FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration

SOUTHWEST DISTRICT • HILLSBOROUGH RIVER BASIN

TMDL Report

Dissolved Oxygen and Nutrient TMDLs for Baker Creek (WBID 1522C) and Mill Creek (WBID 1542A), and Dissolved Oxygen TMDL for Spartman Branch (WBID 1561)

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Acknowledgments

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Identification of Impaired Surface Waters Rule

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STORET Program

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2002 305(b) Report

http://www.dep.state.fl.us/water/docs/2002_305b.pdf

Criteria for Surface Water Quality Classifications

http://www.dep.state.fl.us/legal/rules/shared/62-302t.pdf

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 Tributaries Basin

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U.S. Environmental Protection Agency

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Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the TMDLs for nutrients and dissolved oxygen (DO) for Baker Creek and Mill Creek, and DO for Spartman Branch, located in the Hillsborough River Basin. These waterbodies are part of the Flint Creek watershed system which discharges above Lake Thonotosassa into the Hillsborough River, and they are located in the Tampa Bay Basin (**Figure 1.1**). Using the methodology described in Chapter 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule (IWR), Florida Department of Environmental Protection, (DEP) amended 12-11-2006 and repromulgated 01-02-2007) to identify and verify water quality impairments, the freshwater segments were verified as impaired for DO and nutrients in Baker Creek and Mill Creek, and DO in Spartman Branch. As per the IWR, Baker Creek and Spartman Branch were included on the verified list of impaired waters for the Tampa Bay Tributaries Basin that was adopted by Secretarial Order on May 27, 2004. Mill Creek was included on the verified list of impaired waters for the Tampa Bay Tributaries Basin that was adopted by Secretarial Order on May 19, 2009. 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 instream water quality conditions.

1.2 Identification of Waterbody

Flint Creek is a tributary to the Hillsborough River which is used as a water supply source by the City of Tampa. The Hillsborough River outfalls into Tampa Bay. The major conveyance systems within the Flint Creek watershed include: Baker Creek, Campbell Branch, Holloman's Branch, Pemberton Creek, Baker Canal, Spartman Branch, Mill Creek and Lake Thonotosassa. Lake Thonotosassa is the receiving waterbody for Baker Creek, Baker Canal, Campbell Branch, Pemberton Creek, Spartman Branch and Mill Creek. The Flint Creek system is located between U.S. Highway 301 and just south of State Route 60 (Brandon Blvd). Flint Creek originates on the northeast corner of Lake Thonotosassa and discharges into the Hillsborough River. The Southwest Florida Water Management District (SWFWMD) maintains a control structure at the lake's outfall to Flint Creek to regulate lake elevations.

Topography above the Flint Creek system varies from a high elevation of about 130 feet National Geodetic Vertical Datum (NGVD) along the eastern portion of the watershed to a low of about 30 feet NGVD in the area of Lake Thonotosassa and along the western portion of the watershed. Climate in the watershed and for Hillsborough County may be classified as humid subtropical. Annual average precipitation is around 52.4 inches. Approximately 60 percent of the rainfall occurs during the four month rainy season that extends from June through

September. Hydrologically, stream flow in the system originates by both base flow and stormwater runoff. Base flow results from either lateral inflows or ground water. Ground water contributions to the surface water are from both the surficial and Floridan aquifers. In this part of Hillsborough County, the confining units of the Floridan aquifer are often reduced or absent and the potentiometric surface of the Floridan aquifer is above ground elevation. As a result, the hydrogeologic conditions influence water levels in many lakes, streams, swamps, and marshes within the Flint Creek system. These water levels usually fluctuate seasonally and reach lower levels in late spring.

For assessment purposes, the Department has divided the Coastal Old Tampa Bay Planning Unit, which includes the Hillsborough River Basin, into water assessment polygons with a unique **W**ater**B**ody **ID**entification (WBID) number for each water segment or stream reach. This report will address the Baker Creek (WBID 1522C), Spartman Branch (WBID 1561) and Mill Creek (WBID 1542A) sub-basins in the watershed that were verified as impaired for the water quality variables noted in Section 1.1.

Baker Creek

The Baker Creek segment (WBID 1522C) is a third-order stream located in the north central area of Hillsborough County. It flows in a southeast-to-northwest direction into Lake Thonotosassa. The stream in the WBID area is about 2 miles in length and is flanked by Thonotosassa Rd to the north and Interstate (I)-4 to the south (**Figure 1.2**). The nearest major urban center to Baker Creek is Tampa, approximately eight miles to the east. The Baker Creek System is the relatively short connection from the confluence of the Pemberton Creek and Baker Canal Systems to Lake Thonotosassa. Baker Creek may have been a natural water course at one time, but now it is a rather straight, dredged canal. The distance from the confluence to the Lake is approximately one mile, of which about one-half is through an historic cypress wetland. The creek passes under a private bridge and Thonotosassa Road as it conveys collected flows to Lake Thonotosassa.

The watershed is part of the Gulf Coastal Lowland area, which has a relatively low relief and abundant existence of Karst features. Interaction of surface water with the ground water is frequent in this area. Baker Creek is a Class III freshwater body, whose designated uses under Rule 62-302.400, Florida Administrative Code (F.A.C.), include human recreation and the “propagation and maintenance of a healthy, well-balanced population of fish and wildlife.” Additional information about the creek’s hydrology and geology are available in the Basin Status Report for the Group 1 Tampa Bay Basin (Florida Department of Environmental Protection, 2001) and the Pemberton Creek and Baker Canal Area Stormwater Management Master Plan.

Spartman Branch

Spartman Branch (WBID 1561) is a first-order stream located in the north central area of Hillsborough County (**Figure 1.2**). It flows in northwest directions into Pemberton Creek.

Pemberton Creek then flows into Lake Thonotosassa via Baker Creek. Spartman Branch was channelized some years ago, but some planned recovery of sinuosity and in-stream habitat has since occurred. The stream is approximately 5.4 miles in length and is flanked by I-4 to the north and Sydney Rd to the southeast. A majority of the watershed lies within the major urban center of Plant City. The drainage basin consists primarily of urban development, draining Plant City and the Plant City Municipal Airport.

The watershed is part of the Gulf Coastal Lowland area, which has a relatively low relief and abundant existence of Karst features. Interaction of surface water with the ground water is frequent in this area. Spartman Branch is a Class III freshwater body, whose designated uses under Rule 62-302.400, Florida Administrative Code (F.A.C.), include human recreation and the "propagation and maintenance of a healthy, well-balanced population of fish and wildlife." Additional information about the creek's hydrology and geology are available in the Basin Status Report for the Group 1 Tampa Bay Basin.

Mill Creek

Mill Creek is part of the Pemberton Creek Watershed which is located within Hillsborough County and spans 64.8 square miles (**Figure 1.2**). The stream is approximately 4.2 miles in length and is flanked by I-4 to the north. The climate in Hillsborough County, specifically areas surrounding the Mill Creek watershed, is sub-tropical with annual rainfall averaging approximately 51.75 inches, although rainfall amounts can vary greatly from year to year (CLIMOD, 2008). Based on data from a 30-year period (1971 – 2000), the average summer temperature is 90.8^{o}F, and the average winter temperature is 74.7^{o}F (CLIMOD, 2008). The topography of the Mill Creek watershed reflects its location within the Southwestern Florida Flatwoods or Southern Coastal Plains ecoregion. Elevations range in the upland portion of the watershed from 125 – 150 feet above sea level (FDEP, 2008). The predominant soil type is clayey sand (FDEP, 2008). Major human population centers exist within the watershed, such as the City of Plant City. Mill Creek is a Class III freshwater body, whose designated uses under Rule 62-302.400, Florida Administrative Code (F.A.C.), include human recreation and the "propagation and maintenance of a healthy, well-balanced population of fish and wildlife." Additional information about the creek's hydrology and geology are available in the Basin Status Report for the Group 1 Tampa Bay Basin.

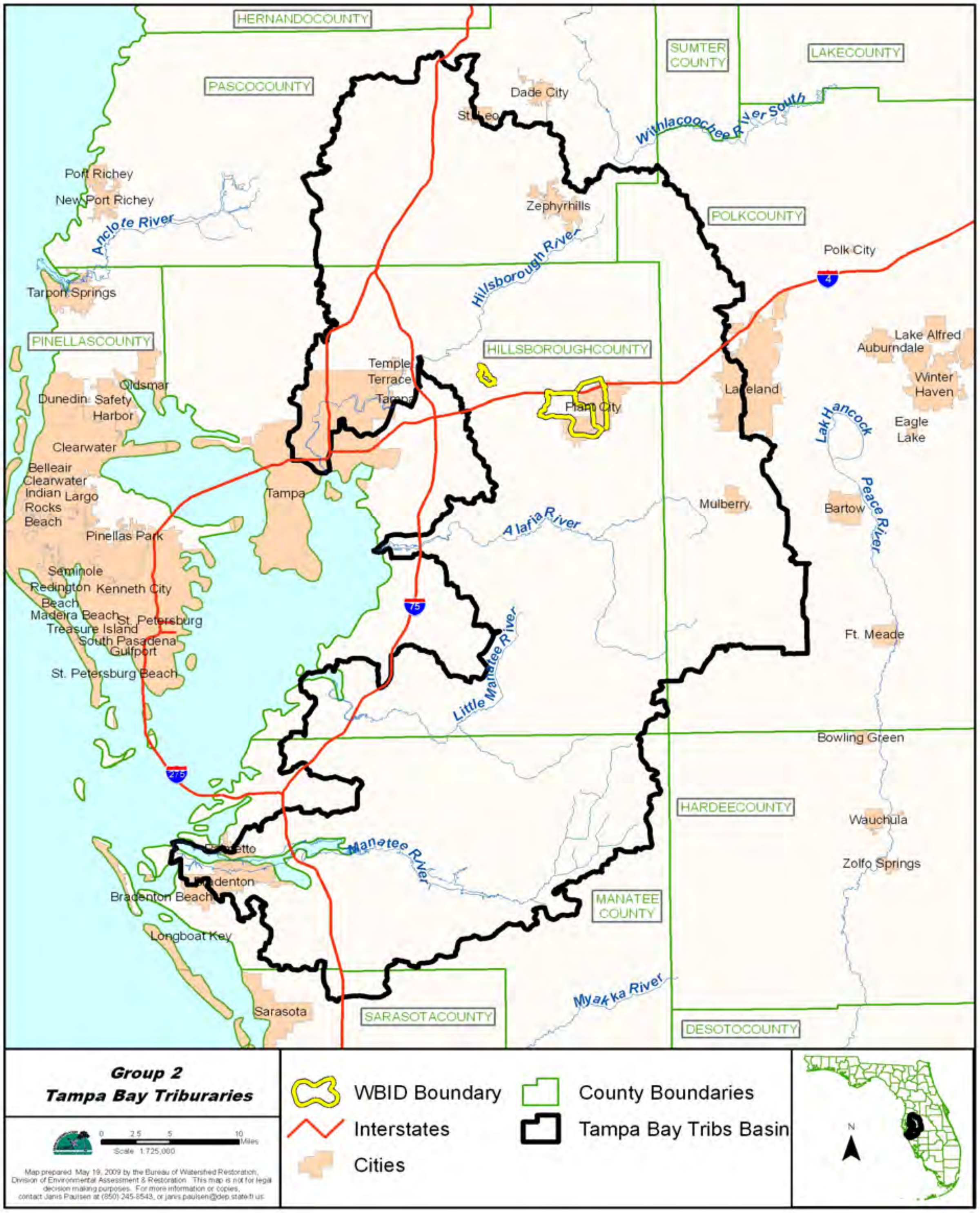

Figure 1.1 Baker Creek, Spartman Branch, and Mill Creek Watershed and Major Geopolitical Features in the Hillsborough River Basin

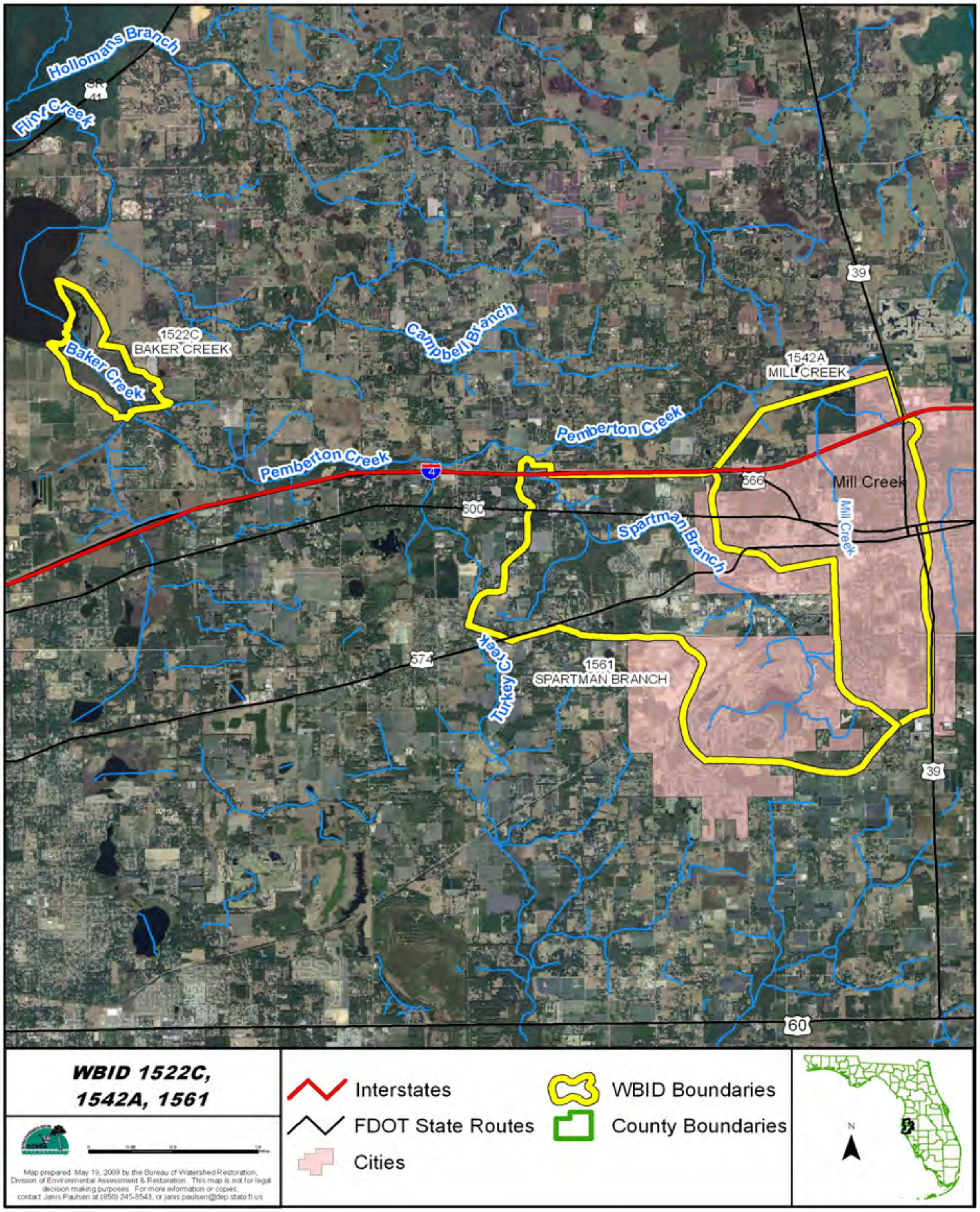

Figure 1.2 Baker Creek, Spartman Branch, and Mill Creek WBIDs in the Hillsborough River Basin

1.3 TMDL Background Information

The TMDL Report for Baker Creek, Spartman Branch and Mill Creek is part of the implementation of the Florida Department of Environmental Protection's (Department) watershed management approach for restoring and protecting water resources and addressing Total Maximum Daily Load (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 requirements of the 1972 federal Clean Water Act and the 1999 Florida Watershed Restoration Act (Chapter 99-223, Laws of Florida). A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet the waterbody's designated uses. A waterbody that does not meet its designated uses is defined as impaired. TMDLs must be developed and implemented for each of the state's impaired waters, unless the impairment is documented to be a naturally occurring condition that cannot be abated by a TMDL or unless a management plan already in place is expected to correct the problem.

The development and implementation of a Basin Management Action Plan, or BMAP, to reduce the amount of pollutants that caused the impairment will follow this TMDL Report. These activities will depend heavily on the active participation of Hillsborough County, SWFWMD, 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. Additional information about the watershed may be found in the Hillsborough County Watershed Atlas.

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) a list of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant causing the identified impairment of the listed waters on a schedule. The Department has developed these lists, commonly referred to as 303(d) lists, since 1992. The list of impaired waters in each basin is also required by the FWRA (Subsection 403.067[4)], Florida Statutes [F.S.]), and the Department is developing basin-specific lists as part of the watershed management cycle.

The 1998 303(d) list included 47 waterbodies (WBIDs) in the Tampa Bay Basin (Florida Department of Environmental Protection, 1998). 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 rule-making process, the Environmental Regulation Commission adopted the new methodology as Chapter 62-303, F.A.C., IWR, (Florida DEP, 2001). The list of waters for which impairments have been verified using the methodology in the IWR is referred to as the Verified List.

2.2 Information on Verified Impairment

Baker Creek

The Department used the IWR to assess water quality impairments in the Baker Creek watershed and verified impairments for DO and nutrients **(Table 2.1).** The main sources of data for the IWR assessment were from stations 21FLHILL24030034 and 21FLHILL107 sampled by the Hillsborough County Environmental Protection Commission (HCEPC) **(Figure 2.1).** The nomenclature for station 21FLHILL24030034 changed in 1999 to 21FLHILL107. The IWR methodology uses chlorophyll-*a* measurements (a measure of algal biomass) to interpret Florida’s narrative nutrient criterion, and the number of DO criterion exceedances is evaluated to assess for DO impairment.

The daily DO and chlorophyll-*a* (Chla) results from 2001 to 2008 (the verified period used for the IWR assessment) were shown in **Figure 2.2.** Seasonal and annual average Chla levels from 2001 to 2008 were also presented in **Figures 2.3 and 2.4**, respectively. Baker Creek is on the Verified List for DO and Chla because, from 2001 to 2008, more than 10 percent of the DO results did not meet the freshwater DO criterion of 5 milligrams per liter (mg/L). Summary statistics for DO from 2001 to 2008 are provided in **Table 2.2.** Annual Chla did not meet the freshwater Chla criterion of 20 micrograms per liter (µg/L) (**Figure 2.4**). The individual water quality measurements for DO and Chla used in the Watershed Analysis Simulation Program (WASP) modeling assessment are provided in **Appendix B**.

Table 2.1 Verified Impaired Listings in the Baker Creek Watershed, WBID 1522C

Parameters of Concern	Priority for TMDL Development	Projected Year for TMDL Development*
Nutrients (Chlorophyll *a*)	High	2008
Dissolved Oxygen	High	2008

*These TMDLs were scheduled to be completed by December 31, 2008, based on a Consent Decree between the EPA and EarthJustice, but the Consent Decree allows a 9-month extension for completing the TMDLs.

Table 2.2 Summary Statistics for DO at Baker Creek from 2001 to 2008

Parameter (mg/L)	Station ID	Number of Samples	Minimum	Maximum	Mean	Median	Exceed-ances	% Excee-dances
Dissolved Oxygen	21FLHILL24030034 / 21FLHILL107	74	1.8	8.4	4.7	4.8	44	59.4

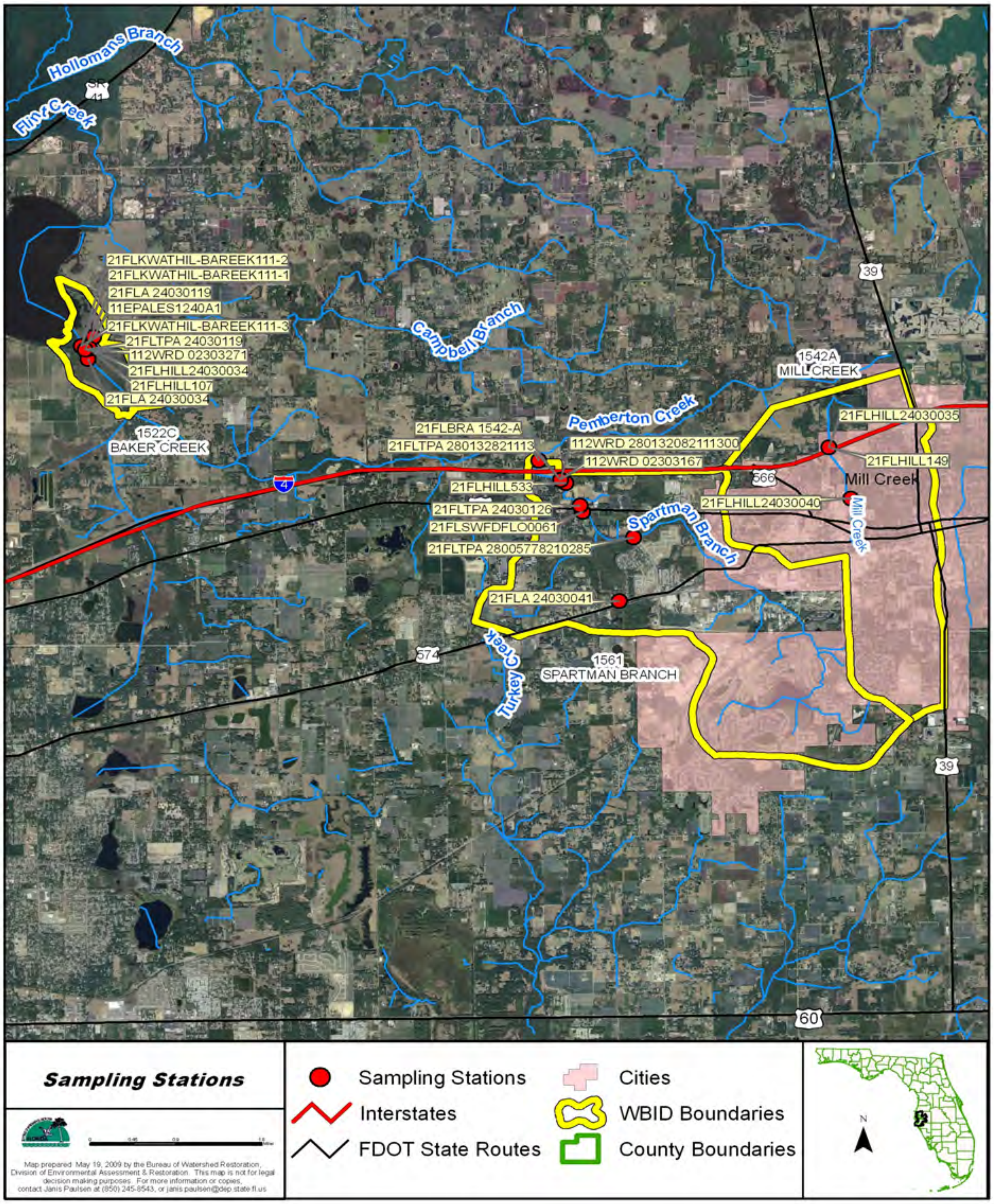

Figure 2.1 Flint Creek Watershed System and Monitoring Locations

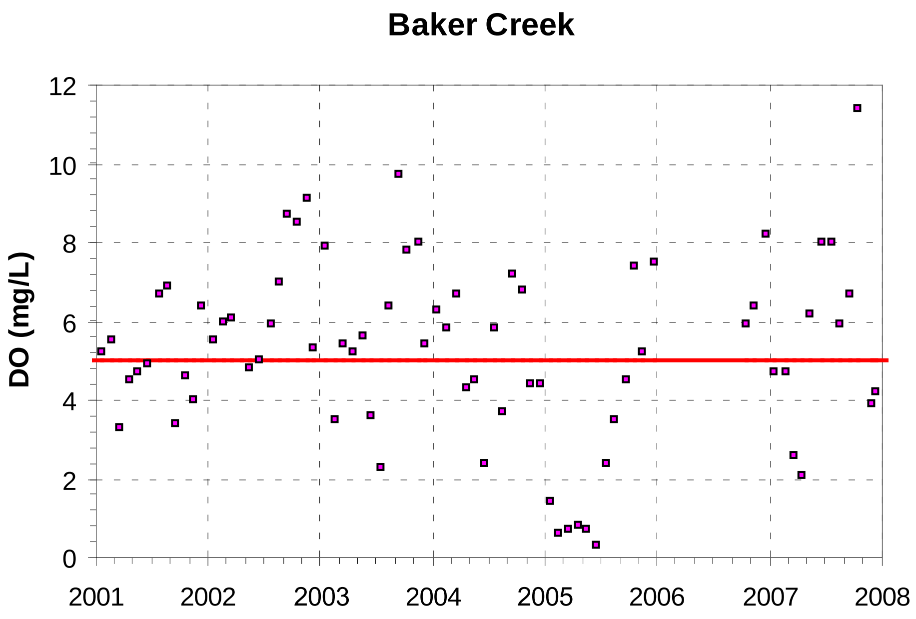

Figure 2.2 Concentrations of Dissolved Oxygen observed from 2001 to 2008 during the Verified Period. Red Line indicates the DO Criteria of 5 mg/L

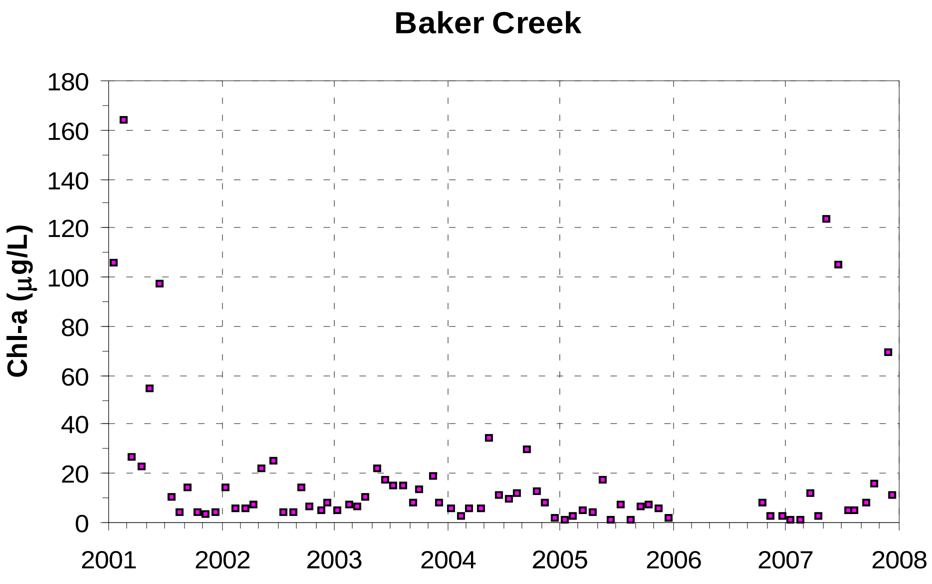

Figure 2.3 Concentrations of Chla observed from 2001 to 2008 at Baker Creek (WBID 1522C) during the Verified Period

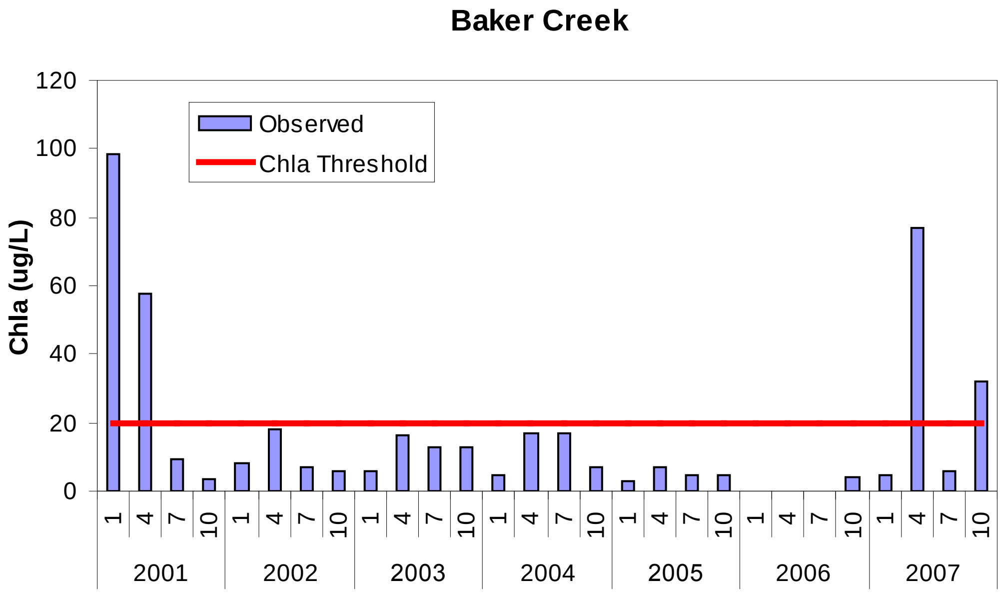

Figure 2.4 Seasonal Variation in Concentrations of Chla observed from 2001 to 2008 at Baker Creek (WBID 1522C) during the Verified Period

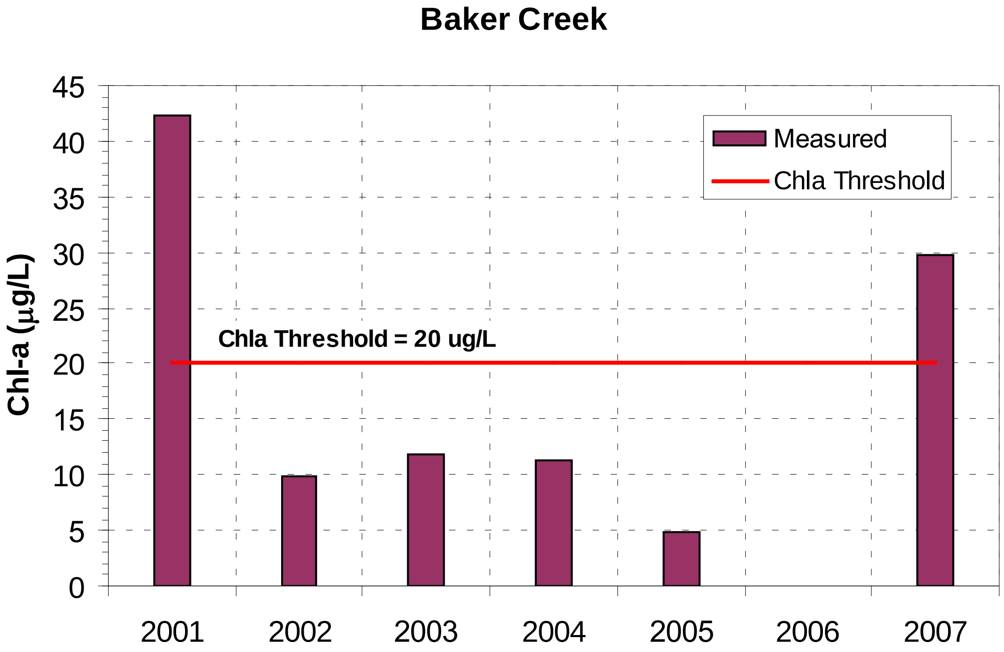

Figure 2.5 Annual Variation in Chlorophyll-*a* from 2001 to 2008 during the Verified Period. The data were not available for 2006 and 2008

Spartman Branch

The Department used the IWR to assess water quality impairment in the Spartman Branch watershed and verified an impairment for DO **(Table 2.3).** The main source of data for the IWR assessment came from DEP Tampa District stations 21FLTPA 24030126 and 21FLTPA 28005778210285 **(Figure 1.2).** The IWR methodology uses the number of DO criterion exceedances to assess for DO impairment.

The DO results for the years 2001 and 2008 are shown in **Figure 2.5.** Spartman Branch is on the Verified List for DO because more than 10 percent of the DO results did not meet the State's freshwater DO criterion of 5 milligrams per liter (mg/L). Summary statistics for DO for the period of 2001 to 2008 are provided in **Table 2.4.** The individual water quality measurements for DO utilized in the WASP modeling assessment and TMDL development are provided in **Appendix B**.

Table 2.3 Verified Impaired Listings for Spartman Branch, WBID 1561

Parameters of Concern	Priority for TMDL Development	Projected Year for TMDL Development*
Dissolved Oxygen	High	2008

*These TMDLs were scheduled to be completed by December 31, 2008, based on a Consent Decree between the EPA and EarthJustice, but the Consent Decree allows a 9-month extension for completing the TMDLs.

Table 2.4 Summary Statistics for Dissolved Oxygen during the Verified Period in Spartman Branch, WBID 1561

Parameter (mg/L)	Station ID	Number of Samples	Minimum	Maximum	Mean	Median	Exceed -ances	% Exceed -ances
Dissolved Oxygen	21FLTPA 24030126	7	3.7	8.3	5.3	4.8	9	60.0
	21FLTPA 28005778210285	8						
	Total	15						

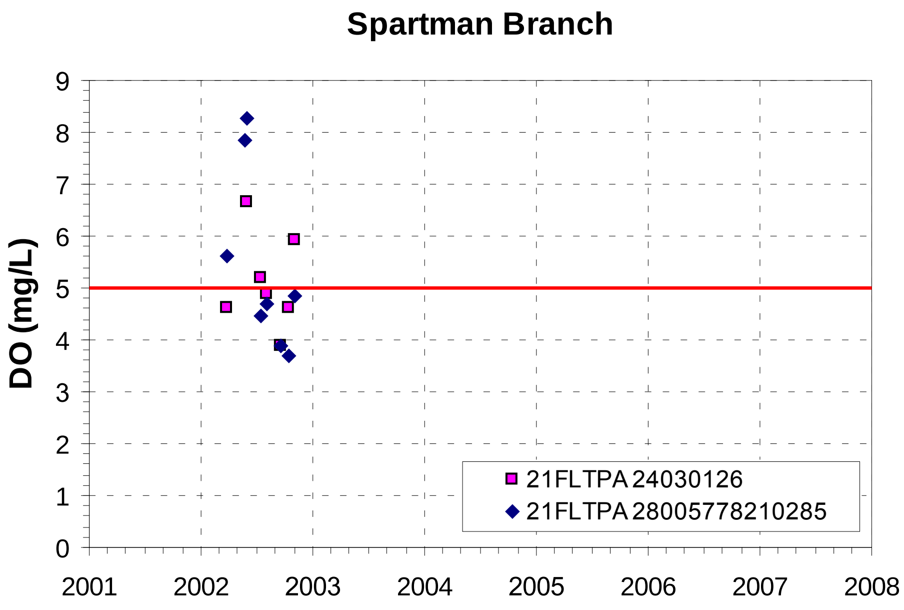

Figure 2.6 Concentrations of Dissolved Oxygen observed in Spartman Branch Watershed from 2001 to 2008

Mill Creek

The Department used the IWR to assess water quality impairments of Mill Creek and verified impairments for DO and nutrients **(Table 2.5).** The main source of data for the IWR assessment was station 21FLHILL149 sampled by the Hillsborough County Environmental Protection Commission (HCEPC). The station name of 21FLHILL24030035 changed in 1999 to 21FLHILL149. The IWR methodology uses Chla measurements (a measure of algal biomass) to interpret Florida's narrative nutrient criterion, and the number of DO criterion exceedances is evaluated to assess for DO impairment.

The daily DO and Chla results from 2001 to 2008 (the verified period used for the IWR assessment) were shown in **Figure 2.7 and Figure 2.8.** Seasonal and annual average Chla levels were also presented in **Figure 2.9 and 2.10**, respectively. Mill Creek is on the Verified List for DO because more than 10 percent of the DO results observed from 2001 to 2008 did not meet the freshwater DO criterion of 5 milligrams per liter (mg/L). Summary statistics for DO from 2001 to 2008 are provided in **Table 2.6.** Annual Chla did not exceed the freshwater Chla criterion of 20 micrograms per liter (µg/L) throughout the verified period but TP was determined to be the causative pollutant for DO impairment (**Figure 2.10**). The individual water quality measurements for DO and nutrients used in the Watershed Analysis Simulation Program (WASP) modeling assessment are provided in **Appendix B**.

Table 2.5 Verified Impaired Listings in the Mill Creek Watershed, WBID 1542A

Parameters of Concern	Priority for TMDL Development	Projected Year for TMDL Development*
Nutrients (Chlorophyll *a*)	High	2008
Dissolved Oxygen	High	2008

*These TMDLs were scheduled to be completed by December 31, 2008, based on a Consent Decree between the EPA and EarthJustice, but the Consent Decree allows a 9-month extension for completing the TMDLs.

Table 2.6 DO Summary Statistics for Mill Creek (WBID 1542A) from 2001 to 2008

Parameter (mg/L)	Station ID	Number of Samples	Minimum	Maximum	Mean	Median	Exceed-ances	% Excee-dances
Dissolved Oxygen	21FLHILL149	72	0.8	10.6	4.6	4.6	43	59.7

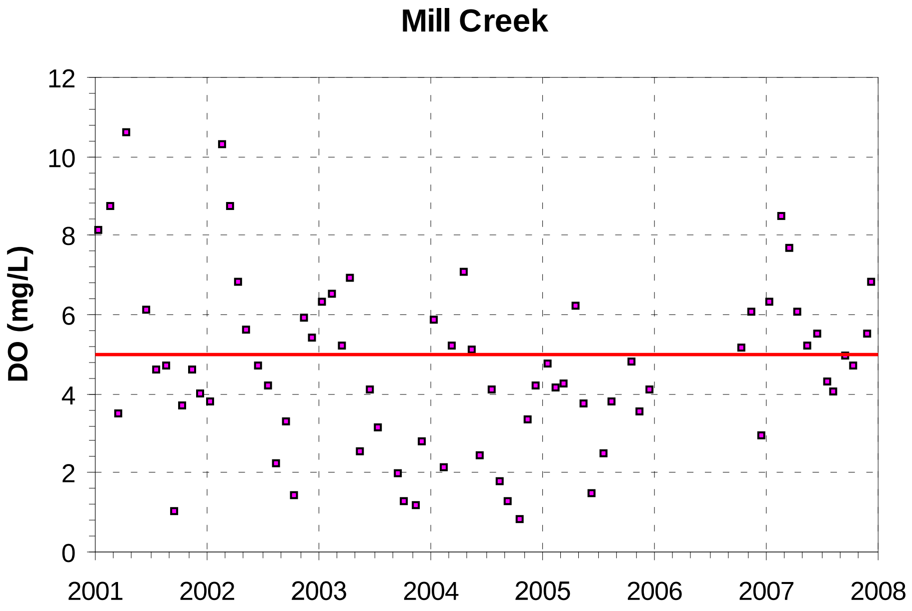

Figure 2.7 Concentrations of Dissolved Oxygen observed from 2001 to 2008 during the Verified Period. Red Line indicates the DO Criteria of 5 mg/L

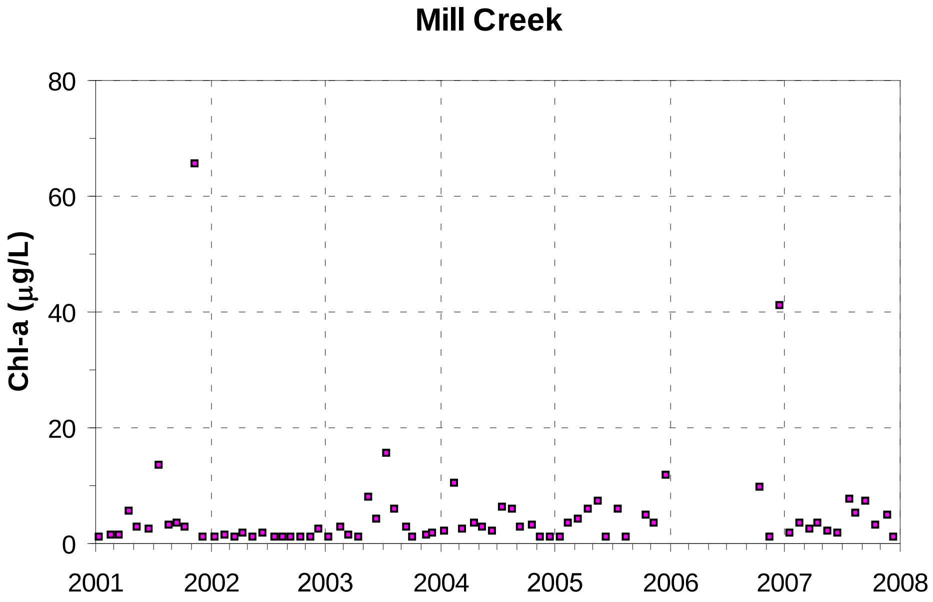

Figure 2.8 Concentrations of Chla observed from 2001 to 2008 at Mill Creek (WBID 1542A) during the Verified Period

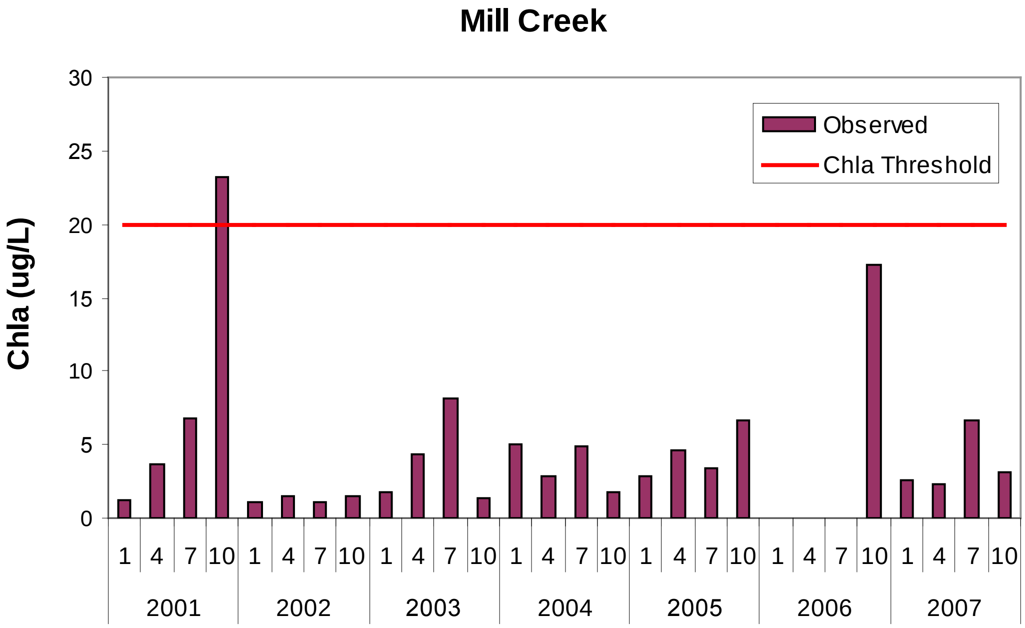

Figure 2.9 Seasonal Variation in Concentrations of Chlorophyll-*a* observed from 2001 to 2008 at Mill Creek (WBID 1542A) during the Verified Period

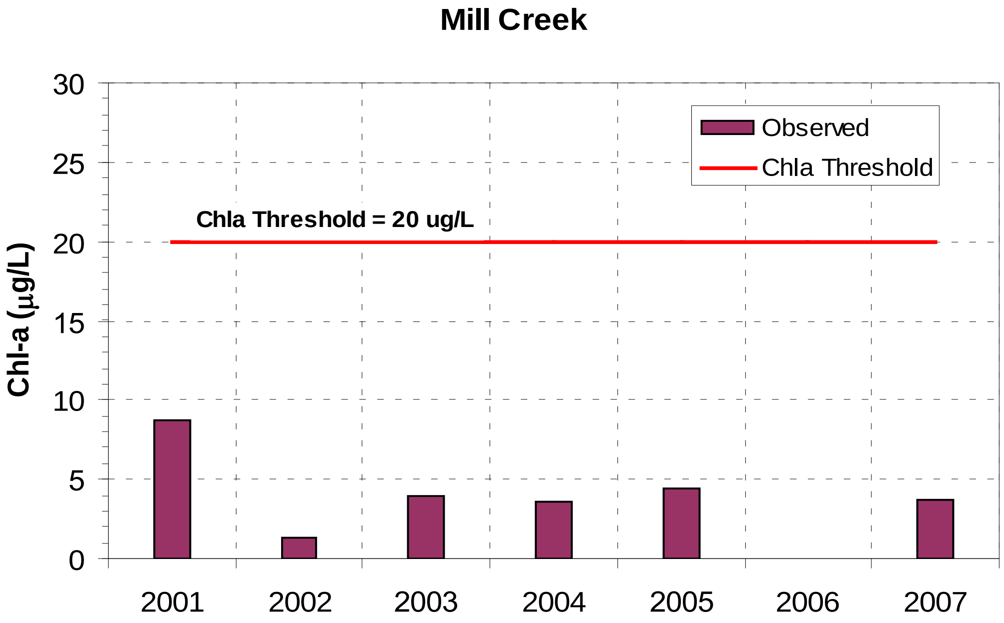

Figure 2.10 Annual Variation in Chlorophyll-*a* from 2001 to 2008 during the Verified Period. The data were not available for 2006 and 2008

2.3 Long-term Water Quality Trends

Long-term water quality data between 1990 and 2007 obtained from Florida STORET for Baker Creek are presented in **Figures 2.11** through **2.15**. In general, the historical water quality trends of TN and TP concentrations in Baker Creek indicate that in-stream concentrations of TN and TP have remained relatively constant over the 18-year period of observation from 1990 to 2007. In the early1990s, the creek exhibited averages of TN and TP concentrations with about 1.2 mg/L and 0.7 mg/L, respectively. The TP concentration of 8.96 mg/L collected on March 28, 1990 was excluded in this analysis. The average of TN/TP ratio during this period was mostly below 10, indicating nitrogen-limited for phytoplankton growth. Sporadic increases in Chla, exceeding the stream threshold of 20 µg/L, were observed mainly in 2000, 2001 and 2007. However, little temporal change in the TN and TP concentrations were observed over the 18-year period of record.

Temporal trend analysis for DO in Spartman Branch where DO is impaired was not possible as limited water quality data were available for the waterbody. As shown in **Figure 2.16**, data were collected from three major monitoring stations (21FLTPA 24030126, 21FLTPA 28005778210285 and 21FLTPA 280132821113) in Spartman Branch. Most of the water quality data were obtained in 2002.

For Mill Creek, the long term water quality data were available from 1990 to 2007 and presented in **Figures 2.17 through 2.22**. Concentrations of TN and TP regularly spike throughout the observation period. Nevertheless, Chla concentrations were below 20 µg/L in most years. The TN/TP ratios indicate an increase in the degree of TN limitation over time due to slight increases in TP concentration relative to TN (**Figure 2.20**). As shown on **Figure 2.21**, the relationship between Chla concentrations and TN/TP ratios indicates that concentrations of Chla are greater when the waterbody is limited by TN rather than co-limited, suggesting that more TP needs to be controlled. This finding can be an important index for the future management efforts on the status of nutrients in a restored waterbody.

Table 2.7 shows summary statistics of historical water quality variables for Mill Creek observed over the period from 1990 to 1999. During this period, the concentrations of TN averaged about 1.28 ± 0.98 mg/L (n = 116) while concentrations of TP averaged 0.333 ± 0.227 mg/L (n = 117). As a result, the TN/TP ratios were found to be less than 10 in many observations during the period, with an average of 4.4 ± 2.9 (n = 116). These data indicate that the waterbody was nitrogen-limiting. In comparison, recent (2000-2007) observations for water quality variables are summarized in **Table 2.8**. Concentrations of TN over the period of 2000-2007 averaged about 1.17 ± 0.92 mg/L (n = 82), showing a little change over the 18-year period. TP concentrations exhibited an average of 0.404 ± 0.311 mg/L (n = 85). **Figure 2.22** shows that DO values less than the 5 mg/L criterion have occurred throughout the period of record. The median between 2000 and 2007 is about 4.4 mg/L less than that (5.9 mg/L) in the observation period of 1990-1999, indicating DO impairment should be addressed for this waterbody. This report will evaluate the relationship between the current nutrient loading from the watershed and the observed concentrations in stream and propose the load reductions required for the waterbodies to meet water quality standards.

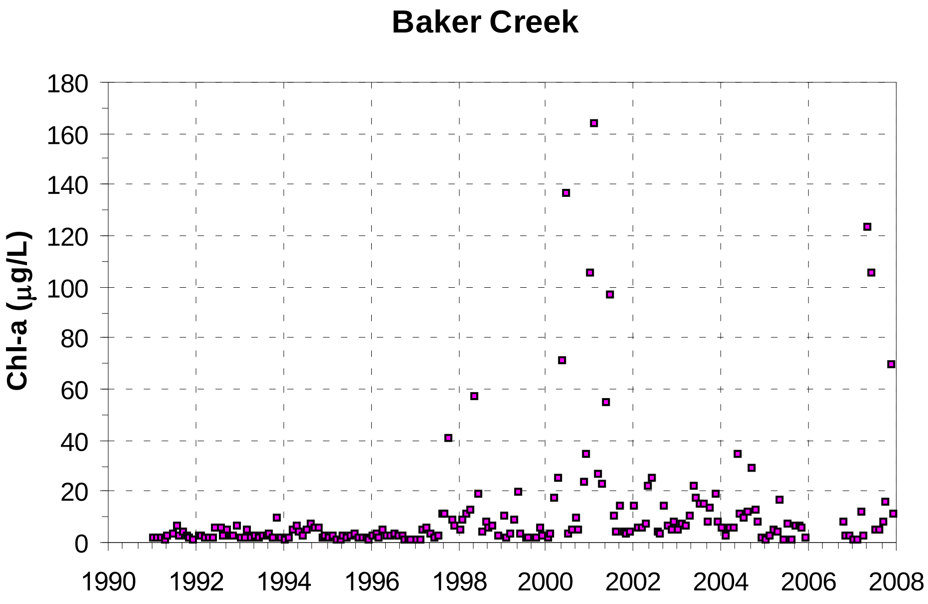

Figure 2.11 Chla Concentrations Measured for Baker Creek from 1990 through 2007

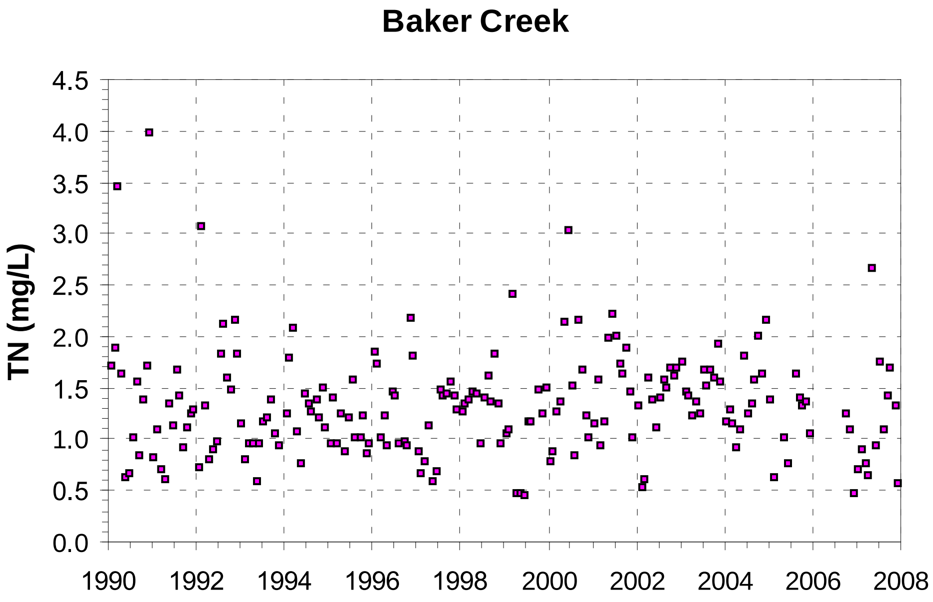

Figure 2.12 TN Concentrations Measured for Baker Creek from 1990 through 2007

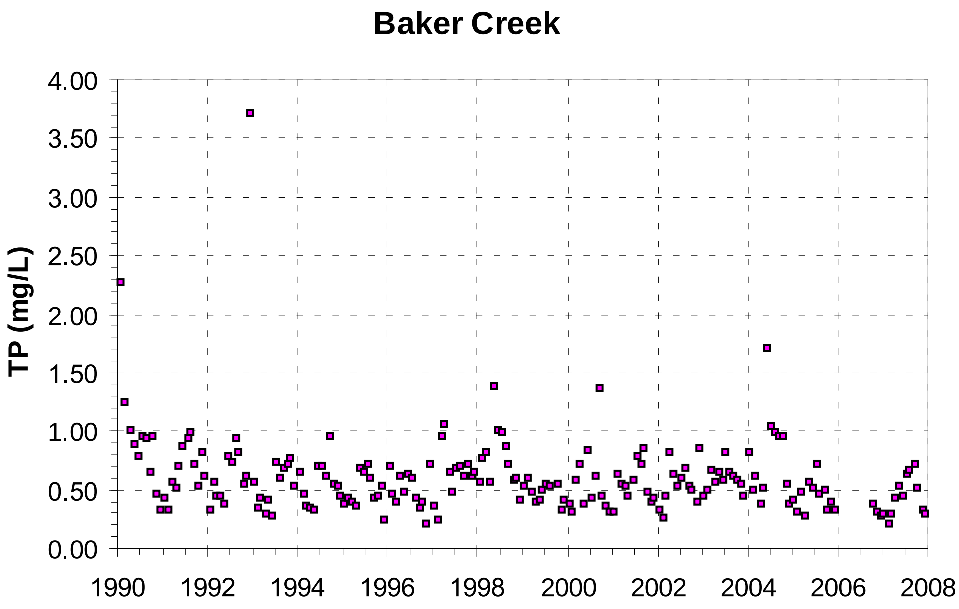

Figure 2.13 TP Concentrations Measured for Baker Creek from 1990 through 2007

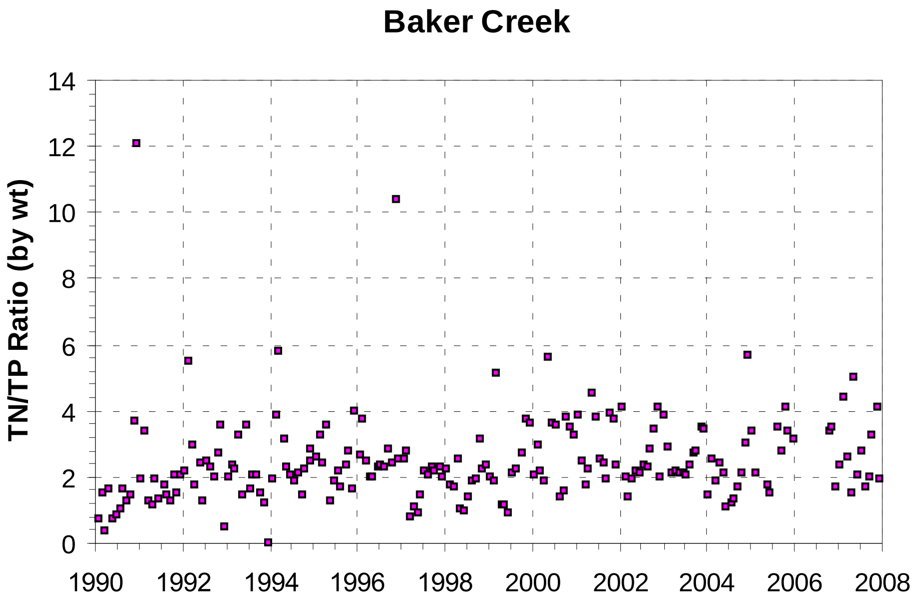

Figure 2.14 Ratios of TN to TP (by wt.) for Baker Creek from 1990 through 2007

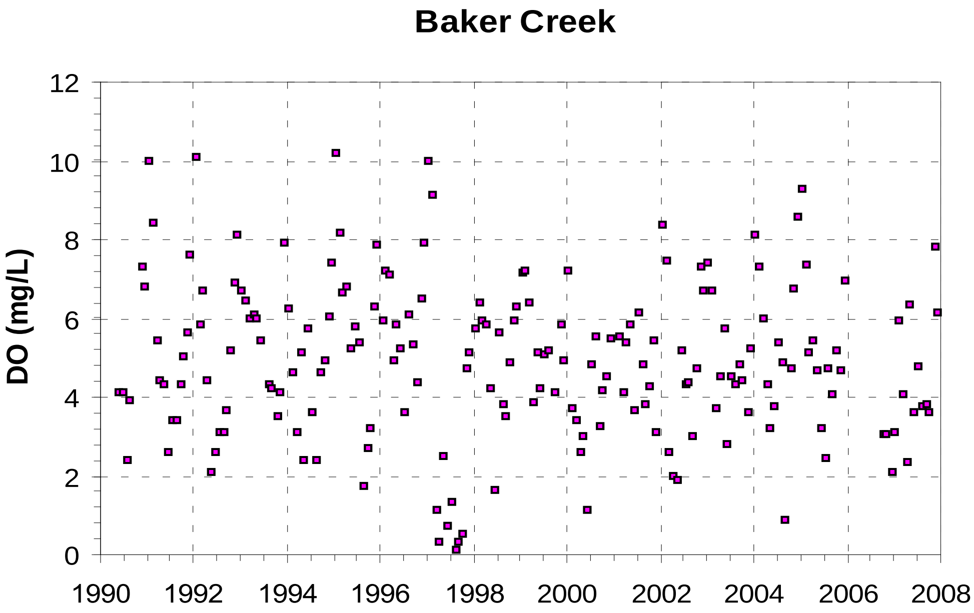

Figure 2.15 DO Concentrations Measured for Baker Creek from 1990 through 2007

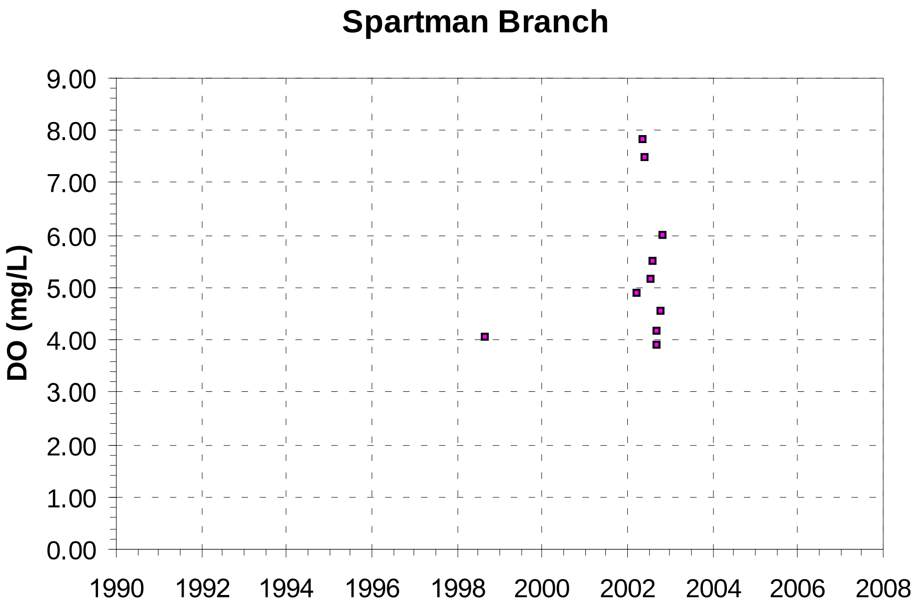

Figure 2.16 DO Concentrations Measured in Spartman Branch

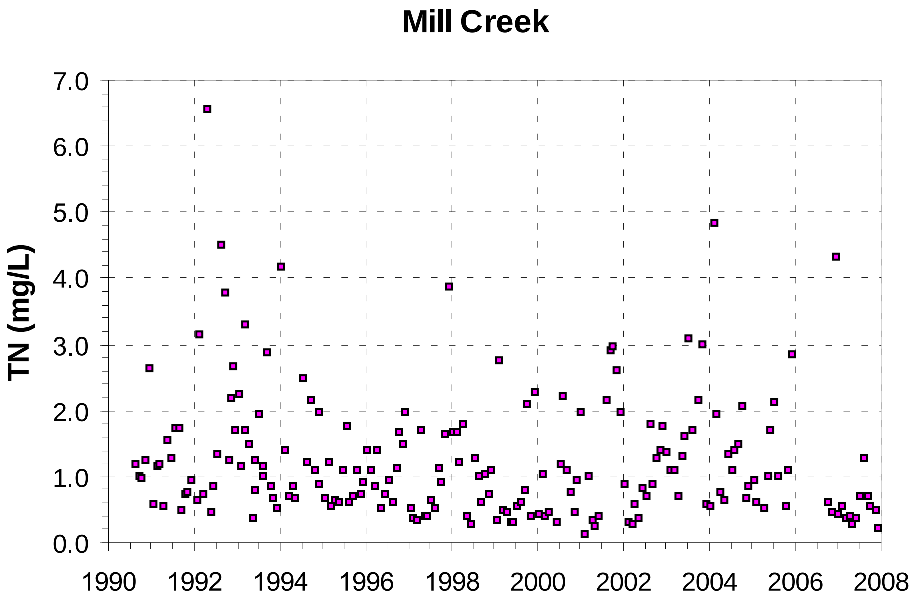

Figure 2.17 Total Nitrogen Concentrations Measured for Mill Creek from 1990 through 2007

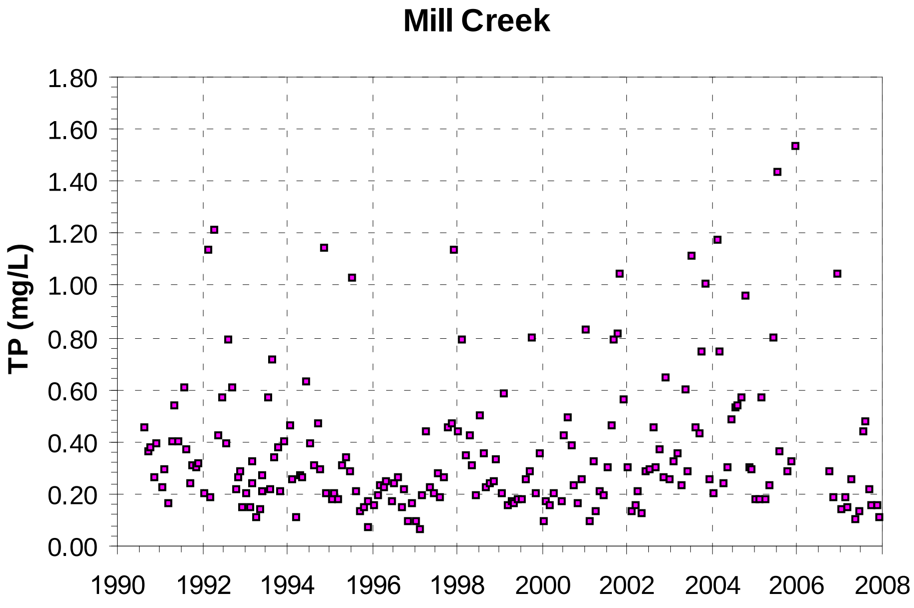

Figure 2.18 Total Phosphorus Concentrations Measured for Mill Creek from 1991 through 2007

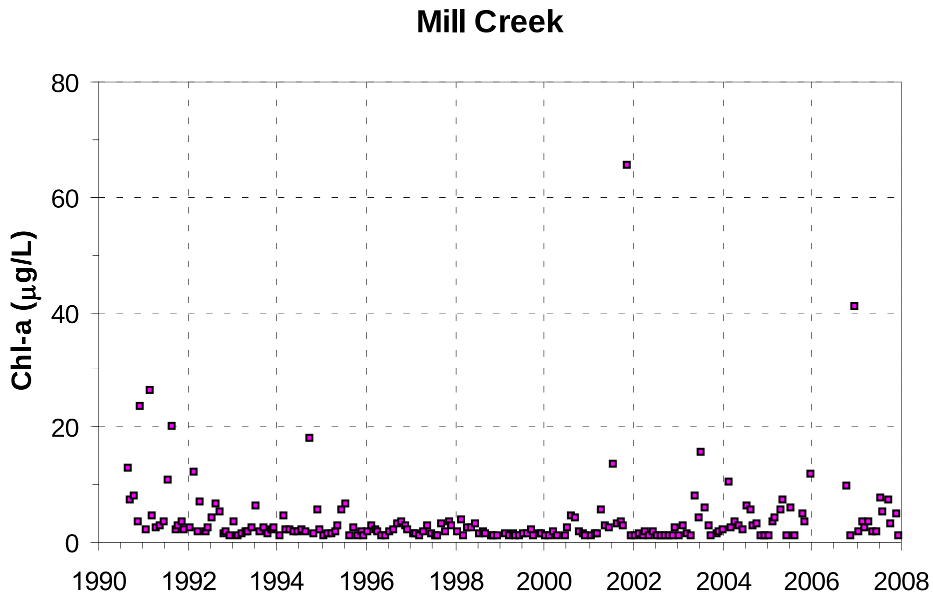

Figure 2.19 Chla Concentrations Measured for Mill Creek from 1991 through 2007

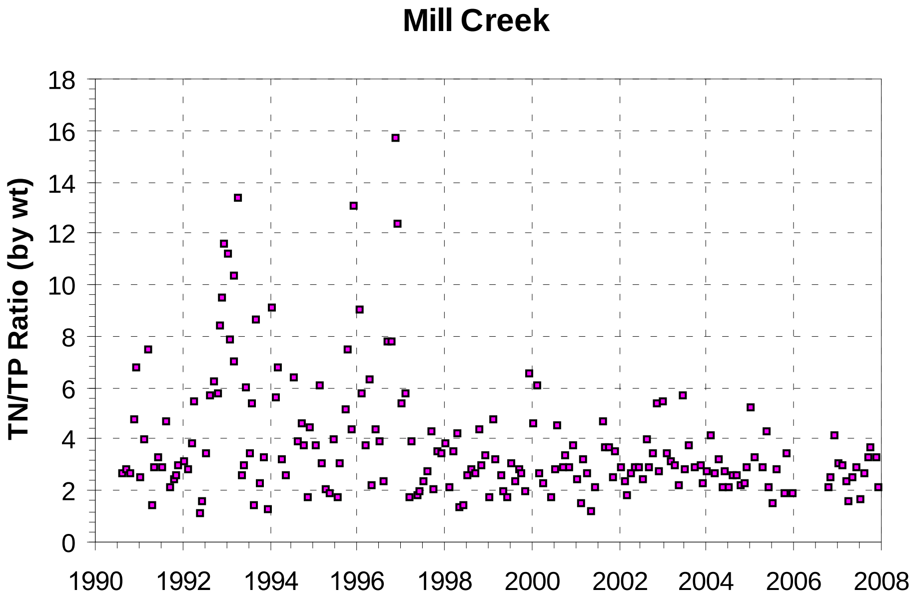

Figure 2.20 Ratios of Total Nitrogen to Total Phosphorus (by wt.) for Mill Creek from 1990 through 2007

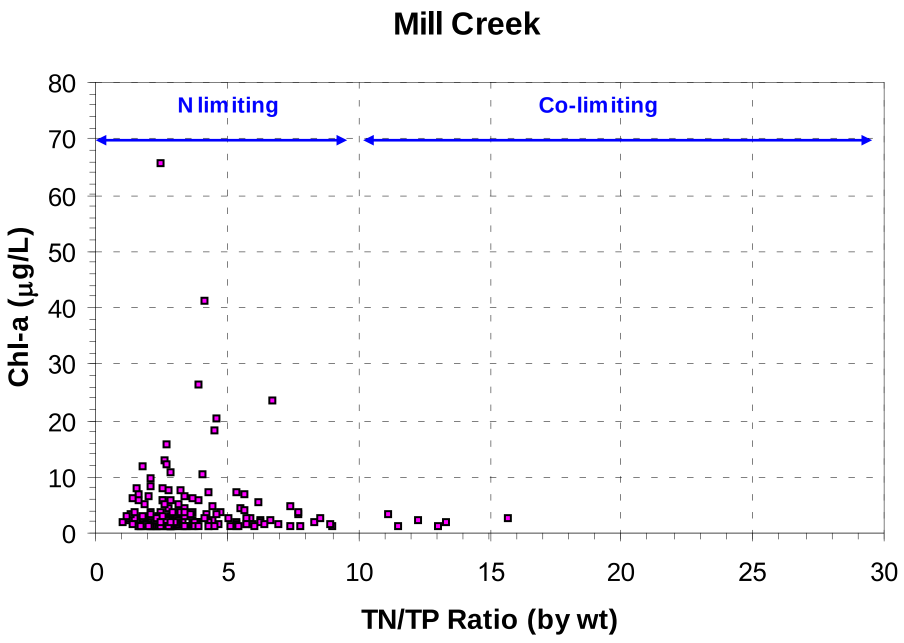

Figure 2.21 Relationship between Chla Concentration versus TN/TP Ratio Observed for Mill Creek

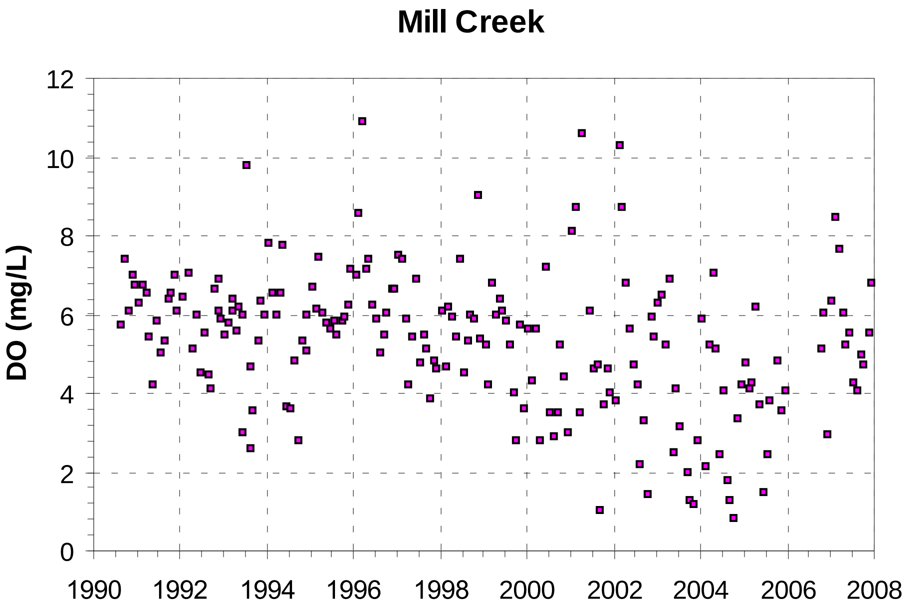

Figure 2.22 Concentrations of Dissolved Oxygen measured for Mill Creek from 1990 through 2007

Table 2.7 Summary Statistics of Water Quality Variables in Mill Creek over the Period of 1990-1999

Water Quality Variable	Unit	Number of Observation	Median	Mean	Standard Deviation	Minimum	Maximum	Coefficient Variation
Chlorophyll-a	µg/L	112	2.0	3.3	4.2	1.0	26.2	128.5%
Total Nitrogen	mg/L	116	1.05	1.28	0.980	0.26	6.535	76.6%
Total Phosphorus	mg/L	117	0.260	0.333	0.227	0.065	1.210	68.2%
DO	mg/L	116	5.9	5.8	1.3	2.6	10.9	22.5%
BOD	mg/L	113	1.15	1.37	0.90	0.20	5.75	65.5%
Color	Pt-Co	117	13	21	19.3	3	120	92.6%
TN/TP Ratio	no unit	116	3.4	4.4	2.9	1.1	15.7	65.2%

Table 2.8 Summary Statistics of Water Quality Variables in Mill Creek over the Period of 2000-2007

Water Quality Variable	Units	Number of Observation	Median	Mean	Standard Deviation	Minimum	Maximum	Coefficient Variation
Chlorophyll-a	µg/L	85	2.4	4.4	8.4	1.0	65.6	189.5%
Total Nitrogen	mg/L	82	0.90	1.17	0.92	0.13	4.82	78.9%
Total Phosphorus	mg/L	85	0.290	0.404	0.311	0.090	1.530	77.0%
DO	mg/L	83	4.4	4.6	2.1	0.8	10.6	44.8%
BOD	mg/L	83	1.0	1.4	1.5	0.2	9.0	102.2%
Color	Pt-Co	83	19	32	28.7	7.5	175	89.3%
TN/TP Ratio	no unit	82	2.8	3.0	1.0	1.2	6.1	33.2%

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 water is 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)**

Baker Creek, Spartman Branch and Mill Creek are classified as a Class III freshwater 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 observed impairments are DO and nutrients for Baker Creek and Mill Creek and DO for Spartman Branch.

3.2 Applicable Water Quality Standards and Numerical Water Quality Targets

3.2.1 DO Criteria

Florida's DO criterion for Class III fresh waterbodies states that DO "shall not be less than 5.0 mg/L, and the normal daily and seasonal fluctuations above this levels shall be maintained." However, DO concentrations in ambient waters can be controlled by many factors, including the DO solubility, which is controlled by temperature; DO enrichment processes influenced by reaeration, which is controlled by flow velocity; photosynthesis of phytoplankton, periphyton, and other aquatic plants; DO consumption from the decomposition of organic materials in the water column and sediment and oxidation of some reductants such as ammonia and metals; and respiration by aquatic organisms.

The DO concentration in some seasons could be naturally low because of the high bacteria respiration supported by a large and constant supply of dissolved organic carbon (DOC) originating from the wetland areas that discharge into streams. Although the major portion of the DOC pool is usually recalcitrant to most bacteria species, some bacteria species adapted to living in blackwater systems can readily use this DOC pool to support their growth. Bacteria activities can be significantly stimulated if nitrogen and phosphorus are added into the system because they provide bacteria with nutrients. Further stimulation of bacteria activities can be observed if DOCs of human origin (usually represented with the biochemical oxygen demand – BOD) are added to the system. Human DOCs are usually easy to decompose and can be readily used by bacteria. These DOCs not only can enhance the metabolic activities of bacteria species that use recalcitrant DOCs, but also provide the carbon source to those bacteria species that can not use recalcitrant DOCs. Therefore, input of human sources of DOC into a blackwater system should be properly controlled to improve the DO condition in these waters.

Another source of DO consumption may originate from the organic materials accumulated in the stream over time. Due to the limited amount of time available to this study, factors that control DO concentration in the streams were not examined by measuring the actual DO consumption rate from each source. Instead, TN, TP, and Chla concentrations were treated as the focus of this study. Possible impacts of these nutrients and phytoplankton on the DO level of the streams were evaluated by comparing the results from various WASP scenarios discussed later.

3.2.2 Interpretation of the Narrative Nutrient Criterion

To place a waterbody segment on the Verified List for nutrients, the Department must identify the limiting nutrient or nutrients causing impairment as required by the IWR. The following method is used to identify the limiting nutrient(s) in streams.

The IWR's numeric Chla threshold for rivers and streams is used 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 streams based on annual average Chla 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 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.

There were no site-specific thresholds for nutrient impairment available for Baker Creek and Mill Creek. Under the IWR, nutrient impairment for freshwater streams is assessed by determining if annual average Chla values exceed 20 μg/L, or if there are annual averages that more than 50 percent greater than the historical value for at least 2 consecutive years. In assessing biological imbalances in streams, the IWR uses 50% above the historical Chla value as one measure of impairment in streams in case Chla data indicate that annual mean Chla values have increased by more than 50% over the historical values for at least two consecutive years. The historical Chla value for Baker Creek estimated from the data collected between 1992 and 1996 was an average of 2.75 μg/L, and an additional 50% to the historical Chla value was calculated to be 4.1 μg/L. Several scenario runs were made by reducing loads until the DO criteria and the site-specific threshold were met for Baker Creek and Mill Creek.

The individual ratios over the entire verified period (i.e., January 1, 2001 to June 30, 2008 are evaluated to determine the limiting nutrient(s). If all the sampling event ratios are less than 10, nitrogen is identified as the limiting nutrient, and if all the ratios are greater than 30, phosphorus is identified as the limiting nutrient. Both nitrogen and phosphorus are identified as limiting nutrients if the ratios are between 10 and 30.

3.2.3 Narrative Nutrient Criteria Definitions

Chlorophyll a (Chla)

Chlorophyll is a green pigment found in plants and is an essential component in the process of converting light energy into chemical energy. Chlorophyll is capable of channeling the energy of sunlight into chemical energy through the process of photosynthesis. In photosynthesis, the energy absorbed by chlorophyll transforms carbon dioxide and water into carbohydrates and oxygen. The chemical energy stored by photosynthesis in carbohydrates drives biochemical reactions in nearly all living organisms. Thus, chlorophyll is at the center of the photosynthetic oxidation-reduction reaction between carbon dioxide and water.

There are several types of chlorophyll; however, the predominant form is chlorophyll a (Chla). The measurement of Chla in a water sample is a useful indicator of phytoplankton biomass, especially when used in conjunction with analysis concerning algal growth potential and species abundance. The greater the abundance of Chla, typically the greater the abundance of algae. Algae are the primary producers in the aquatic food web, and thus are very important in characterizing the productivity of lakes and streams. As noted earlier, Chla measurements are also used to estimate the trophic conditions of lakes and lentic waters.

Total Nitrogen as N (TN)

Total nitrogen is the combined measurement of nitrate (NO_3), nitrite (NO_2), ammonia, and organic nitrogen found in water. Nitrogen compounds function as important nutrients to many aquatic organisms and are essential to the chemical processes that exist between land, air, and water. The most readily bio-available forms of nitrogen are ammonia and nitrate. These compounds, in conjunction with other nutrients, serve as an important base for primary productivity.

The major source of excessive amounts of nitrogen in surface water are the effluent from municipal treatment plants and runoff from urban and agricultural sites. When nutrient concentrations consistently exceed natural levels, the resulting nutrient imbalance can cause undesirable changes in a waterbody’s biological community and drive an aquatic system into an accelerated rate of eutrophication. Usually, the eutrophication process is observed as a change in the structure of the algal community and includes severe algal blooms that may cover large areas for extended periods. Large algal blooms are generally followed by a depletion in dissolved oxygen concentrations as a result of algal decomposition.

Total Phosphorus as P (TP)

Phosphorus is one of the primary nutrients that regulates algal and macrophyte growth in natural waters, particularly in fresh water. Phosphate, the form in which almost all phosphorus is found in the water column, can enter the aquatic environment in a number of ways. Natural processes transport phosphate to water through atmospheric deposition, ground water percolation, and terrestrial runoff. Municipal treatment plants, industries, agriculture, and domestic activities also contribute to phosphate loading through direct discharge and natural transport mechanisms. The very high levels of phosphorus in some of Florida's streams and estuaries are usually caused by phosphate mining and fertilizer processing activities.

High phosphorus concentrations are frequently responsible for accelerating the process of eutrophication, or accelerated aging, of a waterbody. Once phosphorus and other important nutrients enter the ecosystem, they are extremely difficult to remove. They become tied up in biomass or deposited in sediments. Nutrients, particularly phosphates, deposited in sediments generally are redistributed to the water column. This type of cycling compounds the difficulty of halting the eutrophication process.

Chapter 4: ASSESSMENT OF SOURCES

4.1 Overview of Modeling Process

A watershed is the land area which catches rainfall and eventually drains or seeps into a receiving waterbody such as a stream, lake, or ground water (EPA, 1997). Land use pollution loading models have been often used to assess watershed impacts on water quality of a receiving waterbody. A detailed watershed model would be beneficial to estimate time series nutrients loads from potential sources of the watershed to predict algal responses in the receiving waterbody where the time scale of actual biological responses to nutrient loading from the watershed is at least equal to or less than that of the model prediction (EPA 1997).

The external load assessment from the watershed and the resulting in-lake water quality were evaluated using a combination of WAM-WASP. The Watershed Assessment Model (WAM) is a Geographic Information System (GIS) based model that allows users to interactively simulate and assess the environmental effects of various land use changes and associated land use practices. WAM has previously been used to simulate watershed loading in many Florida watersheds such as the Myakka River, Lower St. Johns River, Suwannee River, Lake Okeechobee, Lake Hancock, and Lower Saddle Creek.

Detailed application of WAM and results of watershed water quality and quantity for Hillsborough River and its tributaries was reported by Soil and Water Engineering Technology, Inc. (2005) to Florida Department of Environmental Protection. Briefly, WAM is a grid cell representation of the watershed as opposed to using subbasin polygons. Each cell contains attributes of the dataset, e.g. land use code numbers that can be overlaid with cells of other grids. The benefits of using grids over polygons include computational speed and output resolution. The cell size is dependant on the desired resolution. A grid cell size of 1 hectare (2.47 acres) was chosen with the intent that this would adequately characterize the land use and capture linear features such as highways. WAM was developed to simulate the primary physical processes important for watershed hydrologic and pollutant transport. The WAM GIS coverage includes land use, soils, point source service areas, and rainfall, and are used to calculate the combined impact of the watershed characteristics for a given grid cell. Once the flow and constituent loads for each unique cell within a watershed are determined by various field-scale submodels, the cumulative impact for the entire watershed is determined by first attenuating the constituent to the sub-basin outlets and then calculating an area-weighted factor for the attenuated load generated at each cell. Constituents are attenuated based on the following factors: flow distances (overland to nearest water body, through wetlands or depressions and within streams to the sub-basin outlet), flow rates in each related flow path, and the type of wetland or depression encountered. **Figure 4.1** shows the conceptual routing schemes and flow distances that are calculated for each cell.

A portion of the flow in each cell is converted to ground water based on the soil type and amount of imperviousness estimated for each land use. Surface flow that enters depressions is also converted to ground water (GW in **Figure 4.1**). Ground water is routed to the nearest stream unless directed otherwise.

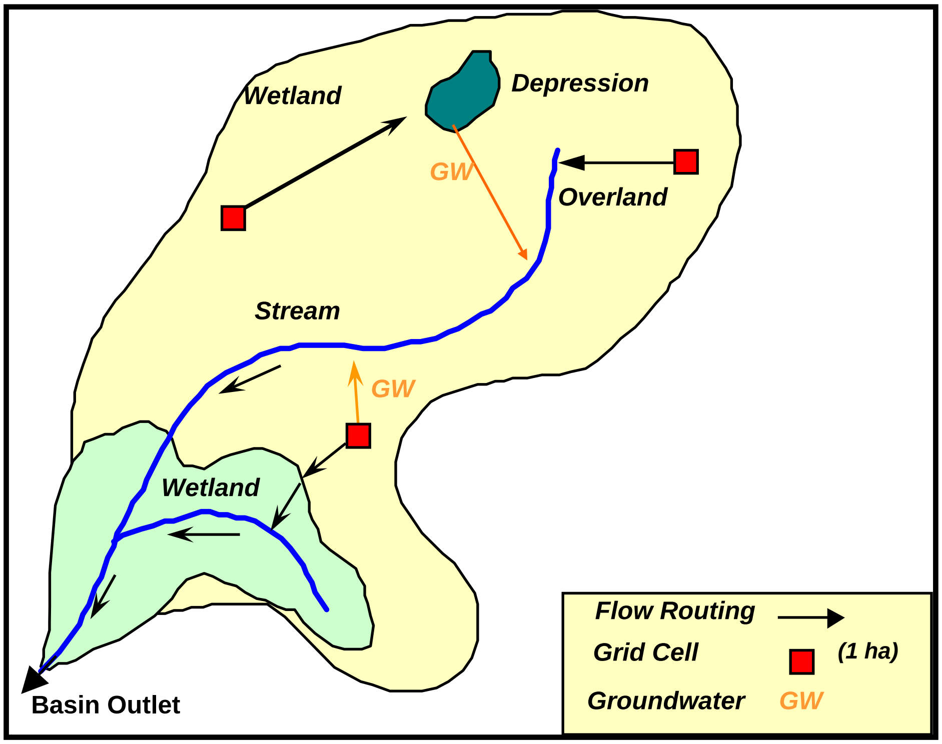

Figure 4.1 WAM Conceptual Routing Diagram (SWET, 2005)

4.2 WAM Setup for Hillsborough River Watershed

WAM was utilized to estimate the flows and water quality throughout the Hillsborough River Watershed. Water quality variables simulated include nonpoint nutrients (ammonia, nitrate, soluble organic nitrogen, particulate nitrogen, soluble and particulate phosphorus), total suspended solids (TSS), Biological Oxygen Demand (BOD), and land sourced dissolved oxygen (DO) loads to the nearest stream (only when linked to WASP). The output from WAM is then used by the WASP model to simulate the DO and Chla responses within the impaired WBIDs.

National Hydrologic Datasets (NHDs) were used for the hydrologic stream network. The Primary Basin Setup procedure in WAM was used to layout and code the stream network. The line segments of the NHDs were coded with numbers in descending order from upstream to downstream, but not all of the segments were used. For modeling purposes, it is possible to represent clusters of segments as one reach. The selected segments, when finished, are referenced to in WAM as model reaches within the hydrologic network.

Model reach types include stream, canal, slough, ground water, and shoreline. The ground water reach is of particular interest. This type of reach was used to create connectivity between isolated surface reaches and the remainder of the reach network. Direct surface water is not routed to this type of reach. This reach type was also used to direct ground water out of the basin to account for groundwater that emerges into offsite streams or springs.

The Blasroute submodel within WAM was modified to allow these ground water withdrawals to be extracted from recharge water actively flowing to a stream and to build a groundwater deficit when groundwater recharge was inadequate to meet withdrawal rates. WAM was further modified to allow surface water to refill the groundwater deficit before flow as allowed. These adjustments allowed WAM to match the rapid drop off of the hydrographs and long periods of no flow observed in the measured data. Septic tank usage was found to be taking place within all of the mapped service areas. To account for this, it was assumed that mostly low density residential would still be on septic, so this land use was cut out of the service area coverage. This helped the water quality and water balance in several basins.

The hydrologic/hydraulic responses to model inputs such as rainfall, land use, soils, and hydrography are investigated first followed by the water quality. The initial data checks for causes of discrepancies are land use type or management misrepresentations and stream network layout errors. For in-stream flow problems, typically flow structure controls or stream profile information have data errors due to data entry errors or problems in the original data sets. Also, ground water withdrawal data are critical for properly balancing water flows. Water quality simulation problems are typically caused by land use mapping errors and limited data for land use management activities such as fertilizer usage, wastewater treatment, and use of retention/detention ponds.

The GIS based processing and user interface in the WAM model allows for a number of user options and features to be provided including:

- Source Cell Mapping of TSS, BOD, and Nutrient Surface and Ground water Loads;
- Tabular Ranking of Land Uses by Constituent Contributions;
- Overland, Wetland, and Stream Load Attenuation Mapped Back to Source Cells;
- Accommodation of Point Source Information;
- Adjustments based on WWTP Service Area locations;
- Hydrodynamic (momentum component turned off to increase speed) Stream Routing of Flow and Constituents with Annual, Daily or Hourly, and Subhourly Outputs; and
- User Interface to Run and Edit Land Use and BMP Scenarios.

Nonpoint source (NPS) data were compared to observed data to be sure that reasonable results were being generated for the non-point delivery of nutrients, BOD, DO, and TSS to the streams. WAM was modified so that the DO load in surface NPS flows were calculated as a fraction of the saturated DO level for the current temperature. The fraction to be used was specified as 75%. Detailed setup and calibration/validation of WAM for this Hillsborough River Watershed was documented in Technical Memorandum submitted by Soil and Water Engineering Technology, Inc. (SWET, 2005).

Rainfall datasets were created from monitoring information obtained from the National Weather Service (NWS). The stations were initially chosen based on their locations for adequate spatial coverage of the study area and for an appropriate period of record. For flexibility in modeling, it is important to have an adequate period of record. A 24-year period between January 1980 and December 2003 was chosen, though it was expected that the model would not use this entire period. The model uses the first five years to reach equilibrium with antecedent conditions. The model output reflects only the remaining years of input data.

Figure 4.2 WAM Rainfall Stations and Zones (SWET, 2005)

The rainfall records were then reviewed for completeness. Some stations were rejected because of abnormal annual rainfall compared to surrounding stations. The data from the selected rainfall stations were formatted and converted to centimeters for use by WAM. Theissen’s method was applied to create rainfall zones for each station as shown in **Figure 4.2.**

4.3 Potential Sources in the Watershed

TMDL analysis is the identification of pollutant source categories, source subcategories, or individual sources of the pollutant of concern in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either “point sources” or “nonpoint sources.” Historically, the term point sources have 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). 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. 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.

4.3.1 Point Sources

There is only one NPDES permitted wastewater treatment facility (FL0037389) in the Mill Creek watershed. The Crystals International, Inc. discharges a maximum flow of 4.02 MGD through a discharge pipe to Westside Canal thence to Pemberton Creek, a tributary to Baker Creek. The only nutrient this facility is permitted to discharge is un-ionized ammonia, at a limit of 0.02 mg/L. The Domestic Wastewater facility of Plant City (FL 0026557), which was relocated to East Canal in late 1997, discharged to Mill Creek only during the period of 1996-1997. There are no permitted wastewater treatment facilities or industrial facilities that discharge either directly or indirectly into the Spartman Branch watershed.

Municipal separate storm sewer systems (MS4s) may discharge nutrients to waterbodies in response to storm events. To address stormwater discharges, the EPA developed the NPDES stormwater permitting program in two phases. Phase I, promulgated in 1990, addresses large and medium MS4s located in incorporated places and counties with populations of 100,000 or more. Phase II permitting began in 2003. Regulated Phase II MS4s, which are defined in Section 62-624.800, F.A.C., typically cover urbanized areas serving jurisdictions with a population of at least 10,000 or discharge into Class I or Class II waters, or Outstanding Florida Waters. The stormwater collection systems in the Baker, and Spartman Creek watersheds, which are owned and operated by Hillsborough County in conjunction with the Florida Department of Transportation, are covered by Phase I MS4 permits. Within the Tampa Bay Basin, the stormwater collection systems owned and operated by Plant City, Hillsborough County, and the Florida Department of Transportation for Hillsborough County are covered by an NPDES municipal separate storm sewer system (MS4) permit, FLS000006. Hillsborough County is the lead co-permittee for the Spartman Branch watershed. In October 2000, Hillsborough County drafted a watershed management plan involving berm construction, channel improvements, and structural upgrades for flood control and some water quality treatment. Other recommendations for the Spartman Branch watershed included beginning a study to identify areas or sources that discharge pathogens, and beginning to provide treatment through the implementation of best management practices (BMPs) to reduce the loadings. The Hillsborough Planning and Growth Management Department is in the process of carrying out a septic tank study for the watershed that identifies the location of septic tanks, assesses their impacts on water quality, and recommends management techniques to improve their efficiency.

4.3.2 Nonpoint Sources and Land Uses

All of the GIS spatial datasets necessary to set up WAM were provided by the Florida Department of Environmental Protection in FDEP's custom Albers projection in the HPGN (metric) datum. Most of the datasets were obtained by FDEP and SWET from other sources including the Southwest Florida Water Management District (land use), Tampa Bay Water, Natural Resources Conservation Service (soils) and United States Geological Survey (topography and hydrography). The SURGO soils datasets were modified to include abbreviated Compname soil designations in order that these attributes would match WAM soils database established for the State. The land use GIS coverage provided by the South West Florida Water Management District (SWFWMD) uses the Florida Land Use Code Classification System (FLUCCS), which is also used by WAM. Therefore, no modifications were necessary. The FLUCCS codes are related by WAM to land use parameter files (LANDUSE.BNZ and LU-EAA.BNZ) for obtaining characterization parameters. Within the Hillsborough River Basin, land use type varies from dense urban to rural and agricultural. The three most dominant land uses are agricultural (31%); residential, industrial, and urban (28%); and wetlands (21%). The dominant agricultural land use in the basin is cropland/pastureland.

Stormwater runoff drains in a network of streams to the Hillsborough River, which discharges to Hillsborough Bay and, ultimately, to Tampa Bay and the Gulf of Mexico. There are special hydrologic features within the basin that had to be accommodated for in the model simulations. A reservoir and flood protection system was constructed in the 1960s. This system includes a widened section of the Hillsborough River and control structures operated to provide flood protection to the southern reaches while maximizing basin storage for consumptive water use. The structures control flow by diverting water to or drawing water from an offsite conveyance system known as the Tampa Bypass Canal.

The spatial distribution and acreage of different land use categories for the Baker Creek, Spartman Branch and Mill Creek watersheds were identified using 1999 and 2006 land use coverage data (scale 1:40,000) contained in the Department's geographic information system (GIS) library.

Baker Creek

Land use categories in the watershed were aggregated using the simplified Level 3 codes tabulated in **Table 4.1**, showing the acreage of the principal land uses in the watershed. Spatial distribution of the principle land uses was shown in **Figure 4.3**. The dominant land use category is the agricultural and primarily low and medium residential areas. The total area occupied by the residential land use category is about 13334 acres and accounts for about 39.0% of the total watershed area (**Figure 4.4**). Another 24% of the watershed is claimed by agriculture or cropland/tree crops. The natural land use area, which includes upland forest, water, and wetland, accounts for about 20% of the total watershed area.

Spartman Branch

Land use categories in the watershed were aggregated using the Level 3 codes tabulated in **Table 4.2**, showing the acreage of the principal land uses in the watershed. The dominant land use category is commercial, showing the total area of 1,232 acres and accounting or about 25% of the total watershed area. The total area occupied by the residential land use categories is about 1,575 acres and accounts for about 32% of the total watershed area (**Figure 4.6**). Another 13% of the watershed is claimed by cropland/pastureland/tree crops. The natural landuse area, which includes upland forest, water, and wetland, accounts for about 25% of the total watershed area.

Mill Creek

As shown in **Figure 4.8** and **Table 4.3**, the predominant land use coverages for Mill Creek 2006 land use are commercial and medium density residential, showing the total area of 1,980 acres and accounting for about 57.3% of the total watershed area. The natural land use areas such as upland forest, water, and wetland account for about 21.1% of the total watershed. Other uses include low density residential (2.7%), high density residential (6.1%), cropland/pasture land/tree crops (5.6%). Compared to the 2006 land use coverages in the Mill Creek watershed, there is no significant difference found in the 1999 land use coverages (**Figure 4.7**). Medium density residential in 2006 has been changed the most among the categories, by about 66.8 acres corresponding to only 2% increase in the total acres of the watershed. The natural land use has slightly increased by 0.5% from 20.6% in 1999 to 21.1% in 2006. Therefore, it was decided that results obtained from the model simulation during the period of 1996-2002 can be applied to the water quality conditions during the verified period of 2001-2008.

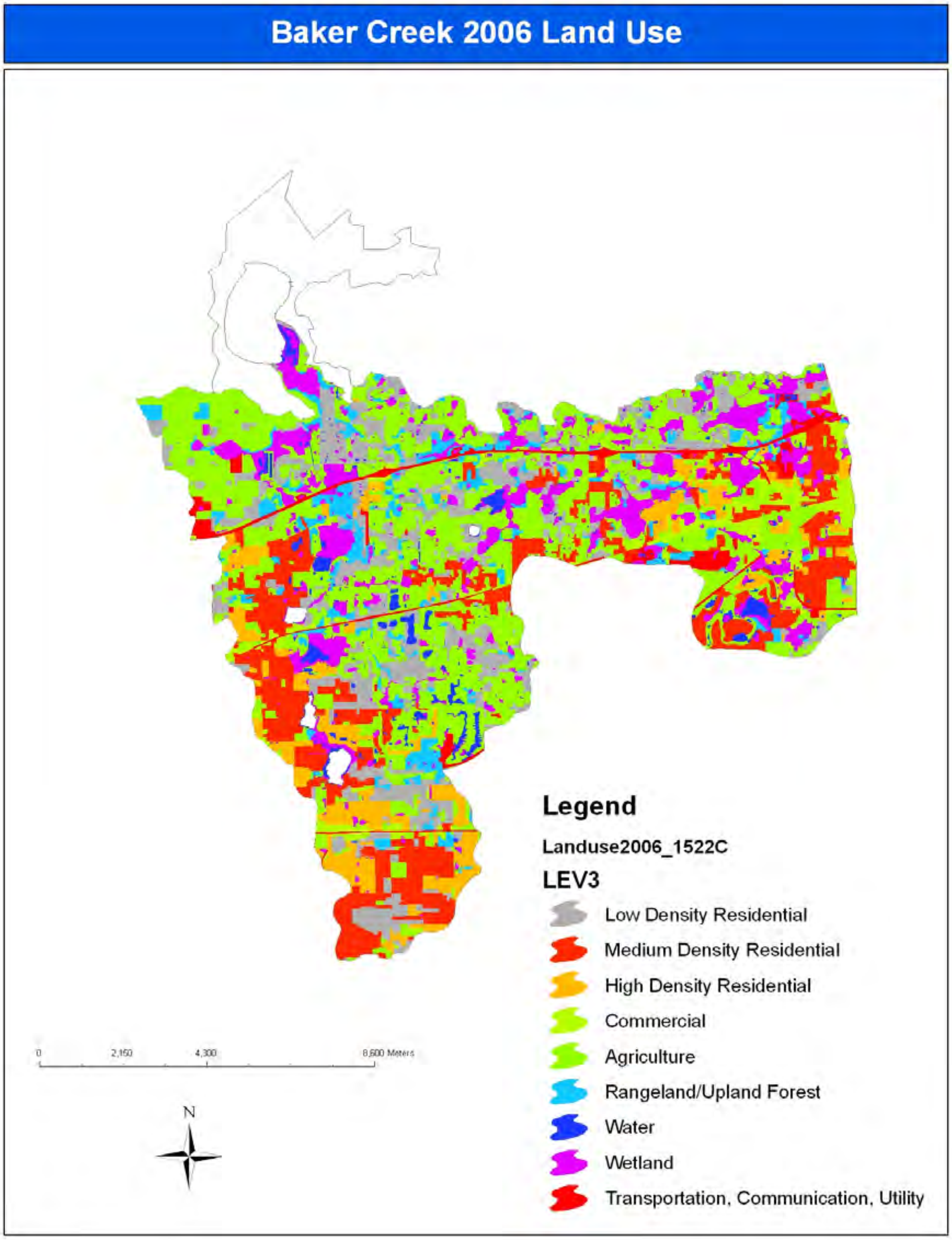

Figure 4.3 Land Use Categories in the Baker Creek Watershed

Table 4.1 Classification of Land Use Categories in the Baker Creek Watershed

FLUCC	Land Use Category	Acres in 2006 (acre)
110	Low density residential	5,394
120	Medium density residential	5,297
130	High density residential	2,643
140	Commercial	4,899
210/220	Cropland/improved pasture/tree crops	8,304
300/400	Undeveloped rangeland/upland forests	2,126
500	Water	8,80
600	Wetlands	3,923
800	Transportation/Communication/Utility	1,080
	Total	34,546

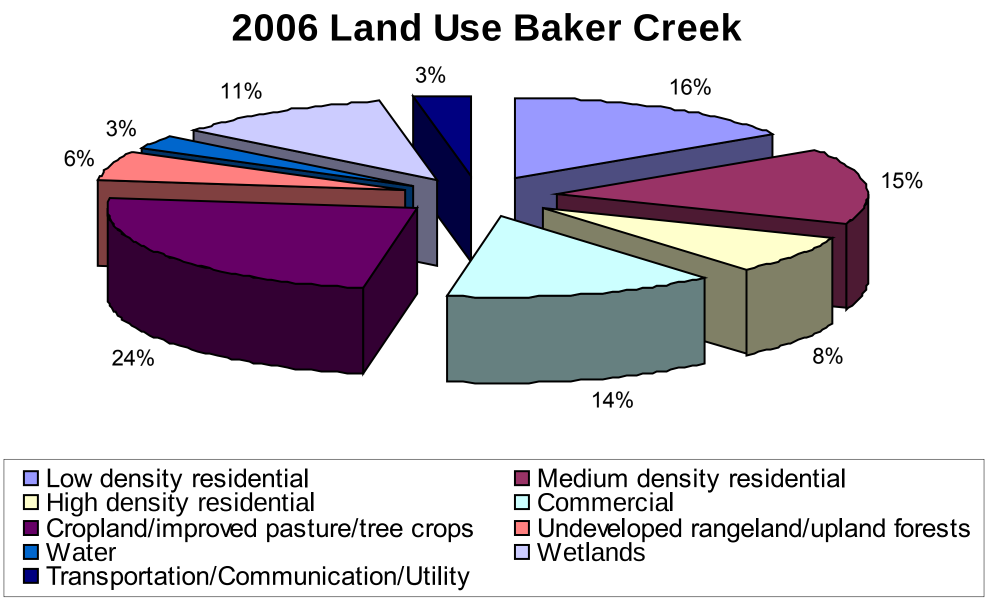

Figure 4.4 Percent Acreage of the 2006 Land Use Categories in the Baker Creek Watershed

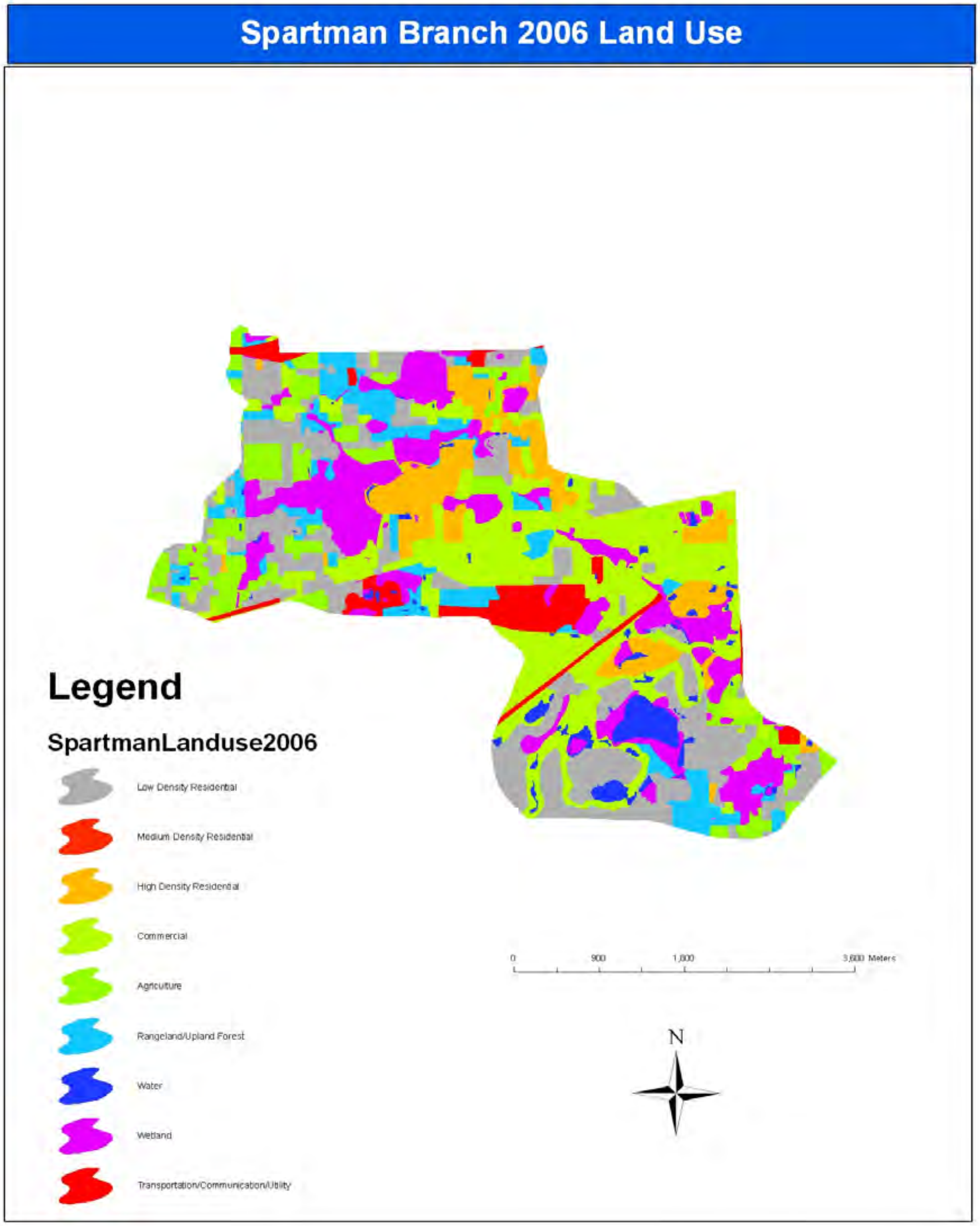

Figure 4.5 2006 Land Use Categories in the Spartman Branch Watershed

Table 4.2 Classification of Land Use Categories in the Spartman Branch Watershed

FLUCC	Land Use Category	Acres in 2006 (acre)
110	Low density residential	281
120	Medium density residential	826
130	High density residential	469
140	Commercial	1,232
210/220	Cropland/improved pasture/tree crops	643
300/400	Undeveloped rangeland/upland forests	254
500	Water	165
600	Wetlands	804
800	Transportation/Communication/Utility	256
	Total	4,927

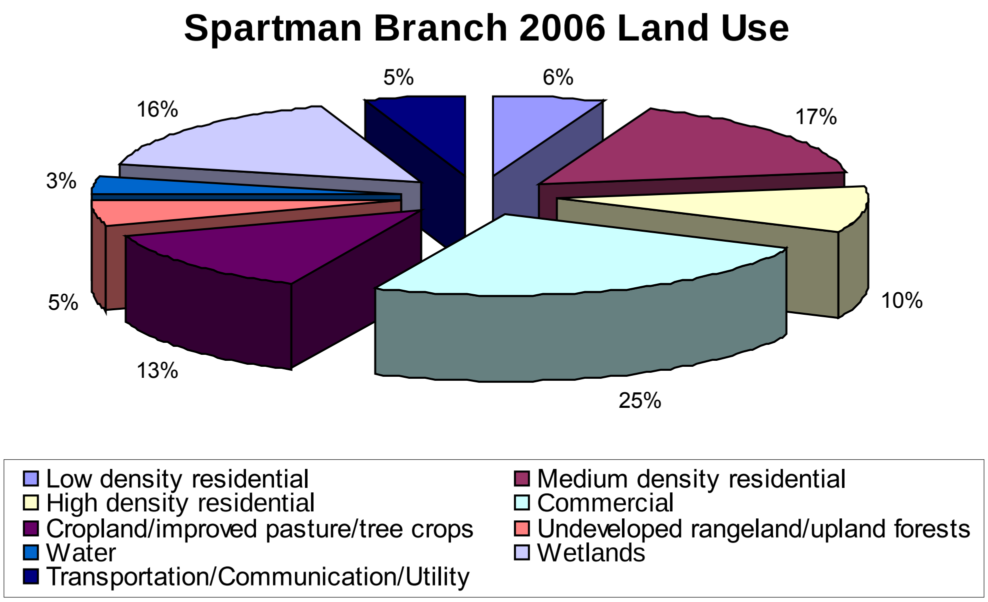

Figure 4.6 Percent Acreage of the 2006 Land Use Categories in the Spartman Branch Watershed

Table 4.3 Total Acreage of the Various Land Use Categories in the Mill Creek Watershed in 1999 and 2006

FLUCC[1]	Land Use Category	Acres in 1999 (acre)	Acres in 2006 (acre)	Changes in Land Use (acre)
110	Low density residential	109.3	93.5	-15.8
120	Medium density residential	898.4	965.2	66.8
130	High density residential	202.2	212.3	10.1
140	Commercial and Industrial	1,023.0	1,014.8	-8.2
210/220	Cropland/improved pasture/tree crops	271.1	194.3	-76.8
300/400	Undeveloped rangeland/upland forests	195.0	176.8	-18.2
500	Water	23.7	24.7	1.0
600	Wetlands	493.8	529.5	35.7
800	Transportation/Communication/Utility	239.3	245.3	6.0
	Total	3,456.4	3,456.4	0.0

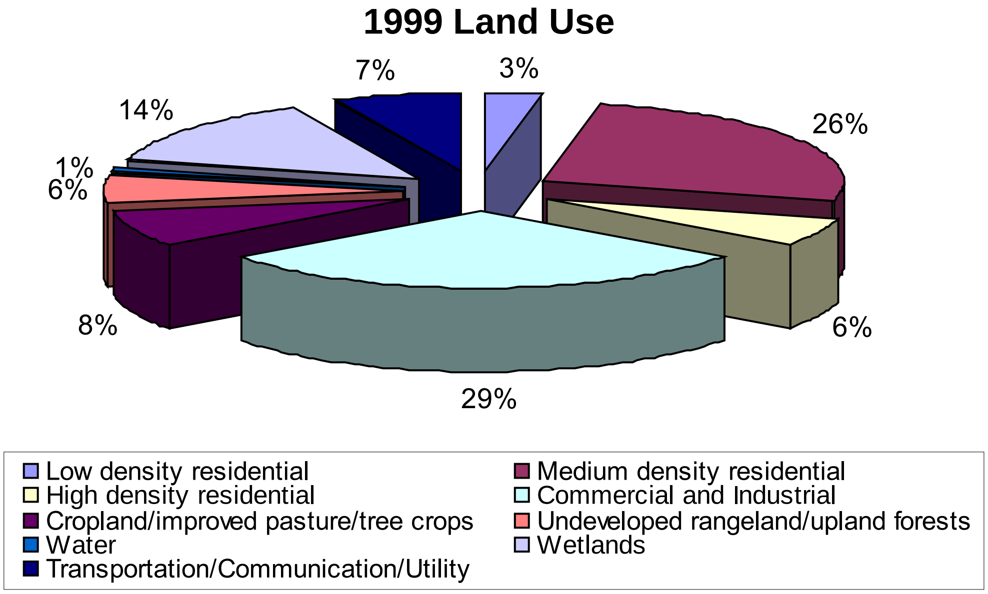

Figure 4.7 Percent Acreage of the 1999 Land Use Categories in the Mill Creek Watershed

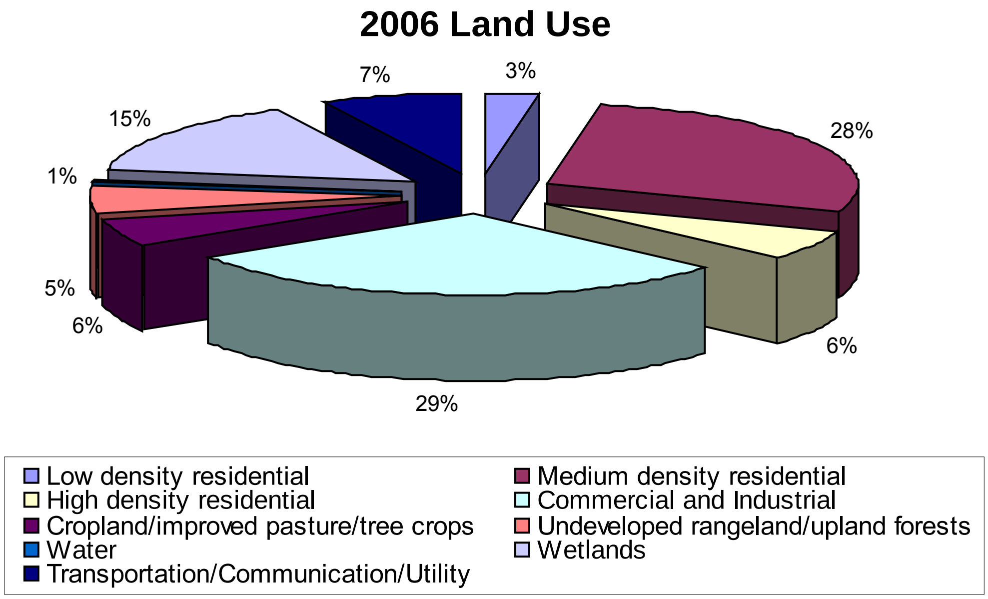

Figure 4.8 Percent Acreage of the 2006 Land Use Categories in the Mill Creek Watershed

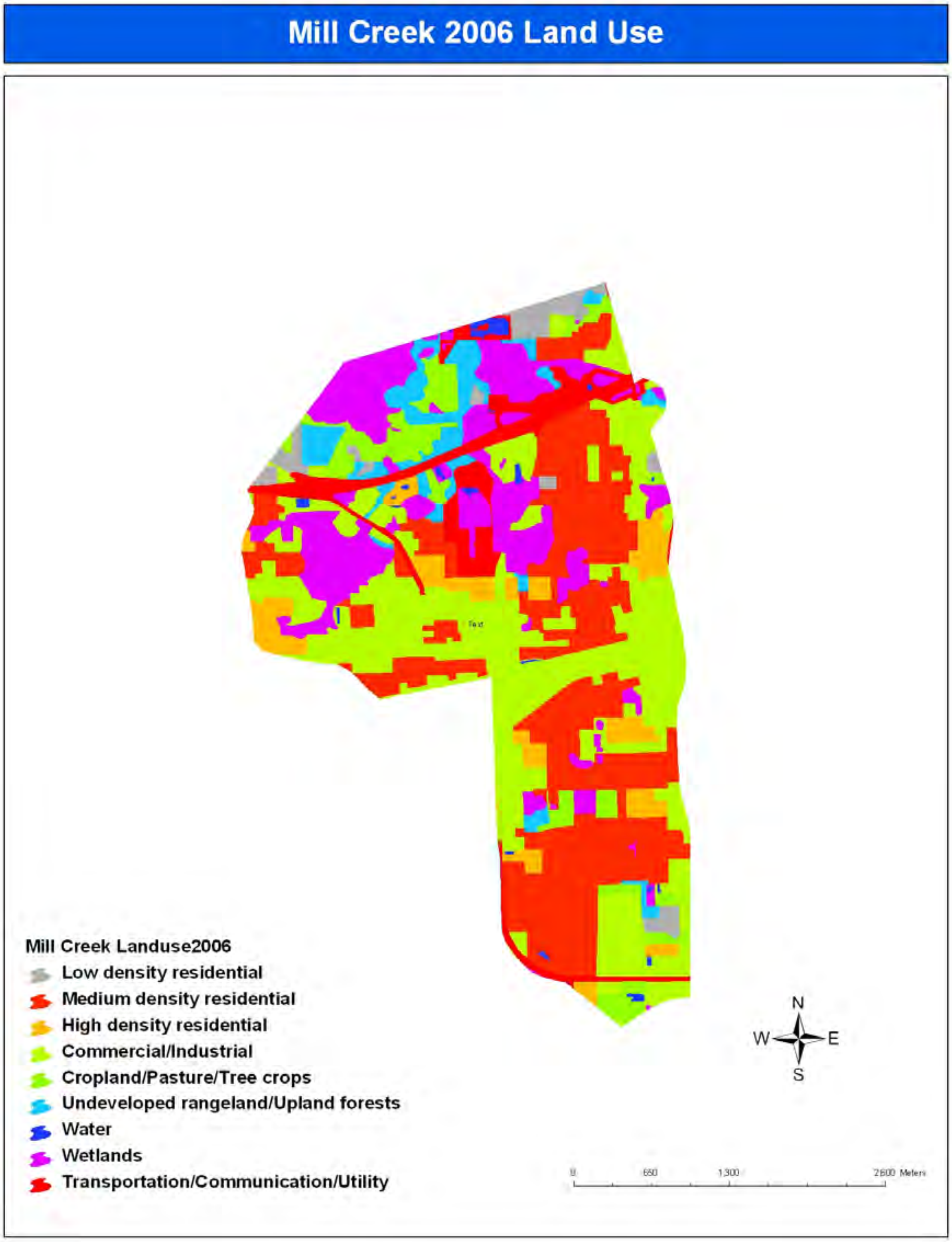

Figure 4.9 2006 Land Use Categories in the Mill Creek Watershed

Hillsborough County Population

The U.S. Bureau reports that the total population for Hillsborough County for 2000 was 998,948 with 425,962 housing units. For all of Hillsborough County, the Bureau reported a housing density of 405 houses per square mile. This places Hillsborough County as having one of the highest housing densities in the state in 2000; a ranking of 6th out of 67 counties in the state of Florida (U.S. Census Bureau, 2004). This is also supported by the land use coverage information, which shows that 30.9 percent of land use is dedicated to residences in Baker Creek, 28.5% in Flint Creek, 30.2% in Lake Thonotosassa, and 28.4% in Spartman Branch. Most of the high housing density is located further west of the Flint Creek watershed in the Tampa Bay and Saint Petersburg areas. The Baker Creek watershed is primarily composed of medium density residential (16.8%), and only 28.39 percent of the total land use in WBID is dedicated to residences. The extrapolated human population (2,666 persons per square mile in Hillsborough County) was approximately 143,910 persons in the Baker Creek watershed, 20,522 persons in the Spartman Branch watershed, and 14,396 persons in the Mill Creek watershed.

Septic Tanks

Onsite sewage treatment and disposal systems (OSTDSs), including septic tanks, are commonly used where providing central sewer is not cost-effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDSs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTDS is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, however, OSTDSs can be a source of nutrients (nitrogen and phosphorus), pathogens, and other pollutants to both ground water and surface water.

Septic tank effluent (STE) characteristics and loading rates have been reported in several studies (CDM, 1991; IFAS, 1984). STE contains varied concentrations of nitrogen, phosphorus, chloride, sulfate, sodium, detergent surfactants, and pathogenic bacteria and viruses. OSTDS use soil adsorption capabilities to remove nutrients and bacteria from the treated effluent. Removal of TN in soils could vary from 40 to 60 percent (IFAS, 1984) before reaching the water table. Once the nitrogen has reached the form of nitrate (NO_3) in the water table, it remains stable as it is transported to a waterbody. Phosphorus is removed from the STE at a higher rate, 50 to 98 percent (CDM, 1991; IFAS, 1984), and from the ground water by sorption and precipitation. Phosphorus-contaminated waterbodies from OSTDS are indicative of proximity of these systems, usually less than 150 ft (IFAS, 1984). When at least two feet of unsaturated soil exist between the infiltration system and the water table, BOD_5 removals of > 90%, TSS removals of > 95% and fecal coliform reductions of > 99% can be expected for a functional and properly maintained septic tank. Bacteria and viruses are effectively removed by adsorption and sorption processes in the ground water and are not transported far from the STE source.

IFAS estimated 11 to 18 lb/yr/capita of TN loading factor to the water table; whereas, a 9.2 lb/yr/capita was reported by EPA (2002). Likewise for TP, the estimated per capita loading factors were 0.4 to 1.6 and 1.2 lb/yr, respectively. The difference relies on the decreasing loading rate of nutrients present in the current composition of detergent supplies that were implemented in recent years.

Hillsborough County Septic Tanks

As of 2001, Hillsborough County had roughly 100,483 septic systems (Florida Department of Health, 2009). Data for septic tanks are based on 1970 – 2001 census results, with year-by-year additions based on new septic tank construction. The data do not reflect septic tanks that have been removed going back to 1970. Based on the number of permitted septic tanks and housing units located in the county, approximately 76 percent of the housing units are connected to a wastewater treatment facility, with the remaining 24 percent utilizing septic tank systems. As of 2007, the county had a cumulative registry of 106,542 septic systems. Data for septic tanks are based on 1971-2007 census results, with year-by-year additions based on new septic tank construction. The data do not reflect septic tanks that have been removed going back to 1970. From fiscal years 1994–2007, an average of 938 permits/year for repairs was issued in Hillsborough County (Florida Department of Health, 2009).

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

The goal of this TMDL development is to identify the maximum allowable TN, and TP loadings from the watershed, so that Baker Creek, Spartman Branch, and Mill Creek will meet the narrative nutrient water quality criterion and the DO threshold and thereby maintain their function and designated use as a Class III water. In order to achieve the goal, the Department selected the Watershed Assessment Model (WAM) as a watershed-scale loading model and the Water Quality Analysis Simulation Program (WASP) as an in-stream water quality model. The linkage of WAM to WASP completed by SWET (2004) enables the Department to simulate in-stream DO and Chlorophyll-a responses to watershed nutrient loading.

5.2 Overview of the Water Quality Analysis Simulation Program (WASP)

The EPA WASP/EUTRO models are designed to simulate time-variable DO, the fate and transport of nutrients, and biological responses in receiving waterbodies. In the model, each waterbody can be divided into segments and each segment can include both the water column and underlying sediment column. The EUTRO module represents several physical-chemical processes that can affect the transport and interaction among the nutrients, phytoplankton, carbonaceous material, and dissolved oxygen (Wool et al., 2007).

The kinetic reactions in the EUTRO module can be described by four major interacting components (**Figure 5.1**):

- phytoplankton kinetics
- phosphorus cycle
- nitrogen cycle
- dissolved oxygen balance

These components consist of eight constituent systems: Ammonium (NH_4^+), Nitrate+Nitrite (NO_3^-+NO_2^-), Ortho-phosphate (PO_4^{3-}), Chlorophyll a (chl a), Dissolved Oxygen (DO), Carbonaceous Biochemical Oxygen Demand (CBOD), Organic Phosphorus (Org P), and Organic Nitrogen (Org N). The time-varying processes of advection, dispersion, point and diffusion mass loading and boundary exchange are presented in this module. The WASP/EUTRO model has been used to simulate eutrophication of Tampa Bay, FL and phosphorus loading to Lake Okeechobee, FL.

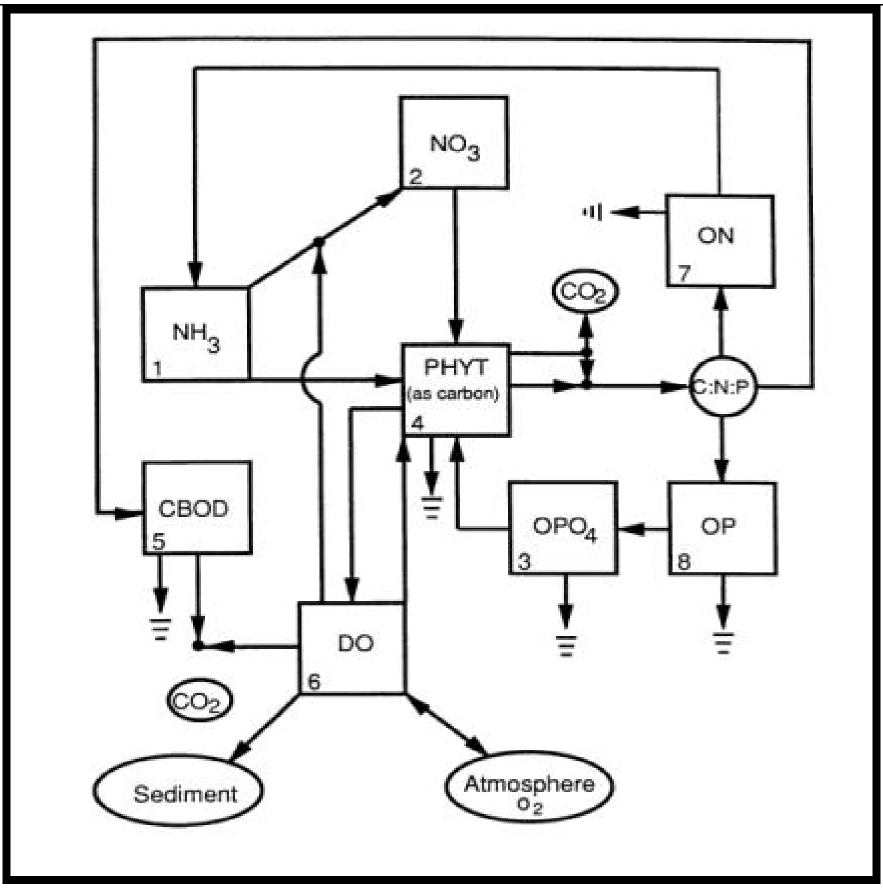

Figure 5.1 Kinetic Structure among the State Variables in the WASP/Eutro Model (WASP, User Manual v6)

5.2.1 WASP Configuration

A comprehensive water quality model using EPA WASP7.1 was developed to simulate DO and nutrient variations within Baker Creek, Spartman Branch, and Mill Creek and to assess the impact of various watershed loading scenarios on these receiving waters. Flow and boundary concentrations simulated by WAM were directly imported to the WASP/EUTRO model for in-stream water quality analysis via the Hydrodynamic Linkage and Import Model Network in WASP (SWET, 2004). The external HYD file controls the number of each segment, the volume of each segment, segmentation and segment geometrics (velocity, slope, length, width, etc), the time domain of the simulation such as the starting time and end time, and the model time step. The Hydrodynamic file information linked to WASP/EUTRO was summarized in **Table 5.1**. Point source contribution was also accommodated in the model. A segment was incorporated into the model for the two point sources from Plant City WRF and Crystals International, Inc. The Plant City discharge was relocated in late 1997, and contributed only during the period (1996-1998).

The boundary concentrations of eight state variables simulated by WAM were uploaded using the WASP Import Model Network. The variables include NH4+, NO3, OPO4, Organic N, Organic P, CBOD, chlorophyll-a and DO. These time series boundary concentrations were defined for each segment. The boundary concentrations of Chla and DO were set to 1.0 µg/L and 75% of DO saturation for all segments so that WASP can simulate in-stream Chla and DO.

Table 5.1 Summary of Hydrodynamic Information Linked to WASP

Start Date and Time	01/01/1996 0:00:00
End Date and Time	12/31/2002 23:42:00
Number Water Quality Model Segments	15
Hydrodynamic Time Step	1080 sec
Water Quality Model Time Step	0.0125 days
Number of Water Quality Time Step per Hydro File Read	1
Total Number of Hydrodynamic Model Outputs	204560

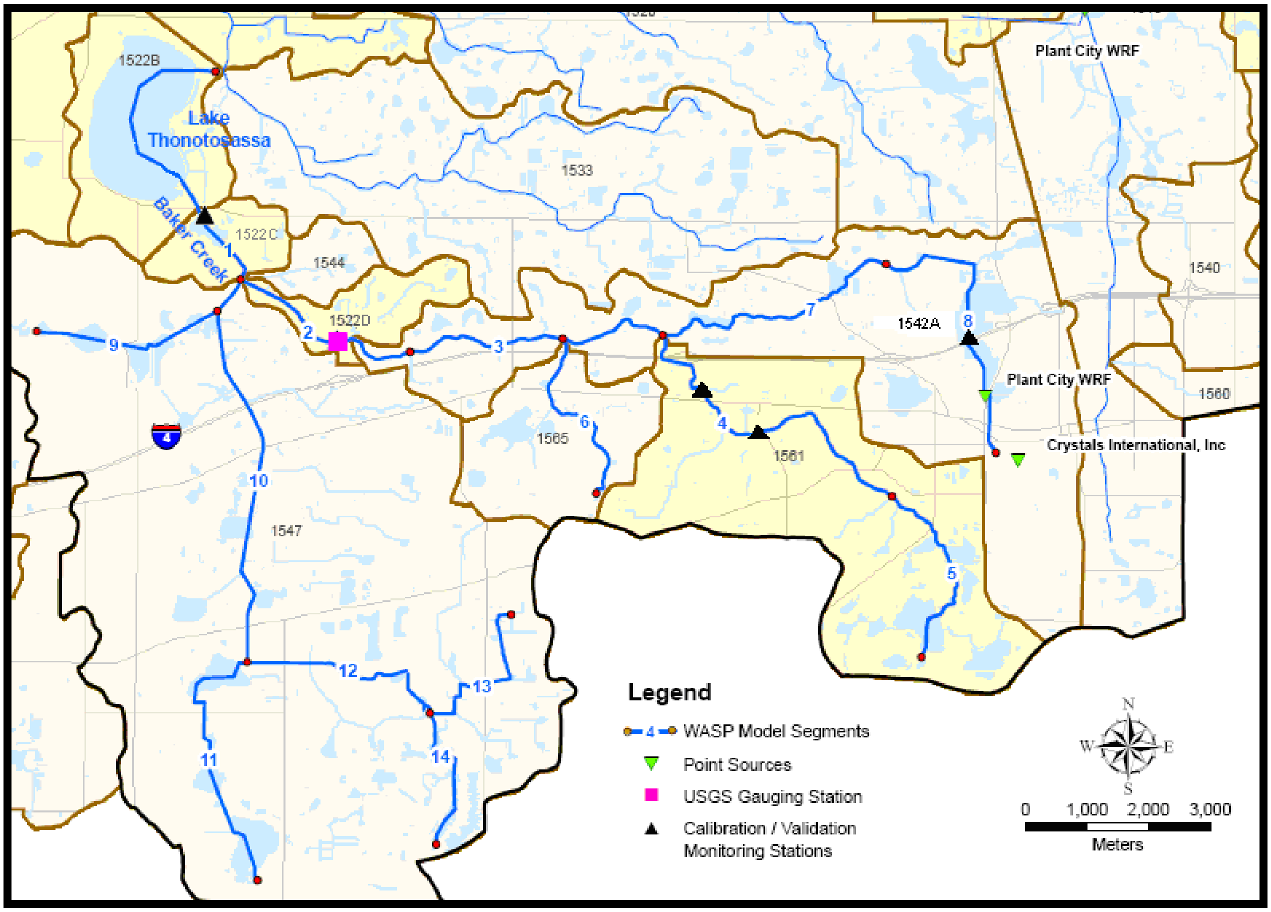

Figure 5.2 WASP Segments, Point Sources, USGS Gauge and EPC Water Quality Monitoring Stations for Bake Creek (WBID 1522C), Spartman Branch (WBID 1561), and Mill Creek (WBID 1542A)

5.3 Model Calibration

5.3.1 Hydrology Calibration

The watershed model (WAM) was initially calibrated by SWET for the Baker Creek watershed flow during the calibration and validation period of January 1, 1996 to December 31, 2002. Hydrology calibration was made using a USGS gage station located near McIntosh Road in WBID 1522D that corresponds to WASP segment 2 (**Figure 5.3**). However, no flow gauge station was available for Spartman Branch or Mill Creek to calibrate the simulated flows (**Figures 5.4 and 5.5**). For Baker Creek, daily flows (cubic meter per second) which were simulated by WAM and then linked to WASP were re-generated by the WASP postprocessor along with observed daily flows at the USGS station for the calibration purpose. A good agreement between the simulated flow and the observed flow was found during both the calibration and validation period, representing wet and dry seasons.

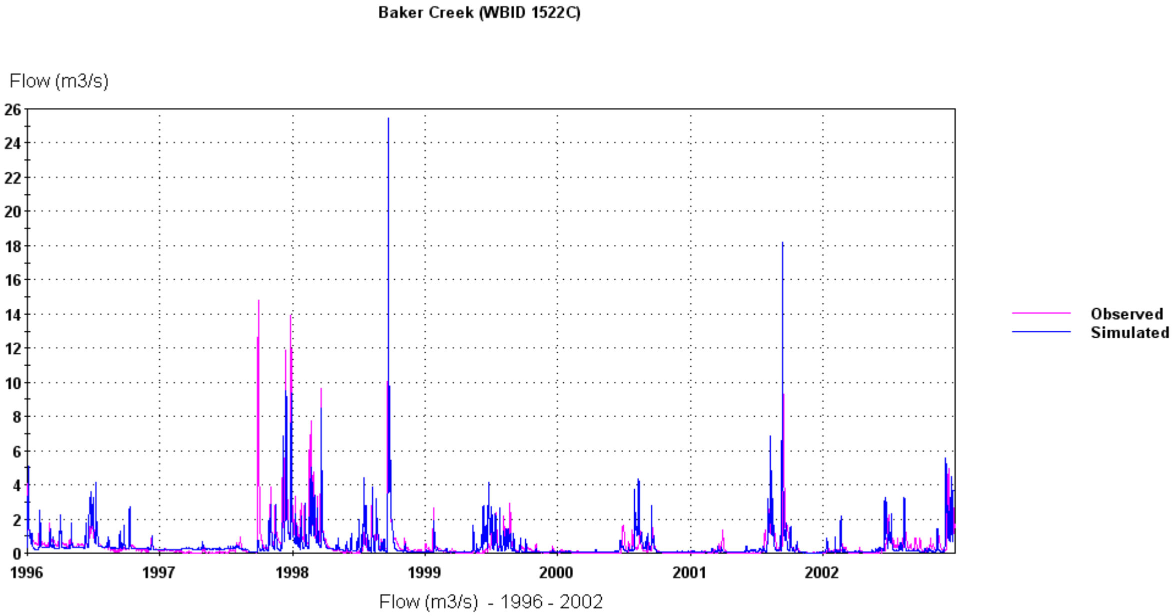

Figure 5.3 Observed versus Simulated Daily Flows (m^3/s) on Baker Creek near McIntosh Road during the Calibration Period from January 1, 1996 to December 31, 2002

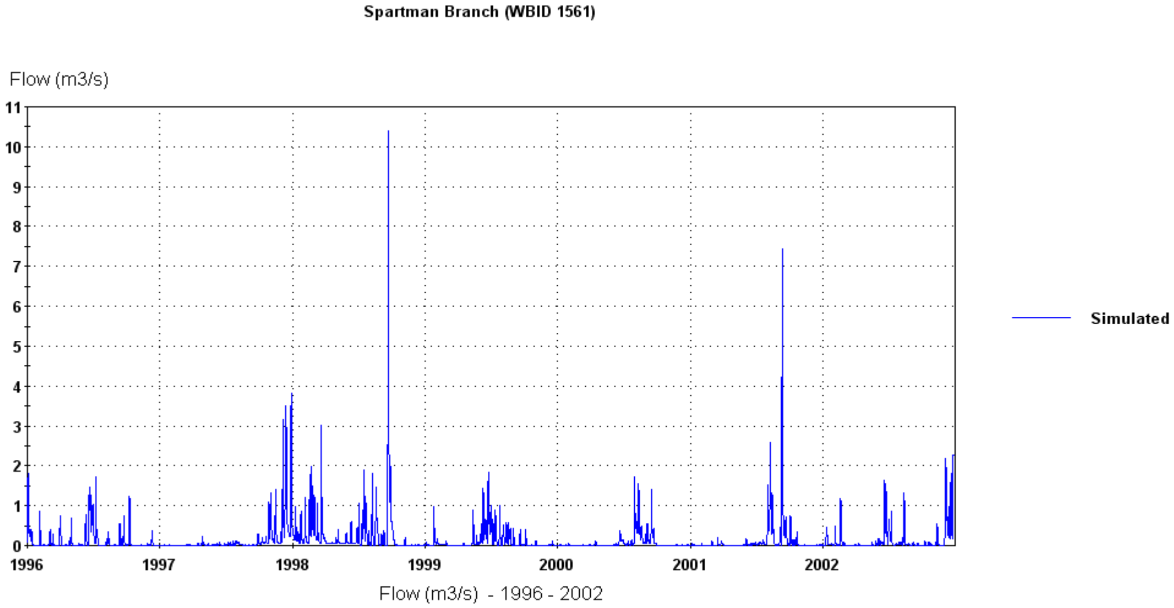

Figure 5.4 Simulated Daily Flows (m^3/s) on Spartman Branch during the Calibration Period from January 1, 1996 to December 31, 2002

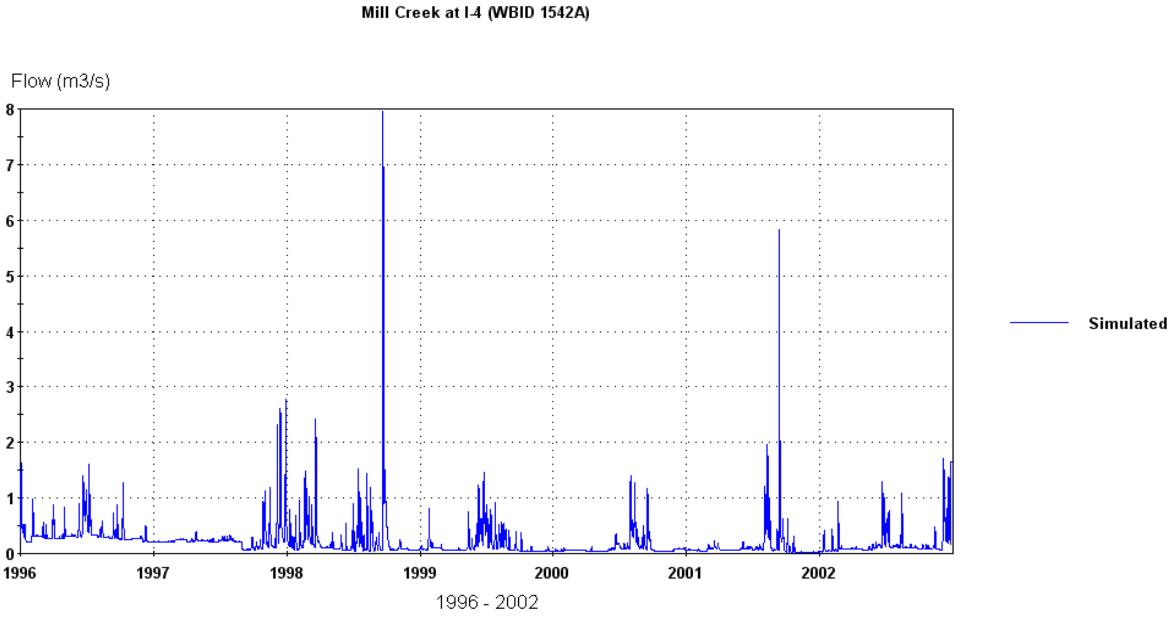

Figure 5.5 Simulated Daily Flows (m^3/s) on Mill Creek during the Calibration Period from January 1, 1996 to December 31, 2002

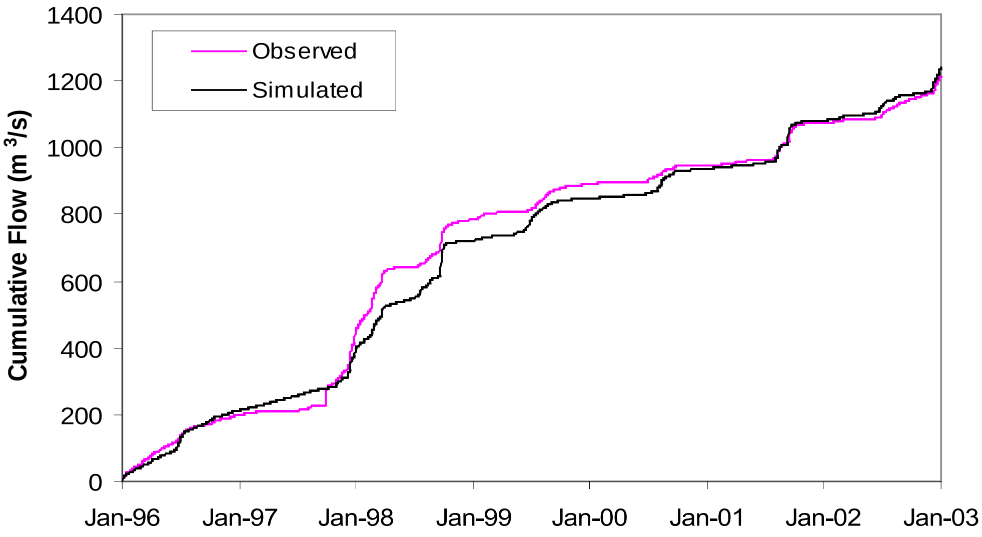

Figure 5.6 Cumulative Observed versus Simulated Flows (m^3/s) on Baker Creek near McIntosh Road during the Calibration Period from January 1, 1996 to December 31, 2002

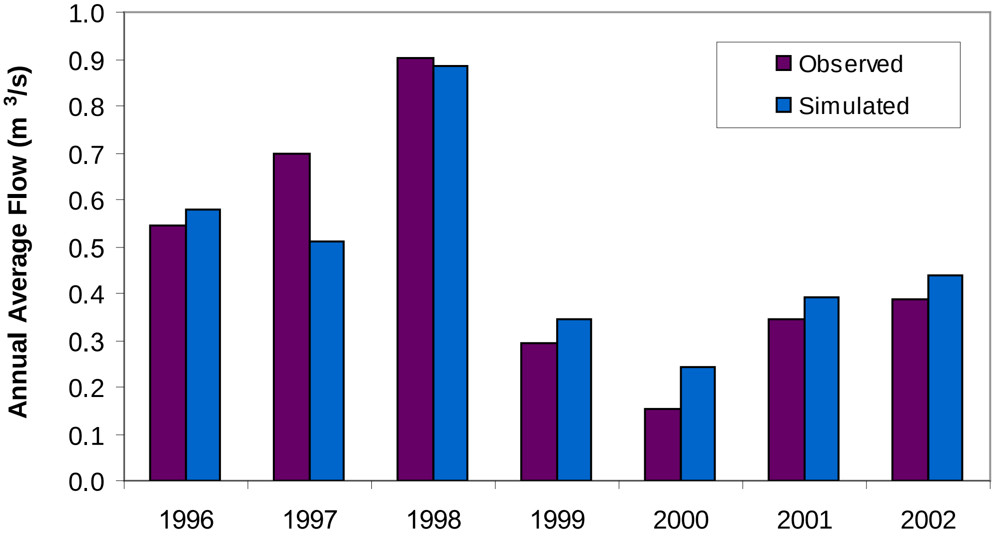

Figure 5.7 Observed versus Simulated Annual Average Flows (m^3/s) on Baker Creek near McIntosh Road during the Calibration Period from January 1, 1996 to December 31, 2002

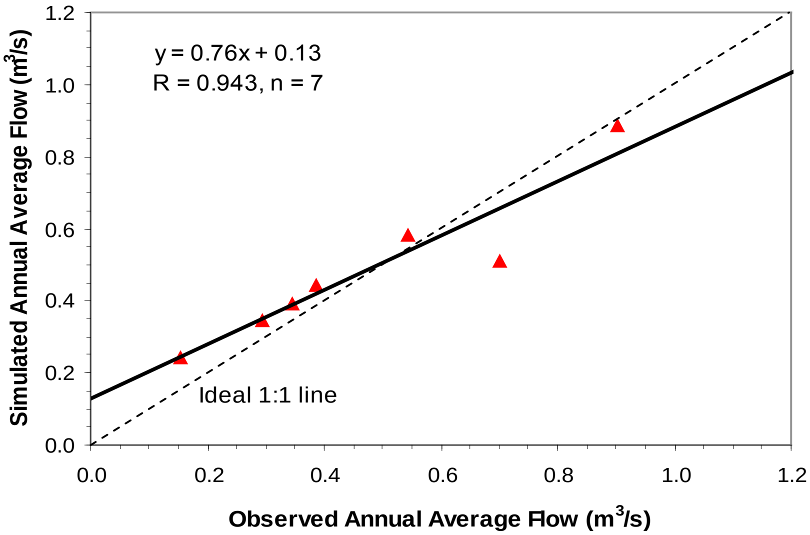

Figure 5.8 Relationship between Observed and Simulated Annual Average Flows (m^3/s) on Baker Creek near McIntosh Road during the Calibration Period from January 1, 1996 to December 31, 2002

A series of statistical analyses was conducted to find out how well the model predicted the pattern and quantity of the actual flows (**Figures 5.6 through 5.8**). Cumulative simulated flows were compared to the increment of the actual flow pattern over the simulation period (**Figure 5.6**). Overall, the increment of the simulated flow over time followed that of the observed flow. The 7-year cumulative flow simulated by the model was about 1240 m^3/s, corresponding to the total measured flow accumulation of about 1214 m^3/s observed during the same period. Such good agreement in total flow quantity provided great reliability when watershed loads of constituents of interest were estimated. Moreover, annual variations in the simulated flow showed only small differences from the observed flow. In **Figure 5.7**, observed annual average flows showed a wide variation over the period, ranging from 0.15-9.0 m^3/sec. Nevertheless, the annual mean flows matched the simulated annual mean flows in the range of 0.24-0.88 m^3/sec. The difference between the annual observed flow and the annual simulated flow, as calculated by the observed annual flow minus the simulated annual flow per each year, was between -0.089 m^3/sec and +0.020 m^3/sec in most years, except for the year 1997 when the difference was about 0.18 m^3/sec. Overall, there is a good relationship between the simulated annual average flows and the observed annual flows over the 7-year period, showing a correlation coefficient (R) of 0.943 (**Figure 5.8**). Based on the annual flow patterns and total quantity of flow, it was decided that the model hydrology simulation was acceptable for estimating watershed loads to the impaired waterbodies of Baker Creek and its tributaries, Spartman Branch, and Mill Creek.

5.3.2 Sensitivity Analysis of WASP Water Quality Parameters

Sensitivity analysis is a primary method of measuring the uncertainty and reliability of model constants and parameters that were applied to the model. Since Baker Creek and Spartman Branch were impaired for DO, WASP parameters controlling time series of DO variations were evaluated for this analysis. The selected parameters were reaeration, CBOD decay rate (Kd), phytoplankton growth rate, nitrification, and sediment oxygen demand (SOD). The reaeration rate coefficient can vary as a function of water velocity, depth, wind and temperature (WASP6.0 manual). In the EUTRO/WASP model, the user may specify a formula among the empirical methods for prediction of the site-specific reaeration coefficient. Considering the hydrological characteristics of the streams, the Covar method was selected to calculate reaeration rate as a function of velocity and depth by one of the three formulas; Owens-Gibbs, Churchill, or O'Connor-Dobbins.

Sediment Oxygen Demand (SOD) can be a major contributor to oxygen depletion in streams compared to other parameters. However, no field measurements of SOD were made for these impaired waterbodies. EPA has measured SOD values in Florida streams which generally ranged from 0.48 to 6.58 g/m^2/day (EPA, 2006). However, the time series of predicted DO concentrations fluctuated significantly with even small variations of SOD values. Therefore, sensitivity analysis for DO was conducted using the upper and lower range of the EPA values for model calibration. As shown in Figure 5.8, the time series variation of DO is highly sensitive to the SOD values in the range of 0.5 to 5.5 g/m^2/day. When model SOD rates were set to the values of 1.0-2.2 g/m^2/day, the model DO simulation appeared to obtain the best fit to the observed DO variations. These values are well in the range of measured SOD values for the Peace River TMDL (EPA, 2006) which were reported to be 3.35 g/m^2/day near Homeland, FL and 1.01 g/m^2/day near Ft. Meade. Moreover, it is reasonable that higher values of SOD (2.2 g/m^2/day) were applied to downstream segments for the DO calibration because a greater accumulation of fine, organic rich sediments would be expected in this segment (i.e., Baker Creek) compared to the upstream segments (i.e., Spartman Branch and Mill Creek). CBOD decay was not a major factor in the DO mass balance because the observed BOD concentrations (BOD_5: 1.9 ± 1.4 mg/L, n = 82) measured by the Hillsborough Environmental Protection Commission (EPC) were typically low in the stream.

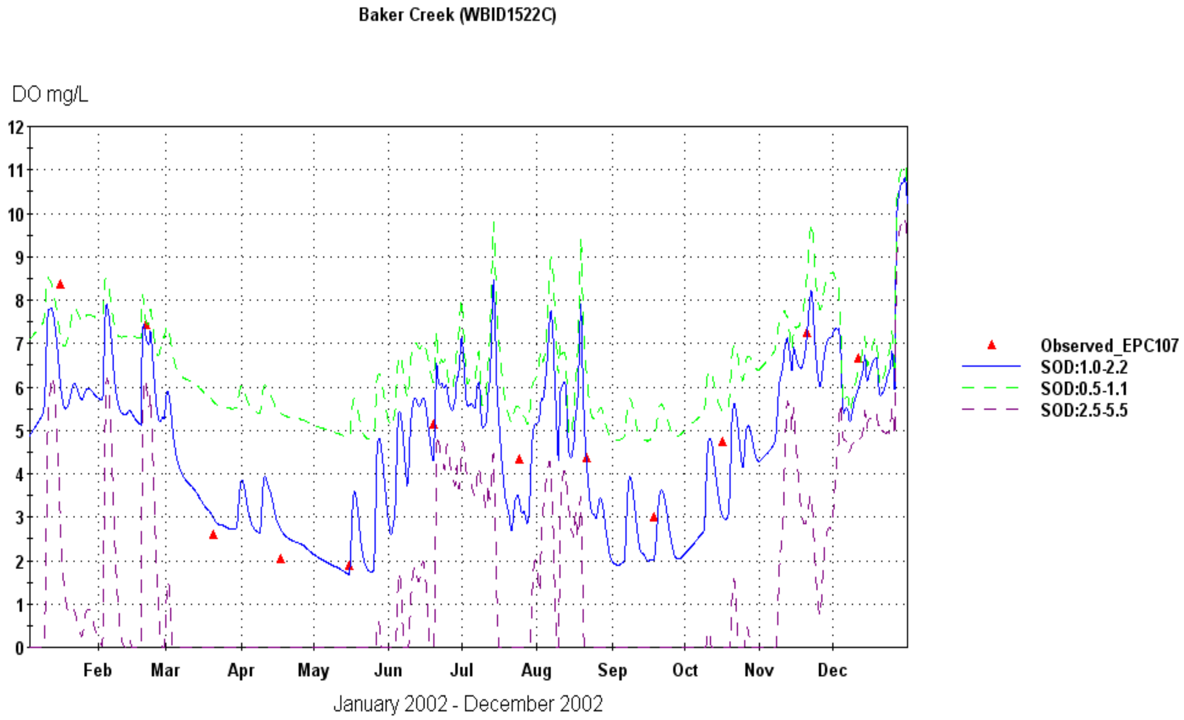

Figure 5.9 Sensitivity Analysis for DO Concentrations in Baker Creek from January 2002 to December 2002 as a Function of SOD

5.3.3 Water Quality Calibration

Three monitoring stations within the model area for each of the waterbodies were used for calibration purposes. These stations are located in Baker Creek upstream of Lake Thonotosassa (21FLHILL107), Spartman Branch (DEP Tampa District stations 21FLTPA 24030126 and 21FLTPA 28005778210285), and Mill Creek (21FLHILL24030035, currently renamed to 21FLHILL149). Monthly concentration data were available at the Baker Creek station over the calibration period (January 1999 through December 2002) for all parameters of interest. The Baker Creek station is located upstream of Lake Thonotosassa, and most of the tributary areas (i.e., Spartman Branch and Mill Creek) to Lake Thonotosassa (as well as the point source discharges) contribute to that station.

The major focus of the calibration was to compare modeled DO and chlorophyll-a concentrations to the observed data obtained from Baker Creek and Spartman Branch. For DO calibration, the sediment oxygen demand (SOD) and primary production were particularly focused on for the Baker Creek, Spartman Branch and Mill Creek DO calibration. The sediment benthic nutrient flux that influences primary production is also an important input parameter for DO and Chla calibration. As there is not any measured information on benthic NH_4 and PO_4 flux for the impaired waterbodies, literature values were used to calibrate the model. Although typical stoichiometric ratios of N and P could be used (Stumm and Morgan, 1981), the model was relatively well calibrated against the observed data when benthic flux N/P ratio was set to 1.0 for these waterbodies. Such phosphorus enrichments in the system possibly reflect high phosphorus environments of the Hillsborough River Watershed (located near phosphate mining areas) as indicated in the stream N/P ratios observed for Baker Creek.

Time series plots and box and whisker plots of the simulated and observed constituents for each impaired waterbody are shown in **Figures 5.10** through **5.20**. The predicted DO for Baker Creek showed reasonable agreement with DO observed from the EPC station 107 over the period of model calibration and validation (**Figure 5.11**). Monthly patterns of simulated DO also matched those of observed DO in a selected year 2002, showing greater DO values in winter and lower values before and after high flow regimes during the summer (**Figure 5.11**). The box and whisker plot also indicated that mean, median, and distribution percentiles of simulated DO over the period of simulation were very similar to those of observed DO (**Figure 5.12**). There were excellent agreements in mean, median, 10th and 90th percentiles of simulated versus observed DO. For example, mean and median for the observed DO were 4.7 mg/L and 4.9 mg/L, much similar to 4.9 mg/L and 5.0 mg/L for the simulated DO. The 10th and 90th percentiles of the observed DO values were 1.7 mg/L and 7.2 mg/L, respectively, whereas the 10th and 90th percentiles of the simulated values in the range were 2.5 mg/L and 7.8 mg/L, respectively. Overall, the results of statistical analyses between simulated versus observed DO indicated that the model well predicted the existing conditions for DO in Baker Creek.

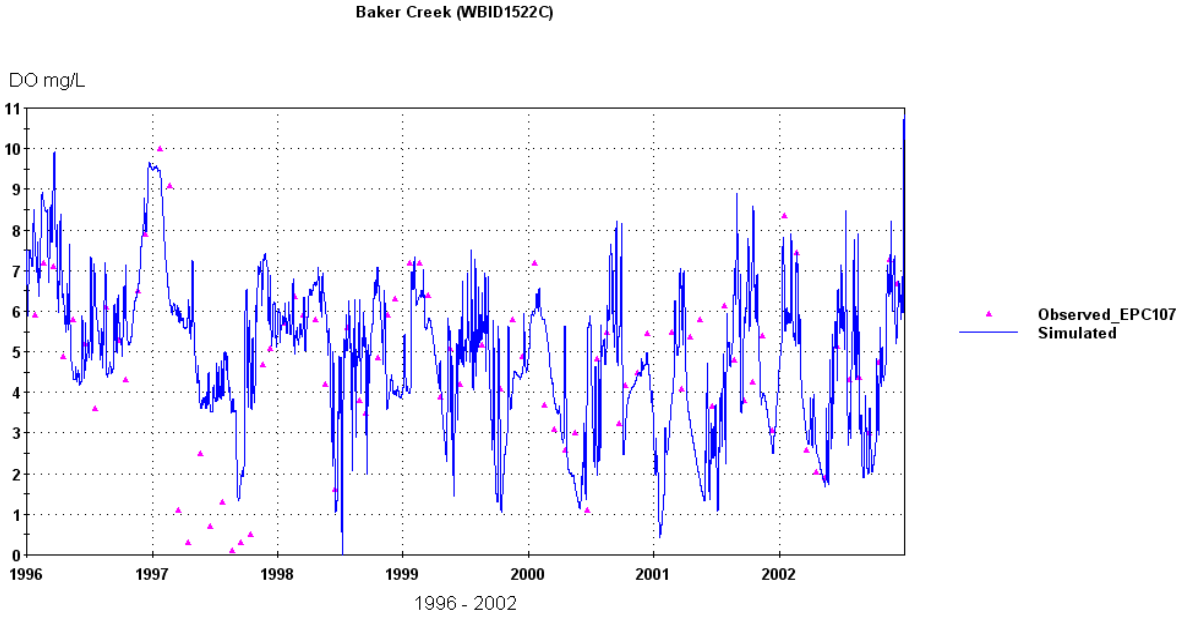

Figure 5.10 Time Series of Simulated versus Observed DO Concentrations in Baker Creek from January 1, 1996 to December 31, 2002

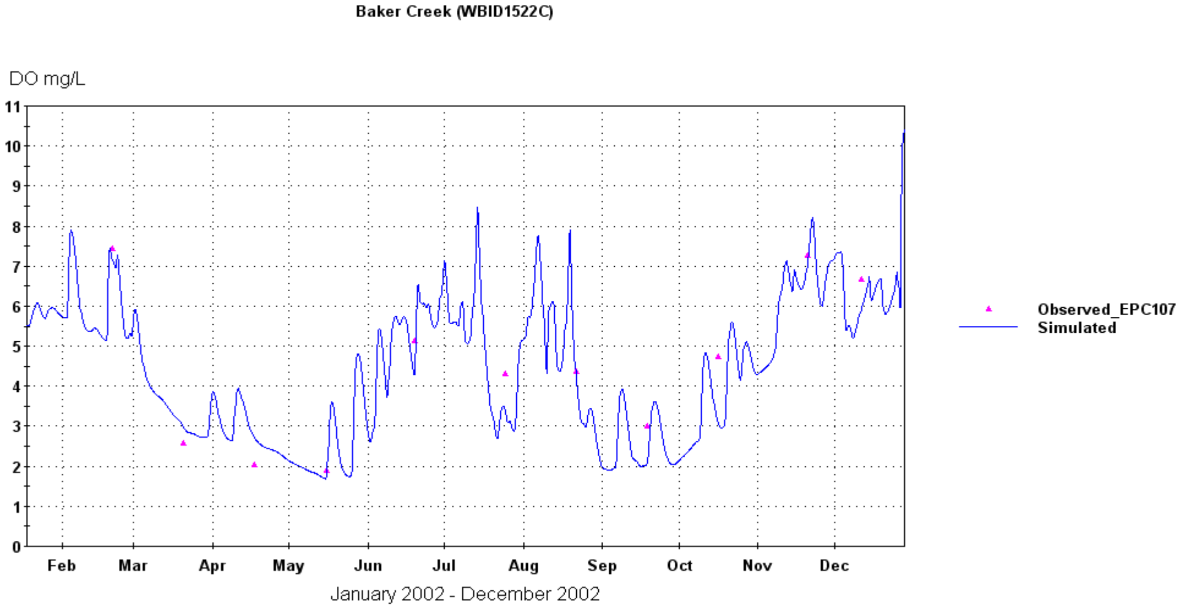

Figure 5.11 Monthly Variations of Simulated versus Observed DO Concentrations in Baker Creek in a Selected Year from January 1, 2002 to December 31, 2002

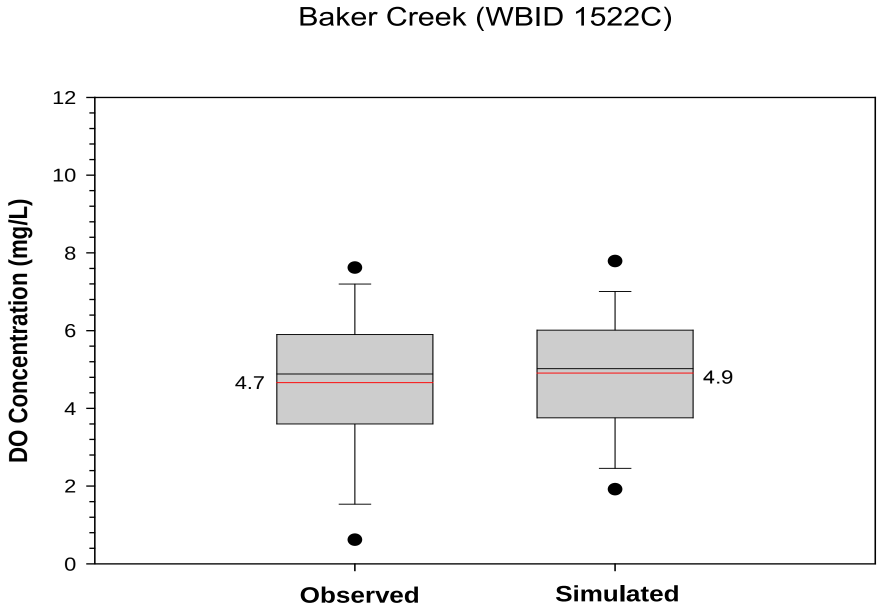

Figure 5.12 Box and Whisker Plot of Simulated and Observed DO Concentrations in Baker Creek. Red Lines and Values in the Plot Represent a Mean Concentration of Each Series

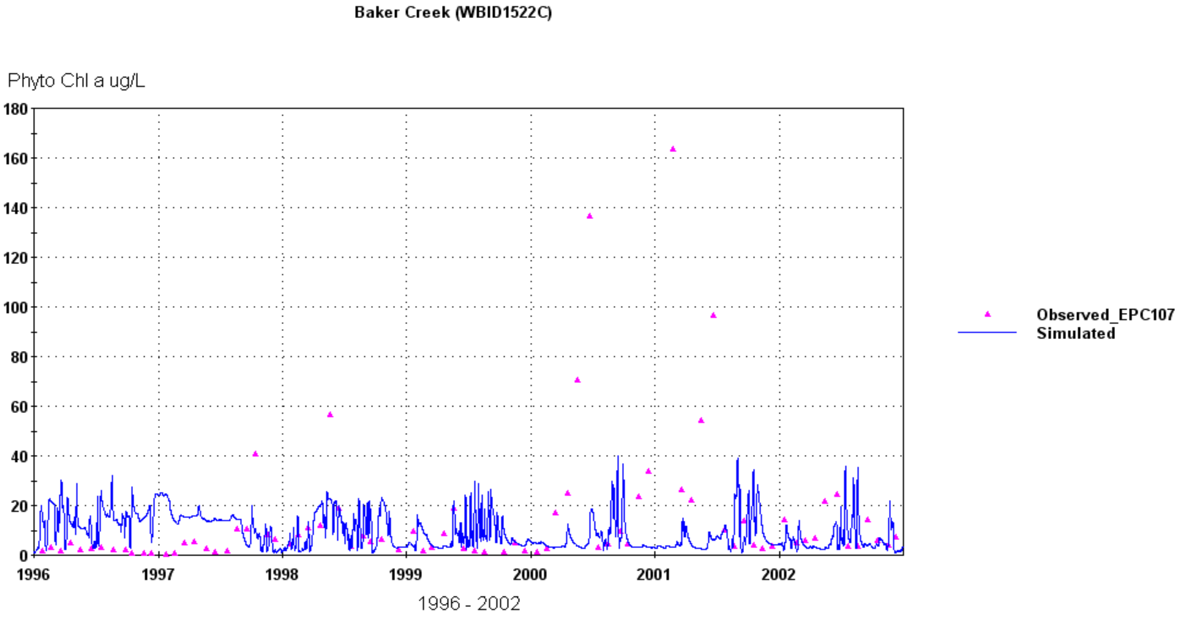

Figure 5.13 Time Series of Simulated and Observed Chlorophyll *a* Concentrations in Baker Creek from January 1, 1996 to December 31, 2002

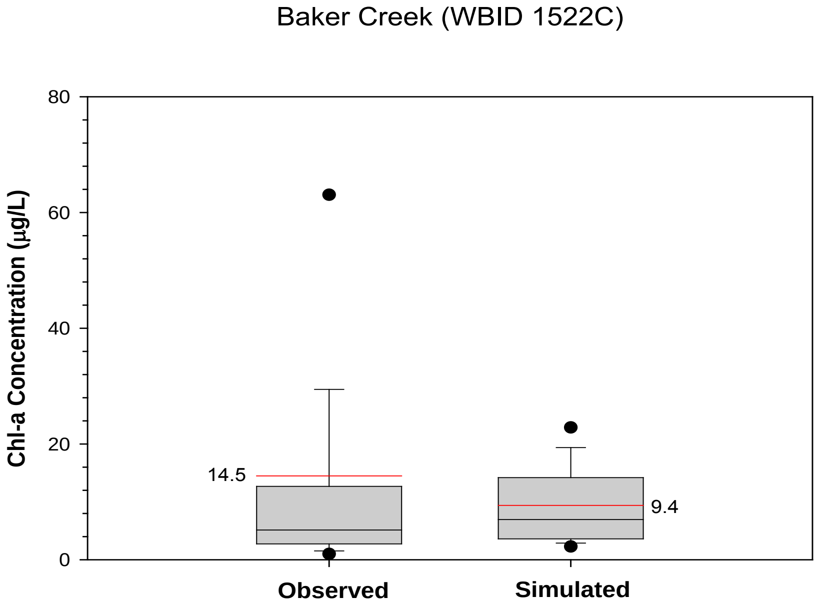

Figure 5.14 Box and Whisker Plot of Simulated versus Observed Chlorophyll *a* Concentrations in Baker Creek. Red Lines and Values in the Plot Represent a Mean Concentration of Each Series

The time series of simulated Chla for Baker Creek plotted against the observed Chla from EPC station 107 generally showed a reasonable agreement with the observed values over the period of calibration and validation (**Figure 5.13**). However, the model under-predicted the intermittent high concentrations observed in 2000 and 2001. Because of these data, a mean concentration of the observed values (14.5 µg/L) was significantly different from that of the simulated values (9.4 µg/L) while a median and the 10th and 90th percentiles of the observed values were very similar to those of the simulated concentrations as shown in the box and whisker plot (**Figure 5.14**).

Simulated DO concentrations for Spartman Branch over the period of model calibration and validation were compared to the observed DO concentrations, as shown in **Figures 5.15** through **5.17**. Sampling data at the Spartman Branch station were only available for part of 1998 and 2002. Thus, no comparison between observed DO values and model results was made for the 1996-1997 and 1999-2001 period. For 2002, monthly patterns of simulated DO followed the observed DO variations over the year, indicating a reasonable model calibration (**Figure 5.16**). Mean, median, and distribution of simulated DO over the simulation period were very similar to those of observed DO (**Figure 5.17**). Even though there are a limited number of observations used for calibration, excellent agreement between simulated versus observed DO were observed in the statistical analyses. For example, the mean and median of observed DO were 5.2 mg/L and 4.8 mg/L, respectively, and very similar to 5.2 mg/L and 5.4 mg/L for simulated DO. The 10th and 90th percentiles of the observed values were 3.9 mg/L and 7.2 mg/L, similar to the 10th and 90th percentiles of the simulated DO of 2.4 mg/L and 8.0 mg/L, respectively.

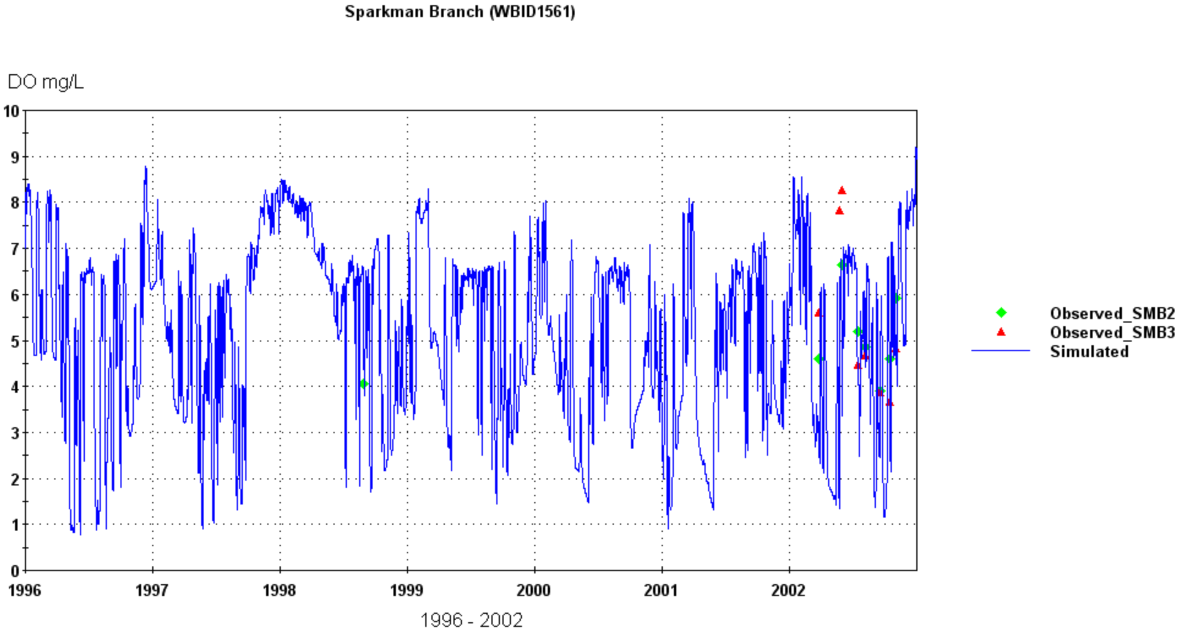

Figure 5.15 Time Series of Simulated versus Observed DO Concentrations in Spartman Branch from January 1, 1996 to December 31, 2002

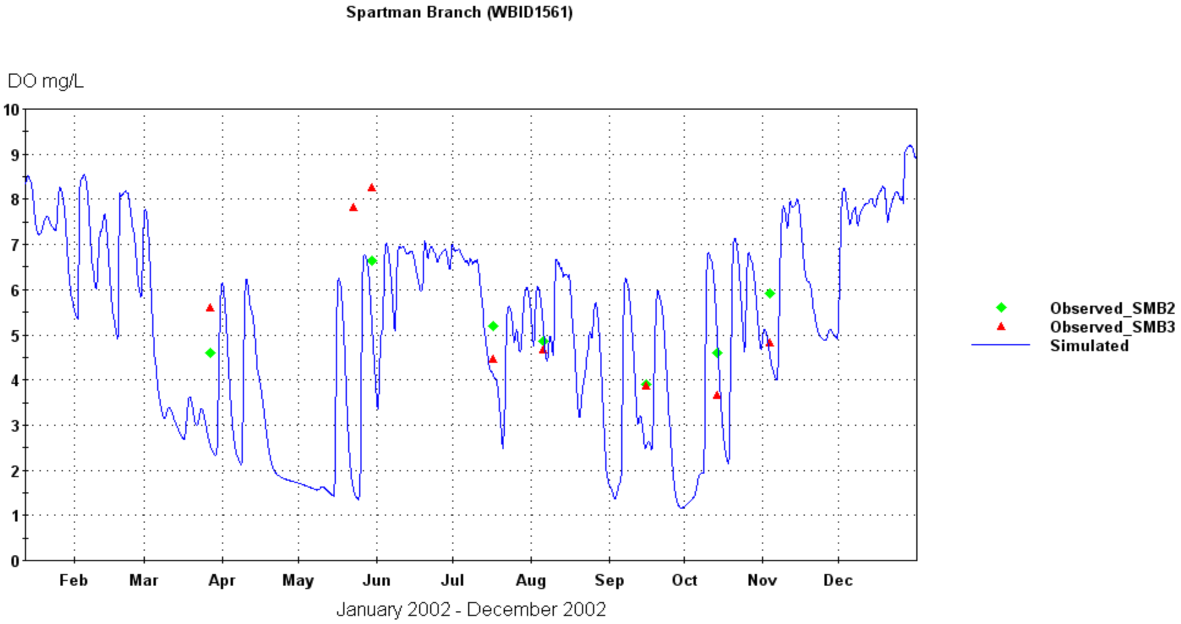

Figure 5.16 Monthly Variations of Simulated versus Observed DO Concentrations in Spartman Branch in a Selected Year from January 1, 2002 to December 31, 2002

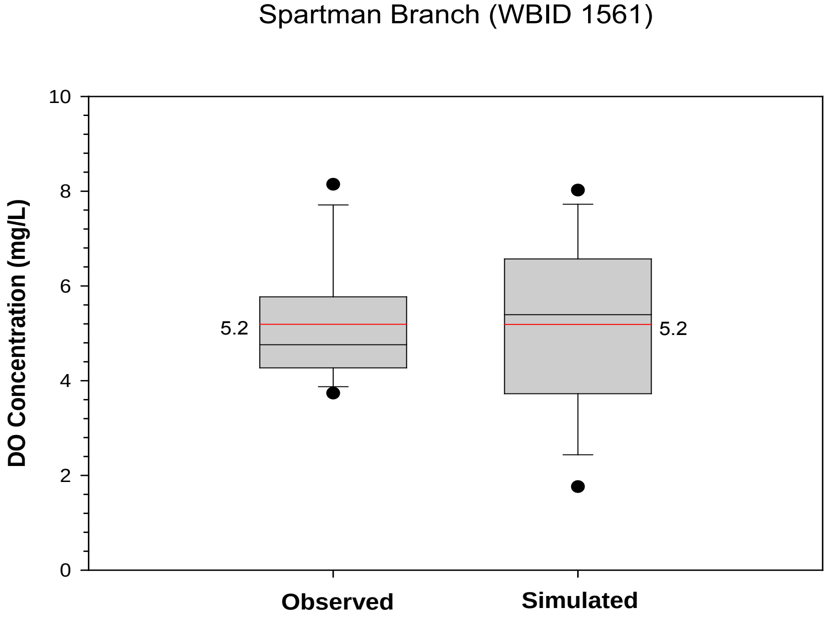

Figure 5.17 Box and Whisker Plot of Simulated versus Observed DO Concentrations in Spartman Branch. Red Lines with Values in the Plot Represent a Mean Concentration of Each Series

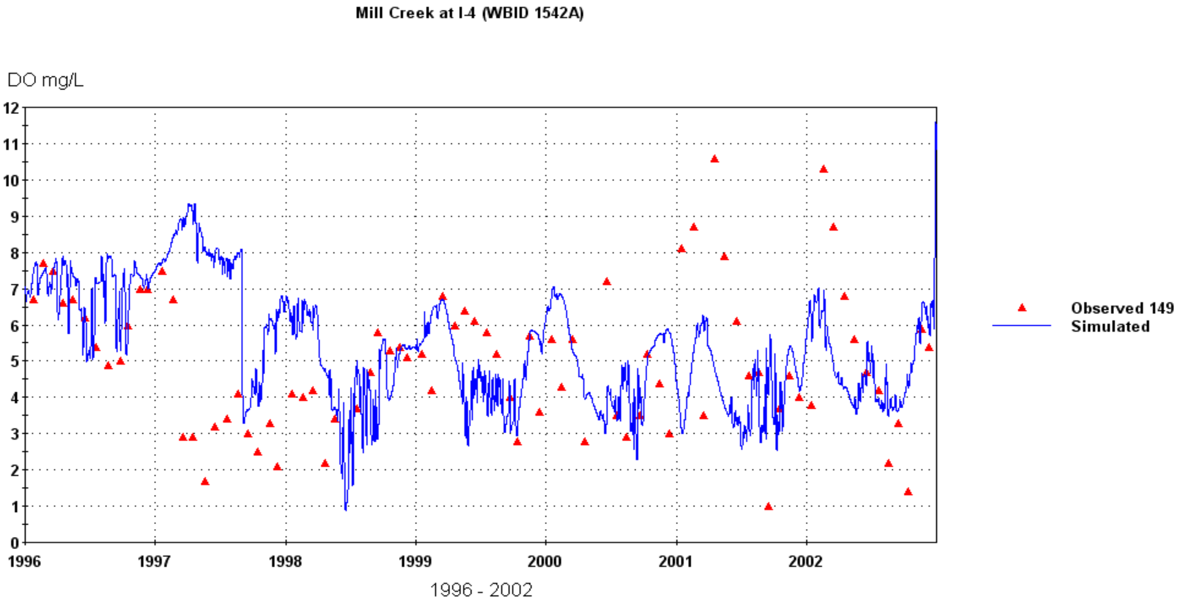

Figure 5.18 Time Series of Simulated versus Observed DO Concentrations in Mill Creek from January 1, 1996 to December 31, 2002

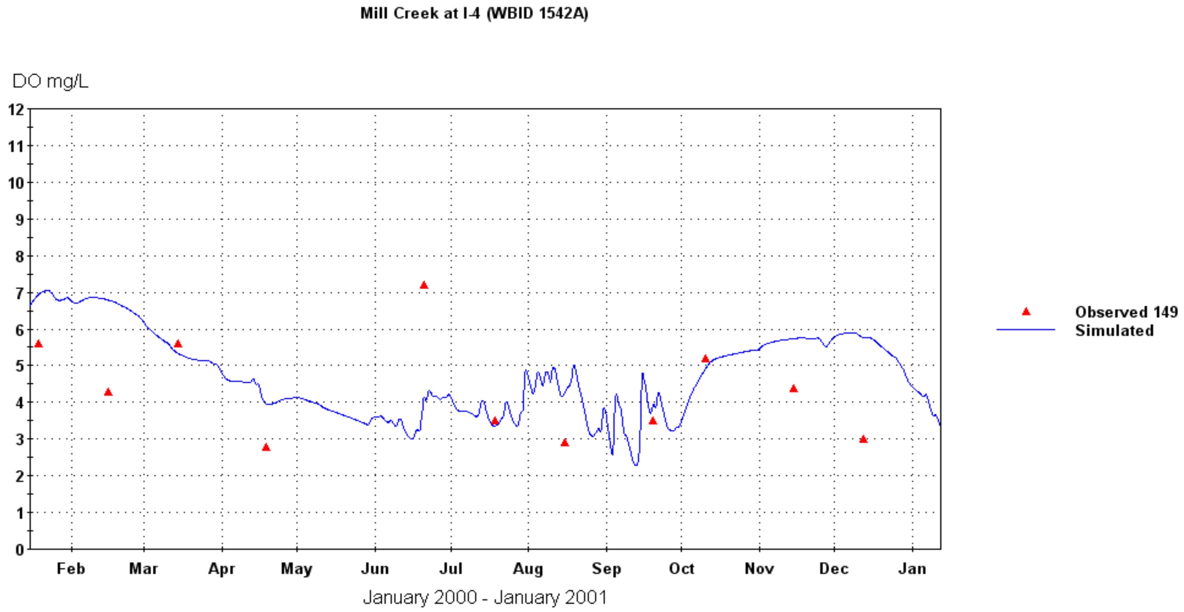

Figure 5.19 Monthly Variations of Simulated versus Observed DO Concentrations in Mill Creek from January 1, 2000 to December 31, 2000

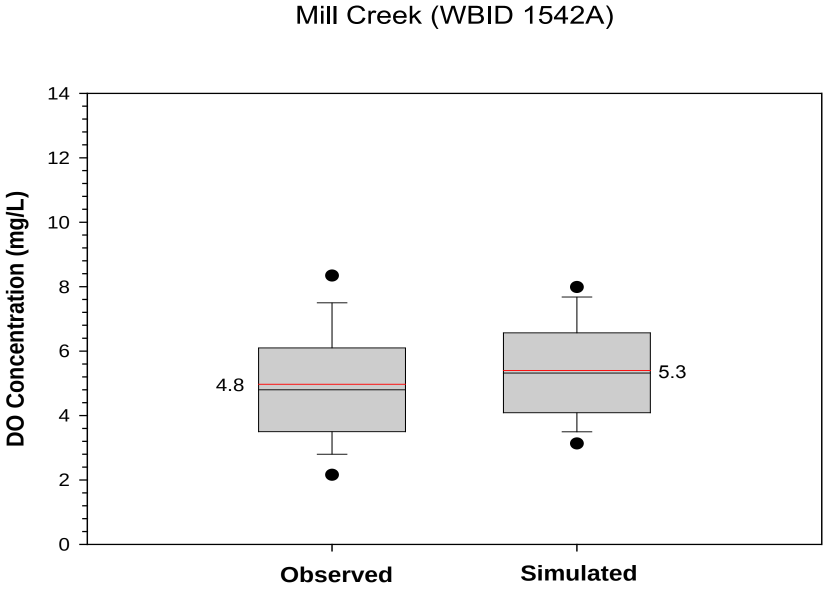

Figure 5.20 Box and Whisker Plot of Simulated versus Observed DO Concentrations in Mill Creek. Red Lines with Values in the Plot Represent a Mean Concentration of Each Series

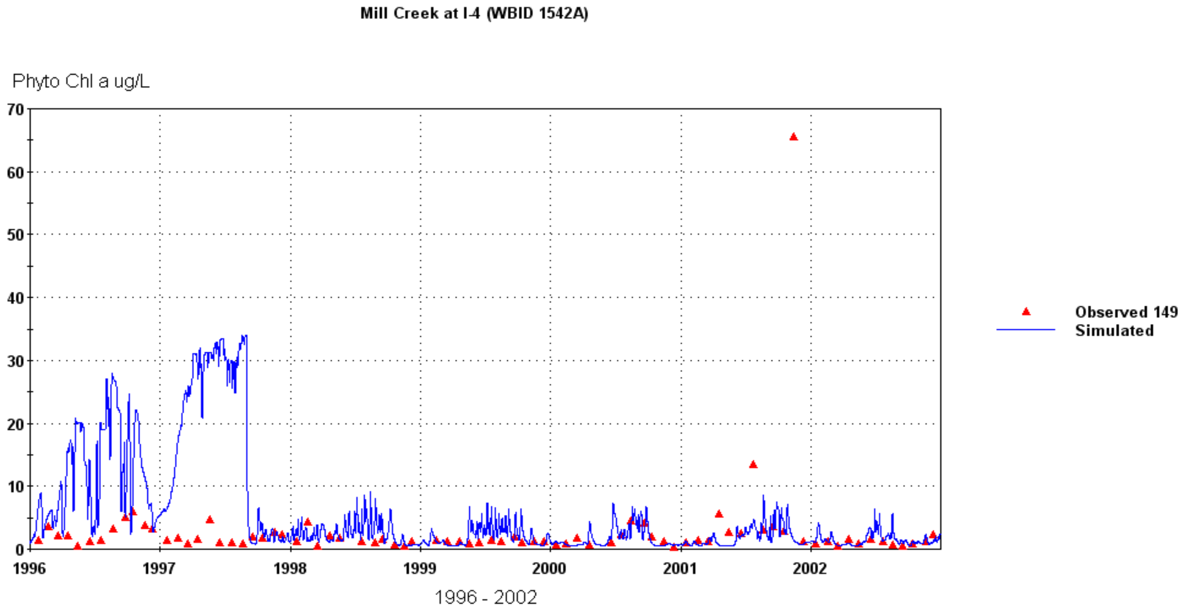

Figure 5.21 Time Series of Simulated and Observed Chla Concentrations in Mill Creek from January 1, 1996 to December 31, 2002

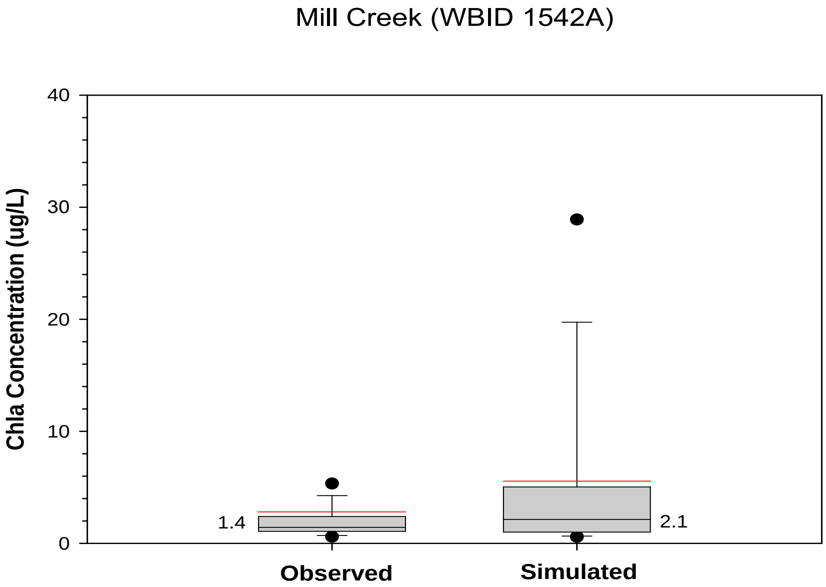

Figure 5.22 Box and Whisker Plot of Simulated versus Observed Chla Concentrations in Mill Creek. Red Lines with Values in the Plot Represent a Mean Concentration of Each Series

The predicted DO for Mill Creek showed reasonable agreement with the observed DO from the EPC station 149 (or STORET station 21FLHILL2400035 and 21FLHILL149) over the period of model simulation (**Figure 5.18**). Monthly patterns of simulated DO also matched to those of observed DO in the year 2000, showing greater DO values in winter and lower values in summer (**Figure 5.19**). The box and whisker plot also indicated that mean, median, and distribution percentiles of simulated DO over the period of simulation were very similar to those of observed DO (**Figure 5.20**). There were excellent agreements in mean, median, 10th and 90th percentiles of simulated versus observed DO. For example, mean and median for the observed DO were 5.4 mg/L and 5.3 mg/L very similar to 5.0 mg/L and 4.8 mg/L for the simulated DO. The 10th and 90th percentiles of the observed DO values were 3.5 mg/L and 7.7 mg/L, respectively whereas the 10th and 90th percentiles of the simulated values in the range were 2.8 mg/L and 8.1 mg/L, respectively. Overall, the results of statistical analyses between simulated versus observed DO indicated that the model did well at predicting the existing conditions for DO in Mill Creek.

The time series of simulated Chla for Mill Creek plotted against the observed Chla generally showed a reasonable agreement with the observed values (**Figure 5.21**). However, the model over-predicted the Chla concentrations observed in 1996 and 1997 before the Plant City WRF was relocated. Because of the discrepancy, a mean concentration of the observed values (2.8 μg/L) was different from that of the simulated values (5.6 μg/L). However, the median (1.4 μg/L) of the observed values were very similar to those (2.1 μg/L) of the simulated concentrations as shown in the box and whisker plot (**Figure 5.22**).

Background Conditions

5.3.4 Natural Land Use Background Conditions

The model calibrated for Baker Creek, Spartman Branch, and Mill Creek were reestablished to estimate water quality conditions in the impaired waterbodies under “natural land use background conditions” for their watersheds. The hydrologic and pollutant loads under natural land cover conditions were estimated using the Hillsborough River Basin Watershed Assessment Model (WAM). The natural land cover loadings developed by this project were then used to run the WASP surface water quality models in order to predict water quality in the basin under background conditions. The model results obtained from the background conditions were used to derive an appropriate water quality baseline that was needed for developing TMDLs. Detailed information on converting the existing conditions to the background land use conditions for this Hillsborough River Watershed was documented in Technical Memorandum submitted by Soil and Water Engineering Technology, Inc. (SWET, 2007). Briefly, WAM generated hydrodynamic files (*.HYD) and boundary concentration files (*.NPS) in WASP format for natural land use background conditions in the Hillsborough River Basin. To generate the conditions in WAM, all land-based anthropogenic loadings used in the WAM set up for existing conditions were to be removed. The WAM algorithm converted land uses that are urban and agricultural (i.e., not forest, wetland or water) to forest by removing the impervious area, modifying surface roughness, adjusting soils infiltration rates, and adjusting

BOD5, TN, TP, and TSS loading factors. Wetland and water land uses remained unchanged and all point source inputs were eliminated for the pre-development setup.

The current hydrography and ground water flows within the watershed are significantly altered from predevelopment conditions because of well fields, structures, and canals. Consequently, the quantity of cumulative flow to the receiving waterbody, Baker Creek, from its tributaries over the 7-year period under the natural land use conditions was reduced by about 18% compared to the flow under the existing conditions (**Figures 5.23** and **5.24**). Such reduced quantity of flow generated by changing the current land use to the natural land use conditions may arbitrarily result in an increase of in-stream concentrations of dissolve chemical constituents and a decrease of DO reaeration in the stream. Therefore, it was decided to use the existing flow conditions with no changes in hydrological characteristics but in land use types because changing the hydrography and groundwater withdrawals would adversely influence our ability to see the land source impacts associated with land use changes.

WASP uploaded the boundary concentration files that WAM generated in WASP format for the natural land use background condition to estimate watershed nutrient loads under the natural land use conditions. Simulated daily loads of TN, organic N, TP, and organic P were estimated for the natural land use background condition of Baker Creek, Spartman Branch, Mill Creek and then compared to those of the existing condition, as shown in **Tables 5.2** through **5.6**. Under the existing condition, simulated long-term daily loads of TN and TP to Baker Creek during 1996-2002 were estimated to be 324 lbs/day and 32.1 lbs/day, respectively (**Table 5.2**). These existing loads were much reduced to the daily loads of 60.1 lbs/day for TN and 2.7 lbs/day under the natural land use condition, corresponding to about 81.5% to 91.5% reductions (**Table 5.3**). Spartman Branch also showed similar percent reductions of TN and TP made under the natural land use condition (**Tables 5.4** and **5.5**). For Mill Creek, existing loads from the Mill Creek watershed were estimated to be about 40.0 lbs/day for TN and 14.0 lbs/day for TP, while natural land use loads would be about 13.9 lbs/day for TN and 0.99 lbs/day for TP. The waste loads from the point source dischargers during the period of 1996-2002 were also estimated, indicating that point source loads of TN and TP to Mill Creek have been reduced since Plant City WRF facility was relocated in late 1997 (**Table 5.8**). With the exclusion of the first two year data, 5-yr averages of TN and TP loads from the facility were about 0.11 lbs/day for TN and 0.011 lbs/day for TP between 1998 and 2002. The maximum permitted load for TN was estimated to be approximately 0.67 lbs/day based on the permitted concentration of un-ionized ammonia at 0.02 mg/L and a maximum flow of 4.02 MGD.

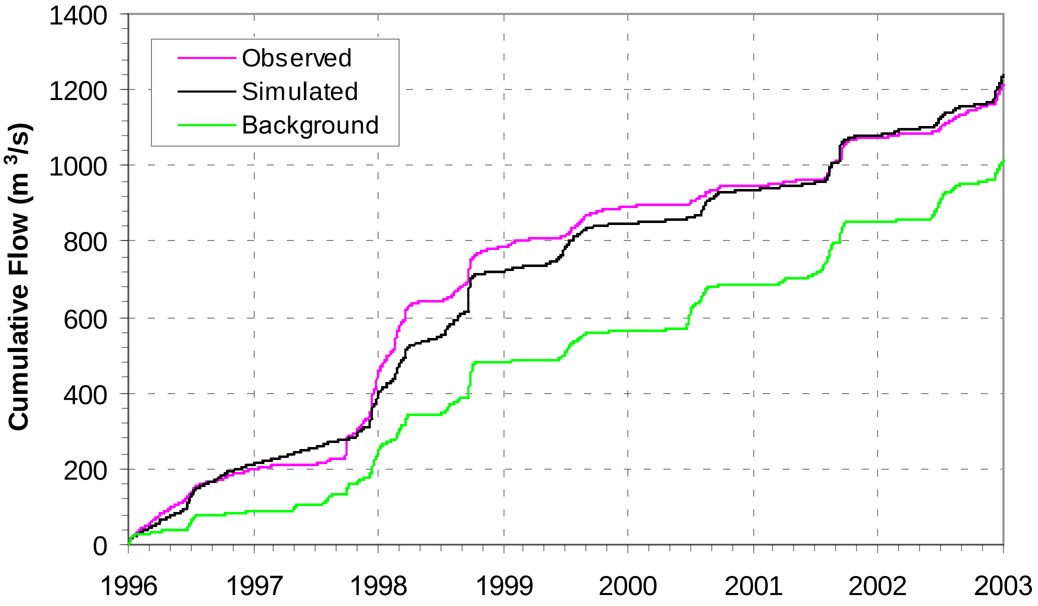

Figure 5.23 Observed, Simulated and Background Cumulative Flow at Baker Creek near McIntosh Park from 1996 to 2002

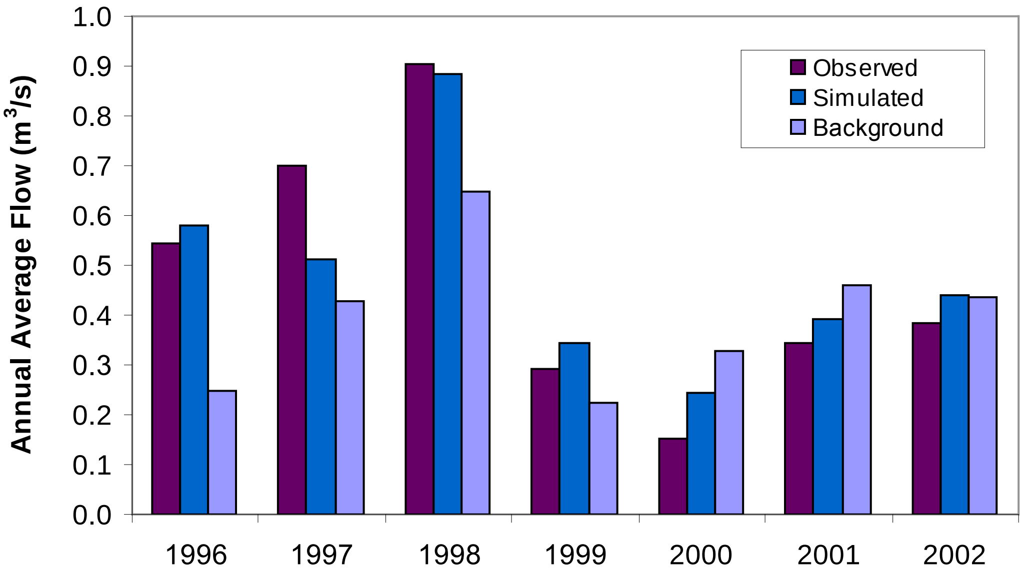

Figure 5.24 Observed, Simulated and Background Annual Average Flow at Baker Creek near McIntosh Park from 1996 to 2002

In order to evaluate the in-stream responses to the natural background load reductions, another important re-adjustment for natural land use conditions was to set up the background SOD rate and benthic nutrient flux which would result from the reduced inputs of organic matter to bottom sediments. A common approach for adjusting SOD rate is to use a linear relationship between SOD rate and organic carbon content of sediment related to water column productivity (Chapra, 1997; Kang and Gilbert, 2008), and has been previously used by the Army Corps of Engineers for the Inland Bays Model and by Hydroqual Inc. for the Appoquinimink Creek model. For the impaired water bodies, the algorithm for the linear assumption that reductions in SOD rate and benthic nutrient flux are directly related to reductions in primary productivity is as follows:

$$(\mathbf{SOD})_{\mathbf{nlu}} = \left[\left\{ \frac{(\mathbf{Chla})_{\mathbf{nlu}}}{(\mathbf{Chla})_{\mathbf{cur}}} \right\} \times (\mathbf{SOD})_{\mathbf{cal}} \right]$$

where $(\mathbf{SOD})_{\mathbf{nlu}}$ is the rate of SOD (or benthic ammonia and phosphate flux) under the natural land use conditions,

$(\mathbf{Chla})_{\mathbf{nlu}} / (\mathbf{Chla})_{\mathbf{cur}}$ is the ratio of an average concentration of Chla under the natural land use conditions to an average concentration of Chla under the current conditions, and

$(\mathbf{SOD})_{\mathbf{cal}}$ is the rate of SOD (or benthic ammonia and phosphate flux) at which the model was calibrated for DO.

The percent SOD and benthic flux reductions corresponding to the reduced primary productivity by changing land use type were estimated and shown in **Table 5.9**. These reductions were used as WASP input parameters for representing pristine in-stream conditions.

Table 5.2 Simulated Daily Loads of TN, Organic N, TP, and Organic P to Baker Creek under the Existing Condition

Year	TN (lbs/day)	Org N (lbs/day)	TP (lbs/day)	Org P (lbs/day)
1996	219	208	32.7	7.50
1997	591	311	24.7	5.66
1998	787	499	67.4	26.02
1999	153	145	20.8	5.44
2000	99	94	16.0	3.84
2001	211	200	33.8	10.38
2002	209	199	29.2	7.88
Average	324	237	32.09	9.53

Table 5.3 Simulated Daily Loads of TN, Organic N, TP, and Organic P to Baker Creek under the Natural Land Use Background Condition

Year	TN (lbs/day)	Org N (lbs/day)	TP (lbs/day)	Org P (lbs/day)
1996	61.2	43.6	2.39	0.270
1997	63.9	46.6	2.37	0.282
1998	120.5	98.0	5.69	0.636
1999	38.2	28.5	1.40	0.189
2000	28.2	19.0	1.35	0.118
2001	52.7	41.8	2.19	0.257
2002	56.2	40.1	3.42	0.249
Average	60.1	45.4	2.69	0.286

Table 5.4 Simulated Daily Loads of TN, Organic N, TP, and Organic P to Spartman Branch under the Existing Condition

Year	TN (lbs/day)	Org N (lbs/day)	TP (lbs/day)	Org P (lbs/day)
1996	34.6	32.0	4.88	1.17
1997	37.3	34.7	6.97	1.41
1998	94.8	87.4	17.36	4.29
1999	34.5	31.7	4.77	1.13
2000	20.5	19.0	3.51	0.74
2001	34.5	32.2	5.97	1.35
2002	42.1	38.8	7.46	1.42
Average	42.6	39.4	7.28	1.64

Table 5.5 Simulated Daily Loads of TN, Organic N, TP, and Organic P to Spartman Branch under the Natural Land Use Background Condition

Year	TN (lbs/day)	Org N (lbs/day)	TP (lbs/day)	Org P (lbs/day)
1996	7.66	6.70	0.196	0.046
1997	9.07	7.93	0.226	0.058
1998	20.01	17.48	0.803	0.125
1999	7.44	6.51	0.181	0.044
2000	5.04	4.40	0.152	0.030
2001	8.42	7.37	0.281	0.053
2002	10.47	9.16	0.476	0.063
Average	9.73	8.51	0.331	0.060

Table 5.6 Simulated Daily Loads of TN, Organic N, TP, and Organic P to Mill Creek under the Existing Condition

Year	TN (lbs/day)	Org N (lbs/day)	TP (lbs/day)	Org P (lbs/day)
1996	58.4	53.3	25.54	2.62
1997	45.8	42.1	18.11	2.10
1998	62.8	58.4	16.77	3.21
1999	28.9	26.7	9.23	1.40
2000	19.6	18.0	7.46	0.91
2001	28.6	26.6	9.03	1.38
2002	36.0	33.3	11.83	1.62
Average	40.0	36.9	13.99	1.89

Table 5.7 Simulated Daily Loads of TN, Organic N, TP, and Organic P to Mill Creek under the Natural Land Use Background Condition

Year	TN (lbs/day)	Org N (lbs/day)	TP (lbs/day)	Org P (lbs/day)
1996	23.46	17.25	1.782	0.089
1997	17.03	12.29	1.400	0.059
1998	18.10	14.55	1.046	0.096
1999	9.80	7.58	0.629	0.042
2000	7.11	5.19	0.604	0.025
2001	9.27	7.48	0.540	0.049
2002	12.21	9.33	0.911	0.052
Average	13.85	10.52	0.987	0.059

Table 5.8 Annual Existing Loads of TN and TP Observed from the Point Source Discharge during the Period of 1996-2002

Year	**TN** (lbs/day)	**Org N** (lbs/day)	**TP** (lbs/day)	**Org P** (lbs/day)
1996	53.93	14.11	8.21	2.46
1997	41.29	10.81	9.29	2.78
1998	0.10	0.00	0.010	0.00
1999	0.12	0.00	0.012	0.00
2000	0.10	0.00	0.010	0.00
2001	0.09	0.00	0.009	0.00
2002	0.14	0.00	0.014	0.00
Average (1996-2002)	13.7	3.56	2.508	0.75
Average (1998-2002)	0.11	0.00	0.011	0.00
Maximum Permitted Load	0.67*	N/A	N/A	N/A

*Maximum Permitted Load for TN was calculated based on the permitted concentration of unionized ammonia at 0.02 mg/L and maximum discharge of 4.02 mgd.

Table 5.9 Average Concentrations of Chlorophyll a under Current and Natural Background Conditions and the Associated SOD and Benthic Flux Percent Reductions

Location	**Model Calibration Average Chl-a (ug/L)**	**Natural Background Average Chl-a (ug/L)**	**SOD and Benthic %Reduction**	**WASP Segment Applied**
Baker Creek	9.38	1.53	83.7%	**1-3, 6, 9-14**
Spartman Branch	6.18	2.35	61.9%	**4-5**
Mill Creek*	1.99	0.89	55.3%	**7-8**

Note: Annual average Chl-a Concentrations were calculated based on IWR 62-303.350.

*Average Chla concentrations were obtained from the data between 1998 and 2002.

As previously discussed, the WASP inputs were reestablished for the natural land use background condition of the watershed and associated in-stream responses, and the boundary concentrations that WAM generated. A comparison of in-stream concentrations of Chla and nutrients for the existing condition versus the natural background condition is provided in **Table 5.10**. In-stream concentrations of Chla, TN and TP were significantly reduced for these waterbodies as a result of changing the land use type. For example, the 7-yr average concentration of Chla for Baker Creek decreased from 9.38 µg/L to 1.53 µg/L. In case of Mill Creek, the first two-year output of model simulation was excluded in calculating the percent reduction of SOD and benthic flux since there was discrepancy in calibrating the model in 1996 and 1997. Improvements in DO concentrations under the natural land use background condition were also found for these impaired waterbodies, showing all values above the DO criteria of 5 mg/L throughout the calibration and validation period (**Figures 25** through **27**).

Table 5.10 Comparison of Annual Mean In-stream Concentrations of Chlorophyll a, TP and TN Obtained from Model Simulation under the Existing Conditions versus the Natural Background Conditions for Baker Creek, Spartman Branch and Mill Creek

Location	Year	Existing Condition			Natural Condition		
		Chl-a (ug/L)	TP (mg/L)	TN (mg/L)	Chl-a (ug/L)	TP (mg/L)	TN (mg/L)
Baker Creek	1996	14.12	0.262	1.193	0.736	0.022	0.137
	1997	12.74	0.435	1.271	0.871	0.036	0.139
	1998	10.12	0.282	1.404	2.106	0.057	0.286
	1999	7.79	0.343	0.914	1.959	0.054	0.209
	2000	6.76	0.396	0.714	1.615	0.073	0.167
	2001	7.83	0.389	0.836	1.698	0.070	0.184
	2002	6.29	0.344	0.886	1.704	0.052	0.207
	Average	9.38	0.350	1.031	1.527	0.052	0.190
Spartman Branch	1996	6.56	0.334	1.021	2.328	0.019	0.297
	1997	6.25	0.367	0.931	2.253	0.025	0.285
	1998	5.42	0.370	1.099	2.452	0.020	0.332
	1999	6.28	0.372	0.971	2.480	0.025	0.303
	2000	5.92	0.400	0.823	2.260	0.027	0.269
	2001	6.49	0.387	0.883	2.304	0.025	0.271
	2002	6.34	0.391	0.953	2.401	0.024	0.300
	Average	6.18	0.374	0.954	2.354	0.024	0.294
Mill Creek	1996	11.62	0.224	1.051	0.189	0.007	0.061
	1997	17.30	0.354	1.137	0.350	0.011	0.084
	1998	2.58	0.214	0.615	1.364	0.022	0.197
	1999	2.09	0.135	0.386	0.841	0.022	0.132
	2000	1.73	0.114	0.287	0.726	0.025	0.105
	2001	2.02	0.143	0.334	0.849	0.027	0.121
	2002	1.52	0.140	0.346	0.647	0.021	0.126
	Average	5.55	0.189	0.594	0.710	0.019	0.118

Note: Annual average concentrations were calculated according to IWR 62-303.350.

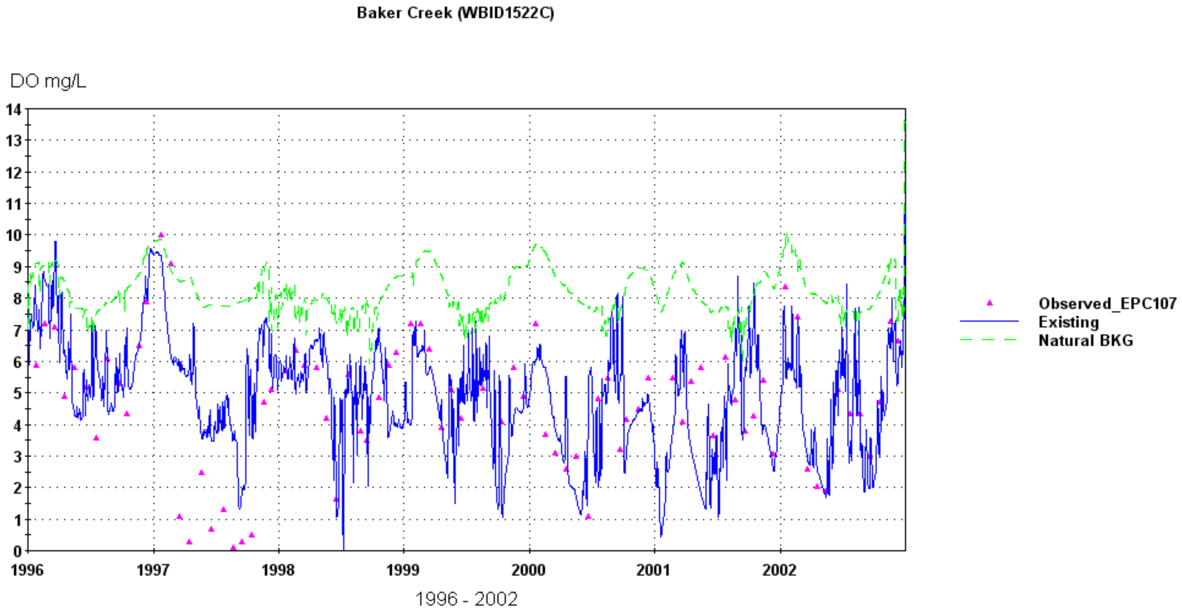

Figure 5.25 Observed, Current and Background DO variations at Baker Creek from 1996 to 2002

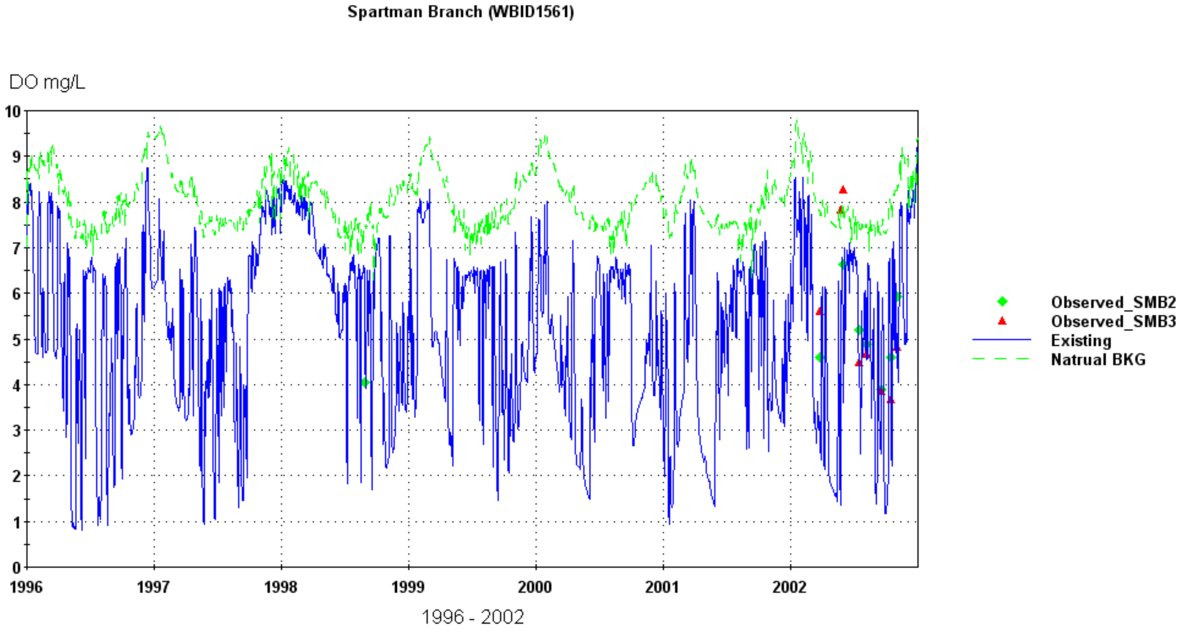

Figure 5.26 Observed, Current and Background DO variations at Spartman Branch from 1996 through 2002

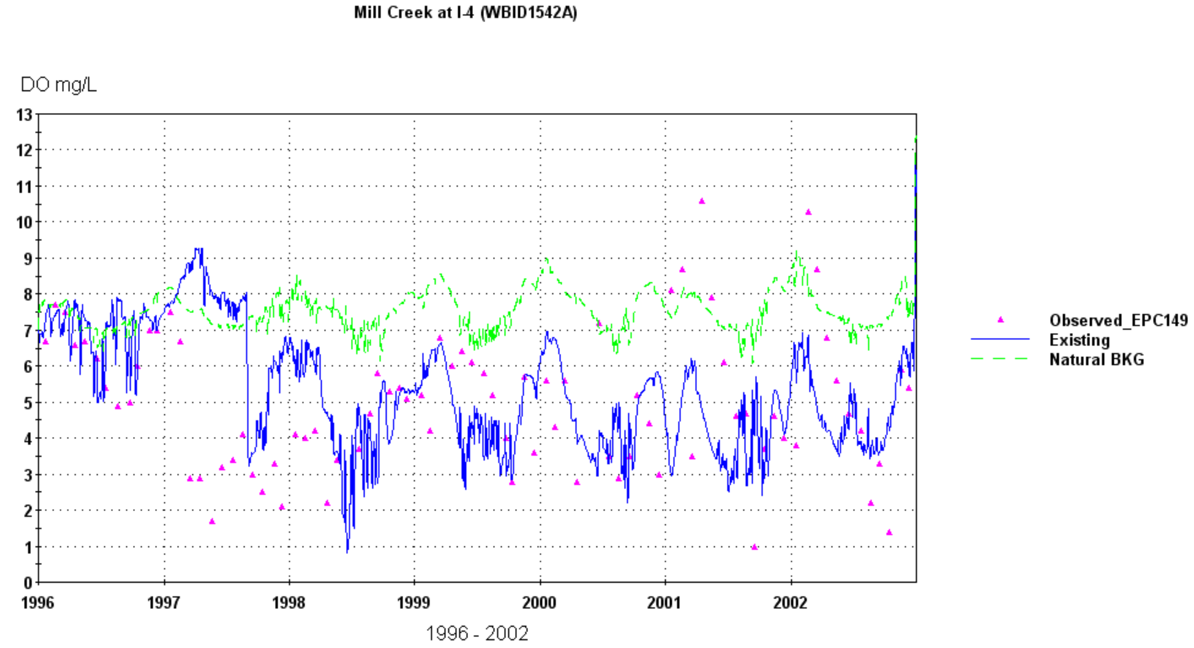

Figure 5.27 Observed, Current and Background DO variations at Mill Creek from 1996 through 2002

5.4 Selection of the TMDL Target

The direct application of the natural background as the chlorophyll a target would not allow for any assimilative capacity; however, it provides the baseline condition of the impaired water bodies for Chla and DO. In assessing biological imbalances in streams, the IWR uses 50% above the historical chlorophyll a value as one measure of impairment in streams in case chlorophyll a data indicate that annual mean chlorophyll a values have increased by more than 50% over the historical values for at least two consecutive years. The historical Chla value for Baker Creek estimated from the data collected between 1992 and 1996 was an average of 2.75 µg/L, and an additional 50% to the historical chlorophyll a value was calculated to be 4.1 µg/L. Therefore, the Department determined that the chlorophyll a target for nutrient assimilative capacity can be an in-between value obtained from the natural background Chla (1.53 µg/L) and 50% above the historical chlorophyll a value (4.1 µg/L). Once the target Chla was established for TMDL development for Baker Creek, the model was rerun with decreasing watershed loads until the Chla target was met. Several scenario runs were made by reducing loads to meet the chlorophyll target for Baker Creek. In addition, it should be noted that a selected load reduction that achieves the chlorophyll a target should meet the DO target (5 mg/L) in Baker Creek, Spartman Branch and Mill Creek as well. Since Spartman Branch and Mill Creek are upstream of Baker Creek and influences downstream water quality, the Department has decided that the same load reduction for Baker Creek would be applied to all tributaries contributing to Baker Creek to meet the DO and nutrient criteria.

A series of scenario simulations was accomplished to develop the TMDL for Baker Creek, Spartman Branch and Mill Creek, by reducing percent nutrient loads of 30%, 65%, 80% and 90%, throughout the watershed over the period of 1996 to 2002. In-stream conditions such as SOD and benthic flux were also adjusted based on the previous equation so that the series of the scenario load reductions from the watershed can reflect in-stream conditions accordingly.

Selected in-stream time-series chlorophyll a and DO concentrations in Baker Creek, Spartman Branch and Mill Creek that responded to load reduction scenarios of nutrients and CBOD delivered from the watershed were shown in **Figures 5.28** through **5.33**. The load reduction with 65% in Baker Creek and Spartman Branch resulted in DO concentrations in both waterbodies exceeding the DO criteria on many occasions especially during summer months between 1996 and 2002 (**Figures 5.29** and **5.31**). When the model was run with the reduction scenario of 80%, DO in Baker Creek, Spartman Branch and Mill Creek met the criteria of 5.0 mg/L throughout the 7-year period, except for Baker Creek only for about 48 hours during September 10-12, 2001 (**Figure 5.30**).

Annual average chlorophyll a concentrations responding to watershed TN and TP loads from current conditions, background conditions, and an 80% load reduction were compared with the chlorophyll a concentration of 50% above the historical value (**Figure 5.34**). Together with meeting the DO criteria for both Baker Creek, Spartman Branch and Mill Creek, the 80% load reduction demonstrates that the annual average chlorophyll a concentrations in Baker Creek and Mill Creek throughout the period are well below the chlorophyll a target of 4.1 µg/L. The annual average chlorophyll a concentrations for Baker Creek under the natural land use condition ranged from 0.74-2.11 µg/L with the long term annual average of 1.53 ± 0.52 µg/L. Bake Creek under the TMDL condition exhibits Chla concentration ranging from 1.1-3.8 µg/L with the long term annual average of 1.80 ± 0.96 µg/L. For Mill Creek, Chla concentrations under the TMDL condition range from 0.79-3.55 µg/L, with the annual average of 0.87 ± 0.08 µg/L during the period of 1998-2002. In addition, the annual average chlorophyll a value of 3.8 µg/L in 1996 obtained from the 80% load reduction was observed to be a marginal value to the chlorophyll a threshold, suggesting that only 80% or more load reduction would prevent the stream from possible impairment. Therefore, it was decided that the 80% load reduction, which met both DO and chlorophyll a criterion over the 7-year period, will best represent the assimilative capacity for the waterbodies, resulting in achieving aquatic life-based water quality criteria in the future.

Calculation of allowable TMDL Load

The model predictions for current condition loads of TN and TP to Bake Creek are 118,260 lbs/yr and 11,712 lbs/yr, respectively. An 80 percent reduction results in allowable loadings of 23,652 lbs/yr for TN and 2,342 lbs/yr for TP to Baker Creek. With the same percent reduction applied to upstream tributaries in order to meet the downstream water quality target, allowable loadings of TN and TP for Spartman Branch are determined to be 3,110 lbs/yr and 531 lbs/yr, respectively. For Mill Creek, current condition loads of TN and TP between 1998 and 2002 are 12,848 lbs/yr and 3,978 lbs/yr, indicating that allowable loadings of TN and TP are 2,569 lbs/yr and 795 lbs/yr, respectively. To calculate a daily allowable loading, each annual average load was divided by 365.

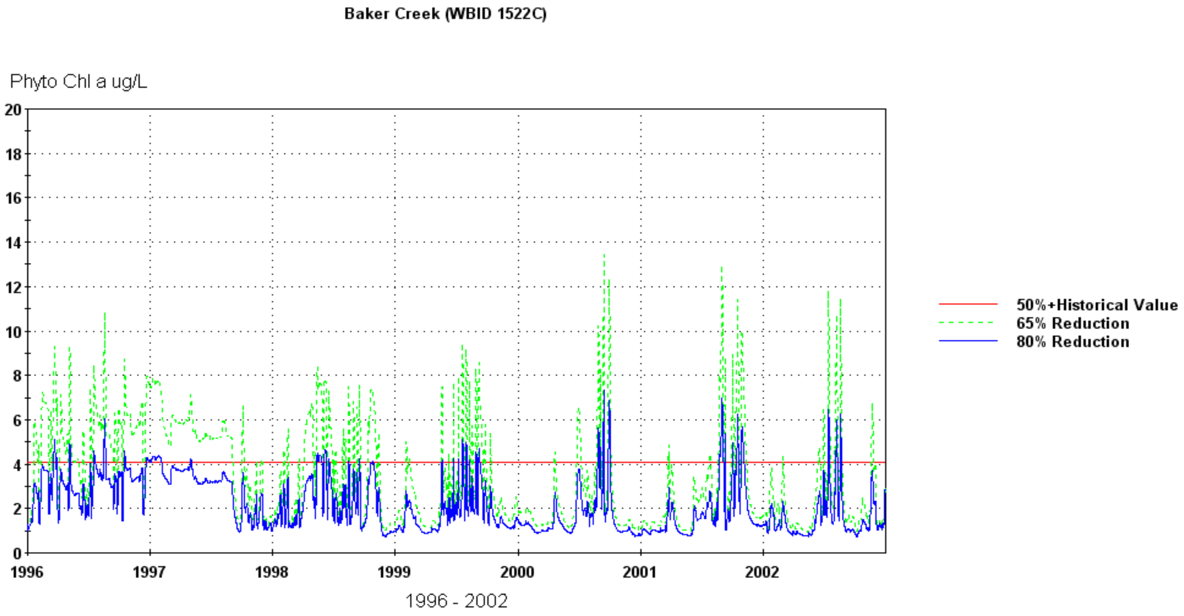

Figure 5.28 Time Series of Chlorophyll a Concentrations as a Function of Load Reductions at Baker Creek from 1996 to 2002 and the Chlorophyll a Threshold represented by 50% above the Historical Value

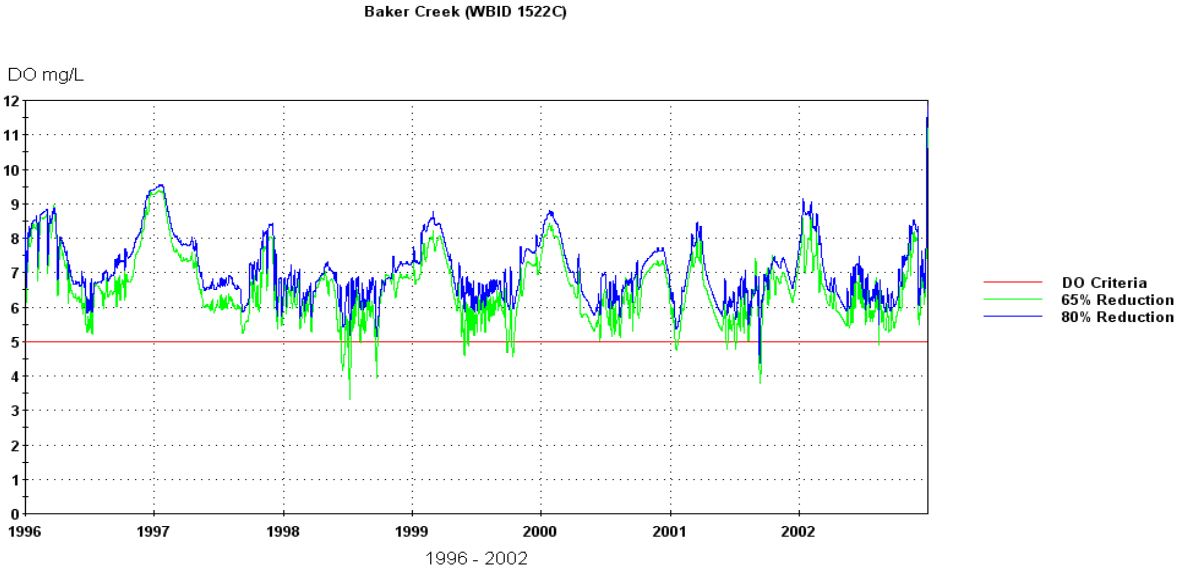

Figure 5.29 Time Series of DO as a Function of Load Reductions at Baker Creek from 1996 to 2002 and the DO Target in the Stream

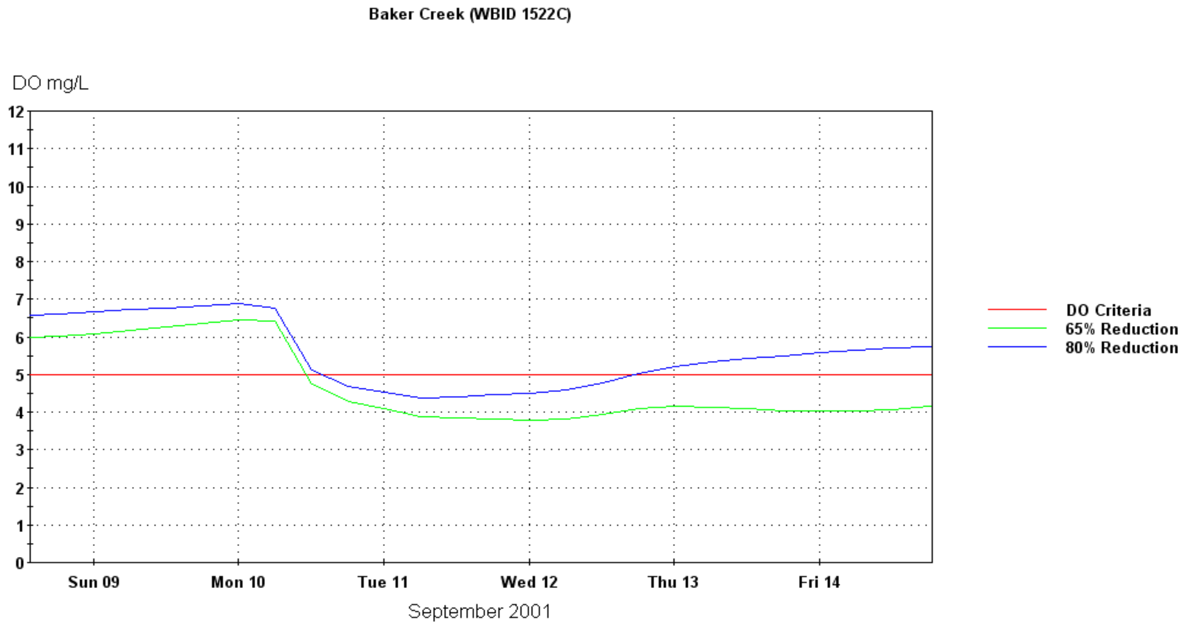

Figure 5.30 Exceedances of DO concentrations that appeared in Baker Creek during September, 2001 when the model ran with 65% and 80% load reductions

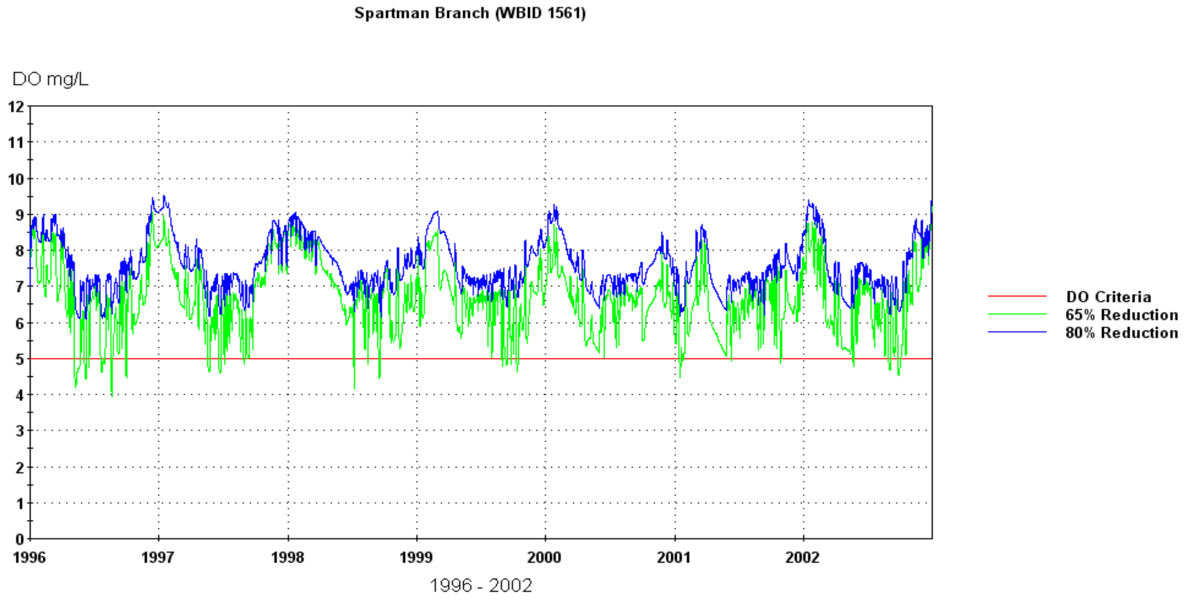

Figure 5.31 DO Target and DO Time Series as a Function of Load Reductions at Spartman Branch from 1996 to 2002

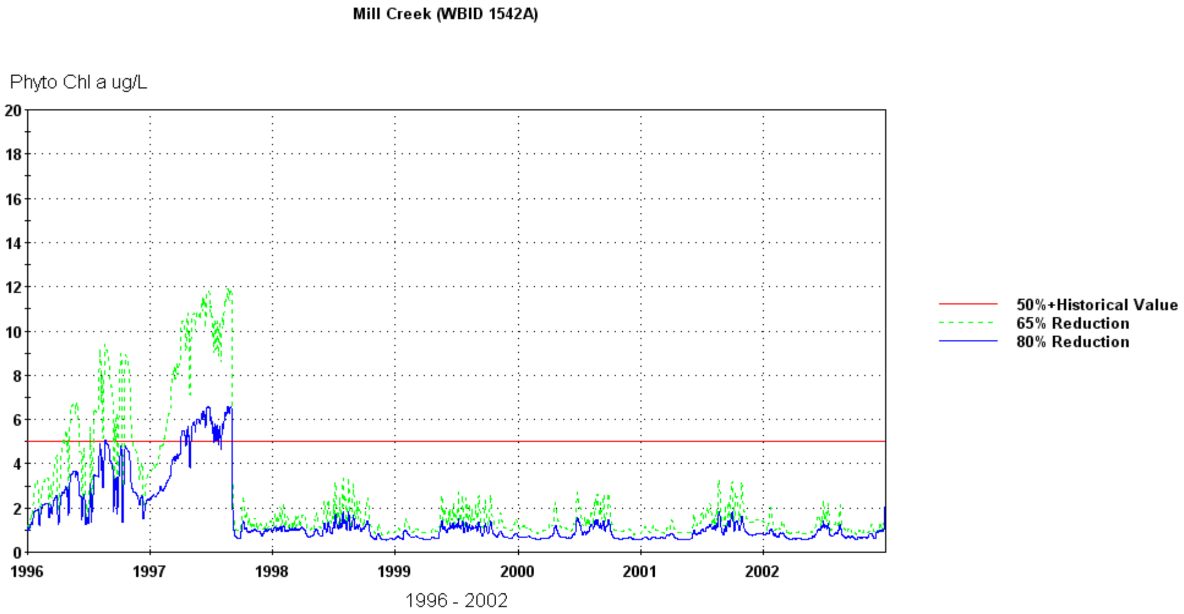

Figure 5.32 Time Series of Chl a Concentrations as a Function of Load Reductions for Mill Creek from 1996 to 2002 and the Chl a Threshold represented by 50% above the Historical Value

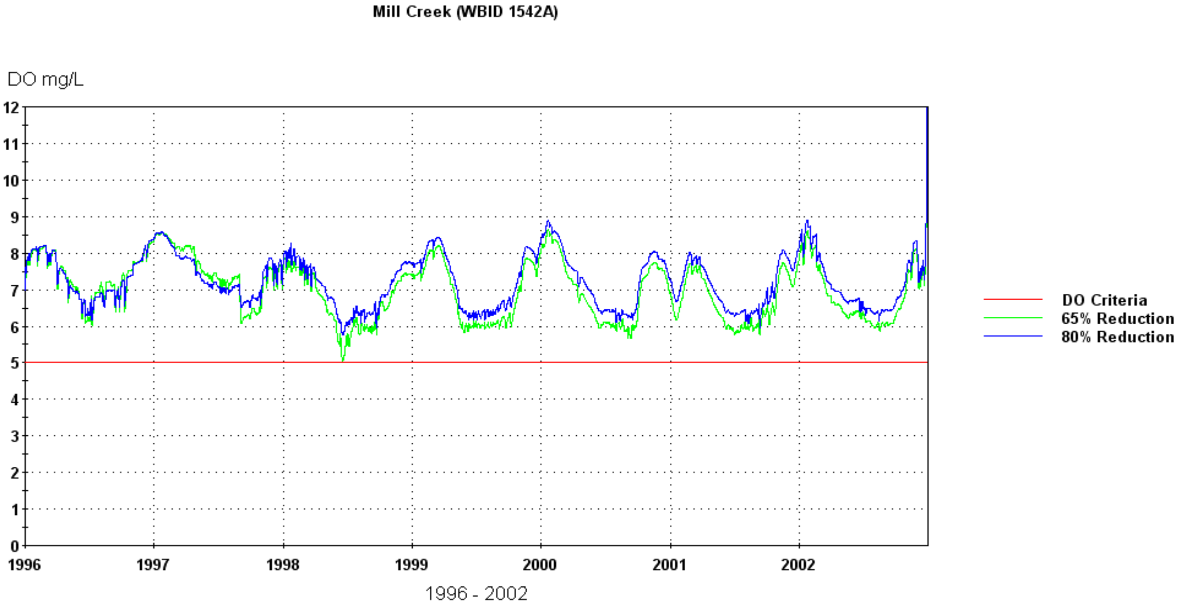

Figure 5.33 DO Target and DO Time Series as a Function of Load Reductions for Mill Creek from 1996 to 2002

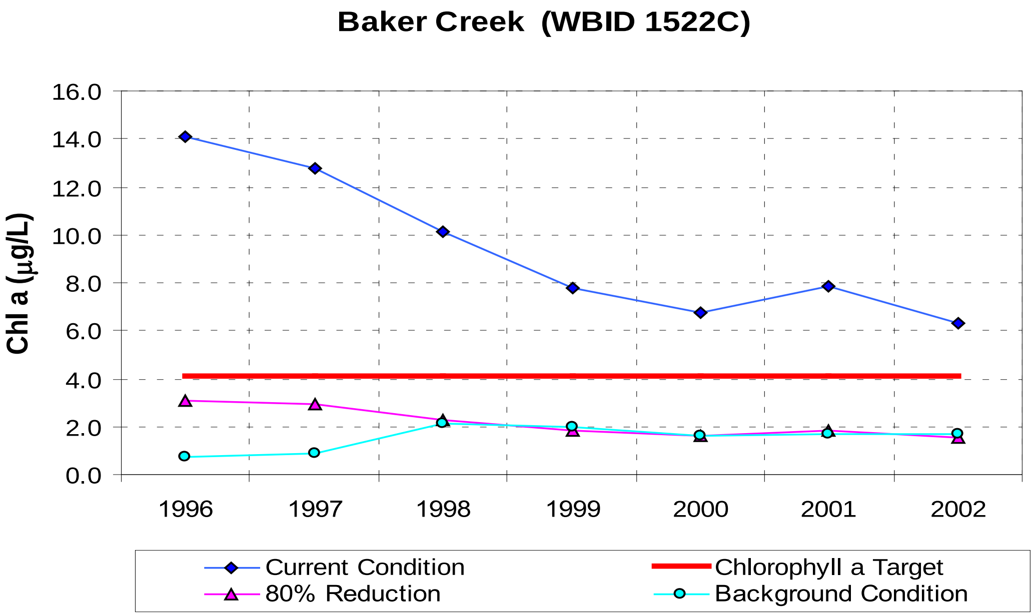

Figure 5.34 Annual Average Chl a from Current Condition, Background Condition and 80% Load Reduction for Baker Creek compared to the Chlorophyll a Target

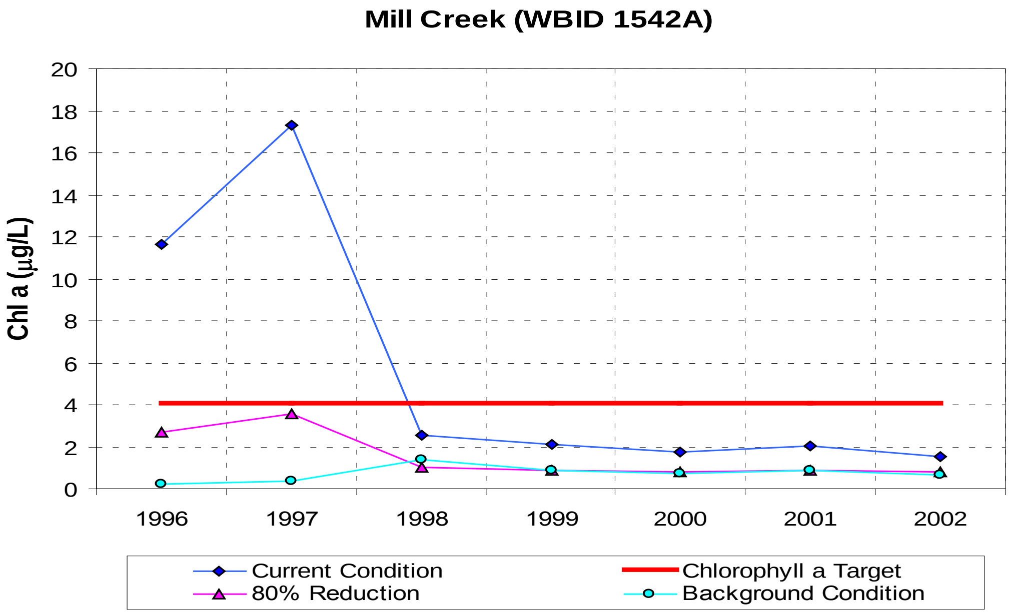

Figure 5.35 Annual Average Chl a Based on Model Predicted Results from Current Condition, Background Condition and 80% Load Reduction for Mill Creek compared to the Chl a Target

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

A TMDL can be 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) that takes into account any uncertainty about the relationship between effluent limitations and water quality:

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

$$\mathbf{TMDL \cong \sum WLAs_{wastewater} + \sum WLAs_{NPDES\ Stormwater} + \sum LAs + MOS}$$

It should be noted that the various components of the 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 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 a 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 is also different than 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.

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 TMDLs for Baker Creek, Spartman Branch and Mill Creek are expressed in terms of pounds per year (converted from kilograms per year as shown in Chapter 5) and percent reductions, and represent the long-term annual average load of TN and TP the waterbody can assimilate and maintain the Class III narrative nutrient criterion.

Table 6.1 Baker Creek TMDL Load Allocations

WBID	Parameter	WLA		LA (lbs/year)	MOS	TMDL (lbs/year)	Percent Reduction
		Wastewater (lbs/year)	Stormwater (% reduction)				
1522C	TN	N/A	80	23,652	Implicit	23,652	80
1522C	TP	N/A	80	2,342	Implicit	2,342	80

N/A Not applicable

*The load reductions of TN and TP will correct the impairments for both nutrients and dissolved oxygen. The allowable loads as pounds/day are for TN 64.8 lbs/day and for TP 6.41 lbs/day.

Table 6.2 Spartman Branch TMDL Load Allocations

WBID	Parameter	WLA		LA (lbs/year)	MOS	TMDL (lbs/year)	Percent Reduction
		Wastewater (lbs/year)	Stormwater (% reduction)				
1561	TN	N/A	80	3,110	Implicit	3,110	80
1561	TP	N/A	80	531	Implicit	531	80

N/A Not applicable

*The load reductions of TN and TP will correct the impairments for both nutrients and dissolved oxygen. The allowable loads as pounds/day are for TN 8.52lbs/day and for TP 1.45 lbs/day.

Table 6.3 Mill Creek TMDL Load Allocations

WBID	Parameter	WLA		LA (lbs/year)	MOS	TMDL (lbs/year)	Percent Reduction
		Wastewater (lbs/year)	Stormwater (% reduction)				
1542A	TN	48.91	80	2,569	Implicit	2,569	80
1542A	TP	4.02	80	795	Implicit	795	80

*The load reductions of TN and TP will correct the impairments for both nutrients and dissolved oxygen. The allowable loads from nonpoint sources as pounds/day are for TN 7.04 lbs/day and for TP 2.18 lbs/day. The allowable loads from point sources as pounds/day are for TN 0.134 lbs/day and for TP 0.011 lbs/day.

6.2 Load Allocation (LA)

The allowable LAs for Baker Creek, Spartman Branch and Mill Creek were presented in **Tables 6.1** through **6.3**. These LAs correspond to reductions from the existing loadings of 80 percent for TN and TP. It should be noted that the LA may include loading from stormwater discharges regulated by the Department and the Water Management District that are not part of the NPDES Stormwater Program **(see Appendix A).**

6.3 Wasteload Allocation (WLA)

NPDES Wastewater Discharges

As noted in Chapter 4, Section 4.3.1, there is only one active National Pollutant Discharge Elimination System (NPDES) permitted facilities that have a surface water discharge located within the Mill Creek watershed. The 80% reduction from the maximum permitted load for TN (see **Table 5.8**) was applied to determine the waste allocation for Mill Creek. Thus, the allowable wasteload calculated using the permitted TN load of 0.67 lbs/day was about 0.134 lbs/day or 48.91 lbs/yr, corresponding to about 2% of the total watershed load of TN. As indicated in **Table 5.8**, this allowable load is slightly higher than the 5-yr averaged existing load (0.11 lbs/day or 40.15 lbs/yr) for TN. For TP, it was decided that the existing load (0.011 lbs/day or 4.02 lbs/yr) for TP was given as the allowable load for TP since there is no permitted value for TP.

NPDES Stormwater Discharges

The wasteload allocation for stormwater discharges is an 80 percent reduction in loadings for TN and TP, which is the required percent reduction in nonpoint sources. It should be noted that any MS4 permittee will only be responsible for reducing the loads associated with stormwater outfalls for which it owns or otherwise has responsible control, and is not responsible for reducing other nonpoint source loads within its jurisdiction.

6.4 Margin of Safety (MOS)

TMDLs must address uncertainty issues by incorporating a MOS into the analysis. The MOS is a required component of a TMDL and accounts for the uncertainty about the relationship between pollutant loads and the quality of the receiving waterbody [Clean Water Act, Section 303(d)(1)(c)]. Considerable uncertainty is usually inherent in estimating nutrient loading from nonpoint sources, as well as predicting water quality response. The effectiveness of management activities (e.g., stormwater management plans) in reducing loading is also subject to uncertainty.

The MOS can either be implicitly accounted for by choosing conservative assumptions about loading or water quality response, or explicitly accounted for during the allocation of loadings. Consistent with the recommendations of the Allocation Technical Advisory Committee (Florida Department of Environmental Protection, February 2001), an implicit margin of safety (MOS) was used in the development of the Baker Creek and its tributaries' TMDLs. An implicit MOS was used because the TMDLs were based on the conservative decisions associated with a number of the modeling assumptions.

Chapter 7: TMDL IMPLEMENTATION

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 primarily 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:

- 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.

References

CDM, 1991. *Sarasota Bay National Estuary Program. Point / Nonpoint Source Pollution Loading Assessment. Phase 1*. January 1991.

Chapra, Steven C., 1997. *Surface Water-Quality Modeling*, McGraw-Hill Companies, Inc., p844.

CLIMOD, 2008. Available: http://climod.nrcc.cornell.edu/

Florida Department of Environmental Protection (FDEP). 2008, Basin status report: Tampa Bay Tributaries Basin. Division of Water Resource Management, FDEP.

Florida Department of Environmental Protection, February 2001. *A Report to the Governor and the Legislature on the Allocation of Total Maximum Daily Loads in Florida.* Florida Department of Environmental Protection, Allocation Technical Advisory Committee, Division of Water Resource Management, Bureau of Watershed Management, Tallahassee, Florida.

—, April 2001. Chapter 62-302, *Surface Water Quality Standards,* Florida Administrative Code (*F.A.C.*), Florida Department of Environmental Protection, Division of Water Resource Management, Bureau of Watershed Management, Tallahassee, Florida.

—, April 2001. *Chapter 62-303, Identification of Impaired Surface Waters Rule (IWR), Florida Administrative Code*. Florida Department of Environmental Protection, Division of Water Resource Management, Bureau of Watershed Management, Tallahassee, Florida.

—, June 2004. Division of Water Resource Management, Bureau of Information Systems, Geographic Information Systems Section, Florida Department of Environmental Protection, Tallahassee, Florida. Available at http://www.dep.state.fl.us/gis/contact.htm

Florida Department of Health, 2009. Florida Department of Health web site. Available at http://www.doh.state.fl.us/; or http://www.doh.state.fl.us/environment/OSTDS/statistics.

Florida Department of Transportation, 1999*. Florida Land Use, Cover and Forms Classification System (FLUCCS)*. Florida Department of Transportation Thematic Mapping Section.

IFAS, 1984. *Impact of On-Site Sewage Disposal Systems on Surface and Ground Water Quality*, November 1984. Prepared by the Institute of Food and Agricultural Sciences Soil Science Department, University of Florida, Gainesville, FL for Florida Department of Health and Rehabilitative Services (HRS).

Kang, W.-J. and Gilbert D., 2008. Nutrient, Un-ionized Ammonia, and DO TMDLs for Lake Trafford, Collier County, Florida. Florida Department of Environmental Protection, Division of Water Resources Management, Watershed Assessment Section, Tallahassee, Florida, June 2008.

Soil and Water Engineering Technology, Inc. (SWET), 2004. *WAM Watershed Assessment Model – Model Documentation and User Manual*, Electronic file provided with SWET training, Accessible at http://www.swet.com/SoftwareWAMUsersManual.html.

Soil and Water Engineering Technology, Inc. (SWET), 2005. Hillsborough River and Tributaries WAM/WASP Model Application, Technical Memorandum, Task Assignment No. 007.05/05-005.

Stumm, W. and Morgan, J. J. 1981. Aquatic Chemistry, 2nd Ed. Wiley-Interscience, New York, 780 pp.

U. S. Census Bureau Web Site. 2009. Available at: http://factfinder.census.gov/

U. S. Environmental Protection Agency, 1997. *Compendium of Tools for Watershed Assessment and TMDL Development, USEPA, Office of Water, Washington, DC 20460, EPA841-B-97-006, May 1997.*

U.S. Environmental Protection Agency, 2002. *Onsite Wastewater Treatment Systems Manual*. EPA /625/R-00/008.
http://www.epa.gov/ordntrnt/ORD/NRMRL/Pubs/625R00008/625R00008.htm

Wool, T. A., Ambrose, R. B., Martin, J. L., and Comer, E. A., 2007. *Water Quality Analysis Simulation Program (WASP) Version 6.0 Draft: User's Manual, US Environmental Protection Agency – Region 4*, Electronic file provided with installation of WASP version 7.2, http://www.epa.gov/athens/wwqtsc/html/wasp.html, Accessed June 2007.

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.

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 permitting program to designate certain stormwater discharges as "point sources" of pollution. The EPA promulgated regulations and began implementation of the Phase I NPDES stormwater program in 1990. 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 implemented Phase I of the MS4 permitting program on a countywide basis, which brought 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. The Department received authorization to implement the NPDES stormwater program in 2000.

An important difference between the NPDES and other state stormwater permitting programs is that the NPDES program covers both new and existing discharges, while the other state programs focus on new discharges. Additionally, Phase II of the NPDES Program, implemented in 2003, expands the need for these permits to construction sites between one and five acres, and to local governments with as few as 1,000 people. 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. It should be noted that all MS4 permits issued in Florida include a re-opener clause that allows permit revisions to implement TMDLs when the implementation plan is formally adopted.

Appendix B: TN, TP, Chlorophyll *a* Raw Data, Model Input Information, and WASP Outputs used in the TMDL Analysis

All data, copies of the model and model input decks used to produce the TMDL reports are available upon request.

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