Final TMDL Report

SOUTHWEST DISTRICT • WITHLACOOCHEE RIVER BASIN • UPPER WITHLACOOCHEE PLANNING UNIT

Nutrient TMDL for Lake Juliana (WBID 1484B)

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

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Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Loads developed to address the nutrient impairment of Lake Juliana, located in the Upper Withlacoochee Planning Unit, which is part of the larger Withlacoochee River Basin. The TMDLs will constitute the site-specific numeric interpretations of the narrative nutrient criterion set forth in Paragraph 62-302.530(47)(b), Florida Administrative Code (F.A.C.), that will replace the otherwise applicable numeric nutrient criteria (NNC) in Subsection 62-302.531(2) for this particular water, pursuant to Paragraph 62-302.531(2)(a), F.A.C. The lake 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 Group 4 Withlacoochee River Basin that was adopted by Secretarial Order on November 2, 2010.

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 standards based on the relationship between pollution sources and receiving waterbody water quality. The TMDLs establish the allowable loadings to Lake Juliana that would restore the waterbody so that it meets the applicable water quality criteria for nutrients.

1.2 Identification of Waterbody

Lake Juliana is located in the city of Auburndale, Florida, in north-central Polk County (**Figure 1.1**). The estimated surface area of Lake Juliana is 924 acres, and the average depth is 12 feet (3.7 meters) with a maximum depth of 19 feet (5.8 meters). The topographic elevation of the lake water surface has ranged from 127.4 to 134.1 feet National Geodetic Vertical Datum (NGVD29) (Polk County 2014). An inlet on the western shore of Lake Juliana receives flow from a canal that drains primarily low-density residential areas. An outlet canal on the eastern side of the lake discharges to Lake Mattie.

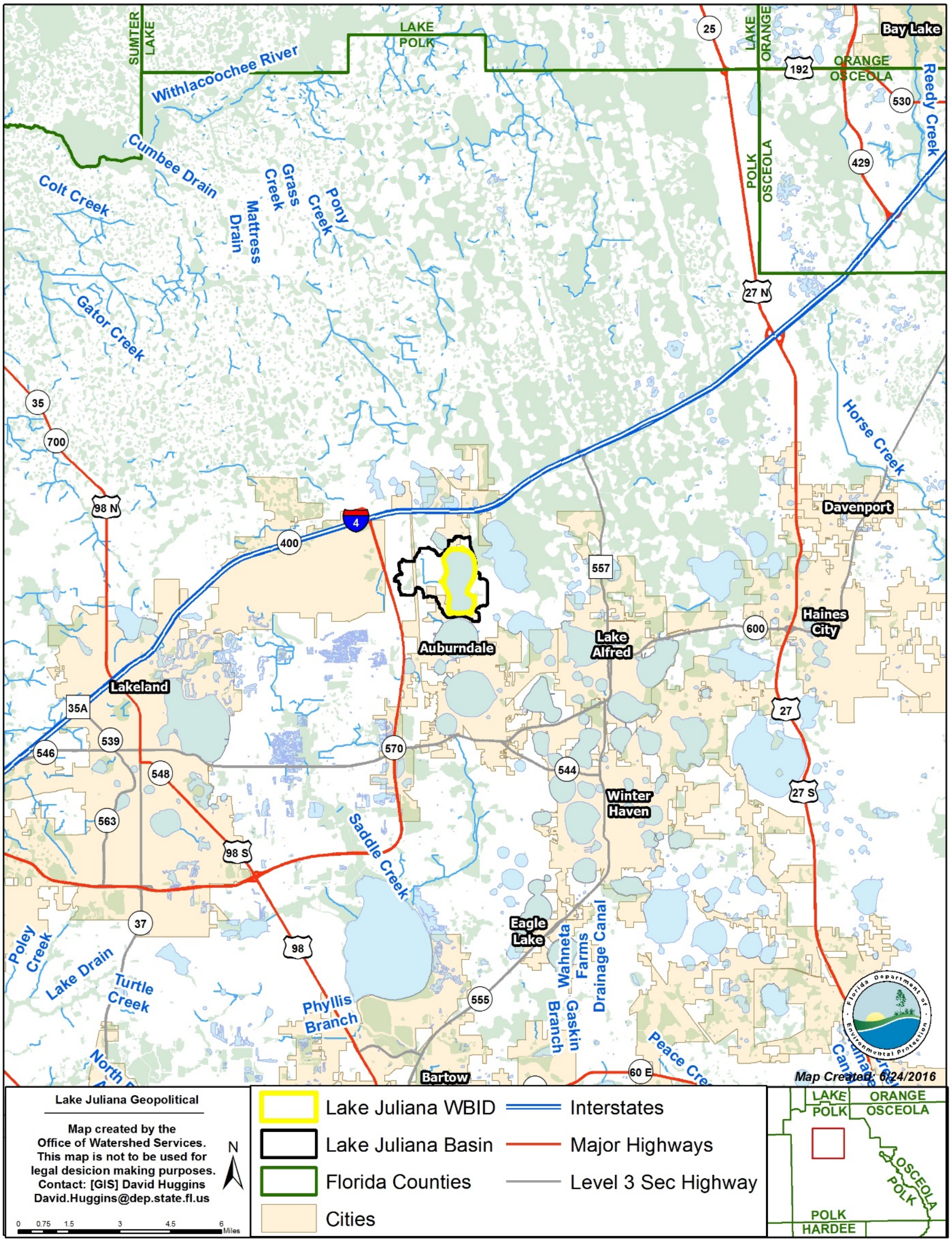

Figure 1.1. Location of the Lake Juliana Basin and Major Geopolitical Features in North-Central Polk County

The Lake Juliana watershed encompasses an area of approximately 2.6 square miles (1,677 acres). Lake Juliana can also receive inflow from Lake Tennessee, depending on the lake surface elevation, via two corrugated pipes located in a vegetated area along the northwest shoreline of Lake Juliana. However, based on stage records the water level of Lake Tennessee has been less than the bottom elevation of the pipes (invert elevation of 131.72 feet) (BCI Engineers and Scientists, Inc. 2008) since December 2005. Prior to that time, the lake surface elevation exceeded the pipe invert elevation intermittently. Considering the potential for inflows from Lake Tennessee, which has a combined watershed area and lake area of 378 acres, the total contributing drainage area to Lake Juliana is 3.2 square miles (2,055 acres).

Watershed land use consists of urban areas, predominantly residential development, located throughout the watershed, and agricultural activity, primarily located in the southern and western portions of the watershed. The watershed area is situated in the Winter Haven/Lake Henry Ridges Lake Region (Region 75-31), an upland karst area with an abundance of lakes characterized as alkaline, having moderately hard water, and eutrophic (Griffith *et al*. 1997). The long-term average annual rainfall for Polk County, based on Southwest Florida Water Management District (SWFWMD) records from 1915 to 2013, is about 52 inches per year.

For assessment purposes, the Florida Department of Environmental Protection has divided the Withlacoochee Basin into watershed assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or surface water segment. Lake Juliana is WBID 1484B. **Figure 1.2** displays the location of the lake WBID, along with major geopolitical and hydrologic features in the watershed.

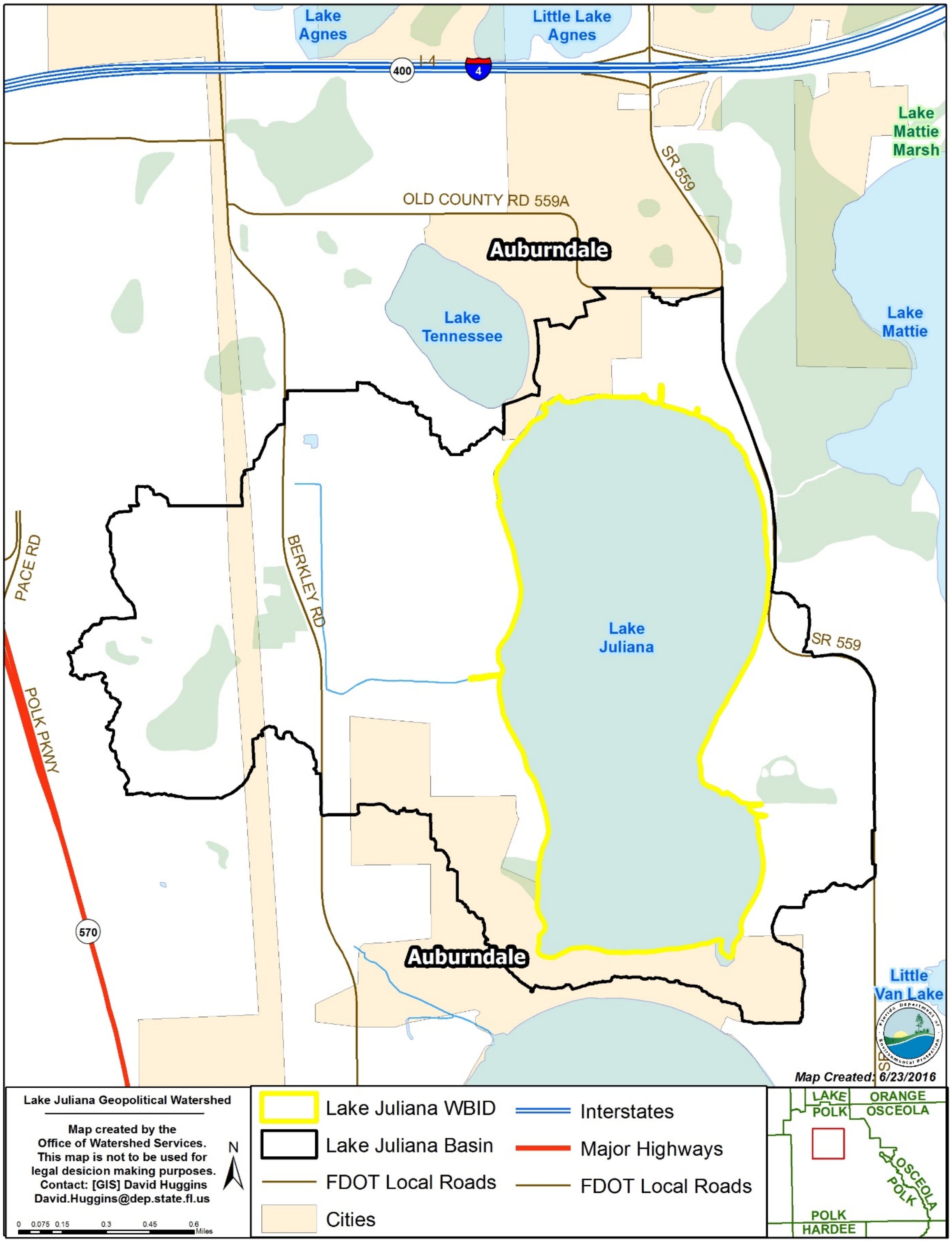

Figure 1.2. Lake Juliana Basin with Major Geopolitical and Hydrologic Features

1.3 Background

This report was developed as part of the department's watershed management approach for restoring and protecting state waters and addressing TMDL Program requirements. The watershed approach, which is implemented using a cyclical management process that rotates through the state's 52 river basins over a five-year cycle, provides a framework for implementing the TMDL Program–related requirements of the 1972 federal Clean Water Act and the 1999 Florida Watershed Restoration Act (FWRA) (Chapter 99-223, Laws of Florida); as amended.

A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet water quality standards, including its applicable water quality criteria and its designated uses. TMDLs are developed for waterbodies that are verified as not meeting their water quality standards. They provide important water quality restoration goals that will guide restoration activities.

This TMDL report will be followed by the development and implementation of a restoration plan to reduce the amount of pollutants that caused the verified impairment of Lake Juliana. These activities will depend heavily on the active participation of the SWFWMD, local governments, businesses, and other stakeholders. The department will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDLs for the impaired waterbody.

Chapter 2: STATEMENT OF WATER QUALITY PROBLEM

2.1 Legislative and Rulemaking History

Section 303(d) of the federal Clean Water Act requires states to submit to the United States Environmental Protection Agency (EPA) a list of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant identified as causing the impairment of the listed waters on a schedule. The department has developed such lists, commonly referred to as 303(d) lists, since 1992. The state's list of impaired waters, referred to as the Verified List, is required by the FWRA (Subsection 403.067[4], Florida Statutes [F.S.]). It is amended annually to include basin updates, and these updates are submitted to the EPA for inclusion on the state's 303(d) list.

Florida's 1998 303(d) list included 10 waterbodies in the Withlacoochee Basin. However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. The Environmental Regulation Commission adopted the new methodology as Chapter 62-303, F.A.C., Identification of Impaired Surface Waters Rule (IWR), in April 2001; the rule was amended in 2006, 2007, 2012, 2013, and 2015.

2.2 Information on Verified Impairment

The department used the IWR to assess water quality impairments in Lake Juliana, and the lake was verified as impaired for nutrients based on elevated annual average Trophic State Index (TSI) values during the Cycle 2 verified period for the Group 4 basins (January 2003 to June 2010). At the time the Cycle 2 assessment was performed, the IWR methodology used the water quality variables total nitrogen (TN), total phosphorus (TP), and chlorophyll *a* (a measure of algal mass, corrected and uncorrected) in calculating annual TSI values and in interpreting Florida's narrative nutrient threshold.

The TSI is calculated based on concentrations of TP, TN, and chlorophyll *a*. The TSI thresholds were set based on annual mean color, where high-color lakes (> 40 platinum cobalt units [PCU]) had a TSI threshold of 60, and lower color lakes (≤ 40 PCU) had a TSI threshold of 40. Exceeding the TSI threshold in any one year of the verified period was sufficient for identifying a lake as impaired for nutrients. For the Cycle 2 assessment, the lake's annual mean TSI value exceeded the impairment threshold of 40 in 2007, 2008, and 2009.

Florida adopted new numeric nutrient criteria (NNC) for lakes, spring vents, and streams in 2011 that were approved by the EPA in 2012 and became effective on October 27, 2014. It is envisioned that these standards, in combination with the related bioassessment tools, will facilitate the assessment of designated use attainment for waters and provide a better means to protect state waters from the adverse effects of nutrient overenrichment. The new lake NNC, which are set forth in Subparagraph 62-302.531(2)(b)1, F.A.C., are expressed as annual geometric mean (AGM) values for chlorophyll *a*, TN, and TP (see **Chapter 3**).

Although the department has not formally assessed the data for Lake Juliana using the new NNC, based on an analysis of the data from 2003 to 2013 in IWR Database Run 49, the preliminary results indicate that Lake Juliana would not attain the new lake NNC for chlorophyll *a* and TN for low-color (< 40 PCU), high-alkalinity (> 20 milligrams per liter [mg/L] calcium carbonate [$CaCO_3$]) lakes, and thus remains impaired for nutrients. This time frame includes the Cycle 2 verified period and water quality data that have been reported more recently. Under the new NNC, Lake Juliana is classified as a lake with lower color (< 40 PCU) and high alkalinity (> 20 mg/L $CaCO_3$), based on the long-term geometric mean values for color and alkalinity. **Table 2.1** lists the preliminary AGM values for corrected chlorophyll *a*, TN, and TP from 2003 to 2013.

Table 2.1. Lake Juliana AGM Values, 2003–2013

ID = Insufficient data to calculate geometric means per the requirements of Chapter 62-30, F.A.C.
µg/L = Micrograms per liter

Note: Values shown in bold and shaded are greater than the new NNC for lakes. Subparagraph 62-302.531(2)(b)1., 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	Corrected Chlorophyll *a* (µg/L)	TN (mg/L)	TP (mg/L)
2003	ID	ID	ID
2004	ID	ID	ID
2005	12	0.84	ID
2006	**21**	0.82	ID
2007	17	0.91	0.02
2008	**28**	**1.31**	0.02
2009	**28**	**1.33**	0.02
2010	**26**	**1.35**	0.03
2011	**43**	**1.72**	0.02
2012	15	0.97	0.02
2013	**28**	**1.34**	0.02

Lake Tennessee, which has the potential to flow into Lake Juliana, was also verified as impaired for nutrients based on elevated annual average TSI values in the Cycle 2 verified period. The annual mean TSI value exceeded the impairment threshold of 40 in 2007, 2008, and 2009. However, based on a preliminary assessment using results from IWR Database Run 49, Lake Tennessee currently attains the new lake NNC for chlorophyll *a*, TN, and TP for low-color (< 40 PCU), low-alkalinity (< 20 mg/L $CaCO_3$) lakes (**Table 2.2**). Note that this assessment includes the chlorophyll *a* AGMs for the 2010 to 2013 period that were calculated outside the IWR database because a method detection limit (MDL) was not reported for the Polk County chlorophyll *a* results. The MDL is required for using results identified with a "U" remark code (which indicates that the compound was analyzed for but not detected) for IWR assessment purposes. A number of chlorophyll *a* results are reported as a value of 3 with the "U" remark code in the IWR database from 2010 to 2013. Chlorophyll *a* results with the "U" code are considered reliable, although the MDL is not reported. For calculation purposes, half the value of 3 was assigned to the nondetect values. Using the nondetect values, the chlorophyll *a* AGMs for the 2010 to 2013 period are less than the applicable chlorophyll *a* threshold, indicating that the lake is currently attaining the NNC through 2013. Lake Tennessee is scheduled to be assessed for IWR listing purposes in 2016 following the department's basin rotation cycle.

The Lake Tennessee AGMs are below the low-color and high-alkalinity NNC thresholds applicable to Lake Juliana; therefore, the lake would not be causing or contributing to the degraded water quality in Lake Juliana if water were to be exchanged between the lakes.

The sources of data for the Cycle 2 IWR assessments of WBID 1484B, and results reported in more recent years, come from stations sampled by Polk County (21FLPOLK…), the SWFWMD (21FLSWFD…), the department's Watershed Monitoring Section (21FLGW…), and the department's Southwest District Office (21FLTPA…). The majority of the available data comes from the monitoring conducted by Polk County, which has been sampling at the center of the lake since 1985 at Station 21FLPOLKJULIANA1. In 1999, the county began sampling for corrected chlorophyll *a*, which is the more common form of chlorophyll *a* used in assessing surface water quality. The other sampling organizations performed monitoring intermittently during this time.

Table 2.2. Lake Tennessee AGM Values, 2003–2013

ID = Insufficient data to calculate geometric means per the requirements of Chapter 62-303, F.A.C.

Notes:
1. Values shown in bold and shaded are greater than the new NNC for lakes. Subparagraph 62-302.531(2)(b)1., 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.
2. The 2010 to 2013 chlorophyll *a* AGMs were calculated outside the IWR database.

Year	Corrected Chlorophyll *a* (µg/L)	TN (mg/L)	TP (mg/L)
2003	ID	ID	ID
2004	ID	ID	ID
2005	**22**	**1.07**	ID
2006	**18**	**0.82**	ID
2007	**21**	**1.24**	**0.02**
2008	**9**	**0.78**	**0.02**
2009	6	0.55	0.02
2010	4	0.62	0.02
2011	3	0.7	0.01
2012	3	0.56	0.02
2013	2	0.49	0.02

Figure 2.1 shows the sampling locations in Lakes Juliana and Tennessee. The individual water quality measurements used in this analysis are included in IWR Database Run 49 and are available on request. Water quality results for the period of record for variables relevant to this TMDL development effort, which were collected by all sampling entities, are displayed in the graphs in **Appendix B**.

In Florida waterbodies, nitrogen and phosphorus are most often the limiting nutrients. A 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 that is necessary for plant growth, but available in quantities smaller than those needed for algae, represented by chlorophyll *a*, and macrophytes to grow.

In the past, management activities to control lake eutrophication focused on phosphorus reduction, as phosphorus was generally recognized as the 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 provides support for this idea, as statistically significant relationships were found between chlorophyll *a* values and both nitrogen and phosphorus concentrations (Department 2012).

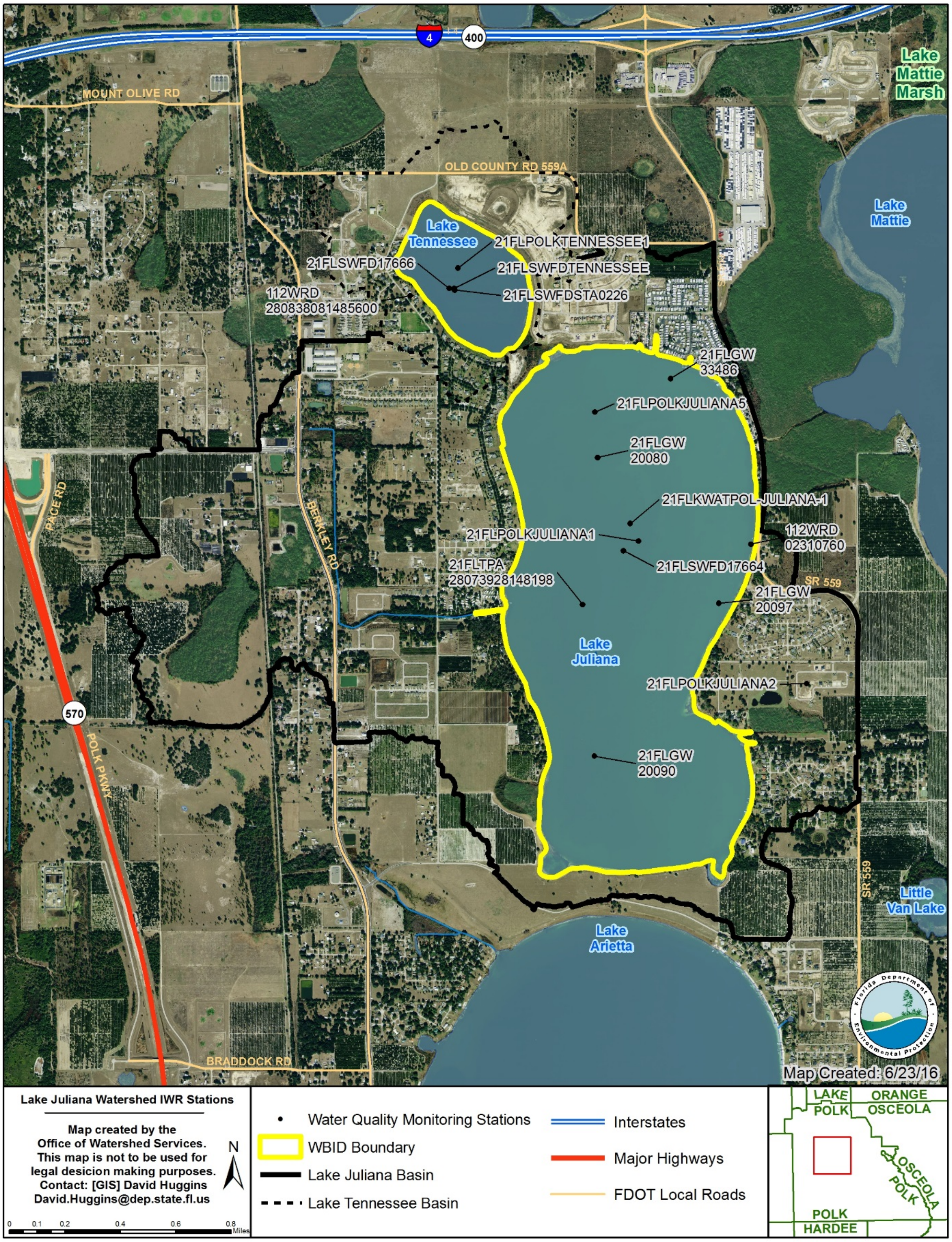

Figure 2.1. Surface Water Monitoring Locations in Lake Juliana and Lake Tennessee

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criteria Applicable to the TMDL

Florida's surface water is protected for six designated use classifications, as follows:

Class I	**Potable water supplies**
Class II	**Shellfish propagation or harvesting**
Class III	**Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife**
Class III-Limited	**Fish consumption; recreation or limited recreation; and/or propagation and maintenance of a limited population of fish and wildlife**
Class IV	**Agricultural water supplies**
Class V	**Navigation, utility, and industrial use (there are no state waters currently in this class)**

Lake Juliana is classified as a Class III freshwater body, with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criterion applicable to the verified impairment (nutrients) for this water is the state of Florida's nutrient criterion in Paragraph 62-302.530(47)(b), F.A.C. Florida has adopted new lake NNC for TN, TP, and chlorophyll *a* in Rule 62-302.531, F.A.C., which went into effect on October 27, 2014. The department has not formally assessed the data for Lake Juliana using the new criteria. However, based on a preliminary analysis of the available data, Lake Juliana would not attain the new NNC for chlorophyll *a* and TN, and is expected to remain listed as verified impaired for nutrients under the new criteria.

The nutrient TMDL presented in this report constitutes a site-specific numeric interpretation of the narrative nutrient criterion set forth in Paragraph 62-302.530(47)(b), F.A.C., that will replace the otherwise applicable NNC in Subsection 62-302.531(2), F.A.C., for this particular water, pursuant to Paragraph 62-302.531(2)(a), F.A.C. The Water Quality Standards template document (**Appendix E**) provides the relevant TMDL information, including documentation that the TMDL provides for the attainment and maintenance of water quality standards in downstream waters (pursuant to Subsection 62-302.531[4], F.A.C.), to support using the TMDL nutrient target as the site-specific numeric interpretation of the narrative nutrient criterion. The targets used in TMDL development are designed to restore surface water quality to meet a waterbody's designated uses. The criteria are based on scientific information used to establish specific levels of water quality constituents that protect aquatic life and human health for particular designated use classifications. As a result, TMDL targets and water quality criteria serve the same purpose, as both measures are designed to protect surface water designated uses.

3.2 Numeric Interpretation of Narrative Nutrient Criterion

The applicable lake NNC are dependent on alkalinity and true color (color), based on long-term period of record (POR) geometric means (GM) (**Table 3.1**). Using this methodology, Lake Juliana is classified as a lake with low color (< 40 PCU) and high alkalinity (> 20 mg/L $CaCO_3$). **Figure B-4** and **Figure B-5** in **Appendix B** show the lake color and alkalinity results, respectively. The chlorophyll *a* NNC for low-color, high-alkalinity lakes is an AGM value of 20 µg/L, which is not to be exceeded more than once in any consecutive three-year period. The associated TN and TP criteria for a lake can vary on an annual basis, depending on the availability of data for chlorophyll *a* and the concentrations of chlorophyll *a* in the lake, as described below.

Table 3.1. State-Adopted Lake Criteria

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

If there are sufficient data to calculate an AGM for chlorophyll *a* and the mean does not exceed the chlorophyll *a* criterion for the lake type in **Table 3.1**, 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 **Table 3.1**. 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. The analyses supporting the criteria represent the best scientific understanding of nutrient and chlorophyll *a* concentrations that each lake type can support while maintaining designated uses and were used as evidence for establishing the appropriate targets for TMDL development for Lake Juliana.

The development of the lake NNC is based on an evaluation of a response variable (chlorophyll *a*) and stressor variables (nitrogen and phosphorus) to develop water quality thresholds that are protective of designated uses (Department 2012). Based on several lines of evidence, the department developed a chlorophyll *a* threshold of 20 µg/L for colored lakes (above 40 PCU) and clear lakes with alkalinity above 20 mg/L $CaCO_3$. Since the department has demonstrated that the chlorophyll *a* threshold of 20 µg/L is protective of designated uses, this value will be used as a water quality target to address the nutrient impairment of Lake Juliana. Based on the best available scientific information, there are no data suggesting that a chlorophyll *a* threshold different from 20 µg/L is necessary to protect the designated uses of Lake Juliana. The department determined that 20 µg/L was fully protective of these uses.

Empirical equations that describe the relationships between chlorophyll *a* and nutrient concentrations in Lake Juliana were then used in the TMDL development approach, which is explained in detail in **Chapter 5**. To determine the site-specific numeric interpretation of the narrative nutrient criterion for TN, the empirical equation that describes the relationship between chlorophyll *a* and TN in Lake Juliana was used to determine the nutrient concentration that would attain the chlorophyll *a* criterion. There is no relationship between lake chlorophyll *a* and TP concentrations, suggesting that the existing TP condition is not a contributor to the lake eutrophication. The available information indicates that the existing lake phosphorus concentrations are not having a detrimental effect on surface water quality and the applicable TP NNC is protective of the designated use.

3.3 Water Quality Variable Definitions

3.3.1 Chlorophyll a

Chlorophyll, a green pigment found in plants, is an essential component in the process of converting light energy into chemical energy. Chlorophyll is capable of channeling the energy of sunlight into chemical energy through the process of photosynthesis. In photosynthesis, the energy absorbed by chlorophyll transforms carbon dioxide (CO_2) and water (H_2O) into carbohydrates and oxygen (O_2). The chemical energy stored by photosynthesis in carbohydrates drives biochemical reactions in nearly all living organisms. Thus, chlorophyll is at the center of the photosynthetic oxidation-reduction reaction between carbon dioxide and water.

There are several types of chlorophyll; however, the predominant form is chlorophyll *a*. The measurement of chlorophyll *a* in a water sample is a useful indicator of phytoplankton biomass, especially when used in conjunction with analysis concerning algal growth potential and species abundance. The greater the abundance of chlorophyll *a*, typically the greater the abundance of algae. Algae are the primary producers in the aquatic web and thus are very important in characterizing the productivity of lakes and streams. As noted earlier, chlorophyll *a* measurements are also used to estimate the trophic conditions of lakes and other lentic waters.

3.3.2 Total Nitrogen as N (TN)

TN is the sum of nitrate (NO_3), nitrite (NO_2), ammonia (NH_3), and organic nitrogen found in water. Nitrogen compounds function as important nutrients to many aquatic organisms and are essential to the chemical processes that take place between land, air, and water. The most readily bioavailable forms of nitrogen are ammonia and nitrate. These compounds, in conjunction with other nutrients, serve as an important base for primary productivity.

The major sources of excessive amounts of nitrogen in surface water are the effluent from wastewater treatment plants and runoff from urban and agricultural land areas. When nutrient concentrations consistently exceed natural levels, the resulting nutrient imbalance can cause undesirable changes in a waterbody's biological community and drive an aquatic system into an accelerated rate of eutrophication. Usually, the eutrophication process is observed as a change in the structure of the algal community and includes severe algal blooms that may cover large areas for extended periods. Large algal blooms are generally followed by a depletion in dissolved oxygen (DO) concentrations as a result of algal decomposition.

3.3.3 Total Phosphorus as P (TP)

Phosphorus is one of the primary nutrients that regulates algal and macrophyte growth in natural waters, particularly in fresh water. Phosphate, the predominant form of phosphorus found in the water column, can enter the aquatic environment in a number of ways. Natural processes transport phosphate to water through atmospheric deposition, ground water percolation, and terrestrial runoff. Municipal treatment plants, industries, agriculture, and domestic activities also contribute to phosphate loading through direct discharge and natural transport mechanisms. The very high levels of phosphorus in some of Florida's streams and estuaries are usually caused by phosphate-mining and fertilizer-processing activities.

High phosphorus concentrations are frequently responsible for accelerating the process of eutrophication, or accelerated aging, of a waterbody. Once phosphorus and other important nutrients enter the ecosystem, they are extremely difficult to remove. They become tied up in biomass or deposited in sediments. Nutrients, particularly phosphates, deposited in sediments generally are redistributed to the water column. This type of cycling compounds the difficulty of halting the eutrophication process.

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

However, the 1987 amendments to the Clean Water Act 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 Clean Water Act 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. However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES stormwater discharges and non-NPDES stormwater discharges, and as such, this chapter does not make any distinction between the two types of stormwater.

4.2 Point Sources

4.2.1 NPDES-Permitted Wastewater Facilities

There are no NPDES-permitted domestic or industrial wastewater facilities discharging in the watershed.

4.2.2 Municipal Separate Storm Sewer System (MS4) Permittees

MS4s may also discharge pollutants 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-size MS4s located in incorporated areas and counties with populations of 100,000 or more. Phase 2 permitting began in 2003. Regulated Phase II MS4s are defined in Rule 62-624.800, F.A.C., and typically cover urbanized areas serving jurisdictions with a population of at least 1,000 or discharging into Class I or Class II waters, or into Outstanding Florida Waters (OFWs).

The stormwater collection systems in the Lake Juliana watershed, which are owned and operated by Polk County, in conjunction with the Florida Department of Transportation (FDOT) District 1, are covered by an NPDES Phase I MS4 permit (FLS000015). The city of Auburndale is a co-permittee in the MS4 permit, and a large portion of the watershed is within the city limits.

4.3 Land Uses and Nonpoint Sources

Nutrient loading from urban areas is most often attributable to multiple sources, including stormwater runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from the improper disposal of waste materials, leaking septic systems, and domestic animals. The largest anthropogenic land use in the Lake Juliana watershed consists of urban areas, and thus urban sources are a significant source of nutrients in the watershed. A sizable agricultural area, particularly in the western and southern parts of the watershed, contributes anthropogenic nutrient loads.

In addition to the nutrient sources associated with anthropogenic activities, birds and other wildlife can also contribute considerable amounts of nutrients to waterbodies through their feces, particularly in areas with bird rookeries. While detailed source information is not always available for accurately quantifying the loadings from wildlife sources, land use information can be used to help identify areas with the potential for wildlife to congregate.

4.3.1 Land Uses

The spatial distribution and acreage of different land use categories were identified using the SWFWMD 1999 and 2011 land use coverage contained in the department's geographic information system (GIS) library.

The direct watershed area for Lake Juliana is approximately 2.6 square miles (1,677 acres) (**Table 4.1**). Lake Juliana can also receive inflow from Lake Tennessee, depending on the lake surface elevation, via two corrugated pipes located in a vegetated area along the northwest shoreline of Lake Juliana. However, based on stage records no instances have been recorded since November 2005 of Lake Tennessee water flowing into Lake Juliana.

Figure 4.1 shows the Lake Tennessee water level measurements for the last 30 years along with the bottom elevation of the pipes that connect the lakes (invert elevation of 131.72 feet). Prior to December 2005, the lake surface elevation exceeded the pipe invert elevation intermittently. As there is the potential for Lake Tennessee to flow into Lake Juliana, the Lake Tennessee watershed land use is listed in **Table 4.2**. Considering the potential for inflows from Lake Tennessee, with a watershed and lake area totaling 378 acres, the total contributing drainage area to Lake Juliana is 3.2 square miles (2,055 acres). As explained in **Chapter 2,** under current conditions Lake Tennessee is attaining the applicable NNC for low-color and low-alkalinity lakes, and the AGMs are below the low-color and high-alkalinity NNC thresholds applicable to Lake Juliana; therefore the lake is not causing or contributing to the degraded water quality in Lake Juliana.

Table 4.1. Lake Juliana Watershed Land Use, 1999 and 2011

- = Empty cell/no data

Land Use	1999 Land Use (Acres)	1999 % of Total	2011 Land Use (Acres)	2011 % of Total	Difference Between 1999 and 2011 (Acres)	% Difference
Low-Density Residential	423.0	25.2%	450.0	26.8%	27.0	6%
Medium-Density Residential	7.3	0.4%	239.2	14.3%	231.9	3,192%
High-Density Residential	68.6	4.1%	75.2	4.5%	6.6	10%
Industrial	0.0	0.0%	7.1	0.4%	7.1	-
Institutional	0.0	0.0%	19.1	1.1%	19.1	-
Urban Open Land	12.7	0.8%	125.3	7.5%	112.6	885%
Cropland and Pastureland	360.6	21.5%	193.4	11.5%	-167.2	-46%
Row Crops	0.0	0.0%	25.5	1.5%	25.5	-
Tree Crops	376.6	22.5%	201.4	12.0%	-175.2	-47%
Nurseries and Vineyards	115.6	6.9%	39.6	2.4%	-76.0	-66%
Other Agriculture Lands	95.4	5.7%	62.7	3.7%	-32.6	-34%
Rangeland + Forest/Rural Open	67.4	4.0%	43.9	2.6%	-23.5	-35%
Water	19.2	1.1%	13.0	0.8%	-6.1	-32%
Wetlands	130.2	7.8%	159.6	9.5%	29.4	23%
Communication and Transportation	0.0	0.0%	21.5	1.3%	21.5	-
Total Watershed Area	**1,677**	**100%**	**1,677**	**100%**	**-**	**-**

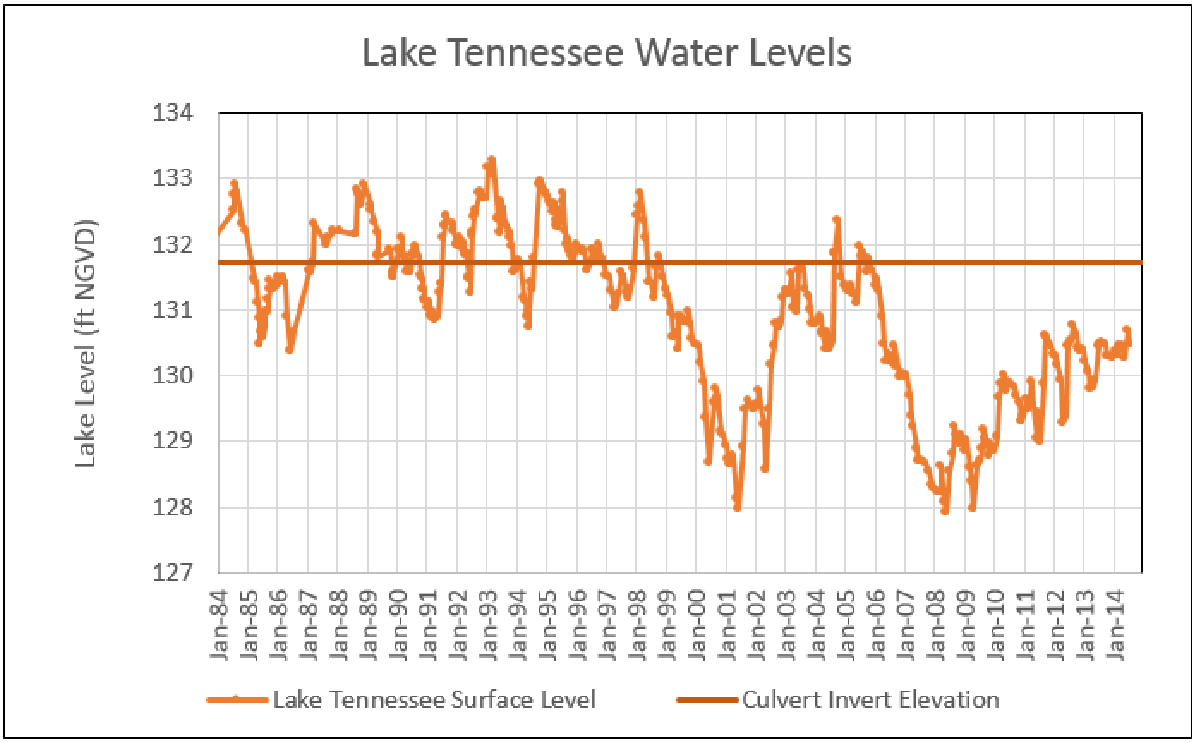

Figure 4.1. Lake Tennessee Surface Level in Relation to the Invert Elevation of the Outlet Pipes

Table 4.2. Lake Tennessee Watershed Land Use, 1999 and 2011

- = Empty cell/no data

Land Use	1999 Land Use (Acres)	1999 % of Total	2011 Land Use (Acres)	2011 % of Total	Difference Between 1999 and 2011 (Acres)	% Difference
Low-Density Residential	52.0	19.3%	41.2	15.3%	-10.8	-21%
Medium-Density Residential	0.0	0.0%	59.5	22.1%	59.5	-
High-Density Residential	0.0	0.0%	3.5	1.3%	3.5	-
Urban Open Land	0.0	0.0%	87.0	32.3%	87.0	-
Cropland and Pastureland	146.1	54.2%	54.2	20.1%	-91.9	-63%
Tree Crops	40.8	15.2%	0.0	0.0%	-40.8	-100%
Other Agriculture Lands	18.7	6.9%	10.8	4.0%	-7.9	-42%
Water	2.8	1.0%	1.3	0.5%	-1.5	-55%
Wetlands	9.0	3.3%	11.8	4.4%	2.8	32%
Total Watershed Area	**269**	**100%**	**269**	**100%**	**-**	**-**

Land use categories in the Lake Juliana contributing drainage area were aggregated using the Florida Land Use Code and Classification System (FLUCCS) (FDOT 1999) expanded Level 1 codes (including low-, medium-, and high-density residential). **Table 4.1** lists the SWFWMD land use types and their corresponding acreages in the Lake Juliana watershed in 1999 and 2011. **Figure 4.2** shows the spatial distribution of different land use types in the Lake Juliana watershed and contributing drainage area for 2011.

As of 2011, the predominant land use in the Lake Juliana watershed is urban use, comprising 55% of the area. Low-density residential is the largest urban use type, covering about 27% of the basin, followed by medium-density residential, which covers about 14% of the area. Agricultural land, primarily located in the western and southern portions of the watershed, includes nurseries and vineyards, tree crops, and cropland/pastureland, and encompasses 31% of the watershed area. Wetlands cover almost 10% of the watershed and are primarily located along the northern and southern shoreline of Lake Juliana and in the western portion of the watershed.

Figure 4.3 displays the spatial distribution of 1999 land use types in the Lake Juliana watershed and contributing drainage area. In contrast to the 2011 land use, the predominant watershed land use in 1999 was agriculture, which made up 36% of the area (**Table 4.1**). The largest agricultural land uses were tree crops and cropland/pastureland, which covered about 57% of the watershed. Urban areas, including residential development and open land, made up 31% of the watershed and were dominated by low-density residential areas, which covered about 25% of the area. The land use comparison shows that most of the agricultural land lost between 1999 and 2011 (451 acres) has been converted to urban areas, primarily residential. This conversion to residential development is still occurring, as the urban open land located on the north side of Lake Juliana is part of a residential development called Lake Juliana Estates, which is still under construction. This development also occupies a large area of urban open land along the north side of Lake Tennessee, which was designated cropland/pastureland in 1999.

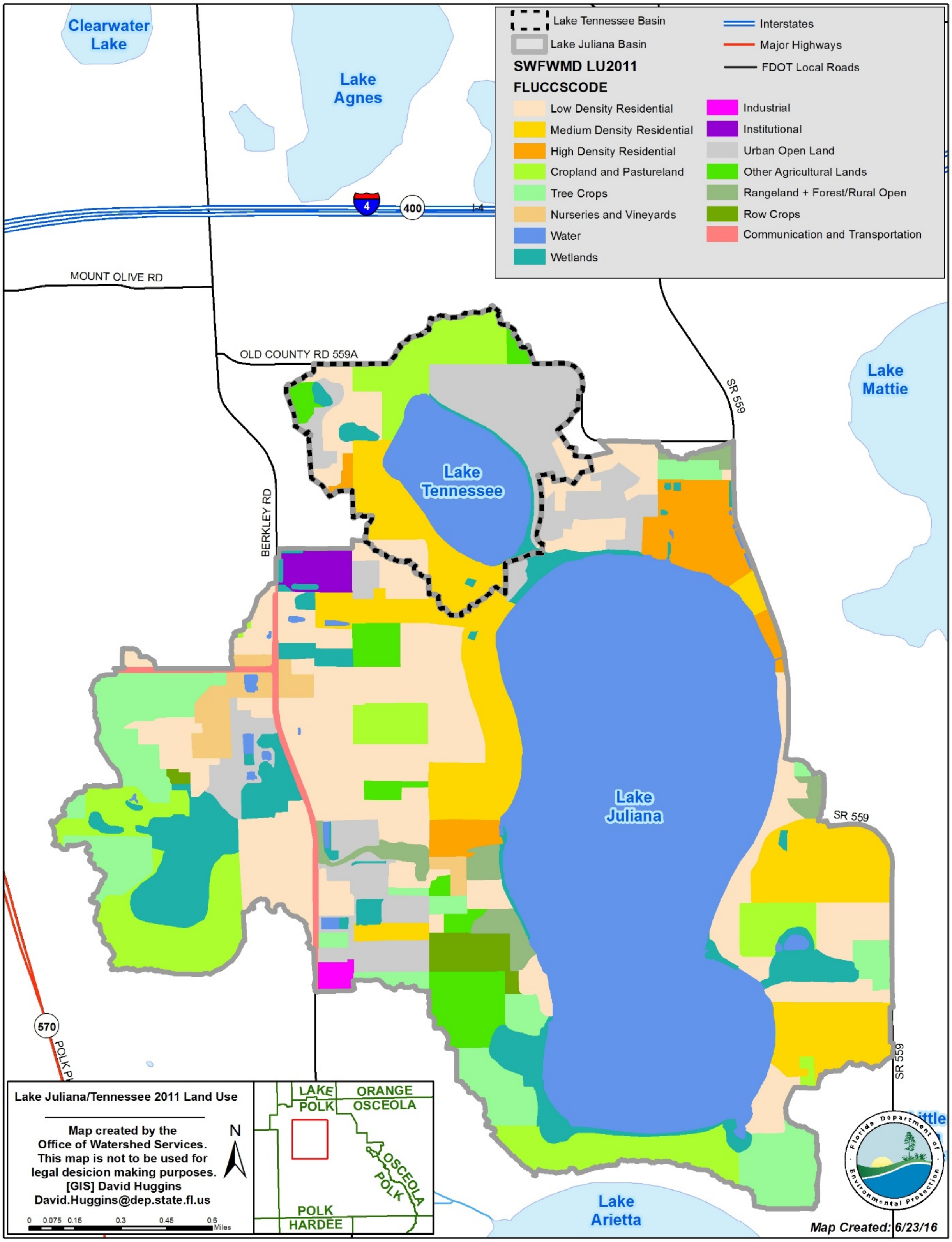

Figure 4.2. Principal Land Uses in the Lake Juliana Contributing Area in 2011

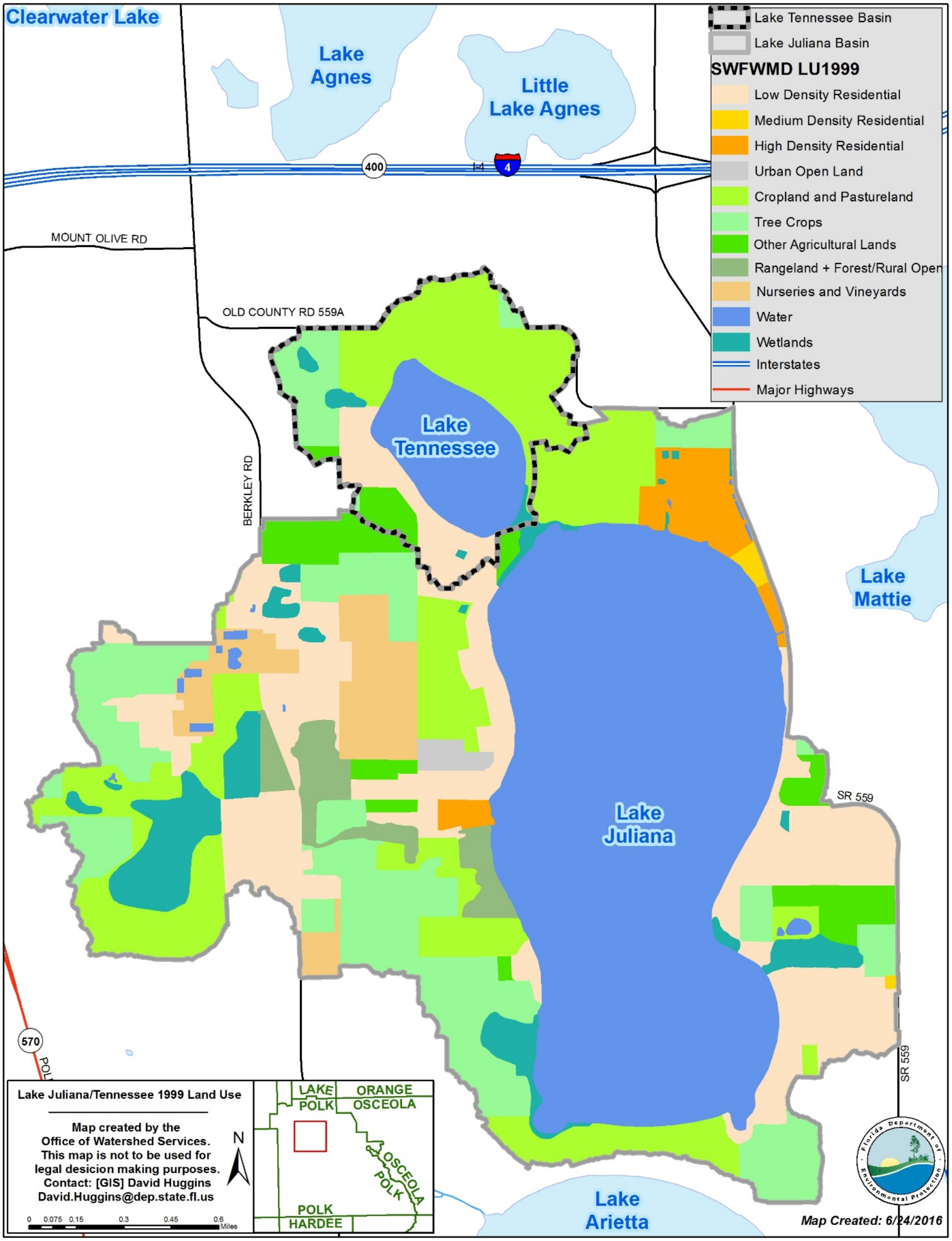

Figure 4.3. Principal Land Uses in the Lake Juliana Contributing Area in 1999

The conversion of agricultural land to residential development is expected to reduce nutrient loadings with the implementation of urban stormwater treatment systems as required by Florida regulations. In 1982, Florida implemented 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, Chapter 62-40, F.A.C, was established as a technology-based program that relies on the implementation of best management practices (BMPs) designed to achieve a specific level of treatment (*i.e.*, performance standards). These stormwater management systems are required to achieve at least an 80% reduction of the average annual load of pollutants that would cause or contribute to violations of state water quality standards, or meet basin-specific design and performance criteria to achieve an adopted TMDL, if established by the department.

4.3.2 Polk County Population

According to the United States Census Bureau, the population density in Polk County in 2010 was 334.9 persons per square mile. The Census Bureau reports that the total population in 2010 for Polk County, which includes (but is not exclusive to) the Lake Juliana watershed, was 602,095, with 279,872 housing units. Polk County occupies an area of approximately 1,798 square miles. For all of Polk County, the housing density is 155.7 houses per square mile (United States Census Bureau 2015).

4.3.3 Polk County Septic Tanks

Onsite sewage treatment and disposal systems (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 ground water and surface water. Information on the location of septic systems was obtained from Florida Department of Health (FDOH) OSTDS GIS coverage dated November 2013.

Figure 4.4 shows the locations of the septic tanks in the Lake Juliana contributing area. Currently the number of septic tanks in the Lake Juliana and Lake Tennessee watersheds are estimated to be 255 and 22, respectively. The septic tanks are distributed throughout the Lake Juliana watershed and the southern portion of the Lake Tennessee watershed.

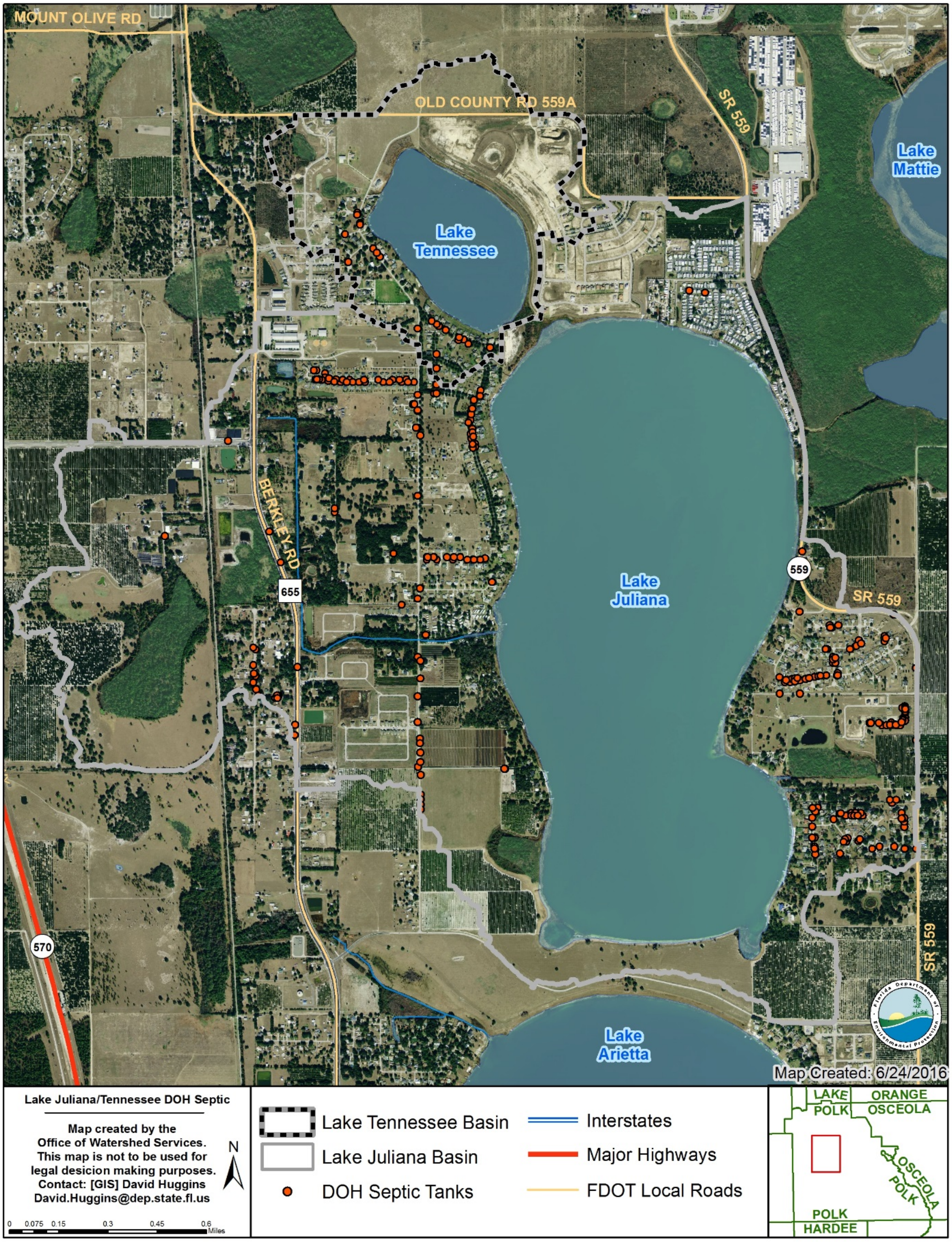

Figure 4.4. Septic Tank Locations in the Lake Juliana Contributing Area

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

The TMDL development process identifies nutrient target concentrations and nutrient reductions for Lake Juliana in order for the waterbody to achieve the applicable nutrient water quality criteria and maintain its function and designated use as a Class III fresh water. The method utilized to address the nutrient impairment included the development of regression equations that relate lake nutrient concentrations to AGM chlorophyll *a* levels. For addressing nonpoint sources (both NPDES and non-NPDES stormwater discharges), the TMDL is expressed as a percent reduction in the existing lake water TN concentrations necessary to meet the applicable chlorophyll *a* target.

The primary focus in the implementation of this TMDL is to maintain the lake's AGM chlorophyll *a* values at or below the target concentration of 20 µg/L through reductions in nutrient inputs to the system. Nutrient reductions are also expected to improve DO levels in the lake. When algae die they become part of the organic matter pool in the water column and the sediments. The decomposition of organic substrates by microbial activity exerts oxygen demand, lowering DO levels. Lower algal biomass should lower the biochemical oxygen (BOD) demand levels in the water column, and sediment oxygen demand (SOD) in the lake should also decrease over time, as reductions in algal biomass will decrease the accumulation of organic matter in lake sediments.

5.2 Analysis of Water Quality

Lake Juliana water quality monitoring has been performed by several organizations. Polk County has routinely sampled the lake since 1985, and a large portion of the data used to assess water quality were obtained at Station 21FLPOLKJULIANA1, located near the center of the lake. Other sampling organizations, including the SWFWMD and the department, have conducted monitoring intermittently throughout the period of record. The individual water quality results for variables relevant to this TMDL effort for the period of record, which were collected by all sampling organizations, are displayed in the graphs in **Appendix B**.

The results collected at the Polk County sampling location near the center of the lake were evaluated to determine if relationships exist between nutrient concentrations and chlorophyll *a* levels. The county monitoring at this location provides a consistent dataset for evaluating surface water quality. The nutrient and chlorophyll *a* AGMs were used in this evaluation to be consistent with the expression of the adopted NNC for lakes. In 1999, the county began sampling for corrected chlorophyll *a*, which is the more common form of chlorophyll *a* used in assessing surface water quality. For the purpose of this analysis, a minimum of two samples per year, collected in different quarters of the year, were used to calculate the AGMs. From 1999 to 2013, sufficient results were collected in most years to calculate the AGM values for corrected chlorophyll *a* and nutrients. Insufficient results were available in 2004 to calculate geometric mean values.

Figure 5.1 shows AGM values for TN and TP results measured at the center of the lake. From 1999 to 2013, the TN AGMs ranged from 0.82 to 1.92 mg/L, and the TP AGMs ranged from 0.01 to 0.04 mg/L.

Lake Juliana water quality was compared with annual lake level and rainfall results obtained from measurements collected by the SWFWMD. The nearest rainfall collection station is Site ROMP 76 Old Polk City (ID 17697), located about three miles north of the lake. The daily rain measurements at this site span the period from 1998 to the present; however, the total annual rainfall in 2000 is not available due to a gap in the dataset between July 2000 and October 2000. The SWFWMD Polk County annual rainfall estimates (based on area-weighted average values) were instead used for comparison with the water quality results, as this dataset includes a rainfall total for the year 2000. The countywide annual rainfall totals correlate well with the rainfall results at the ROMP 76 Old Polk City site (**Figure 5.2**).

Figure 5.3 displays the chlorophyll *a* AGM values along with annual total rainfall. The chlorophyll *a* AGM values in Lake Juliana were above 20 µg/L in many years from 1999 to 2013, and were less than 20 µg/L in 1999, 2005, 2007, and 2012. The geometric means ranged from a low of 13 µg/L in 2005 to a high of 48 µg/L in 2002.

There is no direct significant relationship (p value > 0.05) between the AGM chlorophyll *a* results and contemporaneous annual rainfall, as shown in **Figure 5.4**. Upon further analysis, a moderately strong and significant relationship (r square = 0.47, p value < 0.05) was found between the annual average lake level and the previous year's rainfall, as shown in **Figure 5.5.** This relationship suggests a time lag between rainfall conditions and the response of lake levels to watershed runoff contributions on an annual basis.

One factor that can influence lake level response to rainfall is the hydrologic soil group classification of soils in the watershed. An analysis of the hydrologic soil groups in the watershed indicate that 72% of the drainage area comprises Soil Type A (**Table 5.1**). **Figure 5.6** shows the distribution of the soil types in the watershed. Soil Type A is characterized as high-infiltration soil, which has very low runoff potential, and indicates that the watershed has lower surface runoff and greater migration of water through the subsurface matrix. This factor can contribute to a delayed response of lake level to rainfall.

Additionally, analysis of the chlorophyll *a* AGMs and annual average lake level presented in **Figure 5.7** suggests a slight inverse relationship between these variables (r square = 0.14, p value = 0.1839). A slight inverse relationship is also evident between TN AGMs and annual average lake levels (r square = 0.18, p value = 0.1278) (**Figure 5.8**). The results suggest that factors in addition to external nutrient loadings, such as lake residence time and internal cycling of nutrients, may have some influence on lake chlorophyll *a* levels, since during periods with presumably higher watershed nutrient loadings (*i.e.*, higher lake levels), there is no associated increase in lake chlorophyll *a* and TN results.

Figure 5.9 and **Figure 5.10** illustrate the relationships between chlorophyll *a* and TN and TP AGM concentrations, respectively. Chlorophyll *a* exhibits a strong and significant positive relationship with TN (r square = 0.90, p value < 0.05). The results indicate no apparent relationship between AGM chlorophyll a and TP (r square = 0.01). These observations suggest that with a lowering of the in-lake nitrogen concentrations, chlorophyll *a* concentrations will decrease.

Other information is available to support the idea that additional factors, in addition to watershed nutrient loadings, are affecting lake water quality. This information includes recent monitoring results collected by the department to enumerate the phytoplankton community and water quality results in Lake Juliana and Lake Tennessee. Samples for phytoplankton enumeration, sediment grain size analysis and organic composition, and water quality characterization were collected in August 2014 at the Polk County sampling locations near the center of Lake Juliana, 21FLPOLKJULIANA1 (JULI01), and in Lake Tennessee, 21FLPOLKTENNESSEE1 (TENN01), as shown in **Figure 2.1**. **Appendix C** presents the phytoplankton community results**.** **Appendix D** presents the results for water quality and sediment analyses, as well as depth profiles for physical parameters.

Phytoplankton in the Phylum Cyanophycota (the blue-green algae) were the dominant group in Lake Juliana, representing 98% of the algal community based on cell densities. Many blue-green algae taxa are capable of fixing atmospheric nitrogen, including *Cylindrospermopsis raciborskii,* which was observed in Lake Juliana in considerable numbers. In Lake Tennessee, the phytoplankton results indicated the presence of a more balanced algal community, as green algae (Phylum Chlorophycota) were the dominant group, comprising about 52% of the community based on cell densities, and blue-green algae represented 38% of the community.

The DO depth profile in **Figure D-1** and the measurements obtained at the time of water quality sample collection (listed in **Table D-1**) exhibit patterns of lake stratification. Stratification in lakes can produce anoxic conditions, leading to the accumulation of ammonia when organic matter is decomposed and an increase in ammonia released from the sediment under anaerobic conditions. Water quality results for ammonia (mg N/L) collected near the surface and bottom at Station JULI01, shown in **Figure 5.11**, indicate that a considerably higher level of ammonia is present near the bottom of the Lake Juliana water column. This observation suggests that ammonia has the potential to be released into the water column from sediments and, during lake mixing events, could stimulate phytoplankton growth.

Invasive aquatic plants (notably hydrilla, water hyacinth, and water lettuce) are present in Lake Juliana, and herbicide treatment is conducted at times to control the spread of these plants in the lake. This practice may enhance the cycling of nutrients in the lake, as the decomposition of dead plant material leads to the release of nutrients into the water column that can be a nutrient source for the phytoplankton community. Herbicide treatment information (acres treated and targeted vegetation) was obtained from the Polk County Parks and Natural Resources Office and compared with the lake chlorophyll *a* results (**Figure 5.12**). Since 2000, the lake received herbicide treatment on 14 occasions, and no more than about 3% of the lake surface area was treated during each event. There does not appear to be any relationship between herbicide applications and chlorophyll *a* results.

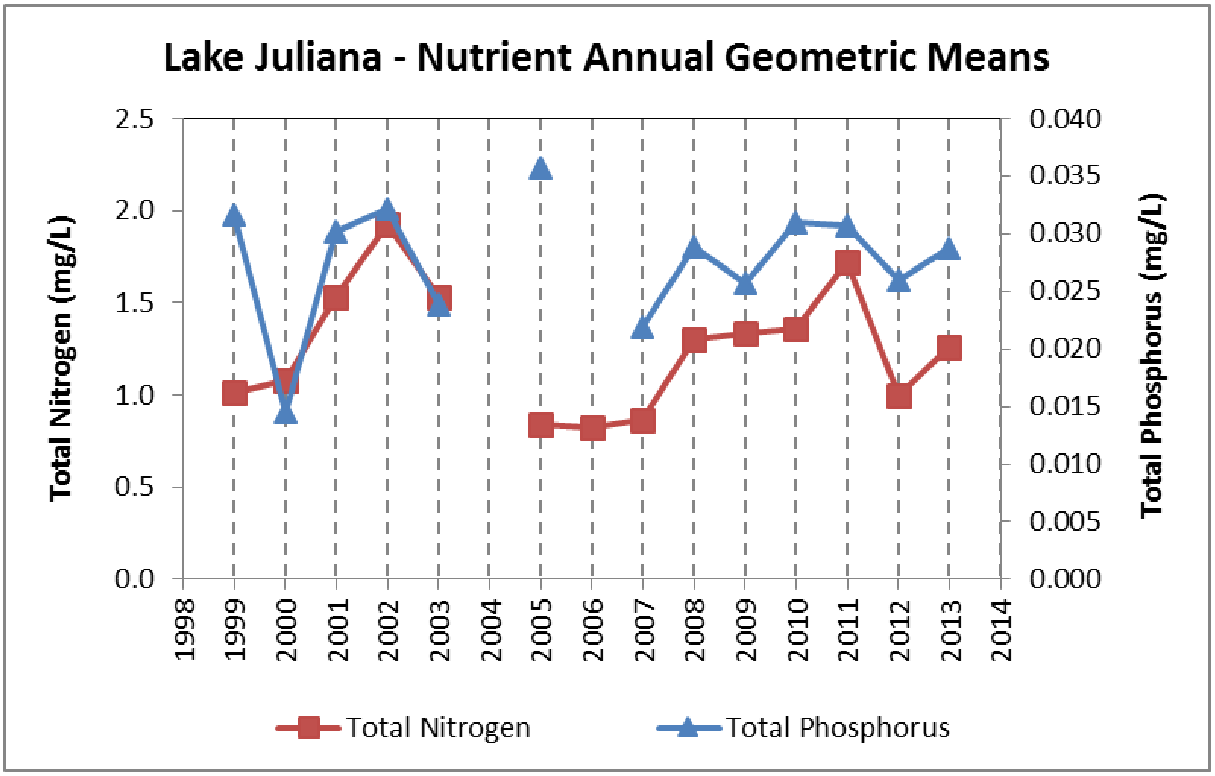

Figure 5.1. TN and TP AGMs in Lake Juliana, Based on Lake Center Results

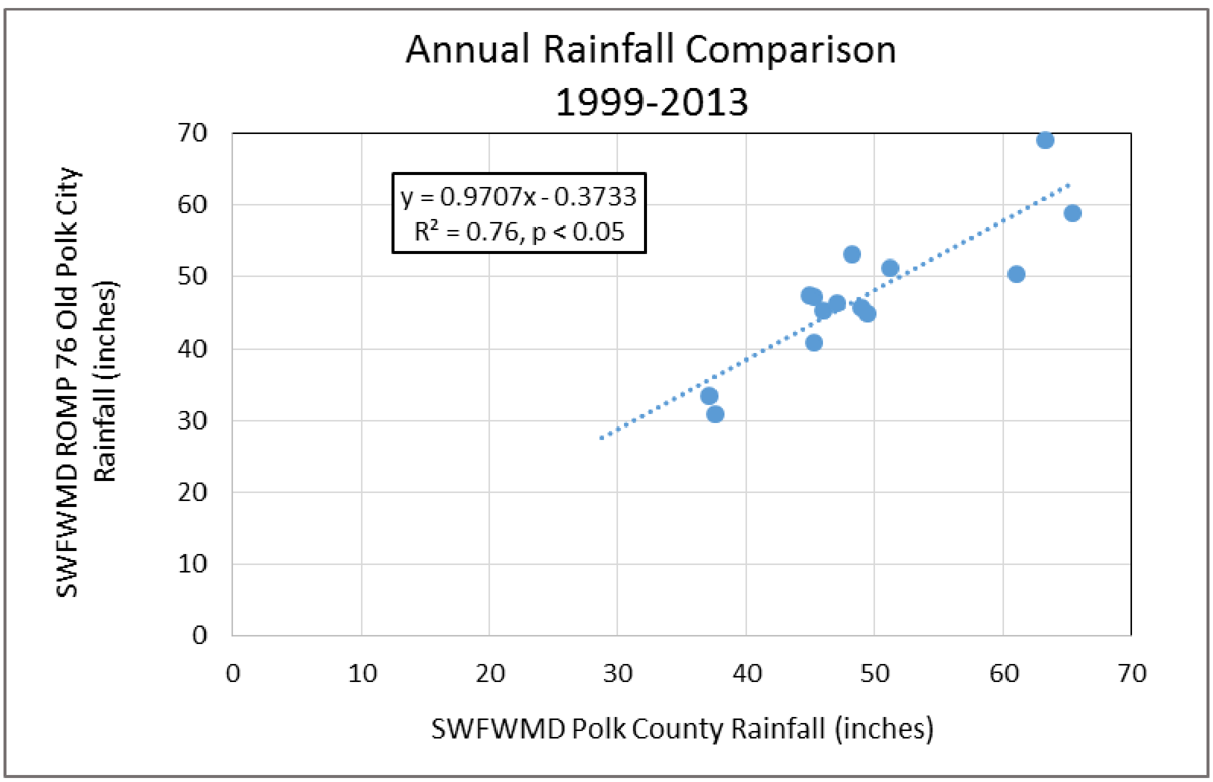

Figure 5.2. Comparison of SWFWMD Site-Specific and Countywide Rainfall Results

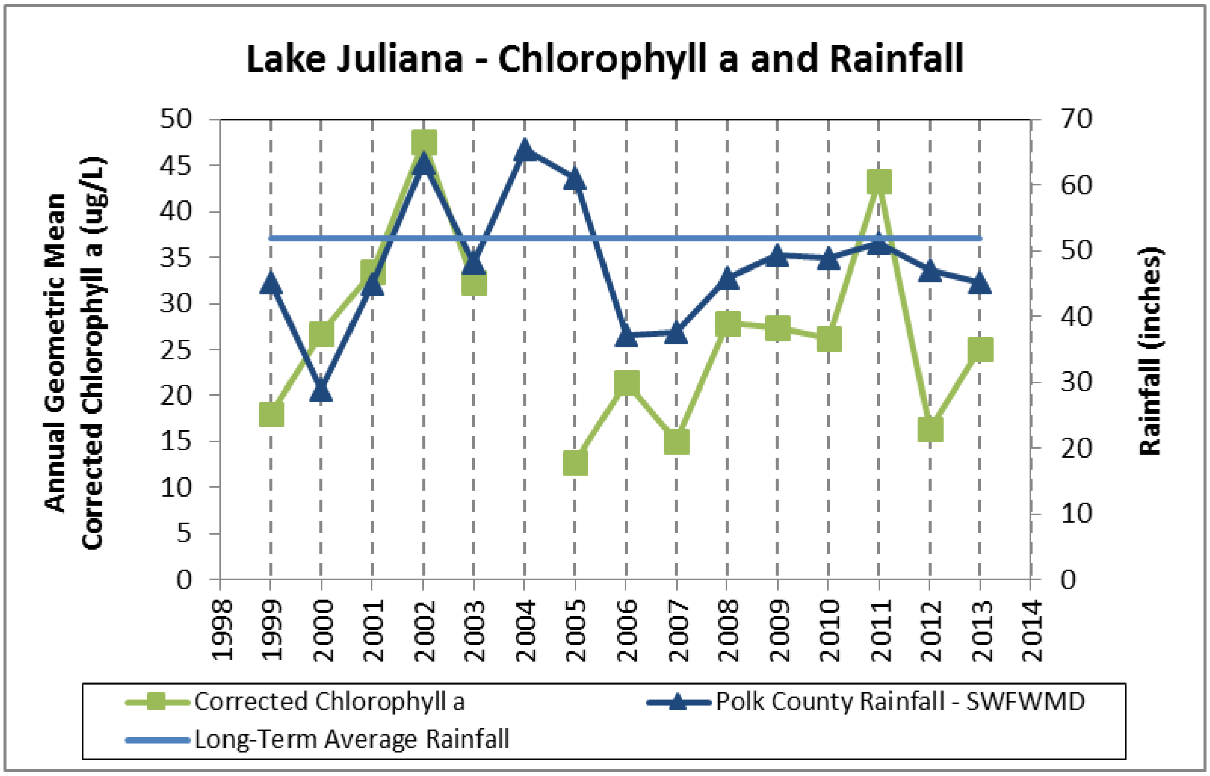

Figure 5.3. Lake Juliana Chlorophyll *a* AGMs, Based on Lake Center Results, and Annual Rainfall

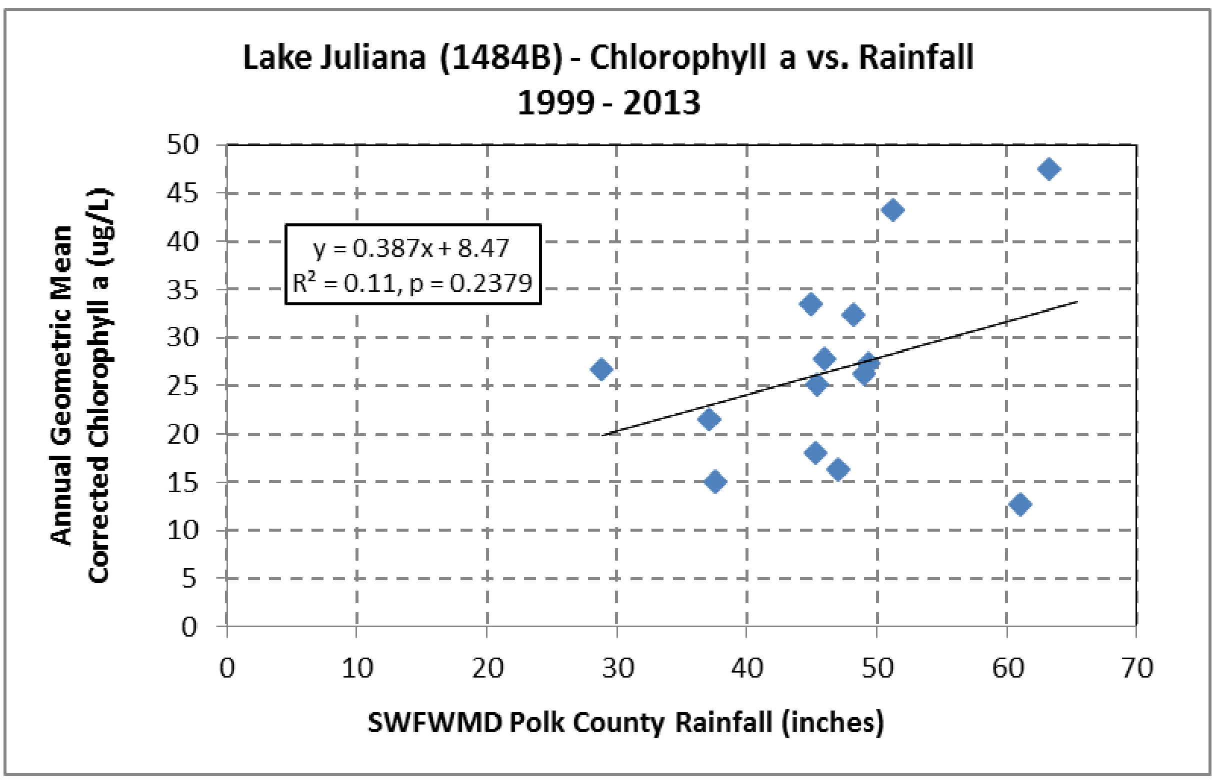

Figure 5.4. Relationship between Lake Juliana Chlorophyll *a* AGMs and Annual Rainfall

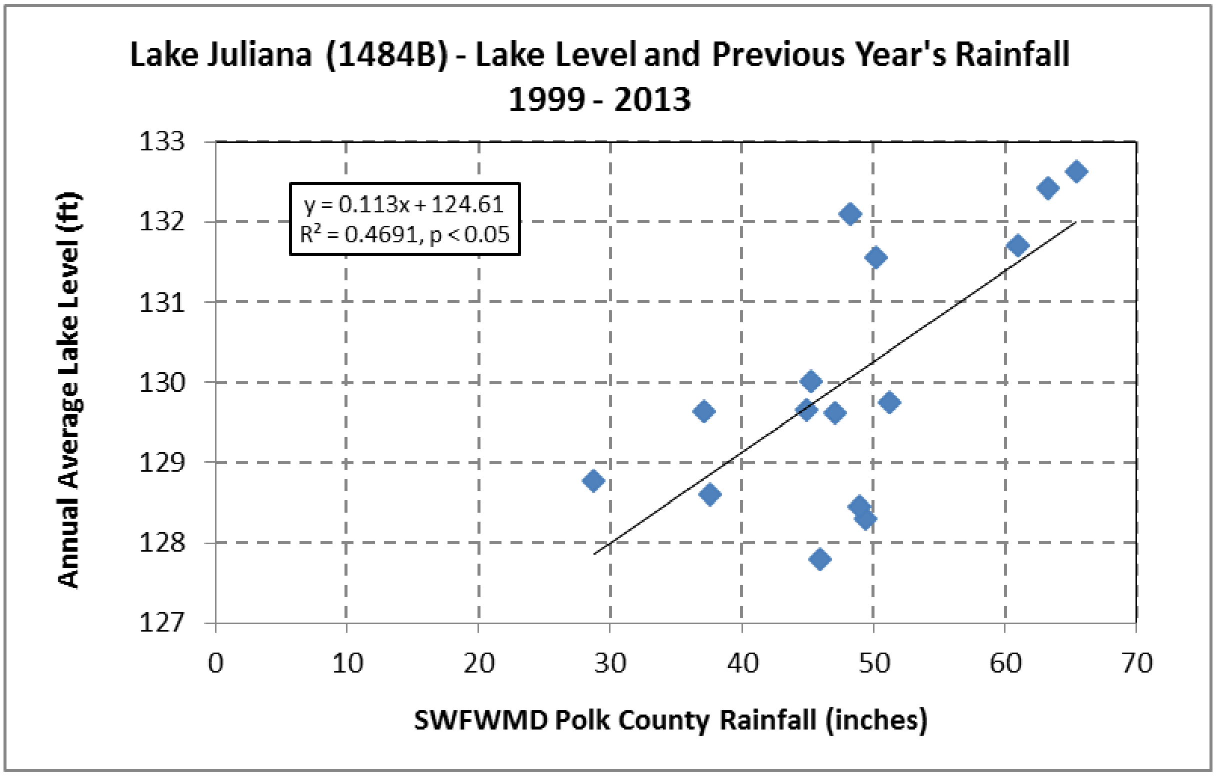

Figure 5.5. Relationship between Lake Juliana Water Level and Previous Year's Rainfall

Table 5.1. Lake Juliana Watershed Hydrologic Soil Group Composition

NA = Not applicable

Soil Group	Description	Acreage	% of Total
A	Deep sandy soils	1,204	71.8%
A/D	Combination of Group A and D soils	396	23.6%
C/D	Combination of Group C and D soils	22	1.3%
C	Sandy soil with high clay or organic content	20	1.2%
B/D	Combination of Group B and D soils	15	0.9%
X	Undefined	11	0.7%
B	Shallow sandy soils	9	0.6%
D	Clayey soils	0	0%
Total	**NA**	**1,677**	**100%**

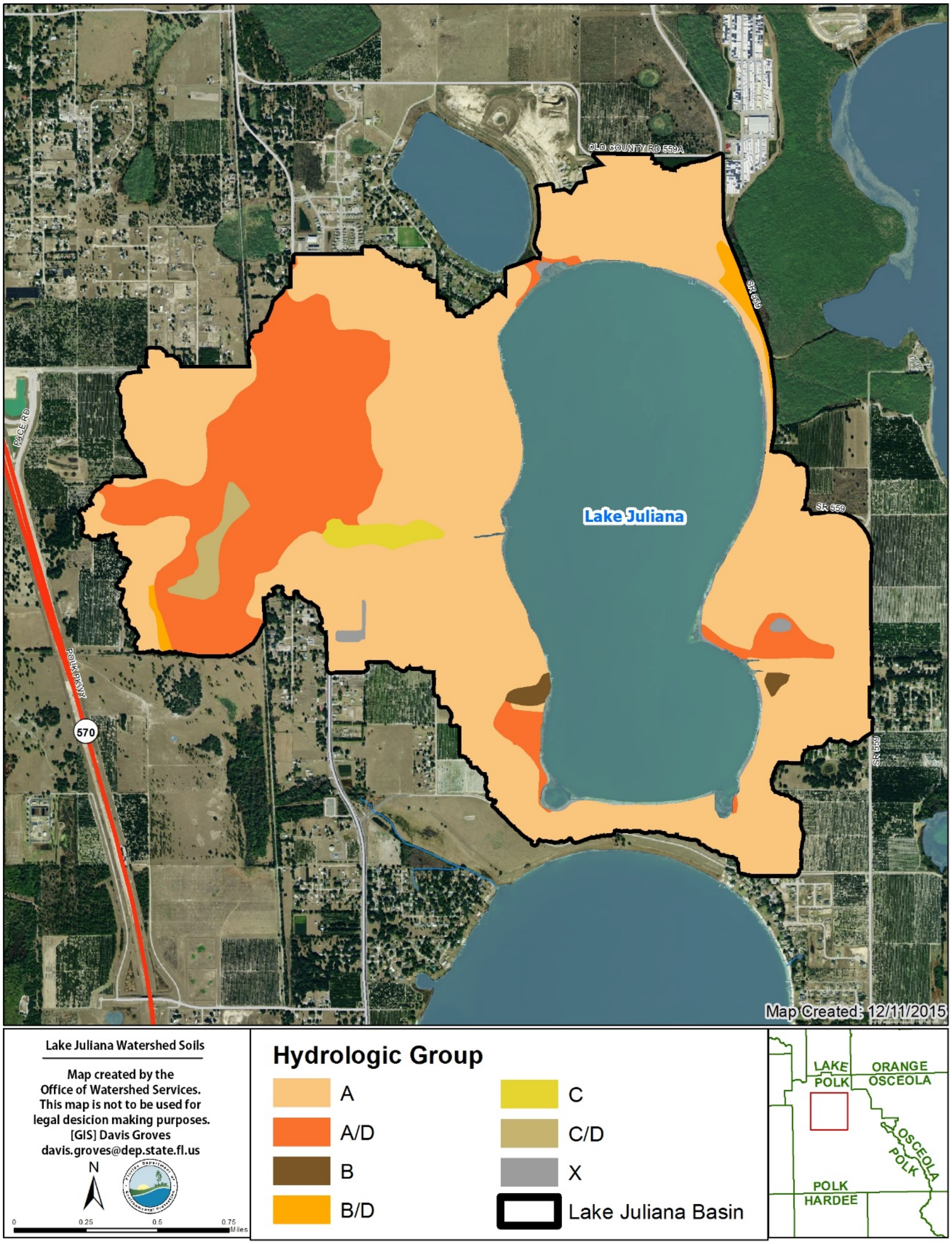

Figure 5.6. Hydrologic Soil Groups in the Lake Juliana Watershed

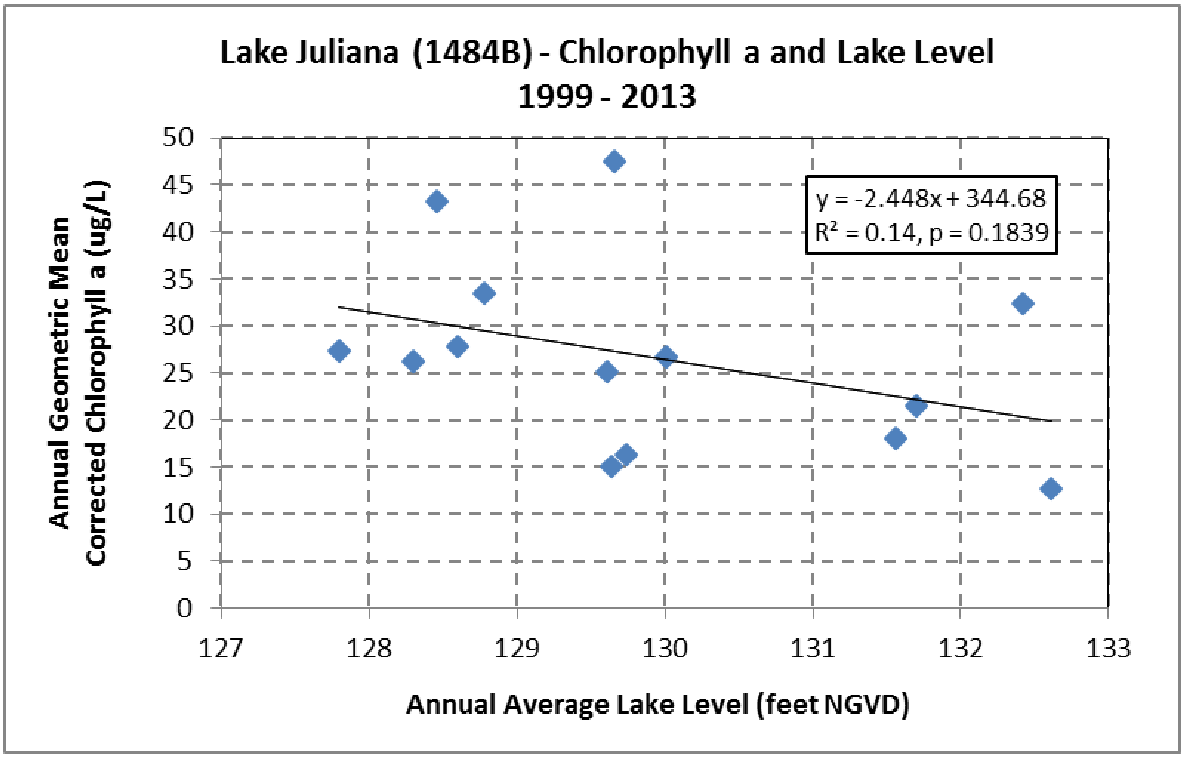

Figure 5.7. Relationship between Lake Juliana Chlorophyll *a* AGMs, Based on Lake Center Results, and Lake Level

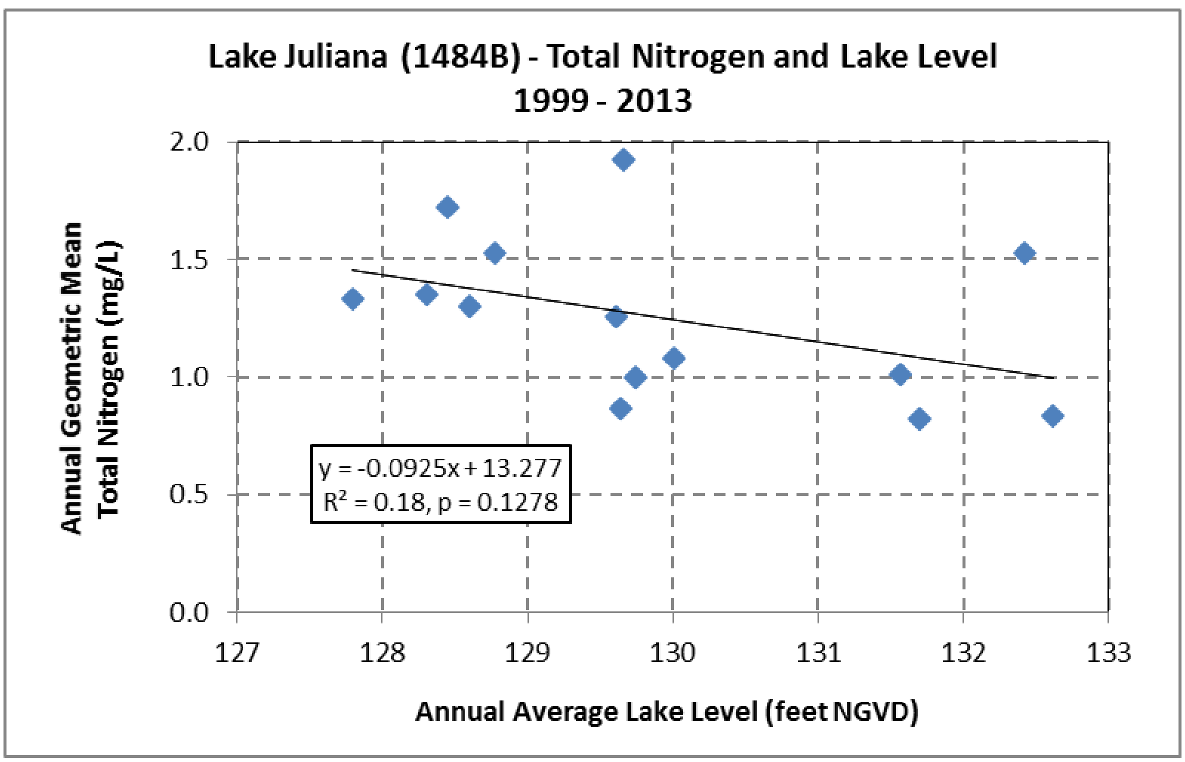

Figure 5.8. Relationship between Lake Juliana TN AGMs, Based on Lake Center Results, and Lake Level

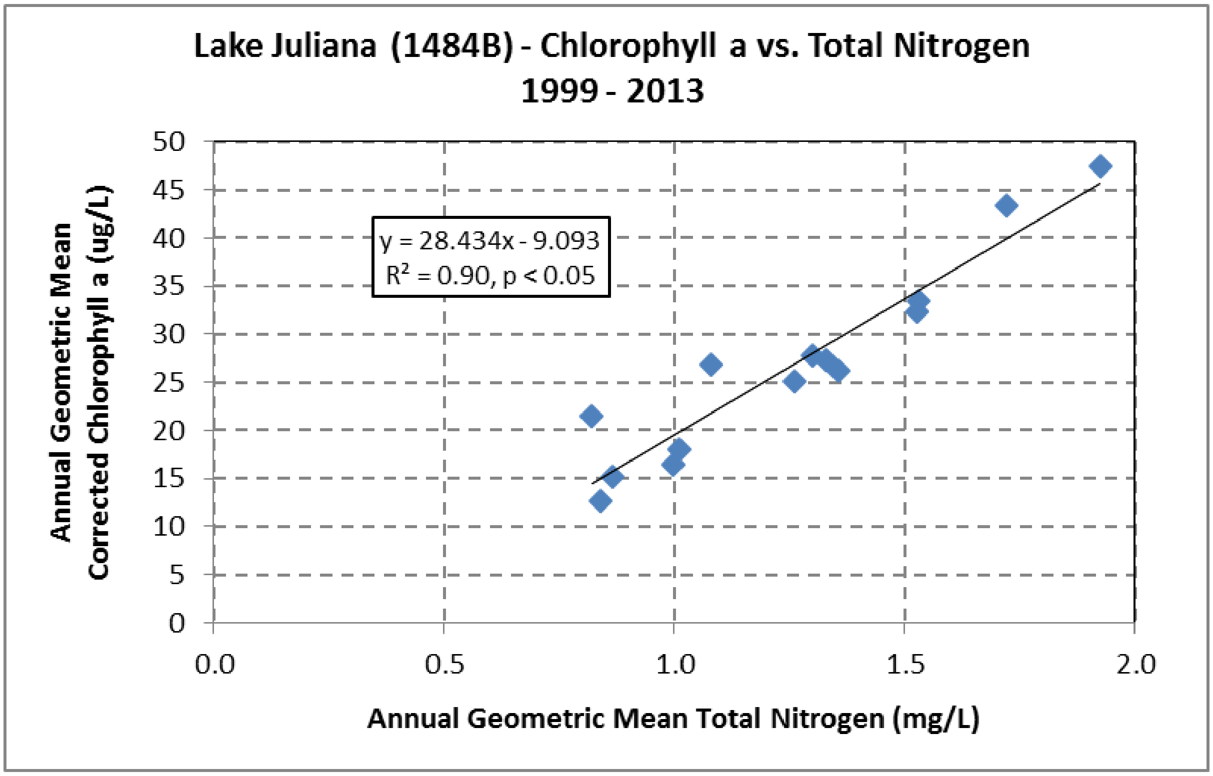

Figure 5.9. Relationship between AGMs of Chlorophyll *a* and TN in Lake Juliana

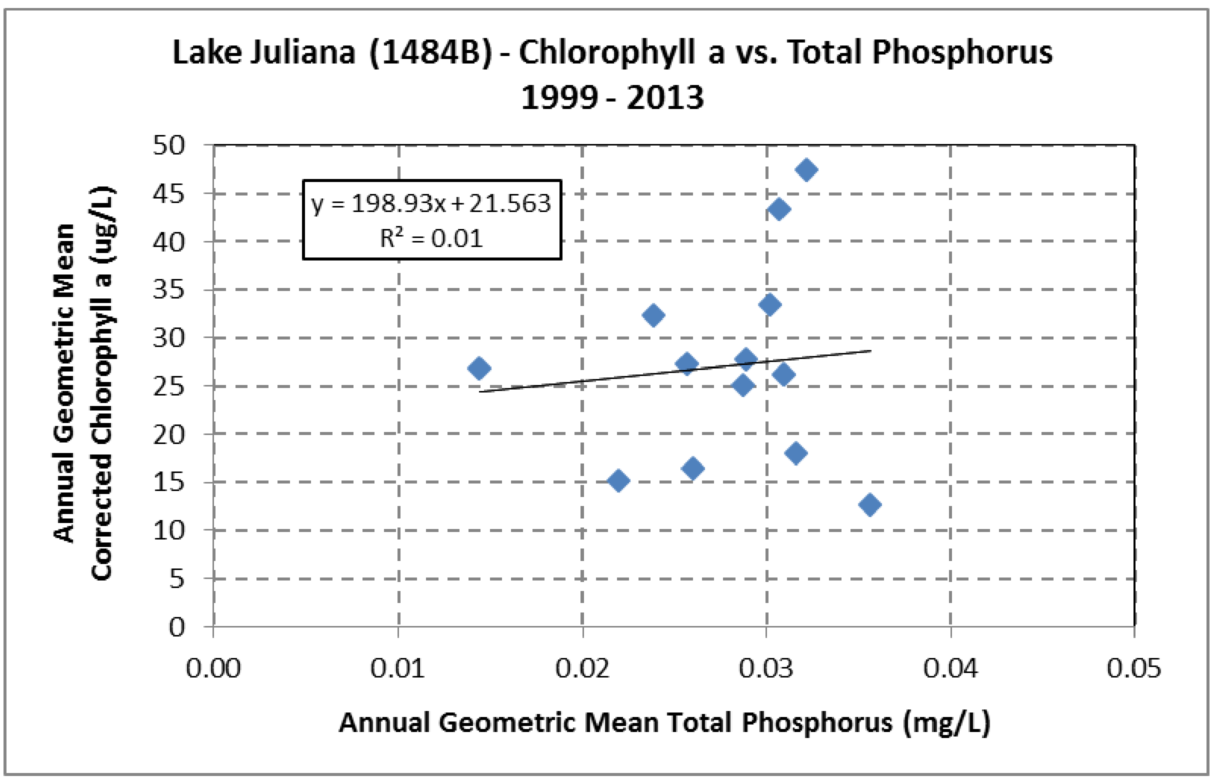

Figure 5.10. Relationship between AGMs of Chlorophyll *a* and TP in Lake Juliana

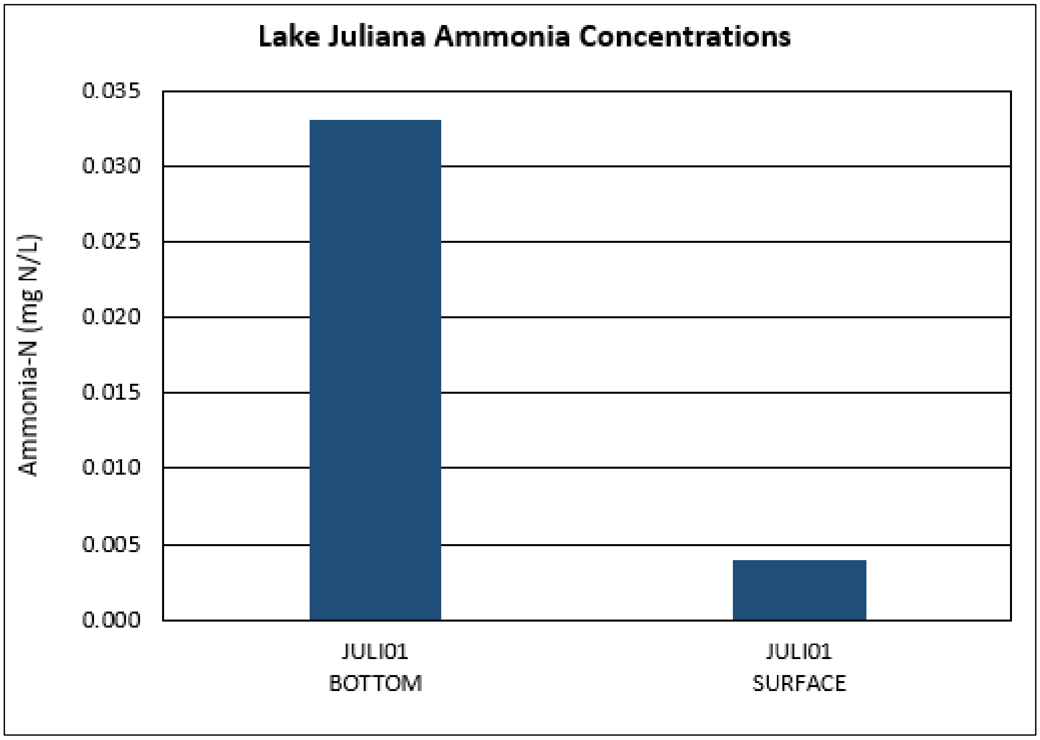

Figure 5.11. Lake Juliana Ammonia Concentrations Collected on August 5, 2014

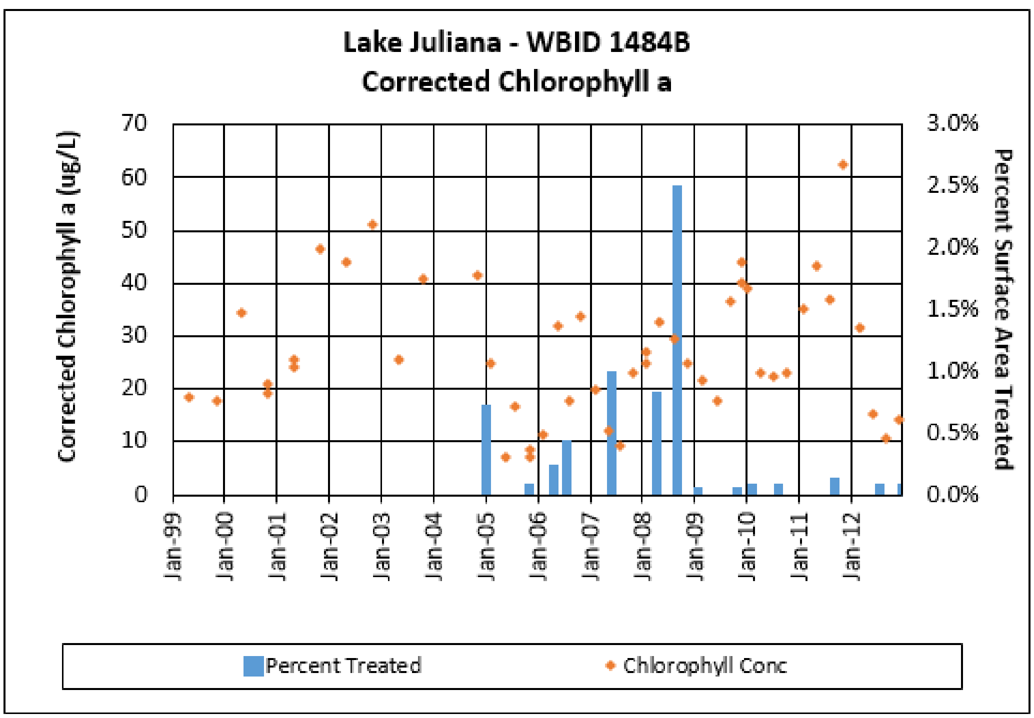

Figure 5.12. Lake Juliana Chlorophyll *a* Results and Lake Area Treated for Invasive Aquatic Plant Growth

5.3 TMDL Development Process

The method used for developing the nutrient TMDL is a percent reduction approach where the percent reduction in the existing lake TN concentration was calculated to meet the TN target. As discussed in **Chapter 3**, the NNC chlorophyll *a* threshold of 20 µg/L, expressed as an AGM, was selected as the response variable target for TMDL development. To identify the TN water quality target, the regression equation explaining the relationship between AGM chlorophyll *a* and TN (**Figure 5.9**) was used to determine the TN concentration necessary to meet the chlorophyll *a* target of 20 µg/L. A TN AGM of 1.03 mg/L results in a chlorophyll *a* AGM of 20 µg/L.

Based on an assessment of the lake results as presented in **Table 2.1**, the TP AGMs did not exceed the applicable NNC of 0.03 mg/L from 2007 to 2013. In the last three years, the geometric means were 0.02 mg/L. The available data indicate that the lake TP results are meeting the applicable NNC. Additionally, there is no relationship between chlorophyll *a* and TP AGM concentrations (**Figure 5.10**), suggesting that the existing TP condition is not a contributor to lake eutrophication. The available information indicates that the existing lake phosphorus concentrations are not having a detrimental effect on surface water quality and the applicable TP NNC is protective of the designated use; thus there is no need to develop a TMDL for TP.

Lake Juliana is expected to meet the applicable nutrient criteria and maintain its function and designated use as a Class III water when surface water TN concentrations are reduced to the target concentration, addressing the anthropogenic contributions to water quality impairment. The approach used to establish the nutrient target and the TMDL addresses meeting the chlorophyll *a* target, which is protective of the lake's designated use.

The existing lake nutrient conditions evaluated for establishing the TMDL were the TN concentrations measured from 2003 to 2013. This period includes the entire Cycle 2 verified period, from January 2003 to June 2010, and water quality in more recent years. The geometric means were calculated from TN results available in IWR Database Run 49. For the purpose of establishing the TMDL, the existing nutrient conditions used in the percent reduction calculation are the maximum TN AGM values in the 2003–13 period. The highest geometric mean value for TN, 1.72 mg/L, occurred in 2011 (**Table 5.2**). The use of the maximum geometric mean value in setting the TMDL is considered a conservative assumption for establishing reductions, as this will ensure that all exceedances of the nutrient targets are addressed.

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

$$\frac{[\text{existing nutrient condition} - \text{target}]}{\text{existing nutrient condition}} \times 100$$

The existing nutrient condition is the maximum TN AGM value. For the maximum TN value of 1.72 mg/L to achieve the target concentration of 1.03 mg/L, a 40% reduction in the lake TN concentration is necessary. The nutrient TMDL value is expressed as an AGM not to be exceeded in any one year. A 40% reduction of the TN concentration from the existing condition represents a general reduction of nitrogen inputs from all possible sources. Reductions needed from anthropogenic sources should be calculated during restoration plan development based on detailed input calculations from all the sources.

Table 5.2. Lake Juliana Nutrient AGMs Used To Calculate the Percent Reduction Needed To Meet the Water Quality Target

ID = Insufficient data to calculate geometric means per the requirements of Chapter 62-303, F.A.C.

YEAR	IWR RUN 49 TN AGM (MG/L)
2003	ID
2004	ID
2005	0.84
2006	0.82
2007	0.91
2008	1.31
2009	1.33
2010	1.35
2011	1.72
2012	0.97
2013	1.34
Maximum Geometric Mean	**1.72**

5.4 Critical Conditions

The estimated assimilative capacity is based on annual conditions, rather than critical/seasonal conditions because (1) the methodology used to determine the assimilative capacity does not lend itself very well to short-term assessments, (2) the department is generally more concerned with the net change in overall primary productivity in the segment, which is better addressed on an annual basis, and (3) the methodology used to determine impairment is based on annual conditions (AGMs or arithmetic means).

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

A TMDL can be 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) that takes into account any uncertainty about the relationship between effluent limitations and water quality.

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

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

It should be noted that the various components of the 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 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 a "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 is also different than 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 BMPs.

This approach is consistent with federal regulations (40 Code of Federal Regulations § 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 TMDL for Lake Juliana is expressed in terms of a nutrient concentration target and the percent reduction for nonpoint sources necessary to meet the target (**Table 6.1**), and represents the maximum lake TN concentration the surface water can assimilate to meet the applicable nutrient criteria. The TMDL will constitute the site-specific numeric interpretation of the narrative nutrient criterion set forth in Paragraph 62-302.530(47)(b), F.A.C., that will replace the otherwise applicable NNC in Subsection 62-302.531(2) for this particular water, when Paragraph 62-302.531(2)(a) F.A.C. becomes effective.

Table 6.1. TMDL Components for Lake Juliana

[1] Represents the AGM lake value not to be exceeded.
[2] As the TMDL represents a percent reduction, it also complies with EPA requirements to express the TMDL on a daily basis. The specified percent reduction represents the generally needed TN reduction from all sources.
NA = Not applicable

WBID	Parameter	TMDL (mg/L)[1]	WLA Wastewater (lbs/year)	WLA NPDES Stormwater (% Reduction)[2]	LA (% Reduction)[2]	MOS
1484B	TN	1.03	NA	40%	40%	Implicit

6.2 Load Allocation (LA)

A TN reduction of 40% is required from nonpoint sources. The percent reduction represents the generally needed total nitrogen reduction from all sources; including stormwater runoff, groundwater contributions, and septic tanks. 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 is expected to result in reduced sediment nutrient flux, which is considered a factor in the lake eutrophication. The percent reductions will contribute to achieving the in-lake chlorophyll *a* AGM target of 20 µg/L. It should be noted that the load allocation includes loading from stormwater discharges that are not part of the NPDES Stormwater Program.

6.3 Wasteload Allocation (WLA)

6.3.1 NPDES Wastewater Discharges

There are no NPDES wastewater facilities that discharge directly to Lake Juliana or its watershed. As such, a WLA for wastewater discharges is not applicable.

6.3.2 NPDES Stormwater Discharges

Polk County and co-permittees (FDOT District 1 and the city of Auburndale) are covered by a Phase I NPDES MS4 permit (FLS000015), and areas within their jurisdiction in the Lake Juliana watershed may be responsible for a 40% TN reduction in current anthropogenic loading. The percent reductions will contribute to achieving the in-lake chlorophyll *a* AGM target of 20 µg/L. 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 (MOS)

TMDLs must address uncertainty issues by incorporating an MOS into the analysis. 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 (Clean Water Act, Section 303[d][1][c]). Considerable uncertainty is usually inherent in estimating nutrient loading from nonpoint sources, as well as predicting water quality response. The effectiveness of management activities (*e.g.*, stormwater management plans) in reducing loading is also subject to uncertainty. 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 (Department February 2001), an implicit MOS was used in the development of the TMDL because of the conservative assumptions that were applied. The TMDL was developed using the highest TN AGM value to calculate the percent reduction and requiring the TMDL target not to be exceeded in any one year.

Chapter 7: NEXT STEPS: 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 that the permit holder prioritize and take action to address a TMDL unless the management actions are already defined in a BMAP. MS4 Phase II permit holders must also implement responsibilities defined in a BMAP.

7.2 BMAPs

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

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

BMAPs describe the management strategies that will be implemented, funding strategies, project tracking mechanisms, and water quality monitoring, as well as fair and equitable allocations of pollution reduction responsibilities to the sources in the watershed. BMAPs also identify mechanisms to address potential pollutant loading from future growth and development. The most important component of a BMAP is the list of management strategies to reduce the pollution sources, as these are the activities needed to implement the TMDL. The local entities that will conduct these management strategies are identified, and their responsibilities are enforceable. Management strategies may include wastewater treatment upgrades, stormwater improvements, and agricultural BMPs. Additional information about BMAPs is available online.

7.3 Implementation Considerations for Lake Juliana

In addition to addressing reductions in watershed pollutant contributions to impaired waters during the implementation phase, it may also be necessary to consider the impacts of internal sources (*e.g.*, sediment nutrient fluxes or the presence of nitrogen-fixing cyanobacteria) and the results of any associated remediation projects on surface water quality. In the case of Lake Juliana, the recent phytoplankton monitoring results and analysis of lake nutrient results suggest that other factors besides watershed loading inputs, such as sediment nutrient fluxes and/or nitrogen fixation, may also be influencing the lake nutrient budget and the growth of phytoplankton. Approaches for addressing these other factors should be included in a comprehensive management plan for the lake. Additionally, the current water quality and lake level monitoring of Lake Juliana and Lake Tennessee should continue and be expanded, as necessary, during the implementation phase to ensure that adequate information is available for tracking restoration progress.

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Appendices

Appendix A: Background Information on Federal and State Stormwater Programs

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs designed to achieve a specific level of treatment (*i.e.*, performance standards) as set forth in Chapter 62-40, F.A.C. In 1994, DEP's 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 (ERP) 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) 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 Clean Water Act 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," which includes eleven categories of industrial activity, construction activities disturbing 5 or more acres of land, and “large" and "medium" municipal separate storm sewer systems (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 throughout the 15 counties meeting the population criteria. The DEP received authorization to implement the NPDES stormwater program in October 2000. The DEP 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 area 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: Graphs of Surface Water Quality Results

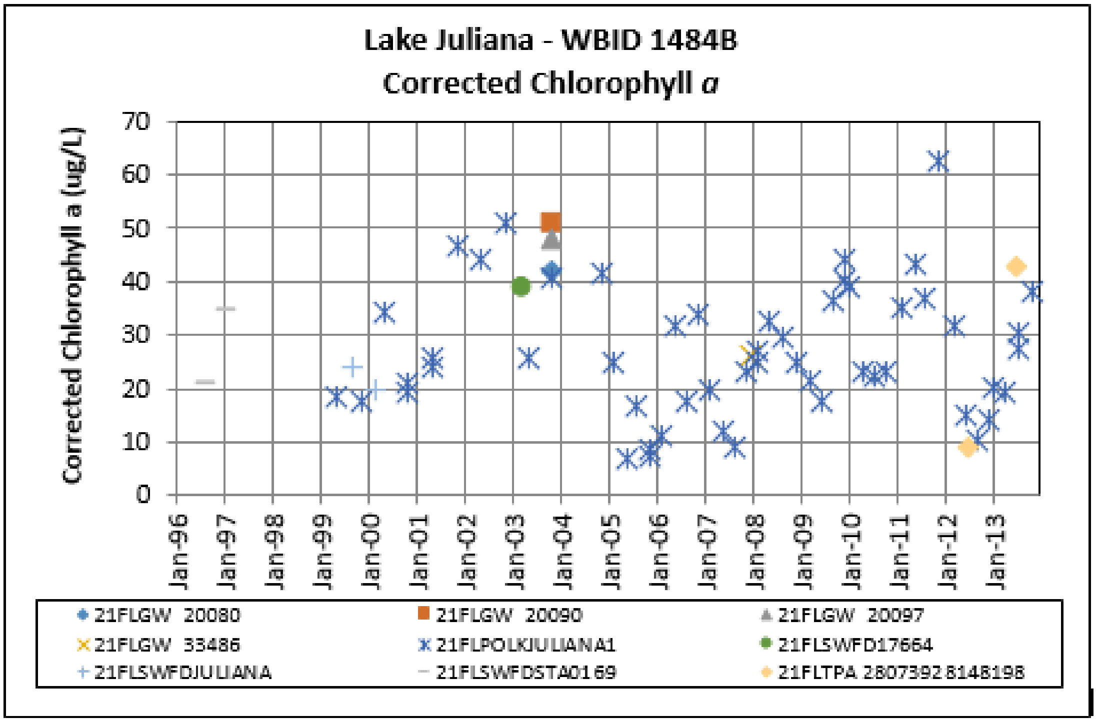

Figure B-1. Lake Juliana Corrected Chlorophyll *a* Results for Period of Record

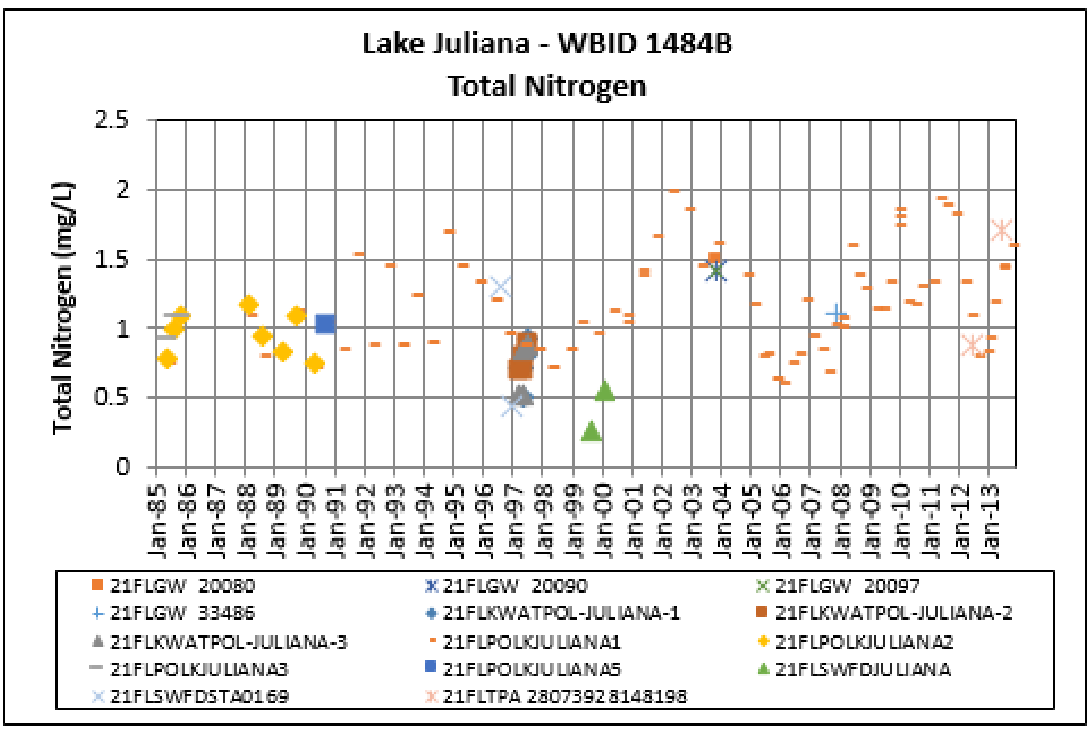

Figure B-2. Lake Juliana TN Results for Period of Record

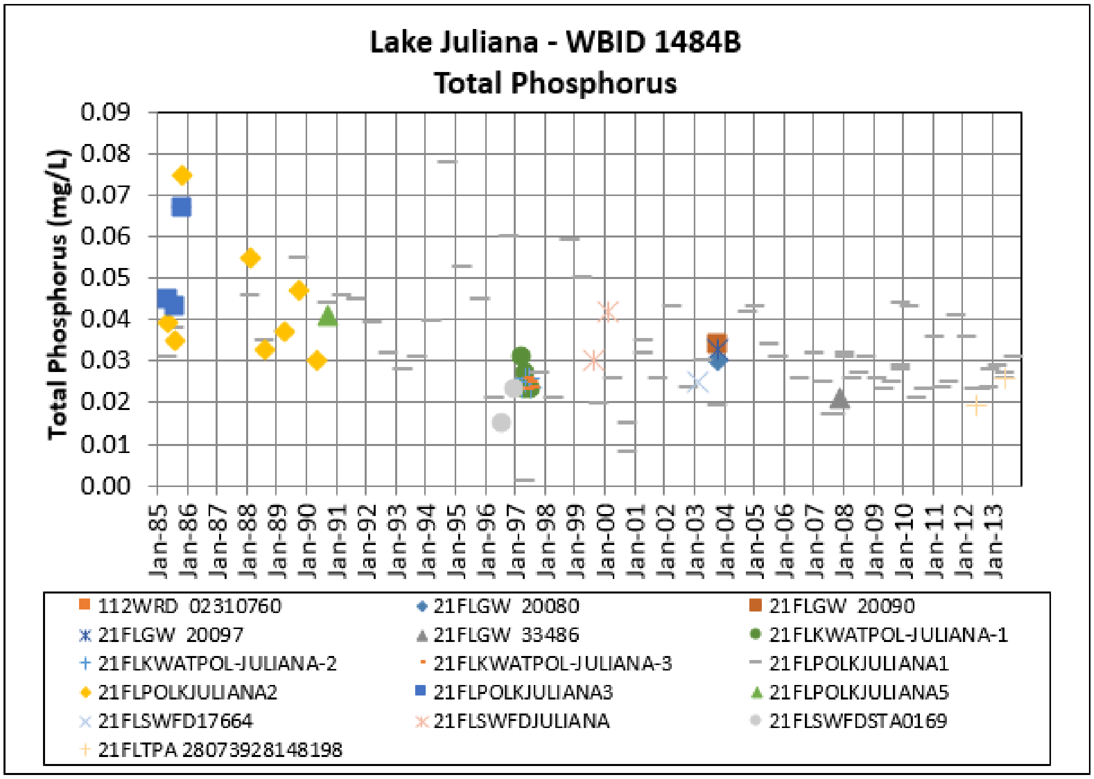

Figure B-3. Lake Juliana TP Results for Period of Record

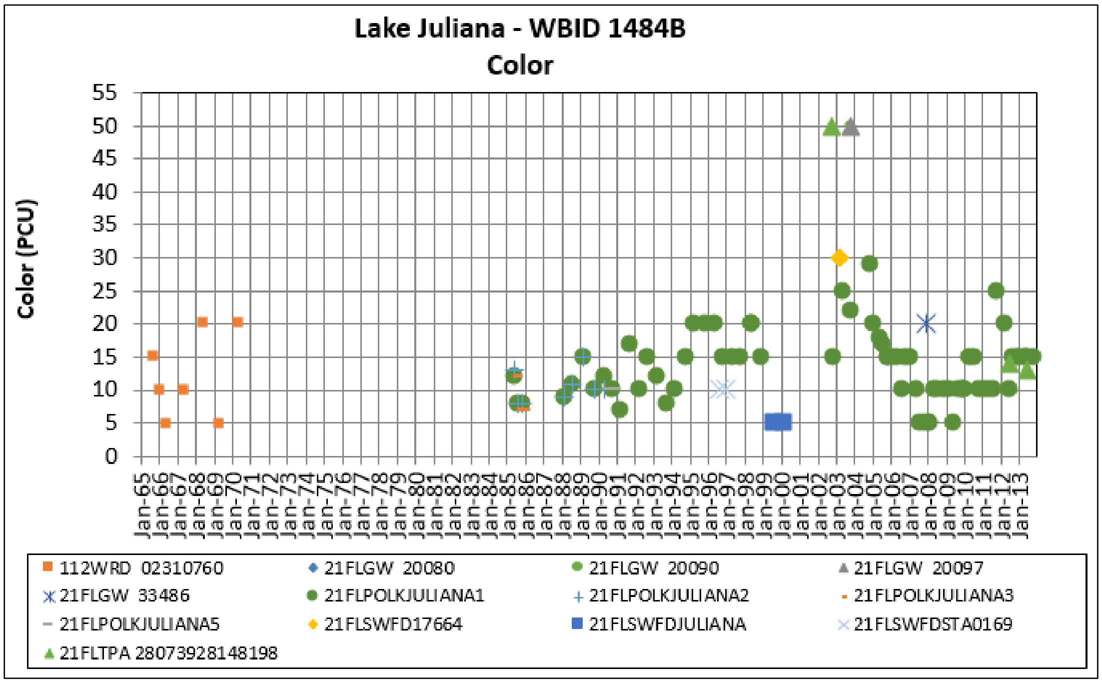

Figure B-4. Lake Juliana Color Results for Period of Record

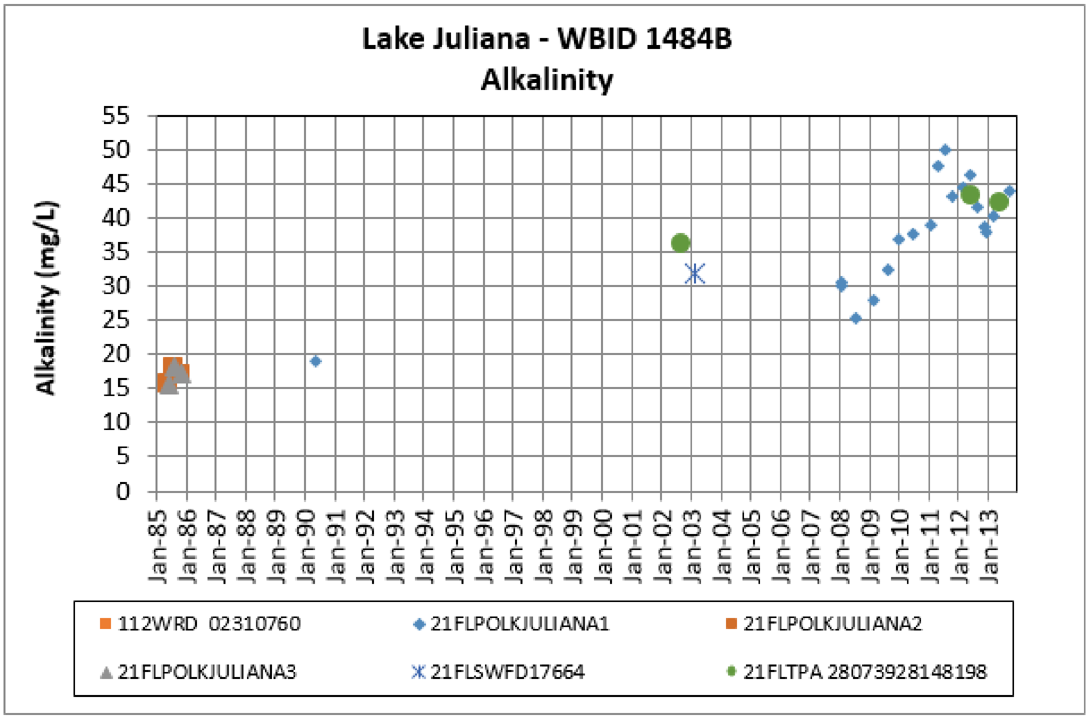

Figure B-5. Lake Juliana Alkalinity Results for Period of Record

Appendix C: Lake Juliana and Lake Tennessee Phytoplankton Results (August 2014)

Table C-1. Lake Juliana Phytoplankton Results (August 5, 2014)

- = Empty cell/no data
N/A = Not applicable

Phylum	Class	Order	Family	Genus	Taxon Name	(# cells/mL)	Phylum (%)
Bacillariophyta	Bacillariophyta	Bacillariophyta	Bacillariophyta	Bacillariophyta	*Bacillariophyta*	805	0.3%
Chlorophycota	Chlorophyceae	Chlorococcales	Chlorococcaceae	Chlorococcum	*Chlorococcum humicola*	161	-
Chlorophycota	Chlorophyceae	Chlorococcales	Chlorococcaceae	Schroederia	*Schroederia judayi*	161	-
Chlorophycota	Chlorophyceae	Chlorococcales	Chlorococcaceae	Tetraedron	*Tetraedron muticum*	161	-
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Chlorella	*Chlorella*	323	-
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Ankistrodesmus	*Ankistrodesmus falcatus*	645	-
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Crucigenia	*Crucigenia tetrapedia*	645	-
Chlorophycota	Chlorophyceae	Klebsormidiales	Elakatotrichaceae	Elakatothrix	*Elakatothrix gelatinosa*	645	-
Chlorophycota	Chlorophyceae	Tetrasporales	Palmellaceae	Sphaerocystis	*Sphaerocystis*	1,129	1.5%
Cryptophycophyta	Cryptophyceae	Cryptomonadales	Cryptomonadaceae	Chroomonas	*Chroomonas*	161	0.1%
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Pseudanabaena	*Pseudanabaena acicularis*	484	-
Cyanophycota	Cyanophyceae	Oscillatoriales	Phormidiaceae	Phormidium	*Phormidium*	968	-
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Limnothrix	*Limnothrix vacuolifera*	1,290	-
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Planktolyngbya	*Planktolyngbya contorta*	1,451	-
Cyanophycota	Cyanophyceae	Chroococcales	Merismopediaceae	Merismopedia	*Merismopedia warmingiana*	5,161	-
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Pseudanabaena	*Pseudanabaena biceps*	5,322	-
Cyanophycota	Cyanophyceae	Chroococcales	Merismopediaceae	Merismopedia	*Merismopedia tenuissima*	7,741	-
Cyanophycota	Cyanophyceae	Nostocales	Nostocaceae	Cylindrospermopsis	*Cylindrospermopsis raciborskii*	10,644	-
Cyanophycota	Cyanophyceae	Chroococcales	Chroococcaceae	Synechocystis	*Synechocystis*	10,966	-
Cyanophycota	Cyanophyceae	Chroococcales	Merismopediaceae	Aphanocapsa	*Aphanocapsa*	20,965	-
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Jaaginema	*Jaaginema gracile*	24,029	-
Cyanophycota	Cyanophyceae	Chroococcales	Merismopediaceae	Aphanocapsa	*Aphanocapsa delicatissima*	32,254	-
Cyanophycota	Cyanophyceae	Nostocales	Nostocaceae	Cylindrospermopsis	*Cylindrospermopsis catemaco*	50,155	-
Cyanophycota	Cyanophyceae	Chroococcales	Microcystaceae	Microcystis	*Microcystis*	82,248	98.1%
Pyrrophycophyta	Dinophyceae	Peridiniales	Glenodiniaceae	Glenodinium	*Glenodinium*	161	0.1%
					Total # cells/mL	**258,675**	**100.0%**

Table C-2. Lake Tennessee Phytoplankton Results, August 4, 2014

- = Empty cell/no data

PHYLUM	CLASS	ORDER	FAMILY	GENUS	TAXON NAME	(# CELLS/ML)	PHYLUM (%)
Bacillariophyta	Bacillariophyta	Bacillariophyta	Bacillariophyta	Bacillariophyta	*Bacillariophyta*	90	2.3%
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Chlorella	*Chlorella*	3	-
Chlorophycota	Chlorophyceae	Chlorococcales	Chlorococcaceae	Schroederia	*Schroederia judayi*	3	-
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Selenastrum	*Selenastrum*	3	-
Chlorophycota	Chlorophyceae	Chlorococcales	Chlorococcaceae	Tetraedron	*Tetraedron caudatum*	3	-
Chlorophycota	Chlorophyceae	Chlorococcales	Chlorococcaceae	Tetraedron	*Tetraedron gracile*	3	-
Chlorophycota	Chlorophyceae	Zygnematales	Desmidiaceae	Closterium	*Closterium acutum variabile*	6	-
Chlorophycota	Chlorophyceae	Zygnematales	Zygnemataceae	Staurodesmus	*Staurastrum cuspidatum*	6	-
Chlorophycota	Chlorophyceae	Chlorococcales	Chlorococcaceae	Tetraedron	*Tetraedron minimum*	6	-
Chlorophycota	Chlorophyceae	Chlorococcales	Characiaceae	Characium	*Characium rostratum*	9	-
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Scenedesmus	*Scenedesmus bijuga*	9	-
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Crucigenia	*Crucigenia tetrapedia*	13	-
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Scenedesmus	*Scenedesmus quadricauda*	13	-
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Oonephris	*Nephrocytium obesum*	13	-
Chlorophycota	Chlorophyceae	Zygnematales	Desmidiaceae	Staurastrum	*Staurastrum sexangulare*	13	-
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Nephrocytium	*Nephrocytium*	19	-
Chlorophycota	Chlorophyceae	Klebsormidiales	Elakatotrichaceae	Elakatothrix	*Elakatothrix*	25	-
Chlorophycota	Chlorophyceae	Zygnematales	Desmidiaceae	Staurastrum	*Staurastrum*	50	-
Chlorophycota	Chlorophyceae	Klebsormidiales	Elakatotrichaceae	Elakatothrix	*Elakatothrix gelatinosa*	63	-
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Oocystis	*Oocystis*	275	-
Chlorophycota	Chlorophyceae	Tetrasporales	Palmellaceae	Sphaerocystis	*Sphaerocystis*	635	-
Chlorophycota	Chlorophyceae	Chlorococcales	Dictyosphaeriaceae	Botryococcus	*Botryococcus braunii*	844	51.8%
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Pseudanabaena	*Pseudanabaena mucicola*	9	-
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Planktolyngbya	*Planktolyngbya lacustris*	16	-
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Jaaginema	*Jaaginema gracile*	25	-
Cyanophycota	Cyanophyceae	Chroococcales	Chroococcaceae	Synechocystis	*Synechocystis*	28	-
Cyanophycota	Cyanophyceae	Chroococcales	Chroococcaceae	Chroococcus	*Chroococcus*	31	-
Cyanophycota	Cyanophyceae	Chroococcales	Chroococcaceae	Chroococcus	*Chroococcus minutus*	31	-
Cyanophycota	Cyanophyceae	Nostocales	Nostocaceae	Anabaena	*Anabaena*	38	-
Cyanophycota	Cyanophyceae	Chroococcales	Chroococcaceae	Chroococcus	*Chroococcus turgidus*	50	-
Cyanophycota	Cyanophyceae	Chroococcales	Merismopediaceae	Aphanocapsa	*Aphanocapsa delicatissima*	250	-
Cyanophycota	Cyanophyceae	Chroococcales	Microcystaceae	Microcystis	*Microcystis*	375	-
Cyanophycota	Cyanophyceae	Chroococcales	Microcystaceae	Microcystis	*Microcystis firma*	625	38.0%

PHYLUM	CLASS	ORDER	FAMILY	GENUS	TAXON NAME	(# CELLS/ML)	PHYLUM (%)
Pyrrophycophyta	Dinophyceae	Peridiniales	Glenodiniaceae	Glenodinium	*Glenodinium*	19	-
Pyrrophycophyta	Dinophyceae	Peridiniales	Glenodiniaceae	Glenodinium	*Glenodinium*	19	-
Pyrrophycophyta	Dinophyceae	Peridiniales	Protoperidiniaceae	Protoperidinium	*Protoperidinium*	266	7.8%
Xanthophyta	Xanthophyceae	Mischococcales	Centritractaceae	Centritractus	*Centritractus belanophorus*	3	0.1%
					Total # cells/mL	**3,889**	**100%**

Appendix D: Lake Juliana and Lake Tennessee Survey Results (August 2014)

Table D-1. Water Quality Results from Lake Juliana (August 5) and Lake Tennessee (August 4)

- = Empty cell/no data
A - Value reported is the arithmetic mean (average) of two or more determinations.
I - The reported value is greater than or equal to the laboratory method detection limit but less than the laboratory practical quantitation limit.
U - Indicates that the compound was analyzed for but not detected.
SU = Standard units
m = Meters
µmhos/cm = Micromhos per centimeter
TDS = Total dissolved solids
TSS = Total suspended solids
NTU = Nephelometric turbidity units

Parameter	JULI01 Surface Results	JULI01 Surface Qualifier Code	JULI01 Bottom Results	JULI01 Bottom Qualifier Code	TENN01 Surface Results	TENN01 Surface Qualifier Code	TENN01 Bottom Results	TENN01 Bottom Qualifier Code
Alkalinity (mg $CaCO_3$/L)	48	-	50	A	20	-	21	-
Ammonia-N (mg N/L)	0.004	I	0.033	-	0.003	I	0.003	I
BOD 5 Day, N-Inhib (mg/L)	2.4	-	2.1	-	0.7	I	1.7	I
Calcium (mg/L)	16.5	-	16.8	-	9.65	-	9.6	-
Chloride (mg Cl/L)	39	-	38	-	29	-	29	-
Chlorophyll *a*, Corrected (µg/L)	35	-	38	-	5.5	-	13	-
Color - true (PCU)	13	-	12	-	8.2	-	8.2	-
DO (mg/L)	6.3	-	0.66	-	7.86	-	7	-
Fluoride (mg F/L)	0.28	-	0.27	-	0.23	-	0.23	-
Kjeldahl Nitrogen (mg N/L)	1.5	-	1.6	-	0.54	-	0.57	-
Magnesium (mg/L)	12.9	-	13	-	9.49	-	9.59	-
NO_2NO_3-N (mg N/L)	0.004	U	0.004	U	0.004	U	0.004	U
O-Phosphate-P (mg P/L)	0.004	U	0.004	U	0.004	U	0.004	U
Organic Carbon (mg C/L)	11	-	11	-	5.3	-	5.4	-
pH (SU)	7.89	-	6.88	-	7.99	-	7.28	-
Phaeophytin-a (µg/L)	1.7	I	2.7	-	0.76	I	3.1	-
Potassium (mg/L)	10.3	-	10.3	-	5.7	-	5.7	-
Sample Depth (m)	0.3	-	4.3	-	0.46	-	3.35	-
Sodium (mg/L)	19.2	-	19.2	-	15.8	-	15.8	-
Specific Conductance (µmhos/cm)	317	-	321	-	235	-	234	-
Sulfate (mg SO_4/L)	35	-	35	-	36	-	36	-
TDS (mg/L)	207	-	200	-	141	A	143	-
Temperature (^{o}C)	30.46	-	29.7	-	31.81	-	31.59	-
Total-P (mg P/L)	0.021	-	0.022	-	0.014	-	0.019	-
TSS (mg/L)	8	I	8	I	3	I	4	I
Turbidity (NTU)	7	-	8.8	A	1.3	-	1.8	-

Table D-2. Sediment Grain Size and Percent Organic Material Results from Lake Juliana (collected August 5) and Lake Tennessee (collected August 4)

- = Empty cell/no data
K - Actual value is known to be less than the value given.

Parameter	JULI01 Results	JULI01 Qualifier Code	TENN01 Results	TENN01 Qualifier Code
Sediment percent Organic	28%	-	34%	-
Sediment Particle Size, percent, <0.063 mm	23%	-	38%	-
Sediment Particle Size, percent, 0.063-0.125mm	25.4%	-	26%	-
Sediment Particle Size, percent, 0.125-0.25 mm	16.2%	-	23.1%	-
Sediment Particle Size, percent, 0.25-0.5 mm	6.14%	-	10.1%	-
Sediment Particle Size, percent, 0.5-2.0 mm	29.3%	-	2.84%	-
Sediment Particle Size, percent, >2.0 mm	1.2%	-	1%	K

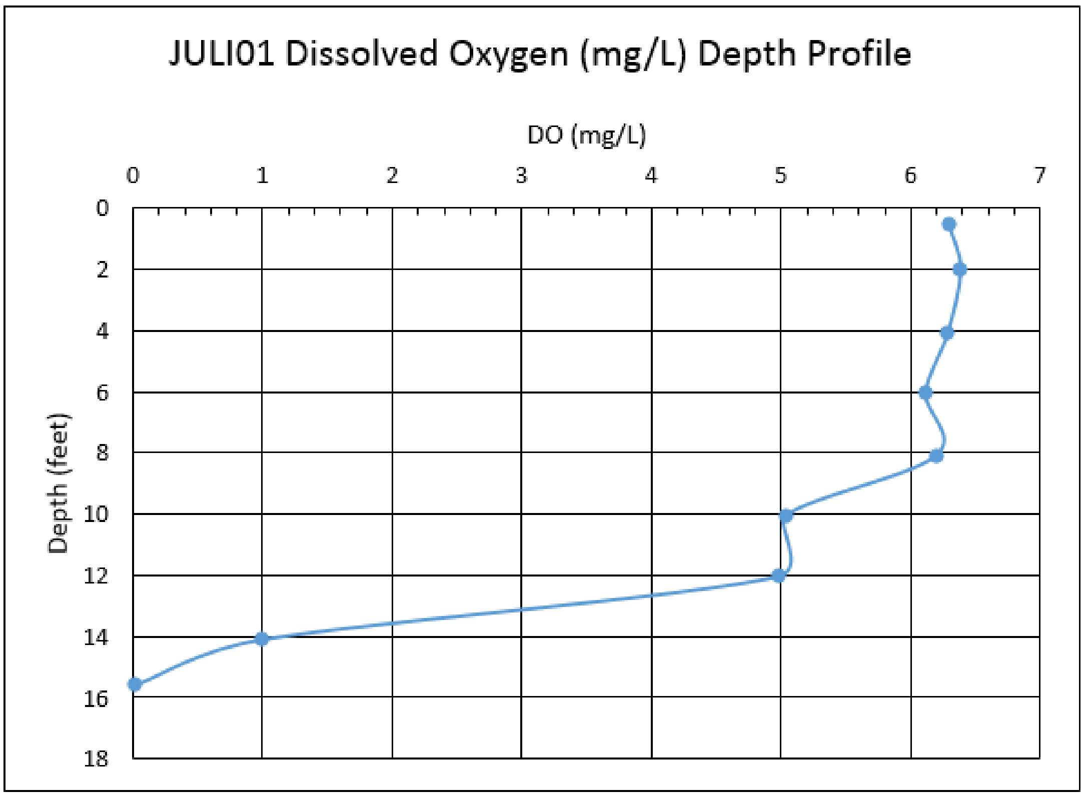

Figure D-1. Depth Profile for DO (mg/L) at JULI01

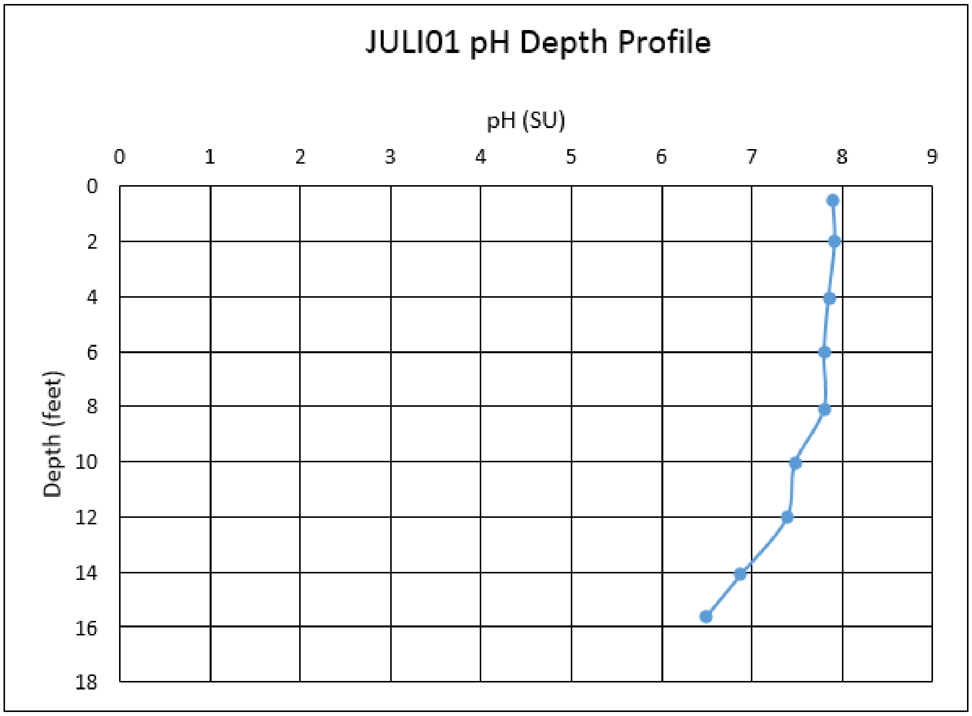

Figure D-2. Depth Profile for pH at JULI01

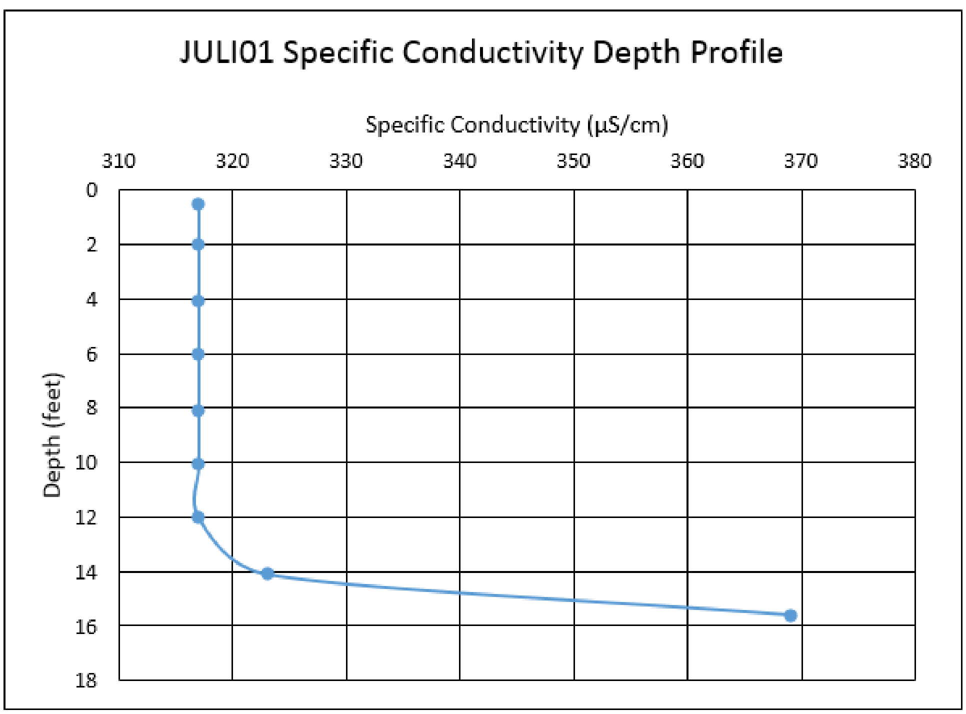

Figure D-3. Depth Profile for Specific Conductivity at JULI01

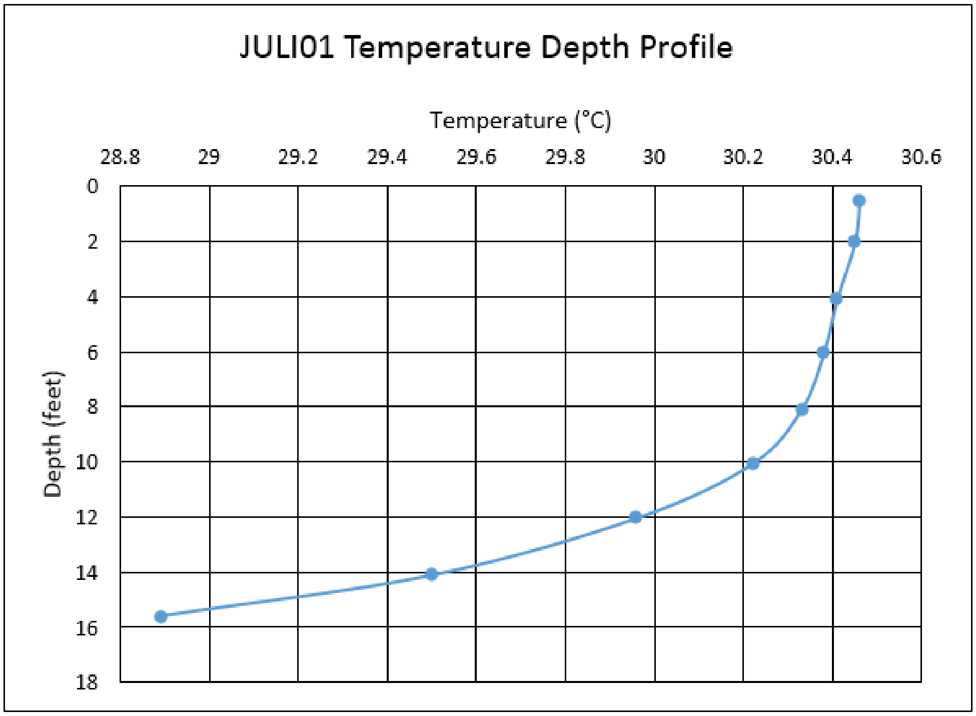

Figure D-4. Depth Profile for Temperature at JULI01

Appendix E: Water Quality Standards Template Document

Table E-1. Spatial Extent of the Numeric Interpretation of the Narrative Nutrient Criterion

— ***Documents location and descriptive information***

LOCATION	DESCRIPTION
Waterbody Name	Lake Juliana
Waterbody Type(s)	Lake
Waterbody ID (WBID)	WBID 1484B (see **Figure E-1**)
Description	Lake Juliana is located inside Auburndale, Polk County, Florida. The estimated surface area of Lake Juliana is 924 acres and the average depth is 12 feet (3.7 meters) with a maximum depth of 19 feet (5.8 meters). The normal pool topographic elevation of the water surface is 129.5 feet NGVD (NGVD29) (Polk County Wateratlas 2014). Lake Juliana has an inlet on the western shore of the lake that receives flow from a canal which drains primarily low-density residential areas. An outlet canal on the eastern side of the lake discharges to Lake Mattie.
Specific Location (Latitude/Longitude or River Miles)	The center of Lake Juliana is located at N: 28^0 7’ 44”/ W: -81^0 48’ 10”. The site-specific criteria apply as a spatial average for the lake, as defined by WBID 1484B.
Map	**Figure E-1** shows the general location of Lake Juliana and its watershed, and **Figure E-2** shows the land uses in the watershed. Land use is predominantly urban, comprising 36% of the area. Low-density residential is the largest urban use type, covering about 18% of the basin, followed by medium-density residential, which covers about 9% of the area. Surface waters cover 35% of the watershed area. Agricultural land, primarily located in the western and southern portions of the watershed, includes nurseries and vineyards, tree crops, cropland, and pastureland, and encompasses 20% of the watershed area. Wetlands cover almost 7% of the watershed and are primarily located along the northern and southern shoreline of Lake Juliana, and in the western portion of the watershed.
Classification(s)	Class III Freshwater
Basin Name (Hydrologic Unit Code [HUC] 8)	Withlacoochee Basin (03100208)

Table E-2. Description of the Numeric Interpretation of the Narrative Nutrient Criterion

— ***Provides specific list of parameters/constituents for which revised water quality criteria are being adopted.***

— ***Provides sufficient detail on magnitude, duration, and frequency to ensure criteria can be used to verify impairment or delisting in the future.***

— ***Indicates how criteria developed are spatially and temporally representative of the waterbody or critical condition.***

NNC	Description
NNC summary: Default nutrient watershed region or lake classification (if applicable) and corresponding NNC	Lake Juliana is low color (≤ 40 PCU) and high alkalinity (> 20 mg/L $CaCO_3$). The generally applicable NNC, which are expressed as AGM concentrations not to be exceeded more than once in any consecutive three-year period, are chlorophyll *a* of 20 µg/L, TN of 1.05 – 1.91 mg/L, and TP of 0.03 – 0.09 mg/L.
Proposed TN, TP, chlorophyll *a*, and/or nitrate+nitrite (magnitude, duration, and frequency)	Numeric interpretations of the narrative nutrient criterion: TN = 1.03 mg/L, expressed as an AGM lake concentration 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 is protective of the designated use, is achieved.
Period of record used to develop the numeric interpretations of the narrative nutrient criterion for TN and TP	The criterion is based on the application of an empirical model developed using data from the 1999–2013 period. The primary dataset for this period is the IWR Run 49 database.
Indicate how criteria developed are spatially and temporally representative of the waterbody or critical condition. **Are the stations used representative of the entire extent of the WBID and where the criteria are applied? In addition, for older TMDLs, an explanation of the representativeness of the data period is needed (*e.g.*, have additional data or information become available since the TMDL analysis?). These details are critical to demonstrate why the resulting criteria will be protective as opposed to the otherwise applicable criteria (in cases where the numeric criterion is otherwise in effect, unlike this case).**	The water quality results applied in the analysis spanned the 1999–2013 period, which included both wet and dry years. The annual average rainfall for 1999–2013 was 45.25 inches/year. The years 2000, 2006, 2007, and 2013 were dry, 1999 and 2008–10 were average, and 2002–05 and 2011 were wet. **Figure E-3** shows the sampling stations in Lake Juliana. The Polk County data collected near the center of the lake at Station 21FLPOLKJULIANA1 were used to develop the regression equations relating nutrient concentrations to chlorophyll *a* levels. The majority of data were collected at this Polk County monitoring station; results collected at other lake sampling locations were similar to the results observed here. The graphs in **Appendix B** of this report present water quality data for variables relevant to TMDL development.

Table E-3. Summary of How the Designated Use(s) Are Demonstrated To Be Protected by the Criteria

— ***Summarizes the review associated with the more recent data collected since the development of the TMDL.***

— ***Evaluates the current relevance of assumptions made in the TMDL development (most likely applicable to existing TMDLs that are subsequently submitted as changes to water quality standards).***

— ***Contains sufficient data to establish and support the TMDL target concentrations or resulting loads***

DESIGNATED USE	DESCRIPTION
History of assessment of designated use support	Lake Juliana was initially verified as impaired for nutrients based on elevated annual average TSI values during the Cycle 2 verified period (the verified period for the Group 4 basins is January 2003 to June 2010). As a result, the lake was included on the Cycle 2 Verified List of impaired waters for the Withlacoochee River Basin adopted by Secretarial Order on November 2, 2010. Based on an analysis of the data from 2003 to 2013 in IWR Database Run 49, the results indicate that Lake Juliana would not attain the generally applicable lake NNC for chlorophyll *a* and TN for low-color, high-alkalinity lakes, and thus remains impaired for nutrients. An analysis of the TP results indicates that the default lake NNC for TP is attained.
Quantitative indicator(s) of use support	A chlorophyll *a* value of 20 µg/L was selected as the response variable target for use in establishing the nutrient TMDLs. This target is based on information in the department's 2012 document, *Technical Support Document: Development of Numeric Nutrient Criteria for Florida Lakes, Spring Vents, and Streams,* which demonstrates that a chlorophyll *a* threshold of 20 µg/L is protective of designated uses for low-color, high-alkalinity lakes. Based on the best available scientific information, there are no data suggesting that a chlorophyll *a* threshold different from 20 µg/L is necessary to protect the designated uses of Lake Juliana. The department determined that 20 µg/L was fully protective of these uses.
Summarize approach used to develop criteria and how it protects uses	The method utilized to address the nutrient impairment is a regression equation that relates lake TN concentrations to the AGM chlorophyll *a* levels. The criterion is expressed as a maximum AGM concentration 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 is protective of the designated use, is achieved.
Discuss how the TMDL will ensure that nutrient-related parameters are attained to demonstrate that the TMDL will not negatively impact other water quality criteria. These parameters must be analyzed with the appropriate frequency and duration. If compliance with 47(a) is not indicated within the TMDL, it should be made clear that further reductions may be required in the future.	The method indicated that the chlorophyll *a* concentration target for the lake will be attained at the TMDL in-lake TN concentration, frequency, and duration. The department notes that there were no impairments for nutrient-related parameters (such as DO or unionized ammonia). The proposed reductions in nutrient inputs will result in further improvements in water quality.

Table E-4. Documentation of the Means To Attain and Maintain Water Quality Standards in Downstream Waters

Downstream Protection and Monitoring	Description
Identification of downstream waters: List receiving waters and identify technical justification for concluding downstream waters are protected	An outlet canal on the eastern side of the lake discharges to Lake Mattie. Lake Mattie is classified as a high-color lake, and the chlorophyll *a* AGMs from 2004 to 2009 (IWR Run 49 database results) are less than the applicable chlorophyll *a* NNC threshold of 20 µg/L. Any inputs from Lake Juliana are not preventing Lake Mattie from attaining its designated use. The reductions in nutrient concentrations prescribed in the TMDL are not expected to cause nutrient impairments downstream and will result in water quality improvements to downstream waters.
Provide summary of existing monitoring and assessment related to implementation of Subsection 62-302.531(4), F.A.C., and trends tests in Chapter 62-303, F.A.C.	Polk County conducts routine monitoring of Lake Juliana approximately four times per year. Future monitoring results from Lake Juliana will be used to assess the effect of the established site-specific numeric interpretation of the narrative nutrient criterion for the lake.

Table E-5. Documentation To Demonstrate Administrative Requirements Are Met

Administrative Requirements	Description
Notice and comment notifications	DEP published a Notice of Rule Development of Rulemaking on April 6, 2015 to initiate TMDL development for impaired waters in the Withlacoochee Basin. A rule development public workshop for the TMDL was held on June 25, 2015
Hearing requirements and adoption format used; responsiveness summary	A public hearing will be held at a future date that will be noticed no less than 45 days prior to the hearing.
Official submittal to EPA for review and GC certification	If the department does not receive a challenge, the certification package for the rule will be prepared by the department's program attorney. At the same time, the department will prepare the TMDL and site-specific interpretation package for the TMDL and submit these documents to the EPA.

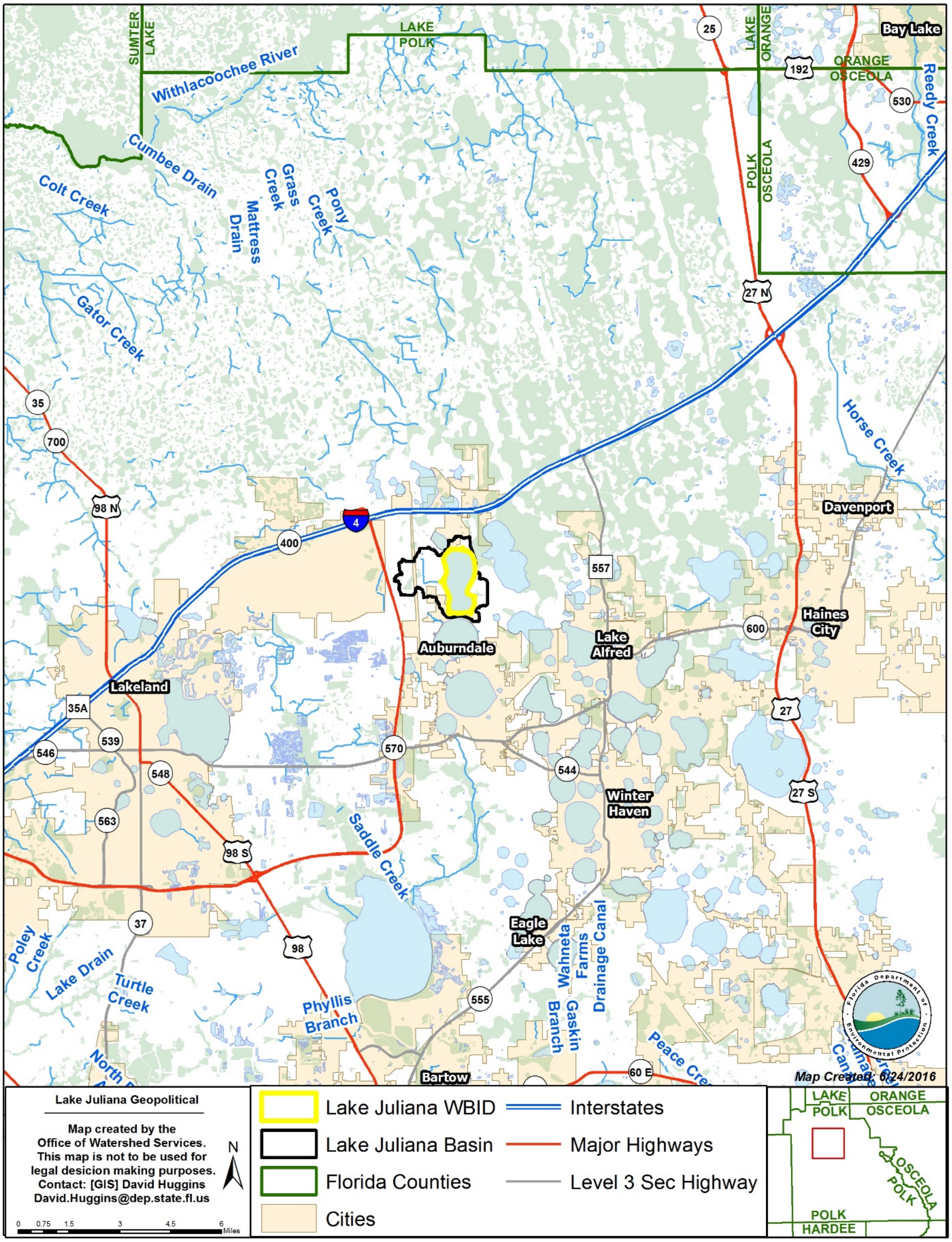

Figure E-1. Location of the Lake Juliana Watershed in North Central Polk County, Florida

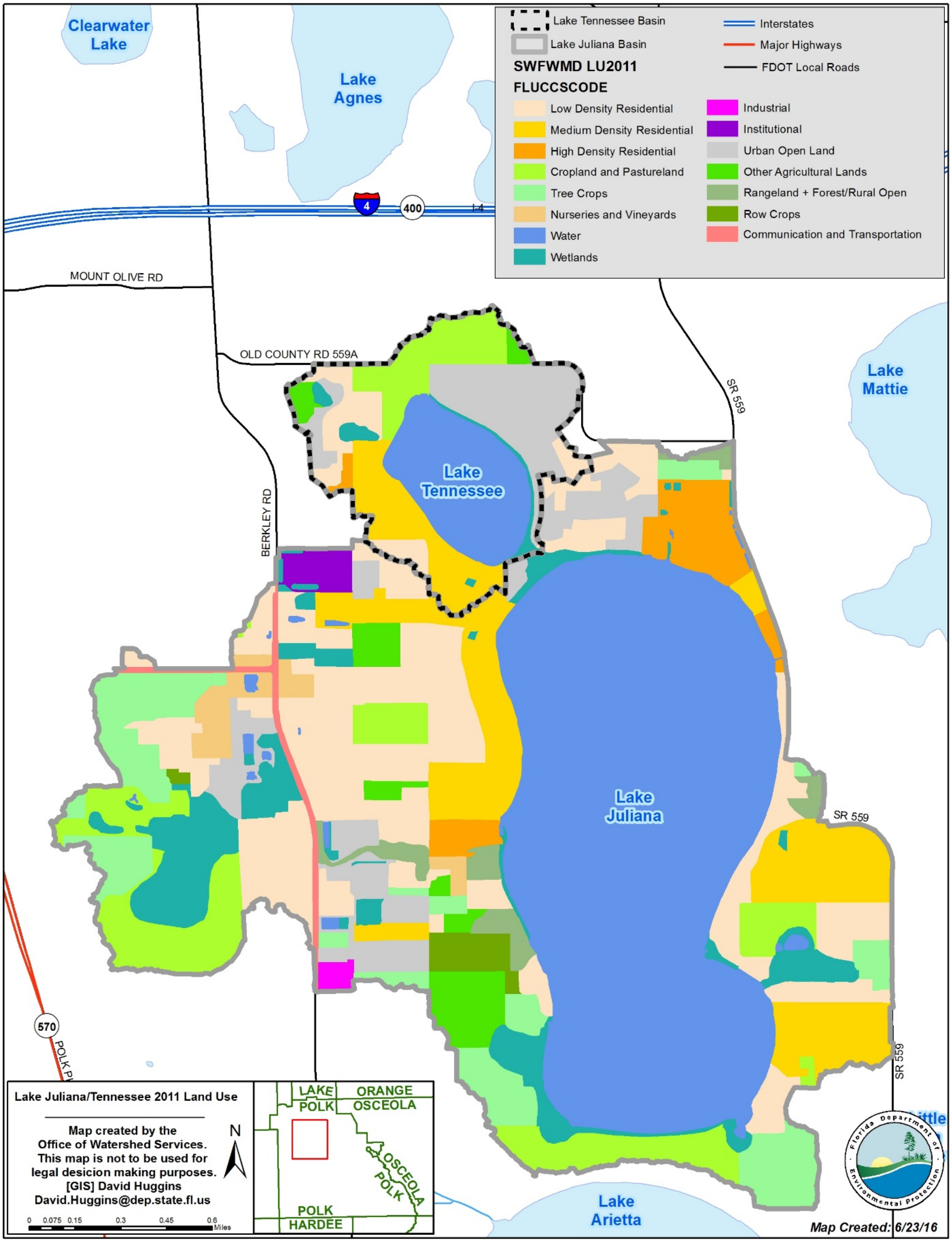

Figure E-2. Lake Juliana Contributing Area Land Use in 2011

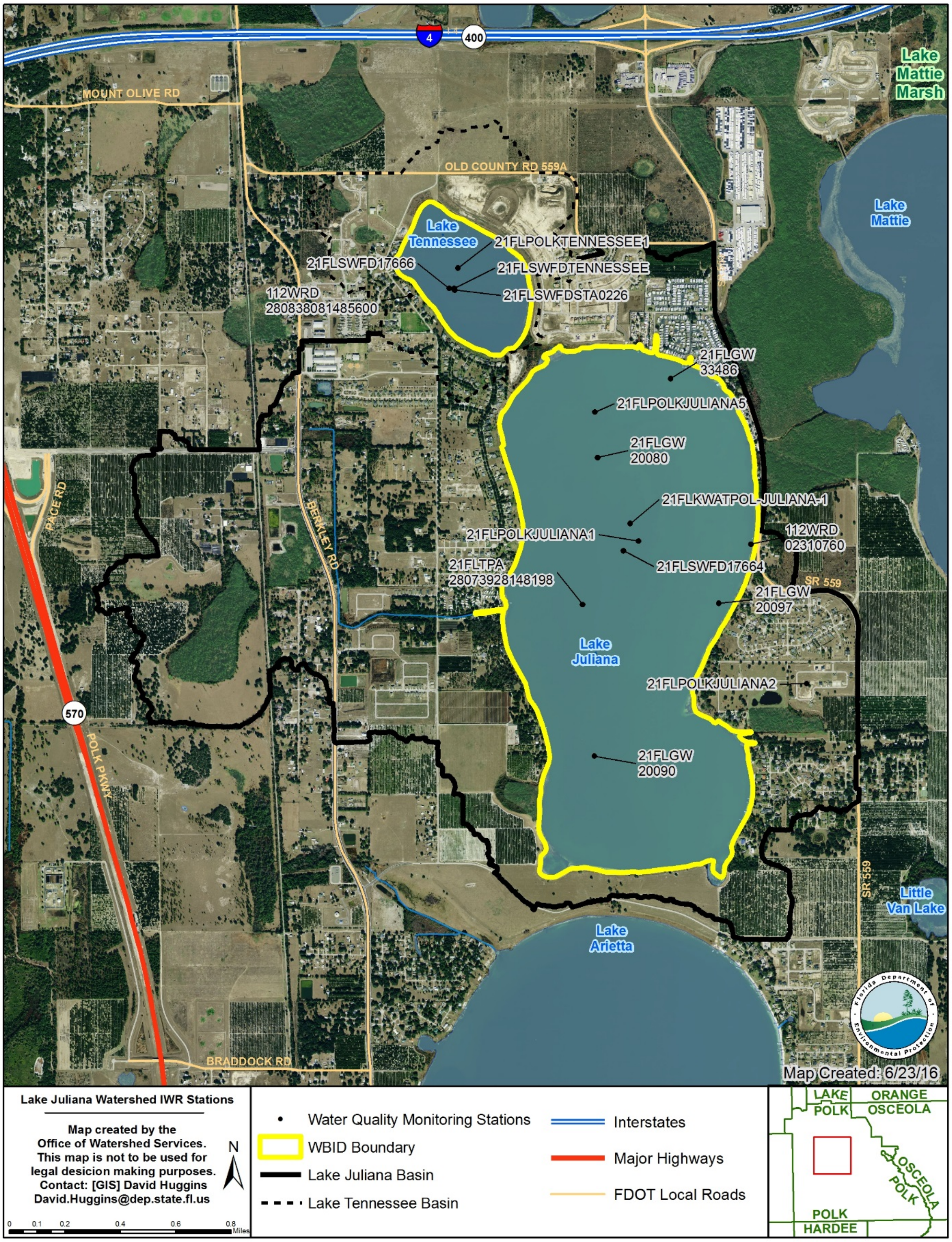

Figure E-3. Lake Juliana and Lake Tennessee Sampling Stations