

US EPA ARCHIVE DOCUMENT

Final
Total Maximum Daily Load
for
Nutrients
in
Little Charlie Creek (WBID 1774)

May 2013



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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
NHD	National Hydrography Data
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 Waterbody for TMDL addressed in this report:

WBID	Segment Name	Class and Waterbody Type	Major River Basin	HUC	County	State
1774	Little Charlie Creek	Class III Freshwater	Middle Peace River Basin	03100101	Hardee, Polk	Florida

TMDL Endpoints/Targets:

The TMDL endpoints are based upon an interpretation of Florida's narrative provisions for nutrients in Class III freshwaters.

The targets are annual geometric mean concentrations not to exceed the values listed below more than once in a three-year period:

TN (mg/l)	TP (mg/l)
1.23	0.38

TMDL Technical Approach:

The TMDL reductions were determined by calculating annual geometric means for ambient data collected in Little Charlie Creek WBID 1774 and comparing these values to the TMDL targets.

TMDL Waste Load and Load Allocation

	Current Condition	TMDL Condition	MS4	LA
Constituent	(mg/l)	(mg/l)	% Reduction	% Reduction
Total Nitrogen	4.06*	1.23	NA	70
Total Phosphorus	0.57*	0.38	NA	33

NOTES: *The current condition for TN is represented by the annual geometric mean from 2008, while the current condition for TP is represented by the annual geometric mean for 2007.

Endangered Species Present (Yes or Blank):

USEPA Lead TMDL (USEPA or Blank): USEPA

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

Major NPDES Discharges to surface waters addressed in USEPA TMDL: None

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. Little Charlie Creek is a Group 3 waterbody managed by the Southwest Florida Water Management District (SWFWMD).

For the purpose of planning and management, the WMD divided the districts into planning units defined as either an individual primary tributary basin or a group of adjacent primary tributary basins with similar characteristics. Little Charlie Creek is located within the Middle Peace River Planning Unit, which extends from Payne Creek in the north down to the confluence of Horse Creek with the Peace River in the south. Planning units contain smaller, hydrological based units called drainage basins, which are further divided into water segments. A water segment usually contains only one unique waterbody type (stream, lake, canal, etc.) and is typically on the order of five square miles in area. Unique waterbody identification (WBIDs) numbers are assigned to each water segment. The stream segment addressed in this TMDL report is designated WBID 1774 (Little Charlie Creek). The geographic location of the WBID is shown in Figure 1. Location of Little Charlie Creek WBID 1774.

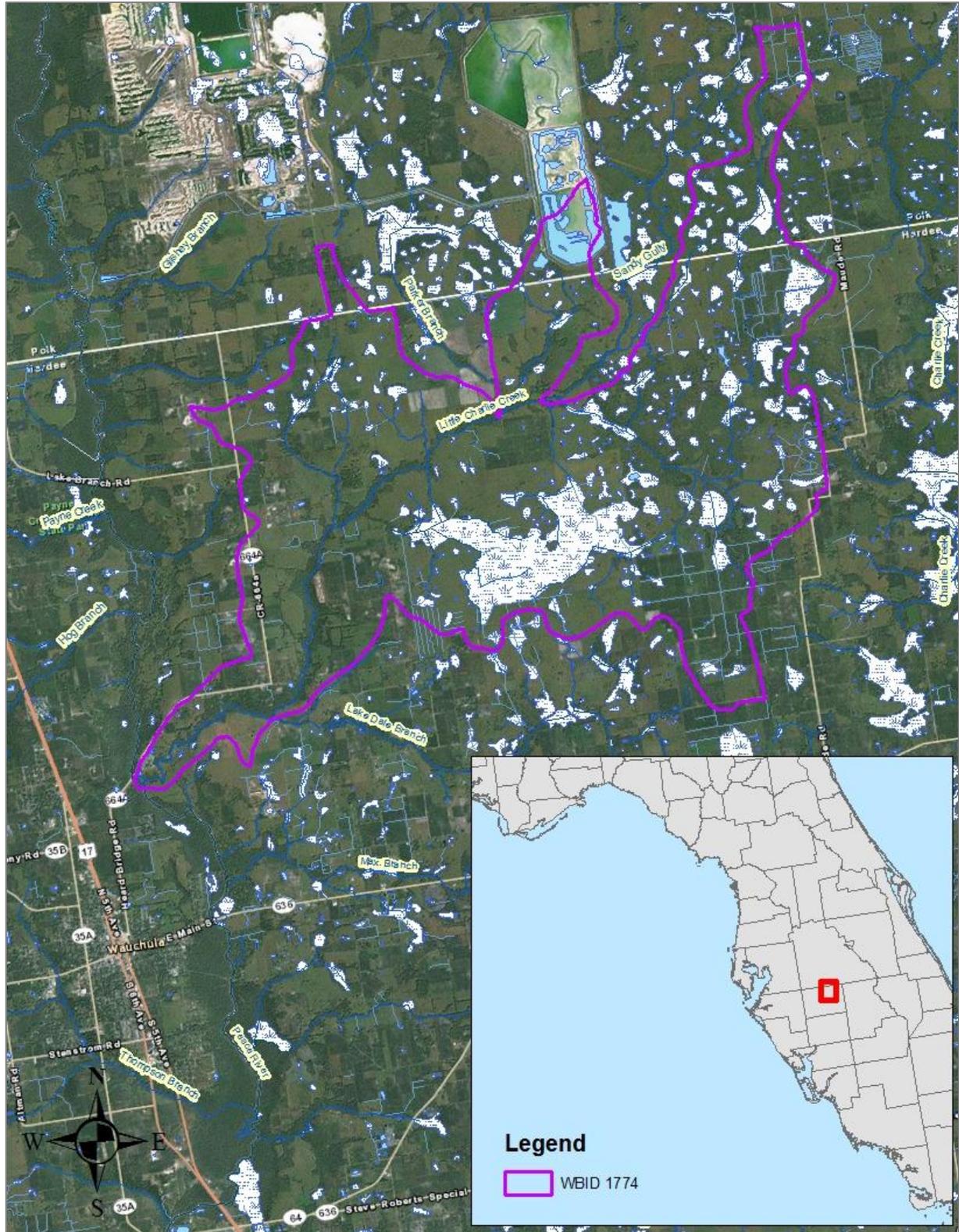


Figure 2. Location of Little Charlie Creek WBID 1774.

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 are collected and examined to determine if the water should be included on the verified list. The IWR defines the thresholds for determining if waters should be placed on the state's planning and verified lists.

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 Middle Peace River Basin as not meeting WQS. After assessing all readily available water quality data, USEPA is responsible for developing a TMDL to address nutrients in WBID 1774 (Little Charlie Creek).

The format of the remainder of this report is as follows: Chapter 3 is a general description of the impaired watershed; Chapter 4 describes the water quality standards and target criteria; and Chapter 5 describes the data assessments; Chapter 6 describes the sources contributing to the impairments; Chapter 7 describes the approach used to develop the TMDL; and Chapter 8 explains the TMDL allocations.

3. Watershed Description

Little Charlie Creek is a direct tributary to the Peace River located on the border between Hardee and Polk counties. The creek and its tributaries, which include Parker Branch, Sandy Gully, and Lake Dale Branch, drain approximately 122 km² (47 mi²). While agriculture and phosphate mining have significantly altered the natural hydrology for most tributaries that drain to the Middle Peace River, the drainages for Little Charlie Creek remains comparatively natural (FDEP, 2007). Much of the water supply for communities in the Middle Peace River basin come from wells dug into the underlying limestone. In this basin, the primary source of groundwater is from the Upper Floridan aquifer, although some water is also drawn from the Hawthorn Formation (PBSJ, 2007). There are no known NPDES-permitted discharges or Municipal Separate Storm Sewer System (MS4) permits in the Little Charlie Creek watershed.

In order to identify possible pollutant sources in the watershed, the latest land use coverage was obtained from FDEP and the SWFWMD. Land use data are based on 2009 land cover features categorized according to the Florida Land Use and Cover Classification System (FLUCCS). Table 1, Figure 3 and Figure 4 show that agriculture and wetlands are the

predominant uses in the Little Charlie Creek watershed. Approximately 65 percent of WBID 1774 is used for agriculture, with the majority of the agricultural areas fitting into the cropland and pastureland category, and a significant portion classified as tree crops. Specifically, of the 11,255 acres of WBID 1774 classified as agriculture, over 75 percent is cropland and pastureland, almost 18 percent is used for tree crops, 7 percent is classified as other open, rural lands, and only 0.06 percent is considered a nursery or vineyard. Between 19 and 20 percent of WBID 1774 is classified as wetland, and almost nine percent of the watershed area is classified as rangeland. Very little forest remains in the watershed. Since there are no permitted wastewater or industrial facilities located in the Little Charlie Creek watershed, stormwater runoff from agricultural areas is considered to be the major contributor of pollutants that cause the nutrient impairment.

Table 1. Landuse distribution in WBID 1774 (Little Charlie Creek).

WBID 1997	Urban, Residential & Built-Up	Agriculture	Rangeland	Forest	Water	Wetlands	Barren Land	Transportation, Communication & Utilities	Total
Level 1 Series ¹	1000 ²	2000	3000 ³	4000	5000	6000	7000	8000	
acres	563	11,255	1535	594	25	3388	0	7.4	17,367
percent	3.2	65	8.8	3.4	0.14	19.5	0	0.04	100%

1. Land use data are based on 2009 land cover features categorized according to the SWFWMD’s modified Florida Land Use and Cover Classification System (FLUCCS). The features were photointerpreted from 2009 color infrared and digital aerial photographs at the 1:8,000 scale. Areas in the table represent the drainage area of WBID 1774, not the entire extent of the watershed.
2. The urban/residential and built-up category includes commercial, industrial, extractive, institutional, and recreational uses.
3. The rangeland category includes dry prairies, shrub and brushland and mixed rangeland.

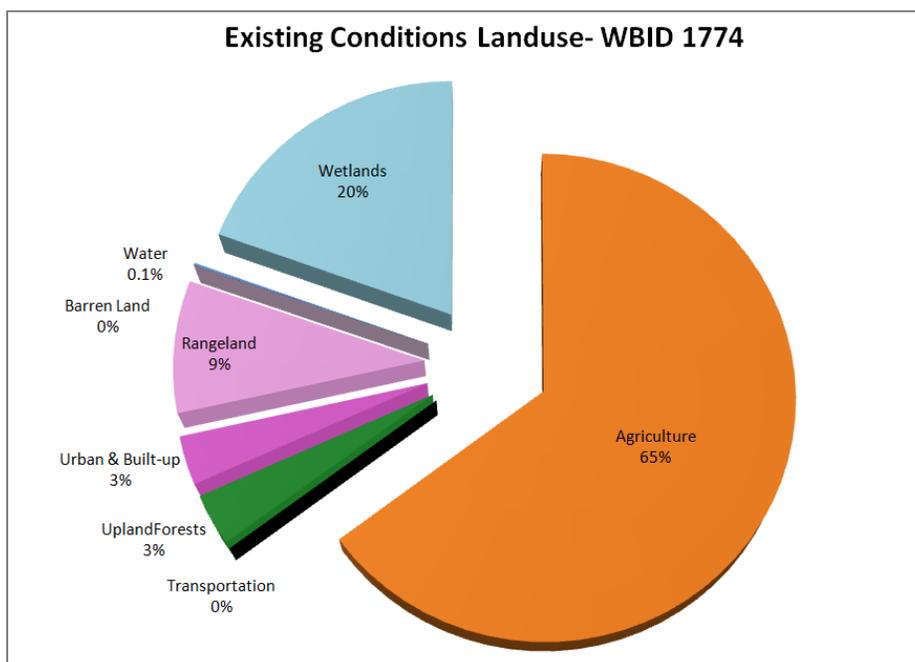


Figure 3. Current (2009) landuse in the Little Charlie Creek Watershed.

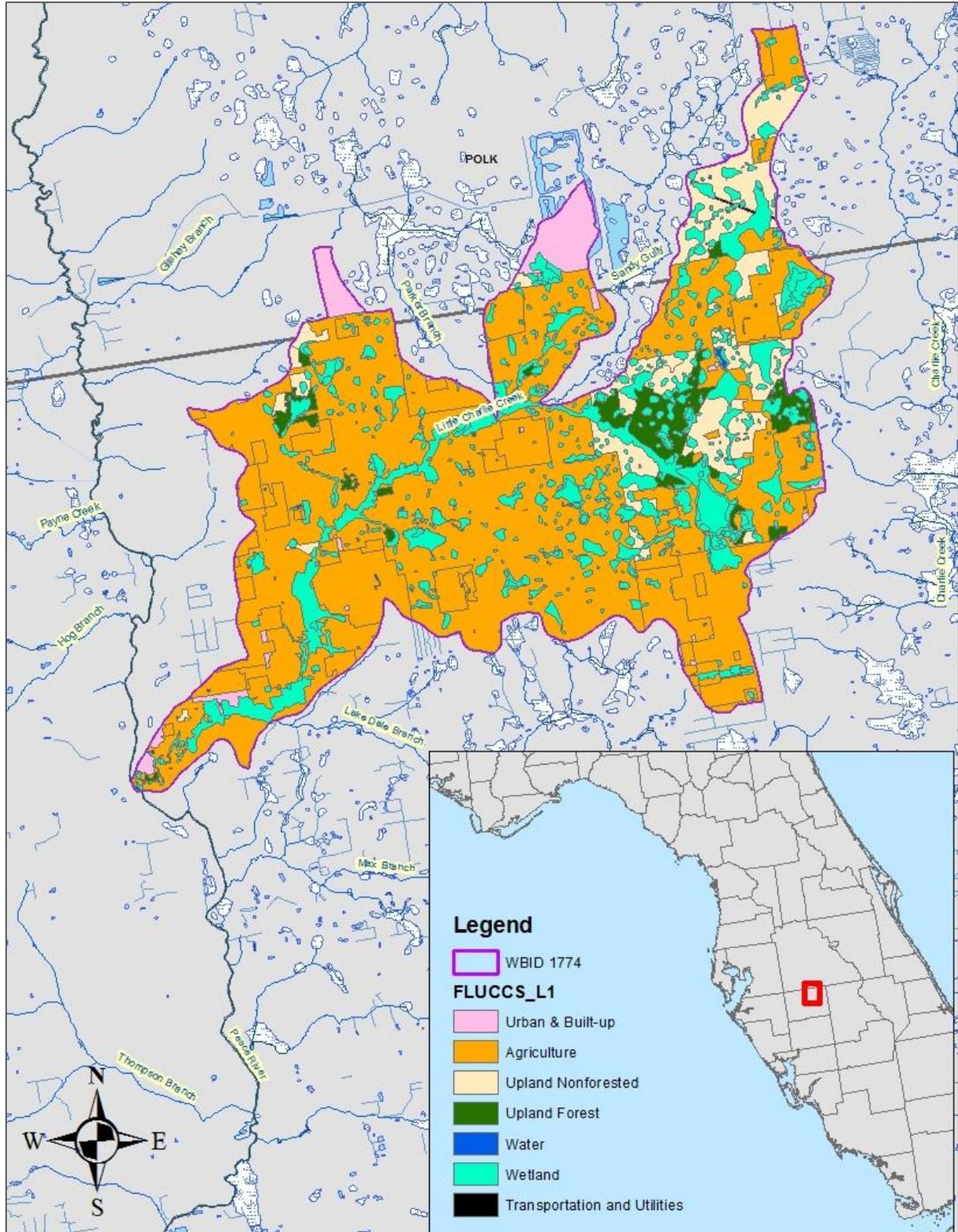


Figure 4. Land use in the Little Charlie Creek watershed.

4. Water Quality Standards/TMDL Targets

WBID 1774 of Little Charlie Creek is a predominantly freshwater Class III stream. The designated uses of Class III waters include recreation, and propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The water quality criteria for protection of Class III waters are established by the State of Florida in the Florida Administrative Code (FAC), Section 62-302.530. The individual criteria should be considered in conjunction with other provisions in water quality standards that apply to all waters, including Section 62-302.500 FAC [Surface Waters: Minimum Criteria, General Criteria], unless alternative or more stringent criteria are specified in FAC Section 62-302.530. In addition, unless otherwise stated, all criteria express the maximum not to be exceeded at any time. The specific criteria addressed in this TMDL document are provided in the following section.

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.

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 (1774). 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 designated used, 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 2 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 2. 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. *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 the following 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.” [FAC 62-302.200(16)]

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.” [FAC 62-302.300(15)]

5. Water Quality Assessment

WBID 1774 of Little Charlie Creek was listed on Florida's 1998 303(d) list for not attaining its designated uses due to nutrients. EPA conducted a water quality assessment to review current water quality data for WBID 1774. The data were obtained from Version 44 of FDEP's IWR database, and the primary constituents evaluated were: DO, biochemical oxygen demand (BOD), chlorophyll-*a* (CHLA), and nutrients. The IWR database contains data from various sources within the state of Florida, including the Water Management Districts and counties.

5.1. *Water Quality Data*

The tables and figures below present the station locations and time series data for dissolved oxygen, biochemical oxygen demand, total nitrogen, total phosphorus, and chlorophyll-*a* observations in Little Charlie Creek. Summary statistics for the water quality data are provided within each figure. The original data are included in the Administrative Record for this report, and are also available upon request.

5.1.1. **WBID 1774: Little Charlie Creek**

Table 3 identifies monitoring stations located in WBID 1774 and lists the time period over which water quality measurements were made at each location during the IWR Version 44 assessment period. Figure 5 illustrates where these monitoring stations are located.

Table 3. Water Quality Monitoring Stations for WBID 1774: Little Charlie Creek.

Station	Station Name	First Date	Last Date	No. Obs
21FLBRA 1774-A	1774 - Little Charlie Creek - at bridge on Heard Ridge	06/21/2007	02/29/2008	174
21FLTPA 273515908146154	TP535 - Little Charlie Cr.	04/08/2009	06/23/2009	30
21FLBRA 1774-B	1774 - Little Charlie Creek - one lane brdg on Boyd Cowart	06/21/2007	02/29/2008	127
21FLTPA 273641908145378	TP536 - Little Charlie Cr.	04/08/2009	06/23/2009	18
21FLBRA 1774-C	1774 - Little Charlie Creek - One lane bridge on Locklar Rd	12/07/2007	02/22/2008	43
21FLTPA 273738008143399	TP537 - Little Charlie Cr.	04/08/2009	06/02/2009	9

No. Obs.= Number of observations (various parameters) in IWR 44 current assessment period.

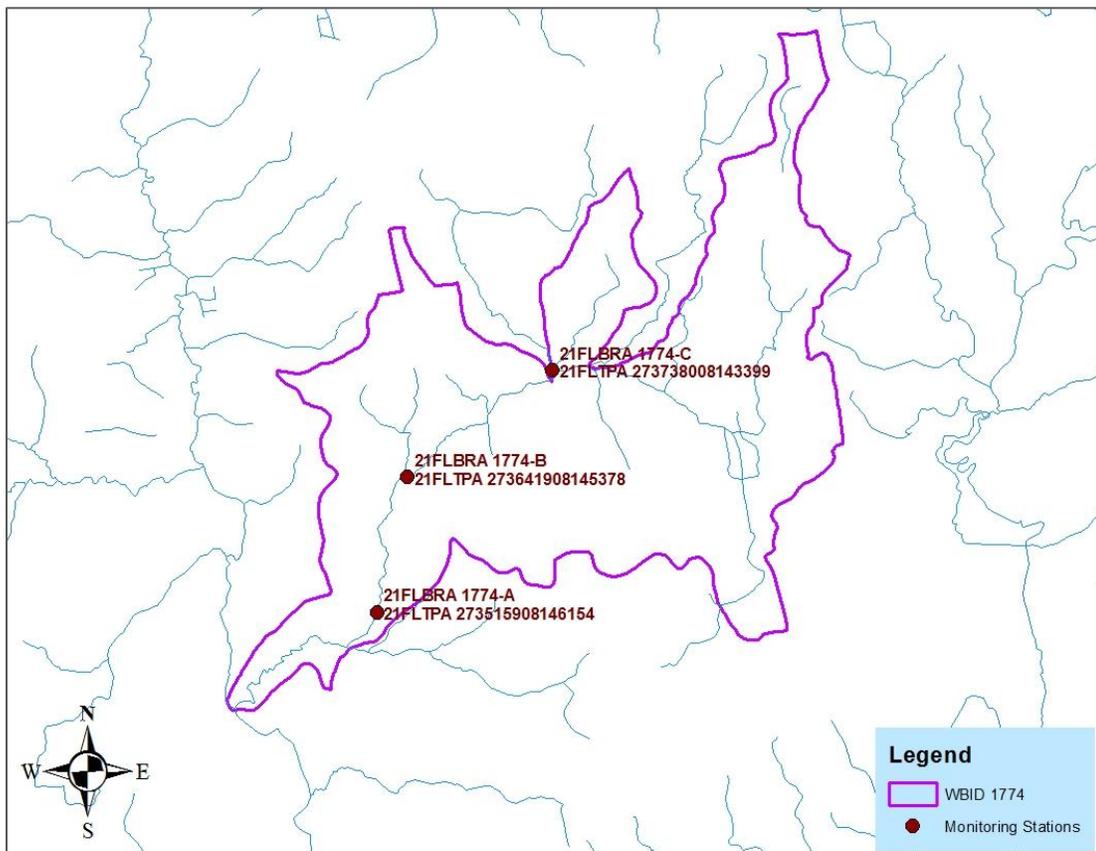


Figure 5. Location of Monitoring Stations in WBID 1774 of Little Charlie Creek.

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 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, as well as the relative contributions of groundwater. However, the natural DO regime may be impacted by pollutants, such as nutrients and oxygen-demanding substances. Replenishment of oxygen levels may be inhibited if excessive growth of aquatic plants above the water surface blocks sunlight from reaching submerged vegetation, reducing their ability to photosynthesize. Decomposition of organic matter, such as dead plants and animals, also uses up DO.

Nutrient levels affect DO concentrations directly and indirectly. The process of nitrification, in which bacteria convert ammonia-nitrogen to nitrate-nitrogen, directly consumes oxygen from the water. Indirect effects of excessive nutrient loading involve over-stimulation of aquatic plant growth, which leads to exacerbated diurnal swings in DO, and decomposition of the algal biomass after it dies and settles to the bottom, a process that consumes oxygen.

Figure 6 provides a time series plot for the measured DO concentrations in Little Charlie Creek. There were 6 monitoring stations used in the assessment that included a total of 41 observations of which 18 (43 percent) fell below the water quality standard of 5 mg/l DO. The minimum value was 1.6 mg/l, the maximum was 10.8 mg/l and the average was 5.7 mg/l.

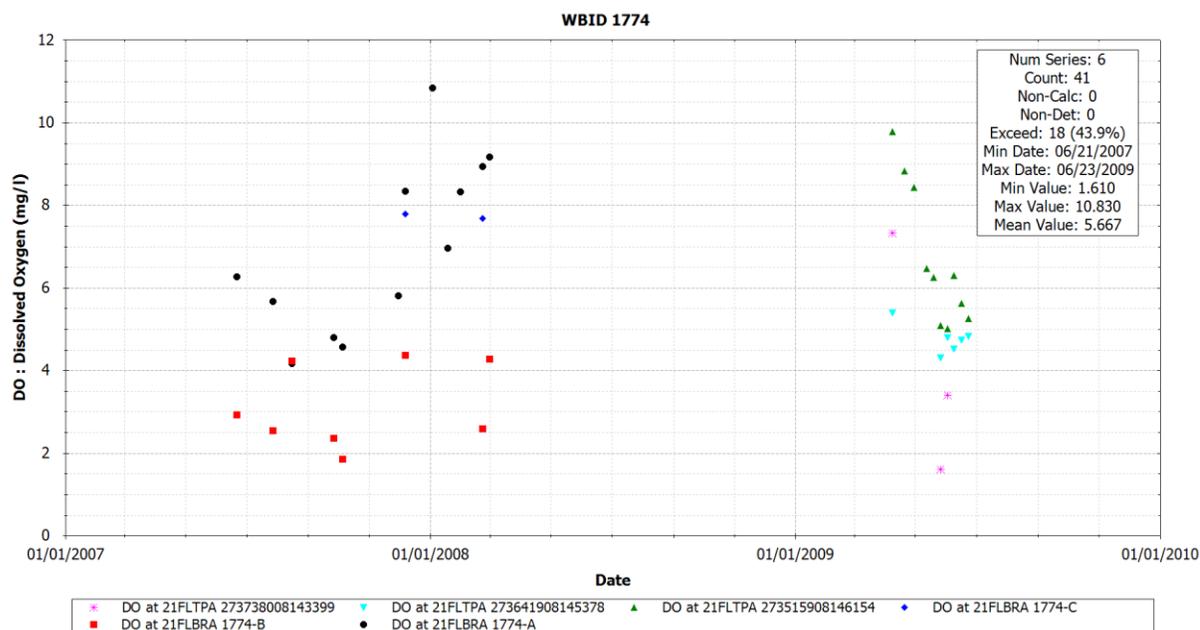


Figure 6. Measured DO in Little Charlie Creek WBID 1774.

Biochemical Oxygen Demand

BOD is a measure of the amount of oxygen used by bacteria as they stabilize organic matter. Figure 7 provides a time series plot for the measured BOD concentrations in the freshwater segment of Little Charlie Creek. There were 3 monitoring stations used in the assessment that

included a total of 22 observations. The minimum value was 2.0 mg/l, the maximum was 3.3 mg/l and the average was 2.1 mg/l.

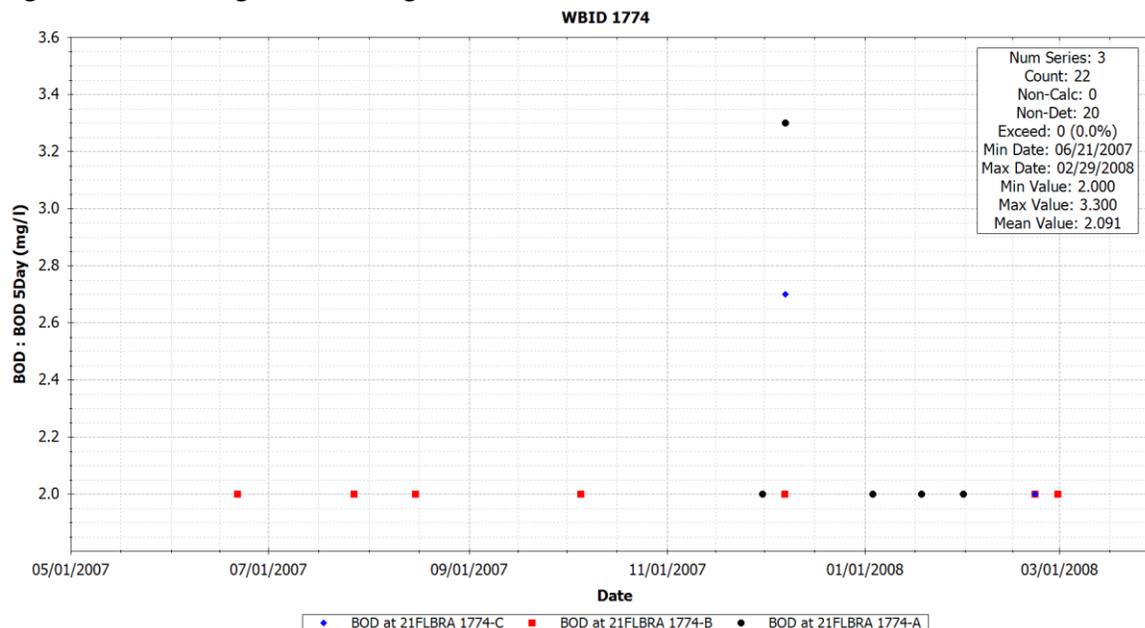


Figure 7. Measured BOD in Little Charlie Creek WBID 1774.

Nutrients

Excessive nutrients in a waterbody can lead to overgrowth of algae and other aquatic plants such as phytoplankton, periphyton and macrophytes. This process depletes oxygen in the water, adversely affecting aquatic life and potentially restricting recreational uses. 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 8 provides a time series plot for the measured TN concentrations in Little Charlie Creek. There were 3 monitoring stations used in the assessment that included a total of 24 observations. The minimum value was 0.49 mg/l, the maximum was 7.4 mg/l and the average was 2.4 mg/l. The TN values measured at station 21FLBRA 1774-A are consistently high, and the nitrogen concentrations there are much higher than the other stations upstream of it, even when all stations are sampled on the same day. TN at the other stations average less than one mg/l TN, while TN at station 21FLBRA 1774-A averages greater than three mg/l. It is also important to note that, unlike stations 21FLBRA 1774-B and 21FLBRA 1774-C, most of the nitrogen measured at station 21FLBRA 1774-A is in the form of nitrate-nitrite, which suggests that a source of nitrogen fertilizer is being introduced to Little Charlie Creek somewhere downstream of stations 21FLBRA 1774-B and 21FLBRA 1774-C.

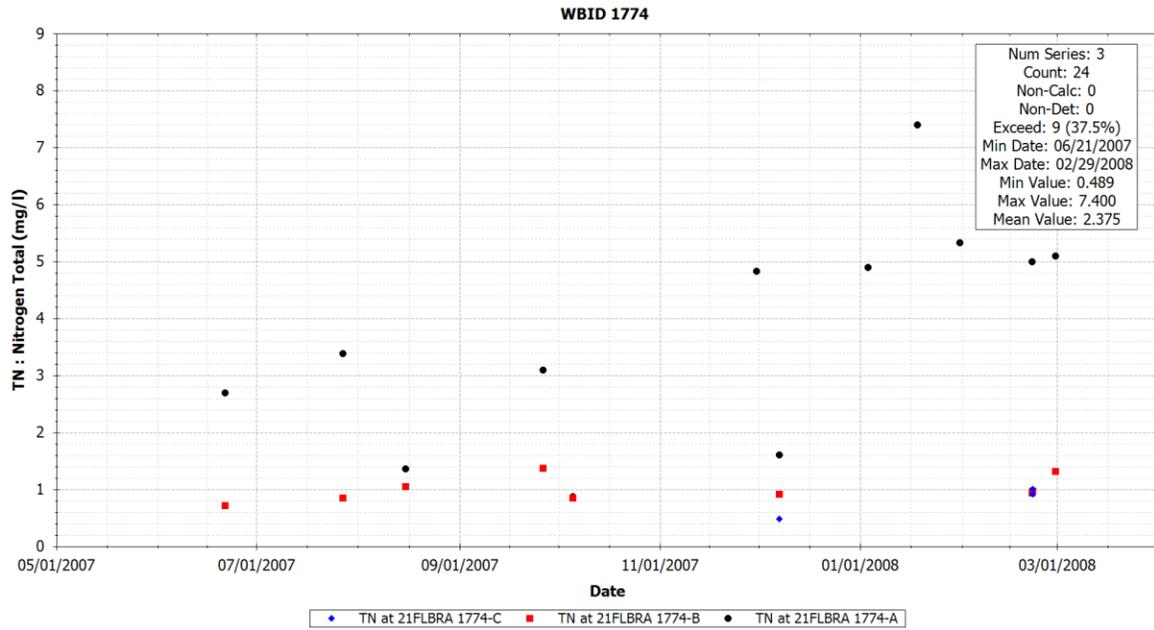


Figure 8. Measured Total Nitrogen in Little Charlie Creek WBID 1774.

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 9 provides a time series plot for the measured total phosphorus concentrations in Little Charlie Creek. There were 3 monitoring stations used in the assessment that included a total of 22 observations. The minimum value was 0.07 mg/l, the maximum was 1.1 mg/l and the average was 0.63 mg/l.

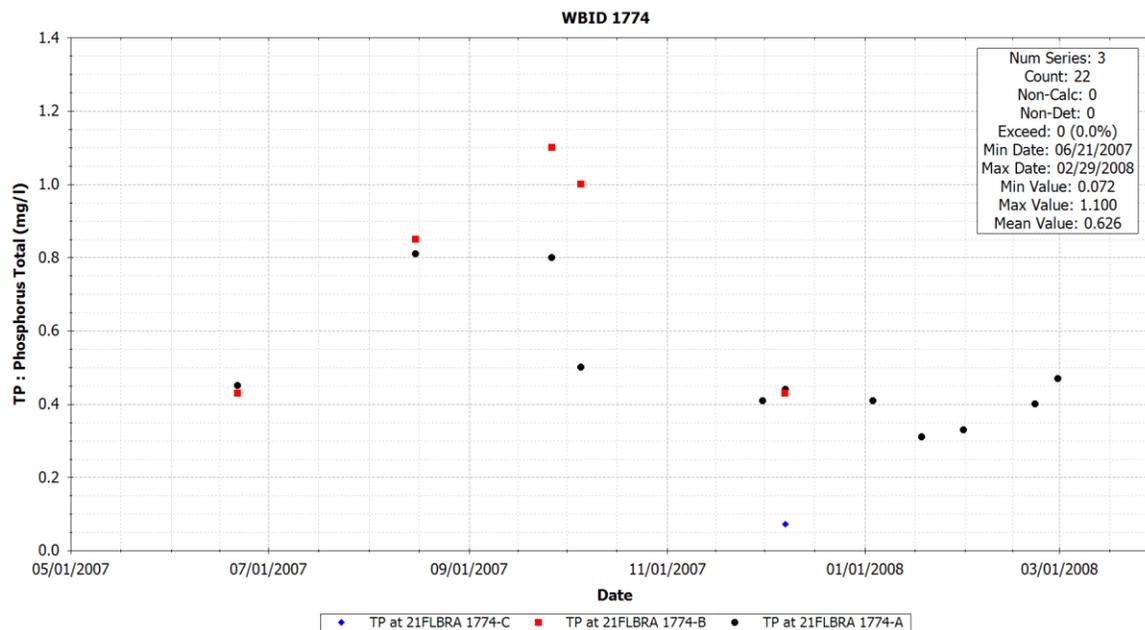


Figure 9. Measured Total Phosphorus in Little Charlie Creek WBID 17741774.

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 10 provides a time series plot for corrected chlorophyll *a* concentrations in Little Charlie Creek. There were 3 monitoring stations used in the assessment that included a total of 19 observations. The minimum value was 1.3 $\mu\text{g/l}$, the maximum was 2.1 $\mu\text{g/l}$ and the average was 1.3 $\mu\text{g/l}$. Although chlorophyll data are limited, they do not suggest that Little Charlie Creek experiences chronic overgrowth of phytoplankton algae. However, it is important to interpret the data with the understanding that measuring chlorophyll concentrations in a water sample only captures phytoplankton, the free-floating algae, and will not capture other types such as attached algae (periphyton), algae growing on bottom sediments (benthic), and other aquatic plants (macrophytes).

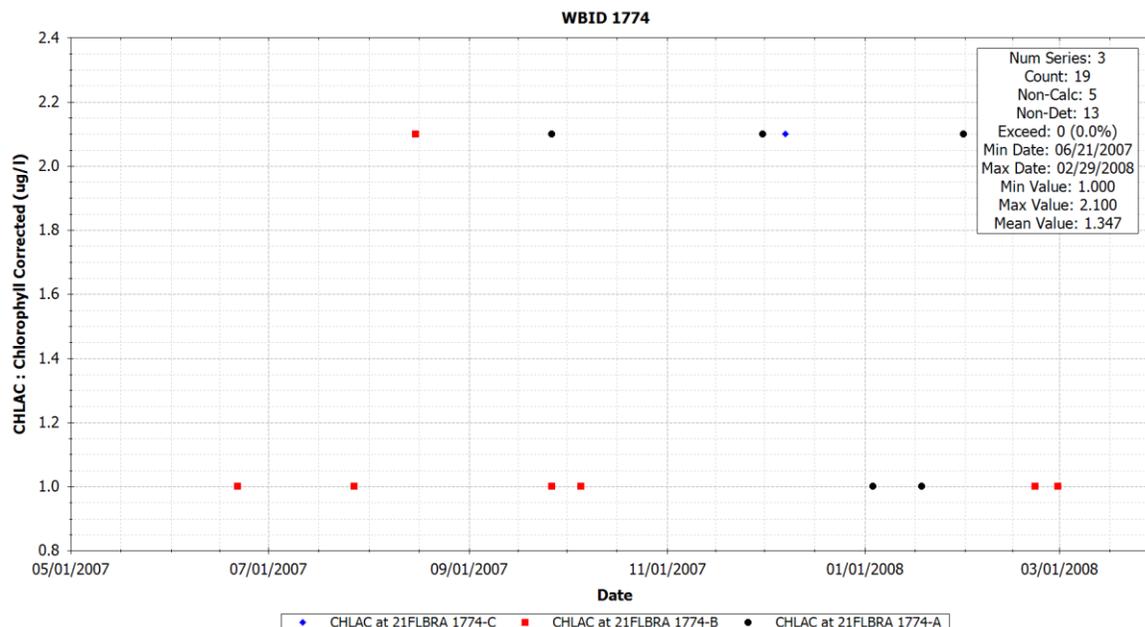


Figure 10. Measured Chlorophyll-a Concentrations in Little Charlie Creek WBID 17741774.

5.2. Summary of Data Assessments

DO in WBID 1774 of Little Charlie Creek 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 show a wide range in concentration. Based on this information, and the presence of potential point and nonpoint sources of relevant pollutants, TMDLs for nutrients are being proposed for WBID 1774.

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 wastewater and industrial NPDES permitted facilities discharging to surface waters within an impaired watershed. There are no NPDES permitted facilities with direct, surface water discharges within the Little Charlie Creek watershed.

6.1.2. Stormwater Permitted Facilities/MS4s

The 1987 amendments to the Clean Water Act designated certain stormwater discharges as point sources requiring NPDES stormwater permits. The regulated activities involve Municipal Separate Storm Sewer Systems (MS4s), construction sites over one acre, and specific industrial operations. Although these types of stormwater discharges are now considered point sources with respect to permitting and TMDLs, they behave similarly to nonpoint sources in that they are driven by rainfall-runoff processes leading to the intermittent discharge of pollutants from land use activities in response to storms.

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 washed into MS4s by stormwater runoff, or dumped directly into them, from being delivered to local waterbodies. Phase I of the program required operators of “medium” and “large” MS4s (generally serving populations of 100,000 or more) to implement a stormwater management program as a means of controlling polluted discharges. 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, and hazardous waste treatment, etc. Because the master drainage systems of most local governments in Florida are interconnected, USEPA implemented Phase 1 of the MS4 permitting program on a countywide basis, which brings in all cities, Chapter 298 urban water control districts, and the

Florida Department of Transportation throughout the 15 counties meeting the population criteria.

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.

Little Charlie Creek (WBID 1774) is not currently affected by an MS4 permit. If areas within the watershed experience population growth to the extent of meeting the MS4 coverage criteria, they may be subsequently designated as a regulated Phase II MS4 by the state of Florida in accordance with Rule 62-620.800, FAC. Any newly designated Phase II MS4 will 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 expected to be a significant source of nutrients and oxygen-demanding substances in the Little Charlie Creek watershed. Land uses in this category comprise only about three 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 4 summarizes the cumulative number of septic systems installed in Hardee and Polk counties 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, 2012). The data do not reflect septic tanks removed from service.

Table 4. County Estimates of Septic Tanks and Repair Permits.

County	Number of Septic Tanks (1970- 2011)	Number of Repair Permits Issued (2001 – 2011)
Hardee	8,757	324
Polk	118,603	11,725

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

Given the high number of septic tanks in these counties, it is possible that leaking septic systems contribute some organic and nutrient loading in the Little Charlie Creek watershed.

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. Land use data and aerial coverage show that agriculture is a very significant use in the Little Charlie Creek watershed, comprising approximately 65 percent of the landuse (Figure 4 and Table 1).

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. About nine percent of the area in Little Charlie Creek WBID 1774 is classified as rangeland.

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 only account for about three percent of the land use in the Little Charlie Creek watershed.

6.2.5. Water and Wetlands

Water and Wetlands have very low event mean concentrations and comprise approximately 20 percent of the land use in WBID 1774.

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. None of WBID 1774 watershed is classified as barren.

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 less than one-half percent of the area in WBID 1774.

7. Analytical Approach

The TMDL reductions were determined by calculating annual geometric means for ambient data collected in Little Charlie Creek WBID 1774 and comparing these values to the TMDL targets. The data were obtained for the current assessment period from FDEP's IWR database (Version 44).

7.1. TMDL Targets

The targets used to develop the nutrient TMDL for Little Charlie Creek are an interpretation of Florida's narrative water quality standard for nutrients (see Section 4.1). Table 5 shows the annual geometric mean concentrations of TN and TP not to be exceeded more than once in any three year period. Details of the derivation of the nutrient targets for this TMDL are presented in Appendix A.

Table 5. TMDL Targets for Nutrients.

TN (mg/l)	TP (mg/l)
1.23	0.38

7.2. Existing Conditions

In order to quantify the extent to which nutrient loadings to Little Charlie Creek need to be reduced, it is necessary to document the current condition of the waterbody. Since the TMDL targets are annual geometric mean concentrations, the stream's current conditions were represented by calculating annual geometric means of TN and TP from ambient data collected in WBID 1774 for the current assessment period (Table 6). In the last fifteen years, TN and

TP data are only available for WBID 1774 in 2007 and 2008. Samples collected on the same day were averaged, and values from all monitoring stations were spatially aggregated to calculate annual geometric means. Values that exceed their corresponding target are bolded, while the highest annual geometric means for each parameter are bracketed. These means were then compared to the target concentrations in Table 5.

Table 6. Annual geometric mean concentrations of TN and TP in WBID 1774.

Year	TN (mg/l)	TP (mg/l)
2007	1.73	[0.57]
2008	[4.06]	0.47

The spatially aggregated annual averages presented in Table 6 do not make evident the differences in nutrient concentrations between sampling stations. Table 7 provides the annual and overall geometric mean concentrations for all TN and TP data collected at sampling stations 1774-A, 1774-B and 1774-C. (To view the location of these stations within WBID 1774, please see Figure 5.) The comparison between years and stations is complicated by the fact that data were not collected at all stations for every sampling date, and the data for 2008 were all taken in the first two months of the year. However, these results do show the significant spatial and temporal variability in nutrient concentrations within the Little Charlie Creek watershed.

Table 7. Geometric mean concentrations in TN and TP by sampling station.

station	1774-A		1774-B		1774-C	
	TN (mg/l)	TP (mg/l)	TN (mg/l)	TP (mg/l)	TN (mg/l)	TP (mg/l)
2007	2.59	0.55	0.94	0.70	0.49	0.07
2008	5.48	0.38	1.07	0.90	1.07	0.92
overall	3.23	0.46	0.98	0.77	0.77	0.39

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:

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

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.

The TMDL reductions were determined by comparing the annual geometric means for ambient data collected in Little Charlie (Table 6), and comparing these values to the TMDL targets (Table 5). The resulting allocations are given below:

Table 8. TMDL Load Allocations for Little Charlie Creek.

	Current Condition	TMDL Condition	MS4	LA
Constituent	(mg/l)	(mg/l)	% Reduction	% Reduction
Total Nitrogen	4.06*	1.65	NA	59
Total Phosphorus	0.57*	0.49	NA	14

NOTES: *The current condition for TN is represented by the annual geometric mean from 2008, while the current condition for TP is represented by the annual geometric mean for 2007.

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. This TMDL considers critical conditions and seasonal variation by including all available data from the past several years; these years represent a range of seasons and environmental conditions. The TMDL also protects critical conditions by using the highest annual concentrations to represent the existing conditions of the stream, and basing the required reductions on those years.

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

This TMDL incorporates an implicit MOS by representing the current condition of Little Charlie Creek using the highest annual geometric means, which results in higher required reductions for the contributing sources. The TMDL is also implicitly conservative because it is calculated to meet the TMDL targets every year, rather than allowing for the targets to be exceeded once every three years, as was contemplated in the technical analysis on which the targets are based.

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 are no NPDES-permitted facilities with direct, surface water discharges within the Little Charlie Creek watershed. Therefore, no WLA was allocated for such facilities.

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.

Little Charlie Creek (WBID 1774) is not currently affected by an MS4 permit. If areas within the watershed experience population growth to the extent of meeting the MS4 coverage criteria, they may be subsequently designated as a regulated Phase II MS4 by the state of Florida in accordance with Rule 62-620.800, FAC. Any newly designated Phase II MS4 will be required to achieve the percent reduction allocation presented in this TMDL.

8.4. Load Allocations

The load allocation for nonpoint sources is expressed as the percent reduction in current loadings of TN and TP coming into Little Charlie Creek that would be needed to meet the TMDL targets.

9. Recommendations/Implementation

EPA recommends that additional data for TN, TP, and CHLAC be collected in Little Charlie Creek so that the seasonal and annual variability of nutrient concentrations may be better evaluated.

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

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.

Florida Department of Environmental Protection (FDEP), 2007. *Peace River Basin Resource Management Plan*, March 2007.

Florida Department of Health (FDOH), 2012, Onsite Sewage Treatment and Disposal Systems Statistical Data, Bureau of Onsite Sewage Programs.
<http://www.doh.state.fl.us/environment/ostds/statistics/ostdsstatistics.htm>

PBS&J, 2007. *Final Report for the Peace River Cumulative Impact Study*. Report prepared for the Florida Department of Environmental Protection Bureau of Mine Reclamation and the Southwest Florida Water Management District, by Jones PBS&J. January 2007.

USEPA, 1991. *Guidance for Water Quality – Based Decisions: The TMDL Process*. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA-440/4-91-001, April 1991.

USEPA, 2010. *Water Quality Standards for the State of Florida's Lakes and Flowing Waters; Final Rule*. 40 CFR Part 131 [EPA-HQ-OW-2009-0596; FRL-9228-7], RIN 2040-AF11 (December 6, 2010).

Appendix A

The targets used to develop the nutrient TMDL for Little Charlie Creek are an interpretation of Florida's narrative water quality standard for nutrients (see Section 4.1). USEPA interpreted Florida's narrative when promulgating numeric water quality criteria for nutrients in Florida's lakes, springs, and flowing waters. Those criteria were promulgated on December 6, 2010 (see 75 Federal Register 75,762). The rule establishes criteria for lakes, springs, and flowing waters that are designated Class I or Class III, in order to implement Florida's narrative nutrient provision at Subsection 62-302-530(47)(b), FAC. On February 18, 2012, the streams criteria were invalidated by the U.S. District Court for the Northern District of Florida and remanded back to USEPA.

In its analysis of nutrient levels in flowing waters, USEPA divided the state of Florida into Nutrient Watershed Regions (NWRs) so that the rivers and streams in them would share similar characteristics such as underlying geologic materials, nitrogen and phosphorus concentrations, and nitrogen to phosphorus ratios. The final rule contains five separate NWRs: Panhandle West, Panhandle East, North Central, West Central and Peninsula (north of Lake Okeechobee, including the Caloosahatchee River Watershed to the west and the St. Lucie Watershed to the east). Additional information about the NWRs and technical details about the development of the criteria may be found in the Final Rule and its supporting documents (USEPA, 2010).

Recently, the State of Florida adopted numeric nutrient criteria that interprets the narrative water quality criterion for nutrients in paragraph 62-302.530(48)(b), F.A.C. (Section 62-302.531(2), F.A.C). The Florida rule provides that the narrative water quality criteria for nutrients in paragraph 62-302.530(47)(a), F.A.C., continues to apply to all Class III waters (Section 62-302.531(1)).

Florida's recently adopted rule applies to streams. For streams that do not have a site specific criteria, Florida's rule provides for biological information to be considered together with nutrient thresholds to determine whether a waterbody is attaining 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 2 are achieved (Section 62-302.531(2)(c) F.A.C).

Florida's rule provides that numeric nutrient criteria are 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). Florida's nutrient criteria are consistent with USEPA promulgated rule.

Little Charlie Creek (WBID 1774) is located in the West Central NWR. The targets for this TMDL were derived based on the re-analysis of the nutrient data for the West Central NWR.

Within the West Central NWR, three sites in WBID 1978 were identified that meets the screening criteria of benchmark sites used in USEPA final rule (details of the screening criteria are described in the technical support document of the promulgated rule).

Table A.1 shows the list of sites and their corresponding period of record and total number of observations. The summary of the TN and TP is shown in Table A.2. The table shows the WBID average annual geometric means. The target TN and TP values were derived using a criterion of no more than one in a three year exceedance.

Table A.1 Reference stations in WBID 1978

Station	Station Name	First Date	Last Date	No. Obs
21FLGW 11200	SWC-LS-1026 DEER PRAIRIE SLOUGH	08/22/2001	08/22/2001	8
21FLSWFD25995 (21FLSWFD_FLO183000045600)	DEER PRAIRIE CREEK ABOVE MYAKKA RIVER	10/12/1998	12/08/2010	971
21FLTPA 25030603	TP126 - DEER PRAIRIE SLOUGH	08/17/1999	11/17/2008	201

Table A.2. WBID 1978 Average Annual Geometric Means

Year	ln TN	ln TP	TN	TP
1998	-0.6416	-2.4462	0.526	0.087
1999	-0.2113	-1.6520	0.810	0.192
2000	0.3607	-0.7164	1.434	0.489
2001	0.0632	-1.0668	1.065	0.344
2002	-0.0067	-1.5949	0.993	0.203
2003	-0.0459	-1.6291	0.995	0.196
2004	0.1089	-1.5552	1.115	0.211
2005	0.0599	-2.3424	1.062	0.096
2006	-0.0687	-1.5821	0.934	0.206
2007	-0.1651	-0.9776	0.848	0.376
2008	-0.1005	-1.0846	0.904	0.338
2010	0.0384	-2.1163	1.039	0.120
Mean	-0.0507	-1.5636		
StDev	-0.0263	-1.5885		
Target			1.23	0.38

Derivation of TMDL Nutrient Target

The TN and TP target concentrations shown in Table A.2. are derived as follows:

1. Using a 95% confidence level (Type I error of 5%), the criterion of no more than one exceedance in any three year period corresponds to an exceedance probability of 0.135 (probability corresponding to an annual geometric mean exceeding a threshold), or alternatively the 86.5th percentile of the distribution of the annual geometric means (the number of annual geometric means exceeding a threshold is binomially distributed).
2. Given that the annual geometric means in Table A.2 are log-normally distributed (assumption of log-normal distribution cannot be rejected using a Kolmogorov-Smirnov test at 5% level of significance), the 86.5th percentile for TN and TP are 1.235 mg/l and 0.381 mg/l, respectively.