FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration

SOUTH DISTRICT • CALOOSAHATCHEE BASIN

FINAL TMDL Report

Nutrient TMDL for the Caloosahatchee Estuary (WBIDs 3240A, 3240B, and 3240C)

Nathan Bailey, Ph.D.
Wayne Magley, Ph.D.
Jan Mandrup-Poulsen
Kevin O'Donnell
Rhonda Peets

September 2009

Acknowledgments

This Total Maximum Daily Load (TMDL) analysis could not have been accomplished without significant contributions from staff in the South Florida Water Management District (SFWMD), Florida Department of Environmental Protection's (Department) South District Office, Lee County Natural Resources, city of Cape Coral, and Caloosahatchee River Basin Technical Working Group.

Extensive editorial assistance provided by Linda Lord.

Extensive technical and logistical support was provided by former Department South Sector Basin Coordinator, Mr. Pat Fricano, currently with the SFWMD.

For additional information on the watershed management approach and impaired waters in the Caloosahatchee Basin, contact:

John Abendroth
Florida Department of Environmental Protection
Bureau of Watershed Restoration
Watershed Planning and Coordination Section
2600 Blair Stone Road, Mail Station 3565
Tallahassee, FL 32399-2400
Email: john.abendroth@dep.state.fl.us
Phone: (850)245–8555
Fax: (850) 245–8434

Access to all data used in the development of this report can be obtained by contacting:

Nathan Bailey
Florida Department of Environmental Protection
Bureau of Watershed Restoration
Watershed Evaluation and TMDL Section
2600 Blair Stone Road, Mail Station 3555
Tallahassee, FL 32399-2400
Email: nathaniel.bailey@dep.state.fl.us
Phone: (850) 245–8465
Fax: (850) 245–8536

Contents

List of Tables

List of Figures

Websites

Florida Department of Environmental Protection, Bureau of Watershed Management

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 Caloosahatchee Basin

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

Water Quality Assessment Report for the Caloosahatchee Basin

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

U.S. Environmental Protection Agency, National STORET Program

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 total nitrogen (TN), which causes high chlorophyll *a* (chl*a*) concentrations in the Caloosahatchee River and Estuary downstream of the Franklin Lock and Dam (Control Structure S-79). Thirty-eight percent of the Caloosahatchee Basin drains via tributaries that empty directly into this portion of the river and estuary. The remaining 62 percent of the Caloosahatchee Basin's runoff flows into tributaries and canals connected to the portion of the river upstream of S-79. The water in the Caloosahatchee River upstream of the S-79 control structure, referred to in this report as the eastern Caloosahatchee or C-43 Canal, is regularly released into the estuary through S-79, which is managed by the U.S. Army Corps of Engineers (USACOE).

During the Cycle 1 assessment of the Caloosahatchee River by the Florida Department of Environmental Protection (Department), several waterbodies were verified as impaired for dissolved oxygen (DO) and/or nutrients. The Caloosahatchee Basin is in Group 3 of a five-group basin rotation schedule in the Department's South District. The Cycle 1 sampling for the verified assessments of the Group 3 waterbodies was carried out between January 1, 1997, and June 30, 2004.

The results of this sampling and data analyses revealed that 6 waterbodies were impaired for DO, and 7 waterbodies were impaired for nutrients (based on excessive chl*a* levels). These results showed that 4 stream and 3 estuarine waterbodies were below Florida's DO criterion for fresh and marine waters, respectively. The assessment of chl*a* data revealed that 3 stream and 3 estuarine waterbodies exceeded the listing threshold of 20 micrograms per liter (μg/L) (for streams) and 11 μg/L (for estuaries and coastal waters), respectively. These waterbodies, as well as the Caloosahatchee River and tributaries east of the estuary, were subsequently included on the Verified List of impaired waters that was adopted by Secretarial Order on May 27, 2004.

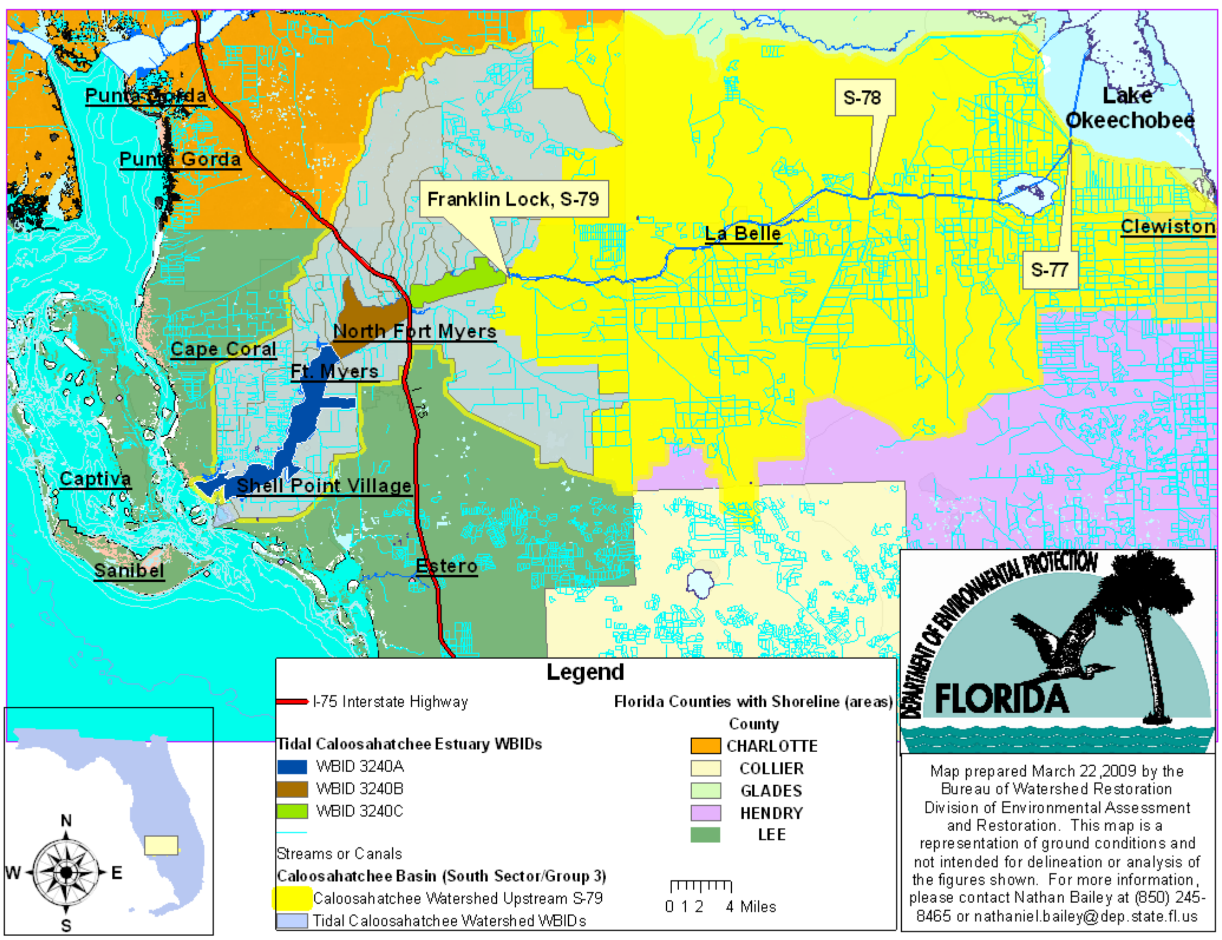
On June 28, 2007, Governor Charlie Crist signed into law Senate Bill 392 (Section 373.4595, Florida Statutes [F.S.]), which was passed unanimously by the Florida Legislature. Subsection 5 of this bill directs the Department to expedite the development and adoption of TMDLs for the Caloosahatchee River and Estuary. The Department is further directed to propose for final agency action, no later than December 31, 2008, TMDLs for nutrients in the tidal portion of the Caloosahatchee River and Estuary. As a result of this legislation, this nutrient TMDL report was developed for those Tidal Caloosahatchee waterbodies. The TMDL for the Tidal Caloosahatchee River establishes the allowable loadings that would restore these waterbodies so that they meets their applicable water quality standard for nutrients.

1.2 Identification of Waterbody

The Caloosahatchee Basin encompasses approximately 1,339 square miles and covers significant portions of four counties. The Department has divided the basin into five planning units: East Caloosahatchee River, West Caloosahatchee River, Orange River, Telegraph Swamp, and Caloosahatchee Estuary. All except one of these Caloosahatchee River sub-basins consist of Class III waters. The exception is the Class I waterbody directly upstream of S-79 (WBID 3235A) that extends from S-79 to the Lee County–Hendry County border and serves as a source of potable water to supplement the water demands of the city of Fort Myers and areas of unincorporated Lee County.

The 75-mile-long Caloosahatchee River originates as the C-43 Canal at the southwest corner of Lake Okeechobee at Structure S-77, and then flows predominantly east to west, eventually discharging into the Gulf of Mexico at San Carlos Bay (**Figure 1.1**). Water flow is controlled by the USACOE, crossing over 3 control structures: the Moore Haven Lock (flow from Lake Okeechobee over S-77 into the C-43/Caloosahatchee River), the Ortona Lock (S-78), and the Franklin Lock (S-79). The distance along C-43 from Moore Haven to the Ortona Lock is approximately 15.5 miles, and the distance from the Ortona Lock to the Franklin Lock is approximately 27.9 miles. The Franklin Lock separates the freshwater portion of the Caloosahatchee Canal on the east, from the 33.2-mile-long, saline tidal estuarine portion of the Caloosahatchee River on the west.

Figure 1.1. Location of the Tidal Caloosahatchee Watershed and Its Tributaries as part of the Caloosahatchee Basin, with Major Geopolitical Features



The locks at Structures 77 and 78 were constructed in the 1930s, while the locks at S-79, along with other channel improvements, were completed in 1965 to improve navigation and flood control along the length of the canal. The USACOE constructed these structures and regularly uses the scientific expertise of the South Florida Water Management District (SFWMD) in their operation (schedule and quantity of releases).

The Caloosahatchee Estuary proper extends from the Franklin Lock (S-79) to Shell Point, adjacent to San Carlos Bay, with Pine Island Sound to the northwest and Estero Bay to the southeast (**Figure 1.1**). The Caloosahatchee River receives flow from Lake Okeechobee, several streams and canals between S-77 and S-78, 14 tributaries between S-78 and S-79, and 23 waterbodies that discharge directly to the estuary below S-79 (**Table 1.1** and **Figure 1.1**). Approximately half of the volume of water that reaches S-79 is water that has passed through S-77 from Lake Okeechobee.

Table 1.1. Tidal Caloosahatchee WBIDs and WBIDs Discharging Directly to the Tidal Caloosahatchee Estuary below S-79

[1] M = Marine; F = Freshwater
[2] Tidal Caloosahatchee WBID

Planning Unit	WBID	Waterbody Name	Waterbody Type	Waterbody Class[1]
Caloosahatchee Estuary[2]	**3240A**	**Tidal Caloosahatchee**	**Estuary**	**IIIM**
Caloosahatchee Estuary[2]	**3240B**	**Tidal Caloosahatchee**	**Estuary**	**IIIM**
Caloosahatchee Estuary[2]	**3240C**	**Tidal Caloosahatchee**	**Stream**	**IIIF**
Caloosahatchee Estuary	3240A1	Cape Coral Tidal	Estuary	IIIM
Caloosahatchee Estuary	3240A2	Cape Coral Freshwater	Stream	IIIF
Caloosahatchee Estuary	3240A4	Deep Lagoon Canal	Estuary	IIIM
Caloosahatchee Estuary	3240B1	Chapel - Bayshore Creeks	Stream	IIIF
Caloosahatchee Estuary	3240B2	Chapel - Bayshore Creeks Marine	Estuary	IIIM
Caloosahatchee Estuary	3240C1	Palm Creek	Stream	IIIF
Caloosahatchee Estuary	3240E	Yellow Fever Creek	Estuary	IIIM
Caloosahatchee Estuary	3240E1	Hancock Creek	Estuary	IIIM
Caloosahatchee Estuary	3240F	Daughtrey Creek	Stream	IIIF
Caloosahatchee Estuary	3240G	Trout Creek	Stream	IIIF
Caloosahatchee Estuary	3240H	Whisky Creek (Wyoua Creek)	Stream	IIIF
Caloosahatchee Estuary	3240I	Manuel Branch	Estuary	IIIM
Caloosahatchee Estuary	3240L	Gilchrest Drain--Powell	Stream	IIIF
Caloosahatchee Estuary	3240M	Stroud Creek	Stream	IIIF
Caloosahatchee Estuary	3240N	Owl Creek	Stream	IIIF
Caloosahatchee Estuary	3240Q	Popash Creek	Stream	IIIF
Orange River	3240J	Billy Creek	Estuary	IIIM
Orange River	3240K	Orange River	Stream	IIIF
Telegraph Swamp	3236	Telegraph Swamp	Stream	IIIF
Telegraph Swamp	3236A	Telegraph Creek	Stream	IIIF

Approximately 75 percent of the Tidal Caloosahatchee watershed is located in Lee County, with the remaining 25 percent in Charlotte County (**Figure 1.1**). The major population centers in the watershed include Cape Coral (population 151,389) (U.S. Census Bureau, 2006), Fort Myers (population 60,531), and North Fort Myers (population 40,214) (U.S. Census Bureau, 2000).

As with the entire state, for assessment purposes the Department divided the planning units of the Caloosahatchee Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. The Caloosahatchee Basin is composed of 42 WBIDs, of which 23 are in the tidal portion of the Caloosahatchee River Estuary Planning Unit.

In 2008, the Department revised the WBID boundaries for several Group 3 Caloosahatchee River WBIDs based on information it received on hydrology and the location of control structures, weirs, and ambient water quality monitoring stations. Prior to the 2008 changes, including the Cycle 1 basin delineation of WBIDs, a significant portion of the Caloosahatchee Estuary was assessed as one large waterbody (WBID 3240A, Tidal Caloosahatchee; **Figure 1.2**). This WBID encompassed segments of the Cape Coral canal system with segments on the south side of the estuary, primarily Deep Lagoon Canal.

The redelineation divided WBID 3240A, Tidal Caloosahatchee, into hydrologically different segments of the estuary. New basin delineations were created for WBID 3240A, Tidal Caloosahatchee; WBID 3240A1, Cape Coral Tidal; and WBID 3240A2, Cape Coral Freshwater. Additional segments of the Tidal Caloosahatchee Estuary (in WBIDs 3240B and 3240C) were separated because they included freshwater streams that discharged to the estuary. The basin delineation for WBID 3240B, Tidal Caloosahatchee, was revised to assess two freshwater creeks separately: Chapel and Bayshore Creeks (WBIDs 3240B1 and 3240B2). The basin delineation for WBID 3240C, Tidal Caloosahatchee, was revised so that Palm Creek (WBID 3240C1) was assessed separately (see **Figure 1.3**). Although there are several waterbodies impaired for different parameters (**Table 1.2**), this TMDL only addresses the nutrient impairment of the three waterbodies—WBIDs 3240A, 3240B, and 3240B—that together form the Tidal Caloosahatchee Estuary.

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.

Figure 1.2. Cycle 1 Basin Delineation for Tidal Caloosahatchee WBIDs below S-79

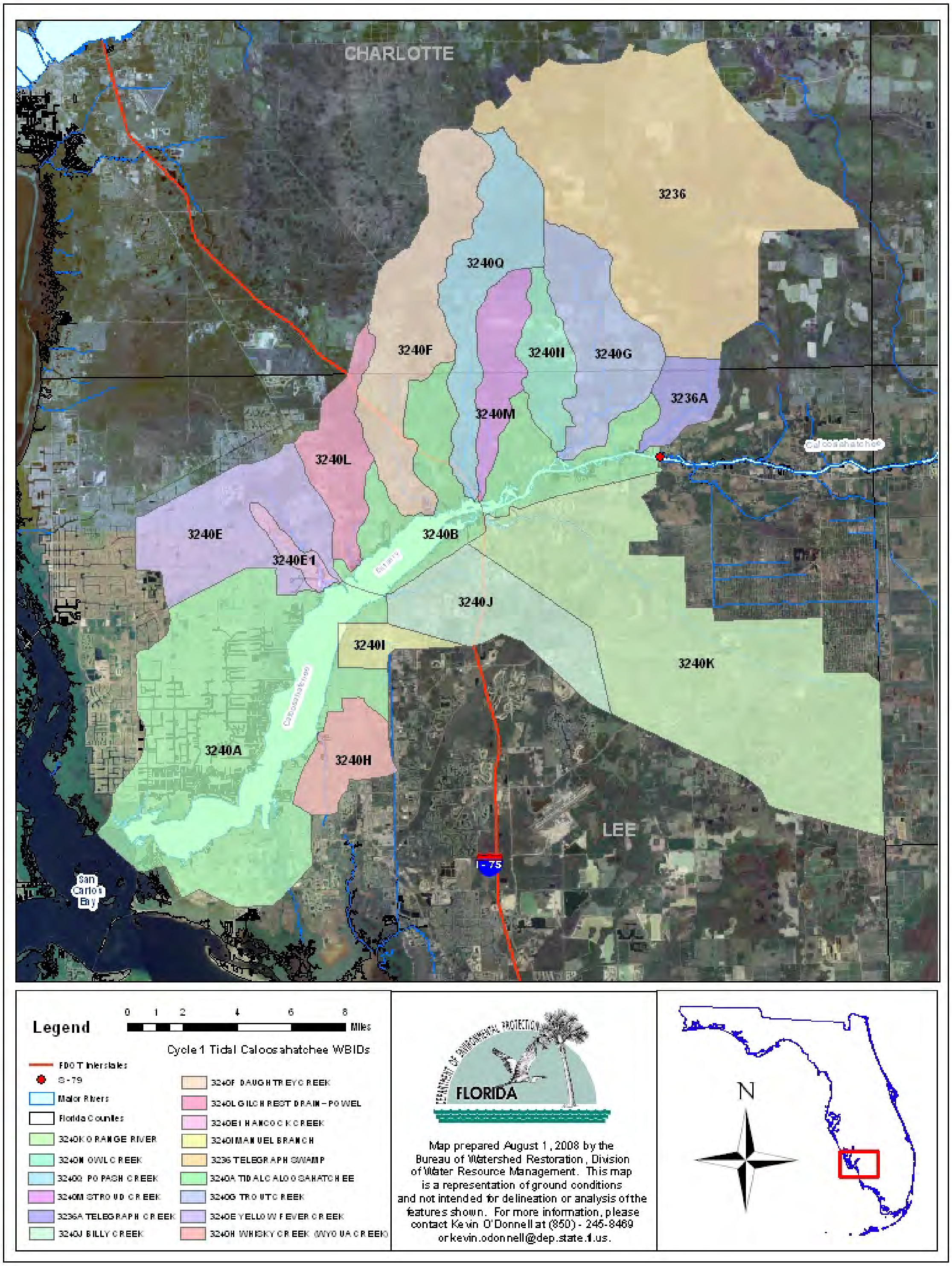


Figure 1.3. Cycle 2 Basin Delineation for Tidal Caloosahatchee WBIDs below S-79

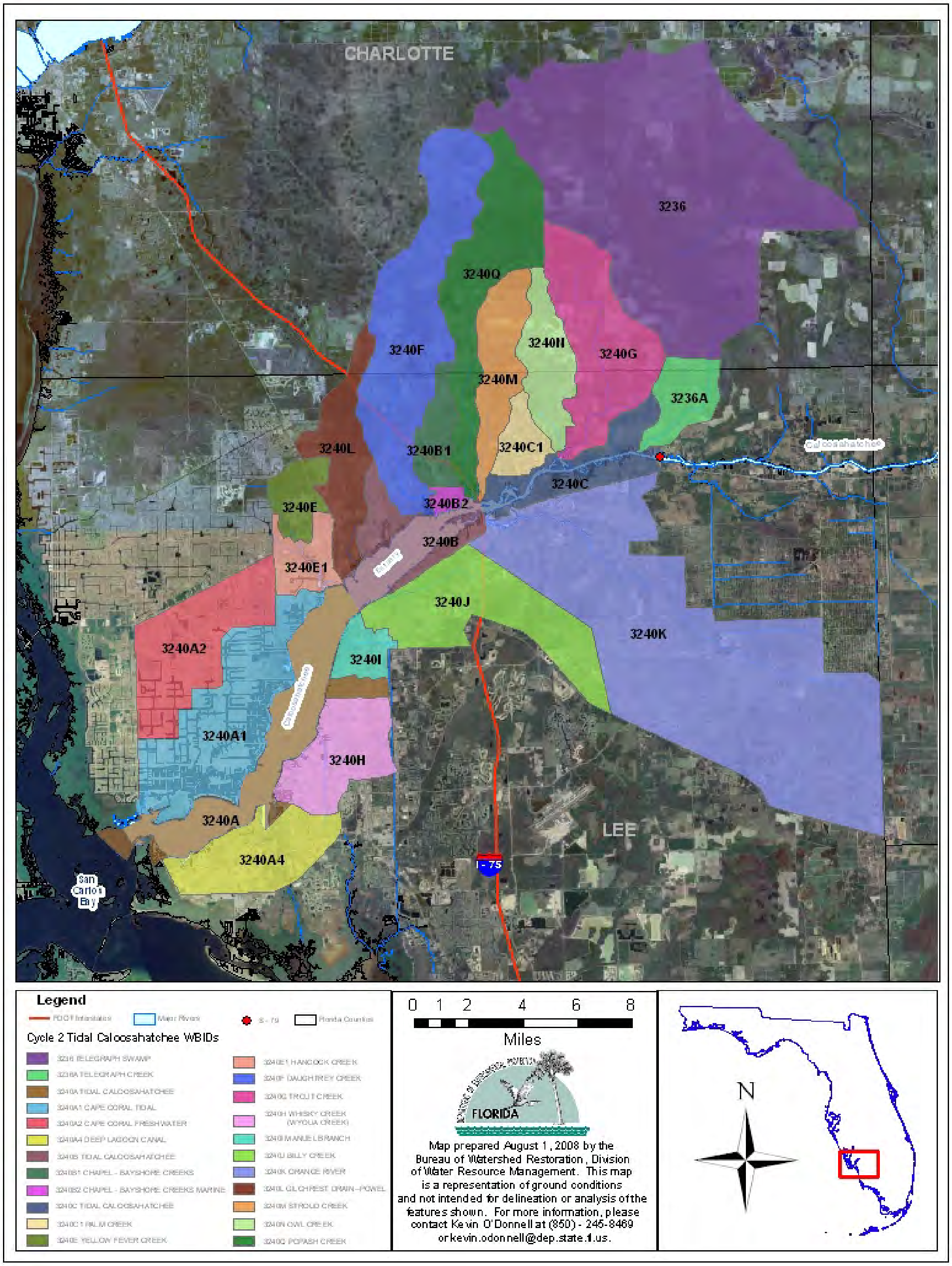


Table 1.2. Group 3 Caloosahatchee Basin (Downstream of S-79) Verified Impaired WBIDs and Parameters (Verified List Based on IWR Run 17, June 2005)

\- = Empty cell/no data
[1] Florida's waterbody classifications are defined as follows:
I = Potable water supplies;
II = Shellfish propagation or harvesting;
IIIF = Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife in fresh water;
IIIM = Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife in marine water;
IV = Agricultural water supplies; and
V = Navigation, utility, and industrial use.

WBID	Waterbody Segment	Waterbody Type	Waterbody Class[1]	1998 303(d) Parameters of Concern	Parameters Assessed Using the Impaired Surface Waters Rule (IWR)
3246	C-21	Stream	IIIF	-	Iron
3240A	Tidal Caloosahatchee	Estuary	IIIM	-	Nutrients (chla)
3240A	Tidal Caloosahatchee	Estuary	IIIM	-	Fecal Coliform
3240A	Tidal Caloosahatchee	Estuary	IIIM	-	DO
3240A	Tidal Caloosahatchee	Estuary	IIIM	-	Copper
3240B	Tidal Caloosahatchee	Estuary	IIIM	-	Nutrients (chla)
3240B	Tidal Caloosahatchee	Estuary	IIIM	-	Fecal Coliform
3240B	Tidal Caloosahatchee	Estuary	IIIM	-	DO
3240C	Tidal Caloosahatchee	Stream	IIIF	-	Nutrients (chla)
3240C	Tidal Caloosahatchee	Stream	IIIF	-	Fecal Coliform
3240C	Tidal Caloosahatchee	Stream	IIIF	-	DO
3240E	Yellow Fever Creek	Estuary	IIIM	-	Fecal Coliform
3240E1	Hancock Creek	Estuary	IIIM	-	Nutrients (chla)
3240E1	Hancock Creek	Estuary	IIIM	-	Fecal Coliform
3240E1	Hancock Creek	Estuary	IIIM	-	DO
3240F	Daughtrey Creek	Stream	IIIF	-	Fecal Coliform
3240G	Trout Creek	Stream	IIIF	Coliform	Fecal Coliform
3240H	Whisky Creek (Wyoua Creek)	Stream	IIIF	-	Fecal Coliform
3240I	Manuel Branch	Estuary	IIIM	-	Lead
3240I	Manuel Branch	Estuary	IIIM	-	Fecal Coliform
3240I	Manuel Branch	Estuary	IIIM	-	Copper
3240I	Manuel Branch	Estuary	IIIM	-	Biology
3240L	Gilchrest Drain—Powel	Stream	IIIF	-	Nutrients (chla)
3240L	Gilchrest Drain—Powel	Stream	IIIF	-	Fecal Coliform
3240L	Gilchrest Drain—Powel	Stream	IIIF	-	DO
3240M	Stroud Creek	Stream	IIIF	-	Nutrients (chla)
3240M	Stroud Creek	Stream	IIIF	-	Fecal Coliform
3240N	Owl Creek	Stream	IIIF	-	Fecal Coliform
3240Q	Popash Creek	Stream	IIIF	-	Nutrients(chla)
3240Q	Popash Creek	Stream	IIIF	-	Fecal Coliform
3240Q	Popash Creek	Stream	IIIF	-	DO
3240J	Billy Creek	Estuary	IIIM	-	Fecal Coliform

This TMDL Report will be followed by the development and implementation of a Basin Management Action Plan (BMAP), to reduce nutrient levels identified by the verified impairments found in the Tidal Caloosahatchee River. Subsection 5 of Senate Bill 392 states that the Department shall initiate the development of basin management plans as soon as practicable as determined necessary by the Department to achieve the TMDLs established for Lake Okeechobee and the estuaries (including Caloosahatchee and St. Lucie). In addition, the legislation provides several other details on how the BMAP is to be pursued (Senate Bill 392, Subsections 5[b], [c], and [d]). The BMAP activities will depend heavily on the active participation of the SFWMD, Florida Department of Agriculture and Consumer Services (FDACS), local governments, businesses, and other stakeholders. The Department will work with these organizations and individuals to undertake and continue reductions in the discharge of pollutants and achieve the established TMDL for this waterbody.

1.3.1 Development of TMDL

This TMDL was developed in cooperation with the SFWMD, Lee County Department of Natural Resources, and cities of Cape Coral, Fort Myers, and Sanibel. There was also active coordination with a variety of local stakeholders throughout the TMDL development process, including meetings and teleconferences between Lee County and the Department's Watershed Planning and Coordination Section. In addition, there were regular meetings between Department officers, local governmental officials, environmental advocacy groups, consultants, and other stakeholders who volunteered to participate in the monthly TMDL Technical Working Group, or whose participation was requested.

The major issues related to the Tidal Caloosahatchee River and Tributaries throughout the TMDL development process were as follows:

1. *Setting the appropriate water quality targets;*
2. *Selecting watershed loading and water quality models;*
3. *Calibrating and validating loads and flows to the Caloosahatchee River; and*
4. *Determining the level of agricultural and urban best management practice (BMP) implementation.*

Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rulemaking History

Section 303(d) of the federal Clean Water Act requires states to submit to the U.S. Environmental Protection Agency (EPA) a list of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant 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 four tributaries of the Tidal Caloosahatchee River: Daughtry Creek (nutrients and DO), Yellow Fever Creek (DO), Trout Creek (coliform and DO), and Manuel Branch (nutrients and DO) (Department, 2003). However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rule-making process, the Environmental Regulation Commission adopted the new methodology as Rule 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001; the rule was amended in 2006 and 2007. The list of waters for which impairments are verified using the methodology in the IWR is referred to as the Verified List.

As indicated earlier, the Department uses a five-year basin rotation process in which it performs a different phase of the TMDL process each year, as follows:

- *Year 1—Preliminary water quality evaluation and the development of a strategic monitoring plan;*
- *Year 2—Complete data collection to verify water quality impairments;*
- *Year 3—TMDL development;*
- *Year 4—Basin Management Action Plan (BMAP) development; and*
- *Year 5—BMAP implementation.*

Subsequently, each basin has a specific year for which the TMDL report development is scheduled.

However, as a result of the special Florida legislative directive in Senate Bill 392, it became necessary to assess and analyze the Tidal Caloosahatchee waterbodies earlier than would be called for by the basin rotation schedule. Because most waterbodies in the basin already had over seven years of data, the expedited TMDL development schedule could be pursued without fear of inadequately representing estuary water quality in the years leading up to the TMDL. The major impact of the expedited TMDL will be to permit the Department, SFWMD, and basin stakeholders to address the nutrient impairments on an earlier schedule.

2.2 Information on Verified Impairment

The Department has used the IWR to assess water quality impairments in the Tidal Caloosahatchee River and Tributaries, and in Cycle 1 verified the impairments for low DO, with TN, total phosphorus (TP), or biochemical oxygen demand (BOD) as the possible causative pollutants, or nutrient impairment based on high chl*a* (**Tables 2.1, 2.2, 2.3,** and **2.4**). The Tidal Caloosahatchee River and some of its tributaries were verified as having low DO concentrations because, based on the assessment using the IWR methodology, there is at least 90 percent confidence that the exceedance rate is greater than or equal to 10 percent. The data are based on samples collected between 1997 and 2004.

Typically, if the TN, TP, and BOD median concentrations were above the statewide 70th percentile threshold level (median values > 1.65, .22, and 2.0 milligrams per liter [mg/L], respectively), these would be suspected as the potential causative pollutant for the low DO concentrations. For WBIDs 3240A, 3240B, and 3240C, only BOD exceeded the set threshold. However, no exceedance of the threshold itself does not preclude the presence of the potential causative pollutant. Also not excluded is the possibility that the depressed levels are due to natural conditions such as ground water influences or stagnant water. In the years since Cycle 1, there have also been high chl*a* and elevated nutrient concentrations (**Tables 2.5** and **2.6**).

Table 2.1. Verified Impaired Parameters for Tidal Caloosahatchee Addressed in This TMDL

WBID	Waterbody Segment	Waterbody Type	Parameters Identified under the IWR	Concentration Causing Impairment
3240A	Tidal Caloosahatchee	Estuary	Nutrients (chl*a*)	Median TN = 0.83 mg/L
3240B	Tidal Caloosahatchee	Estuary	Nutrients (chl*a*)	Median TN = 0.85 mg/L
3240C	Tidal Caloosahatchee	Stream	Nutrients (chl*a*)	Median TN = 1.105 mg/L

Table 2.2. Verified Impaired Parameters for Tidal Caloosahatchee Not Addressed in This TMDL

WBID	Waterbody Segment	Waterbody Type	Parameters Identified under the IWR	Concentration Causing Impairment
3240A	Tidal Caloosahatchee	Estuary	Fecal Coliform	> 400 colonies/100mL
3240B	Tidal Caloosahatchee	Estuary	Fecal Coliform	> 400 colonies/100mL
3240C	Tidal Caloosahatchee	Stream	Fecal Coliform	> 400 colonies/100mL

Table 2.3. Summary of Data for WBIDs Listed as Impaired for Low DO (Cycle 1) for the Tidal Caloosahatchee River and Tributaries

WBID	Waterbody Type	Parameter of Concern	Number of Exceedances	Number of Samples	Identified Causative Pollutant
3240A (In March 2008, divided into 3240A, 3240A1, 3240A2, 3240A3, and 3240A4)	Estuary	DO	203	253	BOD (2.4 mg/L) and Nutrients (chl*a*)
3240B (In March 2008, divided into 3240B, 3240B1, and 3240B2)	Estuary	DO	57	150	Nutrients (chl*a*)
3240C (In March 2008, divided into 3240C and 3240C1)	Stream	DO	216	282	Nutrients (chl*a)*

Table 2.4. Summary of Chla Data for Tidal Caloosahatchee River WBIDS Impaired for Nutrients (Cycle 1)

[1] If the nitrogen:phosphorus (N:P) ratio < 10, the waterbody is N-limited; if > 17 P-limited; between 10 and 17, co-limited (Langan, 1999).

WBID	IWR Threshold (µg/L)	Years Chl*a* above IWR Threshold and Average Concentration	Median TN/TP Ratio[1]
3240A (recently divided into 3240A, 3240A1, 3240A2, 3240A3, and 3240A4	11	1999 (12.2 µg/L) 2000 (17.21 µg/L) 2001 (17.5 µg/L) 2002 (19.22 µg/L)	7.75
3240B (recently divided into 3240B, 3240B1, and 3240B2)	11	2000 (21.42 µg/L)	7.5
3240C (In March 2008, divided into 3240C and 3240C1)	20	2000 (24.77 µg/L)	8.77

Table 2.5. Summary of Nutrient Data for Tidal Caloosahatchee River (WBIDS 3240A, 3240B and 3240C) (Cycle 2 through 2007)

WBID	TN Number of Observations	TN Median (mg/L)	TP Number of Observations	TP Median (mg/L)	Median TN:TP Ratio
3240A	738	0.81	746	0.041	19.8
3240B	194	1.1	193	0.11	10.0
3240C	239	1.23	234	0.12	10.3

Table 2.6. Summary of Chl *a* Data for Tidal Caloosahatchee River WBIDS Impaired for Nutrients (Cycle 2 through 2007)

* Exceeds FDEP IWR Threshold and indicates Chlorophyll_a based nutrient impairment of estuaries

WBID	Annual Mean Concentration (µg/L) 2002	Annual Mean Concentration (µg/L) 2003	Annual Mean Concentration (µg/L) 2004	Annual Mean Concentration (µg/L) 2005	Annual Mean Concentration (µg/L) 2006	Annual Mean Concentration (µg/L) 2007
3240A	**13.1***	8.2	**17.7***	6.8	5.8	7.9
3240B	9	8.6	**12.28***	4.92	3.45	**30.4***
3240C	6.5	9.92	7	6.24	3	7.2

2.3 Information on Past 10 Years, Including Post-Cycle 1 Updated Water Quality

The Department also sampled and collected water quality information for the Caloosahatchee River and Tributaries after the Cycle 1 verified period. **Tables 2.7** and **2.8** provide a statistical summary of TN in WBIDs 3240A, 3240B, and 3240C. Of the stations with 6 or more samples and containing the most samples, the values highlighted in yellow represent values at or above the 75th percentile level median TN concentrations for all stations in that WBID. Those highlighted in red are above the 90th percentile level. **Appendix C** contains tables for all stations in the 23 Tidal Caloosahatchee WBIDs.

Table 2.7. Summary of WBID 3240A, Sample Station TN Data, Cycle 1

WBID	SAMPLE STATION	Results					
		Number of Samples	Median	Minimum	25 Percentile	75 Percentile	Maximum
3240A	21FLSFWMHB04	2	0.90	0.51	0.70	1.10	1.30
	21FLSFWMHB03	3	0.93	0.64	0.78	1.04	1.14
	21FLSFWMHB05	2	0.74	0.64	0.69	0.79	0.84
	21FLA 28020185	5	0.89	0.66	0.66	0.99	1.41
	21FLSFWMGR13	5	0.72	0.12	0.19	0.75	0.88
	21FLSFWMGR5	6	0.67	0.22	0.36	0.74	0.77
	21FLSFWMN6	5	0.70	0.32	0.47	0.77	0.81
	21FLSFWMRD8	5	0.61	0.19	0.48	0.62	0.79
	21FLSCCFMARKER 94	14	0.45	0.35	0.39	0.54	0.90
	21FLSFWMCES05	**40**	**1.00**	0.06	0.58	1.23	2.69
	21FLSFWMCES07	40	0.49	0.06	0.27	0.88	2.47
	21FLSFWMCES08	38	0.25	0.06	0.10	0.43	1.44
	CHNEPTCR339	1	0.27	0.27	0.27	0.27	0.27
	CHNEPTCR386	2	1.27	1.11	1.19	1.34	1.42
	CHNEPTCR436	2	1.10	0.96	1.03	1.17	1.24
	CHNEPTCR418	4	1.37	0.90	1.00	1.77	1.96
	CHNEPTCR394	3	0.90	0.53	0.72	1.17	1.44
	CHNEPTCR387	1	0.51	0.51	0.51	0.51	0.51
	CHNEPTCR393	1	0.48	0.48	0.48	0.48	0.48
	CHNEPTCR395	2	1.24	0.96	1.10	1.38	1.52
	CHNEPTCR403	4	1.21	0.60	0.87	1.72	2.48
	21FLSFWMROOK474	48	0.37	0.10	0.29	0.50	1.10
	CHNEPTCR413	5	0.78	0.59	0.68	0.89	1.40
	CHNEPTCR434	4	1.16	1.06	1.11	1.21	1.29
	CHNEPTCR414	1	0.68	0.68	0.68	0.68	0.68
	CHNEPTCR396	2	1.15	0.90	1.03	1.28	1.40
	CHNEPTCR419	5	1.47	0.48	0.63	1.59	1.60
	CHNEPTCR423	5	0.94	0.66	0.87	0.95	1.41
	CHNEPTCR392	2	0.78	0.68	0.73	0.83	0.88
	CHNEPTCR412	4	1.41	0.84	1.26	1.48	1.67
	CHNEPTCR417	2	1.45	1.40	1.43	1.48	1.50
	CHNEPTCR427	4	1.11	0.72	0.95	1.24	1.35
	CHNEPTCR429	5	0.97	0.92	0.96	1.05	1.60
	CHNEPTCR389	6	0.72	0.46	0.58	1.47	1.92
	CHNEPTCR391	3	0.87	0.62	0.75	1.39	1.90
	CHNEPTCR411	4	1.41	0.72	0.94	1.83	1.90
	CHNEPTCR424	5	0.92	0.58	0.91	1.80	2.66
	CHNEPTCR437	3	1.18	1.00	1.09	1.37	1.55
	CHNEPTCR428	3	0.96	0.86	0.91	1.23	1.50
	CHNEPTCR464	3	1.04	0.78	0.91	1.05	1.07
	CHNEPTCR388	3	0.99	0.76	0.88	1.27	1.55
	CHNEPTCR430	5	1.30	0.75	1.13	1.40	1.60
	CHNEPTCR422	**6**	**1.15**	0.68	1.06	1.23	1.73
	CHNEPTCR435	**9**	**1.31**	0.87	1.10	1.40	1.60
	21FLWQSPLEE670CA	4	0.53	0.38	0.48	0.55	0.59
	21FLSFWMCES06	87	0.89	0.06	0.62	1.24	2.30
	21FLGW 30436	1	0.53	0.53	0.53	0.53	0.53
	21FLGW 30445	1	0.59	0.59	0.59	0.59	0.59
	CAPECRD 350	133	0.47	0.07	0.32	0.62	1.20
	CAPECRD 242	131	0.76	0.07	0.51	1.04	2.78

YELLOW means the median shown is at the 75 Percentile level of all station medians in the WBID*
RED means the median shown is at the 90 Percentile level for all station medians in the WBID*
* For stations with 6 or more samples

Table 2.8. Summary of WBID 3240B, Sample Station TN Data, Cycle 1

WBID	SAMPLE STATION		Results				
		Number of	Median	Minimum	25	75	Maximum
3240B	21FLSFWMHB01	3	1.33	0.73	1.03	1.39	1.45
	21FLSFWMHB02	2	0.89	0.86	0.87	0.90	0.92
	CHNEPTCR451	3	1.03	0.97	1.00	1.18	1.32
	CHNEPTCR461	2	1.23	1.21	1.22	1.23	1.24
	CHNEPTCR444	3	1.05	0.70	0.87	1.09	1.14
	CHNEPTCR447	2	0.74	0.72	0.73	0.75	0.76
	CHNEPTCR454	2	1.16	1.15	1.15	1.16	1.17
	CHNEPTCR452	4	1.14	0.99	1.00	1.28	1.29
	CHNEPTCR442	**6**	**1.18**	0.60	0.99	1.50	1.70
	CHNEPTCR450	2	1.52	1.10	1.31	1.73	1.94
	CHNEPTCR448	3	1.20	0.80	1.00	1.36	1.52
	CHNEPTCR453	5	1.05	0.76	0.89	1.20	1.85
	CHNEPTCR449	3	1.18	0.94	1.06	1.19	1.20
	CHNEPTCR443	5	1.30	0.91	0.94	1.60	2.03
	21FLSFWMCES04	**87**	**1.13**	0.16	0.89	1.46	2.54
	21FLEECO18-6GR	**119**	**0.72**	0.01	0.55	0.95	2.31
3240C	21FLSFWMCES02	**40**	**1.24**	0.41	0.89	1.59	2.17
	CHNEPTCR473	3	1.42	1.21	1.31	1.64	1.86
	CHNEPTCR472	2	1.48	1.36	1.42	1.53	1.59
	CHNEPTCR463	1	0.99	0.99	0.99	0.99	0.99
	CHNEPTCR467	2	1.04	0.92	0.98	1.09	1.15
	CHNEPTCR456	2	1.00	0.69	0.85	1.16	1.31
	CHNEPTCR462	4	1.34	1.02	1.25	1.36	1.37
	CHNEPTCR469	2	1.08	0.85	0.96	1.19	1.30
	CHNEPTCR468	3	1.60	1.06	1.33	1.75	1.90
	CHNEPTCR471	5	1.34	1.15	1.21	1.60	1.77
	CHNEPTCR457	5	1.25	0.63	0.99	1.30	1.50
	CHNEPTCR470	**6**	**1.25**	0.79	1.07	1.62	2.10
	21FLSFWMCES03	**87**	**1.28**	0.36	1.05	1.50	2.11
	21FLEECO28-5GR	103	0.86	0.01	0.62	1.26	2.30
	21FLEECO26-GR20	**117**	**1.11**	0.01	0.90	1.43	10.30

YELLOW means the median shown is at the 75 Percentile level of all station medians in the WBID*

RED means the median shown is at the 90 Percentile level for all station medians in the WBID*

* For stations with 6 or more samples

Chapter 3: DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criteria Applicable to the TMDL

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

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

3.2 Interpretation of Narrative Nutrient Criterion

The Tidal Caloosahatchee River is classified as a Class III estuary 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 not a numeric criterion. Instead, the nutrient criterion is narrative and states 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.).

3.3 Relationship between Nutrients and Aquatic Flora and Fauna

Much research has been carried out in the Caloosahatchee Basin and southwest Florida on the observed relationships between submerged aquatic vegetation and nutrients (McPherson and Miller, 1987; Corbett and Hale, 2006; Janicki Environmental, 2003; Corbett, 2006; Corbett et al., 2005). Many research activities focused on the developed relationships between chl*a*, color, and turbidity, and the percentage of photosynthetically active radiation (PAR) reaching the seagrass meadows. The critical area of seagrass was determined to be the "media deep edge," and this became the target depth for the receipt of minimum PAR percentage consistent with a healthy meadow. That was shown to be 25 percent PAR (Corbett and Hale, 2006). The critical depth varied, depending on the bay, estuary, or riverbed in question (**Table 3.1**). It is the fact that TN is a function of chl*a* (and in some cases color, as shown in the sections below) that allows for the connection between TN and percent PAR.

Table 3.1. Seabed Depth Targets in Southwest Florida Waterbodies (Corbett and Hale, 2006)

Segment	Final Depth Target (meters)
Bokeelia	2.4
Pine Island Sound	2.2
Matlacha Pass	2.0
San Carlos Bay	2.2
Estero Bay	1.6
Tidal Caloosahatchee River	1.0

3.4 Relationship between DO, Nutrients, and BOD

An attempt was made to determine regression relationships between DO and potential causative pollutants as well as chl*a* and nutrients. Thus, an attempt was made to relate paired samples (where analyses for the parameters were made from sample[s] on the same date and approximate time). Observations were made for samples at the watershed level (the entire Tidal Caloosahatchee watershed), on a planning unit level (Tidal Caloosahatchee vs. Orange River vs. Telegraph Creek), on a WBID level, and on a sample station level. Temporally, the observations were attempted on a sample-by-sample basis, a monthly average basis, or a station average over the entire seven-year assessment period, plus intervening years. These attempts were generally unsuccessful.

As expected, the system is too large and varied to make any watershedwide observations on a sample-by-sample basis or by comparing averages over a larger time span. Differences in the watershed (accounting for the variability) include degrees of tidal influence, proximity to anthropogenic activities, and proximity to freshwater sources. There was no observed relationship between nutrients and chl*a* when evaluating the river on a sample-by-sample basis.

One can obtain a better understanding of the complexity and problems associated with developing relationships between chl*a* and potential causative pollutants by looking at **Figures 3.1** and **3.2**. These depict sample concentrations of conductance (reflecting salinity), TN, TP, DO, and BOD for sample stations in WBIDs 3240C and 3240A2. There are large fluctuations in salinity due to the moving interface between Gulf of Mexico tidal water and freshwater inflows over the S-79 structure and to a lesser extent, flows from the tributaries (**Figure 3.1**).

Figure 3.2 displays a sample station with more stable conductance yet wide fluctuations in DO. Because of these complications, computer modeling was used to simulate the Tidal Caloosahatchee and its tributaries. **Appendix H** contains a complete set of graphs showing the station concentration fluctuations with time.

Figure 3.1. Trends in Nutrients, DO, BOD, and Specific Conductance Concentrations in WBID 3240C

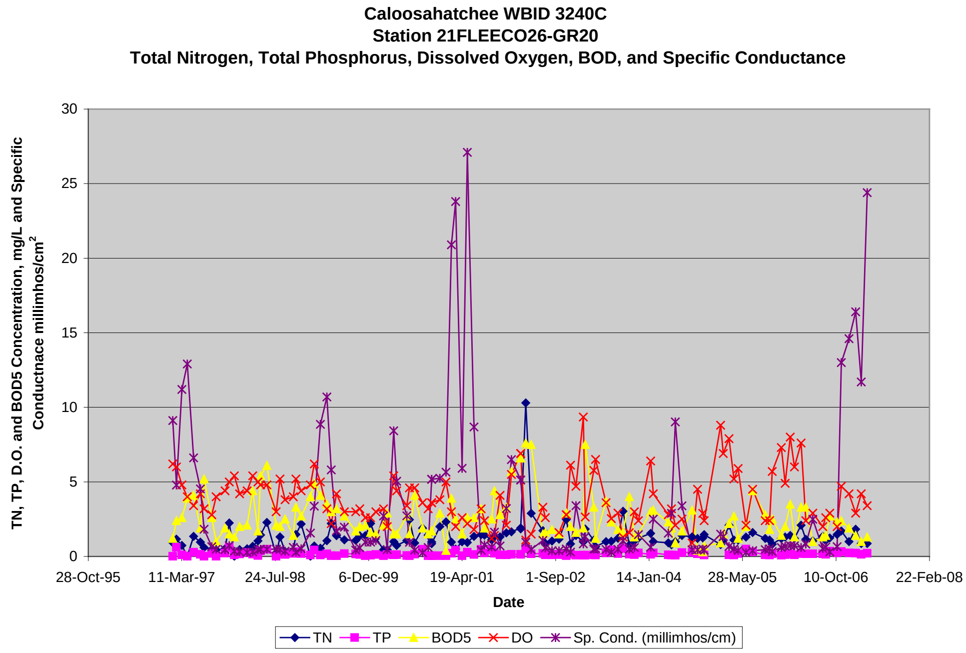
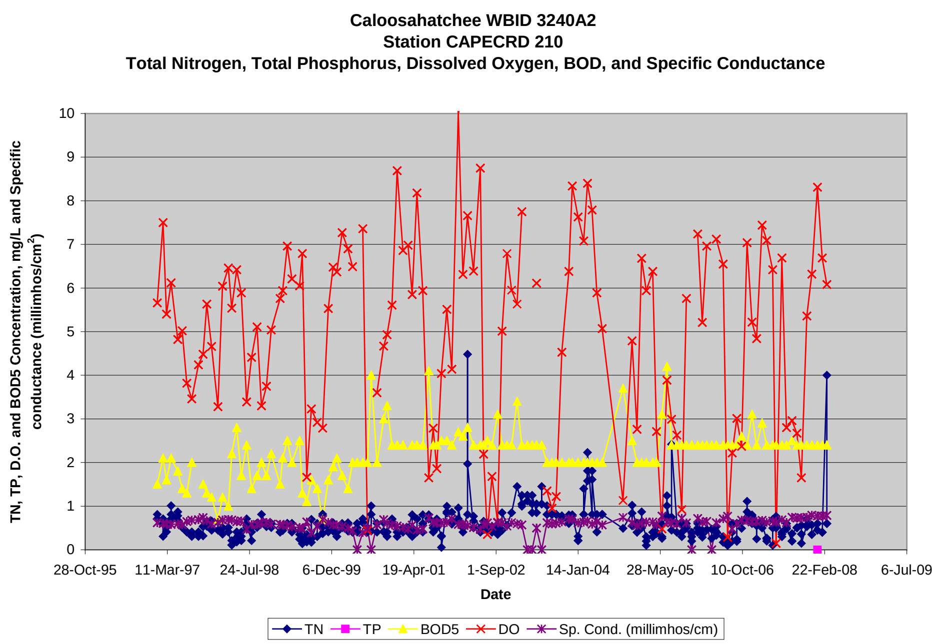


Figure 3.2. Trends in Nutrients, DO, BOD, and Specific Conductance Concentrations in WBID 3240A2



While it was not possible to observe trends in individual paired data points, it was possible to observe relationships for data averaged over long periods. To improve on these relationships, it was decided to divide the basin into regional groupings of WBIDs (shown in **Table 3.2** and **Figure 3.3**). The advantage of sorting stations into regions is that the area observed will face the same system fluctuations, such as salinity influxes. One disadvantage of dividing this data into regional groupings is that the reduced number of stations with which to develop a regression equation weakens the value of the any resultant correlation or regression equations. It is thus clear that additional data collection would increase confidence and help validate these observed relationships.

Figure 3.4 displays the relationships between sample station 10-year median concentrations (1997–2007) of TN vs. DO, chl*a*, TP, and color in the Tidal Caloosahatchee River. To permit these medians to have some degree of significance, all sample stations used required a minimum of 5 samples. Note that WBIDs 3240B2 and 3236 had no stations that met this requirement. Also, for WBIDs 3240A1 and A2 there were no color data. When looking at the remaining median station concentrations, the clearest relationship was between TN and color, with the second strongest relationship between TN and TP, and then TN and DO, with the TN–chl*a* relationship the poorest when making a basinwide observation.

Table 3.2. WBID Groups for Assessing Nutrient Relationships in the Tidal Caloosahatchee Watershed

WBID Group Number	WBIDs in Each Group
1	3240A and A1
2	3240A2
3	3240A4
4	3240B and B1
5	3240F, Q, M
6	3240C, 3240C1
7	3240E, E1, and L
8	3240H, I, J, and K
9	3240G, 3236A, and 3240N

Figures 3.4 through **3.13** display the graphs and regression relationships for the WBID groupings of **Table 3.2**. Note that color and apparent color were separated in the analyses but generally followed the same trend (**Figure 3.4**). In all WBID groups, the relationship between color and TN generally had the highest R^2, with Groups 1, 3, 6, and 9 performing the best. DO's correlation with TN was occasionally fair and exceeded that level only with Groups 6 and 9. Chl*a* and TP relationships with TN were strong with Groups 1, 3, and 9. Chl*a* was also strong with Group 6, and TP was good with Group 8. In all cases where there was good correlation with TP, chl*a*, or DO, there was also good correlation with color.

Figure 3.3. Locations of WBID Groupings Used in Regression Analyses

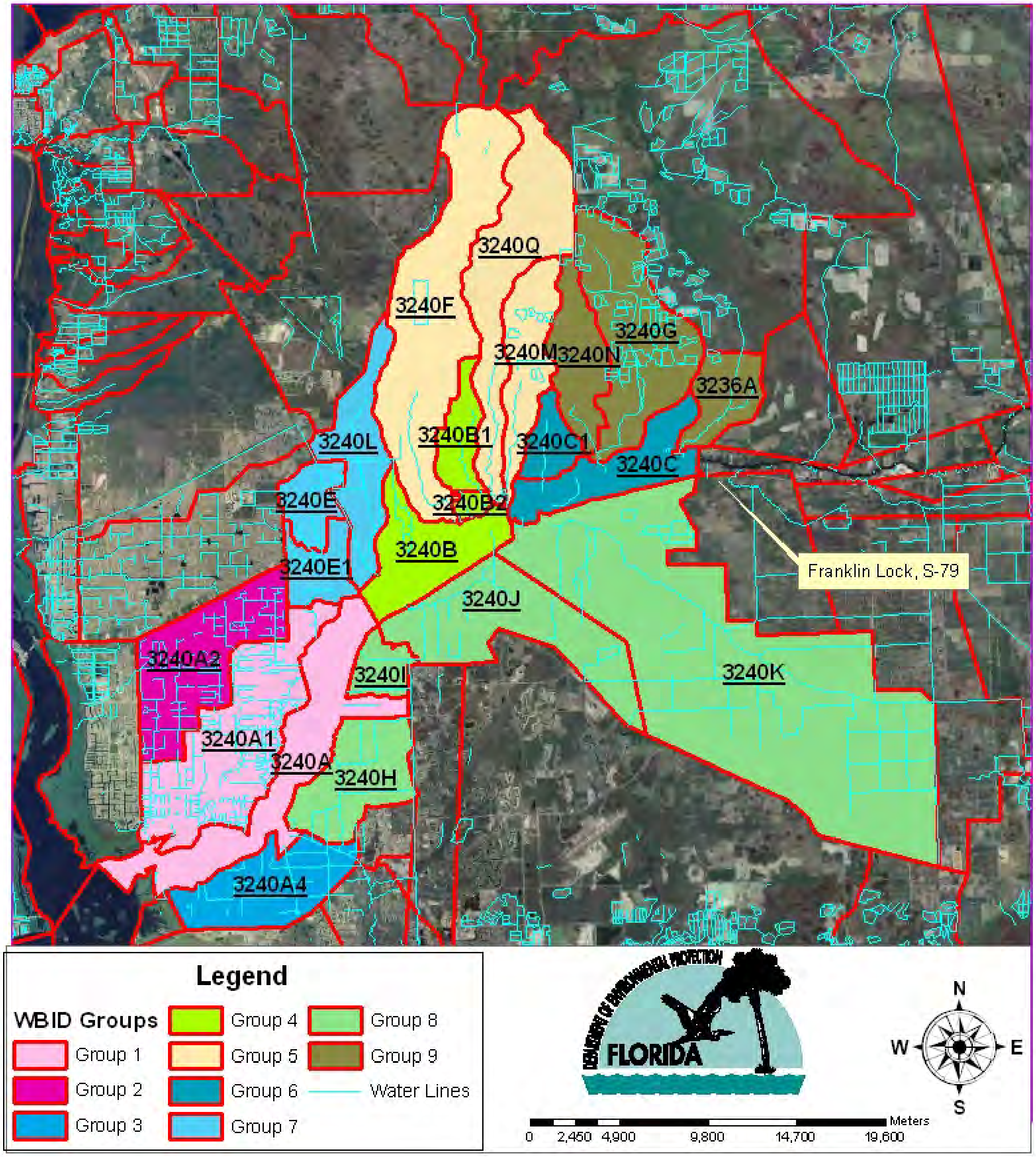


Figure 3.4. Correlation (WBID Groups 1 thru 9) between Sample Station Median TN and DO, BOD, Chl*a*, and Color

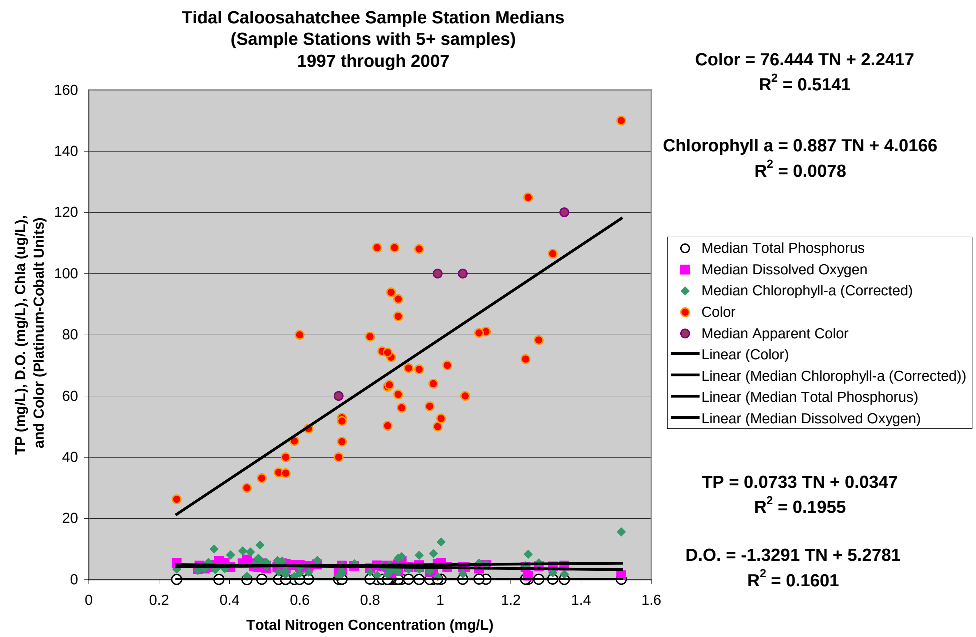


Figure 3.5. Group 1 WBIDs—Correlation between Sample Station Median TN and DO, TP, Chl*a*, and Color

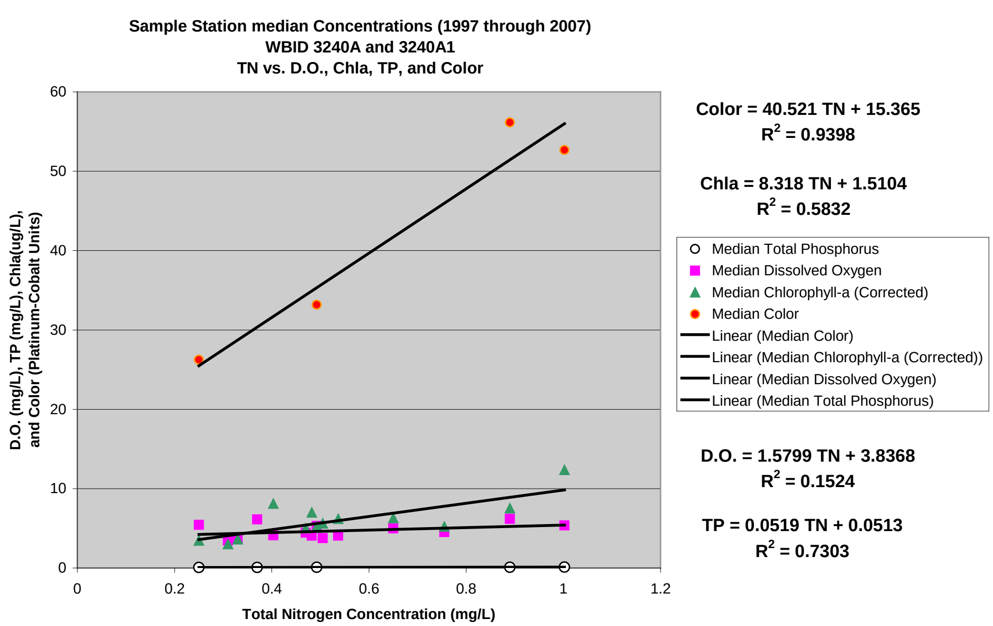


Figure 3.6. Group 2 WBIDs—Correlation between Sample Station Median TN and DO, TP, Chl*a*, and Color

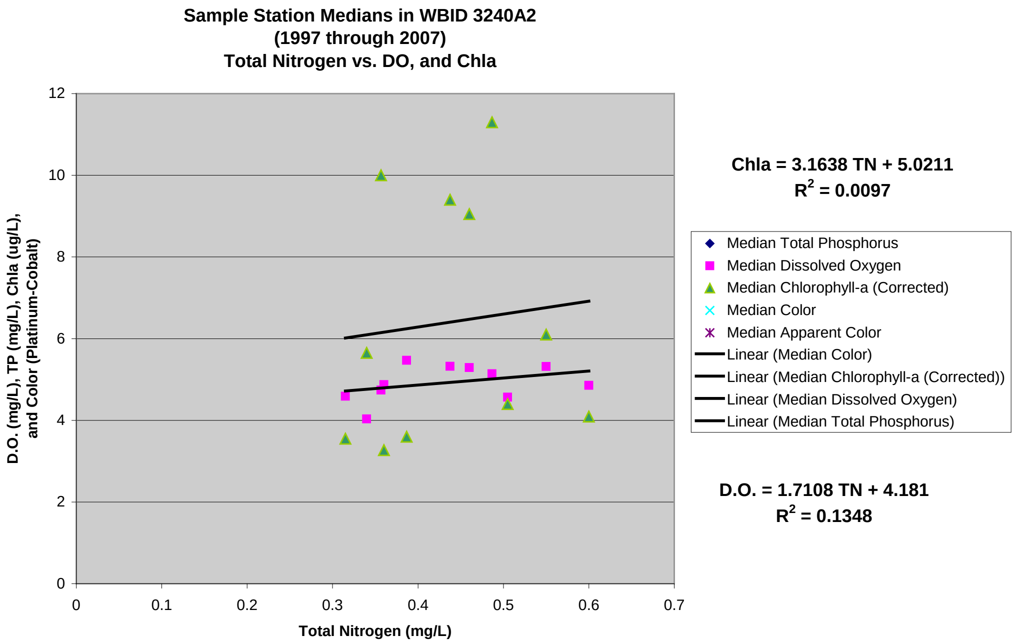


Figure 3.7. Group 3 WBIDs—Correlation between Sample Station Median TN and DO, TP, Chl*a*, and Color

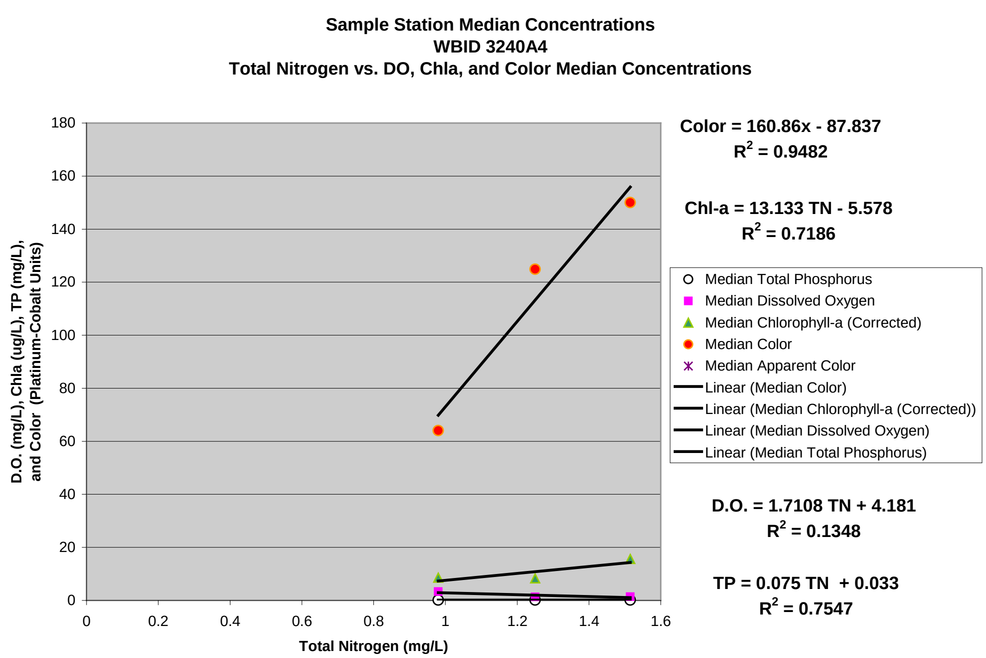


Figure 3.8. Group 4 WBIDs—Correlation between Sample Station Median TN and DO, TP, Chl*a*, and Color

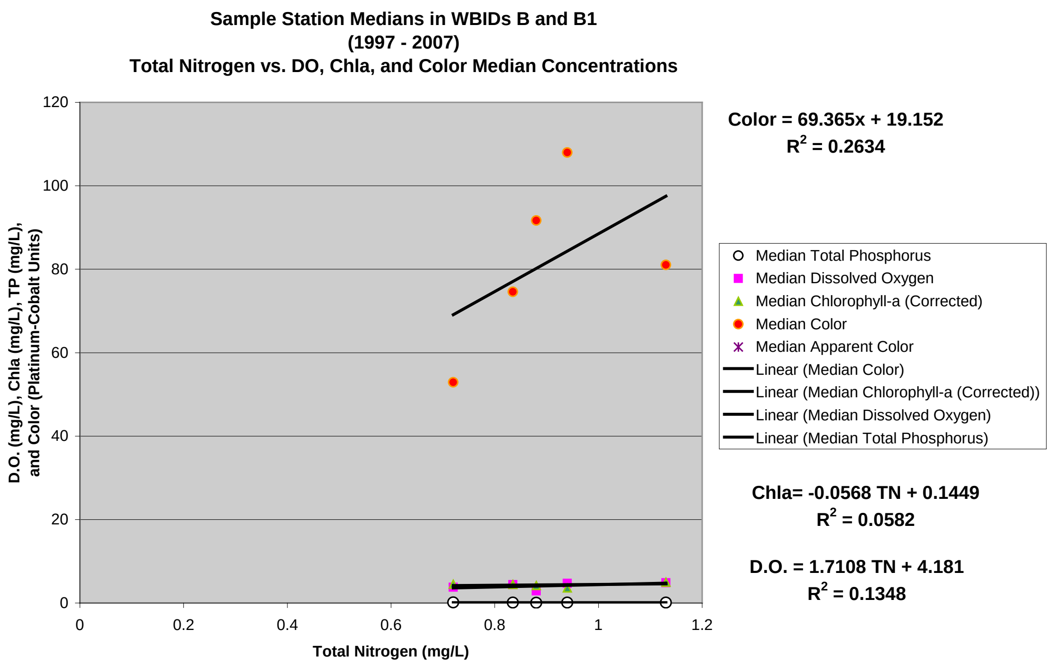


Figure 3.9. Group 5 WBIDs—Correlation between Sample Station Median TN and DO, TP, Chl*a*, and Color

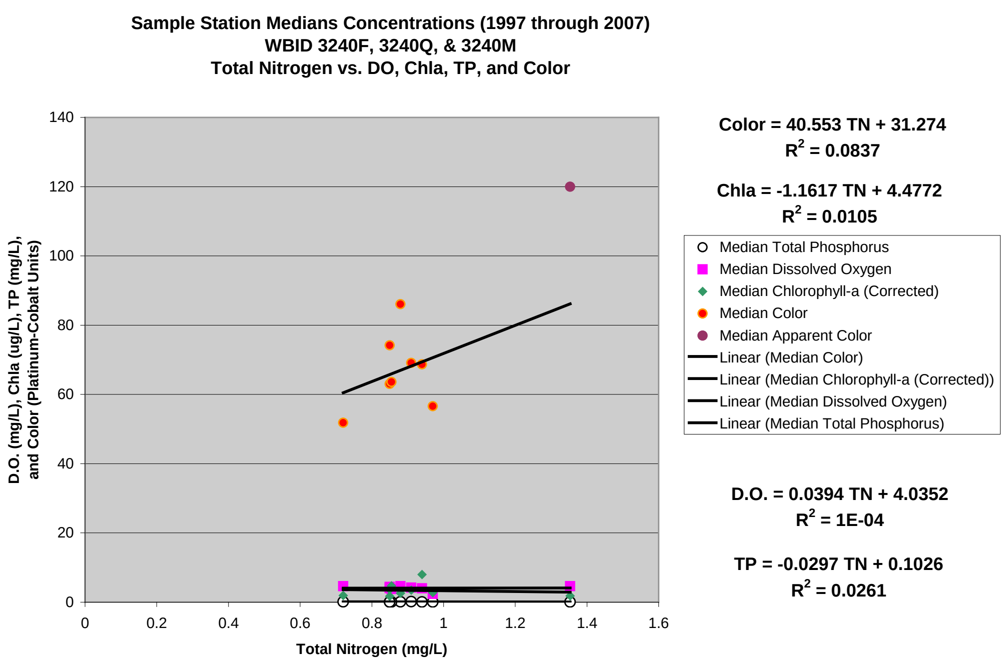


Figure 3.10. Group 6 WBIDs—Correlation between Sample Station Median TN and DO, TP, Chl*a*, and Color

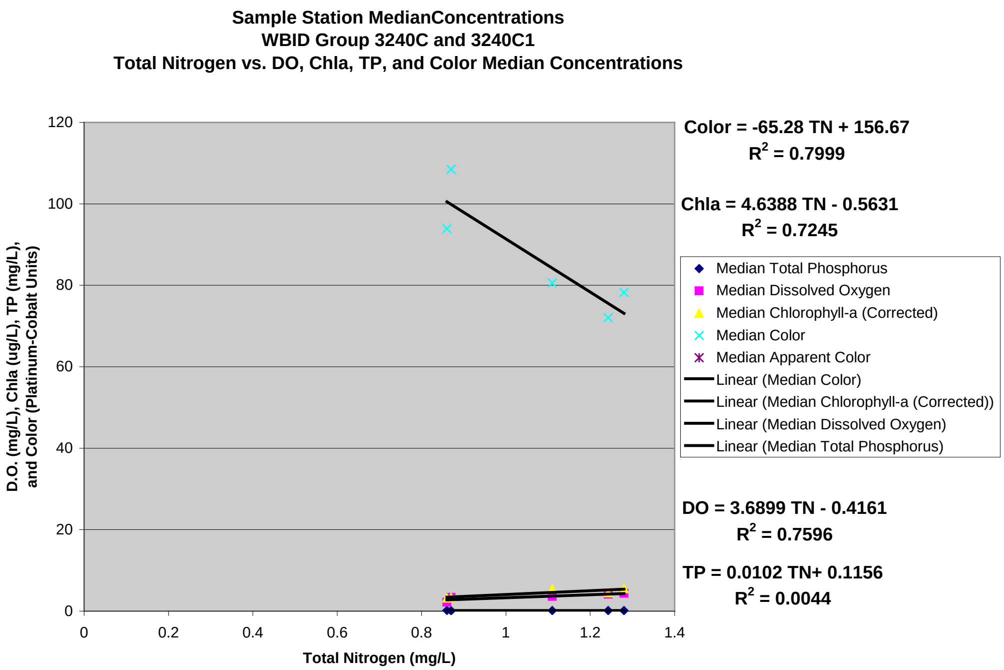


Figure 3.11. Group 7 WBIDs—Correlation between Sample Station Median TN and DO, TP, Chla, and Color

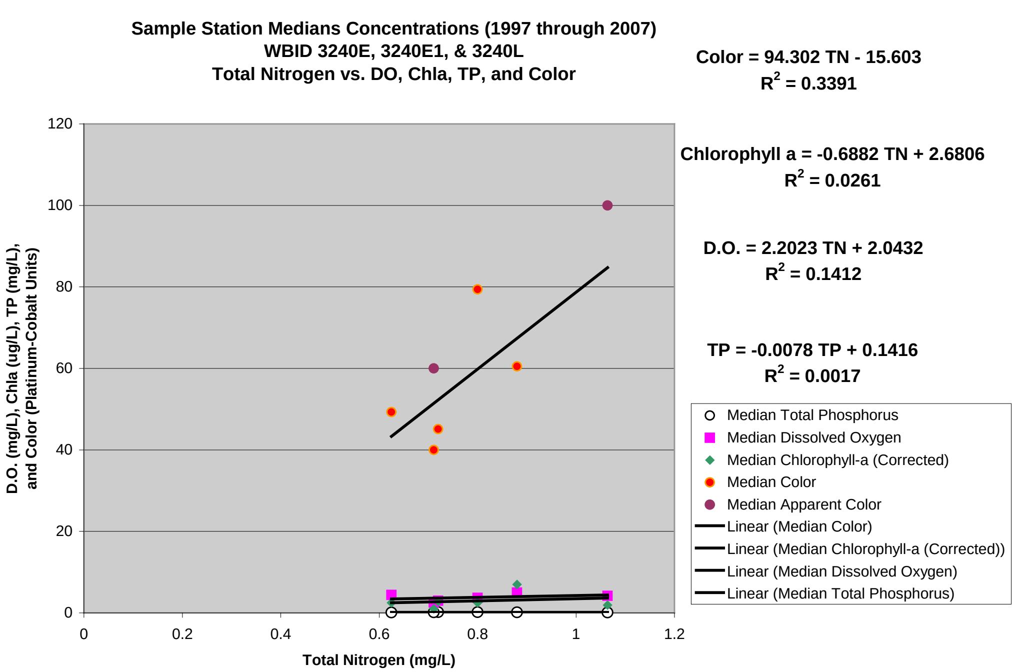


Figure 3.12. Group 8 WBIDs—Correlation between Sample Station Median TN and DO, TP, Chla, and Color

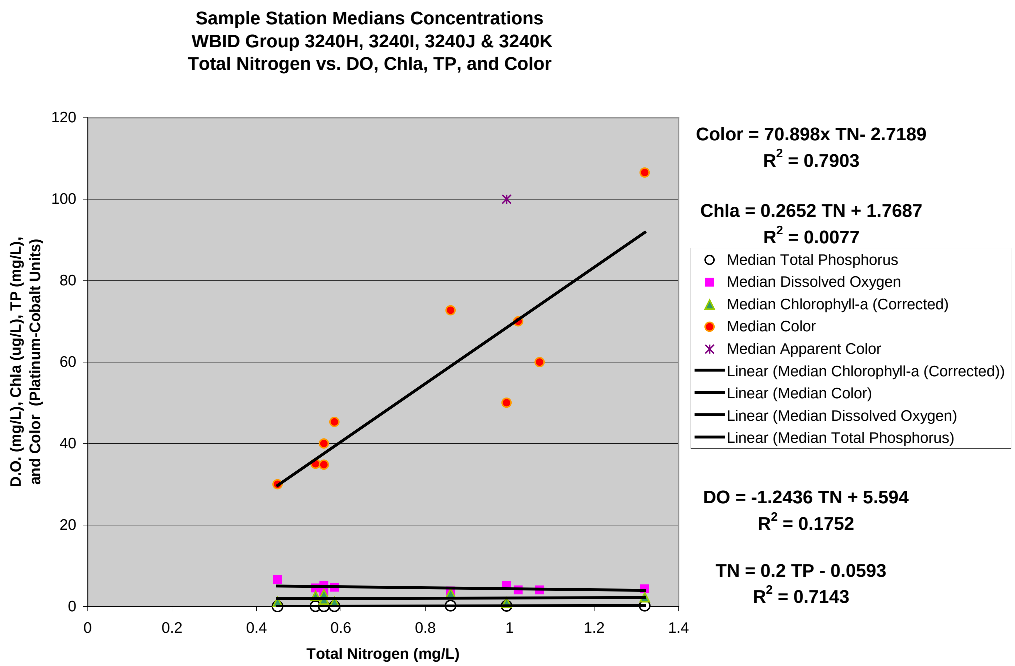
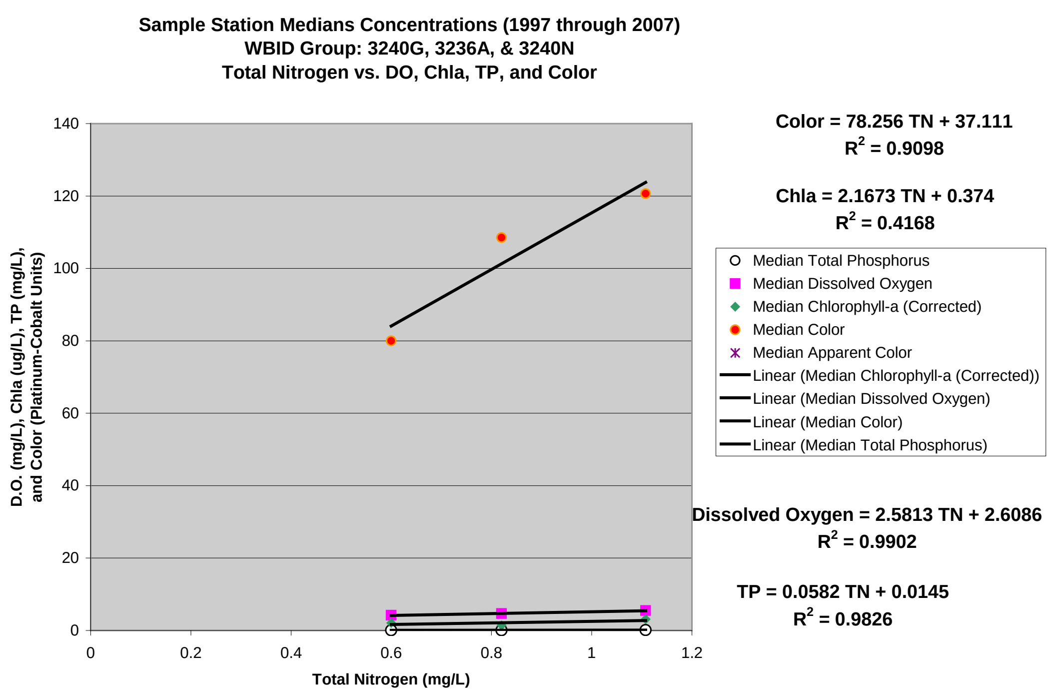


Figure 3.13. Group 9 WBIDs—Correlation between Sample Station Median TN and DO, TP, Chla, and Color



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 nutrients and low DO 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, such as 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 Sources of Nutrients in the Tidal Caloosahatchee River and Tributaries Watershed

4.2.1 Point Sources

Six domestic wastewater treatment facilities are permitted to discharge treated wastewater to the Tidal Caloosahatchee River (**Table 4.1a**). **Table 4.1b** shows the annual nitrogen load resulting from these treatment plants. All meet advanced wastewater treatment (AWT) standards (Section 403.086, F.S.) for nitrogen and provide more stringent phosphorus removal. All offer secondary treatment with additional nutrient removal; some have high-level disinfection and or dechlorination for public access reuse, which is used for urban irrigation. (Note in **Table 4.1b** that a very high percentage of the permitted water for urban reuse is in actuality being used for that purpose.)

Table 4.1a. Tidal Caloosahatchee River Domestic WWTF Discharges

[1] The Average Daily Flow column is the average daily flow (in MGD), averaged on an annual basis, being treated and discharged from the facility (including all disposal types).
[2] The Surface Water Discharge column describes the average daily flow (in MGD) being discharged to the Tidal Caloosahatchee River.
[3] The Reuse Systems Disposal column describes the average daily flow (in MGD) being sent to a reuse system.

Facility Name	NPDES Permit No.	Permitted Flow (MGD)	Year	Average Daily Flow (MGD)[1]	Surface Water Discharge (MGD)[2]	Reuse Systems Disposal (MGD)[3]
Ft. Myers Central	FL0021261	11	2005–07	6.809	5.899	0.91
Ft. Myers South	FL0021270	12	2005–07	8.866	8.866	0
City of Cape Coral	FL0030007	15.1	2005–07	9.405 + deep well injection	3.899	5.506
Waterway Estates	FL0030325	1.25	2005–07	1.07	0.987	0.086
Fiesta Village	FL0039829	5	2005–07	2.89	1.885	1.005

Table 4.1b. Tidal Caloosahatchee River Domestic WWTF Annual Nitrogen Loads

Treatment Facility	Permitted to Caloosahatchee			Permitted to Reuse			Actual Average to Caloosahatchee River		Actual Average To Reuse	
	Flow in Million Gallons	TN Concent. Mg/L	TN Load (LBS)	Flow in Million Gallons	TN Concent. Mg/L	TN Load (LBS)	Flow in Million Gallons	TN Load (LBS)	Flow in Million Gallons	TN Load (LBS)
Fort Myers Central WWTP (FL0021261)	4,015	2.77	92,487	546	2.77	12,612	2,153	49,598	332	7,651
Fort Myers South WWTP (FL0021270)	4,380	2.77	100,895				3,243	74,713		
City of Cape Coral (FL0030007)	5,512	0.47	21,542	10,731	0.47	41,942	1,420	5,550	2,011	7,860
Waterway Estates in North Fort Myers (FL0030325)	456	0.47	1,783	37	0.47	1,355	360	1,408	31	118
Fiesta Village WWTF (FL0039839)	1,825	2.77	42,039	734	2.77	16,900	686	15,807	369	8,492
Total	16,188		258,746	12,048		72,809	7,862	147,076	2,736	23,952

All capacities listed in this section are in annual average daily flow, except those shown for Waterway Estates, which uses both annual average and maximum monthly daily flow.

Fort Myers Central WWTP (FL0021261) has a permitted treatment capacity of 11 million gallons per day (MGD). This facility has two disposal methods for the treated effluent:

- *11 MGD permitted surface water discharge (Caloosahatchee River); and*
- *1.5 MGD public access reuse system. The reuse system has a planned expansion up to 6 MGD in this permit cycle (by 2011).*

Fort Myers South WWTP (FL0021270) has a permitted treatment capacity of 12 MGD. This facility has one disposal method for the treated effluent:

- *12 MGD permitted surface water discharge (Caloosahatchee River).*

Fiesta Village WWTF (FL0039829) has a permitted treatment capacity of 5 MGD. This facility has two disposal methods for the treated effluent:

- *5 MGD permitted surface water discharge (Caloosahatchee River); and*
- *2.01 MGD public access reuse system.*

This facility is also permitted for intermittent discharges from reuse storage/stormwater ponds. These indirect discharges occur only during high-water events.

Waterway Estates in North Ft. Myers WWTF (FL0030325) has a permitted treatment capacity of 1.25 MGD. This facility has two disposal methods for the treated effluent:

- *1 MGD surface water discharge (Caloosahatchee River).*
- *0.95 MGD public access reuse system.*

Unlike other facilities, this facility has a maximum of 1.5 MGD for both capacity and reuse disposal if measured by maximum monthly daily flow as opposed to annual average daily flow.

The **City of Cape Coral (FL0030007)** operates two WWTFs under one collective permit. **Everest WWTF** has a permitted treatment capacity of 8.5 MGD and is currently expanding to a capacity of 13.4 MGD. **Southwest WWTF** has a permitted treatment capacity of 6.6 MGD and is currently expanding to 15.0 MGD. The facilities use 3 methods for the disposal of treated effluent:

- *15.1 MGD capacity surface water discharge (shared–Caloosahatchee River);*
- *29.4 MGD public access reuse system (shared); and*
- *Independent underground injection wells.*

Everest WWTF uses a 3.35 MGD underground injection well. **Southwest WWTF** uses a 3.75 MGD underground injection well that is currently under expansion to 9.6 MGD. When Southwest WWTF completes the expansion to its injection well, it will disconnect from the river outfall and function under an independent permit.

4.2.2 Municipal Separate Storm Sewer System Permittees

The stormwater collection systems are owned and operated by Lee County and co-permittees (city of Cape Coral, city of Fort Myers, town of Fort Myers Beach, and city of Sanibel), all on municipal separate storm sewer (MS4) Phase I Permit FLS000035. As shown in **Table 4.2**, Charlotte County, which has population areas in the northern portions of some Tidal Caloosahatchee WBIDs, is covered by a separate NPDES MS4 (Phase II) permit (FLR04E043).

Table 4.2. MS4 Permittees in the Tidal Caloosahatchee Watershed

County	Name	Permit ID Number	MS4 Type
Lee	Lee County Board of County Commissioners	FLS000035	Phase I
Lee	City of Fort Myers	FLS000035	Phase I
Lee	City of Sanibel	FLS000035	Phase I
Lee	City of Cape Coral	FLS000035	Phase I
Lee	Town of Fort Myers Beach	FLS000035	Phase I
Charlotte	Charlotte County	FLR04E043	Phase II

Land Uses

Land use categories for the Tidal Caloosahatchee watershed were aggregated using both the simplified Level 1 codes as well as the more detailed Level 2 codes. **Table 4.3** displays both Level 1 and Level 2 land uses for the entire Tidal Caloosahatchee (including the Caloosahatchee Estuary and all sub-basins draining into it). **Appendix F** provides the Level 1 and Level 2 land uses for the individual WBIDs in the Tidal Caloosahatchee watershed. The largest Level 1 land use in Tidal Caloosahatchee is urban and built-up (41 percent). Based on Level 2, urban and built-up land uses comprise (in order of highest to lowest percentage) low-density residential (15 percent), medium-density residential (9.3 percent), open land (8.2 percent), high-density residential (3.3 percent), commercial (2.4 percent), recreation (1.3 percent), institutional (0.9 percent), extractive (0.4 percent), and industrial (0.2 percent).

The remaining Level 1 land uses with over 10 percent of land acreage in the Tidal Caloosahatchee watershed include wetland (14.6 percent), agriculture (14.3 percent), and upland forests (13.2 percent). "Wetland" constitutes the highest percentage of undeveloped land use, indicative of the fact that much of the sub-basin was developed around a wetland, where it is not uncommon for DO concentrations to be naturally low.

4.3 Flow Monitoring

4.3.1 Flow at the Control Structures

A substantial amount of flow into the Caloosahatchee River comes from Lake Okeechobee via S-77, where the river originates in south central Florida. The fresh water coming into the Caloosahatchee River from Lake Okeechobee contributes to a delicate balance required for aquatic life in the estuary. **Figure 4.1** summarizes flow into the Caloosahatchee Estuary at various points between the lake and the estuary. Although a majority of the flow from S-79 into the Tidal Caloosahatchee comes from Lake Okeechobee, the figure shows that the watershed discharging into the river between S-78 and S-79 also contributes a substantial amount. Also, as expected, a review of the flow from 1995 to 2005 shows that most of the flow into the Caloosahatchee Estuary occurs during the second and third quarters, which include those months with the highest rainfall. The range in total quarterly flow over S-79 during that 10-year period ranged from a minimum of no recorded flow to a maximum total flow of over 500 billion gallons.

Table 4.3. Level 1 and 2 Land Uses in the Tidal Caloosahatchee Watershed

WBIDs in Tidal Caloosahatchee Level 1 Analysis			WBIDs in Tidal Caloosahatchee Level 2 Analysis		
Landuse Code and Description	Acres	% Total	Landuse Code and Description	Acres	% Total
1000: Urban and Built up	120,945	41.3%	1100: Residential, Low Density	44,815	15.3%
6000: Wetland	42,719	14.6%	2100: Cropland and Pastureland	37,131	12.7%
2000: Agriculture	41,745	14.3%	4100: Upland Coniferous	32,673	11.2%
4000: Upland Forests	38,562	13.2%	1200: Residential, Medium Density	27,172	9.3%
5000: Water	25,668	8.8%	1900: Openland	23,857	8.2%
3000: Rangeland	18,724	6.4%	5100: Streams and Waterways	21,279	7.3%
8000: Transportation, Communication, & Utilities	3,676	1.3%	6200: Wetland Coniferous Forests	17,019	5.8%
7000: Barren Land	685	0.2%	6400: Vegetated Nonforested Wetlands	15,807	5.4%
Total	**292,724**	**100%**	3200: Shrub and Brushland	14,083	4.8%
			1300: Residential, High Density	9,546	3.3%
			6100: Wetland hardwood forests	9,310	3.2%
			1400: Commercial	7,128	2.4%
			1800: Recreation	3,759	1.3%
			3100: Herbaceous	3,681	1.3%
			4200: Upland Hardwood	3,109	1.1%
			5300: Reservoirs	2,843	1.0%
			8100: Transportation	2,828	1.0%
			1700: Institutional	2,717	0.9%
			2200: Treecrops	2,194	0.7%
			4300: Upland Mixed Forest	1,668	0.6%
			2600: Other Open Lands	1,662	0.6%
			1600: Extractive (Mining)	1,292	0.4%
			4400: Tree Plantations	1,112	0.4%
			5200: Lakes	968	0.3%
			3300: Mixed Rangeland	960	0.3%
			8300: Utilities	800	0.3%
			7400: Disturbed land	685	0.2%
			1500: Industrial	658	0.2%
			5400: Bays and Estruaries	578	0.2%
			6300: Wetland Forest Mixed	551	0.2%
			2400: Nurseries and Vineyards	531	0.2%
			2500: Specialty Farms	228	0.1%
			8200: Communication	48	0.02%
			6500: Non Vegetated Wetlands	32	0.01%
			Total	**292,724**	**100%**

4.3.2 Flow Monitoring at Tributaries

During most of the 10-year period described in the previous section, there was no regular flow monitoring for most tributaries flowing into the Caloosahatchee River. In an effort to learn more about tributary flow, and to support future model calibration, the Department initiated the monitoring of several tributaries. This monitoring was carried out by Department staff, who used Marsh-McBirney electromagnetic flow meters during field visits and, more importantly, through a multiyear contract with the U.S. Geological Survey (USGS) to place flow instruments at sites on five tributaries for continuous monitoring.

Table 4.4 shows the results of the flows measured with the Marsh-McBirney meters (through a series of instantaneous readouts taken while staff waded through streams). These monitoring events occurred between June and October 2007. The results of the USGS-contracted monitoring were not available when this TMDL was being developed.

The information should be available in 2009 as rating curve data are collected that will permit the monitored velocities to be converted into flow.

Figure 4.1. Quarterly Total Flow at Control Structures in the Caloosahatchee River

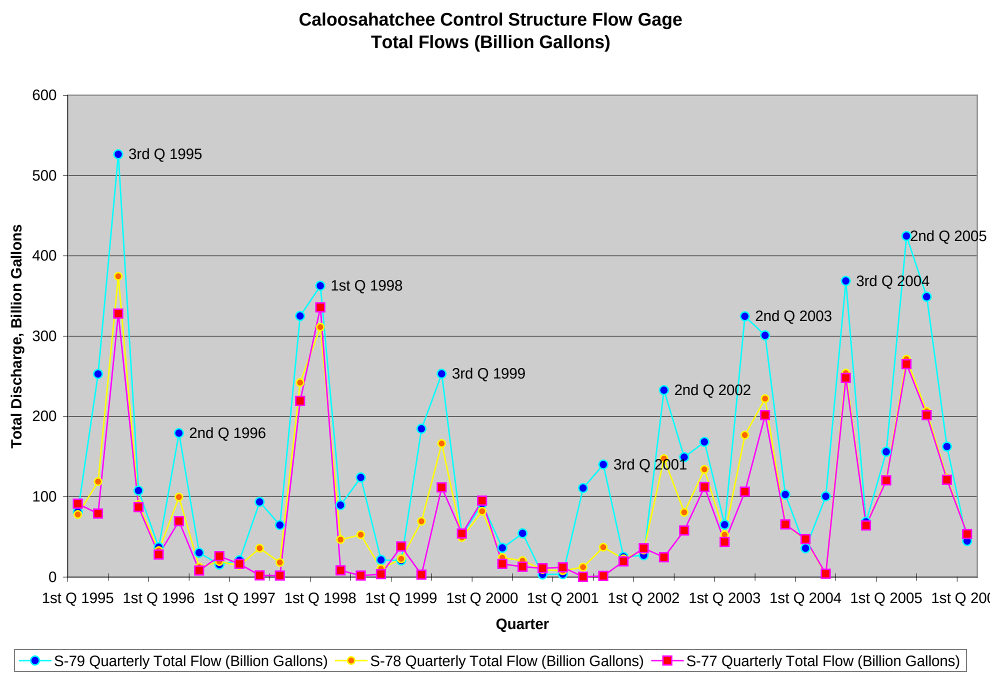


Table 4.4. Flow Measurements of the Caloosahatchee River by Department Staff Using Marsh-McBirney Flow Meter and Wading Rod

	Site	Flow, in cubic feet per second (cfs)								
		Jun 19 2007	Jul 24 2007	Jul 25 2007	Oct 8 2007	Oct 11 2007	Oct 16 2007	Oct 23 2007	Oct 25 2007	Oct 30 2007
1	Manuel Branch				3.6	1.45	1.28	1.65	2.22	2.39
2	Stroud Creek		2		11.1	7.6	3.8	0.36	1.43	2.12
3	Powell Creek				21	15.6	11.38	8.7	8.84	7.6
	at Valencia			2.15						
	at Bayshore		3.55							
	at Marianna/Whidden		6.16							
4	Owl Creek				1.3	0.55	0.29	0.18	0.43	0.25
5	Yellow Fever				11	10.2	8.6	6.7	7.5	8
6	Billy Creek									
	at Marsh			0.57						
	at SR 365	0.21								
	at Ortiz			0.33						
7	Popash									
	at Henderson Grade		1.19							
	at Pritchett 7 I-75		1.56							

4.4 Computer Modeling of Caloosahatchee River Hydrology and Water Quality

Modeling for the Caloosahatchee TMDL was done through use of the watershed model *Hydrological Simulation Model Fortran* (HSPF) linked to a hydrodynamic model *Environmental Fluid Dynamics Code* (EFDC). Both HSPF and EFDC were selected after assessing several other capable and established models that could simulate the Caloosahatchee Basin. All modeling was set up, calibrated, and validated by Dynamic Solution (DSLLC) and Camp Dresser McKee (CDM). CDM and DSLLC also performed the bulk of the simulations, with several simulations, including those used to develop the TMDL, carried out by Department staff.

4.4.1 HSPF

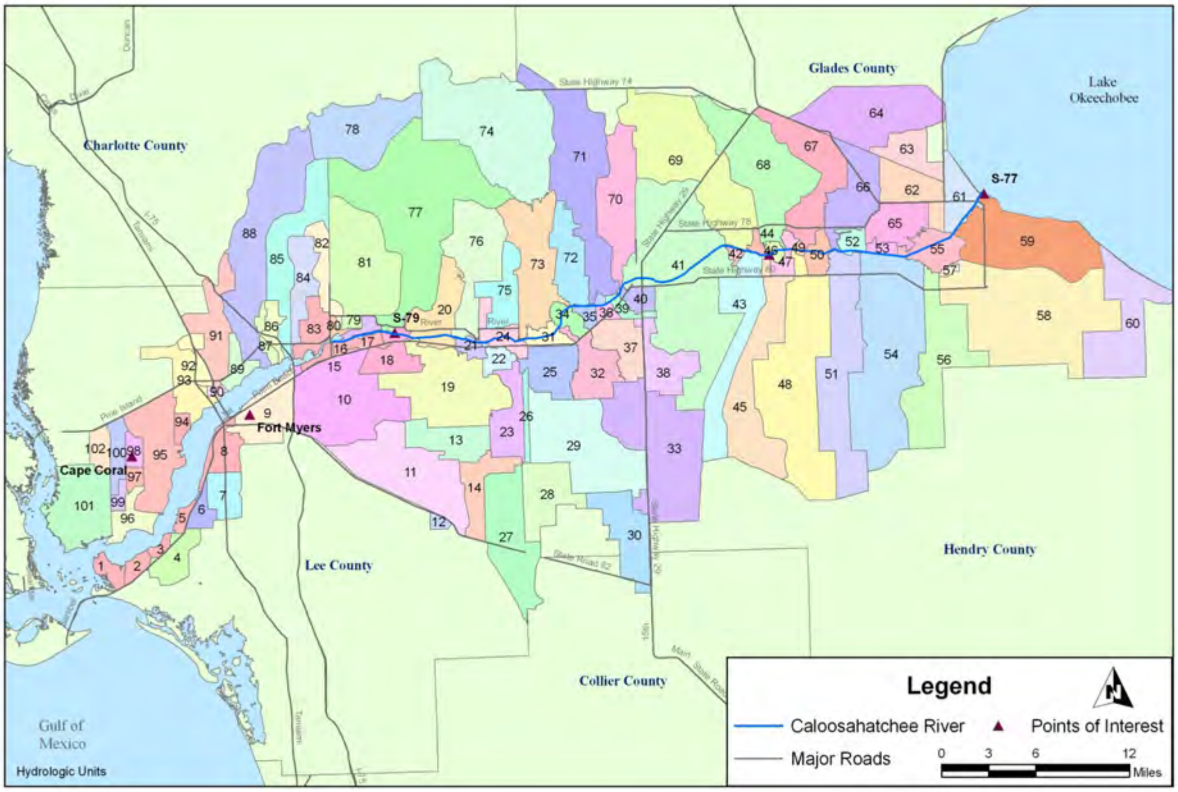
HSPF is supported by the EPA and USGS. It is primarily a lumped parameter watershed runoff model; thus, for each sub-basin, it uses "basin average" input data where soil, land use, and topographic parameters are averaged to create a spatially averaged area. The model is distributive, as "lumped parameter" sub-basins are connected by reaches that simulate tributaries throughout the basin. For the Caloosahatchee River simulation, the Caloosahatchee Basin was divided into 102 such "lumped parameter" sub-basins linked to each other or the Caloosahatchee River via "reaches" (simulating tributaries) or the C-43 Canal (**Figure 4.2**). The Caloosahatchee Estuary downstream of S-79 was simulated using the three-dimensional (3D) grid model, EFDC.

Many initial model parameters are assigned based on the modeler's knowledge of the watershed as well as literature values, and are further refined through the calibration and validation process. HSPF simulates watershed hydrology and nonpoint source pollutant loadings for organic matter, nutrients, sediments, bacteria, and toxic chemicals within a watershed network of delineated sub-basins. For the Caloosahatchee, the HSPF Model was used to simulate flow and the following water quality constituents:

1. *Water temperature;*
2. *Total suspended solids (TSS);*
3. *5-day biochemical oxygen demand (BOD_5) from ultimate BOD (UBOD);*
4. *Nitrogen (TN, total Kjeldahl nitrogen [TKN], nitrate+nitrite [NO_2+NO_3], organic N, free/ionized ammonia [NH_3/NH_4]);*
5. *Phosphorus (TP, organic P, orthophosphate);*
6. *Phytoplankton (as chla); and*
7. *DO.*

HSPF, developed in the late 1970s, has attained widespread use over the past 30 years. The model routes flow and water quality characteristics through a network of river reaches and sub-basins in the watershed experiencing climatic and precipitation events occurring over a period of minutes or many years. The time steps (the period between the recalculation of system variables) vary between minutes and days. The model has

Figure 4.2. Hydrologic Units for HSPF Modeling of the Caloosahatchee Basin



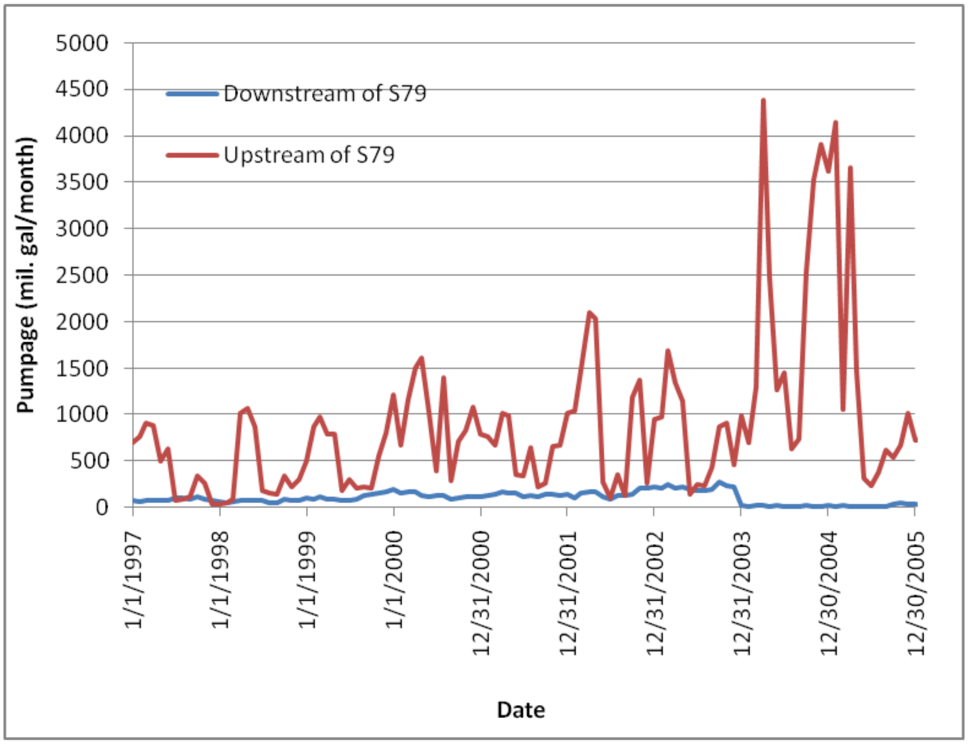
the capability of allowing the user to evaluate an array of agricultural and urban BMPs. It can simulate the following hydrologic processes:

1. *Evaporation;*
2. *Water withdrawals;*
3. *Irrigation;*
4. *Diversions;*
5. *Wastewater discharges;*
6. *Infiltration; and*
7. *Active and deep ground water reservoir storage (**Figure 4.3**).*

HSPF Modeling of Precipitation and Flow

As previously stated, the HSPF Model divides the Caloosahatchee Basin into 102 sub-basins. Time series input data (e.g., rainfall, temperature, and observed flow) were analyzed in Microsoft Excel to perform data quality checks and to estimate data for missing values. Processed time series data were stored in a WDM format for efficient use by the model. Initial model parameters were selected based on literature values.

Figure 4.3. Cumulative Historical Ground Water Pumpage Rates in Areas Upstream and Downstream of S-79



Meteorological data were used to route nonpoint sources through tributary and upstream Caloosahatchee reaches. The sources of the Caloosahatchee Basin hourly precipitation data for the January 1996 through December 2006 simulation periods were Lee County, SFWMD, and National Oceanic and Atmospheric Administration (NOAA) rain gages located in the basin. It was decided that it would be optimal to use precipitation data derived from **NEX**t Generation **RAD**ar (NEXRAD) data, which could compensate for missing data at the precipitation gages, the large watershed area, and significant spatial variation in storm intensity. NOAA's National Weather Service (NWS) maintains 159 Weather Surveillance Radar-1988 Doppler (WSR-88D) sites throughout the United States and some overseas locations that comprise the NEXRAD network.

From three meteorological base data quantities (reflectivity, mean radial velocity, and spectrum width), hourly precipitation data were computed on a seamless 1.1 x 1.1 nautical mile grid. The time series data for all the grid cells located in the Caloosahatchee Basin were obtained and aggregated into 15 area-weighted precipitation time series representing different parts of the basin. Fifteen time series were selected to attain the maximum spatial resolution in precipitation data without exceeding the model limits for the total number of operations in one model. These areas were defined by grouping multiple hydrologic units, as shown in **Figure 4.4**. **Table 4.5** lists the total annual precipitation and variability for each NEXRAD precipitation zone. Precipitation is higher near the coast and gradually decreases towards Lake Okeechobee. The NEXRAD data were compared with the closest hourly NOAA NWS stations.

Figure 4.4. Precipitation Zones Developed from Hourly NEXRAD Data

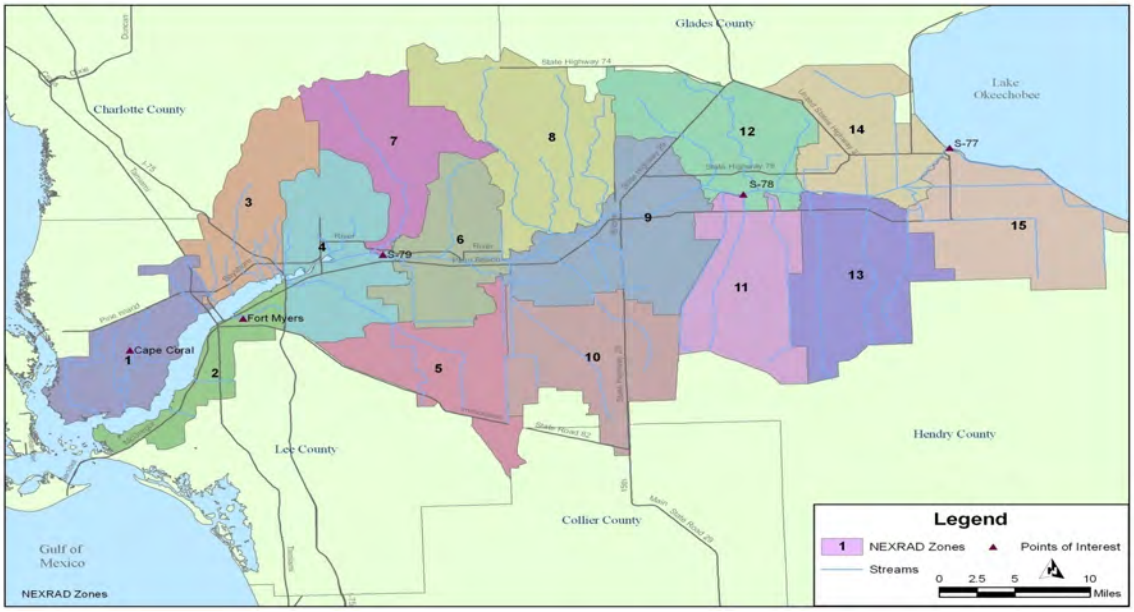


Table 4.5. Total Precipitation (in Inches) by NEXRAD Zone (DSLLC, 2008), 1997–2005

Location	1997	1998	1999	2000	2001	2002	2003	2004	2005
NEXRAD Zone 01	69.0	67.6	69.1	58.9	64.1	83.8	80.4	61.9	75.6
NEXRAD Zone 02	68.1	65.0	69.0	54.8	62.7	76.5	79.1	63.9	80.6
NEXRAD Zone 03	59.8	63.4	66.0	41.5	50.2	66.1	70.0	54.4	67.8
NEXRAD Zone 04	61.6	64.9	61.5	42.2	53.3	70.7	69.5	55.1	70.3
NEXRAD Zone 05	59.0	59.4	63.1	58.3	66.2	64.9	72.7	55.0	68.8
NEXRAD Zone 06	63.8	65.1	63.0	44.6	59.3	69.7	69.3	57.2	73.4
NEXRAD Zone 07	64.7	64.1	60.4	42.9	54.1	71.6	64.7	53.6	67.1
NEXRAD Zone 08	62.6	58.9	58.3	40.8	55.6	67.2	60.3	50.8	65.8
NEXRAD Zone 09	56.4	61.8	60.2	41.7	57.2	69.6	65.8	47.4	69.8
NEXRAD Zone 10	51.0	54.8	65.5	58.1	69.1	62.5	60.2	48.0	68.1
NEXRAD Zone 11	45.6	54.4	59.6	40.7	57.9	59.9	61.1	43.1	71.5
NEXRAD Zone 12	53.8	52.6	57.9	37.1	49.2	65.9	65.3	45.4	65.3
NEXRAD Zone 13	45.4	54.0	57.3	39.6	51.5	56.5	56.2	43.6	67.6
NEXRAD Zone 14	49.8	56.9	58.2	33.8	44.9	53.0	56.4	39.3	59.2
NEXRAD Zone 15	47.1	56.5	59.0	36.6	47.8	50.0	53.0	49.5	62.6
Average	***57.2***	***60.0***	***61.9***	***44.8***	***56.2***	***65.9***	***65.6***	***51.2***	***68.9***
Minimum	***45.4***	***52.6***	***57.3***	***33.8***	***44.9***	***50.0***	***53.0***	***39.3***	***59.2***
Maximum	***69.0***	***67.6***	***69.1***	***58.9***	***69.1***	***83.8***	***80.4***	***63.9***	***80.6***
Standard Deviation	***8.0***	***4.9***	***3.9***	***8.4***	***7.1***	***8.8***	***8.0***	***7.0***	***5.2***

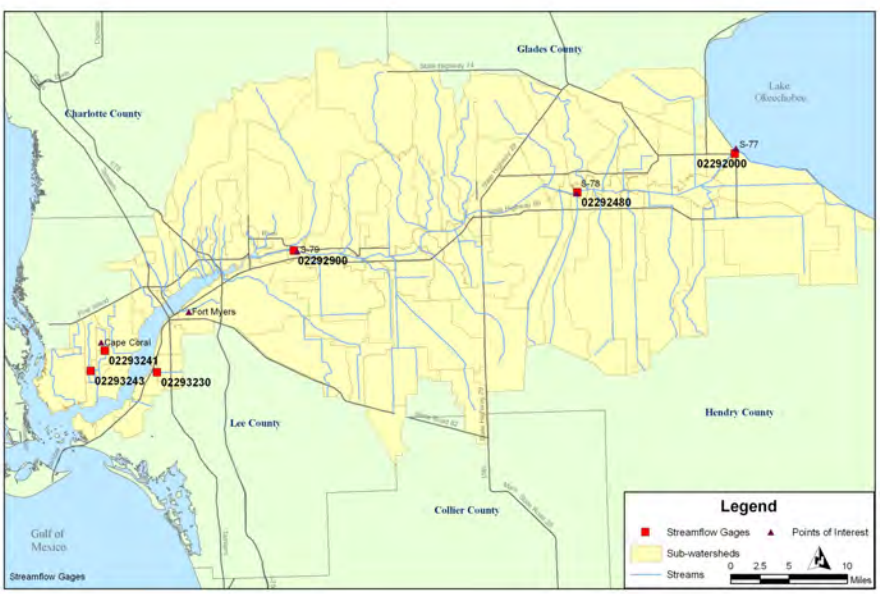
The determination of nonpoint source loading requires an estimation of stream flow rate as well as the pollutant concentration. The rather limited continuous flow monitoring data for the Tidal Caloosahatchee River generally were collected at the control structures of the riverine portion, also known as the C-43 Canal. These primary flow data sites are at the S-77, S-78, and S-79 control structures.

The two USGS gages on the main stem of the Caloosahatchee River and three USGS gages on small tributaries in Ft. Myers and the city of Cape Coral that have long-term flow data were used in the calibration and validation of the computer models. These gages are at the following locations:

- *Caloosahatchee River at S-79, near Olga (02292900);*
- *Caloosahatchee Canal at Ortona Lock, near La Belle (02292480);*
- *Whiskey Creek at Ft. Myers (02293230);*
- *San Carlos Canal at Cape Coral (02293241); and*
- *Courtney Canal at Cape Coral (02293243).*

Figure 4.5 shows the locations of these gages. The daily average flow from the gages at S-79, S-78 (Ortona Lock), and San Carlos Canal was used to calibrate and validate the model.

Figure 4.5. Flow Gages in the Caloosahatchee Basin with Long-Term Daily Flow Records



The quality of daily flow data recorded at the San Carlos Canal and Courtney Canal gages is considered poor by USGS (http://pubs.usgs.gov/wdr/2004/wdr-fl-04-2a/pdf/p344-345.pdf and http://pubs.usgs.gov/wdr/2004/wdr-fl-04-2a/pdf/p342-343.pdf). According to the USGS, measured flows at these gages are impacted by heavy debris buildup on the carp grates installed on top of the weir. Estimated daily flows at Whiskey Creek in Ft. Myers are also considered poor by USGS. Therefore, the daily flows at the San Carlos Canal gage were used with caution for model calibration and validation. During the model calibration effort, flows were computed at the same locations as the gages and compared with observed flows to estimate the appropriate model parameters providing a good match.

Flow calibration of the model was performed using January 2001 through December 2005 flow data, and validation was performed using January 1997 through December 1999 data. A comparison of average annual flows at S-79 (**Tables 4.6** and **4.7**) shows only a 3 percent error in flow calibration over the entire simulation period (including both the calibration and validation periods). However, there was a distinct difference in the model's success at simulating low flow vs. high flow or upper estuary vs. lower estuary (**Figures 4.6** through **4.10** from DSLLC and CDM, 2008) observed in both model calibration and validation.

The average errors in annual flow calibrations at S-78 and San Carlos were 9.0 and -9.0 percent, respectively, during calibration, and -1 and 24 percent during validation. Generally, the hydrologic model performed better in simulating high-flow events than low-flow events. This could be attributable to the inaccuracies in precipitation data. A slight error in rainfall data could result in large discrepancies between observed and simulated flows for low-flow events. There has been speculation that the strange shape of the graph (**Figure 4.10**) is due to problems associated with measurement at low flow, but this could also be because the model is not as accurate at reflecting runoff flow at relatively low-flow conditions.

Table 4.6. Observed and Modeled Annual Average Flows and Associated Errors at S-79 during Model Calibration (DSLLC and CDM, 2008)

- = Empty cell
cfs = cubic feet per second

Station	Year	Annual Average Flow (cfs) Observed	Annual Average Flow (cfs) Modeled	Annual Average Flow (cfs) % Difference
S79	2001	1,120	1,300	14%
S79	2002	2,060	2,170	5%
S79	2003	3,580	3,390	-6%
S79	2004	2,560	2,480	-3%
S79	2005	5,060	5,000	-1%
-	**Average:**	**2,876**	**2,868**	**2%**
S78	2001	291	446	35%
S78	2002	1,350	1,120	-21%
S78	2003	2,420	2,440	1%
S78	2004	1,570	1,820	14%
S78	2005	3,170	3,820	17%
-	**Average:**	**1,760**	**1,929**	**9%**
San Carlos	2001	8.20	6.31	-30%
San Carlos	2002	7.40	8.49	13%
San Carlos	2003	10.20	8.27	-23%
San Carlos	2004	6.00	5.89	-2%
San Carlos	2005	7.70	7.66	-1%
-	**Average:**	**7.90**	**7.32**	**-9%**

Table 4.7. Observed and Modeled Annual Average Flows and Associated Errors at S-79 during Model Validation (DSLLC and CDM, 2008)

- = Empty cell
cfs = cubic feet per second

Station	Year	Annual Average Flow (cfs) Observed	Annual Average Flow (cfs) Modeled	Annual Average Flow (cfs) % Difference
S79	1997	1,040	1,050	1%
S79	1998	3,620	3,740	3%
S79	1999	2,180	2,260	4%
-	**Average**	**2,280**	**2,350**	**3%**
S78	1997	480	432	-11%
S78	1998	2,610	2,830	8%
S78	1999	1,280	1,300	2%
-	**Average**	**1,457**	**1,521**	**-1%**
San Carlos	1997	2.87	5.97	52%
San Carlos	1998	6.58	6.95	5%
San Carlos	1999	5.84	6.81	14%
-	**Average**	**5.10**	**6.58**	**24%**

Figure 4.6. Comparison of Monthly Average Modeled and Observed Flows at S-79 for the Calibration Period

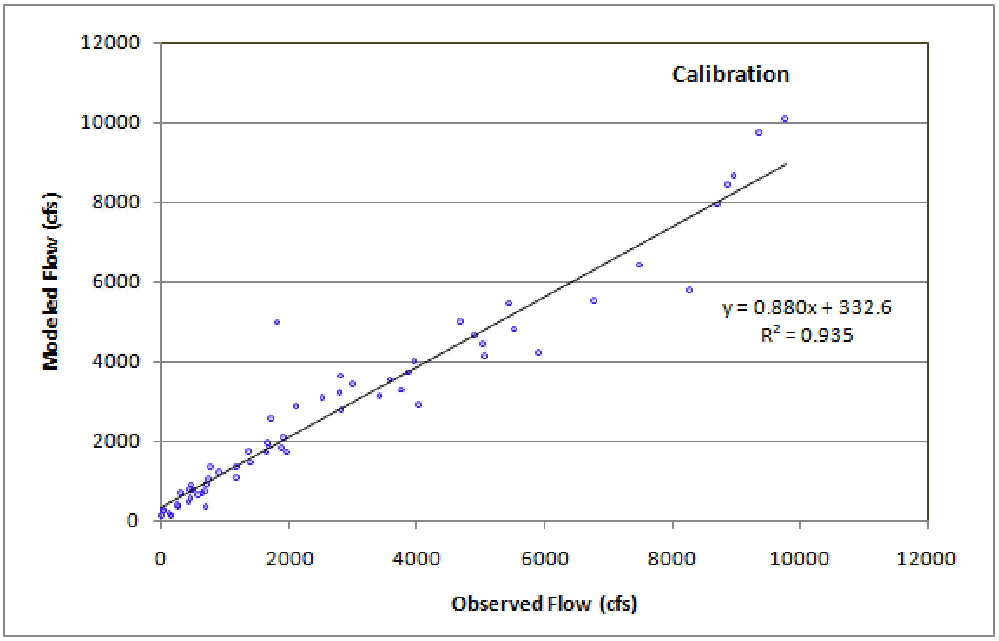


Figure 4.7. Comparison of Monthly Average Modeled and Observed Flows at the San Carlos Canal Gage for the Calibration Period

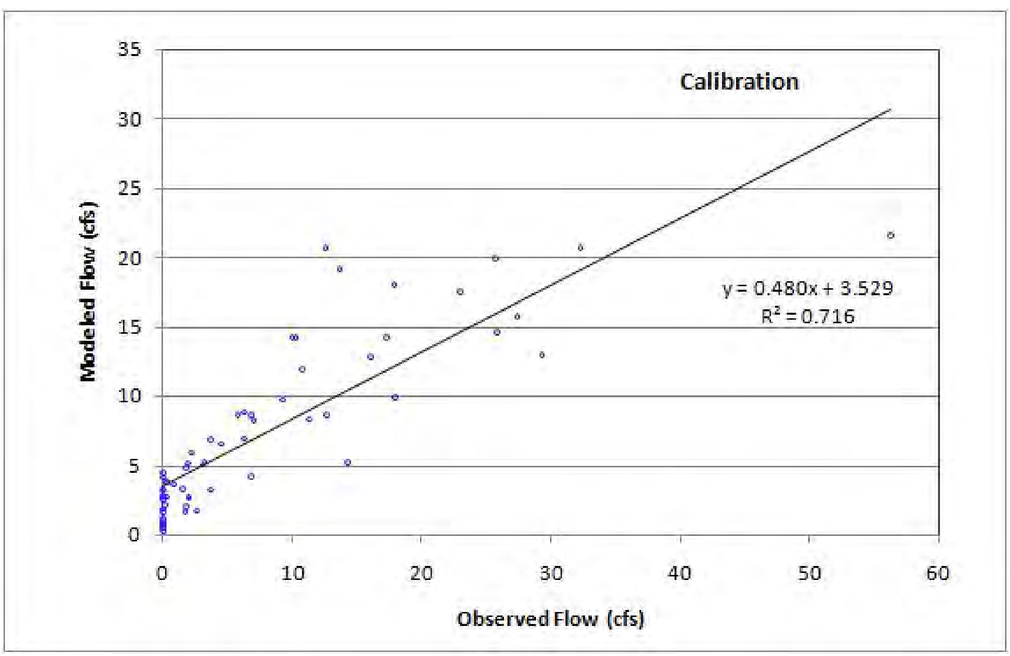


Figure 4.8. Comparison of Monthly Average Modeled and Observed Flows at the San Carlos Canal Gage for the Validation Period

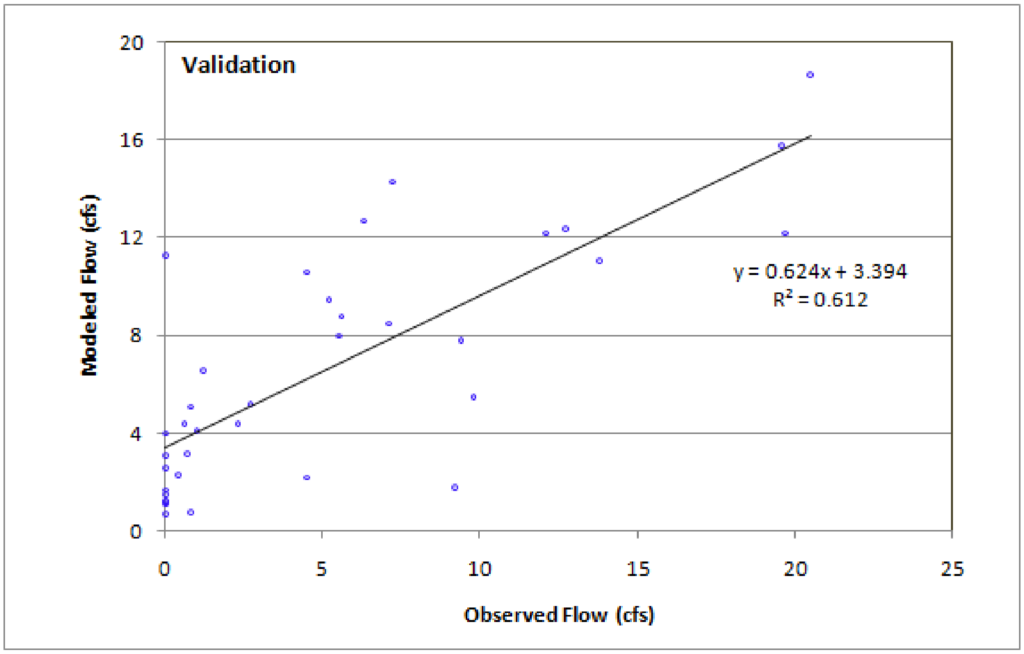


Figure 4.9. Probability of Exceedance of Observed and Modeled Daily Flows at S-79 for the Calibration Period

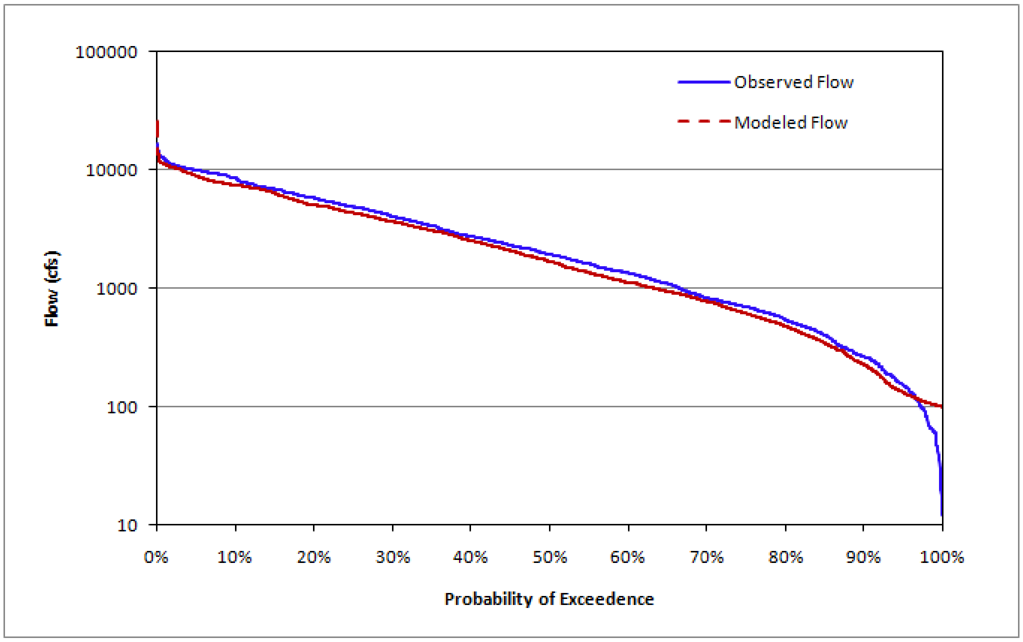
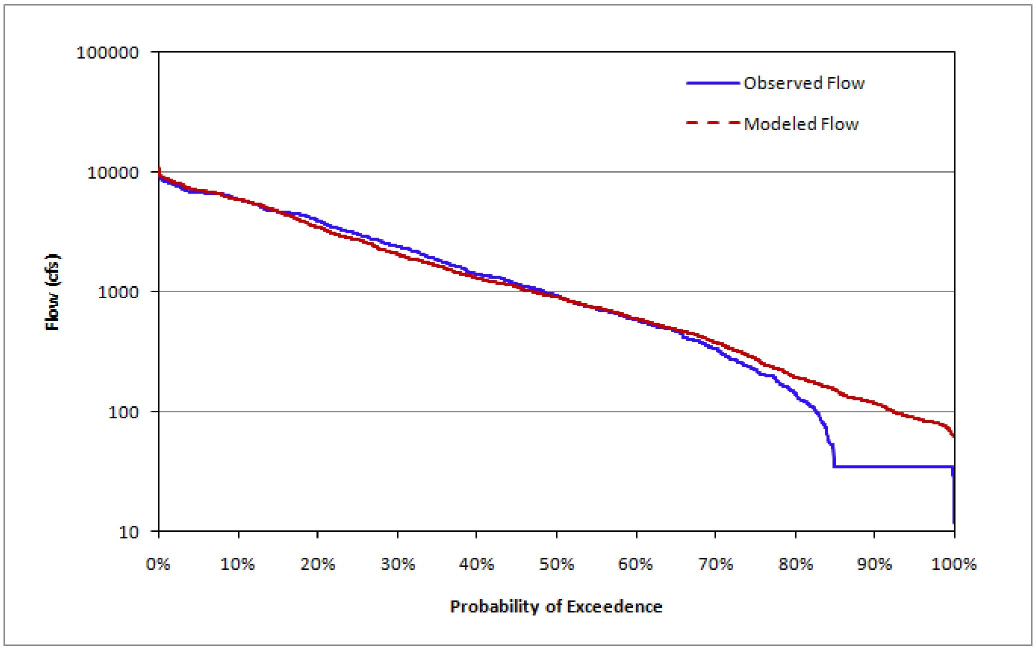


Figure 4.10. Probability of Exceedance of Observed and Modeled Daily Flows at S-78 for the Calibration Period



HSPF Modeling of Water Quality Calibration

The HSPF and EFDC Models were calibrated for nutrients, chl*a*, DO, temperature, and salinity. HSPF simulates in-stream processes in segments known as "reaches," including the computation of the concentrations of water quality constituents within the reach. Each reach is modeled as a completely mixed reactor; in other words, there is no change in concentration within a given reach. Points of calibration for the model (where modeled results were compared with observed data) included the S-79, S-78, and Whiskey Creek (WHISGR10) sample stations (**Figure 4.11**).

The years of comparison were January 2004 through December 2005. Most of the data used in the calibration were ambient data and did not include water quality data during or immediately after storm events whose impact may be lost, particularly for smaller tributaries. The model assumption that all reaches are well-mixed reactors becomes less important as the number of reaches is increased. It is important to realize that part of the role of calibration is to bridge the gap between model assumptions and limitations and the real world system.

The HSPF Model was calibrated for water temperature, TSS, nutrients (nitrate+nitrite, NH_3/NH_4, and phosphate), and DO at the S-79, S-78 and Whiskey Creek stations (DSLLC and CDM, 2008). **Figures 4.12** through **4.15** are examples of calibration and validation efforts for TKN and DO.

Figure 4.11. Water Quality Monitoring Stations in the Caloosahatchee Basin

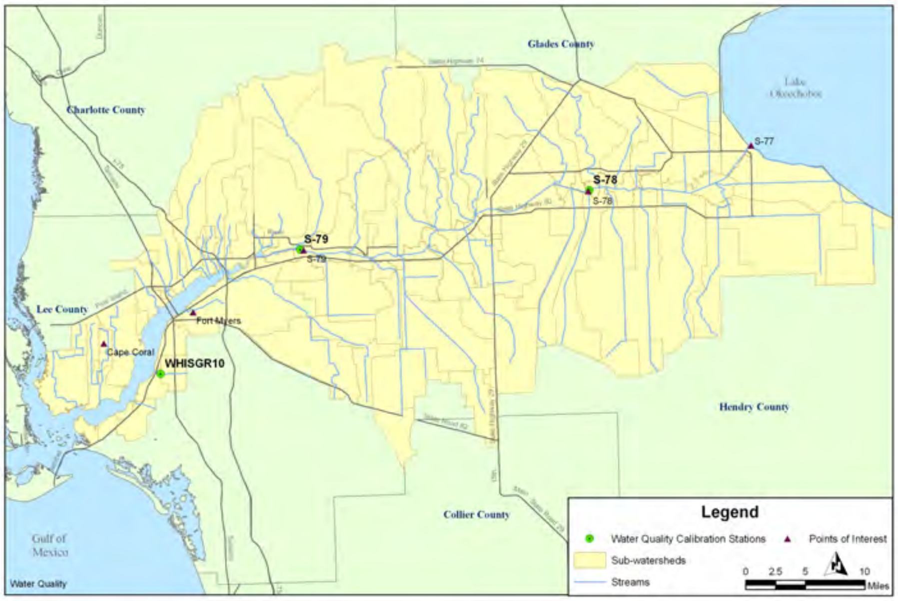


Figure 4.12. Modeled and Observed TKN Concentrations at the S-79 Station for the Model Calibration Period

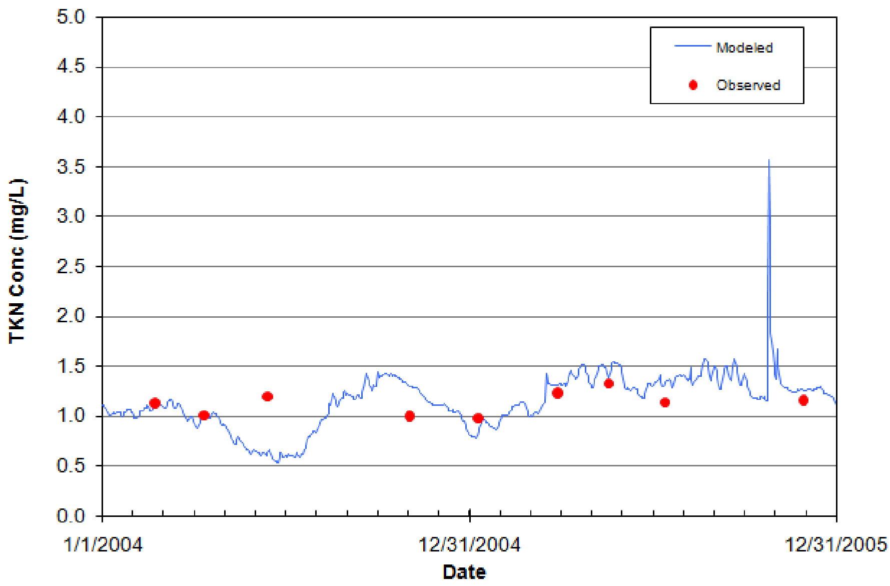


Figure 4.13. Modeled and Observed DO Concentrations at the S-79 Station for the Model Calibration Period

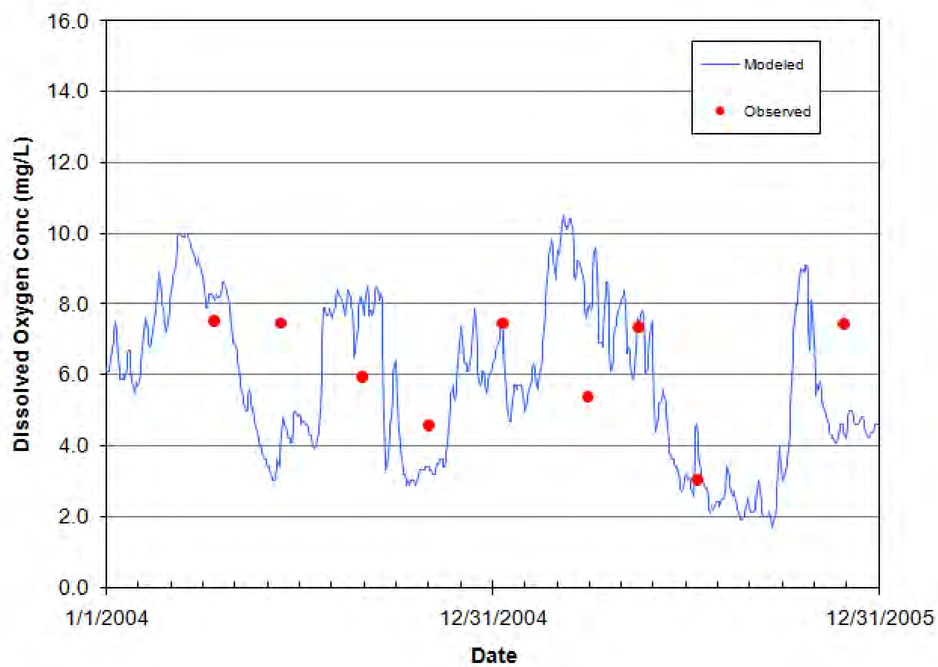


Figure 4.14. Modeled and Observed TKN Concentrations at the S-79 Station for the Model Validation Period

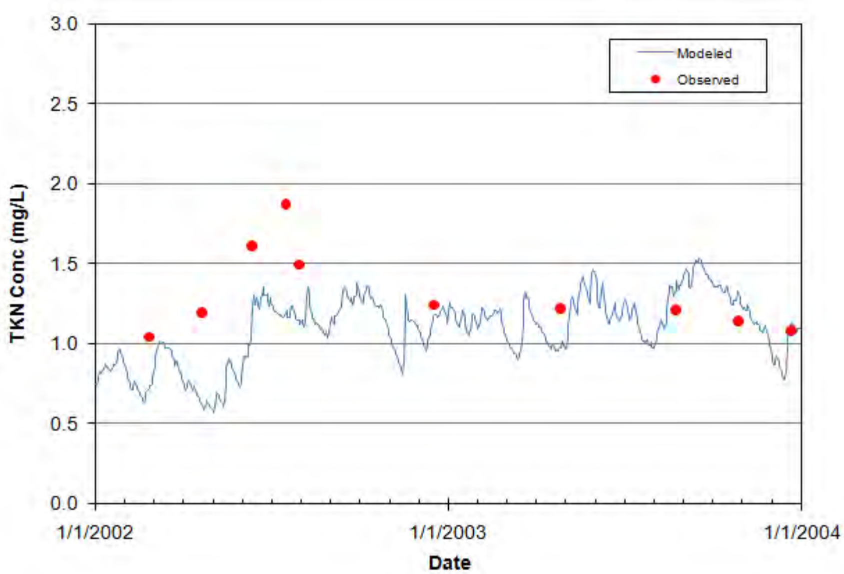
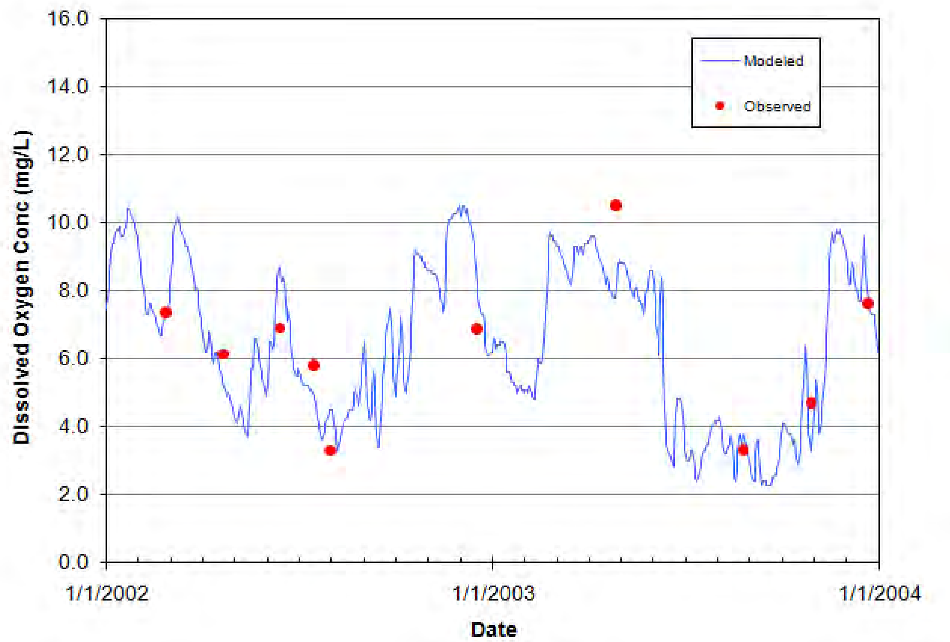


Figure 4.15. Modeled and Observed DO Concentrations at the S-79 Station for the Model Validation Period



4.4.2 EFDC

As stated earlier, the HSPF Model is linked to the hydrodynamic model, EFDC. EFDC is unique among advanced surface water models in that it is designed to use a single source code to interface hydrodynamics with sediment transport, toxic chemicals eutrophication and sediment diagenesis within a single source code. The EFDC Model was developed at the Virginia Institute of Marine Science and is supported by EPA and maintained by Tetra Tech, Inc.

The EFDC model simulates 3D flow by dividing the waterbody into cartesian or curvilinear cells (**Figures 4.16** and **4.17**). The EFDC-simulated estuary receives the HSPF-simulated flow and water quality from the watershed runoff and tributaries. EFDC thus connects the Caloosahatchee Estuary to the Gulf of Mexico and simulates the interaction between this basin and coastal waters. In addition to hydrodynamics, salinity and water temperature, EFDC includes sub-models to simulate sediment transport, eutrophication, toxic contaminants, and sediment diagenesis.

The approach for linking the EFDC Model to its boundaries is the same as that for linking the model to the HSPF Model at several locations. While the HSPF linkages represent the boundaries at tributaries, WWTF point sources, and S-79 control structures, the additional EFDC boundaries include the Gulf of Mexico at the western edge of the model grid. The sediment diagenesis component of the model requires particulate organic carbon, particulate organic nitrogen, and particulate organic phosphorus for three

Figure 4.16. Caloosahatchee Model Grid with Representative Cell Indices

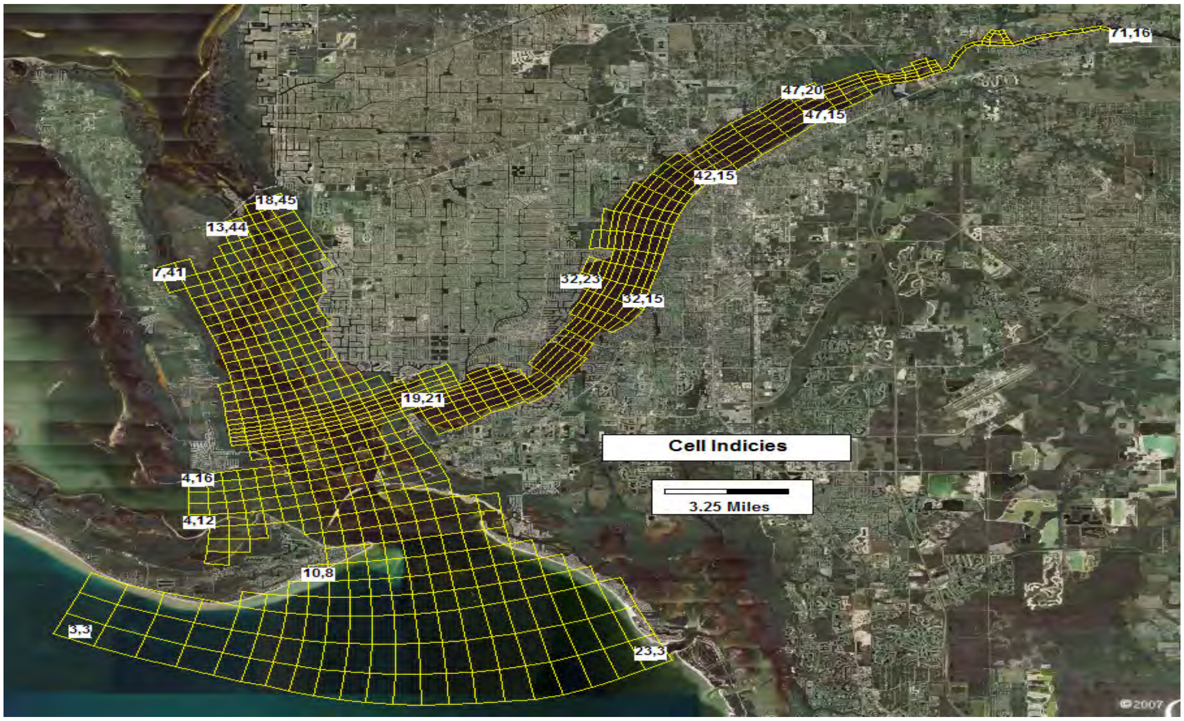
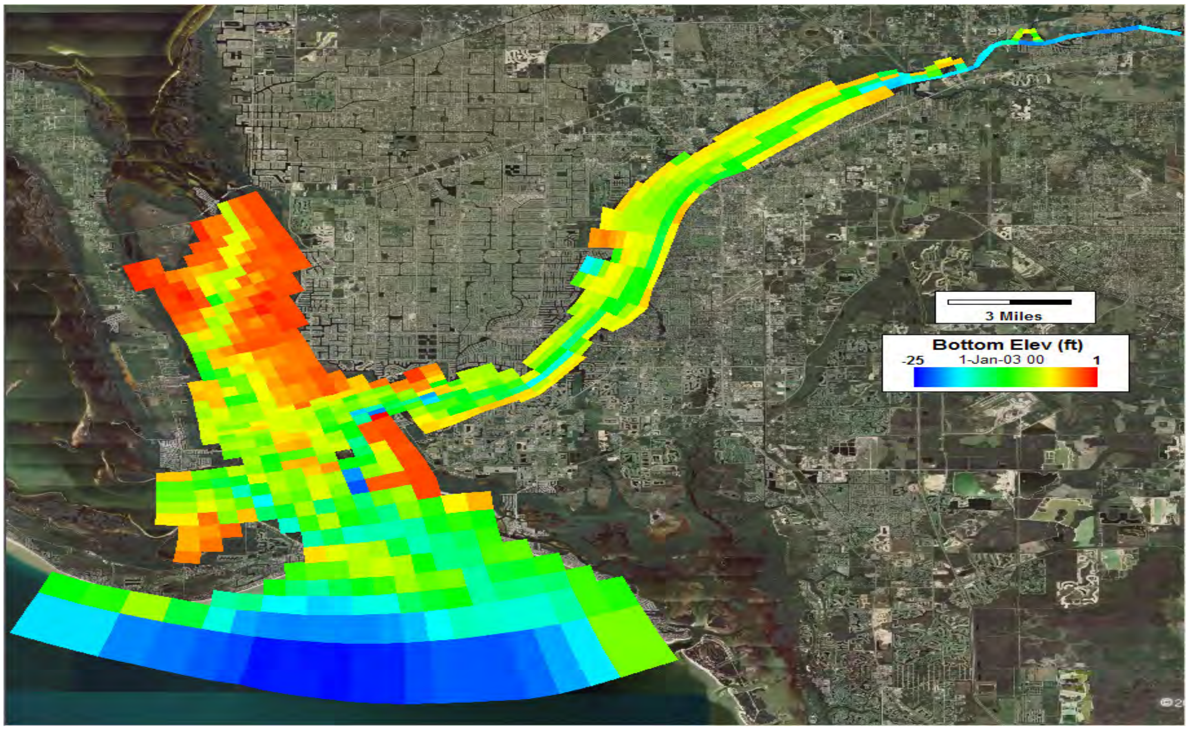


Figure 4.17. EFDC Caloosahatchee Model Area, with Model Bathymetry



reactive sediment classes—i.e., G1, G2, and G3. Typically, the G3 class contains the largest fraction of nutrients but is configured as inert. The G1 class is more reactive (i.e., labile), while the G2 class is slower reacting (i.e., refractory).

The Caloosahatchee sediment total organic carbon (TOC) data were used to assign the initial organic carbon fractions in the sediments. The splits between the G1, G2, and G3 classes used the approach of 1:10:100 ratios, respectively. The organic phosphorus and nitrogen sediment concentrations were derived from the TOC concentrations using the phosphorus/carbon (P/C) and nitrogen/carbon (N/C) Redfield ratios. Thus, the TOC concentrations were very important in establishing initial conditions.

The calibration period for the EFDC Model was January 1, 2003, to December 31, 2003, where multiple stations were calibrated for water level, tide signal, salinity, temperature, and water quality parameters. The validation period was January 1, 2004, to December 31, 2004. **Figures 4.18** through **4.22** display the sample results. A more comprehensive treatment of model calibration and validation is available in the *Draft Task 5 Report* (DSLLC and CDM, 2008).

Figure 4.18. Salinity Calibration at Station CES09

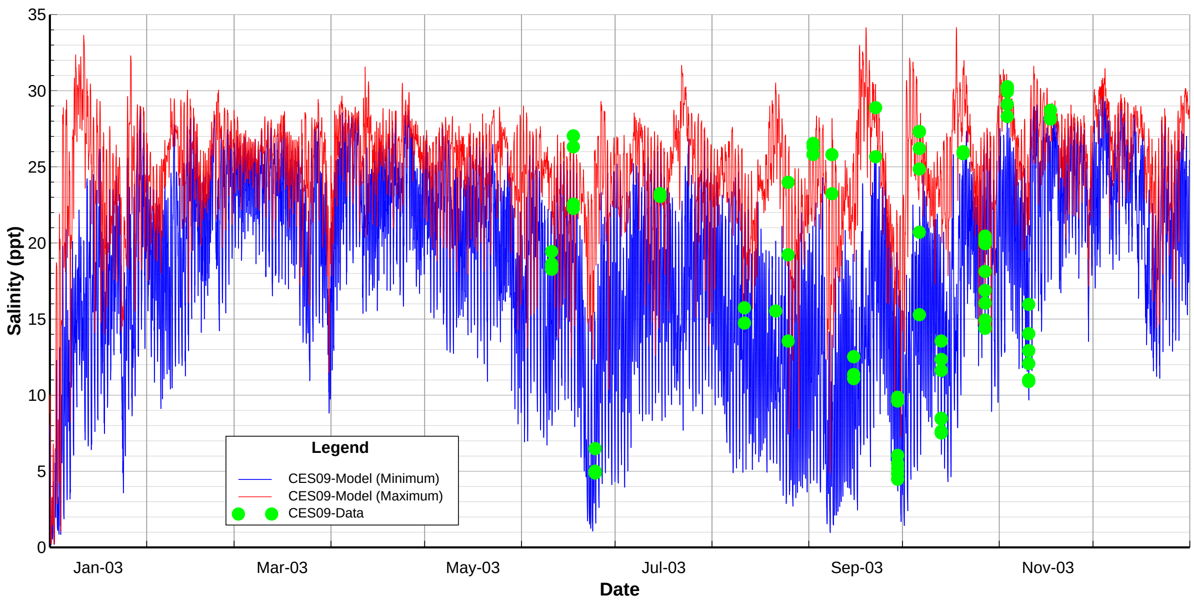


Figure 4.19. DO Calibration Time Series for CES04, Surface Layer

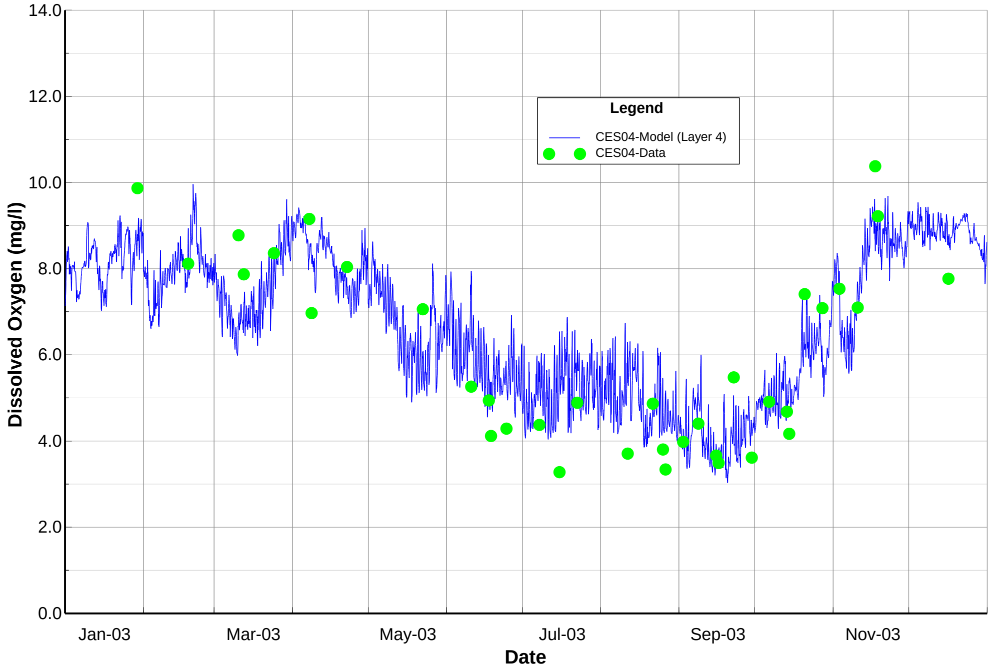


Figure 4.20. DO Calibration Time Series for CES06, Surface Layer

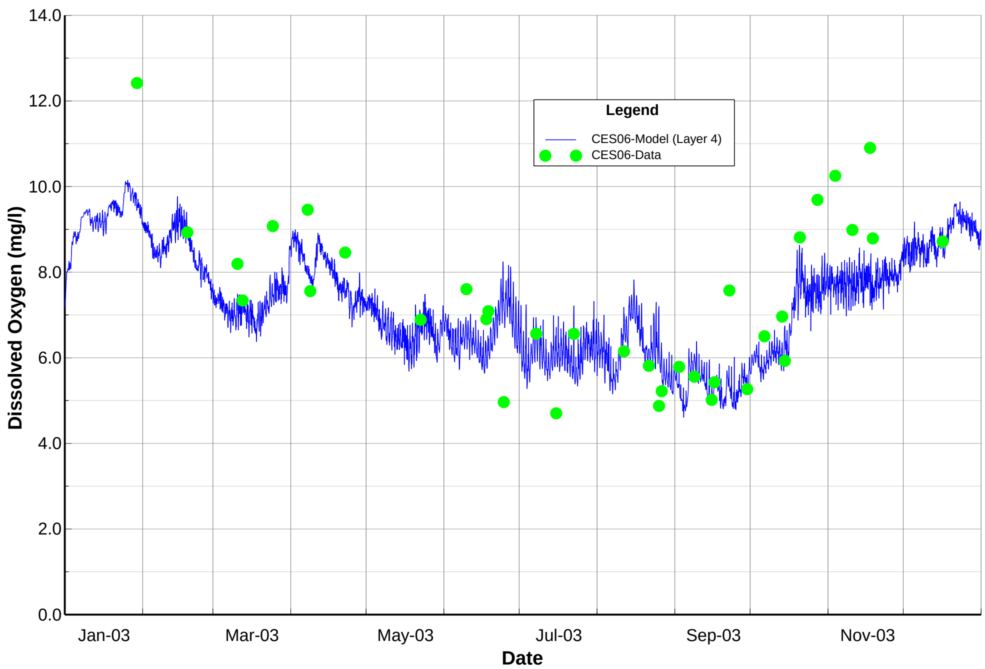


Figure 4.21. Chl *a* Calibration Time Series for CES04, Surface Layer

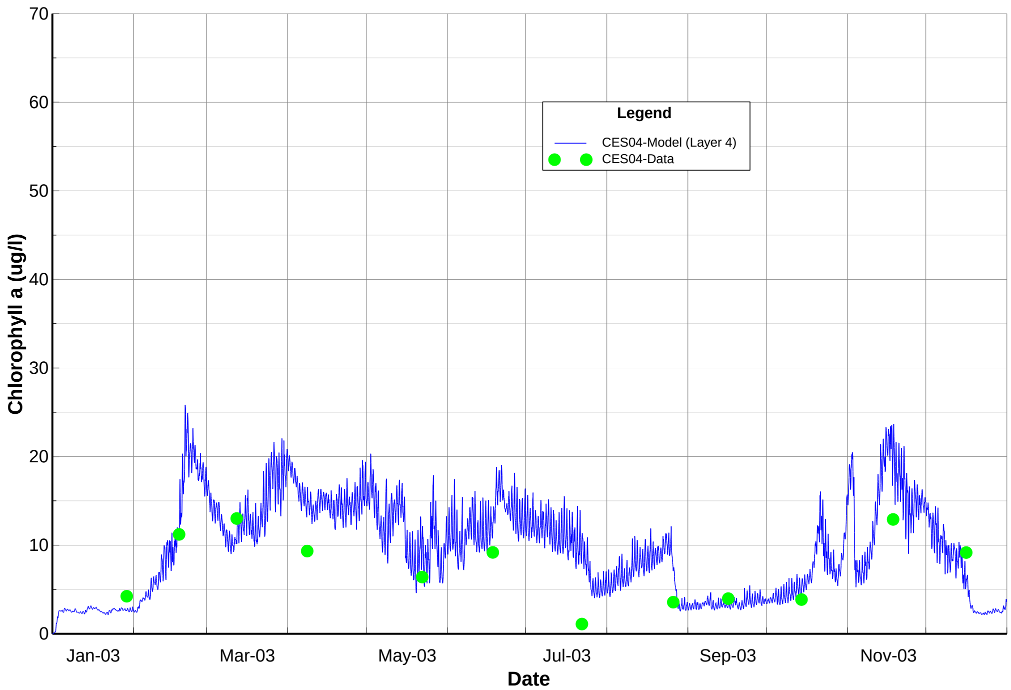
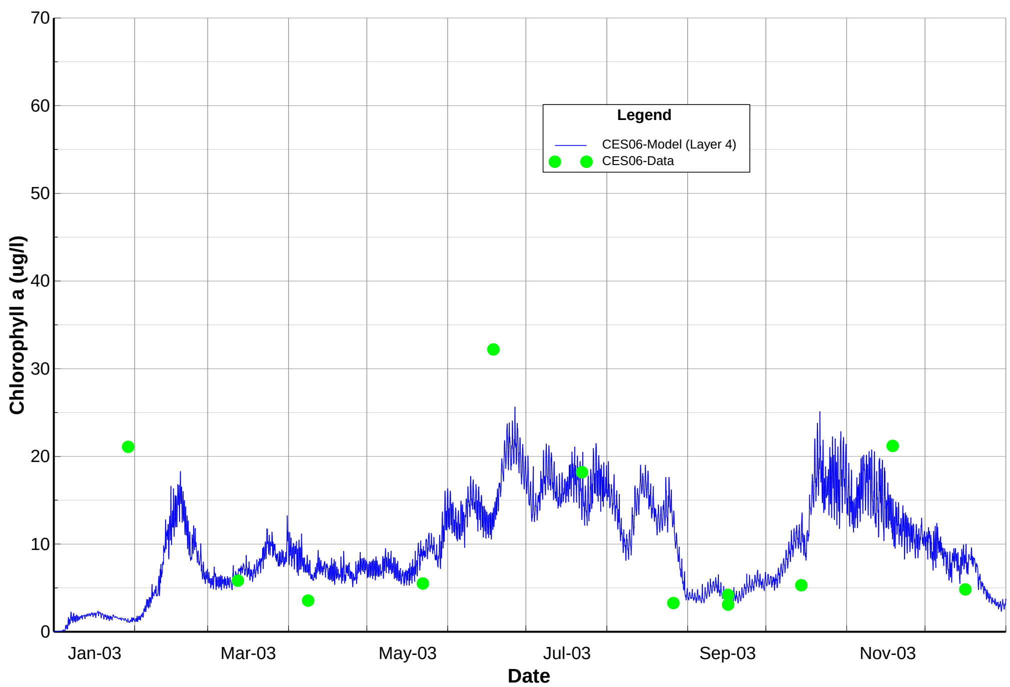


Figure 4.22. Chl *a* Calibration Time Series for CES06, Surface Layer



Stabilization of Benthic Flux through Model Spin-up Runs

In an effort to determine how much time was required for the development of dynamic equilibrium in internal and external loads related to sediment flux, it was suggested that tests be carried out in the modeling (Bierman, 2008). The goal was to determine if a "spin-up" period was necessary—i.e., the impact of sediment flux stabilization on nutrient concentrations in the overlying water column.

This test was performed by first running the model for existing conditions for the period from January 2003 through December 31, 2005. Using the EFDC Model option to write out a set of "restart" (RST) files for the ending date and time of the simulation period, a new set of initial conditions for the hydrodynamic, water quality, and sediment flux model was based on the final results of the previous model run. This process of feeding the conditions of the previous run as the initial conditions for the subsequent run was repeated and reported as follows:

- *Restart 0 (Year 0–3): existing calibration and validation results for 2003–05.*
- *Restart 1 (Year 3–6): use restart files from Restart 0 as initial conditions.*
- *Restart 2 (Year 6–9): use restart files from Restart 1 as initial conditions.*
- *Restart 3 (Year 9–12): use restart files from Restart 2 as initial conditions.*
- *Restart 4 (Year 12–15): use restart files from Restart 3 as initial conditions.*

The model results for DO, chl*a*, ammonia, nitrate, orthophosphate, and water clarity were reported for the grid cell corresponding to Station CES-06, located in the middle of the estuary. **Tables 4.8a** and **4.8b** presents the mean values and percent change, respectively, of these variables for the water column. The results indicate that the spin up had the largest impact on PO4 concentration, which showed a difference of almost 4 percent between RST0 and RST4, while the other variables had a less than 1.8 percent difference between RST0 and RST2, and less than a 1 percent difference between RST0 and RST3.

Scenarios Evaluated

As a result of the spin-up tests, the model simulations of all scenarios were run through RST2 with the goal of stabilizing the sediment flux load before assessing the water quality in the water columns for the desired scenario to be evaluated. The following scenarios were tested in the phase of model development and evaluation (DSLLC and CDM, 2008) to assess the watershed for the TMDL:

1. *Current conditions;*
2. *Background conditions (predevelopment land uses with Lake Okeechobee at its TMDL nutrient target levels); and*
3. *Proposed nutrient reductions that meet the light attenuation target.*

Table 4.8a. Water Column Results from Water Quality Model, Mean Value

Variable	Units	Statistic	RST0: 0–3 yr	RST1: 3–6 yr	RST2: 6–9 yr	RST3: 9–12 yr	RST4: 12–15 yr
WC-SECCHI	meters	Mean Value	1.318	1.3861	1.3863	1.3864	1.3862
WC-PO4	mg-P/L	Mean Value	3.52E-02	3.99E-02	4.21E-02	4.40E-02	4.56E-02
WC-OXY	mg/L	Mean Value	6.4477	6.1016	6.1157	6.1166	6.1187
WC-NO3	mg-N/L	Mean Value	0.13549	0.13982	0.1382	0.13779	0.13755
WC-NH4	mg-N/L	Mean Value	6.84E-02	7.25E-02	7.12E-02	7.09E-02	7.09E-02
WC-CHL	µg Chla/L	Mean Value	5.8428	4.9285	4.9103	4.9155	4.9254

Table 4.8b. Water Column Results from Water Quality Model, Percent Change

Variable	Units	Statistic	RST0: 0–3 yr	RST1: 3–6 yr	RST2: 6–9 yr	RST3: 9–12 yr	RST4: 12–15 yr
WC-SECCHI	meters	% Change	0	5.1641	1.85E-02	2.83E-03	-1.51E-02
WC-PO4	mg-P/L	% Change	0	13.096	5.6697	4.4176	3.6787
WC-OXY	mg/L	% Change	0	-5.3668	0.2313	1.36E-02	3.42E-02
WC-NO3	mg-N/L	% Change	0	3.1964	-1.1636	-0.29636	-0.17338
WC-NH4	mg-N/L	% Change	0	5.9712	-1.7748	-0.39763	-0.10574
WC-CHL	µg Chla/L	% Change	0	-15.648	-0.36899	0.10587	0.20128

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Overall Approach

The overall approach is to model the existing Caloosahatchee River Estuary TN loads using HSPF and EFDC, and then reduce these loads to be consistent with the chl*a* levels that permit the target light attenuation (consistent with a healthy seagrass meadow in San Carlos Bay [at the mouth of the Caloosahatchee Estuary] and critical locations mid-estuary). This meant ensuring that the maximum amount of area in San Carlos Bay 2.2 meters deep or less received a minimum 25 percent PAR, and that the mid- to lower estuary at 1 meter depths or less also received 25 percent PAR.

5.2 Light as a Function of Chl*a*, Color, and Turbidity.

Studies of Charlotte Harbor (the major watershed immediately north of the Caloosahatchee River) revealed that nonchlorophyll suspended matter (detritus, cellular material, and minerals) accounted for an average 72 percent of light attenuation in the water column. It was also found that color in the form of dissolved organic matter—i.e., tannins—accounted for 21 percent, and phytoplankton chlorophyll for 4 percent (McPherson and Miller, 1987). Several studies showed spatial and temporal variabilities in the level of contribution to total light attenuation from nonchlorophyll suspended matter (30 to 72 percent), colored dissolved organic matter (13 to 66 percent), chl*a* (4 to 18 percent) and seawater (3 to 6 percent) (McPherson and Miller, 1994; Dixon and Kirkpatrick, 1999). Dixon (2000) found that seagrasses in the Charlotte Harbor region need between 15 and 30 percent PAR at the depth of the seagrass. The seagrass *T. testudinum* had the greatest light requirements, and *S. filiforme* required the least light. The light criterion was thus set at 25 percent PAR for the Charlotte Harbor region (Corbett and Hale, 2006).

Light attenuation in a water column is described by the Beer-Lambert Law:

$$I(z) = I(o)\exp(-k_e z) \qquad \textbf{(Equation 5.1)}$$

Where:

I(o) = the light intensity at the surface (z=0);
k_e = the attenuation, or extinction, coefficient (with units of meter^{-1}); and
z = the depth of the water column from the surface (z=0) (as meters) to the point where I(z) is estimated.

A 25 percent light intensity at depth z means that at depth z the light intensity is 25 percent of the light intensity found at the surface (depth=0), or I(z) = 0.25 I(o). Using the Beer-Lambert Law,

$$\frac{I(z)}{I(o)} = 0.25 = \exp(-k_e Z_{25\%})$$ **(Equation 5.2)**

$$Z_{25\%} = -\frac{\ln(0.25)}{k_e} = \frac{1.3863}{k_e}$$

The relationship derived by McPherson and Miller (1994) is as follows:

$$k_e = 0.014 * Color + 0.062 * Turbidity + 0.049 * Chla + 0.30$$ **(Equation 5.3)**

For the EFDC Model, DSLLC modified the above equation such that it is a function of (a) apparent color (k_e(o)); (b) inorganic suspended solids (k_e(InorgSS)) ; (c) detrital particulate organic carbon (k_e(POC) where POC=LPOC + RPOC); and (d) algal biomass (as chla) (k_e(Chla)), as shown in **Equation 5.4**:

$$k_e = k_e(o) + k_e(InorgSS) + k_e(POC) + k_e(Chla)$$ **(Equation 5.4)**

$$k_e(InorgSS) = 0.052 * (InorgSS)$$ **(Equation 5.5)**

$$k_e(POC) = 0.174 * 0.45 * (POC)$$ **(Equation 5.6)**

$$k_e(Chla) = 0.031 * (Chla)$$ **(Equation 5.7)**

$$K_e(color) = 0.014 * ApparentColor$$ **(Equation 5.8)**

Crean (2007) presented summary statistics of the distribution of apparent color as a composite of wet and dry season observations for the three regions of the Caloosahatchee Estuary, defined by distance from S-79. Due to a lack of data, color and background light extinction for the open water areas of San Carlos Bay, Gulf of Mexico, Pine Island Sound, and Matlacha Pass were estimated using 80 percent of the color value for Region 3 (**Table 5.1**). In the present configuration of the EFDC Model for the Caloosahatchee Estuary, background light extinction is parameterized using the data of Crean (2007) to define light extinction for four zones based on the median distribution of apparent color.

Table 5.1. Color Zones and Their Corresponding Extinction Coefficients Used in the EFDC Model

Region	Median Apparent Color (platinum cobalt units [PCUs])	k_e (o) as f(Color) (1/meter)
Region 1 (0–10 kilometers [km])	80	1.12
Region 2 (10–30 km)	68	0.95
Region 3 (30–40 km)	30	0.42
Open water	24	0.34

The detailed information about the modeling of color is provided to allow the reader to understand that bottom light irradiance is based on an empirical equation that makes it a function of several environmental variables. As with all environmental models, it is of great importance that data continue to be collected for all of these parameters (chl*a*, suspended solids, color, and organic carbon) to further calibrate and improve the model algorithm.

5.3 Light Attenuation Modeling and Results

The EFDC Model light attenuation component uses the algorithm described above to assess the bottom irradiance for the estuary water column for each grid cell. Doering and Chamberlain (2005) found that chl*a* between 3.2 and 3.9 μg/L in San Carlos Bay and 8 μg/L in the middle estuary were consistent with healthy seagrass growth. When looking at the complete set of parameters, Corbett (2006) determined that concentrations less than 6.9 μg/L chl*a*, turbidity less than 5.4 nephelometric turbidity units (NTU), and color less than 24 PCU produced conditions conducive to a healthy seagrass community. In using the EFDC Model, the goal was to minimize the number of days with less than 25 percent PAR for those grids overlying critical areas such as San Carlos Bay (**Figure 5.1**)

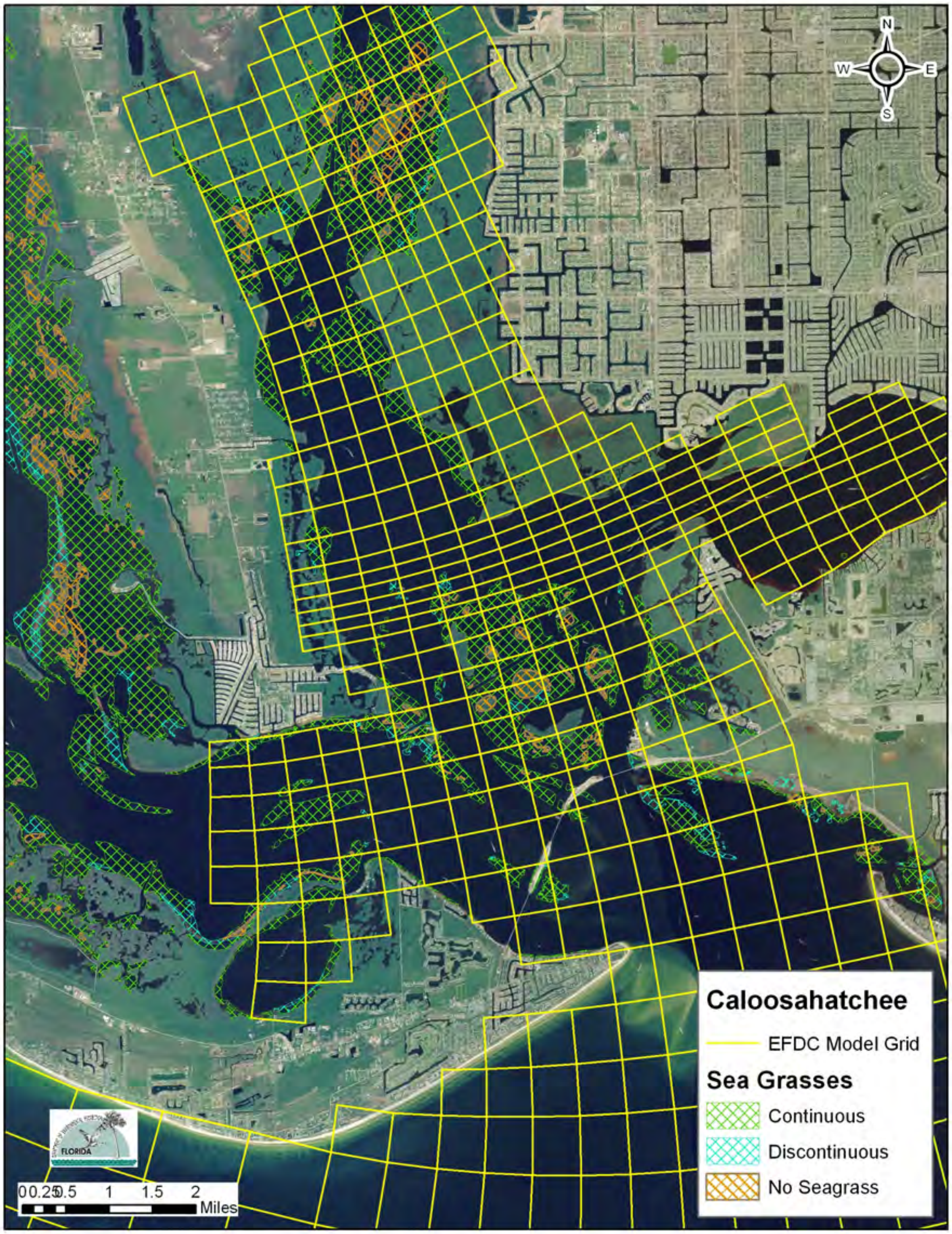
5.3.1 Background Scenario (with Lake Okeechobee at Nutrient TMDL Compliance Levels)

A background level scenario was simulated for the 2003 through 2005 simulation period. The goal of simulating this background scenario was to determine estuary nutrient conditions consistent with "predevelopment" loads and establish that load as the "pristine nutrient load." Besides helping to assess whether a nutrient target derived by other methods can be practically attained, the simulated pristine load can also serve as a vehicle toward the establishment of a target (i.e., a target that is equivalent to 80 percent of the difference between existing and background loads).

For the Caloosahatchee Basin modeling effort, this predevelopment level was simulated by changing all existing land uses to either wetland or upland forests (i.e., all urban, built-up, and agricultural land uses were converted). In addition, the flow entering the Caloosahatchee Basin from Lake Okeechobee was set at the lake's TMDL compliance concentration for TP of 40 parts per billion (ppb), as determined in the Lake Okeechobee TMDL (Department, 2001).

It was also determined, through a review of historical records, that a Lake Okeechobee TN concentration of 1.2 mg/L was consistent with the 40 ppb TP levels. The background simulation did not involve altering the present canal system, control structures, dams, or water release volumes or schedule, because achieving load reductions through altering the hydrology, including hydrologic structures, is beyond the scope of the TMDL Program. The scenario described above, which was applied to the 2003–05 Caloosahatchee Basin HSPF-EFDC simulation, is referred to as either the "Background and Lake Okeechobee at TMDL," or "Background-Plus," scenario.

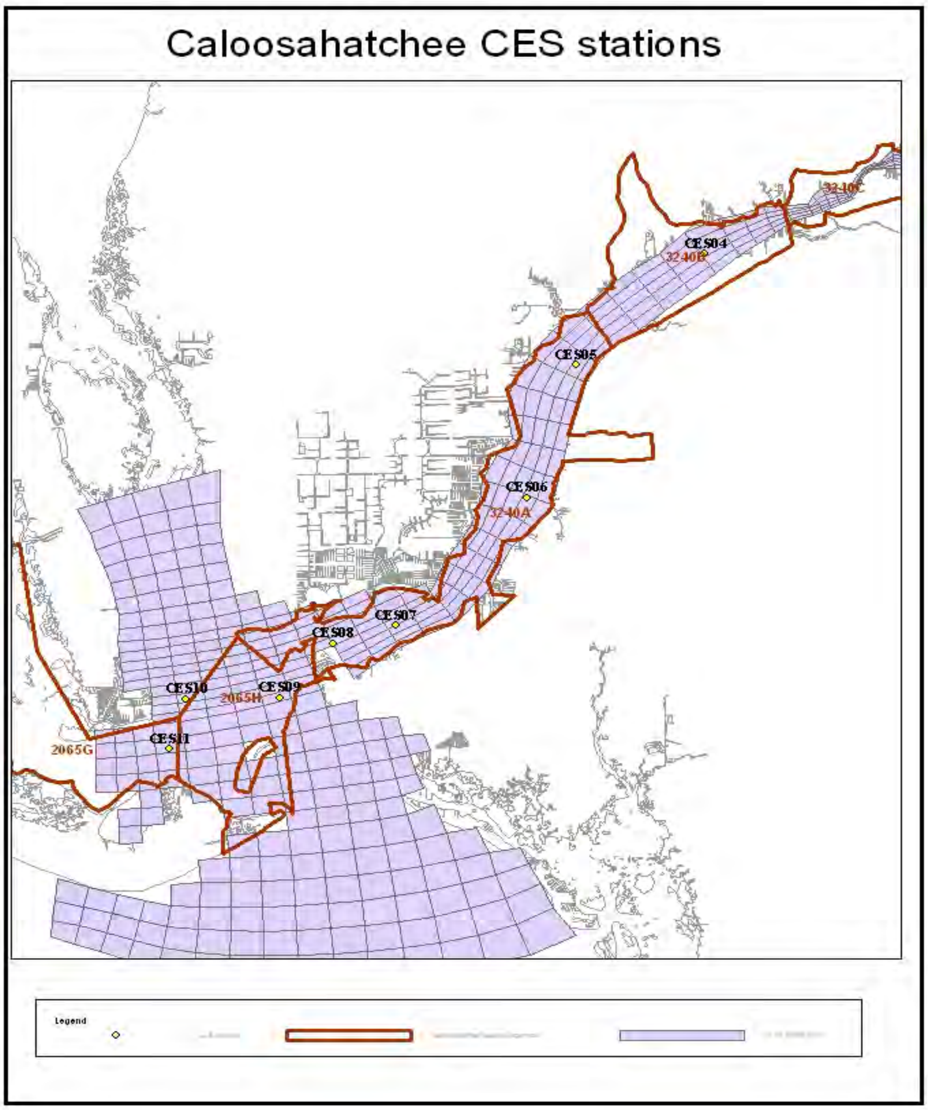
Figure 5.1. EFDC Computer Model Grid over Seagrass in San Carlos Bay



5.3.2 Comparison of Existing Estuarine DO Levels with the Background-Plus Scenario

For the Existing Conditions and Background-Plus scenarios, a simulation including a three year spin-up simulation period was accomplished through the use of the HSPF/EFDC Models (simulation years 2003 through 2005). Hourly DO values for cells associated with Station CES04–CES11 (**Figure 5.2**) were extracted from the Existing Conditions and Background-Plus simulations. These stations are located in or next to WBIDs 2065H (San Carlos Bay), 3240A (Caloosahatchee Estuary Tidal), and 3240B (Caloosahatchee Estuary Tidal).

Figure 5.2. EFDC Model Grid and Sample Stations for DO Comparison of Existing Conditions vs. Background-Plus Scenarios



Cumulative frequency plots comparing the minimum daily and daily average DO depth averaged concentrations for the Existing Conditions and Background-Plus scenarios for all stations were performed. **Figure 5.3** and **Table 5.2** are representative of the figures and tables that describe the comparative study. The study demonstrated that there was no substantial difference between the simulated Background-Plus and Existing Conditions, thus failing to demonstrate that the low DO in the Tidal Caloosahatchee River was more than the result of natural background conditions. This resulted in a determination that it would not be practical to pursue a DO TMDL. **Appendix H** provides further details of the DO investigation, with a complete set of supporting figures and tables.

Figure 5.3. Minimum Daily DO Station Plots for Background-Plus and Existing Conditions Scenarios at Sample Stations CES06 and CES07

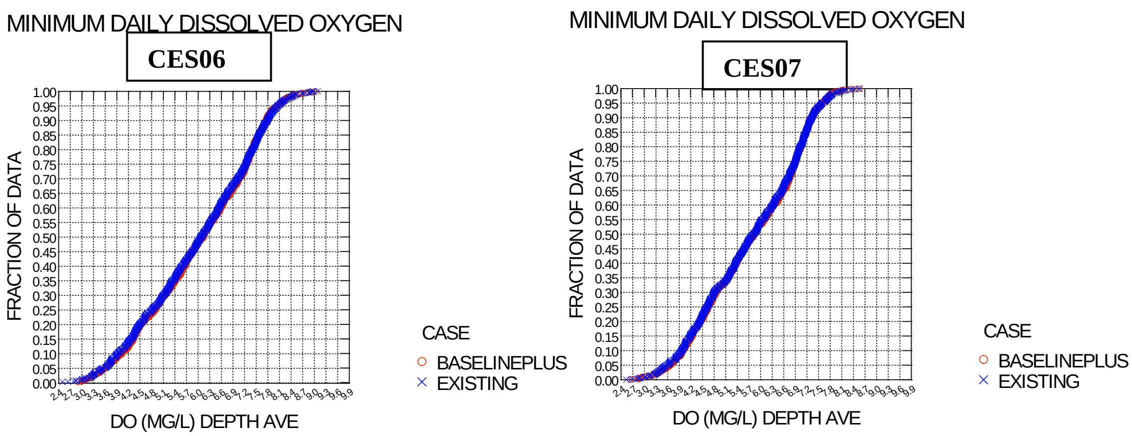


Table 5.2. Summary of Percent of Days (Simulation Period 2003–05) with Daily Minimum DO below 4 mg/L

Station	Cell	Number of Days	Existing Days below 4 mg/L	Existing % Days below 4 mg/L	Baseline Days below 4 mg/L	Baseline % Days below 4 mg/L
CES04	I47J17	1,090	211	19.36%	191	17.52%
CES05	I39J16	1,090	187	17.16%	185	16.97%
CES06	I32J17	1,090	118	10.83%	103	9.45%
CES07	I23J18	1,090	115	10.55%	105	9.63%
CES08	I19J19	1,090	140	12.84%	142	13.03%
CES09	I15J16	1,090	33	3.03%	32	2.94%
CES10	I9J18	1,090	151	13.85%	141	12.94%
CES11	I8J14	1,090	131	12.02%	133	12.20%

5.3.3 Comparing Existing Conditions with Background-Plus and TN Reduction Scenarios

Table 5.3 displays the San Carlos Bay TN, TP, and chl*a* concentrations as a result of EFDC simulations of Existing Conditions and Background-Plus scenarios. The table shows that the simulated Background-Plus concentrations of chl*a* (median) at San Carlos are consistent with the healthy chl*a* seagrass concentrations determined by Doering and Chamberlain (2005). The 75th percentile Background-Plus chl*a* concentrations at the CES04 and CES06 stations (in the mid-Tidal Caloosahatchee) are between the Charlotte Harbor National Estuary Program (Corbett and Hale, 2006) (6.9 μg/L) and Doering and Chamberlain (8 μg/L) concentrations for this area.

Figure 5.4 shows the current percentage bottom irradiance at San Carlos Bay (at a depth of 2.2 meters) as modeled by the EFDC hydrodynamic model. **Figure 5.5** displays the percentage irradiance at the same location and depth for the Background-Plus scenario and the scenario reducing nonpoint source TN by 19.8 percent. The reduction of 19.8 percent was determined by simulating a series of TN reductions to determine the minimum reduction in TN that would permit attaining light attenuation either above 25 percent PAR, or nearly match the Background-Plus scenario (whichever is greater). Note that it was determined that the Background-Plus scenario was equivalent to a 26 percent reduction in TN.

The light attenuation was observed and summarized from the EFDC Model baseline, current condition, and TN reduction simulations (for the area around San Carlos Bay). From the "Plan View" (**Figure 5.2**) of the EFDC Explorer Interface developed by DSLLC, those grids in the San Carlos region (note red star in figure) were indicated to be no deeper than 2.2 meters. This is the same depth above which 25 percent irradiance was desired (which was 2.2 meters, in the case of San Carlos Bay). In **Figure 5.2,** a red star was placed over the point of San Carlos Bay (**Note:** This was not a part of the interface) around which the cells in all colors except grey were selected. The grey indicates that the cell depth is greater than 2.2 meters. Approximately 30 cells were selected, for which the bottom irradiance was displayed (see **Figure 5.3**).

The information as shown in **Figure 5.3** was tabulated and summarized as the average of the monthly average bottom irradiance for the 30 cells selected. The monthly averages for current, baseline, and scenario with TN most closely creating all averages above 25 percent PAR or closest to the baseline condition (whichever was highest).

Table 5.3. Results from Simulation of Existing Conditions and Background-Plus Scenarios at San Carlos Bay, Station CES06, Station CES04, and Just West of S-79

Chorophyll A, Total Nitrogen, and Total Phosphorus Simulated by EFDC in Caloosahatchee Estuary

Location	Statistic	Chlorophyll-A, ug/L EXISTING	Chlorophyll-A, ug/L BACKGROUND and Lake Okee. @ TMDL	Total Nitrogen, mg/L EXISTING	Total Nitrogen, mg/L BACKGROUND and Lake Okee. @ TMDL	Total Phosphorus, ug/L EXISTING	Total Phosphorus, ug/L BACKGROUND and Lake Okee. @ TMDL
San Carlos Bay	75 Percentile	7.387	5.253	0.647	0.501	54.68	42.79
San Carlos Bay	Median	4.733	3.401	0.501	0.426	45.51	35.55
San Carlos Bay	25 Percentile	3.349	2.505	0.410	0.375	35.11	28.12
San Carlos Bay	Maximum	31.017	28.781	2.563	1.485	4814.76	84.78
San Carlos Bay	Minimum	1.330E-12	9.932E-12	0.235	0.235	9.62	7.60
San Carlos Bay	Count	26156	14399	26156	14399	26156	14399
Station CES06	75 Percentile	10.587	7.231	0.911	0.610	60.66	29.32
Station CES06	Median	7.155	5.032	0.630	0.458	39.05	21.52
Station CES06	25 Percentile	5.334	3.793	0.498	0.408	25.83	13.74
Station CES06	Maximum	37.008	29.897	3.681	1.296	425.40	65.99
Station CES06	Minimum	2.599E-07	4.541E-07	0.348	0.318	9.69	7.54
Station CES06	Count	26156	14399	26156	14399	26156	14399
Station CES04	75 Percentile	10.827	7.588	1.252	0.872	104.03	34.84
Station CES04	Median	8.183	5.780	0.881	0.608	54.63	22.25
Station CES04	25 Percentile	4.741	3.821	0.649	0.519	35.01	16.29
Station CES04	Maximum	48.167	52.945	4.868	1.500	598.00	103.84
Station CES04	Minimum	7.080E-10	5.405E-08	0.431	0.382	11.51	6.56
Station CES04	Count	26156	14399	26156	14399	26156	14399
Just West of S79	75 Percentile	7.03431773	5.125079393	1.4226023	1.060819864	127.44	43.96
Just West of S79	Median	5.00241041	3.699142933	1.04629439	0.806293905	85.79	30.77
Just West of S79	25 Percentile	3.15071088	2.776646852	0.78547284	0.631953597	58.91	23.20
Just West of S79	Maximum	70.0205994	69.93703461	4.87913609	1.463989973	598.24	78.02
Just West of S79	Minimum	0.07233848	0.008730624	0.46770814	0.410645485	24.88	11.11
Just West of S79	Count	26156	14399	26156	14399	26156	14399

Figure 5.4. Interface of EFDC Model from which Cells Are Selected for Bottom Irradiance Output

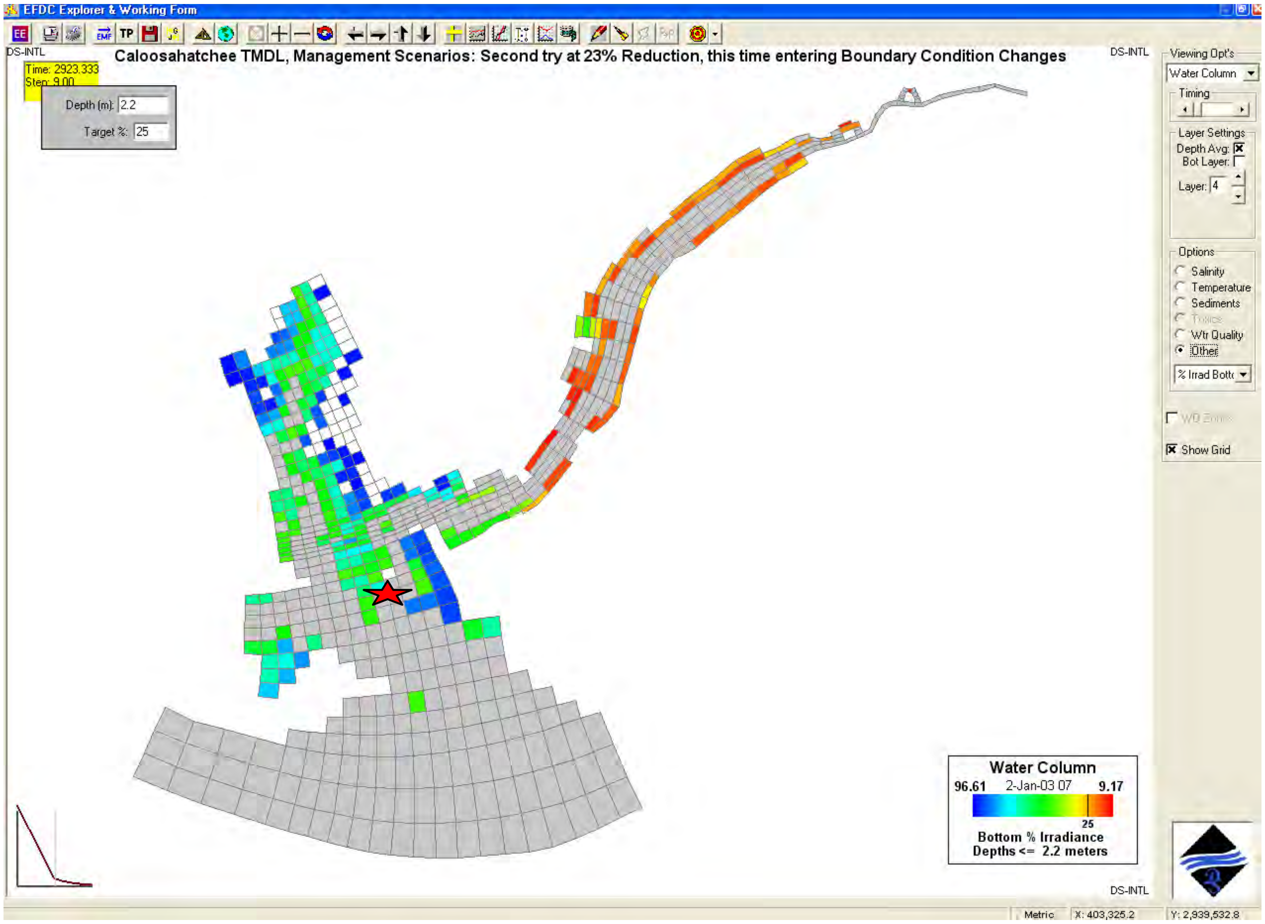
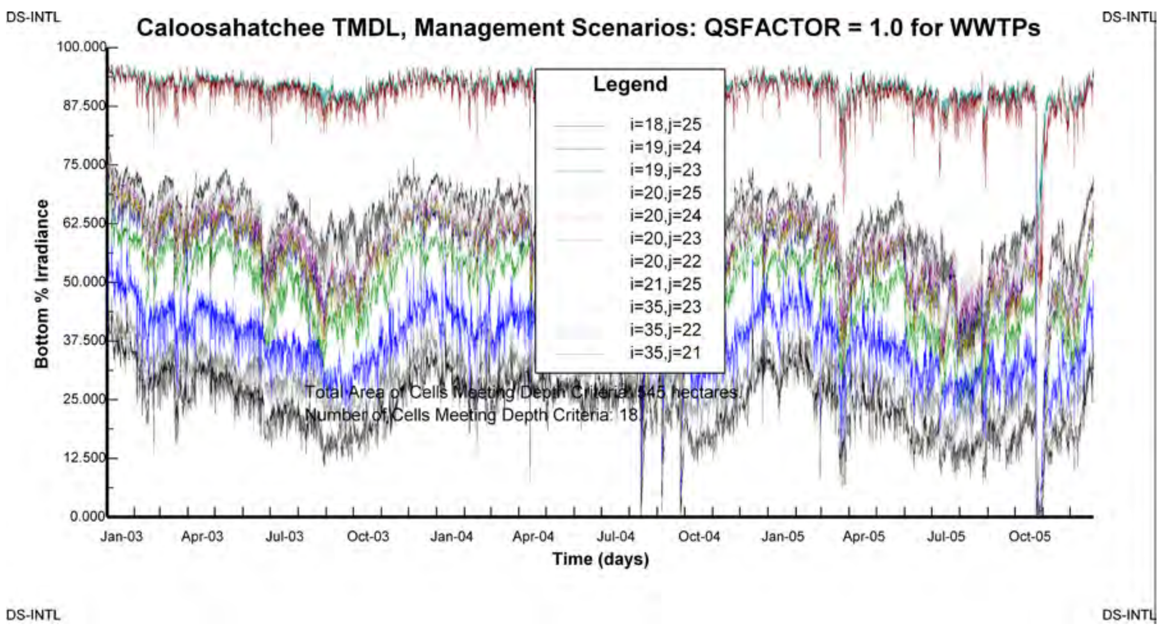


Figure 5.5. Bottom Percent Irradiance for Individual Selected Cells in the San Carlos Region, 2003–05



The goal of light attenuation was to reduce as much as possible (and possibly eliminate) the number of days or months that the submerged seagrass meadows in San Carlos Bay experienced PAR at levels below 25 percent. **Figures 5.6** and **5.7** indicate that even the Background-Plus scenario showed 3 months over the 3-year simulation period where PAR was below 25 percent. The figures also show that the Background-Plus scenario eliminated those periods where 2 consecutive months had average PAR below 25 percent.

The goal was thus to determine a TN reduction that could repeat this, and a 19.8 percent reduction in TN provided such a reduction. The Background-Plus and 19.8 percent TN reduction scenarios also eliminated the single season during the simulation where the seasonal average slightly dipped below 25 percent PAR (see **Figures 5.8** and **5.9**).

As the Background-Plus scenario was equivalent to a 26 percent reduction in TN, it was decided to provide an explicit margin of safety (MOS) by adding 50 percent of the difference between the preliminary target of 20 percent and the Background-Plus level of 26 percent; thus, the proposed TMDL is (20 percent + 26 percent)/2, or a 23 percent reduction in TN.

Figure 5.6. Current Monthly Average Percent Bottom Irradiance (or PAR) at San Carlos Bay

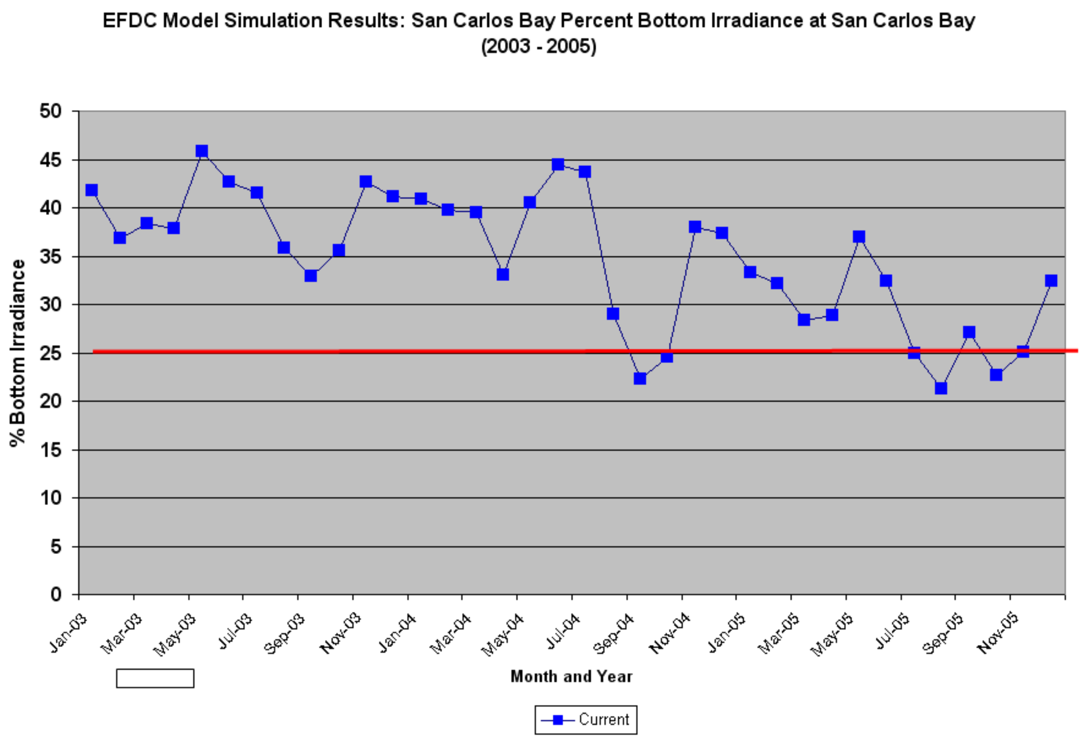


Figure 5.7. Monthly Average Percent Bottom Irradiance for Background-Plus and 19.8 Percent TN Reduction Scenarios

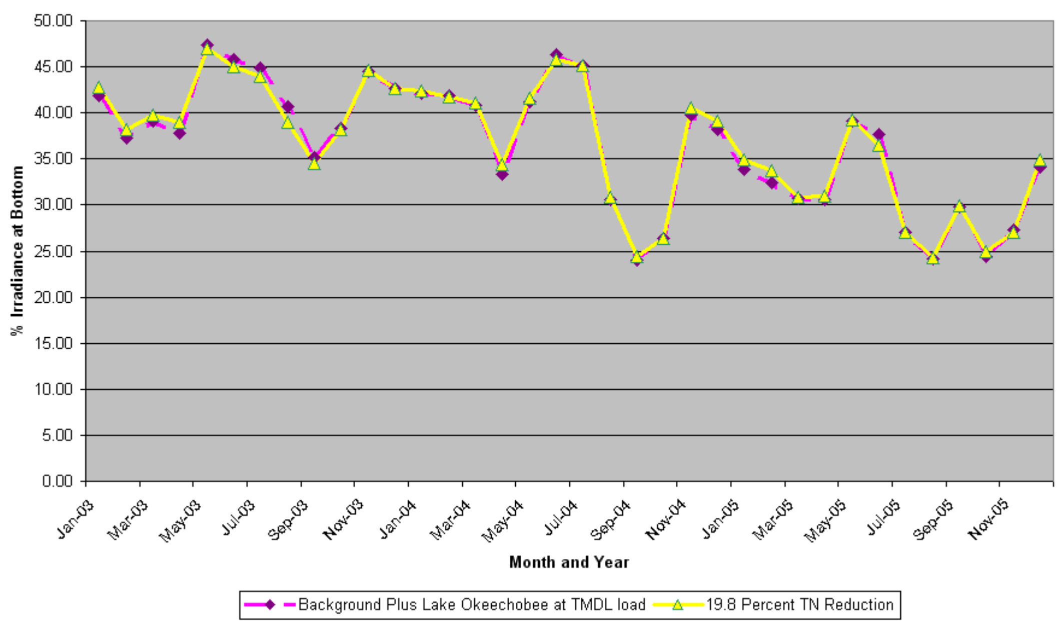


Figure 5.8. Seasonal Average Percent Bottom Irradiance (for Existing Conditions, 2003–05) at San Carlos Bay

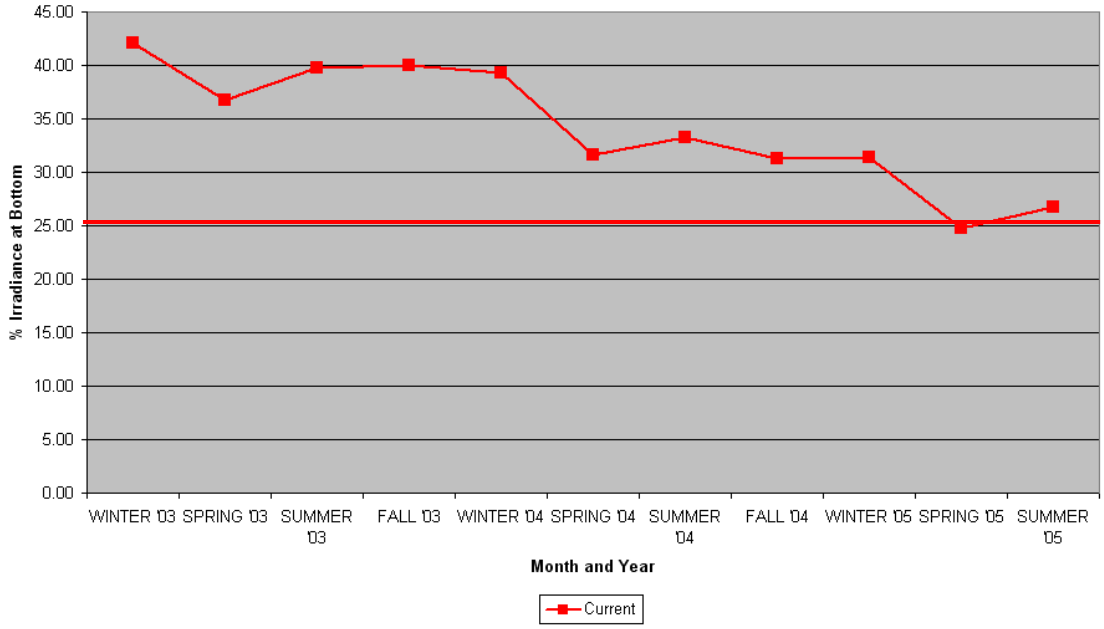
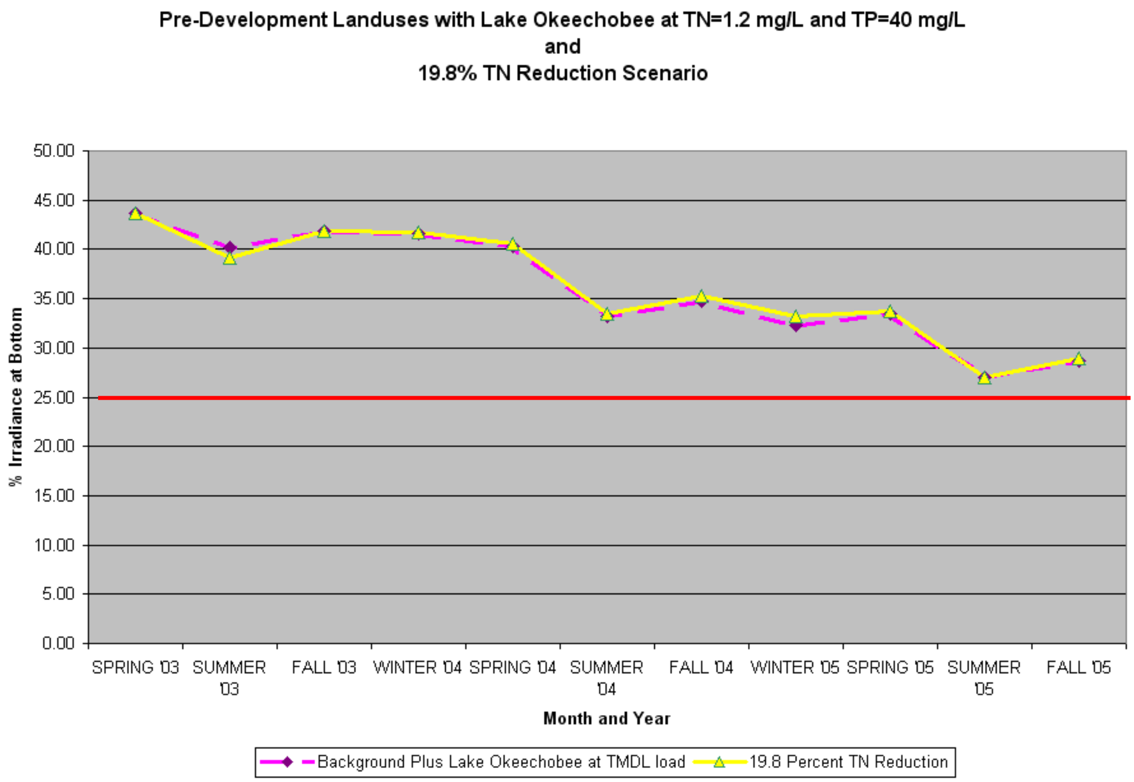


Figure 5.9. Seasonal Average Percent Bottom Irradiance for Background-Plus and 19.8 Percent TN Reduction Scenarios



From the simulated 20 percent reduction in TN, it was shown that the median concentrations of chl*a* and TN for the simulation period were 3.9 μg/L and 0.45 mg/L, respectively. In comparison, recall that Doering and Chamberlain (2005) determined that a healthy chl*a* concentration for San Carlos Bay (to support seagrass meadows and the requisite light percentages) was between 3.2 and 3.9 μg/L. It was also determined from the simulation that in the lower and middle estuary, the median chl*a* concentrations were 6.2 and 7.2 μg/L, respectively, and the TN concentrations were 0.53 and 0.72 mg/L, respectively. The estimated chl*a* concentration is more conservative than the 8 μg/L estimate of Doering and Chamberlain (2005) and consistent with the estimate of Hand et al. (1990), who suggested a TN of concentration of less than 0.7 mg/L in the middle Caloosahatchee Estuary.

5.4 Sources of the Caloosahatchee Watershed Loads

The TN loads reaching the Tidal Caloosahatchee River contain two major components: the load coming into the estuary from the C-43 Canal via the Franklin Lock, and the loads entering the Tidal Caloosahatchee watershed at points downstream of S-79. For the purpose of illustrating the TMDL, the loads obtained from the HSPF Model were divided into four major categories, as follows:

1. *Anthropogenic Caloosahatchee watershed loads;*
2. *Natural background Caloosahatchee watershed loads (predevelopment obtained by modeling all land uses as either wetland or upland forest);*
3. *Loads entering the watershed via Lake Okeechobee; and*
4. *Nonpoint source loads from the WWTFs.*

This division is illustrated in **Tables 5.4** and **5.5** and **Figure 5.9**. Note from **Table 5.4** that 22.4 percent of the upstream load (and 18.5 percent of the entire watershed load) is attributed to watershed anthropogenic activities and preimprovement Lake Okeechobee (category a + b). It is also important to note that 82.5 percent of the load to the Tidal Caloosahatchee arrives from the C-43 Canal, and that the advanced wastewater treatment facilities only contribute 1.2 percent of the total watershed load. **Figure 5.10** summarizes the upstream and downstream loads. With flow from Lake Okeechobee contributing most of the Tidal Caloosahatchee TN load as well as anthropogenic loads, it is anticipated that upstream water quality improvements would play a major role in implementing any required TMDL reduction.

Several scenarios were simulated in the process of evaluating the EFDC Model, including runs with and without point sources (which established the relatively low impact of point sources, as can be surmised by the relatively low percentage of the load they represent). Isolation run simulations set all loads to zero except the load being evaluated (i.e., Tidal Caloosahatchee nutrient flux, S-79 loads, and Gulf Coast impacts). These scenarios, as well as future simulations, may make the model a valuable tool in the Basin Management Action Plan (BMAP) and TMDL implementation phase.

5.5 Critical Conditions

The Tidal Caloosahatchee River and Tributaries TMDL was determined through the simulation of flow and pollutant loads during the entire year, rather than focusing on a critical "low-flow" season or condition. Flow is extremely important in this system, in that flows less than 500 cfs do not adequately maintain the salinity gradient between 0 and 35 parts per thousand (ppt), and flows above 2,800 cfs negatively impact marine seagrasses (Doering et al., 2006). Extreme high flows (> 2,800 cfs) will negatively impact seagrasses in San Carlos Bay. Recent changes in land use have resulted in higher peak flows and volumes during the wet seasons, and lower flows during the dry seasons.

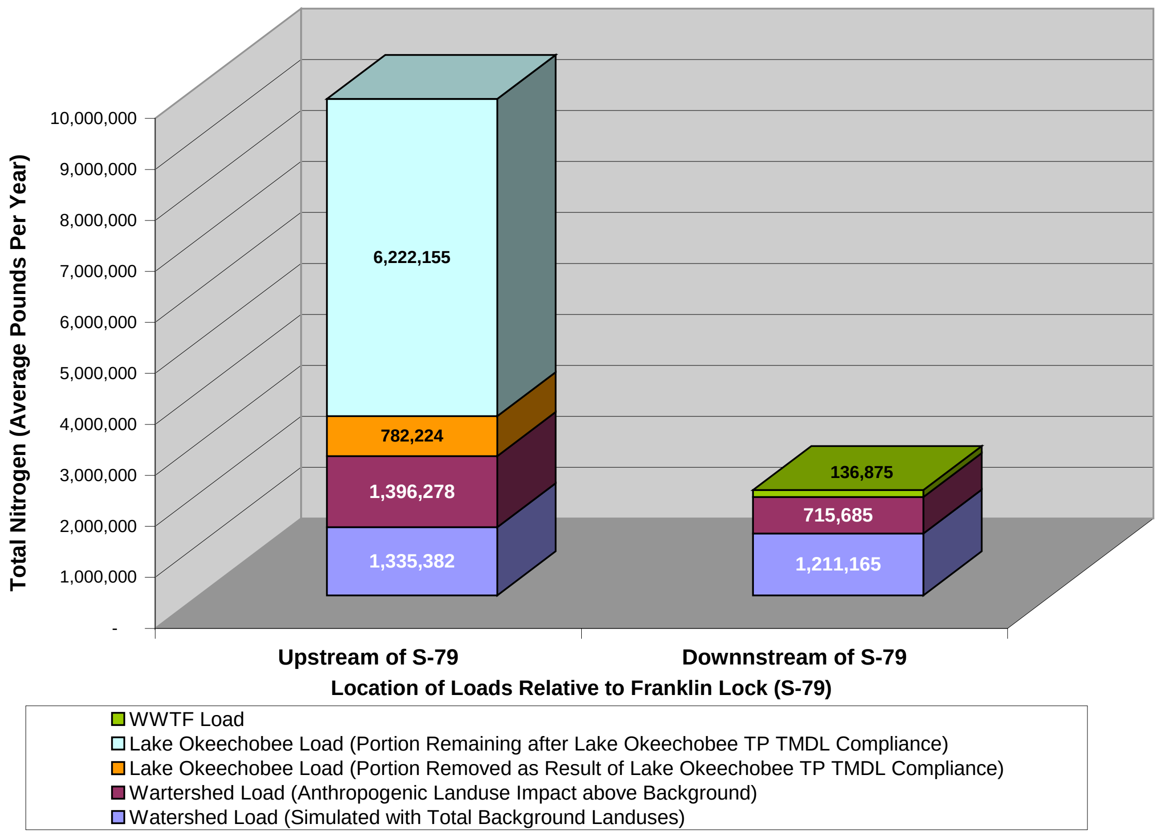
Table 5.4. Simulated TN Loads from Upstream of S-79

Load Source	Pounds per Year	% of Total Upstream (of S-79)	% Entire Watershed Total
a. Portion of TN from Lake Okeechobee predicted to be eliminated as a result of TMDL compliance and other lake improvement activities	782,224	8.0%	6.6%
b. Anthropogenic activities (agricultural, residential, commercial, etc.)	1,396,278	14.4%	11.8%
c. Improved Lake Okeechobee meeting TMDL	6,222,155	63.9%	52.7%
d. Natural background watershed (simulated load if all land use is converted to upland forest and wetland)	1,335,382	13.7%	11.3%
TOTAL:	**9,736,295**	**100%**	**82.5%**

Table 5.5. Simulated TN Loads from Downstream of S-79

Load Source	Pounds per Year	% of Total Downstream (of S-79)	% Entire Watershed Total
a. Point sources (5 wastewater treatment plants)	136,875	6.6%	1.2%
b. Anthropogenic activities (agricultural, residential, commercial, etc.)	715,685	34.7%	6.1%
c. Natural background watershed (forest, wetland)	1,211,165	58.7%	10.3%
TOTAL:	**2,063,827**	**100%**	**17.5%**

Figure 5.10. Tidal Caloosahatchee TN Loads



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:

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

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

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

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 BMPs.

This approach is consistent with federal regulations (40 CFR § 130.2[I]), which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or **other appropriate measure**. The TMDLs for the Tidal Caloosahatchee River and Tributaries are expressed in terms of pounds per year and percent reduction, and represent the amount of TN loading that will reduce the current chl*a* levels to meet required levels (**Table 6.1**).

Table 6.1. TMDL Components and Current Loadings for the Tidal Caloosahatchee River (WBIDs 3240A, 3240B, and 3240C)

Parameter	WLA for Wastewater (pounds/year)	WLA for NPDES Stormwater (% Reduction)	LA (% Reduction)	MOS	TMDL (pounds/year)	Current Loading (pounds/year)
TN	Permitted loads as shown in **Table 4.1b**	23%	23%	Implicit and explicit	9,086,094	11,800,122

6.2 Wasteload Allocation

6.2.1 NPDES Wastewater Discharges

Six domestic wastewater treatment facilities are permitted to discharge treated wastewater to the Caloosahatchee River (**Tables 4.1** and **4.1b**). All these facilities meet AWT standards (Section 403.086, F.S.) for nitrogen and provide more stringent phosphorus removal. Thus, in addition to offering secondary treatment, all of them perform an additional level of nutrient removal. Some also have high-level disinfection and or dechlorination for public access reuse, which is used for urban irrigation. As no facility is expected to cause or contribute substantially to the nutrient load, each is assigned its current permitted load. All must continue to use reuse, deep wells, or other alternatives as required by state or federal permits.

6.2.2 NPDES Stormwater Discharges

The stormwater collection systems are owned and operated by Lee County and co-permittees (city of Cape Coral, city of Fort Myers, town of Fort Myers Beach, and city of Sanibel), all on MS4 Phase I Permit Number FLS000035. 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. It should also be noted that both upstream and downstream anthropogenic sources must be reduced to accomplish the 23 percent TN reduction.

6.3 Load Allocation

The LA is the nonpoint source component of the load, which, combined with WLA stormwater discharges, is responsible for 100 percent of the current load as well as the percentage load reduction. The TMDL is 9,086,094 pounds per year of TN, all of which is allocated to the categories of LA and WLA stormwater. Based on the HSPF and EFDC Model simulations, this represents a TN load reduction of 23 percent.

6.4 Margin of Safety

An implicit MOS is introduced by conservative assumptions such as basing the TN reduction percentage not on matching the overall annual average bottom light irradiance for baseline, but on matching the lowest baseline monthly and seasonal average for bottom irradiance of baseline conditions. This was to not simply meet a numeric average, but to minimize the consecutive days of bottom irradiance to match that of the baseline by linking it to the critical season/month. An added level of protection is provided with an explicit MOS equivalent to 50 percent of the difference between the 20 percent reduction resulting from the computer model simulation and the 26 percent reduction in TN consistent with the Background-Plus scenario. This resulted in an additional 3 percent reduction in TN.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

7.1 Basin Management Action Plan

Following the adoption of this TMDL by rule, the Department will determine the best course of action regarding its implementation. Depending on 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. BMAPs 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 that 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 the following:

- *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 the obligations of wastewater point source, MS4, and non-MS4 stakeholders in TMDL implementation; enhanced transparency in the Department's decision making; and built strong relationships between the Department and local stakeholders that have benefited other program areas.

7.2 Other TMDL Implementation Tools

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. This is 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.

A multitude of assessment tools is 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 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 road map for restoration activities, while still meeting the requirements of Subsection 403.067(7), F.S.

References

Bierman, V. 2008. Telephone and email communications between V. Bierman of LimnoTech and the Department or DSLLC, as well as in Caloosahatchee Modeling Study comments dated September 4, 2008, submitted by the Clean Water Network of Florida, Conservancy of Southwest Florida, and Sanibel Captiva Conservation Foundation.

Corbett, C.A. 2006. Seagrass coverage changes in Charlotte Harbor, Florida. *Florida Scientist 69 (00S2):7–23.*

Corbett, C.A., and J.A. Hale. 2006. Development of water quality targets for Charlotte Harbor, Florida, using seagrass light requirements. *Florida Scientist 69 (00S2): 36-50.*

Corbett, C.A, P.H. Doering, K.A. Madley, J.A. Ott, and D.A. Tomasko. 2005. Issues with using seagrass as an indicator of ecosystem condition. In: Bortone, S.A. (ed.), *Estuarine indicators* (Boca Raton, FL: CRC Press).

Crean, D. 2007. An Analysis of the Water Quality in the Caloosahatchee River Estuary. Paper presented by Dan Crean at December 19, 2007 Research and Water Quality Meeting.

Dixon, L.K. 2000. Establishing light requirements for the seagrass *Thalassia testudinum*. In*:* Bortone, S.A. (ed.), *Seagrasses: Monitoring, ecology, physiology, and management* (Boca Raton, FL: CRC Press).

Dixon, L.K., and G.J. Kirkpatrick. 1999. *Causes of light attenuation with respect to seagrasses in upper and Lower Charlotte Harbor.* Report to the Southwest Florida Water Management District, Surface Water Improvement and Management Program, Tampa, FL, and Charlotte Harbor National Estuary Program.

Doering, P., and R. Chamberlain. 2005. *Water quality in the Caloosahatchee Estuary: Status, trends, and derivation of potential chlorophyll_a goals and associated nitrogen loads.* Deliverable No. 1, Water Quality Report, Florida Coastal Management Program. Grant CZ515.

Doering, P.H., R. Chamberlain, and K. Haunert. 2006. Chlorophyll_a and its uses as an indicator of eutrophication in the Caloosahatchee Estuary, Florida. *Florida Scientist 69(OOS2):51-72.*

Dixon, L.K., and G.J. Kirkpatrick. 1999. *Causes of light attenuation with respect to seagrasses in upper and lower Charlotte Harbor.* Report to the Southwest Florida Water Management District.

Duncan, H. 1995. *Urban stormwater pollutant concentrations and loads.* Chapter 3. Australian Runoff Quality Institution of Engineers, Australia's National Committee on Water Engineering.

Dynamic Solution LLC and Camp Dresser McKee. 2008. *Site specific model selection, preparation, verification, calibration, and validation.* Prepared for the Florida Department of Environmental Protection, Division of Water Resource Management, Watershed Assessment Section, Tallahassee, FL.

Florida Administrative Code. *Rule 62-303, Identification of impaired surface waters.*

———. *Rule 62.302, Surface water quality standards.* Tallahassee, FL.

Florida Department of Environmental Protection. April 2000. *Current biological health and water quality of the Econlockhatchee River and selected tributaries. January and July 1999.* Surface Water Monitoring Section, Orlando, FL.

———. August 2001. *Total Maximum Daily Load for phosphorus: Lake Okeechobee, Florida.* Tallahassee, FL. Available: http://www.dep.state.fl.us/water/tmdl/docs/tmdls/final/gp1/Lake_O_TMDL_Final.pdf.

———. 2003. *Basin status report: Caloosahatchee.* Tallahassee, FL. Available: http://www.dep.state.fl.us/water/basin411/caloosa/status.htm.

———. 2005. *Water quality assessment report: Caloosahatchee.* Available: http://www.dep.state.fl.us/water/basin411/caloosa/assessment.htm.

Florida Watershed Restoration Act. *Chapter 99-223, Laws of Florida.*

Hand, J., V. Tauxe, M. Friedman, and L. Smith. 1990. *Water quality assessment for the state of Florida. Technical appendix.* Tallahassee, FL: Florida Department of Environmental Regulation.

Janicki Environmental Inc. 2003. *Water quality data analysis and report for the Charlotte Harbor National Estuary Program, August 27, 2003.* Available from the Charlotte Harbor National Estuary Program, Fort Myers, FL.

Langan, S.J. 1999. *The impact of nitrogen deposition on natural and semi-natural Ecosystems.* Springer.

McPherson, B.F., and R.L. Miller. 1987. The vertical attenuation of light in Charlotte Harbor, a shallow, subtropical estuary, southwestern Florida. *Estuarine Coastal Shelf Science 25: 21-737.*

———. 1994. Causes of light attenuation in Tampa Bay and Charlotte Harbor, southwestern Florida. *Water Resources Bulletin 30(1): 43-53.*

U.S. Census Bureau. 2000.

———. 2006.

U.S. Geological Survey Website. 2009. *Caloosahatchee River 02293243 Courtney Canal at Cape Coral, FL.* Available: http://pubs.usgs.gov/wdr/2004/wdr-fl-04-2a/pdf/p344-345.pdf.

———. 2009. *Caloosahatchee River 02293241 San Carlos Canal at Cape Coral, FL.* http://pubs.usgs.gov/wdr/2004/wdr-fl-04-2a/pdf/p342-343.pdf).

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 water management districts, along with wetland protection requirements, into the Environmental Resource Permit regulations.

Rule 62-40, F.A.C., also 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.

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 Florida Department of Transportation 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 Program 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 focus 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 to Comments

TO: **Karen Bickford**
Lee County Division of Natural Resources

FROM: **Jan Mandrup-Poulsen**
Dr. Nathan Bailey
Florida Department of Environmental Protection

DATE: **June 19, 2009**

SUBJECT: **Responses to Comments on the FDEP's TMDL for Nutrients in the Estuarine Portion of the Caloosahatchee River (WBIDs 3240 A-C)**

We have received and reviewed your comments regarding the draft TMDL report prepared to address nutrient impairments in the estuarine portion of the Caloosahatchee River. We greatly appreciate your regular participation and contributions! We have addressed your comments in the order in which they were made.

I am submitting comments by e-mail on behalf of Lee County Division of Natural Resources for public record (by Karen Bickford).

1) As previously discussed in our letter to the Department dated September 4, 2008; the County is concerned that confusing or confounded model results may lead to non-achievement of TMDL targets and may make the design and placement process of best management practices more difficult and costly. The August 26th presentation suggested that the historic wetland loading of nitrogen in the Caloosahatchee basin was slightly higher than the current agricultural landuse loading. We do not believe that this is accurate and have consistently commented in the past on the Harper Method and the WMM our concern that these methods over-estimate wetland nitrogen loading and under-estimate agricultural landuse run-off. This may further confuse our ability to reconcile TMDL load reduction goals with actual load reduction when implementing wetland-based BMPs. We are not assured that these concerns have been addressed given the conclusions reached developing the referenced TMDL.

   FDEP Response: The material provided at the end of the revised Chapter 5 of the TMDL report will help illustrate how the loads are broken down. However, as was seen in Everglades West Coast, it is not uncommon for natural loads to be a major component of the loads of a watershed. Although the indicated Harvey Harper event mean concentrations (EMCs) were not explicitly used in the HSPF model, the FDEP is willing to do further investigations into the appropriateness of any variable utilized in its basin modeling process. As part of the ongoing work in this basin, the FDEP intends to work with Lee County and all stakeholders in future TMDL and BMAP phases to enhance the modeled results, a big part of which is the simulated background or natural load, as new or additional information becomes available.

2) In addition, many of the streams west of S-79 are tidal or contain tidal segments. Although classified as Freshwater streams, there are significant periods of time where these segments do not have significant freshwater flow and are dominated by the receiving

water (tidal portion of the Caloosahatchee River). Effectively, the tidal portion of the stream becomes integrated **with receiving** water and has potential to be representative of samples from the watershed as opposed to the receiving water.

FDEP Response: This is an excellent point. FDEP samplers from Tallahassee experienced this when on a recent trip it was observed that flow on Telegraph Swamp freshwater stream at a sample location was either moving in the upstream direction or not flowing at all for an extended period (indicative of tidal influence of the Tidal Caloosahatchee). Recently installed continuous flow monitoring equipment should help to further clarify some of these challenging issues related to continuing analysis of the watershed and sources of loads. This will especially be a focus for the upcoming Caloosahatchee tributary TMDL analysis to be done as part of the 2010 report.

3) *Section 1.2, page 2, line 3* Comment: Typographical error - western Lee County should be: “areas of unincorporated Lee County”

   FDEP Response: The suggested correction was made to the document.

4) *Section 1.2, page 2, paragraph 3, line 1* Comment: “The locks were constructed in the 1930s “ should be: The locks at structures 77 and 78 were constructed in the 1930s, while the locks at structure 79 along with other channel improvements were later completed in 1965 to improve navigation and flood control along the length of the canal.

   FDEP Response: The suggested correction was made to the document.

5) *Section 1.2, page 2, paragraph 3, line 9* Comment: Typographical error - “…through S-77 from Lake Okeechobee.”

   FDEP Response: The suggested correction was made to the document.

6) *Section 1.3, page 6, Table line 3* Caloosahatchee Estuary 3240C Tidal Caloosahatchee Stream 3F Comment: Suggest changing to 3M due to the tidal/estuarine nature of the segment results in radical seasonal swings in salinity west of S-79.

   FDEP Response: A reassessment will be made in the near future, especially considering the recent changes in boundaries for WBID 3240C.

7) *Section 1.3.1 page 6* Comment: Typo remove ‘the”. This included meetings and teleconference discussions between the Lee County and the Department’s Watershed Planning and Coordination Section.

   FDEP Response: The suggested correction was made to the document.

8) *Section 1.3, Page 18, paragraph 2* Comment: As a matter of observation, there are instances where TN values fall and the *Chlorophyll-a* values rise and there are times where there appears to be no influence. This is obviously not necessarily predictable but dependent upon the biological response to sunlight, temperature and nutrient concentrations. Locally, graphical comparisons of nutrient data from year to year at a single station may result in the nutrient concentrations diminishing, yet the *Chlorophyll-a* concentrations increase. Thus, predicting when this type of event occurs is complex at

best and certainly challenges our assessment abilities. Graphing TN against *Chlorophyll-a* may not and did not in the report's effort result in a significant graphic relationship. It has been our experience correlation of the Total Nitrogen and *Chlorophyll-a* relationship may be better developed through a nitrogen mass loading to *Chlorophyll-a* concentration relationship rather than one of concentration to concentration. In this manner, the TN taken up in the production of *Chlorophyll-a* is accounted for in the *l*oading and not just in the instantaneous measurement of the water column.

FDEP Response: We agree. The relationship between chlorophyll_a and total nitrogen on a sample-by-sample basis is extremely difficult to show because of the fluctuations in the levels of other many contributing factors (sunlight, temperature, flow rate, salinity, etc) and thus led to the use of station median concentrations, which resulted in more consistent relationships. As you noted, with time we should gain a more complete understanding of the relationships with loads, which should also provide an improvement. In the exercise outlined in the TMDL report, loads were not used due to a lack of flow data for several of the contributing tributaries. Our data and information will increase over time, hopefully to the point where such a graphical comparison can be attempted.

9) *Section 3.1.1.2 Relationship between DO, Nutrients, and BOD, Page 17, paragraph 1, line 5* Comment: Orange Creek typographical error should be Orange River.

FDEP Response: The suggested correction was made to the document.

10) *Figures 3.1 to 3.14, Pages 20-26* Comment: Graphing parameters that have a large scale disparity (mg/L vs μg/L) causes the smaller scale constituents (TP) to be virtually invisible. It is very difficult to see any trend in the regression analysis.

FDEP Response: We understand this concern; however, the goal of putting several relationships on a single graph was to reduce the number of graphs that the reader had to work through. The use of regression equation and R^2 to summarize the goodness of fit, especially in the case of nitrogen and phosphorus, is a substitute for breaking the graph up into additional graphs.

11) *Figure 3.7, Page 22* Comment: Color and TP are missing from the graphed dataset.

FDEP Response: For some of the WBIDs there was either no data or not enough data (for graphing) for some parameters.

12) *Page 20, paragraph 2, line 2-3* Comment: Typographical error - "…regions is that is that the area…"

FDEP Response: The suggested correction was made to the document.

13) *Page 20, paragraph 2, line 3* RE: "…face the same system fluctuations, such as salinity influxes..." Question: How were these system fluctuations determined (e.g. flow data, streambed characteristics, etc) and are there others besides salinity that were used?

FDEP Response: The statement that you refer to was meant to be a general statement that if we limit the data to specific regions rather than the whole watershed, we are assured that the given region will be experiencing the same

environmental impacts at the time of sampling. For example, if the freshwater-salinity boundary is moving, a WBID-by-WBID comparison of data rather than on a larger scale is a greater assurance that one parameter is being impacted by color or salinity upstream, yet put on same graph with parameters in regions experiencing different impacts. There were no comparisons made on a WBID-by-WBID basis to test this hypothesis.

14) *Page 20, paragraph 2, line 6* Comment: Typographical error - "Thusadded Thus added…"

FDEP Response: The suggested correction was made to the document.

15) *Page 21, Figure 1* Comment: A map in addition to this table (or in the place of this table) that depicts the WBID groupings would be more effective to help the reader verify or understand the concept of the impact of system fluctuations.

FDEP Response: A map has been added to the document to illustrate where the WBID groupings are located.

16) *Figure 3.7, Page 21, Figure 1* Comment: Typographical error - "Table 3.1 WBID groups for assessing relationships nutrient relationships within the Tidal Caloosahatchee"

FDEP Response: The suggested correction was made to the document.

17) *Table 4.1.b, page 29* Comment: TN Concentrations appear to be some sort of average. It seems too anomalous for effluents from the WWTPs south of the river to have the same 2.77 mg/l TN value and those north of the river to have a 0.47 mg/l TN value. It appears that these are permitted values rather than actual annual values as stated in the table. It would be a good idea to cite the sources of these data in conjunction with the Table.

FDEP Response: The 2.77 and 0.47 mg/L represented permitted values and have been removed from the "actual" column in the revised document.

18) *Section 4.2.2.1 Land Uses, page 30, paragraph 1, lines 12-15* RE: "'Wetland' is ranked as the highest percentage of the sub-basins' undeveloped land-use, indicative of the fact that much of the sub-basin was developed around a wetland, a land use where it is not uncommon for the dissolved oxygen concentrations to be naturally low. It should be noted that wetlands are of natural low D.O." Comment: Take into consideration that the Caloosahatchee has been dredged to deepen it, box cut in some places and straightened. That landscape alteration will impact dissolved oxygen quite significantly. Unfortunately we do not have baseline data prior to the alteration to make that comparison. The D.O. values found in deep canals or linear lakes may be comparable at some sample sites in the Caloosahatchee during low/no flow events. This is due to the low D.O. from groundwater interface.

FDEP Response: The alteration to the Caloosahatchee does preclude us from making a straight comparison between present and past wetland conditions that may have promoted low DO. Thus, it becomes more complicated to draw a connection to the low DO observed today. As you state, the lack of data collection before and after channel deepening leaves many questions. Some of these questions can be addressed through additional data collection to determine how much the previous wetland land cover seems like some text is missing here

characteristics on the watershed postdevelopment. The point about the role of ground water in baseflow to possibly influence low DO is also a good question and deserves further consideration and research.

19) *Section 4.3.1 Flow at the Control Structure, page 31* Comment: Paragraph 1 alludes to flows from S-78 and that watershed but there is no mention of S-77 and associated flows (although it is shown in Figure 4.1). The input from Lake Okeechobee to downstream basins is significant in concentration, flow and load and as such should not be omitted from the discussion.

FDEP Response: The paragraph that you refer to has been modified to let the reader know the significant role of flow at S-77.

20) *Figure 4.4 Cumulative historic ground water pumpage rates, page 37* Question: Is the area upstream of S-79 just to S-78 or does it include the watershed to S-77, perhaps it should be specified? Secondly, is this data representative of the general water table quality or is it related to discharge permits and is more indicative of local permit conditions? Should the latter be the case, the values would be biased to the high side and not provide a true representation of potential for the water table aquifer contributions.

FDEP Response: The area upstream of S-79 includes the area feeding into the entire area from S-77 to S-79.

21) *Table 4.4 Flow Measurements of Caloosahatchee by FDEP personnel utilizing Marsh-McBirney and Wading Rod* Comment: There is a typographical error in the table - “Popashe” should be “Popash” and “Pritchet” should be “Pritchett”.

FDEP Response: The suggested correction was made to the document.

22) *Table 4.8 Precipitation Statistics by NEXRAD Zone, page 39* Question: Were these data calibrated using local rain gage stations?

FDEP Response: The NEXRAD rainfall data were developed into 15 precipitation zones in the Caloosahatchee. There was comparison with ground rainfall station data and, as far as is known, there were no large differences between NEXRAD and ground station data. However, this is an area that might benefit from further study and might result in further refinement of the NEXRAD data.

23) *4.4.1.2 HSPF Modeling of Water Quality Calibration. Page 44* Comment: Ambient data does not exclude storm event date, the schedule is made and the samples are collected, if it’s raining or has just rained fine. If it’s not raining or has not rained, that’s fine also. Ambient data allows for natural variability. The only way you could make the statement below is if you evaluated each sample against the weather preceding and at the time of collection. Most of the data utilized in the calibration were ambient data, and does not include the water quality during or immediately after storm events whose impact may be lost particularly for smaller tributaries.

FDEP Response: The sentence that you refer to should be rephrased for greater clarity. The point that was attempted to be made was that storm events, including extreme storm events, are often the major contributors of pollutant loads. Most ambient sampling/monitoring plans are hit or miss (at best), and have a good

chance of missing the impact of load contributions immediately after a major storm. Most sampling involves grab samples obtained during work hours on a weekly or monthly sampling schedule. In Florida, storms are generally high intensity and relatively short in duration; thus, the time span of the storm's runoff impact may be short in comparison to the interval between grab samples. All of the above is stated not to discredit most ambient monitoring plans because they are extremely valuable and in fact the legs which the TMDL Program stands on. However, there are limitations, and uncertainties in load estimation may be the result of inherent sampling limitations as well as due to uncertainties in computer model performance.

24) 5.3 .Light Attenuation Modeling and Results*: Page 57, last paragraph.* Loads or concentration, please state what you are using and reducing, so the paragraph does not get copied and used out of context. Please do this for the rest of the document. This paragraph need some work at least end with a period.

FDEP Response: An additional section was added to hopefully clarify the process that reduced the load and subsequently the concentrations in the estuarine water column. The concentrations were obtained from the model (after reducing the load) to determine if the concentration reductions were consistent with permitting.

25) *Table 6.1 TMDL Components and Current Loadings for Tidal Caloosahatchee River (WBIDs 3240A, 3240B, and 3240C), Page 62* Comment: The SWFFS load reduction goal for the Tidal Caloosahatchee River is 12,000,000 pounds while the proposed 23% TMDL reduction is (23% of 11,671,133 pounds) or 2,684,361 pounds. This assumes the decimal after the 8 in 8,986,772 is actually a comma. However, one may want to verify why there is a difference in the two model efforts as both will be used at the same time and may confuse the average reader.

FDEP Response: Your observations are correct; there can be (and were) different loads and reductions obtained with the modeling efforts. Future efforts to more fully understand these differences can only help in understanding the watershed as well as improving the models. It is definitely important, as you point out, to let the public know that different approaches typically provide different load reductions.

Often the differences are the result of different equations and means of estimations. For example, those models that utilize an event mean concentration of a pollutant may vary with what is understood to come off an agricultural or urban field. And those models that don't use an event mean concentration, but instead utilize a load based on chemical transport phenomena, may rely on differing coefficients driving nutrient transport. The model time step also plays a role in delivering different results.

The EFDC model is a model with a time step of a fraction of a minute, whereas other models such as WMM (for the same area) are based on annual or monthly loads. But the FDEP feels the main reason for differences between the SWFFS study and the FDEP TMDL is the different periods of record. The EFDC model simulated the Caloosahatchee Basin loads over a 3-year period (2003–05), while the SWFFS was for a longer and different period. Also important is what the land uses were during the period of record. The goal and challenge is to sift through these differences in

results from modeling approaches and time spans to get the information required to implement stated load reductions, and this can be part of the BMAP phase.

26) *Section 6.2.2 NPDES Stormwater Discharges, page 62* Comment: This implies the non-point sources not under control of the MS4 will be added to the MS4 WLA for model purposes and this will be discovered during the development of the BMAP. Otherwise, the MS4 will be burdened with removing more than practicable as the load and load reduction were developed from all land uses and activities.

FDEP Response: This was meant to convey that only those areas where the permittee has control over for the MS4 is included. For example, the load from an adjacent farm that does not discharge into the MS4 system, but directly into the stream or estuary or canal (not part of the MS4 system), is not the responsibility of the permittee. This is not added to the MS4 WLA. Another way to look at it is that the TMDL requires a 23% reduction of the Total Nitrogen load to the Tidal Caloosahatchee (WBIDs 3240A, 3240B, and 3240C), which means that the combined load reduction from the MS4 system, the non-MS4 loads such as agriculture or from areas not within MS4 control, as well as the flow from upstream of S-79 sources (including the required Lake Okeechobee reductions), must be equivalent to 23%. A new table has been added to the end of Chapter 5 to help illustrate this. Table 6.1 was also changed to explicitly have 23% in the LA column, which also emphasizes the above. The allocation of which entity is responsible for what percentage is part of the upcoming BMAP phase.

27) *Section 6.3 Load Allocation (LA), Page 62* Comment: This section directly contradicts the statements in 6.2.2 above, as it requires the MS4 to be responsible for 100% of the non-point load. Thus, the "other non-point sources" are part of the MOS which is part of the final MS4 load allocation. This for instance, could be attributable to atmospheric deposition and would add to the total load, thus should be added to the MS4 load allocation. Otherwise, the non-point source input adds to the residual and the TMDL goal cannot be attained.

FDEP Response: As stated above, MS4 permittees will not be required to be responsible for all of the nonpoint source reductions*.*

28) Lee County looks forward to working with the Florida Department of Environmental Protection on the development of this TMDL and the upcoming Basin Management Action Plan. We are dedicated to providing assistance in any way possible and appreciate the efforts and cooperation of the Department to date. We are also interested in obtaining written responses to our questions and comments at your earliest convenience.

FDEP Response: The FDEP is extremely fortunate to have had the benefit of participation from Lee County throughout the Tidal Caloosahatchee TMDL development process. The extremely valuable comments provided above are symbolic of their continued valuable contribution. We welcome and look forward to a continuation of Lee County's participation in the BMAP process, as well as in the development of TMDLs that will be required in the year 2010.

June 17, 2009

Ms. Rae Ann Wessel
Natural Resource Policy Director
Sanibel Captiva Conservation Foundation
(Via E-mail)

Re: FDEP's Responses to Public Comments

Dear Ms. Wessel,

We would like to thank you for your active participation in the development of the Total Maximum Daily Load for nutrients in the estuarine portion of the Caloosahatchee River. Your comments and suggestions were well founded and always appreciated. We have used the point raised in your letter of March 16th, 2009 to enhance the quality of the draft document that was presented at the public workshop on February 27th. We address your comments in the order in which they were made.

1) ***Dissolved Oxygen***

The Department has characterized the dissolved oxygen (DO) problems in the river as a natural condition and has indicated that it will not establish limits for DO in this TMDL, siting that nutrient reductions will have a positive influence on DO. While we agree that in general nutrient reduction will positively affect DO we do not agree that the low DO condition in the Caloosahatchee is natural. Rather we believe that there was insufficient 24 hour data used to evaluate DO in the unique configuration of the river. SCCFs real time autonomous sensor monitoring network, RECON (://recon.sccf.org/index.shtml), clearly shows that DO periods of anoxia are related to high flow events that cannot be characterized as natural and are actively being addressed in order to reduce high flows. In the same manner that the TMDL modeling assumed that the Lake Okeechobee discharges are meeting their TMDL the system should be modeled using optimum flows to reveal the impact of flows on anoxic conditions and distribution in the river.

We feel that the unique configuration of the river and periods of anoxia related to high flows as well as the presence of two endangered species the Manatee and Smalltooth Sawfish make this parameter of significant importance in the establishment of the TMDL for the Caloosahatchee estuary and, later this year, the TMDL for the Caloosahatchee tributaries.

Additionally, there are ongoing studies assessing the impact of sediment oxygen demand in the Caloosahatchee that could provide additional information that needs to be considered with flow and the modeling of the freshwater portion of the river. At a minimum we urge the DEP strike any language suggesting that low DO in the estuary is a natural condition and suggest that the TMDL recognize the need for addressing DO as additional data, including 24 hour DO monitoring and SOD results, become available in order to evaluate the need for a TMDL for dissolved oxygen.

The reviewer makes an excellent point that new continuous dissolved oxygen (DO) data are now available for incorporation into the Caloosahatchee estuary modeling efforts that were not available in time to be used when the modeling study was being designed and conducted. Although time did not permit the assembly of data from 2008 for a model simulation incorporating the recent continuous DO data, the recommendation to continue research into the natural DO concentration in the region is a good one, and recent intensifying of data collection in the tidal Caloosahatchee may help with this effort. In fact, additional data are being gathered (we now have continuous DO data gathered at Marker 52 for the period 5/13/08 through 5/2/09) and anticipate receiving additional sediment oxygen demand results in the near future. The FDEP plans to continue its monitoring, data analysis, and modeling efforts during the implementation of the Basin Management Action Plan (BMAP) for the Caloosahatchee Estuary and as part of future TMDL development and refinement activities in this basin.

To help address the concern about whether the DO levels in the estuary can naturally fall below the state's DO criterion, we examined other monitoring data collected at stations in southwest Florida to determine the natural ranges for DO in this area of Florida. Continuous DO measurements (recorded at 30 minute intervals) were obtained from three sites with low levels of anthropogenic activity. Data from these sites, maintained by the Rookery Bay National Estuarine Research Reserve System (NERRS) was retrieved and processed to obtain daily minimum and daily average concentrations. Stations included the Middle Blackwater River for the 2001 – 2006 period, Faka Union Bay for the 2002 – 2006 period, and Fakahatchee Bay for the 2002 – 2006 period. According to the continuous monitoring data reported at these three sites, DO concentrations were below the Class III daily minimum marine criterion of 4 mg/L 45 (Faka Union site) to 75 (Middle Blackwater River site) percent of the time. The Class III daily average marine criterion of 5 mg/L was not met between 40 (Fakahatchee Bay site) and 65 (Middle Blackwater River site) percent of the time. The DO data for geographically proximal estuaries with relatively little anthropogenic activity demonstrate that it is quite likely there are naturally low DO concentrations in the SW Florida region. Attached you will find a map of the reference sites used to make this assessment, as well as summaries of the land use types in each watershed. Further details about these regional DO levels and a complete summary of the Caloosahatchee DO assessment can be found in TMDL Appendix G, which is available on the FDEP's TMDL web page at: http://www.dep.state.fl.us/water/tmdl/docs/tmdls/draft/gp3/appendices-caloosa-6-16-09.pdf, starting on page 99.

We certainly share your stated concern about the impacts of high freshwater flows that enter the system from Lake Okeechobee and other tributaries to the estuary, but as was discussed at several of the public workshops, this TMDL is not intended to address the impacts tied to the released of freshwater further up in the watershed. Those activities are driven by the schedules established by the Corps of Engineers and the SFWMD in support of protecting the public health and welfare and are beyond the scope of the TMDL.

2) Additionally, there are ongoing studies assessing the impact of sediment oxygen demand in the Caloosahatchee that could provide additional information that needs to be considered with flow and the modeling of the freshwater portion of the river. At a minimum we urge the DEP strike any language suggesting that low DO in the estuary is a natural condition and suggest that the TMDL recognize the need for addressing DO as additional data, including

24 hour DO monitoring and SOD results, become available in order to evaluate the need for a TMDL for dissolved oxygen.

To reiterate the response to Comment 1, FDEP believes the recommendation to continue the data analysis and modeling efforts during the Phase 4 implementation of the Basin Management Action Plan (BMAP) is an excellent one. But the FDEP has reviewed all existing SOD data obtained through recent SFWMD funded studies, and the observed flux values obtained from these studies are consistent with the SOD fluxes in the EFDC simulation model used for the tidal Caloosahatchee Nutrient TMDL. A more complete review of the comparison is provided in Appendix G.

3) ***Model Assumptions***

In our previous comment letter we questioned the selection criteria and assumptions used relative to agricultural BMPs. As we noted at that time the modeling made assumptions about the application of bmps that are neither part of any permit nor monitored or reported. The presentations showed use of bmps in the S4 basin and west of the lake where some of the heaviest loading to the Caloosahatchee is known to originate. The model runs done subsequent to our letter did not address these bmp assumptions which we believe has caused the modeling to underestimate the loading from these basins. We would request that the model be run excluding any bmp that is not part of a permit condition that includes monitoring and compliance conditions.

Additionally, we must note for the record that the model assumes discharges from Lk O to the Caloosahatchee are meeting the lake TMDL of 40 ppb phosphorus or 140 metric tons/year despite the fact that these conditions are unlikely to be achieved decades from now. Lake O averages 500-600 metric tons annually and in 2005 received 900 metric tons. While making these assumptions helps to parse out the basin contribution it underestimates the conditions that the Caloosahatchee will be facing for decades to come.

At the October 2008 stakeholders meeting, a figure was presented illustrating the areas that were assigned BMPs in the HSPF model. The amount of agricultural land that was assigned BMPs in the HSPF model was only 9% of the total agricultural area. The reduction in total nitrogen loads attributed to agricultural BMPs is less than 1% of the watershed load (and this does not include the total nitrogen loads direct to the surface of the estuary or the load from Lake Okeechobee releases). Nevertheless, the FDEP agrees that there must be a greater level of verification of which agricultural BMPs are used, where they are being used, and the level of implementation and their effectiveness. These issues will be further addressed in the BMAP process.

4) ***Nitrogen***

Based on work by Chamberlin & Doering, the Charlotte Harbor National Estuary Program (CHNEP), the Caloosahatchee River Watershed Protection Plan and Janicki (2003) we believe the nitrogen TMDL is a reasonable target not withstanding our concerns about some of the model assumptions noted above.

The FDEP appreciates your comments relative to the Tidal Caloosahatchee Total Nitrogen TMDL, and also seeks your continued assistance and involvement in the TMDL development process as we move into the phase of TMDL development for the upper Caloosahatchee, Caloosahatchee tributaries, and the Basin Management Action Plan and Implementation phases.

Corrections

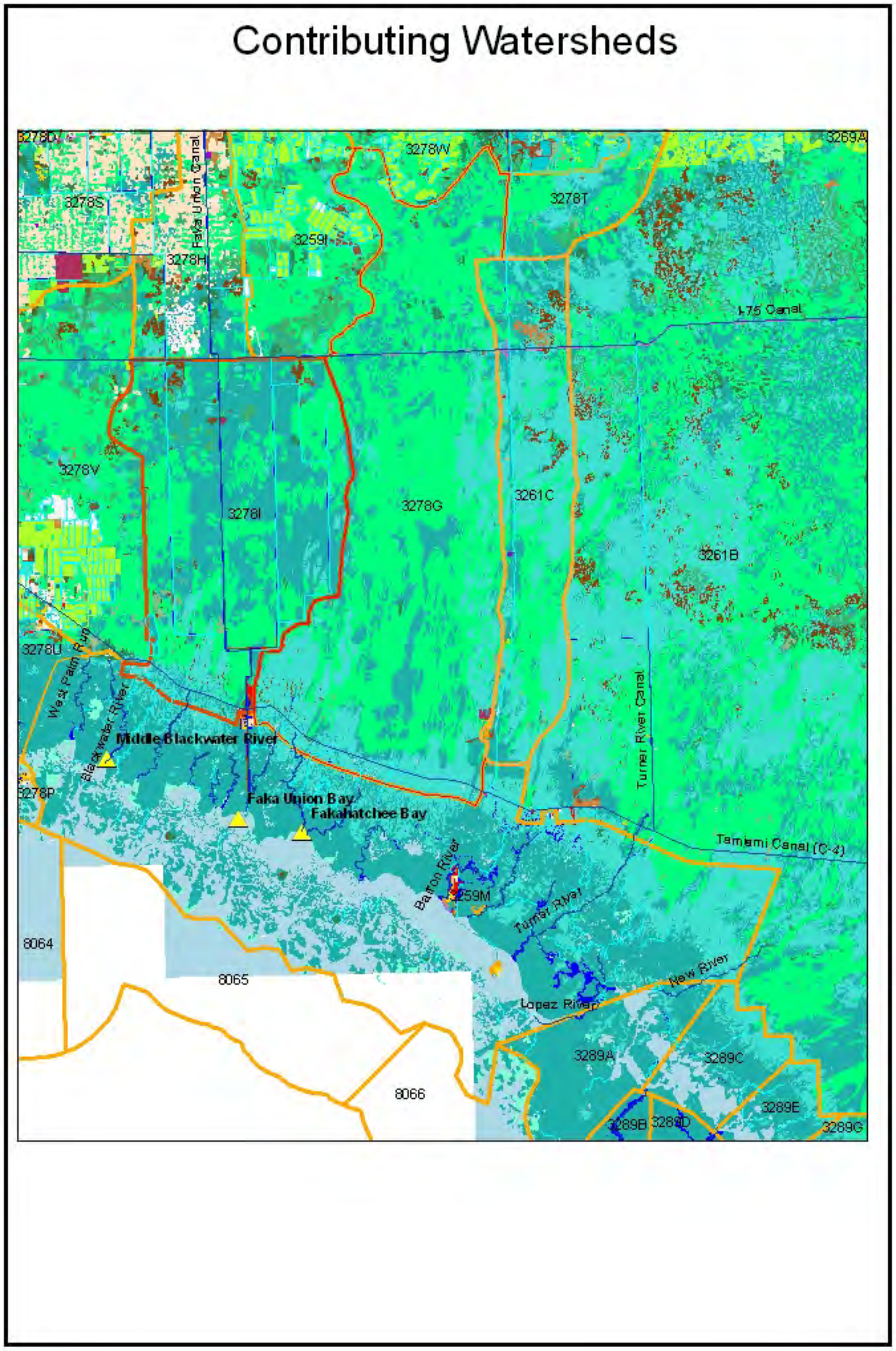
We also note corrections in the description of the Caloosahatchee on page two of the Draft TMDL Report. The river is approximately **75** miles long; 15.5 miles from Moore Haven to Ortona, 27.9 miles from Ortona to Franklin and 33.2 miles from Franklin to San Carlos Bay. The WP Franklin Lock and Dam was completed in 1965.

The above listed corrections have been made to the Draft TMDL document.

In conclusion, your participation in the nearly two-year long TMDL development process has been invaluable to the Department. We look forward to continuing to work with you in the near future.

Sincerely,

Jan Mandrup-Poulsen, Administrator
Watershed Evaluation and TMDL Section
Florida Department of Environmental Protection



Land use summary of contributing watersheds

Mr. Kevin Carter, South Florida Water Management District (SFWMD)
Comments received via e-mail on March 16th, 2009
Draft TMDL report for nutrients in the Caloosahatchee River Estuary

SFWMD Comment 1: We recommend FDEP describes more clearly how "the percentage of bottom irradiance" in Figures 5.3 through 5.5 is obtained in the Environmental Fluid Dynamics Code (EFDC) model. The light attenuation target for a healthy sea-grass meadow in San Carlos Bay is set at a minimum 25% photosynthetically active radiation (PAR) at 2.2 meter depth, which is at the deep edge of the bed. It is critical that the model cells used for this calculation have a mean depth of about 2.2 meters in San Carlos Bay. Otherwise, the modeling results may show an over- or under- estimation of the light requirement, and consequently influence TN load reduction calculations.

Good point, and the recommended clarification was made to the document and should add to the document's transparency. It also makes clear some of the assumptions and potential areas of improvement for the modeled light attenuation, as we move forward.

The criteria of 2.2 meters depth for San Carlos Bay was used to select grid cells within the San Carlos Bay polygon for the analysis of the bottom light available as a function of time for each grid cell that met the depth criteria. The total water column depth of a grid cell, which varied with tidal stage, was used for comparison to the 2.2 meter depth criteria for extraction of the data. Grid cells that had a water column thickness less than or equal to 2.2 meters depth criteria were selected for the analysis. The selected grid cells thus represented a depth range that characterized potential seagrass bed habitat. The bottom light irradiance presented in Figures 5.2 through 5.5 represent the monthly average of the percentage of light available at the bottom with data extracted at the model output interval for each of the grid cells that met the depth criteria for San Carlos Bay. What is <u>not</u> shown in the figures is the 95% confidence interval, or range, of bottom irradiance extracted for the grid cells that met the depth criteria for each monthly interval. The average value for the month is used as the indicator of compliance with the 25% PAR criteria for bottom irradiance for a given management scenario

The depth of the cell actually is the average depth of the cell. Thus, there is an inherent lack of precision that is a function of all spatial models, which although more precise than lumped models, are limited by the grid size. Of course, more grids require/assume more data collection and input. More grids also require more computation time. As a future iteration, it might be of benefit to further reduce the grid sizes for those grids in San Carlos Bay. But for the present model, a 2.2 m depth grid cell most likely includes depths both greater than 2.2 m and less than 2.2 m. The EFDC model thus includes an assessment of all grids with an average depth of 2.2 m or less, with the grids being often 400m x 400 m and greater in dimension. The value of reducing the grid size as well as altering the selection criteria can be determined in the future when further model refinements and improvements are considered.

SFWMD Comment 2: The new light attenuation algorithm in the EFDC model relating chlorophyll <u>a</u>, turbidity, and color, to % irradiation at depths within the estuary water column is based on an empirical regression analysis. We recommend the uncertainties involved in the regression analysis, such as the importance of variables other than chlorophyll <u>a</u> be discussed in more detail. For example, how is the uncertainty of these other variables factored into the TMDL Margin of Safety.

Very Good points. As with all empirical equations, there are uncertainties involved. As recommended, this section has been added to the beginning Chapter 5.1.

Light attenuation in the EFDC model is computed as a function of inorganic suspended solids, detrital particulate organic matter, chlorophyll a and a background color-dependent light extinction coefficient. The attenuation coefficients for inorganic suspended solids, detritus and algae chlorophyll a, which can be found in several water quality modeling textbooks (Thomann & Mueller, 1987; Chapra, 1997; Lung, 2001), are based on the work of Di Toro (1978). The color-dependent background light extinction coefficient is based on the work of McPherson and Miller (1994) from studies in Tampa Bay and Charlotte Harbor. The spatial variation of color used to define background light extinction was based on the average distribution of color in the Caloosahatchee estuary as reported by Crean (2007). The light attenuation algorithm used in EFDC did not use the McPherson and Miller derived coefficients for turbidity and chlorophyll since turbidity can not be estimated from the EFDC state variables for inorganic solids or detrital particulate organic matter

Although the Margin of Safety is designed to make the TMDL more conservative, it cannot compensate for all uncertainties associated with the assessment. Although lengthy research (as described above) was done to increase the level of confidence in the model, computer algorithms based on empirical equations always carry a degree of uncertainty. The calibration and validation exercises were one way the modelers sought to decrease uncertainty. Although the regression equations on which the mathematical model is based could make the analyses results either too protective, or not protective enough of the environment, the Margin of Safety prefers to err on the conservative side regardless. As part of the iterative investigative process for the Caloosahatchee, it might also be beneficial to perform an additional series of sensitivity analyses as part of the future considerations for improving the model.

The recommendation to investigate the uncertainty, or sensitivity, of the light attenuation results in relation to the Margin of Safety for the TMDL determination for nutrient loading is a good suggestion. This is a good recommendation to consider for future modeling efforts by FDEP as work continues on this estuary during Phase 4 [i.e., implementation of the Basin Management Action Plan (BMAP)] for the Caloosahatchee estuary. As an important component of light attenuation in the Caloosahatchee estuary is the spatial and temporal variability of color, future EFDC modeling efforts can be directed towards evaluations of light attenuation results for different management scenarios under “dry” and “wet” hydrologic conditions using the color data compiled by Crean (2007).

June 16, 2009

Ms. Linda Young
Clean Water Network
(Via E-mail)

Re: FDEP's Responses to Comments on the Caloosahatchee Estuary TMDL Report

Dear Ms. Young,

We greatly appreciate the time you have spent working with the Florida Department of Environmental Protection in developing the Total Maximum Daily Loads as part of the initiative to reduce nutrients going to the estuarine portion of the Caloosahatchee River. We have reviewed the comments (provided in blue) contained in your e-mail of March 16th and have addressed them in the order in which they were presented. We found your comments and suggestions to be very helpful in improving the overall quality of the draft TMDL report as it was presented at the final Caloosahatchee TMDL workshop on February 27th.

1) **THE TMDL SHOULD INCORPORATE LIMITS FOR DISSOLVED OXYGEN**

In its public presentations and meetings on the subject, FDEP has indicated that it will not develop limits for dissolved oxygen (DO) for inclusion in the final TMDL. The Department's conclusion is based solely on the outcomes from several model runs which show little or no difference between DO levels under existing conditions, and DO levels which would exist under "baseline" conditions.[1] However, at this stage, there is no data or information to indicate whether or not the model is appropriately sensitive to changes in DO levels. Absent further analysis, FDEP's determination that the Caloosahatchee naturally experiences low DO levels, and consequently its decision to exclude criteria for DO from the TMDL, is premature and lacks scientific support.

The results for DO from the Caloosahatchee model for existing and baseline conditions indicate that the model is relatively insensitive to substantial changes in nutrient loadings from the watershed. Computed daily minimum DO is less than 4 mg/L almost 50 percent of the time in the bottom water layer (Layer 1). In contrast, computed daily minimum DO in the surface water layer (Layer 4) is less than 4 mg/L less than 10 percent of the time. This behavior is consistent with DO control by air-water exchange in the surface layer and by sediment oxygen demand (SOD) in the bottom layer. If this is the case, then computed DO would be expected to be relatively insensitive to changes in nutrient loadings from the watershed.

[1] According to FDEP, "baseline" conditions are those which would exist (a) if there were no point source loads into the Caloosahatchee, (b) if the land-based loads into the Caloosahatchee were set to reflect "pre-development" land uses, and (c) if Lake Okeechobee meets its TMDL criteria for phosphorous.

It is reasonable that computed DO in the surface layer would be controlled by air water exchange. It is also reasonable that SOD would be an important controlling factor in the bottom layer, but not the only controlling factor. Water column processes such as nitrification, algal respiration, and exertion of CBOD would also be expected to be important. Given the insensitivity of computed bottom layer DO to substantial reductions in nutrient loadings from the watershed in the Caloosahatchee model, further investigation of the influence of SOD seems warranted.

Dr. Bierman has suggested that the first step may be to compare computed daily SOD values for 2003-2005 to available field measurements for SOD. It is understood that the most recent SOD measurements do not overlap this time period, but these data will still be useful if model versus data comparisons are made for medians, 25th and 75th percentiles, and ranges. The next step is to conduct sensitivity analyses for 2003-2005 in response to plus/minus variations in SOD values computed by the model. The magnitude of the variations in SOD should be informed by results of the model versus data comparisons, but suggested ranges would be plus/minus 30-50 percent. This would be simpler and more straightforward than post-processing model output to determine the components of DO sources and sinks.

The results from these two suggested steps would indicate whether the SOD values in the calibrated/validated model are reasonable, and they would also provide information to help assess whether the insensitivity of computed bottom layer DO to changes in nutrient loadings from the watershed is reasonable. Depending on the findings, further investigation may be warranted.

Finally, although we realize that FDEP contemplates that the nutrient TMDL will have an indirect impact on the low DO levels in the Caloosahatchee, the parties urge the Department not to rely on this assumption. It is crucially important for future pollution-reduction planning in the Caloosahatchee watershed, as well as for Florida water policy in general, that *all* existing impairments are properly identified, new water quality limits established, and appropriate pollution reducing actions taken. To dismiss the low DO levels a “natural condition” and consequently, to not properly address this issue through the TMDL process, will only create further confusion and mistrust, as well as increasing levels of pollution in Florida’s waters. We strongly urge that FDEP reconsider its decision to exclude DO limits from the nutrient TMDL.

Response:

At your suggestion, since the time of the final TMDL workshop held in February, the FDEP has greatly expanded the documentation used to support our position that the periodic low dissolved oxygen concentrations measured in the Caloosahatchee Estuary are comparable to those seen in other more natural systems in South Florida. We have examined several data sets from more natural estuarine systems also located in Southwest Florida and were able to validate the hypothesis that the low dissolved oxygen levels recorded in the Caloosahatchee are not unexpected, and are indeed consistent in their distribution with those data evaluated from sites maintained by the Rookery Bay National Estuarine Research Reserve System (NERRS). These sites and our analyses are described in further detail at the end of the response to this comment.

As noted by Dr. Bierman, sensitivity analyses are good tools for determining whether a computer model is properly responding to environmental stimuli. In the case of the Caloosahatchee model, an especially important sensitivity analysis is one which includes DO and SOD. Such an analysis was carried out in the development of the EFDC Caloosahatchee model where three different sediment oxygen demand (SOD) values were tested and it was found that phytoplankton Chl a, ammonia, orthophosphate, nitrate and dissolved oxygen were responsive to these changes.

The EFDC modeling of dissolved oxygen, as with other parameters, included calibration and validation which, based on our best professional judgment, were determined to have acceptable results. The FDEP thus utilized the calibrated/validated EFDC model to assess the dissolved oxygen (DO) impairment. This detailed assessment is shown in Appendix G (enclosed). As was noted, the use of the computer model demonstrated that there was no significant difference between the baseline+ (background conditions with Lake Okeechobee at TMDL compliance) and the current conditions (2003 through 2005). Thus, using the background conditions as the lowest practical target for nutrient reductions, the modeling effort resulted in the conclusion that dissolved oxygen levels would still not meet the Class III marine criteria.

The recommendation to use the available benthic flux data for sediment oxygen demand (SOD) to check the results generated by the EFDC sediment diagenesis model is a good one. An excellent opportunity for such a check was provided by the data obtained through two very recent SFWMD funded studies. The first of these studies was titled "The Characterization and Quantification of Benthic Nutrient Fluxes in the Caloosahatchee River and Estuary." This study, carried out by the University of Massachusetts-Dartmouth School of Marine Science and Technology (SMAST) in February 2008, involved the collection of sediment cores at 50 stations distributed throughout the three main segments of the Caloosahatchee River and Estuary. The second SFWMD funded study was carried out by the University of Maryland Center for Environmental Sciences (UMCES). This study was designed to conduct *in situ* chamber incubations at three sites in the Caloosahatchee Estuary to compare in situ measurements to sediment core flux measurements. ("An Assessment of Processes Controlling Benthic Nutrient Fluxes in the Caloosahatchee River and Estuary and the St. Lucie Estuary River and Estuary, August 2008"). The FDEP compared the results of these studies to the simulated SOD by the EFDC model. Under the existing condition scenario, the 25th and 75th percentile SOD fluxes for sampling stations CES04 – CES11 simulated by the EFDC model ranged between -2.1 and -0.76 g/m^2/day over a three-year simulation period. SOD fluxes from the SMAST and UMCES field studies conducted in February 2008 were generally in the -1.5 to -0.5 g/m^2/day range. Both studies did report

sites where there was a net oxygen production. Thus, the TMDL modeled SOD fluxes utilizing the EFDC model were not inconsistent with the February 2008 field measurements, especially considering the recent studies occurred over a brief period (February 2008), while the model simulated daily SOD over a three-year period. Additional details about this comparison are in the TMDL report (see Appendix G.)

As further SOD field data are collected, more comparisons between modeled SOD and observed SOD can be carried out by simulating those years when data are collected and extracting and post-processing the SOD results at selected grid cells that correspond to the benthic flux station locations. The recommendation for the sensitivity analysis of SOD is not a particularly straightforward effort since SOD is internally simulated in the EFDC model as a function of particulate organic matter deposition and a large number of kinetic coefficients that govern diagenesis in the bed. It is not immediately obvious what coefficient(s) or parameter(s) in the sediment diagenesis model should be adjusted to derive a plus/minus variation of 30 to 50 percent. This recommendation could be implemented easily if SOD were not internally simulated, but rather was externally specified for input to the EFDC model as is done for the WASP7 model.

There are other dissolved oxygen monitoring stations in Southwest Florida that can be used in determining the natural ranges for DO in this area. Continuous DO measurements (recorded at 30-minute intervals) were obtained from three sites with low levels of anthropogenic activity. Data from these sites, maintained by the Rookery Bay National Estuarine Research Reserve System (NERRS) were retrieved and processed to obtain daily minimum and daily average concentrations. Stations included the Middle Blackwater River for the 2001–2006 period, Faka Union Bay for the 2002–2006 period, and Fakahatchee Bay for the 2002-2006 period. According to the continuous monitoring data reported at these three sites, DO concentrations were below the Class III daily minimum marine criterion of 4 mg/L at the Faka Union site 45% of the time and 75% of the time at the Middle Blackwater River site. The second prong of the Class III marine criterion (5 mg/L, as a daily average) was not met between 40 (Fakahatchee Bay site) and 65 (Middle Blackwater River site) percent of the time. This compares to the EFDC model results which showed, for the period 2003 through 2005, that the Caloosahatchee Estuary was below the 4 mg/L criterion between 12% and 18% of the time for existing conditions and between 12% and 19% of time for background condition scenario. The DO data for geographically proximal estuaries with relatively little anthropogenic activity demonstrate that it is quite likely there are naturally low DO concentrations in the SW Florida region. Attached you will find a map of the reference sites used to make this assessment, as well as summaries of the land use types in each watershed. Further details about these regional DO levels and a complete summary of the Caloosahatchee DO assessment can be found in TMDL Appendix G, which is available on the FDEP's TMDL web page at: http://www.dep.state.fl.us/water/tmdl/docs/tmdls/draft/gp3/appendices-caloosa-6-16-09.pdf, starting on page 99.

2) PROPOSED REDUCTION IN TOTAL NITROGEN IS NOT PROTECTIVE

In the TMDL document, FDEP has proposed a 23 percent reduction in total nitrogen in order to achieve its target, 25 percent bottom irradiance. The proposed reduction is based on the Department's conclusion that a 19.8 percent reduction in total nitrogen is sufficient to meet the selected target for bottom irradiance, plus an explicit margin of safety.

The parties urge FDEP to consider a more significant reduction in total nitrogen. FDEP's model runs indicate that, in order to achieve baseline conditions, total nitrogen must be reduced by **26 percent**. Accordingly, we urge FDEP to adopt 26 percent as its target reduction in total nitrogen. FDEP has chosen as its starting point a 19.8 percent reduction, without providing the public with any justification for that target. Neither the parties, nor Dr. Bierman, have performed an independent analysis of the proposed reduction in nitrogen, however, the Department's own model simulations indicate that the 19.8 percent reduction in nitrogen is not sufficient to eliminate at least three discrete violations of the target for bottom irradiance. Moreover, these model simulations assume that Lake Okeechobee is meeting the phosphorous limits established in its TMDL, an event which is not likely to happen in the immediate future. FDEP's reliance on a 19.8 percent reduction in nitrogen is arbitrary, lacks scientific support, and does not accomplish the chosen targets for bottom irradiance. In order to have a meaningful effect on nutrient levels in the Caloosahatchee, the parties urge FDEP to incorporate a 26 percent reduction in total nitrogen.

Response:

As you have pointed out, the 19.8% reduction in the nonpoint source total nitrogen load as simulated in the watershed model HSPF made a significant advancement toward the bottom irradiance goal of minimum 25% at a 2.2 meter depth in San Carlos Bay as simulated in the Hydrodynamic computer model EFDC. The points below clearly outline FDEP's rationale for the 23% reduction in Total Nitrogen.

Both the 19.8% reduction in TN, as well as the baseline simulation (which included only pre-development land uses as well as a Lake Okeechobee flow into the basin at TMDL nutrient compliance levels) resulted in three monthly average bottom irradiance levels below the target minimum of 25%. In fact, the simulated 19.8% reduction in total nitrogen resulted in monthly irradiance levels which essentially matched the baseline monthly irradiance, both of which decreased the number of events when light did not meet the 25% minimum from six to three.

It is not the goal of the TMDL Program to return any watershed to a pristine condition, but rather (as required by statute and rule) we are to ensure that designated uses and water quality standards are met. The Department is further directed to determine whether a waterbody does not meet water quality standards at all times, in part or totally, due to natural conditions. In the case of the Caloosahatchee Estuary, the Department has clearly made this demonstration and the nutrient reductions identified are fully supported by the TMDL report and modeling that are available for your review. By way of a reminder, with Dr. Bierman's concurrence, the agreed upon goal of the baseline simulation was to determine a level of nutrient load below which human development could not be held accountable. To further meet this goal, the FDEP proposed that an additional 3% reduction (representing of 50% of the load separating the modeled 19.8% load reduction and the baseline TN load reduction) to provide an acceptable and additional explicit margin of safety (MOS) on top of the model-derived load reductions to be assigned to the contributing sources impacting water quality in the basin.

In summary, the TMDL is a tool to set the goals for pollutant reductions needed to attain standards, or in this case, the standard as translated into the transparency target. Florida law's regarding water quality do not allow the Department to reduce pollutant loading to levels lower than natural conditions. The attainment of the water quality target under natural land uses and a fully restored Lake Okeechobee is equivalent to the TMDL

required reductions without the explicit margin of safety. Therefore, even without the margin of safety, the TMDL limits loading to the amount which will result in achieving natural transparency conditions. If you add the margin of safety to account for any uncertainty, the TMDL provides the appropriate reductions to attain Florida's water quality standards.

3) CONTINUED CONCERNS ABOUT THE MODEL

Finally, the parties would like to reemphasize our continuing concerns related to the calibration of the Caloosahatchee Model. In our prior comment letter of September 4, 2008, and continuing forward, the parties have consistently urged FDEP to (a) calibrate the model to accurately reflect wetlands as non-polluting land uses; and (b) to calibrate the model to reflect a more accurate BMP implementation rate. To our knowledge, FDEP has not addressed these concerns.

In our September 4 letter, the Clean Water Network of Florida, the Conservancy of Southwest Florida, and the Sanibel Captiva Conservation Foundation requested that wetland loading rates be set at zero for all wetland land use areas in all applications for the model, including both the pre-development and existing land use conditions. We noted that because wetlands take runoff from adjacent upland land uses, they can have a significant amount of input in nutrient pollution loading. Wetlands are nutrient reducers - they uptake more nutrients than they produce, notwithstanding the fact that they may seasonally temporarily naturally export nutrients, on an annualized average. Accordingly, we strongly suggested running scenarios where wetland land uses are not attributed a positive pollutant load value. We also urged FDEP to attribute a zero or negative loading rate for natural wetland land use categories for all analysis and TMDL efforts going forward. In our recent discussions with FDEP on this subject, the parties were told that, in response to our concerns, the Department would conduct a watershed-wide mass balance analysis for all land cover types including wetlands and that the Harper concentration rates would not be used. If that has not been done, the parties would continue to have strong outstanding concerns that the loading rates are, in some cases, grossly inaccurate, specifically for natural wetland land cover types. We would like written confirmation from FDEP, with supporting documentation, that a mass balance approach was in fact utilized in the Caloosahatchee TMDL modeling, in order to allay our concerns with regard to this matter.

The parties have also consistently expressed concern that an unrealistic and inaccurately high level of agricultural BMP implementation was assumed for the purposes of the modeling analysis in the development of this TMDL. Because there is little data to support the actual implementation rate and the pollutant removal efficiencies of such BMPs, we requested that the model be calibrated to create a more conservative analysis which includes *only* BMPs that are required and enforceable through a permit by a regulatory agency because, in fact, these are the only BMPs which could realistically be assumed to actually be implemented and maintained. Since September, FDEP has not addressed our concerns, and we again urge FDEP to correct the model to reflect only those BMPs that are enforceable through a permit from a regulatory agency.

Response:

The Department does not consider the wetlands in question to be "sources of pollution." However, as we have previously discussed, all contributing land uses (including wetlands) must have the appropriate loads going to the waterbodies included in the model. At the October 2008 stakeholder meeting, HSPF results were presented, showing the unit loads (i.e., pounds per acre per year) for the various land use types considered in the HSPF model. This presentation showed that the wetlands nutrient loads were lower than any other land use category, including forest and rangeland, and far lower than for agricultural and urban land uses. The nutrient loads for wetlands appeared to be consistent with values from a CH2M HILL/AQUA TERRA technical memorandum provided by Dr. Bierman to Chris Wallen of Dynamic Solutions. In the model, wetland land use accounts for 18% of the watershed area, but only 9% of the watershed load of total nitrogen (which does not include direct input of total nitrogen to the surface of the Tidal Caloosahatchee Estuary, nor the load of total nitrogen from Lake Okeechobee releases).

Your stated desire to model wetlands with a zero or negative load is understood and possibly feasible for some water quality models. However, this was not an approach that could be used with the models selected or for the modeling process adopted for setting the Caloosahatchee TMDL. By way of explanation, a wetland can be seen to produce a negative load if one looks at it from a comparative perspective (i.e., a wetland replacing or even in series with an urban area results in a negative net load). Also, a wetland can be seen to produce a zero load if one sets natural load as being zero (the baseline). But, if one looks at it from the perspective of absolute load and recognize that all land uses produce a load, even natural land uses (because of dead leaves, sediments from wind and water driven erosion, upstream land uses, etc), then wetlands produce a load to the receiving waterbody. As we described at one of the public meetings, it is from this perspective that models, including the HSPF model, assign a load to the wetlands land uses.

The FDEP welcomes your comments and wants to work with you to make sure that future evaluations or modeling appropriately handles wetlands in a way that will satisfy your concerns. As you know, there are spatially distributed models that are based on detailed placement of landuse types with respect to a map, and there are lumped models that simulate watersheds by putting all the particulars of basins (areas, major slopes, major soil horizon thickness, land uses, rainfall, etc) into general equations, providing flow and load as output. The HSPF model is the latter type. Both types of models have their differences, and one disadvantage of the lumped model is that different spatial arrangements of land uses (i.e., urban draining to a wetland) within the basin are not directly simulated. Some of the impacts of these arrangements are approximated

through the results of a rigorous calibration/validation process. It is agreed that wetlands situated downstream of anthropogenic land uses are not given credit for reducing the load of the upstream source. It is the challenge to a modeler to identify such wetland situations and to appropriately adjust the anthropogenic and wetland loads such that this positive wetland impact is simulated, regardless of what model is selected. The FDEP appreciates and encourages your continuing assistance in our efforts to examine in as many ways as necessary the flows and loads coming to the Caloosahatchee River and Estuary.

In closing, the FDEP is very appreciative of the active participation by you and the Clean Water Network staff throughout the Tidal Caloosahatchee nutrient TMDL development process. The final product has been greatly enhanced by this participation and FDEP strongly urges your continued presence as we move into the Basin Management Action Plan (BMAP) phase.

Sincerely,

Jan Mandrup-Poulsen, Administrator
Watershed Evaluation and TMDL Section
Florida Department of Environmental Protection

July 10, 2009

Delivered by Electronic Mail
Mr. Jan Mandrup-Poulsen
Administrator, Watershed Evaluation and TMDL Section
Florida Department of Environmental Protection
2600 Blairstone Road, Mail Station 3555
Tallahassee, Florida 32399-2400

Re: Response to Comments on the draft Nutrient TMDL Report for the Caloosahatchee Estuary, OCG Case Number 08-2291

Dear Mr. Mandrup-Poulsen:

Thank you for your response, dated June 16, 2009, to the comment letter submitted by Clean Water Network of Florida, Inc. and Conservancy of Southwest Florida, regarding the draft nutrient TMDL for the Caloosahatchee Estuary. Although your response did address some of the issues raised in the letter, we continue to have serious concerns with the Draft TMDL report, and especially the Department's decision not to develop limits for dissolved oxygen. Accordingly, Clean Water Network of Florida, Inc. (CWN of FL) respectfully submits the following additional comments for the administrative record. We again urge the Florida Department of Environmental Protection to consider these comments in order to assure that the final report is comprehensive, representative, and based on the best available science.

THE TMDL SHOULD INCORPORATE LIMITS FOR DISSOLVED OXYGEN

The Florida Department of Environmental Protection (FDEP) continues to advocate the position that dissolved oxygen (DO) is naturally low in the Caloosahatchee estuary, and therefore FDEP will not develop limits for DO for inclusion in the TMDL. The CWN of FL joins the Conservancy of Southwest Florida in its continued objection to this conclusion.

In your June 16 response to our comment letter, and in the TMDL report, FDEP has supported its conclusion that low DO is natural to many of the hydrologic systems in Southwest Florida, and specifically in the Caloosahatchee estuary, by comparison to several sites maintained by the Rookery Bay National Estuarine Research Reserve System. This comparison is flawed. FDEP has presented the Rookery Bay estuary as a natural model system, one with few anthropogenic impacts. However, WBIDs 3278I (Faka Union South), 3278G (Fakahatchee Strand), 3261C (Barron River Canal), and 3261B (Tamiami Canal), all impaired for DO, flow into the Rookery Bay estuary, and therefore impact its water quality. The presence of these impaired waterbodies, coupled with the extensive agricultural activities in the surrounding land area, suggests that the Rookery Bay estuary is not an appropriate model system for comparison, and does *not* support the conclusion that waterbodies in Southwest Florida experience naturally low DO.

In contrast, there is evidence to suggest that the Caloosahatchee River and estuary *are* impaired for DO. As one example, in a 2003 study of the Caloosahatchee, Janicki Environmental, Inc. found that water quality in the river has steadily *declined* over time. The study found there were significant temporal trends over the past 10-15 years, with increases in Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS) and turbidity, fecal coliform bacteria, many species of nutrients, and relatedly, a *decrease* in DO levels. Furthermore, Doering and Chamberlain (1998) and Janicki Environmental Inc., (2002) found that Total Nitrogen (TN) and Total Phosphorous (TP) were elevated in the Caloosahatchee compared to statewide median concentrations, reference site concentrations, and historical data (for TP),[2] suggesting that other factors may be influencing DO in the watershed.

Additionally, in 2005 the Environmental Protection Agency (EPA) proposed a draft TMDL for the Caloosahatchee, including at least one WBID in the tidal Caloosahatchee.[3] The TMDL report documents low DO levels throughout the Caloosahatchee river and estuary and lists a number of sources which contribute to the depletion of in-stream DO, including the Fort Meyers Central Waste Water Treatment Plant, which discharges directly into the estuary; stormwater from Lee County, the City of Cape Coral, and the City of Ft. Myers; fertilizers and animal waste from the agriculture in the surrounding land area; and runoff from septic tanks in residential communities. The TMDL report does not attribute the low DO levels to natural conditions.

Ultimately, in excluding limits for DO from the TMDL, FDEP is taking the first step toward delisting the tidal Caloosahatchee from the state 303(d) List, in reliance on its position that the DO is naturally low. EPA's 2008 listing guidance recommends that states *should* list waters which exceed water quality criteria based on a combination of anthropogenic *and* natural sources.[4] Thus, even if we accept that DO is naturally low in the Caloosahatchee estuary, the extensive urban, suburban, and agricultural activities in the land area surrounding the estuary have a documented effect on DO levels that must be addressed.

FDEP's conclusion that low DO is natural to the watershed is unreasonable and lacks support. We strongly urge FDEP to reconsider its decision to exclude DO limits from the TMDL.

THE PROPOSED REDUCTION IN TOTAL NITROGEN IS NOT SUFFICIENTLY PROTECTIVE OF WATER QUALITY

FDEP has proposed a 23 percent reduction in total nitrogen in order to achieve its target, 25 percent bottom irradiance. The proposed reduction is based on the Department's conclusion that a 19.8 percent reduction in total nitrogen is sufficient to meet the selected target for bottom irradiance, plus an explicit margin of safety.

We continue to urge FDEP to adopt a more significant reduction in total nitrogen. In your June 16 response to our comment letter, FDEP noted, "[i]t is not the goal of the TMDL Program to return any watershed to a pristine condition, but rather (as required by statute and rule) we are to ensure that designated uses and water quality standards are met." However, as we have routinely asserted, the proposed 23 percent reduction in total nitrogen does not ensure that the Caloosahatchee estuary will attain water quality standards. To the contrary, the Department's own model simulations indicate that the reduction in nitrogen is not sufficient to eliminate at least *three* discrete violations of the target for bottom irradiance. Moreover, these model simulations assume that Lake Okeechobee is meeting the phosphorous limits established in its TMDL, an event which is not likely in the immediate future. In order to have a meaningful effect on nutrient levels in the Caloosahatchee, we continue to urge FDEP to incorporate a more significant reduction (26 percent) in total nitrogen.

CONTINUED CONCERNS ABOUT THE MODEL

[2] Caloosahatchee Estuary and Charlotte Harbor Conceptual Model, May 22, 2006. Tomma Barnes, SFWMD. Darren Rumbold, SFWMD, Mark Salvato, USFWS.
[3] PROPOSED TOTAL MAXIMUM DAILY LOAD (TMDL) For Nutrients, Biochemical Oxygen Demand and Dissolved Oxygen In the Caloosahatchee River Basin. US EPA Region 4. September 2005.
[4] *Information Concerning 2008Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions*, Sec. 8 (October 12, 2006) < http://www.epa.gov/owow/tmdl/2008_ir_memorandum.html>.

Finally, in our previous comments, both in person and in writing, CWN of FL has consistently urged FDEP to (a) calibrate the model to accurately reflect wetlands as non-polluting land uses; and (b) to calibrate the model to reflect a more accurate BMP implementation rate.

In your June 16 response to our comment letter, FDEP indicated that it could not, with the model selected, attribute loading rates from wetlands at a zero or negative load. CWN of FL joins Conservancy of Southwest Florida in suggesting that a different model be used that could model wetlands with a zero or negative load, as this process would hold vast implications for the outcome. Assessing natural wetlands as being net exporters, expressed as an annualized average positive load value, greatly inflates the load estimated for the natural predevelopment conditions of the area. If the natural predevelopment conditions are the reference target for load reductions, this would result in percentage load reductions which are ultimately insufficient to truly restore water quality conditions. FDEP should not confine itself to a model that does not provide an opportunity for the incorporation of the best available science, which recognizes that wetlands have a negative net nutrient load.

With respect to our second concern, that the model be calibrated to reflect a more accurate BMP implementation rate, FDEP did provide any response in its June 16 response letter. We have consistently expressed our concern that an unrealistic and inaccurately high level of agricultural BMP implementation was assumed for the purposes of the modeling analysis in the development of this TMDL. Because there is little data to support the actual implementation rate and the pollutant removal efficiencies of such BMPs, we requested that the model be calibrated to create a more conservative analysis which includes *only* BMPs that are required and enforceable through a permit by a regulatory agency because, in fact, these are the only BMPs which could realistically be assumed to actually be implemented and maintained.

CONCLUSION

Thank you for your careful consideration of our comments. We hope FDEP will consider incorporating these suggestions into both the Caloosahatchee model and its future modeling and TMDL efforts for other impaired water bodies across Florida. If you have any questions, please feel free to contact us by phone, (850) 222.8701, or email, llyoung2@earthlink.net.

Sincerely,
Linda L. Young
Director
Clean Water Network of Florida, Inc.

July 16, 2009

Ms. Linda L. Young, Director
Clean Water Network of Florida, Inc.
1229 N. Duval Street
Tallahassee, Florida 32303
(Via E-mail)

Re: FDEP's Responses to Comments on the Caloosahatchee Estuary TMDL Report
(Second Set of Comments dated July 10, 2009)

Dear Ms. Young,

We greatly appreciate your continuing commitment to work with the Florida Department of Environmental Protection in developing the Total Maximum Daily Loads as part of the initiative to reduce nutrients going to the estuarine portion of the Caloosahatchee River. We have reviewed the comments (received via e-mail on July 10th) and appreciate your recommendations for improving the overall quality of the draft TMDL report.

As we noted in the draft TMDL report and in our response letter of June 16th, even after all the detailed modeling work and data analyses we shared with you and the stakeholder group, we were still unable to make a meaningful distinction between the naturally occurring dissolved oxygen levels in the Caloosahatchee Estuary from those that may result from anthropogenic source contributions. We agree that it is important to continue to pursue this line of inquiry, and as has been noted, there are on-going initiatives to gather data (e.g., flow data by the USGS and SOD data from the SFWMD) that will allow us to refine the model inputs over time. In addition, although this TMDL report was not explicitly written to address dissolved oxygen, logically DO can only improve with the reductions that are called for in total nitrogen concentrations (as well as the reductions required of total phosphorus in the Lake Okeechobee TMDL). We thank you for reminding us of the TMDL proposed by EPA in September, 2005. We have reviewed that report and believe it will be very useful as we move forward in preparing additional TMDLs as part of the upcoming Group 3 basin effort. As you know, the EPA's report did not address the mainstem of the Caloosahatchee, but rather two of the waterbodies included in the report are tributaries to the estuarine portion. Although neither of these (Daughtrey Creek and Billy Creek) tributaries were verified as impaired for dissolved oxygen or nutrients in the first round of adopted lists, it was because they had not been previously targeted for data collection. Since then, it appears clear that there are sufficient data to support having both of these waters listed due to low DO concentrations.

As we have discussed previously, dissolved oxygen is not a pollutant, rather its concentration levels are a reflection of many outside factors (including biological, chemical, and physical). By having this TMDL require significant reductions in Total Nitrogen (and co-incidentally improvements in Total Phosphorus and Biochemical Oxygen Demand will be realized), the anthropogenic components (urban, suburban, and agricultural loads) you noted in your comments will be addressed. As you and I have personally discussed on many occasions, the impacts to the downstream waters are heavily dependent upon the restoration progress being made in the Lake Okeechobee watershed. However, regardless of the levels of success in achieving either the Lake Okeechobee or the Caloosahatchee TMDLs, the amount of flow being released (a physical factor outside the control of this TMDL) to the system will continue to play a prominent role in determining the DO levels in the river.

The Department remains committed to finding the levels of reduction of nutrients in the Caloosahatchee that fully meet the requirements of state and federal law. We have noted in the draft TMDL report that even when we applied the full natural background conditions to the light penetration module, the same number of events occur when the target light levels are not expected to be achieved. In both cases (i.e., the 23 and 26 percent reductions), the periods during which the failure to meet the preferred target occurs is brief enough that the seagrasses should not be adversely affected.

Regarding your and the Conservancy's continuing concern over the way we've addressed the loading from wetlands, I apologize if we failed to clarify the issue sufficiently. The model selection process was thorough and exhaustive. Hundreds of thousands of dollars have been expended by the Department to create enhancements to widely-used hydrodynamic and water quality models that then allowed us to generate the outputs needed to relate nitrogen levels to algal growth and to sunlight penetration, thus allowing us to predict the reductions needed to achieve restoration and protection of the seagrasses in San Carlos Bay. It is our stated intention to continue to work to improve our overall understanding of the Caloosahatchee River system when we pursue the completion of the Group 3 TMDLs scheduled for next year.

As part of the Basin Management Action Plan process, it will be a priority to gather new data on existing and planned Best Management Practices throughout the watershed. As this information becomes available, we can add it into the model to further enhance its predictive capabilities.

The FDEP and its partners look forward to your continuing participation in the upcoming Caloosahatchee nutrient TMDL implementation process.

Sincerely,

Jan Mandrup-Poulsen, Administrator
Watershed Evaluation and TMDL Section
Florida Department of Environmental Protection

ec: Jennifer Nelson
Jennifer Thera
Drew Bartlett
Meredith Fields
Nathan Bailey
Wayne Magley

July 16, 2009

Ms. Jennifer Hecker
Natural Resource Policy Manager
Conservancy of Southwest Florida
1450 Merrihue Drive
Naples, Florida 34102
(Via E-mail)

Re: FDEP's Responses to Comments on the Caloosahatchee Estuary TMDL Report
(Second Set of Comments dated July 9, 2009)

Dear Ms. Hecker,

We greatly appreciate your continuing commitment to work with the Florida Department of Environmental Protection in developing the Total Maximum Daily Loads as part of the initiative to reduce nutrients going to the estuarine portion of the Caloosahatchee River. We have reviewed the comments in your letter of July 9th (and identical e-mail) and appreciate your recommendations for improving the overall quality of the draft TMDL report.

As we noted in the draft TMDL report and in our response letter of June 16th, even after all the detailed modeling work and data analyses we shared with you and the stakeholder group, we were still unable to make a meaningful distinction between the naturally occurring dissolved oxygen levels in the Caloosahatchee Estuary from those that may result from anthropogenic source contributions. We agree that it is important to continue to pursue this line of inquiry, and as has been noted, there are on-going initiatives to gather data (e.g., flow data by the USGS and SOD data from the SFWMD) that will allow us to refine the model inputs over time. In addition, although this TMDL report was not explicitly written to address dissolved oxygen, logically DO can only improve with the reductions that are called for in total nitrogen concentrations (as well as the reductions required of total phosphorus in the Lake Okeechobee TMDL).

Regarding your continuing concern over the way we've addressed the loading from wetlands, I apologize if we failed to clarify the issue sufficiently. The model selection process was thorough and exhaustive. Hundreds of thousands of dollars have been expended by the Department to create enhancements to widely-used hydrodynamic and water quality models that then allowed us to generate the outputs needed to relate nitrogen levels to algal growth to sunlight penetration, thus allowing us to predict the reductions needed to achieve restoration and protection of the seagrasses in San Carlos Bay. It is our stated intention to continue to work to improve our overall understanding of the Caloosahatchee River system when we pursue the completion of the Group 3 TMDLs scheduled for next year.

As part of the Basin Management Action Plan process, it will be a priority to gather new data on existing and planned Best Management Practices throughout the watershed. As this information becomes available, we can add it into the model to further enhance its predictive capabilities.

The FDEP and its partners look forward to your continuing participation in the upcoming Caloosahatchee nutrient TMDL implementation process.

Sincerely,

Jan Mandrup-Poulsen, Administrator
Watershed Evaluation and TMDL Section
Florida Department of Environmental Protection

ec: Jennifer Nelson
Jennifer Thera
Drew Bartlett
Meredith Fields
Nathan Bailey
Wayne Magley

Mr. Pat Fricano, Former FDEP Basin Coordinator

Below you will find our comments on the Draft Nutrient TMDL for the Caloosahatchee Estuary:

Page 2, first paragraph, 1st line: Regarding class 1 waters, suggest indicating that the class 1 waters only extend from S-79 to the Lee / Hendry County line.
FDEP Response: The TMDL document has been changed to emphasize the aerial extent of Class 1 waters.

Page 2, second paragraph, 4th line: SFWMD **does not** operate S-77, 78 or 79. They were **constructed and are owned and operated** by the US Army Corps of Engineers.
FDEP Response: The document was revised to reflect this. The Corps and SFWMD to work collaboratively concerning fresh water release schedule and quantity, but as you correctly indicated, the structure is owned and operated by the Corps.

Page 3, last paragraph, 2nd line: The statement on what the BMAP will do is not accurate. The BMAP will aim to reduce the nutrient inputs into the Tidal Caloosahatchee, which will **"hopefully"** lead to increased DO levels. DO levels cannot be deliberately increased unless aerators are installed the water column, which could be achieved if necessary, irrespective of nutrient reductions.
FDEP Response: BMAP impact on DO has been removed from document. Although it is generally accepted that the reduction of nutrient can have a positive impact on dissolved oxygen, it is agreed that such a reduction does not always lead to increased dissolved oxygen. Indeed, in the case of the WBIDs for which this TMDL is being developed, this lack of correlation observed in modeling of the basin is the reason a DO TMDL is not being developed.

Page 4, Figure 1.1, figure label: The figure is incorrectly labeled as being the "Tidal Caloosahatchee", when it is in fact a map depicting the entire watershed; not just the tidal portion. Furthermore, the map is a bit busy; recommend that the WBID lines be deleted for the purpose of showing only the major geopolitical features and tributary creeks plus major structures.
FDEP Response: The map (Figure 1.1) has been altered to incorporate the above suggestions.

Page 5, Figure 1.2: Suggest the icon representing the S-79 structure be made more obvious (i.e. larger) on the map.
FDEP Response: This map has been removed, as other maps serve the same purpose.

Page 6, Figure 1.3: Suggest the icon representing the S-79 structure be made more obvious (i.e. larger) on the map.
FDEP Response: This map has been removed, as other maps serve the same purpose.

Page 8, Table 1.2: This table is not cited anywhere in the report's text.
FDEP Response: This Table is now referenced on page 4.

Page 8, Table 1.2, last line in notes: The date of IWR Run 17 was not given. Recommend the date of that particular IWR Run be provided.

FDEP Response: The date is now provided as a footnote to the table (June 2005).

Page 10, Figure 1.3: Suggest the icon representing the S-79 structure be made more obvious (i.e. larger) on the map.

FDEP Response: This map has been removed, as other maps serve the same purpose.

Page 11, 3rd paragraph, lines 3-5: The discussion on the 5-year rotation is incomplete. Recommend it be worded as follows: "Year 1 - preliminary WQ evaluation and development of a strategic monitoring plan; Year 2 – complete data collection to verify WQ impairments.

FDEP Response: Recommended changes made.

Page 11, penultimate line: Referenced Table 2.2 is not relevant to the subject matter at hand, which is about nutrient impairments. Table 2.2 speaks to bacterial impairments.

FDEP Response: With the title of the Chapter "Water Quality Problems," it is thought that the chapter would not be complete without briefly outlining the "non-nutrient" water quality problems associated with the 3 Tidal Caloosahatchee WBIDs that are not addressed by this TMDL.

Page 14, last paragraph, 4th line: Recommend that citations for **Tables 2.5** & **2.7** be in **bold font** to be consistent with the rest of the report.

FDEP Response: Recommended changes made.

Page 17, section 3.1.1: There is a section header there but no text underneath it. Was there some text missing?

FDEP Response: Headings and Sub-headings were changed to eliminate above mentioned confusion.

Page 20, last paragraph, last sentence: The word "thusadded" needs to be separated into two words as "thus added".

FDEP Response: Recommended change made to TMDL document.

Page 21, first paragraph, 3rd sentence: Recommend that citation for **Figure 3.5** be in **bold font** to be consistent with the rest of the report.

FDEP Response: Recommended change made to TMDL document.

Pages 21 through 26, Figures 3.5 – 3.14: It would appear that the only correlations that can be drawn with any accuracy are between sample station median TN concentration and color levels.

FDEP Response: The consistently strongest R^2 involved color and TN. The second strongest R^2 is with the Chlorophyll_a and TN relationship. Both of these factors are involved in the equation for the bottom irradiance.

Page 29, Table 4.1a, figure label: Recommend that the word "Effluents" be removed from the label and replaced with "Dischargers."

FDEP Response: Assume you meant "discharges" and this change was made.

Page 29: Table 4.1b: Recommend that the order of the treatment facilities listed in this table match the order of the treatment facilities listed in the previous table. Also suggest that the second column entitled "Permitted to Reuse" be deleted, since it doesn't really contribute to the discussion, and its significance is adequately captured in the "Actual Average Annually" column.
FDEP Response: The comments concerning maintaining the order of the treatment facilities for both tables helps clarity, and the change was made. Although "Actual Average Annually" column is the sum of "Actual Re-use" and "Actual to River," the column entitled, "Permitted to Re-use" provides the reader with the maximum re-use allowable. Without this information, reader would not be able to calculate % of permitted re-use is actually being carried out. All of this information might be helpful in observing the level of impact (or lack of impact) re-use might have on watershed load, as well as the potential future impact. Based on comments provided by you, this point will be emphasized in TMDL text.

Page 31, Table 4.3: Recommend that this table be made larger; the font size is too small to read.
FDEP Response: Recommended change made to TMDL document.

Pages 32 & 33, Figure 4.1 and Figure 4.2: These two figures communicate the same information. Suggest only one, figure 4.2 since is easier to read, be used.
FDEP Response: Figure 4.1 was removed and corresponding text modified and figures re-numbered.

Page 33, Figure 4.2, figure label: Suggest that the word "Total" be inserted between Quarterly and Flow (i.e. Quarterly Total Flow) to be consistent with the heading above the graph.
FDEP Response: Recommended change made to TMDL document.

Page 36, Figure 4.3: Suggest the icon representing the S-79 structure be made more obvious (i.e. larger) on the map.
FDEP Response: Good point, but the location of S-79 is clearly marked in preceding maps and enlarging the "S-79" label may obscure HSPF sub-basin boundaries. Thus this figure, created by Dynamic Solution, was not altered.

Page 38, second paragraph, 4th sentence from bottom: The figure cited (Figure 4.9) is incorrect. It should be Figure 4.5.
FDEP Response: Recommended change made to TMDL document.

Page 44, second paragraph, last sentence: Recommend that citations for **Figures 4.13 and 4.16** be in **bold font** to be consistent with the rest of the report.
FDEP Response: Recommended change made to TMDL document.

Page 55, second paragraph, 4th paragraph: Suggest you add "(i.e. tannins)" after the words "dissolved organic matter".
FDEP Response: Recommended change made to TMDL document.

Page 56, Table 5.1, figure label: The description of what constitutes "Existing and Background Conditions" should not be relegated to a mere phase in a parenthesis. Rather it should have its own sentence, or perhaps paragraph and be better explained. For instance, what is the benchmark year that constitutes the predevelopment condition? Furthermore, did the predevelopment condition include the existence of canals and structures? A predevelopment watershed land use would not have Lake Okeechobee discharging to the Caloosahatchee River in the first place, since the lake was not historically connected to the river. Whereas TMDLs are not designed to address the impacts of hydrologic alterations like canals and structures, less practiced readers of this document might not understand that concept and incorrectly understand how the system was modeled (with or without these alterations) and what the ensuing BMAP would be required to address in the TMDL implementation. In other words, be very clear about describing the exact nature of the scenarios modeled and why they were modeled.
FDEP Response: A paragraph has been added to clarify what is meant by 'background scenario' simulation.

Page 57, bottom paragraph, 2nd sentence: The sentence starting from Figure 5.3, is a "run on". It is also not clear and could be misconstrued as written to indicate 3 modeled scenario's were being discussed instead of two (i.e. 1) predevelopment, 2) Lake O meeting its TMDL, and 3) reduction in basin TN by 19.8 %).
FDEP Response: The "background with Lake O meeting TMDL" was more clearly labeled throughout the document and referred to as "background-plus."

Page 58, Figure 5.3: Suggest the horizontal line at 25% PAR be highlighted as in Figure 5.2 to indicate what the threshold criteria should be.
FDEP Response: Recommended change made to TMDL document.

Page 59, first paragraph, 3rd sentence: Recommend that citations for **Figures 5.1 and 5.2** be in **bold font** to be consistent with the rest of the report.
FDEP Response: Recommended change made to TMDL document.

Page 59, first paragraph, 7th sentence: The word "0r" between 19.8 and 20% should be "or".
FDEP Response: Recommended change made to TMDL document.

Page 59, first paragraph, penultimate sentence: The phrase "…TN reduction scenarios levels also reduced eliminated the one single season…" didn't make sense. Perhaps one of those words (either reduced or eliminated) was meant to be deleted.
FDEP Response: Recommended change made to TMDL document.

Page 59, Figure 5.4, figure heading: The figure heading is not legible. Also suggest the horizontal line at 25% PAR be highlighted as in Figure 5.2 to indicate what the threshold criteria should be.
FDEP Response: Recommended change made to TMDL document.

Page 62, first paragraph, 3rd line: The statement indicates that the WWTP all offer Secondary Treatment, but the previous sentence indicate they all meet Advanced Wastewater Treatment (AWT) standards. Are these the same, and if so the concepts could be better connected.
FDEP Response: It was meant that all built upon their basic secondary treatment system to offer an additional level of nutrient removal (AWT). This was clarified in the document as per your recommendation.

Page 63, first paragraph, 1st sentence: The 1st sentence is a "run on" and is not clear. It would also be useful to define and understand the difference between an implicit and explicit margin of safety.
FDEP Response: Recommended change made to TMDL document.

Appendix C: Tables with Statistical Summaries of WBID Sample Station Data

Appendix D: Bar Graph Overview of WBID Water Quality Ranges

Appendix E: Statistical Summaries of Color and Conductivity

Appendix F: Land Uses in Tidal Caloosahatchee WBIDS

Appendix G. Location of Ground Water Withdrawals in the Caloosahatchee Basin

Appendix H: Comparison of DO from Model Simulations

Note: Due to their large size, Appendices C through H are provided in a separate document.

Florida Department of Environmental Protection
Division of Water Resource Management
Bureau of Watershed Management
2600 Blair Stone Road, Mail Station 3565
Tallahassee, Florida 32399-2400