Appendix 4-1: Annual Permit Report for Lake Okeechobee Water Control Structures Operation

Permit Report (May 1, 2011–April 30, 2012)
Permit Number: 0174552

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SUMMARY

Based on Florida Department of Environmental Protection (FDEP) permit reporting guidelines, **Table 1** lists key permit-related information associated with this report. **Table 2** lists the attachments included with this report. **Table A-1** in Attachment A lists specific pages, tables, and graphs where project status and annual reporting requirements are addressed. This annual report satisfies the reporting requirements specified in the permit.

Table 1. Key permit-related information.

Project Name:	Lake Okeechobee Operating Permit
Permit Number:	0174552-008
Issue and Expiration Dates:	Issued: 6/18/2007; Expires: 6/18/2012
Project Phase:	Operation
Permit Specific Condition Requiring Annual Report:	14
Relevant Period of Record:	May 1, 2011–April 30, 2012
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Table 2. Attachments included with this report.

Attachment	Title
A	Specific Conditions and Cross-References
B	Water Quality and Hydrologic Data *(Note: Contains Attachments B1–B11)*

INTRODUCTION

The Lake Okeechobee Operating Permit (0174552-001-GL) was issued under the authority of the Lake Okeechobee Protection Act, Chapter 373.4595, Florida Statutes (F.S.), and Title 62, Florida Administrative Code (F.A.C.). This annual report is submitted by the South Florida Water Management District (SFWMD or District) to the Florida Department of Environmental Protection (FDEP) to fulfill the requirements of Modifications 006, 007, and 008 of the Operating Permit (0174552) and Specific Condition 14, Annual Monitoring Reports of the permit. The modifications to the permit include the following:

- Addition of monitoring at site C41H78, which replaces monitoring at structures HP-7, Inflow-1, Inflow-2, Inflow-3, and L-61E
- Change in the duration column for grab samples at S-2 and S-3 when pumping occurs
- Change in grab samples at S-2 and S-3 to include pH, temperature, conductivity, dissolved oxygen, and all chemical parameters listed in **Table 3**
- Replacement of BOD5 with total organic carbon
- Discontinued calcium monitoring
- Modified chlorophyll *a* monitoring requirements
- Modification of the parameter list for sites S-351, S-354, G-207, and G-208

This report includes two sections: (A) *Monitoring Data*, which includes records and general descriptions of data collected to meet the requirements of this permit for Water Year 2012 (WY2012) (May 1, 2011–April 30, 2012), and (B) *Performance Evaluation*, which includes an analysis of these data for Florida Class I water quality exceedances, total phosphorus (TP) loads, applicable records from the ambient pesticide and herbicide monitoring data, and data collected within Lake Okeechobee under the *Lake Okeechobee Research and Monitoring Plan*

A. MONITORING DATA

WATER QUALITY

An attachment of all water quality samples, including qualified samples, collected at Lake Okeechobee structures (**Figure 1**; **Table 4**) was developed from the District's hydrometeorological and water quality database, DBHYDRO (SFWMD, 2012a; **Attachment B1**). These records include analytical results of grab or in situ samples taken throughout the year for 18 parameters required in the Permit (**Table 5**). Daily flow data (**Attachment B2**) and daily rainfall data (**Attachment B3**) also are reported.

The appendices of water quality incorporate the permit-required data and metadata that include (1) date, location, and time of sampling or measurements; (2) person responsible for performing the sampling or measurements; (3) date analyses were performed or the appropriate code as required by Chapter 62-160, F.A.C.; (4) laboratory/person responsible for performing the analyses; (5) analytical methods used, including method detection limit (MDL) and practical quantitation limit (PQL); (6) results of such analyses, including appropriate data qualifiers and all compounds detected; (7) depth of sampling (for grab samples); and (8) flow conditions and weather conditions at the time of sample collection.

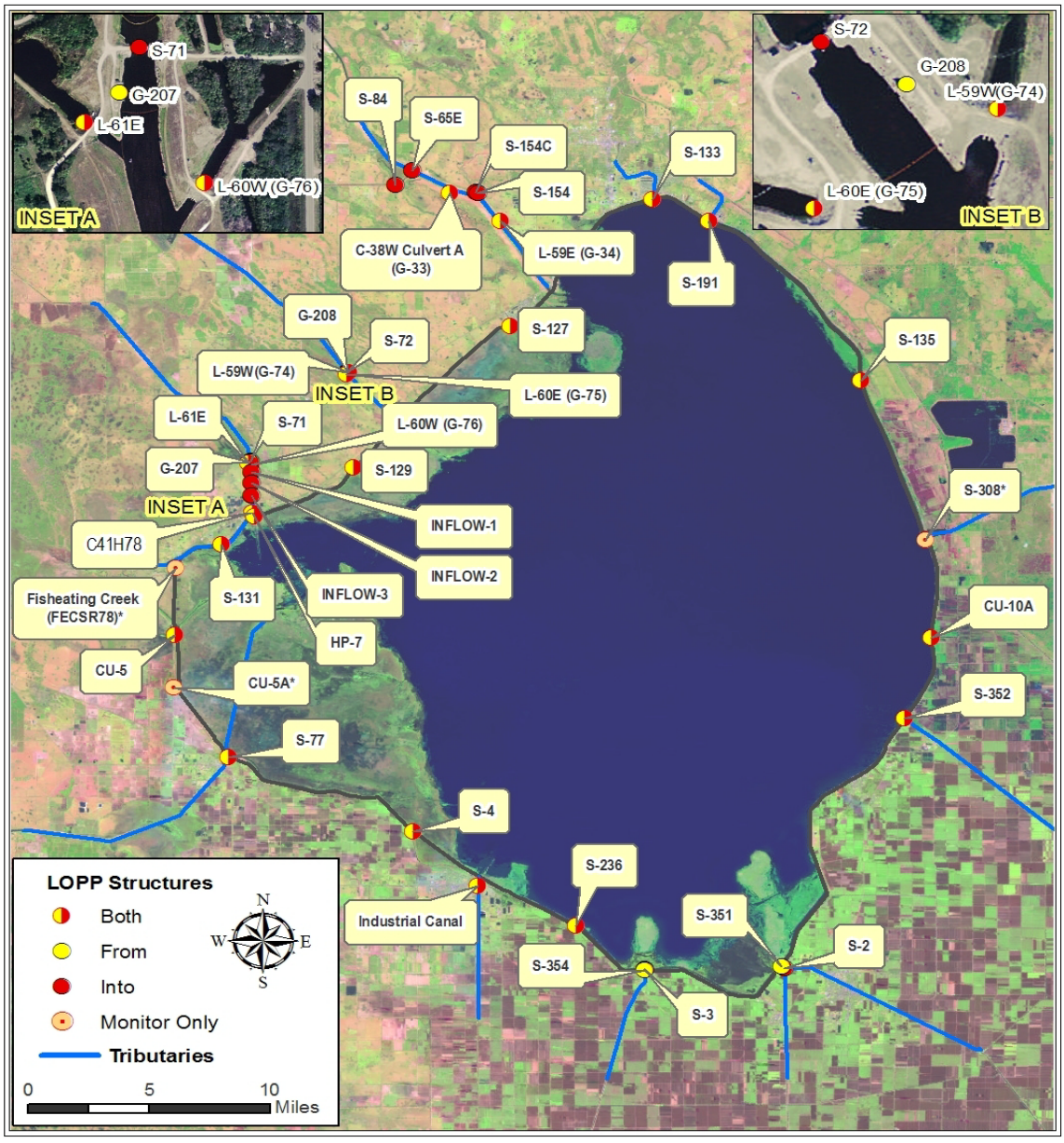

Figure 1. Structures included in the Lake Okeechobee Operating Permit.

Table 3. Water quality monitoring for S-2 and S-3 flood control back pumping for compliance with Permit 0174552-001-GL (Modification 0174552-006-EM).

Site	Type	Duration	Parameters
S-2	ACF*	Event** duration	TP and TN*** only
S-2	Grab	Event duration ≤ 72 hours: Collect one sample for nutrients (TN and TP) and all chemical parameters listed in **Table 5** within 24 hours of initiation of pumping operations. Event duration >72 hours: Collect one sample during first 24 hours, and then every 72 hours.	Physical parameters: pH, temperature, conductivity, and dissolved oxygen Chemical parameters - All chemical parameters listed in **Table 5**.
S-3	ACF*	Event** duration	TN and TP*** only
S-3	Grab	Event duration ≤ 72 hours: Collect one sample for nutrients (TN and TP) and all chemical parameters listed in **Table 5** within 24 hours of initiation of pumping operations. Event duration >72 hours: Collect one sample during first 24 hours, and then every 72 hours.	Physical parameters: pH, temperature, conductivity, and dissolved oxygen Chemical parameters - All chemical parameters listed in **Table 5**.

ACF – auto-sampler composite flow proportional

TP – total phosphorus

* Flow-proportional composite sampler

** An event is defined as continuous or intermittent pumping activity separated by a cessation of 72 hours or greater

*** TN (total nitrogen) = Total Kjeldahl Nitrogen + Nitrate + Nitrite

Table 4. Structures monitored for compliance with Permit 0174552-001-GL (Modification 0174552-006-EM).

Structure	Into/From	DBHYDRO Inflow Direction[5]	Structure Description	Latitude	Longitude
S-2	Into	-	Four unit pump station, 3,600 cfs	26 41 58.81	80 42 48.09
S-3	Into	-	Three unit pump station, 2,670 cfs	26 41 56.24	80 48 26.21
S-4	Both	+	Three unit pump station, 2,805 cfs	26 47 24.64	80 57 42.43
S-65E	Into	+	Gated spillway with six cable operated vertical lift gates, lock structure with sector gates	27 13 31.16	80 57 45.22
S-71	Into	+	Gated spillway, three stem operated vertical lift gates	27 02 03.19	81 04 15.23
S-72[3]	Into	+	Gated spillway, two stem operated vertical lift gates	27 05 35.18	81 00 21.22
S-84	Into	+	Gated spillway with two vertical lift gates	27 12 58.16	80 58 24.22
S-127	Both	+	Five unit pump station, 625 cfs, plus gated spillway/lock	27 07 21.56	80 53 45.41
S-129	Both	+	Three unit pump station, 375 cfs, plus gated spillway	27 01 48.19	81 00 05.22
S-131	Both	+	Two unit pump station, 250 cfs, plus gated spillway, lock	26 58 45.23	81 05 24.72
S-133	Both	+	Five unit pump station, 625 cfs, plus outlet structure	27 12 23.92	80 48 02.59
S-135	Both	+	Four unit pump station, 500 cfs, plus spillway and lock	27 05 12.71	80 39 40.14
S-154C	Into	+	Concrete pipe culvert, one barrel, with gate	27 12 39.58	80 55 11.38
S-154	Into	+	Reinforced concrete box culvert, two barrels, sluice gate	27 12 38.82	80 55 06.24
S-191	Both	+	Gated spillway with three cable operated vertical lift gates	27 11 31.17	80 45 45.20
S-236	Both	+	Three unit pump station, 255 cfs, plus outlet	26 43 40.41	80 51 10.12
S-351[1]	Both	-	Gated spillway with three vertical lift gates	26 42 03.00	80 42 54.96
S-352[1]	Both	-	Gated spillway with two vertical lift gates	26 51 50.61	80 37 56.65
S-354[1]	Both	-	Gated spillway with two vertical lift gates	26 41 55.96	80 48 26.25
CU-5	Both	+	Three barrel corrugated metal pipe, slide gates	26 53 06.93	81 07 18.23
CU-10A	Both	-	Five barrel corrugated metal pipe	26 55 01.45	80 36 51.33
C-38W Culvert A (G-33)	Both	+	Pipe inflow under levee	27 12 39.00	80 56 11.69
G-207	From	-	One unit pump station, 135 cfs	27 1 59.54	81 04 17.36
G-208[3]	From	-	One unit pump station, 135 cfs	27 5 32.65	81 00 20.04

Table 4. Continued.

Structure	Into/From	DBHYDRO Inflow Direction[5]	Structure Description	Latitude	Longitude
S-72 Weir Auxiliary Water Supply Pump Station[4]	From	-	Three unit pump station	27 03 59.36	80 58 41.07
L-59E (G-34)	Both	+	Three barrel culvert	27 11 31.17	80 54 11.21
L-59W(G-74)	Both	+	Two barrel gated culvert	27 06 26.18	80 59 57.22
L-60E (G-75)	Both	+	Two barrel gated culvert	27 05 05.18	81 01 27.22
L-60W (G-76)	Both	+	Two barrel gated culvert	27 01 58.19	81 03 06.23
C41H78[2]	Both	+	Canal downstream of G-207, Inflow-1, Inflow-2, Inflow-3, HP-7, L-61E and S-71	26 59 51.52	81 04 05.90
INDUSCAN	Both	-	Represents flows at S-310	26 45 14.00	80 55 07.22
L-61E[2]	Both	N/A	Two barrel culvert with flashboards	27 01 59.19	81 05 17.23
HP-7[2,3]	Both	N/A	Single barrel culvert with flap gate with winch	27 00 00.00	81 04 10.00
Inflow-1[2,3]	Into	N/A	Single barrel culvert with flap gate, on Harney Pond Canal, downstream of S-71	27 01 36.53	81 04 12.49
Inflow-2[2,3]	Into	N/A	Single barrel culvert with flap gate, on Harney Pond Canal	27 01 10.77	81 04 12.20
Inflow-3[2,3]	Into	N/A	Single barrel culvert with flap gate, on Harney Pond Canal	27 00 41.13	81 04 11.74

[1] Structures have the ability to incorporate the use of temporary forward pumps (see Specific Condition 4) for discharging water from Lake Okeechobee during periods of low water levels.

[2] C41H78 site is used to estimate required inflow and water quality at Inflow-1, Inflow-2, Inflow-3, HP-7, and L-61E, per Modification 0174552-006-EM, dated September 17, 2009.

[3] Locations are approximate, and are not owned or operated by the SFWMD.

[4] S-72 Weir Auxiliary Water Pump Station monitoring is conducted at both S-72 and G-208.

[5] + : Inflow to lake is a positive number; outflow is a negative number.
- : Inflow to lake is a negative number; outflow is a positive number.

cfs – cubic feet per second

Table 5. Parameters monitored and appendices where data are reported for compliance with Permit 0174552-001-GL (Modification 0174552-007).

Parameter Name	Parameter Description	Units	Sample Type	Sampling Frequency	Structures Sampled[1,2]	Attachment
ALK	Alkalinity	mg/L	G	BI-W if flowing, M if not flowing	ALL	B1
TOC	Total Organic Carbon	mg/L	G	BI-W if flowing, M if not flowing	S-308, S-77	B1
CHLA	Chlorophyll *a*	µg/L	G	BI-W if flowing, M if not flowing	S-308, S-77	B1
NH4	Dissolved Ammonia	mg/L	G	BI-W if flowing, M if not flowing	ALL	B1
DO	Dissolved Oxygen	mg/L	INSITU	BI-W if flowing, M if not flowing	ALL	B1
PH	pH	SU	INSITU	BI-W if flowing, M if not flowing	ALL	B1
SCOND	Specific Conductance	µS/cm	INSITU	BI-W if flowing, M if not flowing	ALL	B1
TEMP	Temperature	°C	INSITU	BI-W if flowing, M if not flowing	ALL	B1
TURB	Turbidity	NTU	G	BI-W if flowing, M if not flowing	ALL	B1
TKN	Total Kjeldahl Nitrogen	mg/L	G	BI-W if flowing, M if not flowing	ALL	B1
			ACF	W if flowing	G-207, G-208	B1
TP	Total Phosphorus	mg/L	G	BI-W if flowing, M if not flowing	ALL, FECSR78, S-77, S-308, CU-5A	B1
			ACF	W if flowing, M if not flowing	S-351, S-354	B1
			ACF	W if flowing	G-207, G-208	B1
TN	Total Nitrogen	mg/L	CAL	BI-W if flowing, M if not flowing	ALL	B1
			CAL	W if flowing, M if not flowing	S-351, S-354	B1
			CAL	W if flowing	G-207, G-208	B1
NOX	Nitrate + Nitrite	mg/L	G	BI-W if flowing, M if not flowing	ALL	B1
			ACF	W if flowing	G-207, G-208	B1
SRP	Soluble Reactive Phosphorus	mg/L	G	BI-W if flowing, M if not flowing	ALL	B1
TFE	Total Iron	µg/L	G	Q	ALL	B1
TSS	Total Suspended Solids	mg/L	G	BI-W if flowing, M if not flowing	ALL	B1
FLOW	Flow	CFS	PR	DAV	ALL (pumps)	B2
	Flow	CFS	CAL	DAV	ALL (culverts or gates), FECSR78, S-77, S-308, CU-5A	B2
RAIN	Rainfall Volume	Inches	RG	DAC	Rainfall Sampling Station	B3

Table 5. Continued.

Key to abbreviations:

ALL – structures owned and operated by the District, as specified in **Table 1**	M – monthly
ACF – flow-proportional composite sampler	mg/L – milligrams per liter
BI-W – biweekly	NTU – nephelometric turbidity units
CAL – calculated	µg/L – micrograms per liter
CFS – cubic feet per second	µS/cm – microsiemens per centimeter
DAC – daily accumulation	PR – pump records
DAV – daily average	Q – quarterly
G – grab sample	RG – rain gauge
INSITU – measured with probe on-site	SU – standard units

[1] C41H78 (Harney Pond Canal) monitoring station is the representative monitoring site for HP-7, Inflow-1, Inflow-2, Inflow- 3, and L-61E.

[2] S-72 Weir Auxiliary Water Pump Station monitoring is conducted at both S-72 and G-208.

FLOW DATA

Daily flow data for permitted structures are stored in DBHYDRO (SFWMD, 2012a; **Attachment B2**). Additional flow information for structures that contribute to the TP loads to Lake Okeechobee but are not included in the permit (FECRSR78, S-77, S-308, CU-5A, CU-10, CU-4, CU-12 and CU-12A) are also found in **Attachment B2**. These data were downloaded from DBHYDRO on July 24, 2012. Updates and revisions to the data may occur after this time. As described in the 2011 Annual Permit Report for Lake Okeechobee Water Control Structures Operation (SFWMD, 2011), the monitoring site, C41H78, is operational along the Harney Pond Canal. This new site, as approved in Permit Modification 0174552-006-EM, estimates the combined flow and TP load contribution from the minor structures L-61E, HP7, Inflow 1, Inflow 2, and Inflow 3. To determine the contributions from these minor structures, the flow measured and load calculated from sites S-71, L-60W (G-76), and G-207 are removed from the C41H78 measurement and load calculation. Improvements in measurement at C41H78 allowed for better estimates of flow and load from the small basins using monthly summed data. Only positive flows at C41H78 were summed monthly.

As reported in the 2011 annual permit report, Fisheating Creek flow is now reported using DBKEY WH036 (U.S. Geological Survey, ID 02257000), a site co-located with water quality sampling for the creek (FECRSR78). While the site improves on the accuracy of flow and load to Lake Okeechobee, flows can at times be negative as wind-driven seiches move water from the lake into the creek. Only positive values are used in load calculations to the lake.

Structures S-2 and S-351 and structures S-3 and S-354 share common preferred flow data. Flow into the lake at these locations occurs through S-2 and S-3 pump stations, while flow out of the lake occurs at spillways S-351 and S-354 by either gravity flow or temporary forward pumps.

During WY2012, inflow volume to Lake Okeechobee was approximately 1.9 million acre feet (ac-ft) (**Table 6**). This is smaller than the baseline period (1991–2005) flow of 2.5 million ac-ft (SFWMD et al., 2011). The tributaries contributing the largest flows in WY2012 were S-65E, S-84, S-77, and Fisheating Creek. Except for S-77, all of these are northern basins where the majority of flow to the lake originates. Backflow from the S-77 basin occurred because water levels in the lake were lower than water levels in this southern basin. Because of the dry year, no backpumping after action reports at S-2 and S-3 were required. Flow for routine maintenance did occur at these locations, which was relatively low; as such, no reports were needed as specified in

Specific Condition 5 of the permit. Inflow to Lake Okeechobee in WY2012 began with a typical wet season. Flow to the lake was highest in October 2011 due to the no-name storm event during that month. This event produced almost half of the annual flow to the lake for the water year (see Volume I, Chapter 8).

Lake stage declined from 10.92 feet National Geodetic Vertical Datum (ft NGVD) on May 1, 2011, to 9.53 ft NGVD on June 23, 2011 (**Figure 2**). Modified Phase I and II water restrictions were already in place prior to this reporting period (March 2011). Lake stage gradually increased throughout the summer rainy season until October 7, 2011. At this point, discharge from the no-name storm reached the lake and water levels increased to 13.81 ft NGVD on November 10, 2011 (a 2.73-foot increase in one month). Phase I and II restrictions were discontinued at that time.

In WY2012, outflow from the lake was approximately 750,000 ac-ft (**Table 7**). Discharges to the south (Everglades Agricultural Area) through S-351, S-352, and S-354 were highest in May 2011 and April 2012, followed closely by March 2012 and June 2011 flows. Baseflow releases through S-77 were initiated on December 16, 2011, and continued until March 22, 2012. From April 23–26, 2012, nearly 16,000 ac-ft was released to S-77 to reduce the potential for algal bloom formation in the Caloosahatchee River.

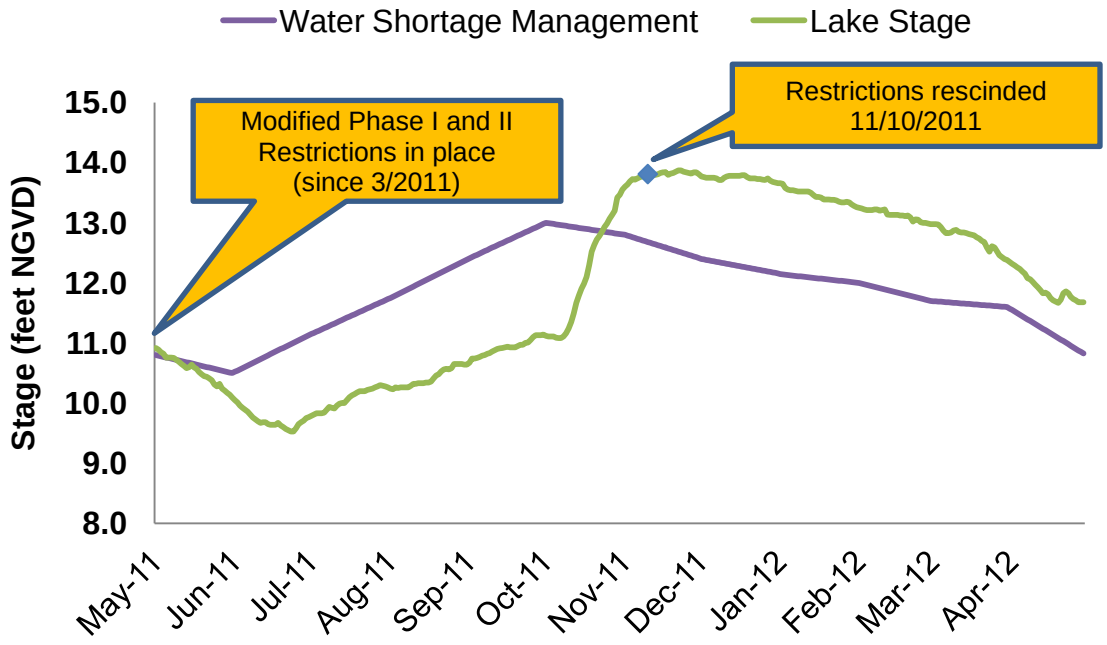

Figure 2. Lake Okeechobee stage values (feet National Geodetic Vertical Datum, or ft NGVD) for WY2012 and water shortage management criteria (from USACE, 2008).

Table 6. Monthly inflow to Lake Okeechobee by structure (acre-feet, or ac-ft) for Water Year 2012 (WY2012) (May 1, 2011–April 30, 2012).

Region	Structure	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	Total
East	L8 (CU-10A)	10	242	6,942	7,111	8,021	5,396	7,180	88	.	257	579	792	36,619
	S-308[2]	934	1,246	8,793	2,646	7,706	14,537	2,741	5,793	1,047	1,720	1,687	839	49,689
	Total	**944**	**1,488**	**15,735**	**9,757**	**15,727**	**19,933**	**9,921**	**5,881**	**1,047**	**1,978**	**2,266**	**1,631**	**86,308**
North	C-38W Culvert A (G-33)	0	0	0	0	0	0	0	0	0	0	0	0	0
	C41H78[3]	4,237	5,714	20,752	11,520	8,369	32,476	5,592	1,623	2,732	3,157	4,266	3,967	104,404
	L61E, HP7, Inflow 1, 2, 3[3]	4,234	2,878	1,182	396	0	0	0	0	1,429	2,467	4,174	3,958	20,718
	CU-5	0	0	778	0	0	0	0	0	0	0	0	0	778
	Fisheating Creek-Lakeport	168	222	7,953	13,029	20,053	29,119	22,058	2,446	721	531	501	214	97,017
	L-59E (G-34)	0	0	0	0	0	0	0	0	0	0	0	0	0
	L-59W(G-74)	0	0	224	1,063	63	3,530	517	1	0	10	6	0	5,414
	L-60E (G-75)	0	0	429	38	28	993	122	3	0	5	0	0	1,618
	L-60W (G-76)	0	0	808	104	109	669	526	111	0	3	9	9	2,348
	S-127	0	0	0	0	0	2,543	1,535	14	0	0	0	0	4,093
	S-129	0	0	2,284	245	2	2,293	828	33	0	0	1,003	639	7,326
	S-131	0	26	1,614	5	0	970	443	31	0	0	0	0	3,090
	S-133	0	0	0	0	0	961	126	35	0	0	0	0	1,122
	S-135	137	0	0	0	0	0	0	22	0	0	0	0	158
	S-154	0	0	1	1	0	3,454	4,537	213	0	.	0	0	8,206
	S-154C	0	0	0	111	208	422	336	133	85	33	39	1	1,367
	S-191	0	0	133	3,942	6,541	29,710	6,947	357	153	37	615	0	48,434
	S-65E	34,832	2,736	50,873	44,032	81,127	651,738	135,599	30,944	35,527	45,363	24,474	10,108	1,147,353
	S-71	3	2,836	18,762	11,020	8,909	38,628	5,930	3,646	1,302	687	83	0	91,806
	S-72	0	553	3,505	2,618	3,154	7,473	4,025	2,791	676	0	0	63	24,859
	S-84	2	354	9,934	10,955	8,837	79,556	34,447	5,594	327	260	317	550	151,132
	Total*	**39,375**	**9,605**	**98,481**	**87,560**	**129,031**	**852,059**	**217,978**	**46,372**	**40,220**	**49,396**	**31,221**	**15,542**	**1,616,840**

Table 6. Continued.

Region	Structure	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	Total
South	CU-10[12]	0	0	0	0	0	0	0	0	0	0	0	0	0
	CU-12[12]	0	0	0	0	0	0	0	0	0	0	0	0	0
	CU-12A[12]	0	0	0	0	0	0	0	0	0	0	0	0	0
	CU-4A[12]	0	0	0	0	0	0	0	0	0	0	0	0	0
	INDUSCAN	437	3,054	14,951	5,043	4,315	3,023	511	127	.	14	103	746	32,325
	S-2 (S-351)	.	83	340	140	210	86	0	231	0	0	0	0	1,091
	S-236	0	0	0	0	0	0	0	0	0	0	0	0	0
	S-3 (S-354)	0	15	281	59	0	89	0	0	0	0	0	0	444
	S-352	.	0	0	0	0	0	0	0	0	0	0	0	0
	S-4	86	76	149	381	273	5,402	557	331	22	31	171	258	7,738
	Total	**524**	**3,228**	**15,721**	**5,624**	**4,798**	**8,600**	**1,068**	**689**	**22**	**46**	**274**	**1,004**	**41,598**
West	CU-5A[2]	2,140	5,920	12,135	6,056	5,470	7,031	4,689	6,982	7,231	6,229	5,208	3,245	72,336
	S-772	2,848	13,510	54,026	28,510	24,002	4,566	0	0	0	.	0	0	127,462
	Total	**4,988**	**19,430**	**66,160**	**34,567**	**29,472**	**11,597**	**4,689**	**6,982**	**7,231**	**6,229**	**5,208**	**3,245**	**199,798**
Grand Total*		**45,831**	**33,750**	**196,098**	**137,508**	**179,028**	**892,189**	**233,657**	**59,924**	**48,521**	**57,649**	**38,970**	**21,421**	**1,944,544**

*

Does not include C41H78 flows

[1] Included in other permits

[2] Provides flows and loads to lake, not owned operated by SFWMD

[3] Calculated as specified in 2011 Annual Permit Report for Lake Okeechobee Water Control Structures Operation (SFWMD, 2011)

Table 7. Monthly discharge flow (ac-ft) from Lake Okeechobee for WY2012.

Station	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	Total
CU-10A	2,897	959	0	0	0	817	3	5,552	13,841	7,355	5,480	2,838	39,740
CU-5	0	0	0	0	0	0	0	0	0	0	0	0	0
CU-5A[2]	1,763	895	0	0	53	137	882	201	0	35	208	672	4,845
G-207	114	0	0	0	8	0	6	10	11	0	6	0	156
G-208	99	0	0	0	7	7	5	6	13	0	6	0	144
INDUSCAN	4,836	2,675	0	24	0	629	1,595	1,883	2,803	2,881	2,208	9,539	29,072
S-127	0	0	0	0	0	0	0	0	0	0	0	0	0
S-129	0	0	0	0	0	0	0	0	0	0	0	0	0
S-131	0	0	0	0	0	0	0	0	0	0	0	0	0
S-135	0	0	0	0	0	0	0	0	0	0	0	0	0
S-308[2]	4,691	2,035	0	1,655	444	92	8,882	4,019	3,766	7,503	3,467	10,646	47,200
S-351[1]	57,877	27,824	52	1,319	0	0	112	1,708	13,807	16,236	37,796	40,015	196,744
S-352[1]	21,816	20,008	46	1,454	1	0	3,959	7,569	16,810	10,347	18,489	29,735	130,234
S-354[1]	40,344	22,389	0	726	0	0	0	1,232	7,481	4,244	22,387	21,915	120,718
S-77[2]	10,169	7,164	0	0	0	0	1,000	21,211	37,190	32,229	40,838	30,657	180,458
Total	144,606	83,949	98	5,178	514	1,682	16,444	43,390	95,722	80,830	130,884	146,015	749,312

[1] Structures have the ability to incorporate the use of temporary forward pumps for discharging water from Lake Okeechobee during periods of low water levels.

[2] Provides flows and loads from the lake; not owned operated by SFWMD.

RAINFALL

Daily rainfall measurements were collected from the stations used to report the Lake Okeechobee Basin rainfall (SFWMD, 2012b), which were used for consistency with Volume I, Chapter 2. Each station has one to four separate methods to record rainfall. One recording method from each station was chosen in the order of Preferred, Operations and Maintenance Department, Telemetry, and Campbell Scientific Recorder. The total monthly rainfall estimate for the Okeechobee Basin was 36.6 inches, which was 7.8 inches below the basin's 30-year average. However, the District-wide rainfall was only 1.9 inches below the 30-year average, due primarily to the October no-name storm event (**Table 8**). This represents a 4 percent rainfall deficit compared to the 30-year averages for the District-wide values and a 21 percent deficit for the Lake Okeechobee Basin. The driest months (November 2011, December 2011, and January 2012) all had less than an inch of rainfall. The drier-than-normal conditions until October 2011 led to drought conditions and water restrictions throughout much of the District beginning in April 2011 (see Volume I, Chapter 2). The October no-name storm event relieved much of the drought conditions, but rainfall since that time has been below the 30-year average district-wide and for the Lake Okeechobee Basin.

Table 8. Monthly rainfall averages (inches) for WY2012 compared to the 30-year period (calendar years 1981–2010).

Month	*Lake Okeechobee*			*District-Wide*		
	1981-2010 Average	WY2012	Difference	1981–2010 Average	WY2012	Difference
May	3.3	1.5	-1.8	3.9	2.2	-1.7
Jun	7.0	5.5	-1.5	8.3	6.2	-2.1
Jul	6.0	5.3	-0.7	7.0	7.1	0.1
Aug	6.7	6.9	0.2	7.8	8.5	0.7
Sep	5.6	4.6	-1.1	6.8	6.4	-0.4
Oct	3.0	6.9	3.9	3.8	10.0	6.2
Nov	1.9	0.5	-1.4	2.4	0.8	-1.7
Dec	1.6	0.6	-1.0	1.9	0.9	-1.0
Jan	1.7	0.2	-1.5	1.9	0.9	-1.0
Feb	2.1	1.0	-1.1	2.3	1.8	-0.6
Mar	3.2	1.4	-1.8	3.1	1.8	-1.3
Apr	2.2	2.1	-0.1	2.5	3.4	0.9
Total	44.3	36.6	-7.8	51.7	49.8	-1.9

B. PERFORMANCE EVALUATION

CLASS I WATER QUALITY ANALYSIS

The parameters included in the Lake Okeechobee Operating Permit with Florida Class I criteria include alkalinity, dissolved oxygen (DO), pH, specific conductivity, turbidity, and total iron (Fe) (**Table 9**). Permit Modification 0174552-006-EM replaced biochemical oxygen demand (BOD) with total organic carbon (TOC), which does not have a Class I criteria. The turbidity criterion of 32.3 nephelometric turbidity units (NTU) was based on natural background values as described in the 2009 annual permit report (SFWMD, 2009). The criterion for conductivity was set to 1,275 microsiemens per centimeter (µS/cm), because this was greater than the 50 percent above background value (SFWMD, 2009).

The water quality data for each station was separated into three categories (inflow, outflow, and no-flow), where appropriate. These categories were determined from daily flow measurements when available (**Attachment B2**) or from visual inspection records (**Attachment B1**). All results not meeting data quality objectives as specified by the FDEP in Chapter 62-160, F.A.C. (denoted in the *flag* column by "yes" in **Attachment B**) were removed from this analysis. All measurements below the detection limit were set to half of the detection limit. The mean, maximum, minimum, number of samples, standard deviation, median, 25^{th} and 75^{th} percentiles, and number of exceedances from Florida Class I standards were determined for each structure for each given flow period (**Attachments B4** through **B6**). The samples that exceeded the Class I criteria were tabulated (**Attachment B7**).

A binomial hypothesis test was used to determine if there was a greater than 10 percent excursion rate of Class I standards ($H0 \leq f0.10$; HA: $f \geq 0.10$) (Weaver and Payne , 2005; SFWMD, 2009). This excursion rate is given a category of concern-C (**Table 10**). All flow and structure sample sets contained fewer than 28 samples (the cutoff at which the type II error rate is greater than 20 percent for the binomial test). Therefore, a preliminary evaluation was used based on the percent of excursions greater than 20 percent ("concern" or C), between 0 and 20 percent ("potential concern" or PC), and 0 percent ("no concern" or NC).

To more accurately evaluate the excursion rate, a longer 10-year period of record (WY2003–WY2012) was used for the binomial hypothesis testing. The categories for the tests were the same as above with the addition of "minimal concern"-MC. The category statistics were C (HA: $f \geq 0.10$), PC (HA: $0.05 \leq f < 0.1$), MC (HA: $0 < f < 0.05$), and NC (H0: $f=0$) (**Table 10**). An evaluation of these data: mean, maximum, minimum, number of samples, standard deviation, median, 25^{th} and 75^{th} percentiles, and number of exceedances from Florida Class I standards were determined for each structure for each given flow period for the previous 10-year period (**Attachment B8**).

Table 9. Class I criteria values for Lake Okeechobee monitoring.

Parameter	Units	Criteria
ALK	mg/L	≥ 20
DO	mg/L	≥ 5
pH	SU	6 - 8.5
SCOND	µS/cm	≤ 1275
TURB	NTU	≤ 32.3 (≤ 29 + 3.3 natural background)
TFE	µg/L	≤ 1000

ALK – alkalinity
DO – dissolved oxygen
SCOND – specific conductivity
TURB – turbidity
TFE – total iron
mg/L – milligrams per liter
SU – standard units
µS/cm – microsiemens per centimeter
NTU – nephelometric turbidity units
µg/L – micrograms per liter

Table 10. Excursion categories for Class I water quality tests (adapted from Weaver and Payne, 2005).

Excursion Category	Class I Water Quality Binomial Test	Preliminary Analysis of Class I Water Quality % Exceedances (less than 28 samples)
Concern	> 10%	>20%
Potential Concern	5 to 10%	> 0% and < 20%
Minimal Concern	0% < and < 5%	N/A
No Concern	0%	0%

DISSOLVED OXYGEN

The Class I criteria for DO specifies that values shall not be less than 5 milligrams per liter (mg/L). DO was sampled at 21 locations during inflow events in WY2012 (**Table 11**; **Attachment B4**). Of these locations, two (S-2 and S-135) were classified as "no concern," one (S-84) as "potential concern," and 18 as "concern." Four other inflow structures were not sampled during inflow events in the current water year. At S-236 and L59E, there were no days with inflow; at C38W, there were four days of inflow; and at S-3, there were six days of inflow. Of the 142 samples collected during inflow events, 75 were below the DO Class I criterion (**Attachment B4**). For the 10-year analysis, all 25 structures were classified as a "concern" (**Table 11**; **Attachment B8**). The low DO may be caused by several factors, including high temperature, high dissolved organic carbon, microbial activity, or laminar flow of water in the canals that prevents turbulent mixing of the water with air. Further research is needed to determine the key factors. Management practices to meet the proposed numeric nutrient criteria may reduce the organic carbon input to the tributaries. Other practices to increase turbulence of the canal flow (e.g., baffle boxes or mechanical mixing) may also improve DO conditions.

For no-flow events, five structures (C-38W, C41H78, S-154C, S-4, and S-65E) were classified as "no concern," nine were classified as "potential concern," and ten were classified as "concern" (**Table 12**). Two structures were not sampled during no-flow events. At CU10-A, there was one no-flow day and, at INDUSCAN, there were none. Of the 233 samples taken during no-flow events, 55 were below the DO Class I criterion (**Attachment B5**). For the 10-year analysis, two structures (C41H78 and INDUSCAN) were classified as "no concern", one (S-65E) as "potential concern" and 23 as "concern" (**Table 12**; **Attachment B8**). Because there is less turbulence during no-flow events, DO is likely to be lower than during flow conditions.

For outflow events, one structure (S-352) was classified as "no concern," two (CU-10A and INDUSCAN) as "potential concern," one (C41H78) as "concern," and five were unmeasured (**Table 13**). Of the five unmeasured structures, CU-5, S-127, S-135, and L-60W had no days of outflow, and L-59W had 20 days of missing flow but no outflow. Of the 43 samples taken during outflow events, four were below the DO Class I criterion (**Attachment B6**). For the 10-year analysis, one structure (S-352) was classified as "minimal concern," two (L-59W and S-135) as "no concern," and the other six as "concern" (**Table 13**; **Attachment B8**). As with inflow events, the low DO may be due to various factors as noted above.

Table 11. Levels of concern[A] for Class I parameters at Lake Okeechobee structures during WY2012 inflow events.

Station	Alkalinity	Dissolved Oxygen	pH	Specific Conductivity	Total Iron	Turbidity
C38W	NC*/ND	C*/ND	NC*/ND	C*/ND	C*/ND	NC*/ND
C41H78	NC/NC*	C/C*	NC/NC*	NC/NC*	NC*/NC*	NC/NC*
CU-10A	NC/NC*	C/C*	NC/NC*	C/PC*	PC*/C*	C/PC*
CU-5	NC*/NC*	C*/C*	NC*/NC*	NC*/NC*	NC*/ND	NC*/NC*
INDUSCAN	NC/NC*	C/C*	NC/NC*	NC/NC*	PC*/NC*	C/NC*
L59E	C/ND	C/ND	NC/ND	C/ND	C*/ND	NC/ND
L59W	NC*/NC*	C*/C*	NC*/NC*	NC*/NC*	C*/ND	NC*/NC*
L60E	C/C*	C/C*	NC/NC*	NC/NC*	NC*/ND	NC/NC*
L60W	NC/NC*	C/C*	NC/NC*	NC/NC*	NC*/NC*	NC/NC*
S127	NC*/NC*	C/C*	NC*/NC*	NC/NC*	NC*/ND	NC*/NC*
S129	NC/NC*	C/C*	NC/NC*	NC/NC*	NC*/ND	NC/NC*
S131	NC/NC*	C/C*	NC/NC*	NC/NC*	NC*/ND	NC/NC*
S133	NC*/NC*	C*/C*	NC*/NC*	NC*/NC*	NC*/ND	PC*/NC*
S135	NC/NC*	C/NC*	NC/NC*	NC/NC*	NC*/NC*	C/NC*
S154	NC/NC*	C/C*	NC/NC*	C/NC*	C*/NC*	NC/NC*
S154C	NC/NC*	C/C*	NC/NC*	C/C*	PC*/NC*	MC/NC*
S191	NC/NC*	C/C*	MC/NC*	NC/NC*	NC*/NC*	NC/NC*
S2	NC*/NC*	C*/NC*	NC*/NC*	C*/C*	NC*/ND	NC*/NC*
S236	NC*/ND	C*/ND	NC*/ND	C*/ND	NC*/ND	NC*/ND
S3	NC*/ND	C*/ND	NC*/ND	PC*/ND	NC*/ND	NC*/ND
S4	NC/NC*	C/C*	NC/NC*	C/C*	NC*/NC*	NC/NC*
S65E	MC/NC	C/C*	MC/NC	NC/NC	PC/NC*	NC/NC
S71	C/NC*	C/C*	MC/NC*	NC/NC*	NC*/NC*	NC/NC*
S72	MC/NC*	C/C*	NC/NC*	NC/NC*	PC*/NC*	NC/NC*
S84	C/NC*	C/PC*	PC/PC*	MC/NC*	PC*/NC*	MC/NC*

[A] C - concern; PC - potential concern; MC - minimal concern; NC - no concern; ND- not determined (no data)

* Less than 28 samples preliminary test used.

Listing before '/' is for WY2003–WY2012; listing after '/' is for WY2012.

Table 12. Levels of concern[A] for Class I parameters at Lake Okeechobee structures during WY2012 no-flow events.

Station	Alkalinity	Dissolved Oxygen	pH	Specific Conductivity	Total Iron	Turbidity
C38W	NC/NC*	C/NC*	C/NC*	C/C*	NC/NC*	C/NC*
C41H78	NC*/NC*	NC*/NC*	NC*/NC*	NC*/NC*	ND/ND	NC*/NC*
CU-10A	NC*/ND	C*/ND	NC*/ND	NC*/ND	NC*/ND	C*/ND
CU-5	NC/NC*	C/C*	NC/NC*	NC/NC*	C/NC*	MC/NC*
INDUSCAN	NC*/ND	NC*/ND	NC*/ND	NC*/ND	ND/ND	NC*/ND
L59E	NC/NC*	C/C*	MC/NC*	C/C*	NC*/NC*	MC/NC*
L59W	MC/NC*	C/C*	MC/PC*	NC/NC*	NC*/NC*	NC/NC*
L60E	NC/NC*	C/PC*	MC/PC*	NC/NC*	PC*/NC*	NC/NC*
L60W	NC/NC*	C/PC*	MC/NC*	NC/NC*	NC*/NC*	NC/NC*
S127	NC/NC*	C/C*	NC/NC*	C/PC*	NC/NC*	NC/NC*
S129	NC/NC*	C/C*	NC/NC*	NC/NC*	NC/NC*	NC/NC*
S131	NC/NC*	C/C*	MC/NC*	NC/NC*	NC/NC*	NC/NC*
S133	NC/NC*	C/C*	MC/PC*	NC/NC*	C/NC*	NC/NC*
S135	NC/NC*	C/PC*	MC/NC*	NC/NC*	NC/NC*	MC/NC*
S154	NC/NC*	C/PC*	MC/PC*	C/C*	C/C*	MC/NC*
S154C	NC*/NC*	C*/NC*	NC*/NC*	C*/C*	NC*/NC*	PC*/NC*
S191	NC/NC*	C/PC*	MC/NC*	PC/NC*	NC*/NC*	NC/NC*
S2	NC/NC*	C/PC*	MC/PC*	C/PC*	C/NC*	C/NC*
S236	NC/NC*	C/C*	NC/NC*	C/C*	NC/NC*	NC/NC*
S3	NC/NC*	C/C*	NC/NC*	C/C*	C/NC*	C/NC*
S352	NC/NC*	C/PC*	MC/NC*	NC/NC*	C*/NC*	C/C*
S4	NC/NC*	C/NC*	MC/NC*	MC/NC*	NC/NC*	MC/NC*
S65E	NC*/NC*	PC*/NC*	NC*/NC*	NC*/NC*	NC*/ND	NC*/NC*
S71	MC/NC*	C/C*	MC/NC*	NC/NC*	NC*/NC*	NC/NC*
S72	MC/NC*	C/PC*	MC/PC*	NC/NC*	NC*/NC*	NC/NC*
S84	MC/NC*	C/PC*	MC/PC*	NC/NC*	PC*/NC*	MC/NC*

[A] C - concern; PC - potential concern; MC - minimal concern; NC - no concern; ND- not determined (no data)

* Less than 28 samples preliminary test used.

Listing before '/' is for WY2003–WY2012; listing after '/' is for WY2012.

Table 13. Levels of concern[A] for Class I parameters at Lake Okeechobee structures during WY2012 outflow events.

Station	Alkalinity	Dissolved Oxygen	pH	Specific Conductivity	Total Iron	Turbidity
C41H78	NC/NC*	C/C*	NC/NC*	NC/NC*	NC*/NC*	NC/NC*
CU-10A	NC/NC*	C/PC*	MC/NC*	MC/NC*	C*/C*	C/C*
CU-5	NC*/ND	C*/ND	NC*/ND	NC*/ND	NC*/ND	NC*/ND
INDUSCAN	NC/NC*	C/PC*	MC/PC*	NC/NC*	PC*/NC*	C/NC*
L59W	NC*/ND	NC*/ND	NC*/ND	NC*/ND	ND/ND	NC*/ND
L60W	NC*/ND	C*/ND	NC*/ND	NC*/ND	NC*/ND	NC*/ND
S127	NC*/ND	C*/ND	NC*/ND	NC*/ND	ND/ND	NC*/ND
S135	NC*/ND	NC*/ND	C*/ND	NC*/ND	ND/ND	NC*/ND
S352	NC/NC*	MC/NC*	MC/NC*	NC/NC*	C*/C*	C/C*

[A] C - concern; PC - potential concern; MC - minimal concern; NC - no concern; ND- not determined (no data)

* Less than 28 samples preliminary test used.

Listing before '/' is for WY2003–WY2012; listing after '/' is for WY2012.

ALKALINITY AND PH

The Class I criteria for alkalinity specifies that the value shall not be less than 20 mg/L $CaCO_3$ equivalents. For inflow events in WY2012, alkalinity was measured at 21 structures (**Table 11**). Four other structures (C-38W, L-59E, S-236, and S-3) were not measured because of few or no inflow events. Only one structure (L-60E) was defined as "concern". Of the 144 measurements, one excursion was found (**Attachment B4**). For the 10-year period, 20 structures were classified as "no concern," two (S65-E and S-72) as "minimal concern," and four (L-59E, L-60E, S-71, S-84) as "concern" (**Table 11**; **Attachment B8**). Low alkalinity was associated with basins in the Indian Prairie, which may indicate natural conditions with more acidic soils from wetlands. Further investigation is needed to confirm this assertion.

For no-flow events, no excursions were found at 24 structures (**Table 12**; **Attachment B5**). Two structures (CU-10A, INDUSCAN) were not measured during no-flow events. Of the 242 samples taken during no-flow events, no excursions were found. For the 10-year period of analysis, 22 structures were classified as "no concern," and four (S-71, S-72, S-84, L-59W) as "minimal concern." (**Table 12**; **Attachment B8**).

For outflow events in WY2012, alkalinity was measured at four structures (**Table 13**; **Attachment B6**). Of the 44 samples taken, no excursions were found. Five structures (CULV-5, L-59W, L-60W, S-127, and S-135) were not measured. For the 10-year period of record, no excursions were found at the nine stations (**Table 13**; **Attachment B8**).

The Class I criteria for pH specifies that the value shall not be below 6.0 or above 8.5. For inflow events, 20 structures were classified as "no concern" and one (S-84) as 'potential concern" (**Table 11**). Of the 152 samples taken during inflow events, only one (9.2 at S-84) was outside the pH criteria range (**Attachment B4**). For the 10-year period, 21 structures were classified as "no concern" three (S-191, S-65E, S-71) as "minimal concern," and one (S-84) as "potential concern" (**Table 11**; **Attachment B8**).

For no-flow events, there were seven structures classified as "potential concern." The remaining 17 structures that were sampled were classified as "no concern" (**Table 12**). Two structures (CU-10A, INDUSCAN) were not measured. Of the 238 samples taken during no-flow events, eight were outside the pH criteria range above 8.5 (**Attachment B5**). For the 10-year period, there were 10 structures listed as "no concern," 15 as "minimal concern," and one as "concern" (C-38W) (**Table 12**; **Attachment B8**). The concern at C-38W was for pH samples above 8.5, which may have been caused by high groundwater inflows or algal blooms.

For outflow events, one structure (INDUSCAN) was classified as "potential concern," and the other three that were measured (C41H78, CU-10A, S-352) as "no concern" (**Table 13**). CU-5, L-59W, L-60W, S-127, and S-135 were not measured. Of the 45 samples taken during outflow events, only one (8.6, INDUSCAN) was outside the pH upper criteria range (**Attachment B6**). For the 10-year period, five structures were classified as "no concern," three structures (CU-10A, INDUSCAN, and S-352) were classified as "minimal concern," and one (S-135) as "concern" (**Table 13**; **Attachment B8**).

CONDUCTIVITY

The conductivity criterion for Lake Okeechobee tributaries is 1,275 microsiemens per centimeter (µS/cm). For inflow events, 17 structures were classified as "no concern," one (CU-10A) as "potential concern," three (S-4, S-154C, S-2) as "concern," and four (C-38W, L-59E, S-236, and S-3) were not sampled (**Table 11**). Of the 152 samples taken during inflow events, 16 exceeded the conductivity criterion (**Attachment B4**). For the 10-year period of record, 15 were classified as "no concern," one (S-84) as "minimal concern," one (S-3) as "potential concern," and eight as "concern" (**Table 11**; **Attachment B8**). High conductivity is likely a result of groundwater seepage.

For no-flow events, 16 structures were classified as "no concern," two (S-127, S-2) as "potential concern," six as "concern," and two (CULV10A, INDUSCAN) were not sampled (**Table 12**). Of the 238 samples taken during no-flow conditions, 36 exceeded the conductivity criterion (**Attachment B5**). For the 10-year period of record, 16 structures were classified as "no concern," one (S-4) as "minimal concern," one (S-191) as "potential concern," and eight as "concern" (**Table 12**; **Attachment B8**). Similar to inflow conditions, high conductivity was likely a result of groundwater seepage.

For outflow events, no excursions were found out of the 45 samples measured among four structures (**Table 13**; **Attachment B6**). CU-5, L-59W, L-60W, S-127, and S-135 were not sampled. For the 10-year period, eight structures were classified as "no concern" and one (CU-10A) as "minimal concern" (**Table 13**; **Attachment B8**).

TURBIDITY

The Class I turbidity criterion for Lake Okeechobee tributaries is 32.3 NTU. The exceedance value was based on 29 NTU plus a background value of 3.3, which was determined based on the median value of turbidity in lake tributaries from 1990–2000 (SFWMD, 2009). For inflow events, there were two excursions from the 148 samples, both occurring at CU-10A. C-38W, S-3, L-50E, and S-236 were not measured (**Attachment B4**; **Table 11**). For the 10-year period, 19 structures were classified as "no concern," two (S-154C and S-84) as "minimal concern," one (S-133) as "potential concern," and three (CU-10A, INDUSCAN, and S-135) as "concern" (**Table 11**; **Attachment B8**). Turbidity concerns in CU-10A and the INDUSCAN may be due to runoff from agricultural lands as well as resuspended sediments that have accumulated in the bottom of the canals during inflow events. Further investigation would be needed to confirm these explanations.

For no-flow events, 23 structures were classified as "no concern," one (S-352) as "concern," and two (CU-10A, INDUSCAN) were not sampled (**Table 12**). Of the 237 samples taken during no-flow conditions, six exceeded the criterion for turbidity (**Attachment B5**). For the 10-year period, 14 structures were classified as "no concern," six (CU-5, L-59E, S-134, S-154, S-4, S-84) as "minimal concern," one (S-154C) as "potential concern," and five (C-38W, CU-10A, S-2, S-3, S-352) as "concern" (**Table 12**; **Attachment B8**). Turbidity concerns in S-2, S-3, S-352, CU-10A, and C-38W may be related to accumulation of sediments in the bottom of the canals.

For outflow events, two structures (C41H78, INDUSCAN) were classified as "no concern," two (CU-10A, S-352) as "concern," and five (CU-5, L-59W, L-60W, S-127, and S-135) were not sampled (**Table 13**). Of the 44 samples taken during outflow events, 11 exceeded the criteria for turbidity (**Attachment B6**). For the 10-year period, three structures (CU-10A, INDUSCAN, and S-352) were classified as "concern" and six as no concern (**Table 13; Attachment B8**). Turbidity concerns at S-352 and CULV10A during outflow could be attributed to their location, which is near the open, turbid waters of the lake. The INDUSCAN location is not as close to open water and is affected by rim canal discharge.

TOTAL IRON

The Class I criterion specifies that total iron shall not to exceed 1 mg/L. While not toxic at this level, the criterion is primarily to prevent staining in clothes washing (Environmental Health Laboratory, 2010). Currently, only one local municipality, the City of Okeechobee, uses lake water for part of its water supply. This parameter is only measured quarterly; therefore, there are enough samples at only a few structures to perform a binomial test with accuracy for the 10-year period. Of the 27 samples taken at 15 structures during inflow events in WY2012, one exceedance at CU-10A was found (**Table 11**; **Attachment B4**). For the 10-year period of record, 15 structures were classified as "no concern," six as "potential concern," and four (C-38W, L-59E, L-59W, S-154) as "concern" (**Table 11**; **Attachment B8**). Iron occurs naturally in soils and groundwater of the Lake Okeechobee watershed resulting in the high concentrations (Ground Water Protection Section, 2009).

For no-flow events, 21 structures were classified as "no concern," one (S-154) as "concern," and three (C41H78, S65E, INDUSCAN) were not measured (**Table 12**). Of the 62 samples taken during no-flow periods, only one at S-154 exceeded the iron standard (**Attachment B5**). For the 10-year period, 16 structures were classified as "no concern," two (L-60E, S-84) as "potential concern," and six (CU-5, S-133, S-154, S-2, S-3, S-352) as concern. Iron concerns at S-133, S-154, S-352, S-2, and S-3 may be attributed to groundwater seepage.

For outflow events, two structures (C41H78, INDUSCAN) were classified as "no concern," two (CU-10A and S-352) as "concern," and four (CU-5, L-59W, L-60W, S-123, S-135) were not sampled (**Table 13**). Of the nine samples taken during outflow periods, four exceeded the criterion for iron (**Attachment B6**). For the 10-year period, three structures (CU-5, C41H78 and L-60W) were classified as "no concern," one (INDUSCAN) as "potential concern," two (CU-10A, S-352) as "concern," and three (S-127, S-135, L-59W) were not measured (**Table 13**; **Attachment B8**). The two concerns, S-352 and CULV10A, may be attributed to the proximity of the structures to the open waters of the lake, which are relatively high in iron (Ground Water Protection Section, 2009).

TOTAL PHOSPHORUS LOADS

The WY2012 TP load to Lake Okeechobee is 377.4 metric tons (mt), which includes an estimated 35 mt from atmospheric deposition (FDEP, 2001; **Table 14**). Most of the surface load comes from the northern watersheds (278.2 mt), followed by the west (38.4 mt), the south (10.3 mt), and the east (5 mt). Target loads based on the Total Maximum Daily Load (TMDL) were exceeded by 199.6 mt in the north, 0.8 mt in the south, 0 mt in the east, and 38.4 mt in the west region. Overall, the WY2012 TP load was greater than the lake's TMDL of 140 mt by about 2.7 times (exceeded by 237.4 mt). The five-year average (WY2008–WY2012) TP load to Lake Okeechobee was 393 mt per year, which also exceeded the TMDL (by 253 mt; **Table 15**). It is important to note that this five-year average includes two regional droughts from October 2006 to August 2008 and the second from December 2010 to October 2011. During these periods, flow and load were reduced substantially to the lake compared to the 1991–2005 baseline of 2.5 million ac-ft and 546 mt TP (SFWMD et al., 2011) (**Table 16**). Further analysis of these loads is presented in Volume I, Chapter 8, which documents the trends of water flow, TP load, and TP mean flow-weighted concentration in each Lake Okeechobee sub-watershed.

Table 14. WY2012 TP loads (metric tons, or mt) for each structure by month.

Region	Structure	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	Total	Target Loads	Total - Target
East	L-8(C10A)	0.0	0.0	1.2	1.3	1.0	0.6	0.6	0.0	0.0	0.0	0.1	0.1	5.0		
	S-308	0.2	0.2	1.7	0.5	1.4	3.0	0.7	1.4	0.2	0.4	0.4	0.2	10.4		
	Total	0.2	0.3	2.8	1.8	2.5	3.6	1.4	1.4	0.2	0.4	0.4	0.3	15.4	16.8	-1.4
North	C-38W C-33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	C41H78	0.6	0.8	1.3	8.4	2.4	2.9	7.3	1.1	0.3	0.3	0.4	0.5	26.4		
	CU-5	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4		
	FECR	0.0	0.2	10.3	4.8	2.8	3.0	2.2	0.2	0.1	0.0	0.0	0.0	23.7		
	L-61E	0.9	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.5	0.4	4.0		
	L-59E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	L-59W	0.0	0.0	0.1	0.4	0.0	0.7	0.1	0.0	0.0	0.0	0.0	0.0	1.3		
	L-60E	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3		
	L-60W	0.0	0.0	0.2	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.6		
	S-127	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.8		
	S-129	0.0	0.0	0.4	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.1	0.0	0.7		
	S-131	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3		
	S-133	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3		
	S-135	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	S-154	0.0	0.0	0.0	0.0	0.0	2.3	3.6	0.2	0.0	0.0	0.0	0.0	6.1		
	S-154C	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.7		
	S-191	0.0	0.0	0.1	2.0	3.4	21.3	4.4	0.2	0.1	0.0	0.1	0.0	31.4		
	S-65E	2.7	0.2	12.9	8.8	8.9	107.7	12.9	2.2	1.9	2.3	1.4	0.8	162.8		
	S-71	0.0	1.2	6.5	2.7	3.5	8.5	1.3	0.7	0.2	0.1	0.0	0.0	24.7		
	S-72	0.0	0.2	0.6	0.6	1.0	2.6	1.6	0.4	0.1	0.0	0.0	0.0	6.9		
	S-84	0.0	0.0	0.7	0.8	0.5	7.8	2.9	0.3	0.0	0.0	0.0	0.0	13.3		
	Total*	3.6	1.8	34.1	20.2	20.2	155.3	29.8	4.3	2.5	2.9	2.2	1.3	278.2	78.6	199.6

Table 14. Continued.

Region	Structure	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	Total	Target Loads	Total-Target
South	CU-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	CU-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	CU-12A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	CU-4A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	INDS	0.1	0.8	4.1	1.1	1.8	0.6	0.1	0.0	0.0	0.0	0.0	0.1	8.7		
	S-2	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3		
	S-236	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	S-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1		
	S-352	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	S-4	0.0	0.0	0.0	0.0	0.0	0.9	0.1	0.1	0.0	0.0	0.0	0.0	1.2		
	Total	0.1	0.8	4.2	1.2	2.0	1.5	0.2	0.1	0.0	0.0	0.0	0.2	10.3	9.6	0.8
West	CU-5A	0.2	0.5	4.0	1.4	1.0	0.7	0.6	1.2	1.0	0.8	0.6	0.3	12.0		
	S-77	0.5	3.0	13.6	5.4	3.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	26.4		
	Total	0.6	3.5	17.5	6.8	4.4	1.2	0.6	1.2	1.0	0.8	0.6	0.3	38.4	0.01	38.4
Grand Total	Surface*	4.5	6.4	58.6	30.0	29.1	161.6	32.0	7.0	3.8	4.0	3.3	2.1	342.4	105.0	237.4
	Atmospheric Deposition													35.0	35.0	
	Sum*													377.4	140.0	237.4

* Does not include C41H78

Table 15. TP loads (mt) to Lake Okeechobee over the past five water years.

Water Year	North	East	South	West	Atmospheric Deposition*	Total
2008	93	95	5	21	35	249
2009	585	22	26	17	35	685
2010	393	17	21	12	35	478
2011	136	2	4	1	35	178
2012	278	15	10	38	35	377
Average	297	30	13	18	35	393
Percent of total	81%	6%	3%	2%	7%	100%

* 35 metric tons/year from atmospheric deposition (FDEP, 2001)

Table 16. Surface flows (millions of ac-ft) to Lake Okeechobee (WY2008–WY2012).

Water Year	North	East	South	West	Total
2008	0.46	0.43	0.02	0.11	1.02
2009	1.82	0.16	0.1	0.1	2.18
2010	2.14	0.09	0.09	0.09	2.41
2011	0.89	0.01	0.03	0.02	0.95
2012	1.617	0.086	0.042	0.2	1.945
Average	1.172	0.15	0.054	0.072	1.448
Percent total	86%	8%	3%	3%	100%

PESTICIDE MONITORING PROGRAM

The District maintains a pesticide monitoring program to meet various permit and other mandated requirements, including Class I (drinking water) criteria of Chapter 62-302, F.A.C. Samples are measured for 73 pesticides and their breakdown products at sites throughout the District region (Pfeuffer, 2011a, b; 2012) on a quarterly basis for water and on an annual/semi-annual basis for sediments, A minor modification of the Lake Okeechobee Water Control Structure Operations Permit (#0174552-010, dated December 18, 2011) eliminated sediment sampling at S-65E, S-191, and FECSR78. Additionally, sediment sampling was reduced to an annual frequency at S-2, S-3, and S-4 for only ametryn, chlordane, DDD, DDE, and DDT analysis. Additional information on the pesticide monitoring program can be found on the District's website at www.sfwmd.gov under the *Scientists & Engineers*, *Environmental Monitoring* section, *Pesticide Reports* link.

For Lake Okeechobee, pesticides are monitored at S-65E, S-191, Fisheating Creek (FECSR78), S-2, S-3, and S-4. The surface water and sediment pesticide data are included in **Attachments B9** and **B10**, respectively. In the three surface water sampling events (July and October 2011, and February 2012), 2,4-D, ametryn, atrazine, atrazine breakdown product, hexazinone, and metribuzin were detected in at least one sample. However, the majority of the hexazinone detections were at the two northern sample sites (S-191 and S-65E) while ametryn, atrazine desethyl, and metribuzin were detected at the three southern sites (S-2, S-3, and S-4) (**Table 17**). The concentrations of most of these pesticides were above the PQL for the respective analytical procedure.

The observed concentration of each compound is compared to the appropriate criterion outlined in Rule 62-302.530, F.A.C. If a pesticide compound is not specifically listed, acute and chronic toxicity criterion are calculated as one-third and one-twentieth, respectively, of the amount lethal to 50 percent of the test organisms in 96 hours, using the lowest technical grade effective concentration (EC_{50}) or lethal concentration (LC_{50}). The EC_{50} is a concentration at which 50 percent of the aquatic species tested exhibit a toxic effect short of mortality within a short (acute) exposure period; the LC_{50} technical grade is a concentration at which 50 percent of the aquatic animals tested die within a short (acute) exposure period. These criteria are determined using data from the summarized literature for the species significant to the indigenous aquatic community (62-302.200, F.A.C.). These values are listed for the water flea (*Daphnia magna*), which is the most susceptible test organism for these pesticides (**Table 17**). Based on excursion categories recommended for the Everglades Protection Area (Weaver and Payne, 2005) any site where a pesticide was detected are to be identified as a potential concern**.**

Due to the permit modification, sediment samples taken in October 2011 represent full site and analytical coverage, while the February 2012 event reflected the modified sampling requirements. Sediment samples showed detectable concentrations of two different pesticides (**Table 18**). Sediment concentrations are compared to freshwater sediment quality assessment guidelines (MacDonald Environmental Sciences, Ltd., and United States Geological Survey, 2003). A value below the threshold effect concentration (TEC) is not expected to have a harmful effect on sediment-dwelling organisms. Values above the probable effect concentration (PEC) demonstrate that harmful effects to sediment-dwelling organisms are likely to be observed.

Table 17. Pesticide residues (micrograms per liter, or µg/L) above the method detection limit found in surface water samples collected by the SFWMD at Okeechobee sampling sites in July and October 2011, and February 2012 (from Pfeuffer, 2011a,b; 2012) and chronic toxicity values for the water flea (*Daphnia magna*). [Note: None of the values exceed the chronic toxicity for *Daphnia magna*.]

Site	Date	Flow	2,4-D	Ametryn	Atrazine	Atrazine Desethyl	Hexazinone	Metribuzin
FECSR78	7/11/2011	Y	BDL	BDL	BDL	BDL	0.14	BDL
	10/25/2011	Y	BDL	BDL	BDL	BDL	BDL	BDL
	2/13/2012	N	0.21[b]	BDL	BDL	BDL	BDL	BDL
S-65E	7/11/2011	Y	BDL	BDL	0.042	BDL	BDL	BDL
	10/25/2011	Y	BDL	BDL	0.043	BDL	BDL	BDL
	2/13/2012	Y	BDL	BDL	0.049	BDL	BDL	BDL
S-191	7/11/2011	N	BDL	BDL	0.018[b]	BDL	0.13	BDL
	10/25/2011	Y	BDL	BDL	BDL	BDL	0.40	BDL
	2/13/2012	N	0.20[b]	BDL	BDL	BDL	0.10	BDL
S-2	7/11/2011	N	0.28[a,b]	0.047[a]	0.24[a]	0.033[a,b]	BDL	0.030[a,b]
	10/25/2011	N	BDL	0.051	0.27	BDL	BDL	BDL
	2/13/2012	N	BDL	0.021[a,b]	0.23[a]	0.022[a,b]	BDL	BDL
S-3	7/11/2011	N	0.22[a]	0.043	0.31	0.058	BDL	BDL
	10/25/2011	N	BDL	0.043	0.42	0.016[b]	BDL	BDL
	2/13/2012	N	BDL	0.017[b]	0.58	0.021[b]	BDL	BDL
S-4	7/11/2011	N	BDL	0.062	0.094	0.011[b]	0.024[b]	BDL
	10/25/2011	N	BDL	0.057	0.35	BDL	BDL	BDL
	2/13/2012	N	BDL	BDL	0.21	0.021[b]	BDL	BDL
Chronic toxicity of *Daphnia magna*			1,250[c]	1,400[c]	345[c]	N/A	7,580[c]	210[d]

N – No
Y - Yes
BDL - result is below the method detection limit; N/A not available

[a] - Results are the average of replicate samples
[b] - Value reported is greater than or equal to the method detection limit and less than the practical quantitation limit
[c] - U.S. Environmental Protection Agency (1991)
[d] - U.S. Environmental Protection Agency (1998)

Dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE) were only detected at S-2, S-3, and S-4. Both compounds are an environmental dehydrochlorination product of dichlorodiphenyltrichloroethane (DDT), a popular insecticide for which the U.S. Environmental Protection Agency (USEPA) cancelled all uses in 1973. The large volume of DDT historically used in the region, the continued persistence of DDT, DDE, and DDD, and the high hydrophobicity of these compounds account for the frequent detections in localized sediments. The latter attribute also results in a significant bioconcentration factor. In sufficient quantities, these residues are known to have reproductive effects in wildlife and potential carcinogenic effects in mammals.

During the reporting period, DDD sediment concentrations detected range from 5.9 to 11 micrograms per kilogram (µg/kg). Any concentration below the TEC (4.9 µg/kg) is not expected to impact sediment-dwelling organisms, while concentrations above the PEC (28 µg/kg) have the possibility for impacting sediment-dwelling organisms. The sediment concentrations detected at S-2 and S-3 were less than the PEC and did not exceed the level of concern. DDE values ranged from 8.1 to 54 µg/kg in these sediments. The TEC is 3.2 µg/kg and the PEC is 31 µg/kg for DDE in freshwater sediments. Both concentrations of DDE detected at S-2 exceeded the PEC, which has the possibility for affecting sediment-dwelling organisms.

Table 18. Pesticide residues (micrograms per kilogram, or µg/kg, dry weight) above the method detection limit found in sediment samples collected by the SFWMD at Okeechobee sampling sites in October 2011 and February 2012 (from Pfeuffer, 2011b; 2012). [Note: Values in bold are above the probable effect concentration.]

Site	Date	DDD-p,p'	DDE-p,p'
S-2	10/25/2011	11 [b]	**49**
	2/13/2012	11 [a,b]	**54** [a]
S-3	10/25/2011	BDL	18 [b]
	2/13/2012	5.9 [b]	28
S-4	10/25/2011	BDL	8.1
	2/13/2012	BDL	BDL

BDL - result is below the method detection limit

[a] - Results are the average of replicate samples

[b] - Value reported is greater than or equal to the method detection limit and less than the practical quantitation limit

IN-LAKE WATER QUALITY MONITORING

The District maintains 37 in-lake sampling stations to monitor water quality in all ecological regions of Lake Okeechobee (**Figure 3**). The effects of nutrient loading, high and low water levels, droughts, and hurricanes on trends and changes in water quality have been evaluated using this information (Havens and James, 2005; James and Havens, 2005; James et al., 2008, 2011a,b). Volume I, Chapter 8 includes a detailed evaluation of these WY2012 data. All water quality samples collected at the in-lake sampling sites (**Figure 3**) was created from a DBHYDRO (SFWMD, 2012a) report, as presented in **Attachment B11**. These records include analytical results of grab samples for the 16 water quality parameters listed in **Table 5**.

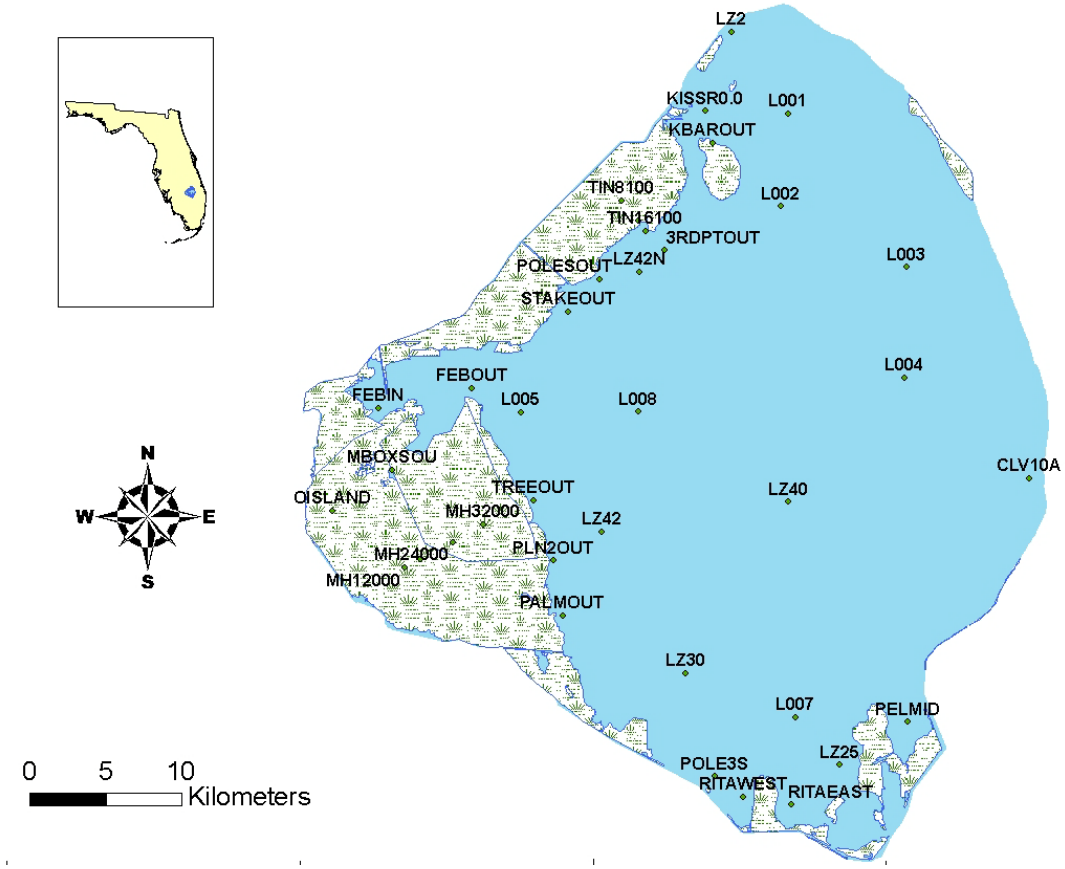

Figure 3. Active water quality monitoring stations in Lake Okeechobee.

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Attachment A: Specific Conditions and Cross-References

Table A-1. Specific conditions, actions taken, and cross-references presented for the Lake Okeechobee Operating Permit (NEEPP Permit #0174552) in this report.

Specific Condition	Description	Applicable Phase	Action Taken	Reported in the 2013 SFER in: *(All references are to Volume III, except where noted as "V1" for Volume I - Chapter 8, and "LOPP" for the 2011 Lake Okeechobee Protection Plan Update)*			
				Narrative (page #'s)	**Figure**	**Table**	**Attachment**
9A	Implementation of the Lake Okeechobee Protection Plan	Operations	Ongoing Lake Okeechobee Protection Plan implementation to meet Lake Okeechobee TMDL by 2015	V1: 8-6 to 8-35	V1: 8-1 to 8-11	V1: 8-3 to 8-10	
9B	Annual compliance evaluation by region	Operations	Annual compliance evaluation (by region) completed, as required	22		14,15	
14	Annual Monitoring Report	Operations	Annual monitoring report completed and submitted, as required	1-36	1-3	1-18	B1-B11
14 A	Water Quality Data	Operations	Data records include all applicable laboratory information specified in Rule 62-160.340(2), F.A.C.	2,3	1	3–5	B1
14 A1	Date, location, and time of sampling or measurements	Operations	Reported, as required		1		B1
14 A2	Person responsible for performing the sampling or measurements	Operations	Reported, as required				B1
14 A3	Dates analyses were performed or the appropriate code as required by Chapter 62-160, F.A.C.	Operations	Reported, as required				B1
14 A4	Laboratory/Person responsible for performing the analyses	Operations	Reported, as required				B1
14 A5	Analytical methods used, including MDL and PQL	Operations	Reported, as required				B1
14 A6	Results of such analyses, including appropriate data qualifiers, and all compounds detected	Operations	Reported, as required				B1
14 A7	Depth of sampling (for grab samples)	Operations	Reported, as required				B1

14 A8	Flow conditions and weather conditions at time of sample collection	Operations	Reported, as required				B1
14 A9	Monthly flow volumes	Operations	Monthly flow volumes reported, as required	8		6-7	
14 B	Performance Evaluation. With the raw data, the permittee must submit an evaluation of the water quality monitoring data collected	Operations	Evaluation of raw water quality data conducted and included in report	14-29		9-18	B4-B11
14 B1	The analysis shall include the identification of exceedances of water quality criteria, other than phosphorus, as well as the frequency of exceedances	Operations	Analysis includes all required information	14-21		9-13	B4-B8
14 B2	The permittee shall determine the annual total phosphorus loading to Lake Okeechobee	Operations	TP loads calculated and included,as required	22,; V1: 8-20 to 8-26,8-38 to 8-39	V1: 8-13 to 8-15	14–16; V1: 8-1, 8-3	
14 B3	The permittee shall report the five-year rolling average of phosphorus loading to Lake Okeechobee	Operations	Five-year rolling average TP loads included, as required	22; V1: 8-20		15, V1: 8-1	
14 B4	The permittee shall provide the data from their ambient pesticide and herbicide monitoring program that is applicable to Lake Okeechobee	Operations	Pesticide and herbicide monitoring program data provided, as required	26-29		17 - 18	B9, B10
14 B5	The permittee shall provide data collected within Lake Okeechobee under the Lake Okeechobee Research and Monitoring Program	Operations	Lake Okeechobee Research & Monitoring Program data provided, as required	30; V1: 8-35 to 8-36, 8-38 to 8-42	3; V1:8-14 to 8-16	V1: 8-11 to 8-13	B11
21	Permit Modifications for the 3-Year Update to the LOPP	Operations	Modification 0174552-008 in effect. Procedure to authorize structure improvements and maintenance added (3c). Also includes changes in responsible persons, programs, offices, and regulation schedule.	1; LOPP			

PQL – Practical Quantitation Limit; MDL – Method Detection Limit; F.A.C. – Florida Administrative Code; NEEPP – Northern Everglades and Estuaries Protection Program; LOPP – Lake Okeechobee Protection Plan

Attachment B: Water Quality and Hydrologic Data

This project information is required by Specific Condition 14 of the Lake Okeechobee Operating Permit (0174552), and by permit modification 006 (0174552-006-EM), and is available upon request.