Stream Assessment Report for Hillsborough River Reaches, Hillsborough County, Florida

April 1 – September 30, 2009
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Reviewed by: Jim Griffin, Ph.D.

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INTRODUCTION

This assessment was conducted to update and enhance existing physical and ecological data for the river reaches of the Hillsborough River. The project is part of the Hillsborough County Lake Assessment program which in 2009 was expanded to include streams. 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 goal of the stream assessment projects is to provide additional data on the river reaches where Stream WaterWatch volunteer stream monitor sites exist and, where appropriate, the greater stream or river reach. These data will then be provided via the Hillsborough County and City of Tampa Watershed Atlas (HCTWA at: www.hillsborough.wateratlas.usf.edu) for use by scientists, government agencies and citizens who volunteer for the Hillsborough County Stream WaterWatch volunteer stream monitoring program. This report should be used in conjunction with the information referenced on the HCTWA and for which hyperlinks will be supplied as appropriate in the report.

The Stream Assessment 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 has, as its primary goal, the rapid assessment of all the streams and river reaches within the County over a five-year period. The product of these investigations will provide the County, riparian property owners and the general public a better understanding of the general health of Hillsborough County rivers and streams, in terms of shoreline development, water quality, stream 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 streams and stream-centered watersheds. This report on the Hillsborough River is the first of several stream reports. Please note that the blue-highlighted words in this report will always indicate hyperlinks. The majority will refer to the HCTWA which can be found at: www.hillsborough.wateratlas.usf.edu.

Figure 1. Photo of Hillsborough River at Rowlett Park taken April 16, 2009.

The Hillsborough River extends from its headwaters, in the southwestern Green Swamp to the east and northeast of the town of Zephyrhills in Pasco County, to Hillsborough Bay in Hillsborough County (Figure 2). This is a distance of 95.7 kilometers or 59.9 river miles (1/24,000 National Hydrology Database GIS feature). The majority of the river (71.3 kilometers or 44.3 river miles) is within Hillsborough County; a lesser amount of the river runs through Pasco County (9.74 miles) and Polk County (5.5 miles). The Hillsborough River is one of two major rivers that originate in the Green Swamp, the other is the Withlacoochee River (please also see the FDEP website description of the Hillsborough River).

Some of the major water features and tributaries of the river include Crystal Springs, Blackwater Creek, Cypress Creek, Trout Creek, the Hillsborough River Reservoir, Tampa Bypass Canal, and the largest lake in Hillsborough County, Lake Thonotosassa, which drains to the river via Flint Creek. The Hillsborough River Watershed drains Polk, Pasco and Hillsborough County and is a major hydrologic component of Hillsborough Bay and the Tampa Bay Estuary. The Hillsborough River has significant hydrologic and water chemistry data which is cataloged and managed through the Water Atlas's Data Download and through linked sites on the Hillsborough River resource page. The Water Atlas contains three oral histories (1, 2, and 3) that provide historic background to better understand this important resource. Additional information on the river are available on the Water Atlas Digital Library.

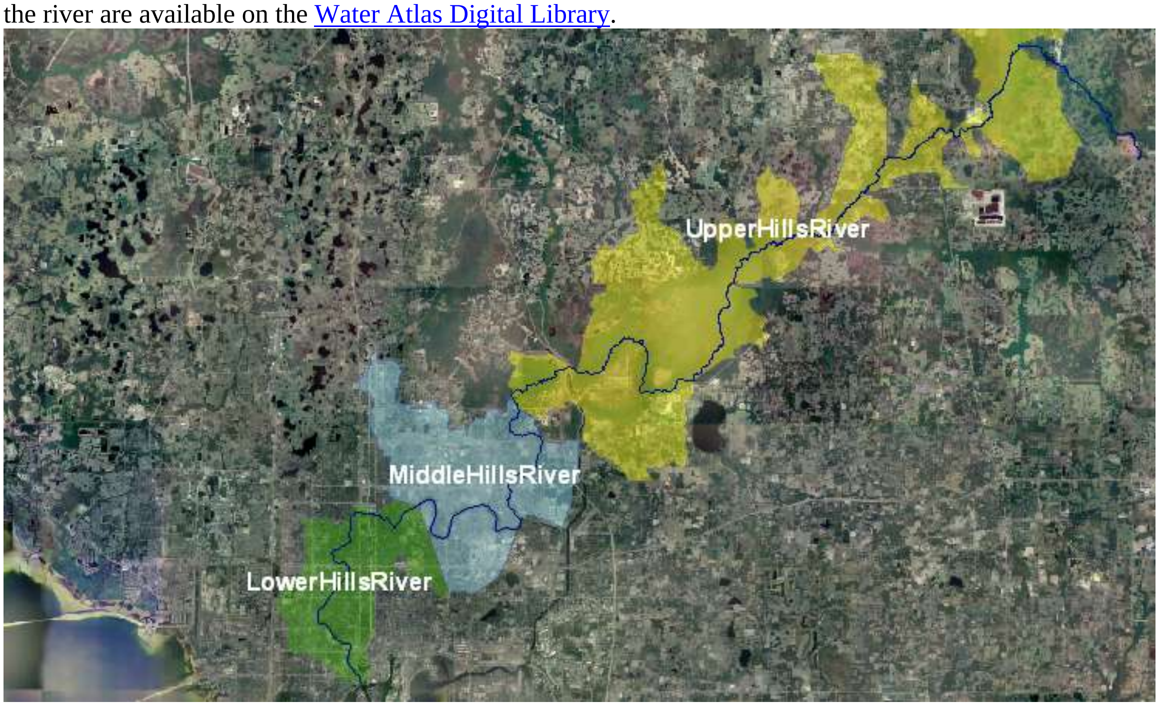

Figure 2. The Hillsborough River can be divided into three segments: the UHR (River above Fletcher Ave Bridge), the MHR (between Fletcher Ave. Bridge and Hillsborough River Dam) and the LHR (from dam to mouth of river) as shown.

Report Format

For the sake of this report and to be consistent with Hillsborough River reports published by the Southwest Florida Water Management District, the Hillsborough River is divided into three regions: the Upper Hillsborough River (UHR), the Middle Hillsborough River (MHR) and the Lower Hillsborough River (LHR). Please see Figure 2. The UHR section stretches from the river source in the Green Swamp to the Fletcher Avenue Bridge, which is just south of the oxbow lake named Lettuce Lake near the University of South Florida. The MHR stretches from the Fletcher Avenue Bridge to the Hillsborough River Dam and includes the Hillsborough River Reservoir, and the LHR stretches from the dam to the mouth of the River in the City of Tampa. Each river segment is discussed in three sections as described below.

The first section of the report provides the results of the overall morphological assessment of the stream by stream reach and Stream WaterWatch site. Primary data products include: a contour (bathymetric) map of the stream, area, volume and depth statistics, and the water level at the time of assessment. Please see Appendix A for the stream morphology reports. These data are useful for evaluating trends and understanding flow regimes and calculating contaminant and nutrient loads. Stream WaterWatch volunteers will find the appropriate morphological reports on the respective Water Atlas (select Stream WaterWatch page to see example for USF Waterfront Park site 106 and view item in "Related Documents and Links"). An example report for USF Waterfront Park is shown in Figure 3 below. Table 1 provides a summary of the morphological data collected or calculated as part of this assessment.

Tidal areas (generally, the reach below the Hillsborough River Dam) presented a problem in determining the gauge elevation to use and therefore we use a mean value of gauge elevation for the period of the assessment. Not included in this report, but a goal of this project is to include LIDAR elevation data for the land area adjacent to mapped segments and allow a complete elevation map for the river at various stages.

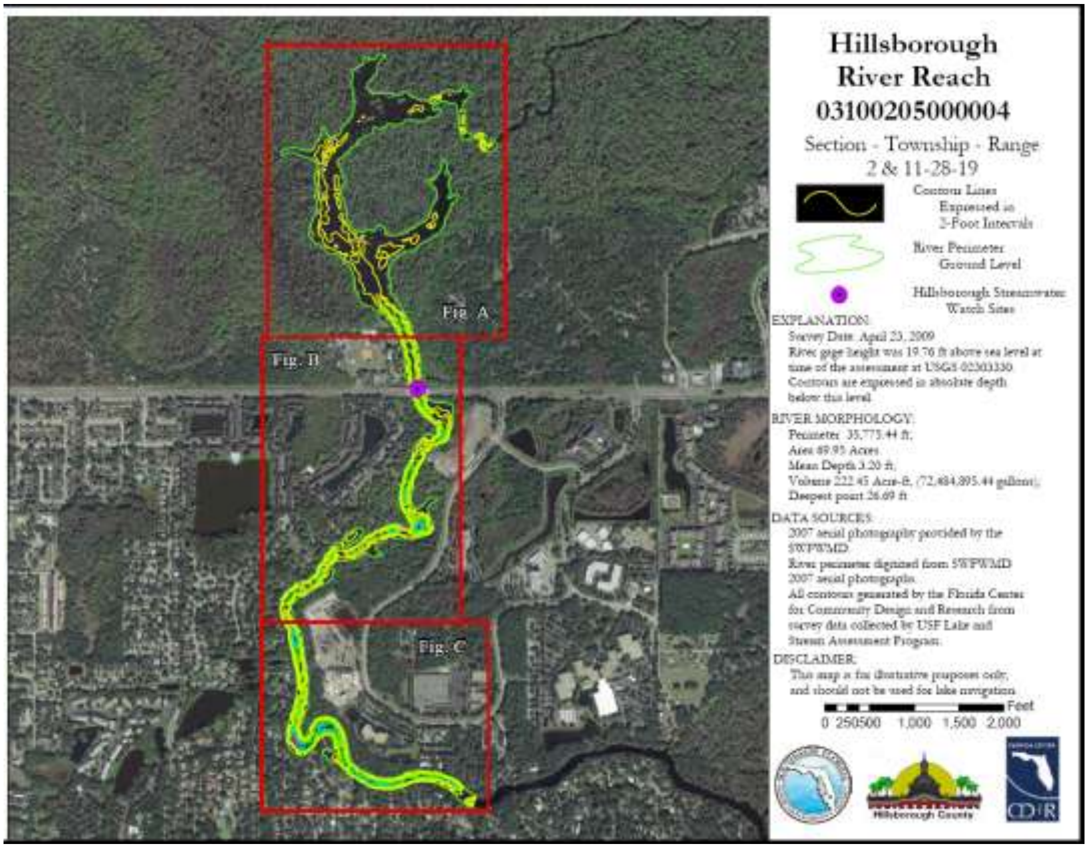

Figure 3. Page 1 of the Hillsborough River Morphology Report for area located near Stream WaterWatch site 106 at USF Riverfront Park.

Table 1. Summary of morphologic data for assessed stream segments

Name	Assessment Date	Gauge Height	Surface Area (planimetric feet)	Surface Area (acres)	Volume (ft^3)	Volume (acre-foot)	Volume (gal)	Mean Depth (ft)	Max Depth (ft)
Hillsborough River State Park	9/28/2009	1.87	386,637.45	8.88	1,583,635.52	36.36	11,846,498.46	-5.547113	-20.68
Hillsborough River 006	7/9/2009	23.98	847,321.52	19.45	2,463,242.02	56.55	18,426,457.61	-4.213183	-9.66
Hillsborough River Morris Bridge	7/7/2009	27.15	572,101.52	13.13	2,589,900.89	59.46	19,373,938.32	-6.889203	-22.879999
Hillsborough River 004	4/23/2009	19.76	3,047,105.42	69.95	9,689,753.94	222.45	72,484,895.44	-3.19606	-26.689999
Hillsborough River 003	4/27/2009	19.21	443,647.61	10.18	1,870,369.89	42.94	13,991,435.36	-5.212481	-19.279999
Hillsborough River 490	5/7/2009	21.78	16,110,087.97	369.84	91,636,302.94	2103.69	685,491,899.82	-7.130926	-34.07
HillsReservoir (6-2-09 to 6-9-09)	6/9/2009	22.53	7,282,371.42	167.18	67,730,980.31	1554.90	506,666,428.91	-10.114313	-37.356003
Hillsborough River Rowlett Park (partial)	8/31/2009	1.17	808,704.41	18.57	1,942,515.15	44.59	14,531,123.12	-4.151727	-12.31
Hillsborough River Rowlett Park (partial)	9/23/2009	2.32	808,704.41	18.57	1,942,515.15	44.59	14,531,123.12	-4.151727	-12.31
Hillsborough River University of Tampa	9/21/2009	11.51	1,967,564.19	45.17	15,839,234.10	363.62	118,486,520.37	-7.313244	-19.58

The second section provides the results of the vegetation assessment conducted on the stream by stream reach and Stream WaterWatch site. These results can be used to better understand and manage stream vegetation. Figures 4, 5 and 6 are maps of the UHR, MHR and LHR vegetation sites. Please see Appendix B for plant species list for areas assessed. Please also see

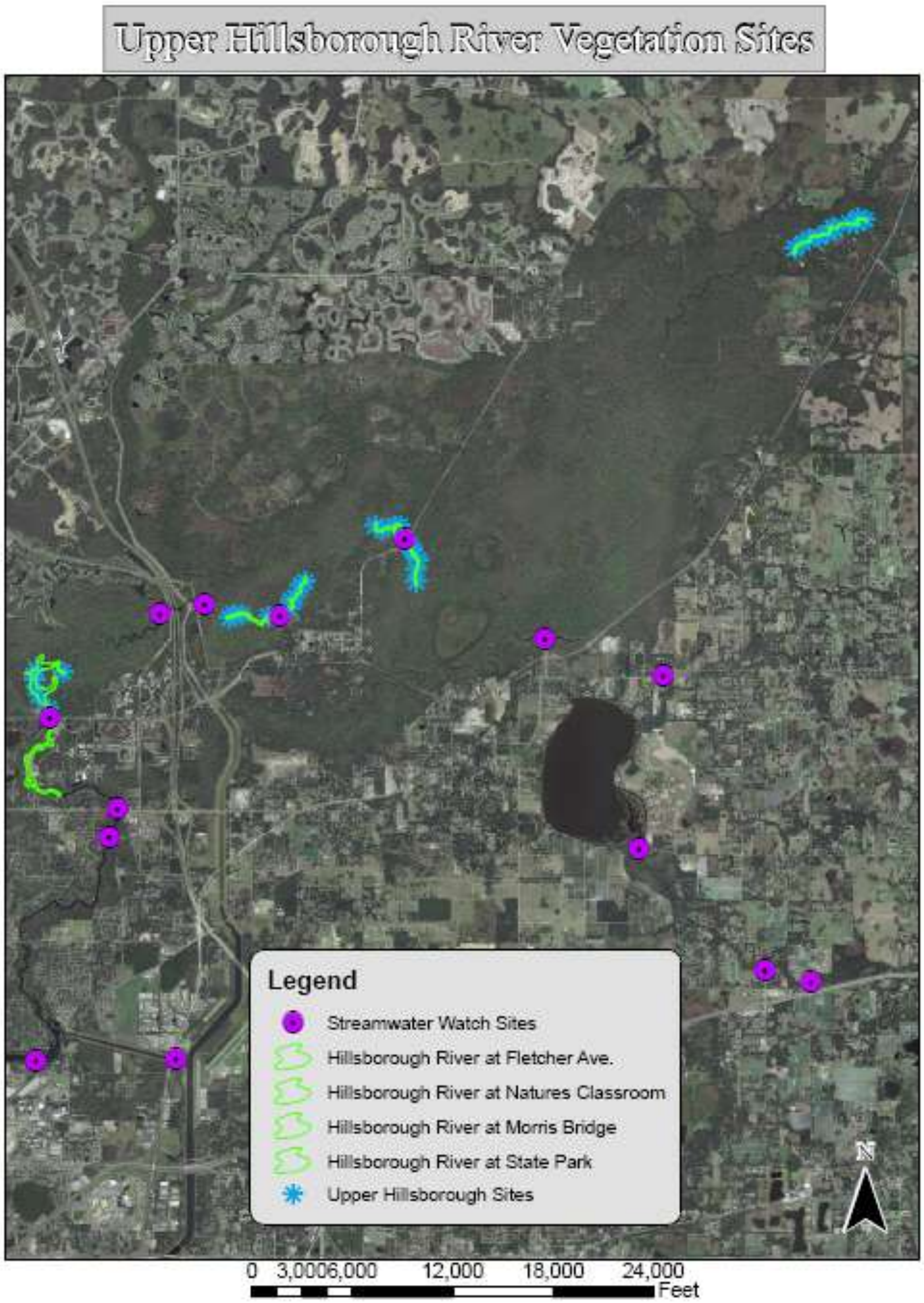

Figure 4. Upper Hillsborough River vegetation sites

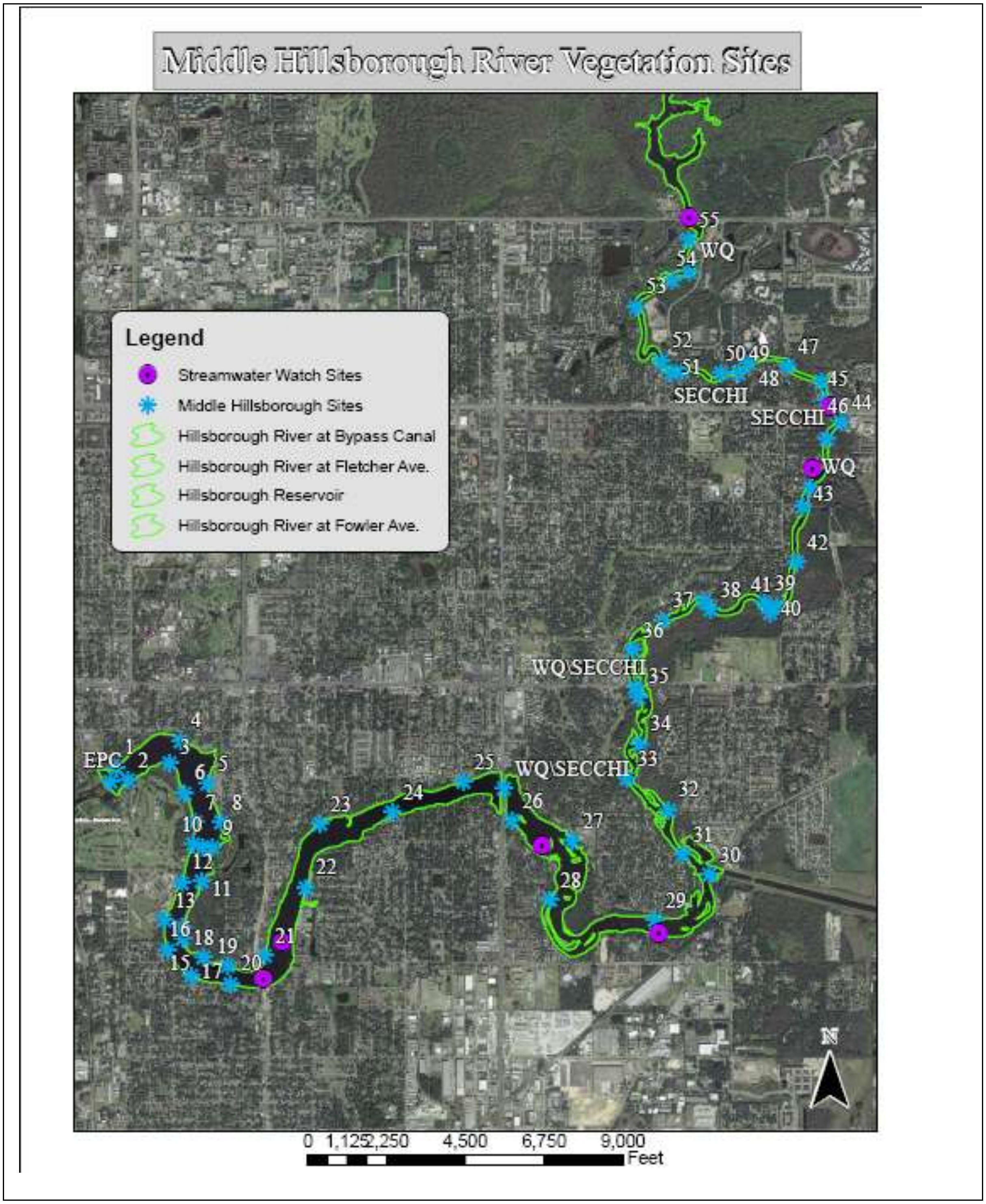

Figure 5. Middle Hillsborough River vegetation sites

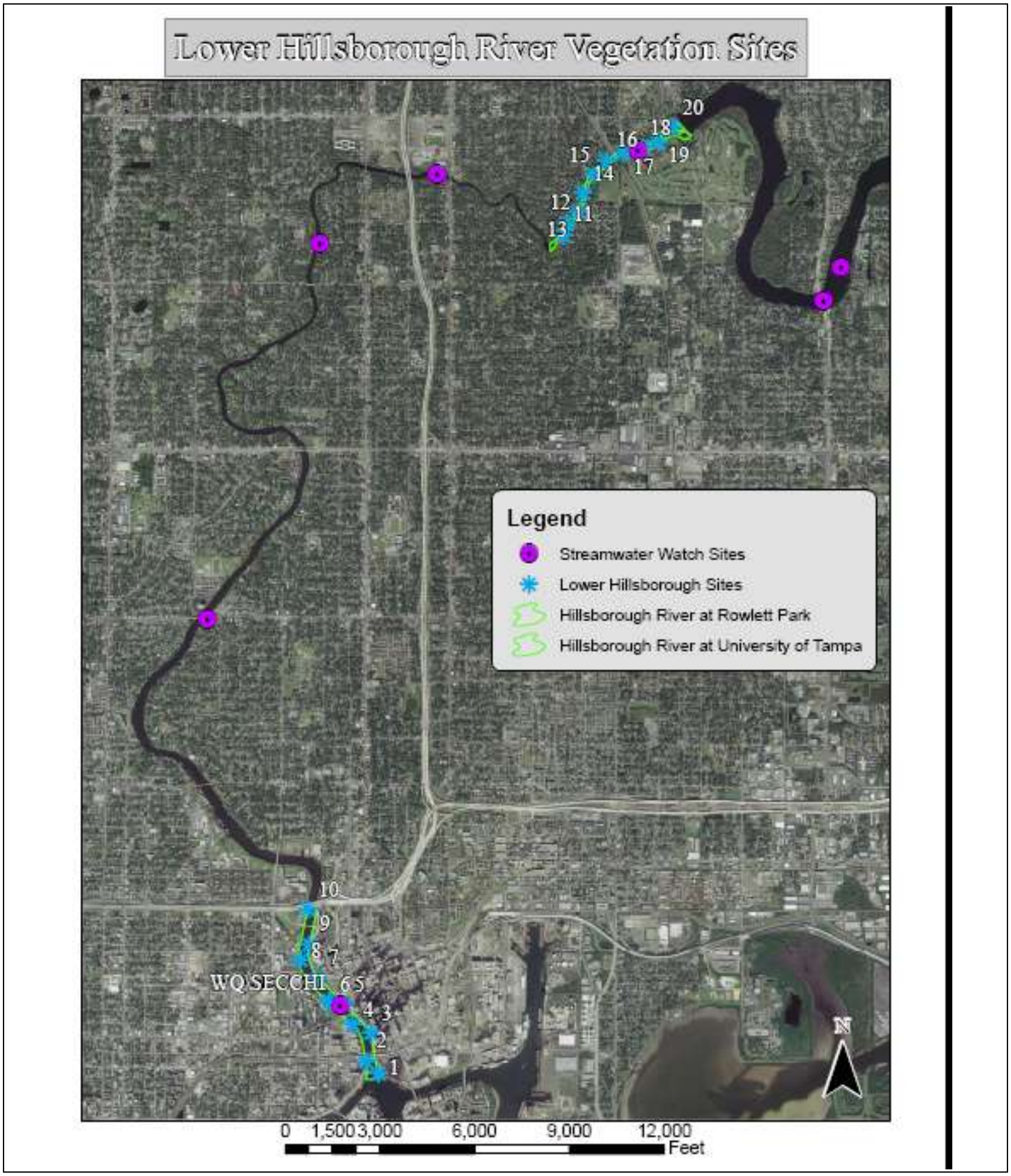

Figure 6. Lower Hillsborough River vegetation sites

Potentially invasive, exotic (non-native) species are identified in the plant list and the percent of exotics is presented in a summary column of the table. The watershed values are provided in the table as a means of reference. This section also includes the results of bottom sampling to determine the extent of loose sediment (bed load) existing within a reach.
The third section provides the results of the water quality sampling of the stream, by stream reach and Stream WaterWatch site. Both field data and laboratory data are presented. The water quality index (WQI)[1] is used to develop a general stream health statement[i]. This index, calculated as a Water Atlas parameter, is provided for each river reach. Please see the HCTWA Hillsborough River Page water quality section for these data. Please see Appendix C for water chemistry data and analysis.

The intent of this assessment is to provide a starting point from which to track changes in the stream, and where previous comprehensive assessment data is available, to track changes in the stream'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 stream. The assessment report should be used in conjunction with existing reports listed in the report bibliography.

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[1] A measure of water quality based on biological diversity and water quality-including levels of dissolved oxygen, coliform bacteria, oxygen-demanding substances, and nutrients. More Information Water Quality Index Learn More »

Section 1: Stream Morphology

Bathymetric Map[ii]. The bottom of the stream was mapped using a Lowrance LCX 28C 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 stream's area, mean and maximum depths, and volume, and the creation of a bottom contour map. Some data gaps exist in areas which either were not planned for the 2009 assessment or were planned but not assessed because the low water levels at the time the assessment was scheduled precluded assessment. Figure 7 is a map of the Hillsborough River areas assessed. Besides pointing out the deeper fishing holes in the stream, the morphologic data derived from this part of the assessment can be valuable to overall management of the stream as well as providing flood storage data and stream volume for flood models. Appendix A contains the reports that were also loaded to the HCTWA as part of the assessment. The images in Appendix A are formatted as embedded documents and must be mouse clicked to open. The individual pages of the report provide contour depths. The steam morphology may be used to classify the stream with methods such as those developed by Rosgen.[ii]

Figure 7. Example of files found in Appendix A and on Water Atlas. The overview page of the morphology report provides the morphologic parameters for that assessed area.

Section 2: Stream Ecology (vegetation)

An important aspect of a stream's ecology is its vegetation cover. Vegetation provides essential habitat and helps to remove nutrients and pollutants that are present in the stream. Part of the health of a stream can be determined by knowing a stream's vegetation composition and cover. Ten vegetation assessment sites were chosen for each stream segment based on the *Stream Assessment Protocol* (copy available on request). 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 high resolution aerial photos are used to provide shore details (docks, structures, vegetation zones) and to calculate the extent of surface vegetation coverage.

For this first year of stream assessments, the methods developed for lakes were used. These methods include a qualitative assessment of the stream vegetation within about a 10-meter distance on either side of the stream site and the sampling (using a ¼-meter sinking quadrangle), harvesting and weighing of vegetation from the sampler. The sample weight is used to estimate the biomass present within an assessed river segment. The hard and soft returns from the bathymetric sampling (Section 1) are then used to determine presence and absence of vegetation and to determine the height of vegetation if present. These data are used to determine percent area coverage (PAC) and the percent volume infestation (PVI) of stream vegetation samples. The PAC is determined from the presence and absence analysis of 100 sites in the stream and the PVI is determined by measuring the difference between hard returns (stream bottom) and soft returns (top of vegetation) for sites (within the 100 analyzed sites) where plants are determined present (Figure 6). A sediment sampler is also used to manually sample sediment to determine hard and soft bottom and for use with collected bathymetric data.

The data collected during the qualitative site vegetation assessments 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 stream is provided in a table in Appendix B. The Watershed value in the table only includes streams sampled during the stream assessment project begun in May of 2009. These data will change as additional streams are sampled. Appendix B includes tables that provide the detailed results from the 2009 aquatic plant assessment for the stream. 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 the stream and is also considered a problem plant for this region of Florida, or is a non-native invasive that is or has the potential to be a problem plant in the stream and has at least 40% occurrence. These two terms are somewhat subjective; however, they are provided to give stream property owners some guidance in the management of plants on their property.

Please remember that to remove or control plants in a wetland (stream shoreline) in Hillsborough County the property owner must secure an Application To Perform Miscellaneous Activities In Wetlands (http://www.epchc.org/forms_documents.htm) permit from the Environmental Protection Commission of Hillsborough County and for management of in-stream vegetation outside the wetland fringe, the property owner must secure a Florida Department of Environmental Protection permit (http://www.dep.state.fl.us/lands/invaspec).

Section 3: Stream Water Chemistry

An important element in any stream assessment is the long-term water chemistry data set. The primary source of water chemistry trend data for the Hillsborough River is the Hillsborough County Environmental Protection Commission's (HCEPC) Monitoring program. These data are augmented by water chemistry and some biological sample data provided by the Hillsborough County Stream WaterWatch volunteer water chemistry monitoring program. Multi-source water chemistry data, including these data, are managed by the Water Atlas program within its spatial and non-spatial databases and are provided to all users through the Data Download system. Water Quality (water chemistry) data can be accessed by using the application directly or by accessing single-site data or water body data from the appropriate Water Atlas water resource water quality page. For example, by going to the Hillsborough River Water Quality Page you are able to select the site and download discrete water chemistry data (Figure 8) or graph the data (including the Water Quality Index) from the same page by selecting the graphing function. The Water Quality Index graphs are presented in river reach order.

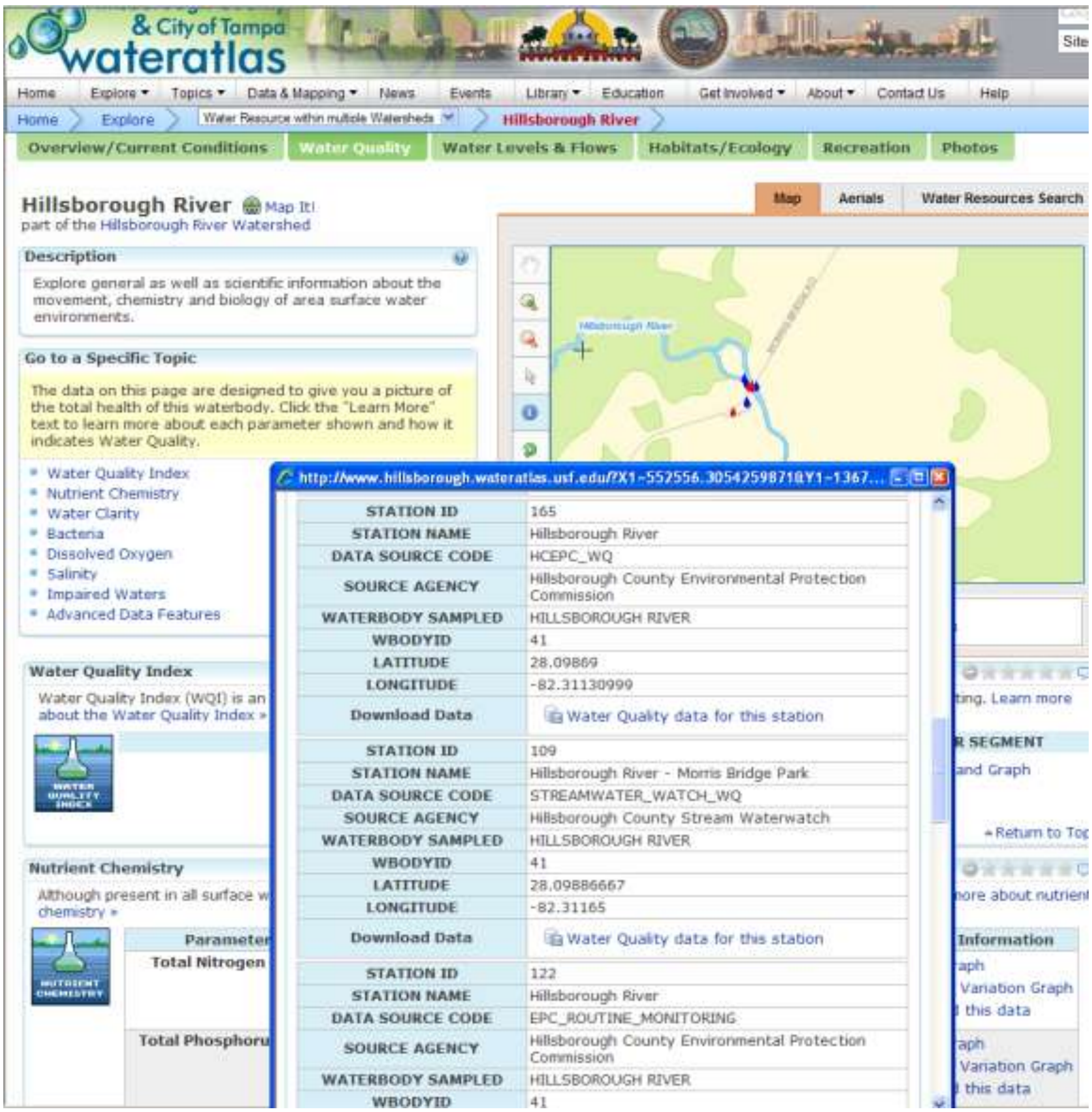

Figure 8. Selecting Sample Stations directly from Water Atlas water resource water quality page.

Another method of using the Water Atlas to review water quality conditions is to use the Water Quality Index layer available on Advanced Mapping. This layer is updated quarterly and shows the most recent water quality index by quarter and for two-year and ten-year intervals. Figure 9 below shows this view for the most recent two-year period (2007–2008) where complete data sets are available.

The reader is encouraged to use the Water Atlas for the most recent water chemistry data and for the most recent water quality index data. The summary provided in this report has a data cutoff of September 2009.

Figure 9. Water Quality Index (WQI) for July–September 2007–2008. Middle river is generally fair and Lower River is generally poor in terms of WQI.

Section 3A. Water Quality Analysis by Source

This section analyzes water chemistry data from the three sources used for the assessment. These are the Hillsborough County Environmental Protection Commission (HCEPC), which is the primary source of water chemistry data for the Hillsborough River, the Stream WaterWatch (SWW) volunteer program water chemistry data, used as a secondary source of water chemistry data, and the Water Atlas Assessment (WAA) data which is used as a snapshot of the water chemistry at the time of the assessment. The source of both the HCEPC and WAA data is the HCEPC laboratory and the SWW data source is the University of Florida LAKEWATCH laboratory. All parametric data is downloaded and available from the Water Atlas Data Download.

Hillsborough County Environmental Protection Commission (HCEPC). Figure 10 shows HCEPC sites and site numbers, the water quality sample data that was used, in part, to characterize the river and to determine river means. The sample numbers and positions shown in Figure 10 correspond to the mean water quality table (Table 2) and to the total nitrogen and total phosphorus graphs (Figure 11) shown below. As is apparent in Figure 12, there is a general trend of reduced nitrogen concentration for downriver stations and no significant trend for phosphorus. This may indicate an input of nitrogen from Crystal Springs (via Big Ditch) and the effects of Blackwater Creek, which enter the Hillsborough River near this station, and the uptake of nitrogen by vegetation within the river, and dilution of the nitrogen from tributaries such as Flint, Cypress and Trout Creeks downriver from the site, and wetland marsh discharges to the river (see river description in the introduction of the report). The graph of Big Ditch total nitrogen (Figure 12) is indicative of the high nitrogen load potential represented by the Big Ditch tributary to the river.

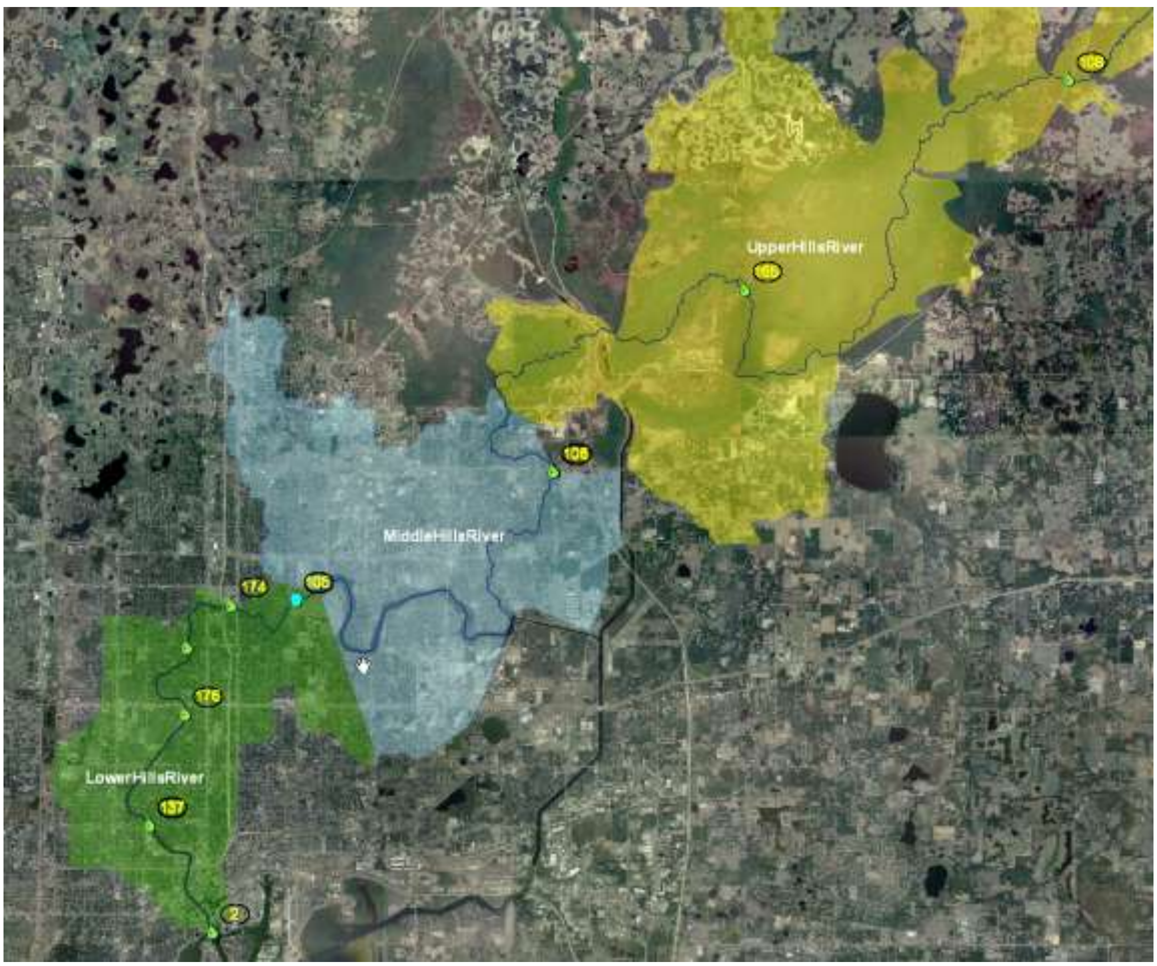

Figure 10. Hillsborough County Environmental Protection Commission (HCEPC) sample stations on Hillsborough River.

Table 2. Five Year Mean Values for HCEPC Stations on Hillsborough River. Please note that the statistic in the Number of Samples column is sum, not mean.

Station ID	Values Number of Samples	Mean of Chla_ug/L	Mean of BOD5_mg/L	Mean of TP_ug/L	Mean of DO_mg/L	Mean of Fcoli_#/100mL	Mean of TN_ug/L	Mean of TSS_mg/L	Mean of Turb_ntu
2	23	6.6	1.2	189.8	5.1	262.6	648.4		2.2
105	65	14.6	1.5	161.0	5.6	294.5	766.6	2.9	1.8
106	48	11.7	1.2	201.3	4.0	73.5	1084.9	33.5	1.5
108	47	1.3	0.5	187.6	6.1	200.9	1710.7		1.5
137	64	14.6	2.0	191.5	4.2	380.6	721.5	7.1	2.8
165	61	4.9	0.9	208.1	4.2	107.0	1281.2	8.1	2.0
174	37	1.3	0.8	104.4	7.1	162.3	385.1	1.5	
176	15	31.0		196.4		104.0	784.0		
River Mean	**360**	**9.6**	**1.3**	**180.7**	**5.0**	**213.1**	**965.5**	**5.7**	**2.1**

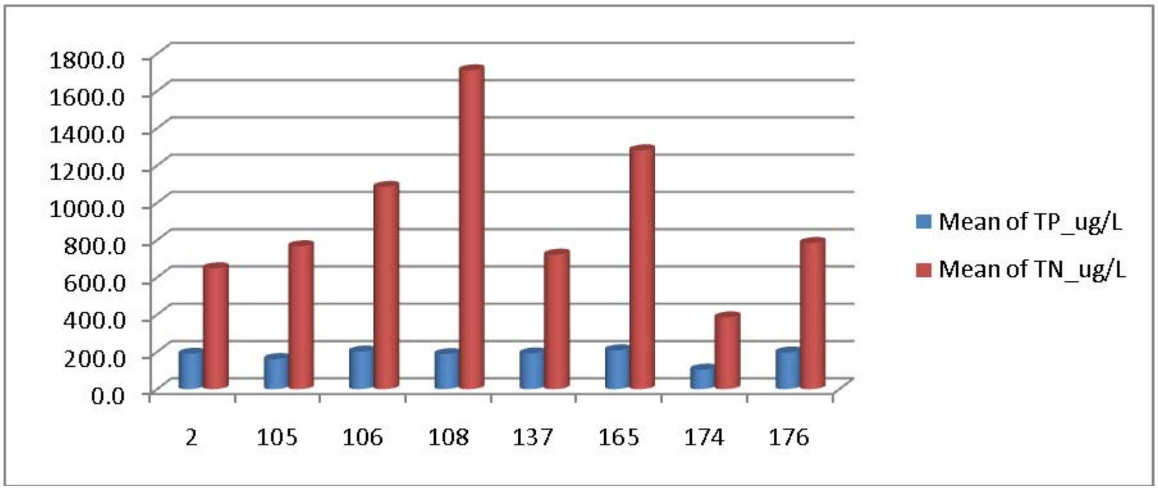

Figure 11. Mean values of total phosphorus and total nitrogen in micrograms per liter (µg/L) for the HEPC stations available for this assessment. Station 2 is at the river mouth near Tampa and Station 108 is near the Hillsborough River State Park and the Big Ditch, Hillsborough River tributary. Site 165 is near Morris Bridge.

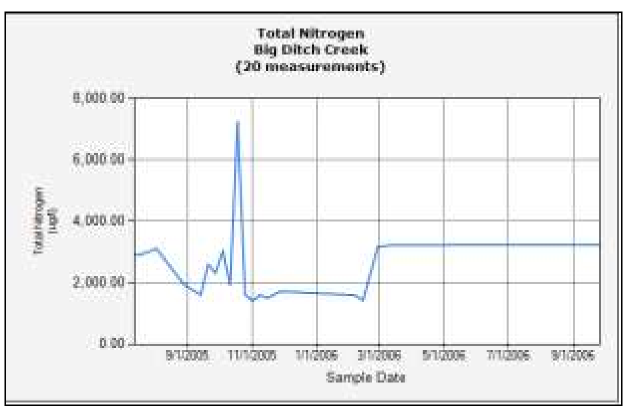

Figure 12. Big Ditch total nitrogen for period of record (Water Atlas Data visualization for Florida Department of Environmental Protection station TP398–Big Ditch).

Stream WaterWatch. Figure 13 below shows SWW sites and site numbers. The sample numbers and positions shown in Figure 13 correspond to the mean water quality table (Table 3) and the total nitrogen and total phosphorus graphs (Figure 14). The same general trend of downriver reduction in nitrogen and little change in phosphorus sample concentrations are seen in these data as the HCEPC data; however, the two datasets do not compare well. This trend can be observed by comparing station 138 in the upper river with downriver sites 109, 119, 106 and 101.

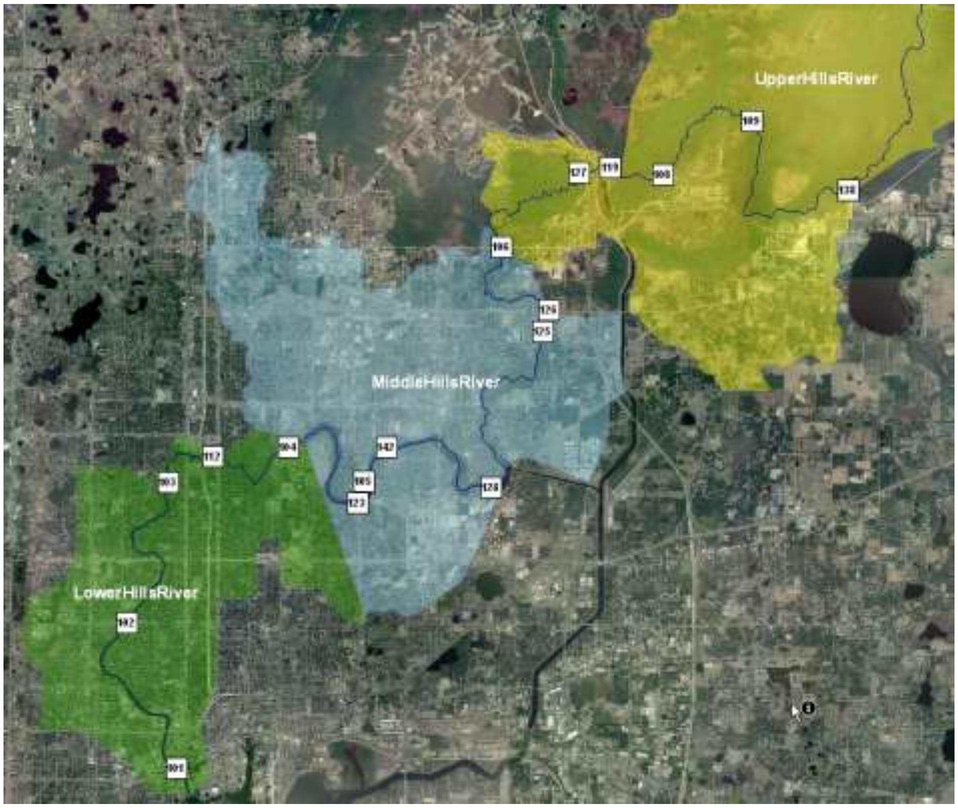

Figure 13. Stream WaterWatch Stations for Hillsborough River

Table 3 Stream WaterWatch site data for total nitrogen and total phosphorus for stations reporting these data:

Sample Sites	Mean of TN_ug/L	Mean of TP_ug/L
101	345.88	115.29
103	502.86	159.19
104	627.69	120.00
106	990.37	126.78
108	898.95	200.84
109	1240.77	137.00
112	627.50	131.71
119	1107.82	180.49
123	813.00	120.50
126	884.17	172.21
127	1020.00	128.00
128	713.48	121.66
138	1540.00	214.00
142	658.00	60.00
River Mean	**846.05**	**144.99**

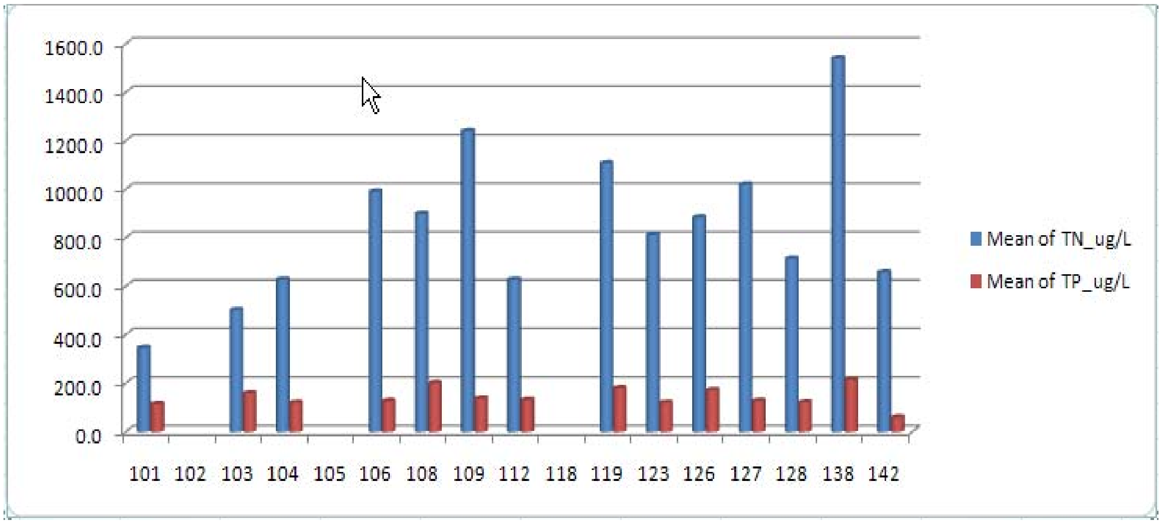

Figure 14. Stream WaterWatch sites total nitrogen and phosphorus for sites reporting this parameter.

Figure 15 is a graph of median and daily discharge based on the gauge at Morris Bridge. The Morris Bridge site will be used to estimate the river loading from the UHR segment.

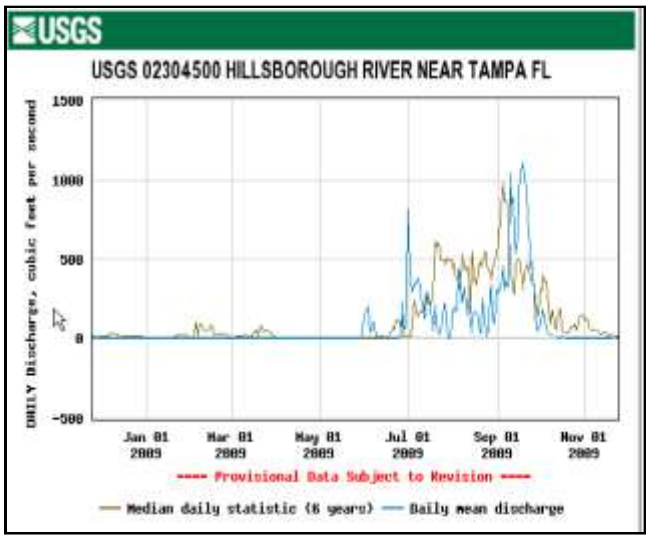

Figure 15. Stream flow at Morris Bridge Road USGS site.

Water Atlas Assessment (WAA). Figure 16 provides the WAA site map and site numbers. The sample numbers and positions shown in Figure 16 correspond to the water quality table (Table 4) and the total nitrogen and total phosphorus graphs (Figure 17). The trend that shows in the HCEPC and SWW site data is not as apparent in these data. There is a definite difference in the stations near the mouth of the river (Station 11) and Station 01 in the upper river; however, the overall trend is not as apparent. The difference in upper and lower river data may indicate the effect of nitrogen from Crystal Springs (via Big Ditch) and the effects of Blackwater Creek which enter the Hillsborough River just above this station. The WAA sampling effort took place between July 22 and September 16, 2009, which was a period of reasonably high flow in the Hillsborough River as is apparent in Figure 15.

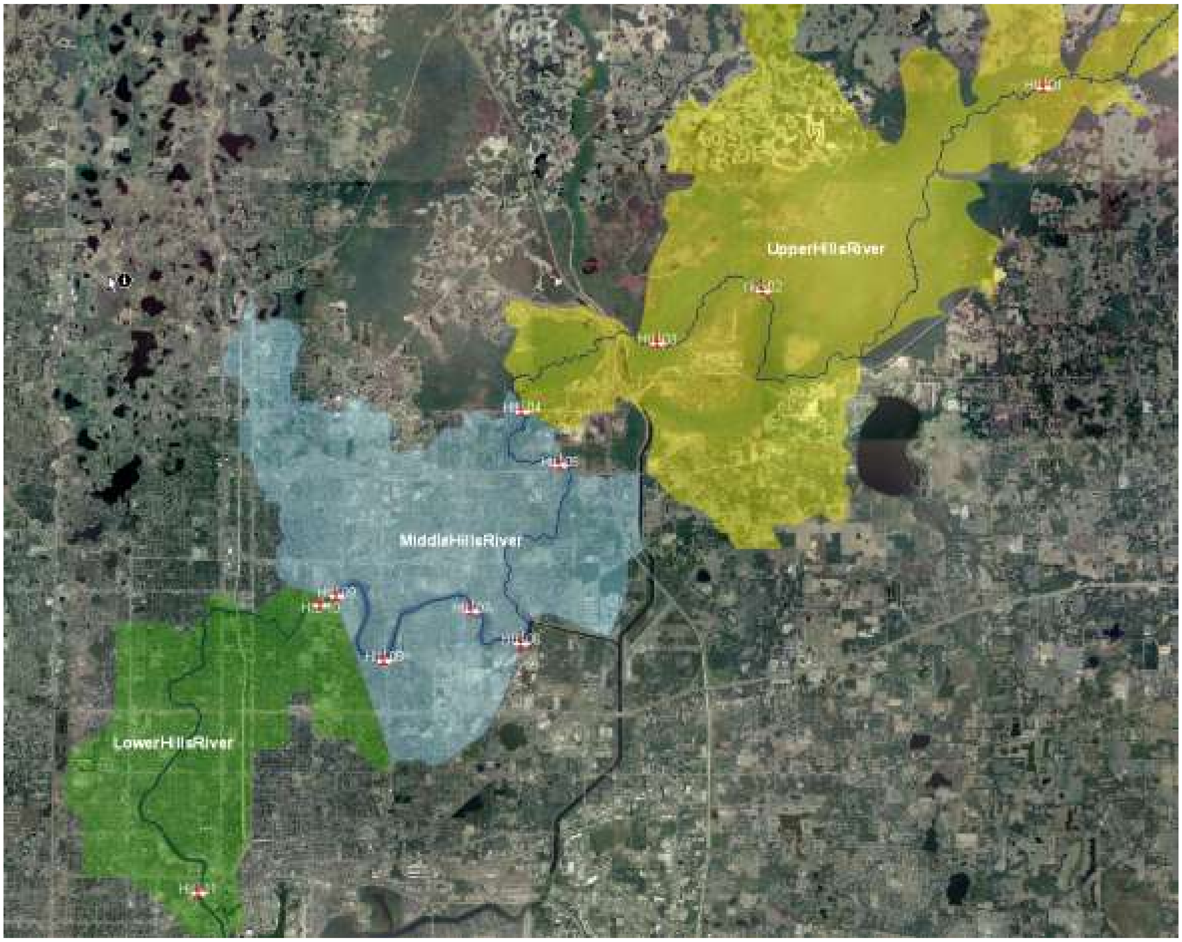

Figure 16. Sample sites for the Water Atlas Stream sampling on Hillsborough River.

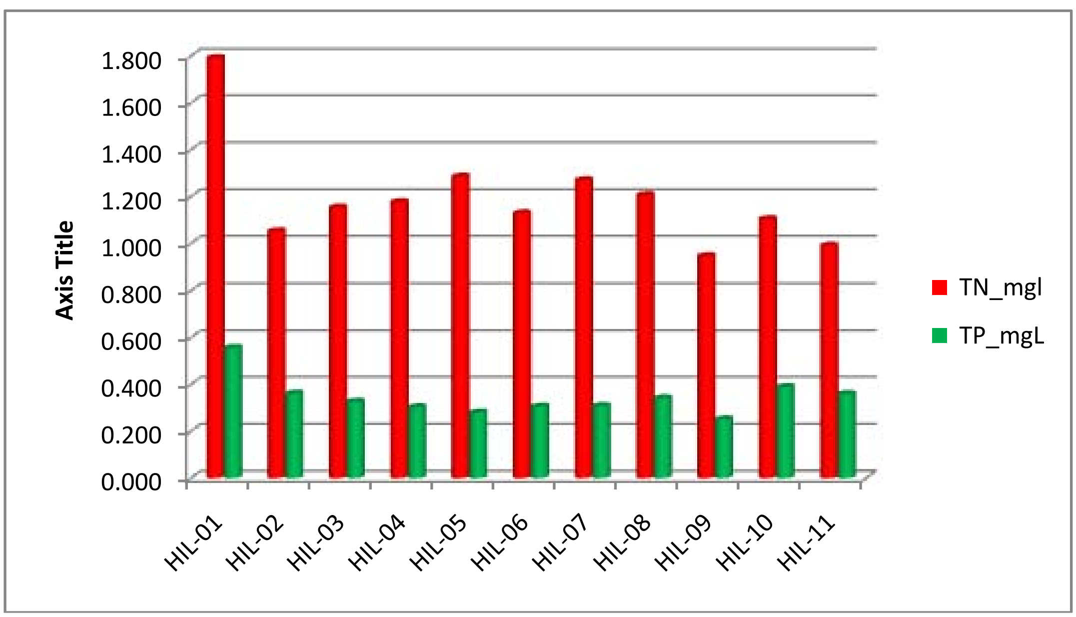

Figure 17. Water Atlas Assessment sampling data results for total nitrogen and phosphorus

Table 4. Sample data from Water Atlas Assessment sampling of Hillsborough River between 7/22–9/16 2009

Row Labels	Chla_ug_L	TN_mgl	TP_mgL	Enterococci_100ml	FC_100_ml	Ammonia_mgl
HIL-01	2.6	1.792	0.556	1420	600	0.081
HIL-02	1.4	1.052	0.361	520	80	0.053
HIL-03	0.9	1.153	0.326	1600	400	0.039
HIL-04	1.0	1.177	0.303	210	140	0.065
HIL-05	1.0	1.285	0.280	100		0.072
HIL-06	1.7	1.129	0.305	260	100	0.060
HIL-07	4.9	1.270	0.308	700	200	0.050
HIL-08	17.5	1.206	0.341	160	380	0.088
HIL-09	39.7	0.946	0.251	440	1180	0.058
HIL-10	4.4	1.104	0.389	520	460	0.094
HIL-11	0.4	0.991	0.359	180	40	0.179
River Mean	**6.0**	**1.179**	**0.342**	**526**	**338**	**0.074**

Section 3B. Water Quality Analysis by Segment.

As stated earlier, for the purposes of this report, the Hillsborough River is divided into three regions: the upper river (UHR) which is the segment from Green Swamp to the Fletcher Avenue Bridge, the middle river (MHR) which is the segment from the Fletcher Avenue Bridge to the Hillsborough River Dam and the lower river (LHR), the section from the dam to the mouth of the river below the University of Tampa. The water quality for this section will be provided as an average of station values for different parameters and as an estimate of annual load (average concentration at the segment boundary times flow volume) for the upper river based on the flow station at Morris Bridge Road (USGS Station 02304500) and for middle river to the lower river using the City of Tampa flow station at the Hillsborough River Dam. Since the lower river is tidal, no flow station is available for this section. The basis for the water chemistry data are the sample data provided by the HCEPC sampling program and the samples collected during the Hillsborough River assessment by FCCDR and analyzed by the HCEPC laboratory. Stream WaterWatch site data is provided but not used in direct analysis. The HCEPC data which provides a mean of river water quality roughly over the period of November 1999 and November 2009 will be used to discuss general water chemistry in the three river segments. The USEPA TMDL report (2004) for the Hillsborough River Basin includes nutrient and chlorophyll data and other pertinent histories and reports will be used to compare water chemistry and for a better understanding of the actual conditions on the river. These reports are referenced though links to the the Water Atlas Digital Librarty. Please also refer to the Hillsborough River Watershed Management Plan, Hillsborough County, August 2001, the Minimum Flows and Levels Reports on the SWFWMD MFL Reports Page, and the Spatial and temporal chemical variability in the Hillsborough River, system, Lori A. Pillsbury and Robert H. Byrne, Marine Chemistry Vol 104, Feb, 2007,

To better understand the nutrient concentration dynamics in the Hillsborough River, a GIS mode is used that employs inverse distance weighted (IDW) calculations to visualize the change of nutrient (TN and TP) concentrations from the uppermost monitored section of the river to the mouth of the river. The samples of river nutrient concentration used in the model are from sampling events conducted between June and August 2009 and represent a period of moderate to relatively high water levels in all sections of the river. Because IDW estimates are radial estimates, model barriers were established where site effect would not be expected to occur and at the Hillsborough River Dam. The effect of a barrier is to remove the influence of a site's value (concentration data) to a river segement that is near the site in radial distance but not in river distance. Figures 18 and 19 show outputs of the model for the full length of the Hillsborough River for total phosphorus and total nitrogen. The HCEPC site 108 is the uppermost site and the Water Atlas Assessment (FCCDR) site 11 is the site nearest the mouth of the river. The model estimates nutrient concentration extent by assuming concentration is reduced as the inverse of distance from the sample site. This of course is not necessarily correct and areas where there are large stretches of the river without a site should not be considered as accurately representing the concentration. The value of the visualization is to allow estimates of concentrations along the course of the river between relatively close sites. The visualization does support the trend observed of reductions in nutrients downriver. In the segment by segment reports below, the visualization will be shown by river segment and for both TN and TP.

Another method used to visualize the water quality of a stream is to map the Water Quality Index (WQI) for the stream. Figure 20 shows the WQI map for WQI calculated from 2007 through 2009 biological and chemical water quality data. This map compares relatively well with the nitrogen and phosphorus visualization maps shown in Figures 18 and 19. [WQI] tracks a number of river system chemical and biological parameters and can be used to compare river segments and provide a general health-of-system estimate.

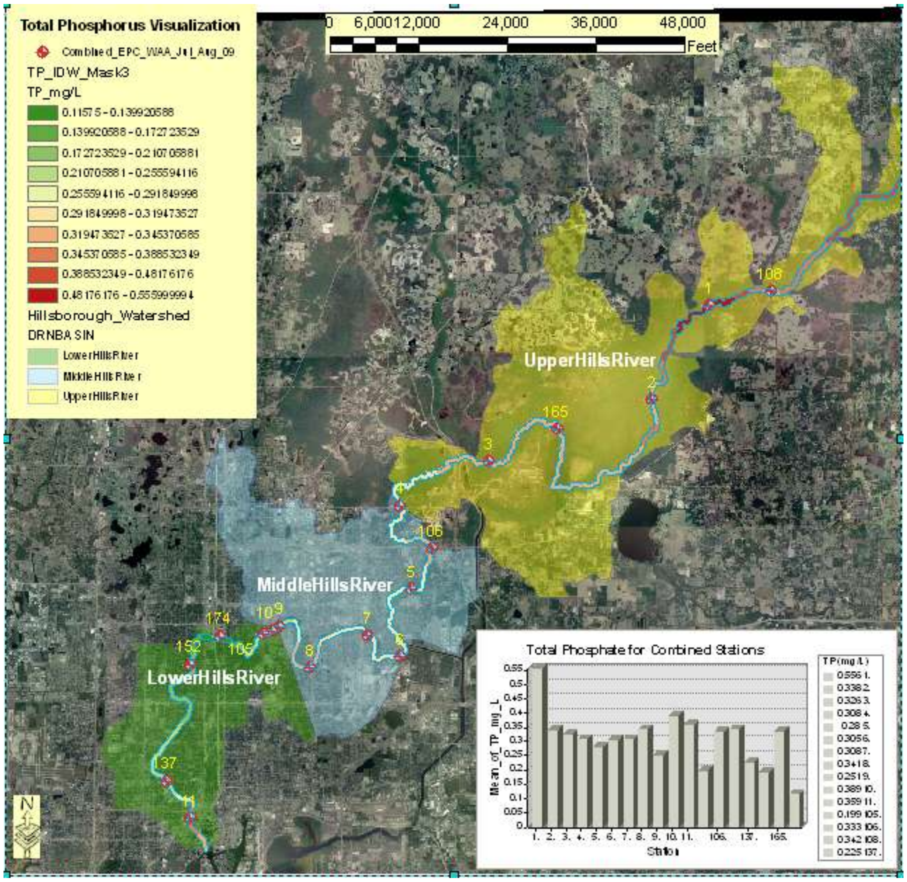

Figure 18. Visualization of TP concentrations for Hillsborough River using IDW model.

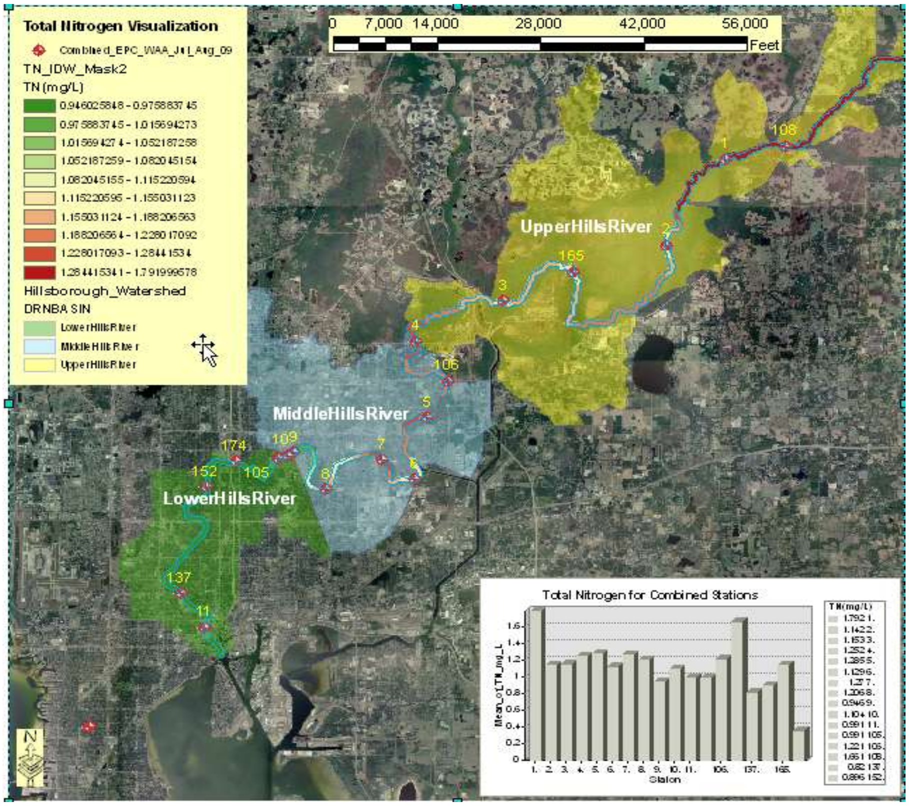

Figure 19. Visualization of TN concentrations for Hillsborough River using IDW model

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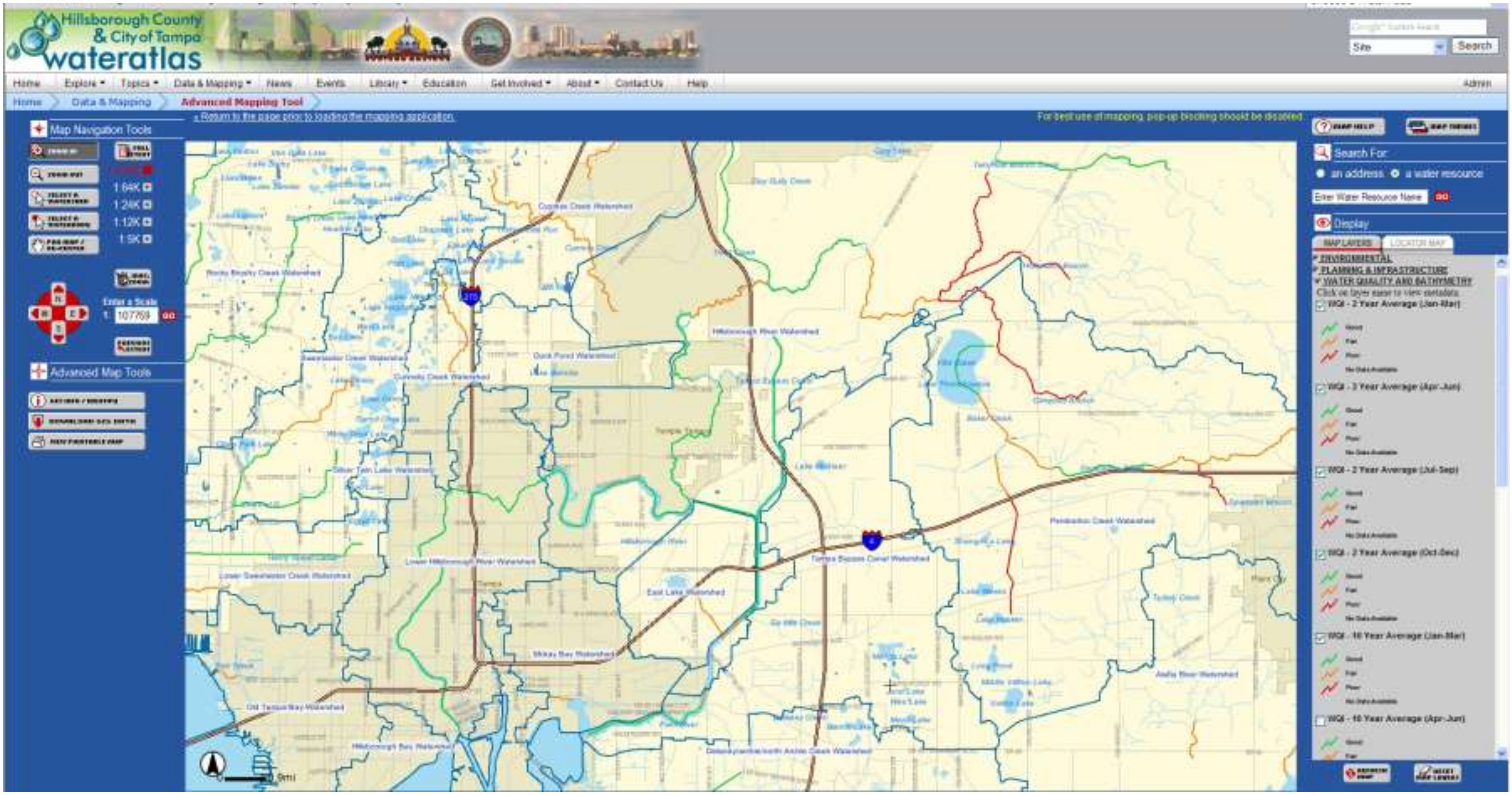


Figure 20. Water Quality Index Map from Hillsborough County and City of Tampa Water Atlas that shows the Upper through Lower Hillsborough River WQI over last two years.

Section 3B1. Upper Hillsborough River (UHR) Segment

As shown in Figure 21, The Upper Hillsborough River Segment is a long, primarily rural stretch of the Hillsborough River. Two Environmental Protection Commission (EPC) long-term water chemistry sites are used to characterize this stretch of the river. Site 108 is near the Hillsborough River State Park and is in a agricultural area of northeast Hillsborough County. This site also lies downriver from Crystal Springs and below the confluence of the Hillsborough River and *Blackwater Creek* that drains parts of northeastern Polk County and northeastern Hillsborough County including *Itchepackesassa Creek* and the *East Side Canal*, which includes significant agricultural and the City of Plant City drainage. Site 165 is near Morris Bridge Road in a mainly undisturbed area characterized by the Hillsborough River floodplain and wetlands. The site is downstream from the confluence of Hillsborough River and *Flint Creek* (drains Lake Thonotosassa) and Hillsborough River and outflow of *Cow House Creek* (drains to the *Tampa Bypass Canal* and middle river near Fowler Ave.).

Figure 21. HCEPC sites in the upper river.

Tables 5 and 6 below provide the mean value for a period of record from 1999 through 2009 for site 108 and 2004–2009 for site 165. These two sites have different periods of record but as can be seen by comparing the two tables, the difference in values for the various parameters remains valid. The two sites demonstrate a significant difference in water chemistry and a general reduction in adverse water quality (lower nutrients, bacteria and turbidity). However there is a reverse trend for dissolved oxygen and chlorophyll a. This may be due to the change in flow regime in the lower portion of this segment. Figure 22 is a plot of site 108 for nutrients and chlorophyll. Nitrogen shows a downward trend with a correlation coefficient, r, of 0.5985 and a coefficient of determination, R^2, of 0.3582. Chlorophyll a shows no significant change over time and phosphorus shows a weak correlation with time ($r = 0.3972$). Figure 22 is a similar plot for station 165 for nutrients and chlorophyll a. You will notice that there is no similar trend with time. Which indicates possible changes in the upper portion of this section have not occured in the lower portion.

The upper portion of the segment receives flows both from Crystal Springs and the upper portion of the Hillsborough River watershed, a mainly agricultural section. A report of nitrogen sources for the Hillsborough River by the Tampa Bay Estuary Program in February 1999 titled "Contribution of Total Nitrogen Loading to the Hillsborough River Reservoir from Crystal Springs" investigated loading from Crystal Springs to the Upper Hillsborough River. This report listed Crystal Springs as a major source of nitrogen loading to the river with and estimated annual load in 1997 at about 104 tons/year. In comparison, the loading from Blackwater Creek was estimated at about 70 tons for that year. In 1994 the spring contributed about 110 tons/year and Blackwater Creek contributed about 220 tons/year, a significantly different relative value. The Blackwater Creek drains much of northeastern Hillsborough County and northwestern Polk County and receives flows from the Eastside Canal which drains portions of Plant City and also recieves treated wastewater from the Plant City wastewater treatment facility.

Table 5. Mean value of parameters from HCEPC sites 108 and 165 for period 1999 to 2009. Please note that site 165 only displays data from 2004–2009. Mean of sites is determined from all sites and is not equivalent to average of mean values.

Station_ID	Mean of BOD5_mg_L	Mean of Chla_ug_L	Mean of DO_mg_L	Mean of Fcoli_100mL	Mean of TN_ug_L	Mean of TP_ug_L	Mean of Turb_ntu
108	0.33	0.51	5.60	118.99	1003.20	143.64	0.84
165	0.24	1.76	3.96	39.27	437.85	73.01	0.31
Mean of Sites	**0.29**	**1.05**	**4.90**	**84.88**	**761.30**	**113.42**	**0.61**

Table 6. Mean value of parameters from HCEPC sites 108 and 165 for period 2004 to 2009. Mean of sites is determined from all sites and is not equivalent to average of mean values.

Station_ID	Mean of BOD5_mg_L	Mean of Chla_ug_L	Mean of DO_mg_L	Mean of Fcoli_100mL	Mean of TN_ug_L	Mean of TP_ug_L	Mean of Turb_ntu
108	0.22	0.41	5.42	82.80	800.69	116.06	0.48
165	0.24	1.76	3.96	39.27	437.85	73.01	0.31
Mean of Sites	**0.23**	**1.07**	**4.71**	**61.69**	**624.71**	**95.18**	**0.39**

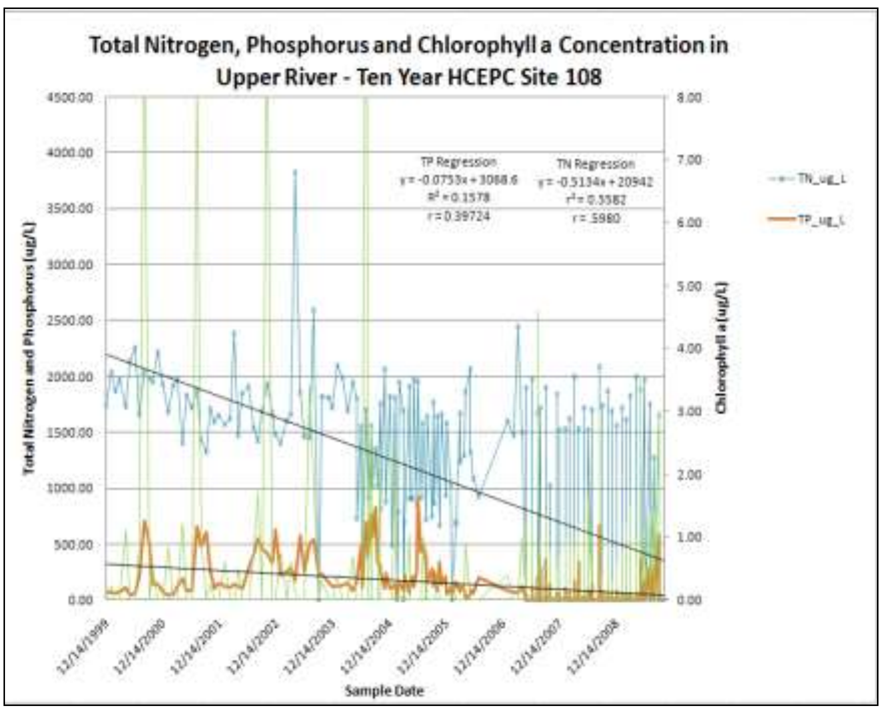


Figure 22. Total nitrogen (TN) , total phosphorus (TP) and chlorophyll a (Chla) in the Upper Hillsborough River between 1999 and 2009. For TN and TP concentration please use the left "Y Axis" scale and for Chla concentration use the right axis scale. All concentrations are shown as micrograms per liter (µg/L).

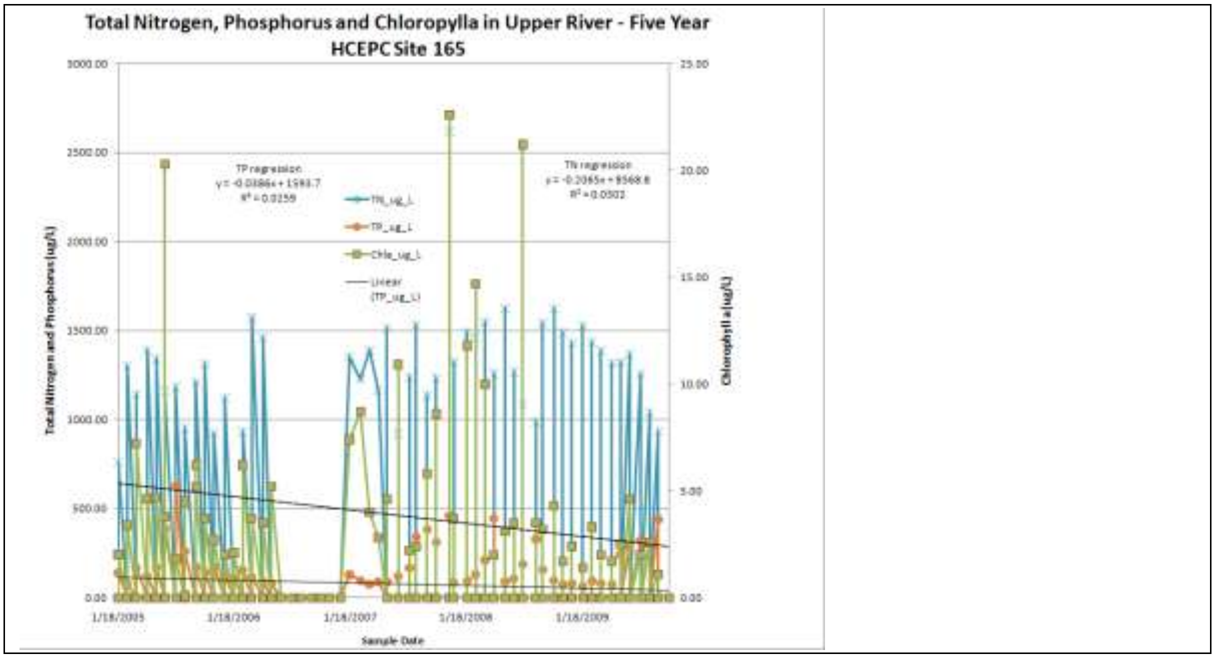


Figure 23. Total nitrogen (TN) , total phosphorus (TP) and chlorophyll a (Chla) in the Upper Hillsborough River between 2005 and 2009. For TN and TP concentration please use the left "Y Axis" scale and for Chla concentration use the right axis scale. All concentrations are shown as micrograms per liter (µg/L).

The USGS flow station at Morris Bridge Road (see Figure 15) and HCEPC site 165 nitrogen and phosphorus concentration data were used to estimate loading for the UHR section. Based on these data, a one-year loading estimate for the UHR in 2009 is 42 tons phosphorus and 165 tons nitrogen with a flow volume of just under 5 billion cubic feet. In comparison, the previously referenced TBEP 1999 report gave an estimated nitrogen load at Morris Bridge Road of about 209 tons in 1997 with a total flow volume of just under 12 billion cubic feet (1997–98 El Niño flooding). The flow for 2009 was significantly below (42%) that of 1997 which would help explain the difference in load. The load will increase with storm duration, although not as a linear function of duration. This is because the amount of a pollutant found in stormwater runoff is reduced by previous events or by a same event of long duration. The effect of storm duration on pollution load is sometimes modeled as a decreasing exponential factor of duration. Please see: "Analytical Urban Storm Water Quality Models Based on Pollutant Buildup and Washoff Processes", Jieyun Chen and Barry J. Adams, M.ASCE, Journal of Environmental Engineering, ASCE, October 2006.

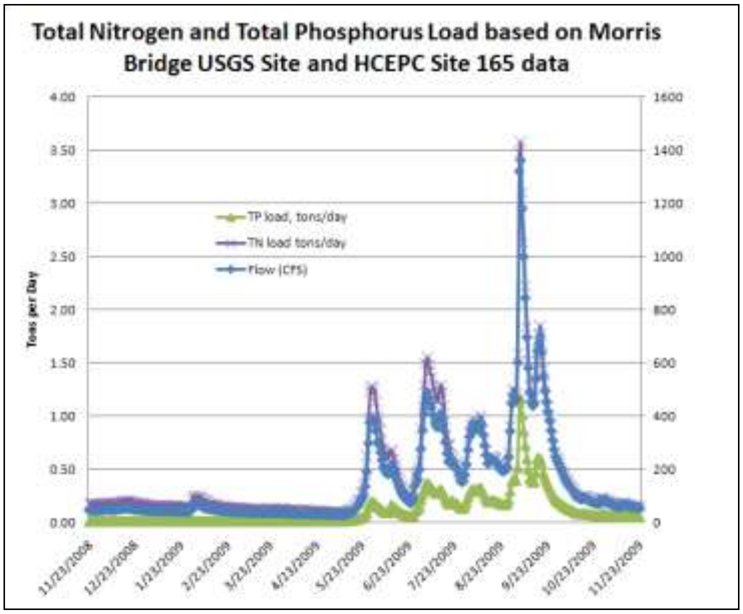


Figure 24. TN and TP load estimates for USGS site 023054500 at Morris Bridge. For TN and TP load estimates please use the left "Y Axis" scale in tons per day and for flow please use the right axis (cubic feet per second).

Figure 24 provides a visualization of total phosphorus concentration and a graph of the sample concentrations on which the visualization was based. The visualization suggests relatively high phosphorus concentrations in the upper portion of the river segment which moderates but is still relatively high throughout the segment. Figure 25 provides the same visualization for nitrogen. The nitrogen concentrations follow similar downriver trends as that of phosphorus, except for site 4 which shows a higher value than the upriver sites (the phosphorus at site 4 was lower). The visualizations are produced by an inverse distance weighted (IDW) spatial model with inputs of nutrient concentrations in mg/L for both the UHR HCEPC sites and the Water Atlas Assessment sites. A mean of values between July and August 2009 was used for the HCEPC sites and the single value from sample events conducted between July and August 2009 was used for WAA sites.

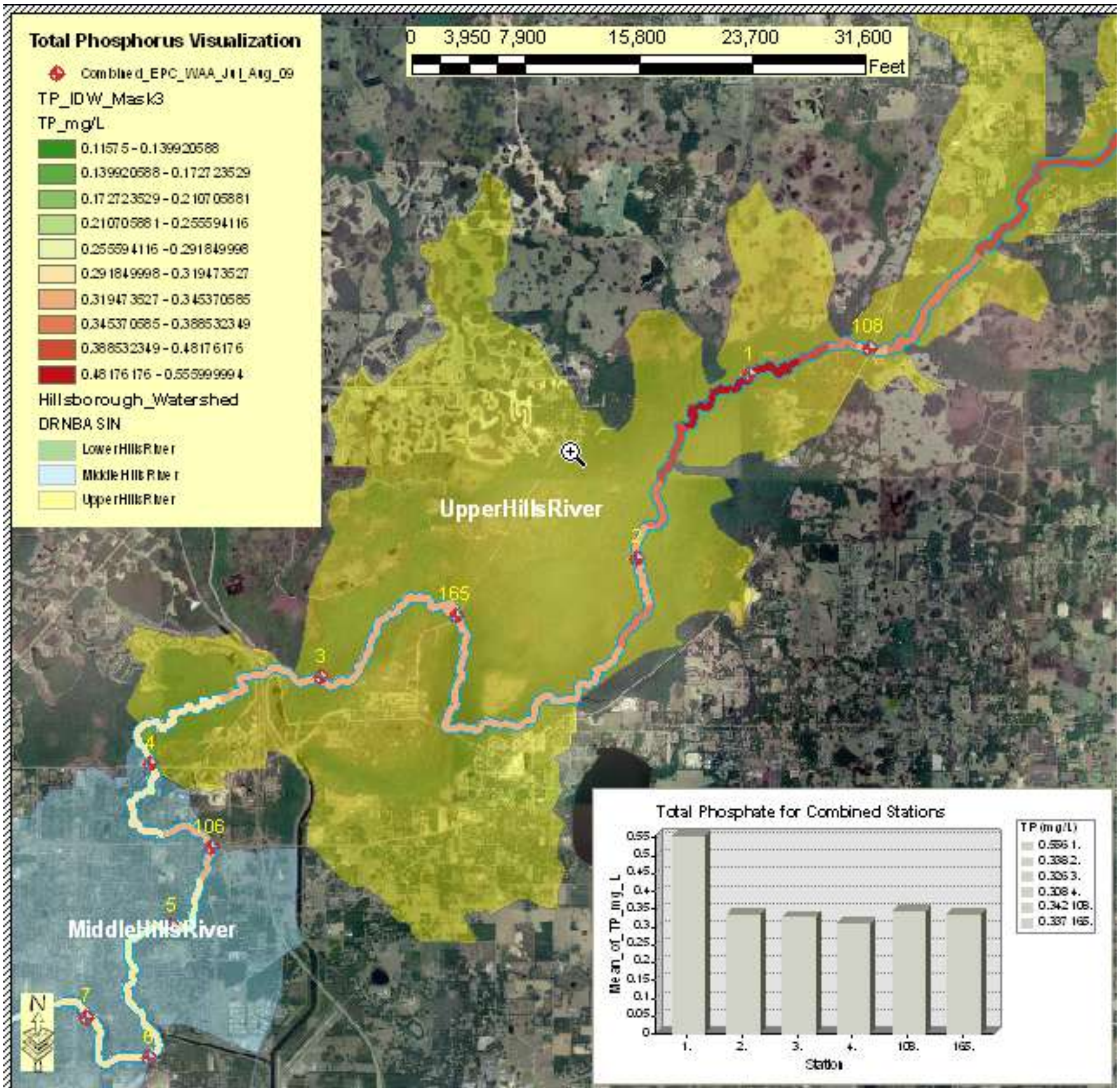


Figure 25. Total phosphorus IDW visualization for the UHR based on WAA sites 1-3 and HCEPC sites 108 and 165. The inserted graph shows the site phosphorus values used for the visualization in blue.

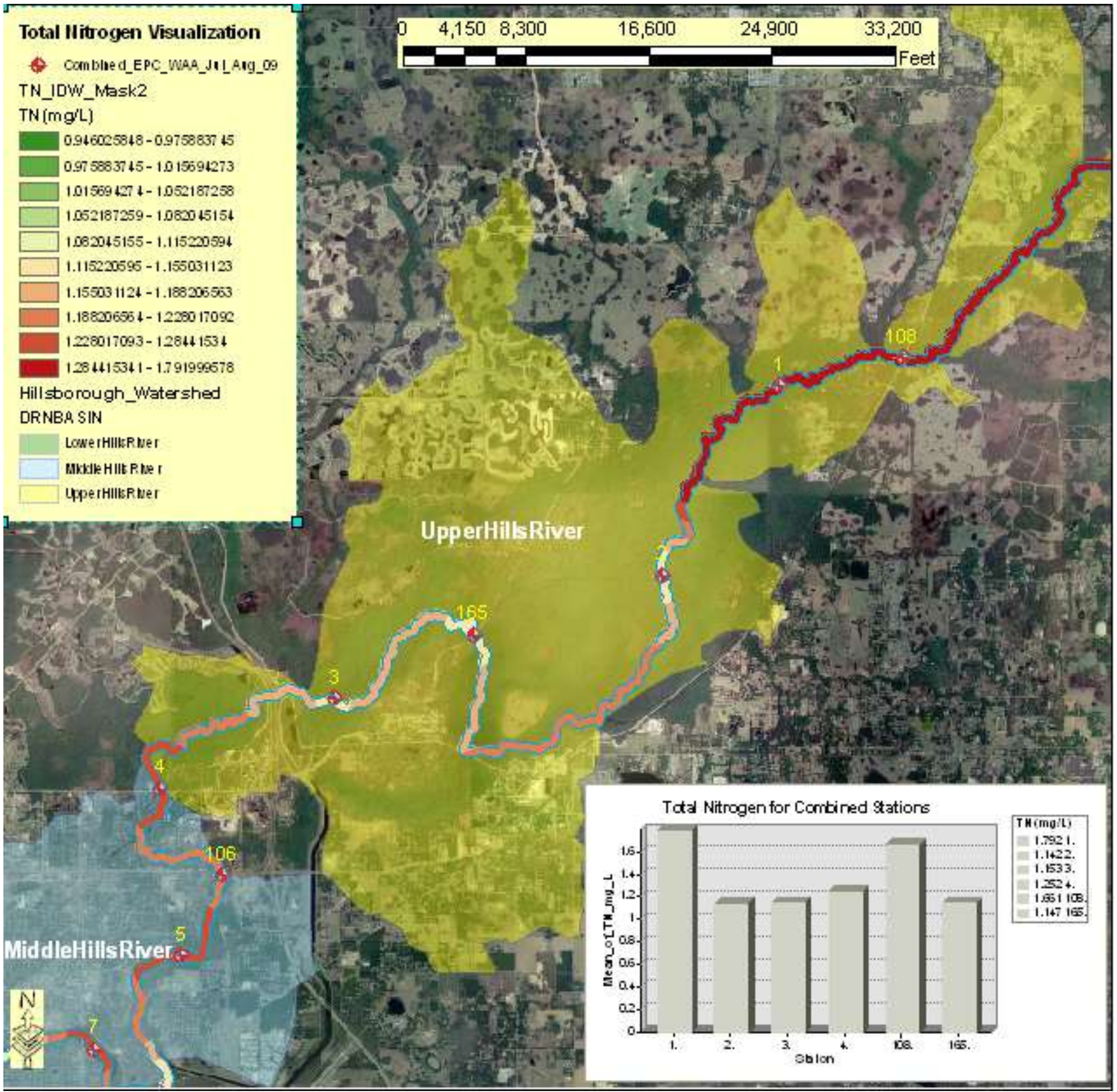


Figure 26. Total nitrogen IDW visualization for the UHR based on WAA sites 1–3 and HCEPC sites 108 and 165. The inserted graph shows the site phosphorus values used for the visualization in blue.

Section 3B2. Middle Hillsborough River (MHR) Segment

As shown in Figure 27, the middle section of the Hillsborough River is characterized by a reasonably wide river segment controlled by the Hillsborough River Dam. Only one long-term site is sampled in this section by HCEPC (Site 106); however there are four Stream WaterWatch sites in the middle section. The mean value for total nitrogen concentraiton from these sites is 952.61 µg/L and the mean phosphorus concentration is 181.32 µg/L, which compares reasonably well with the mean concentrations for these nutrients found in Table 7 and indicates that site 106 is reasonably characteristic of the water chemistry for this section. The middle river receives inputs from the upper river main channel and Cow House Creek, a first order ephemeral wetland creek which connects to the upper river segment between Morris Bridge Road and Highway 301 and directs flows to the Bypass Canal and the middle river segment just north of Fowler Avenue and near HCEPC site 106. Historic sample data for Cow House Creek indicate a total nitrogen of about 1000 µg/L

FDEP EcoSummary for Cow House Creek, published in 1998, gave a nitrogen concentration of 910 µg/L. These data indicate that Cow House Creek nutrient concentration is similar to that of the main channel and not a major source for the River, since essentially it is reconnecting the flow from the upper river. For additional background on Cow House Creek please also see the Oral History by John W. Hamilton, a longtime Cow House Creek resident.

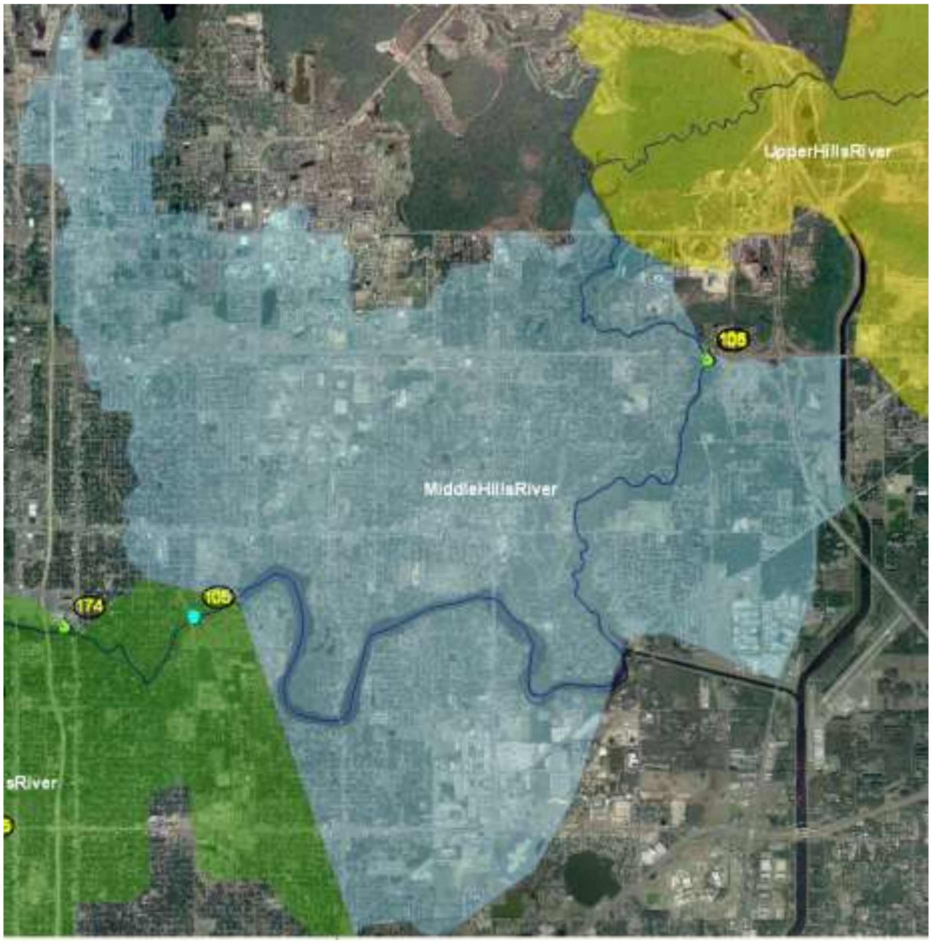


Figure 27. Hillsborough River Middle Section (MHR), showing site 106 used to characterize the River's water chemistry.

Table 7. Mean Values for HCEPC station 106 in upper portion of Middle Hillsborough River (1999–2009)

Station	BOD5_mg_L	Chla_ug_L	DO_mg_L	Fcoli_100m	TN_ug_L	TP_ug_L	Turb_ntu
HCEPC 106	0.77	4.64	3.74	58.04	1045.17	184.43	0.88

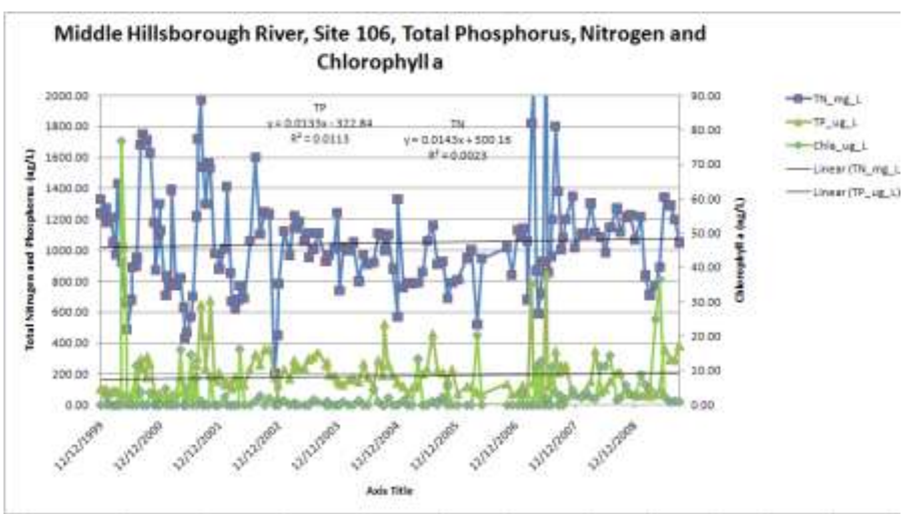


Figure 28. Change over time for nutrients and chlorophyll in the MHR.

Using sample data collected by HCEPC at site 106 and the flow over the Hillsborough River Dam, an estimate of nutrient (TN and TP) load to the lower river was determined. The change in load is driven by the flow over the dam as shown in Figure 29. During the period the water actually flowed over the dam, from May 30 through November 29, 2009, a total load to the LHR of 21.33 tons of phosphorus and 80.38 tons of nitrogen was estimated. During this period a total of 2.722 billion cubic feet of water volume was released. The previously referenced TBEP 1999 study estimated 120 tons of nitrogen loading in 1997 with 12.603 billion cubic feet of water volume released. As for the UHR, the increased flows account for part of the difference in loading and it is postulated that at some point nutrient concentrations are diluted by increased flow volume.

Figure 30 provides a visualization of total phosphorus concentration and a graph of the sample concentrations on which the visualization was based. The visualization suggests slightly varing phosphorus concentration that has an average value of about 300 µg/L (0.3 mg/L). Figure 31 provides the same visualization for nitrogen. The nitrogen values also show no real downriver trend and seem to vary around an average value of about 1,100 µg/L (1.1 mg/L). The visualizations are produced by an inverse distance weighted (IDW) spatial model with inputs of nutrient concentrations in mg/L for both the UHR HCEPC sites and the Water Atlas Assessment sites. A mean of values between July and August 2009 was used for the HCEPC sites and the single value from sample events conducted between July and August 2009 was used for WAA sites. These results are higher than the mean of values shown in Table 7; however, as is apparent by the Figure 28 graph over time of these values, there is a large variation from year to year and the values seem to be seasonal.

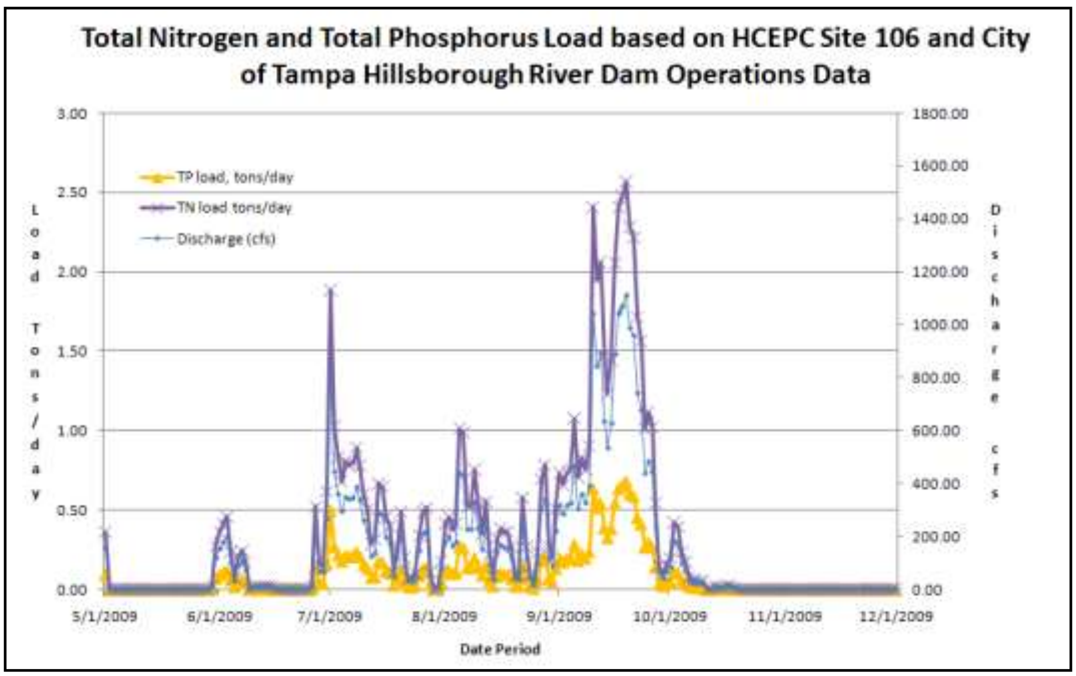


Figure 29. Load estimate based on HCEPC Site 106 (nutrient concentrations) and Hillsborough Dam flow data for period that covers the 2009 Hillsborough River Assessment

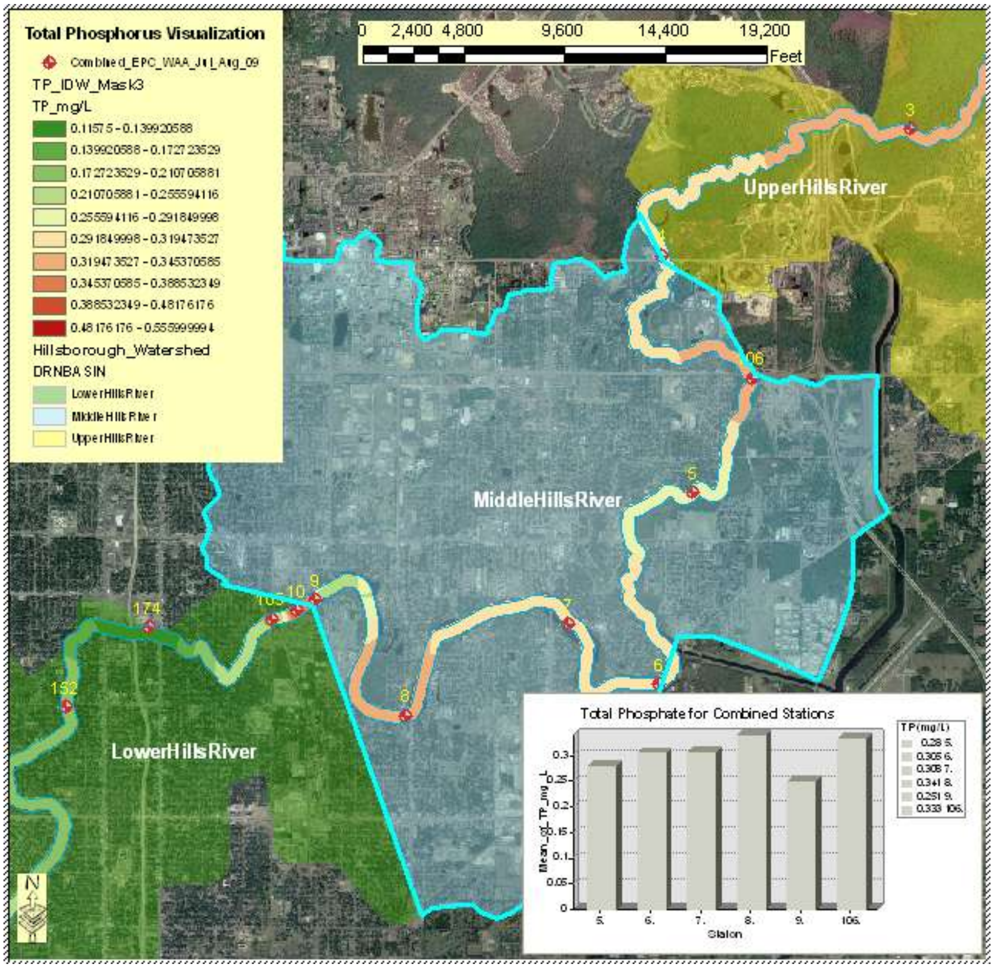


Figure 30. MHR total phosphorus based on an Inverse Distance Weighted Model results for sites Hil 5, 6, 7, 8 and 9 and EPC site 106

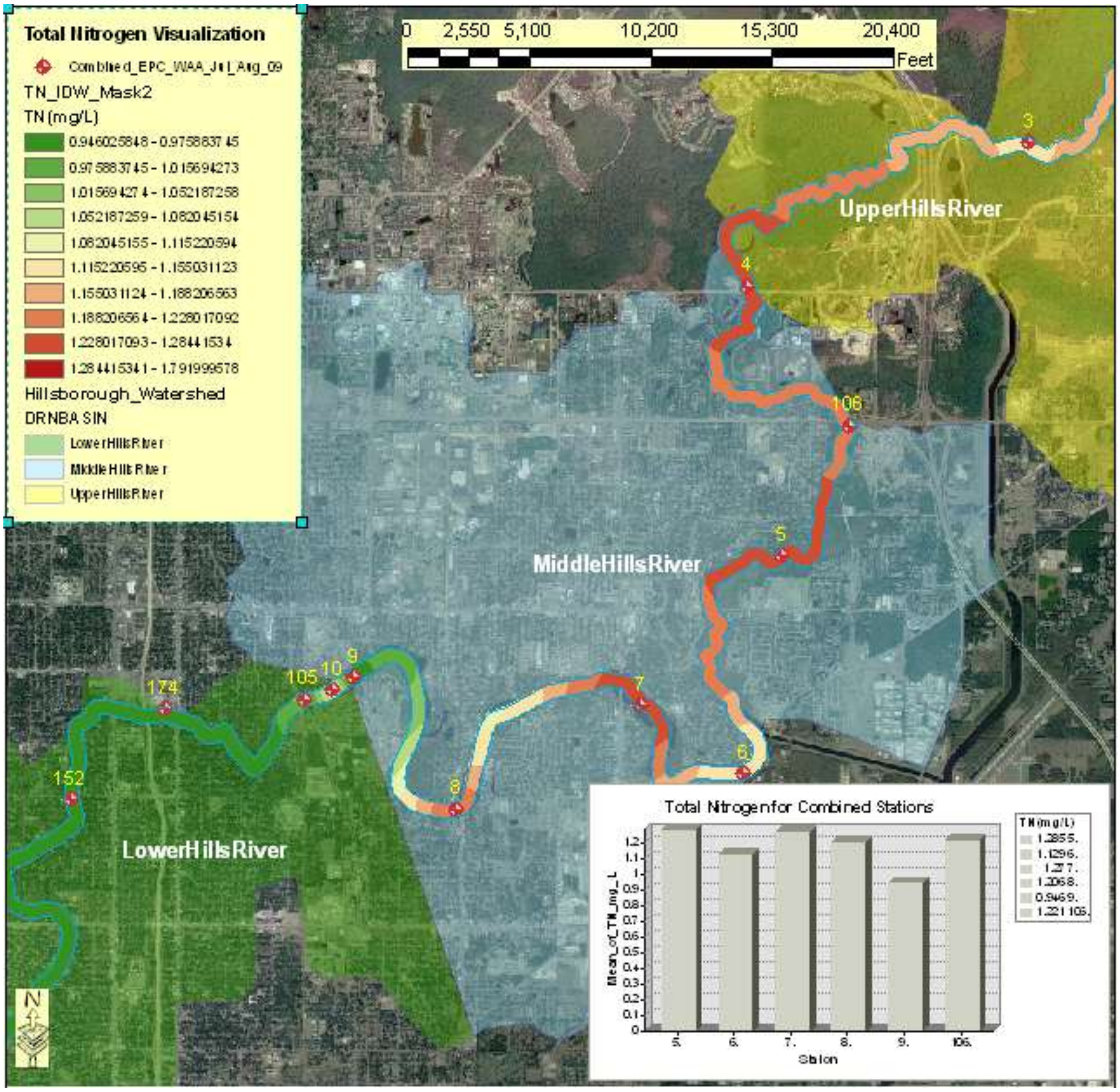


Figure 31. MHR total nitrogen based on an Inverse Distance Weighted Model results for sites Hil 5, 6, 7, 8 and 9 and EPC site 106.

Section 3B3. Lower Hillborough River (LHR) Segment

Figure 32 is a map of the LHR section showing the HCEPC and Water Atlas Assessment (WAA) sites used for the water quality assessment of this section. Figure 33 is an image of the Water Atlas Realtime display for SWFWMD elevation gauge 1906 located between Nebraska Avenue and I-275 bridges and shows the 2009 water levels at this mid-segment site. As shown in this figure, the river segment is characterized by tidal flows as well as inputs from the Hillsborough River Dam. Tide and wind and freshwater flow from dam releases dominate the conditions in the lower river segment. Figure 34 shows Water Atlas Data Download visualization graphs for HCEPC 174, located in the upper portion of the river segment, and 137, located in the downriver portion of the segment. As can be seen by a comparison of the two sites, salinity can reach values similar to Hillsborough Bay and drop to oligohaline conditions (0.5–10 parts ppt) depending on wind and tides and dam releases throughout the LHR segment.

Figure 32. Map of LHR showing the HCEPC and WAA sites used for the water quality assessment of this river section.

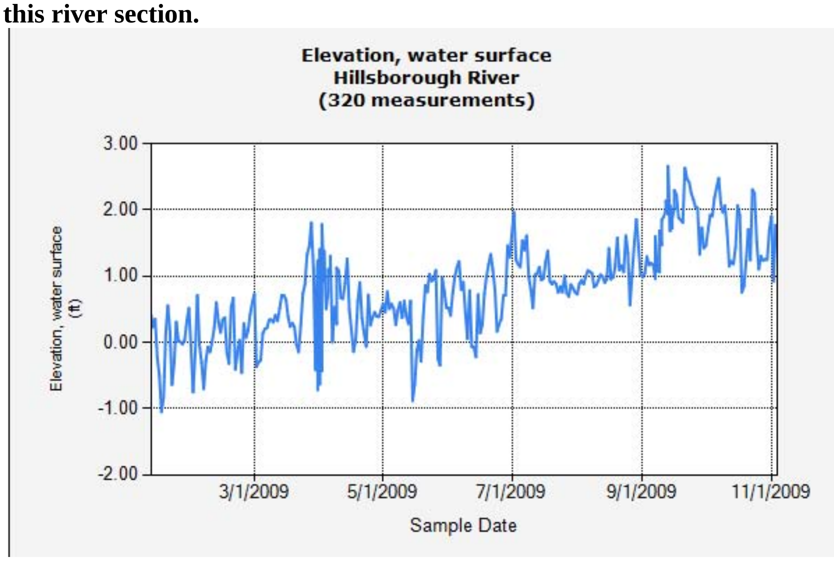


Figure 33. Water level at SWFWMD gauge 1906 located just east of Interstate 275.

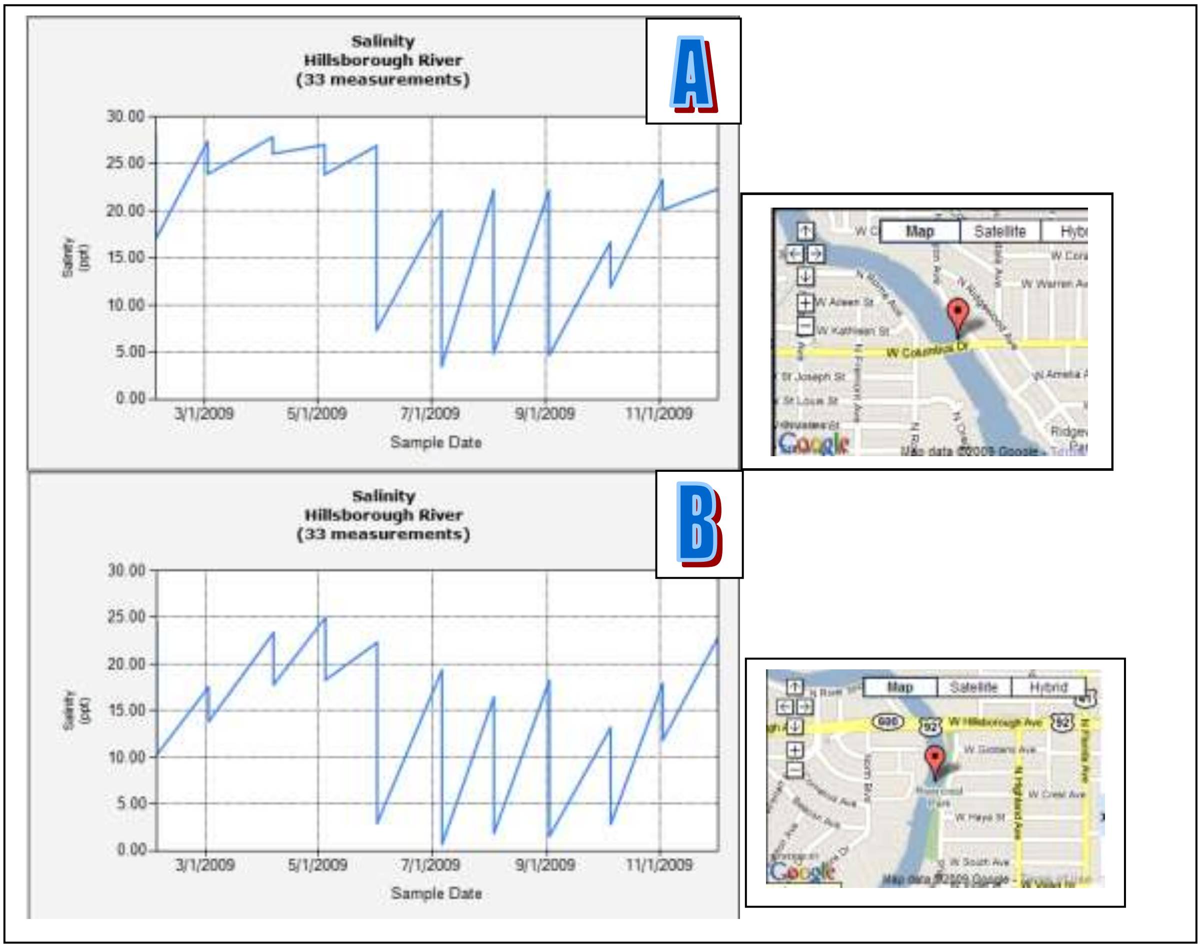


Figure 34. Salinity from HCEPC station 137 (A) located just north of Columbus Drive and HCEPC station 176 located upriver from station 137 (B) just south of the Hillsborough Avenue Bridge. Note, the highlighted links will call Data Download for these sites.

A 2004 USEPA total maximum daily load (TMDL) report titled "Total Maximum Daily Loads for Dissolved Oxygen and Nutrients in the Hillsborough River Basin" set TMDLs for the Middle and Lower Hillsborough River. Figure 35 is a table from that report for nutrients and chlorophyll in the LHR. The range of values compares reasonably well with the nutrient values provided in Table 8. However, the median value for nutrients is below that shown in Table 8. Please note Figure 35 lists all concentrations in mg/L and Table 8 values are in µg/L and so a factor of 1000 must be used for comparison. The USEPA report also makes a consistent units error, listing chlorophyll a as mg/L when the concentration should be listed in µg/L. An inspection of the table and graphs in the report indicates that the error was made in the table. So the actual median value for chlorophyll a from the USEPA report should be 11 µg/L (not 11 mg/L) which is lower than that shown in Table 8. This comparison seems to indicate a possible increasing trend for both nutrients and chlorophyll a in the MHR. However, the data varies significantly with a relative standard deviation for chlorophyll, phosphorus and nitrogen of 61%, 124% and 39%. This variability in the data can also be seen in Figure 36. All three parameters did show a slight but not significant increase of the 10-year period used for the evaluation.

Ambient Water Quality Data Lower Hillsborough River WBID 1443E:

Table 4 Lower Hillsborough River Water Quality Data Summary Statistics

WBID 1443E

Parameter	Obs	Max	Min	Mean	StDev	Median
Dissolved Oxygen (mg/l)	1515	13.30	0.04	4.09	2.31	4.1
Chlorophyll A (mg/l)	679	306.00	0.00	19.30	28.00	11
Phosphorus Total as P (mg/l)	359	1.430	0.010	0.232	0.136	0.210
Nitrogen Total as N (mg/l)	470	2.43	0.27	1.03	0.37	0.95

Figure 35. Water Quality Table for Lower River Taken from USEPA TMDL Report (June 1994 – January 2004).

Table 8. Water chemistry from HCEPC sites in the Lower Hillsborough River (Dec 2004 –Nov 2009). Note the River Mean is a mean for all listed values not the mean of means shown.

Station ID	Samples	Mean of BOD5_mg/L	Mean of Chla_ug/L	Mean of DO_mg/L	Mean of Fcoli_100 ml	Mean of TP_ug/L	Mean of TN_ug/L	Mean of Turb_ntu
2	23	1.2	6.6	5.1	262.6	189.8	648.4	2.2
105	65	1.5	14.6	5.6	294.5	161.0	766.6	1.8
137	64	2.0	14.6	4.2	380.6	191.5	721.5	2.8
152	63	1.7	18.6	3.0	336.2	181.8	783.5	1.6
176	15		31.0		104.0	196.4	784.0	
River Mean	**230**	**1.7**	**16.0**	**4.4**	**314.3**	**180.4**	**748.0**	**2.1**

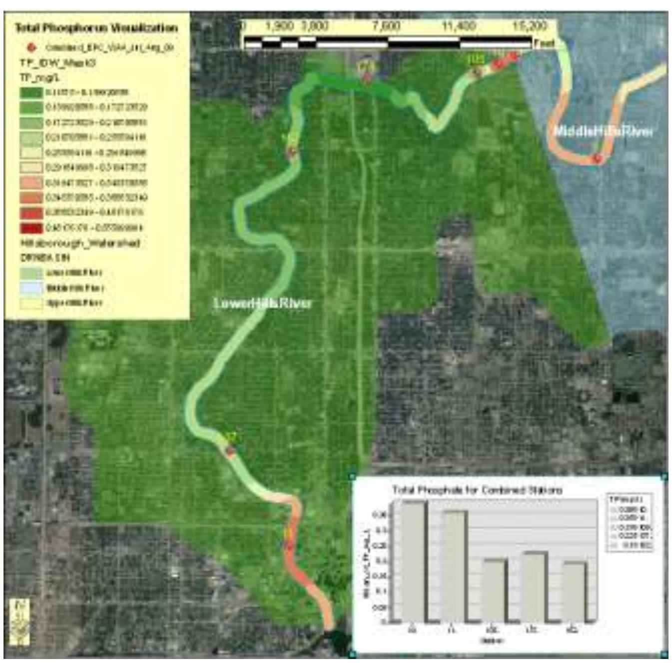


Figure 36. LHR total phosphorus based on an Inverse Distance Weighted Model results for sites Hil 10, and 11, and EPC site 105, 137, 152 and 174. May–August 2009.

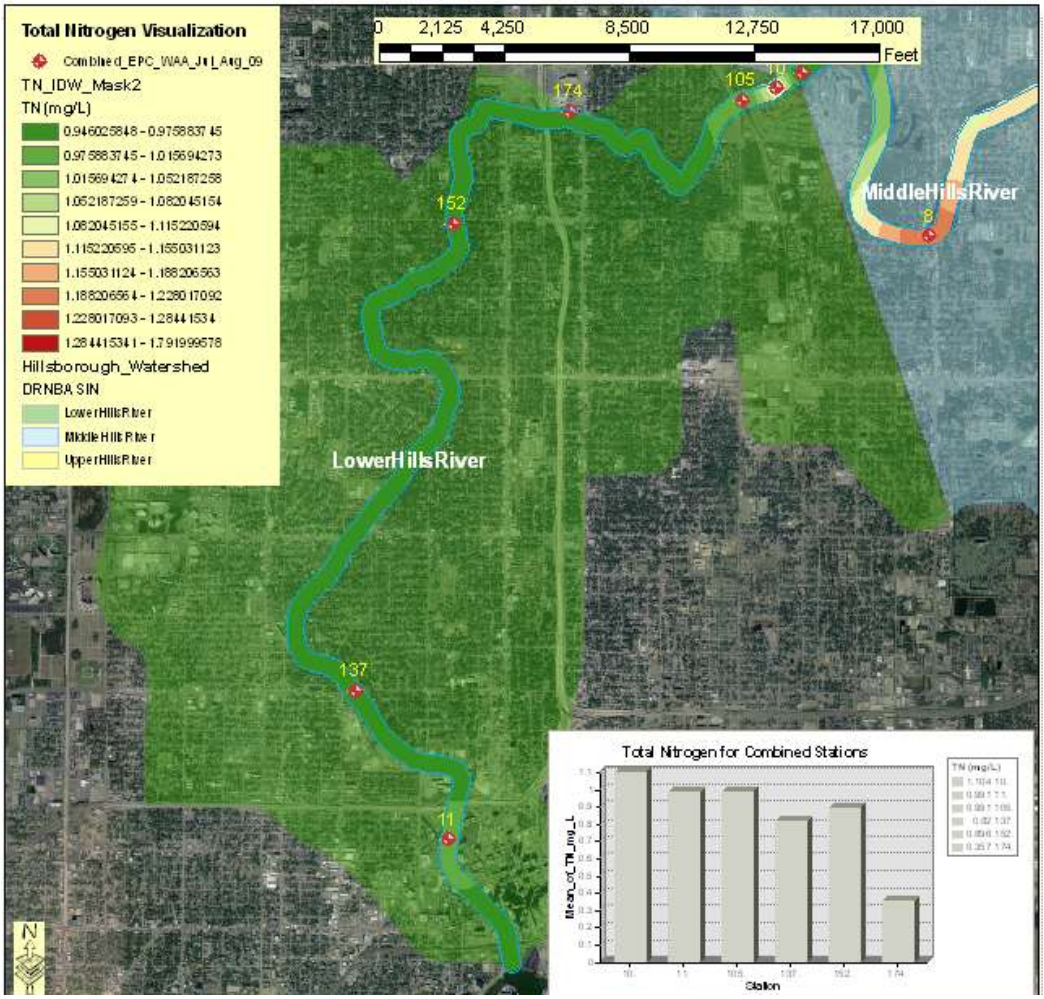


Figure 37. LHR total nitrogen based on an Inverse Distance Weighted Model results for sites Hil 10, and 11, and EPC site 105, 137, 152 and 174.

Appendix A: Stream Morphological Data

Name	Assessment Date	Gauge Height	Surface Area (planimetric feet)	Surface Area (acres)	Volume (ft^3)	Volume (acre-foot)	Volume (gal)	Mean Depth (ft)	Max Depth (ft)
Hillsborough River State Park	9/28/2009	1.87	386,637.45	8.88	1,583,635.52	36.36	11,846,498.46	-5.547113	-20.68
Hillsborough River 006	7/9/2009	23.98	847,321.52	19.45	2,463,242.02	56.55	18,426,457.61	-4.213183	-9.66
Hillsborough River Morris Bridge	7/7/2009	27.15	572,101.52	13.13	2,589,900.89	59.46	19,373,938.32	-6.889203	-22.879999
Hillsborough River 004	4/23/2009	19.76	3,047,105.42	69.95	9,689,753.94	222.45	72,484,895.44	-3.19606	-26.689999
Hillsborough River 003	4/27/2009	19.21	443,647.61	10.18	1,870,369.89	42.94	13,991,435.36	-5.212481	-19.279999
Hillsborough River 490	5/7/2009	21.78	16,110,087.97	369.84	91,636,302.94	2103.69	685,491,899.82	-7.130926	-34.07
Hillsborough River Reservoir -490	6/9/2009	22.53	7,282,371.42	167.18	67,730,980.31	1554.90	506,666,428.91	-10.114313	-37.356003
Hillsborough River Rowlett Park 490	9/23/2009	2.32	808,704.41	18.57	1,942,515.15	44.59	14,531,123.12	-4.151727	-12.31
Hillsborough River University of Tampa -001	9/21/2009	11.51	1,967,564.19	45.17	15,839,234.10	363.62	118,486,520.37	-7.313244	-19.58

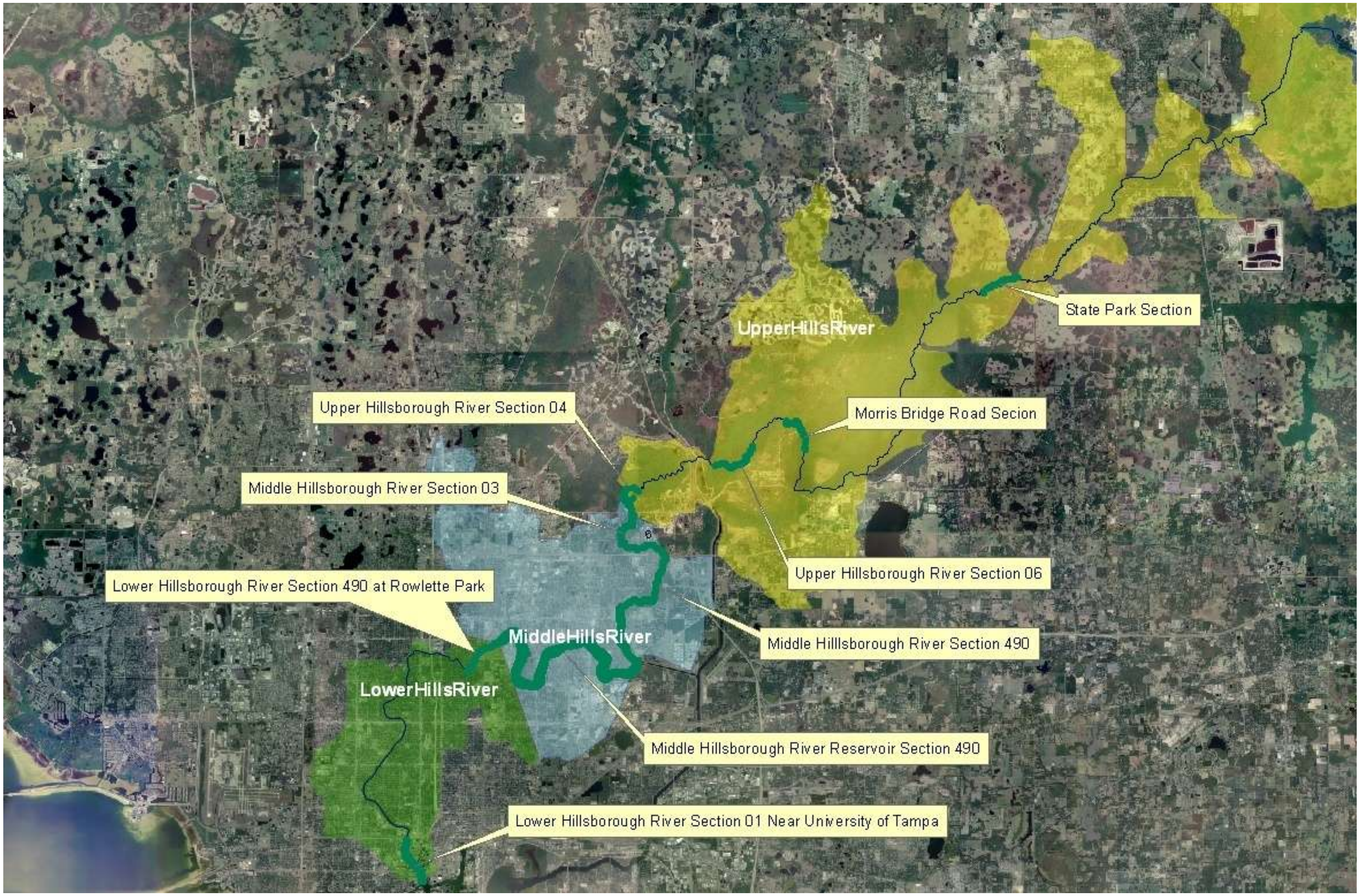
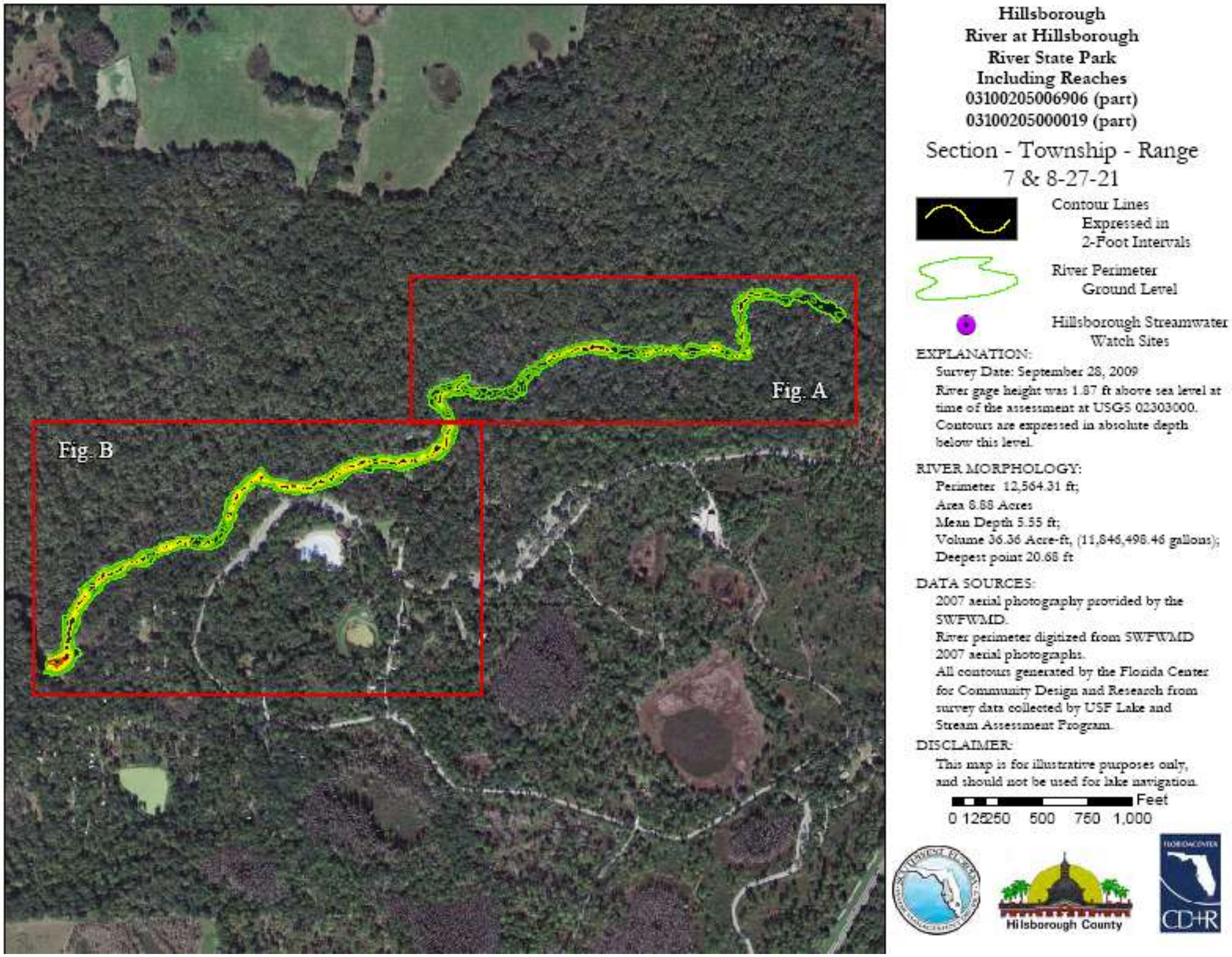
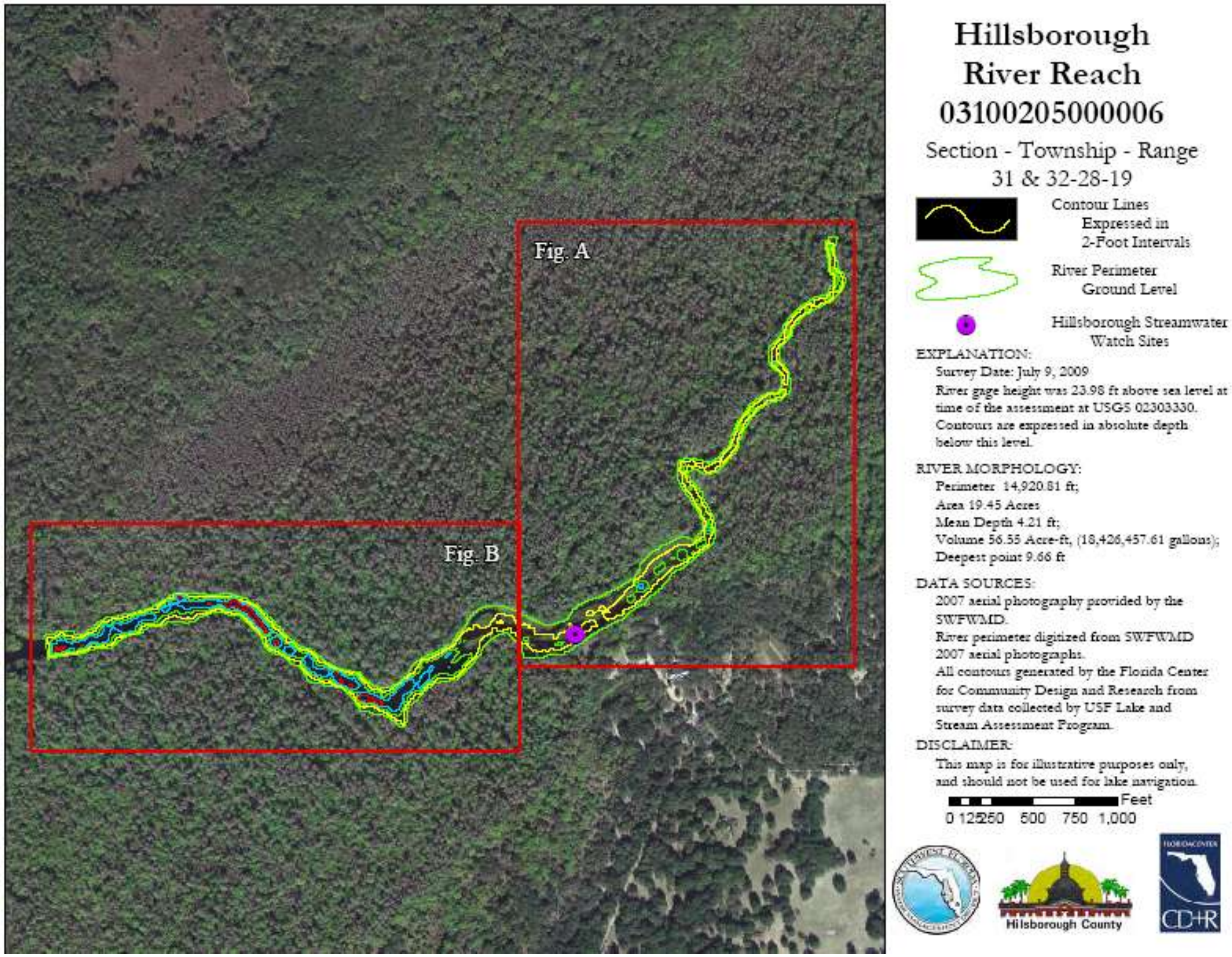


Figure 38. Sections of the Hillsborough River selected and assessed during the first year (2009) of the River Assessment Project. Sections refer to the last numbers of the reach code. The overall reach code is 0310020500xxx. Where only two numbers are shown there is a leading zero.

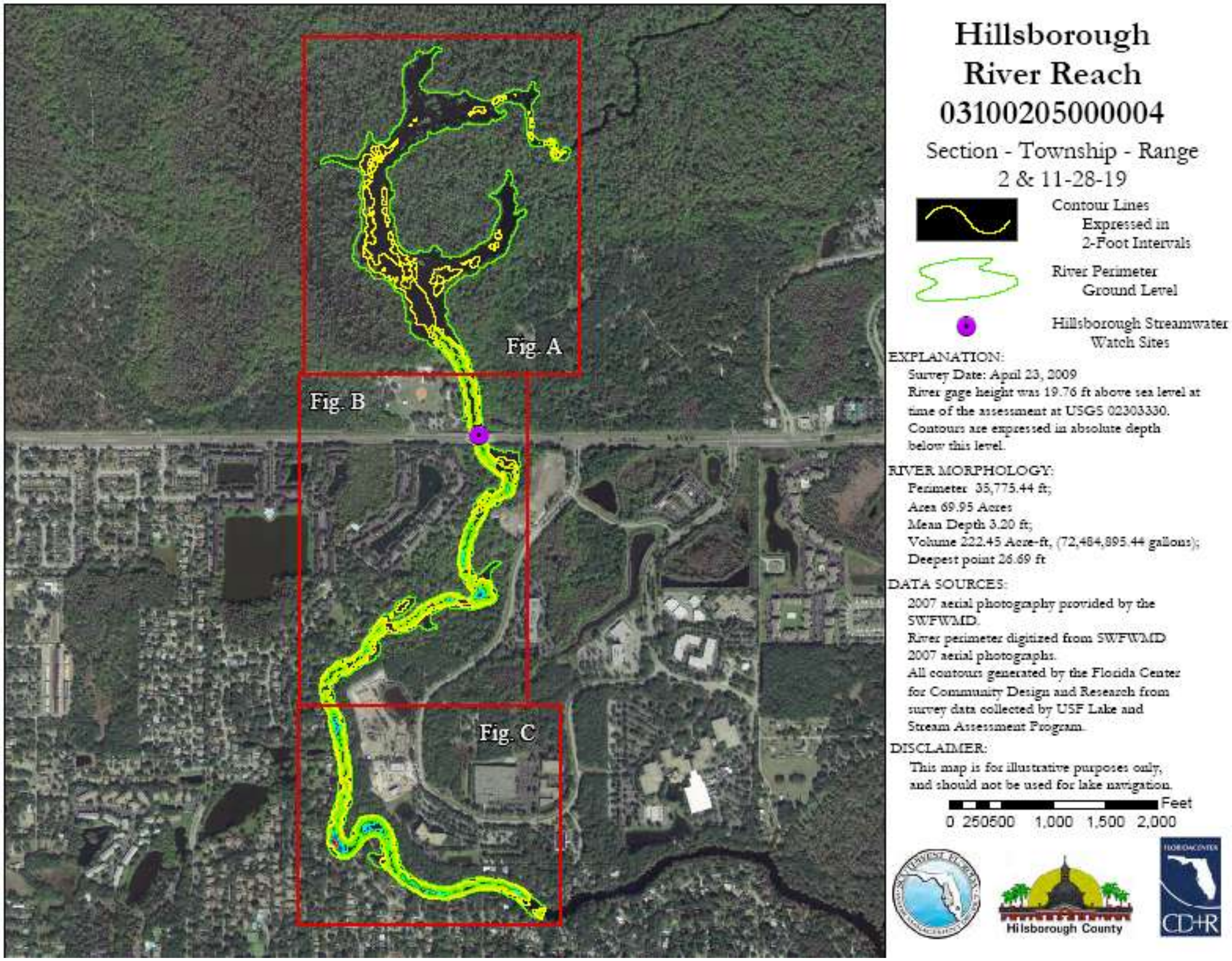
Hillsborough River State Park Morphology Report (Acrobat Report, Please double-click on image to view).



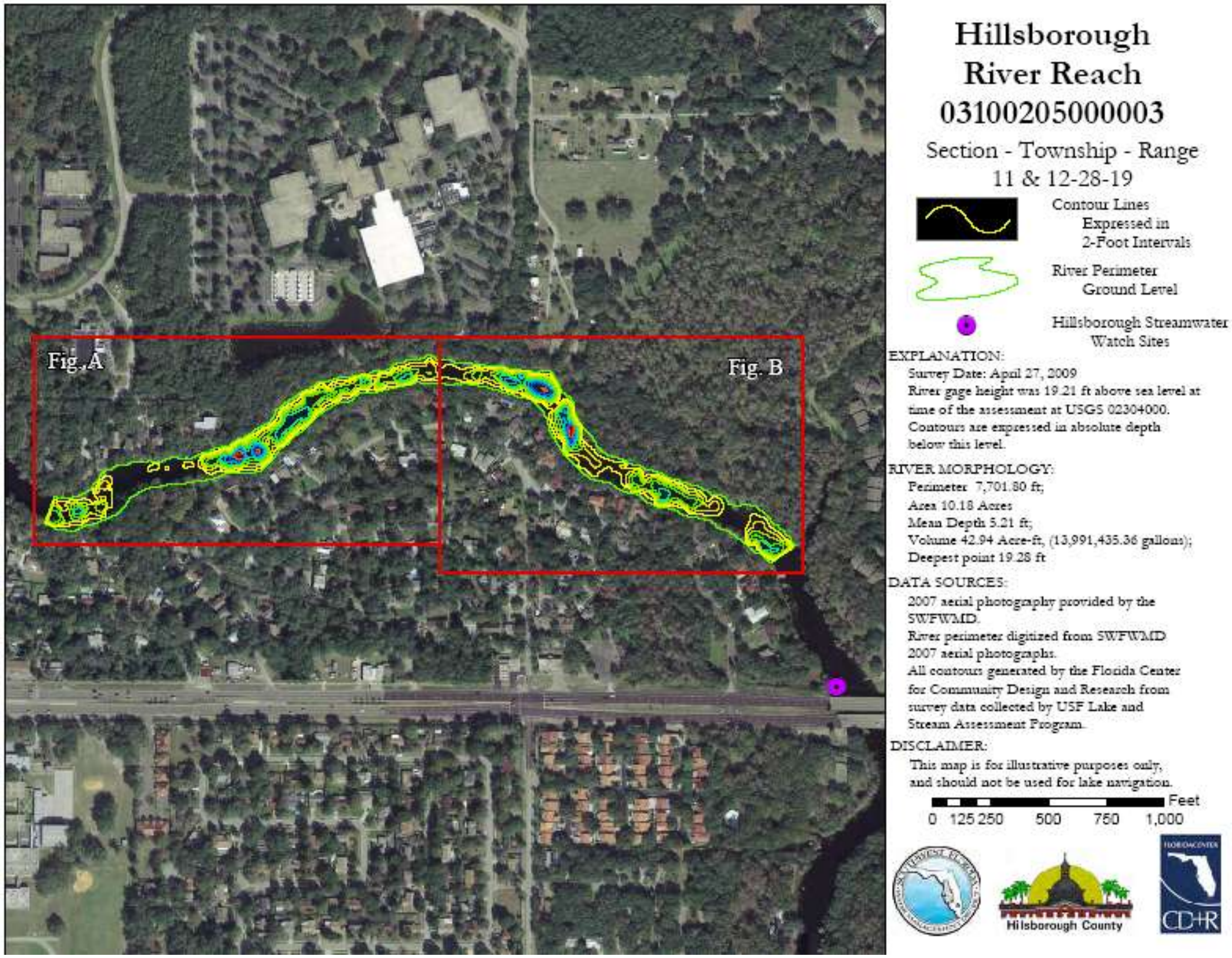
Upper Hillsborough River (Reach 06) Morphology Report (Acrobat Report, Please double-click on image to view).



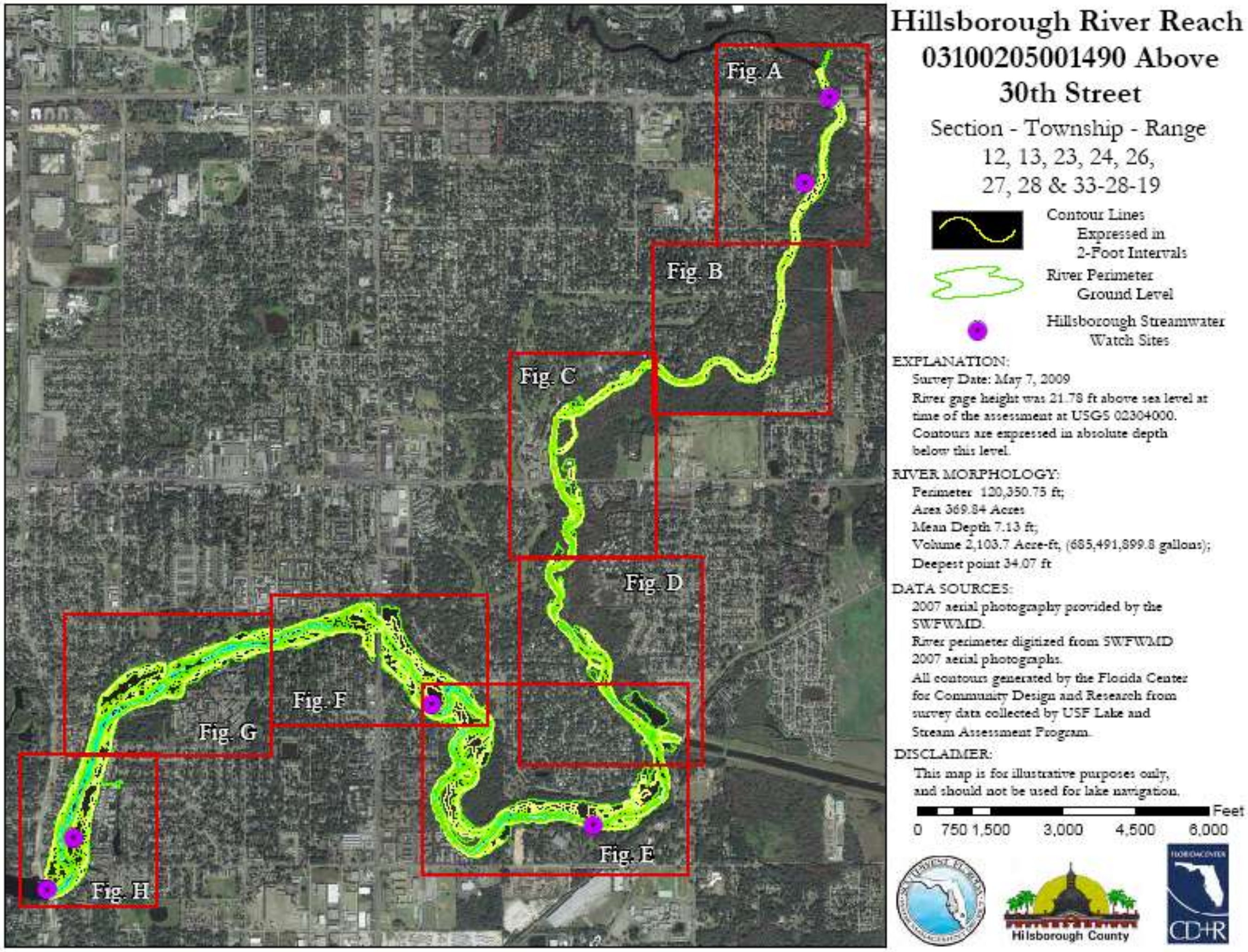
Upper to Middle Hillsborough River (Reach 04) Morphology Report (Acrobat Report, Please double-click on image to view).



Middle Hillsborough River (Reach 03) Morphology Report (Acrobat Report, Please double-click on image to view).

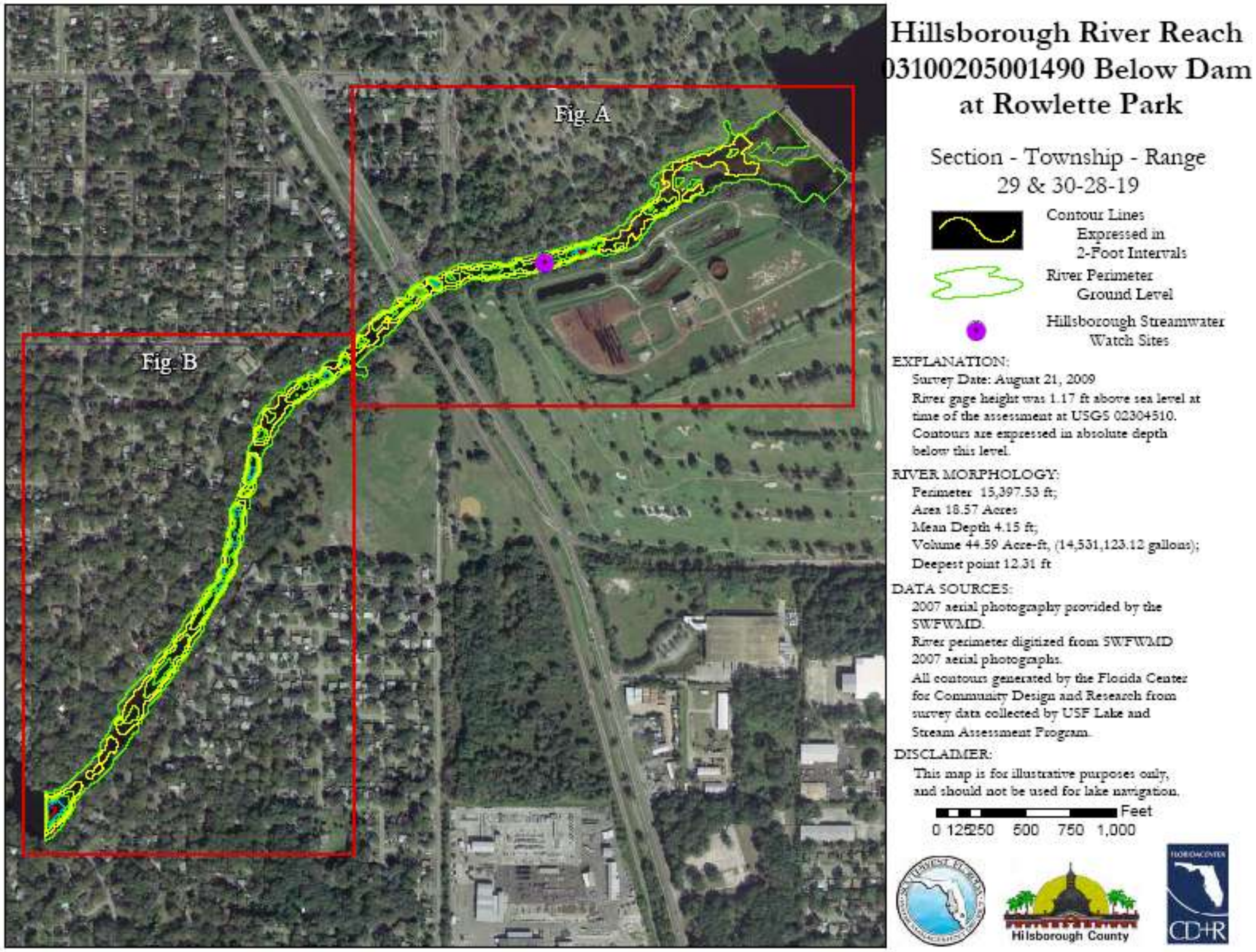


Middle Hillsborough River (Reach 490) Morphology Report (Acrobat Report, Please double-click on image to view).

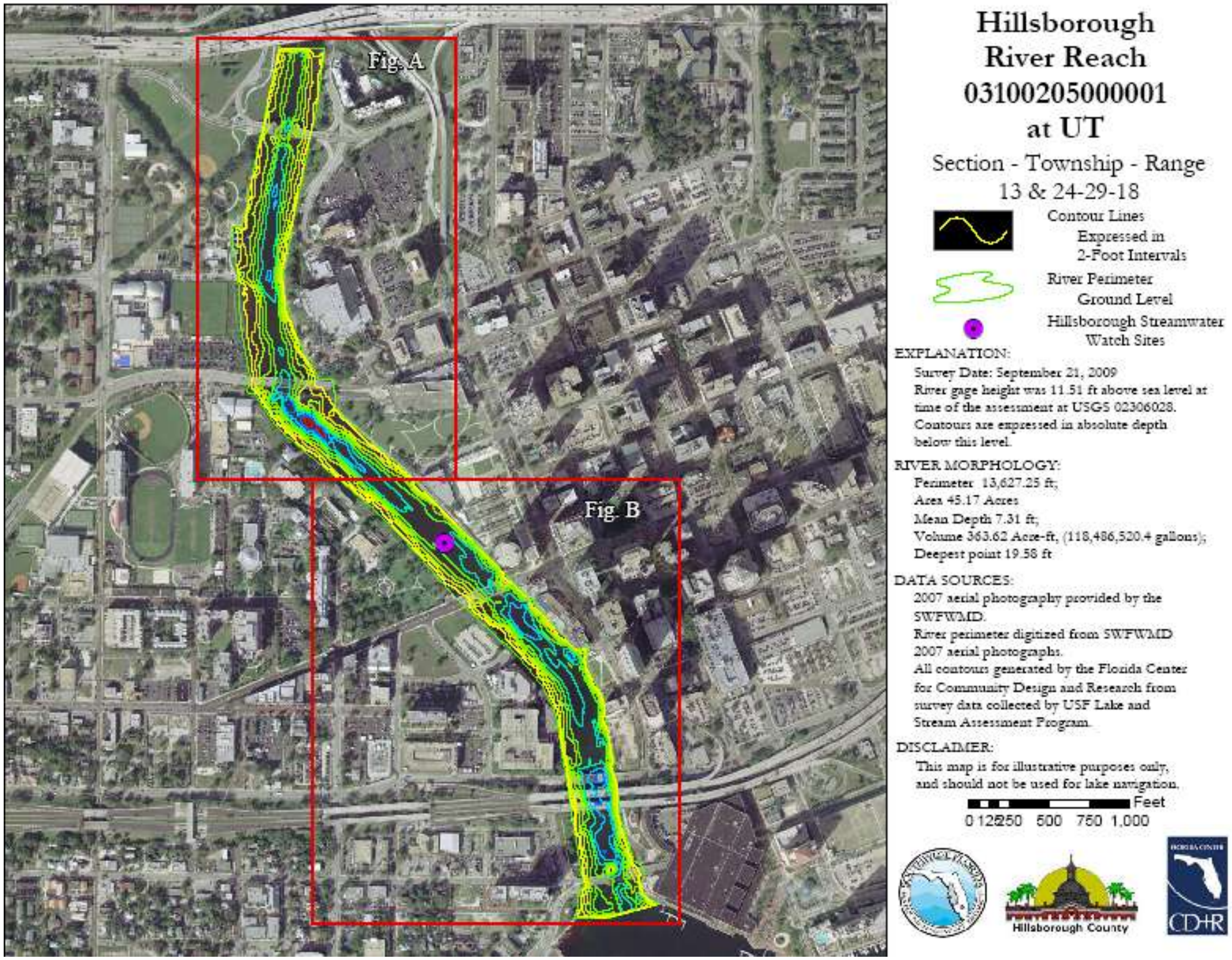


Middle Hillsborough River (Reach 490) Morphology Report (Acrobat Report, Please double-click on image to view). Hillsborough Reservoir Section.

Lower Hillsborough River (Reach 490) Morphology Report (Acrobat Report, Please double-click on image to view). Section includes Rowlett Park Section.



Lower Hillsborough River (Reach 490) Morphology Report (Acrobat Report, Please double-click on image to view). Section includes University of Tampa Section and River mouth.



Appendix B: Stream Vegetation Data

Upper Hillsborough River Emergent Vegetation list (above Fletcher Ave. to Hillsborough River State Park).

Plant Species Code	*Plant Species*	Common Name	Sample Site (Above Fletcher Ave.)					Sample Site (Natures Classroom)										Sample Site (Morris Bridge Park)										Sample Site (Hillsborough State Park)										Percent Occurrence	(N) Native, (NN) Non-native, (I) Invasive, (P) Pest
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35		
TDM	*Taxodium distichum*	Bald Cypress	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1			1		1	1	1		1	1	1	1	1	1	1	1	1	1	85.71%	N
ACE	*Acer rubrum var. trilobum*	Southern Red Maple	1		1	1		1	1	1	1		1	1		1	1	1	1	1	1	1	1		1	1	1		1	1		1	1	1	1	1	1	80.00%	N
APS	*Alternanthera philoxeroides*	Alligator Weed	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		1	1	1	1	1		1		1	1			1				74.29%	NN,I,P
COS	*Cephalanthus occidentalis*	Common Buttonbush	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1		1		1	1	1	1	1	1		1			1					1	71.43%	N
FCA	*Fraxinus caroliniana*	Pop Ash		1	1			1	1	1	1	1	1	1	1	1	1			1			1		1		1	1	1	1	1	1	1	1		1	1	71.43%	N
SSP	*Sabal spp.*	Cabbage Palms, Palmetto																1	1		1	1	1	1	1	1		1	1	1	1		1	1	1	1	1	48.57%	N
UAA	*Ulmus americana*	American Elm		1				1										1			1	1		1		1	1	1	1	1	1	1	1	1	1	1		48.57%	N
PAR	*Paspalum repens*	Water Paspalum						1	1		1	1	1	1	1	1	1		1	1					1	1	1											40.00%	N
MSS	*Mikania scandens*	Climbing Hempvine	1	1	1	1			1		1			1	1	1	1			1				1														34.29%	N,P
FAA	*Forestiera acuminata*	Swamp Privet																										1	1	1	1	1	1	1	1	1	1	28.57%	N
POL	*Polygonum spp.*	Smartweed, Knotweed		1	1	1		1		1	1			1		1	1																					25.71%	N
BOC	*Boehmeria cylindrica*	Bog Hemp, False Nettle						1						1			1			1					1	1		1	1				1					25.71%	N
GAA	*Gleditsia aquatica*	Water Locust			1	1		1		1	1												1	1	1		1											25.71%	N
QLO	*Quercus laurifolia*	Laurel oak					1												1		1							1	1	1	1	1						22.86%	N
CEA	*Colocasia esculenta*	Wild Taro, Dasheen, Coco Yam											1				1											1		1		1		1	1		1	22.86%	NN,I
RVS	*Rumex verticillatus*	Swamp Dock			1				1	1	1			1	1		1																					20.00%	N
SAL	*Salix spp.*	Willow		1								1	1	1		1				1								1										20.00%	N
CAM	*Crinum americanum*	Swamp lily								1						1	1						1							1				1		1		20.00%	N
PSI	*Psychotria sulzneri*	Wild Coffee																											1	1	1		1	1	1	1		20.00%	N
EWI	*Echinochloa walteri*	Coast Cockspur Grass (hairy)		1		1			1					1				1		1																		17.14%	N
QNA	*Quercus nigra*	Water Oak																												1			1	1	1	1	1	17.14%	N
LIQ	*Liquidambar styraciflua*	Sweetgum																										1		1	1	1	1	1				17.14%	N
SBN	*Smilax bona-nox*	Saw Greenbrier Cat Briar																			1	1	1	1		1	1											17.14%	N
IVI	*Itea virginica*	Virginia Willow																												1	1		1	1	1		1	17.14%	N
HYP	*Hypericum spp.*	St. John's Wort										1						1				1		1	1													14.29%	N
SCS	*Scirpus cubensis*	Burhead Sedge,Cuban Scirpus			1	1					1	1																							1			14.29%	N
URL	*Urena lobata*	Caesar's Weed																											1		1				1	1	1	14.29%	NN,I
PTI	*Ptilimnium capillaceum*	Mock Bishop's Weed		1	1	1	1																															11.43%	N
AST	*Aster spp.*	Aster spp., Elliot's Aster																								1		1			1			1				11.43%	N
PCA	*Pontederia cordata*	Pickerel Weed													1	1				1				1														11.43%	N
RHY	*Rhynchospora spp.*	Beaksedge													1	1	1			1																		11.43%	N
RF	*Osmunda regalis*	Royal Fern										1																					1		1		1	11.43%	N

Upper Hillsborough River Emergent Vegetation list (above Fletcher Ave. to Hillsborough River State Park) (continued)

Plant Species Code	*Plant Species*	Common Name	Sample Site (Above Fletcher Ave.)					Sample Site (Natures Classroom)										Sample Site (Morris Bridge Park)										Sample Site (Hillsborough State Park)										Percent Occurrence	(N) Native, (NN) Non-native, (I) Invasive, (P) Pest
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35		
COM	*Commelina spp.*	Dayflower	1																							1								1				8.57%	N
TOX	*Toxicoendron radicans*	Poison Ivy																	1			1									1							8.57%	N
SAB	*Sabatia spp.*	Rosegentian					1								1										1													8.57%	N
VRA	*Vitis rotundifolia*	Muscadine Grape																												1				1			1	8.57%	N
BHA	*Baccharis halimifolia*	Eastern False Willow, Saltbush																												1				1				5.71%	N
CYP	*Cyperus spp.*	Sedge																			1				1													5.71%	N
CAL	*Callicarpa americana*	American Beauty Berry																											1		1							5.71%	N
CCM	*Conoclinium coelestinum*	Mistflower														1	1																					5.71%	N
PIN	*Pinus spp.*	Pine Tree																								1					1							5.71%	N
OCA	*Osmunda cinnamomea*	Cinnamon Fern																											1				1					5.71%	N
ABM	*Amaranthus blitum*	Livid Pigweed																																		1		2.86%	NN
PRS	*Panicum repens*	Torpedo Grass	1																																			2.86%	NN,I
NSS	*Nephrolepsis spp.*	Sword Fern						1																														2.86%	N
TYP	*Typha spp.*	Cattails				1																																2.86%	N
LPA	*Ludwigia peruviana*	Peruvian Primrosewillow																1																				2.86%	N
HCS	*Luziola fluitans*	Watergrass								1																												2.86%	N
BID	*Bidens spp.*	Bur Marigold																																			1	2.86%	N
PLU	*Pluchea spp.*	Marsh Fleabane,Camphorweed														1																						2.86%	N
CYA	*Carya aquatica*	Water Hickory																																1				2.86%	N
WTA	*Sphagneticola (Wedelia) trilobata*	Creeping Oxeye																				1																2.86%	NN,I
BMI	*Bacopa monnieri*	Common Bacopa, Herb-Of-Grace	1																																			2.86%	N
CRX	*Carex spp.*	Sedge					1																															2.86%	N
CNI	*Cirsium nuttallii*	Nuttall's Thistle					1																															2.86%	N
ECT	*Encyclia tampensis*	Butterfly Orchid												1																								2.86%	N
PPP	*Pleopeltis polypodioides*	Resurrection Fern													1																							2.86%	N
AAA	*Ampelopsis arborea*	Peppervine																1																				2.86%	N
TDS	*Tripsacum dactyloides*	Eastern Gamagrass																1																				2.86%	N
NMM	*Nasturtium microphyllum*	Watercress																											1									2.86%	NN,I

Upper Hillsborough River Floating-Leaved Vegetation list (above Fletcher Ave. to Hillsborough River State Park)

Plant Species Code	*Plant Species*	Common Name	Sample Site (Above Fletcher Ave.)					Sample Site (Natures Classroom)										Sample Site (Morris Bridge Park)										Sample Site (Hillsborough State Park)										Percent Occurrence	(N) Native, (NN) Non-native, (I) Invasive, (P) Pest
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35		
NLM	*Nuphar lutea var. advena*	Spatterdock, Yellow Pondlily	1	1	1	1		1	1	1	1	1	1	1	1					1		1						1										42.86%	N,P
HYE	*Hydrocotyl umbellata*	Manyflower Marshpennywort, Water Pennywort		1	1	1		1	1	1	1	1	1	1	1					1			1												1	1		42.86%	N
SMA	*Salvinia minima*	Water Spangles, Water Fern	1	1	1			1	1	1	1	1	1	1	1				1	1																		37.14%	NN,I
ECS	*Eichornia crassipes*	Water Hyacinth						1	1	1	1	1	1	1	1	1			1					1				1						1				37.14%	NN,I
SPI	*Spirodela polyrhiza*	Giant Duckweed	1	1	1	1	1	1	1	1	1	1		1	1																							34.29%	N
PSS	*Pistia stratoides*	Water Lettuce	1	1	1			1	1	1	1				1					1																		25.71%	NN,I
ACA	*Azolla caroliniana*	Carolina Mosquito Fern	1	1		1	1																															11.43%	N,P

Upper Hillsborough River Submerged Vegetation list (above Fletcher Ave. to Hillsborough River State Park)

Plant Species Code	*Plant Species*	Common Name	Sample Site (Above Fletcher Ave.)					Sample Site (Natures Classroom)										Sample Site (Morris Bridge Park)										Sample Site (Hillsborough State Park)										Percent Occurrence	(N) Native, (NN) Non-native, (I) Invasive, (P) Pest
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35		
HPA	*Hygrophila polysperma*	East Indian Hygrophila						1	1	1	1	1		1	1	1	1										1											28.57%	N
ALG	*Algal Spp.*	Algal Mats, Floating	1	1	1	1	1					1																										17.14%	N,P
HVA	*Hydrilla verticillata*	Hydrilla, water thyme	1	1	1	1	1																															14.29%	NN,I,P
LIM	*Limnophila spp.*	Marshweeds, Ambulia						1		1					1		1																					11.43%	N
POT	*Potamogeton spp.*	Pond Weed	1	1	1																																	8.57%	N,P
NGS	*Najas guadelupensis*	Southern Waternymph			1		1																															5.71%	N
MGM	*Micranthemum glomeratum*	Manatee Mudflower, Baby's Tears	1				1																															5.71%	N
SKA	*Sagittaria kurziana*	Springtape																																			1	2.86%	N

Middle Hillsborough River Emergent Vegetation list (below Fletcher Ave. to Hillsborough River Dam)

Plant Species Code	Plant Species	Common Name	Sample Site (Hillsborough Reservoir)																				Sample Site (Bypass Canal to 40th ST)										Sample Site (Bullard Parkway to Bypass Canal)					Sample Site (North of Bullard Parkway)					Sample Site (South of Fowler Ave.)					Sample Site (North of Fowler Ave)					Sample Site (South of Fletcher Ave.)					Percent Occurrence	(N) Native, (NN) Non-native, (I) Invasive, (P) Pest
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55		
APS	Alternanthera philoxeroides	Alligator Weed	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	94.55%	NN,I,P
COS	Cephalanthus occidentalis	Common Buttonbush			1	1	1	1	1	1		1	1	1		1			1	1	1	1		1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1						1	1	1	1	1	1	1		1	1	74.55%	N
TDM	Taxodium distichum	Bald Cypress		1	1	1	1	1	1	1	1	1												1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1		1	1	1	1		1	1	1	1	1	1	1	72.73%	N
MSS	Mikania scandens	Climbing Hempvine		1	1		1	1			1			1	1			1	1				1	1	1		1	1	1	1	1	1		1						1	1	1	1	1	1	1		1	1	1			1	1	1	1	1	61.82%	N,P
QLO	Quercus laurifolia	Laurel oak	1	1	1	1	1	1	1	1	1	1		1	1	1						1		1					1		1		1	1				1	1	1	1	1			1	1	1				1		1	1		1		56.36%	N
BMA	Urochloa mutica	Para Grass	1	1		1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1								1			1								1		1		1	1				1	1							47.27%	NN,I
WAX	Myrica cerifera	Wax Myrtle		1	1					1	1	1	1	1		1		1			1		1									1		1							1	1	1							1		1		1	1			36.36%	N
EWI	Echinochloa walteri	Coast Cockspur Grass (hairy)				1	1																							1		1		1			1		1		1		1	1	1		1	1	1	1	1	1				1	1	34.55%	N
SAL	Salix spp.	Willow		1		1	1				1	1	1		1		1	1	1	1	1					1																			1		1		1	1	1			1				34.55%	N
STS	Schinus terebinthifolius	Brazilian Pepper		1						1	1	1		1	1	1		1			1	1		1				1	1		1	1																1			1			1				32.73%	NN,I,P
POL	Polygonum spp.	Smartweed, Knotweed					1	1			1	1						1	1										1	1	1	1				1					1						1			1	1							27.27%	N
PRS	Panicum repens	Torpedo Grass				1							1	1		1	1								1		1					1									1		1	1			1	1	1								1	27.27%	NN,I
NSS	Nephrolepsis spp.	Sword Fern		1										1					1			1	1		1						1			1				1	1			1			1		1						1		1			27.27%	N
LPA	Ludwigia peruviana	Peruvian Primrosewillow		1				1	1	1	1	1	1		1	1		1	1			1							1														1						1									27.27%	N
EAA	Eclipta alba (prostrata)	False Daisy, Yerba De Tajo	1			1	1												1										1	1	1	1		1							1		1				1	1		1								25.45%	N
BOC	Boehmeria cylindrica	Bog Hemp, False Nettle				1						1							1				1							1			1			1			1									1	1	1	1	1		1				25.45%	N
SSP	Sabal spp.	Cabbage Palms, Palmetto																						1						1						1	1	1	1	1	1	1		1	1	1	1	1										25.45%	N
EBI	Eleocharis baldwinii	Baldwin's Spikerush, Roadgrass																														1		1		1					1		1	1	1	1	1	1	1			1						21.82%	N
CEA	*Colocasia esculenta*	Wild Taro, Dasheen, Coco Yam					1				1		1					1	1			1											1	1						1	1					1												20.00%	NN,I
TYP	Typha spp.	Cattails		1		1		1	1	1	1	1											1		1		1																															18.18%	N
CCA	Cinnamomum camphora	Camphor-tree												1					1					1						1			1	1			1	1				1											1					18.18%	NN,I
ACE	Acer rubrum var. trilobum	Southern Red Maple																						1				1					1	1				1	1	1				1		1		1										18.18%	N
PTI	Ptilimnium capillaceum	Mock Bishop's Weed			1																								1													1	1	1	1	1										1	1	16.36%	N
PAR	*Paspalum repens*	Water Paspalum																																1					1		1	1	1	1	1		1			1								16.36%	N
PLU	*Pluchea spp.*	Marsh Fleabane,Camphorweed																																		1					1		1				1		1	1	1	1		1				16.36%	N
AVS	*Ampelopsis arborea*	Peppervine		1	1			1	1	1	1	1	1			1																																										16.36%	N
LRS	*Ludwigia repens*	Creeping Primrosewillow, Red Ludwigia																																									1	1	1	1		1	1	1				1				14.55%	N
GAA	Gleditsia aquatica	Water Locust						1	1							1		1												1									1								1											12.73%	N
BHA	*Baccharis halimifolia*	Eastern False Willow, Saltbush		1			1				1																							1										1		1		1										12.73%	N
SAB	*Sabatia spp.*	Rosegentian																																		1								1		1				1	1	1		1				12.73%	N
CYO	Cyperus odoratus	Fragrant Flatsedge																												1	1										1		1	1								1						10.91%	N
SAM	Sambucus canadensis	Elderberry				1				1	1				1	1								1																																		10.91%	N
UAA	*Ulmus americana*	American Elm											1																				1	1		1						1	1															10.91%	N
BID	*Bidens spp.*	Bur Marigold				1													1														1												1	1	1											10.91%	N
PFA	*Paederia foetida*	Skunk Vine												1					1																						1					1				1	1							10.91%	NN,I
COM	Commelina spp.	Dayflower	1																1											1			1								1																	9.09%	N
RVS	Rumex verticillatus	Swamp Dock																												1						1							1		1		1											9.09%	N
SSM	*Sapium sebiferum*	Popcorn Tree, Chinese Tallow Tree						1	1			1			1	1																																										9.09%	NN,I
ABM	Amaranthus blitum	Livid Pigweed																					1				1		1	1																												7.27%	NN
QNA	Quercus nigra	Water Oak																					1																	1				1				1										7.27%	N
TOX	Toxicoendron radicans	Poison Ivy																													1							1	1	1																		7.27%	N
BMI	*Bacopa monnieri*	Common Bacopa, Herb-Of-Grace																																									1					1						1			1	7.27%	N
MVA	Magnolia virginiana	Sweetbay Magnolia											1										1															1																				5.45%	N
FCA	Fraxinus caroliniana	Pop Ash																													1			1									1															5.45%	N
CYA	*Carya aquatica*	Water Hickory																																				1		1		1																5.45%	N
AST	*Aster spp.*	Aster spp., Elliot's Aster																																						1		1		1														5.45%	N
HYP	*Hypericum spp.*	St. John's Wort												1																									1	1																		5.45%	N
WTA	*Sphagneticola (Wedelia) trilobat*	Creeping Oxeye																																												1			1				1					5.45%	NN,I
CYP	*Cyperus spp.*	Sedge																																													1		1	1								5.45%	N
URL	*Urena lobata*	Caesar's Weed													1	1			1																																							5.45%	NN,I
DBA	*Dioscorea bulbifera*	Air Potato												1	1				1																																							5.45%	NN, I
PSQ	*Parthenocissus quinquefolia*	Woodbine	1	1						1																																																5.45%	N

Middle Hillsborough River Emergent Vegetation list (below Fletcher Ave. to Hillsborough River Dam) (continued)

Plant Species Code	Plant Species	Common Name	Sample Site (Hillsborough Reservoir)																				Sample Site (Bypass Canal to 40th ST)										Sample Site (Bullard Parkway to Bypass Canal)					Sample Site (North of Bullard Parkway)					Sample Site (South of Fowler Ave.)					Sample Site (North of Fowler Ave)					Sample Site (South of Fletcher Ave.)					Percent Occurrence	(N) Native, (NN) Non-native, (I) Invasive, (P) Pest
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55		
HCS	Luziola fluitans	Watergrass																												1						1																						3.64%	N
LAN	*Lantana spp.*	Lantana																																			1											1										3.64%	NN
CMX	*Cicuta mexicana*	Water Hemlock																																							1		1															3.64%	N
TAS	*Taxodium ascendens*	Pond Cypress											1																													1																3.64%	N
GTM	*Galium tinctorium*	Marsh Bedstraw																																									1		1													3.64%	N
PNA	*Phyla nodiflora*	Frog-fruit, Carpetweed, Turkey Tangle Fogfruit																																									1		1													3.64%	N
UNK	*UNKNOWN SPP*	Unidentified Plant Species		1							1																																															3.64%	N
SET	Setaria spp	Bristlegrass, Foxtail																												1																												1.82%	N
SVA	*Sesbania virgata*	Wand Riverhemp																																1																								1.82%	NN
IRI	*Iris spp.*	Flag																															1																									1.82%	N
LIQ	*Liquidambar styraciflua*	Sweetgum																																						1																		1.82%	N
CPS	*Cyperus polystachyos*	Flat Sedge																																								1																1.82%	N
FAA	*Forestiera acuminata*	Swamp Privet																																							1																	1.82%	N
LOS	*Ludwigia octovalvis*	Mexican Primrosewillow, Long-stalked Ludwigia																																						1																		1.82%	N
CSS	*Cyperus surinamensis*	Flat Sedge																																									1															1.82%	N
FSR	*Fuirena scirpoidea*	Southern Umbrellasedge, Rush Fuirena																																											1													1.82%	N
CAL	*Callicarpa americana*	American Beauty Berry																																														1										1.82%	N
JMS	*Juncus megacephalus*	Bighead Rush																																																		1						1.82%	N
PCA	*Pontederia cordata*	Pickerel Weed																																																1								1.82%	N
SCS	*Scirpus cubensis*	Burhead Sedge,Cuban Scirpus																	1																																							1.82%	N
IAA	*Ipomoea aquatica*	Water Spinach																	1																																							1.82%	NN,I
LED	*Leucaena leucocephala*	White Leadtree									1																																															1.82%	NN,I
PGA	*Ruellia tweediana*	Britton's Wild Petunia					1																																																			1.82%	NN,I
CYP	*Cyperus involucratus*	Umbrella Plant																				1																																				1.82%	N
OCA	*Osmunda cinnamomea*	Cinnamon Fern																	1																																							1.82%	N
LMM	*Lygodium microphyllum*	Old World Climbing Fern																	1																																							1.82%	NN, I
PAN	*Panicum spp.*	Panic grasses																	1																																							1.82%	N
PVA	*Peltandra virginica*	Green Arrow Arum																				1																																				1.82%	N
PIN	*Pinus spp.*	Pine Tree																	1																																							1.82%	N
TOW	*Tradenscantia ohiensis*	Common Spiderwort																	1																																							1.82%	N

Middle Hillsborough River Floating Leaved Vegetation list (below Fletcher Ave. to Hillsborough River Dam).

Plant Species Code	Plant Species	Common Name	Sample Site (Hillsborough Reservoir)																				Sample Site (Bypass Canal to 40th ST)										Sample Site (Bullard Parkway to Bypass Canal)					Sample Site (North of Bullard Parkway)					Sample Site (South of Fowler Ave.)					Sample Site (North of Fowler Ave)					Sample Site (Near Fletcher Ave.)					Percent Occurrence	(N) Native, (NN) Non-native, (I) Invasive, (P) Pest
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55		
NLM	*Nuphar lutea var. advena*	Spatterdock, Yellow Pondlily	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1		1	1		1	1	1	1				1	1	89.09%	N,P
LEN	*Lemna spp.*	Common Duckweed							1																				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		1	1	1	1				45.45%	N
ACA	*Azolla caroliniana*	Carolina Mosquito Fern										1												1				1	1	1		1	1	1	1	1	1	1	1	1	1	1			1				1	1	1	1	1	1	1			43.64%	N,P
SMA	*Salvinia minima*	Water Spangles, Water Fern												1		1														1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1		1	1	1				43.64%	NN,I
SPI	*Spirodela polyrhiza*	Giant Duckweed																						1						1		1		1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1			1	1	1	43.64%	N
PSS	*Pistia stratoides*	Water Lettuce											1											1								1	1	1	1			1	1	1	1	1		1	1	1	1			1	1	1	1	1	1		1	40.00%	NN,I
ECS	*Eichornia crassipes*	Water Hyacinth			1	1		1		1		1	1		1		1		1	1		1																														1						21.82%	NN,I
HYE	*Hydrocotyl umbellata*	Manyflower Marshpennywort, Water Pennywort																										1															1	1			1								1	1	1	12.73%	N

Middle Hillsborough River Submerged Vegetation list (below Fletcher Ave. to Hillsborough River Dam).

Plant Species Code	Plant Species	Common Name	Sample Site (Hillsborough Reservoir)																				Sample Site (Bypass Canal to 40th ST)										Sample Site (Bullard Parkway to Bypass Canal)					Sample Site (North of Bullard Parkway)					Sample Site (South of Fowler Ave.)					Sample Site (North of Fowler Ave)					Sample Site (Near Fletcher Ave.)					Percent Occurrence	(N) Native, (NN) Non-native, (I) Invasive, (P) Pest
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55		
ALG	*Algal Spp.*	Algal Mats, Floating																	1				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1		1	1		1	1						1	1		1	1	47.27%	N,P
POT	*Potamogeton spp.*	Pond Weed																					1	1	1	1	1	1	1	1	1	1	1	1					1		1	1	1	1			1									1	1	36.36%	N,P
HVA	*Hydrilla verticillata*	Hydrilla, water thyme																					1	1	1	1	1		1	1	1	1	1		1	1									1	1	1							1			1	30.91%	NN,I,P
NGS	*Najas guadelupensis*	Southern Waternymph																									1	1		1	1		1	1	1			1		1		1	1		1						1			1				25.45%	N
CDM	*Ceratophyllum demersum*	Coontail																																				1	1		1	1			1	1	1		1					1				16.36%	N
MGM	Micranthemum glomeratum	Manatee Mudflower, Baby's Tears																																		1							1	1														5.45%	N
MUM	*Micranthemum umbrosum*	Shade Mudflower, Baby's Tears																																																1								1.82%	N

Lower Hillsborough River Emergent Vegetation list (below Hillsborough River Dam to River Mouth).

Plant Species Code	Plant Species	Common Name	Sample Site (University of Tampa)										Sample Site (Rowlett Park)										Percent Occurrence	(N) Native, (NN) Non-native, (I) Invasive, (P) Pest
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
QLO	*Quercus laurifolia*	Laurel oak		1	1					1	1	1	1	1	1	1	1	1	1	1	1	1	75.00%	N
SSP	*Sabal spp.*	Cabbage Palms, Palmetto	1	1		1		1		1	1		1		1		1	1	1	1			60.00%	N
ASP	*Acrostichum spp.*	Leather Fern											1	1	1	1	1	1	1	1	1	1	50.00%	N
STS	*Schinus terebinthifolius*	Brazilian Pepper				1							1		1		1	1	1	1			35.00%	NN,I
DBA	*Discorea bulbifera*	Air Potato											1	1		1	1	1	1		1		35.00%	NN,I
BID	*Bidens spp.*	Bur Marigold							1	1				1		1		1				1	30.00%	N
TDM	*Taxodium distichum*	Bald Cypress		1	1								1				1				1	1	30.00%	N
LLA	*Leucaena leucocephala*	Lead Tree				1							1	1		1				1			25.00%	NN,I
UAA	*Ulmus americana*	American Elm						1						1	1				1		1		25.00%	N
CEA	*Colocasia esculenta*	Wild Taro, Dasheen, Coco Yam												1					1	1	1	1	25.00%	NN,I
APS	*Alternanthera philoxeroides*	Alligator Weed											1	1				1				1	20.00%	NN,I
PFA	*Paederia foetida*	Skunk Vine											1			1		1				1	20.00%	NN,I
SHA	*Sesbania herbacea*	Danglepod Sesban							1									1				1	15.00%	N
CCA	*Cinnamomum camphora*	Camphor-tree													1	1			1				15.00%	NN,I
BMI	*Bacopa monnieri*	Common Bacopa, Herb-Of-Grace												1				1				1	15.00%	N
CMX	*Cicuta mexicana*	Water Hemlock															1	1				1	15.00%	N
PNA	*Phyla nodiflora*	Frog-fruit, Carpetweed, Turkey Tangle Fogfruit								1												1	10.00%	N
CIS	*Cyperus involucratus*	Umbrella flat sedge												1		1							10.00%	NN,I
PRS	*Panicum repens*	Torpedo Grass												1								1	10.00%	NN,I
WTA	*Sphagneticola (Wedelia) trilobata*	Creeping Oxeye												1		1							10.00%	NN,I
BPA	*Broussonetia papyrifera*	Paper Mulberry														1		1					10.00%	NN,I
LPA	*Ludwigia peruviana*	Peruvian Primrosewillow																1				1	10.00%	N
NSS	*Nephrolepsis spp.*	Sword Fern											1						1				10.00%	N
PLU	*Pluchea spp.*	Marsh Fleabane,Camphorweed																1	1				10.00%	N
RTA	*Ruellia tweediana*	Mexican Petunia														1		1					10.00%	NN
TYP	*Typha spp.*	Cattails												1								1	10.00%	N
VRA	*Vitis rotunifolia*	Muscadine Grape													1						1		10.00%	
FCA	*Fraxinus caroliniana*	Pop Ash											1								1		10.00%	N

Lower Hillsborough River Emergent Vegetation list (below Hillsborough River Dam to River Mouth) (continued)

Plant Species Code	Plant Species	Common Name	Sample Site (University of Tampa)										Sample Site (Rowlett Park)										Percent Occurrence	(N) Native, (NN) Non-native, (I) Invasive, (P) Pest
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
ABM	*Amaranthus blitum*	Livid Pigweed							1														5.00%	NN
EWI	*Echinochloa walteri*	Coast Cockspur Grass (hairy)							1														5.00%	N
SPA	*Spartina spp.*	Cordgrass			1																		5.00%	N
AGS	*Avicennia germinans*	Black Mangrove					1																5.00%	N
RME	*Rhizophora mangle*	Red Mangrove								1													5.00%	N
NOR	*Nerium oleander*	Oleander				1																	5.00%	NN
BSP	*Bambusa spp.*	Bamboo														1							5.00%	NN
MAH	*Melia azedarach*	Chinaberry													1								5.00%	NN,I
URL	*Urena lobata*	Caesar's Weed																1					5.00%	NN,I
BMA	*Urochloa mutica*	Para Grass																				1	5.00%	NN,I
AVS	*Andropogon virginicus var. glaucus*	Broom grass																				1	5.00%	N
ECT	*Encyclia tampensis*	Butterfly Orchid															1						5.00%	N
BHA	*Baccharis halimifolia*	Eastern False Willow, Saltbush																		1			5.00%	N
CYP	*Cyperus spp.*	Sedge																				1	5.00%	N
LOS	*Ludwigia octovalvis*	Mexican Primrosewillow, Long-stalked Ludwigia																				1	5.00%	N
MSS	*Mikania scandens*	Climbing Hempvine																				1	5.00%	N
WAX	*Myrica cerifera*	Wax Myrtle																		1			5.00%	N
QNA	*Quercus nigra*	Water Oak																			1		5.00%	N
RHY	*Rhynchospora spp.*	Beaksedge																				1	5.00%	N
RVS	*Rumex verticillatus*	Swamp Dock												1									5.00%	N
SAL	*Salix spp.*	Willow																				1	5.00%	N

Lower Hillsborough River Floating Leaved Vegetation list (below Hillsborough River Dam to River Mouth).

Plant Species Code	Plant Species	Common Name	Sample Site (University of Tampa)										Sample Site (Rowlett Park)										Percent Occurrence	(N) Native, (NN) Non-native, (I) Invasive, (P) Pest
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
HYE	*Hydrocotyl umbellata*	Manyflower Marshpennywort, Water Pennywort												1				1				1	15.00%	N
SMA	*Salvinia minima*	Water Spangles, Water Fern															1					1	10.00%	NN,I

Appendix C: Stream Water Chemistry Data

Table 9. River Assessment Water Chemistry for Hillsborough River Sample Sites.

FCCDR_Site	Chla (µg/L)	TN (mg/L)	TP (mg/L)	Enterococci (#/100 mL)	FC (#/100mL)	Ammonia (mg/L)
HIL-01	2.6	1.792	0.556	1420	600	0.081
HIL-02	1.4	1.142	0.338	700		0.043
HIL-02	1.3	0.961	0.384	340	80	0.063
HIL-03	0.9	1.153	0.326	1600	400	0.039
HIL-04	0.8	1.252	0.308	100	100	0.057
HIL-04	1.2	1.101	0.297	320	180	0.072
HIL-05	1.0	1.285	0.280	100		0.072
HIL-06	1.7	1.129	0.305	260	100	0.06
HIL-07	4.9	1.270	0.308	700	200	0.05
HIL-08	17.5	1.206	0.341	160	380	0.088
HIL-09	39.7	0.946	0.251	440	1180	0.058
HIL-10	4.4	1.104	0.389	520	460	0.094
HIL-11	0.4	0.991	0.359	180	40	0.179

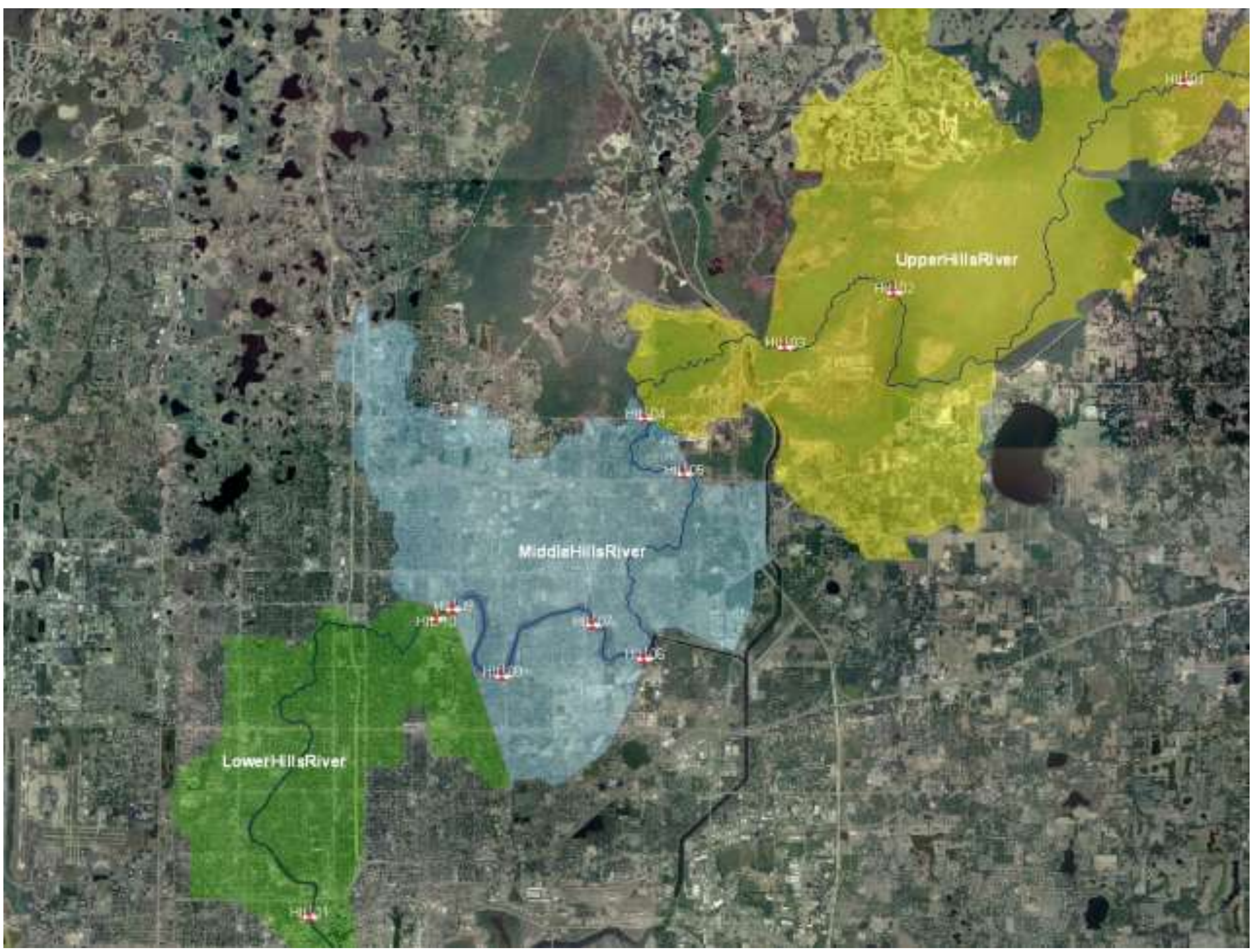


Figure 39. Water Quality Stations in Upper, Middle and Lower Hillsborough River

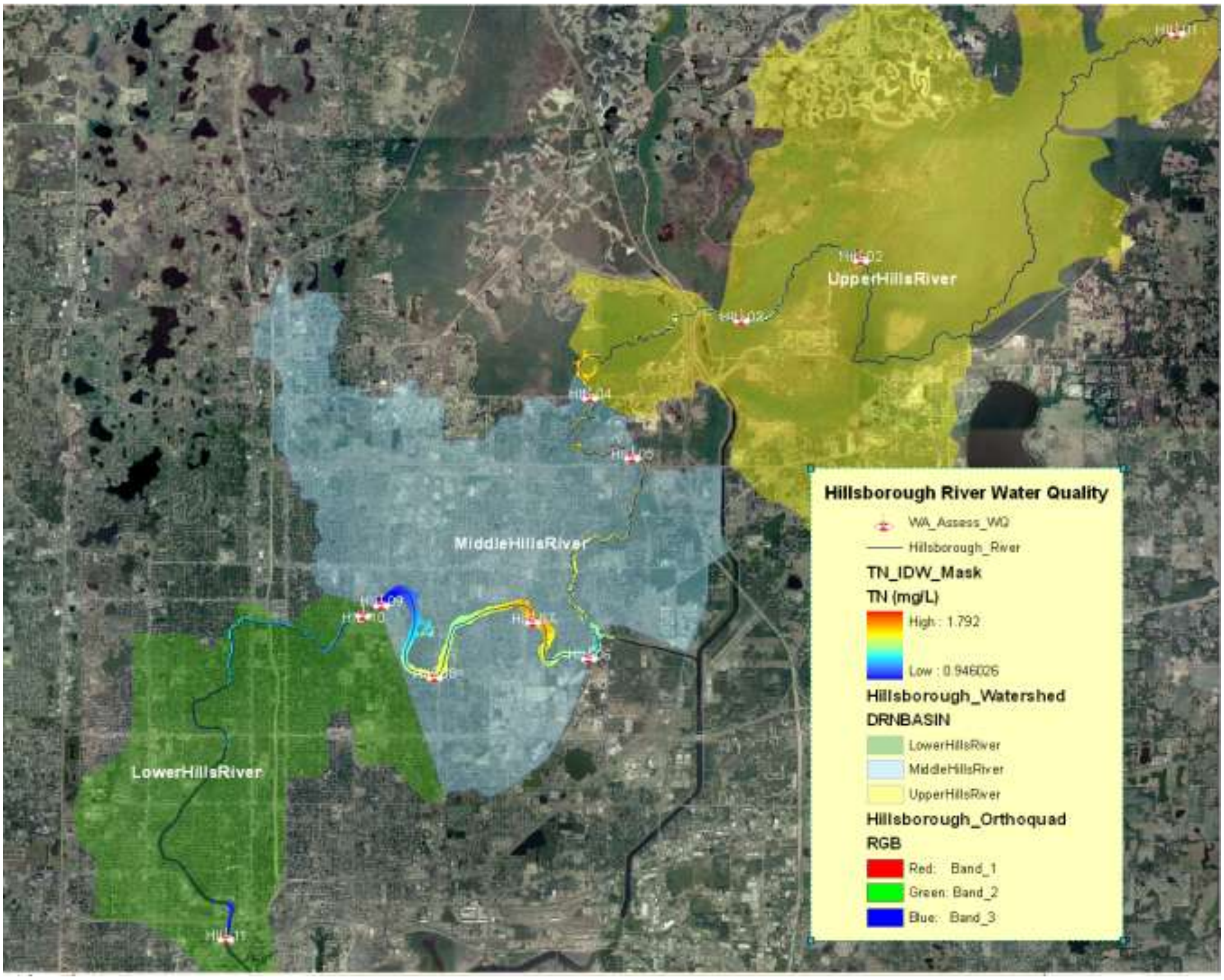


Figure 40. Visualization of Total Nitrogen on Hillsborough River

Row Labels	Chla_ug_L	TN_mgl	TP_mgL	Enterococci_100ml	FC_100_ml	Ammonia_mgl
HIL-01	2.6	1.792	0.556	1420	600	0.081
HIL-02	1.4	1.052	0.361	520	80	0.053
HIL-03	0.9	1.153	0.326	1600	400	0.039
HIL-04	1.0	1.177	0.303	210	140	0.065
Mean	1.4	1.234	0.368	747	272	0.059

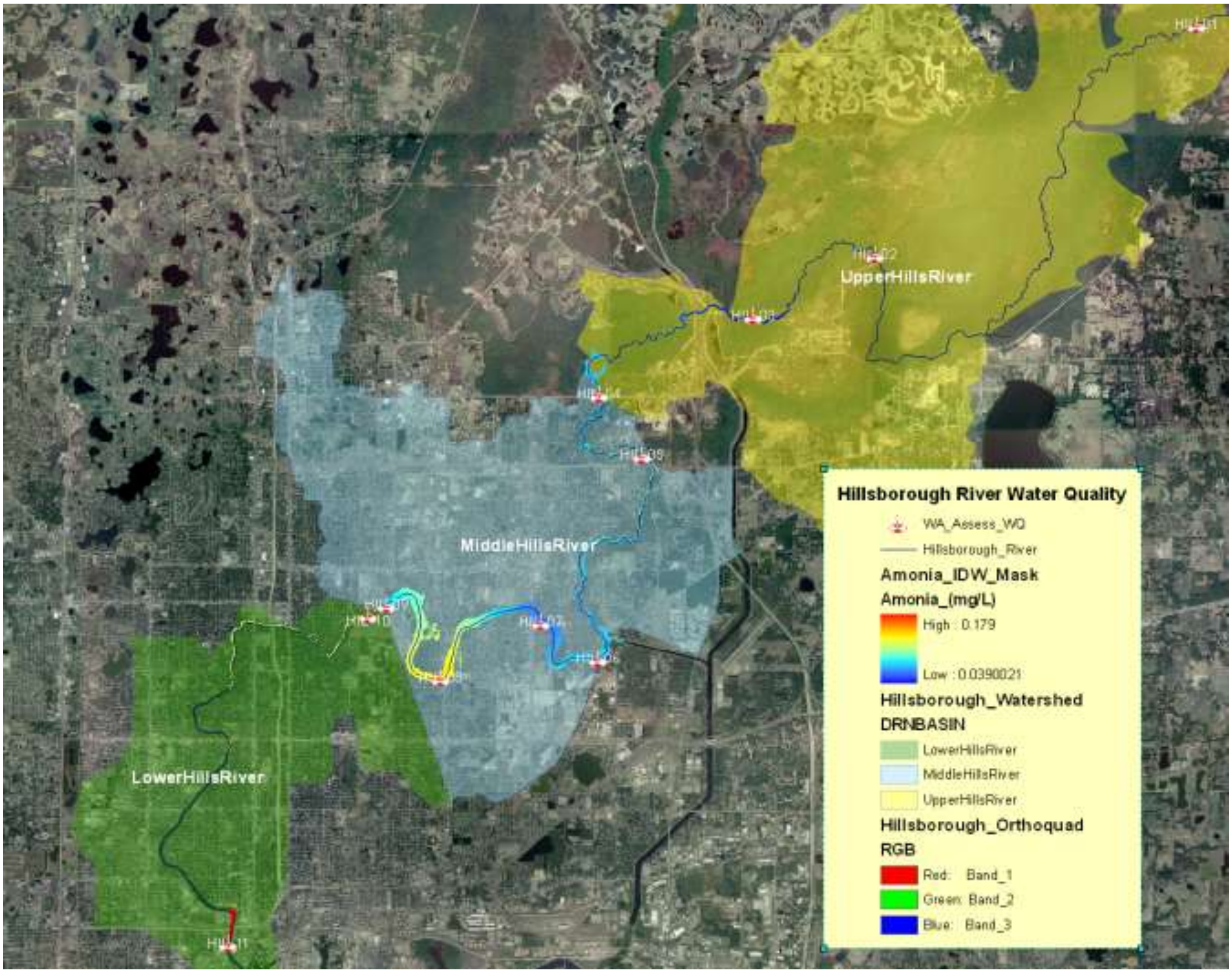


Figure 41. Visualization of Ammonia concentrations on Hillsborough River

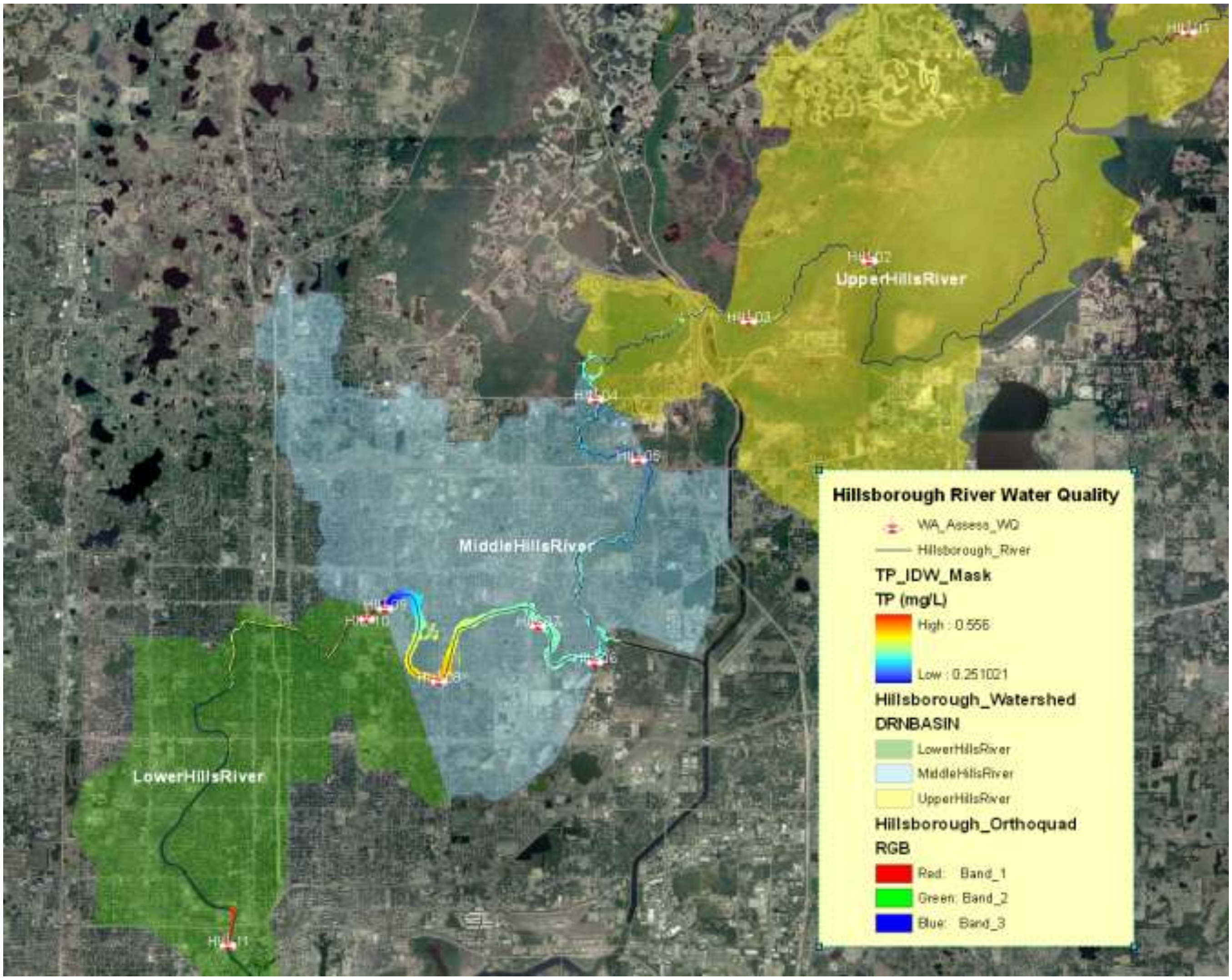


Figure 42. Visualization of Total Phosphorus levels on Hillsborough River

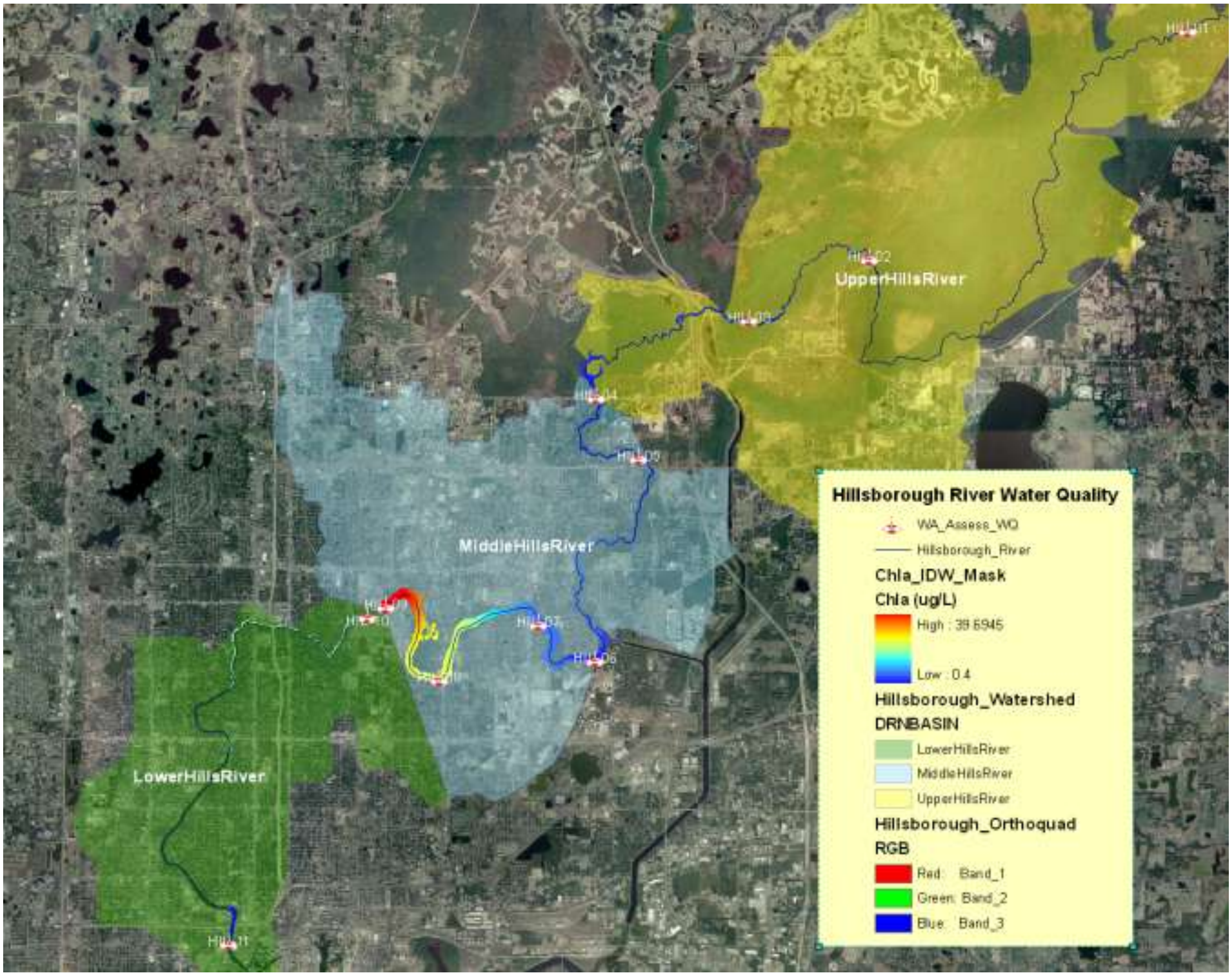


Figure 43. Visualization of Chlorophyll a levels on Hillsborough River

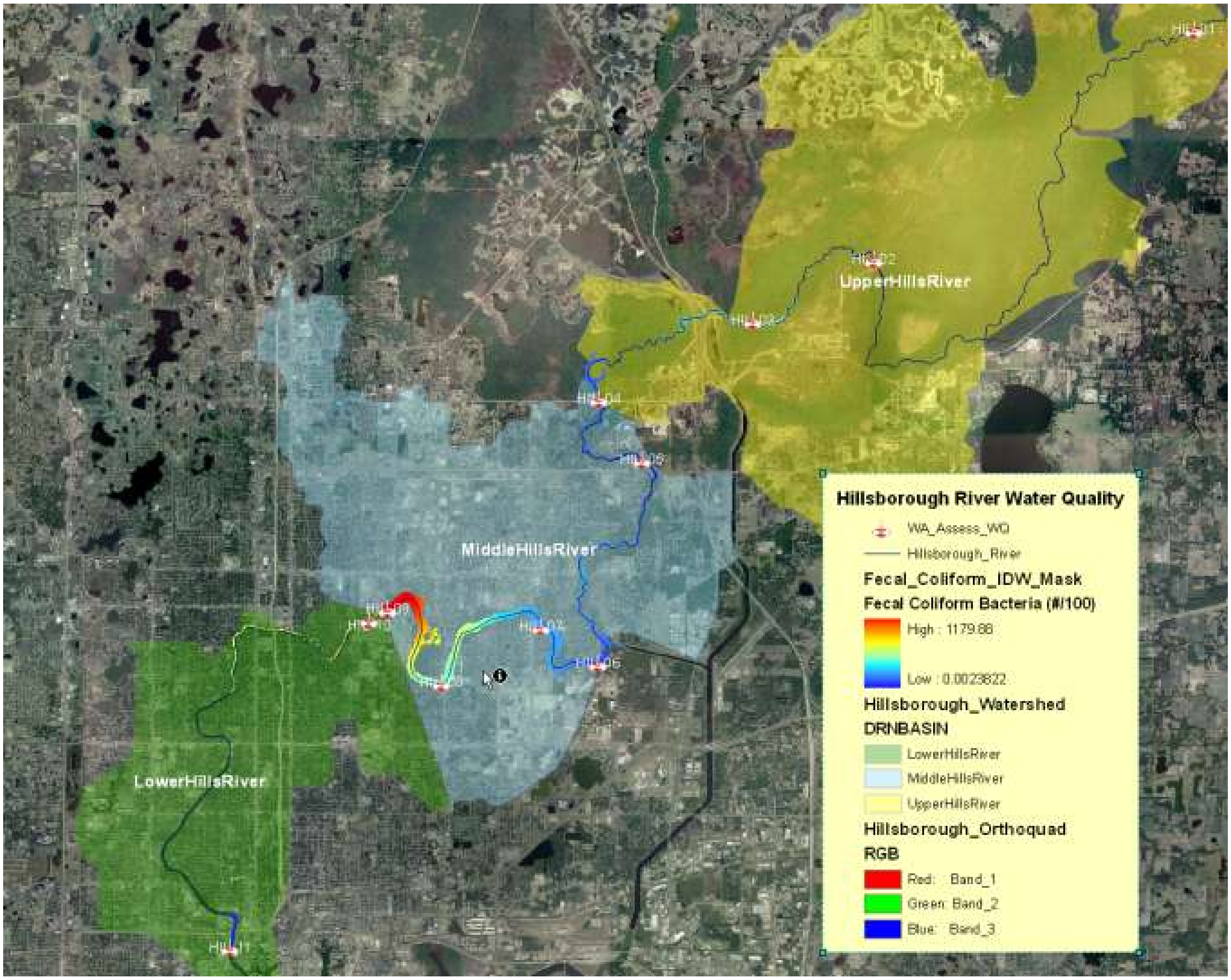


Figure 44. Visualization of Fecal Coliform levels on Hillsborough River

Water Quality Index — A Brief Description of Calculations

The Water Quality Index (WQI) is a method by which the condition or health of a waterbody is represented through the composite ranking of important water quality parameters values. This method is best applied to lotic systems such as streams, canals and bayous. However, one might find that the WQI is also employed for the ranking of quiescent "black waters", since true color imparted by dissolved organics can affect Secchi disk depth: a principal parameter in the calculation of TSI which has been designed for lentic systems such as lakes and estuaries.

Generally speaking, five (5) indicators (below) are used to calculate the WQI; however, as few as two (2) may be used. It is important to note that, with the exception of dissolved oxygen, there is more than one parameter that can be used to represent each WQI indicator. This variance, combined with the flexibility in number of indicators required, and the parameters used to represent them, reveal why the WQI is not an absolute or definitive number. Rather, it is a composite of values designed to present "condition" and to aid in the evaluation of the efficacy of remedial efforts. Finally, it is important to consider that a WQI that is applicable for waters within one region is not necessarily applicable to waters in another. Among other factors, this is due to the natural variance in ambient geological and hydrological conditions between different watersheds and regions.

- Water clarity (measured as turbidity and-or Secchi disk depth).
- Dissolved oxygen
- Oxygen-demanding substances (measured as biochemical oxygen, chemical oxygen demand and-or total organic carbon)
- Nutrients (measured as total nitrogen, nitrite plus nitrate, and-or total phosphorus)
- Bacteria (total coliform and-or fecal coliform).

Calculation

Averaged values for select parameters (used to represent at least two indicators) are each given a numeric value according to a range of values. A WQI "value" is then calculated for a waterbody for each "season" (Jan–Mar, Apr–Jun, Jul–Sep, Oct–Dec) by averaging the rank of each indicator. These seasonal averages (seasonal WQIs) are then averaged and a WQI is assigned that waterbody, for that season, based on the WQI scale (Table 2). This process is repeated using the seasonal WQI values to provide a WQI for the year and-or period of record (POR). Recall that only a minimum of two of the five indicators are required to calculate a WQI for a waterbody. Consequently, some indication of the “completeness” or “representativeness” of the WQI ranking is needed. The term “confidence” is a simple expression of completeness with respect to the number of indicators used to calculate a particular WQI (Table 3). Figure 1 provides averaged, water quality, parameter values for five indicators, and calculates a single index value to serve as an example of seasonal or annual WQI.

Table 2. Water Quality Index (WQI) ranges and their designations.
DEP Form 62-624.600(2), Effective January 28, 2004

WQI	Rating
0 – 45	Good
45 – 60	Fair
> 60	Poor

Table 3. WQI rankings are provided with examples of Confidence values.

WQI	Rating	Confidence	Season
30	Good	5/5	Winter(2000)
40	Good	3/5	Fall(2000)
30	Good	2/5	Summer(2000)
50	Fair	3/5	Summer(2000)

Parameter	Range of Parameter Averages	WQI Value
Turbidity NTU	*value* ≤ 1.5	10
TSS mg/L	4.00 < *value* < 5.50	40
DO mg/L	4.80 < *value* < 5.30	70
BOD mg/L	3.30 < *value* < 5.10	90
COD mg/L	*value* ≤ 16.00	10
TOC mg/L	9.50 < *value* < 12.00	40
TN µg/L	1.00 < *value* ≤ 1.20	50
NOX µg/L	0.07 < *value* ≤ 0.10	50
TP µg/L	0.07 < *value* ≤ 0.09	50
TCOLI /100ml	*value* ≤ 100	50
FCOLI/100ml	10 ≤ *value*	10
Total WQI Parameter Values 230		
WQI Value for Data Set 46 = Fair		

Figure 1. Calculation of WQI from single data set e.g. for one season.

DEP Form 62-624.600(2), Effective January 28, 2004

Overall mean Water Quality Index (WQIm) for rivers and streams in Hillsborough County calculated for the years 2007 and 2008 (see Table 4) revealed that 9 of the County watersheds showed a trend of improving water quality.

Appendix D: Hillsborough County Stream WaterWatch Sites; Additional Information

For further information and to view pictures from the vegetation assesment sites follow the links below. To view the photos taken near the named Stream WaterWatch site select the photo tab on the multi-functional display. To view the associated bathymetry map select the link located in the “Related Documents and Links” box at the bottom of the page.

Stream WaterWatch Program

Hillsborough County Stream WaterWatch is a program developed by Hillborough Community College and the Hillsborough County Department of Public Works Stormwater Management Division. The program currently recieves funding from the Southwest Florida Water Management District (SWFWMD) and is designed to promote citizen involvement in learning about and protecting streams, rivers and lakes. Stream WaterWatch gives volunteers the tools to understand and then start protecting their water resources.

Stream WaterWatch stations found along **Hillsborough River**:

Hillsborough River - Bluffs Blvd.
Hillsborough River - Fowler Avenue
Hillsborough River - Morris Bridge Park
Hillsborough River - Natures Classroom
Hillsborough River - River State Park
Hillsborough River - Riverhills Park
Hillsborough River - Rowlett Park
Hillsborough River - Sligh Avenue West
Hillsborough River - University of Tampa
Hillsborough River - USF Riverfront Park
Hillsborough River - West River
Hillsborough River @ 40th Street Bridge
Hillsborough River @ Riverhills Drive
Hillsborough River @ Scout Park

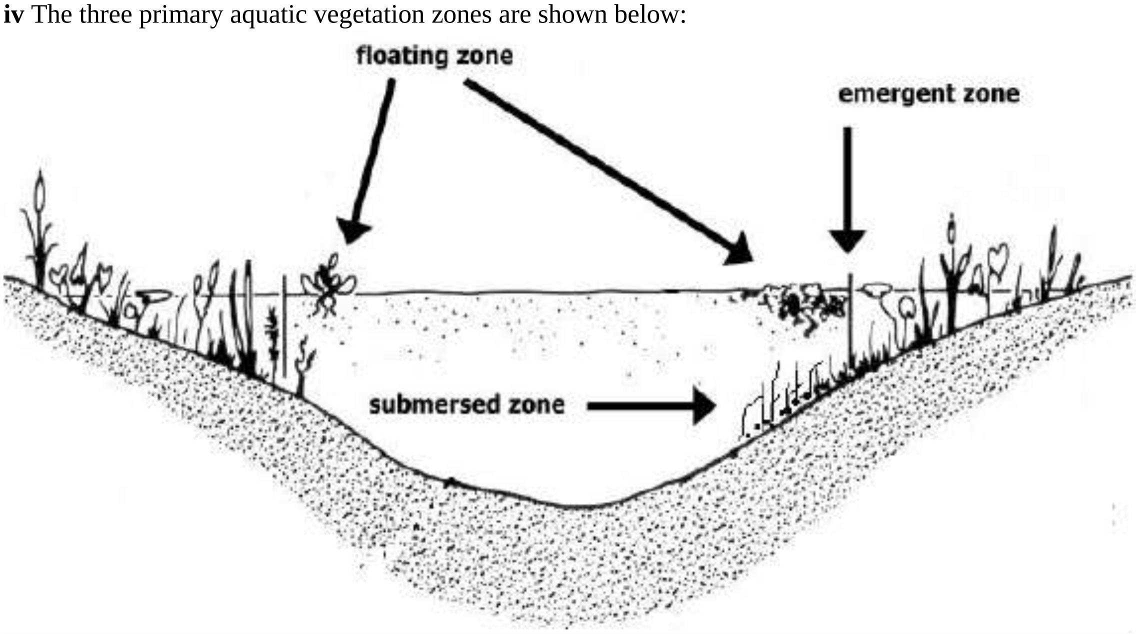
Stream Assessment Footnotes

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/stream/default.asp?wbodyid=5632&wbodyatlas=stream

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. Stream volumes, hydraulic retention time and carrying capacity are important parts of stream 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 form 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 three primary aquatic vegetation zones are shown below:



v A stream is impaired if "(2) For streams with a mean color less than or equal to 40 platinum cobalt units, the annual mean TSI for the stream exceeds 40, unless paleolimnological information indicates the stream was naturally greater than 40, or For any stream, 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 than10 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

vi The Water Quality Index (WQI)[1] is similar to the Trophic State Index (TSI) in that both are used for the statewide assessment of surface waters: the 305(b) Report. WQI is used for streams, black waters (natural tea and coffee-colored waters), and springs, while TSI is used for lakes and estuaries. The WQI is calculated by averaging the values of most or all of the parameters within five water quality parameter categories: 1) water clarity (measured as turbidity and-or Secchi disk depth), 2) dissolved oxygen, 3) oxygen demanding substances (measured as biochemical oxygen, chemical oxygen demand and-or total organic carbon), 4) nutrients (measured as total nitrogen, nitrite plus nitrate, and-or total phosphorus), and 5) bacteria (total coliform and-or fecal coliform).

The Water Atlas presents WQIs over the last four seasons (three month intervals). The WQI "value" for a waterbody is determined by averaging the values (data) of the aforementioned parameters for each "season" (Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec). These seasonal averages are then averaged to provide an overall "rating" or WQI. The term "confidence" expresses the degree of completeness of the index; in other words, "confidence" states how many parameter categories were used to calculate the Overall Water Quality Index.

Ranges of WQI values have been established to provide a general ranking of the waterbody (Figure 1.) WQI values may also include the 'Confidence' (Figure 2) , which provides you with some relative idea as to how much information was used to calculate the WQI for that waterbody.

WQI	Rating
0-45	Good
45-60	Fair
>60	Poor

Figure 1. Water Quality Index (WQI) ranges and their designations.

WQI	Rating	Confidence	Season
30	Good	5/5	Winter (2000)
40	Good	3/5	Fall (2000)
30	Good	2/5	Summer (2000)
50	Fair	3/5	Summer (2000)

Figure 2. WQI rankings are provided with examples of Confidence values.

[1]The acronym WQI also stands for "Water Quality Inspection" in much of the DEP literature.

Spline

The basic form of the minimum curvature Spline interpolation imposes the following two conditions on the interpolant:
The surface must pass exactly through the data points.
The surface must have minimum curvature—the cumulative sum of the squares of the second derivative terms of the surface taken over each point on the surface must be a minimum.
The basic minimum curvature technique is also referred to as thin plate interpolation. It ensures a smooth (continuous and differentiable) surface, together with continuous first-derivative surfaces. Rapid changes in gradient or slope (the first derivative) can occur in the vicinity of the data points; hence, this model is not suitable for estimating second derivative (curvature).
The basic interpolation technique can be applied by using a value of zero for the {weight} argument to the Spline function.
The REGULARIZED option modifies the minimization criteria so third-derivative terms are incorporated into the minimization criteria. The {weight} argument specifies the weight attached to the third-derivative terms during minimization, referred to as tau in the literature. Higher values of this term lead to smoother surfaces. Values between 0 and 0.5 are suitable. Using the REGULARIZED option ensures a smooth surface together with smooth first-derivative surfaces. This technique is useful if the second derivative of the interpolated surface needs to be computed.
The TENSION option modifies the minimization criteria so first-derivative terms are incorporated into the minimization criteria. The {weight} argument specifies the weight attached to the first-derivative terms during minimization, referred to as phi in the literature. A weight of zero results in the basic thin plate Spline interpolation. Using a larger value of weight reduces the stiffness of the plate, and in the limit as phi approaches infinity, the surface approximates the shape of a membrane, or rubber sheets, passing through the points. The interpolated surface is smooth. First derivatives are continuous but not smooth.
The Spline function uses the following formula for the surface interpolation:

$$S(x,y) = T(x,y) + \sum_{j=1}^{N} \lambda_j R(r_j)$$

where:
j = 1, 2, ..., N
N is the number of points.
λ_j are coefficients found by the solution of a system of linear equations.
r_j is the distance from the point (x,y) to the j^{th} point.
T(x,y) and R(r) are defined differently, depending on the selected option.
For the REGULARIZED option:
T(x,y) = a1 + a2x + a3y

$$R(r) = \frac{1}{2\pi}\left\{ \frac{r^2}{4}\left[\ln\left(\frac{r}{2\tau}\right) + c - 1\right] + \tau^2 \left[K_o\left(\frac{r}{\tau}\right) + c + \ln\left(\frac{r}{2\pi}\right)\right]\right\}$$

and for the TENSION option:
T(x,y) = a1

$$R(r) = -\frac{1}{2\pi\varphi^2}\left[\ln\left(\frac{r\varphi}{2}\right) + c + K_o(r\varphi)\right]$$

where:
τ^2 and ϕ^2 are the parameters entered at the command line.
r is the distance between the point and the sample.
K_o is the modified Bessel function.
c is a constant equal to 0.577215.
a_i are coefficients found by the solution of a system of linear equations.
For computational purposes, the entire space of the output raster is divided into blocks or regions equal in size. The number of regions in x and in y directions are the same, and they are rectangular in shape. The number of regions is determined by dividing the total amount of points in input point dataset by the value specified for the number of points. For data less uniformly distributed, the regions may contain a significantly different number of points, with the value for the number of points being only the rough average. If in any region, the number of points is smaller than eight, the region is expanded until it contains a minimum of eight points.

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