

LAKE ASSESSMENT REPORT FOR LAKE KEENE IN HILLSBOROUGH COUNTY FLORIDA

Date Assessed: August 8, 2007

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Reviewed by: Jim Griffin, Ph.D.

INTRODUCTION

This assessment was conducted to update existing physical and ecological data for Lake Keene on the Hillsborough County Watershed Atlas (<http://www.hillsborough.wateratlas.usf.edu/>). The project is a collaborative effort between the University of South Florida's Center for Community Design and Research and Hillsborough County Stormwater Management Section. The project is funded by Hillsborough County and the Southwest Florida Water Management District's Northwest Hillsborough, Hillsborough River and Alafia River Basin Boards. The project has, as its primary goal, the rapid assessing of up to 150 lakes in Hillsborough County during a five year period. The product of these investigations will provide the County, lake property owners and the general public a better understanding of the general health of Hillsborough County lakes, in terms of shoreline development, water quality, lake morphology (bottom contour, volume, area etc.) and the plant biomass and species diversity. These data are intended to assist the County and its citizens to better manage lakes and lake centered watersheds.



Figure 1. General Photograph of Lake Keene taken on August 8, 2007.

The first section of the report provides the results of the overall morphological assessment of the lake. Primary data products include: a contour (bathymetric) map of the lake, area, volume and depth statistics, and the water level at the time of assessment. These data are useful for evaluating trends and for developing management actions such as plant management where depth and lake volume are needed.

The second section provides the results of the vegetation assessment conducted on the lake. These results can be used to better understand and manage vegetation in your lake. A list is provided with the different plant species found at various sites around the lake. Potentially invasive, exotic (non-native) species are identified in a plant list and the percent of exotics is presented in a summary table. Watershed values provide a means of reference.

The third section provides the results of the water quality sampling of the lake. Both field data and laboratory data are presented. The trophic state index (TSI) ⁱ is used to develop a general lake health statement, which is calculated for both the water column with vegetation and the water column if vegetation were removed. These data are derived from the water chemistry and vegetative submerged biomass assessments and are useful in understanding the results of certain lake vegetation management practices.

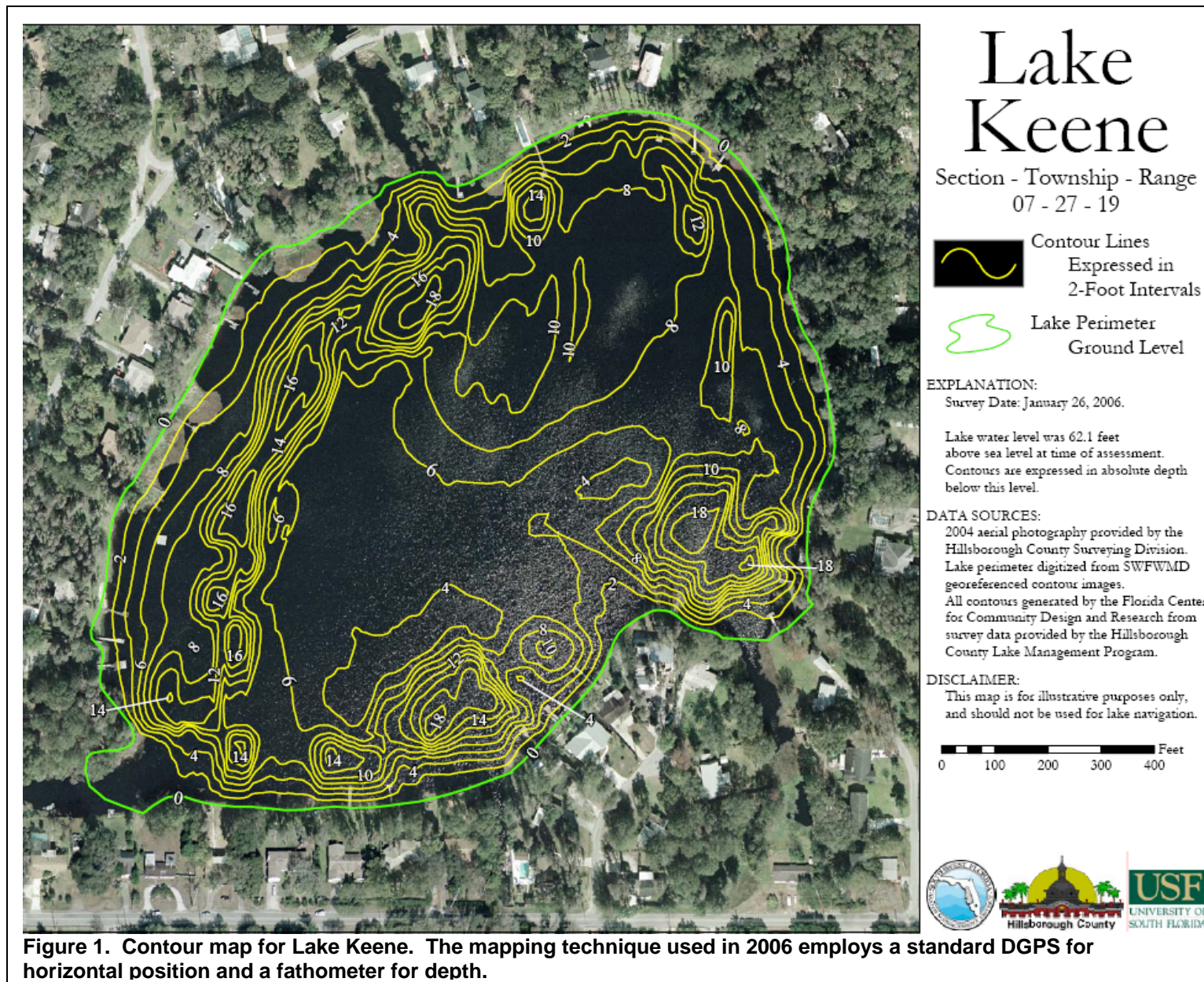
The intent of this assessment is to provide a starting point from which to track changes in your lake, and where previous comprehensive assessment data is available, to track changes in the lake's general health. These data can provide the information needed to determine changes and to monitor trends in physical condition and ecological health of the lake.

Section 1: Lake Morphology

Bathymetric Mapⁱⁱ. The bottom of the lake was mapped using a Lowrance LCX 26C HD Wide Area Augmentation System (WAAS)ⁱⁱⁱ enabled Global Positioning System (GPS) with fathometer (bottom sounder) to determine the boat's position, and bottom depth in a single measurement. The result is an estimate of the lake's area, mean and maximum depths, and volume and the creation of a bottom contour map (Figure 2). Besides pointing out the deeper fishing holes in the lake, the morphologic data derived from this part of the assessment can be valuable to overall management of the lake vegetation as well as providing flood storage data for flood models. Table 1 provides the lake's morphologic parameters in various units.

Table 1. Lake Morphologic Data (Area, Depth, and Volume)

Parameter	Feet	Meters	Acres	Acre-ft	Gallons
Surface Area (sq)	128,024.9	119,475.6	29.52		
Mean Depth	7.0				
Maximum Depth	9.96				
Volume (cubic)	8,953,660.2	253,539		205.5	66,978,049.7
Gauge (above datum)	59.13				



Section 2: Lake Ecology (vegetation)

The lake's apparent vegetative cover and shoreline detail are evaluated using the latest lake aerial photograph as shown in Figure 3 and by use of WAAS enabled GPS. Submerged vegetation is determined from the analysis of bottom returns from the Lowrance 26c HD combined GPS/fathometer described earlier. As depicted in Figure 3, ten vegetation assessment sites were chosen for intensive sampling based on the *Lake Assessment Protocol* (copy available on request) for a lake of this size. The site positions are set using GPS and then loaded into a GIS mapping program (ArcGIS) for display. Each site is sampled in the three primary vegetative zones (emergent, submerged and floating)^{iv}. The latest aerials high resolution aerial photos are used to provide shore details (docks, structures, vegetation zones) and to calculate the extent of surface vegetation coverage. The primary indices of submerged vegetation cover and biomass for the lake, percent area coverage (PAC) and percent volume infestation (PVI), are determined by transiting the lake by boat and employing a fathometer to collect "hard and soft return" data. These data are later analyzed for presence and absence of vegetation and to determine the height of vegetation if present. The PAC is determined from the presence and absence analysis of 100 sites in the lake and the PVI is determined by measuring the difference between hard returns (lake bottom) and soft returns (top of vegetation) for sites (within the 100 analyzed sites) where plants are determined present.

The data collected during the site vegetation sampling include vegetation type, exotic vegetation, predominant plant species and submerged vegetation biomass. The total number of species from all sites is used to approximate the total diversity of aquatic plants and the percent of invasive-exotic plants on the lake (Table 2). The Watershed value in Table 2 only includes lakes sampled during the lake assessment project begun in May of 2006. These data will change as additional lakes are sampled. Tables 3 through 7 detail the results from the 2007 aquatic plant assessment for your lake. These data are determined from the 10 sites used for intensive vegetation surveys. The tables are divided into Floating Leaf, Emergent and Submerged plants and contain the plant code, species, common name and presence (indicated by a 1) or absence (indicated by a blank space) of species and the calculated percent occurrence (number sites species is found/number of sites) and type of plant (Native, Non-Native, Invasive, Pest). In the "Type" category, the term invasive indicates the plant is commonly considered invasive in this region of Florida and the term "Pest" indicates that the plant has a greater than 55% occurrence in your lake and is also considered a problem plant for this region of Florida, or in a non-native invasive that is or has the potential to be a problem plant in your lake and has at least 40% occurrence. These two terms are somewhat subjective; however, they are provided to give lake property owners some guidance in the management of plants on their property. Please remember that to remove or control plants in a wetland (lake shoreline) in Hillsborough County the property owner must secure an [Application To Perform Miscellaneous Activities In Wetlands](http://www.epchc.org/forms_documents.htm) (http://www.epchc.org/forms_documents.htm) permit from the Environmental Protection Commission of Hillsborough and for management of in-lake vegetation outside the wetland fringe (for lakes with an area greater than 10 acres), the property owner must secure a Florida Department of Environmental Protection permit (<http://www.dep.state.fl.us/lands/invaspec/>).

Table 2 Total diversity, percent exotics, and number of EPPC pest plants

Parameter	Lake	Watershed
Total Plant Diversity (# of Taxa)	61	82
% Non-Native Plants	22.95%	24.39%
Total Pest Plant Species	8	11



Figure 3. 2006 six-inch resolution aerial photograph showing location of vegetation assessment sites on Lake Keene. Major emergent and floating vegetation zones as well as structures such as docks are also observable in this aerial.

Table 3. List of Floating Leaf Zone Aquatic Plants Found

Floating Leaved Vegetation

Code	Native, Non-Native (NN), Invasive (I), Pest (P)	Plant Species	Common Name	1	2	3	4	5	6	7	8	9	10	% Occurrence
HYE	Native	<i>Hydrocotyl umbellata</i>	Manyflower Marshpennywort, Water Pennywort	1	1	1	1	1	1	1	1	1	1	100%
NLM	Native, P	<i>Nuphar lutea var. advena</i>	Spatterdock, Yellow Pondlily	1	1	1	1	1	1	1	1	1	1	100%
ECS	NN, I, P	<i>Eichornia crassipes</i>	Water Hyacinth	1	1	1	1	1	1	1	1	1	1	100%
SMA	NN, I, P	<i>Salvinia minima</i>	Water Spangles, Water Fern	1	1	1	1	1	1	1	1	1	1	100%
NNA	Native	<i>Nymphoides aquatica</i>	Banana Lily, Big Floatingheart		1									10%



Figure 4. *Eichornia crassipes*, Water Hyacinth, is a non-native, invasive species from South America. This species is listed as one of the most productive plants on earth, capable of doubling its population in as little as a week. This species can reduce navigational ability in waterways, completely exclude native floating and submerged vegetation, and decrease dissolved oxygen.

Table 4 List of Emergent Zone Aquatic Plants Found
Emergent Vegetation

Code	Native, Non-Native (NN), Invasive (I), Pest (P)	Plant Species	Common Name	1	2	3	4	5	6	7	8	9	10	% Occurrence
PRS	NN, I, P	<i>Panicum repens</i>	Torpedo Grass	1	1	1	1	1	1	1	1	1	1	100%
EBI	Native	<i>Eleocharis baldwinii</i>	Baldwin's Spikerush, Roadgrass	1	1	1	1	1	1	1	1	1	1	100%
BMI	Native	<i>Bacopa monnieri</i>	Common Bacopa, Herb-Of-Grace	1	1	1	1		1	1	1	1	1	90%
CYO	Native	<i>Cyperus odoratus</i>	Fragrant Flatsedge	1		1	1	1	1	1	1	1	1	90%
LPA	Native, P	<i>Ludwigia peruviana</i>	Peruvian Primrosewillow	1	1	1	1	1		1	1	1	1	90%
TAS	Native	<i>Taxodium ascendens</i>	Pond Cypress	1	1	1	1	1		1	1	1	1	90%
EAA	Native	<i>Eclipta alba (prostrata)</i>	False Daisy, Yerba De Tajo	1	1	1	1		1	1	1	1		80%
EWI	Native	<i>Echinochloa walteri</i>	Coastal Cockspur Grass	1	1	1	1	1	1			1	1	80%
APS	NN, I, P	<i>Alternanthera philoxeroides</i>	Alligator Weed	1		1	1	1	1	1		1	1	80%
FSC	Native	<i>Fuirena spp.</i>	Rush Fuirena	1	1			1	1	1	1	1	1	80%
MSS	Native	<i>Mikania scandens</i>	Climbing Hempvine	1	1		1	1	1	1	1	1		80%
COM	Native	<i>Commelina spp.</i>	Dayflower			1	1		1	1	1	1	1	70%
CPS	Native	<i>Cyperus polystachyos</i>	Flat Sedge	1			1		1	1	1	1	1	70%
FBA	Native	<i>Furiera breviseta</i>	Short-Bristled Umbrella-Grass	1	1			1	1	1	1	1		70%
CSS	Native	<i>Cyperus surinamensis</i>	Flat Sedge			1	1		1		1	1	1	60%
FAS	Native	<i>Fimbristylis autumnalis</i>	Fringe-Rush	1				1	1		1	1		50%
TYP	Native	<i>Typha spp.</i>	Cattails	1					1	1		1	1	50%
ACE	Native	<i>Acer rubrum var. trilobum</i>	Southern Red Maple	1		1	1					1	1	50%
CCA	NN, I	<i>Cinnamomum camphora</i>	Camphor-tree	1			1				1	1	1	50%
CAA	Native	<i>Centella asiatica</i>	Asian Pennywort, Coinwort, Spadeleaf						1	1		1	1	40%

Table 5. List of Emergent Zone Aquatic Plants Found

Emergent Vegetation

Code	Native, Non-Native (NN), Invasive (I), Pest (P)	Plant Species	Common Name	1	2	3	4	5	6	7	8	9	10	% Occurrence
BMA	NN, I	<i>Urochloa mutica</i>	Para Grass					1	1	1		1		40%
WTA	NN, I	<i>Sphagneticola (Wedelia) trilobata</i>	Creeping Oxeye		1	1	1						1	40%
LOS	Native	<i>Ludwigia octovalvis</i>	Mexican Primrosewillow, Long-stalked Ludwigia					1		1	1		1	40%
DCS	Native	<i>Drosera capillaris</i>	Pink Sundew			1	1		1					30%
PAR	Native	<i>Paspalum repens</i>	Water Paspalum					1	1			1		30%
MVA	Native	<i>Magnolia virginiana</i>	Sweetbay Magnolia			1	1		1					30%
QLO	Native	<i>Quercus laurifolia</i>	Laurel oak			1	1	1						30%
PNA	Native	<i>Phyla nodiflora</i>	Frog-fruit, Carpetweed, Turkey Tangle Fogfruit				1			1				20%
SPA	NN, I	<i>Sesbania punicea</i>	Spanish Gold, Rattlebox							1	1			20%
BLS	Native	<i>Blechnum serrulatum</i>	Swamp Fern			1					1			20%
LHA	Native	<i>Leersia hexandra</i>	Southern Cutgrass	1		1								20%
PHN	Native	<i>Panicum hemitomon</i>	Maidencane			1		1						20%
POL	Native	<i>Polygonum spp.</i>	Smartweed, Knotweed					1			1			20%
CYP	Native	<i>Cyperus spp.</i>	Sedge	1					1					20%
PBA	Native	<i>Persea borbonia</i>	Redbay	1		1								20%
WAX	Native	<i>Myrica cerifera</i>	Wax Myrtle					1				1		20%
SSM	NN, I	<i>Sapium sebiferum</i>	Popcorn Tree, Chinese Tallow Tree	1							1			20%

Table 6. List of Emergent Zone Aquatic Plants Found

Emergent Vegetation

Code	Native, Non-Native (NN), Invasive (I), Pest (P)	Plant Species	Common Name	1	2	3	4	5	6	7	8	9	10	% Occurrence
STS	NN, I	<i>Schinus terebinthifolius</i>	Brazilian Pepper								1	1		20%
BOC	Native	<i>Boehmeria cylindrica</i>	Bog Hemp, False Nettle							1	1			20%
BID	Native	<i>Bidens spp.</i>	Bur Marigold						1					10%
PCA	Native	<i>Pontederia cordata</i>	Pickerel Weed										1	10%
URL	NN, I	<i>Urena lobata</i>	Caesar's Weed					1						10%
CAS	NN, I	<i>Cyperus alternifolius</i>	Umbrella Sedge, Alternate-Leaf Sedge		1									10%
JUM	Native	<i>Juncus marginatus</i>	Shore Rush, Grassleaf Rush								1			10%
SCS	Native	<i>Scirpus cubensis</i>	Burhead Sedge, Cuban Scirpus	1										10%
GLS	Native	<i>Gordonia lasianthus</i>	Loblolly Bay	1										10%
LAA	Native	<i>Ludwigia arcuata</i>	Ludwigia			1								10%
LRS	Native	<i>Ludwigia repens</i>	Creeping Primrosewillow, Red Ludwigia								1			10%
PEP	Native	<i>Persea palustris</i>	Swampbay					1						10%
PCM	NN, I	<i>Psidium cattleianum</i>	Strawberry Guava			1								10%
PIN	Native	<i>Pinus spp.</i>	Pine Tree				1							10%
SAL	Native	<i>Salix spp.</i>	Willow								1			10%
SAM	Native	<i>Sambucus canadensis</i>	Elderberry		1									10%



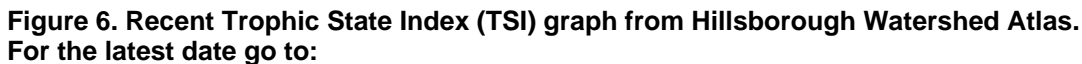
Figure 5. *Paspalum repens*, Water Paspalum, is an infrequently found native grass typically found in water or where it is frequently inundated by water.

Table 7. List of Submerged Zone Aquatic Plants Found

Submerged Vegetation

Code	Native, Non-Native (NN), Invasive (I), Pest (P)	Plant Species	Common Name	1	2	3	4	5	6	7	8	9	10	% Occurrence
MGM	Native	<i>Micranthemum glomeratum</i>	Manatee Mudflower, Baby's Tears	1	1	1		1	1	1			1	70%
ALG	Native	<i>Algal Spp.</i>	Algal Mats, Floating			1	1		1		1			40%
NGS	Native	<i>Najas guadelupensis</i>	Southern Waternymph		1		1			1	1			40%
HVA	NN, I	<i>Hydrilla verticillata</i>	Hydrilla, water thyme									1		10%

A critical element in any lake assessment is the long-term water chemistry data set. The primary source of water quality trend data for Florida Lakes is the Florida LAKEWATCH volunteer and the Florida LAKEWATCH water chemistry data. Hillsborough County is fortunate to have a large cadre of volunteers who have collected lake water samples for significant time period. These data are displayed and analyzed on the Water Atlas as shown in Figure 6 for Lake Keene. Additional data, when available, is also included on the Water Atlas; however, the LAKEWATCH data remains the primary source. By the trend data shown in the figure, the lake may be considered fair to poor health in terms of the trophic state index. This lake is a dark water lake (color > 40 pcu) and as such it must maintain a TSI of below 60 to not be considered impaired by the State of Florida guidelines^v. The lake's long term water quality data indicates enough violations of these criteria to be classified by Florida DEP as impaired. Unfortunately, the last LAKEWATCH data point is in 2004 so a recent trend is not available.



Note: The graph above includes benchmarks for using verbal descriptors of "good", "fair" and "poor". The verbal descriptors for these benchmarks are based on an early determination by stakeholders of the generally acceptable and understood terms for describing the state of lakes. The same benchmarks are used for nutrient graphs (Nitrogen and Phosphorus), chlorophyll graphs and trophic state index (TSI) graphs. The TSI is a calculated index of lake condition based on nutrient and chlorophyll (a) concentrations (please see "Learn more about Trophic State Index"). The benchmarks are established based on the TSI range that relates to a specific descriptor. The source for the TSI concentration relationships is the [Florida Water Quality Assessment, 1996, 305\(b\) \(Table 2-8\)](#).

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useful when compared to the trend data available from LAKEWATCH or other sources. Table 8 contains the summary water quality data and index values and adjusted values calculated from these data. The total phosphorus (TP), total nitrogen (TN) and chlorophyll (a) water chemistry sample data are the results of chemical analysis of samples taken during the assessment and analyzed by the Hillsborough County Environmental Protection Commission laboratory. These data compare reasonably with the mean data from the LAKEWATCH data set for the lake. The trophic state index (TSI) calculated from the sample data (55.2) is significantly below the last (2004) LAKEWATCH data point (65.5); which may indicate improved conditions. Because this lake is presently listed as impaired, it is highly recommended that the LAKEWATCH sampling be resumed to better track conditions.

Tables 9a and 9b contain the field data taken at two locations in the lake using a multi-probe (we use either a YSI 6000 or a Eureka Manta) which has the ability to directly measure the temperature, pH, dissolve oxygen (DO), percent DO (calculated from DO, temperature and conductivity) and Turbidity. These data are listed for three levels in the lake and twice for the surface measurement. The duplicate surface measurement was taken as a quality assurance check on measured data. These data indicate a highly productive, reasonably well mixed lake system which has some anoxic bottom areas.

Table 8. Water Quality Parameters (Laboratory)

<i>Summary Table for Water Quality</i>			
<i>Parameter</i>	<i>Value</i>	<i>Comment</i>	
TP ug/L	23.00		
TN mg/L	1.09		
Chla ug/L	20.70		
Chla TSI	60.43		
TP TSI	50.20		
TN TSI	61.43		
Secchi Disk (SD)	3.19		
TSI	55.32	P limited	
PAC	10%		
PVI	4%		
Adj TP	0.13	P from Veg Added	
Adj TSI	55.38	With additional P	



Figure 7. Lake Keene is classified as Impaired by FDEP as shown on Water Atlas.

Table 9a. Water Quality Parameters (Field-YSI 1)

Sample Location	Time	Temp (°C)	Conductivity (mS/cm3)	Dissolved Oxygen (%)	DO (mg/L)	PH (SU)	ORP (ORP)	Turbidity (NTU)	Secchi Depth (ft)
Surface	13:23	33.08	0.234	129.3	9.26	8.78	17.4	3.1	
Mid	13:26	31.72	0.232	113	8.29	8.12	35.3	4.1	
Bottom	13:28	31.43	0.231	102.4	7.55	7.52	53.1	6.1	
Surface	13:30	33.67	0.234	131.8	9.36	8.84	17	3.2	
Mean Value		32.475	0.23275	119.125	8.615	8.315	30.7	4.125	3.1875

Table 9b. Water Quality Parameters (Field – YSI 2)

Sample Location	Time	Temp (°C)	Conductivity (mS/cm3)	Dissolved Oxygen (%)	DO (mg/L)	PH (SU)	ORP (ORP)	Turbidity (NTU)	Secchi Depth (ft)
Surface	13:39	32.78	0.234	129.8	9.35	8.87	11.8	2.9	
Mid	13:41	31.48	0.234	122.6	9.01	8.43	26.4	3.8	
Bottom	13:44	29.33	0.233	8.6	0.62	6.62	74.8	7.7	
Surface	13:47	33.13	0.234	127.8	9.17	8.86	13.2	2.8	
Mean Value		31.68	0.23375	97.2	7.0375	8.195	31.55	4.3	3.1875

Table 8 also provides data derived from the vegetation assessment which is used to determine an adjusted TSI. This is accomplished by calculating the amount of phosphorus that could be released by existing submerged vegetation if this vegetation were treated with an herbicide or managed by the addition of Triploid Grass Carp (*Ctenopharyngodon idella*). While it would not be expected that all the vegetation would be turned into available phosphorus by these management methods, the data is useful when planning various management activities. Approximately 19 % of the lake has submerged vegetation present and this vegetation represents about 6 % of the available lake volume. The lake has little submerged vegetation and; therefore, the trophic state is not moderated by the presence of vegetation.

To better understand many of the terms used in this report, we recommend that you visit the Hillsborough Watershed Atlas (<http://www.hillsborough.wateratlas.usf.edu>) and explore the “Learn More” areas which are found on the resource pages. Additional information can also be found using the Digital Library on the website.

Section 4: Conclusion

Lake Keene is a small area (29.5 acre) lake that would be considered in the eutrophic or fair category of lakes based on water chemistry. It has a lower than normal concentration of aquatic vegetation. About 10% of the open water areas contain submerged vegetation. Vegetation helps to maintain the nutrient balance in the lake as well as provide good fish habitat. The lake has many open water areas that support various types of recreation and has a fair diversity of plant species. The primary Pest plants in the lake include *Nuphar lutea var. advena*, *Eichornia crassipes*, *Salvinia minima*, *Panicum repens*, *Ludwigia peruviana* and *Alternanthera philoxeroides*. For more information and recent updates please see the Hillsborough Watershed Atlas (water atlas) website at: <http://www.hillsborough.wateratlas.usf.edu>.

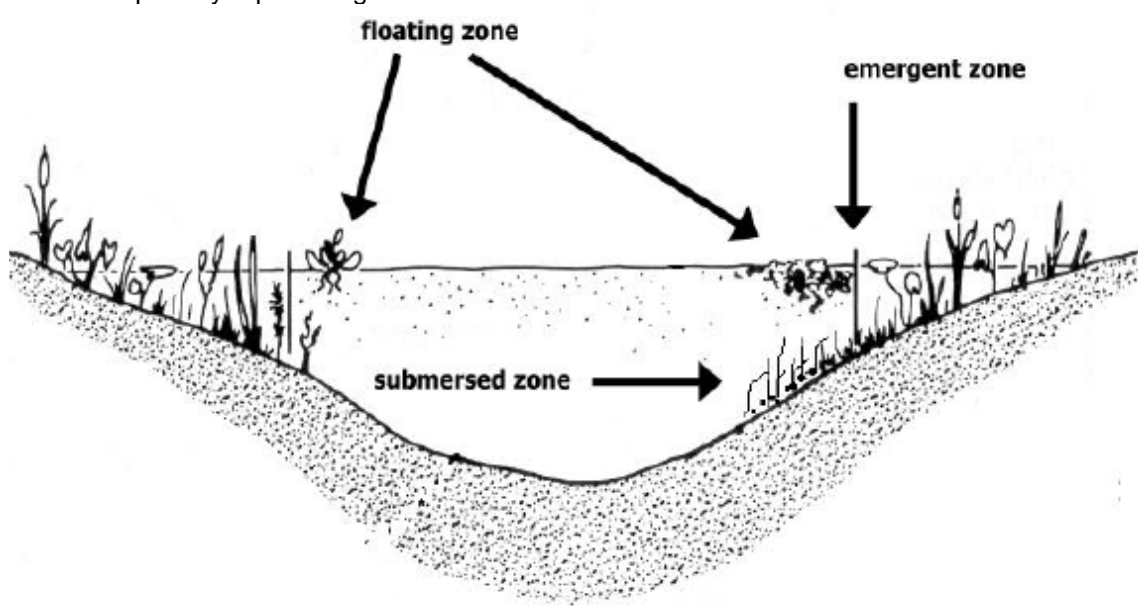
i "Trophic" means "relating to nutrition." The Trophic State Index (TSI) takes into account chlorophyll, nitrogen, and phosphorus, which are nutrients required by plant life. For more information please see *learn more at:*

<http://www.hillsborough.wateratlas.usf.edu/lake/default.asp?wbodyid=5344&wbodyatlas=lake>

ii A bathymetric map is a map that accurately depicts all of the various depths of a water body. An accurate bathymetric map is important for effective herbicide application and can be an important tool when deciding which form of management is most appropriate for a water body. Lake volumes, hydraulic retention time and carrying capacity are important parts of lake management that require the use of a bathymetric map.

iii WAAS is a form of differential GPS (DGPS) where data from 25 ground reference stations located in the United States receive GPS signals from GPS satellites in view and retransmit these data to a master control site and then to geostationary satellites. The geostationary satellites broadcast the information to all WAAS-capable GPS receivers. The receiver decodes the signal to provide real time correction of raw GPS satellite signals also received by the unit. WAAS enabled GPS is not as accurate as standard DGPS which employs close by ground stations for correction, however; it was shown to be a good substitute when used for this type of mapping application. Data comparisons were conducted with both types of DGPS employed simultaneously and the positional difference was determined to be well within the tolerance established for the project.

iv The tree primary aquatic vegetation zones are shown below:



v A lake is impaired if " (2) For lakes with a mean color less than or equal to 40 platinum cobalt units, the annual mean TSI for the lake exceeds 40, unless paleolimnological information indicates the lake was naturally greater than 40, or

For any lake, data indicate that annual mean TSIs have increased over the assessment period, as indicated by a positive slope in the means plotted versus time, or the annual mean TSI has increased by more than 10 units over historical values. When evaluating the slope of mean TSIs over time, the Department shall use a Mann's one-sided, upper-tail test for trend, as described in Nonparametric Statistical Methods by M. Hollander and D. Wolfe (1999 ed.), pages 376 and 724 (which are incorporated by reference), with a 95% confidence level."

Excerpt from Impaired Water Rule (IWR). Please see:

<http://www.dep.state.fl.us/water/tmdl/docs/AmendedIWR.pdf>