Central District • Middle St. Johns Basin

Final TMDL Report

Nutrient TMDLs for Bethel Lake (WBID 2953) and Documentation in Support of the Development of Site-Specific Numeric Interpretations of the Narrative Nutrient Criterion

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Executive Summary

This report presents the total maximum daily loads (TMDLs) developed to address the nutrient impairment of Bethel Lake. The lake is located in Volusia County, with the eastern edge of the watershed bordering the City of Deltona.

Bethel Lake (the segment with waterbody identification [WBID] number 2953) was determined to be impaired (Category 5) for chlorophyll *a*, total nitrogen (TN), and total phosphorus (TP) because the annual geometric means (AGMs) for each parameter exceeded the applicable numeric nutrient criteria (NNC). The waterbody was added to the 303(d) list of impaired waters by Secretarial Order in April 2016.

TMDLs for TN and TP have been developed. **Table EX-1** lists supporting information for the TMDLs. Pursuant to Paragraph 62-302.531(2)(a), Florida Administrative Code (F.A.C.), these TMDLs will constitute the site-specific numeric interpretations of the narrative nutrient criterion set forth in Paragraph 62-302.530(48)(b), F.A.C., that will replace the otherwise applicable NNC in Subsection 62-302.531(2), F.A.C. The TMDLs were developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by the U.S. Environmental Protection Agency.

Table EX-1. Summary of TMDL supporting information for Bethel Lake

Type of Information	Description
Waterbody name (WBID)	Bethel Lake (WBID 2953)
Hydrologic Unit Code (HUC) 8	03080101
Use classification/ Waterbody designation	Class III Freshwater
Targeted beneficial uses	Fish consumption, recreation, and propagation and maintenance of a healthy, well-balanced population of fish and wildlife.
303(d) listing status	Verified List of Impaired Waters for the Group 2 basins (Middle St. Johns) adopted via Secretarial Order dated April 2016.
TMDL pollutants	TN and TP
TMDLs and site-specific interpretations of the narrative nutrient criterion	**Bethel Lake (WBID 2953):** **TN:** 4,234 pounds per year (lbs/yr), expressed as a 7-year rolling average load not to be exceeded. **TP:** 234 lbs/yr, expressed as a 7-year rolling average load not to be exceeded.
Load reductions required to meet the TMDLs	**WBID 2953:** A 45 % TN reduction and a 67 % TP reduction to achieve the applicable AGM chlorophyll *a* criterion for high-color lakes.
Concentration-based lake restoration targets	**WBID 2953:** The nutrient concentrations corresponding to the applicable chlorophyll *a* NNC and the loading-based criteria are a TN AGM of 1.12 milligrams per liter (mg/L) and a TP AGM of 0.04 mg/L, not to be exceeded more than once in any consecutive 3-year period.

Acknowledgments

This analysis was accomplished thanks to significant contributions from staff in the Florida Department of Environmental Protection (DEP) Division of Environmental Assessment and Restoration, specifically, the Office of Watershed Services, Watershed Assessment Section, Standards Development Section, Water Quality Restoration Program, Central Regional Operations Center, and Watershed Evaluation and TMDL Section.

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List of Acronyms and Abbreviations

µg/L	Micrograms Per Liter
ac-ft/yr	Acre-Feet Per Year
AGM	Annual Geometric Mean
BMAP	Basin Management Action Plan
BMPs	Best Management Practices
$CaCO_3$	Calcium Carbonate
CFR	Code of Federal Regulations
Chla	Chlorophyll *a*
CWA	Clean Water Act
° F.	Degrees Fahrenheit
DEP	Florida Department of Environmental Protection
DO	Dissolved Oxygen
EMC	Event Mean Concentration
EPA	U.S. Environmental Protection Agency
F.A.C.	Florida Administrative Code
FDOH	Florida Department of Health
FDOT	Florida Department of Transportation
FL	Florida
F.S.	Florida Statutes
FWRA	Florida Watershed Restoration Act
FWS	U.S. Fish and Wildlife Service
HUC	Hydrologic Unit Code
IPaC	Information for Planning and Conservation
IWR	Impaired Surface Waters Rule
LA	Load Allocation
lbs	Pounds
lbs/yr	Pounds Per Year
m	Meter
m/yr	Meters Per Year
mg/L	Milligrams Per Liter
$mg/m^2/yr$	Milligrams Per Square Meter Per Year
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer System
NA	Not Applicable
NMFS	National Marine Fisheries Service
NNC	Numeric Nutrient Criteria
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OSTDS	Onsite Sewage Treatment and Disposal System
PCU	Platinum Cobalt Units
PET	Potential Evapotranspiration
PLRG	Pollutant Load Reduction Goal
PLSM	Pollutant Load Screening Model
POR	Period of Record

ROC	Runoff Coefficient
SJRWMD	St. Johns River Water Management District
SWIM	Surface Water Improvement and Management
TIGER	Topologically Integrated Geographic Encoding and Referencing
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
U.S.	United States
USACE	U.S. Army Corps of Engineers
WBID	Waterbody Identification
WLA	Wasteload Allocation
WQS	Water Quality Standards
WWTF	Wastewater Treatment Facility

Chapter 1: Introduction

1.1 Purpose of Report

This report presents the total maximum daily loads (TMDLs) developed to address the nutrient impairment of Bethel Lake, located in the Middle St. Johns Basin. Pursuant to Paragraph 62-302.531(2)(a), Florida Administrative Code (F.A.C.), the TMDLs will also constitute the site-specific numeric interpretations of the narrative nutrient criterion set forth in Paragraph 62-302.530(48)(b), F.A.C., that will replace the otherwise applicable numeric nutrient criteria (NNC) in Subsection 62-302.531(2), F.A.C. The waterbody was verified as impaired for nutrients using the methodology in the Identification of Impaired Surface Waters Rule (IWR) (Chapter 62-303, F.A.C.) and was included on the Verified List of Impaired Waters for the Middle St. Johns Basin adopted by Secretarial Order in April 2016.

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and provides water quality targets needed to comply with applicable water quality criteria based on the relationship between pollutant sources and water quality in the receiving waterbody. The TMDLs establish the allowable loadings to Bethel Lake that would restore the waterbody so that it meets the applicable water quality criteria for nutrients.

1.2 Identification of Waterbody

For assessment purposes, the Florida Department of Environmental Protection (DEP) divided the Middle St. Johns Basin (Hydrologic Unit Code [HUC] 8 – 03080101) into watershed assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or surface water segment. Bethel Lake is WBID 2953. **Figure 1.1** shows the location of the waterbody in the basin and major geopolitical and hydrologic features in the region, and **Figure 1.2** contains a more detailed map of the waterbody.

The Bethel Lake Watershed is located in Volusia County adjacent to the City of Deltona. Bethel Lake has a surface area of 201 acres, with an average depth of 6.6 feet.

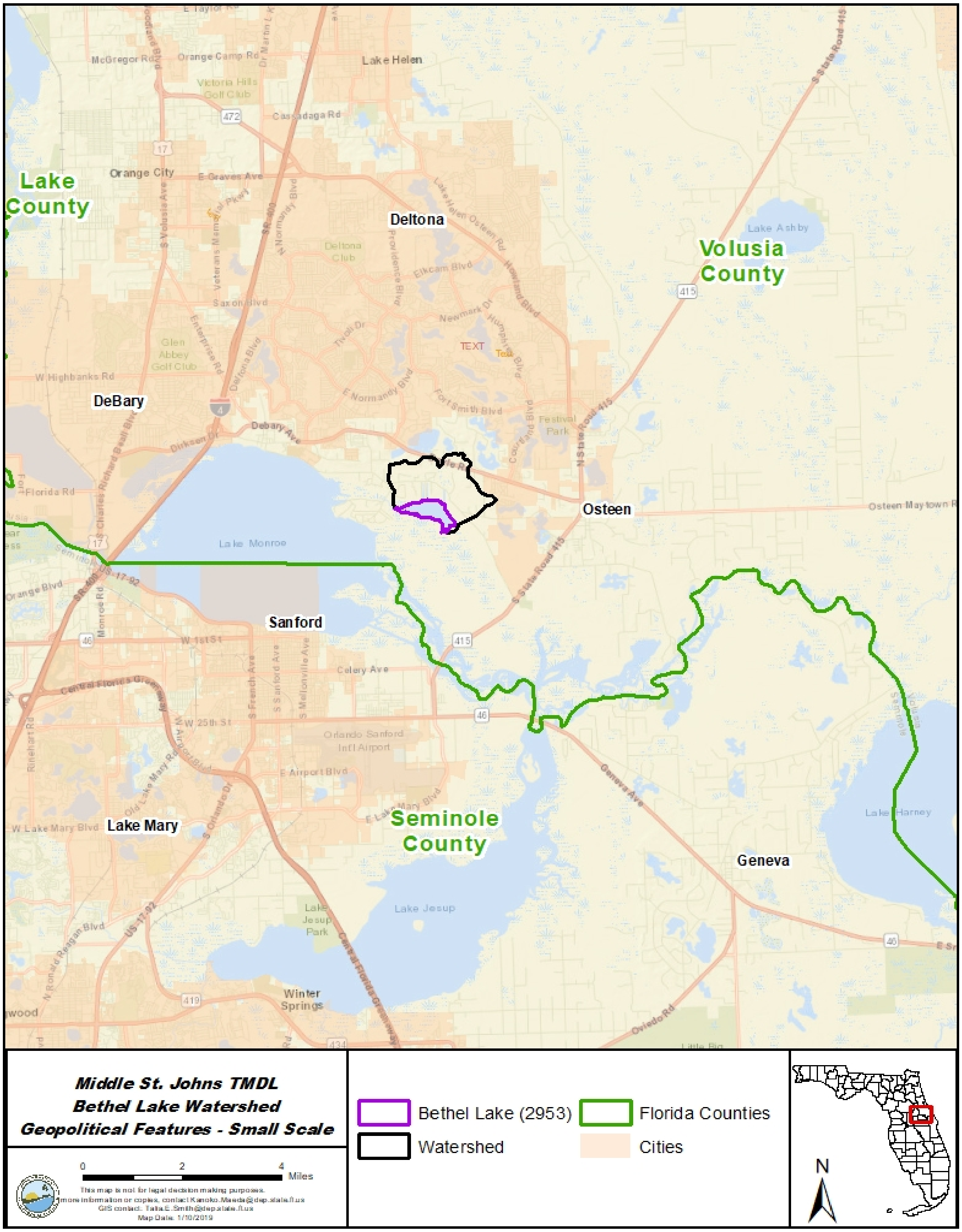


Figure 1.1. **Location of Bethel Lake (WBID 2953) in the Middle St. Johns Basin and major hydrologic and geopolitical features in the area**

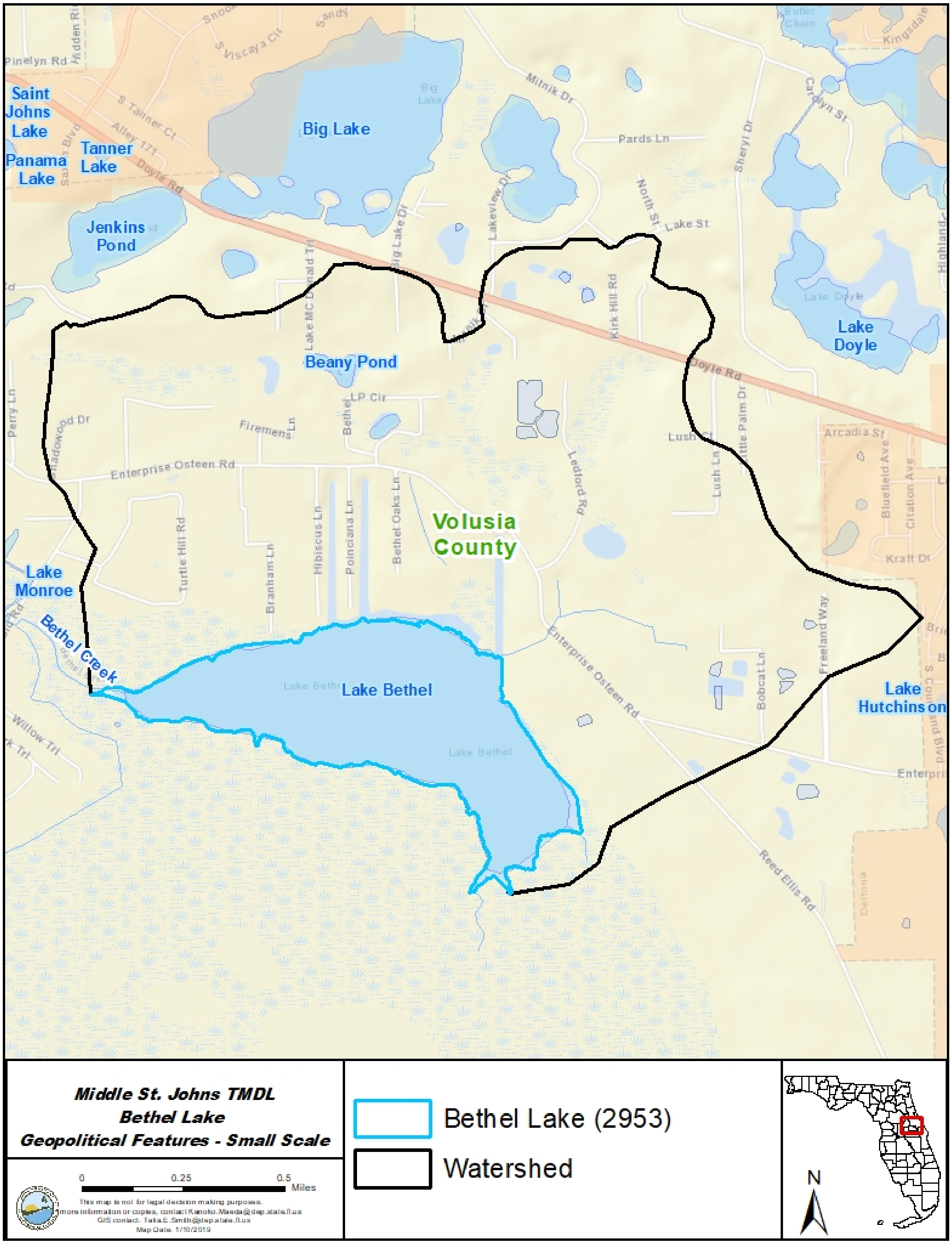


Figure 1.2. Bethel Lake (WBID 2953) Watershed

1.3 Watershed Information

1.3.1 Population and Geopolitical Setting

Bethel Lake and its surrounding watershed cover an area of 1,365 acres. Both the lake and watershed are located entirely in Volusia County, with the eastern edge of the watershed bordering the City of Deltona. Volusia County had a population of 538,692 as of 2017 (U.S. Census Bureau 2018). No major transportation corridors run through the watershed; however, several residential streets surround Bethel Lake. A large portion of the lake's watershed is composed of low-density residential land use, along with wetland hardwood forests and upland mixed forests. The watershed also includes some cropland/pastureland and small areas of other land uses (**Chapter 4** provides detailed summaries of land uses in the watershed).

1.3.2 Topography

Bethel Lake and its watershed are located in the Crescent City/Deland Ridges Lake Region (75-11) and the Eastern Flatlands Lake Region (75-10). The Crescent City/Deland Ridges Lake Region includes sandy upland ridges and thick sandy soils (DEP n.d.). While many of this lake region's lakes are clear and oligotrophic, Bethel Lake falls into the category of darker lakes found at the edge of the ridges, whose inputs include waters from poorly drained soils. These darker lakes are also found in the Eastern Flatlands Lake Region, which includes the lakes connected to the St. Johns River. The Eastern Flatlands Lake Region is characterized by low sandy ridges, valleys, and low-elevation wetlands (DEP n.d.). Elevation in the Bethel Lake Watershed ranges from 5 to 55 feet. The lowest elevation contour of 5 ee surrounds Bethel Lake itself in the southern portion of the watershed, while the highest elevation contours are found along the northern edges of the watershed.

Four small tributaries discharge into the northeast and southeast portions of Bethel Lake. The topography of the watershed also generates overland flow into the lake from the northern portion of the watershed. Bethel Lake is surrounded by vegetated nonforested wetland with the same elevation as the lake.

The tributary flowing into southeast portion of Bethel Lake connects to small streams that in turn connect to small unnamed lakes and surrounding wetland areas. The other three tributaries contributing to Bethel Lake also originate in wetland areas. In addition, three man-made canals flow into the lake. Bethel Lake outflows into Bethel Creek through a tributary located on the western side of the waterbody. Bethel Creek flows into Bethel Creek Cove, which then discharges into Lake Monroe. Lake Monroe discharges into the St. Johns River, which flows north through Big Whirl Lake and Lake Beresford before continuing northward.

1.3.3 Hydrogeological Setting

The watershed for Lake Bethel comprises Hydrologic Soil Groups A, A/D, B/D, C/D, and unclassified lake bottom. These groups are based on the National Cooperative Soil Survey.

Group A soils range from sandy to loamy in texture, characterized by low runoff potential and increased infiltration rates. Soils in Group B range from silty to loamy soil textures and have moderate drainage. Group C soils have low infiltration rates when saturated and are moderately well drained to well drained. Soils in Group D contain higher amounts of clay, often 40 % or more, and have high runoff potential. When unsaturated, Group A/D, B/D, and C/D soils are characteristic of Group A, B, and C soils, respectively, and when saturated they are more characteristic of Group D soils.

Table 1.1 lists the soil hydrologic groups in the Bethel Lake Watershed. Based on the percent acreage of these soil hydrologic groups and the soil characteristics shown in **Figure 1.3**, soils in the watershed are mostly well drained to moderately drained. These drainage characteristics are a significant factor when calculating surface runoff and are described in more detail in **Section 4.4**.

Table 1.1. Acreage of hydrologic soil groups in the Bethel Lake Watershed

Soil Hydrologic Group	Acreage	% Acreage
A	381	28
A/D	157	11
B/D	527	39
C/D	72	5
Unclassified Lake Bottom	219	16
No Data	10	1
Total	**1,366**	**100**

The Bethel Lake Watershed is located in a humid subtropical climate zone characterized by hot and humid summers, mild winters, and a wet season between June and September.

Long-term average rainfall for the Bethel Lake Watershed from 1980 to 2016 was 52 inches per year (in/yr). Rainfall data for the watershed were provided by National Oceanic and Atmospheric Administration (NOAA) Online Weather Data from the Sanford area, FL weather station. The annual average temperature based on the Sanford area weather station was 72.5 degrees Fahrenheit (° F.) from 1980 to 2016 (NOAA 2018).

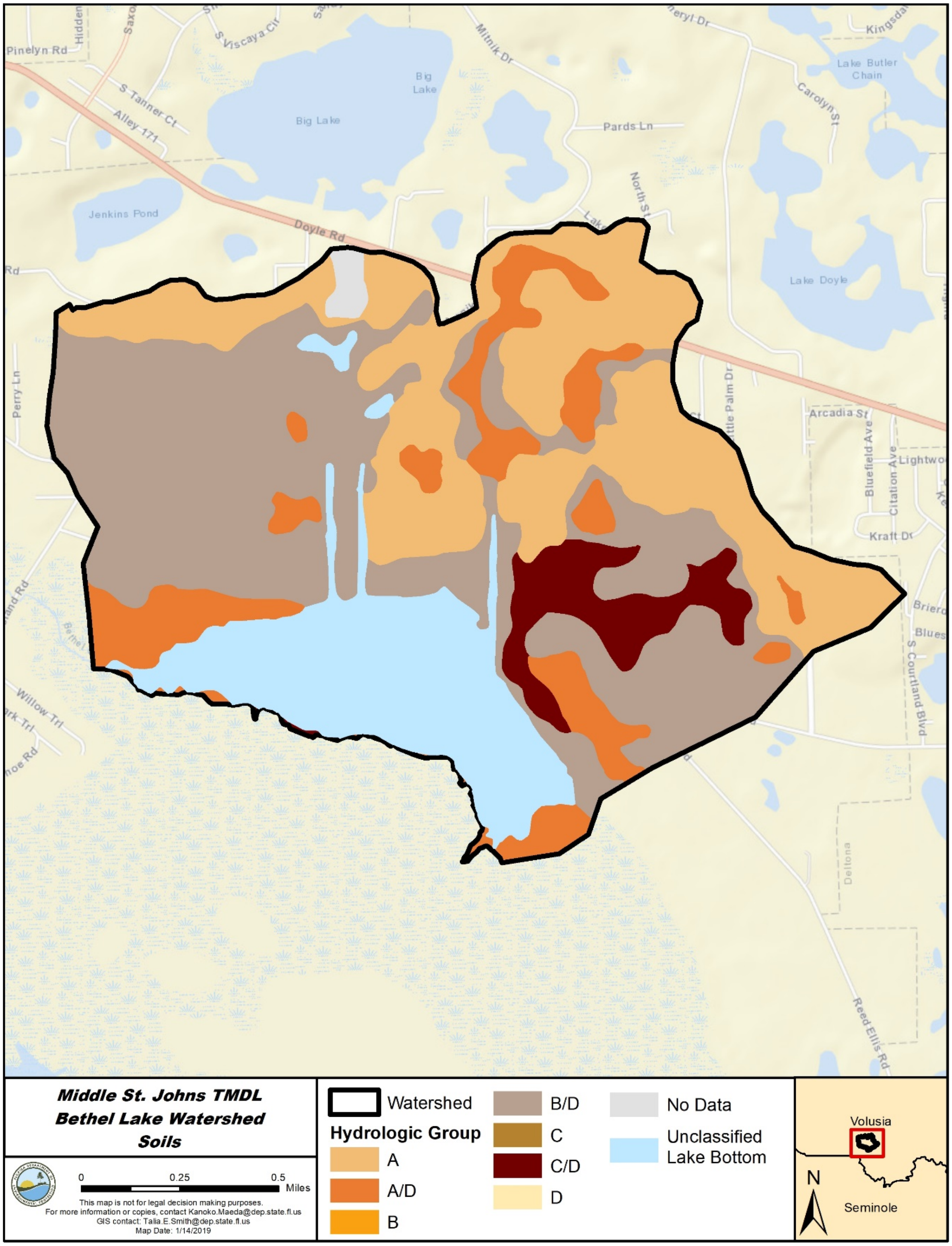


Figure 1.3. Hydrologic soil groups in the Bethel Lake Watershed

Chapter 2: Water Quality Assessment and Identification of Pollutants of Concern

2.1 Statutory Requirements and Rulemaking History

Section 303(d) of the federal Clean Water Act (CWA) requires states to submit to the U.S. Environmental Protection Agency (EPA) lists of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant causing the impairment of listed waters on a schedule. DEP has developed such lists, commonly referred to as 303(d) lists, since 1992.

The Florida Watershed Restoration Act (FWRA) (Section 403.067, Florida Statutes [F.S.]) directed DEP to develop, and adopt by rule, a science-based methodology to identify impaired waters. The Environmental Regulation Commission adopted the methodology as Chapter 62-303, F.A.C. (the IWR), in 2001. The rule was amended in 2006, 2007, 2012, 2013, and 2016.

The list of impaired waters in each basin, referred to as the Verified List, is also required by the FWRA (Subsection 403.067[4], F.S.). The state's 303(d) list is amended annually to include basin updates.

2.2 Classification of the Waterbody and Applicable Water Quality Standards

Bethel Lake is a Class III (fresh) waterbody, with a designated use of fish consumption, recreation, and propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criterion applicable to the verified impairment (nutrients) for the lake is Florida's nutrient criterion in Subparagraph 62-302.530(48)(b), F.A.C. Florida adopted NNC for lakes, spring vents, and streams in 2011. These were approved by the EPA in 2012 and became effective in 2014.

The applicable lake NNC are dependent on alkalinity, measured in milligrams per liter as calcium carbonate (mg/L $CaCO_3$) and true color (color), measured in platinum cobalt units (PCU), based on long-term period of record (POR) geometric means. For the purpose of Subparagraph 62-302.531(2)(b)1., F.A.C., color shall be assessed as true color and shall be free from turbidity. Lake color and alkalinity shall be the long-term geometric mean of all of the data for the POR, based on a minimum of 10 data points over at least 3 years with at least 1 data point in each year. If insufficient alkalinity data are available, long-term geometric mean specific conductance values of all of the data for the POR shall be used, with a value of $\leq$100 micromhos/centimeter (µmhos/cm) used to estimate the 20 mg/L $CaCO_3$ alkalinity concentration until alkalinity data are available. Long-term geometric mean specific conductance shall be based on a minimum of 10 data points over at least 3 years with at least 1 data point in each year.

Using these thresholds and data from IWR Database Run 56, Bethel Lake is classified as a high-color (>40 PCU) lake, as shown in **Table 2.1**. This waterbody is also considered high alkalinity (>20 mg/L $CaCO_3$), although the NNC does not use this measure when assessing high-color lakes.

Table 2.1. Bethel Lake POR long-term geometric means for color and alkalinity

Parameter	Long-Term Geometric Mean	Number of Samples
Color (PCU)	58	43
Alkalinity (mg/L $CaCO_3$)	101	35

The chlorophyll *a* NNC for both high-color and low-color, high-alkalinity lakes is an AGM value of 20 micrograms per liter (µg/L), not to be exceeded more than once in any consecutive 3-year period. The associated total nitrogen (TN) and total phosphorus (TP) criteria for a lake can vary annually, depending on the availability of data for chlorophyll *a* and the chlorophyll *a* concentrations in the lake.

If there are sufficient data to calculate an AGM for chlorophyll *a* and the mean does not exceed the chlorophyll *a* criterion for the lake type in **Table 2.2**, then the TN and TP numeric interpretations for that calendar year are the AGMs of lake TN and TP samples, subject to the minimum and maximum TN and TP limits in the table. If there are insufficient data to calculate the AGM for chlorophyll *a* for a given year, or if the AGM for chlorophyll *a* exceeds the values in the table for the lake type, then the applicable numeric criteria for TN and TP are the minimum values in the table. **Table 2.2** lists the NNC for Florida lakes specified in Paragraph 62-302.530(48)(b), F.A.C.

Table 2.2. Chlorophyll *a*, TN, and TP criteria for Florida lakes (Subparagraph 62-302.531[2][b]1., F.A.C.)

[1] For lakes with color > 40 PCU in the West Central Nutrient Watershed Region, the maximum TP limit shall be the 0.49 mg/L TP streams threshold for the region.

Long-Term Geometric Mean Color and Alkalinity	AGM Chlorophyll *a*	Minimum NNC AGM TP	Minimum NNC AGM TN	Maximum NNC AGM TP	Maximum NNC AGM TN
> 40 PCU	20 µg/L	0.05 mg/L	1.27 mg/L	0.16 mg/L[1]	2.23 mg/L
≤ 40 PCU and > 20 mg/L $CaCO_3$	20 µg/L	0.03 mg/L	1.05 mg/L	0.09 mg/L	1.91 mg/L
≤ 40 PCU and ≤ 20 mg/L $CaCO_3$	6 µg/L	0.01 mg/L	0.51 mg/L	0.03 mg/L	0.93 mg/L

2.3 Determination of the Pollutant of Concern

2.3.1 Data Providers

Table 2.3 lists the data provider for Bethel Lake, including corresponding stations and monitoring beginning and ending dates.

Table 2.3. Bethel Lake data provider

Sampling Station	Data Provider	Activity Beginning Date	Activity Ending Date
21FLCEN 20010366	DEP	2002	2013
21FLCEN 20010367	DEP	2002	2012
21FLCEN 20010991	DEP	2007	2013

At Bethel Lake, DEP (21FLCEN) was the primary data provider for the assessment. **Figure 2.1** shows the lake sampling locations.

The individual water quality measurements discussed in this report are available in IWR Run 56 and are available on request.

2.3.2 Information on Verified Impairment

During the Cycle 3 assessment, the NNC were used to assess Bethel Lake using data collected during the verified period (January 1, 2007–June 30, 2014) based on data from IWR Run 50. Bethel Lake was determined to be verified impaired for chlorophyll *a*, TN, and TP because the AGMs exceeded the NNC more than once in a three-year period. **Table 2.4** lists the AGM values for chlorophyll *a*, TN, and TP during the 2007–14 verified period for Bethel Lake.

Table 2.4. Bethel Lake AGM values for the 2007–14 verified period

ID = Insufficient data
Note: Values shown in boldface type and shaded are greater than the NNC. Rule 62-302.531, F.A.C., states that the applicable numeric interpretations for TN, TP, and chlorophyll *a* shall not be exceeded more than once in any consecutive three-year period.

Year	Chlorophyll *a* (µg/L)	TN (mg/L)	TP (mg/L)
2007	**47**	**1.64**	**0.05**
2008	ID	**1.57**	**0.07**
2009	ID	ID	ID
2010	ID	**1.90**	**0.06**
2011	ID	**1.97**	**0.08**
2012	**48**	**1.71**	**0.06**
2013	**62**	**2.21**	**0.07**
2014	ID	ID	ID

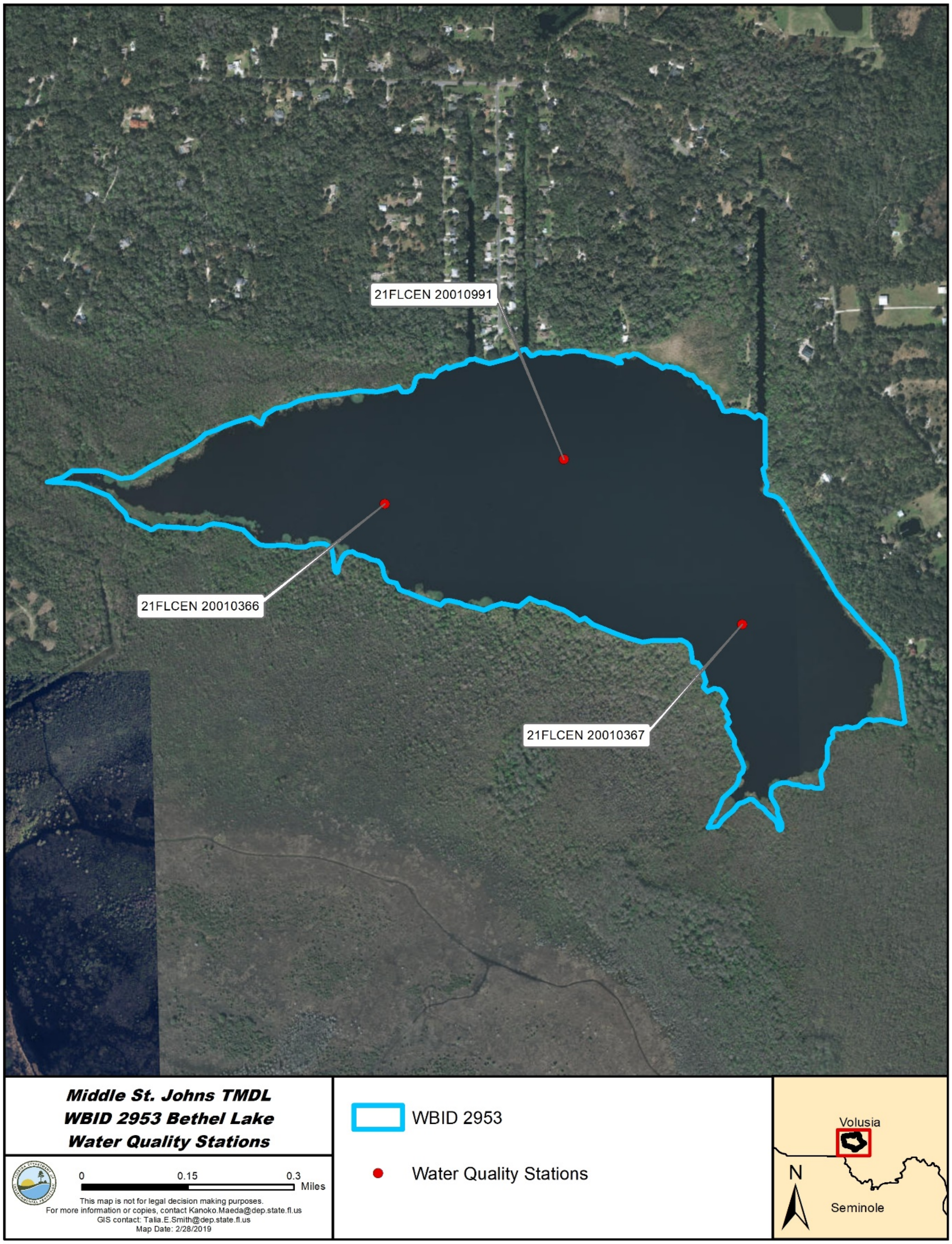


Figure 2.1. Monitoring stations in Bethel Lake

2.4 Relationships Between Water Quality Variables

For Bethel Lake, simple linear regression analyses were used to evaluate the relationships between pollutant variables (TN and TP) and the response variable (chlorophyll *a*). **Figures 2.2** and **2.3** show the relationships between chlorophyll *a* and TN and TP daily values. For days when there was more than one sample on a given day, sample results were averaged for this analysis.

There were strong and significant positive relationships between chlorophyll *a* and TN (R^2 = 0.81, p value < 0.05) and moderately strong and significant relationships between chlorophyll *a* and TP (R^2 = 0.39, p value < 0.05).

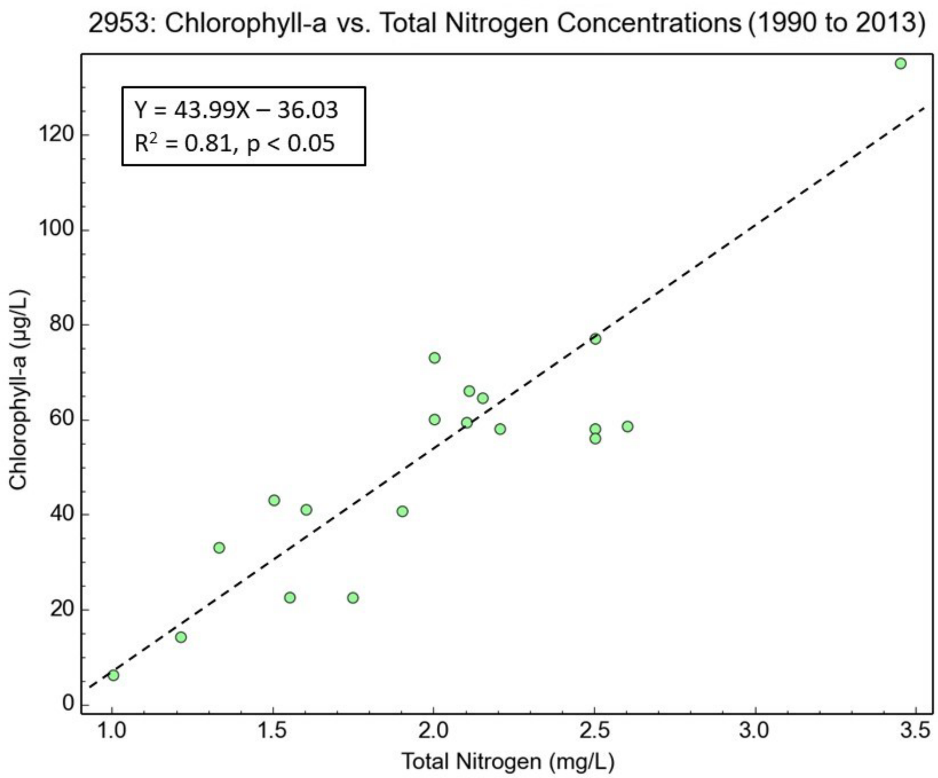


Figure 2.2. Bethel Lake daily chlorophyll *a* vs. TN

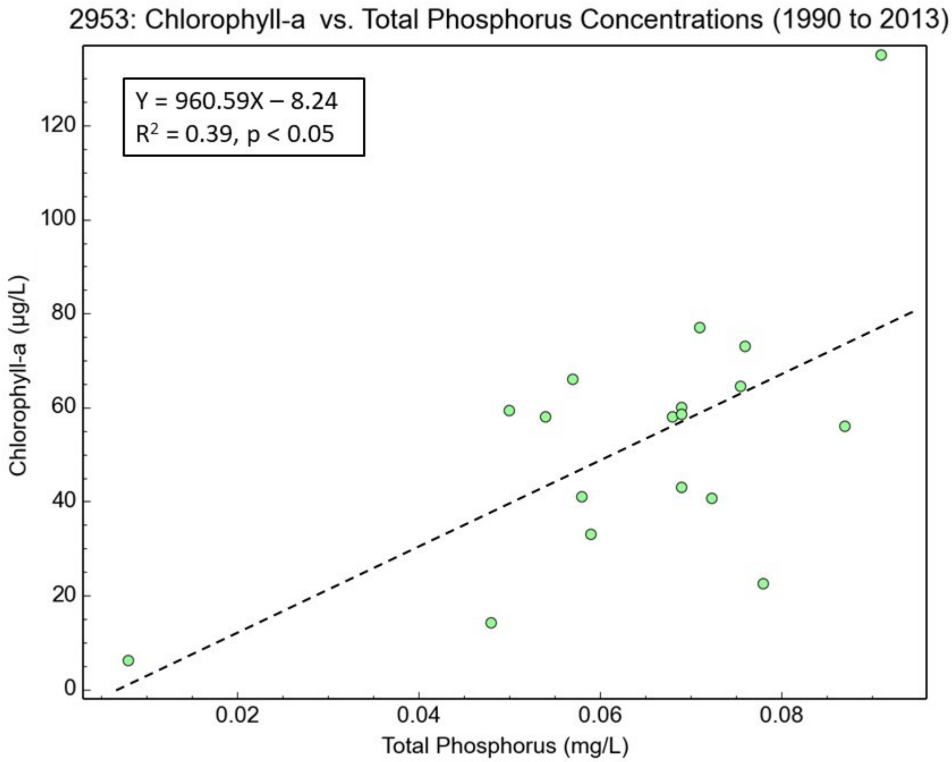


Figure 2.3. Bethel Lake daily chlorophyll *a* vs. TP

Chapter 3: Site-Specific Numeric Interpretation of the Narrative Nutrient Criterion

3.1 Establishing the Site-Specific Interpretation

Pursuant to Paragraph 62-302.531(2)(a), F.A.C., the nutrient TMDLs presented in this report, upon adoption into Chapter 62-304.505, F.A.C., will constitute the site-specific numeric interpretations of the narrative nutrient criterion set forth in Paragraph 62-302.530(48)(b), F.A.C., that will replace the otherwise applicable NNC in Subsection 62-302.531(2), F.A.C. **Table 3.1** lists the elements of the nutrient TMDLs that constitute the site-specific numeric interpretations of the narrative nutrient criterion. **Appendix B** summarizes the relevant details to support the determination that the TMDLs provide for the protection of Bethel Lake for the attainment and maintenance of water quality standards in downstream waters (pursuant to Subsection 62-302.531[4], F.A.C.), and to support using the nutrient TMDLs as the site-specific numeric interpretations of the narrative nutrient criterion.

3.2 Site-Specific Response Variable Target Selection

The generally applicable chlorophyll *a* criteria for lakes were established by taking into consideration, an analysis of lake chlorophyll *a* concentrations statewide, comparisons with a smaller population of select reference lakes, paleolimnological studies, expert opinions, user perceptions, and biological responses. Based on these resources, DEP concluded that an annual average chlorophyll *a* of 20 µg/L in high-color and low-color, high-alkalinity lakes is protective of the designated uses of recreation and aquatic life support (DEP 2012). Color and alkalinity were used as morphoedaphic factors to predict the natural trophic status of lakes. DEP developed a chlorophyll *a* criterion of 20 µg/L for both high-color (> 40 PCU) lakes and low-color (≤ 40 PCU), high-alkalinity (≥ 20 $CaCO_3$) lakes.

There is no information suggesting that Bethel Lake differs from the reference lakes used to develop the NNC. Therefore, DEP has determined that the generally applicable chlorophyll *a* NNC for high-color lakes is the most appropriate TMDL target for the lakes (and will remain the applicable water quality criterion).

3.3 Numeric Expression of the Site-Specific Numeric Interpretation

Numeric site-specific interpretations of the narrative nutrient standard for Bethel Lake were determined for TN and TP using the modeling approach discussed in **Chapter 5** to determine the nutrient loads that resulted in the lake attaining the chlorophyll *a* criterion. The modeling related annual watershed TN and TP loading to in-lake chlorophyll *a*, TN, and TP concentrations. For Bethel Lake, nutrient and chlorophyll concentrations were simulated from 2002 to 2013.

The model was used to determine annual TN and TP loads necessary to meet the target chlorophyll *a* criterion of 20 µg/L in every simulated year. DEP then calculated a rolling 7-year average loading for each parameter. The site-specific interpretations of the narrative nutrient criterion were then set for each parameter at the maximum 7-year rolling average load for Bethel Lake. **Section 5.5** discusses in more detail the method used to determine these loading values.

Site-specific interpretations for Bethel Lake are expressed as a 7-year rolling annual average load not to be exceeded. **Table 3.1** summarizes the site-specific interpretations for TN and TP for Bethel Lake.

Table 3.1. Bethel Lake site-specific interpretations of the narrative nutrient criterion

Waterbody	WBID	7-Year Annual Average TN (lbs/yr)	7-Year Annual Average TP (lbs/yr)
Bethel Lake	2953	4,234	234

DEP also calculated the in-lake TN and TP concentrations, for informational purposes only, corresponding to the load-based TN and TP site-specific interpretations of the narrative criterion that attain the target chlorophyll *a* concentration of 20 µg/L. For Bethel Lake, the TN and TP AGM concentrations of 1.12 and 0.04 mg/L, respectively, are not to be exceeded more than once in any consecutive 3-year period. These concentration-based restoration targets are provided for informational purposes only and will be used to help evaluate the effectiveness of restoration activities. The loads listed in **Table 3.1** are the site-specific interpretations of the narrative criterion for the lake.

3.4 Downstream Protection

Bethel Lake discharges into Bethel Creek (WBID 2953A2), which flows into Lake Monroe (WBID 2893D) (**Figure 3.1**). Bethel Creek is not verified impaired for nutrients. The TMDL-adopted percent reductions for TN and TP for Lake Monroe are 38 % and 31 %, and target concentration for TN and TP are 1.18 mg/L and 0.07, respectively (Gao 2009). In comparison, the reductions for TN and TP required under the Bethel Lake TMDL are 45 % and 67 %, and the target concentrations for TN and TP are 1.12 and 0.04 mg/L, respectively. Since the Bethel Lake reductions are larger and the nutrient targets are lower than those for downstream waters, the TMDL for Bethel Lake is inherently protective.

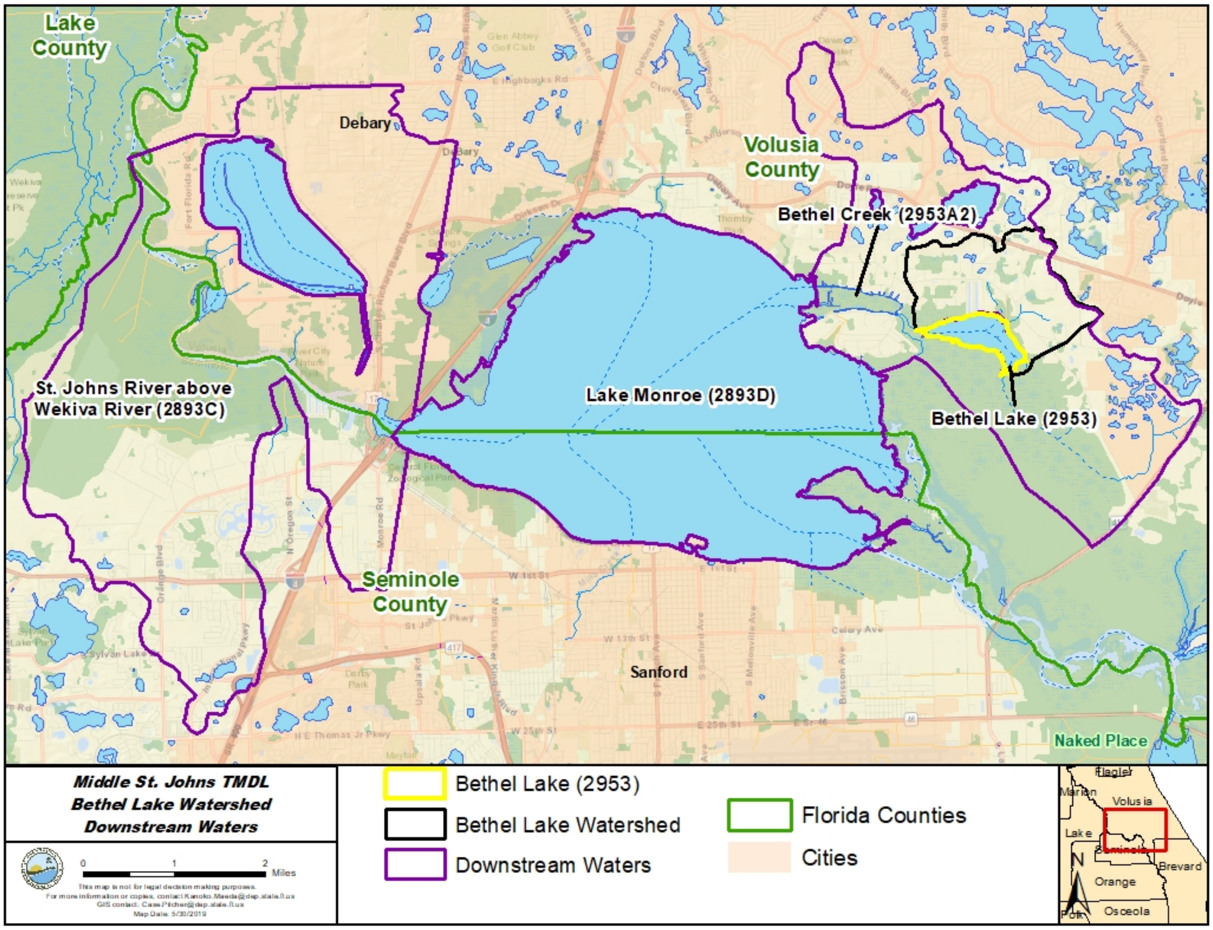


Figure 3.1. Location of Bethel Lake and downstream waters

3.5 Endangered Species Consideration

Section 7(a)(2) of the Endangered Species Act requires each federal agency, in consultation with the services (i.e., U.S. Fish and Wildlife Service [FWS] and NOAA's National Marine Fisheries Service [NMFS]), to ensure that any federal action authorized, funded, or carried out is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat. The EPA must review and approve changes in water quality standards (WQS) such as setting site-specific criteria.

Prior to approving WQS changes for aquatic life criteria, the EPA will prepare an Effect Determination summarizing the direct or indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action. The EPA categorizes potential effect outcomes as either (1) "no effect," (2) "may affect, not likely to adversely affect," or (3) "may affect: likely to adversely affect."

The service(s) must concur on the Effect Determination before the EPA approves a WQS change. A finding and concurrence by the service(s) of "no effect" will allow the EPA to approve an otherwise approvable WQS change. However, findings of either "may affect, not likely to adversely affect" or "may affect: likely to adversely affect" will result in a longer consultation process between the federal agencies and may result in a disapproval or a required modification to the WQS change.

The FWS online Information for Planning and Conservation (IPaC) tool (see **Appendix B**) identifies terrestrial species potentially affected by activities in the watershed. DEP is not aware of any aquatic, amphibious, or anadromous endangered species present in the Bethel Lake Watershed. Furthermore, it is expected that restoration efforts and subsequent water quality improvements will positively affect aquatic species living in the lake and its watershed.

Chapter 4: Assessment of Sources

4.1 Types of Sources

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

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

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

4.2 Point Sources

4.2.1 Wastewater Point Sources

There are no NPDES-permitted wastewater facilities discharging to Bethel Lake or to its watershed.

4.2.2 Municipal Separate Storm Sewer System (MS4) Permittees

Volusia County has a Phase II-C MS4 permit (FLR04E033), and the Florida Department of Transportation (FDOT) District 5 has an MS4 permit (FLR04E024) covering the urbanized area of Volusia County. According to Chapter 62-624, F.A.C., MS4 permit requirements apply to urbanized areas. Based on the 2010 Topologically Integrated Geographic Encoding and

Referencing (TIGER) Census urbanized area coverage data (**Figure 4.1**), none of the Bethel Lake Watershed is located in the urban area. Neither MS4 permit covers the watershed. Areas under the jurisdiction of Volusia County may be required to implement stormwater treatment projects in the future as part of a TMDL implementation strategy. For more information on MS4s in the watershed, send an email to: NPDES-stormwater@dep.state.fl.us.

4.3 Nonpoint Sources

Nutrient loadings to Bethel Lake are primarily generated from nonpoint sources. Nonpoint sources addressed in this analysis mainly include loadings from surface runoff based on land use, onsite sewage treatment and disposal systems (OSTDS), groundwater seepage entering the lake, and precipitation directly onto the lake surface (atmospheric deposition).

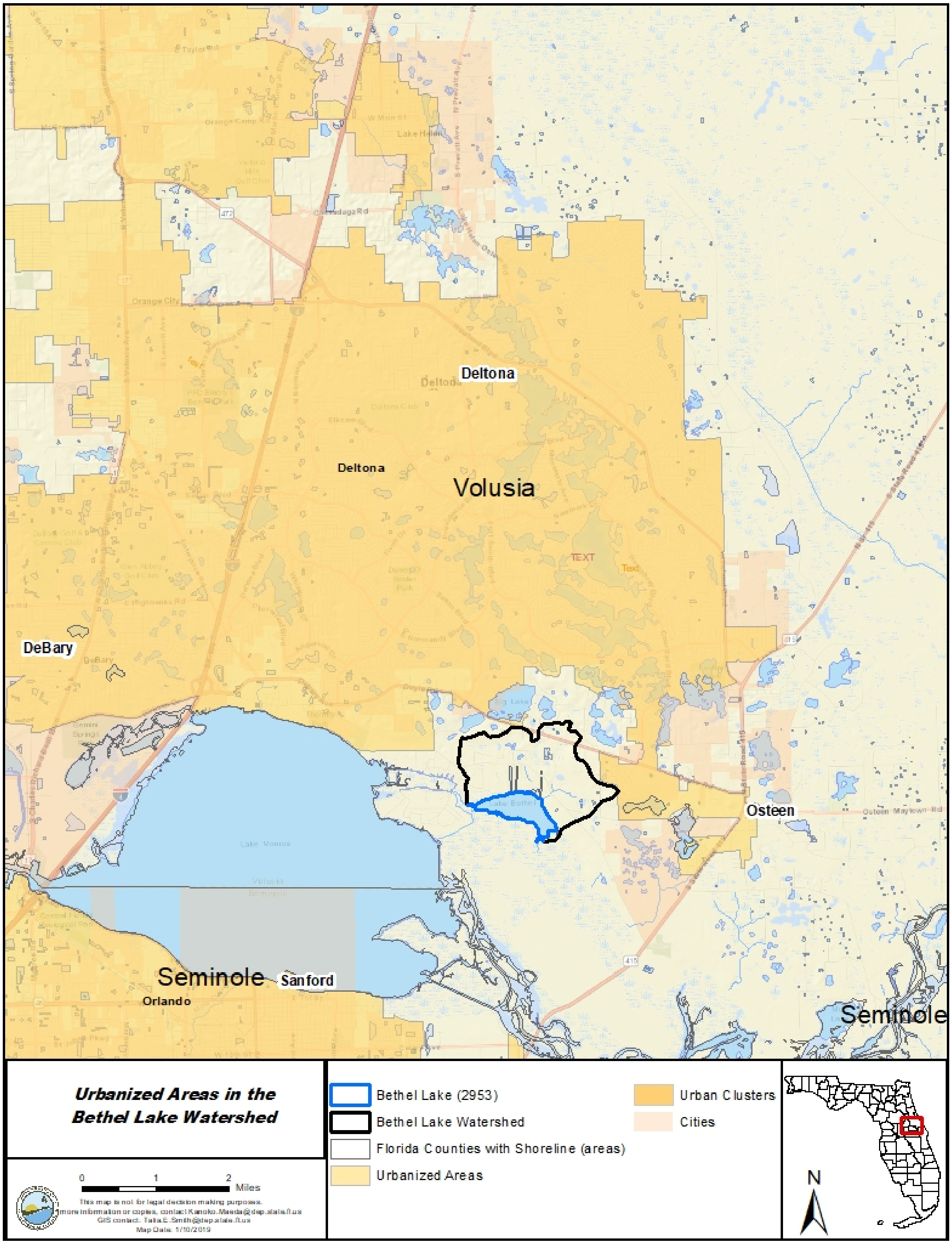


Figure 4.1. Urbanized areas in Volusia County based on TIGER 2010 Census

4.3.1 Land Uses

Land use is one of the most important factors in determining nutrient loadings from the Bethel Lake Watershed. Nutrients can be flushed into a receiving water through surface runoff and stormwater conveyance systems during stormwater events. Both human land use areas and natural land areas generate nutrients. However, human land uses typically generate more nutrient loads per unit of land surface area than natural lands can produce. **Table 4.1** lists land uses in the watershed from 2013 to 2016, based on data from the St. Johns River Water Management District (SJRWMD), and **Figure 4.2** shows the information graphically.

Table 4.1 and **Figure 4.2** show the breakdown of the various land use categories in the Bethel Lake Watershed. Residential low density is the predominant land use, with 31 % coverage. Lakes is the second most common land use with 14 %, followed by upland mixed forests with 14 %, wetland hardwood forests with 12 %, vegetated nonforested wetlands with 9 %, and cropland and pastureland with 8 %. These land use classifications account for 87 % of all land use classifications in the watershed, with all other individual classifications under 5 %.

Table 4.1. SJRWMD land use in the Bethel Lake Watershed, 2013–16

Land Use Code	Land Use Classification	Acres	% of Watershed
1100	Residential Low Density	418	31
1200	Residential Medium Density	26	2
1800	Recreational	12	1
2100	Cropland and Pastureland	108	8
2400	Nurseries and Vineyards	7	0
3200	Shrub and Brushland	6	0
3300	Mixed Rangeland	33	2
4100	Upland Coniferous Forests	51	4
4300	Upland Mixed Forests	185	14
5200	Lakes	197	14
5300	Reservoirs	6	0
6100	Wetland Hardwood Forests	158	12
6200	Wetland Coniferous Forests	19	1
6300	Wetland Forested Mixed	5	0
6400	Vegetated Nonforested Wetlands	121	9
7400	Disturbed Lands	11	1
8200	Communications	2	0
Total		**1,365**	**99**

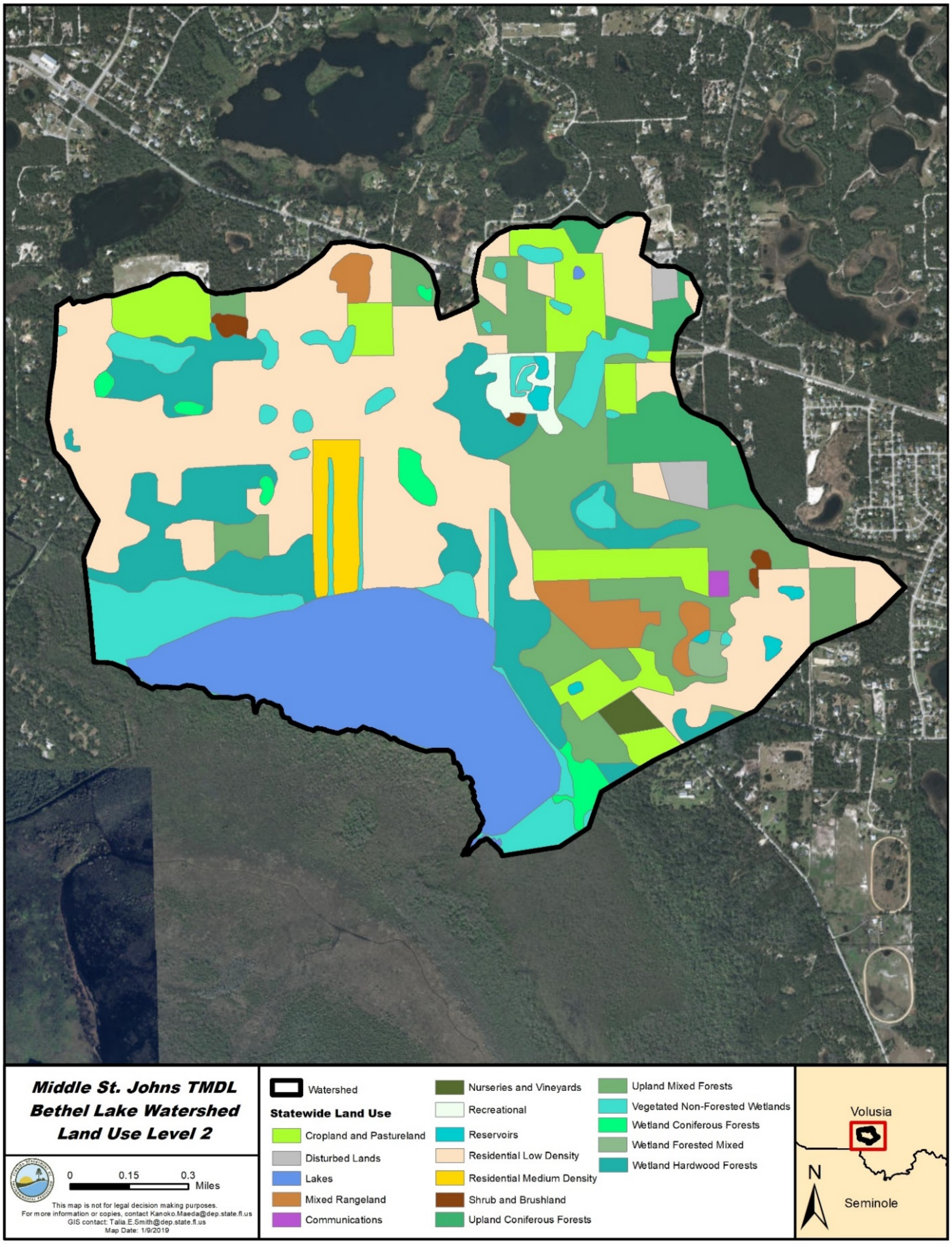


Figure 4.2. Land use in the Bethel Lake Watershed, 2013–16

4.3.2 OSTDS

OSTDS, including septic tanks, are commonly used where providing central sewer service is not cost-effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDS are a safe means of disposing of domestic waste. The effluent from a well-functioning system is comparable to secondarily treated wastewater from a sewage treatment plant. However, OSTDS can be a source of nutrients (nitrogen and phosphorus), pathogens, and other pollutants to both groundwater and surface water.

The Florida Department of Health (FDOH) maintains a list of septic tanks by county. The known septic tanks were summed within a 200-meter buffer zone in the watershed. The Volusia County 2018 database was used to determine the number of known septic tanks within the 200-meter buffer zone for the Bethel Lake Watershed. There are 22 known septic tanks. **Figure 4.3** shows the OSTDS locations in the watershed.

4.3.3 Atmospheric Deposition

Nutrient loadings from the atmosphere are an important component of the nutrient budget in many Florida lakes. Nutrients are delivered through two pathways: wet atmospheric deposition with precipitation and dry particulate-driven deposition. Atmospheric deposition to terrestrial portions of the Bethel Lake Watershed is assumed to be accounted for in the loading rates used to estimate the watershed loading from land. There are no known complete atmospheric deposition data for Bethel Lake. Therefore, loading from atmospheric deposition directly onto the water surface was estimated based on data collected in Lake Apopka by SJRWMD. These included both wet and dry atmospheric deposition data.

The dry deposition portion is expressed as a per area loading rate (areal loading rate) on an annual scale. Wet deposition is delivered by precipitation, and annual wet deposition is therefore expressed as a concentration of solutes in precipitation multiplied by the total volume of precipitation. Both the wet and dry components of the calculated atmospheric nutrient deposition (**Table 4.2**) were added to the waterbody model for Bethel Lake. Atmospheric deposition values in 2013 were estimated by averaging dry deposition and rainfall components for wet deposition values from 2000 to 2012.

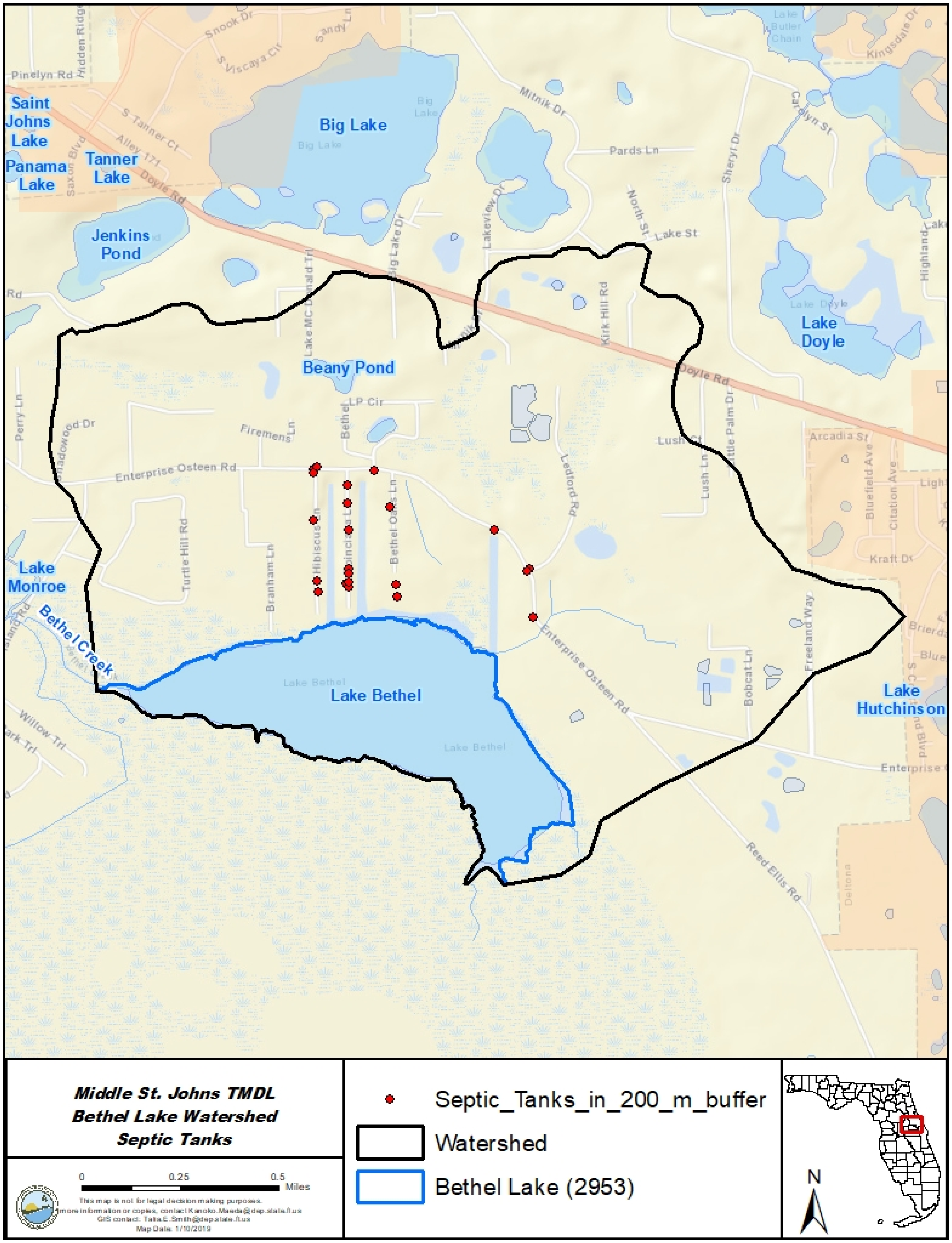


Figure 4.3. OSTDS in the Bethel Lake Watershed

Table 4.2. Calculated atmospheric deposition in Bethel Lake based on field measurements in Lake Apopka, 2000–13

$mg/m^2/yr$ = Milligrams per square meter per year

Year	Dry Deposition TN ($mg/m^2/yr$)	Dry Deposition TP ($mg/m^2/yr$)	Wet Deposition TN ($mg/m^2/yr$)	Wet Deposition TP ($mg/m^2/yr$)	Total Deposition TN ($mg/m^2/yr$)	Total Deposition TP ($mg/m^2/yr$)
2000	253	27	547	13	800	40
2001	145	11	1014	15	1159	26
2002	146	12	848	15	994	27
2003	110	13	854	15	964	28
2004	181	18	957	18	1137	36
2005	136	15	782	16	918	31
2006	186	16	538	8	724	23
2007	221	27	841	20	1062	47
2008	168	23	976	29	1144	52
2009	166	23	541	19	707	42
2010	167	30	528	17	694	47
2011	136	19	527	18	663	38
2012	296	48	884	30	1180	78
2013	178	22	707	17	885	39

4.4 Estimating Watershed Loadings

To simulate nutrient loading from the Bethel Lake Watershed, the Pollutant Load Simulation Model (PLSM) was used. The model uses event mean concentrations (EMCs) along with an estimate of flow to calculate nutrient loading. Flow is estimated based on annual rainfall and a runoff coefficient (ROC). Both EMCs and ROCs are based on land use types (Harper 2012; 1994).

To calculate nutrient loads, Level 2 land use codes for the watershed were matched to similar land use types used by Harper (Harper 2012). ROC values were derived from the Harper 1994 ROCs, which were also matched to Level 2 land use codes (Harper 1994). Annual loading was calculated per unit of land area and was multiplied by the land use area of the basin to derive watershed-scale loading estimates.

4.4.1 Estimating Septic Tank Flow Rate and Nutrient Loadings

Flow was estimated to include septic tank contributions in the watershed loading. To estimate flow, the following equation was used:

$$S * P * W * flr * 365 = Flow\ rate\ (gallons/year)$$

Where:

S = # of known septic tanks within 200 meters.
P = Average number of people per household.
W = Individual water consumption (70 gallons/day).
flr = Flow loss rate (15 %).

There are 22 known septic tanks within 200 meters of Bethel Lake. According to the U.S. Census Bureau, Polk County has an average of 2.44 people per household. Each individual uses approximately 70 gallons of water per day, with a flow loss rate of 15 % (EPA 2002; Tetra Tech 2017). The number of septic tanks, the number of people per household, the individual water consumption, and a value of 0.85 were multiplied to calculate the total flow rate for septic tanks. Flow rates were converted to cubic hectometers for modeling. The lake has a septic tank flow of 0.004 cubic hectometers per year.

Seepage from septic tanks may contribute nutrients to the waterbody. Inorganic nutrients, such as nitrate nitrogen and ammonia, are the main nutrients associated with septic tanks, since the majority of phosphorus loads to groundwater from septic tanks are adsorbed onto soil particles immediately or very soon after discharge. For modeling purposes, these various forms of nutrients are referred to as TN. The flow equation was used to estimate TN loading from septic tanks in the watershed:

$$S * P * I * L = \textit{Total TN (lbs) from septic tanks}$$

Where:

S = # of known septic tanks in groundwater zones.
P = Average number of people per household.
I = # lbs TN per person per septic tank.
L = Percentage of TN lost during seepage.

The number of septic tanks was multiplied by the number of people per household. These values were then multiplied by 9.012, which is the number of pounds of TN per person seeping from a septic tank per year (EPA 2002; Toor et al. 2019), and by 0.50, which accounts for the 50 % nitrogen loss that occurs as septic tank effluent moves through the unsaturated zone to groundwater. **Figure 4.3** shows the locations of the known septic tanks and derived groundwater zones in the watershed, and **Table 4.3** lists the estimated TN load for the watershed.

Table 4.3. Septic tank loads from the watershed

Watershed	TN Load (lbs/yr)
Bethel Lake	241

Chapter 5: Determination of Assimilative Capacity

5.1 Determination of Loading Capacity

Nutrient enrichment and the resulting problems related to eutrophication tend to be widespread and are frequently manifested far (in both time and space) from their sources. Addressing eutrophication involves relating water quality and biological effects such as photosynthesis, decomposition, and nutrient recycling as acted on by environmental factors (rainfall, point source discharge, etc.) to the timing and magnitude of constituent loads supplied from various categories of pollution sources. Assimilative capacity should be related to some specific hydrometeorological condition during a selected period or to some range of expected variation in these conditions.

The goal of this TMDL analysis is to determine the assimilative capacity of Bethel Lake and to identify the maximum allowable TN and TP loadings from the watershed, so that the waterbody will meet the TMDL targets and thus maintain its function and designated uses as a Class III water.

5.2 Evaluation of Water Quality Conditions

Bethel Lake chlorophyll *a* AGMs varied from 47 µg/L in 2007 to 62 µg/L in 2013. From 2002 to 2013, TN AGMs ranged from 1.73 mg/L in 2002 to 2.21 mg/L in 2013. TP AGMs ranged from 0.06 mg/L in 2007 to 0.09 mg/L in 2002.

5.3 Critical Conditions and Seasonal Variation

The estimated assimilative capacity is based on annual conditions, rather than critical/seasonal conditions, because (1) the methodology used to determine assimilative capacity does not lend itself very well to short-term assessments, (2) DEP is generally more concerned with the net change in overall primary productivity in the segment, which is better addressed on an annual basis, (3) the chlorophyll *a* criterion used as the TMDL target is expressed as an AGM, and (4) the methodology used to determine impairment is based on annual conditions (AGM values).

5.4 Water Quality Modeling to Determine Assimilative Capacity

To represent water quality processes occurring in Bethel Lake, the U.S. Army Corps of Engineers (USACE) BATHTUB model was used (Walker 1987; 1999). The BATHTUB model simulates steady-state lake conditions and is set up to simulate water quality based on long-term receiving water conditions. It is designed to represent reservoirs and other large waterbodies with relatively stable water levels.

5.4.1 Water Quality Model Description

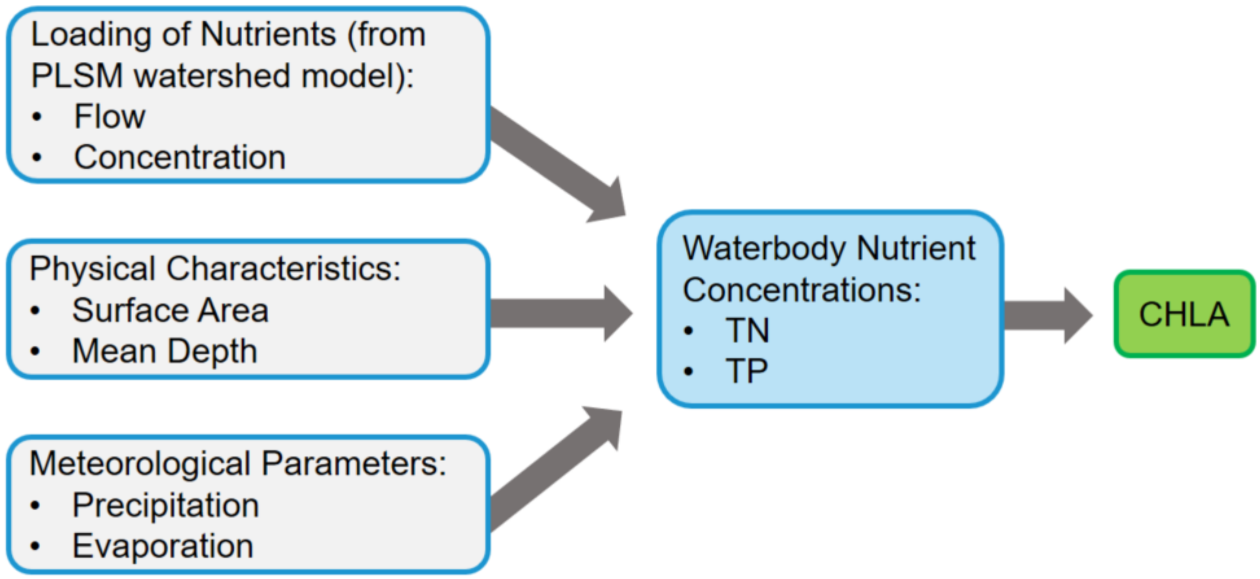
BATHTUB runs on a modeling framework that uses empirical relationships between nutrient loading, meteorological conditions, and physical parameters to estimate algal growth. The model's hydrologic framework includes lakes and lake segments, which may be directly or indirectly connected. Other inputs include the atmospheric deposition of nutrients, rainfall, and evaporation directly on the lake surface. Calculations also include the internal loading of nutrients in lakes.

The primary goal of the BATHTUB model is to estimate nutrient concentrations and algal biomass as they relate to nutrient loadings. Walker (1999) describes methods for choosing the appropriate models for producing these nutrient estimates for different waterbodies. Two categories of models are used to empirically predict lake eutrophication, and this process usually occurs in two stages. The nutrient balance model describes the relationships between nutrient concentrations in the lake to external nutrient loadings, morphometry, and lake hydraulics. The eutrophication response model relates eutrophication indicators in the lake, including nutrient levels, chlorophyll *a*, hypolimnetic oxygen depletion, and transparency (Walker 1999).

The nutrient models in BATHTUB assume that the net accumulation of nutrients in a lake is the difference between nutrient loadings into the lake from various sources and nutrients carried out through outflow and nutrient losses through whatever decay processes occur in the lake. Nutrient models in BATHTUB include a suite of phosphorus and nitrogen sedimentation, chlorophyll, and Secchi depth models.

Figure 5.1 shows the scheme used to relate these various models in BATHTUB. According to this scheme, external nutrient loading, physical characteristics, and meteorological parameters are all applied to the in-lake nutrient concentrations. The physical, chemical, and biological response of the lake to the level of nutrients then produces waterbody nutrient concentrations, and finally chlorophyll *a* growth. In BATHTUB, other limiting factors can be applied, such as nitrogen, phosphorus, light, or flushing, depending on which chlorophyll model is selected.

Bethel Lake was represented as one waterbody in the BATHTUB model because the lake is relatively small and is expected to be spatially homogeneous because of its geometry. The waterbody was modeled yearly, with inputs including the watershed nutrient delivery from the PLSM and septic tank flux (see **Section 4.4**).



Chla = Chlorophyll *a*

Figure 5.1. BATHTUB concept scheme

5.4.2 Morphologic Inputs

The physical characteristics of the lake were input for each year in BATHTUB. Residence time and nutrient fate and transport are two processes that vary based on these physical features. Bethel Lake has an average depth of 6.6 feet, a surface area of 201 acres, and a watershed area of 1,365 acres.

5.4.3 Meteorological Data

Rainfall

Rainfall data (2000–13) for the Bethel Lake Watershed were provided by NOAA Online Weather Data and came from the Sanford area, FL weather station (**Table 5.1**).

Evaporation

The lake evaporation data from the Lake Roberts TMDL report (Kang 2017) were used. The potential evapotranspiration (PET) data were obtained from the Lisbon weather station in 2000 – 2012 by SJRWMD. The data were converted to lake evaporation by multiplying a pan coefficient of 0.76 (Kang 2017). The value in 2013 was calculated using an average of the available data period.

Table 5.1 lists the annual rainfall and evaporation values used in calibrating the BATHTUB model for the waterbody.

Table 5.1. Annual rainfall and lake evaporation rates for the Bethel Lake BATHTUB model calibration

m/yr = Meters per year

Year	Annual Rainfall (m/yr)	Lake Evaporation (m/yr)
2000	0.834	1.14
2001	1.339	1.10
2002	1.682	1.16
2003	1.393	1.13
2004	1.669	1.00
2005	1.541	0.99
2006	0.946	1.06
2007	1.241	1.02
2008	1.720	1.01
2009	1.064	1.03
2010	1.104	1.01
2011	1.225	1.08
2012	1.257	1.05
2013	1.218	1.06

ATMOSPHERIC DEPOSITION

Atmospheric deposition rates (total deposition of TN and TP) were applied to global variables for the Bethel Lake model. These rates were calculated based on data collected by SJRWMD in Lake Apopka (see **Section 4.3.3**) that included both wet and dry atmospheric deposition (see **Table 4.3**).

5.4.4 Watershed Nutrient Inputs

The PLSM was used to simulate surface runoff (see **Section 4.4**). Loading rates from the PLSM were entered for the watershed tributary in the BATHTUB model for yearly simulations.

5.4.5 BATHTUB Model Calibration

The BATHTUB models were set up to simulate in-lake TN, TP, and chlorophyll *a* concentrations. AGMs for chlorophyll *a*, TN, and TP were input into the model as observed values from 2002 to 2013. These observed value AGMs were used to calibrate the BATHTUB model and guided the selection of the appropriate nitrogen, phosphorus, and chlorophyll models.

For the BATHTUB model, Model Option 8, Canf & Bach, Lakes, was used for TP; Model Option 7, Settling Velocity, was used for TN; and Model Option 3, P. N. Low-Turbidity was used for chlorophyll *a* calibration. The P. N. Low-Turbidity chlorophyll *a* model assumes that phytoplankton growth is co-limited by both phosphorus and nitrogen. Because of observed differences between observed and modeled chlorophyll *a* levels, a model coefficient of 1.5 was applied to all modeling years.

The BATHTUB calibrated model resulted in a 6 % difference for long-term averages for chlorophyll *a*, a 7 % difference for long-term averages for TN, and a 12 % difference in long-term averages for TP. **Figures 5.2, 5.3,** and **5.4** show the annual observed value AGMs and the calibrated BATHTUB model results from 2002 to 2013 for chlorophyll *a*, TN, and TP, respectively.

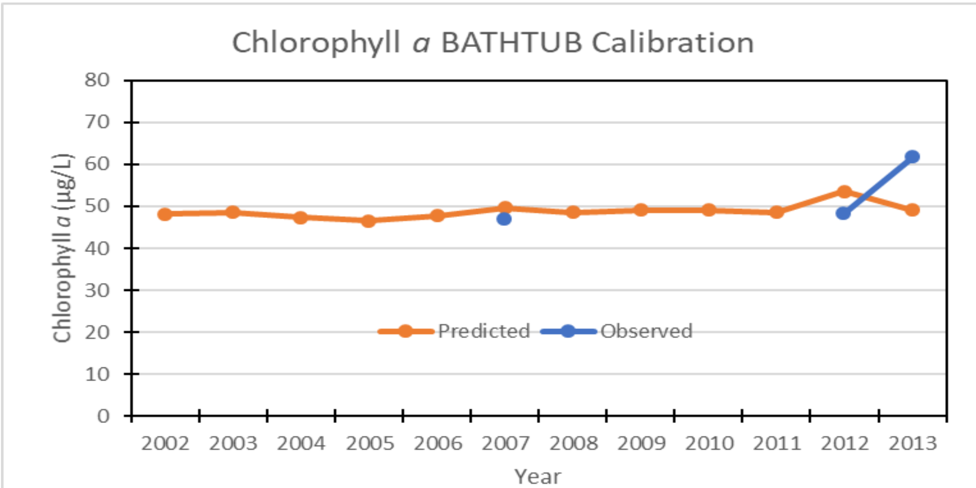


Figure 5.2. Bethel Lake chlorophyll *a* observed and BATHTUB-simulated annual average results, 2002–13

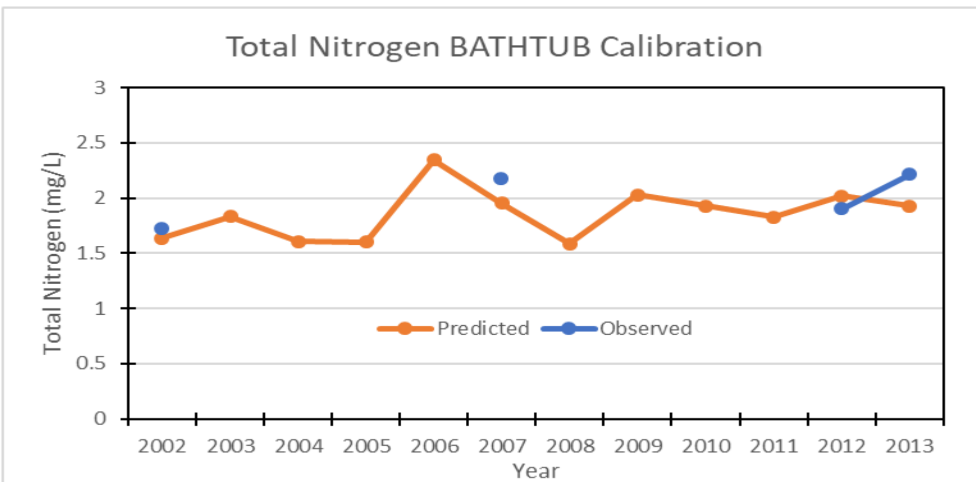


Figure 5.3. Bethel Lake TN observed and BATHTUB-simulated annual average results, 2002–13

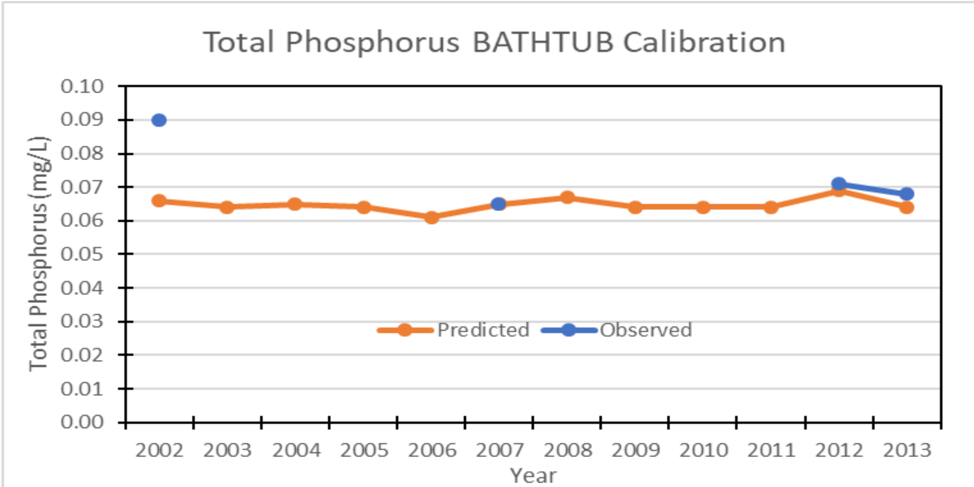


Figure 5.4. Bethel Lake TP observed and BATHTUB-simulated annual average results, 2002–13

5.4.6 Natural Background Condition to Determine Natural Levels of Chlorophyll *a*, TN, and TP

To ensure that the site-specific target would not abate the natural background conditions, the natural background conditions for Bethel Lake were determined using the PLSM and the BATHTUB model. To establish these natural background conditions, all anthropogenic land uses in the current condition PLSM were converted into forest or wetland land uses by changing the hydrologic soil group classifications in the watershed. Wetland and water land uses remained unchanged when developing the natural background.

To convert soil classifications, anthropogenic land uses with Class A and B soils were converted to forests, and anthropogenic land uses with C, D, and dual category soils were converted to wetlands for the watershed. The watershed background loadings were then added to the background BATHTUB model file. OSTDS loadings from were not included in the background model runs. For the lake, the estimated natural background chlorophyll *a* levels were lower than the chlorophyll *a* criterion used as the TMDL target and, as such, the TMDL scenario run described below did not abate the modeled background condition.

5.5 Calculation of the TMDLs

To determine the nutrient loads that achieve the chlorophyll *a* criterion, the anthropogenic TN and TP loads were incrementally reduced until the predicted chlorophyll *a* target was achieved in every year of the modeling period for the waterbody.

For Bethel Lake, 7-year rolling average loads were calculated from the yearly TN and TP loads, and the maximum 7-year averages of TN and TP loads were chosen as the site-specific interpretations of the narrative nutrient criterion. The 7-year average TN and TP target loads necessary to meet the chlorophyll *a* criterion of 20 µg/L (TMDL condition) are 4,234 and 234 lbs/yr, respectively, for Bethel Lake (**Table 6.1**).

To meet the final TMDL loads in Bethel Lake, also referred to as the TMDL condition, 48 % and 70 % reductions in existing TN and TP loads, respectively (2002–13), are required.

Table 5.2 lists the nutrient loads under the TMDL condition for Bethel Lake from 2002 to 2013.

Table 5.2. Bethel Lake TMDL condition nutrient loads, 2002–13

Note: Values shown in boldface type and shaded cells represent the maximum 7-year averages, the 7-year loads used for the calculations, and percent reductions.

Year	Current Condition TN Loads (lbs/yr)	7-Year Rolling Average TN Loads (lbs/yr)	TMDL Condition TN Loads (lbs/yr)	7-Year Rolling Average TN Loads (lbs/yr)	Current Condition TP Loads (lbs/yr)	7-Year Rolling Average TP Loads (lbs/yr)	TMDL Condition TP Loads (lbs/yr)	7-Year Rolling Average TP Loads (lbs/yr)
2002	**8,666**		**4,608**		**802**		245	
2003	**7,467**		**4,083**		**675**		212	
2004	**8,856**		**4,837**		**811**		258	
2005	**7,956**		**4,235**		**745**		234	
2006	**5,282**		**2,934**		**467**		152	
2007	**7,035**		**4,010**		**639**		**229**	
2008	**9,070**	**7,762**	**4,932**	**4,234**	**864**	**715**	**291**	231
2009	5,690	7,337	3,082	4,016	551	679	**198**	225
2010	5,836	7,104	3,128	3,880	580	665	**212**	225
2011	6,250	6,731	3,265	3,655	617	638	**209**	218
2012	7,315	6,640	4,251	3,657	703	632	**287**	226
2013	6,649	6,835	3,664	3,762	617	653	**212**	**234**
Maximum 7-Year Average		**7,762**		**4,234**		**715**		**234**
% Reduction				**45**				**67**

Chapter 6: Determination of Loading Allocations

6.1 Expression and Allocation of the TMDL

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

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

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

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

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

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

This approach is consistent with federal regulations (40 Code of Federal Regulations [CFR] § 130.2[I]), which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or other appropriate measure. The TMDLs for Bethel Lake are expressed in terms of lbs/yr and percent reduction of TN and TP and represent the loads of TN and TP that the waterbody can assimilate while maintaining balanced communities of aquatic flora and fauna (see **Table 6.1**). The Bethel Lake TMDL is based on 7-year rolling averages of simulated loads from 2002 to 2013. For the TMDLs, the restoration goal is to achieve the generally applicable chlorophyll *a* criterion of 20 µg/L, which is expressed as an AGM not to be exceeded more than once in any consecutive 3-year period, thus meeting the water quality criteria and protecting the designated uses for Bethel Lake.

Table 6.1 lists the TMDLs for the Bethel Lake Watershed. The TN and TP loads for the lake will constitute the site-specific numeric interpretations of the narrative nutrient criterion set forth in Paragraph 62-302.530(48)(b), F.A.C., that will replace the otherwise applicable NNC in Subsection 62-302.531(2), F.A.C., for the lake.

Site-specific interpretations for Bethel Lake are expressed as a 7-year rolling annual average load not to be exceeded.

Table 6.1. TMDL components for nutrients in Bethel Lake (WBID 2953)

Note: The LA and TMDL daily load for TN is 12 lbs/day and for TP 1 lb/day.
NA = Not applicable
* The required percent reductions listed in this table represent the reduction from all sources.

Waterbody (WBID)	Parameter	TMDL (lbs/yr)	WLA Wastewater (% reduction)	WLA NPDES Stormwater (% reduction)*	LA (% reduction)*	MOS
2953	TN	4,234	NA	45	45	Implicit
2953	TP	234	NA	67	67	Implicit

6.2 Load Allocation

To achieve the load allocation (LA) for Bethel Lake, 45 % and 67 % reductions in current TN and TP loads, respectively, will be required.

The TMDLs are based on the percent reduction in total watershed loading of TN and TP from all anthropogenic sources. However, it is not DEP's intent to abate natural conditions. It should be noted that the LA includes loading from stormwater discharges regulated by DEP and the water management district that are not part of the NPDES stormwater program (see **Appendix A**).

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

As noted in **Chapter 4**, no active NPDES-permitted facilities in the Bethel Lake Watershed discharge either into the lake or the watershed. Therefore, a WLA for wastewater discharges is not applicable.

6.3.2 NPDES Stormwater Discharges

Volusia County has a Phase II-C MS4 permit (FLR04E033), and FDOT District 5 has an MS4 permit (FLR04E024) covering the urbanized area of Volusia County. Based on the 2010 TIGER Census urbanized area coverage data, none of the Bethel Lake Watershed is located in the urban area. It should be noted that any MS4 permittee is only responsible for reducing the anthropogenic loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction.

6.4 MOS

The MOS can either be implicitly accounted for by choosing conservative assumptions about loading or water quality response, or explicitly accounted for during the allocation of loadings. Consistent with the recommendations of the Allocation Technical Advisory Committee (DEP 2001), an implicit MOS was used in the development of these TMDLs. The MOS is a required component of a TMDL and accounts for the uncertainty about the relationship between pollutant loads and the quality of the receiving waterbody (CWA, Section 303[d][1][c]).

An implicit MOS was used because the TMDLs were based on the conservative decisions associated with a number of the modeling assumptions in determining assimilative capacity (i.e., loading and water quality response). The PLSM uses ROC and EMC values based on loading rates by land use and does not account for the attenuation of flow and nutrients during runoff events. Therefore, these flow and nutrient loading estimates are likely overestimating values. Additionally, the TMDL nutrient load targets were derived based on meeting the chlorophyll *a* criterion in every year of the model simulation, while the criterion is expressed as an AGM, not to be exceeded more than once in any consecutive three-year period.

Chapter 7: Implementation Plan Development and Beyond

7.1 Implementation Mechanisms

Following the adoption of a TMDL, implementation may take place through various measures, including specific requirements in NPDES wastewater and MS4 permits, and, as appropriate, local or regional water quality initiatives or basin management action plans (BMAPs).

Facilities with NPDES permits that discharge to the TMDL waterbody must implement the permit conditions that reflect target concentrations, reductions, or WLAs identified in the TMDL. NPDES permits are required for Phase I and Phase II MS4s as well as domestic and industrial wastewater facilities. MS4 Phase I permits require a permit holder to prioritize and act to address a TMDL unless management actions to achieve that particular TMDL are already defined in a BMAP. MS4 Phase II permit holders must also implement the responsibilities defined in a BMAP or other form of restoration plan (e.g., a reasonable assurance plan).

7.2 BMAPs

Information on the development and implementation of BMAPs is found in Section 403.067, F.S. (the FWRA). DEP or a local entity may initiate and develop a BMAP that addresses some or all of the contributing areas to the TMDL waterbody. BMAPs are adopted by the DEP Secretary and are legally enforceable.

BMAPs can describe the fair and equitable allocations of pollution reduction responsibilities to the sources in the watershed, as well as the management strategies that will be implemented to meet those responsibilities, funding strategies, mechanisms to track progress, and water quality monitoring. Local entities—such as wastewater facilities, industrial sources, agricultural producers, county and city stormwater systems, military bases, water control districts, state agencies, and individual property owners—usually implement these strategies. BMAPs can also identify mechanisms to address potential pollutant loading from future growth and development.

7.3 Implementation Considerations for the Waterbody

In addition to addressing reductions in watershed pollutant contributions to impaired waters during the implementation phase, it may also be necessary to consider the impacts of internal sources (e.g., sediment nutrient fluxes or the presence of nitrogen-fixing cyanobacteria) and the results of any associated remediation projects on surface water quality. Other factors—such as the calibration of watershed nutrient loading, sediment nutrient fluxes, and/or nitrogen fixation—also influence lake nutrient budgets and the growth of phytoplankton. Approaches for addressing these potential factors should be included in a comprehensive management plan for the lake.

Additionally, the current water quality and water level monitoring of Bethel Lake should continue and be expanded, as necessary, during the implementation phase to ensure that adequate information is available for tracking restoration progress.

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Appendices

Appendix A: Background Information on Federal and State Stormwater Programs

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C. In 1994, DEP stormwater treatment requirements were integrated with the stormwater flood control requirements of the water management districts, along with wetland protection requirements, into the Environmental Resource Permit regulations, as authorized under Part IV of Chapter 373, F.S.

Chapter 62-40, F.A.C., also requires the state's water management districts to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a Surface Water Improvement and Management (SWIM) Program plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, they have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka.

In 1987, the U.S. Congress established Section 402(p) as part of the federal CWA Reauthorization. This section of the law amended the scope of the federal NPDES permitting program to designate certain stormwater discharges as "point sources" of pollution. The EPA promulgated regulations and began implementing the Phase I NPDES stormwater program in 1990 to address stormwater discharges associated with industrial activity, including 11 categories of industrial activity, construction activities disturbing 5 or more acres of land, and large and medium MS4s located in incorporated places and counties with populations of 100,000 or more.

However, because the master drainage systems of most local governments in Florida are physically interconnected, the EPA implemented Phase I of the MS4 permitting program on a countywide basis, which brought in all cities (incorporated areas), Chapter 298 special districts; community development districts, water control districts, and FDOT throughout the 15 counties meeting the population criteria. DEP received authorization to implement the NPDES stormwater program in 2000. The authority to administer the program is set forth in Section 403.0885, F.S.

The Phase II NPDES stormwater program, promulgated in 1999, addresses additional sources, including small MS4s and small construction activities disturbing between 1 and 5 acres, and urbanized areas serving a minimum resident population of at least 1,000 individuals. While these urban stormwater discharges are technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that cannot be easily collected and treated by a central treatment facility, as are other point sources of pollution such as domestic and industrial wastewater discharges. It should be noted that Phase I MS4 permits issued in Florida include a reopener clause that allows permit revisions to implement TMDLs when the implementation plan is formally adopted.

Appendix B: Information in Support of Site-Specific Interpretations of the Narrative Nutrient Criterion

Table B-1. Spatial extent of the numeric interpretation of the narrative nutrient criterion

Location	Description
Waterbody names	Bethel Lake
Waterbody type(s)	Lake
WBID	Bethel Lake (WBID 2953) (see **Figure 1.1** of this report)
Description	Bethel Lake is located in Volusia County, with the eastern edge of the watershed bordering the City of Deltona. The lake and its surrounding watershed cover an area of 1,365 acres. Bethel Lake has a surface area of 201 acres, with an average depth of 6.6 feet. Residential low density is the predominant land use in the Bethel Lake Watershed, with 30.59 % coverage. **Chapter 1** of this report describes the Bethel Lake system in more detail.
Specific location (latitude/longitude or river miles)	The center of Bethel Lake is located at N: 28°50'54.8"/W: 81°12'39.5." The site-specific criteria apply as a spatial average for the lake, as defined by WBID 2953.
Map	**Figure 1.1** shows the general location of Bethel Lake and its associated watershed, and **Figure 4.2** shows the land uses in the watershed.
Classification(s)	Class III Freshwater
Basin name (HUC 8)	Middle St. Johns River Basin (03080101)

Table B-2. Description of the numeric interpretation of the narrative nutrient criterion

Numeric Interpretation of Narrative Nutrient Criterion	Information on Parameters Related to Numeric Interpretation of the Narrative Nutrient Criterion
NNC summary: Generally applicable lake classification (if applicable) and corresponding NNC	Bethel Lake is a high-color lake, and the generally applicable NNC, expressed as AGM concentrations not to be exceeded more than once in any 3-year period, are chlorophyll *a* of 20 µg/L, TN of 1.27 to 2.23 mg/L, and TP of 0.05 to 0.16 mg/L.
Proposed TN, TP, chlorophyll *a*, and/or nitrate + nitrite concentrations (magnitude, duration, and frequency)	Numeric interpretations of the narrative nutrient criterion: For Bethel Lake the 7-year rolling average TN and TP loads are 4,234 and 234 lbs/yr, respectively. Nutrient concentrations are provided for informational purposes only. The in-lake TN and TP AGM concentrations for Bethel Lake at the allowable TMDL loading are 1.12 and 0.04 mg/L, respectively, not to be exceeded more than once in any 3-year period. These restoration concentrations represent the in-lake concentrations that would still meet the target chlorophyll *a* concentration of 20 µg/L with a 1-in-3-year exceedance rate.
Period of record used to develop numeric interpretations of the narrative nutrient criterion for TN and TP	The criteria were developed based on the application of the PLSM and the BATHTUB model, which simulated hydrology and water quality conditions from 2002 to 2013 for Bethel Lake. The primary datasets for this period include water quality data from IWR Run 56, NOAA Online Weather Data, and 2013–16 SJRWMD land use coverage. **Sections 2.3** and **4.4** of this report provide a complete description of the data used in the derivation of the proposed site-specific criteria.
How the criteria developed are spatially and temporally representative of the waterbody or critical condition	The model simulated the 2002–13 period for Bethel Lake. The period for the lake included wet and dry years. Long-term average rainfall for the Bethel Lake Watershed from 1980 to 2016 was 52 in/yr. This period captures the hydrologic variability of the system. The model simulated the entire watershed to evaluate how changes in watershed loads impact lake nutrient and chlorophyll *a* concentrations. **Figure 2.1** shows the locations of the sampling stations in Bethel Lake. Monitoring stations were located across the spatial extent and represent the spatial distribution of nutrient dynamics in the lake.

Table B-3. Summary of how designated use(s) are protected by the criterion

Designated Use Requirements	Information Related to Designated Use Requirements
History of assessment of designated use support	DEP used the IWR Database to assess water quality impairments in Bethel Lake (WBID 2953). During the Cycle 3, Group 2 assessment, the NNC were used to assess Bethel Lake during the verified period (January 1, 2007–June 30, 2014), based on data from IWR Run 50. Bethel Lake was determined to be verified impaired for chlorophyll *a*, TN, and TP. **Table 2.4** lists the AGM values for chlorophyll *a*, TN, and TP during the verified period for the waterbody.
Basis for use support	The basis for use support is the NNC chlorophyll *a* concentration of 20 µg/L, which is protective of designated uses for high-color lakes. Based on the available information, there is nothing unique about Bethel Lake that would make the use of the chlorophyll *a* threshold of 20 µg/L inappropriate for the lake.
Approach used to develop criteria and how it protects uses	For the Bethel Lake nutrient TMDLs, DEP created loading-based criteria using the PLSM to simulate loading from the Bethel Lake Watershed, and this information was input into BATHTUB for the lake. DEP established the site-specific TN and TP loadings using the calibrated models to achieve an in-lake chlorophyll *a* AGM concentration of 20 µg/L. The maximum of the 7-year rolling averages of TN and TP loadings to achieve the chlorophyll *a* target was determined by decreasing TN and TP loads from anthropogenic sources into the lake until the chlorophyll *a* target was achieved. **Chapter 3** of this report describes the derivation of the TMDLs and criteria.
How the TMDL analysis will ensure that nutrient-related parameters are attained to demonstrate that the TMDLs will not negatively impact other water quality criteria	Model simulations indicated that the target chlorophyll *a* concentration (20 µg/L) in the lake will be attained at the TMDL loads for TN and TP. DEP notes that no other impairments were verified for Bethel Lake that may be related to nutrients (such as dissolved oxygen [DO] or un-ionized ammonia). Reducing the nutrient loads entering the lake will not negatively affect other water quality parameters in the lake.

Table B-4. Documentation of the means to attain and maintain water quality standards for downstream waters

Protection of Downstream Waters and Monitoring Requirements	Information Related to Protection of Downstream Waters and Monitoring Requirements
Identification of downstream waters: List receiving waters and identify technical justification for concluding downstream waters are protected	Bethel Lake discharges into Bethel Creek (WBID 2953A2), which flows into Lake Monroe (WBID 2893D) (**Figure 2.1**). Bethel Creek is not verified impaired for nutrients. The TMDL-adopted percent reductions for TN and TP for Lake Monroe are 38 % and 31 %, and the target concentrations for TN and TP are 1.18 and 0.07 mg/L, respectively (Gao 2009). In comparison, the reductions for TN and TP required under the Bethel Lake TMDL are 45 % and 67 %, and the target concentrations for TN and TP are 1.12 and 0.04 mg/L, respectively. Since the Bethel Lake reductions are larger and nutrient targets are lower than those for downstream waters, the TMDLs for Bethel Lake are inherently protective.
Summary of existing monitoring and assessment related to the implementation of Subsection 62-302.531(4), F.A.C., and trends tests in Chapter 62-303, F.A.C.	Volusia County and DEP conduct routine monitoring of Bethel Lake. The data collected through these monitoring activities will be used to evaluate the effect of BMPs implemented in the watershed on lake TN and TP loads in subsequent water quality assessment cycles.

Table B-5. Documentation of endangered species consideration

Administrative Requirements	Information for Administrative Requirements
Endangered species consideration	DEP is not aware of any aquatic, amphibious, or anadromous endangered species present in the Bethel Lake Watershed. Furthermore, it is expected that restoration efforts and subsequent water quality improvements will positively affect aquatic species living in the lake and its watershed.

Table B-6. Documentation that administrative requirements are met

Administrative Requirements	Information for Administrative Requirements
Notice and comment notifications	DEP published a Notice of Development of Rulemaking on March 29, 2019, to initiate TMDL development for impaired waters in the Middle St. Johns Basin. A rule development public workshop for the TMDLs was held on May 6, 2019.
Hearing requirements and adoption format used; responsiveness summary	Following the publication of the Notice of Proposed Rule, DEP will provide a 21-day challenge period and a public hearing that will be noticed no less than 45 days prior.
Official submittal to EPA for review and General Counsel certification	If DEP does not receive a rule challenge, the certification package for the rule will be prepared by the DEP program attorney. DEP will prepare the TMDLs and submittal package for the TMDLs to be considered as site-specific interpretations of the narrative nutrient criterion and will submit these documents to the EPA.