Central District • Middle St. Johns Basin

Final TMDL Report

Nutrient TMDLs for Lake Gem (Orange County) (WBID 2997V) 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 Lake Gem, located in Orange County. The northern portion of Lake Gem's watershed is situated in the City of Maitland, while the southeast and eastern portions of the watershed are located in the City of Winter Park.

Lake Gem (the segment with waterbody identification [WBID] number 2997V) was found to be impaired (Category 5) for chlorophyll *a* and total phosphorus (TP) because the annual geometric means (AGMs) for each parameter exceeded the applicable numeric nutrient criteria (NNC) during the verified period. The waterbody was added to the 303(d) list of impaired waters by Secretarial Order in April 2016.

TMDLs for total nitrogen (TN) and total phosphorus (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 Lake Gem

Type of Information	Description
Waterbody name (WBID)	Lake Gem (Orange County) (WBID 2997V)
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	**Lake Gem (WBID 2997V):** **TN:** 1,130 pounds per year (lbs/yr), expressed as a 3-year rolling average load not to be exceeded. **TP:** 68 lbs/yr, expressed as a 3-year rolling average load not to be exceeded.
Load reductions required to meet the TMDLs	**WBID 2997V:** A 0 % TN reduction and a 62 % TP reduction to achieve the applicable annual geometric mean (AGM) chlorophyll *a* criterion for low-color, high-alkalinity lakes.
Concentration-based lake restoration targets	**WBID 2997V:** The nutrient concentrations corresponding to the chlorophyll *a* NNC and the loading-based criteria are a TN AGM of 0.78 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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µg/L	Micrograms Per Liter
µmhos/cm	Micromhos/centimeter
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/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
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 Lake Gem, 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 Lake Gem 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. Lake Gem is WBID 2997V. **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 more detailed map of the waterbody.

The Lake Gem Watershed is located in Orange County in the City of Maitland. The surface area of the lake is 8 acres, with an average depth of 6.6 feet.

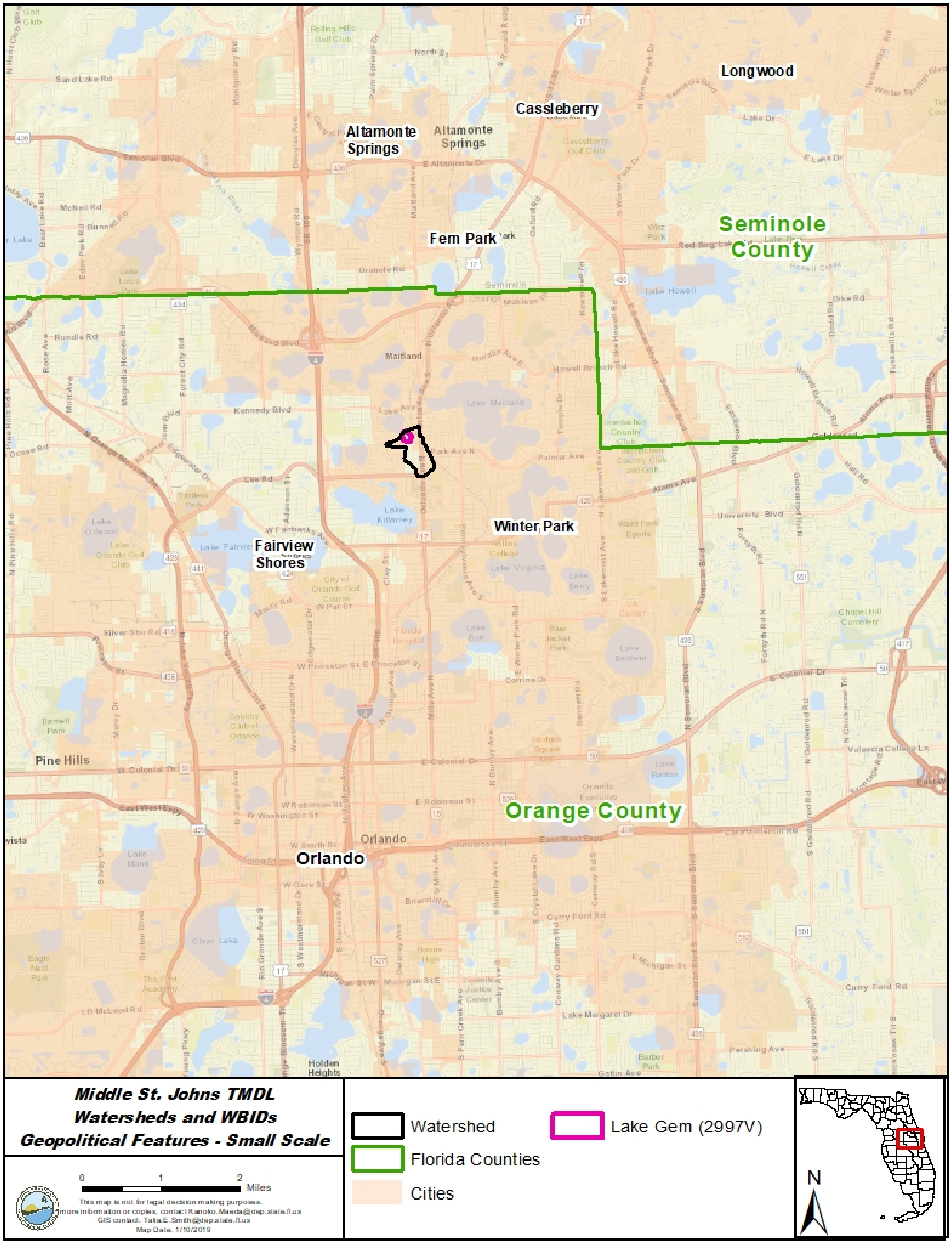


Figure 1.1. Location of Lake Gem (WBID 2997V) in the Middle St. Johns Basin and major hydrologic and geopolitical features in the area

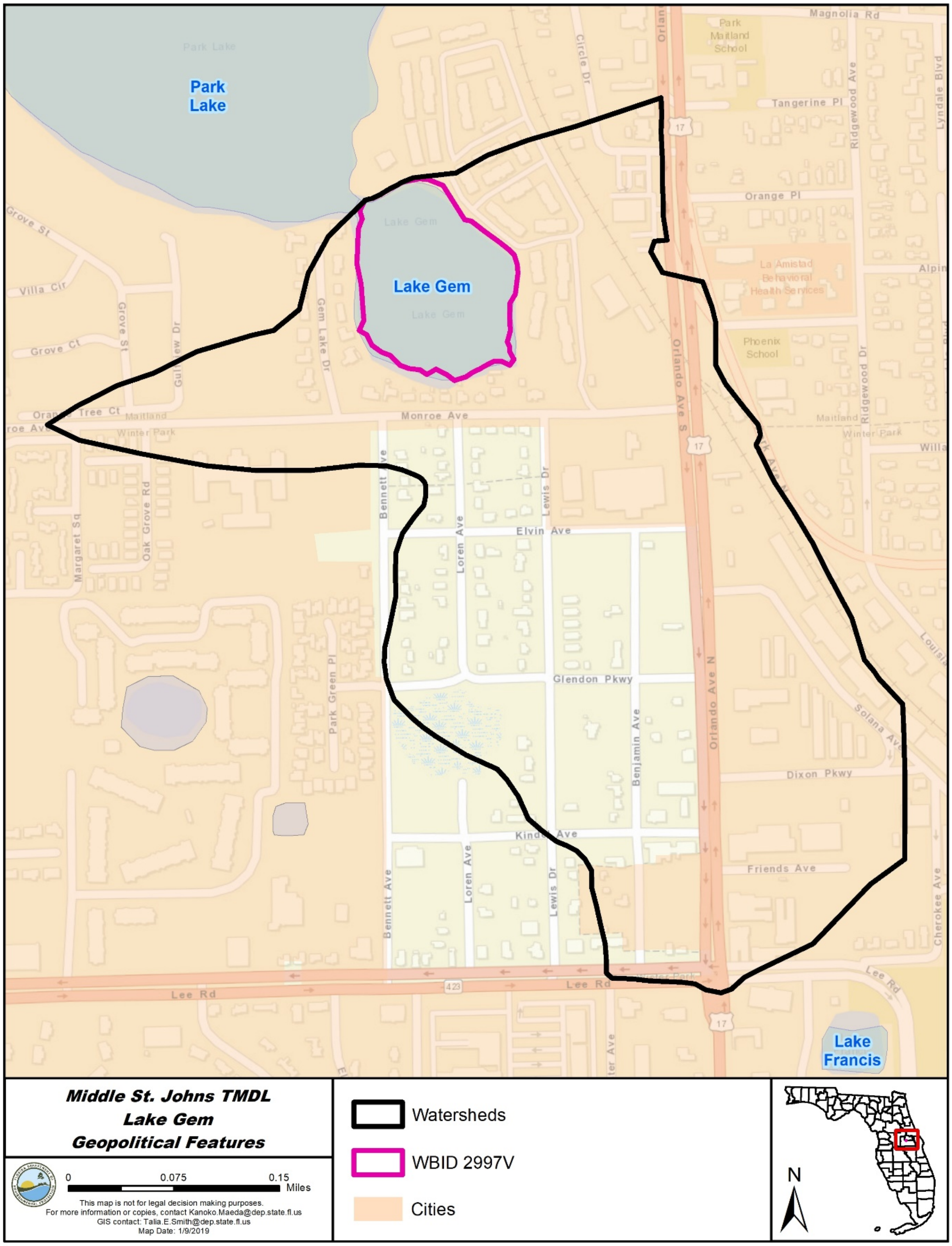


Figure 1.2. Lake Gem (WBID 2997V) Watershed

1.3 Watershed Information

1.3.1 Population and Geopolitical Setting

Lake Gem's watershed, including the waterbody itself, covers an area of 110 acres. Both the lake and watershed are located in Orange County. The northern portion of Lake Gem's watershed is situated in the City of Maitland, while the southeast and eastern portions are located in the City of Winter Park. In 2017, Orange County had a population of 1,348,975 (U.S. Census Bureau 2018). Two major roads run through the watershed: U.S. Highway 17-92 runs north-south, and Lee Road runs east-west (City of Maitland, personal communication, 2018). The majority of the Lake Gem Watershed is composed of commercial and services land use, along with open land, high- and medium-density residential, institutional, and upland hardwood forests. **Chapter 4** contains detailed summaries of land uses in the watershed.

1.3.2 Topography

The Lake Gem Watershed is located in the Orlando Ridge Lake Region (75-21), which is characterized by karst topography with low relief and soils from the Tavares, Smyrna, and Pomello series. Elevations range from 75 to 120 feet. Lakes in this region may have phosphatic and clayey sands in shallow areas, indicating some possible natural phosphorus sources (DEP n.d.). Watershed elevations range from 75 to 95 feet, with the lower elevation contours surrounding the lake itself and the higher elevations located farther away from the waterbody. The 95-foot contours are located in small areas on the southeast and southwest edges of the watershed.

Lake Gem Watershed's drainage is influenced by both topography and structural drainage systems. Portions of U.S. Highway 17-92 drain to Lake Gem through a Florida Department of Transportation (FDOT) easement, while Lee Road cuts through the southern portion of the watershed, sending runoff north of this road into Lake Gem (City of Maitland, personal communication, 2018). Lake Gem is connected to a larger lake, Park Lake, which has an outlet connecting to Lake Maitland via a culvert located under U.S. Highway 17-92. Lake Maitland then connects to Lake Howell via Howell Creek and discharges from Lake Howell to Lake Jesup. From there, Lake Jesup connects to the St. Johns River (City of Maitland, personal communication, 2018).

1.3.3 Hydrogeological Setting

The watershed for Lake Gem 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 for the Lake Gem 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. 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 Lake Gem Watershed

Soil Hydrologic Group	Acreage	% Acreage
A	50	45
A/D	8	7
Unclassified Lake Bottom	7	6
No Data	46	41
Total	**111**	**99**

The Lake Gem 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. The watershed's long-term average rainfall was 51 inches per year (in/yr) from 1980 to 2018. Rainfall data came from the National Oceanic and Atmospheric Administration (NOAA) Online Weather Data Orlando International Airport weather station, Orange County Water Atlas Lake Maitland weather station, and St. Johns River Water Management District (SJRWMD) 12022322 and 12032323 weather stations. For the Lake Gem Watershed, the data from other stations were averaged by date for years when there were gaps in data from one station. For the watershed, the annual average temperature based on the Orlando International Airport weather station was 73 degrees Fahrenheit (° F.) from 1980 to 2018 (NOAA 2018).

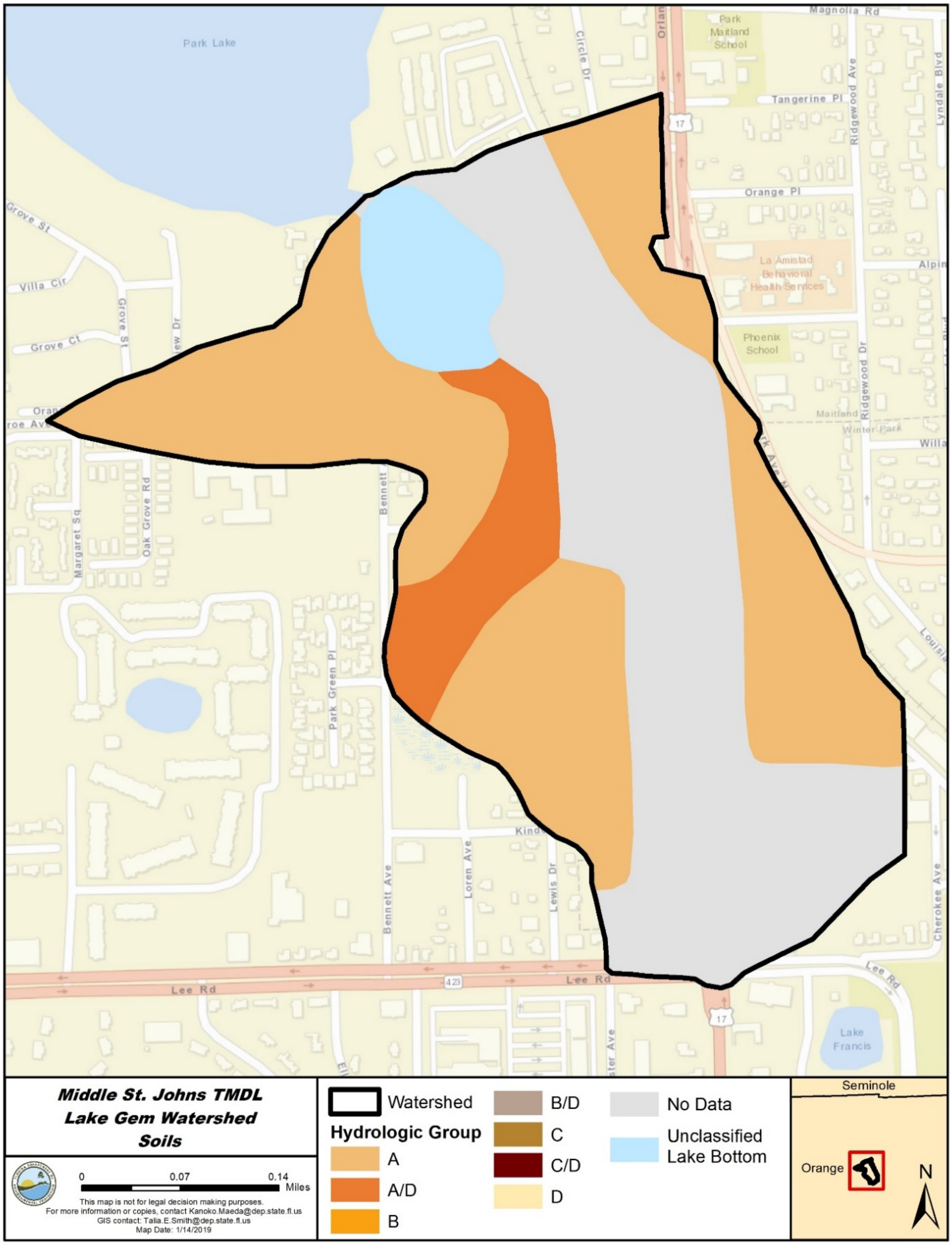


Figure 1.3. Hydrologic soil groups in the Lake Gem Watershed

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

Lake Gem 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 criteria applicable to the verified impairment (nutrients) for the lake are Florida's nutrient criteria in Paragraph 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 Run 56, Lake Gem is classified as a low-color (≤40 PCU), high-alkalinity (> 20 $CaCO_3$) lake, as shown in **Table 2.1**.

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

Parameter	Long-Term Geometric Mean	Number of Samples
Color (PCU)	19	45
Alkalinity (mg/L $CaCO_3$)	72	54

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

Lake Gem's data providers include DEP and Orange County Environmental Protection Division (OCEPD). **Table 2.3** summarizes the data providers for Lake Gem, including corresponding stations and monitoring beginning and ending dates.

Table 2.3. Lake Gem data providers

Sampling Station	Data Provider	Activity Beginning Date	Activity Ending Date
21FLCEN 20011197	DEP	2012	2012
21FLCEN 20011198	DEP	2012	2013
21FLCEN 20011307	DEP	2013	2013
21FLORANHB13	OCEPD	1994	2010

OCEPD provided the majority of the data for the Lake Gem assessment. **Figure 2.1** shows the 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 Lake Gem using data collected during the verified period (January 1, 2007–June 30, 2014) based on data from IWR Run 50. Lake Gem was found to be verified impaired for chlorophyll *a* 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 Lake Gem.

Table 2.4. Lake Gem 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	**28**	0.77	**0.05**
2008	**27**	ID	ID
2009	ID	ID	ID
2010	**32**	ID	ID
2011	ID	ID	ID
2012	**39**	0.76	**0.06**
2013	**44**	0.75	**0.06**
2014	ID	ID	ID

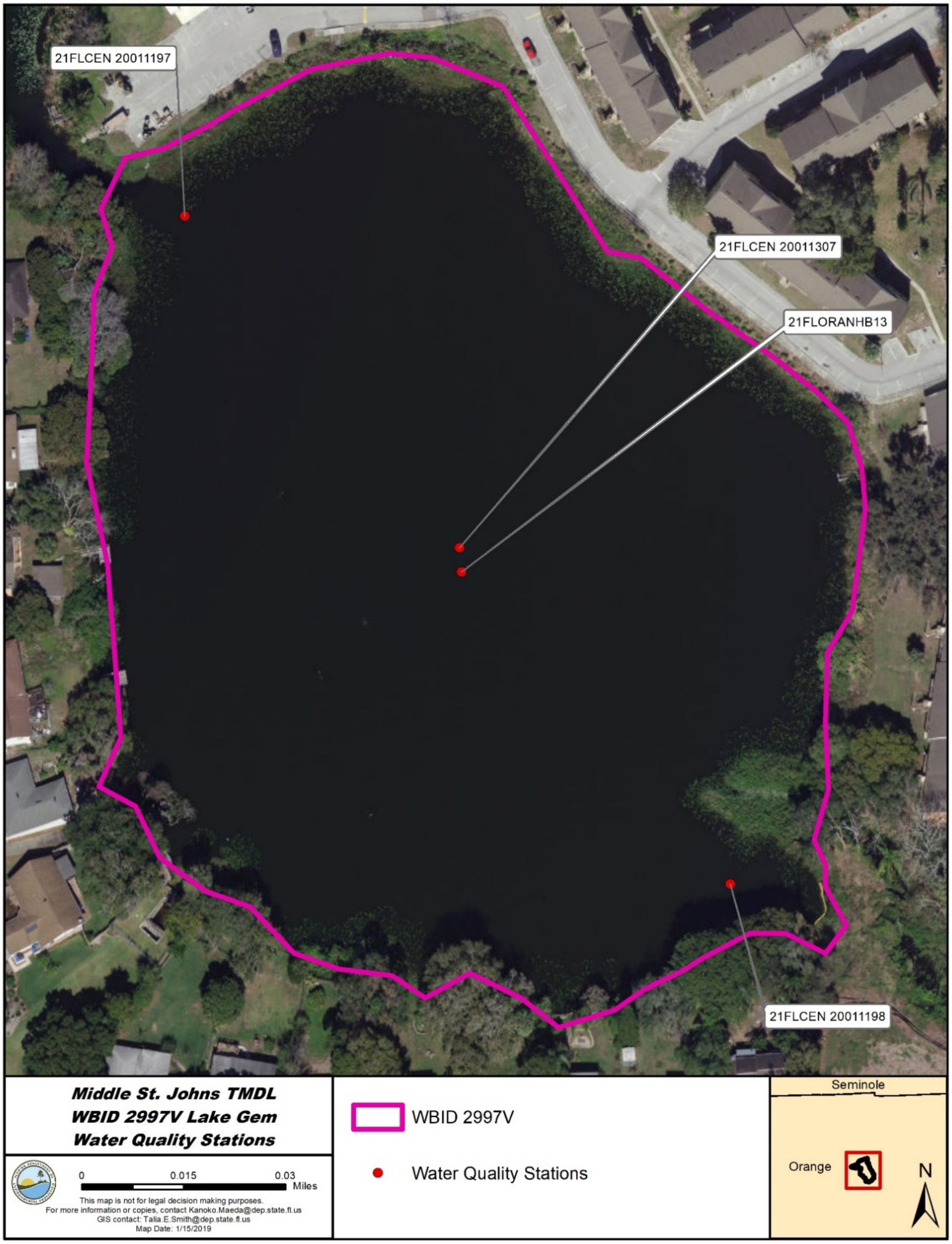


Figure 2.1. Monitoring stations in Lake Gem

2.4 Relationships Between Water Quality Variables

For Lake Gem, 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.

For the lake, there was no significant relationship between both chlorophyll *a* and TN ($R^2 = 0.00$, p value > 0.05) and chlorophyll *a* and TP ($R^2 = 0.10$, p value > 0.05).

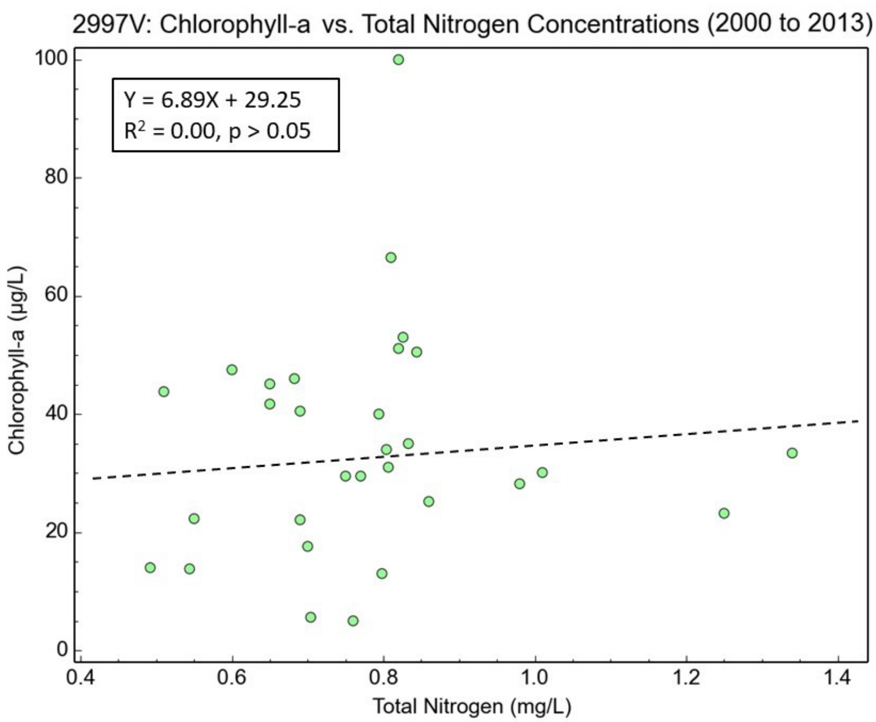


Figure 2.2. Lake Gem daily chlorophyll *a* vs. TN

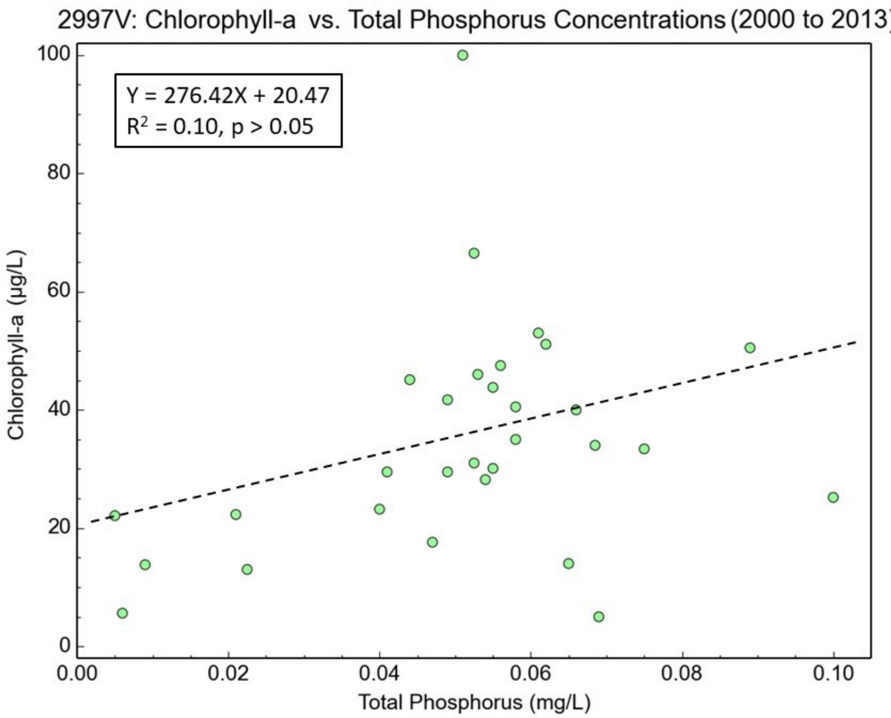


Figure 2.3. Lake Gem daily chlorophyll *a* vs. TP

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 Lake Gem 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 Lake Gem differs from the reference lakes used to develop the NNC. Therefore, DEP has determined that the generally applicable chlorophyll *a* criterion for low-color, high-alkalinity lakes is the most appropriate TMDL target for the lake (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 Lake Gem 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 Lake Gem, nutrient and chlorophyll concentrations were simulated from 2007 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 the rolling 3-year average loading for each parameter. The site-specific interpretations of the narrative nutrient criterion were then set for each parameter at the maximum 3-year rolling average load for Lake Gem. **Section 5.5** discusses the method used to determine these loading values in more detail.

Site-specific interpretations for Lake Gem are expressed as a 3-year rolling annual average load not to be exceeded. **Table 3.1** summarizes the site-specific interpretations for TN and TP for Lake Gem.

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

Waterbody	WBID	3-Year Annual Average TN (lbs/yr)	3-Year Annual Average TP (lbs/yr)
Lake Gem	2997V	1,130	68

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 Lake Gem, the TN and TP AGM concentrations of 0.78 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

Lake Gem is connected to a larger lake, Park Lake (WBID 2997U), which connects to Lake Maitland (WBID 2997C) via Park Lake Outlet (WBID 2997T). These downstream waterbodies do not have water quality impairments for nutrients or dissolved oxygen (DO). Therefore, Lake Gem's nutrient load reductions will likely further protect these downstream waterbodies by decreasing algal biomass and the associated nutrients.

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 Lake Gem 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 Lake Gem or to its watershed.

4.2.2 Municipal Separate Storm Sewer System (MS4) Permittees

The Lake Gem Watershed is covered by an NPDES MS4 Phase I permit (FLS000011), issued to Orange County and co-permittees. **Figure 4.1** shows the permit locations in the watershed. However, the MS4 boundary indicates the jurisdiction boundary. The permittees may be responsible to implement stormwater treatment projects when water is directly discharged to the waterbody. For more information on MS4s in the watershed, send an email to: NPDES-stormwater@dep.state.fl.us. **Table 4.1** lists the permittees/co-permittees and their MS4 permit numbers.

Table 4.1. NPDES MS4 permit with jurisdiction in the Lake Gem Watershed

Watershed	Permit Number	Permittee/Co-permittees	Phase
Lake Gem	FLS000011	Orange County/ City of Maitland/ City of Winter Park	I

4.3 Nonpoint Sources

Nutrient loadings to Lake Gem 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).

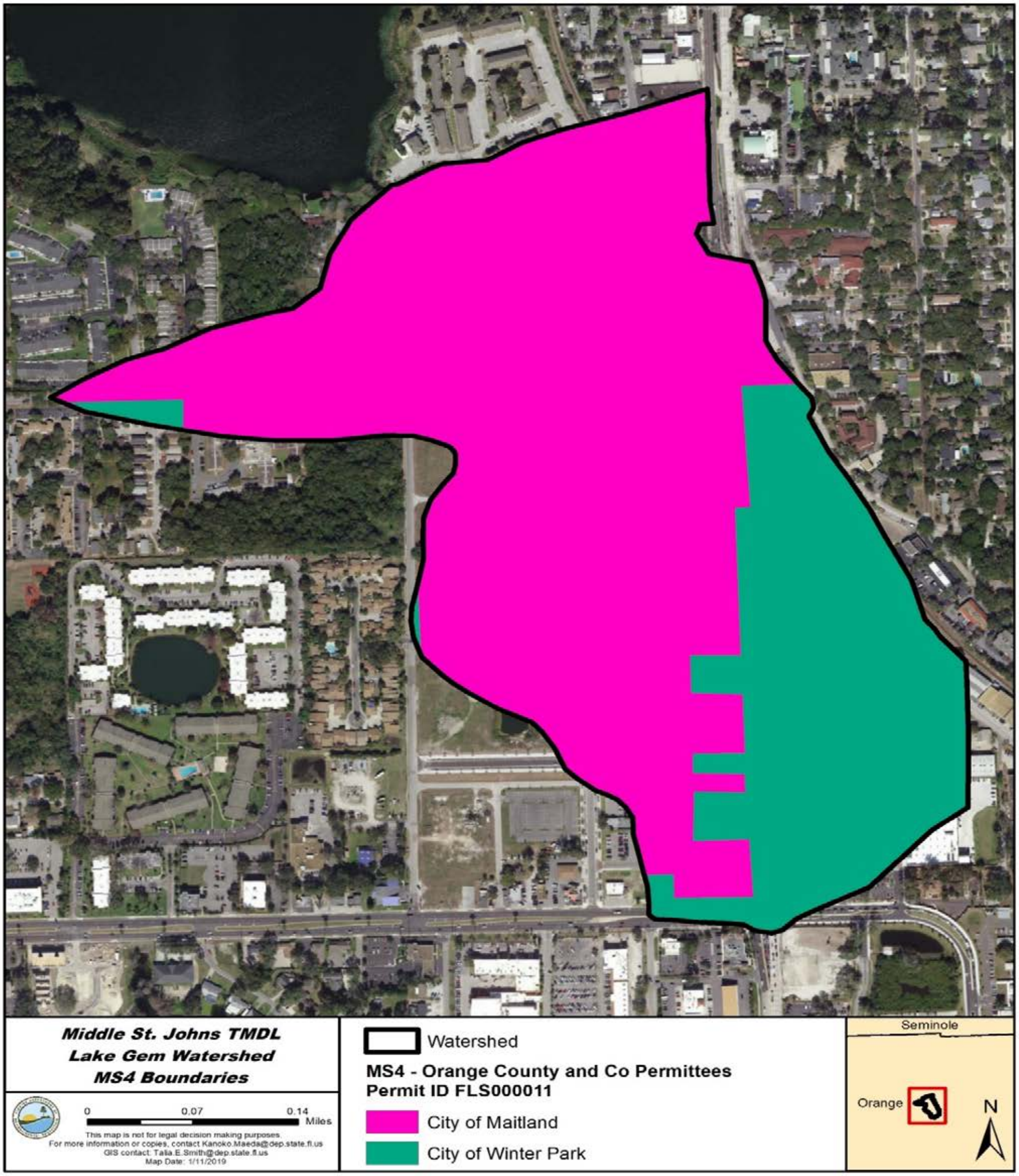


Figure 4.1. Location of MS4 permittees in the Lake Gem Watershed

4.3.1 Land Uses

Land use is one of the most important factors in determining nutrient loadings from the Lake Gem 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 4.2** lists land uses in the watershed from 2013 to 2016, based on data from SJRWMD, and **Figure 4.2** shows the information graphically.

Table 4.2 and **Figure 4.2** show the breakdown of the various land use categories in the Lake Gem Watershed. Commercial and services is the predominant land use with 44 % coverage. Open land follows with 18 %, residential high density with 10 %, residential medium density with 9 %, lakes with 7 %, and transportation with 7 %. These land use classifications account for 95 % of all classifications in the watershed, with all other individual classifications under 5 %.

Table 4.2. SJRWMD land use in the Lake Gem Watershed, 2013–16

Land Use Code	Land Use Classification	Acres	% of Watershed
1200	Residential Medium Density	10	9
1300	Residential High Density	11	10
1400	Commercial and Services	49	44
1700	Institutional	2	2
1900	Open Land	20	18
4200	Upland Hardwood Forests	3	3
5200	Lakes	8	7
8100	Transportation	7	7
Total		**110**	**100**

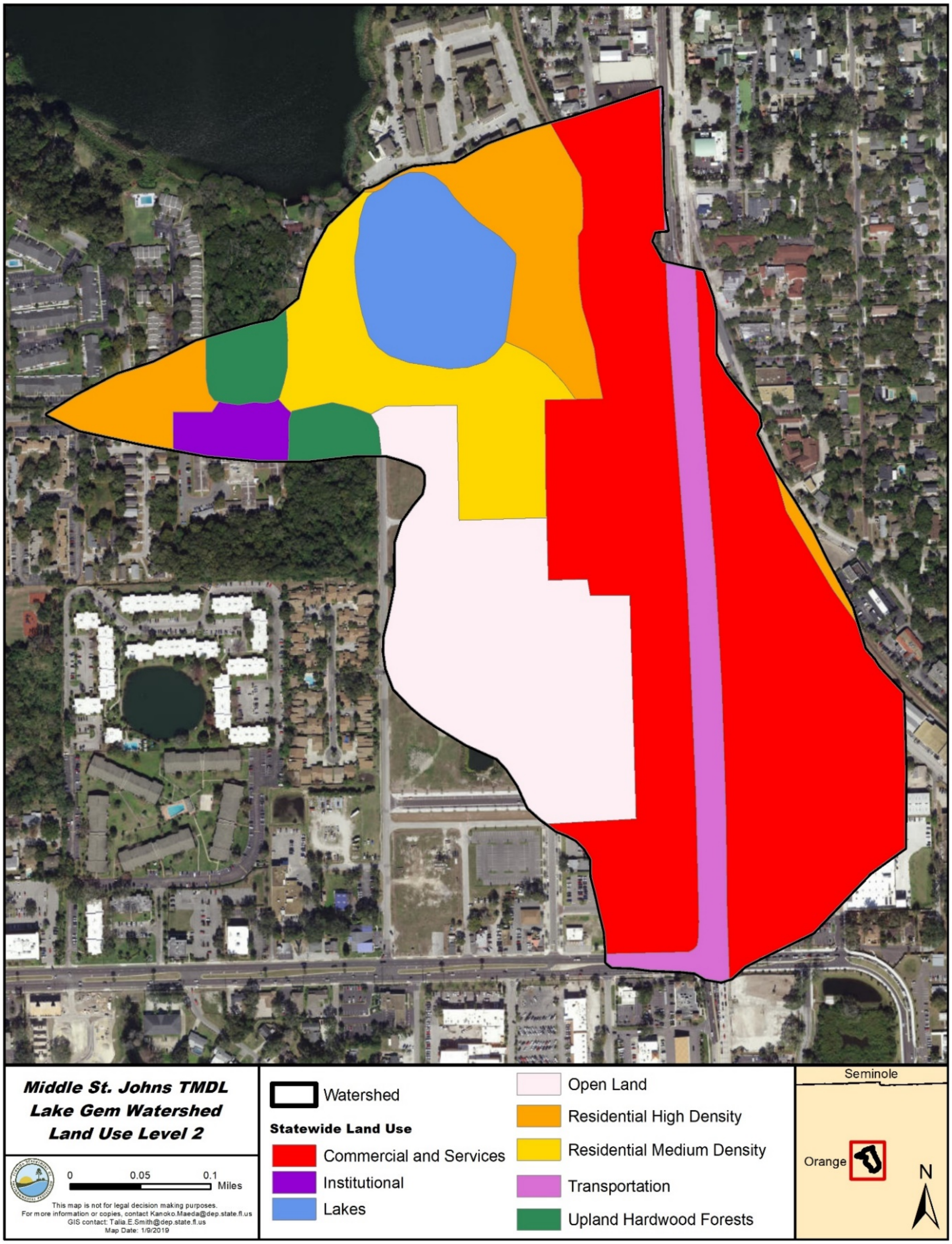


Figure 4.2. Land use in the Lake Gem Watershed, 2013–16

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 Orange County 2018 database was used to determine the number of known septic tanks within a 200-meter buffer zone for the Lake Gem Watershed. In the buffer zone, there are 6 known septic tanks. **Figure 4.3** shows the OSTDS locations in the watershed.

4.3.3 Atmospheric Deposition

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 4.3**) were added to the waterbody model for Lake Gem. Atmospheric deposition values in 2013 were estimated by averaging dry deposition and rainfall components for wet deposition values from 2000 to 2012.

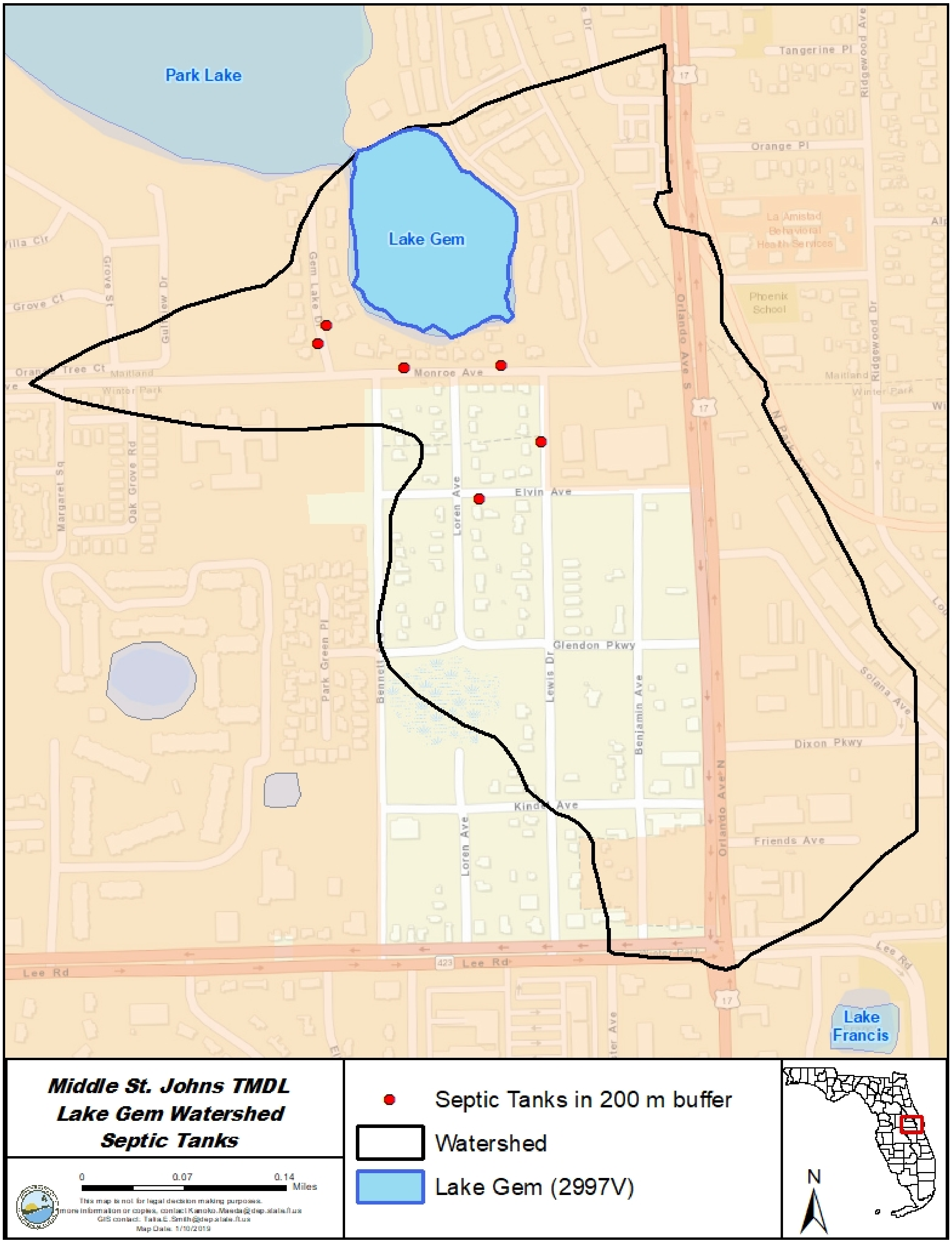


Figure 4.3. OSTDS in the Lake Gem Watershed

Table 4.3. Calculated atmospheric deposition in Lake Gem based on field measurements in Lake Apopka, 2000–12

$mg/m^2/yr$ = 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	569	14	822	40
2001	145	11	959	15	1,104	26
2002	146	12	863	15	1,009	27
2003	110	13	869	16	979	28
2004	181	18	911	17	1,092	35
2005	136	15	803	17	939	32
2006	186	16	596	8	782	24
2007	221	27	706	17	927	44
2008	168	23	841	25	1,009	48
2009	166	23	658	23	824	46
2010	167	30	660	21	827	51
2011	136	19	553	19	689	38
2012	296	48	751	26	1,047	74
2013	178	22	715	18	893	39

4.4 Estimating Watershed Loadings

To simulate nutrient loading from the Lake Gem 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 each 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:

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

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 %).

The number of known septic tanks within a 200-meter buffer of Lake Gem was six. According to the U.S. Census Bureau, Polk County had an average of 2.75 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 4.4** lists the estimated TN load for the watershed.

Table 4.4. Summary of septic tank loads from the watershed

Watershed	TN Load (lbs/yr)
Lake Gem	75

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 Lake Gem 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 Class III waters.

5.2 Evaluation of Water Quality Conditions

Lake Gem chlorophyll *a* AGMs ranged from 16 µg/L in 1998 to 37 µg/L in 2010. From 1994 to 2013, TN AGMs ranged from 0.49 mg/L in 1995 to 0.97 mg/L in 1994. TP AGMs ranged from 0.01 mg/L in 2000 and 2001 to 0.06 mg/L in 2012.

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 Lake Gem, 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

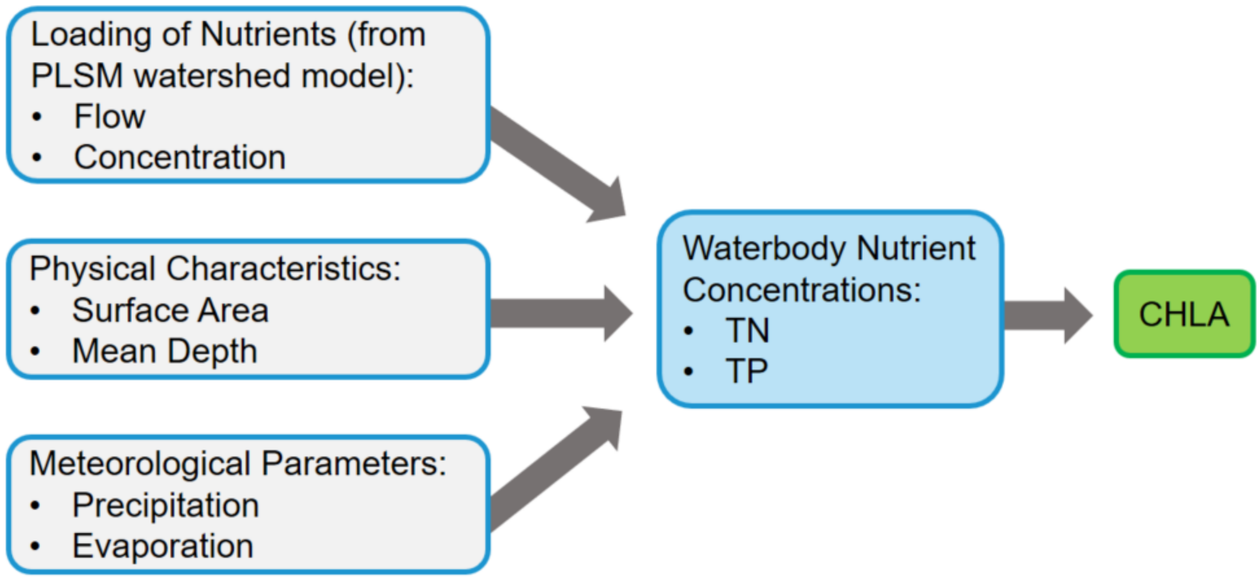
BATHTUB runs on a modeling framework that uses empirical relationships between nutrient loading, meteorological conditions, and physical parameters to estimate algal growth. The model's hydrologic framework includes lakes and lake segments, which may be directly or indirectly connected. Other inputs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

Lake Gem was represented as one waterbody in the BATHTUB model because the lake is 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 in BATHTUB for each year. Residence time and nutrient fate and transport are two processes that vary based on these physical features. Lake Gem has a depth of 6.6 feet, a surface area of 8 acres, and a watershed area of 110 acres (Orange County Water Atlas 2019).

For the watershed nutrient inputs, the modeled watershed area was used as the watershed area input. For the groundwater flux inputs, only the area of the combined groundwater zones (see **Figure 4.3**) for each waterbody was used as the total watershed area input. For Lake Gem, the total groundwater zone area was 29 acres.

5.4.3 Meteorological Data

RAINFALL

Rainfall data (2000–13) for the Lake Gem Watershed (**Table 5.1**) came from NOAA's Online Weather Data Orlando International Airport weather station, Orange County Water Atlas Lake Maitland weather station, and SJRWMD 12022322 and 12032323 weather stations. For the Lake Gem Watershed, the data from other stations were averaged by date for years when there were gaps in data from one station.

EVAPORATION

The lake evaporation data were used from the Lake Roberts TMDL report (Kang 2017). The potential evapotranspiration (PET) data were obtained from the Lisbon weather station for 2000 to 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 pan evaporation rates for the Lake Gem BATHTUB model calibration

m/yr = Meters per year

Year	Annual Rainfall (m/yr)	Lake Evaporation (m/yr)
2000	0.867	1.14
2001	1.267	1.10
2002	1.712	1.16
2003	1.419	1.13
2004	1.590	1.00
2005	1.582	0.99
2006	1.047	1.06
2007	1.042	1.02
2008	1.482	1.01
2009	1.294	1.03
2010	1.381	1.01
2011	1.286	1.08
2012	1.069	1.05
2013	1.232	1.06

ATMOSPHERIC DEPOSITION

Atmospheric deposition rates (total deposition of TN and TP) were applied to global variables for the Lake Gem 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

For Lake Gem, the BATHTUB model was set up to simulate in-lake TN, TP, and chlorophyll *a* concentrations. AGMs for these parameters were input into the model as observed values for 2007 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.

Lake Gem's BATHTUB model was calibrated using Model Option 3, 2nd Order, Fixed, for TP; Model Option 1, 2nd Order, Available Nitrogen, for TN; and Model Option 2, P, Light, T, for chlorophyll *a*. The P, Light, T chlorophyll *a* model assumes that phytoplankton growth is limited not by nitrogen but by phosphorus and light. Because Lake Gem is a low-color lake and only impaired for TP and chlorophyll *a*, this light- and phosphorus-driven model was deemed acceptable for modeling. TP and TN were calibrated by adjusting the decay rates until the observed AGMs more closely matched the predicted values, which was achieved with a model coefficient of 2 for both TP and TN. These calibration factors are within the acceptable range cited in the BATHTUB manual (Walker 1999).

Lake Gem's BATHTUB calibrated model resulted in a 3 % difference in long-term averages for chlorophyll *a*, a 2 % difference in long-term averages for TN, and a 10 % 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 2007 to 2013 for chlorophyll *a*, TN, and TP, respectively.

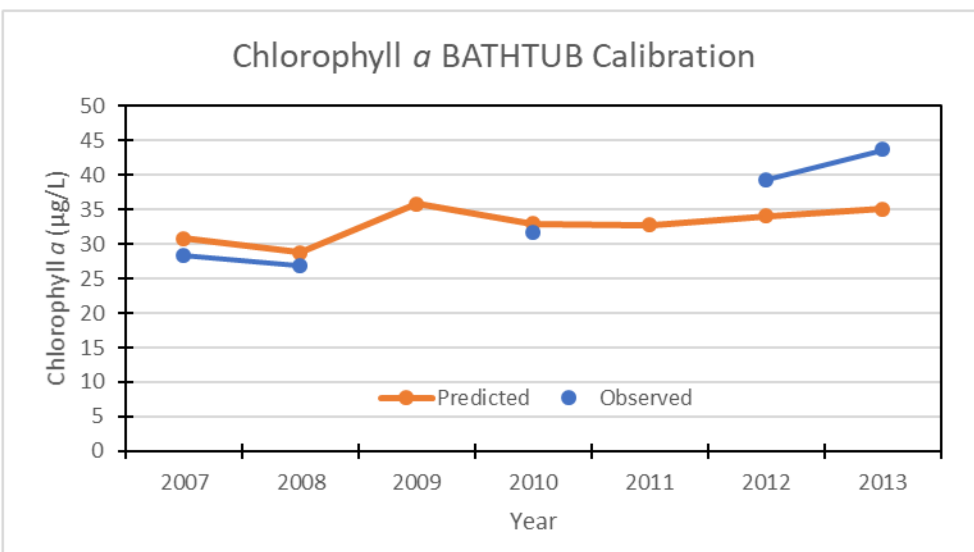


Figure 5.2. Lake Gem chlorophyll *a* observed and BATHTUB-simulated annual average results, 2007–13

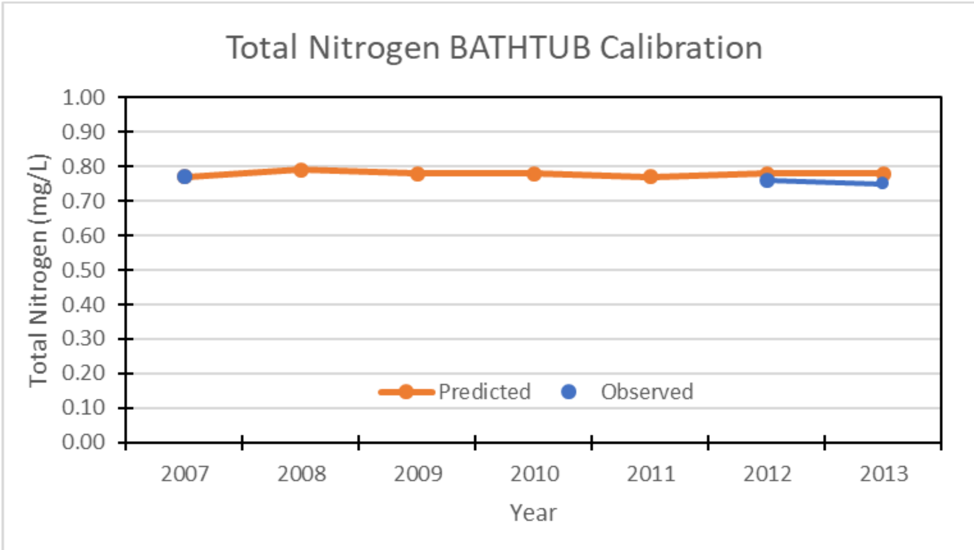


Figure 5.3. Lake Gem TN observed and BATHTUB-simulated annual average results, 2007–13

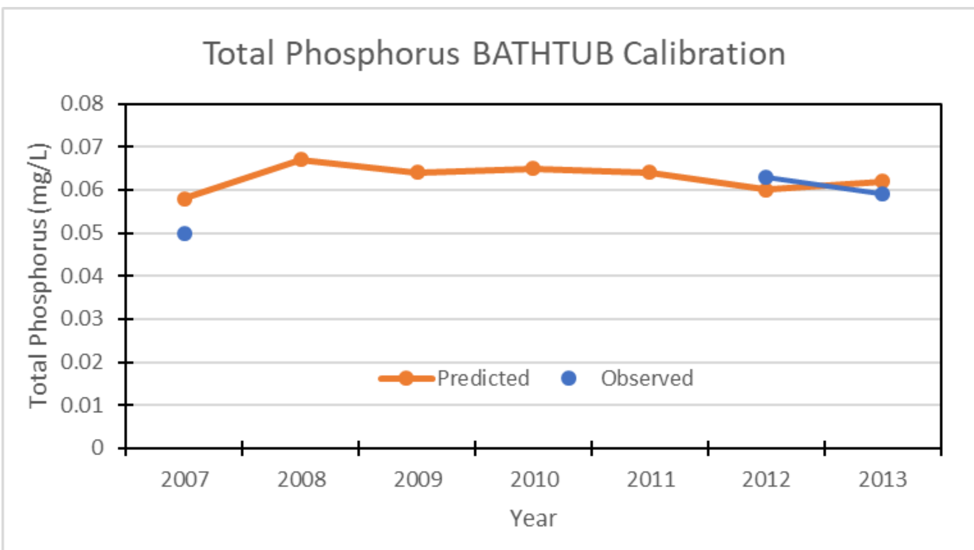


Figure 5.4. Lake Gem TP observed and BATHTUB-simulated annual average results, 2007–13

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 Lake Gem 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. Loadings from OSTDS 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 Lake Gem, 3-year rolling average loads were calculated from the yearly TN and TP loads, and the maximum 3-year averages of TN and TP loads were chosen as the site-specific interpretations of the narrative nutrient criterion. The 3-year TN and TP target loads necessary to meet the chlorophyll *a* criterion of 20 µg/L (TMDL condition) are 1,130 and 68 lbs/yr, respectively, for Lake Gem.

To meet the final TMDL loads, also referred to as the TMDL condition, for Lake Gem, 0 % and 62 % reductions from current loadings are required for TN and TP, respectively (2007–13). **Table 5.2** lists the TMDL condition nutrient loads for Lake Gem from 2007 to 2013.

Table 5.2. Lake Gem TMDL condition nutrient loads, 2007–13

Note: Values shown in boldface type and shaded cells represent the maximum 3-year averages, the 3-year loads used for the calculations, and percent reductions.

Year	Current Condition TN Loads (lbs/yr)	3-Year Rolling Average TN Loads (lbs/yr)	TMDL Condition TN Loads (lbs/yr)	3-Year Rolling Average TN Loads (lbs/yr)	Current Condition TP Loads (lbs/yr)	3-Year Rolling Average TP Loads (lbs/yr)	TMDL Condition TP Loads (lbs/yr)	3-Year Rolling Average TP Loads (lbs/yr)
2007	877		877		132		51	
2008	**1,210**		**1,210**		**187**		**71**	
2009	**1,063**	1,050	**1,063**	1,050	**165**	162	**64**	62
2010	**1,116**	**1,130**	**1,116**	**1,130**	**174**	**176**	**68**	**68**
2011	1,052	1,077	1,052	1,077	163	168	64	65
2012	913	1,027	913	1,027	139	159	55	62
2013	1,012	992	1,012	992	154	152	60	60
Maximum 3-Year Average		**1,130**		**1,130**		**176**		**68**
% Reduction				**0**				**62**

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:

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

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

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

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (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 Lake Gem are expressed in terms of pounds per year 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 Lake Gem TMDL is based on 3-year rolling averages of simulated loads from 2007 to 2013. For these 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 Lake Gem.

Table 6.1 lists the TMDLs for the Lake Gem 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 Lake Gem are expressed as a 3-year rolling annual average load not to be exceeded.

Table 6.1. TMDL components for nutrients in Lake Gem (WBID 2997V)

Note: The LA and TMDL daily load for TN is 3 lbs/day, and for TP 0.2 lbs/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
2997V	TN	1,130	NA	0	0	Implicit
2997V	TP	68	NA	62	62	Implicit

6.2 Load Allocation

To achieve the LA for Lake Gem, 0 % and 62 % 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 Lake Gem Watershed discharge either into the lake or the watershed. Therefore, a WLA for wastewater discharges is not applicable.

6.3.2 NPDES Stormwater Discharges

The MS4 permittees/co-permittees in the Lake Gem Watershed include Orange County, the City of Maitland, and the City of Winter Park. A 0 % reduction in TN and a 62 % reduction in TP from current anthropogenic loading are required for areas within these permittees/co-permittees' jurisdiction in the watershed.

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.

Lake Gem is located in the Lake Jesup BMAP area and is therefore currently included in BMAP activities. The BMAP was adopted in May 2010. However, detailed allocations for load reductions are calculated and assigned to responsible entities in the basin (cities, towns, counties, and state agencies), not to individual waterbodies. DEP has been working on amendments to the 2010 Lake Jesup BMAP. These amendments, to be adopted by Secretarial Order, will be a supplement to the 2010 BMAP and are meant to be used in conjunction with the 2010 BMAP. The 2010 Lake Jesup BMAP remains in full force and effect, except as specifically modified by the amendments.

7.3 Implementation Considerations for the Waterbody

The City of Maitland recently carried out a study through Environmental Research and Design, Inc. (2019) to characterize existing sediment accumulations in Lake Gem. The Study concluded phosphorus recycling from the sediments exhibited significant impacts on Lake Gem water quality. As a follow up to the study, City of Maitland has begun alum treatments, with the first event in September 2019, as a Lake Gem restoration effort to inactivate sediments and reduce sediment phosphorus release. The city will also be collecting monthly water quality samples for monitoring purpose of the alum treatment project. The city plans more alum treatments (up to 4 times) based on the monitoring results (John Bryant, City of Maitland, Personal communication, 2019).

City of Winter Park has performed recent BMPs in the Whole Foods plaza and associated retails south of Dixon Avenue in the Lake Gem Watershed which will provide additional attenuation in the stormwater runoff. The lake receives flow from this area only during large rainfall events (Matt Noonon, City of Winter Park, Personal communication, 2019).

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

References

Environmental Research and Design, Inc. 2019. *Lake Gem Evaluation of Sediment Impacts on Lake Water Quality*. City of Maitland, FL.

Florida Department of Environmental Protection. 2001. *A report to the Governor and the Legislature on the allocation of total maximum daily loads in Florida.* Tallahassee, FL: Bureau of Watershed Management.

———. 2012. *Development of numeric nutrient criteria for Florida lakes, spring vents, and streams.* Technical support document. Tallahassee, FL: Division of Environmental Assessment and Restoration, Standards and Assessment Section.

———. n.d. *Florida lake regions.* Accessed January 9, 2019.

Harper, H. 1994. *Stormwater loading rate parameters for central and south Florida.* Orlando, FL: Environmental Research and Design, Inc.

———. 2012. *BMPTRAINS MODEL: Rainfall characteristics*. PowerPoint slides. Accessed January 16, 2019.

Kang, W. 2017. *Nutrient TMDLs for Lake Roberts (WBID 2872A).* TMDL report. Tallahassee, FL: Florida Department of Environmental Protection.

National Oceanic and Atmospheric Administration. 1982. *Mean monthly, seasonal, and annual pan evaporation for the United States.* NOAA Technical Report NWS 34. Washington, DC: Accessed January 30, 2019.

———. 2018. *NOAA online weather data.* Accessed January 11, 2019.

Toor, G.S., M. Lusk, and T. Obreza. June 2011; reviewed April 2018. *Onsite sewage treatment and disposal systems: An overview*. SL347. Gainesville, FL: University of Florida Institute of Food and Agricultural Sciences. Accessed March 19, 2019.

U.S. Census Bureau. 2018. *Annual estimates of the resident population: April 1, 2010 to July 1, 2017.* Washington, DC: Population Division. Accessed January 9, 2019.

U.S. Environmental Protection Agency. 2002. *Onsite wastewater treatment systems manual*. EPA 625/R-00/008. Washington, DC: Office of Research and Development.

Walker, W.W., Jr. 1987. *Empirical methods for predicting eutrophication in impoundments. Report 4, Phase III: Application manual.* Technical report E-81-9. Vicksburg, MS: U.S. Army Corps of Engineers, Waterways Experiment Station.

———. 1999. *Simplified procedures for eutrophication assessment and prediction: User manual*. Instruction Report W-96-2. Washington, DC: U.S. Army Corps of Engineers.

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	Lake Gem
Waterbody type(s)	Lake
WBID	Lake Gem (WBID 2997V) (see **Figure 1.1** of this report)
Description	Lake Gem is located in Orange County. The northern portion of Lake Gem's watershed is located in the City of Maitland, while the southeast and eastern portions of the watershed are located in the City of Winter Park. The lake and its surrounding watershed cover an area of 110 acres. The surface area of Lake Gem is 8 acres, with an average depth of 6.6 feet. Commercial and services is the predominant land use in the Lake Gem Watershed, with 44.27 % coverage. **Chapter 1** of this report describes the Lake Gem system in more detail.
Specific location (latitude/longitude or river miles)	The center of Lake Gem is located at N: 28°36'47.0"/W: 81°22'06.0." The site-specific criteria apply as a spatial average for the lake, as defined by WBID 2997V.
Map	**Figure 1.1** shows the general location of Lake Gem 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	Lake Gem is a low-color, high-alkalinity lake. 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 1.05 to 1.91 mg/L, and TP of 0.03 to 0.09 mg/L.
Proposed TN, TP, chlorophyll *a*, and/or nitrate + nitrite concentrations (magnitude, duration, and frequency)	Numeric interpretations of the narrative nutrient criterion: For Lake Gem, the 3-year rolling average TN and TP loads are 1,120 and 66 lbs/yr, respectively. Nutrient concentrations are provided for informational purposes only. The in-lake TN and TP AGM concentrations for Lake Gem at the allowable TMDL loading are 0.78 and 0.04 mg/L, respectively, not to be exceeded more than once in any consecutive 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 2007 to 2013 for Lake Gem. The primary datasets for this period include water quality data from IWR Run 56, NOAA Online Weather Data, Orange County Water Atlas, and 2013–16 SJRWMD land use coverage. **Sections 2.3** and **4.4** of this report describe 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 2007–13 period for Lake Gem. The periods for the lake included wet and dry years. Long-term average rainfall for the Lake Gem Watershed was 51 in/yr from 1980 to 2018. 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 Lake Gem. 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 Lake Gem (WBID 2997V). During the Cycle 3, Group 2 assessment, the NNC were used to assess Lake Gem during the verified period (January 1, 2007–June 30, 2014) based on data from IWR Run 50. Lake Gem was found to be verified impaired for chlorophyll *a* 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 low-color, high-alkalinity lakes. Based on the available information, there is nothing unique about Lake Gem 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 Lake Gem nutrient TMDLs, DEP created loading-based criteria using the PLSM to simulate loading from the 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 3-year rolling averages of TN and TP loadings for Lake Gem, 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 provides a more detailed description of 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 Lake Gem that may be related to nutrients (such as 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	Lake Gem is connected to a larger lake, Park Lake (WBID 2997U), which connects to Lake Maitland (WBID 2997C) via Park Lake Outlet (WBID 2997T). These downstream waterbodies do not have water quality impairments for nutrients or DO. Therefore, Lake Gem's nutrient load reductions will likely further protect these downstream waterbodies by decreasing algal biomass and the associated nutrients.
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.	Orange County, SJRWMD, and DEP conduct routine monitoring of Lake Gem. 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 Lake Gem 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.