



# Lake Keene

LAKE HABITAT ASSESSMENT, LAKE VEGETATION INDEX, SUBMERGED  
VEGETATION SURVEY AND WATER QUALITY

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# Methods

## STUDY AREA ANALYSIS

The watershed containing Lake Keene was analyzed using ESRI ArcGIS 10.2. Using this software with 2011 Hillsborough County aerial, Land Use/ Land Cover (LULC), Landscape Development Intensity (LDI) Index values were calculated for the 100 meter buffer surrounding the lake following the procedures of Reiss & Brown 2012 (Reiss & Brown. 2012. Landscape Development Intensity (LDI) Index User's Manual. H.T. Odum Center for Wetlands, University of Florida. March 2012). According to Reiss and Brown "The LDI represents a human disturbance gradient for wetland systems. The LDI is an integrated measure of human activity, combining the effects from air and water pollutants, physical damage, changes in the suite of environmental conditions ... on the structure and processes of landscapes and ecosystems... Natural, undeveloped LU/LC classes have a LDI index value of one. In the Florida framework, the maximum LDI index score is approximately 42."

The LDI is calculated by multiplying each land use coefficient by the percentage of the area of interest occupied by that land use, and then summing the results. The Florida Department of Environmental Protection (DEP) uses the LDI as a tool to estimate potential land use impacts on streams, lakes, and wetlands. LDI values less than two ( $\leq 2$ ) can be considered minimally disturbed."

## LAKE BATHYMETRY AND MORPHOLOGICAL CHARACTERISTICS ASSESSMENT

The **Bathymetric Map**<sup>1</sup> provides the lake's morphologic parameters in various units. The bottom of the lake was mapped using a Lowrance HDS 5 Gen 2 Wide Area Augmentation System (WAAS)<sup>2</sup> 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. 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.

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<sup>1</sup> 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.

<sup>2</sup> 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. For more information, see end note 2.

## LAKE VEGETATION INDEX ASSESSMENT

Hillsborough County requested the implementation of the Florida Department of Environmental Protection methods for Lake Vegetation Index (LVI 1000) (<http://www.dep.state.fl.us/water/sas/sop/sops.htm>) using forms FD 9000-03 (Physical/Chemical Characterization), FD 9000-06 (Lake Habitat Assessment) FD 9000-27 (LVI Field Sheet) and FD 9000-31 (Lake Observation Field Sheet).

The Lake Vegetation Index (LVI) is a rapid assessment protocol in which selected sections of a lake are assessed for the presence or absence of vegetation through visual observation and through the use of a submerged vegetation sampling tool called a Frodus. The assessment results provide a list of species presents and the dominant and where appropriate co-dominant species that are found in each segment. These results are then entered into a scoring table and a final LVI score is determined. LVI scores provide an estimate of the vegetative health of a lake. Our assessment team was trained and qualified by FDEP to conduct these assessment as an independent team and must prequalify each year prior to conducting additional assessments. The LVI method consists of dividing the lake into twelve pie-shaped segments (see diagram below) and selecting a set of four segments from the twelve to include in the LVI. The assessment team then travels across the segment and identifies all unique species of aquatic plant present in the segment. Additionally, a Frodus is thrown at several points on a single five-meter belt transect that is established in the center of the segment from a point along the shore to a point beyond the submerged vegetation zone. For scoring, the threshold score for impairment is 37.

Four metrics are utilized in the Lake Vegetation Index Survey; Dominant Coefficient of Conservatism (CoC), Percent Florida Exotic Pest Plant Council Type 1 (% FLEPPC), Percent Native Taxa, Percent Sensitive Taxa.

The Dominant Coefficient of Conservatism (CoC) metric for the dominant or co-dominate species in each section. The CoC applies a score of 0-10 to each species based on its ecological tolerances and fidelity to pre-settlement conditions. Species with higher scores show a high fidelity to native, undisturbed habitats and are typically sensitive to alterations. Available CoC scores can be obtained from LT 7000 from the Florida Department of Environmental Protection at: <http://www.dep.state.fl.us/water/sas/sop/sops.htm>.

The percent FLEPPC (Florida Exotic Pest Plant Council) Category 1 invasive exotic taxa in a single sampling unit (pie slice) by dividing the number of FLEPPC Category I taxa by the total number of taxa in that sampling unit. Multiply result times 100. Refer to Appendix LVI 1000-1 to determine which plants are on the FLEPPC Category 1 list. Note that not all exotic taxa should be included in this metric, only those listed in Appendix LVI 1000-1 as Category 1 FLEPPC. If the FLEPPC updates their list of Category 1 exotics, those updates shall not be reflected in this calculation until they are included in Appendix LVI 1000-1.

The percent native taxa in a single sampling unit (pie slice) is calculated by dividing the number of native taxa by the total number of taxa in that sampling unit. Multiply result times 100. Nativity status is determined by the Plant Atlas from the Institute for Systematic Botany, and is listed in Appendix LVI 1000-1. For informational purposes, visit the website

<http://www.florida.plantatlas.usf.edu/>. Taxa that are native according to the Plant Atlas from the Institute for Systematic Botany but are not on the list in Appendix LVI 1000-1 may be included in this metric calculation, but inclusion of these additional taxa is not required.

The percent sensitive taxa in a single sampling unit by summing the number of taxa with a C of C (Coefficient of Conservatism) score  $\geq 7$  and then dividing by the total number of taxa in that sampling unit. Multiply result times 100. Refer to Appendix LVI 1000-1 for a list of C of C scores.

The collected bathymetric data is analyzed for submerged aquatic vegetation (SAV) calculations including the percentage of the surface area of the lake inhabited by SAV as well as an estimate of the percent volume of the lake inhabited by SAV. SAV is an important component to a lakes nutrient cycling as well as chlorophyll concentrations due to the SAV and phytoplankton competing for available nutrients in the water column. In addition SAV serves a vital role as habitat for many species of macroinvertebrates and fish as well as substrate for epiphytic algae.

## WATER QUALITY ASSESSMENT

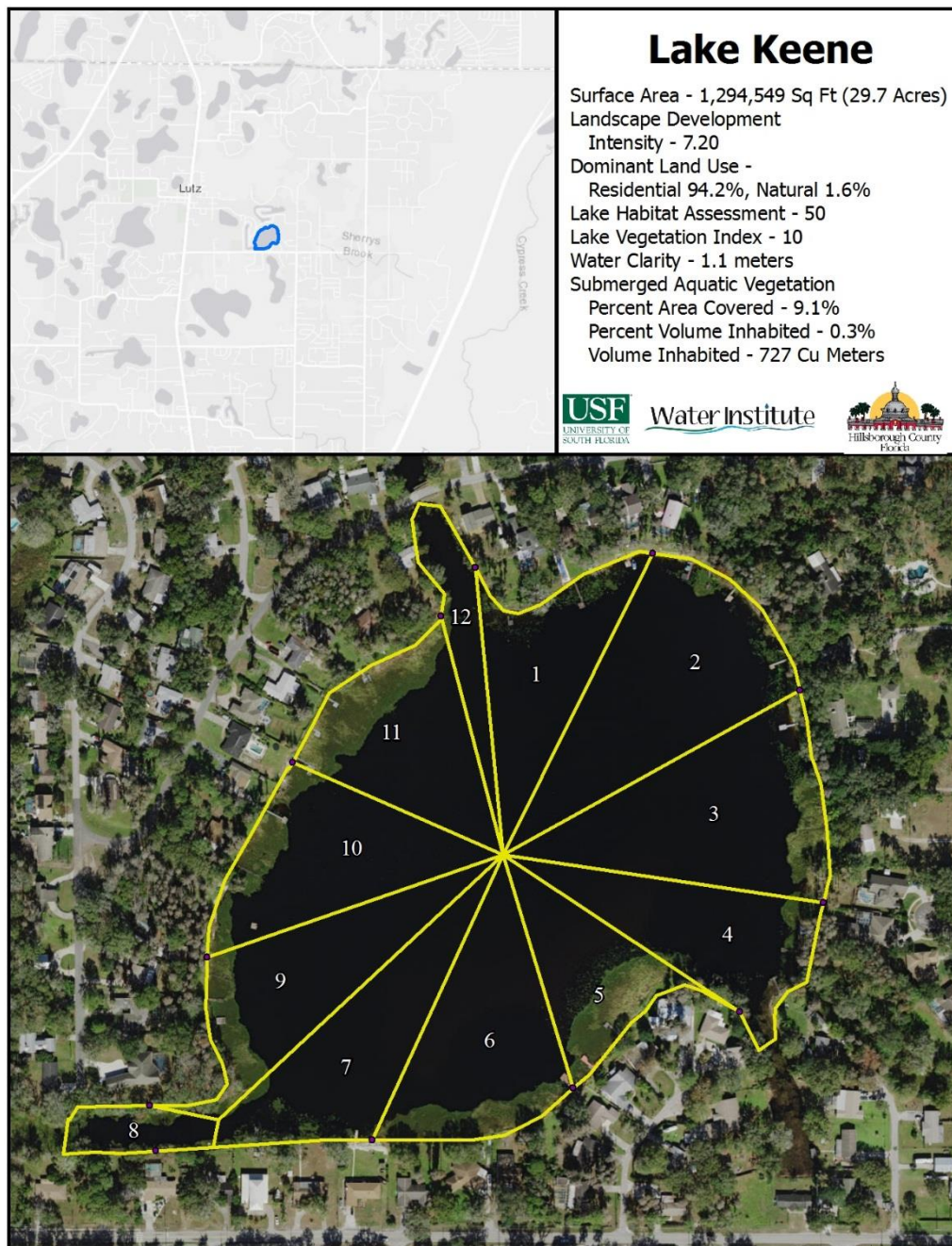
Physical water quality samples were taken using a Eureka Manta Sub-2 multiprobe pre and post calibrated on the day of the assessment. Measurements taken with this device include: depth, conductivity, pH, Dissolved Oxygen (mg/l and % Saturation) and salinity. Chemical water parameters were collected and preserved on ice by USF Water Institute staff and analyzed at the Environmental Protection Commission of Hillsborough County Laboratory. Analysis include; Chlorophyll (a, b, c, t and corrected), Alkalinity, Color, EColi, Enterococci, Ammonia, Nitrates/Nitrites, Total Phosphorous, Kjeldahl Nitrogen and Total Nitrogen. The results of the water quality sampling effort will be discussed in the framework of the FDEP Numeric Nutrient Criteria



## Study Area

Lake Keene is located north of Sunset Lane in the Lutz area of Hillsborough County, Florida. The Landscape Development Intensity Index of the 100 meter buffer around Lake Keene is dominated by Residential land use (94.2%) and Natural Lands (1.6%) land uses. The resulting LDI value for the 100 meter buffer around Lake Keene is 7.2.

*FIGURE 1: 2018 LAKE KEENE ASSESSMENT STUDY AREA MAP*



## Lake Bathymetry and Morphological Characterization

Lake Keene is a depressional system that has been heavily altered in the past due to dredge and fill operations prior to residential construction. The evidence from this activity is shown as the series of deep holes along the northwestern shoreline.

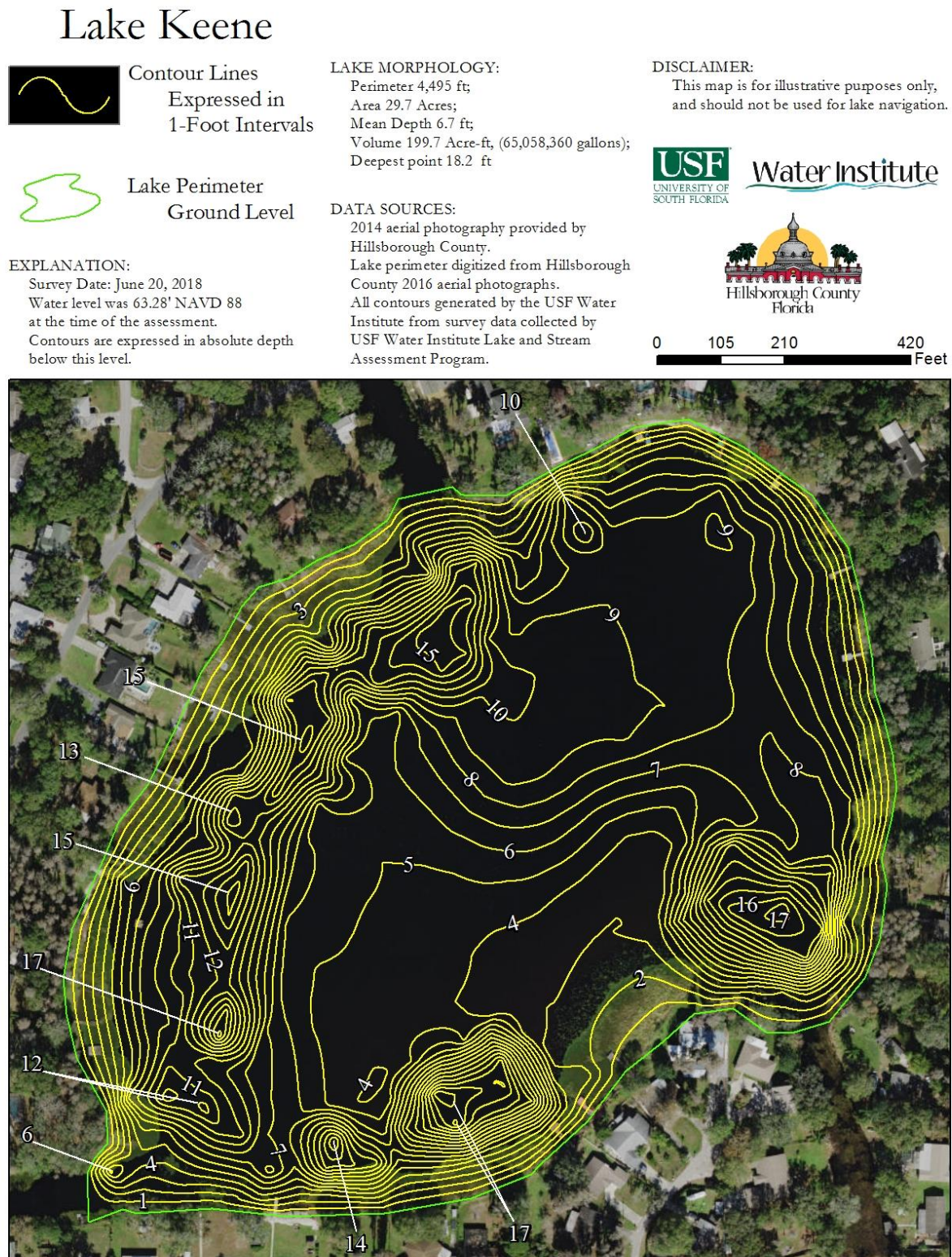
At the time of the assessment, Lake Keene was experiencing normal water levels (63.28 feet above sealevel NAVD 88) resulting in a 29.7 acre water body. Lake Keene at the time of the assessment had a mean water depth of 6.72 feet and a maximum observed depth of 18.15 feet. The volume at this time was approximately 65,058,360 gallons. Figure 2 shows the resulting bathymetric contour map for Lake Keene from data collected on June 20, 2018. The collected data has been overlain the 2016 Hillsborough County aeriels.

*Table 1: Morphological Calculations for Lake Keene*

Parameter	Feet	Meters	Acres	Acre-Ft	Gallons
Surface Area (sq)	1,294,549	120,267	29.7		
Mean Depth	6.72	2.05			
Maximum Depth	18.15	5.53			
Volume (cubic)	8,696,977	246,269		199.7	65,058,360
Gauge (NAVD 88)	63.28	19.29			



Figure 2: 2017 1-Foot Bathymetric Contour Map for Lake Keene





## Lake Habitat and Lake Vegetation Index Assessment



Figure 3 Overview photograph of Lake Keene showing typical shoreline vegetation dominated by *Eichhornia*.

The lake assessment for Lake Keene was conducted on June 20, 2018. Lake Keene received a lake habitat assessment (FEDP form FD 9000-6) score of 50 due to marginal scores for Secchi, Vegetation Quality, Stormwater Inputs, Bottom Substrate Quality, and Adverse Watershed Land Use. Poor scores were achieved for Lakeside Adverse Human Alterations and Upland Buffer Zone.

The water in Lake Keene was characterized as highly tannic and slightly turbid with a color value of 52.6 PCU. The secchi disk depth was 1.1 meters in part due to the high tannins and turbidity. The vegetation quality of the plants in and buffering Lake Keene are dominated by growths of non-native nuisance species such as *Eichhornia crassipes* and *panicum repens*. Some direct inputs of stormwater were noted through pipes and ditches to the lake. The bottom substrate quality was dominated by sand with coarse particulate organic matter near shore and some accumulation of muck. Approximately 67.2% of the surrounding land has been developed for residential housing including several docks. The majority of homeowners have removed the upland buffer zone along the shoreline.



Figure 4 Lake Keene had an abundant growth of *Eichhornia crasipes* at the time of the assessment.



The Lake Vegetation Index identified 41 species of wetland vegetation growing in the four selected sections (Region 2, 5, 8, 11) along Lake Keene. The majority of these species (29) are native species. The remaining 12 species (*Panicum repens*, *Alternanthera philoxeroides*, *Oxycaryum cubense*, *Salvinia minima*, *Eichhornia crassipes*, *Sphagneticola trilobata*, *Urochloa mutica*, *Echinochloa crusgalli*, *Melaleuca quinquenervia*, *Schinus terebinthifolius*, *Sapium sebiferum* and *Ludwigia peruviana*) are non-native and invasive to this region. The vegetation community along Lake Keene is dominated by a variety of emergent species including *Panicum repens*, *Oxycaryum cubense*, *Taxodium* and *Ludwigia peruviana*. The water's surface in Lake Keene was dominated by *Eichhornia crassipes* (Figure 5).

A total of 2 species of submerged aquatic vegetation was observed, *Nitella* and *Eleocharis baldwinii*. Submerged vegetation was rarely observed in the lake due to the large floating mats of *Eichhornia*. By analyzing the collected sonar chart, submerged aquatic vegetation potentially covered approximately 9.1% of the surface area Lake Keene. This submerged vegetation inhabits an estimated 0.3% of the water volume in Lake Keene. Figure 6 shows the results of the SAV analysis indicating the location and percent of the water column inhabited by SAV.

The calculated LVI score for Lake Keene was 10, below the impairment threshold of 37. Figure 7 shows the map of Lake Keene detailing the LVI regions used for the assessment (Regions 2, 5, 8, 11). Table 2 details the species list results of the Lake Vegetation Index. Table 3 details the scoring result for the Lake Vegetation Index.

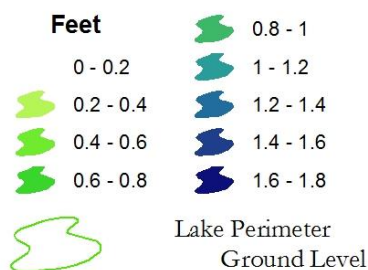


*Figure 5 Eichhornia crassipes dominated the water surface in Lake Keene*



# Lake Keene

## Height of Vegetation



### EXPLANATION:

Survey Date: June 20, 2018  
 Water level was 63.28' NAVD 88 at the time of the assessment.  
 Submerged Aquatic Vegetation was analyzed from collected sonar data.  
 The height of the SAV where present is shown in 0.2 foot increments.

### DATA SOURCES:

2014 aerial photography provided by Hillsborough County.  
 Lake perimeter digitized from Hillsborough County 2014 aerial photographs.  
 All contours generated by the USF Water Institute from survey data collected by USF Water Institute Lake and Stream Assessment Program.

### SAV STATISTICS:

Area 117,775 square ft; 2.7 Acres;  
 (9.1% of Lakes Surface Area)  
 Mean SAV Height 0.22 ft;  
 Volume 25,680 Cubic ft, (192,104 gallons);  
 (0.3 % of Lakes Volume)



Water Institute

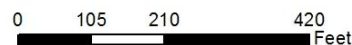


Figure 6 Lake Keene Submerged Aquatic Vegetation Assessment Results



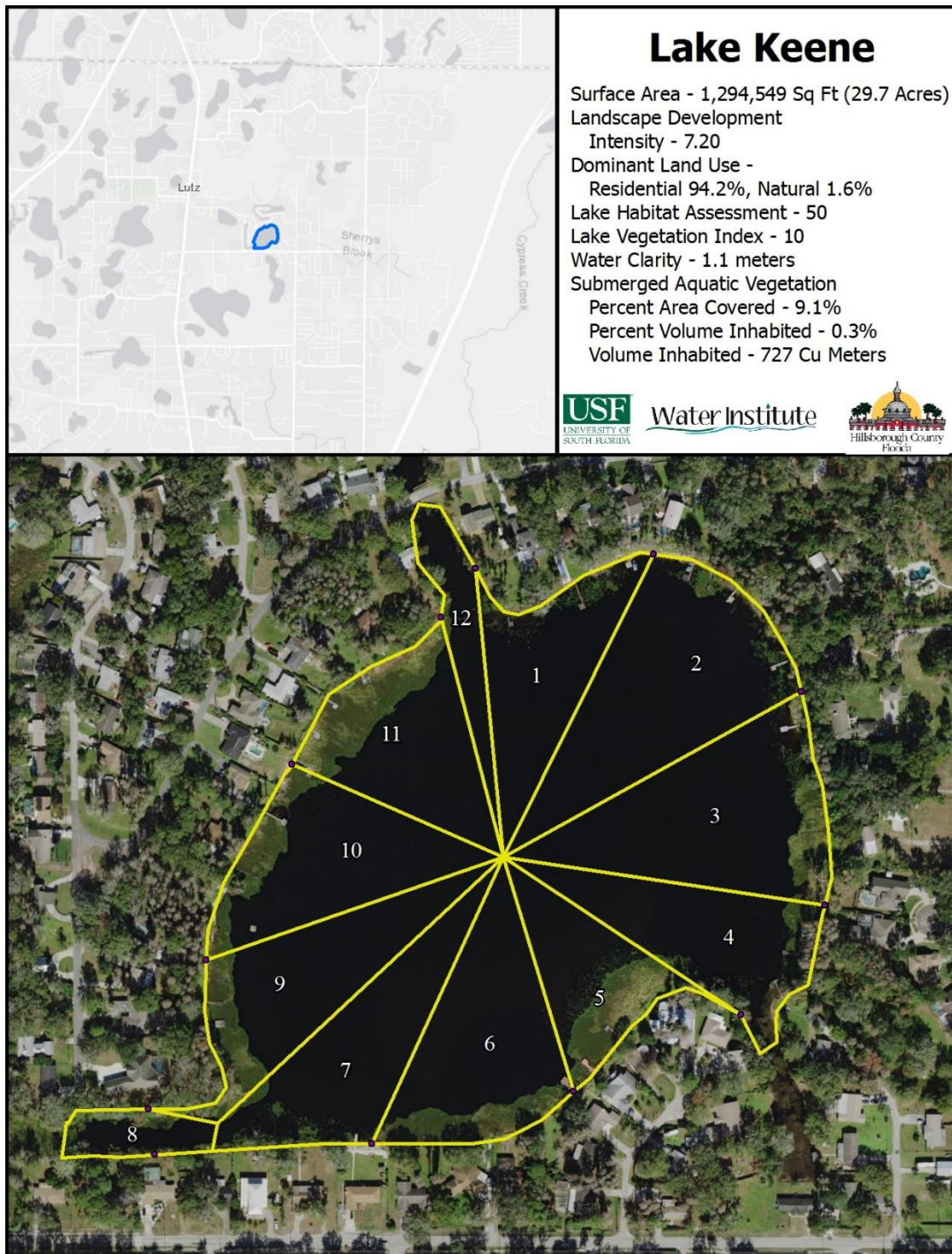


Figure 7: Lake Vegetation Index region map for Lake Keene. Regions 2, 5, 8, 11 were used during the assessment

Table 2: Lake Vegetation Index results for Lake Keene 6/20/2018

SPECIES	CofC	2	5	8	11
<b>Alternanthera philoxeroides</b>	0.00	1	1	1	1
Bacopa monnieri	3.50	1	1	1	1
Blechnum serrulatum	5.50	1	1	1	1
Boehmeria cylindrica	5.00	1	1	1	1
<b>Eichhornia crassipes</b>	0.00	D	D	D	D
Hydrocotyle	2.00	1	1	1	1
Nuphar	3.50	1	1	1	1
<b>Oxycaryum cubense</b>	0.50	1	1	1	1
<b>Panicum repens</b>	0.00	1	1	1	1
<b>Salvinia minima</b>	0.00	1	1	1	1
<b>Sphagneticola trilobata</b>	0.00	1	1	1	1
Taxodium	7.00	1	1	1	1
Typha	1.00	1	1	1	1
<b>Urochloa mutica</b>	0.00	1	1	1	1
Acer rubrum	4.65	1		1	1
<b>Ludwigia peruviana</b>	0.00	1	1		1
Mikania scandens	1.95	1	1		1
<b>Sapium sebiferum</b>	0.00	1		1	1
Cephalanthus occidentalis	5.00			1	1
Diodia virginiana	3.00	1			1
Ludwigia arcuata	3.50	1			1
Polygonum hydropiperoides	2.50	1			1
Baccharis glomeruliflora	3.00	1			
Bidens alba	1.00		1		
Cyperus odoratus	3.00				1
Cyperus polystachyos	1.56	1			
<b>Echinochloa crusgalli</b>	0.22				1
Eleocharis baldwinii	2.82		1		
Erechtites hieracifolia	1.00		1		
Eupatorium capillifolium	0.83				1
Gordonia lasianthus	7.00				1
Habenaria repens	3.50	1			
Ludwigia leptocarpa	3.00				1
<b>Melaleuca quinquenervia</b>	0.00			1	
Myrica cerifera	2.00	1			
Nephrolepis exaltata	3.00	1			
Nitella	6.00		1		
Panicum rigidulum	5.47				1
Sabal palmetto	2.85			1	
Salix caroliniana	2.95			1	
<b>Schinus terebinthifolius</b>	0.00	1			

Table 3: Scoring Summary for the Lake Vegetation Index

LVI Score Summary	Region			
	2	5	8	11
Total # of taxa in sampling unit	27	20	20	28
% Native taxa in sampling unit	62.96296	60	55	64.28571
% FLEPPC CAT 1 taxa in sampling unit	25.92593	25	30	21.42857
% Sensitive taxa in sample unit	3.703704	5	5	7.142857
Dominant CoC in sample unit	0	0	0	0
Native Score $((x-62.5)/37.5)$ or $((x-66.67)/25.89)=$	0	0	0	0
Invasive FLEPPC 1 Score $(1 - (x/30))=$	0.135802	0.166667	0	0.285714
Sensitive Score $(x/(27.78 \text{ or } 20)) =$	0.185185	0.25	0.25	0.357143
Dominant CoC Score $(x/(7.91 \text{ or } 7)) =$	0	0	0	0
Raw Score Total = N+I+S+D =	0.320988	0.416667	0.25	0.642857
Division Factor = (3 D=0 or 4) =	4	4	4	4
Average LVI dividend = Raw /DF	0.080247	0.104167	0.0625	0.160714
South				
LVI Score for sampling unit =	8.024691	10.41667	6.25	16.07143
Total LVI SCORE =	10			



## Water Quality Assessment

Limited long-term water quality data is available for Lake Keene. The majority of the available data was collected as part of the University of Florida LAKEWATCH program (1991-2018) although this dataset is incomplete. Additional data was collected by the US Geological Survey and Hillsborough County Stormwater. Table 4 provides a summary of the Physical/Chemical conditions recorded at the middle of Lake Keene.

*Table 4: Lake Keene Water Quality (Field)*

Depth (m)	Temp °C	pH	DO (mg/L)	DO (%sat)	Cond (unho/cm)	Salinity (ppt)	Secchi Depth (m)
0.06	30.98	7.85	5.12	67.8	183	0.08	1.1
1.11	30.34	7.48	2.2	28.9	181	0.08	
2.29	26.64	7.23	0	0	186	0.09	
POR	24.28	7.1	3.64		153		0.95

The chemical water quality analysis for Lake Keene is shown in Table 5 for the sample taken on June 20, 2018. Table 6 includes this data in the numeric nutrient criteria framework using the data from this assessment as well as the available LAKEWATCH geometric mean values for the period of record since complete data for the past three years for available parameters is not available. Total Phosphorous values were below the nutrient threshold for colored lakes in the west central region with insufficient data developed by FDEP of 0.05 mg/l with a value of 0.037 mg/l for the POR and above the threshold for the single sample with a value of 0.059 mg/l. Total Nitrogen values were below the nutrient threshold for colored lakes with insufficient data developed by FDEP of 1.27 mg/l with a value of 1.214 mg/l for the POR data. The Total Nitrogen value associated with the sample for this assessment was 0.742 mg/l. Chlorophyll-a corrected values are below the nutrient threshold for colored lakes developed by FDEP of 20.0 µg/l with a value of 7.2 µg/l. The UF LAKEWATCH data is for uncorrected chlorophyll-a and has a mean value for the period of record of 17.41 µg/l.

Bacteria testing showed high levels of E. Coli (5900 colonies/100ml) and Enterococci (8100 colonies/100ml) above the rules set forth in FDEP 62-302.530 (<https://www.flrules.org/gateway/RuleNo.asp?title=SURFACE%20WATER%20QUALITY%20STANDARDS&ID=62-302.500>) “Most Probable Number (MPN) or Membrane Filter (MF) counts shall not exceed a monthly average of 200, nor exceed 400 in 10% of the samples, nor exceed 800 on any one day. Monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30 day period.”

Table 5: Lake Keene Water Quality Results from 6/14/18 (Laboratory)

Parameter	Lake Keene (Center)	POR Mean Value	Units
Alkalinity	33.0	54.8	mg/LCaCO <sub>3</sub>
Nitrates/Nitrites	0.035	0.003	mg/L
E. Coli	5900		#/100 ml
Enterococci	8100	60	#/100 ml
Chlorophyll a	9.5	17.4	ug/L
Chlorophyll b	1.6	2.6	ug/L
Chlorophyll c	0.7	1.9	ug/L
Chlorophyll t	11.8		ug/L
Chlorophylla Corr	7.2		ug/L
Chlorophyll-pheo	5.4		ug/L
Ammonia	0.008	0.011	mg/L
Kjeldahl Nitrogen	0.707	1.084	mg/L
Total Nitrogen	0.742	1.214	mg/L
Total Phosphorus	0.059	0.037	mg/L
Color(345)F.45	52.6	117	Pt/Co

Table 6: Numeric Nutrient Criteria Framework

Parameter	Value
Geometric Mean (Geomean) Color (pcu)	117
Number of Samples	3
Geometric Mean Alkalinity (mg/L CaCO <sub>3</sub> )	54.8
Number of Samples	6
Lake Type	Colored Alkaline
Chlorophyll a Criteria (ug/L)	20
Insufficient for Geomean Criteria then P mg/L	0.05
Insufficient for Geomean Criteria then N mg/L	1.27
Geomean Chla ug/L	7.2
Geomean TP mg/L	0.037
Geomean TN mg/L	1.214
Number of Samples	166
Potential Impaired Chlorophyll a	Not Impaired
Potential Impaired TP	Not Impaired
Potential Impaired TN	Not Impaired



## Conclusion

The results of the assessment of Lake Keene shows a healthy lake based on Total Nitrogen, Total Phosphorous and Chlorophyll concentrations according to the FDEP numeric nutrient criteria using the single sample taken during this assessment and limited long term water quality record. The sampling data was insufficient to calculate proper FDEP Numeric Nutrient Criteria values. Consistent Long term sampling would be necessary to determine actual NNC values. The system shows impairment in the vegetation communities according to the Lake Vegetation Index with moderate overall species (41), high occurrences of non-native, invasive species and few sensitive plant species with an overall LVI score of 10. The assessment also revealed a submerged aquatic vegetation community comprising 2 species occupying 9.1% of the surface area and 0.3% of the volume of Lake Keene. Bacteria parameters are of concern due to the high results from the most recent sample.