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

Permit Report (May 1, 2012–April 30, 2013)
Permit Number: 0174552

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Contributors: Cheol Mo, Richard Pfeuffer and Lawrence Glenn

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, graphs, and attachments 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:	0174552-010
Issue and Expiration Dates:	Issued: 6/18/2007; Expires: 6/18/2012 *(A permit renewal request was submitted by the District to the FDEP on April 11, 2012, and is currently under review.)*
Project Phase:	Operation
Permit Specific Condition Requiring Annual Report:	16
Relevant Period of Record:	May 1, 2012–April 30, 2013
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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)*
C	Lake Okeechobee S-2 and S-3 Backpumping After Action Report for August 27–September 5, 2012
D	Lake Okeechobee S-2 Backpumping After Action Report for February 15–16, 2013

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 FDEP to fulfill the requirements of modifications 006, 007, 008, and 010 of the Operating Permit (0174552), and Specific Condition 16 ("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 timing of grab sampling based on duration of pumping at S-2 and S-3
- 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 biochemical oxygen demand 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 2013 (WY2013) (May 1, 2012–April 30, 2013), 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 monitoring data, and data collected though the Lake Okeechobee Research and Monitoring Program.

Table 3. Water quality monitoring for S-2 and S-3 flood control backpumping for compliance with permit 0174552-001-GL (modification number 0174552-006-EM).

Site	Type	Duration	Parameters
S-2	Auto-sampler composite flow proportional (ACF)[1]	Event[2] duration	Total phosphorus (TP) and total nitrogen (TN)[3] only
S-2	Grab	Event duration ≤ 72 hours: collect one sample for nutrients (TP and TN) 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[1]	Event[2] duration	TP and TN[3] only
S-3	Grab	Event duration ≤ 72 hours: collect one sample for nutrients (TP and TN) 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**.

[1] Flow-proportional composite sampler.

[2] An event is defined as continuous or intermittent pumping activity separated by a cessation of 72 hours or greater.

[3] TN (total nitrogen) = total Kjeldahl nitrogen + nitrate + nitrite.

A. MONITORING DATA

WATER QUALITY

Water quality data, including qualified data, collected at Lake Okeechobee structures (**Figure 1**; **Table 4**) was retrieved from the District's hydrometeorological and water quality database, DBHYDRO (SFWMD, 2013a) and included with this report in 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**). In addition, dissolved oxygen (DO) saturation and percent DO saturation were calculated for each DO-temperature pair using the equation listed on page 60 of the technical support document authored by the FDEP (FDEP, 2012) in recognition of an upcoming change to the Class I criteria for dissolved oxygen. This change defines a criterion that DO should not go below 38 percent saturation. Daily flow data (Attachment B2) and daily rainfall data (Attachment B3) also are reported. The water quality information in Attachment B incorporates all data required by the permit.

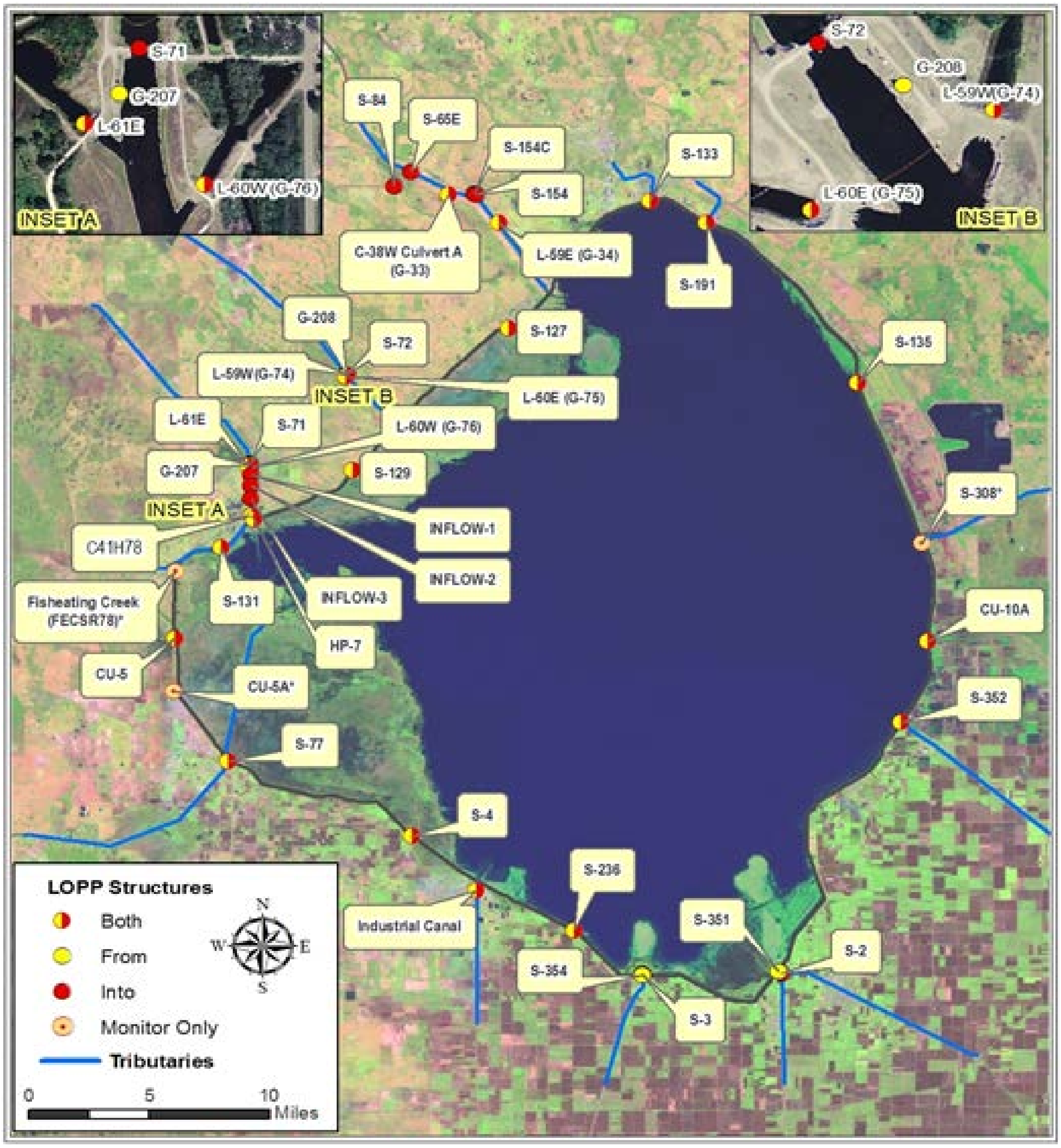

Figure 1. Structures included in the Lake Okeechobee Operating Permit.

Table 4. Structures monitored for compliance with permit 0174552-001-GL (modification number 0174552-006-EM).

Structure	Into/From	DBHYDRO Inflow Direction[5]	Structure Description	Latitude	Longitude
S-2	Into	-	Four unit pump station, 3,600 cubic feet per second (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	Not available (NA)	Two barrel culvert with flashboards	27 01 59.19	81 05 17.23
HP-7[2,3]	Both	NA	Single barrel culvert with flap gate with winch	27 00 00.00	81 04 10.00
Inflow-1[2,3]	Into	NA	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	NA	Single barrel culvert with flap gate, on Harney Pond Canal	27 01 10.77	81 04 12.20
Inflow-3[2,3]	Into	NA	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.

Table 5. Parameters monitored and appendices where data are reported for compliance with permit 0174552-001-GL (modification number: 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	IN SITU	BI-W if flowing, M if not flowing	ALL	B1
PH	pH	SU	IN SITU	BI-W if flowing, M if not flowing	ALL	B1
SCOND	Specific Conductance	µS/cm	IN SITU	BI-W if flowing, M if not flowing	ALL	B1
TEMP	Temperature	°C	IN SITU	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

Key to Abbreviations

ALL – structures owned and operated by the District, as specified in **Table 4**.
ACF – flow-proportional composite sampler
BI-W – biweekly
CAL – calculated
cfs – cubic feet per second
DAC – daily accumulation
DAV – daily average
G – grab sample
IN SITU – measured with probe on-site
M – monthly
mg/L – milligrams per liter
NTU – nephelometric turbidity units
µg/L – micrograms per liter
µS/cm – microsiemens per centimeter
PR – pump records
Q – quarterly
RG – rain gauge
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 AND STAGE DATA

Daily flow data for permitted structures are provided in Attachment B2. Additional flow information for structures not included in the permit (FECRSR78, S-77, S-308, CU-5A, CU-10, CU-4, CU-12, and CU-12A), but which contribute loads and flows to Lake Okeechobee, are provided in Attachment B2. All flow data were retrieved from DBHYDRO (SFWMD, 2013a) on July 8, 2013. Updates and revisions may occur after this time, but will not be reflected in this report.

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 the S-2 and S-3 pump stations, while flow out of the lake occurs at spillways S-351 and S-354, by gravity flow or temporary forward pumps.

Two backpumping after action reports were submitted in WY2013. The first event was from August 27 to September 5, 2012, due to Tropical Storm Isaac, and the second event was from February 15 to 16, 2013, due to a more focused storm event (Attachments C and D).

During WY2013, inflow to Lake Okeechobee was approximately 2.1 million acre feet (ac-ft) (**Table 6**). This is less than the baseline period (1991–2005) of 2.5 million ac-ft (SFWMD et al., 2011). The largest inflows during WY2013 were from S-65E, S-7, Fisheating Creek, and S-84. Inflow to Lake Okeechobee was lower than baseline flows to the lake from May to July in WY2013 (**Figure 2**). Flow increased in August 2012 through October 2012, as a result of Tropical Storm Isaac. This event produced almost half of the annual flow to the lake for the water year [see Volume I, Chapter 8 of the 2014 South Florida Environmental Report (SFER)]. Flows were much lower than average from November 2012 to April 2013.

Lake stage was 11.68 feet National Vertical Datum of 1929 (ft NGVD) on May 1, 2012, and gradually increased until August 26, 2012 (**Figure 3**). Inflows to the lake increased substantially and water levels rose rapidly in the lake due to the rainfall from Tropical Storm Isaac. On September 19, 2012, as lake stage reached 15.17 ft NGVD, regulatory releases to the St. Lucie and Caloosahatchee rivers were initiated. Water levels continued to increase to 15.92 ft NGVD on October 9, 2012, and then declined. On November 14, 2012, regulatory releases were discontinued, while pulse releases and base flow were continued throughout the rest of WY2013.

Outflow from Lake Okeechobee in WY2013 was just over one-million ac-ft (**Table 7**). Nearly half of the discharge was through S-77, primarily for regulatory and base flow releases from September to April. Discharges through S-308 were only one-tenth of the total outflows, primarily in October and November. Discharges to the south (to the Everglades Agricultural Area) through S-351, S-352, and S-354 occurred primarily from November to April, and made up approximately one-fifth of the total outflow from Lake Okeechobee.

Table 6. Monthly inflow to Lake Okeechobee by structure in acre-feet for Water Year 2013 (WY2013) (May 1, 2012–April 30, 2013).

Region	Structure	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	Total
East	L8 (CU-10A)	13,525	24,982	23,300	38,465	22,064	13	NA[4]	NA	NA	NA	NA	NA	122,350
	S-3082	11,569	6,690	7,008	31,273	12,365	73	276	1,561	229	2,201	1,746	345	75,337
	Total	25,094	31,672	30,307	69,739	34,429	87	276	1,561	229	2,201	1,746	345	197,686
North	C-38W Culvert A (G-33)	0	0	0	781	495	1,675	208	97	241	251	199	318	4,265
	C41H78[3]	5,335	17,567	36,967	41,578	76,037	34,499	67	18,864	7,165	4,781	4,068	5,879	252,807
	L61E, HP7, Inflow 1, 2, 3[1,2,3]	4,299	460	0	0	0	0	0	0	0	2,959	3,480	3,599	14,797
	CU-5	0	NA	NA	NA	0	9	0	0	0	0	0	0	9
	Fisheating Creek-Lakeport	493	558	3,336	21,677	109,884	56,588	6,914	1,423	1,442	653	620	961	204,551
	L-59E (G-34)	0	0	0	22	327	2,598	84	0	1	33	39	174	3,278
	L-59W(G-74)	3,969	2,392	700	5,978	1,900	5,883	0	4,827	10	0	0	0	25,660
	L-60E (G-75)	156	340	204	3,665	2,540	779	17	0	0	0	0	0	7,702
	L-60W (G-76)	206	329	437	957	316	1,690	9	66	45	14	0	447	4,515
	S-127	0	632	0	5,841	7,149	3,451	294	220	45	100	48	0	17,780
	S-129	0	1	0	960	3,500	2,200	275	309	137	161	3	358	7,903
	S-131	0	146	2	811	1,799	740	179	208	135	143	3	316	4,480
	S-133	0	5	0	7,078	7,308	6,369	855	963	372	270	7	0	23,227
	S-135	0	2	0	5,645	4,546	3,421	464	1,116	497	620	2	4	16,317
	S-154	0	9	74	12,386	20,076	15,509	3,918	322	2	0	10	0	52,305
	S-154C	0	121	95	986	581	792	72	65	62	8	8	30	2,820
	S-191	0	5,307	2,322	44,299	31,758	26,347	1,794	950	473	460	0	0	113,711
	S-65E	20,334	33,422	32,773	128,120	345,002	190,545	24,292	34,062	17,236	11,555	12,745	13,373	863,459
	S-71	835	16,791	37,825	41,669	83,274	50,996	1,050	19,734	8,404	1,825	602	1,850	264,855
	S-72	172	1,945	7,293	19,577	25,496	16,293	319	3,719	638	326	44	2,012	77,835
	S-84	211	17,978	14,025	41,883	39,493	14,413	624	14,829	2,277	165	317	566	146,781
	Total[5]	30,677	80,437	99,086	341,556	684,950	398,623	41,159	82,811	31,775	19,292	17,929	23,690	1,851,984

Table 6. Continued.

Region	Structure	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	Total
South	CU-10[1,2]	0	0	0	1,724	276	0	0	0	0	0	0	0	2,000
	CU-12[1,2]	0	0	0	3,089	831	0	0	0	0	0	0	0	3,920
	CU-12A[1,2]	0	0	0	0	0	0	0	0	0	0	0	0	0
	CU-4A[1,2]	0	0	0	441	0	0	0	0	0	0	0	0	441
	Industrial Canal	2,912	3,554	943	3,044	2,196	22	NA	434	56	1,324	522	141	15,148
	S-2 (S-351)	59	207	205	26,827	9,369	0	70	0	0	1,899	0	0	38,636
	S-236	0	0	0	421	0	0	0	0	0	0	0	0	421
	S-3 (S-354)	172	174	297	4,198	0	0	0	246	0	0	93	0	5,180
	S-352	0	0	0	670	0	0	0	0	0	0	0	0	670
	S-4	258	231	147	10,346	6,697	4,299	0	574	194	3,600	91	194	26,631
	Total	3,401	4,165	1,592	50,760	19,369	4,321	70	1,254	249	6,823	706	335	93,047
West	CU-5A[2]	2,507	NA	NA	2,022	0	0	NA	300	NA	NA	NA	241	5,070
	S-77[2]	0	0	0	0	0	NA	NA	0	0	0	0	0	0
	Total	2,507	0	0	2,022	0	0	0	300	0	0	0	241	5,070
Total[5]		61,679	116,274	130,985	464,077	738,748	403,031	41,505	85,927	32,254	28,316	20,380	24,611	2,147,787

[1] Included in other permits

[2] Provides flows and loads to lake; not owned or operated by the South Florida Water Management District

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

[4] NA – Not available

[5] Does not include C41H78 flows

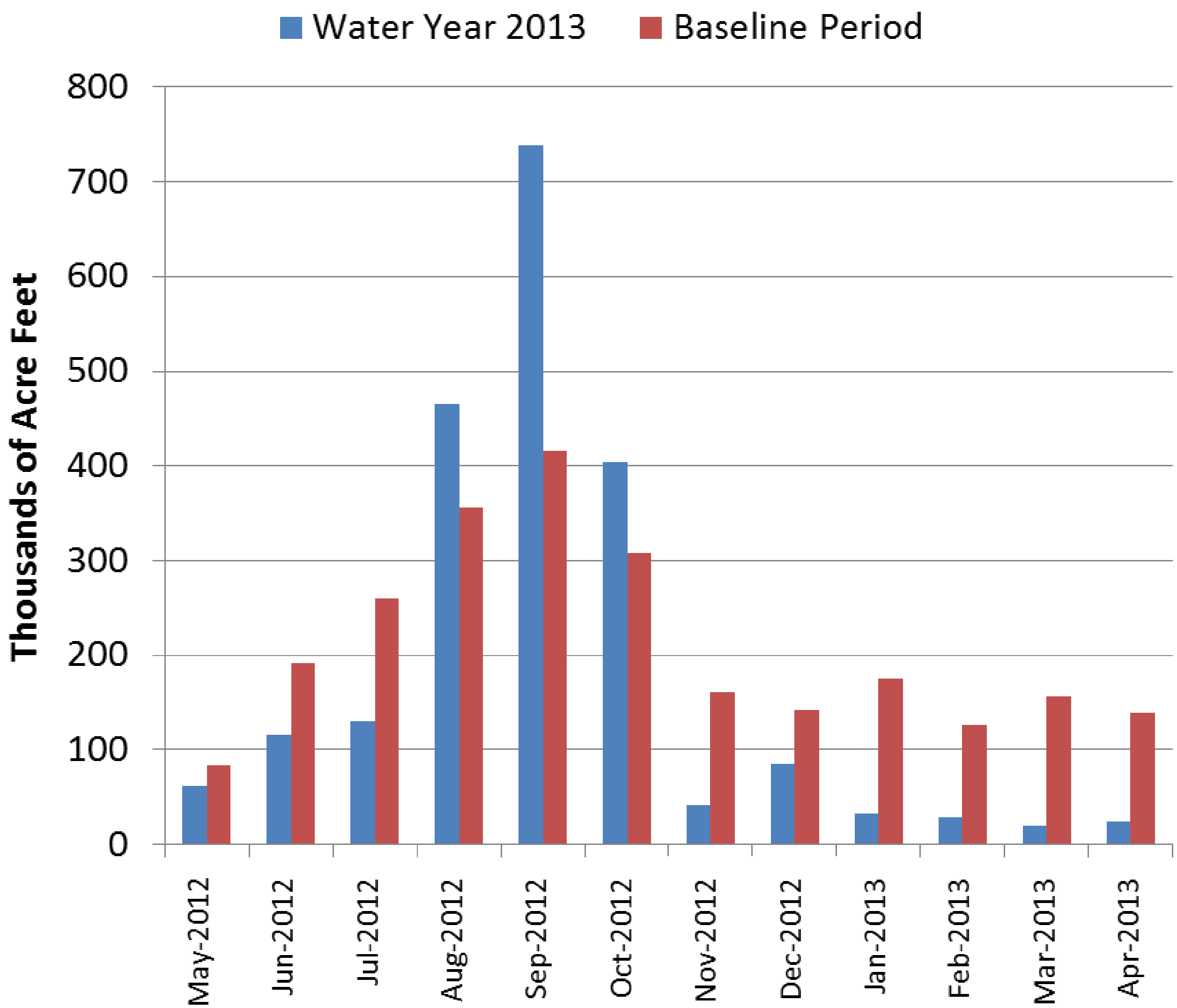

Figure 2. Flow to Lake Okeechobee by month for the baseline period (1991–2005) and Water Year 2013 (WY2013) (May 1, 2012–April 30, 2013).

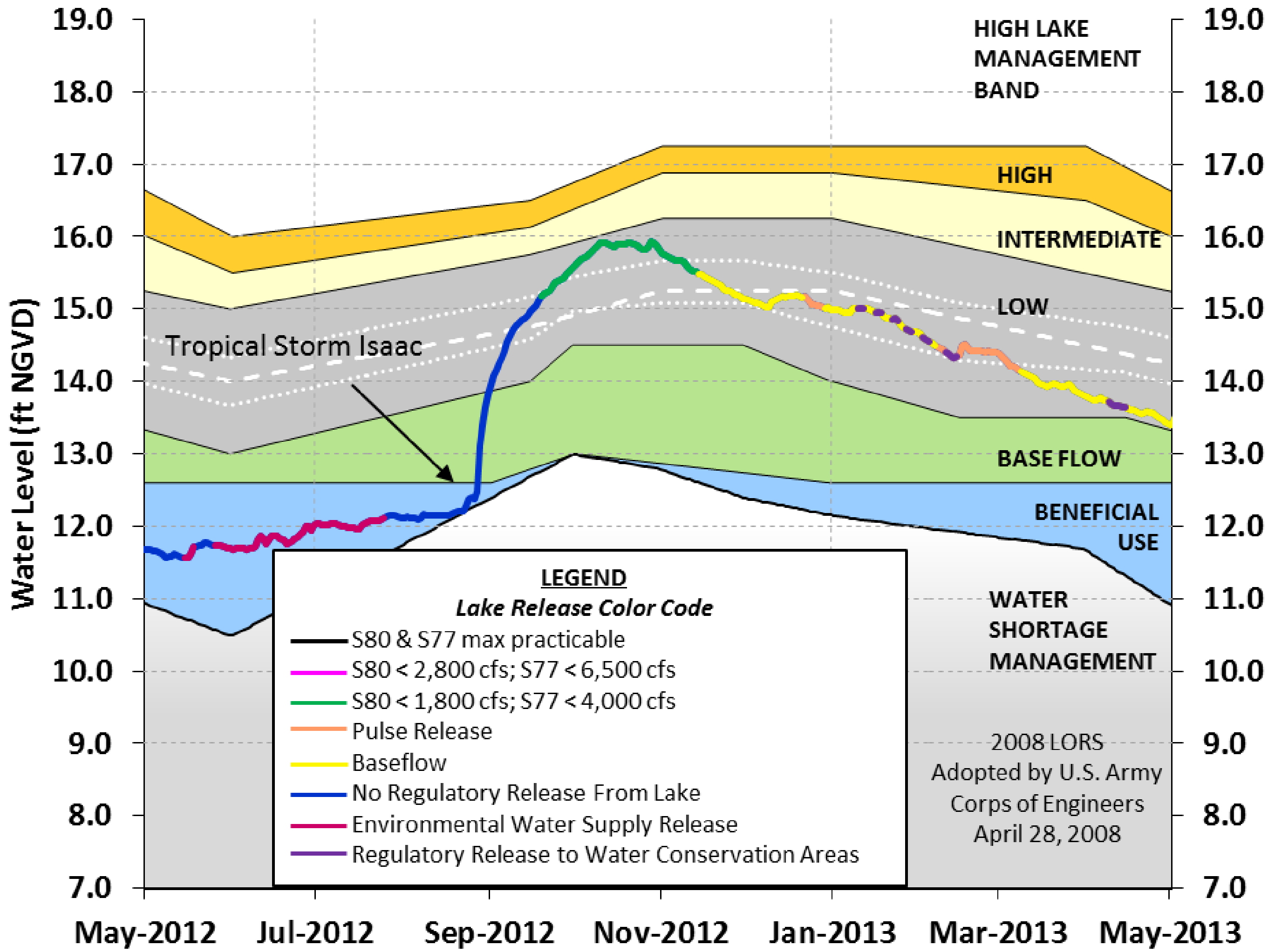

Figure 3. Lake Okeechobee stage values in feet National Geodetic Vertical Datum of 1929 (ft NGVD) for WY2013 and the 2008 Lake Okeechobee Regulation Schedule (2008 LORS). [Note: cfs - cubic feet per second]

Table 7. Monthly discharge flow in acre-feet from Lake Okeechobee for WY2013.

Station	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	Total
CU-10A	537	ND[3]	ND	ND	96	6,976	13,103	23,179	24,434	18,634	20,013	16,123	123,094
CU-5	0	ND	ND	ND	0	0	0	0	0	0	0	0	0
CU-5A[2]	1,739	3,353	3,622	2,635	0	501	7,001	4,051	6,783	4,285	3,703	2,520	40,194
G-207	6	12	12	0	8	8	12	14	0	17	14	17	120
G-208	6	13	13	0	11	9	14	14	0	17	11	14	121
Industrial Canal	2,184	734	1,978	1,304	156	723	4,336	1,707	2,548	1,584	3,249	2,396	22,898
S-127	0	0	0	0	0	0	0	0	0	65	818	282	1,165
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	ND	0	0	0	0	0	0	0	0	0	0	0
S-308[2]	1,743	1,341	225	18	10,506	48,835	18,184	1,644	2,243	5,605	2,529	10,744	103,620
S-351[1]	3,011	206	0	0	0	0	26,285	11,439	22,761	17,814	23,559	6,884	111,959
S-352[1]	3,402	12	1,112	1,597	0	0	13,571	2,105	237	5,952	4,107	5,788	37,883
S-354[1]	3,528	29	0	0	0	0	29,499	10,023	24,153	13,794	10,919	7,521	99,465
S-77[2]	20,297	13,747	4,558	875	27,586	171,955	67,402	37,738	36,375	46,717	43,031	31,085	501,366
Total	36,454	19,447	11,520	6,429	38,365	229,006	179,408	91,914	119,534	114,482	111,953	83,374	1,041,887

[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 or operated by the South Florida Water Management District.
[3] ND – no data.

RAINFALL

Daily rainfall measurements collected from the stations used to report Lake Okeechobee Basin rainfall (SFWMD, 2013b, Attachment B3) were used for consistency with Volume I, Chapter 2 of the 2014 SFER. The rainfall estimates for the Lake Okeechobee Basin and District-wide were 2.8 and 1.2 inches above the 30-year average, primarily due to rainfall from Tropical Storm Isaac (**Table 8**). The driest months (November through March) all had less than two inches of rainfall, contributing to the 2.4-foot recession of lake levels from November to April.

Table 8. Monthly rainfall averages (inches) for WY2013 compared to the 30-year period (calendar years 1981–2010).

Month	*Lake Okeechobee*			*District-Wide*		
	1981–2010 Average	**WY2013**	**Difference**	**1981–2010 Average**	**WY2013**	**Difference**
May	3.3	4.8	1.5	3.9	6.2	2.4
June	7.0	7.1	0.1	8.3	7.5	-0.8
July	6.0	4.8	-1.2	7.0	6.0	-1.0
August	6.7	12.0	5.4	7.8	11.5	3.7
September	5.6	6.0	0.4	6.8	6.6	-0.2
October	3.0	3.9	0.9	3.8	5.3	1.5
November	1.9	0.2	-1.8	2.4	0.3	-2.1
December	1.6	1.7	0.1	1.9	1.9	0.0
January	1.7	0.8	-0.9	1.9	0.6	-1.3
February	2.1	1.8	-0.3	2.3	1.90	-0.4
March	3.2	1.1	-2.1	3.1	1.10	-2.0
April	2.2	2.9	0.7	2.5	3.90	1.4
Total	**44.2**	**47.0**	**2.8**	**51.6**	**52.8**	**1.2**

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, total iron, and turbidity (**Table 9**). Permit modification 0174552-006-EM replaced biochemical oxygen demand with total organic carbon, which does not have a Class I criterion. The turbidity criterion of 32.3 nephelometric turbidity units (NTU) was based on natural background values, as described in the 2009 annual permit report (Unsell, 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 (Unsell, 2009). In anticipation of the changes in Class I DO criteria from 5.0 milligrams per liter (mg/L) to 38 percent DO saturation (FDEP, 2012), percent DO saturation was included in this report.

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

Parameter Name	Parameter Description	Units	Criteria
ALK	Alkalinity	milligrams per liter (mg/L)	≥ 20
DO	Dissolved Oxygen	mg/L	≥ 5
DO%	Percent Dissolved Oxygen Saturation (FDEP, 2012)	%	> 38
pH		standard units	6 - 8.5
SCOND	Specific Conductivity	microsiemens per centimeter (µS/cm)	≤ 1,275
TFE	Total Iron	micrograms per liter (µg/L)	≤ 1,000
TURB	Turbidity	nephelometric turbidity units (NTU)	≤ 32.3 (≤ 29 + 3.3 natural background)

Water quality data for each station was separated into three categories (inflow, no-flow, and outflow), 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 FDEP in Chapter 62-160, F.A.C. 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: $f \leq 0.10$; HA: $f \geq 0.10$) (Weaver and Payne, 2005; Unsell, 2009). This excursion rate is given a category of concern (**Table 10**). All flow and structure sample sets contained fewer than 28 samples for WY2013 (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 10-year period of record (WY2004–WY2013) was included for the binomial hypothesis testing. The categories for the tests were the same as above with the addition of "minimal concern" or MC. The category statistics were C (HA: $f \geq 0.10$), PC (HA: $0.05 \leq f < 0.10$), MC (HA: $0 < f < 0.05$), NC (H0: $f=0$), and ND (no data) (**Table 10**). An evaluation of these data: mean, maximum, minimum, number of samples, standard deviation, median, 25th and 75th percentiles, and number of exceedances from Florida Class I standards were determined for each structure for each given flow period for the 10-year period (Attachment B8).

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 Percent Exceedances (less than 28 samples)
Concern	> 10%	> 20%
Potential Concern	5 to 10%	> 0% and < 20%
Minimal Concern	0% < and < 5%	not applicable
No Concern	0%	0%

Levels of concern for Class I parameters at Lake Okeechobee structures during WY2013 inflow events are listed in **Table 11**. Levels of concern for no-flow events are listed in **Table 12**. **Table 13** lists levels of concern for outflow events. Levels of concern for each Class I parameter are discussed in separate sections following the tables.

Table 11. Levels of concern[a] for Class I parameters at Lake Okeechobee structures during WY2013 inflow events.

Station	Alkalinity	Dissolved Oxygen	Percent Dissolved Oxygen	pH	Specific Conductivity	Total Iron	Turbidity
C-38W	NC/NC*	C/C*	C/C*	NC/NC*	C/C*	PC*/NC*	NC/NC*
C41H78	NC/NC*	C/C*	C/NC*	NC/NC*	NC/NC*	NC*/NC*	NC/NC*
CU-10A	NC/NC*	C/C*	C/PC*	NC/NC*	C/NC*	C*/C*	C/PC*
CU-5	NC*/ND	C*/ND	C*/ND	NC*/ND	NC*/ND	NC*/ND	NC*/ND
INDUSCAN	NC/NC*	C/C*	C/NC*	NC/NC*	NC/NC*	PC*/NC*	C/NC*
L-59E	PC*/NC*	C/NC*	C*/NC*	NC/NC*	C*/NC*	C*/ND	NC*/NC*
L-59W	PC*/C*	C*/C*	C*/C*	NC*/NC*	NC*/NC*	C*/NC*	NC*/NC*
L-60E	C/NC*	C/C*	C/PC*	NC/NC*	NC/NC*	NC*/NC*	NC/NC*
L-60W	NC/NC*	C/C*	C/C*	NC/NC*	NC/NC*	NC*/NC*	NC/NC*
S-127	NC*/NC*	C/C*	C/C*	NC/NC*	NC/NC*	NC*/ND	NC*/NC*
S-129	NC*/ND	C/C*	C/C*	NC/NC*	NC/NC*	NC*/ND	NC/NC*
S-131	NC*/NC*	C/C*	C/NC*	NC/NC*	NC/NC*	NC*/ND	NC/NC*
S-133	NC*/NC*	C*/C*	C*/C*	NC*/NC*	NC*/NC*	NC*/ND	PC*/NC*
S-135	NC*/NC*	C/NC*	C/NC*	NC/NC*	NC/NC*	NC*/ND	C/NC*
S-154	NC/NC*	C/C*	C/C*	NC/NC*	C/NC*	C*/NC*	NC/NC*
S-154C	NC/NC*	C/C*	C/C*	NC/NC*	C/C*	PC*/NC*	MC/PC*
S-191	NC/NC*	C/C*	C/PC*	MC/NC*	NC/NC*	NC*/NC*	NC/NC*
S-2	NC*/NC*	C/C*	C/C*	NC/NC*	C/PC*	PC*/PC*	PC*/PC*
S-236	NC*/ND	C*/ND	C*/ND	NC*/ND	C*/ND	NC*/ND	NC*/ND
S-3	NC*/NC*	C*/C*	C*/C*	NC*/NC*	NC*/NC*	NC*/NC*	NC*/NC*
S-4	NC/NC*	C/C*	C/PC*	NC/NC*	C/NC*	NC*/NC*	NC/NC*
S-65E	MC/NC	C/C	C/C	MC/NC	NC/NC	PC/NC*	NC/NC
S-71	C/PC*	C/C*	C/PC*	NC/NC*	NC/NC*	NC*/NC*	NC/NC*
S-72	MC/NC*	C/C*	C/PC*	NC/NC*	NC/NC*	PC*/NC*	NC/NC*
S-84	C/NC*	C/C*	C/C*	PC/NC*	MC/NC*	PC*/ND	MC/NC*

[a] C – concern; PC – potential concern; MC – minimal concern; NC – no concern; ND –no data

[*] Less than 28 samples preliminary test used.

Listing before "/" is for WY2004–WY2013; listing after "/" is for WY2013.

Table 12. Levels of concern[a] for Class I parameters at Lake Okeechobee structures during WY2013 no-flow events.

Station	Alkalinity	Dissolved Oxygen	Percent Dissolved Oxygen Saturation	pH	Specific Conductivity	Total Iron	Turbidity
C-38W	NC/NC*	C/NC*	C/NC*	C/NC*	C/C*	NC/NC*	C/NC*
C41H78	NC*/NC*	PC*/C*	PC*/C*	NC*/NC*	NC*/NC*	ND/ND	NC*/NC*
CU-10A	NC*/ND	C*/ND	C*/ND	NC*/ND	NC*/ND	NC*/ND	C*/ND
CU-5	NC/NC*	C/C*	C/C*	NC/NC*	NC/NC*	C/NC*	MC/NC*
INDUSCAN	NC*/ND	NC*/ND	NC*/ND	NC*/ND	NC*/ND	ND/ND	NC*/ND
L-59E	NC/NC*	C/C*	C/PC*	MC/NC*	C/NC*	NC/NC*	MC/NC*
L-59W	MC/NC*	C/C*	C/PC*	MC/NC*	NC/NC*	NC/NC*	NC/NC*
L-60E	NC/NC*	C/PC*	C/NC*	MC/NC*	NC/NC*	PC*/NC*	NC/NC*
L-60W	NC/NC*	C/NC*	C/NC*	MC/NC*	NC/NC*	NC*/NC*	NC/NC*
S-127	NC/NC*	C/C*	C/NC*	NC/NC*	C/NC*	NC/NC*	NC/NC*
S-129	NC/NC*	C/NC*	PC/NC*	NC/NC*	NC/NC*	NC/NC*	NC/NC*
S-131	NC/NC*	C/PC*	C/NC*	MC/NC*	NC/NC*	NC/NC*	NC/NC*
S-133	NC/NC*	C/C*	C/PC*	MC/NC*	NC/NC*	C/NC*	NC/NC*
S-135	NC/NC*	C/C*	MC/NC*	MC/NC*	NC/NC*	NC/NC*	MC/NC*
S-154	NC/NC*	C/C*	MC/NC*	MC/NC*	C/NC*	C/C*	MC/NC*
S-154C	NC/NC*	C/C*	C/C*	NC/NC*	C/C*	NC*/NC*	MC/NC*
S-191	NC/NC*	C/C*	MC/NC*	MC/NC*	MC/NC*	NC*/NC*	NC/NC*
S-2	NC/NC*	C/PC*	C/PC*	MC/NC*	C/C*	C/NC*	C/NC*
S-236	NC/NC*	C/C*	C/C*	NC/NC*	C/C*	NC/NC*	NC/NC*
S-3	NC/NC*	C/PC*	C/NC*	NC/NC*	C/C*	C/NC*	C/NC*
S-351	NC*/ND	C*/ND	NC*/ND	NC*/ND	NC*/ND	NC*/ND	NC*/ND
S-352	NC/NC*	C/PC*	MC/NC*	MC/NC*	NC/NC*	C*/NC*	C/PC*
S-354	NC*/ND	PC*/ND	NC*/ND	NC*/ND	NC*/ND	NC*/ND	NC*/ND
S-4	NC/NC*	C/PC*	MC/NC*	MC/NC*	MC/NC*	NC/NC*	MC/NC*
S-65E	NC*/ND	PC*/ND	PC*/ND	NC*/ND	NC*/ND	NC*/ND	NC*/ND
S-71	MC/NC*	C/C*	C/PC*	MC/PC*	NC/NC*	NC*/NC*	NC/NC*
S-72	MC/NC*	C/C*	C/PC*	MC/NC*	NC/NC*	NC/NC*	NC/NC*
S-84	PC/PC*	C/C*	MC/PC*	MC/NC*	NC/NC*	PC*/NC*	MC/NC*

[a] C – concern; PC – potential concern; MC – minimal concern; NC – no concern; ND – 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 WY2013 outflow events.

Station	Alkalinity	Dissolved Oxygen	Percent Dissolved Oxygen Saturation	pH	Specific Conductivity	Total Iron	Turbidity
C-38W	NC*/ND	NC*/ND	NC*/ND	C*/ND	C*/ND	ND/ND	C*/ND
C41H78	NC/NC*	C/C*	C/PC*	NC/NC*	NC/NC*	NC*/NC*	NC/NC*
CU-10A	NC/NC*	C/NC*	MC/NC*	MC/NC*	MC/NC*	C*/C*	C/C*
CU-5	NC*/ND	C*/ND	C*/ND	NC*/ND	NC*/ND	NC*/ND	NC*/ND
INDUSCAN	NC/NC*	C/C*	C/PC*	MC/NC*	NC/NC*	C/NC*	C/NC*
L-59E	NC*/ND	NC*/ND	NC*/ND	NC*/ND	NC*/ND	NC*/ND	NC*/ND
L-59W	NC*/ND	NC*/ND	NC*/ND	NC*/ND	NC*/ND	ND/ND	NC*/ND
L-60E	NC*/ND	C*/ND	NC*/ND	NC*/ND	NC*/ND	ND/ND	NC*/ND
L-60W	NC*/ND	C*/ND	C*/ND	NC*/ND	NC*/ND	NC*/ND	NC*/ND
S-127	NC*/NC*	C*/C*	NC*/NC*	NC*/NC*	NC*/NC*	NC*/NC*	NC*/NC*
S-135	NC*/ND	PC*/ND	PC*/ND	PC*/ND	NC*/ND	NC*/ND	PC*/ND
S-352	NC/NC*	MC/NC*	NC/NC*	MC/NC*	NC/NC*	C*/C*	C/C*

[a] C – concern; PC – potential concern; MC – minimal concern; NC – no concern; ND – no data

[*] Less than 28 samples preliminary test used.

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

Alkalinity

The Class I criteria for alkalinity specifies that the value shall not be less than 20 mg/L calcium carbonate ($CaCO_3$) equivalents. For inflow events in WY2013, alkalinity was measured at 22 structures (**Table 11**). Three structures (CU-5, S-129, and S-236) were not measured because of few or no inflow events. One structure (S-71) was defined as "potential concern", one structure (L-59W) as "concern", and the other 20 as "no concern". Of the 183 measurements, two excursions were found (Attachment B4). For the 10-year period, 18 structures were classified as "no concern", two (S65-E and S-72) as "minimal concern", two (L-59E and L-59W) as "potential concern", and three (L-60E, S-71, and 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 22 structures (**Table 12**; Attachment B5). Five structures (CU-10A, INDUSCAN, S-351, S-354, and S-65E) were not measured during no-flow events. One structure (S-84) was defined as "potential concern". Of the 230 samples taken during no-flow events, one excursion was found. For the 10-year period of analysis, 24 structures were classified as "no concern", and three (L-59W, S-71, and S-72) as "minimal concern", and one (S-84) as "potential concern" (**Table 12**; Attachment B8).

For outflow events in WY2013, alkalinity was measured at five structures (**Table 13**; Attachment B6). Of the 40 samples taken, no excursions were found. Seven structures (C-38W, CU-5, L-59E, L-59W, L-60E, L-60W, and S-135) were not measured. For the 10-year period of record, no excursions were found at the twelve stations (**Table 13**; Attachment B8).

Dissolved Oxygen

The Class I criteria for DO specifies that values shall not be less than 5 mg/L. DO was sampled at 23 structures during inflow events in WY2013 (**Table 11**; Attachment B4). Of these structures, two (L-59E and S-135) were classified as "no concern", all others as "concern". At two structures (CULV5 and S-236), there were two and three days of inflow, and thus no measurements were made. Of the 190 measurements during inflow events, 112 did not meet the DO Class I criterion (Attachment B4).

Using the DO percent saturation criteria as a comparison, five locations were classified as "no-concern" (C41H78, INDUSCAN, L-59E, S-131, and S-135), six as "potential concern" (CU-10A, L-60E, S-191, S-4, S-71, and S-72), and the rest as "concern". Of the 190 measurements, 55 did not meet the criteria of 38 percent saturation. The difference in DO and percent DO saturation results demonstrates the effect of temperature on DO. With higher temperatures, saturation is lower, resulting in lower acceptable DO values during these periods.

Factors other than high temperature could result in the high exceedance of the DO and percent DO saturation criteria. These include high dissolved organic carbon, high microbial activity, high respiration of plants during low light conditions, and/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 organic carbon input to the tributaries. Other practices to increase turbulence of the canal flow (e.g., baffle boxes or mechanical mixing) also may improve DO conditions. For the 10-year analysis, all 25 structures were classified as a "concern" for both the DO and DO percent saturation criteria (**Table 11**; Attachment B8).

For no-flow events, three structures (C-38W, L-60W, and S-129) were classified as "no concern", six (L-60E, S-131, S-2, S-3, S-352, and S-4) were classified as "potential concern", and fourteen were classified as "concern" (**Table 12**). Five structures (CU-10A, INDUSCAN, S-351, S-354, and S-65E) were not sampled during no-flow events. Of the 217 samples taken during no-flow events, 65 were below the DO Class I criterion (Attachment B5). For the 10-year analysis, one structure (INDUSCAN) was classified as "no concern", three (C41H78, S-354, and S-65E) as "potential concern" and 24 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.

Using the DO percent saturation criteria, twelve structures (C-38W, L-60E, L-60W, S-127, S-129, S-131, S-135, S-154, S-191, S-3, S-352, and S-4) were classified as "no concern", seven (L-59E, L-59W, S-133, S-2, S-71, S-72, and S-84) were classified as "potential concern", and four were classified as "concern" (**Table 12**). Of the 217 calculated values for percent DO saturation, only 21 did not meet the criteria of 38 percent.

For outflow events, two structures (CU-10A and S-352) were classified as "no concern", three (C41H78, INDUSCAN, and S-127) as "concern", and seven were not measured (**Table 13**). All seven unmeasured structures (C-38W, CU-5, L-59E, L-59W, L-60E, L-60W, and S-135) had no days of outflow (Attachment B6). Of the 40 samples taken during outflow events, seven were below the DO Class I criterion. For the 10-year analysis, one structure (S-352) was classified as "minimal concern", one (S-135) as "potential concern", three (C-38W, L-59E, and L-59W) as "no concern", and the other seven as "concern" (**Table 13**; Attachment B8). As with inflow events, the low DO may be due to various factors as noted above.

Using the DO percent saturation criteria, three structures (CU-10A, S-127, and S-352) were classified as "no concern", two (C41H78 as INDUSCAN) as "potential concern", and seven were unmeasured (**Table 13**). Of the 40 samples taken, three were below the DO percent saturation criteria. (Attachment B6). For the 10-year analysis, one structure (CU-10A) was classified as "minimal concern", one (S-135) as "potential concern", six (C-38W, L-59E, L-59W, L-60E, S-127, and S-352) as "no concern", and the other four as "concern" (**Table 13**; Attachment B8).

pH

The Class I criteria for pH specifies that the value shall not be below 6.0 or above 8.5. For inflow events, 23 structures were classified as "no concern", and two (CU-5 and S-236) were not measured (**Table 11**). Of the 195 samples taken during inflow events, there were no excursions (Attachment B4). For the 10-year period, 22 structures were classified as "no concern", two (S-191 and S-65E) as "minimal concern", and one (S-84) as "potential concern" (**Table 11**; Attachment B8). Excursions at S-191 and S-65E were below pH 6.0, while the one excursion at S-84 was above pH 8.5.

For no-flow events, one structure (S-71) was classified as "potential concern". The remaining 22 structures sampled were classified as "no concern" (**Table 12**). Five structures (CU-10A, INDUSCAN, S-351, S-354, and S-65E) were not measured. Of the 221 samples taken during no-flow events, one was outside the pH criteria range, above 8.5 (Attachment B5). For the 10-year period, there were 12 structures listed as "no concern", 15 as "minimal concern", and one as "concern" (C-38W) (**Table 12**; Attachment B8). Of the structures listed as "minimal concern", three (S-72, S-84, and S-191) were below the pH 6.0 criterion, while the rest were above the pH 8.5 criterion. 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, there were no excursions in the 40 samples taken (Attachment B6). For seven structures (C-38W, CU-5, L-59E, L-59W, L-60E, L-60W, and S-135), no samples were taken (**Table 13**). For the 10-year period, seven structures were classified as "no concern", three structures (CU-10A, INDUSCAN, and S-352) were classified as "minimal concern", one (S-135) as "potential concern", and one (C-38W) as "concern" (**Table 13**; Attachment B8). The pH excursions at all of these structures exceeded the pH 8.5 criterion.

Specific Conductivity

The specific conductivity criterion for Lake Okeechobee tributaries is 1,275 μS/cm. For inflow events, 20 structures were classified as "no concern", one (S-2) as "potential concern", two (C-38W and S-154C) as "concern", and two (CU-5 and S-236) were not sampled (**Table 11**). Of the 221 samples taken during inflow events, 23 exceeded the conductivity criterion (Attachment B4). For the 10-year period of record, 16 were classified as "no concern", one (S-84) as "minimal concern", and eight (C-38W, CU-10A, L-59E, S-154, S-154C, S-2, S-236, and S-4) as "concern" (**Table 11**; Attachment B8). High conductivity is likely a result of groundwater seepage.

For no-flow events, 18 structures were classified as "no concern", five (C-38W, S-154C, S-2, S-236, and S-3) as "concern", and five (CU-10A, INDUSCAN, S-351, S-354, and S-65E) 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, 18 structures were classified as "no concern", two (S-191 and S-4) as "minimal concern", and eight (C-38W, L-59E, S-127, S-154, S-154C, S-2, S-236, and S-3) 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 40 measurements from five structures (C-41H78, CU-10A, INDUSCAN, S-127, and S-352) sampled (**Table 13**, Attachment B6). Seven structures (C-38W, CU-5, L-59E, L-59W, L-60W, L-60E, and S-135) were not sampled. For the 10-year period, ten structures were classified as "no concern", one (CU-10A) as "minimal concern", and one (C-38W) as "concern" (**Table 13**; Attachment B8).

Total Iron

The Class I criterion specifies that total iron shall not 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, the binomial test could be performed on only a few structures with accuracy for the 10-year period. Of the 32 samples taken at structures during inflow events in WY2013, two exceedances, one at S-2 and one at CU-10A, were found (**Table 11**; Attachment B4). This led to a classification of "concern" for CU-10A, and "potential concern" for S-2. The fourteen other structures sampled for iron during inflow events were classified as "no-concern". Nine structures (CU-5, L-59E, S-127, S-129, S-131, S-133, S-135, S-236, and S-84) were not sampled. For the 10-year period of record, 14 structures were classified as "no concern", seven (C-38W, INDUSCAN, S-154C, S-2, S-65E, S-72, and S-84) as "potential concern", and four (CU-10A, L-59E, L-59W, and 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 (FDEP, 2009).

For no-flow events, 21 structures were classified as "no concern", one (S-154) as "concern", and six (C41H78, CU-10A, INDUSCAN, S-351, S-354, and S-65E) were not measured (**Table 12**). Of the 65 samples taken during no-flow periods, only three at S-154 exceeded the iron standard (Attachment B5). For the 10-year period, 18 structures were classified as "no concern", two (L-60E and S-84) as "potential concern", and six (CU-5, S-133, S-154, S-2, S-3, and S-352) as concern. Iron has not been measured in the last ten years during no flow conditions at C41H78 or INDUSCAN. Iron concerns at S-133, S-154, S-352, S-2, and S-3 may be attributed to groundwater seepage.

For outflow events, three structures (C41H78, INDUSCAN, and S-127) were classified as "no concern", two (CU-10A and S-352) as "concern", and seven (C-38W, CU-5, L-59E, L-59W, L-60E, L-60W, and S-135) were not sampled (**Table 13**). Of the ten samples taken during outflow periods, four exceeded the criterion for iron (Attachment B6). For the 10-year period, six structures (C41H78, CU-5, L-59E, L-60W, S-127, and S-135) were classified as "no concern", three (CU-10A, INDUSCAN, and S-352) as "concern", and three (C-38W, L-60E, and L-59W) were not measured (**Table 13**; Attachment B8). Two of the "concerns", S-352 and CU-10A, may be attributed to the proximity of the structures to the open waters of the lake, which are relatively high in iron (FDEP, 2009).

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 to 2000 (Unsell, 2009). For inflow events, twenty structures were classified as "no concern", three (CU-10A, S-154C, and S-2) as "potential concern", and two (CU-5 and S-236) were not measured (**Table 11**). Of the 191 samples taken, there were three excursions (Attachment B4). For the 10-year period, 18 structures were classified as "no concern", two (S-154C and S-84) as "minimal concern", two (S-133 and S-2) 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, 22 structures were classified as "no concern", one (S-352) as "potential concern", and five (CU-10A, INDUSCAN, S-351, S-354, and S-65E) were not sampled (**Table 12**). Of the 221 samples taken during no-flow conditions, three exceeded the criterion for turbidity (Attachment B5). For the 10-year period, 16 structures were classified as "no concern", seven (CU-5, L-59E, S-135, S-154, S-154C, S-4, and S-84) as "minimal concern", and five (C-38W, CU-10A, S-2, S-3, and 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, three structures (C41H78, INDUSCAN, and S-127) were classified as "no concern", two (CU-10A and S-352) as "concern", and seven (C-38W, CU-5, L-59E, L-59W, L-60E, L-60W and S-135) were not sampled (**Table 13**). Of the 40 samples taken during outflow events, eight exceeded the criteria for turbidity (Attachment B6). For the 10-year period, four structures (C-38W, CU-10A, INDUSCAN, and S-352) were classified as "concern", one (S-135) as "potential concern", and seven as no concern (**Table 13;** Attachment B8). Turbidity concerns at S-352 and CU-10A 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 PHOSPHORUS LOADS

The WY2013 TP load to Lake Okeechobee is 568.6 metric tons (mt), which includes an estimated 35 mt from atmospheric deposition (FDEP, 2001; **Table 14**). Most of the surface load came from the northern watersheds (467.4 mt), followed by the east (36.7 mt), south (29.0 mt), and west (0.4 mt). Target loads based on the Total Maximum Daily Load (TMDL) were exceeded by 388.8 mt in the north region, 19.9 mt in the east region, 19.4 mt in the south region, and 0.39 mt in the west region. Overall, the WY2013 TP load was greater than the lake's TMDL of 140 mt by three times (exceeded by 428.6 mt). The five-year (WY2009–WY2013) average TP load to Lake Okeechobee was 456.6 mt per year, which exceeded the TMDL by 316.6 mt (**Table 15**). It is important to note that this five-year average includes one regional drought, from December 2010 to October 2011. During these periods, flow and load to the lake were reduced substantially 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 of the 2014 SFER, 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 in metric tons for each structure by month.

Region	Structure	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	Total	Target Load	Above Target
East	L-8(C10A)	2.2	2.6	1.6	3.1	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5		
	S-308	2.9	1.4	1.2	11.2	6.4	0.0	0.1	0.3	0.0	0.4	0.3	0.1	24.3		
	Total	5.1	4.0	2.8	14.3	9.3	0.0	0.1	0.3	0.0	0.4	0.3	0.1	36.7	16.8	19.9
North	C-38W C-33	0.0	0.0	0.0	0.1	0.2	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.9		
	C41H78	0.5	2.9	10.0	14.5	26.1	7.4	0.0	3.4	0.9	0.5	0.3	0.6	67.0		
	CU-5	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		
	FECR	0.1	0.1	1.0	5.0	29.3	10.4	1.0	0.2	0.1	0.1	0.1	0.3	47.6		
	L-61E	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	1.3		
	L-59E	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.4		
	L-59W	0.3	0.3	0.1	1.2	0.9	3.7	0.0	0.8	0.0	0.0	0.0	0.0	7.4		
	L-60E	0.0	0.0	0.0	1.2	1.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	2.6		
	L-60W	0.0	0.0	0.0	0.3	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.9		
	S-127	0.0	0.1	0.0	3.3	4.0	1.4	0.1	0.1	0.0	0.0	0.0	0.0	9.0		
	S-129	0.0	0.0	0.0	0.1	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.7		
	S-131	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3		
	S-133	0.0	0.0	0.0	3.7	3.3	1.9	0.2	0.3	0.1	0.1	0.0	0.0	9.7		
	S-135	0.0	0.0	0.0	0.7	0.5	0.4	0.1	0.1	0.1	0.1	0.0	0.0	1.9		
	S-154	0.0	0.0	0.0	7.5	20.3	12.3	2.3	0.1	0.0	0.0	0.0	0.0	42.6		
	S-154C	0.0	0.1	0.1	1.5	1.2	0.7	0.0	0.1	0.0	0.0	0.0	0.0	3.7		
	S-191	0.0	2.1	1.3	28.4	26.2	19.8	0.9	0.3	0.1	0.1	0.0	0.0	79.2		
	S-65E	1.4	3.0	5.8	26.2	71.0	28.4	2.8	2.8	1.5	0.8	0.8	0.8	145.2		
	S-71	0.1	5.4	11.0	14.6	27.3	11.1	0.1	3.9	1.1	0.2	0.1	0.2	75.0		
	S-72	0.0	0.4	1.8	7.1	9.1	4.1	0.1	0.7	0.1	0.0	0.0	0.2	23.5		
	S-84	0.0	1.2	0.9	2.5	5.6	3.6	0.1	1.6	0.2	0.0	0.0	0.0	15.7		
	Total*	2.4	12.8	22.1	103.5	200.3	99.4	7.8	10.9	3.3	1.7	1.3	2.0	467.4	78.6	388.8

Table 14. Continued.

Region	Structure	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	Total	Target Load	Above Target
South	CU-10	0.0	0.0	0.0	1.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2		
	CU-12	0.0	0.0	0.0	0.8	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0		
	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	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1		
	INDS	0.8	0.9	0.2	0.5	0.3	0.0	0.0	0.1	0.0	0.2	0.1	0.0	3.0		
	S-2	0.0	0.0	0.0	12.1	2.9	0.0	0.0	0.0	0.0	0.4	0.0	0.0	15.5		
	S-236	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1		
	S-3	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0		
	S-352	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4		
	S-4	0.0	0.0	0.0	2.4	2.2	1.3	0.0	0.2	0.0	0.5	0.0	0.0	6.8		
	Total	0.8	0.9	0.3	18.4	5.7	1.3	0.0	0.3	0.0	1.1	0.1	0.0	29.0	9.6	19.4
West	CU-5A	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4		
	S-77	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		
	Total	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.01	0.4
Total	**Surface***	8.5	17.7	25.2	136.4	215.2	100.8	7.9	11.6	3.4	3.1	1.7	2.1	533.6	105.0	428.6
Atmospheric Deposition														35.0	35.0	
Sum*														568.6	140.0	428.6

* Does not include C41H78

Table 15. TP loads in metric tons to Lake Okeechobee over the last five water years.

Water Year	North	East	South	West	Atmospheric Deposition*	Total
2009	585	22	26	17	35	685
2010	393	17	21	12	35	478
2011	136	2	4	1	35	178
2012	274	15	10	38	35	373
2013	467.4	36.7	29	0.4	35	569
Average	371	18.6	18	13.7	35	456.6
Percent of total	82%	4%	4%	3%	8%	100%

[1.] 35 metric tons/year from atmospheric deposition (FDEP, 2001).

Table 16. Surface flows in millions of acre-feet to Lake Okeechobee for WY2008–WY2012.

Water Year	North	East	South	West	Total
2009	1.82	0.16	0.10	0.10	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	1.62	0.09	0.04	0.20	1.95
2013	1.85	0.20	0.09	0.01	2.15
Average	1.66	0.11	0.07	0.08	1.93
Percent total	86%	6%	4%	4%	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. On a quarterly basis for water, and an annual/semi-annual basis for sediments, samples are measured for 73 pesticides and their breakdown products at sites throughout the District region (Pfeuffer, 2012a, b, c; 2013). A minor modification of the Lake Okeechobee Water Control Structure Operations Permit Number 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.

For Lake Okeechobee, pesticides are monitored at S-65E, S-191, Fisheating Creek (FECSR78), S-2, S-3, and S-4 (Attachments B9 and B10). In the four surface water sampling events (June, July, and October 2012, and January 2013), 2,4-D, ametryn, atrazine, atrazine breakdown product, bromacil, chlorpyrifos ethyl, hexazinone, metolachlor, metribuzin, norflurazon, and simazine were detected in at least one sample (**Table 17**).

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**). The chlorpyrifos ethyl concentration detected is greater than the calculated chronic toxicity for *Daphnia magna*, and, at this level, exposure can negatively affect macroinvertebrate populations. However, the pulsed nature of agricultural runoff releases to the canal system precludes drawing any conclusions about the effects of long-term average exposures. Based on excursion categories recommended for the Everglades Protection Area (Weaver and Payne, 2005), any site where a pesticide was detected is to be labeled as a potential concern.

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) should not 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 frequently or always observed.

DDD was only detected at S-2 and S-3, while DDE was detected at S-2, S-3, and S-4. DDE is an abbreviation for dichlorodiphenyldichloroethylene [2, 2-bis (4-chlorophenyl)-1, 1-dichloroethene]. This compound is an environmental dehydrochlorination product of DDT, a popular insecticide for which the U.S. Environmental Protection Agency cancelled all uses in 1973. The large volume of DDT used, the persistence of DDT, DDE, and another metabolite, DDD (dichlorodiphenyldichloroethane), and the large hydrophobicity of these compounds account for the frequent detections in sediments. The latter attribute also results in a significant bioconcentration factor. In sufficient quantities, these residues have reproductive effects in wildlife, and carcinogenic effects in many mammals.

Table 17. Pesticide residues in micrograms per liter (µg/L) above the method detection limit found in surface water samples collected by SFWMD at Lake Okeechobee sampling sites in June, July, and October 2012, and January 2013 (From Pfeuffer, 2012a, b, c, 2013), and chronic toxicity values for the water flea (*Daphnia magna*). The chlorpyrifos ethyl concentration exceeds the chronic toxicity for *Daphnia magna*.

Site	Date	Flow	2,4-D	Ametryn	Atrazine	Atrazine Desethyl	Bro-macil	Chlor-pyrifos ethyl	Hexa-zinone	Metola-chlor	Metri-buzin	Norflur-azon	Simazine
FECSR78	6/4/2012	Y	BDL	BDL	0.074	0.015 [b]	BDL	BDL	0.14	BDL	BDL	BDL	BDL
	7/24/2012	Y	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	10/22/2012	Y	BDL	BDL	BDL	BDL	BDL	BDL	0.065 [b]	BDL	BDL	BDL	BDL
	1/28/2013	N	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
S-65E	6/4/2012	Y	BDL	BDL	0.042	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	7/24/2012	N	BDL	BDL	BDL	BDL	0.12 [a,b]	BDL	BDL	BDL	BDL	BDL	BDL
	10/22/2012	Y	BDL	BDL	BDL	BDL	BDL	BDL	0.031 [a,b]	BDL	BDL	BDL	BDL
	1/28/2013	Y	BDL	BDL	BDL	BDL	0.18 [a]	BDL	BDL	0.10 [a,b]	0.041 [a,b]	BDL	BDL
S-191	6/4/2012	N	BDL	BDL	0.033 [b]	BDL	BDL	BDL	0.034 [b]	BDL	BDL	BDL	BDL
	7/24/2012	N	BDL	BDL	0.059	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	10/22/2012	N	0.26 [b]	BDL	0.033 [b]	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	1/28/2013	N	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
S-2	6/4/2012	N	BDL	0.081	0.51	0.033 [b]	BDL	0.018 [b]	BDL	BDL	BDL	BDL	BDL
	7/24/2012	N	BDL	0.048	0.18	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	10/22/2012	N	BDL	0.079	0.21	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	1/28/2013	N	BDL	BDL	0.18	0.031 [b]	BDL	BDL	0.029 [b]	BDL	BDL	BDL	BDL
S-3	6/4/2012	N	BDL	0.04	0.63	0.061	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	7/24/2012	Y	BDL	0.052	0.14	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	10/22/2012	N	0.23 [b]	0.064	0.37	0.013 [b]	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	1/28/2013	N	BDL	BDL	0.2	0.022 [b]	BDL	BDL	0.030 [b]	BDL	BDL	BDL	BDL
S-4	6/4/2012	N	BDL	0.034 [b]	0.51	0.066	BDL	BDL	BDL	BDL	BDL	0.031 [b]	BDL
	7/24/2012	N	BDL	0.025 [b]	0.064	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	10/22/2012	N	BDL	BDL	BDL	BDL	BDL	BDL	0.033 [b]	BDL	BDL	0.049 [b]	BDL
	1/28/2013	N	BDL	BDL	0.23	0.020 [b]	BDL	BDL	0.032 [b]	BDL	BDL	BDL	0.020 [b]
Chronic toxicity of ***Daphnia magna***			1,250 [c]	1,400 [c]	345 [c]	NA	6,050 [d]	0.005 [c]	7,580 [c]	1,175 [c]	210 [e]	750 [c]	55 [c]

Key: N – no; Y – yes; BDL – result is below the method detection limit; NA – 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 (1996)
[e] U.S. Environmental Protection Agency (1998)

The DDD sediment concentrations detected were 2.1 and 16 micrograms per kilogram (µg/kg). Any concentration below the TEC (4.9 µg/kg) should not impact sediment-dwelling organisms, while concentrations above the PEC (28 µg/kg) frequently or always 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 1.0 to 92 µg/kg in these sediments. The TEC is 3.2 µg/kg, and the PEC is 31 µg/kg, for DDE in freshwater sediments. The DDE concentration detected at S-2 exceeded the PEC, and frequently or always had the possibility for affecting sediment-dwelling organisms.

Table 18. Pesticide residues in micrograms per kilograms, dry weight above the method detection limit found in sediment samples collected on January 28, 2013 by the SFWMD at Lake Okeechobee sampling sites (Pfeuffer 2013). The value in **bold** is above the probable effect concentration.

Site	DDD-p,p'	DDE-p,p'
S-2	16 [a]	**92**
S-3	2.1 [a]	11
S-4	BDL	1.0 [ab]

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 sampled 37 locations during WY2013 to monitor water quality in all ecological regions of Lake Okeechobee (**Figure 4**). 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 of the 2014 SFER includes a detailed evaluation of these WY2013 data. All water quality data collected at the in-lake sampling sites (**Figure 4**) was downloaded from DBHYDRO (SFWMD 2013a), as presented in Attachment B11. These records include analytical results of grab samples for the 16 water quality parameters listed in **Table 5**.

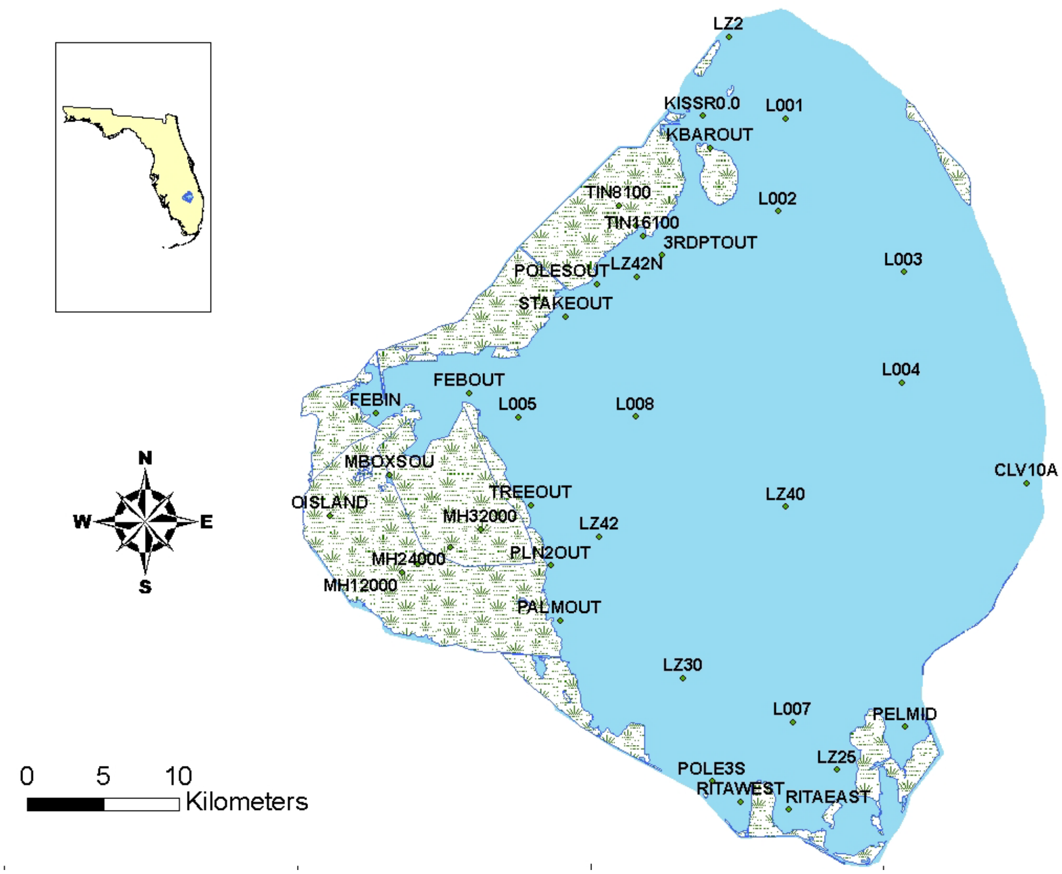

Figure 4. Active water quality monitoring stations in Lake Okeechobee.

LITERATURE CITED

Environmental Health Laboratory. 2010. Iron in Your Water. Volusia County Health Department, Daytona Beach, FL. http://www.floridahealth.gov/CHD/Volusia/EH/lab/#Iron. Accessed December 23, 2010.

FDEP. 2001. Total Maximum Daily Load for Total Phosphorus Lake Okeechobee, Florida. Prepared by the Florida Department of Environmental Protection. Submitted to the U.S. Environmental Protection Agency, Region 4, Atlanta, GA.

FDEP. 2009. Lake Okeechobee (WBIDs 3212 A-I) Evaluation of Natural Sources of Iron in Surface Water. Florida Department of Environmental Protection, Bureau of Watershed Restoration, Tallahassee, FL.

FDEP. 2012. Technical Support Document: Derivation of Dissolved Oxygen Criteria to Protect Aquatic Life in Florida's Fresh and Marine Waters (DRAFT). Florida Department of Environmental Protection, Tallahassee, FL. 196 pp.

Havens, K.E., and R.T. James. 2005. The Phosphorus Mass Balance of Lake Okeechobee, Florida: Implications for Eutrophication Management. *Lake and Reservoir Management*, 21:139-148.

James, R.T. 2011. Appendix 4-1: Annual Permit Report for Lake Okeechobee Water Control Structures Operation. In: *2011 South Florida Environmental Report – Volume III*, South Florida Water Management District, West Palm Beach, FL.

James, R.T., and K.E. Havens. 2005. Outcomes of extreme water levels on water quality of offshore and nearshore regions in large shallow subtropical lake. *Archiv für Hydrobiologie*, 163(2):25-239.

James, R.T., M.J. Chimney, B. Sharfstein, D.R. Engstrom, S.P. Schottler, T. East, and K.R. Jin. 2008. Hurricane effects on a shallow lake ecosystem, Lake Okeechobee, Florida (USA). *Fundamental and Applied Limnology*, 172:273-287.

James R.T., W. Gardner, M. McCarthy, and S. Carini. 2011a. Nitrogen dynamics in Lake Okeechobee: Forms, functions, and changes. *Hydrobiologia*. 669(1):199-212.

James R.T., K.E. Havens, P. McCormick, B. Jones and C. Ford. 2011b. Water quality trends in shallow South Florida lakes and assessment of regional vs. local forcing functions. *Critical Reviews in Environmental Science and Technol*ogy, 41(S1):576–607.

MacDonald Environmental Sciences, Ltd. and United States Geological Survey. 2003. Development and Evaluation of Numerical Sediment Quality Assessment Guidelines for Florida Inland Waters. Submitted to the Florida Department of Environmental Protection, Tallahassee, FL.

Pfeuffer, R.J. 2012a. Pesticide Surface Water Quality Report: June 2012 Sampling Event. South Florida Water Management District, West Palm Beach, FL.

Pfeuffer, R.J. 2012b. Pesticide Surface Water and Sediment Quality Report: July 2012 Sampling Event. South Florida Water Management District, West Palm Beach, FL.

Pfeuffer, R.J. 2012c. Pesticide Surface Water Quality Report October 2012 Sampling Event. South Florida Water Management District, West Palm Beach, FL.

Pfeuffer, R.J. 2013. Pesticide Surface Water and Sediment Quality Report January 2013 Sampling Event. South Florida Water Management District, West Palm Beach, FL.SFWMD. 2013a. DBHYDRO. South Florida Water Management District, West Palm Beach, FL. www.sfwmd.gov/dbhydro. Accessed July 8, 2013.

SFWMD. 2013b. Archived Daily Basin and Individual Site Rainfall. www.sfwmd.gov, under *Scientists & Engineers*, *Live Data* tab, *Rainfall Maps* link (see *Rainfall Historical*, *Monthly* sub-tab). Accessed July 24, 2012.

SFWMD, FDEP, and FDACS. 2011. Lake Okeechobee Protection Program, Lake Okeechobee Protection Plan Update. South Florida Water Management District, West Palm Beach, FL; Florida Department of Environmental Protection, Tallahassee, FL; and Florida Department of Agriculture and Consumer Services, Tallahassee, FL.

USACE. 2008. Central and Southern Florida Project – Water Control Plan for Lake Okeechobee and the Everglades Agricultural Area. U.S. Army Corps of Engineers, Jacksonville, FL. 56 pp.

U.S. Environmental Protection Agency. 1991. Pesticide Ecological Effects Database. Ecological Effects Branch, Office of Pesticide Programs, Washington, DC.

U.S, Environmental Protection Agency 1996. Drinking Water Regulations and Health Advisory. EPA 822-B-96-002, Office of Water, Washington, DC.

U.S. Environmental Protection Agency 1998. Reregistration Eligibility Decision (RED) Metribuzin. EPA 738-R-97-006, Washington, DC. February 1998.

Unsell, D. 2009. Appendix 10-1: Lake Okeechobee Operating Permit Annual Report for Water Year 2008. In: *2009 South Florida Environmental Report – Volume I*, South Florida Water Management District, West Palm Beach, FL.

Weaver, K., and G. Payne. 2005. Chapter 2A: Status of Water Quality in the Everglades Protection Area. In: 2005 South Florida Environmental Report – Volume I, South Florida Water Management District, West Palm Beach, FL.

Attachment A: Specific Conditions and Cross-References

Table A-1. Specific conditions, actions taken, and cross-references presented for the Lake Okeechobee Operating Permit (Northern Everglades and Estuaries Protection Permit Number 0174552) in this report.

Specific Condition	Description	Applicable Phase	Action Taken	**Reported in the 2014 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 [SFWMD et al., 2011])*			
				Narrative (page #s)	**Figure**	**Table**	**Attachment**
6E(3)	Operations at the S2 and S-3 Structures – Event Reporting and Coordination – After Action Reports	Operations	After action reports were submitted on 10/4/2012 and 3/18/2013. Each report was submitted within 45 days of the associated flood control backpumping event.	9		2	C, D
9A	Implementation of the Lake Okeechobee Protection Plan	Operations	Ongoing Lake Okeechobee Protection Plan implementation to meet Lake Okeechobee Total Maximum Daily Load by 2015	V1: 8-1 to 8-48	V1: 8-1 to 8-13	V1: 8-1 to 8-14	
9B	Annual compliance evaluation by region	Operations	Annual compliance evaluation (by region) completed, as required	24		14,15	
16	Annual Monitoring Report	Operations	Annual monitoring report completed and submitted, as required	ALL	ALL	ALL	ALL
16 A	Water Quality Data	Operations	Data records include all applicable laboratory information specified in Rule 62-160.340(2), Florida Administrative Code (F.A.C.)	2 – 4	1	3 – 5	B1
16 A1	Date, location, and time of sampling or measurements	Operations	Reported, as required		1		B1
16 A2	Person responsible for performing the sampling or measurements	Operations	Reported, as required				B1
16 A3	Dates analyses were performed or appropriate code as required by Chapter 62-160, F.A.C.	Operations	Reported, as required				B1
16 A4	Laboratory/person responsible for performing the analyses	Operations	Reported, as required				B1
16 A5	Analytical methods used, including method detection limits and practical quantitation limits	Operations	Reported, as required				B1
16 A6	Results of such analyses, including appropriate data qualifiers, and all compounds detected	Operations	Reported, as required				B1
16 A7	Depth of sampling (for grab samples)	Operations	Reported, as required				B1

Table A-1. Continued.

Specific Condition	Description	Applicable Phase	Action Taken	**Reported in the 2014 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 [SFWMD et al., 2011])*			
				Narrative (page #s)	**Figure**	**Table**	**Attachment**
16 A8	Flow conditions and weather conditions at time of sample collection	Operations	Reported, as required				B1
16 A9	Monthly flow volumes	Operations	Monthly flow volumes reported, as required	9	2	6 – 7	
16 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	16 – 30		9 –18	B4 – B11
16 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	15 – 23		9 –13	B4 – B8
16 B2	The permittee shall determine the annual total phosphorus loading to Lake Okeechobee	Operations	Total phosphorus loads calculated and included,as required	24; V1: 8-27 to 8-34,8-51 to 8-54	V1: 8-16 to 8-18	14 – 16; V1: 8-4,8-6, 8-8, 8-16	
16 B3	The permittee shall report the five-year rolling average of phosphorus loading to Lake Okeechobee	Operations	Five-year rolling average total phosphorus loads included, as required	24; V1: 8-27		15, V1: 8-4	
16 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	28 – 30		17 – 18	B9, B10
16 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: 8-48 to 8-54	4; V1: 8-14, 8-16 to 8-20	V1: 8-15 to 8-17	B11
21	Permit Modifications for the 3-Year Update to the Lake Okeechobee Protection Plan	Operations	Modification 0174552-010 in effect. Procedure to authorize structure improvements and maintenance added (3c). Also includes changes in responsible persons, programs, offices, and regulation schedule.	1; LOPP			

Attachment B: Water Quality and Hydrologic Data

This project information is required by Specific Condition 16 of the Lake Okeechobee Operating Permit (0174552-010), and is available upon request.

Attachment C: Lake Okeechobee S-2 and S-3 Backpumping After Action Report for August 27–September 5, 2012

This report was submitted by the SFWMD to the FDEP on October 4, 2012, in accordance with Specific Condition 6E(3) of the Lake Okeechobee Operating Permit (0174552-010), and is available upon request.

Attachment D: Lake Okeechobee S-2 Backpumping After Action Report for February 15–16, 2013

This report and associated data were submitted by the SFWMD to the FDEP on March 18, 2013, in accordance with Specific Condition 6E(3) of the Lake Okeechobee Operating Permit (0174552-010), and are available upon request.