FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration

CENTRAL DISTRICT • MIDDLE ST. JOHNS BASIN

Final TMDL Report

Dissolved Oxygen TMDL for Smith Canal (WBID 2962)

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Acknowledgments

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Websites

Florida Department of Environmental Protection, Bureau of Watershed Management

TMDL Program

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

Identification of Impaired Surface Waters Rule

http://www.dep.state.fl.us/legal/Rules/shared/62-303/62-303.pdf

STORET Program

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

2008 Integrated Report

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

Criteria for Surface Water Quality Classifications

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

Basin Status Report for the Middle St. Johns Basin

http://www.dep.state.fl.us/water/basin411/sj_middle/status.htm

Water Quality Assessment Report for the Middle St. Johns Basin

http://www.dep.state.fl.us/water/basin411/sj_middle/assessment.htm

U.S. Environmental Protection Agency

Region 4: Total Maximum Daily Loads in Florida

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

National STORET Program

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

Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Load (TMDL) for the pollutants causing the low dissolved oxygen (DO) concentration in Smith Canal in the Middle St. Johns Basin. Smith Canal was verified as impaired for low DO based on the observation that DO values for 28 out of 62 samples during the verified period (January 1, 2001, through June 30, 2008) were lower than the state water quality criterion for a Class III freshwater system. Total phosphorus (TP) was considered the causative pollutant. The canal was therefore included on the Verified List of impaired waters for the Middle St. Johns Basin that was adopted by Secretarial Order on May 19, 2009. The TMDL establishes the allowable loading of TP to Smith Canal that would restore the waterbody so that it meets its applicable water quality criterion for DO.

1.2 Identification of Waterbody

Smith Canal, located in northwest Seminole County in Central Florida, drains an area of about 10 square miles (mi^2) (**Figure 1.1**). Smith Canal (about 6 miles in length) flows northwest, entering the St. Johns River approximately 1.4 miles upstream of the outlet to Lake Monroe (**Figure 1.2**). The Smith Canal watershed includes portions of Sanford (about 49,000 people) and Lake Mary (about 15,000 people) and comprises residential areas, with sparse patches of wetlands and forested land. Additional information about the canal's hydrology and geology are available in the Basin Status Report for the Middle St. Johns (Florida Department of Environmental Protection [Department], 2003).

For assessment purposes, the Department has divided the Middle St. Johns Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. This TMDL addresses Smith Canal (WBID 2962) for low DO.

1.3 Background

This report was developed as part of the Department's watershed management approach for restoring and protecting state waters and addressing TMDL Program requirements. The watershed approach, which is implemented using a cyclical management process that rotates through the state's 52 river basins over a 5-year cycle, provides a framework for implementing the TMDL Program–related requirements of the 1972 federal Clean Water Act and the Florida Watershed Restoration Act (FWRA) (Chapter 99-223, Laws of Florida).

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

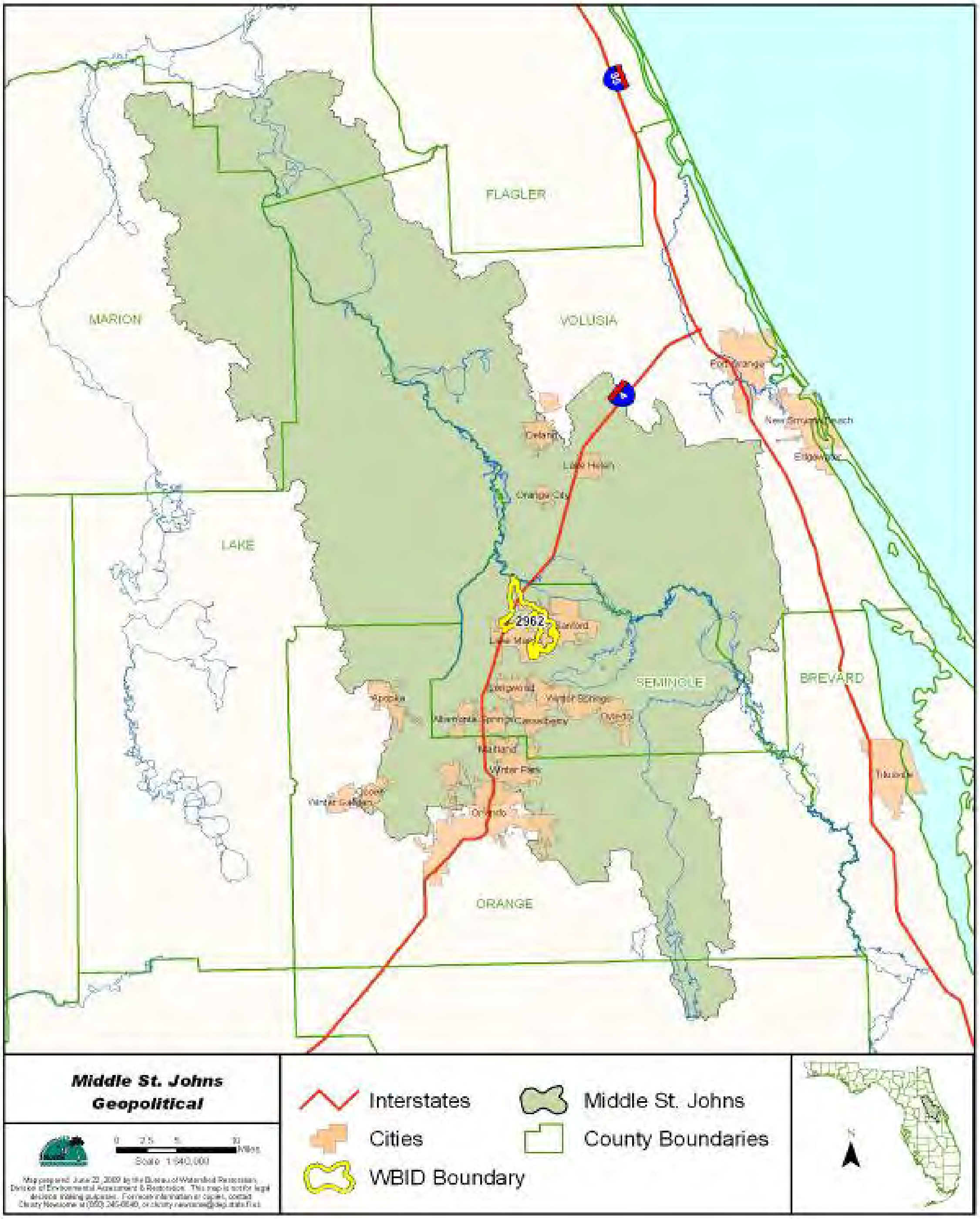

Figure 1.1. Location of the Smith Canal Watershed (WBID 2962) in the Middle St. Johns Basin and Major Geopolitical Features in the Area

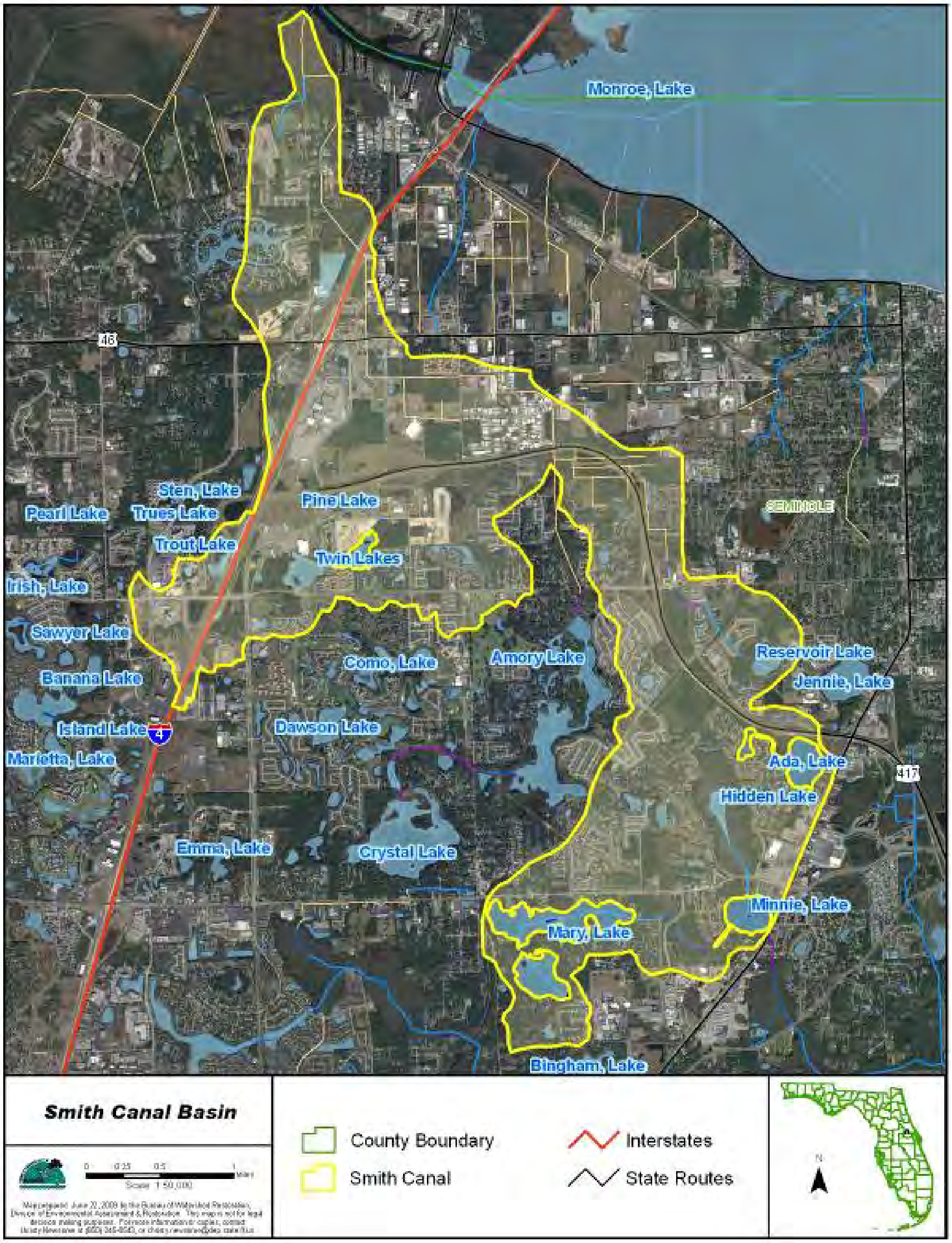

Figure 1.2. Location of the Smith Canal Watershed (WBID 2962) in Seminole County and Hydrologic Features in the Area

This TMDL report will be followed by the development and implementation of a restoration plan, to reduce the amount of phosphorus that caused the verified impairment. These activities will depend heavily on the active participation of the St. Johns River Water Management District (SJRWMD), local governments, businesses, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDLs for impaired waterbodies.

Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rulemaking History

Section 303(d) of the 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 source in each of these impaired 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 list is amended annually to include updates for each basin statewide.

Florida's 1998 303(d) list included 22 waterbodies in the Middle St. Johns Basin. However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rulemaking process, the Environmental Regulation Commission adopted the new methodology as Rule 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001; the rule was modified in 2006 and 2007. 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

The Department used the IWR to assess water quality impairments in Smith Canal and has verified that this waterbody segment is impaired for DO. The verification of impairment was based on the fact that 28 out of 62 DO measurements were lower than the state water quality criterion of 5 milligrams per liter (mg/L) during the verified period (January 1, 2001, through June 30, 2008) (Rule 62-302, F.A.C.), and TP was identified as the causative pollutant. In the first listing cycle (in 2004), biochemical oxygen demand (BOD) was identified as the causative pollutant when the median value was 2.1 mg/L, which exceeded the screening value of 2.0 mg/L. BOD is a chemical procedure for determining the rate of oxygen uptake by microorganisms in a waterbody. **Table 2.1** summarizes the DO monitoring results for the verified period for Smith Canal that were the basis for the impairment determination.

Table 2.1. Summary of DO Monitoring Data for Smith Canal (WBID 2962) During the Verified Period ((January 1, 2001, through June 30, 2008)

- = Empty cell
TN = Total nitrogen

WBID	Parameter	Summary of Observation
2962	Total number of samples	62
2962	IWR-required number of exceedances for the Verified List	10
2962	Number of observed exceedances	28
2962	Number of observed nonexceedances	34
2962	Number of seasons during which samples were collected	4
2962	Highest observation (mg/L)	10.89
2962	Lowest observation (mg/L)	0.72
2962	Median observation (mg/L)	5.22
2962	Mean observation (mg/L)	5.30
2962	Median value for 61 BOD observations (mg/L)	2.0
2962	Median value for 72 TN observations (mg/L)	1.02
2962	Median value for 67 TP observations (mg/L)	0.17
2962	Possible causative pollutant by IWR	TP
-	**FINAL ASSESSMENT:**	**Impaired**

2.3 Seasonal Variation of Nutrients and DO in Smith Canal

Seasonal variations of DO, TN, TP, and BOD concentrations were analyzed using the data collected during the verified period. **Figures 2.1** through **2.4** show the seasonal trends of these parameters in Smith Canal. Peaks in DO concentration were usually observed during the first and fourth quarters, and low concentrations during the second and third quarters (**Figure 2.1**). The majority of TP peak concentrations occurred in the second and third quarters (**Figure 2.2**). This trend appeared to correlate with the trend of DO concentrations, which most of the time reached their lowest points in the second and third quarters. No clear seasonal trend was identified for TN and BOD (**Figures 2.3** and **2.4**).

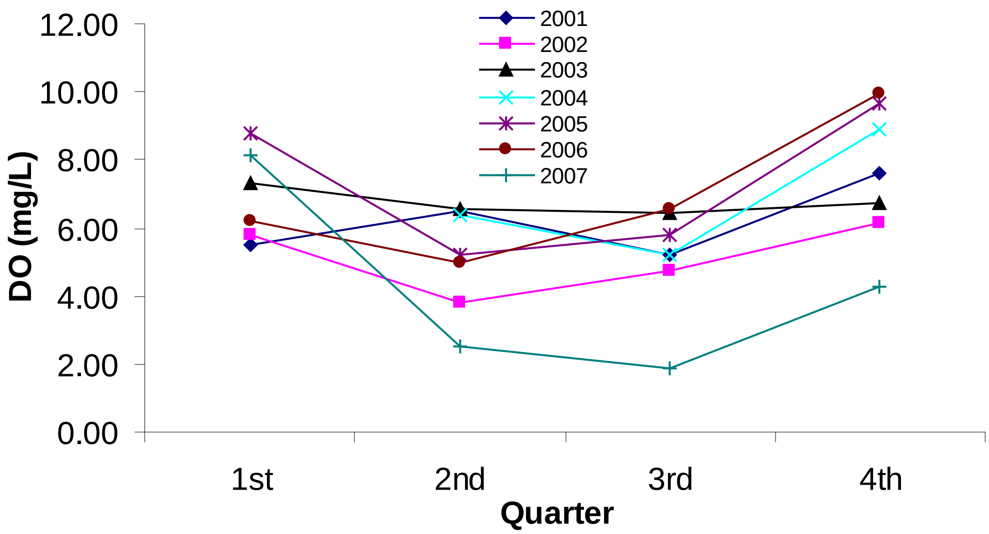

Figure 2.1. Seasonal Dynamics of DO in Smith Canal (WBID 2962)

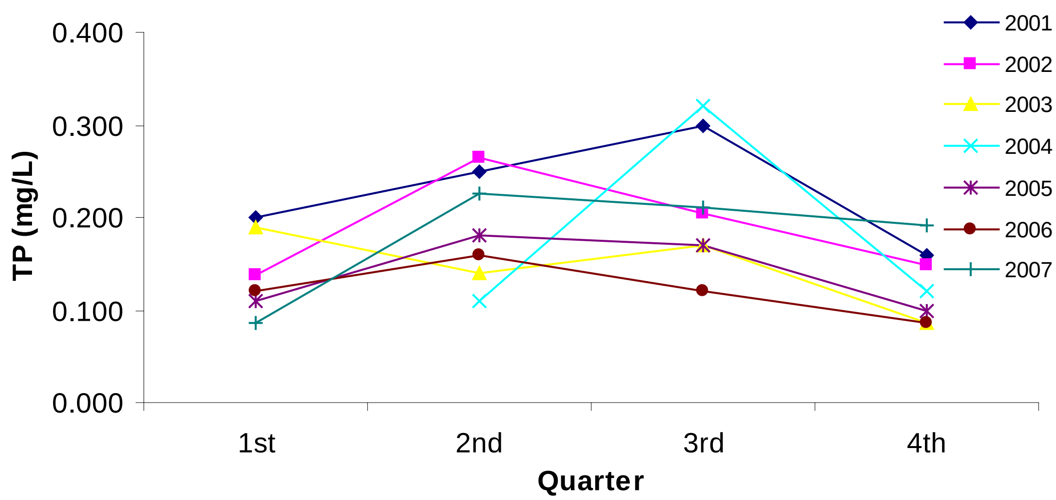

Figure 2.2. Seasonal Dynamics of TP in Smith Canal (WBID 2962)

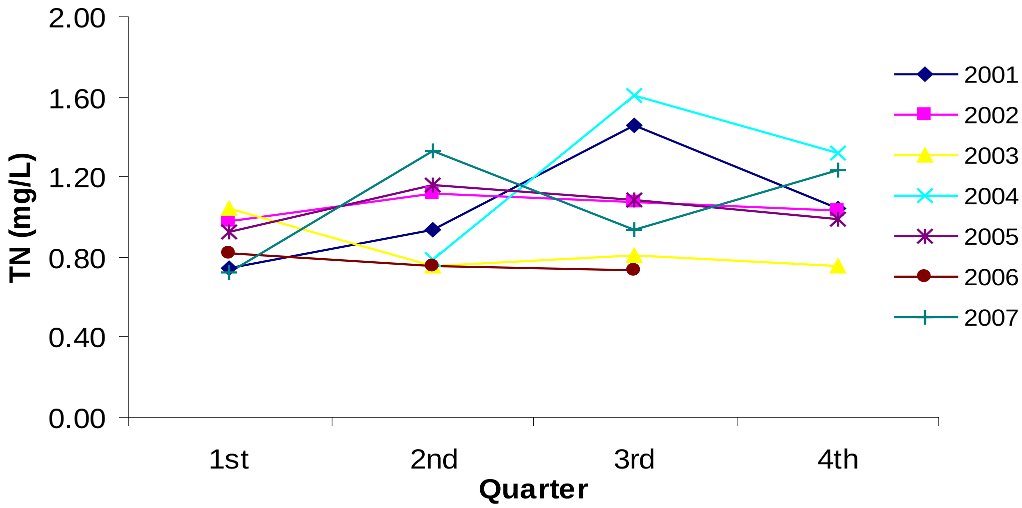

Figure 2.3. Seasonal Dynamics of TN in Smith Canal (WBID 2962)

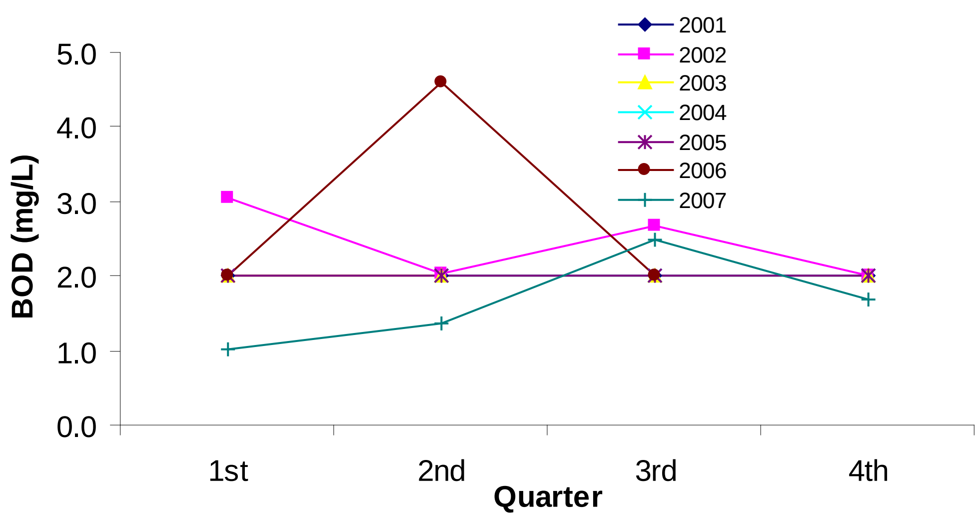

Figure 2.4. Seasonal Dynamics of BOD in Smith Canal (WBID 2962)

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criteria Applicable to the TMDL

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

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

Smith Canal is a Class III waterbody, with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criterion applicable to the impairment addressed by this TMDL report is DO.

3.2 Applicable Water Quality Standards and Numeric Water Quality Target

3.2.1 Dissolved Oxygen

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

Another source of DO consumption may originate from the organic materials accumulated in the river floodplain and at the bottom of contributing wetlands. Due to the limited amount of time available for this analysis, factors that affect DO concentration in Smith Canal were not examined by measuring the actual DO consumption rate from each source. Instead, the possible impacts of these nutrients and organic carbon on the DO level in the canal were analyzed by examining the correlations between DO and TN, TP, and BOD concentrations.

Monthly Trend of Dissolved Oxygen and Percent DO Saturation

DO data retrieved from the IWR database were collected at the 8 sampling stations in Smith Canal (**Figure 3.1**) from 1999 to 2008, during all months except January. **Table 3.1** shows the monthly mean DO concentrations and percent saturation, which range from 1.9 to 8.69 mg/L and 23 to 91 percent, respectively. The results showed a trend in DO concentrations and percent saturation that were low during the warm months and high during the cold months. Among the months in which samples were collected more than once, all DO values exceeded 5 mg/L only in February and December (**Table 3.1**). **Figure 3.2** shows the monthly mean DO concentrations.

Table 3.1. Monthly Mean of DO and Percent DO Saturation, and Number and Percent of Values Less than 5 mg/L, in Smith Canal (WBID 2962), 1999–2008

- = Empty cell/no data

Month	# Samples	DO	% DO saturation	# Less than 5 mg/L	% Less than 5 mg/L
Jan	-	-	-	-	-
Feb	6	7.69	77%	0	0%
Mar	8	6.42	71%	2	25%
Apr	1	6.36	71%	0	0%
May	9	3.21	38%	8	89%
Jun	9	4.54	56%	4	44%
Jul	5	1.90	23%	5	100%
Aug	1	7.21	91%	0	0%
Sep	10	5.28	66%	3	30%
Oct	5	4.29	53%	4	80%
Nov	5	6.29	70%	3	60%
Dec	6	8.69	88%	0	0%

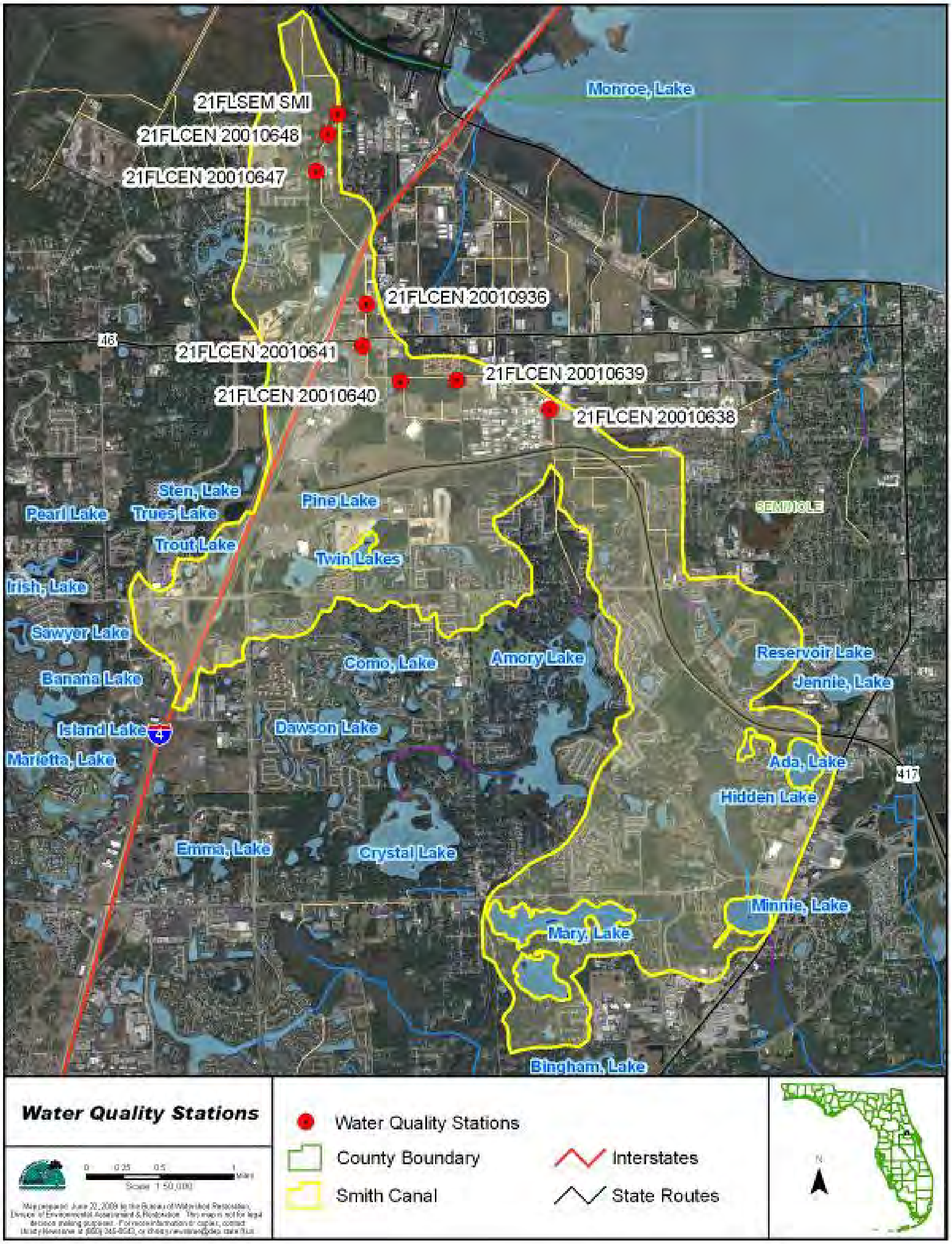

Figure 3.1. Location of the Sampling Stations in Smith Canal (WBID 2962) (Data for DO, TN, TP, and BOD Were Collected from 1999 to 2008)

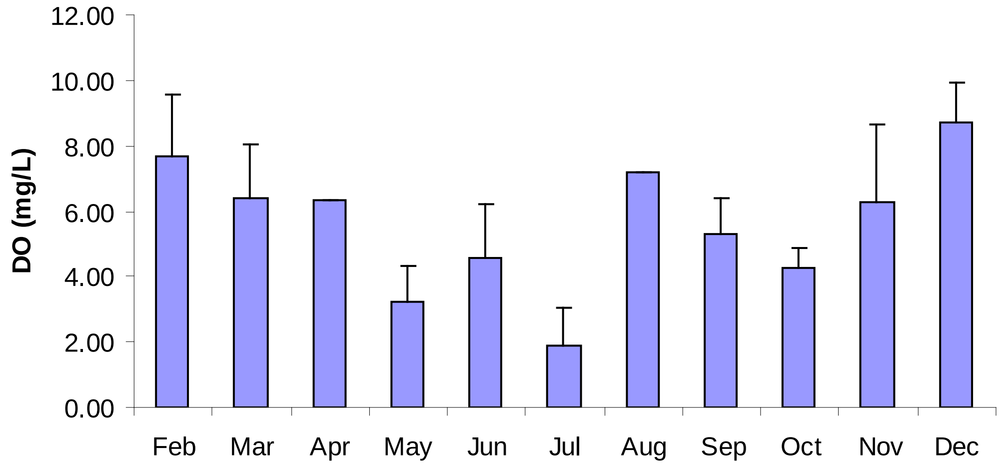

Figure 3.2. Monthly Mean and Standard Deviation of DO in Smith Canal (WBID 2962), 1999–2008

Identification of Causative Pollutant by Correlation Analyses Between DO and TN, TP, and BOD

Raw data retrieved from the IWR database of DO, TN, TP, and BOD concentrations were used for doing quantile regression analysis. The analysis was conducted using the Blossom statistical software package (U.S. Geological Survey [USGS], 2005). Typically, the lower edge of the dataset fits well with the 10^{th} percentile quantile line. The merit of this method is that once the Department sets up a nutrient target, only 10 percent of the time DO concentrations should be less than the 5 mg/L defined by the nutrient target, the 10^{th} percentile quantile line.

Because DO concentrations met the state criterion during the cold months, data from February and December were excluded from the analysis. Significant negative correlations ($P<0.0001$) between DO and TP concentrations were found in the regression analysis and also in the quantile (10^{th} percentile) analysis ($p<0.02$) for Smith Canal (**Figure 3.3**). A weak correlation was observed between DO and TN in the regression analysis ($p<0.012$) (**Figure 3.4**). The R^2 value was 0.12, indicating that the data points are deviating largely from the regression line. In the quantile analysis, the relationship between DO and TN was not statistically significant. There was no correlation between DO and BOD.

These results suggest that the low DO in Smith Canal might be mainly influenced by the elevated phosphorus concentration. To achieve a 5 mg/L DO concentration, the target TP concentration calculated for the canal (based on the 10^{th} percentile quantile regression equation [$y = -24.5x + 7.41$, shown in **Figure 3.3**]) was 0.10 mg/L. Given the weak correlation between DO and TN, a reduction in TP through TMDL implementation would also act to control TN, because the main inputs of anthropogenic TN and TP to Smith Canal are from nonpoint sources.

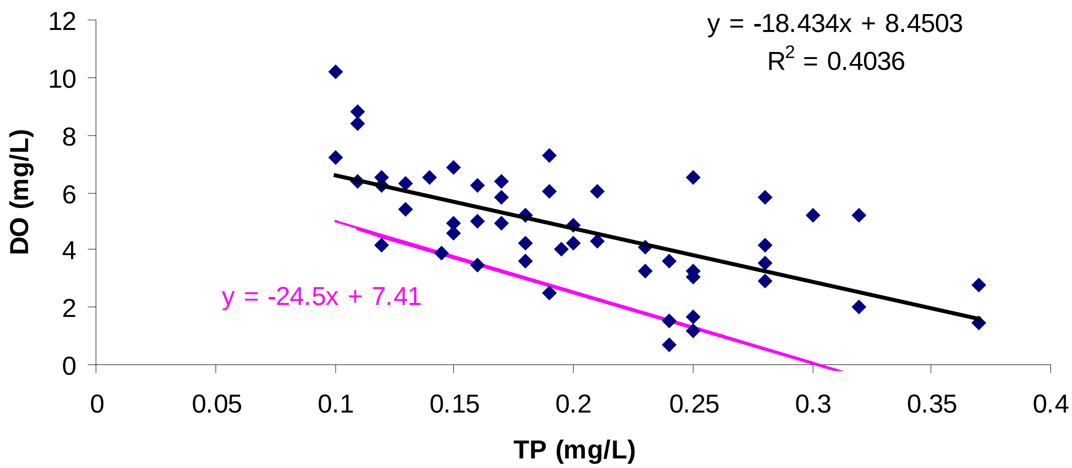

Figure 3.3. Regression Between DO and TP Using Raw Data (Excluding Data from February and December Because These Exceeded DO of 5 mg/L). The dark line indicates least squared line and the pink line, 10th percentile quantile line.

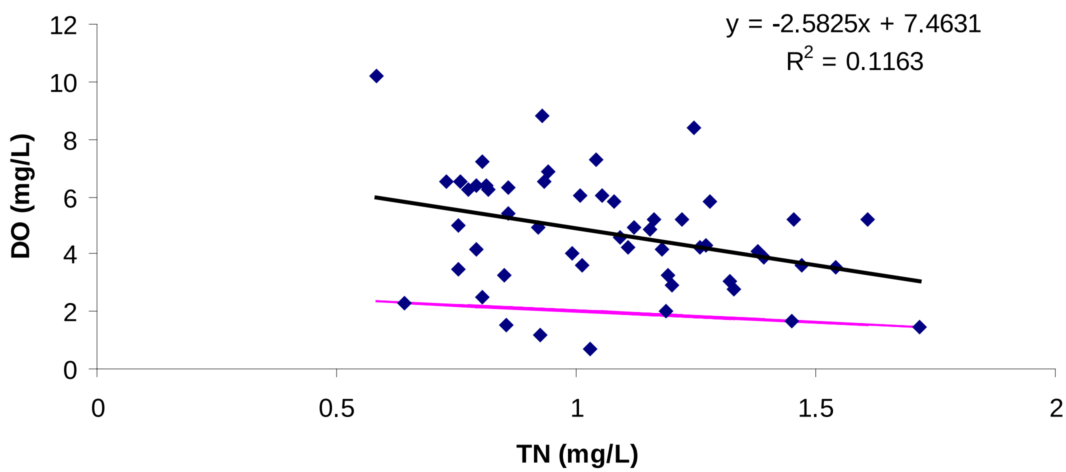

Figure 3.4. Regression Between DO and TN Using Raw Data (Excluding Data from February and December Because These Exceeded DO of 5 mg/L). The dark line indicates least squared line and the pink line, 10th percentile quantile line.

3.2.2 Nutrients

Florida's nutrient criterion is narrative only—i.e., the nutrient concentrations of a body of water shall not be altered so as to cause an imbalance in natural populations of aquatic flora or fauna. Accordingly, a nutrient-related target was needed to represent levels at which an imbalance in flora or fauna is expected to occur. While the IWR provides thresholds for nutrient impairment for lakes based on annual average Trophic State Index (TSI) levels and on annual average Chlorophyll *a* (chl*a*) level (20 micrograms per liter [μg/L]) for streams, these thresholds are not standards and need not be used as the nutrient-related water quality target for TMDLs. Smith Canal (a stream) never exceeded the annual average chl*a* threshold of 20 μg/L and is not impaired for nutrients. However, low DO could cause an imbalance in natural populations of aquatic flora and fauna.

In addition, as part of the listing process, the Department attempts to identify the causative pollutants for the DO-impaired waterbody. The causative pollutants could be BOD or limiting nutrients; TP was considered the causative pollutant in Smith Canal. The limiting nutrients, generally nitrogen (N) and phosphorus (P), are defined as the nutrients that limit plant growth when they are not available in sufficient quantities. A limiting nutrient is a chemical that is necessary for aquatic plant and algal growth, but available in quantities smaller than needed. Once the limiting nutrient in a waterbody is exhausted, plants and algae stop growing. If more of the limiting nutrient is added, aquatic plant and algal populations will grow until nutrients or other environmental factors again limit their growth. Nutrients stimulate algal growth (chl*a*), which is used as an index, and periphyton growth in the water. Reductions in nutrient loadings would be expected to result in decreases in algal and periphyton growth. In addition, the decay of algal and periphyton biomass consumes DO due to bacterial respiration.

Nutrient load reductions are also expected to result in additional benefits for other parameters of concern, including DO and BOD. Bacteria use the dissolved organic carbon (DOC) produced by algae, periphyton, and other aquatic vegetation. The addition of excessive nutrients can stimulate the use of DOC by bacteria, causing their biomass to grow and consume oxygen. Reductions in nutrients will result in lower algal and periphyton biomass levels, and lower algal and periphyton biomass levels will result in smaller diurnal fluctuations in DO, fewer algal-based total suspended solids (TSS), and reduced BOD.

3.2.3 Summary of Applicable Water Quality Target

Based on the correlation analysis between DO and TP, it appears that the low DO in Smith Canal is at least partially caused by elevated TP due to human activities. Therefore, by addressing the critical parameter of TP, the anthropogenically induced depression of DO should be ameliorated. Achieving the target TP concentration of 0.10 mg/L, however, may not eventually improve DO levels in Smith Canal because natural conditions could be among the causes of low DO. Organic materials coming from forested areas along the canal and from aquatic plants densely growing in the canal would contribute to the low DO due to bacterial activities (**Figures 3.5** and **3.6**). Low DO water flowing into the canal from stormwater ponds, where aquatic plants grow densely, could be another source (**Figures 3.7** and **3.8**).

Figure 3.5. Station 21FLCEN 20010639; Forested Area Along Smith Canal

Figure 3.6. Station 21FLCEN 20010639; Aquatic Plants Growing Densely in Smith Canal

Figure 3.7. Near Station 21FLCEN 20010638; Aquatic Plants Growing Densely in Stormwater Pond (DO Was 2.63 mg/L as Measured by the Department on April 20, 2009)

Figure 3.8. Station 21FLCEN 20010638; Outlet of Stormwater Pond

Chapter 4: ASSESSMENT OF SOURCES

4.1 Types of Sources

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

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

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

4.2 Potential Sources of TP in the Smith Canal Watershed

4.2.1 Point Sources

Wastewater Point Sources

No NPDES-permitted wastewater facilities were identified in the Smith Canal watershed.

Municipal Separate Storm Sewer System Permittees

The stormwater collection systems owned and operated by Seminole County with the Florida Department of Transportation (FDOT) District 5 and co-permittees (cities of Casselberry, Winter Springs, Longwood, Lake Mary, and Sanford) are covered by a Phase I NPDES municipal separate storm sewer system (MS4) permit (FLS000038). There are no Phase II MS4 permits identified for Smith Canal.

4.2.2 Nonpoint Sources

Most TP loadings to Smith Canal come from nonpoint sources, including surface runoff, ground water input, nutrient sediment release, and atmospheric deposition directly onto the surface of the creek. This TMDL is based on the TP loadings from the watershed simulated by the Hydrologic Simulation Program–Fortran (HSPF) Model, developed by the SJRWMD. HSPF is a comprehensive package that can be used to develop a combined watershed and receiving water model. It can simulate various species of N and P, chl*a*, BOD, coliform bacteria, metals, and DO concentrations in receiving waters.

The model has three major modules, as follows, that simulate pollutant loadings from the watershed and in-water transport of the pollutants and their effects on chl*a* and DO concentrations:

- *The PERLND Module performs a detailed analysis of surface runoff, interflow, and ground water flow for pervious land areas based on the Stanford Watershed Model. Water quality calculations for sediment in pervious land runoff can include sediment detachment during rainfall events and reattachment during dry periods, with the potential for washoff during runoff events. For other water quality constituents, runoff water quality can be determined using buildup-washoff algorithms, "potency factor" (e.g., factors relating constituent washoff to sediment washoff), or a combination of both.*
- *The IMPLND Module analyzes surface runoff only from impervious land areas and uses buildup-washoff algorithms to determine runoff quality.*
- *The RCHRES Module is used to simulate flow routing and water quality in receiving waters, which are assumed to be one-dimensional. Receiving water constituents can interact with suspended and bed sediments through soil-water partitioning. The HSPF Model can incorporate "special actions" with user-specified algorithms to account for occurrences such as the opening/closing of water control structures to maintain seasonal water stages or other processes beyond the normal scope of the model code.*

Delineation of the Smith Canal Watershed

For modeling purposes, the Department used not waterbody boundaries but drainage basin boundaries delineated by the SJRWMD (Jia, 2008). The SJRWMD developed a HSPF Model for the Lake Monroe drainage basin and delineated the basin into 9 subwatersheds, 2 of which (6 and 7) are in the Smith Canal watershed (**Figure 4.1**). The delineation was based on the stream network and topography of the watershed. The sizes of subwatersheds 6 and 7 were 3,777 and 6,216 acres, respectively, totaling 9,993 acres.

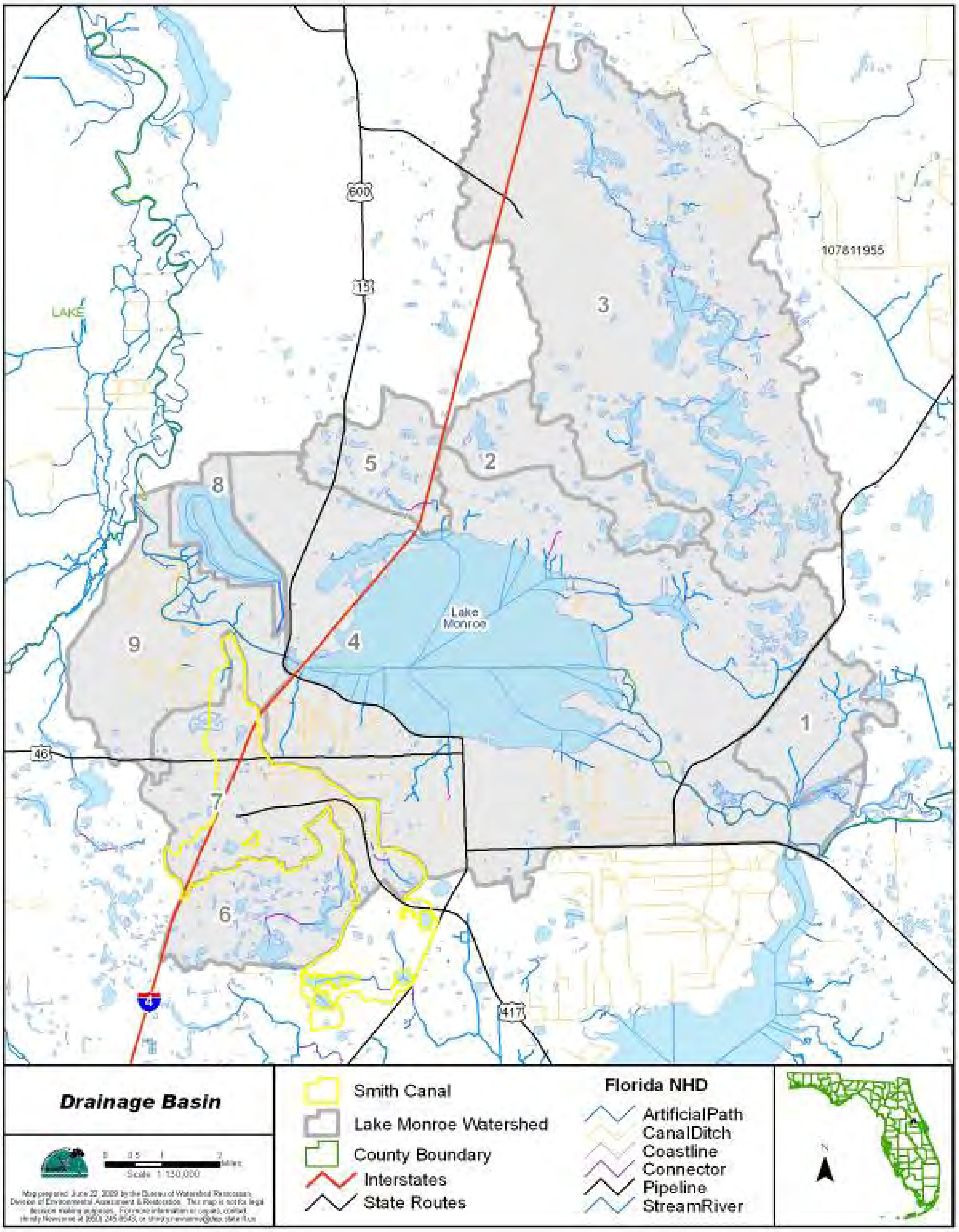

Figure 4.1. Delineation of the Lake Monroe and Smith Canal Drainage Basins for the HSPF Model

Land Uses

Surface runoff could be a very important source of pollutants in the Smith Canal watershed. The amount of surface runoff and pollutant concentrations of surface runoff are significantly influenced by land use types in the watershed. Land uses in the drainage area that discharges to Smith Canal were classified based on the Florida Land Use, Cover and Forms Classification System (FLUCCS) using the SJRWMD's 2000 land use GIS coverage. The land uses were aggregated into 13 different land use categories in this analysis for modeling purposes (Jia, 2008) (**Table 4.1**). **Figure 4.2** shows the spatial distribution of land use types across the drainage area that discharges to Smith Canal.

Table 4.1. Classification of Land Use Categories for the Smith Canal Watershed (WBID 2962) in 2000

Land Use	Acreage	% Acreage
Low-Density Residential (LDR)	559	5.6%
Medium-Density Residential (MDR)	1,646	16.5%
High-Density Residential (HDR)	871	8.7%
Industrial and Commercial (IND)	1,141	11.4%
Mining (MIN)	56	0.6%
Open Land (OPE)	410	4.1%
Pasture	496	5.0%
Agriculture General (AGR)	419	4.2%
Agriculture Tree Crop (AGT)	210	2.1%
Rangeland (RAN)	1,195	12.0%
Forest (FOR)	1,812	18.1%
Water (WAT)	119	1.2%
Wetlands (WET)	1,059	10.6%
Total:	**9,993**	**100%**

The total watershed area discharging to Smith Canal is about 9,993 acres. Urban land uses (low-, medium-, and high-density residential, and industrial and commercial) have the highest acreage among all the land use types (4,217 acres), accounting for about 42.2 percent of the total watershed area (**Table 4.1**). Agricultural land uses occupy about 1,125 acres and account for 11.3 percent of the total watershed. Natural land uses, which include forest, water, and wetland, occupy about 2,990 acres, accounting for about 30 percent of the total watershed area.

Among natural land areas, about 10.6 percent (1,059 acres) of the watershed consists of wetlands. Although wetlands can help to remove pollutant loadings caused by human land uses, the decay of wetland aquatic plants, oxygen consumption from the organic materials accumulated at the bottom, and a consistent supply of humic organic carbon from these areas can significantly contribute to naturally low DO in Smith Canal.

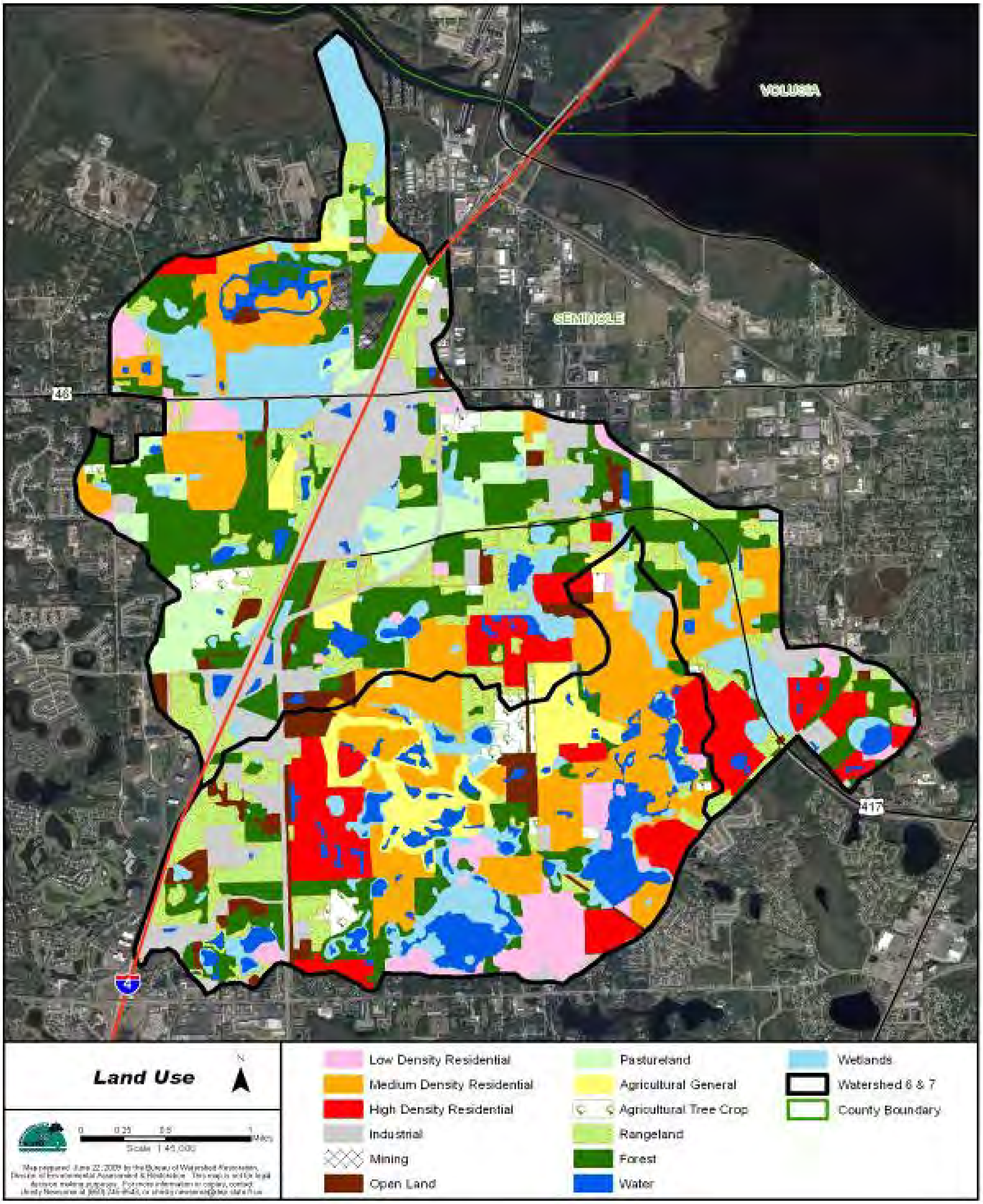

Figure 4.2. Principal Land Use Types in the Smith Canal Watershed (WBID 2962) in 2000

Septic Tanks

Septic tanks are commonly used where providing central sewer is not cost-effective or practical. When properly installed, maintained, and operated, septic tanks are a safe means of disposing of domestic waste. The effluent from a well-functioning septic tank is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, however, septic tanks can be a source of nutrients (N and P), pathogens, and other pollutants to both ground water and surface water.

The number of failing septic tanks in the watershed is estimated based on the reported septic tank repairs in Seminole County. The number of annual repairs in the county ranged from 339 to 570 between 1997 and 2002 (Florida Department of Health [FDOH], 2004). To account for the possibility that not all failing septic tanks in the county are reported and repaired, this analysis uses the high end of the reported range as the average number of failing septic tanks in Seminole County. It is assumed that these failing septic tanks are distributed evenly in residential areas (including low-, medium-, and high-density residential). The total residential area in Seminole County is 60,511 acres, based on 2000 land use coverage obtained from the SJRWMD. The average number of failing septic tanks per acre of residential area is calculated as $570/60{,}511 \approx 0.00942$ per acre in Seminole County. The septic tank failure rate per acre of residential area is assumed to be constant across the Smith Canal watershed. The total residential area in the watershed is 3,076 acres. Thus, the number of failing septic tanks in the watershed is estimated as $0.00942 \times 3{,}076 \approx 29$.

Pollutant contributions from these failing septic tanks are modeled in two ways, depending on their proximity to the stream network in the watershed. For the septic tanks more than 50 feet away from streams, pollutant loadings are handled inexplicitly and are lumped with pollutant loadings from residential areas. Septic tanks within 50 feet of streams are considered direct pipes discharging untreated wastewater to the stream network. These direct pipes are modeled as point sources in the HSPF Model. However, there are no residential areas within 50 feet of the stream network in the Smith Canal watershed.

According to the EPA (1980), the per capita flow rate from a failing septic tank is about 7.18×10^{5} cubic feet per second (cfs). The average number of people per household in Seminole County is 2.59 (U.S. Census Bureau, 2000). The estimated flow rate from a failing septic tank is $7.18 \times 10^{-5} \times 2.59 = 1.86 \times 10^{-4}$ cfs. The pollutant concentrations of failing septic tank effluent are assumed to equal the average concentration measurements in Florida compiled by Parsons Engineering Science (2000). **Table 4.2** shows the average pollutant concentrations used in this analysis. It is assumed that the effluent flow rate and pollutant concentrations are constant over the simulation period.

Table 4.2. Pollutant Concentrations of Failing Septic Tank Effluent

[1] According to Parsons Engineering Science (2000), the average measured BOD_5 = 141 mg/L. This analysis assumes that BOD = 2.5 BOD_5.
[2] This analysis assumes that TSS loads from failing septic tanks contain 50 percent silt and 50 percent clay.
[3] This analysis treats TN loads from septic tanks as nitrate (NO3) loads.
[4] This analysis treats TP loads from septic tanks as orthophosphate (PO4) loads.

Parameter	Concentration (mg/L)
BOD[1]	352.5
TSS[2]	161.0
TN[3]	39.0
TP[4]	11.0

Atmospheric Deposition

The simulation of atmospheric deposition is also handled in two ways in HSPF. While atmospheric deposition to the land surface is lumped into nonpoint source loadings from land uses, atmospheric deposition to stream and lake surfaces is modeled explicitly. This analysis assumes that only inorganic forms of N and P are contributed from atmospheric deposition. Ammonia (NH4) and nitrate (NO3) concentrations of wet deposition are assumed to be the observed mean values, 0.25 mg/L and 1.08 mg/L, at Site F32 of the National Atmospheric Deposition Program (available: http://nadp.sws.uiuc.edu) in Orlando, Florida. The PO4 concentration of wet deposition is assumed to be 0.009 mg/L, which is the same concentration of wet deposition for TP estimated by Brezonik et al. (1983). Inorganic N and P dry deposition rates are assumed to be 150 and 20 milligrams per square meter per year ($mg/m^2/yr$), respectively. These values are equal to the TN and TP dry deposition rates for the Lake Apopka area. It is also assumed that inorganic N dry deposition contains 75 percent NO3 and 25 percent NH4 (S. Brandt-Williams, SJRWMD, personal communication, 2006). The above annual loadings are evenly allocated as the monthly input to the HSPF Model.

4.3 HSPF Model Development

The HSPF Model was originally developed under the joint sponsorship of the EPA and USGS. The model is capable of simulating both hydrologic and water quality processes in the watershed and receiving waterbodies. HSPF Version 12.0 (Bicknell et al., 2001) is used to simulate the hydrologic and water quality processes in the Smith Canal watershed. The data analysis and evaluation focused on the six-year model simulation period from October 1997 through September 2003 to represent recent and existing conditions.

4.3.1 Meteorological Data

HSPF requires eight hourly meteorological time series as input data: precipitation, evaporation, air temperature, wind speed, solar radiation, potential evapotranspiration, dew point temperature, and cloud cover. The precipitation data used in this analysis are hourly Next Generation Weather Radar (NEXRAD) radar rainfall data from OneRain, Inc. The OneRain NEXRAD rainfall data are collected on a two-by-two kilometer grid and cover the entire SJRWMD area.

A GIS tool, Radar Rainfall Tool Version 6.0, was developed by the SJRWMD to calculate the aerial radar rainfall for a particular watershed. This analysis uses the tool to extract the hourly radar rainfall time series for each of the two subwatersheds in the Smith Canal watershed over the simulation period from October 1997 to September 2003. To collect other meteorological data, weather stations near the watershed were analyzed for the types of data collected, length of record, and missing data. **Table 4.3** lists the weather stations used in this analysis. The data from these stations were obtained from the SJRWMD.

Table 4.3. Major Weather Stations in or near the Smith Canal Watershed (WBID 2962)

[1] The original LISBON pan evaporation data after 2000 are problematic because they are significantly lower than their historical averages. These low readings were corrected by David Clapp of SJRWMD. This analysis uses the corrected data.

Station Name	Location	Date Type	Period of Record	Time Interval
LISBON[1]	Lisbon	Pan Evaporation	1/1/1960 – Present	Daily
ORLANDO	Orlando International Airport	Wind Speed Air Temperature Dew Point Temperature Cloud Cover	5/7/1952 – 6/30/1996 for Cloud Cover; 5/7/1952 – 12/31/2002 for others	Hourly
S61W	Lake Tohopekeliga	Solar Radiation	10/20/1992 – Present	Daily

Wind speed data, air temperature data, and dew point temperature data from the ORLANDO weather station are only available up to the end of 2002, and cloud cover data from ORLANDO are not available for the simulation period. The air temperature data and dew point temperature data are extended to September 2003 using their daily average values calculated over the period from January 1993 to September 2002. The wind speed data and cloud cover data are extended to cover the whole simulation period using the monthly average values calculated from January 1993 to September 2002, and July 1987 to June 1996, respectively.

The meteorological data are imported into a Weather Data Management (WMD) database using WDMUtil (EPA, 2001), a utility program for managing meteorological data for HSPF. WDMUtil is used to disaggregate the daily pan evaporation data from LISBON and the daily solar radiation data from S61W into hourly data. The algorithms used for disaggregating the above data can be found in the WDMUtil User's Manual (EPA, 2001).

This analysis assumes that potential evaporation from the water surface equals the potential evapotranspiration in the watershed. The potential evaporation is estimated by applying a pan coefficient to the pan evaporation data from LISBON. An annual pan coefficient of 0.78 is used in this analysis, resulting in an estimated long-term (1960 to 2005) average potential evaporation rate of 47.4 inches per year (in/yr). This estimate is close to the estimated average potential evaporation rate of 46 to 48 in/yr for the watershed by Tibbals (1990).

4.3.2 Observed Flow Data

There are no USGS gaging stations in Smith Canal. The USGS monitors long-term daily flow data at the main stem of the St. Johns River near Sanford and at Deep Creek Diversion Canal near Osteen (**Table 4.4**). The flow data from these sites were directly downloaded from the USGS Website. **Figure 4.3** shows the locations of the USGS gages.

Table 4.4. USGS Flow Station near the Smith Canal Watershed (WBID 2962)

Station Name	Station Number	Period of Record
St. Johns River Near Sanford, FL	02234500	10/1996 – 09/2003
Deep Creek Near Osteen, FL	02234100	10/1996 – 09/2003

4.3.3 Water Quality Sampling Data

Data from two stations, one in Lake Harney (CLH) and the other in Lake Monroe (LMAC), were used for water quality calibration (**Table 4.5**). **Figure 4.3** shows the locations of these water quality sampling stations.

Table 4.5. Sampling Organization, Station Description, and Data Source of the Water Quality Stations Used for Water Quality Calibration

Sampling Organization	Station Description	Source
SJRWMD	CLH LMAC	SJRWMD

4.3.4 Watershed Segmentation

A watershed and its stream network are characterized in HSPF by various pervious land segments (PERLND), impervious land segments (IMPLND), and reach segments (RCHRES) based on subwatershed delineation, land uses, and the ratio of perviousness and imperviousness for each land use. As described in **Section 4.2.2**, land uses in the Smith Canal watershed are grouped into 13 categories. These consolidated land uses are further divided into pervious and impervious fractions. The pervious portion of a land use in a subwatershed is represented as a PERLND, and the impervious portion is represented as an IMPLND. Impervious areas include all surface areas that prevent water from infiltrating into the ground. Typical impervious areas are roofs, roads, and parking lots. **Table 4.6** shows the assignment of pervious/impervious portions for land uses. The remaining land uses are assumed to be 100 percent pervious.

For modeling purposes, the stream network in a subwatershed is grouped together and represented as an RCHRES. The reach segment draining a subwatershed receives the runoff and water quality constituents from the land segments in that subwatershed. For the area without best management practice (BMP) treatment, the runoff and water quality constituents are delivered to the reach segment directly. However, for the area with BMP treatment, the runoff and water quality constituents are first delivered to BMP areas, and then the outputs from BMP areas are delivered to the reach segment.

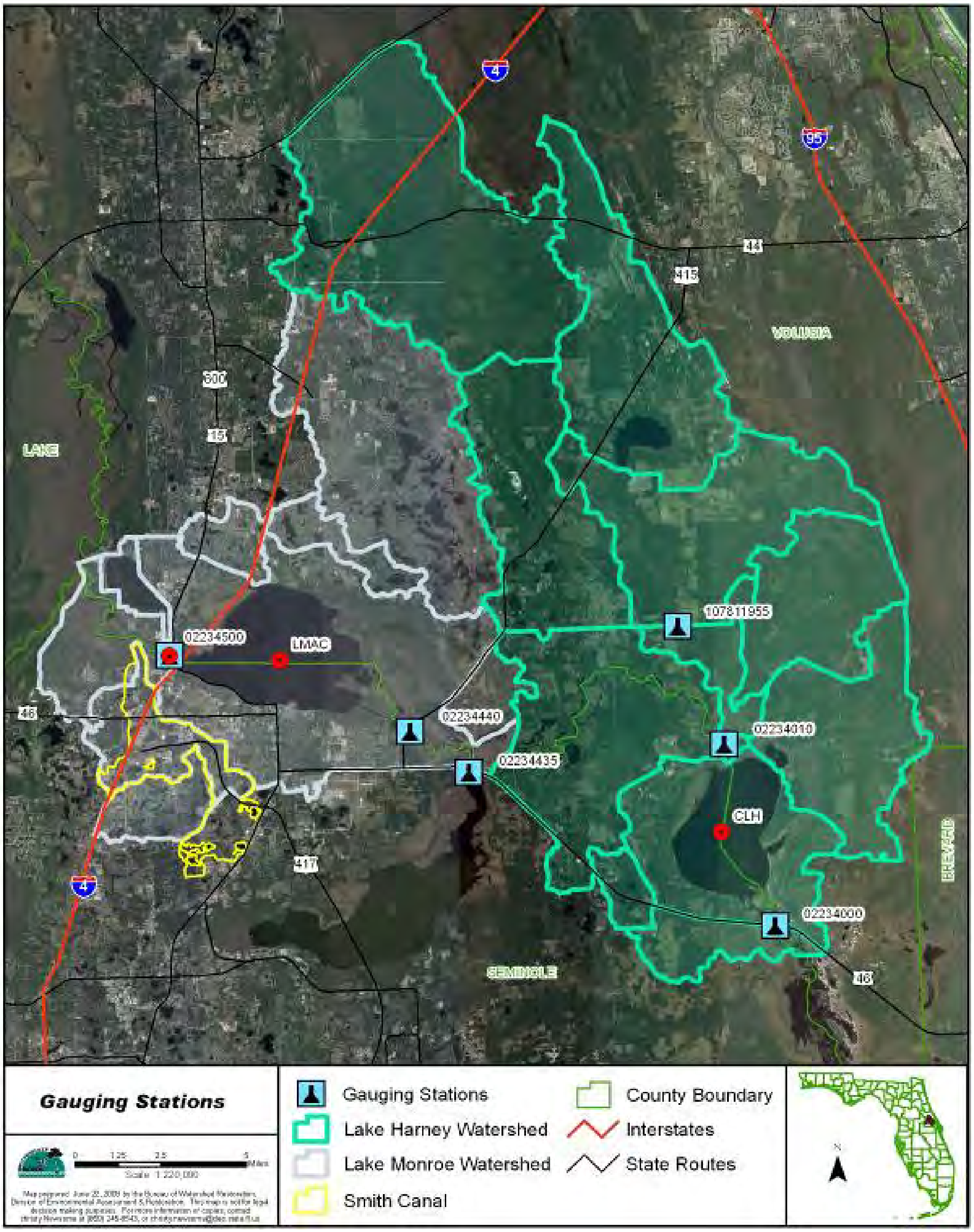

Figure 4.3. Locations of Sampling and Gaging Stations for HSPF Model Calibration in the Smith Canal Watershed (WBID 2962)

Table 4.6. Acreage and Percentage of Pervious/Impervious Portions for Land Uses

Land Use	Module	Acreage	%
Low-Density Residential (LDR)	IMPLND	39	7%
Low-Density Residential (LDR)	PERLND	520	93%
Medium-Density Residential (MDR)	IMPLND	491	30%
Medium-Density Residential (MDR)	PERLND	1155	70%
High-Density Residential (HDR)	IMPLND	446	51%
High-Density Residential (HDR)	PERLND	425	49%
Industrial and Commercial (IND)	IMPLND	884	77%
Industrial and Commercial (IND)	PERLND	257	23%

4.3.5 BMP Characterization

The available BMP data do not support the detailed modeling of BMPs in the Smith Canal watershed. These are mostly on-site and serve relatively small areas. The efforts involved in compiling related information and performing detailed simulations for each individual BMP would be time-consuming. Therefore, this analysis focuses on simulating the effects of various BMPs on peak flow attenuation and pollutant load reduction at subwatershed levels.

An RCHRES is used in the HSPF Model to represent all the dry detention ponds or all the wet detention ponds in a subwatershed. HSPF routes surface runoff, interflow, and their associated water quality constituents generated from the contributing areas through the dry pond RCHRES, and routes surface runoff, interflow, baseflow, and their associated water quality constituents generated from the contributing areas through the wet pond RCHRES.

The effects of swales are simulated by directly applying a set of removal efficiencies to the water quality constituents from their contributing areas. The removal efficiencies for swales are only specified for the water quality constituents associated with surface runoff. No removal efficiencies are applied to water quality constituents associated with interflow and baseflow.

Table 4.7 presents the pollutant removal efficiencies used in the HSPF Model. The removal efficiencies for dry detention pond, wet detention pond, and swale are mainly based on the median values of the reported ranges in *Preliminary Data Summary of Urban Storm Water Best Management Practices* (EPA, 1999), *National Pollutant Removal Database for Stormwater Treatment Practice, 2nd Edition* (Center for Watershed Protection, 2000), and *Literature Review of Stormwater Best Management Practices* (Camp Dresser & McKee [CDM], 2002). These median values are considered reasonable to represent the average performance of individual BMPs at subwatershed levels.

Table 4.7. Pollutant Removal Efficiencies Used in the HSPF Model (Percent)

Water Quality Constituent	Dry Detention Pond	Wet Detention Pond	Swale
TSS	50%	80%	80%
Total Ammonia	5%	25%	15%
Nitrate + Nitrite	5%	25%	15%
PO4	20%	55%	30%
BOD	20%	35%	30%

4.3.6 Hydrologic Calibration

A variety of HSPF hydrologic parameters relating to watershed storage, infiltration, evaporation, and deep percolation are adjusted in the hydrologic calibration processes to match the observed flows at the USGS flow stations. As there were no gaging stations on Smith Canal, the gaging stations used were from the St. Johns River near Sanford (02234500) in the Lake Monroe watershed, and Deep Creek (002234500) in the Lake Harney watershed. **Figures 4.4** and **4.5** compare the simulated flows and the observed flows at the two calibration sites over the calibration period from October 1996 to September 2003. It can be seen that good agreement is achieved between the simulated flows and the observed flows.

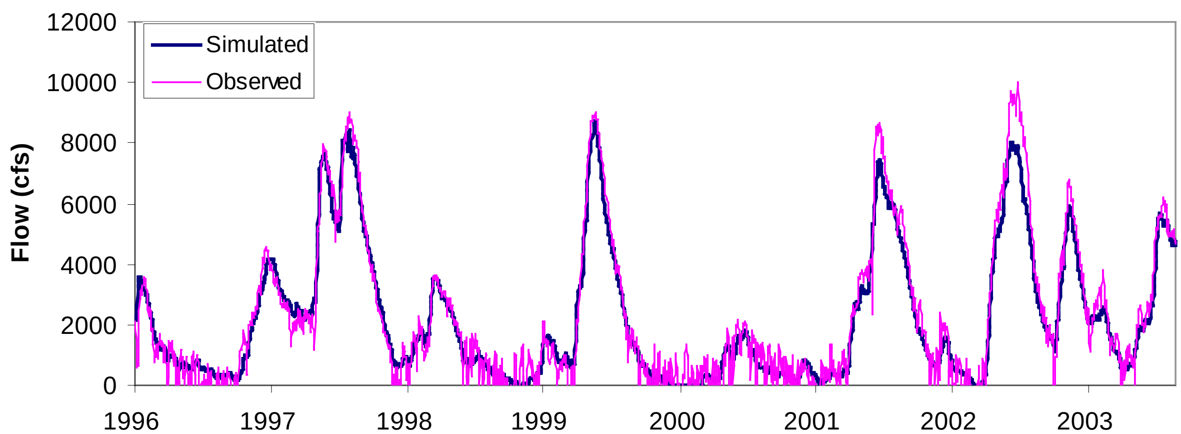

Figure 4.4. Observed and Simulated Daily Flows at the St. Johns River near Sanford (October 1996–September 2003)

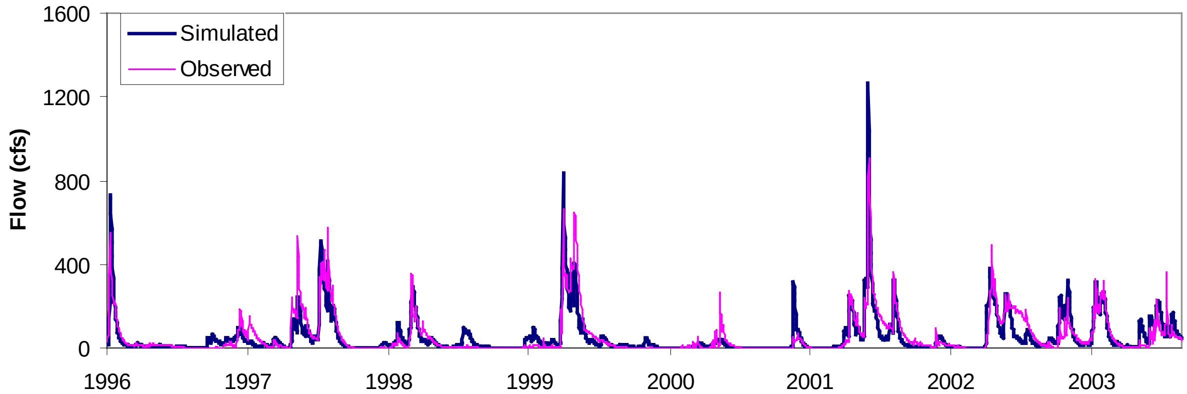

Figure 4.5. Observed and Simulated Daily Flows at Deep Creek (October 1996–September 2003)

4.3.7 Water Quality Calibration

There are limited water quality data available for the Smith Canal watershed. Therefore, the Department used water quality data from other subwatersheds in the Lake Harney (Sampling Station CLH) and Lake Monroe (Sampling Station LMAC) watersheds to see how well the model calibrates the water quality data (**Figure 4.3**). Using other subwatersheds with available water quality data for calibration may reduce the ability of the calibrated HSPF Model to accurately represent the water quality processes and different hydrologic conditions in the Smith Canal watershed.

Water quality calibration involves two major steps, as follows:

1. *Adjusting the land use–specific parameters (e.g., accumulation rates, depletion/removal rates, washoff rates, subsurface concentrations) to match land use loadings with the expected loadings reported in the literature; and*

2. *Selecting the in-stream water quality parameters (e.g., reaeration rate, nitrification rate, phytoplankton growth rate) to reproduce the observed water quality concentrations at calibration sites.*

These two steps are performed adaptively in the calibration process. If good agreement between the simulated and observed in-stream water quality data cannot be achieved in the second step, while maintaining the in-stream water quality parameters within realistic ranges, the land use–specific parameters determined in the first step will be readjusted.

Figures 4.6 through **4.9** compare the observed TN and TP concentrations with the simulated concentrations at Lake Harney and Lake Monroe. For calibration, TN and TP data were available from October 2001 to August 2003. The simulated TN concentrations matched the observed data early in the calibration period, but during the wet period (from late 2002 to 2003), the simulated concentrations were lower than the observed concentrations in Lake Harney. The simulated TP values matched the observed data fairly well in Lake Harney. More observed data were available for Lake Monroe from February 1995 to August 2003. Both simulated TN and TP concentrations fluctuated in a trend and range similar to the observed data in Lake Monroe. In general, simulated water quality concentrations closely match the observed values in Lake Harney and Lake Monroe, indicating that the HSPF Model adequately represents the hydrologic and water quality processes in the watershed.

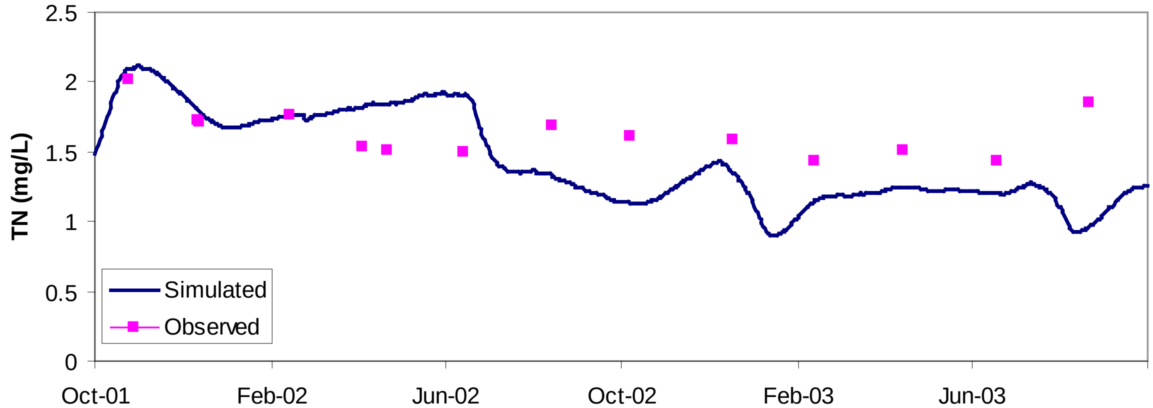

Figure 4.6. Observed and Simulated TN Concentration at the Center of Lake Harney (October 2001–September 2003)

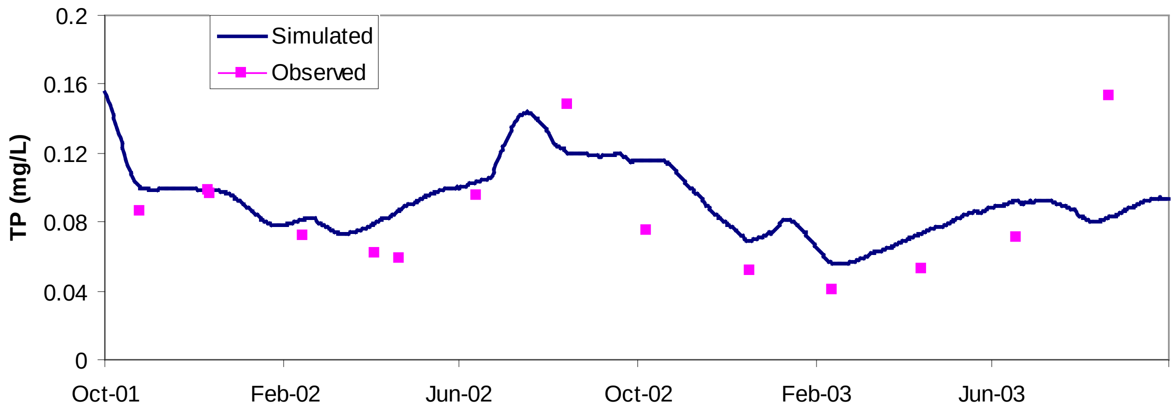

Figure 4.7. Observed and Simulated TP Concentration at the Center of Lake Harney (October 2001–September 2003)

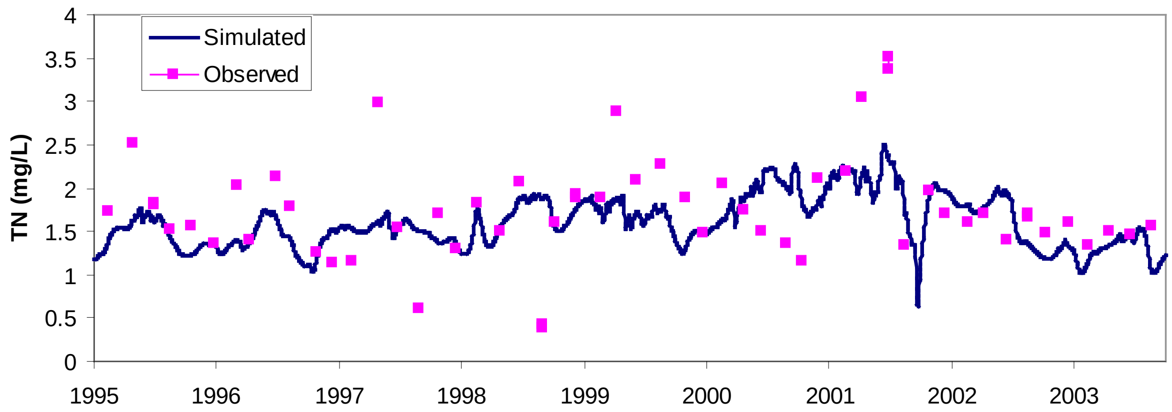

Figure 4.8. Observed and Simulated TN Concentration at the Center of Lake Monroe (January 1995–September 2003)

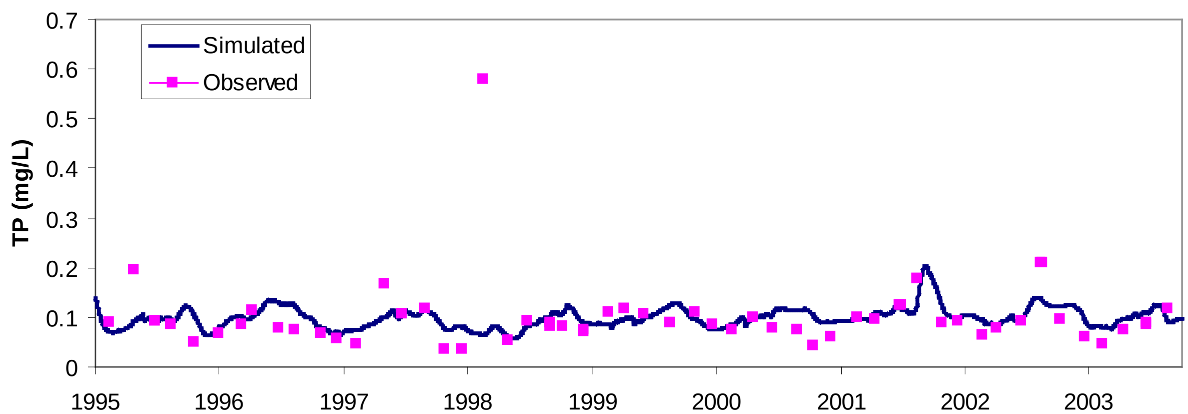

Figure 4.9. Observed and Simulated TN Concentration at the Center of Lake Monroe (January 1995–September 2003)

4.3.8 Existing Loading

Table 4.8 summarizes the estimated existing watershed loadings of flow, TN, and TP. On average, the annual loading from the Smith Canal watershed and atmospheric deposition is 14,270 acre-feet/year (acre-ft/yr). The average annual watershed loadings of TN and TP are 21.71 tons N/yr and 2.64 tons P/yr. There is significant variation between the watershed loadings in the 3 dry years (1997, 1999, and 2000) and those in the 3 wet years (1996, 1998, and 2003). On average, the dry year watershed loadings of flow, TN, and TP are 10,599 acre-ft water/yr, 17.1 metric ton N/yr, and 2.12 tons P/yr, respectively. The wet year watershed loadings are 18,886 acre-ft water/yr, 27.25 tons N/yr, and 3.23 tons P/yr, or approximately 1.5 times the dry year watershed loadings. Loading from atmospheric deposition of TP contributed only about 2 percent to total loading in Smith Canal, and TN added about 5 percent due to the small surface area of the stream.

Table 4.8. Existing Loadings of Flow, TN, and TP from the Smith Canal Watershed (WBID 2962) and Atmospheric Deposition

Year	Flow (acre-ft/yr)	TN (tons/yr)	TP (tons/yr)
1996	17,290	24.86	3.01
1997	9,712	16.41	2.08
1998	20,607	28.44	3.29
1999	11,382	18.19	2.27
2000	10,704	16.71	2.00
2001	12,048	18.28	2.34
2002	13,656	22.32	2.79
2003	18,763	28.44	3.39
Mean:	**14,270**	**21.71**	**2.64**

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Overall Approach

The goal of TMDL development for Smith Canal is to identify the maximum allowable TP loading to the waterbody so that it will meet its water quality standards and maintain its designated uses as a Class III water. As discussed in Chapter 3, the target TP concentrations of 0.10 mg/L proposed by the Department address the DO impairment in the water by controlling aquatic plant growth.

Based on the correlation analyses between DO and TP concentrations in Smith Canal, it appears that any decreases in the in-stream DO level caused by TP of human origin should be addressed if TP concentrations are reduced to 0.1 mg/L. When background conditions (no human-influenced land uses) were simulated using the HSPF Model, annual mean TP concentrations ranged from 0.068 to 0.095 mg/L, averaging 0.084 mg/L (**Table 5.1**). The result shows that the TP target concentration (0.10 mg/L) did not fall below the natural background concentration. Therefore, TP target loadings were estimated by HSPF simulation, using the Department-developed TP target concentration. Finally, the percent reduction for TP loading was calculated based on existing loadings and target loadings. For each yearly loading exceedance, a per-year required reduction was calculated using the following:

$$\textbf{Load reduction} = \frac{\textbf{Existing loading} - \textbf{Background loading}}{\textbf{Existing loading}} \times 100\%$$

After the per-year results were calculated, the median of the individual values was calculated.

Table 5.1. Background Concentration of TP Simulated by the HSPF Model

Year	TP concentration (mg/L)
1996	0.075
1997	0.084
1998	0.093
1999	0.082
2000	0.095
2001	0.089
2002	0.088
2003	0.068
Mean:	**0.084**

5.2 Estimating the Target TP Loading

The target TP loading into Smith Canal was estimated by adjusting the phosphate-related coefficient rate for human-influenced land use in the HSPF Model to reach the target TP concentration of 0.1 mg/L. As no sedimentation was considered using this approach, the estimated TMDL could be lower than the TP loading that can be assimilated in the canal. This makes the TMDL estimate more conservative and therefore adds to the margin of safety. **Table 5.2** lists TP loading under existing conditions, target TP loading, and the percent reduction required to achieve target TP loadings.

The target TP loadings for Smith Canal ranged from 1.5 to 2.44 tons/yr, averaging 1.95 tons/yr. The target loading represents about a 26 percent reduction in TP loading under the existing condition in Smith Canal.

Table 5.2. Existing and Target Loadings for TP and Percent Load Reduction Required To Achieve the Target Loadings

- = Empty cell

Year	Existing Loading (tons/yr)	Target Loading (tons/yr)	Load Reduction (%)
1996	3.01	2.15	29%
1997	2.08	1.62	22%
1998	3.29	2.44	26%
1999	2.27	1.71	25%
2000	2.00	1.50	25%
2001	2.34	1.73	26%
2002	2.79	2.03	27%
2003	3.39	2.39	29%
-	**-**	**Median:**	**26**%

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

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

$$TMDL = \sum WLAs + \sum LAs + MOS$$

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

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

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (1) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is also accounted for within the LA, and (2) TMDL components can be expressed in different terms (for example, the WLA for stormwater is typically expressed as a percent reduction, and the WLA for wastewater is typically expressed as mass per day).

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

The TMDL for Smith Canal in this report is expressed in terms of tons per year (tons/yr) and percent reduction of TP, and represents the maximum long-term annual average TP loadings that the waterbody can assimilate and maintain a balanced aquatic flora and fauna (**Table 6.1**).

Table 6.1. TMDL Components for Smith Canal (WBID 2962)

N/A = Not applicable

WBID	Parameter	TMDL (tons/yr)	WLA for Wastewater (tons/yr)	WLA for NPDES Stormwater (%)	LA (%)	MOS
2962	TP	1.95	N/A	26%	26%	Implicit

6.2 Load Allocation

The long-term annual average load allocation for TP into Smith Canal is 1.95 tons/yr. Nonpoint sources (including the loadings from MS4 stormwater) are responsible for all these loadings. The current long-term annual average TP loadings into Smith Canal are 2.64 tons/yr from all possible sources, including surface runoff, ground water input, and sediment nutrient release.

To achieve the LA, current TP loading into Smith Canal should be reduced by 26 percent. The load reductions need to apply primarily to surface runoff, especially runoff from agricultural areas.

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

No NPDES-permitted wastewater facilities were identified in the Smith Canal watershed.

6.3.2 NPDES Stormwater Discharges

Because no information was available to the Department on the boundaries and locations of all the NPDES stormwater dischargers when this analysis was conducted, the exact stormwater TP loadings from MS4 areas were not explicitly estimated. Seminole County is the lead permittee for Phase I MS4 permits that cover the stormwater facilities. FDOT is the co-permittee for a Phase I permit in the county. The WLA for NPDES stormwater was set as the same percent reduction required to achieve the TMDL as the other conventional nonpoint sources, or a 26 percent reduction in TP loadings into Smith Canal.

6.4 Margin of Safety

Consistent with the recommendations of the Allocation Technical Advisory Committee (Department, 2001), an implicit MOS was used in the development of this TMDL by the conservative decisions associated with a number of modeling assumptions, the development of site-specific alternative water quality targets, and the development of assimilative capacity, which did not account for in-stream losses of TP.

This analysis estimated pollutant loadings by multiplying pollutant concentrations by flow. This process addresses the pollutant loadings that eventually reach a waterbody after attenuation during overland transport. TMDLs estimated using this method could be significantly lower than the pollutant loadings allowed in the watershed and are therefore very conservative, adding to the implicit MOS.

Chapter 7: TMDL IMPLEMENTATION

TMDL Implementation

Following the adoption of this TMDL by rule, the Department will determine the best course of action regarding its implementation. Depending upon the pollutant(s) causing the waterbody impairment and the significance of the waterbody, the Department will select the best course of action leading to the development of a plan to restore the waterbody. Often this will be accomplished cooperatively with stakeholders by creating a Basin Management Action Plan, referred to as the BMAP. Basin Management Action Plans are the primary mechanism through which TMDLs are implemented in Florida [see Subsection 403.067(7) F.S.]. A single BMAP may provide the conceptual plan for the restoration of one or many impaired waterbodies.

If the Department determines a BMAP is needed to support the implementation of this TMDL, a BMAP 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. 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 benefited other program areas.

However, in some basins, and for some parameters, particularly those with fecal coliform impairments, the development of a BMAP using the process described above will not be the most efficient way to restore a waterbody, such that it meets its' designated uses. Why? Because fecal coliform impairments result from the cumulative effects of a multitude of potential sources, both natural and anthropogenic. Addressing these problems requires good old fashioned detective work that is best done by those in the area. There are a multitude of assessment tools that are available to assist local governments and interested stakeholders in this detective work. The tools range from the simple – such as Walk the WBIDs and GIS mapping - to the complex such as Bacteria Source Tracking. Department staff will provide technical assistance, guidance, and oversight of local efforts to identify and minimize fecal coliform sources of pollution. Based on work in the Lower St Johns River tributaries and the Hillsborough River basin, the Department and local stakeholders have developed a logical process and tools to serve as a foundation for this detective work. In the near future, the Department will be releasing these tools to assist local stakeholders with the development of local implementation plans to address fecal coliform impairments. In such cases, the Department will rely on these local initiatives as a more cost-effective and simplified approach to identify the actions needed to put in place a roadmap for restoration activities, while still meeting the requirements of Chapter 403.067(7), F.S.

References

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Appendices

Appendix A: Background Information on Federal and State Stormwater Programs

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Rule 62-40, F.A.C. In 1994, the Department's stormwater treatment requirements were integrated with the stormwater flood control requirements of the state's water management districts, along with wetland protection requirements, into the Environmental Resource Permit regulations.

Rule 62-40, F.A.C., also requires the water management districts to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a Surface Water Improvement and Management (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 implementing 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 5 or more acres of land, and the master drainage systems of local governments with a population above 100,000, which are better known as 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 FDOT throughout the 15 counties meeting the population criteria. The Department received authorization to implement the NPDES Stormwater Program in 2000.

An important difference between the federal NPDES and the state's stormwater/environmental resource permitting programs is that the NPDES Program covers both new and existing discharges, while the state's program focuses on new discharges only. Additionally, Phase II of the NPDES Program, implemented in 2003, expands the need for these permits to construction sites between 1 and 5 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, as are 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 reopener clause that allows permit revisions to implement TMDLs when the implementation plan is formally adopted.

Appendix B: Responses from FDEP to Comments from FDOT District 5

GENERAL COMMENTS

The following comments relate to multiple TMDLs where specific comments are provided below for each of the TMDL documents.

1. The figures that show the WBIDs and also identify the "FDOT Local Roads" are not an accurate depiction of the roadways that FDOT is responsible for. Please isolate out those roads that are part of FDOTs responsibility from those controlled by the Cities and Counties.

   Response: Please specify which figures in the TMDL reports that include aforementioned WBIDs have the “FDOT Local Roads”? This term does not seem to appear in any of the figures in these TMDL reports.

2. The load reductions determined for the non-point sources, which include the WLA for the stormwater (under the MS4 permit) and the LA, have not been allocated but simply applied evenly between the WLA for Stormwater and the LA. Sufficient studies have not have not been presented or have not been completed to determine if an even distribution of the load reductions is justified, therefore some language acknowledging this (within the TMDL and ultimately within the Rule) should be put into both the TMDL documents and ultimately the rules to allow the ability to finalize (and therefore change the assigned reductions) under the BMAP. [WBIDS 2964A, 2964, 2893F, 2893E, 2893D, 2893C and 2962]

   Response: In 2001, the Department submitted to the Governor and Legislature a document outlining the intended process for the allocation of loads under the TMDL Program. One key provision of the proposal was to level the “playing field,” such that once stakeholders had the opportunity to meet and discuss what steps needed to be taken and to get appropriate credit for those initiatives already completed, the specific allocations will be set by the agreements reached under the Basin Management Action Plan (BMAP). This process has been successfully used in several adopted BMAPs and has demonstrated the flexibility that remains after setting the initial reductions for stormwater-related allocations (LA and WLA_{sw}) at identical levels.

   The laws of Florida form the underlying basis for the initial equal allocations. In particular, Section 403.067(6)(b) of Florida Statutes, states in part that:

   “Allocations may also be made to individual basins and sources or as a whole to all basins and sources or categories of sources of inflow to the water body or water body segments. An initial allocation of allowable pollutant loads among point and nonpoint sources may be developed as part of the total maximum daily load. However, in such cases, the detailed allocation to specific point sources and specific categories of nonpoint sources shall be established in the basin management action plan…”

   Additionally, each of the draft TMDL reports contains language in the NPDES Stormwater Discharges section in chapter 6 of the reports (repeated below) to address the issue of allocation between the WLA for stormwater and the LA portions of the TMDL.

"It should be noted that any MS4 permittee is only responsible for reducing the anthropogenic loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction."

SPECIFIC COMMENTS

The following are specific comments that relate to the individual TMDL documents reviewed.

MIDDLE ST. JOHNS BASIN
Smith Canal (WBID 2962) DO

1. The modeling doesn't break out highways as a class but takes the 100 or so classes (FLUCCS) and combines them into 13 major classes, based largely on similarity of hydrologic response. Breakdown by basin, land use, etc. isn't presented. Are these types of more detailed land use/ land cover available? If so, have the loads for these land use/land cover breakdowns been computed? This information would be valuable to better assess allocation during BMAP process.

   Responses: It is correct that the HSPF model takes the more than 100 FLUCCS land uses and combines them into 13 major classes based on the similarities of hydrologic response and pollutant dynamics. The aggregation was conducted to improve the efficiency of model setup, reduce the model simulation time, and make pollutant load estimation more efficient. The sub-basin specific land use and nonpoint source load estimates were not provided in the TMDL report because the report focused on the total pollutant loads that the impaired waters receive from the entire basin instead of detailed allocation of nonpoint source load to the sub-basins. In addition, load allocation during the BMAP stage may be based on jurisdiction boundaries instead of hydrologic boundaries. Providing sub-basin specific loads may not be totally useful for the final allocation. However, if the FDOT needs the information, we would be glad to provide the results.

2. It is not clear how the HSPF modeling was performed and the results processed to determine if the target TN and TP concentration for the WBIDs was achieved and how the associated loads were calculated. There is no mention of whether the in-stream kinetics was considered. Were these considered?

   Response: We will take FDOT's suggestions to put into the TMDL report more information regarding how HSPF model deal with the instream processes of total phosphorus and nitrogen. Basically, HSPF model simulates the phosphorus and nitrogen dynamics in receiving waters using a RCHRES module. This module receives watershed loadings simulated by PERLND (loading from pervious watershed areas) and IMPLND (loading from impervious areas) modules and simulates the sedimentation, resuspension, sediment release, uptake by algae, which turns inorganic nutrients into the organic form, death and decay of algal cells, which turn the organic nutrients back to inorganic forms, nitrification, which turns ammonia into nitrate, denitrification, which turns nitrate into nitrogen gas and causes the nitrogen to loss to the atmosphere, atmospheric deposition directly onto the surface of the receiving water, and output of nutrients into the downstream segments. In addition, impacts of light availability, temperature, and flow velocity on the growth and death of algae, which significantly influence the nutrient dynamics in the receiving water, are also considered in the RCHRES model. More detailed descriptions on the nutrient kinetics in receiving waters handled by HSPF model can be obtained from:

Bicknell, B.R., J.C. Imhoff, J.L. Kittle Jr., T.H. Jobes, and A.S. Donigian, Jr. 2004. *Hydrological Simulation Program – Fortran (HSPF): User's manual for Release 12.* U.S. EPA National Exposure Research Laboratory, Athens, GA, in cooperation with U.S. Geological Survey, Water Resources Division, Reston, VA.

Appendix C: Responses from FDEP to Comments from Seminole County

Seminole County Comment:

The "Dissolved Oxygen TMDL for the Smith Canal (WBID 2962)" document was reviewed with the following comments:

1. Smith Canal is an intermittently dry Urban Ditch
   - Smith Canal was never intended to be swimmable and fishable and is designed, rather to manage and convey stormwater. In parts, it is concrete lined or consists of a manufactured canal cross section. Per the pictures in the TMDL report itself, it is shown to be a drainage ditch with overgrown vegetation.

Response from the Department:

There are two aspects in this comment. First, Smith Canal is a stormwater canal and was not built to support the designated use of a Class III water. This issue has been raised repeatedly in many occasions but is beyond the scope of this TMDL report. For now, the State's water quality standard does not have a designated use classification specifically defined for urban stormwater canals. In other words, there is no water quality criteria specifically established for the urban stormwater conveyance system. Stream water quality criteria are applied to these urban systems. Re-classifying the designated use for the urban canal has been a discussion topic, but no conclusions have been drawn from these discussions. However, Smith Canal discharges to the main stem of the St. Johns River. To achieve the nutrient targets for the main stem segments, the human landuse areas are required to reduce the nitrogen and phosphorus loading by more than 30% from the existing condition. The Smith Canal TMDL per se only requires 26% reduction of total phosphorus (TP). In other words, the Smith Canal TMDL itself did not ask more load reduction than what is needed to protect the main stem water quality condition.

The second aspects of the comment is that factor other than nutrients, for example, overgrown vegetation, may also contribute to the low DO concentration in the canal. In fact, we also realized the uncertainties associated with the nutrient targets established to address the low DO condition in the system. This is exactly why, in Section 3.2.3 of the TMDL report, we put in a disclaimer, indicating that the TMDL focuses on addressing the anthropogenic TP. If we achieve the nutrient target and DO concentration still does not meet the criteria, it would be considered natural due to the input of organic materials from the surrounding woodland and overgrown of the emergent aquatic plants in the canal.

Seminole County Comment :

2. Inconsistent leap between correlation water quality parameters and a causal relationship.
   - Typically, high nutrient concentrations would be shown to correlate to chlorophyll-a concentrations. Then the Chlorophyll-a concentrations would correlate to BOD and there is no mention of these correlations in the report. Without this causal relationship it is insufficient to presume that because TP and DO are correlative, it is the nutrients alone is forcing DO levels below water quality standards. Possible alternatives to the correlation as presented include:

  - o High BOD is caused by the in-stream vegetation and the stagnant nature of the system, between storm events. Whereby, perhaps clearing the vegetation would increase water quality from a DO perspective (removing the DO depression during biomass respiration) but it could increase downstream passage of nutrients via removal of a biomass nutrient sink.
  - o High TP could be from release from sediments during low DO periods, rather than low DO being due to high TP.
- Alternatively, in Smith Canal the dissolved oxygen standard may not properly account for warm waters with high biomass, similar to data showing that "reference" site stations in drainage ditches in the Everglades fail DO standards, despite the fact that they were used for "background" nutrient levels.

Response from the Department:

Nutrients can certainly influence the DO concentration in surface waters through influencing the phytoplankton biomass, which, in most cases, can be represented by the *Chl a* concentration. However, phytoplankton typically dominate water column communities in Lake and high order streams and rivers. For example, the Middle St. Johns River main stem segments receives discharge from the Econlockhatchee River, which in turn receives discharge from the Little Econlockhatchee River, which in turn receives discharge from Crane Strain and Crane Strand Drain, so the main stem segments can be consider 4th order stream (river) segments, in which we would expect certain extent of phytoplankton activities. That is why we looked at the relationship between *Chl a* and nutrient concentrations when we develop nutrient and DO TMDLs for these segments. Smith Canal is different. It is a first-order flow-through system, which is typically characterized by relatively shallow water and low water residence time. Benthic algae and rooted or emergent aquatic vegetations typically dominate the primary producer communities in this kind of system. *Chl a* concentration is not necessarily the best indicator of the biomass of primary producers. This is one reason why we did not just look at the relationship between *Chl a* and nutrient concentrations. In other words, in this kind of system, nutrient can influence the DO concentration through influencing the biomass of benthic algae, which is not very well represented by the *Chl a* concentration. In addition, the sediment from the watershed that is accumulated at the canal bottom also provides nutrient for the growth of aquatic vegetation, which also influence the DO concentration in the canal. This source of TP can also be cut back when the watershed TP loadings into the canal is controlled.

Another source of DO consumption is from the benthic bacteria. As you mentioned, the canal may receive a lot of organic carbon from the riparian vegetation, which represents an important source of organic carbon for bacteria communities in the canal. These bacteria, while use organic carbon to produce their biomass, also need phosphorus for their growth. Excessive input of nutrients into the canal system can stimulate bacteria to take up more organic carbon to produce more bacteria biomass and therefore consume more oxygen in the system. This is another link between nutrient and dissolved oxygen concentration that cannot be manifested through the *Chl a* and nutrient relationship. This is why, for Smith Canal, we addressed the impact of nutrient on DO concentration by looking at the DO and TP relationship directly instead of through the phytoplankton path way.

TP release from the sediment is certainly a possible reason for the correlation between DO and TP in some water systems. However, for Smith Canal, sediment nutrient release may not result in the significant correlation between DO and TP. Sediment nutrient release is typically observed when the sediment redox potential drops below -200 mvolt, which is often observed in the hypolimnion of some deep and stratified lakes and rivers. Dissolved oxygen in Smith Canal, while lower than 5.0 mg/L in some occasions, hasn't created a totally anaerobic condition in the canal yet. Therefore, we feel that the significant correlation between DO and TP reflects that TP controls DO instead of the other way around.

Temperature certainly is a very important factor that may influence the DO concentration in ambient waters, especially for shallow system like Smith Canal. However, during our field survey to the canal, the majority of the canal segments appeared to be covered by tree canopy, which may significantly decrease the temperature during the high temperature summer season. Another interesting observation during the field survey was that, the DO concentration was lower in the early morning, when the water temperature was relatively low, and became higher when the water temperature increased around noon. It appears that night time DO consumption resulted from the respiration of the benthic communities, including benthic algae, benthic bacteria, and root system of the aquatic vegetations may contribute to the low DO in the system, while during the day time, benthic photosynthesis over compensated the DO consumptions by the same communities and caused DO concentration to increase even when the temperature was higher. Of course, this was only based on a one-time field observation and therefore should only be considered as a hypothesis. We would suggest that more studies be conducted for the Smith Canal to better understand the factors that controls the DO concentration in the system. For this TMDL, we proposed to address the TP loadings coming from anthropogenic sources. Remaining low DO after the TP loading target is achieved will be considered a natural condition.

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