Lake Daisy Water Quality Management Plan

Polk County Parks and Natural Resources | August 2015

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LIST OF ACRONYMS

ac-ft	Acre-feet
BMP	Best Management Practice
CHNEP	Charlotte Harbor National Estuary Program
CMP	Corrugated metal pipe
DO	Dissolved oxygen
EMC	Event Mean Concentrations
EPA	US Environmental Protection Agency
ERP	Environmental Resource Permit
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FEMA	Federal Emergency Management Agency
FLUCCS	Florida Land Use and Cover Classification System
IWR	Impaired Waters Rule
lb	Pounds
µg/L	Micrograms per liter
mg/l	Milligrams per liter
MS4	Municipal Separate Storm Sewer System
NNC	Numeric nutrient criteria
NPDES	National Pollutant Discharge Elimination System
OSTDS	Onsite Sewage Treatment and Disposal Systems
PCU	Platinum-Cobalt Units
R^2	Coefficients of determination
SWFWMD	Southwest Florida Water Management District
TMDL	Total maximum daily load
TN	Total Nitrogen
TP	Total Phosphorus
TSI	Tropic State Index
WQMP	Water Quality Management Plan

EXECUTIVE SUMMARY

Lake Daisy is a 130-acre lake within the Peace River-Peace Creek Canal Watershed in Polk County, Florida, and is one of 12 priority lakes selected by Polk County for development of a Water Quality Management Plan (WQMP). This selection resulted from Lake Daisy's ranking in studies the County conducted to help identify reasonable approaches to protect and improve the quality of the County's lakes. This WQMP will be used by the County to prioritize structural and non-structural management actions for Lake Daisy and its watershed.

The purpose of this study was to:

- Review relevant data and information to develop an understanding of the current and historical conditions of the lake and basin.
- Develop a GIS-based map series of the lake and watershed.
- Conduct analyses of water quality data and review existing reports to determine if nutrients are a likely cause of lake impairment.
- Examine other factors that may possibly affect lake conditions.
- Based on the results of the analyses, identify management activities that can be expected to improve lake water quality.
- Compare the potential actions to determine those most likely to improve lake water quality.

The following summarizes findings and recommendations.

FINDINGS

- Lake Daisy is a clear, acidic lake in the Winter Haven/Lake Henry Ridges lake region, which is a karst area with a large number of small-to-medium-size lakes.
- TN has remained stable over the period of record (1989–2015), and TP has experienced a significant decreasing trend. Chlorophyll *a* concentrations have varied widely with no significant trend; however, the range of variation has been smaller in recent years.
- Lake Daisy is currently impaired due to elevated nutrient concentrations based on an elevated Trophic State Index (TSI). However, based on discussions with Florida Department of Environmental Protection staff, the lake is expected to be "de-listed" during the next cycle based on the data currently in the Impaired Waters Rule database for the next verified period, 1/1/2008–6/30/2015.
- The entire dissolved oxygen (DO) record was evaluated against the new DO standard, showing that Lake Daisy has always met the current State DO standard.
- Lake Daisy's 355-acre watershed consists mostly of single-family residential developments. Citrus was the dominant historical land use.
- Lake Daisy's wetland fringe has decreased from 19 to 2 acres since the 1940s.

- No significant relationship exists between chlorophyll *a* concentrations and annual TN and TP loadings; however, a clear, significant relationship exists between the annual geometric mean chlorophyll *a* concentrations and annual hydrologic loadings.

- Grove Shores Mobile Colony operates a domestic wastewater facility near the south shore of Lake Daisy. This extended aeration treatment system is permitted for 0.0117 MGD with disposal by land application (percolation pond).

- Direct runoff appears to be the largest external contributor of nutrients to Lake Daisy, with atmospheric deposition also accounting for an appreciable percentage of the load. Septic tanks, mainly in the Lake Doll neighborhood, and percolation pond effluent likely contribute load as well.

- The loading and water quality analyses completed indicate that internal loading of nutrients is likely a critical component of the total loading to the lake water column.

- Areas contributing untreated runoff include the neighborhood surrounding Lake Doll and the neighborhoods that comprise the southwest portion of the watershed.

RECOMMENDATIONS

- Provide curb-cuts, minor stormwater conveyance system modifications, and other low-cost retrofits to provide stormwater runoff treatment for areas within the Lake Daisy Watershed that are not currently receiving treatment.

- Replace much of the Polk County-owned boat ramp with pervious pavement.

- Plant a littoral zone around Lake Doll as well as the channel connecting Lake Doll to Lake Daisy.

- Conduct groundwater quality screening to evaluate impacts to groundwater.

- Conduct a lake sediment monitoring program to characterize the nature of the lake sediments and obtain estimates of nutrient fluxes across the sediment/water interface.

- Continue environmental programs that benefit Lake Daisy water quality, such as fertilizer ordinance enforcement.

- Consider refining street sweeping program in the Lake Daisy Watershed.

- Consider expanding public education programs to include an Environmental Education Teacher Training Program.

1 INTRODUCTION

This Water Quality Management Plan (WQMP) describes historical and current conditions (Section 2), provides an analysis of relationships between the various water quality and hydrologic attributes (Section 3), and provides descriptions of potential management actions to improve water quality in Lake Daisy (Section 4). Final recommendations are provided in Section 5.

Lake Daisy is within the Peace River-Peace Creek Canal Watershed in Winter Haven, Florida (Latitude 27°59'47"; Longitude 81°39'33"; Figure 1-1). Lake Daisy is in the Winter Haven/Lake Henry Ridges lake region (Griffith et al., 1997), which is a karst area with a large number of small to medium size lakes. Many lakes in this region are alkaline and have moderately hard water with a relatively high mineral content. The lake surface area is 131 acres and its watershed is 355 acres, including the lake.

1.1 REGULATORY STATUS AND SUMMARY OF PREVIOUS STUDIES

Lake Daisy (WBID 1539R) was defined by the Florida Department of Environmental Protection (FDEP) as impaired due to elevated nutrient concentrations based on an elevated Trophic State Index (TSI) during the January 1, 1997 to June 30, 2004 verified period as part of the Group 3, Cycle 1 review. FDEP reported that the Lake Daisy TSI met the verification threshold (TSI=40) in 4 of the 40 samples evaluated during 1997 to 2000. FDEP concluded that Lake Daisy is co-limited by nitrogen and phosphorus based on a nitrogen/phosphorus (TN/TP) ratio median of 22.38. Sixty-six (66) samples from the verified period had a median TN concentration of 0.58 milligrams per liter (mg/L) and a median TP concentration of 0.03 mg/L. In Cycle 2 (from IWR Run 38), Lake Daisy also met the impairment criteria in 2002 and 2008 with values of 45.2 and 43.1, respectively. Those were the only years in Cycle 2 where there were sufficient data to calculate the TSI as data from all four seasons were not available. The FDEP Impaired Waters Rule (IWR) website (http://publicfiles.dep.state.fl.us/dear/IWR/; [FDEP, 2014]) was examined to determine whether the Lake Daisy will remain impaired based on most recent draft IWR run data. The Cycle 3 verified period is 1/1/08 through 6/30/15. The information obtained suggests that Lake Daisy may be delisted during Cycle 3.

Atkins (2013) evaluated the water quality data for the verified period and compared these data to the recently adopted numeric nutrient criteria (NNC) that were adopted by the FDEP and became effective on July 2, 2012 (Florida Administrative Code [FAC] Rule 62-302.531, Numeric Interpretations of Narrative Nutrient Criteria). Lake NNC were based on the predominant water color and alkalinity of a lake. Lake Daisy is a clear, acidic lake based on a long-term geometric mean color of 16 platinum-cobalt units (PCU) and alkalinity of 1 mg/L (Atkins, 2013). Based on these characteristics, the nutrient criteria were determined based on a chlorophyll *a* concentration of 6.0 micrograms per liter (µg/L). The results of their analysis support the initial impairment determination and indicate that Lake Daisy was impaired for elevated chlorophyll *a* and TP concentrations during the verified period using the NNC (Atkins, 2013).

Atkins and ESA (2014) produced a report entitled “Prioritizing Future Actions Related to Impaired Lakes and the FDEP TMDL Program”. They reported that Polk County previously prioritized 23 lakes with either a FDEP-adopted or US Environmental Protection Agency (EPA)-approved nutrient-related total maximum daily loads (TMDLs) as required by their National Pollutant Discharge Elimination System (NPDES) MS4 permit. Their report included a review of those TMDLs, development of a prioritization scheme, and the prioritization of 97 public access lakes.

Lake-specific empirical water quality targets were derived for many of the 97 lakes without TMDLs from correlations between nutrients and chlorophyll *a* concentrations which were compared to the recently approved FDEP nutrient criteria (Atkins and ESA, 2014). The annual percent reduction was calculated to meet the lake-specific annual geometric means. Lake-specific targets were often found to be more stringent than the FDEP nutrient criteria. This was generally the case but for Lake Daisy no correlation was found.

The probable impairment status was also determined using the FDEP NNC (Atkins and ESA, 2014). The water quality data used were limited to a period from 1983 – 2013. The methods for comparison were consistent with those employed by FDEP to determine impairment. Results indicate Lake Daisy would be impaired for TN and TP based on the NNC.

Each lake was assigned to a tier based on the magnitude of the percent concentration reduction required to meet FDEP lake criteria for total nitrogen, total phosphorus and chlorophyll *a* (corrected) (Atkins and ESA, 2014). Fives tiers were created ranging from 0 (no reduction) to 4 (>60% reduction). Each lake was assigned the largest tier score from each of the three parameters.

Within each tier, a context score was determined using the following parameters: regulatory status, potential cooperative partners, lake size, potential socio-economic use, number of MS4 outfall to the lake and the proportion of the basin draining to the lake via County MS4 outfalls (Atkins and ESA, 2014). Each of these scores was weighted based on their relative importance.

Two intensity factors were developed to quantify the changes in water quality status for the waterbody: frequency of standards exceedance and water quality trend (Atkins and ESA, 2014). The percent frequency of exceedance represents the percentage of time a waterbody exceeded the annual criteria for TN, TP or chlorophyll *a* (corrected). The water quality trend score was determined using a seasonal Kendall-Tau test to determine the presence and direction of a trend.

A lake’s final score was the sum of the context and intensity scores (Atkins and ESA, 2014). The context score was calculated as the average weighted score of all factors while the intensity score was computed as the average of the two intensity factors. The final scores were then ranked within each tier. The results of the scoring analysis for Lake Daisy are shown below.

Lake summary and recommendations for Lake Daisy from Atkins and ESA were:

- Regulatory=6
- Lake Size=6
- Number of Partners=6
- Socio-Economic=4
- Number of MS4 Outfalls=6
- Percent of Basin Draining from MS4=8
- Frequency of Exceedance=10
- Water Quality Trend=6
- Average Context=6
- Average Intensity=9
- Final Score=15

Based on the Atkins and ESA assessment report, the following was concluded:

- Regulatory Implications
    - Designated as impaired by FDEP for nutrients based on elevated TSI, TMDL is anticipated.
    - Impairment evaluation using NNC method indicates impairment based on TN and TP requiring 5 percent and 63 percent concentration reductions, respectively.
    - Seven County MS4 outfalls discharge to the lake; permit-specified load reductions may be required to meet TMDL-defined water quality target.
- Locally Derived Targets
    - Correlation between TN or TP and chlorophyll *a* not found using Annual Geometric Means (AGM) (1983–2013).
- Priority Ranking
    - Assigned lake priority #3 of 24 within Tier 4.
    - Seven County MS4 outfalls account for 44 percent of the lake's drainage area.
    - Trend in TP indicates improving water quality.
    - Medium lake with moderately low recreational use.

- Recommendations
  - Evaluate internal and external nutrient loads to the lake.
  - Develop and implement water quality management plan, which presents potential water quality improvement projects.
  - Continue existing water quality improvement projects and monitoring programs.

1.2 Summary of Existing Information

Polk County provided much of the information used in this study, including a GIS stormwater inventory, lake bathymetry, MS4 outfalls, lake drainage area, existing relevant reports and accompanying spreadsheets, water quality data, locations of wastewater facilities, as well as other data. Other sources of data included Southwest Florida Water Management District (SWFWMD), Florida Department of Transportation (FDOT), FDEP, and Federal Emergency Management Agency (FEMA), as well as other public agencies. Appendix A presents the data sets used and the source of origin.

2 HISTORICAL AND CURRENT CONDITIONS

Jones Edmunds and Janicki Environmental assessed historical and current conditions in Lake Daisy and its watershed focusing on changes in land use and surface water hydrology and quality. Our analysis is presented in the following sections.

2.1 REVIEW OF HISTORICAL AND CURRENT WATER QUALITY AND HYDROLOGY

The following discussion of water quality data is based on data reported as Run 49 in the FDEP IWR database. Water quality measurements were initiated 1989. Eight locations located in the central area of the lake have been sampled during various periods of the study record (Figure 2-1). Also, the frequency of samples collected annually has varied substantially, ranging from less than 10 between 1989 and 2004 and the years 2012 and 2013, to between 13 and 26 during the period from 2005 through 2011.

Temporal variation in lake water quality can be significantly influenced by two related physical factors – rainfall and lake stage. Figures 2-2 and 2-3 present the time series for each of these variables.

Total annual rainfall at Lake Daisy ranged from a low of 28 inches in 2000 to a maximum of 63 inches in 2004 (Figure 2-2). Total monthly rainfall with low values at or near 0 inch to a number of peaks rainfall amounts exceeding 10 inches (Figure 2-2). The intra-annual variation in rainfall followed the expected seasonal pattern with the highest amounts from June through September when rainfall totals in excess of 6 inches have occurred (Figure 2-2). With the exception of March, the average rainfall during the dry period months never exceeded 3 inches.

The mean monthly lake stages are presented in Figure 2-3. Lake stages did not display temporal variation similar to that observed in rainfall. Stages typically ranged from 128 to 129.5 feet. The lowest lake stages did follow the low rainfall that was observed during the drought years of 2000 and 2001 and in 2009.

Figure 2-1 Lake Daisy Located Within Peace River-Peace Creek Canal Watershed in Winter Haven, Florida (Lat 27°59'47"; Lon 81°39'33")

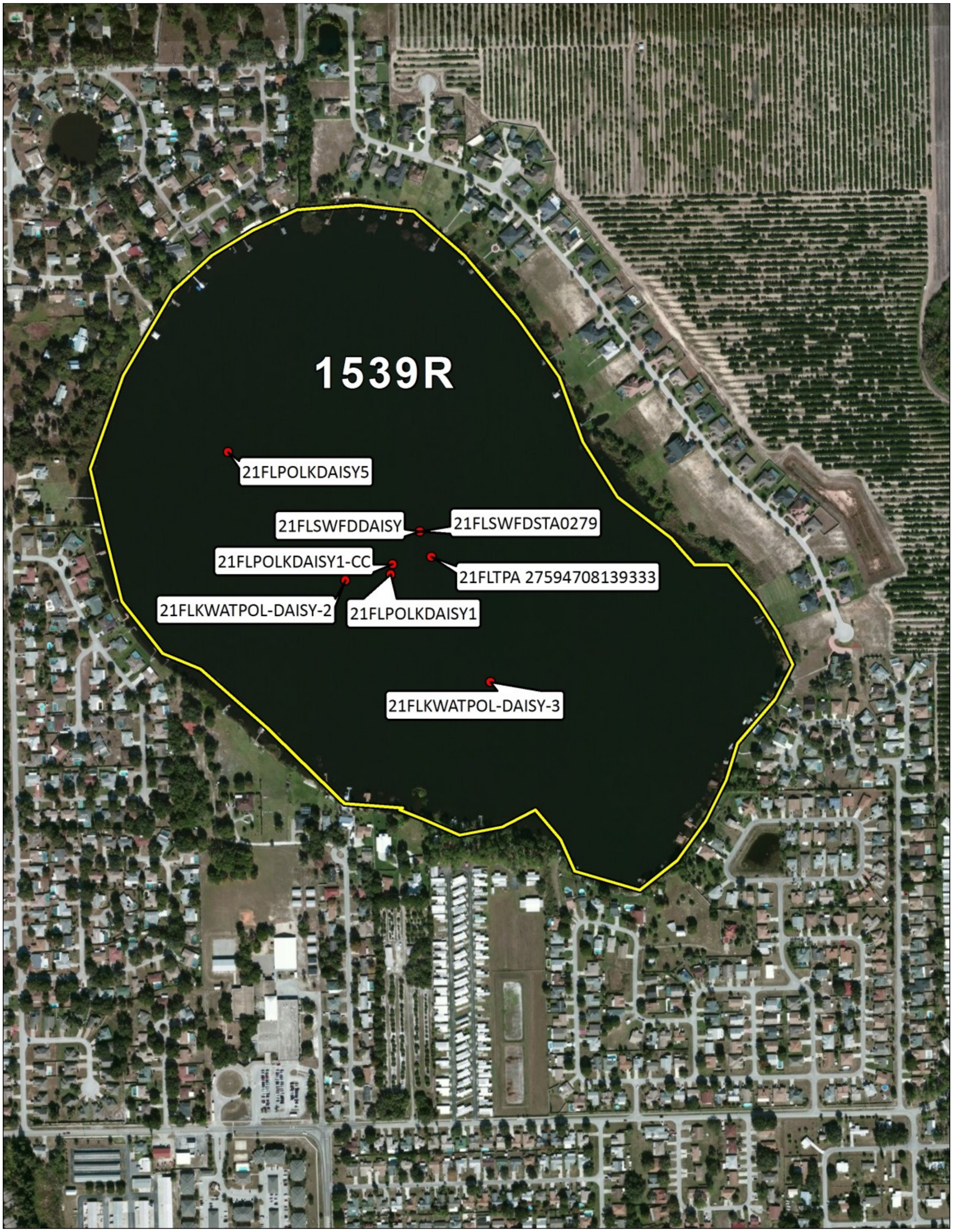
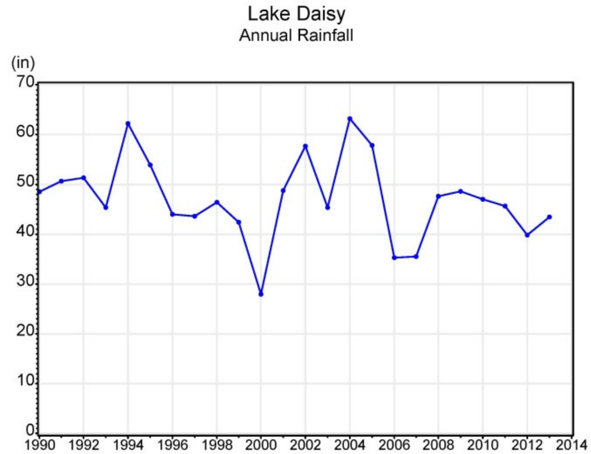
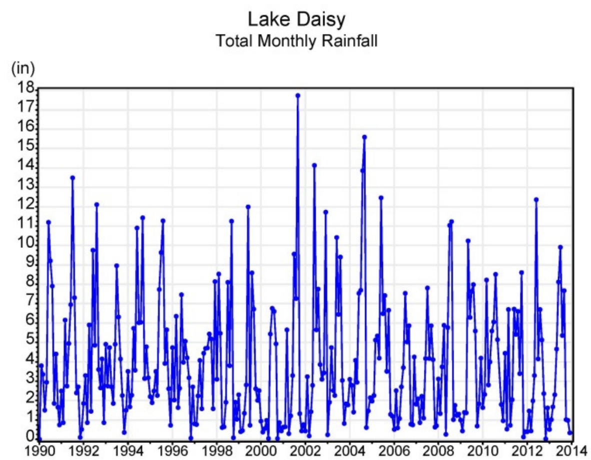


Figure 2-2 Lake Daisy Rainfall
(Top panel-total annual; middle panel-mean monthly; bottom panel mean calendar month)





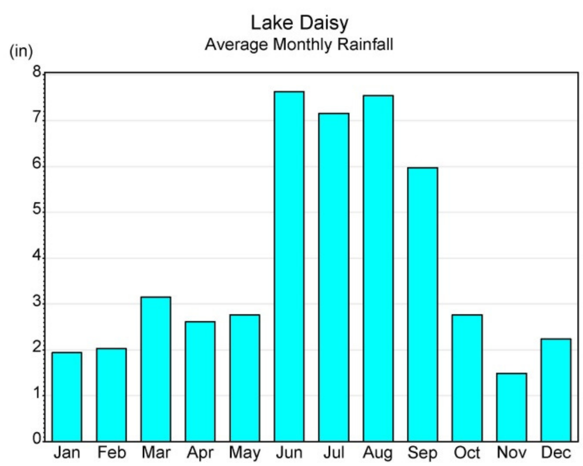
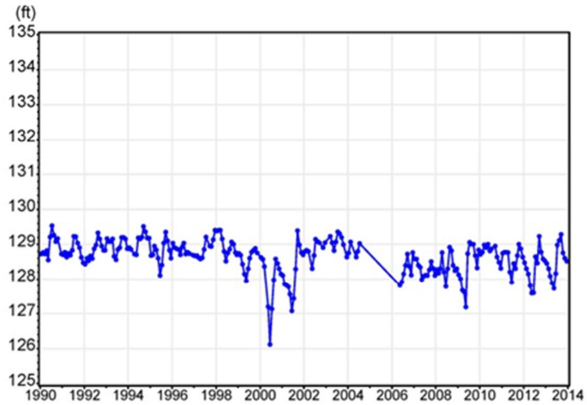
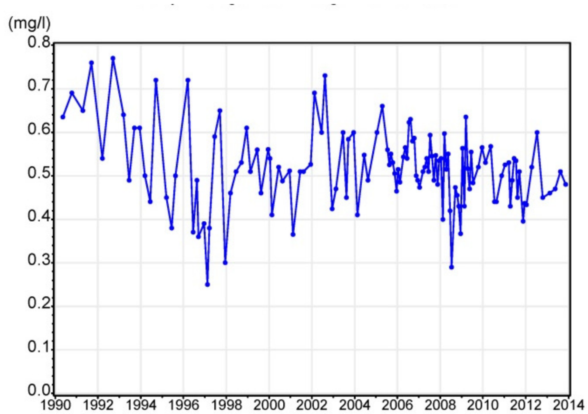


Figure 2-3 Lake Daisy Stage



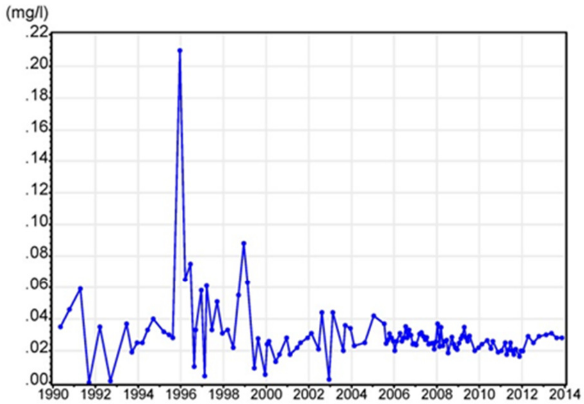
The mean TN concentration for the period April 1989 to November 2013 (a total of 225 observations) was 0.53 mg/L. The long-term record of TN appears quite level, with concentrations generally ranging from near 0.30 mg/L to near 0.7 mg/L (Figure 2-4), however, a single measurement in December 1995 (not shown in Figure 4) was slightly less than 2 mg/L. Since 2006, the temporal variability in the TN concentrations is reduced from that observed in the earlier data. Statistical trend analyses were performed using a seasonal Kendall Tau test (see Appendix B). While the data suggest a small magnitude change in TN concentrations, the trend test confirms the lack of long-term change (p=0.179).

Figure 2-4 Lake Daisy TN Concentrations



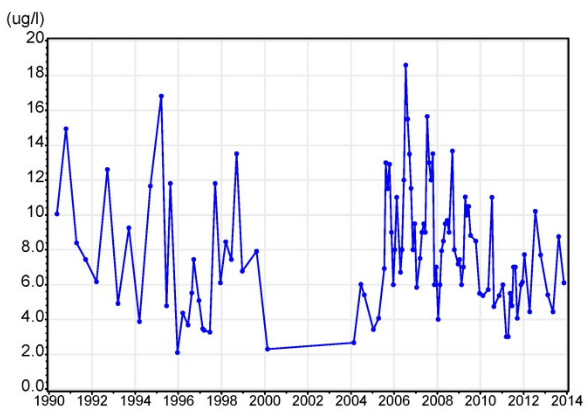
The mean TP concentration for the period April 1989 to November 2013 (a total of 221 observations) was 0.04 mg/L. Variations between sampling occasions were substantial prior to 2006 with measured concentrations generally ranging from near zero to 0.07 mg/L (Figure 2-5), excluding two very high reported values in March 1993 (2 mg/L, not shown on this figure) and December 1995 which was coincident with the highest observed TN concentration. The range of measured values has during the recent period, since 2006, been much narrower with values generally close to the long-term mean concentration. Statistical trend analyses were performed using a seasonal Kendall Tau test (see Appendix B). The trend test indicates a significant (p=0.001) decreasing trend in TP concentrations.

Figure 2-5 Lake Daisy TP Concentrations



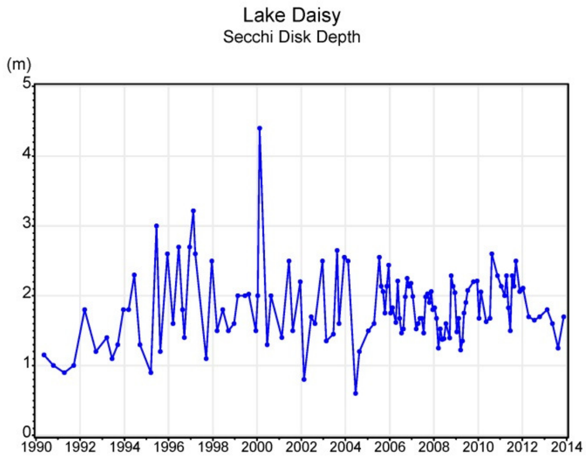
The mean chlorophyll a concentration for the period April 1989 to November 2013 (a total of 182 observations) was 8.48 µg/L. A relatively level long-term record is evident (Figure 2-6). Large variations between measurements, with values ranging from near 2 µg/L to just below 20 µg/L, likely reflect seasonal variations in phytoplankton biomass. The range of variation appears to have decreased during the most recent years. Statistical trend analyses were performed using a seasonal Kendall Tau test (see Appendix B). While the data suggest a small magnitude change in chlorophyll a concentrations, the trend test confirms the lack of long-term change (p=0.723).

Figure 2-6 Lake Daisy Chlorophyll a Concentrations



The mean Secchi Disk depth for the period April 1989 to November 2013 (a total of 226 observations) was 1.80 m. Similar to the long-term record of chlorophyll *a*, the Secchi disk depth time series with few exceptions also appears quite consistent (Figure 2-7). Measured depths generally range from near 1 m to 2.5 m. While the data suggest a small magnitude change in Secchi disc depths, the trend test confirms the lack of long-term change (p=0.758).

Figure 2-7 Lake Daisy Secchi Disk Depths



Florida has recently adopted revised dissolved oxygen (DO) criteria, as provided in FAC 62-303.320 effective as of August 1, 2013, to replace the 5 mg/L DO standard adopted more than 30 years ago. The revised DO criteria are with respect to DO percent saturation, and for the bioregion containing Lake Daisy, FAC 62-302.533 states that no more than 10 percent of the daily average percent DO saturation values shall be less than 38 percent. The 38% criterion is modified slightly based on the time of day of data collection.

Data for Lake Daisy from the IWR Run 49 to evaluate whether the Lake Daisy DO data achieved the recently revised DO criterion or the previous standard. The DO data analyzed were obtained during the period 1989-2013, specifically for the Group 3 Cycle 2 period (1/1/02 – 6/30/09) and the Group 3 Cycle 3 period (1/1/08 – 6/30/15)

During the Cycle 2 period, DO % saturation data were available for 22 samples and the DO % saturation in all samples all greater than the time of day-dependent DO saturation criteria. Similarly, the DO % saturation in all of the 19 samples with available data was greater than the time of day-dependent DO saturation criteria. As expected, evaluation of the DO % saturation data for the entire time period of 1989-2013 indicates all of the DO samples from that period complied with the recently adopted DO standard.

Similar comparisons of available DO data to the previous DO standard were also made. Of the 101 DO samples available for the 1989-2013 period, all were greater than the standard. The lowest DO value was 5.4 mg/L, with only 2 of the 101 samples less than 6 mg/L over the entire 1989-2013 period in Lake Daisy. Therefore, Lake Daisy has always met the State DO standards.

2.2 POLLUTANT LOADING ANALYSIS

2.2.1 INTRODUCTION

A pollutant-loading analysis was conducted for the Lake Daisy Watershed. The methodologies and summary results are provided in Section 2.2.2 followed by a more in-depth discussion of the results in Section 2.2.3.

2.2.2 Pollutant Loading Methodologies

The pollutant-loading analysis was conducted using the methods prescribed by the Polk County Parks and Natural Resources Division to estimate loads to Lake Daisy. The loading assessment includes components for direct runoff, atmospheric deposition, and septic tanks. The lake also receives inflows from the surficial aquifer; however, data are not available to estimate the magnitude of the loads associated with these flows. Loads were estimated for 1990 through 2013. The watershed's land use history was determined in order to calculate loads for land use-dependent loads (direct runoff and septic tank system). To determine the land use history we reviewed historical aerials comparing them against the current aerials and the current SWFWMD land use. Two change points (1993 and 2004) were identified during the period of interest; thus, land use feature classes were prepared for two conditions to supplement SWFWMD's current (2011) land use (Figure 2-8). These land use feature classes include a Pre-1993 land use and a 1993-2004 land use. Figure 2-9 shows the development age that was used to create the land use feature classes. Development age was established by reviewing aerials, Environmental Resource Permits (ERPs), and the Polk County Property Appraisers database. Citrus was the historical land use of the Lake Daisy Watershed (Figure 2-10).

2.2.2.1 Direct Runoff

Using a modified version of the Simple Method in accordance with the Draft Florida Stormwater Quality Applicant's Handbook (FDEP, 2010), the runoff volume was calculated using the area of the basin, the various land use and hydrologic soil group, and the rainfall depth. Next, the pollutant loads were calculated using the runoff volume and the Event Mean Concentrations (EMC) for each pollutant. Subsequently, Best Management Practices (BMPs) were applied to calculate removed loads. The final net load is the difference between the gross and removed load. Intermediate calculations used to develop inputs are described in Appendix C.

Figure 2-8 Existing Land Use

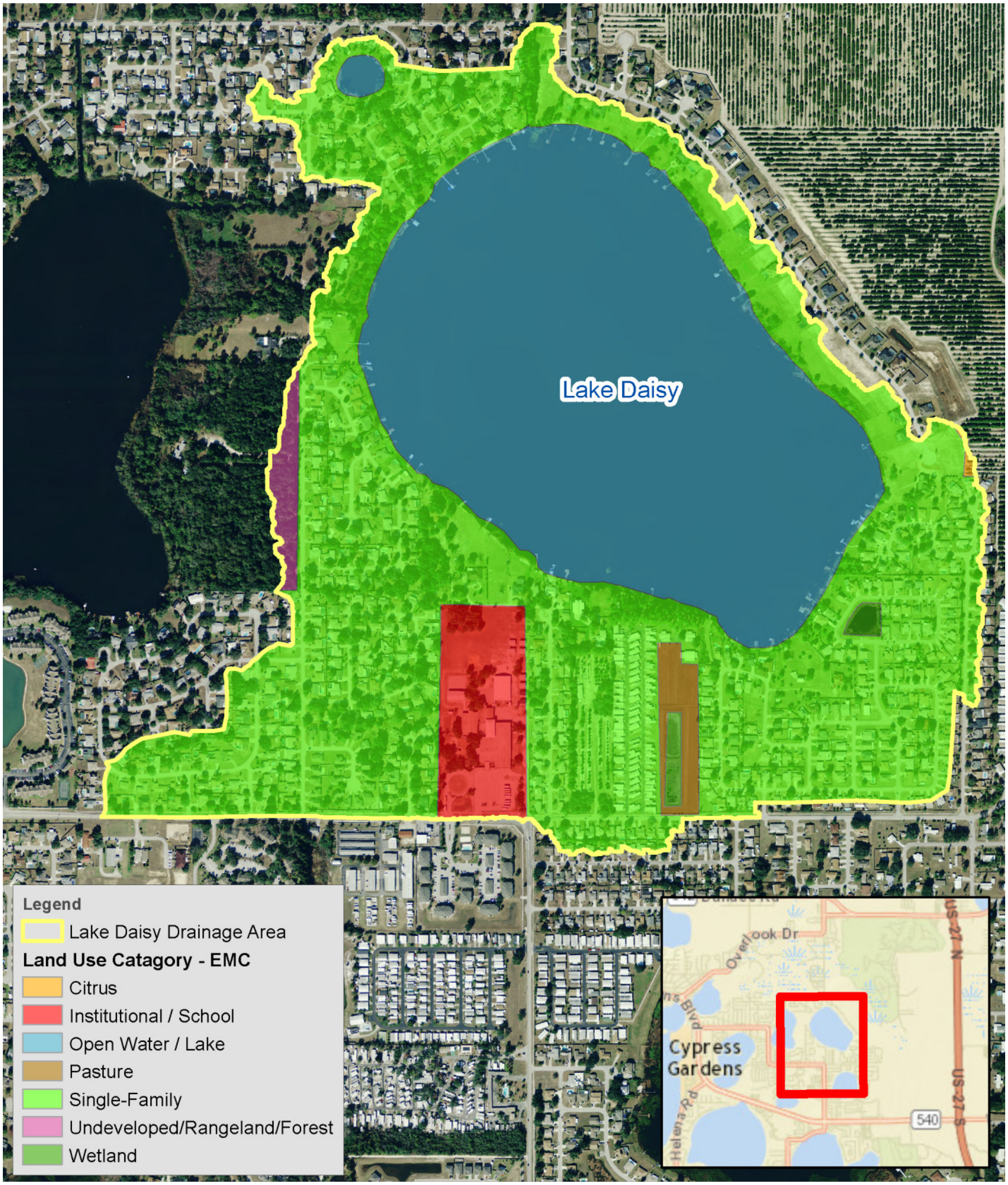


Figure 2-9 Land Use Changes Since 1990

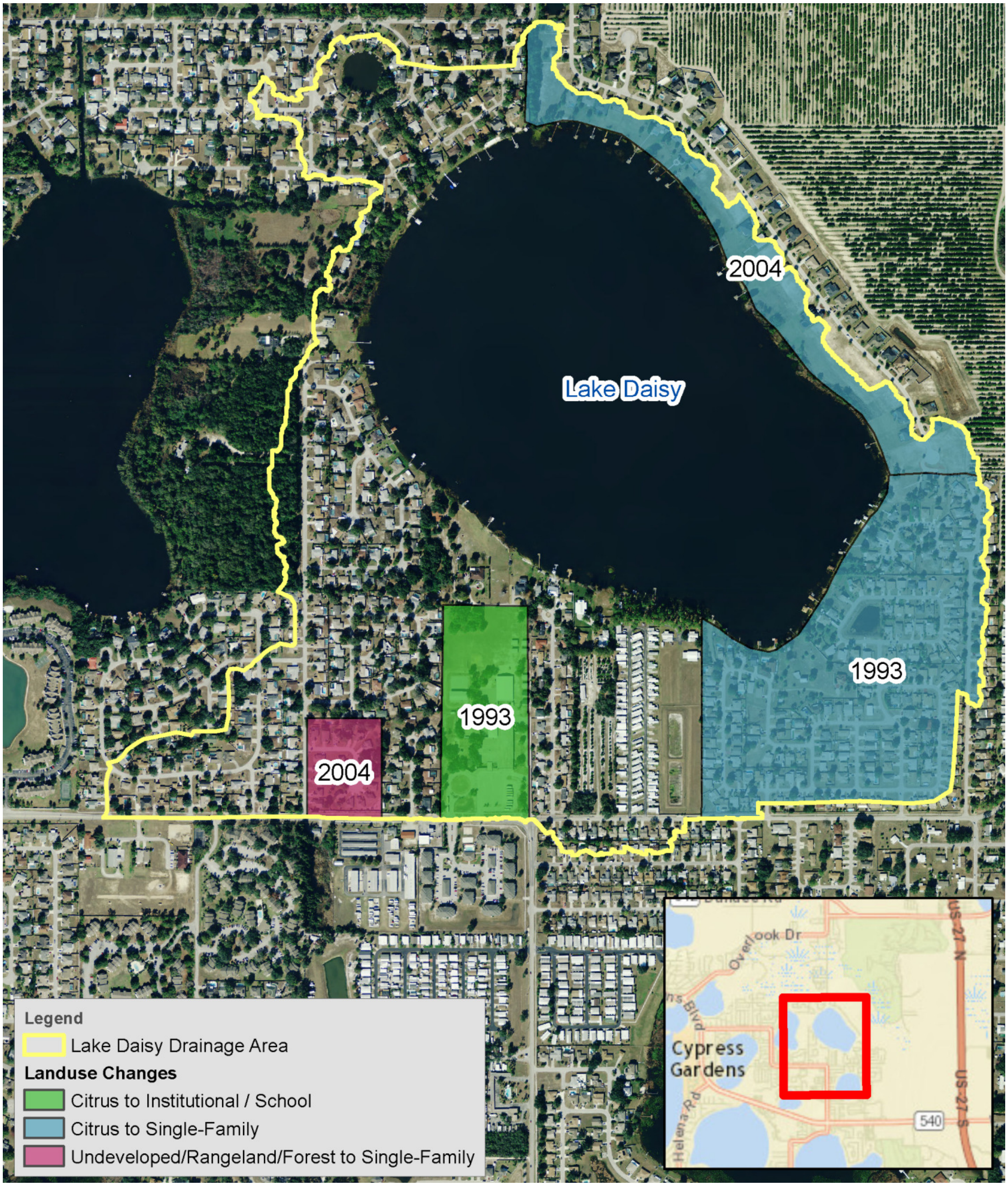


Figure 2-10 1971 Aerial Map

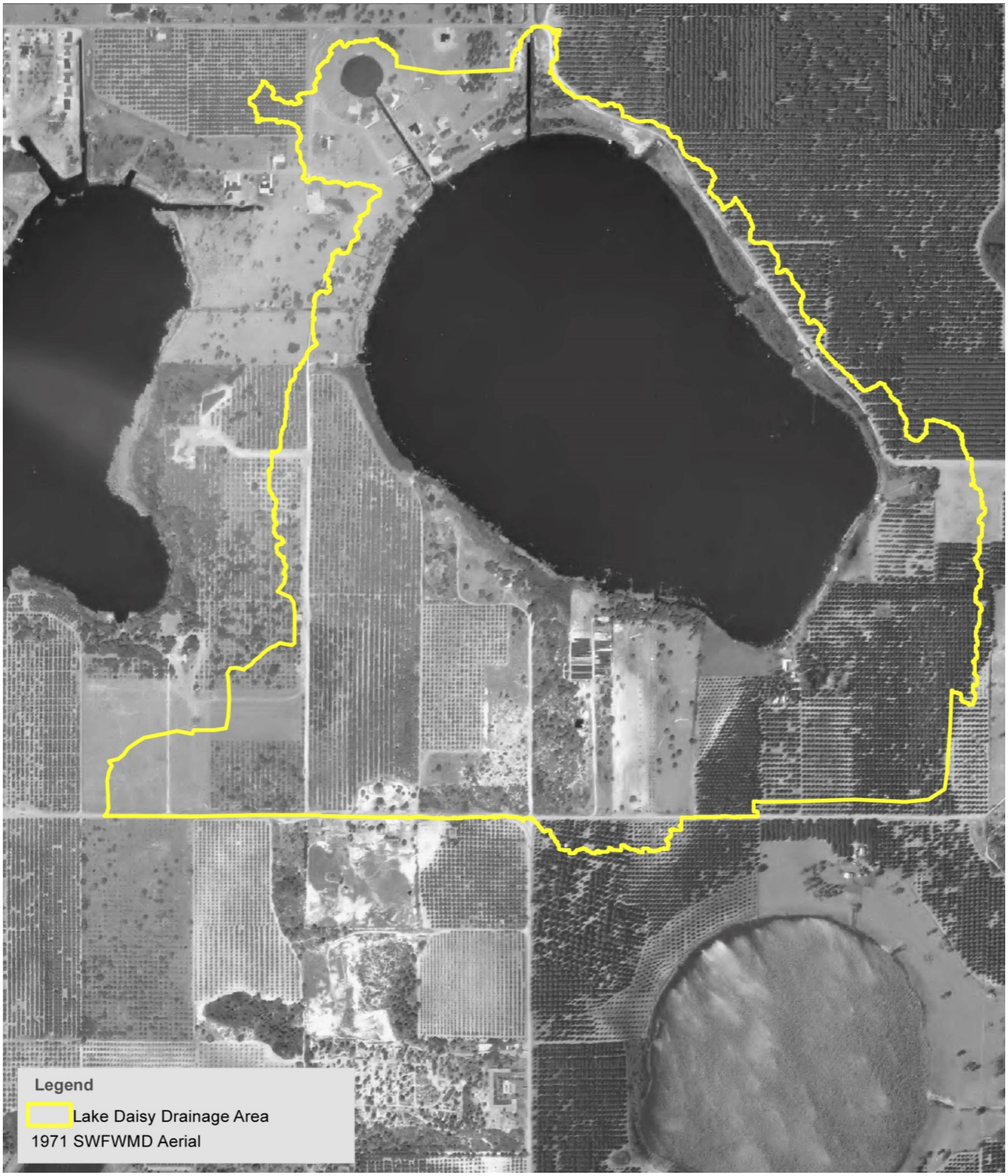


Table 2-1 summarizes the loading input datasets and describes the source and the purpose for which the datasets were used.

Table 2-1 Input Summary

Item	Used for:	Source
Spatial Data		
Aerials	BMP Feature Class	ESRI Imagery Basemap, and FDOT 1971, 2011, 2014
Land Use	Runoff Volume Gross Loads	SWFWMD, 2011; Jones Edmunds 2015
Soil Type (Hydrologic Group)	Runoff Volume Gross Loads	SWFWMD, 2002
PC TMDL Lakes Drainage Areas	Define study area	Polk County
Stormwater Inventory	Drainage Patterns for BMP Feature Class	Polk County
Digital Elevation Model	Drainage Patterns for BMP Feature Class	SWFWMD
BMP Types and Polygons	Removed Loads	Jones Edmunds, 2015
Constants – Lookup Tables		
Event Mean Concentrations	Gross Loads	AMEC, 2013
Runoff Coefficients	Runoff Volume	AMEC, 2013; FDEP, 2010
Percent DCIA	Runoff Volume	AMEC, 2013; FDEP, 2010
BMP Removal Efficiencies	Removed Loads	AMEC, 2013
Rainfall; NEXRAD, SID 24494,	Runoff Volume Station 24494: 1990-1995; NEXRAD Pixel 99422: 1995-2013	SWFWMD

Table 2-2 shows the resulting net direct runoff pollutant loading summarized by year (pounds per year [lb/year]). A more detailed description of the results is provided in Section 2.2.3.

Table 2-2 Net Direct Runoff Loading to Lake Daisy from Drainage Area (TN and TP)

Year	TN (lb/year)	TP (lb/year)	Year	TN (lb/year)	TP (lb/year)
1990	648	106	2002	1188	171
1991	676	111	2003	935	134
1992	685	112	2004	1454	212
1993	934	134	2005	1331	194
1994	1282	184	2006	811	118
1995	1111	160	2007	816	119
1996	907	130	2008	1096	160
1997	899	129	2009	1119	163
1998	957	137	2010	1081	157
1999	874	126	2011	1049	153
2000	575	83	2012	917	133
2001	1,005	144	2013	1000	146

2.2.2.2 Loading from Atmospheric Deposition

To accurately estimate the mass-loading of pollutants from the entire area, the pollutant loading directly on the lake from atmospheric deposition was calculated. Atmospheric deposition is a major source of nitrogen and phosphorus into Lake Daisy.

To calculate this mass, the total deposition (Table 2-3) was calculated by summing the wet and dry deposition. The wet deposition is a function of the measured wet deposition concentration as well as the hydrologic load from rainfall. Janicki Environmental developed a spreadsheet based on data collected at the National Atmospheric Deposition Program's Verna Wellfield site. This spreadsheet was used for atmospheric deposition calculations.

Table 2-3 Direct Loading to Lake Daisy from Atmospheric Deposition

Year	Wet Deposition Total N (lb/year)	Wet Deposition Total P (lb/year)	Total N deposition (lb/year)	Total P deposition (lb/year)
1990	455	7	862	14
1991	452	7	848	14
1992	374	6	713	12
1993	442	7	799	13
1994	674	11	1289	20
1995	559	9	1038	16
1996	359	6	687	11
1997	246	5	457	9
1998	300	5	559	10
1999	354	6	682	11
2000	289	5	517	8
2001	371	6	670	11
2002	393	7	730	13
2003	369	6	693	12
2004	378	7	704	13
2005	416	7	796	14
2006	301	5	559	9
2007	334	5	610	10
2008	331	6	609	11
2009	401	7	775	13
2010	428	7	823	13
2011	315	6	592	10
2012	195	4	362	7
2013	265	5	491	9

2.2.2.3 Loading From Septic Tanks

Central sewage collection facilities are available to most but not all of the neighborhoods surrounding Lake Daisy. Mainly, the Lake Doll neighborhood uses on-site sewage treatment and disposal systems (OSTDS), or septic tank systems. Loads from septic tank systems were predicted by estimating the number of septic tanks in the watershed together with estimated concentrations using a method (Janicki Environmental, 2010) recently applied for the Charlotte Harbor National Estuary Program (CHNEP). The method seeks to estimate the percentage of nitrogen and phosphorus from septic tanks that reaches the lake. Table 2-4 provides the constants used for the analysis. The horizontal and vertical transfer rate accounts for soil attenuation. Relevant pages further explaining the methodology are provided in Appendix D.

Table 2-4 Constants Used for Analysis

Nutrient	Raw Sewage Concentration (mg/L)	Operational Septic Tank		Failed Septic Tank
		Horizontal Transfer Rate	Vertical transfer rate	Delivery Ratio
TN	40	0.1	0.41	0.8
TP	10	1	0.025	0.5

The number of houses on the septic tank system was counted according to the three varying periods (land use change conditions) by reviewing aerials and the Polk County Property Appraisers database. A per capita water use of 60 gallons per day and 2.7 persons per household was used. A septic tank failure rate of 5% was assumed for houses. The number of septic tanks is provided in Table 2-5.

Table 2-5 Septic Tank Count

Item	1990–1992	1993–2003	2004-present
Number of Houses	74	78	83

Septic tank loadings were developed for each of the land use change conditions. The results are provided in Table 2-6.

Table 2-6 Septic Tank Loading

Item	1990–1992	1993–2003	2004-present
TN Load (lb)/yr	115	122	129
TP Load (lb)/Yr	18	19	20

2.2.3 Loading From Grove Shores Percolation Pond

Grove Shores Mobile Colony operates a domestic wastewater facility located near the south shore of Lake Daisy. This extended aeration treatment system is permitted for 0.0117 MGD with disposal by land application (percolation pond). The permitted maximum loading rate to the pond is 0.6 inch per day, which is a lower areal loading rate than a typical individual residential OSTDS (see Appendix E). The permit limit for TN loading to the percolation pond is 12 mg/L, and the expected TP concentration for extended aeration is 2 mg/L. Loads estimated to reach the lake from the percolations pond were calculated in the same manner as for working septic tanks described above, except the estimated septic tank influent was modified in the formula to represent the treated effluent. The resulting annual average net direct loading from this point source summarized by day and year is presented in Table 2-7.

Table 2-7 Effluent Loading

Item	Loading from Percolation Ponds
TN Load (lb)/yr	43
TP Load (lb)/Yr	2

2.2.4 REVIEW OF HISTORICAL AND CURRENT POLLUTANT LOADINGS

Based on the methodologies described above, monthly estimates of TN and TP loadings were calculated for the period 1990-2013. Four sources were reported: direct runoff, atmospheric deposition, septic tanks, and point source.

The total monthly TN and TP loadings, the sum of the loads from direct runoff, atmospheric deposition, and septic tanks are presented in Figures 2-11 and 2-12, respectively. The total TN loads frequently exceeded 400 lb/month through 2005 when the peak monthly TN loads typically near 300 lb/month. With the exception of 1990 to 1993, the lower TN loads were typically 100-125 lb/month. The temporal trends in the total monthly TP loads were similar to those observed in the TN loads. Through 1994 the peak monthly TP loads were never greater than 50 lb/month. From 1995 through 2006 the peak monthly TP loads routinely exceeded 50 lb/month and since 2006 the peak monthly TP loads rarely exceeded that level.

Figure 2-11 Lake Daisy Total Monthly TN Loadings

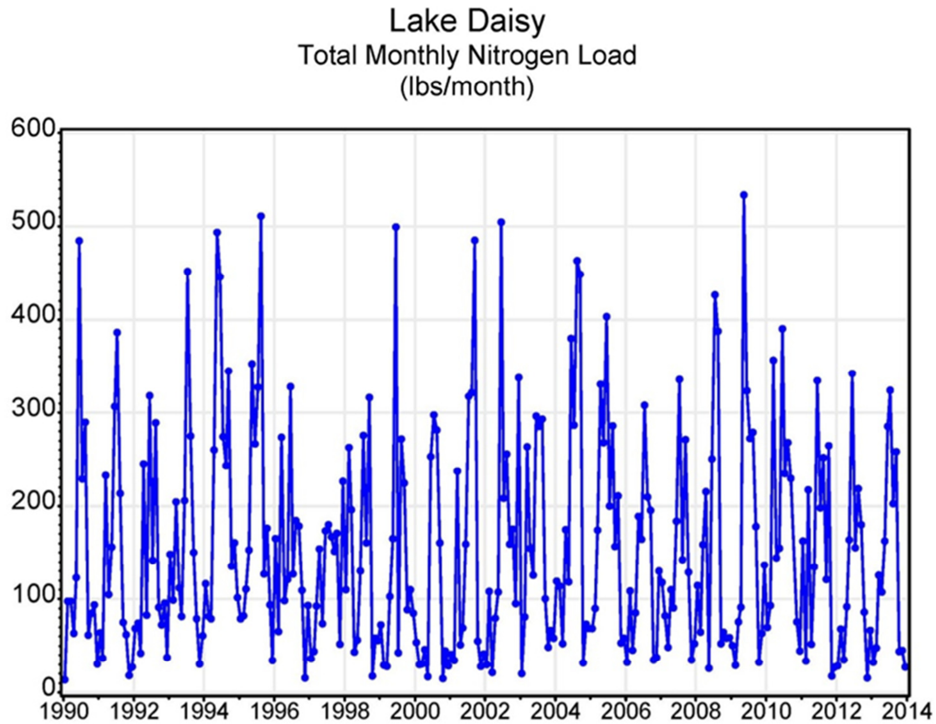
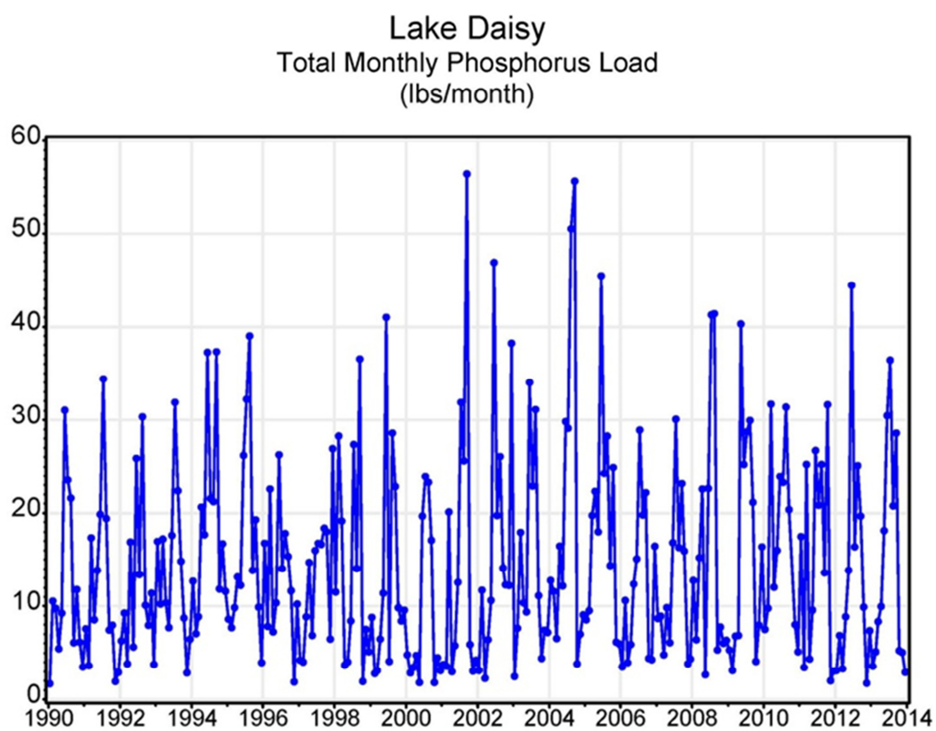


Figure 2-12 Lake Daisy Total Monthly TP Loadings



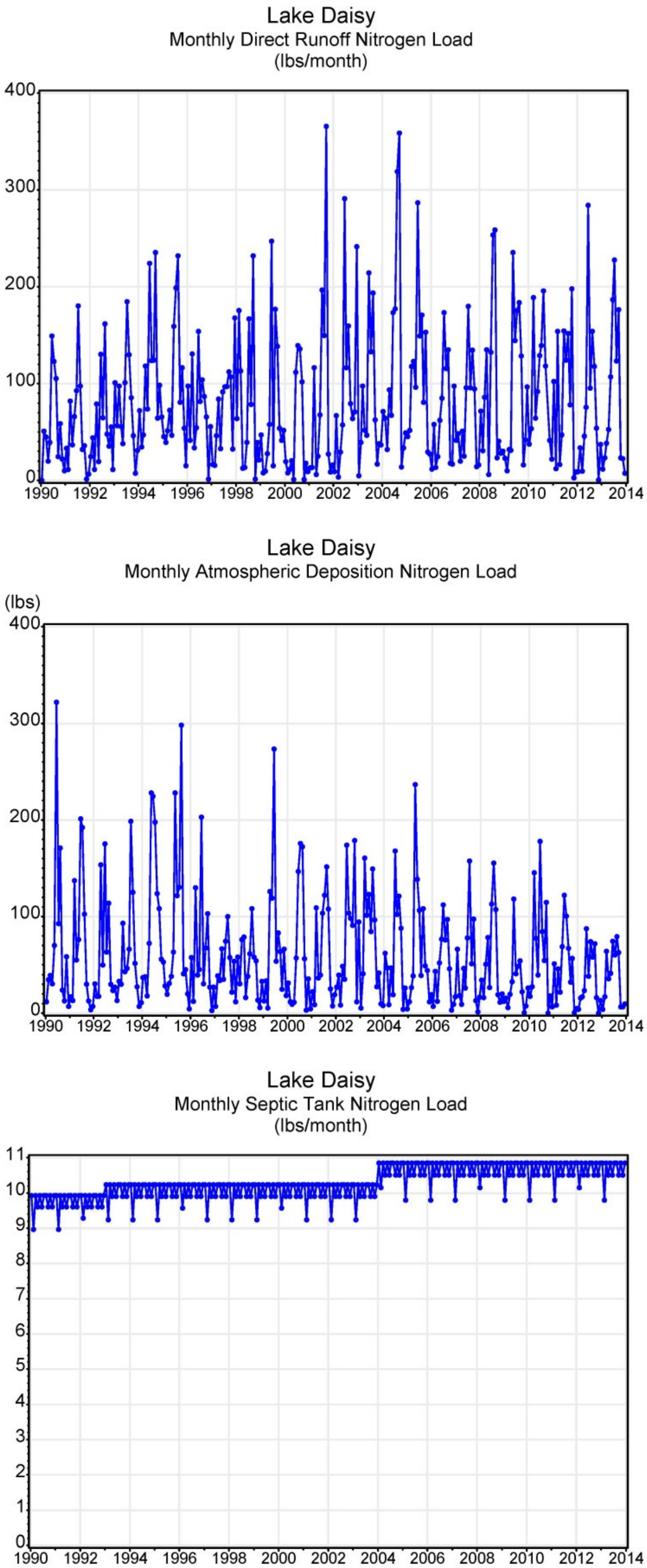
An effective lake management plan will depend on not only knowledge of the total nutrient loading but also the relative importance of the sources of nutrient loads. The monthly TN and TP loadings from direct runoff, atmospheric deposition, and septic tanks are presented in Figures 2-13 and 2-14, respectively. Typical monthly TN loads from direct runoff were less than 250 lb/month, from atmospheric deposition ranged from less than 10 lb/month to greater than 300 lb/month, and from septic tanks were 9-11 lb/month. The most notable temporal trend was found in the TN loads due to atmospheric deposition. Since 2006, those TN loads rarely exceeded 150 lb/month while prior to that period the higher TN loads due to atmospheric deposition routinely exceeded 200 to 300 lb/month. This trend could not be accounted for by temporal trends in rainfall. Therefore, as has been reported for Tampa Bay, the load reduction has been due to reduced nitrogen concentrations in the rainfall. The step trends in septic tank TN loadings was due to the increased number of housing units over time.

Typical monthly TP loads from direct runoff ranged from 10 to 20 lb/month, from atmospheric deposition were less than 2 lb/month, and from septic tanks were less than 2 lb/month. The TP loadings closely followed the temporal trends in rainfall especially during periods of elevated rainfall. As for the TN loads, the step trends in septic tank TP loadings was, again, due to the increased number of housing units.

Figures 2-15 and 2-16 present the contribution of the three nutrient sources to the total annual TN and TP loads, respectively. Over the 1990 to 2013 period the TN load due to atmospheric deposition declined and the relative contribution of atmospheric deposition to the TN loads decreased from approximately 30% to less than 20% (Figure 2-15). In contrast, the relative contribution of direct runoff was more consistent accounting for approximately 50% of the total TN loads. Septic tank load contributions were consistently less than 10%of the total TN load throughout the study period. Point source loads typically accounted for less than 3% of the annual TN load.

Direct runoff loads were the predominant source of TP loads over the 1990 to 2013 period (Figure 16), providing 0% of the load. The relative contributions of septic tank loads to the total TP loads ranged between 7 and 17% of the total TP load. TP loads due to atmospheric deposition were approximately 10% or less throughout the study period. Point sources accounted for 1% of the TP load.

Figure 2-13 Lake Daisy Monthly TN Loadings



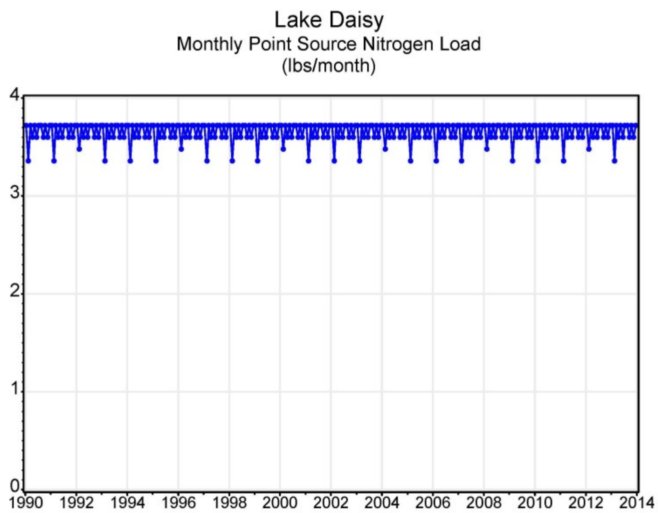
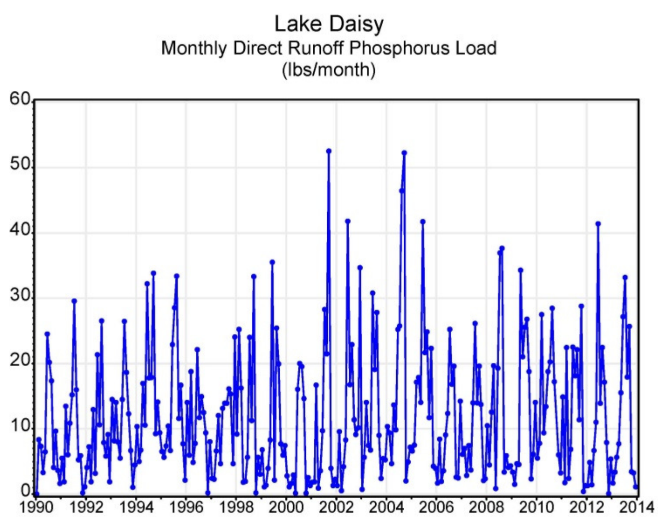
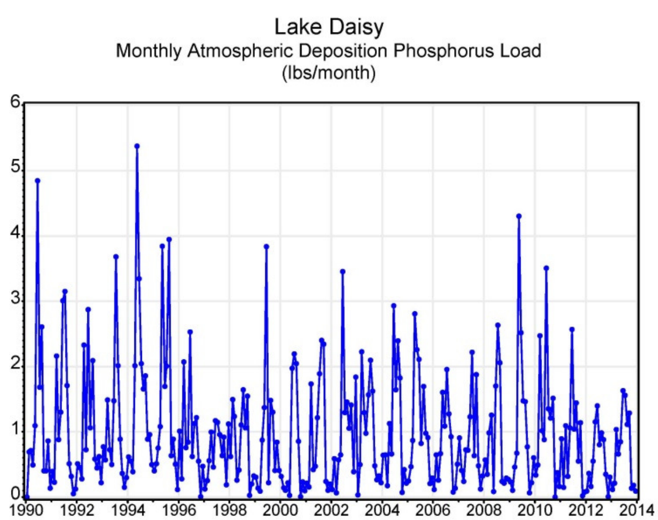
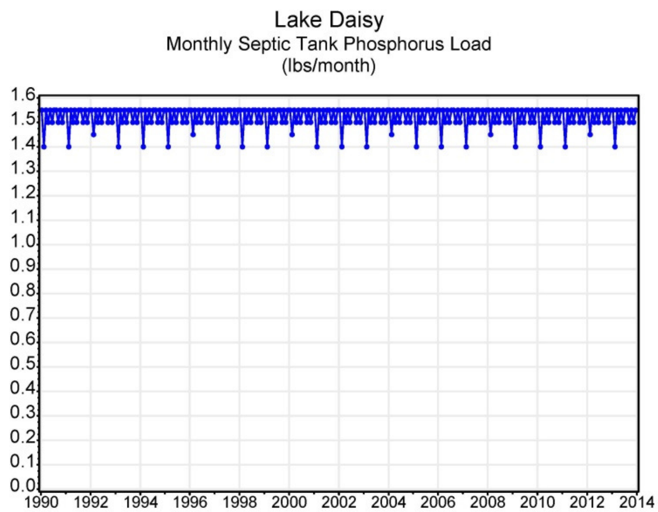


Figure 2-14 Lake Daisy Monthly TP Loadings







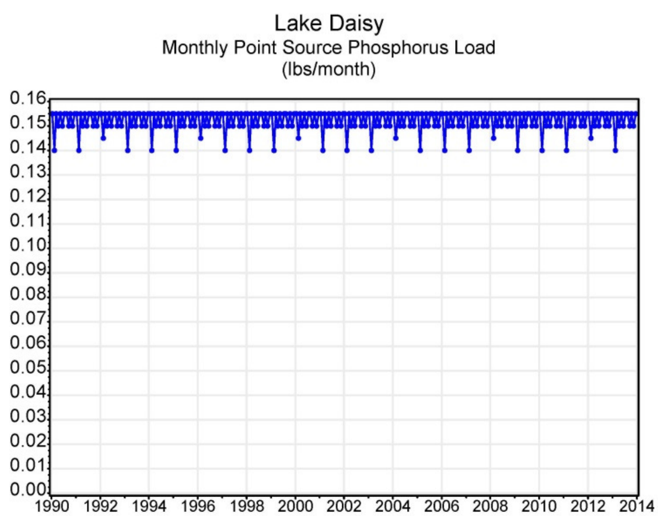


Figure 2-15 Lake Daisy Total Annual TN Loadings by Source

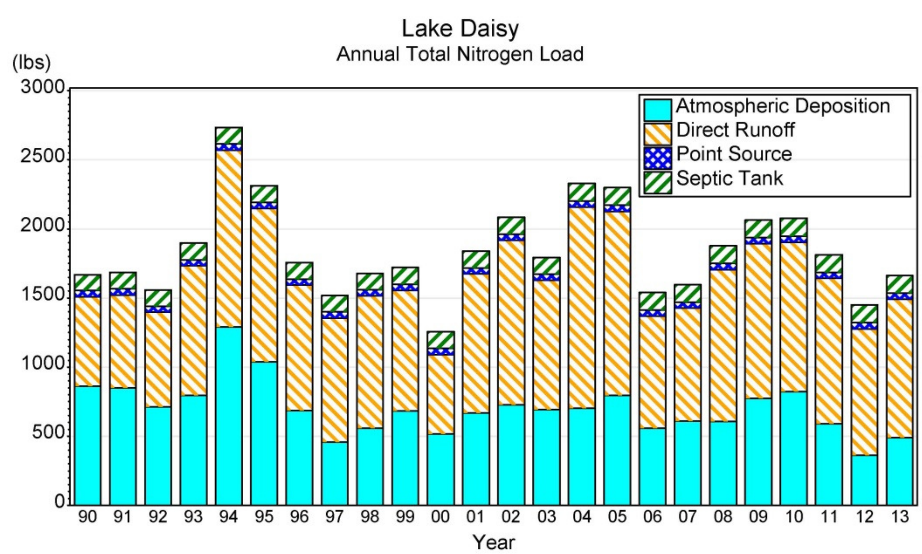
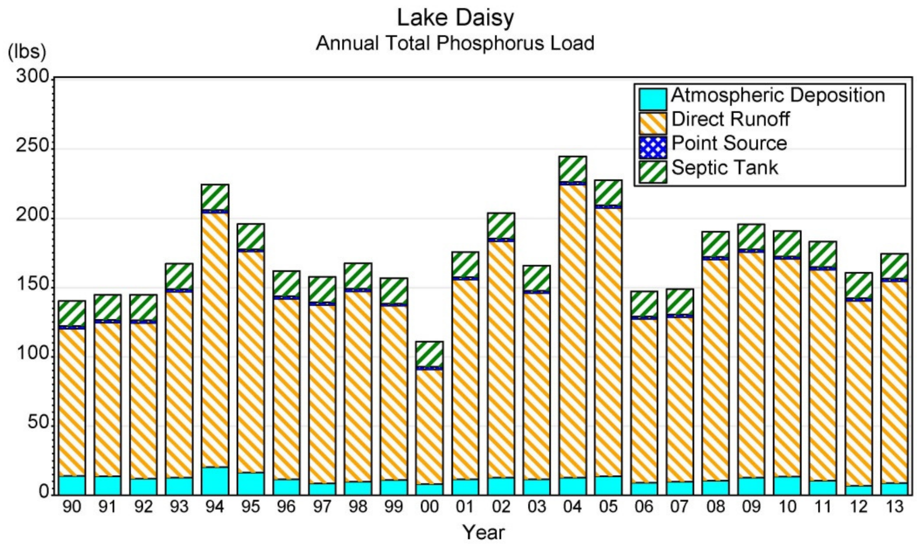


Figure 2-16 Lake Daisy Total Annual TP Loadings by Source



Figures 2-17 and 2-18 present the intra-annual variation in the relative contributions of the three nutrient sources to total TN and TP loads, respectively. The septic tank TN and TP loads were similar throughout the 12 calendar months. The relative contribution of the septic tank loads did not vary throughout the year. The TN and TP loads from both atmospheric deposition and direct runoff, as expected, were greater from June through September both in terms of absolute and relative contributions to the total nutrient loads.

Figure 2-17 Lake Daisy Monthly TN Loadings by Source

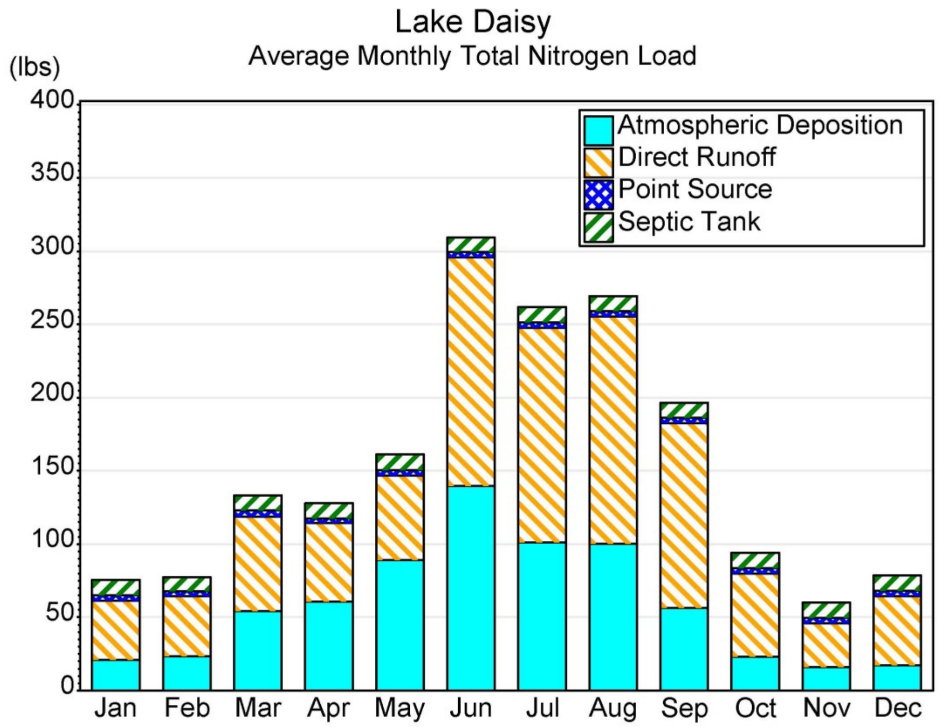
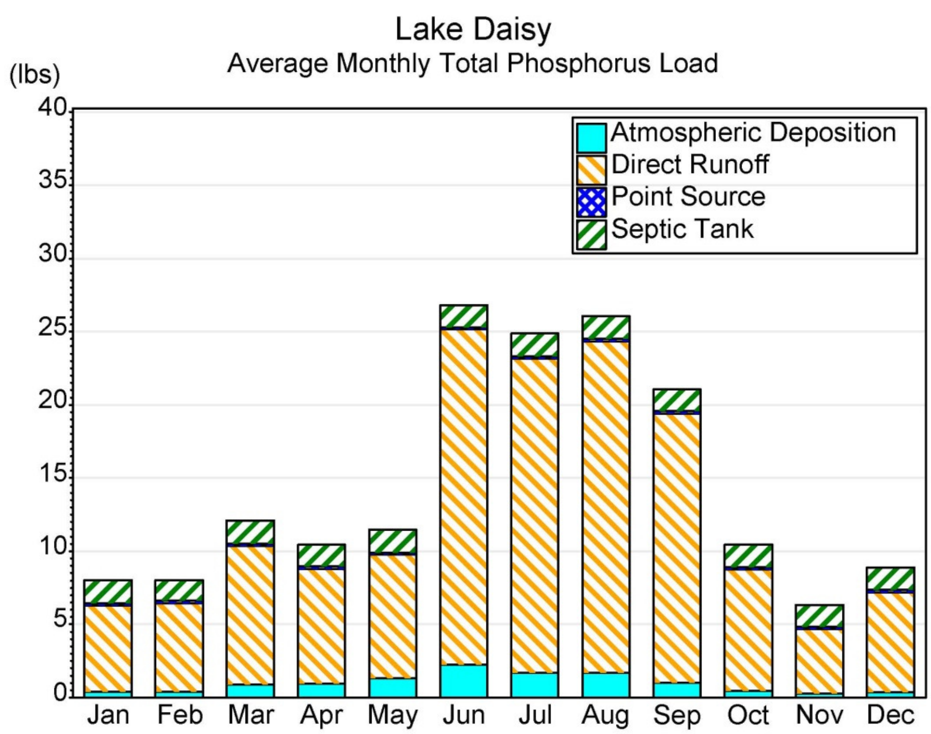


Figure 2-18 Lake Daisy Monthly TP Loadings by Source



2.3 VEGETATION COMMUNITIES (HABITAT)

Lake Daisy is located in an urbanized watershed with minimal acreage of natural or undisturbed habitats remaining. A trend analysis of natural habitats within the Lake Daisy drainage area was completed using historical imagery as the baseline for determining habitats present. Historical images from 1941, 1971, and 2014 were obtained via publicly available online resources and habitats were digitized over the aerial imagery. The habitats present for each year are summarized in Table 2-8 and depicted on Figures 2-19, 2-20, and 2-21.

Table 2-8 Historic Habitat Types

Habitat Type	Acreages/Percentage By Year					
	1941		1971		2014	
Citrus	119	33%	111	31%	0	0%
Forested	6	2%	0	0%	4	1%
Institutional	0	0%	0	0%	15	4%
Open/Disturbed Land	75	21%	73	21%	0	0%
Open Water	137	38%	132	37%	136	38%
Residential	0	0%	26	7%	199	56%
Wetland Fringe	19	5%	14	4%	2	1%

Figure 2-19 Habitat Map (1941)

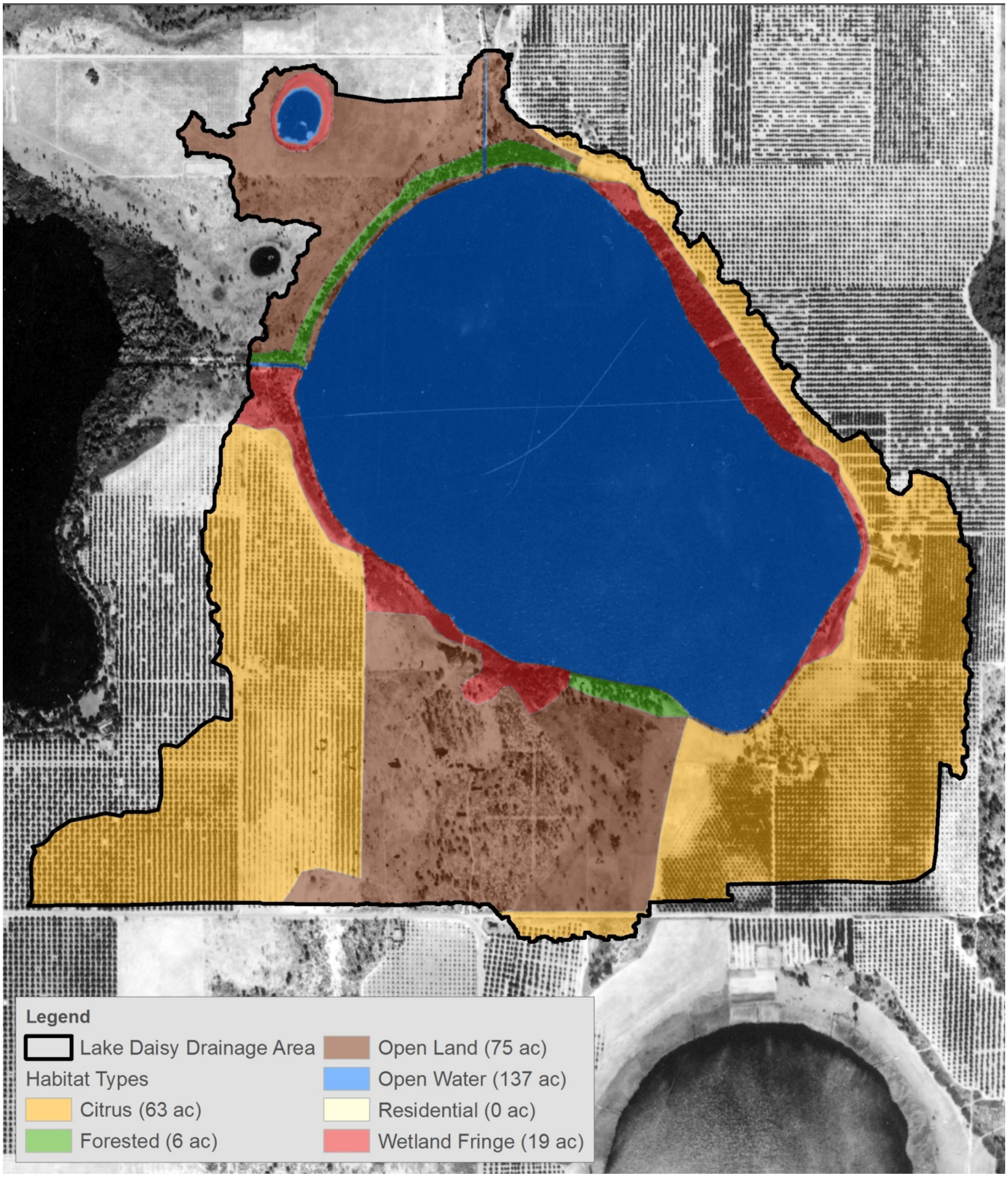


Figure 2-20 Habitat Map (1971)

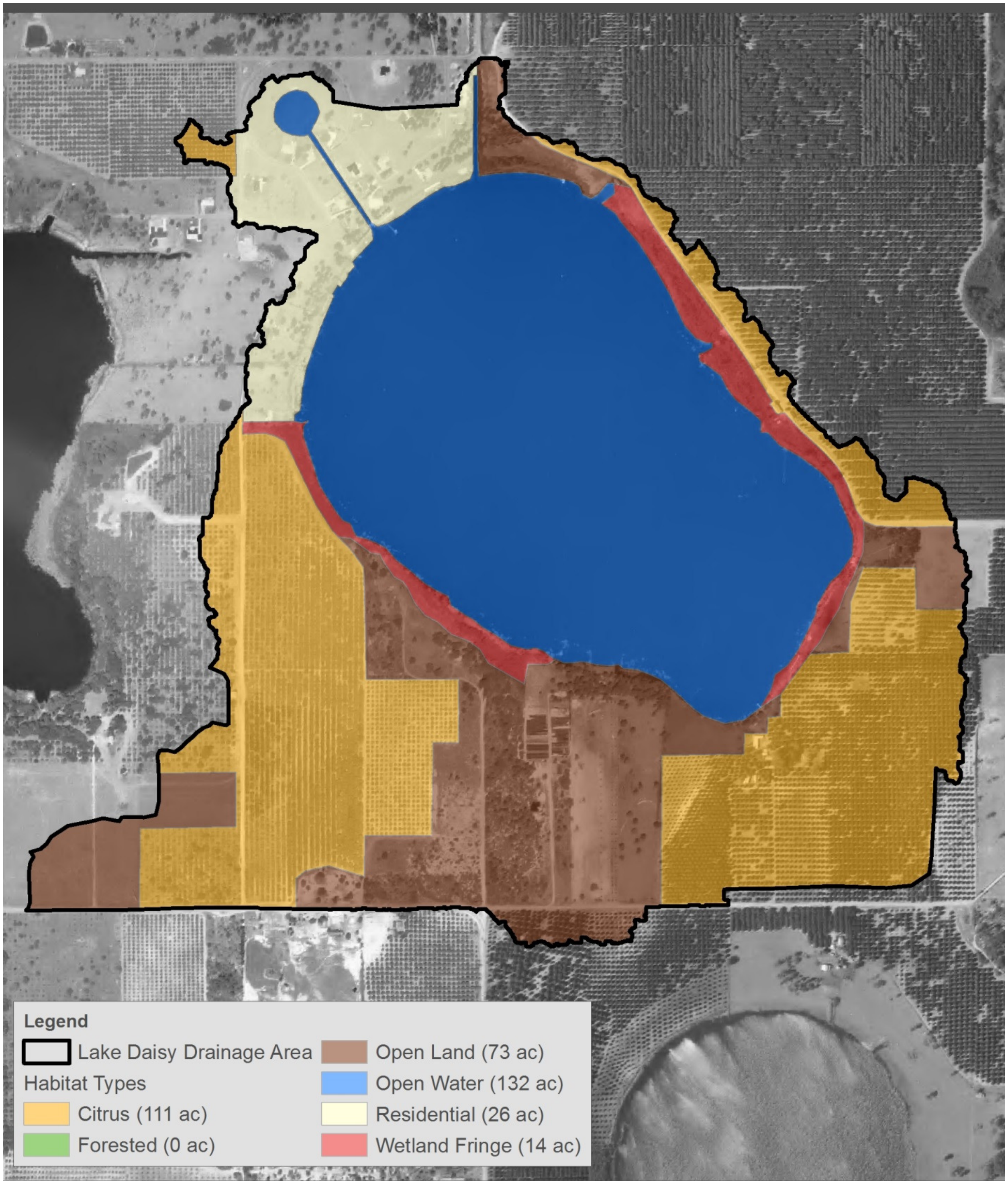
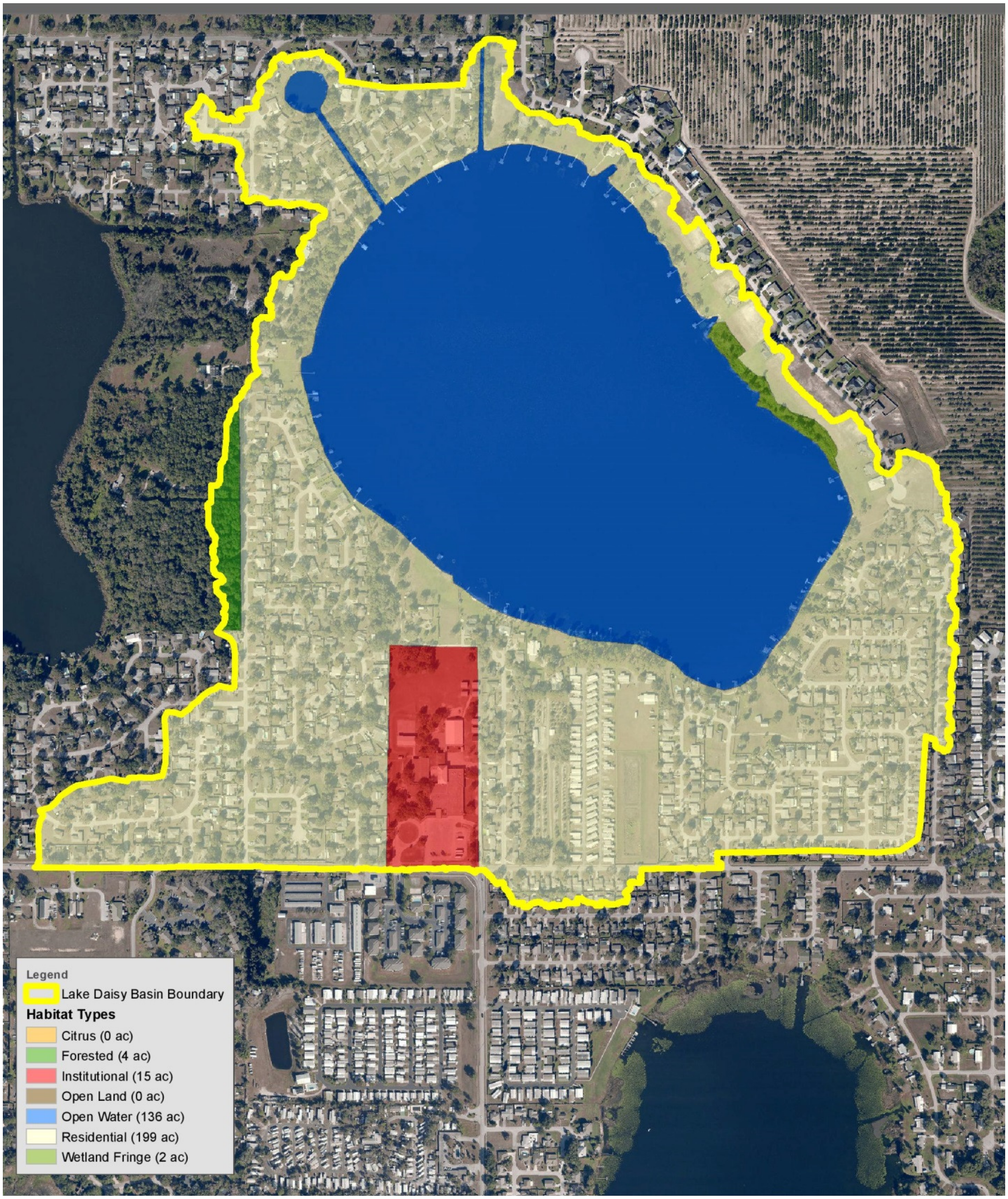


Figure 2-21 Habitat Map (2014)



2.3.1 NATURAL HABITATS

Forested, open water, and wetland fringe habitats are considered natural habitats based on the conditions around Lake Daisy. The forested habitats are only 1 to 2% of the entire drainage area of Lake Daisy. The forested habitat that is currently present and that was present in 1941 has remained isolated with no natural connections to offsite forested habitats. This provides little useful habitat for wildlife species that require such habitat. Based on current conditions and similar habitat in this area, the forested habitats generally consist of a mixture of hardwood and coniferous species and can be classified as Hardwood Conifer Mixed (FLUCCS 4340).

The open water habitat is associated with the water surface of Lake Daisy and has remained intact since 1941. There does not appear to be any type of filling or dredging to the lake as acreages have remained consistent from 1941 to 2014. This type of habitat is classified as Lakes (FLUCCS 5200).

The wetland fringe habitat consists of areas directly adjoining Lake Daisy that are consistent with either a freshwater marsh (FLUCCS 6410). Vegetation is generally low growing shrubs or other aquatic vegetation. Small numbers of cypress or bay trees may have been found within these areas in the 1940s based on the aerial imagery. This habitat has seen a decrease from 19 acres in 1941 to 2 acres in 2014. This is the most significant loss of habitat that is associated with Lake Daisy and does represent a potential concern for its water quality as the fringe wetlands act as the final filtering mechanism for runoff entering the lake and also help to stabilize the shoreline around the lake.

2.3.2 DISTURBED HABITATS

Nearly 90% of the land habitats around Lake Daisy were disturbed or used for citrus production in 1941. In 1971, the transition from agricultural habitats to residential began with over 97% of the land habitats around Lake Daisy being used for residential purposes by 2014.

While no field activities were completed by Jones Edmunds for this portion of the assessment, field notes from the Polk County Invasive Plant Management Program were reviewed and are as follows:

> "Lake Daisy has clear water that is tannic in appearance with a Secchi disc reading of 2.1 meters. The emergent plant community consists of primrose willow (Ludwigia octavalvis/peruviana), duck potato (Sagittaria lancifolia), cattail (typha spp.), pickerel weed (Pontederia cordata), bulrush (Schoenoplectus californicus/validus), burhead sedge (Oxycaryum cubense), spadderdock lily (Nuphar advena), fragrant lily (Nymphaea odorata) as well as various grass species. Lake Daisy does not currently contain any submersed vegetation." These observations are consistent with the wetland fringe and open water habitats described above.

3 IDENTIFICATION AND ASSESSMENT OF FACTORS INFLUENCING WATER QUALITY

3.1 INTRODUCTION

This report is part of the overall Lake Daisy WQMP being developed for the Polk County Parks and Natural Resources Division. The previous tasks included Task 0200 – Develop Data Sets and Task 0300 – Assess Historical and Current Conditions. The results from Task 0300 included an assessment of historical and current water quality and hydrologic conditions and estimation of hydrologic and TN and TP loadings from four sources – atmospheric deposition (the direct loading to the lake surface), non-point sources, point sources, and on-site disposal systems (septic tanks). Building on the data and reviews in Tasks 0200 and 0300, this task includes evaluating potential stressor-response relationships. Atkins and ESA (2014) previously reported correlations between chlorophyll *a* concentrations and TN and TP concentrations in Lake Daisy. These results are reviewed in this section.

3.2 APPROACH

There is a long history of research that examined the relationships between algal biomass or productivity and nutrient conditions in a water body. Perhaps the most notable examined the relationships between nutrient loading and chlorophyll *a* concentrations – in lakes (Vollenweider, 1968) and estuaries (Boynton et al., 1982). In the simplest of terms, this research found that organic carbon production is driven by the rate of the limiting nutrient supply. Dillon and Rigler (1974) and Kerekes (1982) identified the importance of lake residence time on the phosphorus-chlorophyll relationships in lakes.

For this task, we examined the relationship between chlorophyll *a* and nutrient conditions (loads and ambient concentrations). The available chlorophyll *a* data include uncorrected and corrected (i.e., corrected for phaeophytin) values. FDEP uses the corrected values in their assessment of potential impairment. In this case, corrected values have been reported in only 64 samples. In contrast, uncorrected values are reported for 190 samples. Combining corrected and uncorrected values is inappropriate because they are inherently different methods. Therefore, we have used the uncorrected chlorophyll *a* values for our analyses.

Given the potential importance of lake residence time, we also examined the relationship between chlorophyll *a* and hydrologic loadings. We used the SAS code for PROC REG for these analyses. We computed the residuals from the statistically significant regressions to allow us to examine the potential relationships with other factors not specifically included in the model.

3.3 PREVIOUS STUDIES

Atkins and ESA (2014) reported the results of the analysis of empirically derived nutrient targets for water quality. The correlations included ambient TN and TP concentrations. They did not define the specific data used in the analyses. Also, simple plots of the variables they examined would point to the specific nature of the relationship (i.e., negative or positive). Their analyses were reported as correlations and included coefficients of determination (R^2). For Lake Daisy, neither TN nor TP displayed a significant relationship with chlorophyll *a*.

3.4 RESULTS

The regression analyses we conducted in this task included two time scales: monthly and annual. The monthly scale analyses also included a series of lag effects that examined whether the responses in chlorophyll *a* were related to the cumulative loads over 1 to 6 months. The monthly scale analyses did not identify any significant relationships.

For the annual scale analyses, the annual geometric mean chlorophyll *a* concentrations were regressed on:

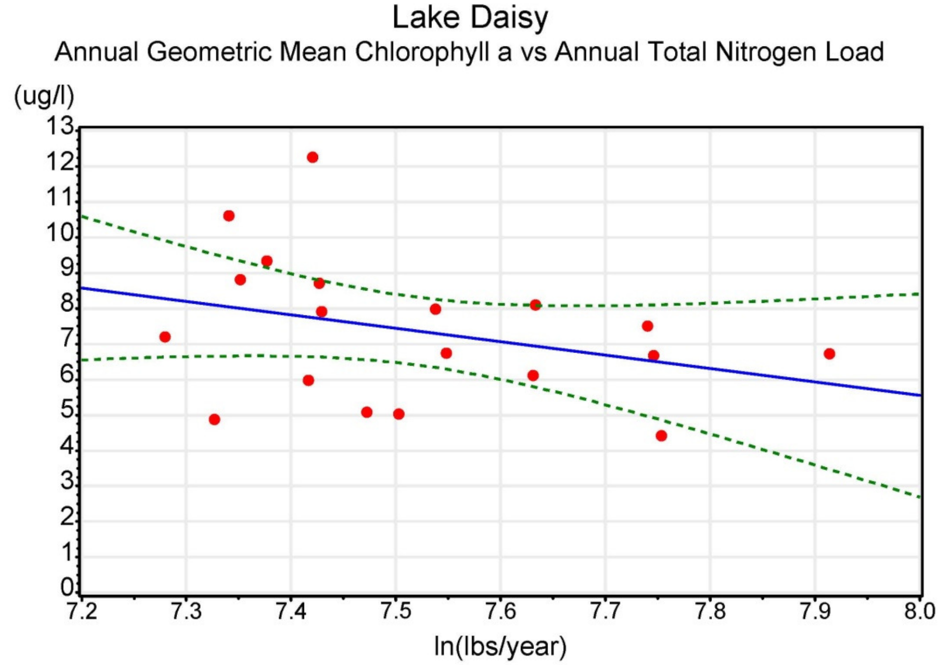
- Annual geometric mean TN concentrations.
- Total annual TN loadings.
- Annual geometric mean TP concentrations.
- Total annual TP loadings.
- Total annual hydrologic loads.

Appendix F presents the complete analyses.

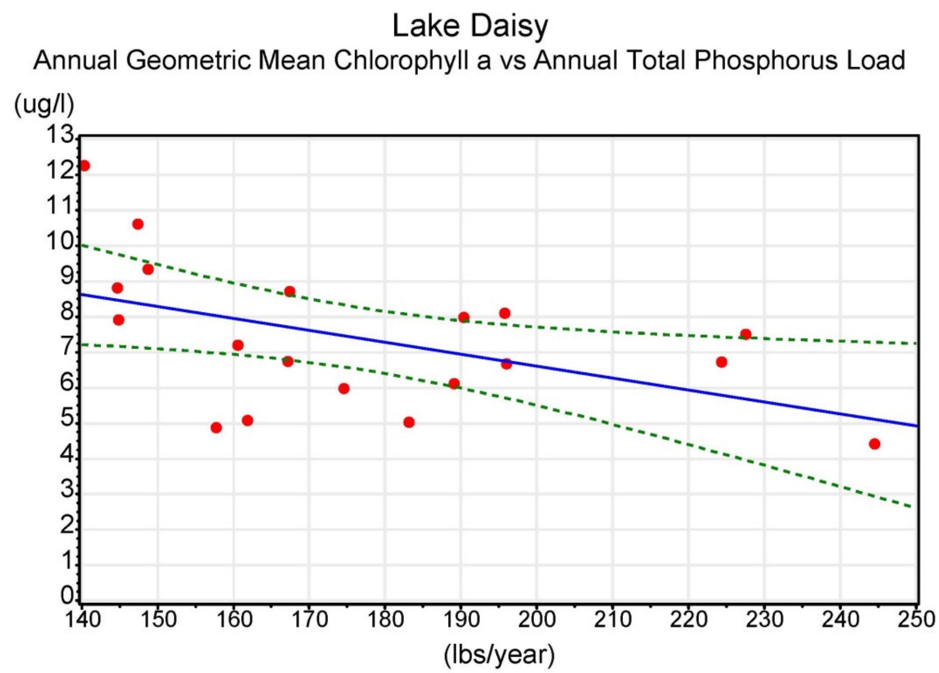
Figure 3-1 presents the relationships between the annual geometric mean chlorophyll *a* concentrations and the total annual TN and TP loadings. Two observations emerge from these plots: (1) no significant relationship exists for either TN or TP loadings, and (2) the relationships are negative, implying the reducing nutrient loadings will lead to increased chlorophyll *a* concentrations. This finding is not reasonable and further analysis is warranted.

As discussed above, lake residence time can be a major determinant of algal production. Since TN and TP loadings are highly correlated and each is highly correlated to the hydrologic loadings, perhaps these negative relationships can be explained by the interannual hydrologic loading variations. Simple logic applies – lower chlorophyll *a* concentrations should result during years with short residence times that result from higher hydrologic loadings. Therefore, the relationship between the annual geometric mean chlorophyll *a* concentrations and annual hydrologic loadings should be negative. Figure 3-2 presents the relationship between the annual geometric mean chlorophyll *a* concentrations and annual hydrologic loadings for Lake Daisy and displays a clear, significant relationship. The R^2 is 0.19 and the slope is significant at $p < 0.05$.

Figure 3-1 Relationship Between Annual Geometric Mean Chlorophyll a Concentrations and Total Annual TN (Top) and TP (Bottom) Loadings

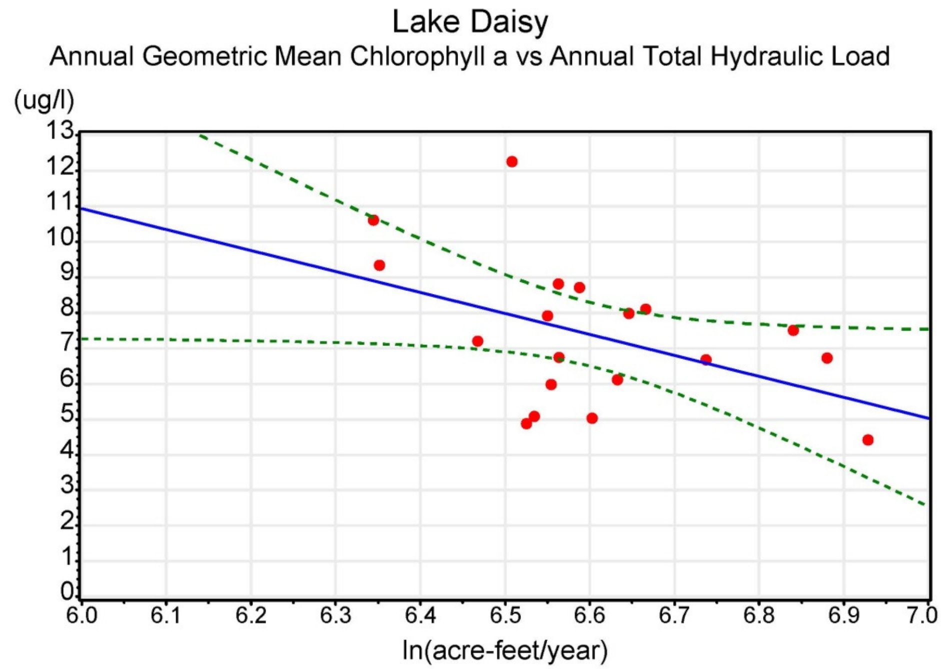


Regression Equation:
geochla = 35.75375 - 3.775124*logtnld



Regression Equation:
geochla = 13.31251 - 0.033533*ann_tpload

Figure 3-2 Relationship Between Annual Geometric Mean Chlorophyll a Concentrations and Total Annual Hydrologic Loading

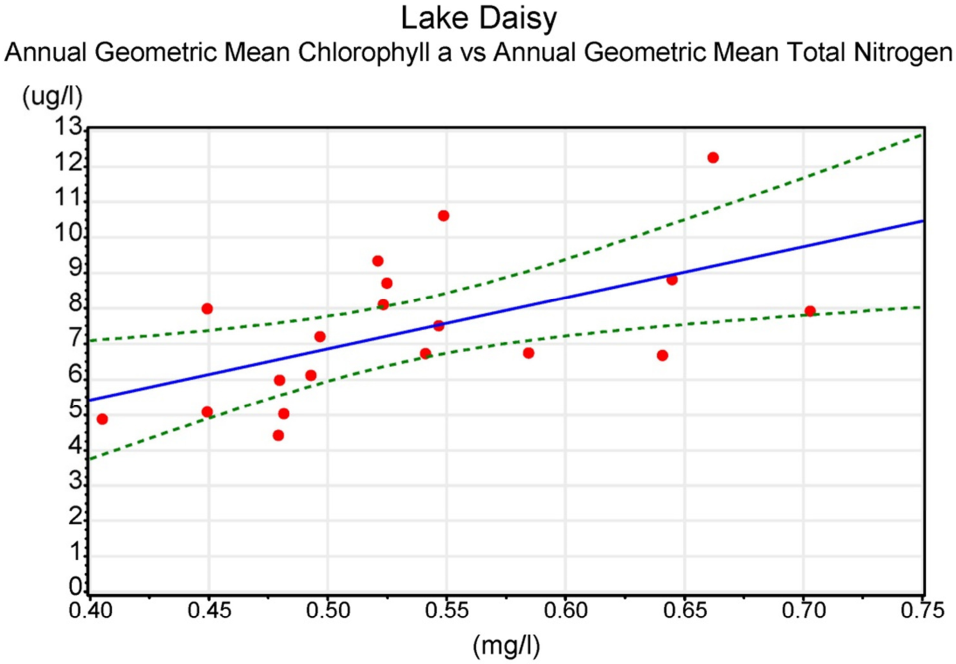


Regression Equation:
geochla = 46.38336 - 5.90687*ln_t_hyrdr

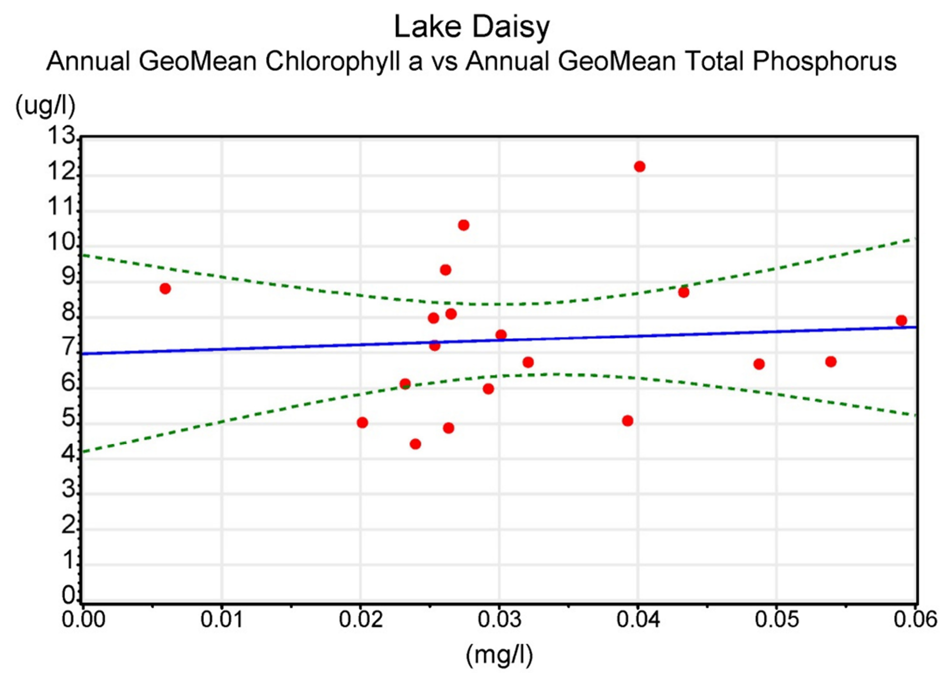
Figure 3-3 presents the relationships between the annual geometric mean chlorophyll *a* concentrations and the annual geometric TN and TP ambient concentrations. The relationship with the annual geometric mean TN concentrations is highly significant ($p < 0.01$ and an $R^2 = 0.32$). The inference then is that the variation in the annual geometric mean chlorophyll *a* concentrations is related to the variation in the annual geometric mean TN concentrations. The relationship between the annual geometric mean chlorophyll *a* concentrations and the annual geometric TP ambient concentrations is not significant.

Effective nutrient management as it relates to lake water quality is typically more efficient and transparent if the management thresholds or targets are expressed as loadings. Figure 3-4 shows the final analyses that we conducted involving the relationship between loadings and ambient concentrations of TN and TP. Neither relationship was significant. This observation could have resulted from the amount and nature of the available data. However, such findings are not totally unexpected. The ambient TN and TP concentrations in a lake can be attributed to external and/or internal sources. In-lake processes can be extremely important determinants of ambient concentrations. Given the physical nature of Lake Daisy, this inference is highly probable. However, this does not negate the need for managing nutrient loading.

Figure 3-3 Relationship Between Annual Geometric Mean Chlorophyll *a* Concentrations and Annual Geometric Mean TN (Top) and Annual Geometric Mean TP (Bottom) Concentrations

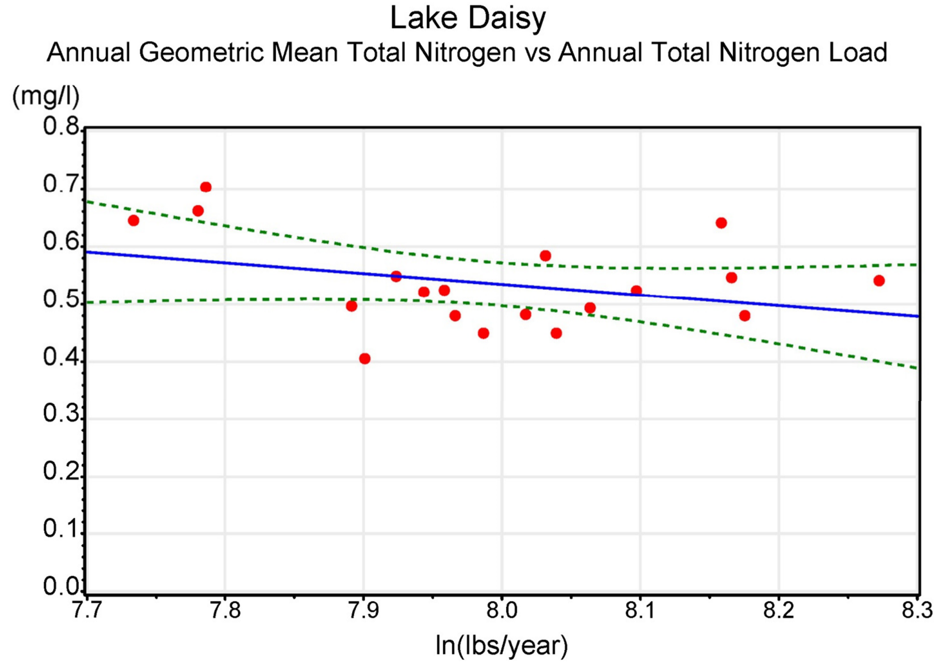


Regression Equation:
geochla = -0.347476 + 14.41479*geotn

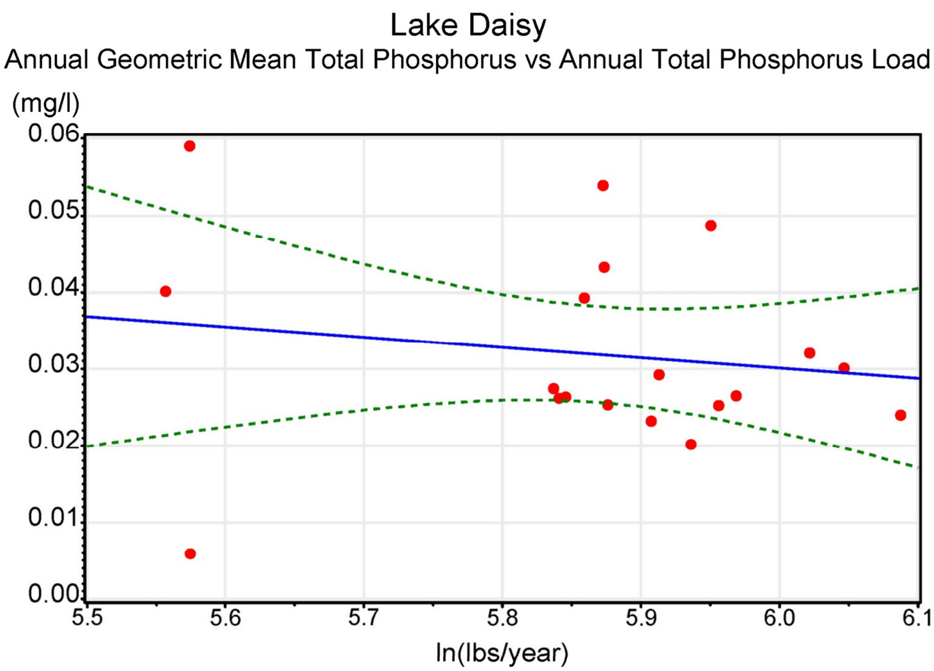


Regression Equation:
geochla = 6.969656 + 12.59711*geotp

Figure 3-4 Relationship Between Annual Geometric Mean TN Concentrations and Total Annual TN Loadings (Top) and Annual Geometric Mean TP Concentrations and Total Annual TP Loadings (Bottom)



Regression Equation:
geotn = 2.013619 - 0.184902*logtnld



Regression Equation:
geotp = 0.11062 - 0.013415*logtpld

3.5 CONCLUSIONS

Atkins and ESA (2014) defined the target chlorophyll *a* concentration for Lake Daisy as 6 micrograms per liter (µg/L). Two significant relationships with the annual geometric mean chlorophyll *a* concentration are (1) with total annual hydrologic loading, and (2) with the annual geometric mean TN concentrations. Inserting the 6-µg/L target chlorophyll *a* into the two regression equations gives the following results:

- Total annual hydrologic loading = 931 acre-feet (ac-ft).
- Annual geometric mean TN concentration = 0.44 mg/L.

This total annual hydrologic loading is relatively high. Managing the hydrologic loading by managing freshwater inflows will assist the efforts to maintain water quality in Lake Daisy.

Similarly, the potential TN target of 0.44 mg/L is relatively low in terms of historical conditions and the NNC level of 0.51. This provides a benchmark against which future monitoring results can be compared. It should be noted that the NNC was set for corrected chlorophyll *a* and that this analysis utilized uncorrected chlorophyll *a* since it made up the majority of the data (190 uncorrected versus 64 corrected).

Based on conversations with FDEP staff (Kevin O'Donnell, personal communication), Lake Daisy is not impaired based on the NNC and the data reported in Run 49 in the FDEP IWR database. Therefore, we could argue that the 6-µg/L chlorophyll *a* target is overly conservative and an alternative threshold level is appropriate. The median annual geometric mean is 7.2 µg/L. If this can be considered a reasonable threshold for the management of Lake Daisy, inserting the chlorophyll *a* threshold of 7.2 µg/L into the two regression equations gives the following results:

- Total annual hydrologic loading = 760 ac-ft.
- Annual geometric mean TN concentration = 0.52 mg/L.

This TN concentration is extremely close to the NNC of 0.51 mg/L.

4 POTENTIAL MANAGEMENT ACTIONS

Jones Edmunds and Janicki Environmental identified a variety of BMPs aimed at improving water quality conditions in Lake Daisy. These BMPs, described in the following subsections, include neighborhood stormwater treatment retrofits, aquatic vegetation, monitoring, and groundwater quality improvements. This BMP analysis focuses on effective and practical management actions tailored to site conditions in the Lake Daisy Watershed. Some of the management actions described below will move forward to the recommendations phase where more specific effectiveness and cost information will be developed. Additionally, a variety of programmatic BMPs are potentially applicable to the Lake Daisy Watershed – some of these programs are already employed by Polk County.

4.1 NEIGHBORHOOD STORMWATER TREATMENT RETROFITS

In identifying potential stormwater treatment retrofits, Jones Edmunds focused on areas that are not currently receiving treatment (see Figure C-2) including the neighborhood surrounding Lake Doll and the neighborhoods that comprise the southwest portion of the watershed.

4.1.1 Lake Doll Neighborhood Stormwater Retrofit

The neighborhood around Lake Doll is served by a 22-foot wide (typical) road with asphalt curb. This BMP includes grading depressional areas within the 50-foot right-of-way as well as providing curb cuts to allow road runoff to percolate into the surrounding, sandy soils. This BMP may also alleviate standing water, which appears to be a prevalent problem - evidence of standing water degrading the road is evident at multiple locations in this neighborhood (Figure 4-1).

Figure 4-1 Lake Doll Neighborhood Roadway Drainage

4.1.2 Southwest Neighborhoods Stormwater Retrofits

These untreated neighborhoods in the southwest portion of the watershed, north of Cypress Gardens Road and east of Garden Grove Elementary School, have roadway sections similar to the typical roadway section in the Lake Doll neighborhood; although, the asphalt curb is not as pervasive. Curb-cuts and grading are potentially a suitable BMP option in these neighborhoods, particularly in areas where evidence of standing water is present. Allowing road runoff to percolate in the right-of-way can reduce loading to the lake and reduce road maintenance requirements.

These neighborhoods also contain storm structures where grading can be accomplished to encourage percolation, such as the location shown in Figure 4-2 along Heron Circle. All grading would be performed above seasonal high water elevation, creating a depression that would allow time to percolate runoff. Excessive flows would discharge as they do now through the grate of the ditch-bottom inlet. Since the control elevation (grate top) would not be altered, this BMP could be constructed without impacts to local flood stage.

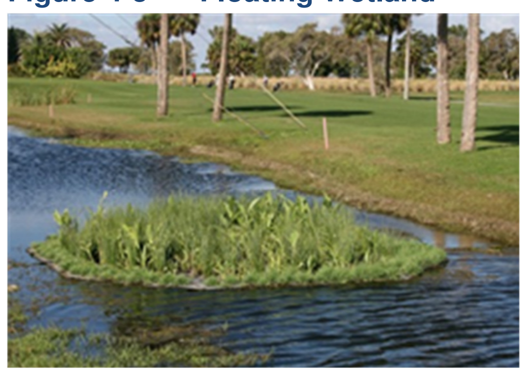
Figure 4-2 Roadway Drainage Along Heron Court

4.2 AQUATIC VEGETATION

BMPs that enhance and protect submerged and emergent aquatic vegetation in Lake Daisy should be encouraged. Countywide efforts to encourage lakefront home owners to plant native, aquatic vegetation would be well spent in the Lake Daisy Watershed; however, this BMP focuses on specific opportunities that are available in the Lake Daisy Watershed on County-owned land. These opportunities include providing wetland plantings in:

1. The finger canal at the north end of the lake just east of Lake Doll and south of Lake Daisy Road.
2. Lake Doll littoral areas.
3. The channel connecting Lake Daisy and Lake Doll.
4. On floating wetlands, such as Beemats (Figure 4-3).

Figure 4-3 Floating Wetland



Planning for this BMP would include a public meeting to aid in community acceptance and to ensure planting designs include consideration for current recreational usage, including navigation.

4.3 MONITORING

Monitoring recommendations include sediment flux monitoring to develop information concerning internal loads and surficial aquifer monitoring to evaluate shallow groundwater quality in the vicinity of Old South Shores. These monitoring BMPs are described in the follow subsections.

4.3.1 Lake Sediment Flux Monitoring

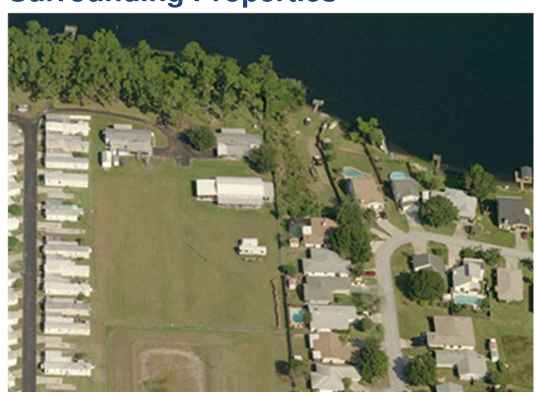
The loading and water quality analyses completed indicate that internal loading of nutrients is likely a critical component of the total loading to the lake water column. A sediment monitoring effort to provide estimates of nutrient fluxes will provide estimates of this loading component. The objective of the sediment monitoring effort is to characterize the nature of the lake sediments and obtain estimates of nutrient fluxes across the sediment/water interface. Sampling sites will be based primarily on bathymetry, with consideration of any additional information available concerning external sources and/or nature of the sediments. No fewer than three sites will be selected for data collection.

Depending upon logistics and budgeting, it may be best to do both in situ and laboratory analyses for estimation of nutrient fluxes, providing two distinct estimation methods. Laboratory measurements entail collection of sediments from the selected sites, typically accomplished using a pole corer, then the core samples are transported to the laboratory where they are placed in an incubator, with samples collected from the incubator at appropriate intervals for gas analysis. In situ measurements employ placing chambers on the lake bottom, with samples siphoned from the chambers at set intervals for analysis. Both the laboratory and in situ measurements provide nutrient flux and sediment oxygen demand estimates which will aid in estimation of the internal loadings to the lake.

4.3.2 Groundwater Monitoring

This BMP involves installing and monitoring two shallow monitoring wells to evaluate impacts to groundwater potentially originating from the Old Grove Shores facility. One well would be installed up-gradient of the facility in the Struthers Road right-of-way, and the second well would be installed down-gradient of the facility. The Lake Daisy Estates Home Owners' Association owns the long, slender parcel adjacent to the Old Grove Shores site down-gradient of the Old Grove Shores Facility (Figure 4-4).

Figure 4-4 Old Grove Shores and Surrounding Properties



4.4 Remediate Percolation Pond Effluent

If the groundwater monitoring program described above indicates elevated nitrate concentrations, then efforts to improve groundwater quality should be undertaken. One possibility would be to connect the Grove Shores sanitary collection system (or effluent) to the sanitary collection system located along Struthers Road. This sanitary system is owned by Winter Haven Utilities. If Winter Haven Utilities agrees to accept this discharge, having the collection infrastructure already in place could make this BMP a good value. Additionally, the pumping system that currently pumps the effluent to the disposal ponds could potentially be used to send the discharge to the sanitary system along Struthers Road.

If Winter Haven Utilities is unable to accept the discharge then an alternate BMP at this location is the construct a denitrification wall down gradient of the percolation ponds. Cooperation with the owner, Grove Shores, will be required. This BMP could work in combination with a yard waste recycling program to provide media.

4.5 PROGRAMMATIC BMPS

In addition to projects, programs centered on sustainability and conservation were identified. Some of these programs have direct nutrient-reduction impacts, whereas others have less quantifiable impacts but are still important to improving environmental quality. Table 4-1 lists many of the potential programs and note which are currently implemented by Polk County.

Table 4-1 Programmatic BMPs

Program Name	Existing County Program
Rainwater Harvesting/Cisterns	No
Fertilizer Ordinance	Yes1
Watercourse Setback	Yes
Septic Tank Pump-Out Regulation	No
Public Outreach and Education	Yes2
Street Sweeping	Yes3
Septic Replacement Program	No
Low-Impact Development (LID)	No
Exotic Plants Management Program	Yes

[1]Polk County Ordinance No. 13-005

[2]Neighborhood Environmental Stewardship Teams Program (NEST)

[3]Not active in Lake Daisy Watershed

5 RECOMMENDATIONS

After formulating potential management actions (Section 4), Jones Edmunds and Janicki Environmental further investigated the possible actions and recommends that the County further pursue the management actions described in this section.

Each project recommendation is listed in Table 5-1, shown in Figures 5-1 and 5-2, and described in the following subsections.

Table 5-1 Proposed BMPs

Proposed BMP No.	Location Name	Project Type
1-9, 11, and 15	Untreated Neighborhoods	Percolation Area
10	Boat Ramp	Pervious Pavement
12	Lake Doll and Lake Doll Canal	Littoral Zone Planting
13	Lake Daisy Estates HOA Lot	Groundwater Monitoring
14	Lake Daisy	Sediment Monitoring

Programmatic recommendations are provided in Section 5.6.

5.1 NEIGHBORHOOD STORMWATER TREATMENT RETROFITS

Areas within the Lake Daisy Watershed that are not receiving treatment include the neighborhood surrounding Lake Doll and the neighborhoods that comprise the southwest portion of the watershed. A field visit was conducted on June 6, 2015, to further investigate and refine the idea for neighborhood stormwater retrofits. These retrofits mainly consist of new percolation areas along neighborhood streets that would be designed to receive stormwater runoff though “curb cuts.” In two instances (BMP No. 1 and BMP No. 2), the proposed modifications also involve altering the stormwater conveyance system. The proposed improvements are described below – first for the typical percolation area and then individually for the BMPs involving conveyance system modifications. Table 5-2 shows the location name and project type for each proposed BMP.

Table 5-2 Percolation Areas and Locations

Proposed BMP No.	Location Name	Project Type
1	Bird Lane	Percolation Area with Control Structure
2	Heron Place	Percolation Area with Control Structure
3	Mockingbird Circle	Percolation Area
4	Mockingbird Court	Percolation Area
5	Audubon Court	Percolation Area
6	Audubon Road 2nd	Percolation Area
7	Coleman Drive	Percolation Area
8	Shore Drive SE	Percolation Area
9	Audubon Road	Percolation Area
11	Heron Circle E	Re-grading Around DBI
15	Bird Lane	Percolation Area

Figure 5-1 Proposed BMP Locations – North

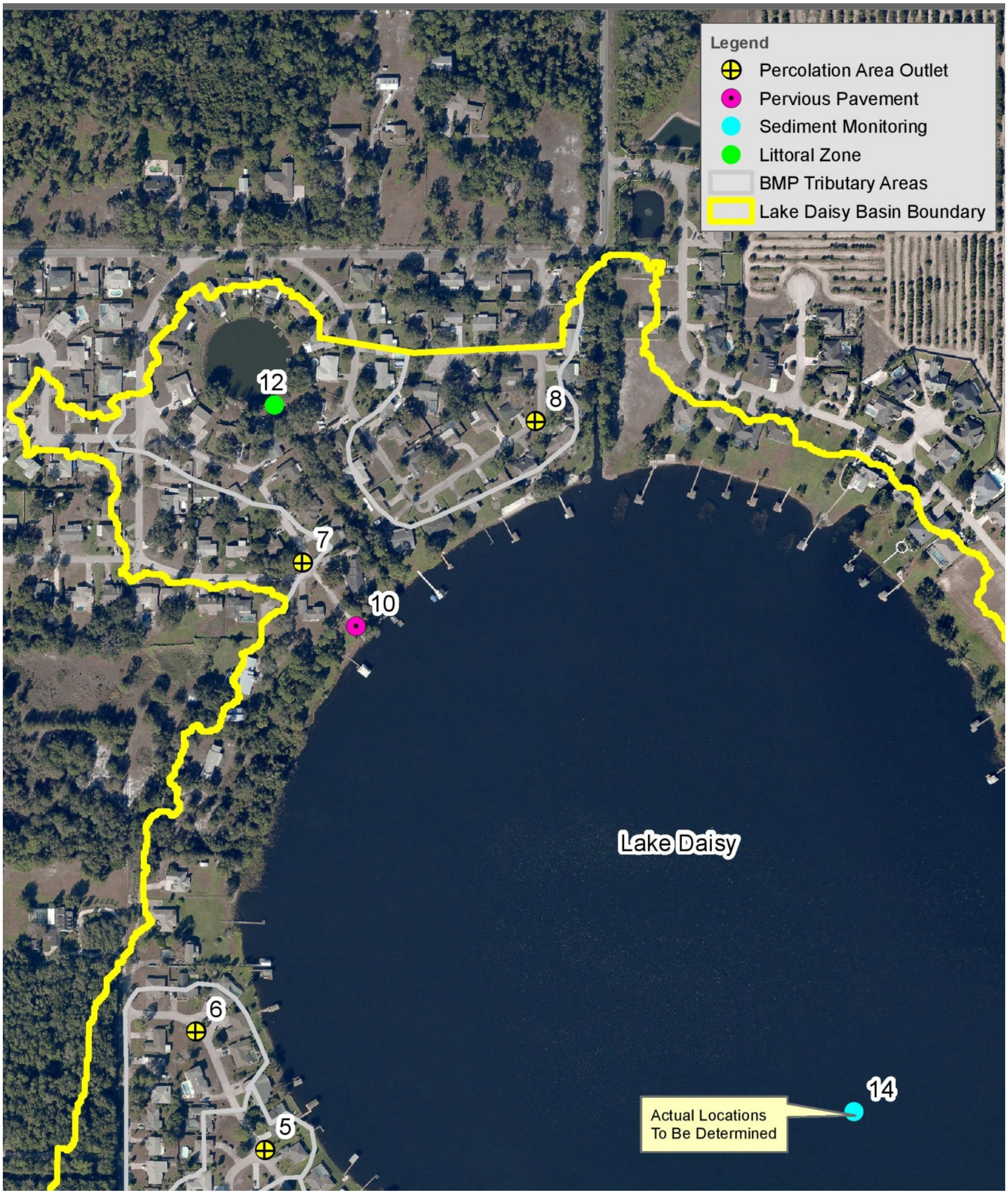


Figure 5-2 Proposed BMP Locations – South

During the site visit, inlets were identified, shown on Figure 5-1 as "Percolation Area Outlets." Table 5-2 lists the Percolation Areas and locations. As noted in the Section 4, the typical right-of-way width is 50 feet and the typical roadway section is 22 feet wide, leaving adequate space for the percolation area. One suitable location along Mockingbird Circle is pictured in Figure 5-3 with the edge of the 50-foot right-of-way staked. The typical percolation area would be approximately 12 feet wide, sloping very gently to a depth of 9 inches to 1 foot. The percolation area would not need to be present along the entire road length. The design would consider other improvements made by the residents and would avoid disturbing landscaping, substantial mailboxes, and other obstacles. In areas where the percolation areas are installed, the County may wish to consider replacing the existing asphalt curb with a concrete ribbon (no curb) or to forgo the curb altogether unless doing so would interfere with drainage or hinder transitioning the existing asphalt curb with the improvements. The edge of pavement treatment will likely vary under different circumstances. The untreated neighborhoods contain about 11,500 feet of road; therefore, assuming the percolation areas are implemented in about a third of the area, the probable cost would be approximately $30,000 – 40,000.

Figure 5-3 Mockingbird Circle (suitable percolation area)

Two of the percolation areas also involve modifying the conveyance system. Drainage from Bird Lane enters a depressional area at the end of the street. This depressional area outfalls through a corrugated metal pipe (CMP) to Lake Daisy. In its current, unmaintained condition, the system likely provides a great deal of percolation. The inlet and outlet pipes are crushed and most runoff from this area, lacking an outfall, likely percolates into the ground. If this area were restored to the design condition, much of the treatment function would be lost; however, as part of a redesign the outlet could be provided with a control structure and provide permanent (not maintenance-dependent) treatment. Another depressional area is located at Heron Place (BMP No. 2). Like the outlet on Bird Street, this pipe is crushed and a pipe replacement design could also include outfitting the pipe with a control structure to provide additional treatment.

Figure 5-4 Roadway Drainage Along Heron Court

Another "non-typical" condition exists near Heron Circle (BMP No. 11, shown in Figure 5-4) where a percolation area could be designed around an existing ditch-bottom inlet. This percolation area would be constructed around the inlet. Like the typical percolation areas, the depth should be shallow. The existing grade would be maintained around the structure for safety and slope down at an approximately 6:1 slope.

Combined, these 11 BMPs will provide an estimated annual average TN removal of about 202 pounds and TP removals of about 34 pounds from the untreated residential neighborhoods in the Lake Daisy Watershed. Table 5-3 provides the estimated load removals by BMP.

Table 5-3 Estimated Load Removal by BMP

Proposed BMP ID	Area (acres)	Location	Gross Load (lb/yr)		Load Reduced (lb/year)		Net Load (lb/year)	
			TN	TP	TN	TP	TN	TP
1 and 11	7	Bird Lane	39	7	24	4	16	3
2, 3, 4, and 11	31	Heron Place, Mockingbird Circle, Mockingbird Court, Heron Circle E	166	28	100	17	66	11
5	5	Audubon Court	25	4	15	3	10	2
6	5	Audubon Road 2nd	26	4	16	3	10	2
7	4	Coleman Drive	24	4	14	2	10	2
8	5	Shore Drive SE	28	5	17	3	11	2
9	5	Audubon Road	28	5	17	3	11	2
Total	62		336	56	202	34	135	23

The removal calculations assume a treatment volume of 0.25-inch runoff, which corresponds to a treatment efficiency of 60% for TN and TP (Harper, 1995). The estimated 0.25-inch runoff volume is achievable considering that, where constructed, the percolation area is capable of providing 0.5 to 1 inch of treatment for the surrounding area. For example, the treatment capacity of a 1-foot-deep, 10-foot-wide percolation area has a treatment capacity of about 10 cubic feet per linear foot. Given a parcel with a length of 150 feet, this percolation area would provide treatment for about 0.8 inch of runoff. Considering the unit length treatment capacity and typical lot size and assuming that the percolation areas would be construed adjacent to about a third of each neighborhood’s road, 0.25 inch of runoff retention is achievable.

5.2 BOAT RAMP PERVIOUS PAVEMENT

The Polk County-owned boat ramp has a concrete apron for boat launching. This project involves replacing the upland portion of the ramp with pervious pavement. The portion of the boat ramp below or near the waterline, with a safety margin, will remain concrete to maintain stability for boat launching. The probable cost to install the estimated 1,000-square feet of pervious pavement is about $5,000.

5.3 AQUATIC VEGETATION

Figure 5-5 Lake Doll Connection

Each area mentioned in Section 4 for possible wetland plantings was visited on June 6, 2015, and planting a littoral zone around Lake Doll as well as the channel connecting Lake Doll to Lake Daisy appears to be the most readily implementable wetland planting option for the Lake Daisy Watershed (Figure 5-5). The finger canal at the north end of the lake just east of Lake Doll and south of Lake Daisy Road contains a concrete wall along much of its length on the east side and is therefore not as "littoral zone-ready" as Lake Doll. Jones Edmunds staff spoke to one of the residents and confirmed that neither Lake Doll nor the connecting channel support boat traffic. The total length of littoral zone (perimeter of lake and channel) is approximately 2,200 feet. Assuming a width of 12 feet equates to a total littoral zone area of about 0.6 acres. The approximate probable cost of this BMP is $12,000.

5.4 GROUNDWATER QUALITY SCREENING

Section 4 described a monitoring program consisting of installing and monitoring two shallow monitoring wells to evaluate impacts to groundwater potentially originating from the Old Grove Shores facility. After further consideration, our current recommendation is to conduct a groundwater quality screening sampling event, as a less formal way to look further into potential impacts.

The proposed screening location is downgradient of the facility on a lot owned by The Lake Daisy Estates Home Owners' Association HOA). Assuming flow in the surficial aquifer generally follows the ground contours (lines of equipotential), a plume originating at the Old Grove Shores percolation ponds would be expected to pass directly through the HOA site to the lake.

The screening sample would be collected by boring a hole with a hand-auger to a depth approximately 10 feet below the lake's water level. The hole would then be purged three times, preferably using a peristaltic pump, and then the sample collected. If a baler is used for purging, the hole should be expanded to avoid disturbing the sides. If elevated nutrients levels are found, the above process should be repeated upgradient of the facility in the Struthers Road right-of-way.

If after conducting this screening analysis, the County believes the facility is causing unacceptable impacts to the lake, the County may wish to consider alternatives to mitigate the problem. One possible option would be to connect to the sanitary sewer collection system located along Struthers Road. This sanitary system is owned by Winter Haven Utilities. If Winter Haven Utilities agrees to accept this discharge, having the collection infrastructure already in place could make this BMP a good value. Additionally, the pumping system that currently pumps the effluent to the disposal ponds could be used to send the discharge to the sanitary system along Struthers Road. On May 28, 2015, a Jones Edmunds staff member was informed by a representative of Winter Haven Utilities that the City would consider accepting the discharge from the Old Groves Facility. A number of factors would need to be considered and addressed including evaluating their capacity (would capital improvements be required on Winter Haven's part), if the City be required to provide service to each unit (or the neighborhood as a whole), and if the mobile home park wants the City to take ownership of the collection system (which would require easements).

If Winter Haven Utilities is unable to accept the discharge, an alternate BMP at this location is the construct a denitrification wall downgradient of the percolation ponds. Cooperation with the owner, Grove Shores, will be required. This BMP could work in combination with a yard waste recycling program to provide media.

5.5 Lake Sediment Monitoring

The loading and water quality analyses completed indicate that internal loading of nutrients is likely a critical component of the total loading to the lake water column. A sediment monitoring effort to provide estimates of nutrient fluxes will provide estimates of this loading component. The objective of the sediment monitoring effort is to characterize the nature of the lake sediments and obtain estimates of nutrient fluxes across the sediment/water interface. Sampling sites will be based primarily on bathymetry, with consideration of any additional information available concerning external sources and/or nature of the sediments. No fewer than three sites will be selected for data collection.

Depending upon logistics and budgeting, it may be best to conduct both in situ and laboratory analyses for estimation of nutrient fluxes, providing two distinct estimation methods. Laboratory measurements entail collecting sediments from the selected sites, typically accomplished using a pole corer, transporting the core samples to the laboratory where they are placed in an incubator, and collecting samples from the incubator at appropriate intervals for gas analysis. In situ measurements involve placing chambers on the lake bottom, with samples siphoned from the chambers at set intervals for analysis. Both the laboratory and in situ measurements provide nutrient flux and sediment oxygen demand estimates, which will aid in estimating the internal loadings to the lake.

At a minimum, a one-time sediment core collection event with laboratory analysis will provide estimated nutrient fluxes between the sediment and water column. An approximate cost estimate to complete this one-time analysis includes collecting three sediment cores and transporting them to the selected laboratory for incubation and analysis. If all necessary laboratory equipment is already available, the approximate cost of collection and analysis is expected to be on the order of $7,000. This approximate cost may be higher, however, if not all necessary laboratory equipment is available, and additional equipment costs (a one-time expense) could be on the order of $15,000.

If the results of the sediment monitoring indicate that internal loading is problematic, the County may wish to consider options to sequester the sediments, such as whole-lake alum treatment.

5.6 PROGRAMMATIC RECOMMENDATIONS

Jones Edmunds recommends that the County continue its environmental programs benefiting Lake Daisy Water Quality, such as fertilizer ordinance enforcement. Additionally, the County should consider extending its street sweeping program into the Lake Daisy Watershed as well as expanding its public education program to include an Environmental Education Teacher Training Program. With Garden Grove Elementary located near the south lake shore, this educational program could directly benefit Lake Daisy. A description of an Environmental Education Teacher Training Program is provided below by an excerpt from the Little Sarasota Bay Water Quality Management Plan (Sarasota County, 2012).

> "Implementing an Environmental Education Teacher Training Program would lead to campus projects that would result in improved natural systems and water quality. The program will teach teachers about their environment, how their individual actions and campus practices can affect the environment, and what they can do to improve it. Teachers will learn to link the outside world to their classrooms while providing instruction in line with the curriculum through campus projects. Projects could include planting buffers, testing water quality, and using rain barrels for irrigation. Incorporating campus projects will foster higher-level thinking and environmental stewardship, so that students can make informed decisions in the future. In addition to the educational component, campus aesthetics, natural systems, and water quality would be improved. The Environmental Education Teacher Training Program should be an approved Florida master in-service program."

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Appendix A

Existing Information

Appendix B

Statistical Trend Analyses

Appendix C

Direct Runoff Loading Calculation Details

Appendix D

Septic Loading Methodology

Excerpt from: Janicki Environmental, Inc. 2010. *Water Quality Target Refinement Project, Task 4: Pollutant Loading Estimates Development, Interim Report 4.* Prepared for Charlotte Harbor National Estuary Program. Ft. Myers, FL.

Appendix E

Grove Shores Mobile Colony WWTF Operating Permit

Appendix F

Lake Daisy Statistical Results