CENTRAL DISTRICT • MIDDLE ST. JOHNS RIVER BASIN

Final TMDL Report

Nutrient TMDLs for Bear Gully Lake (WBID 3009)

and Documentation in Support of the Development of Site-Specific Numeric Interpretations of the Narrative Nutrient Criterion

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March 2018

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Executive Summary

Bear Gully Lake is located in unincorporated Seminole County, Florida. The waterbody was identified as impaired for nutrients based on an elevated annual average Trophic State Index value and was added to the 303(d) list by Secretarial Order on May 27, 2004, as the segment with waterbody identification (WBID) number 3009. Total maximum daily loads (TMDLs) for total nitrogen (TN) and total phosphorus (TP) have been developed, and supporting information for the TMDLs is listed below in **Table EX-1**. These 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 Bear Gully Lake

Type of Information	Description
Waterbody name/ WBID number	Bear Gully Lake/WBID 3009
Hydrologic Unit Code (HUC) 8	03080101
Use classification/ Waterbody designation	Class III/Fresh
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 May 27, 2004.
TMDL pollutants	TN and TP
TMDLs and site-specific interpretations of the narrative nutrient criterion	**Chlorophyll *a*:** 20 micrograms per liter (µg/L), expressed as an annual geometric mean (AGM) concentration not to be exceeded more than once in any consecutive 3-year period. **TN:** 23,166 pounds per year (lbs/yr), expressed as a 7-year average load not to be exceeded. **TP:** 1,387 lbs/yr, expressed as a 7-year average load not to be exceeded.
Load reductions required to meet the TMDLs	A 20 % TN reduction and an 18 % TP reduction to achieve a chlorophyll *a* target of 20 µg/L.

Acknowledgments

This analysis could not have been accomplished without significant contributions from staff in the Florida Department of Environmental Protection (DEP) Office of Watershed Services, Watershed Assessment Section, Standards Development Section, Water Quality Restoration Program, Central Regional Operation Center, and Watershed Evaluation and TMDL Section; and Seminole County. DEP would like to acknowledge Rob Renk and Shannon Wetzel of Seminole County for the substantial field support provided.

Map production assistance was provided by Andrew Morris.

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Chapter 1: Introduction

1.1 Purpose of Report

This report presents the total maximum daily loads (TMDLs) developed to address the nutrient impairment of Bear Gully Lake, located in the Middle St. Johns Basin. The TMDLs will also constitute the site-specific numeric interpretation of the narrative nutrient criterion set forth in Paragraph 62-302.530(90)(b), Florida Administrative Code (F.A.C.), that will replace the otherwise applicable numeric nutrient criteria (NNC) in Subsection 62-302.531(2), F.A.C., for this particular waterbody, pursuant to Paragraph 62-302.531(2)(a), 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 that was adopted by Secretarial Order on May 27, 2004.

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 achieve compliance 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 Bear Gully Lake that would restore the waterbody so that it meets its 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] 03080101) into watershed assessment polygons with a unique waterbody identification (WBID) number for each watershed or surface water segment. Bear Gully Lake is WBID 3009.

Bear Gully Lake is located in southern Seminole County, Florida (**Figure 1.1**). The surface area of the lake is 137 acres, and the average depth is 5 feet (ft), with a maximum depth of 20 ft. The normal pool topographic elevation of the water surface is 47.5 ft above sea level based on the North American Vertical Datum of 1988 (NAVD 88) (Seminole County 2017).

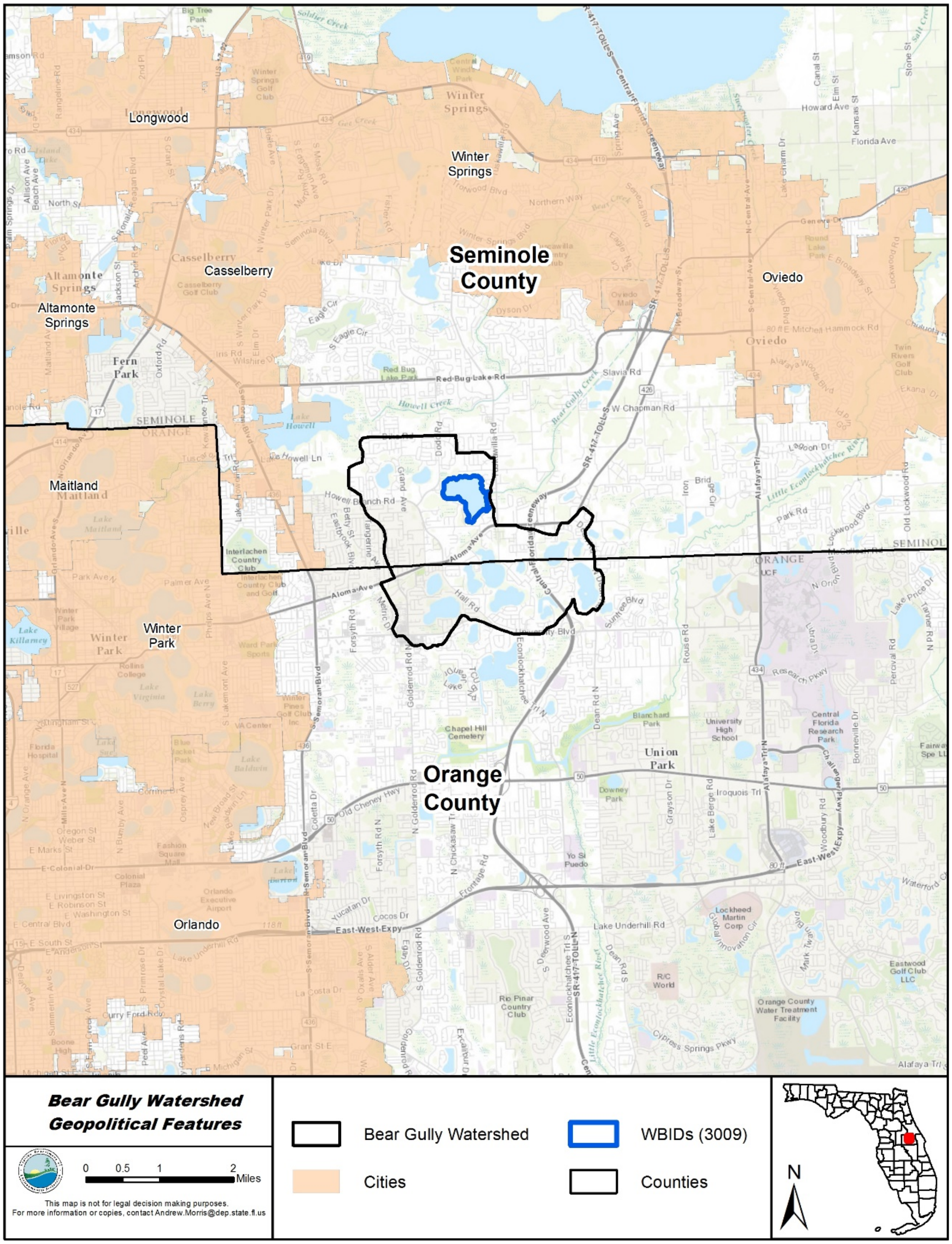

Figure 1.1. Location of Bear Gully Lake (WBID 3009) in Seminole County and major hydrologic and geopolitical features in the area

1.3 Site-Specific Information

1.3.1 Population and Geopolitical Settings

Bear Gully Lake and its drainage basin span 3,850 acres. The lake and the northern portion of the drainage basin are situated in southern, unincorporated Seminole County. The southern portion of the Bear Gully Lake Watershed is located in Orange County, and a smaller portion of the watershed lies within the boundary of Goldenrod, a census-designated place. State Road (SR) 417 and SR 426 are major transportation corridors that run through the watershed. The watershed is included in the Greater Orlando urbanized area, and the predominate land use is medium-density residential. The population density, based on 2010 U.S. Census Block Groups, is 8,603 persons per square mile (U.S. Census Bureau 2017).

1.3.2 Topography

Bear Gully Lake is located in the Orlando Ridge Lake Region (75-21), which consists primarily of urbanized karst area with low relief and elevations ranging from 75 to 120 ft (Griffith et al. 1997). The elevation of the Bear Gully Lake Watershed ranges from 50 ft immediately adjacent to the lake to more than 90 ft on the western boundary of the watershed. The average slope of the watershed is 4.3 %.

The drainage system created by the topography of the Bear Gully Lake Watershed generates a significant amount of inflow from 2 tributaries that enter the lake on the southern and northwestern boundaries of the lake. The southern inflow originates from a system of more than 20 urban lakes that extend into Orange County. A smaller system of interconnected waterbodies contributes to the inflow entering Bear Gully Lake on the northwestern side. The lake drains to Bear Gully Creek at its outlet on the eastern side of the lake. The Bear Gully Lake Watershed is part of the larger Howell Creek Watershed, which discharges north into Lake Jesup and eventually the St. Johns River.

1.3.3 Hydrogeological Setting

The hydrogeological context of Bear Gully Lake includes the topography discussed in the preceding section, along with soil geology, aquifer/groundwater interactions with surface water, and climate. Each of these factors helps to define the inflows and outflows that characterize the Bear Gully Lake Watershed.

The primary soils, based on the National Cooperative Soil Survey, belong in Hydrologic Soil Groups A, A/D, and B/D. Group A soils are sandy to loamy and are associated with a low runoff potential and high infiltration rates. Group B soils are silty to loamy and are moderately drained, and soils in Group D are often greater than 40 % clay and have a high runoff potential. Soils classified in dual hydrologic groups (A/D and B/D) have Type A and B soil characteristics when unsaturated but behave like Type D soil when saturated.

Table 1.1 lists the soil hydrologic groups in the Bear Gully Lake Watershed and their corresponding acreages. Based on the soil characteristics shown in **Figure 1.2**, soils in the watershed are mostly well drained to moderately drained. The hydrologic characteristics of soil can significantly influence the capability of a watershed to hold rainfall or produce surface runoff, and these characteristics are factors in the calculation of soil storage described in **Section 5.3.1.2**.

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

Soil Hydrologic Group	Acreage	% Acreage
A	1,843	47.91
A/D	994	25.84
B/D	102	2.65
Unclassified	908	23.60
Total	**3,847**	**100.00**

The aquifer in Seminole County is composed of beds of sand and shell in the lower part of the deposits of Pliocene and late Miocene Age, the permeable parts of the Hawthorn Formation, and limestone formations of middle and late Eocene Age (Barraclough 1962). Groundwater interactions are through simultaneous groundwater seepage and aquifer recharge in Bear Gully Lake. The downward migration of water in deeper portions of the lake into intermediate aquifer layers occurs at the same time as groundwater moving into the lake above confining layers (Environmental Research and Design [ERD] 2010). The lake bottom elevation is approximately 48 ft NAVD 88, which is about the same elevation as the potentiometric head of the Upper Floridan aquifer.

Bear Gully Lake is in a humid subtropical climate zone, with hot and humid summers, mild winters, and a defined rainy season from June through September. The annual average air temperature, based on data collected from 2003 to 2014 from a weather station located at Orlando International Airport, was 22° C. The summer maximum temperature was 37° C, and the winter minimum temperature -3° C. Long-term average annual rainfall, based on the Doppler radar–converted rainfall data for the period from 2003 through 2014, provided by the St. Johns River Water Management District (SJRWMD), was 51 inches/year (in/yr).

The area is subject to the periodic influence of tropical cyclones. The 2004 Florida hurricane season saw 3 hurricanes pass within 100 miles of Bear Gully Lake (Charley, Frances, and Jeanne), with Charley passing less than 10 miles away. Additionally, during the 2005 through 2008 and 2012 hurricane seasons, at least one named tropical storm or tropical depression came within 100 miles of Bear Gully Lake each year. These storms were close enough to influence weather patterns in the Bear Gully Lake Watershed during the modeling period.

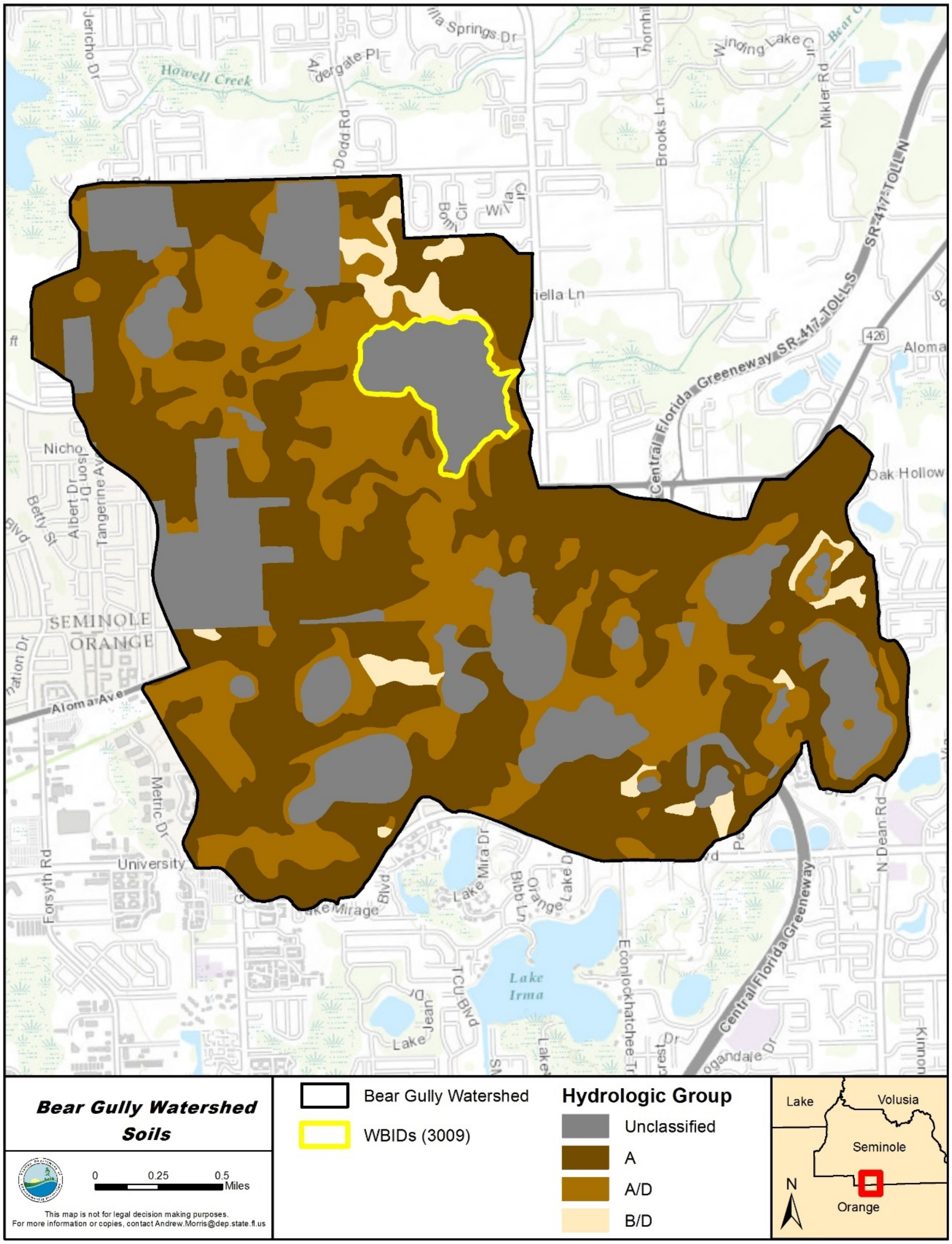

Figure 1.2. Hydrologic soil groups in the Bear Gully Lake Watershed

Chapter 2: Applicable Water Quality Standards and 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. (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 and Numeric Interpretation of the Narrative Nutrient Criterion

Bear Gully 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 this water is Florida's nutrient criterion in Paragraph 62-302.530(90)(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 on October 27, 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. Using this methodology and data from IWR Database Run 52, Bear Gully Lake is classified as a high-color (>40 PCU) lake, as shown in **Table 2.1**, and is considered high alkalinity (>20 mg/L $CaCO_3$). However, alkalinity is not a factor in determining the applicable NNC for high-color lakes.

Table 2.1. Bear Gully Lake long-term geometric means for color and alkalinity for the period of record

Parameter	Long-Term Geometric Mean	Number of Samples
Color (PCU)	45	59
Alkalinity (mg/L $CaCO_3$)	27	76

The chlorophyll *a* NNC for high-color 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 the AGM for chlorophyll *a* exceeds the values in the table for the lake type, then the applicable numeric interpretations for TN and TP are the minimum values in the table. **Table 2.2** lists the NNC for Florida lakes specified in Subparagraph 62-302.531(2)(b)1., 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 Total 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

Data providers for Bear Gully Lake include Seminole County, Florida LakeWatch, DEP Central Regional Operating Center (ROC), and DEP Watershed Evaluation and TMDL Section (WET), with the majority of the available data coming from LakeWatch monitoring. **Table 2.3** summarizes the data providers and their corresponding stations.

Table 2.3. Bear Gully Lake data providers

Sampling Station	Data Provider Name	Activity Begin Date	Activity End Date
21FLSCES150003	Seminole County	1982	1988
21FLSEM BGU	Seminole County	1999	2016
21FLKWATSEM-BEARGULL-1	Florida LakeWatch	1990	2012
21FLKWATSEM-BEARGULL-2	Florida LakeWatch	1997	2009
21FLKWATSEM-BEARGULL-3	Florida LakeWatch	1997	2009
21FLCEN 20010997	DEP (CD)	2007	2007
21FLCEN 20010998	DEP (CD)	2007	2007
21FLCEN 20010999	DEP (CD)	2007	2007
21FLCEN 20011000	DEP (CD)	2007	2007
21FLCEN 20011001	DEP (CD)	2007	2007
21FLWET WETG2001	DEP (WET)	2015	2016
21FLWET WETG2002	DEP (WET)	2015	2016
21FLWET WETG2003	DEP (WET)	2015	2016
21FLWET WETG2004	DEP (WET)	2015	2016

From 1990 to 2012 (excluding 2011), LakeWatch (21FLKWAT) sampled the lake 4 times a month at 3 stations. Seminole County (21FLSCES and 21FLSEM) sampled the lake between 1982 and 2016 (excluding 1987 and 1989–98) for approximately 4 months out of the year at 2 stations. The DEP CD sampled quarterly at 4 stations (21FLCEN) in Bear Gully Lake in 2007. The DEP WET sampled the lake (21FLWET) for 1 month in 2015 and for 3 months in 2016 as a part of a 1-year, quarterly lake study. **Figure 2.1** shows the sampling locations.

Data collected from the DEP Central ROC, and Seminole County were used in the calibration of the EFDC and WASP models, which were used to simulate the hydrodynamics and water quality in Bear Gully Lake and are discussed in further detail in **Chapter 5**.

The individual water quality measurements discussed in this report are available in the IWR Database Run 52 and are available on request. Water quality results for the period of record for variables relevant to this TMDL analysis, collected by all sampling entities, are available on request.

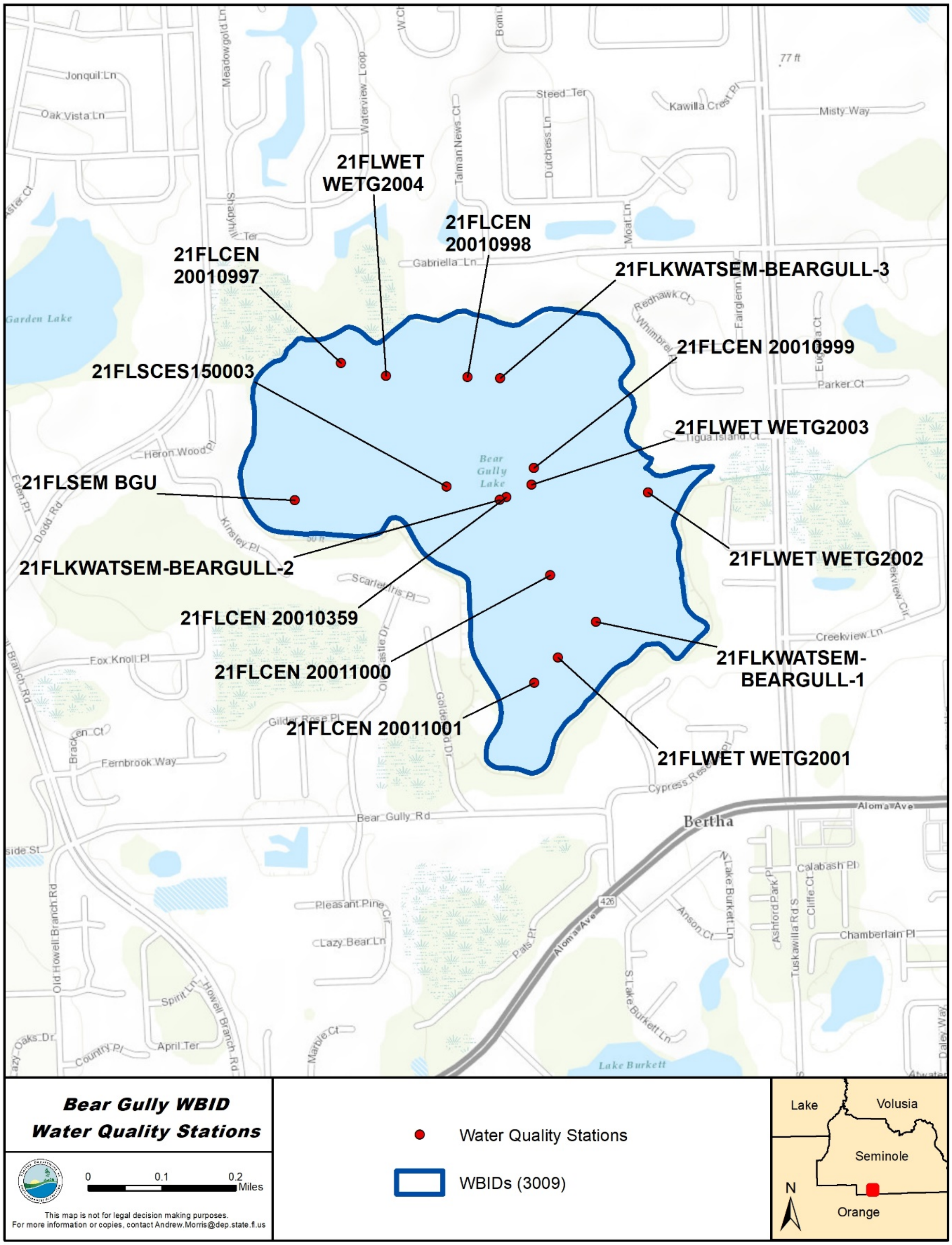

Figure 2.1. Monitoring stations in Bear Gully Lake

2.3.2 Water Quality Trends for Bear Gully Lake

When establishing a nutrient TMDL for any system, it is important to determine the degree to which stressor and response variables are related to appropriately model the impact of nutrients on algal growth and anthropogenic eutrophication, as measured by chlorophyll *a* response. Water quality trends for chlorophyll *a*, TN, and TP were analyzed using data collected during the modeling period for the development of these TMDLs. The model period was 2003 through 2014, and information on how these data were used in the calibration and validation of the model can be found in the final Bear Gully Lake model report (Tetra Tech 2017b). The TN, TP, and chlorophyll *a* AGMs were used in this trend evaluation to be consistent with the expression of the adopted NNC for lakes.

The DEP CD began collecting corrected chlorophyll *a*, the more common form of chlorophyll *a* used in assessing surface water quality, in 2007, and Seminole County began routinely collecting corrected chlorophyll *a* in 2009. Prior to that, uncorrected chlorophyll *a (*chlorophyll *a* with no correction for pheophytin interference) was collected. Pheophytin is a common degradation product of chlorophyll *a* and can interfere with the determination of chlorophyll *a* because these pigments absorb light in the same spectral region as chlorophyll *a*. As a result, chlorophyll a is overestimated when uncorrected for pheophytin.

As seen in **Figure 2.2**, the AGMs of uncorrected chlorophyll *a* have higher ranges than those of the corrected chlorophyll *a* values. Uncorrected chlorophyll *a* AGMs ranged from 29 to 92 µg/L, and a linear trend of the data indicated a positive slope. Corrected chlorophyll *a* AGMs ranged from 14 to 27 µg/L, and a linear trend of the data indicated a negative slope. The AGMs for TN ranged from 1.17 to 3.24 mg/L, and the slope of the linear trend indicated a slightly positive slope (**Figure 2.3**). The AGMs for TP ranged from 0.04 to 0.07 mg/L and had a slightly negative slope (**Figure 2.4**). While these slopes were not statistically significant, the inclination of the slopes provide a generalized assessment of the trends for the data in the more recent years.

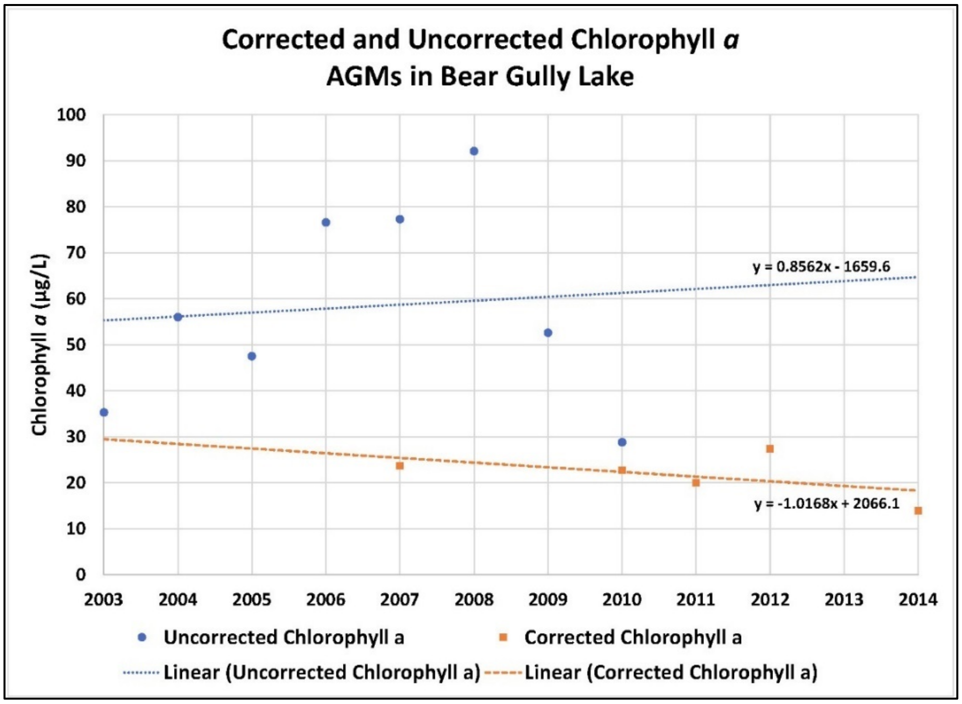

Figure 2.2. Corrected and uncorrected chlorophyll *a* AGMs in Bear Gully Lake

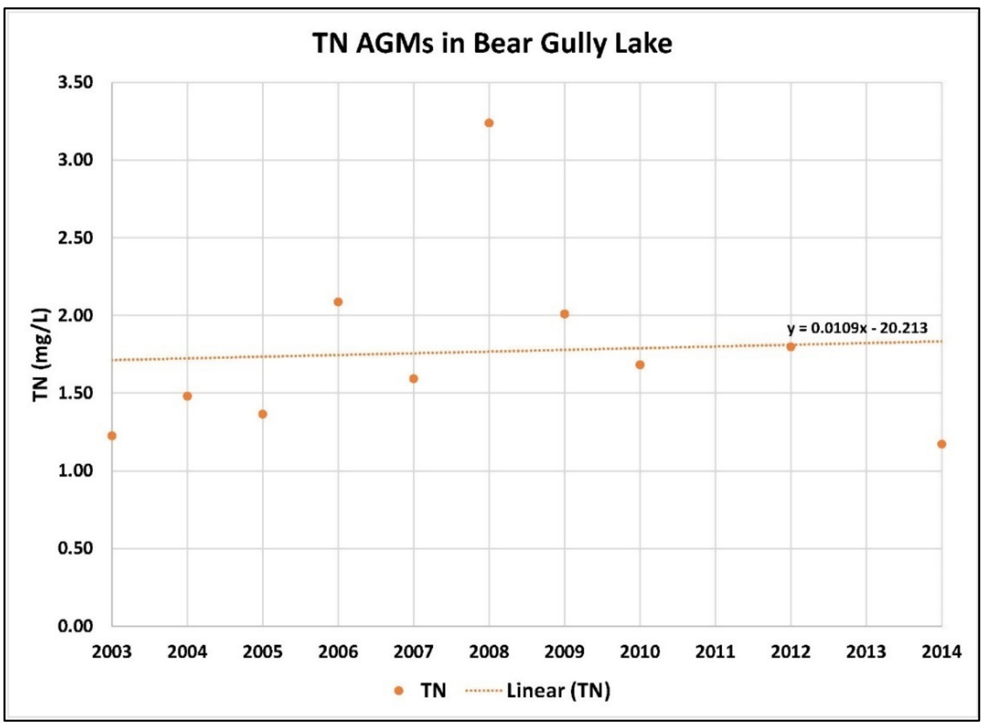

Figure 2.3. TN AGMs in Bear Gully Lake

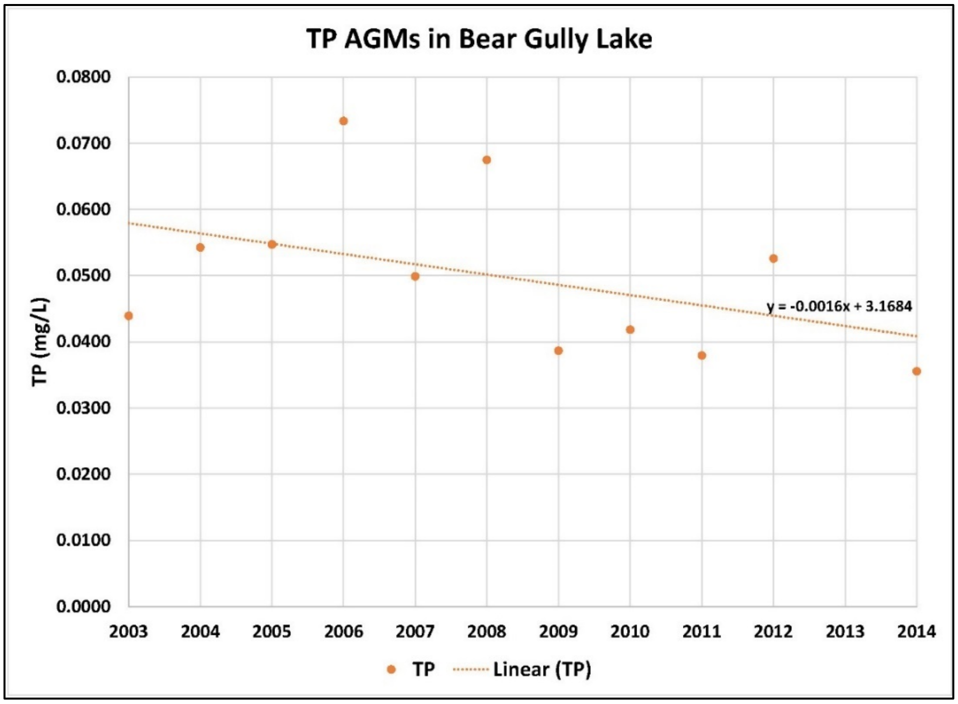

Figure 2.4. TP AGMs in Bear Gully Lake

Simple linear regression analyses were performed to detect relationships between the nutrients (TN and TP) and the response variable (chlorophyll *a*). **Figures 2.5** through **2.8** show the relationships between both uncorrected and corrected chlorophyll *a* AGMs and the TN and TP AGMs. TN exhibited moderately strong and significant relationships with uncorrected chlorophyll *a* ($R^2 = 0.52$, p value < 0.05) and corrected chlorophyll *a* ($R^2 = 0.96$, p value < 0.05). Uncorrected chlorophyll *a* exhibited a strong and significant positive relationship with TP ($R^2 = 0.72$, p value < 0.001), and the relationship between corrected chlorophyll *a* and TP was also strong and statistically significant ($R^2 = 0.81$, p value < 0.05). These observations suggest that with a lowering of the in-lake nutrient concentrations, chlorophyll *a* concentrations will likewise decrease.

DEP also collected phytoplankton samples for phytoplankton enumeration and water quality characterization quarterly from October 2015 to July 2016 at Stations 21FLWETG2001 (BG01), 21FLWETG2002 (BG02), 21FLWETG2003 (BG03), and 21FLWETG2004 (BG04), as shown in **Figure 2.1**. **Figures 2.9** through **2.12** show community composition results, by phylum, at the 4 lake sites during the quarterly sampling events. The overall community was dominated by cyanobacteria (blue-green algae), representing no less than 50 % of the community at all 4 sites during each sampling event. Dominance in algal groups varies naturally throughout the year, but the prolonged dominance of cyanobacteria may be associated with a higher risk for harmful algal blooms. The taxonomic results identified 2 nitrogen-fixing blue-green algae, *Aphanizomenon sp*. and *Cylindrospermopsis sp*., present at each site during every sampling event. The species were found in relatively low numbers, but their presence in a cyanobacteria-dominated lake indicates a possibility of nitrogen fixation in Bear Gully Lake.

Appendix D contains graphs of the results of select water quality analyses and physical parameters. The results indicate that during the study the lake was relatively well mixed across its spatial extent, and water column stratification was minimal. However, nutrient concentrations were elevated and dissolved oxygen (DO) was depressed at the bottom depth of Site BG02 compared with contemporaneous results at the remaining sites during the April 27, 2016 survey.

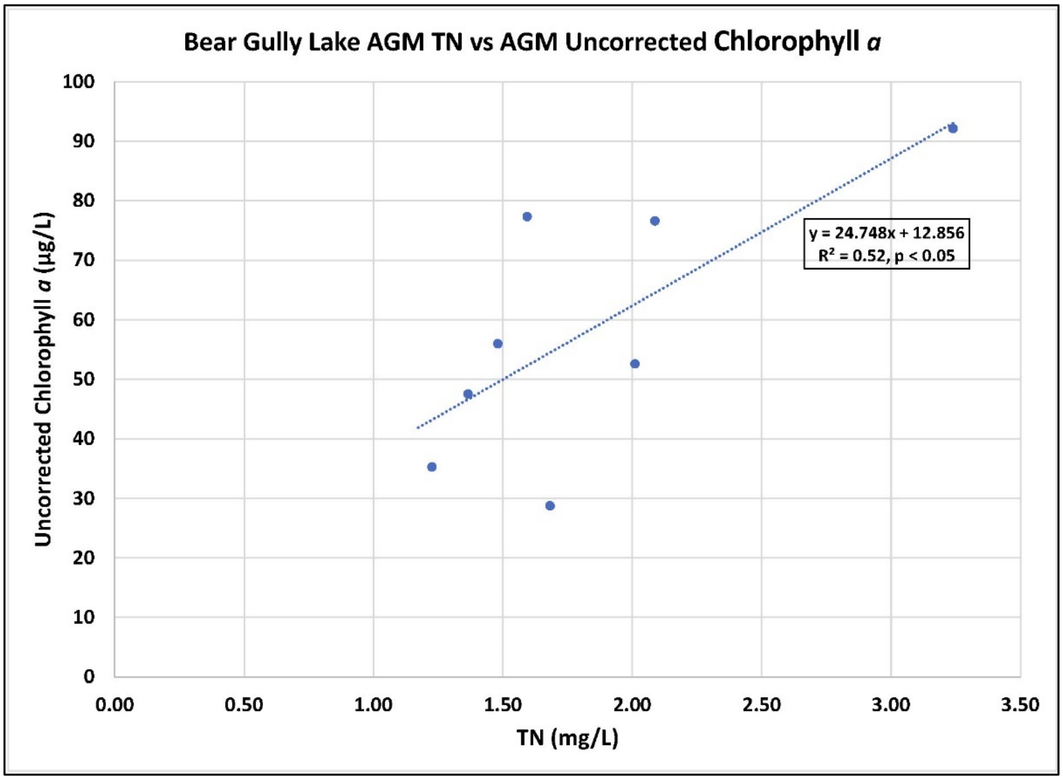

Figure 2.5. Bear Gully Lake AGM TN vs. AGM uncorrected chlorophyll *a*

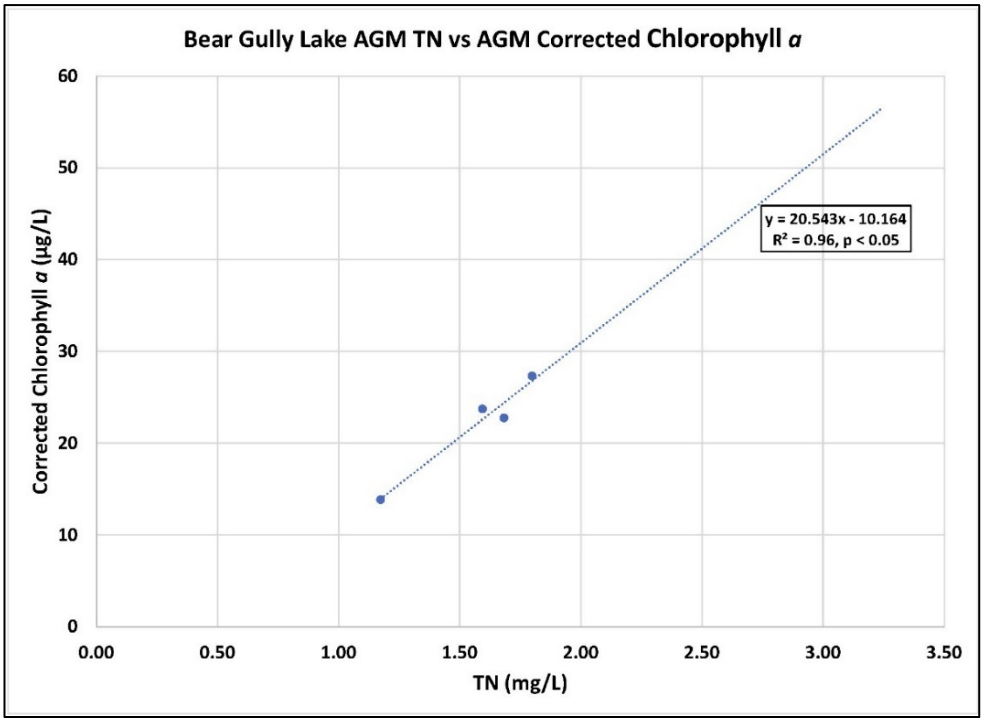

Figure 2.6. **Bear Gully Lake AGM TN vs. AGM corrected chlorophyll *a***

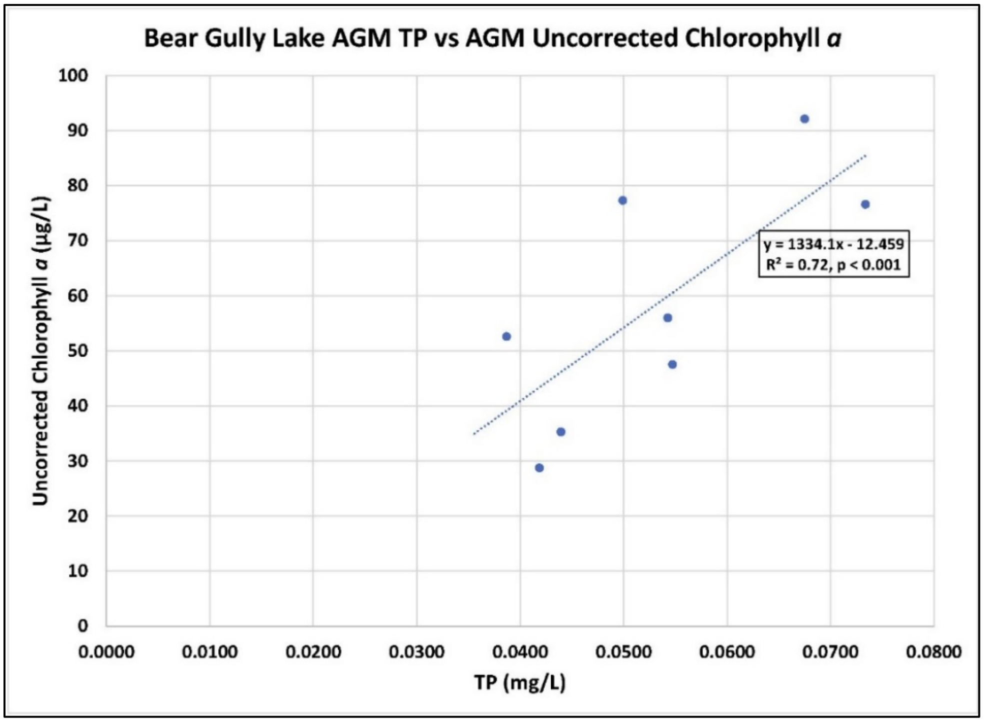

Figure 2.7. **Bear Gully Lake AGM TP vs. AGM uncorrected chlorophyll *a***

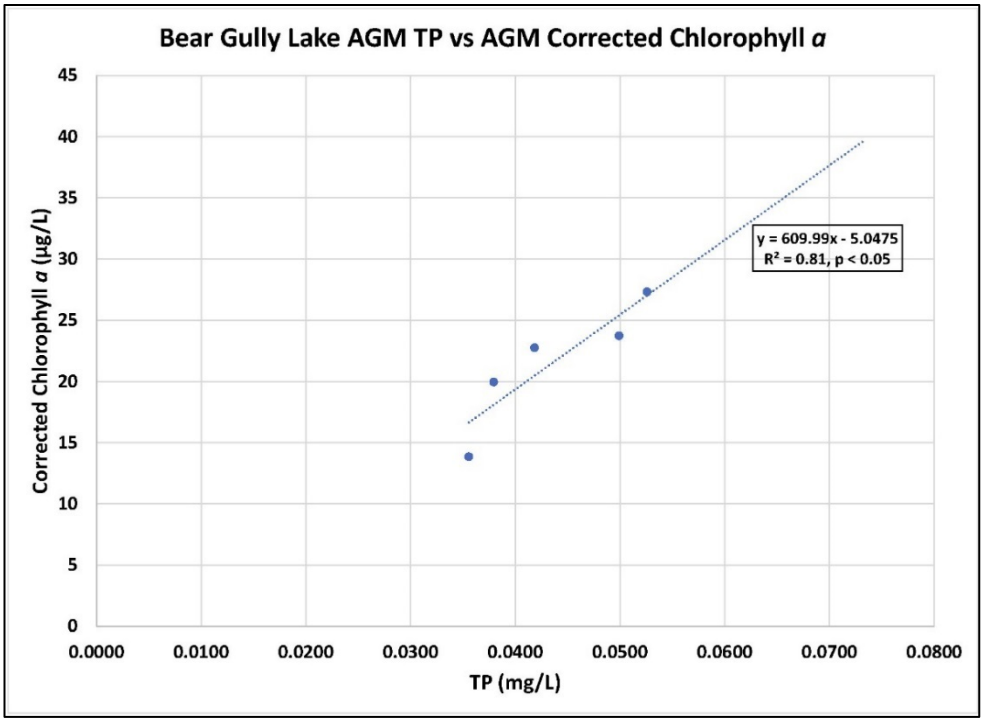

Figure 2.8. **Bear Gully Lake AGM TP vs. AGM corrected chlorophyll *a***

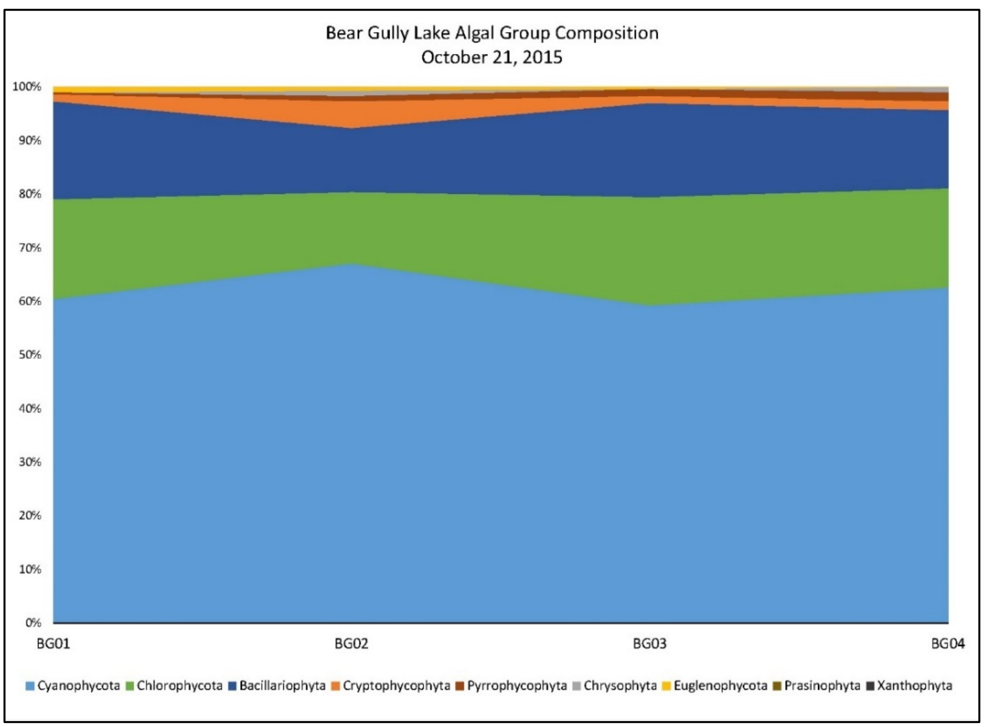

Figure 2.9. **Algal group composition in Bear Gully Lake on October 21, 2015**

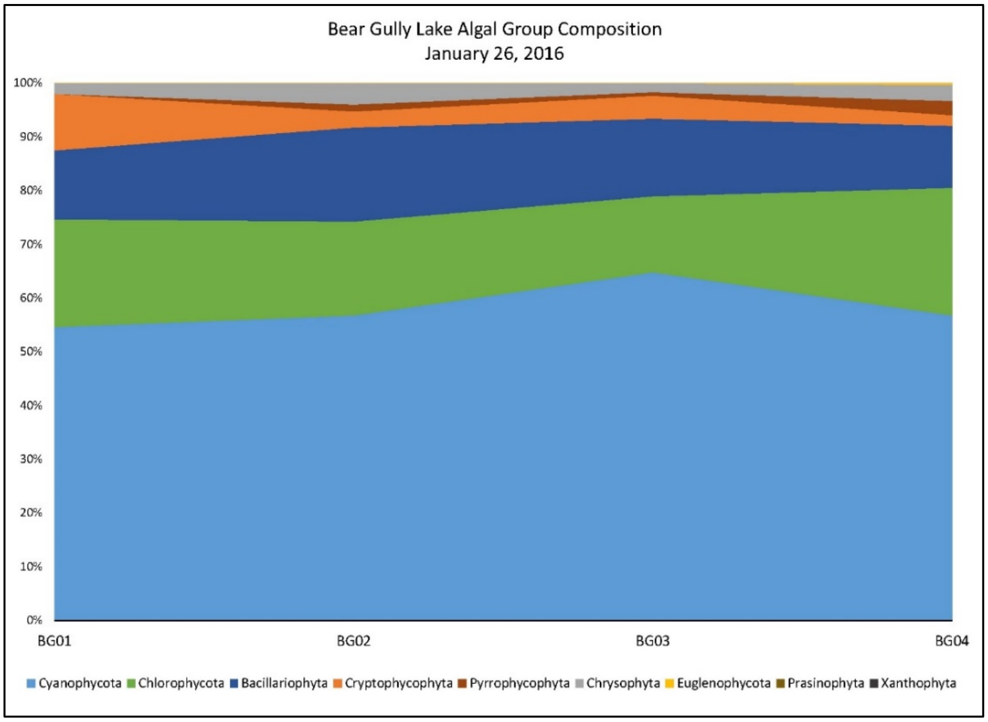

Figure 2.10. Algal group composition in Bear Gully Lake on January 26, 2016

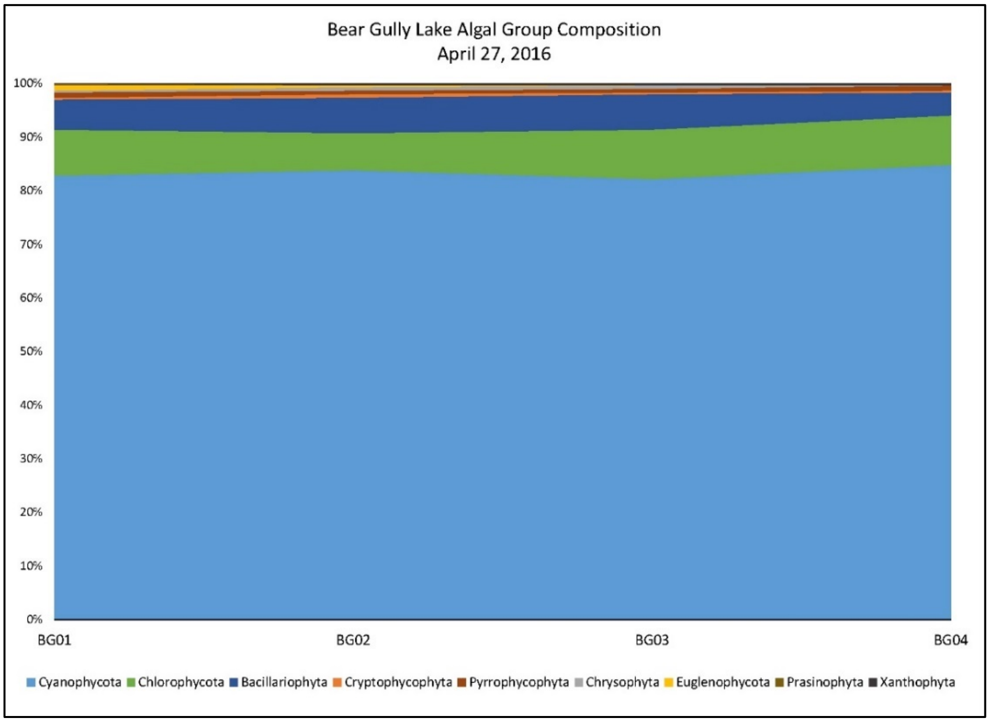

Figure 2.11. Algal group composition in Bear Gully Lake on April 27, 2016

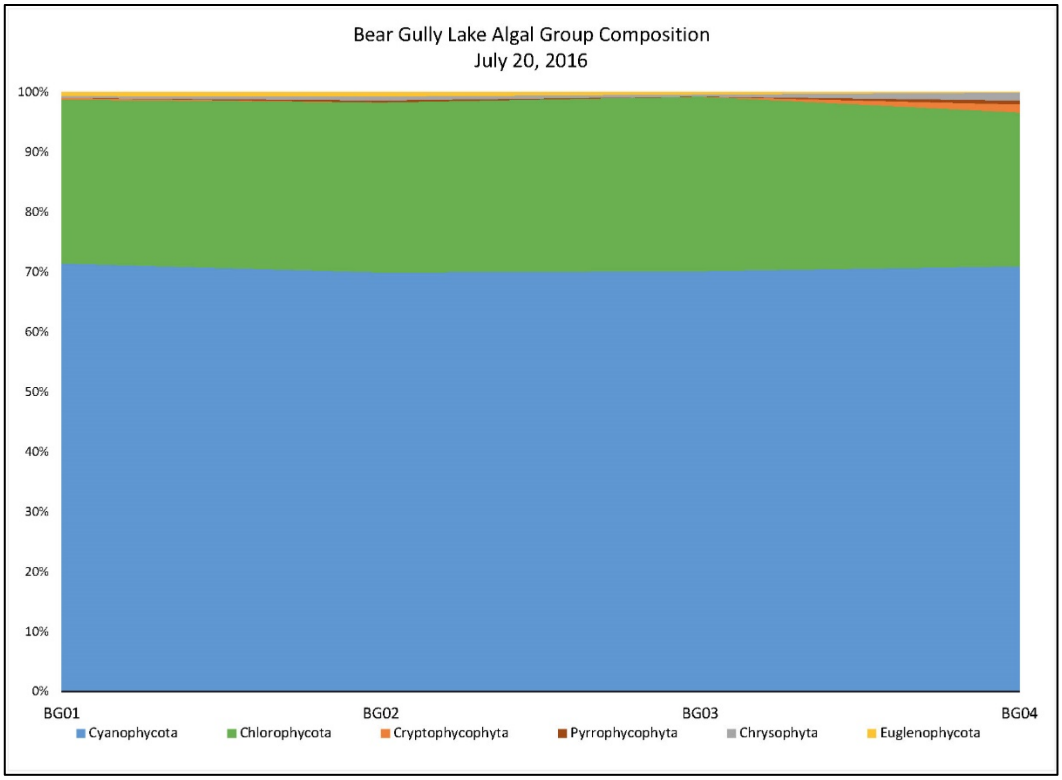

Figure 2.12. Algal group composition in Bear Gully Lake on July 20, 2016

2.3.3 Information on Verified Impairment

Prior to the adoption of the NNC, DEP used the IWR Database to assess water quality impairments in WBID 3009 based on annual average Trophic State Index (TSI). The TSI thresholds were set based on annual mean color, where high-color lakes (> 40 platinum cobalt units [PCU]) had a TSI threshold of 60, and lower color lakes (≤ 40 PCU) had a TSI threshold of 40. Exceeding the TSI threshold in any 1 year of the verified period was sufficient to identify a lake as impaired for nutrients.

At the time the Cycle 1 assessment was performed, WBID 3009 was classified as a high-color lake and the TSI threshold of 60 was exceeded in 1999–2002, identifying the waterbody as impaired for nutrients. In the Cycle 2 verified period (January 2001–June 2008), Bear Gully was classified as a low-color lake, and the lake remained on the Verified List because it's annual mean TSI value exceeded the impairment threshold of 40 in 2001, 2002, and 2007. It should be noted that the Cycle 2 classification as a low-color lake was based on the lowest annual average color value during the assessment period (2007), which has been identified as a drought year. Therefore, the color was likely lower than typical ambient conditions. The long-term geometric mean for color, as seen in **Table 2.1**, provides a better assessment of the overall color regime for Bear Gully Lake.

In 2012, the IWR was amended to incorporate the NNC. Under the revised methodology, lakes are assessed for chlorophyll *a*, TN, and TP as individual parameters, and the TSI is no longer used. At the time of the Group 2 Cycle 3 assessments, Group 2 waterbodies that were previously determined to be impaired for TSI were placed into Category NA Delist (Not Applicable) per Rule 62-720(2)(l), F.A.C. and removed from the Verified List of impaired waters through the Delist List that was adopted by Secretarial Order on April 27, 2016.

During the Cycle 3 assessment, the NNC were used to assess the lake during the verified period (January 1, 2007–June 30, 2014) based on data from IWR Database Run 50. Bear Gully Lake was found to be impaired for chlorophyll *a* (Category 5) because the AGMs exceeded the NNC more than once in a three-year period (2010 and 2012), and the waterbody was added to the 303(d) list for chlorophyll *a*. It was placed on the Planning List (Category 3c) for TN for further investigation and was found not to be impaired (Category 2) for TP. **Table 2.4** lists the AGM values for chlorophyll *a*, TN, and TP during the 2007 to 2014 verified period.

Table 2.4. Bear Gully 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 for lakes. 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	**24**	1.24	0.03
2008	ID	ID	ID
2009	ID	ID	ID
2010	**23**	ID	0.03
2011	20	ID	0.04
2012	**27**	**1.30**	0.04
2013	ID	ID	ID
2014	ID	ID	ID

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

3.1 Rulemaking History for the Site-Specific Interpretation

The nutrient TMDLs presented in this report, upon adoption into Chapter 62-304.505, F.A.C., will constitute the site-specific numeric interpretation of the narrative nutrient criterion set forth in Paragraph 62-302.530(90)(b), F.A.C., that will replace the otherwise applicable NNC in Subsection 62-302.531(2), F.A.C., for this particular waterbody, pursuant to Paragraph 62-302.531(2)(a), F.A.C. **Table 3.2** lists the elements of the nutrient TMDL that constitute the site-specific numeric interpretation of the narrative nutrient criterion. **Appendix B** summarizes the relevant details to support the determination that the TMDLs provide for the protection of Bear Gully Lake and 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 Target Selection

The development of the generally applicable lake NNC was based on the selection of a protective chlorophyll *a* criterion and then evaluation of the relationship between chlorophyll *a* and TN and TP to develop TN and TP concentrations protective of designated uses (DEP 2012). Based on several lines of evidence, DEP developed a chlorophyll *a* criterion of 20 µg/L for high-color lakes (above 40 PCU) and clear lakes with alkalinity above 20 mg/L $CaCO_3$. Since DEP has demonstrated that the chlorophyll *a* criterion of 20 µg/L is protective of designated uses and maintains a balanced aquatic flora and fauna, this value will be used as the water quality target to address the nutrient impairment of Bear Gully Lake, because Bear Gully Lake is a high-color lake. There is no information suggesting that Bear Gully Lake differs from the lakes used as reference for the development of the NNC, and therefore DEP has determined that the generally applicable NNC criteria for high-color lakes is the most appropriate site-specific chlorophyll *a* criterion. The TN and TP loads identified as the site-specific TN and TP standards were determined by using models to determine watershed TN and TP loadings that will achieve the chlorophyll *a* criterion of 20 µg/L.

3.3 Numeric Expression of Target

The TN and TP targets for Bear Gully Lake were established using the modeling approach discussed in detail in **Chapter 5**. This approach links the yearly watershed TN and TP loading simulation to the in-lake chlorophyll *a*, TN, and TP concentration simulation for 2003 through 2014.

The simulated relationship between in-lake AGM concentrations of chlorophyll *a*, TN, and TP and incoming TN and TP loads was used to derive a distribution of yearly TN and TP loads necessary to meet the target chlorophyll *a* criterion of 20 µg/L in Bear Gully Lake in every year. **Section 5.6** discusses in more detail the method used to derive these loading values.

A 7-year rolling average was applied to the distribution of yearly TN and TP loads, and the maximum of the resulting 7-year averages of TN and TPs loads were chosen as the site-specific interpretations of the narrative nutrient criterion pursuant to Paragraph 62-302.530(90)(b), F.A.C. The 7-year average TN and TP target loads necessary to meet the chlorophyll *a* criterion of 20 µg/L (TMDL condition) are 23,166 and 1,387 pounds per year (lbs/yr), respectively (**Table 3.1**).

Table 3.1. Bear Gully Lake TMDL condition nutrient loads

Note: Values shown in boldface type and shaded cells indicate the maximum of the seven-year rolling averages and the seven annual loads corresponding to the maximum seven-year rolling average.

Year	TMDL Condition TN Loads (lbs/yr)	Lagging 7-Year Rolling Average TN Loads (lbs/yr)	TMDL Condition TP Loads (lbs/yr)	Lagging 7-Year Rolling Average TP Loads (lbs/yr)
2003	23,468		1,386	
2004	**28,387**		**1,756**	
2005	**28,942**		**1,749**	
2006	**15,859**		**932**	
2007	**16,062**		**898**	
2008	**26,294**		**1,605**	
2009	**23,072**	23,155	**1,352**	1,383
2010	**23,546**	**23,166**	**1,414**	**1,387**
2011	22,330	22,301	1,333	1,326
2012	18,886	20,864	1,072	1,229
2013	16,082	20,896	912	1,226
2014	24,591	22,114	1,427	1,302

These nutrient loads shall be expressed as a seven-year annual average loads not to be exceeded, and the chlorophyll *a* concentration shall be expressed as an AGM concentration not to be exceeded more than once in any consecutive 3-year period. **Table 3.2** summarizes the chlorophyll *a* concentration and the TMDL loads for TN and TP.

Table 3.2. Site-specific interpretations of the narrative nutrient criterion

Note: TN,TP, and Chlorophyll *a* shall not be exceeded more than once in any consecutive 3-year period.

WBID	AGM Chlorophyll *a* (µg/L)	7-Year Annual Average TN (lbs/yr)	7-Year Annual Average TP (lbs/yr)
3009	20	23,166	1,387

The TN and TP concentrations necessary for restoration are presented for informational purposes only and represent the simulated in-lake TN and TP concentrations corresponding to the target chlorophyll *a* concentrations of 20 µg/L. The TN and TP restoration concentrations for Bear Gully Lake are AGM concentrations of 0.83 and 0.05 mg/L, respectively, and are provided for comparative purposes only. The TMDL loads expressed in **Table 3.2** will be considered the site-specific interpretation of the narrative criterion.

3.4 Downstream Protection

As discussed in **Section 1.3.2**, an outlet on the eastern side of Bear Gully Lake discharges into Bear Gully Creek, which flows into the Howell Creek system, which discharges north into Lake Jesup and eventually into the St. Johns River.

Bear Gully Creek (WBID 2999) flows into Howell Creek below Lake Howell (WBID 2297), both of which are Class III freshwater streams in the Peninsular Stream Nutrient Region for NNC criteria. The applicable nutrient criteria for these stream systems are 0.12 mg/L of TP, 1.54 mg/L of TN, and 20 µg/L of chlorophyll *a*, expressed as AGMs not to be exceeded more than once in any three-year period. During the most recent Cycle 3 assessment period for the Group 2 basins, the chlorophyll *a* AGMs did not exceed 20 µg/L in any year for both Bear Gully Creek and Howell Creek. The TN AGMs did not exceed the TN numeric nutrient threshold in any year during the assessment period for either stream, and the TP AGMs did not exceed the TP numeric nutrient threshold for streams in any year during the assessment period for Howell Creek. Additionally, there was available Stream Condition Index (SCI) data which indicated that Howell Creek supported a healthy biological community. TP AGMs did exceed the TP numeric nutrient threshold for streams more than once in a three-year period during the assessment period in Bear Gully Creek, and the waterbody was added to the Study List for continued monitoring. Biological monitoring results from several surveys taken during the Cycle 3 verified period and in more recent years indicate that there are no floral imbalances and there is healthy fauna in WBID 2999. DEP has determined that if the data show biological health is fully supported in a stream, it may be concluded that the associated nutrient regime is inherently protective of the waterbody, and the stream numeric nutrient standard is achieved (DEP 2013b). Additional data will continue to be collected to confirm the biological health of the streams during the Cycle 4 assessment period, which ends on June 30, 2019.

The Lake Jesup nutrient TMDL (Gao 2006) required a 50 % reduction in nitrogen and a 34 % reduction in phosphorus loads from the entire Lake Jesup watershed, which corresponds to TN, TP, and chlorophyll *a* concentrations of 1.32 mg/L, 0.094 mg/L, and 30.5 µg/L. The TN and TP concentrations that correspond to the TN and TP loads for Bear Gully Lake are of 0.83 and 0.05 mg/L, respectively, and the target chlorophyll *a* concentration is 20 µg/L. Since the restoration concentrations for Bear Gully Lake are lower than the nutrient targets for the Lake Jesup TMDL, the Bear Gully Lake TMDL nutrient reductions meet or exceed the reduction goals set forth by the Lake Jesup TMDL. The TN and TP loads from Bear Gully Lake will be protective of the nutrient conditions in the downstream waters.

Based on these assessment results, as evidenced by the healthy existing conditions in the downstream receiving water, the existing nutrient loads from Bear Gully Lake to Bear Gully Creek and Howell Creek have not led to an impairment of the downstream water and are not preventing downstream waters from attaining its designated uses and maintaining a balanced aquatic flora and fauna. Additionally, the Bear Gully Lake TMDL nutrient reductions meet or exceed the reduction goals for the Lake Jesup TMDL. The reductions in nutrient loads described in this TMDL analysis are not expected to cause nutrient impairments downstream but will result in water quality improvements to downstream waters.

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 failing 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 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

When these TMDLs were being developed, no NPDES-permitted wastewater facilities that discharge to Bear Gully Lake were identified in the watershed.

4.2.2 Municipal Separate Storm Sewer System (MS4) Permittees

The Bear Gully Lake Watershed is covered by two NPDES MS4 Phase I permits (**Figure 4.1**) The stormwater collection systems owned and operated by Seminole County and the Florida Department of Transportation (FDOT) District 5 are covered by NPDES MS4 Phase I Permit

FLS000038, and Orange County and FDOT District 5 are co-permittees covered by Permit FL000011.

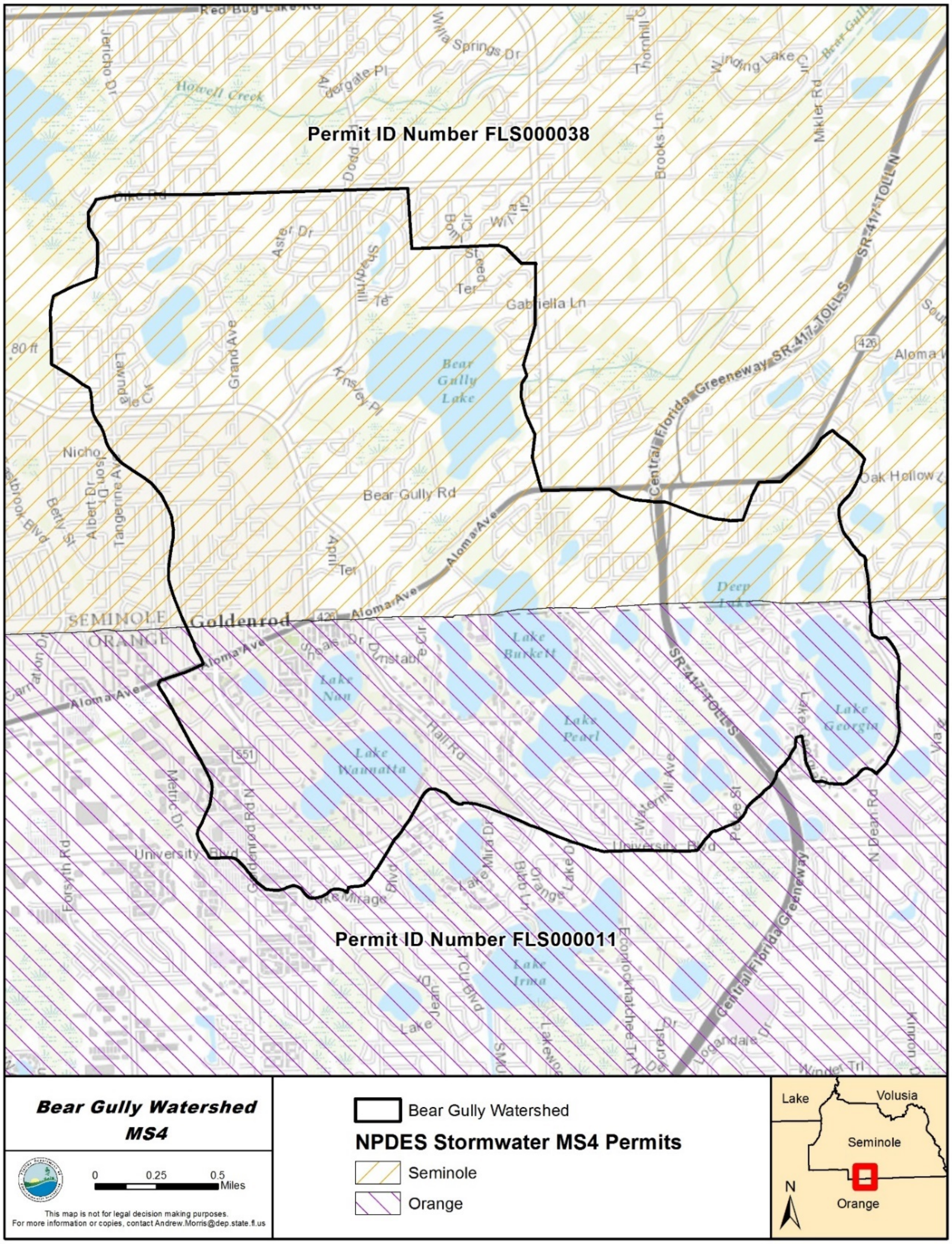

Figure 4.1.   NPDES MS4 permit coverage in the Bear Gully Lake Watershed

4.3 Nonpoint Sources

Pollutant sources that are not NPDES wastewater or stormwater dischargers are generally considered nonpoint sources. Nutrient loadings to Bear Gully Lake are primarily generated from nonpoint sources. Nonpoint sources addressed in this analysis primarily include loadings from surface runoff, groundwater seepage entering the lake, and precipitation directly onto the lake surface (atmospheric deposition).

4.3.1 Land Uses

Land use is one of the most important factors in determining nutrient loadings from the Bear Gully 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.

The land use information used in this analysis came from modeling for the Lake Jesup HSPF model done by Tetra Tech, and information on the method used to calculate land use nutrient loading rates for TN and TP can be found in the Lake Jesup modeling report, *Hydrology and Water Quality Modeling Report for the Lake Jesup Watershed, Florida* (Tetra Tech 2017a). The SJRWMD 2009 land use and land cover were used, and the land use classes in this coverage were grouped into 13 major categories, which were aggregated based on similarities in hydrologic properties and nutrient loads.

Table 4.1 lists the aggregated land use categories from the 2009 SJRWMD coverage and their corresponding acreages. The summary table shows wetlands as one land use type. However, in the HSPF model, Tetra Tech maintained the SJRWMD's representation of wetlands, and the wetland land use category is split into two subgroups to represent riparian (adjacent to streams or lakes) or nonriparian wetlands. The model also accounts for whether riparian wetlands are impacted or pristine. **Figure 4.2** shows the spatial distribution of different land use types in the Bear Gully Lake Watershed.

Based on **Table 4.1**, the total watershed area is 3,847 acres. The predominant land use type is medium-density residential, which covers 1,612 acres and accounts for 42 % of the total watershed area. The second largest land use type is water, which encompasses 612 acres and accounts for 16 % of the watershed. There are more than 20 urban lakes in the Bear Gully Lake Watershed. Overall, anthropogenic land uses, including all the residential, commercial, industrial, and agricultural areas, occupy 2,692 acres of the watershed and account for 70 % of the total watershed area. Among these human land use areas, 95 % are urban lands—including all the residential, commercial, industrial, and recreational areas. Thus, urban land is the predominant human land use in the Bear Gully Lake Watershed. Nutrient loading from urban areas is most often attributed to multiple sources, including stormwater runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from the improper disposal of waste materials, leaking septic systems, and domestic animals.

Table 4.1. 2009 SJRWMD land use in the Bear Gully Lake Watershed

Land Use	Acres	% of Contributing Area
Agriculture General	7	0
Agriculture Tree Crop	38	1
Forest	96	3
High-Density Residential	285	7
Industrial and Commercial	436	11
Low-Density Residential	222	6
Medium-Density Residential	1,612	42
Open Land	22	1
Pasture	92	2
Rangeland	66	2
Water	612	16
Wetland	359	9
Total	**3,847**	**100**

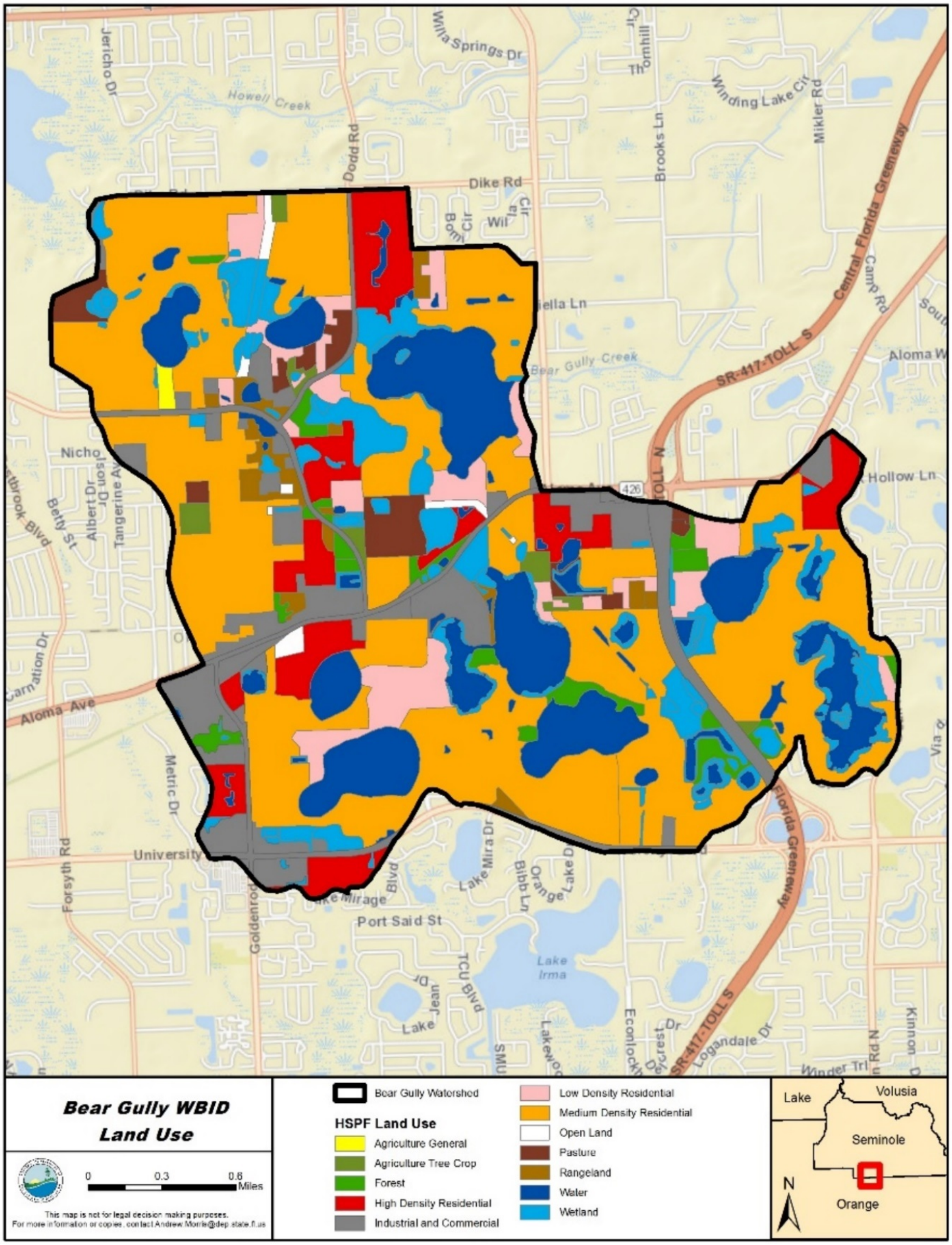

Figure 4.2. Land use in Bear Gully Lake Watershed

4.3.2 Onsite Sewage Treatment and Disposal Systems (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 OSTDS is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, however, OSTDS can be a source of nutrients (nitrogen and phosphorus), pathogens, and other pollutants to both groundwater and surface water.

Information on the location of septic systems was obtained from Seminole and Orange Counties. Based on these data, 2,061 OSTDS are still in operation in the Bear Gully Lake Watershed (**Figure 4.3**). As part of the Lake Jesup HSPF model update, Tetra Tech added representation of all septic systems in the watershed, both failing and properly functioning. The septic system loading was estimated using 2.8 people per household, which is the average number of people per household for the 2 counties based on U.S. Census Bureau data. Tetra Tech used an estimate of 70 gallons of water per day per person (EPA 2002). It was assumed that 15 % of the water used in the house never made it to the septic tank, and that it took an average of 60 days for the septic flow to reach a waterbody. A first-order decay rate was applied to each constituent to determine the concentration after 60 days. For phosphorus, it was assumed that 90 % was absorbed to sediment. Therefore, only 10 % of the effluent concentration was used to calculate decay after 60 days. Nonfailing septic system loads were developed into a direct input time series for each subwatershed.

The SJRWMD used Florida Department of Health (FDOH) data to determine that the number of annual system repairs ranged from 74 to 556 for Seminole County and 973 to 1,199 for Orange County from 2003 to 2012 (FDOH 2013). To account for the possibility that not all failing septic systems were reported and repaired, the high end of the reported ranges was used. Therefore, the estimated septic system failure rates for Seminole County and Orange County are 1.8 % (556 failures out of 30,730 septic tanks) and 1.6 % (1,199 failures out of 74,651 septic tanks), respectively. Both failing and functioning septic tanks were input into the model as point sources. The Lake Jesup modeling report includes the details on the septic system representation (Tetra Tech 2017a).

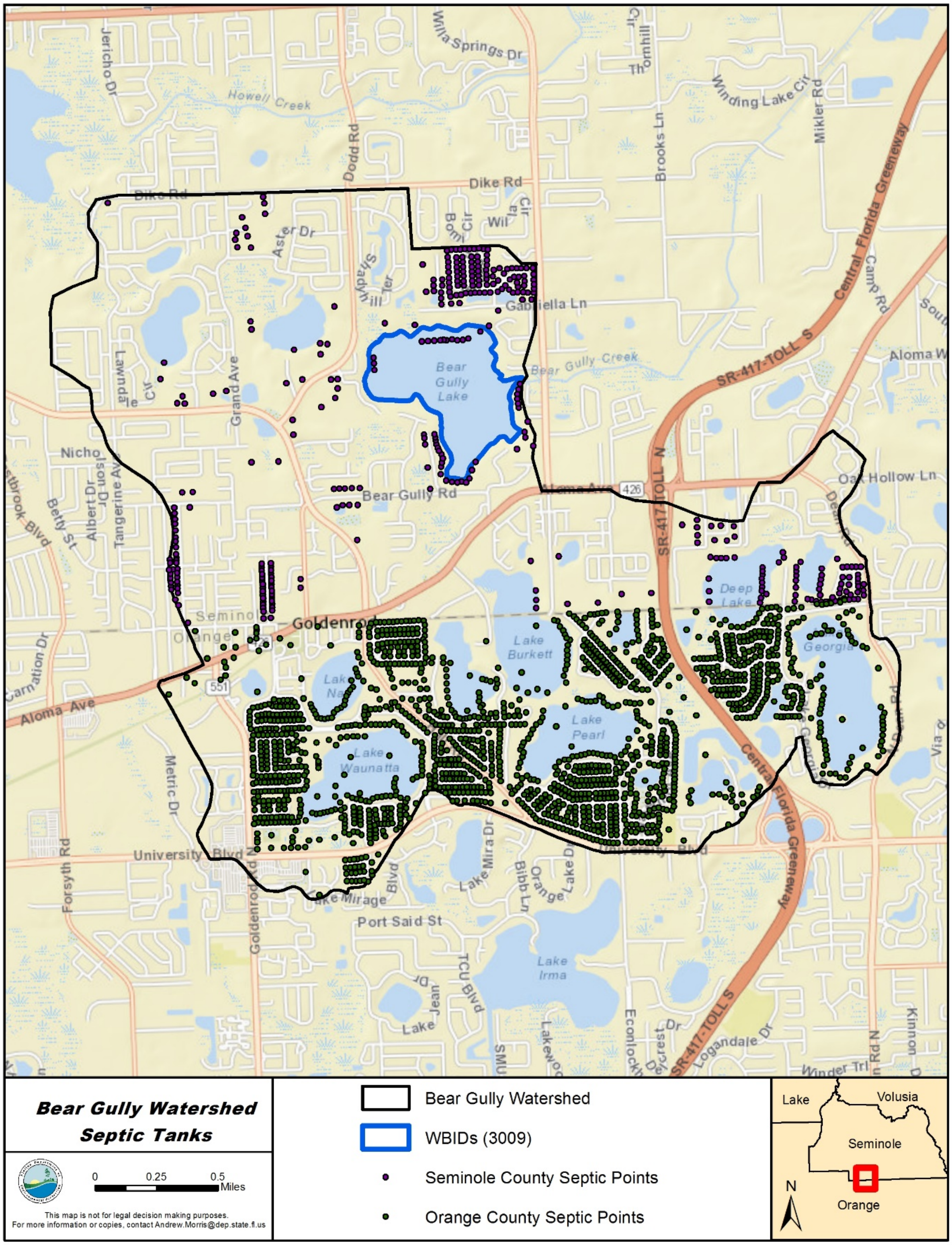

Figure 4.3. Remaining OSTDS (septic tanks) in Bear Gully Lake Watershed

4.3.3 Atmospheric Deposition

Nutrient loadings from the atmosphere are an important component of the nutrient budget in many Florida lakes. Nutrient delivery comes through two pathways: wet atmospheric deposition with precipitation and dry particulate-driven deposition. Atmospheric deposition to terrestrial portions of the Bear Gully Lake Watershed is assumed to be accounted for in the loading rates used to estimate the watershed loading from land. Loading from atmospheric deposition directly onto the water surface was also considered in the loading estimation.

The HSPF model assumes that atmospheric deposition only contributes inorganic forms of nitrogen and phosphorus. NH_4, NO_3, and PO_4 concentrations from wet deposition are set at 0.15 mg N/L, 0.74 mg N/L, and 0.04 mg P/L, respectively. These are the precipitation-weighted mean concentrations from Site FL32 of the National Atmospheric Deposition Program, located in Orange County. NH_4, NO_3, and PO_4 dry deposition rates are set at 37 mg N/m^2/yr, 149 mg N/m^2/yr, and 10 mg P/m^2/yr, respectively, based on the SJRWMD's dry deposition samples measured at Lake Lochloosa in Alachua County. The annual atmospheric deposition loadings are evenly allocated as monthly inputs in the HSPF model (Tetra Tech 2017b).

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 Bear Gully Lake and to identify the maximum allowable TN and TP loadings from the watershed, so that Bear Gully Lake will meet the TMDL targets and thus maintain its function and designated use as a Class III water.

5.2 Selection of Appropriate Tool

For this TMDL analysis, a calibrated model-based prediction was used to estimate the nutrient loads necessary to achieve an AGM chlorophyll *a* concentration of 20 µg/L in every year. The model period used, 2003 through 2014, encompasses the years with complete calendar years' worth of data in the most recent Cycle 3 assessment period (January 1, 2007–June 30, 2014).

Tetra Tech was contracted by DEP to update the Hydrologic Simulation Program – FORTRAN (HSPF) model for the Lake Jesup Watershed, which was originally setup and calibrated by the SJRWMD. Details about the modifications made to the HSPF model can be found in the Lake Jesup modeling report (Tetra Tech 2017a).

The Bear Gully Lake Subwatershed information from the larger Lake Jesup HSPF model was used in the development of the Bear Gully Lake TMDLs. In addition, Tetra Tech developed Environmental Fluid Dynamics Code (EFDC) and Water Quality Analysis Simulation Program (WASP) models for Bear Gully Lake to simulate in-lake hydrodynamics and water quality, respectively.

The HSPF model simulates the hydrology and water quality conditions in the watershed. The EFDC model simulates hydrodynamics, and the WASP model simulates water quality in Bear Gully Lake. The three models were used together to represent the watershed loading and the resulting conditions in Bear Gully Lake (Tetra Tech 2017b).

5.3 Estimating Point and Nonpoint Source Loadings

5.3.1 HSPF Watershed Loading Model

The HSPF model was used to estimate the nutrient loads within and discharged from the Bear Gully Lake Watershed. The Lake Jesup modeling report (Tetra Tech 2017a) describes the updates made to the Lake Jesup HSPF model. Several modifications were made to the HSPF model specifically for use in developing the TMDLs for Bear Gully Lake. Tetra Tech refined the existing model, including the delineation of the Bear Gully Lake Watershed into additional subwatersheds. The updated model delineation for the Bear Gully Lake Watershed was based on information provided by Seminole County. In the HSPF model, Bear Gully Lake is located in Lake Jesup Subbasin 42 and receives discharges from Subbasins 43 and 44, all of which make up the overall Bear Gully Lake Watershed (**Figure 5.1**).

The HSPF model allows DEP to interactively simulate and assess the environmental effects of various land use changes and associated land use practices. The model parameters (impact parameters) simulated for the Bear Gully Lake Watershed include water quantity (surface runoff, interflow, and baseflow), and water quality (TN, organic nitrogen, ammonia nitrogen, nitrogen oxides [NO_X], TP, organic phosphorus, orthophosphorus, phytoplankton as biologically active chlorophyll *a*, temperature, total suspended solids [TSS], DO, and ultimate carbonaceous biological oxygen demand [CBOD]). Datasets of land use, soils, topography and depressions, hydrography, flow data, septic tanks, water use pumpage, point sources, groundwater, atmospheric deposition, solar radiation, control structures, and rainfall (Tetra Tech 2017a) are used to calculate the combined impact of the watershed characteristics for a given modeled area on a waterbody represented in the model as a reach. Data from the Lake Jesup Watershed HSPF model (Subbasins 42 through 44) were used as inputs to the Bear Gully Lake EFDC and WASP models, as described in **Section 5.3.2**.

5.3.1.1 Meteorological Model Inputs

The meteorological data for the HSPF model include precipitation, potential evaporation, air temperature, wind speed, solar radiation, dew point temperature, and cloud cover. Precipitation data were obtained from the SJRWMD's Next-Generation Radar (NEXRAD) Doppler radar rainfall database, and these data are collected on a 2 x 2 kilometer grid. Potential evapotranspiration data and solar radiation data are taken from Geostationary Operational Environmental Satellites (GOES) datasets maintained by the U.S. Geological Survey (USGS). The GOES data are collected daily. Other meteorological data were obtained from the Orlando International Airport weather station and were downloaded from the Integrated Surface Database maintained by the National Oceanic and Atmospheric Administration (NOAA). **Table 5.1** summarizes the meteorological data used in the HSPF model.

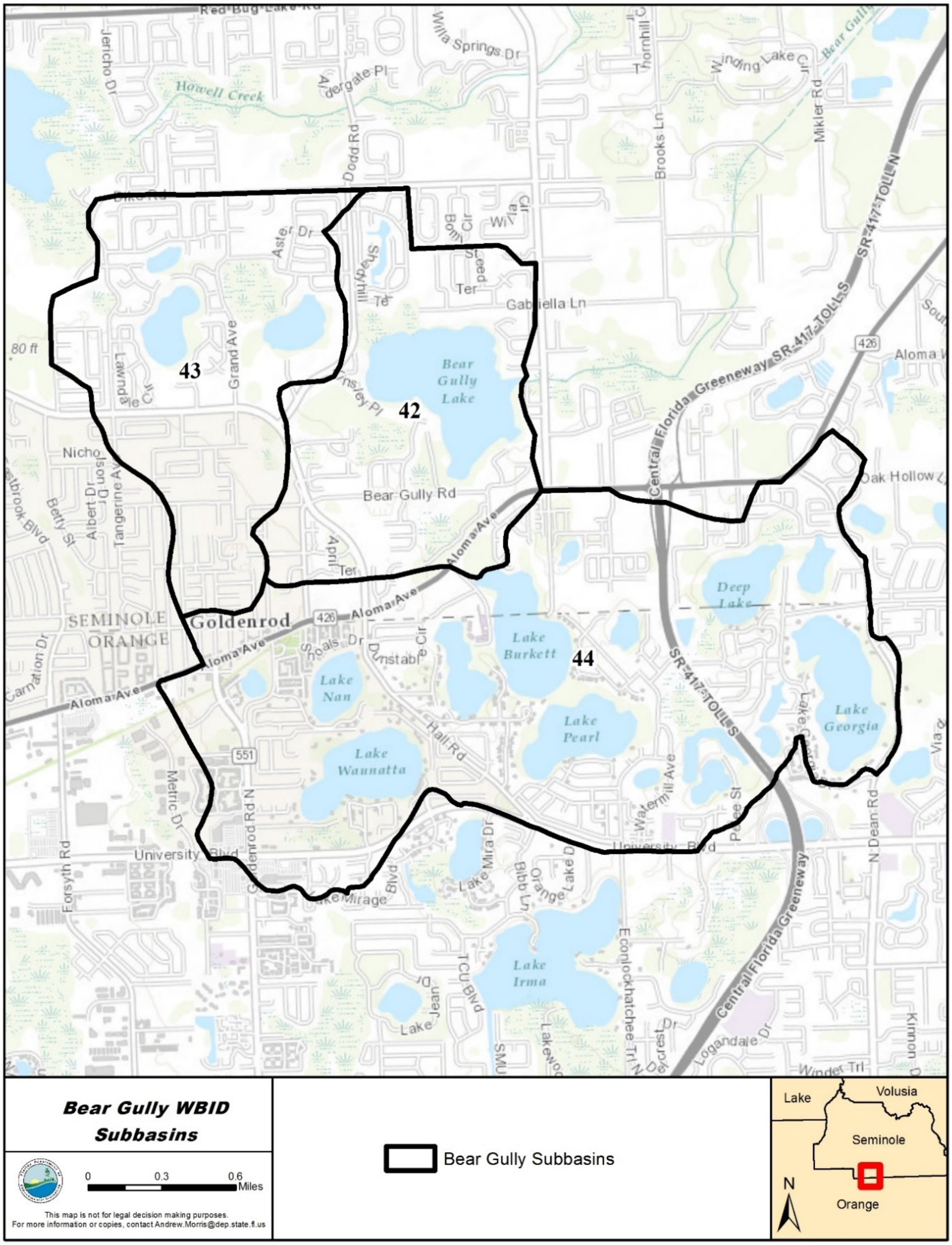

Figure 5.1. HSPF subbasins in Bear Gully Lake Watershed

Table 5.1. Meteorological data for the HSPF model

Data Type	Data Source	Description
Precipitation	SJRWMD	Doppler 2 x 2 km radar grid data
Potential Evaporation	USGS	GOES 2 x 2 km satellite grid data
Solar Radiation	USGS	GOES 2 x 2 km satellite grid data
Air Temperature	NOAA	Orlando International Airport gauge data
Wind Speed	NOAA	Orlando International Airport gauge data
Dew Point Temperature	NOAA	Orlando International Airport gauge data
Cloud Cover	NOAA	Orlando International Airport gauge data

5.3.1.2 Pervious Land Segments (PERLND) Module

The PERLND module of HSPF accounts for surface runoff, interflow, and groundwater flow (baseflow) from pervious land areas. For the purposes of modeling, the total amount of pervious tributary area was estimated as the total tributary area minus the impervious area.

HSPF uses the Stanford Watershed Model methodology as the basis for hydrologic calculations. This methodology calculates soil moisture and water flow between several different types of storage, including surface storage, interflow storage, upper soil storage zone, lower soil storage zone, active groundwater zone, and deep storage. Rain that is not converted to surface runoff or interflow infiltrates into the soil storage zones. Part of the infiltrated water is lost by evapotranspiration, discharged as baseflow, or lost to deep percolation (e.g., deep aquifer recharge).

In the HSPF model, water and wetland land uses were generally modeled as pervious land (PERLND) elements. Since these land use types are expected to generate more flow as surface runoff than other pervious lands, the PERLND elements representing water and wetlands were assigned lower values for infiltration rate (INFILT), upper zone nominal storage (UZSN), and lower zone nominal storage (LZSN).

The hydrology for large waterbodies (e.g., lakes) and rivers and streams that connect numerous lakes throughout the project area was modeled in reaches (RCHRES). For each subbasin containing a main stem reach, a number of acres were removed from the land use in PERLND that were modeled explicitly in RCHRES.

5.3.1.3 Impervious Land Segments (IMPLND) Module

The IMPLND module of HSPF accounts for surface runoff from impervious land areas (e.g., parking lots and highways). For the purposes of this model, each land use was assigned a typical percentage of impervious area, as shown in **Table 5.2**, based on the Lake Jesup HSPF model (Jia 2015).

Table 5.2. Percentage of imperviousness

Land Use Category	% Imperviousness
Low-Density Residential	5
Medium-Density Residential	10
High-Density Residential	35
Industrial Commercial	50

5.3.1.4 Waterbody (RCHRES) Module

The RCHRES module of HSPF conveys flow input from the PERLND and IMPLND modules, accounts for direct water surface inflow (rainfall) and direct water surface outflow (evaporation), and routes flows based on a rating curve supplied by the modeler. In each subbasin of each planning unit model, a RCHRES element was developed that defines the depth-area-volume relationship for the modeled waterbody.

The Bear Gully Lake bathymetry was based on the contour map provided by Seminole County (Seminole County 2017) (**Figure 5.2**). Tetra Tech created site-specific F-Tables for Bear Gully Lake using the bathymetric and lake-level data. The detailed F-Tables, in combination with the revised subwatershed delineations, allowed for a more refined water quantity and quality calibration for the lake.

5.3.1.5 Best Management Practices (BMP) Coverage

The BMP coverage used in the updated Lake Jesup HSPF model includes urban structural BMPs in the Lake Jesup Basin Management Action Plan (BMAP) from 2006 through May 31, 2013 (the end of the 2013 BMAP annual progress report period). The BMPs in the model include baffle boxes, inlet baskets, continuous deflective separation (CDS) units, swales, dry detention ponds, wet detention ponds, City of Orlando 100 % onsite retention, City of Orlando private BMPs, and lake drainage wells. For modeling purposes, these BMPs were grouped into 8 categories based on their pollutant removal efficiencies. In the Bear Gully Lake Watershed, 1,121 acres, or 29 % of the total watershed area of 3,847 acres, is treated by BMPs in the HSPF model. The Lake Jesup BMAP projects in the Bear Gully Lake Watershed include Hall Road improvements, Orange County Capital Improvements Plan (CIP) for Lake Wauntta, and Lake Ann baffle box.

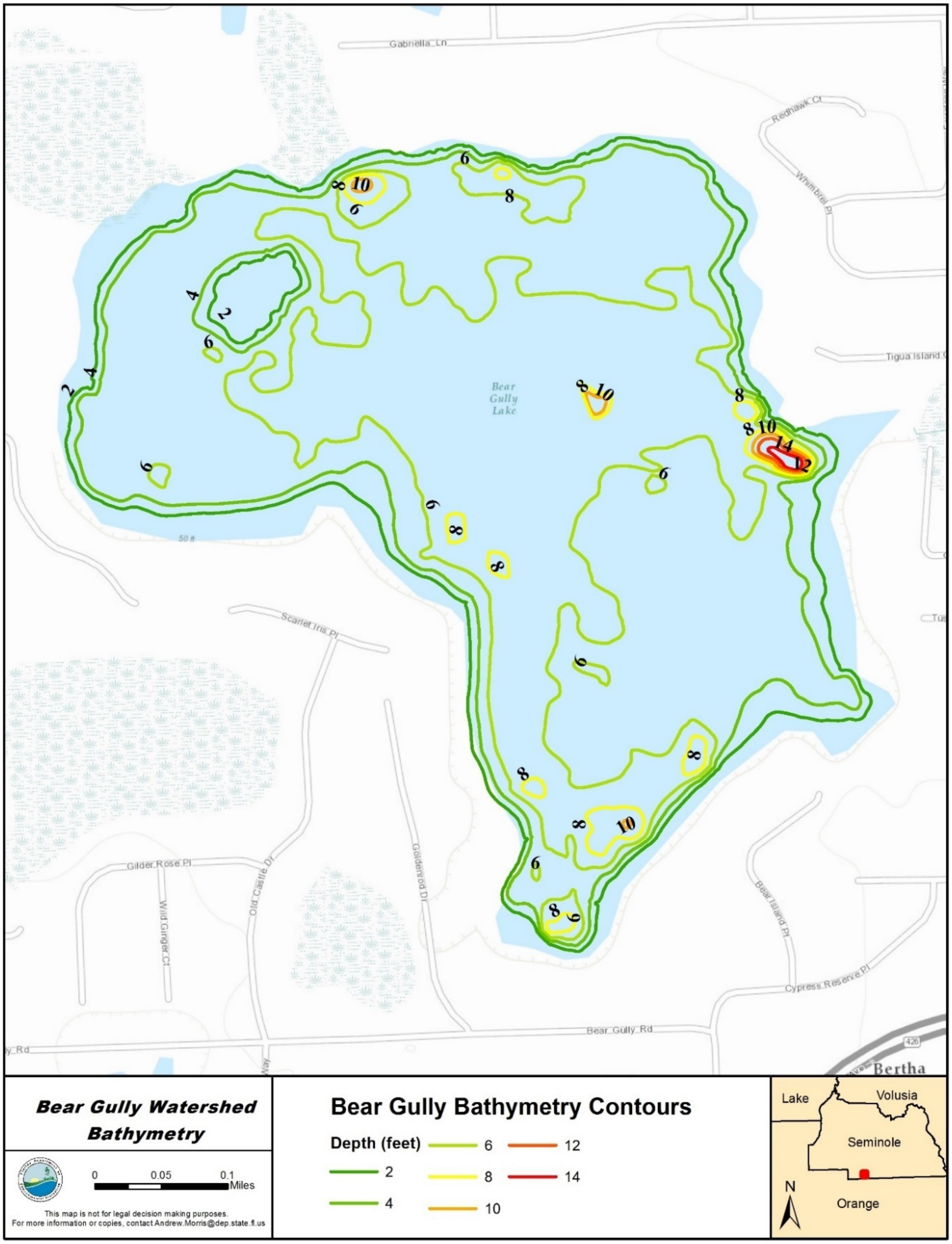

Figure 5.2. Bear Gully Lake bathymetry map

5.3.1.6 Nonpoint Source Loadings

Nonpoint source loads of TN and TP from different types of land use were estimated for the existing conditions in the Bear Gully Lake Watershed based on the HSPF PERLND and IMPLND flows and the corresponding simulated concentrations for each land use category. Literature land use nutrient loading rates for TN and TP represent "edge of field" values (Harper 1994; Soil and Water Engineering Technology [SWET] 2008). The estimated TN and TP loading coefficients for land use types were compared with literature values to make sure that the calibrated loading rates of TN and TP from each land use were reasonable.

Tables 5.3 and **5.4** show the annual average TN and TP loads from various sources to the lake. The averaged total incoming annual loads were 27,867 lbs/yr for TN and 1,608 lbs/yr for TP from the 12-year simulated period. Runoff from Subbasins 43 and 44 was collectively categorized as "Upstream Runoff" and discharged to Bear Gully Lake at a 12-year averaged annual TN load of 18,600 lbs and a TP load of 1,062 lbs, accounting for about 66 % of the total TN loads and about 65 % of the total TP loads to the lake during the simulation period (**Figures 5.3** and **5.4**). Runoff from Subbasin 42 was categorized as "Surface Runoff," as it contributes runoff directly to the lake, and accounted for only 7 % for TN and 9 % for TP of the total loads.

Table 5.3. Summary of TN loading to Bear Gully Lake by source and year

* Flows represent the portion of surface runoff and baseflow treated by BMPs.

Year	Upstream TN Loads (lbs/yr)	Surface Runoff TN Loads (lbs/yr)	Baseflow TN Loads (lbs/yr)	BMPs* TN Loads (lbs/yr)	Atmospheric Deposition TN Loads (lbs/yr)	Total TN Loads (lbs/yr)
2003	19,764	1,950	2,280	3,341	2,000	29,335
2004	24,498	2,381	2,158	3,732	2,715	35,484
2005	24,253	2,483	2,801	4,075	2,565	36,177
2006	12,277	1,612	1,221	3,079	1,634	19,824
2007	13,015	1,367	1,105	2,959	1,632	20,077
2008	22,558	2,308	1,767	3,789	2,446	32,868
2009	19,065	2,217	1,872	3,420	2,265	28,840
2010	19,455	2,411	1,835	3,719	2,012	29,432
2011	19,095	2,271	1,372	3,143	2,031	27,912
2012	15,569	1,790	1,224	3,220	1,804	23,607
2013	12,808	1,561	1,037	3,020	1,677	20,103
2014	20,837	2,332	1,431	3,922	2,216	30,739
Average	**18,600**	**2,057**	**1,675**	**3,452**	**2,083**	**27,867**

Table 5.4. Summary of TP loading to Bear Gully Lake by source and year

* Flows represent the portion of surface runoff and baseflow treated by BMPs.

Year	Upstream TP Loads (lbs/yr)	Surface Runoff TP Loads (lbs/yr)	Baseflow TP Loads (lbs/yr)	BMPs* TP Loads (lbs/yr)	Atmospheric Deposition TP Loads (lbs/yr)	Total TP Loads (lbs/yr)
2003	1,138	130	117	216	90	1,690
2004	1,493	172	111	243	122	2,141
2005	1,449	164	143	263	115	2,133
2006	677	117	63	207	73	1,137
2007	672	97	57	196	73	1,095
2008	1,347	162	91	248	110	1,957
2009	1,083	145	96	223	101	1,649
2010	1,134	162	94	243	90	1,724
2011	1,094	158	71	211	91	1,625
2012	835	120	63	209	81	1,307
2013	680	107	53	196	75	1,112
2014	1,144	164	74	259	99	1,740
Average	**1,062**	**141**	**86**	**226**	**93**	**1,608**

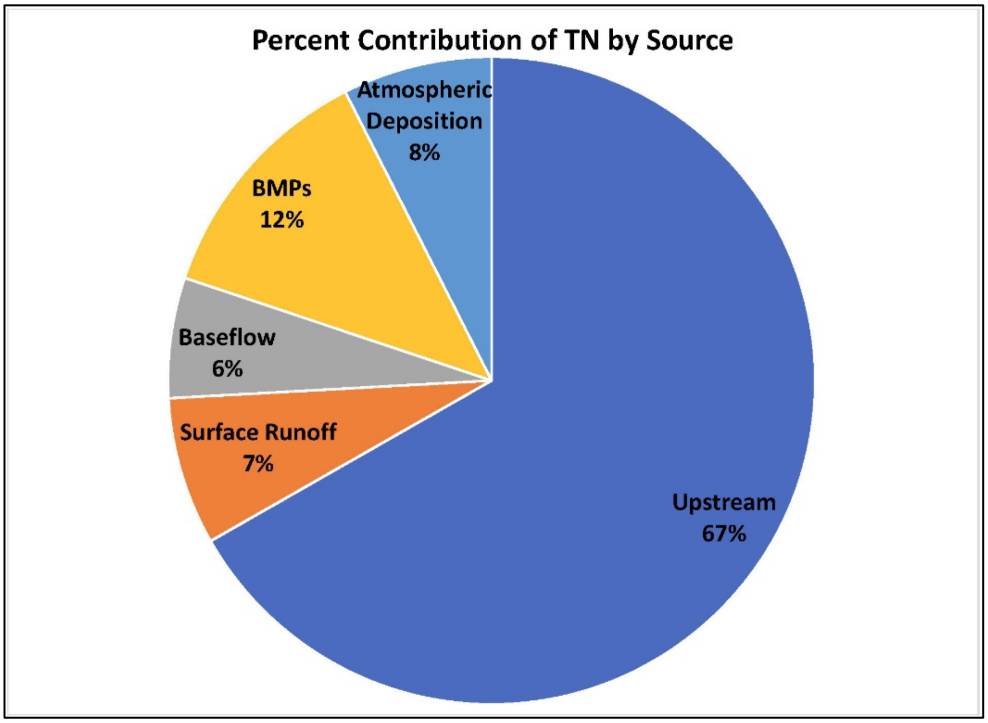

Figure 5.3. Percent TN contribution under the existing condition

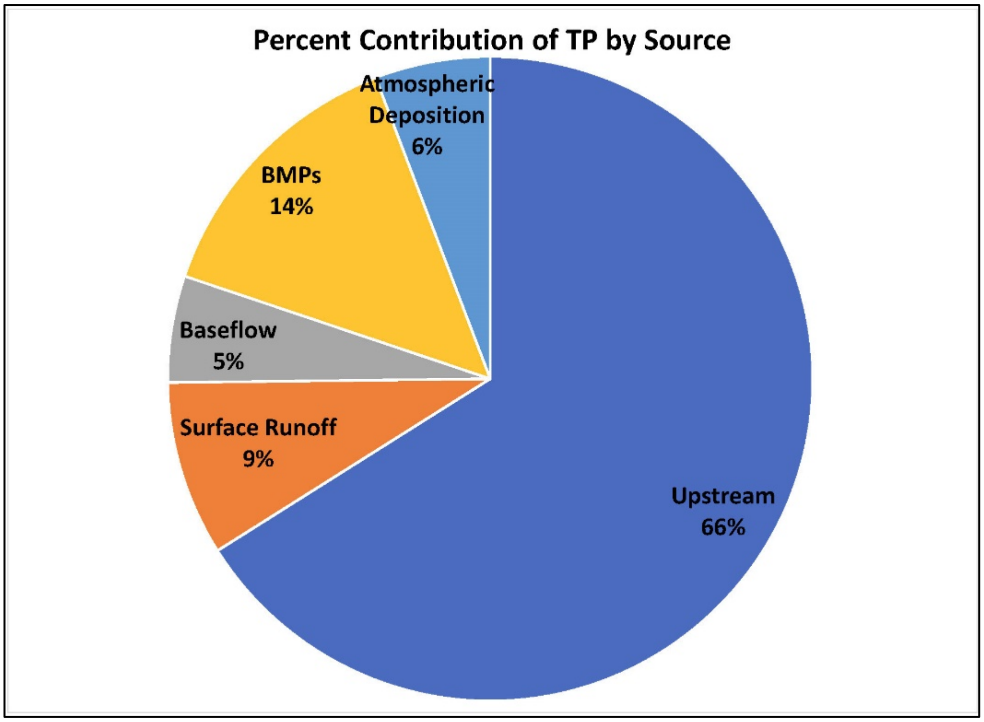

Figure 5.4. Percent TP contribution under the existing condition

5.3.1.7 HSPF Model Calibration

Tetra Tech selected a total of 32 water quality monitoring stations in the Lake Jesup Watershed for model calibration and validation. These stations were selected because they are strategically located throughout the watershed. Of these stations, Tetra Tech selected 8 for model calibration and delineated new model subwatersheds for these stations, including a station in Bear Gully Lake (21FLSEM BGU). The stations selected for calibration were either located in the impaired lakes or close to an existing subwatershed outlet. Tetra Tech parameterized the newly created subwatersheds and receiving water reaches associated with each of the calibration stations, and recalibrated and revalidated the hydrology and water quality simulations in the model. The remainder of the stations were used to validate the model results.

DEP requested that Tetra Tech use the general calibration/validation targets or tolerances for the HSPF model from Donigian (2002) and McCutcheon et al. (1990) to evaluate the model results (**Table 5.5**). As shown in **Table 5.6**, the revised model performs very well for TN, TP, TSS, and DO concentrations. The calibration statistics use the medians of the observed data from the station in Bear Gully Lake and the medians of the simulated data from Subbasin 42 to calculate the percent differences. Matching all parameters to measured data is difficult because of the complex interaction between nutrients and algae and the limited ability of the HSPF model to simulate in-lake processes.

Table 5.5. Donigian 2002 and McCutcheon et al. (1990) Calibration/Validation targets or tolerances for water quality parameters

Category	Water Quality/DO	Nutrients/Chlorophyll *a*
Very Good	< 15%	< 30%
Good	15% - 25%	30% - 45%
Fair	25% - 35%	45% - 60%
Poor	> 35%	> 60%

Table 5.6. Summary of HSPF calibration statistics for water quality parameters

[1] Categories are based on Donigian (2002) and McCutcheon et al. (1990) calibration/validation targets or tolerances for water quality parameters.

Calibration Measure	TN	TP	TSS	DO	BOD
% Difference in Medians	22	2	15	6	27
Category[1]	Very Good	Very Good	Good	Very Good	Fair

5.3.2 EFDC Hydrodynamics Model

The Bear Gully Lake EFDC model grid is based on the contour map from Seminole County. Depths in the lake ranged from 0.8 to 4.1 meters (m). To account for the various depths, the EFDC model was divided into 117 cells with an average cell size of 71 m by 71 m. Each cell is one layer, which is assigned the appropriate depth. **Figure 5.5** illustrates the grid and the average cell depth, in meters.

5.3.2.1 EFDC Model Calibration

Daily inflows and outflows, as well as the temperatures from Subbasin 42 of the Lake Jesup HSPF model were used in the Bear Gully Lake EFDC model to drive the hydrodynamics. The EFDC model was setup for the time period from 2003 through 2014. The projected lake levels or water surface elevations were compared to the measured water levels in Bear Gully Lake, and the simulated temperatures were compared to the in-lake temperature data (Tetra Tech 2017b). **Figures 5.6 and 5.7** illustrate the comparison between the simulated and observed data for the lake's water level and temperatures, respectively. **Table 5.7** represents the EFDC model comparisons of water level and temperature data. Another statistical approach would be to divide the RMS error (1.7 feet) by the maximum range (5.4 feet), giving a 31 % error for the RMS.

Table 5.7. Summary of EFDC calibration statistics for water level and temperature

[1] Categories are based on Donigian (2002) and McCutcheon et al. (1990) calibration/validation targets or tolerances for water quality parameters.

Calibration Measure	Water Level (feet)	Temperature (°F)
% Difference in Medians	5	6
Category[1] for Medians	Very Good	Very Good
% Difference in Means	3	7
Category[1] for Means	Very Good	Very Good

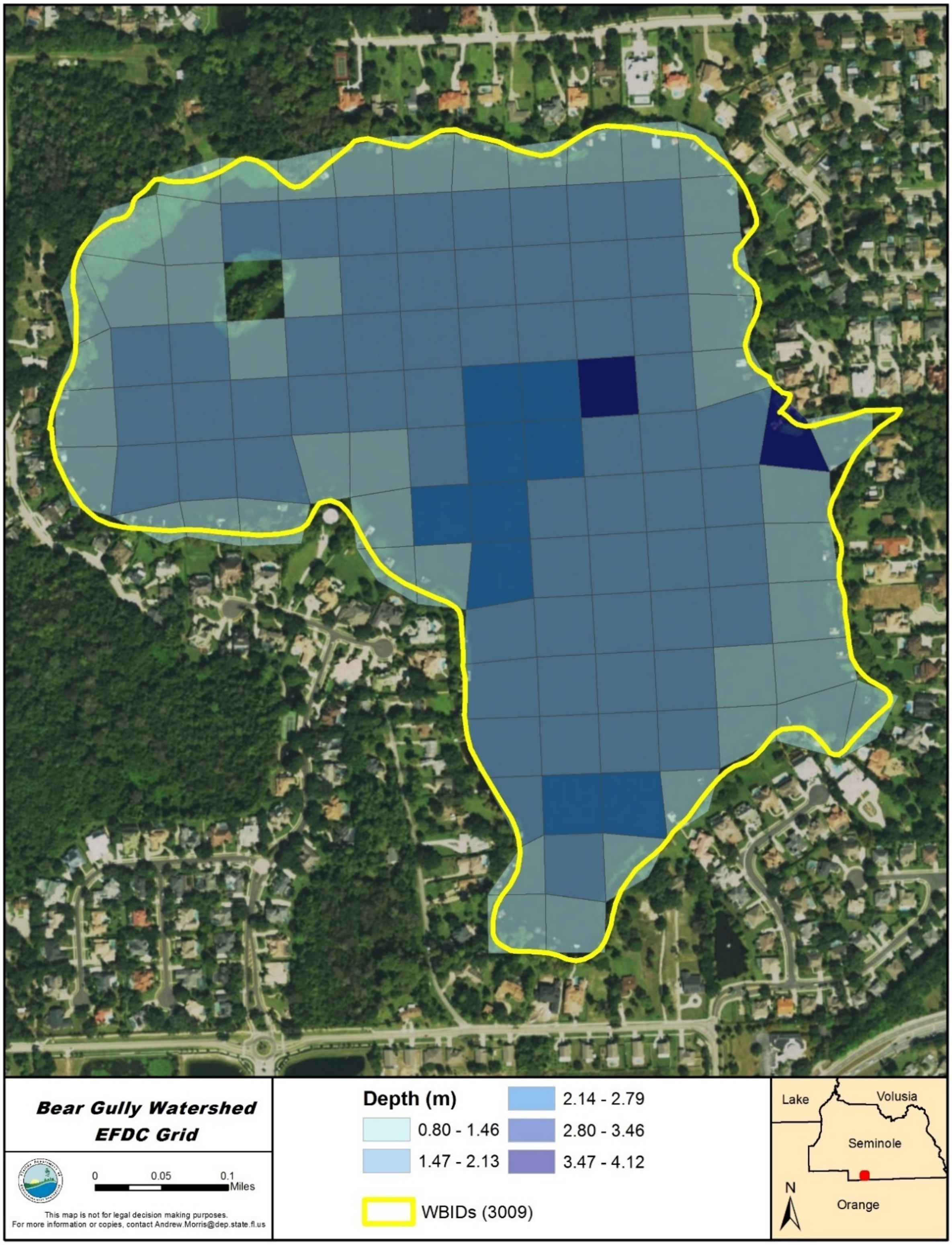

Figure 5.5. Bear Gully Lake EFDC grid

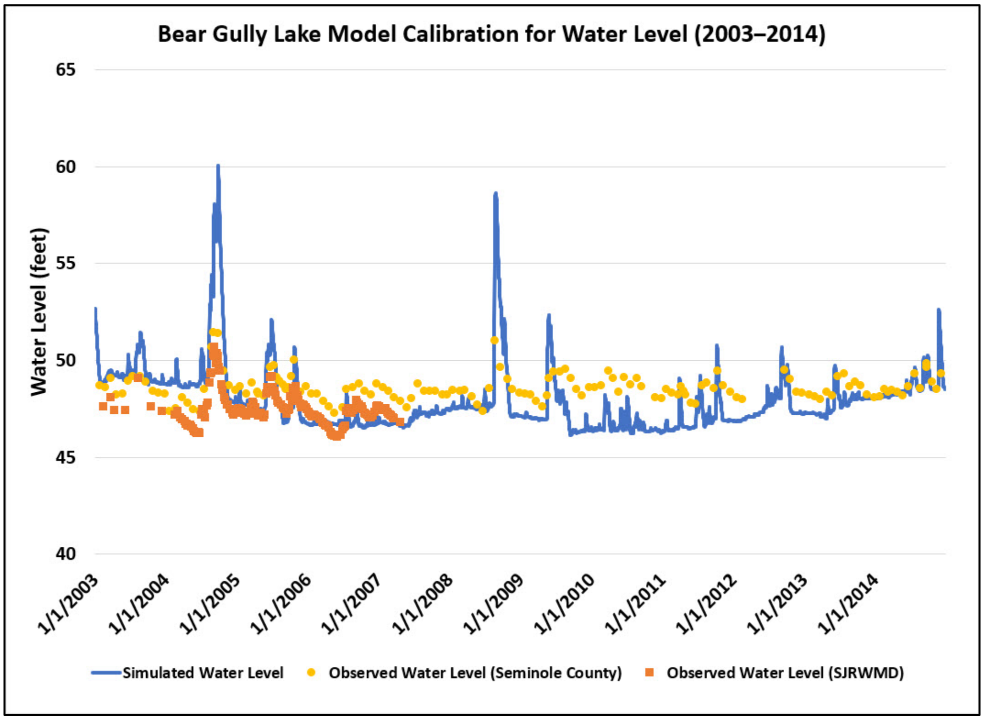

Figure 5.6. Bear Gully Lake model calibration for water level (feet)

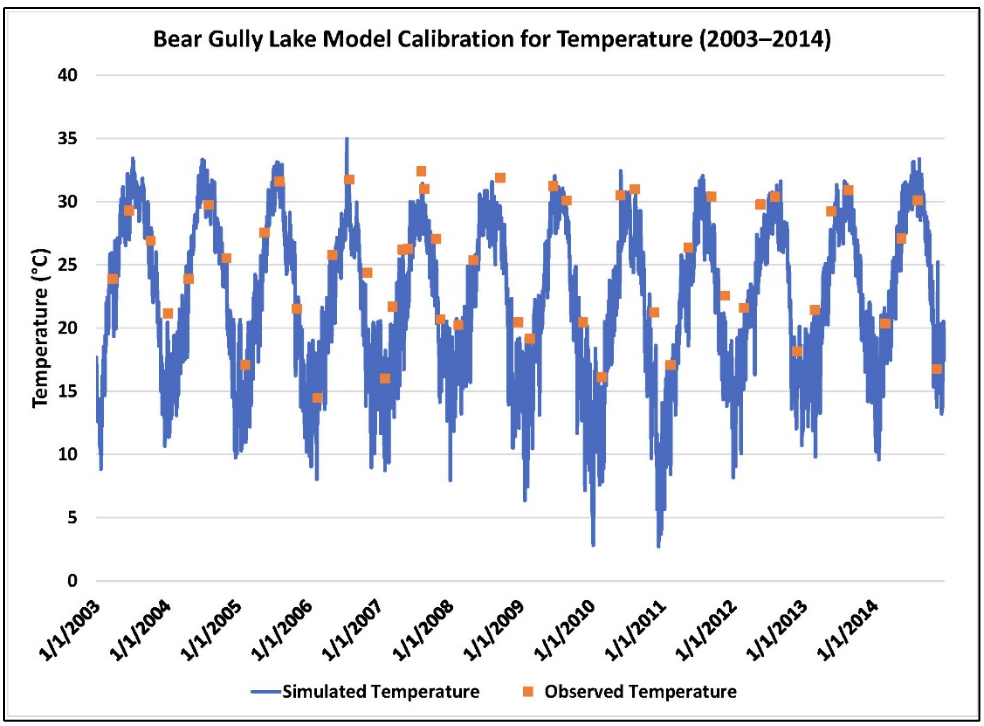

Figure 5.7. Bear Gully Lake model calibration for temperature (°C)

5.3.3 WASP Receiving Water Model

The Bear Gully Lake EFDC model hydrodynamic results (flows, velocities, volumes, and temperatures) were used to drive the Bear Gully Lake WASP model. The advanced eutrophication module of WASP 8.0, which was the same approach used for the Lake Jesup WASP model, was used to simulate water quality in Bear Gully Lake. Additional details about the Lake Jesup EFDC and WASP models are included in the Lake Jesup model report (Tetra Tech 2017a).

The Bear Gully Lake water quality inputs were provided by the Lake Jesup watershed HSPF model (Subbasin 42) and were input into the WASP model as kilograms per day (kg/day) at a daily time step. The total organic nitrogen (OrgN) loads were divided between dissolved organic nitrogen (DON) and dissolved nitrogen (DN) at a 60:40 ratio. The total organic phosphorus (OrgP) loads were divided between dissolved organic phosphorus (DOP) and dissolved phosphorus (DP) at a 10:90 ratio. All of the organic carbon was assigned to detrital carbon.

The initial WASP model kinetic rates were from the Lake Jesup WASP model, with nutrient uptake rates and chlorophyll growth rates adjusted during calibration. The final Bear Gully Lake model report (Tetra Tech 2017b) provides the kinetic rates used in the Bear Gully Lake WASP model. Time series for solar radiation, fraction of the day, wind speed, and air temperature are from the Lake Jesup WASP model. The WASP model uses daily solar radiation and fraction of daylight hours for simulating phytoplankton growth, as well as daily water temperature for the modification of chemical reaction rates and growth and respiration of phytoplankton.

5.3.3.1 WASP Model Calibration and Validation

Water quality data collected in Bear Gully Lake from 2003 through 2014 were used for in-lake water quality calibration. As shown in **Figure 2.1**, several water quality monitoring stations are available for model calibration purposes, and the data from each of the stations were examined as part of data quality control processes to compare with the WASP model simulation results. The lake is relatively small and fairly well mixed. Therefore, the data from the monitoring stations were combined and compared with the WASP model simulation results averaged over the entire lake.

The final Bear Gully Lake modeling report (Tetra Tech 2017b) provided detailed time-series comparisons between observed versus simulated results for DO, NH_4, NO_3, TSS, chlorophyll *a*, TN, and TP. Using the general calibration/validation targets or tolerances based on Donigian (2002) and McCutcheon et al. (1990), the percent differences in the median and mean values of the observed data compared with the model-simulated results indicated that the WASP model performs very well in simulating the water quality for Bear Gully Lake (**Table 5.8**). **Figures 5.8** through **5.10** show the observed versus simulated daily concentrations of TN, TP, and chlorophyll *a* from 2003 to 2014.

Table 5.8. Summary of WASP calibration statistics for water quality parameters

[1] Categories are based on Donigian (2002) and McCutcheon et al. (1990) calibration/validation targets or tolerances for water quality parameters.

Calibration Measure	TN	TP	Chlorophyll *a*	DO	BOD
% Difference in Medians	16	21	6	10	4
Category[1] for Medians	Very Good	Very Good	Very Good	Very Good	Very Good
% Difference in Means	28	16	0	11	2
Category[1] for Means	Very Good	Very Good	Very Good	Very Good	Very Good

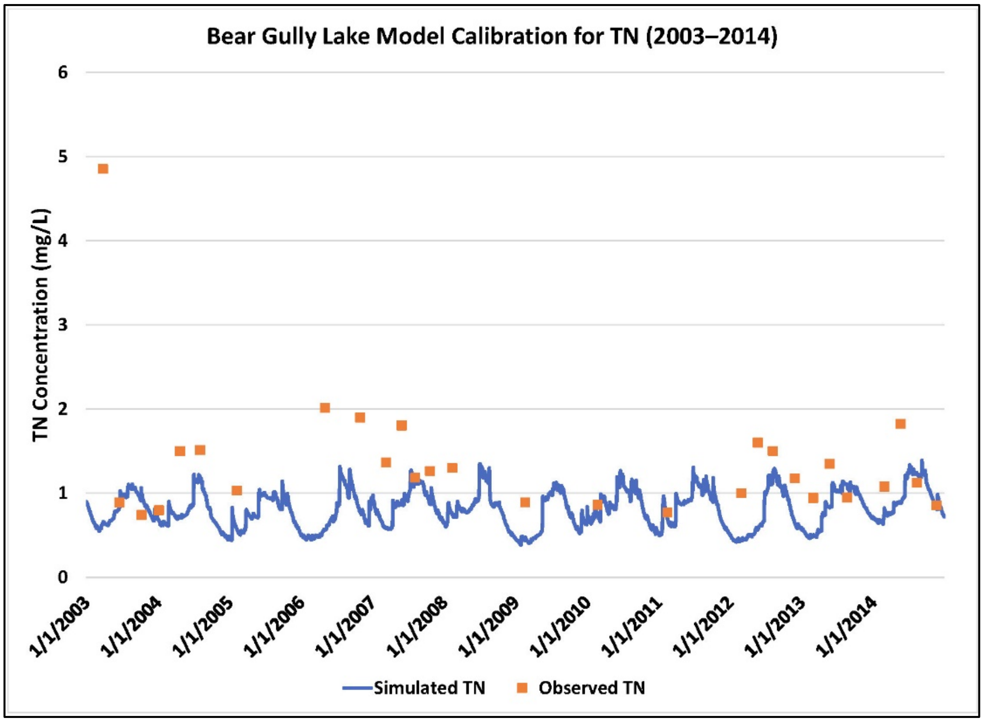

Figure 5.8. Bear Gully Lake model calibration for TN (2003–14)

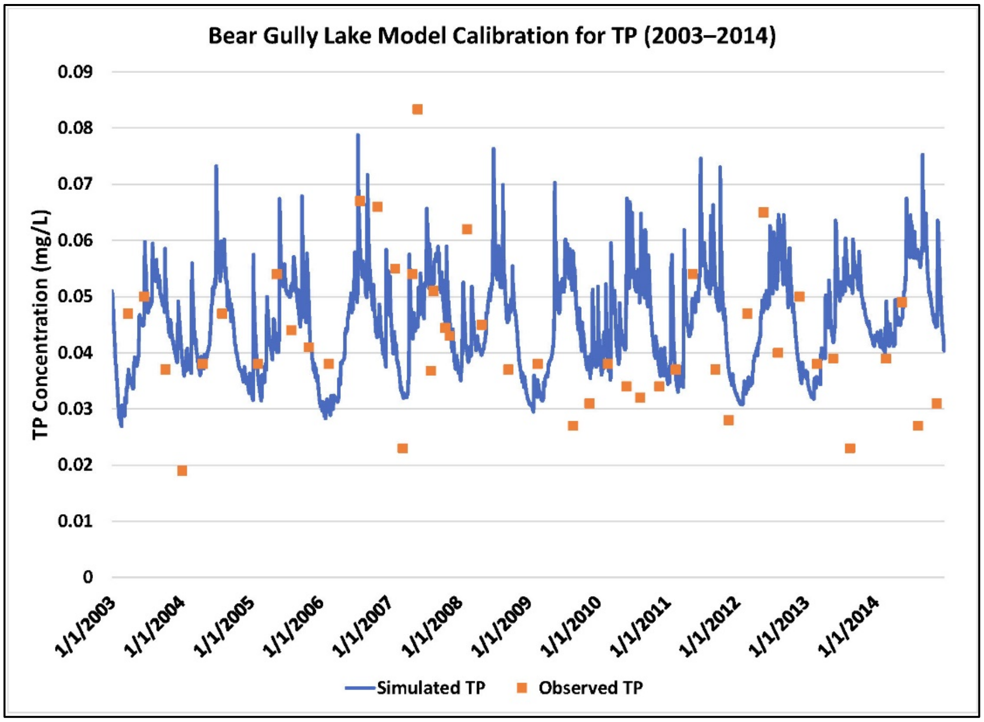

Figure 5.9. Bear Gully Lake model calibration for TP (2003–14)

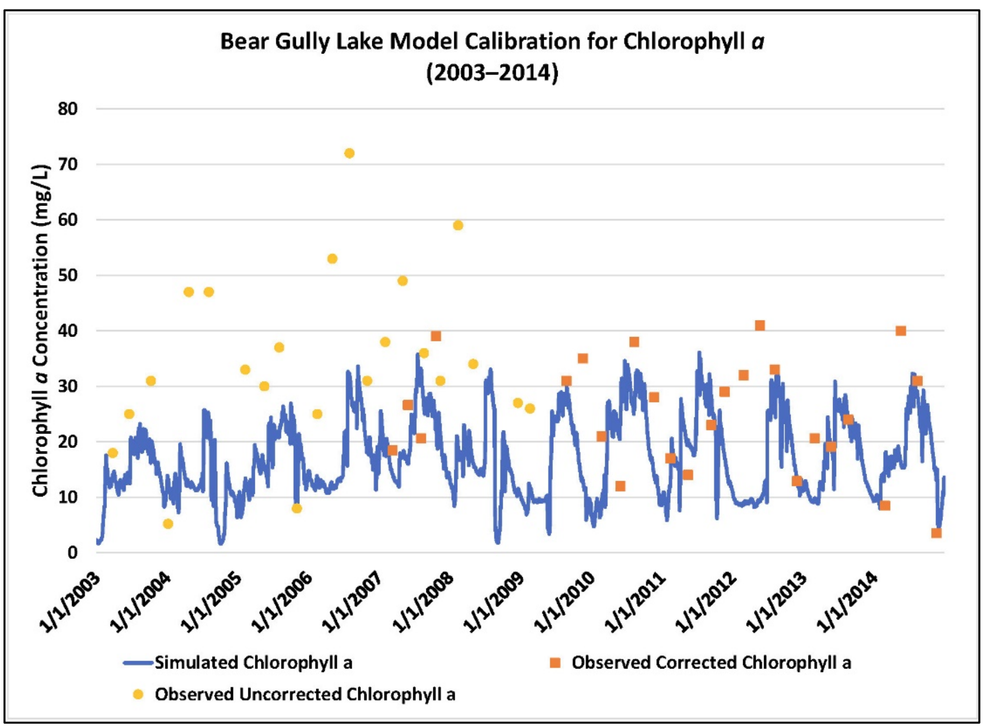

Figure 5.10. Bear Gully Lake model calibration for chlorophyll a (2003–14)

5.3.3.2 WASP Sediment Nutrient Benthic Flux

The sediment diagenesis module was turned on in the calibrated model, and the results from this simulation were reported in the final Bear Gully Lake modeling document (Tetra Tech 2017b). The total simulated nutrient fluxes are summarized in the report, indicating that the mean estimated nutrient flux from sediment was of 8.69 mg/m^2/day for TN and -0.15 mg/m^2/day for TP, corresponding to an annual nutrient load of 4,127 lbs/yr for TN and a loss of 70 lbs/yr for TP. These loads accounted for 12.9 % of the total TN loads and -4.6 % of the total TP loads from all sources to Bear Gully Lake, suggesting that the sediment nutrient flux for TN is a notable source but that TP fluxes are a net sink in the lake.

5.4 Natural Background Conditions To Determine Natural Levels of Chlorophyll *a*, TN, and TP

The natural land use background conditions for the Bear Gully Lake Watershed were established to ensure that the site-specific target does not abate the natural background condition. For this simulation, the wetland and water land uses in the current condition model were kept the same in the natural background simulation and all anthropogenic land uses in the current condition model were converted into forest or wetland land uses based on the land's hydrologic soil group classification. 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. The resulting land use coverage and background simulation results are listed in the final modeling report for Bear Gully Lake (Tetra Tech 2017b). The loading from the watershed in the natural background simulation is 14,910 lbs/yr of TN and 608 lbs/yr of TP.

Simulated daily average concentrations of chlorophyll *a*, TN, and TP for the natural background condition from 2003 to 2014 were converted to AGMs for each year, and compared with simulated AGMs for the existing condition (**Table 5.9**). Based on the background model run results, the predevelopment lake was estimated to have AGM TP concentrations ranging from 0.02 to 0.03 mg/L, with a long-term average of 0.02 mg/L. Predevelopment AGM TN concentrations were estimated to range between 0.37 and 0.56 mg/L, with a long-term average of 0.46 mg/L. Predevelopment AGM chlorophyll *a* ranged between 6 and 13 µg/L, with an long-term average AGM chlorophyll *a* of 10 µg/L. The natural background chlorophyll *a* concentrations are lower than the 20 µg/L chlorophyll *a* target over the 12-year simulated period. These results indicate that a chlorophyll *a* target of 20 µg/L will not abate the natural background condition.

Table 5.9. Simulated AGMs chlorophyll *a*, TN, and TP for the existing and natural background conditions

Year	Existing Condition Chlorophyll *a* (µg/L)	Natural Background Chlorophyll *a* (µg/L)	Existing Condition TN (mg/L)	Natural Background TN (mg/L)	Existing Condition TP (mg/L)	Natural Background TP (mg/L)
2003	15	8	0.95	0.47	0.05	0.02
2004	13	6	0.89	0.43	0.05	0.02
2005	20	11	0.89	0.43	0.05	0.02
2006	22	9	0.84	0.37	0.05	0.02
2007	26	10	1.01	0.43	0.05	0.02
2008	18	9	0.97	0.51	0.05	0.03
2009	17	11	0.79	0.44	0.05	0.02
2010	23	13	0.98	0.47	0.05	0.02
2011	23	13	0.99	0.50	0.05	0.03
2012	18	8	0.83	0.43	0.05	0.03
2013	21	9	0.95	0.45	0.05	0.03
2014	21	10	1.12	0.56	0.06	0.03

5.5 Load Reduction Scenarios To Determine the TMDLs

To achieve the target chlorophyll *a* concentration of 20 µg/L, the TN and TP loads were incrementally reduced until the chlorophyll *a* target was achieved in every year of the modeling period. Meeting the chlorophyll *a* target in every year is considered a conservative assumption for establishing TMDLs, as this will ensure that all exceedances of the nutrient targets are addressed.

For the TP and TN load reduction scenarios, the TN and TP loads were iteratively reduced at the Boundary Scale Factor until the AGMs of simulated chlorophyll *a* did not exceed the target of 20 µg/L in any single year. For the final load reduction scenario, referred to as the TMDL condition, the existing TN and TP loads were reduced by 20 % and 18 %, respectively. **Figures 5.11** through **5.13** show the daily average concentrations for TN, TP and chlorophyll *a* model simulations under the existing condition and TMDL condition.

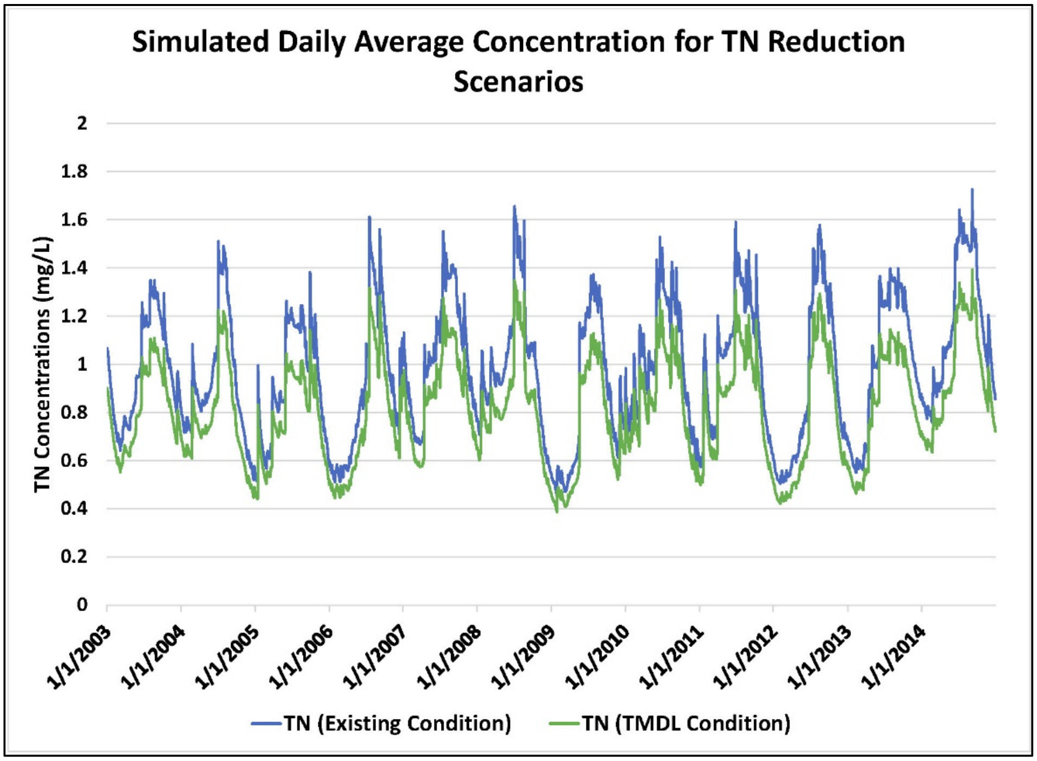

Figure 5.11. Simulated daily average concentration for TN reduction scenarios: Existing condition (no reduction) and TMDL condition (20 % reduction)

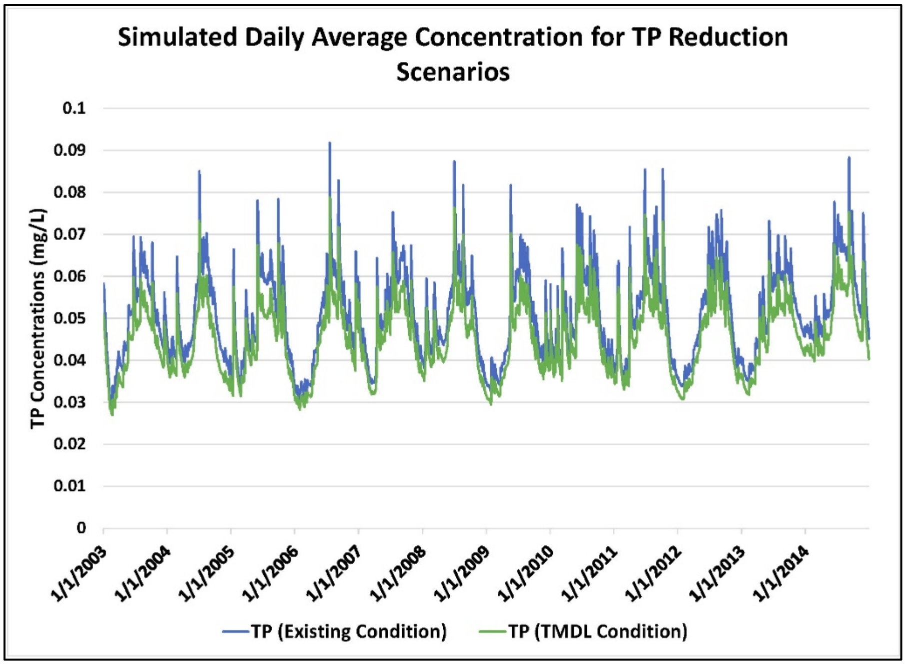

Figure 5.12. Simulated daily average concentration for TP reduction scenarios: Existing condition (no reduction) and TMDL condition (18 % reduction)

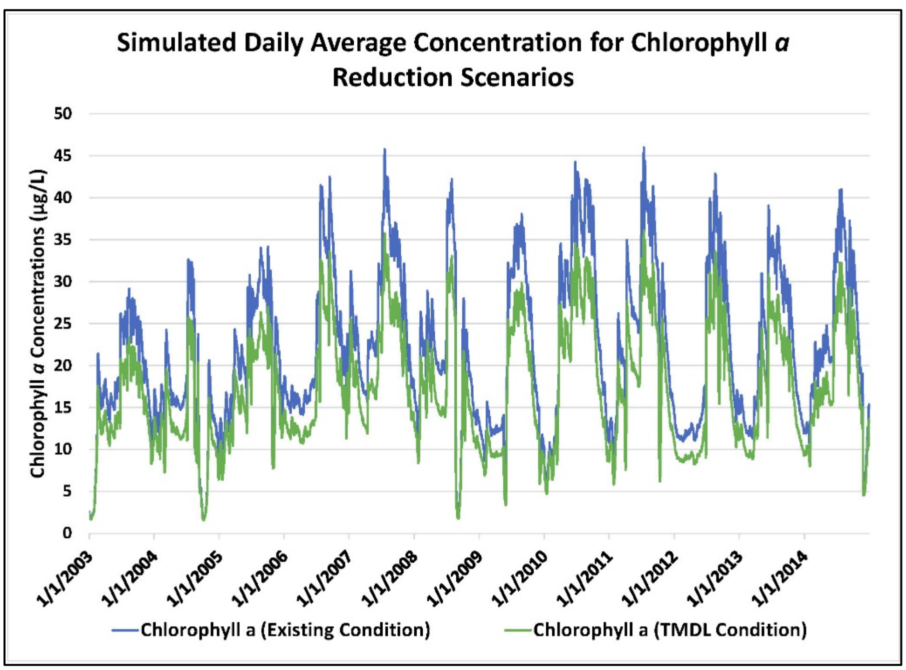

Figure 5.13. Simulated daily average concentration for chlorophyll *a* reduction scenarios: Existing condition (no reductions) and TMDL condition (TN 20 % and TP 18 % reductions)

5.6 Calculation of the TMDLs

All incoming TN and TP loads from upstream Subbasins 43 and 44, surface runoff from Subbasin 42, baseflow, flows treated by BMPs, and direct atmospheric loads, as listed in **Tables 5.3** and **5.4**, are included in the calculation of the allowable TMDLs for Bear Gully Lake.

The percent reductions for TN and TP loads established in **Section 5.5** were applied to the total TN and TP loads for each year of the existing model simulation. **Table 5.10** lists the resulting TMDL condition loads.

Table 5.10. Bear Gully Lake TMDL condition nutrient loads

Year	TMDL Condition TN Loads (lbs/yr)	TMDL Condition TP Loads (lbs/yr)
2003	23,468	1,386
2004	28,387	1,756
2005	28,942	1,749
2006	15,859	932
2007	16,062	898
2008	26,294	1,605
2009	23,072	1,352
2010	23,546	1,414
2011	22,330	1,333
2012	18,886	1,072
2013	16,082	912
2014	24,591	1,427

The TMDL condition loads for TN and TP were used in the derivation of the nutrient TMDL values to be used as the site-specific interpretations of the narrative nutrient criterion for TN and TP, as described in **Section 3.3**. For Bear Gully Lake, a 20 % reduction in the existing TN loads and an 18 % reduction in the existing TP loads are necessary to meet the chlorophyll *a* criterion. The nutrient TMDL values, expressed as a 7-year average load, address the anthropogenic nutrient inputs that contribute to the exceedances of the chlorophyll *a* criterion. The TMDLs for TN and TP are 23,166 lbs/yr and 1,387 lbs/yr, respectively.

5.7 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, and (3) the methodology used to determine impairment is based on annual conditions (AGMs or arithmetic means).

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 acceptable loads among 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 takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

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

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

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

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (1) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is also accounted for within the LA, and (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 Bear Gully 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 a balanced aquatic flora and fauna (see **Table 6.1**). These TMDLs are based on maximum 7-year averages of simulated data from 2003 to 2014. 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, meeting water quality criteria, and thus protecting Bear Gully Lake's designated uses.

Table 6.1. TMDL components for nutrients in Bear Gully Lake (WBID 3009)

Note: The LA and TMDL daily load for TN is 63.5 lbs/day, and for TP 3.8 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
3009	TN	23,166	NA	20	20	Implicit
3009	TP	1,387	NA	18	18	Implicit

6.2 Load Allocation

To achieve the load allocation (LA), current TN and TP loads require a 20 % and 18 % reduction, respectively.

As the TMDLs are based on the percent reduction in total watershed loading and any natural land uses are held harmless, the percent reductions for anthropogenic sources may be greater. It should be noted that the LA includes loading from stormwater discharges regulated by DEP and the water management districts 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 Bear Gully Lake Watershed discharge either into the lake or its watershed. Therefore, a WLA for wastewater discharges is not applicable.

6.3.2 NPDES Stormwater Discharges

The stormwater collection systems in the Bear Gully Lake Watershed which are owned and operated by Orange County and FDOT District 5 are covered by an NPDES Phase I MS4 permit (FLS000011). Seminole County and FDOT District 5 are covered by a Phase I NPDES MS4 permit (FLS000038). Areas within their jurisdiction in the Bear Gully Lake Watershed are responsible for a 20 % reduction in TN and a 18 % reduction in TP from the current anthropogenic loading.

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. As the

TMDLs are based on the percent reduction in total watershed loading and any natural land uses are held harmless, the percent reduction for only anthropogenic sources may be greater.

6.4 Margin of Safety (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]). Considerable uncertainty is usually inherent in estimating nutrient loading from nonpoint sources, as well as in predicting water quality response. The effectiveness of management activities (e.g., stormwater management plans) in reducing loading is also subject to uncertainty.

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 for Bear Gully Lake). The TMDLs were developed using water quality results from both high- and low-rainfall years. Additionally, the TMDL nutrient load targets are established as annual limits not to be exceeded based on the development of site-specific alternative water quality targets, and were derived based on the chlorophyll *a* criterion being met in every year of the model simulation. These provide a MOS for achieving the restoration goal, which is a chlorophyll *a* concentration of 20 µg/L, expressed as an AGM, not to be exceeded more than once in any consecutive 3-year period.

Chapter 7: Implementation Plan Development and Beyond

7.1 Implementation Mechanisms

Following the adoption of a TMDL, implementation takes place through various measures. The implementation of TMDLs may occur through specific requirements in NPDES wastewater and MS4 permits, and, as appropriate, through local or regional water quality initiatives or BMAPs.

Facilities with NPDES permits that discharge to the TMDL waterbody must respond to the permit conditions that reflect target concentrations, reductions, or wasteload allocations 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 are already defined in a BMAP for that particular TMDL. MS4 Phase II permit holders must also implement responsibilities defined in a BMAP or other form of restoration plan (for example, a reasonable assurance plan).

7.2 BMAPs

BMAPs are discretionary and are not initiated for all TMDLs. A BMAP is a TMDL implementation tool that integrates the appropriate management strategies applicable through existing water quality protection programs. DEP or a local entity may develop a BMAP that addresses some or all of the contributing areas to the TMDL waterbody.

Section 403.067, F.S. (FWRA), provides for the development and implementation of BMAPs. BMAPs are adopted by the DEP Secretary and are legally enforceable.

BMAPs describe the management strategies that will be implemented as well as funding strategies, project tracking mechanisms, water quality monitoring, and the fair and equitable allocations of pollution reduction responsibilities to the sources in the watershed. They can also identify mechanisms to address potential pollutant loading from future growth and development.

The most important component of a BMAP is the list of management strategies to reduce pollution sources, as these are the activities needed to implement the TMDLs. The local entities that will conduct these management strategies are identified and their responsibilities are enforceable. Management strategies may include wastewater treatment upgrades, stormwater improvements, and agricultural BMPs.

Bear Gully Lake is located in the Jesup Lake BMAP, which was adopted in May 2010, and is therefore currently included in BMAP activities. The adopted Lake Jesup BMAP and associated annual progress reports are available online.

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. In the case of Bear Gully Lake, 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 other factors should be included in a comprehensive management plan for the waterbody. Additionally, the current water quality and water level monitoring of Bear Gully 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 Rule 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.

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

In 1987, the U.S. Congress established Section 402(p) as part of the federal 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 October 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 name	Bear Gully Lake
Waterbody type(s)	Lake
Waterbody ID (WBID)	WBID 3009 (see **Figure 1.1** of this report)
Description	Bear Gully Lake is located in unincorporated Seminole County, Florida. The watershed covers an area of 3,847 acres, and spans both Seminole and Orange Counties. Bear Gully Lake has a surface area of 137 acres and an average depth of 5 ft., and discharges to Bear Gully Creek at an outlet on the eastern side of the lake. The dominant land use type in the Bear Gully Lake Watershed is medium-density residential (42 %), followed by water and industrial/commercial, which make up 16 % and 11 % of the watershed, respectively. **Chapter 1** of this report contains a more detailed description of the Bear Gully Lake system.
Specific location (latitude/ longitude or river miles)	The center of Bear Gully Lake is located at N: 28°37'29.8"/ W: 81°16'18.2". The site-specific criteria apply as a spatial average for the lake, as defined by WBID 3009.
Map	**Figure 1.1** shows the general location of Bear Gully Lake and its 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	Parameter Information Related to Numeric Interpretation of the Narrative Nutrient Criterion
NNC summary: Default lake classification (if applicable) and corresponding NNC	Bear Gully 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: The NNC for chlorophyll *a* in Bear Gully Lake is 20 µg/L, expressed as an AGM concentration not to be exceeded more than once in any consecutive 3-year period. The TN and TP NNC are expressed as 7-year annual average loads not to be exceeded in any year, and are 23,166 and 1,387 lbs/yr, for TN and TP, respectively. Nutrient concentrations are provided for comparative purposes only. The in-lake TN and TP AGM concentrations for Bear Gully Lake at the allowable TMDL loading are 0.83 and 0.05 mg/L, respectively. These restoration concentrations represent the in-lake concentrations that would still meet the target chlorophyll *a* concentration of 20 µg/L.
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 HSPF model and the receiving water EFDC and WASP models that simulated hydrology and water quality conditions over the 2003 to 2014 period. The primary datasets for this period include water quality data from the IWR Database Run 52, and rainfall and evapotranspiration data from 2002 to 2014. Data from the SJRWMD 2009 land use coverage were used to establish watershed nutrient loads. **Sections 2.3** and **5.3** of this TMDL 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 2003 to 2014 period, which included both wet and dry years. During the simulation period, total annual average rainfall varied from 36.1 to 68.6 inches and averaged 51.4 inches. A comparison with long-term average rainfall data indicated that 2006, 2007, and 2010 were dry years, while 2005, 2008, and 2014 were wet years. This period captures the hydrologic variability of the Bear Gully Lake system. NEXRAD rainfall data the SJRWMD received from the National Weather Service were used as the model input for estimating nutrient loads from the watershed. These rainfall datasets have a spatial resolution of 2 km^2, which accurately represents the spatial heterogeneity of rainfall in the watershed. 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 Bear Gully Lake used in the model calibration process. Monitoring stations were located across the spatial extent and represent the spatial distribution of nutrient dynamics in the lake, as follows: Seminole County (21FLSCES… and 21FLSEM…), Florida LakeWatch (21FLKWAT), DEP CD (21FLCEN…), and DEP WET (21FLWET…). Water quality data for variables relevant to TMDL development are available on request.

Table B-3. Summary of how designated use(s) are demonstrated to be 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 Bear Gully Lake (WBID 3009). The lake was verified as impaired for nutrients based on an elevated annual average TSI during the Cycle 1 verified period for the Group 2 basins (January 1, 1996–June 30, 2003). During the Cycle 3 assessment, the NNC were used to assess the lake during the verified period (January 1, 2007–June 30, 2014) using data from IWR Database Run 50. Bear Gully Lake was found to be impaired for chlorophyll *a* because the AGMs exceeded the NNC more than once in a three-year period (2010 and 2012), and the waterbody was added to the 303(d) list for chlorophyll *a*. The waterbody was placed in Category 3c (Planning List) for further investigation for TN and was found to not be impaired (Category 2) for TP. See **Section 2.3.3** of this report for a detailed discussion.
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 Bear Gully Lake that would make the use of the chlorophyll *a* threshold of 20 µg/L inappropriate for the lake.
Approach used to develop the criteria and how it protects uses	For the Bear Gully Lake nutrient TMDLs, DEP created loading-based criteria using a HSPF watershed loading model to simulate loading from the Bear Gully Lake Watershed, and this information was fed into individual receiving water models (EFDC and WASP) 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, because the 20 µg/L chlorophyll *a* target is the generally applicable NNC demonstrated to be protective of the designated use for high color lakes. The maximum of the 7-year 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 provides a more detailed description of the derivation of the TMDL 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 Bear Gully Lake that may be related to nutrients (such as DO or un-ionized ammonia). Reducing the nutrient loads entering the lake will not negatively impact other water quality parameters of the lake.

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

Downstream Waters Protection and Monitoring Requirements	Information Related to Downstream Waters Protection and Monitoring Requirements
Identification of downstream waters: List receiving waters and identify technical justification for concluding downstream waters are protected	An outlet on the eastern side of Bear Gully Lake discharges into Bear Gully Creek, which flows into Howell Creek system, which in turn discharges north into Lake Jesup and then St. Johns River. Bear Gully Creek and Howell are Class III freshwater streams in the Peninsular Stream Nutrient Region for NNC criteria. The applicable nutrient criteria for these stream systems are 0.12 mg/L of TP, 1.54 mg/L of TN, and 20 µg/L of chlorophyll *a*, expressed as AGMs not to be exceeded more than once in any 3-year period. Neither stream system was assessed as being impaired for TN, TP, or chlorophyll *a* during the most recent Cycle 3 assessment period for the Group 2 basins. Additionally, there was available Stream Condition Index (SCI) data which indicated that Howell Creek supported a healthy biological community, and biological monitoring results from several surveys taken during the Cycle 3 verified period and in more recent years indicate that there are no floral imbalances and there is healthy fauna in Bear Gully Creek. DEP has determined that if the data show biological health is fully supported in a stream, it may be concluded that the associated nutrient regime is inherently protective of the waterbody, and the stream numeric nutrient standard is achieved (DEP 2013b). The Lake Jesup nutrient TMDL (Gao 2006) required a 50 % reduction in nitrogen and a 34 % reduction in phosphorus loads from the entire Lake Jesup watershed, which corresponds to TN, TP, and chlorophyll *a* concentrations of 1.32 mg/L, 0.094 mg/L, and 30.5 µg/L. The TN and TP concentrations that correspond to the TN and TP loads for Bear Gully Lake are of 0.83 and 0.05 mg/L, respectively, and the target chlorophyll *a* concentration is 20 µg/L. Since the restoration concentrations for Bear Gully Lake are lower than the nutrient targets for the Lake Jesup TMDL, the Bear Gully Lake TMDL nutrient reductions meet or exceed the reduction goals set forth by the Lake Jesup TMDL. Based on these assessment results, as evidenced by the healthy existing conditions in the downstream receiving water, the existing nutrient loads from Bear Gully Lake to Bear Gully Creek and Howell Creek have not led to an impairment of the downstream water and are not preventing downstream waters from attaining its designated uses and maintaining a balanced aquatic flora and fauna. Additionally, the Bear Gully Lake TMDL nutrient reductions meet or exceed the reduction goals for the Lake Jesup TMDL. The reductions in nutrient loads described in this TMDL analysis are not expected to cause nutrient impairments downstream but will result in water quality improvements to downstream waters. See **Section 3.6** of this report.
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.	Seminole County and DEP conduct routine monitoring of Bear Gully 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 to demonstrate administrative requirements are met

Administrative Requirements	Information for Administrative Requirements
Notice and comment notifications	DEP published a Notice of Development of Rulemaking on April 6, 2015, to initiate TMDL development for impaired waters in the Middle St. Johns River Basin. Technical workshops for the Bear Gully Lake TMDLs were held on April 13, 2017, to present the general TMDL approach to local stakeholders. A rule development public workshop for the TMDLs was held on September 29, 2017. A 30-day public comment period was provided to the stakeholders. Public comments were received for the TMDLs, and DEP has prepared a responsiveness summary for these comments. DEP published an updated Notice of Development of Rulemaking on January 17, 2017, covering the Middle St. Johns River Basin, to address the need for TMDLs to be adopted within 1 year after the Notice of Development of Rulemaking is published.
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 a site-specific interpretation of the narrative nutrient criterion, and will submit these documents to the EPA.

Appendix C: Important Links

Cover page:
DEP website: http://www.dep.state.fl.us

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Email address, Sara Davis: sara.c.davis@dep.state.fl.us
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Websites:
DEP TMDL Program: http://www.dep.state.fl.us/water/tmdl/index.htm
DEP IWR: http://www.dep.state.fl.us/legal/Rules/shared/62-303/62-303.pdf
DEP Florida STORET Program: http://www.dep.state.fl.us/water/storet/index.htm
DEP 2016 Integrated Report: http://www.dep.state.fl.us/water/docs/2016-Integrated-Report.pdf
DEP Criteria for Surface Water Quality Classifications:
http://www.dep.state.fl.us/legal/Rules/shared/62-302/62-302.pdf
Florida Surface Water Quality Standards:
https://www.flrules.org/gateway/ChapterHome.asp?Chapter=62-302
DEP BMAPs: http://www.dep.state.fl.us/water/watersheds/bmap.htm
EPA Region 4, TMDLs in Florida:
https://archive.epa.gov/pesticides/region4/water/tmdl/web/html/index-2.html
EPA National STORET Program: https://www.epa.gov/waterdata/storage-and-retrieval-and-water-quality-exchange

Chapter 4:
National Atmospheric Deposition Program: http://nadp.sws.uiuc.edu

Chapter 5:
BMAPs: http://www.dep.state.fl.us/water/watersheds/bmap.htm

References:
FDOH OSTDS statistical data:
http://www.doh.state.fl.us/environment/ostds/statistics/repairs.htm

U.S. Census Bureau: https://www.census.gov/

Appendix D: Bear Gully Lake Survey Results

Table D-1. Bear Gully Lake survey results – Collected October 21, 2015

SU = Standard units
µmhos/cm = Micromhos per centimeter

Parameter	BG01 Top	BG02 Top	BG03 Top	BG04 Top
Alkalinity (mg $CaCO_3$/L)	24.0	26.0	26.0	25.0
BOD-5 Day, N-Inhib (mg/L)	1.8	2.1	2.0	1.6
Chlorophyll *a*, Corrected (µg/L)	17.1	17.0	17.6	15.3
DO (mg/L)	7.8	7.2	7.6	6.9
pH (SU)	6.9	6.8	7.0	6.9
Specific Conductance (µmhos/cm)	139.0	140.0	139.0	139.0
Temperature (deg. C)	23.8	23.7	23.7	23.6
Total-N (mg N/L)	1.0	1.0	1.0	1.0
Color - true (PCU)	83.0	83.0	84.0	86.0
Ammonia-N (mg N/L)	0.0	0.0	0.0	0.0
NO_2NO_3-N (mg N/L)	0.0	0.0	0.0	0.0
O-Phosphate-P (mg P/L)	0.0	0.0	0.0	0.0
Total-P (mg P/L)	0.0	0.0	0.0	0.0
Kjeldahl Nitrogen (mg N/L)	1.0	1.0	1.0	1.0
TSS (mg/L)	6.0	8.0	7.0	5.0

Table D-2. Bear Gully Lake survey results – Collected January 26, 2016

Parameter	BG01 Top	BG01 Middle	BG01 Bottom	BG02 Top	BG02 Middle	BG02 Bottom	BG03 Top	BG03 Middle	BG03 Bottom	BG04 Top	BG04 Bottom
Alkalinity (mg $CaCO_3$/L)	24.0	24.0	24.0	25.0	25.0	24.0	25.0	24.0	25.0	24.0	24.0
BOD-5 Day, N-Inhib (mg/L)	2.5	2.9	3.4	3.6	1.9	3.1	4.1	3.1	0.8	3.2	4.0
Chlorophyll *a*, Corrected (µg/L)	9.1	10.9	13.8	9.4	19.4	17.1	11.5	12.4	20.6	8.0	9.9
DO (mg/L)	10.6	10.6	9.8	11.4	9.9	10.0	11.8	11.8	10.7	11.0	11.0
pH (SU)	7.4	7.4	7.3	7.8	7.3	7.3	7.9	7.8	7.3	7.8	7.6
Specific Conductance (umhos/cm)	152.0	151.0	152.0	153.0	152.0	152.0	151.0	151.0	151.0	151.0	151.0
Temperature (deg. C)	14.9	13.5	12.9	14.3	12.9	12.7	14.5	13.6	12.9	15.8	13.3
Total-N (mg N/L)	0.9	0.8	0.9	1.1	1.1	1.1	0.9	1.0	1.1	0.8	1.0
Color - true (PCU)	58.0	59.0	59.0	59.0	58.0	58.0	59.0	59.0	59.0	58.0	60.0
Ammonia-N (mg N/L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NO_2NO_3-N (mg N/L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
O-Phosphate-P (mg P/L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total-P (mg P/L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Kjeldahl Nitrogen (mg N/L)	0.9	0.8	0.9	1.1	1.1	1.1	0.9	1.0	1.1	0.8	1.0
TSS (mg/L)	6.0	7.0	8.0	5.0	9.0	9.0	6.0	6.0	9.0	5.0	6.0

Table D-3. Bear Gully Lake survey results – Collected April 27, 2016

Parameter	BG01 Top	BG01 Middle	BG01 Bottom	BG02 Top	BG02 Middle	BG02 Bottom	BG03 Top	BG03 Middle	BG03 Bottom	BG04 Top	BG04 Bottom
Alkalinity (mg $CaCO_3$/L)	24.0	23.0	24.0	24.0	24.0	25.0	24.0	23.0	24.0	23.0	23.0
BOD-5 Day, N-Inhib (mg/L)	3.4	3.8	4.1	3.5	3.6	6.8	4.2	3.1	4.1	3.9	4.6
Chlorophyll *a*, Corrected (µg/L)	11.8	11.8	13.4	14.3	19.3	31.2	11.5	12.5	16.8	12.5	16.7
DO (mg/L)	9.6	9.5	8.0	8.9	7.7	2.6	9.1	9.0	7.9	8.4	5.6
pH (SU)	8.3	8.2	7.5	7.8	7.1	6.4	8.2	8.1	7.2	7.7	7.0
Specific Conductance (umhos/cm)	154.0	154.0	154.0	154.0	154.0	157.0	154.0	154.0	154.0		155.0
Temperature (deg. C)	25.9	25.6	24.9	28.4	25.2	24.4	26.0	25.9	25.3	26.0	25.7
Total-N (mg N/L)	1.0	1.0	1.0	1.1	1.1	2.0	1.0	1.0	1.2	1.0	1.2
Color - true (PCU)	49.0	50.0	48.0	48.0	49.0	50.0	48.0	49.0	49.0	48.0	48.0
Ammonia-N (mg N/L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NO_2NO_3-N (mg N/L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
O-Phosphate-P (mg P/L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total-P (mg P/L)	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.1
Kjeldahl Nitrogen (mg N/L)	1.0	1.0	1.0	1.1	1.1	2.0	1.0	1.0	1.2	1.0	1.2
TSS (mg/L)	8.0	8.0	8.0	8.0	8.0	40.0	8.0	7.0	10.0	7.0	10.0

Table D-4. Bear Gully Lake survey results – Collected July 20, 2016

Parameter	BG01 Top	BG01 Middle	BG01 Bottom	BG02 Top	BG02 Middle	BG02 Bottom	BG03 Top	BG03 Middle	BG03 Bottom	BG04 Top	BG04 Bottom
Alkalinity (mg $CaCO_3$/L)	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
BOD-5 Day, N-Inhib (mg/L)	3.0	2.9	2.9	2.5	2.9	3.2	2.2	3.1	3.1	3.6	2.9
Chlorophyll *a*, Corrected (µg/L)	17.0	17.0	16.2	18.0	14.0	18.7	19.7	20.4	18.2	19.5	19.6
DO (mg/L)	7.2	6.4	5.2	7.2	6.4	4.6	7.0	6.9	6.6	5.9	5.8
pH (SU)	7.3	6.9	6.5	7.1	6.9	6.5	7.2	7.1	6.9	7.1	7.0
Specific Conductance (umhos/cm)	141.0	141.0	141.0	141.0	141.0	144.0	141.0	141.0	141.0	141.0	141.0
Temperature (deg. C)	30.9	30.7	30.5	31.0	30.6	30.5	30.9	30.8	30.7	36.8	30.8
Total-N (mg N/L)	1.1	1.0	1.1	1.1	1.1	1.2	1.2	1.0	1.1	1.2	1.1
Turbidity (NTU)	4.5	4.4	4.4	4.9	4.3	5.8	4.8	5.1	4.2	4.7	4.7
Color - true (PCU)	45.0	47.0	47.0	47.0	45.0	45.0	46.0	46.0	47.0	49.0	48.0
Ammonia-N (mg N/L)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
NO_2NO_3-N (mg N/L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
O-Phosphate-P (mg P/L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total-P (mg P/L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sulfate (mg SO_4/L)	7.0	7.0	7.1	7.0	7.0	7.0	7.0	7.1	7.1	7.0	7.1
Kjeldahl Nitrogen (mg N/L)	1.1	1.0	1.1	1.1	1.1	1.2	1.2	1.0	1.1	1.2	1.1
TSS (mg/L)	7.0	8.0	6.0	8.0	8.0	8.0	7.0	8.0	7.0	8.0	8.0

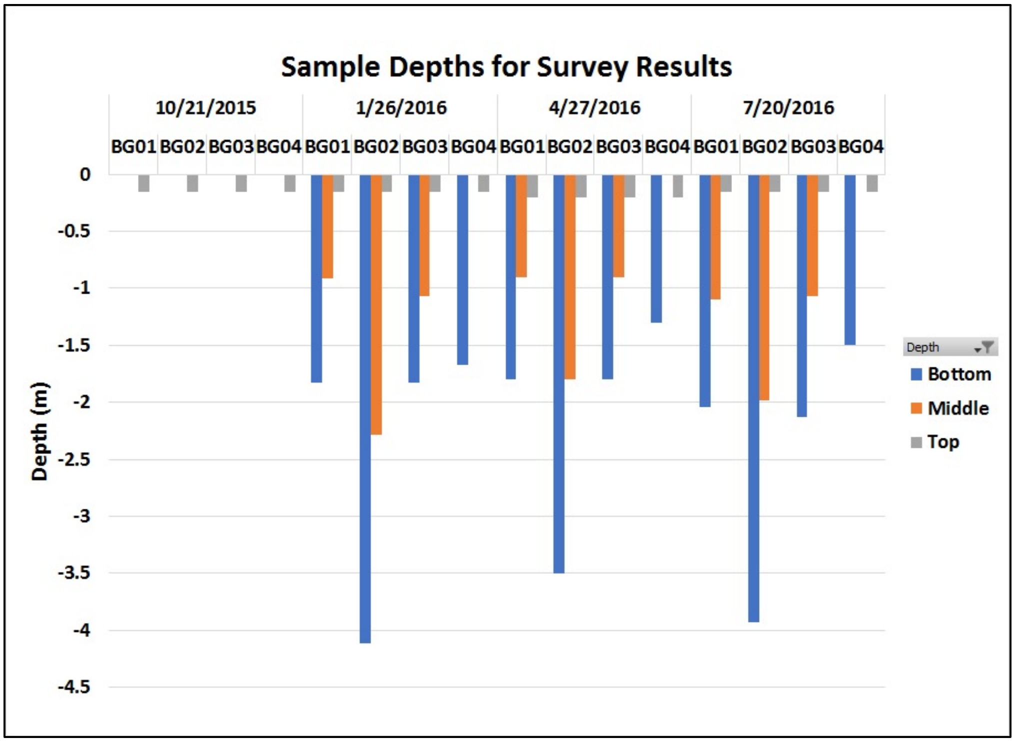

Figure D-1. Sample depths for survey results

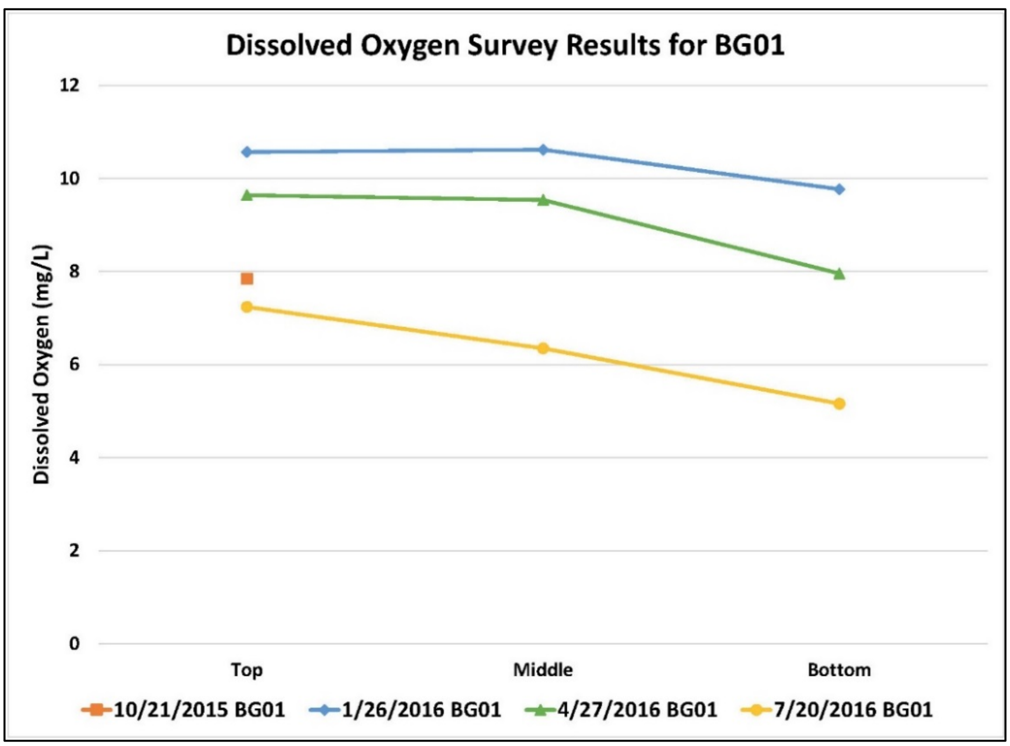

Figure D-2. DO survey results for BG01

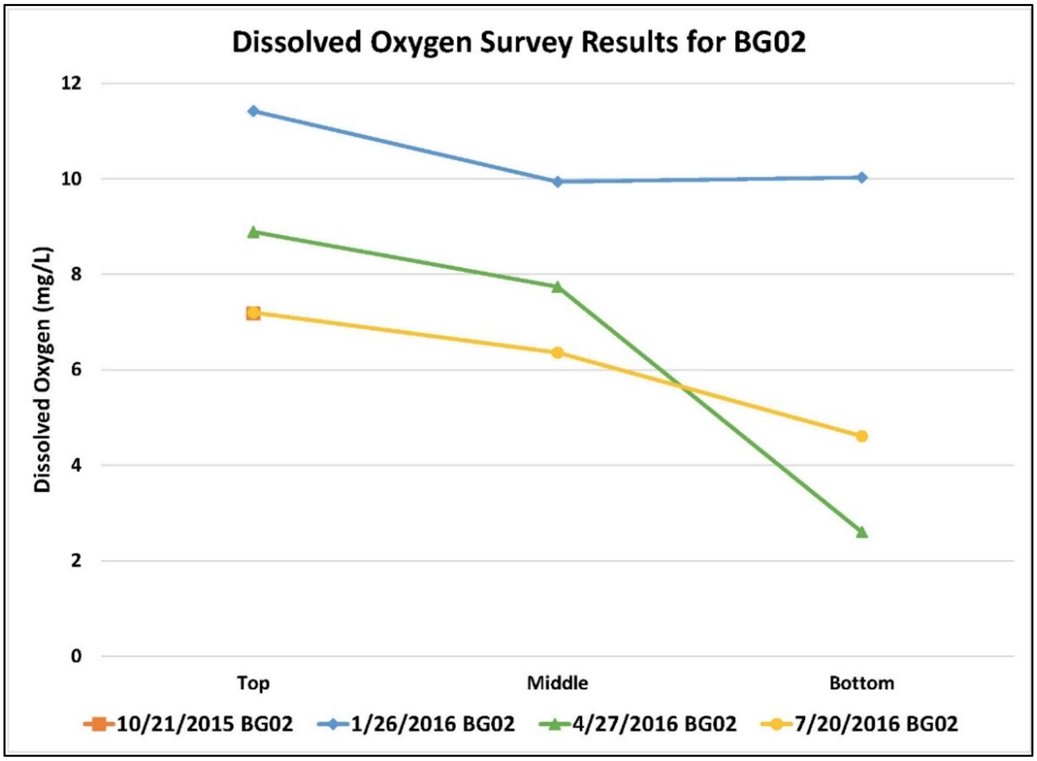

Figure D-3. DO survey results for BG02

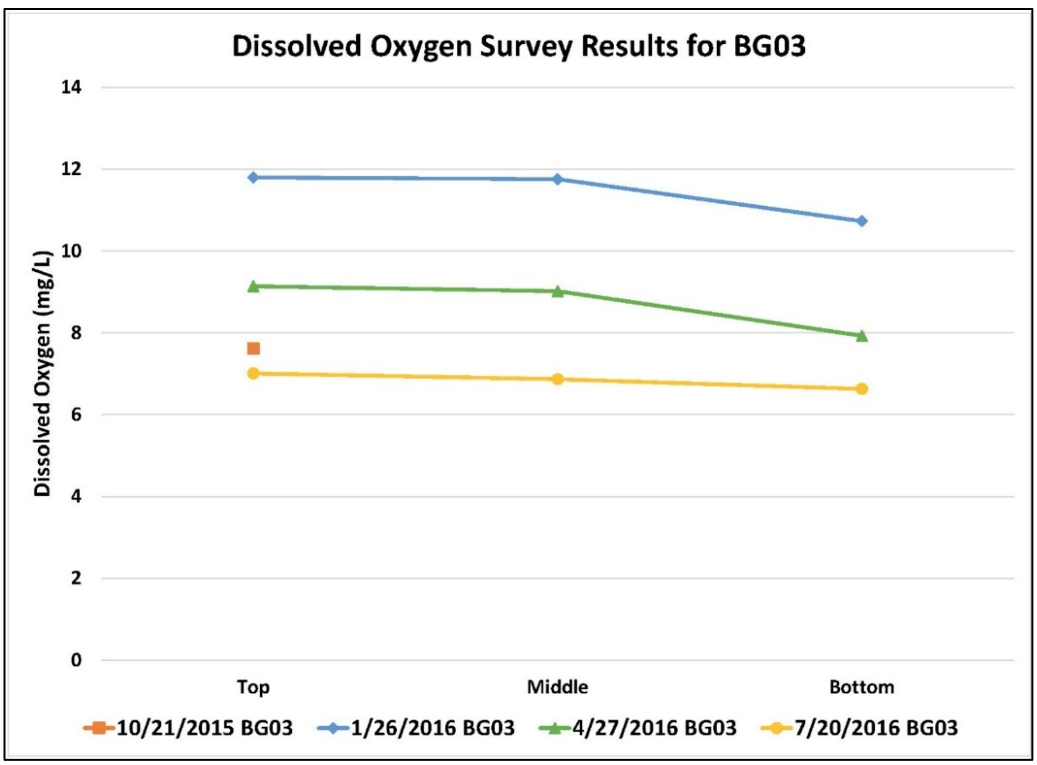

Figure D-4. DO survey results for BG03

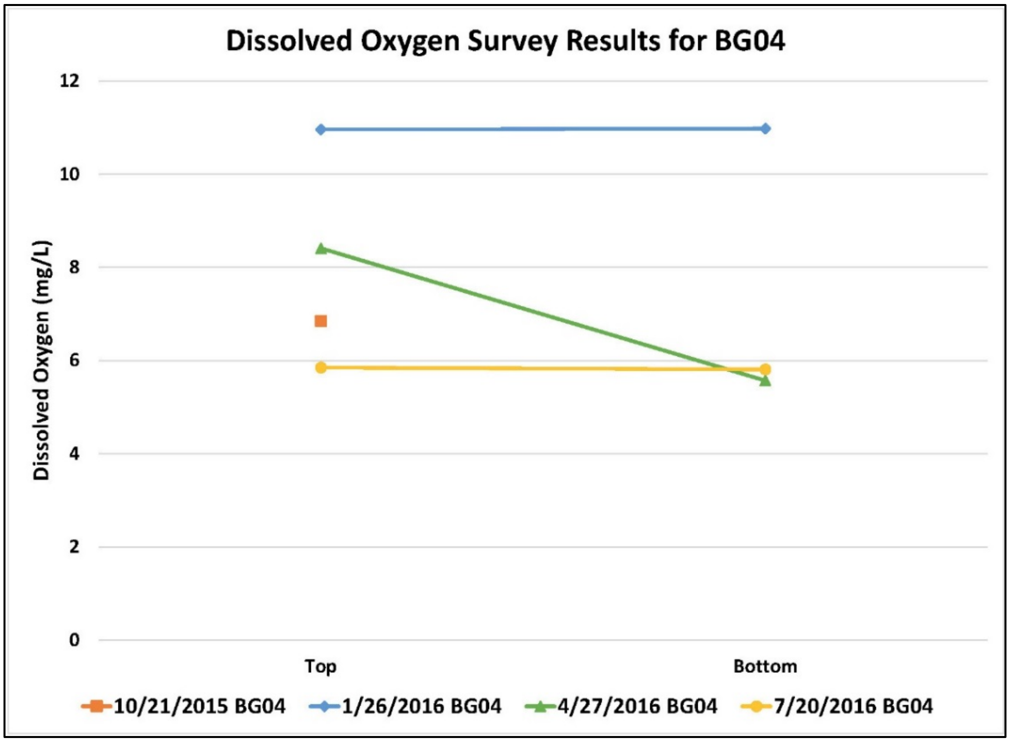

Figure D-5. DO survey results for BG04

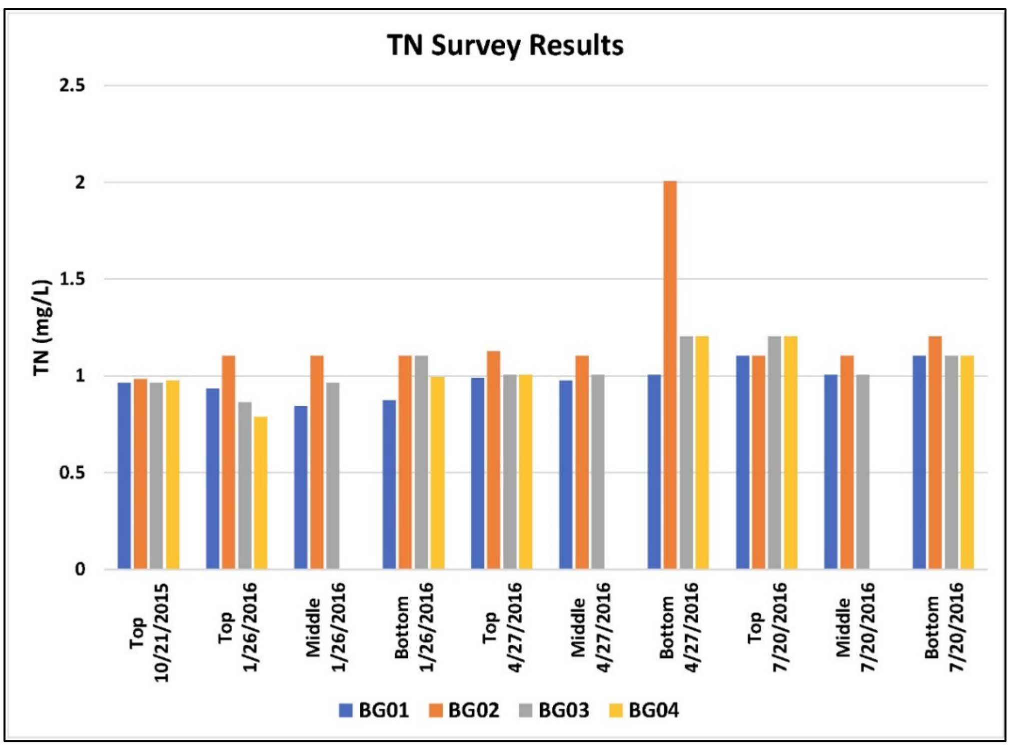

Figure D-6. TN survey results

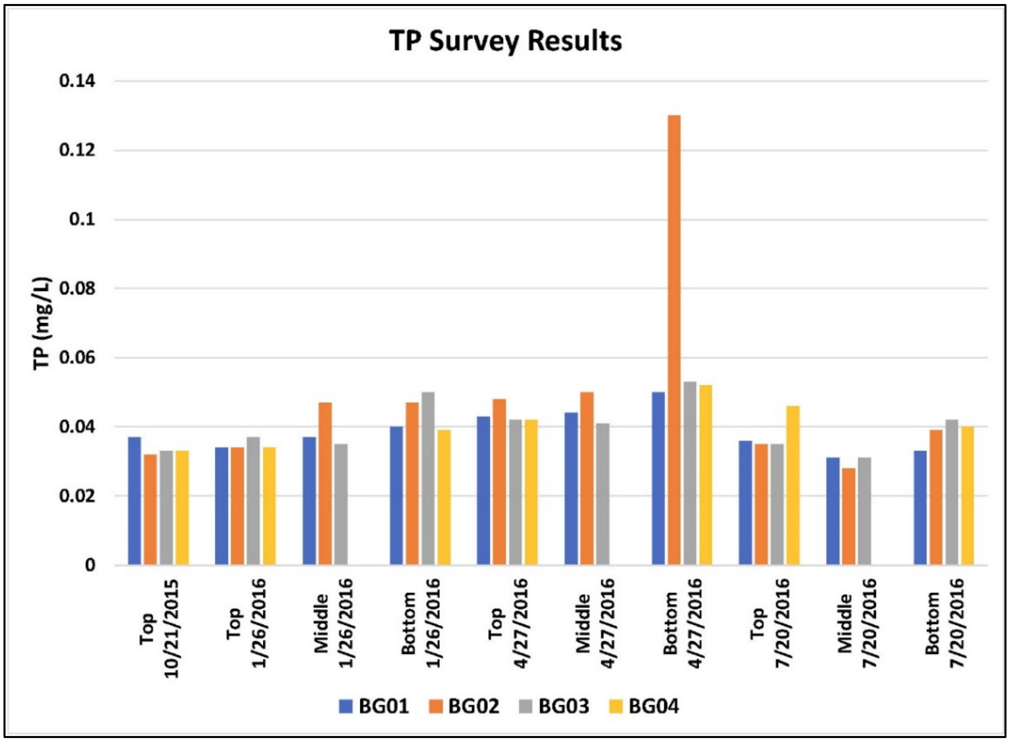

Figure D-7. TP survey results

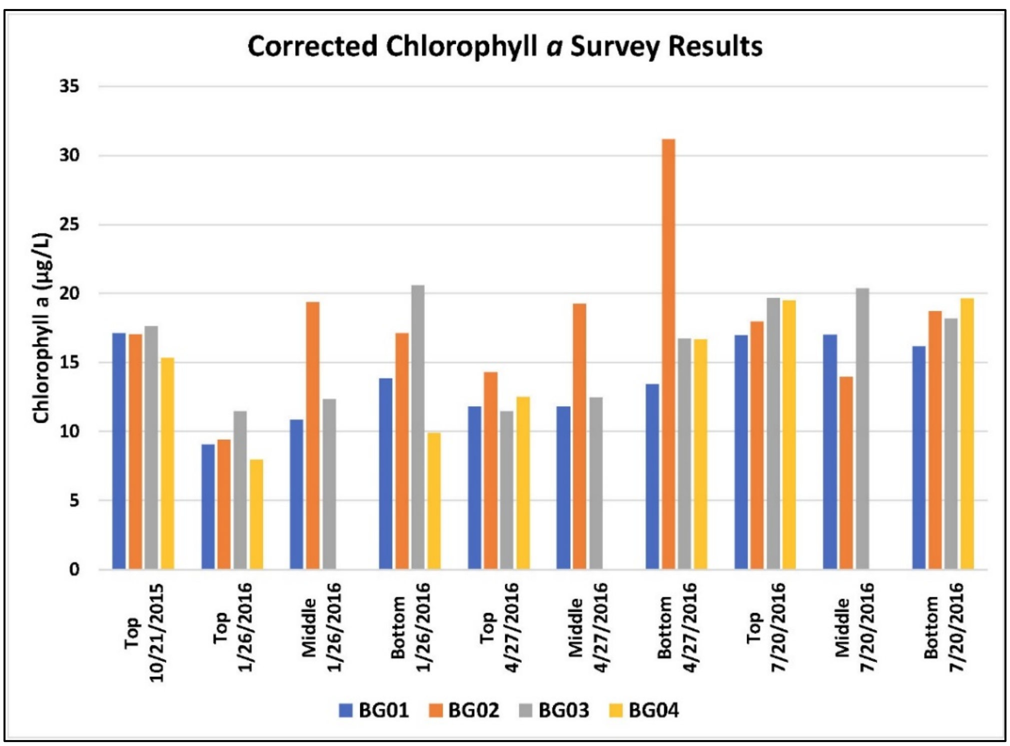

Figure D-8. Corrected chlorophyll *a* survey results