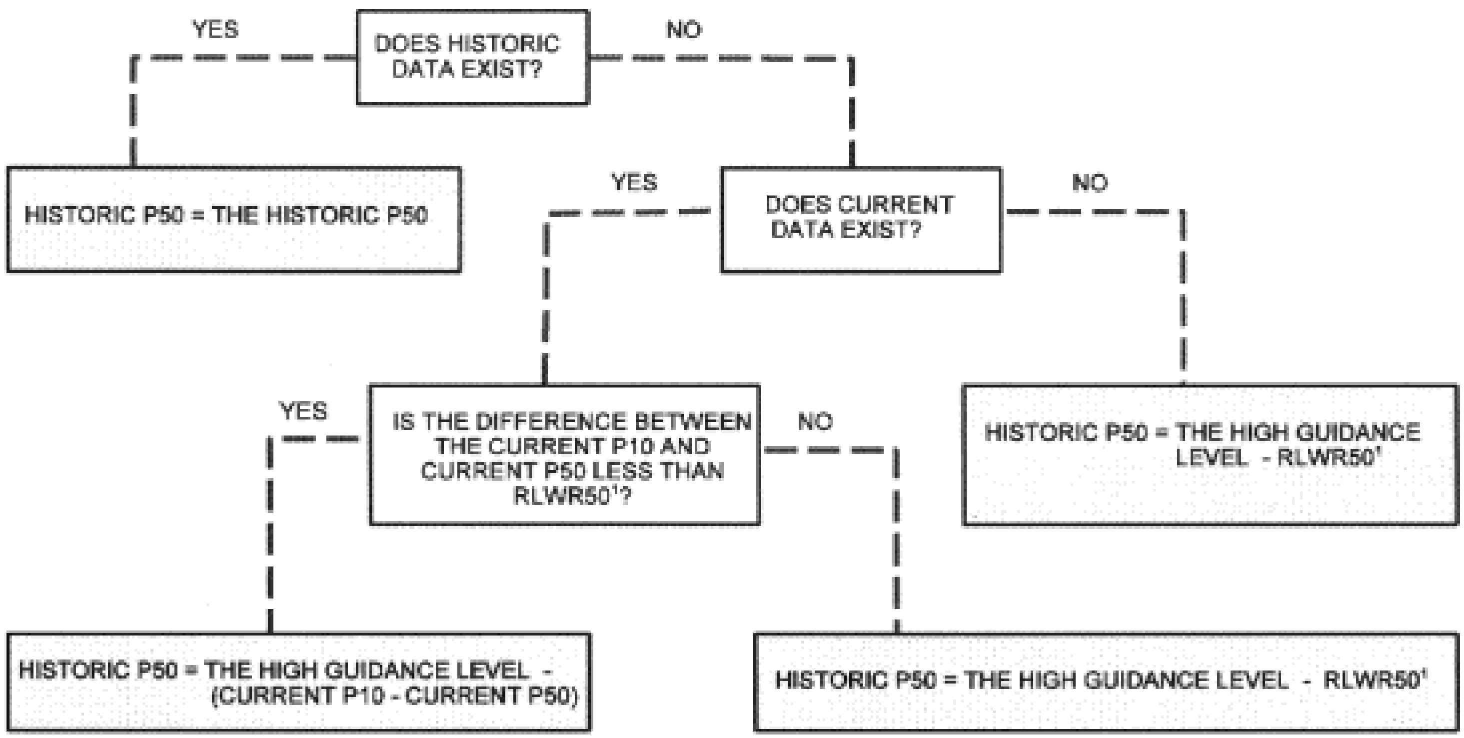
[1] Category 3 Lake Normal Pool Elevation

Figure 5-3. Derivation of the Low Guidance Level (LGL) for Category 3 Lakes.



[1] Reference Lake Water Regime 90

Figure 5-4. Derivation of the Historic P50 for Category 3 Lakes.



[1] Reference Lake Water Regime 50

Section 6

Implementation of Proposed and Existing Methods for Establishing Minimum Levels for Sixteen Lakes in Northwest Hillsborough County, Florida and One Lake in Central Pasco County, Florida

Introduction

Proposed minimum and guidance levels for sixteen lakes in northwest Hillsborough County (Figure 6-1), and one lake in north-central Pasco County (Figure 6-2) were developed using the methods outlined in this report. Fourteen of the lakes are classified as Category 3 lakes. Levels for these lakes were developed using the multiple-parameter approach outlined in Section 5. Three of the lakes are contiguous with fringing cypress wetlands. Levels for these lakes were developed using methods contained in current District rules and outlined in Section 3. Recommended levels for all seventeen lakes are presented in this section along with information used for levels development.

Figure 6-1. Location of lakes with proposed minimum levels in northwest Hillsborough County, Florida.

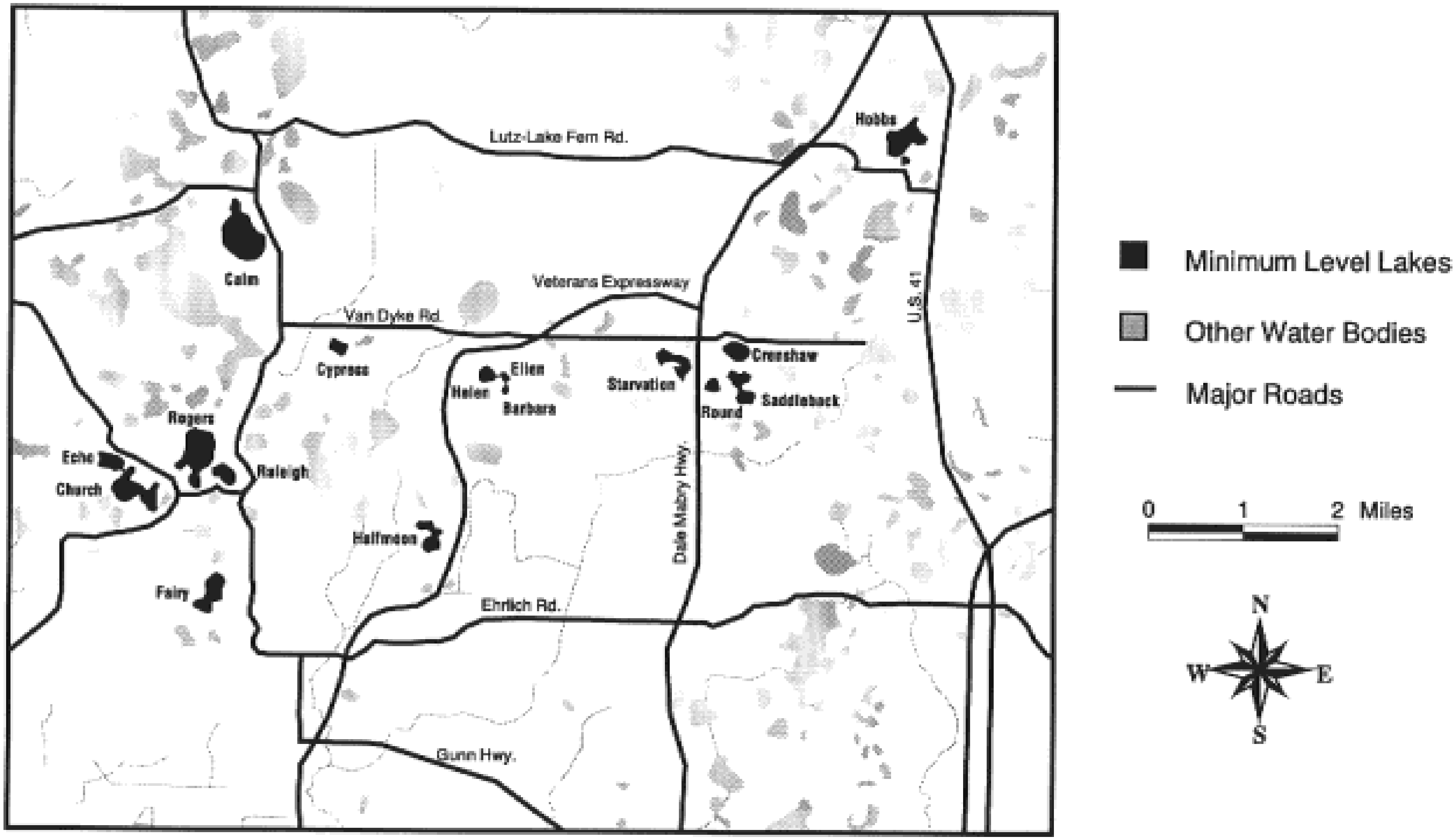
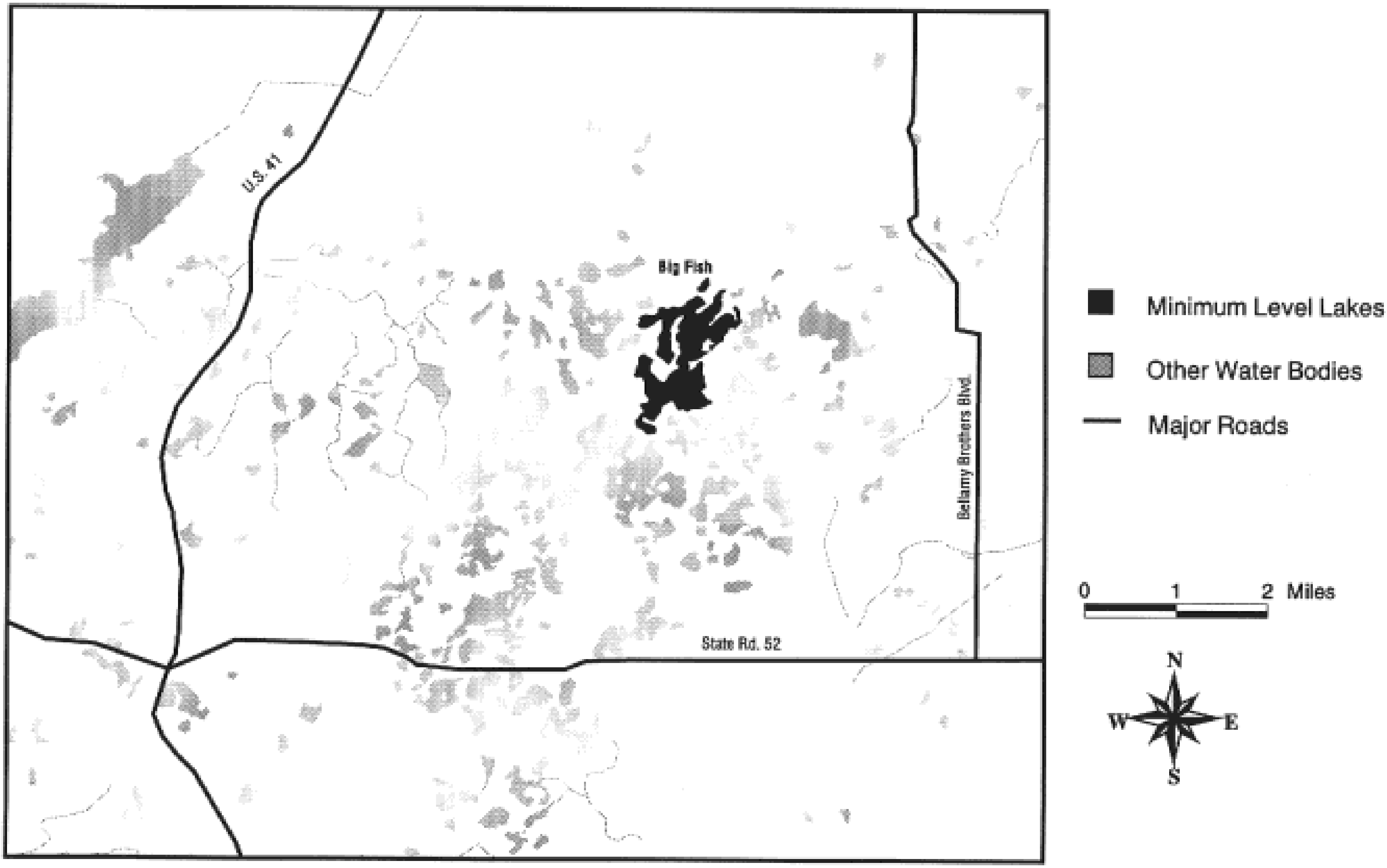


Figure 6-2. Location of the lake with proposed minimum levels in central Pasco County, Florida.



Big Fish Lake

General Lake Description

Big Fish Lake is located in the Coastal Rivers Basin in Pasco County, Florida (Sections 21, 22, 27, 28 and 32 Township 24S, Range 19E). The area surrounding the lake is categorized as the Land-O-Lakes subdivision of the Tampa Plain in the Ocala Uplift Physiographic District; a region of many lakes on a moderately thick plain of silty sand overlying Tampa Limestone (Brooks 1981). As part of the Florida Department of Environmental Protection's Lake Bioassessment/Regionalization Initiative, the area has been identified as the Tampa Plain Lake Region; an area of slightly acidic, darkwater, mesotrophic lakes (Griffith *et al.* 1997).

Surface elevation of the land surrounding Big Fish Lake ranges from approximately 65 to 100 ft, NGVD. A sandy ridge running north to south through the lake's watershed to a berm located along the southern boundary of Sections 27 and 28 divides the watershed into eastern and western sub-basins. Land surface elevations are lowest in the western sub-basin. An east-west oriented ridge in the eastern sub-basin further divides the sub-basin into numerous smaller basins. Surface water pooled in the various sub-basins results in the development of a complex system of interconnected and isolated open water and wetland habitats, which collectively comprise Big Fish Lake. Since summer 2000, the lake has been intermittently augmented with ground water from the Floridan aquifer. The lake has a drainage area of 2.41 square miles and discharges to the west when water level exceeds 76.05 ft, NGVD (Figure 6-3).

The United States Geological Survey 1954 1:24,000 Masaryktown, Fla. and Ehren, Fla. (photorevised in 1988) quadrangle maps indicate a water level elevation of 76 ft, NGVD, a level corresponding to an area of 711 acres (based on a detailed topographic map developed by SWFWMD staff; see discussion below). The Florida Lake Gazetteer (Shafer *et al.* 1986) lists the lake area at 270 acres at this elevation. This discrepancy in reported area values for Big Fish Lake, may, in part, be explained by differences in criteria used to establish lake area. A study conducted by the Natural Resources Conservation Service in the mid-1990s (Werner 1996) illustrates this point. The study provides estimates of wetland acreage on the ranch containing Big Fish Lake, and lists the surface area of the "main body" of the lake at 313 acres, while the area encompassed by the connection of "flats" or low-lying regions between major pools is estimated at 615 acres. These estimates, derived using soil maps of the area, approximate the surface area values of 711 and 270 acres cited above. Thus, the surface area reported in the Florida Lake Gazetteer (277 acres when the surface water elevation is 76 ft, NGVD) corresponds to only a portion of the area within the watershed where open water or wetland habitat exists.

Because of the complex topography of the Big Fish Lake basin and the legislative requirement that minimum levels be established to prevent significant harm to the water resources (*i.e.*, lakes, wetland, streams, aquifers) of a region, a detailed topographic map of the Big Fish Lake basin (Figure 6-4) was developed for estimation of surface areas associated with various water level elevations within the basin. Data used for map production were obtained from field surveys of the dry basin and from 1:200 aerial photograph maps of the basin containing one-foot contour lines and spot elevations prepared using photogrammetric methods. The topographic map was limited to areas bounded by a contour line corresponding to an elevation of 77 ft NGVD surrounding the lake basin in Sections 21, 22, 27 and 28, Township 24S, Range 19E. This elevation was selected upon review of lake stage data for the lake and aerial photographs of the region.

The District has not previously adopted management water levels for Big Fish Lake.

Proposed Minimum and Guidance Levels

Recommended Minimum and Guidance Levels for Big Fish Lake, a Category 3 Lake, are listed in Table 6-1, along with area values for each water level. The Species Richness and Aesthetic Standards for the lake are lower than the Historic P50 elevation. The Species Richness Standard, the more conservative of the two, was used to establish the proposed Minimum Lake Level at 73.05 ft. The proposed Minimum Lake Level is 0.4 ft lower than the Historic P50 elevation. Total lake area at the proposed Minimum Lake Level is about 85% of the area associated with the Historic P50 elevation. The proposed High Minimum Lake Level was established at 75.65 ft, an elevation corresponding to the Minimum Lake Level plus the RLWR50 (2.6 ft) for the Central Hernando County and Central Pasco County region. The proposed High Minimum Lake Level is 0.4 ft below the High Guidance Level and about 5.5 ft below the Low Floor Slab elevation. Lake area at the proposed High Minimum Lake Level is about 85% of that associated with the High Guidance Level. Development of the Guidance Levels listed in Table 6-1 is described in the following sub-section.

Table 6-1. Big Fish Lake: Recommended Minimum and Guidance Levels with Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten Year Flood Guidance Level	77.41	1001.0
High Guidance Level	76.05	724.0
High Minimum Lake Level	75.65	618.7
Minimum Lake Level	73.05	160.3
Low Guidance Level	71.75	104.1

Summary of Data and Analyses Supporting Recommended Minimum and Guidance Levels

Hydrologic data are available for Big Fish Lake for the period from June 1980 through February 1987 and from March 1996 to the present (December 2000) (Figure 6-5; see Figure 6-3 for the location of District water level gauges in the basin). For the entire period of record, the hydrologic data are classified as Current data. These data were used to calculate the Current P10, P50, P90 (Table 6-2). The Category 3 Lake Normal Pool elevation (Table 6-2) was established based on the mean elevation of the lowest extent of saw palmetto (*Serenoa repens*) shrubs fringing the lake (Table 6-3). The low floor slab elevation, structural alteration status and the control point elevation were determined using available one-foot contour interval aerial maps, and field survey information (Tables 6-2 and 6-4, Figure 6-6). The Category 3 Lake Normal Pool elevation is above the control point, so the lake is considered to be Structurally Altered.

Based on the relationship between the control point elevation, the Category 3 Lake Normal Pool elevation, and the Current P10, the High Guidance Level was established at the Current P10 elevation (Table 6-2). The Historic P50 and Low Guidance Level were determined using the High Guidance Level and RLWR50 (2.6 ft) and RLWR90 (4.3 ft) established for the North Central Pasco and Central Hernando County Region (Table 6-2) .

Big Fish Lake is not contiguous with any cypress-dominated wetlands and is therefore classified as a Category 3 Lake. Stands of *Panicum* sp., watershield (*Brasenia schreberi*), and other aquatic macrophytes are common in the lake. Development of a Dock-Use Standard is not appropriate for Big Fish Lake, as the basin only contains a single dock, which is in disrepair. Development of a Basin Connectivity Standard for the lake is also not appropriate based on the complex arrangement of sub-basins within the greater Big Fish Lake basin. A Species Richness Standard was established at 73.05 ft, based on a 15% reduction in lake surface area from that at the Historic P50 elevation. An Aesthetic-Standard for Big Fish Lake was established at the Low Guidance Level elevation of 71.75 ft NGVD. A Recreation/Ski Standard was established at 78.7 ft, based on a critical ski elevation of 77.0 ft and the RLWR5090 (1.7 ft) for the central Hernando County and Central Pasco County region. Review of the dynamic ratio for lake stages bounded by the Current P10 and Current P90 elevations did not indicate that potential changes in basin susceptibility to wind-induced sediment resuspension would be a problem for minimum levels development (Table 4-1, Figure 6-7). Changes in potential herbaceous wetland area as a function of change in lake stage did not indicate that use of any of the identified standards would be inappropriate (Figure 6-7). Coverage of aquatic macrophytes in relation to water transparency was likewise not considered to be an important factor for development of minimum levels for Big Fish Lake, based on the shallow nature of the lake.

The Ten Year Flood Guidance Level was established for Big Fish Lake using the methodology for open basin lakes described in Section 5 of this report. The District used a hydrologic and hydraulic computer model of the Big Fish Lake watershed developed by District staff. The runoff hydrographs were computed using the NRCS Dimensionless Unit Hydrograph method, a 300 shape factor, an 9.5 inch rainfall depth, and a 72-hour Florida Type II Modified rainfall distribution. The conveyance system was simulated with a hydrodynamic routing model. The initial elevation of Big Fish Lake was set at the outlet control point of 76.05 feet NGVD.

Table 6-2. Big Fish Lake: Summary of Elevation Data and Associated Area Values Used for Establishing Minimum Levels

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Current P10	75.89	724.0
Current P50	72.09	114.9
Current P90	67.61	11.7
Category 3 Lake Normal Pool	76.44	1004.3
Low Floor Slab	81.14	NA
Control Point	76.05	724.0
High Guidance Level	76.05 (Control Point)	724.0
Historic P50	73.45 (HGL - RLWR50)	189.0
Low Guidance Level	71.75 (HGL - RLWR90)	104.1
Dock-Use Standard	NA	NA
Basin Connectivity Standard	NA	NA
Species Richness Standard	73.05	160.3
Aesthetic Standard	71.75	104.1
Recreation/Ski Standard	78.7	1053.2

NA = not available / not applicable

Table 6-3. Big Fish Lake: Elevation Data Used for Establishing the Category 3 Lake Normal Pool Elevation. Data collected in October 1996, March and May 1997.

Hydrologic Indicator	Height above Lake Water Level (ft)	Elevation (ft, NGVD)
Edge of Saw Palmetto	NA	77.40
Edge of Saw Palmetto	NA	77.29
Edge of Saw Palmetto	NA	77.11
Edge of Saw Palmetto	NA	77.10
Edge of Saw Palmetto	NA	76.98
Edge of Saw Palmetto	NA	76.90
Edge of Saw Palmetto	NA	76.88
Edge of Saw Palmetto	NA	76.87
Edge of Saw Palmetto	NA	76.87
Edge of Saw Palmetto	NA	76.87
Edge of Saw Palmetto	NA	76.80
Edge of Saw Palmetto	NA	76.69
Edge of Saw Palmetto	NA	76.69
Edge of Saw Palmetto	NA	76.67
Edge of Saw Palmetto	NA	76.66
Edge of Saw Palmetto	NA	76.63
Edge of Saw Palmetto	NA	76.59
Edge of Saw Palmetto	NA	76.57
Edge of Saw Palmetto	NA	76.57
Edge of Saw Palmetto	NA	76.56
Edge of Saw Palmetto	NA	76.55
Edge of Saw Palmetto	NA	76.54
Edge of Saw Palmetto	NA	76.53

Edge of Saw Palmetto	NA	76.53
Edge of Saw Palmetto	NA	76.50
Edge of Saw Palmetto	NA	76.50
Edge of Saw Palmetto	NA	76.50
Edge of Saw Palmetto	NA	76.47
Edge of Saw Palmetto	NA	76.43
Edge of Saw Palmetto	NA	76.41
Edge of Saw Palmetto	NA	76.40
Edge of Saw Palmetto	NA	76.38
Edge of Saw Palmetto	NA	76.36
Edge of Saw Palmetto	NA	76.33
Edge of Saw Palmetto	NA	76.33
Edge of Saw Palmetto	NA	76.32
Edge of Saw Palmetto	NA	76.31
Edge of Saw Palmetto	NA	76.30
Edge of Saw Palmetto	NA	76.30
Edge of Saw Palmetto	NA	76.28
Edge of Saw Palmetto	NA	76.25
Edge of Saw Palmetto	NA	76.24
Edge of Saw Palmetto	NA	76.20
Edge of Saw Palmetto	NA	76.18
Edge of Saw Palmetto	NA	76.18
Edge of Saw Palmetto	NA	76.14
Edge of Saw Palmetto	NA	76.11
Edge of Saw Palmetto	NA	76.10
Edge of Saw Palmetto	NA	76.06
Edge of Saw Palmetto	NA	75.97

Edge of Saw Palmetto	NA	75.97
Edge of Saw Palmetto	NA	75.93
Edge of Saw Palmetto	NA	75.85
Edge of Saw Palmetto	NA	75.84
Edge of Saw Palmetto	NA	75.82
Edge of Saw Palmetto	NA	75.78
Edge of Saw Palmetto	NA	75.43
Mean	**NA**	**76.44**

NA = not available

Table 6-4. Big Fish Lake: Summary of Structural Alteration / Control Point Elevation Information. Numbers correspond to those shown in Figure 6-6.

No.	Description	Elevation (ft, NGVD)
1	Control point: vegetated natural ground	76.05

Figure 6-3. Location of District lake gauges and outlet at Big Fish Lake, Pasco County, Florida.

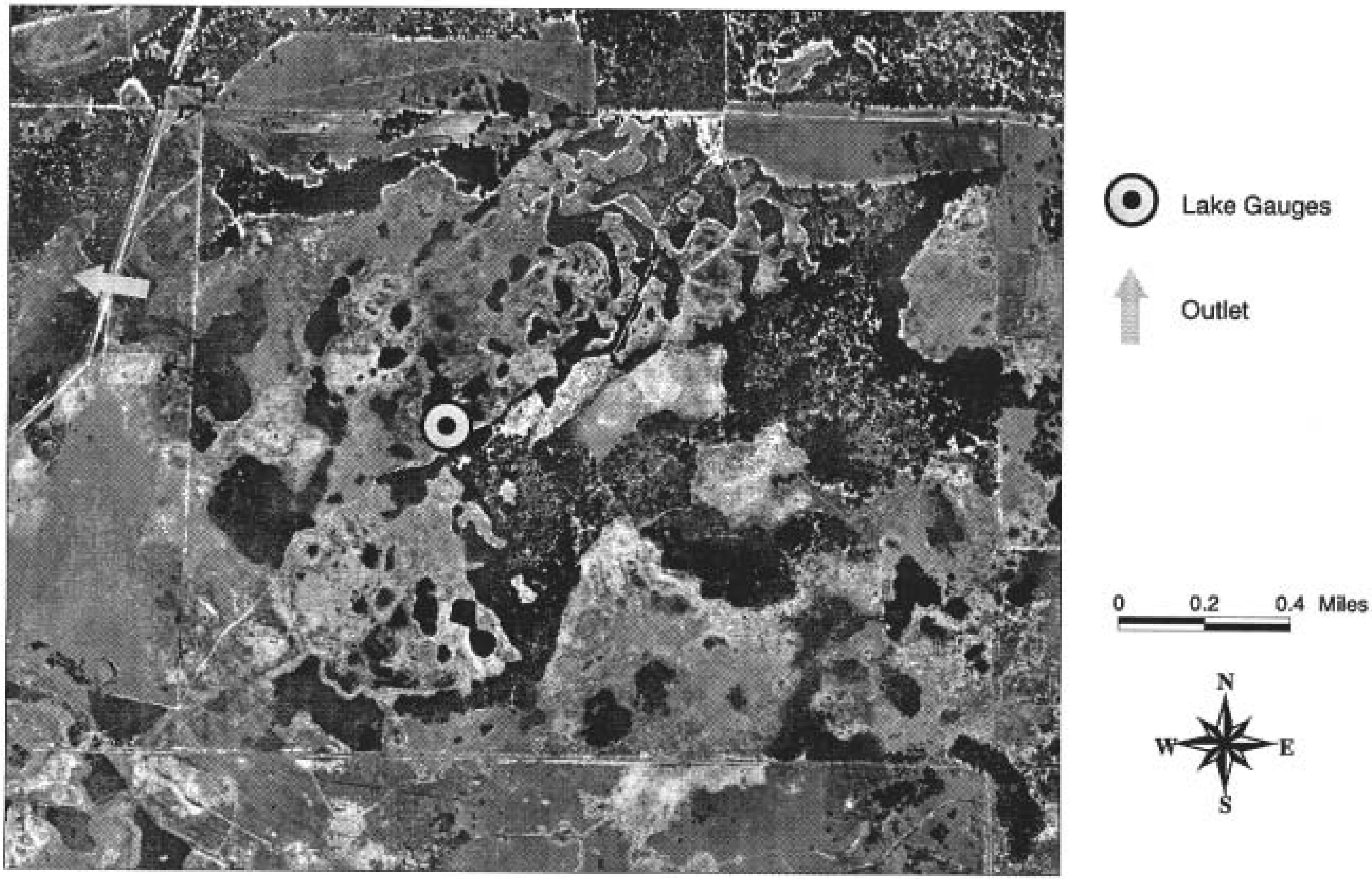


Figure 6-4. One-foot contour map of the Big Fish Lake basin, Paco County, Florida. Values shown are elevations, in feet, above the National Geodetic Vertical Datum.

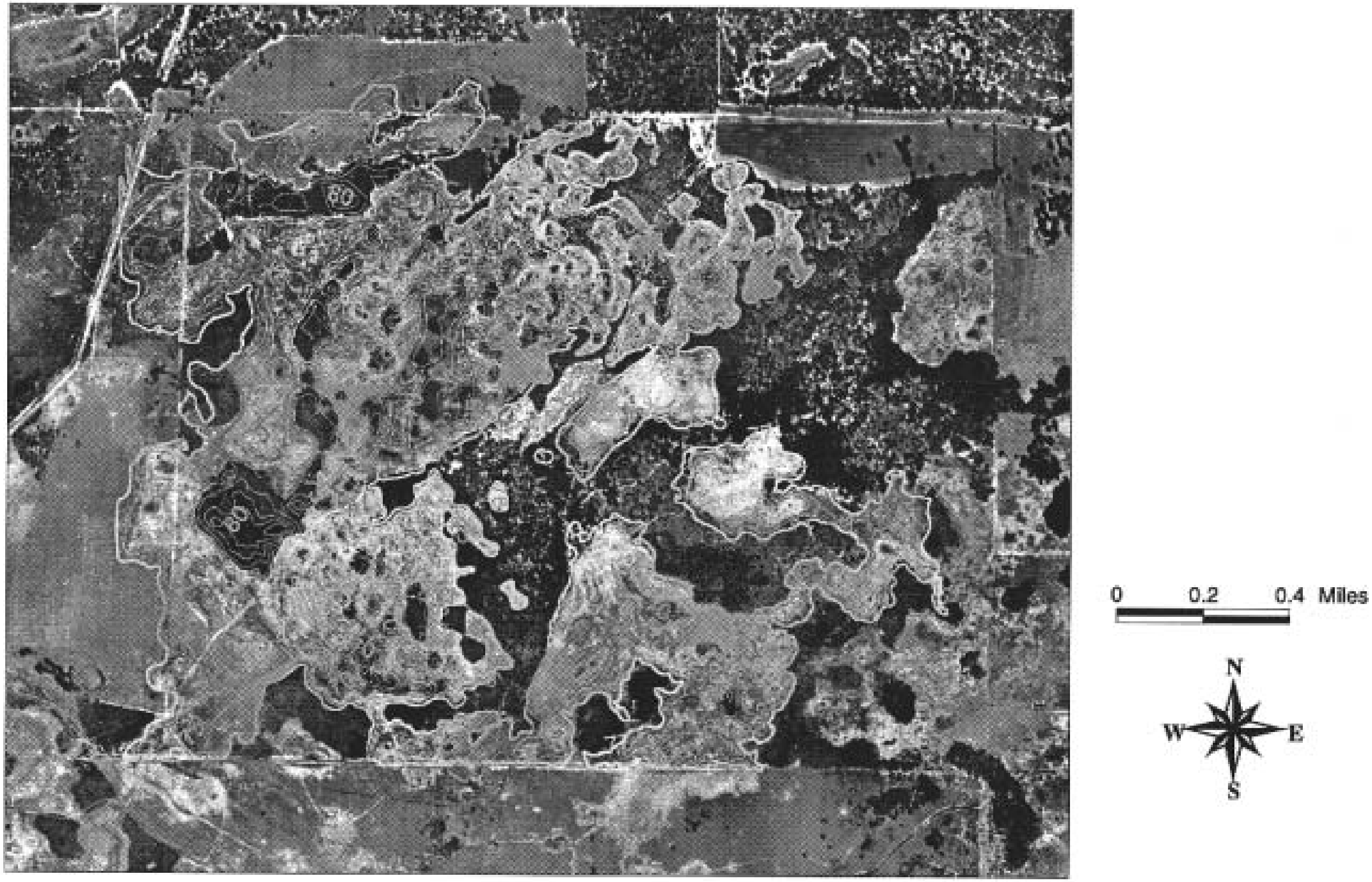


Figure 6-5. Mean monthly water elevations at Big Fish Lake, Pasco County, Florida. Proposed High Minimum Lake Level (HMLL), Minimum Lake Level (MLL), Ten-Year Flood Guidance Level (10-YR), High Guidance Level (HGL), and Low Guidance Level (LGL) are shown as solid or dashed lines.

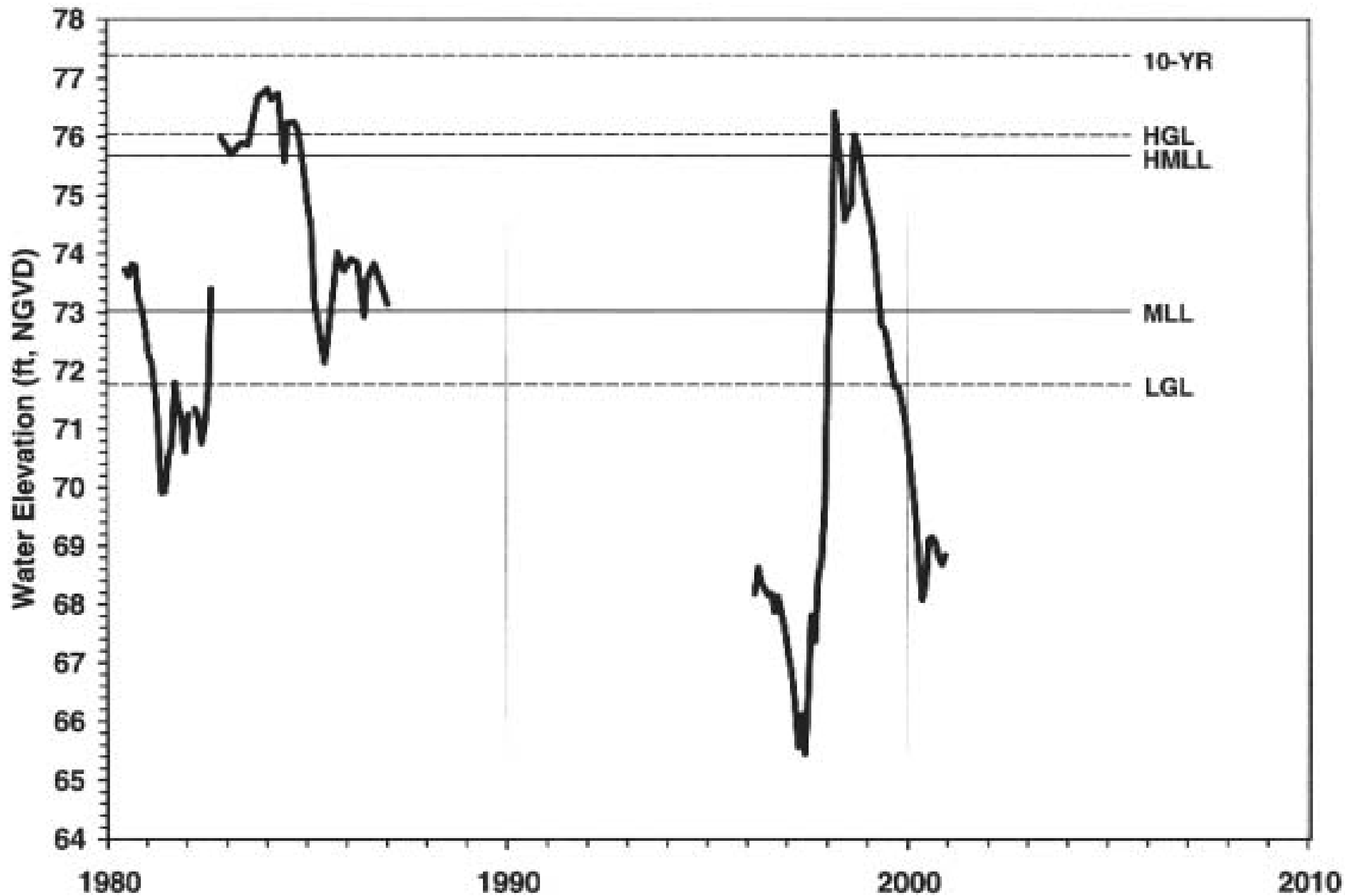


Figure 6-6. Outlet conveyance system for Big Fish Lake, Pasco County, Florida. Numbered site is described in Table 6-4

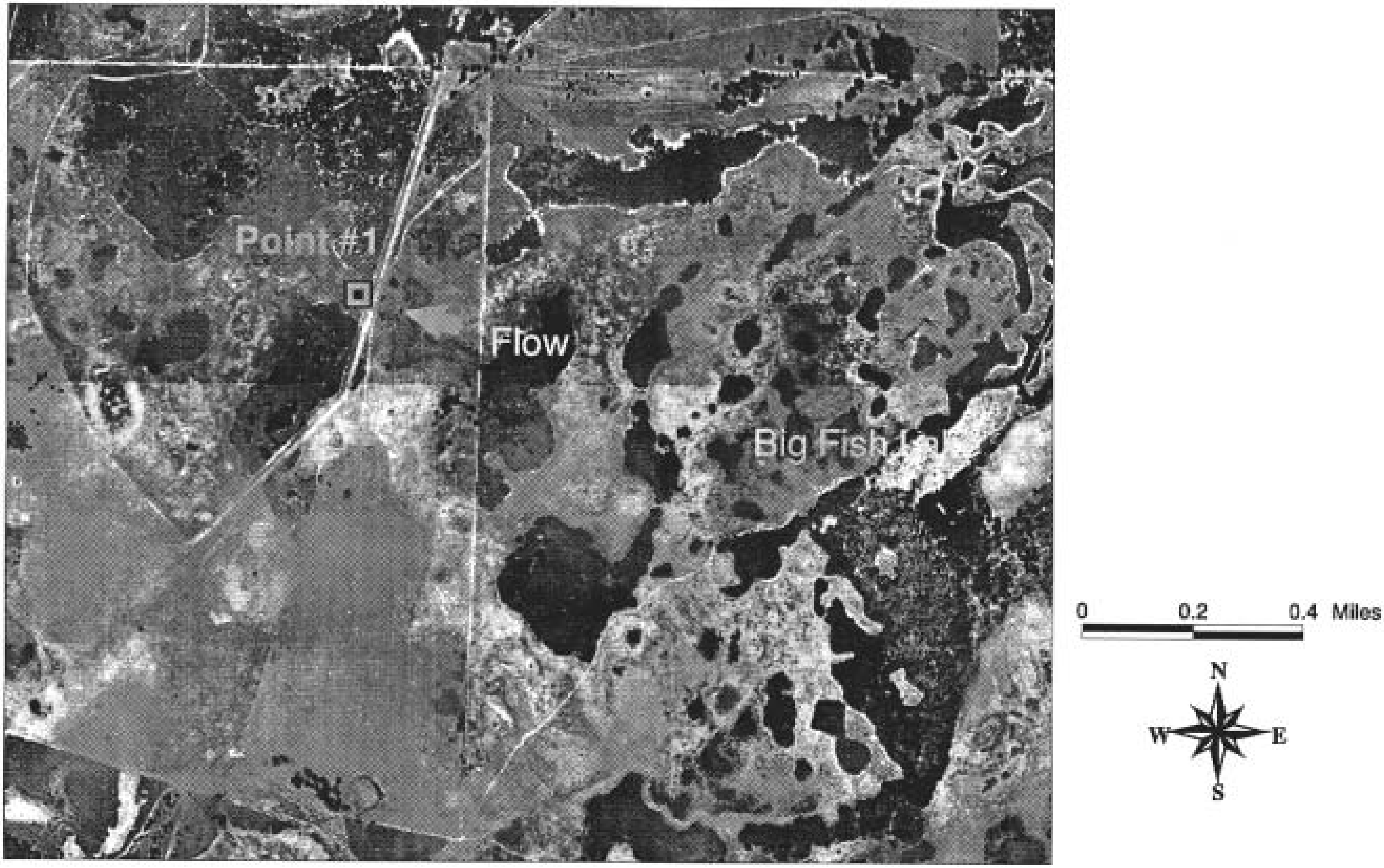
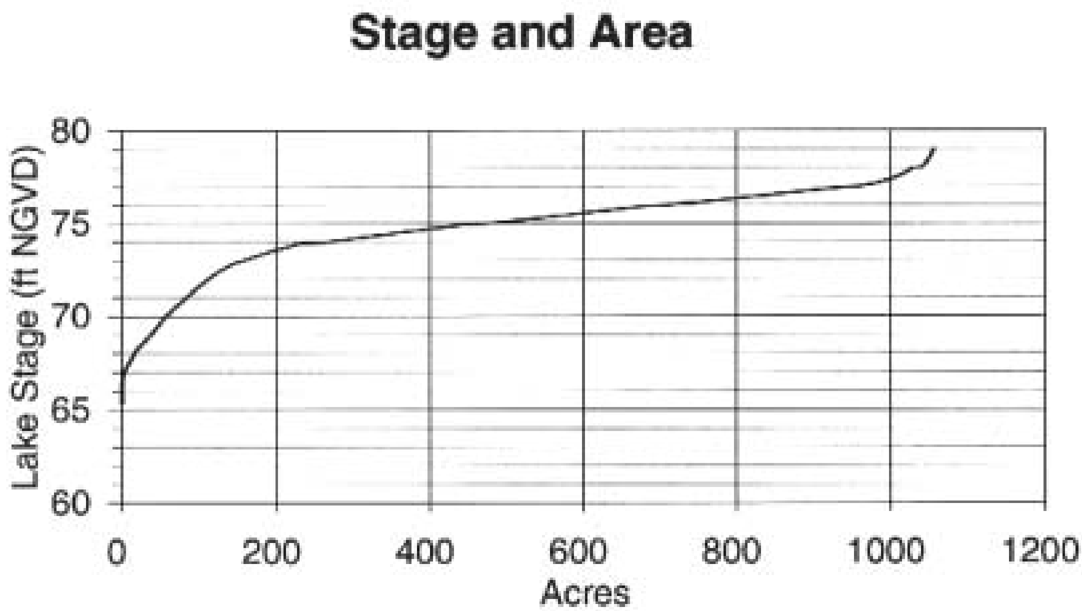


Figure 6-7. Lake area, volume, potential herbaceous wetland area, and dynamic ratio versus lake stage for Big Fish Lake, Pasco County, Florida.



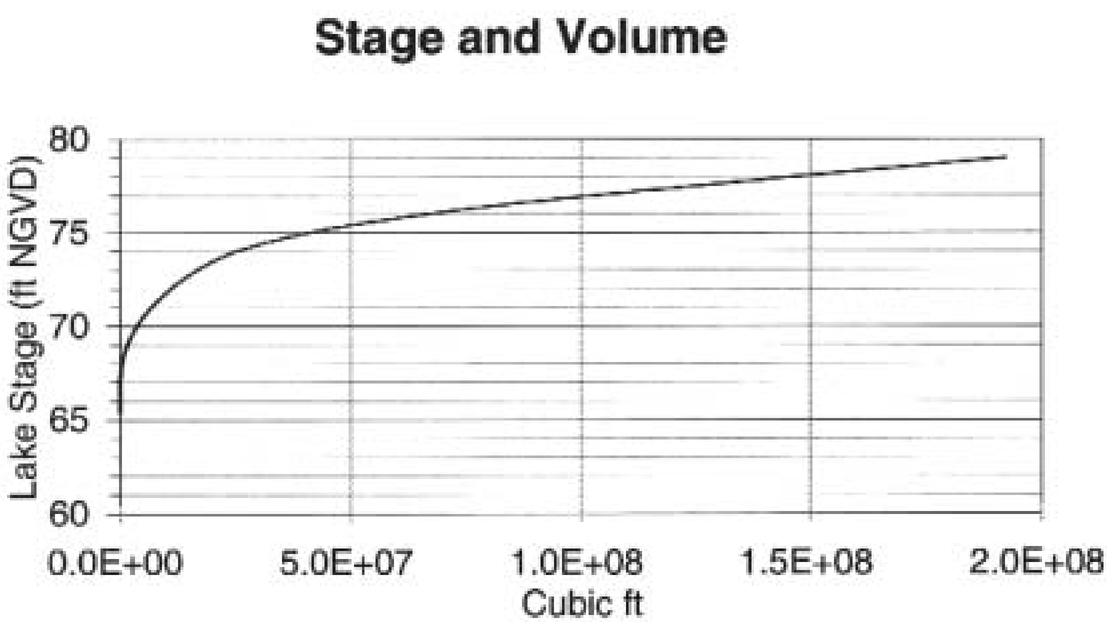
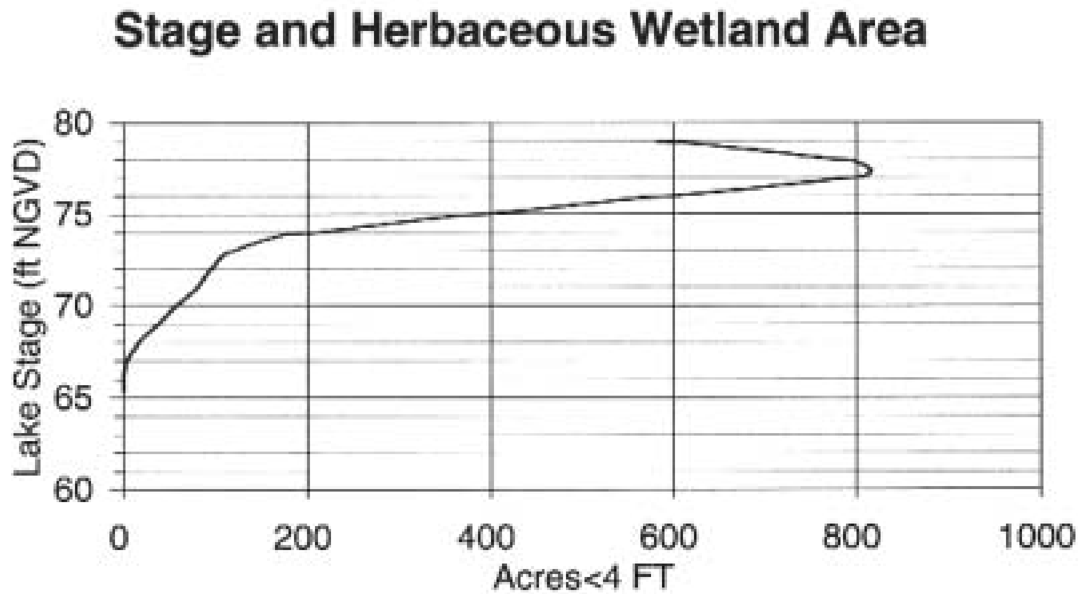
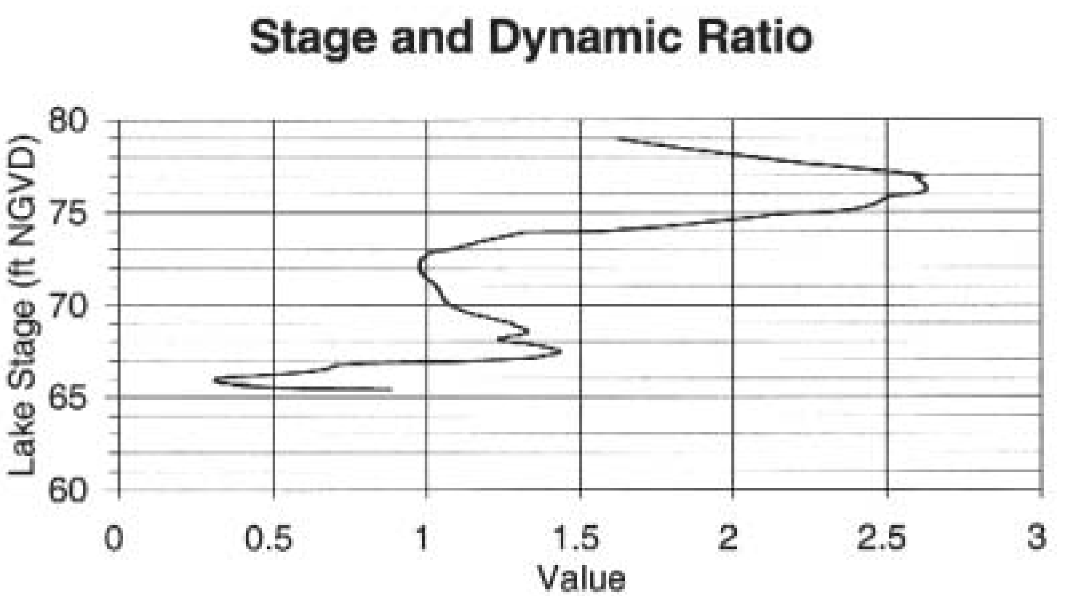


Figure 6-7. (Continued).





Lake Calm

General Lake Description and Previously Adopted Lake Management Levels

Lake Calm is located in the Northwest Hillsborough Basin in Hillsborough County, Florida (Section 14, Township 27S, Range 17E). The area surrounding the lake is categorized as the Land-O-Lakes subdivision of the Tampa Plain in the Ocala Uplift Physiographic District (Brooks 1981); a region of many lakes on a moderately thick plain of silty sand overlying Tampa Limestone. As part of the Florida Department of Environmental Protection's Lake Bioassessment/Regionalization Initiative, the area has been identified as the Keystone Lakes region; an area of numerous slightly acidic, low nutrient, and mostly clear-water lakes (Griffith *et al.* 1997).

The United States Geological Survey 1974 (photorevised 1987) 1:24,000 Odessa, Fla. quadrangle map indicates a water level elevation of 48 ft, NGVD, a level corresponding to an area of 119 acres, based on a topographic map of the basin (see below). The Florida Lake Gazetteer (Shafer *et al.* 1986) lists the lake area at 127 acres at an elevation of 48 ft. The lake has a drainage area of 0.40 square miles and is connected to a small wetland pond along it's southwestern shore which drains to Lake Keystone (Figure 6-8).

A detailed topographic map of the Lake Calm basin (Figure 6-9) was developed for estimation of surface areas associated with various water level elevations. Data used for map production were obtained from field surveys and 1:200 aerial photograph maps of the basin containing one-foot contour lines prepared using photogrammetric methods.

Based on field surveys conducted in 1977, the Governing Board adopted management levels (currently referred to as Guidance Levels) for the lake in September 1980 (Table 6-5).

Table 6-5. Lake Calm: Adopted Guidance Levels (09 September 1980) and Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten Year Flood Guidance Level	52.20	147.9
High Level	50.50	134.2
Low Level	47.50	116.3
Extreme Low Level	45.50	107.4

Proposed Minimum and Guidance Levels

Recommended Minimum and Guidance Levels for Lake Calm, a Category 3 Lake, are listed in Table 6-6, along with area values for each water level. The Basin Connectivity, Species Richness, Aesthetic and Recreation/Ski Standards for the lake are lower than the Historic P50 elevation, and were evaluated for minimum levels development. The Aesthetics Standard, the most conservative of these standards, was used to establish the proposed Minimum Lake Level at 47.31 ft. The proposed Minimum Lake Level is 1.1 ft below the Historic P50 elevation. Total lake area at the proposed Minimum Lake Level is about 96% of the area associated with the Historic P50 elevation. The proposed High Minimum Lake Level was established at 48.31, an elevation corresponding to the Minimum Lake Level plus the RLWR50 (1.0 ft) for the northern Tampa Bay area. The proposed High Minimum Lake Level is 1.1 ft below the High Guidance Level and 2.8 ft below the Low Floor Slab elevation. Total lake area at the proposed High Minimum Lake Level is about 95% of that associated with the Historic P50 elevation. Development of Guidance Levels is described in the following sub-section.

Table 6-6. Lake Calm: Recommended Minimum and Guidance Levels with Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten Year Flood Guidance Level	51.02	138.1
High Guidance Level	49.41	127.0
High Minimum Lake Level	48.31	120.2
Minimum Lake Level	47.31	115.6
Low Guidance Level	47.31	115.6

Summary of Data and Analyses Supporting Recommended Minimum and Guidance Levels

Hydrologic data are available for Lake Calm for the period from January 1965 through the present (December 2000) (Figure 6-10; see Figure 6-8 for the location of the District water level gauge). For the entire period of record, the hydrologic data are classified as Current data. These data were used to calculate the Current P10, P50, P90 (Table 6-7). The Category 3 Lake Normal Pool elevation (Table 6-7) was established based on the elevation of the waterward extent of pine (*Pinus* sp.) trees and the landward extent of holly (*Ilex* sp.) along the shore of the lake (Table 6-8). The low floor slab elevation, extent of structural alteration and the control point elevation were determined using available one-foot contour interval aerial maps, and field surveys (Tables 6-7 and 6-9, Figure 6-11). The Category 3 Lake Normal Pool elevation is above the control point, so the lake is considered to be Structurally Altered.

Based on the relationship between the control point elevation, the Category 3 Lake Normal Pool elevation and the Current P10, the High Guidance Level was established at the control point elevation (Table 6-7). The Historic P50 and Low Guidance Level were determined using the High Guidance Level and the Northern Tampa Bay Region RLWR50 (1.0 ft) and RLWR90 (2.1 ft) statistics (Table 6-7).

Lake Calm is not contiguous with any cypress-dominated wetlands of 0.5 or more acres in size and is therefore classified as a Category 3 Lake. Aquatic macrophytes, including cattail (*Typpha* spp.), rush fuirena (*Fuirena scirpoidea*), maidencane (*Panicum hemitomum*), and fragrant water lily (*Nymphaea odorata*) occur throughout the basin. The Dock-Use Standard was established at 48.86 ft, based on a Dock-End Sediment elevation of 45.76 ft, developed from measurement of 30 docks. The Basin Connectivity Standard was established at 44.6 ft, based on use of power boats in the lake, a critical high-spot elevation of 41.5 ft and the RLWR5090 for the northern Tampa Bay area (1.1 ft). The Species Richness Standard was established at 44.45 ft, based on a 15% reduction in lake surface area from that at the Historic P50 elevation. An Aesthetic-Standard for Lake Calm was established at the Low Guidance Level elevation of 47.31 ft. The Recreation/Ski Standard was established at 41.1 ft, based on a critical ski elevation of 40.0 ft and the RLWR5090 for the northern Tampa Bay area (1.1 ft). Review of the dynamic ratio for lake stages bounded by the Current P10 and Current P90 elevations did not indicate that potential changes in basin susceptibility to wind-induced sediment resuspension would be of concern for minimum levels development (Table 4-1, Figure 6-12). Changes in potential herbaceous wetland area and area of potential aquatic macrophyte colonization with lake stage also did not indicate that use of any of the identified standards would be inappropriate (Figure 6-12).

The Ten Year Flood Guidance Level (Table 6-6) was established for Calm Lake using the methodology for open basin lakes described in Section 5 of this report. The District used the flood information from an existing study of the Brooker Creek Watershed developed by Ayres Associates for Hillsborough County (Ayres 1998a). The Brooker Creek runoff hydrographs were computed using the NRCS Dimensionless Unit Hydrograph method, a 256 shape factor, a 10.0 inch rainfall depth, and a 72-hour rainfall distribution developed by the South Florida Water Management District. The Brooker Creek conveyance system was simulated with the Hillsborough County modified version of EXTRAN, and the hydrodynamic routing component of the Environmental Protection Agency's Stormwater Management Model (SWMM) v.4.31. District staff modified the EXTRAN input data developed by Ayres by setting the initial elevation of Calm Lake at the outlet control point elevation of 49.41 feet NGVD. The modified data set was then used to determine the Ten-year flood level based on runoff hydrographs from the 10-year storm event.

Table 6-7. Lake Calm: Summary of Elevation Data and Associated Area Values Used for Establishing Minimum Levels.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Current P10	49.20	125.3
Current P50	47.52	116.5
Current P90	45.13	105.8
Category 3 Lake Normal Pool	51.35	140.3
Low Floor Slab	51.13	138.9
Control Point	49.41	127.0
High Guidance Level	49.41 (Control Point)	127.0
Historic P50	48.41 (HGL - RLWR50)	120.6
Low Guidance Level	47.31 (HGL - RLWR90)	115.6
Dock-Use Standard	48.86	122.8
Basin Connectivity Standard	44.6	103.2
Species Richness Standard	44.45	102.5
Aesthetic Standard	47.31	115.6
Recreation/Ski Standard	41.1	76.2

NA = not available / not applicable

Table 6-8. Lake Calm: Elevation Data Used for Establishing the Category 3 Lake Normal Pool Elevation. Data collected in January 1997 water level = 46.79 ft, NGVD.

Hydrologic Indicator	Height above Lake Water Level (ft)	Elevation (ft, NGVD)
Toe of waterward pine hummock	5.02	51.81
Base of landward holly species	4.10	50.89
Mean	**4.56**	**51.35**

Table 6-9. Lake Calm: Summary of Structural Alteration / Control Point Elevation Information. Numbers correspond to those shown in Figure 6-11.

No.	Description	Elevation (ft, NGVD)
1	Control point: northeast end of corrugated plastic pipe	49.41
2	Southwest end of corrugated plastic pipe	47.11
3	Southwest end of reinforced concrete pipe	45.70
4	Northeast end of reinforced concrete pipe	47.10

Figure 6-8. Location of District lake gauge and outlet at Lake Calm, Hillsborough County, Florida.

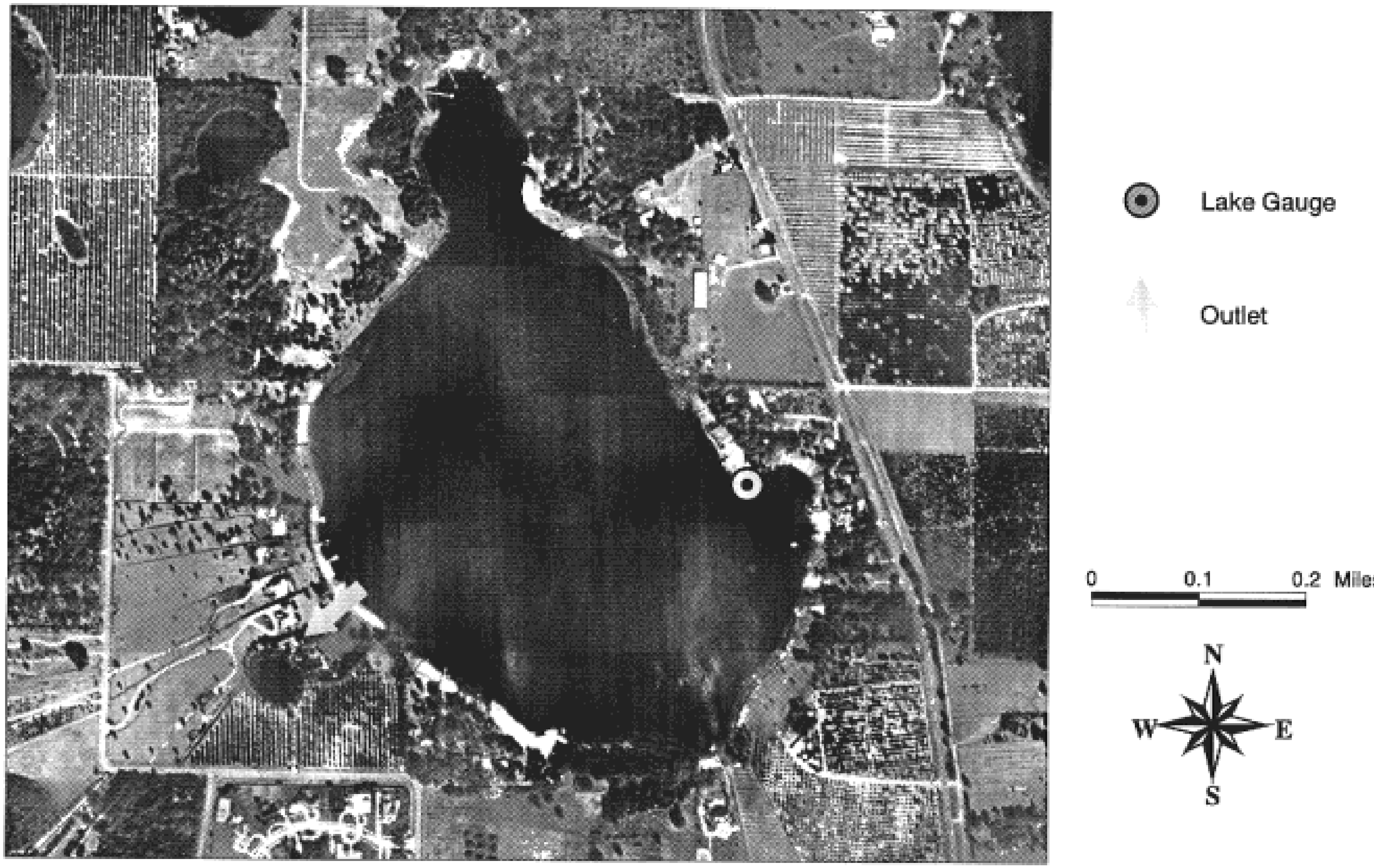


Figure 6-9. One-foot contour map of the Lake Calm basin, Hillsborough County, Florida. Values shown are elevations, in feet, above the National Geodetic Vertical Datum.

Figure 6-10. Mean monthly water elevations at Lake Calm, Hillsborough County, Florida. Proposed High Minimum Lake Level (HMLL), Minimum Lake Level (MLL), Ten-Year Flood Guidance Level (10-YR), High Guidance Level (HGL), and Low Guidance Level (LGL) are shown as solid or dashed lines.

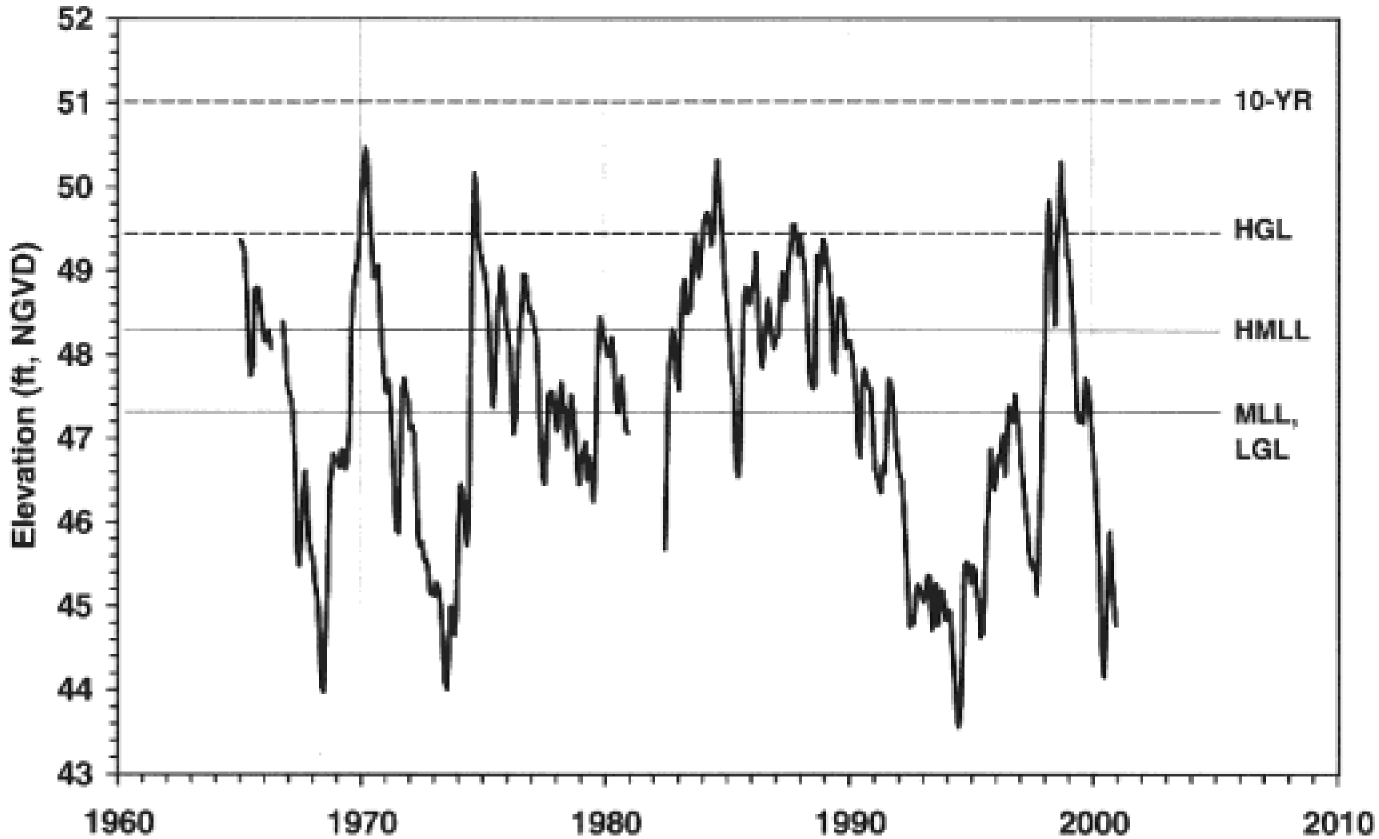
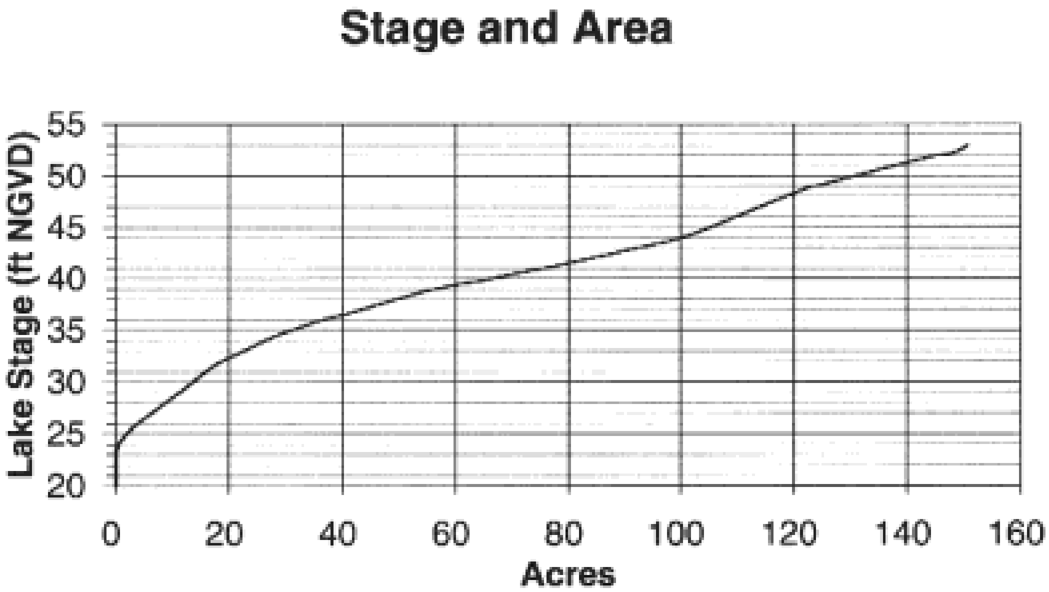


Figure 6-11. Outlet conveyance system for Lake Calm, Hillsborough County, Florida. Numbered sites are described in Table 6-9.

Figure 6-12. Surface area, volume, potential herbaceous wetland area, area potentially colonized by aquatic macrophytes, and dynamic ratio versus lake stage for Lake Calm, Hillsborough County, Florida.



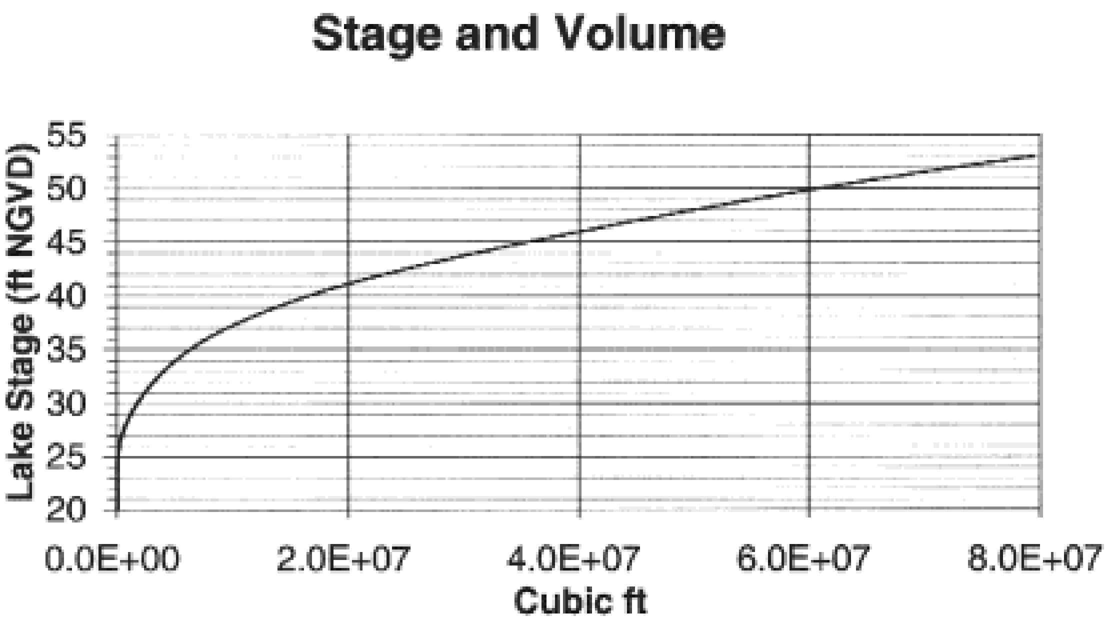
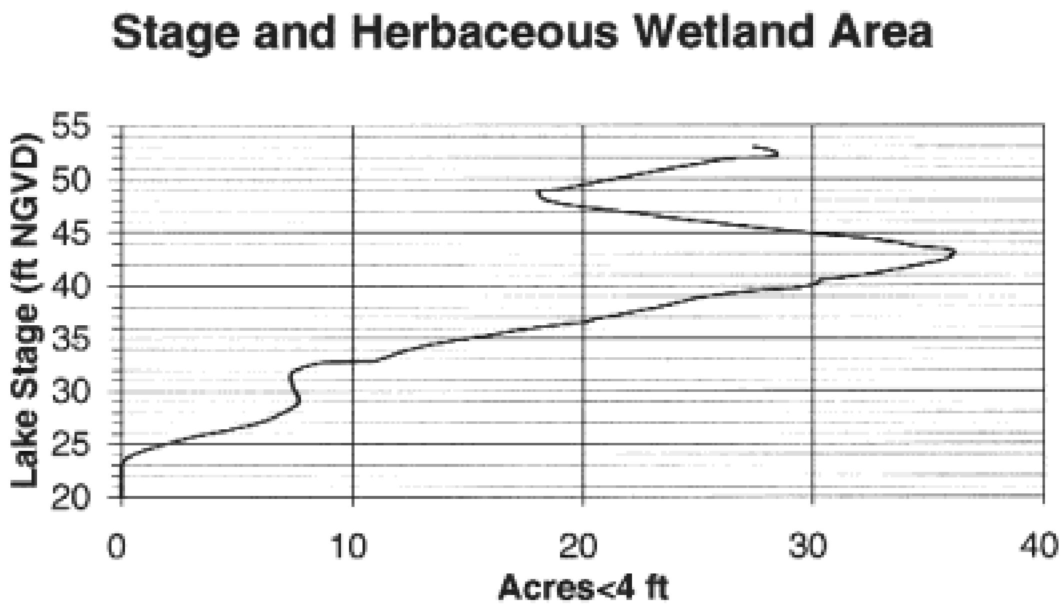


Figure 6-12. (Continued).



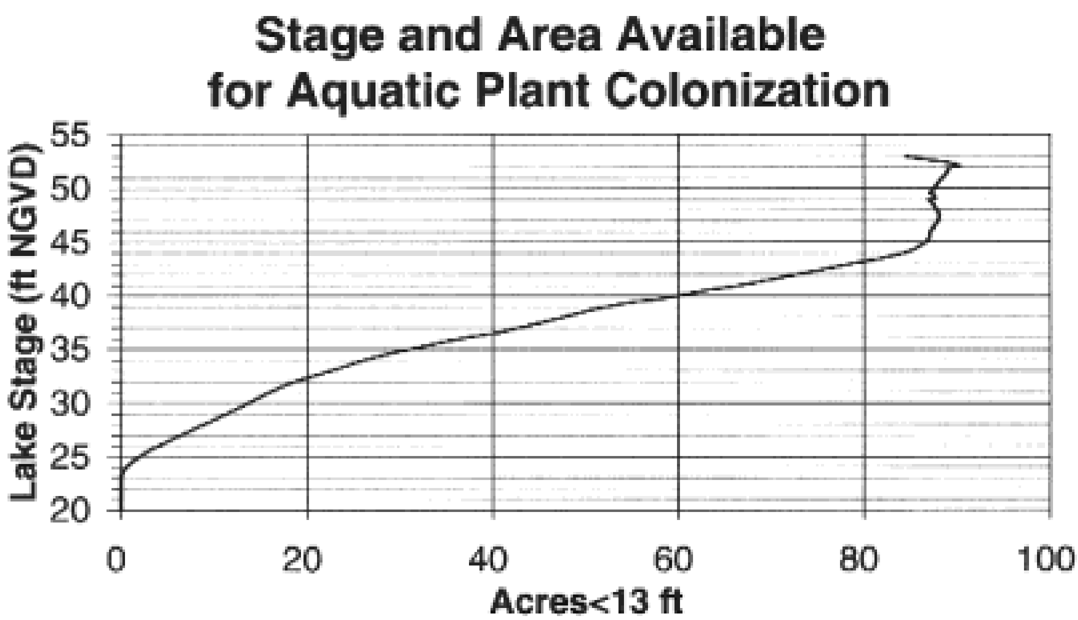
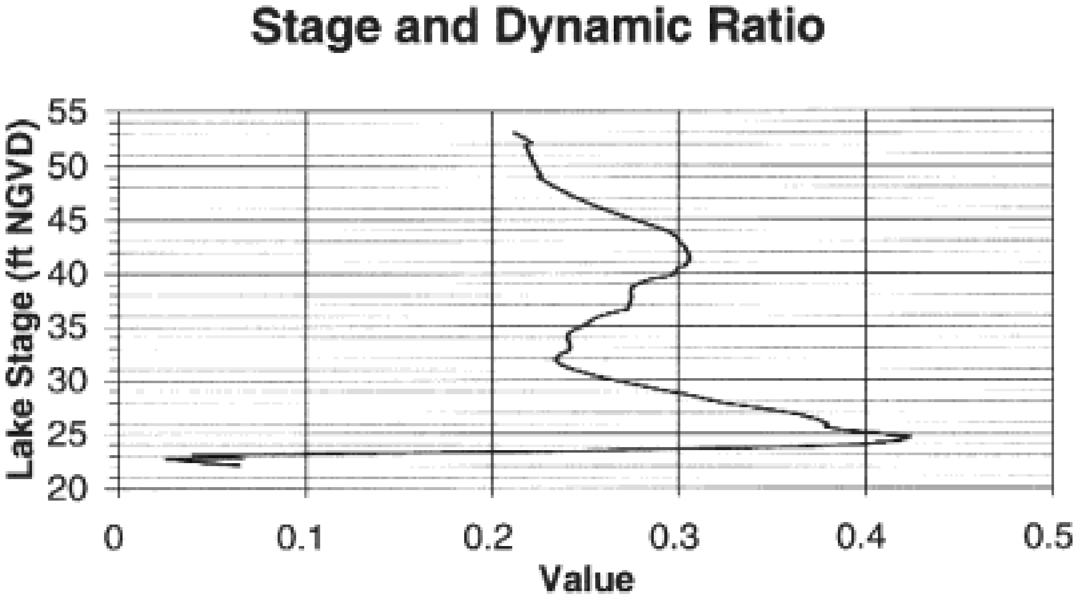


Figure 6-12. (Continued).



Church Lake and Echo Lake

General Lake Description and Previously Adopted Lake Management Levels

Church Lake and Echo Lake are located in the Northwest Hillsborough Basin in Hillsborough County, Florida. Church Lake is found in Sections 27 and 28, Township 27S, Range 17E; Echo Lake occurs in Section 28, Township 27S, Range 17E. The lakes are found along the border of the Land-O-Lakes and Lake Tarpon basin subdivisions of the Tampa Plain in the Ocala Uplift Physiographic District (Brooks 1981); these region are characterized as an area of many lakes on a moderately thick plain of silty sand and an erosional basin partially filled with Late Pleistocene sediments, respectively, overlying Tampa Limestone. As part of the Florida Department of Environmental Protection's Lake Bioassessment/Regionalization Initiative, the area has been identified as the Keystone Lakes region; an area of numerous slightly acidic, low nutrient, and mostly clear-water lakes (Griffith *et al.* 1997).

The United States Geological Survey 1957 (photorevised 1987) 1:24,000 Citrus Park, Fla. quadrangle map indicates a water level elevation of 33 ft, NGVD for Church Lake, a level corresponding to a surface area for both lakes combined of approximately 92 acres. The Florida Lake Gazetteer (Shafer *et al.* 1986) lists the area of Church Lake as 68 acres, and that of Echo Lake as 27 acres at an elevation of 33 ft. Church Lake has a drainage area of 0.51 square miles and Echo Lake has a drainage area of 0.89 square miles. Church lake receives inflow from a small unnamed lake to the east, and is connected via a navigable canal to Echo Lake at elevations exceeding approximately 32.3 ft, NGVD. Because the lakes are connected through a navigable canal, and may be expected to fluctuate in concert, the lakes are treated as a single system – the Church and Echo Lakes system – for the purpose of establishing minimum levels. An outlet along the northwestern shore of Echo Lake connects the lakes to the Brooker Creek drainage system (Figure 6-13).

A detailed topographic map of the Lake Church and Echo system basin (Figure 6-14) was developed for estimation of surface areas associated with various water level elevations. Data used for map production were obtained from field surveys and 1:200 aerial photograph maps of the basin containing one-foot contour lines prepared using photogrammetric methods.

Based on field surveys conducted in 1977, the Governing Board adopted management levels for both lakes in September 1980 (Table 6-10).

Table 6-10. Church and Echo Lakes System: Adopted Guidance Levels (09 September 1980) and Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten Year Flood Guidance Level	36.40	111.9
High Level	36.25	111.2
Low Level	34.00	96.8
Extreme Low Level	31.50	85.5

Proposed Minimum and Guidance Levels

Recommended Minimum and Guidance Levels for the Church and Echo Lake system, a Category 3 Lake system, are listed in Table 6-11, along with area values for each water level. The Dock-Use, Basin Connectivity, Species Richness, Aesthetic and Recreation/SKI Standards for the lake system are all lower than the Historic P50 elevation, and were therefore evaluated for development of minimum levels. The Aesthetic Standard, the most conservative of these standards, was used to establish the proposed Minimum Lake Level at 33.54 ft. The proposed Minimum Lake Level is 1.1 ft below the Historic P50 elevation. Total lake area at the proposed Minimum Lake Level is about 95% of the area associated with the Historic P50 elevation. The proposed High Minimum Lake Level was established at 34.54 ft, an elevation corresponding to the Minimum Lake Level plus the RLWR50 (1.0 ft) for the northern Tampa Bay area. The proposed High Minimum Lake Level is 1.1 ft below the High Guidance Level and 3.6 ft below the Low Floor Slab elevation. Total lake area at the proposed High Minimum Lake Level is about 95% of that associated with the High Guidance Level. Development of Guidance Levels is described in the following sub-section.

Table 6-11. Church Echo Lakes System: Recommended Minimum Levels and Guidance Levels with Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten-Year Flood Guidance Level	36.97	113.5
High Guidance Level	35.64	105.0
High Minimum Lake Level	34.54	99.5
Minimum Lake Level	33.54	94.7
Low Guidance Level	33.54	94.7

Summary of Data and Analyses Supporting Recommended Minimum and Guidance Levels

Hydrologic data are available for the Church and Echo Lake system for the period from June 1931 through September 1937 and from September 1957 to the present (December 2000) (Figure 6-15; see Figure 6-13 for location of the District water level gauge). For the period from January 1964 to the present, the hydrologic data are classified as Current data. These data were used to calculate the Current P10, P50, P90 (Table 6-12). The Category 3 Lake Normal Pool elevation was established based on trunk morphology of large cypress trees along the northen shore of Lake Church and the northeastern shore of Lake Echo (Tables 6-12 and 6-13, Figure 6-13). The low floor slab elevation, extent of structural alteration and the control point elevation were determined using available one-foot contour interval aerial maps, and field surveying (Tables 6-12 and 6-14, Figure 6-16). The Category 3 Lake Normal Pool elevation is above the control point, so the lake system is considered to be Structurally Altered.

Based on the relationship between the control point elevation, the Category 3 Lake Normal Pool elevation and the Current P10, the High Guidance Level was established at the Current P10 elevation (Table 6-12). The Historic P50 and Low Guidance Level were determined using the High Guidance Level and the Northern Tampa Bay Region RLWR50 (1.0 ft) and RLWR90 (2.1 ft) (Table 6-12).

The Church and Echo Lakes system does not contain any cypress-dominated wetland of 0.5 of more acres in size and is therefore classified as a Category 3 Lake system. The lakes do contain abundant stands of cattail (*Typpha* spp.) and fragrant water lily (*Nymphaea odorata*), and other wetland vegetation. A Dock-Use Standard was established at 33.33 ft, based on the Dock-End Sediment elevation of 30.23 ft, developed from measurement of 42 docks. A Basin Connectivity Standard was established at 35.4 ft, based on use of power boats in the lake, a critical high-spot elevation of 32.3 ft and the RLWR5090 for the northern Tampa Bay area (1.1 ft). The Species Richness Standard was established at 31.41 ft, based on a 15% reduction in lake surface area from that at the Historic P50 elevation. The Aesthetic-Standard was established at the Low Guidance Level elevation of 33.54 ft. A Recreation/Ski Standard was established at 31.1 ft, based on a critical ski elevation of 30.0 ft and the RLWR5090 for the northern Tampa Bay area (1.1 ft). Review of the dynamic ratio for lake stages bounded by the Current P10 and Current P90 elevations did not indicate that potential changes in basin susceptibility to wind-induced sediment resuspension would be of concern for minimum levels development (Table 4-1, Figure 6-17). Changes in potential herbaceous wetland area and area of potential aquatic macrophyte colonization with lake stage also did not indicate that use of any of the identified standards would be inappropriate (Figure 6-17).

The Ten Year Flood Guidance Level (Table 6-11) was established for the Lake Church and Echo system using the methodology for open basin lakes described in Section 5 of this report. The District used an existing hydrologic and hydraulic computer model of the Brooker Creek Watershed developed by Ayres Associates for Hillsborough County (Ayres 1998a). The Brooker Creek runoff hydrographs were computed using the NRCS Dimensionless Unit Hydrograph method, a 256 shape factor, a 10.0 inch rainfall depth, and a 72-hour rainfall distribution developed by the South Florida Water Management District. The Brooker Creek conveyance system was simulated with the Hillsborough County modified version of EXTRAN, and the hydrodynamic routing component of the Environmental Protection Agency's Stormwater Management Model (SWMM) v.4.31. District staff modified the EXTRAN input data developed by Ayres by setting the initial elevation of Echo Lake at the outlet control point elevation of 33.75 feet NGVD. The modified data set was then used to determine the 10-year flood level based on runoff hydrographs from the 10-year storm event.

Table 6-12. Church and Echo Lakes System: Summary of Elevation Data and Associated Area Values Used for Establishing Minimum levels.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Current P10	35.64	105.0
Current P50	33.73	95.6
Current P90	30.82	82.3
Category 3 Lake Normal Pool	37.79	NA
Low Floor Slab	38.18 (Church Lake)	NA
Control Point	33.75	95.6
High Guidance Level	35.64 (Current P10)	105.0
Historic P50	34.64 (HGL - RLWR50)	100.0
Low Guidance Level	33.54 (HGL - RLWR90)	94.7
Dock-Use Standard	33.33	93.7
Basin Connectivity Standard	35.4	103.8
Species Richness Standard	31.41	85.2
Aesthetic Standard	33.54	94.7
Recreation/Ski Standard	31.1	83.5

NA = not available / not applicable

Table 6-13. Church and Echo Lakes System: Elevation Data Used for Establishing the Category 3 Lake Normal Pool elevation. Data collected 11 August 1999; water level = 33.07 ft, NGVD.

Hydrologic Indicator	Height above Lake Water Level (ft)	Elevation (ft, NGVD)
Cypress buttress (normal pool) Church Lake	4.10	37.17
Cypress buttress (normal pool) Church Lake	4.10	37.17
Cypress buttress (normal pool) Church Lake	4.40	37.47
Cypress buttress (normal pool) Echo Lake	5.04	38.11
Cypress buttress (normal pool) Echo Lake	4.90	37.97
Cypress buttress (normal pool) Echo Lake	5.23	38.3
Cypress buttress (normal pool) Echo Lake	5.25	38.32
Mean	**4.72**	**37.79**

Table 6-14. Church and Echo Lake System: Summary of Structural Alteration / Control Point Elevation Information. Numbers correspond to those shown in Figure 6-16.

No.	Description	Elevation (ft, NGVD)
1	Southeast end 42" corrugated metal pipe	33.18
2	High point in channel	34.92
3	Control point: southeast end of 18" reinforced concrete pipe	33.75

Figure 6-13. Location of District lake guage, outlet and sites where hydrologic indicators of high water level were measured at Lakes Church and Echo, Hillsborough County, Florida.

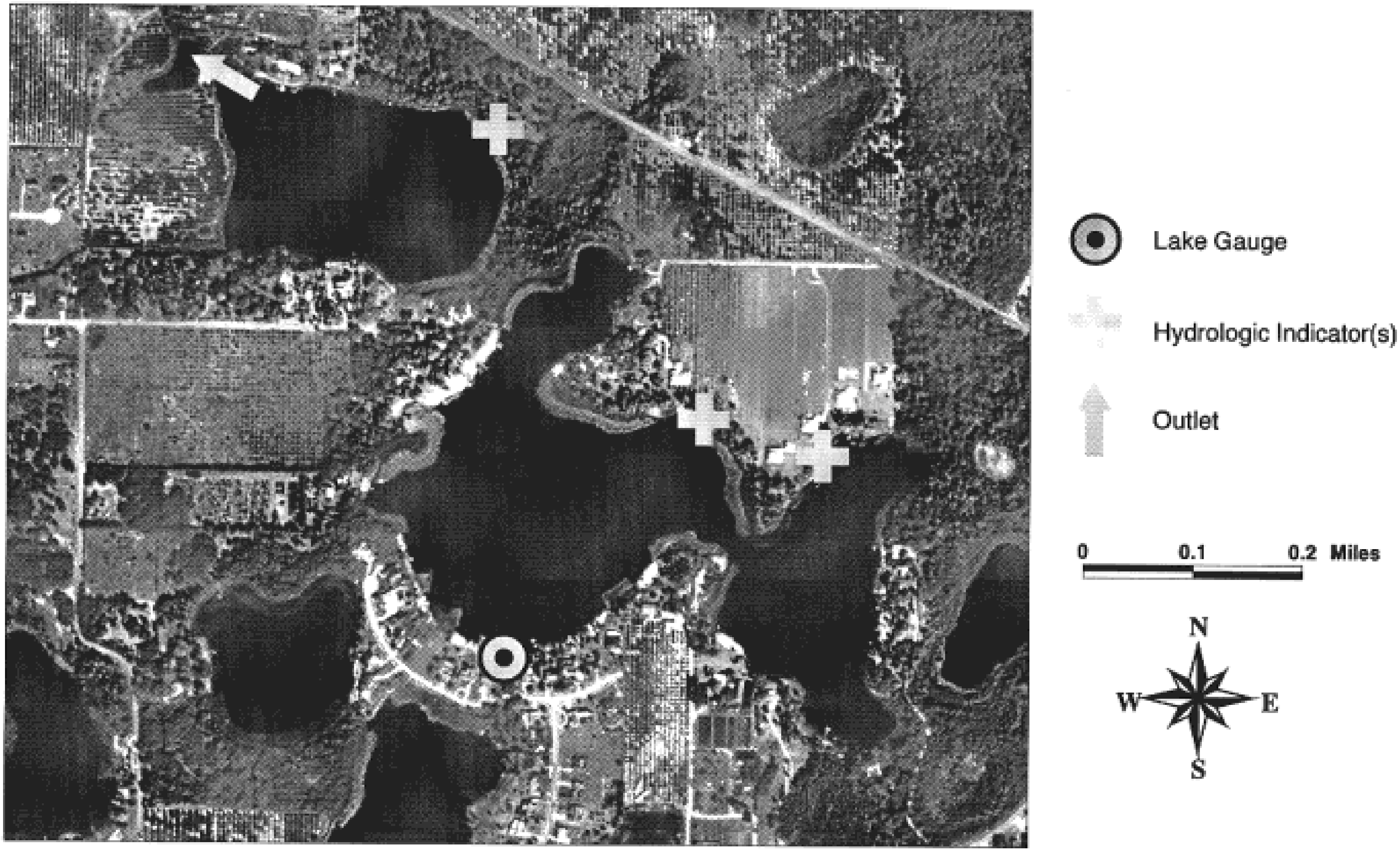


Figure 6-14. One-foot contour map of the Lakes Church and Echo basin, Hillsborough County, Florida. Values shown are elevations, in feet, above the National Geodetic Vertical Datum.

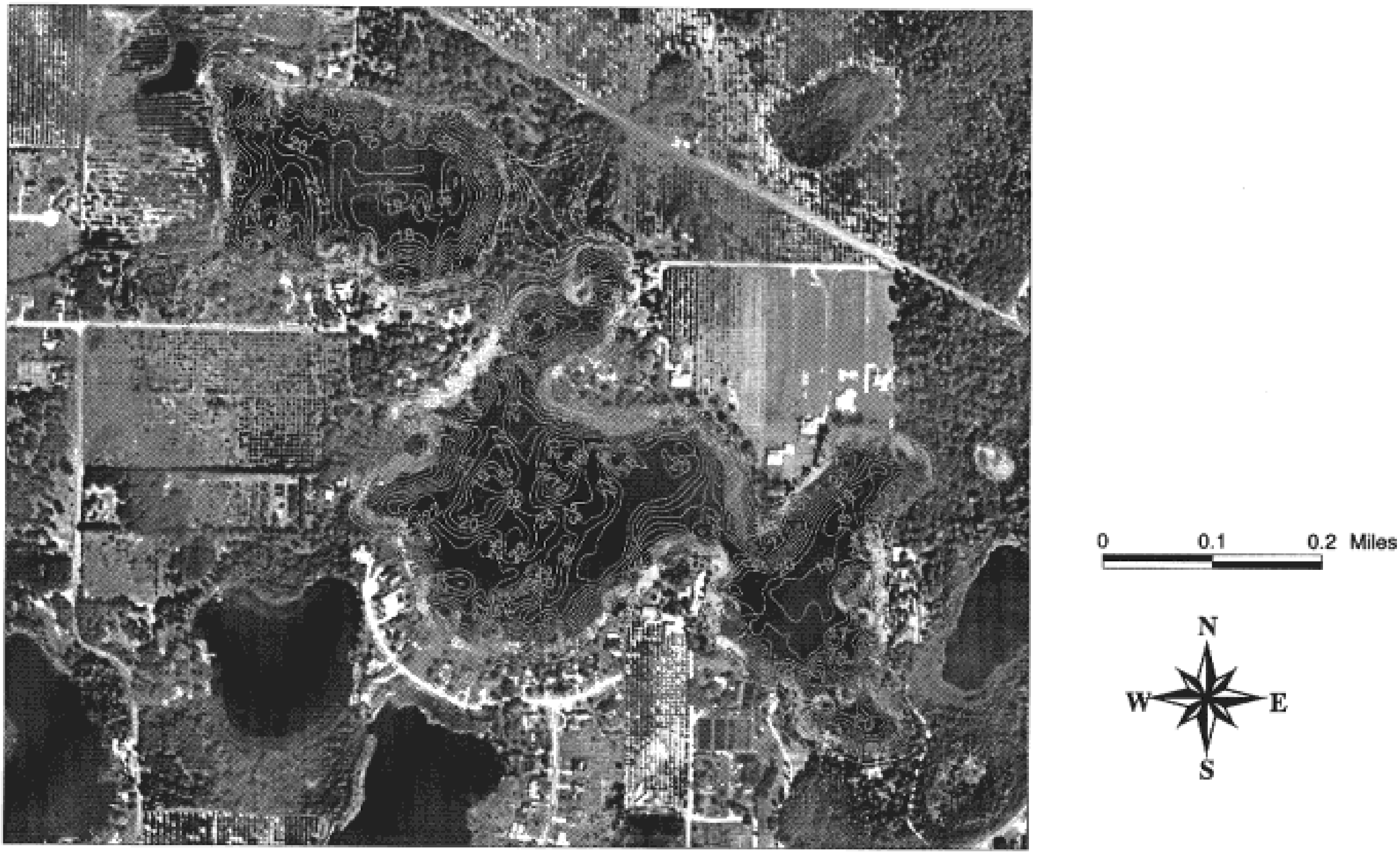


Figure 6-15. Mean monthly water elevations at Church Lake and Echo Lake, Hillsborough County, Florida. Proposed High Minimum Lake Level (HMLL), Minimum Lake Level (MLL), Ten-Year Flood Guidance Level (10-YR), High Guidance Level (HGL), and Low Guidance Level (LGL) are shown as solid or dashed lines.

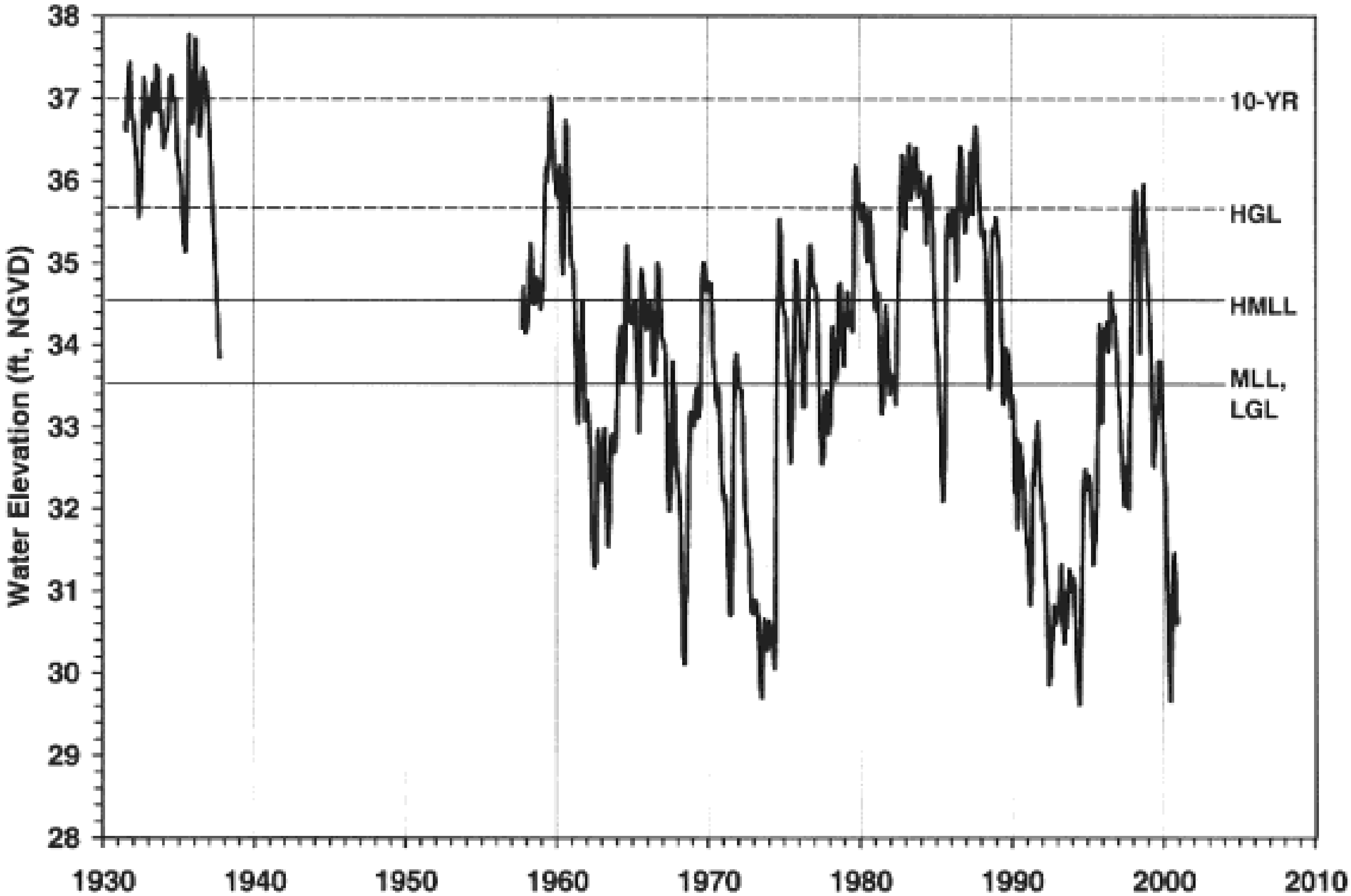


Figure 6-16. Outlet conveyance system for Lakes Church and Echo, Hillsborough County, Florida. Numbered sites are described in Table 6-14.

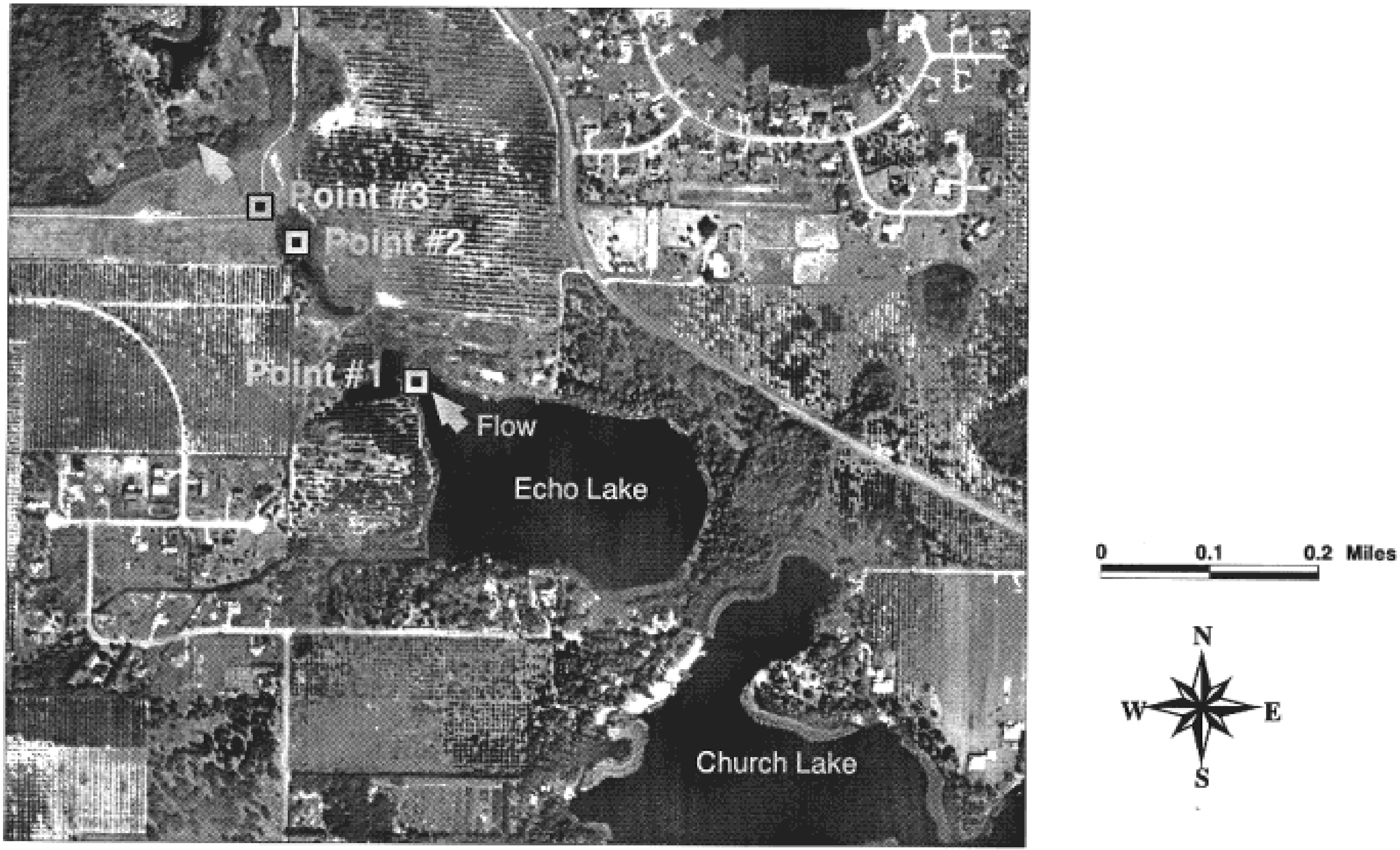
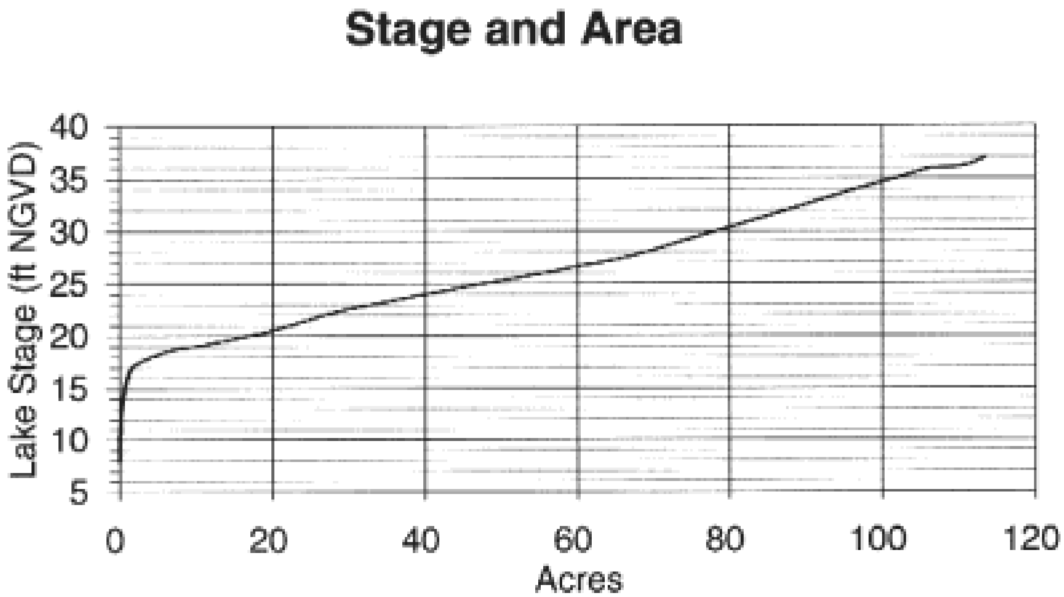


Figure 6-17. Surface area, volume, potential herbaceous wetland area, area potentially colonized by aquatic macrophytes, and dynamic ratio versus lake stage for Lakes Church and Echo, Hillsborough County, Florida.



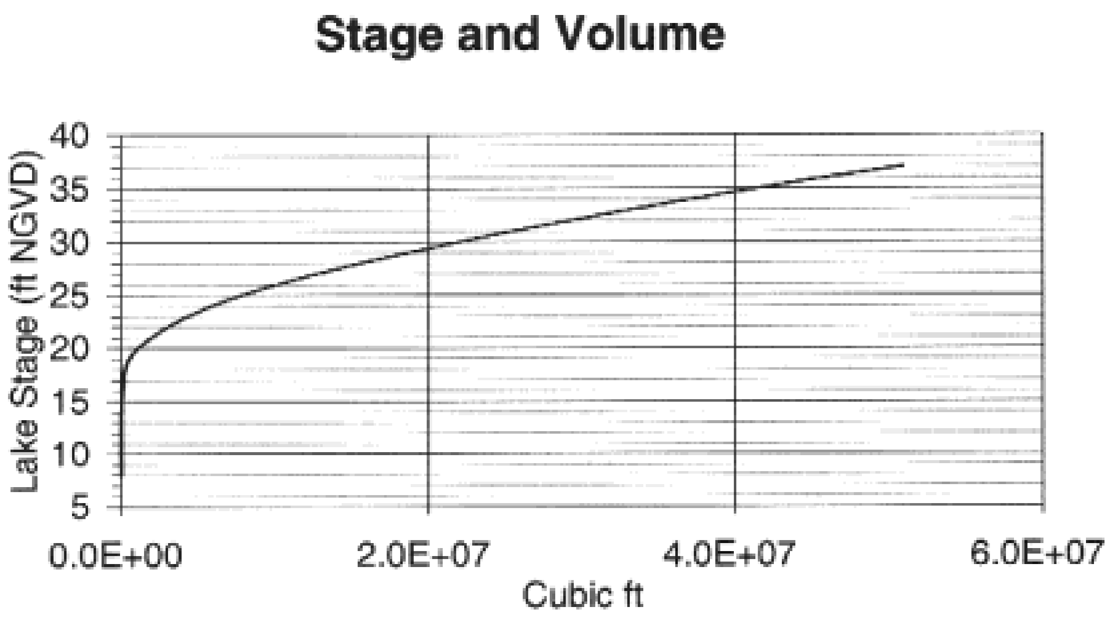
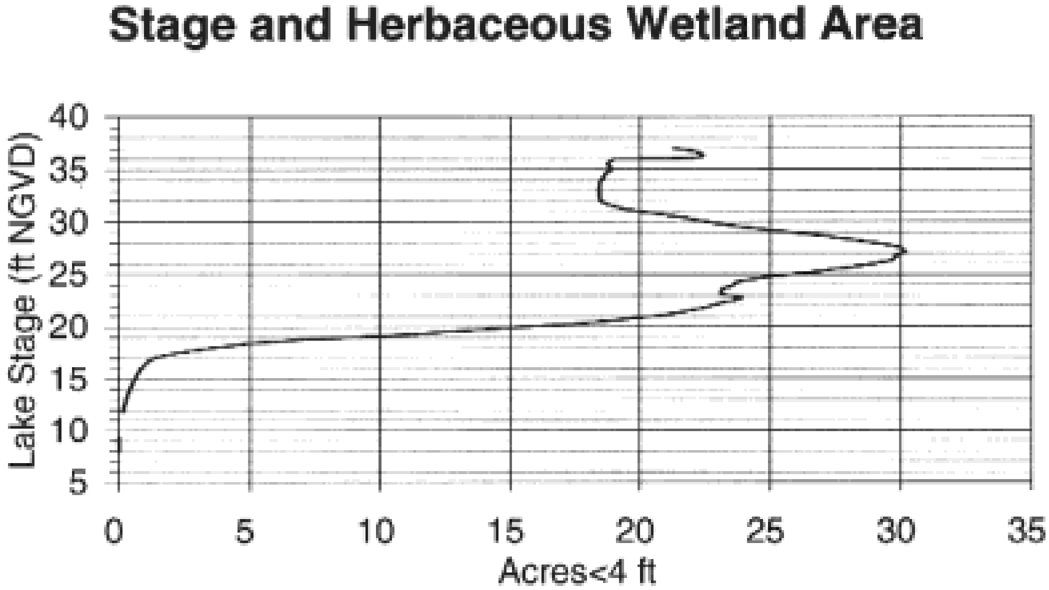


Figure 6-17. (Continued).



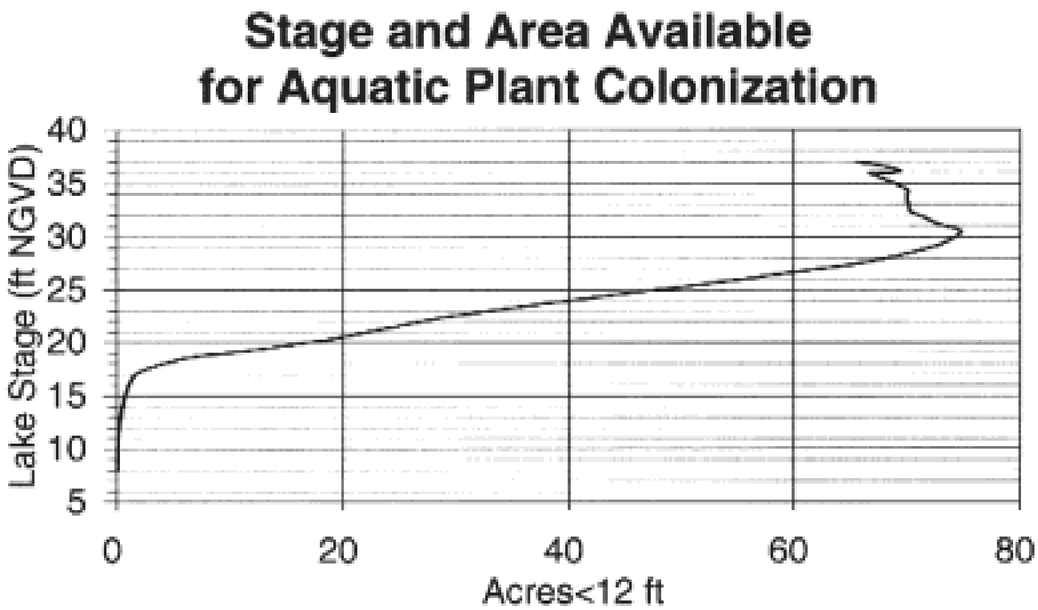
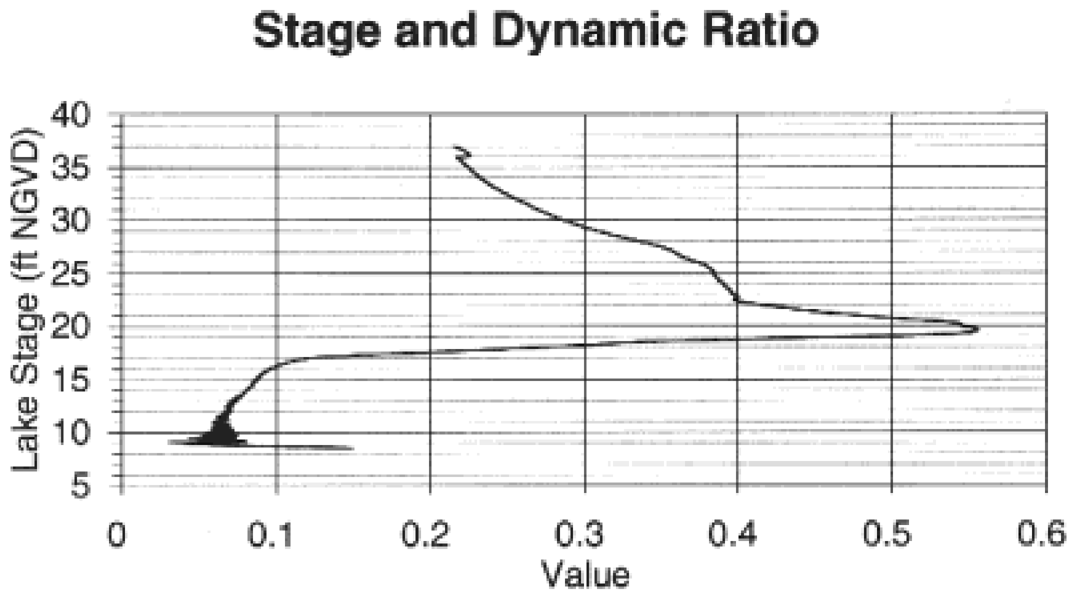


Figure 6-17. (Continued).



Lake Crenshaw

General Lake Description and Previously Adopted Lake Management Levels

Lake Crenshaw is located in the Northwest Hillsborough Basin in Hillsborough County, Florida (Section 22, Township 27S, Range 18E). The area surrounding the lake is categorized as the Land-O-Lakes subdivision of the Tampa Plain in the Ocala Uplift Physiographic District (Brooks 1981); a region of many lakes on a moderately thick plain of silty sand overlying Tampa Limestone. As part of the Florida Department of Environmental Protection's Lake Bioassessment/Regionalization Initiative, the area has been identified as the Land-O-Lakes lake region; an area of numerous neutral to slightly alkaline, low to moderate nutrient, clear-water lakes (Griffith *et al.* 1997).

The 1956 United States Geological Survey (photorevised 1987) 1:24,000 Sulphur Springs, Fla. quadrangle map indicates a water level elevation of 56 ft NGVD for the lake while the 1974 (photorevised 1987) Lutz, Fla. quadrangle map shows the lake at 53 ft NGVD. These elevations correspond to lake surface areas of approximately 39 and 30 acres, respectively. The lake is not included in the Gazetteer of Florida lakes (Shafer *et al.* 1986). The lake has a drainage area of 1.3 square miles. There are no inlets to the lake, however, an augmentation well along the north shore has been used intermittently to supply the basin with water from the Floridan Aquifer during the past thirty years. The lake drains through a ditch on the southern shore that leads to Saddleback Lake (Figure 6-18).

A detailed topographic map of the Lake Crenshaw basin (Figure 6-19) was developed for estimation of surface areas associated with various water level elevations. Data used for map production were obtained from field surveys and 1:200 aerial photograph maps of the basin containing one-foot contour lines prepared using photogrammetric methods.

Based on field surveys conducted in 1977, the Governing Board adopted management levels (currently referred to as Guidance Levels) for the lake in September 1980 (Table 6-15).

Table 6-15. Lake Crenshaw: Adopted Lake Levels (09 September 1980) and Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten Year Flood Guidance Level	57.50	NA
High Level	56.25	NA

Low Level	54.50	32.2
Extreme Low Level	51.00	27.3

NA = not available

Proposed Minimum and Guidance Levels

Recommended Minimum and Guidance Levels for Lake Crenshaw, a Category 3 Lake, are listed in Table 6-16, along with area values for each water level. The Dock-Use, Species Richness, and Aesthetic Standards for the lake are lower than the Historic P50 elevation, and were evaluated for minimum levels development. The Dock-Use Standard, the most conservative of these standards, was used to establish the proposed Minimum Lake Level at 53.45 ft. The proposed Minimum Lake Level is 1.1 ft below the Historic P50 elevation. Lake surface area at the proposed Minimum Lake Level is about 93% of the area associated with the Historic P50 elevation. The proposed High Minimum Lake Level was established at 54.45 ft, an elevation corresponding to the Minimum Lake Level plus the RLWR50 (1.0 ft) for the northern Tampa Bay area. The proposed High Minimum Lake Level is 1.1 ft below the High Guidance Level and 3.8 ft lower than the Low Floor Slab elevation. Lake surface area at the proposed High Minimum Lake Level is about 94% of that associated with the High Guidance Level. Development of Guidance Levels is described in the following sub-section.

Table 6-16. Lake Crenshaw: Recommended Minimum and Guidance Levels with Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten-Year Flood Guidance Level	57.55	38.11*
High Guidance Level	55.52	34.3
High Minimum Lake Level	54.45	32.1
Minimum Lake Level	53.45	30.2
Low Guidance Level	53.42	30.2

* Acreage values are based on extrapolated data

Summary of Data and Analyses Supporting Recommended Minimum and Guidance Levels

Hydrologic data are available for Lake Crenshaw for the period from June 1971 through the present (November 2000) (Figure 6-20; see Figure 6-18 for location of the District water level gauge). For the period from January 1974 to the present, the hydrologic data are classified as Current data. These current data were used to calculate the Current P10, P50, P90 (Table 6-17). The Category 3 Lake Normal Pool elevation was established based on morphology of large cypress trees along the southeastern shore of the lake (Tables 6-17 an 6-18, Figure 6-18). The low floor slab elevation and the control point elevation were determined through field surveying and review of available one-foot contour interval aerial maps (Tables 6-17 and 6-19, Figure 6-21). The Category 3 Lake Normal Pool elevation is above the control point, so the lake is considered to be Structurally Altered.

Based on the relationship between the control point elevation, the Category 3 Lake Normal Pool elevation and the Current P10, the High Guidance Level was established at the Current P10 elevation (Table 6-17). The Historic P50 and Low Guidance Level were determined using the High Guidance Level and the Northern Tampa Bay Region RLWR50 (1.0 ft) and RLWR90 (2.1 ft) (Table 6-17).

Lake Crenshaw is not contiguous with any cypress-dominated wetlands of more than 0.5 acres in size and is therefore classified as a Category 3 Lake. The basin contains abundant stands of *Panicum sp.* and spatterdock (*Nuphar luteum*) and other wetland vegetation. A Dock-Use Standard was established at 53.45 ft, based on a Dock-End Sediment elevation of 50.35 ft, developed from measurement of 16 docks. Development of a Basin Connectivity Standard is not appropriate for Lake Crenshaw. The Species Richness Standard was established at 51.15 ft, based on a 15% reduction in lake surface area from that at the Historic P50 elevation. The Aesthetic-Standard was established at the Low Guidance Level elevation of 53.42 ft. A Recreation/Ski Standard was established at 55.1 ft, based on a critical ski elevation of 50.0 ft and the RLWR5090 for the northern Tampa Bay area (1.1 ft). Review of the dynamic ratio for lake stages bounded by the Current P10 and Current P90 elevations did not indicate that potential changes in basin susceptibility to wind-induced sediment resuspension would be of concern for minimum levels development (Table 4-1, Figure 6-22). Changes in potential herbaceous wetland area and area of potential aquatic macrophyte colonization with lake stage also did not indicate that use of any of the identified standards would be inappropriate (Figure 6-22).

The Ten Year Flood Guidance Level (Table 6-16) was established for Lake Crenshaw using the methodology for open basin lakes described in Section 5 of this report. The District used an existing hydrologic and hydraulic computer model of the Rocky Creek Watershed developed by Hillsborough County (Hillsborough County 1998). The Rocky Creek runoff hydrographs were computed using the NRCS Dimensionless Unit Hydrograph, a 256 shape factor, a 10.0 inch rainfall depth, and a 72-hour rainfall distribution developed by the South Florida Water Management District. The Rocky Creek conveyance system was simulated with the Hillsborough County modified version of EXTRAN, and the hydrodynamic routing component of the Environmental Protection Agency's Stormwater Management Model (SWMM) v.4.31. District staff modified the EXTRAN input data developed by Hillsborough County, by setting the initial elevation of Lake Crenshaw at the outlet control point elevation of 53.88 feet NGVD. The modified data set was then used to determine the 10-year flood level based on runoff hydrographs from the 10-year storm event.

Table 6-17. Lake Crenshaw: Summary of Elevation Data and Associated Area Values Used for Establishing Minimum Levels.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Current P10	55.52	34.3
Current P50	53.50	30.3
Current P90	50.69	26.9
Category 3 Lake Normal Pool	57.38	37.84
Low Floor Slab	58.24	NA
Control Point	53.88	30.8
High Guidance Level	55.52 (Current P10)	34.3
Historic P50	54.52 (HGL - RLWW50)	32.3
Low Guidance Level	53.42 (HGL - RLWR90)	30.2
Dock-Use Standard	53.45	30.2
Basin Connectivity Standard	NA	NA
Species Richness Standard	51.15	27.5
Aesthetic Standard	53.42	30.2
Recreation/Ski Standard	55.1	33.4

NA = not available / not applicable

Table 6-18. Lake Crenshaw: Elevation Data Used for Establishing the Category 3 Lake Normal Pool Elevation. Data collected 12 August 1999; water level = 50.91 ft, NGVD.

Hydrologic Indicator	Height above Lake Water Level (ft)	Elevation (ft, NGVD)
Cypress buttress - normal pool	6.32	57.23
Cypress buttress - normal pool	6.62	57.53
Cypress buttress - normal pool	6.72	57.63
Cypress buttress - normal pool	6.27	57.18
Cypress buttress - normal pool	6.42	57.33
Mean	**6.47**	**57.38**

Table 6-19. Lake Crenshaw: Summary of Structural Alteration / Control Point Elevation Information. Numbers correspond to those shown in Figure 6-21.

No.	Description	Elevation (ft, NGVD)
1	Control point: north end of 42" corrugated metal pipe	53.88
2	Top of metal grate (grass carp gate)	57.57
3	South end of 42" corrugated metal pipe	53.48

Figure 6-18. Location of District lake gauge, outlet and site where hydrologic indicators of high water level were measured at Lake Crenshaw, Hillsborough County, Florida.

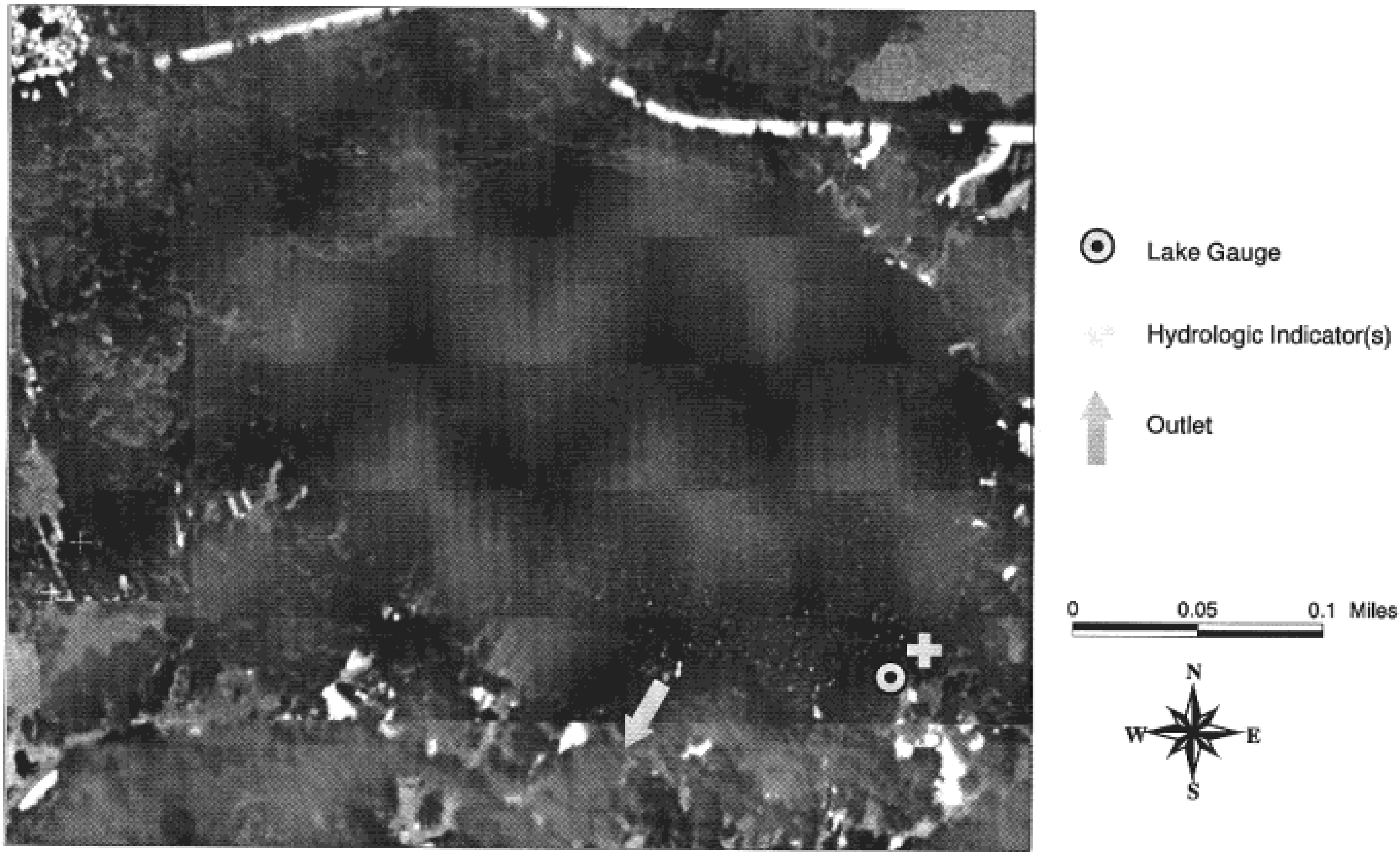


Figure 6-19. One-foot contour map of the Lake Crenshaw basin, Hillsborough County, Florida. Values shown are elevations, in feet, above the National Geodetic Vertical Datum.

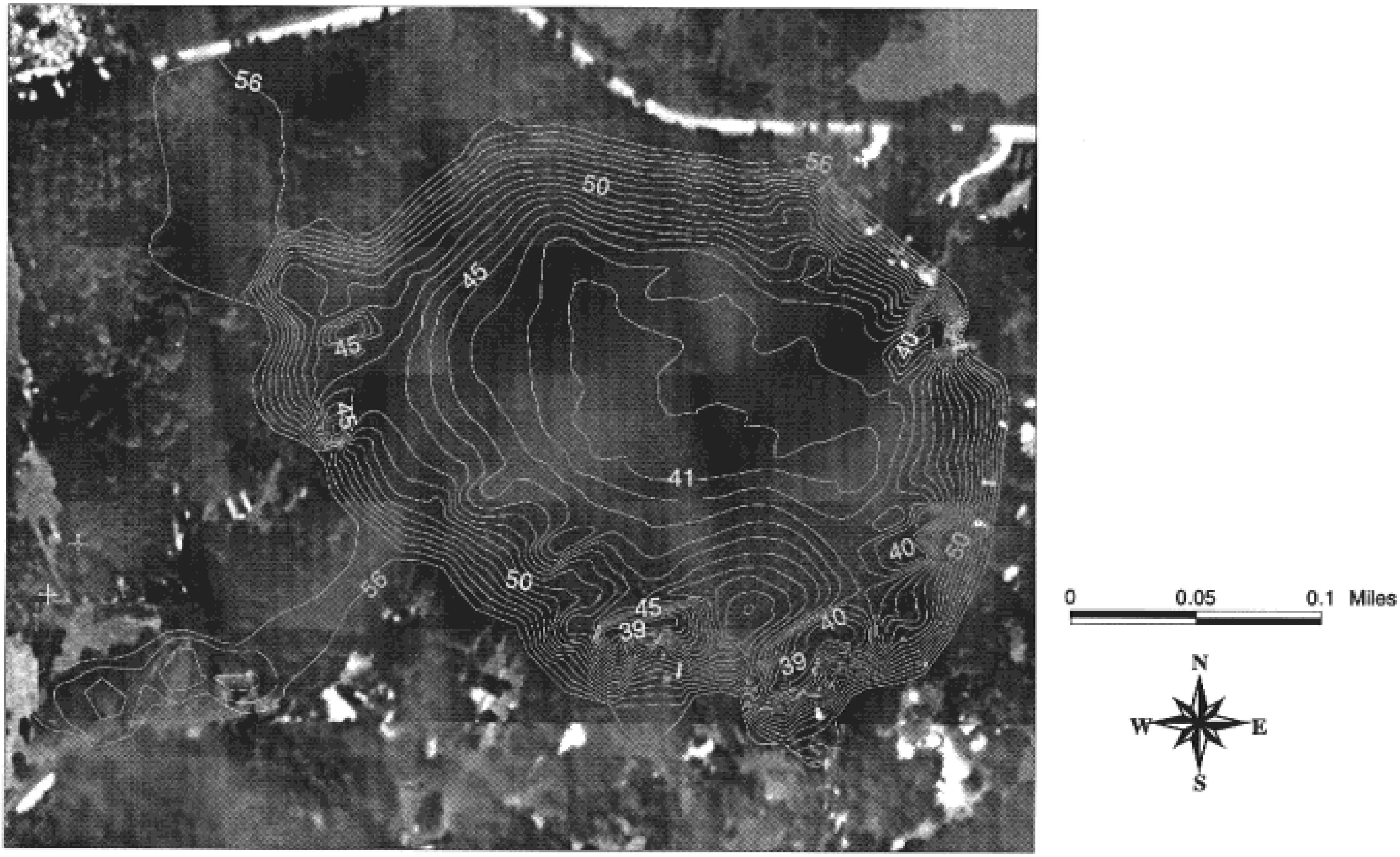


Figure 6-20. Mean monthly water elevations at Lake Crenshaw, Hillsborough County, Florida. Proposed High Minimum Lake Level (HMLL), Minimum Lake Level (MLL), Ten-Year Flood Guidance Level (10-YR), High Guidance Level (HGL), and Low Guidance Level (LGL) are shown as solid or dashed lines.

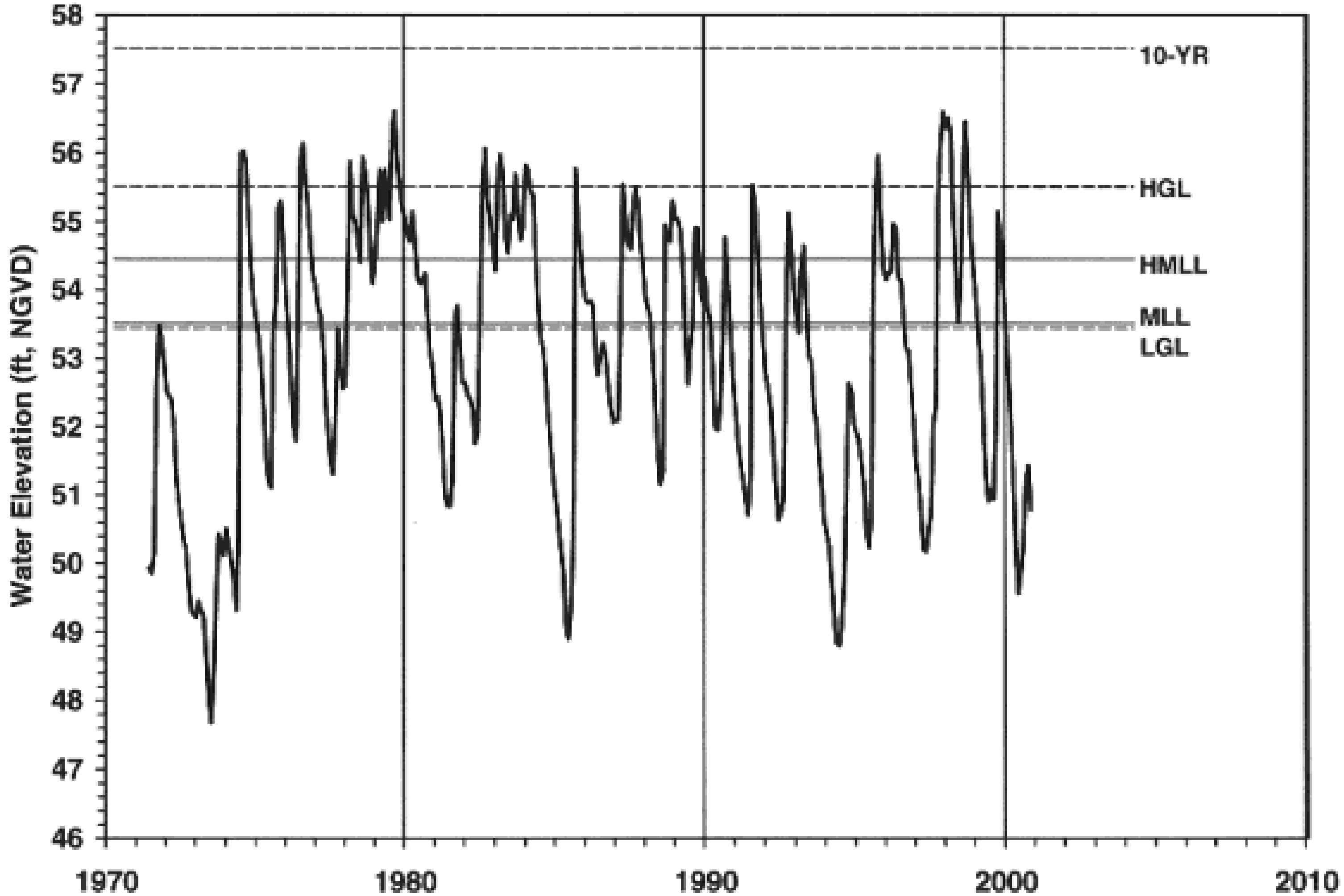


Figure 6-21. Outlet conveyance system for Lake Crenshaw, Hillsborough County, Florida. Numbered sites are described in Table 6-19.

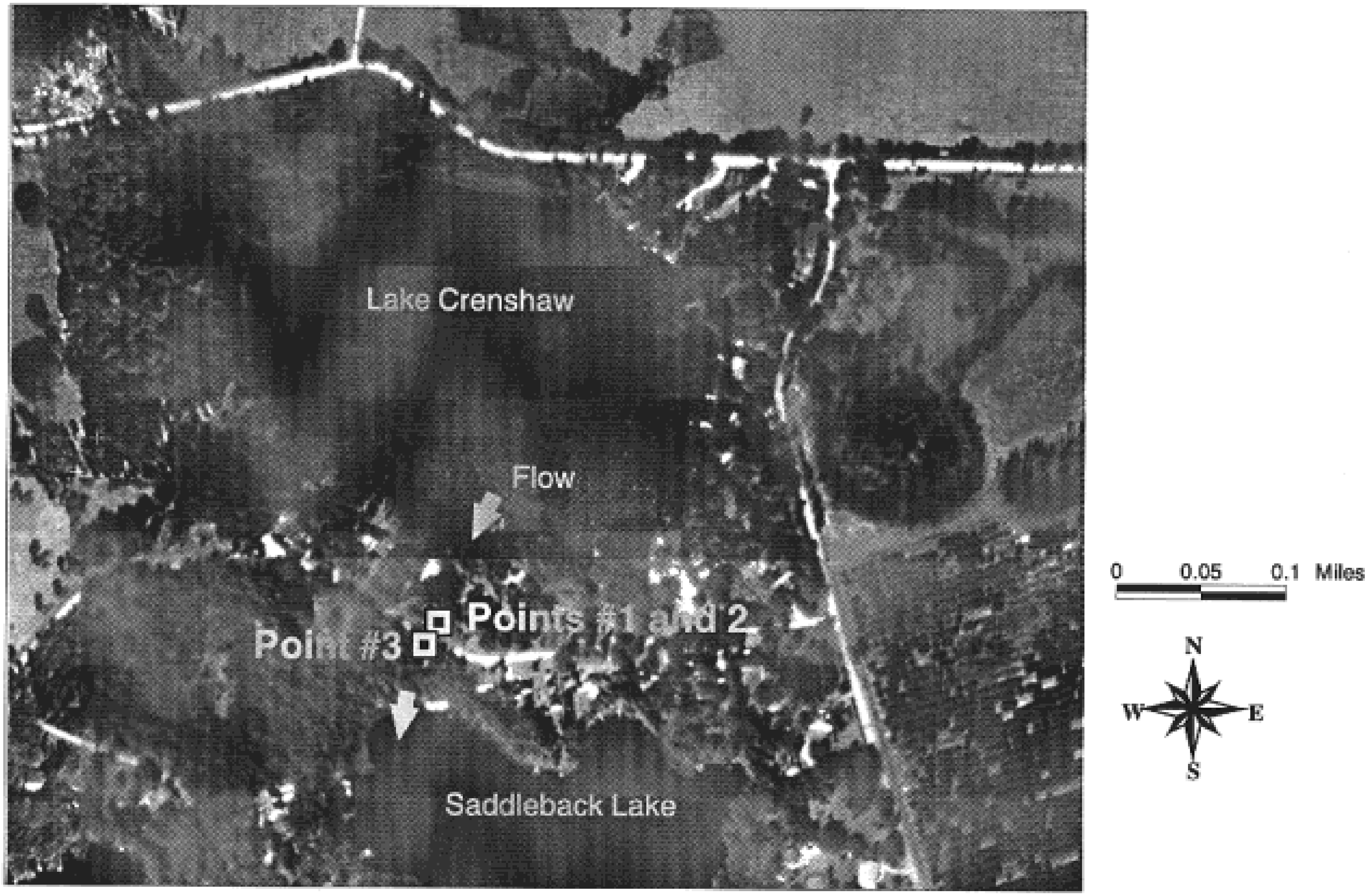
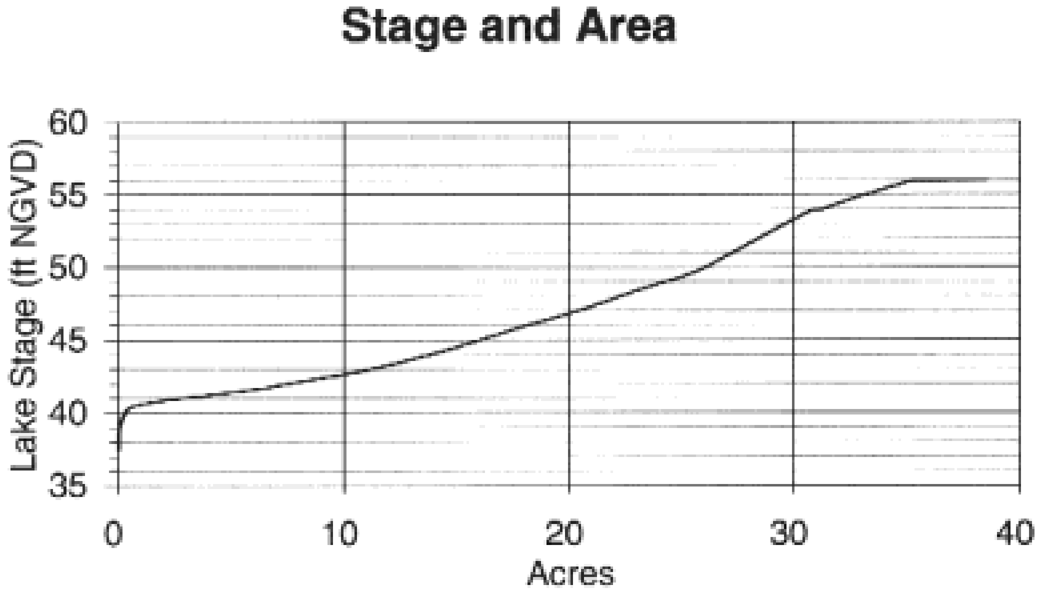


Figure 6-22. Surface area, volume, potential herbaceous wetland area, area potentially colonized by aquatic macrophytes, and dynamic ratio versus lake stage for Lake Crenshaw, Hillsborough County, Florida.



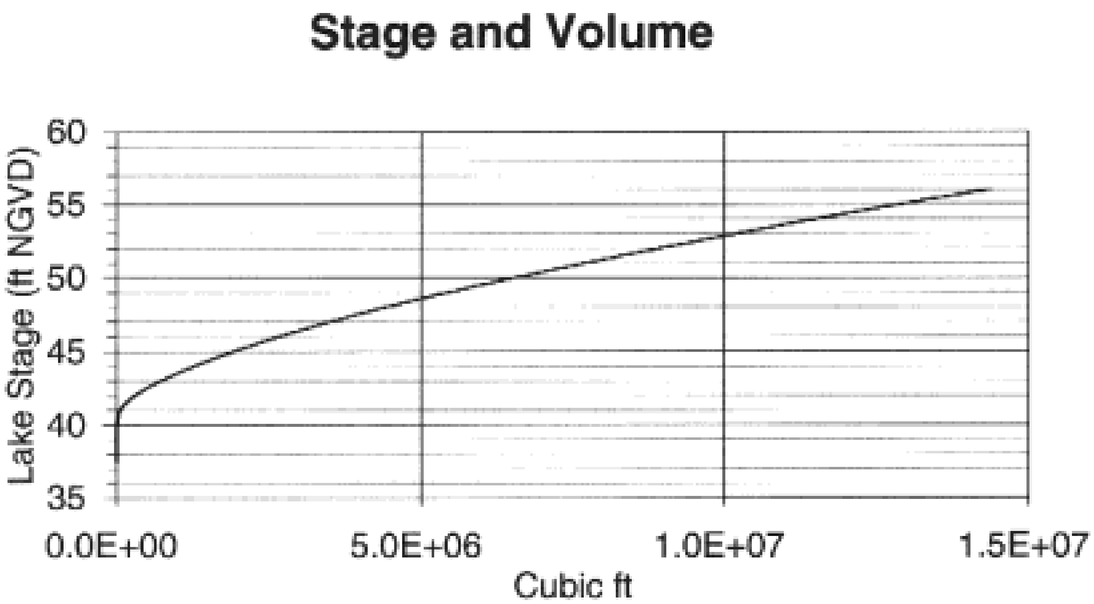
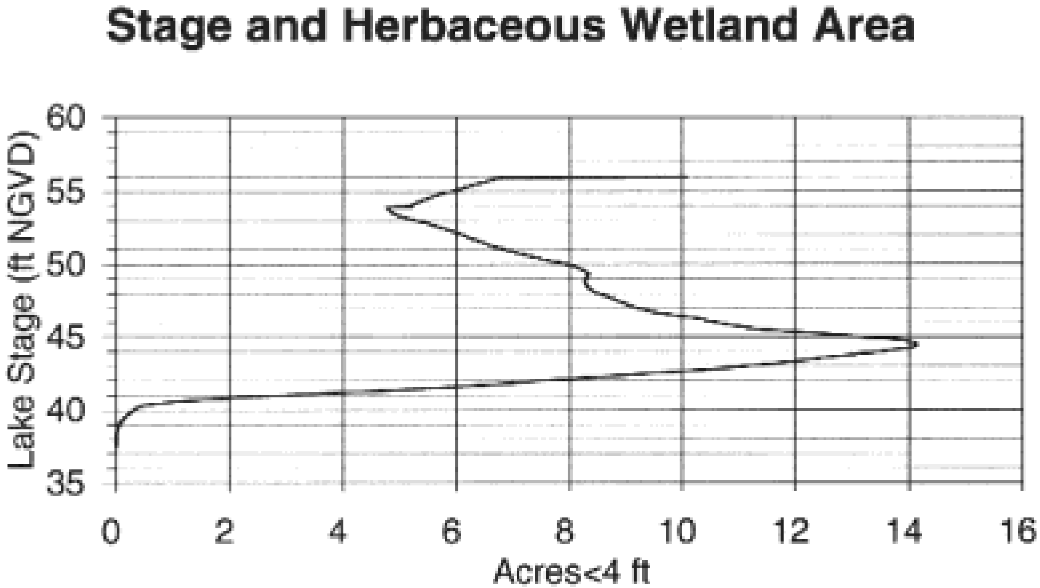


Figure 6-22. (Continued).



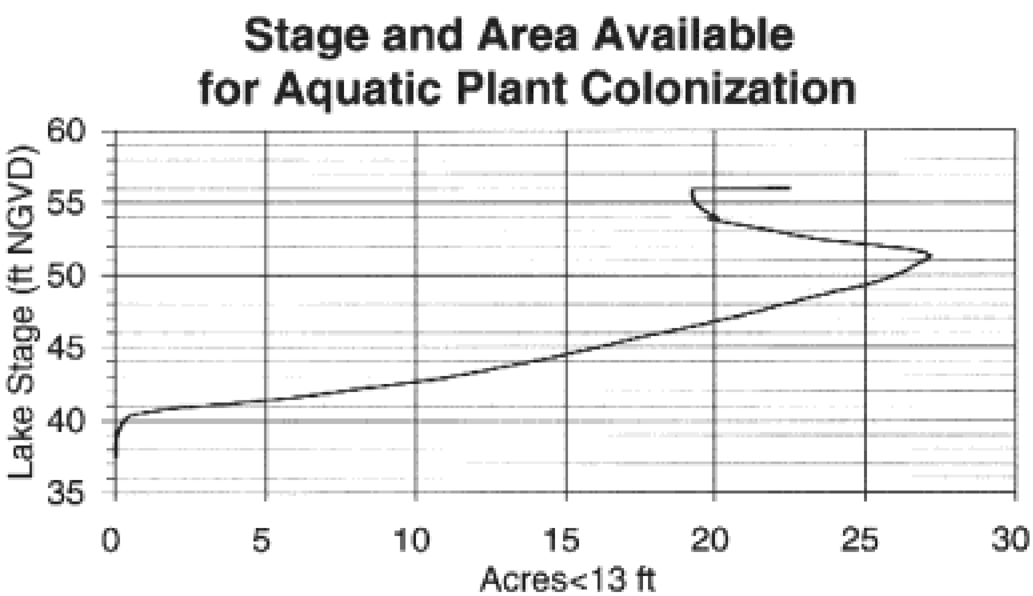
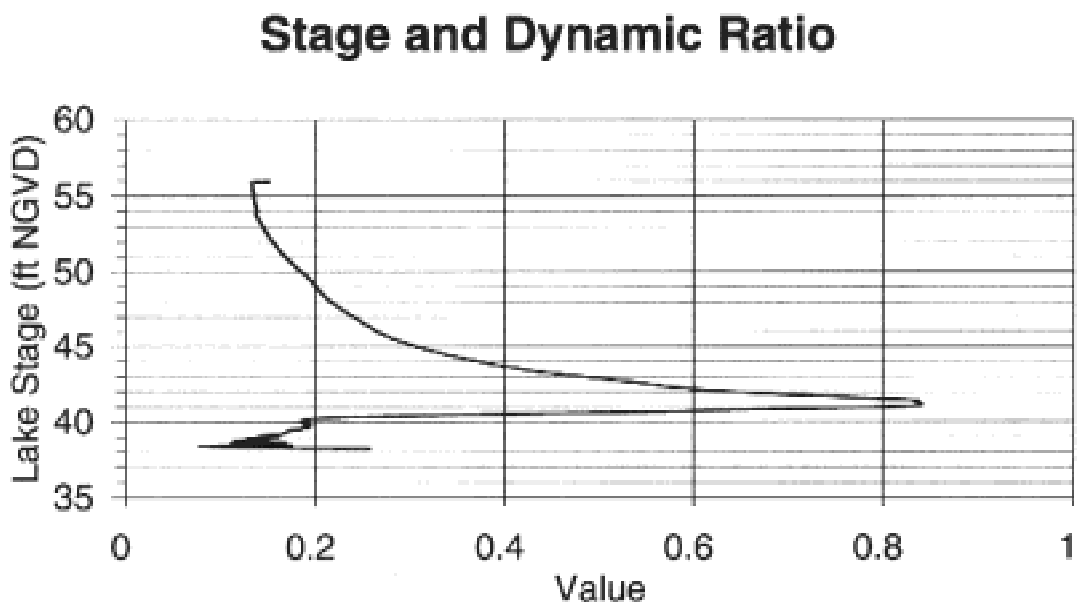


Figure 6-22. (Continued).



Cypress Lake

General Lake Description

Cypress Lake is located in the Northwest Hillsborough Basin in Hillsborough County, Florida (Section 24, Township 27S, Range 17E). The area surrounding the lake is categorized as the Land-O-Lakes subdivision of the Tampa Plain in the Ocala Uplift Physiographic District (Brooks 1981); a region of many lakes on a moderately thick plain of silty sand overlying Tampa Limestone. As part of the Florida Department of Environmental Protection's Lake Bioassessment/Regionalization Initiative, the area has also been identified as the Keystone Lakes region; an area of numerous slightly acidic, low nutrient, and mostly clear-water lakes (Griffith *et al.* 1997).

The United States Geological Survey 1974 (photorevised in 1987) 1:24,000 Odessa, Fla. quadrangle map indicates a water level elevation of 45 ft, NGVD. The Florida Lake Gazetteer (Shafer *et al.* 1986) lists a lake area of 17 acres at this elevation. The lake has a drainage area of 0.08 square miles. An outlet on the southern shore connects the lake to a series of small wetlands that drain to Lake Pretty in the Rocky Creek drainage system (Figure 6-23). Outlets along the western shore of the Cypress Lake drain to the Brooker Creek system during periods of high water.

A detailed topographic map of the Cypress Lake basin (Figure 6-24) was developed for estimation of surface areas associated with various water level elevations. Data used for map production were obtained from field surveys and 1:200 aerial photograph maps of the basin containing one-foot contour lines prepared using photogrammetric methods.

The District has not previously established management levels for Cypress Lake.

Proposed Minimum and Guidance Levels

Recommended Minimum and Guidance Levels for Cypress Lake, a Category 3 Lake, are listed in Table 6-20, along with area values for each water level. The Species Richness and Aesthetic Standards for the lake are lower than the Historic P50 elevation, and were evaluated for minimum levels development. The Aesthetic Standard, the more conservative of the two, was used to establish the proposed Minimum Lake Level at 46.75 ft. The proposed Minimum Lake Level is 1.1 ft below the Historic P50 elevation. Lake area at the proposed Minimum Lake Level is about 90% of the area associated with the Historic P50 elevation. The proposed High Minimum Lake Level was established at 47.75 ft, an elevation corresponding to the Minimum Lake Level plus the RLWR50 (1.0 ft) for the northern Tampa Bay area. The proposed High Minimum Lake Level is 1.1 ft below the High Guidance Level and 4.5 ft lower than the Low Floor Slab elevation. Lake area at the proposed High Minimum Lake Level is about 93% of that associated with the High Guidance Level. Development of Guidance Levels is described in the following sub-section.

Table 6-20. Cypress Lake: Recommended Minimum and Guidance Levels with Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten-Year Flood Guidance Level	49.99	22.1
High Guidance Level	48.85	20.1
High Minimum Lake Level	47.75	18.6
Minimum Lake Level	46.75	17.0
Low Guidance Level	46.75	17.0

Summary of Data and Analyses Supporting Recommended Minimum and Guidance Levels

Hydrologic data are available for Cypress Lake for the period from February 1993 through the present (December 2000) (Figure 6-25; see Figure 6-23 for location of the District lake gauge). For the entire period of record the hydrologic data are classified as Current data. These data were used to calculate the Current P10, P50, P90 (Table 6-21). The Category 3 Lake Normal Pool elevation was established based on large cypress trees along the northeastern lake shore (Table 6-22, Figure 6-23). The low floor slab and control point elevations were determined using available one-foot contour interval aerial maps, and field surveying (Tables 6-21 and 6-23, Figure 6-26). The Category 3 Lake Normal Pool elevation is above the control point, so the lake is considered to be Structurally Altered.

Based on the relationship between the control point elevation, the Category 3 Lake Normal Pool elevation and the Current P10, the High Guidance Level was established at the control point elevation. The Historic P50 and Low Guidance Level were determined using the High Guidance Level and the Northern Tampa Bay Region RLWR50 (1.0 ft) and RLWR90 (2.1 ft) (Table 6-22).

Cypress Lake is not contiguous with a cypress-dominated wetland of 0.5 acres in size and is therefore classified as a Category 3 Lake. The basin contains extensive areas of cattail (*Typha* sp.), pickerelweed (*Pontederia cordata*), rush fuirena (*Fuirena scirpoidea*), maidencane (*Panicum hemitomum*), cordgrass (*Spartina bakeri*) and primrose willow (*Ludwigia* sp.). A Dock-Use Standard was established at 48.5 ft, based on the Dock-End Sediment elevation of 45.4 ft, developed from measurement of 14 docks. Development of a Basin Connectivity Standard is not appropriate for Cypress Lake, based on basin morphology. A Species Richness Standard was established at

46.25 ft, based on a 15% reduction in lake surface area from that at the Historic P50 elevation. An Aesthetic-Standard was established at the Low Guidance Level elevation of 46.75 ft. Development of a Recreation/Ski Standard is not appropriate based on the size of the basin. Review of the dynamic ratio for lake stages bounded by the Current P10 and Current P90 elevations did not indicate that potential changes in basin susceptibility to wind-induced sediment resuspension would be of concern for minimum levels development (Table 4-1, Figure 6-27). Changes in potential herbaceous wetland area and area of potential aquatic macrophyte colonization with lake stage also did not indicate that use of any of the identified standards would be inappropriate (Figure 6-27).

The Ten Year Flood Guidance Level (Table 6-20) was established for Cypress Lake using the methodology for open basin lakes described in Section 5 of this report. The District used an existing hydrologic and hydraulic computer model of the Rocky Creek Watershed developed by Hillsborough County (Hillsborough County 1998). The Rocky Creek runoff hydrographs were computed using the NRCS Dimensionless Unit Hydrograph method, a 256 shape factor, a 9.0 inch rainfall depth, and a 48-hour rainfall distribution based on the Florida Modified Type II Distribution. The Rocky Creek conveyance system was simulated with the Hillsborough County modified version of EXTRAN, and the hydrodynamic routing component of the Environmental Protection Agency's Stormwater Management Model (SWMM) v.4.31. District staff modified the EXTRAN input data developed by Hillsborough County to include additional surveyed elements of the Cypress Lake outlet conveyance system. The initial elevation of Cypress Lake was set at the outlet control point elevation of 48.85 feet NGVD. The modified data set was then used to determine the 10-year flood level based on runoff hydrographs from the 10-year storm event.

Table 6-21. Cypress Lake: Summary of Elevation Data and Associated Area Values Used for Establishing Minimum Levels.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Current P10	48.66	19.9
Current P50	46.65	16.9
Current P90	44.33	13.9
Category 3 Lake Normal Pool	51.38	NA
Low Floor Slab	52.22	NA
Control Point	48.85	20.1
High Guidance Level	48.85 (Control point)	20.1

Historic P50	47.85 (HGL - RLWR50)	18.8
Low Guidance Level	46.75 (HGL - RLWR90)	17.0
Dock-Use Standard	48.5	19.6
Basin Connectivity Standard	NA	NA
Species Richness Standard	46.25	16.2
Aesthetic Standard	46.75	17.0
Recreation/Ski Standard	NA	NA

NA = not available / not applicable

Table 6-22. Cypress Lake: Elevation Data Used for Establishing the Category 3 Lake Normal Pool Elevation. Data collected on 11 March 1998; water level = 49.19 ft, NGVD.

Hydrologic Indicator	Height above Lake Water Level (ft)	Elevation (ft, NGVD)
Cypress buttress - normal pool	2.25	51.44
Cypress buttress - normal pool	2.00	51.19
Cypress buttress - normal pool	2.33	51.52
Mean	**2.19**	**51.38**

Table 6-23. Cypress Lake: Summary of Structural Alteration / Control Point Elevation Information. Numbers correspond to those shown in Figure 6-26.

No.	Description	Elevation (ft, NGVD)
1	Control point: bottom of slot cut in concrete drop inlet	48.85
2	Invert of 30" corrugated metal pipe connected to concrete drop inlet (No. 1 above)	48.85

Figure 6-23. Location of District lake gauge and site where hydrologic indicators of high water level were measured at Cypress Lake, Hillsborough County, Florida.

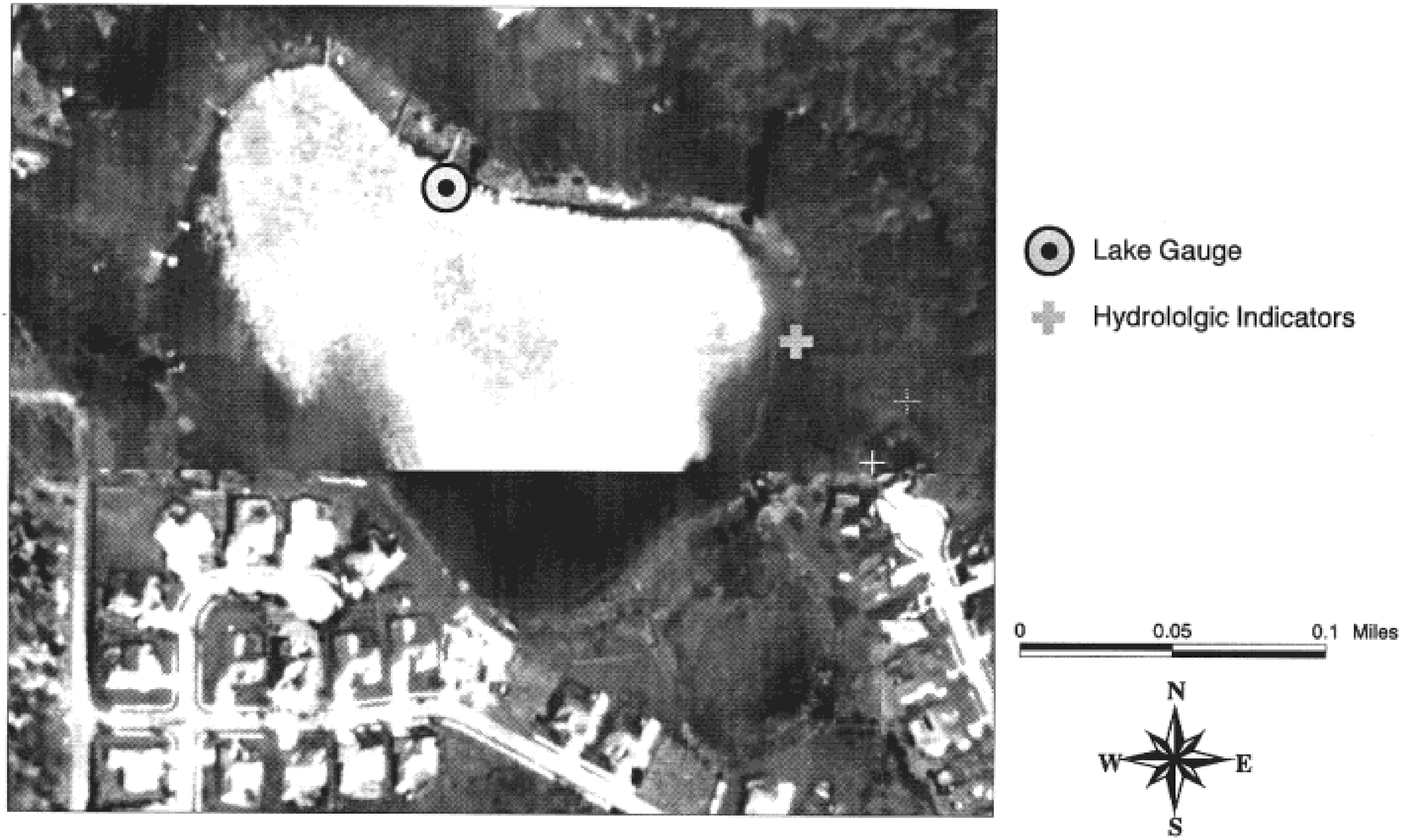


Figure 6-24. One-foot contour map of the Cypress Lake basin, Hillsborough County, Florida. Values shown are elevations, in feet, above the National Geodetic Vertical Datum.

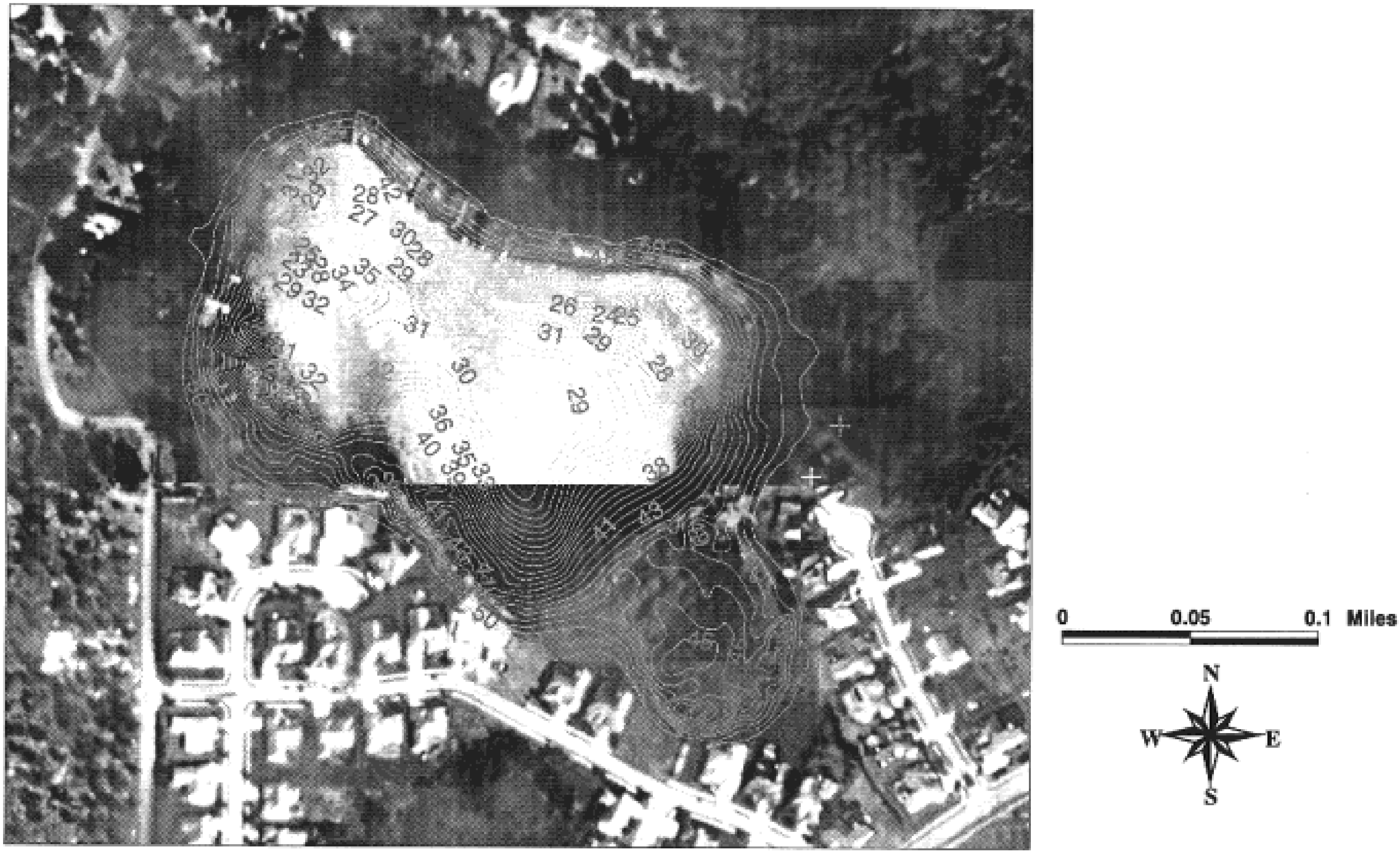


Figure 6-25. Mean monthly water elevations at Cypress Lake, Hillsborough County, Florida. Proposed High Minimum Lake Level (HMLL), Minimum Lake Level (MLL), Ten-Year Flood Guidance Level (10-YR), High Guidance Level (HGL), and Low Guidance Level (LGL) are shown as solid or dashed lines.

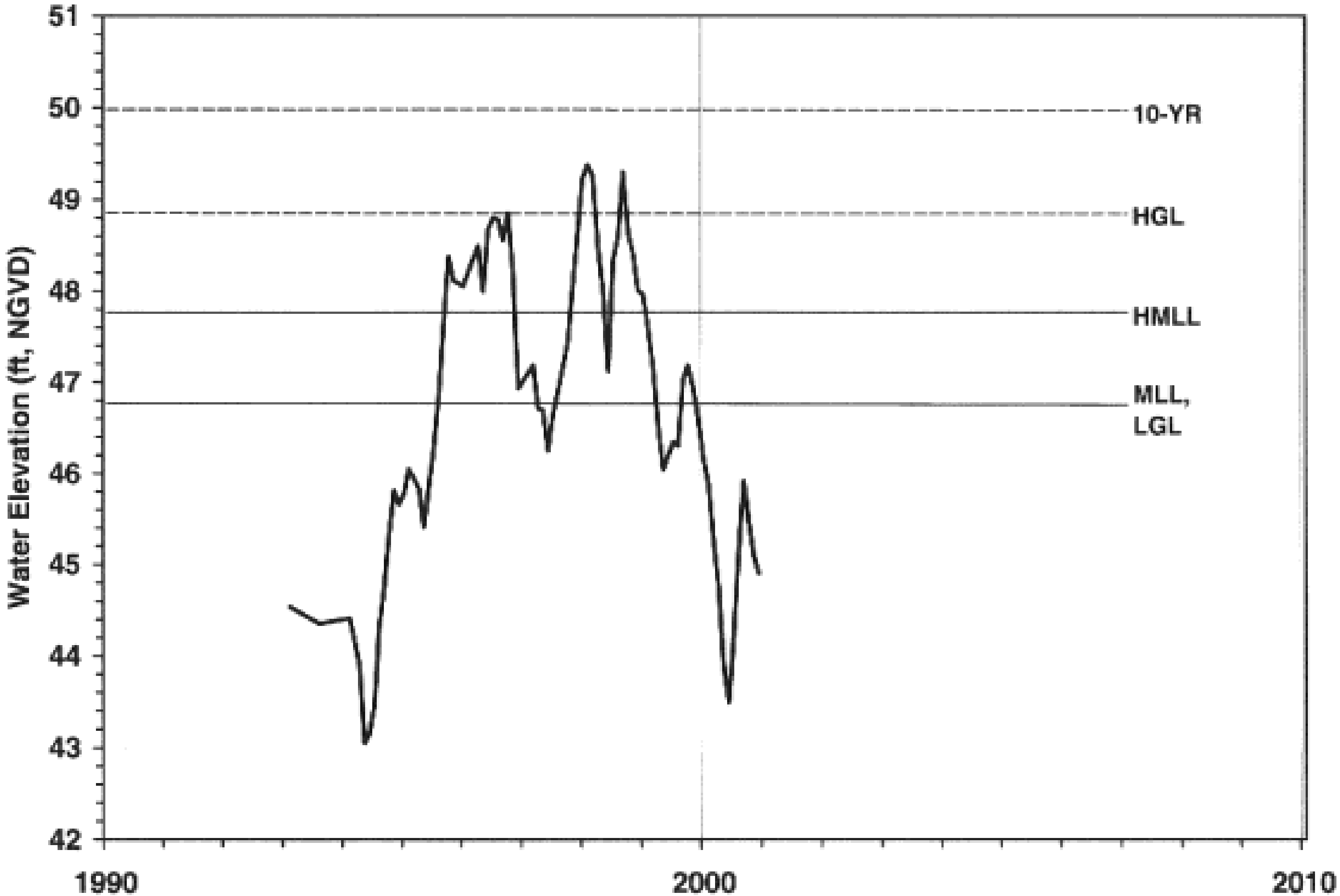


Figure 6-26. Outlet conveyance system for Cypress Lake, Hillsborough County, Florida. Numbered sites are described in Table 6-23.

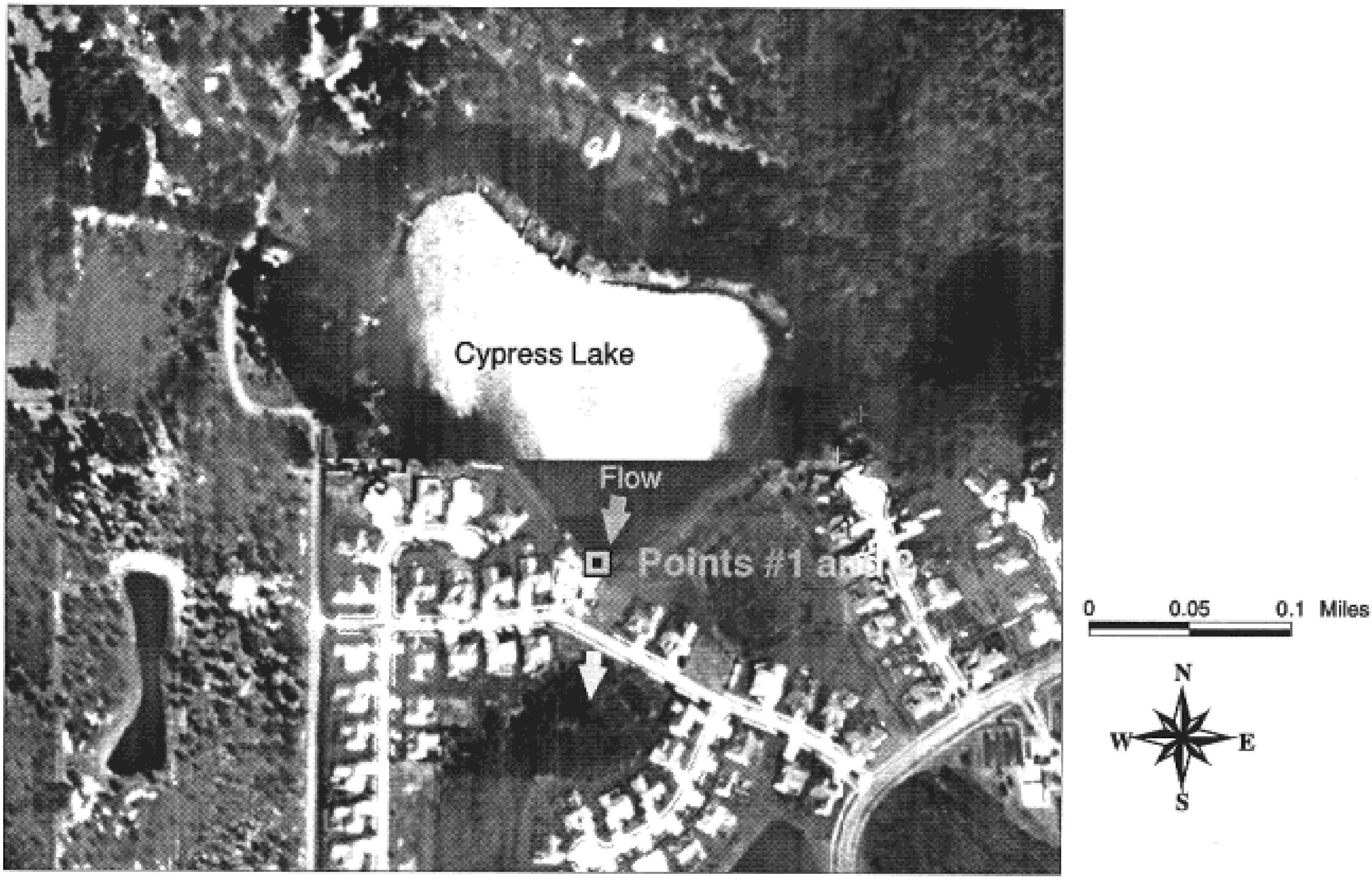
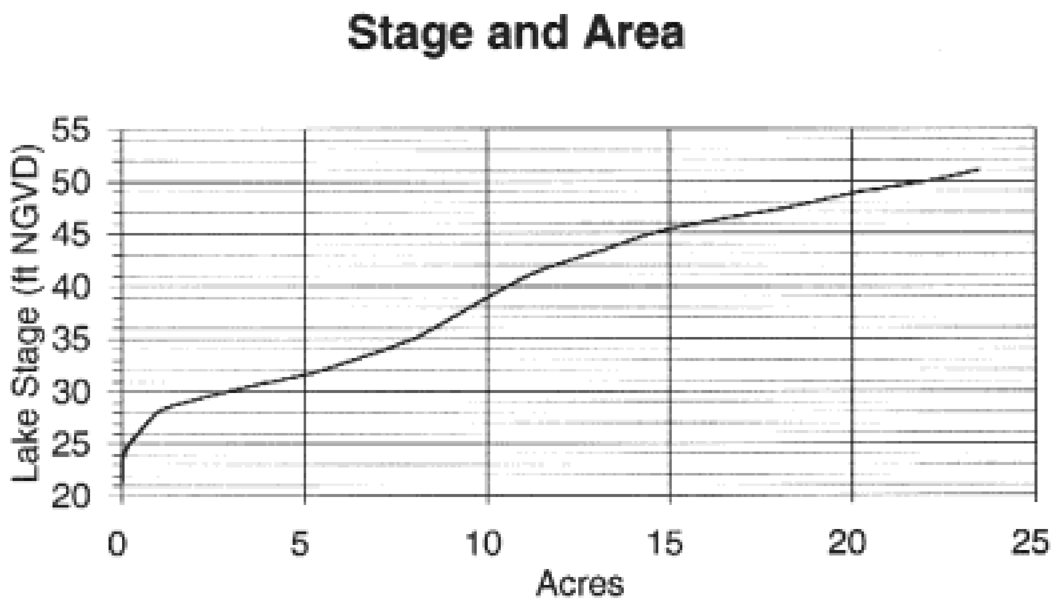


Figure 6-27. Surface area, volume, potential herbaceous wetland area, area potentially colonized by aquatic macrophytes, and dynamic ratio versus lake stage for Cypress Lake, Hillsborough County, Florida.



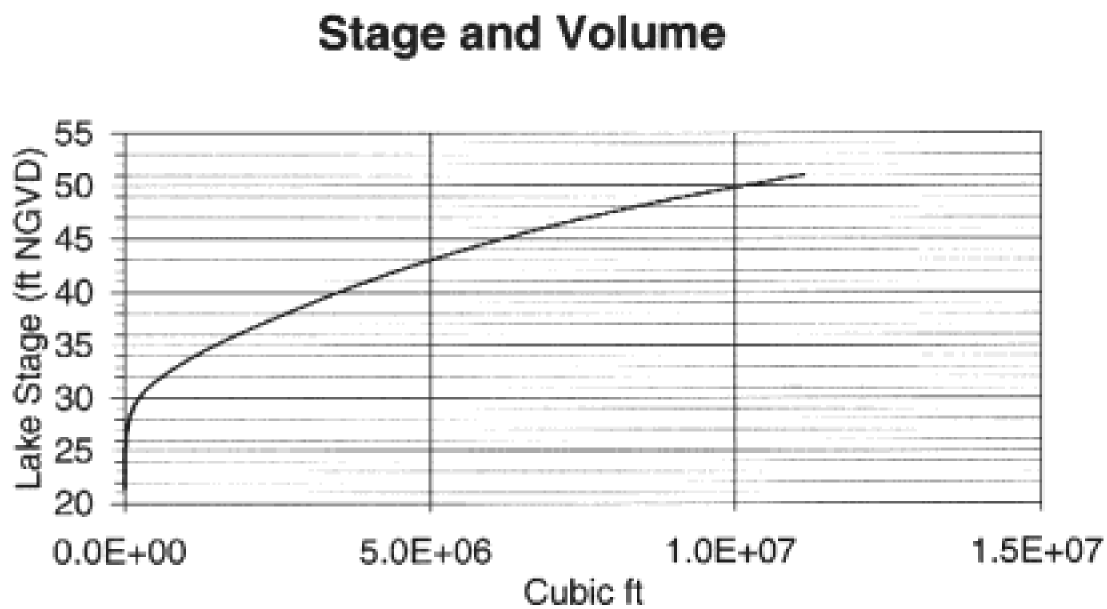
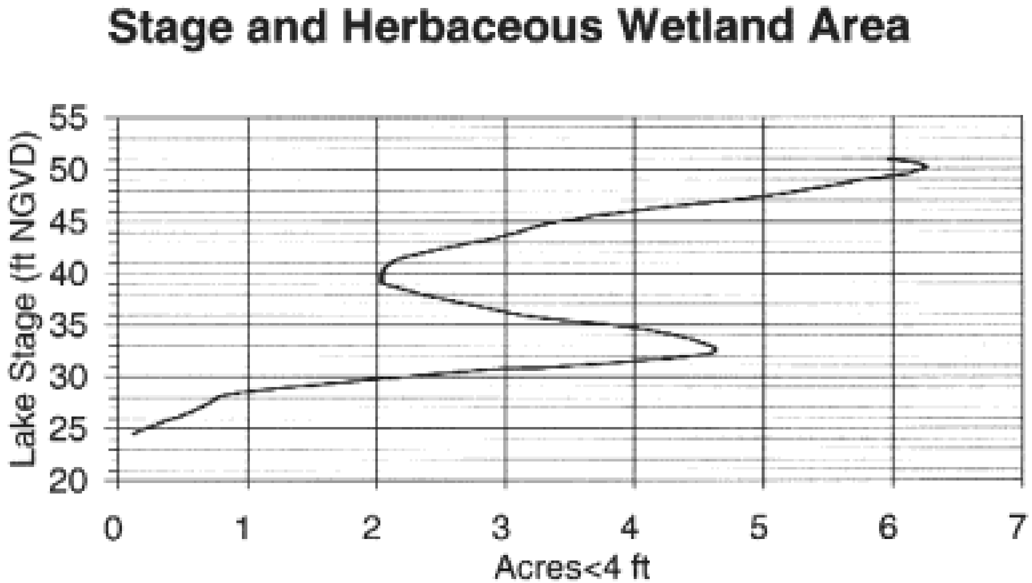


Figure 6-27. (Continued).



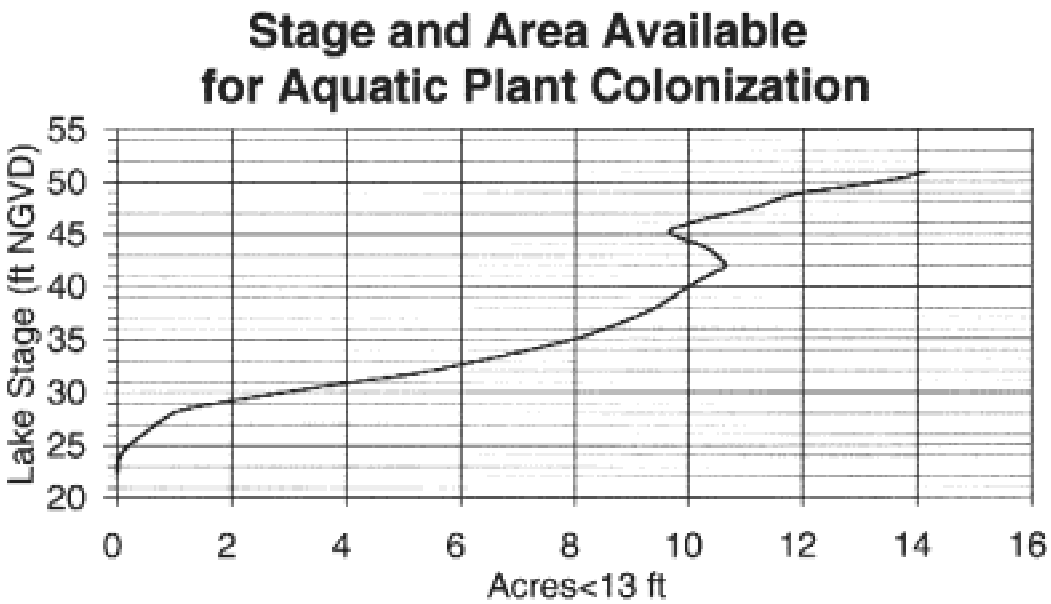
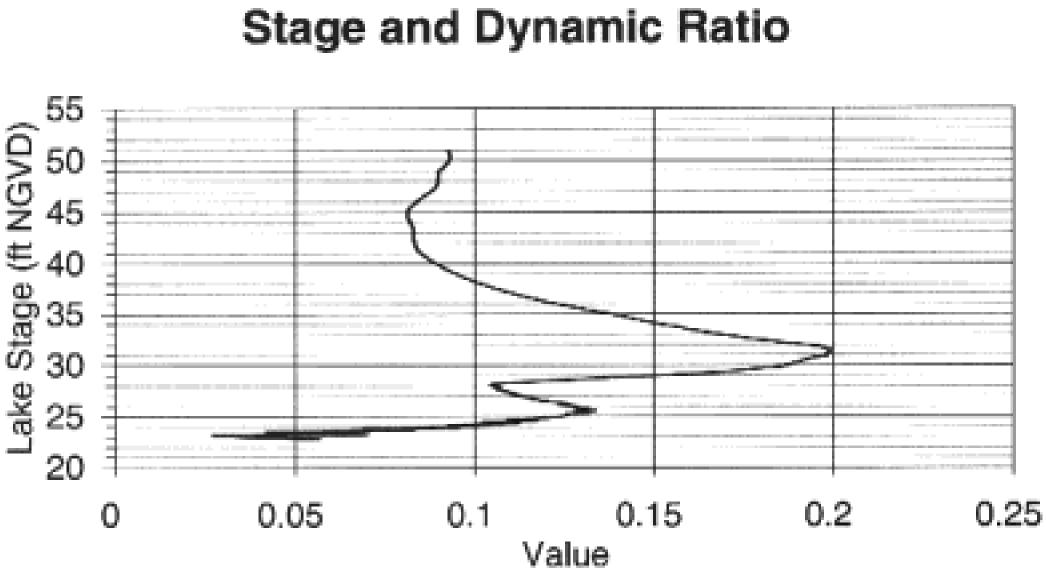


Figure 6-27. (Continued).



Fairy Lake

General Lake Description and Previously Adopted Lake Management Levels

Fairy Lake is located in the Northwest Hillsborough Basin in Hillsborough County, Florida (Section 34, Township 27S, Range 17E). The area surrounding the lake is categorized as the Lake Tarpon Basin subdivision of the Tampa Plain in the Ocala Uplift Physiographic District (Brooks 1981); an erosional basin partially filled with Late Pleistocene sediments overlying Tampa Limestone. As part of the Florida Department of Environmental Protection's Lake Bioassessment/Regionalization Initiative, the area has been identified as the Keystone Lakes region; an area of numerous slightly acidic, low nutrient, and mostly clear-water lakes (Griffith *et al.* 1997).

The 1956 United States Geological Survey (photorevised 1987) 1:24,000 Citrus Park, Fla. quadrangle map indicates a water level elevation of 31 ft, NGVD, a level corresponding to an area of 51 acres. The Florida Lake Gazetteer (Shafer *et al.* 1986) lists the lake surface area as 52 acres at 31 ft. The lake receives inflow through a culvert from a small lake to the east and discharges through a culvert on the southwestern shore (Figure 6-28).

A detailed topographic map of the Fairy Lake basin (Figure 6-29) was developed for estimation of surface areas associated with various water level elevations. Data used for map production were obtained from field surveys and 1:200 aerial photograph maps of the basin containing one-foot contour lines prepared using photogrammetric methods.

Based on field surveys conducted in 1977, the Governing Board adopted management levels (currently referred to as Guidance Levels) for the lake in September 1980 (Table 6-24).

Table 6-24. Fairy Lake: Adopted Guidance Levels (09 September 1980) and Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten Year Flood Guidance Level	36.00	59.9
High Level	34.75	57.8
Low Level	32.00	52.5
Extreme Low Level	29.50	47.7

Proposed Minimum and Guidance Levels

Recommended Minimum and Guidance Levels for Fairy Lake, a Category 3 Lake, are listed in Table 6-25, along with area values for each water level. The Basin Connectivity, Species Richness, Aesthetic and Recreation/Ski Standards for the lake are lower than the Historic P50 elevation, and were evaluated for minimum levels development. The Recreation/Ski Standard, the most conservative of these standards, was used to establish the proposed Minimum Lake Level at 32.10 ft. The proposed Minimum Lake Level is 0.3 ft below the Historic P50 elevation. Lake area at the proposed Minimum Lake Level is about 99% of the area associated with the Historic P50 elevation. The proposed High Minimum Lake Level was established at 33.10 ft, an elevation corresponding to the Minimum Lake Level plus the RLWR50 (1.0 ft) for the northern Tampa Bay area. The proposed High Minimum Lake Level is 0.3 ft below the High Guidance Level and about 4.1 ft lower than the Low Floor Slab elevation. Lake area at the proposed High Minimum Lake Level is about 99% of that associated with the High Guidance Level. Development of Guidance Levels is described in the following sub-section.

Table 6-25. Fairy Lake: Recommended Minimum and Guidance Levels with Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten-Year Flood Guidance Level	34.51	57.4
High Guidance Level	33.42	55.2
High Minimum Lake Level	33.10	54.6
Minimum Lake Level	32.10	52.7
Low Guidance Level	31.32	51.2

Summary of Data and Analyses Supporting Recommended Minimum and Guidance Levels

Hydrologic data are available for Fairy Lake for a few dates from the 1970s and 1980s and for the period from February 1990 to the present (December 2000) (Figure 6-30; see Figure 6-28 for location of the District water level gauge). For the entire period of record, the hydrologic data are classified as Current data. These data were used to calculate the Current P10, P50, P90 (Table 6-26). The Category 3 Lake Normal Pool elevation was established using large cypress trees along the northeastern shore of the lake (Tables 6-26, 6-27, Figure 6-28). The low floor slab and control point elevations were determined using available one-foot contour interval aerial maps, and field surveying (Tables 6-26 and 6-28, Figure 6-31). The Category 3 Lake Normal Pool Elevation is above the control point, so the lake is considered to be Structurally Altered.

Based on the relationship between the control point elevation, the Category 3 Lake Normal Pool elevation and the Current P10, the High Guidance Level was established at the Current P10 elevation (Table 6-26). The Low Guidance Level was established using the High Guidance Level and the Northern Tampa Bay Region RLWR90 (2.1 ft). The Historic P50 was established using the High Guidance Level and the difference between the Current P10 and Current P50 (Table 6-26).

Fairy Lake is not contiguous with any cypress-dominated wetlands of 0.5 acres or more is size and is therefore classified as a Category 3 Lake. The lake contains abundant stands of cattail (*Typpha* spp.) and other wetland vegetation. The Dock-Use Standard was established at 32.54 ft, based on the Dock-End Sediment elevation of 29.44 ft, developed from measurements for 45 docks. The Basin Connectivity Standard was established at 30.6 ft, based on use of power boats in the lake, a critical high-spot elevation of 27.5 ft and the RLWR5090 for the northern Tampa Bay area (1.1 ft). The Species Richness Standard was established at 28.59 ft, based on a 15% reduction in lake surface area from that at the Historic P50 elevation. The Aesthetic-Standard was established at the Low Guidance Level elevation of 31.32 ft. A Recreation/Ski Standard was established at 32.1 ft, based on a critical ski elevation of 31.0 ft and the RLWR5090 for the northern Tampa Bay area (1.1 ft). Review of the dynamic ratio for lake stages bounded by the Current P10 and Current P90 elevations did not indicate that potential changes in basin susceptibility to wind-induced sediment resuspension would be of concern for minimum levels development (Table 4-1, Figure 6-32). Changes in potential herbaceous wetland area and area of potential aquatic macrophyte colonization with lake stage also did not indicate that use of any of the identified standards would be inappropriate (Figure 6-32).

The Ten Year Flood Guidance Level (Table 6-25) was established for Fairy Lake using the methodology for open basin lakes described in Section 5 of this report. The District used flood information from an existing study of the Double Branch Watershed developed by Ayres Associates for Hillsborough County (Ayres 1998b). The methodology used by Ayres for determining flood stages of lakes in the Double Branch Watershed was consistent with the District's methodology. The Double Branch runoff hydrographs were computed using the NRCS Dimensionless Unit Hydrograph method, a 256 shape factor, a 10.0 inch rainfall depth, and a 72-hour rainfall distribution developed by the South Florida Water Management District. The Double Branch conveyance system was simulated with the Hillsborough County modified version of EXTRAN, and the hydrodynamic routing component of the Environmental Protection Agency's Stormwater Management Model (SWMM) v.4.31. Fairy Lake's initial elevation was set at 32.1 feet NGVD, which is within 0.08 ft of the control point, so a modification to the initial lake elevation was not necessary.

Table 6-26. Fairy Lake: Summary of Elevation Data and Associated Area Values Used for Establishing Minimum Levels.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Current P10	33.42	55.2
Current P50	32.36	53.2
Current P90	30.73	50.1
Category 3 Lake Normal Pool	35.29	59.2
Low Floor Slab	37.17	NA
Control Point	32.18	52.8
High Guidance Level	33.42 (Current P10)	55.2
Historic P50	32.42 (HGL - RLWR50)	53.3
Low Guidance Level	31.32 (HGL - RLWR90)	51.2
Dock-Use Standard	32.54	53.5
Basin Connectivity Standard	30.6	49.9
Species Richness Standard	28.59	54.3
Aesthetic Standard	31.32	51.2
Recreation/Ski Standard	32.1	52.7

NA = not available / not applicable

Table 6-27. Fairy Lake: Elevation Data Used for Establishing the Category 3 Lake Normal Pool Elevation. Data collected 11 August 1999; water level = 31.91 ft, NGVD

Hydrologic Indicator	Height above Lake Water Level (ft)	Elevation (ft, NGVD)
Cypress buttress - normal pool	3.65	35.56
Cypress buttress - normal pool	2.76	34.67
Cypress buttress - normal pool	2.76	34.67
Cypress buttress - normal pool	3.79	35.70
Cypress buttress - normal pool	3.79	35.70
Cypress buttress - normal pool	3.51	35.42
Mean	**3.38**	**35.29**

Table 6-28. Fairy Lake: Summary of Structural Alteration / Control Point Elevation information. Numbers correspond to those shown in Figure 6-31.

No.	Description	Elevation (ft, NGVD)
1	South end of 24" reinforced concrete pipe with one wooden flash board in place	33.0
2	Bottom of 24" reinforced concrete pipe	31.63
3	Control point: north end of reinforced concrete pipe	32.18
4	North end of 24" reinforced concrete pipe	31.50

Figure 6-28. Location of District lake gauge, outlet and site where hydrologic indicators of high water level were measured at Fairy Lake, Hillsborough County, Florida.

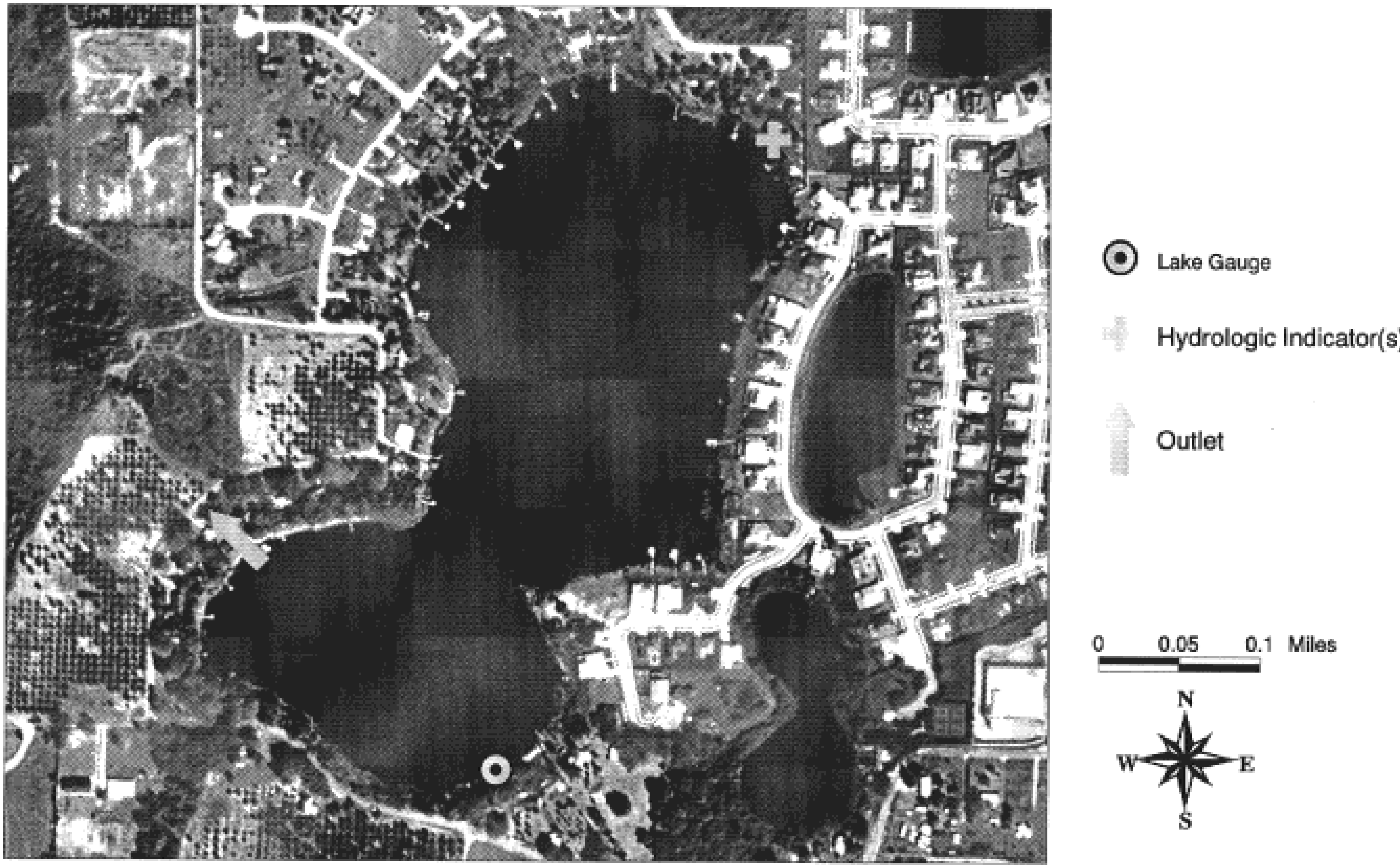


Figure 6-29. One-foot contour map of the Fairy Lake basin, Hillsborough County, Florida. Values shown are elevations, in feet, above the National Geodetic Vertical Datum.

Figure 6-30. Mean monthly water elevations at Fairy Lake, Hillsborough County, Florida. Proposed High Minimum Lake Level (HMLL), Minimum Lake Level (MLL), Ten-Year Flood Guidance Level (10-YR), High Guidance Level (HGL), and Low Guidance Level (LGL) are shown as solid or dashed lines.

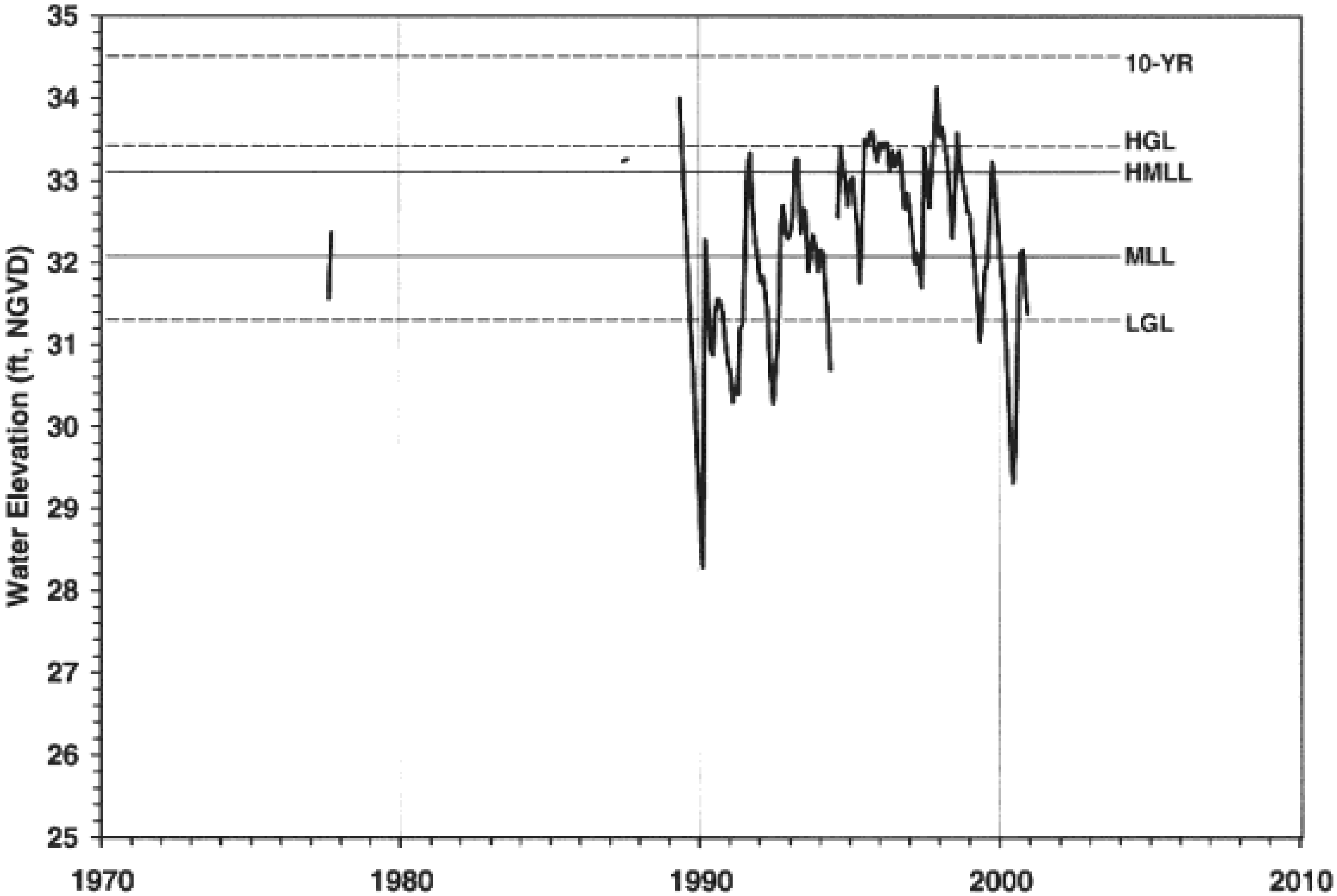
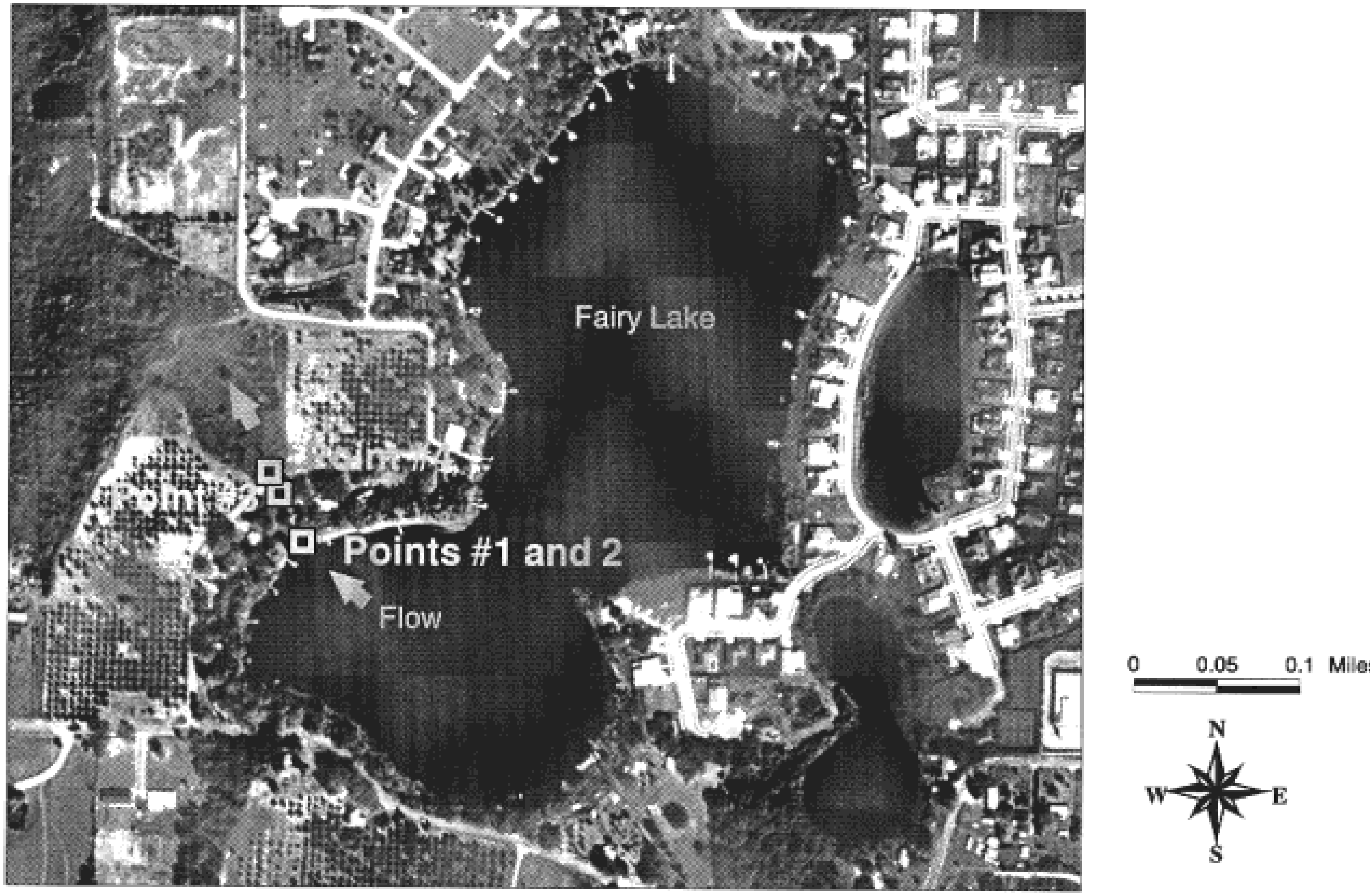
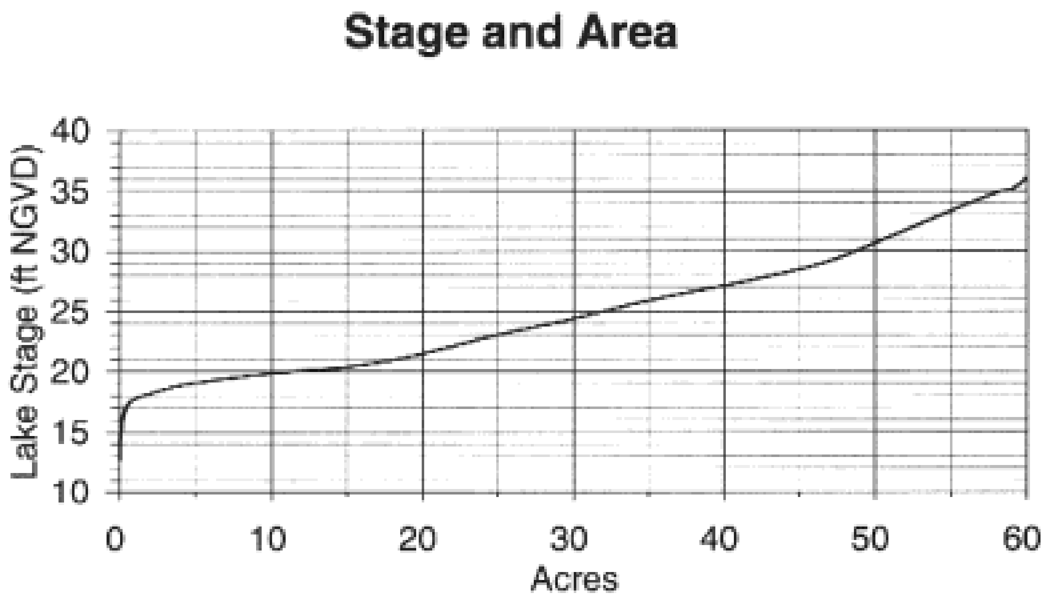


Figure 6-31. Outlet conveyance system for Fairy Lake, Hillsborough County, Florida. Numbered sites are described in Table 6-28.



6-32. Surface area, volume, potential herbaceous wetland area, area potentially colonized by aquatic macrophytes, and dynamic ratio versus lake stage for Fairy Lake, Hillsborough County, Florida.



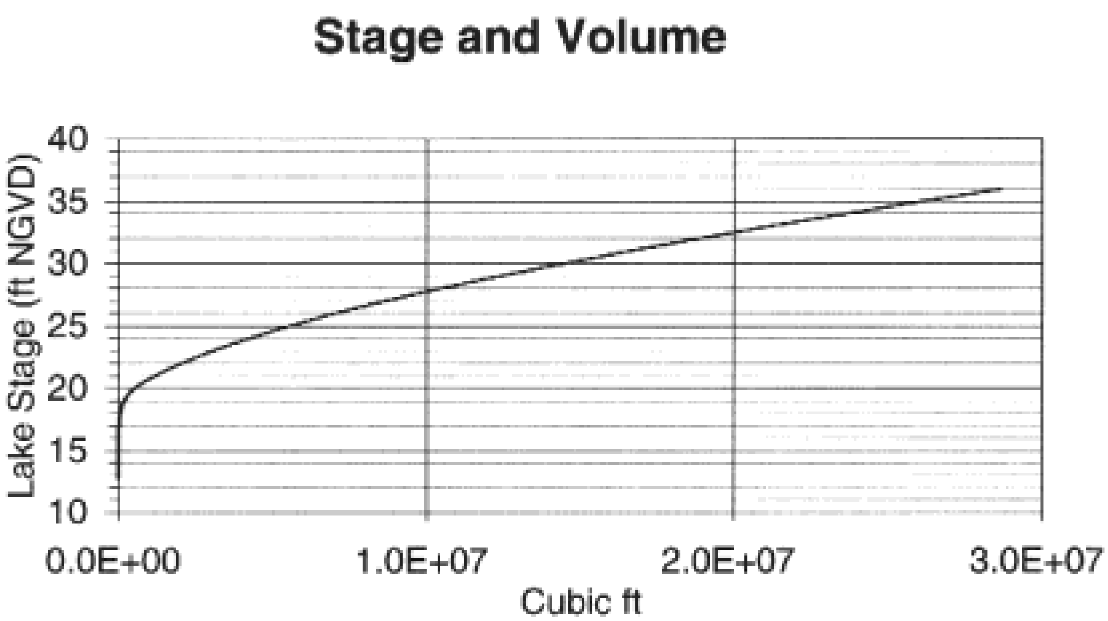
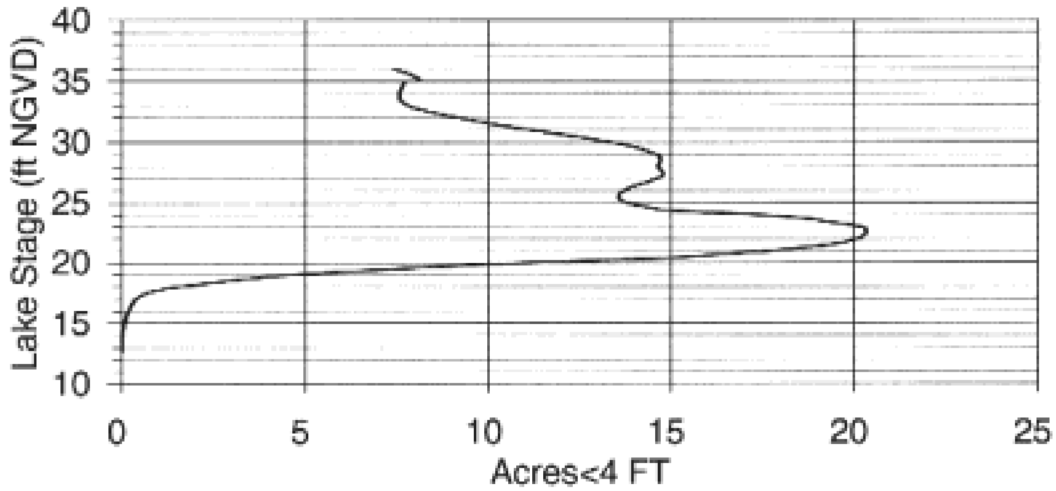


Figure 6-32. (Continued).

Stage and Herbaceous Wetland Area



Stage and Area Available for Aquatic Plant Colonization

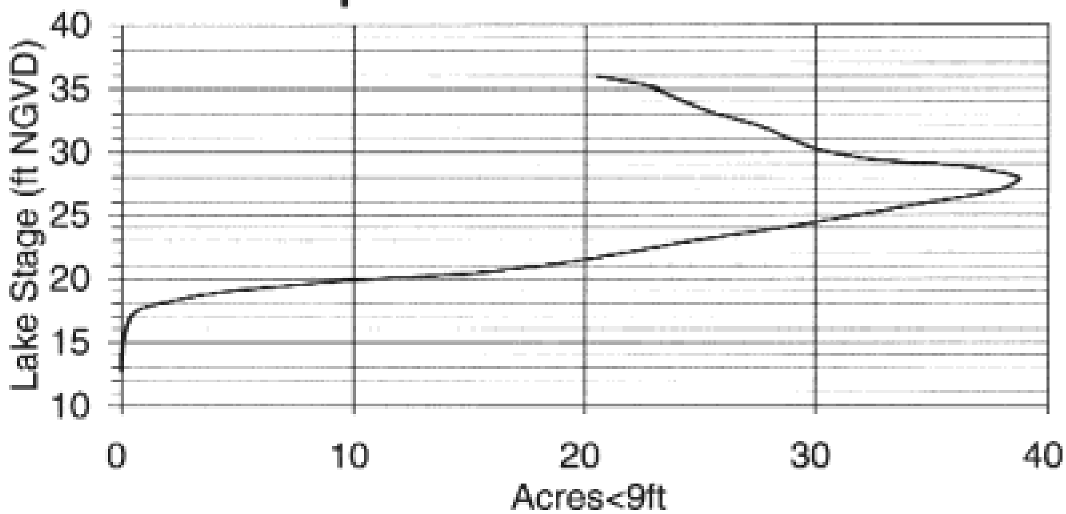
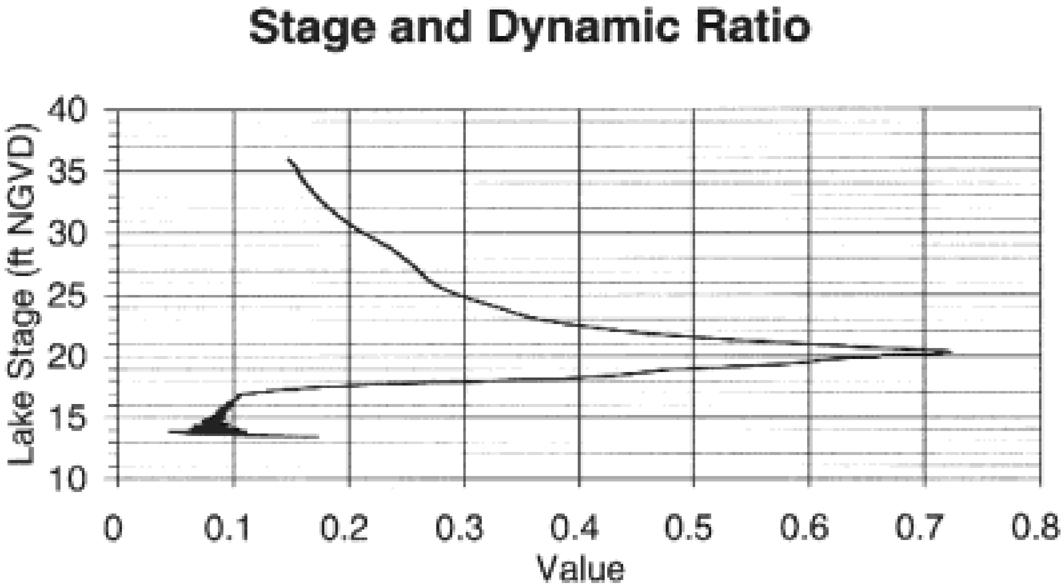


Figure 6-32. (Continued).



Halfmoon Lake

General Lake Description and Previously Adopted Lake Management Levels

Halfmoon Lake is located in the Northwest Hillsborough Basin in Hillsborough County, Florida (Sections 30 and 31, Township 27S, Range 18E, and Sections 25 and 36, Township 27S, Range 17E). The area surrounding the lake is categorized as the Land-O-Lakes subdivision of the Tampa Plain in the Ocala Uplift Physiographic District (Brooks 1981); a region of many lakes on a moderately thick plain of silty sand overlying Tampa Limestone. As part of the Florida Department of Environmental Protection's Lake Bioassessment/Regionalization Initiative, the area has been identified as the Keystone Lakes region; an area of numerous slightly acidic, low nutrient, and mostly clear-water lakes (Griffith *et al.* 1997).

The 1956 United States Geological Survey (photorevised 1987) 1:24,000 Citrus Park, Fla. quadrangle map indicates a water level elevation of 44 ft, NGVD. The Florida Gazetteer (Shafer *et al.* 1986) lists the lake surface area as 32 acres at this elevation. No information is available on the lake basin drainage area. The lake has no inlet, but discharges water to the Rocky Creek system through a water control structure installed on the northwestern shore in 1998 (Figure 6-33). Ground water from the Floridan Aquifer has been used to augment the lake since summer 2000.

A detailed topographic map of the Halfmoon Lake basin (Figure 6-34) was developed for estimation of surface areas associated with various water level elevations. Data used for map production were obtained from field surveys and 1:200 aerial photograph maps of the basin containing one-foot contour lines prepared using photogrammetric methods.

Based on field surveys conducted in 1977, the Governing Board adopted management levels (currently referred to as Guidance Levels) for the Halfmoon Lake in September 1980 (Table 6-29).

Table 6-29. Halfmoon Lake: Adopted Guidance Levels (09 September 1980) and Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten Year Flood Guidance Level	47.00	NA
High Level	45.00	NA
Low Level	42.00	34.0
Extreme Low Level	39.00	30.3

NA = not available

Proposed Minimum and Guidance Levels

Recommended Minimum and Guidance Levels for Halfmoon Lake, a Category 2 Lake, are listed in Table 6-30, along with area values for each water level. The Minimum Lake Level was established at the Historic P50 elevation at 42.45 ft. The proposed High Minimum Lake Level was established at the High Guidance Level at 43.45 ft. The proposed High Minimum Lake Level is about 3.8 ft below the Low Floor Slab elevation. Development of Guidance Levels is described in the following sub-section.

Table 6-30. Halfmoon Lake: Recommended Minimum and Guidance Levels with Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten-Year Flood Guidance Level	44.76	NA
High Guidance Level	43.45	35.9
High Minimum Lake Level	43.45	35.9
Minimum Lake Level	42.45	34.5
Low Guidance Level	41.35	33.2

NA = not available

Summary of Data and Analyses Supporting Recommended Minimum and Guidance Levels

Hydrologic data are available for Halfmoon Lake from April 1981 to the present (December 2000) (Figure 6-35; see Figure 6-33 for location of the District water level gauge). These data cannot be classified as Historic or Current data; a new structure was installed at the lake in spring 1998, so only 2 years of data reflecting current conditions are available. The Normal Pool elevation was established using cypress trees within the swamp occurring along the northeastern shore of the lake (Tables 6-31 and 6-32, Figure 6-33). The low floor slab and control point elevations were determined using available one-foot contour interval aerial maps, and field survey information (Tables 6-31 and 6-33, Figure 6-36). The Normal Pool elevation is above the control point elevation, so the lake is considered to be Structurally Altered.

Based on the relationship between the control point elevation and the Normal Pool elevation, the High Guidance Level was established at the control point elevation (Table 6-31). The Historic P50 and Low Guidance Level were determined using the High Guidance Level and the Northern Tampa Bay Region RLWR50 (1.0 ft) and RLWR90

(2.1 ft) (Table 6-31).

The northwest corner of Halfmoon Lake is contiguous with a cypress-dominated wetland of more than 0.5 acres in size. The lake is classified as a Category 2 Lake because the elevation 1.8 feet below the Normal Pool elevation (44.12 ft) is greater than the Historic P50 elevation. The basin contains abundant stands of cattail (*Typpha* spp.) and *Panicum* grasses.

The Ten Year Flood Guidance Level (Table 6-30) was established for Halfmoon Lake using the methodology for open basin lakes described in Section 5. The District used an existing hydrologic and hydraulic computer model of the Rocky Creek Watershed developed by Hillsborough County (Hillsborough County 1998). The Rocky Creek runoff hydrographs were computed using the NRCS Dimensionless Unit Hydrograph, a 256 shape factor, a 10.0 inch rainfall depth, and a 72-hour rainfall distribution developed by the South Florida Water Management District. The Rocky Creek conveyance system was simulated with the Hillsborough County modified version of EXTRAN, and the hydrodynamic routing component of the Environmental Protection Agency's Stormwater Management Model (SWMM) v.4.31. District staff modified the EXTRAN input data developed by Hillsborough County to include additional surveyed elements of the Halfmoon Lake outlet conveyance system. The initial elevation of Halfmoon Lake was set at the outlet control point elevation of 43.45 feet NGVD. The modified data set was then used to determine the 10-year flood level based on runoff hydrographs from the 10-year storm event.

Table 6-31. Halfmoon Lake: Summary of Elevation Data and Associated Area Values Used for Establishing Minimum Levels.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Current P10	NA	NA
Current P50	NA	NA
Current P90	NA	NA
Normal Pool	45.92	NA
Low Floor Slab	47.28	NA
Control Point	43.45	35.9
High Guidance Level	43.45 (Control Point)	35.9
Historic P50	42.45 (HGL - RLWR50)	34.5
Low Guidance Level	41.35 (HGL - RLWR90)	33.2

NA = not available / not applicable

Table 6-32. Halfmoon Lake: Elevation Data Used for Establishing the Normal Pool Elevation. Data collected 12 August 1999; water level = 40.94 ft, NGVD.

Hydrologic Indicator	Height above Lake Water Level (ft)	Elevation (ft, NGVD)
Cypress buttress - normal pool	4.59	45.53
Cypress buttress - normal pool	5.03	45.97
Cypress buttress - normal pool	4.91	45.85
Cypress buttress - normal pool	5.33	46.27
Cypress buttress - normal pool	5.08	46.02
Cypress buttress - normal pool	4.96	45.90
Cypress buttress - normal pool	5.18	46.12
Cypress buttress - normal pool	4.73	45.67
Cypress buttress - normal pool	5.28	46.22
Cypress buttress - normal pool	4.73	45.67
Mean	**4.98**	**45.92**

Table 6-33. Halfmoon Lake: Summary of Structural Alteration / Control Point Elevation Information. Numbers correspond to those shown in Figure 6-36.

No.	Description	Elevation (ft, NGVD)
1	Control point: bottom of one 18" X 18" and two 12"X 18" slots cut into concrete drop inlet structure	43.45
2	Top of concrete drop inlet structure	45.05
3	East end of 15" reinforced concrete pipe at bottom of drop inlet	42.75
4	West end of 15" reinforced concrete pipe	41.93

Figure 6-33. Location of District lake gauge, lake outlet and site where hydrologic indicators of high water were measured at Halfmoon Lake, Hillsborough County, Florida.

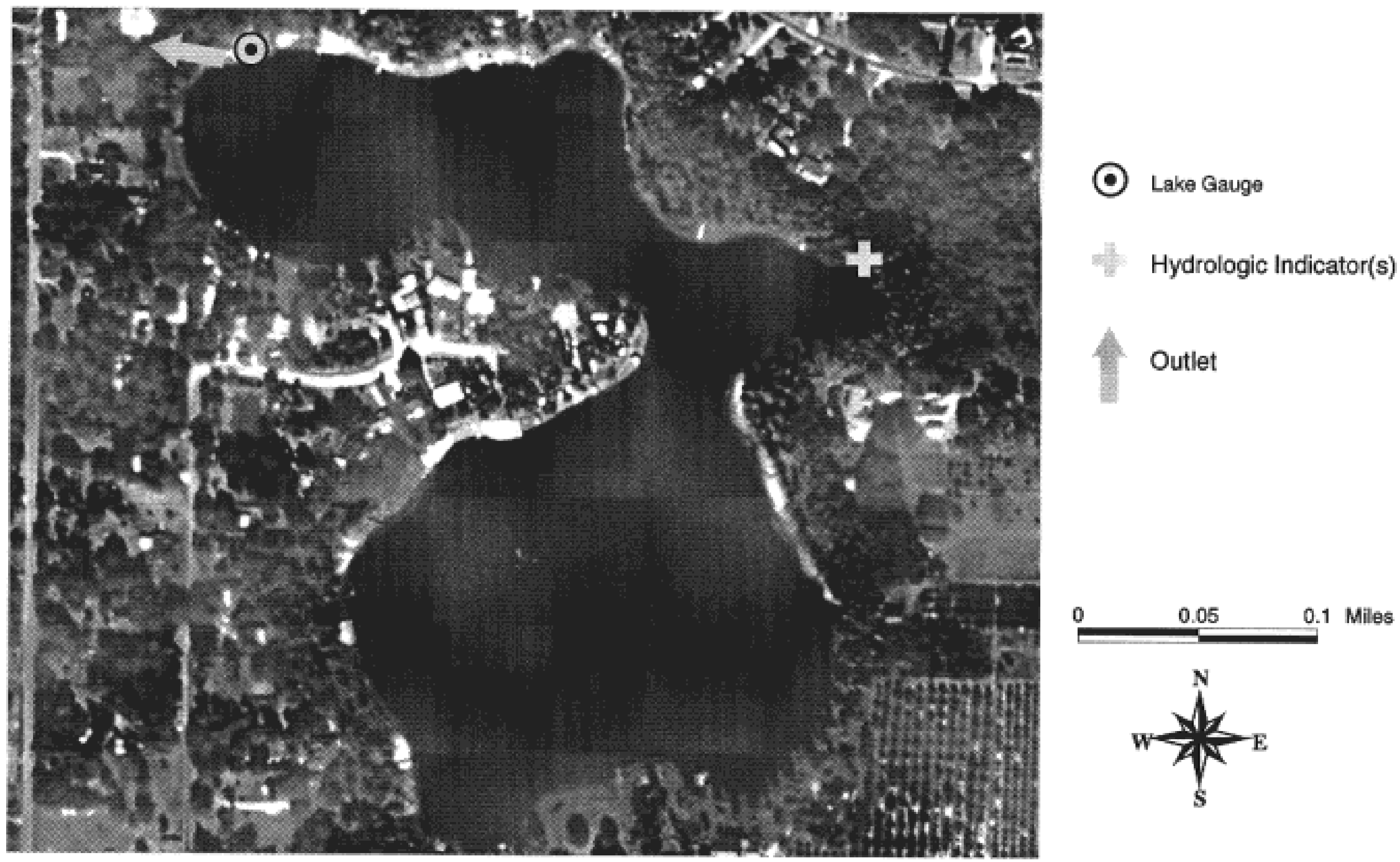


Figure 6-34. One-foot contour map of the Haflmoon Lake Basin, Hillsoborough County, Florida. Values shown are elevation in feet, relative to the National Geodetic Vertical Datum.

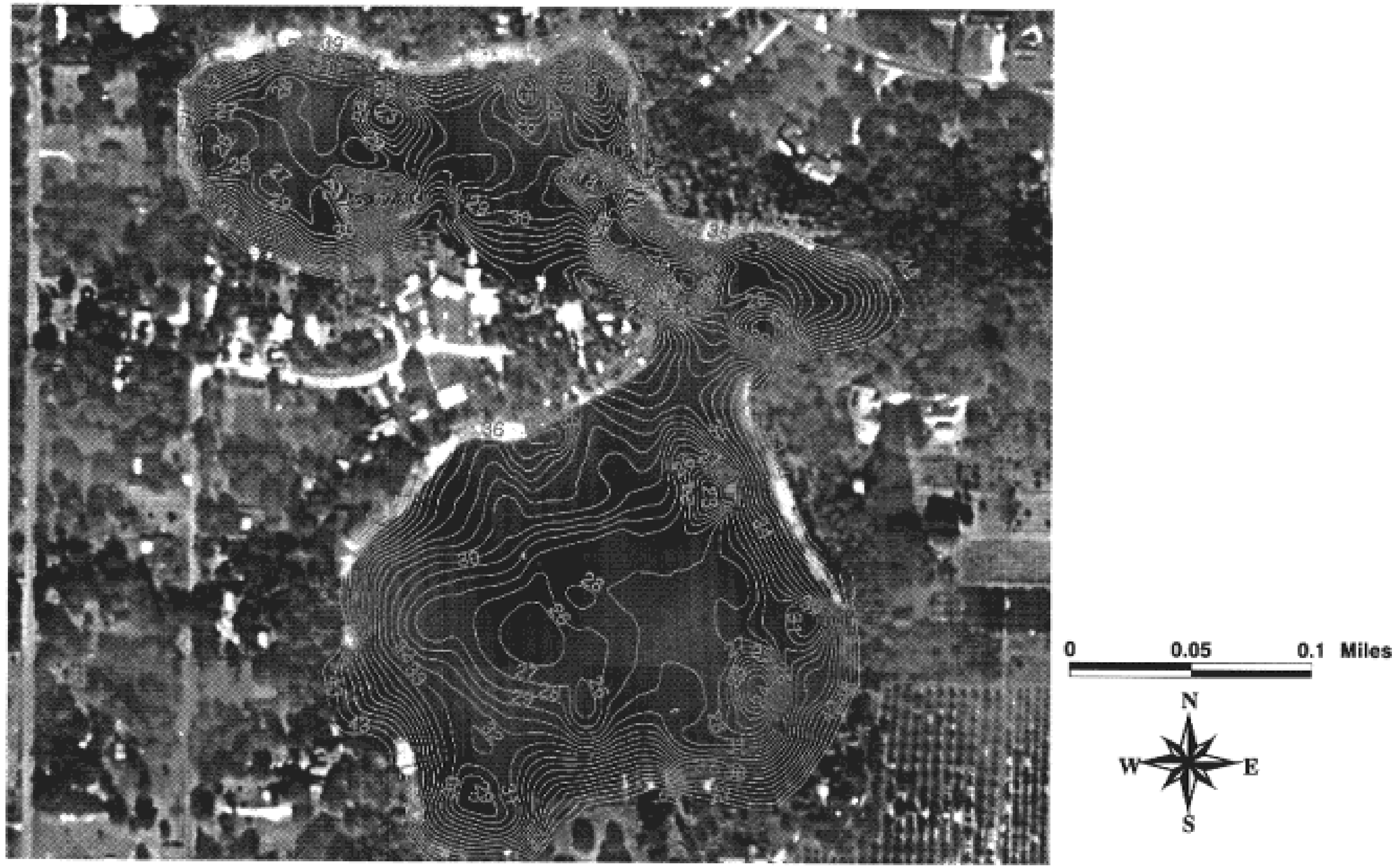


Figure 6-35. Mean monthly water elevations at Halfmoon Lake, Hillsborough County, Florida. Proposed High Minimum Lake Level (HMLL), Minimum Lake Level (MLL), Ten-Year Flood Guidance Level (10-YR), High Guidance Level (HGL), and Low Guidance Level (LGL) are shown as solid or dashed lines.

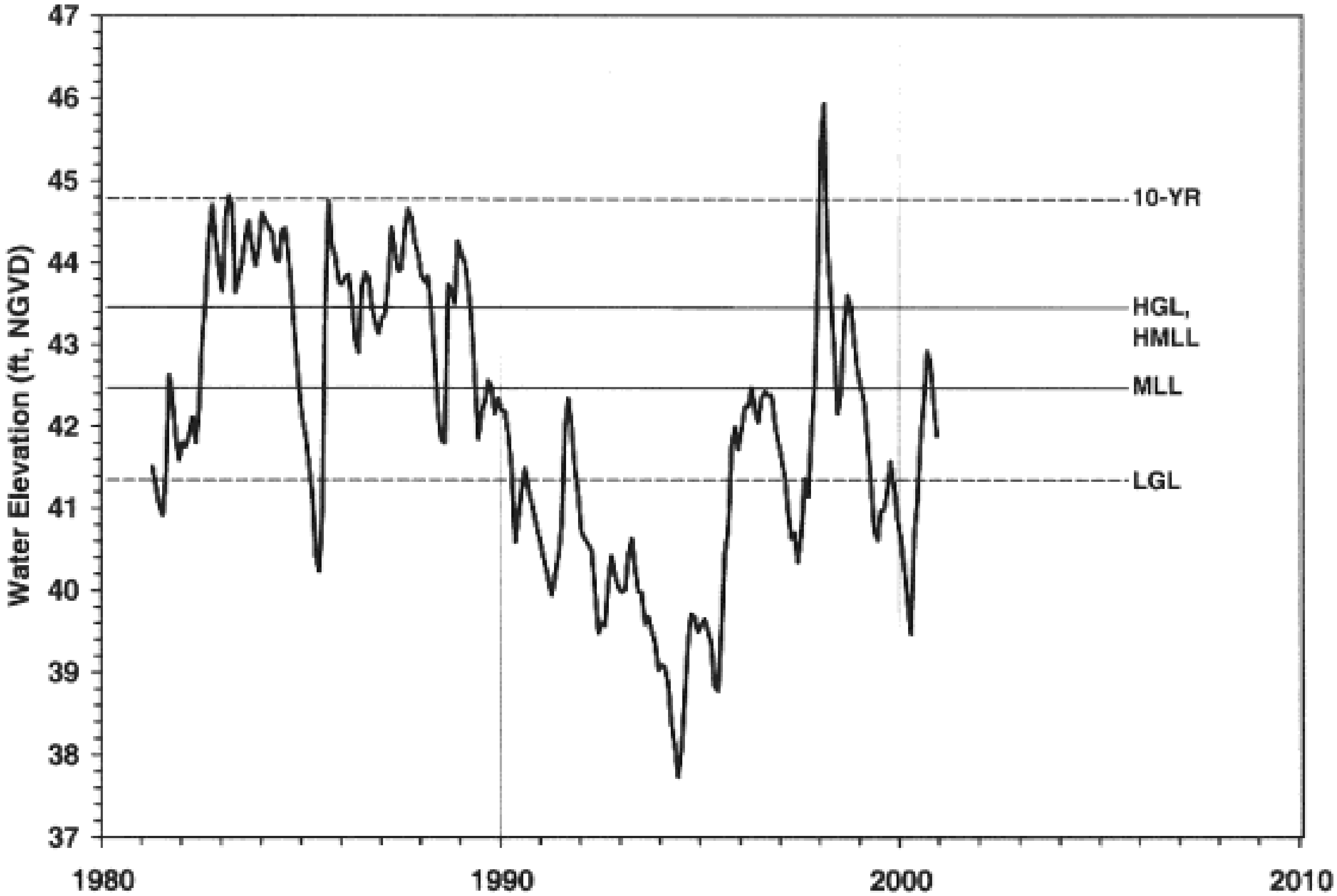
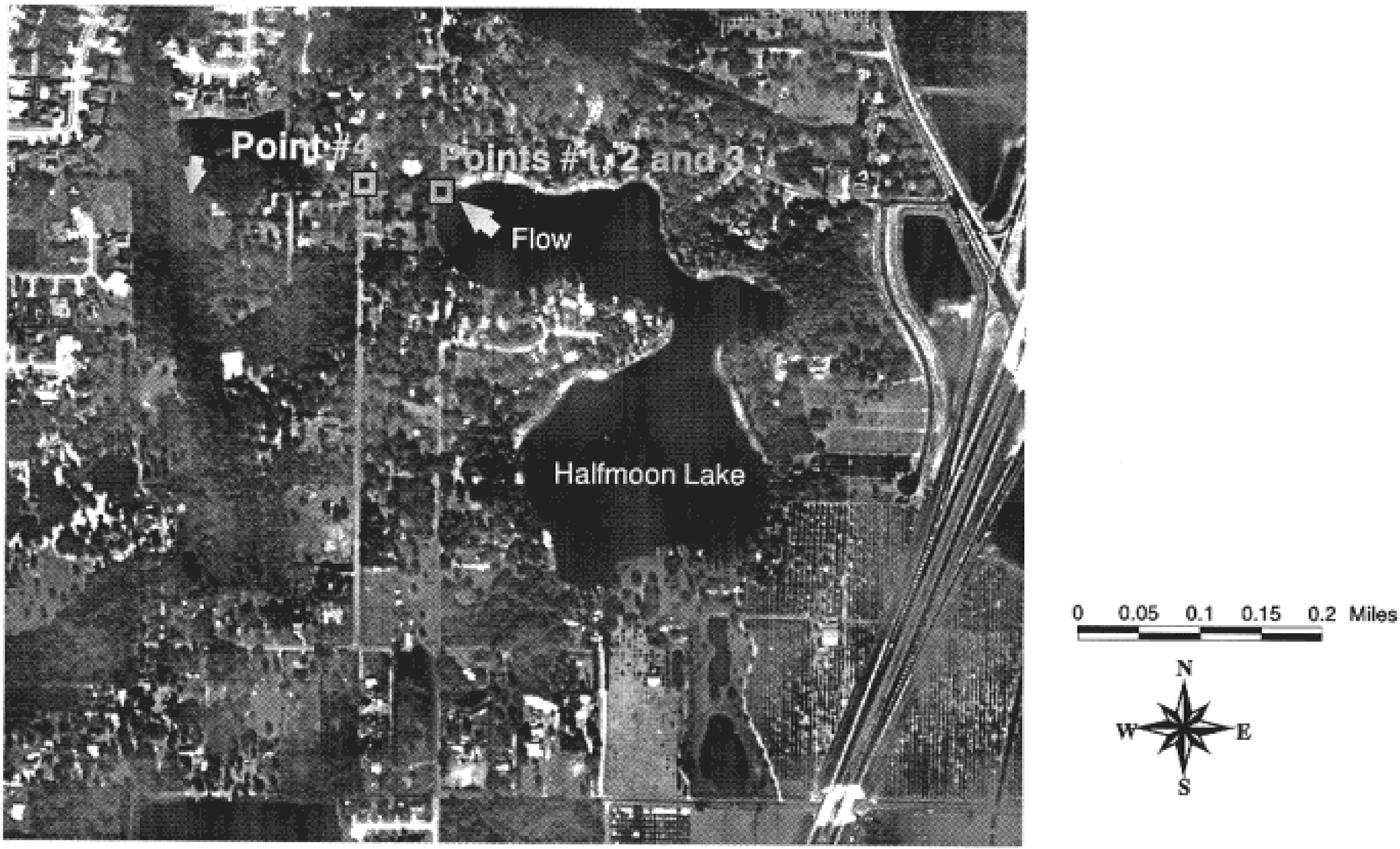


Figure 6-36. Outlet conveyance system for Halfmoon Lake, Hillsborough County, Florida. Numbered sites are described in Table 6-33.



Lakes Helen, Ellen and Barbara

General Lakes Description

Lakes Helen, Ellen and Barbara are located in the Northwest Hillsborough Basin in Hillsborough County, Florida (Section 19, Township 27S, Range 18E). The area surrounding the lake is categorized as the Land-O-Lakes subdivision of the Tampa Plain in the Ocala Uplift Physiographic District (Brooks 1981); a region of many lakes on a moderately thick plain of silty sand overlying Tampa Limestone. As part of the Florida Department of Environmental Protection's Lake Bioassessment/Regionalization Initiative, the area has been identified as the Keystone Lakes region; an area of numerous slightly acidic, low nutrient, and mostly clear-water lakes (Griffith *et al.* 1997).

Lakes Helen, Ellen and Barbara are connected via navigable canals. For the purpose of establishing minimum levels, the three basins, their interconnections (canals) and the large canal contiguous with the southern shore of Lake Helen are grouped together as the Lake Helen, Ellen and Barbara system. At the surface water elevation of 53 ft, NGVD, shown on the 1956 (photorevised 1987) 1:24,000 United States Geological Survey Citrus Park, Fla. quadrangle map, the lake system has an area of 28 acres. The Florida Lake Gazetteer (Shafer *et al.* 1986) lists the surface area of Lake Helen as 16 acres, Lake Ellen as 5 acres, and Lake Barbara as 2 acres at an elevation of 53 ft. Drainage area for the system is 0.18 square miles. No major inlets from other surface water features exist. The system drains to the west through an outlet on the northwest shore of Lake Helen, ultimately connecting through wetland systems to Rock Lake in the Rocky Creek drainage (Figure 6-37).

A detailed topographic map of the Lake Helen, Ellen and Barbara system basin (Figure 6-38) was developed for estimation of surface areas associated with various water level elevations. Data used for map production were obtained from field surveys and from 1:200 aerial photograph maps of the basin containing one-foot contour lines prepared using photogrammetric methods.

The District has not previously adopted management levels for Lakes Helen, Ellen or Barbara.

Proposed Minimum and Guidance Levels

Recommended Minimum and Guidance Levels for the Lake Helen, Ellen and Barbara system, a Category 3 Lake system, are listed in Table 6-34, along with area values for each water level. The Basin Connectivity, Species Richness, and Aesthetic Standards for the lake system are lower than the Historic P50 elevation, and were evaluated for development of minimum levels. The Basin Connectivity Standard, the most conservative of these standards, was used to establish the proposed Minimum Lake Level at 52.10 ft. The proposed Minimum Lake Level is 0.3 ft below the Historic P50 elevation. Lake area at the proposed Minimum Lake Level is about 99% of the area associated with the Historic P50 elevation. The proposed High Minimum Lake Level was established at 53.10 ft, an elevation corresponding to the Minimum Lake Level plus the RLWR50 (1.0 ft) for the northern Tampa Bay area. The proposed High Minimum Lake Level is 0.3 ft below the High Guidance Level and 2.5 ft lower than the Low Floor Slab elevation. Lake area at the proposed High Minimum Lake Level is about 99% of that at the High Guidance Level. Development of Guidance Levels is described in the following sub-section.

Table 6-34. Lake Helen, Ellen and Barbara System: Recommended Minimum and Guidance Levels with Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten-Year Flood Guidance Level	54.43	NA
High Guidance Level	53.37	28.4
High Minimum Lake Level	53.10	28.1
Minimum Lake Level	52.10	26.9
Low Guidance Level	51.27	25.9

NA = not available

Summary of Data and Analyses Supporting Recommended Minimum and Guidance Levels

Hydrologic data are available for Lake Helen for the period from February 1993 through the present (December 2000) (Figure 6-39; see Figure 6-37 for location of the District water level gauge). For the entire period of record, the hydrologic data are classified as Current data. These current data were used to calculate the Current P10, P50, P90 (Table 6-35). The Category 3 Lake Normal Pool elevation was established using cypress trees along the west shore of Lake Helen (Tables 6-35 and 6-36). The low floor slab and control point elevations were determined using available one-foot contour interval aerial maps, and field surveying (Tables 6-35 and 6-37, Figure 6-40). The Category 3 Lake Normal Pool elevation is above the control point, so the lake system is considered to be Structurally Altered.

Based on the relationship between the control point elevation, the Category 3 Lake Normal Pool elevation, and the Current P10, the High Guidance Level was established at the Current P10 elevation (Table 6-35). The Historic P50 and Low Guidance Level were determined using the High Guidance Level and the Northern Tampa Bay Region RLWR50 (1.0 ft) and RLWR90 (2.1 ft) (Table 6-35).

The Lake Helen, Ellen and Barbara system is not contiguous with any cypress-dominated wetlands of 0.5 of more acres in size and is therefore classified as a Category 3 Lake. The basin does contain abundant stands of cattail (*Typha* spp.), spatterdock (*Nuphar luteum*), panic grass (*Panicum* sp.), spikerush (*Eleocharis* sp.) and pickerelweed (*Pontedaria cordata*). The Dock-Use Standard was established at 52.95 ft, based on the Dock-End Sediment elevation of 49.85 ft, developed from measurements for 48 docks. The Basin Connectivity Standard was established at 52.1 ft, based on use of power boats in the lake, a critical high-spot elevation of 49.0 ft and the RLWR5090 for the northern Tampa Bay area (1.1 ft). The Species Richness Standard was established at 49.20 ft, based on a 15% reduction in lake surface area from that at the Historic P50 elevation. The Aesthetic-Standard was established at the Low Guidance Level elevation of 51.27 ft. Development of a Recreation/Ski Standard is not appropriate, based on the size of the lake system. Review of the dynamic ratio for lake stages bounded by the Current P10 and Current P90 elevations did not indicate that potential changes in basin susceptibility to wind-induced sediment resuspension would be of concern for minimum levels development (Table 4-1, Figure 6-41). Changes in potential herbaceous wetland area and area of potential aquatic macrophyte colonization with lake stage also did not indicate that use of any of the identified standards would be inappropriate (Figure 6-41).

The Ten Year Flood Guidance Level (Table 6-34) was established for Lakes Helen, Ellen and Barbara using the methodology for open basin lakes described in Section 5 of this report. The District used an existing hydrologic and hydraulic computer model of the Rocky Creek Watershed developed by Hillsborough County (Hillsborough County 1998). The Rocky Creek runoff hydrographs were computed using the NRCS Dimensionless Unit Hydrograph, a 256 shape factor, a 10.0 inch rainfall depth, and a 24-hour rainfall distribution developed by the South Florida Water Management District. The Rocky Creek conveyance system was simulated with the Hillsborough County modified version of EXTRAN, and the hydrodynamic routing component of the Environmental Protection Agency's Stormwater Management Model (SWMM) v.4.31. District staff modified the EXTRAN input data developed by Hillsborough County to include additional surveyed elements of the Lake Helen outlet conveyance system. The initial elevation of Lakes Helen, Ellen and Barbara were set at the outlet control point elevation of 52.95 feet NGVD. The modified data set was then used to determine the 10-year flood level based on runoff hydrographs from the 10-year storm event.

Table 6-35. Lake Helen, Ellen and Barbara System: Summary of Elevation Data and Associated Area Values Used for Establishing Minimum Levels.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Current P10	53.37	28.4
Current P50	51.41	26.1
Current P90	49.82	24.1
Category 3 Lake Normal Pool	55.23	NA
Low Floor Slab	55.57	NA
Control Point	52.95	27.9
High Guidance Level	53.37 (Current P10)	28.4
Historic P50	52.37 (HGL - RLWR50)	27.3
Low Guidance Level	51.27 (HGL - RLWR90)	25.9
Dock-Use Standard	52.95	27.9
Basin Connectivity Standard	52.1	26.9
Species Richness Standard	49.20	23.2
Aesthetic Standard	51.27	25.9
Recreation/Ski Standard	NA	NA

NA = not available / not applicable

Table 6-36. Lake Helen, Ellen and Barbara System: Elevation Data Used for Establishing the Category 3 Lake Normal Pool Elevation. Data collected 11 March 1998; water level = 53.67 ft, NGVD.

Hydrologic Indicator	Height above Lake Water Level (ft)	Elevation (ft, NGVD)
Cypress buttress - normal pool	1.42	55.09
Cypress buttress - normal pool	1.83	55.50
Cypress buttress - normal pool	1.42	55.09
Mean	**1.56**	**55.23**

Table 6-37. Lake Helen , Ellen and Barbara: Summary of Structural Alteration / Control Point Elevation Information. Numbers correspond to those shown in Figure 6-40.

No.	Description	Elevation (ft, NGVD)
1	Control point: vegetated high point in channel	52.95
2	East end of 24" corrugated metal pipe under Lakeside Drive	51.95

Figure 6-37. Location of District lake gauge and outlet at Lakes Helen, Ellen and Barbara, Hillsborough County, Florida.

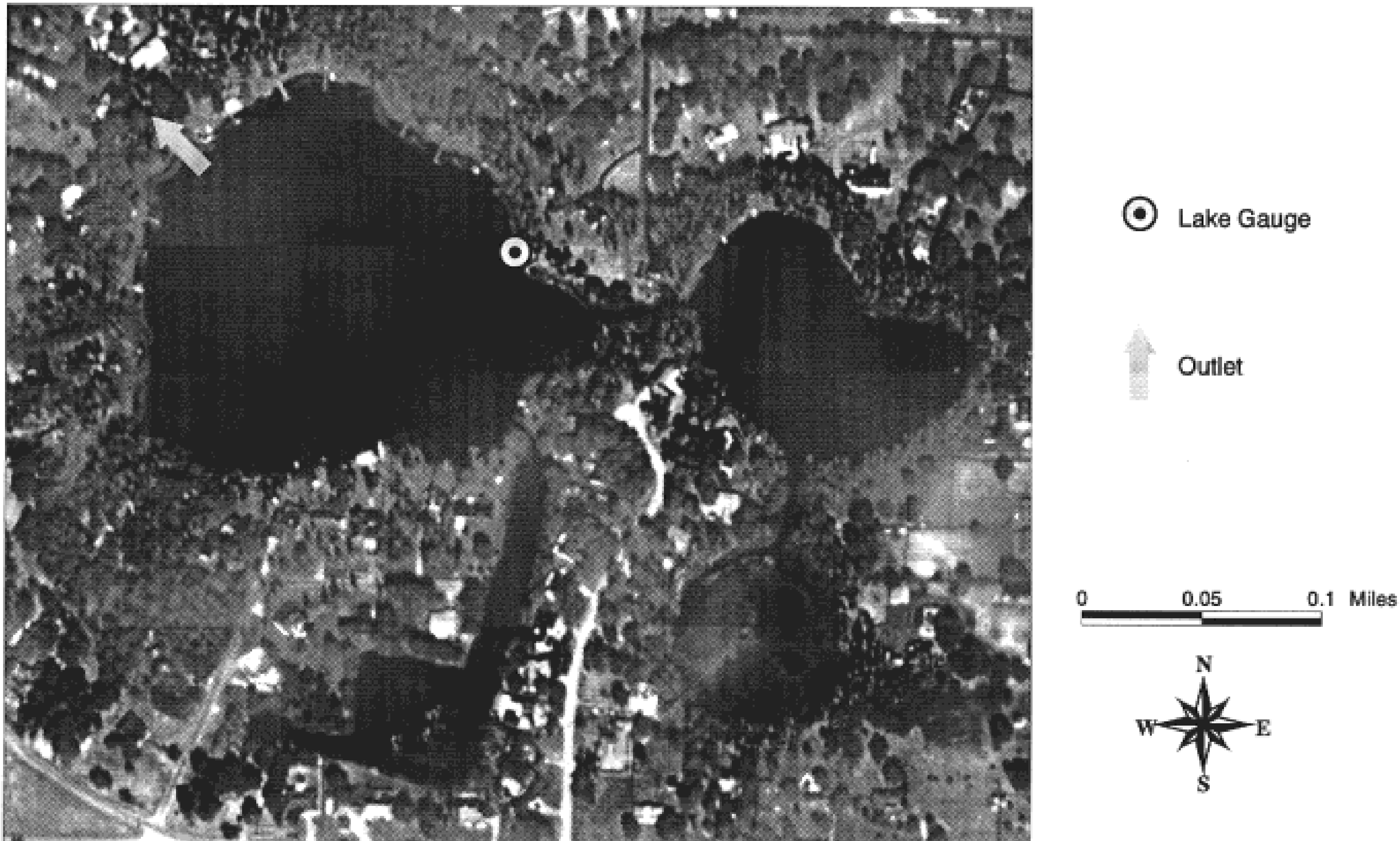


Figure 6-38. One-foot contour map of the Lake Helen, Lake Ellen and Lake Barbara basin, Hillsborough County, Florida. Values shown are elevations, in feet, above the National Geodetic Vertical Datum.

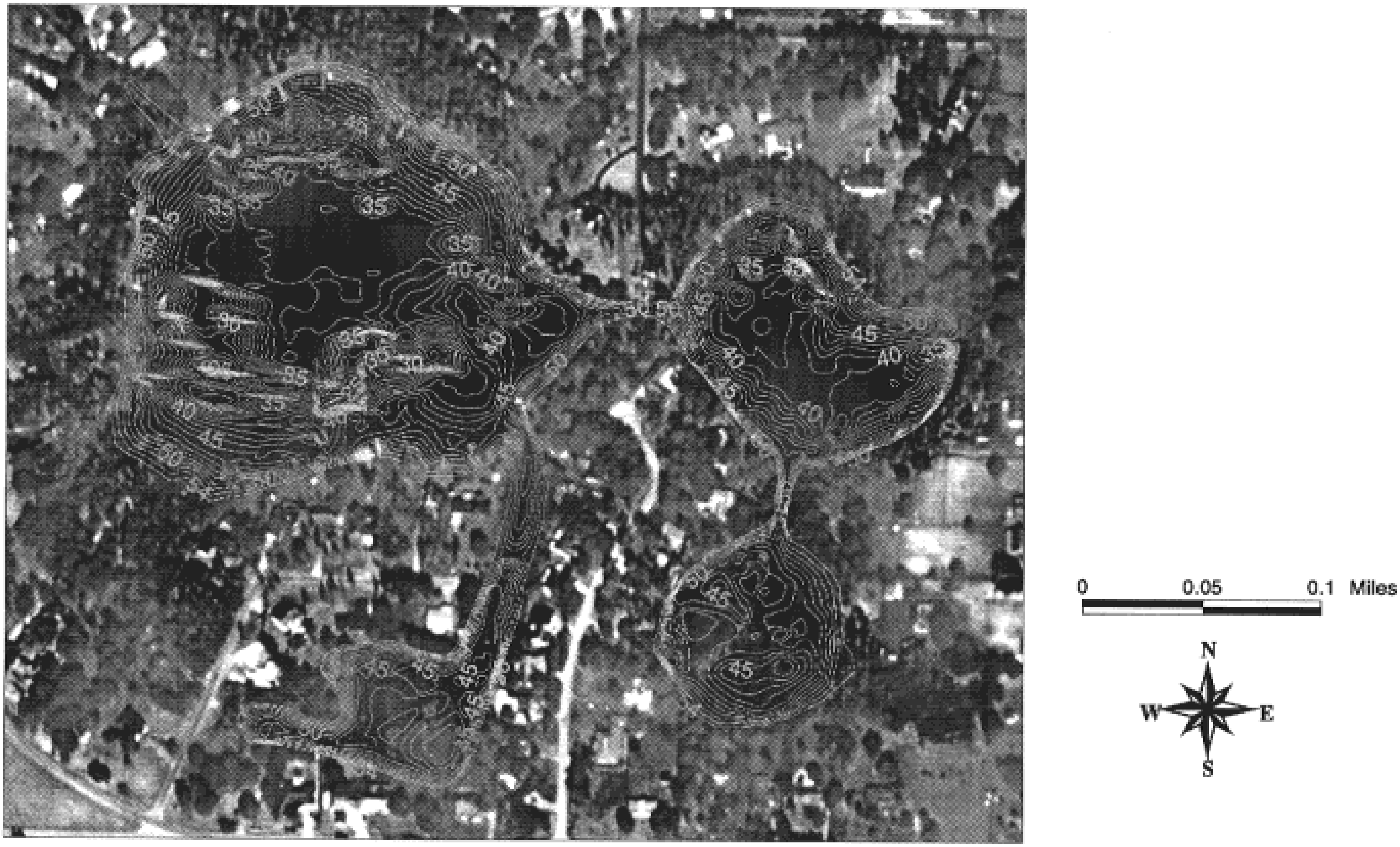


Figure 6-39 Mean monthly water elevations at Lakes Helen, Ellen and Barbara, Hillsborough County, Florida. Proposed High Minimum Lake Level (HMLL), Minimum Lake Level (MLL), Ten-Year Flood Guidance Level (10-YR), High Guidance Level (HGL), and Low Guidance Level (LGL) are shown as solid or dashed lines.

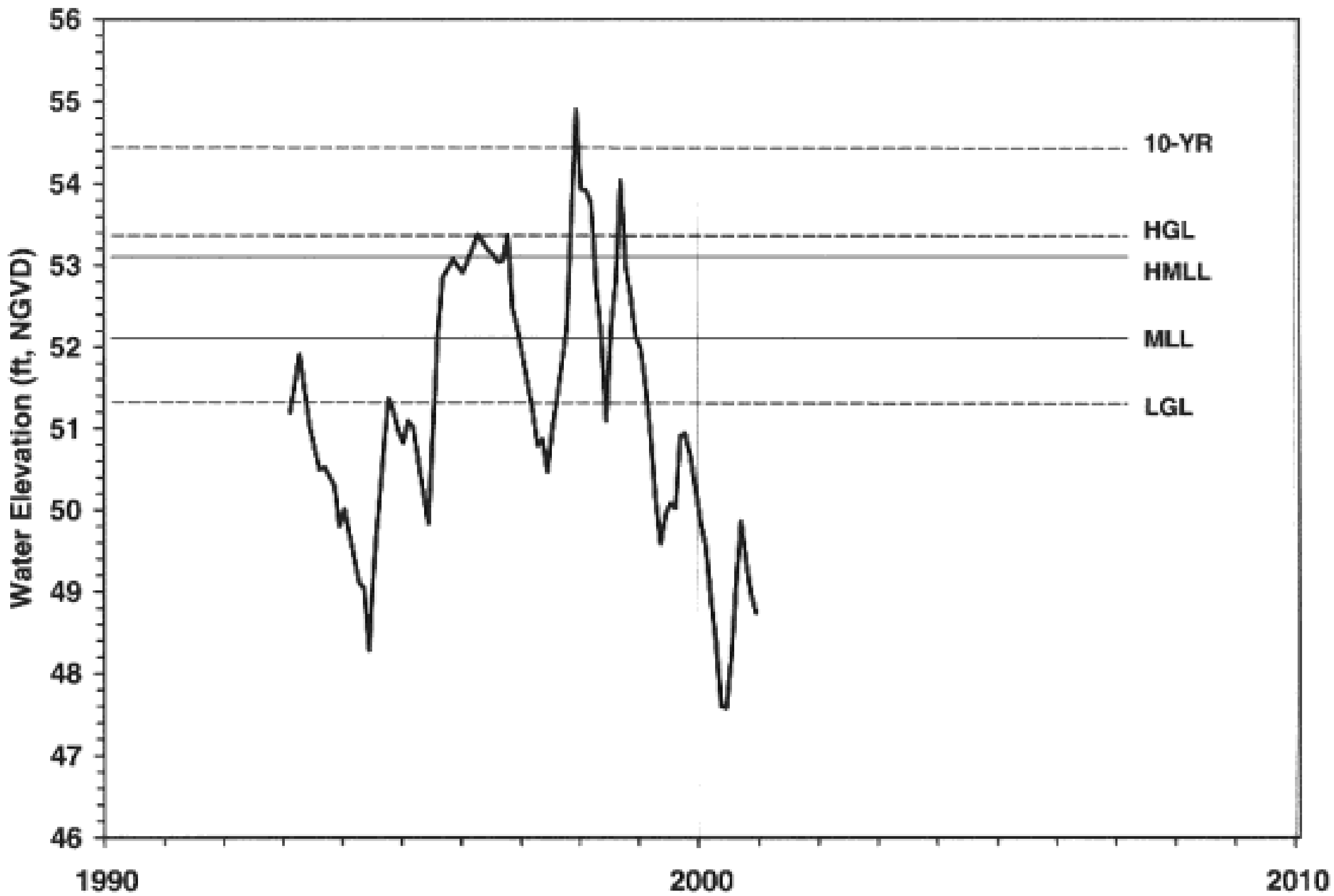
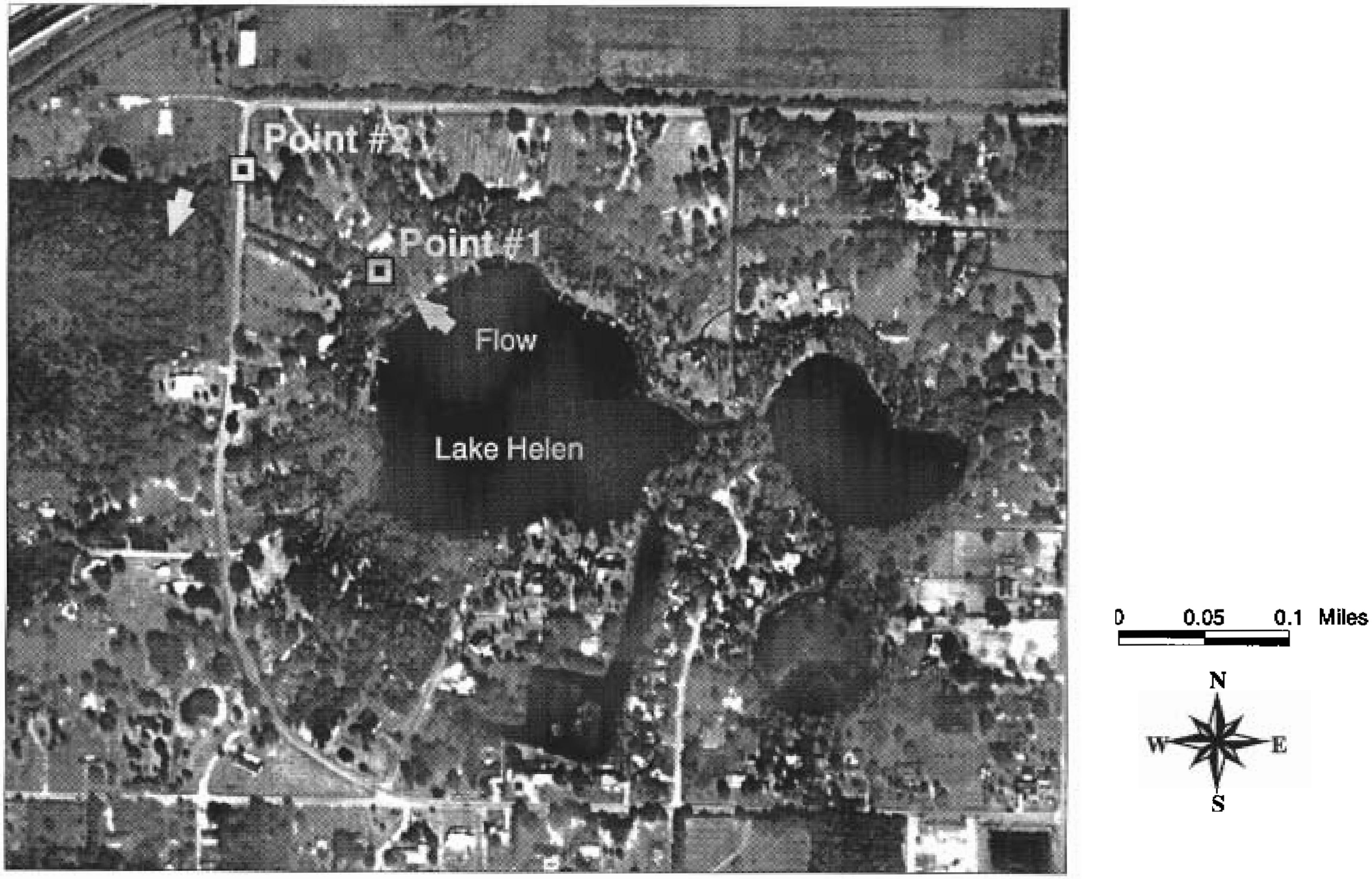
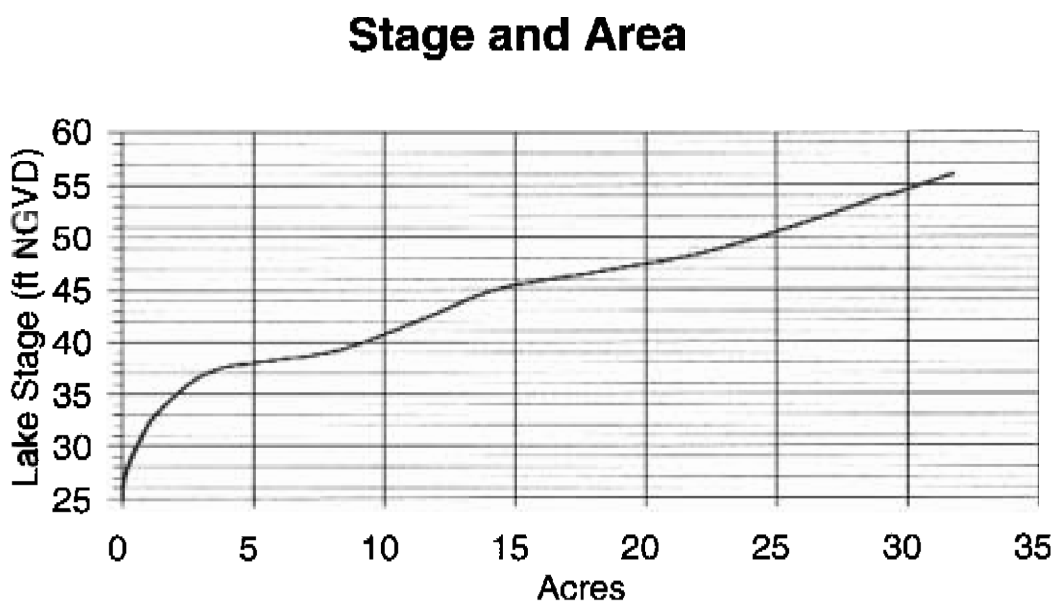


Figure 6-40. Outlet conveyance system for Lakes Helen, Ellen and Barbara, Hillsborough County, Florida. Numbered sites are described in Table 6-37.



6-41. Surface area, volume, potential herbaceous wetland area, area potentially colonized by aquatic macrophytes, and dynamic ratio versus lake stage for Lakes Helen, Ellen and Barbara, Hillsborough County, Florida.



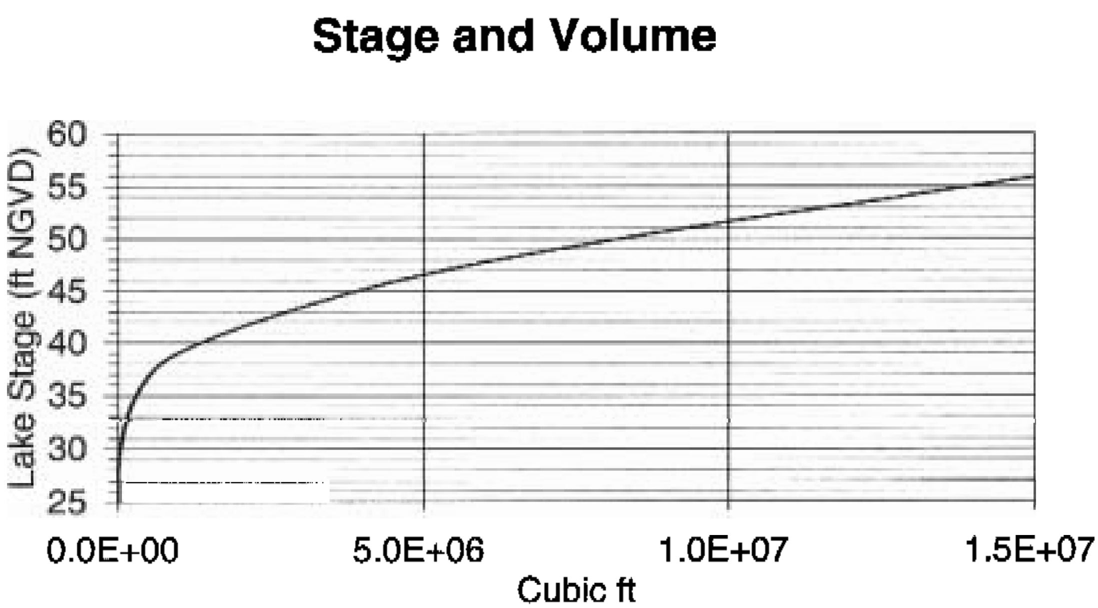
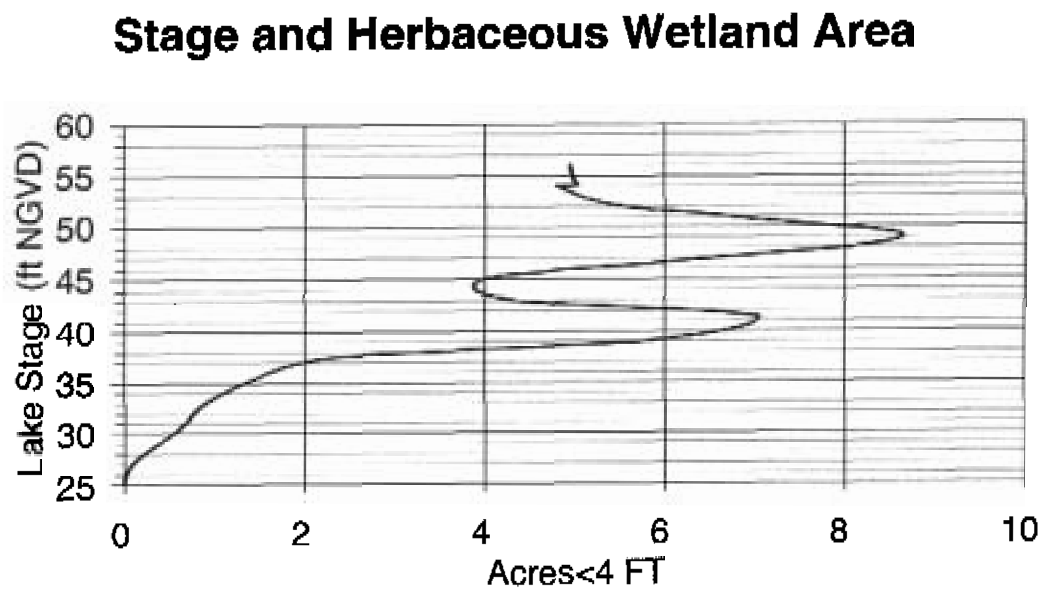


Figure 6-41. (Continued).



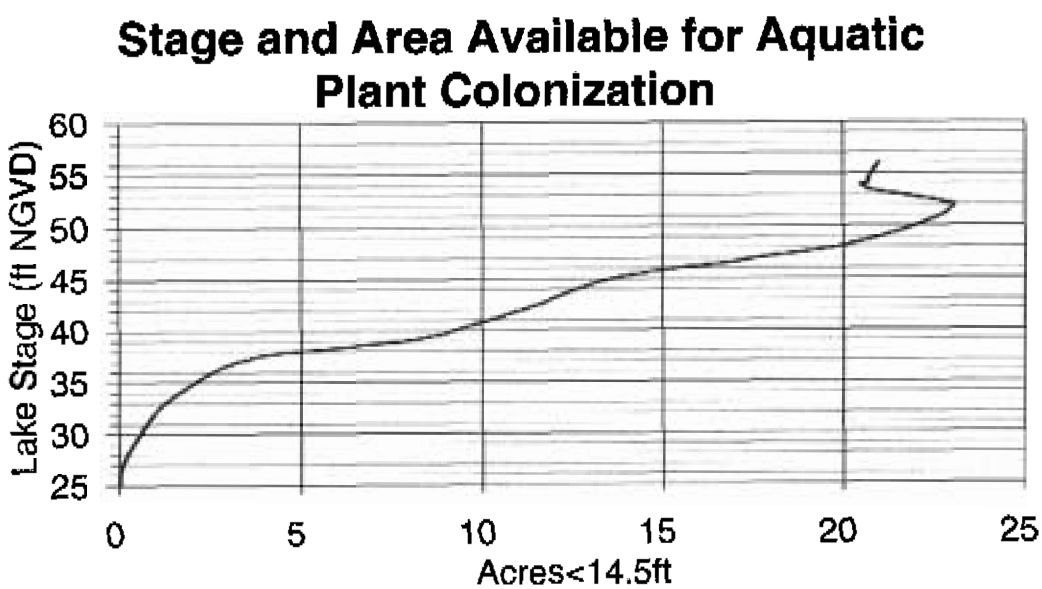
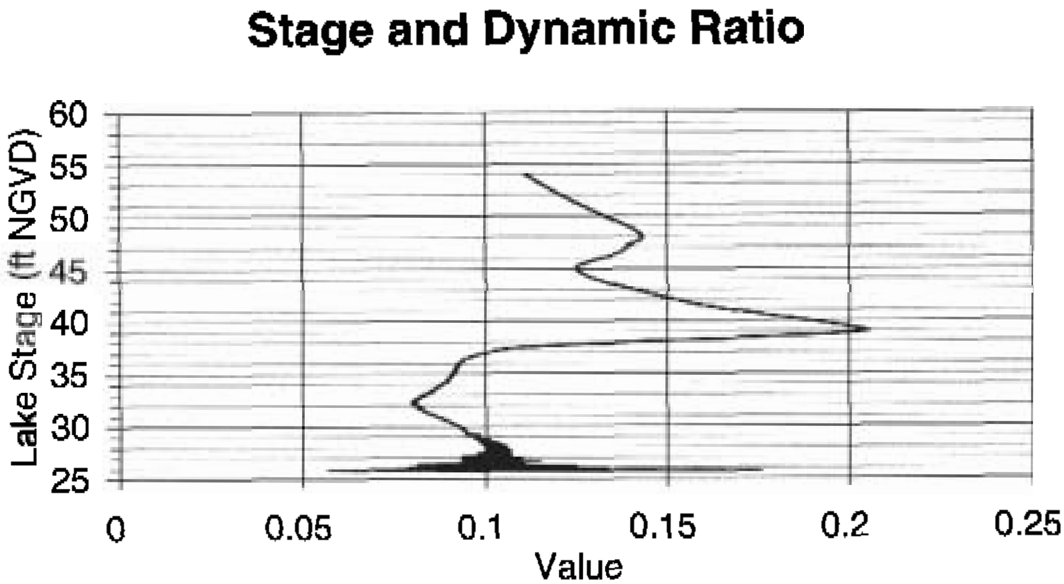


Figure 6-41. (Continued).



Lake Hobbs

General Lake Description and Previously Adopted Lake Management Levels

Lake Hobbs is located in the Northwest Hillsborough Basin in Hillsborough County, Florida (Sections 1,2, 11 and 12, Township 27S, Range 18E). The area surrounding the lake is categorized as the Land-O-Lakes subdivision of the Tampa Plain in the Ocala Uplift Physiographic District (Brooks 1981); a region of many lakes on a moderately thick plain of silty sand overlying Tampa Limestone. As part of the Florida Department of Environmental Protection's Lake Bioassessment/Regionalization Initiative, the area has been identified as the Land-O-Lakes lake region; an area of numerous neutral to slightly alkaline, low to moderate nutrient, clear-water lakes (Griffith *et al.* 1997).

A surface water elevation of 64 ft, NGVD is shown on the 1974 United States Geological Survey (photorevised 1987) 1:24,000 Lutz, Fla. quadrangle map; a level corresponding to a surface area of approximately 69 acres. The Florida Lake Gazetteer (Shafer *et al.* 1986) lists the lake surface area as 67 acres for an elevation of 65 ft. The drainage area for the lake is 0.92 square miles. During periods of high water, the lake receive input through a wetland along the north shore between Lake Hobbs and Little Deer lake. An outlet located in a small embayment along the lake's southern shore drains the lake to Cooper Lake (Figure 6-42).

A detailed topographic map of the Lake Hobbs basin (Figure 6-43) was developed for estimation of surface areas associated with various water level elevations. Data used for map production were obtained from field surveys and 1:200 aerial photograph maps of the basin containing one-foot contour lines prepared using photogrammetric methods.

Based on field surveys conducted in 1977, the Governing Board adopted management levels (currently referred to as Guidance Levels) for the lake in September 1980 (Table 6-38).

Table 6-38. Lake Hobbs: Adopted Lake Levels (09 September 1980) and Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten Year Flood Guidance Level	68.20	NA
High Level	66.75	NA
Low Level	63.25	67.59
Extreme Low Level	61.50	64.16

NA = not available

Proposed Minimum and Guidance Levels

Recommended Minimum and Guidance Levels for Lake Hobbs, a Category 2 Lake, are listed in Table 6-39, along with area values for each water level. The Minimum Lake Level was established at the Historic P50 elevation at 64.61 ft. The proposed High Minimum Lake Level was established at the High Guidance Level at 65.61 ft. The proposed High Minimum Lake Level is 0.85 ft below the Low Floor Slab elevation. Development of Guidance Levels is described in the following sub-section.

Table 6-39. Lake Hobbs: Recommended Minimum and Guidance Levels with

Level	**Elevation (ft, NGVD)**	**Total Lake Area (acres)**
Ten-Year Flood Guidance Level	67.74	NA
High Guidance Level	65.61	84.61
High Minimum Lake Level	65.61	84.61
Minimum Lake Level	64.61	70.42
Low Guidance Level	63.51	68.19

NA = not available

Summary of Data and Analyses Supporting Recommended Minimum and Guidance Levels

Hydrologic data are available for Lake Hobbs for the period from June 1946 through the present (December 2000) (Figure 6-44; see Figure 6-42 for location of the District water level gauge). A review of these data indicated that data collected prior to 1963, a period pre-dating impacts from withdrawals in the region, did not fit the criteria for classification as Historic data. Data from January 1974 to the present were, however, classified as Current data. The Normal Pool elevation was established using cypress trees within a swamp contiguous with the northeastern shore of the lake (Tables 6-40 and 6-41, Figure 6-42). The low floor slab and control point elevations were determined using available one-foot contour interval aerial maps, and field surveying (Tables 6-40 and 6-42, Figure 6-45). The Normal Pool elevation is above the control point elevation, so the lake is considered to be Structurally Altered

Based on relative elevations of the control point, the Normal Pool elevation, and the Current P10, the High Guidance Level was established at the Current P10 elevation (Table 6-40). The Historic P50 and Low Guidance Level were determined using the High Guidance Level and the Northern Tampa Bay Region RLWR50 (1.0 ft) and

RLWR90 (2.1 ft) (Table 6-40).

Lake Hobbs is contiguous with cypress-dominated wetlands of more than 0.5 acres in size. The lake is classified as a Category 2 Lake because the elevation 1.8 feet below the Normal Pool elevation (65.13 ft) is greater than the Historic P50 elevation.

The Ten Year Flood Guidance Level (Table 6-39) was established for Lake Hobbs using the methodology for open basin lakes described in Sections 5 of this report. The District used an existing hydrologic and hydraulic computer model of the Rocky Creek Watershed developed by Hillsborough County (Hillsborough County 1998). The Rocky Creek runoff hydrographs were computed using the NRCS Dimensionless Unit Hydrograph, a 256 shape factor, a 10.0 inch rainfall depth, and a 72-hour rainfall distribution developed by the South Florida Water Management District. The Rocky Creek conveyance system was simulated with the Hillsborough County modified version of EXTRAN, and the hydrodynamic routing component of the Environmental Protection Agency's Stormwater Management Model (SWMM) v.4.31. District staff modified the EXTRAN input data developed by Hillsborough County to include additional surveyed elements of the Lake Hobbs outlet conveyance system. The initial elevation of Lake Hobbs was set at the outlet control point elevation of 65.19 feet NGVD. The modified data set was then used to determine the 10-year flood level based on runoff hydrographs from the 10-year storm event.

Table 6-40. Lake Hobbs: Summary of Elevation Data and Associated Area Values Used for Establishing Minimum Levels.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Current P10	65.61	84.61
Current P50	62.72	66.59
Current P90	60.38	62.09
Normal Pool	66.93	NA
Low Floor Slab	66.46	NA
Control Point	65.19	83.22
High Guidance Level	65.61 (Current P10)	84.61
Historic P50	64.61 (HGL - RLWR50)	70.42
Low Guidance Level	63.51 (HGL - RLWR90)	68.19

Table 6-41. Lake Hobbs: Elevation Data Used for Establishing the Normal Pool Elevation. Data collected 30 March, 1998; water level = 66.25 ft, NGVD, or 13 December, 2000*; water level = 60.64 ft, NGVD.

Hydrologic Indicator	Height above Lake Water Level (ft)	Elevation (ft, NGVD)
Cypress buttress - normal pool	0.75	67.0
Cypress buttress - normal pool	0.67	66.92
Cypress buttress - normal pool	0.83	67.08
Cypress buttress - normal pool	6.15*	66.79*
Cypress buttress - normal pool	6.48*	67.12*
Cypress buttress - normal pool	6.02*	66.66*
Cypress buttress - normal pool	5.87*	66.51*
Cypress buttress - normal pool	6.54*	67.18*
Cypress buttress - normal pool	6.55*	67.19*
Cypress buttress - normal pool	6.60*	67.24*
Cypress buttress - normal pool	6.30*	66.94*
Cypress buttress - normal pool	5.90*	66.54*
Mean	**NA**	**66.93**

NA = not applicable; data collected on dates with differing water level elevation.

Table 6-42. Lake Hobbs: Summary of Structural Alteration / Control Point Elevation Information. Numbers correspond to those shown in Figure 6-45.

No.	Description	Elevation (ft, NGVD)
1	Control point: high point in channel	65.19
2	West end of 36" reinforced concrete pipe under Calvin Lane	64.13
3	South end of 48' X 30" elliptical reinforced concrete pipe under Lake Fern Road	61.74

Figure 6-42. Location of District lake gauge, outlet and site where hydrologic indicators of high water level were measured at Lake Hobbs, Hillsborough County, Florida.

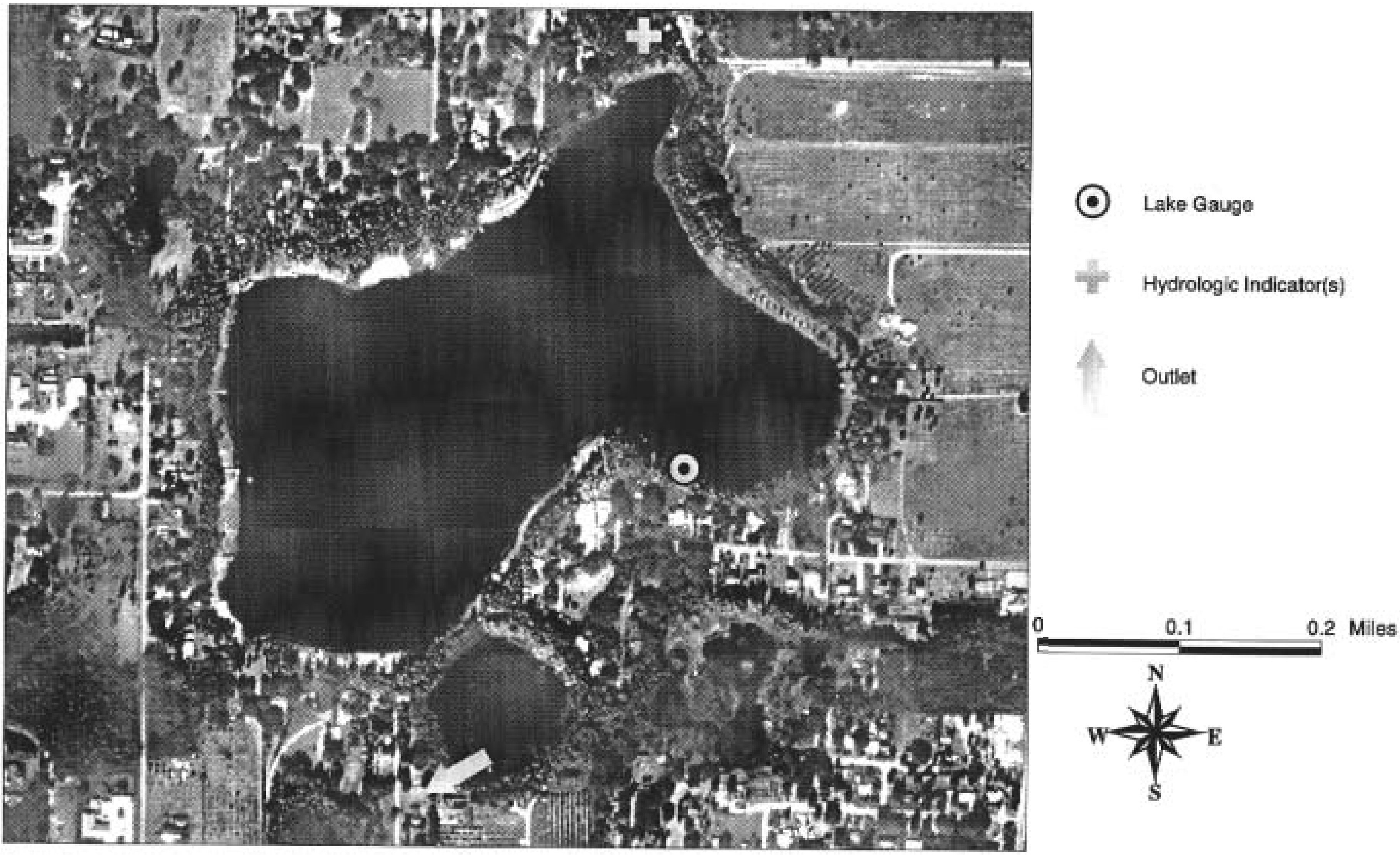


Figure 6-43. One-foot contour map of the Lake Hobbs basin, Hillsborough County, Florida. Values shown are elevation, in feet above the National Geodetic Vertical Datum.

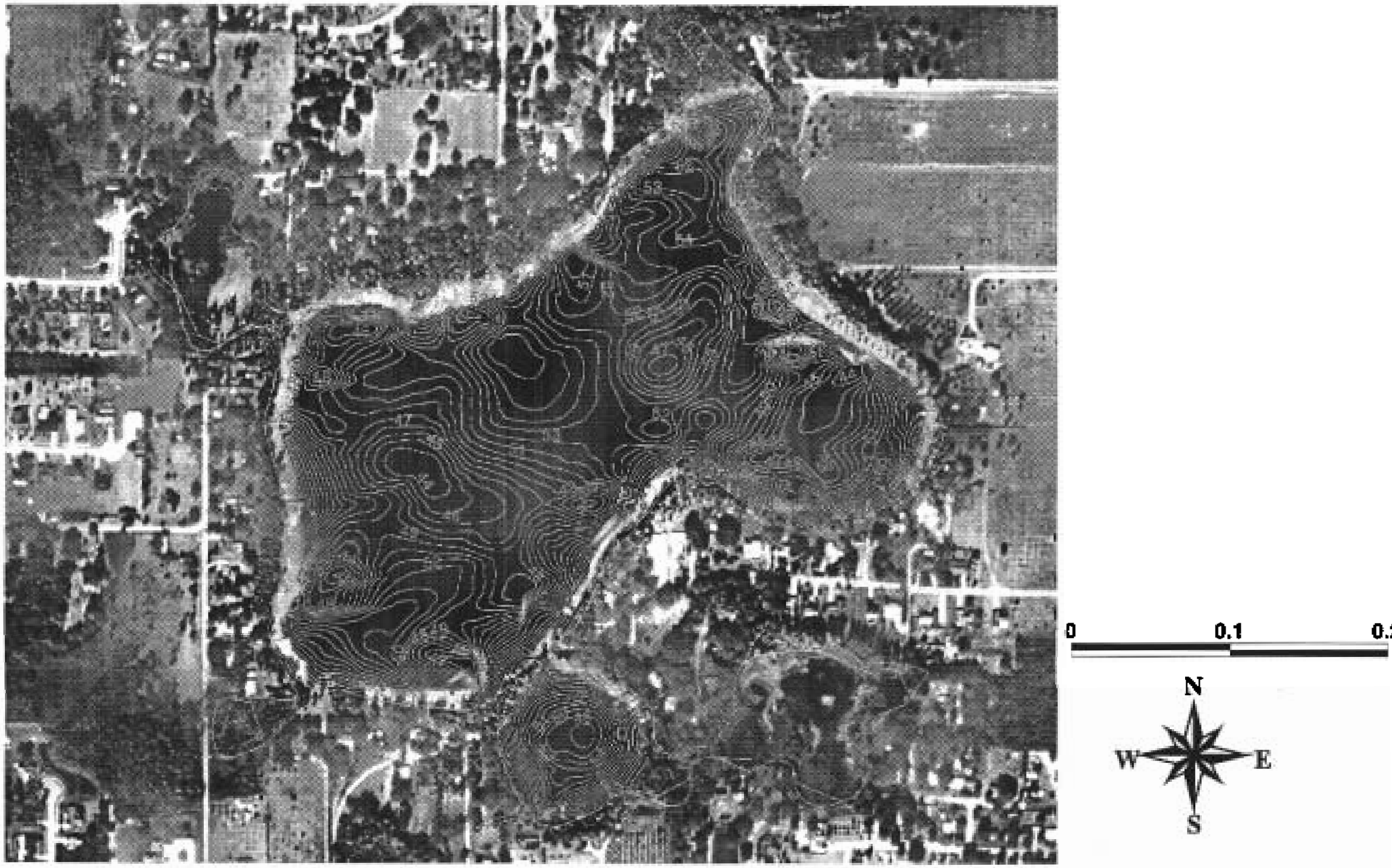


Figure 6-44. Mean monthly water elevations at Lake Hobbs, Hillsborough County, Florida. Proposed High Minimum Lake Level (HMLL), Minimum Lake Level (MLL), Ten-Year Flood Guidance Level (10-YR), High Guidance Level (HGL), and Low Guidance Level (LGL) are shown as solid or dashed lines.

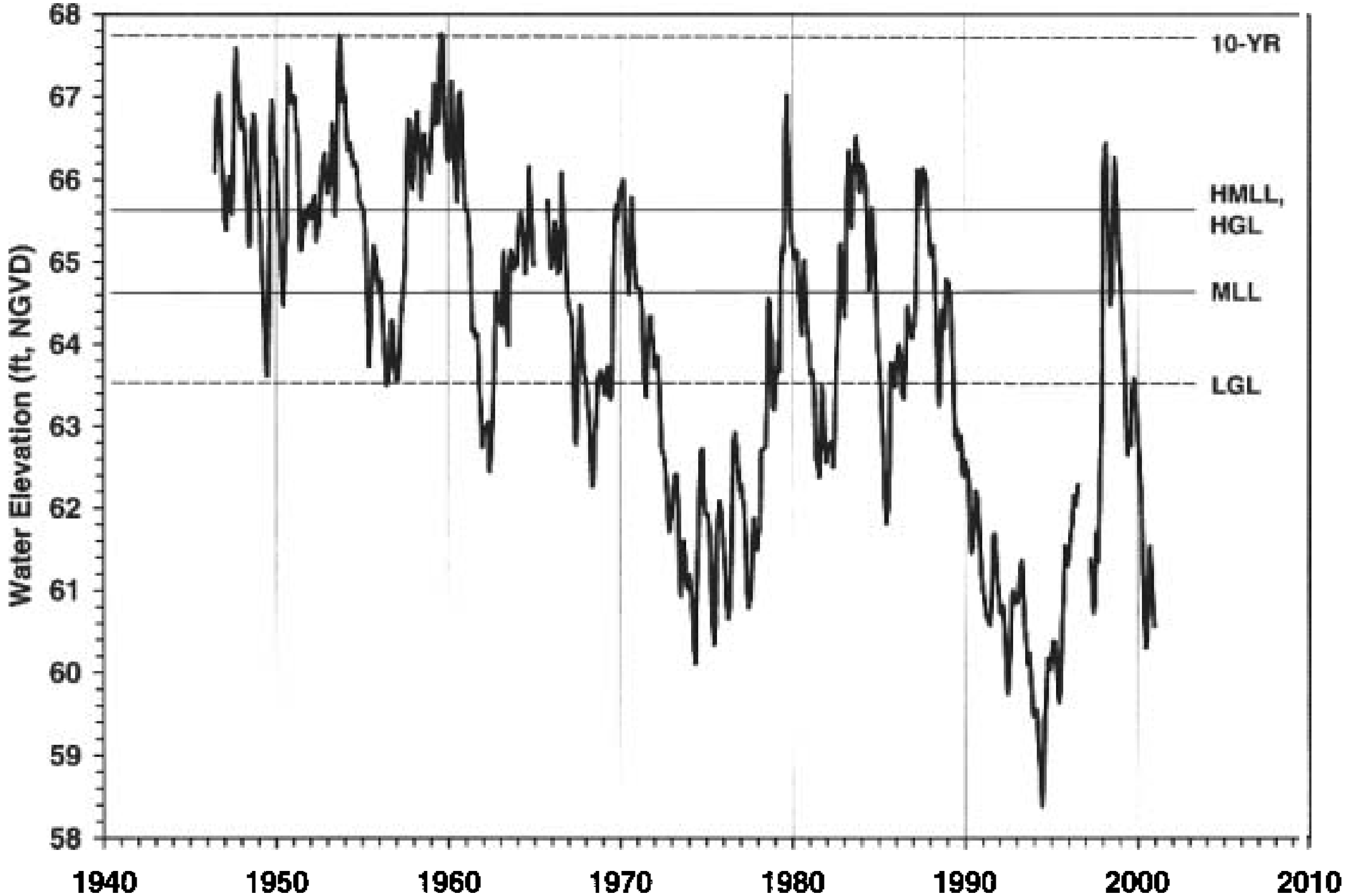
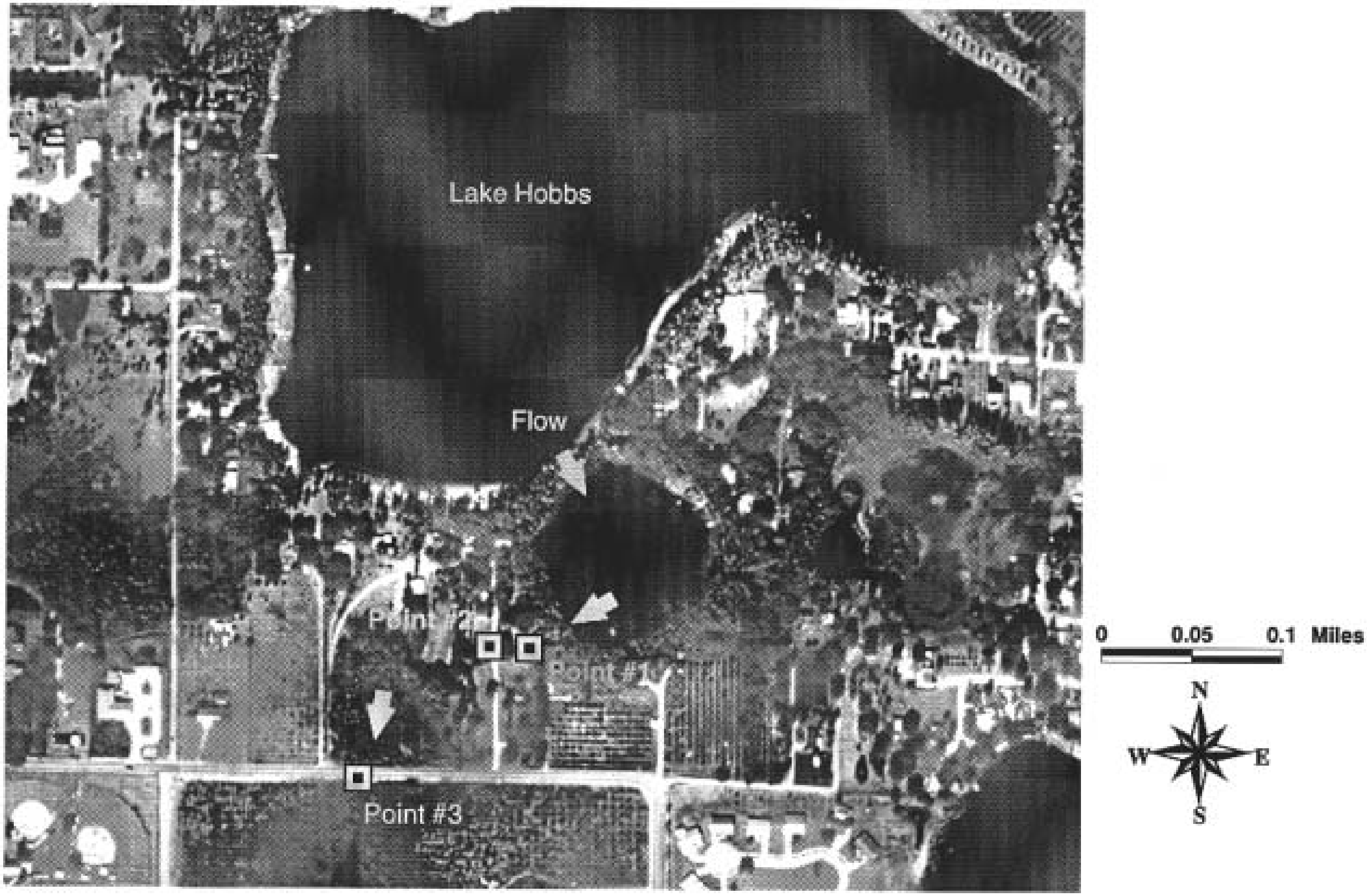


Figure 6-45. Outlet conveyance system for Lake Hobbs, Hillsborough County, Florida. Numbered sites are described in Table 6-42.



Lake Raleigh

General Lake Description and Previously Adopted Lake Management Levels

Lake Raleigh is located in the Northwest Hillsborough Basin in Hillsborough County, Florida (Sections 26 and 27, Township 27S, Range 17E). The area surrounding the lake is categorized as the Land-O-Lakes subdivision of the Tampa Plain in the Ocala Uplift Physiographic District (Brooks 1981); a region of many lakes on a moderately thick plain of silty sand overlying Tampa Limestone. As part of the Florida Department of Environmental Protection's Lake Bioassessment/Regionalization Initiative, the area has been identified as the Keystone Lakes region; an area of numerous slightly acidic, low nutrient, and mostly clear-water lakes (Griffith *et al.* 1997).

The United States Geological Survey 1956 (photorevised 1987) 1:24,000 Citrus Park, Fla. quadrangle map indicates a water level elevation of 38 ft, NGVD, a level corresponding to an area of 23 acres. The Florida Lake Gazetteer (Shafer *et al.* 1986) lists a lake area of 24 acres at this elevation. The lake has no outlet (Figure 6-46).

A detailed topographic map of the Lake Raleigh basin (Figure 6-47) was developed for estimation of surface areas associated with various water level elevations. Data used for map production were obtained from field surveys and 1:200 aerial photograph maps of the basin containing one-foot contour lines prepared using photogrammetric methods.

Based on field surveys conducted in 1977, the Governing Board adopted management levels (currently referred to as Guidance Levels) for the lake in September 1980 (Table 6-43).

Table 6-43. Lake Raleigh: Adopted Guidance Levels (09 September 1980) and Associated Area Values.

Level	Elevation (ft, NGVD)v	Total Lake Area (acres)
Ten Year Flood Guidance Level	43.30	33.1
High Level	42.50	30.9
Low Level	38.00	23.0
Extreme Low Level	35.00	18.3

Proposed Minimum and Guidance Levels

Recommended Minimum and Guidance Levels for Lake Raleigh, a Category 3 Lake, are listed in Table 6-44, along with area values for each water level. The Basin Connectivity, Species Richness, Aesthetic and Recreation/Ski Standards for the lake are lower than the Historic P50 elevation, and were evaluated for development of minimum levels. The Aesthetic Standard, the most conservative of these standards, was used to establish the proposed Minimum Lake Level at 42.82 ft. The proposed Minimum Lake Level is 1.1 ft below the Historic P50 elevation. Lake area at the proposed Minimum Lake Level is about 91% of the area associated with the Historic P50 elevation. The proposed High Minimum Lake Level was established at 43.82 ft, an elevation corresponding to the Minimum Lake Level plus the RLWR50 (1.0 ft) for the northern Tampa Bay area. The proposed High Minimum Lake Level is 1.1 ft below the High Guidance Level and about 3.2 ft lower than the Low Floor Slab elevation. Lake area at the proposed High Minium Level is about 90% of that associated with the High Guidance Level. Development of Guidance Levels is described in the following sub-section.

Table 6-44. Lake Raleigh: Recommended Minimum and Guidance Levels with Associated Area Values.

Level	**Elevation (ft, NGVD)**	**Total Lake Area (acres)**
Ten-Year Flood Guidance Level	45.80	NA
High Guidance Level	44.92	38.5
High Minimum Lake Level	43.82	34.6
Minimum Lake Level	42.82	31.6
Low Guidance Level	42.82	31.6

Summary of Data and Analyses Supporting Recommended Minimum and Guidance Levels

Hydrologic data are available for Lake Raleigh for the period from September 1930 through the present (December 2000) (Figure 6-48; see Figure 6-46 for location of the District water level gauge). For the period from January 1964 to the present, the data are classified as Current data. These data were used to calculate the Current P10, P50, P90 (Table 6-45). The Category 3 Lake Normal Pool elevation (Table 6-45) was established using cypress (*Taxodium* spp.) trees along the east shore of the lake (Table

6-46, Figure 6-46). The low floor slab elevation was established based on a field survey (Tables 6-45 and 6-47, Figure 6-46). There are no surface outlets from Lake Raleigh, so a control point elevation was not established.

Based on the relationship between the Category 3 Lake Normal Pool elevation and the Current P10, the High Guidance Level was established at the Category 3 Lake Normal Pool elevation (Table 6-45). The Historic P50 and Low Guidance Level were determined using the High Guidance Level and the Northern Tampa Bay Region RLWR50 (1.0 ft) and RLWR90 (2.1 ft) (Table 6-45).

Lake Raleigh is not contiguous with any cypress-dominated wetlands of 0.5 of more acres in size and is therefore classified as a Category 3 Lake. The basin does contain sizable stands of maidencane (*Panicum hemitomum*), rush fuirena (*Fuirena scirpoidea*) and other wetland vegetation. No docks are located at the lake, so development of a Dock-Use Standard is not appropriate. The Basin Connectivity Standard was established at 37.6 ft, based on use of power boats in the lake, a critical high-spot elevation of 34.5 ft and the RLWR5090 for the northern Tampa Bay area (1.1 ft). The Species Richness Standard was established at 42.0 ft, based on a 15% reduction in lake surface area from that at the Historic P50 elevation. The Aesthetic-Standard was established at the Low Guidance Level elevation of 42.82 ft. The Recreation/Ski Standard was established at 46.1 ft, based on a critical ski elevation of 45.0 ft and the RLWR5090 for the northern Tampa Bay area (1.1 ft). Review of the dynamic ratio for lake stages bounded by the Current P10 and Current P90 elevations did not indicate that potential changes in basin susceptibility to wind-induced sediment resuspension would be of concern for minimum levels development (Table 4-1, Figure 6-50). Changes in potential herbaceous wetland area and area of potential aquatic macrophyte colonization with lake stage also did not indicate that use of any of the identified standards would be inappropriate (Figure 6-50).

The Ten Year Flood Guidance Level (Table 6-44) was established for Lakes Raleigh using the methodology for closed basin lakes described in Section 5 of this report. The closed basin criteria were selected because Lake Raleigh has no positive outfall. Lake stage in the basin appears to be impacted after 1961 by groundwater withdraws from the Cosme well field. In accordance with the methodology, the 10-year flood level was based on a frequency analysis of the lake stage record from 1930 to 1961. A frequency analysis on stages beyond 1961 would have lowered the 10-year flood level as a result of using lake stages impacted by groundwater withdrawals.

Table 6-45. Lake Raleigh: Summary of Elevation Data and Associated Area Values Used for Establishing Minimum Levels.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Current P10	40.37	26.7
Current P50	37.40	22.1
Current P90	30.65	12.4
Category 3 Lake Normal Pool	44.92	38.5
Low Floor Slab	47.05	NA
Control Point	NA	NA
High Guidance Level	44.92 (Category 3 Lake Normal Pool)	38.5
Historic P50	43.92 (HGL - RLWR50)	34.9
Low Guidance Level	42.82 (HGL - RLWR90)	31.6
Dock-Use Standard	NA	NA
Basin Connectivity Standard	37.60	22.4
Species Richness Standard	42.00	29.7
Aesthetic Standard	42.82	31.6
Recreation/Ski Standard	46.10	NA

Table 6-46. Lake Raleigh: Elevation Data Used for Establishing the Category 3 Lake Normal Pool Elevation. Data collected on 01 June 1998; water level = 38.10 ft, NGVD.

Hydrologic Indicator	Height above Lake Water Level (ft)	Elevation (ft, NGVD)
Cypress buttress - normal pool	6.76	44.86
Cypress buttress - normal pool	6.90	45.00
Cypress buttress - normal pool	6.80	44.90
Cypress buttress - normal pool	6.67	44.77
Cypress buttress - normal pool	7.04	45.14
Cypress buttress - normal pool	6.74	44.84
Mean	**6.82**	**44.92**

Table 6-47. Lake Raleigh: Summary of Structural Alteration / Control Point Elevation Information. Numbers correspond to those shown in Figure 6-49.

No.	Description	Elevation (ft, NGVD)
1	East end of 24" reinforced concrete pipe under Gunn Highway	46.3
2	Natural ground between Lakes Raleigh and Rodgers	42.3

Figure 6-46. Location of District lake gauge and site where hydrologic indicators of high water level were measured at Lake Raleigh, Hillsborough County, Florida.

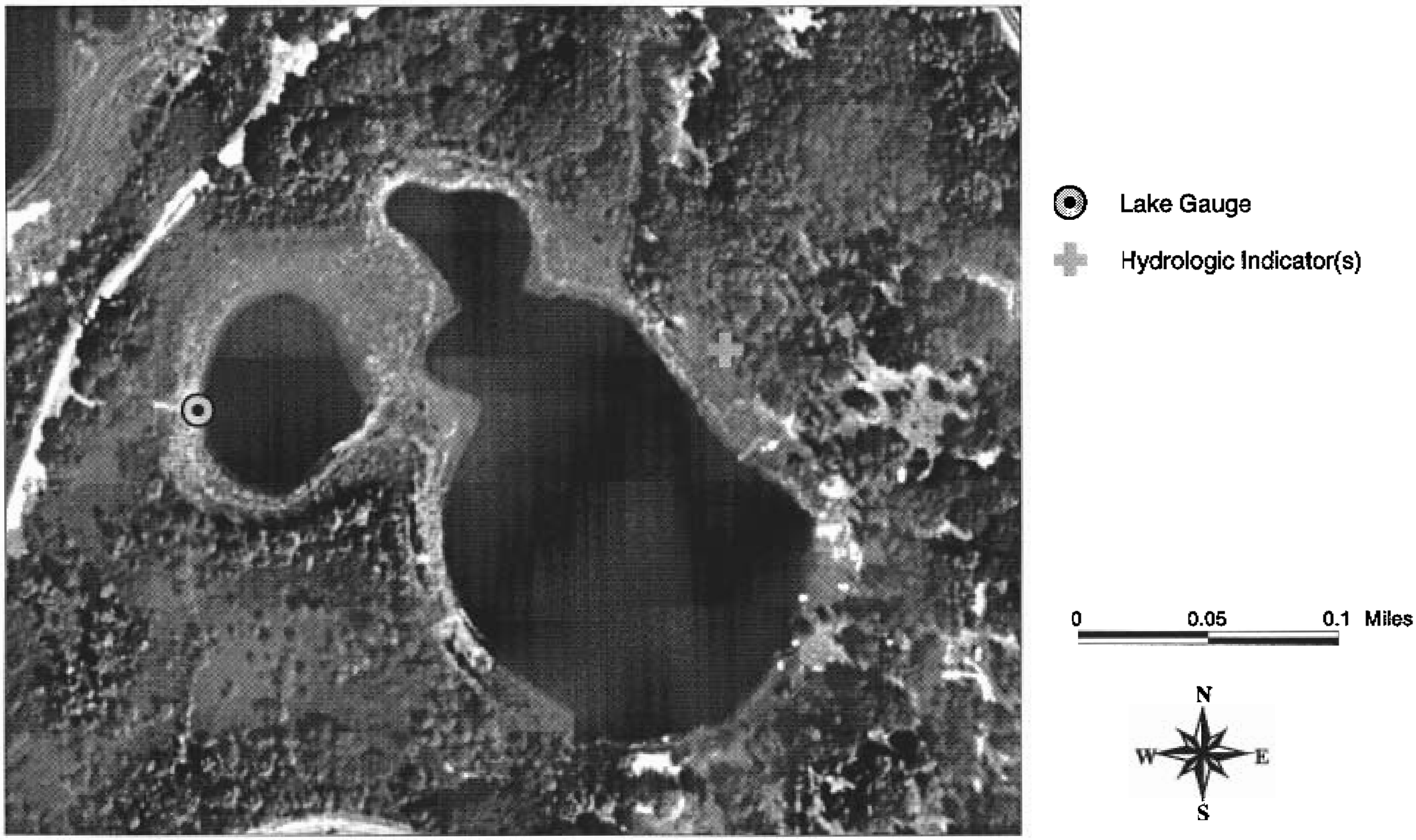


Figure 6-47. One-foot contour map of the Lake Raleigh basin, Hillsborough County, Florida. Values shown are elevations, in feet, above the National Geodetic Vertical Datum.

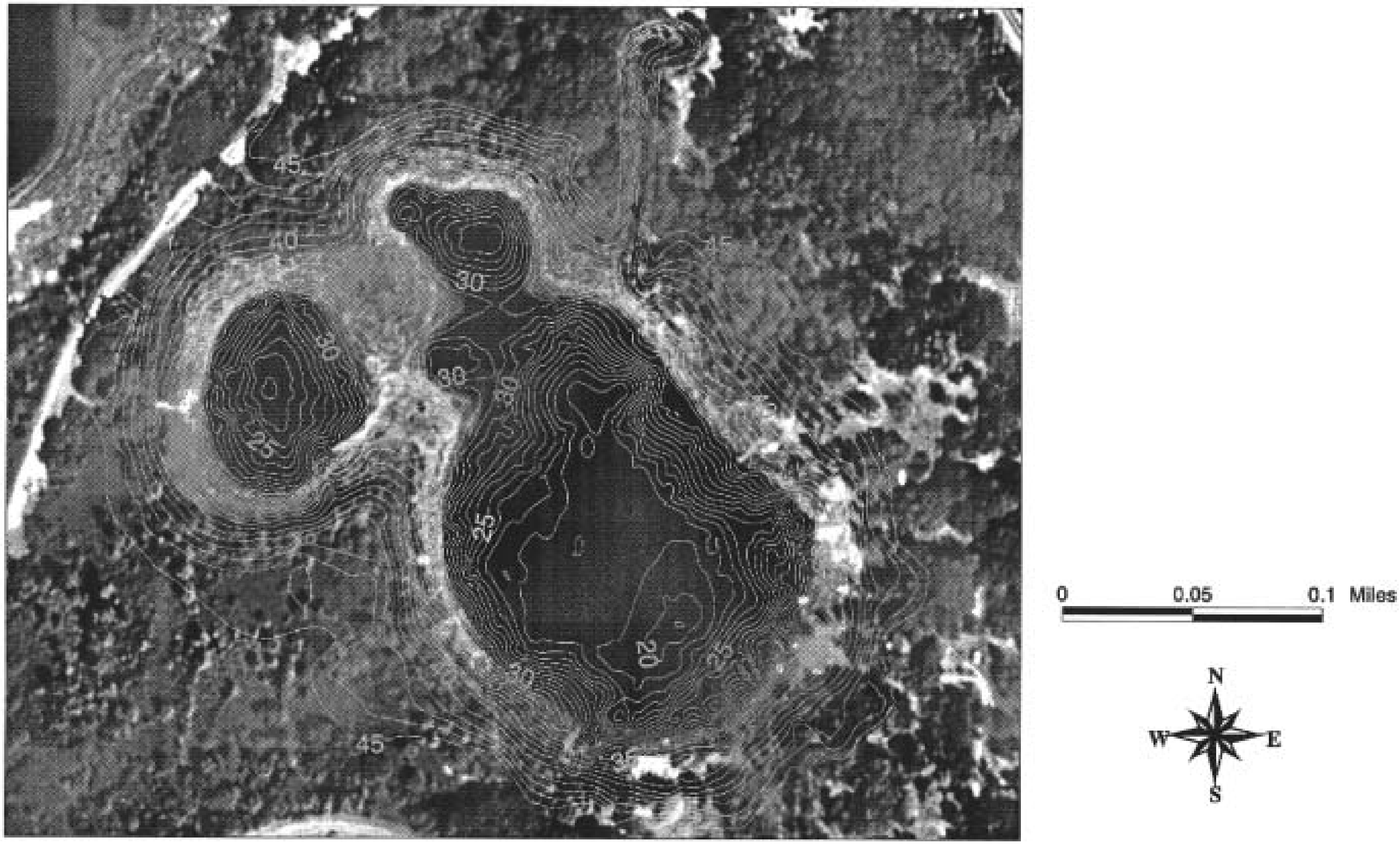


Figure 6-48. Mean monthly water elevations at Lake Raleigh, Hillsborough County, Florida. Proposed High Minimum Lake Level (HMLL), Minimum Lake Level (MLL), Ten-Year Flood Guidance Level (10-YR), High Guidance Level (HGL), and Low Guidance Level (LGL) are shown as solid or dashed lines.

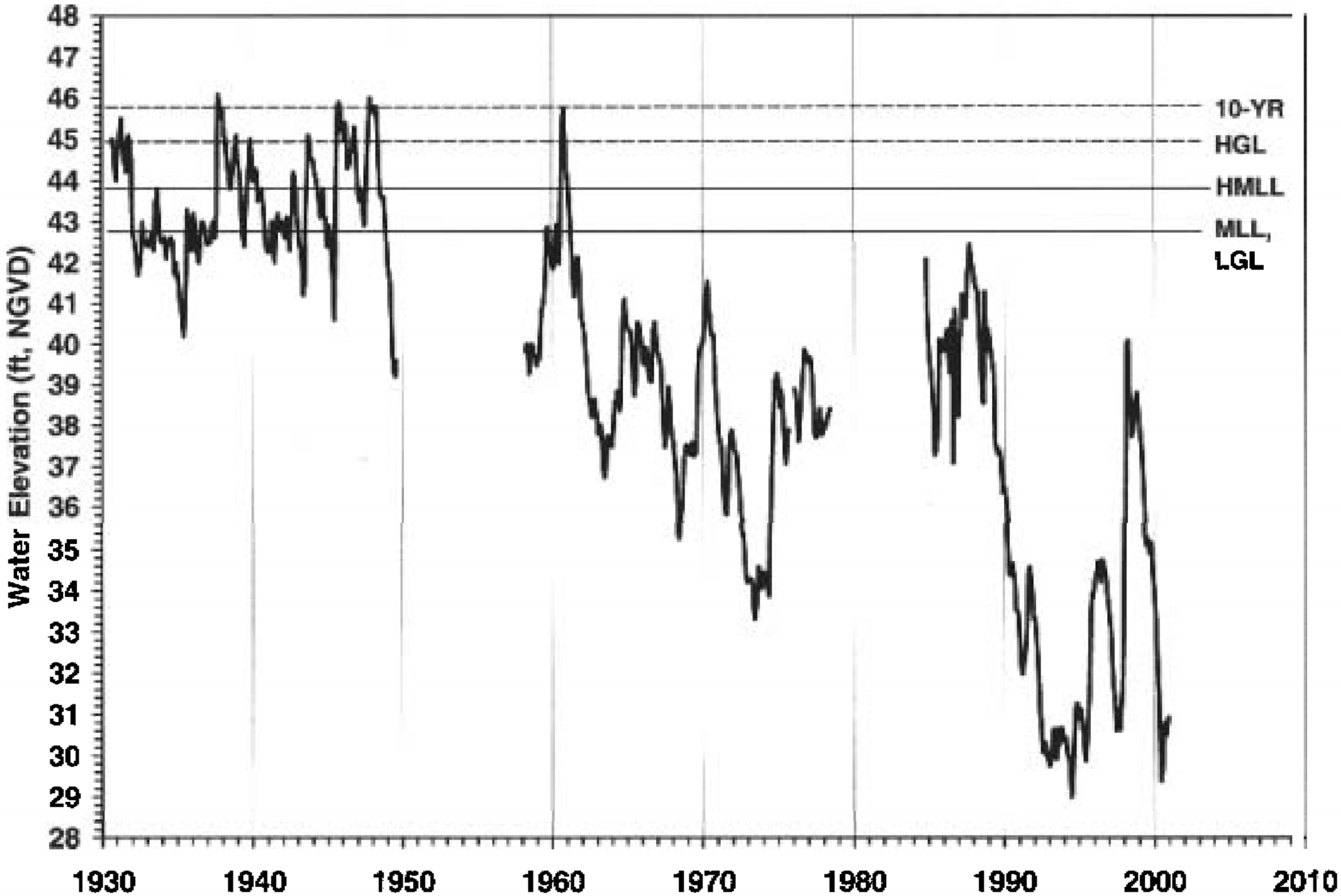
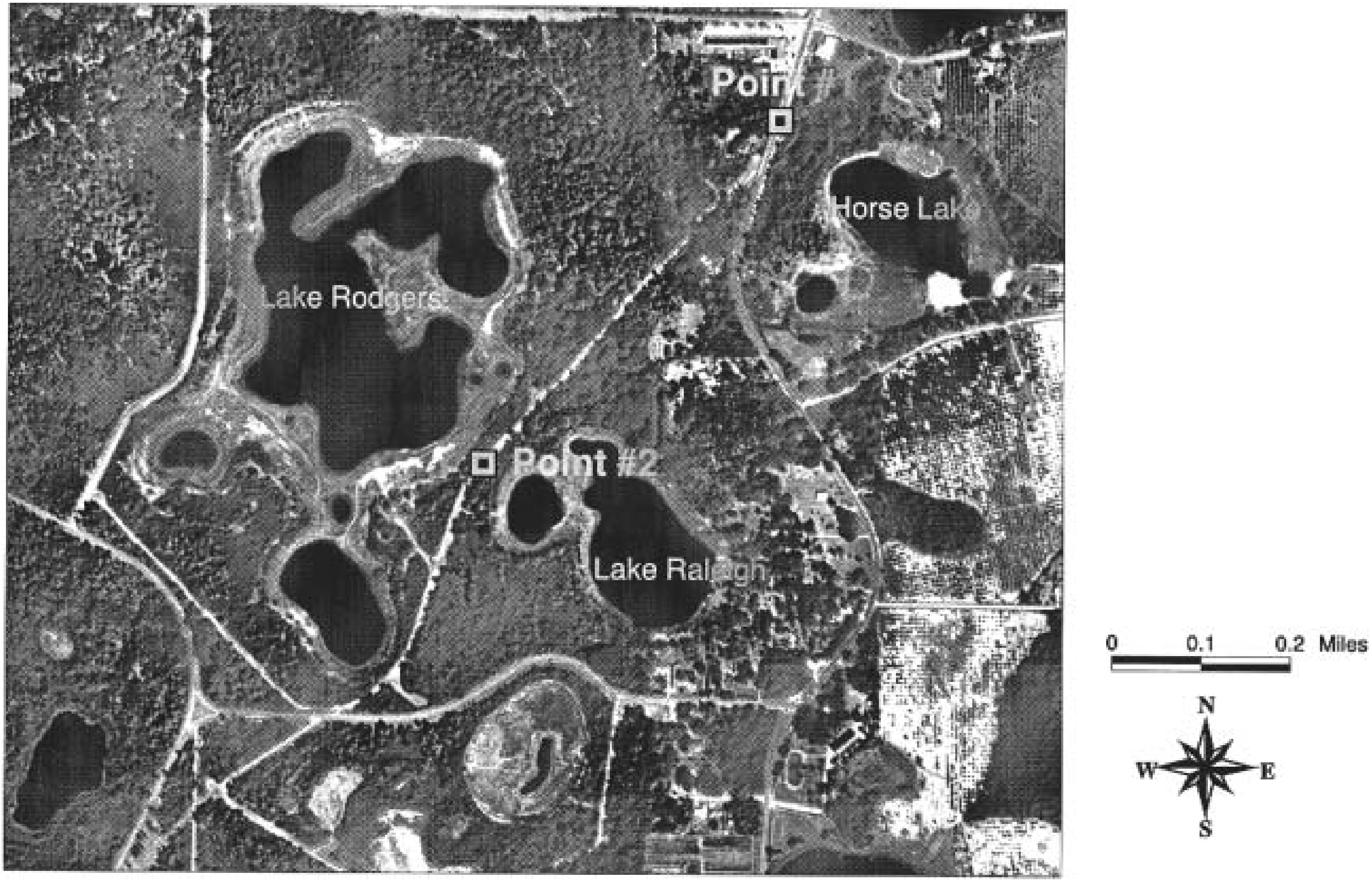
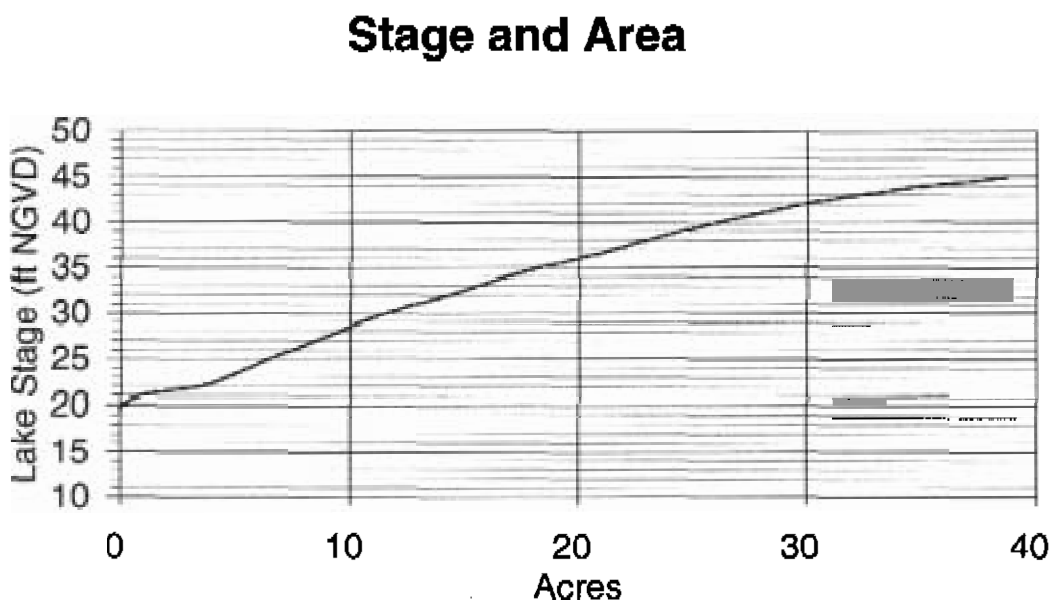


Figure 6-49. Outlet conveyance system for Lake Raleigh, Hillsborough County, Florida. Numbered sites are described in Table 6-47



6-50. **Surface area, volume, potential herbaceous wetland area, area potentially colonized by aquatic macrophytes, and dynamic ratio versus lake stage for Lake Raleigh, Hillsborough County, Florida.**



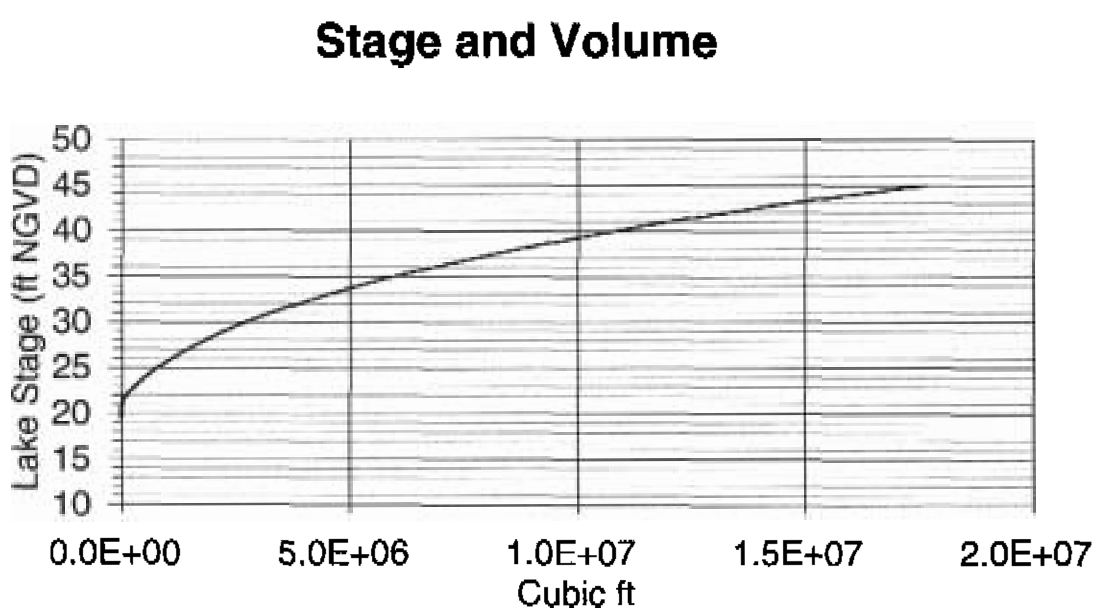
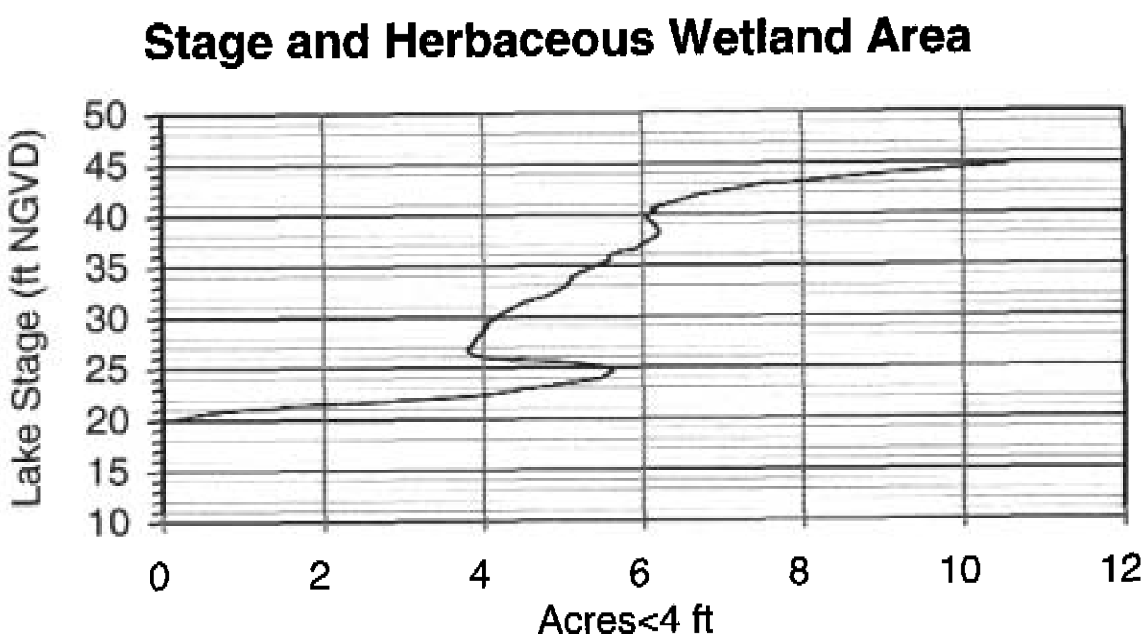


Figure 6-50. (Continued).



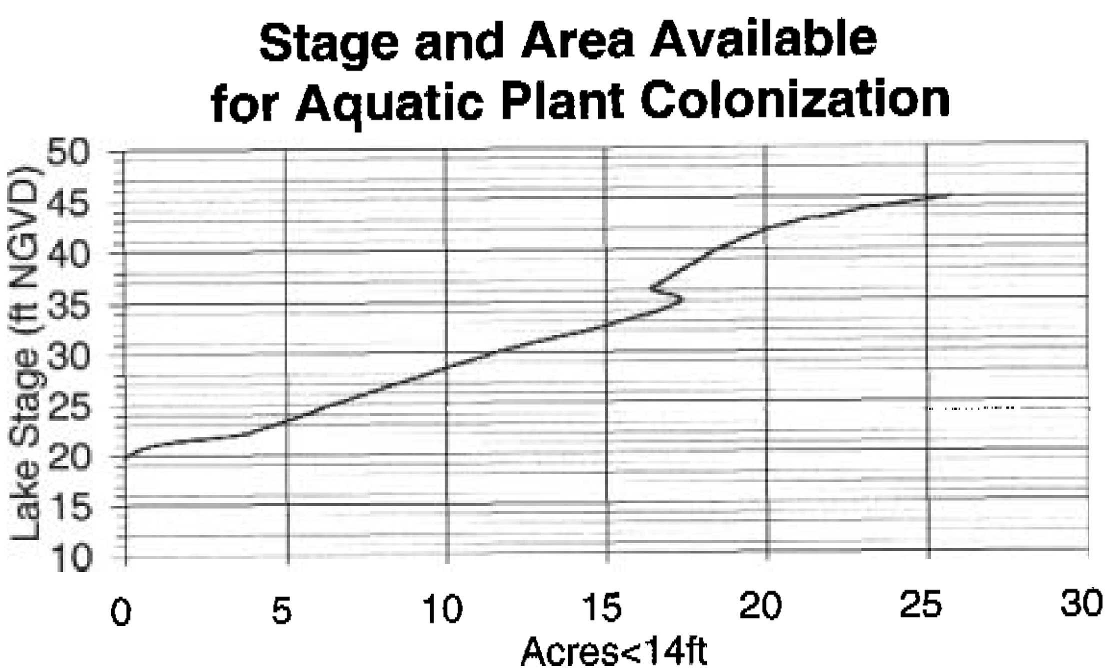
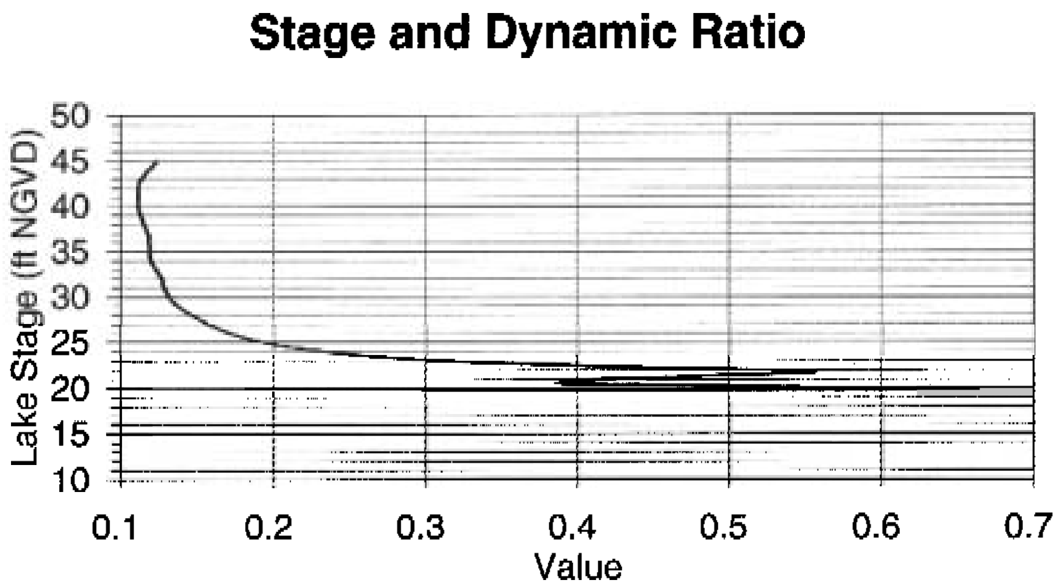


Figure 6-50. (Continued).



Lake Rogers

General Lake Description

Lake Rogers is located in the Northwest Hillsborough Basin in Hillsborough County, Florida (Section 27, Township 27S, Range 17E). The area surrounding the lake is categorized as the Land-O-Lakes subdivision of the Tampa Plain in the Ocala Uplift Physiographic District (Brooks 1981); a region of many lakes on a moderately thick plain of silty sand overlying Tampa Limestone. As part of the Florida Department of Environmental Protection's Lake Bioassessment/Regionalization Initiative, the area has been identified as the Keystone Lakes region; an area of numerous slightly acidic, low nutrient, and mostly clear-water lakes (Griffith *et al.* 1997).

The United States Geological Survey 1956 (photorevised 1987) 1:24,000 Citrus Park, Fla. quadrangle map indicates a water level elevation of 36 ft, NGVD. The Florida Lake Gazetteer (Shafer *et al.* 1986) lists the lake area at 93 acres at this elevation. The lake has no outlet (Figure 6-51).

A detailed topographic map of the Lake Rogers basin (Figure 6-52) was developed for estimation of surface areas associated with various water level elevations. Data used for map production were obtained from field surveys and 1:200 aerial photograph maps of the basin containing one-foot contour lines prepared using photogrammetric methods.

The District has not previously established management levels for Lake Rogers.

Proposed Minimum and Guidance Levels

Recommended Minimum and Guidance Levels for Lake Rogers, a Category 3 Lake, are listed in Table 6-48, along with area values for each water level. The Basin Connectivity, Species Richness, Aesthetics and Recreation/Ski Standards for the lake are lower than the Historic P50 elevation, and were evaluated for development of minimum levels. The Aesthetics Standard, the most conservative of these standards, was used to establish the proposed Minimum Lake Level at 42.82 ft. The proposed Minimum Lake Level is 1.1 ft below the Historic P50 elevation. Lake area at the proposed Minimum Lake Level is about 95% of the area associated with the Historic P50 elevation. The proposed High Minimum Lake Level was established at 43.82 ft, an elevation corresponding to the Minimum Lake Level plus the RLWR50 (1.0 ft) for the northern Tampa Bay area. The proposed High Minimum Lake Level is 1.1 ft below the High Guidance Level. Lake area at the proposed High Minimum Lake Level is about 95% of that associated with the High Guidance Level. Development of Guidance Levels is described in the following sub-section.

Table 6-48. Lake Rogers: Recommended Minimum and Guidance Levels with Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten-Year Flood Guidance Level	45.80	NA
High Guidance Level	44.92	129.3
High Minimum Lake Level	43.82	123.4
Minimum Lake Level	42.82	118.3
Low Guidance Level	42.82	118.3

Summary of Data and Analyses Supporting Recommended Minimum and Guidance Levels

Hydrologic data are available for Lake Rogers for the period from May 1930 through December 1997 (Figure 6-53; see Figure 6-51 for location of the District water level gauge). For the period of record from January 1964 through December 1997 the hydrologic data are classified as Current data. These data were used to calculate the Current P10, P50, P90 (Table 6-49). The Category 3 Lake Normal Pool elevation (Table 6-49) for Lake Rogers was established using the Normal Pool value determined for Lake Raleigh (see Tables 6-45 and 6-46). Saw palmetto (*Serenoa repens*) shrubs and longleaf pine (*Pinus palustris*) trees surrounding Lake Rogers indicate a Normal Pool elevation of 48.68 ft NGVD (Table 6-50). This value is substantially higher than that recently measured at Lake Raleigh (44.92 ft NGVD, Table 6-46); a surprising difference, since the lakes are connected when surface water levels exceed 42.3 ft NGVD. In addition, a survey of the region conducted in 1977 indicates that the saw palmetto fringe existed around Lake Rogers at an elevation of 42.10 ft NGVD (SWFWMD, unpublished data). Because the palmetto line elevation estimated for Lake Rogers is suspect, use of the value established for Lake Raleigh was viewed as a reasonable means to establish the Category 3 Lake Normal Pool for Lake Rogers. Lake Rogers has no surface outlets, and no homes are located adjacent to the basin, so the control point elevation and low floor slab elevation were not established.

Based on the relationship between the Category 3 Lake Normal Pool elevation and the Current P10, the High Guidance Level was established at the Category 3 Lake Normal Pool elevation (Table 6-49). The Historic P50 and Low Guidance Level were determined using the High Guidance Level and the Northern Tampa Bay Region RLWR50 (1.0 ft) and RLWR90 (2.1 ft) (Table Rogers Table 6-49).

Lake Rogers is not contiguous with any cypress-dominated wetlands of 0.5 of more acres in size and is therefore classified as a Category 3 Lake. The basin does contain stands of maidencane (Panicum hemitomum) and other wetland vegetation. No docks are located at the lake, so development of a Dock-Use Standard is not appropriate. The Basin Connectivity Standard was established at 37.6 ft, based on use of power boats in the lake, a critical high-spot elevation of 34.5 ft and the RLWR5090 for the northern Tampa Bay area (1.1 ft). The Species Richness Standard was established at 40.00 ft, based on a 15% reduction in lake surface area from that at the Historic P50 elevation. An Aesthetics Standard was established at the Low Guidance Level elevation of 42.82 ft. The Recreation/Ski Standard was established at 37.1 ft, based on a critical ski elevation of 36.0 ft and the RLWR5090 for the northern Tampa Bay area (1.1 ft). Review of the dynamic ratio for lake stages bounded by the Current P10 and Current P90 elevations did not indicate that potential changes in basin susceptibility to wind-induced sediment resuspension would be of concern for minimum levels development (Table 4-1, Figure 6-55). Changes in potential herbaceous wetland area and area of potential aquatic macrophyte colonization with lake stage also did not indicate that use of any of the identified standards would be inappropriate (Figure 6-55).

The Ten Year Flood Guidance Level (Table 6-48) was established for Lakes Rogers using the methodology for closed basin lakes described in Section 5 of this report. The closed basin criteria were selected because Lake Rogers has no positive outfall. Lake stage in the basin appears to be impacted after 1961 by groundwater withdraws from the Cosme well field. In accordance with the methodology, the 10-year flood level was based on a frequency analysis of the lake stage record from 1930 to 1961. A frequency analysis on stages beyond 1961 would have lowered the 10-year flood level as a result of using lake stages impacted by groundwater withdrawals.

Table 6-49. Lake Rogers: Summary of Elevation Data and Associated Area Values Used for Establishing Minimum Levels.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Current P10	37.86	95.1
Current P50	35.68	84.8
Current P90	29.96	54.0
Category 3 Lake Normal Pool	44.92*	129.3
Low Floor Slab	NA	NA
Control Point	NA	NA
High Guidance Level	44.92 (Category 3 Lake Normal Pool)	129.3

Historic P50	43.92 (HGL - RLWR50)	123.9
Low Guidance Level	42.82 (HGL - RLWR90)	118.3
Dock-Use Standard	NA	NA
Basin Connectivity Standard	37.6	93.7
Species Richness Standard	40.00	105.3
Aesthetic Standard	42.82	118.3
Recreation/Ski Standard	37.1	91.4

NA = not available / not applicable
* Normal Pool elevation established based on hydrologic indicators at Lake Raleigh

Table 6-50. Lake Rogers: Elevation Data Used for Establishing the Category 3 Lake Normal Pool Elevation. Data collected 23 December 1997; water level = 31.86 ft, NGVD.

Hydrologic Indicator	Height above Lake Water Level (ft)	Elevation (ft, NGVD)
Base of Saw Palmetto	16.98	48.84
Base of Saw Palmetto	16.65	48.51
Base of Saw Palmetto	16.32	48.18
Lakeward Long Leaf Pine	17.33	49.19
Mean	**16.82**	**48.68**

Table 6-51. Lake Rogers: Summary of Structural Alteration / Control Point Elevation Information. Numbers correspond to those shown in Figure 6-54.

No.	Description	Elevation (ft, NGVD)
1	East end of 24" reinforced concrete pipe under Gunn Highway	46.3
2	Natural ground between Lakes Raleigh and Rodgers	42.3

Figure 6-51. Location of District lake gauges at Lake Rogers, Hillsborough County, Florida.

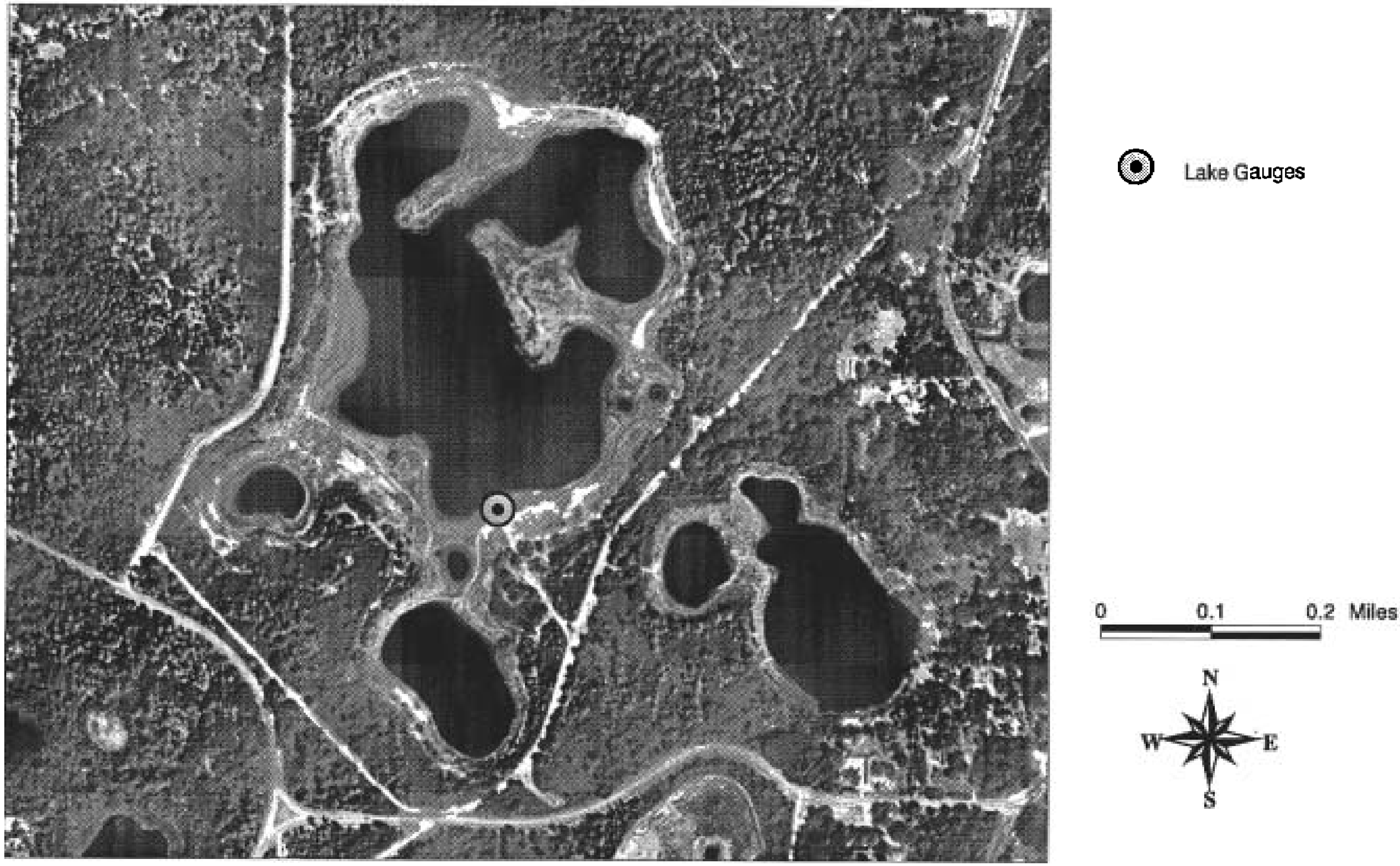


Figure 6-52. One-foot contour map of the Lake Rogers basin, Hillsborough County, Florida. Values shown are elevations, in feet, above the National Geodetic Vertical Datum.

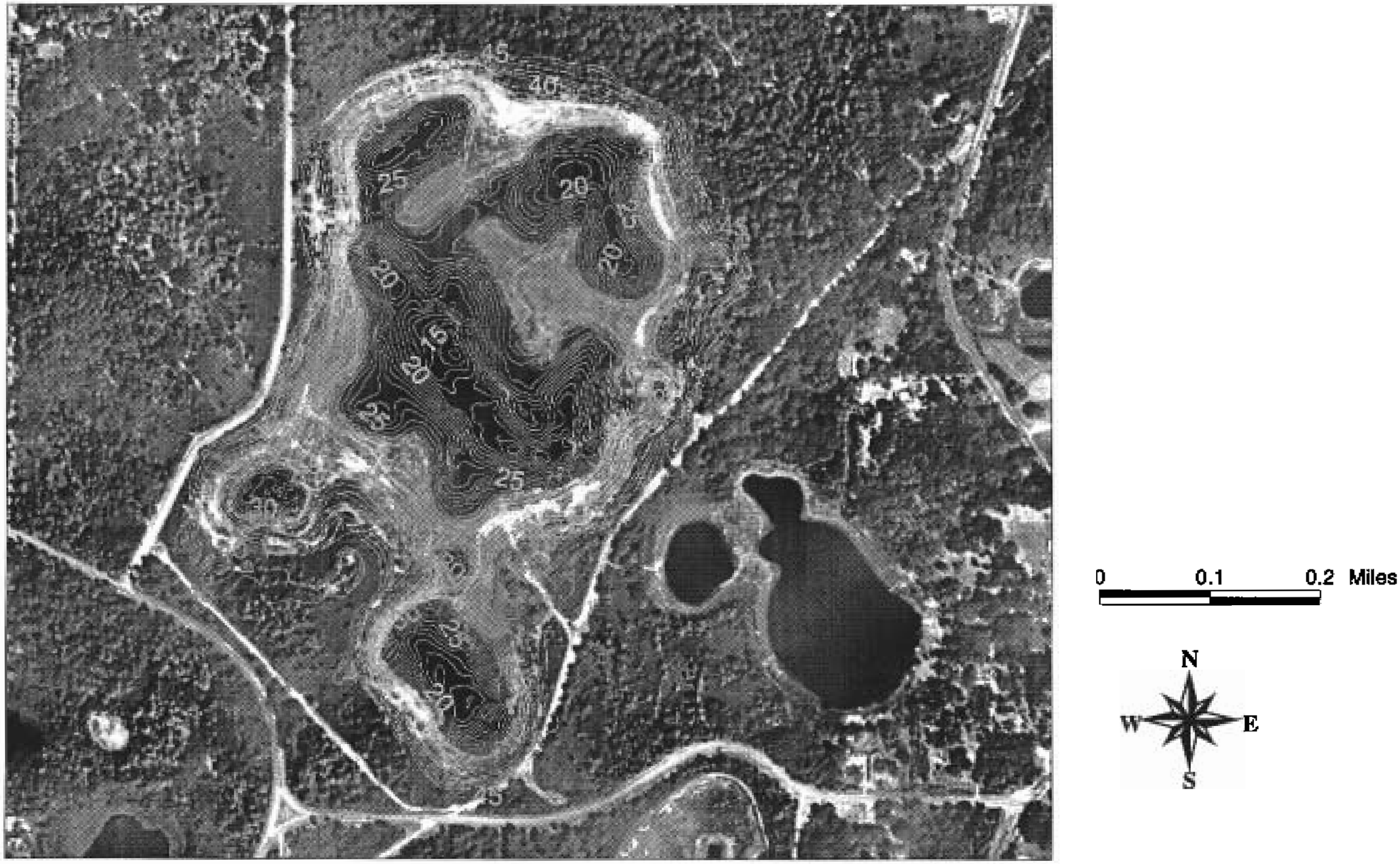
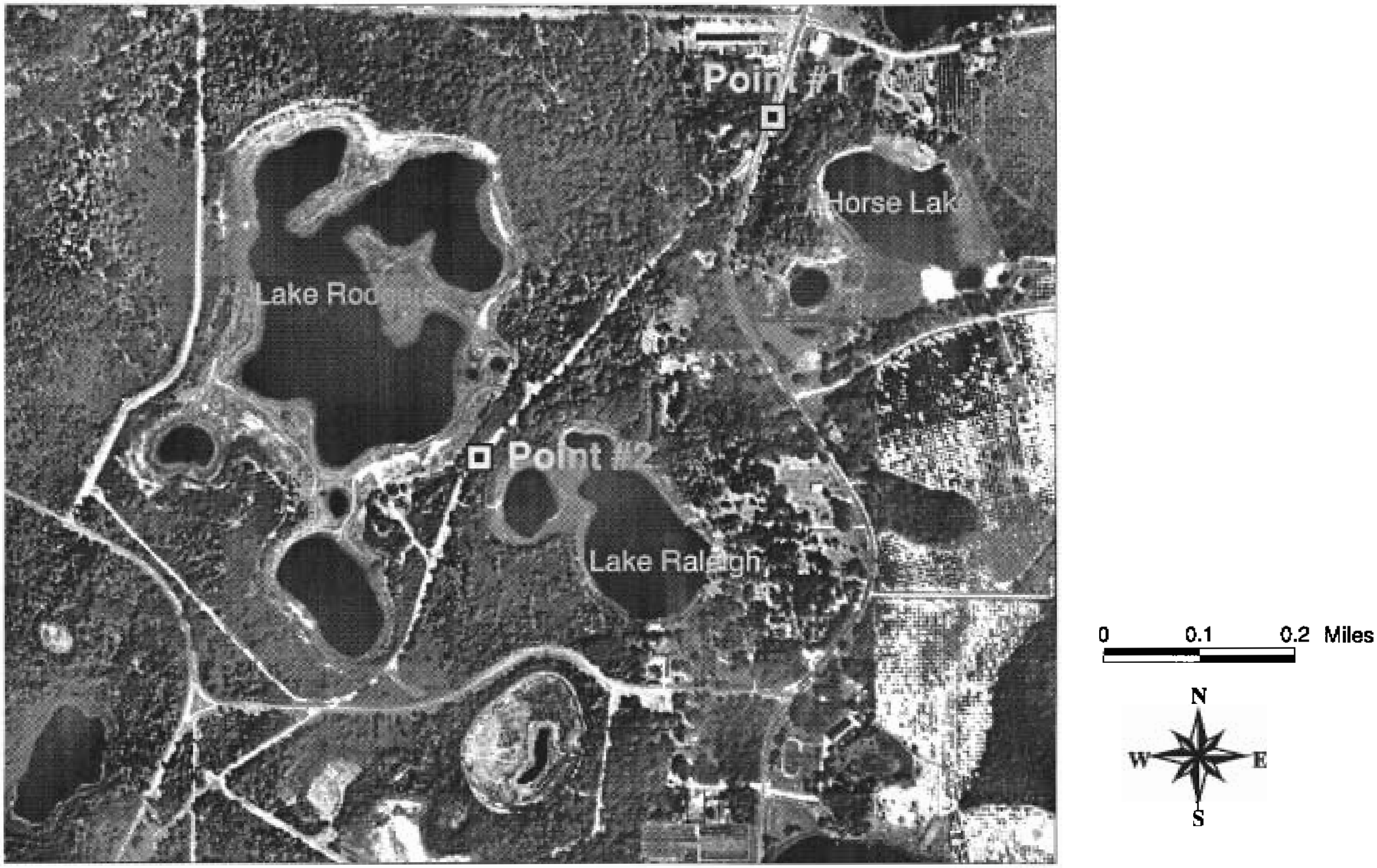
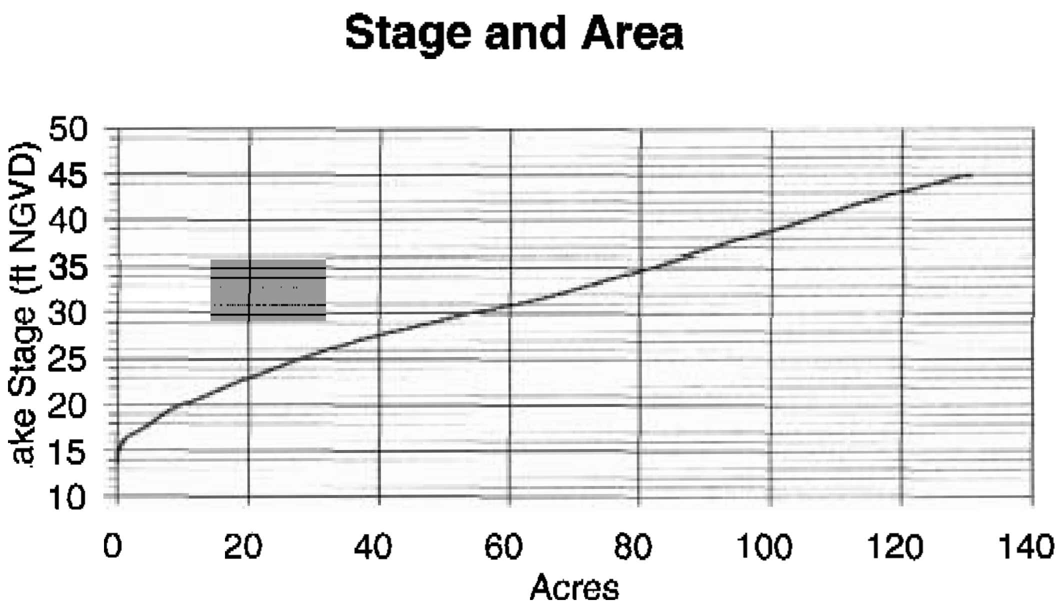


Figure 6-53. Mean monthly water elevations at Lake Rogers, Hillsborough County, Florida. Proposed High Minimum Lake Level (HMLL), Minimum Lake Level (MLL), Ten-Year Flood Guidance Level (10-YR), High Guidance Level (HGL), and Low Guidance Level (LGL) are shown as solid or dashed lines.

Figure 6-54. Outlet conveyance system for Lake Rogers, Hillsborough County, Florida. Numbered sites are described in Table 6-51



6-55. Surface area, volume, potential herbaceous wetland area, area potentially colonized by aquatic macrophytes, and dynamic ratio versus lake stage for Lake Rogers, Hillsborough County, Florida.



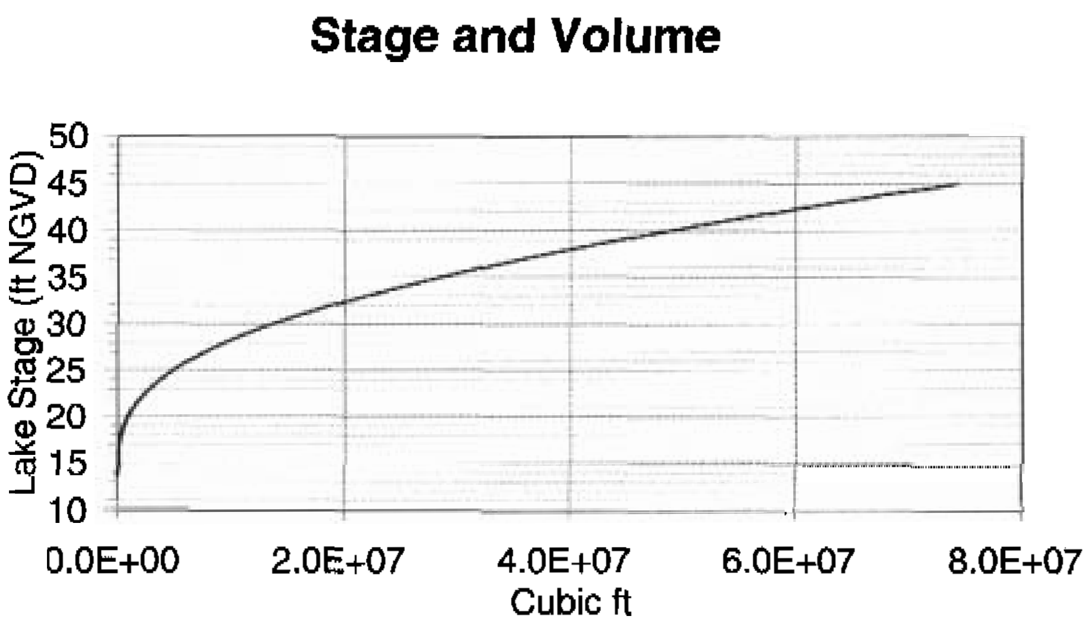
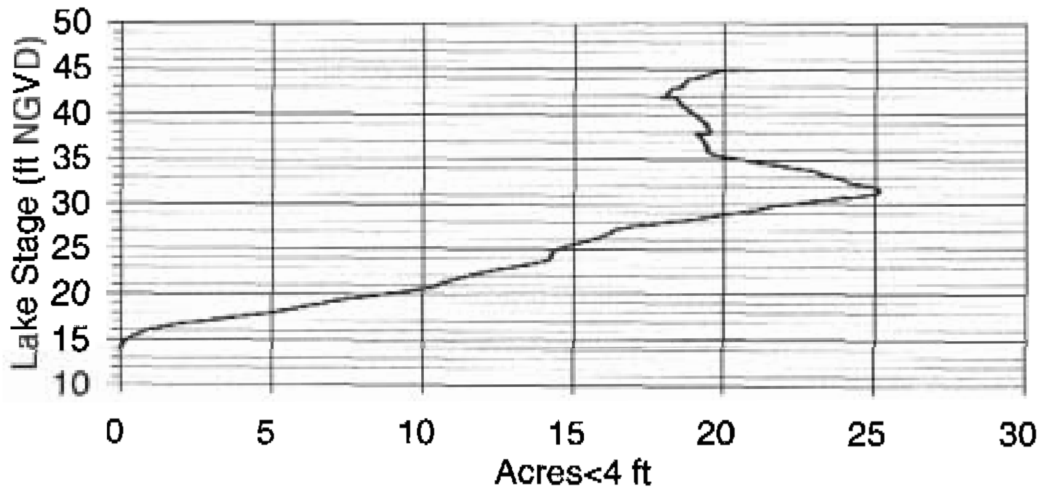


Figure 6-55. (Continued).

Stage and Herbaceous Wetland Area



Stage and Area Available for Aquatic Plant Colonization

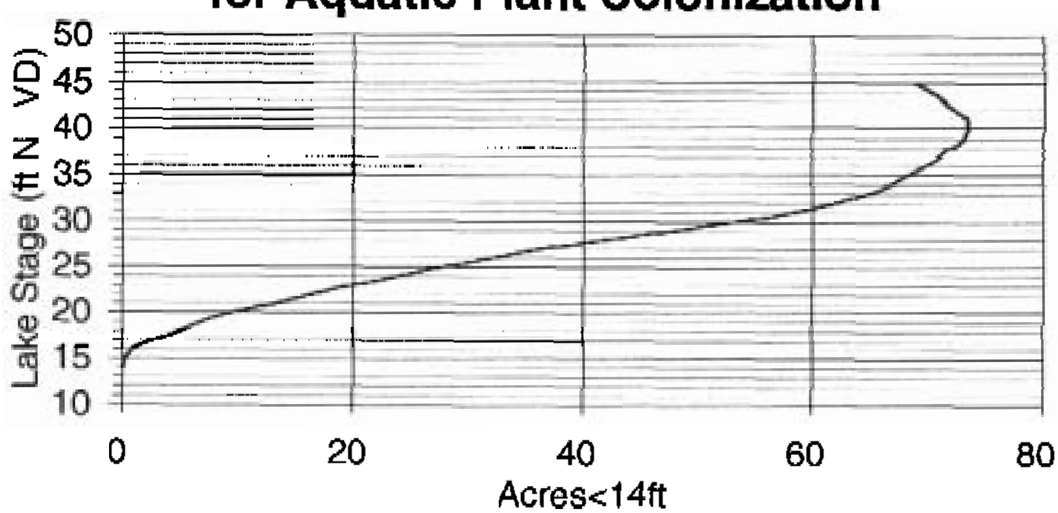
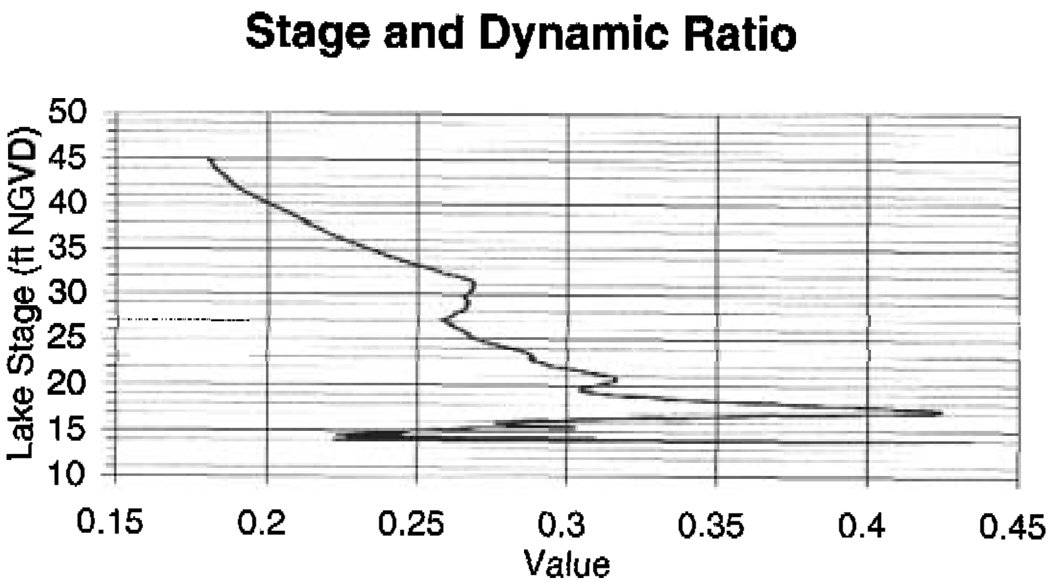


Figure 6-55. (Continued).



Round Lake

General Lake Description

Round Lake is lake located in the Northwest Hillsborough Basin in Hillsborough County, Florida (Sections 21 and 22, Township 27S, Range 18E). The area surrounding the lake is categorized as the Land-O-Lakes subdivision of the Tampa Plain in the Ocala Uplift Physiographic District (Brooks 1981); a region of many lakes on a moderately thick plain of silty sand overlying Tampa Limestone. As part of the Florida Department of Environmental Protection's Lake Bioassessment/Regionalization Initiative, the area has been identified as the Land-O-Lakes lake region; an area of numerous neutral to slightly alkaline, low to moderate nutrient, clear-water lakes (Griffith *et al.* 1997).

A lake surface elevation is not included on the 1956 United States Geological Survey (photorevised 1987) 1:24,000 Sulphur Springs, Fla. quadrangle map or the 1956 (photorevised 1987) Citrus Park, Fla. quadrangle map. The Florida Lake Gazetteer (Shafer *et al.* 1986) lists the lake surface area as 11 acres at an elevation of 53 ft, NGVD. The lake has a drainage area of 0.7 square miles. There are no inlets to the lake, however, an augmentation well along the northeast shore has been used to supply the basin with water from the Floridan Aquifer since the mid-1960s (Stewart and Hughes 1974) The lake drains through a partially filled-in ditch along the western shore which leads to Saddleback Lake (Figure 6-56).

A detailed topographic map of the Round Lake basin (Figure 6-57) was developed for estimation of surface areas associated with various water level elevations. Data for map production were obtained from field surveys and 1:200 aerial photograph maps of the basin containing one-foot contour lines prepared using photogrammetric methods.

The District has not previously established management levels for Round Lake.

Proposed Minimum and Guidance Levels

Recommended Minimum and Guidance Levels for the Round Lake, a Category 3 Lake, are listed in Table 6-52, along with area values for each water level. The Dock-Use Species Richness, and Aesthetic Standards for the lake are lower than the Historic P50 elevation, and were evaluated for development of minimum levels. The Dock-Use Standard, the most conservative of these standards, was used to establish the proposed Minimum Lake Level at 53.26 ft. The proposed Minimum Lake Level is 0.2 ft below the Historic P50 elevation. Lake area at the proposed Minimum Lake Level is about 93% of the area associated with the Historic P50 elevation. The proposed High Minimum Lake Level was established at 54.26 ft, an elevation corresponding to the Minimum Lake Level plus the RLWR50 (1.0 ft) for the northern Tampa Bay area. The proposed High Minimum Lake Level is 0.1 ft above the High Guidance Level and about 3.3 ft lower than the Low Floor Slab elevation. Development of Guidance Levels is described in the following sub-section.

Table 6-52. Round Lake: Recommended Minimum and Guidance Levels with Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten-Year Flood Guidance Level	56.08	NA
High Guidance Level	54.12	11.3
High Minimum Lake Level	54.26	11.5
Minimum Lake Level	53.26	10.5
Low Guidance Level	53.24	10.4

Summary of Data and Analyses Supporting Recommended Minimum and Guidance Levels

Hydrologic data are available for Round Lake for the period from January 1965 through July 1996 (Figure 6-58; see Figure 6-56 for location of lake water level gauge). For the period of record from January 1974 through July 1996, the hydrologic data are classified as Current data. These current data were used to calculate the Current P10, P50, P90 (Table 6-53). The Category 3 Lake Normal Pool elevation (Table 6-53) was established using cypress trees along the west and south shores of the lake (Table 6-54, Figure 6-56). The low floor slab and control point elevations were determined using available one-foot contour interval aerial maps, and field surveys (Tables 6-53 and 6-55, Figure 6-59). The Category 3 Lake Normal Pool elevation is above the control point, so the lake is considered to be Structurally Altered.

Based on the relationship between the control point elevation, the Category 3 Lake Normal Pool elevation, and the Current P10, the High Guidance Level was established at the Current P10 elevation (Table 6-53). The Historic P50 was determined by subtracting the difference between the Current P10 and P50 from the High Guidance Level elevation (Table 6-53). The Low Guidance Level was determined similarly by subtracting the difference between the Current P10 and P90 from the High Guidance Level elevation.

Round Lake is not contiguous with any cypress-dominated wetlands of 0.5 of more acres in size and is therefore classified as a Category 3 Lake. The basin does contain stands of maidencane (*Panicum hemitomum*) and spatterdock (*Nuphar luteum*). A Dock-Use Standard was established at 53.26 ft, based on the Dock-End Sediment elevation of 50.16 ft, developed from measurements for 13 docks. Development of a Basin Connectivity Standard is not appropriate, based on the morphology of the lake basin. A Species Richness Standard was established at 51.4 ft, based on a 15% reduction in lake surface area from that at the Historic P50 elevation. An Aesthetic Standard was established at the Low Guidance Level elevation of 53.24 ft. Development of a Recreation/Ski Standard is not appropriate, based on the size of the lake system. Review of the dynamic ratio for lake stages bounded by the Current P10 and Current P90 elevations did not indicate that potential changes in basin susceptibility to wind-induced sediment resuspension would be of concern for minimum levels development (Table 4-1, Figure 6-60). Changes in potential herbaceous wetland area and area of potential aquatic macrophyte colonization with lake stage also did not indicate that use of any of the identified standards would be inappropriate (Figure 6-60).

The Ten Year Flood Guidance Level (Table 6-52) was established for Round Lake using the methodology for open basin lakes described in Section 5 of this report. The District used an existing hydrologic and hydraulic computer model of the Rocky Creek Watershed developed by Hillsborough County (Hillsborough County 1998). The Rocky Creek runoff hydrographs were computed using the NRCS Dimensionless Unit Hydrograph method, a 256 shape factor, a 10.0 inch rainfall depth, and a 72-hour rainfall distribution developed by the South Florida Water Management District. The Rocky Creek conveyance system was simulated with the Hillsborough County modified version of EXTRAN, and the hydrodynamic routing component of the Environmental Protection Agency's Stormwater Management Model (SWMM) v.4.31. District staff modified the EXTRAN input data developed by Hillsborough County, to include additional surveyed elements of the Round Lake outlet conveyance system. The initial elevation of Round Lake was set at the outlet control point elevation of 53.72 feet NGVD. The District modified data set was then used to determine the 10-year flood level based on runoff hydrographs from the 10-year storm event.

Table 6-53. Round Lake: Summary of Elevation Data and Associated Area Values Used for Establishing Minimum Levels.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Current P10	54.12	11.3
Current P50	53.42	11.3
Current P90	53.24	10.4
Category 3 Lake Normal Pool	55.83	13.8
Low Floor Slab	57.54	NA
Control Point	53.72	10.8

High Guidance Level	54.12 (Current P10)	11.3
Historic P50	53.42 (HGL - Current P10 and P50 difference	11.3
Low Guidance Level	53.24 (HGL - Current P10 and P90 difference	10.4
Dock-Use Standard	53.26	10.5
Basin Connectivity Standard	NA	NA
Species Richness Standard	51.35	9.0
Aesthetic Standard	53.24	10.4
Recreation/Ski Standard	NA	NA

Table 6-54. Round Lake: Elevation Data Used for Establishing the Category 3 Lake Normal Pool Elevation. Data collected 24 June 1999; water level = 52.82 ft, NGVD.

Hydrologic Indicator	Height above Lake Water Level (ft)	Elevation (ft, NGVD)
Cypress buttress - normal pool	2.65	55.47
Cypress buttress - normal pool	3.16	55.98
Cypress buttress - normal pool	3.48	56.30
Cypress buttress - normal pool	3.15	55.97
Cypress buttress - normal pool	2.82	55.64
Cypress buttress - normal pool	2.96	55.78
Cypress buttress - normal pool	3.03	55.85
Cypress buttress - normal pool	2.82	55.64
Cypress buttress - normal pool	3.03	55.85
Mean	**3.01**	**55.83**

Table 6-55. Round Lake: Summary of Structural Alteration / Control Point Elevation Information. Numbers correspond to those shown in Figure 6-59.

No.	Description	Elevation (ft, NGVD)
1	West end of 18" corrugated metal pipe	52.89
2	Bottom of drop inlet structure	53.71
3	Control point: east end of 8" corrugated metal pipe	53.72

Figure 6-56. Location of District gauge, outlet and sites where hydrologic indicators of high water level were measured at Round Lake, Hillsborough County, Florida.

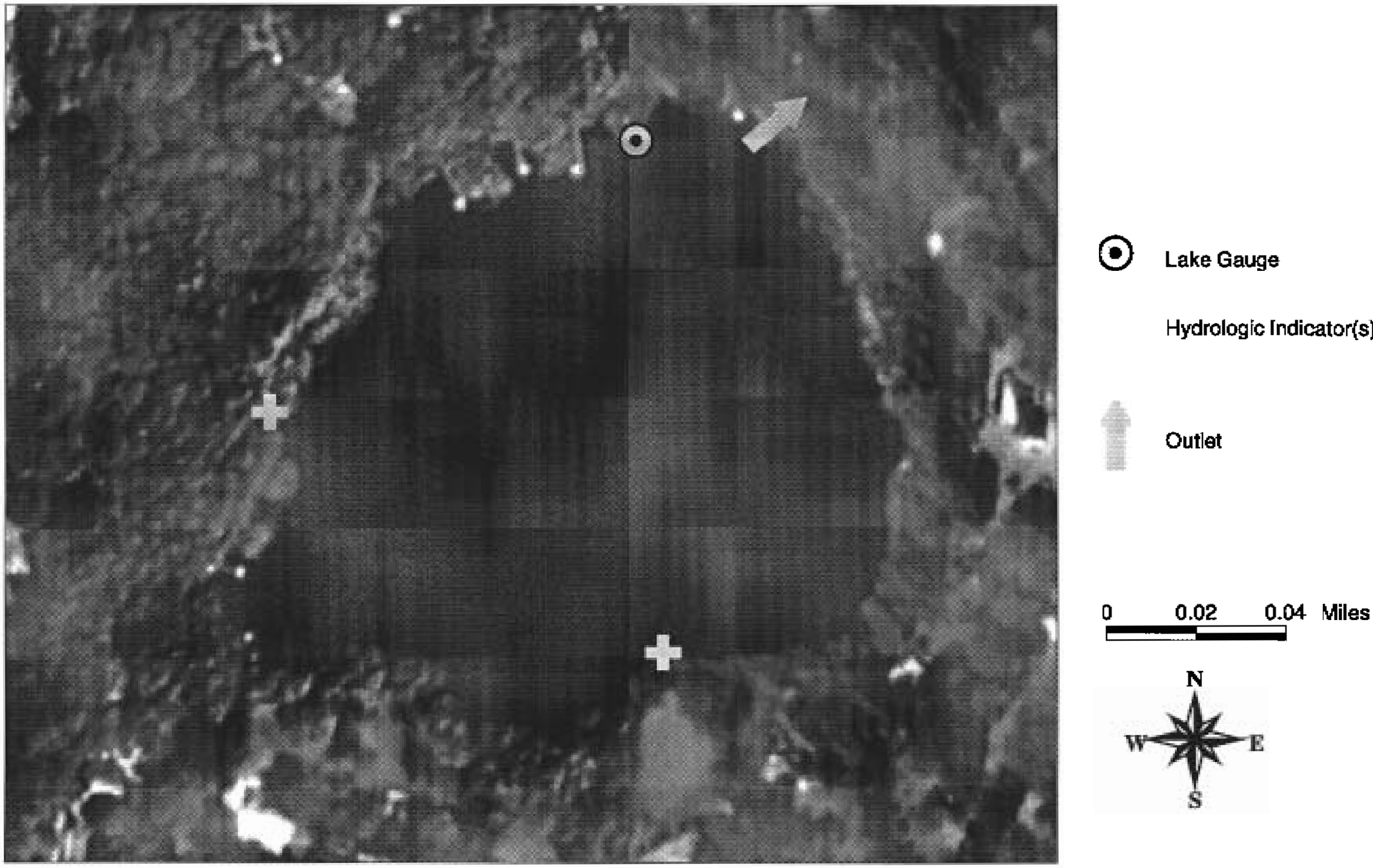


Figure 6-57. One-foot contour map of the Round Lake basin, Hillsborough County, Florida. Values shown are elevations, in feet, above the National Geodetic Vertical Datum.

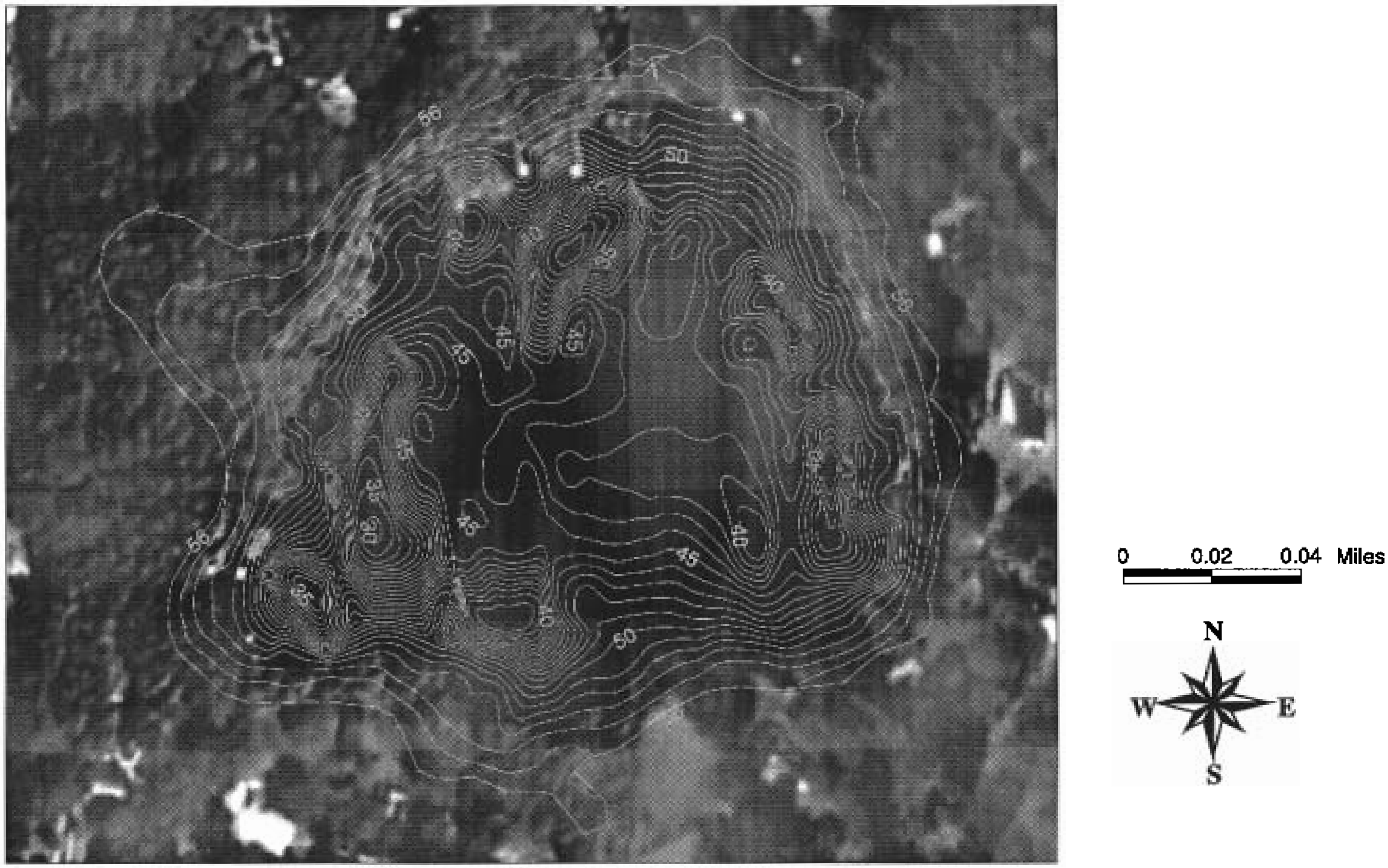


Figure 6-58. Mean monthly water elevations at Round Lake, Hillsborough County, Florida. Proposed High Minimum Lake Level (HMLL), Minimum Lake Level (MLL), Ten-Year Flood Guidance Level (10-YR), High Guidance Level (HGL), and Low Guidance Level (LGL) are shown as solid or dashed lines.

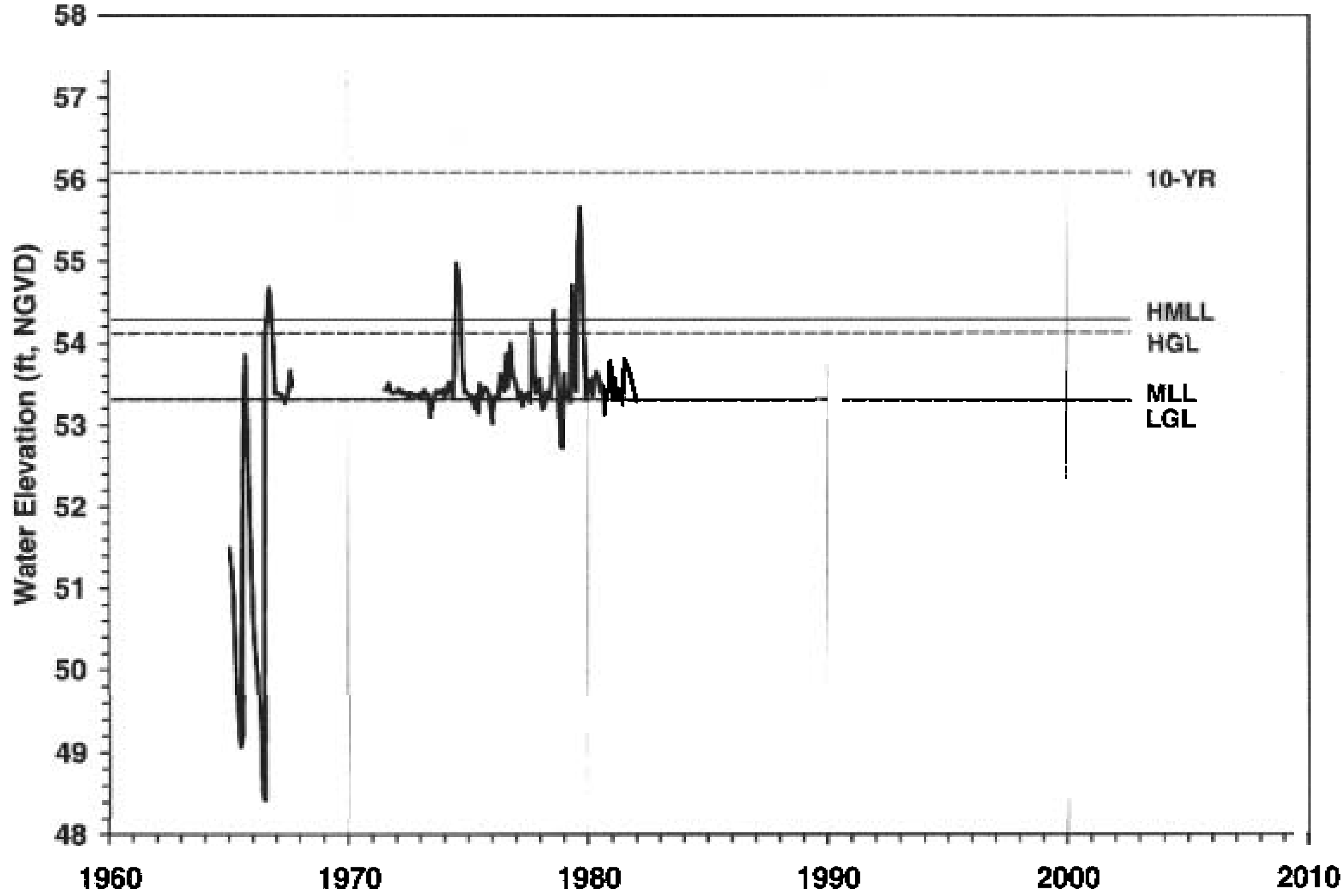
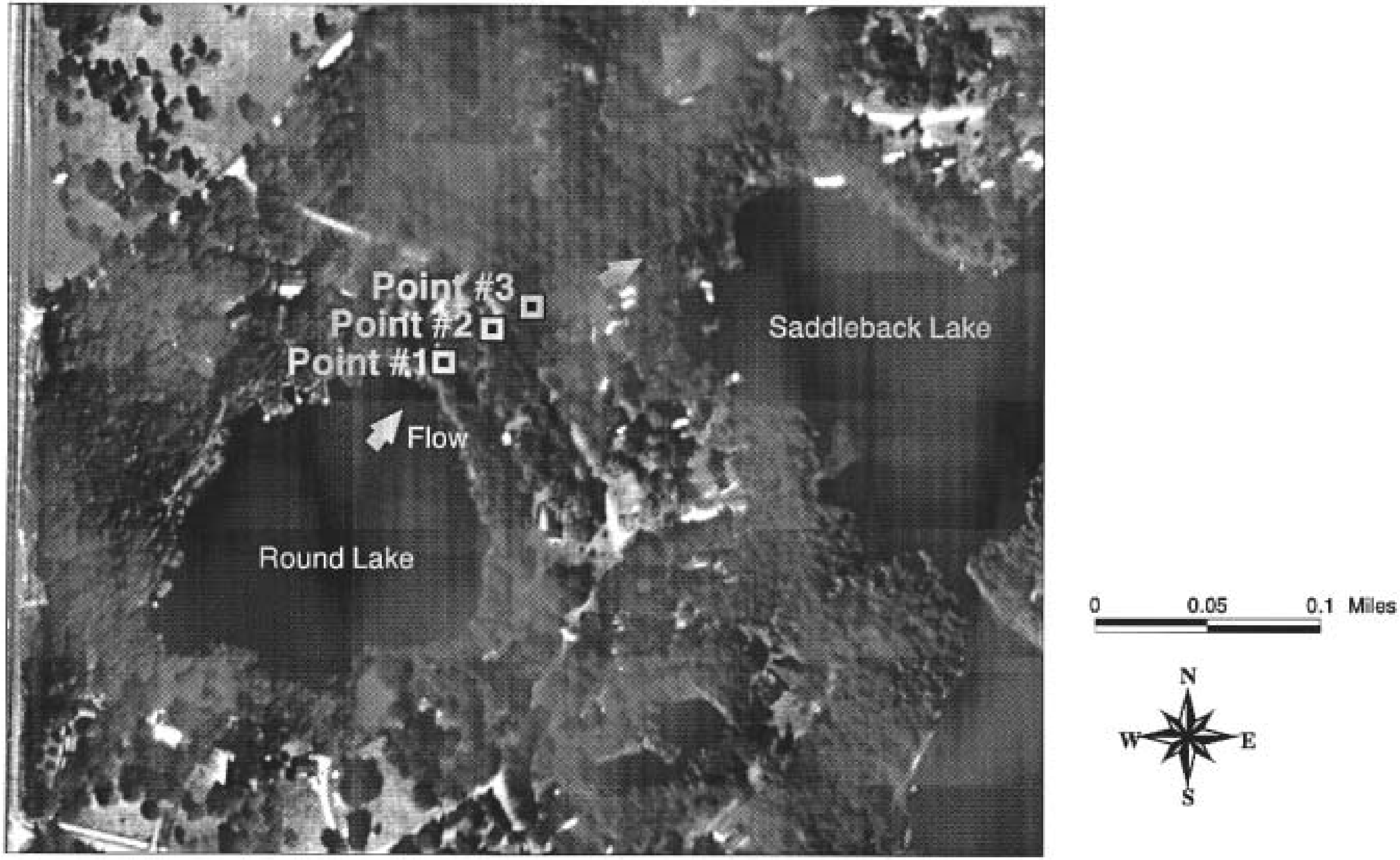
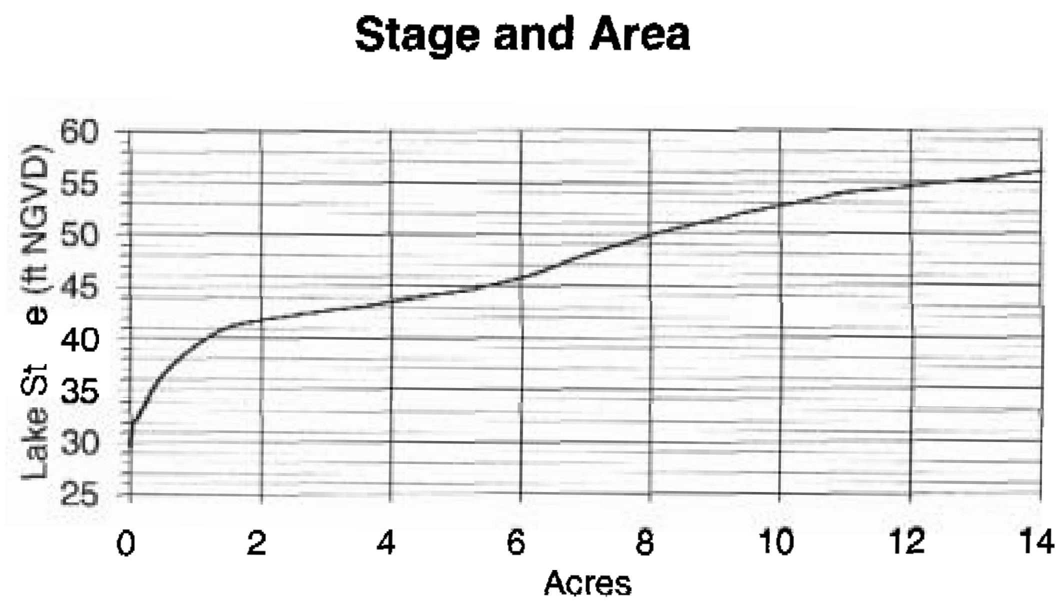


Figure 6-59. Outlet conveyance system for Round Lake, Hillsborough County, Florida. Numbered sites are described in Table 6-55.



6-60. Surface area, volume, potential herbaceous wetland area, area potentially colonized by aquatic macrophytes, and dynamic ratio versus lake stage for Round Lake, Hillsborough County, Florida.



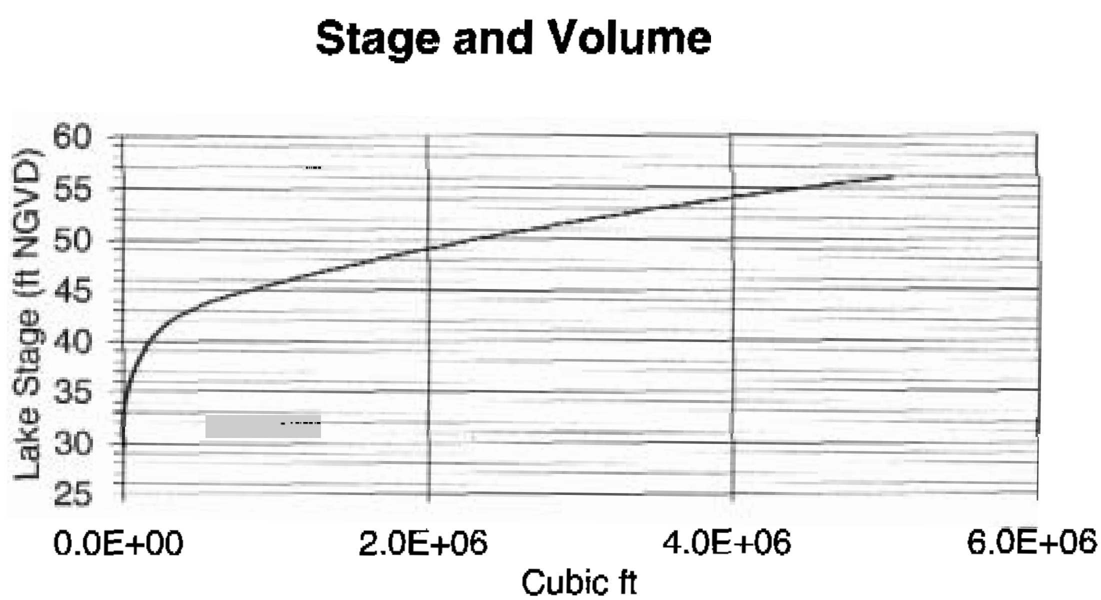
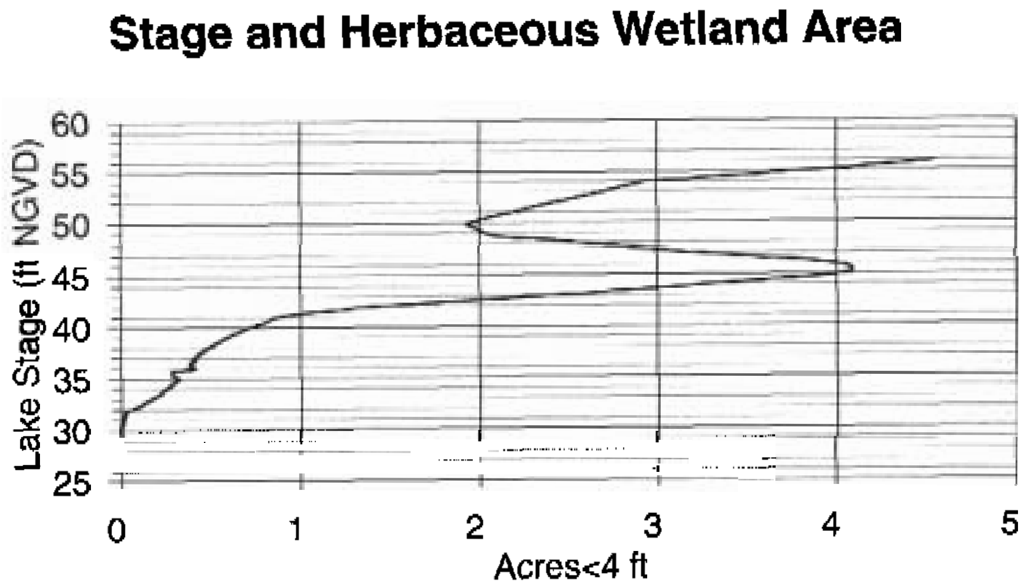


Figure 6-60. (Continued).



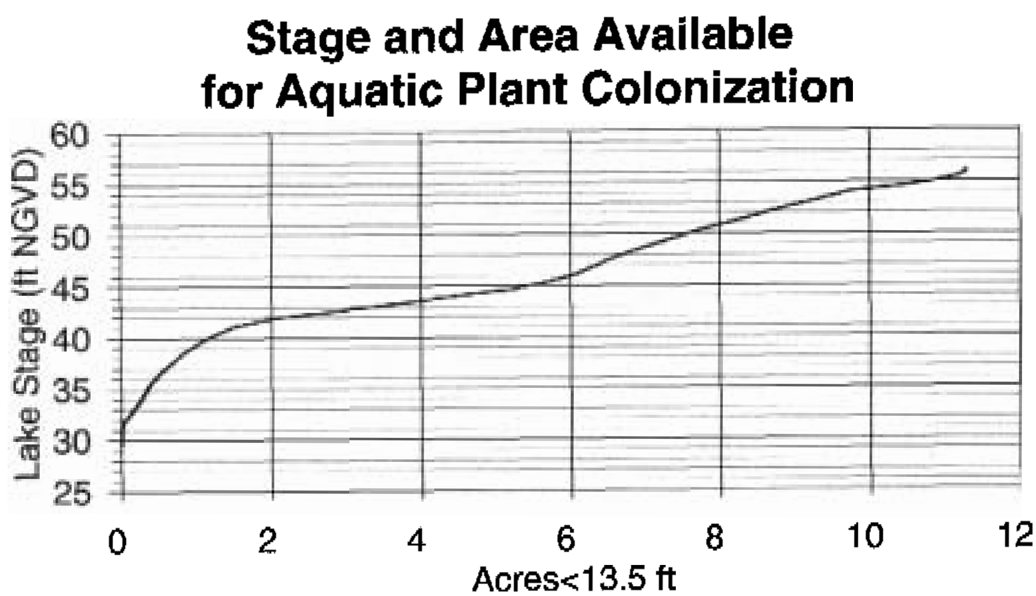
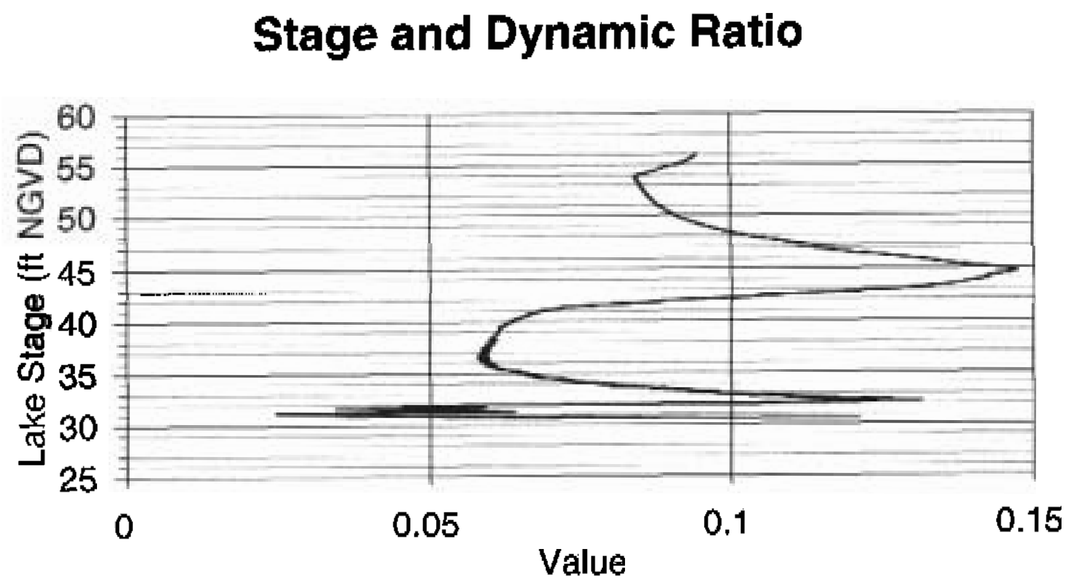


Figure 6-60. (Continued).



Saddleback Lake

General Lake Description

Saddleback Lake is lake located in the Northwest Hillsborough Basin in Hillsborough County, Florida (Section 22, Township 27S, Range 18E). The area surrounding the lake is categorized as the Land-O-Lakes subdivision of the Tampa Plain in the Ocala Uplift Physiographic District (Brooks 1981); a region of many lakes on a moderately thick plain of silty sand overlying Tampa Limestone. As part of the Florida Department of Environmental Protection's Lake Bioassessment/Regionalization Initiative, the area has been identified as the Land-O-Lakes lake region; an area of numerous neutral to slightly alkaline, low to moderate nutrient, clear-water lakes (Griffith *et al.* 1997).

A lake surface elevation of 54 ft is indicated on the 1956 United States Geological Survey (photorevised 1987) 1:24,000 Sulphur Springs, Fla. quadrangle map. The Florida Lake Gazetteer (Shafer *et al.* 1986) lists the lake surface area as 33 acres at an elevation of 54 ft, NGVD. The lake has a drainage area of 1.5 square miles. Inlets to the lake include shallow ditches from Crenshaw Lake to the north and Round Lake to the west. The lake drains through a ditch on the southwestern shore to a wetland area north of Zambito Lake (Figure 6-61). Saddleback Lake has been intermittently augmented with water pumped from the Floridan Aquifer since the mid-1960s (Stewart and Hughes 1974).

A detailed topographic map of the Saddleback Lake basin (Figure 6-62) was developed for estimation of surface areas associated with various water level elevations. Data used for map production were obtained from field surveys and 1:200 aerial photograph maps of the basin containing one-foot contour lines prepared using photogrammetric methods.

Based on field surveys conducted in 1977, the Governing Board adopted management levels (currently referred to as Guidance Levels) for the Saddleback Lake in September 1980 (Table 6-56).

Table 6-56. Saddleback Lake: Adopted Guidance Levels (09 September 1980) and Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten Year Flood Guidance Level	56.50	NA
High Level	55.50	53.0
Low Level	53.00	33.9
Extreme Low Level	50.56	24.2

NA = not available

Proposed Minimum and Guidance Levels

Recommended Minimum and Guidance Levels for the Saddleback Lake, a Category 2 Lake, are listed in Table 6-57, along with area values for each water level. The Minimum Lake Level was established at the Historic P50 elevation at 53.59 ft. The proposed High Minimum Lake Level was established at the High Guidance Level at 54.59 ft. The proposed High Minimum Lake Level is 2.2 ft below the Low Floor Slab elevation. Development of Guidance Levels is described in the following sub-section.

Table 6-57. Saddleback Lake: Recommended Minimum and Guidance Levels with Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten-Year Flood Guidance Level	56.10	NA
High Guidance Level	54.59	45.7
High Minimum Lake Level	54.59	45.7
Minimum Lake Level	53.59	37.2
Low Guidance Level	52.49	29.0

The southwest corner of the north basin of Saddleback Lake is contiguous with a cypress-dominated wetland of more than 0.5 acres in size. The lake is classified as a Category 2 Lake because the elevation 1.8 feet below the Normal Pool elevation (54.15 ft) is greater than the Historic P50 elevation.

The Ten Year Flood Guidance Level (Table 6-57) was established for Saddleback Lake using the methodology for open basin lakes described in Section 5 of this report. The District used an existing hydrologic and hydraulic computer model of the Rocky Creek Watershed developed by Hillsborough County (Hillsborough County 1998). The Rocky Creek runoff hydrographs were computed using the NRCS Dimensionless Unit Hydrograph method, a 256 shape factor, a 10.0 inch rainfall depth, and a 72-hour rainfall distribution developed by the South Florida Water Management District. The Rocky Creek conveyance system was simulated with the Hillsborough County modified version of EXTRAN, and the hydrodynamic routing component of the Environmental Protection Agency's Stormwater Management Model (SWMM) v.4.31. District staff modified the EXTRAN input data developed by Hillsborough County, to include additional surveyed elements of the Saddleback Lake outlet conveyance system. The initial elevation of Saddleback Lake was set at the outlet control point elevation of 53.65 feet NGVD. The modified data set was then used to determine the 10-year flood level based on runoff hydrographs from the 10-year storm event.

Table 6-58. Saddleback Lake: Summary of Elevation Data and Associated Area Values Used for Establishing Minimum Levels.

Level	**Elevation (ft, NGVD)**	**Total Lake Area (acres)**
Current P10	54.59	45.7
Current P50	53.38	36.1
Current P90	52.35	28.6
Normal Pool	55.95	55.0
Low Floor Slab	56.79	NA
Control Point	53.65	37.2
High Guidance Level	54.59 (Current P10)	45.7
Historic P50	53.59 (HGL - RLWR50)	37.2
Low Guidance Level	52.49 (HGL - RLWR90)	29.0

NA = not available / not applicable

Table 6-59. Saddleback Lake: Elevation Data Used for Establishing the "Normal Pool" Elevation. Data collected 13 December, 2000; water level = 52.07 ft, NGVD.

Hydrologic Indicator	Height above Lake Water Level (ft)	Elevation (ft, NGVD)
Cypress buttress - normal pool	3.80	55.87
Cypress buttress - normal pool	3.98	56.05
Cypress buttress - normal pool	3.86	55.93
Cypress buttress - normal pool	4.14	56,.21
Cypress buttress - normal pool	4.34	56.41
Cypress buttress - normal pool	3.83	55.9
Cypress buttress - normal pool	3.92	55.99
Cypress buttress - normal pool	3.67	55.74
Cypress buttress - normal pool	3.85	55.92
Cypress buttress - normal pool	3.38	55.45
Mean	**3.88**	**55.95**

Table 6-60. Saddleback Lake: Summary of Structural Alteration / Control Point Elevation Information. Numbers correspond to those shown in Figure 6-64.

No.	Description	Elevation (ft, NGVD)
1	Control point: sediment in channel north of structure	53.65
2	North end of structure: two 36" corrugated metal culverts	53.20, 53.21

Figure 6-61. Location of District lake gauge, outlet and sites where indicators of high water level were measured at Saddleback Lake, Hillsborough County, Florida.

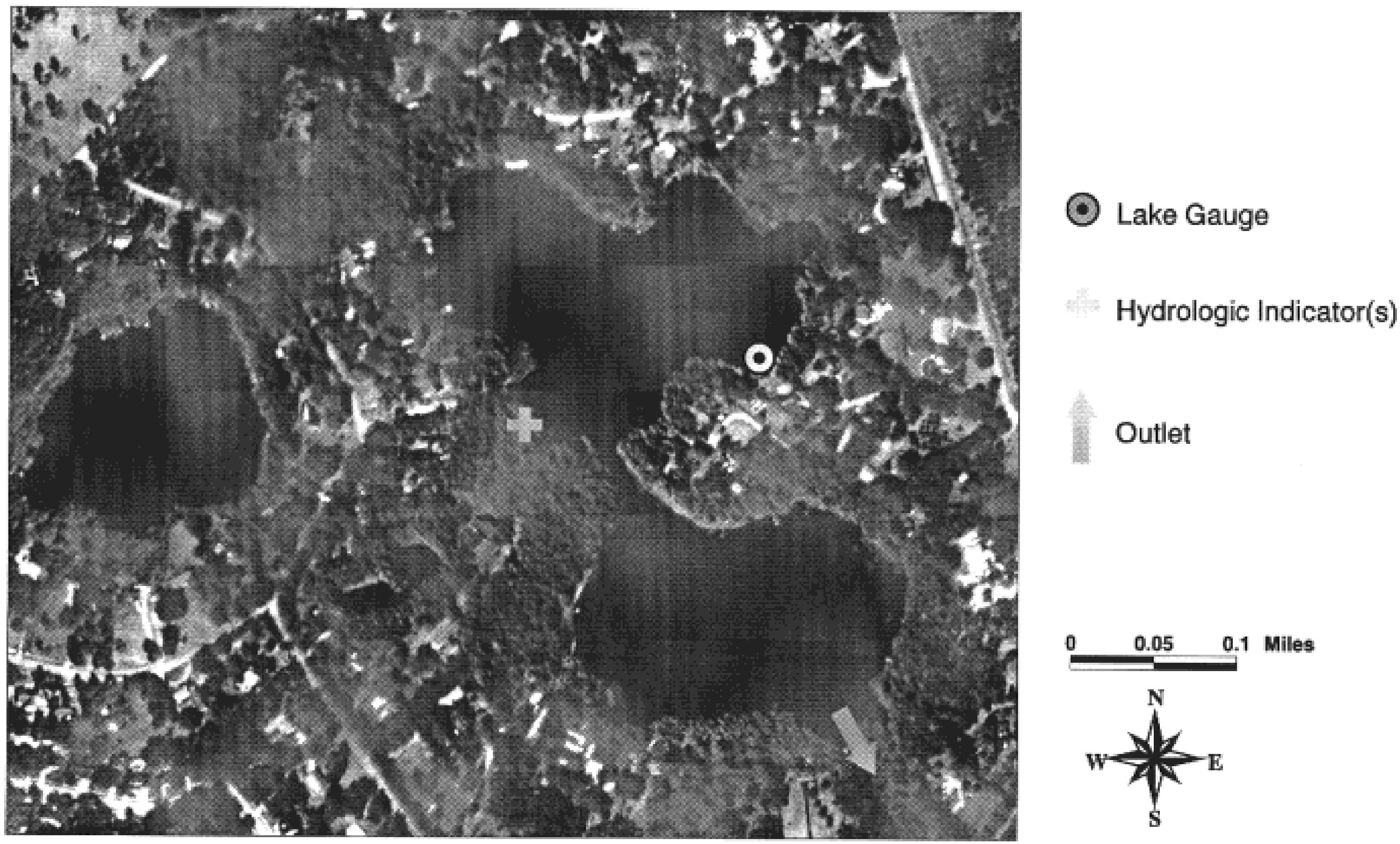


Figure 6-62. One-foot contour map of the Saddleback Lake basin, Hillsborough County, Florida. Values shown are elevations, in feet, above the National Geodetic Vertical Datum.

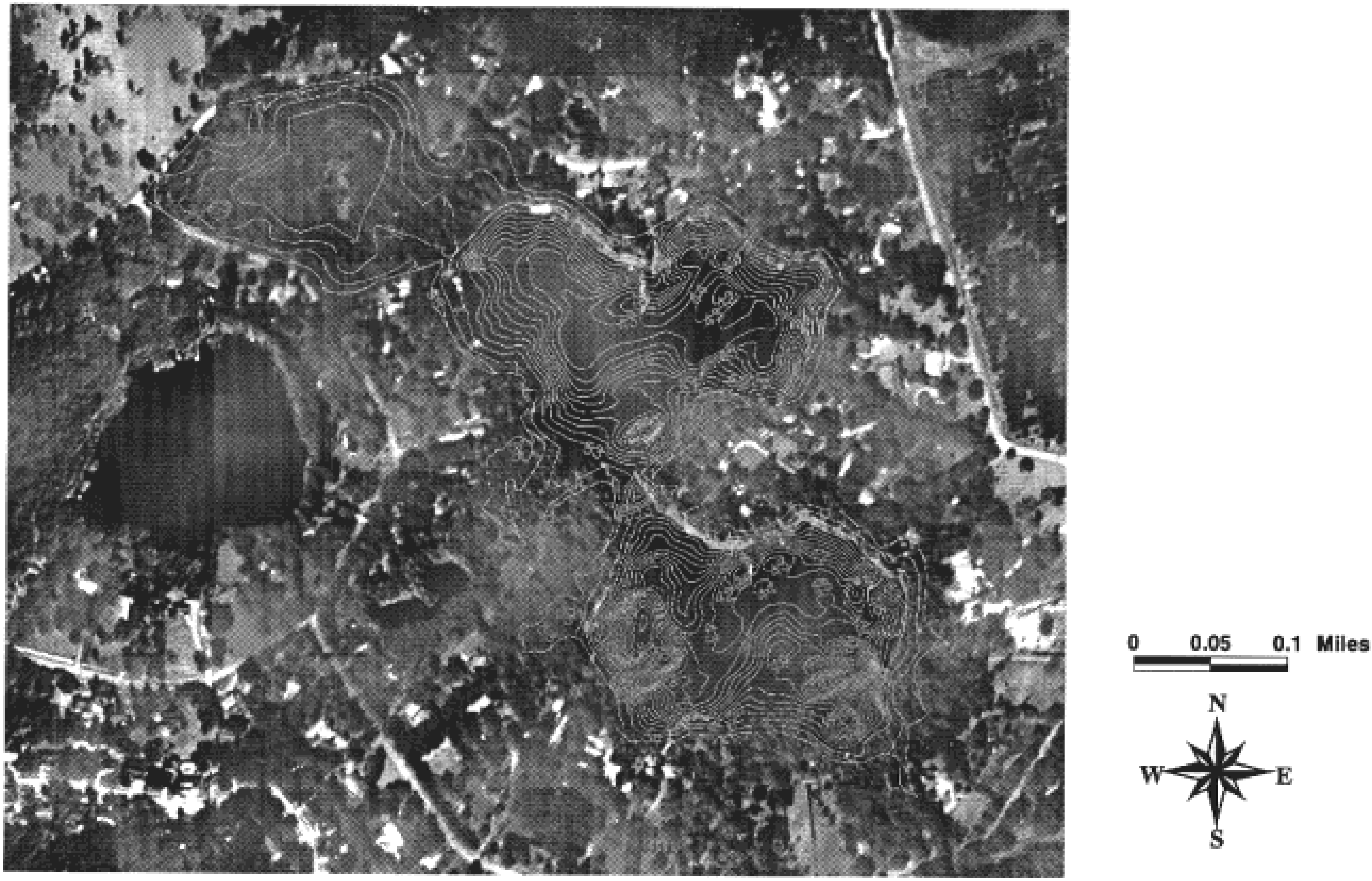


Figure 6-63. Mean monthly water elevations at Lake Saddleback, Hillsborough County, Florida. Proposed High Minimum Lake Level (HMLL), Minimum Lake Level (MLL), Ten-Year Flood Guidance Level (10-YR), High Guidance Level (HGL), and Low Guidance Level (LGL) are shown as solid or dashed lines.

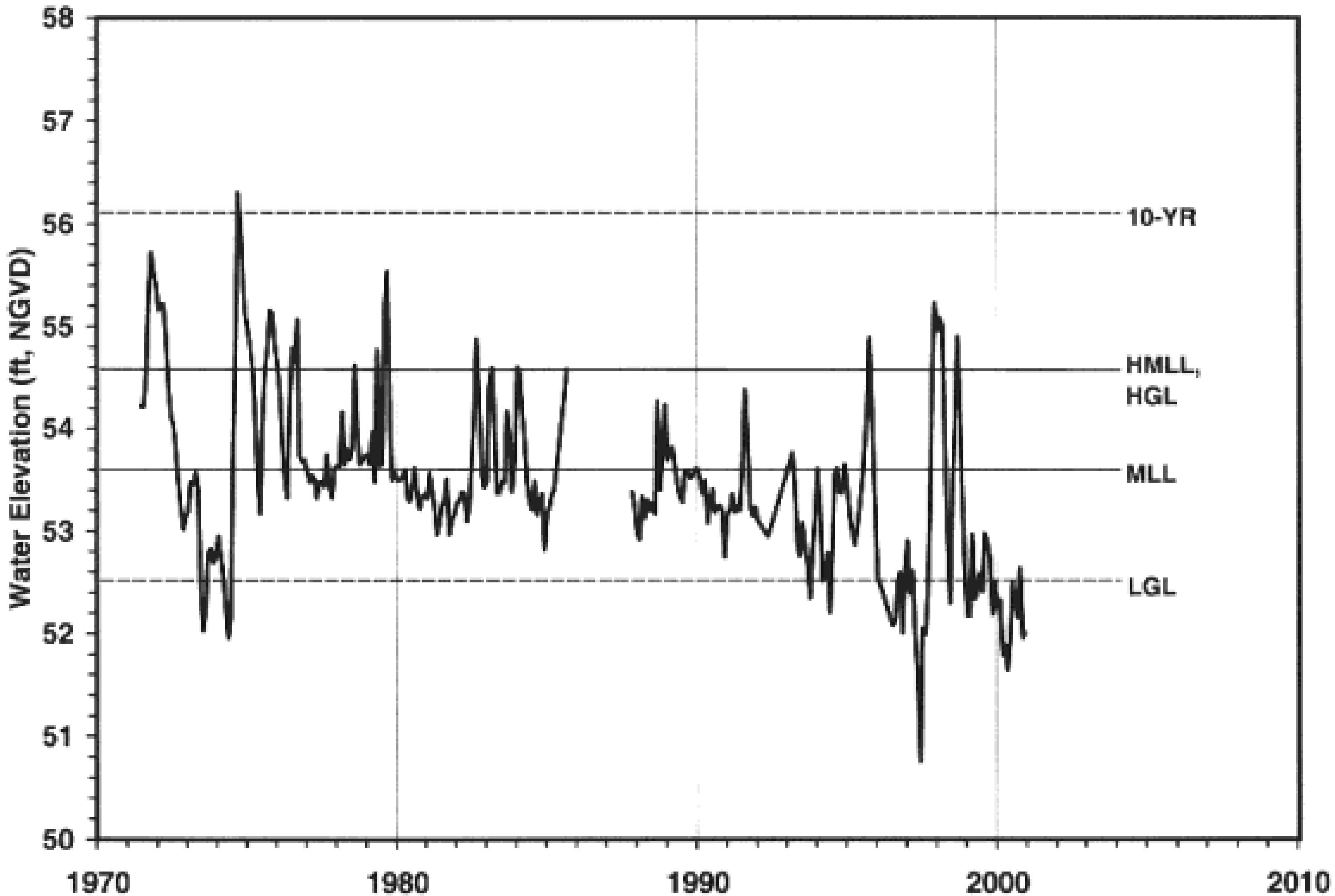
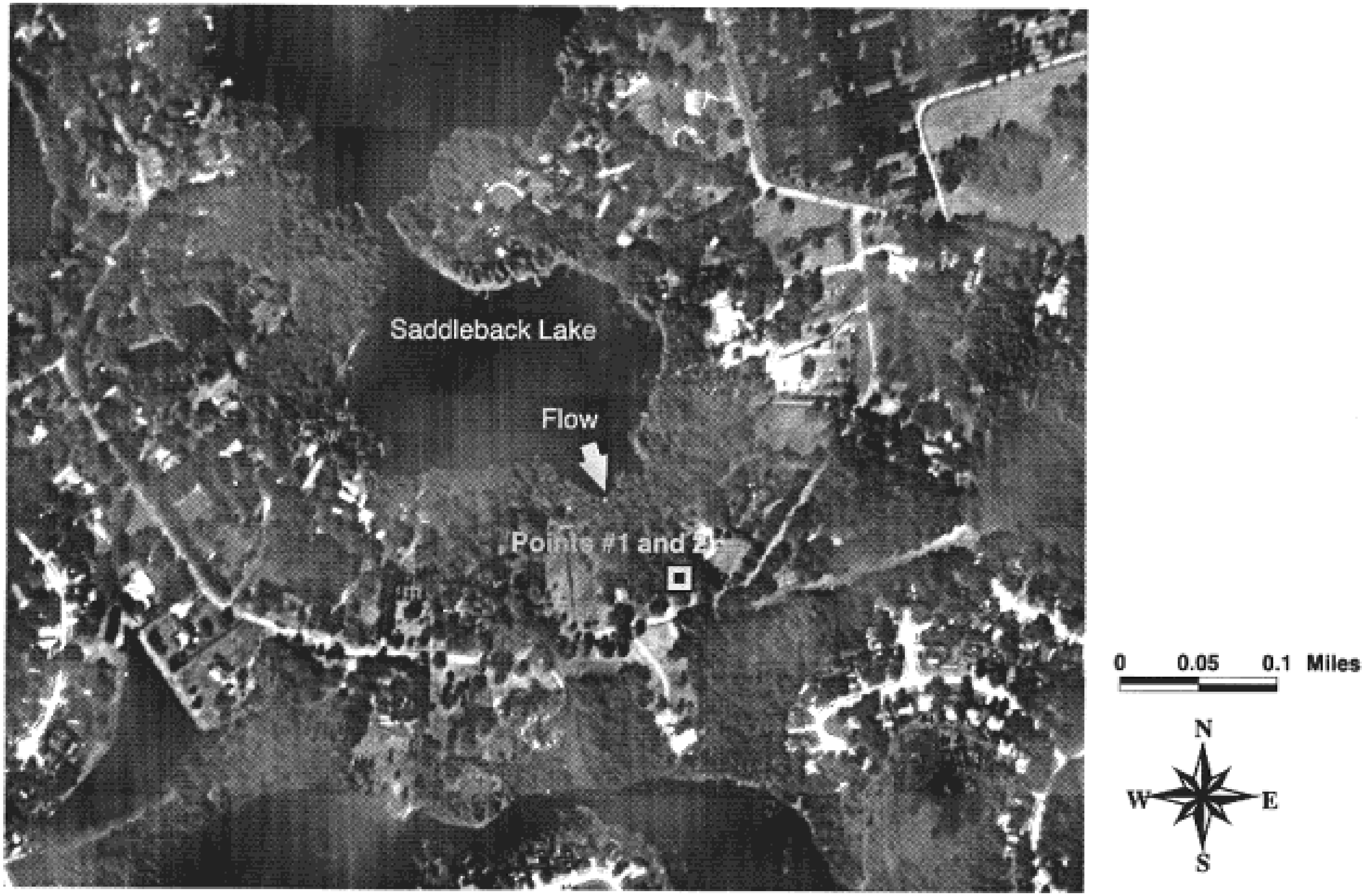


Figure 6-64. Outlet conveyance system for Saddleback Lake, Hillsborough County, Florida. Numbered sites are described in Table 6-55.



Starvation Lake

General Lake Description and Previously Adopted Lake Management Levels

Starvation Lake is located in the Northwest Hillsborough Basin in Hillsborough County, Florida (Section 21, Township 27S, Range 18E). The area surrounding the lake is categorized as the Land-O-Lakes subdivision of the Tampa Plain in the Ocala Uplift Physiographic District (Brook 1982); a region of many lakes on a moderately thick plain of silty sand overlying Tampa Limestone. As part of the Florida Department of Environmental Protection's Lake Bioassessment/Regionalization Initiative, the area has been identified as the Land-O-Lakes lake region; an area of numerous neutral to slightly alkaline, low to moderate nutrient, clear-water lakes (Griffith *et al.* 1997).

A lake surface elevation is not provided on the 1956 United States Geological Survey (photorevised 1987) 1:24,000 Citrus Park, Fla. quadrangle map, although the lake is shown separated into two basins, a state expected when the surface water elevation drops below 46-47 ft NGVD. The Florida Lake Gazetteer (Shafer *et al.* 1986) lists the lake surface area at 52 acres when the water level is at an elevation of 53 ft NGVD. The lake has a drainage area of 0.7 square miles. Inlets to the lake include a culvert connected to a small cypress wetland northwest of the lake, and a canal entering the lake from Lake Jackson to the west. The lake drains through a ditch on the southern shore which leads to Lake Crum (Figure 6-65). Anecdotal reports indicate that Starvation Lake was intermittently augmented with Floridan ground water prior to the 1980s (Hassell 1994).

A detailed topographic map of the Starvation Lake basin (Figure 6-66) was developed for estimation of surface areas associated with various water level elevations. Data used for map production were obtained from field surveys and 1:200 aerial photograph maps of the basin containing one-foot contour lines prepared using photogrammetric methods.

Based on studies completed in 1977, the Governing Board adopted management levels (currently referred to as Guidance Levels) for Starvation Lake in September 1980 (Table 6-61).

Table 6-61. Lake Starvation: Adopted Guidance Levels (09 September 1980) and Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten Year Flood Guidance Level	55.00	NA
High Level	53.00	81.4

Low Level	50.00	55.2
Extreme Low Level	48.00	48.0

NA = not available

Proposed Minimum and Guidance Levels

Recommended Minimum and Guidance Levels for the Starvation Lake, a Category 3 Lake, are listed in Table 6-62, along with area values for each water level. The Basin Connectivity, Species Richness, and Aesthetic Standards for the lake are lower than the Historic P50 elevation, and were evaluated for development of minimum levels. The Species Richness Standard, the most conservative of these standards, was used to establish the proposed Minimum Lake Level at 50.65 ft. The proposed Minimum Lake Level is 1.1 ft below the Historic P50 elevation. Lake area at the proposed Minimum Lake Level is about 85% of the area associated with the Historic P50 elevation. The proposed High Minimum Lake Level was established at 51.65 ft, an elevation corresponding to the Minimum Lake Level plus the RLWR50 (1.0 ft) for the northern Tampa Bay area. The proposed High Minimum Lake Level is 1.1 ft below the High Guidance Level. Lake area at the proposed High Minimum Lake Level is about 91% of that associated with the High Guidance Level. Development of Guidance Levels is described in the following sub-section.

Table 6-62. Starvation Lake: Recommended Minimum and Guidance Levels with Associated Area Values.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Ten-Year Flood Guidance Level	53.77	NA
High Guidance Level	52.72	80.2
High Minimum Lake Level	51.65	72.9
Minimum Lake Level	50.65	62.9
Low Guidance Level	50.62	62.9

NA = not available

Summary of Data and Analyses Supporting Recommended Minimum and Guidance Levels

Hydrologic data are available for Starvation Lake for the period from June 1961 through the present (December 2000) (Figure 6-67, see Figure 6-65 for location of the District water level gauge). For the period of record from January 1974 to the present, the hydrologic data are classified as Current data. These current data were used to calculate the Current P10, P50, P90 (Table 6-63). The Category 3 Lake Normal Pool elevation (Table 6-63) was established based on measurement of the elevation of saw palmetto (*Serenoa repens*) shrubs along the lake shore, and the morphology of buttressed cypress trees along the south shore of Lake Jackson (Table 6-64). Because the lake is in a public park, no homes are found in lake vicinity. The control point elevation was determined using available one-foot contour interval aerial maps, and field surveying (Tables 6-63 and 6-65, Figure 6-68). The Category 3 Lake Normal Pool elevation is above the control point, so the lake is considered to be Structurally Altered.

Based on the relationship between the control point elevation, the Category 3 Lake Normal Pool elevation and the Current P10, the High Guidance Level was established at the control point elevation (Table 6-58). The Historic P50 and Low Guidance Level were determined using the High Guidance Level and the Northern Tampa Bay Region RLWR50 (1.0 ft) and RLWR90 (2.1 ft) (Table 6-63).

Starvation Lake is not contiguous with any cypress-dominated wetlands of 0.5 of more acres in size and is therefore classified as a Category 3 Lake. The basin does contain stands of cattail (Typha sp.) and other wetland vegetation. No docks have been constructed at the lake, so development of a Dock-Use Standard is not appropriate. A Basin Connectivity Standard was established at 49.6 ft, based on use of power boats in the lake, a critical high-spot elevation of 46.5 ft and the RLWR5090 for the northern Tampa Bay area (1.1 ft). A Species Richness Standard was established at 50.65 ft, based on a 15% reduction in lake surface area from that at the Historic P50 elevation. An Aesthetic-Standard was established at the Low Guidance Level elevation of 50.62 ft. A Recreation/Ski Standard was established at 52.1 ft, based on a critical ski elevation of 51.0 ft and the RLWR5090 for the northern Tampa Bay area (1.1 ft). Review of the dynamic ratio for lake stages bounded by the Current P10 and Current P90 elevations did not indicate that potential changes in basin susceptibility to wind-induced sediment resuspension would be of concern for minimum levels development (Table 4-1, Figure 6-69). Changes in potential herbaceous wetland area and area of potential aquatic macrophyte colonization with lake stage also did not indicate that use of any of the identified standards would be inappropriate (Figure 6-69).

The Ten Year Flood Guidance Level (Table 6-62) was established for Starvation Lake using the methodology for open basin lakes described in Section 5 of this report. The District used an existing hydrologic and hydraulic computer model of the Rocky Creek Watershed developed by Hillsborough County (Hillsborough County 1998). The Rocky Creek runoff hydrographs were computed using the NRCS Dimensionless Unit Hydrograph method, a 256 shape factor, a 10.0 inch rainfall depth, and a 72-hour rainfall distribution developed by the South Florida Water Management District. The Rocky Creek conveyance system was simulated with the Hillsborough County modified version of EXTRAN, and the hydrodynamic routing component of the Environmental

Protection Agency's Stormwater Management Model (SWMM) v.4.31. District staff modified the EXTRAN input data developed by Hillsborough County to include additional surveyed elements of the Starvation Lake outlet conveyance system. The initial elevation of Starvation Lake was set at the outlet control point elevation of 52.72 fee NGVD. The modified data set was then used to determine the 10-year flood level based on runoff hydrographs from the 10-year storm event.

Table 6-63. Starvation Lake: Summary of Elevation Data and Associated Area Values Used for Establishing Minimum Levels.

Level	Elevation (ft, NGVD)	Total Lake Area (acres)
Current P10	51.97	75.5
Current P50	48.88	51.5
Current P90	45.66	37.1
Category 3 Lake Normal Pool	53.33	NA
Low Floor Slab	NA	NA
Control Point	52.72	80.2
High Guidance Level	52.72 (Control Point)	80.2
Historic P50	51.72 (HGL - RLWR50)	73.7
Low Guidance Level	50.62 (HGL - RLWR90)	62.9
Dock-Use Standard	NA	NA
Basin Connectivity Standard	49.6	53.9
Species Richness Standard	50.65	62.9
Aesthetic Standard	50.62	62.9
Recreation/Ski Standard	52.1	76.3

NA = not available / not applicable

Table 6-64. Starvation Lake: Elevation Data Used for Establishing the Category 3 Lake Normal Pool Elevation. Data collected from Starvation Lake* on a date when the water level was 66.25 ft, NGVD and from Lake Jackson on 12 August, 1999; water level = 47.44 ft, NGVD.

Hydrologic Indicator	Height above Lake Water Level (ft)	Elevation (ft, NGVD)
Base of saw palmetto	NA	53.50
Base of live oak	NA	52.24
Cypress buttress - normal pool	5.99*	53.43*
Cypress buttress - normal pool	6.00*	53.44*
Cypress buttress - normal pool	6.02*	53.46*
Cypress buttress - normal pool	6.13*	53.57*
Cypress buttress - normal pool	5.85*	53.29*
Cypress buttress - normal pool	6.26*	53.70*
Mean	**NA**	**53.33**

NA = not available
Note: "Base of saw palmetto" and "Base of live oak" values are means of data obtained from Jim Bays/CH2M Hill

Table 6-65. Starvation Lake: Summary of Structural Alteration / Control Point Elevation Information. Numbers correspond to those shown in Figure 6-68.

No.	Description	Elevation (ft, NGVD)
1	Control point: vegetated natural ground	52.72

Figure 6-65. Location of District gauge and outlet at Starvation Lake, Hillsborough County, Florida, and location of hydrologic indicators of high water levels at Lake Jackson, Hillsborough County, Florida.

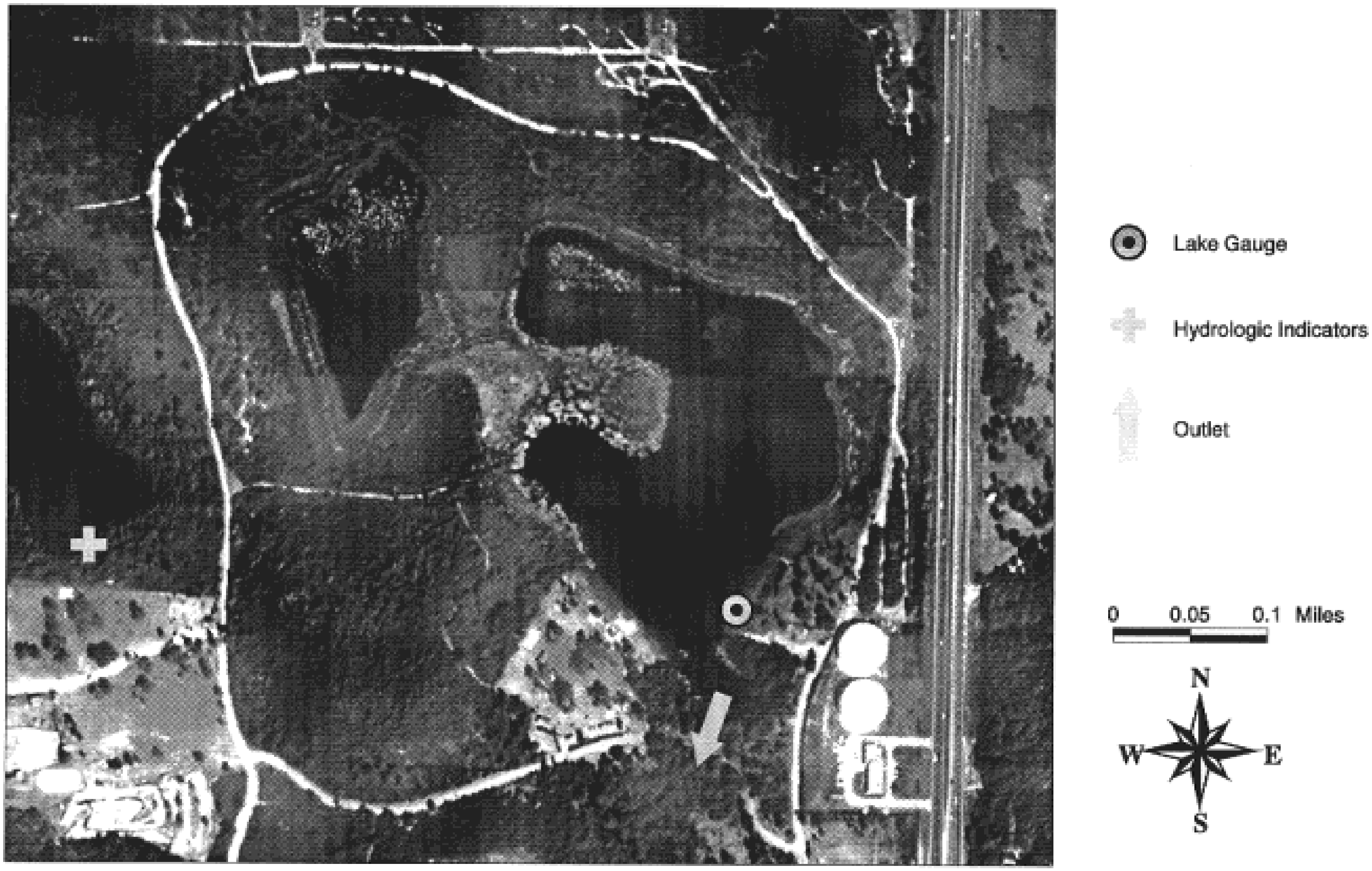


Figure 6-66. One-foot contour map of the Starvation Lake basin, Hillsborough County, Florida. Values shown are elevations, in feet, above the National Geodetic Vertical Datum.

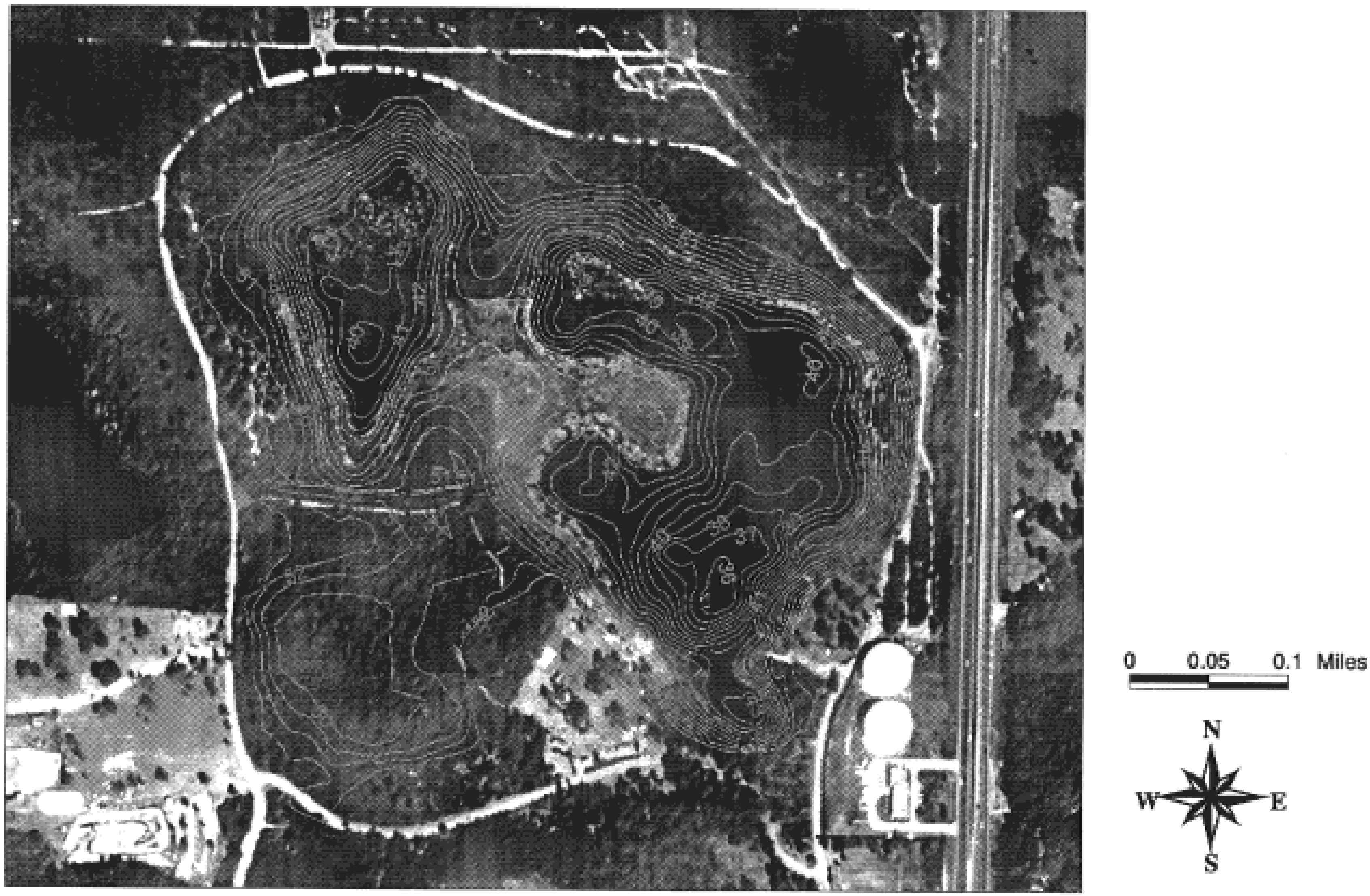


Figure 6-67. Mean monthly water elevations at Starvation Lake, Hillsborough County, Florida. Proposed High Minimum Lake Level (HMLL), Minimum Lake Level (MLL), Ten-Year Flood Guidance Level (10-YR), High Guidance Level (HGL), and Low Guidance Level (LGL) are shown as solid or dashed lines.

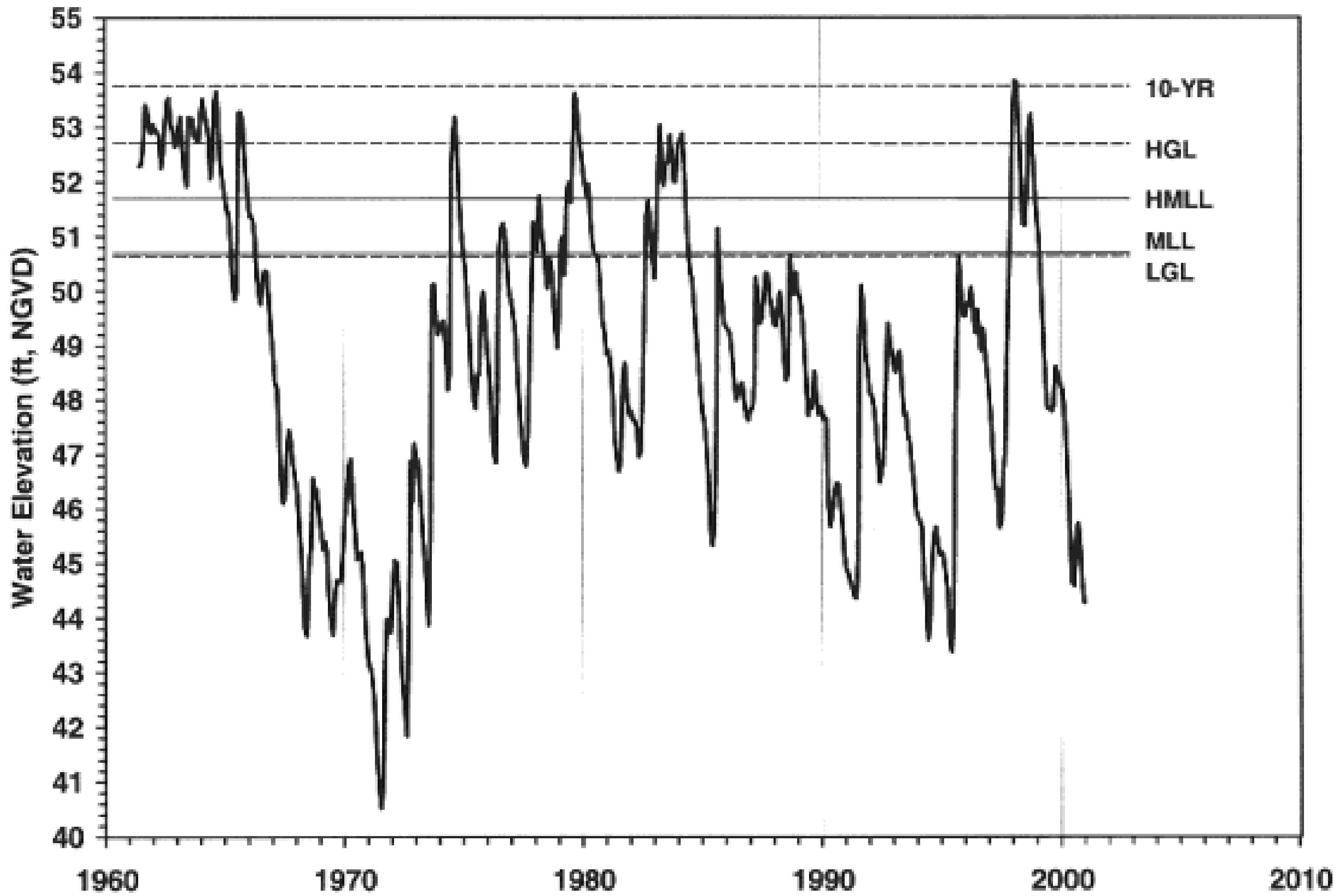
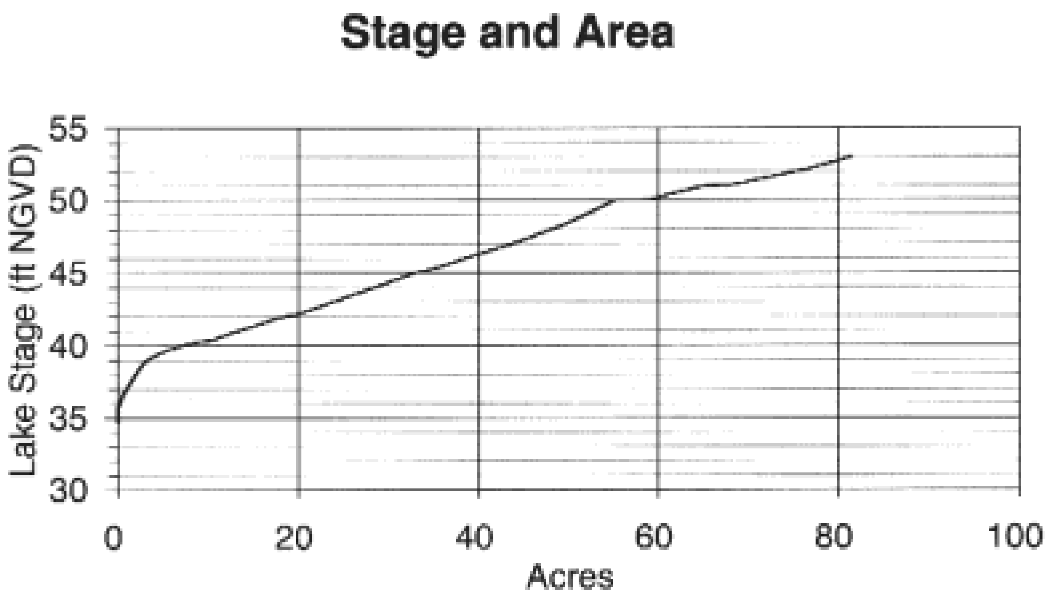


Figure 6-68. Outlet conveyance system for Starvation Lake, Hillsborough County, Florida. Numbered sites are described in Table 6-65.

6-69. Surface area, volume, potential herbaceous wetland area, area potentially colonized by aquatic macrophytes, and dynamic ratio versus lake stage for Starvation Lake, Hillsborough County, Florida.



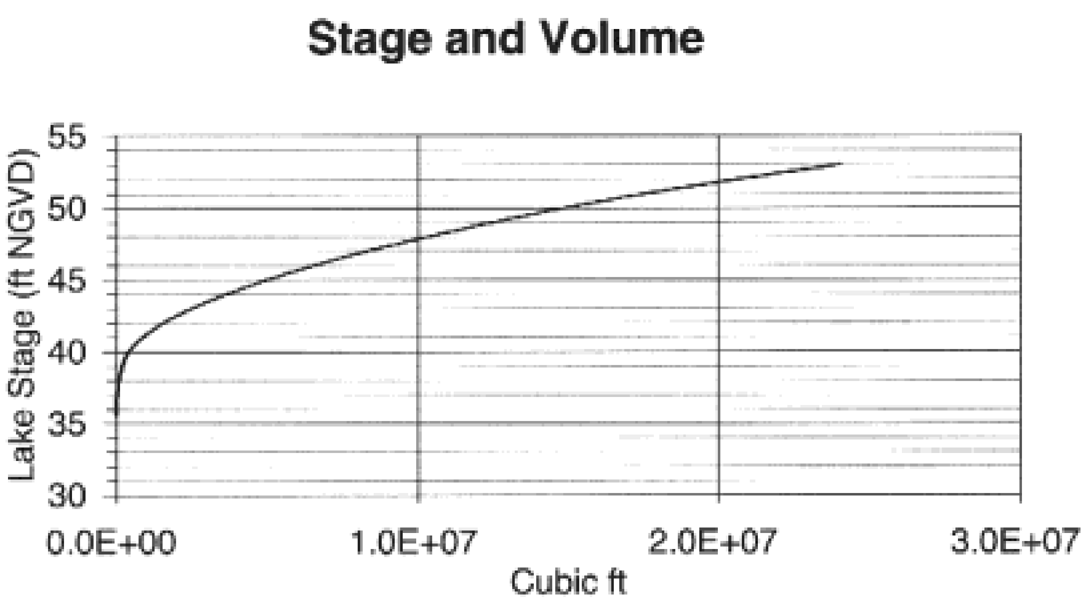
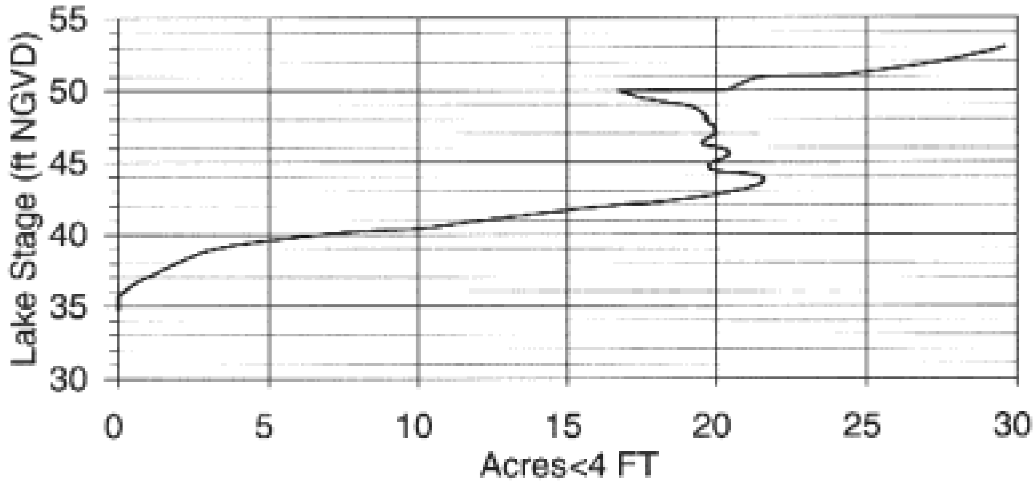


Figure 6-69. (Continued).

Stage and Herbaceous Wetland Area



Stage and Area Available for Aquatic Plant Colonization

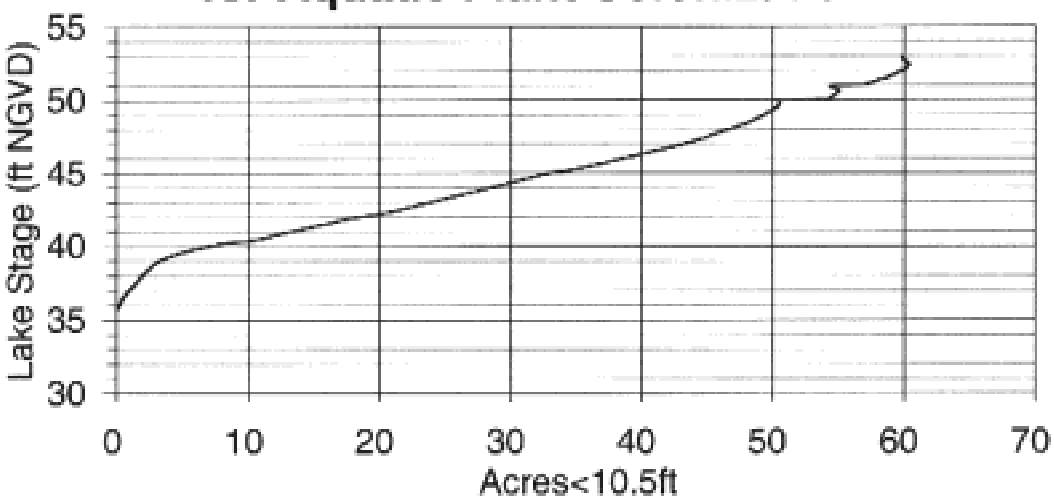
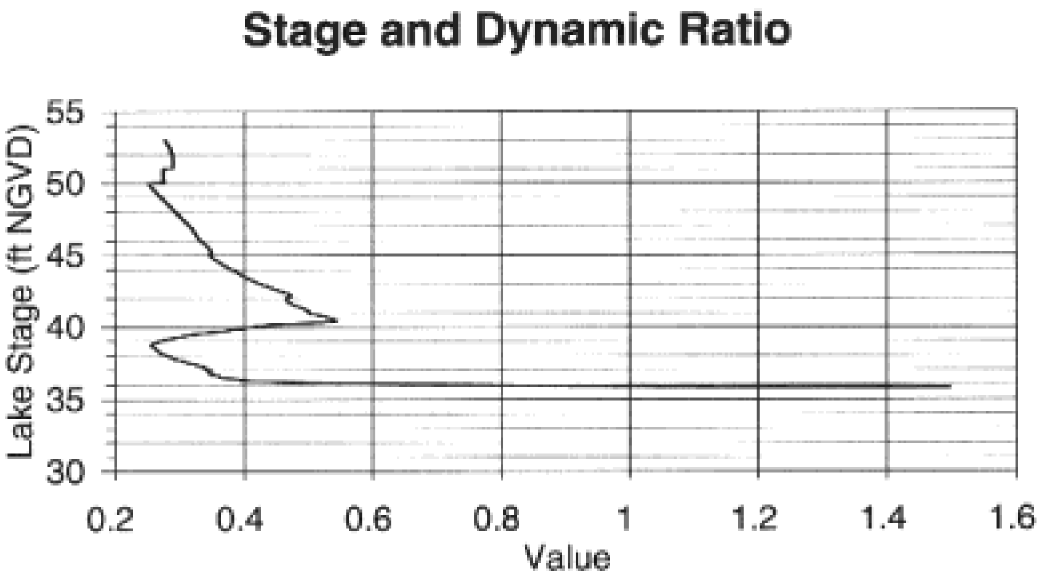


Figure 6-69. (Continued).



Section 7

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Appendices

Appendix A. Sections 373.042 and 373.0421, Florida Statutes.

2000 Florida Statutes

Title XXVIII. NATURAL RESOURCES; CONSERVATION, RECLAMATION, AND USE

Chapter 373. WATER RESOURCES

Part I. STATE WATER RESOURCES PLAN

373.042 Minimum flows and levels.--

(1) Within each section, or the water management district as a whole, the department or the governing board shall establish the following:

(a) Minimum flow for all surface watercourses in the area. 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.

(b) Minimum water level. The minimum water level shall be the level of groundwater in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources of the area.

The minimum flow and minimum water level shall be calculated by the department and the governing board using the best information available. When appropriate, minimum flows and levels may be calculated to reflect seasonal variations. The department and the governing board shall also consider, and at their discretion may provide for, the protection of nonconsumptive uses in the establishment of minimum flows and levels.

(2) By July 1, 1996, the Southwest Florida Water Management District shall amend and submit to the department for review and approval its priority list for the establishment of minimum flows and levels and delineating the order in which the governing board shall establish the minimum flows and levels for surface watercourses, aquifers, and surface water in the counties of Hillsborough, Pasco, and Pinellas. By November 15, 1997, and annually thereafter, each water management district shall submit to the department for review and approval a priority list and schedule for the establishment of minimum flows and levels for surface watercourses, aquifers, and surface waters within the district. The priority list shall also identify those water bodies for which the district will voluntarily undertake independent scientific peer review. By January 1, 1998, and annually thereafter, each water management district shall publish its approved priority list and schedule in the Florida Administrative Weekly. The priority list shall be

based upon the importance of the waters to the state or region and the existence of or potential for significant harm to the water resources or ecology of the state or region, and shall include those waters which are experiencing or may reasonably be expected to experience adverse impacts. The priority list and schedule shall not be subject to any proceeding pursuant to chapter 120. Except as provided in subsection (3), the development of a priority list and compliance with the schedule for the establishment of minimum flows and levels pursuant to this subsection shall satisfy the requirements of subsection (1).

(3) Minimum flows or levels for priority waters in the counties of Hillsborough, Pasco, and Pinellas shall be established by October 1, 1997. Where a minimum flow or level for the priority waters within those counties has not been established by the applicable deadline, the secretary of the department shall, if requested by the governing body of any local government within whose jurisdiction the affected waters are located, establish the minimum flow or level in accordance with the procedures established by this section. The department's reasonable costs in establishing a minimum flow or level shall, upon request of the secretary, be reimbursed by the district.

(4) (a) Upon written request to the department or governing board by a substantially affected person, or by decision of the department or governing board, prior to the establishment of a minimum flow or level and prior to the filing of any petition for administrative hearing related to the minimum flow or level, all scientific or technical data, methodologies, and models, including all scientific and technical assumptions employed in each model, used to establish a minimum flow or level shall be subject to independent scientific peer review. Independent scientific peer review means review by a panel of independent, recognized experts in the fields of hydrology, hydrogeology, limnology, biology, and other scientific disciplines, to the extent relevant to the establishment of the minimum flow or level.

(b) If independent scientific peer review is requested, it shall be initiated at an appropriate point agreed upon by the department or governing board and the person or persons requesting the peer review. If no agreement is reached, the department or governing board shall determine the appropriate point at which to initiate peer review. The members of the peer review panel shall be selected within 60 days of the point of initiation by agreement of the department or governing board and the person or persons requesting the peer review. If the panel is not selected within the 60-day period, the time limitation may be waived upon the agreement of all parties. If no waiver occurs, the department or governing board may proceed to select the peer review panel. The cost of the peer review shall be borne equally by the district and each party requesting the peer review, to the extent economically feasible. The panel shall submit a final report to the governing board within 120 days after its selection unless the deadline is waived by agreement of all parties. Initiation of peer review pursuant to this paragraph shall toll any applicable deadline under chapter 120 or other law or district rule regarding permitting, rulemaking, or administrative hearings, until 60 days following submittal of the final report. Any such deadlines shall also be tolled for 60 days following withdrawal of the request or following agreement of the parties that peer review will no longer be pursued. The department or the governing board shall give significant weight to the final report of the peer review panel when establishing the minimum flow or level.

(c) If the final data, methodologies, and models, including all scientific and technical assumptions employed in each model upon which a minimum flow or level is based, have undergone peer review pursuant to this subsection, by request or by decision of the department or governing board, no further peer review shall be required with respect to that minimum flow or level.

(d) No minimum flow or level adopted by rule or formally noticed for adoption on or before May 2, 1997, shall be subject to the peer review provided for in this subsection.

(5) If a petition for administrative hearing is filed under chapter 120 challenging the establishment of a minimum flow or level, the report of an independent scientific peer review conducted under subsection (4) is admissible as evidence in the final hearing, and the administrative law judge must render the order within 120 days after the filing of the petition. The time limit for rendering the order shall not be extended except by agreement of all the parties. To the extent that the parties agree to the findings of the peer review, they may stipulate that those findings be incorporated as findings of fact in the final order.

History.--s. 6, part I, ch. 72-299; s. 2, ch. 73-190; s. 2, ch. 96-339; s. 5, ch. 97-160.

Note.--Former s. 373.036(7).

373.0421 Establishment and implementation of minimum flows and levels.--

(1) ESTABLISHMENT.--

(a) Considerations.--When establishing minimum flows and levels pursuant to s. 373.042, the department or governing board shall consider 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 an affected watershed, surface water, or aquifer, provided that nothing in this paragraph shall allow significant harm as provided by s. 373.042(1) caused by withdrawals.

(b) Exclusions.--

1. The Legislature recognizes that certain water bodies no longer serve their historical hydrologic functions. The Legislature also recognizes that recovery of these water bodies to historical hydrologic conditions may not be economically or

technically feasible, and that such recovery effort could cause adverse environmental or hydrologic impacts. Accordingly, the department or governing board may determine that setting a minimum flow or level for such a water body based on its historical condition is not appropriate.

2. The department or the governing board is not required to establish minimum flows or levels pursuant to s. 373.042 for surface water bodies less than 25 acres in area, unless the water body or bodies, individually or cumulatively, have significant economic, environmental, or hydrologic value.

3. The department or the governing board shall not set minimum flows or levels pursuant to s. 373.042 for surface water bodies constructed prior to the requirement for a permit, or pursuant to an exemption, a permit, or a reclamation plan which regulates the size, depth, or function of the surface water body under the provisions of this chapter, chapter 378, or chapter 403, unless the constructed surface water body is of significant hydrologic value or is an essential element of the water resources of the area.

The exclusions of this paragraph shall not apply to the Everglades Protection Area, as defined in s. 373.4592(2)(h).

(2) 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 established pursuant to s. 373.042, the department or governing board, as part of the regional water supply plan described in s. 373.0361, shall expeditiously implement a recovery or prevention strategy, which includes the development of additional water supplies and other actions, consistent with the authority granted by this chapter, 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.

The recovery or prevention strategy shall include phasing or a timetable which will allow for the provision of sufficient water supplies for all existing and projected reasonable-beneficial uses, including development of additional water supplies and implementation of conservation and other efficiency measures concurrent with, to the extent practical, and to offset, reductions in permitted withdrawals, consistent with the provisions of this chapter.

(3) The provisions of this section are supplemental to any other specific requirements or authority provided by law. Minimum flows and levels shall be reevaluated periodically and revised as needed.

History.--s. 6, ch. 97-160.

Appendix B. Section 62-40.473, Florida Administrative Code.

Florida Administrative Code
Chapter 62-40 Water Resources Implementation Rule
Part IV. Resource Protection and Management

62-40.473 Minimum Flows and Levels.

(1) In establishing minimum flows and levels pursuant to Section 373.042, consideration shall be given to the protection of water resources, natural seasonal fluctuations in water flows or levels, and environmental values associated with coastal, estuarine, aquatic, and wetlands 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.

(2) Established minimum flows and levels shall be protected where relevant to:

(a) The construction and operation of water resource projects;
(b) The issuance of permits pursuant to Part II, Part IV, and Section 373.086, Florida Statutes; and
(c) The declaration of a water shortage pursuant to Section 373.175 or Section 373.246, Florida Statutes.

(3) Each water management district shall advise the Secretary by January 1, 1995 of the date by which each District shall establish minimum flows and levels for surface waterbodies within the District. Priority shall be given to establishment of minimum flows and levels on waters which are located within:

(a) an Outstanding Florida Water;
(b) an Aquatic Preserve;
(c) an Area of Critical State Concern; or
(d) an area subject to Chapter 380 Resource Management Plans adopted by rule by the Administration Commission, when the plans for an area include waters that are particularly identified as needing additional protection, which provisions are not inconsistent with applicable rules adopted for the management of such areas by the Department and the

Governor and Cabinet.

Specific Authority 373.026, 373.043, 403.061(33), 403.805, FS.
Law Implemented 373.016, 373.042, 373.086, 373.175, 373.223, 373.246, 373.413, FS.

History -- New 5-5-81, Formerly 17-40.08, Amended 12-5-88, Formerly 17-40.080, 17-40.405, 17-40.473, Amended 7-20-95.