Final

Total Maximum Daily Loads

for

Dissolved Oxygen, Nutrients and Biochemical Oxygen Demand

In

Myrtle Slough (WBID 2054)

March 2013

Region 4 serving the southeast

In compliance with the provisions of the Federal Clean Water Act, 33 U.S.C §1251 et. seq., as amended by the Water Quality Act of 1987, P.L. 400-4, the U.S. Environmental Protection Agency is hereby establishing the Total Maximum Daily Load (TMDL) for dissolved oxygen, nutrients, and biochemical oxygen demand in the Peace River Basin (WBID 2054). Subsequent actions must be consistent with this TMDL.

/s/ 3/25/2013

James D. Giattina, Director — Date

Water Protection Division

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LIST OF ABBREVIATIONS

B-MAP	Basin Management Action Plan
BMP	Best Management Practices
BOD	Biochemical Oxygen Demand
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
CO_2	Carbon Dioxide
DO	Dissolved Oxygen
EMC	Event Mean Concentration
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FLUCCS	Florida Land Use Cover Classification System
FS	Florida Statutes
GIS	Geographic Information System
HSPF	Hydrologic Simulation Program Fortan
HUC	Hydrologic Unit Code
IWR	Impaired Surface Waters Rule
KM^2	Square Kilometers
L	Liters
L/FT^3	Liters per Cubic Foot
LA	Load Allocation
LB/YR	Pounds per year
LSPC	Loading Simulation Program C++
MGD	Million Gallons per Day
MG/L	Milligram per liter
ML	Milliliters
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer Systems
NASS	National Agriculture Statistics Service
NH_4	Ammonia Nitrogen
NO_2	Nitrite
NO_3	Nitrate
NPDES	National Pollutant Discharge Elimination System
OBS	Observations
OSTD	Onsite Treatment and Disposal System

SWFWMD	Southwest Florida Water Management District
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WASP	Water Quality Analysis Simulation Program
WBID	Water Body Identification
WLA	Waste Load Allocation
WQS	Water Quality Standards
WMD	Water Management District
WWTP	Waste Water Treatment Plant

SUMMARY SHEET
Total Maximum Daily Load (TMDL)

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

WBID	Segment Name	Class and Waterbody Type	Major River Basin	HUC	County	State
2054	Myrtle Slough	Class III	Peace River Basin	03100101	Charlotte	Florida

TMDL Endpoints/Targets:

Dissolved Oxygen, Nutrients, BOD

TMDL Technical Approach: Calibration of a watershed and water quality model to current conditions, load reduction scenarios to meet water quality standards.

TMDL Waste Load and Load Allocation

	Current Condition		TMDL Condition		MS4	LA
WBID 2054 Myrtle Slough	**WLA (kg/yr)**	**LA (kg/yr)**	**WLA (kg/yr)**	**LA (kg/yr)**	**% Reduction**	**% Reduction**
BOD	NA	80267	NA	62624	22	22
TN	NA	33577	NA	27106	19	19
TP	NA	5389	NA	3612	33	33

Endangered Species Present (Yes or Blank):

USEPA Lead TMDL (USEPA or Blank): USEPA

TMDL Considers Point Source, Non-point Source, or Both: Both

Major NPDES Discharges to surface waters addressed in USEPA TMDL:

Permit ID	Permitee	County	Permit Type
FLR04E043	Charlotte County	Charlotte	Phase II MS4

1. Introduction

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

The Florida Department of Environmental Protection (FDEP) developed a statewide, watershed-based approach to water resource management. Under the watershed management approach, water resources are managed on the basis of natural boundaries, such as river basins, rather than political boundaries. The watershed management approach is the framework FDEP uses for implementing TMDLs. The state's 52 basins are divided into five groups and water quality is assessed in each group on a rotating five-year cycle. FDEP also established five water management districts (WMD) responsible for managing ground and surface water supplies in the counties encompassing the districts. Myrtle Slough is located in the Peace River Basin and is a Group 3 water managed by the Southwest Florida Water Management District (SWFWMD).

For the purpose of planning and management, the WMDs divided the district into planning units defined as either an individual primary tributary basin or a group of adjacent primary tributary basins with similar characteristics. These planning units contain smaller, hydrological based units called drainage basins, which are further divided by FDEP into "water segments". A water segment usually contains only one unique waterbody type (stream, lake, canal, etc.) and is about 5 square miles. Unique numbers or waterbody identification (WBIDs) numbers are assigned to each water segment. This TMDL report addresses WBID 2054 (Myrtle Slough). The WBID is located within the Lower Peace River Planning Unit.

2. Problem Definition

To determine the status of surface water quality in Florida, three categories of data – chemistry data, biological data, and fish consumption advisories – were evaluated to determine potential impairments. The level of impairment is defined in the Identification of Impaired Surface Waters Rule (IWR), Section 62-303 of the Florida Administrative Code (FAC). The IWR is FDEP's methodology for determining whether waters should be included on the state's planning list and verified list. Potential impairments are determined by assessing whether a waterbody meets the criteria for inclusion on the planning list. Once a waterbody is on the planning list, additional data and information will be collected and examined to determine if the water should be included on the verified list.

The TMDL addressed in this document is being established pursuant to commitments made by the United States Environmental Protection Agency (USEPA) in the 1998 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998). That Consent Decree established a schedule for TMDL development for waters listed on Florida's USEPA approved 1998 section 303(d) list. The 1998 section 303(d) list identified numerous WBIDs in the Peace River Basin as not meeting WQS. After assessing all readily available water quality data, USEPA is responsible for developing a TMDL for WBID 2054 (Myrtle Slough). The geographic location of the WBID is shown in Figure 1. The parameters addressed in this TMDL are DO, BOD and nutrients.

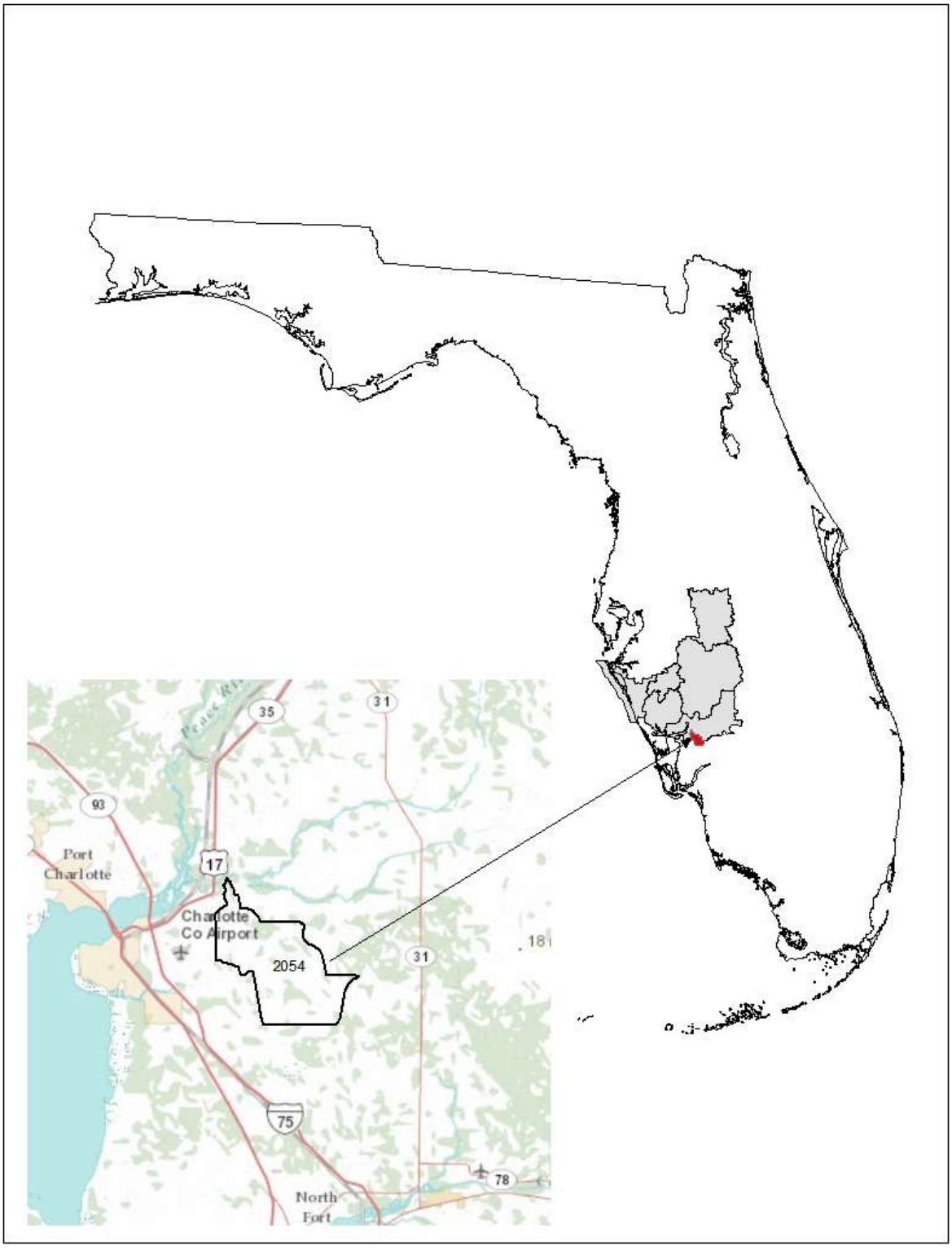

Figure 1 Location Map

3. Watershed Description

Myrtle Slough is within the Coastal Lower Peace River basin. The slough drains to the lower Shell Creek at about a mile downstream of Hendrickson Dam.

In order to identify possible pollutant sources in the watershed, the latest land use coverage was obtained from FDEP. Land use data are based on 2006 land cover features categorized according to the Florida Land Use and Cover Classification System (FLUCCS). Table 1 and Figure 2 shows that land use in the Myrtle Slough watershed is largely undeveloped. Approximately sixty four percent of the watershed is comprised of upland forest (34%) and rangeland (30%). Wetlands are nineteen percent of the watershed. Agriculture and urban land uses are 11% and 4%, respectively. Agriculture is mostly in the northern part of the basin near the confluence of the Myrtle Slough with Shell Creek.

Table 1 Landuse distribution in WBID 2054 (Myrtle Slough)

WBID 1997	Urban Residential & Built-Up	Agriculture	Rangeland	Forest	Water	Wetlands	Barren Land	Transportation& Utilities	Total
FLUCCS Code Level 1 Series[1]	1000[3]	2000	3000[4]	4000	5000	6000	7000	8000	
mi^2	1.26	3.60	9.78	11.07	0.22	6.07	0.03	0.43	27.51
percent	3.9%	11.1%	30.1%	34.1%	0.7%	18.7%	0.1%	1.3%	100%

1. Land use data are based on 2006 land cover features categorized according to the SWFWMD's modified Florida Land Use and Cover Classification System (FLUCCS). The features were photointerpreted from 2006 color infrared and stereo panchromatic aerial photographs at the 1:12,000 scale. Areas in the table represent the WBID only, not the entire extent of the watershed.
2. mi^2= square miles.
3. The urban/residential and built-up category includes commercial, industrial, extractive, institutional, and recreational uses.
4. The rangeland category includes dry prairies, shrub and brushland and mixed rangeland.

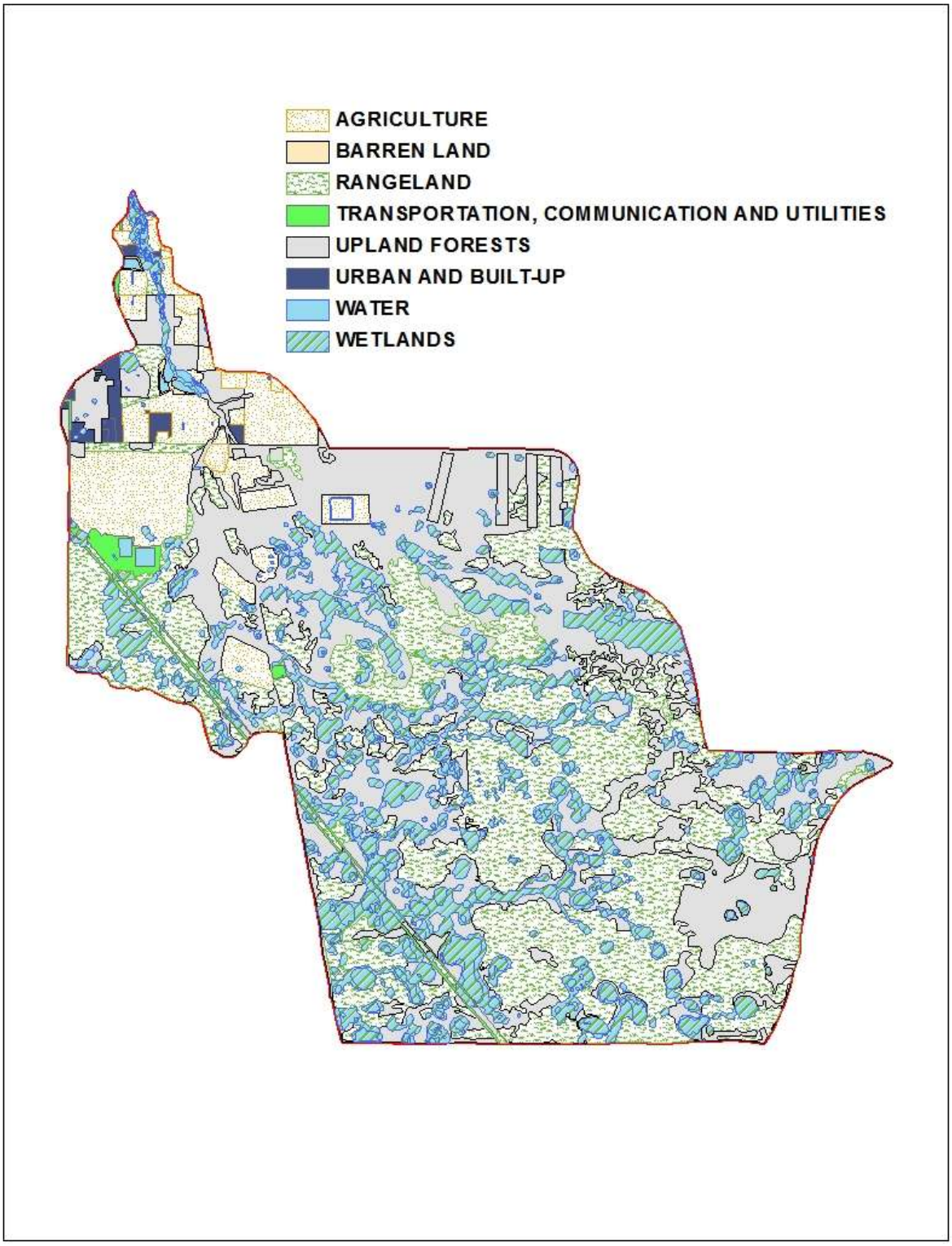

Figure 2 Landuse in the Myrtle Slough Watershed

4. Water Quality Standards/TMDL Targets

The waterbodies in the Myrtle Slough WBID are Class III Freshwater with a designated use of Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife. Designated use classifications are described in Florida's water quality standards. See Section 62-302.400, F.A.C. Water quality criteria for protection of all classes of waters are established in Section 62-302.530, F.A.C. Individual criteria should be considered in conjunction with other provisions in water quality standards, including Section 62-302.500 F.A.C., which established minimum criteria that apply to all waters unless alternative criteria are specified. Section 62-302.530, F.A.C. The WBID addressed in this report was listed due to elevated concentrations of chlorophyll *a*. While FDEP does not have a streams water quality standard specifically for chlorophyll *a*, elevated levels of chlorophyll *a* are frequently associated with a violation of the narrative nutrient standard, which is described below.

4.1. Nutrients Criteria:

The designated use of Class III waters is recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. In 1979, FDEP adopted a narrative criterion for nutrients. FDEP recently adopted numeric nutrient criteria (NNC) for many Class III waters in the state, including streams, which numerically interprets part of the state narrative criterion for nutrients. FDEP submitted its NNC to EPA for review pursuant to section 303(c) of the CWA. On November 30, 2012, EPA approved those criteria as consistent with the requirements of the CWA. The state criteria, however, are not yet effective for state law purposes.

Also, in November 2010, EPA promulgated numeric nutrient criteria for Class III inland waters in Florida, including streams. On February 18, 2012, the streams criteria were remanded back to EPA by the U.S. District Court for the Northern District of Florida for further explanation. On November 30, 2012, EPA re-proposed its stream NNC for those flowing waters not covered by Florida's NNC rule.

Therefore, for streams in Florida, the applicable nutrient water quality standard for CWA purposes remains the Class III narrative criterion.

4.1.1 Narrative Nutrient Criteria

Florida's narrative nutrient criteria provides:

> The discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter. Man induced nutrient enrichment (total nitrogen and total phosphorus) shall be considered degradation in relation to the provisions of Sections 62-302.300, 62-302.700, and 62-4.242. Section 62-302.530(48)(a), F.A.C.

> In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna. Section 62-302.530(48)(b), F.A.C.

Chlorophyll and DO levels are often used to indicate whether nutrients are present in excessive amounts. The target for this TMDL is based on levels of nutrients necessary to prevent violations of Florida's DO criterion, set out below.

4.1.2 Florida's adopted numeric nutrient criteria for streams

While not yet effective as water quality criteria, the FDEP's numeric nutrient criteria represent the state's most recent interpretation of the second part of Florida's narrative criteria, set out at paragraph 62-302.530(47)(b), F.A.C. See section 62-302.531(2). The first part of the narrative criteria, at paragraph 62-302.530(47)(b), F.A.C., also remains applicable to streams in Florida.

Florida's interpretation of its narrative nutrient criteria applies to streams, including (2054). For streams that do not have a site specific criteria, the interpretation provides for biological information to be considered together with nutrient thresholds to determine whether a waterbody is attaining See paragraph 62-302.531(2)(c), F.A.C. The rule provides that the nutrient criteria are attained in a stream segment where information on chlorophyll a levels, algal mats or blooms, nuisance macrophyte growth, and changes in algal species composition indicates there are no imbalances in flora and either the average score of at least two temporally independent SCIs performed at representative locations and times is 40 or higher, with neither of the two most recent SCI scores less than 35, or the nutrient thresholds set forth in Table 4.1 below are achieved. See paragraph 62-302.531(2)(c).

Florida's interpretation provides that nutrient levels should be expressed as a geometric mean, and concentrations are not to be exceeded more than once in any three calendar year period. Section 62-302.200 (25)(e), F.A.C.

Table 4.1 Inland numeric nutrient criteria

Nutrient Watershed Region	Total Phosphorus Nutrient Threshold	Total Nitrogen Nutrient Threshold
Panhandle West	0.06 mg/L	0.67 mg/L
Panhandle East	0.18 mg/L	1.03 mg/L
North Central	0.30 mg/L	1.87 mg/L
Peninsular	0.12 mg/L	1.54 mg/L
West Central	0.49 mg/L	1.65 mg/L

South Florida	No numeric nutrient threshold. The narrative criterion in paragraph 62-302.530(47)(b), F.A.C., applies.	No numeric nutrient threshold. The narrative criterion in paragraph 62-302.530(47)(b), F.A.C., applies.

4.2. Dissolved Oxygen Criteria:

Numeric criteria for DO are expressed in terms of minimum and daily average concentrations. Section 62-302(30), F.A.C., sets out the water quality criterion for the protection of Class III freshwater waters as:

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

4.3. Biochemical Oxygen Demand Criteria:

> Biochemical Oxygen Demand (BOD) shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each class and, in no case, shall it be great enough to produce nuisance conditions. [FAC 62-302.530 (11)]

4.4. Natural Conditions

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

Florida's water quality standards provide a definition of natural background:

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

Florida's water quality standards also provide that:

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

5. Water Quality Assessment

WBID 2054 (Myrtle Slough) was listed as not attaining its designated uses on Florida's 1998 303(d) list for DO, BOD and nutrients. An assessment of available data was conducted to determine the impairment of the water bodies in the WBID. The source for current ambient monitoring data was the Impaired Waters Rule (IWR) data Run 44. Figure 3 shows where the IWR stations are located in the WBIDs. The IWR database contains data from various sources within the state of Florida, including the WMDs and counties.

Figure 3 Location of monitoring stations in Myrtle Slough

5.1. Water Quality Data

The tables and figures below present the monitoring stations and corresponding time series data for DO, TN, TP, BOD, and chlorophyll-*a* observations for Myrtle Slough.

5.1.1. WBID 2054: Myrtle Slough

Table 2 shows a list of the water quality monitoring stations in Myrtle Slough including the date range and the number of observations.

Table 2 Water Quality Monitoring Stations in Myrtle Slough (WBID 2054)

Station	Station Name	First Date	Last Date	No. Obs.
21FLBRA 2054-A	2054 - Myrtle Slough - Crossing on 74 near P.G. Farms	8/9/2007	4/24/2008	94
21FLBRA 2054-B	2054 - Myrtle Slough - crossing on Washington Loop Rd	7/25/2007	5/21/2008	100
21FLBRA 2054-C	2054 - Myrtle Slough - on 74 after Happy Hollow	7/25/2007	4/24/2008	113
21FLFTM 25020432	MYRTLE SLOUGH AT SR764	9/30/2003	12/9/2004	66
21FLFTM 25020529	MYRTLE SLOUGH, WEST FORK AT SR74	8/28/2003	12/9/2004	74
21FLFTM 25020553	MYRTLE SLOUGH, EAST BRANCH BELOW CR 74	9/30/2003	12/9/2004	66
21FLFTM 25020646FTM	MYRTLE SLOUGH WBID 2054 - SITE 5 @ DESROSIER BROS PROPERTY	5/24/2004	12/9/2004	22
21FLGW 14027	SWD-SS-1012 UNKNOWN	8/19/2002	8/19/2002	14
21FLGW 14035	SWD-SS-1023 UNKNOWN	8/19/2002	8/19/2002	14
21FLGW 14040	SWD-SS-1028 UNKNOWN	8/19/2002	8/19/2002	14

Dissolved Oxygen

There are several factors that affect the concentration of dissolved oxygen in a waterbody. Oxygen can be introduced by wind, diffusion, photosynthesis, and additions of higher DO water (e.g. from tributaries). DO concentrations are lowered by processes that use up oxygen from the water, such as respiration and decomposition, and by additions of water with lower DO (e.g. swamp or groundwater). Natural DO levels are a function of water temperature, water depth and velocity, and relative contributions of groundwater. Decomposition of organic matter, such as dead plants and animals, also uses up DO.

Figure 4 provides a time series plot for the measured DO concentrations in Myrtle Slough. There were 10 monitoring stations used in the assessment that included a total of 48 observations of which 18 (38%) fell below the water quality standard of 5 mg/l DO. The minimum value was 0.98 mg/l, the maximum was 8.3 mg/l and the average was 5.35 mg/l.

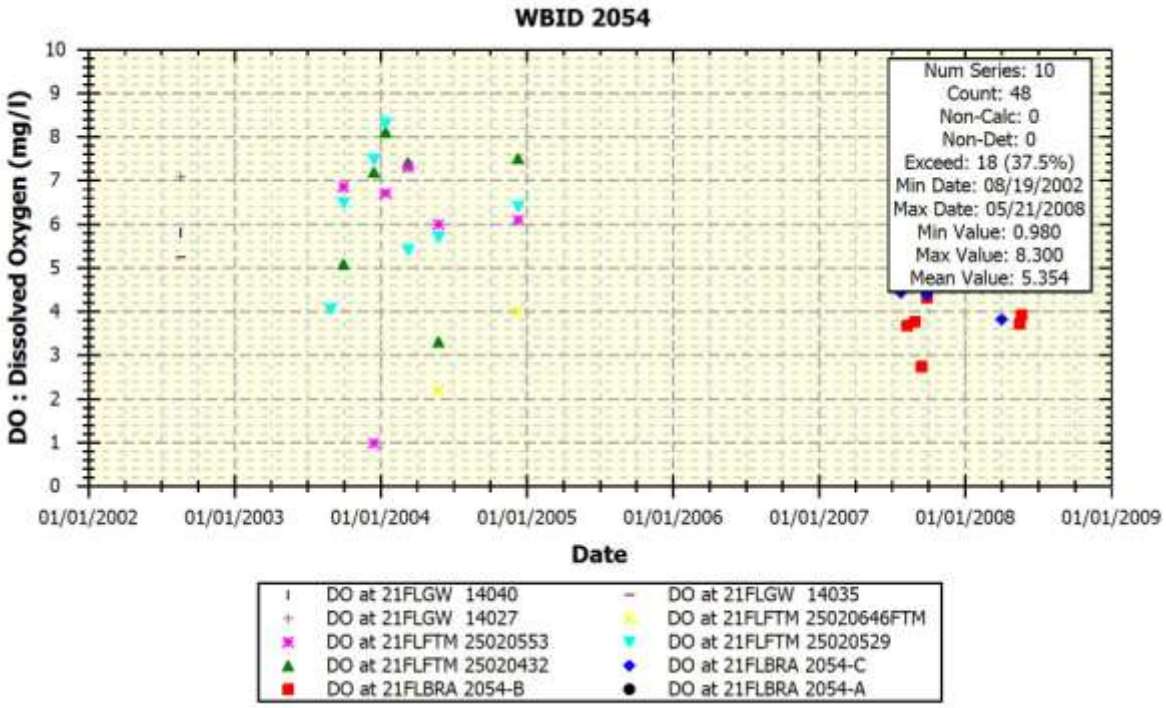

Figure 4 WBID 2054 (Myrtle Slough) Measured DO

Biochemical Oxygen Demand

BOD is a measure of the amount of oxygen used by bacteria as they stabilize organic matter. Figure 5 provides a time series plot for the measured BOD concentrations in Myrtle Slough. There were 3 monitoring stations used in the assessment that included a total of 25 observations. The minimum value was 2.0 mg/l, the maximum was 2.3 mg/l and the average was 2.02 mg/l.

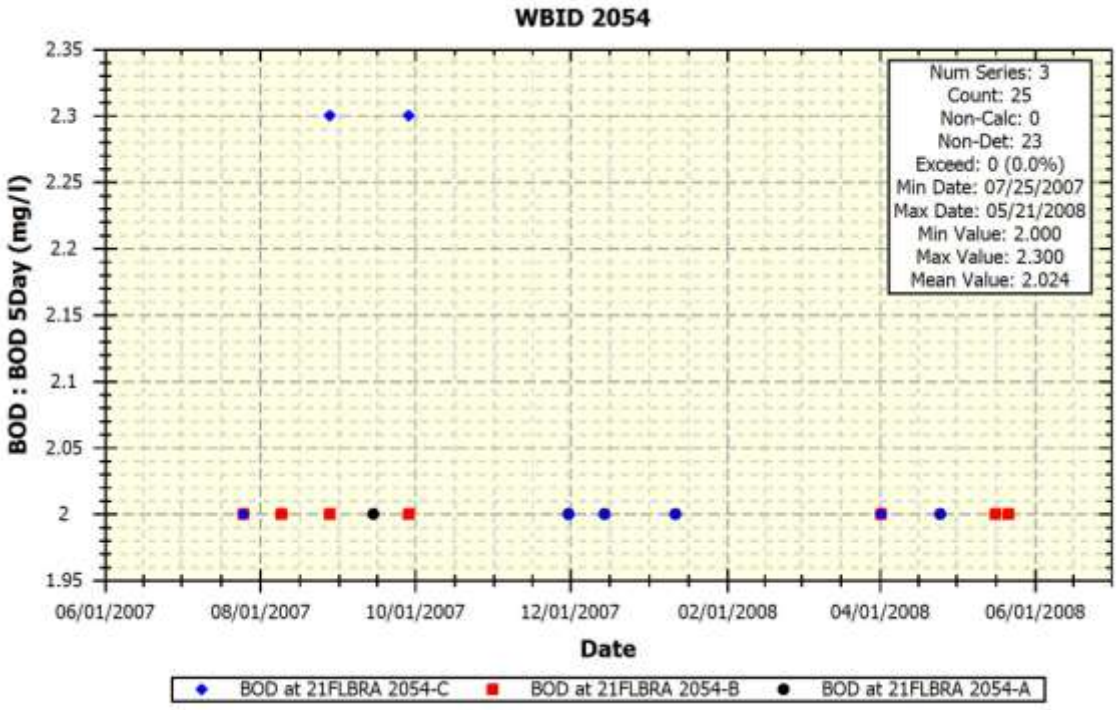

Figure 5 WBID 2054 (Myrtle Slough) Measured BOD

Nutrients

Excessive nutrients in a waterbody can lead to overgrowth of algae and other aquatic plants such as phytoplankton, periphyton and macrophytes. This process can deplete oxygen in the water, adversely affecting aquatic life and potentially restricting recreational uses such as fishing and boating. For the nutrient assessment the monitoring data for total nitrogen, total phosphorus and chlorophyll a are presented. The current standards for nutrients are narrative criteria. The purpose of the nutrient assessment is to present the range, variability and average conditions for the WBID.

Total Nitrogen

Total Nitrogen (TN) is comprised of nitrate (NO3), nitrite (NO2), organic nitrogen and ammonia nitrogen (NH4). Figure 6 provides a time series plot for the measured TN concentrations in Myrtle Slough. There were 10 monitoring stations used in the assessment that included a total of 51 observations. The minimum value was 0.23 mg/l, the maximum was 4.29 mg/l and the average was 1.22 mg/l.

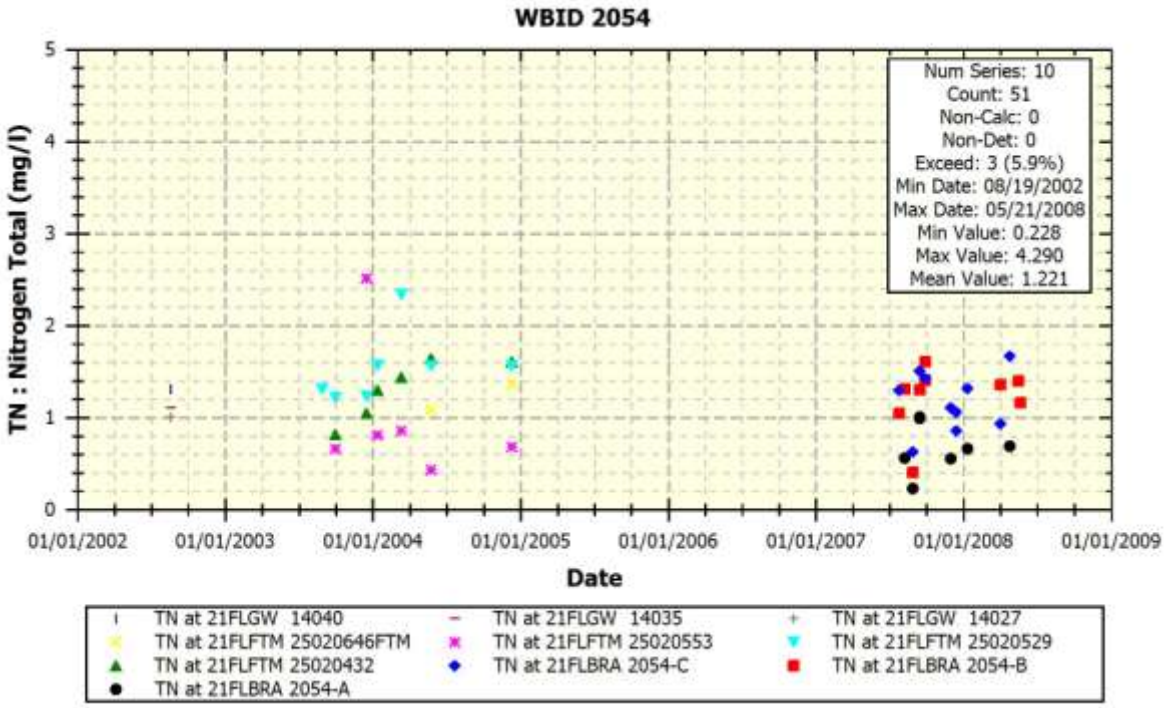

Figure 6 WBID 2054 (Myrtle Slough) Measured Total Nitrogen

Total Phosphorus

In natural waters, total phosphorus exists in either soluble or particulate forms. Dissolved phosphorus includes inorganic and organic forms, while particulate phosphorus is made up of living and dead plankton, and adsorbed, amorphous, and precipitated forms. Inorganic forms of phosphorus include orthophosphate and polyphosphates, though polyphosphates are unstable and convert to orthophosphate over time. Orthophosphate is both stable and reactive, making it the form most used by plants. Excessive phosphorus can lead to overgrowth of algae and aquatic plants, the decomposition of which uses up oxygen from the water. Figure 7 provides a time series plot for the measured total phosphorus concentrations in Myrtle Slough. There were 10 monitoring stations used in the assessment that included a total of 41 observations. The minimum value was 0.007 mg/l, the maximum was 0.36 mg/l and the average was 0.099 mg/l.

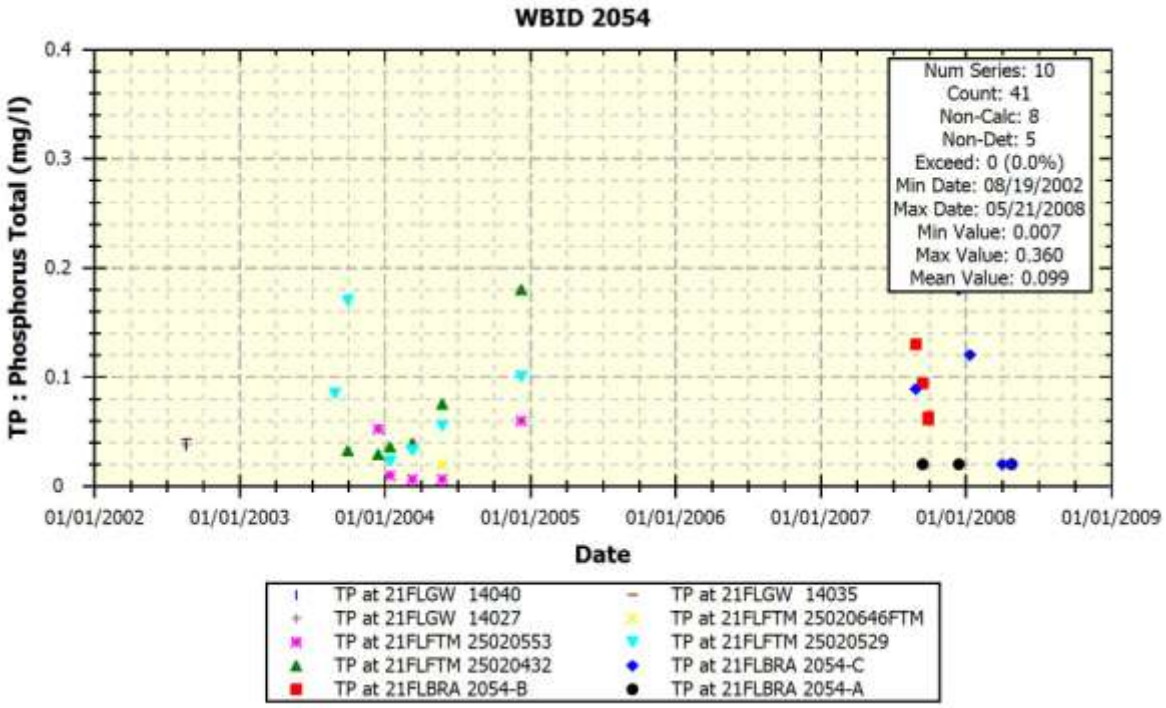

Figure 7 WBID 2054 (Myrtle Slough) Measured Total Phosphorus

Chlorophyll-a

Chlorophyll is the green pigment in plants that allows them to create energy from light. In a water sample, chlorophyll is indicative of the presence of algae, and chlorophyll-*a* is a measure of the active portion of total chlorophyll. Corrected chlorophyll refers to chlorophyll-*a* measurements that are corrected for the presence of pheophytin, a natural degradation product of chlorophyll that can interfere with analysis because it has an absorption peak in the same spectral region.

Figure 8 provides a time series plot for corrected chlorophyll a concentrations in Myrtle Slough. There were 5 monitoring stations used in the assessment that included a total of 24 observations. The minimum value was 1.00 µg/l, the maximum was 7.5 µg/l and the average was 2.73 µg/l.

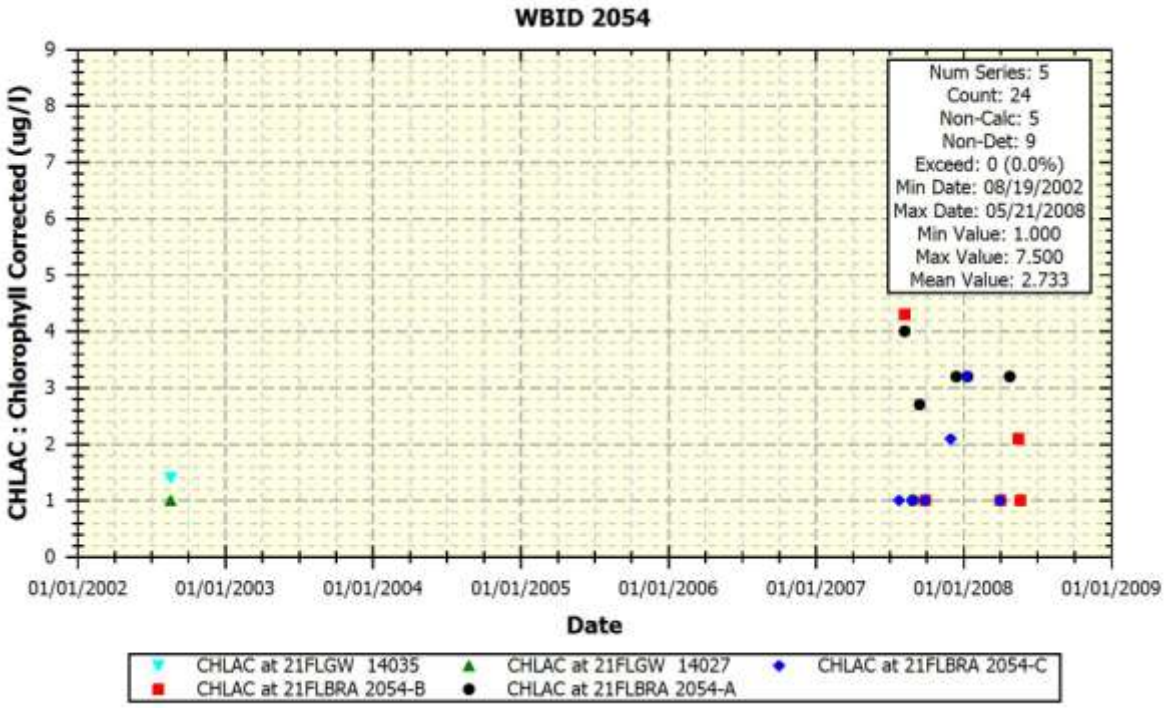

Figure 8 WBID 2054 (Myrtle Slough) Measured Chlorophyll-*a* Concentrations

Stream Flow

Stream flow is an important factor affecting water quality, especially insofar as it determines the available loading capacity for pollutants such as nutrients and bacteria. Flow conditions also influence DO concentrations more directly. Typically, higher flows are associated with higher DO, since the increased flow leads to greater turbulence and aeration. The WBID is ungaged. However, there were some channel rating measurements in the 1960's and 1980's.

5.2. Summary of Data Assessments

A review of the available water quality data shows that DO in WBID 2054 has a wide range in concentration and is frequently below the Class III freshwater criterion of 5 mg/l, even at different times of the year. Nitrogen concentrations are elevated and also show a wide range in concentration. Based on this information, and the presence of potential point and nonpoint sources of relevant pollutants, a TMDL for DO, BOD, and nutrients is being proposed for WBID 2054.

6. Source and Load Assessment

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

6.1. Point Sources

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted discharges include continuous discharges such as wastewater treatment facilities as well as some stormwater driven sources such as municipal separate storm sewer systems (MS4s), certain industrial facilities, and construction sites over one acre.

6.1.1. Wastewater/Industrial Permitted Facilities

A TMDL wasteload allocation (WLA) is given to traditional wastewater and industrial NPDES permitted facilities discharging to surface waters within an impaired watershed. There are no NPDES-permitted facilities that discharge within the Myrtle Slough watershed.

6.1.2. Stormwater Permitted Facilities/MS4s

MS4s are point sources also regulated by the NPDES program. According to 40 CFR 122.26(b)(8), an MS4 is "a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):

> (i) Owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law)...including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the Clean Water Act that discharges into waters of the United States;
>
> (ii) Designed or used for collecting or conveying storm water;
>
> (iii) Which is not a combined sewer; and
>
> (iv) Which is not part of a Publicly Owned Treatment Works."

MS4s may discharge nutrients and other pollutants to waterbodies in response to storm events. In 1990, USEPA developed rules establishing Phase I of the NPDES stormwater program, designed to prevent harmful pollutants from being washed by stormwater runoff into MS4s

(or from being dumped directly into the MS4) and then discharged from the MS4 into local waterbodies. Phase I of the program required operators of "medium" and "large" MS4s (those generally serving populations of 100,000 or greater) to implement a stormwater management program as a means to control polluted discharges from MS4s. Approved stormwater management programs for medium and large MS4s are required to address a variety of water quality related issues including roadway runoff management, municipal owned operations, hazardous waste treatment, etc.

Phase II of the rule extends coverage of the NPDES stormwater program to certain "small" MS4s. Small MS4s are defined as any MS4 that is not a medium or large MS4 covered by Phase I of the NPDES stormwater program. Only a select subset of small MS4s, referred to as "regulated small MS4s", requires an NPDES stormwater permit. Regulated small MS4s are defined as all small MS4s located in "urbanized areas" as defined by the Bureau of the Census, and those small MS4s located outside of "urbanized areas" that are designated by NPDES permitting authorities.

In October 2000, USEPA authorized FDEP to implement the NPDES stormwater program in all areas of Florida except Indian tribal lands. FDEP's authority to administer the NPDES program is set forth in Section 403.0885, Florida Statutes (FS). The three major components of NPDES stormwater regulations are:

- MS4 permits that are issued to entities that own and operate master stormwater systems, primarily local governments. Permittees are required to implement comprehensive stormwater management programs designed to reduce the discharge of pollutants from the MS4 to the maximum extent practicable.

- Stormwater associated with industrial activities, which is regulated primarily by a multisector general permit that covers various types of industrial facilities. Regulated industrial facilities must obtain NPDES stormwater permit coverage and implement appropriate pollution prevention techniques to reduce contamination of stormwater.

- Construction activity general permits for projects that ultimately disturb one or more acres of land and which require the implementation of stormwater pollution prevention plans to provide for erosion and sediment control during construction.

The WBID is in Charlotte County which is covered by a Phase II-c MS4 permit (FLR04E043). Stormwater discharges conveyed through the storm sewer system covered by the permit are subject to the WLA of the TMDL. Any newly designated MS4s will also be required to achieve the percent reduction allocation presented in this TMDL.

6.2. Nonpoint Sources

Nonpoint sources of pollution are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. For nutrients, these sources include runoff of agricultural fields, golf courses, and lawns, septic tanks, and residential developments outside of MS4 areas. Nonpoint source pollution generally involves a buildup of pollutants on the land surface that wash off during rain events and as such, represent contributions from diffuse sources, rather than from a defined outlet. Potential nonpoint sources are commonly identified, and their loads estimated, based on land cover data. Most methods calculate nonpoint source loadings as the product of the water quality concentration and runoff water volume associated with certain land use practices. The mean concentration of pollutants in the runoff from a storm event is known as the Event Mean Concentration, or EMC.

6.2.1. Urban Areas

Urban areas include land uses such as residential, industrial, extractive and commercial. Land uses in this category typically have somewhat high total nitrogen event mean concentrations and average total phosphorus event mean concentrations. Nutrient loading from MS4 and non-MS4 urban areas is attributable to multiple sources including stormwater runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals.

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as outlined in Chapter 403 FS, was established as a technology-based program that relies upon the implementation of Best Management Practices (BMPs) that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, FAC.

Florida's stormwater program is unique in having a performance standard for older stormwater systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: "the pollutant loading from older stormwater management systems shall be reduced as needed to restore or maintain the beneficial uses of water." [FAC 62-40-.432(2)(c)]

Nonstructural and structural BMPs are an integral part of the State's stormwater programs. Nonstructural BMPs, often referred to as "source controls", are those that can be used to prevent the generation of nonpoint source pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimization of impervious surfaces. Technology-based structural BMPs are used to mitigate the increased stormwater peak discharge rate, volume, and pollutant loadings that accompany urbanization.

Urban, residential, and commercial developments are not likely important nonpoint sources of nutrients and oxygen-demanding substances in the Myrtle Slough watershed. Land uses in this category only comprise about 4 percent of the watershed area.

Onsite Sewage Treatment and Disposal Systems (Septic Tanks)

As stated above leaking septic tanks or onsite sewage treatment and disposal systems (OSTDs) can contribute to nutrient loading in urban areas. Water from OSTDs is typically released to the ground through on-site, subsurface drain fields or boreholes that allow the water from the tank to percolate (usually into the surficial aquifers) and either transpire to the atmosphere through surface vegetation or add to the flow of shallow ground water. When properly sited, designed, constructed, maintained, and operated, OSTDs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTD receives natural biological treatment in the soil and is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, OSTDs can be a source of nutrients, pathogens, and other pollutants to both ground water and surface water.

The State of Florida Department of Health publishes data on new septic tank installations and the number of septic tank repair permits issued for each county in Florida. Table 3 summarizes the cumulative number of septic systems installed in Charlotte County since the 1970 census and the total number of repair permits issued for the last ten fiscal years between 2001-02 and 2010-11 (FDOH, 2011). The data do not reflect septic tanks removed from service. Leaking septic systems could be a relevant source of organic and nutrient loading in the Myrtle Slough watershed.

Table 3 County Estimates of Septic Tanks and Repair Permits

County	Number of Septic Tanks (1970- 2011)	Number of Repair Permits Issued (2001 – 20011)
Charlotte	42,558	2396

Note: Source: http://www.doh.state.fl.us/environment/ostds/statistics/ostdsstatistics.htm

6.2.2. Agriculture

Agricultural lands include improved and unimproved pasture, row and field crops, tree crops, nurseries, and specialty farms. Agricultural activities, including runoff of fertilizers or animal wastes from pasture and cropland and direct animal access to streams, can generate nutrient loading to streams. The highest total nitrogen and total phosphorus event mean concentrations are associated with agricultural land uses.

The USDA National Agricultural Statistics Service (NASS) compiles Census of Agriculture data by county for virtually every facet of U.S. agriculture (USDA NASS, 2007). According to 2007 Census of Agriculture data, there were 112 farms which fertilized approximately 31,778 acres with commercial fertilizer, lime and soil conditioners in Charlotte County, Florida. Livestock counts of cattle and pigs in Charlotte County are provided in Table 4.

Because agricultural census data are collected at the county level, the extent to which these values pertain to agricultural fields within the impaired WBID is not specified.

Land use data and aerial coverage of the watershed show that the agricultural uses in the Myrtle Slough watershed are in the lower part of the watershed (Figure 2). Agriculture comprises 11% percent of the land use in WBID 2054.

Table 4 2007 Agricultural Census Data for Livestock in Charlotte County, FL

County	Livestock	Number of Farms	Number of Animals
Charlotte	Cattle and Calves	141	26937
	Hogs and Pigs	4	46

Note: 1. A farm is defined as any place from which $1,000 or more of agricultural products were produced and sold, or normally would have been sold, during the census year.

6.2.3. Rangeland

Rangeland includes herbaceous, scrub, disturbed scrub and coastal scrub areas. Event mean concentrations for rangeland are about average for total nitrogen and low for total phosphorus. Rangeland comprises 30 percent of the land use in the Myrtle Slough watershed.

6.2.4. Upland Forests

Upland forests include flatwoods, oak, various types of hardwoods, conifers and tree plantations. Event mean concentrations for upland forests are low for both total nitrogen and total phosphorus. Upland forests consist of 34 percent of the land use in the Myrtle Slough watershed.

6.2.5. Water and Wetlands

Water and Wetlands have very low event mean concentrations and comprise about 20 percent of the land use in the Myrtle Slough watershed.

6.2.6. Barren Land

Barren land includes beaches, borrow pits, disturbed lands and fill areas. Event mean concentrations for barren lands tend to be higher in total nitrogen. Barren lands comprise less than one percent of the watershed.

6.2.7. Transportation, Communications and Utilities

Transportation uses include airports, roads and railroads. Event mean concentrations for these types of uses are in the mid-range for total nitrogen and total phosphorus. This land use comprises about 1.3 % of the watershed.

7. Analytical Approach

In the development of a TMDL there needs to be a method for relating current loadings to the observed water quality problem. This relationship could be: statistical (regression for a cause and effect relationship), empirical (based on observations not necessarily from the water body in question) or mechanistic (physically and/or stochastically based) that inherently relate cause and effect using physical and biological relationships.

Two mechanistic models were used in the development of this TMDL. The first model is a dynamic watershed model that predicts the quantity of water and pollutants that are associated with the rainfall-runoff process. The second model is an in-stream dynamic water quality model that integrates the loadings from the watershed model to predict the water quality in the receiving water body.

The period of simulation that was considered in the development of this TMDL is 2002 to 2009. The models were used to predict time series for total nitrogen, total phosphorus, BOD, dissolved oxygen, and chlorophyll a. The models were calibrated to current conditions and were then used to predict improvements in water quality as function of reductions in loadings.

More details on the model application in the development of the Myrtle Slough TMDL are presented in Appendix A.

7.1. Loading Simulation Program C++ (LSPC)

The Loading Simulation Program C++ (LSPC) was used to represent the hydrological and water quality conditions in the watershed. LSPC is a comprehensive data management and modeling system that is capable of representing loading, both flow and water quality, from non-point and point sources and simulating in-stream processes. It is capable of simulating flow, sediment, metals, nutrients, pesticides, and other conventional pollutants, as well as temperature and pH for pervious and impervious lands and water bodies. LSPC was configured to simulate the watershed as a series of hydrologically connected sub-watersheds.

LSPC was used to simulate runoff (flow, total nitrogen, total phosphorus and BOD) from the land surface using an hourly time step for current and natural conditions of the Myrtle Slough watershed. The predicted time series were used as boundary conditions for the receiving waterbody model to predict in-stream water quality.

7.2. Water Quality Analysis Simulation Program (WASP)

The Water Quality Analysis Simulation Program (WASP v7.5) is a dynamic compartment-modeling program for aquatic systems, including both the water column and the underlying benthos. The time-varying processes of advection, dispersion, point and diffuse mass loading and boundary exchange are represented in the basic program. The conventional pollutant model within the WASP framework is capable of predicting time varying concentrations for chlorophyll *a*, dissolved oxygen, nutrients (nitrogen, phosphorus) as function of loadings, flows, and environmental conditions.

WASP was calibrated to the current conditions in Myrtle Slough using loadings from the LSPC model. Furthermore, WASP was used in determining the load reductions that would be needed to achieve the water quality standards for DO and nutrient targets for Myrtle Slough.

7.3. Scenarios

Several modeling scenarios were developed and evaluated in this TMDL determination. A full description of each of these scenarios is presented in Appendix A.

7.3.1. Current Condition

The first scenario is to model the current conditions of the watershed. The watershed model was parameterized using the current land uses and measured meteorological conditions to predict the current loadings of nitrogen, phosphorus and BOD. The predicted water quality loadings and flow time series were passed on to the in-stream water quality model where algal, nitrogen, phosphorus, BOD and DO concentrations were predicted over time. The models (watershed and water quality) were calibrated to an eight year period of time to take into account varying environmental, meteorological or hydrological conditions on water quality. The predicted existing condition annual average concentrations are presented in Table 5.

Table 5 Existing Condition Annual Average Model Predictions (2002-2009)

Constituent	WBID 2054
TN (mg/L)	1.07
TP (mg/L)	0.124
BOD (mg/L)	2.34
DO (mg/L)	5.31
Chlorophyll a (ug/L)	2.91

The current condition simulation was used to determine the base loadings for Myrtle Slough (Table 6). These existing condition loadings were compared with the TMDL scenario to determine the percent reduction in nutrient loads that will be needed to achieve water quality standards.

Table 6 Existing Condition Annual Average Nutrient Loads (2002-2009)

	WBID 2054	
Constituent	WLA (kg/yr)	LA (kg/yr)
BOD	NA	80267
TN	NA	33577
TP	NA	5389

7.3.2. Natural Condition

The natural condition scenario was developed to estimate what water quality conditions would exist if there were minimal to no impact from anthropogenic sources. There are no wastewater/industrial point source dischargers in the Myrtle Slough watershed. For the purpose of this analysis any land use that is associated with man induced activities (urban, agriculture, transportation, barren lands and rangeland) were converted to its native undisturbed land use and the associated event mean concentration for nitrogen, phosphorus and BOD were used. These natural condition loadings from the watershed model were passed onto the water quality model where natural water quality conditions were predicted. The natural condition water quality predictions are presented in Table 7.

Table 7 Natural Condition Annual Average Model Predictions (2002-2009)

Constituent	WBID 2054
TN (mg/L)	0.90
TP (mg/L)	0.086
BOD (mg/L)	1.31
DO (mg/L)	7.07
Chlorophyll a (ug/L)	1.17

The purpose of the natural conditions scenario is to determine whether water quality standards can be achieved without abating the naturally occurring loads from the watershed. Simulation results show that the DO standard is not achievable under natural conditions. Therefore, the TMDL determination will set the allowable loads to the natural condition scenario.

Table 8 provides the annual average load predictions for total nitrogen, total phosphorus, and BOD.

Table 8 Natural Condition Annual Average Nutrient Loads (2002-2009)

	WBID 2054	
Constituent	WLA (kg/yr)	LA (kg/yr)
BOD	NA	62624
TN	NA	27106
TP	NA	3612

Figure 9 provides a time series of DO concentrations under existing and natural conditions. The model predicts approximately 45% and 9% exceedances of the DO criteria for existing and natural conditions, respectively.

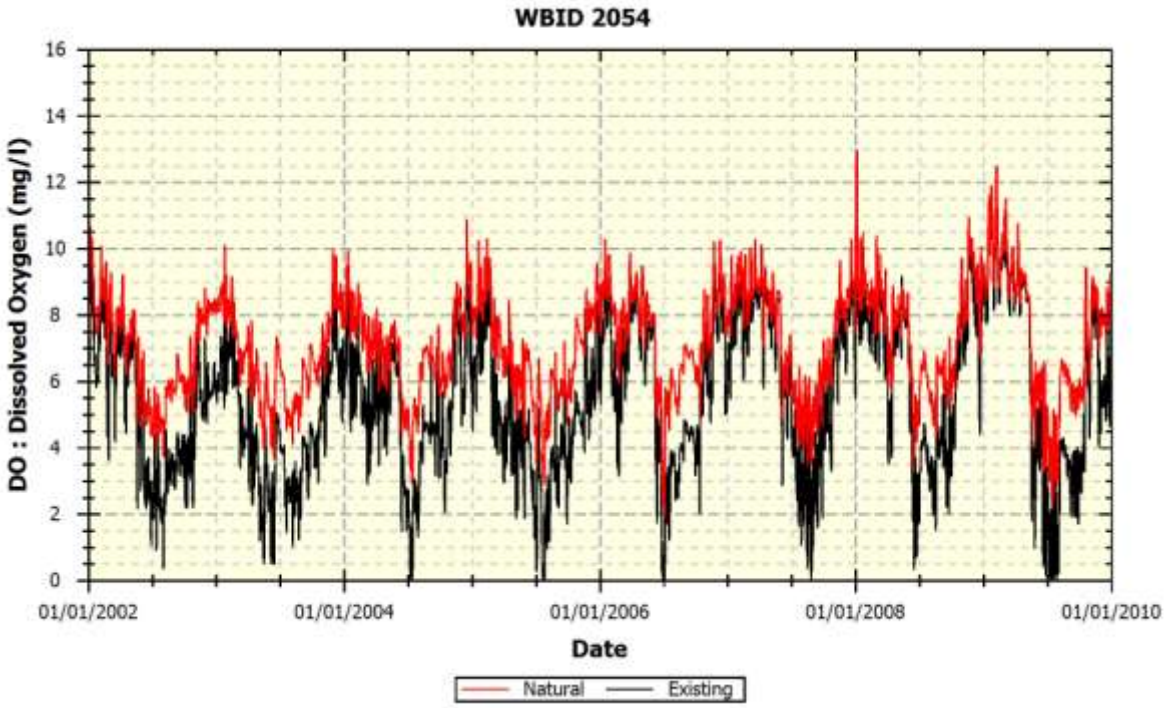

Figure 9 Existing and Natural Condition DO in WBID 2054

8. TMDL Determination

The TMDL for a given pollutant and waterbody is comprised of the sum of individual wasteload allocations (WLAs) for point sources, and load allocations (LAs) for both nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is represented by the equation:

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

The TMDL is the total amount of pollutant that can be assimilated by the receiving waterbody and still achieve water quality standards and the waterbody's designated use. In TMDL development, allowable loadings from all pollutant sources that cumulatively amount to no more than the TMDL must be set and thereby provide the basis to establish water quality-based controls. These TMDLs are expressed as annual mass loads, since the approach used to determine the TMDL targets relied on annual loadings. The TMDLs targets were determined to be the conditions needed to restore and maintain a balanced aquatic system. Furthermore, it is important to consider nutrient loading over time, since nutrients can accumulate in waterbodies.

During the development of this TMDL, it was determined that the natural condition scenario (removal of all anthropogenic sources and landuses) does not meet the Florida standards for DO. The reductions prescribed in this TMDL reduce the current loadings to the natural condition. The allocations are given in Table 9.

Table 9 TMDL Load Allocations for Myrtle Slough (WBID 2054)

WBID 2054	Current Condition		TMDL Condition		MS4	LA
Constituent	WLA (kg/yr)	LA (kg/yr)	WLA (kg/yr)	LA (kg/yr)	% Reduction	% Reduction
BOD	NA	80267	NA	62624	22	22
TN	NA	33577	NA	27106	19	19
TP	NA	5389	NA	3612	33	33

8.1. Critical Conditions and Seasonal Variation

USEPA regulations at 40 CFR 130.7(c)(1) require TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. The critical condition is the combination of environmental factors creating the "worst case" scenario of water quality conditions in the waterbody. By achieving the water quality standards at critical conditions, it is expected that water quality standards should be achieved during all other times. Seasonal variation must also be considered to ensure that water quality standards will be met during all seasons of the year, and that the TMDLs account for any seasonal change in flow or pollutant discharges, and any applicable water quality criteria or designated uses that are expressed on a seasonal basis.

The critical condition for nonpoint source loadings and wet weather point source loadings is typically an extended dry period followed by a rainfall-runoff event. During the dry weather period, nutrients build up on the land surface, and are washed off by rainfall. The critical condition for continuous point source loading typically occurs during periods of low stream flow when dilution is minimized. Although loading of nonpoint source pollutants contributing to a nutrient impairment may occur during a runoff event, the expression of that nutrient impairment is more likely to occur during warmer months, and at times when the waterbody is poorly flushed. Because of the eight year simulation period used in the model development, the model encompasses both critical and seasonal variations to determine the annual average allowable load.

8.2. Margin of Safety

The Margin of Safety accounts for uncertainty in the relationship between a pollutant load and the resultant conditions of the waterbody. There are two methods for incorporating an MOS into TMDLs (USEPA, 1991):

- Implicitly incorporate the MOS using conservative model assumptions to develop allocations
- Explicitly specify a portion of the total TMDL as the MOS and use the remainder for Allocations

The Myrtle Slough TMDL was developed using an implicit margin of safety by using conservative assumptions throughout the modeling process.

8.3. Waste Load Allocations

Only MS4s and NPDES facilities discharging directly into lake segments (or upstream tributaries of those segments) are assigned a WLA. The WLAs, if applicable, are expressed separately for continuous discharge facilities (e.g., WWTPs) and MS4 areas, as the former discharges during all weather conditions whereas the later discharges in response to storm events.

8.3.1. Wastewater/Industrial Permitted Facilities

There is no continuous discharge NPDES permitted point sources in the Myrtle Slough Watershed; therefore, no WLA was calculated.

8.3.2. Municipal Separate Storm Sewer System Permits

The WLA for MS4s are expressed in terms of percent reductions equivalent to the reductions required for nonpoint sources. Given the available data, it is not possible to estimate loadings coming exclusively from the MS4 areas. Although the aggregate wasteload allocations for stormwater discharges are expressed in numeric form, i.e., percent reduction, based on the information available today, it is infeasible to calculate numeric WLAs for individual stormwater outfalls because discharges from these sources can be highly intermittent, are usually characterized by very high flows occurring over relatively short time intervals, and carry a variety of pollutants whose nature and extent varies according to geography and local land use. For example, municipal sources such as those covered by this TMDL often include numerous individual outfalls spread over large areas. Water quality impacts, in turn, also depend on a wide range of factors, including the magnitude and duration of rainfall events, the time period between events, soil conditions, fraction of land that is impervious to rainfall, other land use activities, and the ratio of stormwater discharge to receiving water flow.

This TMDL assumes for the reasons stated above that it is infeasible to calculate numeric water quality-based effluent limitations for stormwater discharges. Therefore, in the absence of information presented to the permitting authority showing otherwise, this TMDL assumes

that water quality-based effluent limitations for stormwater sources of nutrients derived from this TMDL can be expressed in narrative form (e.g., as best management practices), provided that: (1) the permitting authority explains in the permit fact sheet the reasons it expects the chosen BMPs to achieve the aggregate wasteload allocation for these stormwater discharges; and (2) the state will perform ambient water quality monitoring for nutrients for the purpose of determining whether the BMPs in fact are achieving such aggregate wasteload allocation.

All Phase 1 MS4 permits issued in Florida include a re-opener clause allowing permit revisions for implementing TMDLs once they are formally adopted by rule. Florida may designate an area as a regulated Phase II MS4 in accordance with Rule 62-620.800, FAC. Florida's Phase II MS4 Generic Permit has a "self-implementing" provision that requires MS4 permittees to update their stormwater management program as needed to meet their TMDL allocations once those TMDLs are adopted. Permitted MS4s will be responsible for reducing only the loads associated with stormwater outfalls which it owns, manages, or otherwise has responsible control. MS4s are not responsible for reducing other nonpoint source loads within its jurisdiction. All future MS4s permitted in the area are automatically prescribed a WLA equivalent to the percent reduction assigned to the LA. The MS4 service areas described in Section 6.2.1 of this report are required to meet the percent reduction prescribed in Table 9 through the implementation of BMPs.

8.4. Load Allocations

The load allocation for nonpoint sources was assigned a percent reduction in BOD and nutrient loadings from the current loadings coming into Myrtle Slough (See Table 9).

9. Recommendations/Implementation

This TMDL is based on mechanistic modeling of the dissolved oxygen and eutrophication processes using available meteorologic data, hydrologic data, stream geometry, water chemistry data and the evidence of low reaeration, high detrital loading, strong photosynthetic activity, and SOD. The lack of SOD measurements, reaeration measurements, aquatic macrophyte and periphyton measurements introduces uncertainty into this TMDL. Collection of these additional data will help reduce uncertainty and better assess the contribution of potential sources, the timing of any water quality exceedances, and necessary reductions.

The initial step in implementing a TMDL is to more specifically locate pollutant source(s) in the watershed. FDEP employs the Basin Management Action Plan (B-MAP) as the mechanism for developing strategies to accomplish the specified load reductions. Components of a B-MAP are:

- Allocations among stakeholders
- Listing of specific activities to achieve reductions
- Project initiation and completion timeliness
- Identification of funding opportunities
- Agreements
- Local ordinances
- Local water quality standards and permits
- Follow-up monitoring

10. References

Florida Administrative Code. Chapter 62-40, Water Resource Implementation Rule.

Florida Administrative Code. Chapter 62-302, Surface Water Quality Standards.

Florida Administrative Code. Chapter 62-303, Identification of Impaired Surface Waters.

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