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FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration,

Bureau of Watershed Restoration

SOUTHWEST DISTRICT • TAMPA BAY BASIN

**TMDL Report
Dissolved Oxygen and Nutrient TMDL
for the Bullfrog Creek Tidal Segment
(WBID 1666A)**

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June 22, 2009

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Web sites

Florida Department of Environmental Protection, Bureau of Watershed Restoration

TMDL Program

<http://www.dep.state.fl.us/water/tmdl/index.htm>

Identification of Impaired Surface Waters Rule

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

STORET Program

<http://www.dep.state.fl.us/water/storet/index.htm>

2008 305(b) Report

http://www.dep.state.fl.us/water/docs/2008_Integrated_Report.pdf

Criteria for Surface Water Quality Classifications

<http://www.dep.state.fl.us/water/wqssp/classes.htm>

Basin Status Report for the Tampa Bay Basin

http://www.dep.state.fl.us/water/tmdl/stat_rep.htm

Water Quality Assessment Report for the Tampa Bay Basin

http://www.dep.state.fl.us/water/tmdl/stat_rep.htm

U.S. Environmental Protection Agency

Region 4: Total Maximum Daily Loads in Florida

<http://www.epa.gov/region4/water/tmdl/florida/>

National STORET Program

<http://www.epa.gov/storet/>

Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Load (TMDL) for dissolved oxygen and nutrients for the tidal segment of Bullfrog Creek (WBID 1666A) located in the Tampa Bay Group 1 Basin – Coastal Hillsborough Bay Tributary Planning Unit (**Figure 1.1**). This water segment of Bullfrog Creek was verified impaired for dissolved oxygen and nutrients (based on elevated chlorophyll-a), and was included on the Verified List of impaired waters for the Tampa Bay Basin that was adopted by Secretarial Order on June 3, 2008. The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and provides water quality targets needed to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality. The TMDL establishes the allowable loadings to the Bullfrog Creek Tidal Segment (WBID 1666A) that would restore the waterbody so that it meets its applicable water quality criteria for dissolved oxygen and nutrients.

1.2 Identification of Waterbody

To provide a smaller-scale geographic basis for assessing, reporting, and documenting water quality improvement projects, FDEP divides basin groups into smaller areas called planning units. Planning units help organize information and management strategies around prominent sub-basin characteristics and drainage features. To the extent possible, planning units were chosen to reflect sub-basins that had previously been defined by the Southwest Florida Water Management District (SWFWMD) and the Tampa Bay Estuary Program. Bullfrog Creek is located within the Coastal Hillsborough Bay Tributary Planning Unit. For assessment purposes, the Department has divided the Coastal Hillsborough Bay Tributary Planning Unit into water assessment polygons with a unique **waterbody identification** (WBID) number for each water segment. The marine reach of Bullfrog Creek is identified as WBID 1666A (**Figure 1.1**).

1.2.1 Bullfrog Creek Watershed

The Bullfrog Creek watershed is divided into five water assessment units: Bullfrog Creek Tidal Segment (WBID 1666A), Bullfrog Creek Freshwater Segment (WBID 1666), Little Bullfrog Creek (WBID 1688) and two small tributaries, Unnamed Creek (WBID 1686) and Unnamed Stream (WBID 1713). The watershed is located in the southern portion of Hillsborough County, adjacent to the I-75 corridor (**Figure 1.2**). The main channel of Bullfrog Creek is divided into a marine segment, approximately 3.1 miles long and a freshwater segment, approximately 16.3 miles long, and flows in a north-westerly direction into Hillsborough Bay along its eastern shoreline just south of the mouth of the Alafia River. Little Bullfrog Creek is approximately 5.8 miles long and flows in a south-westerly direction feeding into the freshwater segment of Bullfrog Creek near its midpoint. Bullfrog Creek (Fresh), Bullfrog Creek (Marine), and Little Bullfrog creek encompass 27.0, 2.2, and 7.4 square mile drainage areas, respectively. There are no major city limits within the Bullfrog Creek watershed. The City of Tampa (336,823 people) is located about 10 miles northwest of Bullfrog Creek. There are three incorporated areas (CDP – Census Designated Place) located within the watershed including: Gibsonton (8,752 people) encompassing all of Bullfrog Creek (Marine) and portions of the northeastern

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edges of Bullfrog Creek (Fresh), and Wimauma (4,246 people) and Greater Sun Center (16,321 people) covering portions of the southern outskirts of Bullfrog Creek (Fresh). Additional information about the stream's hydrology and geology are available in the Basin Status Report for the Tampa Bay Basin (Florida Department of Environmental Protection [Department], 2001).

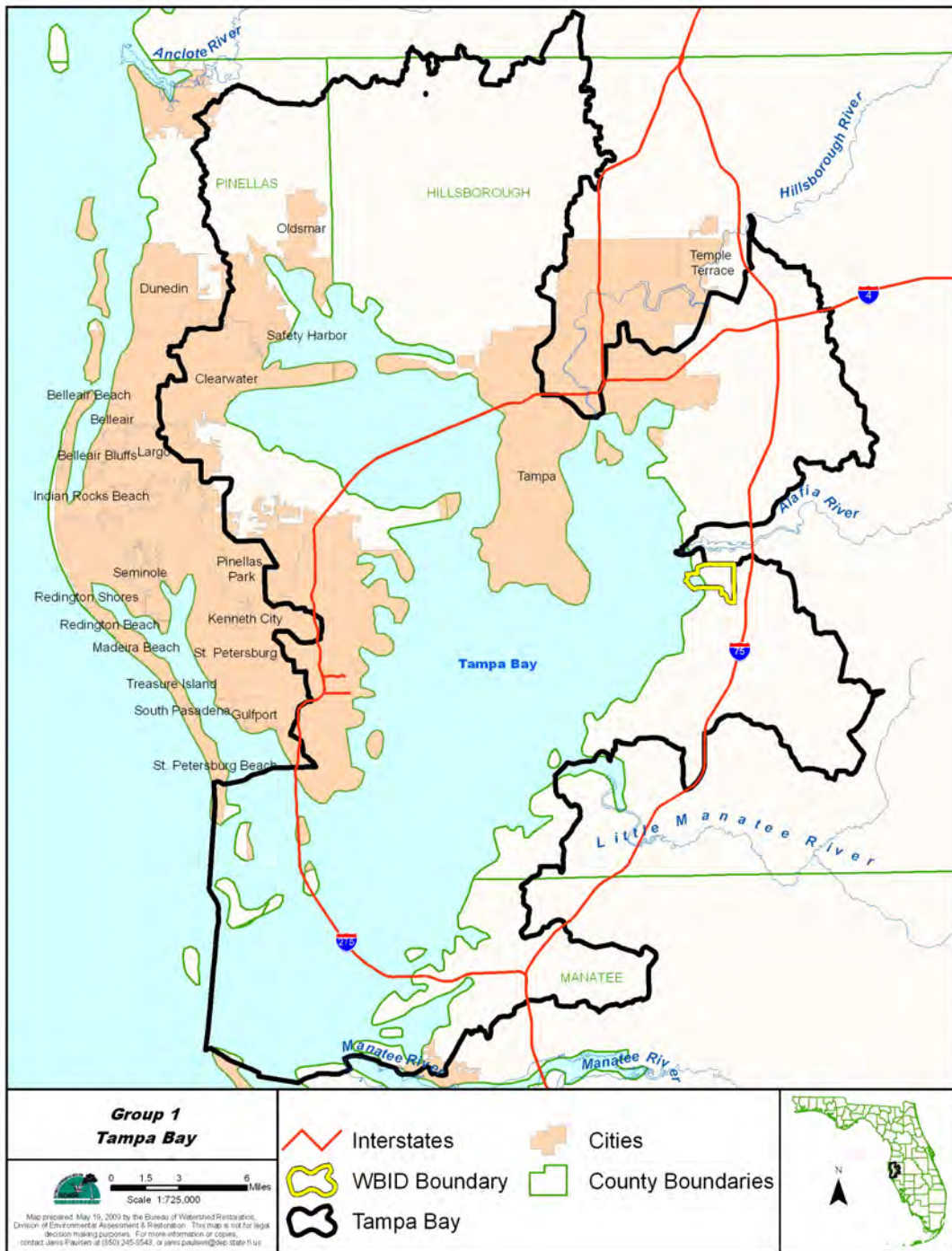


Figure 1.1 Location of the Bullfrog Creek Tidal Segment (WBID 1666A) with Major Geopolitical Features in the Tampa Bay Basin

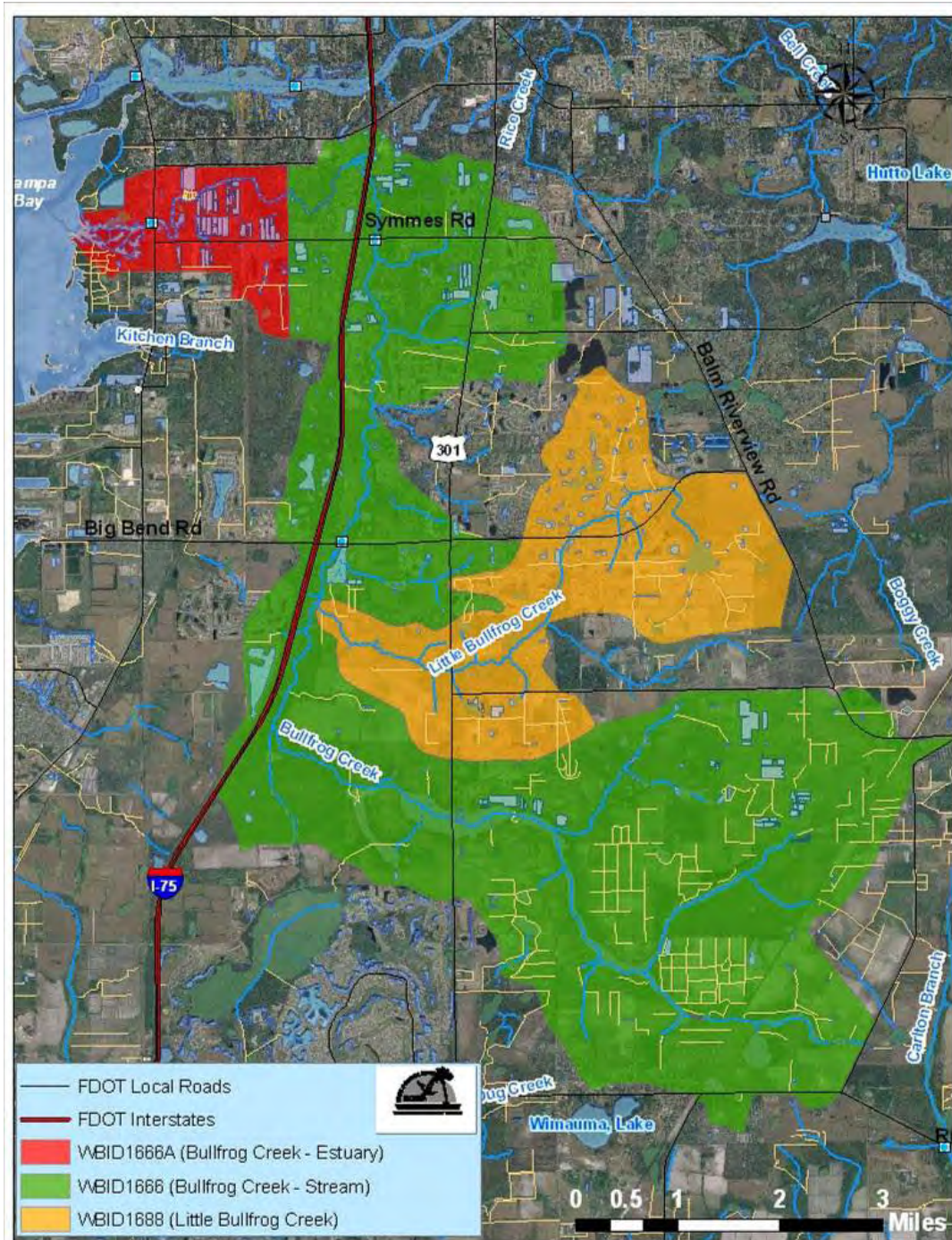


Figure 1.2 Location of Bullfrog Creek (WBID 1666A), Bullfrog Creek (WBID 1666), and Little Bullfrog Creek (WBID 1688)

1.3 Background

This report was developed as part of the Florida Department of Environmental Protection's (Department) watershed management approach for restoring and protecting state waters and addressing TMDL Program requirements. The watershed approach, which is implemented using a cyclical management process that rotates through the state's fifty-two river basins over a five-year cycle, provides a framework for implementing the TMDL Program-related requirements of the 1972 federal Clean Water Act and the 1999 Florida Watershed Restoration Act (FWRA, Chapter 99-223, Laws of Florida).

A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet water quality standards, including its applicable water quality criteria and its designated uses. TMDLs are developed for waterbodies that are verified as not meeting their water quality standards. TMDLs provide important water quality restoration goals that will guide restoration activities.

This TMDL Report may be followed by the development and implementation of a Basin Management Action Plan (BMAP) that would restore the waterbody so that it meets its applicable water quality criteria for dissolved oxygen and nutrients. These activities will depend heavily on the active participation of the Southwest Florida Water Management District, local governments, businesses, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDLs for impaired waterbodies.

Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rulemaking History

Section 303(d) of the federal Clean Water Act requires states to submit to the U.S. Environmental Protection Agency (EPA) lists of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant causing impairment of listed waters on a schedule. The Department has developed such lists, commonly referred to as 303(d) lists, since 1992. The list of impaired waters in each basin, referred to as the Verified List, is also required by the FWRA (Subsection 403.067[4], Florida Statutes [F.S.]); the state's 303(d) list is amended annually to include basin updates.

Florida's 1998 303(d) list included several waterbodies in the Tampa Bay Basin. Bullfrog Creek (WBID 1666A) is 1998 303(d) listed. However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rulemaking process, the Environmental Regulation Commission adopted the new methodology as Rule 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001; the rule was modified in 2006 and 2007.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments and has verified the impairments for dissolved oxygen and nutrients in the Bullfrog Creek tidal segment (**Table 2.1**). **Table 2.2** provides the assessment results for dissolved oxygen following the IWR methodology. The WBID was verified as impaired for dissolved oxygen because more than 10 percent of the values were below the Class III marine criterion minimum value of 4 milligrams/liter (mg/L) over the course of the verified period. For the verified nutrient impairment, annual average chlorophyll-*a* values serve as the primary measurement for assessing nutrient impairment in estuaries under the IWR. During the verified period, the annual average chlorophyll-*a* values for the tidal segment (WBID 1666A) were above the site specific alternative chlorophyll *a* threshold of 15 micrograms per liter (µg/L), averaging between 18.5 µg/L and 39.0 µg/L (**Table 2.3 and Figure 2.3**). According to the IWR, if the annual mean chlorophyll-*a* for any one year in the verified period is greater than the chlorophyll-*a* threshold, the water is verified as impaired. For the estuary segments of waterbodies tributary to Hillsborough Bay, the Hillsborough Bay chlorophyll *a* target of 15 µg/L, developed by the Tampa Bay Estuary Program to protect and restore seagrass, is used as the alternative chlorophyll *a* threshold. Further discussion of water quality target development for this TMDL is provided in Chapter 3.

The IWR data were based on samples collected during the verification period (January 2000 – June 2007). The main sources of data for the IWR assessment came from stations sampled by the Hillsborough County Environmental Protection Commission (21FLHILL...), Florida DEP

TMDL Report: Bullfrog Creek Tidal Segment (WBID 1666A), DO and Nutrients

Southwest District (21FLTPA...), Florida Game and Freshwater Fish Commission (21FLGFWF...), USGS (112WRD...), , and Florida Lake Watch (21FLKWAT...). The Florida Lake Watch data, however, can not be used for verification purposes, but have been included in the analysis of nutrient data used for TMDL development. The individual water quality measurements used in this analysis are available in the IWR database, and are available upon request. For Bullfrog Creek (WBID 1666A) 32 exceedances out of 95 samples in the verified period exceeded the dissolved oxygen criterion. Annual average chlorophyll-a values exceeded 15 ug/L in all years in the 2000-2006 period. The limiting nutrient was determined to be nitrogen based on a total nitrogen to total phosphorus (TN/TP) ratio of 3.4, (n=91). The median value for total nitrogen (TN) in the verified period is 1.19 mg/L, (n = 91).

Table 2.1 Verified Impairments for Bullfrog Creek (WBID 1666A)

WBID	Waterbody Segment Name	Parameters Included on the 1998 303(d) List	Parameter Causing Impairment	Projected Year for TMDL Development*
1666A	Bullfrog Creek	Nutrients (Chl _a)	Nutrients (Chl _a)	2008
1666A	Bullfrog Creek	Dissolved Oxygen	Nutrients (TN)	2008

*The projected year for TMDL development was 2008, but the Settlement Agreement between EPA and Earthjustice, which drives the TMDL development schedule for waters on the 1998 303(d) list, allows an additional nine months to complete the TMDLs. As such, these TMDLs are to be adopted and submitted to EPA by September 30, 2009.

Table 2.2 Summary of Dissolved Oxygen Data Collected During Verification Period (January 2000 – June 2007) for Bullfrog Creek (WBID 1666A)

Waterbody Segment Name	Total Number of Samples	IWR-required number of exceedances for the Verified List	Number of observed exceedances	Number of observed nonexceedances	Number of seasons data was collected
Bullfrog Creek	95	14	32	63	4

Table 2.3 Chlorophyll a Annual Averages During the Verification Period (January 2000 – June 2007) for Bullfrog Creek (WBID 1666A)

Year	Chlorophyll-a Annual Average (ug/L)
2000	24.87
2001	19.99
2002	25.31
2003	25.35
2004	38.99
2005	18.53
2006	19.57

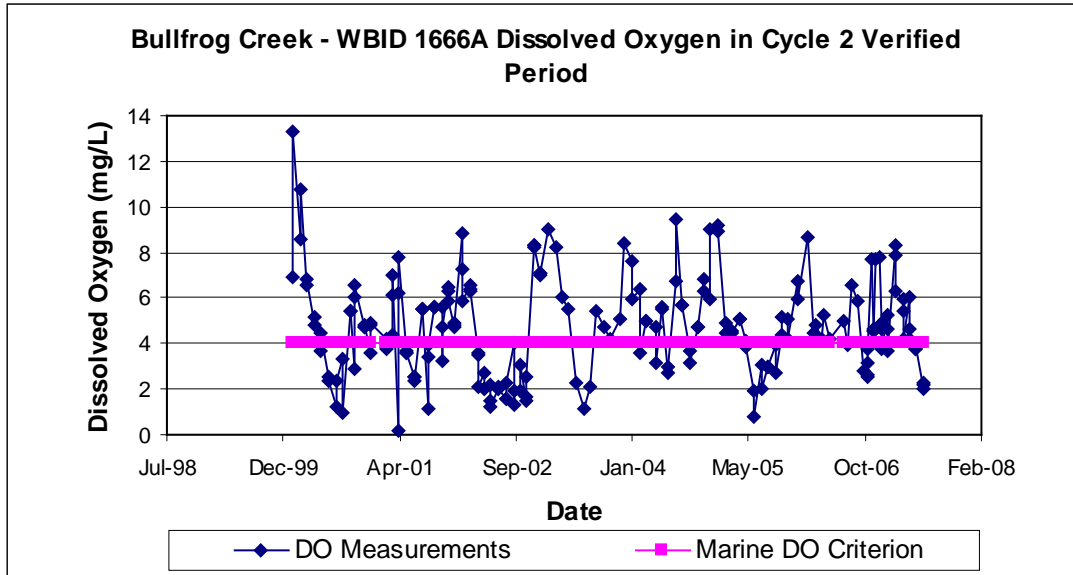


Figure 2.1 Dissolved Oxygen Measurements in the Cycle 2 Verification Period (January 2000 – June 2007)

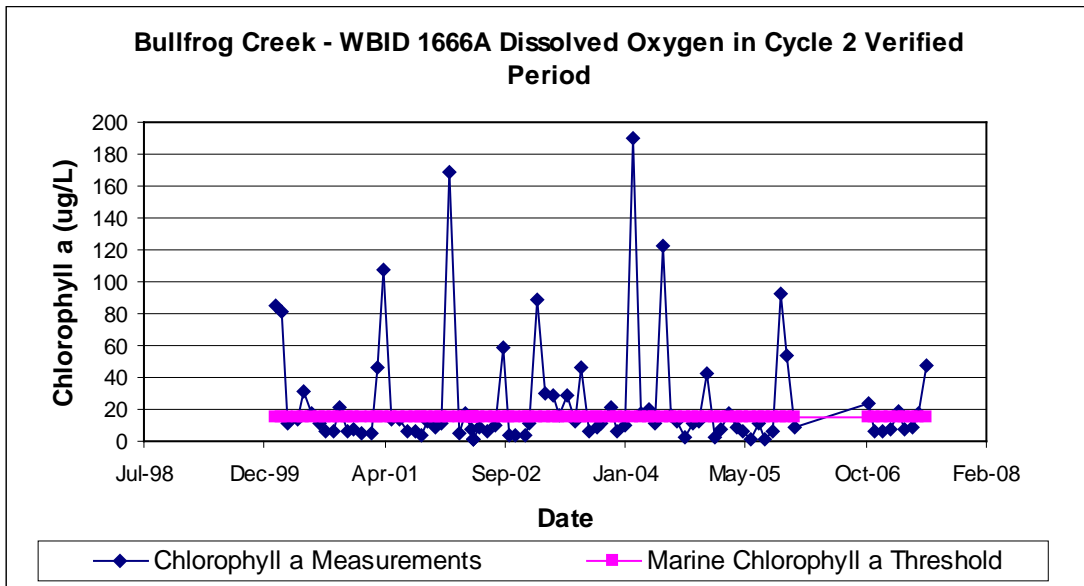


Figure 2.2 Chlorophyll a Measurements in the Cycle 2 Verification Period (January 2000 – June 2007)

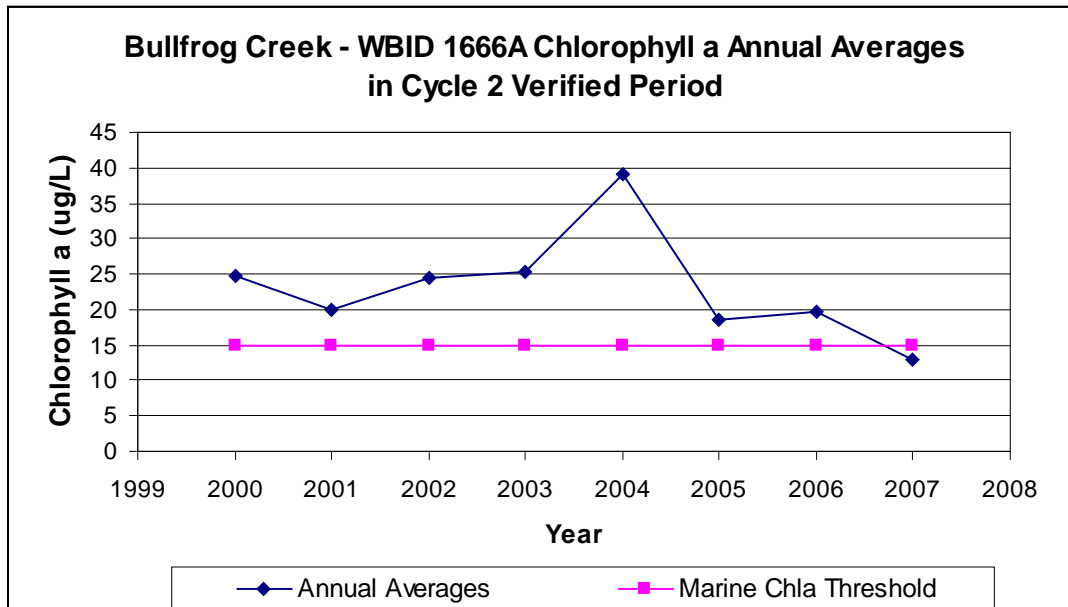


Figure 2.3 Chlorophyll a Annual Averages in the Cycle 2 Verification Period (2000 - 2007)

As part of the verified listing process, the Department attempts to identify the limiting nutrient or nutrients for the impaired waterbody. The limiting nutrient, generally nitrogen or phosphorus, is defined as the nutrient that limits plant growth when it is not available in sufficient quantities. A limiting nutrient is a chemical that is necessary for plant growth, but available in quantities smaller than those needed for algae, represented by chlorophyll-*a*, and macrophytes to grow. Once the limiting nutrient in a waterbody is exhausted, algae stop growing. If more of the limiting nutrient is added, larger algal populations will result until nutrients or other environmental factors again limit their growth.

In Florida waterbodies, nitrogen and phosphorus are most often the limiting nutrients, and nitrogen is typically the limiting nutrient in most Florida estuaries. There is a general understanding in the marine scientific community that nitrogen is the principal cause of nutrient over enrichment in coastal systems (National Research Council, 1993) and an analysis of the data from the Bullfrog Creek tidal segment supports this conclusion.

Determining the limiting nutrient in a waterbody can be accomplished by calculating the ratio of nitrogen to phosphorus in the waterbody, with water column ratios of total nitrogen (TN) to total phosphorus (TP) of less than 10 indicating that nitrogen is limiting. The median TN to TP ratio is 3.3 (computed from n=100 values), indicating that nitrogen is the limiting nutrient in the tidal segment of Bullfrog Creek.

Since nitrogen is the limiting nutrient, reductions in TN loadings would be expected to result in decreases in algal growth, and are measured as decreases in chlorophyll *a* levels. Reductions in TN loading are also expected to result in additional benefits, including improvement in DO

conditions and decreases in biochemical oxygen demand (BOD). BOD is defined as the amount of oxygen required by bacteria while stabilizing decomposable organic matter under aerobic conditions (Sawyer & McCarty, 1967). Reductions in nutrients will result in lower algal biomass levels in the water column, and lower algal biomass levels will result in smaller diurnal fluctuations in DO, fewer algal-based total suspended solids, and reduced BOD.

2.3 Factors That Influence Nutrient Concentrations

Recent data compiled by Harper & Baker (2007) demonstrated that increasing intensity of landuse generally results in increasing nutrient runoff concentration and an increase in runoff volume. Both urbanization and increasing intensity of agricultural landuse (e.g. conversion from rangeland to a managed pasture) can result in increased delivery of nutrients to local receiving waters. Specific agricultural activities that can contribute to the declining health of the system include water flow changes due to the creation of secondary and tertiary canal systems for use in irrigation and flood control and the introduction of nutrients via fertilization. Urbanization can result in reduction of pervious areas for infiltration of runoff, which contributes significantly to increased runoff and nutrient load (Harper & Baker, 2007). Other activities associated with urbanization also increase nutrient inputs such as the installation of septic tanks, sewage overflows, fertilizer usage, and the use of irrigation quality water in sprinkler systems in golf courses and new housing developments. The impact of agricultural and urban activities on eutrophication of receiving waters can be decreased through the implementation of best management practices (BMPs).

2.4 Factors That Influence Dissolved Oxygen

The availability of DO in a marine or freshwater system is highly variable due to several factors. Oxygen is produced in the water column by photosynthesis and is consumed by respiration of plants, animals and aerobic bacteria, and by chemical reactions that occur in brackish waters due to the interaction of sunlight, humic and fulvic materials, as well as oxidation and reduction reactions. The ability of a system to absorb oxygen from the atmosphere is dependent on flow factors such as water depth and turbulence. Elevated nitrogen and phosphorus compounds contribute to excess algae growth. Under high nutrient levels, algae grow rapidly and raise DO concentrations during daylight hours. Respiration by the dense algal populations and other consumers reduce DO concentrations during the night. When phytoplankton cells die, they sink towards the bottom, and are decomposed by bacteria, a process that further reduces DO in the water column.

Factors that may cause significant oxygen depletion include BOD and sediment oxygen demand (SOD). BOD, including carbonaceous BOD (CBOD) and nitrogenous BOD (NBOD) may be the product of both naturally occurring oxygen use from the decomposition of organic materials, and the stabilization of waste products associated with nonpoint source runoff. The significance of any of these factors depends on the specific stream conditions. BOD related to microorganisms is called CBOD. The source material for CBOD is organic matter. CBOD results when oxygen is consumed by microorganisms in converting organic material into CO₂, H₂O, nutrients, energy, and new cells. Algal cells contain organic chemicals that consume oxygen during decomposition. BOD related to chemical oxidation is called NBOD. The source materials for NBOD include organic matter that decays to ammonia, and ammonia entering the system

through stormwater systems or runoff. Nitrification, the process of oxidizing ammonia to nitrates by microorganisms, requires almost 5 mg/L of DO (NBOD) for every milligram per liter of ammonia that is oxidized.

SOD is the overall demand for DO from the water column that is exerted by the combination of biological, biochemical, and chemical processes at the sediment-water interface. The primary sources of SOD are anaerobic (low-oxygen) chemical compounds in the riverbed sediments and particulate BOD (including algae and other sources of organic matter) that settle out of the water column. SOD is generally composed of biological respiration from benthic organisms and the biochemical (i.e., bacterial) decay processes in the top layer of deposited sediments. In addition to DO depletion, degradation of organic matter in the sediment results in the release of oxygen-demanding (i.e., reduced) nutrients, metals, ammonium, iron, manganese, sulfide, and ammonia (Price et al, 1994). These soluble chemicals are released into the water and exert a relatively rapid (i.e., it occurs on a timescale of hours) oxygen demand as the reduced chemicals are oxidized. Some oxidation processes, such as nitrification of ammonia to nitrate, require bacteria and may be slower (i.e., days). In stratified waters, the sediment and the bottom layer of water are somewhat "trapped" and the oxygen is depleted as a result of decay of organic matter and lack of exchange of oxygenated water from upper layers (EPA, 2007).

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criteria Applicable to the TMDL

Florida's surface waters are protected for five designated use classifications, as follows:

Class I	Potable water supplies
Class II	Shellfish propagation or harvesting
Class III	Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife
Class IV	Agricultural water supplies
Class V	Navigation, utility, and industrial use (there are no state waters currently in this class)

3.2 Applicable Water Quality Standards and Numeric Water Quality Targets

The Bullfrog Creek (WBID 1666A) is a Class III waterbody, with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criteria applicable to the impairment addressed by this TMDL are for DO and the narrative nutrient criteria.

3.2.1 Interpretation of Dissolved Oxygen Criterion

The Class III marine criterion for DO, as established by Subsection 62-302.530(30), F.A.C., states that DO shall not average less than 5.0 mg/L in a 24-hour period, and shall not be less than 4 mg/L, and that normal daily and seasonal fluctuations above these levels shall be maintained.

3.2.3 Interpretation of Narrative Nutrient Criterion

Florida's nutrient criterion is narrative only—nutrient concentrations of a body of water shall not be altered so as to cause an imbalance in natural populations of aquatic flora or fauna. Accordingly, a nutrient-related target was needed to represent levels at which an imbalance in flora or fauna is expected to occur. While the IWR provides a threshold for nutrient impairment for estuaries based on annual average chlorophyll a levels, these thresholds are not standards and need not be used as the nutrient-related water quality target for TMDLs. In fact, in recognition that the IWR thresholds were developed using statewide average conditions, the IWR (Section 62-303.450, F.A.C.) specifically allows the use of alternative, site-specific

thresholds that more accurately reflect conditions beyond which an imbalance in flora or fauna occurs in the waterbody.

In translating the narrative nutrient criterion to develop a nutrient target for this TMDL, the first step in this process was to identify a chlorophyll a target. The Department selected a chlorophyll a target of 15 ug/L, that was developed for the adjacent Hillsborough Bay segment by the Tampa Bay Estuary Program for making resource-based management decisions (Janicki and Wade, 1996; Janicki et al., 2000). The chlorophyll a target was developed as part of the nitrogen management strategy to protect and restore seagrass meadows in the bay. The Department uses this water quality target as an alternative chlorophyll a threshold for the Hillsborough Bay segments and the estuary segments tributary to the bay to perform nutrient assessments following the IWR methodology. Applying the bay threshold to the adjacent estuary segments provides for consistency in assessing nutrients in this area of Tampa Bay. **Figure 3.1** displays the water segments in the Tampa Bay watershed where the resource based chlorophyll a targets are used as alternative chlorophyll a thresholds.

As the lower Hillsborough Bay segment (WBID 1558D), that Bullfrog Creek flows into, currently has annual average chlorophyll a values less than the alternative threshold, the recently measured total nitrogen (TN) concentrations in the bay were used to derive the water quality target used for TMDL development. **Table 3.1** provides the lower Hillsborough Bay annual average chlorophyll a and TN values along with rainfall from 1995 to 2006. Over this time frame, as annual average TN concentrations have exhibited a general decrease in the bay, there has been a similar decreasing trend in annual average chlorophyll a concentrations. This decreasing trend in Hillsborough Bay TN and chlorophyll a values has occurred in years with above and below average rainfall.

Table 3.1 Lower Hillsborough Bay (WBID 1558D) Annual Average Total Nitrogen and Chlorophyll a Concentrations and Annual Rainfall.

Year	Annual Average Total N (mg/L)	Annual Average Chlorophyll a (ug/L)	Hillsborough Bay Watershed Annual Rainfall (in.) ¹
1995	0.87	21.2	56
1996	0.76	16.3	51
1997	0.74	14.3	65
1998	0.86	21.3	58
1999	0.64	11.8	44
2000	0.92	8.6	37
2001	0.87	17.3	55
2002	0.79	14.2	64
2003	0.58	14.1	59
2004	0.56	14.7	65
2005	0.52	10.7	55
2006	0.46	11.6	43

¹ From Tampa Bay Estuary Program 2004 - 2007 Pollutant Loading Update Report

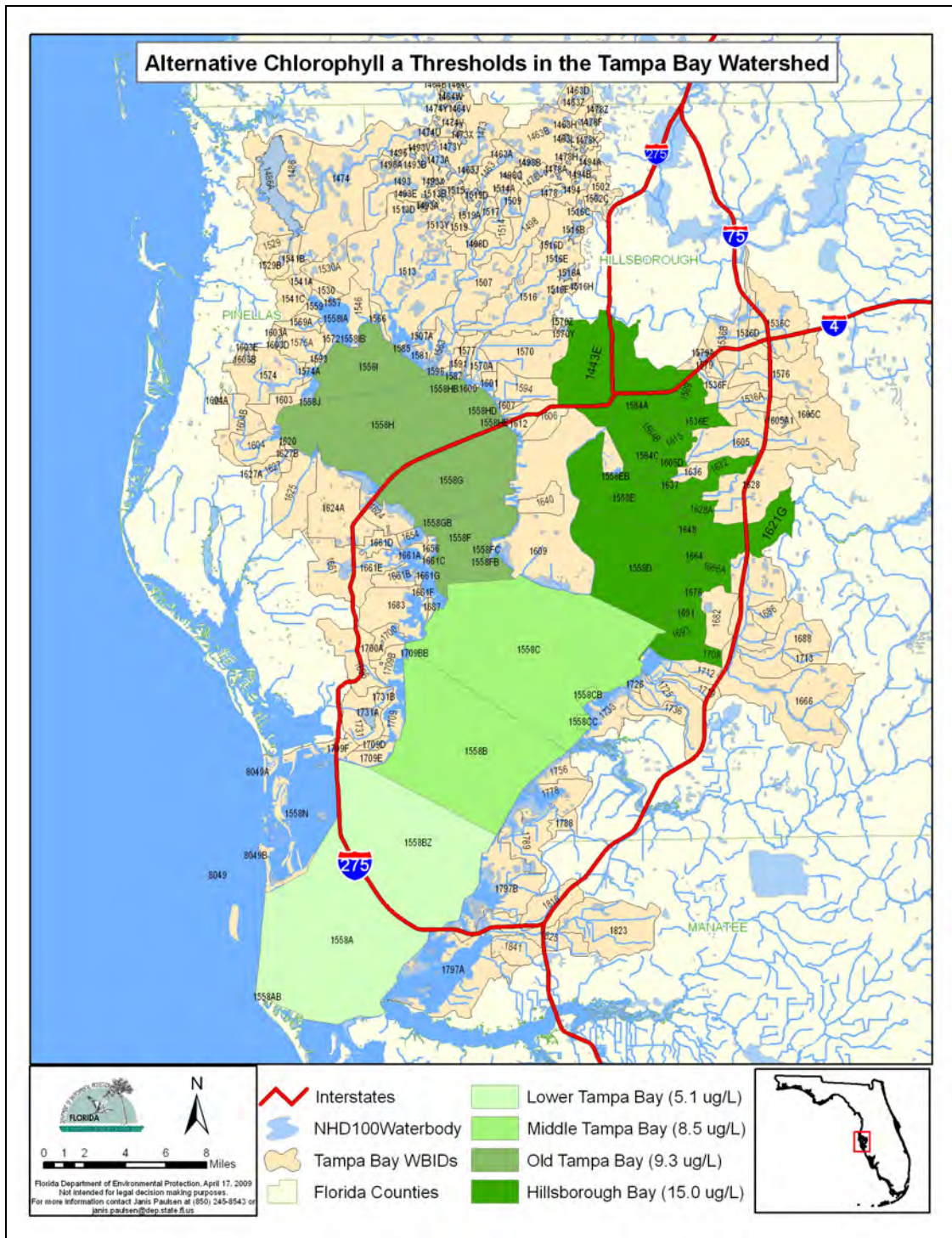


Figure 3.1 Tampa Bay Watershed Alternative Chlorophyll a Thresholds

Chapter 4: ASSESSMENT OF SOURCES

4.1 Types of Sources

An important part of the TMDL analysis is the identification of pollutant source categories, source subcategories, or individual sources of pollutants in the impaired waterbody and the amount of pollutant loadings contributed by each of these sources. Sources are broadly classified as either “point sources” or “nonpoint sources.” Historically, the term point sources has meant discharges to surface waters that typically have a continuous flow via a discernable, confined, and discrete conveyance, such as a pipe. Domestic and industrial wastewater treatment facilities (WWTFs) are examples of traditional point sources. In contrast, the term “nonpoint sources” was used to describe intermittent, rainfall-driven, diffuse sources of pollution associated with everyday human activities, including runoff from urban land uses, agriculture, silviculture, and mining; discharges from failing septic systems; and atmospheric deposition.

However, the 1987 amendments to the Clean Water Act redefined certain nonpoint sources of pollution as point sources subject to regulation under the EPA’s National Pollutant Discharge Elimination System (NPDES) Program. These nonpoint sources included certain urban stormwater discharges, including those from local government master drainage systems, construction sites over five acres, and a wide variety of industries (see **Appendix A** for background information on the federal and state stormwater programs).

To be consistent with Clean Water Act definitions, the term “point source” will be used to describe traditional point sources (such as domestic and industrial wastewater discharges) *and* stormwater systems requiring an NPDES stormwater permit when allocating pollutant load reductions required by a TMDL (see **Section 6.1**). However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES stormwater discharges and non-NPDES stormwater discharges, and as such, this source assessment section does not make any distinction between the two types of stormwater.

4.2 Point Sources

4.2.1 NPDES Permitted Wastewater Facilities

There are no NPDES permitted facilities with discharges to the surface waters of the Bullfrog Creek tidal segment or upstream areas of the watershed.

4.2.2 Municipal Separate Storm Sewer System Permittees

Municipal separate storm sewer systems (MS4s) may also discharge pollutants to waterbodies in response to storm events. To address stormwater discharges, the EPA developed the

NPDES stormwater permitting program in two phases. Phase 1, promulgated in 1990, addresses large and medium-size MS4s located in incorporated areas and counties with populations of 100,000 or more. Phase 2 permitting began in 2003. Regulated Phase 2 MS4s are defined in Section 62-624.800, F.A.C., and typically cover urbanized areas serving jurisdictions with a population of at least 10,000, or discharging into Class I or Class II waters, or into Outstanding Florida Waters.

The stormwater collection systems owned and operated by Hillsborough County and Co-Permittees (FDOT District 7 & Florida's Turnpike Enterprise, and City of Plant City) are covered by a Phase I NPDES municipal separate storm sewer system (MS4) permit (FLS000006). There were no Phase II MS4 permits identified for the Bullfrog Creek watershed.

4.3 Land Uses and Nonpoint Sources

Nonpoint source pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. Nonpoint pollution is caused by rainfall moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water (EPA, 1994).

Nutrient loading from urban areas is most often attributable to multiple sources, including stormwater runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals. In agricultural areas, agricultural fertilizing or nutrients from wildlife and agricultural livestock wastes are sources contributing to the pollutant load.

Land Uses

The spatial distribution and acreage of different land use categories were identified using the SWFWMD 2004 land use coverage (scale 1:40,000) contained in the Department's geographic information system (GIS) library, as this time frame represents land cover near the midpoint of the verified assessment period. Land use categories in the watershed were aggregated using the simplified Level 1 codes and are tabulated in **Tables 4.1**. **Figure 4.2** shows the principal land uses in the watershed.

As shown in **Tables 4.1**, the entire Bullfrog Creek watershed drains 25,744 acres (40.2 miles²). The dominant land use is agriculture, accounting for 45 percent of the watershed area. The largest activity, cropland and pastureland, accounts for about 60 percent of the agriculture. Urban areas (urban and built-up; low-, medium-, and high-density residential) make up about 24 percent of the watershed, with the largest proportion in low density residential areas. Rangeland and forest account for 17 percent of the area while water and wetlands make up another 12 percent.

Table 4.1 Classification of Land Use Categories in the Bullfrog Creek Watershed, 2004

Level 1 Code	Landuse	Acreage	Percent of Total
1000	Urban Open	1,932	7.5
1100	Low Density Residential	2,056	8.0
1200	Medium Density Residential	735	2.9
1300	High Density Residential	1,351	5.2
2000	Agriculture	11,680	45.4
3000+4000	Rangeland + Forest/Rural Open	4,383	17.0
5000	Water	612	2.4
6000	Wetlands	2,341	9.1
7000	Barren Land (Transportation)	110	0.4
8000	Communication and Transportation	544	2.1
Total		25,744	100.0

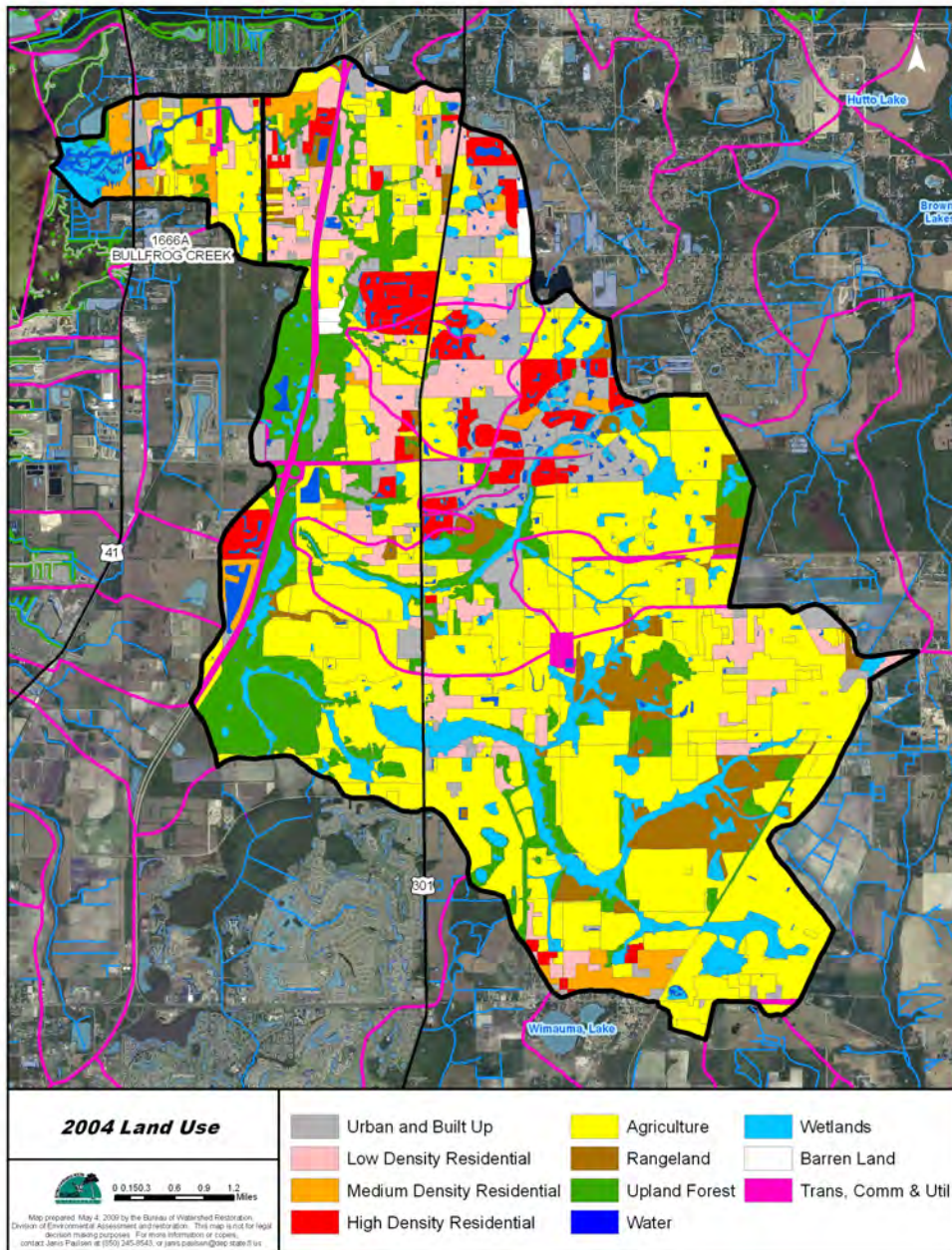


Figure 4.1 Principal Land Uses in the Bullfrog Creek Watershed, 2004

Septic Tanks

Septic tanks are another potentially important source of pollution, including nitrogen. Information on the location of septic systems was obtained from Hillsborough County, which is based on an on-going study to identify septic tanks. The septic tank database was developed

from records obtained from the Florida Department of Health and sewer billing records (David Glicksberg, personal communication).

The septic tanks located in the Bullfrog Creek watershed are displayed in **Figure 4.2**. Currently the number of septic tanks in the watershed is estimated to be 526. The map shows that a large number of systems are located in the area draining to the tidal segment of Bullfrog Creek.

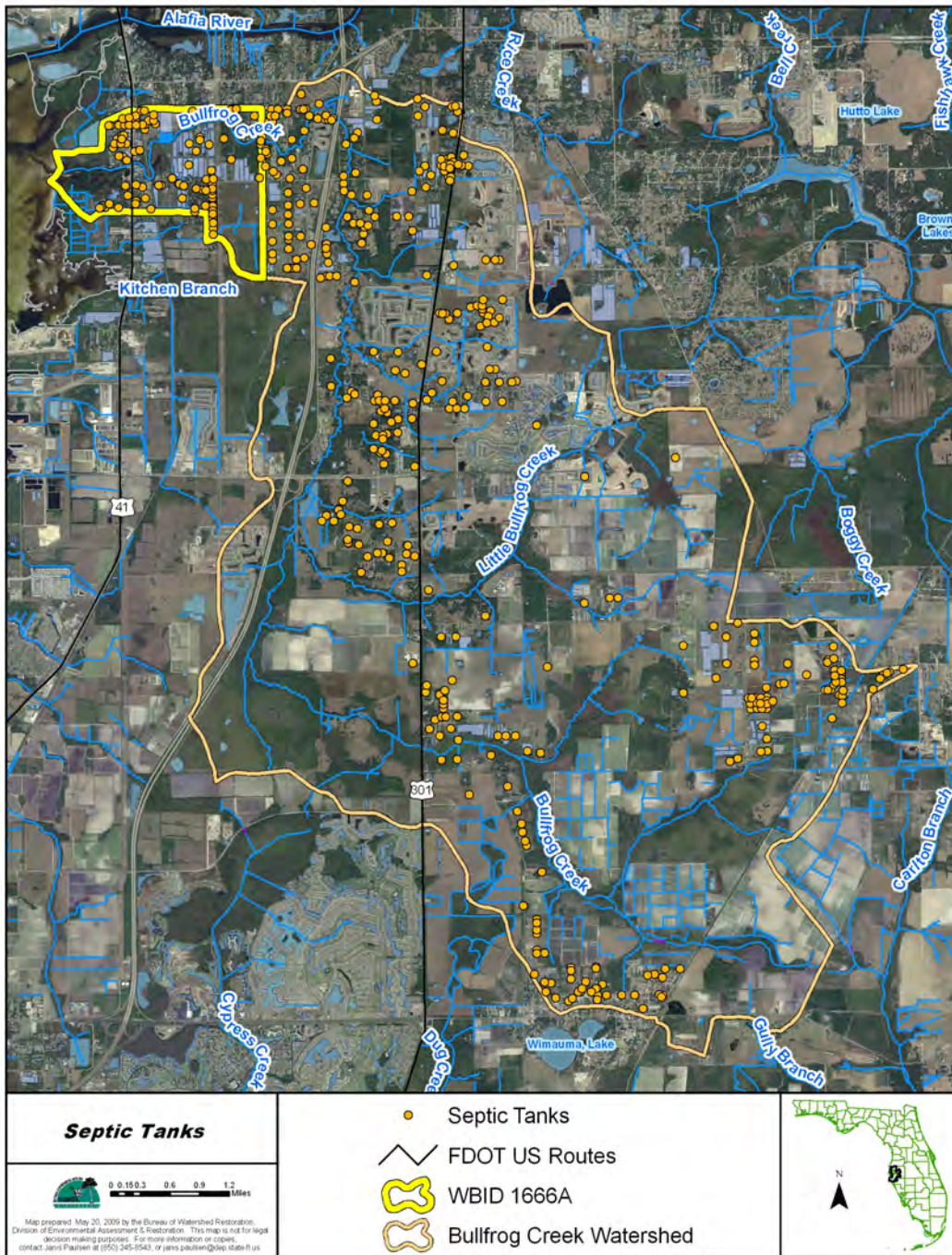


Figure 4.2 Distribution of Onsite Sewage Systems (Septic Tanks) in the Bullfrog Creek Watershed

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

The goal of the TMDL development process is to identify a Total N target for the estuarine area of Bullfrog Creek, so that the water segment will meet the applicable DO and nutrient water quality criteria and maintain its' function and designated use as a Class III water. The Department initially attempted to determine the tidal creek's assimilative capacity through a statistical evaluation of water quality data, but the relationships between the response variables (DO and chlorophyll a) and pollutant concentrations were not that strong. In this case, information used to develop the TMDL was based on observations of water quality changes in the tidal segment of Bullfrog Creek and lower Hillsborough Bay indicating a general decreasing trend in chlorophyll a and total nitrogen levels in recent years.

5.2 Analysis of Water Quality

Water quality monitoring in the Bullfrog Creek tidal segment has been performed by five different agencies and the sampling locations are shown in **Figure 5.1**. The majority of data has been collected by the Hillsborough County EPC, where they sample three stations approximately monthly. This includes sampling 2 stations in the freshwater reach of the creek (Stations 132 and 167) and one station in the tidal reach at US Highway 41 (Station 144). The majority of data used for the assessment and TMDL development has been collected at Station 144.

Water quality trends in chlorophyll a and total nitrogen concentrations in the tidal reach of Bullfrog Creek and lower Hillsborough Bay indicate a decrease in both variables over time. The annual average chlorophyll a values in the Bullfrog Creek estuary, in both the water segment as a whole and at the Hillsborough County EPC station, exhibit a decreasing trend over the verified period which is occurring coincident with decreases in the lower Hillsborough Bay segment, **Figures 5.2 and 5.3**. Additionally, annual average total nitrogen concentrations show a similar decreasing trend, **Figures 5.4 and 5.5**. The chlorophyll a and total N annual average values at station 144 are similar to the pattern observed using all the data collected in the water segment, WBID 1666A.

As stated, there were no strong relationships found between nutrient levels and chlorophyll a, to develop a predictive model. However, the results indicate that generally lower chlorophyll a concentrations are associated with lower total N concentrations. At the long-term HCEPC in tidal Bullfrog Creek, 13 percent of the variation in chlorophyll a can be explained by total N, **Figure 5.6**. Additionally, other explanatory variables were analyzed along with total N, (e.g. freshwater inflow, temperature, and total phosphorus), but the inclusion of them in the regression analysis did not considerably improve the relationship.

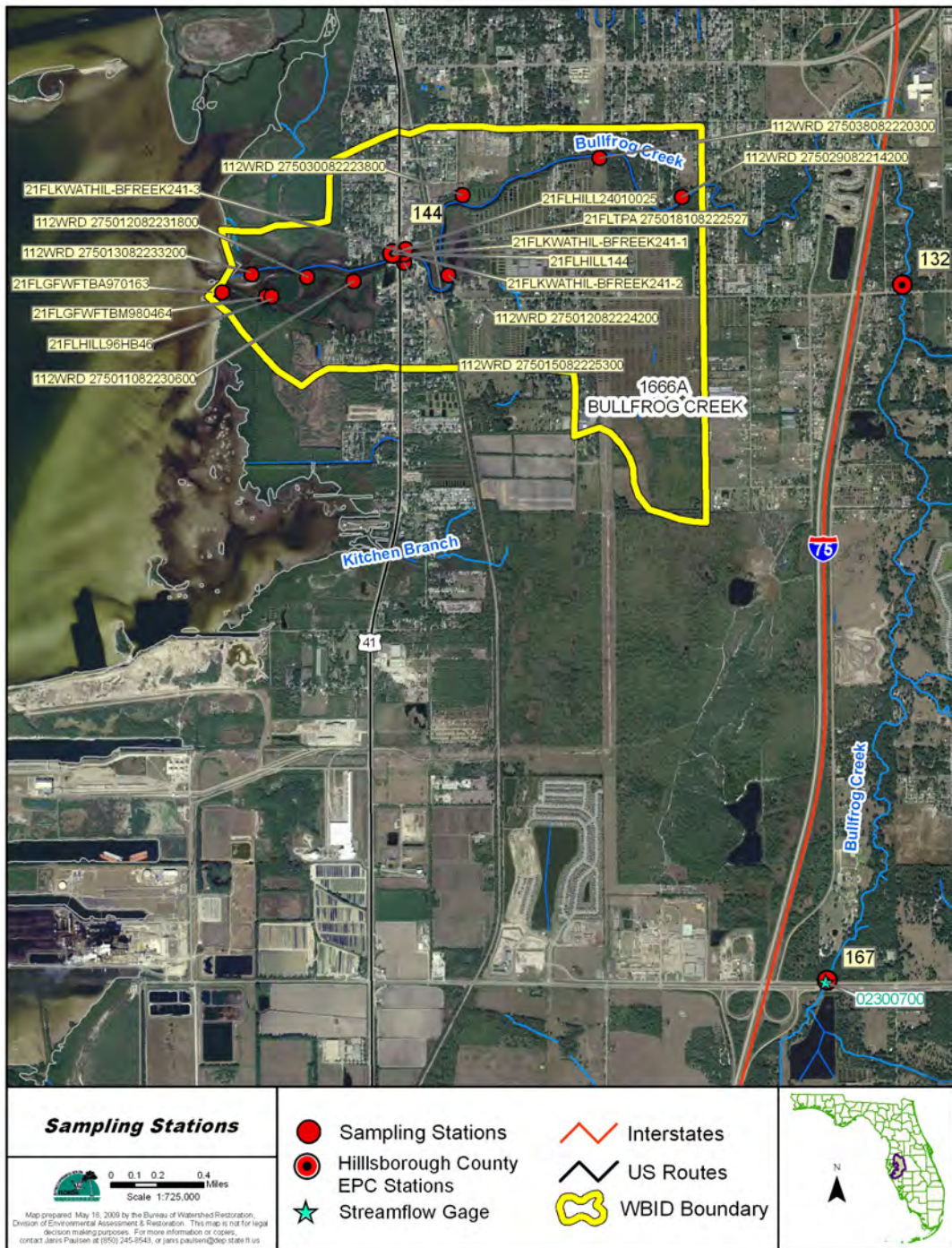


Figure 5.1 Monitoring Locations in the Bullfrog Creek Tidal Segment and the Hillsborough County EPC Freshwater Stations

Figure 5.2 Annual Average Chlorophyll a Concentrations in the Bullfrog Creek and lower Hillsborough Bay WBIDs

Figure 5.3 Bullfrog Creek Annual Average Chlorophyll a Concentrations at Hillsborough County EPC stations

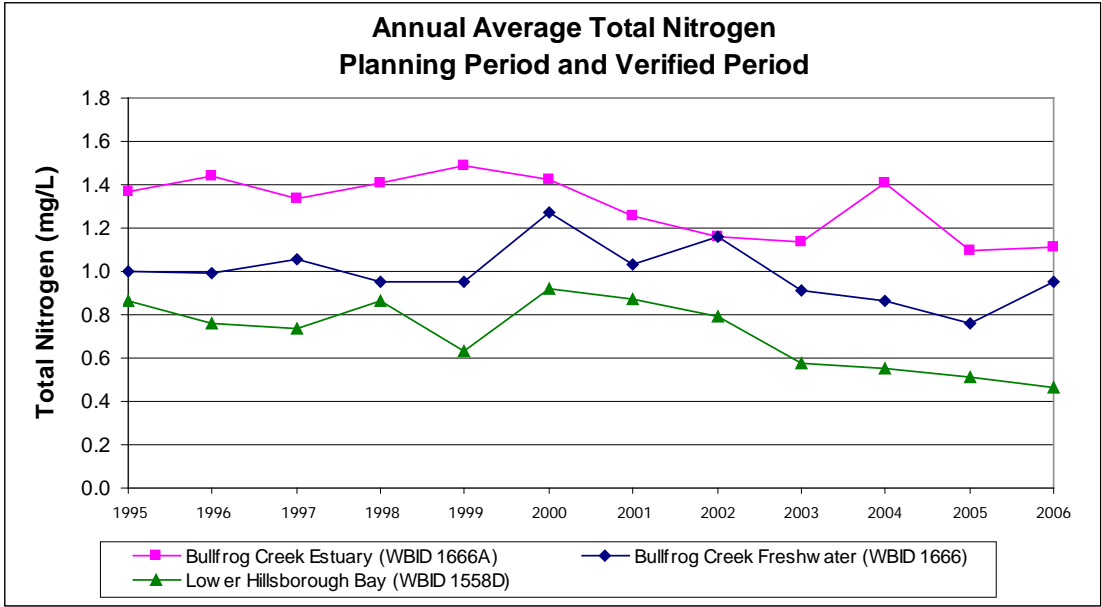


Figure 5.4 Annual Average Total N Concentrations in the Bullfrog Creek and lower Hillsborough Bay WBIDs

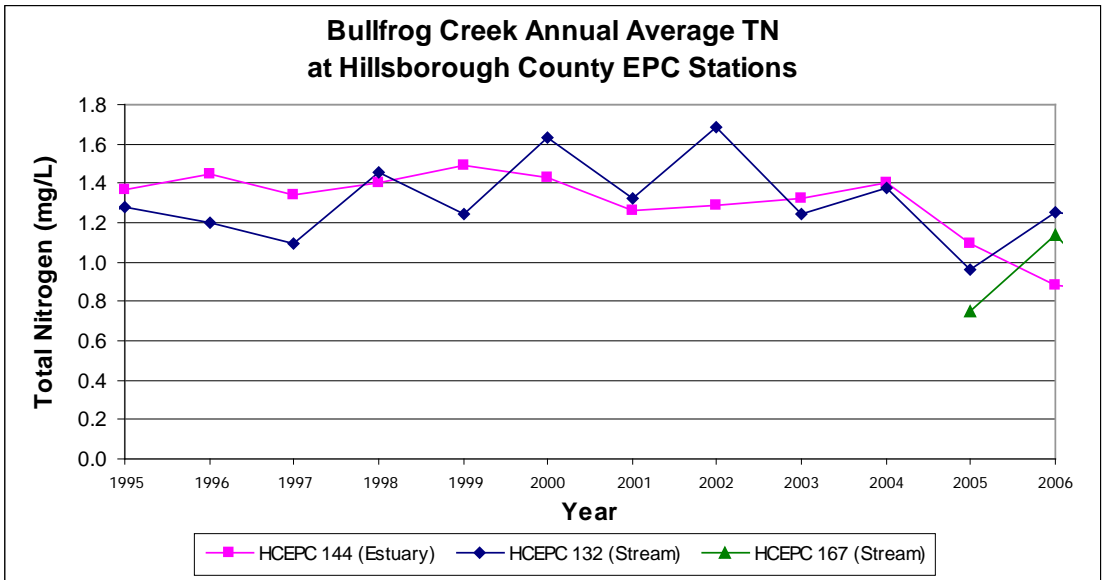


Figure 5.5 Bullfrog Creek Annual Average Total N Concentrations at Hillsborough County EPC stations

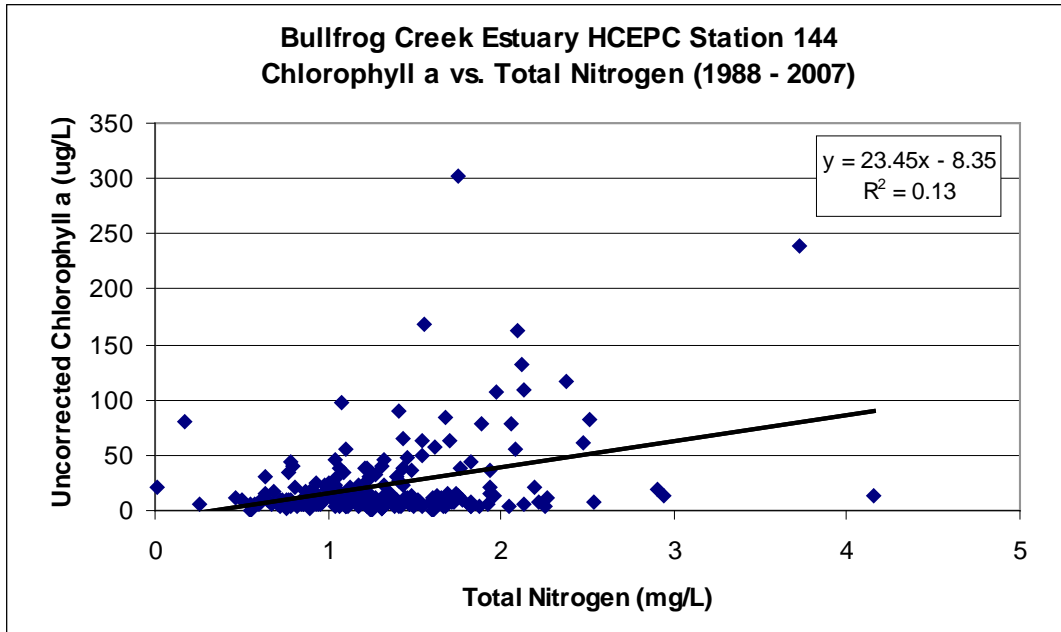


Figure 5.6 Relationship Between Chlorophyll a and Total Nitrogen in the Bullfrog Creek Tidal Segment

5.3 Relationship Between Nutrients and DO

Reductions in TN concentrations are also expected to result in additional benefits for other parameters of concern, including DO and BOD. As described in Chapter 2, reduced algal biomass, as measured by chlorophyll a, should result in lower BOD levels. During daylight hours, algal photosynthesis consumes nutrients and organic matter. The organic matter acts as an energy reserve, and oxygen is released. The reverse process, respiration, may occur simultaneously and dominate during dark periods of the day. During respiration, algae consume oxygen and their energy reserve to produce carbon dioxide and water. Because photosynthesis creates oxygen and respiration depletes oxygen, the algae affect the estuary's oxygen sources. Swings in oxygen can be induced by diurnal light patterns where oxygen levels rise during daylight and become depleted at night.

Figure 5.7 shows that 58 percent of the variation in BOD can be explained by the chlorophyll a concentration, suggesting that reductions in chlorophyll a levels would result in improvements to dissolved oxygen. Lower algal biomass should lower the BOD levels in the creek, and sediment oxygen demand (SOD) in the area should also decrease over time as algal biomass reduction reduces the accumulation of organic matter in the sediments. Sediment processes play an important role in regulating water quality and are particularly important in a shallow estuary. A portion of the organic matter produced in the water column settles to the sediment surface. Sediment processes influence DO in the water column by serving as a long-term repository of oxygen demand. A reduction of both algal BOD and SOD will have a positive impact on DO concentrations in the water column.

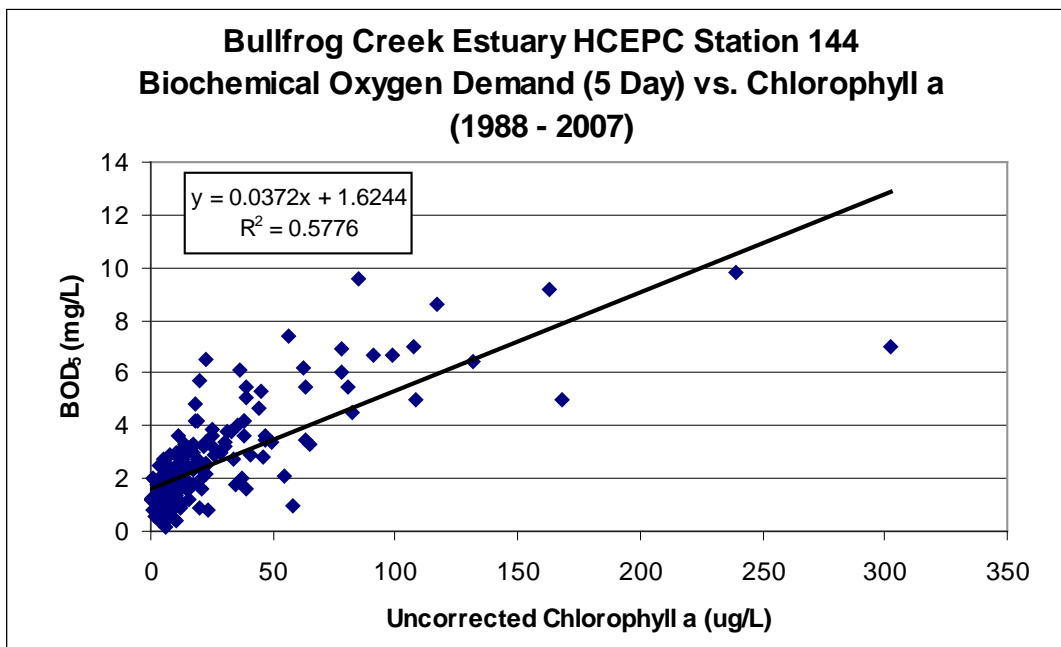


Figure 5.7 Relationship Between Biochemical Oxygen Demand and Chlorophyll a in the Bullfrog Creek Tidal Segment

5.4 Percent Reduction Approach

The TMDL calculation was developed using the “percent reduction” approach. For this method, the selected water quality target for TMDL development is the average of the annual average TN concentrations from the eight years when chlorophyll a in lower Hillsborough Bay was below the threshold value of 15 ug/L. The annual average TN concentrations are from the years 1997, 1999, 2000, and 2002 to 2006, **Table 3.1**. The average of these annual average values is 0.65 mg/L. The percent reduction was calculated using the following equation.

$$\frac{[\text{measured exceedance} - \text{target}]}{\text{measured exceedance}} \times 100$$

The measured exceedances used in the percent reduction calculation are the Bullfrog Creek tidal segment annual average TN concentrations from 2000 to 2006, **Table 5.1**. The percent reduction in the average of these TN annual averages, 47 percent, is the TN reduction used for establishing the TMDL. In other words, to achieve the TN target of 0.65 mg/L in the Bullfrog Creek tidal segment, the percent reduction needed in the current TN concentration of 1.23 mg/L is 47 percent. Annual average values were used in establishing the TMDL in this case as the IWR nutrient assessment is performed using annual average chlorophyll a values.

Table 5.1 Annual Average Total Nitrogen Values for the Bullfrog Creek Tidal Segment

Year	Bullfrog Creek Tidal Segment Annual Average TN Concentration (mg/L)
2000	1.43
2001	1.26
2002	1.16
2003	1.14
2004	1.41
2005	1.10
2006	1.11
Average	1.23

5.5 Critical Conditions

The TMDL was based on annual average conditions (i.e., values from all four seasons in a calendar year) rather than critical/seasonal conditions because of the following:

- a) The methodology used to determine assimilative capacity does not lend itself very well to short-term assessments,
- b) The net change in overall primary productivity, which is better addressed on an annual basis, is generally a better indicator of an imbalance in flora or fauna, and
- c) The methodology used to determine impairment is based on an annual average and requires data from all four quarters of a calendar year.

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. A TMDL is expressed as the sum of all point source loads (Wasteload Allocations, or WLAs), nonpoint source loads (Load Allocations, or LAs), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\text{TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

As discussed earlier, the WLA is broken out into separate subcategories for wastewater discharges and stormwater discharges regulated under the NPDES Program:

$$\text{TMDL} \cong \sum \text{WLAs}_{\text{wastewater}} + \sum \text{WLAs}_{\text{NPDES Stormwater}} + \sum \text{LAs} + \text{MOS}$$

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (a) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is also accounted for within the LA, and (b) TMDL components can be expressed in different terms (for example, the WLA for stormwater is typically expressed as a percent reduction, and the WLA for wastewater is typically expressed as mass per day).

WLAs for stormwater discharges are typically expressed as “percent reduction” because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges also differs from the permitting of most wastewater point sources. Because stormwater discharges cannot be centrally collected, monitored, and treated, they are not subject to the same types of effluent limitations as wastewater facilities, and instead are required to meet a performance standard of providing treatment to the “maximum extent practical” through the implementation of best management practices (BMPs).

This approach is consistent with federal regulations (40 CFR § 130.2[I]), which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or **other appropriate measure**. The TMDL for the Bullfrog Creek tidal segment (WBID 1666A) is expressed in terms of a percent reduction in total nitrogen to meet both the DO and nutrient criteria (**Table 6.1**).

Table 6.1 TMDL Components for the Bullfrog Creek Tidal Segment (WBID 1666A)

WBID	Parameter	TMDL (mg/L)	WLA		LA (% Reduction) ²	MOS
			Wastewater (mg/L)	NPDES Stormwater (% Reduction) ²		
1666A	Total N	0.65	N/A ¹	47%	47%	Implicit

¹ N/A = not applicable

² As the TMDL represents a percent reduction, it also complies with EPA requirements to express the TMDL on a daily basis.

6.2 Load Allocation

A total nitrogen reduction of 47 percent is required from nonpoint sources. It should be noted that the load allocation includes loading from stormwater discharges that are not part of the NPDES Stormwater Program.

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

There are currently no permitted NPDES discharges in the Bullfrog Creek watershed; however, any future discharge permits issued in the watershed will also be required to meet the state's Class III criteria for DO and nutrients and contain appropriate discharge limitations on nitrogen that will comply with the TMDL as well as existing state requirements related to discharges to Outstanding Florida Waters.

6.3.2 NPDES Stormwater Discharges

Hillsborough County and Co- Permittees (FDOT District 7 & Florida's Turnpike Enterprise, and City of Plant City) are covered by a Phase I NPDES municipal separate storm sewer system (MS4) permit (FLS000006) and areas within their jurisdiction in the Bullfrog Creek watershed may be responsible for a 47 percent reduction in current anthropogenic TN loading. It should be noted that any MS4 permittee is only responsible for reducing the anthropogenic loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction. There are no Phase II MS4 permits identified in the Bullfrog Creek watershed.

6.4 Margin of Safety

Consistent with the recommendations of the Allocation Technical Advisory Committee (Department, February 2001), an implicit MOS was used in the development of this TMDL. A MOS was included in the TMDL by selecting, as the nutrient target, the average of the annual average TN concentrations that occurred when chlorophyll a in lower Hillsborough Bay was below the threshold value of 15 ug/L.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

Following the adoption of this TMDL by rule, the Department will determine the best course of action regarding its implementation. Basin Management Action Plans are the primary mechanism through which TMDLs are implemented in Florida (see Subsection 403.067[7] F.S.). However, other Department-initiated options are available including a decision document and direct NPDES permit modifications. These options are described below. The Department also has the discretion to defer TMDL implementation to a later date if insufficient resources are available to develop an appropriate implementation plan. In some instances where the Department has deferred action, local agencies may work together to develop local implementation plans to meet the TMDL. Such plans should be developed in close consultation with the Department.

7.1 NPDES Permit Modifications

In a case where TMDL requirements are applicable to permitted sources only, the Department may opt to implement the TMDL solely through NPDES permit requirements. This may include modifications to municipal stormwater, domestic wastewater, or industrial wastewater permits. Because of the extent to which nonpoint non-permitted sources (such as agriculture) affect water resources in Florida, this option is unlikely to be used often.

7.2 Decision Document

Absent the need for pollutant reductions to be allocated to specific stakeholders, a decision document may be developed. This implementation approach is applicable if sufficient projects and restoration efforts are ongoing that target the TMDL pollutant of concern such that no additional efforts would be expected of the local stakeholders. This implementation approach documents stakeholder implementation efforts and identifies the expected benefits of such, relative to the TMDL. Developing a decision document instead of a BMAP is appropriate where the universe of projects being implemented is extensive enough that the resources needed for BMAP development would not result in significant additional projects being implemented. No formal action is required of the Department to adopt a decision document.

7.3 Basin Management Action Plan

Basin Management Action Plans (BMAPs) are the most comprehensive approach to TMDL implementation. BMAPs are developed through collaborative processes with the cooperation of local stakeholders and are applicable where multiple sources are affecting a waterbody. Goals of this process are to reach consensus on the scientific foundation, whether or not detailed allocations are necessary and viable, if needed, how detailed allocations will be calculated, and how load reductions will be accomplished.

Once adopted by order of the Department Secretary, BMAPs are enforceable through wastewater and municipal stormwater permits for point sources and through BMP implementation for nonpoint sources. Among other components, BMAPs typically include:

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- Water quality goals (based directly on the TMDL);
- Refined source identification;
- Load reduction requirements for stakeholders (quantitative detailed allocations, if technically feasible);
- A description of the load reduction activities to be undertaken, including structural projects, nonstructural BMPs, and public education and outreach;
- A description of further research, data collection, or source identification needed in order to achieve the TMDL;
- Timetables for implementation;
- Implementation funding mechanisms;
- An evaluation of future increases in pollutant loading due to population growth;
- Implementation milestones, project tracking, water quality monitoring, and adaptive management procedures; and
- Stakeholder statements of commitment (typically a local government resolution).

BMAPs are updated through annual meetings and may be officially revised every five years. Completed BMAPs in the state have improved communication and cooperation among local stakeholders and state agencies, improved internal communication within local governments, applied high-quality science and local information in managing water resources, clarified obligations of wastewater point source, MS4 and non-MS4 stakeholders in TMDL implementation, enhanced transparency in DEP decision-making, and built strong relationships between DEP and local stakeholders that have benefitted other program areas. If the Department chooses to move forward with a BMAP, it will be developed through a transparent stakeholder-driven process intended to result in a plan that is cost-effective, technically feasible, and meets the restoration needs of the applicable waterbodies.

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Appendices

Appendix A: Background Information on Federal and State Stormwater Programs

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C.

The rule requires the state's water management districts (WMDs) to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a SWIM plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, stormwater PLRGs have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka. No PLRG has been developed for Newnans Lake at the time this study was conducted.

In 1987, the U.S. Congress established Section 402(p) as part of the federal Clean Water Act Reauthorization. This section of the law amended the scope of the federal NPDES stormwater permitting program to designate certain stormwater discharges as "point sources" of pollution. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific Standard Industrial Classification (SIC) codes, construction sites disturbing five or more acres of land, and master drainage systems of local governments with a population above 100,000, which are better known as municipal separate storm sewer systems (MS4s). However, because the master drainage systems of most local governments in Florida are interconnected, the EPA has implemented Phase 1 of the MS4 permitting program on a countywide basis, which brings in all cities (incorporated areas), Chapter 298 urban water control districts, and the Florida Department of Transportation throughout the fifteen counties meeting the population criteria.

An important difference between the federal and state stormwater permitting programs is that the federal program covers both new and existing discharges, while the state program focuses on new discharges. Additionally, Phase 2 of the NPDES Program will expand the need for these permits to construction sites between one and five acres, and to local governments with as few as 10,000 people. These revised rules require that these additional activities obtain permits by 2003. While these urban stormwater discharges are now technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that cannot be easily collected and treated by a central treatment facility similar to other point sources of pollution, such as domestic and industrial wastewater discharges. The Department recently accepted delegation from the EPA for the stormwater part of the NPDES Program. It should be noted that most MS4 permits issued in Florida include a re-opener clause that allows permit revisions to implement TMDLs once they are formally adopted by rule.



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