Lake Tohopekaliga Nutrient Reduction Plan

FINAL

December 2011

CDM

Acknowledgements

The Lake Tohopekaliga Nutrient Reduction Plan (NRP) was prepared as part of a locally funded effort to establish baseline nutrient loading to the lake and lay a foundation for future research needs in order to fully understand lake dynamics. This plan was developed by the Stakeholders and Technical Support Partners identified below, with participation from affected local, regional, and state governmental interests.

Entity	Technical Staff
Osceola County[1]	Kimberly Lawrence, David May
City of Kissimmee[1]	Nagel Altrui, James Arsenault, Lawrence Clough
City of St. Cloud[1]	Kevin Felblinger
City of Orlando[1]	Lisa Henry, Jim Hunt, Lisa Lotti, Nabil Muhaisen
Orange County	Julie Bortles, Catherine Johnson
Florida Department of Transportation District 5[1]	Richard Earp (ESciences, Inc.)
Florida Department of Environmental Protection	Julie Espy, Stanley Ganthier, Dianne Hughes, Keith Parmer, Kalina Warren, Tiffany Busby (Wildwood Consulting), Marcy Policastro (Wildwood Consulting)
South Florida Water Management District	Trish Burke, Christine Carlson, Kevin Carter, Mark Daron, Steffany Gornak, Tom James Brad Jones, Hiram (Raulie) Raulerson, Cecelia Weaver, Joyce Zhang
Florida Fish and Wildlife Conservation Commission	Kim Love, Martin Mann
Florida Department of Agricultural and Consumer Services	Linda Crane
Florida Farm Bureau	Charles Shinn
Reedy Creek Improvement District	Mike Crikis, Jeff Holland, Eddie Snell
University of Florida IFAS, Osceola County	Eleanor Foerste

1. Financial contributor to preparation of the NRP.

Table of Contents

Tables

Figures

Executive Summary

In the 2010 adopted verified listing of impaired waters, the Florida Department of Environmental Protection (FDEP) determined that Lake Tohopekaliga was impaired for nutrients based on an increasing trend in trophic state index (TSI). Local stakeholders including Osceola County and the City of Kissimmee disagreed with the listing and entered into discussions with FDEP over the justification for the impairment listing. An independent analysis performed by the City and the County convinced FDEP to consider modifying the cause of impairment to an imbalance of flora and fauna, which is included under the narrative nutrient criteria in Chapter 62-303, Florida Administrative Code (FAC). FDEP's decision to rely on the narrative nutrient criteria is due to the abundant growth of hydrilla that is present in the lake based on hydrilla biocover data collected by the Florida Fish and Wildlife Conservation Commission (FWCC) since 2001. Due to the complex interactions between ambient water quality, hydrilla and management activities within Lake Tohopekaliga which still have yet to be completely understood, FDEP agreed that more research and a better understanding of lake dynamics is needed before appropriate water quality targets (i.e., total maximum daily load (TMDL)) can be set for the lake. Therefore, in addition to modifying the cause for impairment, FDEP would also consider modifying the lake's assessment status from Category 5 (i.e., water quality standards are not attained and a TMDL is required) to Category 4e (i.e., impaired, but recently completed or on-going restoration activities are underway to restore the designated uses of the waterbody) if FDEP is provided assurance that measures are being put in place to reduce nutrients to the lake. As a result of this decision, local stakeholders decided to develop a Nutrient Reduction Plan (NRP) for Lake Tohopekaliga to address FDEP's requirements to facilitate the change in assessment category. For the purpose of this document, a Stakeholder is defined as those entities committing the resources to satisfy FDEP's request of preparing the NRP in order to offset the need to develop a TMDL at this time. Technical support partners consist of entities that provided technical support and resources throughout this process (**Table ES-1**).

Lake Tohopekaliga is one of the larger lakes in Osceola County and its watershed represents the headwaters of the Kissimmee Chain of Lakes (KCOL) which ultimately flow into Lake Okeechobee and the Everglades in South Florida. Lake Tohopekaliga has a surface area of about 34 square miles (22,000 acres (SFWMD, 2011)) and drains a watershed of about 473 square miles, including a large portion of both Osceola County and Orange County, the entire City of Kissimmee, City of Belle Isle, City of Edgewood and portions of the City of Orlando and the City of St. Cloud (**Figure ES-1**).

Lake Tohopekaliga is one of nineteen Central and South Florida Project water bodies in the KCOL whose lake levels and outflows are managed by the SFWMD pursuant to regulations prescribed by the Secretary of the Army, and the effect of these regulations on water quality is not entirely understood.

Several aspects of the lake are managed for purposes other than water quality (e.g., flood control, habitat) and there is still needed research on the effect these activities have on water quality.

Table ES-1
Lake Tohopekaliga Nutrient Reduction Plan
Stakeholders and Technical Resource Participants

Entity	Role
Osceola County	Stakeholder
City of Kissimmee	Stakeholder
City of St. Cloud	Stakeholder
City of Orlando	Stakeholder
Florida Department of Transportation	Stakeholder
Florida Department of Environmental Protection	Technical Support
South Florida Water Management District	Technical Support
Florida Fish and Wildlife Conservation Commission	Technical Support
Florida Department of Agricultural and Consumer Services	Technical Support
Florida Farm Bureau	Technical Support
Reedy Creek Improvement District	Technical Support
Orange County	Technical Support
University of Florida IFAS	Technical Support

The purpose of the Lake Tohopekaliga NRP is to document local efforts that achieve nutrient reductions and to provide additional time to assess the complex relationships within the lake, including the relationships among nutrients, TSI, macrophytes and other factors. The NRP will:

1) Define nutrient loading to the lake (by entity);

2) Document projects and activities identified since 2009 that result in overall nutrient reduction to Lake Tohopekaliga; and

3) Identify research needs to improve understanding of nutrient dynamics within the lake with an emphasis on how the overgrowth and management of aquatic plants have affected nutrient concentrations and interactions.

One of the important questions identified in this NRP is how nonpoint source pollution, lake level control, aquatic plant management and fisheries habitat improvement interact and the overall combined effect on the lake's water quality. Lake and watershed management is a shared responsibility of the federal, state and local municipalities. Currently municipal stakeholders control land-based pollutant loads from their respective jurisdictions that are discharged into the tributaries and the lake itself within the watershed. The stakeholders are able to regulate these discharges through enforcement of their National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit. The permit contains many elements, several of which address identification of illicit discharges, public outreach and education and local ordinances. Federal and state agencies are authorized and/or mandated to cooperatively manage hydrology, aquatic plants and fisheries habitat in consultation with local stakeholders.

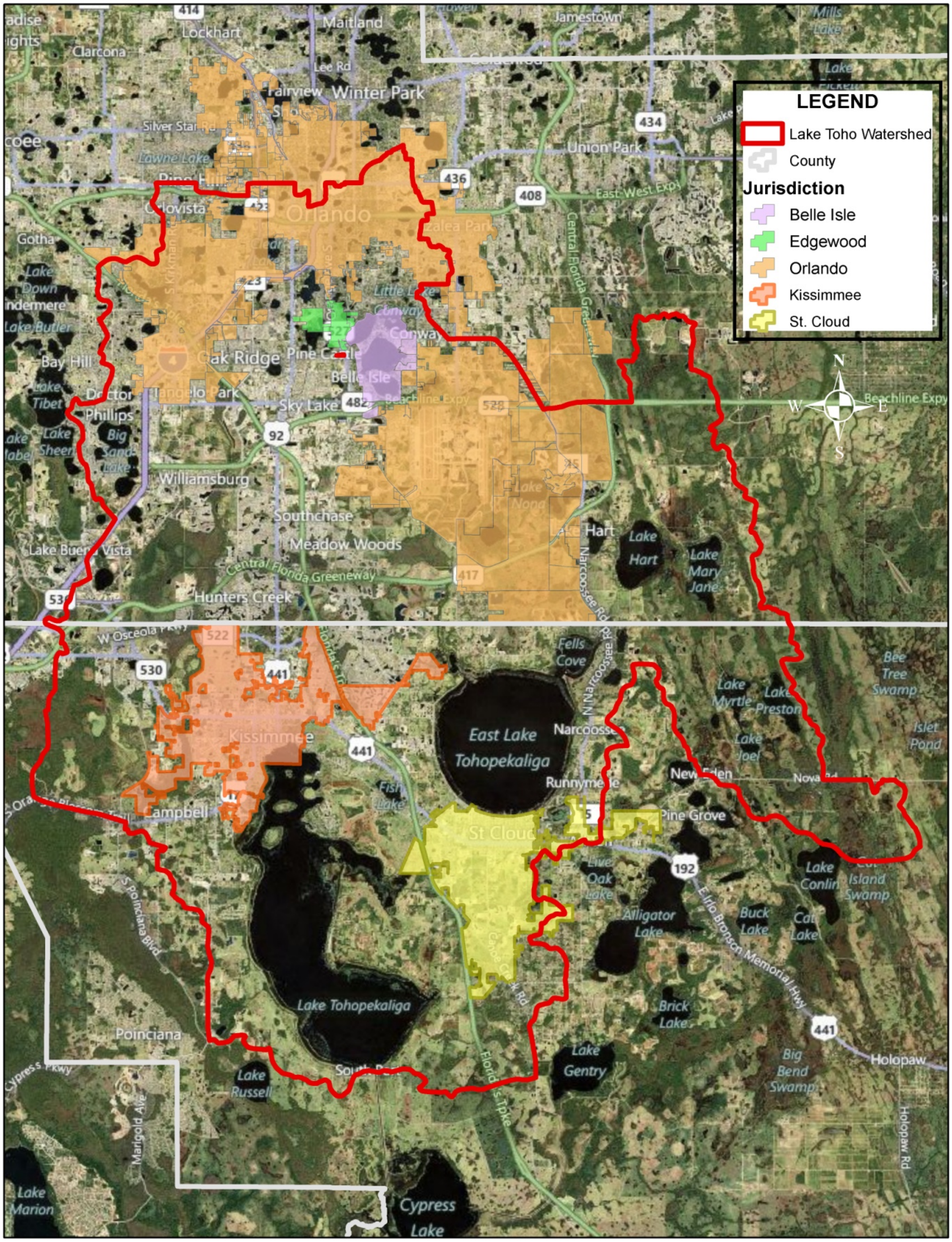

Figure ES-1 Lake Tohopekaliga Study Area

It is a goal of this NRP that the state agencies and local stakeholders will continue to collaborate to determine how nonpoint source pollution, lake level control, aquatic plant management and fisheries habitat improvement interact and the overall combined effect on the lake's water quality.

As part of the NRP, the baseline loading for total nitrogen (TN) and total phosphorus (TP) was calculated using existing models (i.e., Hydrologic Simulation Program - FORTRAN (HSPF) developed for the purposes of establishing TMDLs for the Upper Kissimmee River Basin)and available geographic information systems (GIS) tools. The year 2008 was defined as the baseline starting condition by the stakeholders. The baseline loads for 2008 represents the total load with no existing treatment in place (**Table ES-2**). The baseline loading provided in Table ES-2 represents the total load generated with no existing treatment in place. Agriculture loads were considered separately as this fall under the authority of the Florida Department of Agricultural and Consumer Services (FDACS).

Table ES-2
Baseline Pollutant Load Results by Jurisdiction[1]

Jurisdiction/ Area	Area (Acres)[3]	TN Anthropogenic Load (lbs/yr)	TN Natural Load (lbs/yr)	TN Total Load (lbs/yr)	TP Anthropogenic Load lbs/year)	TP Natural Load (lbs/year)	TP Total Load (lbs/yr)
Osceola County	103,001	180,399	83,266	263,665	21,054	4,791	25,845
City of Kissimmee	11,731	88,912	5,202	94,113	11,867	379	12,246
City of St. Cloud	8,582	56,658	3,451	60,109	6,740	251	6,991
Orange County	83,500	313,648	51,436	365,084	31,878	2,653	34,531
City of Orlando	34,302	130,501	13,281	143,782	12,792	601	13,393
FDOT	2,501	26,222	463	26,686	3,183	36	3,219
Agriculture	39,310	---	---	208,412	---	---	19,505
Other[2]	19,956	92,603	8,692	101,295	5,966	228	6,194
Totals:	***302,883***	***888,943***	***165,791***	***1,263,146***	***93,480***	***8,939***	***121,924***

1 – Load results are estimates based on modeled projections.
2 - Other is defined as areas including Reedy Creek Improvement District, Greater Orlando Aviation Authority (GOAA), Expressway and toll roads (i.e., Orlando-Orange County Expressway Authority, Osceola County Expressway Authority) Belle Isle and Edgewood.
3 - With the exception of the Agriculture category, the areas reported do not include agricultural acreage.

Using the baseline pollutant loading as the starting point for the loading analysis, it was then necessary to determine the existing load. For the purposes of this NRP, the existing load is defined as the load that takes into account treatment provided through existing stormwater best management practices (BMPs) that was in place as of 2008 (baseline year). Existing loads for TN and TP (**Tables ES-3** and **ES-4,** respectively) were calculated for the Stakeholders (i.e., those entities committing the resources to prepare the NRP) listed below only:

- Osceola County;
- City of Kissimmee;
- City of St. Cloud;
- City of Orlando; and
- FDOT.

Modeled results indicate that Stakeholders are reducing approximately 25 and 41 percent of the baseline TN and TP load, respectively, from their own jurisdictions through existing BMP treatment (Tables ES-3 and ES-4).

Table ES-3
Existing Treated TN Load Results[1] by Stakeholder

Jurisdiction/ Area	Jurisdictional Area (ac)	TN Baseline Anthropogenic Load (lbs/yr)	TN Existing Anthropogenic Load (lbs/yr)	TN Anthropogenic Load Reduction (%)	TN Natural Treated Load (lbs/yr)	TN Total Existing Load (lbs/yr)
Osceola County	103,001	180,399	140,698	22.0%	82,198	222,896
City of Kissimmee	11,731	88,912	70,175	21.1%	4,834	75,009
City of St. Cloud	8,582	56,658	42,152	25.6%	3,292	45,444
City of Orlando	34,302	130,501	68,848	47.2%	11,393	80,241
FDOT	2,501	26,222	20,848	20.5%	389	21,237
Totals:	***160,117***	***482,692***	***342,721***	***29.0%***	***102,106***	***444,827***

1 – Load results are estimates based on modeled projections.

Table ES-4
Existing Treated TP Load Results[1] by Stakeholder

Jurisdiction/ Area	Jurisdictional Area (ac)	TP Baseline Anthropogenic Load (lbs/yr)	TP Existing Anthropogenic Load (lbs/yr)	TP Anthropogenic Load Reduction (%)	TP Natural Treated Load (lbs/yr)	TP Total Existing Load (lbs/yr)
Osceola County	103,001	21,054	13,253	37.1%	4,674	17,927
City of Kissimmee	11,731	11,867	7,357	38.0%	327	7,684
City of St. Cloud	8,582	6,740	3,681	45.4%	230	3,911
City of Orlando	34,302	12,792	5,811	54.6%	435	6,246
FDOT	2,501	3,183	2,227	30.0%	27	2,254
Totals:	***160,117***	***55,636***	***32,329***	***41.9%***	***5,693***	***38,002***

1 – Load results are estimates based on modeled projections.

The Stakeholders in the Lake Tohopekaliga Watershed then provided information on projects and programs that are in place or will be implemented to reduce nutrients to Lake Tohopekaliga in the next five years. These management actions are in one of two major categories: (1) projects completed since 2009; and (2) planned projects and programs. The TN and TP load reductions associated with these projects were calculated using the same modeling tools described previously. The project load reductions have been summarized by Stakeholder in **Table ES-5**. For several projects, not enough information was available to quantify the load reduction, therefore, it is anticipated that the nutrient load removal through planned and proposed projects is higher than what is reported in Table ES-5.

Table ES-5
Project Load Reduction Summary[1]

Jurisdiction	Project TN Load Reduction (lbs/yr)	Project TP Load Reduction (lbs/yr)
City of Kissimmee	3,070	1,204
City of St. Cloud	2,529	221
Osceola County	19,154	1,844
City of Orlando	7,986	2,505
FDOT	1,380	416
Orange County[2]	225	97
Totals:	***34,344***	***6,287***

1. Load reduction results are estimates based on modeled projections.
2. These represent only management actions/activities that could be quantified without modeling.

During the formulation of the NRP, it was evident that more research is needed in order to set appropriate water quality targets for Lake Tohopekaliga and to define what the balanced condition for the lake is. Two major knowledge gaps were consistently identified throughout the stakeholder process:

1) The interaction between nutrients (external and internal loads), sediments, macrophytes and the water column; and

2) The effect of long-term management activities (i.e., lake level management, hydrilla control, habitat improvement) on the lake's ambient water quality.

Stakeholders discussed potential research needs in order to better understand lake dynamics and identify potential activities that will eventually lead to setting appropriate water quality targets. During this discussion, it was also revealed that a literature search is currently underway by the University of Florida regarding the linkage between submerged aquatic vegetation and nutrients, with an emphasis on hydrilla. It is anticipated the results of this literature search will yield information that will help refine future research needs. Therefore, it was recommended to establish research priorities that are more general in nature for the time being. Once the literature review is complete, the Stakeholders will re-convene during implementation of the NRP to refine the research needs.

A monitoring plan was developed as part of the Lake Tohopekaliga NRP and is designed to enhance the understanding of basin loads, identify areas with high nutrient concentrations, and track water quality trends. This information will be used to assess water quality conditions in the basin and determine how to best proceed with setting water quality targets. The Stakeholders and technical support partners agreed to the following objective for the Lake Tohopekaliga NRP monitoring plan:

Identify major inputs to Lake Tohopekaliga and East Lake Tohopekaliga to calculate the loading to the impaired waterbodies and to identify areas of high nutrients in the watershed.

To achieve this objective, the monitoring plan focuses on two types of parameters to track water quality trends (**Tables ES-6** and **ES-7**). The core parameters are directly related to the parameters believed by FDEP to be causing impairment in Lake Tohopekaliga. Supplemental parameters are monitored primarily to support the interpretation of the core water quality parameters and to gather additional information about the contributions from the watershed to the lake. For the first year of NRP monitoring, the minimum sampling frequency will be quarterly, which is currently budgeted by most of the Stakeholders and technical support partners. Additional samples will be collected, as budgets allow, during the first year of monitoring. The ideal sampling for the NRP monitoring plan is 12 samples per year, with nine samples collected in the wet season and three samples collected in the dry season (December through May). A monitoring network of sampling stations was also established by the Stakeholders.

Table ES-6
Core and Supplemental Water Quality Parameters for Tributaries Sampling

Core Parameters	Supplemental Parameters
Total phosphorus as P	Total suspended solids (TSS)/turbidity
Nitrate/nitrite as N	Chloride
Total Kjeldahl nitrogen (TKN) as N	True color/total organic carbon (TOC)
Dissolved oxygen (DO)	Orthophosphate as P
pH	Alkalinity
Temperature	
Conductivity	

Table ES-7
Water Quality Parameters for In-Lake Sampling

Core Parameters
Total phosphorus as P
Orthophosphate as P
Nitrate/nitrite as N
Total Kjeldahl nitrogen (TKN)
Ammonium
Nitrogen dioxide
Chlorophyll
Alkalinity
Turbidity
Chloride
Color
TSS

The Stakeholders and technical support partners will track implementation efforts and monitor water quality to measure effectiveness of the NRP. Stakeholders will meet periodically to discuss progress, research priorities and monitoring. An update will be provided to FDEP two years after NRP completion. FDEP will also require an update on research priorities within one year of completion of the NRP, so that in Year 2 the progress of research and implementation of projects can be reported.

Section 1
Context, Purpose and Scope of Plan

1.1 Water Quality Standards

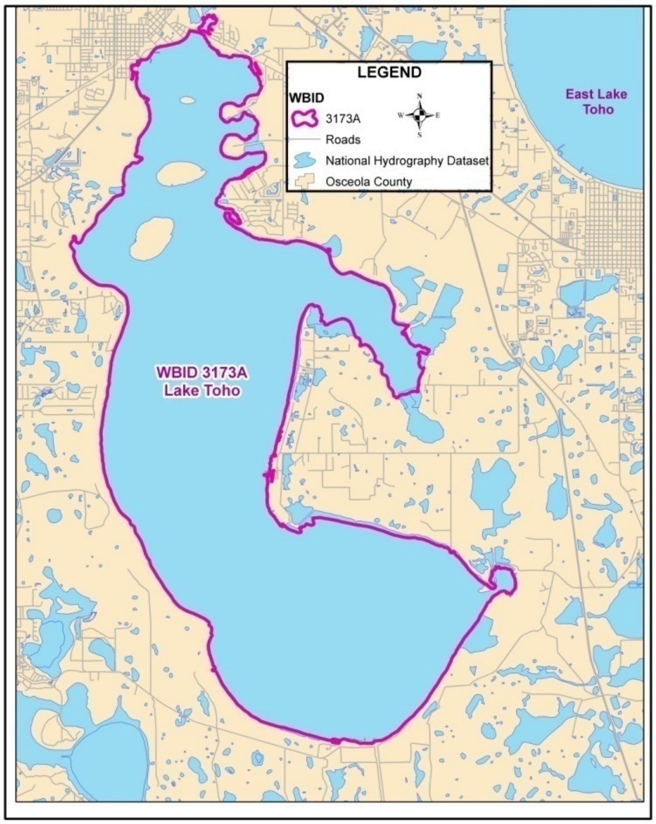

Figure 1-1 WBID 3173A (Lake Tohopekaliga)

The Impaired Waters Rule (IWR), Chapter 62-303, Florida Administrative Code (FAC), establishes a formal mechanism for identifying surface waters in Florida that are impaired (do not meet applicable water quality standards) by pollutants. Waters that are verified as being impaired by a pollutant are listed on the state's 303(d) list pursuant to the Florida Watershed Restoration Act (FWRA) and Section 303(d) of the Clean Water Act. Once listed, Total Maximum Daily Loads (TMDLs) may be developed for the pollutants causing the impairment of the listed waters. In the adopted verified listing of Lake Tohopekaliga (Toho) in 2010, the Florida Department of Environmental Protection (FDEP) found Lake Toho to be impaired for nutrients based on an increasing trend in trophic state index (TSI), which is representative of a total measure of algal biomass in the lake. FDEP defines Lake Toho as waterbody identification (WBID) unit 3173A (**Figure 1-1**). Osceola County and the City of Kissimmee entered into discussions with FDEP over the justification for the impairment listing. It was the County and the City's belief that an algal based analysis, such as the TSI, was not the most appropriate tool for assessing impairment of the lake. Based on additional information gathered by FDEP in reviewing the concerns of the City and County, FDEP determined that the cause of impairment for the lake is an imbalance of flora, based on abundant hydrilla. Florida Water Quality Standards (Chapter 62-302, FAC) provides narrative nutrient criteria (Rule 62-302.530(47), FAC), which is applied for impaired waters assessments using Rule 62-303.350, FAC as follows:

62-303.350 Interpretation of Narrative Nutrient Criteria

TSIs and annual mean chlorophyll a values shall be the primary means for assessing whether a water should be assessed further for nutrient impairment. Other information indicating an imbalance in flora or fauna due to nutrient enrichment, including, but not limited to, algal blooms, excessive macrophyte growth, decrease in the distribution (either in density or areal coverage) of seagrasses or other submerged aquatic vegetation, changes in algal species richness, and excessive diel oxygen swings, shall also be considered.

FDEP's decision to rely on the narrative nutrient criteria is due to the abundant growth of hydrilla that is present in the lake based on hydrilla biocover data collected by the Florida Fish and Wildlife Conservation Commission (FWCC) since 2001. An appropriate measure of impairment for the lake should take into account the long-term management of Lake Toho and its potential impacts on water quality. Lake Toho has been highly managed since the 1960s and a TMDL based on TSI would not accurately set appropriate water quality targets due to the complex interactions between ambient water quality, hydrilla and management activities which still have yet to be completely understood. In fact the reasons for why the lake has been managed in the past (i.e., lake level control, hydrilla coverage) may have contributed to the decline in water quality. Therefore, how the lake is mandated to be assessed for water quality in the future should also be part of the considerations for managing the lake. FDEP agreed that more research and a better understanding of lake dynamics is needed before appropriate water quality targets can be set for the lake. Therefore, in addition to modifying the cause for impairment, FDEP would also consider modifying the lake's assessment status from Category 5 (i.e., water quality standards are not attained and a TMDL is required) to Category 4e (i.e., impaired, but recently completed or on-going restoration activities are underway to restore the designated uses of the waterbody) if FDEP is provided assurance that measures are being put in place to reduce nutrients to the lake. As a result of this decision, local stakeholders decided to develop a nutrient reduction plan for Lake Toho to address FDEP's requirements to facilitate the change in assessment category.

1.2 Background

In mid-2011, Osceola County, the City of Kissimmee, the City of St. Cloud, the City of Orlando and the Florida Department of Transportation (collectively referred to as Stakeholders) decided to develop a Nutrient Reduction Plan (NRP) for Lake Toho. In addition to the Stakeholders, technical resources providing input and assistance during the development of the NRP included Orange County, Florida Farm Bureau, South Florida Water Management District (SFWMD), FWCC, and Florida Department of Agricultural and Consumer Services (FDACS).

Lake Toho is a managed system and has been altered from its natural state over time due to regulated activities by the U.S. Army Corps of Engineers (Corps), U.S. Fish and Wildlife (USFWS), FWCC and SFWMD. During the decision making process of whether to pursue the development of the NRP, the Stakeholders acknowledged several key items:

- The management of in-lake concerns for Lake Toho (i.e., lake levels, hydrilla control, habitat improvement) is ultimately the responsibility of the state agencies with consideration and input from the local municipalities;
- A better understanding is needed of nutrient dynamics in the lake and how the overgrowth and management of aquatic plants have affected nutrient concentrations and interactions;

- Although an extensive set of water quality data exists to estimate protective water quality targets for the lake, development of targets that will be effective for current impairment should take coverage of aquatic macrophytes into account; and,

- Stakeholders have the authority and responsibility to control land-based pollutant loads from their respective jurisdictions within the watershed.

1.2.1 History of Lake Tohopekaliga

Lake Toho is one of the larger lakes in Osceola County and its watershed represents the headwaters of the Kissimmee Chain of Lakes (KCOL) which ultimately flow into Lake Okeechobee and the Everglades in South Florida. Lake Toho has a surface area of about 34 square miles (22,000 acres (SFWMD, 2011)) and drains a watershed of about 473 square miles, including a large portion of Osceola County (204.5 square miles) and Orange County (147 square miles), the entire City of Kissimmee (21 square miles), City of Belle Isle (3 square miles), City of Edgewood (1.5 square miles) and portions of the City of Orlando (80 square miles) and the City of St. Cloud (16 square miles). Of the total 473 square mile watershed, approximately 17 square miles are considered closed basins and do not have a free outfall to the Lake Toho system (**Figure 1-2**).

Lake Toho is one of nineteen Central and South Florida Project water bodies in the KCOL whose lake levels and outflows are managed by the SFWMD pursuant to regulations prescribed by the Secretary of the Army, and the effect of these regulations on water quality is not entirely understood. Several aspects of the lake are managed for purposes other than water quality (e.g., flood control, habitat) and there is still needed research on the effect these activities have on water quality.

The movement of water through the KCOL is regulated by nine water control structures that were part of the Central and Southern Florida Project (C&SF Project). Prior to the C&SF Project, water from the lakes and wetlands in the KCOL overflowed natural drainage divides during wet periods and moved slowly southward through the Kissimmee River to Lake Okeechobee. In 1948, Congress authorized the Corps to build the C&SF Project to provide flood control and water supply, among other purposes. In 1954, flood control works were authorized for the Kissimmee Basin as an addition to the C&SF Project. Constructed between 1960 and 1971, the project included the dredging of canals between lakes and construction of nine water control structures to regulate lake levels and outflows (SFWMD, 2011). Alteration to Lake Toho's natural hydrology began as early as the late 1800's when the lakes in the area were channelized for steamboat traffic (Anderson and Chamberlain 2005). During this time, Hamilton Disston began excavating canals between the lakes to improve navigation and drainage of the surrounding lands. In 1902 the Rivers and Harbors Act authorized a federal dragging and snagging operation from the town of Kissimmee to Fort Basinger. Flood control works for the Kissimmee Basin were authorized by the Federal Rivers and Harbors Act of 1954 as an addition to the C&SF Project (SFWMD, 2011). Water control structures and canals regulating flows to and from Lake Toho were completed in 1964 (Blake, 1980), marking the end of natural water level fluctuations. Water levels in Lake Toho are controlled by the S-61 water control structure. This resulted in a reduction in the range of stage levels from at least 10.5 feet to a maximum of 3.6 feet (Wegener et al., 1973).

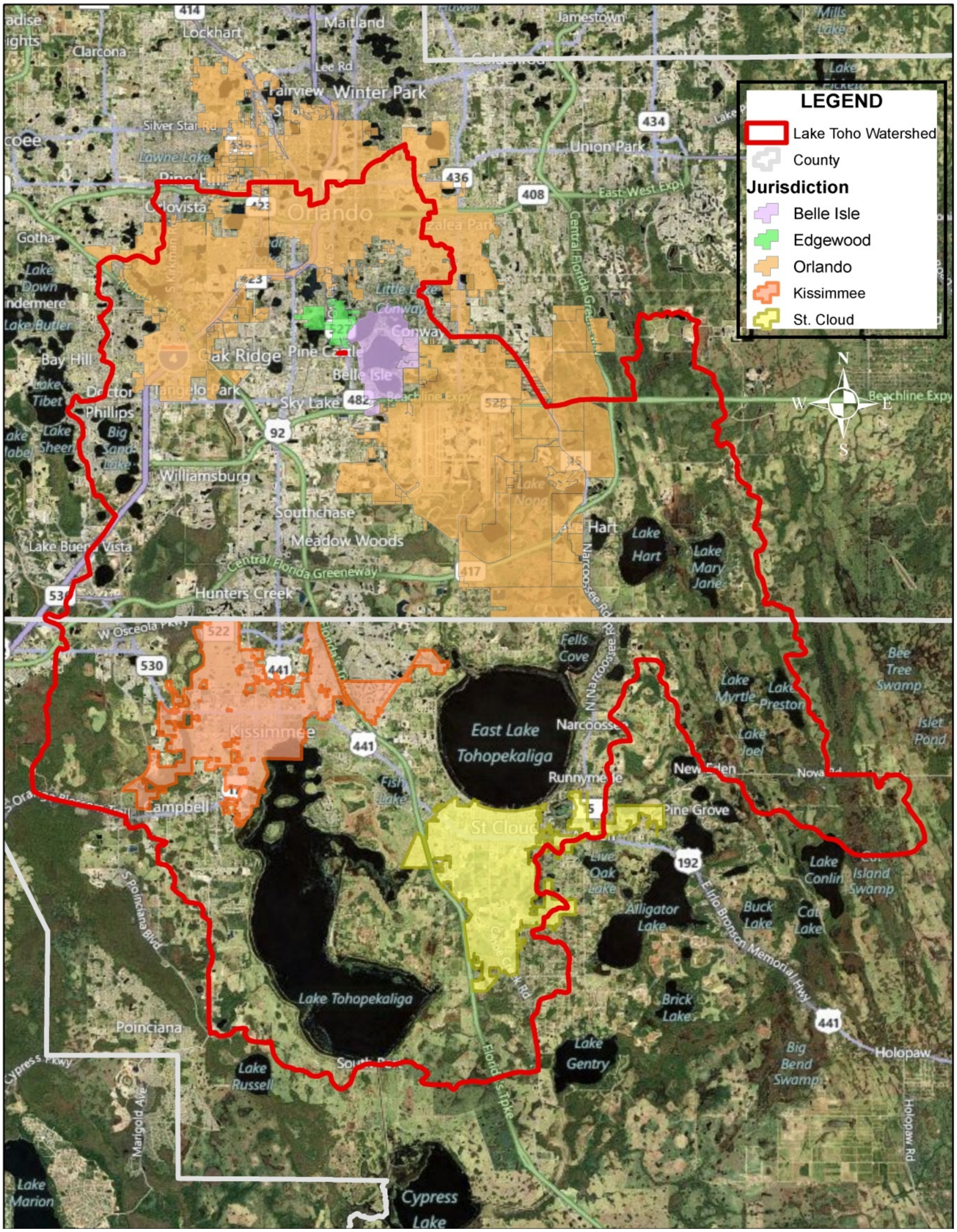

Figure 1-2 Lake Tohopekaliga Study Area

Prior to the construction of the nine water control structures, mean daily stage data were collected from sites established by the U.S. Geological Survey (USGS) during the 1930s and 1940s (Parker et al., 1955). The USGS sites were in the approximate locations of the present C&SF Project structures. Data collection began in 1941 for most of these lakes. Although these reference data pre-date water level regulation by the C&SF Project, lake water levels were most likely influenced by earlier canal construction, channelization, and construction of a federal navigable waterway between the town of Kissimmee on Lake Toho and the Kissimmee River (Anderson and Chamberlain 2005).The hydrograph for the lake has been "dampened" (i.e., peak stage has decreased and has been spread out over a longer duration) compared to its pre-regulation (i.e., 1960s) characteristics (**Figure 1-3**).

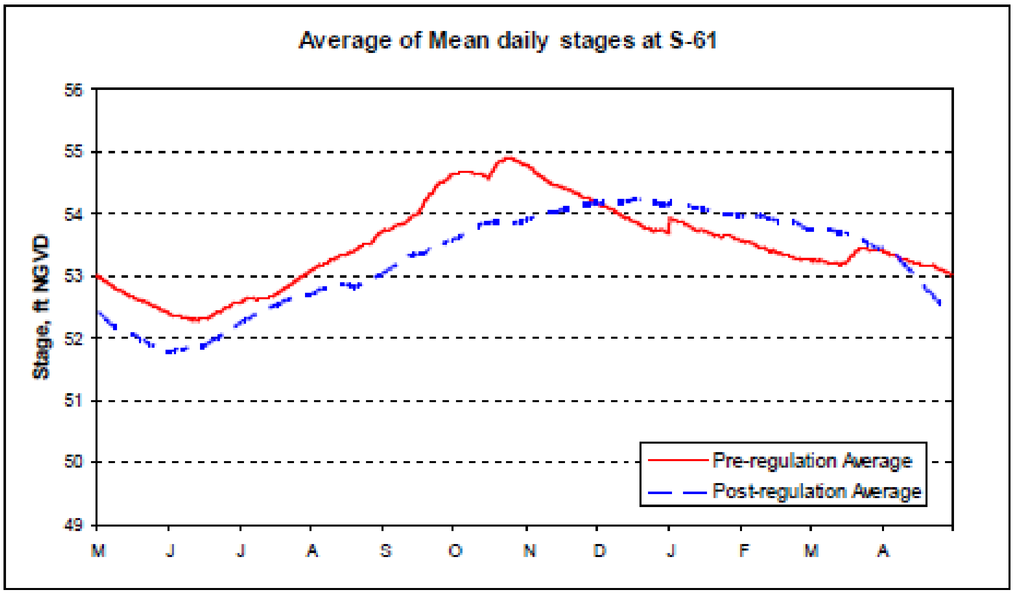

Figure 1-3 Average of Mean Daily Stage at S-61 Water Control Structure, Lake Tohopekaliga Outlet (*Source: 2011 Interagency Draft Kissimmee Chain of Lakes Long-Term Management Plan*)

Over time, water quality and wildlife habitat in the KCOL has declined. This deterioration is attributed to a number of factors, including stabilized lake water levels, landscape changes within the lake's watersheds, increased nutrient runoff, and invasion of exotic species (SFWMD, 2011). Release of nutrients, specifically phosphorus, into the water column can result when there is less turnover due to stabilized lake levels (i.e., lower water volumes). Shallower depths can also create a greater potential for wind-induced sediment re-suspension (PBS&J, 2010). For lakes such as Lake Toho, which are dominated by surface water flows and located at lower elevations, decreased lake levels can disconnect the lake from historical shoreline wetlands, reducing the benefits of wetland-derived tannins that buffer the effects of increased nutrients (PBS&J, 2008).

Municipal wastewater inputs to Lake Toho and its tributaries began in the 1940s (Wegener et al., 1973). Rapid population growth resulted in treatment plant expansions, and by the early 1960s, wastewater treatment facilities operated by Orange County and the cities of Orlando, Kissimmee, and St. Cloud were discharging secondary effluent to the lake that contained high nutrient concentrations. By the late 1960s, water quality, aquatic habitat, and biological communities within the lake were on the decline and in 1979 annual phosphorus loading to the lake was 11 times higher and nitrogen loads had nearly doubled compared to natural conditions (Williams, 2001). Frequent algal blooms were documented (Jones et al., 1983) in Lake Toho and downstream lakes in the early 1980s and elevated phosphorus concentrations were observed as far south as the northern end of Lake Kissimmee (Jones, 2005). Efforts to reduce phosphorus concentrations in effluent from the two largest point sources began in 1982, followed by complete removal of all wastewater treatment plant discharges by 1988 (SFWMD, 2011).

As conditions in the lake declined during this time period due to municipal wastewater discharges, it was also observed that aquatic habitat was deteriorating. Other major factors contributing to this deterioration were water level stabilization and nonpoint source pollution associated with development within the watershed due to rapid population growth. In 1971, the first of several major drawdowns in the lake occurred as an effort to moderate or reverse symptoms of habitat degradation, specifically to improve fisheries. The drawdown consisted of a 7-foot vertical drop in water level from high regulation stage of 55.0 feet National Geodetic Vertical Datum (NGVD) to a drawdown stage of 48.0 feet NGVD (Parmer et al., 2011). Subsequent drawdowns were conducted in 1979, 1987 and 2004. During these drawdowns, significant areas (i.e., several thousand acres) of the lake bottom were exposed and organic accumulation was removed to facilitate habitat restoration. During the 2004 drawdown, much of the removed material was formed into large piles in the shallow parts of the lake to form artificial islands (Hoyer et al., 2008).

According to the *2011 Interagency Draft Kissimmee Chain of Lakes Long-Term Management Plan* (SFWMD, 2011), recreational uses of Lake Toho include fishing, hunting (e.g., duck, frog, alligator, turkey, etc.), boating, canoeing, wildlife viewing, ecotourism, picnicking, and sightseeing. The lake is designated by the FWCC as a fish management area and is renowned for its largemouth bass, black crappie, bluegill, and redear sunfish fisheries. These fisheries attract numerous fishing tournaments and are valued in the millions of dollars to the local economy (Bell, 2006). The lake is recognized as a destination for bird watching and is the primary nesting and foraging habitat for resident populations of the endangered snail kite (*Rostrhamus sociabilis*) and endangered whooping crane (*Grus Americana*) in the KCOL. Lake Toho can also function as a refuge for the Everglades snail kites when drought conditions in southern Florida impact habitat quality for this species.

Lake levels are managed by SFWMD through a Corps approved regulation schedule that provides for operational flexibility. SFWMD, the Corps and USFWS routinely collaborate on how best to use this operational flexibility to accommodate snail kite nesting and foraging and to support snail kite population recruitment. Lake Toho's water level is regulated through the S-61 structure. The regulation schedule prescribes a seasonal water level to manage within. The lake level is regulated at an elevation of 55.0 feet NGVD from November through March, followed by a spring recession to elevation 52.0 feet NGVD. Water levels are returned to the summer pool at elevation 53.5 feet NGVD at the start of the rainy season (June 1) and slowly returned to the high pool elevation of 55.0 feet during September and October. The minimum elevations are intended to preserve minimum flows downstream (SFER, 2009).

Control of hydrilla (*Hydrilla verticillata*) has been a challenge in Lake Toho since the 1980s. FWCC is the agency responsible for managing hydrilla in the lake and has been doing so since 2008. Areal coverage of hydrilla has reached levels of up to 80 percent of the lake in the recent past and the majority of the lake is infested at densities not seen in other lakes in the KCOL (except Cypress Lake). With a standing crop of more than 12,000 acres reported in 2008, Lake Toho is one of the most heavily hydrilla-infested waters in the state. Nearly 4,700 acres of hydrilla were controlled in Lake Toho during fiscal year 2007-2008 at a cost of $3.03 million (SFWMD, 2011). Prior to 2008, FDEP administered the invasive plant management program and the policy implemented at that time was to maintain the target plant population at the lowest feasible level as determined by the Department. FWCC's current position is that for waterbodies where hydrilla is already well established, it will be managed at levels that are commensurate with the primary uses and functions of that waterbody as well as fish and wildlife (FWCC, 2011). This constitutes a significant shift in policy of management approaches. Currently one of the primary functions of hydrilla in Lake Toho is to support the endangered snail kite population, and is thus being managed by FWCC for that purpose.

The dominance by hydrilla raises several concerns for water management and potential problems for fish and wildlife. The high density leads to concerns that the plants could exacerbate flooding by blocking water movement. A high density of submersed plant material interferes with natural wind mixing and flow patterns of the lake. At high densities the plant creates a less favorable environment for fish (limits foraging) and leads to declines in fish populations. Dense mats of hydrilla also interfere with feeding by snail kites. Like most submersed plants, hydrilla obtains most of its nutrients from the sediments (Schardt, 2011), but after treatment with herbicide dead plants contribute to the build-up of organic sediments and storage of nutrients in the sediment. Because lake water levels tend to rise and fall quickly in response to large rainfall events, Osceola County becomes concerned with flood event storage whenever Lake Toho water levels are within 0.5 feet of its maximum regulatory water levels. Thus floating invasive plants and hydrilla are managed at the lowest feasible levels adjacent to inflows and outfalls to prevent water from backing up during high flow periods (Parmer 2011).

Conversely, hydrilla has also shown to provide benefit to the lake as well. Research has shown that a certain balance of hydrilla increases young-of-year fish abundance, is an excellent substrate for macroinvertebrates, improves water clarity (and thus water quality) and provides desirable habitat for endangered species such as the snail kite (Mann, 2011).

Aquatic plant management in the KCOL has been complicated by the changing responses of hydrilla to herbicides, evolving lake level management requirements of the Kissimmee River Restoration Plan (KRRP), and snail kites (SFWMD, 2011). Because of the critical need for snail kites to raise more offspring next year and the unexpected large losses of hydrilla in past recent years, the FWCC and the USFWS took a cautious approach to controlling hydrilla in the winter of 2010-2011. To ensure that snail kites will have hydrilla during the early nesting season of 2011, hydrilla was controlled only in areas of the lake where water must flow freely for flood-control purposes, where it restricts boat access at public boat ramps, and where the majority of navigation is likely to occur (Parmer et al., 2011).

According to the *2011 Interagency Draft Kissimmee Chain of Lakes Long-Term Management Plan* (SFWMD, 2011), the presence of hydrilla in the lake may be potentially masking a nutrient impairment. The SFWMD has also identified Lake Toho as the top ranked management priority in the KCOL because of the size of the resource, the value of fish and wildlife assets, the economic value of recreational activities on the lake, and the number of existing and anticipated management challenges.

1.3 The Lake Tohopekaliga Nutrient Reduction Plan

In light of Lake Toho's history and complex management facing the resource as well as FDEP's consideration of modifying the lake's assessment status, the Stakeholders decided in mid-2011 to embark on developing the NRP. There were several benefits to this approach identified throughout the overall process. Developing the NRP prior to state or federal action (i.e., a TMDL) is a proactive way for Stakeholders and agencies to determine the most efficient and effective management of the lake. The

NRP also delays the TMDL regulatory process while a better understanding of the lake's nutrient dynamics is gained. The TMDL process does not always allow for ample time to collect additional data, gain a better understanding of the system in question and establish realistic and appropriate water quality targets. As a result of the NRP, Stakeholders will be credited for proactive efforts to reduce nutrients within the Lake Toho watershed. These credits could also apply to other downstream impaired waters (i.e., Lakes Cypress and Kissimmee). If reductions are deemed to be substantial and successful, Stakeholders may not have further reductions assigned to them for impairments identified in the future. The process also allows Stakeholders and the public involved to take ownership of the successes in improving the lake's water quality and demonstrates commitment to environmental resources and sustainability.

1.3.1 Plan Purpose and Scope

The purpose of the Lake Toho NRP is to document local efforts that achieve nutrient reductions and to provide additional time to assess the complex relationships within the lake, including the relationships among nutrients, TSI, macrophytes and other factors. The NRP will:

1) Define baseline nutrient loading to the lake (by entity);

2) Document projects and activities identified since 2009 that result in overall nutrient reduction to Lake Toho; and

3) Identify research needs to improve understanding of nutrient dynamics within the lake with an emphasis on how the overgrowth and management of aquatic plants have affected nutrient concentrations and interactions.

Lake and watershed management is a shared responsibility of the federal, state and local municipalities. Currently, municipal stakeholders control land-based pollutant loads that are discharged into the tributaries and the lake itself within the watershed. The stakeholders regulate these discharges through enforcement of their National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit. The permit contains many elements some of which include identification of illicit discharges, public outreach and education and local ordinances. Federal and state agencies are authorized and/or mandated to cooperatively manage hydrology, aquatic plants and fisheries habitat in consultation with local stakeholders. While the stakeholders actively participate in the process regarding management of Lake Toho and are provided the opportunity to offer input, the overall management of the hydrology, aquatic plants and fisheries habitat is ultimately the responsibility of the state agencies. It is a goal of this NRP that the state agencies and local stakeholders will continue to collaborate to determine how nonpoint source pollution, lake level control, aquatic plant management and fisheries habitat improvement interact and the overall combined effect on the lake's water quality.

1.3.2 Major Inputs and Potential Nutrient Sources

Major hydrologic inputs into Lake Toho include Shingle Creek, East Lake Toho and localized stormwater runoff (**Figure 1-4**). Shingle Creek is the largest tributary discharging into Lake Toho and represents 34 percent of the total inflow into that lake. East Lake Toho is connected to Lake Toho via the C-31 (St. Cloud) Canal and flow into Lake Toho is regulated by the S-59 structure. The two major inflows into East Lake Toho are Boggy Creek and the C-29B (Ajay-East Toho) Canal. Boggy Creek is the largest tributary discharging into East Lake Toho and enters at the northwestern corner of the lake and contributes approximately 69 percent of the total inflows to the lakes. The Ajay-East Toho Canal discharges water into East Lake Toho from Lakes Hart and Mary Jane (SFWMD, 2011).

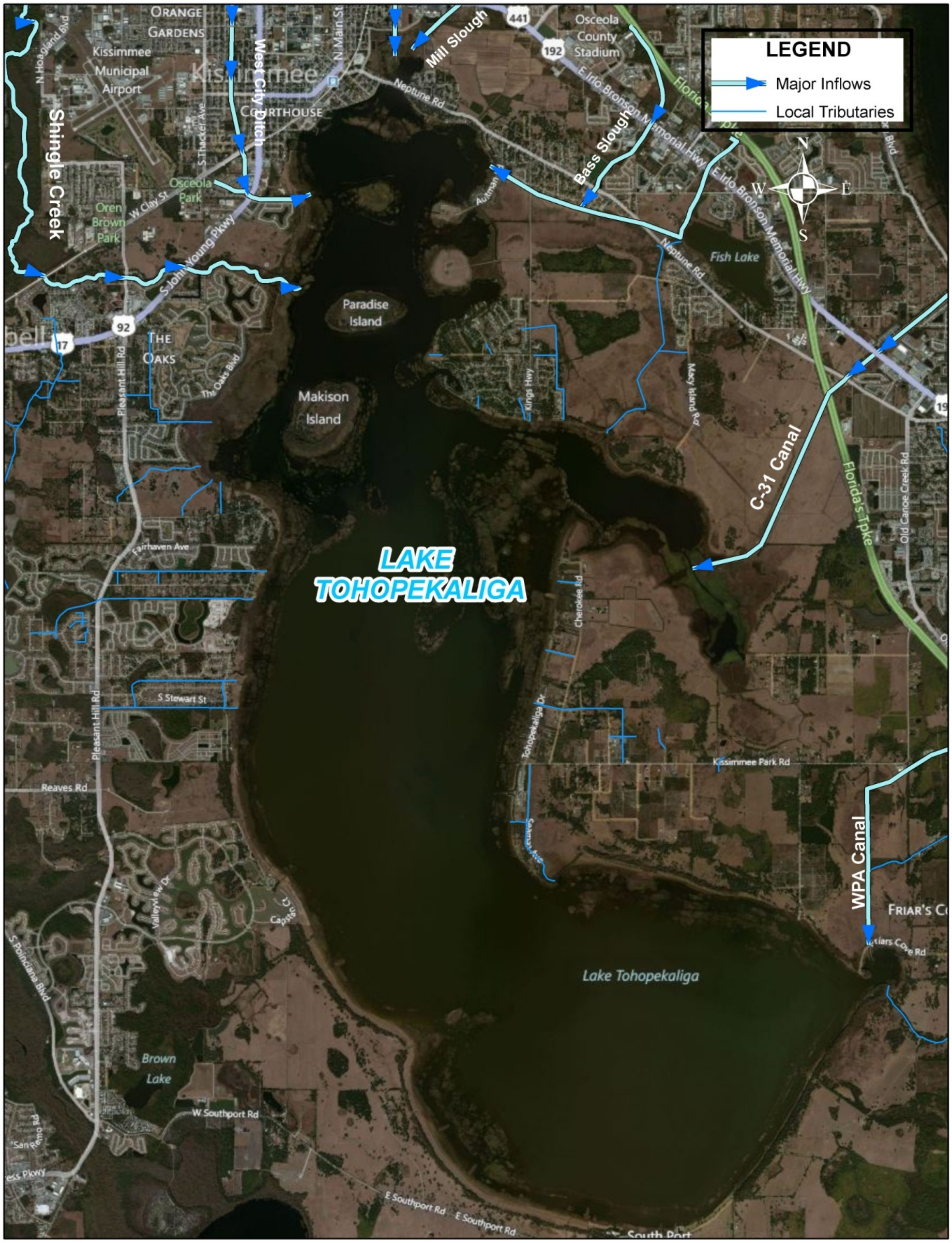

Figure 1-4 Major Inflows of Tributaries and Stormwater into Lake Tohopekaliga

Stormwater runoff in the watershed has also increased over the years due to development and alteration of the landscape. The increased urbanization of this basin is evidenced by increased density of housing that contributes to increased flow and volumes entering the lake. Stormwater regulations implemented by the SFWMD help to manage and reduce the impact of stormwater, but do not completely address all stormwater runoff or the nutrient loading carried by that runoff. Development constructed before 1982 generally does not include stormwater treatment unless it has been retrofitted (Parmer et al., 2011). Based on the SFWMD's draft 2008/2009 existing land use, the Lake Toho watershed generally consists of 37 percent urbanized land uses while the remaining 63 percent is agriculture or natural lands.

Previous land use activities (e.g., wastewater inputs, agriculture) have increased phosphorus (i.e., legacy) in soils of the Lake Toho and the larger Lake Okeechobee watersheds. This legacy phosphorus is present as the result of historical anthropogenic activities and may be available for transport. There is also antecedent phosphorus that occurs naturally in soils based on the native properties of the soils and atmospheric (dry and wet) deposition. It is recognized that atmospheric deposition has risen due to anthropogenic activities (HDR, 2010).

A detailed nutrient budget specific to Lake Toho has not been evaluated since 1992. A nutrient budget was created by James et al. (1994) for the eleven year period from 1982 to 1992. This budget specifically addressed the loading reductions found with the removal of direct wastewater discharges into tributary streams and a lake level drawdown and muck removal project in 1987. It was estimated that on average, the TP load to the lake was about 78 tons/year before 1987, and it was reduced to 26 tons/year after 1988. A similar reduction was measured for TN loading with 578 tons/year before 1987 and 202 tons/year after 1988. Over that 11 year period, the lake was a net TP sink with the exception of 1990. Conversely, the lake acted as a net exporter of TN for 8 of the 11 years (James et. al., 1994).

The SFWMD recently (2010) completed a nutrient budget for the entire Lake Okeechobee watershed (HDR, 2010). The study consisted of collecting data from landowners and local agencies and businesses to characterize phosphorus and nitrogen import and export practices for relevant land uses within specific regions. This information was assessed to develop phosphorus and nitrogen import coefficients for each land use in each region/sub-watershed. A graphical user interface (GUI) was used to perform the nutrient budget analysis for the Lake Okeechobee watershed. This nutrient budget showed that the Lake Toho watershed is a net importer of both nitrogen and phosphorus. Lake Toho has a net import of about 213 and 1,714 tons of phosphorus and nitrogen, respectively, on an annual basis. The study concluded that while urban land uses only comprise 12 percent of the Lake Okeechobee watershed, they represent 29 percent of the total net phosphorus import. Most of the urban land uses are located in the Upper Kissimmee region. The extensive lake system in the Upper Kissimmee River Basin is providing significant retention and nutrient buffering for the water passing through them. There is concern that if the water quality of these lakes and nutrient retention capability declines, their nutrient buffering capacity may also decline resulting in increased nutrient discharges to the Kissimmee River and Lake Okeechobee.

Since the cessation of wastewater discharges, nonpoint source nutrient runoff to the lake continues to be a concern; however, the SFWMD is cooperating with FDEP, FDACS, and local governments to reduce runoff from agricultural and non-agricultural sources. A detailed nutrient budget specific to Lake Toho would identify and quantify inputs and outputs of nutrients to the lake and can either be watershed (i.e., land use) focused or lake focused. The SFWMD has indicated that they may develop this as future funding allows. Previous efforts to develop nutrient budgets have focused on either a certain time period or the larger Lake Okeechobee watershed as described below.

1.3.3 Entities Generating or Managing Pollution Sources

The following sections identify and briefly discuss the major categories of pollutant sources that exist and the entities responsible for managing these sources.

1.3.3.1 Domestic and Industrial Wastewater Sources

There are no current facilities discharging wastewater into the Lake Toho watershed (FDEP, 2011), although there were historical wastewater discharges that contributed to the degradation in water quality and sediment and associated phosphorus build up in the lakes. Domestic sewage treatment plants discharged into the Shingle Creek and Boggy Creek watersheds as early as the 1940s and by 1986 an estimated 30 million gallons a day were being discharged. (Wegener et al., 1973) To address growing problems in the lakes, rapid infiltration basins (RIBs) were established beginning in 1988 to dispose of treated wastewater into groundwater and to eliminate direct wastewater discharges to these surface waters. (Parmer et al., 2011) Wastewater facilities and RIB discharges in the Lake Toho watershed are regulated by Florida Department of Environmental Protection Central District, located in Orlando.

1.3.3.2 Agricultural Runoff

Agricultural runoff also contributes to nutrient loads in the Lake Toho region. The nutrient concentration of agricultural runoff varies depending on soil type, crop type, fertilizer types, fertilizer application practices, irrigation techniques, and soil control measures. Nutrients from agricultural activities can reach surface waters through direct surface flows, surficial groundwater flows, and through sediment loss into surface waters. As of 2009 in the Lake Toho watershed, there were about 35,186 acres in cropland, pasture and improved pasture as well as 2,936 acres in citrus groves (**Table 1-1**). Rangeland and ornamental nurseries comprise the remaining crop types, for a total agricultural area of approximately 39,310 acres.

Table 1-1
Lake Tohopekaliga Nutrient Reduction Plan
Estimated 2009 Agricultural Land Use Acreages by Commodity

Agricultural Land Use Type	Estimated Acres in 2008/2009
Cropland and Pasture	35,186
Nursery-Ornamentals	302
Other/General	886
Citrus/Tree Crops	2,936
Total:	**39,310**

Source: SFWMD, 2011.

Use of erosion and sediment controls and appropriate irrigation and fertilizer practices are the responsibility of the individual growers. The State of Florida has adopted best management practice (BMP) manuals for the various types of agricultural commodities to provide guidance to growers on in-field management techniques to prevent erosion and pollution migration to surface waters. Growers who sign notices of intent (NOIs) for the BMPs applicable to their crop type, location, and site attributes are provided a presumption of compliance with nutrient control requirements. FDACS administers the Florida BMP program and works with growers on which practices apply to their sites. The Florida Farm Bureau also works to educate growers on their responsibilities and to convey issues related to water quality impairments. In cases where growers fail to sign NOIs or perform prescribed water quality monitoring in lieu of BMP implementation, enforcement responsibilities are performed by FDEP and/or SFWMD.

When used, the BMPs reduce the quantity of sediments and nutrients that are released into surface waters. Even with the use of BMPs, however, not all agricultural loads are eliminated and agricultural land uses can still be sources of nutrients. Additionally, even when intensive agricultural practices are discontinued, the legacy agricultural soils can remain rich in nutrients and continue to release higher nutrient concentrations than the new land use would suggest.

1.3.3.3 Urban Stormwater Runoff

Urban stormwater sources contribute nutrient loads to the basin either through direct sheetflow to the lakes, surficial groundwater flows, or with the tributaries that flow into Lake Toho and East Lake Toho. Common sources of nutrients in urban stormwater include fertilizers, leaves and lawn maintenance waste, pet and domestic animal waste, runoff from road and impervious surfaces, malfunctioning septic tank systems, and, in some cases, wastewater collection system problems such as exfiltration from the sewer collection system, lift station failures, and sanitary sewer overflows.

Control and maintenance of urban stormwater are the responsibility of the local government entity or special district with water management responsibilities. Some urban stormwater entities hold municipal separate storm sewer (MS4) permits which define their specific stormwater management responsibilities. MS4-Phase I permits are issued to large or medium sized jurisdictions, based on their applicable U.S. Census Bureau population data. MS4-Phase II permits are issued to smaller jurisdictions and have fewer management responsibilities, although areas that do not meet the minimum population criteria can still be designated by FDEP as permittees. Some stormwater entities do not hold MS4 permits, but they still convey and control urban stormwater that discharges into surface waters of the state. Ten urban stormwater entities in the basin have been issued stormwater permits (**Table 1-2**).

Table 1-2
Lake Tohopekaliga Nutrient Reduction Plan
Urban Stormwater Entities in the Lake Tohopekaliga and East Lake Tohopekaliga Basins

Urban Stormwater Entity	MS4-Phase I Permittee	MS4-Phase II Permittee	No/Other MS4 Permit
City of Kissimmee		X	
City of Orlando	X		
City of St. Cloud		X	
Florida Department of Transportation-District 5	X	X	
Greater Orlando Airport Authority[1]			X
Orange County	X		
City of Belle Isle	X		
City of Edgewood	X		
Osceola County		X	
Reedy Creek Improvement District	X		

1. Multi-Sector Generic Permit (MSGP) holder for stormwater discharge associated with industrial activity.

Permitted urban stormwater sources are required to promote source controls to minimize pollutant inputs to stormwater and also to provide some treatment for pollutants of concern through structural BMPs or maintenance activities. Even with the use of urban BMPs and source controls, some nutrient loads usually remain in stormwater discharges.

1.3.3.4 Atmospheric Deposition

The atmosphere is also a source of nitrogen inputs, either through dry particles settling on the water or land surfaces, or through wet deposition from rainfall. Atmospheric deposition of nitrogen can be significant and is generated through a variety of local, regional and international sources. Local sources include vehicles with internal combustion engines, fires, and power plants. Regional sources include vehicles, industrial sources and power plants that are upwind of the region, while recognizing that wind direction can vary based on weather conditions. International sources can also be a factor for particles that are transferred into the upper atmosphere and then fall as atmospheric conditions release them. Although atmospheric sources are often considered to be uncontrollable, local factors such as changes automobile fuel sources and rates of use, as well as power plant fuel changes and air stack improvements can change the rate of atmospheric deposition locally. Long term weather conditions such as droughts and El Niño/La Niña shifts can also affect the quantity of nitrogen deposition that occurs in a given area. The FDEP is responsible for air emission permits under delegation from the U.S. Environmental Protection Agency and the federal Clean Air Act.

1.3.4 Stakeholder Involvement

In order to prepare the NRP, a stakeholder process was initiated in mid-2011. The stakeholder process provided an opportunity for local, regional and state governments (as well as other third party interest) to: participate in and help drive the process; provide data and research input into the development of the NRP documentation; and provide feedback on the final developed NRP.

The stakeholder group consists of the local, regional, and state agencies interested in Lake Toho and the technical support group consists of entities that provided technical support and resources throughout this process (**Table 1-3**). For the purpose of this document, a Stakeholder is defined as those entities committing the resources to satisfy FDEP's request of preparing the NRP in order to offset the need to develop a TMDL at this time. These Stakeholders are also regulated under the National Pollutant Discharge Elimination System (NPDES) MS4 program. Technical support partners including Orange County and the Reedy Creek Improvement District (RCID) are also regulated under the MS4 NPDES program. As permittees, the Stakeholders are legally responsible for stormwater discharges to their local MS4 and certain regulatory processes (such as TMDLs) are enforceable through the NPDES MS4 permit. Stakeholders and technical resource participants were routinely contacted to identify upcoming meetings and provided meeting presentation material, minutes of meetings, and other material useful to the understanding of the process.

Table 1-3
Lake Tohopekaliga Nutrient Reduction Plan
Stakeholders and Technical Resource Participants

Entity	Role
Osceola County	Stakeholder
City of Kissimmee	Stakeholder
City of St. Cloud	Stakeholder
City of Orlando	Stakeholder
Florida Department of Transportation	Stakeholder
Florida Department of Environmental Protection	Technical Support
South Florida Water Management District	Technical Support
Florida Fish and Wildlife Conservation Commission	Technical Support
Florida Department of Agricultural and Consumer Services	Technical Support
Florida Farm Bureau	Technical Support
Reedy Creek Improvement District	Technical Support
Orange County	Technical Support
University of Florida IFAS	Technical Support

The remaining sections of the NRP will address water quality trends within Lake Toho, proposed management actions, research priorities and water quality monitoring.

Section 2
Identification of the Impaired Waters

2.1 Lake Tohopekaliga Impairment History

FDEP has divided the state into five basin groups for assessment of water quality status, and these groups are evaluated on a five-year cycle to determine if the waterbodies within each basin are meeting the state's water quality standards. Lake Tohopekaliga (Toho) is in the Kissimmee River Basin, which is part of Group 4.

In 1998, Lake Toho was listed as impaired for unionized ammonia, nutrients, and mercury in fish tissue on the State of Florida's 303(d) list. The next evaluation of the Group 4 basins occurred in 2006, and this Cycle 1 assessment was based on data from 1998-2005 (Parmer et al., 2011). During this evaluation, Lake Toho was found to be no longer impaired for unionized ammonia and nutrients, and these parameters were removed from the 1998 303(d) list of impairments. However, the lake continued to be impaired for mercury in fish tissue. East Lake Toho was also listed as impaired for mercury in fish tissue in the Cycle 1 assessment. Many of the waterbodies in the state have this impairment, and the majority of the mercury is from atmospheric deposition. FDEP is currently developing a statewide plan to address the mercury impairments.

The Cycle 2 assessment for the Group 4 waterbodies was completed in 2010 and was based on data from the verified period (VP), which is defined as January 1, 2003 through June 30, 2010. Lake Toho remained impaired for mercury in fish tissue and was also found to be impaired for nutrients based on TSI. The nutrient impairment was included because there was an increasing trend in TSI over the data period, as described in more detail below. East Lake Toho was also listed as impaired for nutrients in Cycle 2 because the TSI values exceeded the threshold of 40 TSI units in 2009 (Parmer et al., 2011).

2.1.1 Water Quality Trends

TSI is a calculation that uses TN, TP, and chlorophyll-a concentrations, and is dependent on the TN/TP ratio. When the ratio of TN /TP is less than 10, the system is considered to be limited by TN. If the ratio of TN/TP is greater than 10 but less than 30, productivity can be limited by either TN or TP. When TN/TP is greater than 30, the system is considered to be limited by TP (Parmer et al., 2011). Based on the period of record, Lake Toho is co-limited by TN and TP (see **Figure 2-1**), whereas East Lake Toho is TP limited.

The color in the lake also affects the TSI threshold for meeting water quality standards. If the color is 40 platinum cobalt units (PCU) or less, 40 is used as the TSI assessment threshold. If the color is greater than 40 PCU, 60 is used as the TSI threshold. Lake Toho was originally listed as impaired in the Cycle 2 assessment because the color in 2007 fell below 40 PCU (**Figure 2-2**). This meant the TSI threshold was 40. Since the lake did not meet the threshold

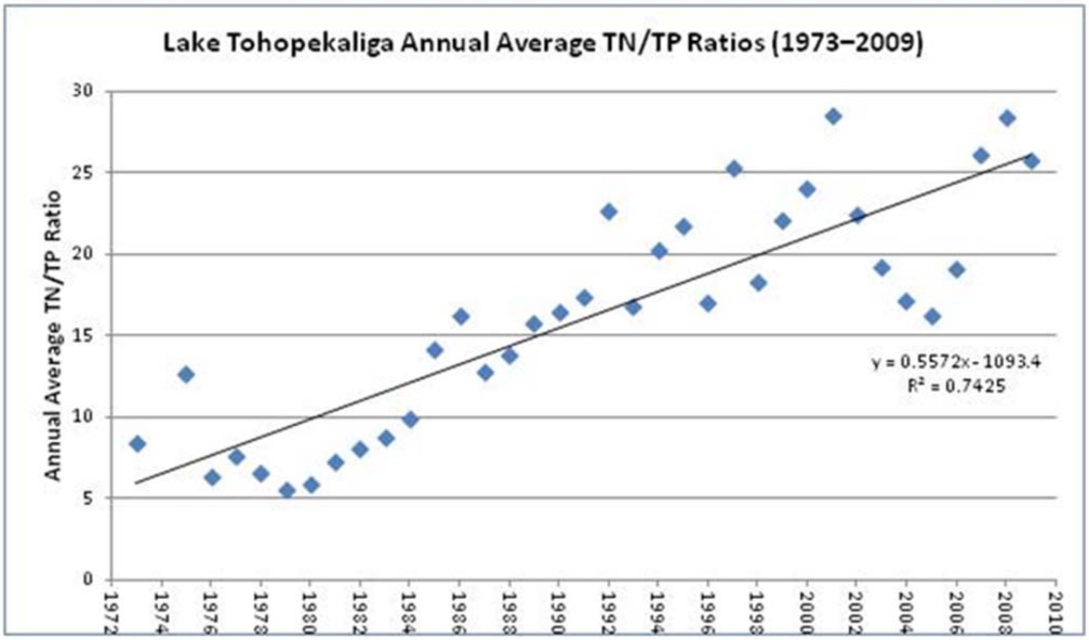

Figure 2-1 Trend in Lake Tohopekaliga TN/TP Ratio (Source: Parmer et al., 2011)

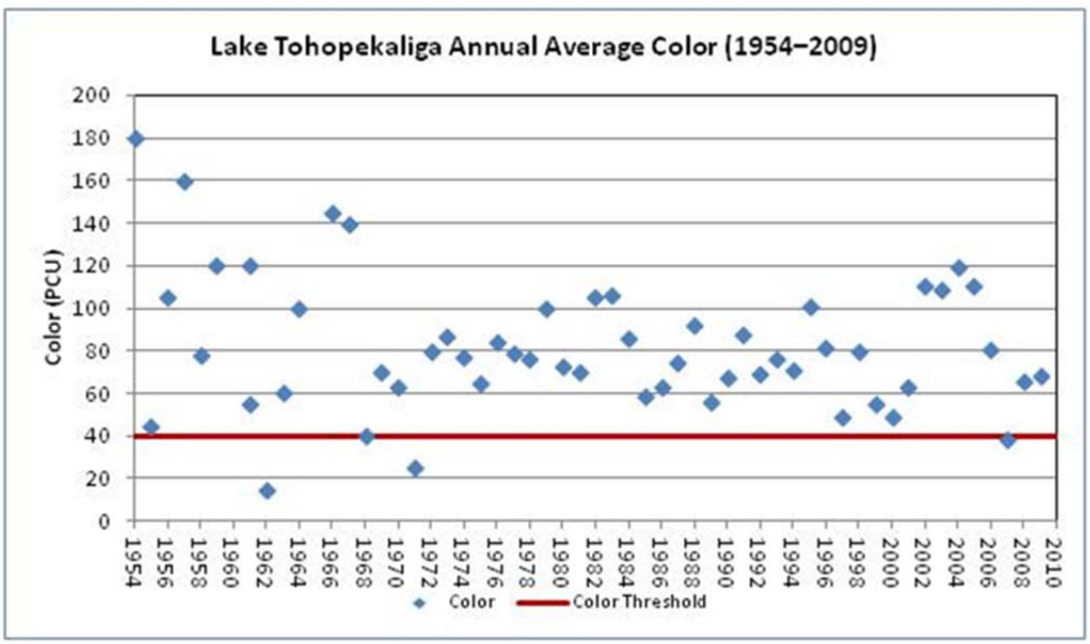

Figure 2-2 Annual Average Color Values for Lake Tohopekaliga (Source: Parmer et al., 2011)

of 40, it was considered impaired. Historically, Lake Toho is a colored lake, although there have been a few times in the period of record where the color has fallen below 40 PCU (see Figure 2-2). After the Cycle 2 draft list of impaired waters was released, FDEP obtained additional data that resulted in an increasing trend in TSI over the data period. The TSI trend analysis indicated that there was a greater than five unit increase in the TSI over the period of analysis, as shown in **Figure 2-3** (Parmer et al., 2011). Therefore, Lake Toho was determined by FDEP to be impaired for an increasing trend in TSI.

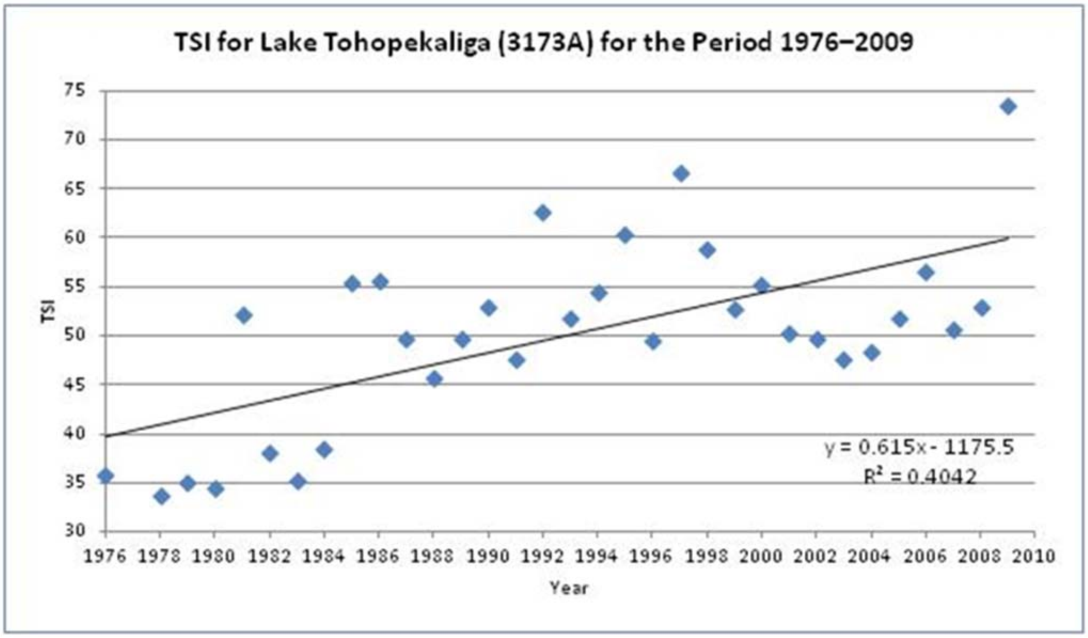

Figure 2-3 Trends in Lake Tohopekaliga TSI (Source: Parmer et al., 2011)

The TN, TP, and chlorophyll-a data for Lake Toho were also analyzed separately by FDEP. TN (**Figure 2-4**), TP (**Figure 2-5**), and chlorophyll-a (**Figure 2-6**) have all decreased over the period of record. However, the TN/TP ratio has increased over this same period (see Figure 2-1). The change in the TN/TP ratio indicates that Lake Toho has been undergoing a shift since the 1970s. The increase in the TN/TP ratio can be caused by several factors including increasing biomass, increased stormwater runoff, varying uptake and discharge rates, and anoxic bottom sediments resulting in a higher exchange of nutrients (Parmer et al., 2011). It is unknown how lake management activities have affected TN/TP ratios.

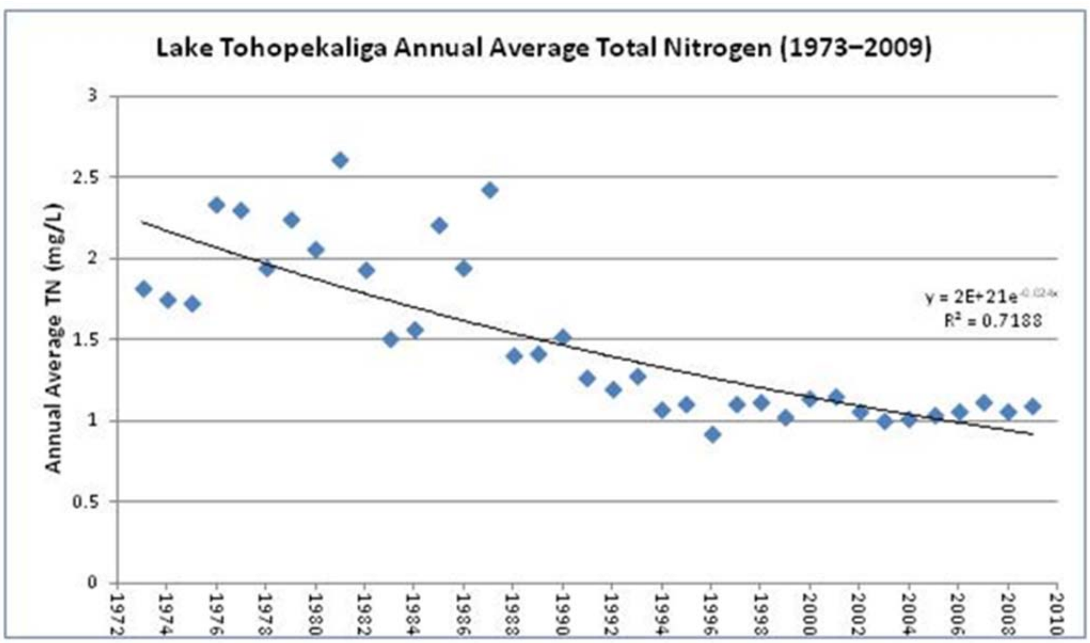

Figure 2-4 Trends in Lake Tohopekaliga Average Annual TN (Source: Parmer et al., 2011)

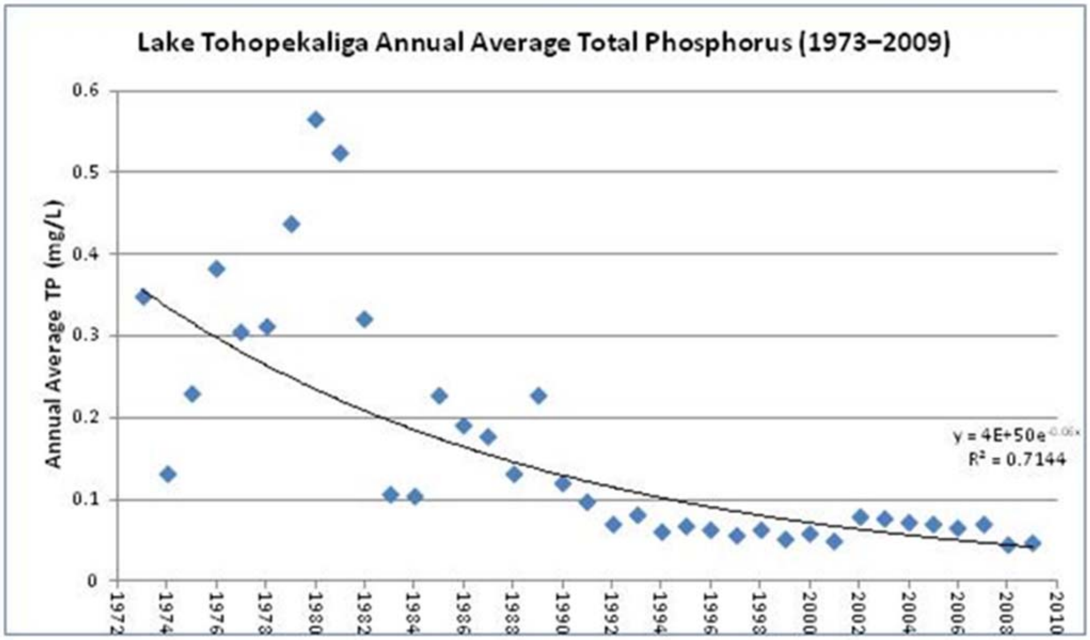

Figure 2-5 Trends in Lake Tohopekaliga Average Annual TP (Source: Parmer et al., 2011)

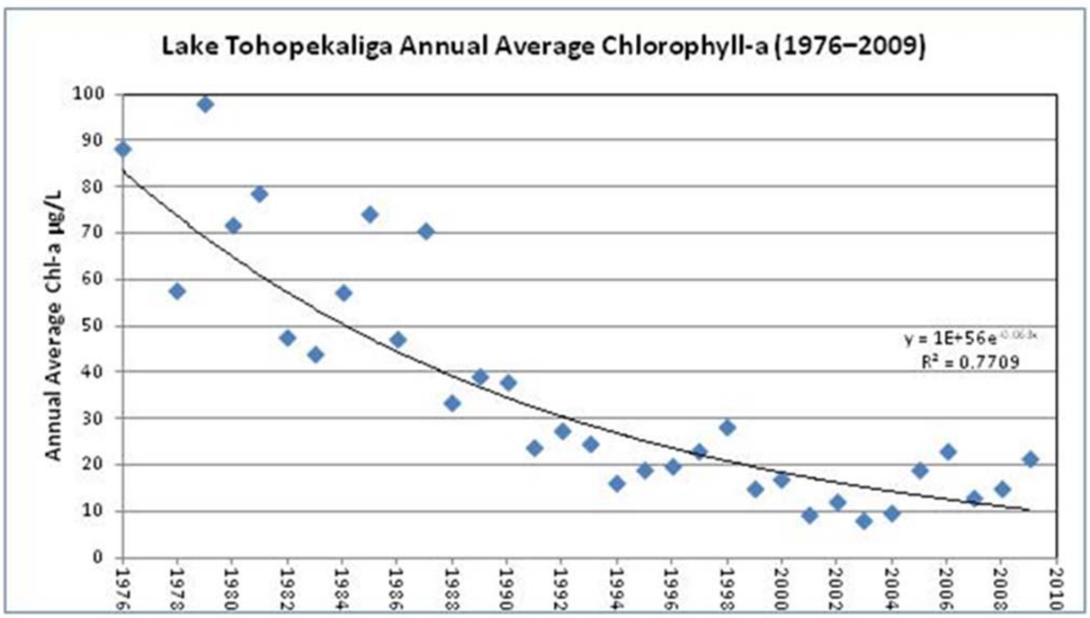

Figure 2-6 Trends in Lake Tohopekaliga Average Annual Chlorophyll-a (Source: Parmer et al., 2011)

2.1.2 Stakeholder Water Quality Assessment

In response to the Cycle 2 assessment for Lake Toho, the City of Kissimmee and Osceola County performed an independent analysis to verify FDEP's overall assessment to list Lake Toho as impaired for nutrients. The following paragraphs summarize the independent assessment as well as the results that were used by the City and the County to pose questions to FDEP concerning the validity of the impairment listing for TSI.

As previously mentioned, Lake Toho was listed as impaired for nutrients based on a significant positive slope in the trend analysis of TSI values. Section 62-303.352, FAC, requires the following:

"For any lake, data indicate that annual mean TSIs have increased over the assessment period, as indicated by a positive slope in the means plotted versus time, or the annual mean TSI has increased by more than 10 units over historical values. When evaluating the slope of mean TSIs over time, the Department shall require at least a 5 unit increase in TSI over the assessment period and use a Mann's one-sided, upper-tail test for trend, as described in Nonparametric Statistical Methods by M. Hollander and D. Wolfe (1999 ed.), pages 376 and 724 (which are incorporated by reference), with a 95% confidence level."

The raw water quality data for WBID 3173A (Lake Toho) contained within the 2010 Impaired Waters Rule (IWR) Retrieval Tool Microsoft Access® (Run 41) database were reviewed and analyzed. Color data included in the raw data were analyzed and averaged for each year of the VP. The results are shown in **Table 2-1** and were compared to values reported by FDEP in the adopted verified list.

Table 2-1
Lake Tohopekaliga Nutrient Reduction Plan
Annual Color for Lake Tohopekaliga during the Verified Period

VP Year	Annual Average Color (PCU)	Annual Color (PCU) Reported by FDEP
2003	108	109
2004	118	119
2005	110	111
2006	81	81
2007	48	38
2008	65	66
2009	69	71

As can be seen from the results in the table, Lake Toho would be considered a colored lake (i.e., mean color greater than 40 PCU) during the VP. The results closely compared with the values reported by FDEP with the exception of 2007.

The TN/TP ratio is required to determine which nutrient limits algal growth. A TN/TP ratio was calculated for each sample where both TN and TP were collected. A total number of 289 samples were included with the resulting median of 19.1. As the resulting TN/TP ratio is between 10 and 30, growth of algal biomass in the lake is co-limited by TN and TP. The calculated median TN/TP ratio of 19.1 was consistent with the median TN/TP ratio of 19.1 reported by FDEP (based on 290 samples).

The annual TSI was calculated for each year of the VP using the raw data. TSI values were only calculated where TN, TP and corrected chlorophyll-a data were collected on the same date. As per Section 62-303.350, F.A.C., at least one sample for each season is required to calculate the TSI. If there are multiple TSI values in a season, the average value for that season is calculated. The four seasonal values are then averaged to calculate the annual mean for the calendar year. The calculated annual average TSI values are comparable to the values reported by FDEP (**Table 2-2**).

Table 2-2
Lake Tohopekaliga Nutrient Reduction Plan
Lake Tohopekaliga Annual Average TSI

Year	Annual Average TSI Calculation	FDEP reported Annual Average TSI
2003	48.5	48
2004	46.9	48
2005	52.1	52
2006	55.6	56
2007	51.2	51
2008	52.5	53
2009	54.7	56

In accordance with Section 62-303.352, FAC. the Mann-Kendall test for increasing trend was performed on the calculated TSI values (**Table 2-3**). The Mann-Kendall test was also performed for the FDEP reported TSI values in order to replicate the results as a quality control check. The Mann-Kendall test is a non-parametric trend test suitable for determining trends over time. The null hypothesis is that there is no trend and the alternative hypothesis is that there is an increasing trend. A probability of less than 0.05 would be sufficient to reject the null hypothesis (i.e., there is a significant trend when the null hypothesis is rejected). Large positive values of the Mann-Kendall statistic (S) indicate measurements taken at a later date tend to be larger than those taken earlier (i.e. an increasing trend) while large negative values of S indicate measurements taken later in time are likely to be smaller (i.e. a decreasing trend.)

The results of the Mann-Kendall analysis show that for the TSI values reported by FDEP, there is a statistically significant increasing trend over time for the assessment period (i.e., $p<0.05$). However, when using the calculated TSI values from the independent analysis, the test shows there is not a statistically significant increasing trend over time.

Table 2-3
Lake Tohopekaliga Nutrient Reduction Plan
Mann-Kendall TSI Trend Analysis

Year	Annual Average TSI Calculation (all data)	FDEP reported Annual Average TSI
2003	48.5	48
2004	46.9	48
2005	52.1	52
2006	55.6	56
2007	51.2	51
2008	52.5	53
2009	54.7	56
Mann-Kendall Statistic (S):	**11**	**13**
N (number of samples):	**7**	**7**
Upper Tail Probability:	**0.068**	**0.035**

This independent analysis was also reviewed by FDEP. Follow-up discussions with FDEP identified several important factors. The reason for the difference in TSI results was due to how the TN/TP ratio was interpreted. In the independent assessment, nutrients in the lake are co-limiting and the corresponding TSI calculation for co-limiting nutrients was applied to all sampling data. FDEP's approach differed slightly in that even though Lake Toho is listed as co-limited by TN and TP based on the reported median TN/TP ratio, FDEP considers the TN/TP ratio (and therefore the limiting nutrient) for each water quality sample individually, and applied the TSI calculation accordingly (i.e., the TSI calculation varied depending on the limiting nutrient at the time the sample was taken). The difference in these two approaches (and therefore interpretation of the IWR) resulted in a different conclusion for the impairment of Lake Toho. FDEP recognizes that the resulting TSI values from the County's independent analysis are very similar to their own, yet result in the lake not being impaired. Another significant finding is that the TSI values for 2003 and 2004 were the lowest during the VP. Coincidentally, an artificial drawdown on the lake was initiated in 2004 in order to: 1) offset lake succession that resulted from cultural eutrophication, water level stabilization, expansion of invasive aquatic macrophytes, and especially the accumulation of organic material from aquatic plant monocultures in the littoral zone; 2) improve lake access and aesthetics; and 3) restore fish and wildlife habitat toward historic plant community characteristics and improve sport fishing opportunities (Hoyer et. al. 2008). The low TSI values in 2003 and 2004 essentially anchor the trend. This was the primary reason why FDEP believed the TSI trend impairment should be removed because the artificial drawdown is not representative of normal lake conditions. Like other management activities affecting the lake, it is still unknown what the long-term impact the artificial drawdowns have had on water quality within Lake Toho.

2.1.3 Final Cause of Impairment

Based on the independent analysis and subsequent discussion, FDEP agreed that the TSI is not the appropriate assessment (i.e., algal based) tool to apply to Lake Toho. Further data collection was performed by FDEP and is summarized in *Draft Lake Tohopekaliga (Water Body Identification 3173A), Kissimmee River Basin Group 4 Cycle 2, Upper Kissimmee Planning Unit, Impaired Waters Rule Assessment* (2011). Information in this document was presented at a public meeting to local stakeholders in April 2011. At this presentation, FDEP's final assessment of the lake was that it was impaired for nutrients due to high nutrient loads which are masked by excessive macrophytes (i.e., hydrilla). FDEP supported this final assessment based on hydrilla biocover, increasing TN/TP ratio, TSI trend, and both upstream and downstream impairments. This final assessment is also supported by the interpretation of narrative nutrient criteria (62-302.530(47), FAC) as previously described in Section 1.1 of the NRP.

The use of biocover and increasing TN/TP ratio in assessing Lake Toho's impairment status may pose some challenges in the future. FWCC, who is the responsible agency for managing hydrilla in the lake, will continue to manage hydrilla coverage to support the nesting habits of the endangered snail kite. Therefore, using an assessment parameter that is artificially managed may not be an appropriate indicator of ambient water quality and therefore impairment. Additionally, significant downward trends in TN, TP and chlorophyll-a over time (Figures 2-4, 2-5 and 2-6) have been observed for the lake. However, FDEP has indicated that the increasing trend in TN/TP ratio is also an indicator of the lake's impairment status. TP is typically more easily removed by traditional urban best management practices (BMPs) and retrofits. As a result of this NRP, it is anticipated that external load reductions in the watershed will occur over time due to capital improvement projects and it is likely that TP will be reduced at a greater rate than TN. Therefore, the-load reduction improvements may continue to drive the TN/TP ratio towards an increasing trend. Through the implementation of the NRP, the Stakeholders hope to collect additional data to gain a better understanding of the lake dynamics and water quality trends.

Section 3
Management Actions

"Management actions" refers to the suite of activities that the Lake Tohopekaliga (Toho) Stakeholders will be conducting to achieve long-term nutrient reductions to the lake. These include structural and nonstructural activities. Projects and activities were submitted to provide FDEP assurance that each entity has a plan on how they are working to reduce nutrients to Lake Toho. As part of the NRP, load reductions associated with projects and activities were quantified using modeling tools and accepted literature. The following paragraphs discuss the modeling approach, modeling results and identify specific management actions committed to by the Stakeholders. In addition to specific management actions, the Stakeholders also identified a number of research priorities to further understand the dynamics of Lake Toho and to identify appropriate water quality targets in the future.

3.1 Pollutant Load Analysis

During the stakeholder process, several discussions took place regarding the selection of a modeling tool to calculate nutrient loads within the watershed. Due to the limited time to develop the NRP, credence was given to models that were previously developed for the Lake Toho watershed or models that could be developed in a relatively short amount of time. At the time of model selection, two main options for modeling were identified:

- Pollutant load wash-off model.
- Existing Hydrologic Simulation Program - FORTRAN (HSPF) developed by FDEP for the purposes of establishing TMDLs for the Upper Kissimmee River Basin.

During the stakeholder meetings, the advantages and disadvantages were presented to the Stakeholders. The Stakeholders ultimately decided to use the Upper Kissimmee River Basin HSPF model as it is more robust than a pollutant load wash-off model and was already developed. Due to project time constraints, CDM developed an approach (explained further in this section) to use the HSPF model output to develop pollutant loadings by jurisdiction.

3.1.1 HSPF Modeling

CDM obtained the latest 2011 version of the HSPF model applied by FDEP to develop TMDLs in the Upper Kissimmee River Basin. The model was originally developed, calibrated and validated by CDM under contract to FDEP (2008). FDEP then used the model to determine load reductions required for impaired waters in the watershed to meet water quality standards. The version used for this lake Toho effort represents the current 2011 version updated by FDEP.

The original HSPF model was calibrated and validated based on a continuous simulation of years 1996 through 2006. The continuous simulation used NexRAD data provided by FDEP to establish the rainfall by model subbasin during that time period. Model input parameters were calibrated and validated so that modeled hydrologic processes such as surface runoff, infiltration, evapotranspiration and groundwater outflow (baseflow) were representative of observed flows in the watershed. Similarly, model input parameters were calibrated and validated so that modeled concentrations and loads of TN and TP in surface runoff and baseflow were representative of observed conditions for the impaired waters (at the time of the 2008 analysis) and loading rates that have been measured for various land use categories in Florida.

3.1.1.1 Application to Lake Toho Nutrient Reduction Plan

For the Lake Toho NRP, the HSPF model has been used for several different purposes, including the following:

- Determination of average annual loading rates of total nitrogen (TN) and total phosphorus (TP) for various combinations of land use category and soil type; and,
- Determination of average residence times for lakes and major creeks/streams that are part of the watershed conveyance system to Lake Toho.

Average annual load and average residence time calculations were based on continuous simulation results for years 1997 through 2005. The year 1996 was considered a “startup” year in the model, in which results could be influenced by the defined initial conditions for soil moisture, impoundment volumes, receiving water concentrations, and other watershed and receiving water conditions. Therefore, it was excluded from the output analysis. The year 2006 was also excluded, because it was an unusually dry year that did not have available NexRAD data (data from two local stations were used in the model).

Average Annual Load by Land Use Category and Soil Type

Rainfall input data for each modeled HSPF subbasin were evaluated and compared to the mean and distribution of historical data (**Figure 3-1**). . Long-term rainfall data at two local NOAA stations produce the following average annual rainfall totals:

- Kissimmee 2 (1949 – 2007): 48.95 in/yr
- Orlando International Airport (1975 – 2006): 49.99 in/yr

The average of these two is 49.5 in/yr, which was used as the target for average annual rainfall input for the continuous simulation. For the HSPF model subbasins, average annual rainfall during the period of 1997 through 2005 ranged from 44.1 to 53.5 inches per year. Rainfall for HSPF model subbasin 250, which had an average annual rainfall of 49.6 in/yr, was used as the basis for the calculation of average annual loads by land use category and soil type.

The Upper Kissimmee River Basin HSPF model included nine general land use categories. These are:

- Commercial/Industrial
- Cropland/Improved Pasture
- High Density Residential
- Medium Density Residential
- Low Density Residential
- Forest/Rangeland
- Unimproved Pasture
- Wetlands

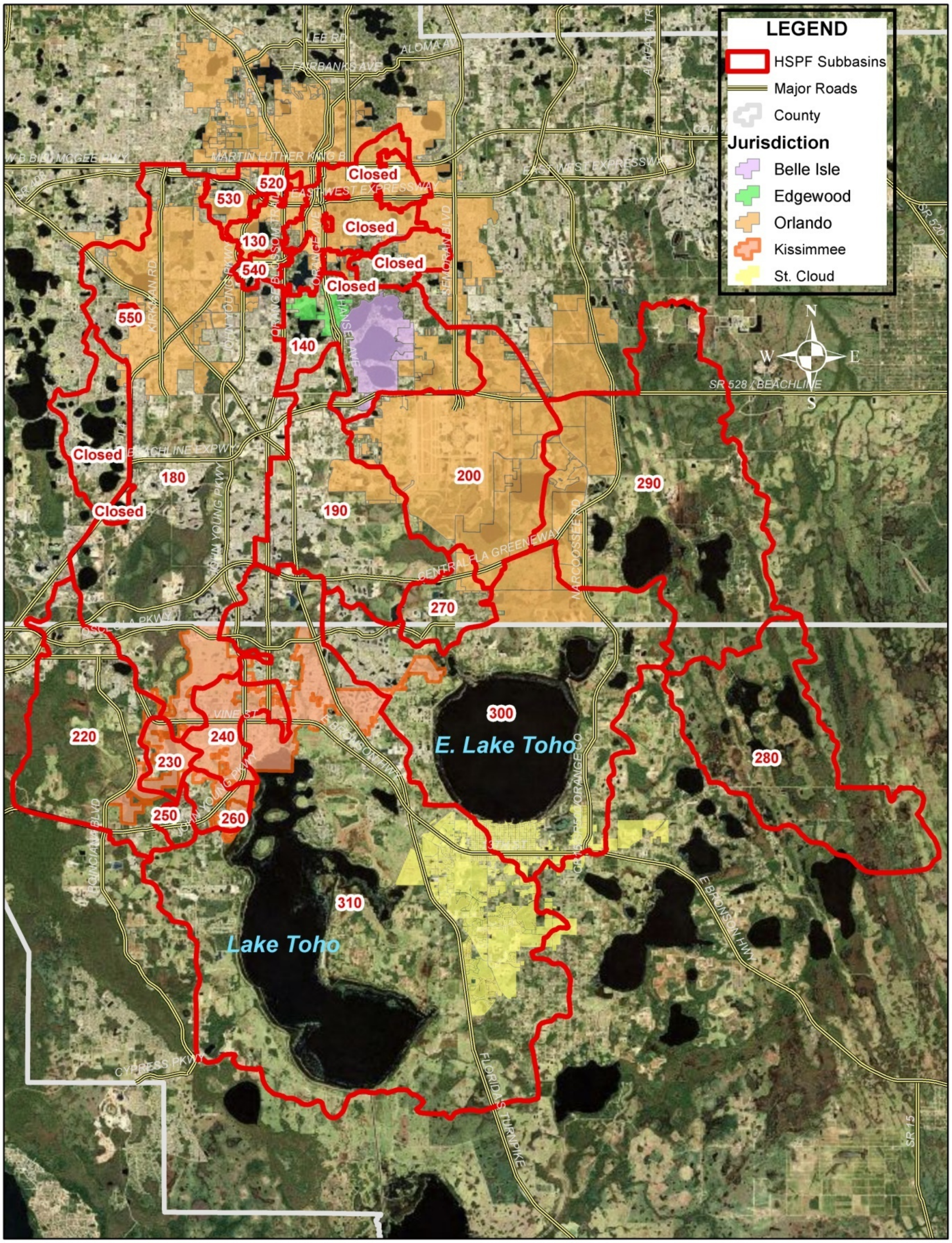

Figure 3-1 HSPF Subbasins

The Florida Land Use and Cover Classification System (FLUCCS) was the basis for establishing the land cover in the watershed for the existing model (year 2000 land use) and for the current study (year 2008/2009 land use). In the initial model development, the various FLUCCS land codes within the watershed were assigned to one of the model land use categories (**Appendix A)**. For consistency, the same assignments of FLUCCS codes to land use categories were used for the Lake Toho NRP.

HSPF simulates land-based flows and loads by calculating "unit loads" (e.g., inches of runoff, pounds per acre of load) for pervious areas and impervious areas in the watershed. Examples of pervious areas would include forested areas and lawns, and examples of impervious areas would include parking lots, buildings and streets. The flows and loads from pervious areas can vary substantially based on factors such as soil type (e.g., less runoff for type "A" sandy soils compared to type "D" clay soils) and anthropogenic impacts (e.g., fertilization), whereas flows and loads from impervious areas tend to be more uniform. For a given land use category and soil type, the flows and loads are the sum of the flows and loads from the pervious and impervious fractions of that land use.

The HSPF model was used to calculate average annual loads of TN and TP for the years 1997 through 2005 (**Table 3-1**).

Note that there is not a land use category for water bodies. The HSPF watershed model accounts for loads to water bodies that are part of the watershed conveyance system (such as Lake Toho and East Lake Toho) by assigning a concentration of TN and TP to the rainfall onto the water surface. The concentrations are 0.77 mg/l for TN and 0.023 mg/l for TP. For an average annual rainfall of 49.5 inches per year, the corresponding average annual rainfall load is 8.6 and 0.3 lb/ac/yr for TN and TP, respectively. For the purposes of this NRP, only land based loads were calculated, therefore rainfall loadings to water bodies were not considered.

<u>Average Residence Time for Watershed Conveyance System</u>

The HSPF model generated loads from all land areas within the watershed (Table 3-1). As these loads are routed through the watershed conveyance system to Lake Toho, losses may occur through physical, chemical and biological processes, particularly in lakes that are part of the conveyance system.

In the HSPF watershed model, the land-based flows and loads are discharged to model reaches. These reaches route the flows and loads through the watershed and also account for various water quality processes by explicitly modeling the processes (e.g., phytoplankton growth, death and settling; settling of organic nitrogen and phosphorus).

In the Lake Toho NRP, the load reduction through the watershed conveyance system is estimated based on calculated average residence time in the model reaches. The *Draft Environmental Resource Permit (ERP) Stormwater Quality Applicant's Handbook* (FDEP, 2010) includes regression analyses for wet detention ponds, allowing the user to estimate TN and TP removal as a function of residence time. The relationships for TN and TP are:

$$\% \text{ TN removal} = (43.75 * t_d) / (4.38 + t_d); \text{ and,}$$

$$\% \text{ TP removal} = 40.13 + 6.372 * \ln(t_d) + 0.213 * (\ln(t_d))^2$$

where t_d is the residence time in days.

Table 3-1
Lake Tohopekaliga Nutrient Reduction Plan
Average Annual Loads by Land Use Category and Soil Type

Land Use Category	Soil Type	TP (lb/ac/yr)	TN (lb/ac/yr)
Commercial/Industrial	A	1.96	14.3
	B	2.01	14.7
	C	2.04	15.0
	D	2.08	15.3
Cropland/Improved Pasture	A	0.23	1.7
	B	0.95	6.8
	C	1.43	10.3
	D	2.11	15.4
High Density Residential	A	1.26	9.2
	B	1.40	10.4
	C	1.48	11.0
	D	1.57	11.8
Low Density Residential	A	0.33	2.5
	B	0.60	4.6
	C	0.77	5.9
	D	0.95	7.3
Medium Density Residential	A	0.68	5.0
	B	0.91	6.8
	C	1.04	7.9
	D	1.20	9.0
Forest/Rangeland	A	0.02	0.5
	B	0.12	1.7
	C	0.18	2.6
	D	0.29	3.6
Unimproved Pasture	A	0.06	0.7
	B	0.32	2.9
	C	0.49	4.4
	D	0.72	6.3
Wetland	A	---	---
	B	---	---
	C	---	---
	D	0.09	1.4

The ultimate products of the analysis are TN and TP delivery ratios, which represent the ratio of land-based TN and TP load actually delivered to Lake Toho from the land-based load generated in the watershed. The delivery ratio is essentially 1 minus the load reduction percentage in the reach (or reaches) between the load generation point and the lake. For example, if a land-based load travels through a reach with a residence time that is expected to result in 60% reduction of the TP load, then the delivery ratio for TP would be 40% or 0.4 as a decimal.

Results of the residence time analysis and subsequent determination of delivery ratios are presented by HSPF subbasin (**Tables 3-2 and 3-3**), considering that some subbasin loads are conveyed through a single reach while others are routed through several reaches in series before discharge to Lake Toho.

Table 3-2 includes HSPF subbasins that are associated with Shingle Creek, City Ditch Canal and Lake Toho. Subbasins 130 and 170 are routed through Clear Lake and Big Sand Lake, respectively, which have very long residence times of over one year. For both of those subbasins, the TN delivery ratio is 0.57 (because the regression relationship presented in the FDEP draft handbook essentially limits TN reduction to 43%). The TP delivery ratios for the two subbasins are 0.09 and 0.17, respectively. All other reaches were represented in HSPF as free-flowing reaches with limited residence time and so have delivery ratios of 1.0.

Table 3-3 includes HSPF subbasins that are associated with areas north and east of Lake Toho, including all area that is routed through East Lake Toho. The average residence time for East Lake Toho is 283 days, so all subbasins in the table have a cumulative conveyance system of at least 283 days. The longest total residence time is 669 days for subbasin 140, which is routed through Lake Conway and East Lake Toho. Again, these residence times are long enough to result in a TN delivery ratio of 0.57, The TP delivery ratios range from 0.09 to 0.17.

3.1.2 Baseline Pollutant Loading

This section describes how the HSPF model output was used in conjunction with other data sources to quantify a baseline pollutant load for the Lake Toho watershed. For the Lake Toho NRP, the HSPF model has been used for several different purposes, including the following:

- Generating TN and TP pollutant loading rates for land use and soil types for an average rainfall year; and,
- Identifying average residence times for reaches and lakes within the HSPF model in order to estimate delivery (i.e. attenuation) ratios.

In order to generate baseline pollutant loads for the Lake Toho watershed, CDM compiled numerous data sources including SFWMD 2008/2009 draft existing land use, jurisdictional boundaries, soil data and subbasin boundaries (previously shown in Figure 3-1). The baseline load represents the existing untreated land-based pollutant load generated for the entire Lake Toho Watershed. 2008 was used as the starting point for the analysis and to represent the baseline condition. The average annual rainfall of 49.6 in/yr, mentioned previously in Section 3.1.1.1, was used as the basis for the calculation of the baseline loading by land use category and soil type. For the purposes of the baseline loading, CDM calculated TN and TP for the following jurisdictions/areas:

- Osceola County;
- City of Kissimmee;
- City of St. Cloud;
- Orange County;
- City of Orlando;
- FDOT;
- Agriculture; and
- Natural Lands.

Table 3-2
Lake Tohopekaliga Nutrient Reduction Plan
Delivery Ratios for Shingle Creek, City Ditch Canal, and Lake Toho HSPF Subbasins

HSPF Subbasin	HSPF Reaches from Subbasin To Lake Toho	Residence Time (days)	TN Delivery Ratio	TP Delivery Ratio
130	Clear Lake, Shingle Creek (180), Shingle Creek (230), Shingle Creek (250), Shingle Creek (260)	600	0.57	0.10
180	Shingle Creek (180), Shingle Creek (230), Shingle Creek (250), Shingle Creek (260)	---	1.00	1.00
230	Shingle Creek (230), Shingle Creek (250), Shingle Creek (260)	---	1.00	1.00
220	Shingle Creek (220), Shingle Creek (250), Shingle Creek (260)	---	1.00	1.00
240	City Ditch Canal (240)	---	1.00	1.00
250	Shingle Creek (250), Shingle Creek (260)	---	1.00	1.00
260	Shingle Creek (260)	---	1.00	1.00
310	Lake Toho Direct (310)	---	1.00	1.00
520	Lake Lorna Doone (520)	---	0.58	0.24
530	Lake Mann (530)	---	0.57	0.17
540	Lake Catherine (540)	---	0.59	0.30
550	Lake Cain (550)	---	0.56	0.00

Table 3-3
Lake Tohopekaliga Nutrient Reduction Plan
Delivery Ratios for HSPF Subbasins Upstream of East Lake Toho

HSPF Subbasin	HSPF Reaches from Subbasin To Lake Toho	Residence Time (days)	TN Delivery Ratio	TP Delivery Ratio
140	Lake Conway (140), East Branch Boggy Creek (200), Boggy Creek (270), East Lake Toho (300)	669	0.57	0.09
190	West Branch Boggy Creek (190), Boggy Creek (270), East Lake Toho (300)	283	0.57	0.17
200	East Branch Boggy Creek (200), Boggy Creek (270), East Lake Toho (300)	305	0.57	0.16
270	Boggy Creek (270), East Lake Toho (300)	283	0.57	0.17
280	Lakes Myrtle, Preston (280), Lakes Hart, Mary Jane (290), East Lake Toho (300)	601	0.57	0.10
290	Lakes Hart, Mary Jane (290), East Lake Toho (300)	455	0.57	0.13
300	East Lake Toho (300)	283	0.57	0.17

Both agriculture and natural lands were broken out as separate loads. FDACS administers the Florida BMP program and works with growers on which practices apply to their sites. As FDACS oversees this process for agriculture (and not the local jurisdictions), it was assigned its own load. This is also consistent with the approach for Basin Management Action Plans (BMAPs) throughout the state. Additionally, natural lands were broken out as the types of loads that are deemed natural. Therefore, it is beneficial to the Stakeholders to be able to distinguish between anthropogenic (i.e., controllable) loads and natural loads. A description of how agriculture and natural lands were identified is described below.

3.1.2.1 Existing Land Use Review

The SFWMD draft 2008/2009 land cover/land use data (**Figure 3-2**) was refined based on 2008/2009 aerial photography obtained from FDEP's Bureau of Survey and Mapping Land Boundary Information System (LABINS). Where there were significant discrepancies, the GIS layer was modified to be consistent with the aerial photography. For some northern areas of the watershed, the SJRWMD 2004 land cover land use data was used and refined based on the 2008/2009 aerial photography. Additionally, residential land use types were verified throughout the coverage using parcel data to ensure consistency among the Stakeholders. SFWMD defines low density residential as areas that have from ½ to 2 acres for each dwelling unit and areas with more than 2 acres per dwelling are classified as rural residential. Areas with over 5 acres per dwelling unit are incorporated into the surrounding land use. Medium density residential is defined as areas that have from 2 to 5 dwelling units per acre and high density residential is defined as areas that have more than 5 dwelling units per acre.

As described in previous sections agriculture and natural lands were broken out as separate loads. Agriculture loads included all land cover codes in the 2000 category. Natural loads included upland-non-forested (FLUCCS code 3000), upland forests (FLUCCS code 4000), water (FLUCCS code 5000), and wetlands (FLUCCS code 6000). Based on feedback provided by FDACS, improved pasture land uses in the watershed have very little nutrients added to them compared to unimproved pasture. Therefore, improved pasture received the same loading rates as unimproved pasture land use types, which is a modification from the original HSPF model. According to FDACS, there are currently no feeding operations in the watershed, therefore FLUCCS codes 2300 (feeding operations) and 2100 (poultry feeding operations) were reassigned to 2100 (cropland and pastureland).

3.1.2.2 Soils

Soil survey geographic (SSURGO) data for the watershed was obtained from Natural Conservation Service (NRCS) via the SFWMD. As mentioned previously, average annual loading rates of TN and TP are based on soil type as well as land use. Each soil type has been assigned to a soil association, a soils series, and to one of the four Hydrologic Soil Groups (A, B, C, or D) established by the NRCS **(Figure 3-3)**. Hydrologic Soil Group A is comprised of soils having very high infiltration potential and low runoff potential. Those soils with moderate infiltration rates when thoroughly wetted are classified as Hydrologic Soil Group B. Group C soils are those soils with low infiltration rates while Hydrologic Soil Group D is characterized by soils with a very low infiltration potential and a high runoff potential. Dual class soils (e.g., B/D) are soils assigned to two hydrologic groups. The first letter represents drained areas and the second letter represents undrained areas.

For soils with a combined soil type, i.e. A/D, B/D, and C/D the soils were represented as type D in the model. Some areas in the watershed did not have an assigned soil type and were classified as urban areas, water, or pits. For urban areas the soil type D was assigned for use in the model, those areas that overlaid water were not given a soil type since the model represents only land based loads, any remaining areas were assigned a soil type consistent with the surrounding areas.

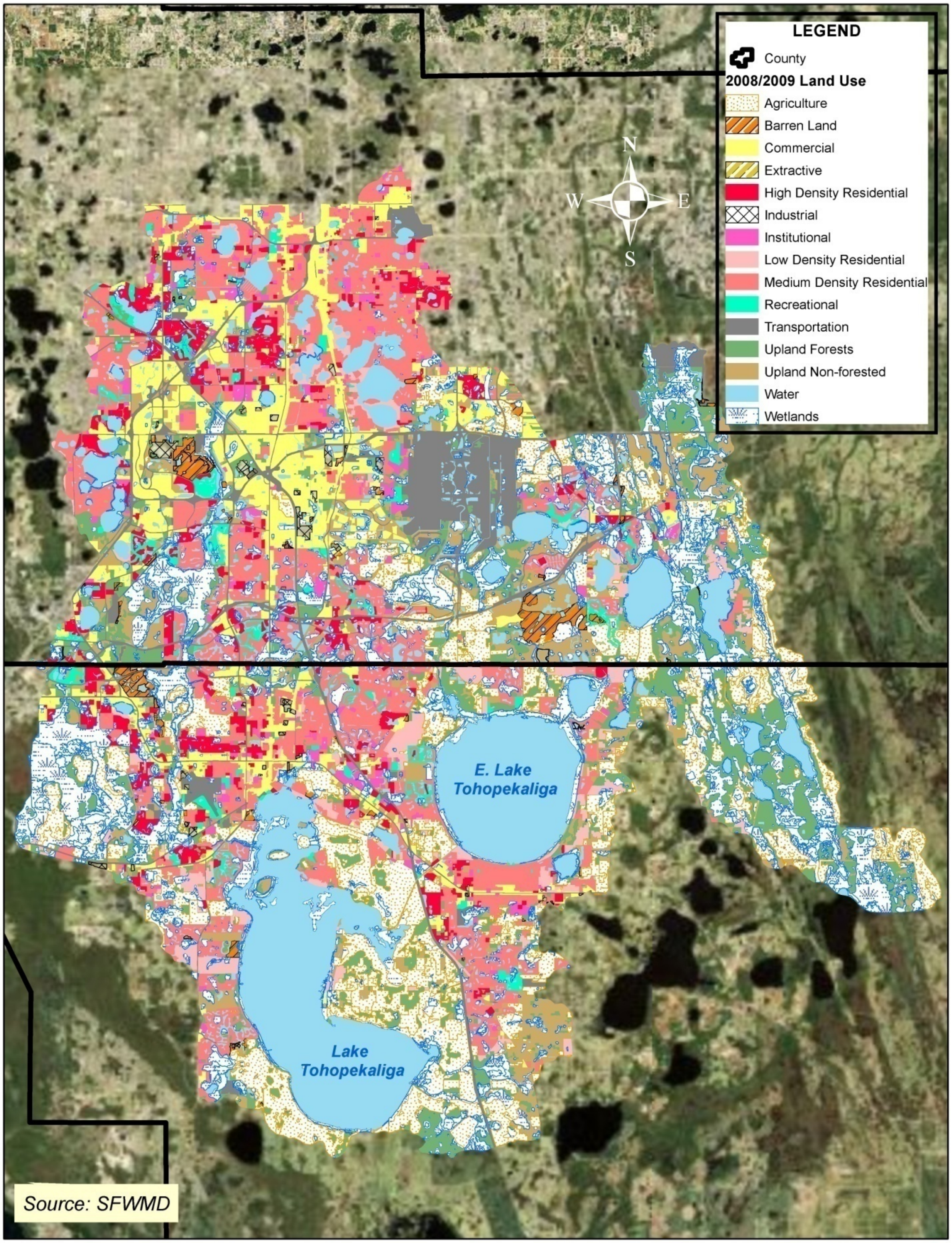

Figure 3-2 2008/2009 Existing Land Use

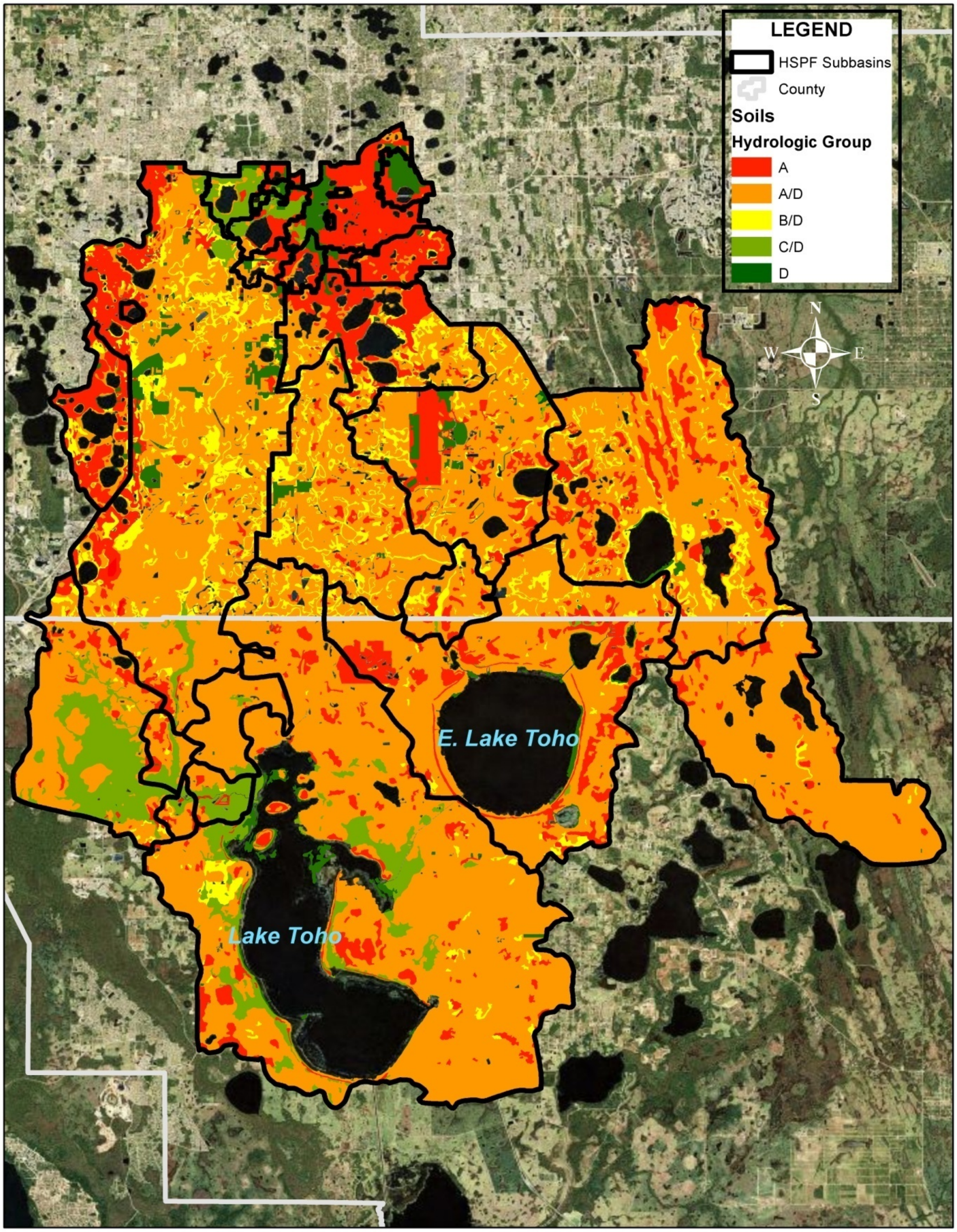

Figure 3-3 Hydrologic Soil Groups

3.1.2.3 Baseline Pollutant Load Calculation

CDM generated a coverage using the geographic information systems (GIS) software package ArcGIS Version 9.3 that integrated jurisdictional areas, HSPF subbasins, the refined existing 2008/2009 land use, and the soils layers. Acreages for each of the resulting polygons were calculated using the processing capabilities of ArcGIS. This information was then imported into a Microsoft® Access database. A series of queries were developed to use the imported attribute data from ArcGIS to calculate the resulting baseline TN and TP pollutant loads (**Table 3-4**). In general, the following steps were taken:

1) Import the integrated land use/HSPF subbasins/jurisdictional/soils coverage attribute information into the Microsoft® Access database;

2) Multiply the acreages of each polygon from the GIS layer in Step 1 using the land based TN and TP loading rates (Table 3-1, defined as look-up tables in Microsoft® Access);

3) Using the resulting loading calculated in Step 2, apply the delivery ratios for the appropriate subbasin (Tables 3-2 and 3-3, also defined as a look-up table in Microsoft® Access); and

4) Sum the loads per polygon by jurisdiction and subbasin.

It should be noted that the HSPF subbasins identified as "Closed" (Figure 3-1) were not included in the loading calculation. These are subbasins that do not have a positive outfall and therefore do not contribute flow to the conveyance systems discharging to Lake Toho.

Table 3-4
Lake Tohopekaliga Nutrient Reduction Plan
Baseline Pollutant Load Results by Jurisdiction

Jurisdiction/ Area	Area (Acres)[2]	Natural Area (Acres)	Developed Area (Acres)	TN Anthropogenic Load (lbs/yr)	TN Natural Load (lbs/yr)	TN Total Load (lbs/yr)	TP Anthropogenic Load (lbs/year)	TP Natural Load (lbs/year)	TP Total Load (lbs/yr)
Osceola County	103,001	80,033	22,968	180,399	83,266	263,665	21,054	4,791	25,845
City of Kissimmee	11,731	3,533	8,198	88,912	5,202	94,113	11,867	379	12,246
City of St. Cloud	8,582	2,146	6,436	56,658	3,451	60,109	6,740	251	6,991
Orange County	83,500	41,755	41,745	313,648	51,436	365,084	31,878	2,653	34,531
City of Orlando	34,302	11,856	22,446	130,501	13,281	143,782	12,792	601	13,393
FDOT	2,501	292	2,209	26,222	463	26,686	3,183	36	3,219
Agriculture	39,310	---	----	---	---	208,412	---	---	19,505
Other[1]	19,956	9,028	10,928	92,603	8,692	101,295	5,966	228	6,194
Totals:	***302,883***	***148,643***	***154,240***	***888,943***	***165,791***	***1,263,146***	***93,480***	***8,939***	***121,924***

1 - Other is defined as areas including Reedy Creek Improvement District, Greater Orlando Aviation Authority (GOAA), Expressway and toll roads (i.e., Orlando-Orange County Expressway Authority, Osceola County Expressway Authority) Belle Isle and Edgewood.
2 – With the exception of the Agriculture category, the areas reported do not include agricultural acreage.

The agricultural load was also broken out by jurisdictional area (**Table 3-5**) and is provided for informational purposes.

Table 3-5
Lake Tohopekaliga Nutrient Reduction Plan
Baseline Agricultural Loads by Jurisdiction

Jurisdiction	Agricultural Area (acres)	Agricultural TN Load (lbs/yr)	Agricultural TP Load (lbs/yr)
City of Kissimmee	1,627	9,883	1,107
City of St. Cloud	1,359	9,267	1,049
Osceola County	26,647	152,916	16,103
City of Orlando	2,402	10,096	313
Orange County	6,393	21,602	751
FDOT	12	58	7
Other[1]	871	4,590	175
Totals:	***39,310***	***208,412***	***19,505***

1. Other is defined as areas including Reedy Creek Improvement District, Greater Orlando Aviation Authority (GOAA), Expressway and toll roads (i.e., Orlando-Orange County Expressway Authority, Osceola County Expressway Authority) Belle Isle and Edgewood.

3.1.3 Existing Pollutant Loading

Using the baseline pollutant loading as a starting point, it was then necessary to determine the existing load. For the purposes of this NRP, the existing load is defined as the load that takes into account existing stormwater BMP treatment. 2008 was used as the starting point for the analysis for both the baseline and existing condition. The average annual rainfall of 49.6 in/yr, mentioned previously in Section 3.1.1.1, was used as the basis for the calculation of the existing load by land use category and soil type. Existing loads were calculated for the Stakeholders (i.e., those entities committing the resources to prepare the NRP) listed below only:

- Osceola County;
- City of Kissimmee;
- City of St. Cloud;
- City of Orlando; and
- FDOT.

FDACS also provided information on agricultural growers in the watershed who have signed up for Notice-of-Intent (NOIs) to implement BMPs as well as their plan to sign up remaining areas. Removal efficiencies for agricultural BMPs are not documented as well as they are for traditional urban BMPs. Therefore, an existing load for agricultural areas could not be determined. Documentation of NOI coverage will be discussed later in this document.

3.1.3.1 BMP Treatment Areas

As part of the development of the NRP, CDM worked with the Stakeholders to identify existing stormwater treatment within their jurisdictional areas. CDM developed preliminary draft GIS layers of developed areas treated by BMPs primarily based on review of 2008 high-resolution digital aerial photography obtained from FDEP's Bureau of Survey and Mapping LABINS and parcel data. Where information was available, several of the jurisdictions were able to provide information on existing stormwater ponds, subdivisions with treatment and areas served by retrofit projects. CDM made an initial attempt to incorporate all this information into a comprehensive GIS layer which depicted the treated area and specified the type of treatment. These layers were then distributed to the existing Stakeholders for review and comment. It should be noted that due to the limited time and resources for the development of the NRP, this effort did not include an exhaustive search of development permits and field verification. It is considered a best estimate based on available resources and input from the Stakeholders based on their local knowledge of the system. Approximately 81 percent of the Stakeholder jurisdictional area in the Lake Toho Watershed is treated by existing BMPs (**Table 3-6**). It should be noted that BMP treatment types and areas were identified and delineated within the jurisdictions of the Stakeholders only (**Table 3-7**).

Table 3-6
Lake Tohopekaliga Nutrient Reduction Plan
Summary of BMP Treatment Areas

Subbasin ID	Jurisdictional Area[1] (acres)	Area Treated (acres)	Developed Area (acres)	% Area Treated by BMPs
City of Kissimmee	11,731	6,200	8,192	75.7%
City of St. Cloud	8,582	5,781	6,432	89.9%
Osceola County	103,001	18,405	22,953	80.2%
City of Orlando	34,302	18,247	22,431	81.3%
FDOT	2,501	1,724	2,208	78.1%
Totals:	***160,117***	***50,357***	***62,215***	***80.9%***

1 – Excludes agricultural areas

Table 3-7
Lake Tohopekaliga Nutrient Reduction Plan
Summary of BMP Treatment Types

BMP Treatment Type	Area Treated (acres)
Alum Injection	74
Baffle Box/ Wet Detention Retrofit/Alum Injection	2
Baffle Box/Alum Injection	1
Dry Detention	2,147
Dry Detention/Alum Injection	3
Dry Detention/Packed Bed Filter/Alum Injection	5
Dry Detention/Wet Detention Retrofit Treatment Train	181
Dry Detention /Exfiltration	4
Dry Detention /Wet Detention Retrofit/Alum Injection	97
Dry/Wet Detention	521
Exfiltration / Wet Detention Retrofit/Alum Injection	6
Exfiltration	23
Inlet Baskets/Alum Injection	63
Inlet Baskets/Baffle Box/Alum Injection	2
Inlet Baskets/Dry Detention/Alum Injection	8

Table 3-7 (*continued*)
Lake Tohopekaliga Nutrient Reduction Plan
Summary of BMP Treatment Types

BMP Treatment Type	Area Treated (acres)
Inlet Baskets/Dry Detention/Wet Detention Retrofit	1
Inlet Baskets/Wet Detention Retrofit	155
Packed Bed Filter/Alum Injection	105
Retention	10
Retention/ Wet Detention Retrofit/Alum Injection	167
Swale	2,246
Swale/Dry Detention	11
Swale/Dry Detention/Wet Detention	37
Swale/Wet Detention	275
Wet Detention	38,182
Wet Detention Retrofit	2,101
Wet Detention Retrofit/Alum Injection	1,359
Wet Detention/Alum Injection	9
Wet Detention/Wet Detention	1,930
Wet Detention/Wet Detention Retrofit Treatment Train	494
Wet Detention /Exfiltration	11
Wet Detention /Wet Detention Retrofit/Alum Injection	126
Alum Injection	74
Totals:	***50,357***

The BMP treatment areas are shown graphically on **Figure 3-4**. The removal efficiencies associated with these BMPs (**Table 3-8**) are approved by FDEP and are being applied in other basins throughout the state for BMAP purposes and were therefore used for consistency.

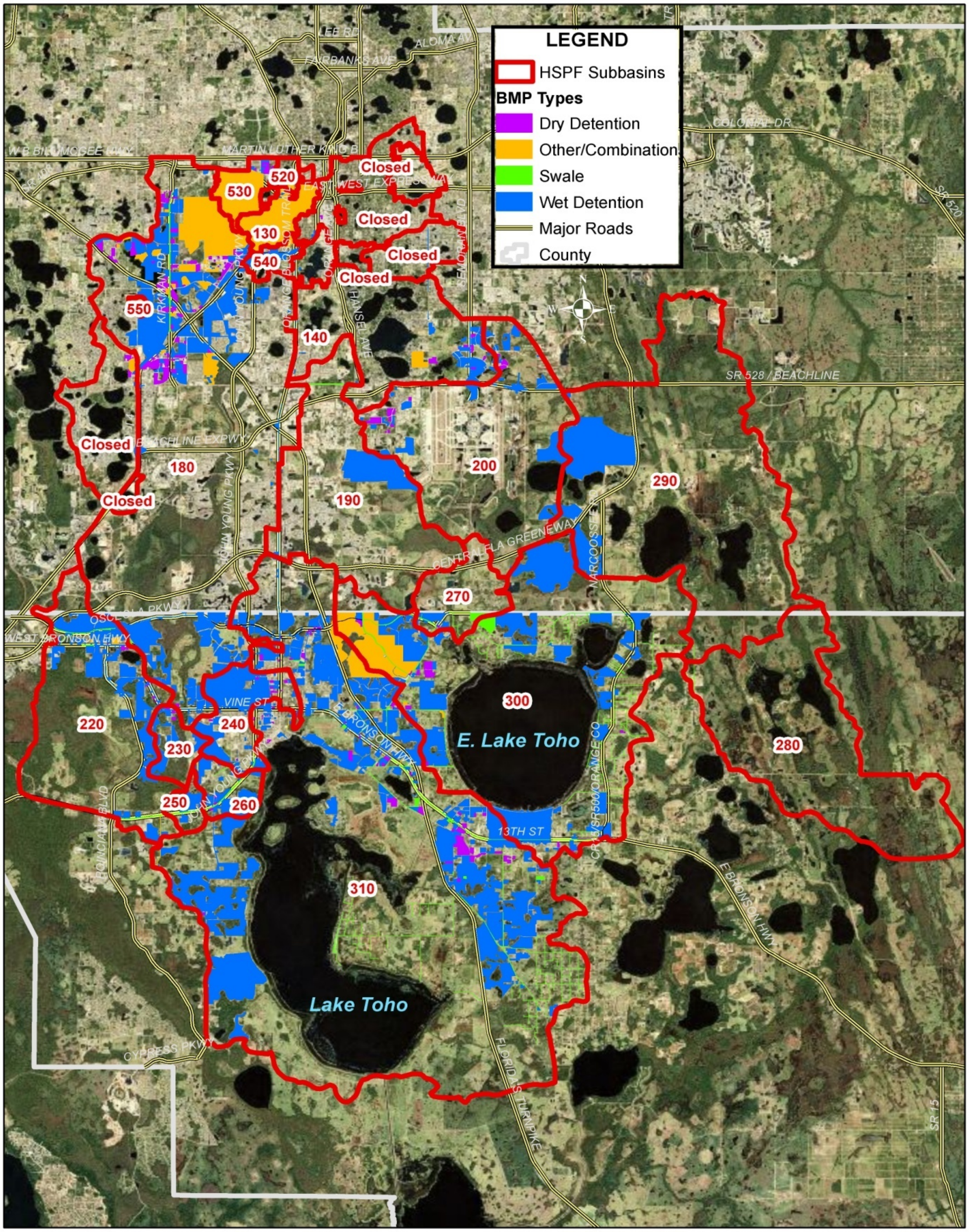

Figure 3-4 Existing BMP Treatment Areas

Table 3-8
Lake Tohopekaliga Nutrient Reduction Plan
BMP Efficiencies

BMP Treatment Type	TP % Reduction	TN % Reduction	Data Source
Off-line Retention 0.25 treatment volume	40	40	Harper, H. & D. Baker. 2007. Evaluation of Current Stormwater Design Criteria within the State of Florida.
Off-line Retention 0.50 treatment volume	62	62	
Off-line Retention 0.75 treatment volume	75	75	
Off-line Retention 1.00 treatment volume	84	84	
On-line Retention 0.25 treatment volume	30	30	
On-line Retention 0.50 treatment volume	52	52	
On-line Retention 0.75 treatment volume	65	65	
On-line Retention 1.00 treatment volume	74	74	
Grass swales with swale blocks or raised culverts	Use on-line retention BMPs above	Use on-line retention BMPs above	Evaluation of Harper data
Grass swales without swale blocks or raised culverts	50% of value for grass swales with swale blocks or raised culverts	50% of value for grass swales with swale blocks or raised culverts	Evaluation of Harper data
Wet detention ponds	% Removal = $44.53 + 6.146 * \ln(t_d) + 0.145 * (\ln(t_d))^2$; where t_d is the mean annual residence time	% Removal = $(43.75 * t_d)/(4.38 + t_d)$; where t_d is the mean annual residence time	Figures 13.2 and 13.3 in Draft Stormwater Treatment Applicant's Handbook
BMP treatment trains using a combination of BMPs	Use BMP Treatment Train (TT) equation: BMP TT Efficiency = $Eff_1 +((1-Eff_1)*Eff_2)$	Use BMP Treatment Train (TT) equation: BMP TT Efficiency = $Eff_1 +((1-Eff_1)*Eff_2)$	Draft Stormwater Treatment Applicant's Handbook
Dry detention	10	10	Harper, H. & D. Baker. 2007.
Baffle box	2.3	0.5	FDEP Final Report Contract S0236 Effectiveness of Baffle Boxes
Nutrient baffle box (2nd generation)	15.5	19.05	FDEP Final Report Contract S0236 Effectiveness of Baffle Boxes
Catch basins/inlet filters	Determine kg of materials removed and multiply by 300.8 mg/kg (commercial), 423.4 mg/kg (residential), or 536.97 mg/kg (highway)	Determine kg of materials removed and multiply by 467.2 mg/kg (commercial), 773.8 mg/kg (residential), or 785.4 mg/kg (highway)	Final Report of Florida Stormwater Association Municipal Separate Storm Sewer BMP Project
Street sweeping	Determine kg of materials removed and multiply by 381.2 mg/kg (commercial), 374.9 mg/kg (residential), or 349.7 mg/kg (highway)	Determine kg of materials removed and multiply by 429.6 mg/kg (commercial), 832.4 mg/kg (residential), or 546.4 mg/kg (highway)	Final Report of Florida Stormwater Association Municipal Separate Storm Sewer BMP Project
Alum injection	90	50	Evaluation of Harper data
Stormwater reuse	Estimate amount water not discharged annually because used for irrigation.	Estimate amount water not discharged annually because used for irrigation.	Evaluated on a case-by-case basis
Stormceptor	13	2	FDEP Final Report Contract S0095 Sanford Stormceptor project

Table 3-8 (*continued*)
Lake Tohopekaliga Nutrient Reduction Plan
BMP Efficiencies

BMP Treatment Type	TP % Reduction	TN % Reduction	Data Source
Continuous deflective separation (CDS) units	10	Not applicable	FDEP Final Report Contract WM793 Broadway Outfall Project
Floating islands	20	20	Chapter 14 Draft Stormwater Treatment Applicant's Handbook
Public education	1-6, depending on extent of program	1-6, depending on extent of program	Evaluation of CWP. 2002. *Watershed Treatment Model Version 3.1*. See separate calculation spreadsheet.
Low impact development practices	Cannot quantify	Cannot quantify	Cannot quantify
Packed Bed Filter	82	63	Monitoring Case Study-Packed Bed Filter BMP Near Lake Beardall, Orlando, Florida (DRMP, 1995)
Inlet Baskets	5	5	BMP Efficiency Values for the Lake Jesup BMAP (2008)
Exfiltration Trench	100% of retained volume	100% of retained volume	Harper, H. & D. Baker. 2007.

3.1.3.2 Existing Pollutant Load Calculation

Using the GIS layer generated for the BMP treatment areas, CDM then calculated the existing TN and TP load by Stakeholder (**Tables 3-9** and **3-10**) using an approach similar to that described under Section 3.1.2.1. In general, the following steps were taken:

1) Integrate the BMP GIS layer with the integrated land use/HSPF subbasins/jurisdictional/soils coverage attribute information;

2) Import the integrated BMP/land use/HSPF subbasins/jurisdictional/soils coverage attribute information into the Microsoft® Access database;

3) Multiply the acreages of each polygon from the GIS layer in Step 1 using the land based loading TN and TP loading rates shown in Table 3-1 (defined as look-up tables in Microsoft® Access);

4) Using the resulting loading calculated in Step 3, apply the BMP removal efficiencies (i.e., 1 - percent removal) as specified in (Table 3-7, also defined as a look-up table in Microsoft® Access) to those polygons with a BMP designation;

5) Using the resulting loading calculated in Step 4, apply the delivery ratios for the appropriate subbasin (Tables 3-2 and 3-3, also defined as a look-up table in Microsoft® Access); and

6) Sum the loads per polygon by jurisdiction to achieve the existing treated load by jurisdiction.

Similar to the baseline pollutant load calculation, HSPF subbasins identified as "Closed" (Figure 3-1) were not included in the existing treated load calculation.

Table 3-9
Lake Tohopekaliga Nutrient Reduction Plan
Existing Treated TN Load Results by Stakeholder

Jurisdiction/ Area	Jurisdictional Area (ac)	TN Baseline Anthropogenic Load (lbs/yr)	TN Existing Anthropogenic Load (lbs/yr)	TN Anthropogenic Load Reduction (%)	TN Natural Treated Load (lbs/yr)	TN Total Existing Load (lbs/yr)
Osceola County	103,001	180,399	140,698	22.0%	82,198	222,896
City of Kissimmee	11,731	88,912	70,175	21.1%	4,834	75,009
City of St. Cloud	8,582	56,658	42,152	25.6%	3,292	45,444
City of Orlando[1]	34,302	130,501	68,848	47.2%	11,393	80,241
FDOT	2,501	26,222	20,848	20.5%	389	21,237
Totals:	***160,117***	***482,692***	***342,721***	***29.0%***	***102,106***	***444,827***

1. City of Orlando anthropogenic load also takes into account pollutant removal through drain wells (see Table 3-11)

Table 3-10
Lake Tohopekaliga Nutrient Reduction Plan
Existing Treated TP Load Results by Stakeholder

Jurisdiction/ Area	Jurisdictional Area (ac)	TP Baseline Anthropogenic Load (lbs/yr)	TP Existing Anthropogenic Load (lbs/yr)	TP Anthropogenic Load Reduction (%)	TP Natural Treated Load (lbs/yr)	TP Total Existing Load (lbs/yr)
Osceola County	103,001	21,054	13,253	37.1%	4,674	17,927
City of Kissimmee	11,731	11,867	7,357	38.0%	327	7,684
City of St. Cloud	8,582	6,740	3,681	45.4%	230	3,911
City of Orlando[1]	34,302	12,792	5,811	54.6%	435	6,246
FDOT	2,501	3,183	2,227	30.0%	27	2,254
Totals:	***160,117***	***55,636***	***32,329***	***41.9%***	***5,693***	***38,002***

1. City of Orlando anthropogenic load also takes into account pollutant removal through drain wells (see Table 3-11)

In addition to traditional urban BMPs whose tributary areas were delineated using GIS, the City of Orlando identified several lakes within their jurisdiction that are served by drain wells for lake level control purposes. Based on communication with the City, these lakes are not closed and have the capacity to discharge to conveyance systems that ultimately discharge to Lake Toho. Drain wells allow for discharge of surface water to the aquifer, thereby removing a load that would otherwise be discharged downstream. This load is estimated using the average nutrient concentration within the lake as well as the flow rate into the well.

CDM obtained the well dimensions for each lake from the Central Florida Drainage Well Inventory prepared by Hartman & Associates, Inc. (2003). The City provided long-term nutrient concentration data for each lake. Using the well opening dimensions and the historical stage of each lake, CDM calculated the flow rate into the well. In many cases, the calculated flow rates were an order of magnitude higher than the expected assimilative capacity of the well. From direct discharge measurements and groundwater modeling performed by the USGS, Bradner (1996) found that drainage well recharge rates for several wells within Orange County, Florida ranged from 0.04 to 4.7 cubic feet per second (cfs). CDM performed some calculations using maximum permissible velocities (Chapter 62-528, FAC), well equations and published local hydrogeologic information in order to estimate potential flow rates into the drainage wells at Lake Lorna Doone and Lake Richmond. The resulting estimated recharge rates ranged from 5 to 20 cfs. Therefore, CDM applied a more conservative approach and used a 5.0 cfs flow rate to calculate the annual TN and TP load removal associated with each drainwell (**Table 3-11**). It is important to note that this is a conservative estimate and it is recommended that site-specific data is collected in order to more accurately quantify the performance of these wells in terms of discharge. This annual load removal due to drain wells is already reflected in the treated loads previously reported (Tables 3-9 and 3-10).

The Stakeholders also expressed a desire to represent the pollutant load by subbasin to identify where potential nutrient loading “hot spots” occur. Therefore, CDM reported the existing TN and TP loading by subbasin (**Table 3-12**) and also calculated the overall TN and TP loading rate by subbasin. The highlighted rows are those subbasins with the relatively highest loading rates of nutrient per acre. These represent some of the more urbanized subbasins in the watershed (**Figures 3-5** and **3-6**). Please note that these values should be used with care as the existing treated load was only calculated for the jurisdictional areas of the five Stakeholders. The baseline load for the remaining areas was used to calculate the subbasin loading rate. HSPF subbasins identified as "Closed" (Figure 3-1) were not included in Table 3-12. These are subbasins that do not have a positive outfall and therefore do not contribute flow to the conveyance systems discharging to Lake Toho.

Table 3-11
Lake Tohopekaliga Nutrient Reduction Plan
City of Orlando Drain Well Nutrient Load Removal

Lake	Annual TN Load Removed by Drain Well (lbs/yr)	Annual TP Load Removed by Drain Well (lbs/yr)
Lake Lorna Doone	6,883	334
Lake Richmond	18,292	628
Lake Warren	N/A	N/A

N/A – Not applicable as the Lake Warren drainage well elevation is above the historical average elevation of the lake.

Table 3-12
Lake Tohopekaliga Nutrient Reduction Plan
Existing Pollutant Load Results by Subbasin

Subbasin ID	Area (acres)	TN Load (lbs/yr)	TN Subbasin Loading Rate (lbs/ac/yr)	TP Load (lbs/yr)	TP Subbasin Loading Rate (lbs/ac/yr)
130	1,757.1	2,340	1.33	8	0.00
140	10,949.4	36,135	3.30	760	0.07
180	45,624.5	330,482	7.24	39,577	0.87
190	15,193.3	66,052	4.35	2,493	0.16
200	17,923.7	84,643	4.72	3,110	0.17
220	15,088.7	65,998	4.37	6,804	0.45
230	1,749.3	8,509	4.86	812	0.46
240	3,913.2	31,729	8.11	3,447	0.88
250	886.4	5,296	5.97	579	0.65
260	1,840.1	11,269	6.12	1,165	0.63
270	3,518.9	10,444	2.97	363	0.10
280	18,560.9	29,954	1.61	515	0.03
290	32,067.0	62,169	1.94	1,508	0.05
300	37,135.8	61,907	1.67	1,867	0.05
310	77,091.2	321,829	4.17	34,920	0.45
520	216.9	499	2.30	6	0.03
530	1,607.0	5,753	3.58	166	0.10
540	868.0	3,899	4.49	224	0.26
550	201.6	299	1.49	0	0.00

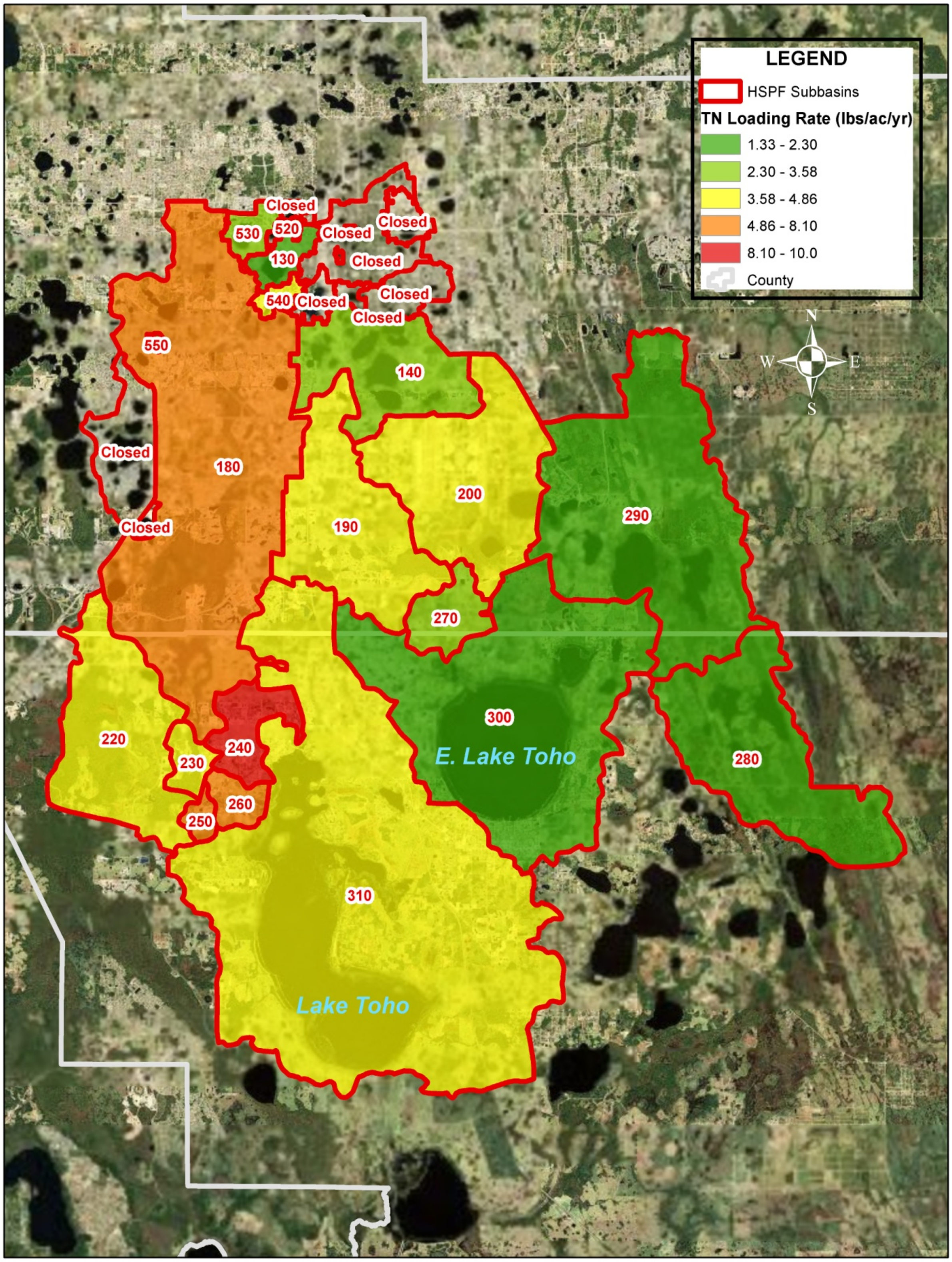

Figure 3-5 TN Subbasin Loading Rates

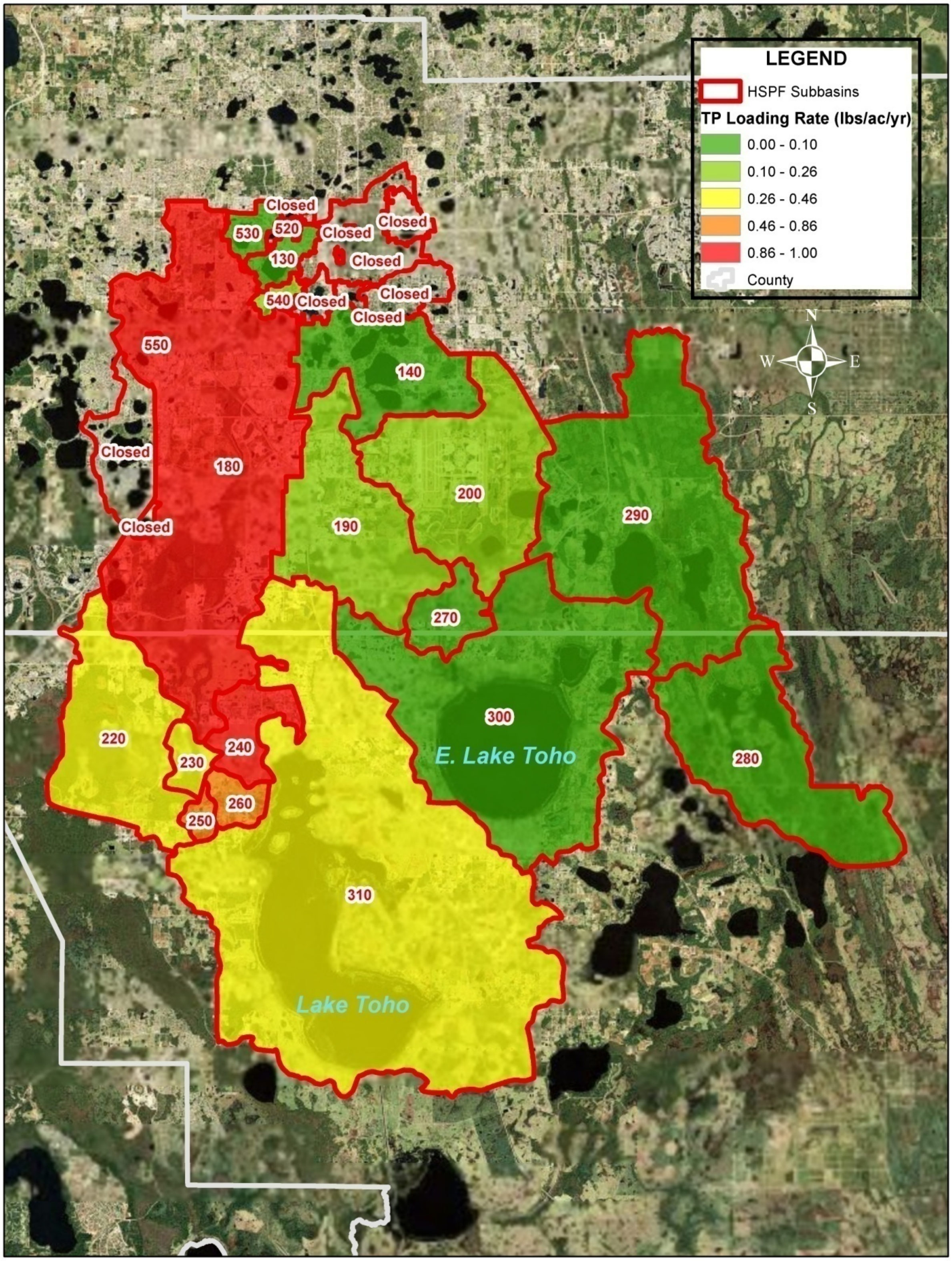

Figure 3-6 TP Subbasin Loading Rates

3.2 Management Actions to Reduce Nutrient Loading

The Stakeholders in the Lake Toho Watershed provided information on projects and programs that they have in place or will be implemented to reduce nutrients to Lake Toho in the next five years. These management actions are in one of two major categories: (1) projects completed since 2009; and (2) planned projects and programs.

Stakeholders and entities committing to management actions to reduce nutrients include the following:

- Osceola County (Stakeholder);
- City of Kissimmee (Stakeholder);
- City of St. Cloud (Stakeholder);
- City of Orlando (Stakeholder);
- FDOT(Stakeholder);
- Orange County (Technical Support); and
- FDACS (Technical Support).

Management actions had to meet several criteria to be considered eligible for credit in the NRP. All projects and programs were required to address nutrient loads (specifically TN and TP) to receive credit. In addition, future management actions were given credit for the portion of the load reduction that was over and above any permit requirements. This criterion was needed since permit conditions are established to maintain the current condition (prevent further impacts from the development) and do not contribute to the improvement of water quality.

During the stakeholder process, it was brought to the group's attention that more stringent Environmental Resource Permit (ERP) permitting requirements for new development within the Lake Toho watershed were recently implemented (2009) by the SFWMD. Follow-up discussions with the SFWMD indicated that these more stringent requirements have been implemented because Lake Toho eventually discharges to Lake Okeechobee (an impaired water body). SFWMD must implement its existing rules to ensure non-degradation of Outstanding Florida Waters (OFWs) and prevent further degradation of impaired waters or waters that do not meet state water quality standards as a result of new stormwater discharges. While the existing rules require a permit applicant to provide reasonable assurance to demonstrate that a proposed project will not degrade an OFW and will not contribute causative pollutants to an impaired water, they do not provide design or operational criteria for the types of additional measures to be incorporated into a project design to provide the requisite reasonable assurance (SFWMD, 2009). To provide this reasonable assurance, the SFWMD is requiring an extra 50 percent treatment volume for discharges to OFWs, impaired waters or other water bodies that do not meet water quality standards (commonly referred to by the Stakeholders as the 150 percent requirement). In addition to this additional 50 percent increase in treatment volume, the SFWMD encourages other options including:

- Stormwater pollution prevention plan (SWPPP) for construction activities resulting in greater than 1 acre;
- Post-construction pollution prevention plan to be submitted as part of the permit application;
- Increased average wet season hydraulic residence time of wet detention ponds to at least 21 days using a maximum depth of 12 feet from the control elevation to calculate the residence time.
- Source controls;

- Stormwater conveyance and pretreatment BMPs; and
- Stormwater treatment system enhancements.

It should be noted that these are not considered new regulations but an interpretation of existing regulations by the SFWMD. A methodology on how to apply credit for projects in other BMAPs that fall under this requirement has not yet been completed. For this reason, projects in this NRP will only be identified but their load reduction credit will not be quantified.

In addition, the SFWMD is also working towards amending the Lake Okeechobee phosphorus source control rule. The amended rule will expand the Lake Okeechobee watershed boundary to include the entire Lake Toho watershed. The objective of the SFWMD's regulatory source control program is to establish criteria and performance metrics that ensure runoff to the tributaries and canals that discharge into Lake Okeechobee allow the SFWMD to meet the legislative policies established in Chapter 373, Florida Statutes (FS).

Based on the project eligibility requirements, the entities submitted structural and nonstructural projects to reduce the land-based nonpoint source loading from stormwater within their jurisdictional boundaries. The existing treated load for each project area was calculated using the same methodology described in Section 3.1.3.2. The proposed project load removal (**Table 3-13**) was then calculated by applying the appropriate BMP efficiency (previously shown in Table 3-8).

Table 3-13
Lake Tohopekaliga Nutrient Reduction Plan
Management Actions by Stakeholder

Project Number	Project Name	Project Detail	Project Type	Treatment Acres	End Date	Status	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)
City of Kissimmee								
KS-1	Education and Outreach[1]	PSAs, pamphlets, presentations, website, illicit discharge program	Education	N/A	Ongoing	Ongoing	701.8	73.6
KS-2	Street Sweeping[1]	Sweep 8,500 miles/yr	Street Sweeping	N/A	Ongoing	Ongoing	1,530.0	1,020.0
KS-3	Lake Tivioli	Addition of stormwater treatment	Wet detention pond	132.8	Unknown	Unknown	285.1	50.9
KS-4	Expansion of Civic Center Pond	Addition of stormwater treatment	Wet detention pond	198.2	Unknown	Planned	Not quantified	Not quantified
KS-5	Lakefront Park Redevelopment	Addition of stormwater treatment	Swales	31.8	Unknown	Construction	7.3	1.0
KS-6	Lakefront Park Redevelopment	Addition of stormwater treatment	2nd generation baffle boxes	252.4	Unknown	Envisioned, Not funded	545.4	58.6
KS-7	Judge Farms Feasibility Analysis	Feasibility study to explore opportunities for large scale surface water retrofit/alternative water supply	Feasibility Study	N/A	2012	Ongoing Study	Not quantified	Not quantified
KS-8	Oak Street Widening from West of Main Street to US 192	Wet detention pond	150% requirement met	N/A	Unknown	Planned	Not quantified	Not quantified
KS-8	Expansion of MLK Boulevard pond	Wet detention pond	150% requirement met	N/A	Unknown	Planned	Not quantified	Not quantified
KS-10	MLK Boulevard Phase III from Thacker Avenue to Dyer Boulevard	Dry detention/wet detention pond	150% requirement met	N/A	Unknown	Planned	Not quantified	Not quantified
Total	**N/A**	**N/A**	**N/A**	**615.2**	**N/A**	**N/A**	**3,069.6**	**1,204.1**

1. Activities began before 2009.

Table 3-13 (*continued*)
Lake Tohopekaliga Nutrient Reduction Plan
Management Actions by Stakeholder

Project Number	Project Name	Project Detail	Project Type	Treatment Acres	End Date	Status	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)
City of St. Cloud								
SC-1	Lakeshore Reclaim Augmentation	Stormwater harvesting (permitted up to 2 MGD)	Stormwater harvesting	N/A	09/11	Ongoing	Not quantified[2]	Not quantified[2]
SC-2	Education and Outreach[1]	FYN; landscaping, irrigation, fertilizer, pet waste management ordinances; PSAs; pamphlets; website; illicit discharge program	Education	N/A	Ongoing	Ongoing	2,529.1	220.9
SC-3	Judge Farms Feasibility Analysis	Feasibility study to explore opportunities for large scale surface water retrofit/alternative water supply	Feasibility Study	N/A	2012	Ongoing Study	Not quantified	Not quantified
Total	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**2,529.1**	**220.9**

1. Activities began before 2009.
2. The city will need to collect information on the amount of stormwater that goes to reuse annually to quantify credit.

Project Number	Project Name	Project Description	Treatment Acres	Project Cost	End Date	Status	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)
Osceola County								
OSC-1[1]	Boggy Creek II - Pond 1 (150% plus additional treatment)	Wet detention pond	8.2	$6,712,156 (Ponds 1, 2, 3)	Unknown	Started	0.5	0.0
OSC-2[1]	Boggy Creek II - Pond 2 (150% plus additional treatment)	Wet detention pond	6.2	$6,712,156 (Ponds 1, 2, 3)	Unknown	Started	0.1	0.0
OSC-3[1]	Boggy Creek II - Pond 3 (150% plus additional treatment)	Wet detention pond	5.9	$6,712,156 (Ponds 1, 2, 3)	Unknown	Started	0.3	0.0
OSC-4	John Young Pwy Widening Parnell St. to Osceola Pkwy Pond A	Wet detention pond	23.8	Unknown	04/2011	Completed	0.9	0.3
OSC-5	Narcoossee Rd IB - Pond 2 and 3	Wet detention pond	21.6	Unknown	09/2011	Completed	4.9	0.3

Table 3-13 (*continued*)
Lake Tohopekaliga Nutrient Reduction Plan
Management Actions by Stakeholder

Project Number	Project Name	Project Description	Treatment Acres	Project Cost	End Date	Status	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)
OSC-6	Narcoossee Rd III - Pond C3A & C3B	Wet detention pond	19.4	Unknown	Ongoing	Ongoing	6.9	0.3
OSC-7	Narcoossee Rd III - Pond D3	Wet detention pond	24.2	Unknown	Ongoing	Ongoing	2.0	0.1
OSC-8	Narcoossee Rd III - Pond E1	Wet detention pond	10.8	Unknown	Ongoing	Ongoing	1.9	0.1
OSC-9[1]	Hoagland Blvd II - Pond 3 (150% plus additional treatment)	Wet detention pond	36.7	Unknown	Unknown	Ongoing	21.6	6.4
OSC-10[1]	Poinciana III –Swales 1, 2, and 3 (150% plus additional treatment)	Swales with blocks or raised culverts	60.6	Unknown	Ongoing	Ongoing	0.5	0.0
OSC-11	Stewart Street Regional Pond Retrofit	Wet detention pond	2,300	Unknown	2009	Completed	2,667.0	381.3
OSC-12	East Lake Reserve Reuse[2]	Stormwater reuse	3.7	Unknown	12/2028	Ongoing	255.9	5.8
OSC-13	Bass Road Landfill Reuse	Stormwater reuse	0.9	Unknown	04/2031	Planned and Funded	537.1	40.2
OSC-14	Neptune Road Reuse[2]	Stormwater reuse	3.0	$640,690	09/2027	Ongoing	849.0	62.0
OSC-15	Waterside Vista Reuse	Stormwater reuse	0.3	Unknown	02/2030	Ongoing	29.0	0.7
OSC-16	Bellalago & Isles of Bellalago Reuse	Stormwater reuse	327.0	Unknown	05/2031	Ongoing	3,807.5	277.6
OSC-17	Poinciana Commerce Center Reuse[2]	Stormwater reuse	1.3	Unknown	06/2028	Ongoing	33.6	2.8
OSC-18	Kissimmee Bay Reuse[2]	Stormwater reuse	130.0	Unknown	10/2030	Ongoing	588.9	13.1
OSC-19	Remington Reuse	Stormwater reuse	139.0	Unknown	11/2015	Ongoing	382.6	15.1
OSC-20	Eagle Lake Reuse[2]	Stormwater reuse	17.3	Unknown	07/2023	Ongoing	1,204.6	84.6
OSC-21	La Quinta Inn Reuse[2]	Stormwater reuse	2.8	Unknown	10/2022	Ongoing	90.8	7.0
OSC-22	Street Sweeping[2]	Street Sweeping	N/A	Unknown	Ongoing	Ongoing	226.8	151.2
OSC-23	Education[2]	FYN; landscaping, irrigation, fertilizer, pet waste ordinances; PSAs; pamphlets; website; illicit discharge program	N/A	Unknown	Ongoing	Ongoing	8,441.9	795.2

Table 3-13 (*continued*)
Lake Tohopekaliga Nutrient Reduction Plan
Management Actions by Stakeholder

Project Number	Project Name	Project Description	Treatment Acres	Project Cost	End Date	Status	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)
OSC-24	Judge Farms Feasibility Analysis	Feasibility study to explore opportunities for large scale surface water retrofit/alternative water supply	N/A	Unknown	2012	Ongoing	Not quantified	Not quantified
OSC-25	Marydia Sewer Improvements	Septic tank replacement program	N/A	Unknown	Unknown	Envisioned, Not Funded	Not quantified	Not quantified
OSC-26	Bill Beck - Pond A, B, and C	Wet detention pond	150% requirement met	$7,198,754	Unknown	Started	Not quantified	Not quantified
OSC-27	Boggy Creek 1 - Ponds A, C-1, and C-2	Wet detention pond	150% requirement met	$16,782,823	Unknown	Started	Not quantified	Not quantified
OSC-28	Carrol St. JYP to Thacker Ave (Ph 2)	Wet detention pond	150% requirement met	$4,221,836	2016	Envisioned, Not Funded	Not quantified	Not quantified
OSC-29	Carrol St. JYP to Old Dixie Hwy (Ph 1)	Wet detention pond	150% requirement met	$14,181,153	2016	Envisioned, Not Funded	Not quantified	Not quantified
OSC-30	Neptune Rd II & III (4 ponds)	Wet detention pond	150% requirement met	Unknown	Unknown	Envisioned, Not Funded	Not quantified	Not quantified
OSC-31	Old Canoe Creek Rd - Ponds A and B	Wet detention pond	150% requirement met	Unknown	2016	Started	Not quantified	Not quantified
OSC-32	Osceola Parkway II - Pond I	Wet detention pond	150% requirement met	Unknown	Unknown	Started	Not quantified	Not quantified
OSC-33	Hoagland Blvd I (& Airport) - Pond 100	Dry detention	150% requirement met	Unknown	Unknown	Ongoing	Not quantified	Not quantified
OSC-34	Hoagland Blvd I (& Airport) - Pond 200	Retention BMPs	150% requirement met	Unknown	Unknown	Ongoing	Not quantified	Not quantified
OSC-35	Hoagland Blvd III - Pond 2A	Wet detention pond	150% requirement met	Unknown	Unknown	Ongoing	Not quantified	Not quantified
OSC-36	Shady Lane US-192 to Partin Settlement -Pond 10	Wet detention pond	150% requirement met	Unknown	Ongoing	Ongoing	Not quantified	Not quantified
Total	**N/A**	**N/A**	**3,142.7**	**N/A**	**N/A**	**N/A**	**19,154.3**	**1,844.1**

1. The load reduction shown is for the additional amount beyond the 150% treatment requirement. The credit associated with only the 150% increase in treatment volume has not been quantified.
2. Activities began before 2009.

Table 3-13 (*continued*)
Lake Tohopekaliga Nutrient Reduction Plan
Management Actions by Stakeholder

Project Number	Project Name	Project Detail	Project Type	Treatment Acres	Project Cost	End Date	Status	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)
City of Orlando									
ORL-1	Lake Angel/Conroy Basin Drainage Project - 18th St/Parramore Ave Baffle Box	Baffle box installed to remove gross pollutants, including organic debris, sediment and litter.	2nd generation baffle box – closed basin	5.4	$578,138 (both ORL-1 and 2)	Aug-09	Completed	0.0	0.0
ORL-2	Lake Angel/Conroy Basin Drainage Project - 19th St/Parramore Ave Baffle Box	Baffle box installed during project to remove gross pollutants, including organic debris, sediment and litter.	2nd generation baffle box – closed basin	10.9	$578,138 (both ORL-1 and 2)	Aug-09	Completed	0.0	0.0
ORL-3	Miscellaneous Neighborhoods Storm Sewer Improvements Lake Holden - Albert Shores	Storm drainage improvements throughout Lake Holden Terrace, W. Illiana St., Sunrise Court, Wadsworth Ave, Joseph St, Compton Ave., Pineloch Ave, Albert St., and Richard Place.	2nd generation baffle boxes and Storm Flo unit – closed basin	86.23	$3,511,000	2012	Started	0.0	0.0
ORL-4	Pine Street/Orange Blossom Trail Corridor Stormwater Improvements	Installation of 1,800 feet of stormwater pipe from Pine Street to Lake Lorna Doone, which includes a baffle box.	2nd generation baffle box	11.49	$577,822	May-10	Completed	7.1	0.0
ORL-5	Lake Pineloch Basin Inlet Baskets	Remove gross pollutants, including organic debris and sediment, from runoff and suspend from standing water level to prevent leaching.	Catch basin inserts/inlet filters	120.70	$40,480	2009	Completed	0.2	0.1
ORL-6	Lorna Doone Wetlands	Wetland created to remove pollutants from runoff; a new weir was installed that increased residence time.	Wet detention pond	29.52	Unknown	2011	Completed	Not quantified	Not quantified
ORL-7	Street Sweeping[1]	Street sweeping of 17,903 curb miles/yr	Street sweeping	N/A	$1,800,000 - annually	Ongoing	Ongoing	3,222.5	2,148.4
ORL-8	Public Education[1]	FYN; landscaping, irrigation, pet waste management ordinances; PSAs; pamphlets; website; illicit discharge program	Public education	N/A	Unknown	Ongoing	Ongoing	4,775.9	356.6
Total	**N/A**	**N/A**	**N/A**	**264.2**	**N/A**	**N/A**	**N/A**	**7,985.6**	**2,505.1**

1. Activities began before 2009.

Table 3-13 (*continued*)
Lake Tohopekaliga Nutrient Reduction Plan
Management Actions by Stakeholder

Project Number	Project Name	Project Type	Project Cost	Annual O&M Costs	End Date	Status	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)
Orange County								
OC-1	Education and Outreach[1]	FYN; landscaping, irrigation, fertilizer, pet waste ordinances; PSAs; pamphlets; website; illicit discharge program	Unknown	$0	Ongoing	Ongoing	Not quantified	Not quantified
OC-2	Lake Odell Curb Inlet Baskets	Catch basin inserts/inlet filters	$3,000	$666	2008	Ongoing	0.8	0.3
OC-3	Lake Conway Inlet Baskets	Catch basin inserts/inlet filters	$50,000	$11,100	2009	Ongoing	3.9	1.3
OC-4	Lake Holden Curb Inlet Baskets	Catch basin inserts/inlet filters	$41,000	$9,102	2009	Ongoing	22.3	7.3
OC-5	Lake Jessamine Inlet Baskets	Catch basin inserts/inlet filters	$110,000	$24,420	2008	Ongoing	13.6	4.5
OC-6	Hansel Avenue Pond Improvements	Treatment train	$224,713	$2,500	2008	Completed	Not quantified	Not quantified
OC-7	Lake Conway Street Sweeping[1]	Street sweeping	$0	$44,015	Ongoing	Ongoing	115.7	52.1
OC-8	Lake Holden Street Sweeping[1]	Street sweeping	$0	$15,198	Ongoing	Ongoing	40.0	18.0
OC-9	Lake Jessamine Street Sweeping[1]	Street sweeping	$0	$11,003	Ongoing	Ongoing	28.9	13.0
OC-10	Lisa Waterway CDS	CDS unit	$225,000	$5,362	Ongoing	Completed	Not quantified	Not quantified
OC-11	Lake Cane Catch Basins	Catch basin inserts/inlet filters	Unknown	Unknown	2012	Planned and Funded	Not quantified	Not quantified
OC-12	Lake Pineloch Alum Treatment	Alum injection	$153,272	$0	2011	Planned and Funded	Not quantified	Not quantified
OC-13	Lake Cane Alum Treatment	Alum injection	Unknown	$0	2012	Planned and Funded	Not quantified	Not quantified
OC-14	Lake Floy Lake Alum Treatment	Alum injection	Unknown	$0	2012	Planned and Funded	Not quantified	Not quantified

Table 3-13 (*continued*)
Lake Tohopekaliga Nutrient Reduction Plan
Management Actions by Stakeholder

Project Number	Project Name	Project Type	Project Cost	Annual O&M Costs	End Date	Status	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)
OC-15	Lake Pineloch Alum Injection	Alum injection	Unknown	Unknown	2013	Envisioned, Not Funded	Not quantified	Not quantified
OC-16	Lake Pineloch Keystone Baffle Box	2nd generation baffle box	Unknown	Unknown	2013	Planned and Funded	Not quantified	Not quantified
OC-17	Bumby Alum Injection	Alum injection	Unknown	Unknown	2013	Envisioned, Not Funded	Not quantified	Not quantified
OC-18	Lake Anderson Mobile Alum Injection	Alum injection	Unknown	Unknown	2012	Envisioned, Not Funded	Not quantified	Not quantified
OC-19	Lake Gem Mary Alum Injection	Alum injection	Unknown	Unknown	2013	Envisioned, Not Funded	Not quantified	Not quantified
OC-20	Randolph Ave Stormcepter	Stormceptor	Unknown	Unknown	Unknown	Completed	Not quantified	Not quantified
OC-21	Randolph Ave CDS	CDS unit	Unknown	Unknown	Unknown	Completed	Not quantified	Not quantified
OC-22	Randolph Pond	Dry detention	Unknown	Unknown	Unknown	Completed	Not quantified	Not quantified
OC-23	Lake Anderson Study	Public education	$83,029	$0	2012	Completed	Not quantified	Not quantified
OC-24	Lake Christie Study	Public education	$79,784	$0	2012	Planned and Funded	Not quantified	Not quantified
OC-25	Lake Jennie Jewel Study	Public education	$99,970	$0	2012	Planned and Funded	Not quantified	Not quantified
OC-26	Lake Condel Study	Public education	$66,061	$0	2012	Planned and Funded	Not quantified	Not quantified
OC-27	Shingle/Boggy/Hart Basin Street Sweeping[1]	Street sweeping	Unknown	Unknown	Ongoing	Ongoing	Not quantified	Not quantified
Total	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**225.2**	**96.5**

1. Activities began before 2009.

Table 3-13 (*continued*)
Lake Tohopekaliga Nutrient Reduction Plan
Management Actions by Stakeholder

Project Number	Project Name	Project Detail	Project Type	Treatment Acres	End Date	Status	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)
FDOT								
FDOT-1	239266-3-Ponds 1, 2, and 3	SR 15 (Hoffner Ave) widening project	Wet detention pond	33.1	2015	Planned and Funded	23.4	1.4
FDOT-2	239266-4-Pond 4	SR 15 (Hoffner Ave) widening project	Wet detention pond	16.5	2015	Planned and Funded	14.0	0.6
FDOT-3	407143-2	Widen / Resurface Sand Lake Road (SR 482) from Presidents Drive to OBT.	Swales/dry detention	31.8	2011	Ongoing	45.7	6.2
FDOT-4	407143-3	Six Lane Sand Lake Road (SR 482) from Turkey Creek to West of JYP.	Wet detention pond	63.3	Unknown	Envisioned, Not Funded	183.5	42.9
FDOT-5	239683-1	Widen (4 to 6 lane) SR 500 (US 192) from Eastern Ave. to Nova Road.	Wet detention pond	88.4	2013	Planned and Funded	69.3	5.2
FDOT-6	239682-1	Widen (4 to 6 lane) SR 500 (US 192) from Aeronautical Drive to Budinger Ave.	Wet detention pond	109.6	2013	Planned and Funded	274.6	67.2
FDOT-7	Public Education	Pamphlets, website, illicit discharge program	Public education	N/A	Ongoing	Ongoing	156.4	16.7
FDOT-8	Street Sweeping	Street sweeping – 433,876 kg/yr	Street sweeping	N/A	Ongoing	Ongoing	613.1	276.1
Total	**N/A**	**N/A**	**N/A**	**342.7**	**N/A**	**N/A**	**1,379.8**	**416.2**

Based on the methodology previously described, the project load reductions by Stakeholder jurisdiction are estimated to be about 34,344 lbs/yr of TN and 6,287 lbs/yr of TP (**Table 3-14**). It is important to note that similar to the baseline and existing TN and TP loads, these are also estimates based on the best available data and FDEP-approved BMP removal efficiencies.

Table 3-14
Lake Tohopekaliga Nutrient Reduction Plan
Project Load Reduction Summary

Jurisdiction	Project TN Load Reduction (lbs/yr)	Project TP Load Reduction (lbs/yr)
City of Kissimmee	3,070	1,204
City of St. Cloud	2,529	221
Osceola County	19,154	1,844
City of Orlando	7,986	2,505
FDOT	1,380	416
Orange County	225	97
Totals:	***34,344***	***6,287***

For several projects, not enough information was available to quantify the load reduction (Table 3-13). As mentioned previously, those projects that fall under the 150 percent requirement have only been identified and their load removal has not been quantified. Therefore, it is anticipated that the nutrient load removal through planned and proposed projects is higher than what is reported in Tables 3-13 and 3-14. It is recommended that during NRP implementation, the Stakeholders supplement the existing project information so that the remaining load reductions can be quantified.

3.2.1 Agricultural BMPs

As mentioned previously, nutrient loads from agriculture were treated separately as these are under the jurisdiction of FDACS. Florida law provides for growers to reduce their impacts to water quality through the voluntary implementation of BMPs adopted by FDACS. In some cases, these BMPs are required. Agricultural BMPs are practical, cost-effective actions that agricultural producers can implement to reduce the amount of pesticides, fertilizers, animal waste, and other pollutants entering our water resources. BMPs are designed to benefit water quality while maintaining or even enhancing agricultural production. FDACS develops and adopts BMPs by rule for different types of agricultural operations. The Office of Agricultural Water Policy (OAWP) is the division of FDACS that is actively involved in the development of BMPs, addressing both water quality and water conservation on a site specific, regional, and watershed basis. Most of the BMPs are outlined in specific manuals, which can be found on the FDACS website: http://www.floridaagwaterpolicy.com/BestManagementPractices.html.

Under this process, growers submit a Notice of Intent (NOI) to implement specific BMPs contained in an FDACS BMP manual or rule. In some areas of the state, growers develop site-specific conservation plans that contain the appropriate BMPs. Any grower operating in an area covered by applicable FDACS BMPs is eligible to submit an NOI under the appropriate manual or rule. In areas with FDEP adopted BMAPs that include agriculture, growers must implement BMPs or conduct water quality monitoring. Enrollment in FDACS BMP programs is continuous and FDACS has a long-term commitment to enlisting and providing assistance to growers to implement BMPs.

According to the SFWMD draft 2008/2009 land cover/land use data, there are approximately 39,310 acres of agricultural land within the Lake Toho watershed, accounting for approximately 13 percent of the total watershed acreage. Most of the agricultural acreage is within Osceola County. The primary land cover type is improved pasture, which makes up 70 percent of the total agricultural acres. Unimproved pasture accounts for an additional 14 percent. The remaining agricultural acres in the land use data are a mix of row/field crops, citrus, nurseries, and a small number of horse farms. Because most of the watershed is urban, a significant portion of the land identified as agriculture in the watershed is likely no longer in production, and OAWP will work to identify those acres through the BMP enrollment effort in the watershed. As of June 30, 2011, fifteen NOIs to implement BMPs covering 6,149 acres have been received by the OAWP (**Table 3-15**).

Table 3-15
Lake Tohopekaliga Nutrient Reduction Plan
Agricultural BMP Enrollment Summary

Land Use Code	Code Description	Related FDACS BMP Programs	Comments	Acreage Enrolled	No. of NOIs
2120	Unimproved Pasture	Cow/Calf		5,645.5	1
2130	Woodland Pasture				
2110	Improved Pasture				
		Future (hay)	Vegetable/Agronomic Crops manual under revision	0.0	0
2140	Row Crop	Vegetable/Agronomic Crops		0.0	0
2150	Field Crops				
2160	Mixed Crops				
2210	Citrus	Ridge Citrus		496.8	12
		Flatwoods Citrus		0.0	0
2230	Other Groves	Specialty Fruit & Nut		0.0	0
2240	Abandoned Tree Crops (citrus)	N/A	Out of production/ abandoned - no enrollment needed	N/A	N/A
2300	Animal Feeding Operation	Conservation Plan Rule		0.0	0
2310	Cattle Feeding Operation				
2320	Poultry Feeding Operation				
2410	Tree Nurseries	Future	Nursery manual being expanded	N/A	N/A
		Specialty Fruit & Nut		0.0	0
2430	Ornamentals	Container Nursery		7.0	2
2420	Sod Farm	Sod		0.0	0
2500	Specialty Farms	Conservation Plan Rule		0.0	0
2510	Horse Farm	Future	Equine manual pending adoption	N/A	N/A
2540	Aquaculture	(FDACS Aquaculture Division)	Aquaculture Certification Program	N/A	N/A
			Totals:	**6,149.3**	**15**

Most of this acreage is associated with cow/calf and citrus operations. In coordination with the Osceola County UF IFAS/Extension Agent, OAWP staff in the Northern Everglades office is working to contact and enroll producers within the Lake Toho watershed. OAWP also plans to work with the Osceola County chapter of the Florida Cattlemen's Association to hold workshops for cow/calf producers in the watershed. Workshops for other commodities will be scheduled in coordination with the UF/IFAS Extension and other grower organizations.

3.3 Assessment of Future Growth and New Sources

Future growth impacts were evaluated for the Lake Toho Watershed. As development occurs in the watershed, additional impervious area is created, thereby increasing runoff and the potential for pollutants to be discharged to surface waters. Population growth can also affect pollutant loading by increasing the intensity of activities such as traffic, lawn fertilization, pet ownership, and others. To maintain the load reductions gained through BMAP implementation, local governments, businesses, citizens, and others will need to practice pollution prevention on a continuing basis through land use decisions, ordinance adoption and enforcement, public education efforts, BMPs, personal habits, and other means.

Transportation Analysis Zone (TAZ) data were selected as the primary data source for evaluating future population projections in the Lake Toho watershed. The TAZ data for Orange and Osceola counties were provided by METROPLAN ORLANDO, which is the metropolitan planning organization for Orange, Osceola, and Seminole counties. TAZs are areas delineated by state and/or local transportation officials for tabulating traffic-related data; especially journey-to-work and place-of-work statistics. TAZ data are based on U.S. Census data and Bureau of Economic and Business Research projections, and the data are reviewed closely by local planners during their compilation. TAZ data include a variety of demographic and transportation statistics. For this analysis, only the population estimates were used. Population data were aggregated across all housing types (e.g., single family, multifamily). These future growth estimates do not include increases in commercial or industrial activities not associated with increases in residential population. The TAZ area used to provide population growth estimates for the watershed is shown in **Figure 3-7**. Population estimates were available up through 2030 and the expected growth estimates within the watershed are summarized in **Table 3-16**. The year 2004 is used as the baseline as the model used by METROPLAN ORLANDO is calibrated to this base year.

Table 3-16
Lake Tohopekaliga Nutrient Reduction Plan
Population Estimates within the Lake Tohopekaliga Watershed

	2004 Population	2015 Population	2020 Population	2025 Population	2030 Population
Study Area Population	315,973	593,370	642,399	688,371	740,747
Annual Average Growth Rate		8.0%	6.5%	5.6%	5.2%

As described previously in Section 3.2, the SFWMD's more stringent permitting requirements for projects that discharge into impaired waters (i.e., an extra 50 percent treatment volume is required for discharges to OFWs, impaired waters or other water bodies that do not meet water quality standards) within the Upper Kissimmee River Basin will also help in addressing pollutant loads associated with future growth.

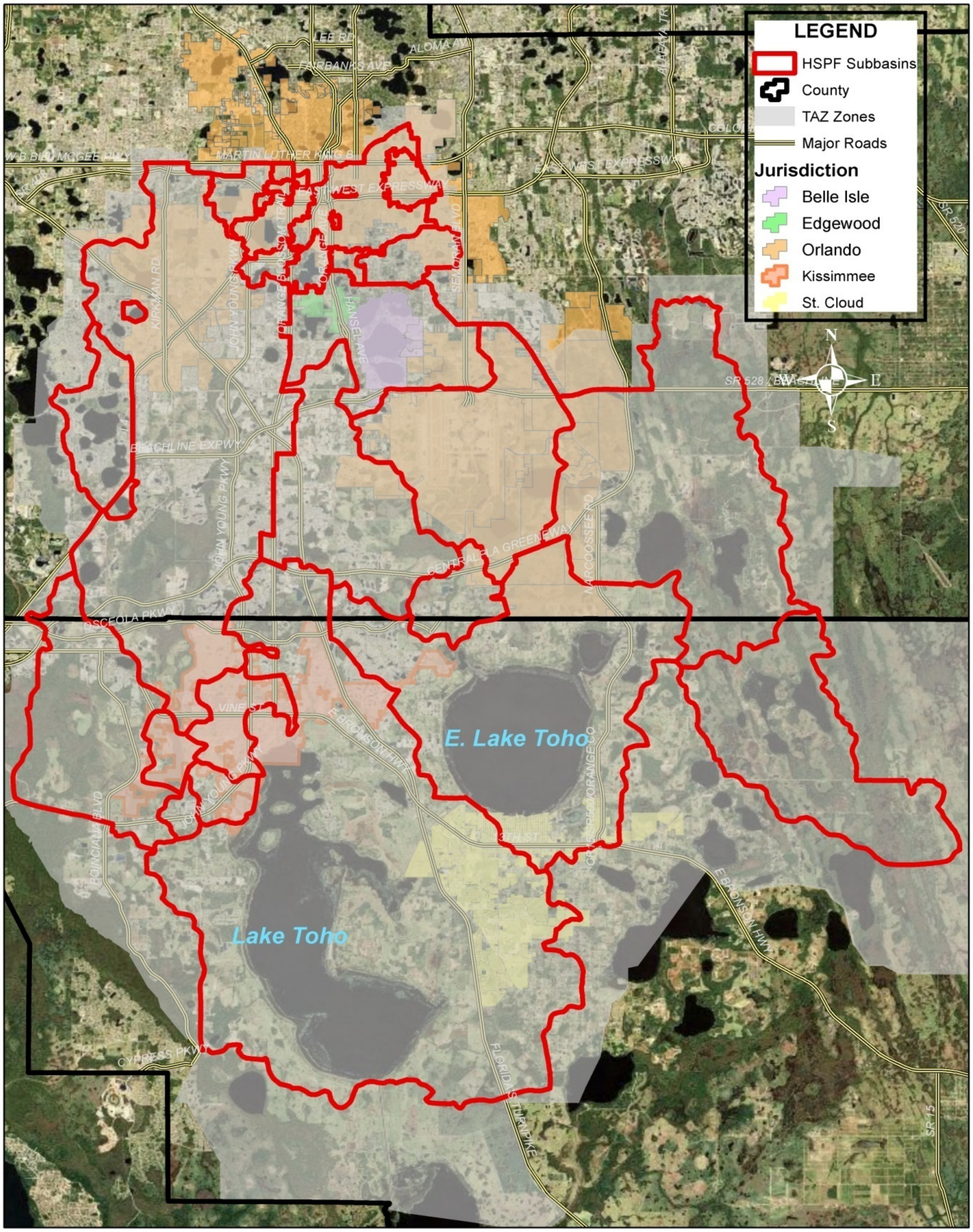

Figure 3-7 Study Area Transportation Analysis Zones

Section 4
Research Priorities

4.1 Research Priorities

During the formulation of the NRP, it was evident that more research is needed in order to set appropriate water quality targets for Lake Tohopekaliga (Toho) and to define what the balanced condition for the lake is. Two major knowledge gaps were consistently identified throughout the stakeholder process:

1) The interaction between nutrients (external and internal loads), sediments, macrophytes and the water column; and,

2) The effect of long-term management activities (i.e., lake level management, hydrilla control, habitat improvement) on the lake's ambient water quality.

During the stakeholder process, local governments and agencies discussed whether hydrilla biocover should be used to assess long-term improvements in the lake due to reduction of external nutrient loads. As mentioned previously in the NRP, FWCC currently manages hydrilla coverage to support the endangered snail kite population. The snail kite has lost most of its historic nesting and feeding habitat in South Florida because of drought and floods, and many have migrated north to Lake Toho. FWCC and the USFWS biologists have detailed how hydrilla provides a structure on which apple snails climb to the surface of the water, where the Everglade snail kite can eat them. Abundant hydrilla and apple snails make Lake Toho one of the most desirable areas in the state for snail kites to find plenty of food and to nest (FWCC, 2011). During the NRP process, FWCC has indicated that depending on the nesting habits of the snail kite and the conditions each year, the agency may increase or decrease the biocover. Therefore, the idea of using hydrilla biocover as a tool to assess future water quality improvements by the Stakeholders was abandoned.

In terms of current research, Osceola County was awarded a $2.88 million dollar grant by EPA to conduct a project to find alternative ways to manage hydrilla and hygrophila (and other invasive exotic plants) in the Upper KCOL. The demonstration project is overseen by IFAS and began in 2006 and will last until March 2012. FWCC maps the lake vegetation in order to document impacts to hydrilla and non-target native plants. Information from both of these programs has enabled FWCC resource managers to better predict the response of snail kites and native vegetation to changes in hydrilla populations (IFAS (Harris), 2011).

In light of these issues, Stakeholders discussed potential research needs in order to better understand lake dynamics and identify potential activities that will eventually lead to setting appropriate water quality targets. During this discussion, it was also revealed that a literature search is currently underway by the University of Florida regarding the linkage between submerged aquatic vegetation and nutrients, with an emphasis on hydrilla.

on hydrilla. It is anticipated the results of this literature search will yield information that will help refine future research needs. Therefore, at this point in time, it was recommended to establish research priorities that are more general in nature. Once the literature review is complete, the Stakeholders can re-convene during implementation of the NRP to refine the research needs. Through the stakeholder process, the following list of questions was formulated:

1) What is the current assimilative capacity of Lake Toho?

2) What confounding factors are impeding our ability to assess assimilative capacity?

3) Is hydrilla having a beneficial, adverse, or no effect on the assimilative capacity?

4) What is an acceptable nutrient loading rate for Lake Toho?

5) Do system operations (i.e., lake management activities) have a beneficial, adverse, or no effect on lake nutrient cycling?

It is important to recognize that some of these research questions may also have limitations. The Stakeholders responsible for developing the NRP have been tasked with reducing external nutrient loads to Lake Toho. The linkage between external nutrient loads and temporal impacts on hydrilla growth remains an unknown. It is likely that even with external nutrient reductions over the next five years, any reduction in coverage of hydrilla will be coincidental or will be due to invasive plant control administered by the agencies. For a lake of this size, continued decreasing downward TN and TP trends may not be a result of external nutrient load reductions only, but a combination of all the management practices and the biology of the lake. Therefore, future assessments of the lake's impairment status will need to be carefully selected to make sure all these factors are taken into consideration and the most appropriate tool is applied. The adaptive management process (described in Section 5) also allows the Stakeholders to refine and modify the direction of the research as more information is gathered and learned about the complexities of interactions between external nutrient loads, macrophytes, internal cycling and lake management activities.

In addition to the research questions listed above, the SFWMD has also identified some of its own internal research priorities related to Lake Toho. These are draft and subject to change depending on funding and resources. However, there may also be opportunity for these to complement and match several of the NRP research priorities.

SFWMD Research Goal: Understand the nutrient dynamics to maintain assimilative capacity of the lake.

- Priority Item: Establish a nutrient budget – the SFWMD envisions starting with a gross nutrient budget using existing in-lake and tributary data and enhancing it by first determining the amount of nutrients stored in plants and then the amount of nutrients stored in sediments. This analysis will not be at the sub-watershed level.
- Status: In general, the information needed is available and is currently being compiled with a goal for completion by the end of fiscal year 2012.

- Priority Item: Determine if there are there excessive nutrients being loaded into the lake.
- Status: The SFWMD currently has partial information and is still in need of additional tributary data (flow and water quality) to perform sub-watershed level nutrient budget.

- Priority Item: Determine the current assimilative capacity of the lake
- Status: This will be based on gross nutrient budget information and is currently being compiled with a goal for completion by the end of fiscal year 2012.

- Priority Item: Determine the TP in the lake and how it is distributed between the water, plants, and sediment.
- Status: SFWMD has already compiled some information for this item. This should be coordinated with the University of Florida literature search for the NRP.

- Priority Item: Determine how the chemical and physical properties of sediments influence plant distributions and water quality.
- Status: This is considered future work and analysis and requires further discussions and coordination.

- Priority Item: Determine what internal cycling processes are effecting lake nutrient concentrations and light availability.
- Status: This is considered future work and analysis and requires further discussions and coordination.

- Priority Item: Determine what information is available in the literature for plant tissue phosphorus for key community types including periphyton.
- Status: This is considered future work and analysis but the University of Florida literature search may provide some information.

- Priority Item: Determine sediment typing, distribution, and nutrient concentrations and comparison with Lake Okeechobee and Lake Istokpoga (this assumes Lake Toho is similar to Lake Okeechobee and Lake Istokpoga).
- Status: This is considered future work and analysis and requires further discussions and coordination.

4.2 Additional Information

Once the research questions were formulated, CDM then followed up with several local experts to obtain additional feedback. These experts (FWCC, University of Florida and SFWMD) all provided responses, each with unique perspectives on potential positive or negative habitat/ecological attributes associated with varying densities of hydrilla. The following is a summary of feedback obtained from these local experts that is presented for informational purposes **only**. It should be noted that these are professional opinions that have not yet been vetted through peer review publications. In addition, several documents related to this subject matter were also referenced. As this NRP is not intended to be a research document itself, it is important to showcase some of the many challenges lake managers (at both the local and state level) will be faced with in defining the balanced condition for the lake. The information presented here is not intended to be an exhaustive compilation of all the complexities involving the presence of hydrilla. This information may also be useful when the research plan is re-visited during the implementation of the NRP. Due to the wide variety of responses, the comments were organized by category (biological, chemical and physical).

Biological

- Hydrilla has been shown to be an excellent plant as a substrate for many macroinvetebrates (Mann, 2011).
- An overabundance of hydrilla can have a negative effect on fish growth and fishing effort (Mann, 2011).
- The growth habit of hydrilla enables it to compete effectively for sunlight. It can elongate very rapidly, up to one inch per day, until it nears the water surface (IFAS, 2011).
- When hydrilla grows to and mats at the surface, periphyton grows on the hydrilla, and thick masses of filamentous algae can cover the hydrilla mat (Schardt, 2011).
- Hydrilla can out-compete native plants. It has the ability for luxury consumption of phosphorus and can grow in low-light conditions where other plants cannot survive (Mann, 2011).
- Research has shown young of the year fish abundance increased with increased submersed plant species coverage including (primarily) hydrilla, and has been found to be optimal around 20-40% coverage (Mann, 2011).
- Several thousands of coots, a species of wading bird, can congregate and consume hydrilla during winter months – what influence does this have on localized N and P levels? (Schardt, 2011). There is limited information available regarding the link between water bird feeding on vast beds of hydrilla and potential impacts on lake water quality. While impacts may ultimately be localized, very little is known about this phenomenon when considering the fact that extensive hydrilla coverage is concentrating very high numbers of feeding birds. Given the fact this conversion of plant material to soluble nutrients is occurring on a daily basis, some research to predict weekly and seasonal loading impacts would be of value (Netherland, 2011).
- The survival of the snail kite has become the overriding factor in aquatic plant management planning and operations on the KCOL. Although snail kites may not fully rebound until previous habitats are reclaimed in south Florida, FWCC expects to be able to enhance their territory on the KCOL through a variety of habitat improvement projects, including the thoughtful management of hydrilla (IFAS (Harris), 2011).
- Over the last six years, more snail kites have been nesting on the KCOL and fewer have been nesting in south Florida. In fact, Lake Toho has had the highest number of snail kite nests in the state each year since 2006. Scientists think there are several reasons, including a lack of snails in the Everglades and an explosion of exotic snails in the KCOL (IFAS (Welch), 2011)

Chemical

- Nitrogen appears to be the most important nutrient related to hydrilla growth (Schardt, 2011).
- Like most submersed plants, hydrilla gets most of its nutrients from the sediments (Schardt, 2011).
- Hydrilla may “pump” excess nutrients into the water column (Schardt, 2011).
- Nutrient content in hydrilla tissues varies throughout the year (Schardt, 2011).

- Research has shown that most of the nutrients taken up in the water column when hydrilla is present are taken up by the attached epiphytes. Overall, nutrients within epiphytes make up the bulk of the total nutrients that are found within or on hydrilla. In other words, the hydrilla has the lesser role of the two. Research has also shown water quality variables such as TP, TN, chlorophyll-a (chl-a) concentrations can be significantly decreased (statistically) when submersed vegetation exceeds 30 percent or greater of the lake volume. This is probably due to epiphytic uptake; and decreased re-suspension of sediments (hydrilla stabilizes the lake bottom).

- Studies have shown that after hydrilla was removed by grass carp, water quality degraded (Mann, 2011).

- While extensive hydrilla growth (and the associated epiphytes) can result in increased water clarity and reduce the amount of nutrients available in the water column (i.e. improve water quality), excessive hydrilla growth in water of better quality would still result in Lake Toho being placed on the impaired list. Moreover, hydrilla can take advantage of the improved light availability and grow into new regions. The maxim that hydrilla creates conditions for more hydrilla to grow is often used. From a research perspective, it would be desirable to test the hypothesis that light availability in Lake Toho is a greater driver of hydrilla growth when compared to water column and sediment nutrients (Netherland, 2011).

- In most nutrient budget studies, the factor that contributes most of the nutrients to be available in a system is internal cycling due to re-suspension of sediments. Most of the variability within nutrient cycling models is explained by these phenomena. This is why most water quality improvement projects within lakes usually consist of dredging bottom sediments. Although no studies have occurred on Lake Toho regarding this process, algal blooms occur after wind events on Lake Toho which result in waves and internal currents that suspend sediments (Mann, 2011).

- The lake was identified to be placed on the State's impaired waterbody list due to excessive invasive macrophyte growth (specifically hydrilla), and the assumption is that reducing the external nutrient load will reduce the amount of hydrilla growth. In the short- and medium-term, this may prove to be an inaccurate assumption. A more appropriate research hypothesis is that reducing the external load of nutrients into the lake will impact the growth and spread of hydrilla over a 1-, 2-, 5-, and 10-year horizon (Netherland, 2011).

- There is limited information regarding nutrient and chlorophyll-a dynamics following large-scale hydrilla management on Lake Toho. It is generally assumed that any impacts are localized and ephemeral, but there is not an abundance of data to support this assumption. If hydrilla again becomes established on thousands of acres of Lake Toho (a reasonable scenario given current rates of spread), the large amount of nutrients sequestered in the plant tissue can be rapidly released to the water column (Netherland, 2011).

- It is somewhat paradoxical that extensive hydrilla will likely serve to result in reduced nutrient and chlorophyll levels in the lake when compared to external loads; however, these extensive beds are the reason the lake has been placed on the impaired list of waterbodies by FDEP. While reduction in external nutrient loading is a worthy goal, the lag between these reductions and a resultant decrease in hydrilla growth and coverage could be significant (Netherland, 2011).

Physical

- Hydrilla leaves and stems senesce and detritus falls to the bottom throughout the year, especially during the winter months (Schardt, 2011).
- Sediment accumulation can double under a dense stand of hydrilla vs. open water (more detritus generated / slower breakdown) (Schardt, 2011).
- Hydrilla can not only cover the bottom, but also fill the water column and form dense mats at the water surface, limiting oxygen and light penetration into the water (Schardt, 2011).
- Hydrilla has covered the surface of as much as 15,000 acres of Lake Toho (Schardt, 2011).
- Summer surface water temperatures in Florida hydrilla mats exceeds 100°F (Schardt, 2011).
- pH can fluctuate between 7-10 in just a few hours in a dense hydrilla mat. Oxygen readings in hydrilla mats fall near to 0 mg/l and sediments can also become anoxic (Schardt, 2011).
- Temperature, oxygen and pH can be altered positively or negatively by hydrilla. Algae has similar effects for oxygen, pH, alkalinity among others (Mann, 2011).
- Dense masses of hydrilla at water inflows can trap suspended material causing increased localized sediment build-up (Schardt, 2011).
- Hydrilla can be a navigation hazard, an aesthetics issue and costly to manage (Mann, 2011).
- Hydrilla may have impacts on water movement and flood control (Mann, 2011).
- Hydrilla cover can prevent wind and wave action from reaching and re-suspending sediments (Schardt, 2011).

Section 5
Water Quality Monitoring

5.1 Water Quality Monitoring Plan

The Lake Tohopekaliga (Toho) NRP monitoring plan is designed to enhance the understanding of basin loads, identify areas with high nutrient concentrations, and track water quality trends. This information will be used to assess water quality conditions in the basin and determine how to best proceed with setting water quality targets. The sampling stations, parameters, and frequencies outlined in this monitoring plan may be modified as appropriate to match changing environmental conditions and funding resources. When making modifications to the plan, the Stakeholders should ensure that the monitoring network continues to provide the necessary information to achieve the monitoring objective noted in the section below.

5.1.1 Objective, Sampling Parameters, and Frequency

It is critical for a monitoring plan to have focused objectives to provide the information needed to evaluate implementation success. The Stakeholders and technical support partners agreed to the following objective for the Lake Toho NRP monitoring plan:

Identify major inputs to Lake Toho and East Lake Toho to calculate the loading to the impaired waterbodies and to identify areas of high nutrients in the watershed.

To achieve the objective above, the monitoring plan focuses on two types of parameters to track water quality trends. The core parameters are directly related to the parameters believed by FDEP to be causing impairment in Lake Toho. Supplemental parameters are monitored primarily to support the interpretation of the core water quality parameters and to gather additional information about the contributions from the watershed to the lake. The parameters (**Table 5-1**) only apply to the tributaries sampling as part of the monitoring network, and, at a minimum, the core parameters will be tracked by the Stakeholders and technical support partners at the tributaries stations. Some of the Stakeholders may not be able to monitor for all of the core parameters until the start of the next fiscal year. The in-lake sampling is conducted by SFWMD and they will maintain the current suite of parameters they currently monitor for (**Table 5-2**).

For the first year of the NRP monitoring, the minimum sampling frequency will be quarterly, which is currently budgeted by most of the Stakeholders and technical support partners. Additional samples should be collected, as budget allows, to provide the most data possible during the first year of monitoring. For subsequent years, the minimum sampling requirement will be six samples per year at each station in the monitoring network. Since seasonality is an important factor in the loading to Lake Toho, these six samples will be collected with four samples in the wet season (June through November) and two samples in the dry season (December through May). The ideal sampling for the NRP monitoring plan is 12 samples per year, with nine samples collected in the wet season and three samples collected in the dry season (December through May).

Table 5-1
Lake Tohopekaliga Nutrient Reduction Plan
Core and Supplemental Water Quality Parameters for Tributaries Sampling

Core Parameters	Method Detection Limits
Total phosphorus as P	0.0004 mg/L
Nitrate/nitrite as N	0.05 mg/L
Total Kjeldahl nitrogen (TKN) as N	0.05 mg/L
Dissolved oxygen (DO)	0.1 mg/L
pH	0.1 SU
Temperature	0.1 degree C
Conductivity	1 umhos/cm
Supplemental Parameters	**Method Detection Limits**
Total suspended solids (TSS)/turbidity	1 mg/L/ 0.1 NTU
Chloride	0.5 mg/L
True color/total organic carbon (TOC)	5 PCU/ 1 mg/L
Orthophosphate as P	0.0004 mg/L
Alkalinity	2 mg/L

Table 5-2
Lake Tohopekaliga Nutrient Reduction Plan
Water Quality Parameters for In-Lake Sampling

Core Parameters	Method Detection Limits
Total phosphorus as P	0.0004 mg/L
Orthophosphate as P	0.0004 mg/L
Nitrate/nitrite as N	0.05 mg/L
Total Kjeldahl nitrogen (TKN)	0.05 mg/L
Ammonium	10 ug/L
Nitrogen dioxide	4 ug/L
Chlorophyll	2 mg/L
Alkalinity	0.1 NTU
Turbidity	0.5 mg/L
Chloride	5 PCU
Color	1 mg/L
TSS	0.01 mg/L

5.1.2 Monitoring Network

The monitoring network builds on existing efforts in the basin by the City of Kissimmee, City of Orlando, Orange County, Osceola County, and SFWMD. The tributaries stations to be monitored by the Stakeholders and technical support partners as part of the Lake Toho NRP monitoring network (**Table 5-3, Figures 5-1** through **Figure 5-4)** will be sampled for the core parameters previously listed (Table 5-1) at the frequency outlined in the section above. SFWMD will continue to sample for the parameters listed in Table 5-2 on a monthly basis for the in-lake stations. The U.S. Geological Survey (USGS) sites are continuous flow stations that will be used to help calculate loading to Lake Toho. FDEP has also recommended that additional monitoring stations be included as part of the in-lake sampling. As this sampling is currently performed by SFWMD, the Stakeholders will take these additional stations into consideration and continue to coordinate with SFWMD as funding and resources become available to include these stations.

In addition to the stations in the monitoring network, the entities in the basin are conducting sampling that will provide supplemental data to meet the monitoring plan objective (**Appendix B**). .

5.1.3 Quality Assurance/Quality Control and Data Management

The collection of water quality data will be conducted in a manner consistent with FDEP's standard operating procedures (SOPs) for quality assurance/quality control (QA/QC). The most current version of these procedures can be downloaded from http://www.dep.state.fl.us/labs/library/lab_sops.htm. All Stakeholders and technical support partners contributing data in support of the NRP agree to follow these SOPs.

The Florida STORET database will serve as the primary resource for storing ambient data and providing access for all stakeholders, in accordance with Section 62-40.540, FAC. Stakeholders and technical; support partners have agreed to upload data to STORET in a timely manner, after the appropriate QA/QC checks have been completed. Applicable data collected by the entities responsible for monitoring will be uploaded to STORET regularly, but at least annually.

STORET uploads are only appropriate for data that represent ambient conditions. Other data, such as biological and flow data, will be maintained by the entity that collected the samples. Stakeholders agree to provide this data to other partners upon request and when appropriate for inclusion in data analyses in support of the NRP.

5.2 Adaptive Management Measures

Adaptive management is a structured iterative process of optimal decision-making in the face of uncertainty and involves setting up a mechanism for making adjustments when circumstances change or feedback indicates a more effective strategy is needed. Adaptive management measures include:

- Procedures to determine whether additional cooperative strategies are needed.
- Criteria/process for determining whether and when plan components need to be revised due to changes in costs, environmental impacts, social effects, watershed conditions, or other factors.
- Descriptions of what the role of the Stakeholders will be subsequent to NRP completion.

Table 5-3
Lake Toho Nutrient Reduction Plan
Lake Tohopekaliga NRP Monitoring Network

Sampling Entity	Station Description	Year Site Established	Station Type
Orange County	BCA Boggy Creek A (Tradeport Drive)	1982	Water Quality
Orange County	S-62	2011	Water Quality
Orange County	SCC Shingle Creek C (Central Florida Pkwy)	1972	Water Quality
Orlando/Orange County	Shingle Creek	1999	Water Quality
Orlando/Orange County	Boggy Creek	1999	Water Quality
Osceola County	JUDGES_DCH	2011	Water Quality
Osceola County	PARTIN_CNL	2011	Water Quality
Osceola County	RUNNYMEDE	2011	Water Quality
Osceola County	LAKE_AJAY	2011	Water Quality
Kissimmee	MS 3 Mill Slough Outfall	2007	Water Quality
Kissimmee	MS 4 Bass Slough Outfall	2007	Water Quality
Kissimmee	MS 5 Bass Slough Lakeside Estates	2007	Water Quality
Kissimmee	MS 6 Mill Slough Mill Run	2007	Water Quality
Kissimmee	MS 13 Outfall Airport and West City Ditch	2007	Water Quality
Kissimmee	MS 14 Shingle Creek Outfall	2007	Water Quality
Kissimmee	MS 15 Shingle Creek Town Center Blvd.	2007	Water Quality
Kissimmee	MS 17 Shingle Creek North of US 192	2007	Water Quality
SFWMD	ET05253114	2007	Water Quality
SFWMD	ET06253113	2007	Water Quality
SFWMD	LT32263013	2007	Water Quality
SFWMD	A03	1981	Water Quality
SFWMD	B02	1981	Water Quality
SFWMD	B06	1981	Water Quality
SFWMD	B09	1981	Water Quality
SFWMD	ABOGGN	2009	Water Quality
SFWMD	BHSHINGLE	2006	Water Quality
SFWMD	CL18273011	2011	Water Quality
SFWMD/Osceola County	BS-59	1981	Water Quality
SFWMD	S-61	1942	Flow
SFWMD	TOHOW	2000	Stage
USGS	2262900 Boggy Creek near Taft	1959	Flow
USGS	2263800 Shingle Creek at Airport near Kissimmee	1958	Flow

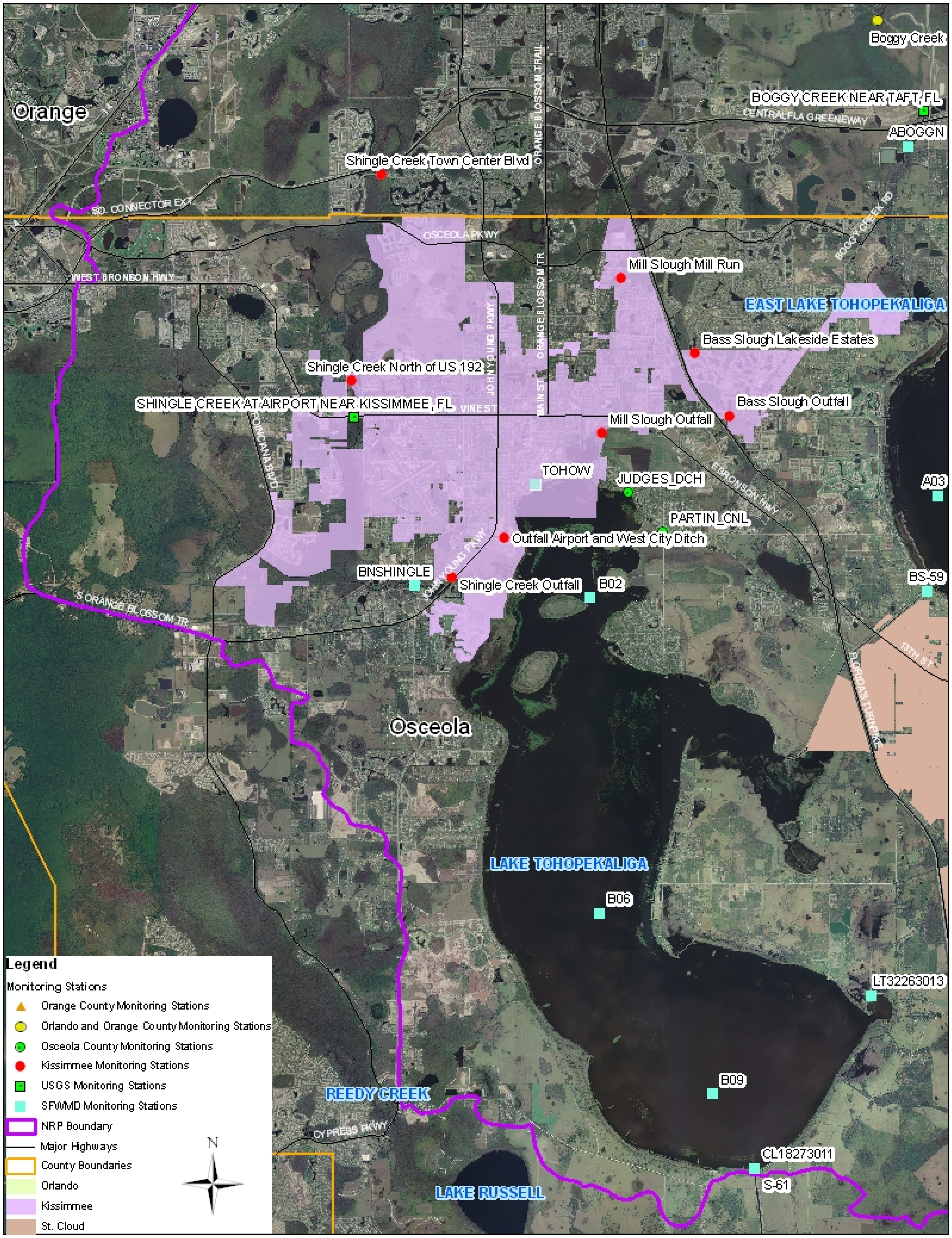

Figure 5-1 NRP Monitoring Network - Southwest Basin

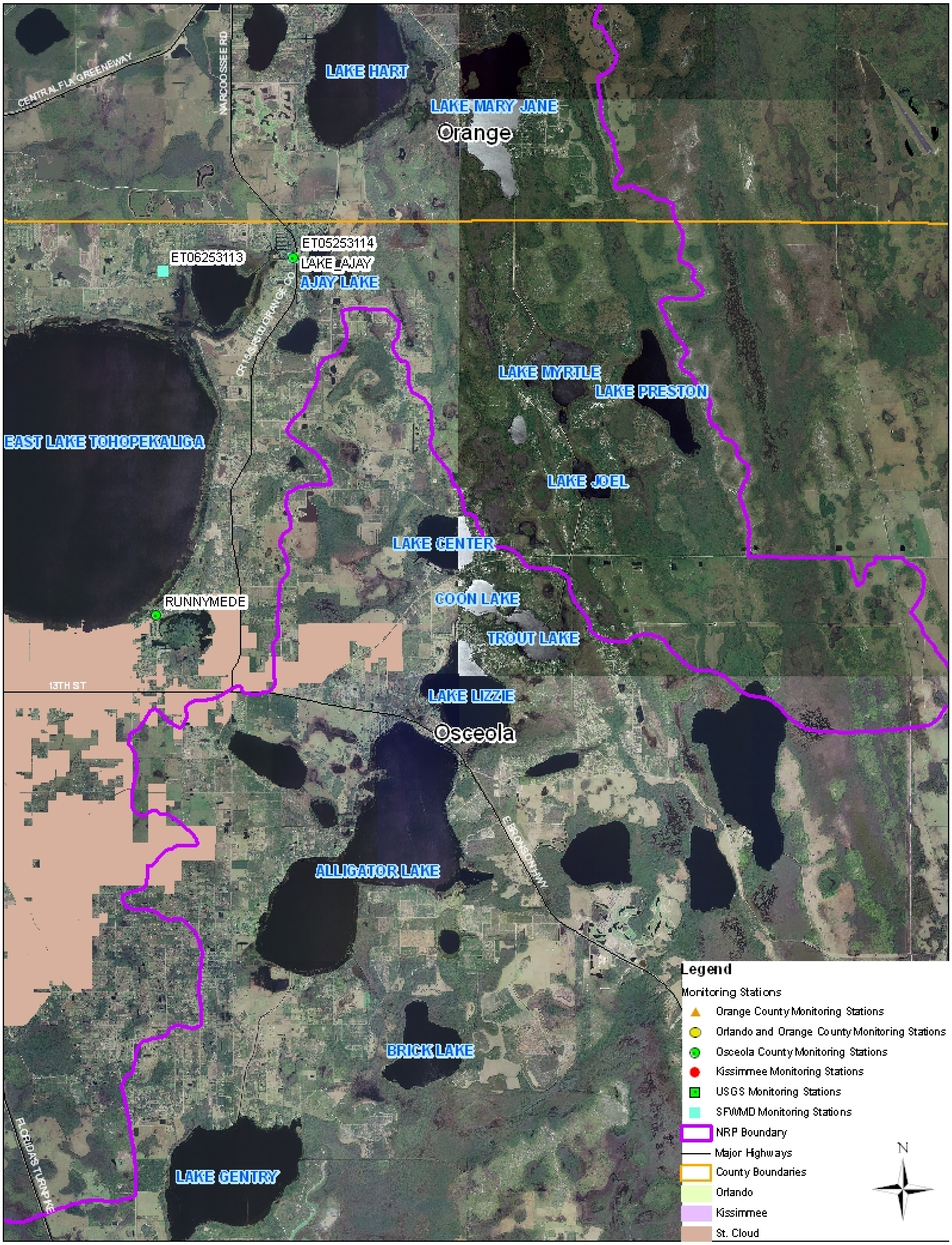

Figure 5-2 NRP Monitoring Network - Southeast Basin

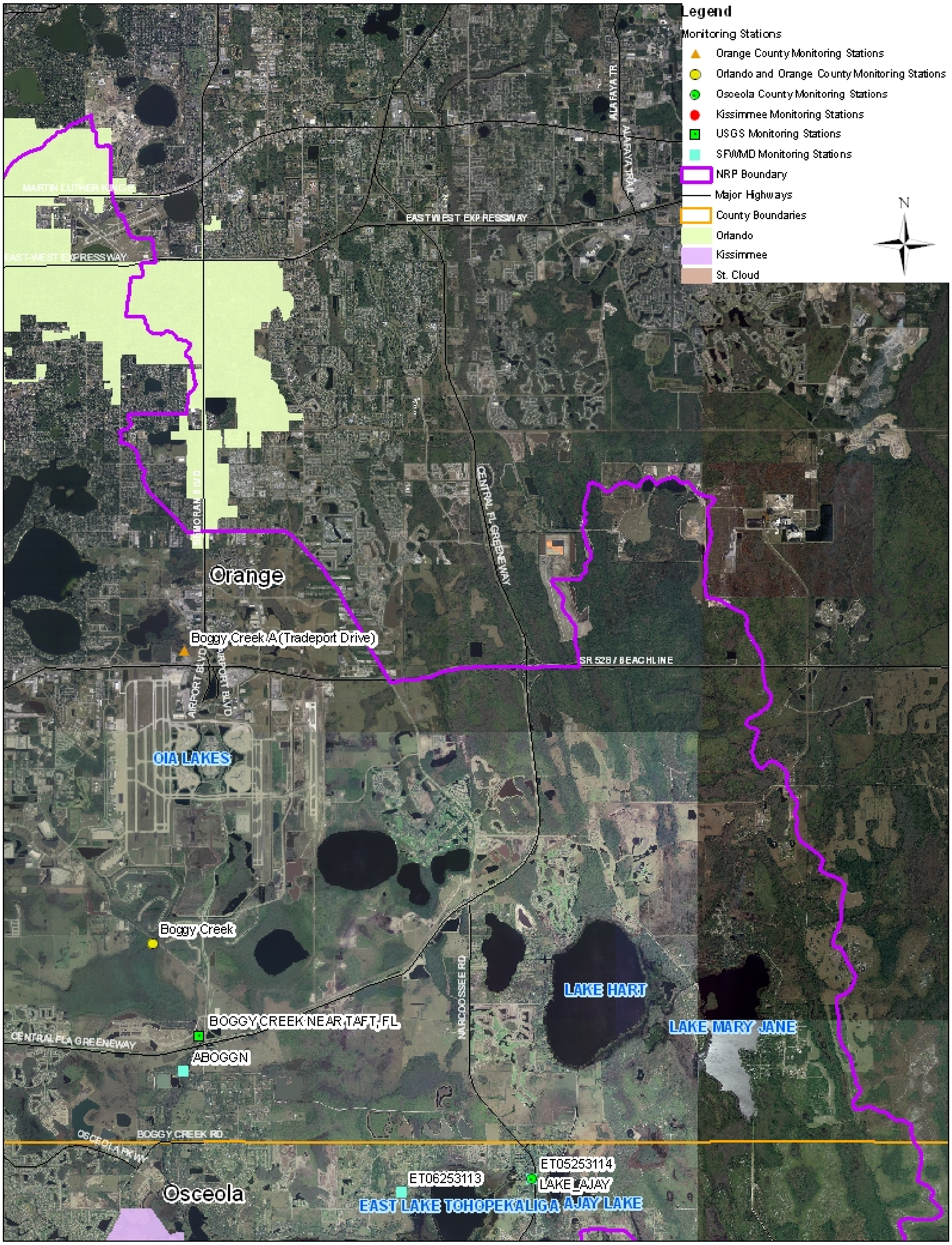

Figure 5-3 NRP Monitoring Network - Northeast Basin

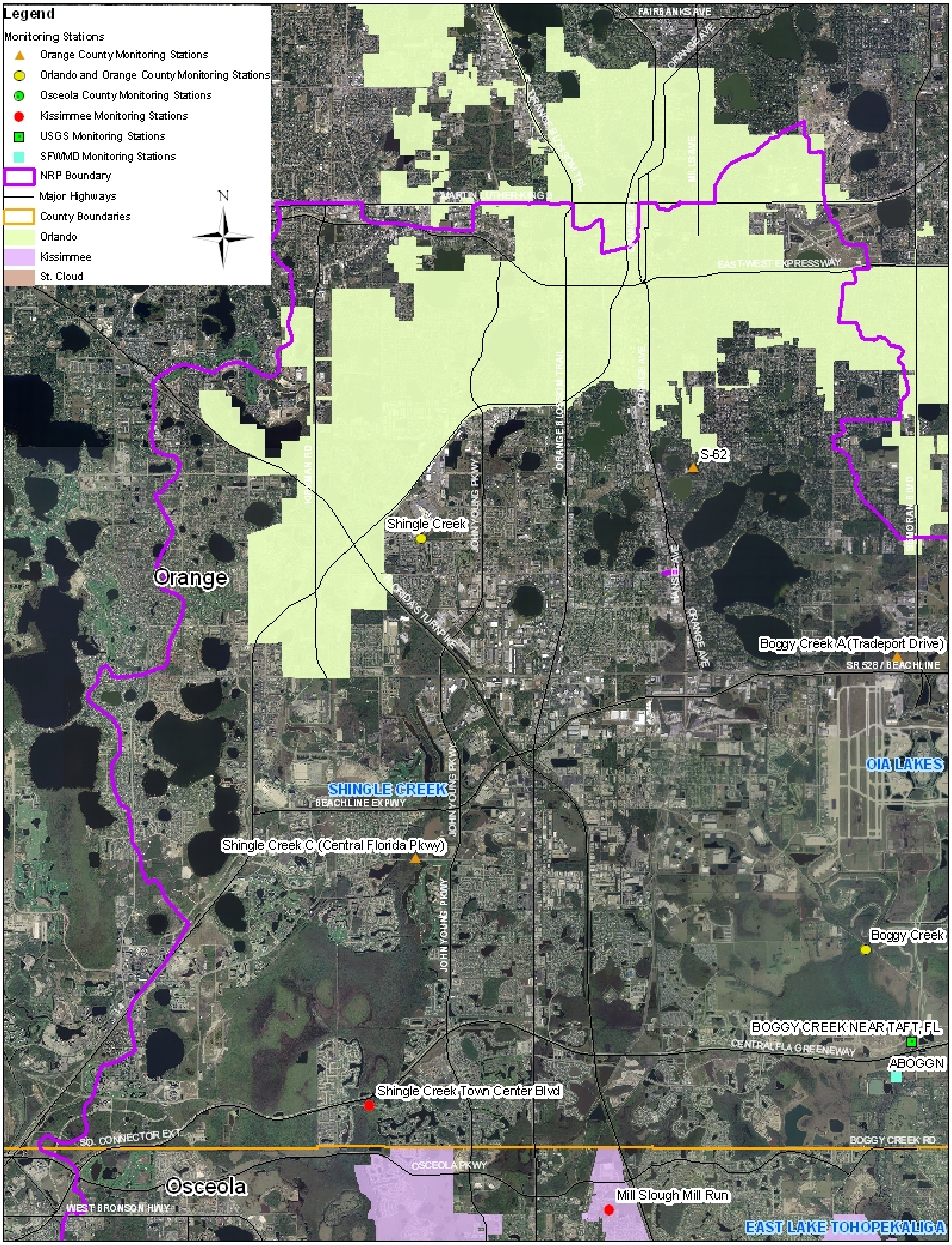

Figure 5-4 NRP Monitoring Network - Northwest Basin

Tracking implementation, monitoring water quality and pollutant loads, and periodic stakeholder meetings to share information and expertise are key components of adaptive management. The information the Stakeholders and technical support partners receive from implementation tracking, water quality monitoring and research activities will help determine what changes to the NRP are needed to ensure that the goals for the basin are achieved.

The Stakeholders and technical support partners will meet periodically to review project status and water quality conditions in Lake Toho and its tributaries. At this time, available information will be used to evaluate projects and monitoring efforts. Modifications from the original NRP may occur at that time, if conditions warrant. For example, if a more feasible and/or effective alternative to a particular project listed in the original NRP is found and proposed by a stakeholder as a substitute, such modifications to the project list may be made at these periodic meetings. An annual implementation report can also be distributed to Stakeholders and technical support partners for their review and input. These meetings will also serve as a vehicle for updating stakeholders on existing research activities, identifying additional research needs and discussing important findings that work toward the common goal of defining the balanced condition for the lake. This information and a periodic water quality trend analysis can form the basis of the annual review meetings.

5.3 Tracking Implementation

The Stakeholders and technical support partners will track implementation efforts and monitor water quality to measure effectiveness of the NRP. FDEP will require an update of all activities two years (Year 2) after NRP completion. The Stakeholders plan to meet in the second quarter of 2012 to discuss research priorities once the literature search (currently underway by the University of Florida) is complete. The Stakeholders are considering holding meetings to discuss research priorities that coincide with the KCOL Long Term Management Plan meetings. This is beneficial as discussions pertaining to research also coalesce with the goals of the long term management plan. SFWMD is currently looking into the feasibility of conducting these meetings in concert with one another. FDEP will also require an update on research priorities within one year of completion of the NRP, so that in Year 2 the progress of research and implementation of projects can be reported.

The Stakeholders and technical support partners will also meet periodically to discuss the monitoring plan implementation, review progress and to make sure they are on track to provide an update report to FDEP by December, 2013. At these periodic meetings, Stakeholders can also address implementation issues, consider new information, and determine additional corrective actions, as needed. It may be useful to conduct a monitoring plan kickoff, either through email or a meeting, to inform stakeholders when the monitoring plan elements should be started. This helps in avoiding unnecessary delays and moving forward with implementation of the monitoring plan.

Section 6
Commitment to Nutrient Reduction Plan Implementation

6.1 Stakeholder Commitment

Successful implementation requires that Stakeholders and technical support partners identified in this NRP willingly and consistently work together towards the common goal of gaining understanding of the complex relationship between water quality, macrophytes and lake management activities through research and additional study. Implementation of this plan will result in moving towards defining the balanced condition for Lake Tohopekaliga (Toho) while proactively reducing nutrients loads from jurisdictional land-based controllable sources. This collaboration fosters the sharing of ideas, information, and resources. By preparing this NRP, the Lake Toho Stakeholders and technical support partners have demonstrated their willingness to confer with and support each other in their efforts.

The Stakeholders and technical support partners accepted the Final Lake Toho NRP in December 2011 on behalf of the entities they represent since they have been actively involved throughout the NRP process. Acceptance of the plan means that:

1) Stakeholders and technical support partners shall continue their demonstrated commitment of implementation of the projects identified in the NRP;

2) Stakeholders and technical support partners will implement the monitoring plan described in Section 5; and

3) Stakeholders and technical support partners will help define research efforts and coordinate with other agencies undertaking specific research activities. If feasible, Stakeholders may also elect to pursue individual research efforts, however, this is not a requirement of the NRP.

The adaptive management process described in Section 5 of the NRP allows Stakeholders and technical support partners to evaluate their progress and adjust their approach as needed in order to best meet the goals of the NRP. In addition to this acceptance, it is understood that as staff and board members change over time, the entities identified in this NRP still continue to show support for the efforts identified.

It is also recognized by FDEP and the Stakeholders that management activities implemented as a result of this NRP may also receive credit for downstream impaired waters (i.e., Lakes Cypress and Kissimmee). If load reductions within the Lake Toho watershed are deemed substantial enough, it may avoid the need for additional load reductions to downstream impaired waters.

Section 7
References

Anderson, D.H. and J.R. Chamberlain. 2005. Impacts of channelization on the hydrology of the Kissimmee River, Florida. In S.G. Bousquin, D.H. Anderson, G.W. Williams, and D.J. Colangelo (eds). Establishing a Baseline: Studies of the Channelized Kissimmee River. Volume I Kissimmee River Restoration Studies. South Florida Water Management District, West Palm Beach, FL. Technical Publication ERA 432.

Bell, F. W. 2006. Economic Sectors at Risk from Invasive Aquatic Weeds for the Kissimmee Chain of Lakes in Osceola County, Florida, 2004-2005. For: Florida Department of Environmental Protection, Bureau of Invasive Plant Management, Tallahassee, Florida. Department of Economics, Florida State University, Tallahassee, Florida.

Blake, N.M. 1980. Land into Water – Water into Land. University Presses of Florida, Tallahassee, Florida.

Bradner, L.A. 1996. Estimation of Recharge Through Selected Drainage Wells and Potential Effects from Well Closure, Orange County, Florida. United States Geologic Survey, Tallahassee, Florida. Open-File Report 96-316.

Florida Fish and Wildlife Conservation Commission. 2011. Agency Position on Hydrilla Management.

Florida Fish and Wildlife Conservation Commission. 2011. Release: Public Meeting to Provide Updates on Kissimmee Chain Invasive Plant Management.

HDR Engineering, Inc. 2010. Nutrient Budget Analysis for the Lake Okeechobee Watershed. South Florida Water Management District, West Palm Beach, Florida.

Harris, Ed. 2011. Florida Under Siege: Invasive Species Threaten Florida's Ecosystems [Brochure]. Retrieved from http://plants.ifas.ufl.edu/osceola/pdf/Invaders_Pamphlet_2011_Final.pdf.

Hoyer, M.V., R.W. Bachmann, and D.E. Canfield. 2008. Lake Management (muck removal) and Hurricane Impacts to the Trophic State of Lake Tohopekaliga, Florida. Lake and Reservoir Management 24:57-68.

Hughes, Dianne K. August 25, 2011. Personal communication. Florida Department of Environmental Protection. West Palm Beach, Florida.

James, R.T., K. O'dell, and V.H. Smith. 1994. Water Quality Trends in Lake Tohopekaliga, Florida, USA: Responses to Watershed Management. Water Resources Bulletin 30(3):531-546.

Jones, B.L. 2005. Water quality in the channelized Kissimmee River. Chapter 5 in S.G. Bousquin, D.H. Anderson, G.W. Williams and D.J. Colangelo (eds). Kissimmee River restoration studies Volume I – establishing a baseline: pre-restoration studies of the channelized Kissimmee River.

Jones, B.L., P.S. Millar, T.H. Miller, D.R. Swift and A.C. Federico. 1983. Preliminary Water Quality and Trophic State Assessment of the Upper Kissimmee Chain of Lakes. Technical Memorandum, DRE-167, South Florida Water Management District, West Palm Beach, FL.

Mann, M. 2011. Personal Communication. Biologist, Florida Fish and Wildlife Conservation Commission, Kissimmee, Florida.

Netherland, M. 2011. Personal Communication. Courtesy Associate Professor, University of Florida Institute of Food and Agricultural Sciences, Gainesville, Florida.

PBS&J. 2010. Winter Haven Chain of Lakes Water Quality Management Plan. Final Report to the City of Winter Haven.

PBS&J. 2008. Winter Haven Chain of Lakes Pre-BMAP (Basin Management Action Plan) Assessment. Prepared for the Florida Department of Environmental Protection.

Parker, G.G., G.E. Ferguson and S.K. Love. 1955. Water Resources of Southeastern Florida. U.S. Geological Survey Water Supply Paper 1255. U.S. Government Printing Office, Washington, DC.

Parmer, Keith D. Ph.D., J.C. Albright, and M. Paulic. 2011. Draft Lake Tohopekaliga (Water Body Identification 3173A) Kissimmee River Basin Group 4 Cycle 2 Upper Kissimmee Planning Unit Impaired Waters Rule Assessment. Florida Department of Environmental Protection, Tallahassee, Florida.

Schardt, J. 2011. Personal Communication. Environmental Administrator, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.

South Florida Water Management District, Florida Fish and Wildlife Conservation Commission, Florida Department of Environmental Protection, Florida Department of Agriculture and Consumer Services, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service and Osceola County. 2011. 2011 Interagency Draft Kissimmee Chain of Lakes Long-Term Management Plan. South Florida Water Management District, West Palm Beach, FL.

South Florida Water Management District. 2009. 2009 South Florida Environmental Report. South Florida Water Management District, West Palm Beach, FL.

Wegener, W.L., V. P. Williams, and D. Holcomb. 1973. Water Level Manipulation. Annual Progress Report. Federal Aid in Fish Restoration. Florida Game and Fresh Water Fish Commission, Tallahassee, Florida.

Welch, Zack. 2011. Florida Under Siege: Invasive Species Threaten Florida's Ecosystems [Brochure]. Retrieved from http://plants.ifas.ufl.edu/osceola/pdf/Invaders_Pamphlet_2011_Final.pdf.

Williams, V.P. 2001. Effects of point-source removal on lake water quality: A case history of Lake Tohopekaliga, Florida. Lake and Reservoir Management. 17: 315-329.

Appendix A
Lake Tohopekaliga Nutrient Reduction Plan
FLUCCS Land Use Code Assignments

See the following pages.

Appendix A
Lake Tohopekaliga Nutrient Reduction Plan
FLUCCS Land Use Code Assignments

FLUCCS	***DESCRIPTION***	***Land Use Description***
1100	RESIDENTIAL LOW DENSITY < 2 DWELLING UNITS	Low density residential
1100	RESIDENTIAL, LOW DENSITY - LESS THAN 2 DWELLING UNITS PER ACRE	Low density residential
1110	LOW DENSITY: FIXED SINGLE FAMILY UNITS	Low density residential
1120	LOW DENSITY: MOBILE HOME UNITS	Low density residential
1130	LOW DENSITY: MIXED UNITS, FIXED AND MOBILE HOME UNITS	Low density residential
1180	RURAL RESIDENTIAL	Unimproved pasture / woodland pasture
1190	LOW DENSITY UNDER CONSTRUCTION	Low density residential
1190	LOW DENSITY: UNDER CONSTRUCTION	Low density residential
1200	RESIDENTIAL MED DENSITY 2->5 DWELLING UNIT	Medium density residential
1200	RESIDENTIAL, MEDIUM DENSITY	Medium density residential
1210	MEDIUM DENSITY: FIXED SINGLE FAMILY UNITS	Medium density residential
1220	MEDIUM DENSITY: MOBILE HOME UNITS	Medium density residential
1230	MEDIUM DENSITY: MIXED UNITS, FIXED AND MOBILE HOME UNIT	Medium density residential
1290	MEDIUM DENSITY UNDER CONSTRUCTION	Medium density residential
1290	MEDIUM DENSITY: UNDER CONSTRUCTION	Medium density residential
1300	RESIDENTIAL HIGH DENSITY	High density residential
1300	RESIDENTIAL, HIGH DENSITY	High density residential
1310	HIGH DENSITY: FIXED SINGLE FAMILY UNITS	High density residential
1320	HIGH DENSITY: MOBILE HOME UNITS	High density residential
1330	MULTIPLE DWELLING UNITS, LOW RISE	High density residential
1340	MULTIPLE DWELLING UNITS, HIGH RISE	High density residential
1350	HIGH DENSITY: MIXED UNITS, FIXED AND MOBILE HOME UNITS	High density residential
1390	HIGH DENSITY UNDER CONSTRUCTION	High density residential
1390	HIGH DENSITY: UNDER CONSTRUCTION	High density residential
1400	COMMERCIAL AND SERVICES	Commercial / industrial
1411	SHOPPING CENTERS	Commercial / industrial
1423	WHOLESALE SALES & SERVICES - JUNK YARDS	Commercial / industrial
1460	OIL AND GAS STORAGE - NOT INDUSTRIAL OR MANUFACTURING	Commercial / industrial
1480	CEMETERIES	Commercial / industrial
1490	COMMERCIAL AND SERVICES - UNDER CONSTRUCTION	Commercial / industrial
1490	COMMERCIAL AND SERVICES UNDER CONSTRUCTION	Commercial / industrial
1500	INDUSTRIAL	Commercial / industrial
1510	FOOD PROCESSING	Commercial / industrial
1550	OTHER LIGHT INDUSTRIAL	Commercial / industrial
1550	OTHER LIGHT INDUSTRY	Commercial / industrial
1560	OTHER HEAVY INDUSTRIAL	Commercial / industrial
1590	INDUSTRIAL UNDER CONSTRUCTION	Commercial / industrial
1600	EXTRACTIVE	Commercial / industrial
1611	STRIP MINES - CLAY	Commercial / industrial
1620	SAND AND GRAVEL PITS	Commercial / industrial
1630	ROCK QUARRIES	Commercial / industrial
1660	HOLDING PONDS	Commercial / industrial
1700	INSTITUTIONAL	Medium density residential
1710	EDUCATIONAL FACILITIES	Medium density residential
1730	MILITARY	Medium density residential
1750	GOVERNMENTAL	Medium density residential
1800	RECREATIONAL	Low density residential
1810	SWIMMING BEACH	Low density residential
1820	GOLF COURSE	Low density residential
1830	RACE TRACKS	Low density residential
1840	MARINAS AND FISH CAMPS	Low density residential
1850	PARKS AND ZOOS	Low density residential
1860	COMMUNITY RECREATIONAL FACILITIES	Low density residential
1870	STADIUMS - FACILITIES NOT ASSOCIATED WITH HIGH SCHOOLS, COLLEGES, OR UNIVERSITIES	Low density residential
1870	STADIUMS: NOT ACADEMIC	Low density residential

Appendix A
Lake Tohopekaliga Nutrient Reduction Plan
FLUCCS Land Use Code Assignments

FLUCCS	***DESCRIPTION***	***Land Use Description***
1890	OTHER RECREATIONAL < RIDING STABLES, GO-CART TRACKS, SKEET RANGES, ET	Low density residential
1900	OPEN LAND	Rangeland / upland forests
1920	INACTIVE LAND WITH STREET PATTERN	Rangeland / upland forests
1920	INACTIVE LANDS WITH STREET PATTERN BUT WITHOUT STRUCTURES	Rangeland / upland forests
2100	CROPLAND AND PASTURELAND	Cropland
2110	IMPROVED PASTURE	Unimproved pasture / woodland pasture
2110	IMPROVED PASTURES	Unimproved pasture / woodland pasture
2120	UNIMPROVED PASTURE	Unimproved pasture / woodland pasture
2120	UNIMPROVED PASTURES	Unimproved pasture / woodland pasture
2130	WOODLAND PASTURE	Unimproved pasture / woodland pasture
2130	WOODLAND PASTURES	Unimproved pasture / woodland pasture
2140	ROW CROPS	Cropland
2150	FIELD CROPS	Cropland
2200	TREE CROPS	Cropland
2210	CITRUS GROVES	Cropland
2220	FRUIT ORCHARDS	Cropland
2230	OTHER GROVES	Cropland
2240	ABANDONED TREE CROPS/ABANDONED GROVES	Cropland
2300	FEEDING OPERATIONS	Cropland
2310	CATTLE FEEDING OPERATIONS	Cropland
2320	POULTRY FEEDING OPERATIONS	Cropland
2400	NURSERIES AND VINEYARDS	Cropland
2410	TREE NURSERIES	Cropland
2420	SOD FARMS	Cropland
2430	ORNAMENTALS	Cropland
2431	SHADE FERNS	Cropland
2440	VINEYARDS	Cropland
2500	SPECIALTY FARMS	Cropland
2510	HORSE FARMS	Cropland
2520	DAIRIES	Cropland
2540	AQUACULTURE	Cropland
2550	TROPICAL FISH FARMS	Cropland
2600	OTHER OPEN LANDS <RURAL>	Unimproved pasture / woodland pasture
2610	FALLOW CROP LAND	Unimproved pasture / woodland pasture
2610	FALLOW CROPLAND	Rangeland / upland forests
3100	HERBACEOUS	Rangeland / upland forests
3100	HERBACEOUS (DRY PRAIRIE)	Rangeland / upland forests
3200	SHRUB AND BRUSHLAND	Rangeland / upland forests
3200	UPLAND SHRUB AND BRUSH LAND	Rangeland / upland forests
3200	UPLAND SHRUB AND BRUSHLAND	Rangeland / upland forests
3210	PALMETTO PRAIRIES	Rangeland / upland forests
3300	MIXED RANGELAND	Rangeland / upland forests
4100	UPLAND CONIFEROUS FOREST	Rangeland / upland forests
4110	PINE FLATWOODS	Rangeland / upland forests
4120	LONGLEAF PINE - XERIC OAK	Rangeland / upland forests
4130	SAND PINE	Rangeland / upland forests
4200	UPLAND HARDWOOD FOREST	Rangeland / upland forests
4200	UPLAND HARDWOOD FORESTS	Rangeland / upland forests
4200	UPLAND HARDWOOD FORESTS - PART 1	Rangeland / upland forests
4210	XERIC OAK	Rangeland / upland forests
4220	BRAZILIAN PEPPER	Rangeland / upland forests
4240	MELALEUCA	Rangeland / upland forests
4270	LIVE OAK	Rangeland / upland forests
4271	OAK - CABBAGE PALM FOREST	Rangeland / upland forests
4280	CABBAGE PALM	Rangeland / upland forests
4340	HARDWOOD - CONIFER MIXED	Rangeland / upland forests

Appendix A
Lake Tohopekaliga Nutrient Reduction Plan
FLUCCS Land Use Code Assignments

FLUCCS	*DESCRIPTION*	*Land Use Description*
4340	HARDWOOD / CONIFEREROUS MIXED	Rangeland / upland forests
4340	HARDWOOD CONIFER MIXED	Rangeland / upland forests
4400	TREE PLANTATIONS	Rangeland / upland forests
4410	CONIFEROUS PLANTATIONS	Cropland
4430	FOREST REGENERATION AREAS	Cropland
5100	STREAMS AND WATERWAYS	Water
5110	NATURAL RIVER, STREAM, WATERWAY	Water
5120	CHANNELIZED WATERWAYS, CANALS	Water
5200	LAKES	Water
5250	MARSHY LAKES	Water
5250	OPEN WATER WITHIN A FRESHWATER MARSH / MARSHY LAKES	Water
5300	RESERVOIRS	Water
6100	WETLAND HARDWOOD FOREST	Wetlands
6100	WETLAND HARDWOOD FORESTS	Wetlands
6110	BAY SWAMPS	Wetlands
6111	BAYHEAD	Wetlands
6150	STREAM AND LAKE SWAMPS (BOTTOMLAND)	Wetlands
6170	MIXED WETLAND HARDWOODS	Wetlands
6172	MIXED SHRUBS	Wetlands
6181	CABBAGE PALM HAMMOCK	Wetlands
6200	WETLAND CONIFEROUS FOREST	Wetlands
6200	WETLAND CONIFEROUS FORESTS	Wetlands
6210	CYPRESS	Wetlands
6215	CYPRESS - DOMES/HEADS	Wetlands
6216	CYPRESS - MIXED HARDWOODS	Wetlands
6240	CYPRESS - PINE - CABBAGE PALM	Wetlands
6250	HYDRIC PINE FLATWOODS	Wetlands
6250	WET PINELANDS HYDRIC PINE	Wetlands
6300	WETLAND FORESTED MIXED	Wetlands
6400	VEGETATED NON-FORESTED WETLANDS	Wetlands
6410	FRESHWATER MARSHES	Wetlands
6410	FRESHWATER MARSHES / GRAMINOID PRAIRIE - MARSH	Wetlands
6410	FRESHWATER MARSHES / GRAMINOID PRAIRIE-MARSH	Wetlands
6411	FRESHWATER MARSHES - SAWGRASS	Wetlands
6430	WET PRAIRIES	Wetlands
6440	EMERGENT AQUATIC VEGETATION	Wetlands
6450	SUBMERGENT AQUATIC VEGETATION	Wetlands
6460	MIXED SCRUB-SHRUB WETLAND (TREELESS HYDRIC SAVANNA)	Wetlands
6500	NON-VEGETATED WETLAND	Wetlands
6520	SHORELINES	Wetlands
6530	INTERMITTENT PONDS	Wetlands
7100	BEACHES OTHER THAN SWIMMING BEACHES	Rangeland / upland forests
7200	SAND OTHER THAN BEACHES	Rangeland / upland forests
7400	DISTURBED LAND	Rangeland / upland forests
7410	RURAL LAND IN TRANSITION WITHOUT INDICATORS OF ACTIVITY	Rangeland / upland forests
7420	BORROW AREAS	Rangeland / upland forests
7430	SPOIL AREAS	Rangeland / upland forests
8100	TRANSPORTATION	Commercial / industrial
8110	AIRPORTS	Commercial / industrial
8115	GRASS AIRPORTS	Commercial / industrial
8120	RAILROADS (RAILYARDS)	Commercial / industrial
8120	RAILROADS AND RAILYARDS	Commercial / industrial
8130	BUS AND TRUCK TERMINALS	Commercial / industrial
8140	ROADS AND HIGHWAYS	Commercial / industrial
8180	AUTO PARKING FACILITIES - WHEN NOT DIRECTLY RELATED TO OTHER LAND USE	Commercial / industrial
8191	HIGHWAYS - UNDER CONSTRUCTION	Commercial / industrial

Appendix A
Lake Tohopekaliga Nutrient Reduction Plan
FLUCCS Land Use Code Assignments

FLUCCS	***DESCRIPTION***	***Land Use Description***
8200	COMMUNICATION	Commercial / industrial
8200	COMMUNICATIONS	Commercial / industrial
8300	UTILITIES	Commercial / industrial
8310	ELECTRICAL POWER FACILITIES	Commercial / industrial
8320	ELECTRICAL POWER TRANSMISSION LINES	Rangeland / upland forests
8330	WATER SUPPLY PLANTS - INCLUDING PUMPING STATIONS	Commercial / industrial
8340	SEWAGE TREATMENT	Commercial / industrial
8350	SOLID WASTE DISPOSAL	Commercial / industrial
8360	TREATMENT PONDS (NON-SEWAGE)	Commercial / industrial

Appendix B
Additional Monitoring Efforts in the Lake Tohopekaliga Basin

In addition to the stations included in the NRP monitoring network, Stakeholders have other monitoring stations in the Lake Tohopekaliga Basin. Data from these stations could be used to supplement the information gathered from the NRP monitoring network to help achieve the monitoring plan objective. Information pertaining to these stations includes the responsible entity, year the site was established, frequency of the sampling, sampling parameters for the additional monitoring stations (**Table B-1**), and locations **(Figures B-1** though **Figure B-4)**.

Table B-1
Lake Tohopekaliga Nutrient Reduction Plan
Additional Monitoring Stations in the Lake Toho Basin

Sampling Entity	Station Description	Year Established	Sampling Frequency	Sampling Parameters
Orange County	BC1 Anderson	Mar-70	Quarterly	(53 total parameters collected) Field, Wet Chemistry, Metals, Nutrients, Bacteria, Chlorophyll
Orange County	BC11 Gatlin	Mar-70	Quarterly	
Orange County	BC16E Jennie Jewel E	Mar-89	Quarterly	
Orange County	BC16W Jennie Jewel W	Mar-89	Quarterly	
Orange County	BC17M Jessamine M	Mar-89	Quarterly	
Orange County	BC17E Jessamine NE	Jun-94	Quarterly	
Orange County	BC17SW Jessamine SW	Jun-94	Quarterly	
Orange County	BC2 George (aka: Barber)	Dec-86	Quarterly	
Orange County	BC20 Mary Jess	Mar-89	Quarterly	
Orange County	BC22 Pineloch	Mar-89	Quarterly	
Orange County	BC3 Bass	Aug-81	Quarterly	
Orange County	BC45 Tyner	Mar-06	Quarterly	
Orange County	BC5 Bumby	Feb-94	Quarterly	
Orange County	BC6 Conway NE	Oct-72	Quarterly	
Orange County	BC7 Conway NW	Oct-72	Quarterly	
Orange County	BC8 Conway M	Oct-72	Quarterly	
Orange County	BC9 Conway S	Oct-72	Quarterly	
Orange County	BCC Boggy Creek C (SR 530)	Oct-72	Quarterly	
Orange County	BCE Boggy Creek E (SR 527)	Jan-87	Quarterly	
Orange County	H2 Hart	Oct-72	Quarterly	
Orange County	H3 Mary Jane	May-72	Quarterly	
Orange County	H6 Whippoorwill	Oct-72	Quarterly	
Orange County	SC1 Bryan	Jan-98	Quarterly	
Orange County	SC13 Marsha	Jun-73	Quarterly	
Orange County	SC14 Palm	Jun-73	Quarterly	
Orange County	SC17 Little Sand	Aug-76	Quarterly	
Orange County	SC21 Spring	Oct-72	Quarterly	
Orange County	SC30 Big Sand S	Mar-67	Quarterly	
Orange County	SC40 Willis	Feb-79	Quarterly	
Orange County	SC5 Tyler	Nov-68	Quarterly	
Orange County	SC7 Clear	Mar-66	Quarterly	
Orange County	SCD Shingle Creek D	Mar-72	Quarterly	
Orange County	SCH Shingle Creek H	Mar-76	Quarterly	
Orange County	SCM Americana Canal	Dec-98	Quarterly	
Orange County	SCN Shingle Creek N	Jan-98	Quarterly	
Orlando	Lake Angel	9/12/1989	Quarterly	Secchi, pH, DO,

Table B-1
Lake Tohopekaliga Nutrient Reduction Plan
Additional Monitoring Stations in the Lake Toho Basin

Sampling Entity	Station Description	Year Established	Sampling Frequency	Sampling Parameters
Orlando	Lake Beardall	2/14/1989	Quarterly	Temperature, Specific Conductance, Alkalinity, BOD, NO2, NO3, NH3, TKN, TN, OP, TP, TDS, TSS, TVSS, Chlorophyll-a corrected, Turbidity,
Orlando	Buck Lake	4/20/1994	Quarterly	
Orlando	Lake Cane	3/31/1999	Quarterly	
Orlando	Lake Catherine	3/15/2001	Quarterly	
Orlando	Clear Lake (North)	2/20/1997	Quarterly	
Orlando	Clear Lake (South)	2/20/1997	Quarterly	
Orlando	Lake Farrar	5/15/1990	Quarterly	
Orlando	Lake Fran	10/19/1999	Quarterly	
Orlando	Lake Gem Mary	5/8/1990	Quarterly	
Orlando	Lake George	5/22/1990	Quarterly	
Orlando	Lake Hiawassee (North)	1/30/2003	Quarterly	
Orlando	Lake Hiawassee (South)	1/30/2003	Quarterly	
Orlando	Lake Holden (North)	3/15/2001	Quarterly	
Orlando	Lake Holden (South)	3/15/2001	Quarterly	
Orlando	Lake Kozart	3/13/1990	Quarterly	
Orlando	Lake Lorna Doone	3/19/1985	Quarterly	
Orlando	Lake Mann (North)	7/17/2001	Quarterly	
Orlando	Lake Mann (South)	7/17/2001	Quarterly	
Orlando	Lake Mare Prairie	6/12/1990	Quarterly	Secchi, pH, DO, Temperature, Specific Conductance, Alkalinity, BOD, NO2, NO3, NH3, TKN, TN, OP, TP, TDS, TSS, TVSS, Chlorophyll-a corrected, Turbidity, Color
Orlando	Lake Michelle (East)	3/29/2001	Quarterly	
Orlando	Mud Lake	4/20/1994	Quarterly	
Orlando	Lake Nona (North)	4/20/1994	Quarterly	
Orlando	Lake Nona (South)	4/20/1994	Quarterly	
Orlando	Lake Pamela	3/27/1990	Quarterly	
Orlando	Lake Pineloch	5/1/1990	Quarterly	
Orlando	Lake Porter	9/14/1989	Quarterly	
Orlando	Red Lake	4/20/1994	Quarterly	
Orlando	Lake Richmond	3/13/1990	Quarterly	
Orlando	Rock Lake	3/22/1990	Quarterly	
Orlando	Lake Sandy	3/15/1990	Quarterly	
Orlando	Spring Lake (Southwest)	5/15/1997	Quarterly	
Orlando	Lake Sunset	3/6/1990	Quarterly	
Orlando	Lake Tennessee	3/20/1990	Quarterly	
Orlando	Turkey Lake (North)	1/2/1985	Quarterly	
Orlando	Turkey Lake (South)	1/2/1985	Quarterly	
Orlando	Lake Walker	4/6/1988	Quarterly	

Table B-1
Lake Tohopekaliga Nutrient Reduction Plan
Additional Monitoring Stations in the Lake Toho Basin

Sampling Entity	Station Description	Year Established	Sampling Frequency	Sampling Parameters
Orlando	Lake Warren	3/30/2001	Quarterly	
Osceola County	KISS_VIEW	Fall 2011	Monthly	
Osceola County	POIN_FIRE	Fall 2011	Monthly	
Osceola County	S_STEWART	Fall 2011	Monthly	
Osceola County	N_STEWART	Fall 2011	Monthly	TP , TKN, NOx
Osceola County	S_GRANADA	Fall 2011	Monthly	
Osceola County	N_GRANADA	Fall 2011	Monthly	
Osceola County	PH_MHPK	Fall 2011	Monthly	
Osceola County	GRANDVIEW	Fall 2011	Monthly	
Osceola County	KNGHWY_DCH	Fall 2011	Monthly	
Osceola County	FISH_LAKE	Fall 2011	Monthly	
Osceola County	ORNGWOOD	Fall 2011	Monthly	
Osceola County	SEAMAN	Fall 2011	Monthly	
Osceola County	WPA_CNL	Fall 2011	Monthly	
Osceola County	GATOR_BAY	Fall 2011	Monthly	
Osceola County	FANNY_BASS	Fall 2011	Monthly	TP , TKN, NOx
Osceola County	REMINGTON	Fall 2011	Monthly	
Osceola County	E_LK_BLVD	Fall 2011	Monthly	
Osceola County	PEBBLE_PT	Fall 2011	Monthly	
Osceola County	QUAIL_RDG	Fall 2011	Monthly	
Osceola County	CIRCLE_K	Fall 2011	Monthly	
Osceola County	TURNBERRY	Fall 2011	Monthly	
Osceola County	JIM_BRANCH	Fall 2011	Monthly	
Kissimmee	MS 1 Dakin Avenue Outfall	Jan-07	Quarterly	
Kissimmee	MS 2 East City Ditch Outfall	Jan-07	Quarterly	
Kissimmee	MS 7 Jackson Street Outfall	Jan-07	Quarterly	
Kissimmee	MS 8 Lake Tivoli Outfall	Jan-07	Quarterly	Ammonia, TKN, Nitrate-Nitrite, Organic Nitrogen, PO4, TP, TDS, TSS, COD, pH, Chlorophyll a, Hardness, Lead, Copper, Iron, Zinc, Total Coliforms, Fecal Coliforms, E. Coli
Kissimmee	MS 9 Lake Tivoli Inlet	Jan-07	Quarterly	
Kissimmee	MS 11 West City Ditch Outfall	Jan-07	Quarterly	
Kissimmee	MS 12 Airport Ditch Outfall	Jan-07	Quarterly	
Kissimmee	MS 20 Shingle Creek at Gateway Airport	Jan-07	Quarterly	
Kissimmee	MS 22 Shingle Creek at Good Sam	Jan-07	Quarterly	
Kissimmee	MS 24 Brown Canal at Poinciana Blvd	Jan-07	Quarterly	

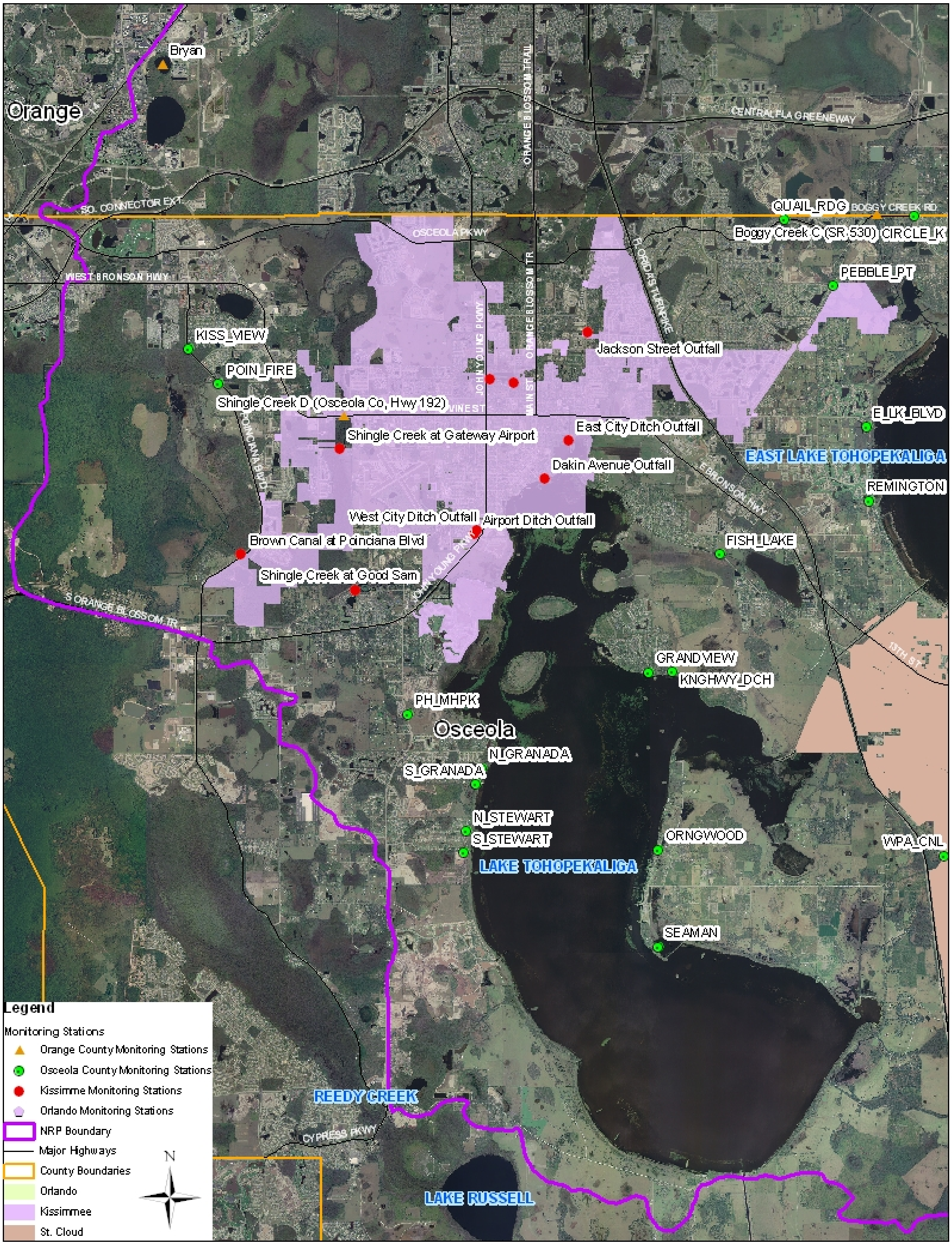

Figure B-1 Additional Monitoring Stations - Southwest Basin

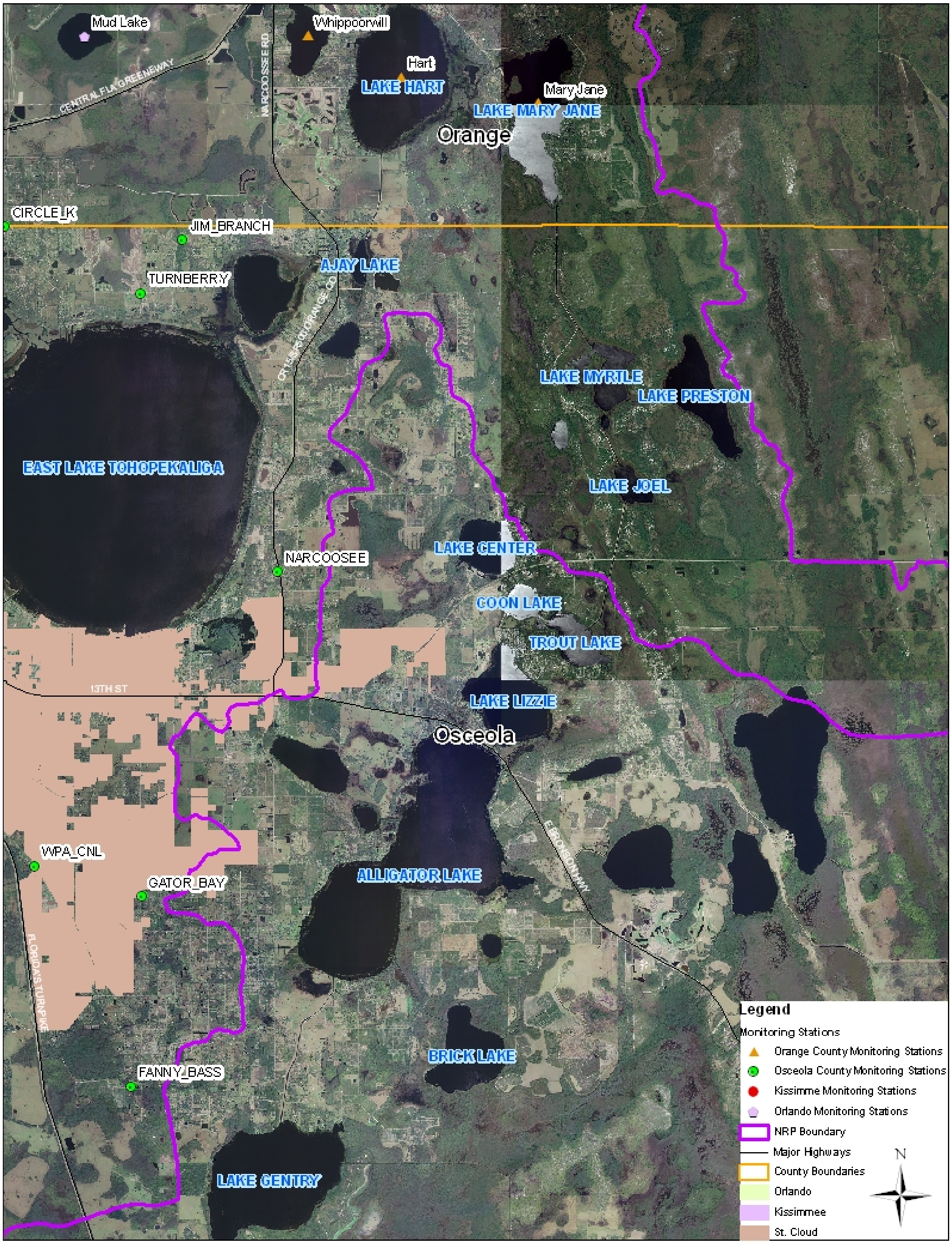

Figure B-2 Additional Monitoring Stations - Southeast Basin

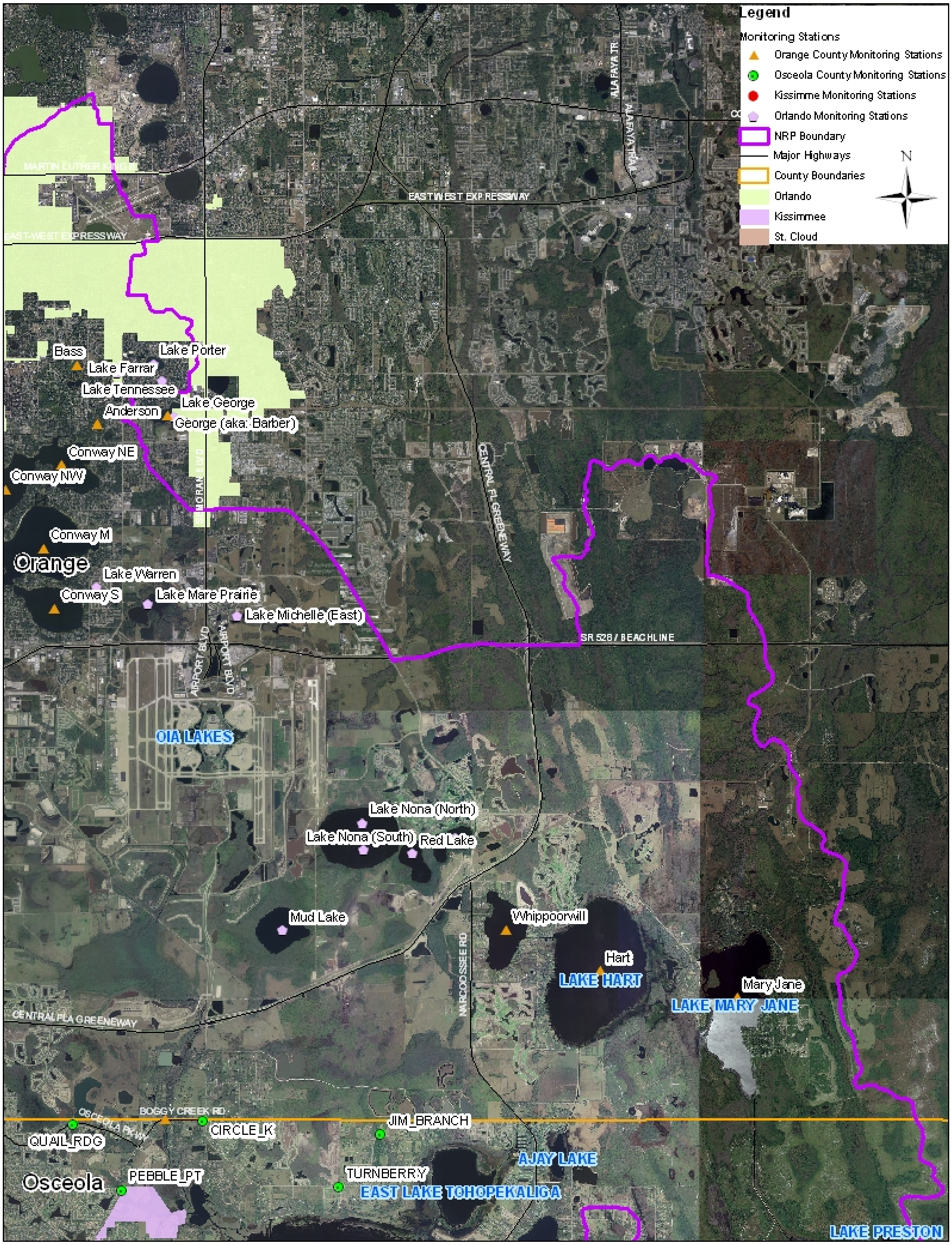

Figure B-3 Additional Monitoring Stations - Northeast Basin

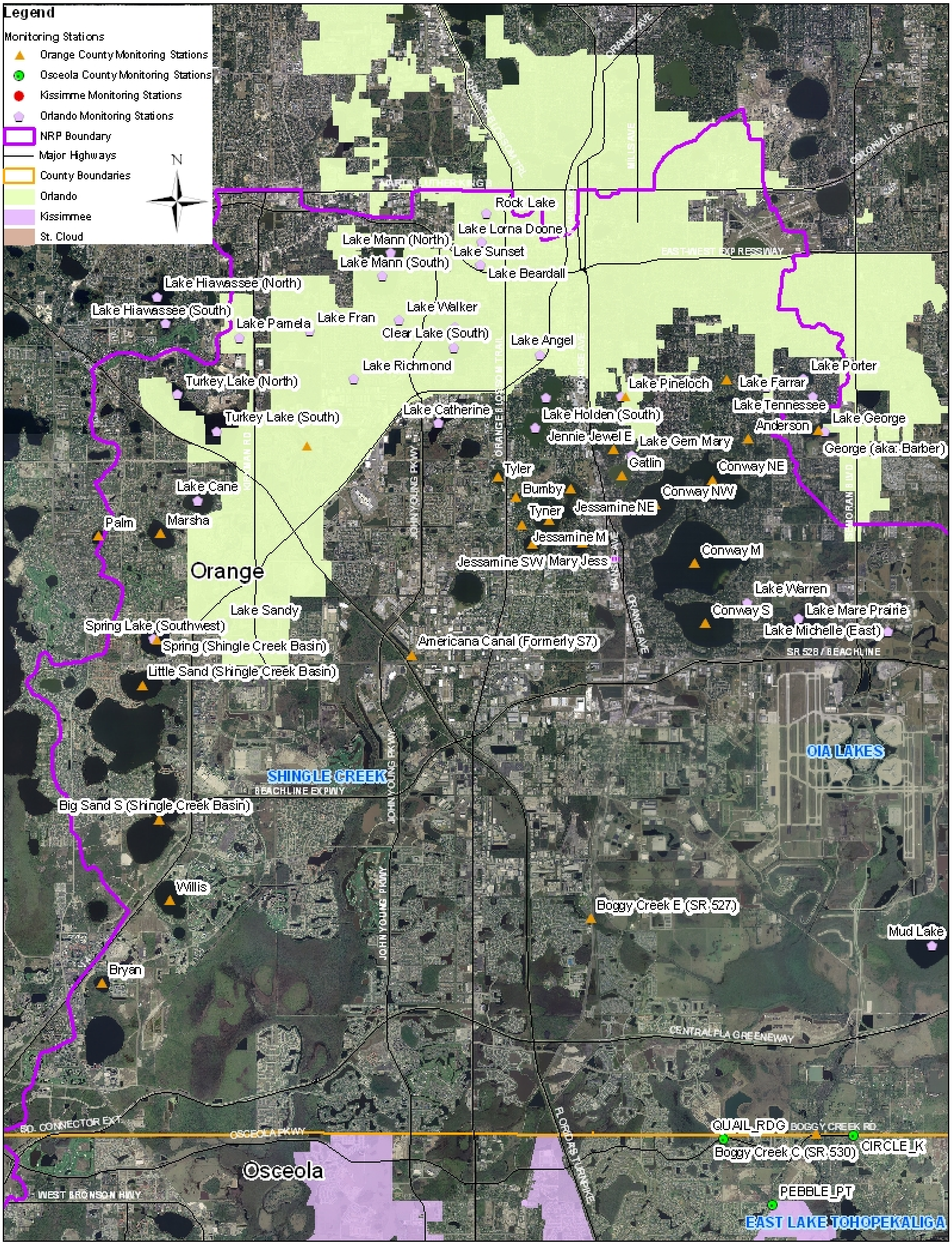

Figure B-4 Additional Monitoring Stations – Northwest Basin

CDM®

www.cdm.com