



# Hillsborough River Reservoir

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

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# Methods

## STUDY AREA ANALYSIS

The watershed containing the Hillsborough River Reservoir 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.

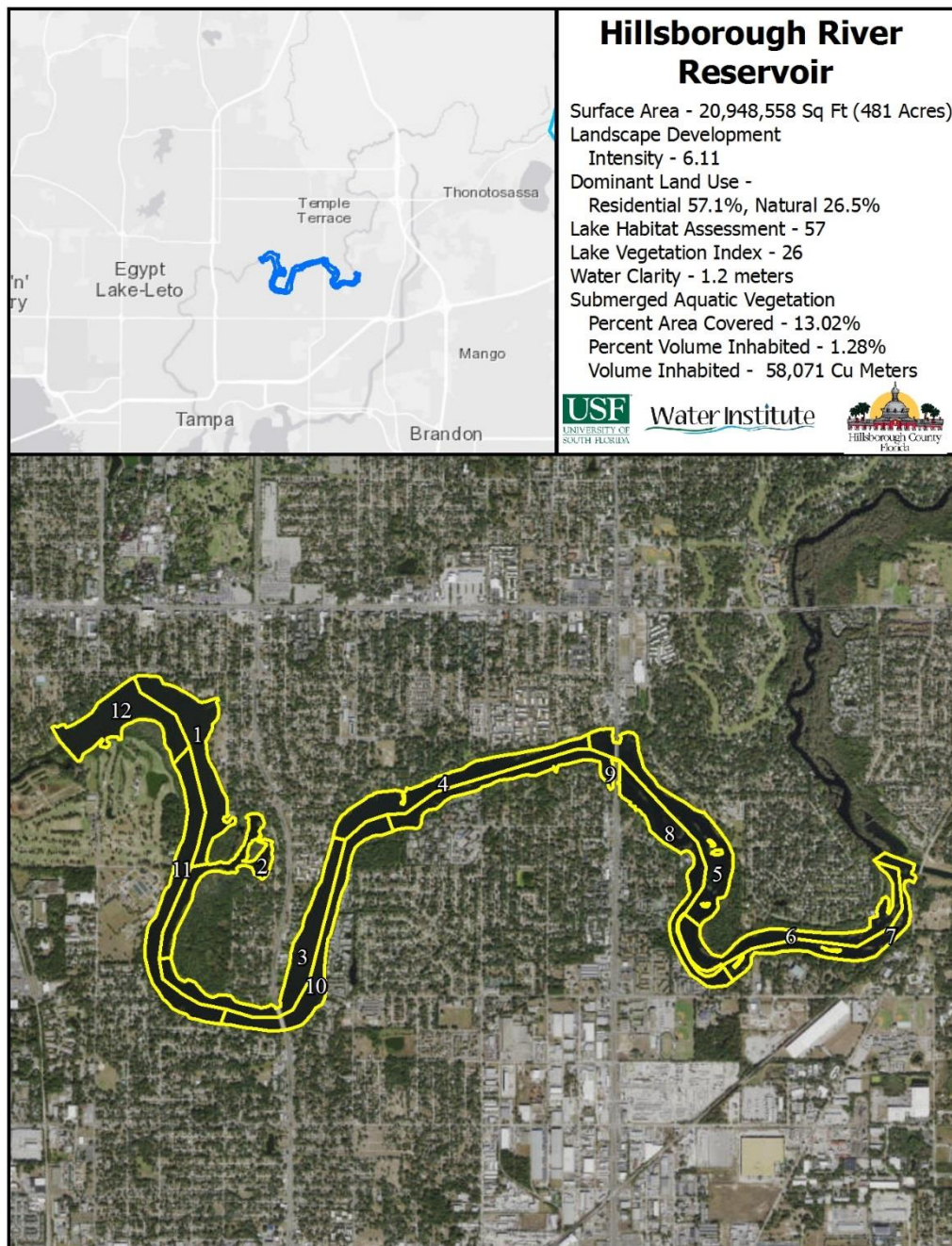
## WATER QUALITY ASSESSMENT

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

The Hillsborough River Reservoir is located in central Hillsborough County, Florida. The Landscape Development Intensity Index of the 100 meter buffer around the Hillsborough River Reservoir is dominated by Residential (57.1%) and Natural (26.5%) land uses. The resulting LDI value for the 100 meter buffer around Hillsborough River Reservoir is 6.11.

*FIGURE 1: 2018 HILLSBOROUGH RIVER RESERVOIR ASSESSMENT STUDY AREA MAP*



## Lake Bathymetry and Morphological Characterization

Hillsborough River Reservoir is a portion of the Hillsborough River between the Bypass Canal and the Dam at Rowlett Park. The control of the water levels has drastically changed the system from its pre-development state. Much of the shoreline has been fortified with seawalls along the residential sections.

At the time of the assessment, Hillsborough River Reservoir was experiencing normal water levels (22.59 feet above sealevel NAVD 88) resulting in a 481 acre water body. Hillsborough River Reservoir at the time of the assessment had a mean water depth of 7.66 feet and a maximum observed depth of 31.4 feet. The volume at this time was approximately 1,200,448,459 gallons. Figures 2, 3 and 4 shows the resulting bathymetric contour map for Hillsborough River Reservoir from data collected on July 21, 2018. The collected data has been overlain the 2016 Hillsborough County aeriels.

*Table 1: Morphological Calculations for Hillsborough River Reservoir*

Parameter	Feet	Meters	Acres	Acre-Ft	Gallons
Surface Area (sq)	20,948,558	1,946,168	480.9		
Mean Depth	7.66	2.33			
Maximum Depth	31.4	9.57			
Volume (cubic)	160,475,505	4,544,117		3,684	1,200,448,459
Gauge (NAVD 88)	22.59	6.89			

Figure 2: 2017 4-Foot Bathymetric Contour Map for Hillsborough River Reservoir

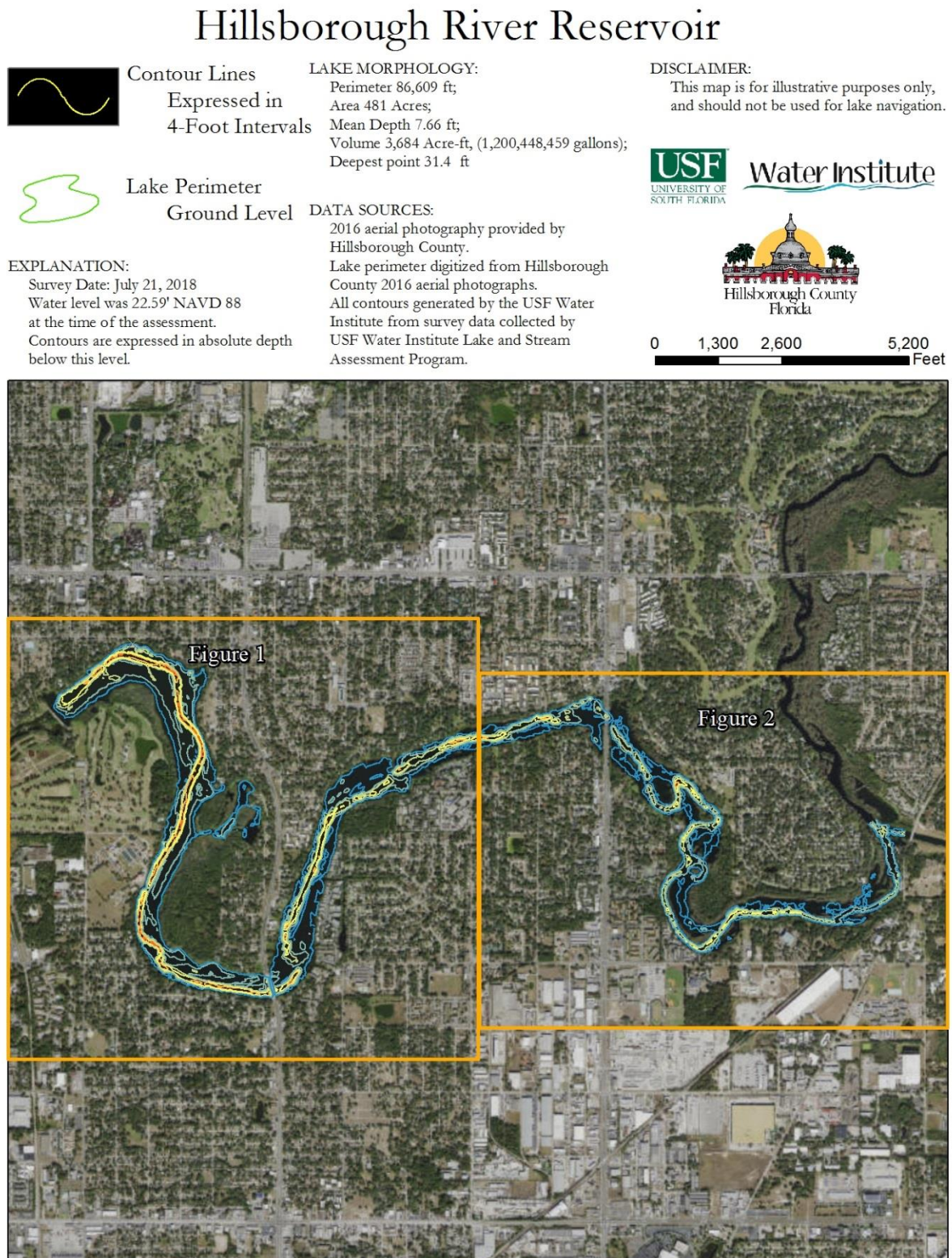


Figure 3: 2017 4-Foot Bathymetric Contour Map for Hillsborough River Reservoir

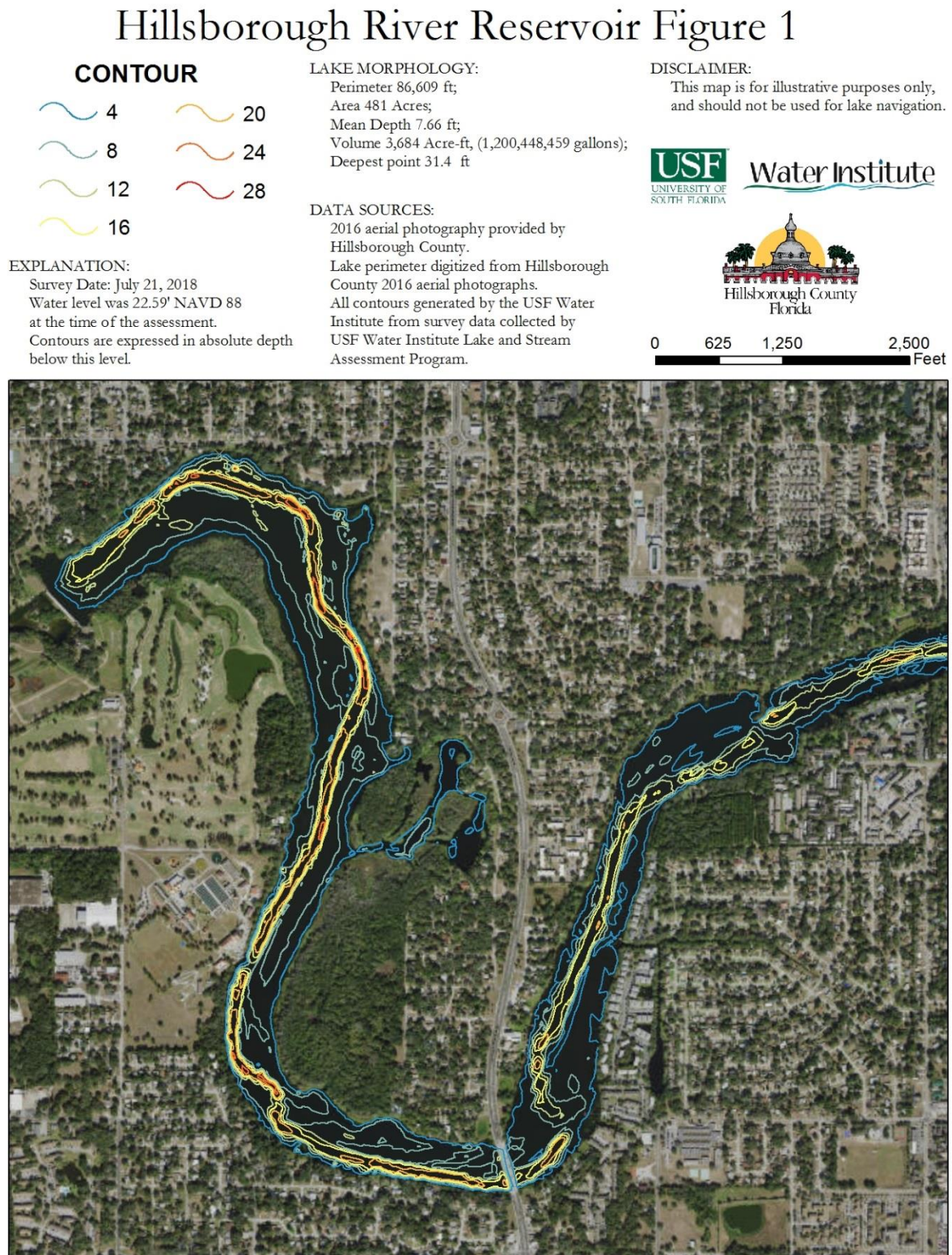
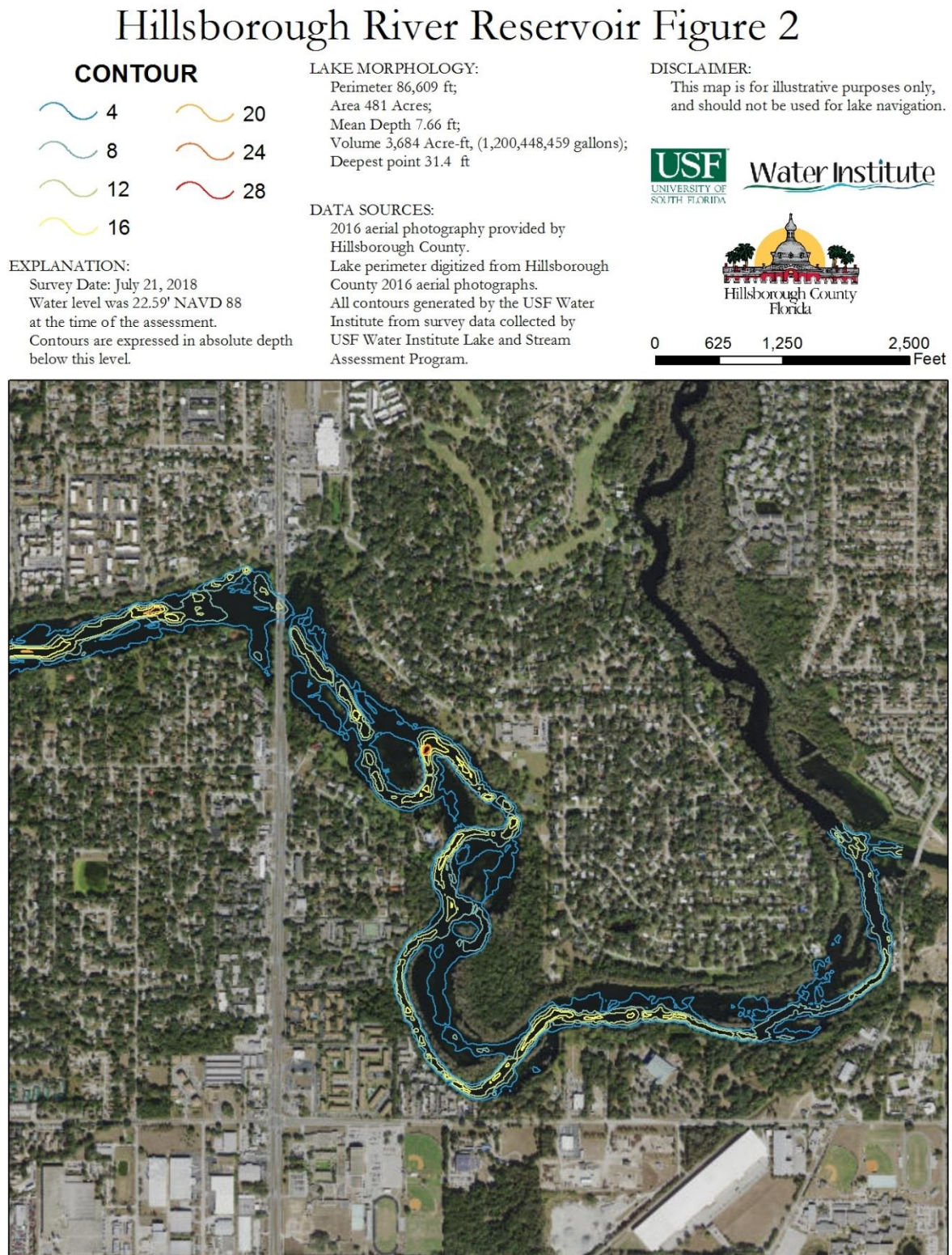


Figure 4: 2017 4-Foot Bathymetric Contour Map for Hillsborough River Reservoir



## Lake Habitat and Lake Vegetation Index Assessment



*Figure 5 Overview photograph of the Hillsborough River Reservoir showing typical shoreline vegetation in a undeveloped area.*

The lake assessment for the Hillsborough River Reservoir was conducted on July 21, 2018. The Hillsborough River Reservoir received a lake habitat assessment (FEDP form FD 9000-6) score of 57 due to suboptimal scores for Secchi, Vegetation Quality and Bottom Substrate Quality. Marginal scores were achieved for Stormwater Inputs, Upland Buffer Zone and Adverse Watershed Land Use. Lakeside Adverse Human Alterations received poor scores.

The water in the Hillsborough River Reservoir was characterized as highly tannic and moderately turbid with a color value of 111.9 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 the Hillsborough River Reservoir are predominantly native species with moderate growths of non-native nuisance species such as *Schinus terebinthifolius*, *Panicum repens* and *Hydrilla verticillata*. Some direct inputs of stormwater were noted through pipes and ditches to the reservoir. The bottom substrate quality was dominated by sand with coarse particulate organic matter near shore and some accumulation of muck. Approximately 57% of the surrounding land has been developed for residential housing including several docks and seawalls. Few homeowners have maintained an upland buffer zone along the shoreline.



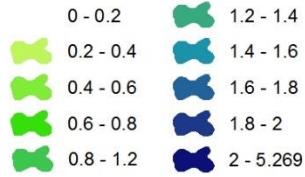
Figure 6 The shoreline of the Hillsborough River Reservoir has been developed extensively with docks and seawalls, removing the buffering capacity of shoreline vegetation.

The Lake Vegetation Index identified 58 species of wetland vegetation growing in the four selected sections along Hillsborough River Reservoir. The majority of these species (43) are native species. The remaining 15 species (*Panicum repens*, *Alternanthera philoxeroides*, *Dioscorea bulbifera*, *Eichhornia crassipes*, *Hydrilla verticillata*, *Landoltia punctata*, *Pistia stratiotes*, *Schinus terebinthifolius*, *Urochloa mutica*, *Sphagneticola trilobata*, *Salvinia minima*, *Colocasia esculenta*, *Cyperus alternifolius*, *Ruellia simplex* and *Ludwigia peruviana*) are non-native and invasive to this region. The vegetation community along Hillsborough River Reservoir is dominated by a variety of emergent species including *Panicum repens*, *Fraxinus caroliniana*, *Taxodium* and *Schinus terebinthifolius*. The water's surface in Hillsborough River Reservoir was dominated by *Nuphar*. A total of 3 species of submerged aquatic vegetation were observed, *Hydrilla verticillata*, *Ceratophyllum demersum* and *Najas guadalupensis*. Submerged vegetation was limited in the lake due to the low water visibility and tanins blocking available light. By analyzing the collected sonar chart, submerged aquatic vegetation potentially covered approximately 13.0% of the surface area of Hillsborough River Reservoir. This submerged vegetation inhabits an estimated 1.28% of the water volume in Hillsborough River Reservoir. Figure 7 shows the results of the SAV analysis indicating the location and percent of the water column inhabited by SAV.

The calculated LVI score for Hillsborough River Reservoir was 26, below the impairment threshold of 37. Figure 8 shows the map of Hillsborough River Reservoir detailing the LVI regions used for the assessment (Regions 1, 4, 7, 10). Table 2 details the species list results of the Lake Vegetation Index. Table 3 details the scoring result for the Lake Vegetation Index.

# Hillsborough River Reservoir

## Height of Vegetation



 Perimeter

### EXPLANATION:

Survey Date: July 21, 2018  
Water level was 22.59' 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:

2016 aerial photography provided by Hillsborough County.  
Lake perimeter digitized from Hillsborough County 2016 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 2,727,699 square ft; 62.6 Acres;  
(13.0% of Lakes Surface Area)  
Mean SAV Height 0.75 ft;  
Volume 2,050,762 Cu ft, (15,340,869 gal);  
(1.28 % of Lakes Volume)



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0 1,350 2,700 5,400 Feet

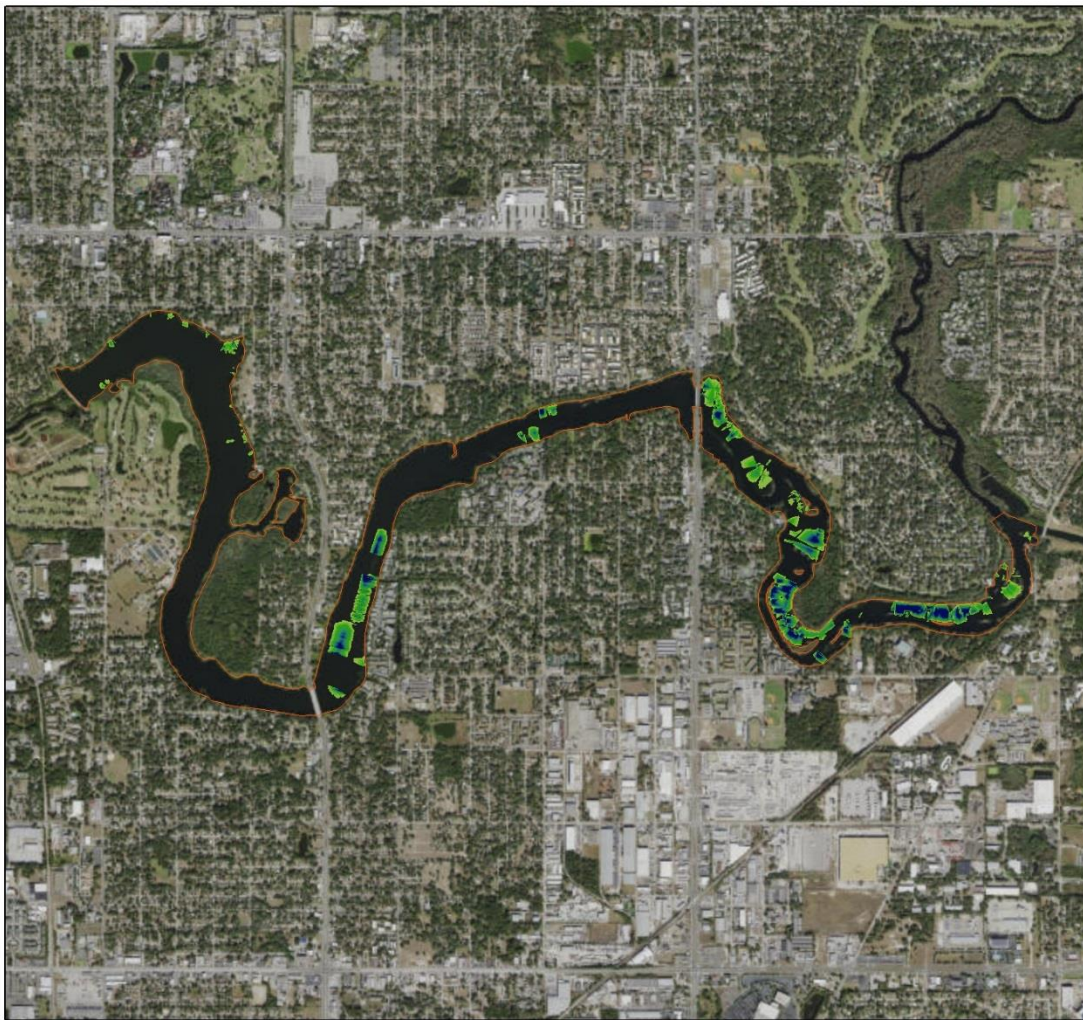


Figure 3 Hillsborough River Reservoir Submerged Aquatic Vegetation Assessment Results

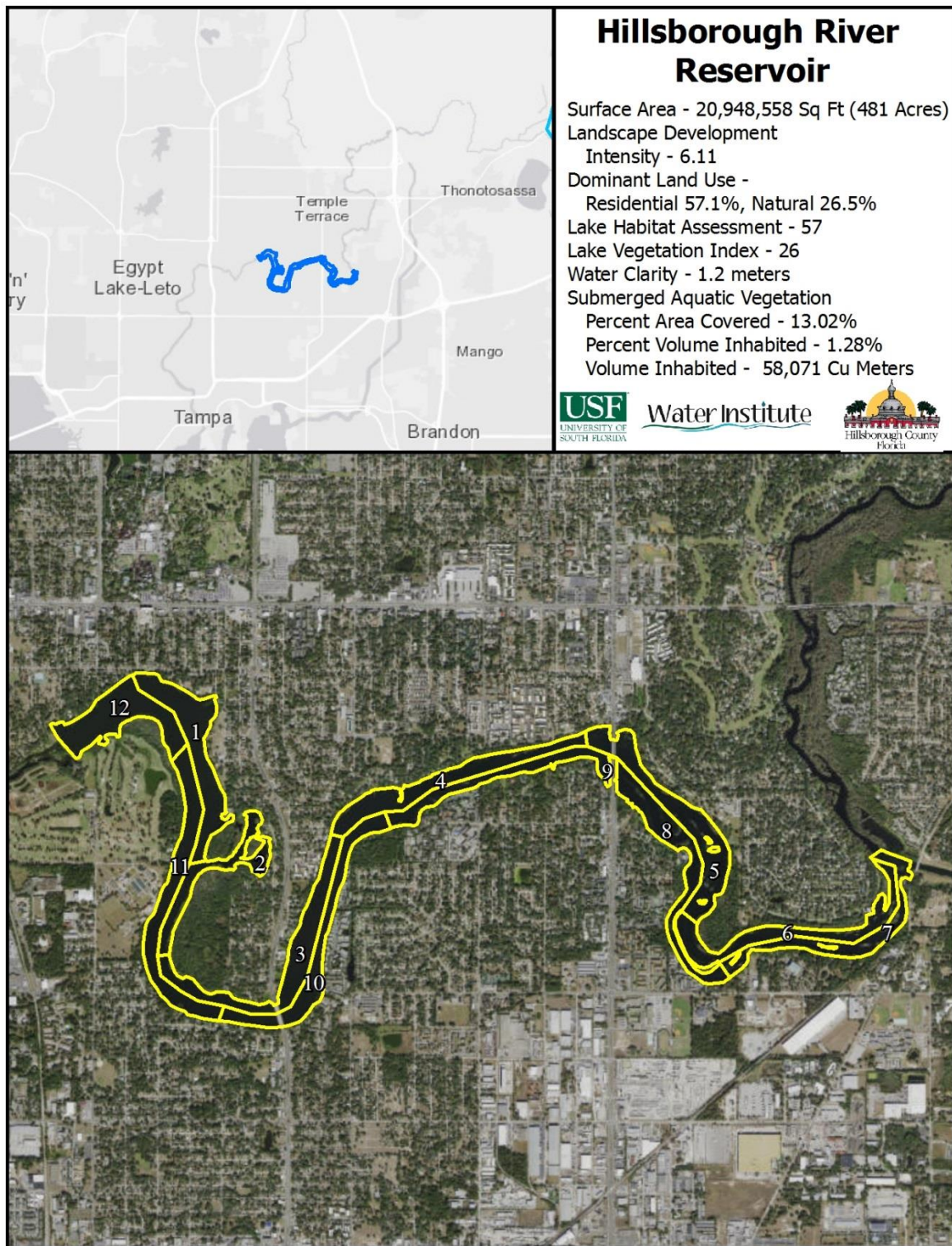


Figure 8: Lake Vegetation Index region map for Hillsborough River Reservoir

Table 2: Lake Vegetation Index results for Hillsborough River Reservoir 7/21/2018 (continued on next page)

SPECIES	CofC	1	4	7	10
<b>Alternanthera philoxeroides</b>	0.00	1	1	1	1
Bacopa monnieri	3.50	1	1	1	1
Bidens alba	1.00	1	1	1	1
Boehmeria cylindrica	5.00	1	1	1	1
Cephalanthus occidentalis	5.00	1	1	1	1
<b>Dioscorea bulbifera</b>	0.00	1	1	1	1
Eclipta prostrata	2.00	1	1	1	1
<b>Eichhornia crassipes</b>	0.00	1	1	1	1
Fraxinus caroliniana	5.21	1	1	1	1
<b>Hydrilla verticillata</b>	0.00	1	1	C	C
Hydrocotyle	2.00	1	1	1	1
<b>Landoltia punctata</b>	0.00	1	1	1	1
Lemna	1.00	1	1	1	1
Ludwigia grandiflora	4.00	1	1	1	1
<b>Ludwigia peruviana</b>	0.00	1	1	1	1
Mikania scandens	1.95	1	1	1	1
Myrica cerifera	2.00	1	1	1	1
Nephrolepis exaltata	3.00	1	1	1	1
Nuphar	3.50	D	D	C	C
<b>Pistia stratiotes</b>	0.00	1	1	1	1
Quercus laurifolia	4.00	1	1	1	1
Quercus nigra	2.50	1	1	1	1
Sabal minor		1	1	1	1
Salix caroliniana	2.95	1	1	1	1
<b>Salvinia minima</b>	0.00	1	1	1	1
<b>Schinus terebinthifolius</b>	0.00	1	1	1	1
Taxodium	7.00	1	1	1	1
<b>Urochloa mutica</b>	0.00	1	1	1	1
Vitis rotundifolia	1.18	1	1	1	1
Acer rubrum	4.65		1	1	1
Ampelopsis arborea	3.25	1	1	1	
Andropogon glomeratus	3.00		1	1	1
Azolla caroliniana	1.81		1	1	1
Ceratophyllum demersum	4.16	1	1	1	
<b>Colocasia esculenta</b>	0.00	1		1	1
Ludwigia arcuata	3.50	1	1		1

SPECIES	CofC	1	4	7	10
<b>Panicum repens</b>	0.00	1	1	1	
Paspalum repens	5.60		1	1	1
Sesbania herbacea	1.00	1	1		1
<b>Sphagneticola trilobata</b>	0.00	1	1		1
Thalia geniculata	6.00	1	1		1
Typha	1.00	1	1		1
Acer saccharinum	6.89		1		1
Crinum americanum	9.00			1	1
<b>Cyperus alternifolius</b>	0.00		1		1
Cyperus polystachyos	1.56		1	1	
Cyperus surinamensis	2.03		1	1	
Ilex cassine	6.00		1	1	
Phyla nodiflora	1.92		1	1	
Woodwardia areolata	6.50			1	1
Baccharis glomeruliflora	3.00		1		
Carya aquatica	7.00			1	
Gleditsia aquatica	7.09		1		
Ludwigia octovalvis	2.00	1			
Magnolia virginiana	7.00	1			
Najas guadalupensis	5.07	1			
Nelumbo lutea	5.50		1		
<b>Ruellia simplex</b>	0.00				1

Table 3: Scoring Summary for the Lake Vegetation Index

LVI Score Summary	Region			
	1	4	7	10
<b>Total # of taxa in sampling unit</b>	41	50	44	44
<b>% Native taxa in sampling unit</b>	68.29268	74	72.72727	68.18182
<b>% FLEPPC CAT 1 taxa in sampling unit</b>	24.39024	18	22.72727	22.72727
<b>% Sensitive taxa in sample unit</b>	4.878049	4	6.818182	4.545455
<b>Dominant CoC in sample unit</b>	3.5	3.5	1.75	1.75

<b>Native Score ((x-62.5)/37.5) or ((x-66.67)/25.89)=</b>	0.062676	0.283121	0.233962	0.058394
<b>Invasive FLEPPC 1 Score (1 - (x/30))=</b>	0.186992	0.4	0.242424	0.242424
<b>Sensitive Score (x/(27.78 or 20)) =</b>	0.243902	0.2	0.340909	0.227273
<b>Dominant CoC Score (x/(7.91 or 7)) =</b>	0.5	0.5	0.25	0.25
<b>Raw Score Total = N+I+S+D =</b>	0.99357	1.383121	1.067295	0.778091
<b>Division Factor = (3 D=0 or 4) =</b>	4	4	4	4
<b>Average LVI dividend = Raw /DF</b>	0.248393	0.34578	0.266824	0.194523
<b>South</b>				
<b>LVI Score for sampling unit =</b>	24.83926	34.57802	26.68238	19.45227
<b>Total LVI SCORE =</b>	26			

## Water Quality Assessment

Limited long-term water quality data is available for the Hillsborough River Reservoir. The available data was collected by USGS, FDEP, Hillsborough County Stormwater, Streamwater Watch and University of Florida LAKEWATCH program (1968-2014), however this dataset is incomplete. Table 4 provides a summary of the Physical/Chemical conditions recorded at the middle of the Hillsborough River Reservoir.

*Table 4: Hillsborough River Reservoir Water Quality (Field)*

Depth (m)	Temp °C	pH	DO (mg/L)	DO (%sat)	Cond (unho/cm)	Salinity (ppt)	Secchi Depth (m)
0.05	29.44	8.82	7.29	94.1	159	0.07	1.4
1.18	26.62	8.41	6.84	84	158	0.07	
3.64	25.58	8.24	2.68	32.3	159	0.07	
POR	22.45	7.38	3.30	35.52	279	0.22	0.82

The chemical water quality analysis for the Hillsborough River Reservoir is shown in Table 5 for the sample taken on June 13, 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 above the nutrient threshold for clear alkaline lakes in the west central region with insufficient data developed by FDEP of 0.03 mg/l with a value of 0.137 mg/l for the POR and above the threshold for the single sample with a value of 0.336 mg/l. If sampling were to be sufficient (previous three years of quarterly sampling) the threshold could be as high as 0.09 mg/L. Total Nitrogen values were above the nutrient threshold for clear alkaline lakes with insufficient data developed by FDEP of 1.05 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 1.175 mg/l. If sampling were to be sufficient (previous three years of quarterly sampling) the threshold could be as high as 1.91 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 11.4 µg/l. The UF LAKEWATCH data is for uncorrected chlorophyll-a and has a mean value for the period of record of 4.74 µg/l.

Bacteria testing showed low levels of E. Coli (33 colonies/100ml) and Enterococci (73 colonies/100ml) below 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: Hillsborough River Reservoir Water Quality Results from 6/13/18 (Laboratory)*

<b>Parameter</b>	<b>Hillsborough River Reservoir (Center)</b>	<b>POR Mean Value</b>	<b>Units</b>
Alkalinity	76.0	102.4	mg/LCaCO <sub>3</sub>
Nitrates/Nitrites	0.024	0.044	mg/L
E. Coli	33		#/100 ml
Enterococci	73	145.5	#/100 ml
Chlorophyll a	31.4	4.74	ug/L
Chlorophyll b	5.1	1.94	ug/L
Chlorophyll c	2.1	2.76	ug/L
Chlorophyll t	35.7		ug/L
Chlorophylla Corr	25.7	11.4	ug/L
Chlorophyll-pheo	8.0		ug/L
Ammonia	0.021	0.024	mg/L
Kjeldahl Nitrogen	1.151	0.601	mg/L
Total Nitrogen	1.175	1.214	mg/L
Total Phosphorus	0.336	0.137	mg/L
Color(345)F.45	111.9	37	Pt/Co

Table 6: Numeric Nutrient Criteria Framework

Parameter	Value
Geometric Mean (Geomean) Color (pcu)	37
Number of Samples	83
Geometric Mean Alkalinity (mg/L $\text{CaCO}_3$ )	102.4
Number of Samples	49
Lake Type	Clear Alkaline
Chlorophyll a Criteria (ug/L)	20
Insufficient for Geomean Criteria then P mg/L	0.03
Insufficient for Geomean Criteria then N mg/L	1.05
Geomean Chla Corrected ug/L	11.4
Geomean TP mg/L	0.137
Geomean TN mg/L	1.214
Number of Samples	844
Potential Impaired Chlorophyll a	Not Impaired
Potential Impaired TP	Impaired
Potential Impaired TN	Impaired

## Conclusion

The results of the assessment of the Hillsborough River Reservoir shows an impaired lake based on Total Nitrogen and Total Phosphorous 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. Difficulty arises in which set of NNC requirements are appropriate to use with the system changing between a colored system and a clear system seasonally. The system also shows impairment in the vegetation communities according to the Lake Vegetation Index with high overall species (58), high occurrences of non-native, invasive species and few sensitive plant species with an overall LVI score of 26. The assessment also revealed some submerged aquatic vegetation community comprising 3 species occupying 13.02% of the surface area and 1.28% of the volume of the Hillsborough River Reservoir.