Central District • Kissimmee River Basin

Final TMDL Report
Nutrient TMDLs for Lake Persimmon (WBID 1938E)

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

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Executive Summary

Lake Persimmon is located in Highlands County, Florida. The lake was identified as impaired for nutrients based on exceedances of the applicable chlorophyll *a*, and total nitrogen (TN) criteria for Florida lakes (Subparagraph 62-302.531[2][b]1., Florida Administrative Code) and were added to the 303(d) list by Secretarial Order in June 2017. Total maximum daily loads (TMDLs) for TN and TP have been developed, and the TN and TP TMDLs will serve as site-specific interpretations of the narrative nutrient criterion for the lake. Supporting information for the TMDLs is listed in **Table EX-1**. The TMDLs were developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by the U.S. Environmental Protection Agency.

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

Type of Information	Description
Waterbody name/ WBID number	Lake Persimmon (WBID 1938E)
Hydrologic Unit Code (HUC 8)	03090101
Use classification/ Waterbody designation	Class III Freshwater
Targeted beneficial uses	Fish consumption; recreation; and propagation and maintenance of a healthy, well-balanced population of fish and wildlife.
303(d) listing status	Verified List of Impaired Waters for the Group 4 basins (Kissimmee River Basin) adopted via Secretarial Order dated June 27, 2017.
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 concentration not to be exceeded more than once in any consecutive 3-year period. TN: 1,247 pounds per year (lbs/yr), expressed as a rolling 7-year average load not to be exceeded. TP: 58 lbs/yr, expressed as a rolling 7-year average load not to be exceeded.
Load reductions required to meet the TMDLs	A 42 % TN reduction and a 51 % TP reduction to achieve a chlorophyll *a* target of 20 µg/L.

Acknowledgments

This analysis was accomplished thanks to significant contributions from staff in the Florida Department of Environmental Protection (DEP) Division of Environmental Assessment and Restoration, specifically, the Office of Watershed Services, Watershed Assessment Section, Standards Development Section, Water Quality Restoration Program, South Regional Operations Center, and Watershed Evaluation and TMDL Section. DEP would like to acknowledge, Clinton Howerton, Jr., Clell Ford and J.D. Forster of Highlands County for the substantial support provided.

Map production assistance was provided by Janis Morrow.

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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 Lake Persimmon, located in the Kissimmee River Basin. The TMDLs will also constitute the site-specific numeric interpretation of the narrative nutrient criterion set forth in Paragraph 62-302.530(48)(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 Kissimmee River Basin adopted by Secretarial Order on June 27, 2017.

The TMDL process identifies the sources of the pollutant, provides water quality targets needed to achieve compliance with applicable water quality criteria, and quantifies the amount of a pollutant that can be assimilated in a waterbody based on the relationship between pollutant sources and water quality in the receiving waterbody. The TMDLs establish the allowable loadings to Lake Persimmon 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 Kissimmee River Basin (Hydrologic Unit Code [HUC 8] 03090101) into watershed assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or surface water segment. Lake Persimmon is WBID 1938E. **Figure 1.1** shows the location of the WBID in the basin and major geopolitical and hydrologic features in the region, and **Figure 1.2** provides a more detailed map of the WBID and its watershed boundary.

Lake Persimmon (Latitude N27^{o}21'17, Longitude W81^{o}24'22) is located just west of U.S. Highway 27 and a few miles north of the town of Lake Placid in Highlands County (**Figure 1.1**). The surface area of the lake is 49 acres (ac), and the average depth is 4.1 feet (ft) below the lake surface, with a maximum depth of 11 ft at the lake center.

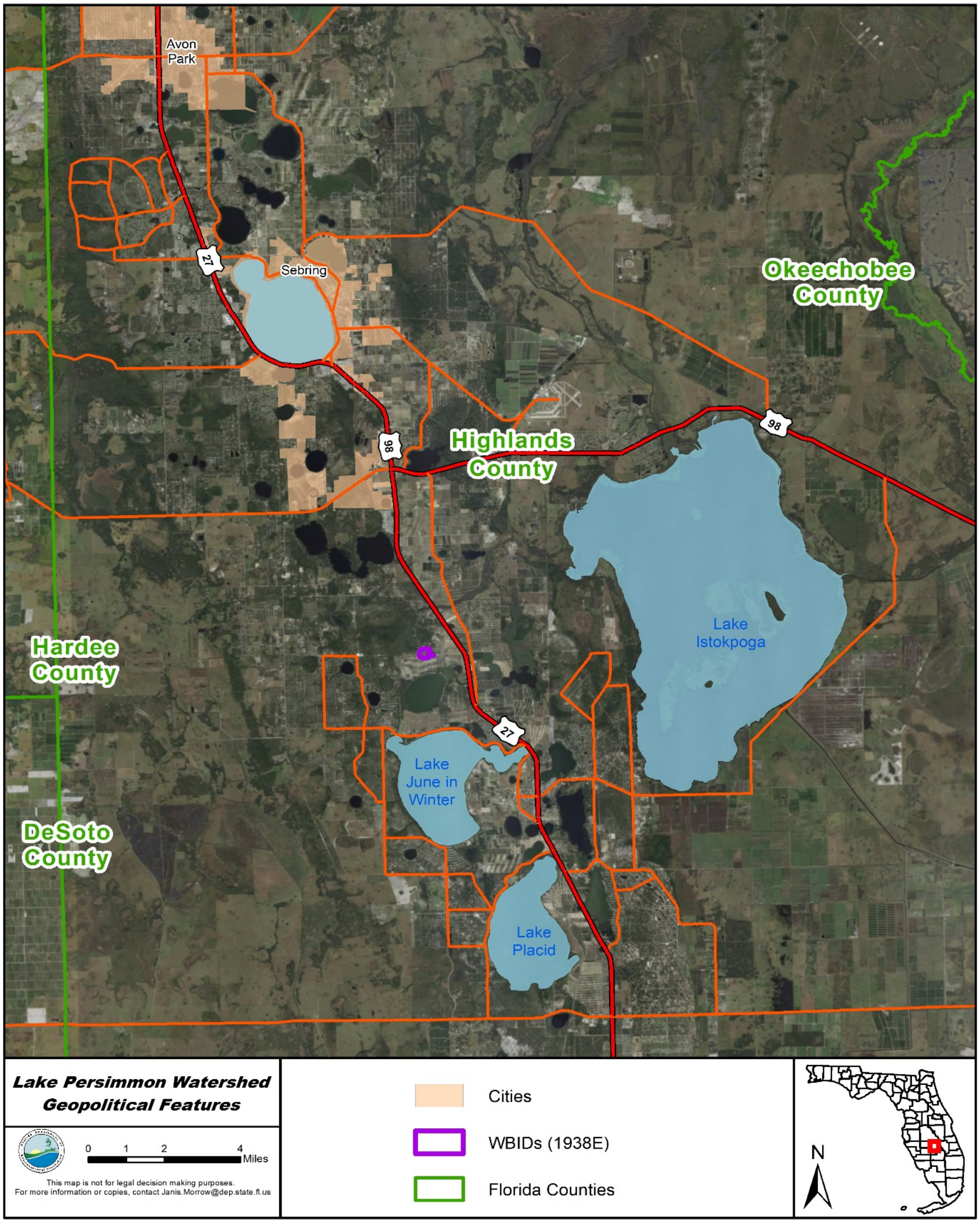

Figure 1.1. **Location of Lake Persimmon (WBID 1938E) and major hydrologic and geopolitical features in the area**

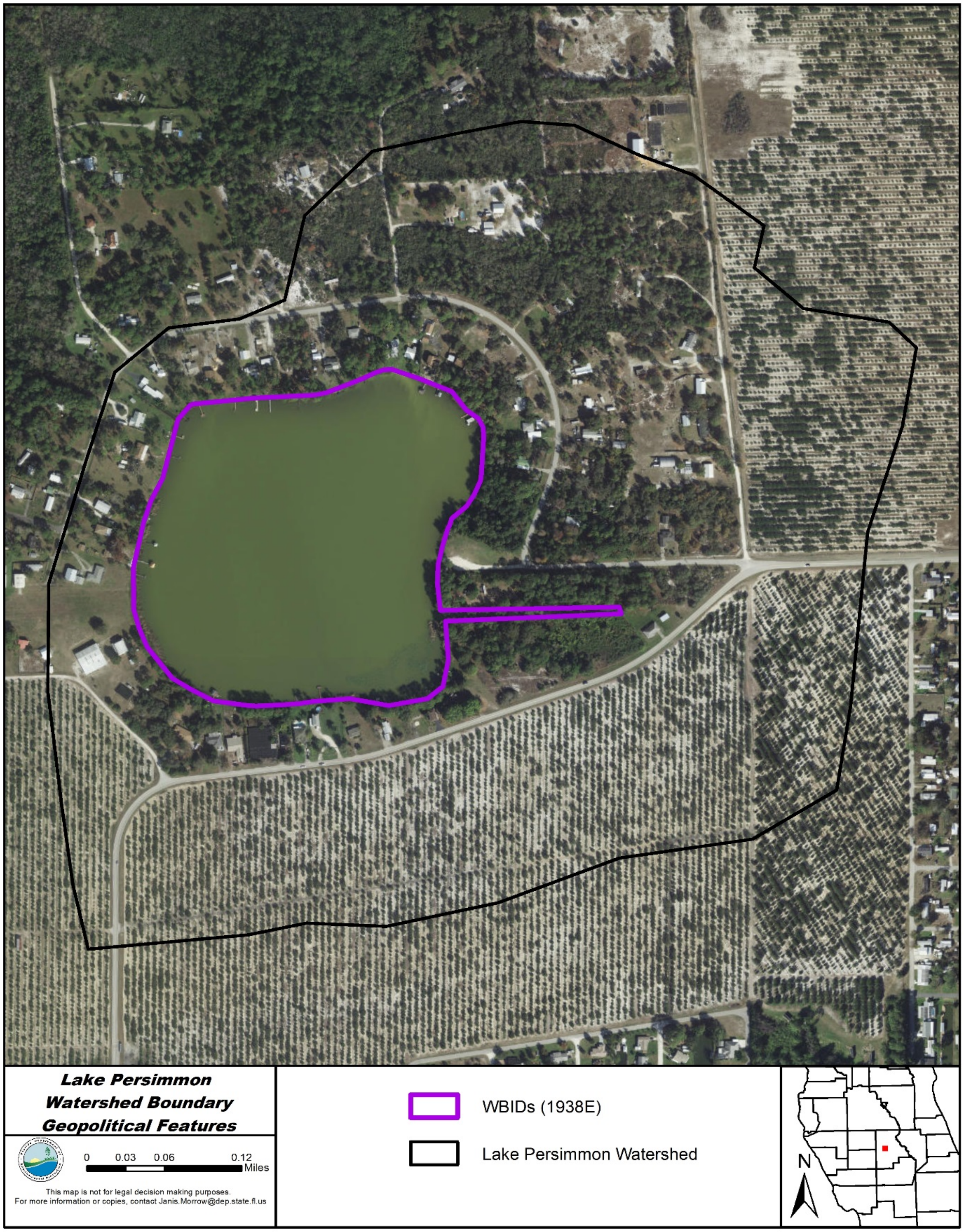

Figure 1.2. **Lake Persimmon (WBID 1938E) and its watershed boundary**

1.3 Watershed Information

1.3.1 Population and Geopolitical Setting

Lake Persimmon and its drainage basin are situated in Highlands County, 8 miles south of Sebring and 0.5 miles north of Lake Frances. Land use in the watershed is mainly citrus agriculture, which was established between 1944 and 1957 (Riedinger-Whitmore et al. 2005). Based on 1990 land cover, 43 % of the area consists of citrus agriculture, 24 % low-density residential, and 22 % pine flatwoods (SWFWMD 2000). Citrus agriculture now accounts for 45 % of the drainage area, followed by low-density residential with 43 % of the watershed. The rest of the area is classified as forest/rangeland and wetland. The population density, based on 2010 U.S. Census Block Groups, is 97 persons per square mile (U.S. Census Bureau 2017).

1.3.2 Topography

The general flow direction in the Lake Istokpoga Planning Unit flows south into Lake Istokpoga. No hydraulic control structures in the planning unit alter the flow direction. Lake Persimmon receives drainage from the surface water drainage area of its subbasin with elevations of 75 to 100 ft National Geodetic Vertical Datum (NGVD). In contrast, the lake water seeps out via the lower-lying area of the basin, located on the northwest side of the lake, with elevations of 65 to 75 ft NGVD. The lake has no direct connection to downstream surface waterbody but its outflow including baseflow may seep north to adjacent marsh terrain where topographic elevations are lowest, with the range of 60 to 65 ft NGVD as explained in the following subsection.

1.3.3 Hydrogeological Setting

Lake Persimmon and its drainage basin are located in the Lake Wales Ridge as defined by White (1970). Its hydrogeology can be described as that of a Florida ridge lake with unconsolidated sands and clays in a surficial aquifer system that overlies an irregular limestone surface of the Upper Floridian aquifer (Sacks et al. 1998). The geology of the lake is dominated by deeply weathered beach and dune sand, with some clay lenses of the preglacial Pleistocene (Brooks 1981). Such hydrogeological characteristics favor the rapid infiltration of rainwater in the watershed, and surface water runoff is limited even though there is a shallow (<1.0 meter [m]) canal on the east side of the lake for access. There is no defined tributary directly connected to downstream or upstream waterbodies. A small, narrow drainage ditch along the northwest side of the lake is the only outflow to adjacent marsh terrain during high-flow conditions (Rutter 2005).

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 Lake Persimmon Watershed and their corresponding acreages. Based on the soil characteristics, as shown in **Figure 1.3**, soils 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 infiltration rates.

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

Soil Hydrologic Group	Acreage	% Acreage
A	121	70
A/D	46	27
B/D	6	3
Total	**173**	**100**

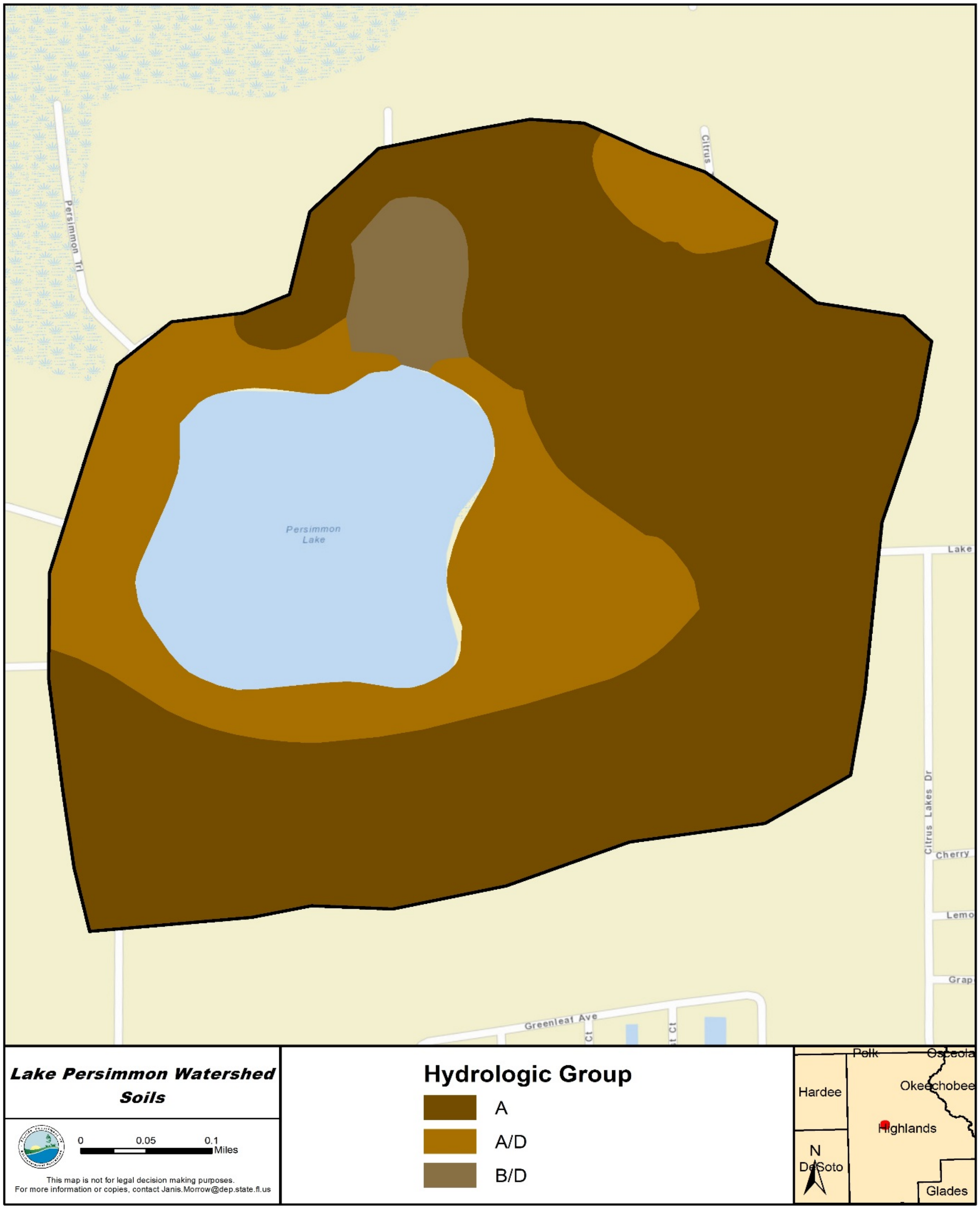

Figure 1.3. Hydrologic soil groups in the Lake Persimmon Watershed

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

2.1 Statutory Requirements and Rulemaking History for Assessments

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

The Florida Watershed Restoration Act (FWRA) (Section 403.067, Florida Statutes [F.S.]) directed DEP to develop, and adopt by rule, a science-based methodology to identify impaired waters. The Environmental Regulation Commission adopted the methodology as Chapter 62-303, F.A.C. (the Impaired Surface Waters Rule, or IWR), in 2001. The rule was amended in 2006, 2007, 2012, 2013, and 2016 (DEP 2015).

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

2.2 Classification of the Waterbody and Applicable Water Quality Standards

Lake Persimmon is a Class III (fresh) waterbody, with a designated use of fish consumption, recreation, and propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criteria applicable to the verified impairment (nutrients) for this waterbody are Florida's lake nutrient criterion in Paragraph 62-302.531(2)(b)1, F.A.C. Florida adopted NNC for lakes, spring vents, and streams in 2011. These were approved by the EPA in 2012 and became effective in 2014.

The generally 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 53, Lake Persimmon is classified as a low-color (<40 PCU), high-alkalinity (>20 mg/L $CaCO_3$) lake, as shown in **Table 2.1**.

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

Parameter	Long-Term Geometric Mean	Number of Samples
Color (PCU)	19	59
Alkalinity (mg/L $CaCO_3$)	35	49

The chlorophyll *a* NNC for a low-color, high-alkalinity lake 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 total nitrogen (TN) and total phosphorus (TP) criteria for a lake can vary annually, depending on the availability of data for chlorophyll *a* and the concentrations of chlorophyll *a* in the lake.

If there are sufficient data to calculate an AGM for chlorophyll *a* and the AGM 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 (µg/L)	Minimum NNC AGM TP (mg/L)	Minimum NNC AGM TN (mg/L)	Maximum NNC AGM TP (mg/L)	Maximum NNC AGM Total TN (mg/L)
>40 PCU	20	0.05	1.27	0.16[1]	2.23
≤ 40 PCU and > 20 mg/L $CaCO_3$	20	0.03	1.05	0.09	1.91
≤ 40 PCU and ≤ 20 mg/L $CaCO_3$	6	0.01	0.51	0.03	0.93

2.3 Determination of the Pollutant of Concern

2.3.1 Data Providers

Data providers for Lake Persimmon include Highlands County, Florida LakeWatch, Southwest Florida Water Management District (SWFWMD), and DEP, with the majority of the available data coming from LakeWatch monitoring. **Table 2.3** summarizes the data providers and their corresponding stations. From 1994 to 2011, Florida LakeWatch (21FLKWATHIG) sampled the lake once a month at three stations for uncorrected chlorophyll *a*, TN, and TP. DEP and SWFWMD (21FLFTM and 21FLSWFD) sampled the lake bimonthly or quarterly in 2004 and 2013 through 2016. For modeling and TMDL target-setting purposes, data provided by Florida LakeWatch were not used because no corrected chlorophyll *a* data were available when the TMDLs were developed. Data collected from Highlands County, SWFWMD, and DEP were used in the model calibration for TMDL development in Lake Persimmon and are discussed in further detail in **Chapter 5**. **Figure 2.1** shows the sampling locations in the WBID. The individual water quality measurements discussed in this report are available in IWR Database Run 53 and are available on request.

Table 2.3. Lake Persimmon data providers

Sampling Station	Data Provider Name	Activity Begin Date	Activity End Date
21FLFTM 26010303	DEP (South District)	2004	2016
21FLFTM 26010678FTM	DEP (South District)	2004	2014
21FLFTM 26010679FTM	DEP (South District)	2004	2014
21FLFTM 26010680FTM	DEP (South District)	2004	2004
21FLFTM 26010681FTM	DEP (South District)	2004	2004
21FLKWATHIG-PERSIMMON-1	Florida LakeWatch	1994	2011
21FLKWATHIG-PERSIMMON-2	Florida LakeWatch	1994	2011
21FLKWATHIG-PERSIMMON-3	Florida LakeWatch	1994	2011
21FLSWFD23720	SWFWMD	2006	2014

2.3.2 Information on Verified Impairment

DEP used the IWR to assess water quality impairments in the Group 4 Kissimmee River Basin and verified that Lake Persimmon was impaired for nutrients based on elevated annual average Trophic State Index (TSI) values during the Cycle 1 verified period (January 1, 1998–June 30, 2005). When the Cycle 1 assessment was performed, the IWR methodology used the water quality variables TN, TP, and chlorophyll *a* to calculate annual TSI values to interpret Florida's narrative nutrient criterion.

The TSI thresholds were set based on annual mean color, where high-color lakes (> 40 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 single year of the verified period was sufficient to identify a lake as impaired for nutrients. For the Cycle 1 assessment, Lake Persimmon was classified as high color and had annual mean TSI values exceeding the impairment threshold of 60 from 1998 to 2004.

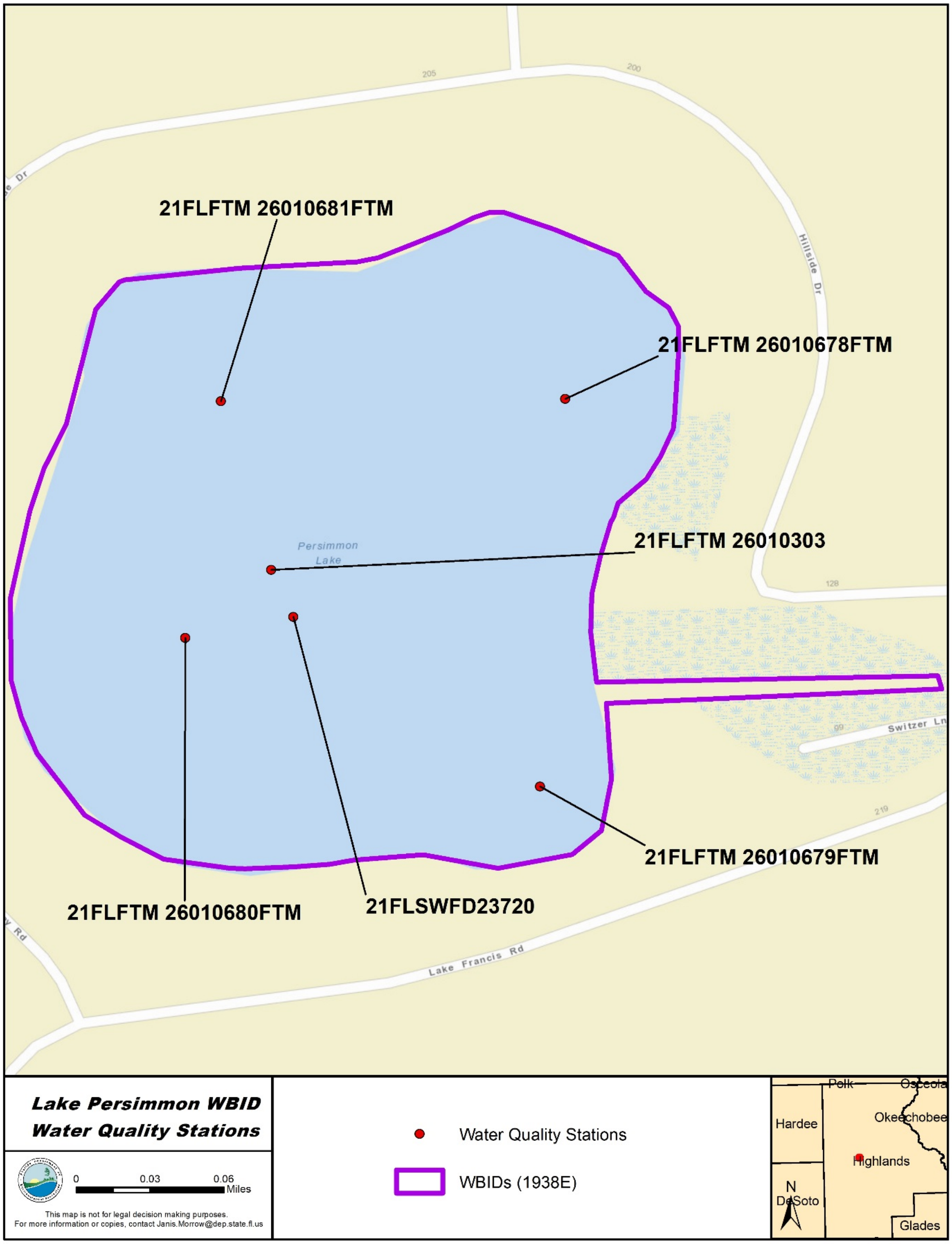

Figure 2.1. Monitoring stations in Lake Persimmon

On July 2, 2012, the IWR was amended to incorporate the numeric interpretations of Florida's narrative nutrient criterion (Rule 62-302.531, F.A.C.). Under the revised IWR methodology, lakes are assessed for chlorophyll *a*, TN, and TP as individual parameters, and the TSI is no longer used. In Cycle 3, the IWR methodology used the new lake NNC (Table 2.2). At the time of the Group 4 Cycle 3 assessments (planning period, January 1, 2004–December 31, 2013; verified period, January 1, 2009–June 30, 2016), all waterbodies previously determined to be impaired for TSI were placed into Category NA Delist (Not Applicable) per Paragraph 62-303.720(2)(l), F.A.C.

Under the revised methodology, Lake Persimmon was not impaired for TP based on AGM values calculated for 2004, and 2013–16. However, it was impaired for chlorophyll *a* (exceeding the criterion in 2013–16) and TN (exceeding the criterion in 2004 and 2013–16). Lake Persimmon was submitted to the EPA as an addition to the 303(d) list for these parameters. **Table 2.4** lists the AGM values assessed during the Cycle 3 verified period from 2009 to 2016.

Table 2.4. Lake Persimmon AGM values during the verified period, 2009–16

ID = Insufficient data.

Year	Chlorophyll *a* (µg/L)	TN (mg/L)	TP (mg/L)
2009	ID	ID	ID
2010	ID	ID	ID
2011	ID	ID	ID
2012	ID	ID	ID
2013	47	2.15	0.03
2014	43	2.10	0.02
2015	43	2.29	0.02
2016	32	2.44	0.02

2.4 Relationships Between Water Quality Variables

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 January 1, 2004–June 30, 2016 for Lake Persimmon. **Figure 2.2** shows time-series of water quality data. Individual water quality measurements (daily raw data) for TN, TP, and chlorophyll *a* were also used for the model calibration and validation, as discussed in further detail in **Chapter 5**.

TN and chlorophyll *a* concentrations remained high over the 13-year period, averaging 2.4 ± 0.5 mg/L for TN and 48 ± 17 µg/L for chlorophyll *a*, while TP concentrations were relatively lower, averaging 0.03 ± 0.01 mg/L. Because of elevated TN concentrations, the TN/TP ratios (by weight) in the lake appeared to be high, averaging 92 ± 32 (n = 44) over the period, indicating that the lake was strongly limited by phosphorus for phytoplankton growth (**Figure 2.2**). No significant temporal changes in TN, TP, and chlorophyll *a* concentrations in the lake were observed during the period, with coefficients of variation (CV) of 21 % for TN, 45 % for TP, and 21 % for chlorophyll *a*.

The AGMs of chlorophyll *a* during the assessment period from 2004 to 2016 are available only for 2013 through 2016, and the AGMs of TN and TP for 2004 and 2013 through 2016, when data requirements were sufficient to calculate the AGMs. With these AGMs available, no positive relationship between chlorophyll *a* AGMs, TN AGMs, and TP AGMs was identified.

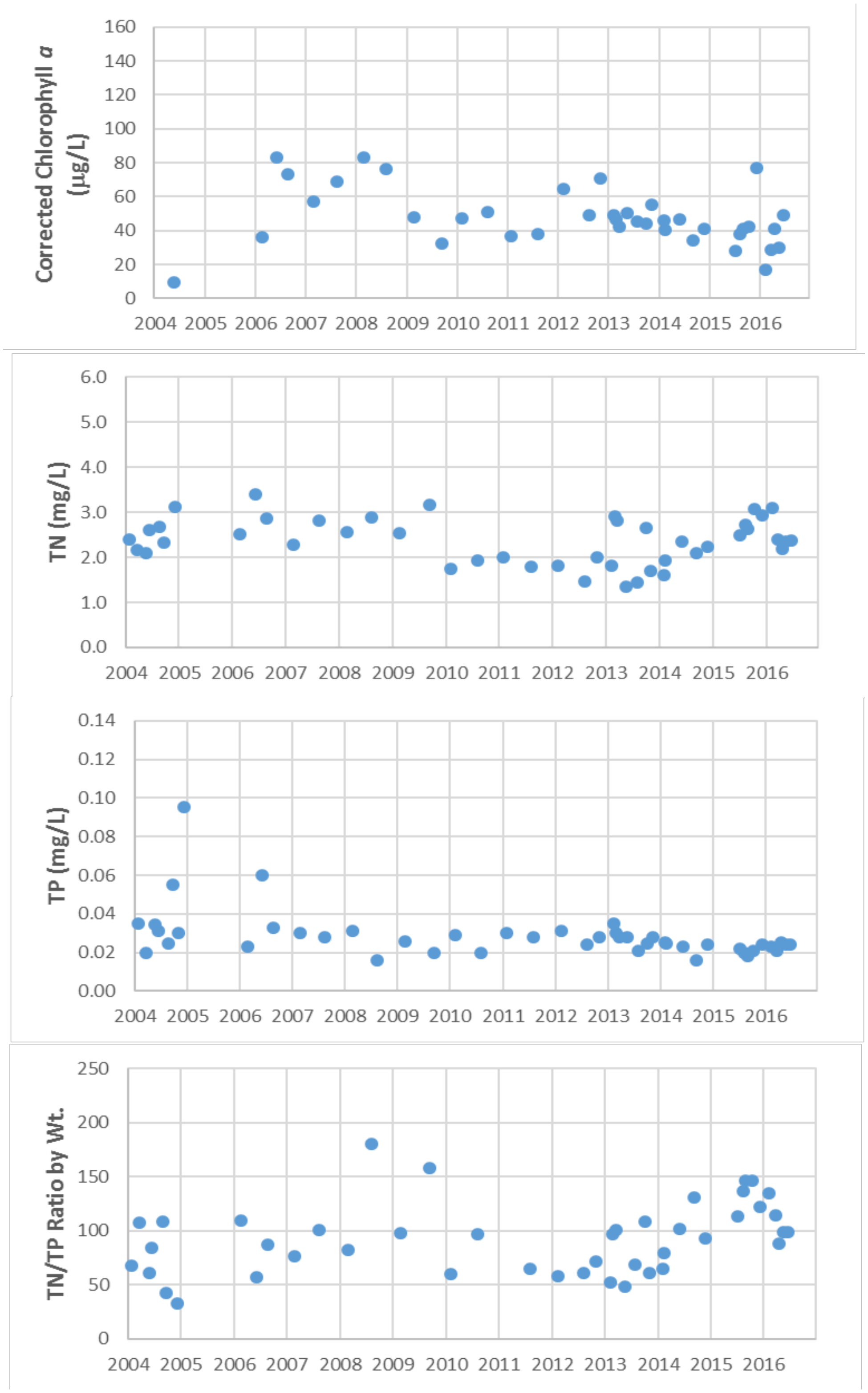

Figure 2.2. Temporal trends of corrected chlorophyll a, TN, TP, and TN/TP ratio (by weight) in Lake Persimmon during the assessment period

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

3.1 Establishing the Site-Specific Interpretation

The nutrient TMDLs presented in this report, upon adoption into Rule 62-304.515, F.A.C., and approval by EPA, will constitute the site-specific numeric interpretation of the narrative nutrient criterion set forth in Paragraph 62-302.530(48)(b), F.A.C., that will replace the otherwise applicable NNC for low color and high alkalinity lakes, pursuant to Paragraph 62-302.531(2)(a), F.A.C. **Table 3.2** lists the elements of the nutrient TMDLs 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 Lake Persimmon 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 Response Variable Target Selection

The development of the generally applicable lake NNC was based on the selection of a protective chlorophyll *a* criterion and then an 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 lakes with low color (less than 40 PCU) and high alkalinity (higher than 20 mg/L $CaCO_3$). DEP demonstrated that the chlorophyll *a* criterion of 20 µg/L is protective of designated uses and maintains the health of a balanced community of aquatic flora and fauna in low color, high alkalinity lakes. There is no information available suggesting that Lake Persimmon requires lower chlorophyll *a* levels, and therefore DEP has determined that the generally applicable NNC chlorophyll *a* criterion for a low-color, high-alkalinity lake 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 the Site-Specific Numeric Interpretation

The TN and TP targets for Lake Persimmon were established using the modeling approach discussed in detail in **Chapter 5**. The site-specific interpretations of the narrative nutrient criterion were determined by using watershed and waterbody models to find TN and TP loadings that would achieve the chlorophyll *a* criterion of 20 µg/L. The simulated chlorophyll *a* corresponding to the simulated TN and TP loads were also compared with the model-simulated natural background chlorophyll *a* to avoid abating the natural background condition.

Model output was used to calculate the total annual load for each model year, and then 7-year rolling averages were calculated for each parameter (**Table 3.1**). The site-specific numeric interpretations of TN and TP were then set at the maximum 7-year averages of TN and TP loads that met the chlorophyll *a* criterion of 20 µg/L (TMDL condition). The resultant TN and TP criteria are 1,247 and 58 pounds per year (lbs/yr), respectively, and are expressed as a rolling 7-year average not to be exceeded.

Table 3.1. Lake Persimmon TMDL condition nutrient loads

Note: Values shown in boldface type with an asterisk indicate the maximum of the seven-year rolling averages.

Year	TMDL Condition TN Loads (lbs/yr)	7-Year Rolling Average TN Loads (lbs/yr)	TMDL Condition TP Loads (lbs/yr)	7-Year Rolling Average TP Loads (lbs/yr)
2005	1,317		60	
2006	941		45	
2007	764		34	
2008	1,602		78	
2009	800		36	
2010	1,071		50	
2011	632	1,018	28	47
2012	1,246	1,008	57	47
2013	1,301	1,059	61	49
2014	1,447	1,157	67	54
2015	1,451	1,135	67	52
2016	1,584	**1,247***	72	**58***

Table 3.2 summarizes loads for TN and TP that will be considered the site-specific interpretation of the narrative criterion. 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 chlorophyll *a* criterion of 20 µg/L. The TN and TP restoration concentrations for Lake Persimmon are AGM concentrations of 1.48 and 0.02 mg/L, respectively, not to be exceeded in any year.

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

Note: Chlorophyll *a* shall not be exceeded more than once in any consecutive three-year period.

WBID	AGM Chlorophyll *a* (µg/L)	Rolling 7-Year Annual Average TN (lbs/yr)	Rolling 7-Year Annual Average T (lbs/yr)
1938E	20	1,247	58

3.4 Downstream Protection

There are no defined drainage canals or streams connecting Lake Persimmon to downstream waterbodies, but a narrow, man-made ditch on the northwest side of the lake is the only outlet during a high-flow regime. During normal flow conditions, the lake most likely seeps out to the adjacent marsh terrain via subsurface interflow and baseflow to maintain and balance its water level. The seepage flow from the lake may eventually drain through the marsh terrain to Josephine Creek, 1.1 miles northeast of Lake Persimmon. Based on the Cycle 3 assessment, Josephine Creek was listed as verified impaired for nutrients (macrophytes), while chlorophyll *a* was not assessed because of insufficient data during the verified period. Since there is no direct hydrologic connection of Lake Persimmon to a remote creek, Josephine Creek, the outflow from Lake Persimmon will not have an impact on water quality of the creek. However, the restoration targets for Lake Persimmon compared with the applicable stream nutrient thresholds for Peninsular streams (0.12 mg/L of TP, and 1.54 mg/L of TN, expressed as AGMs not to be exceeded more than once in any 3-year period [DEP 2013b]), showing that the restoration targets of Lake Persimmon will meet the applicable stream nutrient thresholds. Therefore, the Lake Persimmon TMDL will be protective of stream water quality.

3.5 Endangered Species Consideration

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

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

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

DEP is not aware of any endangered species or designated critical habitat present in Lake Persimmon. Furthermore, it is expected that water quality improvements resulting from these restoration efforts will positively affect aquatic species living in the lake and its watershed.

Chapter 4: Assessment of Sources

4.1 Types of Sources

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

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

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

4.2 Point Sources

4.2.1 Wastewater Point Sources

When these TMDLs were being developed, no NPDES-permitted wastewater facilities were identified in the Lake Persimmon watershed.

4.2.2 Municipal Separate Storm Sewer System (MS4) Permittees

MS4s may discharge nutrients to waterbodies in response to storm events. To address stormwater discharges, the EPA developed the NPDES stormwater permitting program in two phases. Phase I, promulgated in 1990, addresses large and medium MS4s located in incorporated places and counties with populations of 100,000 or more. Phase II permitting began in 2003. Regulated

Phase II MS4s, defined in Section 62-624.800, F.A.C., typically cover urbanized areas serving jurisdictions with a population of at least 10,000 or discharge into Class I or Class II waters, or Outstanding Florida Waters. When these TMDLs were being developed, no MS4 permits were identified in the Lake Persimmon Watershed.

For more information on MS4s, send an email to NPDES-stormwater@dep.state.fl.us.

4.3 Nonpoint Sources

Nutrient loadings to Lake Persimmon are generated from nonpoint sources. The 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 Lake Persimmon 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 produce. Land use coverages in the watershed were aggregated using the Florida Land Use, Cover, and Forms Classification Code System (FLUCCS) (Florida Department of Transportation [FDOT] 1999).

Table 4.1 lists land uses in the watershed in 2009, based on data from SWFWMD 2009 coverage, and **Figure 4.1** shows the spatial distribution of these land use types. The total watershed area for Lake Persimmon is 173.9 ac. Cropland/tree crops and low-density residential are major land uses, comprising 77.7 and 75.3 ac, respectively (**Table 4.1**). These 2 categories accounted for 88 % of the total acreage, suggesting that fertilizer use and septic tank leakage are the major nonpoint sources of nutrients for the lake. The remaining land uses are open land/upland forests (11.5 ac) and wetlands (9.4 ac), accounting for 12 % of the total watershed area.

Table 4.1. SWFWMD 2009 land use in the Lake Persimmon Watershed

Land Use Code	Land Use Classification	Acres	% of Watershed
2200	Cropland/Tree Crops	77.7	45
1100	Low-Density Residential	75.3	43
1900	Open Land/Forest	11.5	7
6150/6430	Wetlands	9.4	5
Total		**173.9**	**100**

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.

The Camp Dresser McKee (CDM) report (2008) described in detail how loading from septic tanks was included in the Upper Kissimmee Chain of Lakes Hydrologic Simulation Program – FORTRAN (HSPF) Model. The assessment of septic tank contributions to impaired lakes was not directly accounted for in the HSPF Model because data accounting for the direct contribution of flow and nutrient loads from septic tanks to surface waters were not available for this area. Instead, the model implicitly included septic tank contributions by estimating the nutrient contributions of low-, medium-, and high-density residential areas containing a degree number of septic tanks and a variety of fertilizer uses to surface waters. The percent failure rate for septic tanks does not provide quantitative information on how much a failed septic tank leaks and the amount of flow and nutrients attenuated in soils and subsurface waters. If necessary, individual contribution from anthropogenic sources of interest in the watershed can be quantified in more detail during the BMAP) process. **Figure 4.2** shows the locations of OSTDS in the Lake Persimmon Watershed from the Florida Department of Health (FDOH) database (FDOH 2013).

4.3.3 Atmospheric Deposition

Nutrient loadings from the atmosphere are an important component of the nutrient budget in many Florida lakes. Nutrients are delivered through two pathways: wet atmospheric deposition with precipitation and dry particulate-driven deposition. Atmospheric deposition to terrestrial portions of the Lake Persimmon 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.

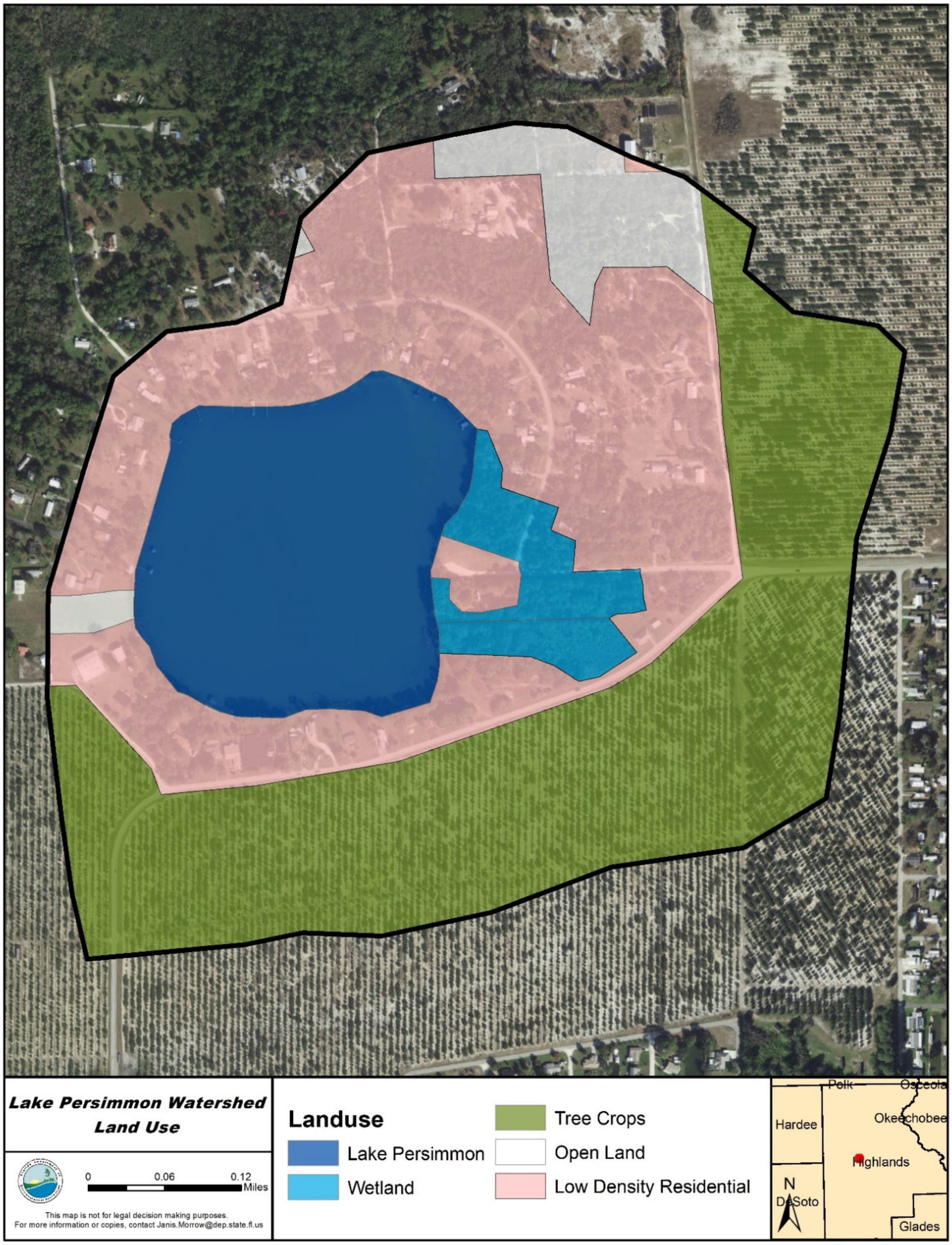

Figure 4.1. Land use in the Lake Persimmon Watershed

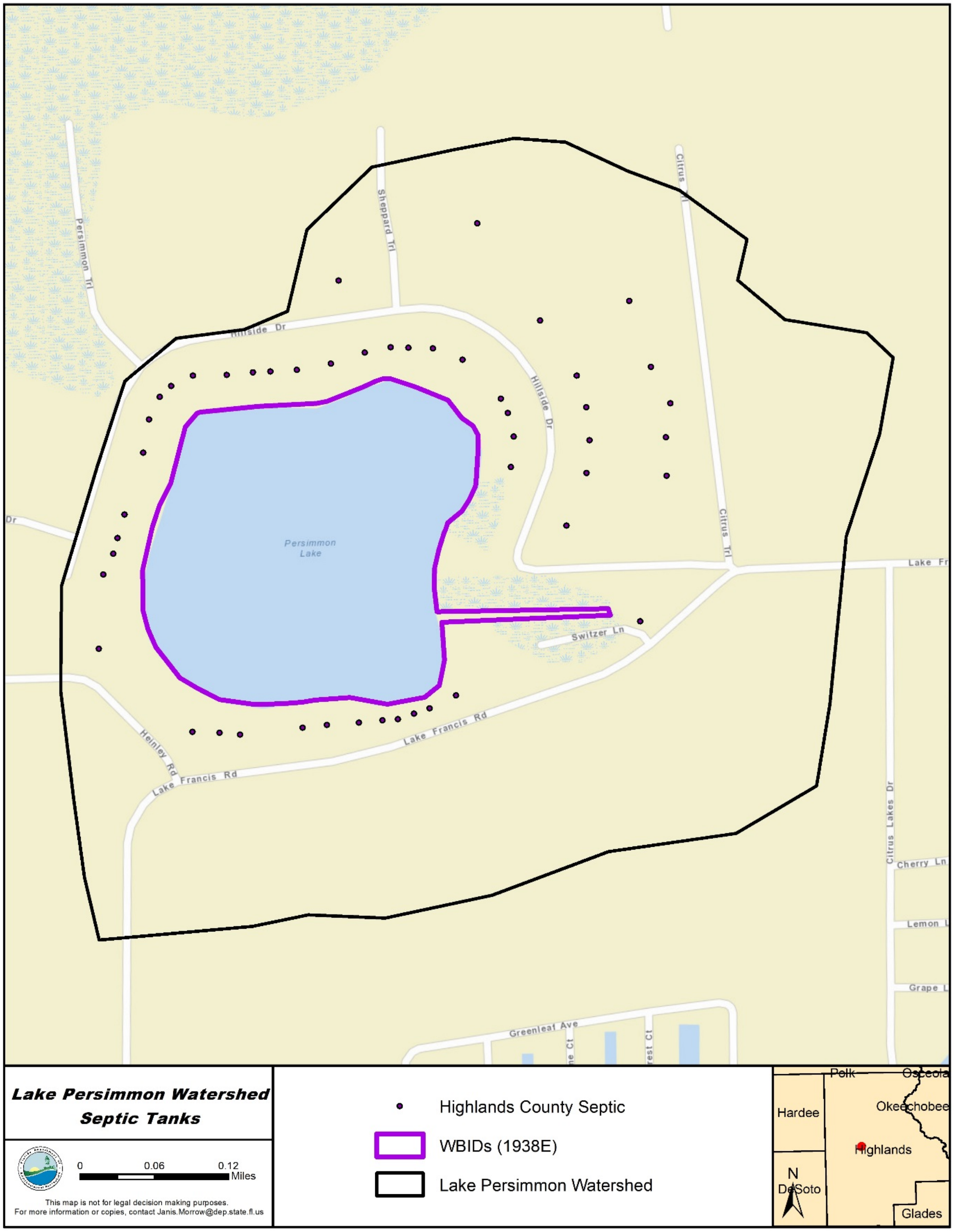

Figure 4.2. OSTDS in the Lake Persimmon Watershed

4.4 Estimating Watershed Loadings

4.4.1 HSPF Model Approach

HSPF is a comprehensive package that can be used to develop a combined watershed and receiving water model (EPA 2015; Bicknell et al. 2001). The model is capable of simulating both hydrologic and water quality processes in the watershed and receiving waterbodies. This dynamic model allows the input of rainfall, temperature, evaporation, evapotranspiration (ET), point source flows and loads, upstream or tributary inflows and constituent loads, sediment mass and associated constituent loads, and other time series data. It also allows the input of parameters related to the physical characteristics of a watershed (including topography, land uses, soil types, and agricultural practices) to conduct watershed simulations.

HSPF is used to conduct dynamic simulations of water quantity and quality in several layers, including the land surface, several soil zones, and the groundwater table. The watershed simulations can generate stormwater runoff flows and concentrations or loads of sediments, biochemical oxygen demand (BOD), nutrients, bacteria, pesticides, metals, toxic chemicals, and other water quality constituents. The flows and loadings from the watershed can then be used together with channel and boundary information to conduct in stream simulations, which then yield dynamic results of flow, constituent concentrations, and loads at user-selected locations.

HSPF can also simulate the transport of flow and sediment, and their associated water quality constituents, in stream channels and mixed reservoirs. These simulations include hydraulics, constituent advection, the transport of conservative constituents, inorganic sediment, generalized quality constituents, water temperature, nutrient cycles, dissolved oxygen (DO)–related processes, first-order decay, sediment sorption and desorption, and other water quality processes. To conduct hydrology simulations in HSPF, the user must provide a rating relationship that relates flow, water depth, water surface area, and water volume at each model reach. While being a dynamic model, HSPF does not accept a dynamic downstream boundary condition and cannot simulate backwater effects.

4.4.1.1 Pervious Land Segments (PERLND) Module

The PERLND Module of HSPF accounts for surface runoff, interflow, and baseflow (shallow groundwater flow) 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 through ET, 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).

4.4.1.2 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 4.2**, based on the Upper Kissimmee Chain of Lakes HSPF Model (CDM 2008).

Table 4.2. Percentage of imperviousness

Land Use Category	% Imperviousness
Commercial/Industrial	80
Cropland/Improved Pasture/Tree Crops	0
High-Density Residential	50
Low-Density Residential	10
Medium-Density Residential	25
Rangeland/Upland Forests	0
Unimproved Pasture/Woodland Pasture	0
Wetlands	0

4.4.1.3 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. For the Lake Persimmon Watershed, a RCHRES element defines the depth-area-volume relationship for the modeled waterbody. The depth-area-volume relationship was constructed based on the contour map available from LakeWatch, and a site-specific F-distribution table was created for Lake Persimmon.

4.4.2 Meteorological and Stage Data

Meteorological data—including rainfall, evaporation/ET, solar radiation, wind speed, air temperature, and dew point temperature—were obtained from the Sebring station of the Florida Automatic Weather Network (FAWN), an observation platform owned by the University of Florida, where hourly meteorological data are recorded. The weather station is located at Sebring, Highlands County, 2 miles northeast of Lake Persimmon. Hourly meteorological data, including air temperature, solar radiation, wind speed, and dew point temperature, were extracted from January 1, 2004, to December 31, 2016. Daily potential ET data were available at the station and later converted to hourly values for the model using the WDMUtil that is included with the EPA BASINS (Better Assessment Science Integrating Point and Nonpoint Sources) tool kit (EPA 2015). Daily cloud cover data were obtained from the NOAA Bartow station. Lake stage data were retrieved from the SWFWMD database. If the POR at a given station was missing data for a month or longer, the data from the closest station were used to complete the dataset. However, if data were missing for only a short period (i.e., days), the average of the day before and the day after was used to represent the data for the missing days. **Table 4.3** summarizes the meteorological and lake stage data sources used in the HSPF Model.

Rainfall is generally the most important input data required for hydrologic simulation, as it drives the hydrology, hydraulics, and transport in the system. **Figure 4.3** shows hourly and annual rainfall during the modeling period from 2004 to 2016. On an annual basis, total annual rainfall ranged from 38.0 to 59.5 inches (in), with an average annual rainfall of 49.7 ± 7.7 in. The 13-year average rainfall during this period was similar to the long-term average rainfall (51.9 in per year) based on the 71-year record from the Mountain Lake National Weather Service station located in Polk County (Swancar et al. 2000). The deficiency in annual rainfall from the long-term average was significant in 2006, 2007, 2009, and 2011, while excessive annual rainfall was observed in 2008 and 2014 through 2016. During the period of model simulation, rainfall data captured dramatic environmental conditions with dry years (2006, 2007, 2009, and 2011) and wet years (2008 and 2014 through 2016), which were reflected in the HSPF Model.

Table 4.3. Meteorological and lake stage data for the HSPF Model

Data Type	Data Source	Description
Rainfall	FAWN	Hourly data
Potential ET	FAWN	Daily data
Solar Radiation	FAWN	Hourly data
Air Temperature	FAWN	Hourly data
Wind Speed	FAWN	Hourly data
Dew Point Temperature	FAWN	Hourly data
Cloud Cover	NOAA	Daily data
Lake Stage	SWFWMD	Daily observation data

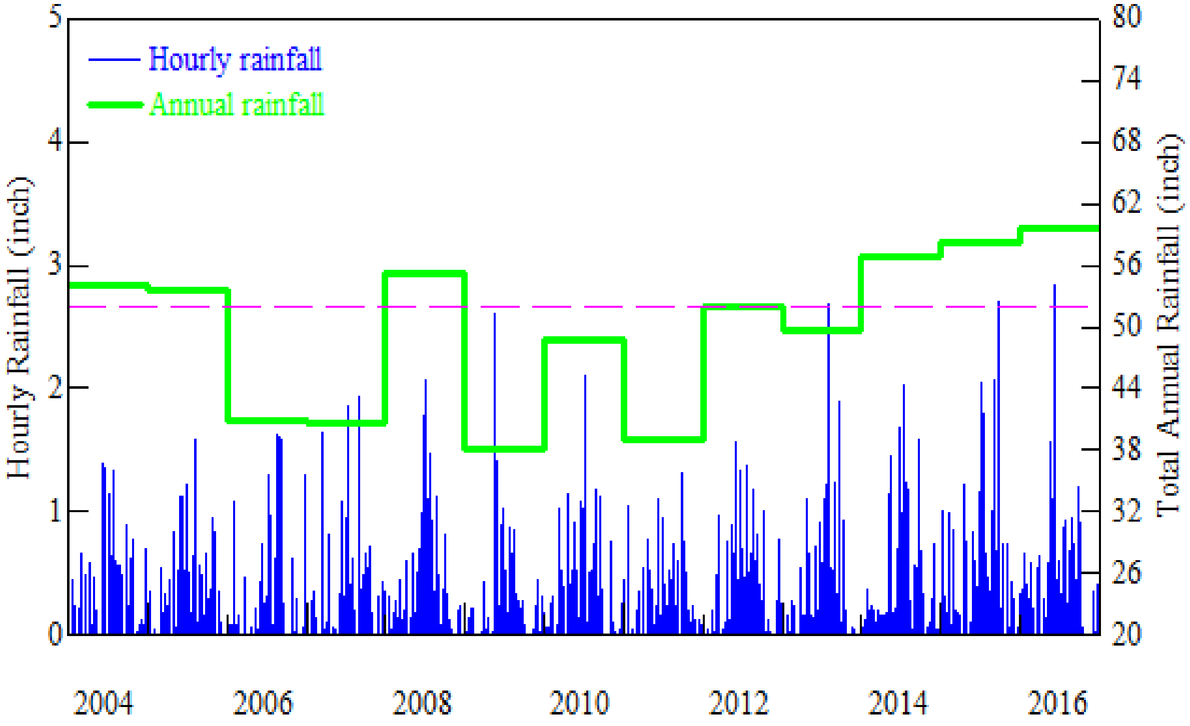

Figure 4.3. **Hourly and total annual rainfall at the Sebring station during the period of model simulation, 2004–16. The dotted line represents the 71-year long-term average rainfall observed in Polk County.**

4.4.3 Hydrology Calibration for Lake Persimmon

The HSPF Model, based on the aggregated land use categories, was used to simulate the watershed hydraulics and hydrology as well as in-lake water quality. The predicted lake level was a result of the water balance between water gains from the watershed and losses from the lake. Therefore, it is important to evaluate lake levels over time to develop reasonable water budgets.

The simulated lake levels were calibrated and validated using the observed gauge data obtained from January 1, 2004, to December 31, 2016 (**Figure 4.4**). Simulated lake levels ranged from 64.7 to 66.5 ft, averaging 65.9 ft (n = 4749) over the simulation period. Similarly, the observed data ranged from 64.0 to 67.0 ft and averaged 65.7 ft (n = 620), indicating that the model simulation well represents the long-term average stage for Lake Persimmon.

A series of statistical analyses was conducted to find out how well the model predicted daily and annual lake elevations. For a daily comparison, a relationship between daily observed lake levels and simulated lake levels is shown in **Figure 4.5**, indicating a positive correlation, with a correlation coefficient (r) of 0.894 (n = 620). A box-whisker plot indicates that the median (65.8

ft) observed lake level is similar to the median (66.0 ft) simulated lake level (**Figure 4.6**). General calibration and validation targets by Donigian (2002) and McCutcheon et al. (1990) for HSPF applications were used to evaluate the model results.

Table 4.4 summarizes the targets or tolerances for hydrology and water quality parameters. Overall differences in the median values between simulated and observed data for Lake Persimmon are 0.3 %, indicating that the model performed very well, predicting overall patterns and levels throughout the modeling period, although there was a noticeable discrepancy between the observed and simulated lake levels in 2011 and 2012 (**Figure 4.4**).

Table 4.5 lists the observed and simulated annual mean lake levels for Lake Persimmon during the simulation period from 2004 to 2016. The simulated annual mean lake level varied from 65.7 to 66.1 ft over the 13-year period, similar to the observed levels of 64.9 to 66.2 ft. The percent differences between observed simulated mean lake levels varied between 0.0 % and 1.5 % over the years. The 13-year long-term mean lake level was 65.7 ft from the observation and 65.9 ft from the simulation, indicating only a 0.3 % difference. Based on the point-to-point calibration and annual patterns of lake level, it was decided that the hydrology simulation was acceptable for estimating watershed loads to Lake Persimmon.

Table 4.4. Calibration/validation targets or tolerances for hydrology and water quality parameters (Donigian 2002; McCutcheon et al. 1990)

Category	Hydrology/Flow (%)	Water Quality/DO (%)	Nutrients/Chlorophyll *a* (%)
Very Good	<10	<15	<30
Good	10–15	15–25	30–45
Fair	15–25	25–35	45–60
Poor	>25	>35	>60

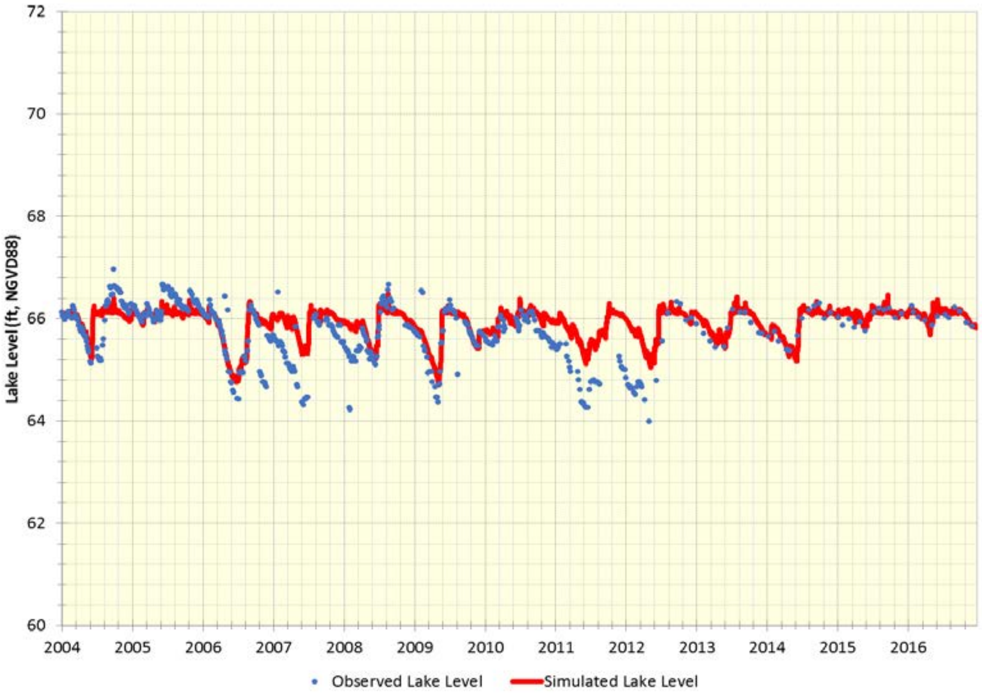

Figure 4.4. Observed lake level (ft, NGVD88) versus simulated lake level (ft) during the model simulation period, 2004–16

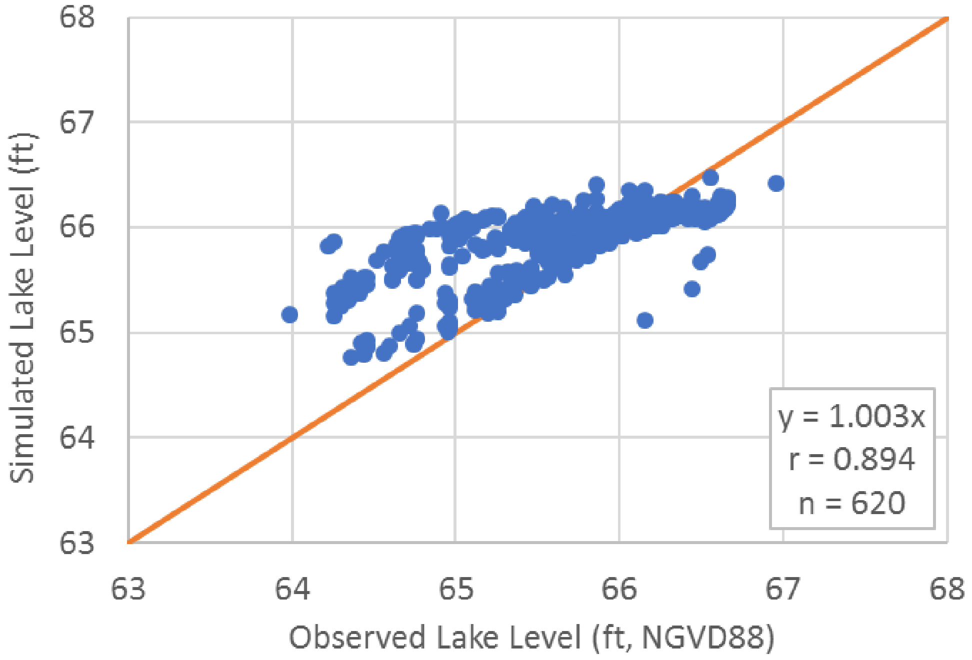

Figure 4.5. Daily lake level calibration during the simulation period, 2004-16. r and n represent a correlation coefficient and the number of observations, respectively. The orange line is the 1 to 1 line.

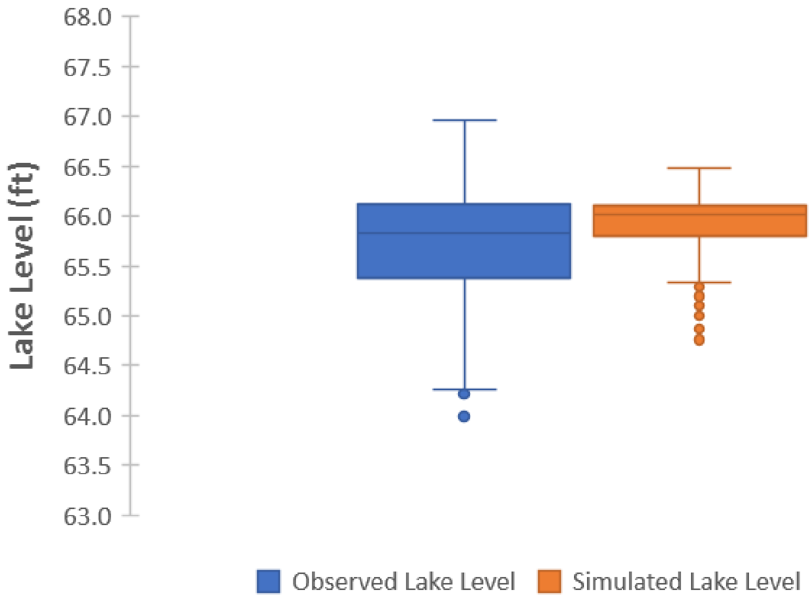

Figure 4.6. Box-whisker plot of daily observed versus simulated lake level (ft) during the simulation period, 2004–16

Table 4.5. Summary of statistics of observed versus simulated annual mean lake level (ft) in Lake Persimmon, 2004–16

Year	Observed Lake Level (ft)	Standard Deviation (ft)	Simulated Lake Level (ft)	Standard Deviation (ft)	Percent Difference (%)
2004	66.0	0.4	66.0	0.2	0.0
2005	66.2	0.2	66.1	0.1	0.2
2006	65.5	0.6	65.7	0.5	0.2
2007	65.4	0.5	65.9	0.2	0.8
2008	65.7	0.5	65.9	0.2	0.4
2009	65.6	0.5	65.7	0.4	0.2
2010	65.8	0.2	66.0	0.1	0.4
2011	64.9	0.4	65.8	0.2	1.5
2012	65.0	0.7	65.9	0.3	1.3
2013	65.8	0.3	65.9	0.2	0.2
2014	65.9	0.3	65.9	0.3	0.1
2015	66.0	0.1	66.1	0.1	0.1
2016	66.0	0.1	66.1	0.1	0.1
Average	**65.7**	**0.4**	**65.9**	**0.2**	**0.4**

4.4.4 Water Budget for Lake Persimmon

Lake water budget is an important tool for understanding the relative importance of water inflow and outflow. Water pathways (i.e., surface runoff, interflow, baseflow, and direct precipitation) through each land use category that carry nutrients from nonpoint and point sources were identified in the HSPF Model, and nutrient loads from different types of land use were then quantified. For this estimate, Schematic and Mass-Link blocks in HSPF were created to separate monthly flow components (i.e., surface runoff, interflow, baseflow) entering the receiving waterbody. Outflows (i.e., evaporation, overflows, seepage out) from the lake were also estimated.

Figure 4.7 shows monthly total inflows to the lake over the simulation period from 2004 to 2016. Monthly direct precipitation was the largest inflow to the lake, ranging from 0.0 to 77.3 acre-feet (ac-ft), with a monthly average of 15.7 ac-ft. Monthly surface runoff was the lowest, ranging from 0.0 to 18.4 ac-ft, with a 13-year average of 2.7 ac-ft, while monthly interflow and baseflow ranged from 0.0 to 74.9 ac-ft and from 0.02 to 67.0 ac-ft, respectively. The long-term averages of monthly interflow and baseflow were 5.8 and 11.9 ac-ft, respectively. Based on total monthly inflows, the seasonal patterns of the incoming waters to Lake Persimmon are as follows:

1. A much greater volume of water was observed entering the lake during the wet season from May through September of each year compared with the dry season, showing a distinctive seasonal pattern.

2. Direct rainfall was the most important component in lake recharge throughout the simulation period.

3. Baseflow and interflow compared with surface runoff were the major contributors of water to the lake from the watershed during the summer months of each year.

4. In most months, the quantity of interflow and baseflow was proportionally associated with the amounts of rainfall, and thus derived by intensity of local rainfall and not by deep groundwater conditions.

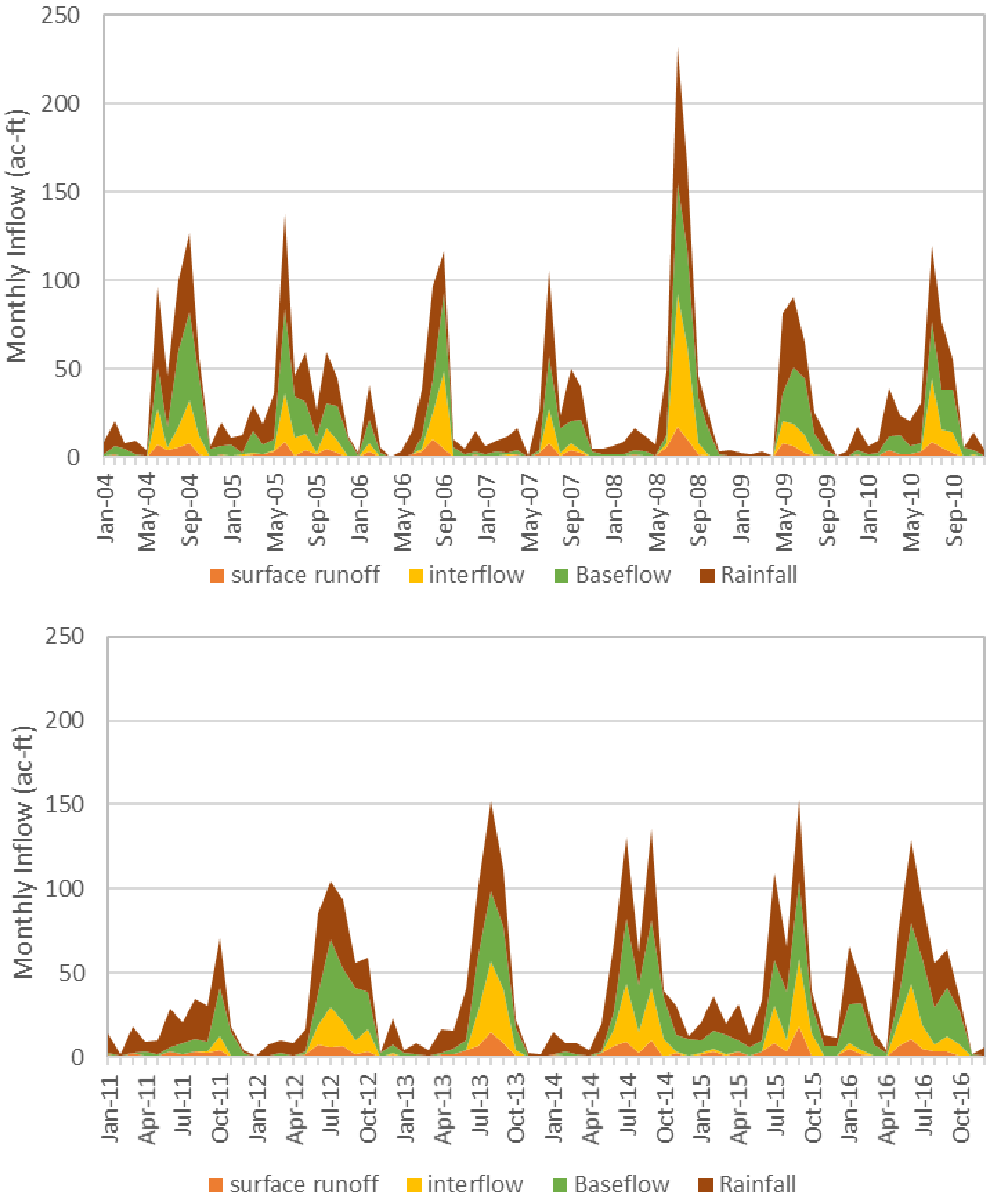

Figure 4.7. **Simulated monthly inflows to Lake Persimmon during the simulation period, 2004–10 (top) and 2011–16 (bottom)**

Total annual inflows and outflows were also estimated to construct a water budget for Lake Persimmon. **Table 4.6** lists total annual inflows and outflows. In 2016, when the annual rainfall (59.5 in) was highest, total inflows (591 ac-ft) to the lake were highest during the simulation period. During the dry years (2006, 2007, 2009, and 2011) as defined by the previous section, the simulated inflows to the lake were much lower than those in the wet years. Reductions in incoming interflow and baseflow during the dry years were especially noticeable, compared with those in the wet years. **Figure 4.8** shows the percent contribution of each pathway to the lake over the 13-year period. On a long-term average basis, direct precipitation is the largest contributor of water at 45 %, followed by baseflow (32 %), interflow (16 %), and surface runoff (7 %). Although each individual component of incoming waters is critical in maintaining the lake water level over the period, the simulated results suggest that baseflow and interflow played an important role in carrying water from the watershed, accounting for 48 % of the incoming flows to the lake.

Table 4.6. Simulated total annual inflows and outflows (ac-ft) for Lake Persimmon, 2004–16

Year	Surface Runoff (ac-ft)	Interflow (ac-ft)	Baseflow (ac-ft)	Direct Rainfall (ac-ft)	Evaporation (ac-ft)	Outflow (ac-ft)	Total Watershed Inflow (ac-ft)
2004	33	68	180	220	-177	-325	502
2005	33	66	177	219	-175	-321	495
2006	27	66	95	162	-178	-171	350
2007	23	27	88	165	-181	-128	303
2008	41	137	169	225	-176	-397	572
2009	22	36	99	152	-178	-136	309
2010	31	60	117	199	-181	-219	407
2011	21	10	72	157	-185	-72	260
2012	32	72	153	211	-183	-281	468
2013	39	98	140	202	-178	-317	480
2014	37	99	168	231	-177	-345	535
2015	46	85	178	238	-186	-362	548
2016	39	87	222	243	-176	-423	591
Average	**33**	**70**	**143**	**202**	**-179**	**-269**	**448**

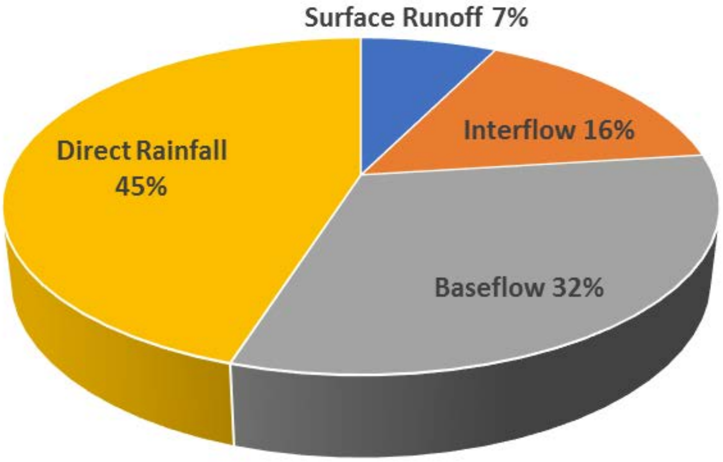

Figure 4.8. Simulated percent long-term average inflows to Lake Persimmon during the simulation period, 2004–16

4.4.5 Estimating Watershed Nutrient Loadings

Monthly watershed loads of TN and TP to Lake Persimmon were generated using the report function of the HSPF Model. As with the estimates of monthly inflows and outflows, monthly TN and TP loadings from different land use types were estimated from the HSPF PERLND and IMPLND flows and the corresponding concentrations of runoff for each land use category during the model simulation period. For PERLND, loads of TN and TP in PERLND and IMPLND were calculated in the GQUAL (general quality constituent) component of HSPF. **Figures 4.9** and **4.10** show the estimated monthly loads of TN and TP for the existing condition in the Lake Persimmon Watershed; annual TN and TP loads were calculated by summing the monthly loads for each year.

The annual TN and TP loading coefficients for different land use types were compared with literature values to ensure that the calibrated loading rates of TN and TP from each land use were reasonable (**Tables 4.7** and **4.8**). The loading coefficients of TN and TP for open land/forest ranged from 0.8 to 3.7 pounds per acre per year (lbs/ac/yr) and 0.02 to 0.12 lbs/ac/yr, respectively. These coefficients are comparable to the literature values for the forest land use type, with load coefficients of 2.1 ± 0.4 lbs/ac/yr for TN and 0.1 ± 0.03 lbs/ac/yr for TP (Frink 1991) and 2.4 lbs/ac/yr for TN and 0.04 lbs/ac/yr for TP (Donigian 2002). For cropland/tree crop, export coefficients of TN and TP ranged from 3.3 to 15.7 lbs/ac/yr and 0.17 to 1.00 lbs/ac/yr, respectively. The agreements between the simulated loading rates and the literature values indicate that the simulated TN and TP loadings for different land use types for the Lake Persimmon Watershed are reasonable.

Table 4.7. Comparison between simulated TN loading rates for Lake Persimmon land uses and the expected TN loading ranges from the literature (Donigian 2002)

Land Use Type	Simulated TN Loading Rate (lbs/ac/yr)	TN Loading Rate (lbs/ac/yr) by Donigian (2002)
Low-Density Residential	10.5 (5.0–14.8)	8.5 (5.6–15.7) for Urban
Cropland/Tree Crops	10.3 (3.3–15.7)	5.9 (3.4–11.6) for Agriculture
Wetlands	2.5 (0.8–3.7)	2.2 (1.4–3.5)
Open Land/Upland Forest	1.7 (0.5–3.0)	2.4 (1.4–4.3) for Forest

Table 4.8. Comparison between simulated TP loading rates for the Lake Persimmon land uses and the expected TP loading ranges from the literature (Donigian 2002)

Land Use Type	Simulated TP Loading Rate (lbs/ac/yr)	TP Loading Rate (lbs/ac/yr) by Donigian (2002)
Low-Density Residential	0.69 (0.40–0.95)	0.26 (0.20–0.41) for Urban
Cropland/Tree Crops	0.62 (0.17–1.00)	0.30 (0.23–0.44) for Agriculture
Wetlands	0.06 (0.02–0.10)	0.03 (0.02–0.05)
Open Land/Upland Forest	0.08 (0.02–0.12)	0.04 (0.03–0.08) for Forest

Figures 4.11 and **4.12** show the percent TN and TP loads exported from different land use types in the Lake Persimmon Watershed. The results indicate that cropland and tree crops delivered averages of 798 lbs/yr of TN and 48 lbs/yr of TP to the lake, accounting for 49 % and 48 % of the total watershed loads, respectively. Similarly, low-density residential discharged averages of 792 lbs/yr of TN and 52 lbs/yr of TP to the lake, or 48 % and 51 % of the total watershed loads, respectively. These anthropogenic land uses are major contributors of TN and TP to the lake, as supported by the result of a paleolimnological study with nitrogen isotope signatures of organic matter (Riedinger-Whitmore et al. 2005). Natural land use types such as forest and wetlands accounted only for 3 % of the TN loads and 2 % of the TP loads.

The annual TN and TP loads from various transport pathways—including direct rainfall, surface runoff, interflow, and baseflow—were estimated for the existing condition to calculate the existing total TN and TP loads to Lake Persimmon (**Tables 4.9** and **4.10**). The TN load via baseflow is the major contributor, delivering a 13-year averaged annual TN load of 950 lbs/yr, followed by an annual TN load (612 lbs/yr) via interflow.

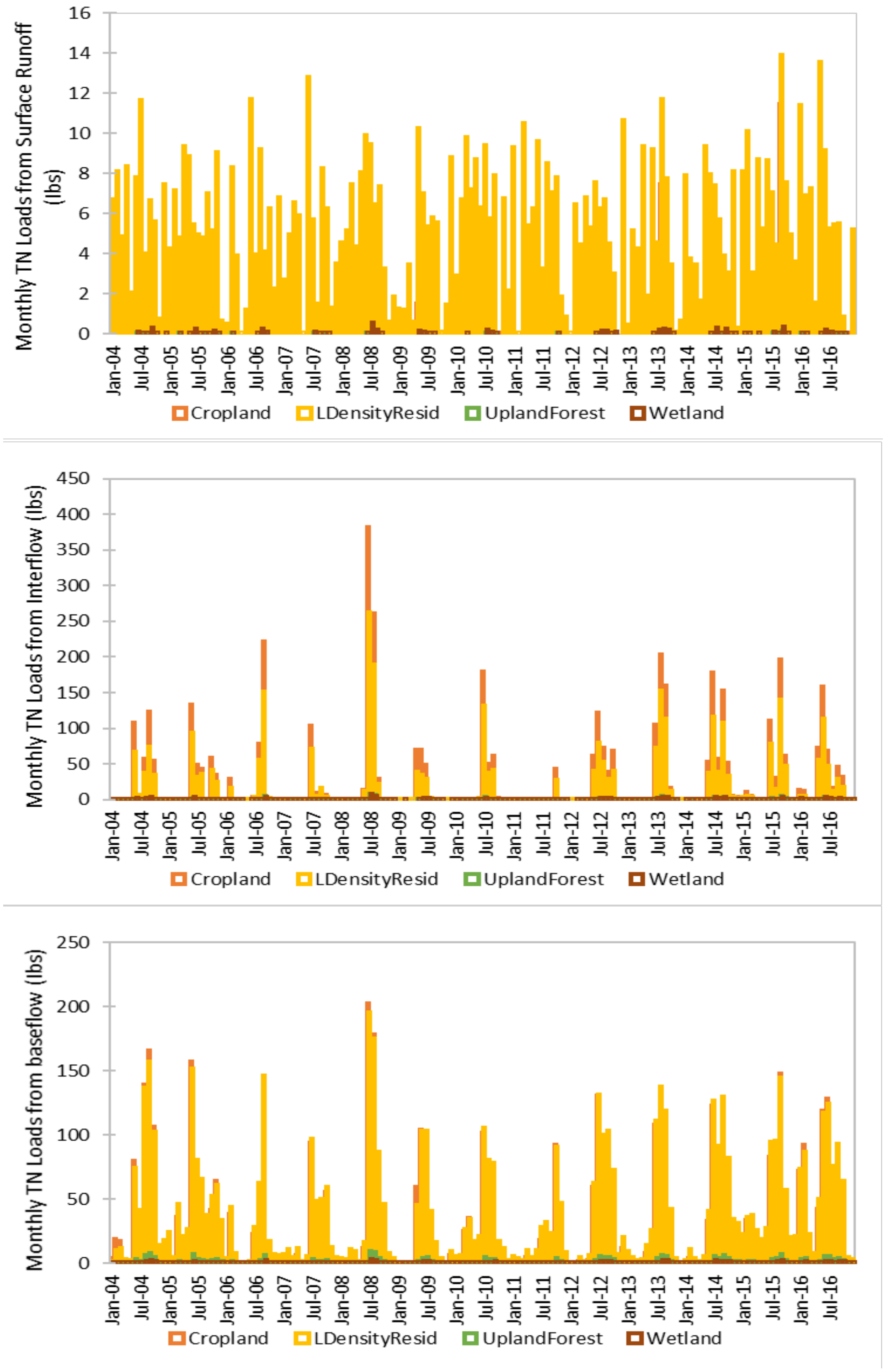

Figure 4.9. Simulated monthly TN loads to Lake Persimmon via surface runoff (top), interflow (middle), and baseflow (bottom) during the simulation period, 2004–16

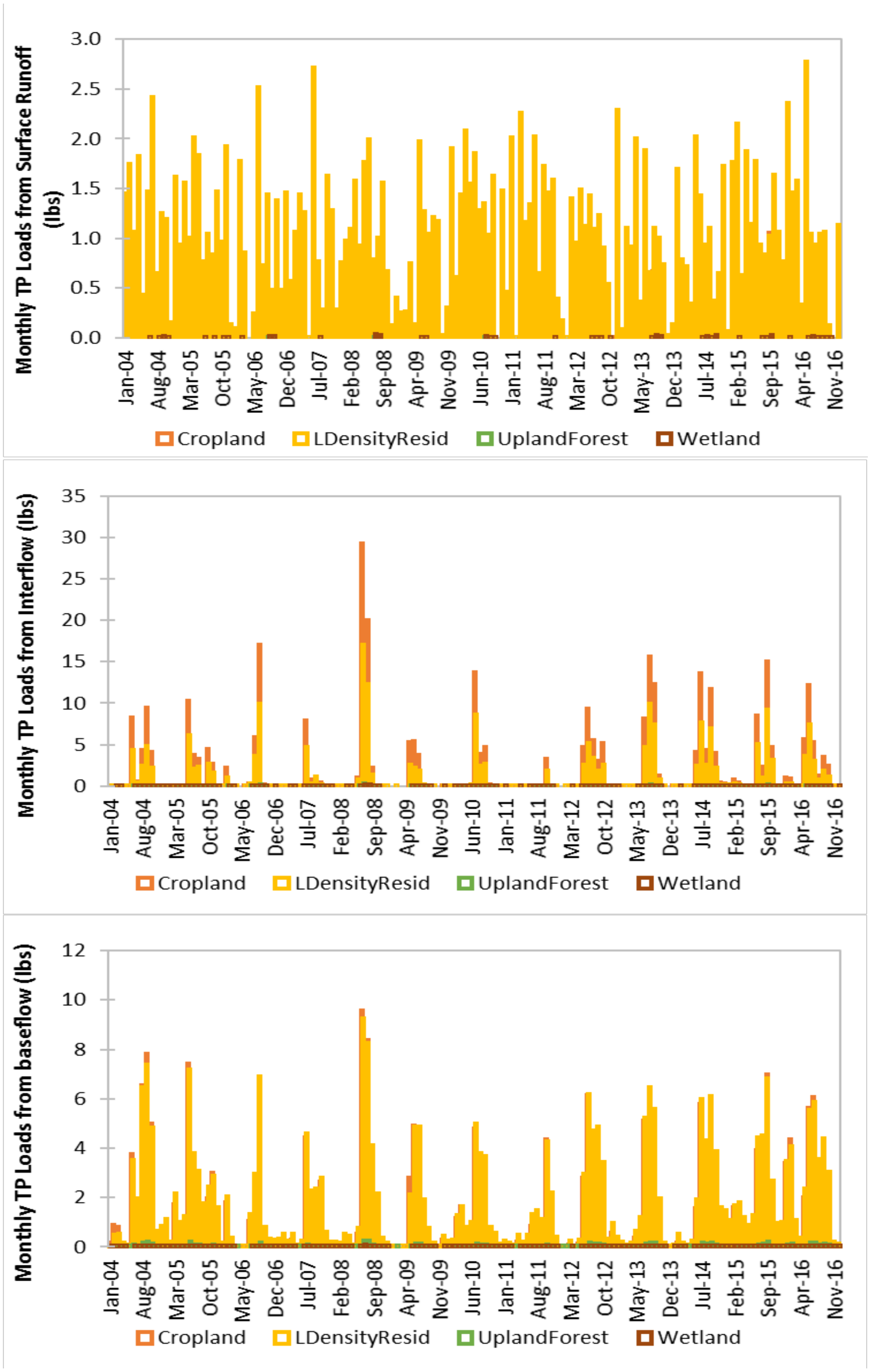

Figure 4.10. Simulated monthly TP loads to Lake Persimmon via surface runoff (top), interflow (middle), and baseflow (bottom) during the simulation period, 2004–16

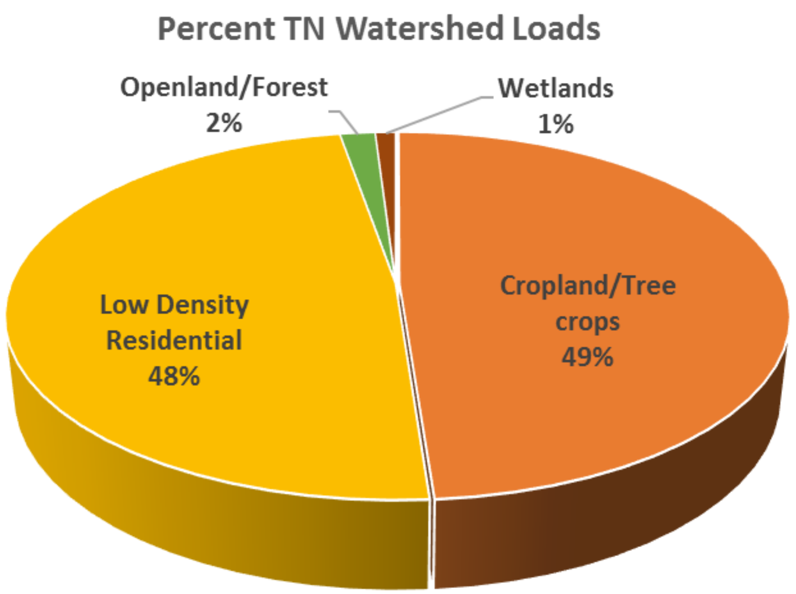

Figure 4.11. Percent TN loads to Lake Persimmon from different land use types during the simulation period, 2004–16

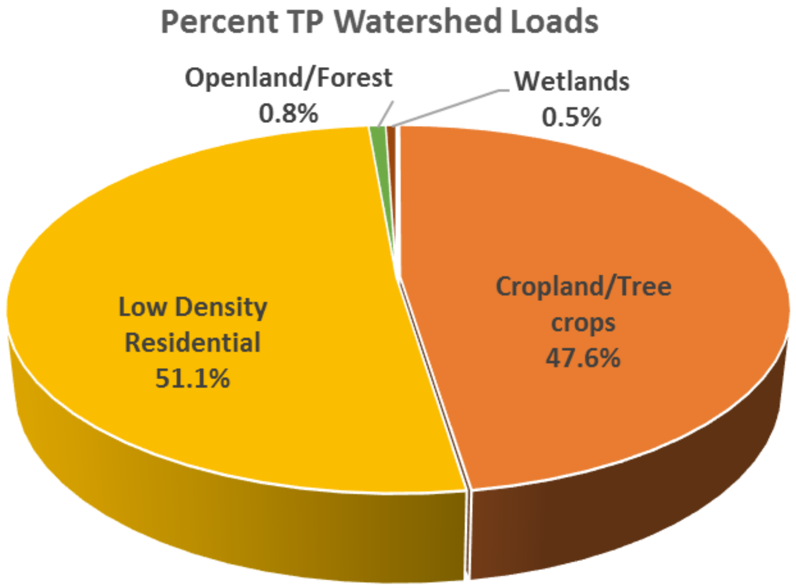

Figure 4.12. Percent TP loads to Lake Persimmon from different land use types during the simulation period, 2004–16

The average annual TP loads via baseflow and interflow were 44 and 43 lbs/yr, respectively. These loads accounted for 76 % of the total TN load and 77 % of the total TP load to the lake during the simulation period. Direct rainfall contributions were calculated at an average annual TN load of 424 lbs/yr and a TP load of 13 lbs/yr, accounting for 21 % of the total TN load and 11 % of the total TP load to the lake. Surface runoff TN and TP contributions were only 3 % and 12 % to the lake, respectively. Overall, rainfall-derived interflow and baseflow are the most important means to deliver TN and TP from the watershed. Under the existing condition, the simulated existing total loads of TN and TP to Lake Persimmon, as a 13-year long-term average, were 2,058 and 114 lbs/yr, respectively (**Tables 4.9** and **4.10**).

Table 4.9. Simulated annual TN loads (lbs/yr) to Lake Persimmon via various transport pathways under the existing condition

Year	Direct Rainfall TN (lbs/yr)	Surface Runoff TN (lbs/yr)	Interflow TN (lbs/yr)	Baseflow TN (lbs/yr)	Total TN Load (lbs/yr)
2004	462	77	591	1,200	2,329
2005	460	75	575	1,172	2,283
2006	341	64	581	632	1,618
2007	345	62	243	586	1,235
2008	473	78	1,203	1,122	2,876
2009	320	54	307	660	1,341
2010	417	78	530	783	1,808
2011	329	71	86	487	972
2012	442	65	626	1,020	2,153
2013	425	72	863	929	2,289
2014	484	70	866	1,112	2,532
2015	500	100	742	1,181	2,524
2016	510	79	736	1,468	2,795
Average	**424**	**73**	**612**	**950**	**2,058**

Table 4.10. Simulated annual TP loads (lbs/yr) to Lake Persimmon via various transport pathways under the existing condition

Year	Direct Rainfall TP (lbs/yr)	Surface Runoff TP (lbs/yr)	Interflow TP (lbs/yr)	Baseflow TP (lbs/yr)	Total TP Load (lbs/yr)
2004	14	15	42	56	127
2005	14	15	41	55	124
2006	10	12	41	30	93
2007	10	12	17	27	67
2008	14	14	85	52	165
2009	10	10	22	31	73
2010	12	15	38	37	102
2011	10	15	6	23	53
2012	13	13	44	48	118
2013	13	11	61	43	128
2014	14	12	61	52	140
2015	15	17	53	55	139
2016	15	14	52	68	150
Average	**13**	**13**	**43**	**44**	**114**

Chapter 5: Determination of Assimilative Capacity

5.1 Determination of Loading Capacity

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

The goal of this TMDL analysis is to determine the assimilative capacity of Lake Persimmon and to identify the maximum allowable TN and TP loadings from the watershed, so that Lake Persimmon will meet the TMDL target (chlorophyll *a*) and thus maintain its function and designated use as a Class III water.

5.2 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.

5.3 Water Quality Modeling to Determine Assimilative Capacity

5.3.1 Water Quality Calibration for Lake Persimmon

Water quality data collected in Lake Persimmon from 2004 through 2016 were used for in-lake water quality calibration. As shown in **Figure 2.1**, six water quality monitoring stations were available for model calibration purposes, and the data from each station were examined as part of data quality control processes to compare with the HSPF Model simulation results. Since the lake is relatively small and well-mixed, the data from the monitoring stations were combined and compared with the model simulation results. The simulated daily data obtained from the calibrated HSPF Model were later converted to AGM values for TMDL development to be consistent with the expression of the generally applicable NNC for lakes.

Figures 5.1 through **5.10** show detailed time-series comparisons and box-whisker plots between observed versus simulated results for temperature, DO, TN, TP, and chlorophyll *a* from 2004 to 2016. 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 are listed in **Table 5.1**, indicating that the HSPF Model performs very well in simulating water quality in Lake Persimmon.

Table 5.1. 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	Temperature	DO	TN	TP	Chlorophyll *a*
% Difference in Medians	4	18	10	40	18
Category[1] for Medians	Very Good	Very Good	Very Good	Good	Very Good
% Difference in Means	1	12	9	28	19
Category[1] for Means	Very Good	Very Good	Very Good	Very Good	Very Good

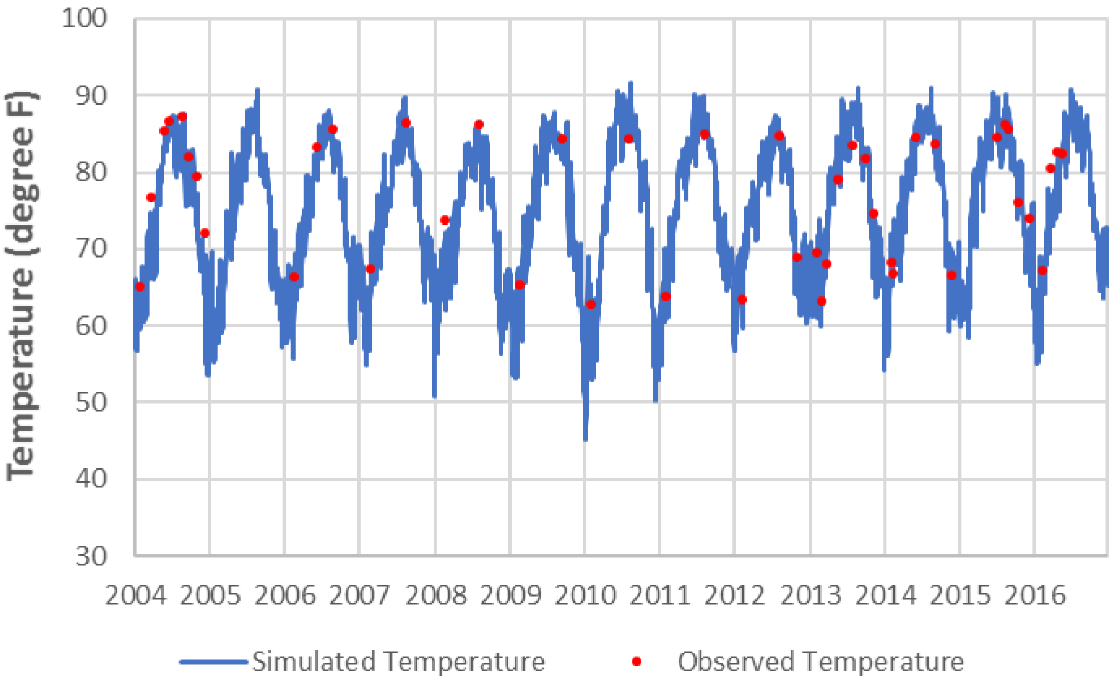

Figure 5.1. Time-series of observed versus simulated temperature (°F) in Lake Persimmon, 2004–16

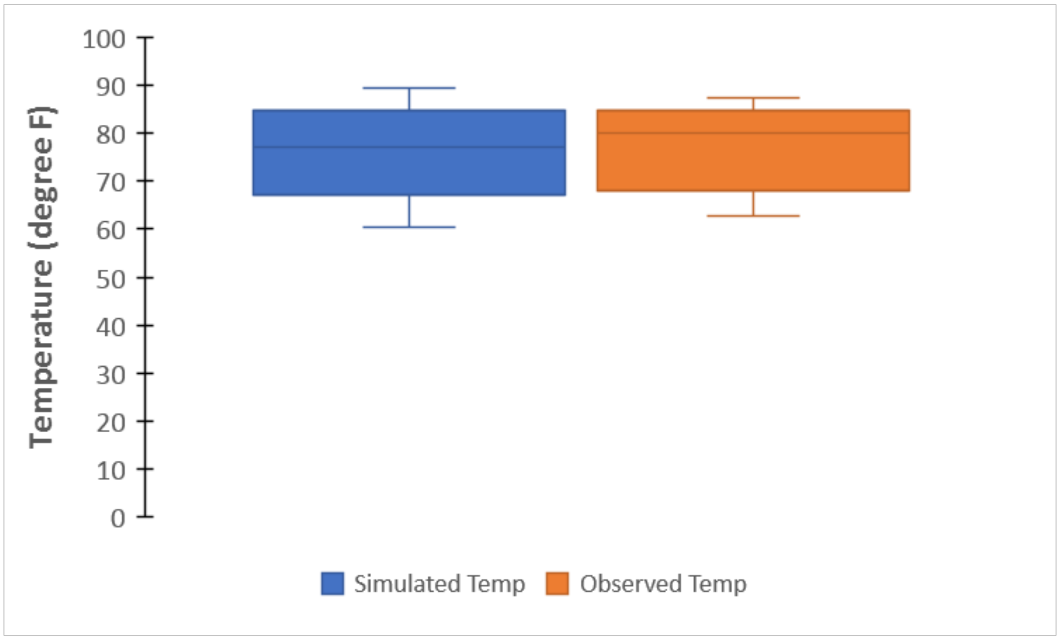

Figure 5.2. **Box-whisker plot of simulated versus observed temperature (°F) in Lake Persimmon**

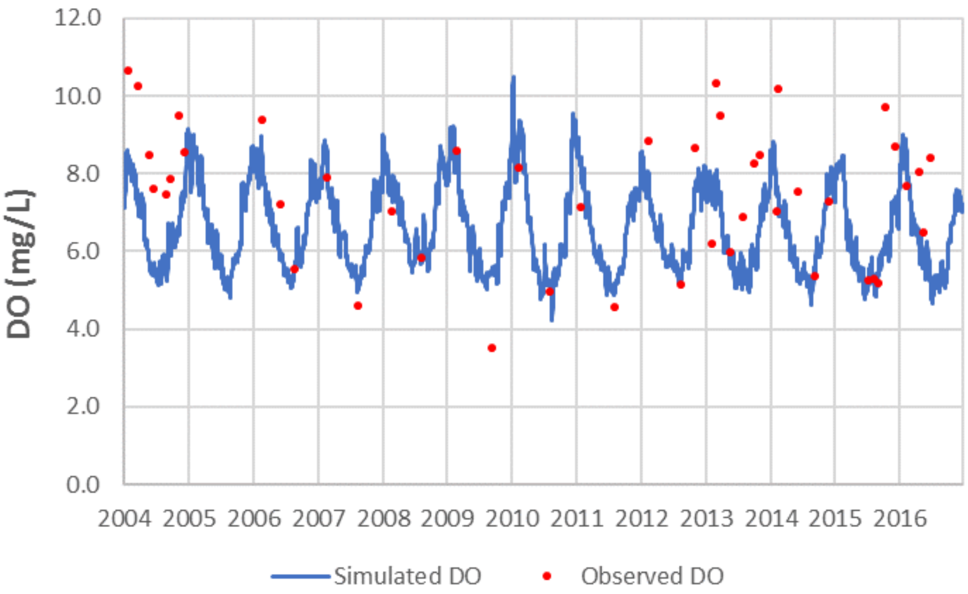

Figure 5.3. **Time-series of observed versus simulated DO (mg/L) in Lake Persimmon, 2004–16**

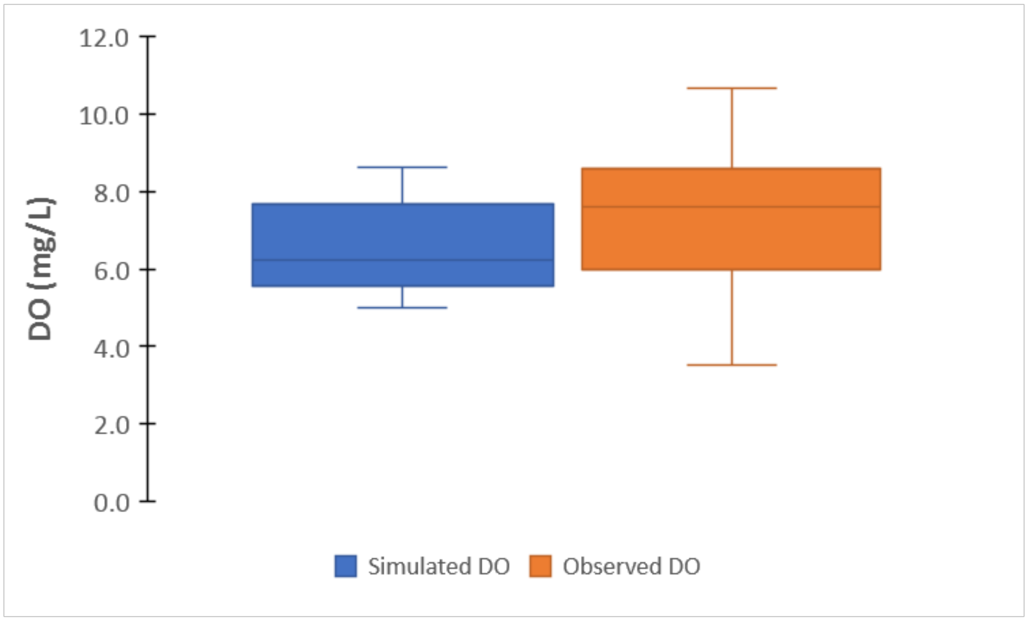

Figure 5.4. Box-whisker plot of simulated versus observed DO (mg/L) in Lake Persimmon

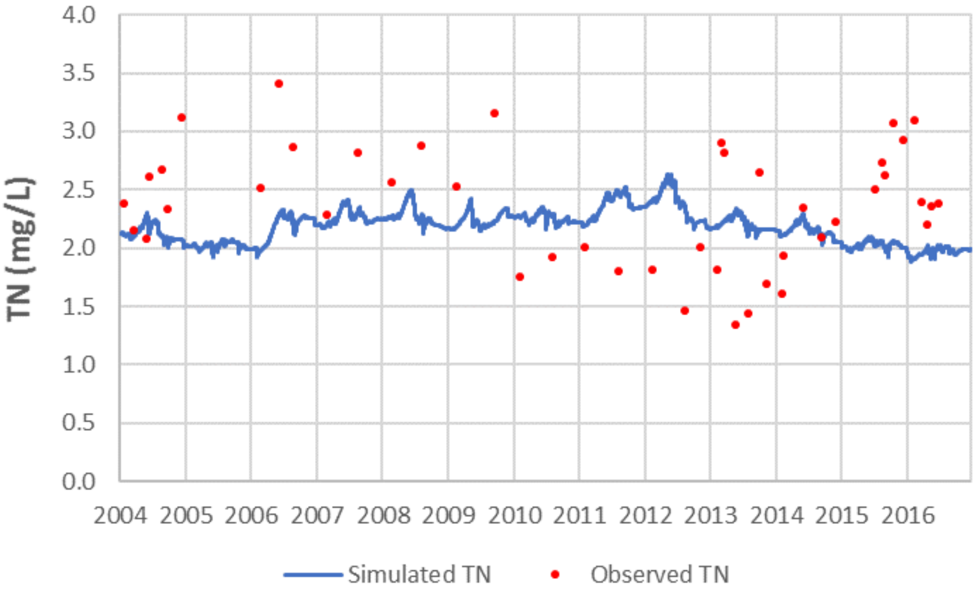

Figure 5.5. Time-series of observed versus simulated TN (mg/L) in Lake Persimmon, 2004–16

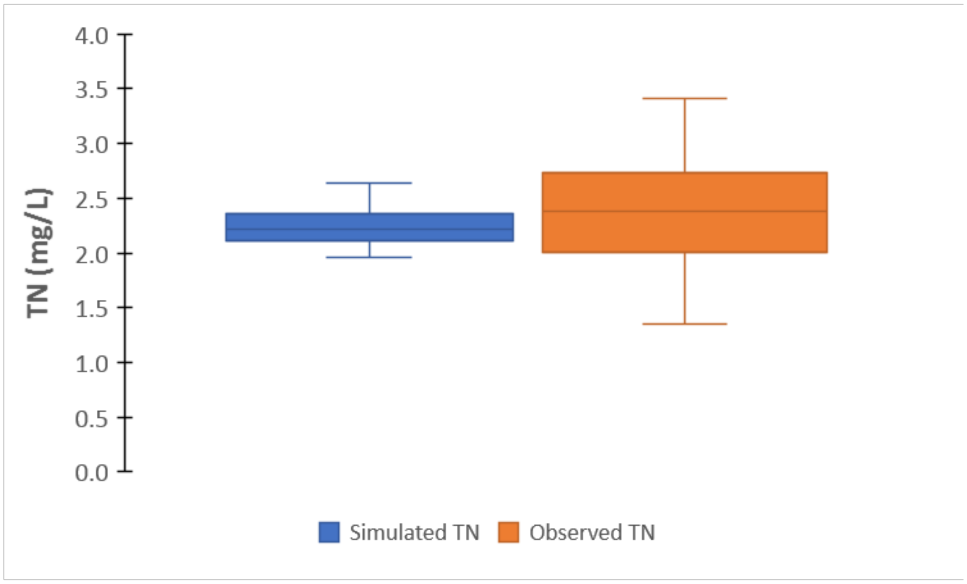

Figure 5.6. **Box-whisker plot of simulated versus observed TN (mg/L) in Lake Persimmon**

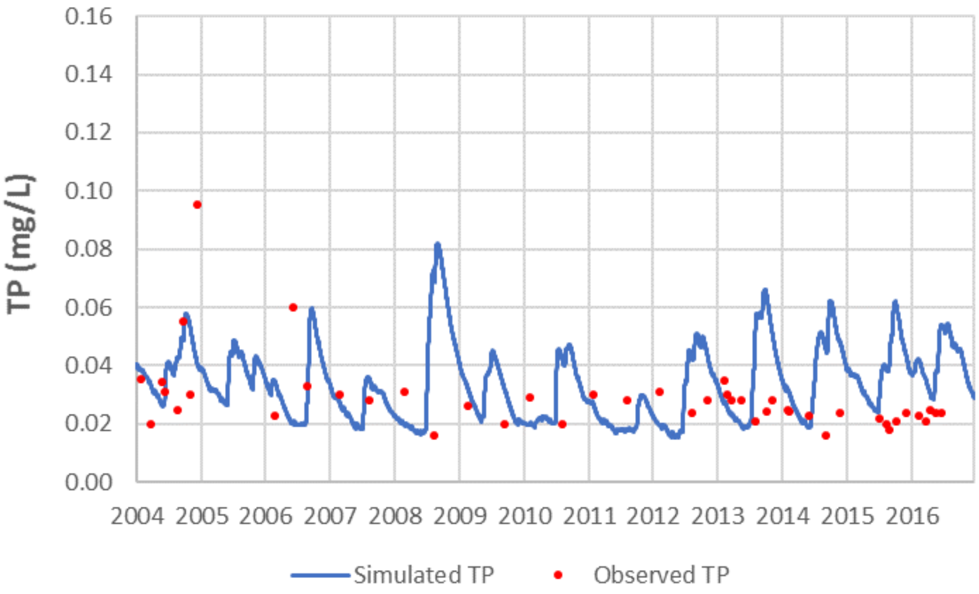

Figure 5.7. **Time-series of observed versus simulated TP (mg/L) in Lake Persimmon, 2004–16**

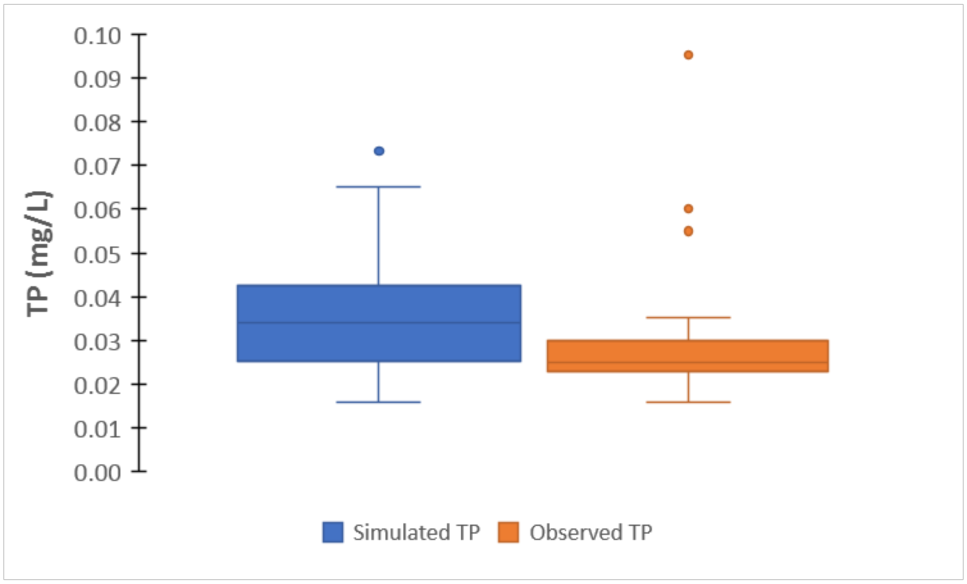

Figure 5.8. Box-whisker plot of simulated versus observed TP (mg/L) in Lake Persimmon

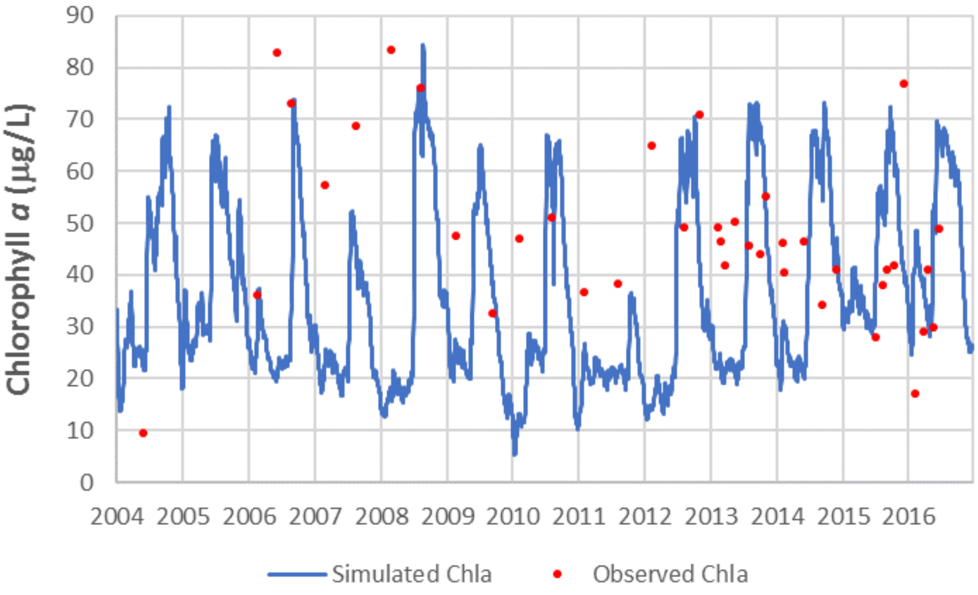

Figure 5.9. Time-series of observed versus simulated chlorophyll *a* (µg/L) in Lake Persimmon, 2004–16

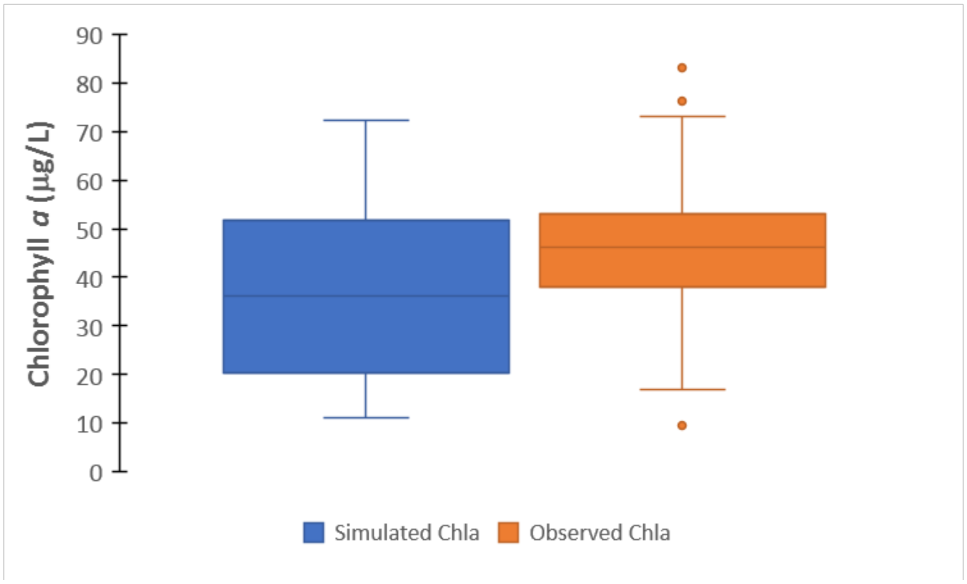

Figure 5.10. Box-whisker plot of simulated versus observed chlorophyll *a* (µg/L) in Lake Persimmon

5.3.2 Natural Background Conditions to Determine Natural Levels of Chlorophyll *a*, TN, and TP

The natural background conditions for the Lake Persimmon Watershed were established to ensure that the proposed restoration target will not abate the natural background condition, which based on the scenario run it meets this requirement. For this simulation, the wetland and forest land uses in the current condition model were kept the same, but all anthropogenic land uses in the current condition model were converted into forest and wetland land uses based on the hydrologic soil group classification. Anthropogenic land uses with Class A and B soils were converted to forests, and anthropogenic land uses with Class C and D as well as dual category soils were converted to wetlands. The background simulation was performed from 2004 to 2016, with the first year of simulation given as a model spin-up time.

5.3.3 Load Reduction Scenarios to Determine the TMDLs

To achieve the TMDL target chlorophyll *a* concentration of 20 µg/L in the lake, the TN and TP loads from the watershed, but not direct atmospheric TN and TP loads, were incrementally reduced until the chlorophyll *a* target was met 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 any conditions during the simulation period with the exceedances of the target, including dry and wet years, are addressed.

Model results for the current condition and the load reduction scenario that attained the chlorophyll *a* target in each year are shown in **Figures 5.11** through **5.16**. When the existing watershed TN and TP loads were reduced by 53 % and 58 %, respectively, the AGMs of simulated chlorophyll *a* did not exceed the target (20 µg/L) in any single year (**Figure 5.16**).

Under the watershed load reduction condition with a 58 % reduction in TP and a 53 % reduction in TN that meets the chlorophyll *a* target, the AGMs of simulated in-lake TP concentration ranged from 0.01 to 0.02 mg/L, and for TN, simulated AGMs ranged from 1.15 to 1.48 mg/L. For informational purposes, the TP and TN concentrations that result from the TP and TN reduction scenarios were also calculated, and "restoration nutrient targets" are set as the maximum AGMs of TP and TN at 0.02 and 1.48 mg/L, respectively, not to be exceeded in any year (**Figures 5.12** and **5.14**).

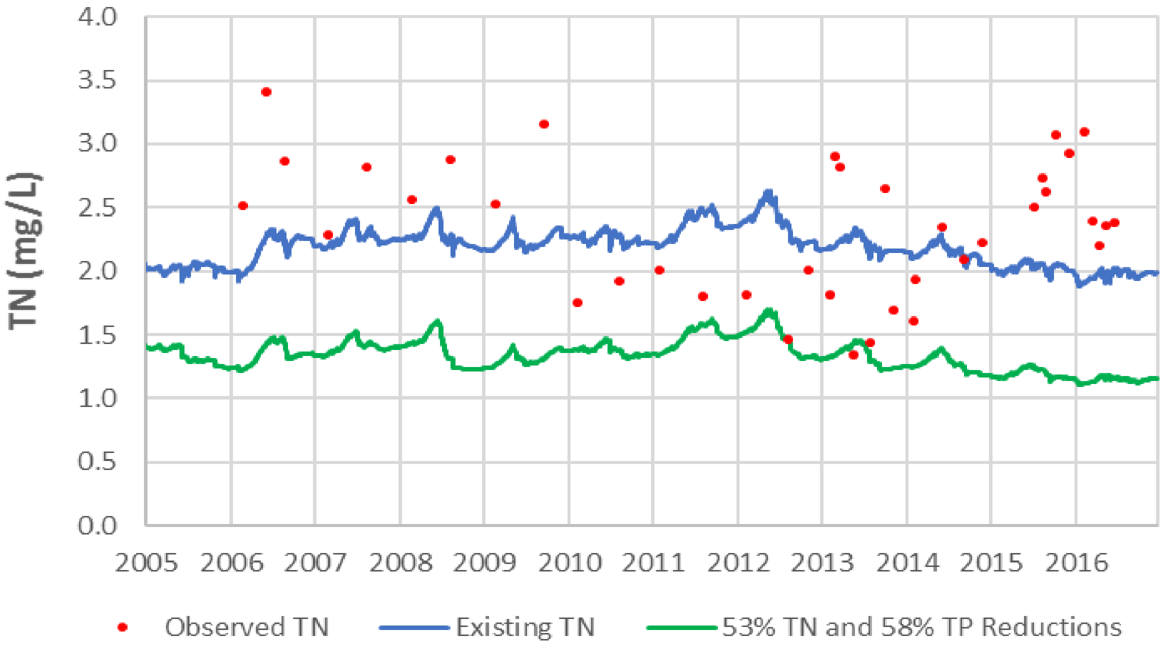

Figure 5.11. Time-series of simulated TN (mg/L) in Lake Persimmon for existing and load reduction conditions

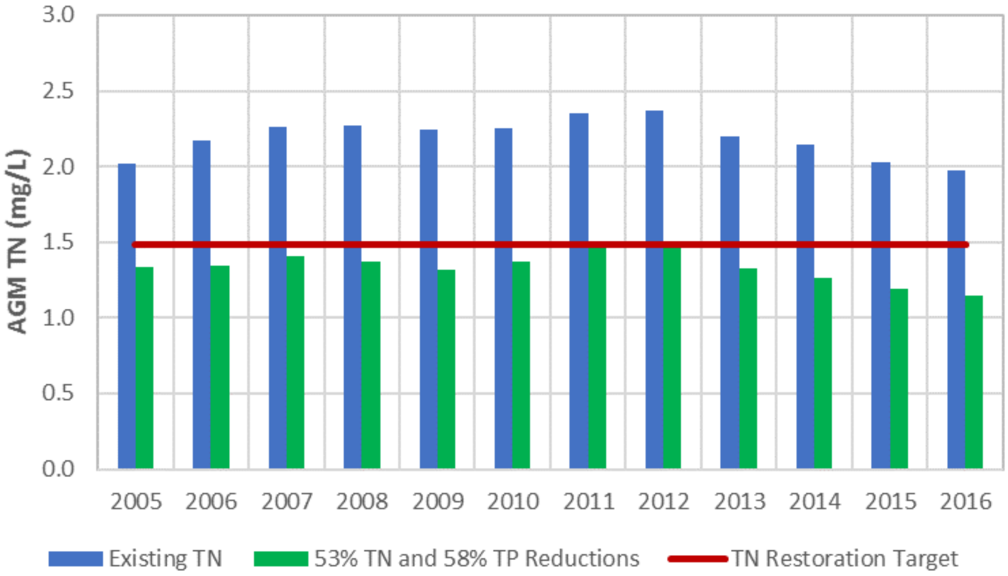

Figure 5.12. AGMs of simulated TN (mg/L) in Lake Persimmon for existing and load reduction conditions

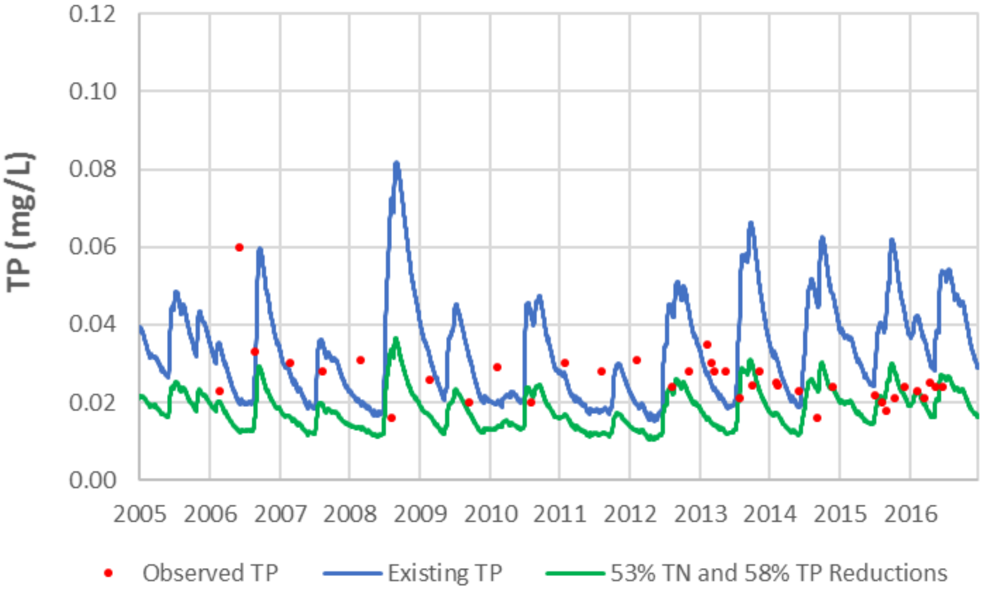

Figure 5.13. Time-series of simulated TP (mg/L) in Lake Persimmon for existing and load reduction conditions

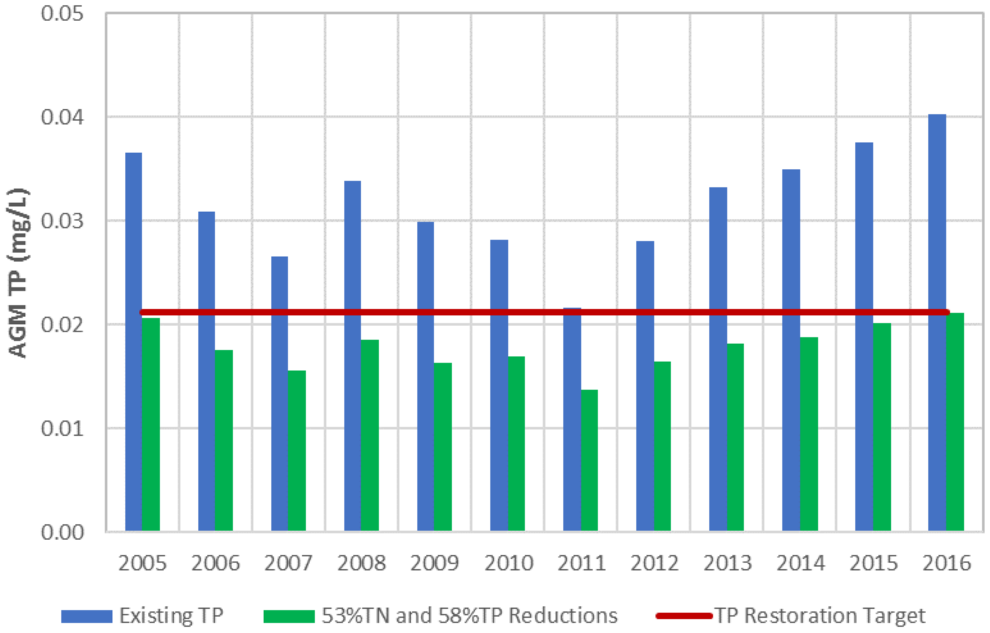

Figure 5.14. AGMs of simulated TP (mg/L) in Lake Persimmon for existing and load reduction conditions

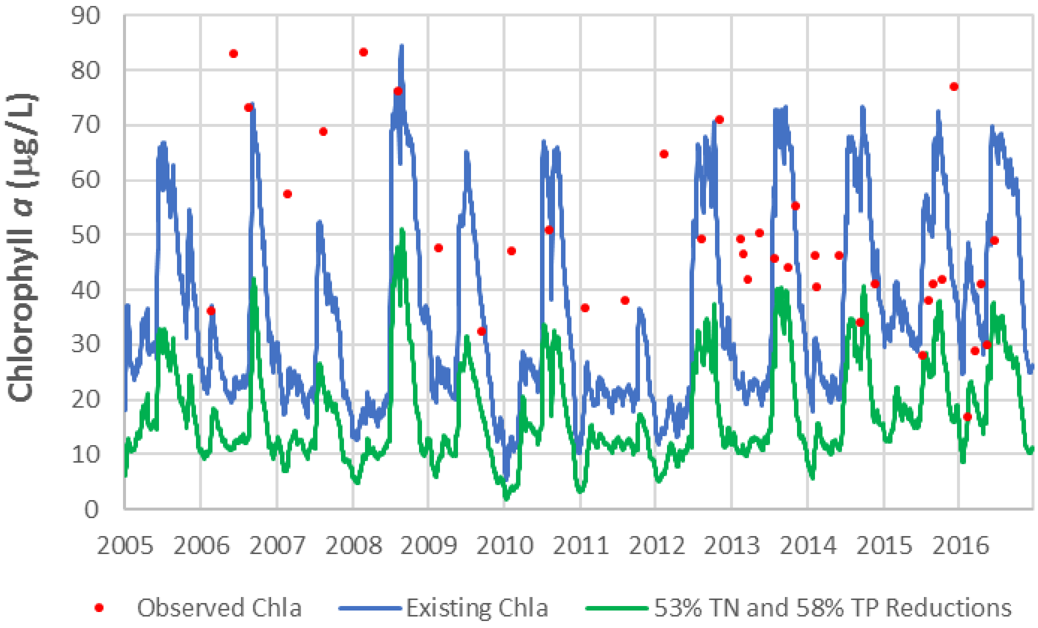

Figure 5.15. Time-series of simulated chlorophyll a (µg/L) in Lake Persimmon for existing and load reduction conditions

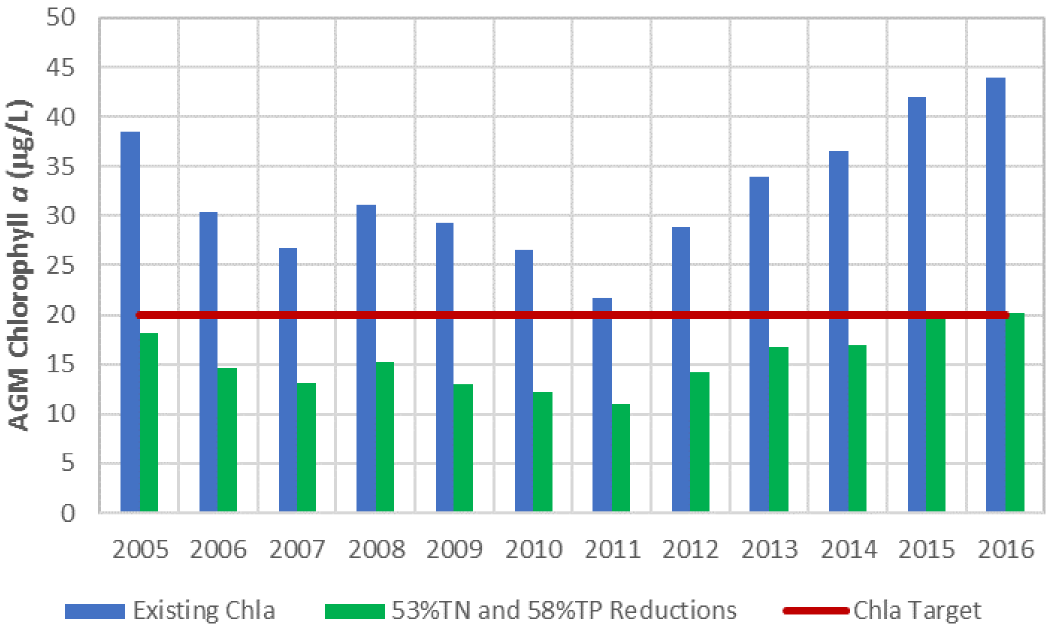

Figure 5.16. AGMs of simulated chlorophyll a (µg/L) in Lake Persimmon for existing and load reduction conditions

5.4 Calculation of the TMDLs

All incoming TN and TP loads from Lake Persimmon surface runoff, interflow, baseflow, and direct atmospheric loads should be included to calculate the allowable TMDLs for the lake. However, the direct atmospheric deposition of TN and TP on the lake surface is not regulated by the CWA and was kept the same for the TMDL load and percent reduction as the existing atmospheric TN and TP deposition.

Tables 5.2 and **5.3** list the annual existing watershed, direct rainfall, and allowable loads of TN and TP for Lake Persimmon. TMDL percent reductions for TN and TP were calculated from the maximum of the rolling 7-year averages of the existing total (watershed plus direct rainfall) TN and TP loads and the maximum of the rolling 7-year averages of allowable total TN and TP loads. The calculated percent reductions are 42 % for TN and 51 % for TP. The final TMDLs for TN and TP, calculated as the maximum loads of TN and TP from 7-year rolling averages of the allowable total TN and TP loads, are 1,247 lbs/yr for TN and 58 lbs/yr for TP from all sources, not to be exceeded in any year.

Table 5.2. Existing watershed TN loads and allowable total (watershed plus direct rainfall) TN loads for the TMDLs

Note: Values shown in boldface type with an asterisk indicate the maximum of the seven-year rolling averages for each condition.

Year	Existing Watershed TN Load (lbs/yr)	Direct Rainfall TN (lbs/yr)	Existing Total TN Load (lbs/yr)	Allowable Watershed TN Load (lbs/yr) after 53 % TN Reduction	Allowable Total TN Load (lbs/yr) after 53 % TN Reduction	7-Year Rolling Average Existing Total TN Load (lbs/yr)	7-Year Rolling Average Allowable Total TN Load (lbs/yr)
2005	1,823	460	2,283	857	1,317		
2006	1,277	341	1,618	600	941		
2007	890	345	1,235	418	764		
2008	2,404	473	2,876	1,130	1,602		
2009	1,020	320	1,341	479	800		
2010	1,391	417	1,808	654	1,071		
2011	643	329	972	302	632	1,733	1,018
2012	1,711	442	2,153	804	1,246	1,715	1,008
2013	1,864	425	2,289	876	1,301	1,811	1,059
2014	2,048	484	2,532	963	1,447	1,996	1,157
2015	2,024	500	2,524	951	1,451	1,946	1,135
2016	2,284	510	2,795	1,074	1,584	**2,153***	**1,247***
Average	**1,615**	**421**	**2,035**	**759**	**1,180**		

Table 5.3. Existing watershed TP loads and allowable total (watershed plus direct rainfall) TP loads for the TMDLs

Note: Values shown in boldface type with an asterisk indicate the maximum of the seven-year rolling averages for each condition.

Year	Existing Watershed TP Load (lbs/yr)	Direct Rainfall TP (lbs/yr)	Existing Total TP Load (lbs/yr)	Allowable Watershed TP Load (lbs/yr) after 58% TP Reduction	Allowable Total TP Load (lbs/yr) after 58% TP Reduction	7-Year Rolling Average Existing Total TP Load (lbs/yr)	7-Year Rolling Average Allowable Total TP Load (lbs/yr)
2005	110	14	124	46	60		
2006	83	10	93	35	45		
2007	57	10	67	24	34		
2008	151	14	165	64	78		
2009	63	10	73	27	36		
2010	89	12	102	37	50		
2011	44	10	53	18	28	97	47
2012	105	13	118	44	57	96	47
2013	116	13	128	49	61	101	49
2014	126	14	140	53	67	111	54
2015	125	15	139	52	67	108	52
2016	135	15	150	57	72	**119***	**58***
Average	**100**	**13**	**113**	**42**	**55**		

Chapter 6: Determination of Loading Allocations

6.1 Expression and Allocation of the TMDL

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

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

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

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

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (1) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is also accounted for 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 NPDES stormwater WLA is expressed as a percent reduction in the stormwater from MS4 areas. The LA and TMDLs for Lake Persimmon are expressed in loads (lbs/yr) and percent reductions, and represent the loads of TN and TP from all sources that the waterbody can assimilate while maintaining a balanced aquatic flora and fauna (**Table 6.1**). These TMDLs are based on 7-year rolling averages of simulated data from

2005 through 2016. The restoration goal is to restore the lake using the AGM chlorophyll *a* criterion of 20 µg/L, not to be exceeded more than once in any consecutive 3-year period, meeting the water quality criteria and thus protecting the lake's designated use.

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

Table 6.1. TMDL components for nutrients in Lake Persimmon (WBID 1938E)

Note: The LA and TMDL daily load for TN is 3.4 lbs/day, and for TP 0.16 lbs/day.
NA = Not applicable
* The required loads and percent reductions listed in this table represent the load and reduction from all sources, including direct rainfall.

Waterbody (WBID)	Parameter	TMDL (lbs/yr)	WLA Wastewater (% reduction)	WLA NPDES Stormwater (% reduction)*	LA (% reduction)*	MOS
1938E	TN	1,247	NA	42	42	Implicit
1938E	TP	58	NA	51	51	Implicit

6.2 Load Allocation

To achieve the LA, a 42 % and 51 % reduction in current TN and TP loads, respectively, will be required.

The TMDLs are based on the percent reduction in total loading; however, it is not DEP's intent to abate natural conditions. It should be noted that the LA includes loading from stormwater discharges regulated by DEP and the water management 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 Lake Persimmon Watershed discharge either into the lake or its watershed.

6.3.2 NPDES Stormwater Discharges

No active stormwater collection system in the Lake Persimmon Watershed is currently owned and operated by Highlands County or other entities. It should be noted that any MS4 permittee is only responsible for reducing the anthropogenic loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction.

6.4 Margin of Safety

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.

The conservative decisions associated with a number of the modeling assumptions were made in determining the assimilative capacity (i.e., watershed loading and water quality response) of the lake. For example, the model calibration and validation period was extended to the 13-year simulation to capture a worst-case condition to ensure that any exceedances of the TMDL target would be addressed. 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 criteria, and were derived based on meeting the chlorophyll *a* target 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 to achieve that particular TMDL are already defined in a BMAP. MS4 Phase II permit holders must also implement the responsibilities defined in a BMAP or other form of restoration plan (e.g., a reasonable assurance plan).

In February 2013, DEP initiated the Lake Okeechobee BMAP development process and held a series of technical meetings involving stakeholders and the general public. The Lake Okeechobee BMAP process engages local stakeholders and promotes coordination and collaboration to address nutrient reductions. Throughout BMAP development, DEP requested that stakeholders provide information on activities and projects that would reduce nutrient loading. The Lake Persimmon watershed falls within the Lake Okeechobee BMAP boundary, so local stakeholders in the watershed of Lake Persimmon were invited to participate in the Lake Okeechobee BMAP development process. The Lake Okeechobee BMAP was adopted in December 2014 to implement the TP TMDL, and BMAP stakeholders are contacted annually to request information on the status of existing projects and any new or planned projects. A 5-Year Review is due to the legislature and Governor in December 2019, and periodic updates to the BMAP will be conducted during the first 10-year implementation phase, as necessary and appropriate.

7.2 BMAPs

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

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

Additional information about BMAPs is available online.[1]

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 results of any associated remediation projects on surface water quality. For Lake Persimmon, other factors such as the calibration of watershed and water quality components via interflow and baseflow also influence lake nutrient budgets and the growth of phytoplankton. Approaches to addressing these other factors should be included in a comprehensive management plan for the waterbody. Additionally, the current water quality monitoring and surface water and well–level monitoring of Lake Persimmon 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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[1] https://floridadep.gov/dear/water-quality-restoration/content/basin-management-action-plans-bmaps.

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Appendices

Appendix A: Background Information on Federal and State Stormwater Programs

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

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

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

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

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

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

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

Location	Description
Waterbody name	Lake Persimmon
Waterbody type(s)	Lake
WBID	WBID 1938E (see **Figure 1.1** of this report)
Description	Lake Persimmon is located just west of US 27 and a few miles north of the town of Lake Placid in Highlands County. The lake has a surface area of 49 acres and an average depth of 4.1 ft below the lake surface. The watershed covers an area of 174 acres, and the dominant land use type is cropland/tree crops (45 %), followed by low-density residential (43 %). **Chapter 1** of this report describes the Lake Persimmon system in more detail.
Specific location (latitude/longitude or river miles)	The center of Lake Persimmon is located at Latitude N: 27º21'17, Longitude W: 81º24'22. The site-specific criteria apply as a spatial average for the lake, as defined by WBID 1938E.
Map	**Figure 1.1** shows the general location of Lake Persimmon and its watershed, and **Figure 4.1** shows the land uses in the watershed.
Classification(s)	Class III Freshwater
Basin name (HUC 8)	Kissimmee River Basin (03090101)

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

Numeric Interpretation of Narrative Nutrient Criterion	Information on Parameters Related to Numeric Interpretation of the Narrative Nutrient Criterion
NNC summary: Generally applicable lake classification and corresponding NNC	Lake Persimmon is a low-color and high alkalinity 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 1.05 to 1.91 mg/L, and TP of 0.03 to 0.09 mg/L.
Proposed TN, TP, chlorophyll *a*, and/or nitrate + nitrite concentrations (magnitude, duration, and frequency)	Numeric interpretations of the narrative nutrient criterion: Chlorophyll *a* in Lake Persimmon is the applicable annual geometric mean criterion for low color and high alkalinity lakes (20 µg/L). The TN and TP TMDL/H1 are expressed as a rolling 7-year annual average loads not to be exceeded, and are 1,247 and 58 lbs/yr for TN and TP, respectively. Nutrient concentrations are also provided for comparative purposes only. The in-lake TN and TP AGM concentrations for Lake Persimmon at the allowable TMDL loading are 1.48 and 0.02 mg/L, respectively. These restoration concentrations represent the in-lake concentrations that would still meet the 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 that simulated hydrology and water quality conditions from 2004 to 2016. The primary datasets for this period include water quality data from IWR Database Run 53, and rainfall and ET data from 2004 to 2016. Data from the SWFWMD 2009 land use coverage were used to establish watershed nutrient loads. **Sections 4.4** and **5.3** of this TMDL report describe the data used in the derivation of the proposed site-specific criteria.
How the criteria developed are spatially and temporally representative of the waterbody or critical condition	The model simulated the 2004 to 2016 period, including a model spin-up time of 2004. During the simulation period, total annual average rainfall ranged from 38.0 to 59.5 in, with an average annual rainfall of 49.7 in. A comparison with 71-year average rainfall data indicated that 2006, 2007, 2009, and 2011 were dry years, while 2008, 2014, 2015, and 2016 were wet years. This period captures the hydrologic variability of the Lake Persimmon system. Hourly meteorological data obtained from the FAWN Sebring station were used as the model input for estimating nutrient loads from the watershed. The weather station, which is located at Sebring, Highlands County, 2 miles northeast of Lake Persimmon, accurately represented local meteorological conditions in the watershed over the simulation period. The model simulated the entire watershed to evaluate how changes in watershed loads impact lake nutrient and chlorophyll *a* concentrations. **Figure 2.1** shows the locations of the sampling stations in Lake Persimmon used in the model calibration process. Monitoring stations were located across the spatial extent and properly represent a well-mixed lake. Water quality data for variables relevant to TMDL development are available on request.

Table B-3. Summary of how designated uses are protected by the criterion

Designated Use Requirements	Information Related to Designated Use Requirements
History of assessment of designated use support	DEP used the IWR Database to assess water quality impairments in Lake Persimmon (WBID 1938E). During the Cycle 3 assessment, the NNC were used to assess the lake during the verified period (January 1, 2009–June 30, 2016) using data from IWR Database Run 53. Lake Persimmon was found to be impaired for chlorophyll *a* and TN because the AGMs exceeded the NNC more than once in a 3-year period (in 2013–16 for chlorophyll *a*, and in 2004 and from 2013 to 2016 for TN). The waterbody was added to the 303(d) list for chlorophyll *a* and TN. See **Section 2.3.2** 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 low-color and high alkalinity lakes. Based on the available information, there is nothing unique about Lake Persimmon that would make the use of the chlorophyll *a* threshold of 20 µg/L inappropriate for the lake.
Approach used to develop criteria and how it protects uses	For the Lake Persimmon nutrient TMDLs, DEP established the site-specific TN and TP loadings using the calibrated HSPF Model to achieve an in-lake chlorophyll *a* AGM concentration of 20 µg/L. The maximum of the 7-year rolling averages of TN and TP loadings to achieve the chlorophyll *a* target was determined by decreasing watershed TN and TP loads from anthropogenic sources into the lake until the chlorophyll *a* target was achieved in every year. **Chapter 5** of this report provides a more detailed description of the derivation of the TMDLs and criteria.
How the TMDL analysis will ensure that nutrient-related parameters are attained to demonstrate that the TMDLs will not negatively impact other water quality criteria	Model simulations indicated that the target chlorophyll *a* concentration (20 µg/L) in the lake will be attained at the TMDL loads for TN and TP. No other impairments were verified for Lake Persimmon 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

Protection of Downstream Waters and Monitoring Requirements	Information Related to Protection of Downstream Waters and Monitoring Requirements
Identification of downstream waters	There are no defined drainage canals or streams connecting Lake Persimmon to downstream waterbodies, but a narrow, man-made ditch on the northwest side of the lake is the only outlet during a high-flow regime. During normal flow conditions, the lake most likely seeps out to the adjacent marsh terrain via subsurface interflow and baseflow to maintain and balance its water level. The seepage flow from the lake may eventually drain through the marsh terrain to Josephine Creek, 1.1 miles northeast of Lake Persimmon. Based on the Cycle 3 assessment, Josephine Creek was listed as verified impaired for nutrients (macrophytes), while chlorophyll *a* was not assessed because of insufficient data during the verified period. Since there is no direct hydrologic connection of Lake Persimmon to a remote creek, Josephine Creek, the outflow from Lake Persimmon will not have an impact on water quality of the creek. However, the restoration targets for Lake Persimmon compared with the applicable stream nutrient thresholds for Peninsular streams (0.12 mg/L of TP, and 1.54 mg/L of TN, expressed as AGMs not to be exceeded more than once in any 3-year period [DEP 2013b]), showing that the restoration targets of Lake Persimmon will meet the applicable stream nutrient thresholds. Therefore, the Lake Persimmon TMDL will be protective of stream water quality.
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.	Highlands County and DEP conduct routine monitoring of Lake Persimmon. 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. Additionally, the current water quality monitoring and surface water and well–level monitoring of Lake Persimmon should continue and be expanded, as necessary, during the implementation phase to ensure that adequate information is available for tracking restoration progress.

Table B-5. Documentation of endangered species consideration

Administrative Requirements	Information for Administrative Requirements
Endangered species consideration	DEP is not aware of any endangered species or designated critical habitat in Lake Persimmon. Furthermore, it is expected that improvements in water quality resulting from these restoration efforts will positively impact aquatic species living in the lake and its watershed.

Table B-6. Documentation that administrative requirements are met

Administrative Requirements	Information for Administrative Requirements
Notice and comment notifications	DEP published a Notice of Development of Rulemaking on February 21, 2018, to initiate TMDL development for impaired waters in the Kissimmee River Basin. A rule development public workshop for the TMDLs was held on June 7, 2018. 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.
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.