TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Nutrients and Dissolved Oxygen

In

South Branch
(WBID 1456)

Prepared by:

US EPA Region 4
61 Forsyth Street SW
Atlanta, Georgia 30303

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In compliance with the provisions of the Federal Clean Water Act, 33 U.S.C §1251 et. seq., as amended by the Water Quality Act of 1987, P.L. 400-4, the U.S. Environmental Protection Agency is hereby establishing this Total Maximum Daily Load (TMDL) for nutrients and dissolved oxygen in South Branch (WBID 1456). Subsequent actions must be consistent with this TMDL.

____________/s/______________________ 03/31/08__

James D. Giattina
Director
Water Management Division

Date

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AWT	Advanced Waste Treatment
BMP	Best Management Practices
BPJ	Best Professional Judgment
CFS	Cubic Feet per Second
CFU	Colony Forming Units
DEM	Digital Elevation Model
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
FAC	Florida Administrative Code
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer Systems
NASS	National Agriculture Statistics Service
NLCD	National Land Cover Data
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSTD	Onsite Sewer Treatment and Disposal Systems
PLRG	Pollutant Load Reduction Goal
Rf3	Reach File 3
RM	River Mile
STORET	STORage RETrieval database
TBN	Total Bioavailable Nitrogen
TBP	Total Bioavailable Phosphorus
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WBID	Water Body Identification
WCS	Watershed Characterization System
WLA	Waste Load Allocation
WMP	Water Management Plan

SUMMARY SHEET
Total Maximum Daily Load (TMDL)

1. 303(d) Listed Waterbody Information

State: Florida

Major River Basin: Anclote River (HUC 03100207)

1998 303(d) Listed Waterbodies for TMDLs addressed in this report:

WBID	Segment Name and Type	County	Constituents(s)
1456	South Branch (freshwater)	Pasco	Dissolved Oxygen (DO), Nutrients

2. TMDL Targets and Approach

The State of Florida has narrative criteria for nutrients stating that in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna. The target for DO is based on the State of Florida's water quality criteria for DO, which requires that in no case should the concentration of dissolved oxygen be less than 5 mg/L in freshwater streams. The tiered approach used to develop these TMDLs involved three analyses; regression techniques, reference conditions, and undisturbed landuse conditions. The regression analysis did not identify relationships between causal and effect parameters strong enough to develop the TMDL. The reference approach supported modest reductions in TP and TN, while the undisturbed landuse approach supported large reductions to achieve undisturbed conditions. Since the goal of the TMDL is to improve the quality of South Branch so it supports its designated uses of recreation and aquatic life support, the reference approach was selected as the best analysis for this TMDL target.

3. TMDL Allocations for Nutrients in WBID 1456 (South Branch)

WBID	Parameter	WLA	LA	MOS	TMDL
		MS4			
1456	TN	27% reduction	27% reduction	implicit	27% reduction
	TP	30% reduction	30% reduction	implicit	30% reduction

4. **Endangered Species (yes or blank):** Yes

5. **EPA Lead on TMDL (EPA or blank):** EPA

6. **TMDL Considers Point Source, Nonpoint Source, or both:** Both

7. **Major NPDES Discharges to surface waters addressed in EPA TMDL:**
MS4 permit #FLS00032

TOTAL MAXIMUM DAILY LOAD (TMDL) FOR NUTRIENTS AND DISSOLVED OXYGEN IN SOUTH BRANCH (WBID 1456)

1. INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology-based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not meeting water quality standards. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources (USEPA, 1991).

The State of Florida Department of Environmental Protection (FDEP) has developed 303(d) lists since 1992. The process by which Florida implements section 303(d) requirements is set forth in the Florida Watershed Restoration Act (FWRA) of 1999 (s. 403.067, Florida Statutes). The FDEP list of impaired waters in each basin, referred to as the "Verified List", is also adopted pursuant to the FWRA (Subsection 403.067[4], Florida Statutes). However, the FWRA also states 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-rule-making process, the Florida Environmental Regulation Commission adopted the new methodology as Chapter 62-303, Florida Administrative Code (Identification of Impaired Surface Waters Rule, or IWR), in April 2001. The TMDLs developed in this report are for impaired waters that are on the 1998 303(d) list but not FDEP's verified list. They are being proposed pursuant to EPA commitments in the 1998 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998).

FDEP developed a statewide, watershed-based approach to water resource management. Following this approach, water resources are managed on the basis of natural boundaries, such as river basins, rather than political boundaries. The watershed management approach is the framework FDEP uses for implementing TMDLs. The state's 52 basins are divided into 5 groups. Water quality is assessed in each group on a rotating five-year cycle. The Springs Coast Group 5 Basin is shown in Figure 1 and includes 6 major rivers; Crystal River, Homosassa, Chassahowitzka, Weeki Wachee, Anclote, and Pithlachascotee. Florida also established five water management districts (WMD) responsible for managing ground and surface water supplies in the counties encompassing the districts. South Branch is located in the Southwest Florida Water Management District (SWFWMD).

To provide a more detailed geographic basis for identifying and assessing water quality improvement activities, the basin was subdivided into smaller areas called planning units. A planning unit is either an individual large tributary basin or a group of smaller adjacent tributary basins with similar characteristics. Planning units help organize information and management strategies around prominent watershed characteristics. These planning units contain smaller, hydrological based units called drainage basins, which are further divided into "water segments". A water segment usually contains only one unique waterbody type (stream, lake, canal, etc.) and is about five square miles. Unique numbers or waterbody identification (WBIDs) numbers are assigned to each water segment.

2. PROBLEM DEFINITION

Florida's final 1998 Section 303(d) list identified WBIDs in the Springs Coast River Basin as potentially not supporting water quality standards (WQS). This document addresses the nutrient and dissolved oxygen (DO) listings for WBID 1456, South Branch (Table 1). The geographic location of the Springs Coast River Basin and the Anclote River/ Coastal Pinellas County Planning Unit is shown in Figure 1.

Table 1. TMDLs Developed by EPA for South Branch.

WBID	Name	Planning Unit	Parameter of Concern
1456	South Branch	Anclote River/ Coastal Pinellas County	DO and Nutrients/Chlorophyll-a

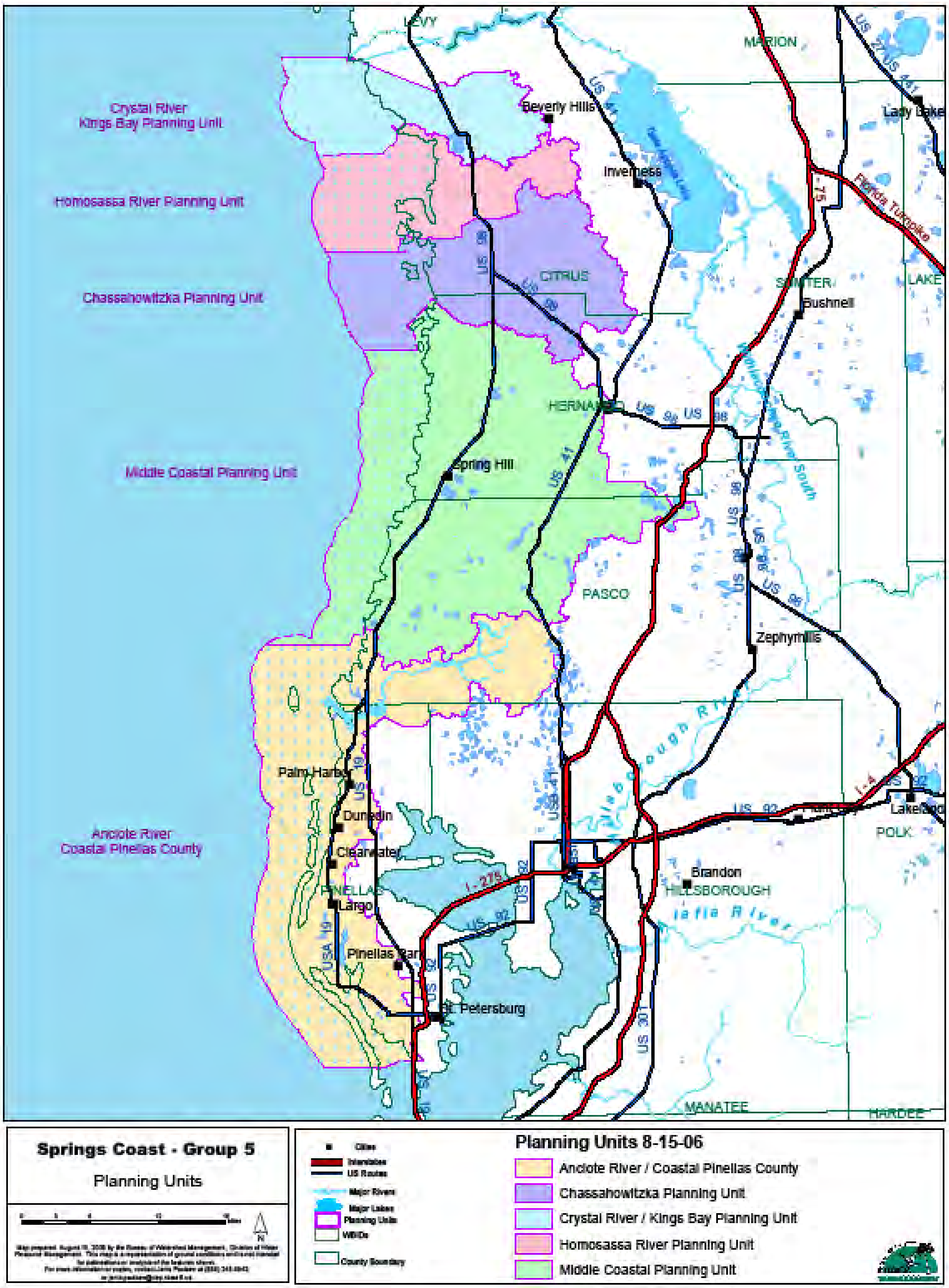

Figure 1. Springs Coast Basin and Planning Units

3. WATERSHED DESCRIPTION

WBID 1456 is a Class III freshwater stream, located just north of Odessa in Pasco County, FL. South Branch is a direct tributary to the main stem of the Anclote River, which enters the Gulf of Mexico just north of Tarpon Springs. The Anclote River/Coastal Pinellas County Planning Unit covers about 252 square miles and contains 78 segments with WBIDs. The Anclote River, which originates in a swampy, low-lying area of south-central Pasco County, flows through the northwestern corner of Pinellas County and enters the Gulf of Mexico just north of Tarpon Springs. The principal tributaries to the river are Cross Cypress Branch, Sandy Branch, and South Branch. Near the coast are Salt Bayou, Whitcomb Bayou, and Kraemer Bay.

WBID 1456 has some residential development, which in total takes up about 15% of the watershed area. Agricultural lands used for crops and/or pasture are the only other significant anthropogenic land cover, comprising approximately one-third of the watershed (31%). Water, wetlands, and forested areas make up a little less than half of the total WBID area. Land cover data for WBID 1456 (South Branch) are summarized in Table 2 and shown spatially in Figure 2.

Table 2. Landuse in South Branch (WBID 1456)

Urban & Residential (1100-1390)	Comm, Ind, Public** (1400, 1500, 1700, 1800,1900)	Agriculture (2000 series)	Rangeland (3000)	Forest (4000 series)	Water (5000 series)	Wetlands (6000 series)	Barren & Extractive (7000 series, 1600)	Transp & Utilities (8000 series)
1,521	401	3,064	181	1,146	528	2,782	89	250
15%	4%	31%	2%	12%	5%	28%	1%	3%

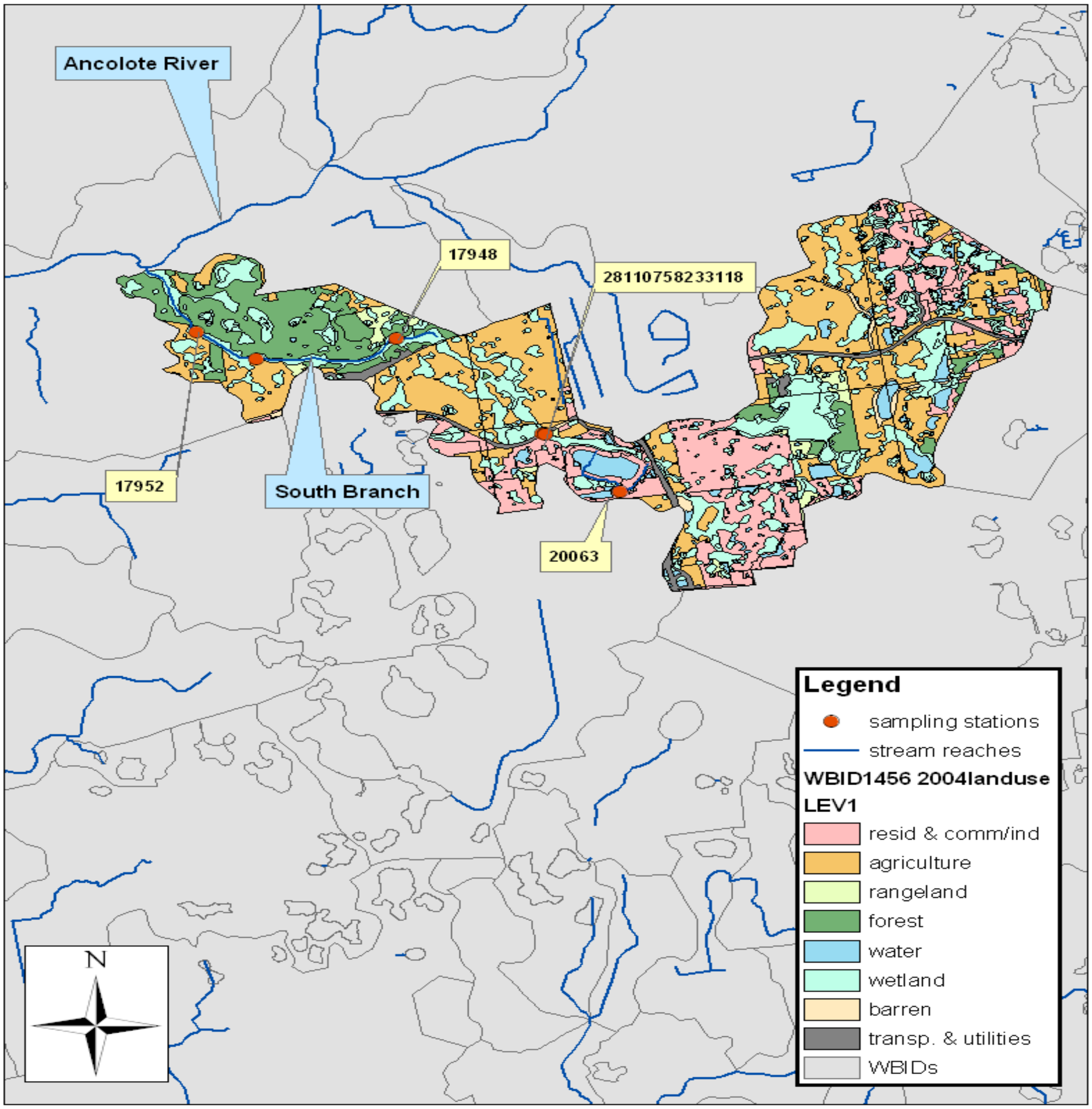

Figure 2. Landuse and sampling stations in South Branch (WBID 1456)

Pictures of South Branch taken from a 2007 EPA site visit are shown in Figure 3 and Figure 4. The color of the stream appears relatively dark in these photographs; however, it is not clear that South Branch is a true blackwater stream. The FDEP website characterizes blackwater streams by warm water temperatures, low stream gradients, extensive riparian swamps, and waters darkly stained from humic substances leached from their catchments. Because of the high content of naturally occurring organic matter and low dissolved oxygen in waters in the associated riparian wetlands of South Branch, periods of low dissolved oxygen may naturally occur in these stream segments that serve as outflows and drain the wetlands areas. Blackwater streams typically have color greater than 250 PCU, pH less than 6 su, and high Total Organic Carbon (TOC). The average color of South Branch is elevated (142 PCU), but much less than 250 PCU. The color stays between 100 and 200 most of the time, but it ranges from 70-250 PCU. The pH is not acidic, ranging from 6.2 to 8.1, and averaging 6.85 standard units. The water is clearly dark, but not so dark as to completely prevent occasional algal blooms in areas that happen to be more open to sunlight.

Figure 3. South Branch looking upstream from State Route 54

Figure 4. South Branch 100 meters upstream of State Route 54, looking downstream

4. WATER QUALITY STANDARDS AND TARGET IDENTIFICATION

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)

South Branch is classified as Class III freshwaters, with a designated use of recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The water quality criteria for protection of Class III waters are established by the State of Florida in the Florida Administrative Code (F.A.C.), Section 62-302.530. The individual criteria should be considered in conjunction with other provisions in water quality standards, including Section 62-302.500 F.A.C. [Surface Waters: Minimum Criteria, General Criteria] that apply to all waters unless alternative criteria are specified in F.A.C. Section 62-302.530. In addition, unless otherwise stated, all criteria express the maximum not to be exceeded at any time. While the State of Florida does not have numeric criteria for nutrients, a narrative criterion exists as described below. The specific criteria that apply to WBID 1456 are described below.

4. 1 Nutrients (Freshwater)

The discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter [Section 62.302 F.A.C.]. In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora and fauna [Section 62.302.530 F.A.C.]

Because the State of Florida does not have numeric criteria for nutrients, chlorophyll and DO levels are used to indicate whether nutrients are present in excessive amounts.

4. 2 Dissolved Oxygen

Freshwater: Dissolved Oxygen (DO) shall not be less than 5.0 (milligrams/liter). Normal daily and seasonal fluctuations above these levels shall be maintained.

4. 3 Biochemical Oxygen Demand (Freshwater)

Biochemical Oxygen Demand (BOD) shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each class and, in no case, shall it be great enough to produce nuisance conditions.

4. 4 Natural Conditions

In addition to the standards for nutrients, DO and BOD described above, Florida’s standards include provisions that address waterbodies which do not meet the standards due to “natural background” conditions.

“’Natural Background’ shall mean the condition of waters in the absence of man-induced alterations based on the best scientific information available to the Department. The establishment of natural background for an altered waterbody may be based upon a similar unaltered waterbody or on historical pre-alteration data.” [Section 62-302.200(15) FAC].

Florida standards also state at 62-302.300(15) FAC that “pollution which causes or contributes to new violations of water quality standards or to continuation of existing violations is harmful to the waters of this State and shall not be allowed. Waters having water quality below the criteria established for them shall be protected and enhanced. However, the Department shall not strive to abate natural conditions.”

4. 5 Water Quality Target Identification

In addition to returning the subject waterbody to a condition that is fully supporting the applicable water quality standard, allocations in a TMDL must not result in, or contribute to, violation of any other water quality standards for the waterbody or water quality standards downstream. This presents a special challenge for developing nutrient TMDLs, given the very nature of nutrients and their interaction in aquatic systems. Nutrients are only a driver of a process, and that process, known as primary productivity, is ubiquitous. Since that process can generally be assumed to occur throughout an entire network of interconnected waterbodies, nutrient TMDLs should consider the near-field, intermediate, and far-field impacts of nutrients and associated biomass.

Aquatic life becomes impaired by nutrients when excess amounts of nutrients are expressed in excess primary productivity. Primary productivity refers to the collective actions of plants (autotrophs) to utilize the energy of sunlight through the process of photosynthesis to fix carbon and available nutrients into biomass of living organisms. This is, of course, an essential process on which all plants and animals depend, and it serves as an intersection of the global cycles of critical elements carbon, hydrogen, oxygen, nitrogen, and phosphorus (C, H, O, N, & P). In aquatic systems, the normal cycles of C, H O, N, and P can be distorted by anthropogenic activities in the watershed which generate extra N & P that can enter adjacent waterbodies by surface runoff and ground water inflow. These excess nutrients then drive excess primary productivity, and the extra accumulated biomass is seen as an over-abundance of aquatic plants, such as excess algal blooms or macrophyte vegetation. This produces nuisance conditions which affect aesthetic values and recreation. When certain algal species are involved which are able to produce toxins, as in Harmful Algal Blooms (HABs), human health can be affected by exposure through drinking water, direct contact, or inhalation.

Aquatic life use can be impacted directly by excess algal blooms or macrophyte abundance through loss of habitat or other competitive disadvantages. But even more widespread impact occurs indirectly through depression or depletion of dissolved oxygen that occurs when excess primary production eventually decomposes and creates a great demand for dissolved oxygen. This lowers the available oxygen for other aquatic life. Most aquatic life becomes stressed by chronic low oxygen conditions and is virtually eliminated when oxygen depletion persists for a significant period of time. Impairment of aquatic life use is the common result of excess eutrophication of a waterbody. Since excess primary production resulting from excess available nutrients creates the problem in the waterbody, protection of aquatic life requires control of available nutrients in order to restrict primary productivity. But it should be kept in mind that resultant productivity may lag introduction of nutrients in space and time, and that fact must be considered when correlating nutrient levels with response. Proximal production may be temporarily suppressed by limitation of light, the amount of one nutrient, high velocity and turbulence, or lack of substrate, but transported bio-available nutrients will be utilized at some point. When these excess nutrients are expressed, they will drive excess productivity and adversely affect aquatic life in that location. The frequency and extent of these low oxygen events affects organisms differently, with non-motile and long-lived organisms among the most sensitive.

Primary productivity as a process is driven by a number of factors, and moderated by others. The major nutrients, nitrogen and phosphorus (N & P), along with certain minor nutrients, are required as inputs for intermediary metabolic steps associated with photosynthesis. Since these steps are a series of chemical reactions, their net stoichiometry is what ultimately determines the utilization of the inputs to the process. These stoichiometric relationships provide some explanation for the ratios originally reported by Redfield, and widely used today to interpret aquatic nutrient dynamics and manage water quality. The Redfield ratio for nitrogen and phosphorus is given as N : P = 16 : 1 (or N : P = 7.2 : 1 by weight). In general practice, a functional range is used with a ratio greater than 30 considered P limited, between 30 and 10 considered co-limited, and less than 10 considered nitrogen limited.

This practice allows for a wide mid-range of co-limitation where neither nutrient conclusively controls primary production. Limiting nutrient analysis by Redfield ratio comparison can be a useful tool for insight into nutrient limitation, but it should be applied with understanding of its limitations. The practice of identifying a single nutrient target to address a problem of excess cultural eutrophication presumes that the system is, and will remain, in steady state equilibrium. This is an oversimplification whose weakness has been noted before. In 1971, Dr. Eugene P. Odum in Fundamentals of Ecology, stated:

“Since cultural eutrophication usually produces a highly “unsteady” state, involving severe oscillations (i.e., heavy blooms of algae followed by die-offs, which in turn trigger another bloom on release of nutrients), then the “either/or” argument may be highly irrelevant because phosphorus, nitrogen, carbon dioxide and many other constituents may rapidly replace one another as limiting factors during the course of transitory oscillations. Accordingly, there is no theoretical basis for any “one factor” hypothesis under such transient-state conditions.”

It is important to realize that the Redfield ratio is a generalization that is thought to capture stoichiometry of reactions that occur inside of cells, and that actual uptake of nutrients by cells (or organisms), may be moderated by adaptation for things like storage capability or alternative biochemistry. These adaptations can be particularly effective in highly enriched situations. In addition, aquatic macrophytes can respond differently than algae to nutrient limitation ratios in the water column, and often exactly opposite. This could be very important in cases where impairment can involve either, and the overall effect on nutrient dynamics should not be underestimated. Calculation of Redfield ratios from an existing data set of ambient grab samples by averaging over time and space tends to over-simplify the system. While this might effectively characterize the prevailing pattern of nutrient limitation, it may not reflect periods or events of shorter duration when very different nutrient conditions exist.

Under conditions of phosphorus limitation, even if local excess primary productivity is controlled to a large extent by phosphorus reduction alone, there will be consequent export of excess nitrogen. The larger the excess of nitrogen, the greater the contribution to nitrogen sensitive downstream systems; therefore, concurrent reduction of nitrogen in the basin is often warranted in order to protect downstream use. But there may also be an additional near-field justification for nitrogen reduction. At those times when local primary productivity is being effectively suppressed by phosphorous limitation, biological uptake of N is restricted, which may leave the chemically reduced constituents of nitrogen, such as ammonia and organic N, to directly exert their oxygen demand in a setting that is already under oxygen stress.

Waters listed as impaired due to nutrients are typically highly enriched systems with elevated levels of both TP and TN throughout and conditions of low dissolved oxygen are common. In this situation, control of both TP and TN as nutrient inputs may be necessary to prevent adverse impacts in both near-field and far-field waters. The EPA "Nutrient Criteria Technical Guidance Manual" for lakes and reservoirs recommends criteria development should include investigating the historical record, establishing the reference condition, utilization of models, attention to downstream effects, and expert assessment of information (USEPA 2000). EPA recognizes that development of targets for nutrient TMDLs is a similar process to criteria development, although TMDL development is often constrained by available data and time.

5. WATER QUALITY ASSESSMENT

An assessment of the available water quality data collected in South Branch and used to develop the TMDL are described in this section of the report. There were no biological assessment reports found for this water body to assess the biological health of the stream.

5. 1 Water Quality Data and Sampling Stations

A list of monitoring stations in WBID 1456 is provided in Table 3 and shown spatially in Figure 2. Data collected at these stations between 1994 and 2004 and distributed in IWR Run 28, was used to assess water quality in South Branch. One DO measurement was recorded on 6/24/03 at three of the stations. Most of the rest of the DO measurements were made between 2004 and early 2005 at station 28110758233118. This station is located just upstream of the crossing with State Route 54 (see Figure 5). A summary of nutrient and DO data collected in the WBID is provided in Table 4. The original data are included in the Administrative Record for this TMDL, and are available upon request.

Table 3. Water quality monitoring stations in WBID 1456

Station	Station Name	First Date	Last Date
21FLGW 17948	SWA-LR-1006 South Branch Anclote River	6/24/2003	6/24/2003
21FLGW 17952	SWA-LR-1010 South Branch Anclote River	6/24/2003	6/24/2003
21FLGW 20063	SWA-SS-1028 Unnamed small stream	6/24/2003	6/24/2003
21FLTPA 28110758233118	TP214-South Branch	2/23/2004	1/18/2005

Table 4: Summary Statistics for water quality data in WBID 1456

Parameter	Obs	Min	Max	Mean	StDev	Median
BOD, carbonaceous 5-day	17	0.42	2.5	1.2	0.7	1

Parameter	Obs	Min	Max	Mean	StDev	Median
(mg/l)						
Chlorophyll A, corrected (ug/l)	27	1	40	4.5	10.1	1
Color (PCU)	27	70	250	142	49	150
Dissolved Oxygen (mg/l)	32	0.78	10.45	4.36	2.19	3.85
Flow (cfs)**	2	0.04	0.35	0.20	0.22	0.20
Nitrogen Ammonia as N (mg/l)	25	0.01	0.21	0.05	0.04	0.04
Nitrate Nitrite (mg/l)	26	0.004	0.04	0.02	0.01	0.02
pH (su)	32	6.2	8.09	6.85	0.40	6.76
Diss. Orthophosphate as P (mg/l)	26	0.01	0.16	0.03	0.03	0.02
Water Temperature (Celsius)	32	8.0	27.8	22.7	5.3	25.0
Nitrogen Kjeldahl as N (mg/l)	27	0.73	1.70	1.08	0.18	1
Nitrogen, Total as N (mg/l)	26	0.75	1.71	1.10	0.18	1.04
Total Organic Carbon (mg/l)	27	13	24	19	3	19
Phosphorus Total as P (mg/l)	27	0.03	0.26	0.09	0.05	0.08
Total Suspended Solids (TSS ;mg/l)	27	4	50	9	12	5
Turbidity (NTU)	27	0.85	33	6.1	7.6	3.5

NOTE: Flow data are from 1994 and were measured near station 28110758233118. All other summary statistics are for data collected from 1999-2005.

Land cover data in Figure 2 identifies many areas of wetlands. In fact, upstream of sampling station 28110758233118, South Branch does not show up as a stream reach in the National Hydrography Database or as open water in the land use coverage; it is classified as a wetland. This certainly implies that the stream does not have much flow, if any. While there is a vegetation buffer lining the length of South Branch, the landuse is not completely natural (i.e. forest or wetland), as residential developments are located upstream of some of the sampling stations (Figure 5). The extent these developments would connect hydrologically with the sampling stations is unknown. Figure 6 is a closer image of the central portion of WBID 1456. Station 28110758233118 can be seen just upstream of the road crossing, as well as station 20063 south of the large, purple polygon. This appears to be a lake, surrounded by a road (Ivy Lake Drive) and houses.

Stream flow was not often measured to confirm the suspicion that a lack of flow could explain the low DO concentrations. Only two flow measurements were discovered in the available data, and both were measured near station 28110758233118 in 1994 (one in February and the other in August). Both values are very low (0.04 cfs and 0.35 cfs). The images from the 2007 EPA site visit also appear to show a lack of flow.

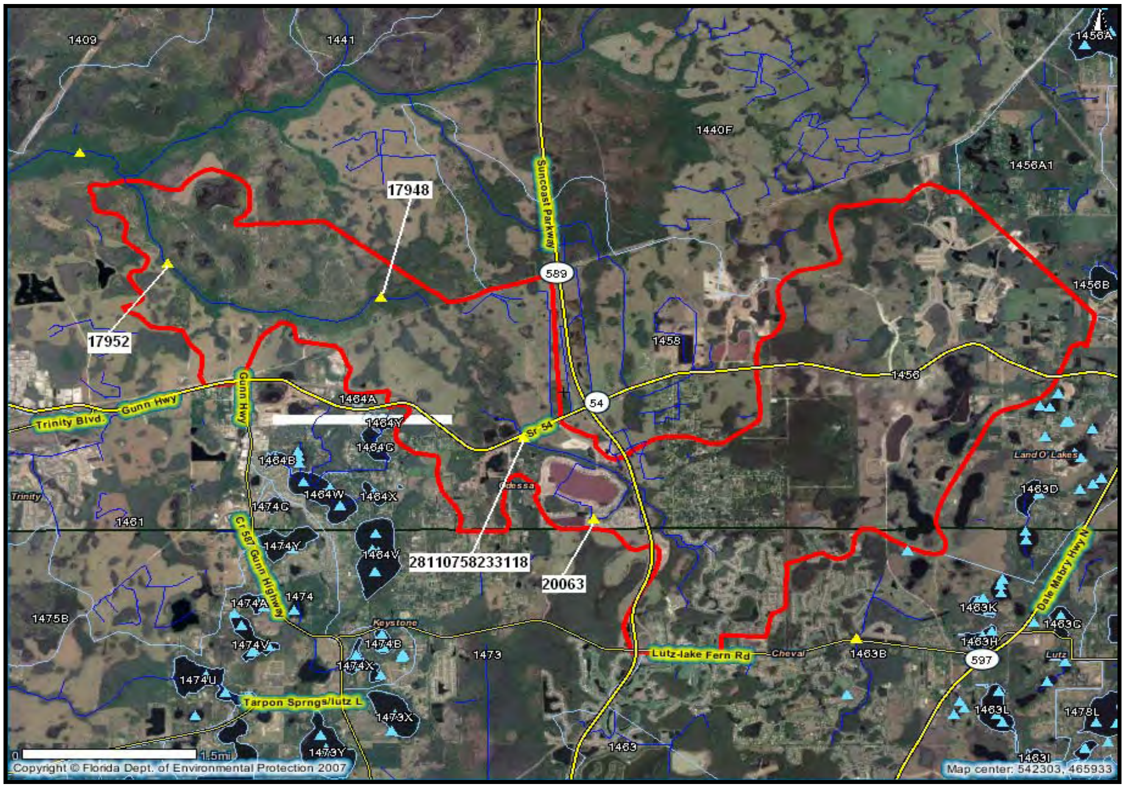

Figure 5. Aerial image of WBID 1456 (South Branch)

Figure 6: Close-up of WBID 1456 near DO sampling stations

5. 2 Dissolved Oxygen

There are several factors that affect the concentration of dissolved oxygen (DO) in a waterbody. Oxygen can be introduced by wind, diffusion, photosynthesis, and additions of higher DO water (e.g. from tributaries). Dissolved oxygen concentrations are lowered by processes that use up oxygen from the water, such as respiration and decomposition, and by additions of water with lower DO (e.g. swamp or groundwater). Natural DO levels are a function of water temperature, water depth and velocity, and relative contributions of groundwater. Warm water holds less oxygen than cool water, and slower-flowing, less turbulent water has less diffusion of atmospheric oxygen into it. Because it is not in contact with air, groundwater naturally has lower concentrations of oxygen dissolved in it. Decomposition of organic matter, such as dead plants and animals, also uses up dissolved oxygen.

DO levels naturally fluctuate over the course of a day. Respiration and decomposition may consume oxygen dissolved in the water. During daylight, submerged aquatic plants take up carbon dioxide and produce oxygen as by-products of photosynthesis. At night, photosynthesis does not occur and so the oxygen-consuming processes dominate. The temporal distribution of DO data collected in South Branch is provided graphically in Figure 7. The data shows that DO concentrations in WBID 1456 are highly variable and below 5 mg/l more than half of the time (see Table 4). Out of 32 measurements, 21 samples were less than 5 mg/l (65%). DO in the WBID ranged from 0.78 mg/l to 10.45 mg/l and averaged 4.4 mg/l.

The wide range of DO concentrations indicates that DO levels are strongly influenced by photosynthesis and respiration. Photosynthesis by algae and other submerged plants is usually associated with an increase in both DO and pH, as plants take up carbon dioxide and release oxygen into the water. Respiration is associated with lower DO concentrations and lower pH, as plants use up oxygen and release carbon dioxide back into the water. Carbon dioxide (CO2) dissociates in water to create carbonic acid, so increasing its concentration tends to make the water more acidic (i.e. have lower pH), while decreasing CO2 tends to make the water more alkaline (i.e. have a higher pH). There is some relationship between DO and pH in WBID 1456, again lending support that aquatic plants are a major driver of DO concentrations in South Branch, at least at the location of the main sampling station (Figure 5). This is not surprising given the swampy nature of the area. Site visits confirm that there is an abundance of vegetation in and around the water (see Figure 3 and Figure 4).

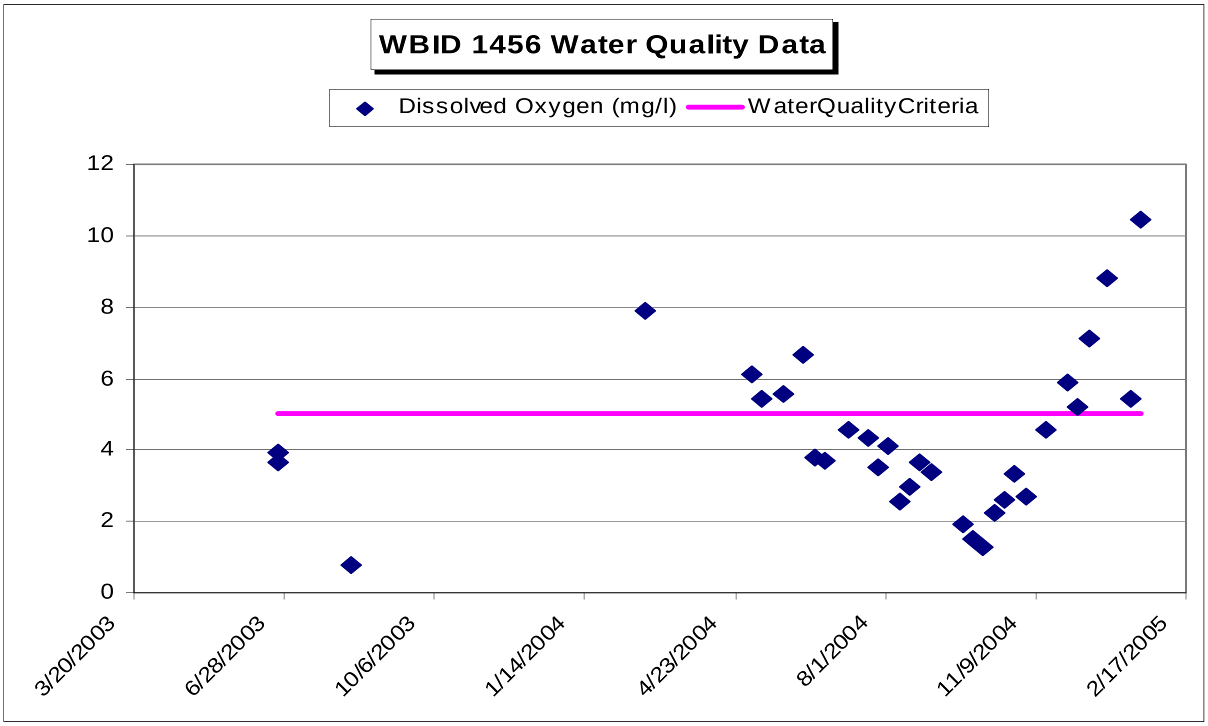

Figure 7. DO measurements in South Branch

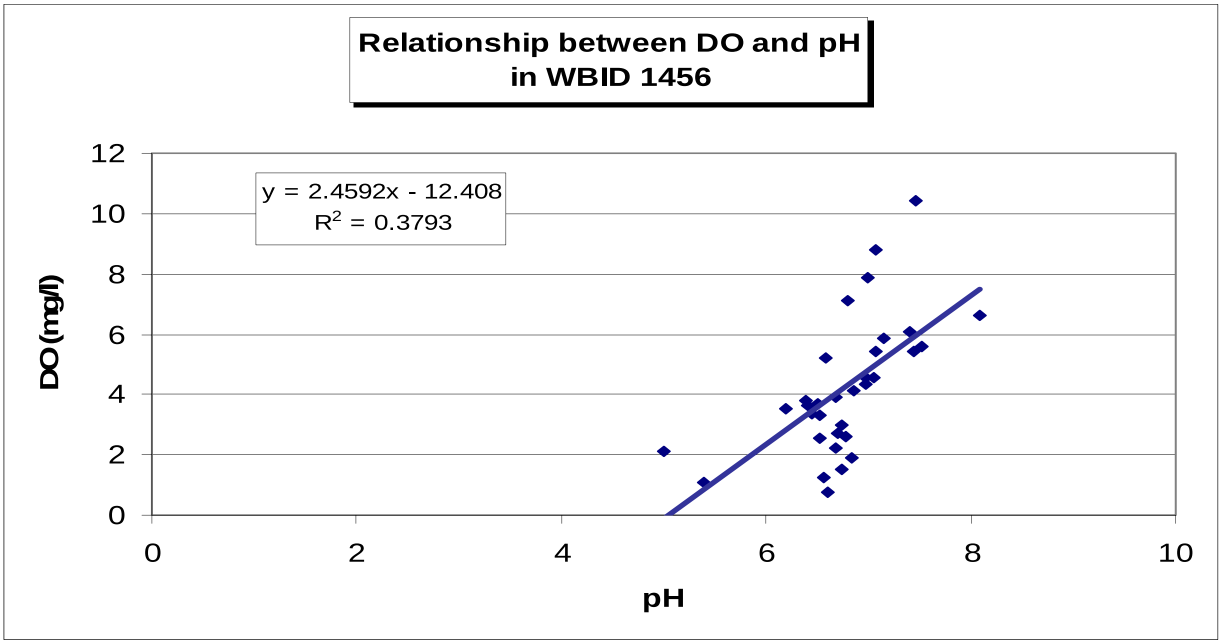

Figure 8. Relationship between DO and pH in South Branch

Biochemical oxygen demand (BOD) is a measure of the amount of oxygen consumed by organisms in breaking down organic material. Given the abundance of vegetation, it is a little surprising that BOD reached a maximum concentration of only 2.5 mg/l (see Table 4), and that there is not a correlation between BOD and DO.

Total Organic Carbon (TOC) is a measure of the organic content of the water. TOC is important because higher carbon/organic contents generally mean that more oxygen will be consumed when this matter is decomposed by microorganisms. Natural vegetation is a source of such organic material, although TOC may also be contributed by wastewater treatment plant discharges, carbon-containing industrial effluents, and agriculture. Based on the available data, there is not a correlation between TOC and DO.

The available water quality data does not indicate a significant correlation between DO and TP (see Figure 9). However, there is some relationship between DO concentrations and nitrogen, both TN and total Kjeldahl nitrogen (TKN), as shown in Figure 10 and Figure 11, respectively. TKN is the sum of organic nitrogen and ammonia. High concentrations of TKN typically result from the decay of organic matter, such as plant and animal wastes. These organic materials may be natural, or they may result from urban or industrial sources. Fertilizer runoff is another potential source. Nitrification of ammonia to nitrite and then nitrate can use up DO from the water. It is not clear whether all of the nutrients are from natural or anthropogenic sources. The available data do not reveal a significant correlation between DO and nitrate-nitrite.

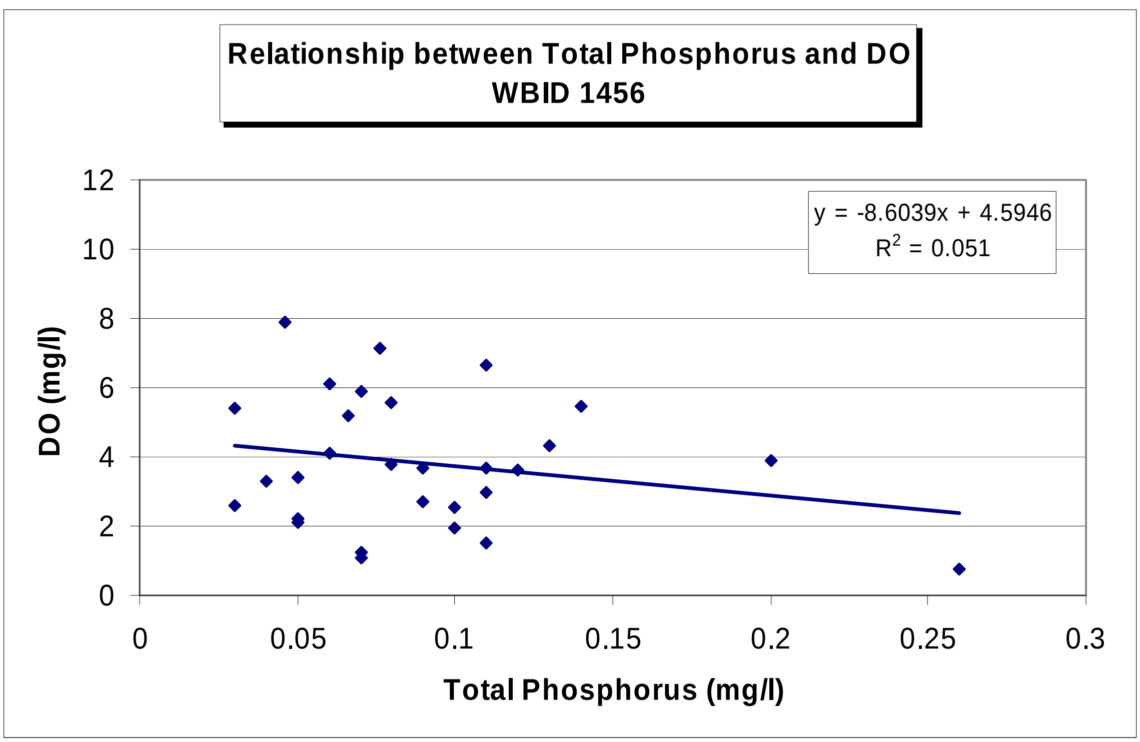

Figure 9. Relationship between TP and DO

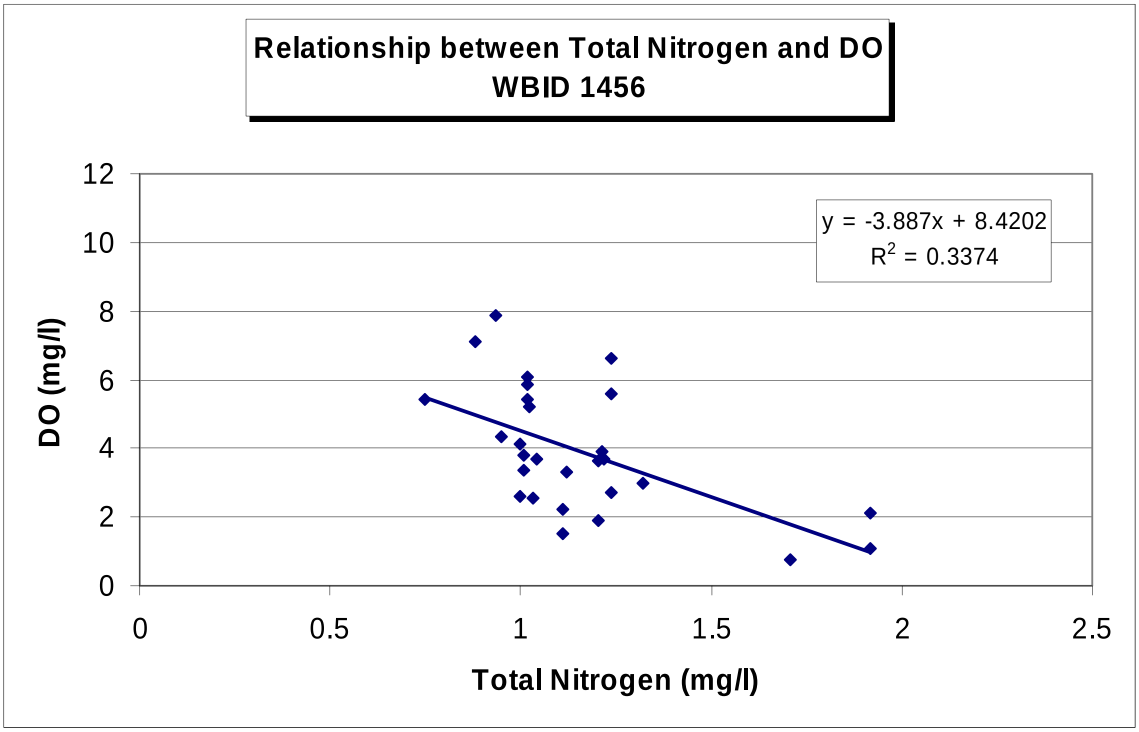

Figure 10. Relationship between TN and DO

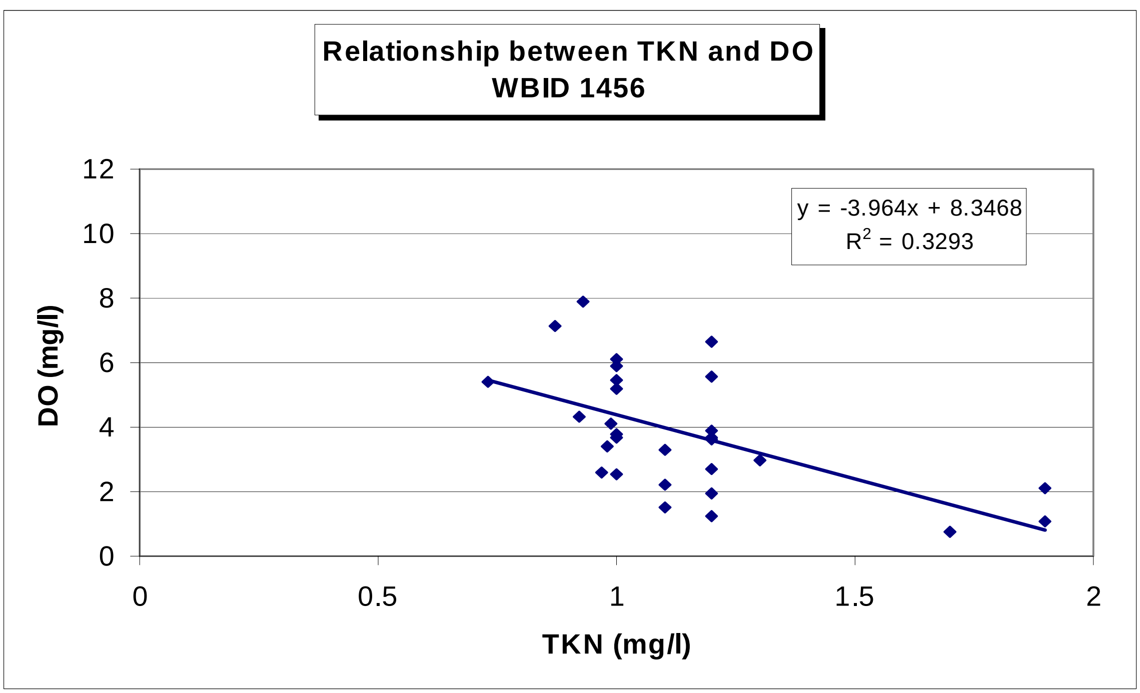

Figure 11. Relationship between TKN and DO

Water temperature data in South Branch average about 22.7 degrees Celsius, and show characteristic seasonal variability, with the highest temperatures in the summer months (June through September), and decreasing temperatures through the fall and winter months (see Figure 12). Water temperature frequently has an influence on DO concentrations, since hotter water is not capable of holding as much DO as cooler water. The data do show some correlation between DO and water temperature indicating other influences are not so great as to completely mask the effect (see Figure 13).

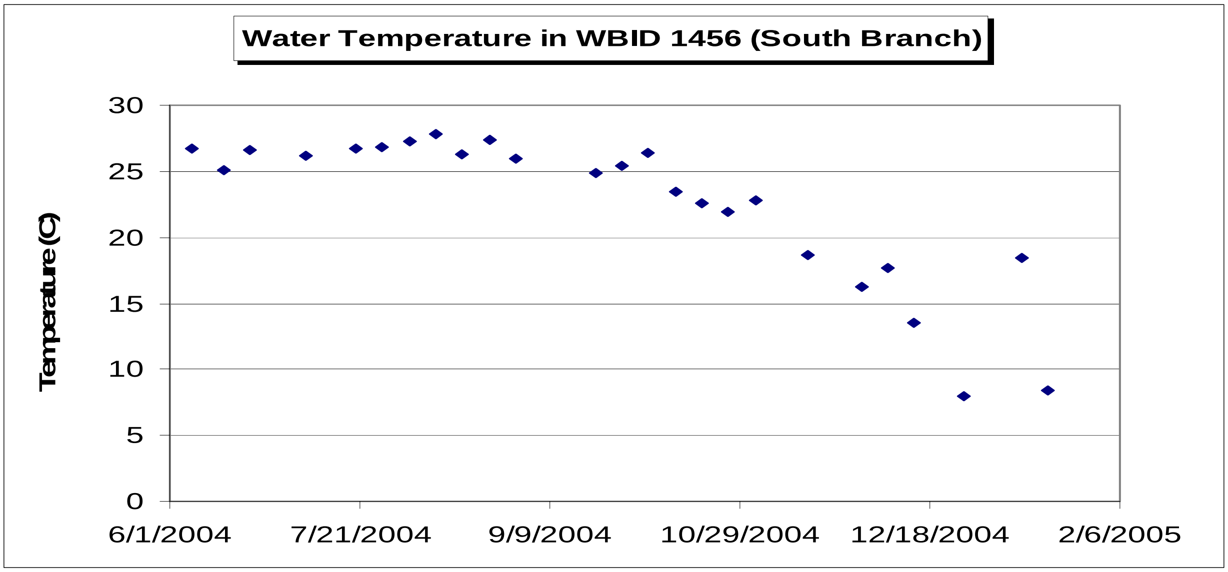

Figure 12. Water temperature in South Branch

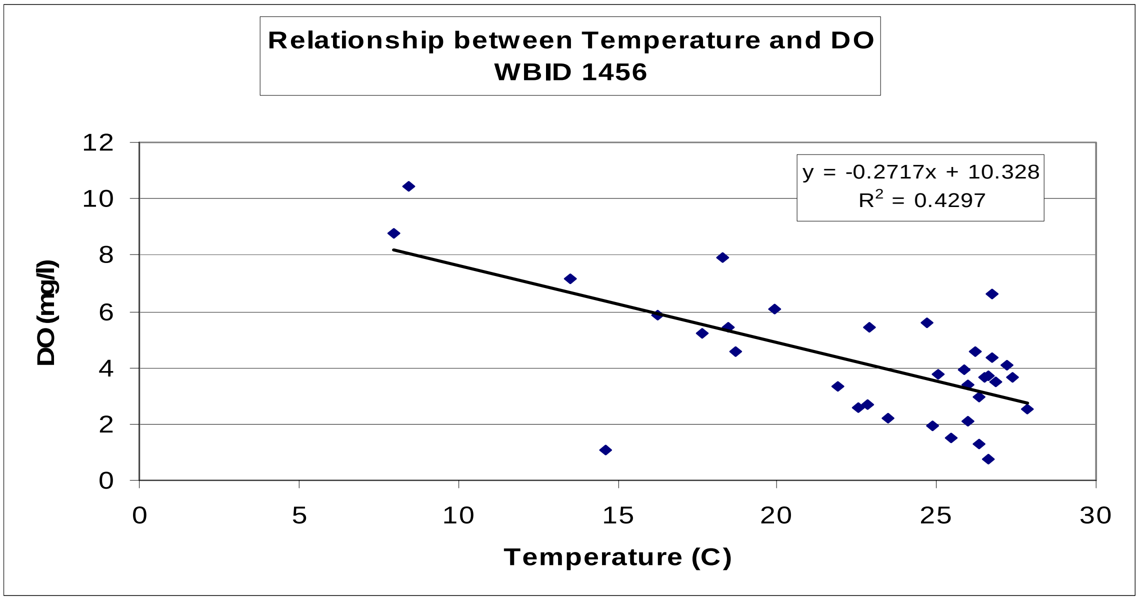

Figure 13. Relationship between water temperature and DO

5. 3 Chlorophyll and Nutrients

Chlorophyll is the green pigment in plants that allows them to create energy from light. In a water sample, chlorophyll is indicative of the presence of algae, and chlorophyll-a is simply a measure of the active portion of total chlorophyll. Corrected chlorophyll refers to chlorophyll-a measurements that are corrected for the presence of pheophytin, a natural degradation product of chlorophyll that can interfere with analysis because it has an absorption peak in the same spectral region. Corrected chlorophyll-a was measured in South Branch 27 times at four stations. Most of the time, corrected chlorophyll concentrations are very low (<2 ug/l, see Table 4). Because of this, there is no correlation with DO when the entire dataset is used in the analysis (see Figure 14) . There were many sampling events when DO levels were low although chlorophyll was also at very low concentrations. However, there are a few highly elevated chlorophyll measurements. Although the chlorophyll data are somewhat limited, having been collected mostly in one year (2004), they suggest that algal concentrations are low most of the time.

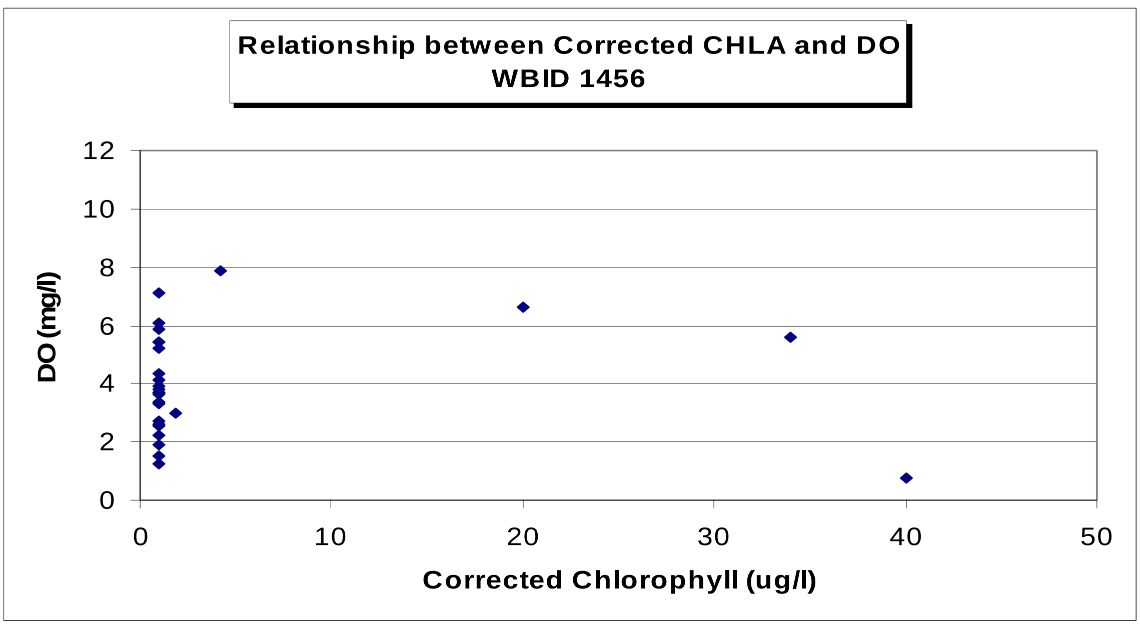

Figure 14. Relationship between corrected chlorophyll-a and DO

Most of the corrected chlorophyll-a measurements are relatively low, and both the average TN and TP are below FDEP's screening thresholds for streams (1.6 mg/L TN and 0.22 mg/L TP). Total Nitrogen is comprised of nitrate (NO3), nitrite (NO2), organic nitrogen and ammonia nitrogen. TN measurements in South Branch ranged from 0.75 mg/l to 1.71 mg/l, and had an average of 1.10 mg/l, with a median of 1.04 mg/l. Most of the TN appears to consist of organic nitrogen. High concentrations of organic nitrogen typically result from the decay of organic matter, such as plant and animal wastes. These organic materials may be natural, or they may result from urban or industrial sources. Fertilizer runoff is another potential source. Nitrification of ammonia to nitrite and then nitrate can use up DO from the water.

Phosphorus is usually the growth-limiting nutrient in freshwaters. TP measurements in South Branch ranged from 0.03 mg/l to 0.26 mg/l, and had an average of 0.09 mg/l, with a median of 0.08 mg/l. In natural waters, TP exists in either in soluble or particulate forms. Dissolved phosphorus includes inorganic and organic forms, while particulate phosphorus is made up of living and dead plankton, and adsorbed, amorphous, and precipitated forms. Inorganic forms of phosphorus include orthophosphate and polyphosphates, though polyphosphates are unstable and convert to orthophosphate over time. Orthophosphate is both stable and reactive, making it the form most used by plants. High levels of TP may result from wastewater and septic system effluent, agriculture (including fertilizers and animal waste), soil erosion, phosphate mining, or industrial sources. Excessive phosphorus can lead to overgrowth of algae and aquatic plants, the decomposition of which uses up oxygen from the water. In turn, low oxygen levels near bottom sediments can free additional phosphorus from the sediments.

The ratio of inorganic nitrogen to dissolved orthophosphate in South Branch ranges between 0.71 to 12, with a mean of 4.27 and a median of 2.33. A ratio less than 7.2 generally indicates nitrogen limitation, whereas a high ratio indicates that phosphorus is the limiting nutrient. These N/P ratios indicate that nitrogen is typically the limiting nutrient, but that South Branch may occasionally be co-limited by both nitrogen and phosphorus. Although nutrient levels may directly and indirectly affect DO concentrations, neither TN, TP, nor any of their constituents show significant correlations with DO levels in South Branch.

6. SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of pollutants in the watershed and the amount of loading contributed by each of these sources. Sources are broadly classified as either point or non-point sources. Nutrients enter surface waters from both point and non-point sources.

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted facilities, including certain urban stormwater discharges such as municipal separate stormwater systems (MS4 areas), certain industrial facilities, and construction sites over one acre, are storm-water driven sources considered “point sources” in this report.

Non-point sources of pollution are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These include nutrient runoff of agricultural fields, golf courses, and lawns, septic tanks, and residential developments outside of MS4 areas. These sources generally, but not always, involve accumulation of nutrients on land surfaces and wash off as a result of storm events.

6. 1 Point Sources

The Odessa subregional Waste Water Treatment Plant (WWTP) has some compliance monitoring wells in the area, but there are no NPDES permitted facilities that discharge directly to surface water in the South Branch watershed.

Municipal Separate Storm Sewer Systems (MS4s) may also discharge nutrients to waterbodies in response to storm events. Large and medium MS4s serving populations greater than 100,000 people are required to obtain a NPDES storm water permit under the Phase I storm water regulations. After March 2003, small MS4s serving urbanized areas are required to obtain a permit under the Phase II storm water regulations. An urbanized area is defined as an entity with a residential population of at least 50,000 people and an overall population density of 1,000 people per square mile. WBID 1456 may be affected by Phase I MS4 permit #FLS00032, which is held by Pasco County, and other co-permittees. Each permittee covered in the permit is ultimately responsible for the MS4 discharges resulting from their jurisdiction, including TMDLs and WLAs. Since no MS4 water quality data were available for South Branch, the MS4 pollutant loads were not specifically analyzed. The MS4 loads were indirectly included in the TMDL analysis through the use of landuse GIS coverages, landuse loading rates for urban areas and the observed in-stream water quality data.

6. 2 Nonpoint Sources

Nonpoint sources that ultimately contribute to depletion of in-stream dissolved oxygen include sources of nutrients such as animal waste, waste-lagoon sludge, fertilizer application to agricultural fields, lawns, and golf courses, and malfunctioning onsite sewage treatment and disposal systems or septic tank systems. Most non-point source pollutant loads were included in the TMDL analysis indirectly through the use of landuse GIS coverages, landuse loading rates, and the observed instream water quality data. Land cover acreages and percentages for WBID 1456 were provided in Table 2.

6.2.1 Wildlife

Wildlife deposit bacteria deposit their feces onto land surfaces where it can be transported during storm events to nearby streams. Generally, the nutrient load from wildlife is assumed to be background, as the contribution from this source is small relative to the load from urban and agricultural areas in most watersheds. In addition, any strategy employed to control this source would probably have a negligible impact on obtaining water quality standards.

6.2.2 Agricultural Uses

Agricultural activities, including runoff of fertilizers and animal wastes from pasture and cropland, can impact water quality. Agricultural runoff is presumed to be an important pollutant source in WBID 1456, since agricultural uses, including citrus groves and silviculture, comprise over 30% of the WBID. Farm data from the 2002 Census of Agriculture indicate that there were 168,716 acres of farmland in 1222 farms in Pasco County (NASS, 2002).

6.2.3 Onsite Sewerage Treatment and Disposal Systems (Septic Tanks)

Onsite sewage treatment and disposal systems (OSTDs) including septic tanks are commonly used where providing central sewer is not cost effective or practical. Most septic tanks are used for individual households of small commercial establishments that are in rural or remote areas, or in urban areas not served by a domestic wastewater facility. Water from septic tanks is generally released to the ground through a subsurface drain field after natural biological treatment. Most of the effluent is released to the subsurface through on-site subsurface drain fields or boreholes that allow the water from the tank to percolate into the ground (usually into the surficial aquifers) and either transpire to the atmosphere through surface vegetation or add to the flow of shallow ground water.

When properly sited, designed, constructed, maintained, and operated, OSTDs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTD is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, OSTDs can be a source of nutrients (nitrogen and phosphorus), BOD, pathogens, and other pollutants to both ground and surface water.

The State of Florida Department of Health (DOH) publishes statistics regarding septic tanks on a county basis (see: http://www.doh.state.fl.us/environment/OSTDS/statistics/ostdsstatistics.htm). Table 5 summarizes the number of septic systems installed since the 1970 census and the total number of repair permits issued between 1997 and 2004. The data in Table 5 do not account for septic tanks removed from service.

Table 5. Estimates of Septic Tanks and Repair Permits for Pasco County (FDOH, 2005)

County	Number of Septic Tanks (2004)	Number of Repair Permits Issued (1997 – 2004)
Pasco	68,069	4,958

6.2.4 Urban and Commercial Development

Nutrient loading from urban and commercial areas is attributable to multiple sources including storm water 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. Urban and commercial development is an important nonpoint source in WBID 1456 (South Branch). Residential uses comprise about 15% of WBID 1456, while commercial, industrial, and public lands account for 4%.
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 outlined in Chapter 403 Florida Statutes (F.S.), was established as a technology-based program that relies upon 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.

Florida's stormwater program is unique in having a performance standard for older stormwater systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: "the pollutant loading from older stormwater management systems shall be reduced as needed to restore or maintain the beneficial uses of water" (Section 62-4-.432 (5)(c), F.A.C.). Nonstructural and structural BMPs are an integral part of the State's stormwater programs. Nonstructural BMPs, often referred to as "source controls", are those that can be used to prevent the generation of NPS pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimizing impervious surfaces. Technology-based structural BMPs are used to mitigate the increased stormwater peak discharge rate, volume, and pollutant loadings that accompany urbanization.

7. ANALYTICAL APPROACH

The nutrient targets for the DO and nutrient TMDLs were developed by applying a tiered approach, which uses independent approaches that have varying strengths and weaknesses. The first tier applies the regression approach, which attempts to develop a simple regression model to analyze the relationship between the low instream DO and nutrients. If a regression relationship does not exist, then the second tier is applied. The second tier involves applying an ecoregional reference condition approach consistent with EPA's peer-reviewed "Nutrient Criteria Technical Guidance Manual" to develop a target. In the third tier, the EPA tool BASINS PLOAD was applied to current landuse and a reference undisturbed landuse condition. A summary of the approaches that were applied is discussed below.

7. 1 Tier 1, Regression Approach

The regression approach attempts to develop a regression model to analyze the relationships between instream DO and nutrients and BOD. The regression approach combines the known kinetic relationships for the sources and sinks of dissolved oxygen with correlation and regression statistics. Based on the known mechanisms of the sources and sinks of DO, a simple regression model is attempted. If the regression model is successful in being developed, then the variation in the observed DO can be explained by variables such as temperature, BOD, chlorophyll, nutrients, organic carbon, and/or flow. Statistics are used to explore the relationships of the water quality data in the watershed depending on the water quality parameters that were recorded.

If correlation exists between DO and nutrients, the regression approach can be used to develop the TMDL. The DO criterion can be targeted to determine the nutrient target and the percent reduction. This method typically involves multivariate regressions to develop a predictive equation. This equation can then be used to determine necessary reductions to attain the DO criterion. Regressions were explored and discussed in the water quality assessment section

(section 5.2), but no relationships in the data were strong enough to demonstrate the DO criterion could be met. Although the analysis was informative, this regression method was not used to develop the TMDL.

7. 2 Tier 2, Ecoregional Reference Condition

Tier 2 uses an ecoregional reference condition approach consistent with EPA's peer-reviewed "Nutrient Criteria Technical Guidance Manual" to develop nutrient targets. This reference condition approach was used to develop a local (i.e., WBID) target (USEPA, 2000). Depending on the type and extent of available data, EPA suggests three methods for determining nutrient targets: 1) directly determined from an unimpacted reference site; 2) empirically determined from a dataset from unimpacted reference sites; or 3) empirically determined from an all stream dataset. Application of these methods requires robust datasets consisting of multiple stations, samples, seasons, and years. A limitation of this approach is that it does not factor in the aquatic condition of streams used in the dataset.

A sufficient number of unimpacted reference sites with sufficient datasets were not available to EPA in the Peninsula Bioregion to establish targets based on reference stream measurements. EPA's guidance manual encourages selecting a reference condition from a smaller geographic scale (i.e., watershed versus state-wide) with a robust dataset as this improves similarity and comparability of the streams. Information from all streams in the Peninsula Bioregion watersheds provides a sufficiently robust dataset representing a range of conditions that approximates a normal distribution.

Data was extracted from the IWR28 for all of the WBIDs located in the Peninsula Bioregion of Florida (Figure 15). Only WBIDs within the Peninsula Bioregion of Florida classified as freshwater streams were used in this analysis. This consists of 349 WBIDs that contain 2392 water quality monitoring stations. EPA's guidance suggests that the 25th percentile of the data is inherently protective of water quality. For the development of this TMDL, the 25th percentile of TP and TN were selected as targets. This robust dataset of 53,688 TP measurements and 47,444 TN measurements were collapsed to WBID median values and statistically ranked. When plotted, the TP data approximates a normal distribution. Table 6 provides the percentile distribution of TP and TN for the Peninsula Bioregion of Florida. These percentiles were calculated by determining WBID median values for all TN and TP data within each individual WBID; then using the WBID medians to calculate percentiles. The 25th percentile annual average concentrations for TP and TN are 0.064 mg/l and 0.94 mg/l, respectively.

Figure 15. Florida Bioregion Designation

Table 6. Florida Peninsula Bioregion Percentile Distribution

Percentile	TP (mg/l)	TN (mg/l)
5	0.037	0.59
10	0.045	0.74
15	0.050	0.81
20	0.059	0.89
25	0.064	0.94
30	0.073	0.98
35	0.080	1.01
40	0.088	1.07
45	0.098	1.11
50	0.107	1.14
55	0.120	1.20
60	0.141	1.25
65	0.160	1.32
70	0.190	1.38
75	0.228	1.45

Percentile	TP (mg/l)	TN (mg/l)
80	0.280	1.56
85	0.376	1.72
90	0.570	1.86
95	0.963	2.23

The annual average observed TN concentration in WBID 1456 is 1.28 mg/l, and this would have to be reduced by 27 percent to achieve the reference condition-based target of 0.94 mg/l. The annual average TP observed in the WBID was 0.091 mg/l, and this would have to be reduced 30 percent to achieve the reference condition-based target of 0.064 mg/l. Therefore this approach shows that with these reductions, South Branch can be improved to meet reference conditions that would support aquatic life and recreation.

7. 3 Tier 3, Undisturbed Landuse Condition

Tier 3 involves applying a watershed loading model such as EPA's BASINS PLOAD model to determine a target representative of least disturbed landuse conditions (EPA, 2001). This is simulated by changing disturbed landuses in the watershed to reflect least disturbed landuse such as forest and wetlands. Urban and agricultural landuses are considered disturbed landuses in this analysis. Average annual pollutant loads associated with the undisturbed conditions are determined and considered as the TMDL target.

Average annual nonpoint source loads of nutrients discharging into the stream from the watershed were estimated using a spreadsheet based on EPA's PLOAD model:

$$LP = \Sigma u\ (P * PJ * RVu * Cu * Au * 2.72 / 12)$$

Where: LP = Pollutant load, lbs
P = Precipitation, inches/year
PJ = Ratio of storms producing runoff (default = 0.9)
RVu= Runoff Coefficient for land use type u, inches of runoff/inches of rain
RVu=0.05 + (0.009 * Iu); Iu = percent imperviousness
Cu = Event Mean Concentration for land use type u, milligrams/liter
Au = Area of land use type u, acres

This method calculates nonpoint source loadings for nutrients as the product of the water quality concentration and runoff water volume associated with certain land use practices. An annual average rainfall of 55 inches was determined for WBID 1456, using a nearby meterological station in Brooksville, Florida. The station is maintained as part of the Florida Automated Weather Network (FAWN). The default ratio of 0.9 for storms producing runoff was used. Landuse data entered into the spreadsheet were based on the SWFWMD 1999 land use/cover features categorized according to the Florida Land Use and Cover Classification System

(FLUCCS; see Table 7). The features were photo interpreted from 1:12,000 UGSG color infrared (CIR) digital orthophoto quarter quadrangles (DOQQs). Event Mean Concentrations (EMCs) for each landuse type in Florida were compiled by Harper and Baker (2003), and are provided in Table 8.

Table 7. Land cover data (square meters) by FLUCCS code

FLUCCS CODE	WBID 1456 Land cover Data (m2)
1000	1,623,001
1100	1,230,345
1200	3,625,751
1300	1,298,732
2000	12,399,557
3000	733,044
4000	4,636,606
5000	2,137,712
6000	11,258,440
7000	359,282
8000	1,012,384

Table 8. EMCs for various land uses (from Harper and Baker, 2003)

FLUCCS ID	Land Use	TN (mg/l)	TP (mg/l)
4000	Forest/rural open	1.09	0.046
1000 –	Urban open	1.12	0.18
2000	Agriculture	2.32	0.344
1100	Low-density residential	1.64	0.191
1200	Medium-density residential	2.18	0.335
1300	High-density residential	2.42	0.49
8000	Communication and	2.23	0.27
3000 + 7000	Rangeland	2.32	0.344
5000	Water	1.60	0.067
6000	Wetlands	1.01	0.09

Average annual nonpoint source loads of TN and TP generated from the PLOAD spreadsheet for existing and undisturbed conditions are shown in Table 9. The percent reductions necessary to achieve undisturbed conditions are also provided in Table 9. This approach shows that relatively high reductions are necessary to achieve undisturbed conditions.

Table 9. Average Annual Nonpoint Source Loads estimated for WBID 1456

Parameter	Existing NPS Load (kg/day)	Undisturbed NPS Load (kg/day)	Percent Reduction
Total Nitrogen	40	18.9	53%
Total Phosphorus	4.8	0.94	81%

7. 4 Summary of Tiered Approach for Nutrient Targets

In summary, the tiered approach used to develop these TMDLs involved three analyses: regression techniques, reference conditions, and undisturbed landuse conditions. The regression analysis did not identify relationships between causal and effect parameters strong enough to develop the TMDL. The reference approach supported moderate reductions in TP and TN, while the undisturbed landuse approach supported large reductions to achieve undisturbed conditions. Since the goal of the TMDL is to improve the quality of South Branch so it supports its designated uses of recreation and aquatic life support, the reference approach was selected as the best analysis for this TMDL target.

7. 5 Development of Total Maximum Daily Loads

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations, WLA), non-point source loads (Load Allocations, LA), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$TMDL = WLA + LA + MOS$$

The objective of a TMDL is to allocate loads among the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measure. The TMDLs for South Branch are shown in Table 10 and are expressed as the reduction from current levels of TN and TP that are expected to achieve the DO standard.

A tiered approach was used to determine targets for these TMDLs, and a reference approach that supported moderate reductions in TP and TN was selected as the best analysis for this TMDL target. According to this reference condition analysis the TN concentration in WBID 1456 would have to be reduced by 27 percent to achieve the reference condition-based target of 0.94 mg/l. Accordingly, the TP concentration would have to be reduced 30 percent to achieve the reference condition-based target of 0.064 mg/l. The Best Management Practices (BMPs) used to implement the percent reductions should result in meeting WQS on a daily basis. The percent reductions are applied equally to both point and nonpoint sources, since the WLA is comprised completely of the MS4. The goal of these reductions is to decrease the long-term loading of nutrients to the South Branch, and thereby decrease excess productivity and improve the dissolved oxygen level. This should ultimately restore aquatic life support in the waterbody.

Table 10. TMDL Allocations

WBID	Parameter	WLA	LA	MOS	TMDL
		MS4			
1456	TN	27% reduction	27% reduction	implicit	27% reduction
	TP	30% reduction	30% reduction	implicit	30% reduction

7.5.1 MS4 and Nonpoint Source Allocations

The primary mode for transport of nutrients to streams is during a storm event. Modification of the land surface from a pervious land cover to an impervious surface results in higher peak flow rates that wash nutrient-enriched water into the stream. The load allocation calls for reductions in average annual nutrient loadings from nonpoint sources throughout the watershed equal to the percent reductions provided in Table 10. The percent reductions are applied equally to both point and nonpoint sources, as the WLA is comprised completely of the MS4. These reductions are expected to allow DO concentrations to recover to a condition that will support aquatic life.

7.5.2 Margin of Safety

There are two methods for incorporating a Margin of Safety (MOS) in the analysis: a) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations.

An implicit MOS was incorporated in the analyses through conservative assumptions in developing the reference condition target. These assumptions include basing the target on the 25th percentile of the all streams dataset, since concentrations below these values have a high probability of being inherently protective of aquatic life.

7.5.3 Critical Conditions and Seasonal Variation

The critical conditions can be defined as the environmental conditions requiring the largest reduction to meet standards. By achieving the reduction for critical conditions, water quality standards should be achieved during all other times.

Seasonal variation must also be considered to ensure that water quality standards will be met during all seasons of the year. For South Branch, seasonal variation was considered by analyzing all available water quality data, representing various seasons and incorporating changes in flow and meteorological conditions such as temperature, rainfall, and rainfall intensity. The dataset used to derive the targets included a robust dataset of 53,688 TP measurements and 47,444 TN measurements representing all seasons.

8. RECOMMENDATIONS

Determining the source of nutrients in waterbodies is the initial step to implementing a nutrient TMDL. FDEP employs the Basin Management Action Plan (B-MAP) as the mechanism for developing strategies to accomplish the necessary load reductions. Components of a B-MAP are:
Allocations among stakeholders
Listing of specific activities to achieve reductions
Project initiation and completion timeliness
Identification of funding opportunities
Agreements
Local ordinances
Local water quality standards and permits
Follow-up monitoring

As this TMDL is implemented, the Agency strongly encourages the development of site-specific DO and nutrient criteria for South Branch (WBID 1456).

9. REFERENCES

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