FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration
Water Quality Evaluation and TMDL Program

SOUTHWEST DISTRICT • PEACE RIVER BASIN • UPPER PEACE RIVER PLANNING UNIT

Final TMDL Report

Nutrient TMDL For Lake Hollingsworth (WBID 1549X)

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

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Acknowledgments

This study could not have been accomplished without contributions from staff in the Florida Department of Environmental Protection's Southwest District Office and the Division of Environmental Assessment and Restoration Office of Watershed Services. The Department also recognizes the City of Lakeland and Polk County Natural Resource Division for their contributions towards understanding the issues, history, and processes at work in the Lake Hollingsworth watershed.

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Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Loads (TMDLs) developed to address the nutrient impairment of Lake Hollingsworth, which is located in the Upper Peace River Planning Unit, that is part of the larger Peace River Basin. The TMDLs will constitute the site specific numeric interpretation 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 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, Rule 62-303, F.A.C.) and was included on the Verified List of impaired waters for the Sarasota Bay – Peace River – Myakka River Group 3 Basin that was adopted by Secretarial Order on June 17, 2005.

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 Hollingsworth that would restore the waterbody so that it meets its applicable water quality criteria for nutrients

1.2 Identification of Waterbody

Lake Hollingsworth is located inside the city of Lakeland, Polk County, Florida, (**Figure 1.1**). The lake's watershed encompasses 2.5 square miles (1,612 acres) in west central Polk County. The lake's watershed includes Lake Morton, a natural lake with a surface area of 40 acres, and Lake Horney, a man-made lake created by the dredging of a natural willow wetland in the 1950s that has a surface area of 7 acres. The lake levels of both lakes are maintained by adjustable control structures and the outlets of each lake discharge to Lake Hollingsworth. The outlet for Lake Hollingsworth is connected to Lake Bentley, which flows into a series of lakes that drain to Lake Hancock. Lake Hancock discharges to lower Saddle Creek, which along with the Peace Creek Drainage Canal, makes up the headwaters of the Peace River. The estimated surface area of Lake Hollingsworth is 356 acres. The average lake volume is 3,001,061 m^3 ($7.93 * 10^8$ gallons). The average depth of the lake is 3.9 ft. (1.2 m), with a maximum depth of 14.2 ft. (4.3 m). The watershed area is within the Lakeland/Bone Valley Upland Lake Region (Region 75-30), which consists of areas covered by phosphatic sand or clayey sand (Griffith et al. 1997).

Urban land covers three-quarters of the watershed area, and the predominant land area is medium density residential development. Agricultural activity, that included citrus cultivation, began in the watershed around 1880 and the city of Lakeland incorporated the watershed by 1885. Residential development occurred on the lake's west shore by the 1930s and the lake received inputs of septic systems before domestic sewage treatment systems were installed (Riedinger-Whitmore et al. 2005).

The climate of the Lake Hollingsworth and Peace River watershed area is generally subtropical with an annual average temperature of about 73 degrees. Annual rainfall in or near the Peace River drainage basin averages 50 to 56 inches, and approximately 60 percent of the rainfall occurs from June through September (SWFWMD, 2004). The long-term average annual rainfall for Polk County, based on Southwest Florida Water Management District (SWFWMD) records in the period from 1915 to 2013, is about 52 inches/year.

For assessment purposes, the Department has divided the Peace River Basin into watershed assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or surface water segment. Lake Hollingsworth has been given the WBID number 1549X. **Figure 1.2** displays the location of the lake WBID with the major geopolitical and hydrologic features.

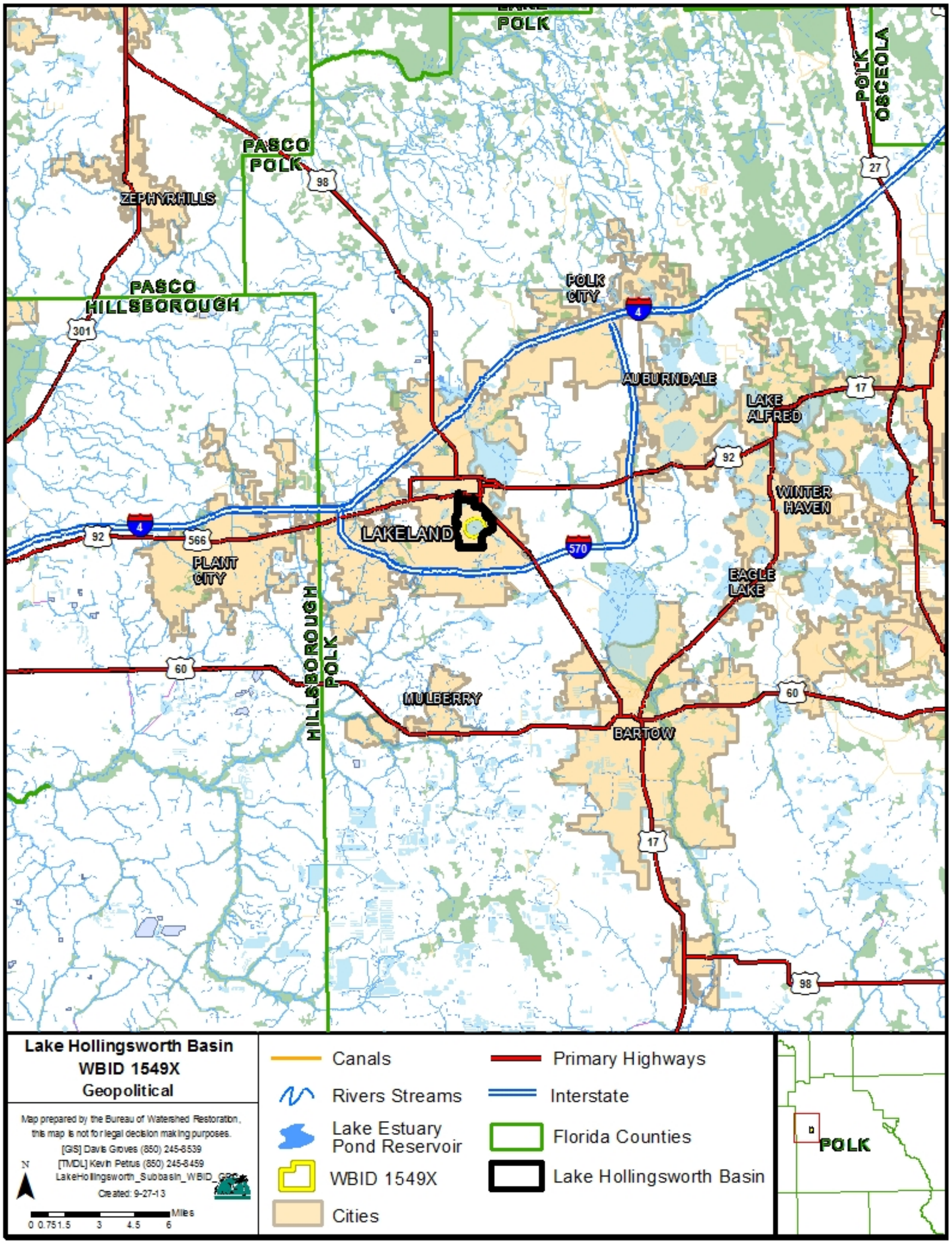

Figure 1.1 Location of the Lake Hollingsworth Basin and Major Geopolitical Features in West Central Polk County.

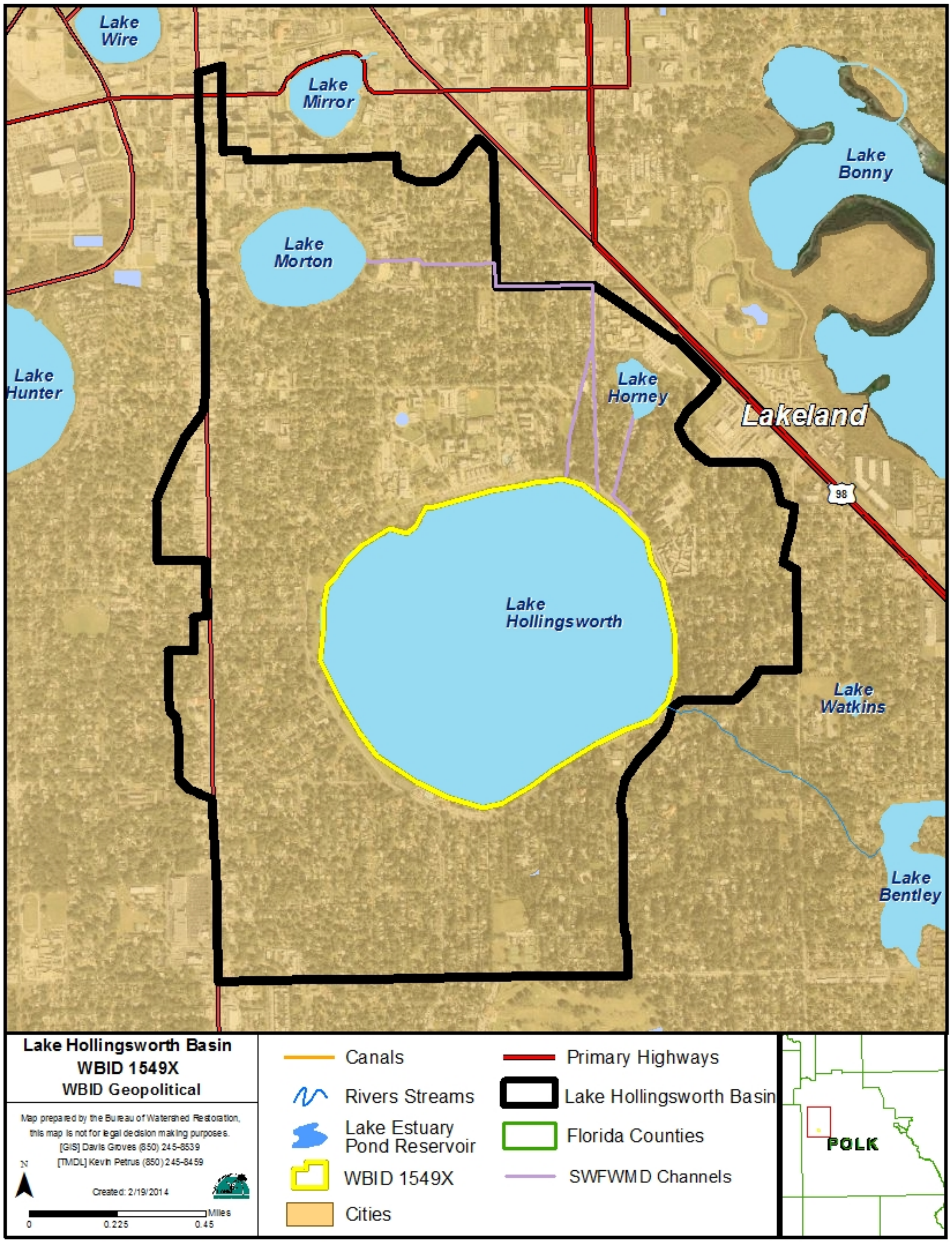

Figure 1.2 The Lake Hollingsworth Basin with Major Geopolitical and Hydrologic Features.

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 5-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 Hollingsworth. These activities will depend heavily on the active participation of the Southwest Florida Water Management District (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 U. S. 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 EPA for inclusion on the state's 303(d) list.

Florida's 1998 303(d) list included 51 waterbodies in the Peace River 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 Rule 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001; the rule was amended in 2006, 2007, 2012, and 2013.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in Lake Hollingsworth, and the lake was verified as impaired for nutrients based on elevated annual average Trophic State Index (TSI) values during the Cycle 1 verification period (the verified period for the Group 3 basins is from January 1997 to June 2004). At the time the Cycle 1 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*. Exceeding a TSI of 60 in any one year of the verified period was sufficient for identifying a lake as impaired for nutrients. All annual mean TSI values in the 1996 to 2002 period exceeded the impairment threshold of 60. In the more recent Cycle 2 verification period (January 2002 to June 2009), the annual mean TSI values continued to exceed the threshold of 60.

Florida adopted new numeric nutrient standards for lakes, spring vents, and streams in 2011, which were approved by the EPA in 2012. It is envisioned that these standards, in combination with the related bioassessment tools, will facilitate the assessment of designated use attainment for its waters and provide a better means to protect state waters from the adverse effects of nutrient over-enrichment. 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 values for chlorophyll a, TN, and TP, which are further described in Chapter 3.

Although the Department has not formally assessed the data for Lake Hollingsworth using the new NNC, based on an analysis of the data from 2002 to 2012 in IWR Database Run 48, the preliminary results indicate that Lake Hollingsworth would not attain the new lake NNC for chlorophyll a, TN, and TP for low color (< 40 PCU), high alkalinity (> 20 mg/L CaCO3) lakes, and thus remains impaired for nutrients. This time frame represents the Cycle 2 verification period and water quality in more recent years that has been reported. Under the new NNC, Lake Hollingsworth is classified as a lake with low color (<40 PCU) and high alkalinity (>20 mg/L CaCO3), based on the long-term geometric mean values for color and alkalinity. The preliminary annual geometric mean values for chlorophyll a, TN, and TP during the 2002 to 2012 period are presented in **Table 2.1**.

The sources of data for the Cycle 1 and Cycle 2 IWR assessments of WBID 1549X come from stations sampled by Polk County (21FLPOLK…), and Florida LakeWatch (21FLKWAT…). The majority of the available data comes from the monitoring conducted by Polk County. The county has been sampling at the center of the lake since 1984 at station 21FLPOLKHOLLINGSWORTH1. In 1999, the county began sampling at the center of the lake for corrected chlorophyll a, which is the more common form of chlorophyll a used in assessing surface water quality. The other sampling organizations conduct monitoring intermittently. The sampling locations are displayed in **Figure 2.1.** The individual water quality measurements used in this analysis are available in the IWR database (Run 48), and are available upon request. Water quality results for the period of record for variables relevant to this TMDL effort, which were collected by all sampling entities, are displayed in the graphs in **Appendix B**.

Table 2.1 Lake Hollingsworth Annual Geometric Mean Values for the 2002 to 2012 Period.

Year	Chlorophyll a (ug/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
2002	74	1.81	0.1
2003	52	1.48	0.07
2004	24	1.07	0.04
2005	56	1.77	ID
2006	67	2	ID
2007	69	1.79	0.07
2008	54	1.54	0.07
2009	48	1.64	0.07
2010	ID	ID	ID
2011	79	2.56	0.11
2012	104	2.66	0.09

ID - Insufficient Data to Calculate Geometric Means per the Requirements of Rule 62-303.

Note: Values shown shaded are greater than the new NNC for lakes. Rule 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.

In Florida waterbodies, nitrogen and phosphorus are most often the limiting nutrients. The limiting nutrient is defined as the nutrient(s) that limit plant growth (both macrophytes and algae) when it is not available in sufficient quantities. A limiting nutrient is a chemical 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 that the reduction of both nitrogen and phosphorus is necessary to control algal growth in aquatic systems (Conley et al. 2009, Paerl 2009, Lewis et al. 2011, Paerl and Otten 2013). Furthermore, the analysis used in the development of the Florida lake NNC support this idea as statistically significant relationships were found between chlorophyll a values and both nitrogen and phosphorus concentrations (Florida DEP, 2012).

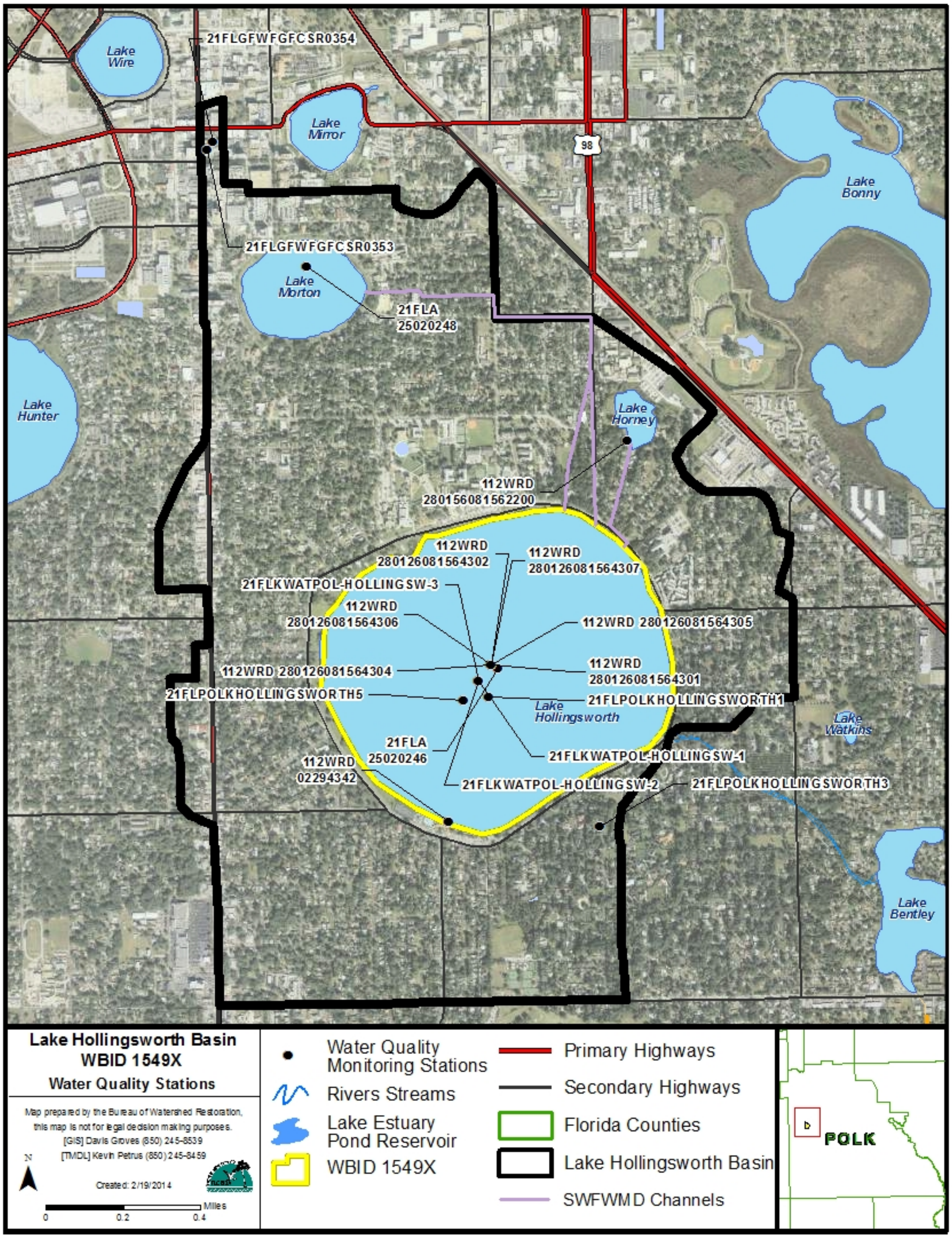

Figure 2.1 Surface Water Monitoring Locations in the Lake Hollingsworth Watershed.

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 Hollingsworth is classified as a Class III freshwater waterbody, 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 impairments (nutrients) for this water is the state of Florida's nutrient criterion in Paragraph 62-302.530(47)(b), Florida Administrative Code (F.A.C.). Florida has newly adopted lake criteria in Rule 62-302.531, F.A.C., for total nitrogen, total phosphorous, and chlorophyll a that went into effect on October 27, 2014. The Department has not formally assessed the data for Lake Hollingsworth using the new criteria. However, based on preliminary analysis of the available data, Lake Hollingsworth would not attain the new NNC, and is expected to remain listed as verified impaired for nutrients under the new criteria.

The nutrient TMDLs presented in this report constitute site specific numeric interpretations 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 in **Appendix D**, provides the relevant TMDL information, including information that the TMDL provides for the attainment and maintenance of water quality standards in downstream waters (pursuant to subsection 62-302.531(4)), to support using the TMDL nutrient targets as the site specific numeric interpretations of the narrative nutrient criterion. Targets used in TMDL development are designed to restore surface water quality to meet a waterbody's designated use. 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 use.

3.2 Numeric Interpretation of Narrative Nutrient Criterion

The applicable lakes NNC are dependent on the alkalinity and true color (color), based on the long-term period of record (POR) geometric means (GM), **Table 3.1**. Using this methodology, Lake Hollingsworth is classified as a lake with low color (<40 PCU) and high alkalinity (>20 mg/L CaCO3). The new chlorophyll a NNC for low color, high alkalinity lakes is an annual geometric mean value of 20 ug/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 nutrients and chlorophyll *a* in the lake, as described below. If there are sufficient data to calculate an annual geometric mean 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 shall be the annual geometric means of lake TN and TP samples, subject to the minimum and maximum TN and TP limits in the table below. If there are insufficient data to calculate the annual geometric mean chlorophyll *a* for a given year, or the annual geometric mean chlorophyll *a* exceeds the values in **Table 3.1** for the lake type, then the applicable numeric interpretations for TN and TP shall be 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 Hollingsworth.

The development of the lake NNC are 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 (Florida DEP, 2012). Based on several lines of evidence, the DEP developed a chlorophyll *a* threshold of 20 µg/L for colored lakes (above 40 PCU) and clear lakes with alkalinity above 20 mg/L CaCO3. Since the Department has demonstrated that the chlorophyll a threshold of 20 ug/L is protective of designated uses, this value will be used as a water quality target to address the nutrient impairment of Lake Hollingsworth. Empirical equations that describe the relationships between chlorophyll a and nutrient concentrations in Lake Hollingsworth were then used in the TMDL development approach, which is explained in detail in Chapter 5.

Table 3.1. State Adopted Lake Criteria

Long Term Geometric Mean Lake Color and Alkalinity	Annual Geometric Mean Chlorophyll *a*	Minimum Calculated Annual Geometric Mean Total Phosphorus NNC	Minimum Calculated Annual Geometric Mean Total Nitrogen NNC	Maximum Calculated Annual Geometric Mean Total Phosphorus NNC	Maximum Calculated Annual Geometric Mean Total Nitrogen NNC
>40 Platinum Cobalt Units	20 µg/L	0.05 mg/L	1.27 mg/L	0.16 mg/L[1]	2.23 mg/L
≤ 40 Platinum Cobalt Units and > 20 mg/L CaCO3	20 µg/L	0.03 mg/L	1.05 mg/L	0.09 mg/L	1.91 mg/L
≤ 40 Platinum Cobalt Units and ≤ 20 mg/L CaCO3	6 µg/L	0.01 mg/L	0.51 mg/L	0.03 mg/L	0.93 mg/L

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.

3.3 Water Quality Variable Definitions

Chlorophyll *a*

Chlorophyll is a green pigment found in plants and 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.

Total Nitrogen as N (TN)

Total nitrogen 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 exist 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 concentrations as a result of algal decomposition.

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, including those from local government master drainage systems, construction sites over 5 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 that discharge within the watershed.

4.2.2 Municipal Separate Storm Sewer System Permittees

Municipal separate storm sewer systems (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 1, 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 2 MS4s are defined in Section 62-624.800, F.A.C., and typically cover urbanized areas serving jurisdictions with a population of at least 10,000 or discharging into Class I or Class II waters, or into Outstanding Florida Waters.

The stormwater collection systems in the Lake Hollingsworth watershed, which are owned and operated by Polk County, in conjunction with the Florida Department of Transportation (FDOT) District 1, are covered by a NPDES Phase I MS4 permit (Permit No. FLS000015). The city of Lakeland is a co-permittee in the MS4 permit and the entire 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 improper disposal of waste materials, leaking septic systems, and domestic animals. As the Lake Hollingsworth watershed is primarily urban and there is no agricultural land use present, the anthropogenic nutrient load in the basin originates from urban sources.

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 that have 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 where there is 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 2011 land use coverage contained in the Department's geographic information system (GIS) library.

Land use categories within the Lake Hollingsworth watershed were aggregated using the Florida Land Use Code and Classification System (FLUCCS) expanded Level 1 codes (including low, medium, and high density residential) and are tabulated in **Table 4.1**. **Figure 4.1** shows the spatial distribution of the principal land uses in the watershed. The total watershed area is 1,612 acres and the majority of this area consists of urban land use, which covers 75 percent of the watershed. The predominant urban area is residential, making up about 55 percent of the land area with the majority, 53 percent, being medium density residential. Other urban areas include institutional land use (10.4 percent), the largest area being Florida Southern College property, and commercial and services (7.8 percent). Surface waters make up about one-quarter of the watershed area, most of which are the surface areas of lakes Hollingsworth, Morton, and Horney. Forests and wetlands cover less than one percent of the area.

Table 4.1 Classification of Land Use Categories in the Lake Hollingsworth Watershed in 2011

FLUCCs Code	Landuse	Acreage	Percent of Total
1200	Medium Density Residential	857	53.2
1300	High Density Residential	21	1.3
1400	Commercial and Services	126	7.8
1700	Institutional	167	10.4
1800	Recreational	32	2.0
4300	Upland Mixed Forests	6	0.4
5000	Water	397	24.6
6000	Wetlands	4	0.2
Total	All Combined	1,612	100.0

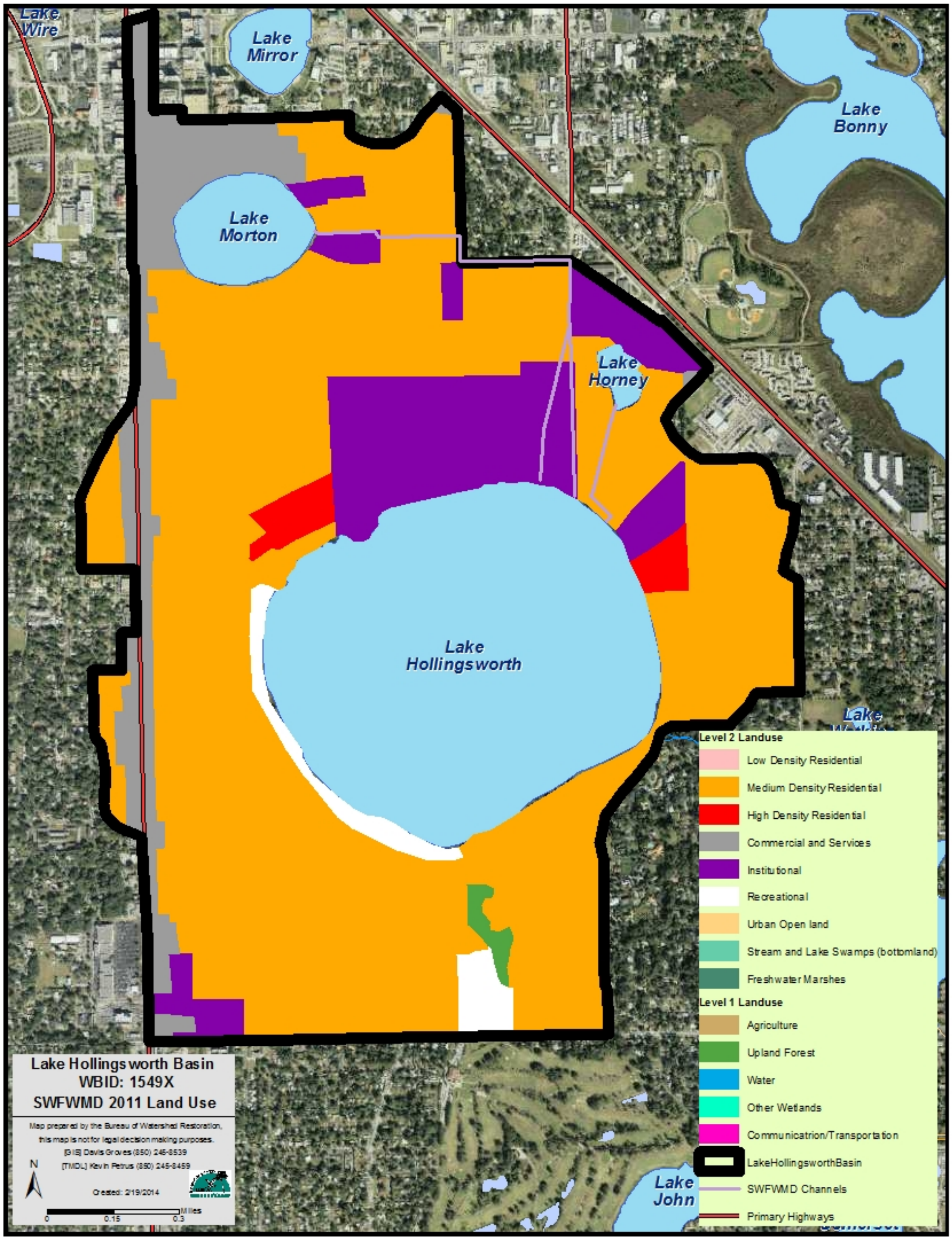

Figure 4.1 Principle Land Uses in the Lake Hollingsworth Watershed in 2011

Polk County Population

According to the U.S Census Bureau, the population density in Polk County, in the year 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 Hollingsworth watershed, was 602,095, with 281,385 housing units. Polk County occupies an area of approximately 1,798 square miles. For all of Polk County, the housing density is 156.5 houses per square mile. (U. S. Census Bureau Web site, 2014).

Polk County Septic Tanks

Onsite sewage treatment and disposal systems (OSTDSs), 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, OSTDSs 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, OSTDSs 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 a Florida Department of Health Onsite Sewage Treatment and Disposal Systems GIS coverage dated November 2012.

The septic tanks located in the Lake Hollingsworth watershed are displayed in **Figure 4.2**. The majority of the land parcels are connected to central sewer and there is estimated to be only four septic tanks in the basin.

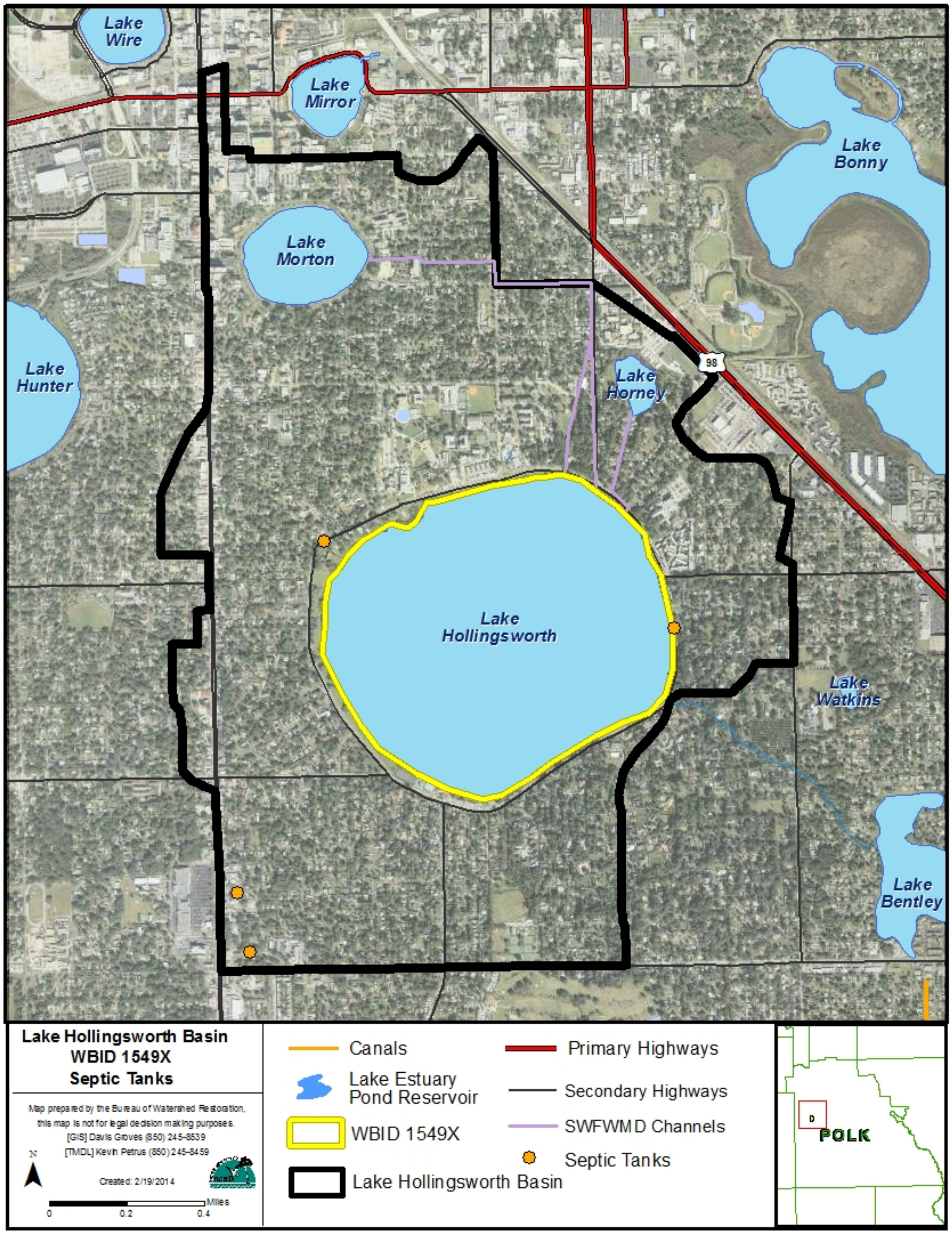

Figure 4.2 Septic Tank Locations within the Lake Hollingsworth Watershed

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 Hollingsworth 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 methods utilized to address the nutrient impairment included the development of regression equations that relate lake nutrient concentrations to the annual geometric mean chlorophyll a levels and the evaluation of paleolimnological results to establish a water quality target for total phosphorus. For addressing nonpoint sources (both NPDES stormwater discharges and non-NPDES stormwater discharges), the TMDLs are expressed as percent reductions in the existing lake water total nitrogen and total phosphorus concentrations necessary to meet the applicable chlorophyll a target while taking into consideration the estimated pre-disturbance conditions in the lake.

The primary focus in the implementation of this TMDL is to maintain the lake's annual geometric mean chlorophyll a values at or below the target concentration of 20 ug/L through reductions in nutrient inputs to the system. Nutrient reductions are also expected to result in improvements of dissolved oxygen levels within 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 an oxygen demand which leads to a lowering of dissolved oxygen levels. Lower algal biomass should lower the biochemical oxygen demand levels in the water column, and sediment oxygen demand in the lake should also decrease over time as reductions in algal biomass will result in less accumulation of organic matter in the lake sediments.

5.2 Analysis of Water Quality

Monitoring of Lake Hollingsworth water quality in recent years, since 1999, has been performed by two different entities. Polk County has been routinely sampling the lake since 1984 and a large portion of the data used to assess water quality were obtained at station 21FLPOLKHOLLINGSWORTH1, which is located near the center of the lake. The other sampling organization, Florida LakeWatch, conducted monitoring at three locations from the last quarter of 2001 to the first quarter of 2004, and in 2007 and 2008. 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 data set for evaluating surface water quality. The nutrient and corrected chlorophyll a annual geometric means 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 annual geometric means. In the 1999 to 2012 period, there were sufficient results collected to calculate annual geometric mean values for corrected chlorophyll a and nutrients.

Annual geometric mean values for total nitrogen (TN) and total phosphorus (TP) results measured at the center of the lake are presented in **Figure 5.1**. The TN and TP annual means exhibited a similar pattern over the time frame analyzed. During the 1999 to 2012 period, TN annual means ranged from 1.38 mg/L in 2004 to 4.60 mg/L in 2000, and the TP annual means ranged from 0.053 mg/L in 2004 to 0.571 mg/L in 2000.

The chlorophyll a annual geometric mean values along with annual total rainfall are presented in **Figure 5.2**. The chlorophyll a annual geometric mean values in Lakes Hollingsworth were above 20 ug/L throughout the 1999 to 2012 period and ranged from 24 ug/L in 2004 to 149 ug/L in 2000. The lowest chlorophyll a annual means typically occurred in years with the highest rainfall (i.e. 2002 and 2004). Linear regression analysis comparing the annual geometric mean chlorophyll a results to annual rainfall, **Figure 5.3,** indicates that there is a significant inverse relationship between these variables (p value < 0.05). The results suggest that factors in addition to external nutrient loadings, such as lake residence time and internal cycling of nutrients, may be exhibiting a considerable influence on lake chlorophyll a levels since in years with presumably higher watershed nutrient loadings (i.e. higher rainfall years) the chlorophyll a results tend to be lower.

Information obtained from recent monitoring by the DEP Southwest District to enumerate the phytoplankton community and a lake diagnostic study support that other factors, in addition to watershed nutrient loadings, are having an effect on lake water quality.

Samples for phytoplankton enumeration and water quality characterization were collected near the center of the lake in June 2013. The water quality measurements are presented in **Table 5.1** and the phytoplankton community results are presented in **Appendix C**. Phytoplankton in the Phylum Cyanophycota (the blue-green algae) were the dominant group, representing 65 percent of the algal community based on cell densities. Many blue-green algae taxa are capable of fixing atmospheric nitrogen, among them are *Aphanizomenon sp.* and *Cylindrospermopsis raciborskii*, which were observed in Lake Hollingsworth.

A diagnostic feasibility study of the lake completed in 1994 identified that organic sediment was responsible for as much as seventy to eighty percent of the nutrient enrichment in the lake (Lakeland, 2005). A lake sediment volume assessment determined that the average total depth of the lake was 10 feet but that accumulated organic sediment occupied 6 feet (60%) of the lake volume and resulted in a mean lake depth of 4 feet (Lakeland, 2005). As a result of the 1994 feasibility study the city of Lakeland conducted a lake sediment dredging project. The dredging project implemented between 1997 and 2001, is described in the 2005 City of Lakeland Stormwater Utility Overview and Status Report (Lakeland, 2005). The following information was obtained from this report: 1) dredging resulted in the removal of 2.9 million cubic yards of organic sediments; 2) dredging was halted due to a record two year drought; and 3) some targeted sediment deposits remain in the lake, which may be recommended for removal in the future.

The relationships between the chlorophyll a and TN and TP annual geometric mean concentrations are presented in **Figure 5.4** and **Figure 5.5**, respectively. Chlorophyll a exhibits a strong and significant positive relationship with TN (r square = 0.83, p value < 0.05) and TP (r square = 0.66, p value < 0.05). These observations suggest that with a lowering of the in-lake nutrient concentrations the chlorophyll a concentrations will likewise decrease.

Invasive aquatic plants occur within Lake Hollingsworth, (most notably hydrilla, water hyacinth, and water lettuce) 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 within the lake, as the decomposition of dead plant material leads to the release of nutrients into the water column which 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 to the lake chlorophyll a results, **Figure 5.6**. In general, since the year 2000, the herbicides have been applied to a relatively small lake area (only four of thirty-seven treatment events covered more than 20 percent of the lake surface area). There does appear to be increases in chlorophyll a concentrations following the larger treatment events, however, chlorophyll a levels remain high during periods when there is no treatment or at times when smaller surface areas are treated.

Table 5.1 Water Quality Results at the Time of Phytoplankton Sampling on June 27, 2013.

Parameter	Value	Qualifier Code
Alkalinity (mg CaCO3/L)	46	
Biochemical Oxygen Demand-5 Day (mg/L)	3.9	
Chloride (mg Cl/L)	25	
Chlorophyll-a, Corrected (ug/L)	37	
Color - true (PCU)	13	
Dissolved Oxygen (mg/L)	9.51	
Fluoride (mg F/L)	0.28	
Kjeldahl Nitrogen (mg N/L)	1.5	
NO2NO3-N (mg N/L)	0.004	U
O-Phosphate-P (mg P/L)	0.004	U
Organic Carbon (mg C/L)	11	
pH (SU)	8.77	
Phaeophytin-a (ug/L)	1.7	U
Sample Depth (m)	0.2	
Specific Conductance (umhos/cm)	186	
Sulfate (mg SO4/L)	3.8	
TDS (mg/L)	119	
Temperature (deg. C)	30.62	
Total-P (mg P/L)	0.031	
TSS (mg/L)	13	I
Turbidity (NTU)	7.1	

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.

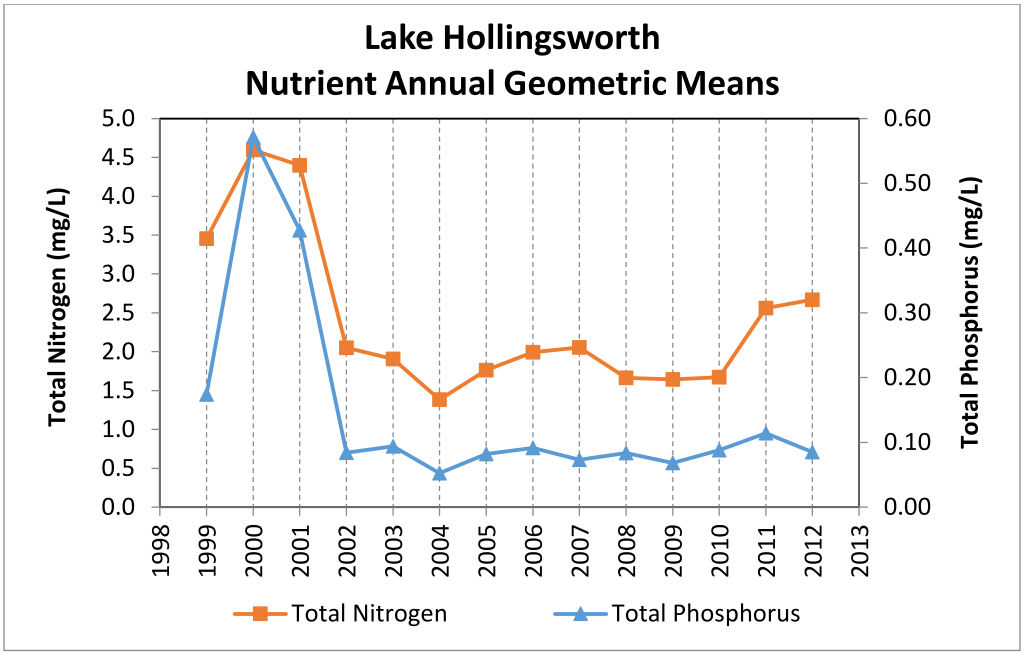

Figure 5.1 Total Nitrogen and Total Phosphorus Annual Geometric Means in Lake Hollingsworth.

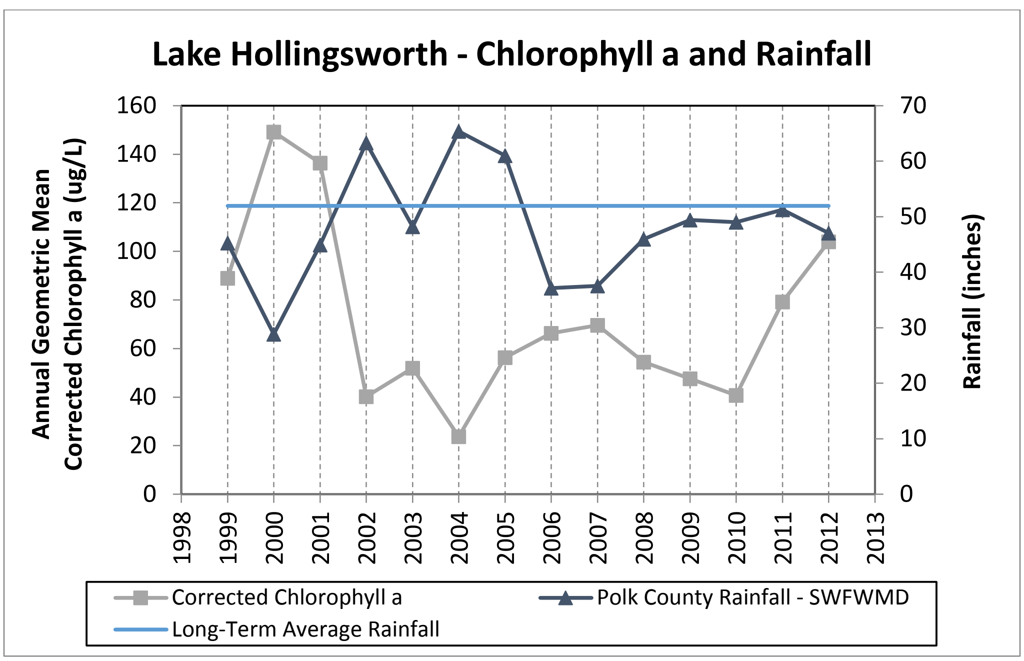

Figure 5.2 Lake Hollingsworth Chlorophyll a Annual Geometric Means and Annual Rainfall.

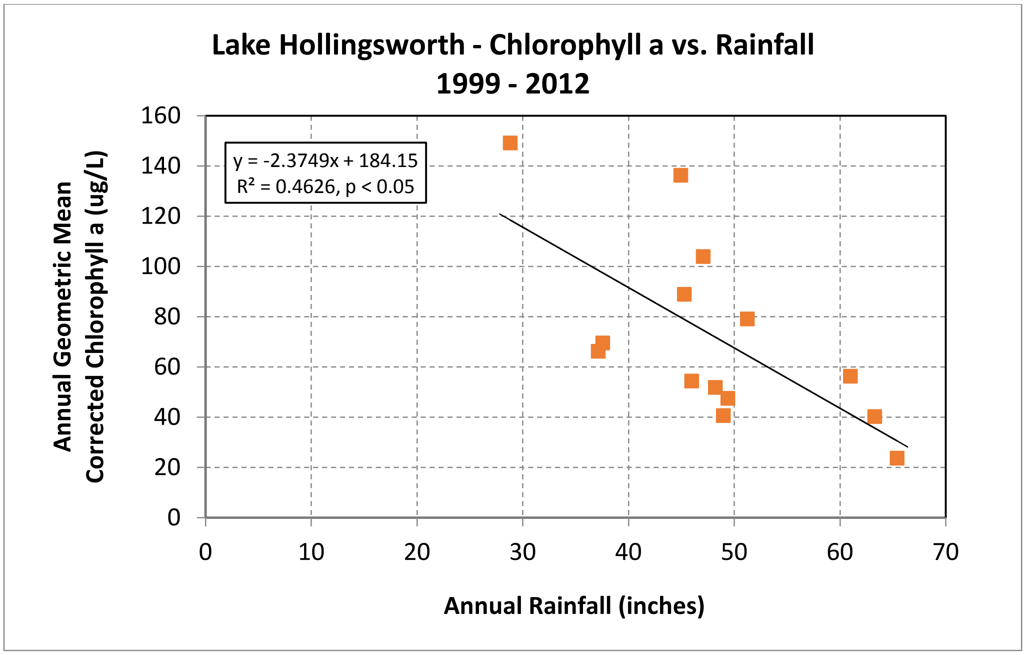

Figure 5.3 Relationship Between Lake Hollingsworth Chlorophyll a Annual Geometric Means and Annual Rainfall.

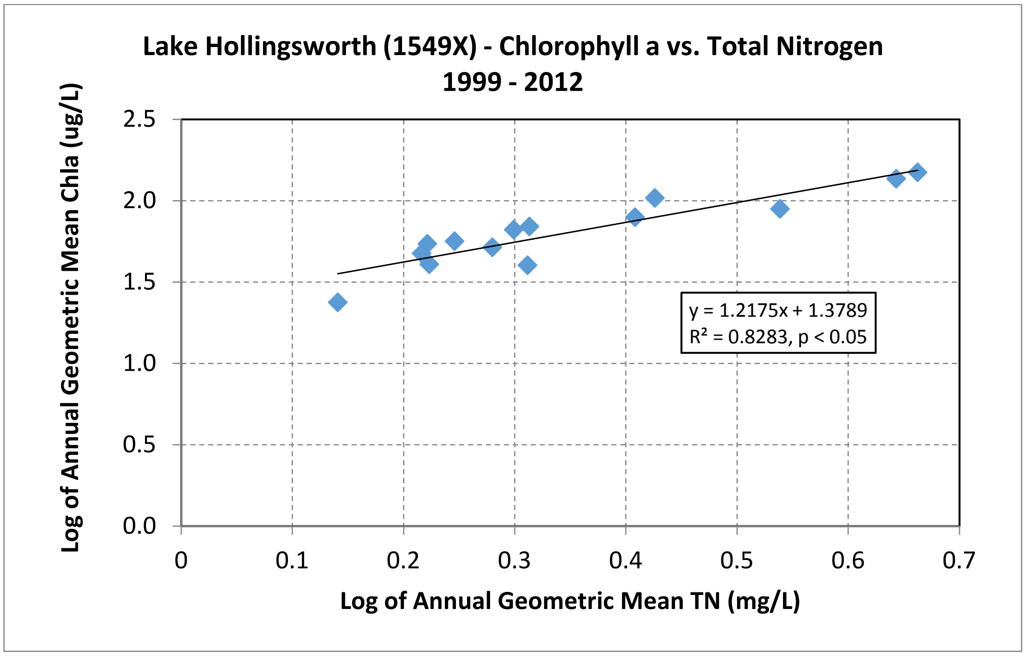

Figure 5.4 Relationship Between Annual Geometric Means of Chlorophyll a and Total Nitrogen in Lake Hollingsworth.

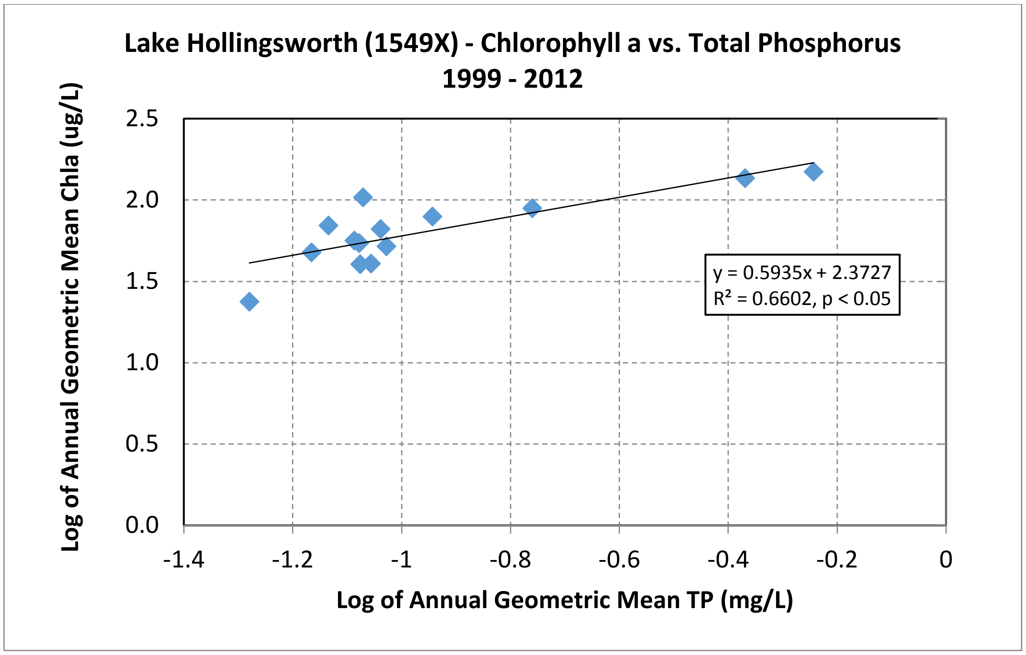

Figure 5.5 Relationship Between Annual Geometric Means of Chlorophyll a and Total Phosphorus in Lake Hollingsworth.

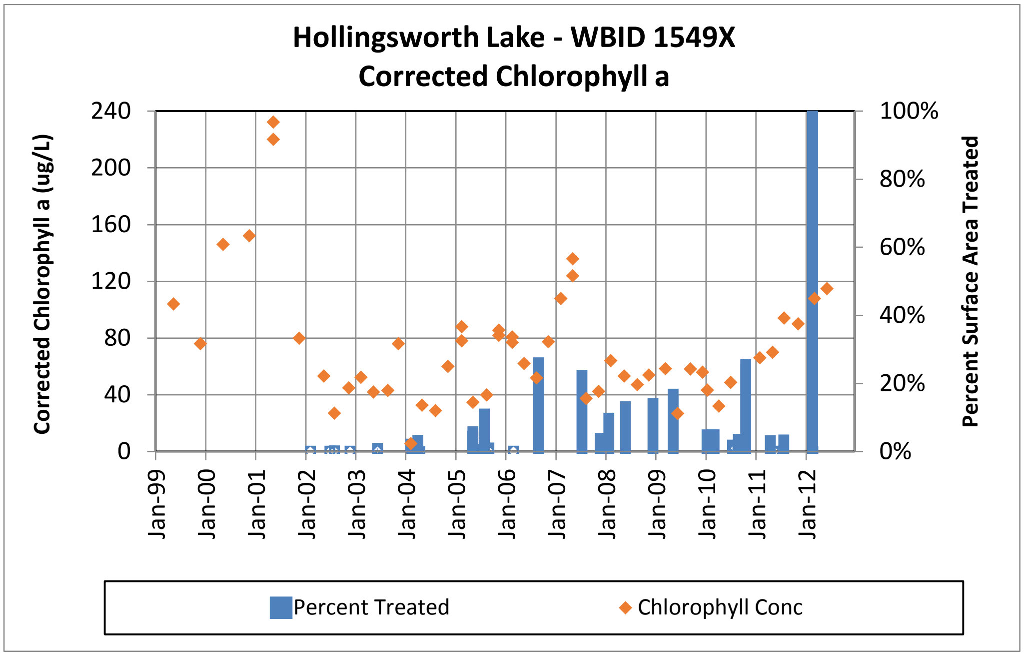

Figure 5.6 Lake Hollingsworth Chlorophyll a Results and Lake Area Treated for Invasive Aquatic Plant Growth.

5.3 The TMDL Development Process

The method used for developing the nutrient TMDLs is a percent reduction approach, whereby the percent reductions in the existing lake TN and TP concentrations were calculated to meet the nutrient water quality targets. As discussed in Chapter 3, the NNC chlorophyll a threshold of 20 ug/L, expressed as an annual geometric mean, was selected as the response variable target for TMDL development. To identify the TN water quality target, the regression equation explaining the relationship between annual geometric mean chlorophyll a and TN, **Figure 5.4**, was used to determine the TN concentration necessary to meet the chlorophyll a target of 20 ug/L. An annual TN geometric mean of 0.86 mg/L results in a chlorophyll a annual geometric mean of 20 ug/L.

The TP water quality target was derived in a different fashion to take into consideration the pre-disturbance inferred water quality from a paleolimnological study. Although a significant relationship was found between annual geometric mean chlorophyll a and TP, **Figure 5.5**, the predicted TP concentration necessary to achieve the chlorophyll a target of 20 ug/L, using the regression equation, is less than the TP results obtained from the paleolimnological study. The inferred TP values derived from the paleolimnological study ranged from 20-36 ug/L (Brenner et al. 1999). The estimated TP values represent lake water quality prior to and into the first decade of the 20^{th} century. Using the regression equation, a TP concentration of 15 ug/L results in a chlorophyll a concentration of 20 ug/L. As FL regulations prevent the abatement of natural conditions, an alternative method is needed to identify the TP target. The high value in the TP range from the paleolimnological results, 36 ug/L, was selected as the TP target.

Since the pre-disturbance TP results represent an estimate of average conditions, a method was applied to relate averages to geometric means using the dataset applied in NNC development. Using all the state-wide lake TP data, used to develop the lake NNC thresholds, (Florida DEP, 2012), the comparison of average and geometric mean values shows that there is a strong linear relationship, **Figure 5.7**. The expression of this relationship in the form of an equation: TP geometric mean = TP average * 0.9373. In the case of Lake Hollingsworth, the pre-disturbance average value, selected as the TP target is equivalent to a geometric mean of 33 ug/L. For TMDL development, a TP value of 33 ug/L expressed as a geometric mean is being applied as a water quality target.

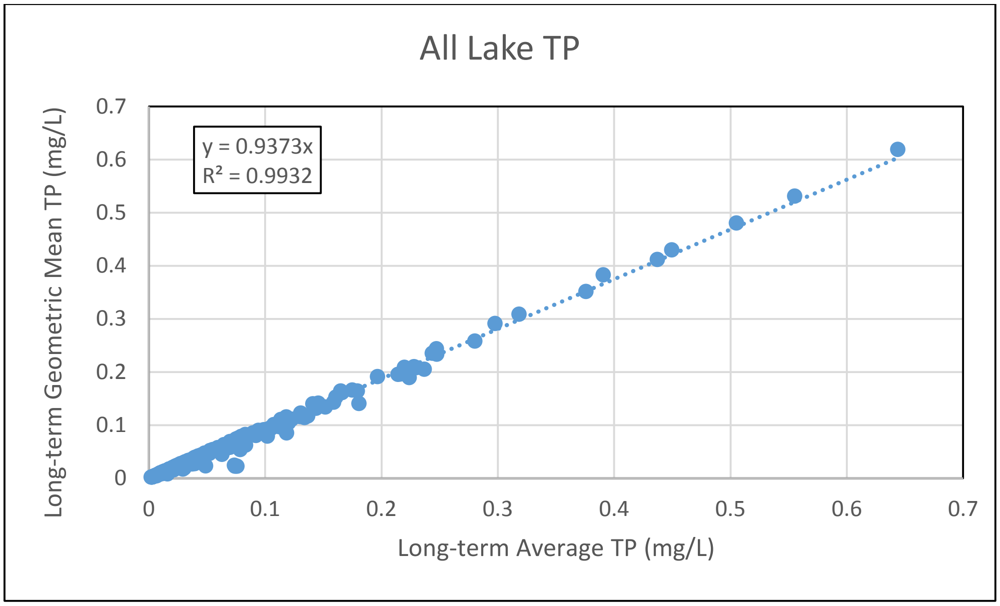

Figure 5.7 Relationship Between Total Phosphorus Annual Geometric Means and Averages (Arithmetic Means) from Lake Results Used in NNC Development.

Lake Hollingsworth is expected to meet the applicable nutrient criteria and maintain its function and designated use as a Class III water when surface water nutrient concentrations are reduced to the target concentrations, which will address the anthropogenic contributions to the water quality impairment. The approaches used to establish the nutrient targets, address meeting the chlorophyll a target and take into consideration the estimated pre-disturbance conditions in the lake.

Existing lake nutrient conditions used in establishing the TMDLs were the conditions measured in the 2002-2012 period. This period includes the entire Cycle 2 verified period and water quality in more recent years. The existing nutrient conditions used in the percent reduction calculation are the median values of the TN and TP annual geometric means that exceed the water quality targets. The geometric means were calculated from nutrient results available in IWR Database Run 48. All of the annual TN and TP geometric means in the 2002-2012 period exceed the water quality targets, **Table 5.2**. The use of the median of the geometric mean values is considered a conservative assumption for establishing reductions to address anthropogenic watershed runoff contributions because the lake results indicate that the chlorophyll a annual geometric means are inversely related to rainfall.

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

$$\frac{\text{[measured exceedance – target]}}{\text{measured exceedance}} \times 100$$

The measured exceedances in this case are the medians of the TN and TP annual geometric mean values that exceed the water quality targets. For the existing geometric mean TN concentration of 1.78 mg/L to achieve the target concentration of 0.86 mg/L, a 52 percent reduction in the lake TN concentration is necessary. A 57 percent reduction in the existing annual geometric mean TP concentration of 0.07 mg/L is necessary to meet the target concentration of 0.03 mg/L. These nutrient TMDL values, which are expressed as annual geometric means, address the anthropogenic nutrient inputs which contribute to the exceedances of the chlorophyll a restoration target.

Table 5.2 Lake Hollingsworth Nutrient Annual Geometric Means Used to Calculate the Percent Reductions Needed to Meet the Water Quality Targets.

Year	IWR Run 48 TN Annual Geometric Mean (mg/L)	IWR Run 48 TP Annual Geometric Mean (mg/L)
2002	1.81	0.10
2003	1.48	0.07
2004	1.07	0.04
2005	1.77	ID
2006	2.00	ID
2007	1.79	0.07
2008	1.54	0.07
2009	1.64	0.07
2010	ID	ID
2011	2.56	0.11
2012	2.66	0.09
Median	**1.78**	**0.07**

ID - Insufficient Data to Calculate Geometric Means per the Requirements of Rule 62-303.

5.4 Critical Conditions

The estimated assimilative capacity is based on annual conditions, rather than critical/seasonal conditions because (a) the methodology used to determine the assimilative capacity does not lend itself very well to short-term assessments, (b) 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 (c) the methodology used to determine impairment is based on annual conditions (annual geometric means 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:

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

It should be noted that the various components of the TMDL equation may not sum up to the value of the TMDL because a) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is accounted for within the LA, and b) 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 a mass per day].

WLAs for stormwater discharges are typically expressed as “percent reduction” because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges 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 Best Management Practices.

This approach is consistent with federal regulations [40 CFR § 130.2(I)], which state that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or **other appropriate measure**. The TMDLs for Lake Hollingsworth are expressed in terms of nutrient concentration targets and the percent reductions for nonpoint sources necessary to meet the targets, **Table 6.1,** and represent the maximum lake nutrient concentrations the surface water can assimilate to meet the applicable nutrient criteria. The TMDLs will constitute the site specific numeric interpretation 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 in subsection 62-302.531(2) for this particular water, pursuant to paragraph 62-302.531(2)(a) F.A.C.

Table 6.1 TMDL Components for Lake Hollingsworth

WBID	Parameter	TMDL (mg/L)[1]	WLA Wastewater (lbs/year)	WLA NPDES Stormwater (% Reduction)[2]	LA (% Reduction)[2]	MOS
1549X	Total Nitrogen	0.86	NA	52%	52%	Implicit
1549X	Total Phosphorus	0.03	NA	57%	57%	Implicit

[1] Represents the annual geometric mean lake value that is 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.
NA - Not Applicable

6.2 Load Allocation (LA)

A total nitrogen reduction of 52 percent and a total phosphorus reduction of 57 percent is required from nonpoint sources. 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 Hollingsworth 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 Lakeland) are covered by a Phase I NPDES municipal separate storm sewer system (MS4) permit (FLS000015) and areas within their jurisdiction in the Lake Hollingsworth watershed may be responsible for a 52 percent total nitrogen reduction and a 57 percent total phosphorus reduction in current anthropogenic loading. It should be noted that any MS4 permittee is only responsible for reducing the anthropogenic loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction.

6.4 Margin of Safety (MOS)

TMDLs must address uncertainty issues by incorporating a 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 (Florida Department of Environmental Protection, February 2001), an implicit margin of safety (MOS) was used in the development of these TMDLs because of the conservative assumptions that were applied. The TMDLs were developed using water quality results from both high and low rainfall years during a period when lake chlorophyll a concentrations tended to be inversely related to rainfall.

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. Implementation of TMDLs may occur through specific requirements in NPDES wastewater and municipal separate storm sewer (MS4) permits, and, as appropriate, through local or regional water quality initiatives or Basin Management Action Plans (BMAPs).

Facilities with NPDES permits that discharge to the TMDL waterbody must respond to the permit conditions that reflect target concentrations, reductions, or wasteload allocations identified in the TMDL. NPDES permits are required for Phase I and Phase II MS4s as well as domestic and industrial wastewater facilities. MS4 Phase I permits require that the permit holder prioritize and take action to address a TMDL unless their management actions are already defined in a BMAP. MS4 Phase II permit holders must also implement responsibilities defined in a BMAP.

7.2 Basin Management Action Plans

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 the 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.

Section 403.067, Florida Statutes, called the “Florida Watershed Restoration Act” provides for the development and implementation of BMAPs. BMAPs are adopted by the Secretary of the Department and are legally enforceable.

BMAPs describe the management strategies that will be implemented as well as funding strategies, project tracking mechanisms, 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 best management practices.

Additional information about BMAPs is available at the following Department web site: http://www.dep.state.fl.us/water/watersheds/bmap.htm

7.3 Implementation Considerations for Lake Hollingsworth

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 Hollingsworth, the previous diagnostic study and the recent phytoplankton monitoring suggest that other factors besides external loading inputs, such as sediment nutrient fluxes and/or nitrogen fixation, are also influencing the lake nutrient budgets and the growth of phytoplankton. Approaches for addressing these other factors should be included in a comprehensive management plan for the lake.

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Appendix A: Background Information on Federal and State Stormwater Programs

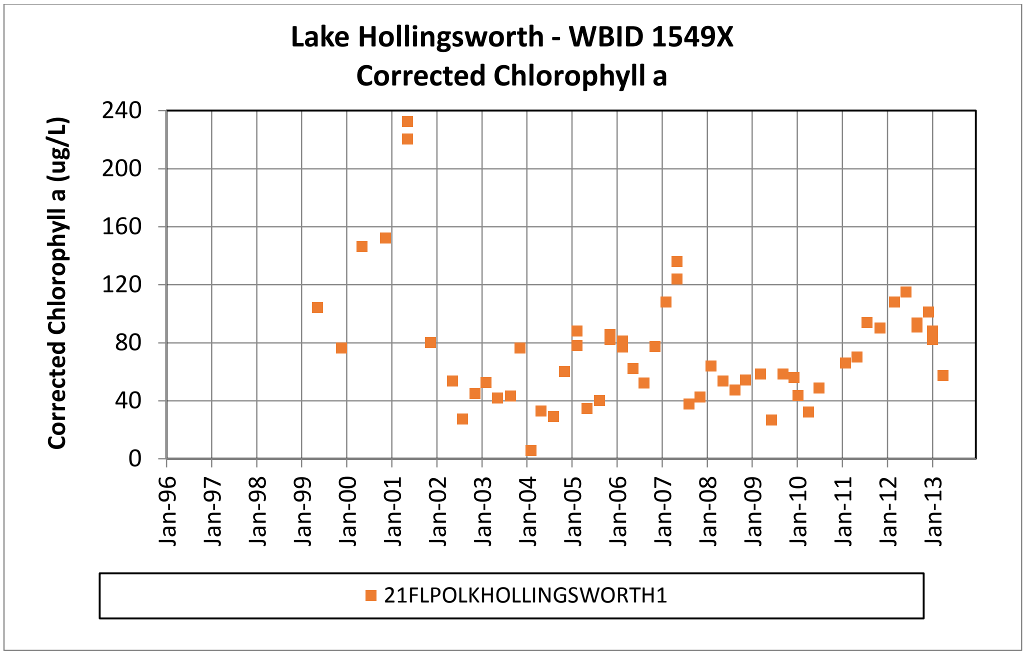
In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C.

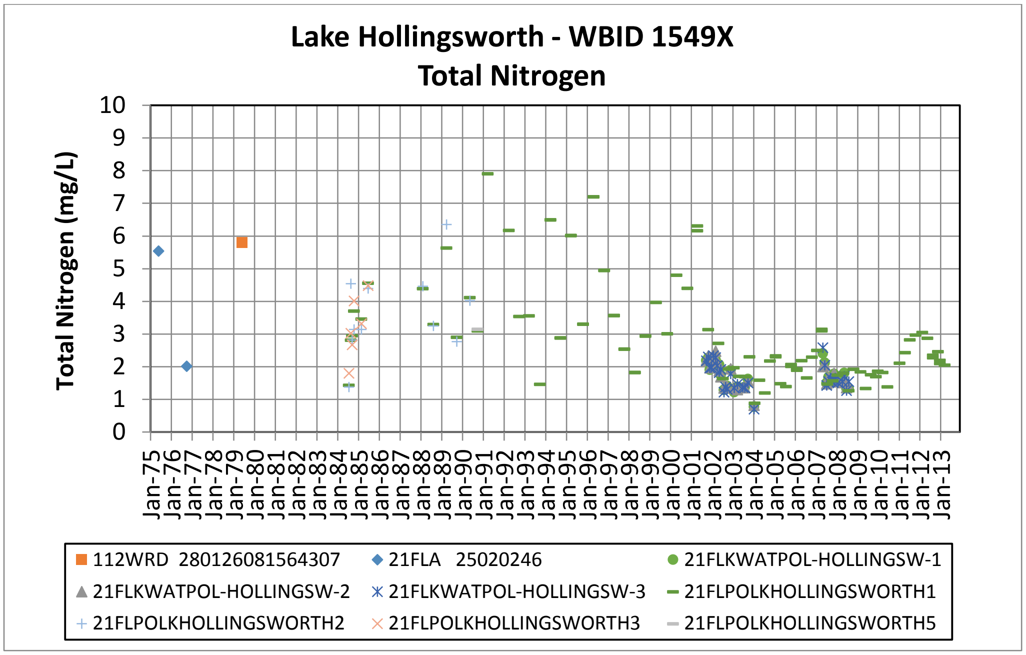
The rule requires the state's water management districts (WMDs) to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a SWIM plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, stormwater PLRGs have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka.

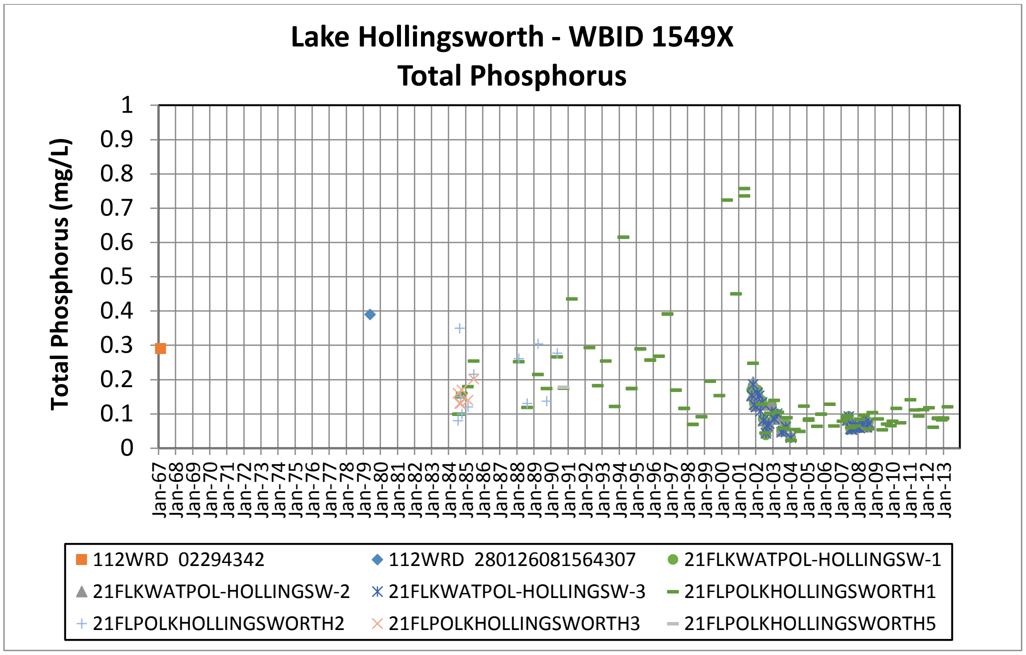
In 1987, the U.S. Congress established Section 402(p) as part of the federal Clean Water Act Reauthorization. This section of the law amended the scope of the federal NPDES stormwater permitting program to designate certain stormwater discharges as "point sources" of pollution. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific Standard Industrial Classification (SIC) codes, construction sites disturbing five or more acres of land, and master drainage systems of local governments with a population above 100,000, which are better known as municipal separate storm sewer systems (MS4s). However, because the master drainage systems of most local governments in Florida are interconnected, the EPA has implemented Phase 1 of the MS4 permitting program on a countywide basis, which brings in all cities (incorporated areas), Chapter 298 urban water control districts, and the Florida Department of Transportation throughout the fifteen counties meeting the population criteria.

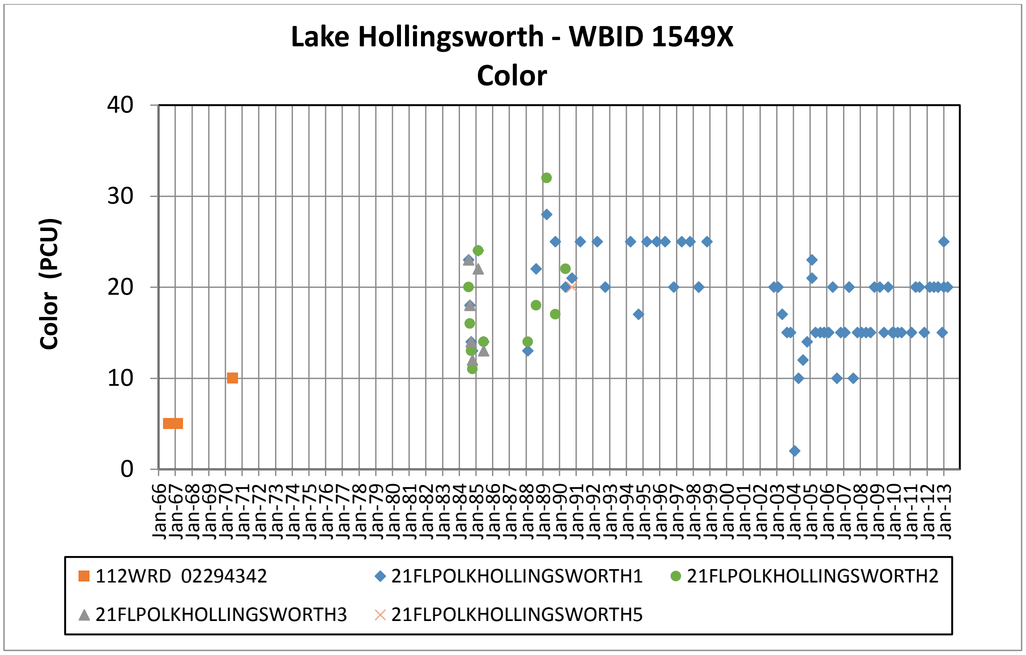
An important difference between the federal and state stormwater permitting programs is that the federal program covers both new and existing discharges, while the state program focuses on new discharges. Additionally, Phase 2 of the NPDES Program will expand the need for these permits to construction sites between one and five acres, and to local governments with as few as 10,000 people. These revised rules require that these additional activities obtain permits by 2003. While these urban stormwater discharges are now 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 similar to other point sources of pollution, such as domestic and industrial wastewater discharges. The Department recently accepted delegation from the EPA for the stormwater part of the NPDES Program. It should be noted that most MS4 permits issued in Florida include a re-opener clause that allows permit revisions to implement TMDLs once they are formally adopted by rule.

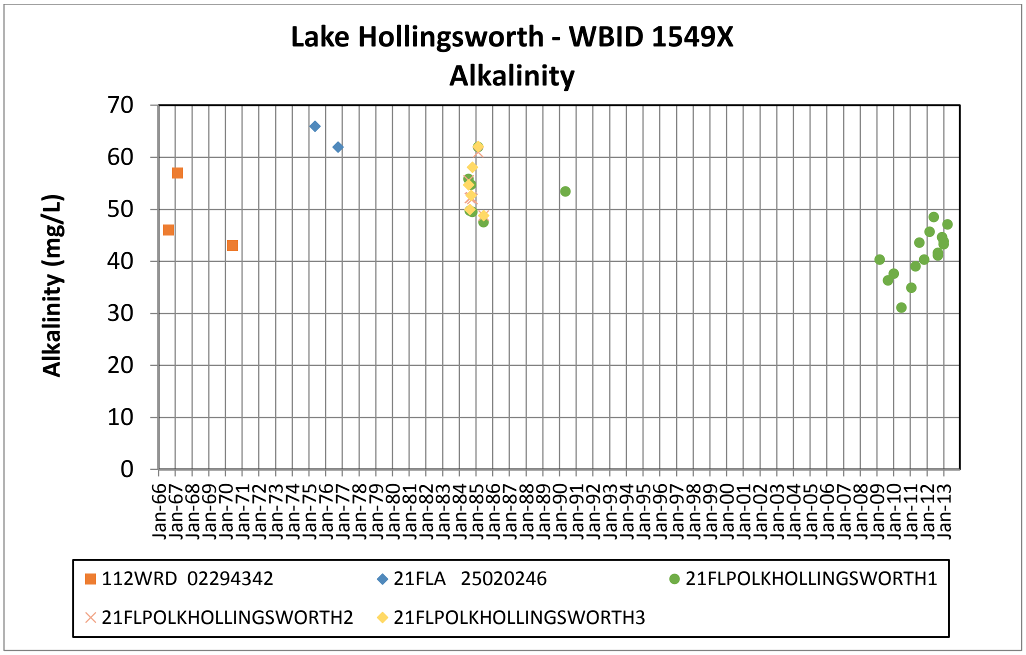
Appendix B: Graphs of Surface Water Quality Results






Lake Hollingsworth - WBID 1549X
Total Phosphorus
Total Phosphorus (mg/L)
112WRD 02294342
112WRD 280126081564307
21FLKWATPOL-HOLLINGSW-1
21FLKWATPOL-HOLLINGSW-2
21FLKWATPOL-HOLLINGSW-3
21FLPOLKHOLLINGSWORTH1
21FLPOLKHOLLINGSWORTH2
21FLPOLKHOLLINGSWORTH3
21FLPOLKHOLLINGSWORTH5


Lake Hollingsworth - WBID 1549X
Color
Color (PCU)
112WRD 02294342
21FLPOLKHOLLINGSWORTH1
21FLPOLKHOLLINGSWORTH2
21FLPOLKHOLLINGSWORTH3
21FLPOLKHOLLINGSWORTH5


Lake Hollingsworth - WBID 1549X
Alkalinity
Alkalinity (mg/L)
0
10
20
30
40
50
60
70
Jan-66 Jan-67 Jan-68 Jan-69 Jan-70 Jan-71 Jan-72 Jan-73 Jan-74 Jan-75 Jan-76 Jan-77 Jan-78 Jan-79 Jan-80 Jan-81 Jan-82 Jan-83 Jan-84 Jan-85 Jan-86 Jan-87 Jan-88 Jan-89 Jan-90 Jan-91 Jan-92 Jan-93 Jan-94 Jan-95 Jan-96 Jan-97 Jan-98 Jan-99 Jan-00 Jan-01 Jan-02 Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11 Jan-12 Jan-13
112WRD 02294342
21FLA 25020246
21FLPOLKHOLLINGSWORTH1
21FLPOLKHOLLINGSWORTH2
21FLPOLKHOLLINGSWORTH3

Appendix C: Lake Hollingsworth Phytoplankton Results – Collected June 27, 2013

Phylum	Class	Order	Family	Genus	Taxon Name	(# counted)	(# per mL)	Phylum (%)
Bacillariophyta	Bacillariophyta	Bacillariophyta	Bacillariophyta	Bacillariophyta	Bacillariophyta	17	5,921	5.6
Chlorophycota	Chlorophyceae	Volvocales	Chlamydomonadaceae	Chlamydomonas	Chlamydomonas	1	348	
Chlorophycota	Chlorophyceae	Zygnematales	Desmidiaceae	Closterium	Closterium venus	1	348	
Chlorophycota	Chlorophyceae	Chlorococcales	Coelastraceae	Coelastrum	Coelastrum cambricum	1	348	
Chlorophycota	Chlorophyceae	Chlorococcales	Coelastraceae	Coelastrum	Coelastrum morus	1	348	
Chlorophycota	Chlorophyceae	Zygnematales	Desmidiaceae	Euastrum	Euastrum denticulatum	1	348	
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Oocystis	Oocystis gloeocystiformis	1	348	
Chlorophycota	Chlorophyceae	Chlorococcales	Hydrodictyaceae	Sorastrum	Sorastrum americanum	1	348	
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Tetradesmus	Tetradesmus wisconsinensis	1	348	
Chlorophycota	Chlorophyceae	Chlorococcales	Chlorococcaceae	Tetraedron	Tetraedron trigonum	1	348	
Chlorophycota	Chlorophyceae	Chlorococcales	Hydrodictyaceae	Pediastrum	Pediastrum obtusum	2	697	
Chlorophycota	Chlorophyceae	Chlorococcales	Chlorococcaceae	Schroederia	Schroederia judayi	2	697	
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Scenedesmus	Scenedesmus dimorphus	3	1,045	
Chlorophycota	Chlorophyceae	Zygnematales	Desmidiaceae	Spondylosium	Spondylosium planum	3	1,045	
Chlorophycota	Chlorophyceae	Zygnematales	Desmidiaceae	Staurastrum	Staurastrum	3	1,045	
Chlorophycota	Chlorophyceae	Chlorococcales	Chlorococcaceae	Tetraedron	Tetraedron regulare	3	1,045	
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Ankistrodesmus	Ankistrodesmus falcatus	4	1,393	
Chlorophycota	Chlorophyceae	Chlorococcales	Dictyosphaeriaceae	Botryococcus	Botryococcus braunii	4	1,393	
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Crucigenia	Crucigenia rectangularis	4	1,393	
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Selenastrum	Selenastrum	4	1,393	
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Scenedesmus	Scenedesmus abundans	5	1,741	
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Scenedesmus	Scenedesmus bijuga	5	1,741	
Chlorophycota	Chlorophyceae	Chlorococcales	Chlorococcaceae	Tetraedron	Tetraedron minimum	5	1,741	
Chlorophycota	Chlorophyceae	Zygnematales	Desmidiaceae	Cosmarium	Cosmarium emarginatum	7	2,438	
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Chlorella	Chlorella	12	4,180	
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Scenedesmus	Scenedesmus quadricauda	13	4,528	29.1
Cyanophycota	Cyanophyceae	Chroococcales	Synechococcaceae	Aphanothece	Aphanothece nidulans	1	348	

Phylum	Class	Order	Family	Genus	Taxon Name	(# counted)	(# per mL)	Phylum (%)
Cyanophycota	Cyanophyceae	Chroococcales	Merismopediaceae	Merismopedia	Merismopedia warmingiana	2	697	
Cyanophycota	Cyanophyceae	Chroococcales	Merismopediaceae	Aphanocapsa	Aphanocapsa planctonica	3	1,045	
Cyanophycota	Cyanophyceae	Nostocales	Nostocaceae	Aphanizomenon	Aphanizomenon flosaquae	6	2,090	
Cyanophycota	Cyanophyceae	Chroococcales	Microcystaceae	Microcystis	Microcystis wesenbergii	7	2,438	
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Planktolyngbya	Planktolyngbya limnetica	10	3,483	
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Planktolyngbya	Planktolyngbya contorta	13	4,528	
Cyanophycota	Cyanophyceae	Nostocales	Nostocaceae	Cylindrospermopsis	Cylindrospermopsis raciborskii	23	8,011	
Cyanophycota	Cyanophyceae	Chroococcales	Synechococcaceae	Rhabdogloea	Rhabdogloea	32	11,146	
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Jaaginema	Jaaginema gracile	39	13,584	
Cyanophycota	Cyanophyceae	Chroococcales	Chroococcaceae	Synechocystis	Synechocystis	59	20,550	64.6
Pyrrophycophyta	Dinophyceae	Peridiniales	Glenodiniaceae	Glenodinium	Glenodinium	2	697	0.7
					Total	302	105,185	100

Appendix D: Water Quality Standards Template Document

Table D-1. Spatial Extent of the Numeric Interpretation of the Narrative Nutrient Criterion: Documentation of location and descriptive information

Waterbody Location Information	**Description of Waterbody Location Information**
Waterbody Name	Lake Hollingsworth
Waterbody Type(s)	Lake
Water Body ID (WBID)	WBID 1549X (See Figure 1)
Description	Lake Hollingsworth is located inside the City of Lakeland, Polk County, Florida. The surface area of the lake is 356 acres, and the watershed encompasses 1,612 acres. The average lake volume is 7.93 * 10^8 gallons. The average depth of the lake is 3.9 ft., with a maximum depth of 14.2 ft. The lake outlet is connected to Lake Bentley, which flows into a series of lakes that drain to Lake Hancock. Lake Hancock discharges to lower Saddle Creek, which along with the Peace Creek Drainage Canal, makes up the headwaters of the Peace River.
Specific Location (Latitude/ Longitude or River Miles)	The center of Lake Hollingsworth is located at N: 28^0 1’27”/ W: -81^0 56’40”. The site specific criteria apply as a spatial average for the lake, as defined by WBID 1549X.
Map	The general location of Lake Hollingsworth and its watershed are shown in Figure 1, and the land uses of the watershed are shown in Figure 2 (provided at the end of this document). Land use is predominately urban, with approximately 55 percent of the land area developed into medium and high density residential areas. Other urban land uses include institutional land use (10.4 percent) and commercial and services land use (7.8 percent). Surface waters cover about 25 percent of the watershed.
Classification(s)	Class III Freshwater
Basin Name (HUC 8)	Peace River Basin (03100101)

Table D-2. Description of the Numeric Interpretation of the Narrative Nutrient Criterion: Provides specific list of parameters/constituents for which state numeric nutrient criteria are adopted, site specific numeric interpretation are proposed; 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

Numeric Interpretation of Narrative Nutrient Criterion	Parameter Information Related to Numeric Interpretation of the Narrative Nutrient Criterion
Numeric Nutrient Criteria (NNC) Summary: Default Nutrient Watershed Region or Lake Classification (if applicable) and corresponding numeric nutrient criteria	Lake Hollingsworth is low color (≤ 40 Platinum Cobalt Units) and high alkalinity (> 20 mg/L CaCO3), and the default NNC, which are expressed as Annual Geometric Mean (AGM) concentrations not to be exceeded more than once in any three year period, are Chlorophyll a (Chla) of 20 µg/L, total nitrogen (TN) of 1.05 mg/L – 1.91 mg/L, and total phosphorus (TP) of 0.03 mg/L – 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 = 0.86 mg/L, expressed as an annual geometric mean lake concentration not to be exceeded in any year. TP = 0.03 mg/L, expressed as an annual geometric mean 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 Criteria	The TN criterion is based on application of an empirical model developed using data from the 1999-2012. The primary dataset for this period is the IWR Run 48 database. The results of a paleolimnological study of Lake Hollingsworth were used to derive a TP concentration target because the empirical model relating chlorophyll a to TP resulted in a TP concentration less than background conditions. The paleolimnological results are presented in the following document: **Brenner, M., T.J. Whitmore, J.H. Curtis, D.A. Hodell, and C.L. Schelske. 1999. *Stable isotope (^{13}C and ^{15}N) signatures of sedimented organic matter as indicators of historic lake trophic state*. Journal of Paleolimnology 22: 205-221.**

Numeric Interpretation of Narrative Nutrient Criterion	**Parameter Information Related to Numeric Interpretation of the Narrative Nutrient Criterion**
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 area apply? In addition, for older TMDLs, an explanation of the representativeness of the data period is needed (e.g., has 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 a numeric criterion is otherwise in effect unlike this case).	The water quality results applied in the analysis spanned the 1999 - 2012 period, which included both wet and dry years. The annual average rainfall for 1999-2012 was 48.2 inches/year. The years 2000, 2006, and 2007 were dry years, 2009 to 2011 were average years, and 2002, 2004, and 2005 were wet years. Figure 3 (below) shows the sampling stations in Lake Hollingsworth. The Polk County data collected near the center of the lake at station 21FLPOLKHOLLINGSWORTH1 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 there. Water quality data for variables relevant to TMDL development are presented in graphs in the Appendix of the Lake Hollingsworth TMDL report.

Table D-3. Designated Use, Verified Impairment, and Approach to Establish Protective Restoration Targets: 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, and evaluates the current relevance of assumptions made in the TMDL development (most likely applicable for existing TMDLs that are subsequently submitted as changes to WQS); Contains sufficient data to establish and support the TMDL target concentrations or resulting loads

Designated Use Requirements	**Information Related to Designated Use Requirements**
History of assessment of designated u support.	Lake Hollingsworth was initially verified as impaired during the Cycle 1 assessment (the verified period was January 1, 1997, to June 30, 2004) due to excessive nutrients, because the Trophic State Index (TSI) threshold of 60 was exceeded using the methodology in the Identification of Impaired Surface Waters Rule (IWR) (Chapter 62-303, F.A.C.). As a result, the lake was included on the Cycle 1 Verified List of impaired waters for the Sarasota Bay-Peace River-Myakka River Basin that was adopted by Secretarial Order on June 17, 2005. During the Cycle 2 assessment (verified period of January 1, 2002, to June 30, 2009), the impairment for nutrients was documented as continuing, as the TSI threshold of 60 was exceeded. Based on an analysis of the data from 2002 to 2012 in IWR Database Run 48, the results indicate that Lake Hollingsworth would not attain the default lake NNC for chlorophyll a, TN, and TP for low color, high alkalinity lakes, and thus remains impaired for nutrients.
Quantitative indicator(s) of use support	A Chla value of 20 ug/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 titled, *Technical Support Document: Development of Numeric Nutrient Criteria for Florida Lakes, Spring Vents and Streams*, which demonstrates a Chla threshold of 20 ug/L is protective of designated uses for low color, high alkalinity lakes.
Summarize Approach Used to Develop Criteria and How it Protects Uses	The methods utilized to address the nutrient impairment included a) the development of regression equations that relate the lake TN and TP concentrations to the annual geometric mean chlorophyll a levels, and b) the evaluation of paleolimnological results to refine the water quality target for total phosphorus consistent with pre-disturbance conditions. The criteria are expressed as maximum annual geometric mean concentrations not to be exceeded in any year. Establishing the frequency as not to be exceeded in any year ensures that the chlorophyll a NNC, which is protective of the designated use, is achieved.

Designated Use Requirements	Information Related to Designated Use Requirements
Discuss how the TMDL will ensure that nutrient related parameters attained to demonstrate that the TMDL will not negatively impact other water quality criteria. These parameters mus analyzed with the appropriate frequen and duration. If compliance with 47(a not indicated within the TMDL, it sho be clear that further reductions may b required in the future.	The method indicated that the Chla concentration target for the lake will be attained at the TMDL in-lake TN concentration, frequency and duration, while taking into consideration the estimated pre-disturbance phosphorus condition in the lake. 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 D-4. Documentation of the Means to Attain and Maintain WQS of Downstream Waters

Downstream Waters Protection and Monitoring Requirements	Information Related to Downstream Waters Protection and Monitoring Requirements
Identification of Downstream Waters: List receiving waters and identify technical justification for concluding downstream waters are protected.	The nearest downstream waters to Lake Hollingsworth include Banana Lake Canal and Banana Lake. The Lake Hollingsworth watershed comprises about 16 percent of the Banana Lake basin area. The existing Lake Hollingsworth watershed TN and TP loads are 34 percent and 3 percent, respectively, of the Banana Lake basin total nutrient loadings. The Lake Hollingsworth nutrient concentration targets of 0.86 mg/L for TN and 0.03 mg/L for TP are less than the West Central Nutrient Watershed Region stream nutrient thresholds of 1.65 mg/L for TN and 0.49 mg/L for TP that are applicable to Banana Lake Canal. The West Central Nutrient Watershed Region stream thresholds, expressed as annual geometric means, may be exceeded once in a three year period and are higher than the annual geometric mean lake TMDL nutrient targets. Since the TMDL nutrient targets are lower than the stream nutrient thresholds for the area and are expressed as a frequency of “not to be exceeded in any year” the TMDL targets are clearly protective of the applicable stream thresholds. The reductions in nutrient concentrations prescribed in the TMDL are not expected to cause nutrient impairments downstream and will actually result in water quality improvements to downstream waters.
Provide summary of existing monitoring and assessment related to implementation of rule 62-302.531(4) and trends tests within Chapter 62-303, F.A.C.	Polk County conducts routine monitoring of Banana Lake, approximately three to four times per year. Future monitoring results from waters downstream of Lake Hollingsworth, and from Lake Hollingsworth itself, will be used to assess the effect of the established site specific numeric interpretation of the narrative nutrient criterion on downstream waters.

Table D-5. Documentation to Demonstrate Administrative Requirements Are Met

Administrative Requirements	Information for Administrative Requirements
Notice and comment notifications	A public workshop was conducted by the Department on March 26, 2014 in Bartow, Florida to obtain comments on the draft nutrient TMDLs for four lakes in the Peace River Basin, including Lake Hollingsworth. The workshop notice indicated that these nutrient TMDLs, if adopted, constitute site specific numeric interpretations of the narrative nutrient criterion set forth in paragraph 62-302.530(47)(b), F.A.C., that would replace the otherwise applicable numeric nutrient criteria in subsection 62-302.531(2) for these particular waters, upon paragraph 62-302.531(2)(a), F.A.C., becoming effective. No formal public comments were received at the workshop. In addition, a 30 day comment period was provided to allow opportunity for the general public to submit written comments to the Department. No formal comments were received related to the establishment of the TMDLs as the site specific interpretation of the narrative nutrient criteria or on the TMDLs themselves.
Hearing requirements and adoption format used; Responsiveness summary	The Notice of Proposed Rule for this TMDL was published in the Florida Administrative Register on November 26, 2014. No requests for a hearing were received during the 21-day challenge period. The rule for this TMDL, subsection 62-304.625(14), F.A.C., became effective on February 19, 2015.
Official submittal to EPA for review and GC Certification	

Figure 1. Location of the Lake Hollingsworth Watershed in West Central Polk County, Florida

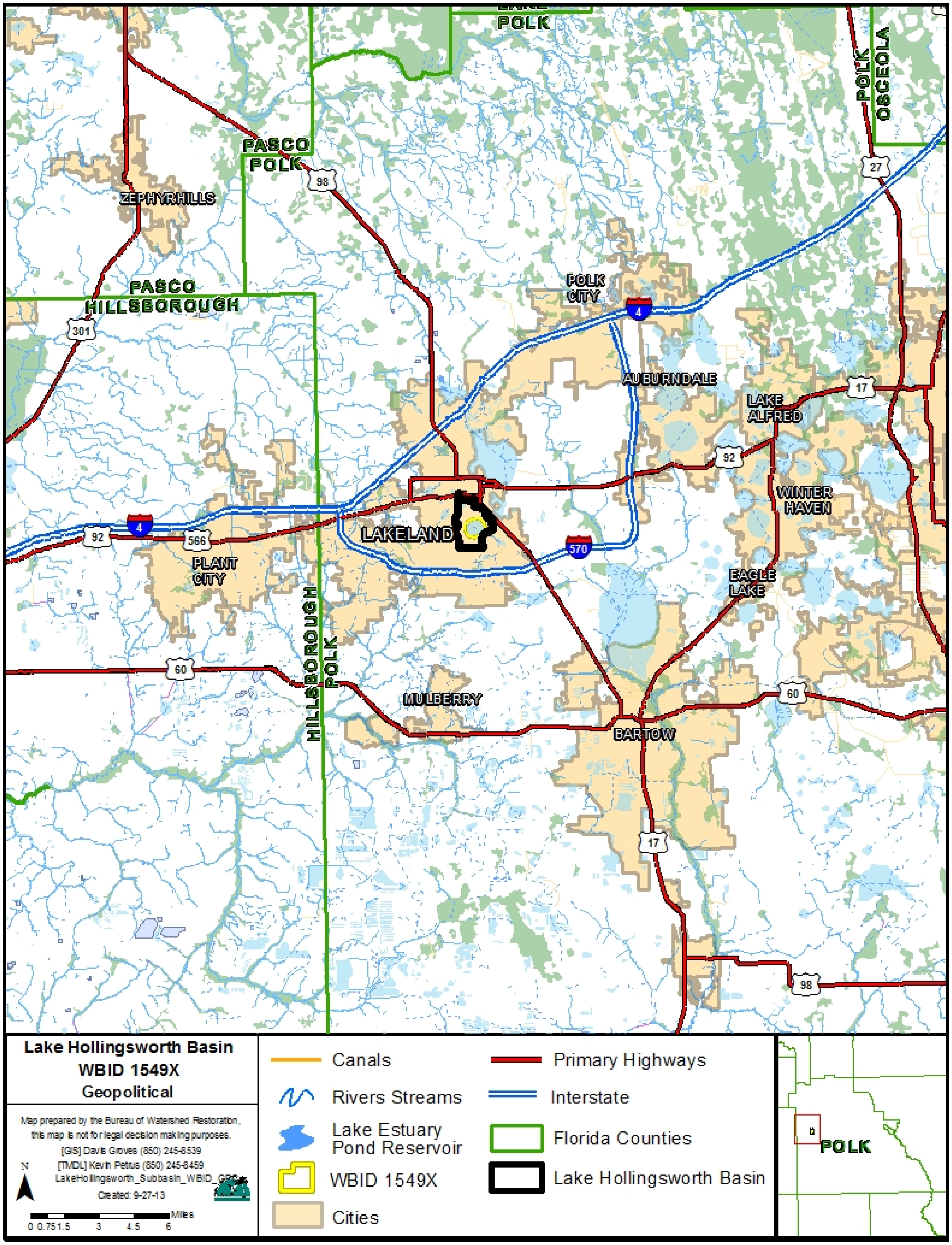


Figure 2. Lake Hollingsworth Watershed Land Use

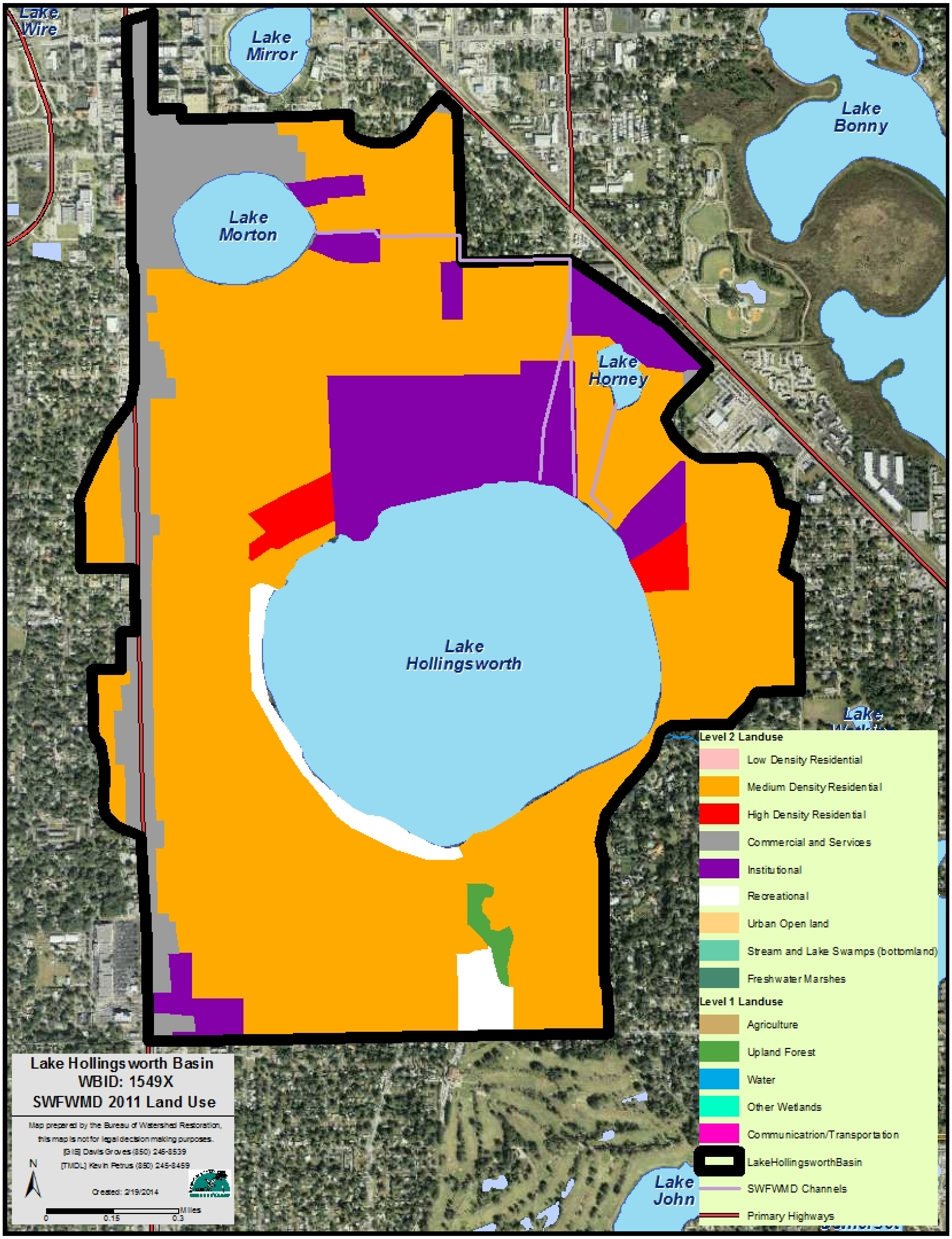


Figure 3. Lake Hollingsworth Sampling Stations