Central District Middle St Johns River Basin

Final Report

Nutrient TMDLs for Lakes Terrace (WBID 3168X3), Lawsona (WBID 3168Z9), Davis (WBID 3168Y4), Wade (WBID 3168W3), and Weldona (WBID 3168Y8) and Documentation in Support of the Development of Site-Specific Numeric Interpretations of the Narrative Nutrient Criterion

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Executive Summary

This report presents the total maximum daily loads (TMDLs) developed to address the nutrient impairments in Lakes Terrace, Lawsona, Davis, Wade, and Weldona. These lakes have exceedances of the applicable lake numeric nutrient criteria (NNC) in subsection 62-302.531(2), F.A.C. Lakes Davis, and Wade were verified impaired as part of the Cycle 3 Group 4 assessment; Lakes Lawsona and Weldona were verified impaired for total phosphorus (TP) and chlorophyll *a* (Chla), respectively, as part of the Cycle 3 Group 4 assessment. Lake Terrace was verified impaired in the Biennial Assessment 2020 - 2022, and Lakes Lawsona and Weldona were verified impaired for Chla and TP, respectively, as part of the Biennial Assessment 2020 - 2022.

Pursuant to paragraph 62-302.531(2)(a), F.A.C., the nutrient TMDLs will, upon adoption, 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 NNC in subsection 62-302.531(2), F.A.C.

TMDLs for total nitrogen (TN) and total phosphorus (TP) have been developed. **Table EX-1** lists supporting information for the TMDLs. 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 Lakes Terrace, Lawsona, Davis, Wade and Weldona.

Type of Information	Description
Waterbody name (waterbody identification [WBID] number)	Lake Terrace (3168X3), Lake Lawsona (3168Z9), Lake Davis (3168Y4), Lake Wade (3168W3) and Lake Weldona (3168Y8)
Hydrologic Unit Code (HUC) 8	03090101 – Middle St. Johns River Basin
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 Cycle 3 – Lakes Lawsona, Davis, Wade and Weldona, and verified list for the Biennial Assessment 2020 - 2022assessment – Lakes Terrace, Lawsona and Weldona
TMDL pollutants	Total nitrogen (TN) and total phosphorus (TP)
TMDLs and site-specific interpretations of the narrative nutrient criterion	**Lake Terrace (3168X3), Lake Lawsona (3168Z9), Lake Davis (3168Y4), Lake Wade (3168W3) and Lake Weldona (3168Y8):** **TN:** 0.80 milligrams per liter (mg/L), expressed as an annual geometric mean (AGM) not to be exceeded. **TP: 0.05** mg/L, expressed as an AGM not to be exceeded.
Load reductions required to meet the TMDLs	**Lake Terrace (WBID 3168X3):** 18% TN reduction and 0% TP reduction to achieve a chlorophyll *a* target of 20 micrograms per liter (µg/L) **Lake Lawsona (WBID 3168Z9)**: 32% TN reduction and 38% TP reduction to achieve a chlorophyll *a* target of 20 µg/L **Lake Davis (WBID 3168Y4)**: 50% TN reduction and 62% TP reduction to achieve a chlorophyll *a* target of 20 µg/L **Lake Wade (WBID 3168W3):** 41% TN reduction and 55% TP reduction to achieve a chlorophyll *a* target of 20 µg/L **Lake Weldona (WBID 3168Y8):** 62% TN reduction and 72% TP reduction to achieve a chlorophyll *a* target of 20 µg/L

Acknowledgments

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µg/L	Micrograms Per Liter
AGM	Annual Geometric Mean
BMAP	Basin Management Action Plan
BMP	Best Management Practice
$CaCO_3$	Calcium Carbonate
CFR	Code of Federal Regulations
CWA	Clean Water Act
DEP	Florida Department of Environmental Protection
EPA	U.S. Environmental Protection Agency
F.	Fahrenheit
F.A.C.	Florida Administrative Code
DOH	Florida Department of Health
DOT	Florida Department of Transportation
FLUCCS	Florida Land Use, Cover and Forms Classification System
F.S.	Florida Statutes
ft	Feet
FWRA	Florida Watershed Restoration Act
HUC	Hydrologic Unit Code
ID	Insufficient Data
IWR	Impaired Surface Waters Rule
LA	Load Allocation
MDL	Minimum Detection Limit
mg/L	Milligrams Per Liter
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer System
NA	Not Applicable
NAD	North American Datum
NNC	Numeric Nutrient Criteria
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSTDS	Onsite Sewage Treatment and Disposal System
PCU	Platinum Cobalt Unit
PLRG	Pollutant Load Reduction Goal
POR	Period of Record
SJRWMD	St. John's River Water Management District
SWIM	Surface Water Improvement and Management (Program)
TMDL	Total Maximum Daily Load
TN	Total Nitrogen

Chapter 1: Introduction

1.1 Purpose of Report

This report presents the total maximum daily loads (TMDLs) developed to address the nutrient impairments of Lakes Terrace, Lawsona, Davis, Wade and Weldona, located in the Middle St. Johns River Basin.

Pursuant to paragraph 62-302.531(2)(a), Florida Administrative Code (F.A.C.), the nutrient TMDLs will also 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 numeric nutrient criteria (NNC) in subsection 62-302.531(2), F.A.C. Lakes Davis and Wade were verified impaired as part of the Cycle 3 Group 4 assessment; Lakes Lawsona and Weldona were verified impaired for TP and chlorophyll *a* respectively, as part of the Cycle 3 Group 4 assessment. Lake Terrace was verified impaired in the Biennial Assessment 2020 - 2022

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and provides water quality targets needed to achieve compliance with applicable water quality criteria based on the relationship between pollutant sources and water quality in the receiving waterbody. The TMDLs establish allowable loadings to Lakes Terrace, Lawsona, Davis, Wade and Weldona that would restore the waterbodies so that they meet their applicable water quality criteria for nutrients.

1.2 Identification of Waterbody

For assessment purposes, the Florida Department of Environmental Protection (DEP) divided the Middle St Johns 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 Terrace is WBID 3168X3, Lake Lawsona is WBID 3168Z9, Lake Davis is 3168Y4, Lake Wade is 3168W3 and Lake Weldona is 3168Y8. **Figure 1.1** shows the location of the WBIDs in the basin and major geopolitical and hydrologic features in the region, and **Figures 1.2a-e** contains more detailed maps of the WBIDs and their watersheds, and the major geopolitical and hydrologic features surrounding them.

Lakes Terrace, Lawsona, Davis, Wade and Weldona are located in east-central Orange County in a primarily residential area south of Orlando Executive Airport. All six lakes are also within Orlando city limits east of the I4-Spessard L Holland East-West Expressway Interchange. They are located within the Little Econlockhatchee River watershed. These lakes do not have any surficial hydrologic connections to other water bodies. According to the City of Orlando (2019), the lakes are all eutrophic in nature. Surface area and depth information for each lake is shown in **Table 1.1** (City of Orlando, 2019).

Table 1.1 Area, average depth, and maximum depth for the impaired lakes.

Lake Name	Area (ac)	Average Depth (m)	Maximum Depth (m)
Lake Terrace	5	3.9	5.3
Lake Lawsona	9	2.2	4.2
Lake Davis	17	1.9	Not Reported
Lake Wade	3	1.8	2.4
Lake Weldona	9	2.3	4.5

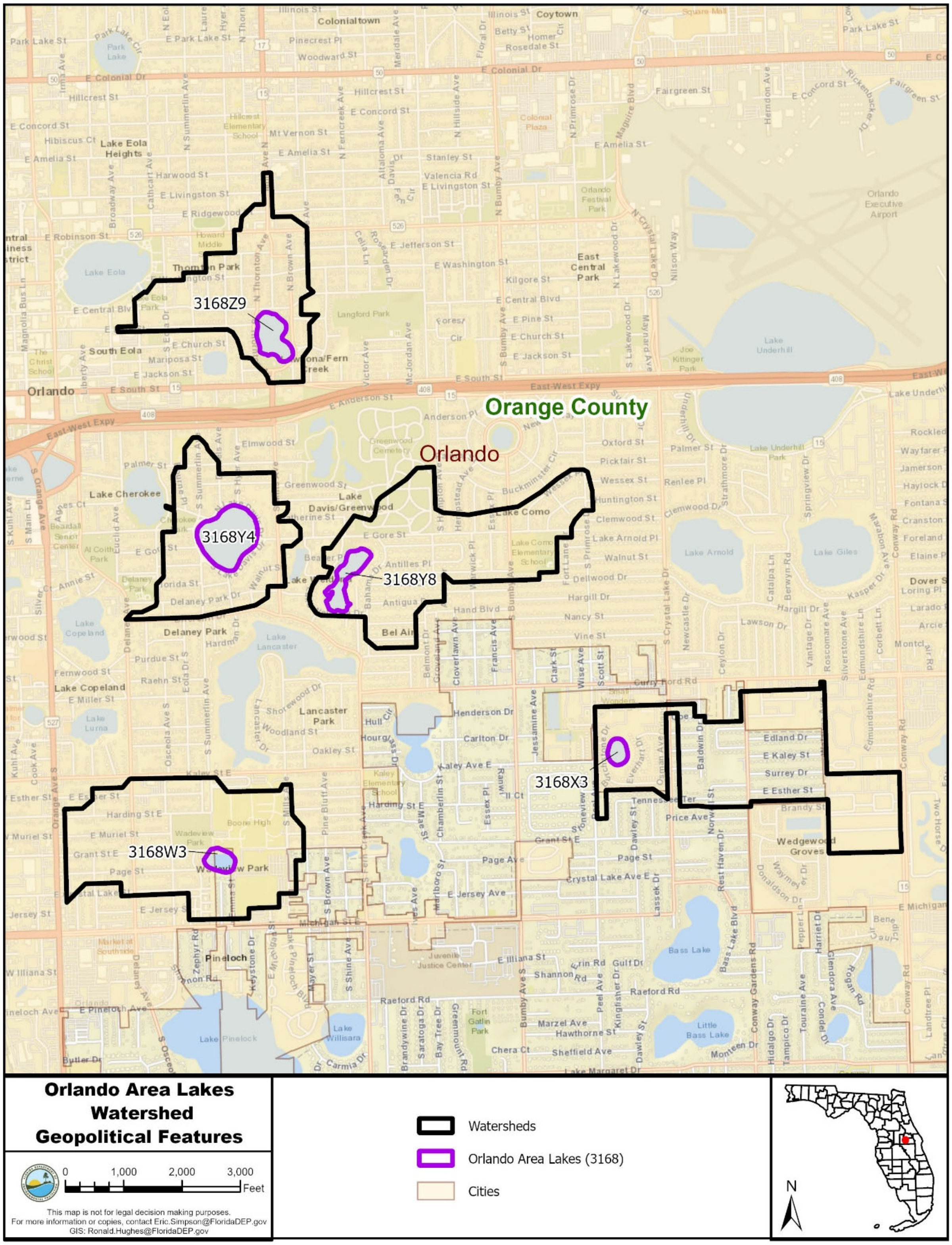

Figure 1.1 Relative location of the TMDL lakes and their watersheds.

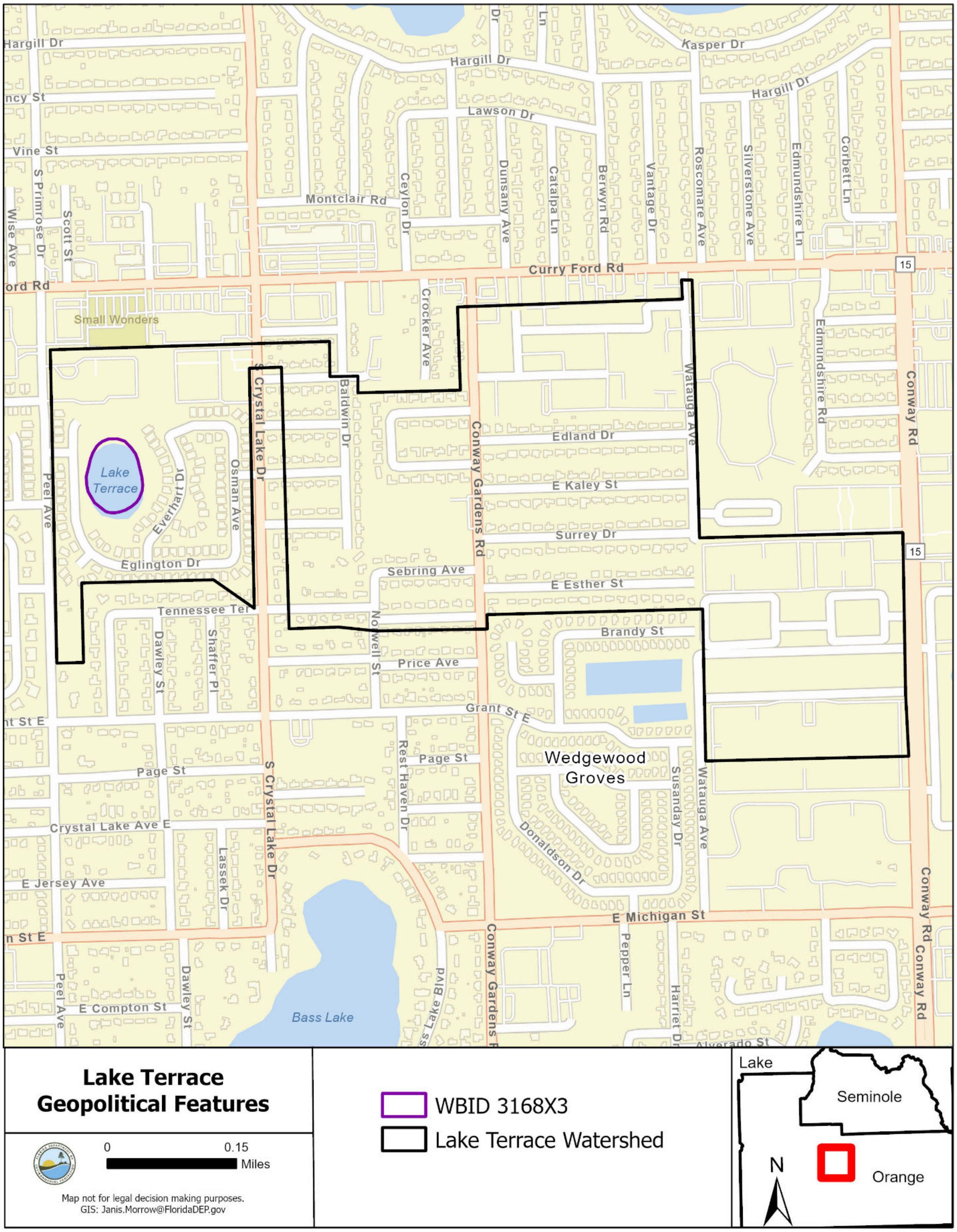

Figure 1.2a Lake Terrace (WBID 3168X3) and its watershed.

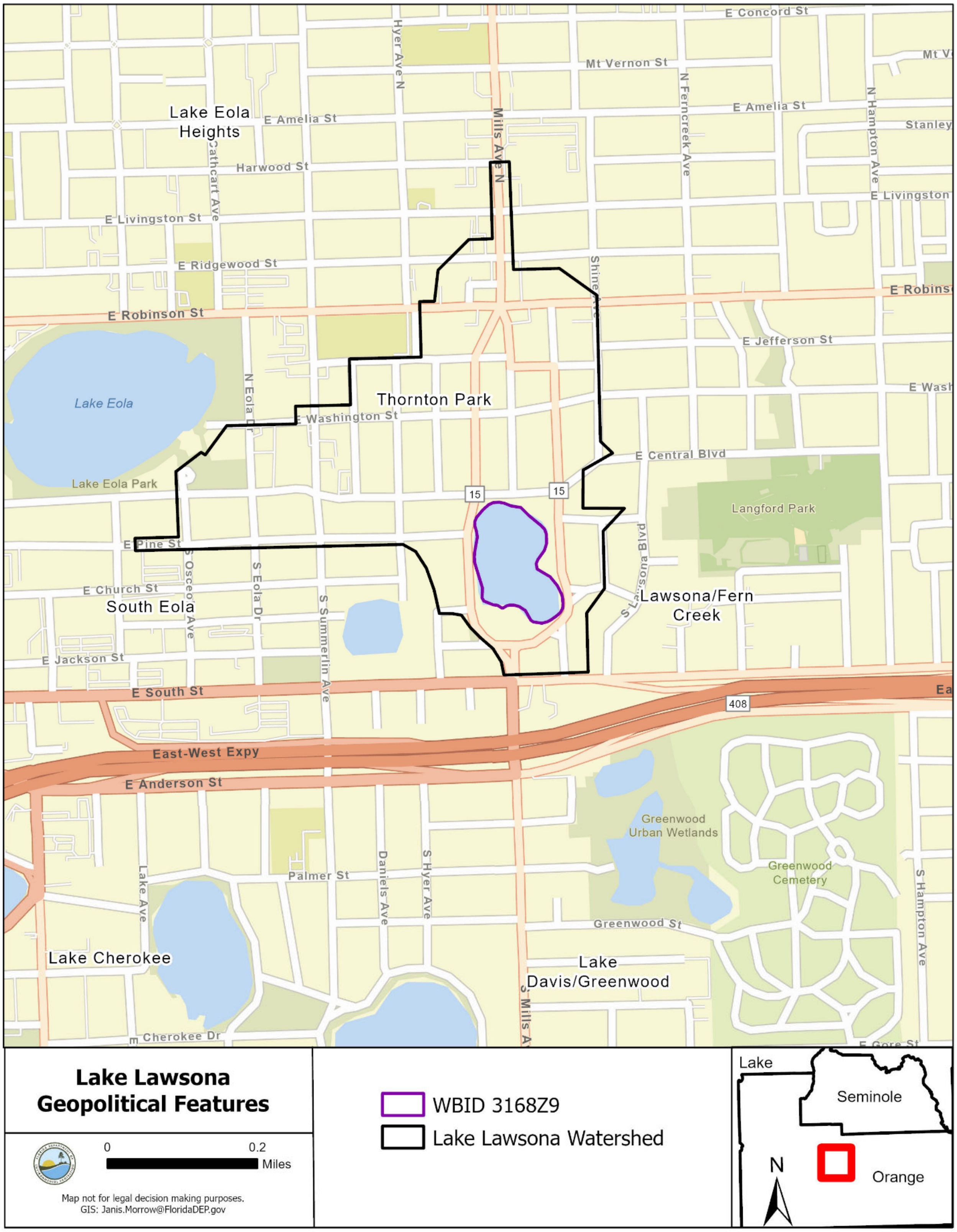

Figure 1.2b Lake Lawsona (WBID 3168Z9) and its watershed.

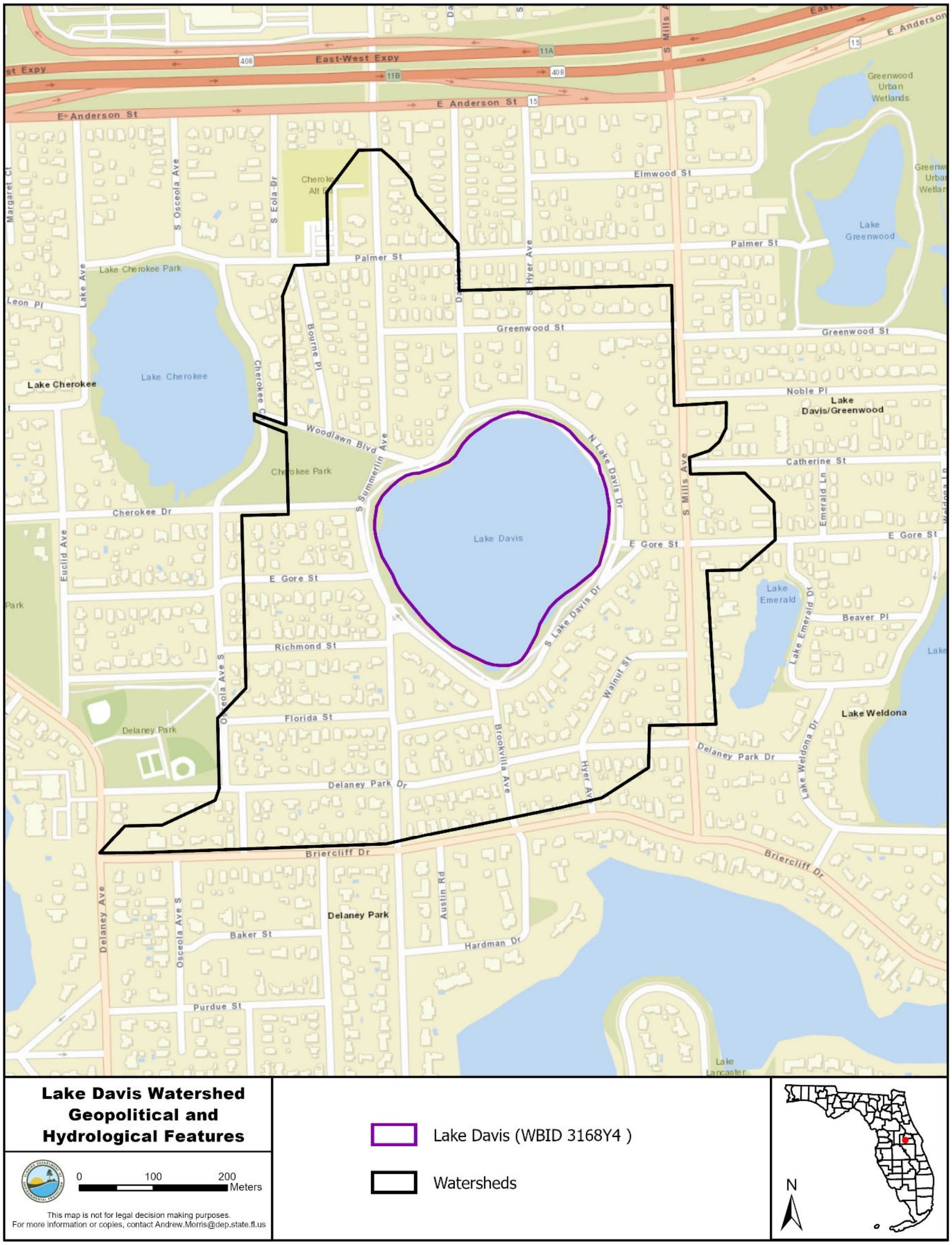

Figure 1.2c Lake Davis (WBID 3168Y4) and its watershed.

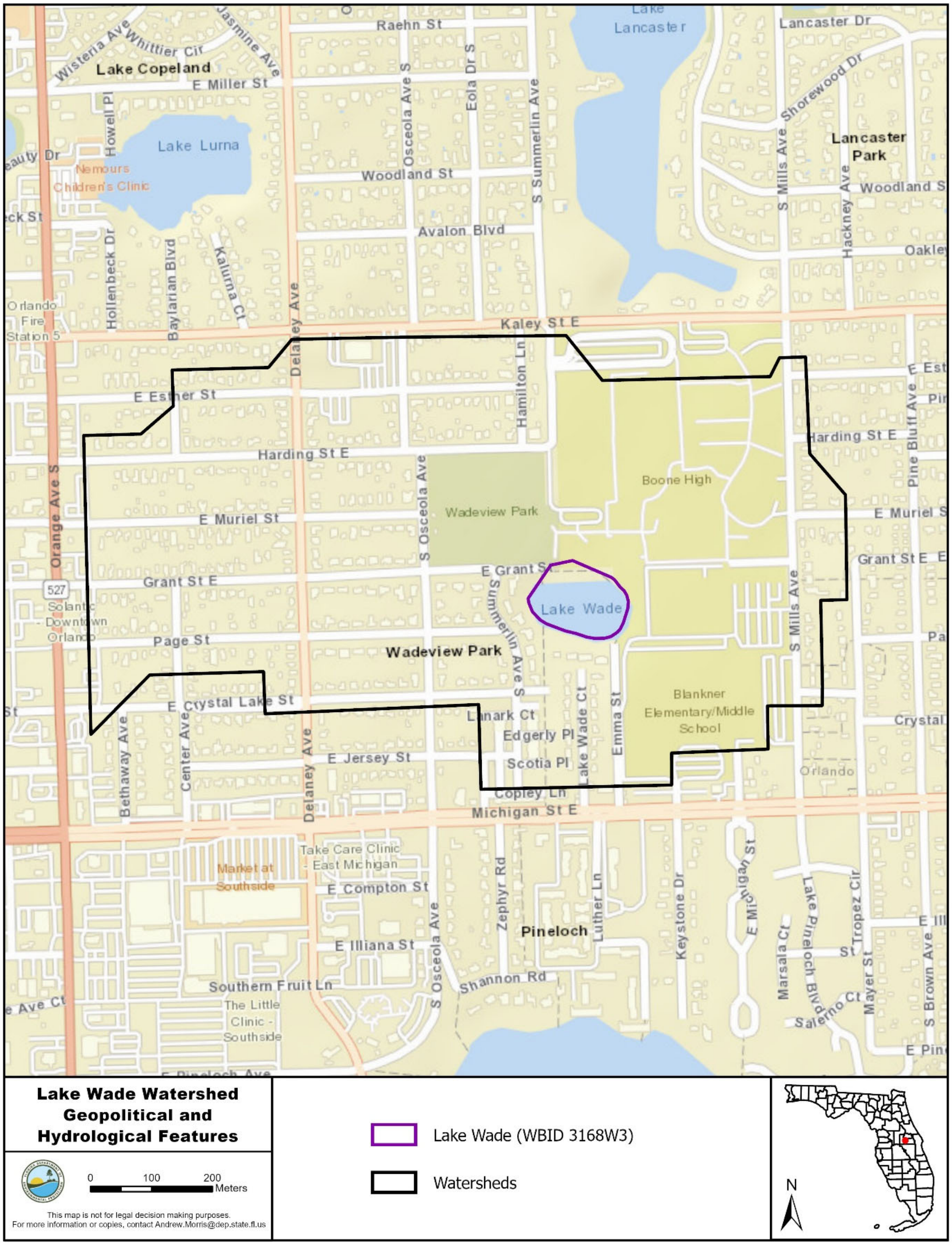

Figure 1.2d Lake Wade (WBID 3168W3) and its watershed.

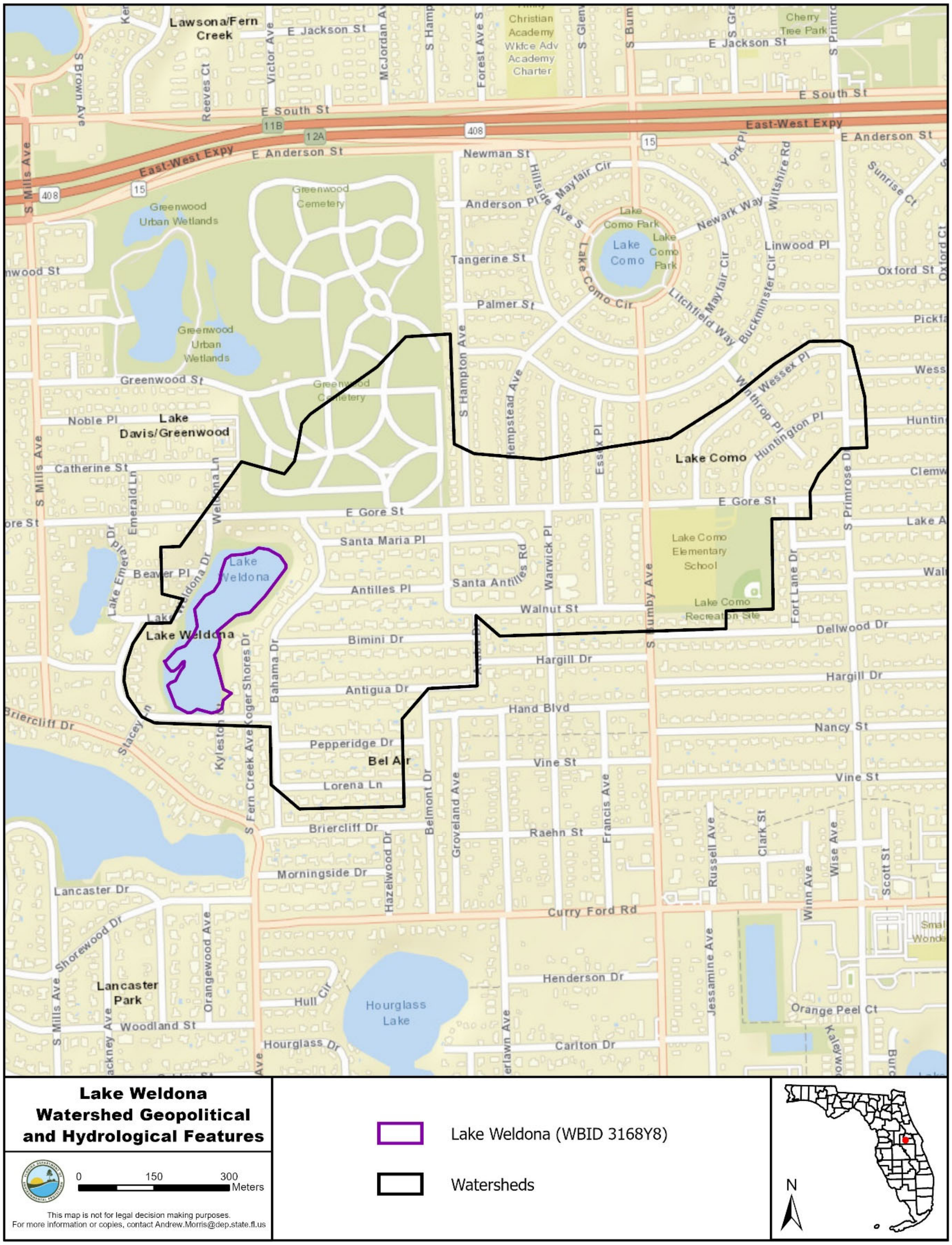

Figure 1.2e Lake Weldona (WBID 3168Y8) and its watershed.

1.3 Watershed Information

1.2.1 Population and Geopolitical Setting

Lakes Terrace, Lawsona, Davis, Wade, and Weldona and their watersheds, are all located wholly within Orlando city limits. The population of Orlando was 309,154 as of 2021, and the population density was about 3,004 people per square mile as of 2020.

1.2.2 Topography

The hydrologic characteristics of soil can significantly influence the capability of a watershed to hold rainfall or produce surface runoff. Soils are generally classified as one of four major types based on their hydrologic characteristics (Viessman et al. 1989). Lakes Terrace, Wade, and Weldona all have soils entirely within hydrologic soil group A, denoting well-drained soils with low runoff potential. Soils in this group are typically sand, loamy sand, or sandy loam. Lakes Lawsona and Davis are also mostly group A, there is also a presence of type A/D soils. Group A/D soils have high runoff potential unless drained, i.e., under natural conditions, it is a group D soil. When drained, it acts as a group A soil. **Table 1.2** shows the area of each soil type by watershed, and **Figures 1.3** shows the geographical distribution of the soil types within the lakes' respective watersheds.

Table 1.1 Summary of soil hydrologic group areas for Lakes Terrace, Lawsona, Davis, Wade and Weldona watersheds.

Soil Hydrologic Group	Lake Terrace (acres)	Lake Lawsona (acres)	Lake Davis (acres)	Lake Wade (Acres)	Lake Weldona (acres)
Group A	174	86	95	176	96
Group B	0	0	0	0	0
Group C	0	0	0	0	0
Group D	0	0	0	0	0
Group A/D	7	23	6	0	0
Group B/D	0	0	0	0	0
Water	2	9	16	3	7
Total	183	118	117	179	171

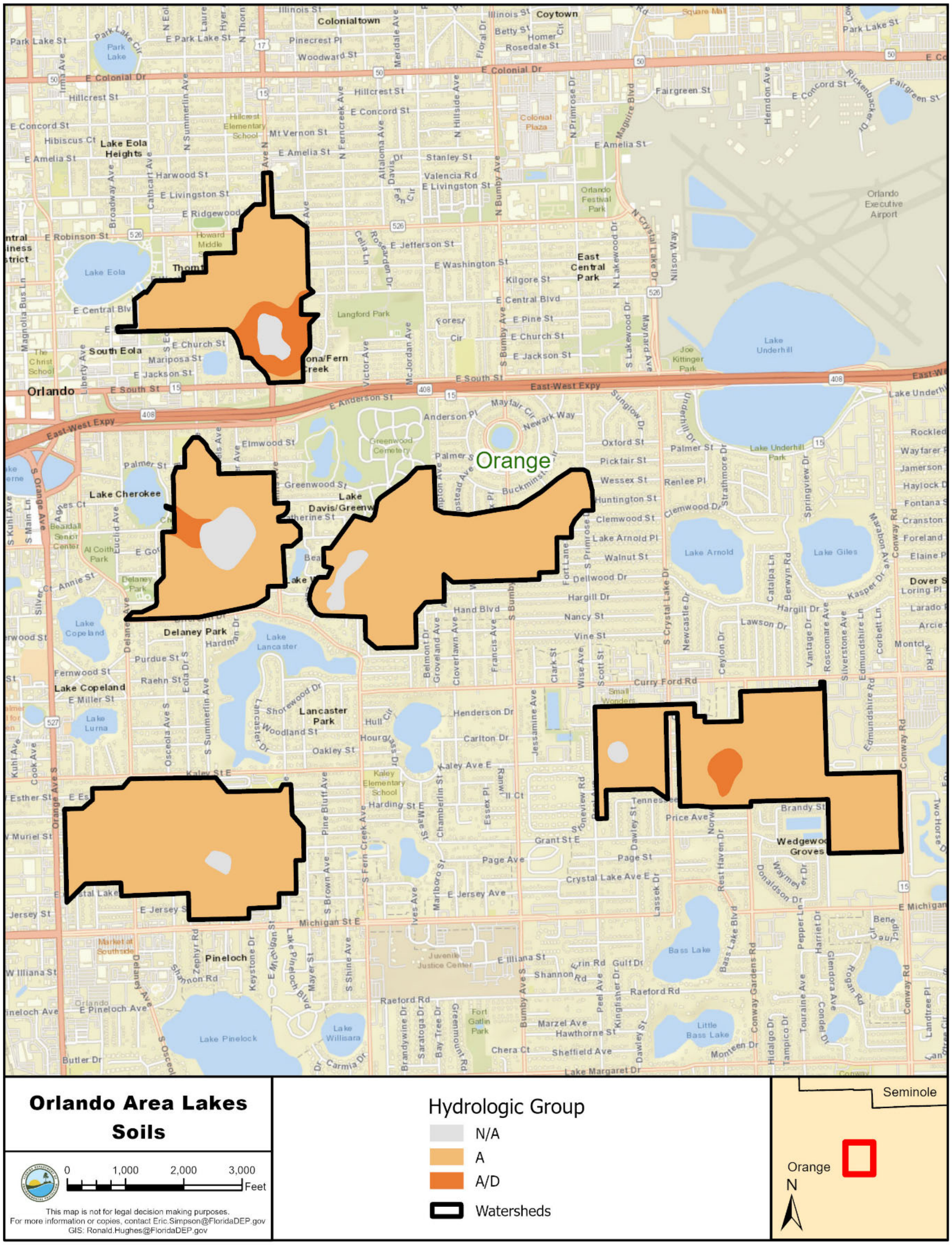

Figure 1.3 Hydrologic soil group for each lake's watershed.

These lakes are in Florida Lake Region 75-21, also known as the Orlando Ridge (Griffith et al. 1997). This is a highly karstic area with an elevation of 75 to 120 feet. The karst features, coupled with the fact that these lakes do not drain to any surface waters and are surrounded by well-drained type A soils, indicates that these are important areas for groundwater drainage. Orlando is also a region of relatively high aquifer transmissivity, meaning water moves rapidly through the rock into the aquifer system (Kuniansky et. al, 2012).

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

2.1 Statutory Requirements and Rulemaking History

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

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

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

2.2 Classification of the Waterbody and Applicable Water Quality Standards

Lakes Terrace, Lawsona, Davis, Wade and Weldona are Class III (fresh) waterbodies, with a designated use of fish consumption, recreation, and propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criterion applicable to the verified impairment (nutrients) for these waterbodies is Florida's nutrient criterion in paragraph 62-302.530(48)(b), F.A.C.

The applicable lake NNC are dependent on alkalinity, measured in milligrams per liter as calcium carbonate (mg/L $CaCO_3$), and true color (color), measured in platinum cobalt units (PCU), based on long-term period of record (POR) geometric means (**Table 2.1**). For the six lakes exceeding the NNC, the POR alkalinity geometric means ranged from 38 mg/L $CaCO_3$ in Lake Terrace to 49 mg/L $CaCO_3$ in Lake Davis. The POR geometric means for color ranged from 13 PCU in Lake Terrace to 24 PCU in Lake Davis. **Table 2.2** shows the color and alkalinity data used in the derivation of this TMDL.

Table 2.1 Chlorophyll *a*, TN, and TP criteria for Florida lakes (Subparagraph 62-302.531(2)(b)1., F.A.C.).

* For lakes with color > 40 PCU in the West Central Nutrient Watershed Region, the maximum TP limit is the 0.49 mg/L TP streams threshold for the region.

Long-Term Geometric Mean Lake Color and Alkalinity	AGM Chlorophyll *a* (µg/L)	Minimum Calculated AGM TP NNC (mg/L)	Minimum Calculated AGM TN NNC (mg/L)	Maximum Calculated AGM TP NNC (mg/L)	Maximum Calculated AGM TN NNC (mg/L)
>40 PCU	20	0.05	1.27	0.16*	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

The chlorophyll *a* NNC for low-color, high alkalinity lakes is an annual geometric mean (AGM) value of 20 micrograms per liter (µg/L), not to be exceeded more than once in any consecutive 3-year period. The associated total nitrogen (TN) and TP criteria for a lake can vary annually, depending on the availability of data for chlorophyll *a* and the concentrations of chlorophyll *a* in the lake. If there are sufficient data to calculate an AGM for chlorophyll *a* and the mean does not exceed the chlorophyll *a* criterion for the lake type listed in **Table 2.1**, 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 2.1** lists the NNC for Florida lakes specified in subparagraph 62-302.531(2)(b)1., F.A.C. The data used to calculate the lake classifications for these six lakes is taken from IWR Run 65.

Table 2.2 Long-term geometric means for color and alkalinity for the POR.

Waterbody	POR for Color	Long-Term Geometric Mean Color (PCU)	POR for Alkalinity	Long-Term Geometric Mean Alkalinity (mg/L $CaCO_3$)
Lake Terrace	2012-2022	13	2005-2022	33
Lake Lawsona	2013-2022	23	2001-2022	46
Lake Davis	2012–2021	26	1993–2020	48
Lake Wade	2012–2020	18	1993–2020	50
Lake Weldona	2012–2020	21	1993–2020	40

2.3 Determination of the Pollutant of Concern

2.3.1 Data Providers

The sources of lake nutrient data used in the most recent verified assessment periods, beginning in 2013 for Lakes Terrace, Lawsona, Davis, Wade and Weldona are stations sampled by the City of Orlando and the DEP Central District. **Figures 2.1a-e** show these sampling locations in the WBIDs.

Most of the data used in this report were collected by the City of Orlando, with some sampling done by the DEP.

The individual water quality measurements discussed in this report for the verified assessment period from 2009 through 2016 are available in IWR Run 65 Database and are available on request.

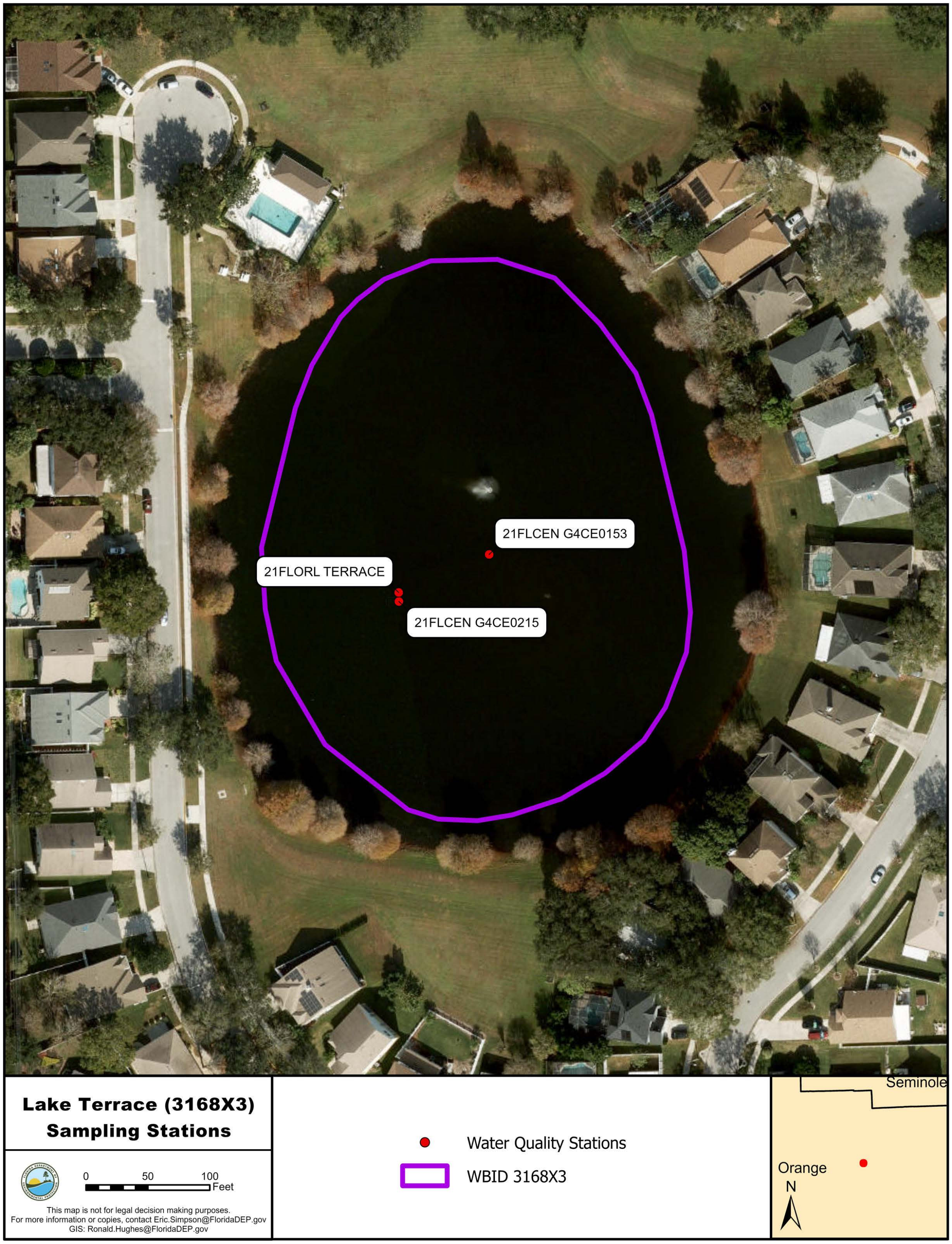

Figure 2.1a Lake Terrace (WBID 3168X3) sampling stations.

Figure 2.1b Lake Lawsona (WBID 3168Z9) sampling stations.

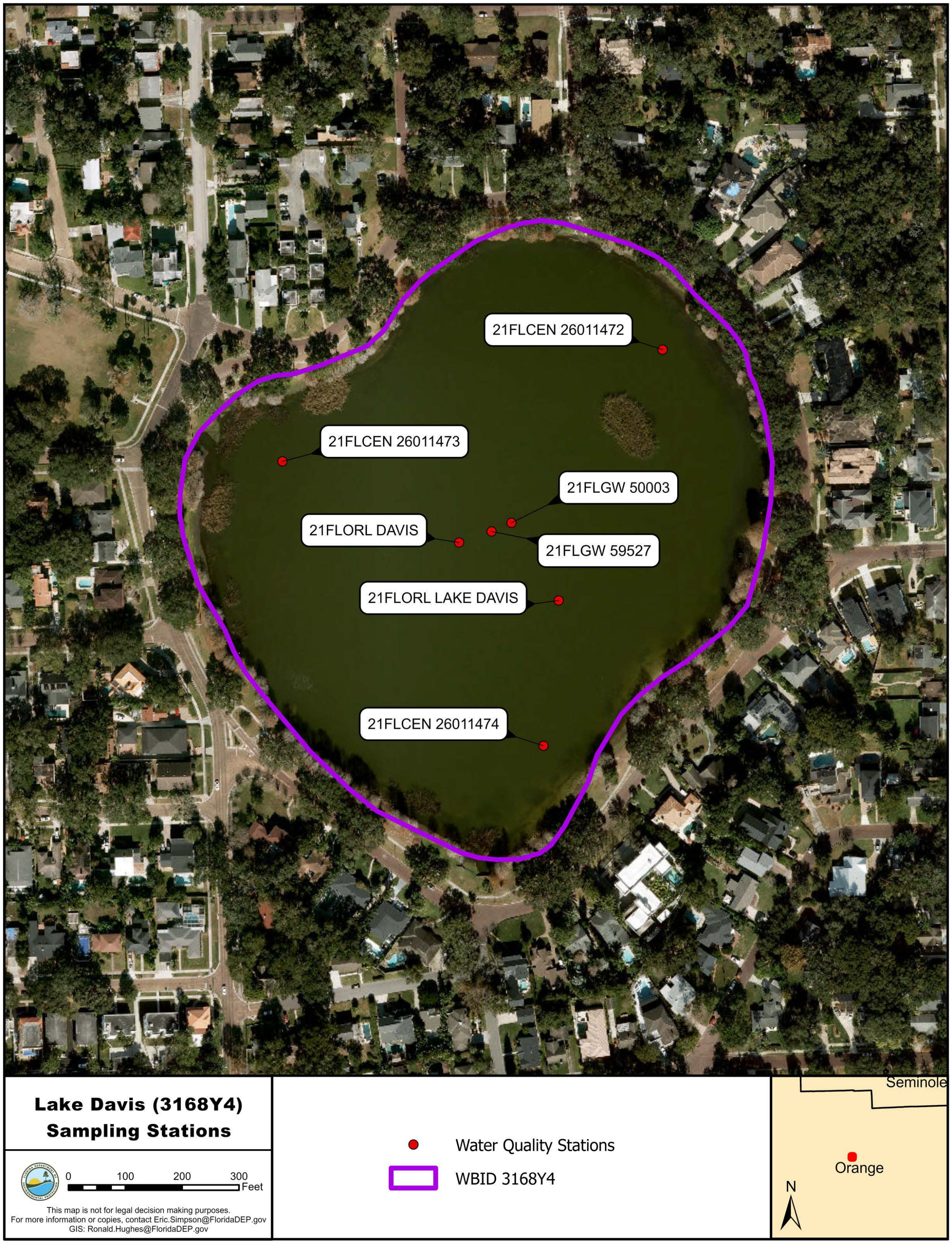

Figure 2.1c Lake Davis (WBID 3168Y4) sampling stations.

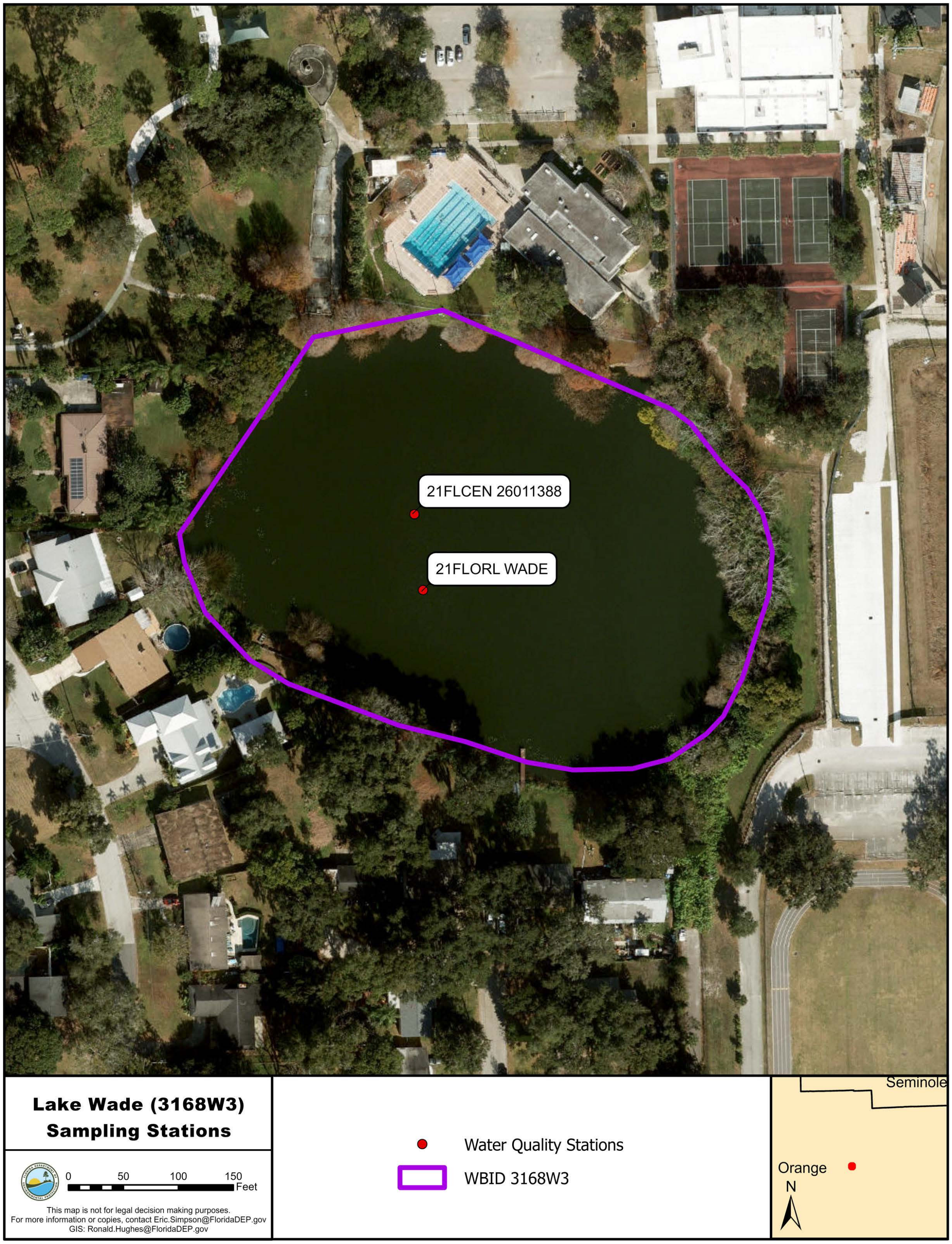

Figure 2.1d Lake Wade (WBID 3168W3) sampling stations.

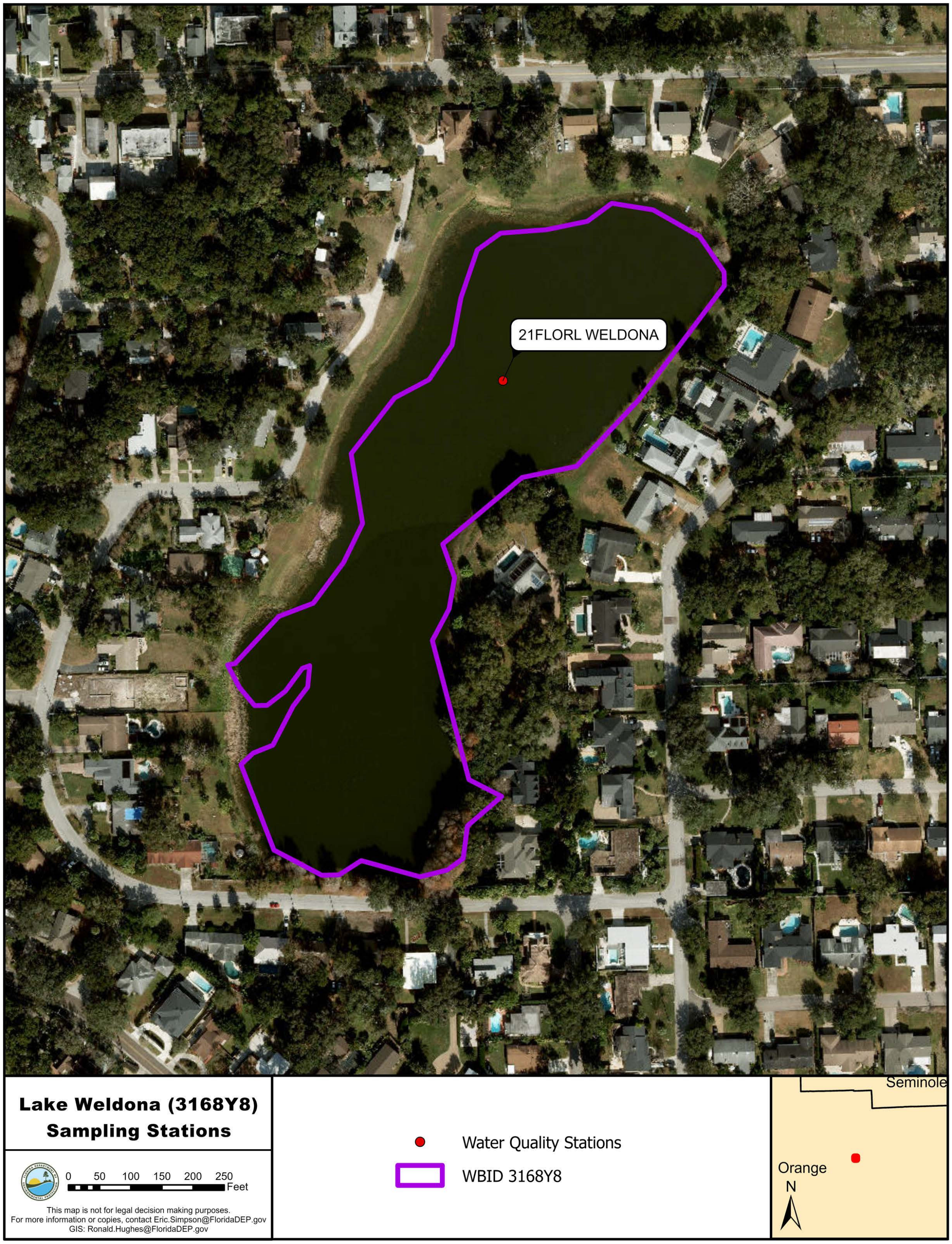

Figure 2.1e Lake Weldona (WBID 3168Y8) sampling stations.

2.3.2 Information on Verified Impairment

Lakes Terrace and Lawsona (WBIDs 3168X3 and 3168Z9 respectively) were assessed for lake NNC as part of the statewide Biennial Assessment 2020- 2022. The verified period was January 1, 2013, through June 30, 2020. Data for this assessment are stored in the IWR Run 60 Access Database.

Lake Davis (WBID 3168Y4), Lake Wade (WBID 3168W3), and Lake Weldona (WBID 3168Y8) were assessed by applying the lake NNC as part of the Group 4, Cycle 3 IWR assessment. The verified period was January 1, 2009, through June 30, 2016. Data for the Group 4, Cycle 3 IWR assessment are stored in the IWR Run 53 Access database.

Tables 2.2a-e lists the AGM values for chlorophyll *a*, TN, and TP for Lakes Terrace, Lawsona, Wade, Davis and Weldona, respectively, during the verified periods in which they were first assessed as impaired and AGM results for subsequent years. The AGMs were calculated using the most recent results found in the IWR Run 65 Database. To be assessed as impaired (Category 5) for nutrients, AGMs for a particular nutrient had to have exceeded the NNC more than once in a three-year period.

Lake Terrace is assessed as impaired for chlorophyll *a* due to the AGM exceeding 20 µg/L in 2018-2020. It is impaired for TP due to the AGM exceeding 0.03 mg/L in 2018-2020

Chlorophyll *a* is impaired in Lake Lawsona due to the AGM exceeding 20 µg/L in 2018-2020, and impaired for TP due to the AGM exceeding 0.03 mg/L from 2015-2021.

Lake Davis was assessed as impaired for chlorophyll *a*, TN, and TP because chlorophyll *a* AGMs exceeded 20 µg/L in 2009 and 2011–2013, TN AGMs exceeded 1.05 mg/L in 2009 and 2011–2014, and TP AGMs exceeded 0.03 mg/L from 2009–2014.

Lake Wade was assessed as impaired for chlorophyll *a*, TN, and TP because chlorophyll *a* AGMs exceeded 20 µg/L in 2009, and 2012–2014, TN AGMs exceeded 1.05 mg/L in 2009, 2010, and 2012–2014, and TP AGMs exceeded 0.03 mg/L in 2009, 2010, and 2012–2014. Lake Weldona was assessed as impaired for chlorophyll *a* because AGMs exceeded 20 µg/L from 2009–2012.

Lake Weldona was not assessed as impaired for TN and TP during the verified period because, even though TN AGMs exceeded 1.05 mg/L in 2009–2012 and TP AGMs exceeded 0.03 mg/L in 2009–2012, there was insufficient data at the time to assess color and classify the lake.

Table 2.3a Lake Terrace AGM values for the 2013-2019 verified period.

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

Year	Chlorophyll a (µg/L)	TN (mg/L)	TP (mg/L)
2015	6	0.68	0.02
2016	ID	ID	ID
2017	8	0.46	0.03
2018	**24**	0.73	**0.05**
2019	**33**	0.97	**0.05**
2020	**29**	0.77	**0.05**
2021	16	0.9	0.04

Table 2.3b Lake Lawsona AGM values for the 2013-2019 verified period.

Year	Chlorophyll a (µg/L)	TN (mg/L)	TP (mg/L)
2015	12	0.79	0.05
2016	11	0.76	0.06
2017	14	0.65	0.07
2018	**25**	0.82	**0.07**
2019	**28**	0.81	**0.07**
2020	**22**	0.86	**0.08**
2021	20	0.77	0.08

Table 2.3c Lake Davis (WBID 3168Y4) AGM values for the 2009–16 verified period.

ID = Insufficient data
Note: Values shown in boldface type and shaded are greater than the NNC for lakes. Rule 62-302.531, F.A.C, states that the applicable numeric interpretations for TN, TP, and chlorophyll *a* shall not be exceeded more than once in any consecutive 3-year period.

Year	Chlorophyll *a* (µg/L)	TN (mg/L)	TP (mg/L)
2009	**39**	**1.7**	**0.09**
2010	17	1.05	**0.06**
2011	**57**	**2.01**	**0.11**
2012	**23**	**1.61**	**0.1**
2013	**39**	**1.45**	**0.12**
2014	ID	**1.14**	**0.08**
2015	**29**	**1.08**	**0.07**
2016	**32**	**1.2**	**0.08**
2017	**65**	**1.13**	**0.13**
2018	**36**	**1.28**	**0.10**
2019	**37**	1.03	**0.07**
2020	**36**	**1.15**	**0.08**
2021	**43**	**1.47**	**0.05**

Table 2.3d Lake Wade (WBID 3168W3) AGM values for the 2009–16 verified period.

ID = Insufficient data
Note: Values shown in boldface type and shaded are greater than the NNC for lakes. Rule 62-302.531, F.A.C, states that the applicable numeric interpretations for TN, TP, and chlorophyll *a* shall not be exceeded more than once in any consecutive 3-year period.

Year	Chlorophyll *a* (µg/L)	TN (mg/L)	TP (mg/L)
2009	**34**	**1.21**	**0.1**
2010	ID	**1.25**	**0.1**
2011	ID	ID	ID
2012	**29**	**1.35**	**0.11**
2013	**22**	**1.2**	**0.08**
2014	**48**	**1.11**	**0.1**
2015	**28**	0.94	**0.07**
2016	**37**	0.95	**0.08**
2017	**33**	**1.11**	**0.07**
2018	**35**	0.98	**0.09**
2019	**28**	0.74	**0.05**
2020	**38**	0.82	**0.1**
2021	**36**	0.91	**0.08**

Table 2.3e Lake Weldona (WBID 3168Y8) AGM values for the 2009–16 verified period.

ID = Insufficient data

Note: Values shown in boldface type and shaded are greater than the NNC for lakes. Rule 62-302.531, F.A.C, states that the applicable numeric interpretations for TN, TP, and chlorophyll *a* shall not be exceeded more than once in any consecutive 3-year period.

Year	Chlorophyll *a* (µg/L)	TN (mg/L)	TP (mg/L)
2009	**23**	**1.33**	**0.07**
2010	**34**	**1.57**	**0.08**
2011	**55**	**1.92**	**0.13**
2012	**35**	**2.1**	**0.18**
2013	ID	ID	ID
2014	ID	ID	ID
2015	**27**	0.99	**0.05**
2016	**28**	1.05	**0.06**
2017	**51**	0.77	**0.12**
2018	**32**	0.96	**0.09**
2019	**33**	0.86	**0.06**
2020	**35**	0.9	**0.07**
2021	**36**	**1.14**	**0.07**

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

3.1 Establishing the Site-Specific Interpretation

Pursuant to paragraph 62-302.531(2)(a), F.A.C., the nutrient TMDLs presented in this report will, upon adoption into Rule 62-304.625, F.A.C., 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 3.1** 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 Lakes Terrace, Lawsona, Davis, Wade and Weldona, 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.

When developing TMDLs to address nutrient impairment, it is essential to address those nutrients that typically contribute to excessive plant growth. In Florida waterbodies, nitrogen and phosphorus are most often the limiting nutrients. The limiting nutrient is defined as the nutrient(s) that limit plant growth (both macrophytes and algae) when it is not available in sufficient quantities. A limiting nutrient is a chemical necessary for plant growth, but available in quantities smaller than those needed for the optimal growth of algae, represented by chlorophyll *a*, and macrophytes.

In the past, management activities to control lake eutrophication focused on phosphorus reduction, as phosphorus was generally recognized as the most limiting nutrient in freshwater systems. Recent studies, however, have supported the reduction of both nitrogen and phosphorus as necessary to control algal growth in aquatic systems (Conley et al. 2009; Paerl 2009; Lewis et al. 2011; Paerl and Otten 2013). Furthermore, the analysis used in the development of the Florida lake NNC support this idea, as statistically significant relationships were found between chlorophyll *a* values and both nitrogen and phosphorus concentrations (DEP 2012).

3.2 Site-Specific Response Variable Target Selection

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

The generally applicable chlorophyll *a* criteria are assumed to be protective of individual Florida lakes, absent information that shows either (1) more sensitive aquatic life use (i.e., a more responsive floral community), or (2) a significant historical change in trophic status (i.e., a significant increasing trend in color and/or alkalinity). Long-term datasets of color, alkalinity, and nutrients in this TMDL suggest that they do not differ from the population of lakes used in the development of the NNC. Therefore, DEP has determined that the generally applicable chlorophyll *a* criterion for low-color, high-alkalinity lakes is appropriate for the lakes in question, will serve as the TMDL water quality target, and will remain the applicable water quality criterion.

3.3 Numeric Expression of the Site-Specific Numeric Interpretation

Regression models describing the relationships between chlorophyll *a* and nutrient concentrations (TN and TP) were developed, using the AGM values for all 6 impaired lakes, along with 8 lakes assessed as not impaired for nutrients. The lakes assessed as not impaired were selected based on attributes similar to the impaired lakes. The attributes included size (3-100 acres surface area), lack of surficial connections to other water bodies, and being located in the same lake region (Orlando Ridge), surficial geology (undifferentiated sediments) and drainage basin (Middle St. Johns River) as the impaired lakes. The TMDL development approach using regression analyses is explained in detail in **Chapter 5**. This approach uses the linear regression relationships between nutrients and chlorophyll *a* to set the nutrient target concentrations. The simple linear regression equations representing the relationships between chlorophyll *a* AGMs and TN and TP AGMs were used to identify the in-lake nutrient concentrations necessary to achieve the chlorophyll *a* restoration target of 20 µg/L.

Applying the equations indicate the site-specific numeric interpretation of the narrative criterion and TMDL target for TN is 0.80 mg/L and for TP is 0.05 mg/L. The target concentrations are then used to determine the percent reductions in current in-lake concentrations necessary to meet the targets, for the period from 2015 to 2022.

The nutrient criteria are all expressed as AGM concentrations in these lakes. The chlorophyll *a* concentration is expressed as an AGM concentration not to be exceeded more than once in any consecutive three-year period. The TN and TP concentrations are expressed as AGM concentrations never to be exceeded.

Tables 3.1 summarize the TMDL target values, and more information on the mathematical relationships and percent reductions is shown in **Chapter 5.**

Table 3.1 Site-specific interpretations of the narrative nutrient criterion.

Note: Frequency refers to the time interval not to be exceeded. Chlorophyll *a* shall not be exceeded more than once in any consecutive three-year period. TN and TP are never to be exceeded.

Waterbody/ WBID	AGM Chlorophyll *a* (µg/L)	Chlorophyll *a* Frequency	AGM TN (mg/L)	TN Frequency	AGM TP (mg/L)	TP Frequency
Lake Terrace	20	Once in a three-year period	0.80	No exceedance	0.05	No exceedance
Lake Lawsona	20	Once in a three-year period	0.80	No exceedance	0.05	No exceedance
Lake Davis	20	Once in a three-year period	0.80	No exceedance	0.05	No exceedance
Lake Wade	20	Once in a three-year period	0.80	No exceedance	0.05	No exceedance
Lake Weldona	20	Once in a three-year period	0.80	No exceedance	0.05	No exceedance

3.4 Downstream Protection

Lakes Terrace, Lawsona, Davis, Wade and Weldona are all internally drained seepage lakes without any surface hydrological connections. It is expected that implementation of the TMDL to reduce Chlorophyll *a*, TN and TP will lead to enhancement of water quality in the area.

3.5 Endangered Species Considerations

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

Prior to approving WQS changes for aquatic life criteria, the EPA will prepare an Effect Determination summarizing the direct and 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 aquatic species present in Lakes Terrace, Lawsona, Davis, Wade and Weldona or their watersheds. Furthermore, water quality improvements resulting from these restoration efforts are expected to positively affect aquatic species living in the lakes and their respective watersheds.

Chapter 4: Assessment of Sources

4.1 Types of Sources

An important part of the TMDL analysis is the identification of pollutant source categories, source subcategories, or individual sources of the pollutant of concern in the target watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either point sources or nonpoint sources. Historically, the term "point sources" has meant discharges to surface waters that typically have a continuous flow via a discernable, confined, and discrete conveyance, such as a pipe. Domestic and industrial wastewater treatment facilities (WWTFs) are examples of traditional point sources. Point sources also include 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). 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.

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 a National Pollutant Discharge Elimination System (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

Currently, there are no NPDES-permitted wastewater facilities that discharge Lakes Terrace, Lawsona, Davis, Wade or Weldona or that discharge to surface waters in their respective watersheds.

4.2.2 Municipal Separate Storm Sewer System (MS4) Permittees

The Lake Lawsona, Lake Davis and Lake Weldona watersheds are covered by one NPDES MS4 Phase I permit; Lake Terrace's and Lake Wade's watersheds are covered by two separate Phase I MS4 permits. Only co-permittees whose jurisdictions are included, wholly or in part, within the boundaries of the Lakes Terrace, Lawsona, Davis, Wade and Weldona watersheds are listed here. Also note that while these permittees are located wholly or partially within the Lakes Terrace, Lawsona, Davis, Wade and Weldona watersheds, the permittees do not have jurisdiction over the entire contributing areas for each lake, nor are they responsible for any discharge if they do not have an outfall discharging to the watershed. For more information on MS4s in the watershed, send an email to NPDES-stormwater@dep.state.fl.us. **Table 4.1** lists the permittees/co-permittees and their MS4 permit numbers.

Table 4.1 NPDES MS4 permits with jurisdiction in the Lakes Terrace, Lawsona, Davis, Wade and Weldona watersheds.

Lake	Permit Number	Permittee/Co-Permittees	Phase
Terrace, Lawsona, Davis, Wade, Weldona	FLS000014	City of Orlando	I
Terrace, Wade	FLS000011	Orange County, FDOT District 5	I

4.3 Nonpoint Sources

Pollutant sources that are not NPDES wastewater or stormwater dischargers are generally considered nonpoint sources. Nutrient loadings to Lakes Terrace, Lawsona, Davis, Wade and Weldona are mainly generated from nonpoint sources. Nonpoint sources addressed in this analysis primarily include loadings from surface runoff, baseflow and precipitation directly onto the lake surface (atmospheric deposition).

4.3.1 Land Use

Land use is one of the most important factors in determining nutrient loadings from the Lakes Terrace, Lawsona, Davis, Wade and Weldona Watersheds. Nutrients can be flushed into a receiving water through surface runoff and stormwater conveyance systems during stormwater events. Both human land use areas and natural land areas generate nutrients. However, human land uses typically generate more nutrient loads per unit of land surface area than natural lands can produce. **Tables 4.2-3** lists land use in the watershed in 2016 based on data from The St. Johns River Water Management District., and **Figure 4.1** shows the information graphically for each individual lake. **Tables 4.4-5** list land use from the same source in the watersheds of the unimpaired lakes. **Tables 4.6-7** list the land use percentages averaged for impaired and unimpaired lakes. "Unimpaired lakes have a higher average percentage of commercial land use (27.4% vs. 8.4%), recreation (2.8% vs. 1.5%) and High Density Residential (11.2% vs. 10.5%). Impaired lakes have higher percentages of institutional (9.6% vs. 4.0%) and Medium Density Residential (62.5% vs. 34.8%)."

Lake Terrace (WBID 3168X3) has a contributing watershed of 180 acres, excluding the lake itself. Of this area, 42.4% is medium density residential housing, 48.9% is high density residential, 0.54% is commercial and services and 3.8% is institutional

Lake Lawsona (WBID 3169Z9) has a contributing watershed of 110 acres, excluding the lake. 61% of this is medium density residential. 1.7% is high-density residential, 26.3% is commercial and services, 2.5% is recreational and 1.7% is transportation.

Lake Davis (WBID 3168Y4) has a contributing watershed, excluding the lake, of 99 acres. 81% is medium density residential, <1% is high density residential, 2% is institutional, <1% is recreational and 2% is herbaceous dry prairie.

Lake Wade (WBID 3168W3) has a contributing watershed, excluding the lake, of 176 acres. It is 55% medium density residential, 2% high density residential, 2% commercial, 33% institutional, 5% recreational and <1% vegetated non-forested wetlands.

Lake Weldona (WBID 3168Y8) has a contributing watershed, excluding the lake, of 163 acres. 73% is medium density residential, 13% is commercial, 9% is institutional and 1% is vegetated non-forested wetlands.

Overall, the watersheds in question are primarily medium and high density residential with minimal undisturbed areas, which may result in a high level of runoff.

Table 4.2 St. Johns River Water Management District land use in the Lakes Terrace and Lawsona watersheds in 2016.

Land Use Description	Lake Terrace Acres	Lake Terrace Percent	Lake Lawsona Acres	Lake Lawsona Percent
Residential Medium Density	78	42.4	72	61
Residential High Density	90	48.9	2	1.7
Commercial and Services	1	0.54	31	26.2
Institutional	7	3.8	0	0
Recreational	0	0	3	2.5
Lakes	0	0	8	6.8
Vegetated Non-Forested Wetlands	0	0	0	0
Transportation	0	0	2	1.7
Utilities	0	0	0	0
Reservoirs	8	0	0	0
Herbaceous Dry Prairie/Open Land	0	0	0	0

Table 4.3 St. Johns River Water Management District land use in the Lakes Davis, Wade and Weldona watersheds in 2016.

Land Use Description	Lake Davis Acres	Lake Davis Percent	Lake Wade Acres	Lake Wade Percent	Lake Weldona Acres	Lake Weldona Percent
Residential Medium Density	95	81	99	55	125	73
Residential High Density	<1	<1	4	2	0	0
Commercial and Services	0	0	4	2	23	13
Institutional	2	2	58	33	14	9
Recreational	<1	<1	10	5	0	0
Lakes	18	15	3	2	8	4
Vegetated Non-Forested Wetlands	0	0	1	<1	1	1
Transportation	0	0	0	0	0	0
Utilities	0	0	0	0	0	0
Reservoirs	0	0	0	0	0	0
Herbaceous Dry Prairie/Open Land	2	2	0	0	0	0

Table 4.4 Land Use in the watersheds of the unimpaired lakes used in this analysis.

Land Use Description	Cherokee (Acres)	Cherokee (Percent)	Copeland (Acres)	Copeland (Percent)	Dot (Acres)	Dot (Percent)	Lancaster (acres)	Lancaster (Percent)
Residential Medium Density	69	47	23	50	0	0	279	83.8
Residential High Density	10	7	6	13	96	31	0	0
Commercial and Services	24	16	3	7	117	37	0	0
Institutional	7	5	0	0	37	12	11	3.3
Recreational	14	9	0	0	38	12	0	0
Lakes	13	9	14	30	0	0	40	12
Vegetated Non-Forested Wetlands	0	0	0	0	0	0	3	0.9
Transportation	10	7	0	0	0	0	0	0
Utilities	0	0	0	0	0	0	0	0
Reservoirs	0	0	0	0	6	2	0	0
Herbaceous Dry Prairie/Open Land	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	15	5	0	0
Open Land	1	1	0	0	2	1	0	0
Upland Hardwood Forests	0	0	0	0	2	1	0	0
Upland Mixed Forests	0	0	0	0	0	0	0	0
Wetland Coniferous Forests	0	0	0	0	0	0	0	0
Wetland Forested Mixed	0	0	0	0	0	0	0	0

Table 4.5 Land Use in the watersheds of the remaining unimpaired lakes in this analysis.

Land Use Description	Druid (Acres)	Druid (Percent)	Fredrica (Acres)	Fredrica (Percent)	Gear (Acres)	Gear (Percent)	Lurna (Acres)	Lurna (Percent)	Park (Acres)	Park (Percent)
Residential Medium Density	71	41	0	0	6	13	47	39	52	39
Residential High Density	10	6	94	37	3	7	0	0	0	0
Commercial and Services	43	25	22	9	27	60	58	48	60	45
Institutional	23	13	0	0	0	0	1	1	2	2
Recreational	0	0	0	0	2	4	0	0	0	0
Lakes	0	0	65	25	7	16	8	7	11	8
Vegetated Non-Forested Wetlands	19	11	1	0	0	0	0	0	0	0
Transportation	0	0	1	0	0	0	6	5	7	5
Utilities	0	0	4	2	0	0	0	0	0	0
Reservoirs	0	0	0	0	0	0	0	0	0	0
Herbaceous Dry Prairie/Open Land	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0
Open Land	0	0	0	0	0	0	0	0	0	0
Upland Hardwood Forests	0	0	0	0	0	0	0	0	0	0
Upland Mixed Forests	0	0	43	17	0	0	0	0	0	0
Wetland Coniferous Forests	0	0	7	3	0	0	0	0	0	0
Wetland Forested Mixed	8	5	18	7	0	0	0	0	0	0

Table 4.6 Average land use percentage for impaired and unimpaired lake watersheds.

Average Percentage	Commercial and Services	Herbaceous Dry Prairie/ Open Land	Industrial	Institutional	Lakes	Open Land	Recreational	Reservoirs
Average Impaired percentage	8.4	0.4	0	9.6	5.6	0	1.5	0
Average Unimpaired percentage	27.4	0	0.6	4	11.9	0.2	2.8	0.2

Table 4.7 Continued average land use percentage for impaired and unimpaired lake watersheds

Average Percentage	Residential High Density	Residential Medium Density	Transportation	Upland Hardwood Forests	Upland Mixed Forests	Utilities	Vegetated Non-Forested Wetlands	Wetland Coniferous Forests	Wetland Forested Mixed
Average Impaired percentage	10.5	62.5	0.3	0	0	0	0.2	0	0
Average Unimpaired percentage	11.2	34.8	1.9	0.1	1.9	0.2	1.3	0.3	1.3

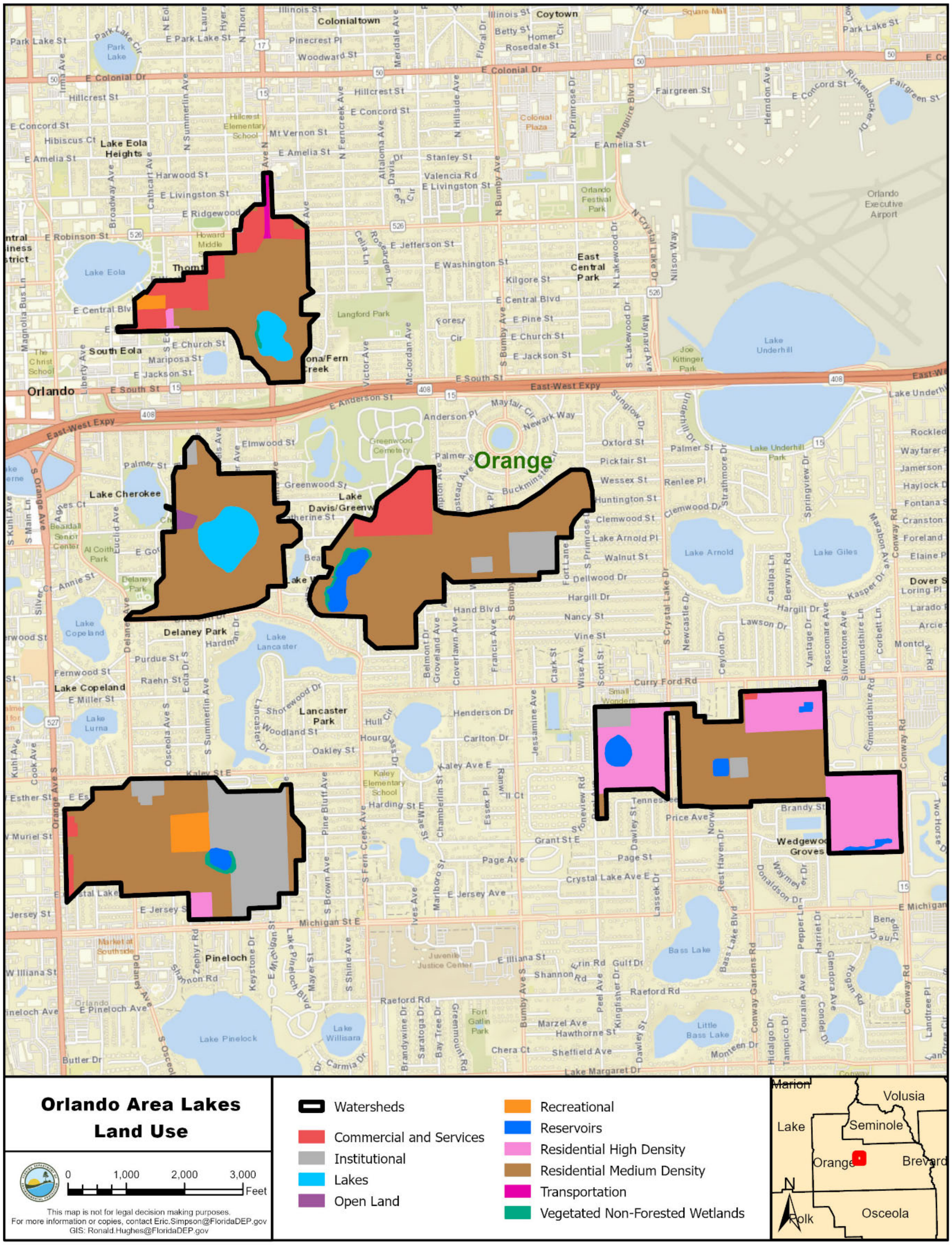

Figure 4.1 Land use for each lake's watershed.

4.3.2 Onsite Sewage Treatment and Disposal Systems (OSTDS)

OSTDS, commonly referred to as septic systems, are used to treat domestic wastewater 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. OSTDS can be a source of nutrients (nitrogen and phosphorus), pathogens, and other pollutants to both groundwater and surface water.

The Florida Department of Health (DOH) maintains a list of septic systems by county, and the FDOH Florida Water Management Inventory dataset was used to determine the number of "known" and "likely" septic systems in the area. **Figure 4.2** shows the approximate locations of OSTDS in the watersheds in 2024 based on centroids of parcels with septic systems. The number of reported OSTDS by watershed for lakes in this TMDL is shown in **Table 4.8. Table 4.9** shows this same information for the unimpaired lakes used in this analysis. Most of the OSTDS in this group of lakes are located in the Lake Terrace watershed; 104 out of 135, or 77%.

Table 4.8 Number of OSTDS by watershed for the TMDL waterbodies.

Watershed	Number of "Known" and "Likely" OSTDS
Terrace	104
Lawsona	0
Davis	0
Wade	16
Weldona	4

Table 4.9 Number of OSTDS by watershed for unimpaired lakes.

Watershed	Number of "Known" and "Likely" OSTDS
Cherokee	31
Copeland	103
Dot	20
Druid	181
Fredrica	313
Gear	13
Lurna	42
Park	3
Lancaster	11

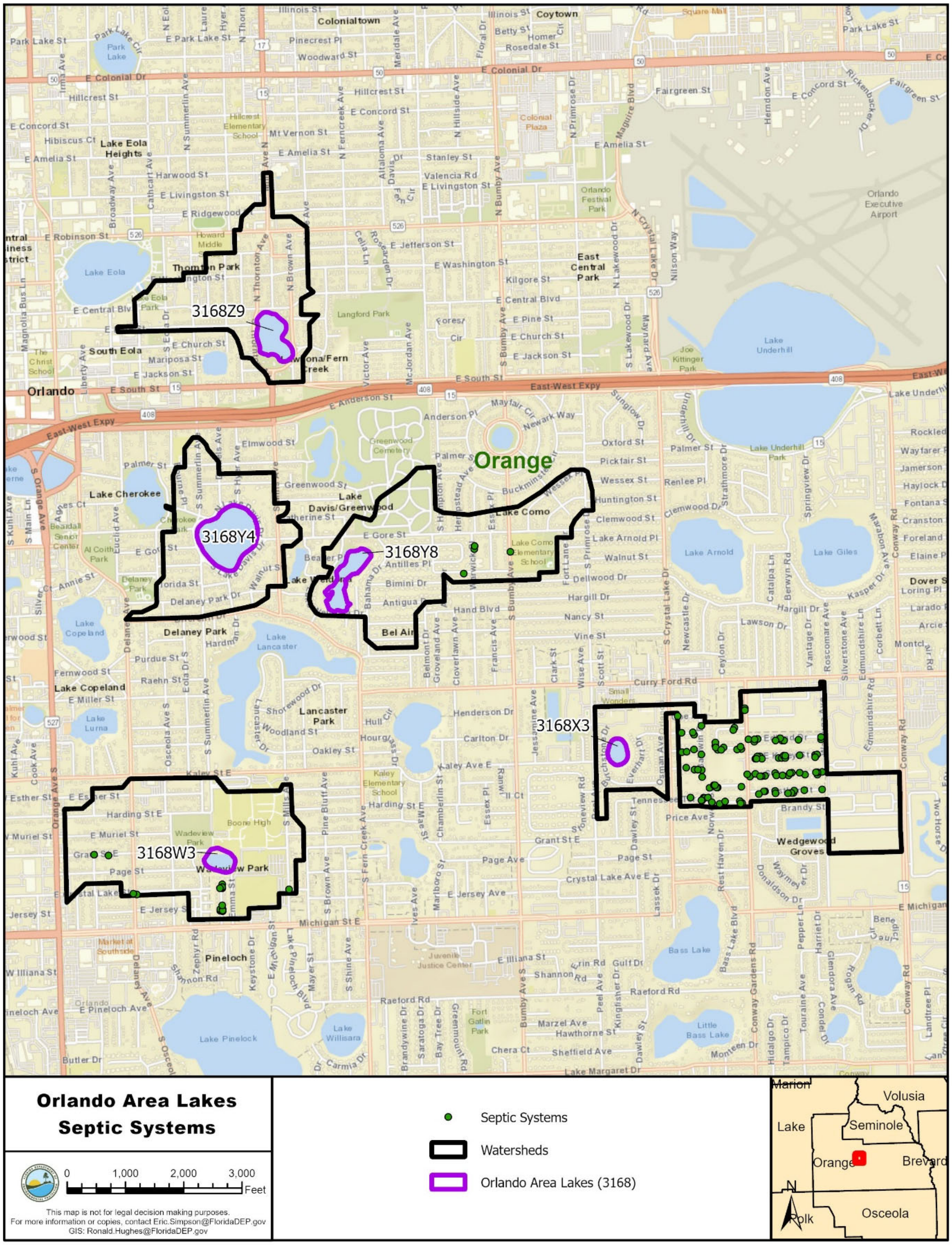

Figure 4.2 OSTDS in each lake's watershed.

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 Lakes Terrace, Lawsona, Davis, Wade and Weldona and to identify the maximum allowable TN and TP lake concentrations and the necessary reductions in the in-lake nutrient concentrations, so that the lakes will meet the TMDL restoration target for chlorophyll *a* and thus maintain their function and designated use as Class III freshwaters.

5.2 Evaluation of Water Quality Conditions

5.2.1 Water Quality Data-Handling Procedures for TMDL Development

For the water quality analyses conducted for TMDL development, AGMs were used in order to be consistent with the expression of the adopted NNC for lakes. The results found in the IWR Run 65 Database were used to calculate AGMs. The AGMs were calculated using a minimum of four samples per year, with at least one of the samples collected in the May to September period and at least one sample collected from other months. Values with an "I" qualifier code, defined as values greater than or equal to the method detection limit (MDL) but less than the practical quantitation limit (PQL), were used as reported. Values reported as either compound analyzed for but not detected or is less than the MDL, "U" or "T" qualifier codes, respectively, were changed to the MDL divided by the square root of 2. Values with "G" or "V" qualifier codes, associated with results that do not meet data quality objectives, were removed from the analysis. Negative values and zero values were also removed. Multiple sample results collected in the same day at the same station were averaged.

The AGM calculation method for this purpose is somewhat different than the one used to calculate AGMs for performing water quality assessments, following the IWR methodology in Chapter 62-303, F.A.C. The IWR methods are designed to determine compliance with surface water quality criteria that focuses more on measurement uncertainty associated with qualified results. For results reported to be less than the MDL or PQL, the IWR rule follows the same method used for determining compliance with permit effluent limits. Results applied in TMDL development are used in part to describe the variability in ambient water quality, and not compliance with criteria, and for this reason results reported as less than the MDL or PQL are expressed differently when calculating AGMs. Therefore, the AGMs listed in **Tables 2.3** through **2.5** in **Chapter 2** may not exactly match the AGMs used in these analyses and for TMDL development.

5.2.2 Relationships Between Water Quality Variables

Water quality monitoring for nutrients in all five impaired lakes in this TMDL document has been conducted primarily by the City of Orlando. **Figures 5.1a-c** show the POR chlorophyll *a*, TN and TP AGM values, respectively, for the impaired lakes.

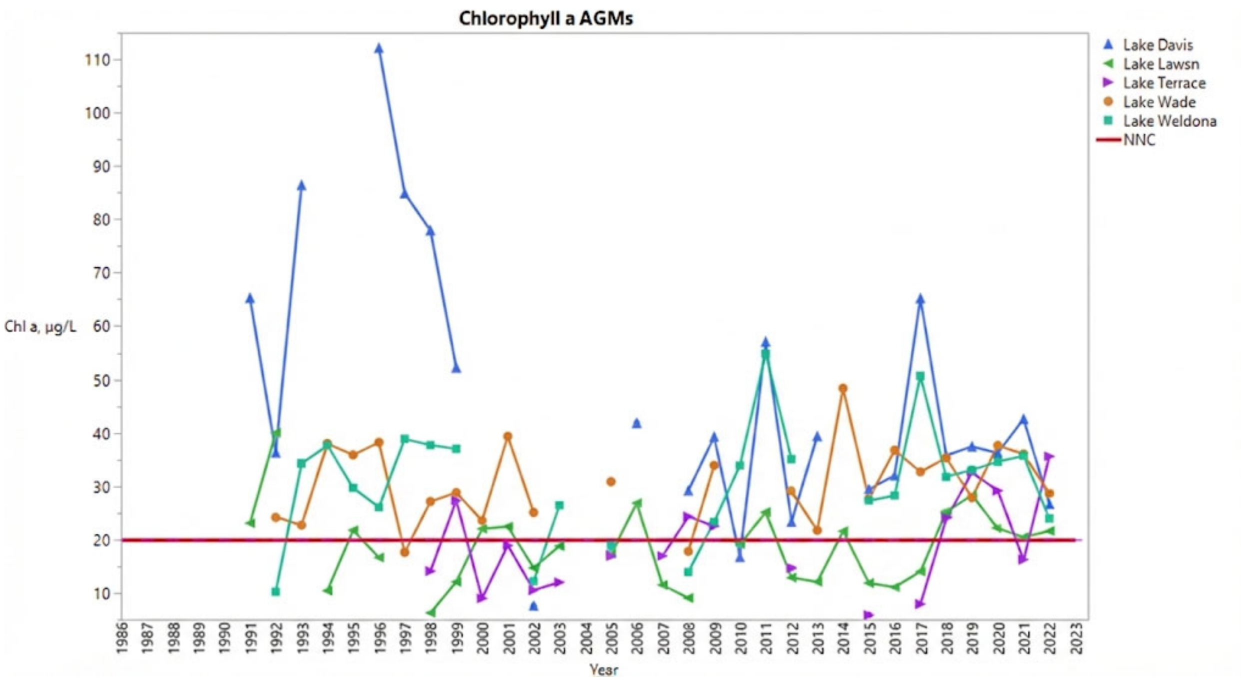

Figure 5.1a Chlorophyll *a* AGMs for the POR within the five lakes in the TMDL, along with the NNC for chlorophyll *a*.

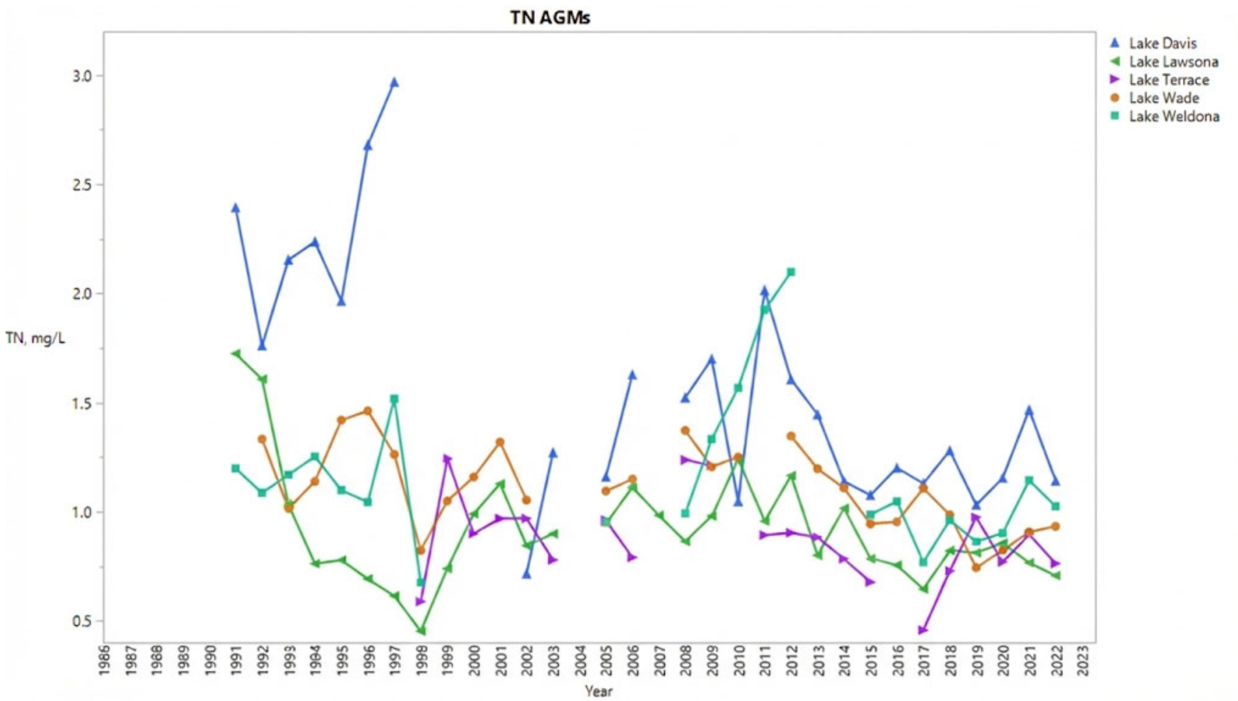

Figure 5.1b TN AGMs for the POR within the five lakes in the TMDL.

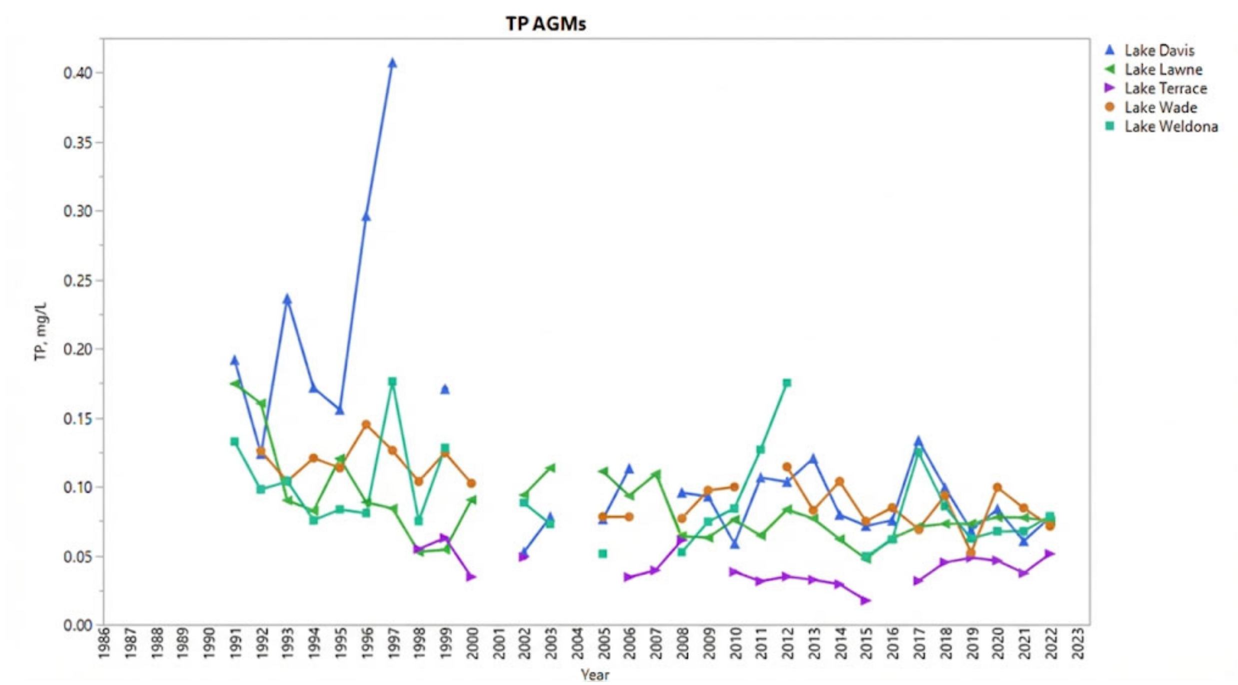

Figure 5.1c TP AGMs for the POR within the five lakes in the TMDL.

The chlorophyll *a* AGMs shown in **Figure 5.1a** indicate that the lakes are chronically above the NNC of 20 µg/L. These numbers show some variation in recent years, with spikes in every lake except Wade. Concentrations range from 6 to 28 µg/L, 6 to 36 µg/L, 18 to 48 µg/L, 12 to 55 µg/L and 8 to 85 µg/L for Lakes Lawsona, Terrace, Wade, Weldona and Davis, respectively.

TN AGMs, shown in **Figure 5.1b**, are slightly less variable than chlorophyll a, particularly in recent years. Like chlorophyll a, Lake Davis has the highest levels of TN. Only Lakes Wade and Davis are on the verified list for TN; the AGMs range from 0.74-1.37 mg/L and 0.72-2.97 mg/L for these lakes, respectively.

TP AGMs, shown in **Figure 5.1c**, are relatively constant in recent years, except for spikes in Lakes Davis and Weldona in 2017. All lakes are typically above the minimum NNC of 0.03 mg/L; the concentrations range from 0.05 to 0.11, 0.02 to 0.06, 0.05 to 0.13, 0.05 to 0.18 and 0.05 to 0.41 for Lakes Lawsona, Terrace, Wade, Weldona and Davis, respectively.

There is a slight downward trend in TN and TP over time for these five lakes, but the concentrations are still often above the NNC, particularly for TP for which all five lakes are impaired. Chlorophyll has a less consistent trend over time and more spikes in concentration.

As a point of comparison, a set of lakes not exceeding the applicable NNC (assessed as not impaired for nutrients) were identified based on shared characteristics to the five nutrient impaired lakes. The selection process took into consideration the following: lack of surficial connections to other water bodies according to the National Hydrological Dataset, matching surficial geology from Florida's STATEMAP geology (undifferentiated sediments), size (3-100 acres in surface area), lake type (low color, high alkalinity), and being located in the same drainage basin (Middle St. Johns River) and lake region (Orlando Ridge) as the impaired lakes. Nine lakes not impaired for nutrients were identified in this process and are listed in **Table 5.1** along with the nutrient impaired lakes.

The chlorophyll *a*, TN, and TP AGMs for the not impaired lakes used in this evaluation are shown in **Figures 5.2a-c**, respectively.

Figure 5.3 shows annual rainfall in the area of the lakes, as recorded at the Orlando International Airport (OIA) National Oceanic and Atmospheric Agency (NOAA) weather station. The long-term average rainfall at this location is 48.97 inches per year.

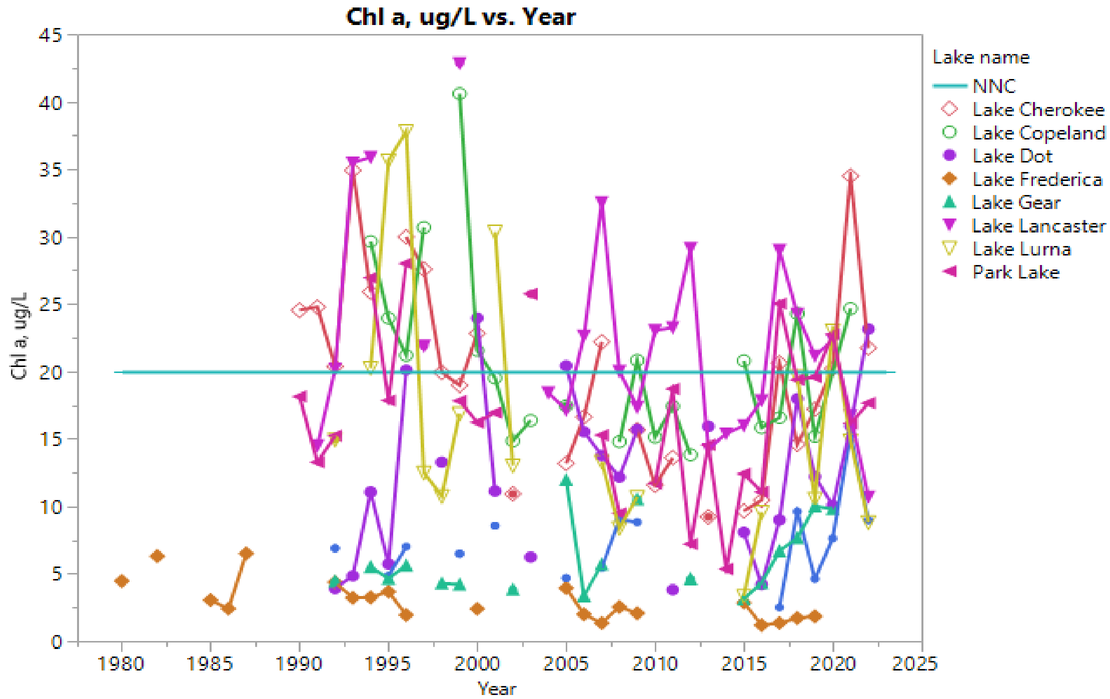

Figure 5.2a POR chlorophyll *a* AGMs for the unimpaired lakes with the chlorophyll *a* NNC.

Figure 5.2a shows chlorophyll *a* AGMs for the unimpaired lakes used in TMDL development. While some of these lakes occasionally exceed the NNC for chlorophyll *a*, these lakes typically remain near or below the NNC. Lake Frederica has historically had the lowest Chlorophyll *a* levels, but other lakes have dynamic nutrient levels throughout the period of record.

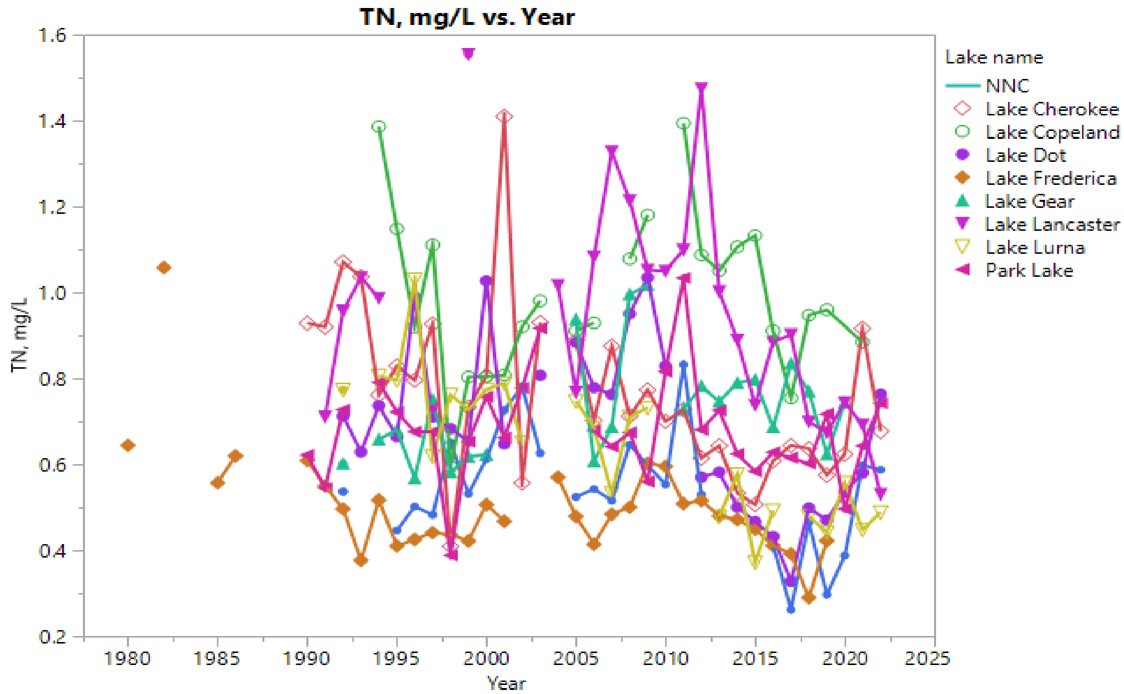

Figure 5.2b POR TN AGMs for the unimpaired lakes.

Figure 5.2b shows TN AGMs for the unimpaired lakes in this TMDL. TN Concentrations are variable by lake and by year, but Lake Frederica typically has the lowest values for TN. In recent years, TN levels have dropped for most of the lakes shown here.

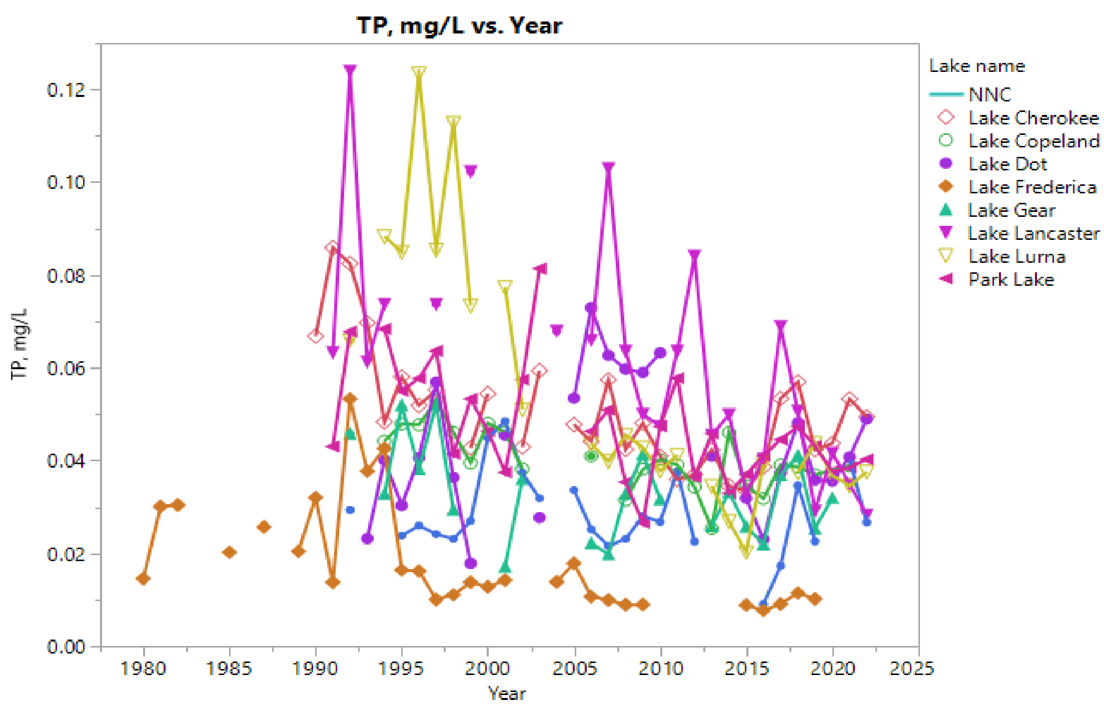

Figure 5.2c POR TP AGMs for the unimpaired lakes.

Figure 5.2c shows TP AGMs for the unimpaired lakes in this analysis. TP concentrations in the unimpaired lakes are, like TN, trending down in recent years, particularly for Lake Dot. Lake Frederica has the lowest TP values as well as chlorophyll *a* and TN.

Table 5.1 List of lakes assessed as nutrient impaired and the not impaired lakes used for comparison.

Note: Values shown in boldface type and shaded are the nutrient impaired lakes.

WBID	Lake
2997Q	Lake Dot
3036	Lake Frederica
3023D	Lake Gear
2997O	Park Lake
3168W2	Druid Lake
3168X6	Lake Cherokee
3168M	Lake Copeland
3168Y4	**Lake Davis**
3168Y	Lake Lancaster
3168Z9	**Lake Lawsona**
3168Y6	Lake Lurna
3168X3	**Lake Terrace**
3168W3	**Lake Wade**
3168Y8	**Lake Weldona**

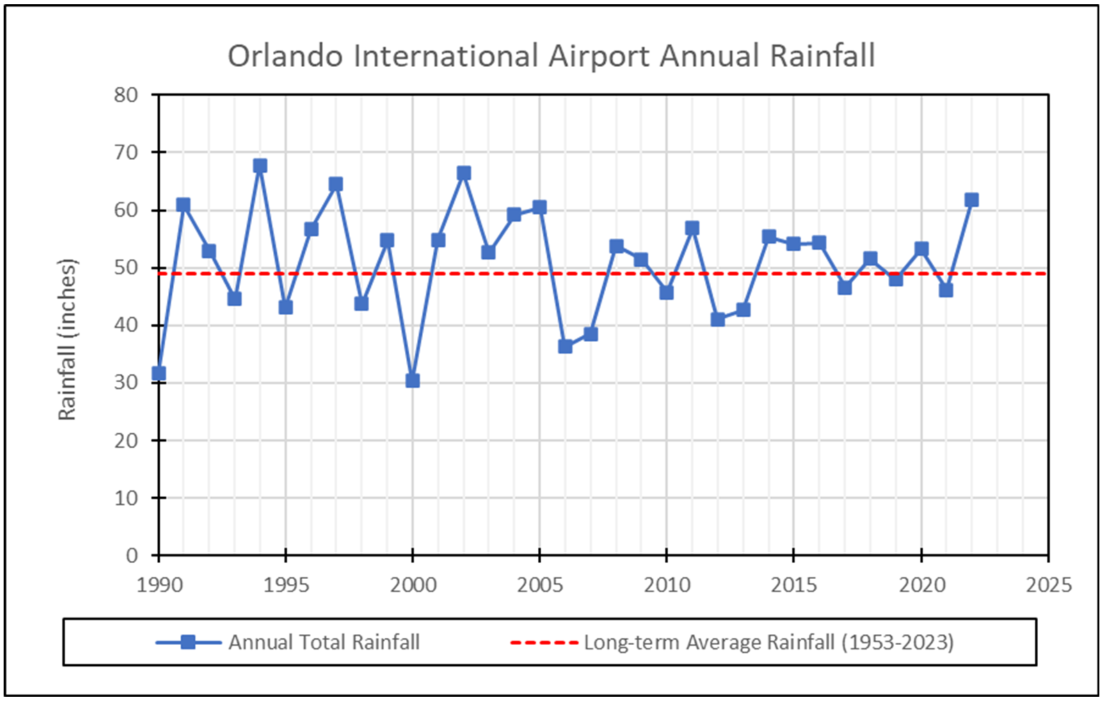

Figure 5.3 Annual precipitation for Orlando International Airport, along with the long-term average.

Relationships between nutrients and chlorophyll *a*, were evaluated by grouping the AGM values for the five nutrient impaired lakes with the values for the nine not impaired lakes. The relationships between chlorophyll *a* and TN AGMs (**Figure 5.4**) and chlorophyll *a* and TP AGMs (**Figure 5.5**), when applying the AGMs for all 14 lakes indicate a strong positive response of chlorophyll *a* to nutrient concentrations. The relationships are based on data in the 2015–2022 period. During this time frame there were sufficient data to calculate AGMs for at least seven lakes in each year. The AGMs are log-transformed (natural log, Ln) in the figures as the chlorophyll *a* and TP values are not normally distributed. TN values were found to be normally distributed. The simple linear regression results indicate that 55 percent of the variation in chlorophyll a is explained by TN concentrations and 79 percent of chlorophyll a variation is explained by TP concentrations.

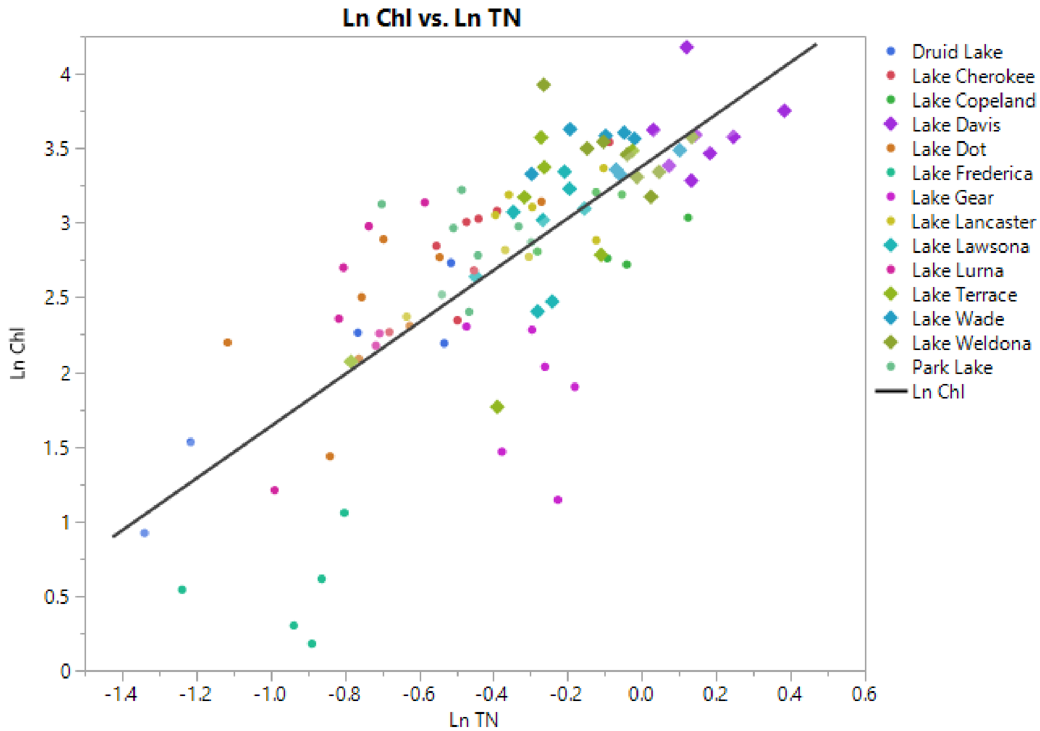

Figure 5.4 Natural log transformed relationship between chlorophyll *a* and TN, along with a regression line, for the lakes in the TMDL regression using AGMs from 2015-2022.

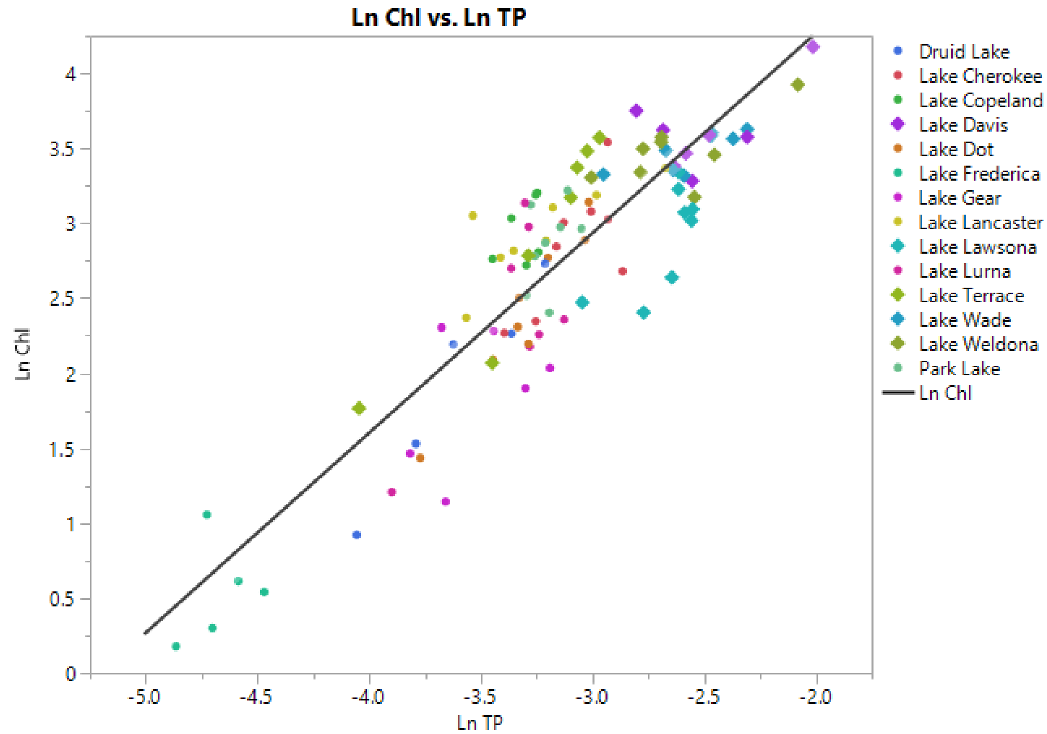

Figure 5.5 Natural log transformed relationship between chlorophyll *a* and TP, along with a regression line, for the lakes in the TMDL regression using AGMs from 2015-2022.

5.3 Critical Conditions and Seasonal Variation

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

5.4 Water Quality Analysis to Determine Assimilative Capacity

The strong positive significant relationships (*p* values < 0.0001) of chlorophyll *a* to in-lake TN and TP concentrations as shown in **Figures 5.4** and **5.5**, respectively, support applying simple linear regression models to establish the TMDL nutrient targets. The linear regression equations for the relationships can used to identify the TN and TP AGM concentrations needed to achieve the chlorophyll *a* restoration target of 20 µg/L. As discussed in Chapter 3, the NNC chlorophyll *a* threshold of 20 µg/L, expressed as an annual geometric mean, was selected as the response variable target for TMDL development. **Appendix C** provides the detailed regression results and parameter estimates for the simple linear regression analyses. The relationships are based on the AGMs in the period of 2015-2022, which represents the most complete set of AGM values for the fourteen lakes used in these analyses. The 2015–2022 period, included years with both above- and below-average precipitation. Rainfall measured at the Orlando International Airport indicates that 2017, 2019, and 2021 were years with below-average precipitation, while 2015-16, and 2022 were years with above-average precipitation.

To evaluate the effects of nutrient interactions on chlorophyll *a* concentrations, a multiple linear regression (MLR) analysis was conducted using the same AGMs applied in the development of the simple linear regression models. The results of the MLR analysis show a significant relationship between lake chlorophyll *a* levels and nutrient (TN and TP) concentrations. The regression model indicates that 82% of the variation in chlorophyll *a* is attributed to TN and TP concentrations (r squared adjusted = 0.82, p values < 0.0001). **Appendix C** presents detailed regression results and parameter estimates for the relationship.

The MLR equation was used to confirm that the chlorophyll *a* restoration target can be achieved with the TN and TP concentrations derived using the simple linear regression models, as explained in **Section 5.5**.

5.5 Calculation of the TMDLs

The DEP developed the generally applicable statewide NNC based on robust empirical relationships between nutrients and chlorophyll *a* derived from a large dataset of lakes statewide, and an evaluation of the relationships between chlorophyll *a* and TN and TP in those lakes. Similarly, for this TMDL effort, empirical relationships between chlorophyll *a* and TN and TP concentrations were developed using data from all 14 of the relevant lakes. The regression equations representing the relationships between chlorophyll *a* AGMs and TN and TP AGMs are as follows:

$$\boldsymbol{Ln(Corrected\ Chlorophyll\ \mathrm{a}) = 3.38173 + 1.75955 * Ln(TN)}$$

$$\boldsymbol{Ln(Corrected\ Chlorophyll\ a) = 6.93641 + 1.33332 * Ln(TP)}$$

As explained in **Chapter 3,** the generally applicable chlorophyll *a* criterion of 20 µg/L for low-color, high-alkalinity lakes is appropriate for the lakes in this document and will serve as the water quality restoration target. The available information suggests that designated use attainment for the six impaired lakes would be protected at the chlorophyll *a* criterion. The TN and TP limits necessary to achieve the chlorophyll *a* restoration target are derived using the above linear regression equations. The TN and TP values were input into the equations to two decimal places, consistent with the significant figures used to express the generally applicable NNC, to determine the nutrient concentrations resulting in a chlorophyll *a* concentration that will not cause the chlorophyll *a* concentration to exceed 20 µg/L. Application of the equations indicate the TN and TP AGM concentrations necessary to meet the chlorophyll *a* criterion are 0.80 mg/L and 0.05 mg/L, respectively.

The TN and TP target concentrations were then input to the following MLR equation to evaluate the effect of nutrient interactions on chlorophyll *a* concentrations:

$$\boldsymbol{Corrected\ Chlorophyll\ a = exp(6.34927 + 0.56644 * Ln(TN) + 1.08138 * Ln(TP))}$$

Applying the nutrient concentrations, derived using the simple linear regression models, in the MLR equation results in a chlorophyll *a* AGM of 20 µg/L, which confirms the restoration target is attainable accounting for the interaction of in-lake TN and TP conditions.

The lakes are expected to meet the applicable chlorophyll *a* criterion and maintain their function and designated use as Class III freshwater when surface water nutrient concentrations are reduced to the target concentrations, addressing the anthropogenic contributions to the water quality impairments.

The method used to determine the reductions needed to attain the nutrient TMDLs is the percent reduction approach. Existing lake nutrient conditions used in the percent reduction calculations were selected by considering the nutrient concentrations measured in the 2013 to 2022 period. The existing nutrient conditions used to calculate the required reductions were the maximum TN and TP AGMs in each lake that exceeded the water quality targets. The geometric means were calculated from nutrient results available in the IWR Run 65 Database.

The equation used to calculate the percent reductions is as follows:

$$\frac{\textbf{[measured exceedance (maximum AGM) – target] X 100}}{\textbf{measured exceedance (maximum AGM)}}$$

Tables 5.2a-b lists the percent reductions in the maximum AGM concentrations needed to achieve the TN AGM target of 0.80 mg/L and the TP AGM target of 0.05 mg/L. The TN percent reductions range from a high of 62% in Lake Weldona to a low of 18% in Lake Terrace. TP reductions range from 72% for Lake Weldona to 0% for Lake Terrace. The nutrient AGM TMDL values and the associated percent reductions address the anthropogenic nutrient inputs contributing to the exceedances of the chlorophyll *a* criterion.

Table 5.2a TN Percent Reductions required for Lakes Terrace, Lawsona, Davis, Wade and Weldona.

Year	Lake Terrace TN AGM	Lake Lawsona TN AGM	Lake Davis TN AGM	Lake Wade TN AGM	Lake Weldona TN AGM
2013	0.9	1.17	1.61	1.35	2.1
2014	0.88	0.8	1.45	1.2	ID
2015	0.78	1.02	1.14	1.11	ID
2016	0.68	0.79	1.08	0.94	0.99
2017	ID	0.76	1.2	0.95	1.05
2018	0.46	0.64	1.13	1.11	0.77
2019	0.73	0.82	1.28	0.98	0.96
2020	0.97	0.81	1.03	0.74	0.86
2021	0.77	0.86	1.15	0.82	0.9
2022	0.76	0.71	1.14	0.93	1.02
Maximum	0.97	1.17	1.61	1.35	2.1
TMDL Target	0.80	0.80	0.80	0.80	0.80
Percent Reduction	18	32	50	41	62

Table 5.2b TP Percent Reductions required for Lakes Terrace, Lawsona, Davis, Wade and Weldona.

Year	Lake Terrace TP AGM	Lake Lawsona TP AGM	Lake Davis TP AGM	Lake Wade TP AGM	Lake Weldona TP AGM
2013	0.03	0.08	0.1	0.11	0.18
2014	0.03	0.08	0.12	0.08	ID
2015	0.03	0.06	0.08	0.1	ID
2016	0.02	0.05	0.07	0.07	0.05
2017	ID	0.06	0.08	0.08	0.06
2018	0.03	0.07	0.13	0.07	0.12
2019	0.05	0.07	0.1	0.09	0.09
2020	0.05	0.07	0.07	0.05	0.06
2021	0.05	0.08	0.08	0.1	0.07
2022	0.05	0.08	0.08	0.07	0.08
Maximum	0.05	0.08	0.13	0.11	0.18
TMDL Target	0.05	0.05	0.05	0.05	0.05
Percent Reduction	0	38	62	55	72

Chapter 6: Determination of Loading Allocations

6.1 Expression and Allocation of the TMDL

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

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

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

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

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

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

This approach is consistent with federal regulations (40 Code of Federal Regulations [CFR] § 130.2(I)), which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity or other appropriate measure. The TMDLs for Lakes Terrace, Lawsona, Davis, Wade and Weldona are expressed in terms of in-lake nutrient concentration targets and the percent reductions in existing nutrient conditions necessary to meet the targets, and represent the lake nutrient concentrations the waterbodies can assimilate while maintaining a balanced aquatic flora and fauna (see **Table 6.1**). These TMDLs are expressed as maximum AGM values for TN and TP, not to be exceeded. The restoration goal is to achieve the generally applicable chlorophyll *a* criterion of 20 µg/L, which is expressed as an AGM not to be exceeded more than once in any consecutive 3-year period. This protects each lake's designated use.

Table 6.1 lists the TMDLs for Lakes Terrace, Lawsona, Davis, Wade and Weldona. 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., for these particular waters.

6.2 Load Allocation

The TMDLs are based on the percent reductions in in-lake nutrient concentrations. To achieve the LA, decreases in current TN and TP loads to the lakes will be required to meet the percent reductions, as specified in **Table 6.1**. The percent reductions represent the generally needed TN and TP reductions from all sources; including stormwater runoff, groundwater contributions and septic tanks. Although the TMDLs are based on the percent reductions from all sources to the lakes, it is not DEP's intent to abate natural conditions. The needed reduction from anthropogenic inputs will be calculated based on more detailed source information when a restoration plan is developed. The reductions in nonpoint source nutrient loads are expected to result in reduced sediment nutrient flux, which is commonly a factor in lake eutrophication.

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 discharge either into the waterbodies or their watersheds. Therefore, a WLA for wastewater discharges is not applicable.

6.3.2 NPDES Stormwater Discharges

Orange County and DOT District 5 (as a copermittee) are covered by a Phase I NPDES MS4 permit (FLS000011). Some lakes also fall within the City of Orlando's Phase I permit (FLS000014). Areas within these jurisdictions may be responsible for percent reductions in current TN and TP loadings to the lakes, as indicated in **Table 6.1**.

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.

Table 6.1 TMDL components for nutrients in Lakes Terrace, Lawsona, Davis, Wade and Weldona.

Note: MOS is implicit.
NA = Not applicable
[1] Represents the AGM lake value not to be exceeded.
[2] The required percent reductions listed in this table represent the reduction from all sources.

Waterbody Name (WBID)	Parameter	TMDL (mg/L)[1]	WLA Wastewater (% reduction)	WLA NPDES Stormwater (% reduction)[2]	LA (% reduction)[2]
Lake Terrace (3168X3)	TN	0.80	NA	18	18
	TP	0.05	NA	0	0
Lake Lawsona (3168Z9)	TN	0.80	NA	32	32
	TP	0.05	NA	38	38
Lake Davis (3168Y4)	TN	0.80	NA	50	50
	TP	0.05	NA	62	62
Lake Wade (3168W3)	TN	0.80	NA	41	41
	TP	0.05	NA	55	55
Lake Weldona (3168Y8)	TN	0.80	NA	62	62
	TP	0.05	NA	72	72

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. 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.

Consistent with the recommendations of the Allocation Technical Advisory Committee (DEP 2001), an implicit MOS was used in the development of the TMDLs because of the conservative assumptions that were applied. The conservative elements are as follows:

- The reductions were developed using the highest measured AGM TN and TP values to calculate the percent reductions.
- Require that the TMDL nutrient targets are not to be exceeded in any one year.

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 basin management action plans (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).

7.2 BMAPs

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

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

Additional information about BMAPs is available on DEP's website.

7.3 Implementation Considerations for the Waterbody

Prior attempts at nutrient abatement should be considered in determining appropriate restoration approaches for the lakes in this TMDL document. These lakes are hydrologically isolated and most likely fed by groundwater, which may affect the options in remedying the nutrient impairments. Their urban setting and particular land use activities should also be taken into consideration in terms of the watershed load contributions.

Existing nutrient reduction and management infrastructure and plans should be included in any future pollutant mitigation strategies. In addition to addressing reductions in watershed pollutant contributions to impaired waters during the implementation phase, it is also necessary to consider the impacts of internal sources (e.g., sediment nutrient fluxes or the presence of nitrogen-fixing cyanobacteria) and the results of any associated remediation projects on surface water quality. Approaches for addressing these other factors should be included in comprehensive management plans for the waterbodies. Additionally, the current water quality monitoring of the lakes for nutrient variables (chlorophyll *a*, TN and TP) should continue and be expanded, as necessary, during the implementation phase to ensure that adequate information is available for tracking restoration progress. Consideration should be given to expanding monitoring to include likely sources of nutrients to the waterbodies to better guide restoration activities.

Stakeholders should focus on nutrient control strategies that help decrease in-lake nutrient concentrations sufficient to reduce chlorophyll *a* levels below the applicable NNC. Once each lake is consistently meeting the NNC over the assessment period, it can be assumed that the TMDLs are being met.

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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 five or more acres of land, and large and medium MS4s located in incorporated places and counties with populations of 100,000 or more.

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

The Phase II NPDES stormwater program, promulgated in 1999, addresses additional sources, including small MS4s and small construction activities disturbing between one and five 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 Terrace, Lake Lawsona, Lake Davis, Lake Wade and Lake Weldona
Waterbody type(s)		Lake
WBID		Lake Terrace (3168X3), Lake Lawsona (3168Z9), Lake Davis (3168Y4), Lake Wade (3168W3) and Lake Weldona (3168Y8) respectively. (see **Figure 1.2** of this report)
Description		All five lakes are located within the City of Orlando in Orange County. They do not have any surface water connections to other water bodies and range in area from 3 to 43 acres. Average depth ranges from 1.6 m to 3.9 m. The lakes are located near the urban center of Orlando and residential development (medium-density or high density residential) is the predominant anthropogenic land use in each lake's watershed. **Chapter 1** of this report provides more detail on the system.
Specific location (latitude/longitude or river miles)	**Terrace**	28.5208810545216, -81.34617424075516
	Lawsona	28.54081903037027, -81.36431550724289
	Davis	28.531337368997, -81.36679602774136
	Wade	28.516205431960984, -81.36757713096817
	Weldona	28.529334498203944, -81.3608197209311
Map		**Figure 1.1** shows the general location of the lakes and their watersheds, and **Figure 4.1** shows the land uses in the watersheds.
Classification(s)		Class III Freshwater
Basin name (HUC 8)		Middle St. Johns 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	Lakes Terrace, Lawsona, Davis, Wade and Weldona are classified as low-color (<40 PCU), high-alkalinity (> 20 mg/L $CaCO_3$) lakes, 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: **Lakes Terrace, Lawsona, Davis, Wade, and Weldona** **TN:** 0.80 mg/L, expressed as an AGM not to be exceeded. **TP:** 0.05 mg/L, expressed as an AGM not to be exceeded.
Period of record used to develop numeric interpretations of the narrative nutrient criterion for TN and TP	AGM values from 2015-22 for nutrient impaired and not impaired lakes (14 total) that share similar characteristics were used to set the TN and TP criteria for the six impaired lakes.
How the criteria developed are spatially and temporally representative of the waterbody or critical condition	The water quality results applied in the analysis included years with both above- and below-average precipitation The 2015–2022 period, included years with both above- and below-average precipitation. Rainfall measured at the Orlando International Airport indicate that 2017, 2019, and 2021 were years with below-average precipitation, while 2015-16, and 2022 were years with above-average precipitation. **Figures 2.1a-f** show the sampling stations in the six lakes where TMDLs were developed. Monitoring stations were located across the spatial extent and represent the spatial distribution of nutrient dynamics in the lakes. **Chapter 5** contains graphs showing water quality results for the variables relevant to TMDL development.

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

Designated Use Requirements	Information Related to Designated Use Requirements
History of assessment of designated use support	During the Cycle 3 assessment and Biennial Assessment 2020 - 2022, the NNC were used to assess the lakes during the verified period (2009–15 and 2015-21, respectively) based on data from IWR Database Run 53 and 60. Lakes Davis and Wade were verified impaired as part of the Cycle 3 Group 4 assessment; Lakes Lawsona and Weldona were verified impaired for TP and chla respectively, as part of the Cycle 3 Group 4 assessment. Lake Terrace was verified impaired in the Biennial Assessment 2020 - 2022, and Lakes Lawsona and Weldona were verified impaired for chla and TP, respectively, as part of the Biennial Assessment 2020 - 2022.
Basis for use support	The basis for use support is the NNC chlorophyll *a* concentration of 20 µg/L, which is protective of designated uses for low-color, high-alkalinity lakes. Based on the available information, there is nothing unique about the lakes that would make the use of the chlorophyll *a* threshold of 20 µg/L inappropriate.
Approach used to develop criteria and how it protects uses	The method used to address the nutrient impairment were simple linear regression model equations that relate chlorophyll *a* levels to the lake TN and TP AGM concentrations. The criteria are expressed as maximum AGM concentrations not to be exceeded in any year. Establishing the frequency as not to be exceeded in any year ensures that the chlorophyll *a* NNC, which are protective of designated use, is achieved.
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	The method indicated that the chlorophyll *a* concentration restoration target for the lakes will be attained at the TMDL in-lake TN and TP concentration, frequency, and duration. DEP notes that there were no impairments for nutrient-related parameters (such as dissolved oxygen [DO] or un-ionized ammonia). The proposed reductions in nutrient inputs will result in further improvements in water quality.

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

Protection of Downstream Waters and Monitoring Requirements	Information Related to Protection of Downstream Waters and Monitoring Requirements
Identification of downstream waters: List receiving waters and identify technical justification for concluding downstream waters are protected	The six lakes in this TMDL development effort are all hydrologically isolated (no surface water connections); therefore, there are no downstream waters to consider.
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.	The city of Orlando, the SJRWMD, and DEP conduct routine monitoring of these lakes. 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 concentrations in subsequent water quality assessment periods.

Table B-5 Documentation of endangered species consideration

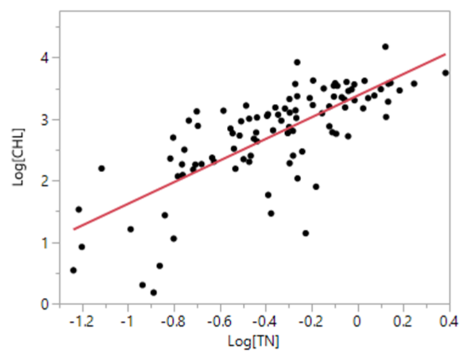
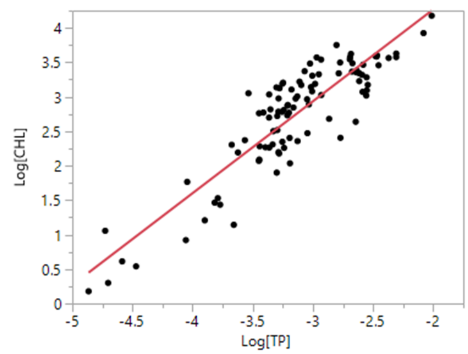
Administrative Requirements	Information for Administrative Requirements
Endangered species consideration	DEP is not aware of any endangered aquatic species present in the impaired lakes or their watersheds. Furthermore, it is expected that improvements in water quality resulting from these restoration efforts will positively impact aquatic species living in the lakes and their respective watersheds.

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 January 16, 2024, to initiate TMDL development for impaired waters in the Middle St. Johns River basin. A rule development public workshop for the TMDLs was held on February 22, 2025
Hearing requirements and adoption format used; responsiveness summary	Following the publication of the Notice of Proposed Rule, DEP will provide a 21-day challenge period and a public hearing that will be noticed no less than 45 days prior.
Official submittal to EPA for review and General Counsel certification	If DEP does not receive a rule challenge, the certification package for the rule will be prepared by the DEP program attorney. DEP will prepare the TMDLs and submittal package for the TMDLs to be considered a site-specific interpretation of the narrative nutrient criterion and will submit these documents to the EPA.

Appendix C: Full results of the single and multiple regression analyses

Table C-1 Results of the single regression analyses.

Statistic	Ln(CHL) By Ln(TN)	Ln(CHL) By Ln(TP)
Regression Chart		
Equation	Ln(CHL) = 3.3817258 + 1.7559478*Ln(TN)	Ln(CHL) = 6.9364086 + 1.3333162*Ln(TP)
R-square	0.556702	0.793081
R-square Adj	0.552269	0.790969
Root Mean Square Error	0.544101	0.371771
Mean of Response	2.743685	2.743685
Observations	100	100
F Ratio	123.1155	375.6145
Prob > F	<.0001	<.0001
Intercept Estimate	3.3817258	6.9364086
Slope Estimate	1.7559478	1.3333162
Intercept t Ratio	27.58	31.62
Slope t Ratio	11.10	19.38
Intercept Prob > t	<0.0001	<0.0001
Slope Prob > t	<0.0001	<0.0001

Actual by Predicted Plot

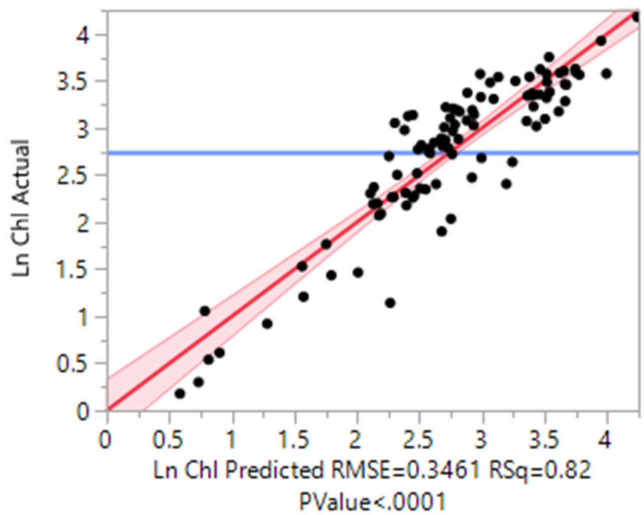


Figure C-1 Regression chart for the multiple regression analysis.

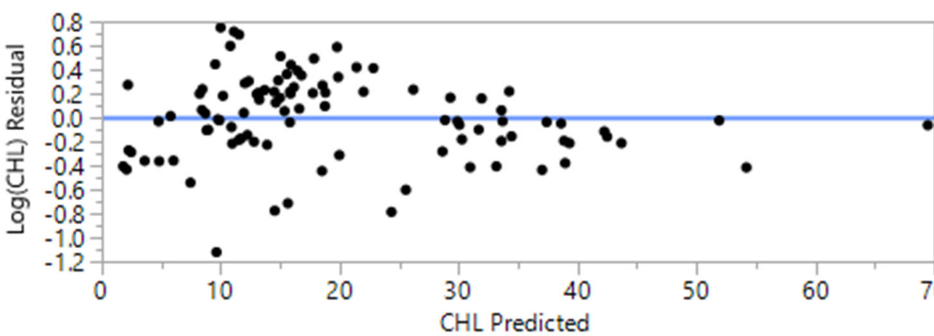


Figure C-2 Residuals from the multiple regression analysis.

Table C-2 Full results of the multiple regression analysis.

Summary of Fit

RSquare	0.82247
RSSquare Adj	0.81881
Root Mean Square Error	0.34613
Mean of Response	2.74589
Observations (or Sum Wgts)	100

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	2	53.838759	26.9194	224.689
Error	97	11.621317	0.1198	**Prob > F**
C. Total	99	64.460076		<0.0001

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob > |t|	VIF
Intercept	6.34927	0.251384	25.26	<0.0001	N/A
Ln(TN)	0.56644	0.141363	4.01	0.0001	1.9636
Ln(TP)	1.08138	0.089754	12.05	<0.0001	1.9636

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Ln(TN)	1	1	1.92364	16.0561	0.0001
Ln(TP)	1	1	17.39113	145	<0.0001