FINAL

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Water Resource Management, Bureau of Watershed Management

SOUTH DISTRICT • EVERGLADES WEST COAST BASIN

TMDL Report

Dissolved Oxygen TMDL for Imperial River, WBID 3258E

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August 19, 2008

Acknowledgments

This TMDL analysis could not have been accomplished without significant support and assistance provided by the Florida Department of Environmental Protection, Tallahassee and Fort Myers offices, South Florida Water Management District; Lee County Division of Natural Resources; and Charlotte Harbor National Estuary Program.

Editorial assistance provided by Jan Mandrup-Poulsen, Kevin O'Donnell, David Tyler, and Linda Lord.

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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

https://www.flrules.org/gateway/ChapterHome.asp?Chapter=62-303

STORET Program

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

2006 305(b) Report

http://www.dep.state.fl.us/water/tmdl/docs/2006_Integrated_Report.pdf

Criteria for Surface Water Quality Classifications

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

Basin Status Reports and Water Quality Assessment Reports

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

U.S. Environmental Protection Agency

Region 4: Total Maximum Daily Loads in Florida

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

National STORET Program

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Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Load (TMDL) for dissolved oxygen (DO) for the freshwater portion of the Imperial River, in the Everglades West Coast Basin in southwest Florida. The Imperial River appears on the 1998 303(d) Consent Decree listing for DO. In addition, using the methodology described in Rule 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), to identify and verify water quality impairments, the Imperial River was verified as impaired for DO and was included on the Verified List of impaired waters for the Everglades West Coast Basin that was adopted by Secretarial Order.

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 pollutant sources and instream water quality conditions. For most of Florida, the threshold value (used as a guideline) for potential causative pollutants for low DO is determined at the state-wide 70th percentile concentration. Because the hydrology of the Everglades West Coast Basin is unique, the state-wide thresholds are less useful as a guideline; thus this TMDL analysis uses another approach to develop target concentrations. Thresholds for causative pollutants were developed through the calculation of a percent reduction using a region-based reference concentration.

1.2 Identification of Waterbody

The Imperial River is a freshwater stream located in the Estero Bay Planning Unit within the Everglades West Coast Basin (**Figure 1.1**). Estero Bay proper is a shallow, subtropical lagoon with an area of 17.7 square miles (mi^2) (11,317 acres) and is separated from the Gulf of Mexico by barrier islands. Seagrass beds are common in the bay, but high turbidity restricts seagrass growth to shallow depths. The Estero and Imperial Rivers and Spring, Mullock, and Hendry Creeks are the major tributaries that flow into Estero Bay.

The Estero Bay region is generally characterized by slow, sheet-flow drainage patterns that are typical of the flat, wetland-dominated, southern Florida landscape. In the past, the naturally dispersed water patterns distributed nutrients over broad areas of wetland vegetation. Seasonal fluctuations in flow from rainfall created the necessary salinity regime in Estero Bay for good estuarine productivity. Increased development since the 1960s has led to changes in the natural river systems around Estero Bay, altering freshwater inflow patterns (Florida Department of Environmental Protection [Department], 2003).

The Imperial River watershed covers approximately 23.1 mi^2 (14,784 acres), of which 6.9 mi^2 (4,416 acres) are surface waters (**Figure 1.2**). Oak Creek and Leitner Creek flow into the upstream portion of the Imperial River. Both of these drainage areas, as well as the adjacent watershed, contain extensive areas of cropland and pastureland. As the Imperial River runs adjacent to the city of Bonita Springs, it receives extensive amounts of urban runoff along the majority of its length (Department, 2003).

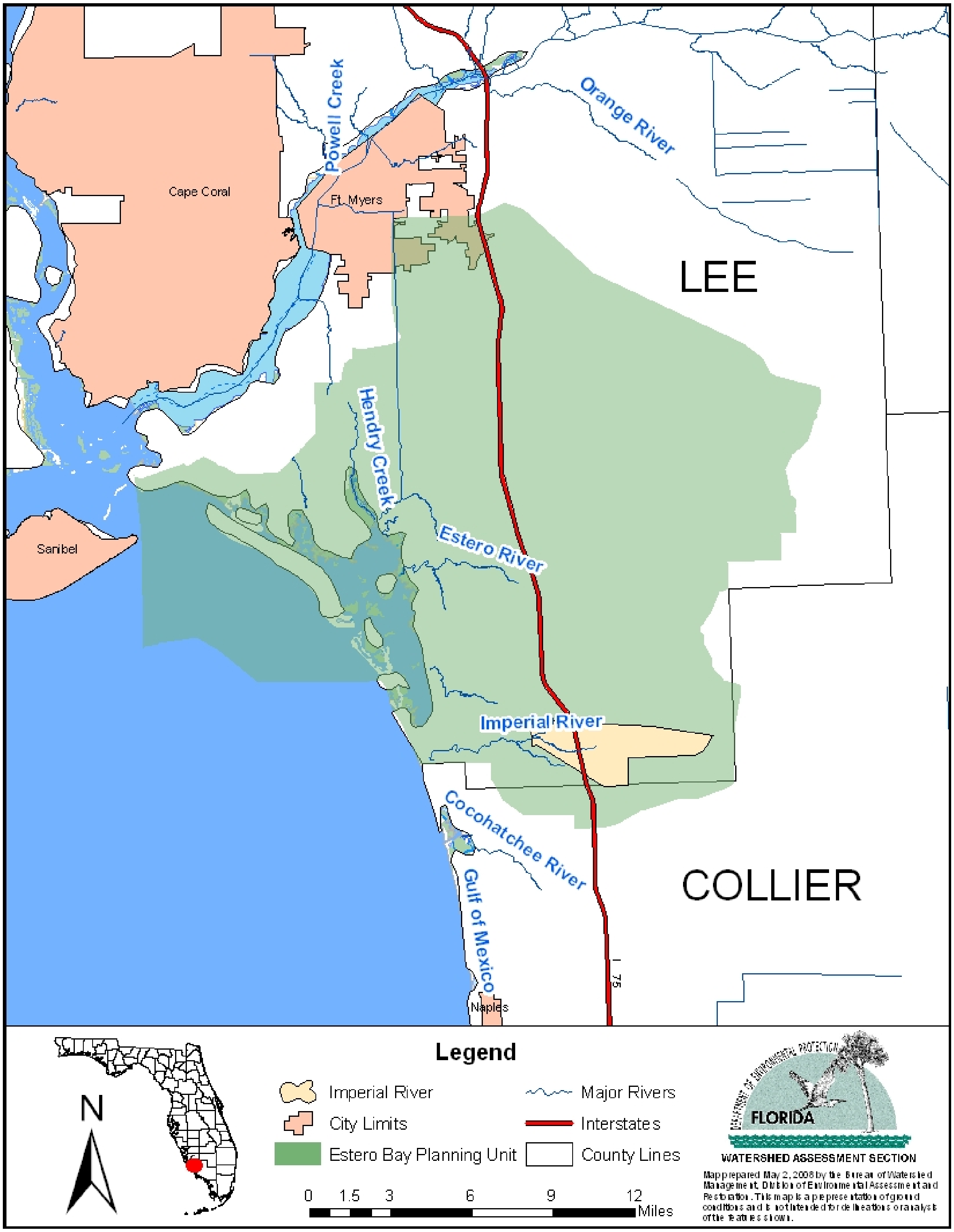

Figure 1.1 Location of the Imperial River Watershed in the Lee County Estero Bay Planning Unit

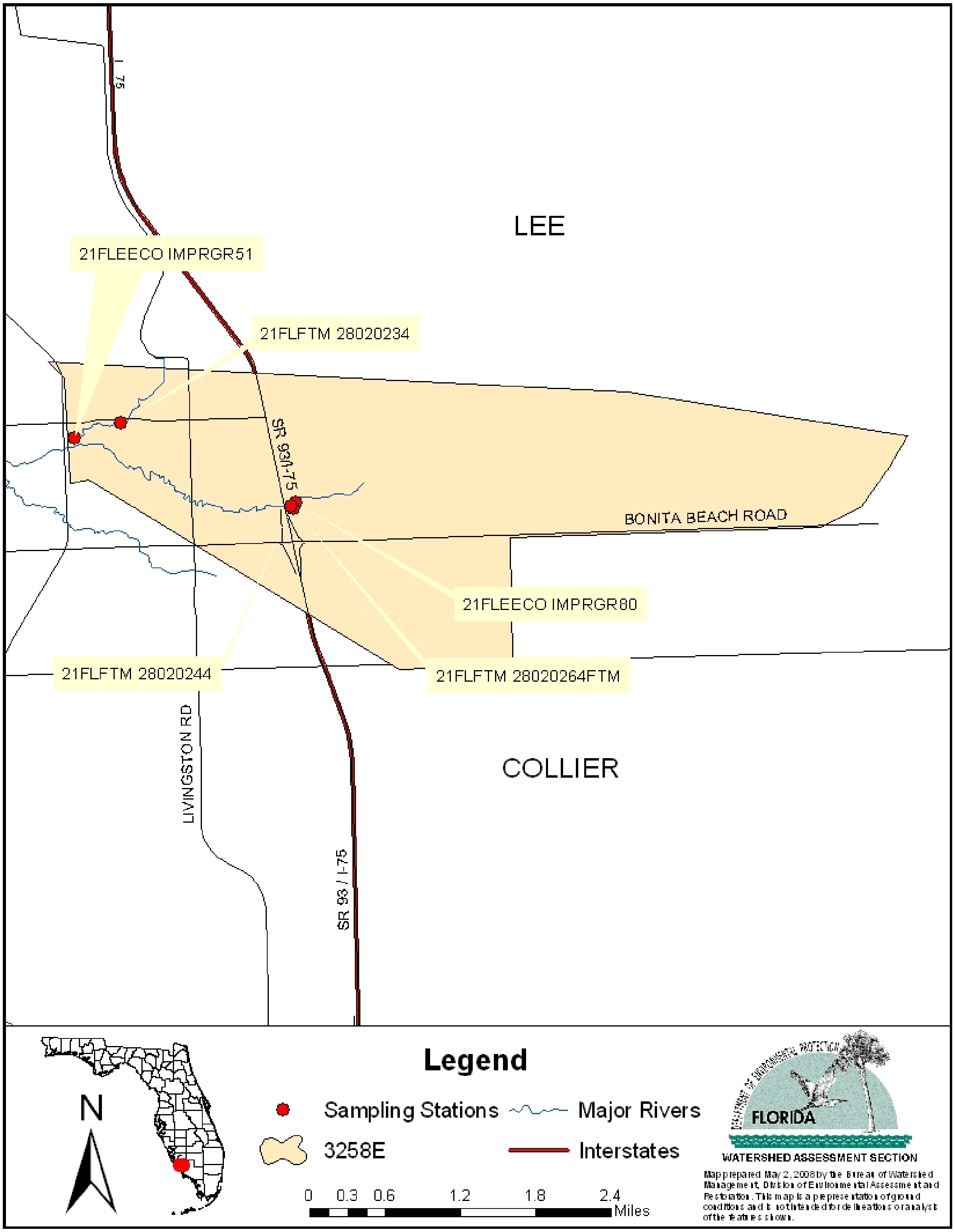

Figure 1.2 Imperial River Watershed (WBID 3258E) and Sample Stations

The Department has divided the Everglades West Coast Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (**WBID**) number for each watershed or stream reach. For purposes of water quality analysis, the Imperial River is divided into a marine and a freshwater portion. The freshwater portion of the Imperial River is WBID 3258E (**Figure 1.1**), and the marine portion is WBID 3258E1. This report presents the TMDL for DO for the freshwater portion of the Imperial River, WBID 3258E.

The topography of the Imperial River watershed reflects its location within the Southwestern Florida Flatwoods ecological region. Elevations range from around 5 to 10 feet above sea level in the western part of the watershed near the coast and around 10 to 15 feet above sea level in the eastern part of the watershed. The predominant soil type is shelly sand and clay, which exhibits moderate to good natural drainage (Department, 2003).

The Imperial River watershed is rapidly being developed in response to a continuing influx of new residents. Land use in interior areas primarily consists of cattle, vegetable, and citrus farms. Retirement, tourism, and the service industries drive the economy. Additional information about the river's hydrology and geology are available in the Basin Status and Assessment Reports for the Everglades West Coast Basin (Department, 2003).

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 1999 Florida Watershed Restoration Act (FWRA) (Chapter 99-223, Laws of Florida).

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

This TMDL report will be followed by the development and implementation of a Basin Management Action Plan, or BMAP, which will be designed to reduce the amount of total nitrogen (TN) needed to address the DO impairment in the freshwater portion of the Imperial River. These activities will depend heavily on the active participation of the South Florida Water Management District (SFWMD), Lee County Division of Natural Resources Environmental Section, Charlotte Harbor National Estuary Program (CHNEP), Florida Department of Transportation (FDOT), local 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.

1.3.1 Development of TMDL

This TMDL was developed in cooperation with the SFWMD, Lee County Division of Natural Resources, and CHNEP. There was also active coordination with a variety of local stakeholders throughout the TMDL development process. This included meetings and teleconference discussions between Department representatives, Lee County officials, environmental advocacy groups, consultants, and other stakeholders who volunteered to participate or whose participation was requested.

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 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 the Imperial River (WBID 3258E) in the Everglades West Coast 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, F.A.C. (Identification of Impaired Surface Waters Rule, or IWR) (FDEP, 2001a); the IWR was subsequently 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 the Imperial River and has verified the impairments for low DO (**Tables 2.1 and 2.2**). The Imperial River was verified as impaired for DO based on data indicating that the exceedance rate is greater than or equal to 10 percent. The data are based on samples collected between the January 1, 2000, and June 30, 2007. **Appendix B** contains the DO and TN data for the Imperial River (WBID 3258E).

Table 2.1. Verified Impaired Listing for DO for the Imperial River, WBID 3258E

Planning Unit	WBID	Priority for TMDL Development	Projected Year for TMDL Development	Comments (# of Exceedances/ # of Samples) PP = Planning Period VP = Verified Period
Estero Bay	3258E	Low	2007	PP = 141 / 154; VP = 56 / 79. TN median = 0.94 mg/L, TP = 0.039 mg/L, and BOD = 1.2 mg/L. Listed as impaired on Cycle 1 Verified List.

mg/L – Milligrams per liter.
TP – Total phosphorus.
BOD – Biological oxygen demand.

Table 2.2. Summary of DO Data for the Imperial River, WBID 3258E

Parameter	Summary of Observations
Total number of samples	104
IWR - required number of violations for the Verified List	15
Number of observed violations	90
Number of observed non-violations	14
Number of seasons during which samples were collected	4
Screening value for BOD (mg/L)	2.0
Screening value for TN (mg/L)	1.6
Screening value for TP (mg/L)	0.22
Median value for BOD observations (mg/L)	1.1
Median value for TN observations (mg/L)	0.96
Median value for TP observations (mg/L)	0.03
Possible causative pollutant under IWR	TN
Final Assessment	**Impaired**

Chapter 3: DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criterion 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)**

The Imperial River (WBID 3258E) is considered a Class III waterbody, with a designated use of recreation, propagation, and the 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 is for DO.

3.2 Applicable Water Quality Standards and Numeric Water Quality Targets

3.2.1 Interpretation of Narrative BOD and Nutrient Criteria

Florida's Surface Water Quality Standard (Rule 62-302, F.A.C) states that, for Class III freshwater waterbodies, the DO concentration

> *Shall not be less than 5.0 (mg/L). Normal daily and seasonal fluctuations above these levels shall be maintained.*

BOD shall not be increased to exceed values that would cause DO to be depressed below the established DO limit, and in no case shall it be great enough to produce nuisance conditions. Florida's narrative nutrient criteria state that the discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in Rule 62-302, F.A.C. It also states that in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora and fauna (Section 62-302.530, F.A.C.).

3.2.2 Identification of Causative Pollutants

Factors that influence the temporal and spatial variation of DO concentrations in receiving waters include atmospheric interchange, photosynthetic respiration, eutrophication, temperature, flow, depth, increased organic waste entering the water (e.g., manure from feedlots, septic tank wastewater), increased loadings of TN and TP, ground water inputs, and sediment oxygen demand (University of Florida–Institute of Food and Agricultural Sciences [UF–IFAS], 2003). It is known that ground water discharges low in DO contribute to occurrences of low DO (MacPherson et al., 2007). However, a frequent cause of low DO concentrations in receiving waters is due to pollutants. Low DO is also caused by a process known as eutrophication, in which plant nutrients enter a river, lake, or ocean, and phytoplankton blooms may occur. Typical causative pollutants in a waterbody are TN, TP, and BOD.

While phytoplankton through photosynthesis raise DO concentrations during daylight hours, respiration by the dense population of a bloom reduces DO concentrations at night. When phytoplankton cells die, they sink towards the bottom and are decomposed by bacteria, a process that further reduces DO in the water column. Therefore, TN and TP are inversely related to DO (Kils et al., 1989).

The next step in assessing the data of the potential causative pollutants is to determine if there is a correlation between those values. **Figure 3.1** is a plot of the relationship between DO and TN medians, using only those stations where the number of samples is high enough to prevent undue bias of the median. The R^2 is 0.44, which is not unusual when considering the other variables (not included in this linear equation) that typically affect DO concentrations. **Appendix D** shows the stations used to develop this graph.

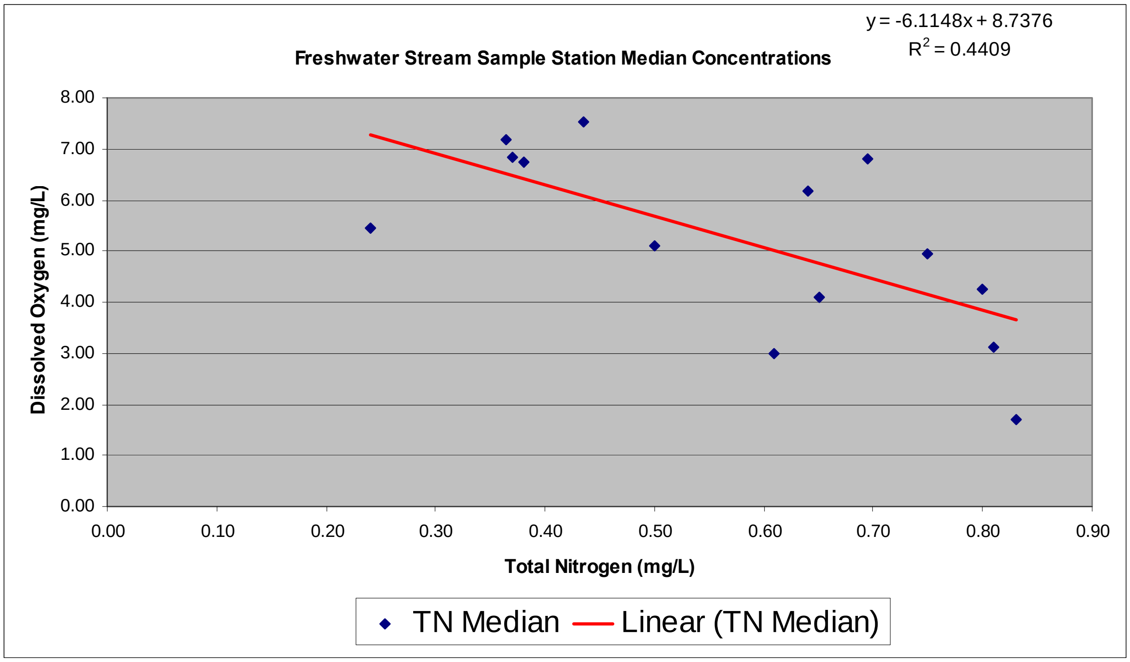

Figure 3.1. Relationship between Sample Station Median DO and TN in the Southwest Coast Planning Unit

After verifying the low DO in the Imperial River, the Department identified the causative pollutants by investigating those parameters typically responsible for depressed DO. One method of identifying causative pollutants is to use statewide screening level concentrations set at the 70th percentile of all STORET data across the state from 1970 to 1987. The usefulness of this approach is based on a lack of significant regional differences in a waterbody that meets its intended designated uses. The Department's statewide screening level for streams is 2.0 mg/L for BOD5, 1.6 mg/L for TN, and 0.22 mg/L for TP.

3.2.3 Calculating Reference Concentrations for Potential Causative Pollutants for Low DO

As stated earlier, for most of the state the threshold value for potential causative pollutants for low DO is determined at the statewide 70th percentile concentrations. The hydrology of the Everglades West Coast Basin is unique, and the statewide threshold guidelines are less useful. Thus, another approach is used to develop target concentrations. In this TMDL, thresholds for causative pollutants were developed through the calculation of a region-based reference concentration.

The reference concentration should preferably be based on similar sites in the watershed that represent "natural conditions." However, because of the difficulty in matching DO-impaired waterbodies (with similar hydrology observed in the Everglades West Coast) to ones with no/low anthropogenic land uses, it was determined that this would not be practical.

Instead, the 75th percentile of the medians from freshwater WBIDs in the Southwest Coast Planning Unit was used as the reference concentration target. Sample statistics were completed for TN data for freshwater stations with land use characteristics that demonstrated relatively low impacts from urban development. These stations are located in WBIDs that are representative of "natural condition" waterbodies. The reference concentration target for TN is 0.74 mg/L, TP is 0.04 mg/L, and BOD is 1.85 mg/L (**Table 3.1**). **Table 3.2** lists the stations used to develop the reference concentration target. **Table 3.3** shows the land use statistics for WBIDs used to develop the reference concentration.

Table 3.1. Class 3F Region-based Reference Concentration Thresholds for Causative Pollutants in the Everglades West Coast Basin

75th Percentile Reference Value			
Waterbody Class	TN (mg/L)	TP (mg/L)	BOD (mg/L)
3F	0.74	0.04	1.85

Note: 3F stands for a Class III freshwater.

Table 3.2. Statistical Summary of Freshwater Sample Stations in the Southwest Coast Planning Unit WBIDs

WBID	Station Number	Number of Samples	Minimum	Maximum	Median
3278G	21FLSFWMBC12	59	0.005	1.260	0.240
3278G	21FLSFWMBC18	60	0.005	5.320	0.610
3278G	21FLSFWMBC19	59	0.005	4.230	0.810
3278G	21FLSFWMBC21	59	0.005	4.520	0.800
3278G	21FLSFWMCHKMATE	15	0.005	2.000	0.830
3278H	21FLFTM 28030070FTM	5	0.588	0.839	0.695
3278H	21FLSFWMFAKA858	56	0.008	1.240	0.750
3278I	21FLSFWMBC10	57	0.010	1.300	0.370
3278I	21FLSFWMBC20	59	0.005	5.030	0.650
3278I	21FLSFWMBC7	58	0.010	1.360	0.435
3278I	21FLSFWMBC8	60	0.005	1.470	0.365
3278I	21FLSFWMBC9	57	0.010	1.540	0.500
3278I	21FLSFWMFAKA	58	0.010	2.700	0.380
3278V	21FLSFWMBC22	57	0.010	1.800	0.640
				75th Percentile of Medians =	**0.74**

Table 3.3. Summary of Reference WBIDs with Land Use Data

Land Use Code and Description	Acres	% Total
WBID 3278I		
6000: Wetland	56,313.00	94.72%
4000: Upland Forests	1,151.60	1.94%
3000: Rangeland	1,117.30	1.88%
5000: Water	628.4	1.06%
1000: Urban and Built up	97.3	0.16%
8000: Transportation, Communication, and Utilities	93.9	0.16%
2000: Agriculture	50.1	0.08%
Total	**59,451.70**	**100.00%**
WBID 3278V		
6000: Wetland	35,737.30	66.19%
2000: Agriculture	7,532.90	13.95%
4000: Upland Forests	4,939.70	9.15%
3000: Rangeland	3,199.60	5.93%
1000: Urban and Built up	1,588.40	2.94%
8000: Transportation, Communication, and Utilities	478.6	0.89%
5000: Water	355.6	0.66%
7000: Barren Land	159.4	0.30%
Total	**53,991.50**	**100.00%**
WBID 3278G		
6000: Wetland	92,282.20	97.65%
4000: Upland Forests	1,091.40	1.15%
5000: Water	335.2	0.35%
2000: Agriculture	239.7	0.25%
3000: Rangeland	213.5	0.23%
8000: Transportation, Communication, and Utilities	198.7	0.21%
1000: Urban and Built up	114.8	0.12%
7000: Barren Land	24.6	0.03%
Total	**94,500.00**	**100.00%**
WBID 3278H		
6000: Wetland	12,569.10	45.79%
3000: Rangeland	7,770.70	28.31%
4000: Upland Forests	4,381.20	15.96%
1000: Urban and Built up	1,473.30	5.37%
2000: Agriculture	860.5	3.13%
5000: Water	243	0.89%
8000: Transportation, Communication, and Utilities	100.3	0.37%
7000: Barren Land	51.6	0.19%
Total	**27,449.60**	**100.00%**

3.2.5 Overall Summary

Decreased DO concentrations in receiving waters are often a consequence of pollution and the outcome of a process known as eutrophication, in which plant nutrients enter a river, lake, or ocean, and phytoplankton blooms are encouraged. Therefore, TN is inversely related to DO, as seen in **Figure 3.1**. Because the Everglades West Coast hydrology is unique, the statewide thresholds are less useful as a guideline; thus another approach is used here to develop target concentrations. In this TMDL, thresholds for causative pollutants were developed through the calculation of a region-based reference concentration. The TN concentration exceeds the threshold, and this TMDL analysis focuses on the TN threshold. Thus, by reducing TN to a median value of 0.74 mg/L, the Department believes the anthropogenic effects would be captured, resulting in DO improvement.

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 or pollutants causing impairment 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" 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. However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES stormwater discharges and non-NPDES stormwater discharges, and as such, this source assessment section does not make any distinction between the two types of stormwater.

4.2 Potential Point Sources of TN and Low DO in the Imperial River Watershed

4.2.1 NPDES Wastewater Facilities

No permitted surface water discharge wastewater facilities exist that discharge directly to the Imperial River watershed.

4.2.2 Non-NPDES Wastewater Facilities

There are three non-NPDES surface water discharge wastewater facilities in the watershed: Glades Haven Park, Bonita Springs Utilities East, and Hunter's Ridge Wastewater Treatment Plant (**Figure 4.1** and **Table 4.1)**. The disposal system used at Glades Haven Park is extended aeration to effluent to percolation ponds. Bonita Springs Utilities East uses a membrane process known as membrane bioreactor (MBR). The Hunter's Ridge WWTP uses a 0.079 million gallon per day (mgd) extended aeration and 0.100 mgd contact stabilization (CS) process.

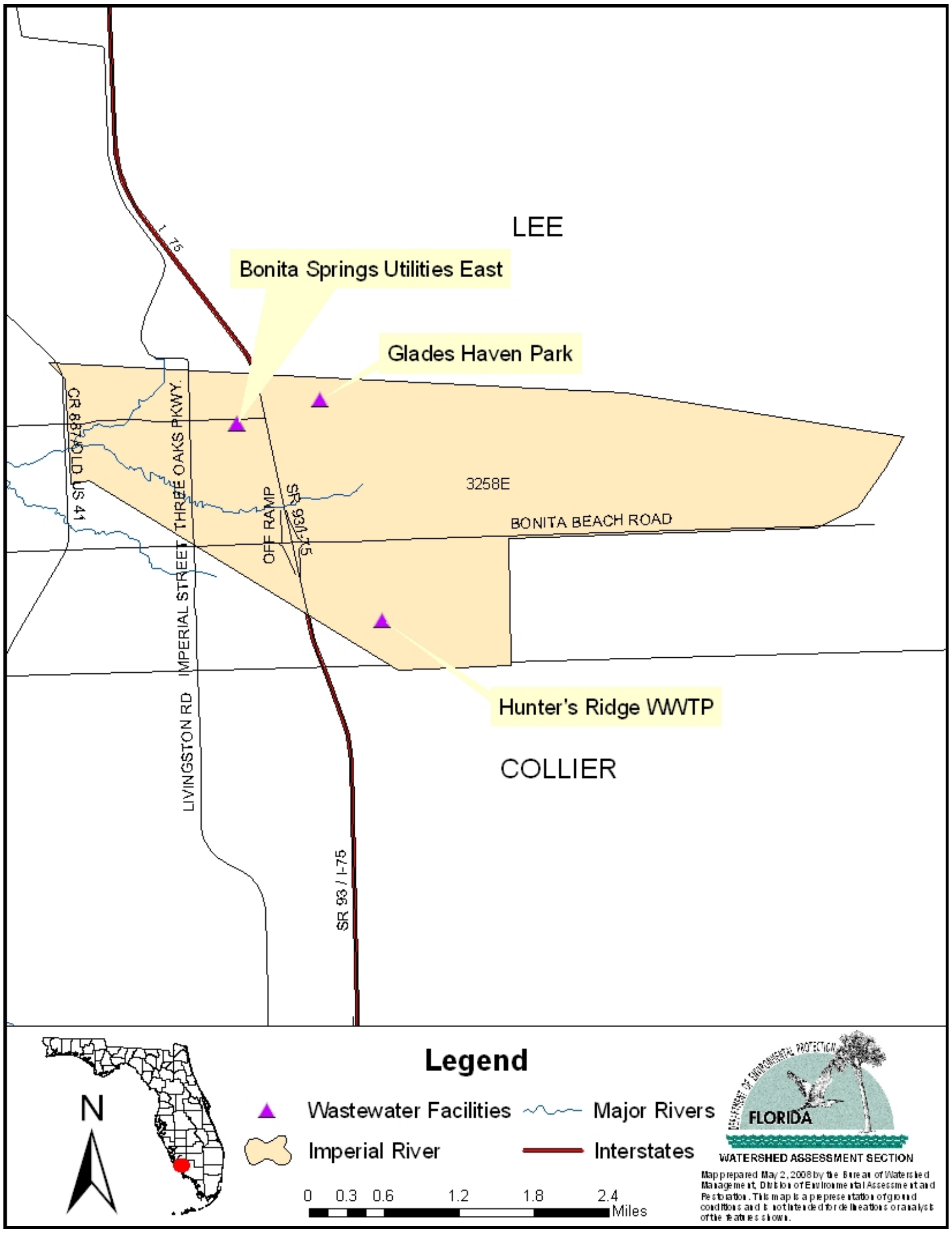

Figure 4.1. Non-NPDES Wastewater Facilities Located in the Imperial River Watershed

Table 4.1. Non-NPDES Wastewater Facilities Located in the Imperial River (WBID 3258E) Watershed

Facility Name	Type	Permit
Glades Haven Park	Domestic Wastewater	FLA014467: WAFR Facility # 14467
Bonita Springs Utilities East	Domestic Wastewater	FLA287113: WAFR Facility # 287113
Hunter's Ridge WWTP	Domestic Wastewater	FLA014541: WAFR Facility # 14541

4.2.3 Municipal Separate Storm Sewer System Permittees

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. The stormwater collection systems in the Imperial River watershed, which are owned and operated by Lee County, the city of Bonita Springs, and FDOT, are all covered by a Phase I MS4 permit (#FLS 000035).

4.3 Land Uses and Nonpoint Sources

4.3.1 Land Uses

Nutrient loading from urban areas is most often attributable to multiple sources, including stormwater runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary wastewater, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals. The spatial distribution and acreage of different land use categories were identified using 1999 land use coverage data (scale 1:60,000) contained in the Department's Geographic Information System (GIS) library. Land use categories were lumped into Level 1 and Level 2 Florida Land Use Cover and Forms Classification System (FLUCCS) categories (Harper and Baker, 2003). The freshwater portion of the Imperial River watershed is approximately 32 percent urban and 41 percent is wetlands. The remaining 27 percent of land use consists of rangeland, upland forests, agriculture, water, barren land, and transportation/utilities. The SFWMD provided the 1999 land use categories (**Figure 4.2**; **Tables 4.2** and **4.3**).

Table 4.2. Classification and Description of Level 1 1999 Land Use Categories in the Imperial River Watershed

Land Use Code and Description	Acres	% Total
6000: Wetland	2,452.1	41.75%
1000: Urban and Built up	1,884.0	32.08%
3000: Rangeland	511.3	8.71%
4000: Upland Forests	392.5	6.68%
5000: Water	232.6	3.96%
2000: Agriculture	187.0	3.18%
8000: Transportation, Communication, and Utilities	158.4	2.70%
7000: Barren Land	54.8	0.93%
Total	**5,872.8**	**100%**

Table 4.3. Classification and Description of Level 2 1999 Land Use Categories in the Imperial River Watershed

Land Use Code and Description	Acres	% Total
1100: Residential, Low Density	199.3	3.39%
1200: Residential, Medium Density	696.4	11.86%
1300: Residential, High Density	519.0	8.84%
1400: Commercial	61.5	1.05%
1500: Industrial	27.9	0.48%
1700: Institutional	25.0	0.43%
1800: Recreation	354.9	6.04%
2100: Cropland and Pastureland	132.6	2.26%
2400: Nurseries and Vineyards	42.4	0.72%
2500: Specialty Farms	12.0	0.20%
3100: Herbaceous	429.8	7.32%
3200: Shrub and Brushland	60.0	1.02%
3300: Mixed Rangeland	21.4	0.37%
4100: Upland Coniferous	346.5	5.90%
4200: Upland Hardwood	15.5	0.26%
4300: Upland Mixed Forest	30.5	0.52%
5100: Streams and Waterways	21.7	0.37%
5200: Lakes	5.0	0.09%
5300: Reservoirs	205.9	3.51%
6100: Wetland Hardwood Forests	927.2	15.79%
6200: Wetland Coniferous Forests	1,436.7	24.46%
6300: Wetland Forest Mixed	6.2	0.11%
6400: Vegetated Nonforested Wetlands	82.1	1.40%
7400: Disturbed land	54.8	0.93%
8100: Transportation	120.7	2.05%
8200: Communication	18.9	0.32%
8300: Utilities	18.8	0.32%
Total	**5,872.8**	**100%**

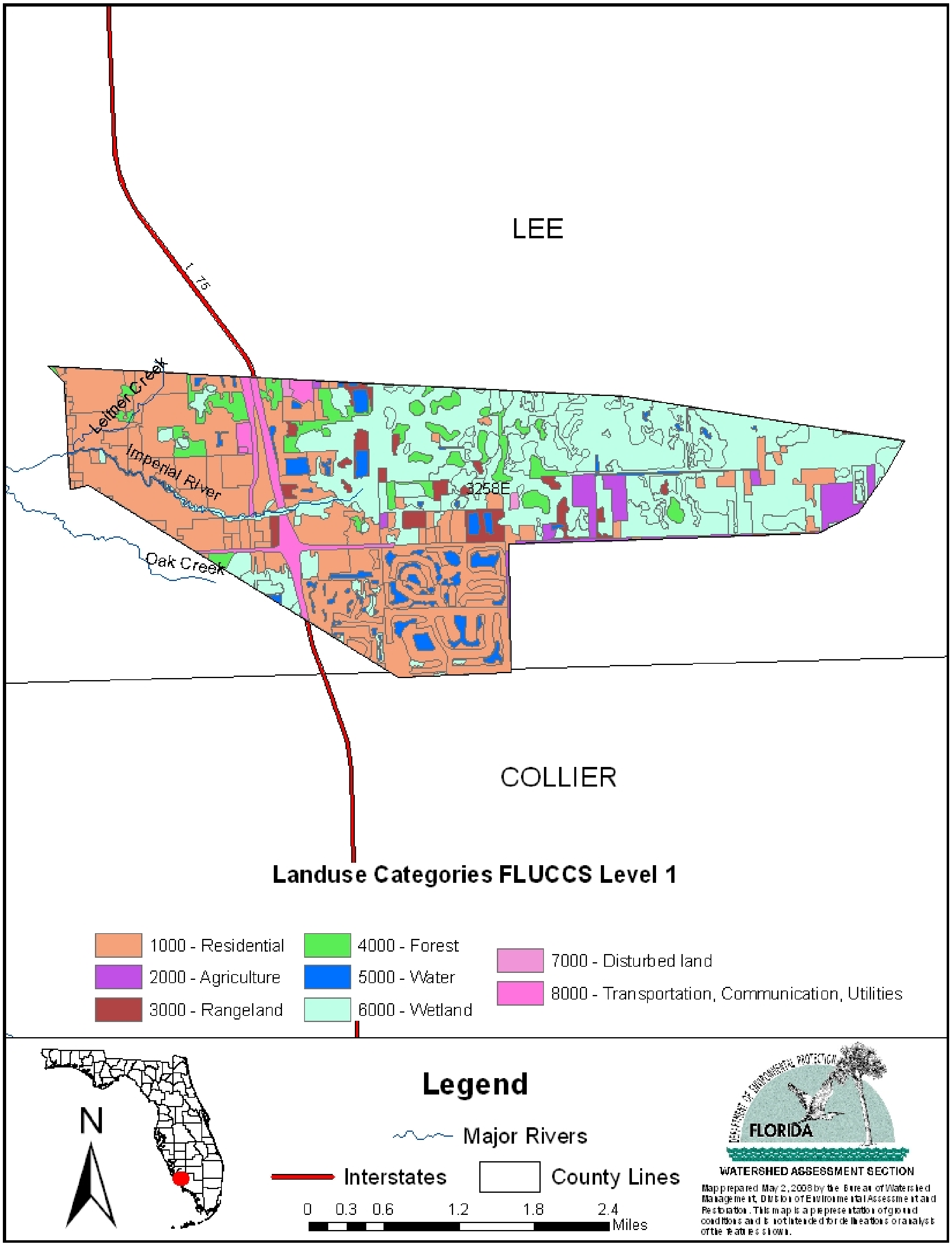

Figure 4.2. Land Use Map of the Imperial River Watershed

Population

According to the U.S. Census Bureau, the population density in the city of Bonita Springs in 2000 was 929.40 people per square mile of land area. The Bureau reports that the total population for the city was 32,797 with 23,329 housing units (U.S. Census Bureau Website, 2008).

4.3.2 Estimating Nonpoint Loadings

Estimating Runoff Using the Watershed Management Model

Lee County's climate is subtropical to tropical, with annual rainfall averaging approximately 52 inches, although rainfall amounts can vary greatly from year to year. The majority of the watershed's annual rainfall comes during the wet season from summer thunderstorms and tropical systems (May through October). High-intensity rain events with short-duration thunderstorms are common during the wet season in south Florida (Broward County, 2003). Dry-season rainfall (November through April) usually stems from frontal systems that can produce significant rainfall, but that occur less frequently than storms during the wet season. At times, this pattern is disrupted by a weather condition known as El Niño, which can cause wetter winters and drier summers (Department, 2003). The average summer temperature is 83^{o}F., and the average winter temperature is 65^{o}F. (National Oceanic and Atmospheric Administration [NOAA], 2008).

The Watershed Management Model (WMM) was used to estimate annual runoff using annual rainfall and land use. It was originally designed to estimate annual or seasonal pollutant loadings from a given watershed and evaluate the effect of watershed management strategies on water quality (Camp Dresser and McKee [CDM], 1998). The Department originally funded the WMM development under contract to CDM, and CDM subsequently refined the model. For this TMDL, the model was used to compute runoff in the Imperial River watershed (WBID 3258E).

The fundamental assumption of the model is that the amount of stormwater runoff from any given land use is in direct proportion to annual rainfall. The quantity of runoff is controlled by that fraction of the land use category that is characterized as impervious and the runoff coefficients of both pervious and impervious area. The governing equation is as follows:

$$\text{(1) } R_L = [C_p + (C_I - C_p)\, IMP_L] * I$$

Where:

R_L = total average annual surface runoff from land use L (inches/year),
IMP_L = fractional imperviousness of land use L,
I = long-term average annual precipitation (inches/year),
C_P = pervious area runoff coefficient, and
C_I = impervious area runoff coefficient.

The data required for applying the WMM to compute annual runoff include the following:

- Area of all the land use categories,

- Percent impervious area of each land use category, and
- Annual precipitation.

Data Required for Estimating Annual Runoff. To estimate the precipitation-derived runoff from the upstream portion of the Imperial River watershed (WBID 3258E) using the WMM, the following data were obtained:

A. Precipitation data were obtained from the NOAA-NEXRAD rainfall database. **Tables 4.4** and **4.5** show the annual and monthly rainfall, respectively, for Lee County, Estero Bay Planning Unit.

B. Areas of different land use categories in the Imperial River watershed were obtained by aggregating Level 1 land use coverage (**Table 4.2**) and by separating the low-, medium-, and high-density residential land uses from the urban land use category (**Table 4.3**). These categories were used because the percent perviousness of these categories is available for southwest Florida. In the upstream portion of the Imperial River watershed (WBID 3258E), the predominant land uses are urban and wetlands, which comprise approximately 73 percent of the watershed's total area. The remaining 27 percent of land use consists of rangeland, upland forests, agriculture, water, barren land, and transportation/utilities.

C. Percent impervious area of each land use category is a very important parameter in estimating surface runoff using the WMM. Nonpoint pollution monitoring studies throughout the United States over the past 15 years have shown that annual per-acre discharges of urban stormwater pollution are positively related to the amount of imperviousness in land use (CDM, 1998). Theoretically, the impervious area is the area that does not retain water; therefore, 100 percent of the precipitation falling on the impervious area should become surface runoff. In practice, however, the runoff coefficient for the impervious area typically ranges between 95 and 100 percent. Impervious runoff coefficients lower than this range occurs in the literature, but usually the number should not be lower than 80 percent. For the pervious area, the runoff coefficient usually ranges from 10 to 20 percent. However, values lower than this range was also observed in the literature (CDM, 1998).

Table 4.4 NOAA-NEXRAD Annual Rainfall Data for Lee County, Estero Bay Planning Unit

Year	Precipitation (inches)
1996	41.6
1997	49.8
1998	52.6
1999	59.6
2000	56.4
2001	61.8
2002	64.5
2003	73.5
2004	57.4
2005	70.1
Average	**58.7**

Table 4.5 NOAA-NEXRAD Monthly Rainfall Data for Lee County Estero Bay Planning Unit

Month	Precipitation (inches)
1	1.28
2	1.62
3	2.55
4	1.60
5	2.80
6	11.32
7	10.40
8	10.42
9	9.33
10	3.13
11	2.23
12	1.57
Average	**4.85**

Table 4.6. Estimated Runoff for Nonpoint Sources Using the WMM for the Freshwater Portion of the Imperial River (WBID 3258E)

1999 Level 1 FLUCCS	Area (acres)	% Impervious	Impervious Runoff Coefficient	Pervious Runoff Coefficient	Effective Precipitation (inches/year)[1]	Runoff (acre-feet)
A. Forest/Rural Open	392.5	0.005[1]	0.95	0.159	58.26	310.5
B. Urban	469.4	0.005[1]	0.95	0.0414	58.26	104.8
C. Agriculture/Pasture	187	0.037[2]	0.95	0.317	58.26	309.1
D. Low-Density/Residential	199.3	0.124[2]	0.95	0.150	58.26	241.5
E. Medium-Density/Residential	696.4	0.187[2]	0.95	0.0877	58.26	841.7
F. High-Density/Residential	519	0.296[2]	0.95	0.12	58.26	921.4
G. Rangeland	511.3	0[1]	0.95	0.12	58.26	297.9
H. Transportation, Communication, and Utilities	158.4	0.362[2]	0.95	0.12	58.26	323.3
I. Barren Land	54.8	0[1]	0.95	0.542	58.26	144.2
J. Wetland	2452.1	0.3[3]	0.95	0.23	58.26	5309.6
K. Water	232.6	0.3[3]	0.95	0	58.26	321.8
Total	5872.8					9125.9

[1] CDM, 1998.
[2] Brown, M. T. 1995.
[3] Harper and Livingston 1999.

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

The goal of this TMDL analysis is to reduce the anthropogenic TN loads to conditions comparable to those found in the surrounding unimpaired watersheds. The methodology used for this TMDL was a percent reduction approach between the existing condition concentration and the region-based reference concentration.

5.2 Data Used in the Determination of the TMDL

Six stations located in the upstream portion of the Imperial River (WBID 3258E) have DO and TN observations. Data providers include the Department and Lee County, which maintains routine sampling sites. **Table 5.1** shows data collection information for each of the stations. **Figure 1.2** shows the locations of the sample sites.

Table 5.1. Data Collectors and Station List for the Imperial River, WBID 3258E

Station Description	STORET ID	Data Provider	First Year Sampled	Last Year Sampled	Total # of Samples in Verified Period
Imperial River	21FLEECOIMPRGR80	Lee County	2004	2007	963
Imperial River at Orr Rd in Bonita Spr.	21FLFTM 28020264FTM	Department	2000	2002	163
Imperial River at Orr Road	21FLFTM 28020244	Department	2000	2006	81
Imperial River - Leitner Creek @ Goodwin Rd	21FLEECOIMPRGR51	Lee County	1990	2007	1589
Leitner Cr near Terry Str, Bonita Spr	21FLFTM 28020234	Department	2000	2000	20

5.3 TMDL Development Process

Exceedances in the Imperial River occur throughout the year and because of the lack of matching flow data are assumed to happen under all flow conditions. Exceedances of the state criterion were compared with the water quality target. For each individual exceedance, an individual required reduction was calculated using the following:

$$\frac{[(\text{observed value}) - (\text{water quality target})]}{(\text{observed value})} \times 100$$

After the individual reduction was calculated, the median of all the individual values was calculated because there was no single critical condition. The median reduction for TN is 24.87 percent.

5.4 Existing and Allowable Loads

The Department's Group 1 Verified List states that the median existing concentration of TN is 0.96 mg/L. The median allowable concentration of TN is 0.74 mg/L. Along with the average runoff volume calculated in **Table 4.6**, these allowable concentrations were used to estimate the annual TN loadings. **Table 5.2** shows the median existing and allowable concentrations for nutrient loading estimates for the Imperial River, WBID 3258E.

Table 5.2 Estimated Annual Existing and Allowable TN Loadings in the Imperial River, WBID 3258E

	Median Existing Concentration (mg/L)	Median Allowable Concentration (mg/L)	Existing Load (lbs)*	Allowable Load (lbs)*
TN	0.96	0.74	23, 830	18, 865

Lbs – pounds.
*Load (lbs) = Concentration (mg/L) x 9,125.9 (acre-feet) x 2.72

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. The goal of the TMDL development for the Imperial River (WBID 3258E) is to identify the maximum allowable TN loadings to the river so that it will meet applicable water quality standards and maintain its designated use as a Class III water.

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) that takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

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

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

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

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

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

This approach is consistent with federal regulation 40 CFR § 130.2[I] (EPA, 2003), which states that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or other appropriate measure. The TMDL for the Imperial River is expressed as a percent reduction, and represents the reduction needed to improve the DO concentrations to meet applicable water quality standards (**Table 6.1**).

Table 6.1.TMDL Components and Current Loadings for the Imperial River (WBID 3258E)

WBID	Parameter	TMDL (mg/L)	WLA		LA (% reduction)[1]	MOS
			Wastewater (mg/L)	NPDES Stormwater (% reduction)[1]		
3258E	TN	0.74	N/A	24.87	24.87	Implicit

[1]As the TMDL represents a percent reduction; it also complies with EPA requirements to express the TMDL on a daily basis.
N/A – Not applicable

6.2 Load Allocation

A TN reduction of 24.87 percent is needed for nonpoint sources, as provided in **Table 6.1,** and represents the allowable nutrient load that would result in DO improvements. It should be noted that the LA includes loading from stormwater discharges regulated by the Department and the water management districts that are not part of the NPDES Stormwater Program (see **Appendix A**).

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

There are no permitted NPDES surface water discharges for the Imperial River.

6.3.2 NPDES Stormwater Discharges

The WLA for the Phase I MS4 permit (# FLS 000035) issued to Lee County, the city of Bonita Springs, and FDOT is a reduction in TN that would result in DO improvements. It should be noted that any MS4 permittee is only responsible for reducing the 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.

6.4 Margin of Safety

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 (Section 303[d][1][c], Clean Water Act). Considerable uncertainty is usually inherent in estimating nutrient loading from nonpoint sources, as well as in predicting water quality response. The effectiveness of management activities (e.g., stormwater management plans) in reducing loading is also subject to uncertainty. For the freshwater portion of the Imperial River, an implicit MOS was employed.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

7.1 Basin Management Action Plan

Following the adoption of this TMDL by rule, the next step in the TMDL process is to develop an implementation plan for the TMDL, referred to as the BMAP. This document will be developed over the next year in cooperation with local stakeholders, who will attempt to reach a consensus on detailed allocations and on how load reductions will be accomplished. The BMAP will include, among other things:

- Appropriate load reduction allocations among the affected parties,
- 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 to achieve the TMDL,
- Timetables for implementation,
- Confirmed and potential funding mechanisms,
- Any applicable signed agreement(s),
- Local ordinances defining actions to be taken or prohibited,
- Any applicable local water quality standards, permits, or load limitation agreements,
- Milestones for implementation and water quality improvement, and
- Implementation tracking, water quality monitoring, and follow-up measures.

An assessment of progress toward the BMAP milestones will be conducted every five years, and revisions to the plan will be made as appropriate, in cooperation with basin stakeholders.

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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.

Rule 62-40, F.A.C., requires the state's 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. No PLRG had been developed for Newnans Lake at the time this report was developed.

In 1987, the U.S. Congress established Section 402(p) as part of the federal Clean Water Act Reauthorization. This section of the law amended the scope of the federal NPDES stormwater permitting program to designate certain stormwater discharges as "point sources" of pollution. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific standard industrial classification (SIC) codes, construction sites disturbing 5 or more acres of land, and 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 has implemented Phase 1 of the MS4 permitting program on a countywide basis, which brings in all cities (incorporated areas), Chapter 298 urban water control districts, and 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 and state stormwater permitting programs is that the federal program covers both new and existing discharges, while the state program focuses on new discharges. Additionally, Phase II of the NPDES Program expands the need for these permits to construction sites between 1 and 5 acres, and to local governments with as few as 10,000 people. The revised rules required that these additional activities obtain permits by 2003. While these urban stormwater discharges are now technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that cannot be easily collected and treated by a central treatment facility, as are other point sources of pollution such as domestic and industrial wastewater discharges. The Department recently accepted delegation from the EPA for the stormwater part of the NPDES Program. It should be noted that most MS4 permits issued in Florida include a reopener clause that allows permit revisions to implement TMDLs once they are formally adopted by rule.

Appendix B: Water Quality Measurements Used in the Verified Period Assessment, January 1, 2000 – June 30, 2007

Date	Time	Depth	Station	DO Result (mg/L)	TN Result (mg/L)
1/4/2000	1200	0.5	21FLEECOIMPRGR51	2.1	1.14
2/3/2000	1200	0.5	21FLEECOIMPRGR51	2.18	0.69
3/13/2000	1200	0.5	21FLEECOIMPRGR51	0.8	1.17
4/4/2000	1200	0.5	21FLEECOIMPRGR51	2.37	2.27
5/1/2000	1200	0.5	21FLEECOIMPRGR51	3.4	0.72
6/5/2000	1200	0.5	21FLEECOIMPRGR51	1.94	0.81
7/11/2000	1000	0.5	21FLEECOIMPRGR51	2.03	2.35
8/30/2000	800	0.5	21FLEECOIMPRGR51	4.2	1.26
9/6/2000	1120	1.5	21FLFTM 28020244	3.6	0.932
9/27/2000	800	0.5	21FLEECOIMPRGR51	2.7	0.98
10/3/2000	1547	1	21FLFTM 28020264FTM	4.25	0.827
10/5/2000	800	0.5	21FLEECOIMPRGR51	3.2	1.63
10/9/2000	1056	1	21FLFTM 28020234	2.6	0.931
11/13/2000	905	0.5	21FLEECOIMPRGR51	3.36	0.88
12/11/2000	840	0.5	21FLEECOIMPRGR51	2.4	0.73
1/9/2001	900	0.5	21FLEECOIMPRGR51	4.09	0.18
1/17/2001	1220	1.6	21FLFTM 28020244	6.68	1.93
2/22/2001	845	0.5	21FLEECOIMPRGR51	3.09	0.65
3/19/2001	1525	1.5	21FLFTM 28020264FTM	2.97	1.25
3/27/2001	845	0.5	21FLEECOIMPRGR51	2.16	0.85
4/19/2001	849	0.5	21FLEECOIMPRGR51	2.89	0.43
5/24/2001	915	0.5	21FLEECOIMPRGR51	0.17	1.41
6/11/2001	910	0.5	21FLEECOIMPRGR51	0.61	0.85
7/10/2001	937	0.5	21FLEECOIMPRGR51	1.7	0.9
7/23/2001	911	0.5	21FLEECOIMPRGR51	6.1	1.13
8/9/2001	925	0.5	21FLEECOIMPRGR51	2.23	0.79
8/28/2001	905	0.5	21FLEECOIMPRGR51	3.2	0.55
9/11/2001	921	0.5	21FLEECOIMPRGR51	3.1	0.61
9/19/2001	930	0.5	21FLEECOIMPRGR51	2.76	0.59
9/19/2001	1720	0.5	21FLFTM 28020264FTM	3.43	0.74
10/4/2001	910	0.5	21FLEECOIMPRGR51	2.19	0.68
10/15/2001	1025	0.5	21FLEECOIMPRGR51	2.1	0.52
11/13/2001	932	0.5	21FLEECOIMPRGR51	3.1	0.62
12/20/2001	915	0.5	21FLEECOIMPRGR51	4.57	0.82
1/15/2002	1210	0.5	21FLFTM 28020264FTM	3.3	
1/22/2002	926	0.5	21FLEECOIMPRGR51	3.9	0.68
2/7/2002	915	0.5	21FLEECOIMPRGR51	3.4	0.52
3/14/2002	838	0.5	21FLEECOIMPRGR51	6.43	0.51
4/18/2002	817	0.5	21FLEECOIMPRGR51	4.64	0.94
4/23/2002	1105	0.5	21FLFTM 28020264FTM	2.7	1.039
5/8/2002	811	0.5	21FLEECOIMPRGR51	2.19	0.8
6/5/2002	843	0.5	21FLEECOIMPRGR51	1.72	0.91

Date	Time	Depth	Station	DO Result (mg/L)	TN Result (mg/L)
6/19/2002	1316	0.5	21FLFTM 28020264FTM	3.55	1.09
6/24/2002	850	0.5	21FLEECOIMPRGR51	2.6	0.77
7/8/2002	1550	0.5	21FLFTM 28020264FTM		1.05
7/18/2002	839	0.5	21FLEECOIMPRGR51	1.4	0.79
7/31/2002	900	0.5	21FLEECOIMPRGR51	1.8	0.68
8/5/2002	852	0.5	21FLEECOIMPRGR51	1.7	0.73
8/20/2002	1855	0.5	21FLFTM 28020264FTM	4.9	1.08
8/22/2002	852	0.5	21FLEECOIMPRGR51	2.12	0.7
10/16/2002	1052	0.5	21FLEECOIMPRGR51	5.4	0.86
11/5/2002	1140	0.5	21FLEECOIMPRGR51	4.01	0.85
12/16/2002	1130	0.5	21FLEECOIMPRGR51	7.58	0.6
1/7/2003	940	0.5	21FLEECOIMPRGR51	9.27	0.51
2/17/2003	947	0.5	21FLEECOIMPRGR51	6.74	0.73
3/19/2003	929	0.5	21FLEECOIMPRGR51	2.82	1.16
4/30/2003	927	0.5	21FLEECOIMPRGR51	0.8	0.45
5/28/2003	1115	0.5	21FLEECOIMPRGR51	5.24	1.01
6/23/2003	1120	0.5	21FLEECOIMPRGR51	4.82	0.85
7/30/2003	1054	0.5	21FLEECOIMPRGR51	2.8	0.94
8/28/2003	1020	0.5	21FLEECOIMPRGR51	2.96	1.56
9/11/2003	1040	0.5	21FLEECOIMPRGR51	3.86	0.43
10/9/2003	1009	0.5	21FLEECOIMPRGR51	4.27	0.693
11/24/2003	945	0.5	21FLEECOIMPRGR51	4.5	0.8
12/10/2003	1046	0.5	21FLEECOIMPRGR51	3.1	0.84
1/15/2004	930	0.5	21FLEECOIMPRGR80	2.7	0.98
1/15/2004	1010	0.5	21FLEECOIMPRGR51	4.2	0.64
2/4/2004	945	0.5	21FLEECOIMPRGR80	4.1	0.79
2/4/2004	1010	0.5	21FLEECOIMPRGR51	6.6	0.75
3/2/2004	1005	0.5	21FLEECOIMPRGR80	5.1	0.98
3/2/2004	1040	0.5	21FLEECOIMPRGR51	5.4	0.75
4/1/2004	946	0.5	21FLEECOIMPRGR80	2.1	1.08
4/1/2004	1008	0.5	21FLEECOIMPRGR51	3.5	0.73
5/12/2004	933	0.5	21FLEECOIMPRGR80	2.1	0.83
5/12/2004	955	0.5	21FLEECOIMPRGR51	2.6	0.94
6/10/2004	943	0.5	21FLEECOIMPRGR80	1.8	1.34
6/10/2004	1008	0.5	21FLEECOIMPRGR51	1.9	0.82
7/1/2004	1029	0.5	21FLEECOIMPRGR80	2	1.53
7/1/2004	1053	0.5	21FLEECOIMPRGR51	2	0.92
7/28/2004	941	0.5	21FLEECOIMPRGR80	1.65	1.14
7/28/2004	1003	0.5	21FLEECOIMPRGR51	1.91	0.72
8/4/2004	950	0.5	21FLEECOIMPRGR80	3.4	1.07
8/4/2004	1008	0.5	21FLEECOIMPRGR51	2.9	0.99
9/13/2004	1001	0.5	21FLEECOIMPRGR80	2.6	0.85
9/13/2004	1020	0.5	21FLEECOIMPRGR51	2.2	0.72
9/28/2004	913	0.5	21FLEECOIMPRGR80	3.4	0.84
9/28/2004	931	0.5	21FLEECOIMPRGR51	3.1	0.82
10/27/2004	1040	0.5	21FLEECOIMPRGR80	4.1	0.907

Date	Time	Depth	Station	DO Result (mg/L)	TN Result (mg/L)
10/27/2004	1101	0.5	21FLEECOIMPRGR51	3.7	0.797
11/8/2004	930	0.5	21FLEECOIMPRGR80	3.7	1.2
11/8/2004	950	0.5	21FLEECOIMPRGR51	4.1	0.962
12/6/2004	930	0.5	21FLEECOIMPRGR80	1.4	1.32
12/6/2004	952	0.5	21FLEECOIMPRGR51	2.2	0.942
1/6/2005	937	0.5	21FLEECOIMPRGR80	1.7	1.1
1/6/2005	1007	0.4	21FLEECOIMPRGR51	4.5	0.61
2/7/2005	928	0.5	21FLEECOIMPRGR80	2	1.3
2/7/2005	956	0.3	21FLEECOIMPRGR51	2.8	0.86
3/23/2005	1117	0.5	21FLEECOIMPRGR80	4.9	1
3/23/2005	1140	0.5	21FLEECOIMPRGR51	4.8	0.88
4/5/2005	938	0.8	21FLEECOIMPRGR80	1.9	0.82
4/5/2005	1002	0.4	21FLEECOIMPRGR51	4.1	0.53
5/12/2005	1012	0.4	21FLEECOIMPRGR80	2.1	1.3
5/12/2005	1039	0.3	21FLEECOIMPRGR51	2.4	0.81
6/9/2005	951	0.5	21FLEECOIMPRGR80	5.1	0.9
6/9/2005	1017	0.5	21FLEECOIMPRGR51	2.9	0.13
7/7/2005	942	0.5	21FLEECOIMPRGR80	3	1.6
7/7/2005	1009	0.5	21FLEECOIMPRGR51	2.6	1.4
8/8/2005	1018	0.5	21FLEECOIMPRGR80	3.5	0.8
8/8/2005	1041	0.5	21FLEECOIMPRGR51	3	0.86
9/14/2005	1012	0.5	21FLEECOIMPRGR80	3.8	0.97
9/14/2005	1037	0.5	21FLEECOIMPRGR51	2.3	0.84
10/17/2005	1018	0.5	21FLEECOIMPRGR80	4.8	0.83
10/17/2005	1045	0.5	21FLEECOIMPRGR51	3.7	0.79
11/8/2005	1000	0.5	21FLEECOIMPRGR80	3.4	0.73
11/8/2005	1022	0.5	21FLEECOIMPRGR51	2.5	0.8
12/12/2005	955	0.5	21FLEECOIMPRGR80	5.5	0.95
12/12/2005	1016	0.4	21FLEECOIMPRGR51	4	0.84
1/5/2006	937	0.5	21FLEECOIMPRGR80	3.7	1.5
1/5/2006	956	0.4	21FLEECOIMPRGR51	4.2	1
2/6/2006	1500	1	21FLFTM 28020244	5.7	1.34
2/13/2006	1045	0.5	21FLEECOIMPRGR80	4.8	1
2/13/2006	1107	0.4	21FLEECOIMPRGR51	6.7	0.56
3/8/2006	944	0.5	21FLEECOIMPRGR80	2.2	0.5
3/8/2006	1007	0.25	21FLEECOIMPRGR51	4	0.2
4/24/2006	946	0.5	21FLEECOIMPRGR80	1.9	1.12
4/24/2006	1003	0.5	21FLEECOIMPRGR51	2.4	0.73
5/17/2006	940	0.5	21FLEECOIMPRGR80	2.2	1.08
5/17/2006	1000	0.5	21FLEECOIMPRGR51	2.1	0.94
6/13/2006	1007	0.5	21FLEECOIMPRGR80	1.7	1.15
6/13/2006	1027	0.5	21FLEECOIMPRGR51	1.3	0.97
7/3/2006	1014	0.5	21FLEECOIMPRGR80	2.9	1.18
7/3/2006	1035	0.4	21FLEECOIMPRGR51	3.2	0.66
8/29/2006	950	0.5	21FLEECOIMPRGR80	4.5	0.7
8/29/2006	1008	0.5	21FLEECOIMPRGR51	2.6	0.73

Date	Time	Depth	Station	DO Result (mg/L)	TN Result (mg/L)
9/18/2006	950	0.5	21FLEECOIMPRGR80	3.1	0.7
9/18/2006	1006	0.5	21FLEECOIMPRGR51	2.2	0.81
10/24/2006	943	0.5	21FLEECOIMPRGR80	3	1.18
10/24/2006	1011	0.3	21FLEECOIMPRGR51	3.9	0.81
11/14/2006	924	0.5	21FLEECOIMPRGR80	2.2	1.26
11/14/2006	943	0.5	21FLEECOIMPRGR51	4.3	0.84
12/21/2006	917	0.4	21FLEECOIMPRGR80	1.5	1.01
12/21/2006	936	0.3	21FLEECOIMPRGR51	2.5	0.6
1/29/2007	932	0.4	21FLEECOIMPRGR80	2.7	1.01
1/29/2007	954	0.3	21FLEECOIMPRGR51	3.1	0.67
2/22/2007	936	0.2	21FLEECOIMPRGR80	2.1	1.02
2/22/2007	955	0.3	21FLEECOIMPRGR51	3.8	0.61
3/8/2007	933	0.2	21FLEECOIMPRGR80	1.9	1.12
3/8/2007	950	0.3	21FLEECOIMPRGR51	3.1	0.53

Appendix C: Calculation of TN Reductions for the TMDL for Imperial River, WBID 3258E

Date	Time	Depth	Station	TN Value (mg/L)	TN % Reduction
1/4/2000	1200	0.5	21FLEECOIMPRGR51	1.14	35.09
3/13/2000	1200	0.5	21FLEECOIMPRGR51	1.17	36.75
4/4/2000	1200	0.5	21FLEECOIMPRGR51	2.27	67.40
6/5/2000	1200	0.5	21FLEECOIMPRGR51	0.81	8.64
7/11/2000	1000	0.5	21FLEECOIMPRGR51	2.35	68.51
8/30/2000	800	0.5	21FLEECOIMPRGR51	1.26	41.27
9/6/2000	1120	1.5	21FLFTM 28020244	0.932	20.60
9/27/2000	800	0.5	21FLEECOIMPRGR51	0.98	24.49
10/3/2000	1547	1	21FLFTM 28020264FTM	0.827	10.52
10/5/2000	800	0.5	21FLEECOIMPRGR51	1.63	54.60
10/9/2000	1056	1	21FLFTM 28020234	0.931	20.52
11/13/2000	905	0.5	21FLEECOIMPRGR51	0.88	15.91
1/17/2001	1220	1.6	21FLFTM 28020244	1.93	61.66
3/19/2001	1525	1.5	21FLFTM 28020264FTM	1.25	40.80
3/27/2001	845	0.5	21FLEECOIMPRGR51	0.85	12.94
5/24/2001	915	0.5	21FLEECOIMPRGR51	1.41	47.52
6/11/2001	910	0.5	21FLEECOIMPRGR51	0.85	12.94
7/10/2001	937	0.5	21FLEECOIMPRGR51	0.9	17.78
7/23/2001	911	0.5	21FLEECOIMPRGR51	1.13	34.51
12/20/2001	915	0.5	21FLEECOIMPRGR51	0.82	9.76
4/18/2002	817	0.5	21FLEECOIMPRGR51	0.94	21.28
4/23/2002	1105	0.5	21FLFTM 28020264FTM	1.039	28.78
6/5/2002	843	0.5	21FLEECOIMPRGR51	0.91	18.68
6/19/2002	1316	0.5	21FLFTM 28020264FTM	1.09	32.11
7/8/2002	1550	0.5	21FLFTM 28020264FTM	1.05	29.52
8/20/2002	1855	0.5	21FLFTM 28020264FTM	1.08	31.48
10/16/2002	1052	0.5	21FLEECOIMPRGR51	0.86	13.95
11/5/2002	1140	0.5	21FLEECOIMPRGR51	0.85	12.94
3/19/2003	929	0.5	21FLEECOIMPRGR51	1.16	36.21
5/28/2003	1115	0.5	21FLEECOIMPRGR51	1.01	26.73
6/23/2003	1120	0.5	21FLEECOIMPRGR51	0.85	12.94
7/30/2003	1054	0.5	21FLEECOIMPRGR51	0.94	21.28
8/28/2003	1020	0.5	21FLEECOIMPRGR51	1.56	52.56
12/10/2003	1046	0.5	21FLEECOIMPRGR51	0.84	11.90
1/15/2004	930	0.5	21FLEECOIMPRGR80	0.98	24.49
3/2/2004	1005	0.5	21FLEECOIMPRGR80	0.98	24.49
4/1/2004	946	0.5	21FLEECOIMPRGR80	1.08	31.48
5/12/2004	933	0.5	21FLEECOIMPRGR80	0.83	10.84
5/12/2004	955	0.5	21FLEECOIMPRGR51	0.94	21.28

Date	Time	Depth	Station	TN Value (mg/L)	TN % Reduction
6/10/2004	1008	0.5	21FLEECOIMPRGR51	0.82	44.78
6/10/2004	943	0.5	21FLEECOIMPRGR80	1.34	9.76
7/1/2004	1053	0.5	21FLEECOIMPRGR51	0.92	51.63
7/1/2004	1029	0.5	21FLEECOIMPRGR80	1.53	19.57
7/28/2004	941	0.5	21FLEECOIMPRGR80	1.14	35.09
8/4/2004	1008	0.5	21FLEECOIMPRGR51	0.99	30.84
8/4/2004	950	0.5	21FLEECOIMPRGR80	1.07	25.25
9/13/2004	1001	0.5	21FLEECOIMPRGR80	0.85	12.94
9/28/2004	931	0.5	21FLEECOIMPRGR51	0.82	11.90
9/28/2004	913	0.5	21FLEECOIMPRGR80	0.84	9.76
10/27/2004	1040	0.5	21FLEECOIMPRGR80	0.907	18.41
11/8/2004	950	0.5	21FLEECOIMPRGR51	0.962	38.33
11/8/2004	930	0.5	21FLEECOIMPRGR80	1.2	23.08
12/6/2004	952	0.5	21FLEECOIMPRGR51	0.942	43.94
12/6/2004	930	0.5	21FLEECOIMPRGR80	1.32	21.44
1/6/2005	937	0.5	21FLEECOIMPRGR80	1.1	32.73
2/7/2005	956	0.3	21FLEECOIMPRGR51	0.86	43.08
2/7/2005	928	0.5	21FLEECOIMPRGR80	1.3	13.95
3/23/2005	1140	0.5	21FLEECOIMPRGR51	0.88	26.00
3/23/2005	1117	0.5	21FLEECOIMPRGR80	1	15.91
4/5/2005	938	0.8	21FLEECOIMPRGR80	0.82	9.76
5/12/2005	1039	0.3	21FLEECOIMPRGR51	0.81	43.08
5/12/2005	1012	0.4	21FLEECOIMPRGR80	1.3	8.64
6/9/2005	951	0.5	21FLEECOIMPRGR80	0.9	17.78
7/7/2005	1009	0.5	21FLEECOIMPRGR51	1.4	53.75
7/7/2005	942	0.5	21FLEECOIMPRGR80	1.6	47.14
8/8/2005	1041	0.5	21FLEECOIMPRGR51	0.86	13.95
9/14/2005	1037	0.5	21FLEECOIMPRGR51	0.84	23.71
9/14/2005	1012	0.5	21FLEECOIMPRGR80	0.97	11.90
10/17/2005	1018	0.5	21FLEECOIMPRGR80	0.83	10.84
12/12/2005	1016	0.4	21FLEECOIMPRGR51	0.84	22.11
12/12/2005	955	0.5	21FLEECOIMPRGR80	0.95	11.90
1/5/2006	956	0.4	21FLEECOIMPRGR51	1	50.67
1/5/2006	937	0.5	21FLEECOIMPRGR80	1.5	26.00
2/6/2006	1500	1	21FLFTM 28020244	1.34	44.78
2/13/2006	1045	0.5	21FLEECOIMPRGR80	1	26.00
4/24/2006	946	0.5	21FLEECOIMPRGR80	1.12	33.93
5/17/2006	1000	0.5	21FLEECOIMPRGR51	0.94	31.48
5/17/2006	940	0.5	21FLEECOIMPRGR80	1.08	21.28
6/13/2006	1027	0.5	21FLEECOIMPRGR51	0.97	35.65
6/13/2006	1007	0.5	21FLEECOIMPRGR80	1.15	23.71

Date	Time	Depth	Station	TN Value (mg/L)	TN % Reduction
7/3/2006	1014	0.5	21FLEECOIMPRGR80	1.18	37.29
9/18/2006	1006	0.5	21FLEECOIMPRGR51	0.81	8.64
10/24/2006	1011	0.3	21FLEECOIMPRGR51	0.81	37.29
10/24/2006	943	0.5	21FLEECOIMPRGR80	1.18	8.64
11/14/2006	943	0.5	21FLEECOIMPRGR51	0.84	41.27
11/14/2006	924	0.5	21FLEECOIMPRGR80	1.26	11.90
12/21/2006	917	0.4	21FLEECOIMPRGR80	1.01	26.73
1/29/2007	932	0.4	21FLEECOIMPRGR80	1.01	26.73
2/22/2007	936	0.2	21FLEECOIMPRGR80	1.02	27.45
3/8/2007	933	0.2	21FLEECOIMPRGR80	1.12	33.93
				Median % Reduction =	**24.87**

Appendix D: Sample Stations and Median Concentration Data

Table D.1. Freshwater Sample Stations in the Southwest Coast Planning Unit used in the TN-DO Correlation

WBID	Station	Latitude	Longitude	DO Median (mg/L)	TN Median (mg/L)	Observations
3278G	21FLSFWMBC12	26.00883	-81.45811	5.44	0.240	59
3278G	21FLSFWMBC18	25.91867	-81.39096	3	0.610	60
3278G	21FLSFWMBC19	25.92696	-81.41765	3.13	0.810	59
3278G	21FLSFWMBC21	25.96047	-81.50022	4.24	0.800	59
3278G	21FLSFWMCHKMATE	26.14361	-81.38929	1.71	0.830	15
3278H	21FLFTM 28030070FTM	26.29331	-81.52947	6.8	0.695	3
3278H	21FLSFWMFAKA858	26.29288	-81.52964	4.96	0.750	56
3278I	21FLSFWMBC10	26.10314	-81.05234	6.82	0.370	57
3278I	21FLSFWMBC20	25.96104	-81.51664	4.11	0.650	59
3278I	21FLSFWMBC7	25.99276	-81.52181	7.525	0.435	58
3278I	21FLSFWMBC8	25.99330	-81.49038	7.18	0.365	60
3278I	21FLSFWMBC9	26.15317	-81.55526	5.1	0.500	57
3278I	21FLSFWMFAKA	25.96051	-81.50951	6.755	0.380	58
3278V	21FLSFWMBC22	26.05711	-81.68396	6.18	0.640	57

Appendix E: Public Comments and FDEP Responses

Appendix E.1: Kevin Carter / SFWMD

The below comments were received by email from Mr. Kevin Carter of the South Florida Water Management District (SFWMD) on July 18, 2008

Comment 1.: Our major comments focus on the setting of the total nitrogen (TN) threshold of 0.74 mg/l in order for the water body to meet the state of Florida's (Florida Administrative Code 62-302 http://www.dep.state.fl.us/legal/Rules/shared/62-302/302-Table.pdf) dissolved oxygen (DO) water quality criteria of 5.0 mg/l (note the TN value of 0.74 mg/l was stated at Public Workshop on 07/11/2008 and differs very slightly from what is written in the DRAFT TMDL report which is 0.76 mg/l).

FDEP Response: All of the dissolved oxygen TMDL reports for freshwater will be revised to state the correct TN threshold of 0.74 mg/L, which was used in the TMDL presentation.

Comment 2: We would like the FDEP to consider the following District observations based on our brief data investigation of the DRAFT TMDL report's "Appendix B. Water Quality Measurements Used in the Verified Period Assessment."

• Overall, this table has 171 observations of TN and DO measurements taken concurrently in the Imperial River between January 2000 to March 2007.
• Of those 171 observations, the TN concentrations were less than the 0.74 mg/l threshold proposed by the DRAFT TMDL report 47 times (27.5%).
• Of those 47 observations where TN concentrations were less than 0.74 mg/l, dissolved oxygen concentrations failed the state of Florida's 5.0 mg/l DO criteria 41 times (87.2%).

Based solely on the historical ambient data, the occurrence of TN values less than 0.74 mg/l does not regularly ensure DO values will achieve water quality criteria compliance. Some variability is to be expected with instream DO concentrations because of the many diverse reasons for low DO values (e.g., groundwater inputs). However, the relatively high percentage of failures (87.2%) should be considered carefully as the FDEP moves forward with its TMDL process for this WBID. In addition, the FDEP should review the other DO TMDLs within this round for the EWC (Hendry Creek WBIDs 3258B and 3258B1; Gordon River WBID 3278K) to determine if a similar TN and DO dynamic exists across the watershed.

FDEP Response: The Department agrees there are other significant factors affecting the dissolved oxygen concentration within the Imperial River, such as groundwater inputs, atmospheric deposition, and hydrologic modifications. The TMDL report focused on the total nitrogen threshold since it had the best relationship with DO and it exceeded the reference concentrations, which was not the case for total phosphorus and BOD. Thus, reducing total nitrogen to a median value of 0.74 mg/L (using the 75^{th} percentile of the medians from freshwater WBIDs in the Southwest Coast Planning Unit) was used as the reference concentration target. Applying this target to reduce total nitrogen, the Department believes the anthropogenic affects would be captured, which would result in dissolved oxygen improvement. As was noted in your comments, the Everglades West Coast has uniquely high number of waterbodies with naturally low dissolved oxygen. This was the reason for utilizing waterbodies in the Everglades West Coast as reference conditions. An observation of the relatively lower TN in these reference waterbodies, as well as the correlation between DO and TN in the entire region, indicate that a decrease in the TN can result an increase in the dissolved oxygen. The FDEP does not predict a final dissolved oxygen concentration after the anthropogenic activities have been modified to reduce total nitrogen.
The FDEP agrees with your comment that more work remains to be done to understand the local hydrology and positively affect change through a collaborative effort between local stakeholders and FDEP, which can occur during the Basin Management Action Plan (BMAP) development phase of the TMDL process.

Appendix E.2: Lee county Division of Natural Resources

The below comments were received by email from the Lee County Division of Natural Resources on July 17, 2008

Comment 1:
[There should be a] detailed review of the adequacy of the present database to support more detailed modeling, or to support determination of reference nutrient values with identification of data gaps. We need to know for future modeling efforts what data is lacking so that we can determine if and what additional data collection can be done.

FDEP Response: The department will also seek ways to work closer with local stakeholders to identify data gaps and develop water quality monitoring plans to develop as complete possible data set for the development of future TMDLs. For TMDLs that have been developed, During the implementation or Basin Management Action Plan (BMAP) phase, the Department will work with all interested stakeholders to identify data gaps for supplemental data collection to assist in the identification of effective management activities.

Comment 2:
Conducting a detailed peer review that assesses the following issues:

- Additional consideration must be given to the idea of "natural condition" for DO and the influence of SOD and system hydrology in the overall DO conditions. We do not have SOD data in this area as well as the affects of groundwater due to man-made alterations in the basin are as yet unknown.
- We recommend an evaluation of the present DO TMDLs against the precedent that has been established in recent delistings based upon determination of low "natural" DO levels.
- Variability in the baseline or reference levels of TN will have a significant impact upon the percent reduction in the system.

FDEP Response: The Department agrees that gaining an understanding of the affects of SOD and groundwater inputs and man-made alterations will help assess and restore this waterbody, so that water quality meets the established water quality standards.

The Department has proposed for Delisting several waterbodies that have low dissolved oxygen and no causative pollutant has been found, providing supporting evidence the low DO is due to natural conditions. The impact of land use change and urban development in the Hendry Creek watershed provide evidence to support that the low DO in Hendry Creek is predominantly due to anthropogenic affects.

The TMDL document will be revised to include reference WBIDs and stations from WBIDs that have low urban impacts and the TN reference concentration value will be changed accordingly.

Comment 3:

The County recognizes the approximate nature of these initial TMDLs and believes they have value for planning purposes.

FDEP Response: The Department will include the finalized TMDLs developed for the Everglades West Coast basin in the next phase of the TMDL process known as the Basin Management Action Plan (BMAP) development.

Comment 4:

Seasonal data needs to be collected for those TMDLs that currently consider only concentrations.

FDEP Response: The data used to develop the TMDLs were typically collected during each month of the calendar year, covering each season. This also includes variability occurring during the wet / dry seaons.

Comment 5:

The draft TMDLs are not sufficient for developing allocations.

FDEP Response: The Department will utilize the TMDLs developed for the Everglades West Coast basin as a starting point for the next phase of the TMDL process known as the Basin Management Action Plan (BMAP) development. Detailed allocations, as well as more refined TMDL calculations should be pursued and can be completed during the BMAP development phase.

Comment 6:

Detailed modeling must be completed, using viable seasonal water quality and stream flow data, to establish actual pollutant loadings (not concentrations) to serve as the basis of any credible determination of required annual pollutant load reductions, or subsequent allocation of reductions to the stakeholders.

FDEP Response: The Department will pursue flow monitoring and include any reliable accurate flow data, as it becomes available, to develop pollutant load and water quality models.

Comment 7:

The recent draft TMDLs prepared by FDEP provide very limited source assessments and will need detailed evaluation and assessment of pollutant sources prior to the development of accurate allocation of pollutant loads.

FDEP Response: The Department will include the finalized TMDLs developed for the Everglades West Coast basin in the next phase of the TMDL process known as the Basin Management Action Plan (BMAP) development. Detailed allocations, sources assessment, as well as more refined TMDL calculations can be completed during the BMAP.

Comment 8:

Detailed examination of the potential seasonal impact of septic tanks/OSTDSs and their annual pollutant load contribution is required which should include:

- Accurate quantification of the number of septic systems within the watershed (e.g. FDEP did not obtain Lee County’s manhole data to determine where central sewer exists versus septic tanks.);
- Identification of the location of the existing systems. (e.g. There was no mention of package plant locations in the TMDL report.); and
- Estimation of the percentage of the septic tank population that have failed. The assumption that a permit for repair represents failure and that all repairs are permitted is a narrow assumption with the potential for more failures than are accounted for.

FDEP Response: The Department would appreciate any additional information to better reflect accurate septic tank coverages, sewer service areas, and package plant coverages within the Hendry Creek watershed. The information listed above can be incorporated into the TMDL document for this basin. The assumption that repaired septic tanks is an accurate representation of potentially failing septic tanks has been used in several Department fecal coliform TMDLs and is used only as information in the TMDL document.

Comment 9:

Evaluation of cross-border levels of contribution where WBIDs are shared between Lee County and adjacent counties so that these loads can be attributed to the proper stakeholders.

FDEP Response: The Department will include the finalized TMDLs developed for the Everglades West Coast basin in the next phase of the TMDL process known as the Basin Management Action Plan (BMAP) development. Detailed allocations, sources assessment, as well as more refined TMDL calculations can be completed during the BMAP.

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