Stormwater & Lakes Management Plan Strategic Update

Task 1 – Develop GIS Database for Existing BMPs
Task 2 – Develop Water Quality Database & Evaluate Water Quality Trends
Task 3 – Review & Update of Prior BMP Recommendations

To:	City of Maitland
Date	May 4, 2016
From:	Amec Foster Wheeler Environment & Infrastructure, Inc.

Task 1-Develop GIS Database for Existing BMPs

Technical Memo

To: Paul Ritter, City of Maitland

From: Lance Lumbard, Amec Foster Wheeler Environment & Infrastructure, Inc.

Date: May 4, 2016

Re: Task 1 - Develop GIS Database for Existing BMPs
Amec Foster Wheeler Project No. 600314.7

Beginning in 1996, the City of Maitland has prepared and routinely updated a Stormwater Lakes Management Plan (SLMP). The SLMP contains information regarding water quality trends and provides guidance regarding structural and non-structural water quality improvement Best Management Practices (BMPs) for the City's lakes.

The City recently determined that strategic updates of certain sections of the SLMP would be more informative and cost-effective than a complete SLMP update. To assist the City with these updates, Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler) was assigned three critical tasks including: field verification and development of a Geographic Information Systems (GIS) database for existing BMPs maintained by the City as documented in the 2011 SLMP; updates of water quality trends to include Trophic State Index (TSI) and assessment of potential impairments using new Numeric Nutrient Criteria (NNC); and review and update of prior BMP recommendations.

The information provided in this technical memorandum is intended to satisfy **Task 1** to develop and provide the City with a GIS database for existing BMPs. Although BMP location information exists in prior versions of the SLMP, the information has never been consolidated into simplified maps that can be easily referenced. Amec Foster Wheeler has worked with the available information in prior SLMPs to compile citywide location maps for ponds, swales, and structural BMPs including continuous deflection systems (CDS) and nutrient separating baffle boxes (NSBB). This task also provides the City with the necessary information to set up and maintain a GIS database for current and future stormwater BMPs.

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Amec Foster Wheeler conducted initial field verification and photography of existing stormwater pond, swale, and structural “pipe-end” BMPs in October 2015 and a draft inventory map was provided to the City on October 19, 2015. The information was updated and revised in the following weeks and the revised pond, swale, and BMP structure information is provided in **Tables 1** through **3**. Maps of the pond, swale, and BMP structures are provided in **Figures 1** through **3**. The digital ArcGIS data and associated photographs are provided with this memorandum on the accompanying CD.

Amec Foster Wheeler located and cataloged a total of 34 individual stormwater ponds draining to 12 stormwater lakes. In addition, 14 swale systems, 6 continuous deflection systems (CDS), and 5 nutrient separating baffle boxes (NSBB) were located and cataloged. Some swale systems provide treatment for the Little Wekiva Basin and do not drain to the City’s stormwater lakes. The updated and verified GPS information was cross-referenced with **Table 2-1** from the 2011 SLMP update and the existing names were assigned to the updated numbering system presented in the attached figures and tables.

FUTURE EFFORTS

The GIS information provided as a result of this effort provides a framework for the City to continue to build their stormwater database. A comprehensive stormwater BMP and structure database would provide the City with a useful asset management tool for planning and budgeting purposes. Asset management is also imperative for future NPDES compliance as the City continues to work with state and federal agencies to develop this program.

Tables

Table 1
Stormwater Ponds

Pond ID	Pond Status	Photo ID*	Lake Basin Name	City Stomrwater BMP (from SLMP)	Inspection Date	Inspection Time
1	Dry	1205	Shadow	Maitland Ballfield (Keller Rd.)	10/30/2015	10:23:00 AM
2	Dry	1206	Shadow	Maitland Ballfield (Keller Rd.)	10/30/2015	10:25:00 AM
3	Dry	1206	Shadow	Maitland Ballfield (Keller Rd.)	10/30/2015	10:25:00 AM
4	Dry	0047	Shadow	Maitland Ballfield (Keller Rd.)	10/16/2015	3:03:00 PM
5	Dry	1208	Lucien	Lake Destiny Soccer Field	10/30/2015	11:48:00 AM
6	Dry	1223-1225	Minnehaha	Annex Bldg.	10/30/2015	1:00:00 PM
7	Dry	0016	Minnehaha	Versailles Circle Ret. Area	10/15/2015	3:09:00 PM
8	Wet	0016	MInnehaha	Versailles Circle Ret. Area	10/15/2015	3:09:00 PM
9	Dry	1215-1218	Charity	Southview Dr. - Swales & Pond	10/30/2015	12:14:00 PM
10	Wet	0031	Faith	Lake Shore Drive (O.C.)	10/15/2015	4:30:00 PM
11	Dry	0013-0015	Minnehaha	Maitland Community Park	10/15/2015	2:53:00 PM
12	Wet	0030	Sybelia	Hill Rec. Ret. Area (O.C.)	10/15/2015	4:03:00 PM
13	Wet	0044	Shadow	Public Works Complex	10/16/2015	2:11:00 PM
14	Wet	0041-0042	Shadow	Winfield Ret. O.C. (Fennel / Bob Tail)	10/16/2015	1:26:00 PM
15	Dry	1211-1214	Jackson	Bellamy Park Ret. Area	10/30/2015	11:59:00 AM
16	Dry	1219-1222	Catherine	Palmetto / Lake Catherine	10/30/2015	12:36:00 PM
17	Dry	0062	Lily	Lake Lily Park	10/19/2015	2:41:00 PM
18	Dry	0068-0069	Maitland	Live Oak Swales / Pond	10/19/2015	3:34:00 PM
19	Dry	0070-0071	Maitland	Fort Maitland Park Swales / Pond	10/19/2015	3:43:00 PM
20	Dry	0079-0082	Sybelia	Senior Center Swales / Pond	10/19/2015	4:50:00 PM
21	Dry	0079-0082	Sybelia	City Hall Complex Swales / Pond	10/19/2015	4:50:00 PM
22	Dry	0078	Sybelia	City Hall Complex Swales / Pond	10/15/2015	3:36:00 PM
23	Dry	0024	Nina	Lake Nina Offline Retention Area	10/15/2015	3:38:00 PM
24	Dry	0021	Nina	Lake Nina Offline Retention Area	10/15/2015	3:35:00 PM
25	Dry	0007	Wekiva	Water Plant #4 (Thistle Lane)	10/15/2015	1:51:00 PM
26	Dry	0011,1226	Minnehaha	Arapaho & Thunderbird	10/15/2015	2:30:00 PM
27	Dry	0010	Minnehaha	Arapaho & Thunderbird	10/15/2015	2:36:00 PM
28	Dry	0030	Minnehaha	Martin's Ret. Pond (Sequoia Trail)	10/15/2015	4:01:00 PM
29	Dry	N/A	Sybelia	George Ave/ Lake Sybelia Dr.	N/A	N/A
30	Dry	0061	Sybelia	Retention Area Lake Sybelia near Horatio	10/16/2015	4:46:00 PM
31	Dry	0048	Park	Park Detention Area (*not named in SLMP*)	10/16/2015	3:31:00 PM
32	Dry	N/A	Sybelia	Lift Station #5 (Hillman)	N/A	N/A
33	Dry	1229	Minnehaha	Detention Area Chippewa Trail	10/30/2015	1:42:00 PM
34	Dry	0040	None	Maitland Blvd. Swale (*not named in SLMP*)	10/16/2015	1:28:00 PM

*Photos provided in accompanying CD

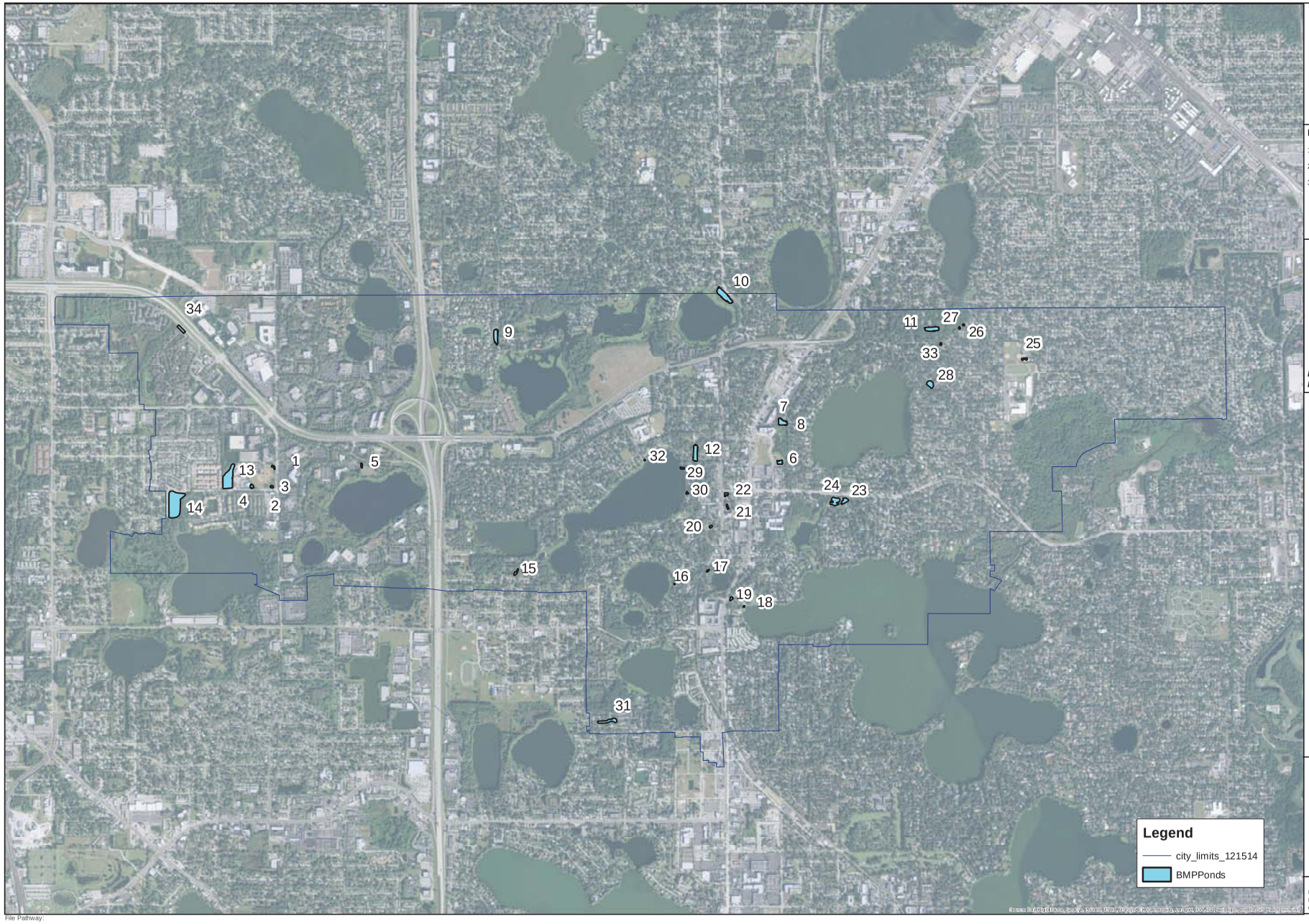
Table 2
Stormwater Swales

Swale ID	Photo ID	Lake Basin Name	City Stomrwater BMP (from SLMP)	Inspection Date	Inspection Time	Swale Length (ft)
1	0037	Sybelia	Lake Sybelia - Swales	10/15/2015	5:03:00 PM	744.57
2	0072-0074	Maitland	Live Oak - Swales / Pond	10/19/2015	3:58:00 PM	206.09
3	0078	Sybelia	City Hall Complex - Swales	10/19/2015	4:43:00 PM	480.16
4	007	None (Wekiva)	Domerich Elementary School - Swales	10/15/2015	1:51:00 PM	287.19
5	0009	None (Wekiva)	Maitland Middle School - Swales	10/15/2015	2:14:00 PM	997.22
6	0083	Charity	Southview Dr. - Swales	10/19/2015	5:06:00 PM	308.05
7	0051-0056	Sybelia	Lake Sybelia - Swales	10/16/2015	3:50:00 PM	3316.08
8	N/A	Charity	Sandspur - Swales (*no swale evident*)	N/A	N/A	571.92
9	N/A	Lake Lily	No swale evident (*not named in SLMP*)	N/A	N/A	383.13
10	0068-0069	Maitland	Fort Maitland Park - Swales / Pond	10/19/2015	3:34:00 PM	37.11
11	0018-0019	Nina	Lake Nina Swales (*not named in SLMP*)	10/15/2015	3:23:00 PM	751.37
12	N/A	Sybelia	Robinhood Court Flume (n*o swale evident*)	N/A	N/A	68.79
13	0027	Maitland	Lake Maitland - Swales (*not named in SLMP*)	10/15/2015	3:51:00 PM	1543.54
14	N/A	None (Wekiva)	Dyan Way Swale (private - *no swale evident*)	N/A	N/A	390.64

Table 3
Structural BMPs

Structure ID	Lake Basin Name	Structure Type	City Stormwater BMP (from SLMP)
1	Sybelia	CDS	CDS Unit Lake Sybelia - Audubon Center
2	Lily	CDS	CDS Unit Lake Lily- Maitland Ave/ 17-92
3	Lily	NSBB	The Villages at Lake Lily Bafle Box / Gabion
4	Minnehaha	NSBB	Dommerich Drive Baffle Box (*not named in SLMP*)
5	Minnehaha	NSBB	Chippewa Trail Baffle Box
6	Minnehaha	NSBB	South Lake Minnehaha Baffle Box (*not named in SLMP*)
7	Maitland	NSBB	East Adams Drive Baffle Box (*not named in SLMP*)
8	Minnehaha	NSBB	The Q Baffle Box
9	Sybelia	CDS	CDS Unit Lake Sybelia - Audubon Way
10	Minnehaha	CDS	Sybelia Parkway South CDS (*not named in SLMP*)
11	Minnehaha	CDS	Sybelia Parkway North CDS (*not named in SLMP*)

Figures



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Notes:

1- Project No.: 600314X7

2- Data Sources - City of Maitland

3- This map is intended to be used for planning purposes only. It is not a survey.

Location Map Not to Scale

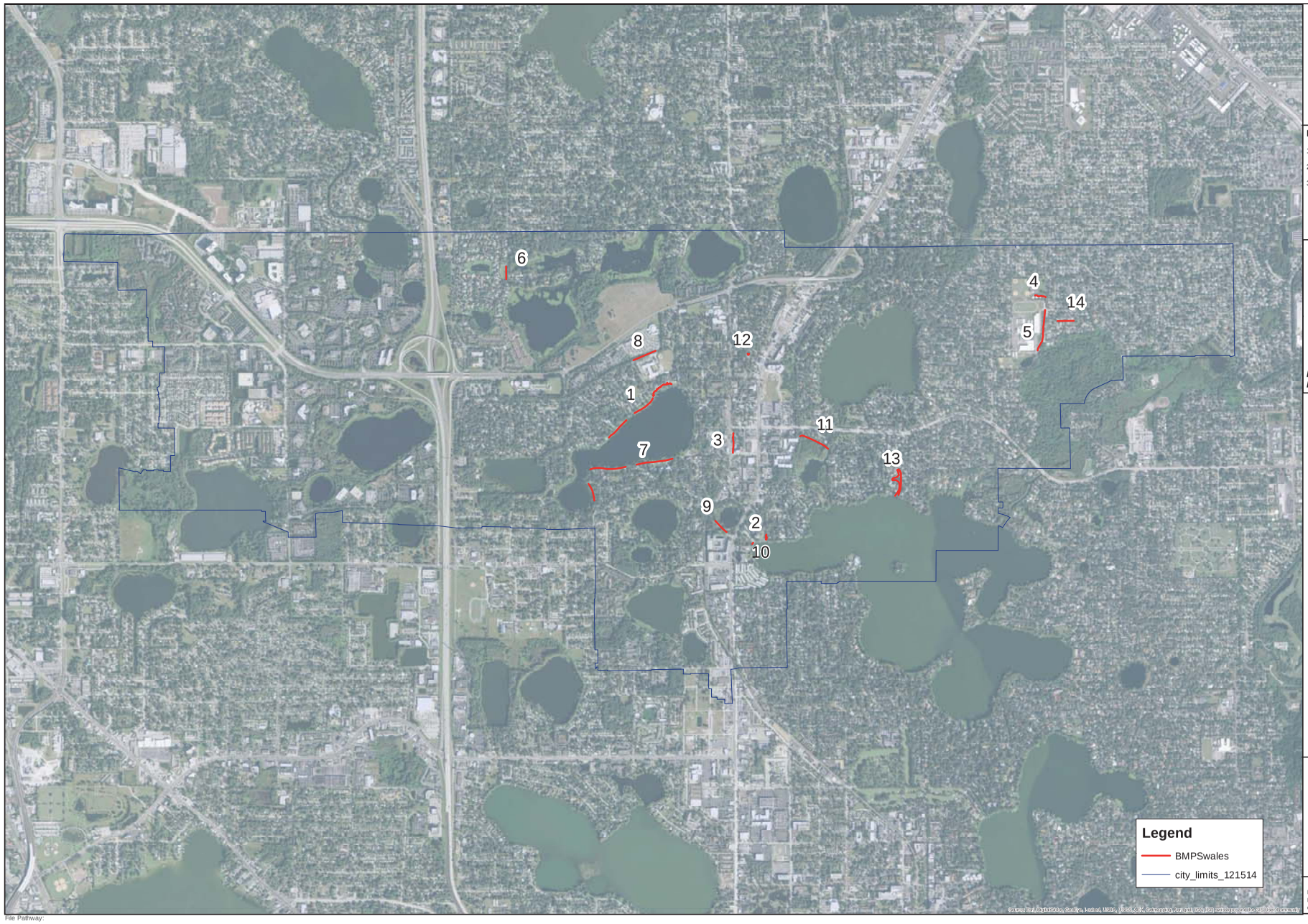
N

0 500 1,000 2,000
1" =

Figure 1
City of Maitland Stormwater Ponds
600314X7
Maitland, FL

Date: 1/19/2016
Revised:
Checked By: LML

File Pathway:



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Location Map Not to Scale

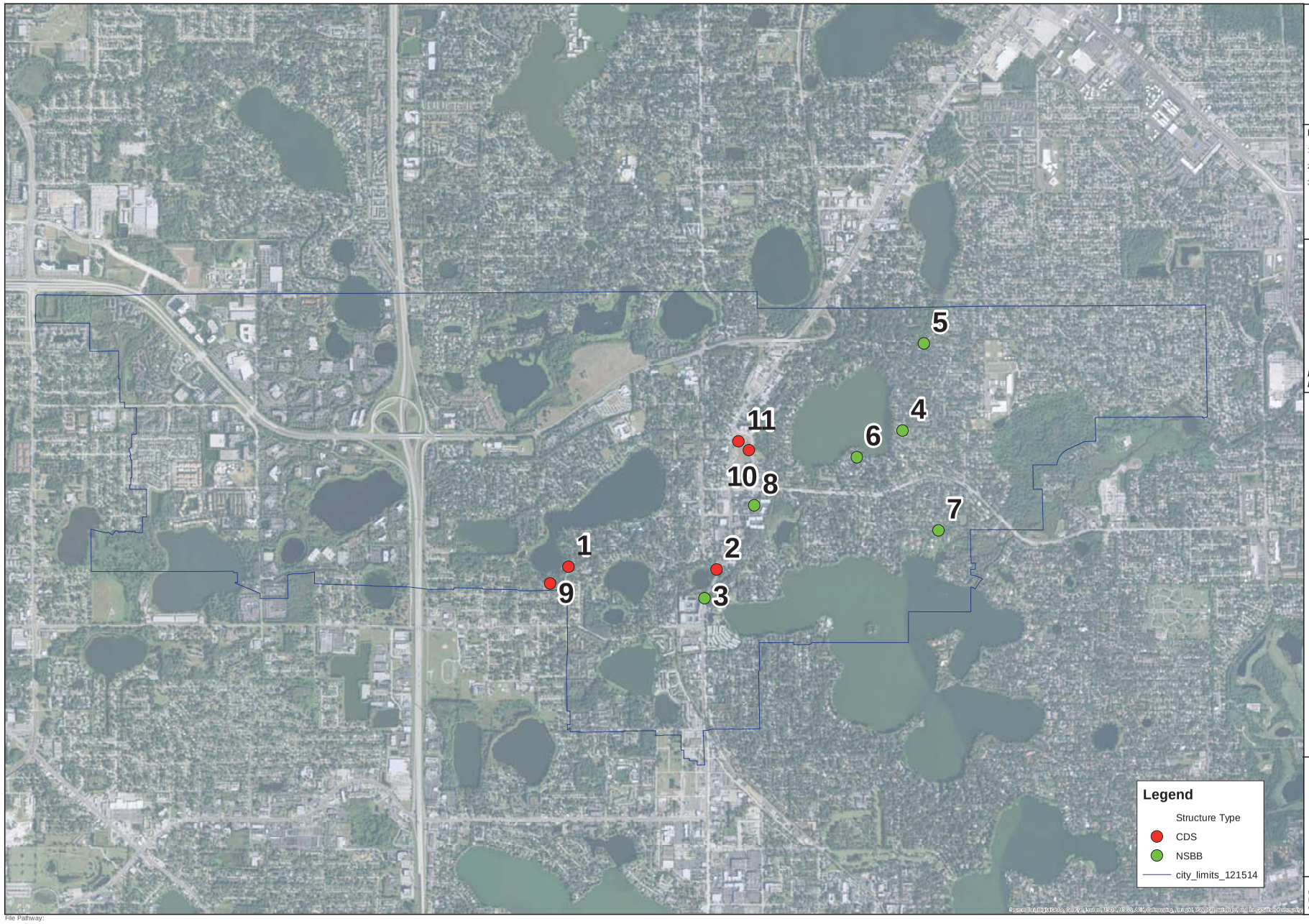
N

1" = 0 500 1,000 2,000

Figure 2
City of Maitland Stormwater Swales
600314X7
Maitland, FL

Date: 1/19/2016
Revised:
Checked By: LML

File Pathway:



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N

0 500 1,000 2,000

1" =

Figure 3
City of Maitland
BMP
Structures
600314X7
Maitland, FL

Date: 1/19/2016
Revised:
Checked By: LML

File Pathway:

Task 2-Develop Water Quality Database & Evaluate Water Quality Trends

Technical Memo

To: Paul Ritter, City of Maitland

From: Lance Lumbard, Amec Foster Wheeler

Date: May 4, 2016

Re: Task 2 - Develop Water Quality Database and Evaluate Water Quality Trends
Amec Foster Wheeler Project No. 600314.7

Beginning in 1996, the City of Maitland has prepared and routinely updated a Stormwater Lakes Management Plan (SLMP). The SLMP contains information regarding water quality trends and provides guidance regarding structural and non-structural water quality improvement Best Management Practices (BMPs) for the City's lakes.

The City recently determined that strategic updates of certain sections of the SLMP would be more informative and cost-effective than a complete SLMP update. To assist the City with these updates, Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler) was assigned three critical tasks including: field verification and development of a Geographic Information Systems (GIS) database for existing BMPs maintained by the City as documented in the 2011 SLMP; updates of water quality trends to include Trophic State Index (TSI) and assessment of potential impairments using new Numeric Nutrient Criteria (NNC); and review and update of prior BMP recommendations.

The information provided in this technical memorandum is intended to satisfy **Task 2** to provide a water quality database for the City's use and to perform water quality analyses of the City's stormwater lakes using the City's period-of-record data.

OVERVIEW

The water quality of a Florida lake is commonly assessed by determining the trophic state of the lake. The trophic state is a measure of the degree of productivity in the water column. Eutrophication is the process in which a lake becomes nutrient enriched, which in turn, alters the chemical, physical, and biological characteristics of the lake. Most of the changes in a lake's characteristics result from increased plant production, which is in turn caused by increased levels of nutrients. The City has a relatively long term record for most of its 22 lakes to evaluate both long-term average TSI and TSI trends.

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Since most water quality problems associated with Florida lakes can be attributed to eutrophication, trophic state measurements may be used as an indicator to detect changes over time and to rank lakes by water quality. The City has historically used the Florida Trophic State Index (Brezonik 1984), which was derived using data from 313 Florida lakes. A lake is assigned a Trophic State Index (TSI) by entering key water quality parameters [total nitrogen (TN, mg/L), total phosphorous (TP, mg/L), chlorophyll a (chl a, ug/L), and Secchi depth (SD, m) for measuring water transparency] into an empirical formula (see below).

A. Phosphorus-Limited Lakes (TN/TP >30):

$$TSI\ (AVG) = 1/3\ [TSI\ (chl\ a) + TSI\ (SD) + TSI\ (TP)]$$

Where:

$$TSI\ (chl\ a) = 16.8 + 14.4\ \ln(chl\ a)$$
$$TSI\ (SD) = 60.0 - 30.0\ \ln(SD)$$
$$TSI\ (TP) = 23.6\ \ln(TP) - 23.8$$

B. Nitrogen-Limited Lakes (TN/TP<10):

$$TSI\ (AVG) = 1/3\ [TSI\ (chl\ a) + TSI\ (SD) + TSI\ (TN)]$$

Where:

$$TSI\ (chl\ a) = 16.8 + 14.4\ \ln(chl\ a)$$
$$TSI\ (SD) = 60.0 - 30.0\ \ln(SD)$$
$$TSI\ (TN) = 59.6 + 21.5\ \ln(TN)$$

C. Nutrient-Balanced Lakes (10 $\leq$TN/TP $\leq$30):

$$TSI\ (AVG) = 1/3\ [TSI\ (chl\ a) + TSI\ (SD) + 0.5\ (TSI\ (TP) + TSI\ (TN))]$$

Where:

$$TSI\ (chl\ a) = 16.8 + 14.4\ \ln(chl\ a)$$
$$TSI\ (TN) = 56 + 19.8\ \ln(TN),\ TSI(TP) = 18.6\ \ln(TP) - 18.4$$
$$TSI\ (SD) = 60.0 - 30.0\ \ln(SD)$$

Based on the Trophic State Index value, the lake is then characterized into one of the 4 trophic states using the long-term average TSI: oligotrophic, mesotrophic, eutrophic, or hypereutrophic.

A lake, which has low nutrient concentrations in the water column, will typically have good water transparency because the algae densities are low. These lakes are termed oligotrophic and are generally considered as having excellent water quality. Oligotrophic lakes tend to be deep with abundant oxygen and a small amount of organic material on the bottom. Lakes are assigned an oligotrophic status if their Trophic State Index was less than 50 (Brezonik 1984). Using available data through 2015, 82% of City's lakes were considered oligotrophic using this criterion.

Lakes with moderate nutrient levels and water quality characteristics above oligotrophic conditions are termed mesotrophic. Mesotrophic lakes will typically only have occasional water quality problems and are generally considered to have good water quality. Lakes were assigned a mesotrophic status if Trophic State Index values were between 50 and 61. Using available data through 2015, 18% of City lakes were considered mesotrophic using this criterion.

As nutrient concentrations increase in a lake, algae density typically increases and water transparency typically decreases. A lake with high levels of nutrients and algae is termed eutrophic. Eutrophic lakes are highly productive and will have the potential for water quality problems resulting from severe algae blooms that can deplete oxygen and form mucky organic layers on the lake bottom. Lakes were assigned a eutrophic status if Trophic State Index values were between 61 and 70. Using available data through 2015, none of the City's lakes were considered eutrophic.

Lakes that have reached advanced stages of the eutrophication process are termed hypereutrophic. Persistent algae blooms, extreme fluctuations in dissolved oxygen and deep organic muck layers are characteristics of these lakes. Hypereutrophic lakes in the City tend to be shallow and have mucky sediments from organic material, which is produced in the lake faster than it can be removed by decomposition processes. Lakes were assigned a hypereutrophic status if Trophic State Index values were greater than 70. Using data through 2015, no lakes in the City of Maitland were classified as hypereutrophic.

The Florida Department of Environmental Protection uses TSI values to assign a good, fair or poor rating to Florida lakes and has historically used the TSI as a narrative interpretation of water quality impairments. However, numeric nutrient criteria (NNC) are now being utilized to determine impairments as shown in **Figure 1** below. Use of TSI for water quality analysis and lake health assessment remains an important tool for the City of Maitland. Analysis of water quality within the City's lakes using TSI and NNC are provided in the corresponding sections below.

Figure 1
Florida Lakes NNC Criteria

Long Term Geometric Mean Lake Color and Alkalinity	Annual Geometric Mean Chlorophyll *a*	Minimum calculated numeric interpretation		Maximum calculated numeric interpretation	
		Annual Geometric Mean Total Phosphorus	Annual Geometric Mean Total Nitrogen	Annual Geometric Mean Total Phosphorus	Annual Geometric Mean Total Nitrogen
> 40 Platinum Cobalt Units	**20 µg/L**	**0.05 mg/L**	**1.27 mg/L**	**0.16 mg/L[1]**	**2.23 mg/L**
≤ 40 Platinum Cobalt Units and > 20 mg/L $CaCO_3$	**20 µg/L**	**0.03 mg/L**	**1.05 mg/L**	**0.09 mg/L**	**1.91 mg/L**
≤ 40 Platinum Cobalt Units and ≤ 20 mg/L $CaCO_3$	**6 µg/L**	**0.01 mg/L**	**0.51 mg/L**	**0.03 mg/L**	**0.93 mg/L**

From: "Implementation of Florida's Numeric Nutrient Standards".

Available at http://www.dep.state.fl.us/water/wqssp/nutrients/

The City has operated its lake surface water quality monitoring program for more than 20 years and long-term trends are now available to gauge the overall health of the City's lakes. More importantly, the City can begin to see the results of long-term water quality management efforts implemented over the past two decades.

The trophic status of Maitland's lakes is critically related to total phosphorus loadings. Available water quality data shows that phosphorus is an important nutrient in each of the City's lakes. **Table 1** summarizes several lake characteristics that are important in the assessment of their water quality. Lakes Destiny, Harvest, Lucien, Maitland, and Sybelia are phosphorus limited, meaning the addition of phosphorus will result in increased algae production. The remaining lakes are all balanced, meaning that additions of either phosphorus or nitrogen may stimulate algae growth. In all cases, additional loadings of phosphorus would have adverse effects on trophic status. For this reason, the City should continue to focus on the reduction of phosphorus loadings, when compared with other pollutants. The basis and interpretation of other factors presented in **Table 1** will be described throughout this section.

Table 1
Summary Lake Characteristics Relevant to Water Quality

Lake	Basin Area (Acres)	Lake Area (Areas)	TSI	Period-of-Record Trend	Trophic State	Limiting Nutrient
Lake Catherine	77	23	34	I	Oligotrophic	Balanced
Lake Charity	343	56	37	I	Oligotrophic	Balanced
Lake Destiny	164	36	32	S	Oligotrophic	Phosphorus
Lake Eulalia	17	6	39	I	Oligotrophic	Balanced
Lake Faith	191	33	32	S	Oligotrophic	Balanced
Lake Gem	289	8	58	I	Mesotrophic	Balanced
Lake Harvest	46	10	34	S*	Oligotrophic	Phosphorus
Lake Hope	140	31	39	I	Oligotrophic	Balanced
Lake Hungerford	102	16	44	I	Oligotrophic	Balanced
Lake Jackson	124	22	49	S	Oligotrophic	Balanced
Lake Lily	54	5	53	I	Mesotrophic	Balanced
Lake Lomond	68	8	37	I	Oligotrophic	Balanced
Lake Love	20	4	37	I	Oligotrophic	Balanced
Lake Lucien	387	53	32	S	Oligotrophic	Phosphorus
Lake Maitland	1333	443	46	I	Oligotrophic	Phosphorus
Lake Minnehaha	603	95	50	I	Mesotrophic	Balanced
Lake Nina	91	12	49	I	Oligotrophic	Balanced
Park Lake	153	32	52	I	Mesotrophic	Balanced
Lake Shadow	334	75	46	I	Oligotrophic	Balanced
Lake Sybelia	513	80	40	I	Oligotrophic	Phosphorus
Lake Waumpi	767	12	49	S	Oligotrophic	Balanced
Lake Woods	NA	NA	39	S	Oligotrophic	Balanced

*Lake Harvest 5-year recent TSI trend indicates deteriorating water quality

Note: NA = Not Available

Period-of-Record Trend: D = Deteriorating
S = Stable
I = Improving

LAKE WATER QUALITY AND TRENDS

Since 1993, the City has developed a valuable database by operating a long term water quality monitoring network. Water quality samples have been collected and analyzed on a monthly basis for each of the lake's identified in **Table 1**, with the exception of Lake Waumpi and Lake Woods. Parameters routinely analyzed include alkalinity, pH, TP, orthophosphate, TN, ammonia, nitrate, nitrite, total Kjeldahl nitrogen, TSS, volatile suspended solids, total dissolved solids, fecal and total coliforms, Secchi depth, and chlorophyll-a. Of these, TP, TN, Secchi depth, and chlorophyll-a are used directly in calculating the trophic state index (TSI).

The City's water quality data base is comprehensive and represents a valuable resource for assessing water quality conditions and trends. The water quality data itself represents a superior resource for assessing lake quality than could be achieved using models that are simplistic representations of complex lake processes. The primary results used to support this SLMP were the trends in TSI for the various lakes, leading to a relatively reliable estimate of present day lake quality and permitting the prioritization of some lakes as potentially degraded or degrading and requiring prioritization for City action to maintain or restore their water quality.

TROPHIC STATE INDEX (TSI)

Trophic State Index (TSI) is a summary water quality characteristic for lakes that indicates the degree of eutrophication. Trends in annual average TSI were examined to determine if lake-specific water quality was improving, deteriorating, or stable. These results were used to develop the most reliable estimate possible for the current data trophic state of each lake, and its probable future trophic state. TSI graphs are shown in **Appendix A**.

Linear regression analysis of TSI versus year was used to evaluate trends. Regression results are provided in **Appendix B**. Based on TSI, all of the City's lakes are either stable or improving. Stable lakes include Lakes Destiny, Faith, Harvest, Jackson, Lomond, Lucien, Waumpi, and Woods.

All lakes were evaluated for short-term TSI over the past five years to provide the opportunity for corrective action in the event deteriorating water quality conditions were identified. No significant positive or negative trends were identified for the prior five years with the exception of Lake Harvest. Lake Harvest TSI has been increasing from a historic low in 2011, so even though a significant rend is present, this may not be an indication of a problem.

TSI SUMMARY

For lakes with no statistically significant trend in water quality, as indicated by TSI, the most reliable estimate of TSI is the long term average. For lakes with a statistically significant trend the current value of TSI is more reliable than an average that includes older data that are no longer representative of lake quality conditions. Nonetheless, TSI varies from year to year, and even from month to month. Consequently the most recent observation is not necessarily very reliable as an indicator of the overall health of the lake. Where a statistically significant trend exists, as determined by regression analysis, the regression equation (best fit line through the data) represents the most reliable estimated of present day water quality. **Table 1** presents the best estimate of TSI at this time for lakes monitored by the City and addressed in the SLMP. The TSI value shown in **Table 1** is the long term average for most of the lakes. However, for lakes with significant trends it may be reasonable to use the current TSI value.

The analysis of trends, with results summarized in **Table 1** indicates that Lake Gem, with a eutrophic TSI value of 59 continues to exhibit the poorest water quality of Maitland's lakes. Lakes Eulalia, Shadow, and Sybelia both have marginally insignificant declining water quality trends over the past five years. Efforts to address further water quality deterioration in these lakes is recommended. The rest of the City's lakes have fair or good water quality, as indicated by TSI.

Interestingly, FDEP has identified water quality impairments in Lakes Lucien, Sybelia, Shadow, and Park Lake based on exceedance of TSI using the previous narrative nutrient criteria. This is likely a result of independent FDEP sampling and should be explored further. TSI values are no longer utilized as a metric for making impairment determinations. Instead, FDEP will utilize NNC to determine impairments in the future although the process is still being implemented.

WATER QUALITY DATA AND NUMERIC NUTRIENT CRITERIA

As shown in **Figure 1**, NNC require determination of both color and alkalinity which are used to establish a matrix for determination of acceptable water quality limits for chlorophyll-a, total phosphorus, and total nitrogen. Calculation of geometric means is required for all values. While there are numerous possibilities within the matrix, the City's lakes will generally fall into the category of platinum cobalt units (PCU) ≤ 40 and > 20 mg/L $CaCO_3$. As long as chlorophyll-a concentration is below 20 ug/L the lakes are not considered impaired if total phosphorus is less than 0.090 mg/L and/or total nitrogen is less than 1.91 mg/L. Exceedance of chlorophyll-a will result in use of the minimum criteria of total phosphorus less than 0.03 mg/L and total nitrogen less than 1.05 mg/L.

Table 2 provides an assessment of potential impairments that could exist using the City's data and NNC criteria. It should be noted that the City does not currently provide data to the FDEP so this evaluation should only be used as a guide for potential NNC impairments. FDEP collects and interprets its own data for impairment purposes. It is recommended that the City discuss future impairment designations with the FDEP to possibly prevent the potential for TMDL development given the City's extensive data record of water quality improvement.

As indicated in **Table 2**, the vast majority of the City's lakes are not expected to be classified as impaired under the new NNC. However, Lake Eulalia is considered a "soft" water lake (alkalinity < 20 mg/L) and it exceeds its long-term average maximum total phosphorus concentration of 0.03 mg/L. It should be noted, however, that the exceedance is marginal (0.001 mg/L) and additional data may have a significant impact on future impairment designations. Since Lake Eulalia is also exhibiting possible short term water quality declines, this would be a reasonable lake to continue future water quality management efforts.

Table 2
Evaluation of Water Quality Using NNC

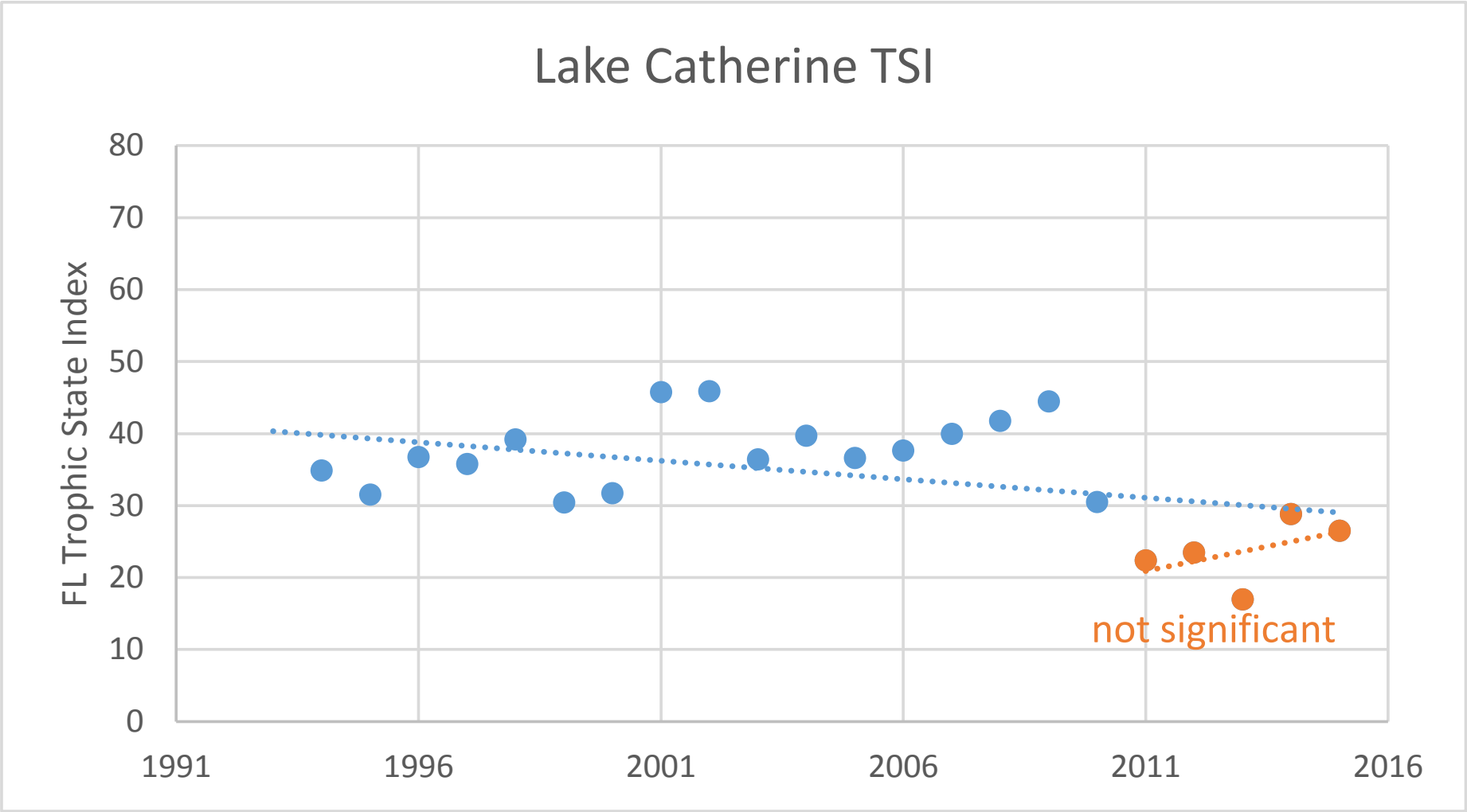
Lake	Color (Long-term Geomean)	Alkalinity (Long-term Geomean)	Chloropyll-a (Long-term Geomean)	TN (Long-term Geomean)	TP (Long-term Geomean)	Color Category	Alkalinity Category	Max chl-a (ug/L)	Below max chl-a?	Max TN (mg/L)	Exceeds Max TN?	Max TP (mg/L)	Exceeds Max TP?	Likely NNC Impairment Status	Current FDEP Impairment Status
Catherine	13.14	20.22	2.05	0.54	0.021	<40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Not Impaired
Charity	18.42	18.81	2.92	0.62	0.026	<40 PCU	<20 mg/L	6	YES	0.93	NO	0.03	NO	Not Impaired	Not Impaired
Destiny	12.40	30.66	1.95	0.54	0.021	<40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Not Impaired
Eulalia	19.82	12.29	3.67	0.61	0.031	<40 PCU	<20 mg/L	6	YES	0.93	NO	0.03	YES	Potentially Impaired	Not Impaired
Faith	18.09	33.11	2.09	0.51	0.021	<40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Not Impaired
Gem	21.00	76.81	20.74	0.90	0.062	<40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Not Impaired
Harvest	26.11	32.43	2.82	0.59	0.033	<40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Not Impaired
Hope	21.00	36.54	3.57	0.68	0.027	<40 PCU	>20 mg/L	**20**	YES	1.91	NO	0.09	NO	Not Impaired	Not Impaired
Hungerford	18.45	46.94	5.66	0.83	0.035	<40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Not Impaired
Jackson	11.90	24.85	9.13	0.81	0.044	<40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Not Impaired
Lily	18.42	61.52	11.51	0.86	0.063	<40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Not Impaired
Lomond	18.79	30.42	3.43	0.48	0.025	<40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Not Impaired
Love	15.39	23.60	2.95	0.52	0.028	<40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Not Impaired
Lucien	43.19	48.73	4.07	0.54	0.021	>40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Impaired (TSI)
Maitland	14.36	45.45	8.51	0.77	0.030	<40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Not Impaired
Minnehaha	26.68	46.67	6.82	0.84	0.038	<40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Not Impaired
Nina	20.81	41.36	8.20	0.72	0.034	<40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Not Impaired
Park	22.84	64.77	11.67	0.81	0.044	<40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Impaired (TSI)
Shadow	20.46	43.46	8.93	0.73	0.037	<40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Not Impaired
Sybelia	8.84	22.96	5.03	0.60	0.032	<40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Impaired (TSI)
Waumpi	37.80	46.60	5.12	1.00	0.046	<40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Not Impaired
Woods	23.18	50.40	2.88	0.96	0.022	<40 PCU	>20 mg/L	20	YES	1.91	NO	0.09	NO	Not Impaired	Not Impaired

SUMMARY OF FINDINGS

Water quality in most of Maitland's lakes has improved significantly over the past 20 years. Improvements may be a positive reflection of structural BMP projects and citizen actions in response to the education program completed by the City, Friends of Maitland's Waterways, and others.

The City's water quality monitoring program has produced a valuable record of water quality over the past 23 years and permits trends in lake quality to be evaluated from the data itself, rather than requiring the use of simplified water quality models. Continuation of the lake water quality monitoring program is vital to provide the information the City will need to make cost-effective decisions regarding lake quality improvement projects. While most technical reports focus on scientific indicators such as nutrient loadings and TSI levels, the most evident indicators are more aesthetic, such as littoral vegetation, wildlife and fishery health, water clarity, and the number of algae bloom incidents.

Appendix A


Lake Catherine TSI
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70
60
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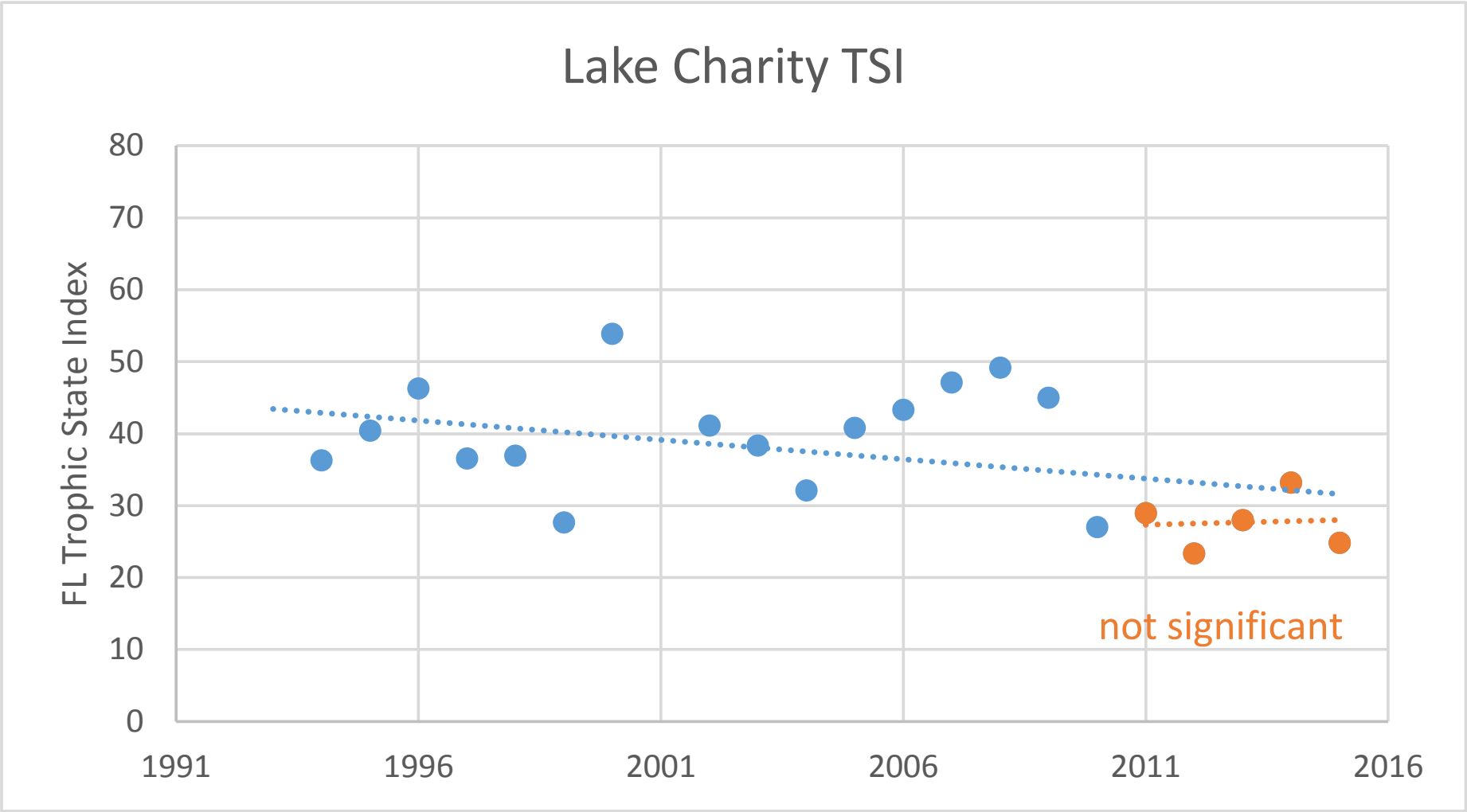
1991
1996
2001
2006
2011
2016
not significant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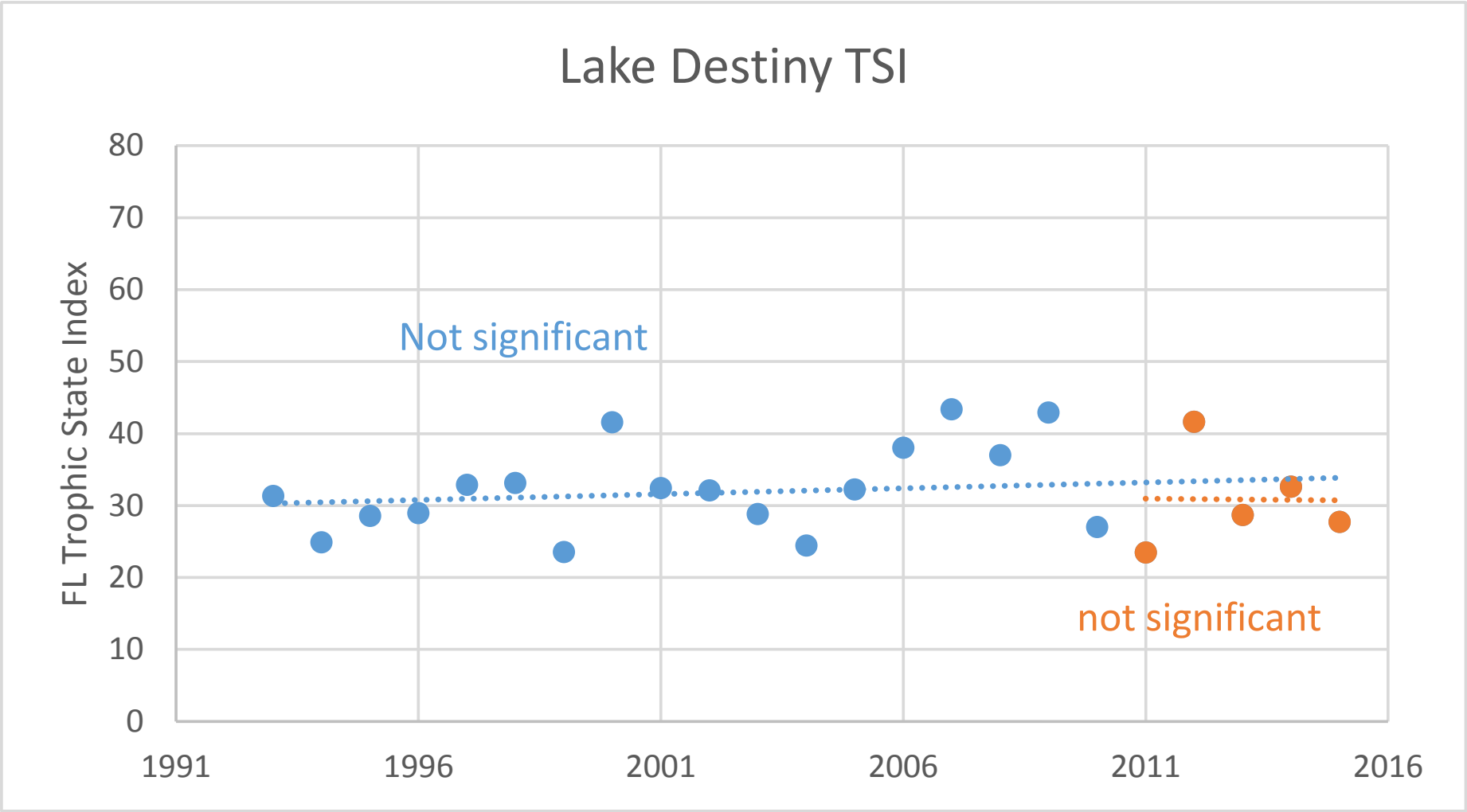
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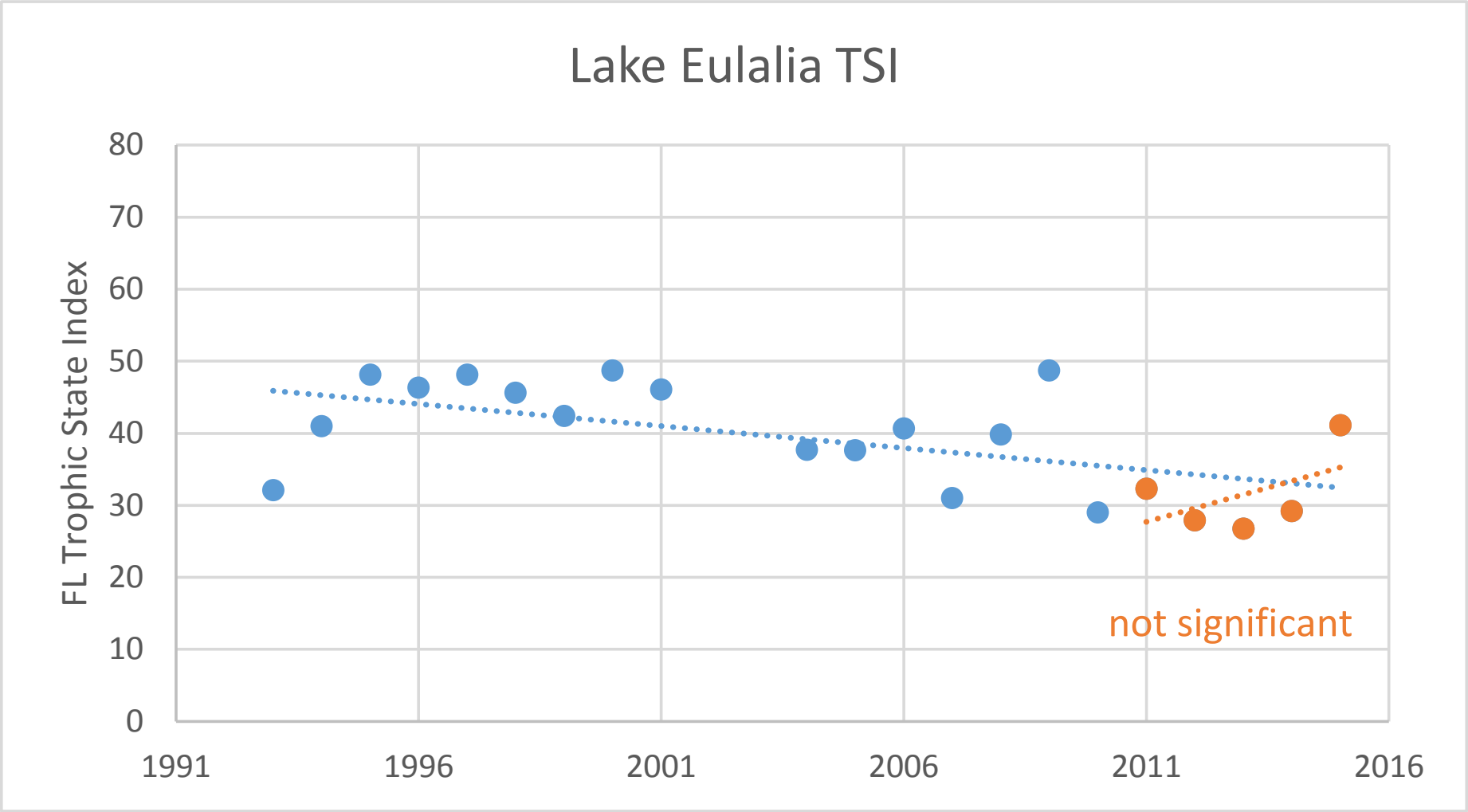
not significant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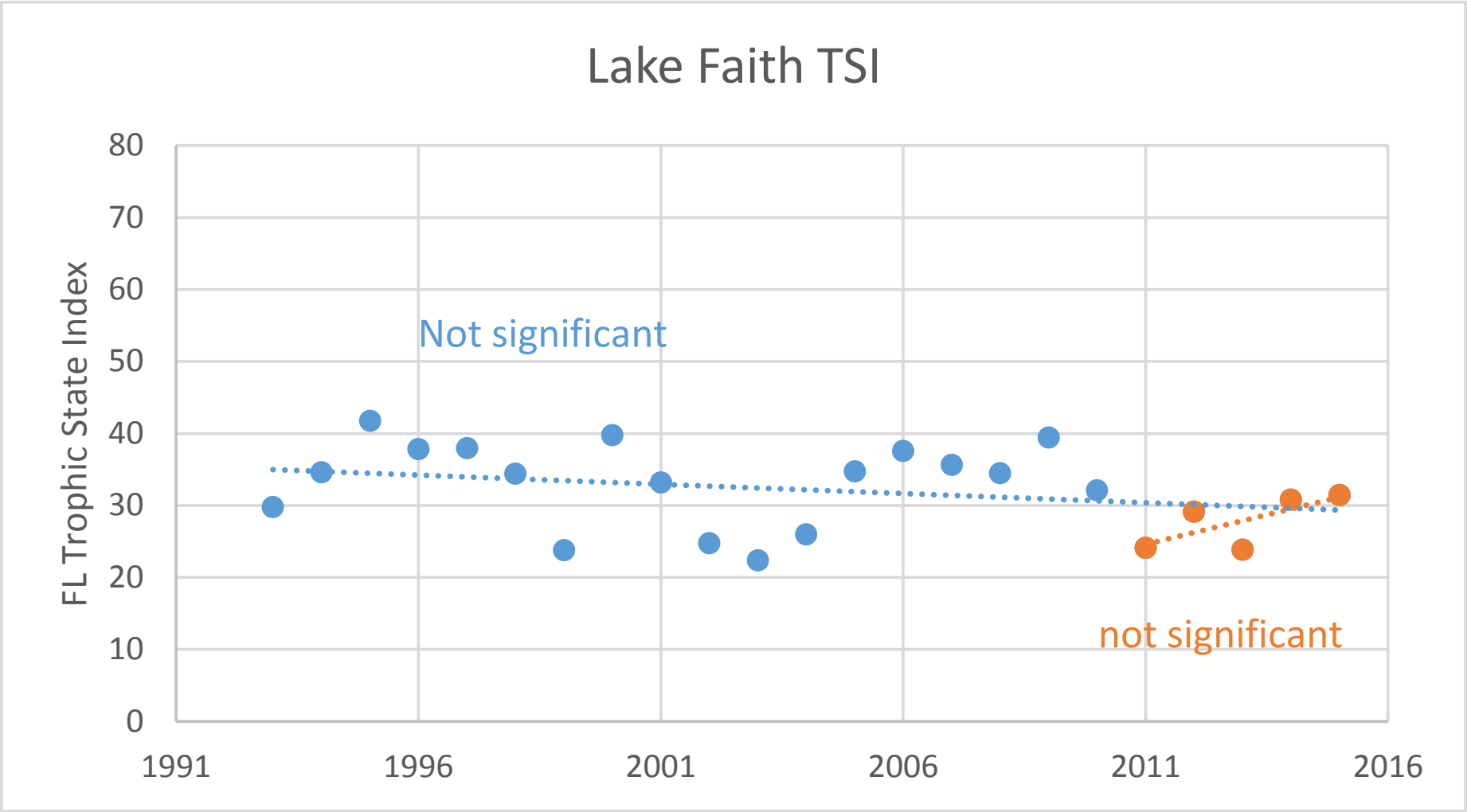
not significant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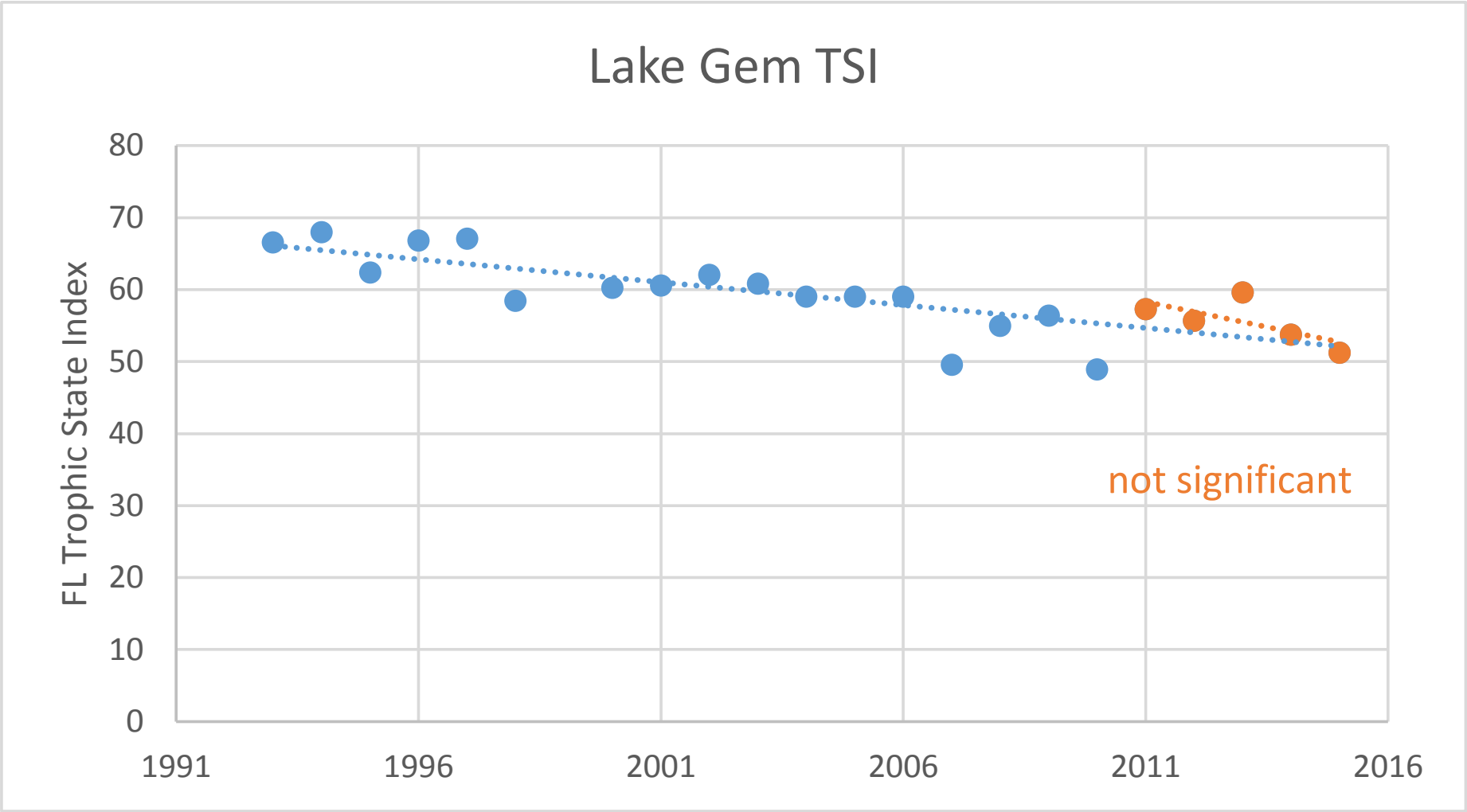
2016
Not significant
not significant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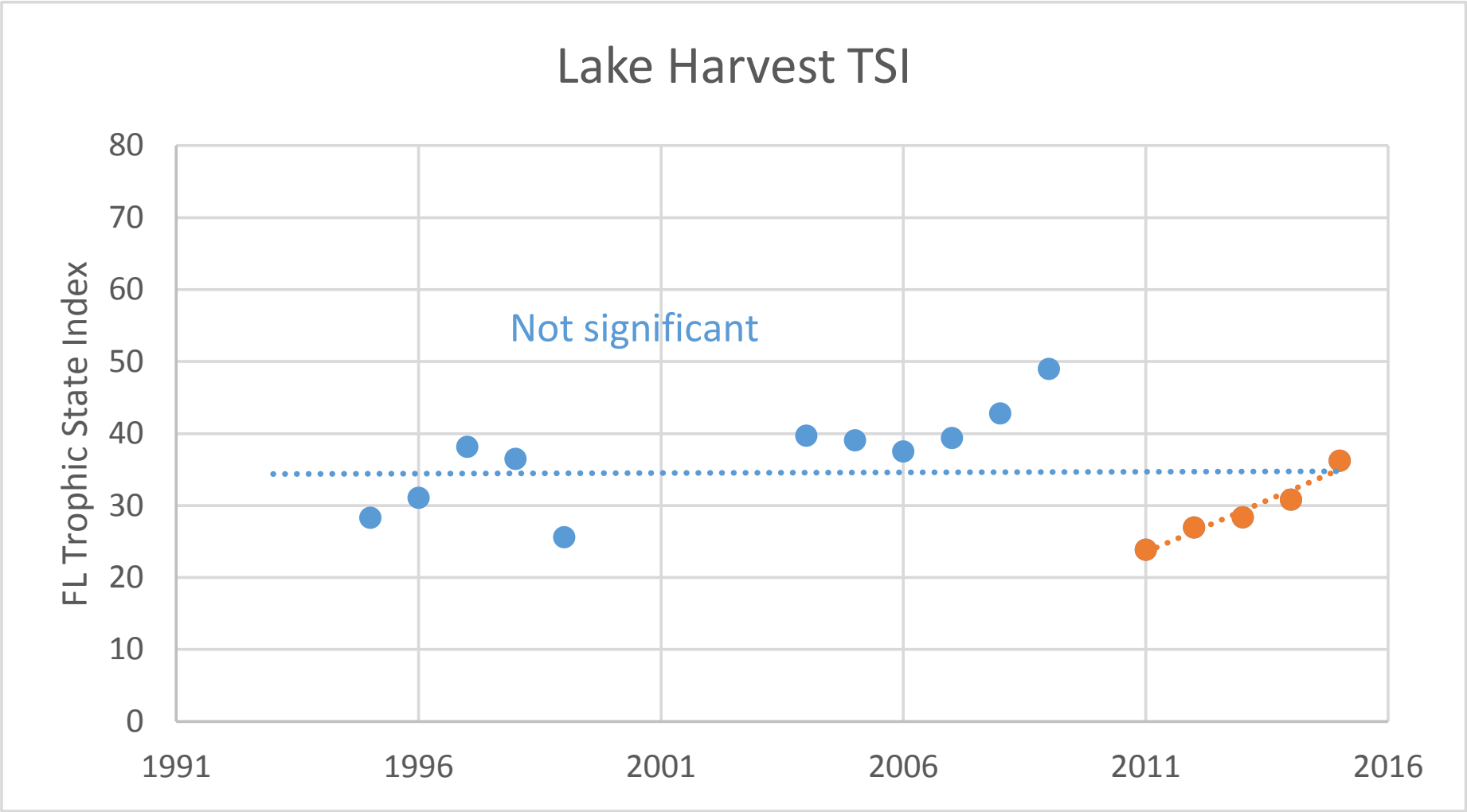
not significant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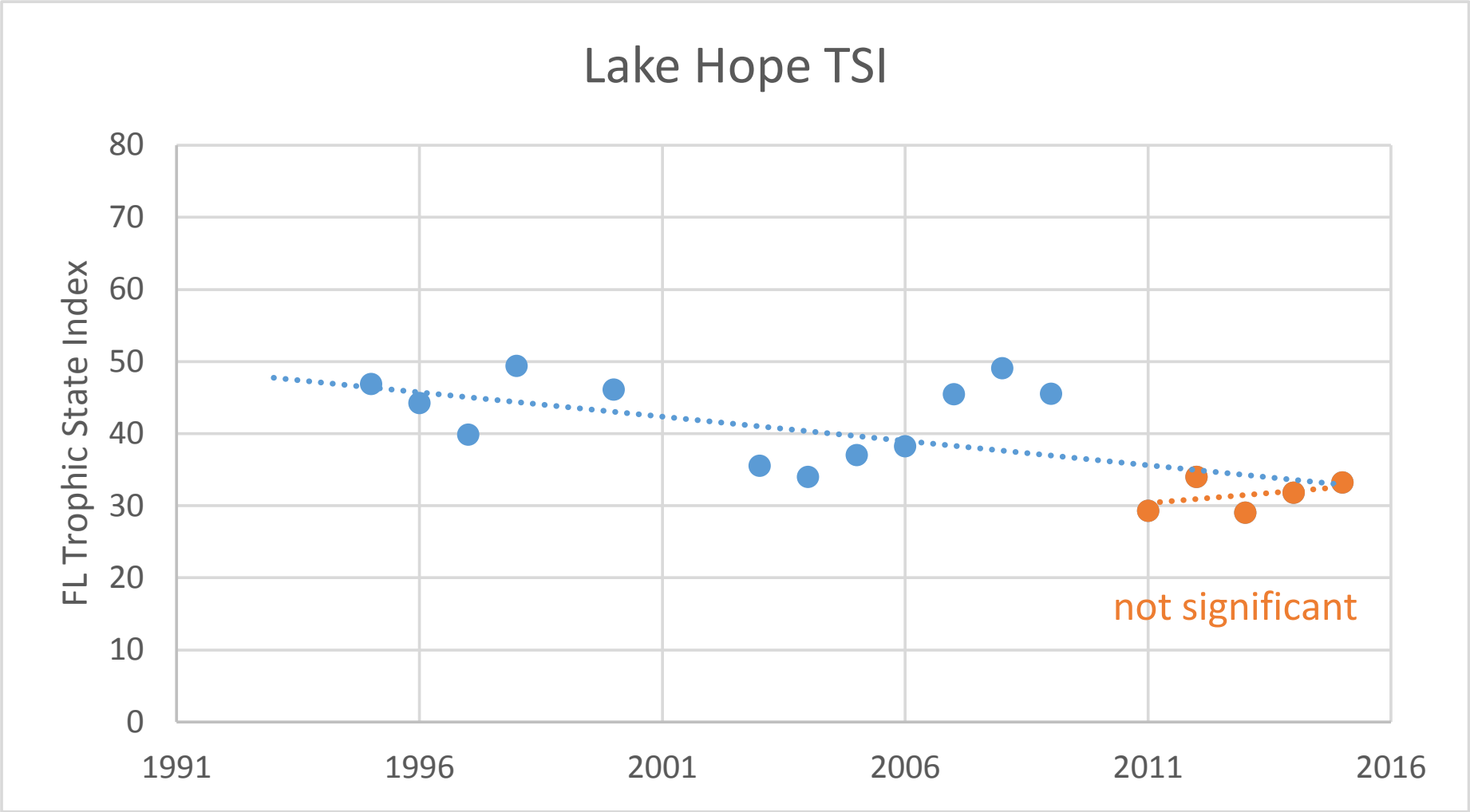
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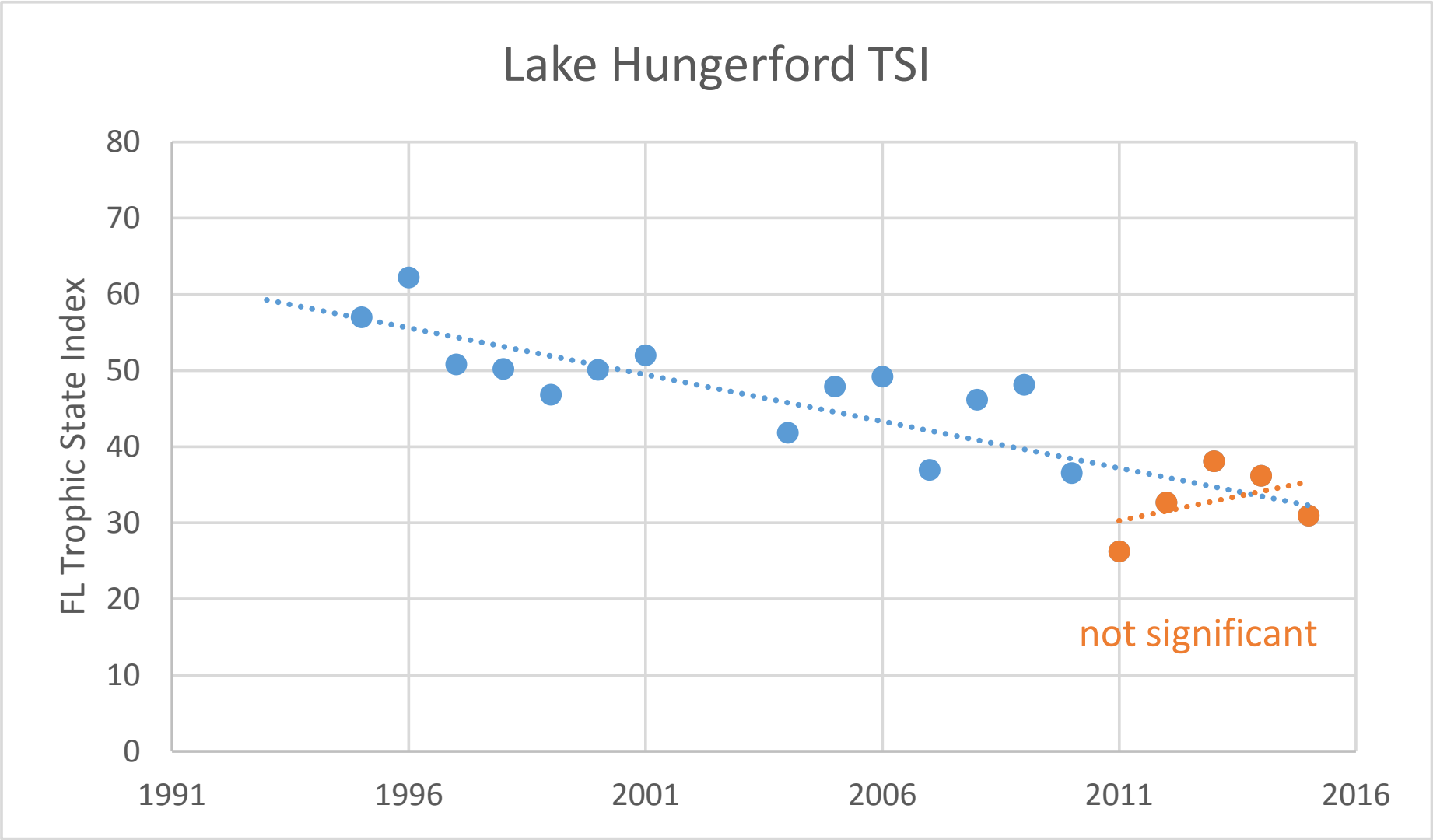
2016
not significant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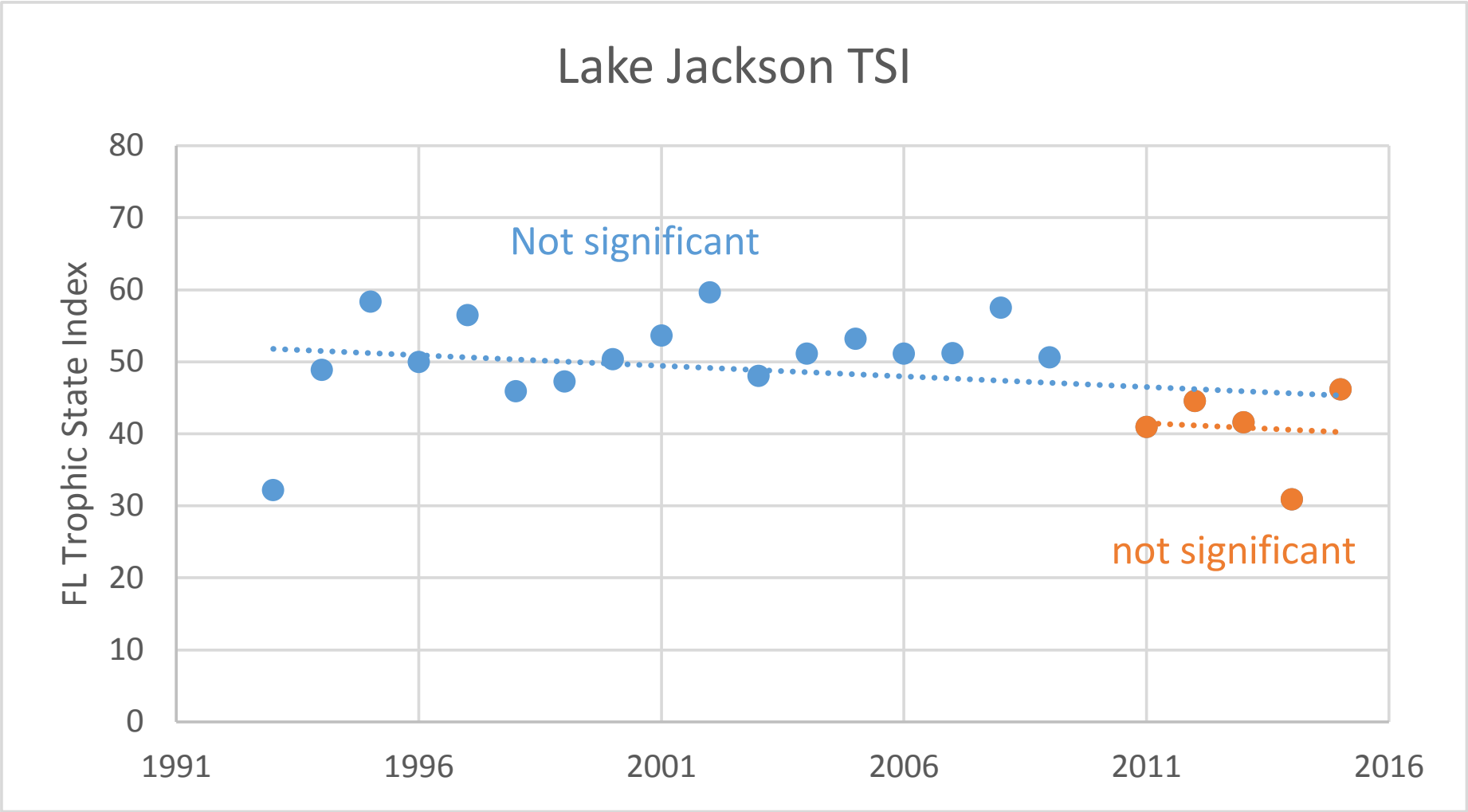
2016
not significant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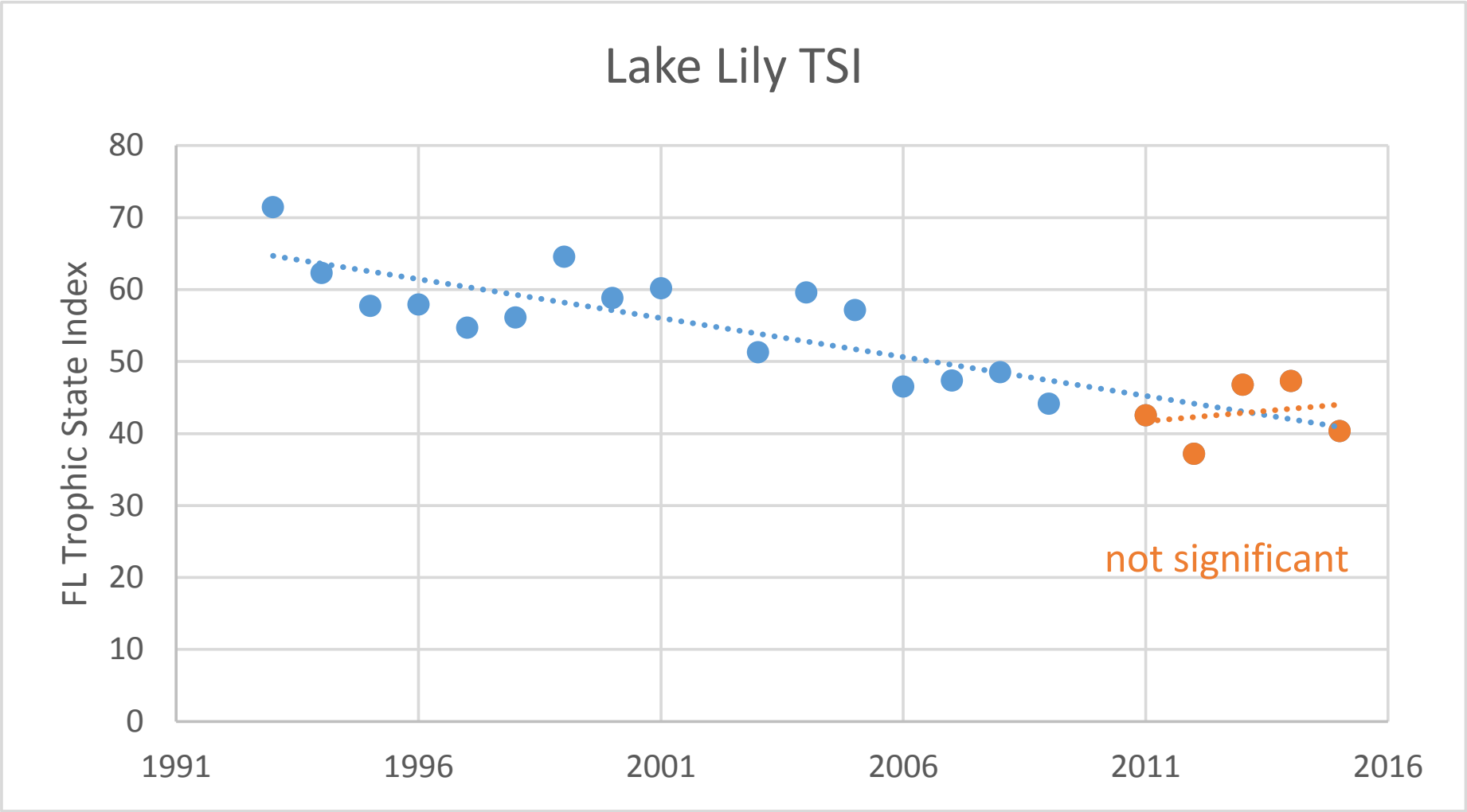
2016
Not significant
not significant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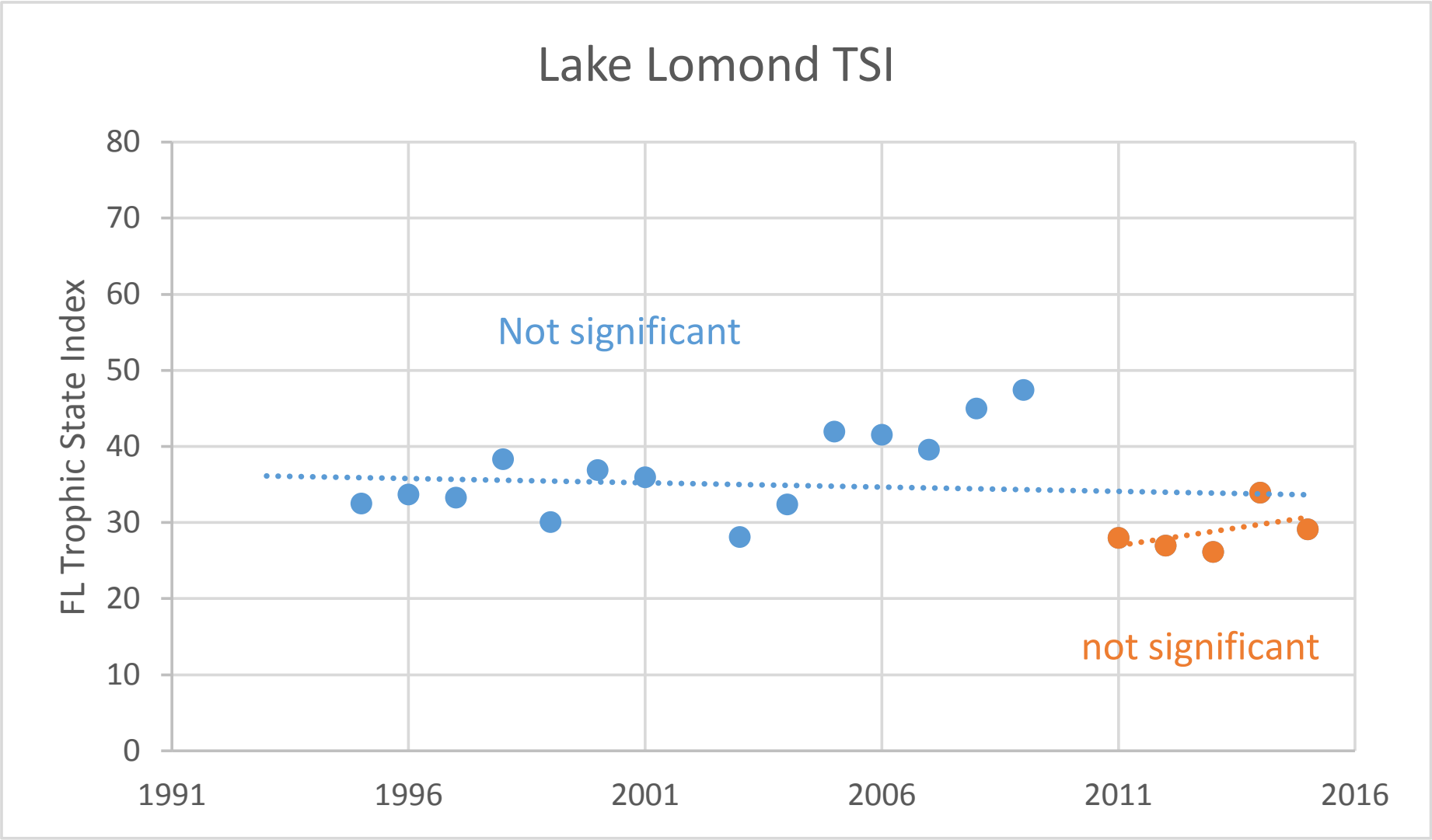
2016
not significant


Lake Lomond TSI
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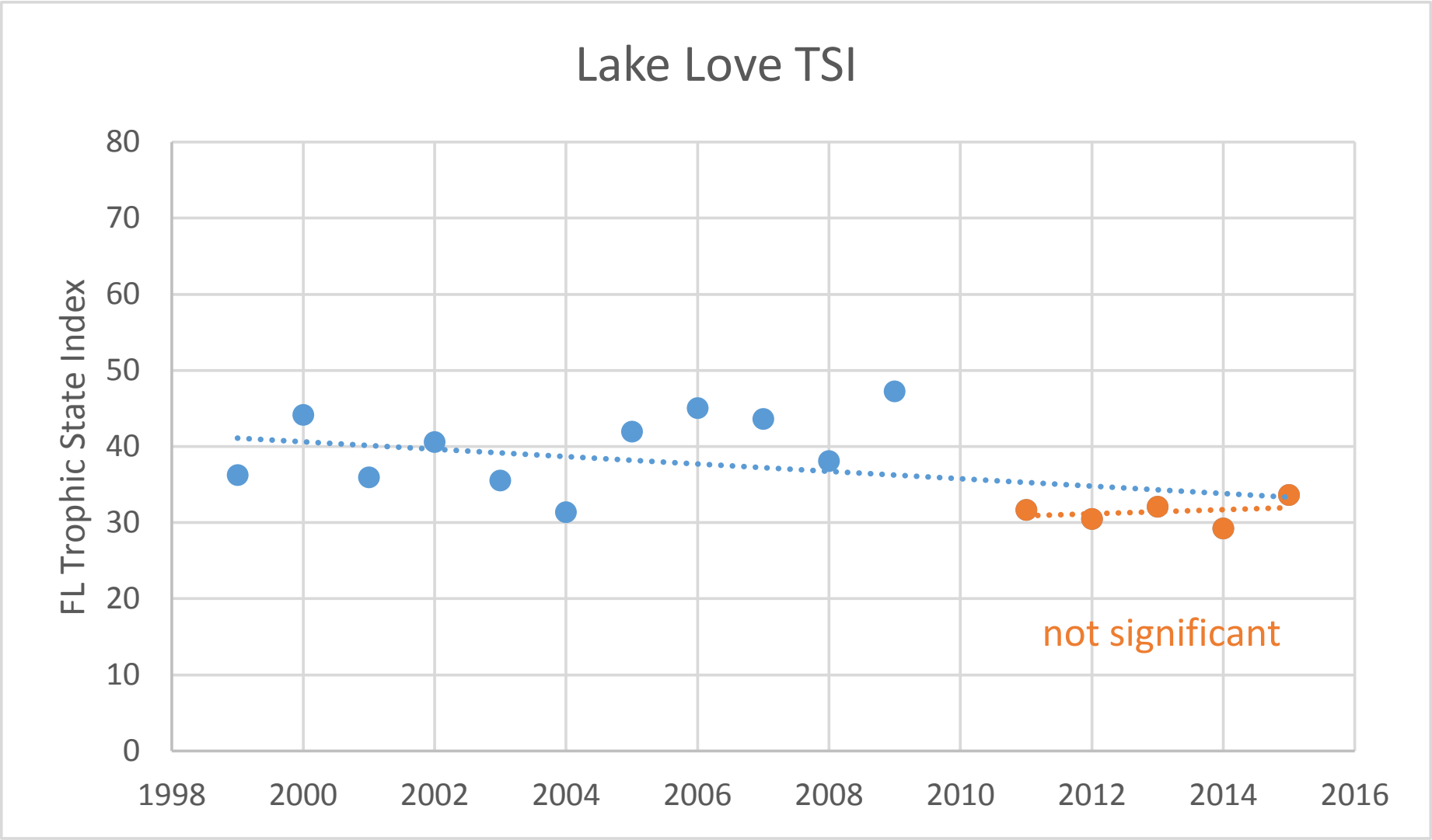
2016
Not significant
not significant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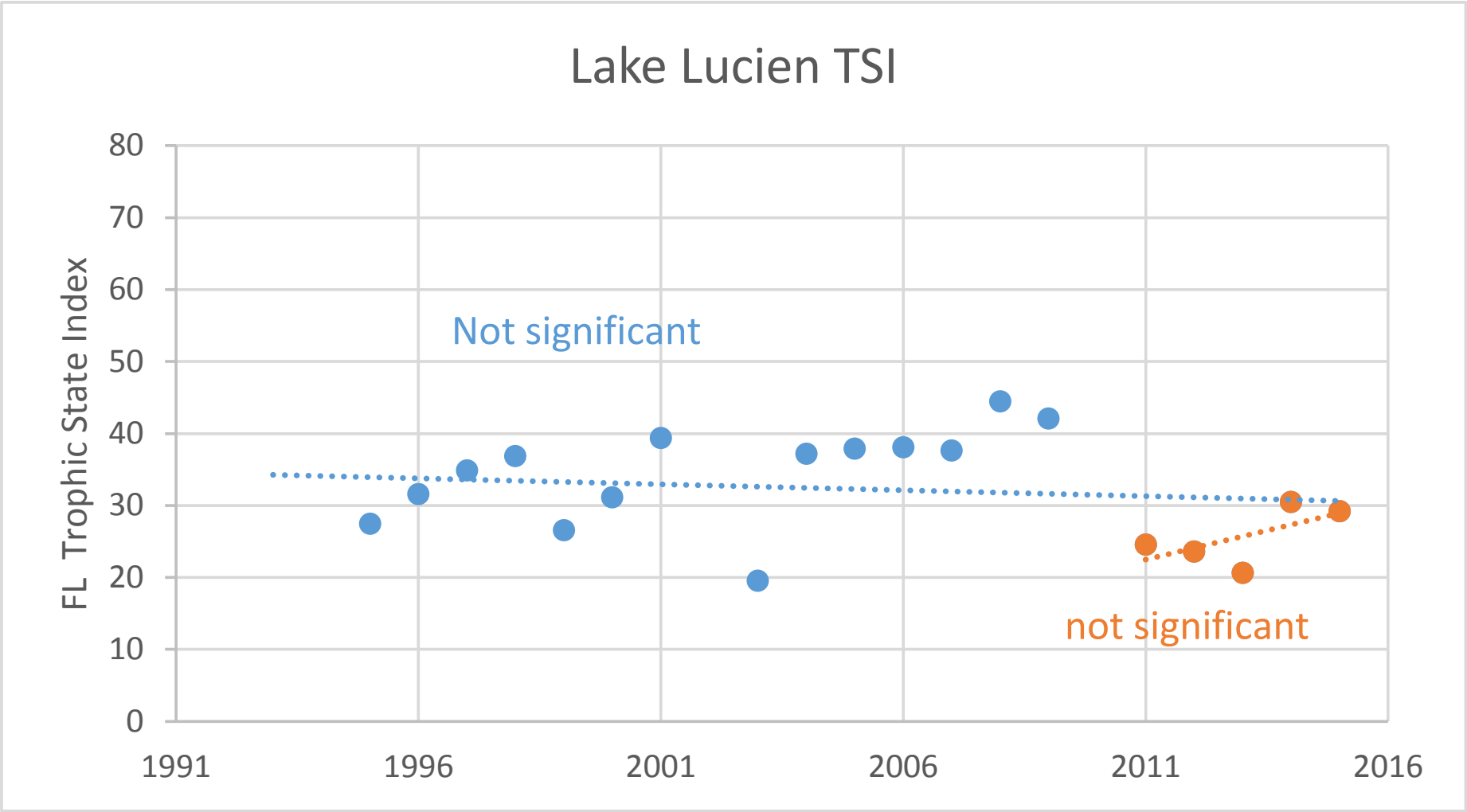
2016
not significant


Lake Lucien TSI
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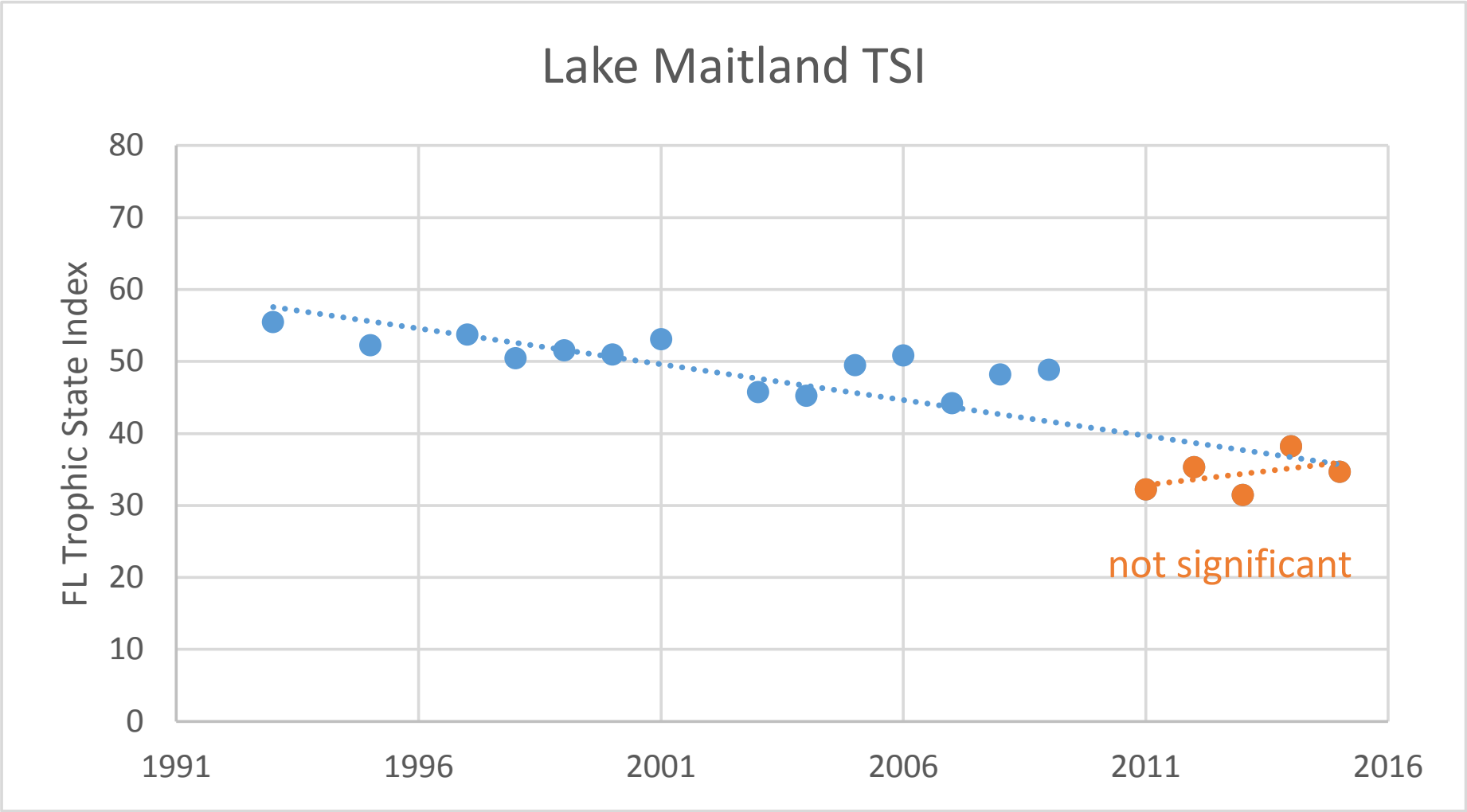
2016
Not significant
not significant


Lake Maitland TSI
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1991
1996
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2016
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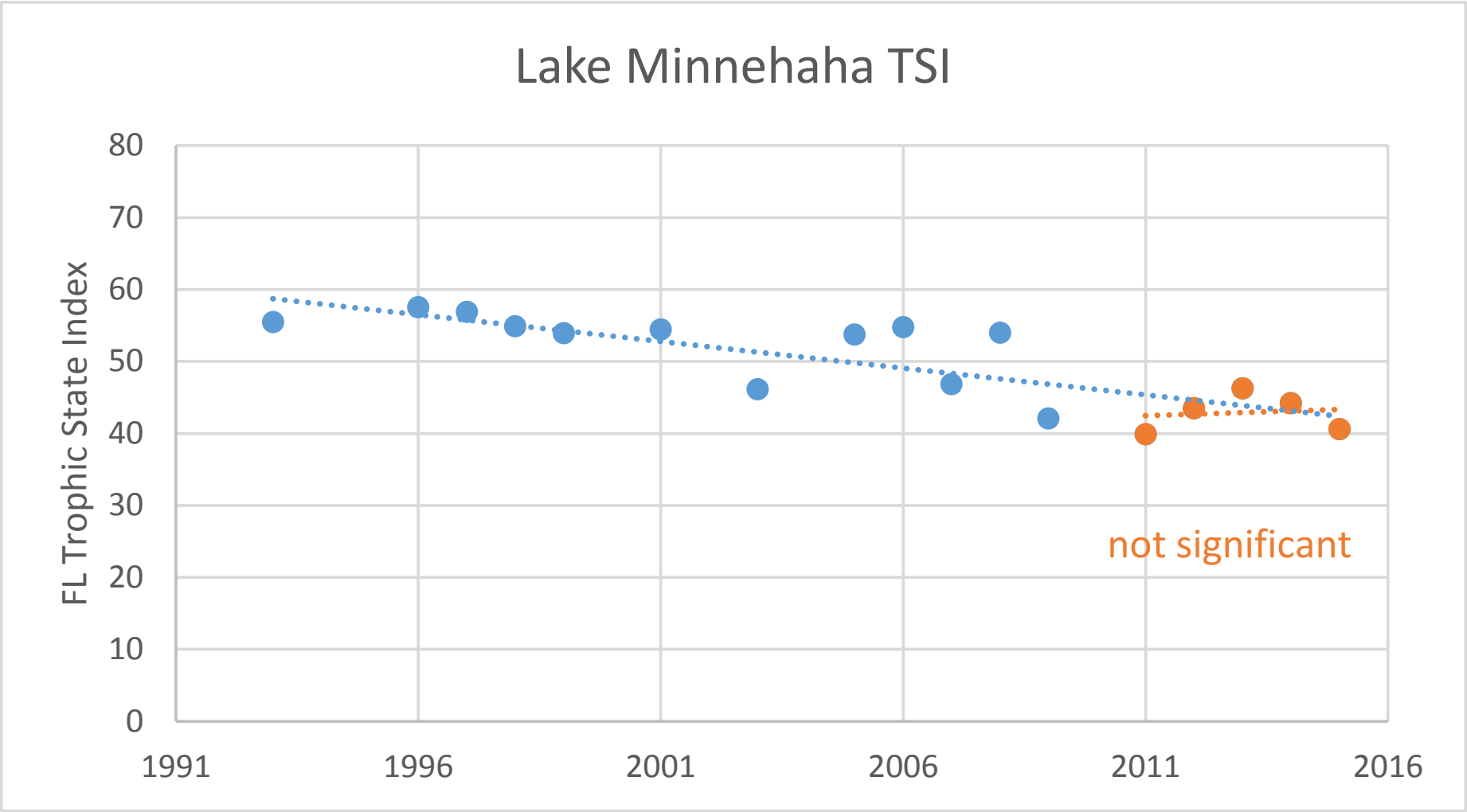
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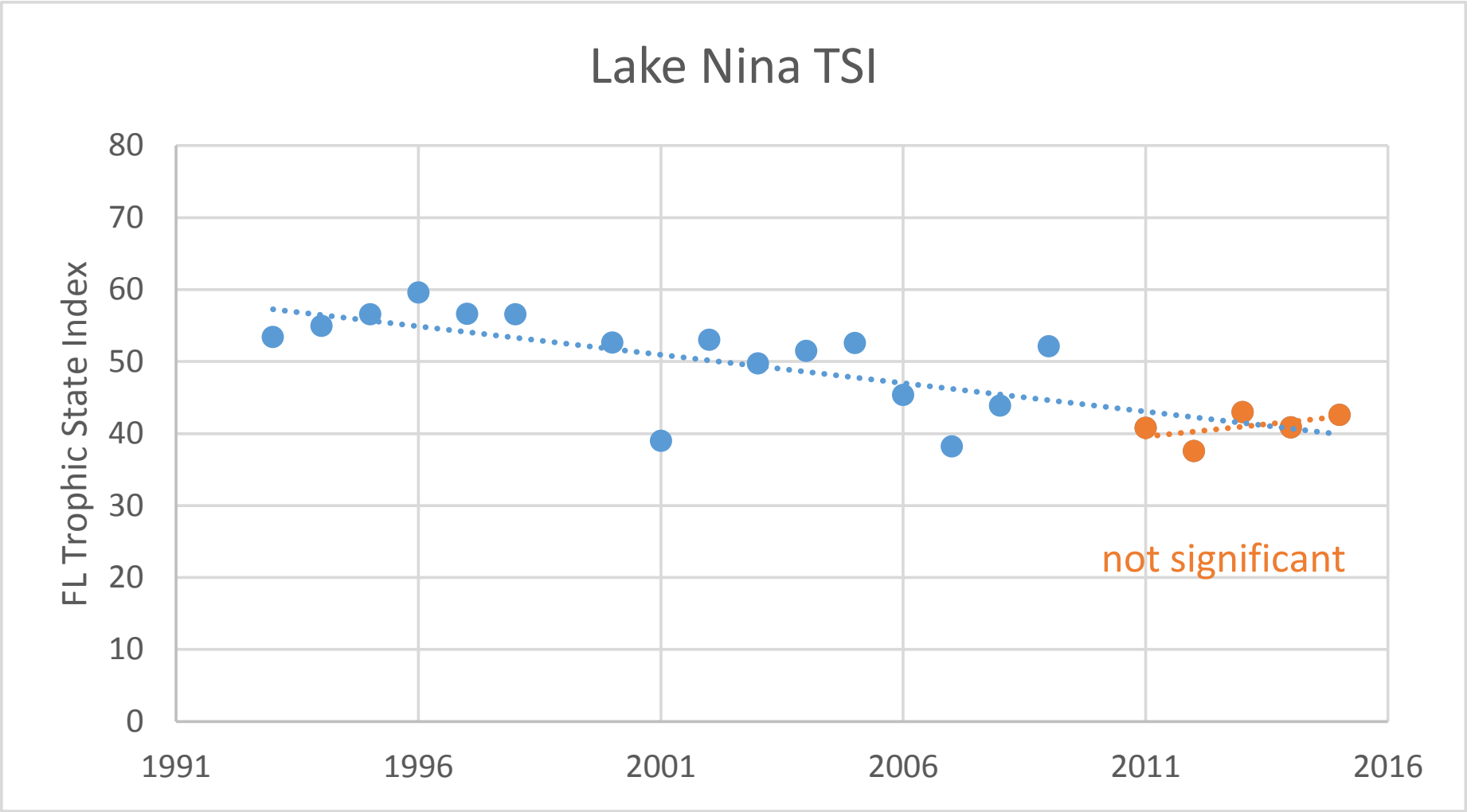
2016
not significant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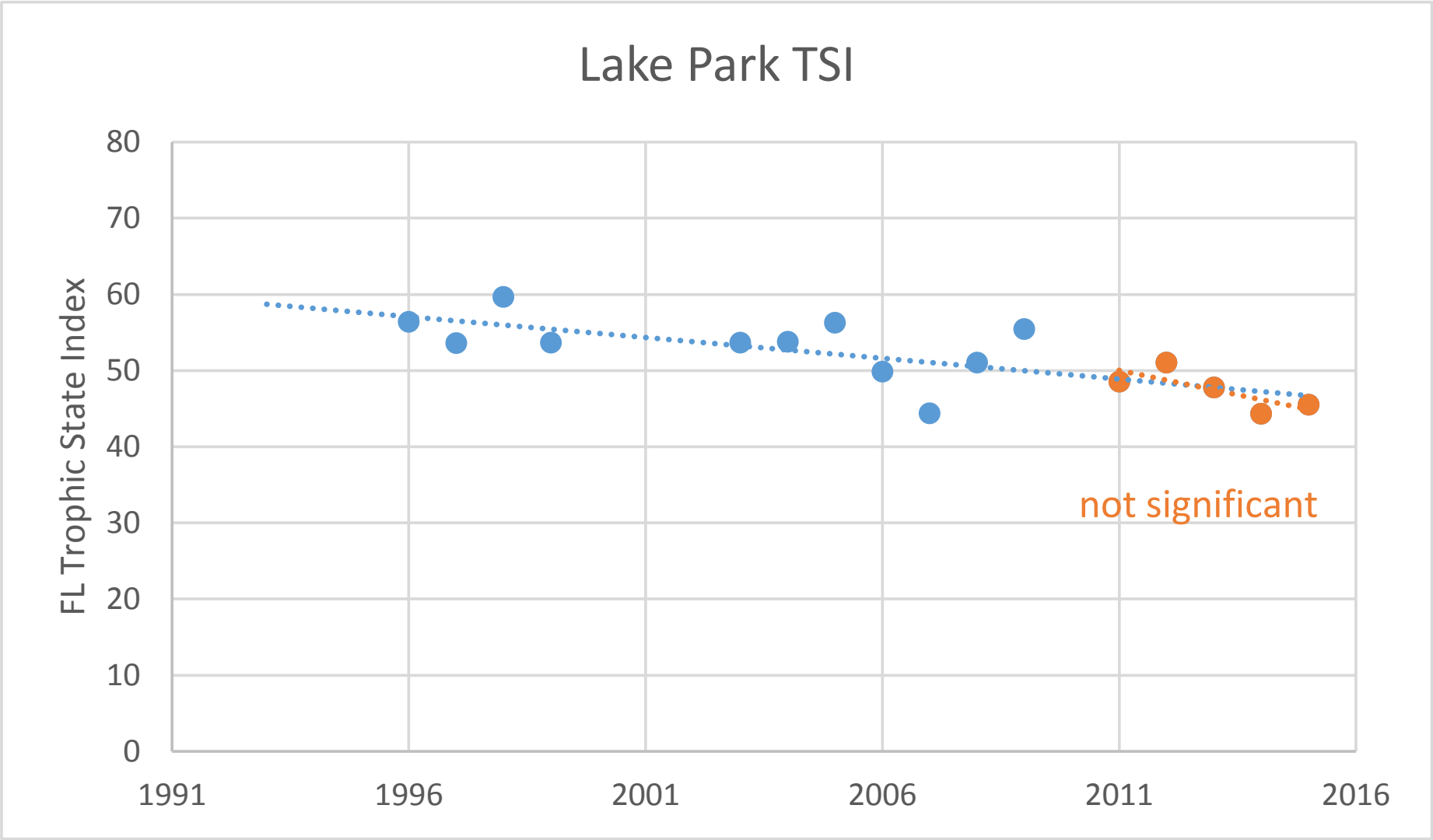
2016
not significant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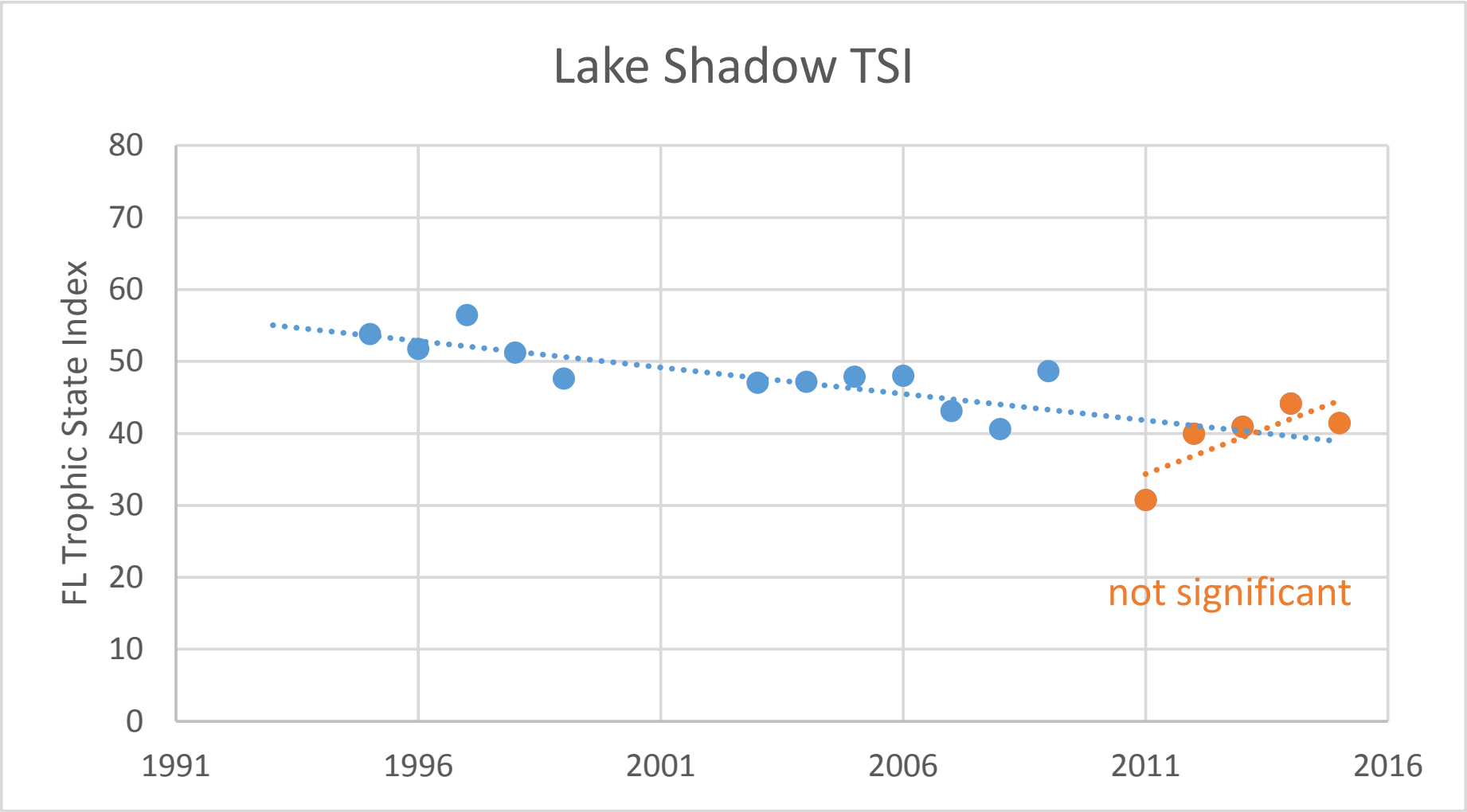
2016
not significant


Lake Shadow TSI
FL Trophic State Index
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70
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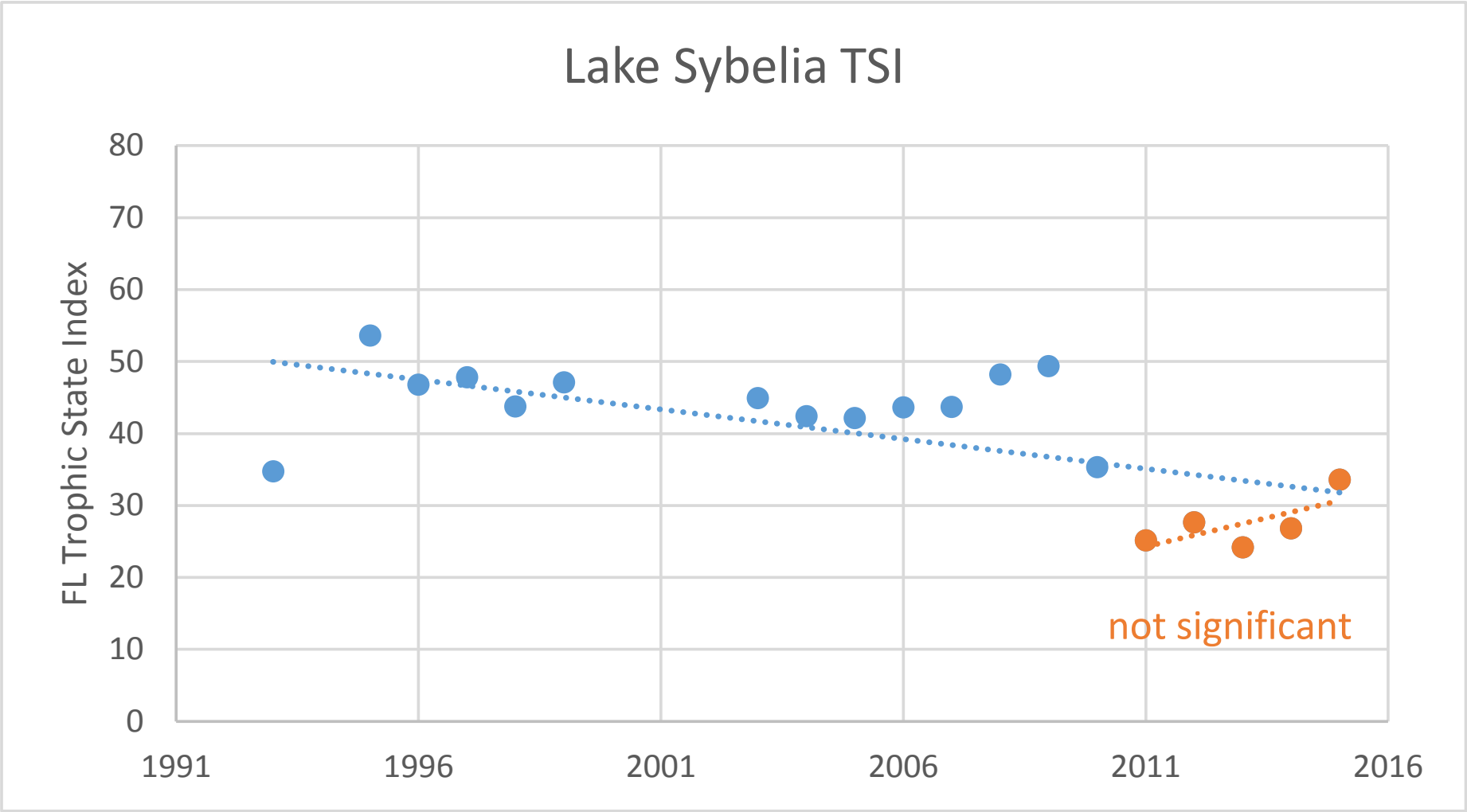
1991
1996
2001
2006
2011
2016
not significant


Lake Sybelia TSI
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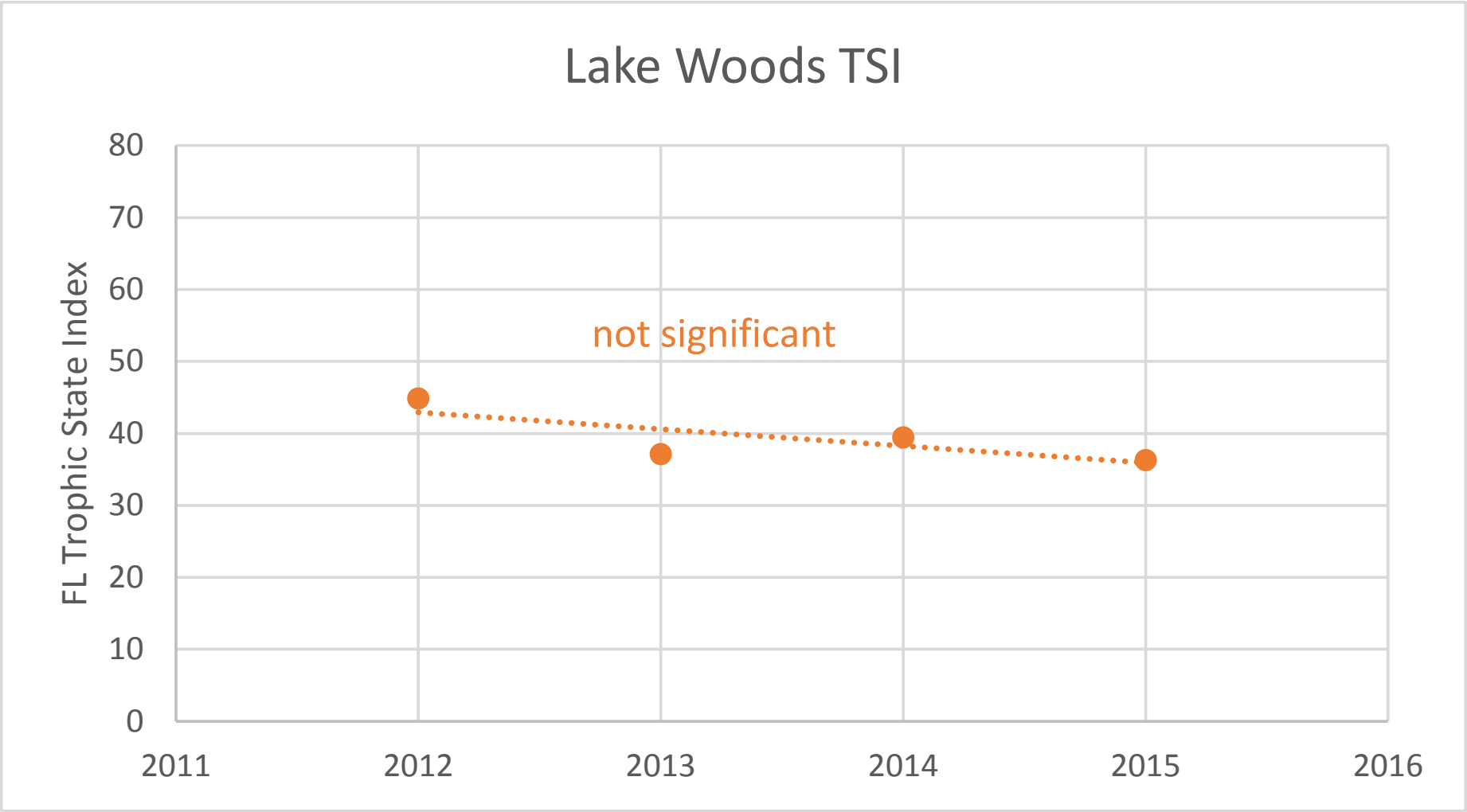
1991
1996
2001
2006
2011
2016
not significant


Lake Woods TSI
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2011
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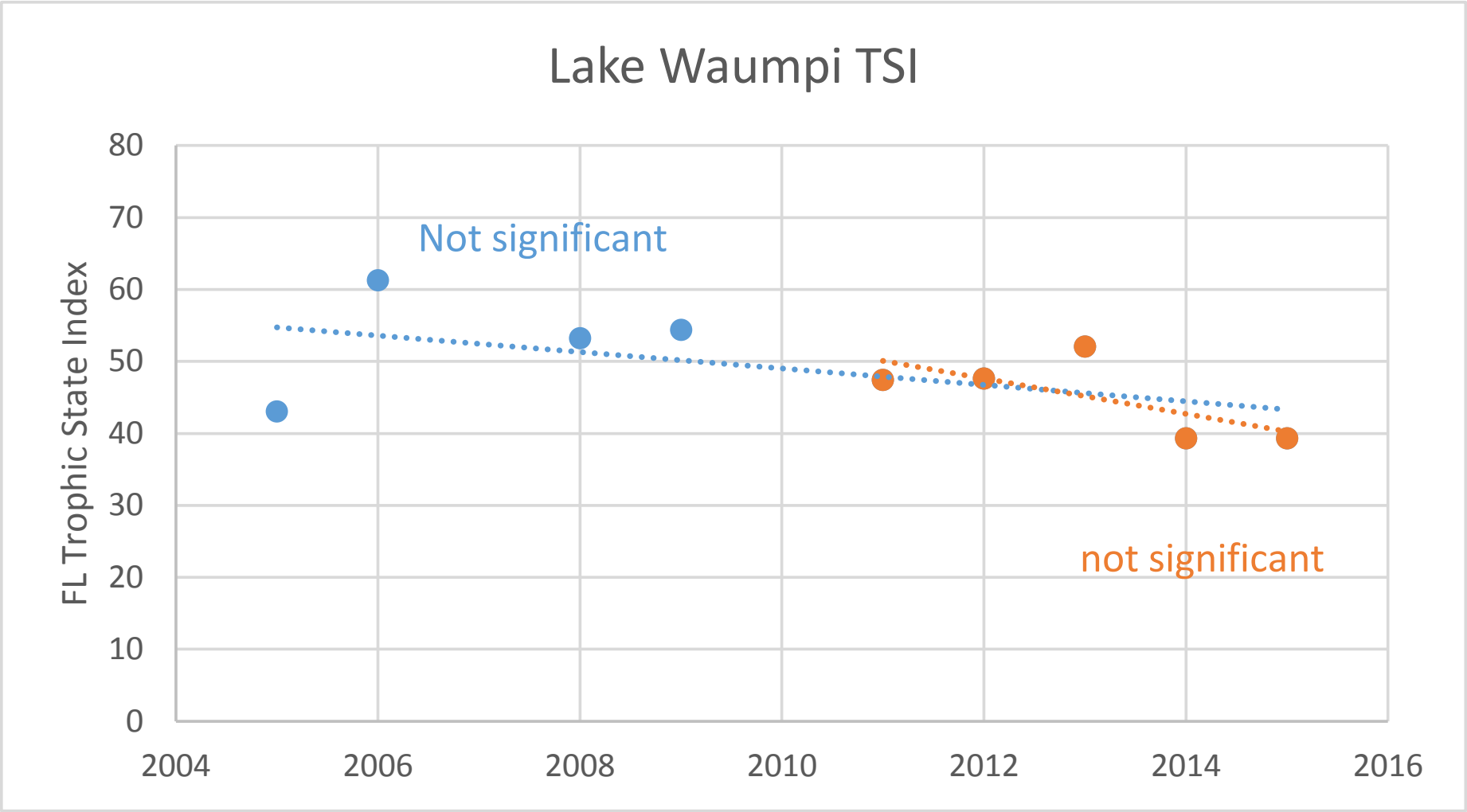
2015
2016
not significant


Lake Waumpi TSI
FL Trophic State Index
80
70
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40
30
20
10
0
2004
2006
2008
2010
2012
2014
2016
Not significant
not significant

Appendix B

Lake	Year	FL TSI
Catherine	1994	34.91134
	1995	31.55875
	1996	36.75113
	1997	35.78749
	1998	39.17703
	1999	30.44757
	2000	31.71554
	2001	45.79447
	2002	45.86905
	2003	36.3965
	2004	39.74136
	2005	36.63249
	2006	37.65619
	2007	39.98615
	2008	41.74335
	2009	44.47473
	2010	30.52596
	2011	22.37479
	2012	23.47375
	2013	16.98045
	2014	28.84127
	2015	26.48888

Long-term Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.43496
R Square	0.18919
Adjusted R	0.14865
Standard E	7.071402
Observatio	22

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	233.3569	233.3569	4.666696	0.043068
Residual	20	1000.095	50.00473		
Total	21	1233.452			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Iper 95.0%*
Intercept	1063.44	476.3427	2.23251	0.037175	69.80648	2057.073	69.80648	2057.073
X Variable	-0.51335	0.237635	-2.16025	0.043068	-1.00905	-0.01765	-1.00905	-0.01765

5-year Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.477271
R Square	0.227788
Adjusted R	-0.02962
Standard E	4.570294
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	18.4843	18.4843	0.884942	0.416251
Residual	3	62.66275	20.88758		
Total	4	81.14705			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Iper 95.0%*
Intercept	-2713.18	2909.297	-0.93259	0.419825	-11971.9	6545.498	-11971.9	6545.498
X Variable	1.35957	1.445254	0.940714	0.416251	-3.23987	5.959012	-3.23987	5.959012

Charity	1994	36.27142
	1995	40.40786
	1996	46.25586
	1997	36.52572
	1998	36.95941
	1999	27.64655
	2000	53.8586
	2002	41.14303
	2003	38.37855
	2004	32.11413
	2005	40.77789
	2006	43.29595
	2007	47.1293
	2008	49.14296
	2009	44.99118
	2010	27.02716
	2011	28.97168
	2012	23.32741
	2013	27.98233
	2014	33.2402
	2015	24.83534

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.413562
R Square	0.171033
Adjusted R	0.127403
Standard E	8.02012
Observatio	21

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	252.15	252.15	3.920101	0.062383
Residual	19	1222.124	64.32233		
Total	20	1474.274			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Iper 95.0%*
Intercept	1114.731	544.2533	2.048184	0.054616	-24.4041	2253.867	-24.4041	2253.867
X Variable	-0.53753	0.271492	-1.97992	0.062383	-1.10577	0.030706	-1.10577	0.030706

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.067118
R Square	0.004505
Adjusted R	-0.32733
Standard E	4.451343
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	0.268994	0.268994	0.013576	0.914607
Residual	3	59.44336	19.81445		
Total	4	59.71236			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Iper 95.0%*
Intercept	-302.482	2833.576	-0.10675	0.921726	-9320.19	8715.223	-9320.19	8715.223
X Variable	0.16401	1.407638	0.116515	0.914607	-4.31572	4.643744	-4.31572	4.643744

Lake	Year	FL TSI
Destiny	1993	31.35919
	1994	24.89736
	1995	28.5425
	1996	28.98805
	1997	32.88048
	1998	33.16709
	1999	23.53012
	2000	41.59251
	2001	32.41922
	2002	32.14574
	2003	28.86189
	2004	24.46116
	2005	32.25291
	2006	38.02001
	2007	43.34955
	2008	36.99536
	2009	42.9278
	2010	27.03221
	2011	23.50515
	2012	41.62426
	2013	28.72825
	2014	32.61048
	2015	27.72793
Eulalia	1993	32.08697
	1994	40.9791
	1995	48.16791
	1996	46.36246
	1997	48.15402
	1998	45.63106
	1999	42.39031
	2000	48.72449
	2001	46.08502
	2004	37.72807
	2005	37.67398
	2006	40.69851
	2007	31.03276
	2008	39.85074
	2009	48.72176
	2010	29.01407
	2011	32.33191
	2012	27.95131
	2013	26.7609
	2014	29.21046
	2015	41.15097

Long-term Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.178686
R Square	0.031929
Adjusted R	-0.01417
Standard E	6.196133
Observatio	23

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	26.59086	26.59086	0.692613	0.414641
Residual	21	806.2334	38.39207		
Total	22	832.8243			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	-292.773	390.3288	-0.75007	0.461536	-1104.51	518.9605	-1104.51	518.9605
X Variable	0.162097	0.194774	0.832234	0.414641	-0.24296	0.567152	-0.24296	0.567152

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.570812
R Square	0.325826
Adjusted R	0.290343
Standard E	6.402703
Observatio	21

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	376.439	376.439	9.182648	0.006884
Residual	19	778.8975	40.99461		
Total	20	1155.337			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	1264.695	404.457	3.126897	0.005552	418.1571	2111.233	418.1571	2111.233
X Variable	-0.61154	0.201809	-3.03029	0.006884	-1.03393	-0.18915	-1.03393	-0.18915

5-year Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.013127
R Square	0.000172
Adjusted R	-0.3331
Standard E	7.902472
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	0.032288	0.032288	0.000517	0.983287
Residual	3	187.3472	62.44906		
Total	4	187.3795			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	145.2232	5030.45	0.028869	0.978782	-15863.9	16154.36	-15863.9	16154.36
X Variable	-0.05682	2.498981	-0.02274	0.983287	-8.0097	7.89605	-8.0097	7.89605

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.515992
R Square	0.266248
Adjusted R	0.021664
Standard E	5.727567
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	35.7107	35.7107	1.088574	0.373464
Residual	3	98.41508	32.80503		
Total	4	134.1258			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	-3772.54	3645.978	-1.03471	0.376896	-15375.7	7830.59	-15375.7	7830.59
X Variable	1.889728	1.811216	1.043348	0.373464	-3.87437	7.653825	-3.87437	7.653825

Lake	Year	FL TSI
Faith	1993	29.79585
	1994	34.61439
	1995	41.8005
	1996	37.8429
	1997	37.94063
	1998	34.4199
	1999	23.80154
	2000	39.801
	2001	33.21255
	2002	24.79947
	2003	22.36938
	2004	26.01763
	2005	34.75515
	2006	37.60559
	2007	35.67429
	2008	34.50896
	2009	39.47898
	2010	32.10877
	2011	24.10443
	2012	29.13867
	2013	23.87042
	2014	30.82532
	2015	31.45417
Gem	1993	66.58366
	1994	68.00176
	1995	62.39049
	1996	66.83756
	1997	67.04669
	1998	58.47637
	2000	60.2304
	2001	60.55448
	2002	62.04159
	2003	60.83636
	2004	59.00056
	2005	59.00629
	2006	59.00219
	2007	49.53939
	2008	54.99917
	2009	56.36141
	2010	48.89558
	2011	57.2628
	2012	55.67626
	2013	59.60194
	2014	53.7612
	2015	51.22771

Long-term Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.297956
R Square	0.088778
Adjusted R	0.045386
Standard E	5.68692
Observatio	23

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	66.16869	66.16869	2.045966	0.167322
Residual	21	679.1622	32.34106		
Total	22	745.3309			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	544.6004	358.2506	1.520166	0.143384	-200.423	1289.623	-200.423	1289.623
X Variable	-0.2557	0.178767	-1.43037	0.167322	-0.62747	0.116063	-0.62747	0.116063

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.808094
R Square	0.653016
Adjusted R	0.635667
Standard E	3.252821
Observatio	22

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	398.2589	398.2589	37.63962	5.39E-06
Residual	20	211.6169	10.58084		
Total	21	609.8757			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	1332.828	207.6353	6.419085	2.92E-06	899.7089	1765.948	899.7089	1765.948
X Variable	-0.63559	0.103598	-6.13511	5.39E-06	-0.85169	-0.41948	-0.85169	-0.41948

5-year Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.709326
R Square	0.503144
Adjusted R	0.337525
Standard E	2.972933
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	26.85053	26.85053	3.037963	0.179695
Residual	3	26.515	8.838332		
Total	4	53.36552			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	-3270.65	1892.47	-1.72824	0.182391	-9293.33	2752.035	-9293.33	2752.035
X Variable	1.638613	0.940124	1.742975	0.179695	-1.35328	4.630507	-1.35328	4.630507

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.688668
R Square	0.474264
Adjusted R	0.299018
Standard E	2.688337
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	19.55874	19.55874	2.706284	0.198503
Residual	3	21.68147	7.227156		
Total	4	41.24021			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	2870.738	1711.306	1.677513	0.192035	-2575.4	8316.876	-2575.4	8316.876
X Variable	-1.39853	0.850127	-1.64508	0.198503	-4.10401	1.306957	-4.10401	1.306957

SUMMARY OUTPUT

Lake	Year	FL TSI
Harvest	1995	28.33398
	1996	31.08305
	1997	38.13423
	1998	36.46966
	1999	25.60078
	2004	39.67864
	2005	39.09764
	2006	37.54172
	2007	39.41512
	2008	42.81155
	2009	48.99743
	2011	23.85023
	2012	26.99328
	2013	28.40043
	2014	30.8073
	2015	36.26171

Long-term Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.016778
R Square	0.000282
Adjusted R	-0.07113
Standard E	7.220873
Observatio	16

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	0.205556	0.205556	0.003942	0.950823
Residual	14	729.9742	52.14101		
Total	15	730.1797			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	-0.12609	552.9501	-0.00023	0.999821	-1186.09	1185.834	-1186.09	1185.834
X Variable	0.017311	0.275707	0.062788	0.950823	-0.57402	0.608643	-0.57402	0.608643

5-year Trend Significance

Regression Statistics	
Multiple R	0.973346
R Square	0.947403
Adjusted R	0.92987
Standard E	1.231917
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	82.00767	82.00767	54.03704	0.005203
Residual	3	4.552859	1.51762		
Total	4	86.56053			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	-5735.36	784.1973	-7.31367	0.005279	-8231.03	-3239.7	-8231.03	-3239.7
X Variable	2.863698	0.389566	7.350989	0.005203	1.623924	4.103472	1.623924	4.103472

Lake	Year	FL TSI
Hope	1995	46.88684
	1996	44.22755
	1997	39.88908
	1998	49.37596
	2000	46.0952
	2003	35.57506
	2004	34.00332
	2005	37.05445
	2006	38.24091
	2007	45.46907
	2008	49.10321
	2009	45.53074
	2011	29.32413
	2012	34.03882
	2013	29.0361
	2014	31.78992
	2015	33.23539

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.630771
R Square	0.397873
Adjusted R	0.357731
Standard E	5.583581
Observatio	17

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	309.0099	309.0099	9.911669	0.00663
Residual	15	467.6457	31.17638		
Total	16	776.6556			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	1391.023	429.3404	3.239907	0.005496	475.9054	2306.14	475.9054	2306.14
X Variable	-0.67399	0.214084	-3.14828	0.00663	-1.1303	-0.21769	-1.1303	-0.21769

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.390755
R Square	0.152689
Adjusted R	-0.12975
Standard E	2.397138
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	3.106517	3.106517	0.540614	0.515444
Residual	3	17.23881	5.746272		
Total	4	20.34533			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	-1090.48	1525.938	-0.71463	0.526426	-5946.7	3765.733	-5946.7	3765.733
X Variable	0.557361	0.758042	0.735265	0.515444	-1.85507	2.969788	-1.85507	2.969788

Lake	Year	FL TSI
Hungerforc	1995	56.98282
	1996	62.25785
	1997	50.82179
	1998	50.23792
	1999	46.83975
	2000	50.10098
	2001	52.03743
	2004	41.82928
	2005	47.93222
	2006	49.23638
	2007	36.95506
	2008	46.21074
	2009	48.15062
	2010	36.57553
	2011	26.29133
	2012	32.70903
	2013	38.09336
	2014	36.18878
	2015	30.96754

Long-term Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.849016
R Square	0.720829
Adjusted R	0.704407
Standard E	5.089749
Observatio	19

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	1137.11	1137.11	43.89448	4.29E-06
Residual	17	440.3943	25.90554		
Total	18	1577.505			

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	2504.048	371.2784	6.744394	3.43E-06	1720.719	3287.377	1720.719	3287.377
X Variable	-1.22668	0.185151	-6.62529	4.29E-06	-1.61731	-0.83605	-1.61731	-0.83605

5-year Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.439571
R Square	0.193223
Adjusted R	-0.0757
Standard E	4.787258
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	16.46646	16.46646	0.718499	0.458906
Residual	3	68.75353	22.91784		
Total	4	85.21998			

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	-2550.27	3047.409	-0.83686	0.46409	-12248.5	7147.95	-12248.5	7147.95
X Variable	1.283217	1.513864	0.847643	0.458906	-3.53457	6.101008	-3.53457	6.101008

Jackson	1993	32.21266
	1994	48.89156
	1995	58.35636
	1996	50.01821
	1997	56.52753
	1998	45.95498
	1999	47.26174
	2000	50.35802
	2001	53.67604
	2002	59.63738
	2003	48.0375
	2004	51.14886
	2005	53.20719
	2006	51.11977
	2007	51.2211
	2008	57.50441
	2009	50.60942
	2011	40.94611
	2012	44.58124
	2013	41.61255
	2014	30.94496
	2015	46.21775

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.270206
R Square	0.073011
Adjusted R	0.026662
Standard E	7.312314
Observatio	22

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	84.2276	84.2276	1.575233	0.223917
Residual	20	1069.399	53.46993		
Total	21	1153.626			

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	637.7605	469.3916	1.358696	0.189371	-341.373	1616.894	-341.373	1616.894
X Variable	-0.29401	0.234258	-1.25508	0.223917	-0.78267	0.19464	-0.78267	0.19464

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.082243
R Square	0.006764
Adjusted R	-0.32431
Standard E	6.842956
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	0.956658	0.956658	0.02043	0.895403
Residual	3	140.4782	46.82605		
Total	4	141.4348			

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	663.4791	4355.998	0.152314	0.888607	-13199.3	14526.21	-13199.3	14526.21
X Variable	-0.3093	2.163933	-0.14293	0.895403	-7.1959	6.577301	-7.1959	6.577301

Lake	Year	FL TSI
Lily	1993	71.47286
	1994	62.30031
	1995	57.76709
	1996	57.93611
	1997	54.7274
	1998	56.15191
	1999	64.58221
	2000	58.82011
	2001	60.19549
	2003	51.30806
	2004	59.61017
	2005	57.15772
	2006	46.51641
	2007	47.35819
	2008	48.51639
	2009	44.15563
	2011	42.53821
	2012	37.21184
	2013	46.81518
	2014	47.32461
	2015	40.38276
Lomond	1995	32.48973
	1996	33.72257
	1997	33.28625
	1998	38.31656
	1999	30.09376
	2000	36.88966
	2001	35.94458
	2003	28.11643
	2004	32.37368
	2005	41.96363
	2006	41.54546
	2007	39.57889
	2008	45.01465
	2009	47.44386
	2011	27.98116
	2012	26.98584
	2013	26.12714
	2014	33.92329
	2015	29.13899

Long-term Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.860271
R Square	0.740066
Adjusted R	0.726385
Standard E	4.578024
Observatio	21

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	1133.747	1133.747	54.09536	5.71E-07
Residual	19	398.2077	20.9583		
Total	20	1531.955			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	2217.962	294.3568	7.534942	4.03E-07	1601.866	2834.058	1601.866	2834.058
X Variable	-1.08043	0.146898	-7.35495	5.71E-07	-1.38789	-0.77297	-1.38789	-0.77297

5-year Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.213689
R Square	0.045663
Adjusted R	-0.27245
Standard E	4.842583
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	3.366178	3.366178	0.143543	0.730008
Residual	3	70.35182	23.45061		
Total	4	73.718			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	-1125.06	3082.627	-0.36497	0.739346	-10935.4	8685.231	-10935.4	8685.231
X Variable	0.580188	1.531359	0.378871	0.730008	-4.29328	5.453656	-4.29328	5.453656

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.115321
R Square	0.013299
Adjusted R	-0.04474
Standard E	6.369476
Observatio	19

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	9.295824	9.295824	0.229129	0.638269
Residual	17	689.6937	40.57022		
Total	18	698.9895			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	260.1367	470.7828	0.552562	0.587756	-733.128	1253.402	-733.128	1253.402
X Variable	-0.1124	0.234816	-0.47867	0.638269	-0.60782	0.383017	-0.60782	0.383017

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.478058
R Square	0.22854
Adjusted R	-0.02861
Standard E	3.103867
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	8.562008	8.562008	0.888729	0.41537
Residual	3	28.90197	9.633991		
Total	4	37.46398			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	-1833.82	1975.818	-0.92813	0.421799	-8121.76	4454.115	-8121.76	4454.115
X Variable	0.925311	0.981529	0.942724	0.41537	-2.19835	4.048974	-2.19835	4.048974

Lake	Year	FL TSI
Lucien		
	1995	27.46971
	1996	31.61466
	1997	34.90324
	1998	36.89243
	1999	26.55348
	2000	31.15441
	2001	39.40657
	2003	19.58764
	2004	37.22505
	2005	37.92848
	2006	38.12136
	2007	37.65568
	2008	44.49209
	2009	42.12439
	2011	24.59424
	2012	23.59426
	2013	20.65717
	2014	30.49982
	2015	29.21202

Long-term Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.145345
R Square	0.021125
Adjusted R	-0.03646
Standard E	7.37769
Observatio	19

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	19.96919	19.96919	0.366876	0.552714
Residual	17	925.3153	54.43031		
Total	18	945.2845			

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Iper 95.0%*
Intercept	362.589	545.3022	0.664932	0.515014	-787.898	1513.076	-787.898	1513.076
X Variable	-0.16474	0.271984	-0.6057	0.552714	-0.73858	0.409095	-0.73858	0.409095

5-year Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.626119
R Square	0.392025
Adjusted R	0.189367
Standard E	3.669938
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	26.05354	26.05354	1.934413	0.258486
Residual	3	40.40535	13.46845		
Total	4	66.45889			

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Iper 95.0%*
Intercept	-3223.49	2336.16	-1.37983	0.261495	-10658.2	4211.211	-10658.2	4211.211
X Variable	1.614111	1.160536	1.390832	0.258486	-2.07923	5.307456	-2.07923	5.307456

Lake	Year	FL TSI
Love	1999	36.27972
	2000	44.19098
	2001	35.94458
	2002	40.59089
	2003	35.51901
	2004	31.35606
	2005	41.94512
	2006	45.05896
	2007	43.64907
	2008	38.06963
	2009	47.24049
	2011	31.68323
	2012	30.49086
	2013	32.07786
	2014	29.26894
	2015	33.62975

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.43105
R Square	0.185804
Adjusted R	0.127647
Standard E	5.415796
Observatio	16

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	93.70853	93.70853	3.19488	0.09553
Residual	14	410.6319	29.33085		
Total	15	504.3404			

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Iper 95.0%*
Intercept	1010.544	544.4905	1.855944	0.084632	-157.272	2178.36	-157.272	2178.36
X Variable	-0.48496	0.27132	-1.78742	0.09553	-1.06689	0.09696	-1.06689	0.09696

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.256141
R Square	0.065608
Adjusted R	-0.24586
Standard E	1.840421
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	0.713485	0.713485	0.210645	0.677473
Residual	3	10.16145	3.387151		
Total	4	10.87494			

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Iper 95.0%*
Intercept	-506.265	1171.551	-0.43213	0.694822	-4234.66	3222.132	-4234.66	3222.132
X Variable	0.267111	0.581992	0.458961	0.677473	-1.58505	2.119271	-1.58505	2.119271

Lake	Year	FL TSI
Maitland	1993	55.45665
	1995	52.24647
	1997	53.71909
	1998	50.47596
	1999	51.58114
	2000	50.9941
	2001	53.07444
	2003	45.75286
	2004	45.22097
	2005	49.47399
	2006	50.85871
	2007	44.19325
	2008	48.21827
	2009	48.86684
	2011	32.23187
	2012	35.32107
	2013	31.48761
	2014	38.2134
	2015	34.68525
Minnehaha	1993	55.50812
	1996	57.5156
	1997	56.91122
	1998	54.877
	1999	53.95041
	2001	54.42785
	2003	46.12913
	2005	53.74388
	2006	54.80466
	2007	46.8259
	2008	53.97724
	2009	42.12439
	2011	39.88951
	2012	43.50789
	2013	46.2724
	2014	44.203
	2015	40.62203

Long-term Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.857789
R Square	0.735801
Adjusted R	0.72026
Standard E	4.07714
Observatio	19

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	787.0278	787.0278	47.34551	2.66E-06
Residual	17	282.5922	16.62307		
Total	18	1069.62			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Ipper 95.0%*
Intercept	2037.199	289.4008	7.03937	1.99E-06	1426.617	2647.782	1426.617	2647.782
X Variable	-0.9933	0.144358	-6.88081	2.66E-06	-1.29787	-0.68873	-1.29787	-0.68873

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.82338
R Square	0.677954
Adjusted R	0.656485
Standard E	3.625135
Observatio	17

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	414.9759	414.9759	31.57726	4.89E-05
Residual	15	197.1241	13.14161		
Total	16	612.1			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Ipper 95.0%*
Intercept	1537.485	264.7577	5.807139	3.46E-05	973.167	2101.802	973.167	2101.802
X Variable	-0.74198	0.13204	-5.61936	4.89E-05	-1.02342	-0.46055	-1.02342	-0.46055

5-year Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.460736
R Square	0.212278
Adjusted R	-0.0503
Standard E	2.742943
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	6.082568	6.082568	0.80845	0.434844
Residual	3	22.57121	7.523737		
Total	4	28.65378			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Ipper 95.0%*
Intercept	-1535.57	1746.066	-0.87944	0.443911	-7092.33	4021.194	-7092.33	4021.194
X Variable	0.779908	0.867395	0.899139	0.434844	-1.98053	3.540346	-1.98053	3.540346

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.129808
R Square	0.01685
Adjusted R	-0.31087
Standard E	3.012526
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	0.466624	0.466624	0.051417	0.835188
Residual	3	27.22593	9.07531		
Total	4	27.69255			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Ipper 95.0%*
Intercept	-391.939	1917.673	-0.20438	0.851135	-6494.83	5710.954	-6494.83	5710.954
X Variable	0.216015	0.952644	0.226753	0.835188	-2.81572	3.247754	-2.81572	3.247754

Lake	Year	FL TSI
Nina	1993	53.41039
	1994	54.98968
	1995	56.56659
	1996	59.62668
	1997	56.63846
	1998	56.60966
	2000	52.66065
	2001	38.99367
	2002	53.04166
	2003	49.77445
	2004	51.51181
	2005	52.58555
	2006	45.40763
	2007	38.24241
	2008	43.88634
	2009	52.13795
	2011	40.79395
	2012	37.55855
	2013	42.97063
	2014	40.86423
	2015	42.59956
Park	1996	56.38353
	1997	53.63679
	1998	59.70761
	1999	53.66844
	2003	53.64604
	2004	53.76636
	2005	56.28072
	2006	49.88385
	2007	44.41702
	2008	51.07026
	2009	55.4694
	2011	48.58757
	2012	51.07218
	2013	47.78649
	2014	44.31149
	2015	45.55724

Long-term Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.771336
R Square	0.594959
Adjusted R	0.573641
Standard E	4.604707
Observatio	21

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	591.7604	591.7604	27.90885	4.24E-05
Residual	19	402.8632	21.20333		
Total	20	994.6236			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	1629.428	299.235	5.44531	2.97E-05	1003.121	2255.734	1003.121	2255.734
X Variable	-0.78885	0.149322	-5.28288	4.24E-05	-1.10138	-0.47631	-1.10138	-0.47631

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.743199
R Square	0.552344
Adjusted R	0.520369
Standard E	3.154227
Observatio	16

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	171.8619	171.8619	17.27403	0.00097
Residual	14	139.2881	9.949149		
Total	15	311.15			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	1146.466	263.4359	4.351974	0.000663	581.4524	1711.48	581.4524	1711.48
X Variable	-0.54579	0.131319	-4.1562	0.00097	-0.82744	-0.26414	-0.82744	-0.26414

5-year Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.510791
R Square	0.260908
Adjusted R	0.014544
Standard E	2.125479
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	4.784354	4.784354	1.059034	0.379146
Residual	3	13.55298	4.51766		
Total	4	18.33733			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	-1351.42	1353.009	-0.99882	0.39149	-5657.29	2954.463	-5657.29	2954.463
X Variable	0.69169	0.672135	1.029094	0.379146	-1.44734	2.830725	-1.44734	2.830725

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.766778
R Square	0.587949
Adjusted R	0.450599
Standard E	1.959654
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	16.43875	16.43875	4.280652	0.13037
Residual	3	11.52073	3.840243		
Total	4	27.95948			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	2628.404	1247.45	2.107021	0.125723	-1341.54	6598.348	-1341.54	6598.348
X Variable	-1.28214	0.619697	-2.06897	0.13037	-3.25429	0.690016	-3.25429	0.690016

Lake	Year	FL TSI
Shadow	1995	53.78219
	1996	51.74532
	1997	56.47231
	1998	51.22116
	1999	47.65523
	2003	47.05004
	2004	47.17782
	2005	47.88024
	2006	47.99444
	2007	43.12664
	2008	40.61241
	2009	48.63405
	2011	30.75588
	2012	39.9989
	2013	40.93059
	2014	44.14778
	2015	41.44555

Long-term Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.784833
R Square	0.615963
Adjusted R	0.590361
Standard E	3.937693
Observatio	17

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	373.0415	373.0415	24.05877	0.00019
Residual	15	232.5814	15.50543		
Total	16	605.6229			

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	1518.205	300.1633	5.057931	0.000142	878.4224	2157.988	878.4224	2157.988
X Variable	-0.73416	0.149676	-4.90497	0.00019	-1.05318	-0.41513	-1.05318	-0.41513

5-year Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.791094
R Square	0.625829
Adjusted R	0.501105
Standard E	3.603857
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	65.16911	65.16911	5.017724	0.110959
Residual	3	38.96335	12.98778		
Total	4	104.1325			

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	-5099.38	2294.095	-2.22283	0.112746	-12400.2	2201.455	-12400.2	2201.455
X Variable	2.552824	1.13964	2.240028	0.110959	-1.07402	6.179666	-1.07402	6.179666

Sybelia	1993	34.73172
	1995	53.5884
	1996	46.77144
	1997	47.8173
	1998	43.79116
	1999	47.10264
	2003	44.95713
	2004	42.44332
	2005	42.16695
	2006	43.65889
	2007	43.70136
	2008	48.18436
	2009	49.35666
	2010	35.3333
	2011	25.17633
	2012	27.64957
	2013	24.16515
	2014	26.80465
	2015	33.58233

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.634555
R Square	0.40266
Adjusted R	0.367522
Standard E	7.165135
Observatio	19

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	588.3215	588.3215	11.45951	0.003519
Residual	17	872.7656	51.33915		
Total	18	1461.087			

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	1694.545	488.7472	3.467118	0.002947	663.378	2725.711	663.378	2725.711
X Variable	-0.82518	0.243763	-3.38519	0.003519	-1.33948	-0.31089	-1.33948	-0.31089

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.686997
R Square	0.471965
Adjusted R	0.295953
Standard E	3.083479
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	25.4947	25.4947	2.681439	0.200048
Residual	3	28.52353	9.507842		
Total	4	54.01823			

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	-3186.69	1962.84	-1.62351	0.20294	-9433.33	3059.939	-9433.33	3059.939
X Variable	1.596706	0.975082	1.63751	0.200048	-1.50644	4.699851	-1.50644	4.699851

Lake	Year	FL TSI
Waumpi	2005	43.04726
	2006	61.25649
	2008	53.22515
	2009	54.40894
	2011	47.45876
	2012	47.61475
	2013	52.08762
	2014	39.32365
	2015	39.33609

Long-term Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.548751
R Square	0.301127
Adjusted R	0.201288
Standard E	6.570785
Observatio	9

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	130.2221	130.2221	3.016131	0.126013
Residual	7	302.2265	43.17521		
Total	8	432.4485			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	2342.729	1320.949	1.773521	0.11942	-780.817	5466.276	-780.817	5466.276
X Variable	-1.14115	0.657078	-1.7367	0.126013	-2.69489	0.412595	-2.69489	0.412595

5-year Trend Significance

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.687744
R Square	0.472992
Adjusted R	0.297322
Standard E	4.728603
Observatio	5

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	60.2037	60.2037	2.692511	0.199357
Residual	3	67.07906	22.35969		
Total	4	127.2828			

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	4984.35	3010.071	1.655891	0.19632	-4595.04	14563.74	-4595.04	14563.74
X Variable	-2.45364	1.495316	-1.64089	0.199357	-7.21241	2.305117	-7.21241	2.305117

Woods	2012	44.83209
	2013	37.12225
	2014	39.43781
	2015	36.28347

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.782839
R Square	0.612837
Adjusted R	0.419255
Standard E	2.932007
Observatio	4

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	27.21514	27.21514	3.165779	0.217161
Residual	2	17.19332	8.596662		
Total	3	44.40846			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	4736.974	2640.168	1.794194	0.214637	-6622.75	16096.7	-6622.75	16096.7
X Variable	-2.33303	1.311233	-1.77926	0.217161	-7.97481	3.308751	-7.97481	3.308751

Task 3-Review and Update of Prior BMP Recommendations

Technical Memo

To: Paul Ritter, City of Maitland

From: Lance Lumbard, Amec Foster Wheeler

Date: May 4, 2016

Re: Task 3 - Review and Update of Prior BMP Recommendations
Amec Foster Wheeler Project No. 600314.7

Beginning in 1996, the City of Maitland has prepared and routinely updated a Stormwater Lakes Management Plan (SLMP). The SLMP contains information regarding water quality trends and provides guidance regarding structural and non-structural water quality improvement Best Management Practices (BMPs) for the City's lakes.

The City recently determined that strategic updates of certain sections of the SLMP would be more informative and cost-effective than a complete SLMP update. To assist the City with these updates, Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler) was assigned three critical tasks including: field verification and development of a Geographic Information Systems (GIS) database for existing BMPs maintained by the City as documented in the 2011 SLMP; updates of water quality trends to include Trophic State Index (TSI) and assessment of potential impairments using new Numeric Nutrient Criteria (NNC); and review and update of prior BMP recommendations.

The information provided in this technical memorandum is intended to satisfy **Task 3** to review the prior BMP recommendations and provide updated recommendations.

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BMP RECOMMENDATIONS AND COSTS

The City has been working from a list of conceptual BMPs that includes nearly 400 potential projects and $112 million in capital costs. Amec Foster Wheeler was tasked with updating and streamlining the current project list to provide recommendations for future projects that are most suitable for construction. The following information provides an overview of the revised two-step BMP selection process and provides the City with a comprehensive, yet strategically updated projects list for the current 2016-2020 five year plan and beyond.

LAKE PRIORITIZATION

The first step in the revised BMP selection process involved creation of a "top ten" list of priority lakes. All lakes were ranked according to the criteria shown in **Table 1**. Lake prioritization scores were determined using the Trophic State Index (TSI) as calculated in **Task 2** and other water quality and public access criteria similar to those used in the prior SLMP. A new "priority waterbodies contributing to Lake Jesup" criterion was added for the purpose of this update. This criterion provides additional weight to waterbodies for which the City is required to implement load reduction projects to achieve Lake Jesup Total Maximum Daily Load requirements.

Top ten lakes include (in order) Lakes Minnehaha, Gem, Maitland, Park, Waumpi, Lily, Nina, Sybelia, Jackson, and Shadow. Lakes Sybelia, Jackson and Shadow score considerably lower than the top seven. These lakes are discussed in detail in the next section.

The top ten list reduces the original list of 400 possible projects by about 75 percent, leaving approximately 100 projects which the City may consider for further analysis in step two. Unlike the prior SLMPs, leaf basket and leaf trap projects were considered collectively and discussed later since they can generally be implemented easily but require a special maintenance program.

Step two involved ranking individual projects by pollutant load contribution and load removal efficiency. Higher ranking BMP alternatives maximize load reduction per dollar spent. **Table 2** provides the comprehensive list of BMP alternatives and their rankings based on step two. BMP alternatives were ranked using total weighted scores from step 1, relative load contribution, and cost per pound of TP removal using the prior SLMP data. Because the BMPs alternatives ranked in this step are already associated with the "top ten" list, the City can be confident that projects on this list meet a minimum standard for use of public funds.

BMPs evaluated in 2011 were generally retained if they had not yet been implemented. Costs of these retained 1996 BMPs were escalated by 5.4% over 5 years from 2011 to 2016, using the construction cost index published by Engineering News Record. The pollutant loading reductions associated with each retained BMP were re-evaluated using pollutant loading efficiencies presented in **Table 5-2**, and rescored using revised screening criteria reflecting current water quality status and revised guidance from the Lakes Advisory Board (LAB).

Outfalls with substantial changes in land use, or where BMPs had been implemented since 2011 were reviewed in greater detail and an updated list of BMP alternatives was developed. New and innovative BMP alternatives, for which new information are available to support more reliable performance evaluation and cost estimation were considered and substituted for prior BMPs in some outfalls, with emphasis on lakes that continue to exhibit a need for water quality improvement, or are otherwise highly ranked by LAB recommended criteria. Land, construction,

and operation and maintenance costs used in the 2011 SLMP were increased by 5.4% to account for inflation through 2015 (http://www.usinflationcalculator.com/). Land cost was included for all alternatives that require dedicated land, even if the land is already owned by the City to reflect an opportunity cost, wherein the land could not be used to achieve other City goals. Thus these land costs are an appropriate evaluation criterion, but may not represent actual outlays to the City.

The BMP options were sized to meet the minimum treatment volumes specified by the St. Johns River Water Management District (SJRWMD). All of the BMP treatment efficiencies used in the pollutant reduction calculations are based on the full treatment volumes. SJRWMD does not require that retrofit stormwater treatment systems be designed to minimum criteria; however, the pollutant removal efficiencies and BMP effectiveness would be greatly reduced if a lesser volume were treated.

The sizing of most of the recommended BMPs was based on SJRWMD criteria. The systems that did not have regulatory criteria were sized using previous working designs and published data on stormwater runoff. The dry detention, wet detention, and wetland treatment systems were sized according to the storage and treatment of the first inch of runoff from the contributing area. The retention and exfiltration trench systems were sized based on the storage and treatment of the first one-half inch of runoff from the contributing area. The swale systems were sized based on the 80% of the volume of runoff from the 3-year/one-hour storm event. The sediment sump/inlet was designed to remove the large solids found in stormwater runoff. The sediment sump/inlet system is sized only to treat stormwater during minor storm events.

Operation and maintenance (O&M) costs were estimated using prior SLMP data, where annual O&M costs are defined. All O&M and Total Costs presented in this section reflect Net Present Worth costs using a 6% discount rate and a 25 year term. Cost-effectiveness rankings used to develop recommendations are based on Net Present Worth costs.

LAKE BASIN EVALUATIONS

Each of the top ten lake basins are evaluated below in order of the ranking resulting from step one. This section identifies the subbasins of each lake, the drainage area, the quantity of pollutants contributed by each outfall, and potential BMPs. Similar to the previous SLMPs, the percent of the total phosphorus loading to the lake from each outfall is identified as a means of characterizing the priority of an action on each outfall to overall lake quality. Existing BMPs that were identified in **Tasks 1** and **2** and are not included in this step. In addition, in-lake BMP alternatives are not considered individually, but are discussed as part of the programmatic lake management project section. In prior SLMPs, five BMP alternatives were identified per outfall which often resulted in a “no recommendation”. For clarity, any “no recommendation” alternative has been removed from this SLMP update.

Lake Minnehaha

Lake Minnehaha is a 95-acre lake with a 508-acre contributing area, resulting in a total basin area of 603 acres. The land use in the basin is predominantly Single Family Residential (68%). The predominant soil type in the basin is hydrologic soil group A (73%). The contributing drainage area is divided into twenty-four subbasins and there are three additional contributing subbasins located outside the city (6 acres). **Figure 1** shows the Lake Minnehaha basin and subbasins. Lake Minnehaha receives discharge from Lake of the Woods and discharges into Lake Maitland through Lake Nina.

Pollutant Loading by Outfall

There are twenty outfalls discharging to Lake Minnehaha. All outfalls are within the City limits. The existing TSI for the lake is fair (mesotrophic), and its water quality indices are stable. Pollutant loading rates for each outfall are listed in **Table 3**. Stormwater from approximately 19% of the contributing land area is already treated by existing BMPs. Outfall MI122, which drains seven subbasins totaling 19% of the total contributing land area, including areas outside the City of Maitland, has the highest pollutant loading rates for all stormwater pollutants and contributes 30% of the TP loading to Lake Minnehaha.

Subbasins MI2, MI4, MI22, MI23, MI91, MI92, and MI97 do not have direct discharges into Lake Minnehaha and contribute pollutants to adjacent parcels. Subbasin MI1 contributes sheet flow pollutants to the lake. The runoff from the other subbasins flow to the lake through inlets and culverts.

BMP Alternatives

Table 4 lists the BMP options for each outfall and their estimated costs. **Table 5** identifies the most cost-effective BMPs by ranking them by the percent overall phosphorus removal in terms of dollars spent per pound removed. The most cost-effective options for treating TP discharging to Lake Minnehaha are:

- M103-2 – Some work has taken place in this area, but additional work is possible and could provide significant reductions due to the land use in this area. This project could be completed for an estimated $911,452
- MI116-1 – Off-Line Retention could reduce TP discharges by 1% at a total cost of $62,640. This project is currently planned.
- MI117-2 – Sediment Sump / Inlets could reduce TP loading by 2% at a total cost of approximately $337,305.
- MI103-3, MI110-2, MI112-2, and MI113-3 – All of these options are the same technology (Sediment Sump / Inlets); each would remove 1% of TP loading; and their costs are similar ($230,000 to $260,000). Each is also the most cost-effective option for the specific outfall. A nutrient separating baffle box is currently planned for outfall MI-114.
- MI117-1 – Infiltration Systems / Trenches could remove 6% of TP loading to Lake Minnehaha (more TP removed than MI117-2) but at a much higher cost of approximately $1,065,929.
- MI105-2 - This BMP alternative consists of a sediment sump in Lake-of-the-Woods Creek prior to discharge into Lake Minnehaha. The sump would be constructed on the east side of Dommerich Drive to provide sufficient maintenance access.

A variety of other BMP options are also summarized in **Table 5**, but the options summarized above appear the most promising, either because of their cost-effectiveness, or their impact of lake quality by the percent of TP loading that they could remove.

Lake Gem

Lake Gem is an 8-acre lake with a 281-acre contributing area, resulting in a total basin area of 289 acres. The land use in the basin is a primarily a mixture of Low-Intensity Commercial (42%), Single Family Residential (23%), and Multi-Family Residential (16%). The predominant soil type in the basin is hydrologic soil group A (48%), with D (37%) and C (15%). Although Lake Gem is entirely within the City, more than 80% of its drainage area is outside the City limits, which limits the City's ability to have a significant impact on the quality of Lake Gem. The City's ability to maintain or improve water quality of Lake Gem is further limited by the fact that approximately 1/3 of the TP loading to Lake Gem comes from upstream discharge from Lake Killarney, also outside the control of the City. Considering these factors, only about 12% of the TP loading to Lake Gem comes from City sources. Lake Gem is connected to Lake Maitland through Park Lake. **Figure 2** shows the Lake Gem basin and subbasins.

Pollutant Loading By Outfall

Pollutant loading rates for each outfall are listed in **Table 6**. Outfall GE191 (non-City source area) contributes more than 59% of the total TP loading. This outfall also is the largest contributor of TN, BOD, and TSS loadings to Lake Gem.

All of the subbasins have direct discharges into the lake, and none of the subbasins can contribute pollutants to adjacent parcels. Runoff from the subbasins flows into the lake through inlets and a culvert or concrete flumes.

There are five outfalls to Lake Gem. The existing TSI for the lake is fair (mesotrophic), but its water quality index shows an improving water quality trend towards an oligotrophic state. This may be attributable to the BMPs that have been implemented as a result of the City's previous efforts. If this trend continues, Lake Gem may reach an oligotrophic state in the near future.

BMP Alternatives

Table 7 lists the BMP options for each outfall and the estimated costs. **Table 8** identifies the most cost-effective BMPs by ranking them by the percent overall phosphorus removal in terms of dollars spent per pound removed. The most cost-effective BMP options for treating stormwater pollutant loadings to Lake Gem would be:

- GE101-2 – Nutrient separating baffle boxes are currently proposed and budgeted to treat this outfall.
- GE102-1 – Nutrient separating baffle boxes are currently proposed and budgeted to treat this outfall.
- GE103-4 – Nutrient separating baffle boxes are currently proposed and budgeted to treat this outfall.
- GE104-2 – Nutrient separating baffle boxes are currently proposed and budgeted to treat this outfall.

Lake Waumpi

Lake Waumpi is a 12-acre lake with a contributing land area of 767 acres. Most of Lake Waumpi, and its drainage area, are outside the City of Maitland. Lake Waumpi receives inputs from Lake Maitland after Maitland's discharge flows through a wetland. Lake Waumpi discharges to Lake Howell. Lake Waumpi has a relatively high flow through and low water residence time. Lake Waumpi receives 19% of its TN load from upstream sources (Lake Maitland and wetland areas). The predominant land uses in the basin are Single Family Residential (41%), Multi-Family Residential (23%), and Recreation / Open Space (18%). The predominant soil type in the basin is hydrologic soil group A (72%). Lake Waumpi is subdivided into two subbasins one in the City (32 acres) and one outside the City of Maitland (723 acres) (**Figure 3**). Lake Waumpi also receives water from the surrounding wetlands. These wetlands have been considered in the analysis of BMPs to reduce TP loadings to Lake Waumpi.

Pollutant Loading by Outfall

Pollutant loading rates for each outfall are listed in **Table 9**. There are several outfalls discharging stormwater to Lake Waumpi. The existing TSI for the lake is fair (mesotrophic), and its water quality indices are stable. More than 97% of the TP loading to Lake Waumpi is from outside the City of Maitland, and consequently City actions could not have much impact on the quality of Lake Waumpi.

BMP Alternatives

Table 10 lists the BMP options for each outfall and their estimated costs. **Table 11** identifies the most cost-effective BMPs by ranking them by the percent overall phosphorus removal in terms of dollars spent per pound removed. The most cost-effective options to reduce TP loadings to Lake Waumpi are:

- WA111-1 – A Baffle Box could be used in place of the storm manhole at the intersection of Tomahawk Trail and Mohawk Trail to reduce the TP loadings to Wetland-14 (WE-14), which in turn would reduce TP loadings to Lake Waumpi by 1% for a total cost of approximately $101,791; the endwall the connects the outfall pipes from the proposed baffle box to the wetland would also need to be replaced because of its poor current state.
- WE113-1 – Off-Line Retention: Construction of a sedimentation basin near the inlet on Tuscarora Trail that discharges into the wetlands that ultimately discharges to Lake Waumpi. The inlet currently suffers from sedimentation build up within the inlet and also in the pipe that discharges stormwater to the wetlands. This BMP could reduce TP loadings by 3% at a cost of approximately $435,723. If this improvement could be contained within City owned property, the cost could be considerably reduced.
- WE114-2 – Siltation Basin: The creek, that flows from the endwall at the intersection of Tomahawk Trail and Mohawk Trail through the wetland, could be deepened and widened where it meets Temple Trail in order to increase the detention time through that area before discharging under Temple Trail back into Wetland-95 and ultimately into Lake Waumpi. This BMP could reduce TP loadings to Lake Waumpi by 2% at a cost of approximately $177,547.

Lake Maitland

Lake Maitland is a 443-acre lake with 178 acres within the City limits. The contributing drainage area is 890 acres, with a resultant total basin area of 1,333 acres. Lake Maitland is the largest lake in the City of Maitland. The predominant land use in the basin is Single Family Residential (59%). The predominant soil type in the basin is hydrologic soil group A (90%). The contributing drainage area is divided into twenty-one subbasins, and there are five additional contributing subbasins located outside the city (631 acres). Therefore approximately 60% of the lake surface is outside the City and approximately 71% of the contributing land area is outside city limits as well. **Figure 4** shows the Lake Maitland basin and subbasins. Lake Maitland is connected to lakes Nina and Minnehaha, and it discharges to wetlands to the east.

Pollutant Loading by Outfall

There are twenty-four outfalls in Lake Maitland. The existing TSI for the lake is excellent (oligotrophic), and its water quality indicators exhibit a statistically significant trend of improvement. Production is thought to be phosphorus limited. Pollutant loading rates for each subbasin are listed in **Table 12**. Outfall 194 (outside the City) contributes the predominant load of stormwater pollutants to Lake Maitland with 62% of TP loading.

Only subbasins MA9 and MA17 do not have direct discharges into the lake and contribute pollutants to adjacent parcels. Subbasins MA1, MA7, MA19, MA20, MA21, MA91, MA92, MA94, and MA95 contribute sheet flow pollutants to the Lake Maitland. The runoff from the other subbasins flow to the lake through inlets and culverts.

BMP Alternatives

Table 13 lists the BMP options for each outfall and their estimated costs. **Table 14** identifies the most cost- effective BMPs by ranking them by the percent overall phosphorus removal in terms of dollars spent per pound removed. The most cost-effective BMP options for reducing TP loadings to Lake Maitland would be:

- MA102-2, MA103-2, MA104-2, MA105-2, MA108-3, MA114-3, and MA120-2 – Sediment Sump / Inlets could each reduce TP loading by approximately 1% at a total approximate cost between $85,000 and $210,000;
- MA114-1 – Off-Line Retention treatment of this outfall would have a greater TP loading reduction, but at much greater cost of $1,516,326.
- Infiltration Systems Trenches are a potential option for the MA102, MA103, M105, MA114, and MA120 outfalls, but these are significantly more expensive ranging between $310,000, and $740,000.

A variety of other BMP options are summarized in **Table 14**.

Park Lake

Park Lake is a 32-acre lake with a 121-acre contributing area, resulting in a total basin area of 153 acres. The land use in the basin is a mixture of Multi-Family Residential (37%), Single Family Residential (28%) and Recreation / Open Space (17%). The predominant soil type in the basin is hydrologic soil group A (75%). The contributing drainage area is divided into ten subbasins, and there are three additional contributing subbasins located outside the City (18 acres, i.e., 15% of contributing land area). **Figure 5** shows the Park Lake basin and subbasins. Park Lake discharges into Lake Maitland.

Pollutant Loading by Outfall

There are eleven outfalls discharging to Park Lake. The existing TSI for the lake is excellent (oligotrophic), and its water quality indices are improving. Pollutant loading rates for each subbasin are listed in **Table 15**. Outfall PA108, draining subbasins PA7, PA8, and PA9, a total of 33 acres, has the highest loading rates for all stormwater pollutants, including 22% of TP loading to Park Lake.

Subasins PA91, PA92, and PA93 do not have direct discharges into the lake and contribute pollutants to adjacent parcels. Subbasins PA9, PA91, PA92, and PA93 do not contribute sheet flow pollutants to the lake. Runoff from subbasins PA1, PA2, PA5, PA8, and PA9 flow to the lake through inlets and culverts.

BMP Alternatives

Table 16 lists the BMP options for each outfall and their estimated costs. **Table 17** identifies the most cost- effective BMPs by ranking them by the percent overall phosphorus removal in terms of dollars spent per pound removed. The most cost-effective BMP options to reduce TP loading to Park Lake are:

- Sediment Sump / Inlets are currently budgeted for outfalls PA101, and PA108, but are also potential alternatives for PA102, PA103, PA104, PA105 and PA110; total cost to implement these BMPs range from $63,245 (PA104-1) to $379,468 (PA108-4).
- Infiltration Systems / Trenches for PA103 could remove 9% of TP loading for a total cost of approximately $319,778.
- Off-Line Retention is the most cost-effective option for outfall PA102; option PA102-1 could remove 12% of TP loading for a total cost of $501,959.

Lake Lily

Lake Lily is a 5-acre lake with a 49-acre contributing area, resulting in a total basin area of 54 acres. Predominant land uses are Low-Intensity Commercial (40%), High-Intensity Commercial (26%), and Recreation / Open Space (21%). The predominant soil type in the basin is hydrologic soil group D (64%). The contributing drainage area is divided into six subbasins. **Figure 6** shows the Lake Lily basin and subbasins. Lake Lily discharges into Lake Maitland through a circular culvert.

Pollutant Loading by Outfall

There are six outfalls discharging to Lake Lily. The existing TSI for the lake is excellent (oligotrophic), and its water quality indices indicate a steady trend of improving water quality. This may be attributable to the BMPs that have been implemented since the original SLMP and the 2006 SLMP. If this trend continues, Lake Lily will continue to demonstrate oligotrophic water quality in the future. Pollutant loading rates for each subbasin are listed in **Table 18**.

Approximately 62% of the contributing land area is already treated by existing BMPs. Outfalls LI102 and LI103 contribute the bulk of the TP loading to Lake Lily (38% and 37% of total lake loading, respectively).

All of the subbasins have direct discharges into the lake, and none of the subbasins contribute pollutants to adjacent parcels. The runoff from all subbasins flow into the lake by overland flow and through inlets and culverts.

BMP Alternatives

Table 19 lists the BMP options for each outfall and their estimated costs. **Table 20** identifies the most cost- effective BMPs ranking them by the percent overall phosphorus removal in terms of dollars spent per pound removed. The most cost- effective options for reducing TP loadings to Lake Jackson would be:

- LI101-2 – Exfiltration in subbasin LI01 and would reduce TP loading to Lake Lily by 19% at a total cost of approximately $390,841.
- LI102-2 –Sediment Sump / Inlets would remove 8% of TP to Lake Lily at a total cost of approximately $189,729.
- LI105-2 – Swales would have a small effect on TP loadings (less than 1%), but are relatively cost- effective.
- LI103-2 – Infiltration Systems / Trenches in subbasin LI03 and would reduce TP loading to Lake Lily by 17%, but at a relatively high cost of approximately $461,903.
- LI102-1 – Infiltration Systems / Trenches in subbasin LI02 and would reduce TP loading to Lake Lily by 25% at a total cost of approximately $700,253. Although this is a much more costly option than sediment sump / inlets for subbasin LI02, the reduction in TP loading would be much greater.

Table 20 identifies additional cost-effective options that could be implemented with benefits to the quality of Lake Lily.

Lake Nina

Lake Nina is a 12-acre lake with a 79-acre contributing area, resulting in a total basin area of 91 acres. The predominant land uses in the basin are Single Family Residential (58%), followed by Recreation / Open Space (18%), and Multi-Family Residential (15%). The predominant soil type in the basin is hydrologic soil group A (68%). **Figure 7** shows the Lake Nina basin and subbasins. The contributing drainage area is divided into six subbasins. Lake Nina is located between Lake Minnehaha and Lake Maitland.

Pollutant Loading by Outfall

There are five outfalls discharging to Lake Nina. The existing TSI for the lake is excellent (oligotrophic), and its water quality indices show improving water quality. This is an improvement since 2006 when the lake was considered to be mesotrophic. This improvement in water quality may be attributable to the Lake Nina Stormwater Treatment Project that was implemented back in 2002. The lake is currently thought to be phosphorus limited. Pollutant loading rates for each outfall are listed in **Table 21**. Stormwater from approximately 12% of the contributing land area is already treated by existing BMPs. Outfall NI105 has the highest TP loading to Lake Nina with 33% of total lake loading. Outfall NI105 also has the highest loadings of BOD and TSS. Outfall NI102, which drains subbasins NI2 and NI3 and is partially treated by existing BMPs, also has relatively high loadings of TP, BOD, and TSS, and the highest loading of TN of any outfall.

Only subbasins NI3 and NI5 do not have direct discharges into the lake and contribute pollutants to adjacent parcels. Subbasins NI1, NI2, and NI6 contribute sheet flow pollutants to the lake. The runoff from subbasin NI4 flows into the lake through inlets and a culvert.

BMP Alternatives

Table 22 lists the BMP options for each outfall and their estimated costs. **Table 23** identifies the most cost- effective BMPs by ranking them by the percent overall phosphorus removal in terms of dollars spent per pound removed. The most cost-effective options for treating TP discharging to Lake Minnehaha are:

- NI102-2 – A nutrient separating baffle box / exfiltration system is currently planned for this outfall location at a cost of approximately $200,000.

Lake Sybelia

Lake Sybelia is an 80-acre lake with a 433-acre contributing area. The predominant land use in the basin is Single Family Residential (62%). The predominant soil type in the basin is hydrologic soil group A (67%). The contributing drainage area is divided into twenty-one subbasins, and there are three additional contributing subbasins located outside the City (116 acres). **Figure 8** shows the Lake Sybelia basin and subbasins. Lake Sybelia has no positive outfall.

Pollutant Loading by Outfall

There are twenty outfalls in Lake Sybelia. The existing TSI for the lake is excellent (oligotrophic), and its water quality indices are stable. Pollutant loading rates for each outfall are listed in **Table 24**. Stormwater discharging from approximately 41% of the contributing land area to Lake Sybelia is already treated by existing BMPs. Large amounts of pollutants come into Lake Sybelia from the off-site subbasins SY91, SY92, and SY93. Outfall SY114, which drains 74 acres including two subbasins outside the City of Maitland, contributes the highest TP loading of any outfall, SY115, which also drains areas outside the City, is next highest in TP loading. This suggests that City actions may have a limited effect on Lake Sybelia.

Only subbasins SY9 and SY12 do not have direct discharges into the lake and contribute pollutants to adjacent parcels. Subbasins SY14, SY15, SY16, SY19, and SY21 contribute sheet flow pollutants to the lake. Runoff from all subbasins, except SY9 and SY12, flow into the lake through inlets and culverts.

BMP Alternatives

Table 25 lists the BMP options for each outfall and their estimated costs. **Table 26** identifies the most cost- effective BMPs by ranking them by the percent overall phosphorus removal in terms of dollars spent per pound removed. The most cost-effective options to reduce TP loadings to Lake Sybelia are:

- SY110-1 – Infiltration systems could reduce 438 pounds of TP load to Lake Sybelia over 20 years. The project cost is estimated at $106,593.
- SY110-2 – Swales could reduce TP by 131 pounds over 20 years for approximately $34,013.
- SY110-3 – Sediment Sump / Inlet could reduce TP loading by 131 pounds over 20 years for approximately $42,163.
- SY117-1 – An exfiltration system is currently planned for this outfall at a cost of $120,630. This project could reduce loading to Lake Sybelia by 88 pounds over 20 years.

A variety of other BMP options were evaluated and summarized in **Tables 25** and **26**.

Lake Jackson

Lake Jackson is a 22-acre lake with a 102-acre contributing area, resulting in a total basin area of 124 acres. The land use in the basin is primarily Single Family Residential (61%) and Recreation / Open Space (34%). The predominant soil type in the basin is hydrologic soil group A (80%). The contributing drainage area is divided into eight subbasins. **Figure 9** shows the Lake Jackson basin and subbasins. Lake Jackson discharges into Lake Sybelia through a rectangular weir.

Pollutant Loading by Outfall

There are seven outfalls in Lake Jackson. The existing TSI for the lake is fair (mesotrophic), and its water quality indices are stable. Pollutant loading rates for each outfall are listed in **Table 27**. Approximately 12% of the contributing land area is already treated by existing BMPs. Outfalls JA101, JA102, and JA103 each produce similar TP, TN, and BOD loadings to Lake Jackson and together contribute 66% of TP loading. JA106 has the highest TSS loading.

All of the subbasins have direct discharges into the lake and none of these subbasins can contribute pollutants to adjacent parcels. Subbasins JA2 and JA3 do not contribute sheet flow pollutants to the lake. The runoff from these subbasins flow into the lake through inlets and culverts.

BMP Alternatives

Table 28 lists the BMPs options evaluated for each outfall and their estimated costs. **Table 29** identifies the most cost-effective BMPs by ranking them by the percent overall phosphorus removal in terms of dollars spent per pound removed. The most cost-effective options for reducing TP loadings to Lake Jackson would be:

- JA106-4 – Sediment Sump / Inlets would reduce TP loading to Lake Jackson by 4% at a total cost of $147,568; this BMP is considerable more cost-effective than other BMP options evaluated for Lake Jackson.
- JA103-1 – Infiltration Systems / Trenches would reduce TP loading by 10% at a total cost of approximately $585,906.
- JA102-1 – Infiltrations Systems / Trenches would reduce TP loading by 8% at a total cost of approximately $568,496.
- JA102-2 – Baffle Boxes would reduce TP loading by 3% at a cost of approximately $305,372. Baffle boxes have similar cost-effectiveness with Infiltration Systems / Trenches but require less land.
- JA103-1 – Infiltration Systems / Trenches in subbasin JA03 have similar benefits as in JA02.
- JA106-1 – Off-Line Retention would reduce TP loading by 19% at a total cost of approximately $2,675,863. This alternative would have greater impact on Lake Jackson but is not as cost-effective as other BMP options.

Lake Shadow

Lake Shadow is a 75-acre lake with a contributing land area of 259 acres, for a total basin area of 334 acres. Approximately 55% of the lake surface is not within the City of Maitland. The basin supports a mixture of land uses including Single Family Residential (22%), Low-Intensity Commercial (21%), Recreation / Open Space (21%), Multi-Family (19%) and High-Intensity Commercial (13%). The predominant soil type in the basin is hydrologic soil group D (59%). The contributing drainage area is divided into five subbasins, and one of these is outside the City of Maitland (contributing 70 acres). **Figure 10** shows the Lake Shadow basin and subbasins. Lake Shadow receives discharge from Lake Lucien and has no outlet.

Pollutant Loading by Outfall

There a five outfalls discharging to Lake Shadow. The existing TSI for Lake Shadow is excellent (oligotrophic), and its water quality indices are stable. Pollutant loading rates for each subbasin are listed in **Table 30**. Approximately 63% of the contributing land area in Lake Shadow is already treated by existing BMPs. Outfall SH191, which drains areas outside the City of Maitland, produces the highest stormwater pollutant loading rates to Lake Shadow, contributing 46% of TP loading. This contribution from outside the City will make it difficult for the City to have much impact on the water quality of Lake Shadow. Of the subbasins within the City, SH102 is the predominant contributor with 41% of TP loading. Most of the contributing area to this outfall is already treated by an existing BMP.

BMP Alternatives

Since much of the lake and contributing area is outside the City, and such a great percentage of the stormwater is already treated, there are few remaining options for the City to implement to improve water quality of Lake Shadow (**Tables 31** and **32**). The most cost-effective options identified are in the subbasin outside the City and would require action by other jurisdictions. No action by the City of Maitland is warranted at this time.

RANKING OF BMPS

For clarity, all outfalls identified in the BMP alternatives above are shown in **Figure 11**. The BMP ranking criteria used in the 2011 SLMP (Kimley Horn, 2011) were reviewed and modified in consultation with City of Maitland staff and the LAB. SLMP ranking criteria have typically been reviewed in the context of:

- New regulatory developments and funding mechanisms
- Developments in City of Maitland policies and goals
- Experience of the City of Maitland in implementing and securing funding for BMPs
- New regulatory developments include developing implementation of FDEP's Impaired Waters Rule and TMDLs

The criteria needed revision to reflect the availability of funds from sources other than the City of Maitland for certain projects as a meaningful evaluation criterion. Since 1996 the City has chartered a Community Redevelopment Authority (CRA) to develop a plan and secure funding for critical redevelopment of the City center. Projects in the CRA area may be preferred and have alternative funding sources.

PROGRAMMATIC BMP CONSIDERATIONS

The city currently manages a street sweeping program which provides numerous benefits which can be considered credit for Lake Jesup loading. Leaf baskets or other similar gross solid BMP collection devices could be considered for most curb or grate inlets within the City where an opportunity exists to reduce loading to priority lakes. Inlet baskets may also receive credit for load reduction to Lake Jesup. While leaf baskets are relatively easy to install, the City should carefully consider the level of staffing necessary to make a significant impact to load reduction with leaf baskets.

Low impact design (LID) is another potentially significant component of a BMP implementation program. However, LID is difficult to apply as a retrofit project since it typically requires an overarching element of comprehensive planning and usually involves many small project components. In some cases, however, installation of small swales, rain gardens, curb cuts, and other minor construction projects within City property may be easily accomplished. In addition, the City can consider cooperating with new development to achieve TMDL load reduction goals through LID implementation in areas within or adjacent to proposed construction. LID also presents an opportunity for public outreach and education as many of the same practices used in designing new developments can be implemented by the homeowners themselves in non-LID communities.

Figures

Figure 1- Lake Minnehaha Drainage Basin

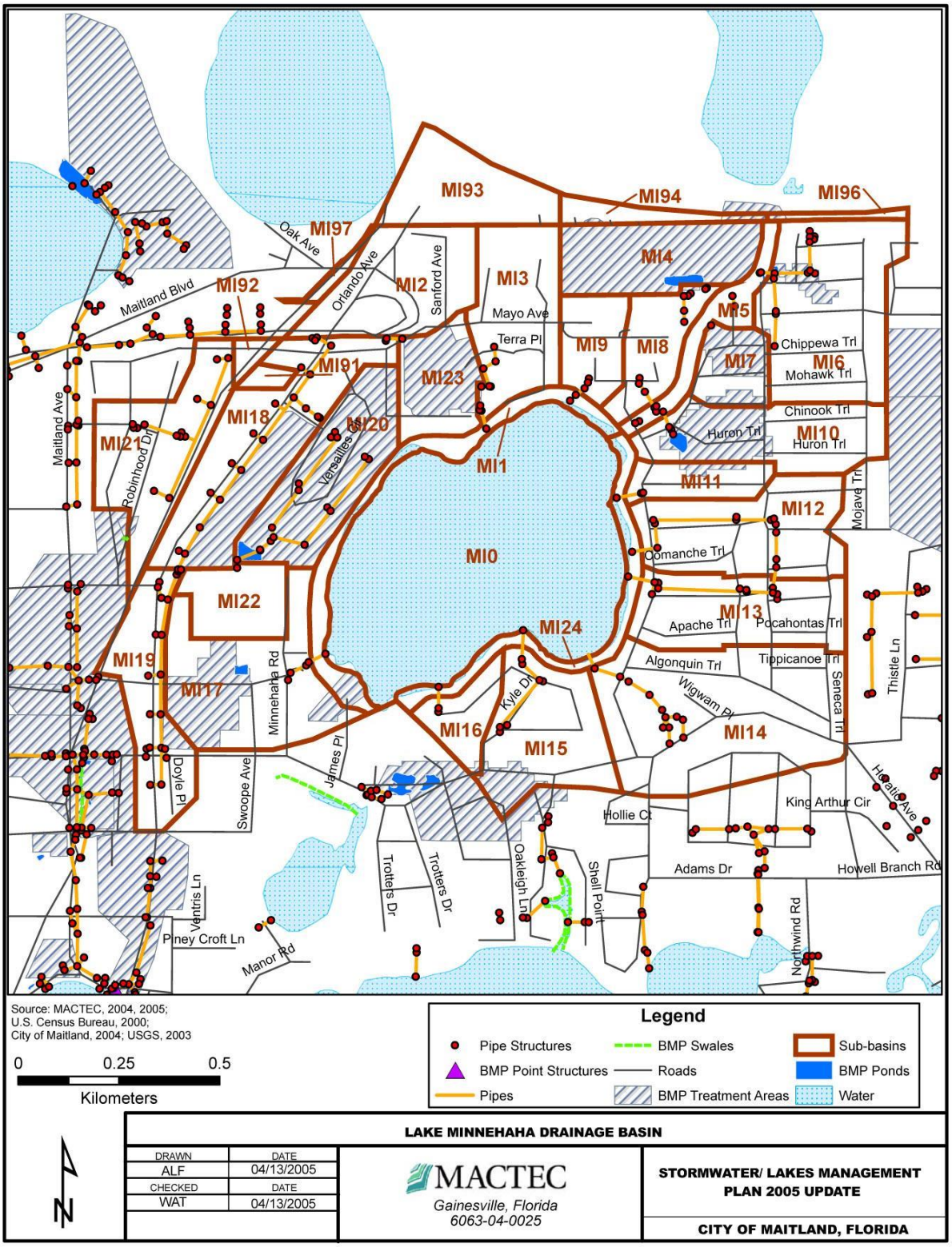


Figure 2 - Lake Gem Drainage Basin

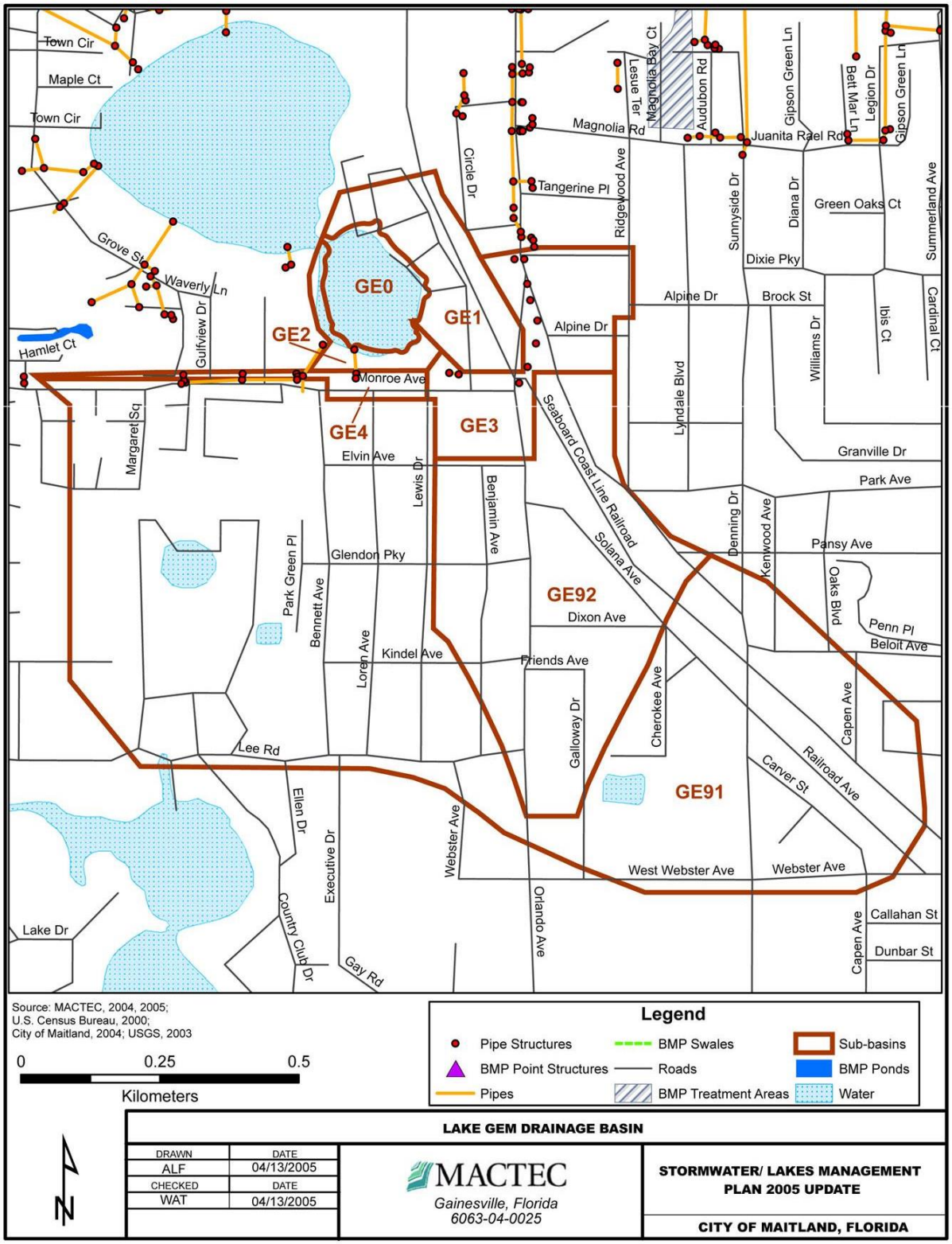


Figure 3 - Lake Waumpi Drainage Basin

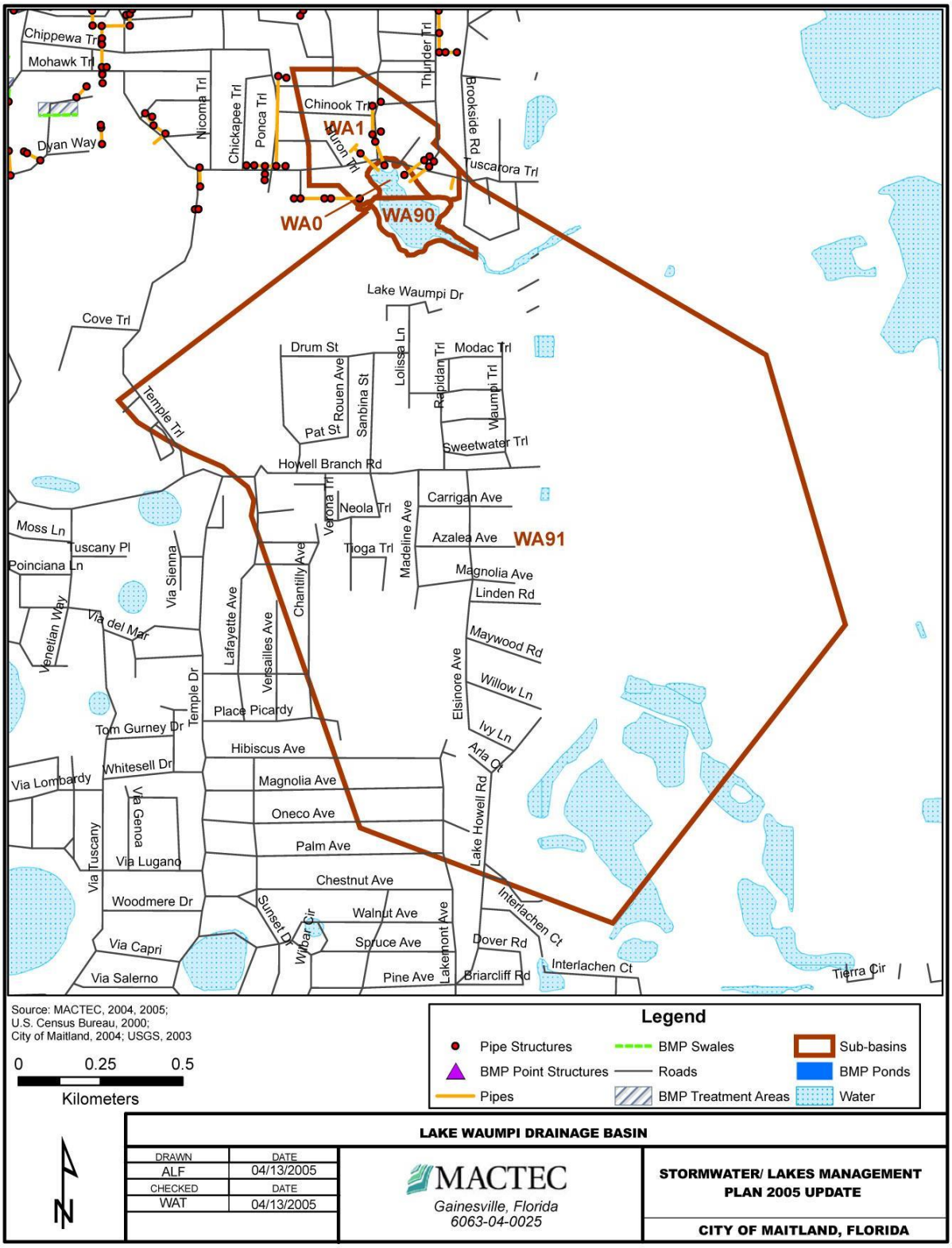


Figure 4 - Lake Maitland Drainage Basin

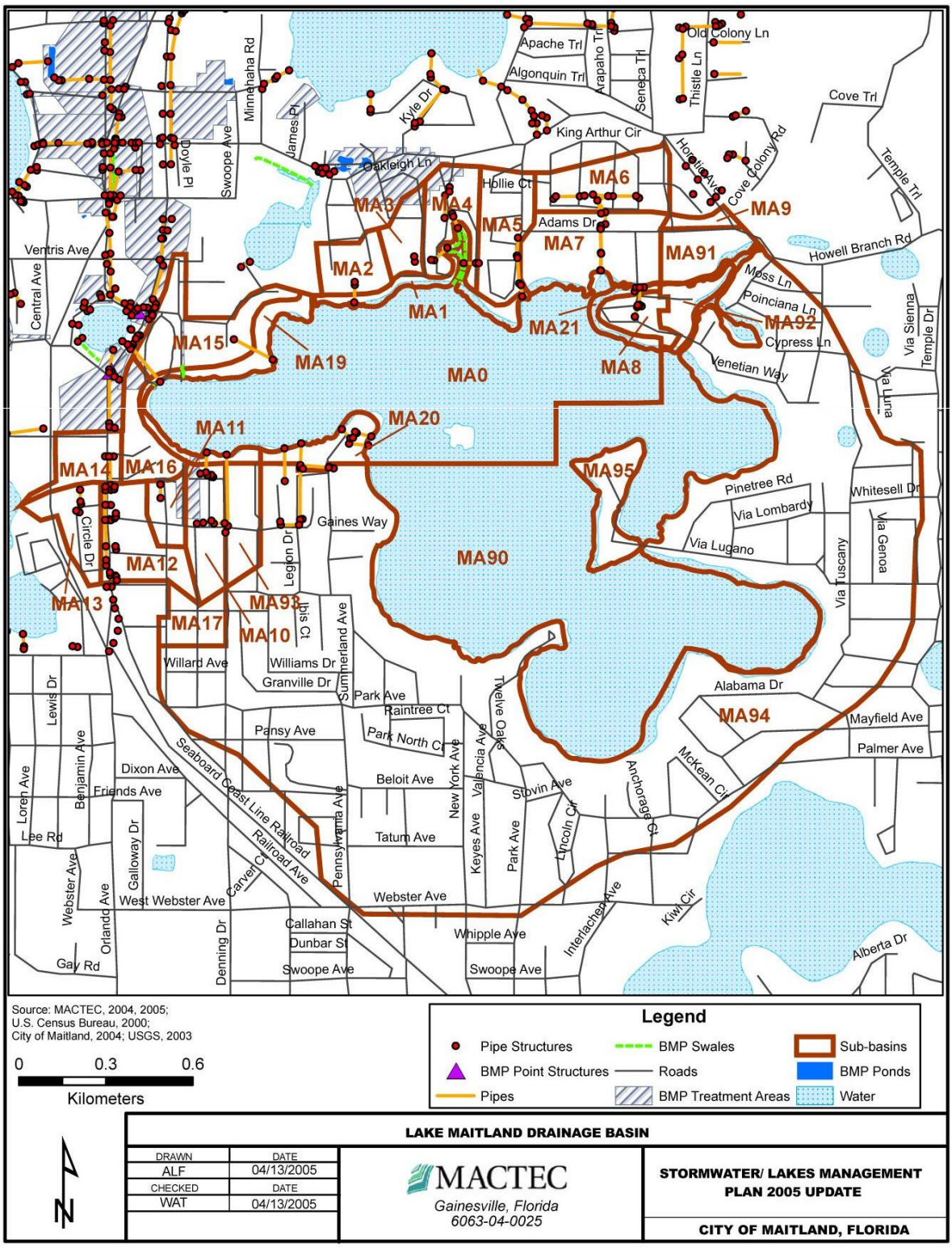


Figure 5 - Park Lake Drainage Basin

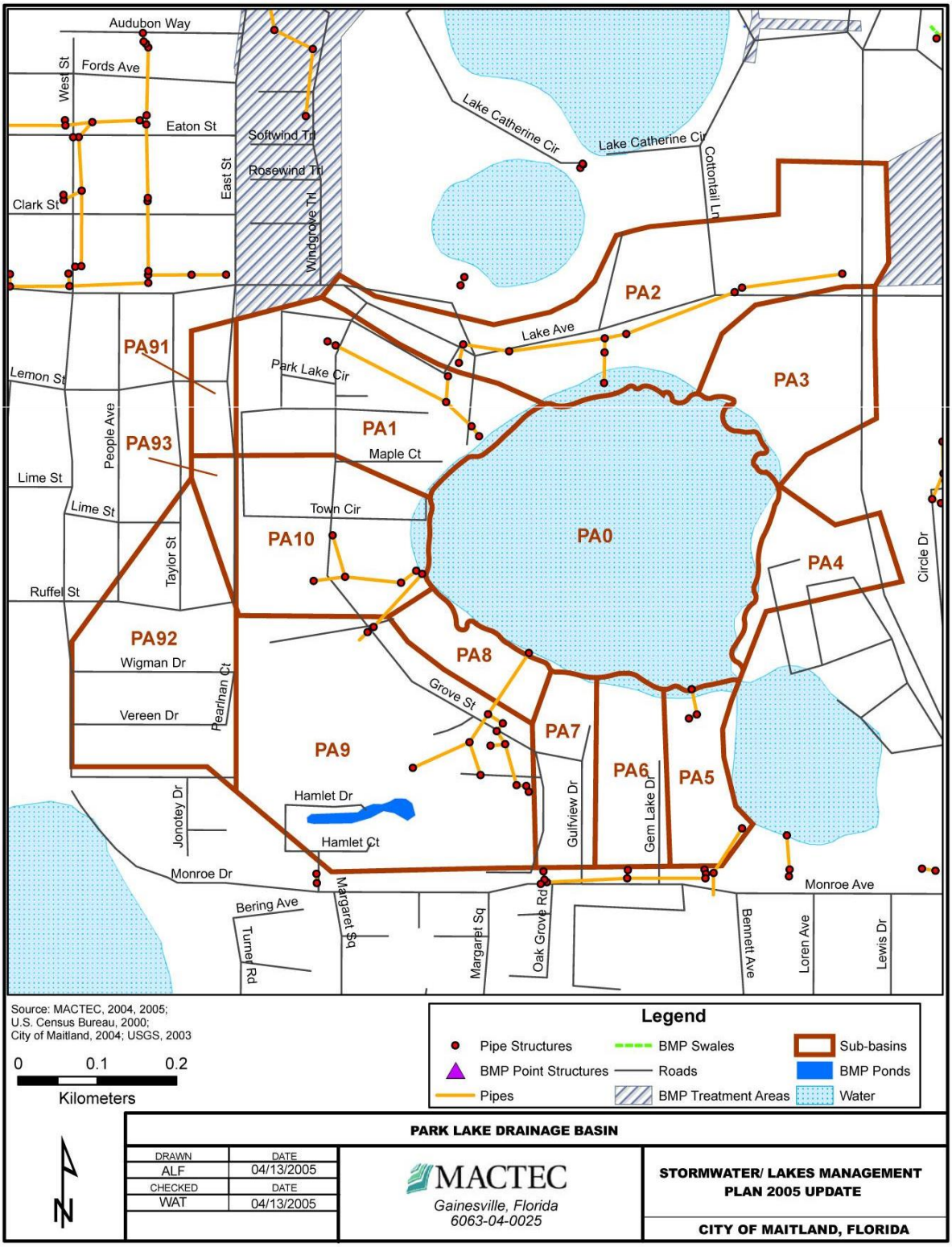


Figure 6 - Lake Lilly Drainage Basin

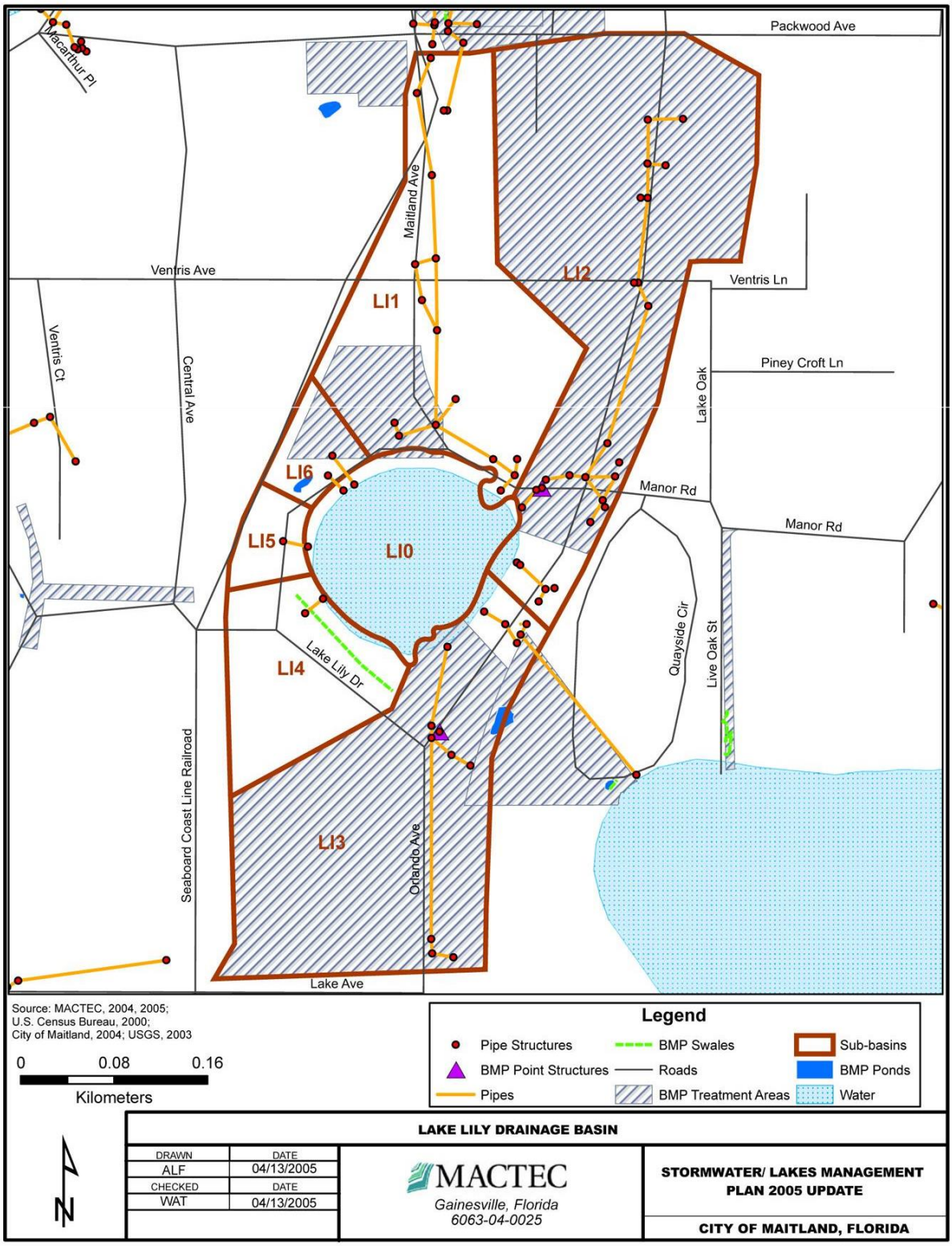


Figure 7 - Lake Nina Drainage Basin

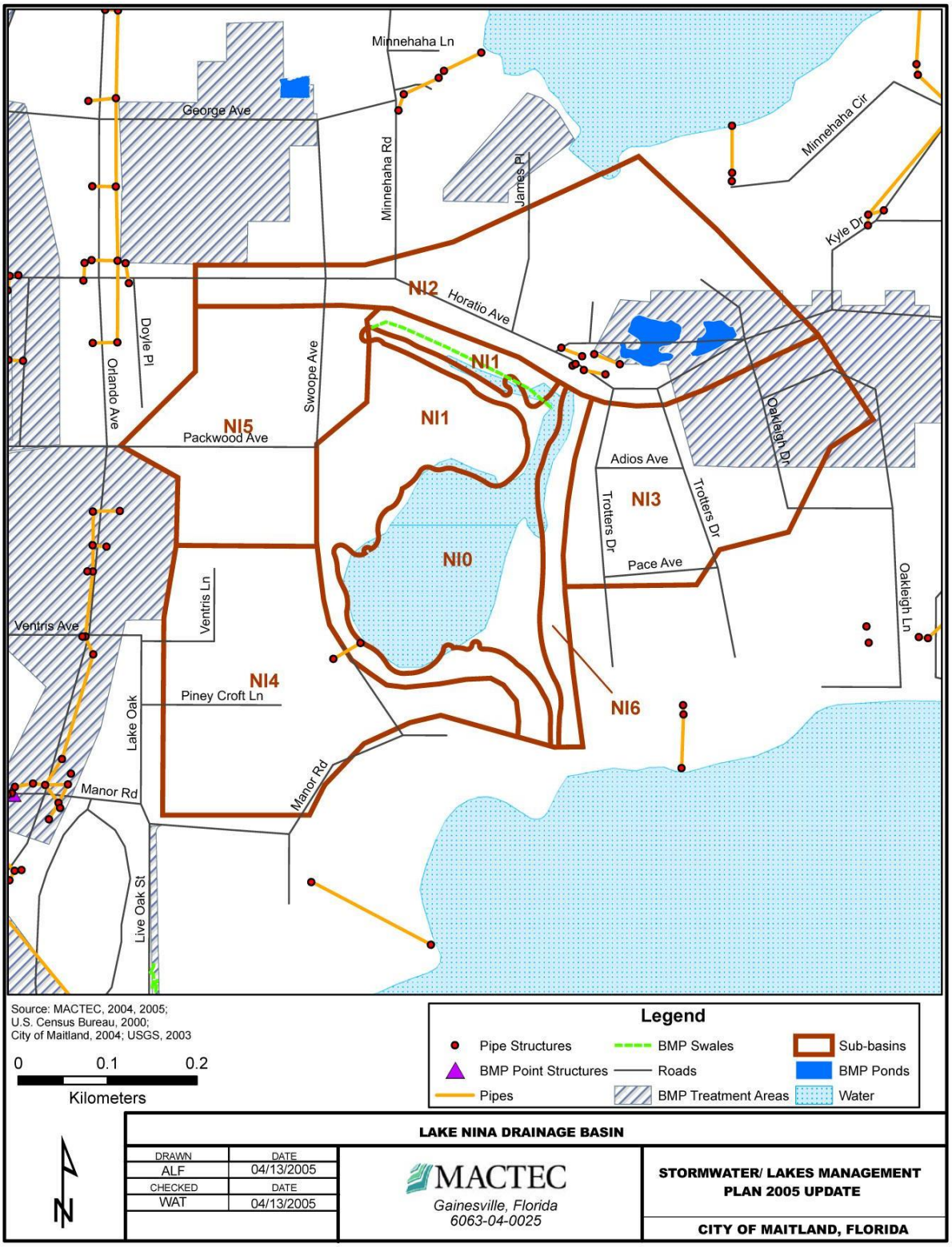


Figure 8 - Lake Sybelia Drainage Basin

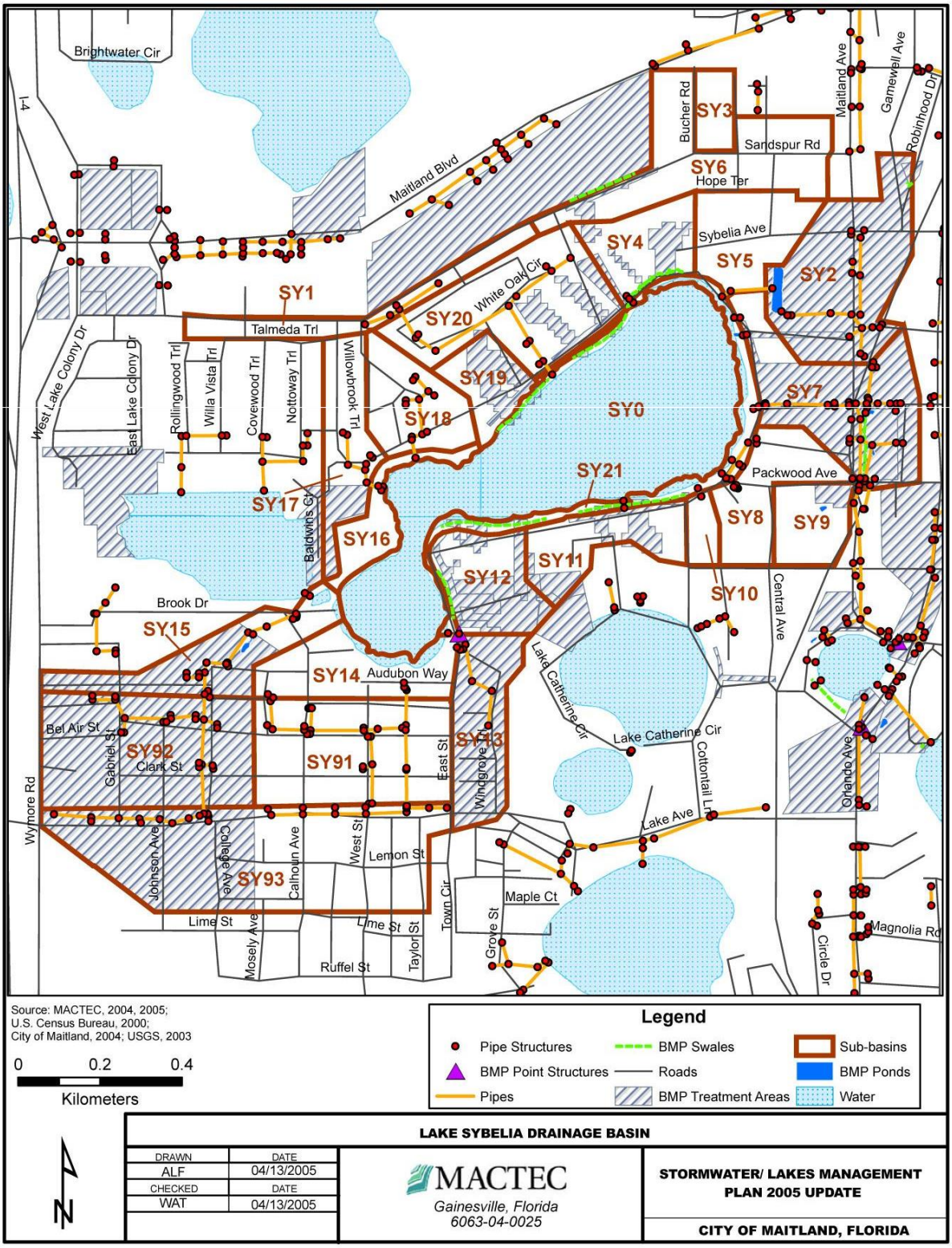


Figure 9 - Lake Jackson Drainage Basin

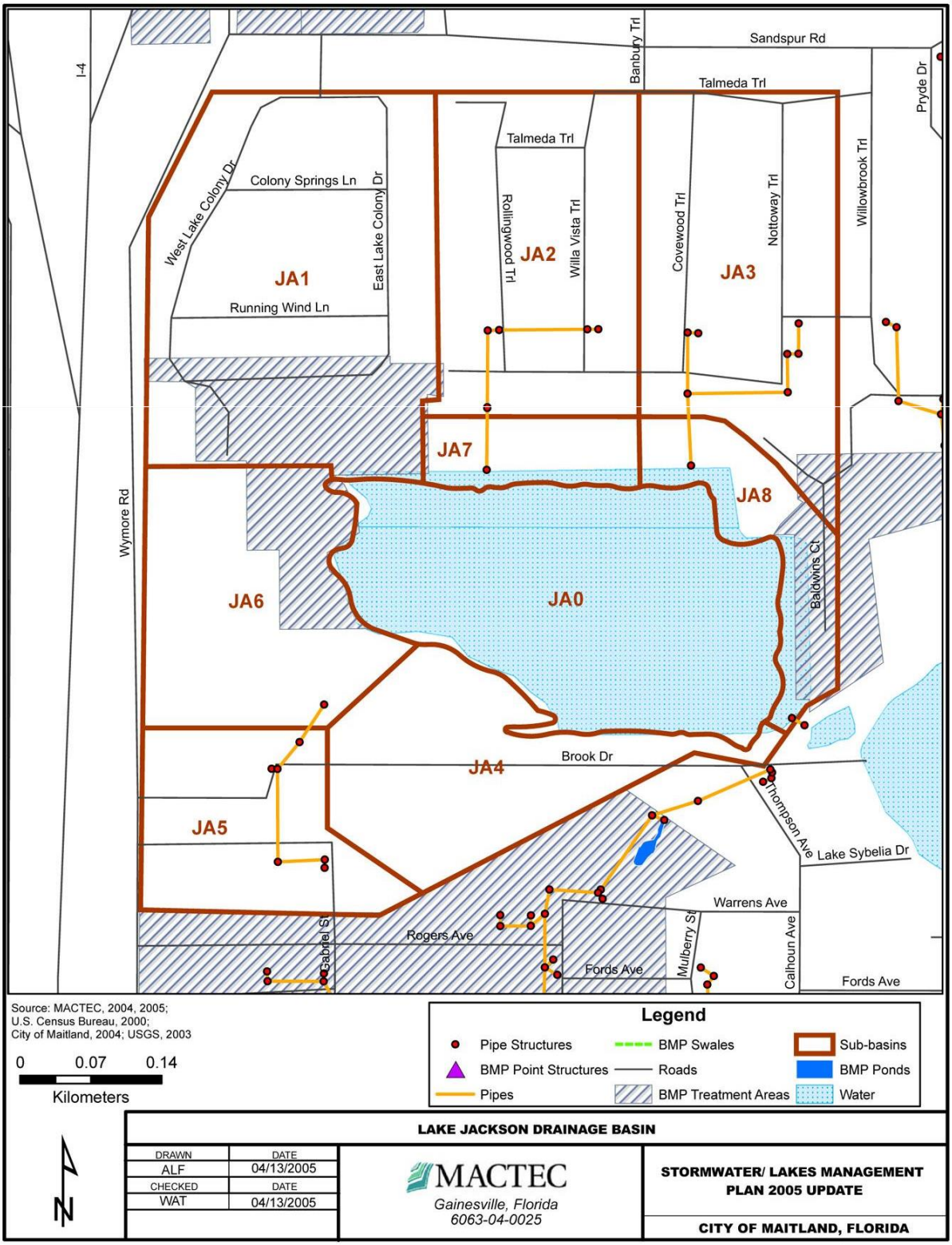
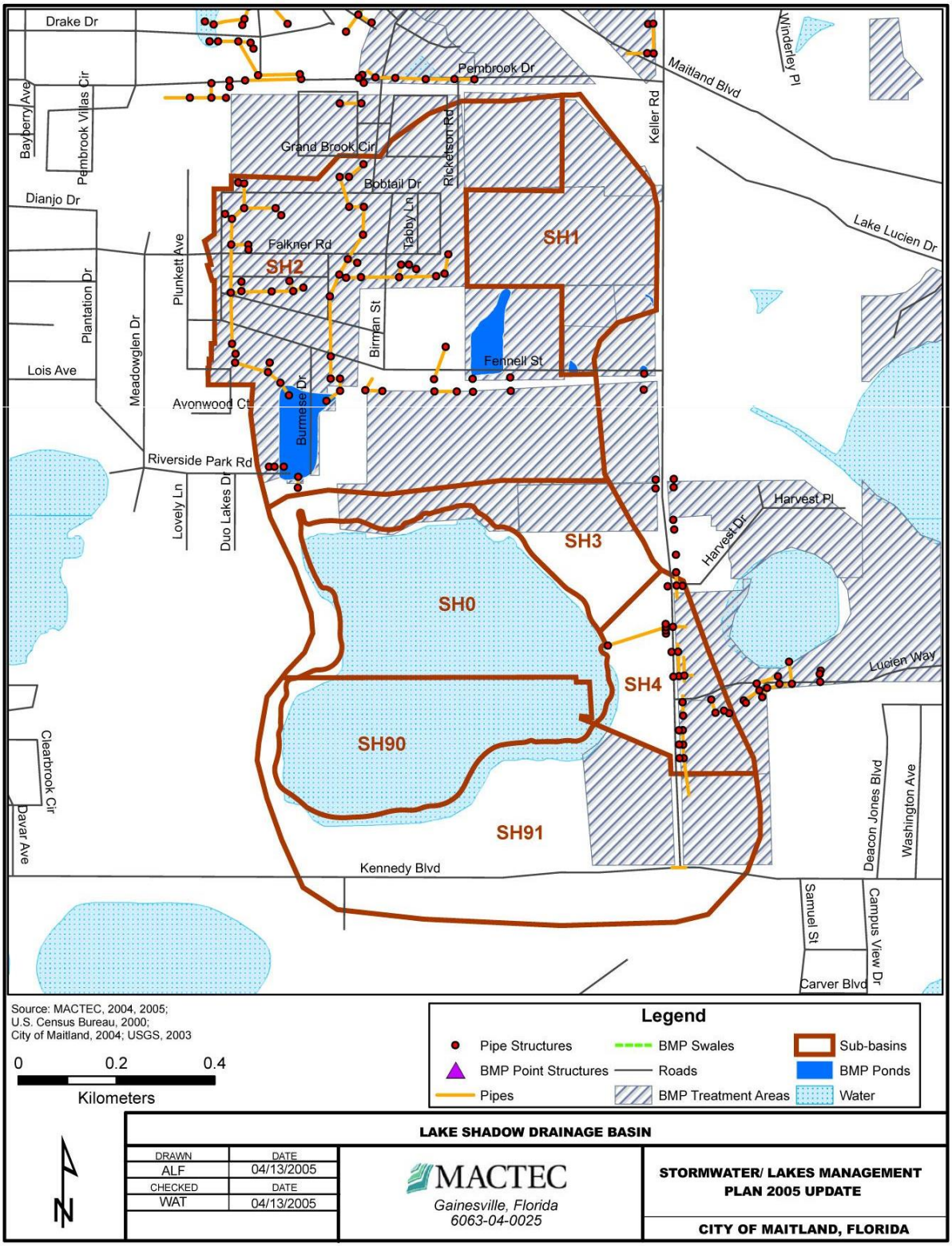
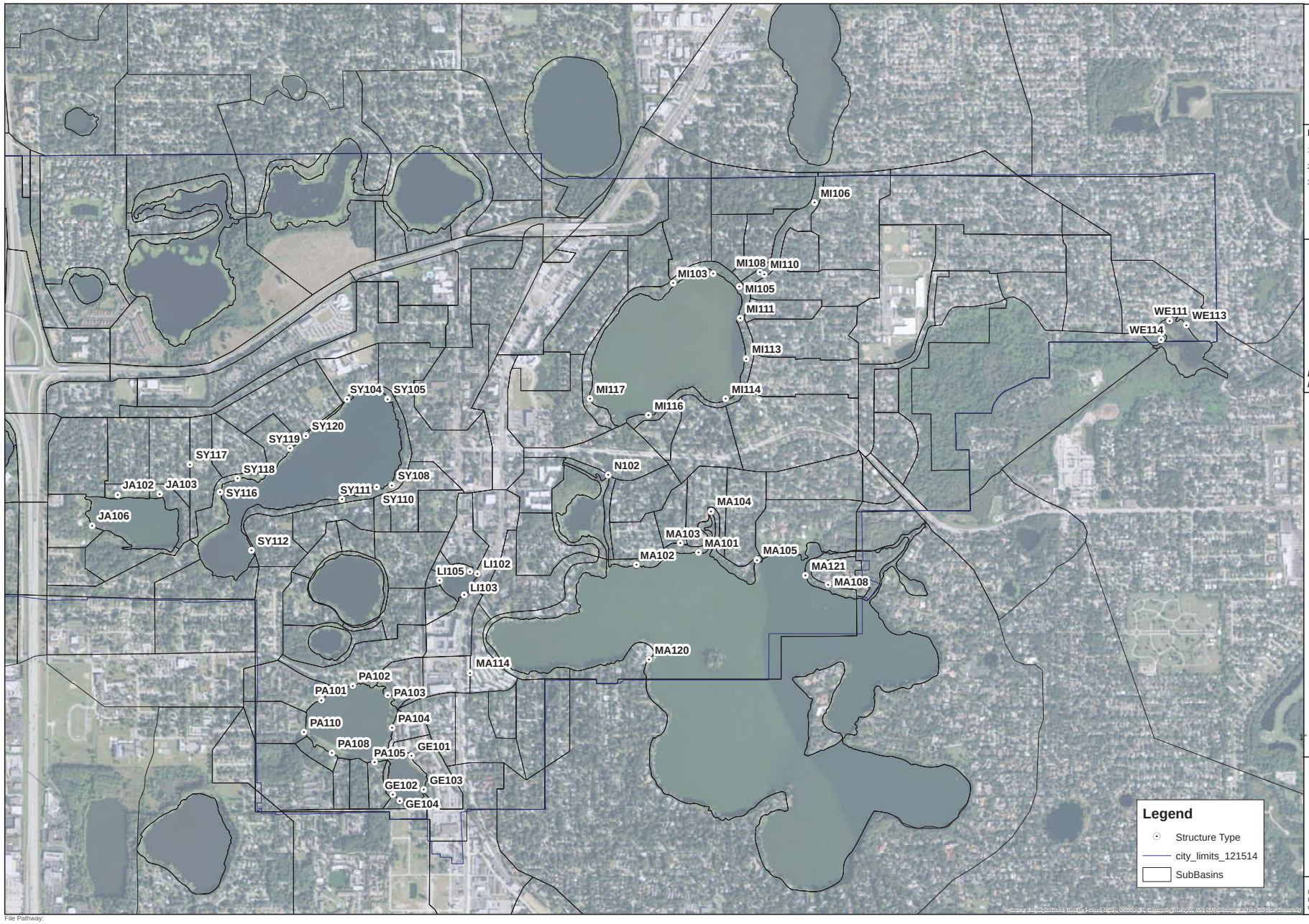


Figure 10 - Lake Shadow Drainage Basin





amec foster wheeler

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2000 E. Edgewood Drive Ste #215
Lakeland, FL 33803
CA-5392
(863) 667-2345

Notes:

1- Project No.: 600314X7

2- Data Sources -

3- This map is intended to be used for planning purposes only. It is not a survey.

Location Map Not to Scale

N

0 500 1,000 2,000

3" =

Figure 11
City of Maitland
Outfall
Structures
600314X7
Maitland, FL

Date: 1/19/2016
Revised:
Checked By: LML

File Pathway:

Tables

Table 1 - Step one BMP Selection Criteria

Weight	15	15	25	5	7	**15**	7	1	1	15	7	1	1	115
Lake	**Priority Waterbodies Contributing to Lake Jesup**	**Visibility and Access for Education Potential**	**TSI Relative Comparison**	**Negative Trends**	**Within the City**	**Relative Total P Concentration**	**Relative TN Concentration**	**Relative BOD Concentration**	**Relative TSS Concentration**	**Relative Total P**	**Relative Total N**	**Relative Total BOD**	**Relative Total TSS**	**Total Lake Score**
Minnehaha	15	13.85	17.31	0.00	7.00	9.07	4.34	0.39	0.27	7.85	4.06	0.61	0.53	80.27
Gem	15	1.15	25.00	0.00	4.20	14.76	5.98	0.76	0.74	6.12	2.68	0.56	0.69	77.66
Waumpi	15	0.00	16.35	0.00	2.80	13.63	5.30	0.51	0.41	15.00	6.31	1.00	1.00	77.31
Maitland	15	12.69	13.46	0.00	2.80	6.87	3.38	0.28	0.17	13.14	7.00	0.96	0.72	76.47
Park	15	5.77	19.23	0.00	7.00	14.12	4.98	0.50	0.39	3.10	1.18	0.20	0.19	71.67
Lily	0	15.00	20.19	0.00	7.00	15.00	7.00	1.00	0.60	1.16	0.59	0.14	0.10	67.79
Nina	15	10.38	16.35	0.00	7.00	10.88	4.37	0.41	0.30	1.42	0.62	0.09	0.09	66.90
Sybelia	0	12.69	7.69	0.00	7.00	7.68	3.63	0.30	0.23	5.65	2.89	0.40	0.38	48.55
Jackson	0	8.08	16.35	0.00	7.00	6.10	3.31	0.25	0.16	1.08	0.64	0.08	0.06	43.11
Shadow	0	5.77	13.46	0.00	5.60	7.81	3.61	0.32	0.29	3.74	1.87	0.27	0.31	43.06
Hungerford	0	6.92	11.54	0.00	2.80	11.29	4.94	0.48	0.47	1.65	0.78	0.13	0.15	41.16
Destiny	0	12.69	0.00	0.00	4.20	7.90	5.17	0.59	0.54	1.86	1.32	0.25	0.28	34.80
Charity	0	5.77	4.81	0.00	7.00	5.41	3.30	0.26	0.20	2.66	1.76	0.23	0.22	31.60
Hope	0	5.77	6.73	0.00	5.60	5.66	2.87	0.20	0.10	1.14	0.62	0.07	0.05	28.81
Love	0	0.00	4.81	0.00	7.00	10.80	3.78	0.35	0.28	0.31	0.12	0.02	0.02	27.48
Catherine	0	5.77	1.92	0.00	7.00	7.25	3.53	0.28	0.17	0.80	0.42	0.05	0.04	27.24
Lomond	0	0.00	4.81	0.00	7.00	6.35	5.35	0.87	1.00	0.62	0.56	0.15	0.22	26.93
Lucien	0	0.00	0.00	0.00	7.00	5.30	4.72	0.61	0.67	2.94	2.84	0.60	0.83	25.53
Faith	0	5.77	0.00	0.00	5.60	5.65	4.14	0.39	0.34	1.55	1.23	0.19	0.21	25.07
Eulalia	0	3.46	6.73	0.00	7.00	4.24	2.13	0.18	0.13	0.10	0.06	0.01	0.01	24.04
Harvest	0	3.46	1.92	5.00	7.00	3.52	2.00	0.14	0.15	0.23	0.14	0.02	0.02	23.62

= top ten lakes

Table 2 - Step two BMP Selection Criteria

Lake	SubBasin	Outfall Designation	BMP Option	BMP Description	Future or Planned Project Score	TP Outfall Score	Relative Costing Score	Relative Step 1 Score	Total Score
Gem	GE1	GE101	2	Nutrient Separating Baffle Box	10	33.29	34.80	18.59	96.68
Minnehaha	M5	MI105	2	Sediment Sump / Inlet	10	35.00	27.81	20.00	92.81
Park	PA1	PA101	2	Sediment Sump / Inlet	10	33.29	32.76	15.38	91.43
Maitland	MA14	MA114	3	Sediment Sump / Inlet	0	35.00	33.21	17.96	86.16
Maitland	MA14	MA114	1	Off-Line Retention	0	35.00	31.35	17.96	84.31
Gem	GE2	GE102	1	Nutrient Separating Baffle Box	10	20.26	34.28	18.59	83.14
Park	PA3	PA103	2	Sediment Sump / Inlet	0	33.77	32.87	15.38	82.02
Park	PA3	PA103	1	Infiltration Systems Trenches	0	33.77	32.85	15.38	82.00
Park	PA4	PA104	1	Sediment Sump / Inlet	0	32.42	33.09	15.38	80.89
Gem	GE3, GE92	GE103	4	Nutrient Separating Baffle Box	10	18.37	33.74	18.59	80.71
Park	PA10	PA110	1	Infiltration Systems Trenches	0	33.16	31.59	15.38	80.12
Park	PA10	PA110	2	Sediment Sump / Inlet	0	33.16	31.12	15.38	79.66
Maitland	MA14	MA114	2	On-Line Retention	0	35.00	25.63	17.96	78.59
Gem	GE4	GE104	2	Nutrient Separating Baffle Box	10	15.20	33.48	18.59	77.27
Waumpi		WE111	1	Baffle Box	10	12.03	33.75	18.41	74.19
Park	PA8, PA7, PA9	PA108	4	Sediment Sump / Inlet	10	16.58	30.34	15.38	72.29
Minnehaha	MI16	MI116	1	Off-Line Retention	10	7.60	33.52	20.00	71.12
Waumpi		WE114	2	Siltation Basin	0	15.75	33.92	18.41	68.08
Minnehaha	M11	MI111	2	Sediment Sump / Inlet	0	12.66	34.37	20.00	67.04
Minnehaha	MI9	MI109	2	Sediment Sump / Inlet	0	12.16	34.20	20.00	66.36
Minnehaha	MI17	MI117	2	Sediment Sump / Inlet	0	14.86	30.92	20.00	65.78

Table 2. (continued)

Lake	SubBasin	Outfall Designation	BMP Option	BMP Description	Future or Planned Project Score	TP Outfall Score	Relative Costing Score	Relative Step 1 Score	Total Score
Minnehaha	MI17	MI117	1	Infiltration Systems Trenches	0	14.86	30.70	20.00	65.56
Maitland	MA3	MA103	2	Sediment Sump / Inlet	0	12.66	34.55	17.96	65.17
Minnehaha	MI14	MI114	3	Nutrient Separating Baffle Box	10	12.97	22.11	20.00	65.08
Lily	LI1	LI101	2	Exfiltration	10	9.82	31.65	13.29	64.76
Minnehaha	MI8	MI108	2	Sediment Sump / Inlet	0	10.13	34.03	20.00	64.16
Maitland	MA5	MA105	2	Sediment Sump / Inlet	0	11.73	34.03	17.96	63.72
Maitland	MA20	MA120	2	Sediment Sump / Inlet	0	11.26	34.34	17.96	63.55
Maitland	MA2	MA102	2	Sediment Sump / Inlet	0	11.05	34.44	17.96	63.45
Maitland	MA8	MA108	1	Off-Line Retention	0	10.13	35.00	17.96	63.09
Maitland	MA4	MA104	2	Sediment Sump / Inlet	0	10.81	34.24	17.96	63.00
Maitland	MA8	MA108	3	Sediment Sump / Inlet	0	10.13	34.65	17.96	62.74
Maitland	MA8	MA108	2	Infiltration Systems Trenches	0	10.13	34.60	17.96	62.69
Park	PA2	PA102	1	Off-Line Retention	0	13.82	32.46	15.38	61.65
Minnehaha	MI3, MI93	MI103	3	Sediment Sump / Inlet	0	11.95	29.36	20.00	61.31
Minnehaha	MI13	MI113	3	Sediment Sump / Inlet	0	12.33	28.85	20.00	61.18
Maitland	MA3	MA103	1	Infiltration Systems Trenches	0	12.66	30.47	17.96	61.09
Minnehaha	M11	MI111	1	Infiltration Systems Trenches	0	12.66	28.08	20.00	60.74
Minnehaha	MI3	MI103	1	Off-Line Retention	0	11.95	28.03	20.00	59.98
Maitland	MA5	MA105	1	Infiltration Systems Trenches	0	11.73	29.61	17.96	59.30
Nina	NI2, NI3	NI102	2	Nutrient Separating Baffle Box	10	9.57	26.79	12.81	59.17
Maitland	MA20	MA120	1	Infiltration Systems Trenches	0	11.26	29.90	17.96	59.11
Minnehaha	MI10	MI110	2	Sediment Sump / Inlet	0	9.69	28.85	20.00	58.54

Table 2. (continued)

Lake	SubBasin	Outfall Designation	BMP Option	BMP Description	Future or Planned Project Score	TP Outfall Score	Relative Costing Score	Relative Step 1 Score	Total Score
Minnehaha	MI9	MI109	1	Infiltration Systems Trenches	0	12.16	26.33	20.00	58.49
Maitland	MA2	MA102	1	Infiltration Systems Trenches	0	11.05	28.75	17.96	57.76
Minnehaha	MI13	MI113	1	Off-Line Retention	0	12.33	25.32	20.00	57.66
Sybelia	SY17	SY117	1	Exfiltration Nottoway	10	11.58	33.00	2.95	57.53
Minnehaha	MI6, MI96	MI106	2	Sediment Sump / Inlet	0	11.26	26.26	20.00	57.51
Minnehaha	MI13	MI113	2	Infiltration Systems Trenches	0	12.33	25.02	20.00	57.36
Park	PA5	PA105	2	Sediment Sump / Inlet	0	8.11	33.75	15.38	57.23
Park	PA2	PA102	3	Sediment Sump / Inlet	0	13.82	27.84	15.38	57.04
Park	PA2	PA102	2	On-Line Retention	0	13.82	27.60	15.38	56.79
Minnehaha	MI6	MI106	1	Infiltration Systems Trenches	0	11.26	25.21	20.00	56.47
Minnehaha	MI3	MI103	2	Infiltration Systems Trenches	0	11.95	23.86	20.00	55.81
Maitland	MA4	MA104	1	Infiltration Systems Trenches	0	10.81	26.46	17.96	55.22
Minnehaha	MI8	MI108	1	Infiltration Systems Trenches	0	10.13	24.69	20.00	54.82
Park	PA5	PA105	1	Off-Line Retention	0	8.11	30.59	15.38	54.07
Waumpi		WE113	1	Off-Line Retention	0	0.00	33.19	18.41	51.60
Sybelia	SY10	SY110	1	Infiltration Systems Trenches	0	13.51	34.70	2.95	51.16
Sybelia	SY10	SY110	2	Swales	0	13.51	34.67	2.95	51.13
Sybelia	SY10	SY110	3	Sediment Sump / Inlet	0	13.51	34.58	2.95	51.04
Maitland	MA21	MA121	1	Swales	0	10.13	22.90	17.96	50.99
Shadow	SH91	SH191	2	Off-Line Retention	0	19.11	31.40	0.00	50.50
Lily	LI2	LI102	2	Sediment Sump / Inlet	0	5.53	31.12	13.29	49.94
Lily	LI3	LI103	2	Infiltration Systems Trenches	0	5.96	30.55	13.29	49.80
Shadow	SH91	SH191	1	On-Line	0	19.11	30.46	0.00	49.56

Table 2. (continued)

Lake	SubBasin	Outfall Designation	BMP Option	BMP Description	Future or Planned Project Score	TP Outfall Score	Relative Costing Score	Relative Step 1 Score	Total Score
				Retention					
Lily	LI3	LI103	3	Sediment Sump / Inlet	0	5.96	30.16	13.29	49.41
Lily	LI2	LI102	1	Infiltration Systems Trenches	0	5.53	30.41	13.29	49.23
Lily	LI2	LI102	3	Bioretention	0	5.53	29.92	13.29	48.73
Sybelia	SY18	SY118	3	Sediment Sump / Inlet	0	11.58	33.38	2.95	47.91
Sybelia	SY8, SY9	SY108	1	On-Line Retention	0	12.33	32.45	2.95	47.74
Lily	LI5	LI105	3	Sediment Sump / Inlet	0	0.00	33.89	13.29	47.19
Lily	LI3	LI103	1	Off-Line Retention	0	5.96	27.70	13.29	46.95
Sybelia	SY19	SY119	2	Sediment Sump / Inlet	0	10.13	33.86	2.95	46.94
Lily	LI5	LI105	2	Swales	0	0.00	33.41	13.29	46.70
Sybelia	SY5	SY105	1	Off-Line Retention	0	10.13	33.40	2.95	46.48
Sybelia	SY5	SY105	3	Sediment Sump / Inlet	0	10.13	33.14	2.95	46.23
Sybelia	SY11	SY111	2	Sediment Sump / Inlet	0	9.35	33.38	2.95	45.69
Sybelia	SY4	SY104	2	Sediment Sump / Inlet	0	11.82	30.75	2.95	45.52
Sybelia	SY12	SY112	2	Sediment Sump / Inlet	0	8.68	33.38	2.95	45.02
Sybelia	SY8, SY9	SY108	2	Infiltration Systems Trenches	0	12.33	28.09	2.95	43.38
Sybelia	SY18	SY118	1	Off-Line Retention	0	11.58	28.55	2.95	43.08
Sybelia	SY5	SY105	2	Swales	0	10.13	29.65	2.95	42.73
Lily	LI5	LI105	1	Infiltration Systems Trenches	0	0.00	29.16	13.29	42.45
Sybelia	SY8, SY9	SY108	3	Sediment Sump / Inlet	0	12.33	26.43	2.95	41.72
Sybelia	SY19	SY119	1	Infiltration Systems Trenches	0	10.13	25.37	2.95	38.45
Sybelia	SY16	SY116	1	Swales	0	2.53	32.03	2.95	37.51
Jackson	JA3	JA103	1	Infiltration Systems Trenches	0	11.92	24.64	0.03	36.59
Shadow	SH91	SH191	3	Bioretention	0	19.11	16.20	0.00	35.31
Sybelia	SY4	SY104	1	Infiltration Systems Trenches	0	11.82	20.52	2.95	35.29

Table 2. (continued)

Lake	SubBasin	Outfall Designation	BMP Option	BMP Description	Future or Planned Project Score	TP Outfall Score	Relative Costing Score	Relative Step 1 Score	Total Score
Jackson	JA6	JA106	4	Sediment Sump / Inlet	0	6.23	28.50	0.03	34.76
Sybelia	SY20	SY120	2	Sediment Sump / Inlet	0	11.05	20.68	2.95	34.68
Jackson	JA2	JA102	1	Infiltration Systems Trenches	0	11.40	22.42	0.03	33.85
Sybelia	SY18	SY118	2	Infiltration Systems Trenches	0	11.58	18.10	2.95	32.62
Sybelia	SY11	SY111	1	Infiltration Systems Trenches	0	9.35	19.31	2.95	31.61
Maitland	MA1	MA101	1	Swales	0	12.16	0.00	17.96	30.11
Sybelia	SY20	SY120	1	Infiltration Systems Trenches	0	11.05	15.85	2.95	29.85
Sybelia	SY12	SY112	1	Infiltration Systems Trenches	0	8.68	18.10	2.95	29.73
Jackson	JA3	JA103	2	Baffle Box	0	11.92	16.96	0.03	28.90
Jackson	JA2	JA102	2	Baffle Box	0	11.40	16.96	0.03	28.38
Jackson	JA6	JA106	1	Off-Line Retention	0	6.23	10.02	0.03	16.28

Note: Orange highlight indicates current City project

Table 3 - Minnehaha Pollutant Loading Rates by Outfall

Outfall	SubBasin	Area (Acres)	% Area Treated	Total P (kg/yr)	Total N (kg/yr)	BOD (kg/yr)	TSS (kg/yr)	% Total P
MI100	MI0	95	0%	0	0	0	0	0%
MI101	MI1	13	0%	8	60	182	714	2%
MI102	MI2	22	0%	5	97	315	2,318	2%
MI103	MI3, MI93	39	1%	23	172	638	4,188	8%
MI104	MI4, MI94	25	84%	1	28	65	288	0%
MI106	MI6, MI96	36	6%	20	163	477	1,894	7%
MI107	MI7	8	67%	3	25	69	286	1%
MI108	MI8	12	1%	6	51	155	613	2%
MI109	MI9	10	0%	6	45	137	539	2%
MI110	MI10	23	39%	11	93	236	966	4%
MI111	MI11	8	12%	5	36	105	417	1%
MI112	MI12	26	0%	15	122	372	1,461	5%
MI113	MI13	23	0%	14	109	332	1,302	4%
MI114	MI14	50	0%	32	238	733	3,205	10%
MI115	MI15	23	14%	14	102	310	1,356	4%
MI116	MI16	8	3%	3	24	67	295	1%
MI117	MI17	30	33%	22	158	769	4,809	7%
MI121	MI21	25	1%	16	159	653	3,991	5%
MI122	MI22, MI18, MI19, MI20, MI91, MI92, MI97	94	38%	91	632	3,005	19,455	30%
MI123	MI23	13	67%	4	30	85	352	1%
MI124	MI24	10	0%	5	43	128	506	2%
Totals		**603**		**307**	**2,418**	**8,922**	**4,316**	

Source: SLMP, 2011.

Table 4 - Minnehaha BMP Phosphorus Reduction and Estimated Cost

Outfall Designation	BMP Option #	BMP Description	Total % Phosphorus Removed	Cost			
				Land Cost	Construction Cost	Capital Cost	O&M Cost
MI103	1	Off-Line Retention	2%	$363,577.30	$196,760.72	$560,338.02	$11,805.85
MI103	2	Infiltration Systems Trenches	2%	$0.00	$828,593.67	$828,593.67	$82,859.16
MI103	3	Sediment Sump / Inlet	1%	$0.00	$197,973.87	$197,973.87	$33,924.04
MI105	2	Sediment Sump / Inlet	0%	$0	$290,000.00	$250,000.00	$40,000.00
MI106	2	Sediment Sump / Inlet	1%	$0.00	$305,959.34	$305,959.34	$52,428.07
MI108	1	Infiltration Systems Trenches	1%	$0.00	$383,734.00	$383,734.00	$38,372.98
MI108	2	Sediment Sump / Inlet	0%	$0.00	$107,985.46	$107,985.46	$18,504.02
MI109	1	Infiltration Systems Trenches	1%	$0.00	$323,008.84	$323,008.84	$32,300.88
MI109	2	Sediment Sump / Inlet	0%	$0.00	$89,988.41	$89,988.41	$15,420.02
MI110	2	Sediment Sump / Inlet	1%	$0.00	$215,970.92	$215,970.92	$37,008.05
MI111	1	Infiltration Systems Trenches	1%	$0.00	$258,407.07	$258,407.07	$25,840.92
MI111	2	Sediment Sump / Inlet	0%	$0.00	$71,990.31	$71,990.31	$12,336.02
MI113	1	Off-Line Retention	3%	$1,039,586.	$140,984.09	$1,180,569.59	$8,459.40
MI113	2	Infiltration Systems Trenches	2%	$0.00	$742,920.33	$742,920.33	$74,292.24
MI113	3	Sediment Sump / Inlet	1%	$0.00	$215,970.92	$215,970.92	$37,008.05
MI114	3	Sediment Sump / Inlet	1%	$0.00	$449,939.95	$449,939.95	$77,100.10
MI116	1	Off-Line Retention	1%	$0.00	$59,094.62	$59,094.62	$3,545.66
MI117	1	Infiltration Systems Trenches	6%	$0.00	$969,026.52	$969,026.52	$96,902.65
MI117	2	Sediment Sump / Inlet	2%	$0.00	$287,961.23	$287,961.23	$49,344.06

Source: SLMP, 2011.

Table 5 - Minnehaha BMP Ranking by Cost

Outfall Designation	BMP Option #	BMP Alternative	Total Cost	20-yr TP Reduction	$ per lb TP Removed
MI111	2	Sediment Sump / Inlet	$84,326.32	182.40	$462.32
MI109	2	Sediment Sump / Inlet	$105,408.43	182.40	$577.90
MI108	2	Sediment Sump / Inlet	$126,489.49	182.40	$693.47
MI116	1	Off-Line Retention	$62,640.27	60.80	$1,030.27
MI122	3	Infiltration Systems Trenches	$3,339,910.98	1337.60	$2,496.94
MI117	2	Sediment Sump / Inlet	$337,305.30	121.60	$2,773.89
MI117	1	Infiltration Systems Trenches	$1,065,929.17	364.80	$2,921.95
MI103	3	Sediment Sump / Inlet	$231,897.92	60.80	$3,814.11
MI113	3	Sediment Sump / Inlet	$252,978.97	60.80	$4,160.84
MI110	2	Sediment Sump / Inlet	$252,978.97	60.80	$4,160.84
MI111	1	Infiltration Systems Trenches	$284,247.99	60.80	$4,675.13
MI103	1	Off-Line Retention	$572,143.87	121.60	$4,705.13
MI105	2	Sediment Sump / Inlet	$290,000.00	60.80	$4,769.74
MI109	1	Infiltration Systems Trenches	$355,309.72	60.80	$5,843.91
MI106	2	Sediment Sump / Inlet	$358,387.40	60.80	$5,894.53
MI113	1	Off-Line Retention	$1,189,028.99	182.40	$6,518.80
MI106	1	Infiltration Systems Trenches	$1,202,368.42	182.40	$6,591.93
MI113	2	Infiltration Systems Trenches	$817,212.58	121.60	$6,720.50
MI108	1	Infiltration Systems Trenches	$422,106.97	60.80	$6,942.55
MI103	2	Infiltration Systems Trenches	$911,452.82	121.60	$7,495.50

Adapted from SLMP, 2011.

Table 6 - Gem Pollutant Loading Rates by Outfall

Outfall	SubBasin	Area (Acres)	% Area Treated	Total P (kg/yr)	Total N (kg/yr)	BOD (kg/yr)	TSS (kg/yr)	% Total P
GE100	GE0	8	0%	0	0	0	0	0%
GE101	GE1	14	0%	23	126	642	4,103	10%
GE102	GE2	3	0%	3	19	65	327	1%
GE103	GE3, GE92	75	0%	68	470	2,825	23,371	29%
GE104	GE4	4	0%	3	18	64	334	1%
GE191	GE91	185	0%	140	945	4,611	35,900	59%
Totals		**289**		**236**	**1,578**	**8,208**	**64,035**	

Source: SLMP, 2011.

Table 7 - Gem BMP Phosphorus Reduction and Estimated Cost

Outfall Designation	BMP Option #	BMP Description	Total % Phosphorus Removed	Costs			
				Land Cost	Construction Cost	Capital Cost	O&M Cost
GE101	2	Nutrient Separating Baffle Box	1%	$0.00	$125,979.35	$125,979.35	$21,588.03
GE102	1	Nutrient Separating Baffle Box	0%	$168,527.22	$33,034.47	$201,561.69	$9,480.73
GE103	4	Sediment Sump / Inlet	5%	$0.00	$665,890.85	$665,890.85	$114,108.15
GE104	2	Nutrient Separating Baffle Box	0%	$91,976.26	$29,515.16	$121,491.42	$8,471.00

Source: SLMP, 2011.

Table 8 - Gem BMP Ranking by Cost

Outfall Designation	BMP Option #	BMP Alternative	Total Cost	20-yr TP Reduction	$ per lb TP Removed
GE101	2	Nutrient Separating Baffle Box	$125,453.78	426.6	$294.08
GE102	1	Nutrient Separating Baffle Box	$124,288.03	142.2	$874.04
GE103	4	Sediment Sump / Inlet	$125,453.75	85.3	$1,470.39
GE104	2	Nutrient Separating Baffle Box	$250,907.50	142.2	$1,764.47

Adapted from SLMP, 2011.

Table 9 - Waumpi Pollutant Loading Rates by Outfall

Outfall	SubBasin	Area (Acres)	% Area Treated	Total P (kg/yr)	Total N (kg/yr)	BOD (kg/yr)	TSS (kg/yr)	% Total P
WE100	WE0	4	0%	0	0	0	0	0%
WE111	WE1	32	0%	19	148	452	1,776	3%
WE113	WE3	8	0%	0	0	0	0	0%
WE114	WE4	723	0%	562	3,562	14,115	91,215	97%
Totals		**767**		**581**	**3,710**	**14,567**	**92,990**	

Source: SLMP, 2011.

Table 10 - Waumpi BMP Phosphorus Reduction and Estimated Cost

Outfall Designation	BMP Option #	BMP Description	Total % Phosphorus Removed	Costs			
				Land Cost	Construction Cost	Capital Cost	O&M Cost
WE111	1	Baffle Box	1%	$0.00	$48,694.80	$48,694.80	$53,096.30
WE113	1	Off-Line Retention	3%	$326,792.70	$102,769.22	$429,561.92	$6,165.90
WE114	2	Siltation Basin	2%	$118,575.00	$55,634.34	$174,209.34	$3,338.02

Source: SLMP, 2011.

Table 11 - Waumpi BMP Ranking by Cost

Outfall Designation	BMP Option #	BMP Alternative	Total Cost	20-yr TP Reduction	$ per lb TP Removed
WE114	2	Siltation Basin	$177,547.35	232.40	$763.97
WE111	1	Baffle Box	$101,791.10	116.20	$876.00
WE113	1	Off-Line Retention	$435,727.82	348.60	$1,249.94

Adapted from SLMP, 2011.

Table 12 - Maitland Pollutant Loading Rates by Outfall

Outfall	SubBasin	Area (Acres)	% Area Treated	Total P (kg/yr)	Total N (kg/yr)	BOD (kg/yr)	TSS (kg/yr)	% Total P
MA100	MA0	178	0%	0	0	0	0	0%
MA101	MA1	10	0%	6	47	143	561	1%
MA102	MA2	11	0%	6	49	147	580	1%
MA103	MA3	8	11%	5	37	111	438	1%
MA104	MA4	15	13%	8	65	197	779	2%
MA105	MA5	19	0%	11	88	268	1,052	2%
MA107	MA6, MA7	50	0%	28	223	672	2,648	6%
MA108	MA8	8	0%	4	35	106	415	1%
MA109	MA9	3	0%	1	9	23	97	0%
MA110	MA10	15	15%	8	62	190	758	2%
MA111	MA11	7	16%	7	42	170	920	1%
MA112	MA12	19	0%	23	142	738	4,989	4%
MA113	MA13	12	0%	14	96	583	4,150	3%
MA114	MA14	11	0%	19	119	681	3,991	4%
MA115	MA15	23	4%	6	143	588	3,418	1%
MA116	MA16	11	14%	1	90	384	2,685	0%
MA117	MA17	9	0%	8	51	178	883	1%
MA119	MA19	14	4%	11	72	246	1,248	2%
MA120	MA20	9	0%	5	41	125	494	1%
MA121	MA21	4	0%	2	18	46	170	0%
MA190	MA90	265	0%	0	0	0	0	0%
MA191	MA91	12	0%	4	33	86	359	1%
MA192	MA92	7	0%	3	25	68	272	1%
MA193	MA93	12	0%	6	50	150	594	1%
MA194	MA94	587	0%	315	2,517	7,836	34,440	62%
MA195	MA95	13	0%	8	61	182	709	2%
Totals		**1,333**		**508**	**4,113**	**13,918**	**66,649**	

Source: SLMP, 2011.

Table 13 - Maitland BMP Phosphorus Reduction and Estimated Cost

Outfall Designation	BMP Option #	BMP Description	Total % Phosphorus Removed	Costs			
				Land Cost	Construction Cost	Capital Cost	O&M Cost
MA101	1	Swales	1%	$2,297,147.68	$71,575.03	$2,368,722.71	$20,542.46
MA102	1	Infiltration Systems Trenches	1%	$0.00	$390,841.12	$390,841.12	$39,084.43
MA102	2	Sediment Sump / Inlet	0%	$0.00	$107,982.30	$107,982.30	$18,504.02
MA103	1	Infiltration Systems Trenches	1%	$0.00	$284,247.99	$284,247.99	$28,424.27
MA103	2	Sediment Sump / Inlet	0%	$0.00	$89,985.25	$89,985.25	$15,420.02
MA104	1	Infiltration Systems Trenches	1%	$0.00	$532,964.59	$532,964.59	$53,296.56
MA104	2	Sediment Sump / Inlet	0%	$0.00	$143,976.40	$143,976.40	$24,672.03
MA105	1	Infiltration Systems Trenches	2%	$0.00	$675,088.05	$675,088.05	$67,508.70
MA105	2	Sediment Sump / Inlet	0%	$0.00	$179,970.50	$179,970.50	$30,840.04
MA108	1	Off-Line Retention	0%	$0.00	$59,094.62	$59,094.62	$3,545.66
MA108	2	Infiltration Systems Trenches	0%	$0.00	$284,247.99	$284,247.99	$28,424.27
MA108	3	Sediment Sump / Inlet	0%	$0.00	$71,988.20	$71,988.20	$12,336.02
MA114	1	Off-Line Retention	6%	$1,436,324.80	$75,472.72	$1,511,797.52	$4,527.98
MA114	2	On-Line Retention	4%	$2,448,297.60	$108,672.67	$2,556,970.27	$13,156.03
MA114	3	Sediment Sump / Inlet	1%	$0.00	$107,982.30	$107,982.30	$18,504.02
MA120	1	Infiltration Systems Trenches	1%	$0.00	$319,778.33	$319,778.33	$31,978.36
MA120	2	Sediment Sump / Inlet	0%	$0.00	$125,979.35	$125,979.35	$21,588.03
MA121	1	Swales	0%	$2,444,137.46	$33,034.47	$2,477,171.93	$9,480.73

Source: SLMP, 2011.

Table 14 - Maitland BMP Ranking by Cost

Outfall Designation	BMP Option #	BMP Alternative	Total Cost	20-yr TP Reduction	$ per lb TP Removed
MA108	1	Off-Line Retention	$62,640.27	1527.00	$41.02
MA108	3	Sediment Sump / Inlet	$84,324.22	305.40	$276.11
MA108	2	Infiltration Systems Trenches	$312,672.26	1018.00	$307.14
MA103	2	Sediment Sump / Inlet	$105,405.27	305.40	$345.14
MA102	2	Sediment Sump / Inlet	$126,486.32	305.40	$414.17
MA120	2	Sediment Sump / Inlet	$147,567.38	305.40	$483.19
MA104	2	Sediment Sump / Inlet	$168,648.43	305.40	$552.22
MA105	2	Sediment Sump / Inlet	$210,810.54	305.40	$690.28
MA114	3	Sediment Sump / Inlet	$126,486.32	101.80	$1,242.50
MA114	1	Off-Line Retention	$1,516,325.51	610.80	$2,482.52
MA103	1	Infiltration Systems Trenches	$312,672.26	101.80	$3,071.44
MA120	1	Infiltration Systems Trenches	$351,756.69	101.80	$3,455.37
MA105	1	Infiltration Systems Trenches	$742,596.75	203.60	$3,647.33
MA102	1	Infiltration Systems Trenches	$429,925.55	101.80	$4,223.24
MA104	1	Infiltration Systems Trenches	$586,261.15	101.80	$5,758.95
MA114	2	On-Line Retention	$2,570,126.30	407.20	$6,311.71
MA121	1	Swales	$2,486,652.66	305.40	$8,142.28
MA101	1	Swales	$2,389,265.17	101.80	$23,470.19

Adapted from SLMP, 2011.

Table 15 - Park Pollutant Loading Rates by Outfall

Outfall	SubBasin A	Area (Acres)	% Area Treated	Total P (kg/yr)	Total N (kg/yr)	BOD (kg/yr)	TSS (kg/yr)	% Total P
PA100	PA0	32	0%	0	0	0	0	0%
PA101	PA1	14	0%	23	114	508	3,336	19%
PA102	PA2	22	0%	15	109	463	3,065	13%
PA103	PA3	9	0%	15	76	349	2,369	13%
PA104	PA4	5	0%	8	40	183	1,236	7%
PA105	PA5	5	0%	2	19	57	227	2%
PA106	PA6	5	0%	1	9	21	146	1%
PA108	PA8, PA7, PA9	33	0%	27	154	604	3,848	22%
PA110	PA10	11	0%	18	92	412	2,740	15%
PA191	PA91	2	0%	2	12	42	205	1%
PA192	PA92	14	0%	8	64	194	763	7%
PA193	PA93	2	0%	1	7	22	86	1%
Totals		**153**		**120**	**697**	**2,856**	**18,023**	

Source: SLMP, 2011.

Table 16 - Park BMP Phosphorus Reduction and Estimated Cost

Outfall Designation	BMP Option #	BMP Description	Total % Phosphorus Removed	Costs			
				Land Cost	Construction Cost	Capital Cost	O&M Cost
PA101	2	Sediment Sump / Inlet	4%	$0.00	$125,983.57	$125,983.57	$21,588.03
PA102	1	Off-Line Retention	12%	$358,303.08	$135,524.37	$493,827.46	$8,131.61
PA102	2	On-Line Retention	7%	$627,980.58	$188,379.31	$816,359.89	$22,805.40
PA102	3	Sediment Sump / Inlet	2%	$0.00	$197,973.87	$197,973.87	$33,924.04
PA103	1	Infiltration Systems Trenches	9%	$0.00	$290,707.96	$290,707.96	$29,070.37
PA103	2	Sediment Sump / Inlet	3%	$0.00	$89,988.41	$89,988.41	$15,420.02
PA104	1	Sediment Sump / Inlet	2%	$0.00	$53,993.26	$53,993.26	$9,252.01
PA105	1	Off-Line Retention	1%	$26,592.42	$42,716.51	$69,308.93	$2,563.33
PA105	2	Sediment Sump / Inlet	0%	$0.00	$53,993.26	$53,993.26	$9,252.01
PA108	4	Sediment Sump / Inlet	5%	$0.00	$323,956.39	$323,956.39	$55,512.07
PA110	1	Infiltration Systems Trenches	7%	$0.00	$355,309.72	$355,309.72	$35,531.39
PA110	2	Sediment Sump / Inlet	2%	$0.00	$107,985.46	$107,985.46	$18,504.02
PA110	3	Endwall Leaf / Trash Screens	0%	$0.00	$1,030.81	$1,030.81	$2,110.11

Source: SLMP, 2011.

Table 17 - Park BMP Ranking by Cost

Outfall Designation	BMP Option #	BMP Alternative	Total Cost	20-yr TP Reduction	$ per lb TP Removed
PA105	2	Sediment Sump / Inlet	$63,245.27	72.00	$878.41
PA104	1	Sediment Sump / Inlet	$63,245.27	48.00	$1,317.61
PA103	2	Sediment Sump / Inlet	$105,408.43	72.00	$1,464.01
PA103	1	Infiltration Systems Trenches	$319,778.33	216.00	$1,480.46
PA101	2	Sediment Sump / Inlet	$147,571.59	96.00	$1,537.20
PA102	1	Off-Line Retention	$501,959.07	288.00	$1,742.91
PA110	1	Infiltration Systems Trenches	$390,841.12	168.00	$2,326.44
PA110	2	Sediment Sump / Inlet	$126,489.49	48.00	$2,635.20
PA105	1	Off-Line Retention	$71,872.26	24.00	$2,994.68
PA108	4	Sediment Sump / Inlet	$379,468.46	120.00	$3,162.24
PA102	3	Sediment Sump / Inlet	$231,897.92	48.00	$4,831.21
PA102	2	On-Line Retention	$839,165.29	168.00	$4,995.03

Adapted from SLMP, 2011.

Table 18 - Lily Pollutant Loading Rates by Outfall

Outfall	SubBasin	Area (Acres)	% Area Treated	Total P (kg/yr)	Total N (kg/yr)	BOD (kg/yr)	TSS (kg/yr)	% Total P
LI100	LI0	5	0%	0	0	0	0	0%
LI101	LI1	11	16%	7	57	386	3,485	16%
LI102	LI2	17	94%	17	131	751	2,799	38%
LI103	LI3	13	95%	17	125	692	2,143	37%
LI104	LI4	5	0%	4	27	159	1,088	8%
LI105	LI5	1	0%	0	2	8	75	0%
LI106	LI6	1	42%	0	3	17	170	1%
Totals		**54**		**46**	**345**	**2,013**	**9,760**	

Source: SLMP, 2011.

Table 19 - Lily BMP Phosphorus Reduction and Estimated Cost

Outfall Designation	BMP Option #	BMP Description	Total % Phosphorus Removed	Costs			
				Land Cost	Construction Cost	Capital Cost	O&M Cost
LI101	2	Exfiltration	19%	$0.00	$355,309.72	$355,309.72	$35,531.39
LI102	1	Infiltration Systems Trenches	25%	$0.00	$636,593.87	$636,593.87	$63,659.49
LI102	2	Sediment Sump / Inlet	8%	$0.00	$161,973.45	$161,973.45	$27,756.04
LI102	3	Bioretention	14%	$142,290.00	$264,664.67	$406,954.67	$26,947.62
LI103	1	Off-Line Retention	24%	$972,089.44	$86,391.11	$1,058,480.55	$5,183.57
LI103	2	Infiltration Systems Trenches	17%	$0.00	$419,911.49	$419,911.49	$41,991.36
LI103	3	Sediment Sump / Inlet	5%	$0.00	$125,979.35	$125,979.35	$21,588.03
LI105	1	Infiltration Systems Trenches	1%	$0.00	$32,300.88	$32,300.88	$3,230.51
LI105	2	Swales	1%	$0.00	$7,707.90	$7,707.90	$2,212.35
LI105	3	Sediment Sump / Inlet	0%	$0.00	$17,997.05	$17,997.05	$3,084.00

Source: SLMP, 2011.

Table 20 - Lily BMP Ranking by Cost

Outfall Designation	BMP Option #	BMP Alternative	Total Cost	20-yr TP Reduction	$ per lb TP Removed
LI105	3	Sediment Sump / Inlet	$21,081.05	27.00	$780.78
LI105	2	Swales	$9,920.25	9.00	$1,102.25
LI101	2	Exfiltration	$390,841.12	171.00	$2,285.62
LI102	2	Sediment Sump / Inlet	$189,729.49	72.00	$2,635.13
LI103	2	Infiltration Systems Trenches	$461,902.85	153.00	$3,018.97
LI102	1	Infiltration Systems Trenches	$700,253.36	225.00	$3,112.24
LI103	3	Sediment Sump / Inlet	$147,567.38	45.00	$3,279.28
LI102	3	Bioretention	$433,902.29	126.00	$3,443.67
LI105	1	Infiltration Systems Trenches	$35,531.39	9.00	$3,947.93
LI103	1	Off-Line Retention	$1,063,664.13	216.00	$4,924.37

Adapted from SLMP, 2011.

Table 21 - Nina Pollutant Loading Rates by Outfall

Outfall	SubBasin	Area (Acres)	% Area Treated	Total P (kg/yr)	Total N (kg/yr)	BOD (kg/yr)	TSS (kg/yr)	% Total P
NI100	NI0	12	0%	0	0	0	0	0%
NI101	NI1	12	0%	9	56	210	1,231	17%
NI102	NI2, NI3	36	27%	17	126	395	2,080	31%
NI104	NI4	17	0%	9	69	219	994	16%
NI105	NI5	13	0%	18	100	516	3,651	33%
NI106	NI6	3	0%	2	12	37	145	3%
Totals		**91**		**54**	**364**	**1,376**	**8,101**	

Source: SLMP, 2011.

Table 22 - Nina BMP Phosphorus Reduction and Estimated Cost

Outfall Designation	BMP Option #	BMP Description	Total % Phosphorus Removed	Costs			
				Land Cost	Construction Cost	Capital Cost	O&M Cost
NI102	2	Baffle Box / Exfiltration System	2%	$0.00	$200,000	$200,000	$37,008.00

Source: SLMP, 2011.

Table 23 - Nina BMP Ranking by Cost

Outfall Designation	BMP Option #	BMP Alternative	Total Cost	20-yr TP Reduction	$ per lb TP Removed
NI102	2	Baffle Box / Exfiltration System	$237,008	42	$5,537.30

Source: SLMP, 2011.

Table 24 - Sybelia Pollutant Loading Rates by Outfall

Outfall	SubBasin	Area (Acres)	% Area Treated	Total P (kg/yr)	Total N (kg/yr)	BOD (kg/yr)	TSS (kg/yr)	% Total P
SY100	SY0	80	0%	0	0	0	0	0%
SY102	SY2, SY6	56	55%	25	213	754	6,135	11%
SY103	SY3	5	0%	3	22	68	265	1%
SY104	SY4	12	30%	7	55	255	2,334	3%
SY105	SY5	14	0%	7	59	187	853	3%
SY107	SY7	27	87%	10	81	334	2,992	5%
SY108	SY8, SY9	23	5%	14	110	521	4,060	7%
SY110	SY10	3	0%	2	16	47	186	1%
SY111	SY11	13	38%	6	55	115	504	3%
SY112	SY12	14	66%	6	57	87	426	3%
SY113	SY13	16	100%	9	76	241	514	4%
SY114	SY14, SY91, 1/2 of SY93	74	17%	52	346	1,292	7,557	23%
SY115	SY15, SY92, 1/2 of SY93	80	76%	30	210	740	4,739	14%
SY116	SY16	8	2%	1	16	34	153	1%
SY117	SY17	14	24%	8	62	155	642	3%
SY118	SY18	14	0%	8	63	193	757	4%
SY119	SY19	8	50%	4	37	69	315	2%
SY120	SY1	11	0%	6	46	148	662	3%
SY120	SY20	29	18%	14	118	318	1,293	7%
SY121	SY21	13	11%	7	56	202	1,303	3%
Totals		**513**		**219**	**1,698**	**5,761**	**35,691**	

Source: SLMP, 2011.

Table 25 - Sybelia BMP Phosphorus Reduction and Estimated Cost

Outfall Designation	BMP Option #	BMP Description	Total % Phosphorus Removed	Costs			
				Land Cost	Construction Cost	Capital Cost	O&M Cost
SY104	1	Infiltration Systems Trenches	1%	$0.00	$387,610.61	$387,610.61	$38,760.85
SY104	2	Sediment Sump / Inlet	1%	$0.00	$107,985.46	$107,985.46	$18,504.02
SY105	1	Off-Line Retention	2%	$0.00	$91,849.78	$91,849.78	$5,511.37
SY105	2	Swales	1%	$0.00	$123,328.54	$123,328.54	$35,395.43
SY105	3	Sediment Sump / Inlet	0%	$0.00	$143,980.62	$143,980.62	$24,672.03
SY108	1	On-Line Retention	3%	$0.00	$204,668.88	$204,668.88	$24,777.43
SY108	2	Infiltration Systems Trenches	4%	$0.00	$742,920.33	$742,920.33	$74,292.24
SY108	3	Sediment Sump / Inlet	1%	$0.00	$215,970.92	$215,970.92	$37,008.05
SY110	1	Infiltration Systems Trenches	0%	$0.00	$96,902.65	$96,902.65	$9,690.48
SY110	2	Swales	0%	$0.00	$26,428.00	$26,428.00	$7,584.58
SY110	3	Sediment Sump / Inlet	0%	$0.00	$35,995.15	$35,995.15	$6,168.01
SY111	1	Infiltration Systems Trenches	1%	$0.00	$419,911.49	$419,911.49	$41,991.36
SY111	2	Sediment Sump / Inlet	0%	$0.00	$125,983.57	$125,983.57	$21,588.03
SY112	1	Infiltration Systems Trenches	1%	$0.00	$452,212.38	$452,212.38	$45,220.82
SY112	2	Sediment Sump / Inlet	0%	$0.00	$125,983.57	$125,983.57	$21,588.03
SY116	1	Swales	1%	$0.00	$69,064.40	$69,064.40	$19,821.52
SY117	1	Swales	2%	$0.00	$93,730.11	$93,730.11	$26,900.19
SY118	1	Off-Line Retention	2%	$284,184.75	$91,849.78	$376,035.58	$5,511.37
SY118	2	Infiltration Systems Trenches	1%	$0.00	$452,212.38	$452,212.38	$45,220.82
SY118	3	Sediment Sump / Inlet	0%	$0.00	$125,983.57	$125,983.57	$21,588.03
SY119	1	Infiltration Systems Trenches	1%	$0.00	$258,407.07	$258,407.07	$25,840.92
SY119	2	Sediment Sump / Inlet	0%	$0.00	$89,988.41	$89,988.41	$15,420.02
SY120	1	Infiltration Systems Trenches	3%	$0.00	$1,536,230.30	$1,536,230.30	$153,622.61
SY120	2	Sediment Sump / Inlet	1%	$0.00	$359,951.54	$359,951.54	$61,680.08

Source: SLMP, 2011.

Table 26 - Sybelia BMP Ranking by Cost

Outfall Designation	BMP Option #	BMP Alternative	Total Cost	20-yr TP Reduction	$ per lb TP Removed
SY110	1	Infiltration Systems Trenches	$106,593.13	438.00	$243.36
SY110	2	Swales	$34,012.58	131.40	$258.85
SY110	3	Sediment Sump / Inlet	$42,163.16	131.40	$320.88
SY119	2	Sediment Sump / Inlet	$105,408.43	131.40	$802.20
SY105	1	Off-Line Retention	$97,361.14	87.60	$1,111.43
SY118	3	Sediment Sump / Inlet	$147,571.59	131.40	$1,123.07
SY111	2	Sediment Sump / Inlet	$147,571.59	131.40	$1,123.07
SY112	2	Sediment Sump / Inlet	$147,571.59	131.40	$1,123.07
SY105	3	Sediment Sump / Inlet	$168,652.65	131.40	$1,283.51
SY117	1	Exfiltration Nottoway	$120,630.30	87.60	$1,377.06
SY108	1	On-Line Retention	$229,446.31	131.40	$1,746.17
SY116	1	Swales	$88,885.93	43.80	$2,029.36
SY104	2	Sediment Sump / Inlet	$126,489.49	43.80	$2,887.89
SY105	2	Swales	$158,723.97	43.80	$3,623.83
SY118	1	Off-Line Retention	$381,546.95	87.60	$4,355.56
SY108	2	Infiltration Systems Trenches	$817,212.58	175.20	$4,664.46
SY108	3	Sediment Sump / Inlet	$252,978.97	43.80	$5,775.78
SY119	1	Infiltration Systems Trenches	$284,247.99	43.80	$6,489.68
SY120	2	Sediment Sump / Inlet	$421,631.62	43.80	$9,626.29
SY104	1	Infiltration Systems Trenches	$426,371.46	43.80	$9,734.51
SY111	1	Infiltration Systems Trenches	$461,902.85	43.80	$10,545.73
SY118	2	Infiltration Systems Trenches	$497,433.19	43.80	$11,356.92
SY112	1	Infiltration Systems Trenches	$497,433.19	43.80	$11,356.92
SY120	1	Infiltration Systems Trenches	$1,689,852.90	131.40	$12,860.37

Adapted from SLMP, 2011.

Table 27 - Jackson Pollutant Loading Rates by Outfall

Outfall	SubBasin	Area (Acres)	% Area Treated	Total P (kg/yr)	Total N (kg/yr)	BOD (kg/yr)	TSS (kg/yr)	% Total P
JA100	JA0	22	0%	0	0	0	0	0%
JA101	JA1	25	25%	9	91	274	1,139	21%
JA102	JA2	16	0%	9	74	226	888	22%
JA103	JA3	17	3%	10	80	238	940	23%
JA104	JA4, JA5	22	0%	6	57	148	680	15%
JA106	JA6	13	24%	4	38	208	1,896	10%
JA107	JA7	4	2%	2	14	42	168	4%
JA108	JA8	6	34%	2	21	41	185	6%
Totals		**124**		**43**	**376**	**1,177**	**5,897**	

Source: SLMP, 2011.

Table 28 - Jackson BMP Phosphorus Reduction and Estimated Cost

Outfall Designation	BMP Option #	BMP Description	Total % Phosphorus Removed	Costs			
				Land Cost	Construction Cost	Capital Cost	O&M Cost
JA102	1	Infiltration Systems Trenches	8%	$0.00	$516,814.14	$516,814.14	$51,681.84
JA102	2	Baffle Box	3%	$0.00	$146,084.40	$146,084.40	$159,287.86
JA103	1	Infiltration Systems Trenches	10%	$0.00	$532,642.06	$532,642.06	$53,263.89
JA103	2	Baffle Box	3%	$0.00	$146,084.40	$146,084.40	$159,287.86
JA106	1	Off-Line Retention	19%	$2,584,287.84	$86,391.11	$2,670,678.95	$5,183.57
JA106	4	Sediment Sump / Inlet	4%	$0.00	$125,979.35	$125,979.35	$21,588.03
JA107	1	Swales	2%	$765,716.24	$30,216.07	$795,931.26	$8,672.31

Source: SLMP, 2011.

Table 29 - Jackson BMP Ranking by Cost

Outfall Designation	BMP Option #	BMP Alternative	Total Cost	20-yr TP Reduction	$ per lb TP Removed
JA106	4	Sediment Sump / Inlet	$147,567.38	33.60	$4,391.89
JA103	1	Infiltration Systems Trenches	$585,905.95	84.00	$6,975.07
JA102	1	Infiltration Systems Trenches	$568,495.98	67.20	$8,459.76
JA103	2	Baffle Box	$305,372.26	25.20	$12,117.95
JA102	2	Baffle Box	$305,372.26	25.20	$12,117.95
JA106	1	Off-Line Retention	$2,675,862.53	159.60	$16,766.06
JA106	4	Sediment Sump / Inlet	$147,567.38	33.60	$4,391.89
JA103	1	Infiltration Systems Trenches	$585,905.95	84.00	$6,975.07

Adapted from SLMP, 2011.

Table 30 - Shadow Pollutant Loading Rates by Outfall

Outfall	SubBasin	Area (Acres)	% Area Treated	Total P (kg/yr)	Total N (kg/yr)	BOD (kg/yr)	TSS (kg/yr)	% Total P
SH100	SH0	34	0%	0	0	0	0	0%
SH101	SH1	30	97%	1	107	350	3,418	0%
SH102	SH2	115	84%	59	439	1,022	7,521	41%
SH103	SH3	25	44%	12	85	249	1,777	8%
SH104	SH4	20	42%	7	64	199	1,543	5%
SH190	SH90	41	0%	0	0	0	0	0%
SH191	SH91	70	25%	66	407	2,123	14,528	46%
Totals		**334**		**145**	**1,101**	**3,942**	**28,787**	

Source: SLMP, 2011.

Table 31 - Shadow BMP Phosphorus Reduction and Estimated Cost

Outfall Designation	BMP Option #	BMP Description	Total % Phosphorus Removed	Costs			
				Land Cost	Construction Cost	Capital Cost	O&M Cost
SH191	2	Off-Line Retention	9%	$421,601.05	$206,495.46	$628,096.52	$12,389.77
SH191	1	On-Line Retention	6%	$421,601.05	$102,402.42	$524,002.42	$12,397.15
SH191	3	Bioretention	1%	$118,575.00	$220,553.72	$339,128.72	$26,947.62

Source: SLMP, 2011.

Table 32 - Shadow BMP Ranking by Cost

Outfall Designation	BMP Option #	BMP Alternative	Total Cost	20-yr TP Reduction	$ per lb TP Removed
SH191	2	Off-Line Retention	$640,486.29	261.00	$2,453.97
SH191	1	On-Line Retention	$536,399.57	174.00	$3,082.76
SH191	3	Bioretention	$366,076.33	29.00	$12,623.32

Adapted from SLMP, 2011.

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