Appendix 3-1: Annual Permit Report for the Everglades Stormwater Treatment Areas

Permit Report (May 1, 2013–April 30, 2014)

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SUMMARY

As part of Everglades restoration, the construction and operation of large freshwater treatment wetlands are mandated by the Everglades Forever Act (EFA) (Chapter 373.4592, Florida Statutes). These wetlands, known as the Everglades Stormwater Treatment Areas (STAs), have been constructed south of Lake Okeechobee as part of the Everglades water quality restoration efforts (www.sfwmd.gov/sta) to remove excess total phosphorus (TP) from surface waters prior to entering the Everglades Protection Area (EPA) (**Figure 1**). The total area of the STAs including infrastructure components is approximately 68,000 acres, with approximately 57,000 acres of effective treatment area currently authorized to operate under an EFA permit issued by the Florida Department of Environmental Protection (FDEP) in September 2012.

The Everglades STAs [STA-1 East (STA-1E), STA-1 West (STA-1W), STA-2, STA-3/4, STA-5/6] (**Figure 2**) operate pursuant to EFA and National Pollutant Discharge Elimination System (NPDES) permits and their associated Consent Orders (COs). This appendix serves as the reporting mechanism for requirements contained in those permits and COs for the STAs during Water Year 2014 (WY2014) (May 1, 2013–April 30, 2014). The detailed annual report for the Everglades STAs is presented in this appendix and Volume I, Chapter 5B.

Based on 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.

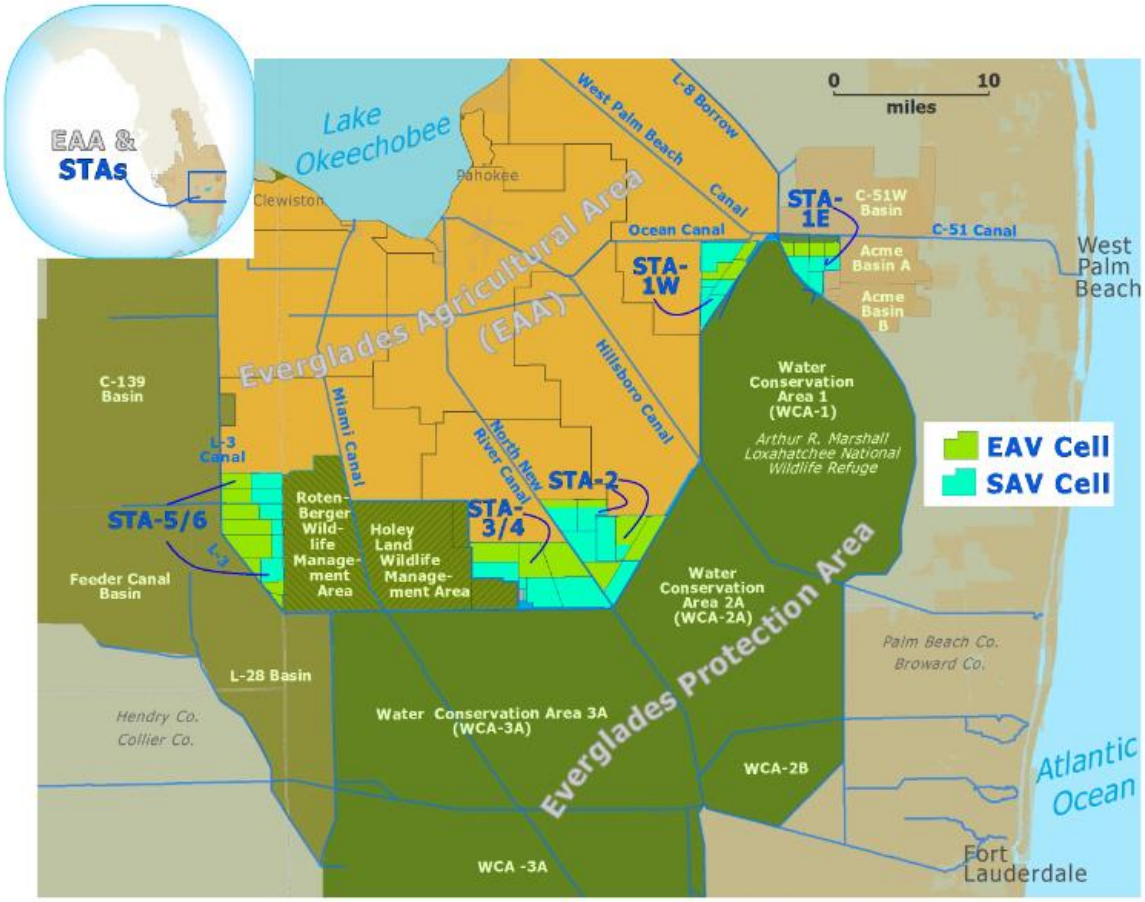

Figure 1. Location of the Everglades STAs.

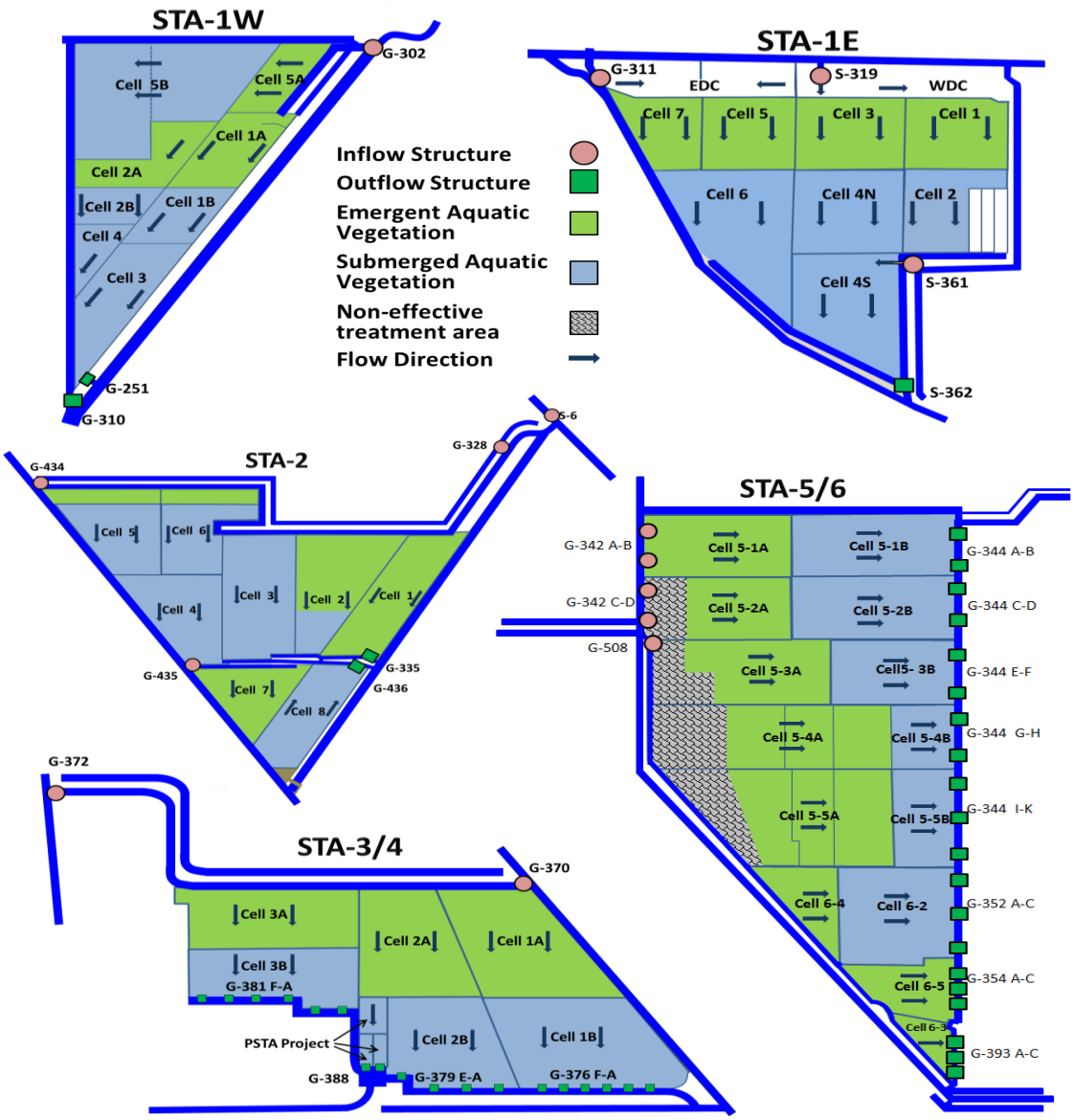

Figure 2. STA schematics showing configuration of treatment cells, flow direction, dominant vegetation type, and locations of inflow and outflow structures.

Table 1. Key permit-related information.

Project Name:	Everglades Construction Project
Permit Numbers:	0311207 (EFA), FL0778451 (NPDES), Consent Order-OGC FILE NO.12-1149 (EFA) and OGC FILE NO. 12-1148 (NPDES)
Issue and Expiration Date:	Issued: 9/10/2012; Expires: 9/9/2017 (EFA & NPDES)
Project Phase:	Operation
Permit Specific Condition Requiring Annual Report:	25
Reporting Period:	May 1, 2013–April 30, 2014
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Table 2. Attachments included with this report.

Attachment	Title
A	Specific Conditions and Cross-References
B	Water Quality Data
C	Annual Permit Compliance Monitoring Report for Mercury in the STAs
D	Rotenberger Wildlife Management Area Restoration and STA Downstream Transect Monitoring
E	STA Herbicide Application Summary for Water Year 2014
F	Annual Permit Compliance Monitoring Report for Other Toxicants in the STAs

INTRODUCTION

In 1994 the EFA authorized the Everglades Agricultural Area (EAA) Best Management Practices (BMPs) and the Everglades STAs. As a major component of Everglades restoration, the STAs are intended to remove excess TP from surface waters prior to those waters entering the EPA. STAs are constructed wetlands that retain nutrients through several mechanisms including plant growth, accumulation of dead plant material in a layer of peat, settling and sorption, precipitation, and microbial activities.

This appendix reports on the permit compliance aspect of the Everglades STAs: STA-1E, STA-1W, STA-2, STA-3/4, and STA-5/6 (**Figures 1** and **2**). The STAs operate under EFA, NPDES permits and COs. Varying in size, configuration, and period of operation, the STAs are shallow freshwater marshes divided into treatment cells by interior levees. Water flows through these systems via water control structures, such as pump stations, gates, or culverts. The dominant plant communities in the treatment cells are broadly classified as emergent aquatic vegetation (EAV), submerged aquatic vegetation (SAV), and floating aquatic vegetation (FAV). Both native and nonnative vegetation play a role in phosphorus removal in the STAs. Vegetation management activities include control of undesirable species that impact the hydraulics.

This appendix summarizes STA performance during WY2014 to fulfill various permit reporting mandates for total phosphorus and other water quality parameters, including dissolved oxygen (DO), mercury (Hg) and other toxicants, and other nutrients and major ions. Attachments A through F provide supplementary information for this report (**Table 2**).

STA PERFORMANCE

This section presents the annual data required by STA operating permits, COs, and downstream monitoring. A cross-reference listing for the permit reporting requirements is presented in Attachment A. The District performed all sampling and analysis in compliance with Chapter 62-160, F.A.C., and the District's Laboratory Quality Manual (SFWMD, 2013a) and Field Sampling Quality Manual (SFWMD, 2013b). Water quality data are provided in Attachment B. The annual permit compliance monitoring report for mercury in the STAs is presented in Attachment C.

PERMIT STATUS AND REPORTING REQUIREMENTS

Permit Compliance for Phosphorus

As part of the permit compliance for phosphorus, annual STA performance will not be evaluated for compliance with the water quality-based effluent limitation (WQBEL) until all CO corrective actions are completed. Until such time, only comparisons with the WQBEL will be made (see **Table 3** and **Figure 3**. The reader is referred to CO OGC FILE NO. 12-1149 accompanying EFA Permit 0311207 for more information. The WQBEL was developed to be protective of the EPA and allow for the achievement of the phosphorus criterion established in Rule 62-302.540, Florida Administrative Code (F.A.C.). The criterion, and therefore the WQBEL, was based on the best available science and the understanding of the biogeochemical processes of the receiving water body at the time the criterion was adopted.

The WQBEL consists of two components (1) a maximum TP annual flow-weighted mean (AFWM) of 19 parts per billion (ppb) in any water year; and, (2) a TP long-term flow-weighted mean (LTFWM) of 13 ppb not to be exceeded in more than three out of five water years on a

rolling basis. The term AFWM means the annual flow-weighted mean for all of the combined outflow structures for an individual STA.

Any factors or activities that impacted the STAs treatment capabilities are noted in **Table 4.** STA performance for WY2014 is presented in **Tables 5** and **6. Table 5** shows the total volume, flow, and flow-weighted mean results for each STA during WY2014. **Table 6** shows the annual flow, load, and flow-weighted mean results for each permitted site by STA. The information fulfilling the permit-related reporting requirement for the amount of water diverted around the STAs in WY2014 is presented in **Table 7**.

Table 3. Total Phosphorus Annual Flow-Weighted Mean Outflow Concentrations for Water Years 2010-2014[1].

Water Year [2]	Facility						
	STA-1E	STA-1W	STA-2	STA-3/4	STA-5/6 [3]	STA-5	STA-6
2010	*94*	*40*	*37*	15	*51*	*52*	*49*
2011	*22*	*25*	15	16	*31*	*47*	*25*
2012	*21*	*22*	12	19	*40*	*32*	*75*
2013	*26*	*36*	*22*	14	17		
2014	*41*	*24*	19	14	*23*		

[1] Determination of compliance with the WQBEL will begin after construction of all corrective actions, estimated to occur in 2024.

[2] A water year begins May 1 and ends April 30. For example, Water Year 2014 is from May 1, 2013 through April 30, 2014.

[3] With the completion of Compartment C, STAs 5 and 6 are considered one facility (STA-5/6) under the permits issued September 10, 2012. STA-5 and STA-6 data were combined to provide a single tracking value for water year starting with 2013.

Values 13 ppb or less are in black; values greater than 13 ppb and less than or equal to 19 ppb are in orange; values greater than 19 ppb are in red.

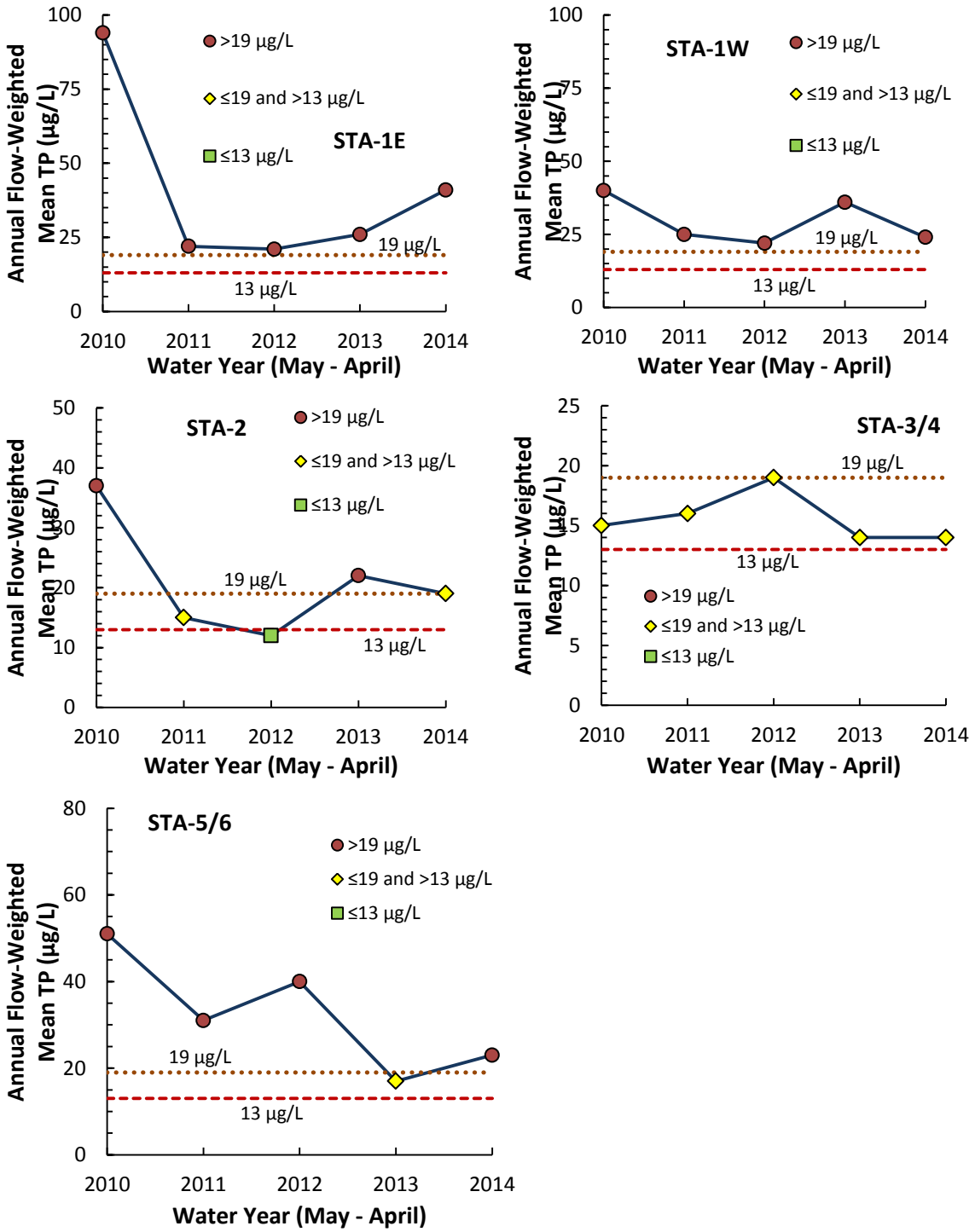

Figure 3. Annual flow-weighted TP concentrations for combined outflows of each STA compared to the WQBEL Two-Part Criteria. The two reference lines shown on the plots above identify the long-term (13 micrograms per liter [µg/L]) and the annual (19 µg/L) limits of the WQBEL.

Table 4. Factors/activities impacting STA treatment capabilities.

STA	Long-Term Plan Enhancements	Recovery	Maintenance	Outside of Agency Control
STA-1E		Recovery of SAV in Cell 6 continued into WY2014 and southern naiad has replaced Hydrilla over most of the cell. Plantings of giant bulrush improved emergent plant cover in Cell 7.	Giant bulrush planted in Cells 4N and 7. Mechanical harvesting of 13 acres of floating mats in Cell 7. Inoculations of southern naiad in Cells 4S, 4N and 6. Aerial herbicide treatment of willow and primrose willow in Cell 1.	Eastern flow-way remains offline due to activities associated with decommissioning of the United States Army Corps of Engineers (USACE) Periphyton-Based Stormwater Treatment Area (PSTA) Demonstration Project. Numerous culvert repairs were made throughout the STA and S-362 trash rake structure repairs were completed in May 2013. Initially, the L-8 FEB project will function as a multipurpose FEB to capture, store, and deliver stormwater runoff to STA-1E, STA-1W, and the Loxahatchee River. After the STA-1W expansion is complete and the in-basin storage project for the Loxahatchee River is complete, the L-8 FEB project will transition to primarily storing runoff and delivering flows to optimize treatment performance of STA-1E and STA-1W. Structure repairs are projected to be completed by Oct. 2016. Performance of the western flow way of STA-1E has been impacted by topographic deficiencies and deep water conditions in Cells 5 and 7. Control of floating plants in Cell 4N was limited by snail kite nesting from Jan. through Sep. 2013, and from March 2014 through the end of FY14.
STA-1W			Giant bulrush planting in Cells1A, 1B, 2B, 4 and 5B. Planting of Thalia in hydraulic short circuit in Cell 1A and 5A. Inoculations of southern naiad in Cells 2B, 3, and 4.	
STA-2	Cell 2 vegetation conversion was initiated in WY2010 and continued in WY2014.	Reestablishment of SAV in Cell 4, which had dried out during Comp B construction.	Short circuit blocked with Thalia and giant bulrush plantings in Cell 3. Incremental conversion of SAV in cell 5, 6, and 8. Inoculation of southern naiad in Cells 2, 5, 6, and 8. Aerial herbicide treatment of willow and primrose willow in Cells 5 and 6. Giant bulrush and Thalia planting in graded portion of Cell 8. Cells 7 and 8 make up Flow-way 5 of the South Build-out (SBO) and were part of the Compartment B Build-out Project. Efforts to address high ground surface elevations over an area of approximately 50 acres at the north end of Cell 8 began in January 2014 and were completed in April 2014. The cell remains offline for vegetative grow-in.	
STA-3/4			Plantings of giant bulrush to enhance emergent cover in Cell 1A and 2A, inoculation of Valisneria in Cells 1B and 3B, inoculation of southern naiad in Cell 2B. Aerial herbicide treatment of cattail in Cells 1B and 2B.	
STA-5/6			Herbicide applications to reduce cover of willow and primrose willow in emergent cells (Cells 1A, 2A, 3A, 4A, 5A, and 6-4), water lettuce in Cell 4A, and cattail in 5B. Herbicide treatments to eliminate exotic plants from the non-effective treatment areas of Cells 4A and 5A of Compartment C. Inoculations of southern naiad in Cell 3B and southern naiad and chara in Cell 4B. Plantings of giant bulrush to close gaps in emergent vegetation strips in Cells 1B, 2B, and 4B and to enhance emergent cover in Cell 1A.	Flow-ways 6, 7, and 8 were in dryout conditions from April 10, 2014 through June 24, 2014. Dryout conditions are realized when there is no longer an existing connection of water between each sampling area and its associated cell. This implies that the samples to be collected at compliance stations would be from isolated pools of water; therefore, data of this type is only representative of the surface water directly adjacent to the structure being samples, not the cell as a while.

Table 5. STA performance for WY2014.

	STA-1E	STA-1W	STA-2	STA-3/4	STA-5/6	All STAs
			Inflow			
Total Inflow Volume (acre-feet)	127,469	227,633	376,122	467,461	103,113	1,301,797
Total Inflow TP Load (metric tons)	26.026	48.835	39.893	41.183	25.145	181.081
AFWM Concentration Inflow TP (ppb)	166	174	86	71	198	113
			Outflow			
Total Outflow Volume (acre-feet)	124,518	241,103	402,474	466,010	105,656	1,339,760
Total Outflow TP Load (metric tons)	6.325	7.046	9.626	8.302	2.985	34.283
FWM Outflow TP (ppb)	41	24	19	14	23	21
TP Retained (metric tons)	**19.702**	**41.789**	**30.267**	**32.880**	**22.160**	**146.798**

Table 6. STA annual performance by station for WY2014

STA	Flow Structures Represented	WQ Station Name	Annual Flow (acre-feet)	Annual TP-Load (metric tons)	AFWM TP (ppb)
STA-1E	S-319 (inflow)	S-319 (inflow)	55,271	13.686	201
	G-311 (inflow)	G-311 (inflow)	61,475	11.622	153
	S-361 (inflow)	S-361 (inflow)	10,724	0.719	54
	S-362 (outflow)	S-362 (outflow)	124,518	6.325	41
STA-1W	G-302 (inflow)	G-302 (inflow)	227,633	48.835	174
	G-251 (outflow)	G-251 (outflow)	32,531	0.785	20
	G-310 (outflow)	G-310 (outflow)	208,572	6.260	24
STA-2	S-6 (inflow)	S-6 (inflow)	264,338	32.070	98
	G-328 (inflow)	G-328 (inflow)	39,531	1.900	39
	G-434 (inflow)	G-434 (inflow)	57,544	5.130	72
	G-435 (inflow)	G-435 (inflow)	10,345	0.763	60
	Additional (Inflows)[1]	Additional (Inflows)[1]	4,363	0.030	6
	G-335 (outflow)	G-335 (outflow)	170,789	3.747	18
	G-436 (outflow)	G-436 (outflow)	231,686	5.879	21
STA-3/4	G-370 (inflow)	G-370 (inflow)	143,414	16.017	91
	G-372 (inflow)	G-372 (inflow)	324,047	25.165	63
	G-376A-C (outflow)	G-376B (outflow)	110,507	1.694	12
	G-376D-F (outflow)	G-376E (outflow)	82,909	1.368	13
	G-379A-C (outflow)	G-379B (outflow)	56,799	1.717	25
	G-379D-E, G-388 (outflow)	G-379D (outflow)	24,430	0.546	18
	G-381A-B (outflow)	G-381B (outflow)	100,083	1.499	12
	G-381C-F (outflow)	G-381E (outflow)	91,282	1.480	13
STA-5/6	G-342A (inflow)	G-342A (inflow)	12,065	2.750	185
	G-342B (inflow)	G-342B (inflow)	13,609	2.264	135
	G-342C (inflow)	G-342C (inflow)	12,584	2.248	145
	G-342D (inflow)	G-342D (inflow)	12,029	3.772	254
	G-406 (inflow)	G-406 (inflow)	2,530	0.190	61
	G-508 (inflow)	G-508 (inflow)	47,958	13.476	228
	Additional (Inflows)[2]	Additional (Inflows)[2]	2,338	0.445	154
	G-344A (outflow)	G-344A (outflow)	11,217	0.202	15
	G-344B (outflow)	G-344B (outflow)	11,000	0.236	17
	G-344C (outflow)	G-344C (outflow)	15,758	0.346	18
	G-344D (outflow)	G-344D (outflow)	9,912	0.219	18
	G-344E (outflow)	G-344E (outflow)	1,692	0.077	37
	G-344F (outflow)	G-344F (outflow)	1,624	0.061	30
	G-344G (outflow)	G-344G (outflow)	9,768	0.337	28
	G-344H (outflow)	G-344H (outflow)	8,010	0.288	29
	G-344I - K (outflow)	G-344I - K (outflow)	689	0.025	30
	G-352A-C (outflow)	G-352B (outflow)	28,247	0.987	28
	G-354A-C (outflow)	G-354C (outflow)	6,097	0.180	24
	G-393A-C (outflow)	G-393B (outflow)	1,643	0.027	13

[1] Additional inflows G328I, G338, and G339 will be added or subtracted depending on direction of flow to get the total inflow
[2] Additional inflows G342O and G407 will be added or subtracted depending on direction of flow to get a total inflow.

Table 7. Information fulfilling the permit-related reporting requirement for the amount of water diverted around the STAs in WY2014.

STA	Structure	A. Low Flow Water Supply			B. Other Diversion*		
		Low Flow Water Supply, Gate Maintenance, etc.			*Flood Control, Avoid Substantial Damage to Treatment Facilities, Conflicts with Endangered Species Act, Migratory Bird Treaty Act, and Other Federal Species Protection Requirements*		
		Volume (acre-feet)	TP Load (metric tons)	FWM TP (ppb)	Volume (acre-feet)	TP Load (metric tons)	FWM TP (ppb)
STA-1E	G-300	--	--	--	9,530	3.845	327
	Total	--	--	--	9,530	3.845	327
STA-1W	G-301	--	--	--	5,108	2.051	325
	Total	--	--	--	5,108	2.051	325
STA-2	G-338	4	0.001	267	--	--	--
	G-339	11	0.001	62	--	--	--
	Total	15	<0.0001	62	----	----	----
STA-3/4	G-371	3	<0.0001	47	--	--	--
	G-373	4	<0.0001	41	2,752	0.255	75
	Total	7	<0.0001	44	2,752	0.255	75
STA-5/6	G-407	1	<0.0001	46	----	----	----
	Total	1	<0.0001	46	----	----	----
All STAs	**Total**	**23**	**0.003**	**90**	**17,390**	**6.151**	**287**

*Diversion due to Tropical Storm Andrea (June 2013).

Water Quality Parameters Other Than Phosphorus

In addition to TP, the District is required to monitor other water quality parameters in the STAs (EFA Permit Table 2). Of these parameters, those with applicable Florida Class III water quality standards are shown in **Table 8.**

Table 8. Water quality parameters with Florida Class III criteria specified in Sections 62-302.530 and 62-302.533 (Dissolved Oxygen), F.A.C.

Parameter	Units	Florida Class III Criteria [a]
Dissolved Oxygen	%	Not more than 10 percent of daily average percent dissolved oxygen (DO) saturation values less than 38 percent saturation.
Specific Conductance	µS/cm	Not > 50 percent of background or > 1,275 µS/cm, whichever is greater
pH	SU	Not < 6.0 or > 8.5
Alkalinity	mg $CaCO_3$/L	Not < 20 mg/L

mg/L – milligrams per liter; µS/cm – microsiemens per centimeter; SU – standard units; mg $CaCO_3$/L – milligrams calcium carbonate per liter

[a] Because the STAs are freshwater systems, the background concentration for specific conductance is assumed to be less than 1,275 µS/cm.

Of the parameters listed in Table 2 of the permit, Specific Condition 17 requires that alkalinity, specific conductance, total nitrogen, nitrate + nitrite (NO_x), and sulfate measured at STA outflows and inflows be evaluated to determine compliance.

Water Year 2014 Performance

There were no observations of alkalinity at any of the STA outflows below the state Class III standard (20 mg/L).

For water quality parameters that do not have a Florida Class III standard, excursions are noted when the annual outflow FWM concentrations are higher than the annual inflow FWM concentrations. An STA may have individual excursions from the standard yet be in overall compliance with the permit if it meets the remaining components of the EFA three-part assessment.

WY2014 monitoring data for permitted water quality parameters other than TP at the STA inflows and outflows are included in Attachment B. Annual FWM concentrations at inflows and outflows of the STAs, including excursion analysis, are summarized in **Table 9**. During WY2014, no excursions occurred at any of the STAs. Also, none of these annual FWM concentrations measured at the outflows of each STA exceeded the Class III criteria and were lower than the corresponding STA inflow annual FWM concentrations.

Inflow and outflow FWM concentrations were compared statistically with a significance level (α) of 0.05. The Shapiro-Wilk test of normality was used to determine if data sets deviated significantly from normality. Those data sets that did not deviate significantly from a normal distribution (i.e., $p > 0.05$) were analyzed using the Student's t-test. Data sets that deviated

significantly from normality ($p < 0.05$) were tested using the Mann-Whitney U test (a non-parametric equivalent of the Student's t-test).

During WY2014, 20 data sets did not deviate from normal distribution and five data sets did show deviation. Therefore, both the Mann-Whitney U and Student's t-test were used to compare the inflow and outflow FWM concentrations accordingly. These statistical comparisons are summarized in **Table 10** by parameter and STA. Of the 25 data sets evaluated, ten comparisons exhibited statistically significant differences between inflow and outflow FWM concentrations. For all ten data sets, inflow FWM concentrations were significantly higher than outflow FWM concentrations.

Table 9. Summary of annual FWM concentrations of parameters other than TP for inflow and outflow of the STAs during WY2014.

Storm Water Treatment Areas	**Annual Flow-Weighted Mean[a]**			
Parameters	**Inflow**		**Outflow**	
	No. Obs.[b]	**Results**	**No. Obs.[b]**	**Results**
STA-1E				
Specific Conductance (µS/cm)	77 (156)	899	36 (52)	788
Dissolved Sulfate (mg/L)	70 (109)	58.7	18 (26)	47.8
Total Alkalinity (mg $CaCO_3$/L))	70 (109)	192.35	18 (26)	175.51
Nitrate+Nitrite (mg N/L)	70 (109)	0.295	18 (26)	0.144
Total Nitrogen (mg/L)	70 (109)	2.23	18 (26)	1.59
STA-1W				
Specific Conductance (µS/cm)	27 (52)	993	68 (104)	929
Dissolved Sulfate (mg/L)	22 (34)	75.4	49 (72)	70.8
Total Alkalinity (mg $CaCO_3$/L))	22 (34)	239.62	49 (72)	208.94
Nitrate+Nitrite (mg N/L)	22 (34)	1.064	48 (71)	0.207
Total Nitrogen (mg/L)	22 (34)	3.65	49 (72)	2.17
STA-2				
Specific Conductance (µS/cm)	88 (209)	1146	101 (105)	1025
Dissolved Sulfate (mg/L)	78 (130)	69.8	51 (52)	52.8
Nitrate+Nitrite (mg N/L)	78 (130)	0.714	51 (52)	0.029
Total Nitrogen (mg/L)	78 (130)	3.17	51 (52)	2.01
STA-3/4				
Specific Conductance (µS/cm)	49 (100)	980	191 (350)	877
Dissolved Sulfate (mg/L)	51 (93)	68.5	187 (259)	60.8
Nitrate+Nitrite (mg N/L)	51 (93)	1.645	162 (232)	0.105
Total Nitrogen (mg/L)	51 (93)	3.79	187 (259)	1.93
STA-5/6				
Specific Conductance (µS/cm)	119 (316)	467	161 (706)	443
Dissolved Sulfate (mg/L)	113 (182)	9.5	142 (239)	3.4
Nitrate+Nitrite (mg N/L)	113 (182)	0.069	140 (236)	0.006
Total Nitrogen (mg/L)	113 (182)	1.74	144 (243)	1.34

mg/L – milligrams per liter; µS/cm – microsiemens per centimeter; mg $CaCO_3$/L – milligrams calcium carbonate per liter
mg N/L – milligrams nitrogen per liter.

[a] Annual flow-weighted means are computed for inflows and outflows by combining the data from individual stations

[b] Total number of samples collected with flow (total number of samples collected regardless of flow)

Table 10. Statistical comparison of monthly FWM concentrations at inflows and outflows of the STAs for other water quality parameters for WY2014.

Parameter Name	Variables	Storm Water Treatment Areas				
		STA1E	STA-1W	STA-2	STA-3/4	STA-5/6
Alkalinity	p-Value	0.646	0.341	NA	NA	NA
	Structure	Inflow	Inflow	NA	NA	NA
	Statistical Test	2-Sample t-Test	2-Sample t-Test	NA	NA	NA
Nitrate+Nitrite	p-Value	0.056	***0.002***	***<0.001***	***<0.001***	***0.013***
	Structure	Inflow	***Inflow***	***Inflow***	***Inflow***	***Inflow***
	Statistical Test	Mann-Whitney	***Mann-Whitney***	***Mann-Whitney***	***Mann-Whitney***	***Mann-Whitney***
Specific Conductance	p-Value	0.596	0.642	0.801	0.269	0.622
	Structure	Inflow	Inflow	Inflow	Inflow	Inflow
	Statistical Test	2-Sample t-Test	2-Sample t-Test	2-Sample t-Test	2-Sample t-Test	Mann-Whitney
Sulfate	p-Value	0.861	0.138	0.332	0.507	***0.009***
	Structure	Inflow	Inflow	Inflow	Inflow	***Inflow***
	Statistical Test	2-Sample t-Test	2-Sample t-Test	2-Sample t-Test	2-Sample t-Test	***Mann-Whitney***
Total Nitrogen	p-Value	0.166	0.162	0.083	0.114	0.783
	Structure	Inflow	Inflow	Inflow	Inflow	Inflow
	Statistical Test	Mann-Whitney	2-Sample t-Test	2-Sample t-Test	2-Sample t-Test	2-Sample t-Test

[a] Probability level (p-value) computed using appropriate comparison test. A significance level (α) of 0.05 was used. When p-value was less than 0.05, the parameter concentrations were significantly different between the inflow and outflow. Significant p-values are presented in the table as italicized and bolded values.

[b] STA structure group (pooled inflow or pooled outflow) exhibiting higher parameter concentrations during the water year.

[c] Statistical test used to compare inflow and outflow water quality data. Choice of test was based on distributional assumptions. If the distribution of data did not significantly deviate from normality, the Student t test (t Test) was used. When the distribution of data deviated significantly from normality, the Mann-Whitney test (non-parametric equivalent) was used.

Dissolved Oxygen

STA outflow DO concentrations are evaluated for compliance with the State water quality standard. The DO criteria for Class III surface waters (that includes the Everglades Protection Area), established more than 30 years ago, had been 5.0 milligrams per liter (mg/L). DO concentrations below 5.0 milligrams per liter (mg/L) occur commonly throughout the EPA, including interior marsh sites minimally impacted by nutrient enrichment or cattail invasion. Frequent DO levels below 5.0 mg/L, however, are typical in macrophyte-dominated wetlands where photosynthesis and respiration result in wide diel swings in DO levels. FDEP conducted a study in 2005-2006 that confirmed DO concentrations in minimally disturbed water bodies did not relate well to the 5 mg/L criterion. A new standard was developed based on percent saturation rather than concentration, in part because percent saturation accounts for the inherent relationship between temperature and DO. The new DO standard became effective during Water Year 2014 (August 2013): *no more than 10 percent of the daily average percent DO saturation (% DO) values shall be below 38 percent in the Everglades Bioregion* (62-302.533, F.A.C.) for data collected throughout the day (diel monitoring data). For single measurements (grab samples) such as what takes place in the STAs, there is a provision for a "time-of-day" adjustment of the daily average criterion (FDEP 2013). The new DO standard was applied to STA outflow DO concentration data for the entire WY2014.

Despite the change to the DO State water quality standard for Class III waters, the Everglades Marsh DO Site Specific Alternative Criteria (SSAC) remains unchanged. The SSAC, used to evaluate DO levels at marsh monitoring locations in the Everglades Protection Area, was approved by the U.S. Environmental Protection Agency as a revision to the State of Florida's water quality standards in 2004. Because low DO concentrations often measured in the EPA represent natural variability in this type of ecosystem, the FDEP, pursuant to Subsection 62-302.800(1), F.A.C., promulgated a SSAC for DO in the Everglades. This SSAC addresses the natural fluctuations that influence background DO levels. Weaver et al. (2008) explains the SSAC and its development and application in assessing DO excursions. The specific methods for determining compliance are set forth in the DO SSAC (Weaver and Payne, 2004).

Previous reports (Jorge et al., 2002; Goforth et al., 2003, 2004, 2005; Pietro et al., 2006, 2007) provided monitoring results, comparisons, and evaluations for diel DO in the STAs. These reports were used to assess the impact of STA discharges on the downstream Everglades ecological system or downstream water quality with respect to DO and pursuant to EFA permits and associated administrative orders for STA-1E, STA-1W, STA-2, STA-3/4, and STA-5/6. These reports also provided data to the FDEP for developing the DO SSAC. DO SSAC comparisons have been used to assess the STAs (except STA-5/6) since WY2007 (Pietro et al., 2008). STA-5/6 did not have a diel DO permit requirement when the DO SSAC was adopted.

With respect to DO, the EFA permit also requires the District to evaluate whether STA discharges may have influenced Everglades Marsh sites that were not in compliance with the DO SSAC. Compliance with the DO SSAC at marsh stations is analyzed in Volume I, Chapter 3A. The analysis and discussion of marsh stations out of compliance and possibly influenced by an STA's discharge, using existing and historical facility and marsh data is presented later in this section.

SUMMARY AND ANALYSIS

Biweekly grab sample DO concentration measurements at STA discharge structures during WY2014 are provided in Attachment B. A summary of annual DO concentrations and percent saturation for individual structure and for each STA are shown in **Table 11**. In addition, the percent saturation criteria and percentage of samples exceeding the criteria are shown in **Table 11**.

The method for determination of compliance with the new DO water quality standard is as follows: the percent DO saturation is calculated from each sample based on measured DO concentration and temperature (DO observations). An adjustment to the 38 percent saturation value based on the time of day each sample was collected (adjusted criterion values) and pairwise comparisons are made between DO observations and adjusted criteria values. The percentage of DO observations throughout the year less than the corresponding criteria values is then determined for compliance.

The values in the "Calculated Dissolved Oxygen Criteria" column are shown to indicate by how much the DO saturation percentage was adjusted from the standard (38 percent) based on the time of day samples were taken and cannot be used to directly determine whether an outflow structure was in compliance. The percentage of DO observations less than the DO saturation criterion values is shown for each outflow structure and STA is shown in the "Percent Excursion from Criteria" column. Any value greater than 10 percent in this column indicates the structure or STA is not in compliance with the criteria.

From **Table 11**, STA-1E (structure S-362) was the only facility in compliance with the new DO water quality standard: two percent of the observed DO percent saturation values were less than the standard—much less than the 10% allowed by the criteria. The calculated dissolved oxygen criteria value of 40.2% reflects an average adjustment of 2.2% saturation made to the 50 observations at S-362 because of the time of day each sample was collected. More than half of the observations from STA-5/6 (57.9%), 37% from STA-1W, 17.7% from STA-3/4, and 14% from STA-2 were less than the standard—all in exceedance of the criteria.

Lower DO saturation at outflow structures is often associated with prolonged periods of stagnant (zero-flow) conditions. For example, at the two STA-1W outflow structures G-251 (collocated with water quality station ENR012) and G-310, the annual average DO saturation at G-251 was 30.4% while discharging only 32,500 acre-feet of water compared to G-310 where the comparable DO saturation value was over 67% with more than six times the G-251 volume discharged (208,600 acre-feet).

As shown in Volume I, Chapter 3A, seven interior sampling locations within the EPA failed the DO SSAC in WY2014: five within the Refuge (LOX4, LOXA105, LOXAZ1, LOXAZ2, and X1), one in WCA-2 (WCA2F1), and one in WCA-3 (CA318). All marsh stations in ENP met the annual DO SSAC limit.

Refuge marsh station LOX4 is approximately 3.6 km from STA-1E outflow structure S-362 and approximately 1 km from the rim canal. Although this is the first time in the last five years this unimpacted site failed to meet the DO SSAC limit, it is not likely it is the result of S-362 discharge since DO at S-362 met the water quality standard. Furthermore, intervening stations LOXA135 (in the rim canal just downstream of S-362), LOXA136, and LOXA137 (approximately 0.6 km and 1.1 km from the rim canal downstream of S-362) all passed the DO SSAC limit.

Refuge marsh station LOXA105 is approximately one km from STA-1W outflow structures G-310 and G-251 and approximately 0.7 km from the rim canal. This impacted site failed the DO SSAC limit in three of the past five years. Discharge from the STA-1W outflow structures is not the likely cause of the failure of station LOXA105 to meet the DO SSAC limit in WY 2014. Structure G-310, which discharged 87 percent of the STA-1W outflow in WY 2014 had a mean DO concentration of 5.56 mg/L and was in compliance with the State water quality standard. Also, intervening marsh station LOXA104.5 passed the DO SSAC limit.

Refuge marsh stations LOXAZ1 and LOXAZ2 are both more than 14 km south of STA-1W outflow structures. Station LOXAZ1 failed the DO SSAC limit in four of the past five years;

station LOXAZ2 failed in three of the last five years. Failure to meet the DO SSAC limit at these two stations is not likely due to STA discharges.

Refuge marsh station X1, approximately 12 km south of STA-1W outflow structures and approximately 260 meters from the rim canal did not pass the DO SSAC limit; however, this was based on only one DO sample.

WCA-2 impacted site WCA2F1 failed to meet the DO SSAC limit in each of the previous five years. Due to its remote location from STA-2 outflow structures it is unlikely that discharge from STA-2 contributed to this condition. Similarly in WCA-3, the failure of marsh station CA318 to meet the DO SSAC limit for the last three consecutive years is not likely due to STA discharge due to its remote location (more than 40 km) from the outflow structures.

Table 11. Annual DO concentrations, percent saturation criteria and percent excursion from criteria at outflow stations for each STA as well as across the entire STA.

STA	Outflow Structures	No. of Obs.	Dissolved Oxygen		Calculated Dissolved Oxygen Criteria[1]	Percent Excursion from Criteria
			Mean ± St. Deviation[2]			
			(mg/L)	% Saturation	% Saturation	
STA-1E	S362	50	5.30 ± 1.58	64.8% ± 17.0%	40.2% ± 1.8%	2.0%
STA-1W	ENR012	50	2.49 ± 1.47	30.4% ± 19.1%	34.8% ± 1.3%	68.0%
	G310	50	5.56 ± 1.71	67.3% ± 19.4%	33.7% ± 0.8%	6.0%
	All	100	4.03 ± 2.21	48.9% ± 26.7%	34.3% ± 1.2%	37.0%
STA-2	G335	49	4.43 ± 1.35	53.2% ± 15.0%	36.3% ± 1.1%	12.2%
	G436	51	4.22 ± 1.27	50.6% ± 14.0%	35.6% ± 1.4%	15.7%
	All	100	4.32 ± 1.31	51.9% ± 14.5%	35.9% ± 1.3%	14.0%
STA-3/4	G376B	49	3.93 ± 1.16	47.1% ± 13.0%	36.3% ± 0.9%	18.4%
	G376E	49	3.99 ± 1.20	48.1% ± 14.4%	37.2% ± 1.1%	18.4%
	G379B	49	4.12 ± 1.06	49.6% ± 11.0%	38.0% ± 1.2%	14.3%
	G379D	49	4.32 ± 1.14	52.5% ± 12.7%	38.8% ± 1.2%	16.3%
	G381B	49	4.13 ± 1.26	49.6% ± 13.4%	39.8% ± 1.4%	30.6%
	G381E	49	4.85 ± 1.28	59.0% ± 15.5%	40.6% ± 1.3%	8.2%
	All	294	4.22 ± 1.21	51.0% ± 13.9%	38.5% ± 1.9%	17.7%
STA-5/6	G342A	48	4.79 ± 1.98	58.2% ± 23.3%	40.5% ± 1.6%	31.3%
	G344B	50	3.08 ± 1.62	35.8% ± 16.8%	35.8% ± 0.9%	54.0%
	G344C	50	3.31 ± 1.71	39.1% ± 18.1%	36.2% ± 0.9%	44.0%
	G344D	50	3.26 ± 1.70	38.0% ± 17.5%	36.7% ± 1.0%	52.0%
	G344E	52	2.57 ± 1.43	30.2% ± 14.3%	37.5% ± 1.6%	71.2%
	G344F	52	2.79 ± 1.47	32.8% ± 15.3%	38.1% ± 1.6%	69.2%
	G344G	52	3.35 ± 1.28	39.9% ± 13.6%	38.5% ± 1.5%	44.2%
	G344H	52	3.48 ± 1.48	41.2% ± 15.6%	39.2% ± 1.6%	48.1%
	G344I	45	3.27 ± 1.56	39.0% ± 17.8%	39.7% ± 1.6%	62.2%
	G344J	45	3.62 ± 1.48	43.4% ± 16.7%	40.1% ± 1.7%	46.7%
	G344K	45	3.59 ± 1.66	43.0% ± 18.6%	40.5% ± 1.7%	53.3%
	G352B	50	2.64 ± 1.45	31.2% ± 16.1%	36.3% ± 1.3%	62.0%
	G354C	50	1.94 ± 1.26	22.1% ± 13.9%	37.1% ± 1.6%	84.0%
	G393B	50	2.16 ± 1.29	24.7% ± 13.9%	37.4% ± 1.8%	88.0%
	All	693	3.04 ± 1.59	35.8% ± 17.4%	37.7% ± 2.1%	57.9%

[1] Calculated Dissolved Oxygen Criteria Florida Class III criteria specified in Sections 62-302.530 and 62-302.533 (Dissolved Oxygen), F.A.C.

[2] Arithmetic mean ± Standard Deviation (SD)

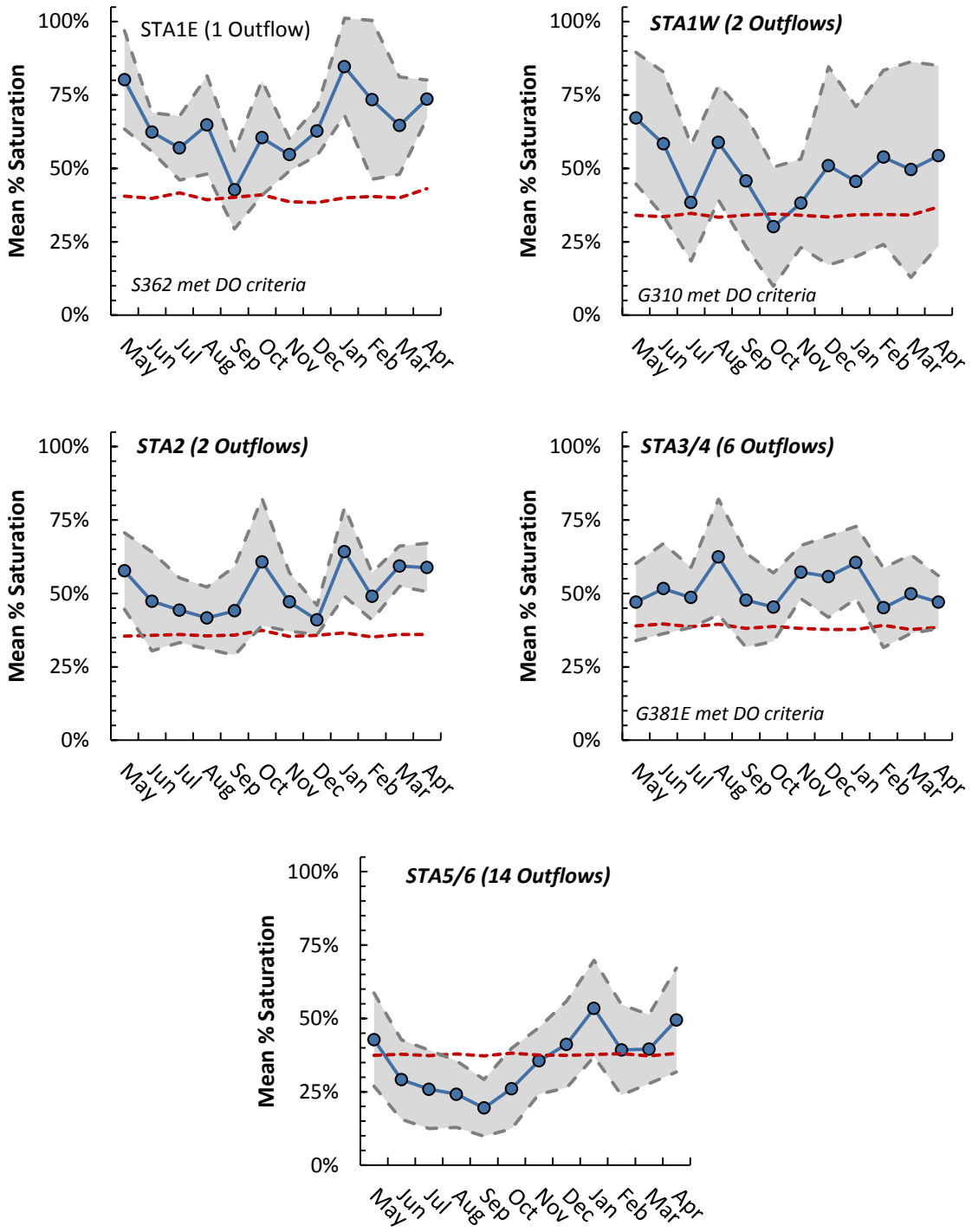

Figure 4. Mean monthly percent saturation of dissolved oxygen during WY2014 for the five permitted STAs referenced to the calculated Class III criteria (expressed as percent saturation and shown as red dashed line). Shaded region represents one standard deviation around the mean.

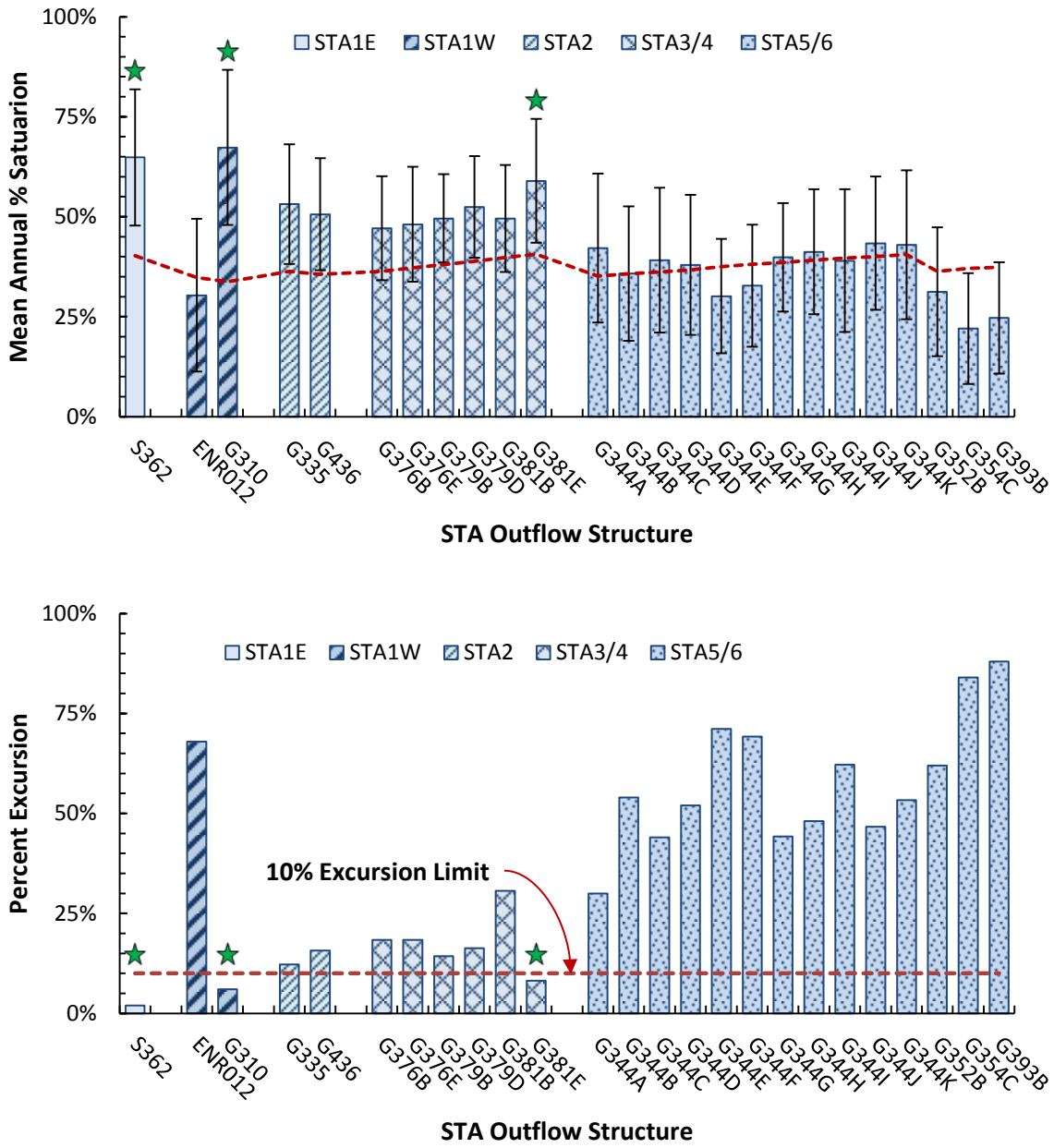

Figure 5. (Top) Bar plot depicting mean annual percent dissolved oxygen saturation (± standard deviation) for each outflow structure at the five permitted STAs with the mean annual DO criteria represented as a red dashed line. (Bottom) Bar plot showing the annual percent excursion from the calculated DO criteria with the 10% excursion limit depicted as a red dashed line. Annual excursion frequencies at structures exceeding the 10% limit line indicate that those structures do not meet the DO criteria. Structures in both plots that met the calculated DO criteria are identified by a star (★)

Mercury

During WY2014, there were no violations of the Florida surface water quality standard (62-302.530, F.A.C.) and the United States Environmental Protection Agency (USEPA) surface water quality criterion of 12 nanograms per liter (ng/L) of total mercury (THg) during the reporting year for any of the STAs currently monitored. Total mercury concentrations in fish within STA interior stations for WY2014 did not exceed USEPA predator protection criteria for trophic level 3 (TL3) fish of 77 nanograms per gram (ng/g) for mosquitofish and sunfish, and trophic level 4 (TL4) fish of 346 ng/g for largemouth bass. In general, THg concentration in fish for all trophic levels collected from STA interior are lower than those collected from the EPA.

Since WY2009, mercury monitoring in STA-1W has been under Phase 3 - Tier 3 which terminates mercury monitoring. STA-1 East (STA-1E) mercury monitoring is under Phase 3 - Tier 1. Collection for surface water THg and methylmercury (MeHg) collections were terminated since WY2009. Collection for mosquitofish is on a semiannual basis. Collection of large-bodied fishes is on a triennial basis with no sample collection in WY2014. Mercury concentration in mosquitofish from the interior marshes was below the USEPA's TL3 criterion. Average THg concentration in the downstream Water Conservation Area (WCA)-1 marsh site exceeded the USEPA's predator protection TL3 criterion Mercury monitoring in STA-2 Cells 1, 2 and 3 is under Phase 3 - Tier 3 which terminates monitoring. Mercury monitoring in the North Buildout (NBO), which includes Cells 4, 5, and 6, and the South Buildout (SBO), which includes Cells 7 and 8, is under Phase 2 - Tier 1. The THg concentrations in NBO and SBO inflow and outflow were considerably lower than the USEPA surface water criterion (12 ng/L) and MeHg concentration displayed a net reduction of 24%. The average THg concentrations in mosquitofish from STA-2 marsh interior and the downstream site were 10 ng/g and 18 ng/g respectively in WY2014. The average THg concentration in sunfish and LMB were 60 ng/g and 184 ng/g from interior cells. No mosquitofish within and downstream of STA-2 contained mercury concentrations above both the USEPA predator protection criteria for TL 3 fish. The average THg concentrations in sunfish and LMB from the downstream locations were above USEPA criterion for TL 3 (77 ng/g) and TL 4 (346 ng/g) fish.

Mercury monitoring in STA-3/4 is under Phase 3 - Tier 3, which terminates monitoring. Mercury monitoring in STA-5/6 Flow-ways 1 and 2 is terminated. Flow-ways 3, 4, 5, and 6 were under Phase 2 - Tier 1 monitoring. Water-column concentrations of both THg and MeHg in these flow-ways were well below USEPA surface water criterion for THg (12 ng/L). At the outflow, net reductions of THg and MeHg loads were 22% and 44%, respectively. Mosquitofish collected from Flow-ways 3, 4, 5 and 6 interior and downstream in WY2014 contained one of the lowest annual mean THg concentrations among STAs currently under mercury monitoring. The average annual mosquitofish composite for WY2014 and each individual mosquitofish composite for all locations in these flow-ways and the downstream site did not exceed USEPA predator protection criterion for TL 3 fish. Sunfish collected from the interior marsh and downstream contained the lowest THg concentrations among STAs. LMB collected in the interior site of the flow-ways, had an annual average level well below the USEPA TL 4 fish criterion while those collected from the downstream site had an average concentration above the USEPA TL 4 fish criterion.

Rotenberger Wildlife Management Area Restoration and STA Transect Monitoring

The District monitors adjacent wetland areas that receive discharges from the STAs, which include the Refuge (adjacent to STA-1E and STA-1W), WCA-2A (adjacent to STA-2), and the Rotenberger Wildlife Management Area (adjacent to STA-5/6) (**Figure 1**). Water and sediment quality, flow, stage and vegetation data are collected at inflow points and along prescribed

transects to assess changes in conditions as water moves south. In accordance with the annual reporting requirements of related permits, these WY2014 data are provided in Attachment D.

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Attachment A: Specific Conditions and Cross-References

Table A-1. Specific conditions, actions taken, and cross-references presented in this report for the Everglades Stormwater Treatment Areas (EFA permit 0311207).

Specific Condition	Description	Applicable Phase	Action Taken	Where Reported in the *2015 South Florida Environmental Report**			
				Narrative (pages)	**Figures**	**Tables**	**Attachments**
3	Public Use	All	Recreational facilities were maintained in accordance with the permit requirements.	V2: 6B			
4	Project Construction	Construction	STA-1E, Comp. B and Comp. C were still under construction, no official ops yet.				
5	Project Operation and Maintenance	Operations/ Maintenance	STAs were operated and maintained consistent with permit requirements.				
6	As-Built Certification and Record	Construction	G-434, G-435, and G-436 certifications submitted 9/26/12; Environmentally Sensitive Areas and STA-6 redundant levee removal certifications submitted 3/25/13.				
7	Pump Station and Structure Maintenance	Maintenance	Documentation of temporary maintenance operations of discharge and diversion structures is kept by SFWMD Operations Control Center staff in log books. Corresponding flow and concentration measurements were also taken as required.				
8	Contamination Sites and Residual Agrichemicals	Construction	No contaminated sites discovered				
9	Vegetation and Operational Enhancements	Operations	STA-1E Cell 7 herbicide appl. and planting (3/6/13); STA-1W Cells 5A, 1A, 2B, 4 herbicide treatments, inoculations, bulrush plantings (3/5/13); STA-3/4 Cell 1A boat ramp (3/26/13); STA-3/4 Cell 2A drawdown (1/28/13); STA-5 weather shelter (12/11/12).				
10	STA Operation Plans and Modifications	Operations	There were no updates to STA Operation Plans in WY2014.				

Table A-1. Continued.

Specific Condition	Description	Applicable Phase	Action Taken	Where Reported in the *2015 South Florida Environmental Report**			
				Narrative (pages)	**Figures**	**Tables**	**Attachments**
11	Hydropattern Restoration	Operations	STAs were operated in order to improve Everglades water supply and hydroperiod, as required.				
12	Rotenberger Wildlife Management Area Restoration	Operations/ Maintenance		V3: 22			V3: D
14	Water Quantity and Flooding Impacts	All	STAs were operated so as not to adversely affect adjacent lands with regard to flooding impacts and water supply needs of the region.				
15	Phosphorus Criterion	Operations		V3: 5,6	V3: 3	V3: 3,5, 6	
16	Diversion	Operations/ Maintenance	After Action Report for STA-1E, STA-1W, and STA-3/4 diversions (TS Andrea) was submitted 6/27/13.	V3: 6		V3: 7	
17	Comparison of Outflows to Inflows	Operations		V3: 12–13			V3: B
18	Dissolved Oxygen	Operations		V3: 12,16-18	V3: 4,5	V3: 8, 11	
19	Factors Outside Permittee's Control	All	There were no non-compliance events or failures to achieve permit conditions.				
20	Endangered Species/Migratory Bird Treaty Act	All	No non-compliance events occurred.				
21 (A-C)	Turbidity Monitoring	Construction/ Maintenance	SFWMD provided turbidity monitoring results for projects that could generate turbidity in receiving waters to FDEP as required.				
22	Transect Monitoring	Operations		V3: 22, 23			V3: D
23A	Mercury and Other Toxicants	Operations		V3: 22			V3: C, F
23B	Long Term Monitoring	Operations		V1: 5B			
24 (A-B)	Annual Levee and Structure Inspections and Reports	Operations	Annual STA Structure & Levee Report was submitted on 3/28/13				
24B	Periodic (5-Year) Levee and Structure Inspections and Reports	Operations	STA-2 Cells1-3 5-yr Periodic Structure and Levee Report submitted 4/9/13				

Table A-1. Continued.

Specific Condition	Description	Applicable Phase	Action Taken	Where Reported in the *2015 South Florida Environmental Report**			
				Narrative (pages)	**Figures**	**Tables**	**Attachments**
25	Annual Monitoring Reports	Operations	Annual report completed as required	V3: All	V3: All	V3: All	V3: All
25A	Quality Assurance and Quality Control	Operations	Sampling and analysis were performed according to permit requirements and per Chapter 62-160, F.A.C., and the SFWMD's water quality monitoring plan.				V3: B
25B	Water Quality Data	Operations					V3: B
25C	Performance Evaluation	Operations		V3: 5, 6, 12, 13, 16-18	V3: 3-5	V3: 3, 5, 6, 9-11	
25D	Herbicide and Pesticide Tracking	Operations					V3: E
25E 1	Implementation Activities; Trend analysis of Flows and Loads to the Facilities	All		V1: 5B		V1: 5B-1	
25E 2	Facility design mods	Construction/ Maintenance	N/A				
25E 4	Delays	All	N/A				
25E 5	Facility Recovery Plans	All	No plans being implemented				
25E 6	Noncompliance	All	None				
25E 8	Downstream transects monitoring	Operations					V3: D
25E 9	Recommended revisions to facilities	All	None				
25E 10	Summary of reports required in Specific Condition 15	Operations	Summary of Annual Discharge Performance Report was submitted on 7/28/13	V3: 5–6	V3: 3	V3: 3	
25E 11	Summary of STA Ops Impacts from ESA / MBTA	Operations		V1: 13; 16 (1E); 21 (1W); 26 (2); 33 (3/4); 38 (5/6)			App. 5B-2
26	Removal of Parameters	Operations	A mercury monitoring reduction request was approved by FDEP on 10/2/2013 for portions of STA-2 and STA-5/6.				V3: C

Specific Condition	Description	Applicable Phase	Action Taken	Where Reported in the *2015 South Florida Environmental Report**			
				Narrative (pages)	**Figures**	**Tables**	**Attachments**
27	Public Health, Safety, or Welfare	All	Discharges authorized by the permit did not cause or contribute to violations of water quality standards or pose a serious danger to public health, safety, or welfare, and no additional parameters were requested to be monitored by FDEP.				
28	Temporary Suspension of Sampling	All	Sampling was not suspended during WY2014.				
29	Permit Renewal	All	Not needed during WY2014				
30	Permit Modifications	All	Although an exemption (file number 0311207-002) was issued on 3/6/13for the S-6 communication tower, there were no modifications to the permit during the reporting period.				

* “V1” refers to Volume I, Chapter 5B; “V3” refers to Volume III, Appendix 3-1; otherwise “V” refers to Volume.

Attachment B: Water Quality Data

This project information is required by Specific Condition 25 of the Everglades Construction Project Stormwater Treatment Areas permit (0311207), and is available upon request.

All sampling and monitoring data referenced in this attachment were collected, analyzed, reported, and retained in accordance with Chapter 62-160, F.A.C.

Attachment C: Annual Permit Compliance Monitoring Report for Mercury in the Stormwater Treatment Areas

Ben Gu and Nicole Howard

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KEY FINDINGS AND OVERALL ASSESSMENT

This report summarizes data from compliance monitoring of mercury storage, reduction, release, and biomagnification in the stormwater treatment areas (STAs) for Water Year 2014 (WY2014) (May 1, 2013–April 30, 2014). Key findings are provided in the following paragraphs.

There were no violations of United States Environmental Protection Agency (USEPA) surface water quality criterion of 12 nanograms of total mercury (THg) per liter (ng/L) during the reporting year at any of the STAs currently monitored. The STAs have met all action level requirements listed in A Protocol for Monitoring Mercury and Other Toxicants (SFWMD and FDEP, 2011). Total mercury concentrations in mosquitofish, sunfish, and largemouth bass (LMB) in STA interior stations for WY2014 did not exceed United States Fish and Wildlife Service (USFWS) and USEPA predator protection criteria of 77 nanograms per gram (ng/g) for trophic level 3 (TL3) fish (mosquitofish and sunfish) and 346 ng/g for trophic level 4 (TL4) fish (LMB). In general, THg concentration in fish for all trophic levels collected from STA interior are lower than those collected from the Everglades Protection Area (see Gu and Howard, 2014).

STA 1 West (STA-1W): Since WY2009, mercury monitoring in STA-1W has been under Phase 3 - Tier 3 which terminates monitoring (see the Phase 3: Operational Monitoring section of this attachment).

STA 1 East (STA-1E): During WY2014, STA-1E mercury monitoring is under Phase 3 - Tier 1. Collection for surface water THg and methylmercury (MeHg) collections were terminated. Collection for mosquitofish was on a semiannual basis. Collection of large-bodied fishes was on a triennial basis with no sample collection in WY2014. Mercury concentration in mosquitofish from the interior marshes was below the USEPA's predator protection Trophic Level (TL) fish 3 criterion of 77 nanograms per gram (ng/g). Average THg concentration in the downstream Water Conservation Area (WCA)-1 marsh site exceeded the USEPA's predator protection TL fish 3 criterion of 77 ng/g.

STA-2: During WY2014, mercury monitoring at STA-2 Cells 1, 2 and 3 is under Phase 3 - Tier 3 which terminates monitoring. Mercury monitoring in the North Buildout (NBO), which includes Cells 4, 5, and 6, and the South Buildout (SBO), which includes Cells 7 and 8, is under Phase 2 - Tier 1. The THg concentrations in NBO and SBO inflow and outflow were considerably lower than the USEPA surface water criterion (12 ng/L) and MeHg concentration

displayed a net reduction of 24%. The average THg concentrations in mosquitofish from STA-2 marsh interior and the downstream site were 10 ng/g and 18 ng/g, respectively in WY2014. The average THg concentration in sunfish and LMB were 60 ng/g and 184 ng/g from interior cells. No mosquitofish within and downstream of STA-2 contained mercury concentrations above both the USEPA predator protection criteria for TL 3 fish. The average THg concentrations in sunfish and LMB from the downstream locations were above USEPA criterion for TL 3 (77 ng/g) and TL 4 (346 ng/g) fish.

STA-3/4: Consistent with the *Protocol for Monitoring Mercury and Other Toxicants* (SFWMD and FDEP, 2011), mercury monitoring in STA-3/4 was moved to Phase 3 - Tier 3 which terminates mercury monitoring on February 20, 2013 after receiving concurrence from the Florida Department of Environmental Protection (FDEP).

STA-5/6: Flow-ways 1 and 2 are under Phase 3 - Tier 3 which terminates mercury monitoring. Flow-ways 3, 4, 5, and 6 were under Phase 2 - Tier 1 monitoring. Water-column concentrations of both THg and MeHg in these flow-ways were moderate for the inflows and outflows during WY2014 and well below USEPA surface water criterion for THg (12 ng/L). At the outflow, net reductions of THg and MeHg loads were 22% and 44%, respectively. Mosquitofish collected from Flow-ways 3, 4, 5 and 6 interior and downstream in WY2014 contained one of the lowest annual mean THg concentrations among STAs currently under monitoring for mercury. The average annual mosquitofish composite for WY2014 and each individual mosquitofish composite for all locations within these flow-ways and the downstream site did not exceed USEPA predator protection criterion for TL 3 fish (77 ng/g). Sunfish collected from the interior marsh and downstream contained the lowest THg concentrations among STAs. LMB collected in the interior site of the flow-ways, displayed an annual average level well below the USEPA TL 4 fish criterion while those collected from the downstream site displayed an average concentration above the USEPA TL 4 fish criterion.

INTRODUCTION

This attachment contains the annual permit compliance monitoring report for mercury in the Everglades STAs by the South Florida Water Management District (District or SFWMD) and summarizes the mercury-related reporting requirements of FDEP Permit Number 0311207 Specific Condition 23A (STA-1W and STA-1E), STA-2, STA-3/4 and STA-5/6 under the Everglades Forever Act (EFA) [Chapter 373.4592, Florida Statutes (F.S.)].

This report summarizes the results of monitoring in WY2014 for surface water in STA-2 and STA-5/6, and fish of multiple trophic levels in STA-1E, STA-2, and STA-5/6. The results of mercury monitoring downstream of the STAs in accordance with these permits, as well as non-Everglades Construction Project (non-ECP) discharge structures (Permit Number 06.502590709), are reported separately in Appendix 3-2, Attachment F.

This report consists of key findings and overall assessment, an introduction and background, a summary of the Mercury Monitoring and Assessment Program (MMAP), and monitoring results. The background section briefly summarizes previously identified and published concerns regarding possible impacts of STA operations on South Florida's mercury problem. The following sections summarize MMAP, quality assurance/quality control (QA/QC), followed by a summary and discussion of monitoring results. The monitoring results section comprises the bulk of new discussion. The last section of this attachment provides updates on mercury monitoring network optimization in each STA.

BACKGROUND

STAs are constructed wetlands designed to remove phosphorus from stormwater runoff originating from upstream agricultural areas and other areas, including Lake Okeechobee releases. The original six STAs, totaling over 65,000 acres and approximately 45,000 acres of effective treatment area, were built as part of the Everglades Construction Project (ECP) authorized under the EFA (Chapter 373.4592, F.S.).

Even before passage of the EFA in 1994, concerns were being raised that attempts to reduce downstream eutrophication could inadvertently aggravate the mercury problem known to be present in the Everglades (Ware et al., 1990; Mercury Technical Committee, 1991). These concerns stemmed from studies in other areas that showed flooded soils in new impoundments were sources of inorganic mercury (Cox et al., 1979). Of greater concern, studies also showed wetlands to be a significant site of mercury methylation.

MeHg is more bioaccumulative and toxic than the inorganic or elemental form of mercury (St. Louis et al., 1994; Rudd, 1995). Decomposition of flooded terrestrial vegetation and soil carbon in new reservoirs was reported to stimulate the sulfate-reducing bacteria that methylate inorganic mercury (Kelly et al., 1997; Paterson et al., 1998). Environments that favor methylation also drive bioaccumulation. For example, Paterson et al. (1998) found that annual fluxes of MeHg increased 10 to 100 times through a zooplankton community after impoundment.

Newly created reservoirs were also found to contain fish with elevated mercury levels (Abernathy and Cumbie, 1977; Bodaly et al., 1984; Bodaly and Fudge, 1999). This so-called "reservoir effect" can persist for several decades after initial soil flooding (Bodaly et al., 1984; Verdon et al., 1991; Fink et al., 1999). For instance, Verdon et al. (1991) reported that total mercury levels in northern pike (*Esox lucius*) increased from 0.61 to 2.99 parts per million (ppm or milligrams per liter) and continued to increase nine years after the initial soil flooding. Given these observations, Kelly et al. (1997) recently recommended that in siting a new reservoir, total land area flooded should be minimized, and flooding of wetlands, which contain more organic carbon than uplands, should be avoided.

However, applying these recommendations directly to the Everglades is problematic because most of the observations were made in deep water lakes or reservoirs in temperate regions. In a report to the SFWMD on the potential impact of nutrient removal on the Everglades mercury problem, Watras (1993) stated that "the boreal and temperate watersheds, wetlands and reservoirs studied to date are very different geologically, hydrologically, meteorologically and ecologically from the subtropical systems in the Everglades." Watras recommended monitoring and integrating mass balance and process-oriented studies to understand how this subtropical system would behave. Such studies were initiated in 1994 with the start-up of the prototype STA, the Everglades Nutrient Removal (ENR) Project (later incorporated within STA-1W). Baseline collections at the ENR Project found no evidence of MeHg spikes in either surface water (PTI, 1994 attributed to KBN, 1994a; Watras, 1993, 1994) or resident fish [mosquitofish (Gambusia holbrooki) and LMB (Micropterus salmoides)] (PTI, 1994 attributed to KBN, 1994b].

During the first two years of operation, median concentrations of THg and MeHg in unfiltered surface water were reported to be 0.81 and 0.074 ng/L, respectively (Miles and Fink, 1998). These low levels persisted in later years: from January 1998 through April 1999, median water column concentrations in the interior marsh (i.e., excluding inflows and outflows) were 0.81 ng THg per liter (/L) and 0.04 ng MeHg/L (Rumbold and Fink, 2002). Resident fish also continued to have only low mercury levels: 8–75 ng/g in mosquitofish, and 100–172 ng/g in LMB age-standardized to three years (age-3) (Miles and Fink, 1998; SFWMD, 1999a; Lange et al., 1999). Finally, a mass balance assessment found the ENR Project to be a net sink for both THg and MeHg, removing approximately 70 percent of the inflow mass (Miles and Fink, 1998).

Nonetheless, to provide continuing assurance that EFA implementation does not exacerbate the mercury problem, the FDEP construction and operating permits issued for the STAs require the SFWMD to monitor levels of THg and MeHg in various abiotic (e.g., surface water and sediment) and biotic (e.g., fish and bird tissues) media, both within STAs and the downstream receiving waters (see also Appendix 3-2, Attachment F of this volume).

Results from monitoring programs at STAs constructed and operated since 1999 (after the ENR Project) have revealed transitory spikes in MeHg production (see previous reports published by the SFWMD, including Rumbold and Fink, 2002). Combined with the results of a 1999 field study on the effect that drought and muck fires had on mercury cycling in the Everglades (Krabbenhoft and Fink, 2001), these monitoring results demonstrated that spikes can sometimes occur following dryout and rewetting. Accumulating evidence suggests that oxidation of sulfide pools in the sediments (e.g., organic sulfide, disulfides, acid volatile sulfides) during dryout can lead to increased methylation upon rewetting of the marsh either by providing free sulfate, which stimulates sulfate-reducing bacteria or, in highly sulfidic areas, by reducing porewater sulfide, which can inhibit methylation (Benoit et al., 1999a and b).

SUMMARY OF THE MERCURY MONITORING AND ASSESSMENT PROGRAM

The following section provides information on current monitoring and reporting activities used for the District's MMAP (SFWMD, 1999c). The MMAP was initially developed for the ECP, the Central and Southern Florida Project, and the Everglades Protection Area (EPA). The SFWMD developed and submitted a plan to the FDEP, the USEPA, and the United States Army Corps of Engineers (USACE) in compliance with the permit requirements (SFWMD, 1999b) and was later approved. Details on the procedures for ensuring the quality of and accountability for data generated under this monitoring program were set forth in the SFWMD's Quality Assurance Project Plan (QAPP) for the MMAP (SFWMD, 1999c), which was also approved on issuance of the FDEP permit. QAPP revisions were approved by the FDEP on June 7, 1999.

On February 13, 2006, a revised sampling protocol was approved by the FDEP and the District that was entitled *A Protocol for Monitoring Mercury and Other Toxicants*, which is referred to as the Protocol. Adapted from Rumbold and Pfeuffer (2005), this new plan was developed to replace the initial plan developed under the MMAP. The primary drivers of the Protocol are to (1) streamline sampling procedures, (2) eliminate the need for extended, open-ended sampling activities, and (3) phase out surface water sampling. The Protocol continues to use the QAPP modified in 1999. As of May 16, 2008, all mercury monitoring within each STA follows the Protocol. On September 29, 2009, additional modifications to the Protocol were approved by the FDEP that involved altering the fish collection length for LMB to the current range of 307–385 millimeters (mm). The Protocol was formally updated in April 2011 (SFWMD and FDEP, 2011) to reflect the agreed-upon change in the size of fish collected for analysis and is in agreement with CERP Guidance Memorandum (CGM) 42 on the same subject. The change in size reflects a more appropriate age for evaluating contaminant concentrations.

PROTOCOL FOR MONITORING MERCURY AND OTHER TOXICANTS

Phase 1: Baseline Collection and Assessment

Phase 1 baseline collection and assessment is meant to provide information regarding the likelihood that a constructed facility under an EFA project may exacerbate or create a mercury (or other toxicant) problem. Identifying problematic areas will allow managers to avoid sites or areas

that may present risk. Phase 1 is operated under three levels: Tier 1 (Compilation and Review of Available Data), Tier 2 (Field Sampling), and Tier 3 (Bioaccumulation Tests and Dynamic Modeling). Under Tier 1, the environmental site assessment (ESA) is evaluated to determine (1) if any corrective actions were taken during the ESA, (2) there was potential for contamination, or (3) the time interval between the ESA and project construction. If information data gaps exist, or where the preponderance of baseline data demonstrates a potential problem, then Phase 1 - Tier 2 or Tier 3 is initiated. Under Phase 1 - Tier 2, three representative soil/sediment cores are collected and analyzed from five locations within each operable unit [i.e., Operating Unit (OU) - each independently operated treatment train] or each 1,000 acre parcel, whichever is smaller, At each location, three cores from the 0-to-4 centimeter (cm) horizon are collected and composited as a single soil sample and analyzed for several constituents that help evaluate MeHg production and mercury bioaccumulation.

Phase 1, Tier 3 is initiated if at least one of the following occurs: (1) absolute concentrations of MeHg or average percent MeHg in sediments/soils from an OU exceeds the 90 percent upper confidence level of the basin average or, if not available, the 75th percentile concentration (percent MeHg) for all basins; or (2) ambient fish collected with the project boundary demonstrate excessive bioaccumulation that exceeds the 90 percent upper confidence level of the basin-wide average or, if that value is not available, the 75th percentile concentration for all basins. Phase 1 - Tier 3 is used to evaluate extending uncertainties surrounding mercury bioaccumulation. This is accomplished through the use of bioaccumulation testing and modeling.

Phase 2: Monitoring During Three-Year Stabilization Period

If Phase 1 monitoring is not necessary, then Phase 2 - Tier 2 monitoring can occur following OU flow-through. Under Phase 2 - Tier 1, one surface water sample is collected and analyzed for THg and MeHg on a quarterly basis at inflow and outflow structures. Additionally, at least 100 mosquitofish are collected quarterly from multiple locations within each OU to be composited and analyzed for THg. Sunfish (*Lepomis* spp.) and LMB ($n \geq 5$) are collected and analyzed for THg annually.

Six criteria are used to evaluate the performance of each OU with respect to mercury bioaccumulation and enhancement (SFWMD and FDEP, 2011). These criteria are related to long-term trends in fish tissue concentrations, surface water THg/MeHg loading, and water quality standards. If any of the action criteria is exceeded, then Phase 2 - Tier 2 is triggered. Tier 2 sequentially involves (1) notifying the permitting authority, (2) resampling the media that triggered Tier 2 monitoring, (3) evaluating the spatial and temporal extent of the mercury bioaccumulation/enhancement accompanied with bioaccumulation modeling, and (4) developing an adaptive management plan.

Phase 3: Operational Monitoring

If after the first three years of monitoring, neither downstream loading nor residue levels in fish have exceeded action levels in the two years prior, then the project can move into Phase 3 - Tier 1. Under Phase 3 - Tier 1, (1) surface water sampling is discontinued, (2) the frequency of mosquitofish collection is reduced to semiannually, and (3) the frequency of large-bodied fish collection is reduced to one collection every three years. If the conditions are not met within the first three years, then criteria can be reevaluated annually based on the preceding two-year period.

Phase 3 - Tier 2 is triggered if (1) the annual average THg levels in mosquitofish progressively increase over time, (2) any semiannual mosquitofish composite exceeds the 90 percent upper confidence level of the basin-wide annual average (or, if basin-specific data are lacking, exceeds the 75th percentile concentration for the period of record for all basins), or (3) if triennial monitoring of large-bodied fish (i.e., in years 6–9) reveal tissue mercury levels have

statistically increased over time (i.e., over two or more years) or have become elevated to the point of exceeding the 90 percent upper confidence level of the basin wide annual average (or if basin-specific data are lacking, exceeds the 75th percentile for the period of record for all basins).

If fish under Phase 3 operational monitoring have not exceeded action levels by the ninth year, project-specific mercury monitoring can be moved into Phase 3 - Tier 3. Under Phase 3, Tier 3, all of the project's mercury-related monitoring is discontinued; however, project managers are cautioned that action levels may be revised in the future.

QUALITY ASSURANCE MEASURES

QA/QC is integral to all monitoring programs. A stringent QA/QC program is especially critical when dealing with ultra-trace concentrations of analytes in natural and human-impacted environments. Quality assurance includes design, planning, and management activities conducted prior to implementing the project to ensure that the appropriate types and quantities of data will be collected with the required representativeness, accuracy, precision, reliability, and completeness. The goals of QA are to ensure (1) standard collection, processing, and analysis techniques will be applied consistently and correctly, (2) the number of lost, damaged, and uncollected samples will be minimized, (3) the integrity of the data will be maintained and documented from sample collection to entry into the data record, and (4) data are usable based on project objectives.

Quality assurance (QA) measures are incorporated during the sample collection and laboratory analysis to evaluate the quality of the data. These measures give an indication of measurement error and bias (or accuracy and precision). Aside from using these results to indicate data quality, an effective QA program must utilize quality control (QC) results to determine areas of improvement and implement corrective measures. QC measures include both internal and external checks. Typical internal QC checks include replicate measurements, internal test samples, method validation, blanks, and the use of standard reference materials. Typical external QC checks include split and blind studies, independent performance audits, and periodic proficiency examinations. Data comparability is a primary concern because mercury-related degradation of water quality is defined here as relative to baseline data generated by one or more laboratories. It is important to establish and maintain comparability of the performance and results among participating laboratories assessing the reporting units and calculations, database management processes, and interpretative procedures. Comparability of laboratory performance must be ensured if the overall goals of the monitoring program are to be realized.

Laboratory Quality Control

Data for this program was generated by the District and FDEP, both of which are certified by the Florida Department of Health under the National Environmental Laboratory Accreditation Program. The following methods were utilized when analyzing samples for THg and MeHg during WY2014 FDEP–USEPA Method 1631E (Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry); USEPA Draft Method 1630 (Methylmercury in Water and Tissues by Distillation, Extraction, Aqueous Phase Ethylation, Purge and Trap, Isothermal GC Separation, Cold Vapor Atomic Fluorescence Spectrometry); USEPA Method 245.6 [Mercury in Tissues by Cold Vapor AAS (uses liquid digestion)]; EPA 7471A [Mercury in Solids by Cold Vapor AAS (uses liquid digestion)]; District–EPA 7473 [Mercury in Solids and Tissues by Direct Thermal Decomposition, Amalgamation and AA (does not incorporate liquid digestion)]. All of these methods use performance-based standards employing the appropriate levels of QA/QC required by the National Environmental Laboratory Accreditation Conference (NELAC), the specific reference method, and the Protocol.

Field Quality Control Samples

For WY2014, 22 field QC samples, including equipment blanks (both laboratory-cleaned equipment blanks and field-cleaned equipment blanks), and replicate samples were collected for both THg and MeHg surface water samples at STA-2 and STA-5/6. These field QC check samples represented approximately 40 percent of the 20 water samples collected during this reporting period. The results of the field QC blanks are summarized in **Table C-1**. A field kit prep blank is a sample of the deionized distilled water for field QC that remains at the lab to monitor low-level background inorganic mercury contamination of the laboratory deionized distilled water system, which can vary over time. Field kit prep blanks were discontinued effective June 16, 2012 according to the Water Quality Monitoring Division Quality Assurance Team Investigation Report QATI 110616-1. An equipment blank is collected at the beginning of every sampling event, and a field clean equipment blank is collected at the end of the event. A trip blank is a blank sample of deionized distilled water that is used to identify potential contamination during field transport. For this field collection blank, deionized distilled water is carried through the field collection trip, remains sealed in a container, and is then analyzed with all other samples at the FDEP laboratory. Trip blanks were discontinued effective June 16, 2012 according to the Water Quality Monitoring Division Quality Assurance Team Investigation Report QATI 033111-1. For WY2014, there were no flagged QA/QC samples for THg and MeHg samples.

The sample corrective action criterion for field-cleaned equipment blanks and equipment blanks is currently 10x the field-cleaned equipment blanks/equipment blanks level. All routine samples associated with an field-cleaned equipment blanks or equipment blanks are flagged if its value is less than 10x the method detection limit (MDL) of 0.1 ng/L for THg, or 0.022 ng/L for MeHg.

Analytical and Field Sampling Precision

Field replicates samples are collected from the same source as the routine sample using the same sampling equipment. The resulting data are compared to the results of routine samples to evaluate sampling precision.

Laboratory replicates are aliquots of the same sample that are prepared and analyzed within the same run. The results from duplicate analyses are used to evaluate analytical precision.

WATER SAMPLES

To assess the precision of field collection and analysis, 28 replicate, unfiltered surface water samples (8 THg and 8 MeHg) and mosquitofish composites (12 THg) collected at STA-2 and STA-5/6 were processed during WY2014. **Table C-2** reflects the results of sample analyses. Two replicate samples were matched with one surface water sample. For WY2014, all the THg and MeHg relative standard deviations for water samples were below the required 20 percent QA/QC precision level. However, two mosquitofish replicate samples collected at ST1ELX on October 24, 2013 and ST6DC on October 8 2013, respectively, had relative standard deviations that were above 20 percent QA/QC precision level.

Table C-1. Field QC blanks from STA-2 and STA-5/6 for WY2014. MDLs are 0.1 ng/L for THg and 0.022 ng/L for MeHg.

QC	THg						MeHg					
	Sample Size	Collection Frequency (%)	Mean Concentration of QC Samples (ng/L)	Number > MDL	Number Flagged	% Flagged[a]	Sample Size	Collection Frequency (%)	Mean Concentration of QC Samples (ng/L)	Number > MDL	Number Flagged	% Flagged[a]
Equipment Blanks	12	9.3	-0.1	0	0	0	12	9.3	-0.022	0	0	0
Field-Cleaned Equipment Blanks	8	6.2	-0.1	0	0	0	8	6.2	-0.022	0	0	0

[a] Percentage of all (QA/QC+ monitoring) samples collected for WY2014 (sample size = 64 for THg and sample size = 64 for MeHg).

Table C-2. Relative standard deviations for samples collected within STA-1E, STA-2, and STA-5/6 during WY2014.

Media	Sample Size	% Relative Standard Deviation[a]		
		Minimum	Maximum	Mean
Surface Water THg	8	1.7	6.5	4.6
Surface Water MeHg	8	3.8	6.4	5
Mosquitofish THg	12	2.1	23.8	13.9

a. Relative Standard Deviation = standard deviation/average x 100. It is calculated for each sampling event with replicate samples separately (1 sample value + two replicate samples)

SEDIMENT COMPOSITE SAMPLES

No sediment samples were collected for mercury analysis during WY2014.

Inter-Laboratory Comparability Studies

To ensure further reproducibility between ongoing mercury sampling initiatives and to evaluate the performance of the District and contract laboratories used for mercury analysis, round robin and performance testing studies for water, fish, and sediment are routinely initiated. These studies are performed by the District and contracted laboratories (Battelle et al., 2011; Wageningen Evaluating Programmes for Analytical Laboratories, 2013-2014; ERA, Colorado 2013-2014).

SURFACE WATER AND FISH

As in previous years, inter-laboratory studies were conducted by the FDEP to assess the comparability of THg and MeHg analysis in water for several laboratories. Participating laboratories receive nine samples of ambient water from the Everglades for analysis of THg and/or MeHg. In WY2014, the District participated in the Quality Assurance of Information for Marine Environmental Monitoring in Europe (QUASIMEME) studies Round 73 and Round 2014.1 to assess their performance in quantifying mercury in fish.

SEDIMENT

In WY2014, the District laboratory participated in ERA's Soil 84 and Soil 86 Performance Testing studies to obtain a regular independent assessment of a laboratory's performance and meet requirements for certification for Hg in solid and biological tissue samples. Continued National Environmental Laboratory Accreditation Program (NELAP) certification requires successful participation in performance testing studies every six months.

SELECTION OF FISH SPECIES AND SIZE RANGE

The proper interpretation of residue levels in tissues can sometimes prove problematic due to the confounding influences of age or species of collected animals. For comparison, special procedures are used to normalize the data (Wren and MacCrimmon, 1986; Hakanson, 1980). To be consistent with the reporting protocol used by the Florida Fish and Wildlife Conservation Commission (Lange et al., 1998, 1999), mercury concentrations in LMB were standardized to an expected mean concentration in three-year old fish at a given site by regressing mercury against age (EHg3). Currently, the Florida Fish and Wildlife Conservation Commission targets LMB between lengths of 307–385 mm, which includes age-3 fish. This length range is targeted to

eliminate the need for fish aging. Sunfish were not aged. Instead, arithmetic means were reported. Additionally, the distribution of the different species of sunfish [warmouth (*Lepomis gulosus*), spotted sunfish (*L. punctatus*), bluegill (*L. macrochirus*), and redear sunfish (*L. microlophus*)] that were collected during electroshocking was also qualitatively considered as a potential confounding influence on mercury concentrations prior to each comparison. The target sunfish species is bluegill.

SITE DESCRIPTIONS

Site descriptions and operational plans for STA-1W, STA-1E, STA-2, STA-3/4, and STA-5/6 are published elsewhere and can be provided upon request. Maps of selected monitoring locations are given with the data for each STA in the *Monitoring Results* section of this attachment.

MONITORING RESULTS

Mercury monitoring in STAs follows the *Protocol for Monitoring Mercury and Other Toxicants* (SFWMD and FDEP, 2011). For WY2014, surface water samples were collected from STA-2 and STA-5/6 for THg and MeHg analysis; mosquitofish were collected from STA-1E, STA-2, and STA-5/6; and sunfish and LMB samples were collected from STA-2 and STA-5/6 for THg analysis. Data are summarized in **Tables C-3** through **C-6** for all of the STAs. Detailed results from each STA are discussed in the following sections.

Table C-3. THg and MeHg inflow and outflow loads[a] in grams for WY2014.

STA	Inflow Load		Outflow Load		% Reduction[b]	
	THg	MeHg	THg	MeHg	THg	MeHg
STA-1W	Terminated					
STA-1E	Terminated					
STA-2 NBO/SBO	190.9	38.6	348.4	29.5	-82.5%	23.6%
STA-5/6 Flow-ways 3,4,5,6	44.6	8.1	34.9	4.5	21.7%	44.4%

[a] Calculated as total flow volume for water year (m^3) x average THg or MeHg concentration ($g\ m^{-3}$)

[b] (inflow–outflow/inflow)*100

Table C-4. Concentration of THg (ng/g, wet weight) in mosquitofish composite samples from STAs during WY2014.

STA	Collection Date	Interior Fish	Collection Date	Outflow/Downstream Fish
STA-1W	Monitoring terminated			
STA-1E	Oct-13	22	Oct-13	115
	Apr-14	19	Apr-14	54
	Mean	21		85
STA-2 (NBO)	Jul-13	7*	July-13	28
	Oct-13	4	Nov-13	15
	Feb-14	5	Feb-14	12
	Mean	5		18
STA-2 (SBO)	Jul-13	37*	Jul-13	28
	Oct-13	22	Nov-13	15
	Feb-14	6	Feb-14	12
	Mean	14		18
STA-3/4	Monitoring terminated			
STA-5/6 (Flow-way 3)	Jul-13	20	Jul-13	33**
	Oct-13	13	Oct-13	24
	Feb-14	14	Feb-14	26
	Mean	16		32
STA-5/6 (Flow-way 4)	Jul-13	30	Jul-13	33**
	Oct-13	7	Oct-13	24
	Feb-14	12	Feb-14	26
	Mean	16		32
STA-5/6 (Flow-way 5)	Jul-13	12	Jul-13	33**
	Oct-13	19	Oct-13	24
	Feb-14	15	Feb-14	26
	Mean	15		21
STA-5/6 (Flow-way 6)	Jul-13	18	Jul-13	33**
	Oct-13	17	Oct-13	24
	Feb-14	18	Feb-14	26
	Mean	18		32

* Data were flagged as a result of analysis based on improperly preserved samples. Outflow THg for STA-5/6 were data from STA6DC with one sampling event from RA1 on July 17, 2013.

Table C-5. Concentration of THg (ng/g, wet weight) in sunfish collected from STAs in WY2014 (mean ± standard deviation). Sample size is in parentheses. Cumulative mean includes all data for the period of record.

STA	Interior Fish	Outflow/Downstream Fish
STA-1W	No Results; Monitoring terminated in 2009	
STA-1E	No Results; Monitoring on triennial frequency	
Cumulative mean	68	165
STA-2	60±61 (5)	184±224(20)
Cumulative mean	56	127
STA-3/4	No Results; Monitoring terminated in 2013	
STA-5/6 Flow-way 3, 4, 5, 6	33±21(5)	28±25(5)
Cumulative mean	42	82

Table C-6. Concentrations of THg (ng/g, wet weight) in LMB collected in the STAs between 307–385 mm for WY2014 (mean ± standard deviation, sample size). In parentheses, all data are presented, including data within and outside of the 307–385 mm range. Cumulative mean includes all fish for the period of record.

STA	Interior Fish	Outflow/Downstream Fish
STA-1W	No Results Monitoring terminated in 2009	
STA-1E	No Results; Monitoring on triennial frequency	
STA-2	155±114, 7 (131±97,10)	449±181, 7 (350±137,20)
Cumulative mean	147	330
STA-3/4	No Results; Monitoring terminated in 2013	
STA-5/6 Flow-way 3, 4, 5,6	213, 2 (168±87,5)	394±94, 4 (469±166,5)
Cumulative mean	202	377

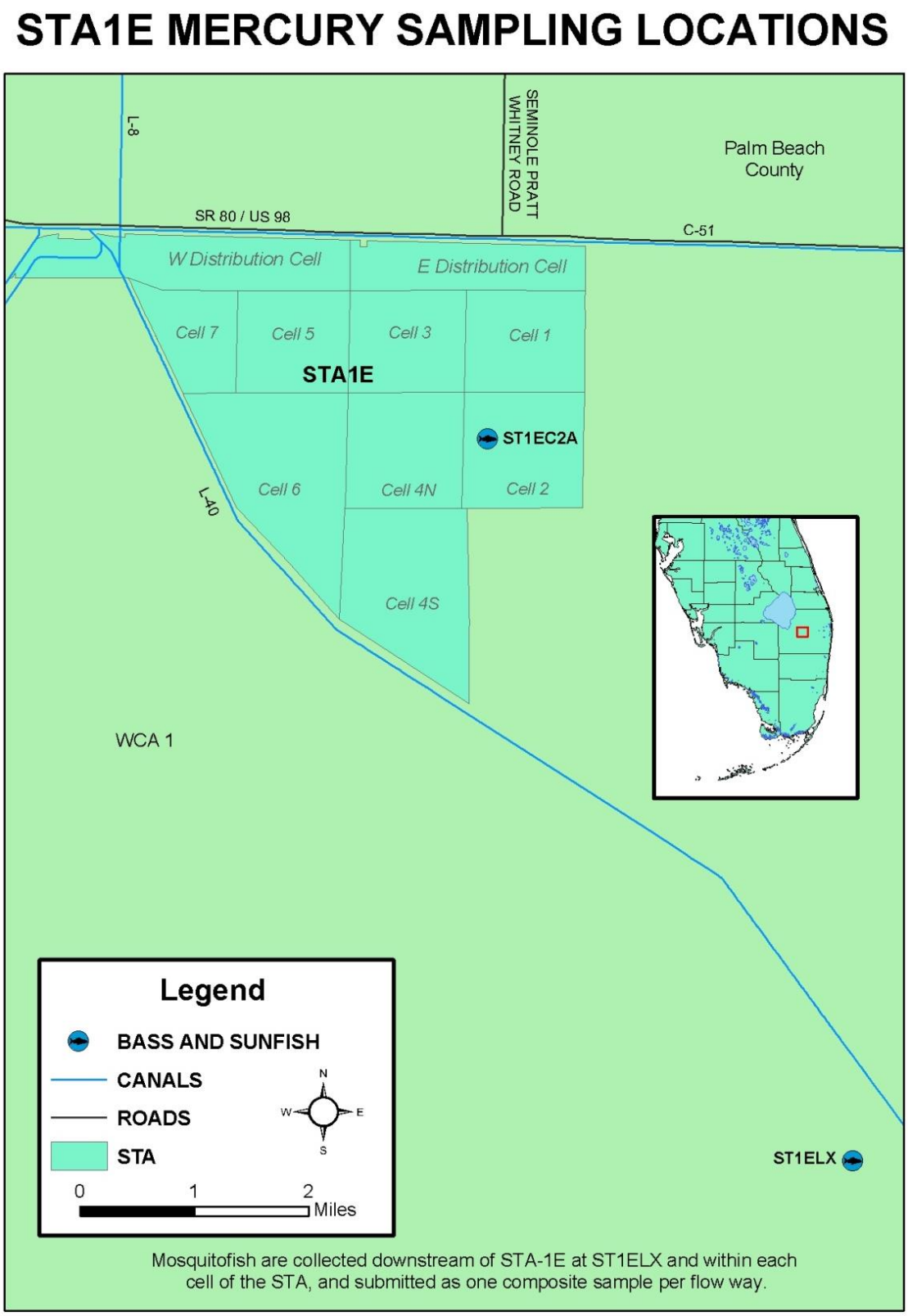

Figure C-1. Map of STA-1E showing mercury monitoring sites. Mosquitofish are collected downstream of STA-1E at ST1ELX and within each cell of the STA, and submitted as one composite sample per flow-way.

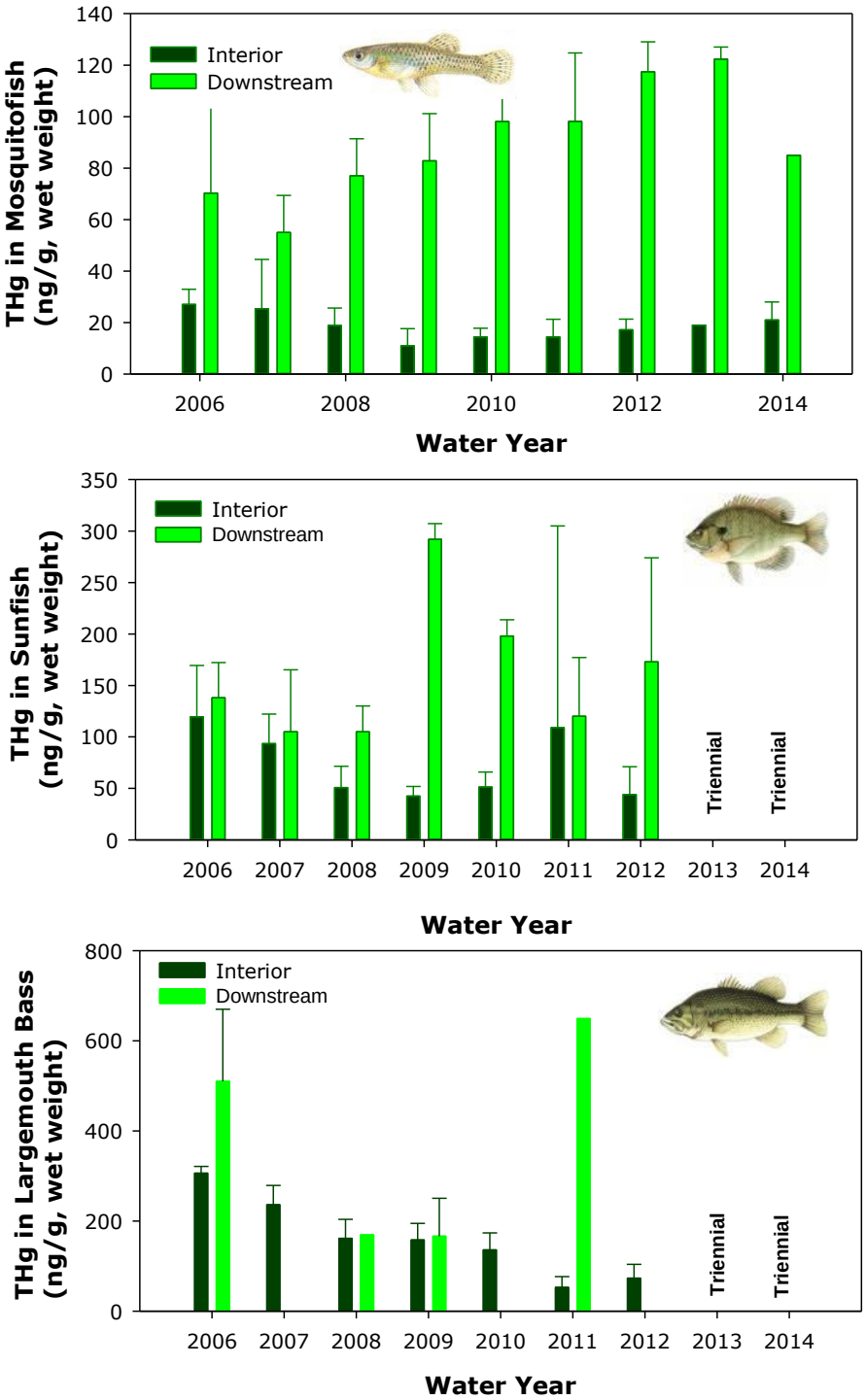

Figure C-2. THg concentrations (ng/g, wet weight, mean ± standard deviation) in mosquitofish composites (top), whole sunfish (middle), and fillets of LMB (bottom) collected at STA-1E. During Phase 3 - Tier 1, large-bodied fish samples were not taken in WY2014.

STA-1E

STA-1E is currently under Phase 3 Tier 1 monitoring. Mosquitofish composites were collected biannually in the interior marsh and a downstream site in WY2014. Results showed that mosquitofish THg concentration was 115 ng/g in October 2013 and 54 ng/g in April 2014, displaying large variation between the two collection events (**Table C-4**). Large-bodied fish collection for STA-1E is on triennial basis and no samples were collected for WY2014 (**Figure C-2**). The next and final collection for large-bodied fish to fulfill the Phase 3 - Tier 1 requirement is in WY2015 (Calendar Year 2014).

STA-2

STA-2 Cells 2 and 3, met mercury start-up criteria in September 2000 and November 2000, respectively. In August 2001, flow-through operation of Cell 1 was approved under a permit modification. Cell 1 met start-up criteria in November 26, 2002. Operational monitoring for mercury at STA-2 began during the third quarter of 2001 after completion of the S-6 connection (Rumbold and Fink, 2002, 2003; Rumbold 2004, 2005; Rumbold et al., 2006). The most recently developed area, Cell 4, passed mercury start-up criteria and flow-through began in 2007. February 29, 2012, the FDEP approved transfer of STA-2 mercury monitoring from Phase 2 - Tier 1: Routine Monitoring during Stabilization Period for STA-2 Cells 1, 2 and 3 to Phase 3 – Tier 3: Routine Operational Monitoring after Year 9 and Phase 3 – Tier 1: Routine Operational Monitoring from Year 4 to Year 9 for STA-2 Cell 4. Phase 3 – Tier 3 implemented the termination of all site specific mercury monitoring at STA-2 Cells 1, 2, and 3 (**Figure C-3**).

The District constructed two new flow-ways in STA-2, known as Everglades Agricultural Area (EAA) Compartment B Buildout Project (Compartment B). These new flow-ways consist of the NBO, which includes Cells 4, 5, and 6 and the SBO, which includes Cells 7 and 8. Compartment B incorporates the existing Cell 4 (**Figure C-3**). Start-up monitoring (sediment and mosquitofish) in Compartment B began on October 2011. On December 20, 2012, FDEP approved the start-up monitoring be moved to Phase 2 – Tier 1: Routine Monitoring during the Stabilization Period, which requires quarterly collection of surface water samples for THg and MeHg, quarterly and annual collection of mosquitofish composite and large-bodied fish samples for THg analysis. Surface water samples were collected at the STA-2 inflow (S6, G328, G434, and G435) and outflow (G335 and G436) stations. Mosquitofish composite samples were collected from NBO and SBO and a downstream station (CA2NF) in WCA-2. Large-bodied fish samples were collected in Cell 4 (STA2C4A) of NBO and Cell 8 (STA2C8A) and WCA-2 (CA2NF).

Four quarterly sampling events for surface water mercury were taken in WY2014. Results show that THg concentrations at the inflow and outflow did not exceed the USEPA surface water quality criterion of 12 ng/L (**Figure C-4**). Similar to WY2013, the average THg concentration from the two STA-2 inflow sites (G328 and S6) in WY2014 was lower than the average outflow concentration (G335 and G436). The THg concentrations at the inflow site to NBO (G434) and to SBO (G435) were also equal to or lower than the outflow sites. By contrast (also similar to WY2013), the average MeHg concentration at the inflow was higher than that at the outflow (**Figure C-4**).

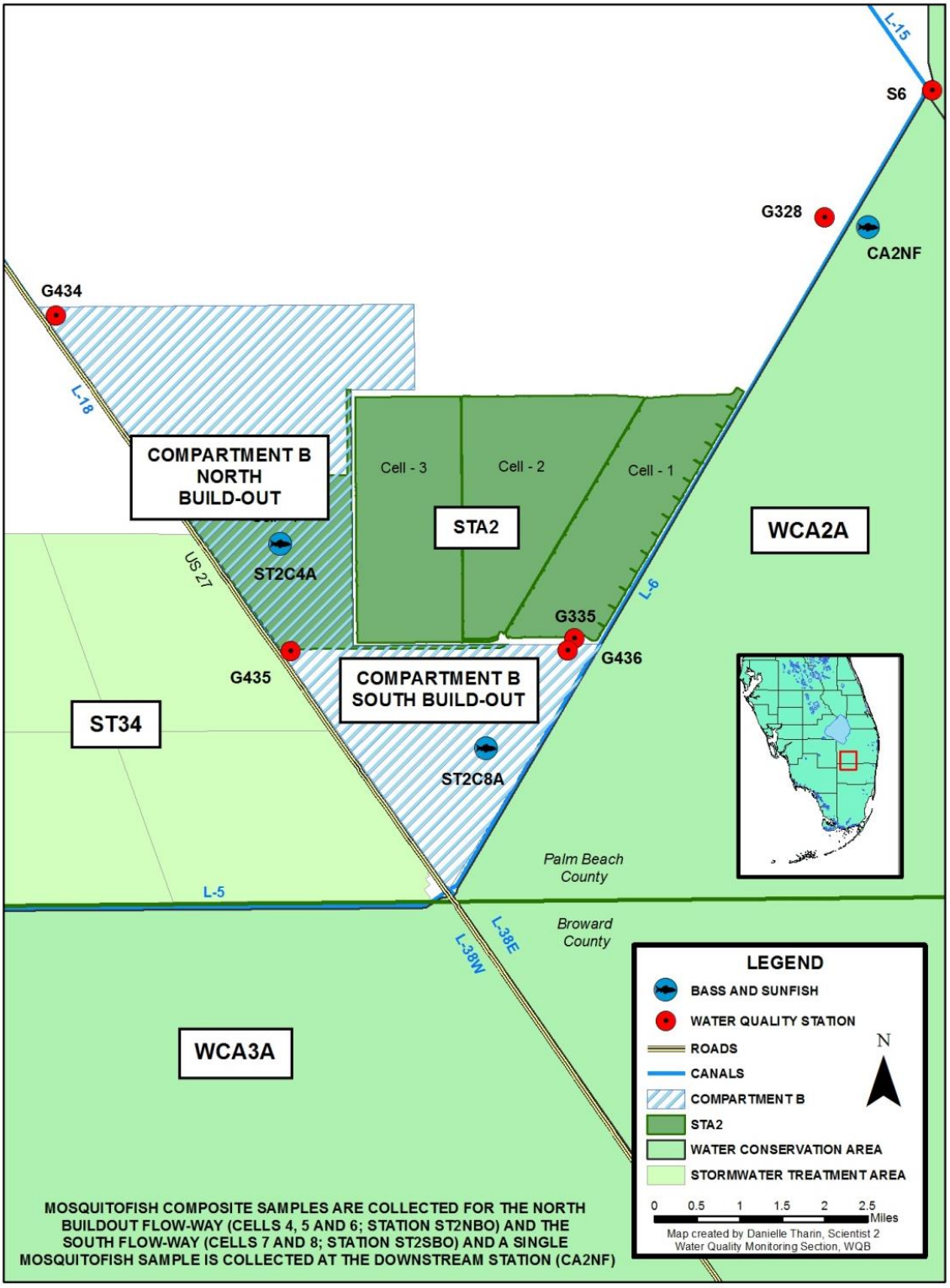

Figure C-3. Map of STA-2 showing current mercury monitoring sites. Mosquitofish samples are collected from downstream station CA2NF and in each cell, and then submitted as a composite for each flow-way.

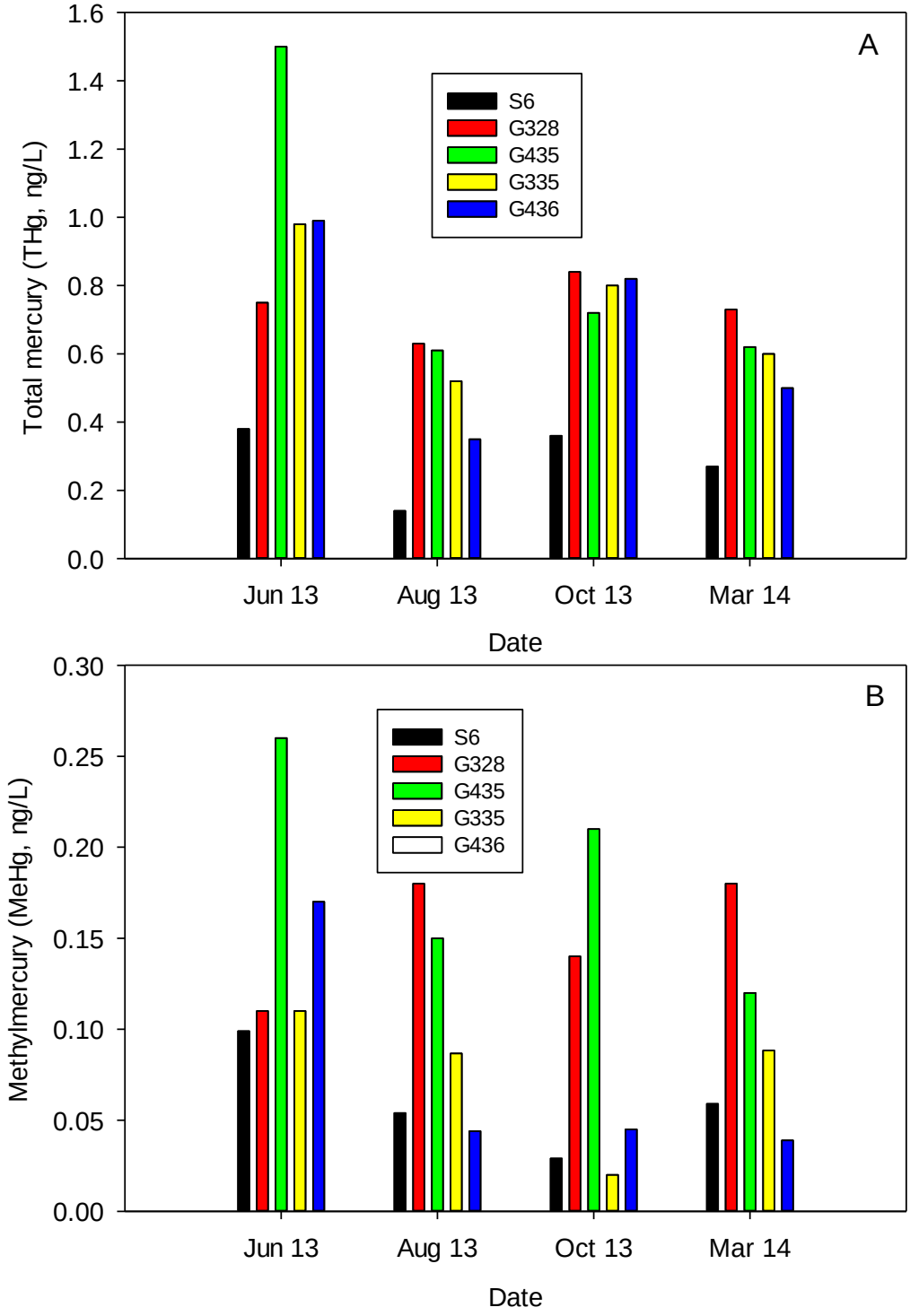

Figure C-4. Concentrations of (A) THg and (B) MeHg in unfiltered surface water collected at inflow (S6, G328, G434, and G435) and outflow (G436 and G335) stations from STA-2 during WY2014.

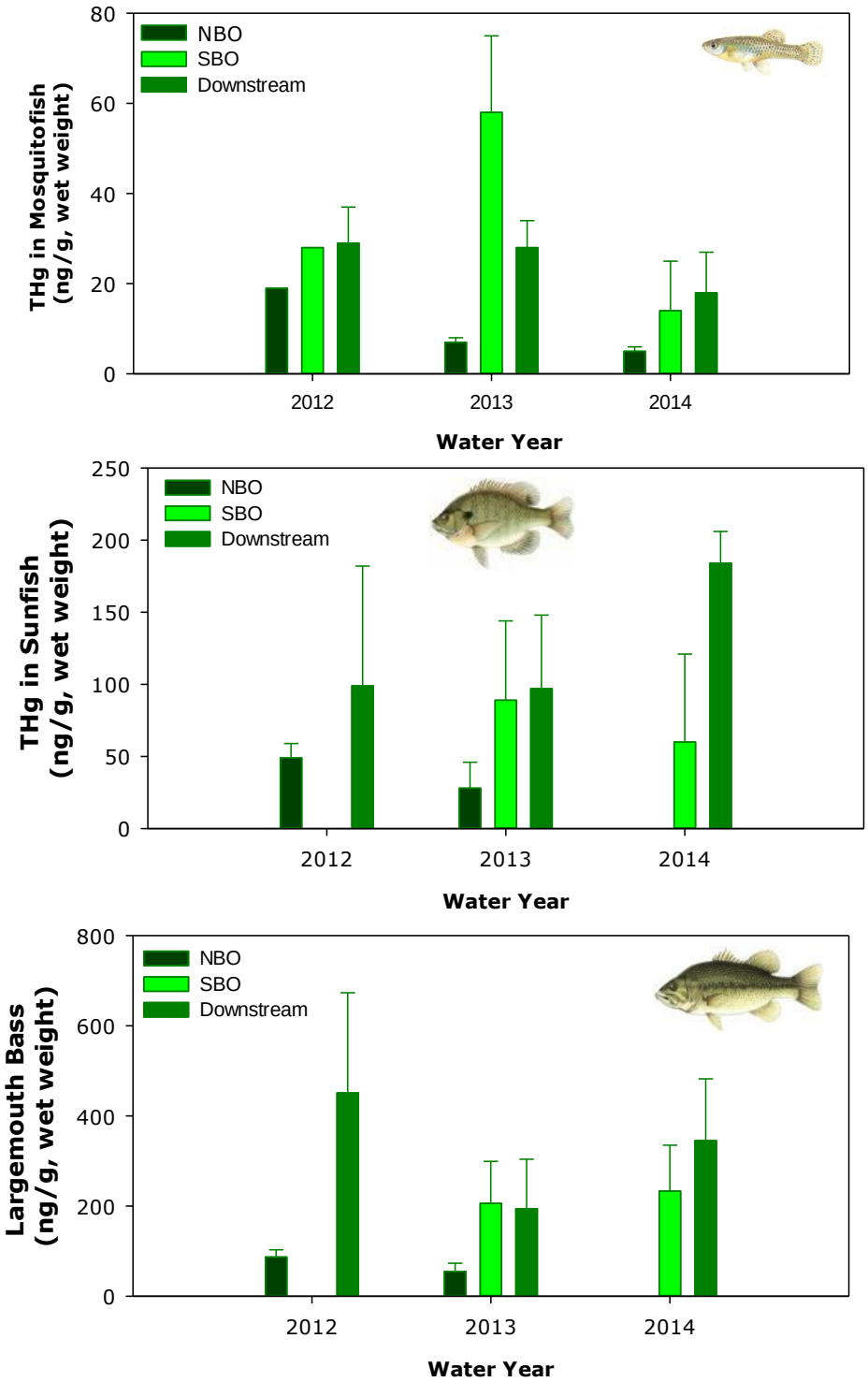

Figure C-5. Mercury concentrations (ng/g, wet weight, mean ± SD) in mosquitofish composites (top), whole sunfish (middle), and fillets of largemouth bass (bottom) collected at STA2C4A (NBO), STA2C8A (SBO) and the downstream site at WCA-2 (CA2NF) from WY2012 to WY2014.

Because part of the inflow went through other cells, which are not currently monitored for mercury and NBO and SBO shared the same outflow, we cannot evaluate the mercury reduction for NBO and SBO separately. Therefore, mercury load estimates were conducted for the entire STA-2. The annual mercury loading from S6, G328, and G435 was 190.9 grams of THg and 29.5 grams of MeHg. The outflow mercury load was 348.4 grams of THg and 34.9 grams of MeHg, which represented a net output of 82.5% of THg and a net reduction of 24% for MeHg (**Table C-3**). The net production of THg within STA-2 was likely the result of dryout and rewetting, which facilitated mercury oxidation. However, this process did not result in a net production of the more toxic form of mercury (MeHg) in STA-2 outflow.

Table C-4 and **Figure C-5** summarize the results from the operational monitoring of mercury concentrations in STA-2 Compartment B (ST2C4A and ST2C8A) mosquitofish for WY2014. The THg concentration in mosquitofish from the STA-2 marsh interior remained the lowest among actively monitored STAs. In WY2014, the average mosquitofish composite for the NBO was 5 ng/g while the average THg concentration for SBO was 14 ng/g, both of which were well below USEPA or USFWS TL 3 fish criterion (77 ng/g and 100 ng/g). The average THg concentration of mosquitofish at the downstream site was 18 ng/g, which was also well below USEPA or USFWS TL 3 fish criterion.

STA-3/4

On February 20, 2013 the FDEP approved the transfer of STA-3/4 mercury monitoring from Phase 3 - Tier 1: Routine Operational Monitoring from Year 4 to Year 9 to Phase 3 - Tier 3: Routine Operational Monitoring After Year 9. This implemented the termination of all site specific mercury monitoring at STA-3/4. Prior to this approval, THg levels in mosquitofish composite samples collected on October 22, 2012 were 10 ng/g for the interior marshes (an average of three cells) and 22 ng/g for a downstream site, respectively, which were well below USEPA predator protection criteria for TL 3 fish.

STA-5/6

On December 31, 2009, the FDEP approved the District's request to move mercury monitoring in Flow-ways 1 and 2 from Phase 3 - Tier 1 to Phase 3 - Tier 3. This implemented termination of all site-specific mercury monitoring in those flow-ways. Flow-way 3 is under Phase 2 - Tier 1 Monitoring: Routine Monitoring during the Stabilization Period. In September 2012, the District completed construction of the EAA Compartment C Buildout Project (Compartment C). Compartment C includes the G-508 pump station, STA-5 Flow-way 4 (consisting of Cells 5-4A and 5-4B), STA-5 Flow-way 5 (consisting of Cells 5-5A and 5-5B), and STA-6 Cell 6-4. STA-6 Cell 6-4, combined with the existing Cell 6-2, formed Flow-way 6. The entire STA-5, STA-6, and Compartment C Buildout complex is now referred to as STA-5/6. Compartment C passed the start-up monitoring in 2012 and is currently under Phase 2 - Tier 1 monitoring (**Figure C-6**).

In July 2013, the District completed one year (i.e., four quarterly sampling events) of Phase 2 - Tier 1: Routine Monitoring during Stabilization Period. Based on guidance contained in the Protocol, after one year of monitoring, project managers may elect to reduce the number of OUs sampled for large-bodied fish to one OU with the highest observed concentration of mercury and one downstream station and assess results as "worst case". Consistent with this guidance and with concurrence of the FDEP, the District terminated large-bodied fish monitoring at STA-5/6 Flow-ways 3 (station STA5C3B1), 4 (station STA5C4B1), and 6 (station STA6S2) and retained monitoring at Flow-way 5 (station STA5C5B1) as "worst case", effective October 2, 2013. Based on an evaluation submitted to the FDEP on October 1, 2013, it was determined that Flow-way 6 has slightly higher concentrations of mercury than Flow-way 5, however, Flow-way 6 is

maintained at lower operational priority for receiving inflow water for treatment and tends to dry out. Large-bodied fish was monitored in Flow-way 5 since it was determined to have the second highest concentrations of mercury, a higher operational priority than Flow-way 6, and there is a greater likelihood of obtaining bass, sunfish, and mosquitofish samples.

The Protocol requires fish monitoring at one downstream station per project. In September 2012, Compartment C combined with the former STA-5 and STA-6 to form STA-5/6. Because the STA-5/6 complex now operates as one project, the number of downstream stations was reduced from two (i.e., stations RA1 in Rotenberger Wildlife Management Area (WMA) and STA6DC in the STA-5/6 discharge canal) to one (i.e., STA6DC). Downstream mosquitofish THg concentrations were significantly higher at STA6DC than RA1. Furthermore, Rotenberger WMA does not provide hydrological conditions favorable for recruitment of large-bodied fish and the District was frequently unable to obtain a full quota (n=5) of LMB at station RA1. For these reasons and with concurrence of the FDEP, station STA6DC was retained as the STA-5/6 downstream monitoring station and all monitoring was terminated at station RA1, effective October 2, 2013.

STA5/6 MERCURY SAMPLING LOCATIONS

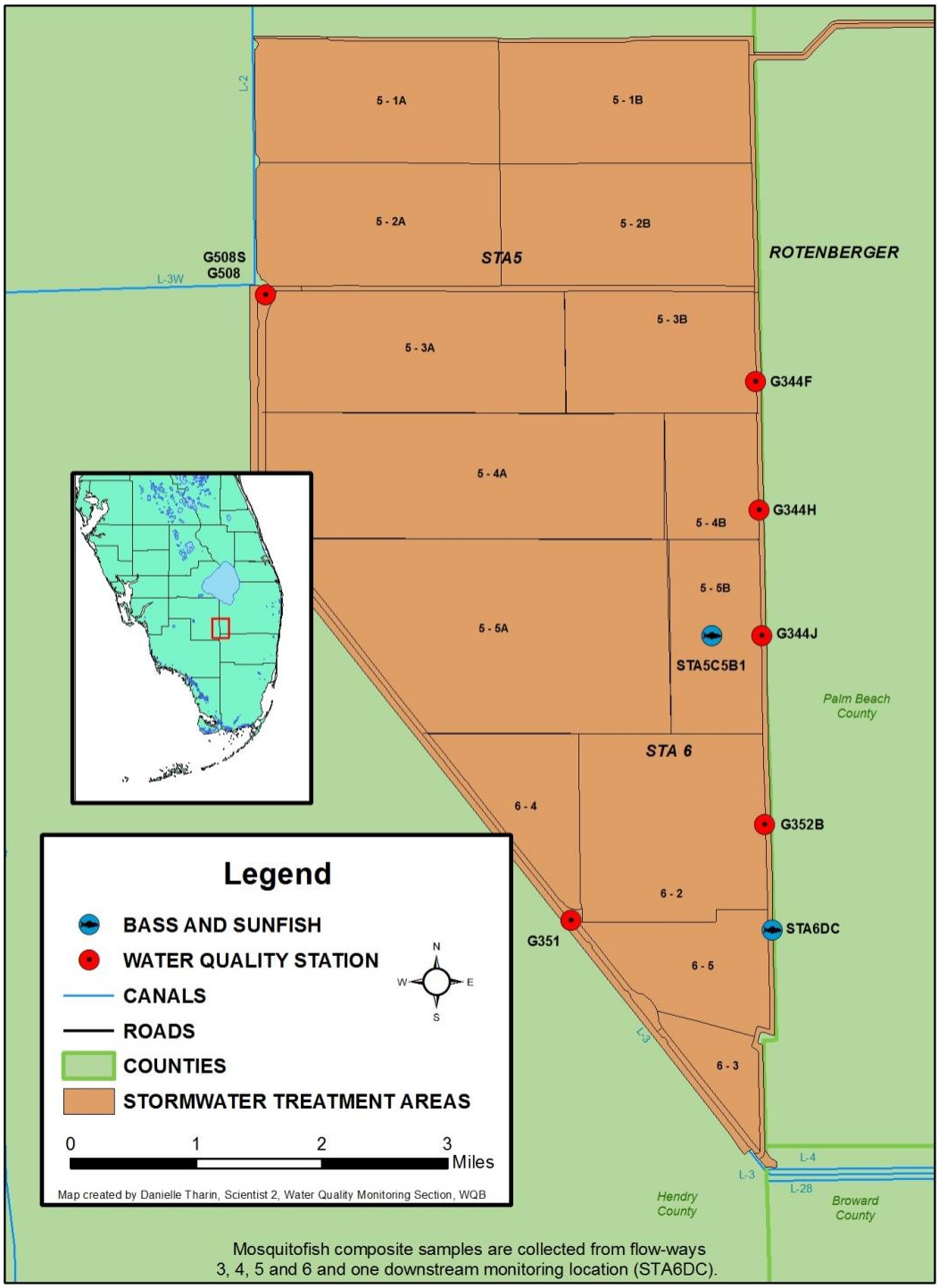

Figure C-6. Map of STA-5/6 showing current mercury monitoring sites. Mosquitofish composite samples are collected for each flow-way and composited, and collected at two downstream sites (RA1, first quarter only) and (STA6DC). Large-bodied fish are collected at one interior station (STA5CB1) and a downstream site (STA6DC).

Four quarterly samples for THg and MeHg in surface water were collected from an inflow station (G508) and each of the four flow-way outflows (Flow-way 3, 4, 5, and 6) in WY2014 (**Figure C-7**). Water column concentrations of THg and MeHg from Flow-way 3 in WY2014 displayed some of the lowest values compared to the other flow-ways. This is consistent with the results from WY2013. No THg sample was above the 12 ng/L USEPA surface water criterion. For WY2014, inflow and outflow THg load were 44.6 and 34.9 grams per year (g/yr), reflecting a 21.7% reduction at the outflow. The inflow and outflow MeHg loads were 8.1 and 4.5 g/yr, reflecting a 44.4% reduction (**Table C-3**).

Mosquitofish composites collected from Flow-ways 3, 4, 5 and 6 in WY2014 (**Figure C-6**) contained low annual mean mercury concentrations (**Figure C-8**), compared to the other STAs (**Table C-4**). The average annual mosquitofish composite for WY2014 (16 ng/g) and each individual mosquitofish composite (7 to 30 ng/g) for all locations within STA-5/6 Flow-ways 3 to 6 and the downstream site (ST6DC) did not exceed the period of record 75th percentile for all downstream Everglades sampling locations.

Large-bodied fish samples were collected at one interior station (STA5C5B) and one downstream station (STA6DC) during WY2014 (**Figure C-6**). Sunfish collected from the interior marsh and the downstream stations in WY2014 contained an average THg level of 33 ng/g and 28 ng/g, respectively (**Table C-5**) which is below the TL 3 fish standard (77 ng/g and 100 ng/g) by USEPA and USFWS, respectively. The THg concentration in whole sunfish from the downstream in WY2014 was considerably lower than that in previous water years (**Figure C-8**).

For WY2014, ten individuals of LMB were caught from the interior station and the downstream station. Among these fishes, only two individuals from the interior marsh and three individuals form the downstream station fell into the range of total length (307 to 385 mm) required by the Protocol. The average THg concentration was 213 ng/g for the interior (**Table C-6**) which is below the USEPA TL 4 fish standard (346 ng/g). The average THg concentration for the downstream station was 394 ng/g which is higher than those in the previous two water years (**Figure C-8**).

Regarding the risk to fish-eating wildlife, the resident mosquitofish within and downstream from STA-5/6 contained average mercury levels below the USEPA criterion of 77 ng/g for TL 3 fish species. No bluegills from Flow-ways 3 through 6 and the downstream site exceeded the USEPA criterion (77 ng/g) of TL 3 fish. No LMB from the interior marsh and only one of the five individuals from the downstream site were above the USEPA criterion of TL 4 fish (346 ng/g). Therefore, the risk of mercury exposure to fish-eating wildlife foraging preferentially at interior and downstream locations within STA-5/6 is low.

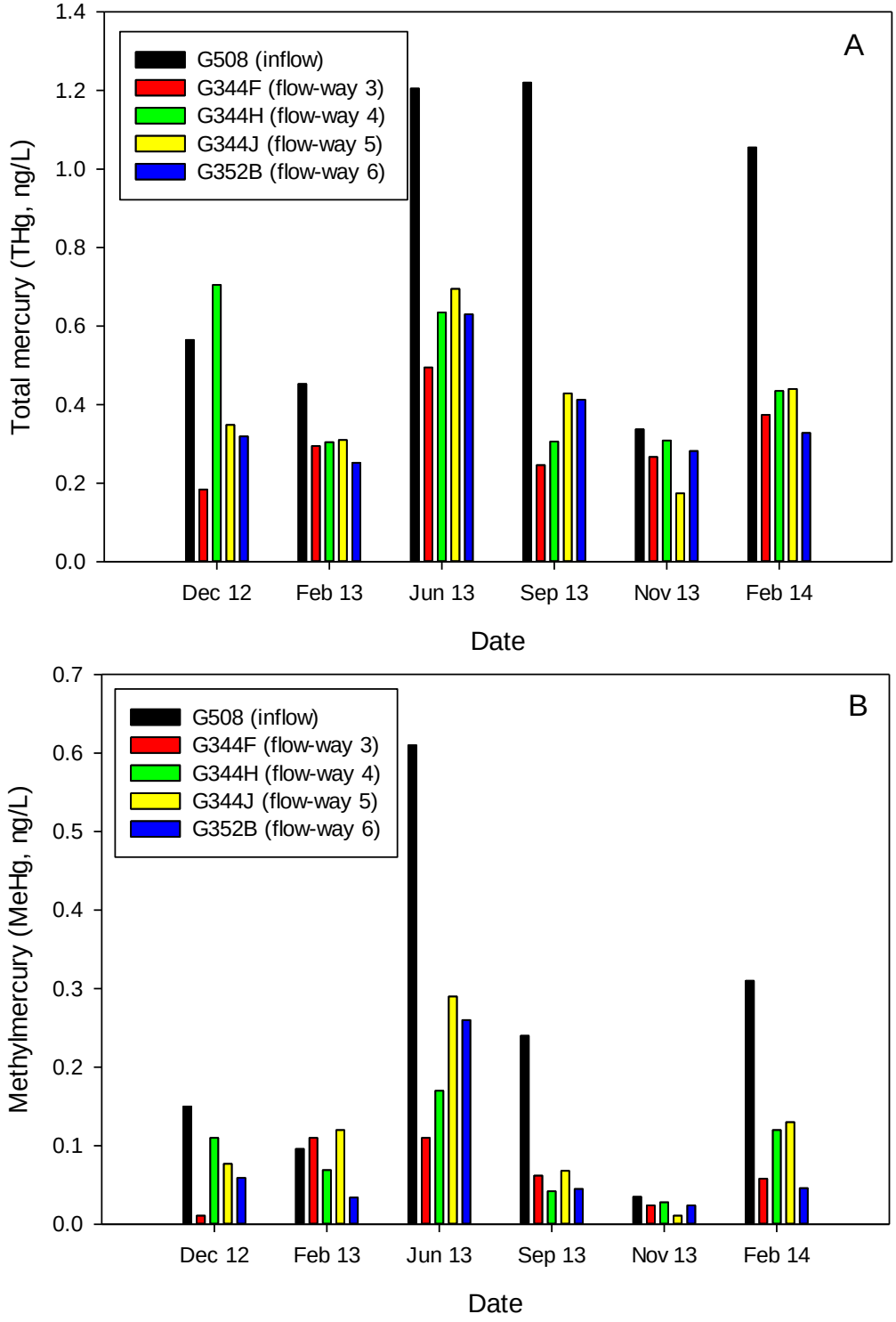

Figure C-7. Concentrations of THg (A) and MeHg (B) in unfiltered surface water collected at inflow and outflow (G508) of Flow-ways 3 (G344F), 4 (G344H), 5 (G344J), and 6 (G352B) of STA-5/6.

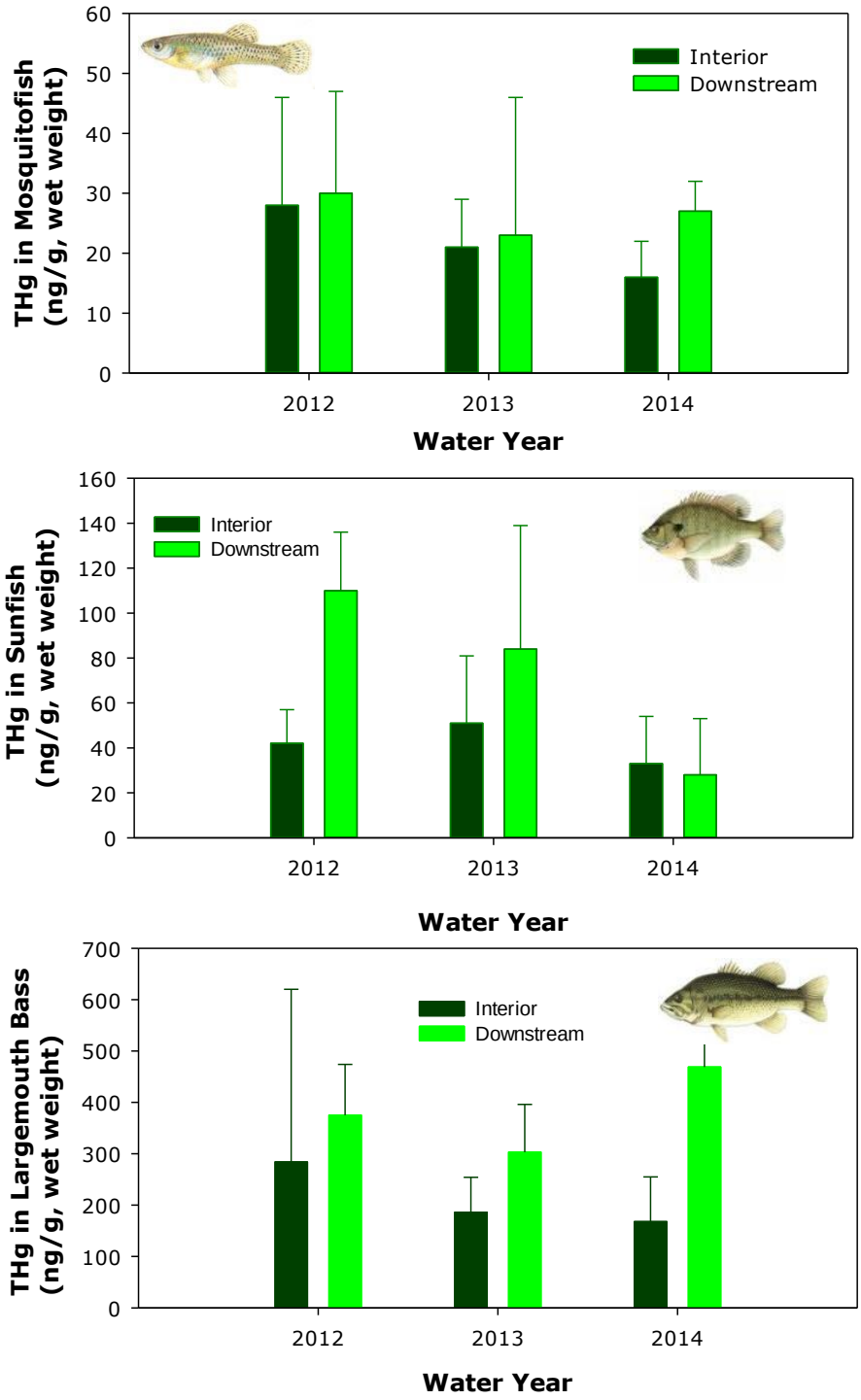

Figure C-8. Mercury concentrations (ng/g, wet weight, mean ± standard deviation) in mosquitofish composites (top), whole sunfish (middle), and fillets of LMB (bottom) collected at Flow-ways 3, 4 and 5 (mosquitofish and sunfish) and all sites (LMB) within STA-5/6.

MERCURY MONITORING NETWORK OPTIMIZATION

The summaries below provide information on the current mercury monitoring phase for each STA. These phases are concurrent with guidance contained in the Protocol (FDEP and SFWMD, 2011).

STA-1W

The permit modification for moving from Phase 3 - Tier 1 to Phase 3 - Tier 3 was issued August 21, 2009. Phase 3 - Tier 3 terminates all mercury monitoring in STA-1W (mosquitofish stations ST1W13COM, ST1W24COM, ST1WC5COM, ENR012, G310, and ST1WLX; bass and sunfish stations ST1W51, ENR012, G310, and ST1WLX).

STA-1E

Mercury monitoring in STA-1E is currently in Phase 3 - Tier 1. On February 29, 2012 the FDEP approved transfer of STA-1E mercury monitoring from Phase 2 - Tier 1: Routine Monitoring during Stabilization Period to Phase 3 - Tier 1: Routine Operational Monitoring from Year 4 to Year 9 for all flow-ways (Western, Central and Eastern), which include Cells 1, 2, 3, 4N, 4S, 5, 6 and 7. Phase 3 - Tier 1 terminated all mercury surface water monitoring at STA-1E (stations G-311, S-362, S-361, and S-319), reduced the mosquitofish monitoring frequency from quarterly to semiannually, bass and sunfish monitoring frequency from annually to triennially, and reduced the number of bass and sunfish monitoring stations from all flow-ways to one flow-way with the historically highest mercury concentrations (station ST1EC2A in Cell 2 of the Eastern Flow-way) and one downstream station (ST1ELX). Bass and sunfish monitoring were terminated in the Central (station ST1EC4SA in Cell 4S) and Western (station ST1EC6A in Cell 6) flow-ways.

STA-2

Mercury monitoring in STA-2 is currently in Phase 3 - Tier 3: Routine Operational Monitoring after Year 9 for Cells 1, 2, and 3 and Phase 2 - Tier 1: Routine Monitoring during Stabilization Period for Compartment B Cells 4, 5, 6, 7 and 8.

On February 29, 2012, the FDEP approved transfer of STA-2 mercury monitoring from Phase 2 - Tier 1: Routine Monitoring during Stabilization Period for Cells 1, 2 and 3 of STA-2 to Phase 3 - Tier 3: Routine Operational Monitoring after Year 9 and Phase 3 - Tier 1: Routine Operational Monitoring from Year 4 to Year 9 for Cell 4 of STA-2. Phase 3 - Tier 3 implemented the termination of all site specific mercury monitoring at STA-2 Cells 1, 2, and 3 (mosquitofish stations ST2C1COM, ST2C2COM, and ST2C3COM).

In August 2012, the District completed construction of the EAA Compartment B Buildout Project (Compartment B). Compartment B includes three pump stations (G-434, G-435, and G-436) and two flow-ways: the NBO, which includes Cells 4, 5, and 6, and the SBO, which includes Cells 7 and 8. Compartment B incorporated the existing Cell 4. Startup monitoring for mercury and other toxicants was performed for Compartment B in September (mosquitofish) and October (sediment) of 2011 to capture the “first-flush effect” when the NBO and SBO were initially inundated. Compartment B met the mercury and other toxicant startup criteria as specified in Specific Condition 23 of EFA Permit Number 0311207 in October 2011 (see data summary provided in correspondence from H. Andreotta, SFWMD dated December 14, 2012). On December 20, 2012, the FDEP approved transfer of monitoring from Phase 1 - Tier 2: Field Sampling for Initial Startup Monitoring Prior to Discharge to Phase 2 - Tier 1: Routine Monitoring during Stabilization Period for Compartment B (Cells 4, 5, 6, 7 and 8).

In July 2013, the District completed one year (i.e., four quarterly sampling events) of Phase 2 - Tier 1: Routine Monitoring during Stabilization Period. Based on guidance contained in the Protocol (page 14, 2nd paragraph), after one year of monitoring, project managers may elect to reduce the number of OUs sampled for large-bodied fish to one OU with the highest observed concentration of mercury and one downstream station and assess results as "worst case". Consistent with this guidance (see data summary provided in correspondence from H. Andreotta, SFWMD dated October 1, 2013) and with concurrence of FDEP, the District terminated large-bodied fish monitoring at the Compartment B NBO station ST2C4A and will monitor SBO station ST2C8A as "worst case", effective October 2, 2013.

The Protocol also states that "if, after one year of monitoring, action level criteria are met, surface water sampling for other toxicants would be discontinued. If levels of other toxicants in tissues do not exceed recognized background tissue concentrations or benchmarks established in ecological risk assessments completed as part of the ESA, then sampling would be discontinued." Compartment B met these criteria (see data summary provided in correspondence from H. Andreotta, SFWMD dated October 1, 2013) and on October 2, 2013, the FDEP approved termination of monitoring for other toxicants.

STA-3/4

Mercury monitoring in STA-3/4 is currently in Phase 3 - Tier 3. In October 2012, all Phase 3 - Tier 1 mercury monitoring criteria were met (see correspondence from H. Andreotta (District) dated January 17, 2013). On February 20, 2013 the FDEP approved transfer of STA-3/4 mercury monitoring from Phase 3 - Tier 1: Routine Operational Monitoring from Year 4 to Year 9 to Phase 3 - Tier 3: Routine Operational Monitoring after Year 9. This implemented the termination of all site specific mercury monitoring at STA-3/4 (semiannual mosquitofish monitoring at stations STA34C1COM, STA34C2COM, and STA34C3COM and triennial bass and sunfish monitoring at stations STA34C22 and L5F1.)

STA-5/6

Mercury monitoring at STA-5/6 is currently in Phase 3 - Tier 3: Routine Operational Monitoring after Year 9 for Flow-ways 1, 2, 7, and 8 and Phase 2 - Tier 1: Routine Monitoring during Stabilization for Flow-ways 3, 4, 5, and 6. STA-5 Flow-ways 1 and 2 met Phase 3 - Tier 3 Routine Operational Monitoring after Year 9 conditions in November 2008 (see data summary provided in correspondence from G. Vince, SFWMD dated October 12, 2009 and data for the final November 2009 fish collection submitted to FDEP in December 2009 by H. Andreotta, SFWMD).

The FDEP issued minor permit modification 0236905-001 June 6, 2008, approving transfer of mercury monitoring from Phase 2 - Tier 1: Routine Monitoring during Stabilization Period to Phase 3 - Tier 3: Routine Operational Monitoring from Year 4 to Year 9 for STA-6 Section 1. Phase 3 - Tier 3 implemented the termination of all site specific mercury monitoring at STA-6 Section 1.

In September 2012, the District completed construction of the EAA Compartment C Buildout Project (Compartment C). Compartment C includes the G-508 pump station, STA-5 Flow-way 4 (consisting of Cells 5-4A and 5-4B), STA-5 Flow-way 5 (consisting of Cells 5-5A and 5-5B), and STA-6 Cell 6-4. STA-6 Cell 6-4, combined with the existing Cell 6-2, forms Flow-way 6. The entire STA-5, STA-6, and Compartment C Buildout complex is now referred to as STA-5/6.

Startup monitoring for mercury and other toxicants was performed for Compartment C in September (mosquitofish) and October (sediment) 2011 to capture the "first-flush effect" when the project was initially inundated. Compartment C met the mercury and other toxicant startup

criteria as specified in Specific Condition 23 of EFA Permit Number 0311207 in October 2011 (see data summary provided in correspondence from H. Andreotta, SFWMD dated December 14, 2012). December 20, 2012, the FDEP approved transfer of monitoring from Phase 1 - Tier 2: Field Sampling for Initial Startup Monitoring Prior to Discharge to Phase 2 - Tier 1: Routine Monitoring during Stabilization Period for Compartment C (Flow-ways 4, 5, and 6).

In July 2013, the District completed one year (i.e., four quarterly sampling events) of Phase 2 - Tier 1: Routine Monitoring during Stabilization Period. Based on guidance contained in the Protocol, after one year of monitoring, project managers may elect to reduce the number of OUs sampled for large-bodied fish to one OU with the highest observed concentration of mercury and one downstream station and assess results as "worst case". Consistent with this guidance and with concurrence of the FDEP, the District terminated large-bodied fish monitoring at STA-5/6 Flow-ways 3 (station STA5C3B1), 4 (station STA5C4B1), and 6 (station STA6S2) and will monitor Glow-way 5 (station STA5C5B1) as "worst case" effective October 2, 2013. Based on an evaluation submitted to the FDEP on October 1, 2013, it was determined that Flow-way 6 has slightly higher concentrations of mercury than Flow-way 5, however, Flow-way 6 is maintained at lower operational priority for receiving inflow water for treatment and tends to dry out. Large-bodied fish will be monitored in Flow-way 5 since it was determined to have the second highest concentrations of mercury, a higher operational priority than Flow-way 6, and there is a greater likelihood of obtaining bass, sunfish, and mosquitofish samples.

The Protocol requires fish monitoring at one downstream station per project. In September 2012, Compartment C combined with the former STA-5 and STA-6 to form STA-5/6. Because the STA-5/6 complex now operates as one project, the number of downstream stations was reduced from two (i.e., stations RA1 in Rotenberger WMA and STA6DC in the STA-5/6 discharge canal) to one (i.e., STA6DC). Downstream mosquitofish THg concentrations were significantly higher at STA6DC than RA1. Furthermore, Rotenberger WMA does not provide hydrological conditions favorable for recruitment of large-bodied fish and the District was frequently unable to obtain a full quota (n=5) of LMB at station RA1. For these reasons and with concurrence of the FDEP, station STA6DC was retained as the STA-5/6 downstream monitoring station and all monitoring was terminated at station RA1 effective October 2, 2013.

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Attachment D: Rotenberger Wildlife Management Area Restoration and STA Downstream Transect Monitoring

Thomas Dreschel

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In addition to the information provided in this attachment, additional supplemental information is required by Specific Conditions 12(a), 12(b), and 25(b), of the EFA Permit (0311207). This supporting information is available upon request.

HYDROPATTERN RESTORATION AND STA DISCHARGE MONITORING ON THE DOWNSTREAM AREAS

This section presents results from monitoring conducted in the areas downstream of the Everglades Stormwater Treatment Areas (STAs), including the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge or WCA-1; **Figure D-1**), Water Conservation Area (WCA)-2A (**Figure D-4**), and the Rotenberger Wildlife Management Area (RWMA; **Figure D-8**). Everglades Forever Act (EFA) Permit Number 0311207, EFA Consent Order OGC FILE NO. 12-1149 and National Pollutant Discharge Elimination System (NPDES) Consent Order OGC FILE NO. 12-1148 requires the characterization of the effects of STA discharges on adjacent marsh areas. This characterization is based on monthly samples collected for specific conductance (conductivity) and total phosphorus (TP). Water quality monitoring stations in the marsh areas have been chosen along a transect from the discharge points and are categorized as "impacted" or "unimpacted" based on sediment TP levels. Those transect stations in areas where sediment TP levels are greater than 500 milligrams per kilogram (mg/kg) are identified as impacted.

This year we are reporting on additional soil parameters that have been included as part of a new permit requirement. We will be reporting every two years on Total Phosphorus, Total Nitrogen, Total Carbon, Percent Ash Content, Bulk Density, and Total Calcium. Soils at all twenty-eight (28) marsh stations continue to be collected every odd year and the three (3) canal stations (Z-0, LOXA104, and LOXA135) shall not be sampled for soils.

Due to a change in procedure in the analytical laboratory, some of the soil samples reported this year have been qualified due to the holding time exceeding 28 days. The samples affected are listed in table D-21 presented in the Soils Analysis Qualifier Section beginning on page 101 of this Attachment with a more detailed explanation. The laboratory will now use an intermediate step to establish soil sample stability and laboratory procedures have been streamlined.

[1] Florida Fish and Wildlife Conservation Commission, Miami/Fort Lauderdale area

Monitoring data for each transect are provided in **Attachment B**. A summary of specific conductance and TP collected for these transects is provided in **Tables D-1** and **D-2**, respectively. These water quality data are also graphically presented as notched box-and-whisker plots along with the results of the monitoring conducted as part of the hydropattern restoration monitoring, which includes vegetation and water level.

Table D-1. Summary statistics for specific conductance in microsiemens per centimeter (µS/cm) measurements collected during Water Year 2014 (WY2014) (May 1, 2013–April 30, 2014) at transect stations from STA outflows. [Note: km – kilometers]

STA Transects		Station Information		Distance (km)[2]	No. of Obs.	Mean ± SD[3]	Min	Percentiles[4]			Max	Geometric Mean
		Station	Category[1]					25th	50th	75th		
STA-1E	1	LOXA135	Rim Canal	0.00	12	968 ± 208	86	48	1018	1105	1307	946
		LOXA136	Impacted	0.56	12	563 ± 248	81	39	592	776	871	499
		LOXA137	Impacted	1.07	12	432 ± 230	47	200	419	634	757	367
		LOXA138	Unimpacted	2.11	12	242 ± 113	119	142	242	290	523	220
		LOXA139	Unimpacted	3.93	9	121 ± 36	85	90	101	154	173	116
STA-1W	1	LOXA104	Rim Canal	0.00	12	802 ± 164	516	711	836	914	1066	786
		LOXA104.5	Impacted	0.31	10	777 ± 174	330	793	824	871	920	751
		LOXA105	Impacted	0.77	10	668 ± 260	243	517	716	902	972	610
		LOXA106	Impacted	1.09	9	613 ± 240	187	390	680	807	870	556
		LOXA107	Impacted	2.21	6	266 ± 96	148	200	243	367	393	251
		LOXA107U	Unimpacted	3.38	10	146 ± 31	102	122	140	173	191	143
		LOXA108	Unimpacted	4.07	7	114 ± 30	60	98	116	136	149	110
	2	LOXAZ0	Rim Canal	0.00	12	808 ± 165	534	718	788	967	1025	792
		LOXAZ1	Impacted	0.25	11	641 ± 278	108	542	816	829	931	545
		LOXAZ2	Impacted	1.44	12	369 ± 200	94	178	424	540	676	309
		LOXAZ3	Impacted	3.48	12	149 ± 42	98	105	158	177	225	144
		LOXAZ4	Unimpacted	5.82	12	151 ± 72	85	98	130	172	319	138

Table D-1. (Continued).

STA Transects		Station Information		Distance (km)[2]	No. of Obs.	Mean ± SD[3]	Min	Percentiles[4]			Max	Geometric Mean
		Station	Category[1]					25th	50th	75th		
STA-2	1	2AN.25	Impacted	0.25	12	1102 ± 101	973	1049	1064	1173	1296	1098
		2AN1	Impacted	0.98	12	1086 ± 103	912	1021	1078	1147	1271	1082
		2AN2	Impacted	1.98	11	1073 ± 133	863	977	1063	1166	1316	1065
		2AN4	Impacted	3.77	12	1038 ± 151	825	896	1058	1162	1274	1028
		2AN5	Unimpacted	4.83	10	990 ± 144	820	877	974	1078	1232	981
		2AN6	Unimpacted	5.82	10	948 ± 164	768	833	903	1061	1250	936
	2	2AC.25	Impacted	0.25	11	1073 ± 99	923	992	1073	1148	1245	1069
		2AC2	Impacted	1.88	11	1046 ± 144	855	936	1054	1170	1280	1037
		2AC4	Unimpacted	3.77	9	962 ± 142	807	877	905	1071	1251	953
		2AC5	Unimpacted	4.80	8	895 ± 82	795	830	892	934	1054	892
	3	2AFS.25	Impacted	0.34	11	1036 ± 64	939	996	1024	1080	1172	1034
		FS1	Impacted	1.02	9	1045 ± 80	945	979	1033	1100	1166	1042
		FS3	Impacted	3.09	12	986 ± 121	799	895	974	1033	1202	979
		CA29	Unimpacted	6.17	12	951 ± 145	695	870	970	1039	1147	940
STA-5/6	1	ROTC1	Impacted	0.23	11	477 ± 156	275	327	500	616	689	452
		ROTC2	Impacted	2.30	11	410 ± 181	194	242	413	575	647	371
		ROTC3	Impacted	4.20	8	359 ± 153	153	219	377	489	548	327

[1] Categories of “impacted” and “unimpacted” refer to station identification based on sediment phosphorus concentrations, Impacted stations have sediment total phosphorus concentrations of 500 milligrams per kilogram. This categorization of sampling stations is presented in the EFA Consent Order OGC FILE NO. 12-1149 and National Pollutant Discharge Elimination System (NPDES) Consent Order OGC FILE NO. 12-1148

[2] Distance along transect from canal in kilometers (km)

[3] SD = Standard Deviation

4 50th Percentile - Median

Table D-2. Summary statistics for TP in micrograms per liter (µg/L) measurements collected during WY2014 at transect stations from STA outflows.

STA Transects		Station Information		Distance (km)[2]	No. of Obs.	Mean ± SD[3]	Min	Percentiles[4]			Max	Geometric Mean
		Station	Category[1]					25th	50th	75th		
STA-1E	1	LOXA135	Rim Canal	0.00	12	42 ± 11	29	32	40	49	69	40
		LOXA136	Impacted	0.56	12	15 ± 4	7	14	17	17	20	15
		LOXA137	Impacted	1.07	12	9 ± 2	7	8	9	10	13	9
		LOXA138	Unimpacted	2.11	11	8 ± 2	4	6	7	10	11	7
		LOXA139	Unimpacted	3.93	9	8 ± 2	6	6	7	9	11	8
STA-1W	1	LOXA104	Rim Canal	0.00	12	50 ± 67	24	25	31	35	261	36
		LOXA104.5	Impacted	0.31	10	32 ± 35	13	16	20	28	128	24
		LOXA105	Impacted	0.77	10	20 ± 15	9	13	15	20	62	17
		LOXA106	Impacted	1.09	9	10 ± 3	5	9	10	13	14	10
		LOXA107	Impacted	2.21	6	9 ± 2	7	8	9	11	12	9
		LOXA107U	Unimpacted	3.38	10	7 ± 3	5	6	7	8	14	7
		LOXA108	Unimpacted	4.07	7	9 ± 5	5	6	8	10	19	8
	2	LOXAZ0	Rim Canal	0.00	12	28 ± 18	16	20	21	31	82	25
		LOXAZ1	Impacted	0.25	11	24 ± 8	16	17	24	27	40	23
		LOXAZ2	Impacted	1.44	12	12 ± 2	9	11	12	14	15	12
		LOXAZ3	Impacted	3.48	12	7 ± 2	4	7	7	8	11	7
		LOXAZ4	Unimpacted	5.82	12	6 ± 1	5	6	6	7	8	6

Table D-2. (Continued)

STA Transects		Station Information		Distance (km)[2]	No. of Obs.	Mean ± SD[3]	Min	Percentiles[4]			Max	Geometric Mean
		Station	Category[1]					25th	50th	75th		
STA-2	1	2AN.25	Impacted	0.25	12	20 ± 5	16	18	18	20	32	20
		2AN1	Impacted	0.98	12	16 ± 4	11	13	16	18	25	16
		2AN2	Impacted	1.98	11	11 ± 2	8	10	11	12	14	11
		2AN4	Impacted	3.77	12	7 ± 2	5	6	7	7	11	7
		2AN5	Unimpacted	4.83	10	6 ± 1	5	6	6	7	7	6
		2AN6	Unimpacted	5.82	10	6 ± 1	4	5	6	7	7	6
	2	2AC.25	Impacted	0.25	11	13 ± 2	11	12	13	15	16	13
		2AC2	Impacted	1.88	11	7 ± 1	5	6	7	7	8	7
		2AC4	Unimpacted	3.77	9	6 ± 1	4	5	6	6	8	6
		2AC5	Unimpacted	4.80	8	6 ± 1	5	5	5	6	8	6
	3	2AFS.25	Impacted	0.34	11	20 ± 2	17	18	20	21	22	19
		FS1	Impacted	1.02	9	16 ± 2	14	15	16	17	20	16
		FS3	Impacted	3.09	12	7 ± 1	5	7	7	8	9	7
		CA29	Unimpacted	6.17	12	5 ± 1	3	4	4	6	8	5
STA-5/6	1	ROTC1	Impacted	0.23	10	13 ± 3	8	10	13	15	18	12
		ROTC2	Impacted	2.30	11	8 ± 2	6	7	8	10	13	8
		ROTC3	Impacted	4.20	8	10 ± 2	7	8	10	11	14	9

[1] Categories of “impacted” and “unimpacted” refer to station identification based on sediment phosphorus concentrations, Impacted stations have sediment total phosphorus concentrations of 500 milligrams per kilogram. This categorization of sampling stations is presented in the EFA Consent Order OGC FILE NO. 12-1149 and National Pollutant Discharge Elimination System (NPDES) Consent Order OGC FILE NO. 12-1148

[2] Distance along transect from canal in kilometers (km)

[3] SD = Standard Deviation

[4] 50th Percentile - Median

Transects in the Refuge (**Figure D-1**) exhibited decreases in both specific conductance and TP concentrations within 1 kilometer (km) of the rim canal during WY2014 (**Figures D-2** and **D-3**). Geometric mean specific conductance values measured in the western transect (downstream of STA-1W outflows) decreased by approximately 30 percent or 230 microsiemens per centimeter (µS/cm) and geometric mean TP concentrations for this transect decreased by approximately 72 percent or 26 micrograms per liter [µg/L or parts per billion (ppb)] within 1 km of the rim canal station. The eastern transect (downstream of the STA-1E outflow) exhibited a decrease of approximately 60 percent or 579 µS/cm in specific conductance and 78 percent or 32 µg/L in TP within 1 km of the rim canal. An additional transect (LOXAZ0 to LOXAZ4) was added to the monitoring requirement. This transect is located in the southwestern portion of the Refuge. Geometric mean specific conductance for this transect decreased by 61 percent or 483 µS/cm within approximately 1.5 km from the rim canal. Geometric mean TP concentrations decreased by 51 percent or 13 µg/L. Stations located more than 1 km from the rim canal for all three transects had geometric mean TP concentrations ranging from 6 to 12 ppb with geometric mean specific conductance values ranging from 110 - 556 µS/cm (**Tables D-1** and **D-2**). Typical specific conductance values for rain-fed marshes in the Everglades are less than 200 µS/cm (McCormick et al. 2011). Only one specific conductance measurement exceeded the Class III criterion of 1,275 µS/cm. This value (1,305 µS/cm) was measured at LOXA135 in the eastern rim canal on December 5, 2013. Discharge from the STA-1E outflow structure, S362, for December 2 – 9, 2013, ranged from 1294 to 1370 µS/cm and appears to have contributed to elevated specific conductance observed in the rim canal at that time.

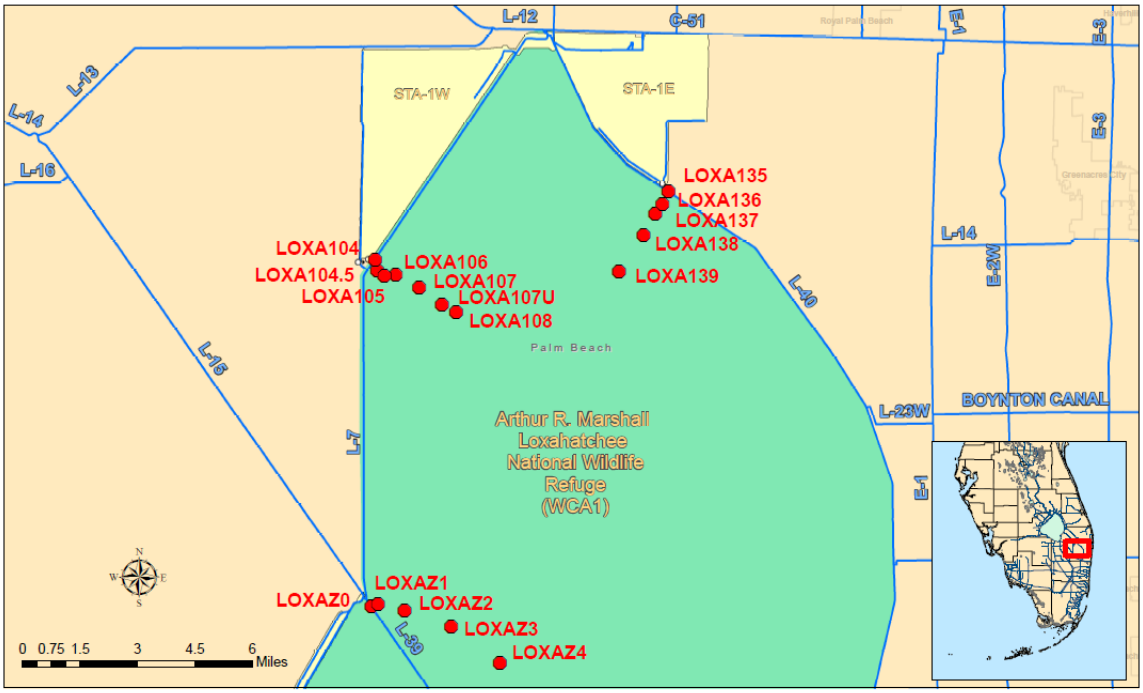


Figure D-1. Locations of marsh transect stations in the Refuge and outflow structures from STA 1 West (STA-1W) and STA 1 East (STA-1E).

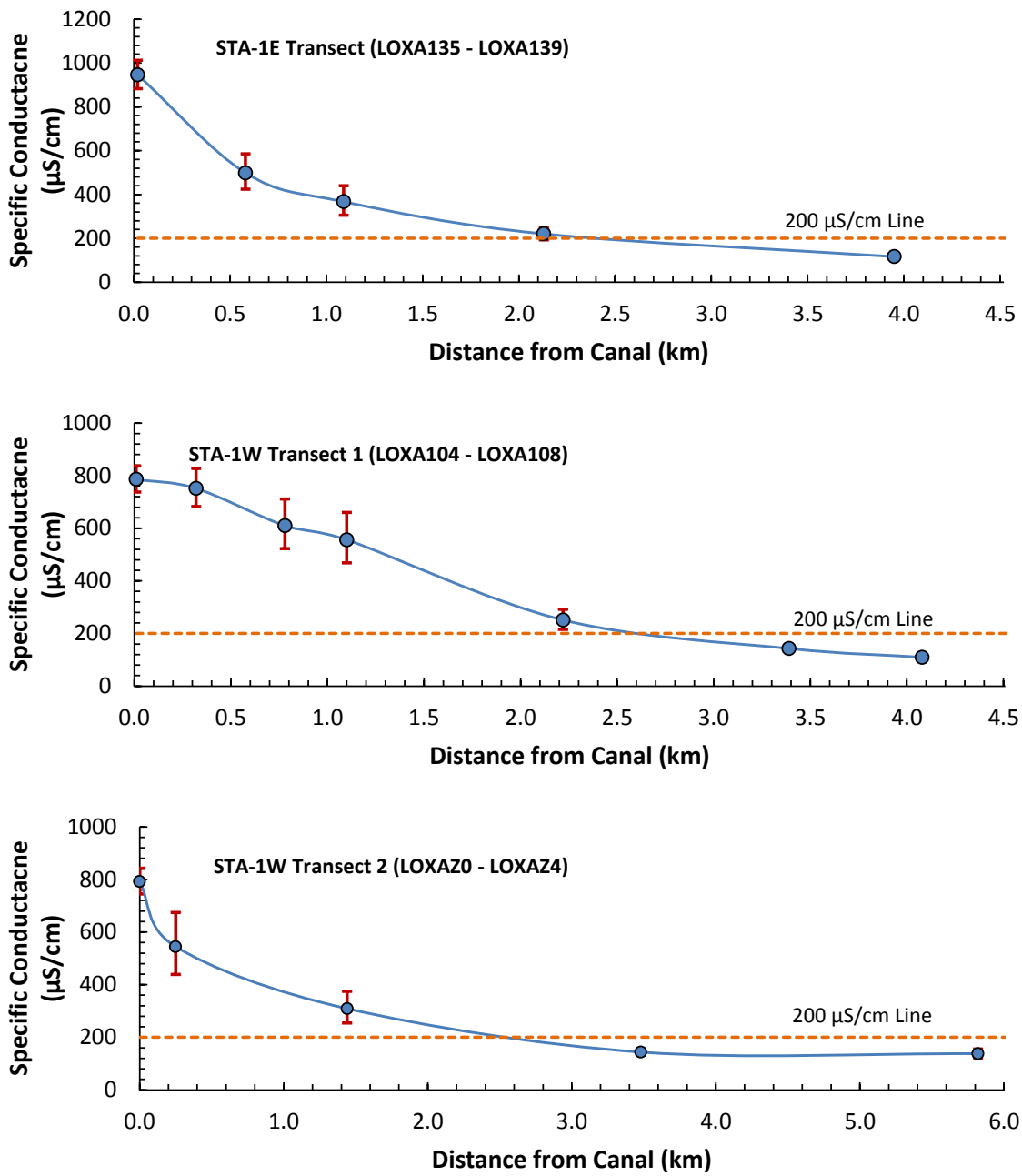


Figure D-2. Plots of geometric mean specific conductance measured at transect stations downstream of STA-1W and STA-1E during Water Year 2014 (WY2014) (May 1, 2013–April 30, 2014). The error bars represent the standard error around the calculated geometric mean. The 200 µS/cm reference line is presented to identify the upper specific conductance limit observed in "rain-driven" portions of the Refuge.

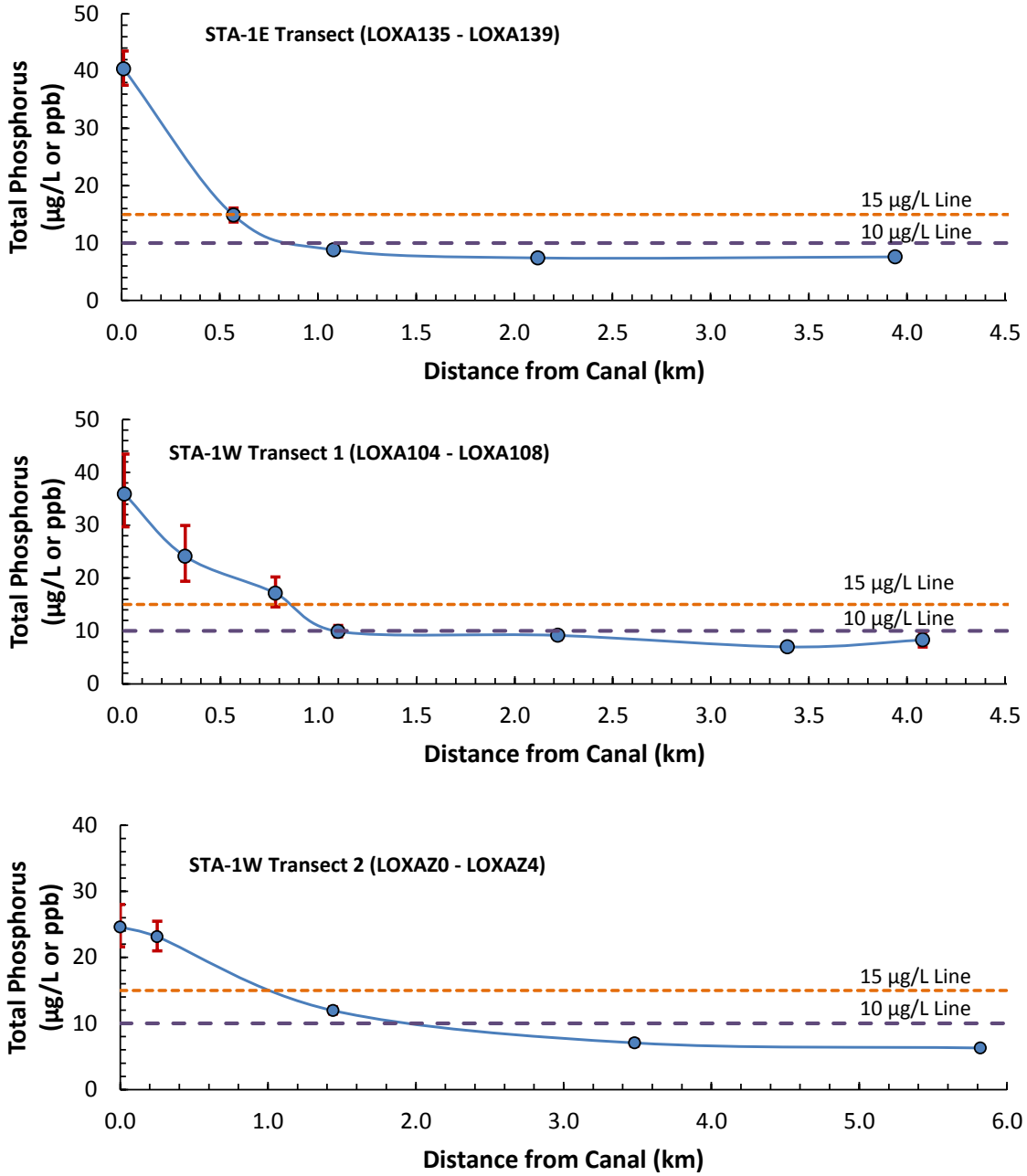


Figure D-3. Plots of geometric TP concentrations measured at transect stations downstream of STA-1W and STA-1E during WY2014. The error bars represent the standard error around the calculated geometric mean. Two reference lines (10 and 15 µg/L) are only presented to identify long-term and annual limit used in the Phosphorus Rule.

The average specific conductance levels for the STA-1E transect were 348 ± 246 µS/cm (geometric mean = 289; median = 286) and 483 ± 341 µS/cm (geometric mean = 358; median = 341) for Water Year (WY) 2013 (May 1, 2012–April 30, 2013) and WY2014, respectively. A Mann-Whitney test indicated that the observed increase in specific conductance from WY2013 to WY2014 was not statistically significant (Mann-Whitney test, p-value = 0.184). The average TP concentration for this transect was 14 ± 9 µg/L (geometric mean = 11; median = 9) for WY2013 and 17 ± 11 µg/L (geometric mean = 13; median =11) for WY2014 with no statistical difference observed between the two years (Mann-Whitney test, p-value = 0.401). The STA-1W Transect 1 had specific conductance averaging 361 ± 230 µS/cm (geometric mean = 298; median = 311) for WY2013 and 522 ± 560 µS/cm (geometric mean = 397; median = 560) for WY2014. Based on the specific conductance data for these two years, WY2013 had statistically lower levels than WY2014 (Mann-Whitney test, p-value = 0.019). A comparison of TP concentration between these two water years for this transect shows that no statistical difference in TP concentrations was observed (p-value = 0.593) with averages of 19 ± 12 µg/L (geometric mean = 14; median = 12) for WY2013 and 22 ± 13 µg/L (geometric mean = 15; median = 13) for WY2014. No statistical difference was observed between WY2013 and WY2014 with respect to specific conductance (p-value = 0.969) and TP concentrations (p-value = 0.706) measured at STA-1W Transect 2. Specific conductance measured during WY2013 averaged 376 ± 255 µS/cm (geometric mean = 296; median = 255) compared to 420 ± 261 µS/cm (geometric mean = 302; median 261) for WY2014. During WY2013, TP concentrations averaged 13 ± 12 µg/L (geometric mean = 11; median 12) compared to 15 ± 12 µg/L (geometric mean = 12; median 12) for WY2014. Additional statistical summaries for transects associated with STA-1E and STA-1W outflows are provided in **Tables D-3** and **D-4**.

Table D-3. Comparison of surface water specific conductance collected at permit compliance stations in the Refuge during WY2013 and WY2014.

STA (Transect)	Station	Specific Conductance (µS/cm)					
		WY2013			WY2014		
		No. of Samples	Mean ± SD	Geometric Mean	No. of Samples	Mean ± SD	Geometric Mean
STA-1E (Transect 1)	LOXA135	12	725 ± 254	684	12	968 ± 208	946
	LOXA136	12	335 ± 151	314	12	563 ± 248	499
	LOXA137	12	260 ± 70	250	12	432 ± 230	367
	LOXA138	11	215 ± 60	207	12	242 ± 113	220
	LOXA139	10	166 ± 49	159	9	121 ± 36	116
STA-1W (Transect 1)	LOXA104	12	748 ± 200	720	12	802 ± 164	786
	LOXA104.5	11	447 ± 103	437	10	777 ± 174	751
	LOXA105	12	352 ± 91	342	10	668 ± 260	609
	LOXA106	10	307 ± 77	299	9	613 ± 240	556
	LOXA107	7	203 ± 60	197	6	266 ± 96	251
	LOXA107U	9	158 ± 60	151	10	146 ± 31	143
	LOXA108	9	140 ± 58	131	7	114 ± 30	110
STA-1W (Transect 2)	LOXAZ0	4	804 ± 145	794	12	808 ± 165	792
	LOXAZ1	4	519 ± 119	509	11	641 ± 278	545
	LOXAZ2	4	260 ± 17	260	12	369 ± 200	309
	LOXAZ3	4	161 ± 15	161	12	149 ± 42	144
	LOXAZ4	4	136 ± 9	136	12	151 ± 72	138

Table D-4. Comparison of TP concentrations collected at permit compliance stations in the Refuge during WY2013 and WY2014.

STA (Transect)	Station	Total Phosphorus (µg/L)					
		WY2013			WY2014		
		No. of Samples	Mean ± SD	Geometric Mean	No. of Samples	Mean ± SD	Geometric Mean
STA-1E (Transect 1)	LOXA135	11	27 ± 10	25	12	42 ± 11	40
	LOXA136	11	17 ± 11	15	12	15 ± 4	15
	LOXA137	11	10 ± 4	10	12	9 ± 2	9
	LOXA138	10	7 ± 3	7	11	8 ± 2	7
	LOXA139	9	7 ± 1	7	9	8 ± 2	8
STA-1W (Transect 1)	LOXA104	11	30 ± 15	28	12	50 ± 67	36
	LOXA104.5	10	32 ± 43	23	10	32 ± 35	24
	LOXA105	11	22 ± 23	17	10	20 ± 15	17
	LOXA106	9	11 ± 6	10	9	10 ± 3	10
	LOXA107	6	8 ± 1	8	6	9 ± 2	9
	LOXA107U	8	7 ± 1	7	10	7 ± 3	7
	LOXA108	8	8 ± 3	8	7	9 ± 5	8
STA-1W (Transect 2)	LOXAZ0	4	22 ± 2	22	12	28 ± 18	25
	LOXAZ1	9	15 ± 7	14	11	24 ± 8	23
	LOXAZ2	4	11 ± 3	11	12	12 ± 2	12
	LOXAZ3	4	7 ± 2	7	12	7 ± 2	7
	LOXAZ4	4	6 ± 2	5	12	6 ± 1	6

Soils

Wetland soils in WCA-1 were sampled two times during WY2014, August and October. A summary of soil phosphorus, nitrogen, carbon, calcium, ash and moisture content along transects stations is provided in **Table D-5**. Soil P content decrease with distance from the rim canal along all three transects with concentrations generally being less than 500 mg/kg at a distance of 2 to 2.5 kilometers. Overall, soil P decreased by 63 to 73 percent along the three transects. Soil N content exhibited an inverse relationship with distance from the rim canal with concentrations increasing along all three transects into WCA1. Generally, soil N increased by 8 to 19 percent. All the other parameters either exhibited no change along the three transects or a slight increase from the rim canal. Similar soil concentrations were observed in WCA-1 by Corstanje et al. (2006). A graphical presentation of the soil data for WCA-1 is provided in **Figures D-15 – D-19**.

Additionally, soil TP measured in WY2014 were compared to those measured along the same transects in WY2011 (**Table D-6**). Generally, soil TP measured in WY2011 appeared to be approximately two percent lower along the STA-1E transect 1 and six percent lower also along transect 1 from STA-1W. A statistical comparison was performed for each monitoring station using a two-sample t-test (**Table D-6**). The results of the test indicate that while sediment TP content changed at each monitoring station between the two water years, the changes were not statistically significant ($p > 0.05$).

Table D-5. Soil P, N, C, Ca, ash, and moisture content measured in WY2014 during August and October in WCA-1. Each mean was calculated from data of at least three cores collected at three marsh transects to a depth of 10 cm.

STA Transect	Transect	Distance from Canal (km)	Station	Soil Quality (Mean ± Standard Deviation)					
				Total P (mg/kg)	Total N (%)	Total C (%)	Total Ca (%)	Total Ash (%)	Moisture (%)
STA-1E	1	0.56	LOXA136	820 ± 168	4.0 ± 0.3	49 ± 1	2.1 ± 0.1	8.5 ± 1.5	90 ± 2
		1.07	LOXA137	614 ± 125	4.0 ± 0.1	48 ± 1	1.8 ± 0.2	8.0 ± 0.2	92 ± 1
		2.11	LOXA138	336 ± 130	4.3 ± 0.4	49 ± 2	1.8 ± 0.1	8.4 ± 1.5	93 ± 0[b]
		3.93	LOXA139	297 ± 69	4.3 ± 0.3	51 ± 1	1.5 ± 0.2	6.7 ± 0.8	93 ± 1
STA-1W	1	0.31	LOXA104.5	1,098 ± 12	3.2 ± 0.0[a]	48 ± 0[b]	2.2 ± 0.4	8.8 ± 1.7	94 ± 1
		0.77	LOXA105	860 ± 86	3.2 ± 0.3	48 ± 0[b]	2.6 ± 0.1	9.7 ± 1.2	94 ± 2
		1.09	LOXA106	564 ± 44	3.3 ± 0.1	47 ± 1	2.9 ± 0.5	11.5 ± 0.7	92 ± 2
		2.21	LOXA107	564 ± 31	3.0 ± 0.0[a]	48 ± 1	2.3 ± 0.1	9.0 ± 0.1	92 ± 0[b]
		3.38	LOXA107U	315 ± 92	3.5 ± 0.6	53 ± 4	1.9 ± 0.0[a]	9.2 ± 1.7	92 ± 1
		4.07	LOXA108	380 ± 61	3.8 ± 0.3	47 ± 1	1.5 ± 0.3	10.2 ± 1.4	94 ± 1
	2	0.25	LOXAZ1	1,125 ± 72	3.3 ± 0.3	50 ± 1	1.8 ± 0.3	7.0 ± 1.2	94 ± 2
		1.44	LOXAZ2	717 ± 125	4.2 ± 0.6	48 ± 1	1.8 ± 0.5	7.5 ± 2.4	94 ± 2
		3.48	LOXAZ3	320 ± 42	4.2 ± 0.3	49 ± 2	1.9 ± 0.2	8.7 ± 0.5	93 ± 1
		5.82	LOXAZ4	304 ± 46	4.1 ± 0.4	49 ± 1	1.5 ± 0.2	7.4 ± 1.8	93 ± 1

[a] Reported standard deviation <1

[b] Reported standard deviation <0.1

Table D-6. Comparison of soil P concentrations collected at transects in WCA-1 during WY2011 and WY2014. Soil P concentrations above 500 mg/kg are considered impacted.

STA Transect	Transect	Distance from Canal (km)	Station	Mean Soil TP ± Standard Deviation (mg/kg)		Two-Sample t-Test p-value
				Water Year 2011	Water Year 2014	
STA-1E	1	0.56	LOXA136	906 ± 147	820 ± 168	0.483
		1.07	LOXA137	746 ± 68	614 ± 125	0.205
		2.11	LOXA138	279 ± 3	336 ± 130	0.530
		3.93	LOXA139	276 ± 39	297 ± 69	0.628
STA-1W	1	0.31	LOXA104.5	1012 ± 112	1098 ± 12	0.315
		0.77	LOXA105	634 ± 185	860 ± 86	0.155
		1.09	LOXA106	531 ± 19	564 ± 44	0.325
		2.21	LOXA107	530 ± 15	564 ± 31	0.183
		3.38	LOXA107U	386 ± 60	315 ± 92	0.334
		4.07	LOXA108	322 ± 38	380 ± 61	0.244

WCA-1 Macrophyte Composition along the Permit Compliance Transects

Macrophyte surveys in WCA-1 were initiated in 2012. There are three transects in WCA-1: LOXA104.5 to LOXA108 is located in the west central region of WCA-1 and is closest to the discharge from STA-1 West (STA-1W); LOXA136 to LOXA139 is located in the east central region nearest the discharge from STA-1 East (STA-1E); and LOXAZ1-LOXAZ4 is located in the southwest region downstream of the future STA-1W expansion.

The frequency of occurrence of several dominant macrophyte species was measured along fixed transects biannually from 2012 through 2013. Using point-intercept survey methodology, the presence of sawgrass (*Cladium jamaicense*) and cattail (*Typha* spp.) at one-meter intervals along 10 meter transects was recorded. Only data from the permit compliance sites are presented in this report. **Tables D-7**, **D-8,** and **D-9** show the frequency of occurrence of cattail and sawgrass along each transect. At the western transect, site LOXA104.5 (0.31 km from the nearest discharge point), was dominated by cattail. At LOXA105 approximately 0.77 km from the discharge point, sawgrass was the dominant plant species. Sawgrass was dominant at the remainder of the sites (LOXA106, LOXA107 and LOXA107U) on the western transect except at LOXA108. LOXA108 has been a wet prairie site dominated by Tracy's beaksedge (*Rhynchospora tracyi*) since 2012 when the vegetation surveys were initiated. Tracy's beaksedge remains the dominant species at LOXA108 but sawgrass increased in frequency of occurrence in WY2014.

The east central transect consisted of four marsh sites LOXA139, LOXA138, LOXA137 and LOXA136 and one canal site, LOXA135. LOXA136 is approximately 0.5 km from the inflow point and is the only station where cattail was present. Cattail was not present at any of the other sites on the east central transect. Sawgrass was present at LOXA137, LOXA138, and LOXA139 but was not dominant at any site. At LOXA136, cattail and duck potato (*Sagittaria lancifolia*) were most prevalent. LOXA137 was dominated by a mix of emergent species including maidencane (*Panicum hemitomon*), pickerelweed (*Pontedaria cordata*), and slim spikerush (*Eleocharis elongate*). LOXA138 was dominated by slim spikerush and LOXA139 was dominated by Tracy's beaksedge.

Table D-7. Number of points (out of 10 possible points at one meter intervals along each line transect) of WCA-1 at monitoring locations in WY2014.

Date	LOXA104.5		LOXA105		LOXA106		LOXA107		LOXA107U		LOXA108	
	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW
Nov 2013	10	0	0	9	0	10	0	10	0	10	0	8
July 2014	10	0	0	9	0	10	0	10	0	10	0	9

Table D-8. Number of points (out of 10 possible points at one meter intervals along each line transect) of WCA-1 at monitoring locations in WY2014.

Date	LOXA136		LOXA137		LOXA138		LOXA139	
	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW
Nov 2013	6	0	0	3	0	4	0	3
May 2014	9	0	0	2	0	3	0	2

At the southwest transect, LOXAZ1 was 0.25 km from the inflow point. Cattail and Peruvian water primrose (*Ludwigia peruviana*) were co-dominant at LOXAZ1. Sawgrass and cattail were co-dominant at LOXAZ2, which is roughly 1.5 km from the inflow point. No cattail was present at sites LOXAZ3 and LOXAZ4, which are approximately 3.5 and 6 km from inflow point, respectively. Sawgrass was present at LOXAZ3 and LOXAZ4 but was not a dominant species (**Table D-9**). LOXAZ3 and LOXAZ4 were characterized by a slough natural community co-dominated by fragrant waterlily (*Nymphaea odorata*) and eastern purple bladderwort (*Utricularia purpurea*).

Table D-9. Number of points (out of 10 possible points at one meter intervals along each line transect) of WCA-1 at monitoring locations in WY2014.

Date	LOXAZ1		LOXAZ2		LOXAZ3		LOXAZ4	
	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW
Nov 2013	10	0	8	7	0	3	0	5
May 2014	8	0	7	8	0	3	0	3

NORTHWESTERN WATER CONSERVATION AREA 2A

WCA-2A Monitoring Objectives

In accordance with the EFA, the South Florida Water Management District (District or SFWMD) has been monitoring the effect of water discharged from STA-2 into the northwestern region of WCA-2A. These releases are intended to restore the hydropattern and ecological functionality of the marshes downstream of STA-2. The STA-2 EFA permit requires that the District implement a monitoring and assessment program to monitor and evaluate ecological changes associated with STA-2 discharges into the area. This annual report addresses the (1) beneficial environmental effects, including changes in water quality, soil, vegetative conditions, inundation, and timing of discharges, and (2) any adverse environmental effects, including imbalances in natural populations of flora or fauna, changes in periphyton communities, or other undesirable consequences of the hydropattern restoration.

WCA-2A Configuration

STA-2 primarily discharges into WCA-2A through six culverts (G-336A–F structures) (**Figure D-4**). STA-2 discharges are also released through G-336G into the discharge canal south of STA-2. Approximately 1 km northeast of the S-7 pump station, the levee separating this discharge canal from WCA-2A is degraded, allowing discharge passing through G-336G to passively enter WCA-2A. Three transects (N-, C-, and S-transects) were established in 1998 to monitor environmental and ecological changes in the area. In 2005, a new transect (FS-transect) was established to monitor the STA-2 discharges through the degraded levee northeast of S-7. The FS-transect includes locations at 0.25, 1, 2, and 3 km from the degraded levee. There are two EFA permit compliance monitoring transects that consist of selected stations from the N-, C-, and FS-transects and also include station CA29.

WCA-2A Hydropattern Restoration

Hydropattern improvements resulting from STA-2 discharges are presented in Pietro et al. (2009) and Garrett and Ivanoff (2008). Permanent stage recorders were installed at WC2AN1 and WC2AS1 (**Figure D-4**) stations in WY2009 and both gauges began recording data in June 2009,

and are currently still available for sites WC2AN1 and WC2AS1. Water depths were determined by subtracting estimated ground elevation from the stages. Results showed that in WY2014, both the north and the south stations were inundated throughout the water year (**Figure D-5**). Mean above ground water depth ranged from 24.7 inches (in) at WC2AN1 to 9.2 in at WC2AS1. Compared to WY2013, depths and number of inundation days were higher in 2014. Water depths at the north station fluctuated between 14 and 48 inches. Water depths at the south station fluctuated between 2 and 27 inches. Water level never got below ground at either site.

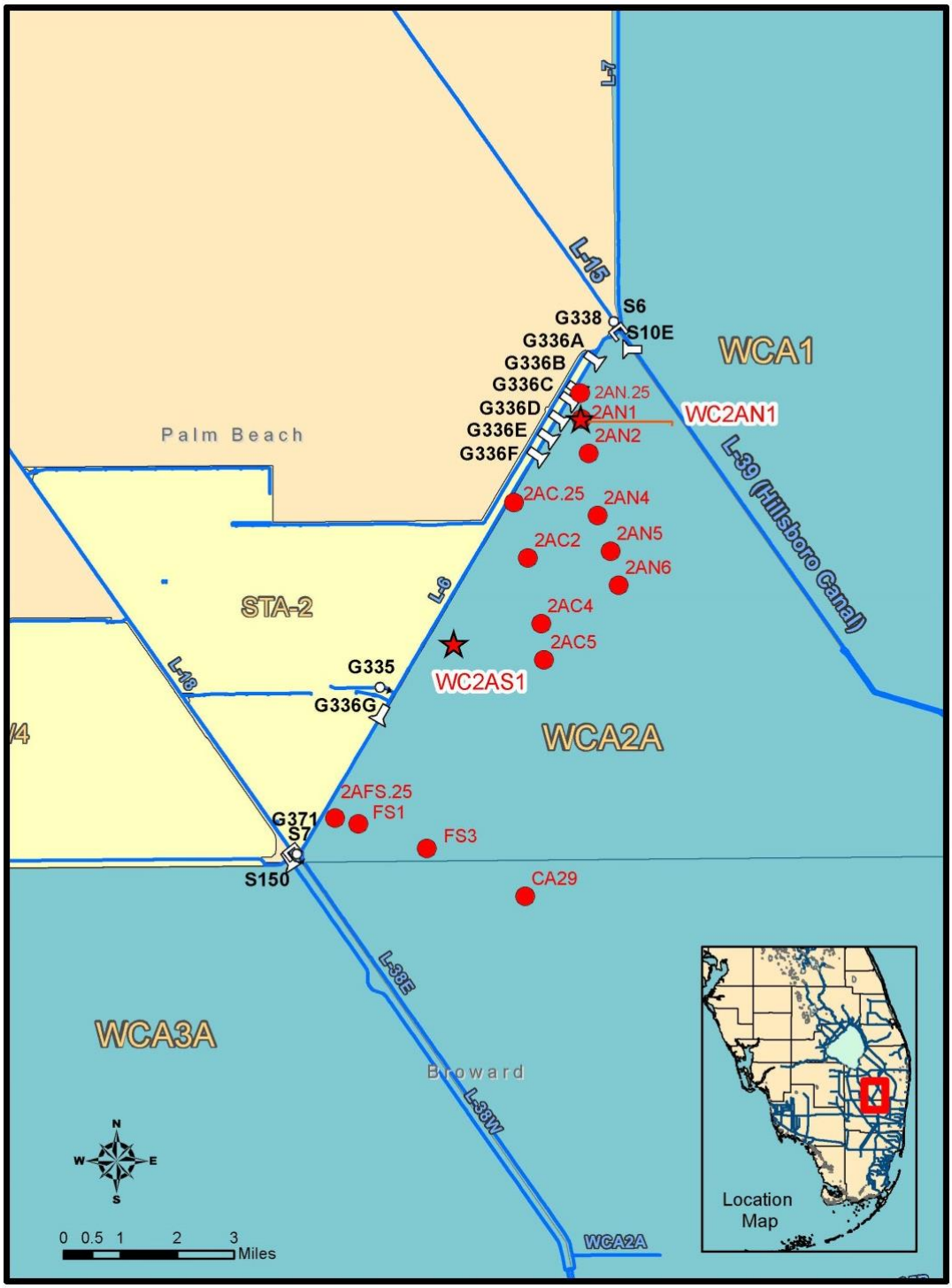


Figure D-4. Location of STA-2 discharge structures, including the G-336A–G discharge culverts in relation to sampling stations along transects in the northwestern section of WCA-2A

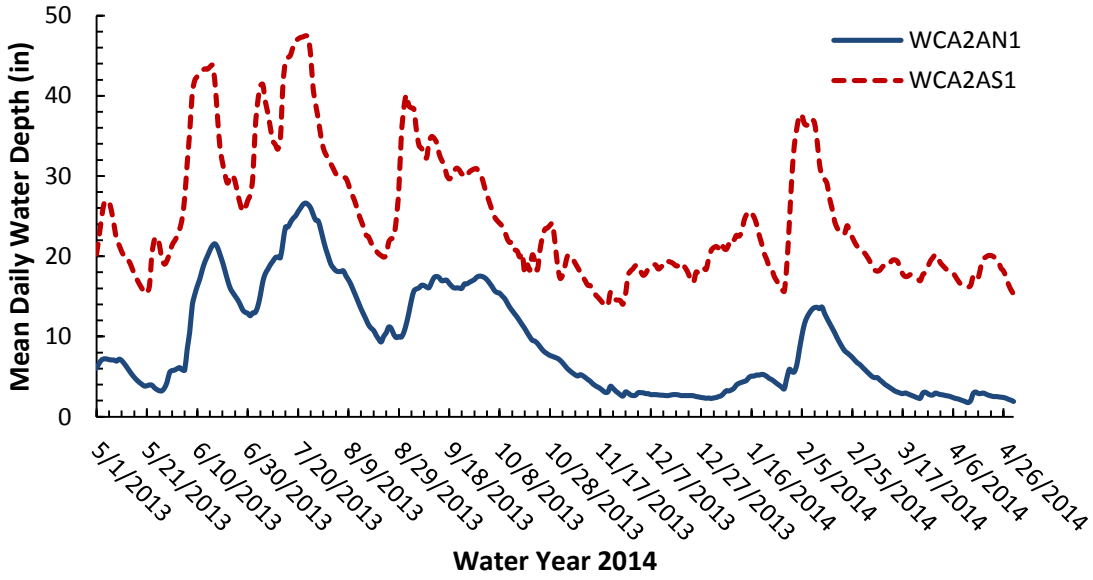


Figure D-5. Mean daily water depths for WY2014 derived from two stage recorders deployed along the northwest region of WCA-2A. See **Figure D-4** for the location of these stations.

EFA Permit Compliance Transect Total Phosphorus and Specific Conductance at STA-2 Downstream Area (WCA-2A)

Three EFA permit compliance transects are downstream of the STA-2 discharge. These transects are monitored to characterize the effects of STA-2 discharges on the marsh. They are in the western part of the WCA, with Transect 1 in the northern portion, Transect 2 in the central portion and Transect 3 in the southern portion (**Figure D-4**). Transect 1 is near the G-336A-G structure and consists of six marsh monitoring stations (2AN.25, 2AN1, 2AN2, 2AN4, 2AN5, and 2AN6) extending approximately 5 km into the WCA. Transect 2 is located 4 km south of Transect 1 and consists of four marsh monitoring stations (2AC.25, 2AC2, 2AC4 and 2AC5). The third transect is downstream of the G-336G structure and consists of four marsh monitoring stations (2AFS.25, FS1, FS3, and CA29) extending approximately 6 km into WCA-2A.

Geometric mean specific conductance during WY2014 ranged from 892 to 1,098 µS/cm for the three transects (**Table D-10**). Specific conductance levels along the northern transect between 0.25 and 4 km from L-6 ranged from 1,028 to 1,092 µS/cm and decreased to 936 µS/cm at 5 km into the marsh (**Figure D-6**). Geometric mean specific conductance levels changed little along the central and southern transects during WY2014, 892 to 1069 and 940 to 1042 µS/cm, respectively (**Figure D-6**). Three specific conductance measurements, two along the northern transect and one along the central transect, exceeded the Class III criterion of 1,275 µS/cm. These high specific conductance values were recorded during the dry season of the year (December through April). A statistical comparison of specific conductance for WY2013 and WY2014 is provided in **Table D-10**. No statistically significant difference was observed between specific conductance measure in WY2013 and WY2014 for the northern, central, and southern transects (Mann-Whitney p-values 0.45, 0.35, and 0.12, respectively).

Geometric mean TP concentrations in WY2014 ranged from 4 to 20 µg/L across the three transects with stations located closer to the canal exhibiting higher TP concentrations (**Table D-11**). By 4 km from the canal, TP concentrations for all three transects were below 7 µg/L

(**Figure D-7**). TP concentrations in the northern transect decreased from a geometric mean concentration of 20 µg/L at 2AN.25 to 6 µg/L at 5 km from the discharge point. In the central transect, geometric mean TP concentrations decrease from 13 µg/L at the station closest to the discharge canal to 6 µg/L, approximately 5 km into the marsh. Along the southern transect, the geometric mean TP concentration near the inflow was 19 µg/L and decreased to 4 µg/L approximately 6 km into the marsh. All transects exhibited a significant reduction in TP concentrations at 1 to 2 km from the inflow.

The Mann-Whitney test was used to determine statistically significant difference for TP data between WY2013 and WY2014. Based on the analysis, no statistically significant differences were observed for the northern, central and southern transects (p-values 0.55, 0.66, and 0.93, respectively) between the two water years. The observed difference between geometric mean TP concentrations for these two years was <1 µg/L with WY2014 having lower concentrations.

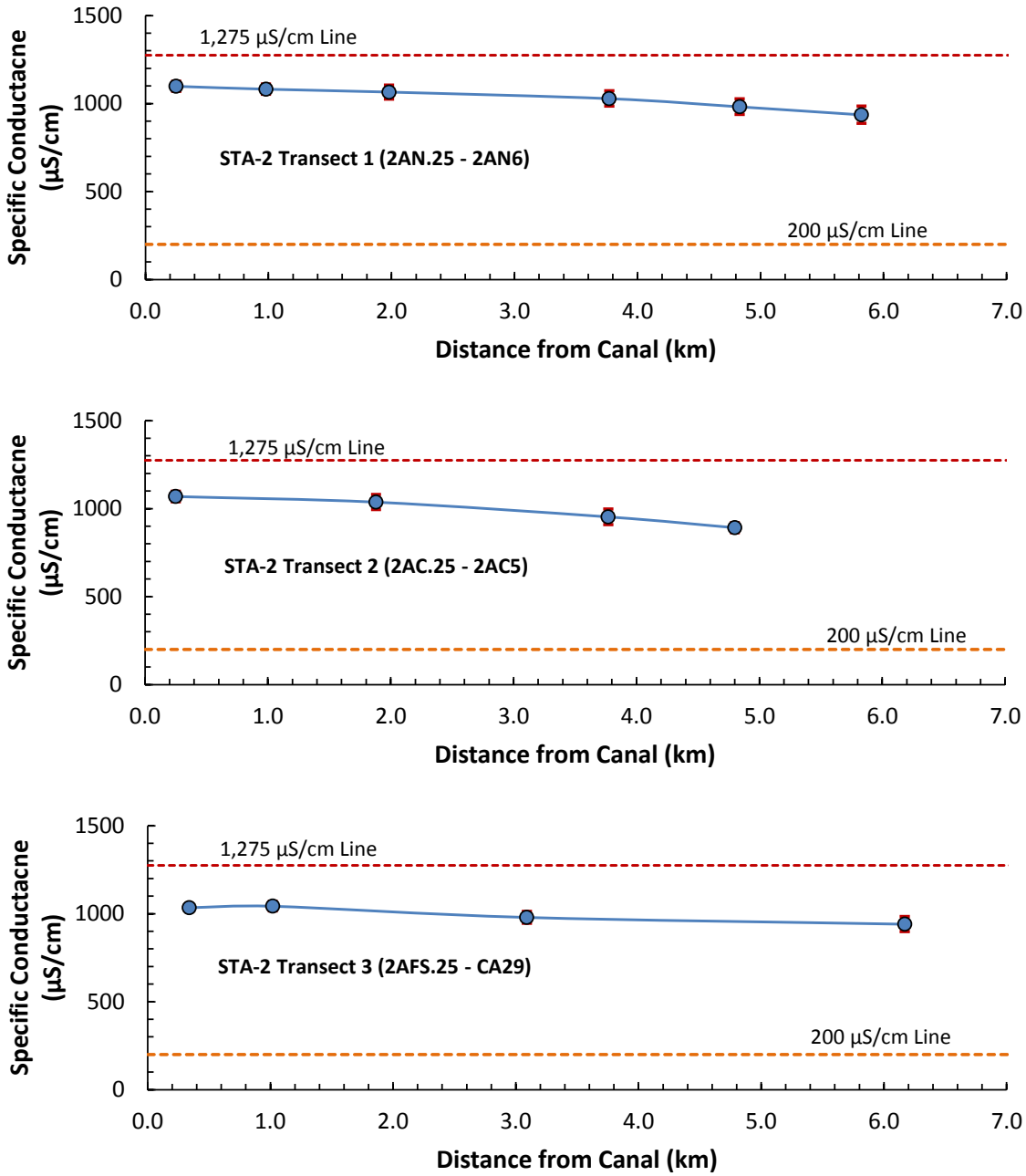


Figure D-6. Plots of geometric mean specific conductance measured at transect stations in WCA-2 downstream of STA-2 during WY2014. The error bars represent the standard error around the calculated geometric mean. The 1,275 µS/cm reference line is presented to identify the Class III freshwater criterion.

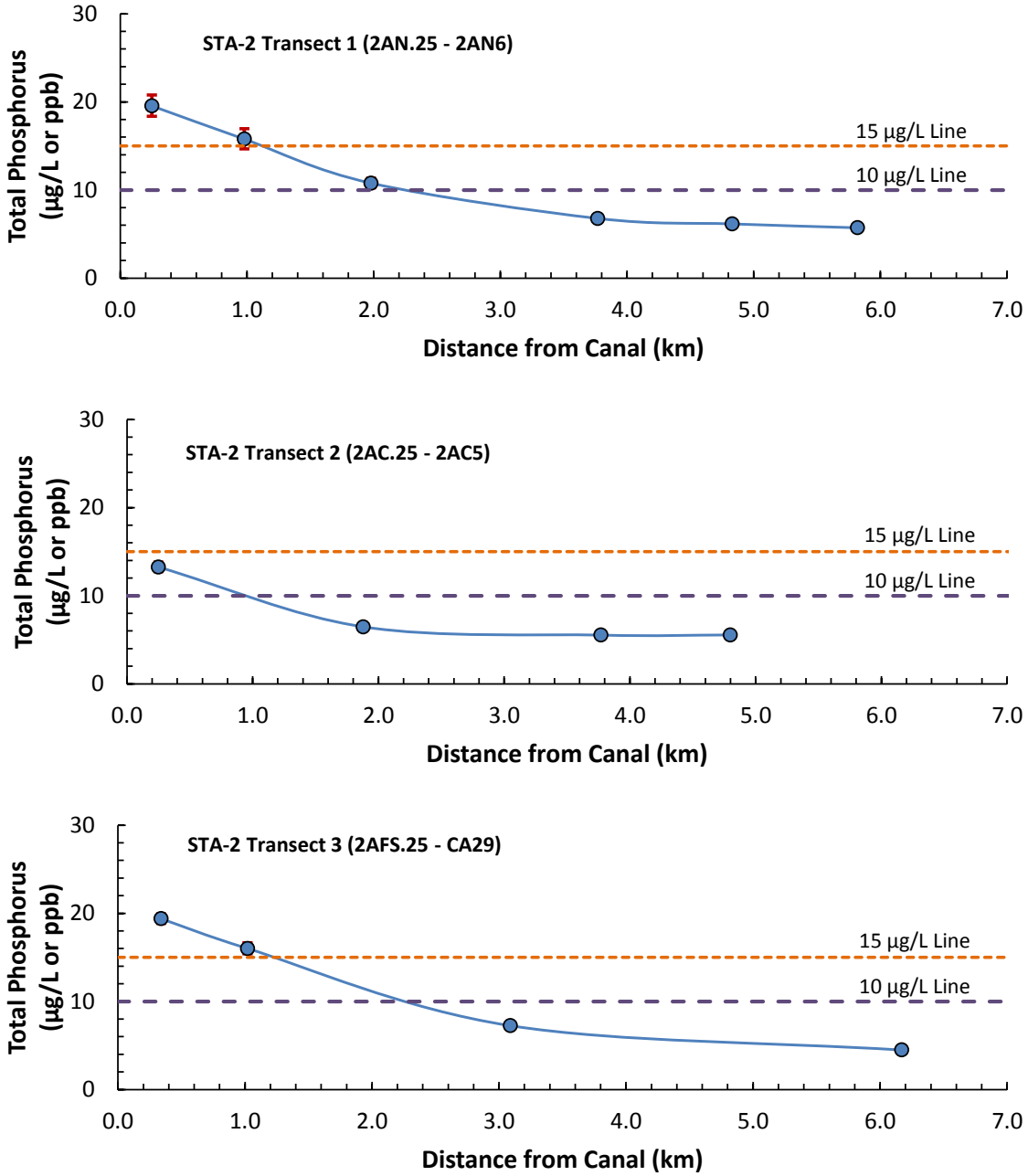


Figure D-7. Plots of geometric total phosphorus (TP) concentrations measured at transect stations in WCA-2 downstream of STA-2 during WY2014. The error bars represent the standard error around the calculated geometric mean. Two reference lines (10 and 15 µg/L) are presented to identify long-term and annual limit used in the Phosphorus Rule.

Table D-10. Comparisons of surface water specific conductance between WY2013 and WY2014 at the permit compliance transect stations in WCA-2.

STA (Transect)	Station	Specific Conductance (µS/cm)					
		WY2013			WY2014		
		No. of Samples	Mean ± SD	Geometric Mean	No. of Samples	Mean ± SD	Geometric Mean
STA-2 (Transect 1)	2AN.25	12	1070 ± 73	1068	12	1102 ± 101	1098
	2AN1	12	1072 ± 73	1069	12	1086 ± 103	1082
	2AN2	9	1063 ± 80	1061	11	1073 ± 133	1065
	2AN4	11	1090 ± 141	1082	12	1038 ± 151	1028
	2AN5	9	1048 ± 202	1031	10	990 ± 144	981
	2AN6	9	997 ± 221	976	10	948 ± 164	936
STA-2 (Transect 2)	2AC.25	12	1073 ± 78	1070	11	1073 ± 99	1069
	2AC2	10	1069 ± 134	1062	11	1046 ± 144	1037
	2AC4	10	969 ± 238	943	9	962 ± 142	953
	2AC5	8	989 ± 216	969	8	895 ± 82	892
STA-2 (Transect 3)	2AFS.25	11	1087 ± 115	1082	11	1036 ± 64	1034
	FS1	10	1081 ± 114	1076	9	1045 ± 80	1042
	FS3	12	1065 ± 234	1040	12	986 ± 121	979
	CA29	12	929 ± 239	900	12	951 ± 145	940

Table D-11. Comparisons of surface water TP concentrations between WY2013 and WY2014 at the permit compliance transect stations in WCA-2.

STA (Transect)	Station	Total Phosphorus (µg/L)					
		WY2013			WY2014		
		No. of Samples	Mean ± SD	Geometric Mean	No. of Samples	Mean ± SD	Geometric Mean
STA-2 (Transect 1)	2AN.25	12	19 ± 9	18	12	20 ± 5	20
	2AN1	12	17 ± 8	15	12	16 ± 4	16
	2AN2	9	10 ± 3	10	11	11 ± 2	11
	2AN4	11	8 ± 3	7	12	7 ± 2	7
	2AN5	9	8 ± 3	8	10	6 ± 1	6
	2AN6	9	7 ± 3	7	10	6 ± 1	6
STA-2 (Transect 2)	2AC.25	12	13 ± 4	12	11	13 ± 2	13
	2AC2	10	8 ± 4	7	11	7 ± 1	6
	2AC4	10	7 ± 2	6	9	6 ± 1	6
	2AC5	8	5 ± 1	5	8	6 ± 1	6
STA-2 (Transect 3)	2AFS.25	11	20 ± 8	19	11	20 ± 2	19
	FS1	10	17 ± 8	16	9	16 ± 2	16
	FS3	12	7 ± 2	7	12	7 ± 1	7
	CA29	12	6 ± 4	5	12	5 ± 1	4

Soils

During WY2014, soil samples were collected at marsh locations along three transects. A summary of soils data for each transect is provided in **Table D-12**. Soil TP concentrations for all three transects exhibited a remarkable decrease (37 to 65 percent) with distance from the canal. Soil Ca also exhibited a decreasing trend from the canal. The highest soil Ca concentration (9.5 percent) was observed at 2AN.25 (Transect 1). This high Ca content coincided with a higher mineral content for this location as shown by the ash content (32 percent) and the lower soil C content (2.9 percent). Conversely, soil N levels increased as a function of distance from the canal along Transects 1 and 2; and remained relatively constant along Transect 3. The lowest soil N content was observed at 2AN.25 (**Table D-12**). Generally, soil content measured during WY2014 for the parameters listed in **Table D-12** were comparable to levels reported by Rivero et al (2007) for WCA-2A. A graphical presentation of the soil data for WCA-2A is provided in **Figures D-20 – D-24**.

Table D-12. Soil P, N, C, Ca, ash, and moisture content measured in WY2014 during August and October in WCA-2A. Each mean was calculated from data of at least three cores collected at three marsh transects to a depth of 10 cm.

STA Transect	Transect	Distance from Canal (km)	Station	Soil Quality (Mean ± Standard Deviation)					
				Total P (mg/kg)	Total N (%)	Total C (%)	Total Ca (%)	Total Ash (%)	Moisture (%)
STA-2	1	0.25	2AN.25	1,029 ± 32	2.9 ± 0.3	39 ± 3	9.5 ± 2.5	31.8 ± 5.3	82 ± 2
		0.98	2AN1	830 ± 61	3.5 ± 0.1	46 ± 1	4.7 ± 0.7	16.5 ± 1.9	87 ± 2
		1.98	2AN2	761 ± 115	3.2 ± 0.1	46 ± 2	4.1 ± 0.3	13.8 ± 0.1	89 ± 2
		3.77	2AN4	614 ± 39	3.3 ± 0.1	45 ± 2	4.9 ± 1.2	18.3 ± 2.7	90 ± 1
		4.83	2AN5	660 ± 83	3.4 ± 0.0[a]	46 ± 1	3.8 ± 0.3	15.0 ± 0.5	93 ± 2
		5.82	2AN6	557 ± 80	3.4 ± 0.2	45 ± 3	5.5 ± 1.9	18.7 ± 4.7	91 ± 1
	2	0.25	2AC.25	706 ± 39	3.4 ± 0.0[a]	47 ± 0[b]	5.0 ± 0.5	16.4 ± 1.3	86 ± 1
		1.88	2AC2	636 ± 139	3.3 ± 0.2	46 ± 0	3.9 ± 0.7	15.8 ± 1.8	89 ± 1
		3.77	2AC4	480 ± 22	3.3 ± 0.1	47 ± 1	4.0 ± 0.0[a]	14.9 ± 1.0	90 ± 1
		4.8	2AC5	447 ± 42	3.3 ± 0.1	47 ± 0[b]	4.3 ± 0.4	15.3 ± 1.0	89 ± 0[b]
	3	0.34	2AFS.25	1,137 ± 132	3.3 ± 0.1	47 ± 0[b]	4.3 ± 0.4	14.1 ± 0.7	90 ± 0[b]
		1.02	FS1	1,226 ± 225	3.2 ± 0.1	47 ± 0[b]	3.6 ± 0.6	11.5 ± 1.5	92 ± 1
		3.09	FS3	580 ± 41	3.6 ± 0.2	47 ± 0[b]	3.3 ± 0.1	12.7 ± 0.8	90 ± 0[b]
		6.17	CA29	399 ± 99	3.7 ± 0.4	45 ± 4	3.5 ± 1.0	14.8 ± 4.9	91 ± 0[b]

[a] Reported standard deviation <1

[b] Reported standard deviation <0.1

A comparison of soil TP content measured for monitoring locations in WCA-2A during WY2014 to soil TP levels reported for WY2013 is provided in **Table D-13**. Soil TP content measured in WY2014 appears to be slightly higher than amounts measured in WY2013. A statistical comparison was performed for each monitoring station using a two-sample t-test. The statistical results suggest that while soil TP content changed for each monitoring station between WY2013 and WY2014, the changes were not statistically significant ($p \geq 0.05$) for all stations except 2AN4 ($p = 0.043$). Average soil TP content at 2AN4 increased from WY2013 to WY2014 by approximately 16 percent or 84 mg/kg. The percent difference in soil TP for 2AN4 between the two water years to the observed difference at 2AN2 but smaller than the observed difference for 2AN5, both of which did not exhibit statistical differences in soil TP between WY2013 and WY2014.

Table D-13. Comparison of soil P concentrations collected at transects in WCA-2A during WY2011 and WY2014. Soil P concentrations above 500 mg/kg are considered impacted.

STA Transect	Transect	Distance from Canal (km)	Station	Mean Soil TP ± Standard Deviation (mg/kg)		Two-Sample t-Test p-value
				Water Years 2013	Water Year 2014	
STA-2	1	0.25	2AN.25	977 ± 116	1029 ± 32	0.528
		0.98	2AN1	881 ± 111	830 ± 61	0.527
		1.98	2AN2	748 ± 23	761 ± 115	0.773
		3.77	2AN4	530 ± 22	614 ± 39	0.043
		4.83	2AN5	544 ± 18	660 ± 83	0.064
		5.82	2AN6	488 ± 60	557 ± 80	0.303
	2	0.25	2AC.25	835 ± 130	706 ± 39	0.223
		1.88	2AC2	580 ± 90	636 ± 139	0.593
		3.77	2AC4	492 ± 24	480 ± 22	0.538
		4.8	2AC5	479 ± 15	447 ± 42	0.321
	3	0.34	2AFS.25	1016 ± 208	1137 ± 132	0.452
		1.02	FS1	1161 ± 30	1226 ± 225	0.665
		3.09	FS3	554 ± 15	580 ± 41	0.323
		6.17	CA29	431 ± 51	399 ± 99	0.647

WCA-2A Macrophyte Composition along the Permit Compliance Transects

The frequency of occurrence of several dominant macrophyte species was measured along fixed transects each year from 2005 through 2014 for most sites in WCA-2A. In 2010, four additional sites, 2AN5, 2AN6, 2AC5 and CA29 were added to the transects in WCA-2A. Using a point-intercept survey methodology, the presence of sawgrass (*Cladium jamaicense*) and cattail (*Typha* spp.) at one-meter intervals along 10 meter transects was recorded. Only data from the permit compliance sites are presented in this report. **Tables D-14** and **D-15** show the frequency of cattail and sawgrass along each transect. The northern transect, site 2AN.25 (0.25 km from the nearest G-336 discharge point), was dominated by cattail with little sawgrass present. At 2AN1 approximately 1 km from the discharge point on the northern transect, cattail and sawgrass were co-dominant. No cattail was present at sites 2AN2, 2AN4, 2AN5, and 2AN6 located between 2 and 6 km from the inflow point over the survey period (**Table D-14**).

The C transect is located between the northern and southern transects. Site 2AC.25 is closest to the L6 canal and 2AC5 is the farthest away. Although only 0.1 km from the L6 canal, 2AC.25 is approximately 1.5 km from the nearest inflow point, G336F. Sawgrass and willow (*Salix caroliniana*) are co-dominate at 2AC.25 and cattail is conspicuously absent from the site. Sawgrass is dominant at 2AC2, 2AC4, and 2AC5 (**Table D-15**).

At the southern transect, sites 2AFS.25 and FS1 are located approximately 0.25 km and 1 km from the inflow point, respectively. Both sawgrass and cattail were co-dominant at 2AFS.25 and FS1. No noteworthy change in the frequency of occurrence for either sawgrass or cattail was recorded at 2AFS.25 or FS1 since 2010. Sawgrass was dominant at sites FS3 and CA29 (**Table D-16**). Sawgrass has maintained a constant frequency of occurrence at FS3 since 2005 when monitoring was initiated at this site. The 10 meter transect at CA29 runs through a sawgrass ridge and the slightly deeper slough habitat bordering it. There has been slight variation year to year with the frequency of occurrence of sawgrass at this site but overall, since 2010 when vegetation surveys began, there has been little change in the vegetation community at this site.

Table D-14. Number of points (out of 10 possible points at one-meter intervals along each transect) at the northern transect locations of WCA-2A where sawgrass (Saw) or cattail (Cat) was present in WY2014.

Date	2AN.25		2AN1		2AN2		2AN4		2AN5		2AN6	
	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW
Nov 2013	10	0	10	10	0	10	0	10	0	10	0	10
May 2014	10	2	10	10	0	10	0	10	0	10	0	10

Table D-15. Number of points (out of 10 possible points at one-meter intervals along each transect) at the central transect locations of WCA-2A where sawgrass (Saw) or cattail (Cat) was present WY2014.

Date	2AC.25		2AC2		2AC4		2AC5	
	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW
Nov 2013	0	10	0	10	0	10	0	10
May 2014	0	10	0	10	0	10	0	10

Table D-16. Number of points (out of 10 possible points at one-meter intervals along each transect) at the southern transect locations of WCA-2A where sawgrass (Saw) or cattail (Cat) was present.

Date	2AFS.25		CA29		FS1		FS3	
	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW
Nov 2013	9	10	0	8	9	10	0	10
May 2014	10	9	0	7	10	10	0	10

ROTENBERGER WILDLIFE MANAGEMENT AREA

Restoration and Monitoring Objectives

The Rotenberger Hydropattern Restoration Project is a component of the District's Everglades restoration efforts. The project goal is to slow, halt, and eventually reverse the ecosystem degradation within the RWMA (**Figure D-8**), primarily by restoring a more natural hydropattern. The degradation has been caused by overly dry conditions that have resulted in repeated peat fires, soil oxidation and compaction, nutrient release from surface soils, and conversion of obligate wetland vegetative communities to upland-type communities. Anticipated benefits of the restoration efforts include the preservation and encouragement of additional desirable wetland vegetation species and the initiation of peat formation.

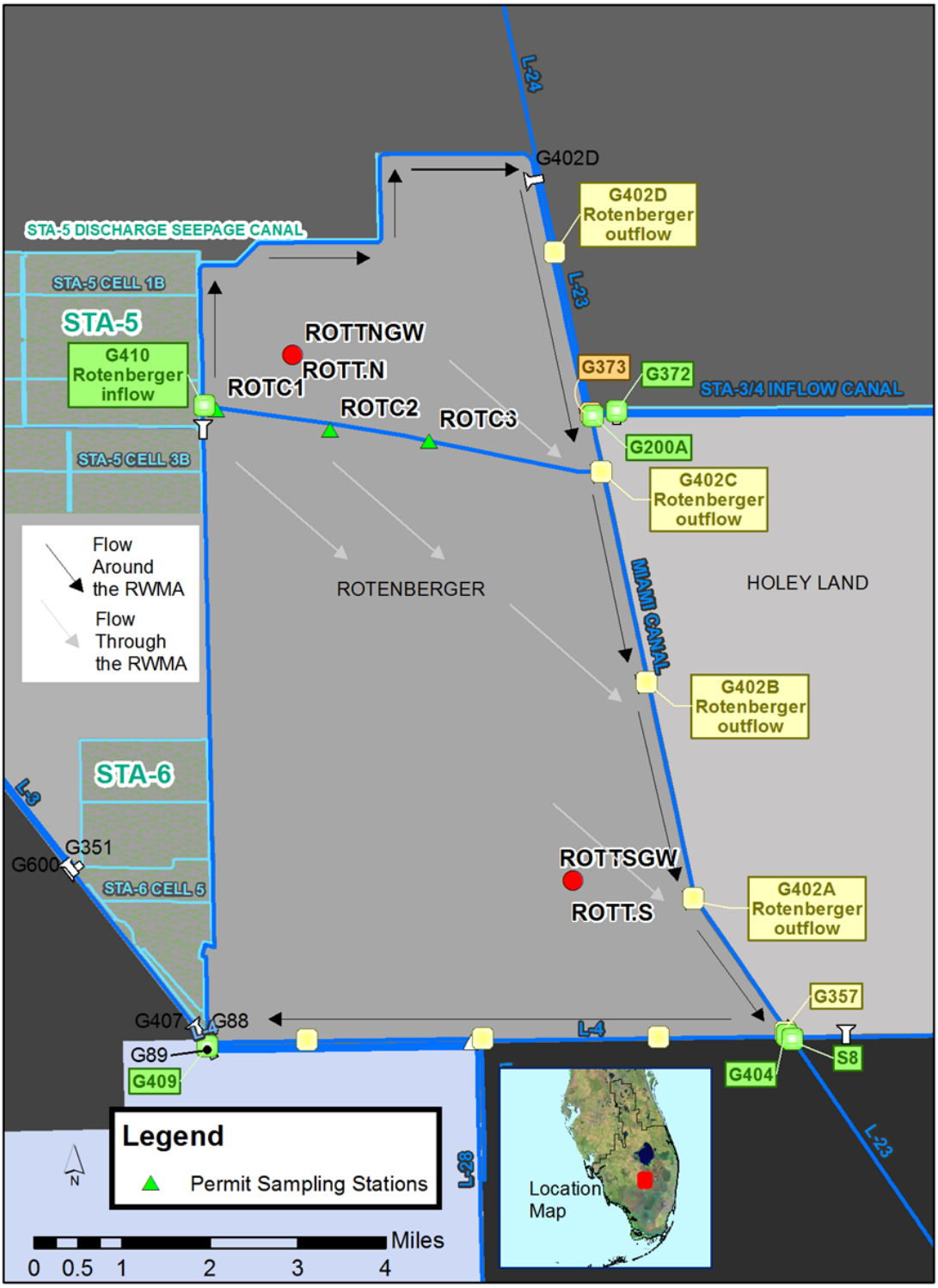


Figure D-8. Map of the Rotenberger Wildlife Management Area (RWMA) showing major structures and monitoring transect ROTC (permit compliance monitoring transect). Rott.N and Rott.S are the locations of the permanent stage recorders and newly installed groundwater wells.

Configuration

Project features include a 240-cubic foot per second (cfs) electric pump station (G-410) to withdraw treated water from the STA-5/6 discharge canal for release into the RWMA. This pump station distributes water through a 10-mile spreader canal located parallel to the west perimeter levee of the area. Surface water that is released out of the RWMA goes into the Miami Canal (L-28 canal) through four gated culverts (G-402A through G-402D) along the eastern boundary of the RWMA. There is a quarter-mile collection canal upstream of each outlet structure.

The ROTC1, ROTC2, and ROTC3 stations are EFA permit compliance locations within the RWMA. Monitoring data for the stations downstream of STA-5/6 can be found within two District databases, Everglades Research Database Production and DBHYDRO. Water levels have historically been monitored at the Rott.N and Rott.S stage gauges.

Water Budget

Annual water budgets from 2003 to 2014 are presented in **Table D-17**. Historically, Eighty percent of the inflows are attributed to rainfall and eighty six percent of the outflows are attributed to evapotranspiration (ET) in the water budget. Both rainfall and surface water inflow through G-410 were below average and below WY2013. Surface water outflows were higher than average and higher than WY2013. ET was above average but a bit lower than WY2013. Seepage values were not accounted for in these calculations. Errors include seepage losses or gains and measurement errors. Water level declined from the beginning to the end of the Water Year. Since the ending stage was lower, there was loss of surface water storage. Daily average head and tail water fluctuations at the G410 pump is shown in **Figure D-9a**. Daily average head and tail water fluctuations at the G402 A, B, and C culverts are shown in **Figure D-9b**.

Table D-17. Water budgets calculated for WY2003–WY2014. Inflows in acre-feet (ac-ft) represent discharges into the RWMA from the G-410 structure and outflows represent water releases from the G-402A–C structures.

Water Year	Inflow	Rainfall	Total Inflow	Outflow	ET	Total Outflow	Change in storage	Error %
				(ac-ft)				
2003	54,306	111,179	165,485	25,312	12,5410	150,722	70	-9.3
2004	16,849	114,620	131,469	352	12,3546	123,898	-20	-5.9
2005	44,414	113,868	158,282	33,788	12,3847	157,635	33	-0.4
2006	29,886	114,605	144,491	54,648	12,4451	179,099	-792	20.9
2007	16,195	85,538	101,733	4,630	12,3403	128,033	-731	22.3
2008	11,646	108,725	120,371	0	124,900	124,900	11,431	13.0
2009	32,297	102,125	134,422	25,126	128,177	153,303	-11,187	5.3
2010	40,582	152,423	193,005	21,295	12,5578	146,873	1,018	-26.5
2011	17,922	116,675	134,597	21,622	138,200	159,822	-13,365	8.1
2012	32,472	135,025	167,497	5,192	137,575	142,767	16,050	-5.6
2013	37,055	146,325	183,380	11,009	134,125	145,134	13,200	-15.2
2014	20,934	119,325	140,259	41,092	133,825	17,4917	-13,200	13.6
Total	***354,558***	***1,420,433***	***1,774,991***	***244,066***	***1,543,037***	***1,787,103***	***15,707***	***1.6***
	G-410 Inflow	**Rainfall**					**G-402 Outflow**	**ET**
% of inflow	20%	80%				% of Outflow	14%	86%

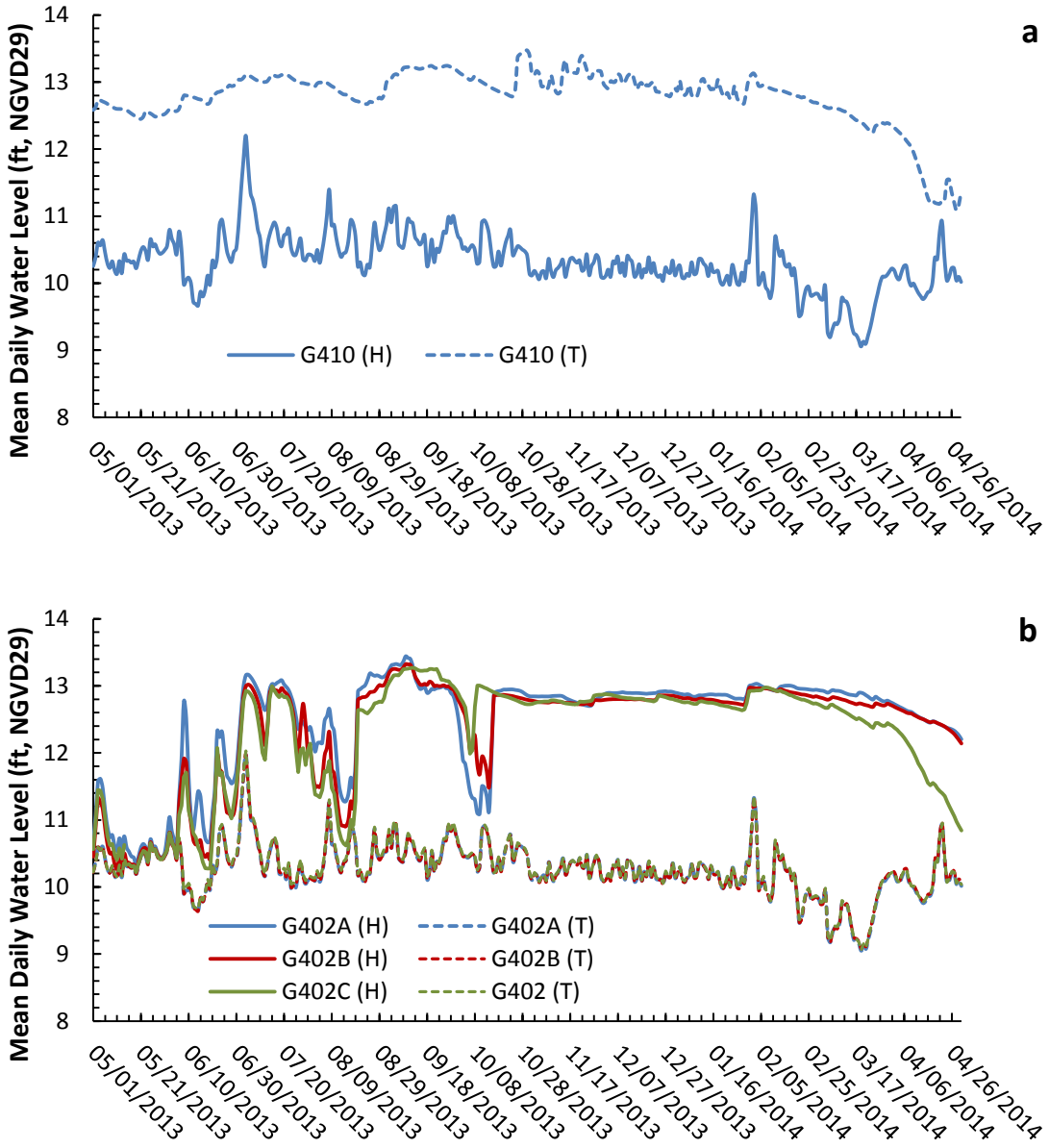


Figure D-9. (a) Daily head (H) and tailwater (T) fluctuation at G410 pump station. (b) Daily head and tailwater fluctuation at G402 A, B, C culverts.

Hydrologic and Total Phosphorus Loads

A total of 20,933 acre-feet (ac-ft) of STA-5/6 water was conveyed into the RWMA through the G-410 pump station in WY2014 (**Figure D-10**). This volume is approximately 16,100 ac-ft less than for the WY2013 discharge. An estimated 0.47 metric tons (mt) of phosphorus was imported to the RWMA during WY2014, resulting in an inflow flow-weighted mean (FWM) TP concentration of 17 µg/L. While the TP load to the RWMA was higher during WY2013, the FWM concentration was lower (TP load = 0.69 mt and TP FWM = 15 µg/L for WY2013). A Pearson correlation analysis of FWM TP concentrations with time did not exhibited a statistically significant decreasing trend in WY2014 (r = -0.20, p-value = 0.55). The slope of the regression was shown not to be statistically different from zero. A similar analysis for TP load indicated that while loads exhibited a decreasing trend, the slope of the line was also not statistically different from zero (r = -0.06; p-value = 0.85).

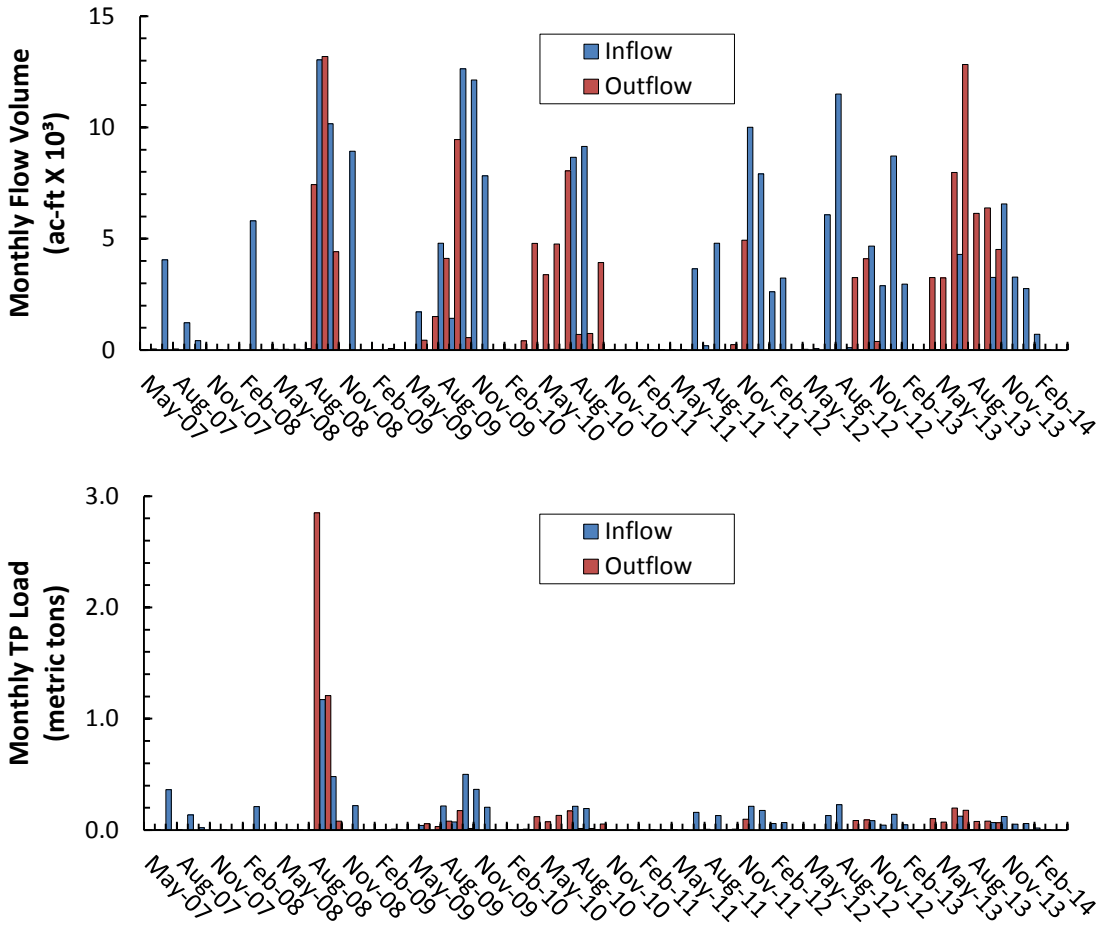


Figure D-10. Monthly flow volumes (top) and TP loads (bottom) for inflow and outflow structures at the RWMA for WY2008 through WY2014.

Approximately 41,092 ac-ft of water was released through the G-402A–C structures during WY2014, approximately 30,100 ac-ft more than in WY2013. The total load of TP released from the RWMA through the G-402A-C structures during WY2014 was 0.67 mt or 0.39 mt higher than discharged from the wildlife management area in WY2013. The resulting annual FWM TP concentration for WY2014 at the RWMA outflow was 13 µg/L (**Figure D-11**). While the outflow load of TP from RWMA was higher during WY2014, the FWM concentration was lower than for WY2013 (TP Load = 0.28 mt and FWM TP = 21 µg/L). Additionally, outflow loads and FWM TP concentrations decreased during WY2014. Based on trend analysis for each parameter with time using the Pearson correlation, FWM concentrations did not exhibit a statistically significant decrease (r = -0.76, p-value = 0.08) at a significance level of 0.05, while TP loads did decrease significantly (r = -0.80, p-value = 0.002).

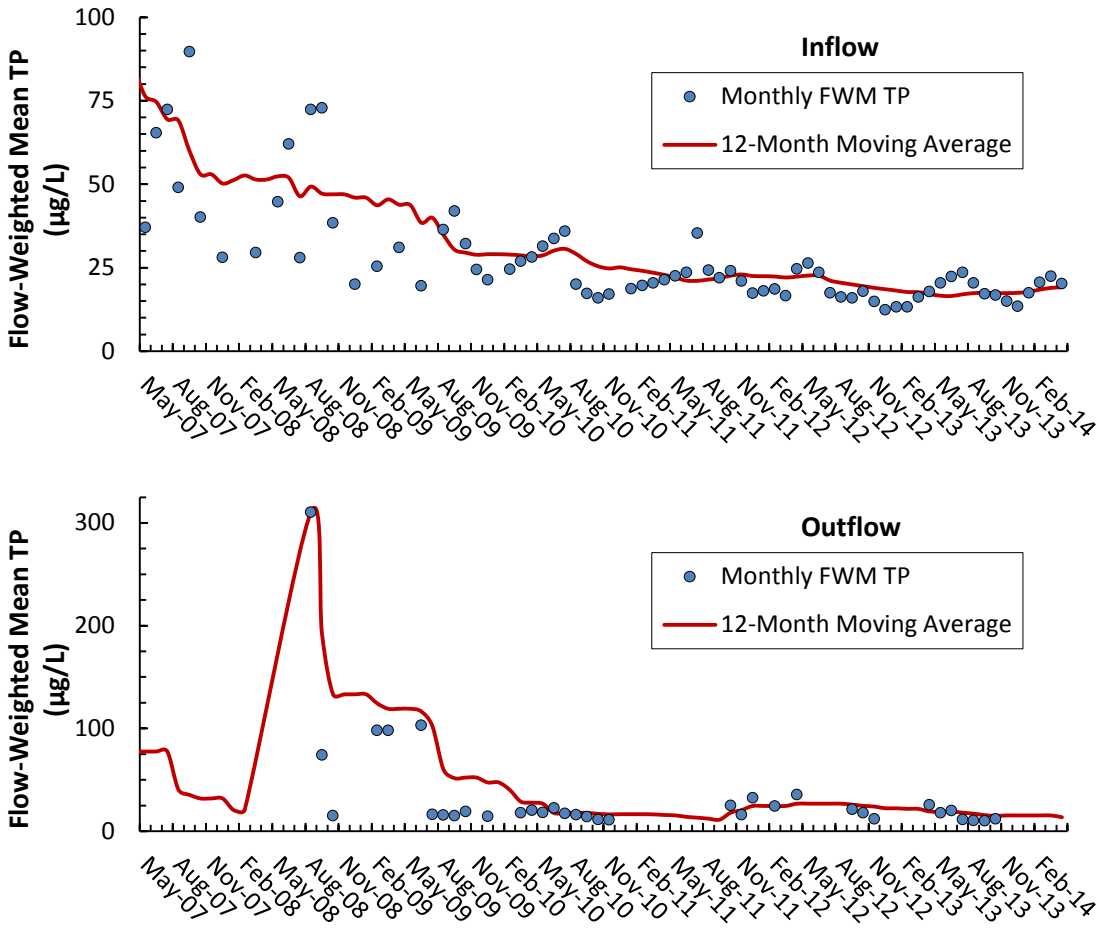


Figure D-11. Comparison of monthly flow-weighted mean TP concentrations with the 12-month moving average of the flow-weighted means for the RWMA inflow (top) and outflow (bottom) structures during WY2008 through WY2014.

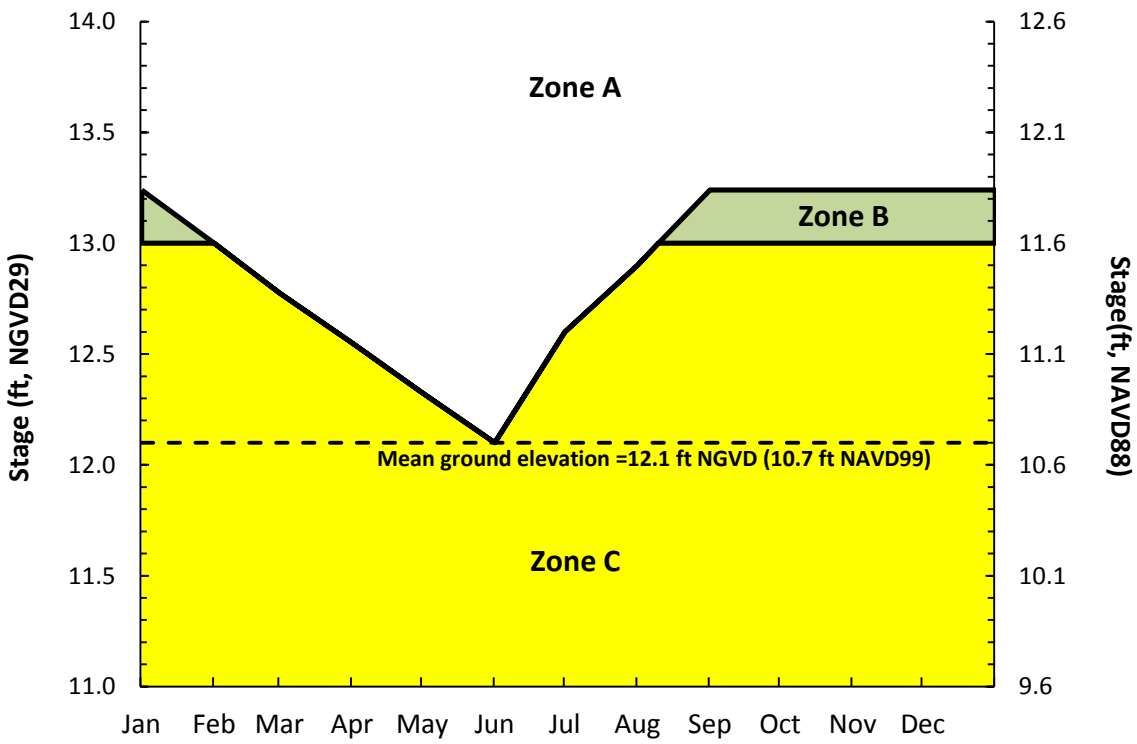
Although the annual inflow FWM TP concentration to the RWMA was higher than the annual outflow concentration to the RWMA, the inflow TP load during WY2014 was lower than the outflow TP load by 0.22 mt. The higher annual TP load from the RWMA probably resulted from an excess of 20,000 ac-ft conveyed through the combined outflow structures (G402A-C) compared with the G-410 inflow pump station.

Hydropattern Restoration

Starting in June 2008, the District began meeting with the Florida Fish and Wildlife Conservation Commission (FWC) and the Florida Department of Environmental Protection (FDEP) to review the RWMA Operation Plan (SFWMD, 2004) and revise and improve the interim regulation schedule in an effort to better achieve the hydropattern restoration goals for the RWMA. An initial step in the process was to obtain an updated survey of the RWMA, which was completed in December 2008. The RWMA was surveyed in 2004 and 2008. The calculated ground elevation from the 2008 survey was 12.14 feet National Geodetic Vertical Datum 1929 (ft NGVD).

The daily target stages for the RWMA in the previous years were set based on the District's Natural System Model (NSM) values plus 0.25 feet (ft). The 0.25 ft was added to minimize the potential for excessive dry-out during the dry season. In April 2009, consensus was reached on a modified interim regulation schedule that attempts to maintain the hydropattern restoration goals while also addressing the diverse biological needs of the RWMA and minimizing the risk of muck and/or peat fires. The biological needs considered were those of tree islands, native open-marsh vegetation [e.g., sawgrass and maidencane (*Panicum hemitomon*)], periphyton, wading birds, aquatic macrofauna [e.g., crayfish (*Procambarus alleni*)], and upland faunal species (e.g., mammals). It is recognized that during severe droughts when no supplemental water is available, the RWMA will dry out.

In the modified regulation schedule (**Figure D-12**), when water levels are within either Zone A or Zone C and regional water conditions allow RWMA inflow and outflow, structures will be managed in an effort to return water levels to the regulation schedule or Zone B. The District continues to communicate all water management actions to the FWC (SFWMD, 2010).



Zone	Operational Direction
A	Manage inflows (G410) and/or outflows (G402A, G402B, G402C and G402D) to return to regulation schedule of Zone B.
B	Discretionary Zone: manage inflows and/or outflows to maintain water levels within Zone B, if possible, based on an assessment of historical, climatic, and regional water conditions. Coordination with FWC required.
C	If regional water conditions allow, manage inflows and/or outflows to return to regulation schedule or Zone B.

Figure D-12. Modified interim regulation schedule for RWMA.

Monitoring has ended at the ROTT.N (ROTTN-L) and ROTT.S (ROTTS-L) surface water monitoring sites, but the substitute monitoring sites, ROTTNGW and ROTTSGW, respectively, have replaced them (**Figure D-8**). WY2013 and WY2014 daily average RWMA stages, average ground elevation, and the interim operation plan target stages are depicted in **Figure D-13**. Water level was above ground from the beginning to the end of WY2014. Generally, the first six months water level was higher than the target except in August, with levels being close to the target the rest of the water year.

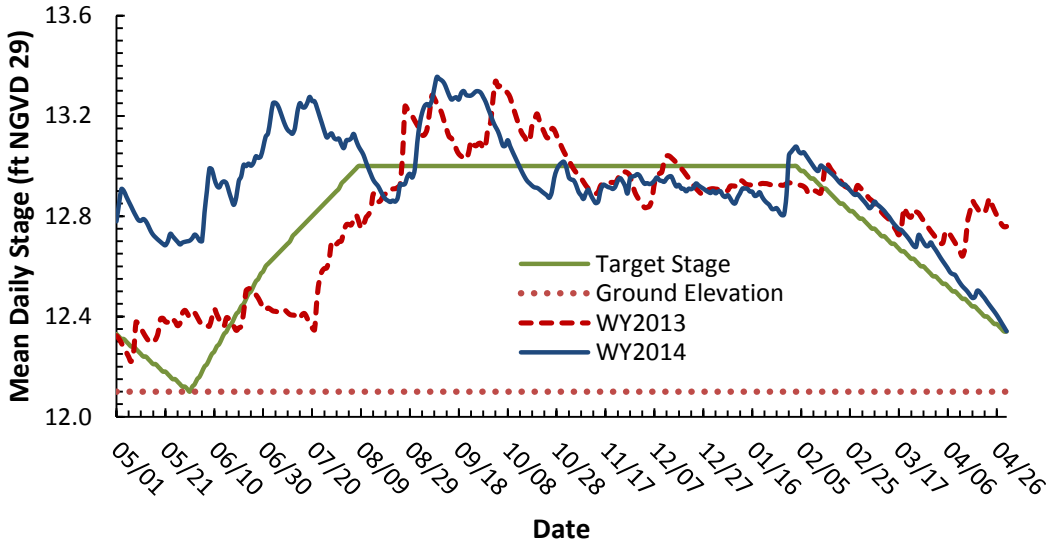


Figure D-13. Daily mean RWMA stages, average ground elevation, and interim operation plan target stages.

EFA Permit Compliance Transect Total Phosphorus and Specific Conductance at STA-5/6 Downstream Area

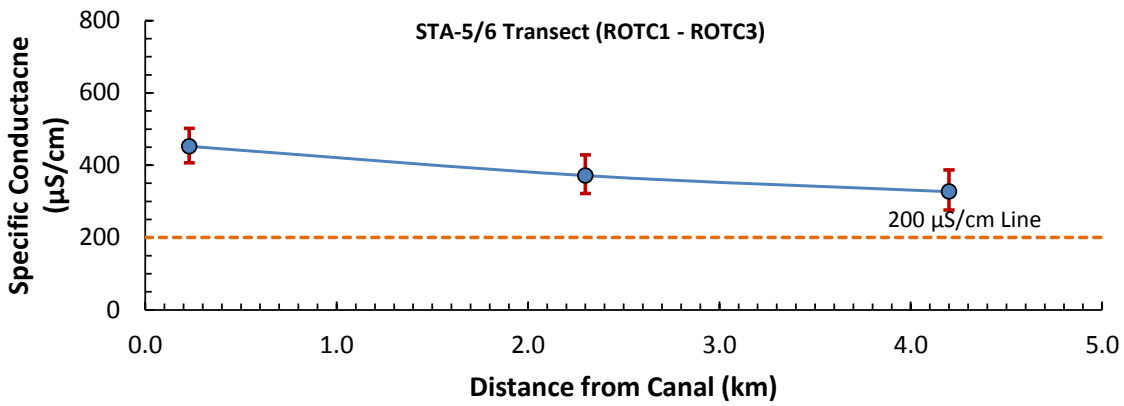
As previously mentioned, the RWMA EFA permit compliance transect comprises three monitoring stations (ROTC-1, ROTC-2, and ROTC-3) that extend approximately 4 km downstream of pump station G-410 (**Figure D-8**). All stations along this transect are identified as impacted.

All specific conductance levels measured along the RWMA transect were well below the 1,275 µS/cm for Class III waters during WY2014 (**Table D-1**). Geometric mean specific conductance levels in WY2014 decreased by approximately 28 percent along the RWMA transect. Geometric mean TP concentrations exhibited a decrease of approximately 25 percent from 12 µg/L, at the marsh station closest to the inflow, to 9 µg/L, at a distance of 4 km from the canal (**Figure D-14**).

A comparison of specific conductance and TP concentrations for WY2013 and WY2014 is provided in **Table D-18**. A statistically significant difference was observed between specific conductance data from WY2013 and WY2014 (Mann-Whitney p-value <0.001). Specific conductance in WY2013 (geometric mean = 578 µS/cm; median = 599 µS/cm) was lower than in WY2014 (geometric mean = 386 µS/cm; median = 431 µS/cm). A statistically significant decrease in TP concentrations was observed between data for WY2013 and WY2014 (p-value = 0.03) with concentrations for WY2013 being higher by 3 µg/L (geometric mean = 13 µg/L; median = 12 µg/L) compared to WY2014 (geometric mean and median = 10 µg/L)

Table D-18. Comparison of the surface water mean (± 1 SD) specific conductance and TP concentration between WY2013 and WY2014 at the permit compliance stations in the RWMA.

STA (Transect)	Station	WY2013			WY2014		
		No. of Samples	Mean ± SD	Geometric Mean	No. of Samples	Mean ± SD	Geometric Mean
				Specific Conductance (µS/cm)			
STA-5/6 (Transect 1)	ROTC1	11	654 ± 101	646	11	477 ± 156	452
	ROTC2	9	562 ± 154	542	11	410 ± 181	371
	ROTC3	9	562 ± 178	536	8	359 ± 153	327
				Total Phosphorus (µg/L)			
	ROTC1	11	20 ± 5	19	10	13 ± 3	12
	ROTC2	9	10 ± 4	9	11	8 ± 2	8
	ROTC3	9	11 ± 4	10	8	10 ± 2	9



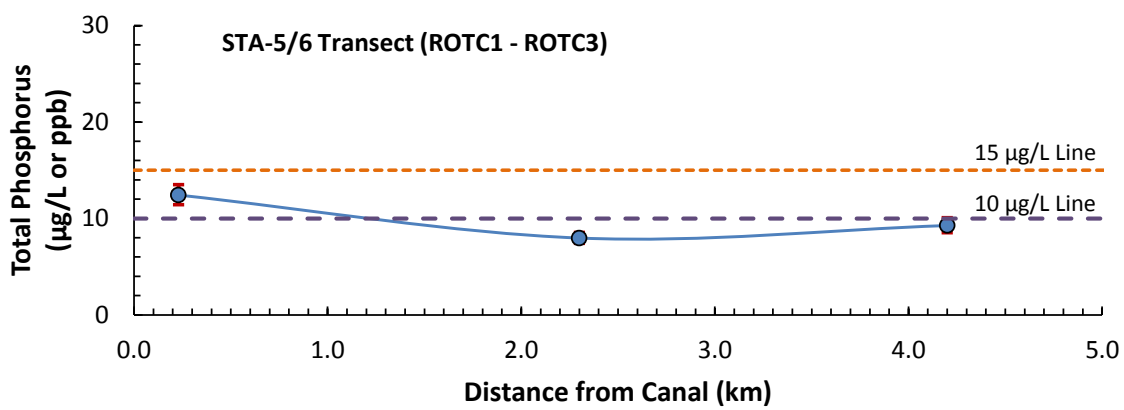


Figure D-14. Plots of geometric mean specific conductance and TP concentrations measured at transect stations in RWMA downstream of STA-5/6 during WY2014. Error bars represent the standard error around the calculated geometric mean. The 1,275 µS/cm reference line on specific conductance plot is presented to identify the Class III freshwater criterion. The TP Rule does not apply to the RWMA; 10 and 15 µg/L lines on the TP plot are presented for reference only.

Soils

Data for soils sampled during WY2014 at three transect stations in the RWMA are provided in **Table D-19**. Soil TP content followed a similar pattern identified for transects in WCA-1 and WCA-2A with soil content decreasing as a function with distance from the discharge canal. Station ROTC1, located approximately 0.3 km from the discharge canal, exhibited soil content that is more mineral than organic. This station had the lowest soil N and soil C content while soil P, Ca and ash content were higher than at the other two monitoring locations. The lowest soil P level (332 mg/kg) was observed at ROTC2 where soil Ca and ash values were also low while soil N and C levels were at their highest for the transect. No soil data was collected in previous monitoring years; therefore, no temporal comparison could be made. A graphical presentation of the soil data for RWMA is provided in **Figure D-25**.

Table D-19. Soil P, N, C, Ca, ash, and moisture content measured in WY2014 during July in RWMA. Each mean was calculated from data of at least three cores collected at the marsh transect to a depth of 10 cm.

STA Transect	Transect	Distance from Canal (km)	Station	Soil Quality (Mean ± Standard Deviation)					
				Total P (mg/kg)	Total N (%)	Total C (%)	Total Ca (%)	Total Ash (%)	Moisture (%)
STA-5/6	1	0.23	ROTC1	1,187 ± 543	2.0 ± 0.6	27 ± 8	7.0 ± 2.9	53.8 ± 15.8	83 ± 5
		2.30	ROTC2	332 ± 57	3.4 ± 0.1	48 ± 5	3.5 ± 0.3	18.0 ± 9.5	84 ± 2
		4.20	ROTC3	595 ± 307	3.1 ± 0.1	42 ± 2	4.6 ± 1.5	30.3 ± 5.4	81 ± 4

[a] Reported standard deviation <1
[b] Reported standard deviation <0.1

Macrophyte Coverage

Using a point intercept survey methodology, the areal coverage of dominant macrophyte species has been surveyed at the three permit-mandated stations along fixed 10-meter transects twice a year (dry and wet seasons) since 2004. The presence of sawgrass and cattail at 1-meter intervals was recorded (**Table D-20**). Sawgrass and cattail coverage remained relatively unchanged at the ROTC1 station from previous years. Cattail was the dominant species, present at every survey point at ROTC1. This is not unexpected since ROTC1 is the closest station to the Rotenberger inflow where total phosphorus (TP) concentrations were highest (**Table D-18**). Both sawgrass and cattail were present at ROTC2 and ROTC3 where surface water TP concentrations were low (**Table D-18**). ROTC3 has exhibited very little variation in vegetation community remaining consistently sawgrass dominant during the survey period, 2004–2014. ROTC2 is a mixed cattail sawgrass marsh. Although there has been some variation in the frequency of occurrence of cattail throughout the history of this station, ROTC2 remains sawgrass dominated marsh for the time being.

Table D-20. Number of points (out of 10 possible points at one-meter intervals along each transect) where sawgrass (Saw) or cattail (Cat) was present in WY2014.

Date	ROTC1		ROTC2		ROTC3	
	CAT	SAW	CAT	SAW	CAT	SAW
Oct 2013	10	2	3	8	1	10
Mar 2014	10	3	3	10	3	10

Restoration Activities

In 2009, the District, in cooperation with the FWC, began the restoration of 19 acres of tree islands in the southwest corner of the RWMA. Restoration began with the treatment and removal of exotic species including Brazilian pepper (*Schinus terebinthifolius*) and primrose willow (*Ludwigia peruviana*). These tree islands were initially planted with 3,000 native tree and shrub species, which are protected from wildlife damage with metal exclosures. The FWC planted an additional 384 trees and shrubs on these islands in 2010–2011. In 2013, in order to meet the survival rate established for the initial planting, an additional 1,028 plants were planted by the District in coordination with the FWC. These islands are cooperatively maintained on an annual basis for both exotic plants and metal exclosure upkeep.

The FWC conducts various other restoration activities in RWMA each year. For 2013–2014, approximately 284 acres were treated for exotic plants, including tree islands, levee, and marsh habitats. Other restoration activities conducted in RWMA included the prescribed burning of 2,742 acres, metal exclosure maintenance for all planted tree islands in RWMA (4,758 exclosures on 18 tree islands), and the additional planting of 564 trees and shrubs on tree islands. Additionally, annual aerial cattail surveys are conducted to monitor cattail expansion within RWMA.

The FWC completed restoration of the old farms located within RWMA in 2011. This multi-year project included the mechanical removal or degradation of 10.7 miles of berms and canals. These features altered surface flow throughout 1,758 acres along the eastern boundary of the area. The work was funded by the FWC Aquatic Habitat Restoration and Enhancement (AHRE) program, and performed by Rio-Bak Corporation from May 2009 to May 2011 at a cost of $109,000. Photo-monitoring is performed periodically to document the effects of the restoration activities. The FWC plans to chemically treat invasive cattail in the old farm areas in 2014-2015.

Also in 2013-2014, the FWC completed the removal of an unimproved road leading to an abandoned drill pad island in order to restore hydrologic flow. The drill pad island was retained as it has undergone several restoration efforts, including exotic plant control and native tree and shrub planting, and it provides habitat similar to a natural tree island. This work was funded by the FWC AHRE program at a cost of $28,300, and performed by Ag-Scape Services.

Collaborative restoration work in Rotenberger between FWC and the District continues.

Soils Analysis Qualifier

To comply with permits and mandates, and be accountable to oversight bodies, other government agencies, and the general public, all of the sampling, quality assurance (QA), and management personnel make every effort to assure data quality and integrity. In compliance with F.A.C. 62-160 (FDEP's QA rule) data collected in a method that diverges from the Chemistry Lab Quality Manual (CLQM) must be qualified with a data qualifier code from F.A.C. 62-160.700. Qualifier codes provide additional information about sample results so that data users can make informed decisions about the results, and do not mean that that the data are not usable.

According to the SOP for Preparation and Homogenization of Soil, Sediment, and Tissue, soil samples need to prepared for analysis within 28 days of collection and analyzed within 6 months. For WY2014, all soils data analyses were completed within 6 months; however, for

much of the data, sample preparation time exceeded 28 days. These data were qualified with the data qualifier code 'Q'[2], to indicate this.

Although some samples were not prepared within the 28-day period, no samples were prepared more than 12 days beyond the maximum holding time **(Table D-21),** and all samples were kept refrigerated at 4°C from the time of collection to preparation. This low temperature minimizes microbial activity that could skew results. For phosphorus and calcium, the samples are stable because there is no gaseous phase that would allow these elements to escape the sample container before analysis. Also, previous laboratories did not have a 28-day preparation holding time to comply with and, consequently, would not have had to qualify results in a similar situation.

In light of these factors, the quality of the samples is not believed to have been compromised, and there should be no impact on the data usability for the reported parameters. To reduce the possibility of future data being qualified, the laboratory will now use an intermediate step to establish soil sample stability, and laboratory procedures have been streamlined.

Table D-21. Sampling dates for soil transect stations where the 28-day sample preparation limit was exceeded, and number of days beyond the 28-day preparation limit until samples were prepared.

STA Transect		Monitoring Station	Sampling Event	Days Beyond 28
STA-1E	1	LOXA136	Aug 2013	6
		LOXA137	Aug 2013	7
		LOXA138	Aug 2013	7
		LOXA139	Aug 2013	7
STA-1W	1	LOXA104.5	Aug 2013	12
		LOXA105	Aug 2013	12
		LOXA106	Aug 2013	12
		LOXA107	Aug 2013	12
		LOXA107U	Aug 2013	12
		LOXA108	Aug 2013	12
STA-2	1	2AN.25	Jul 2013	1
		2AN1	Jul 2013	2
STA-2	1	2AN2	Jul 2013	1
		2AN4	Jul 2013	1
		2AN5	Jul 2013	2
		2AN6	Jul 2013	2
	2	2AC.25	Jul 2013	1
		2AC2	Jul 2013	10
		2AC4	Jul 2013	10
		2AC5	Jul 2013	10
	3	2AFS.25	Jul 2013	9
		FS1	Jul 2013	9
		FS3	Jul 2013	9
		CA29	Jul 2013	9

[2] Sample held beyond the accepted holding time. This code shall be used if the value is derived from a sample that was prepared or analyzed after the approved holding time restrictions for sample preparation or analysis, from .Section 62-160.700, F.A.C.

Soils Analysis Parameters Graphs

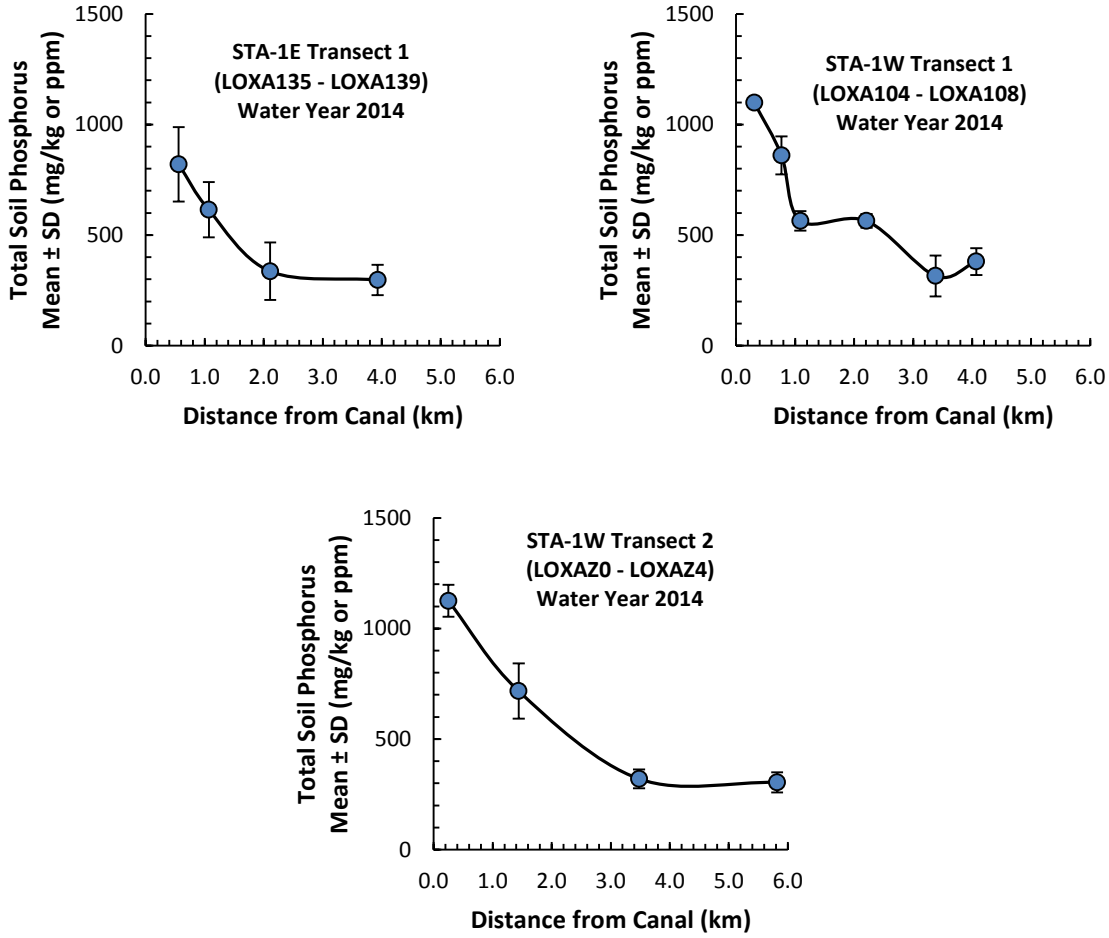


Figure D-15. Plots of mean soil P (± standard deviation) content for WY2014 as a function of distance for three transects in WCA-1**.**

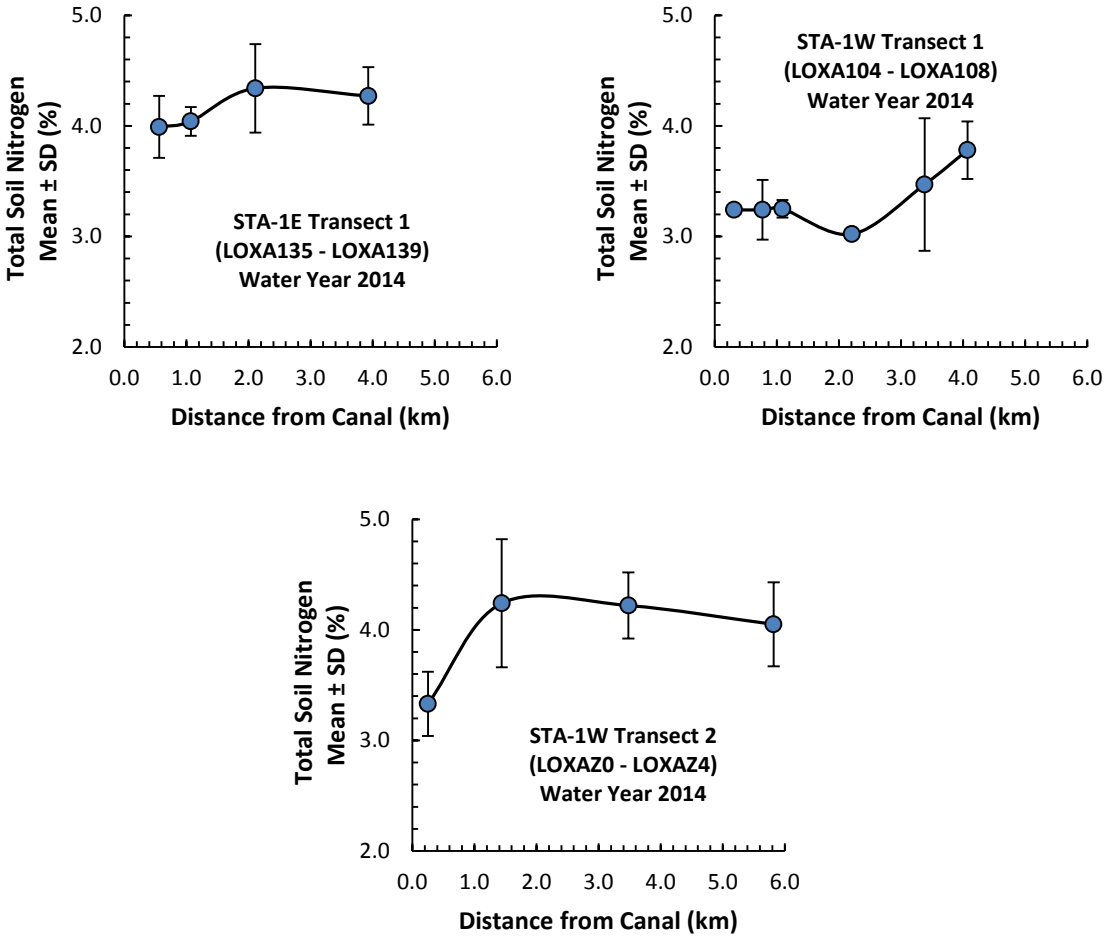


Figure D-16. Plots of mean soil N (± standard deviation) content for WY2014 as a function of distance for three transects in WCA-1.

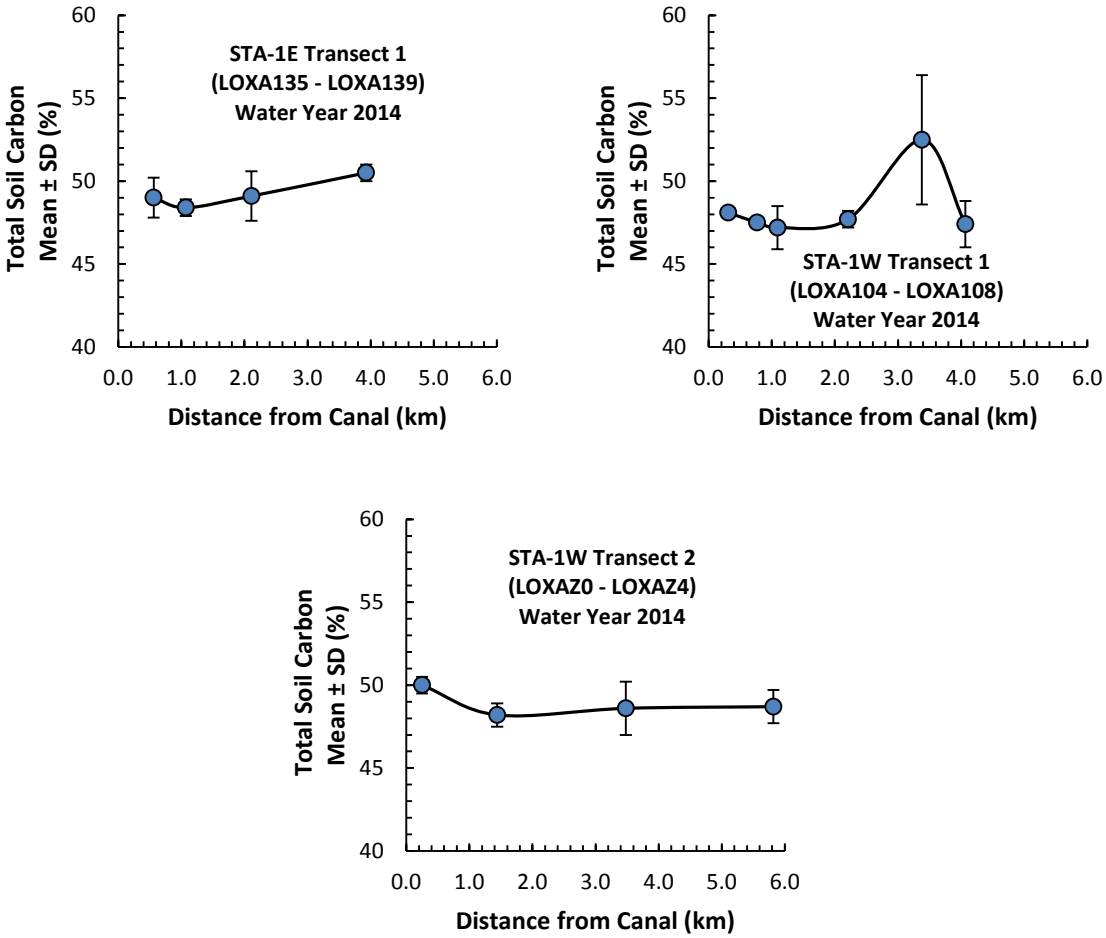


Figure D-17. Plots of mean soil C (± standard deviation) content for WY2014 as a function of distance for three transects in WCA-1.

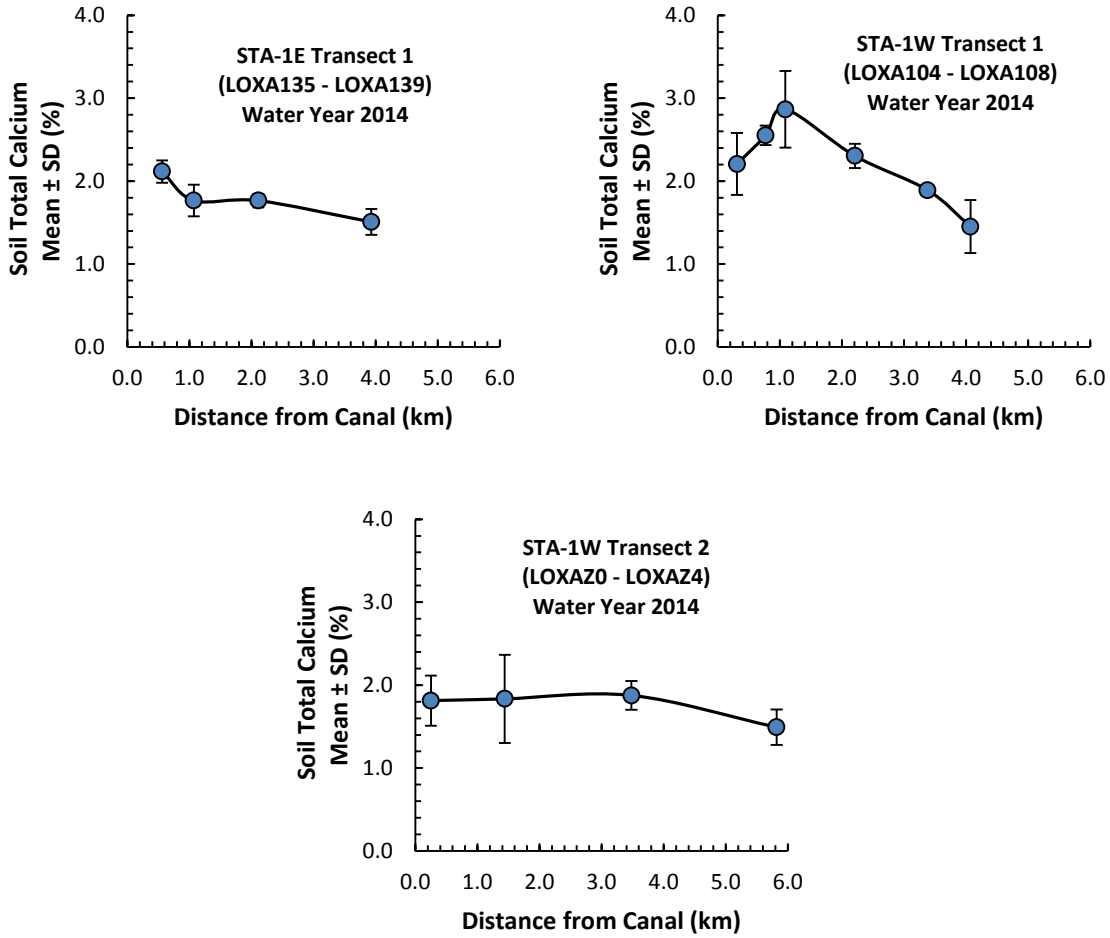


Figure D-18. Plots of mean soil Ca (± standard deviation) content for WY2014 as a function of distance for three transects in WCA-1.

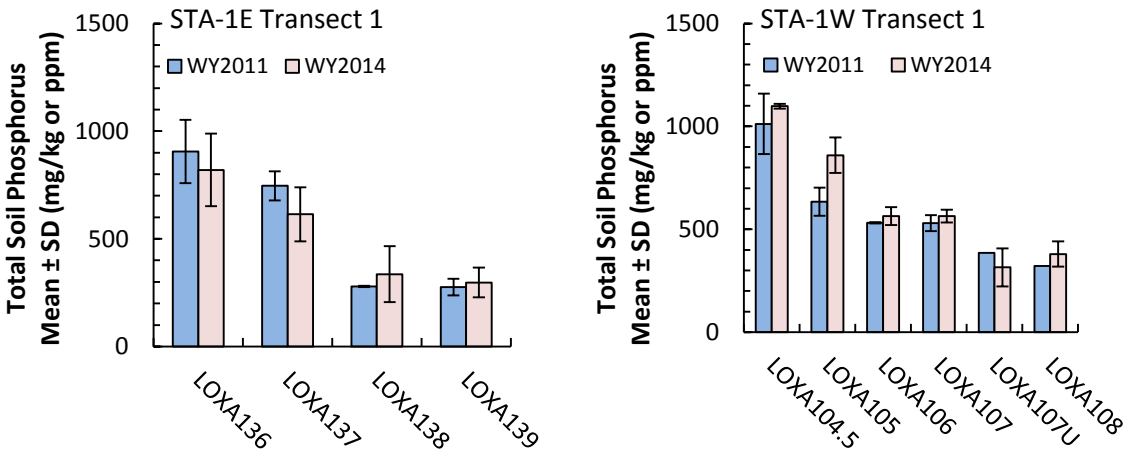


Figure D-19. Mean soil P (± standard deviation) content measured during WY2011 and WY2014 along two monitoring transect stations in WCA-1.

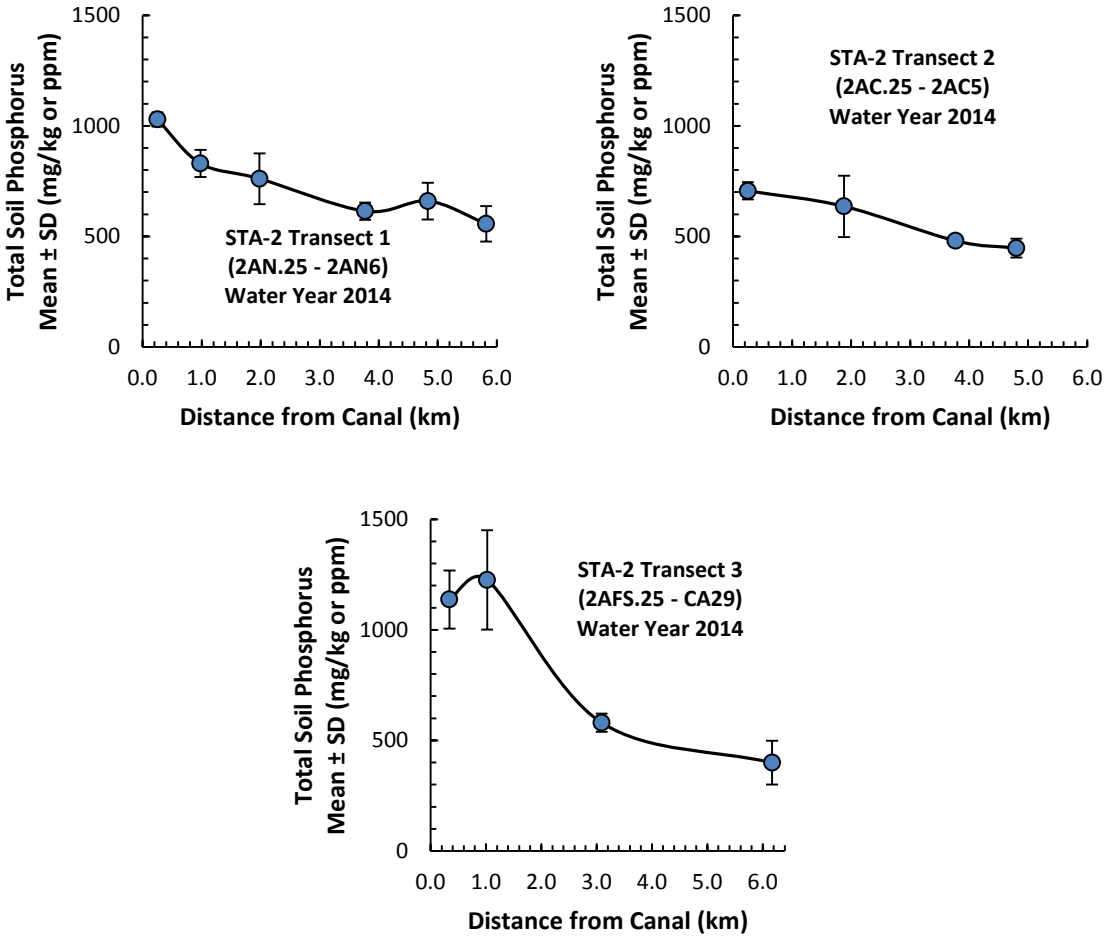


Figure D-20. Plots of mean soil P (± standard deviation) content for WY2014 as a function of distance for three transects in WCA-2A.

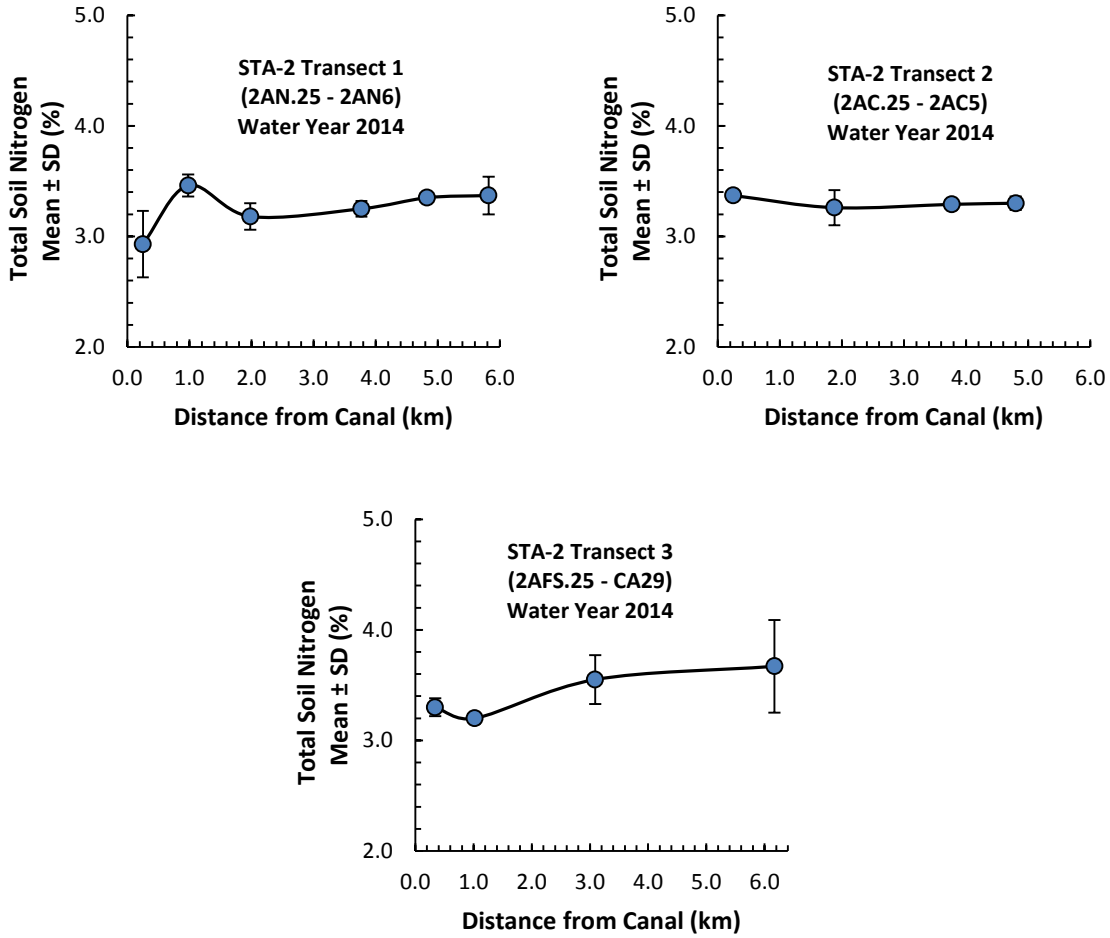


Figure D-21. Plots of mean soil N (± standard deviation) content for WY2014 as a function of distance for three transects in WCA-2A.

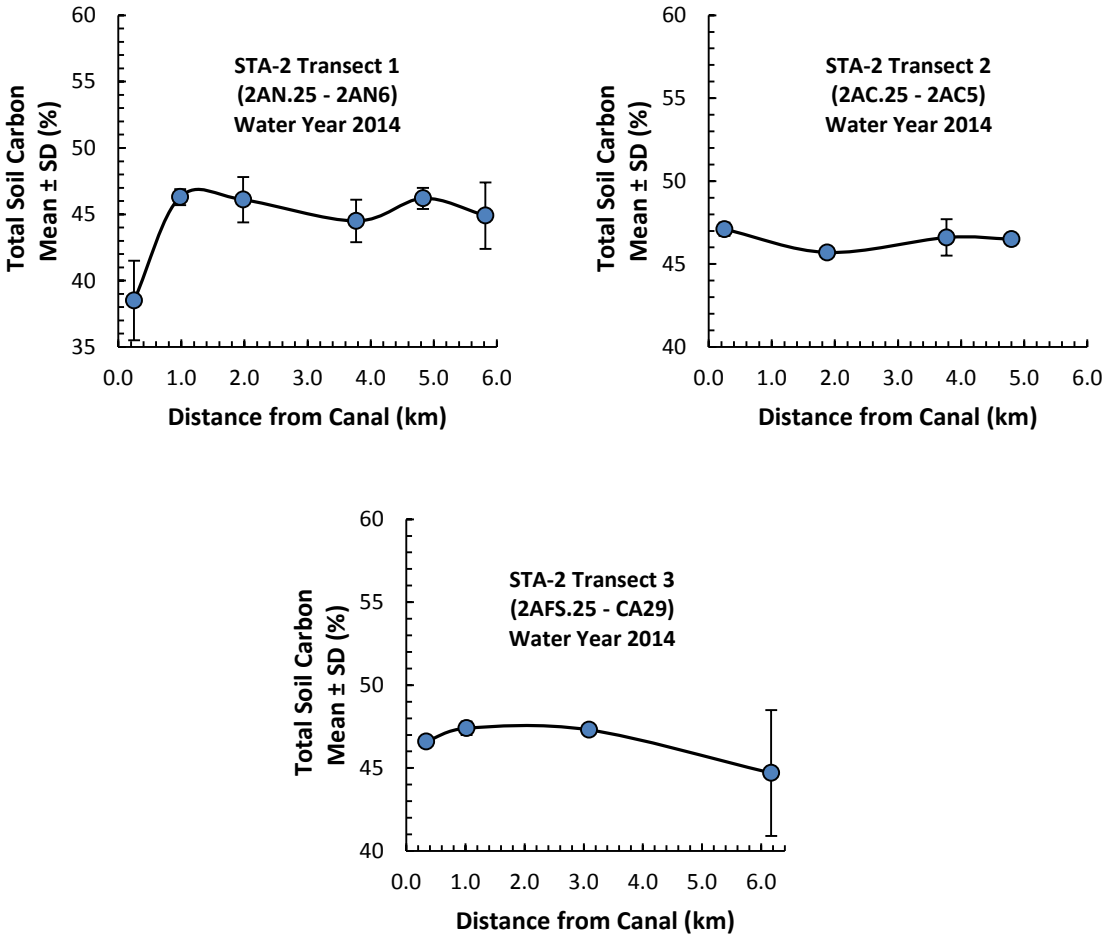


Figure D-22. Plots of mean soil C (± standard deviation) content for WY2014 as a function of distance for three transects in WCA-2A.

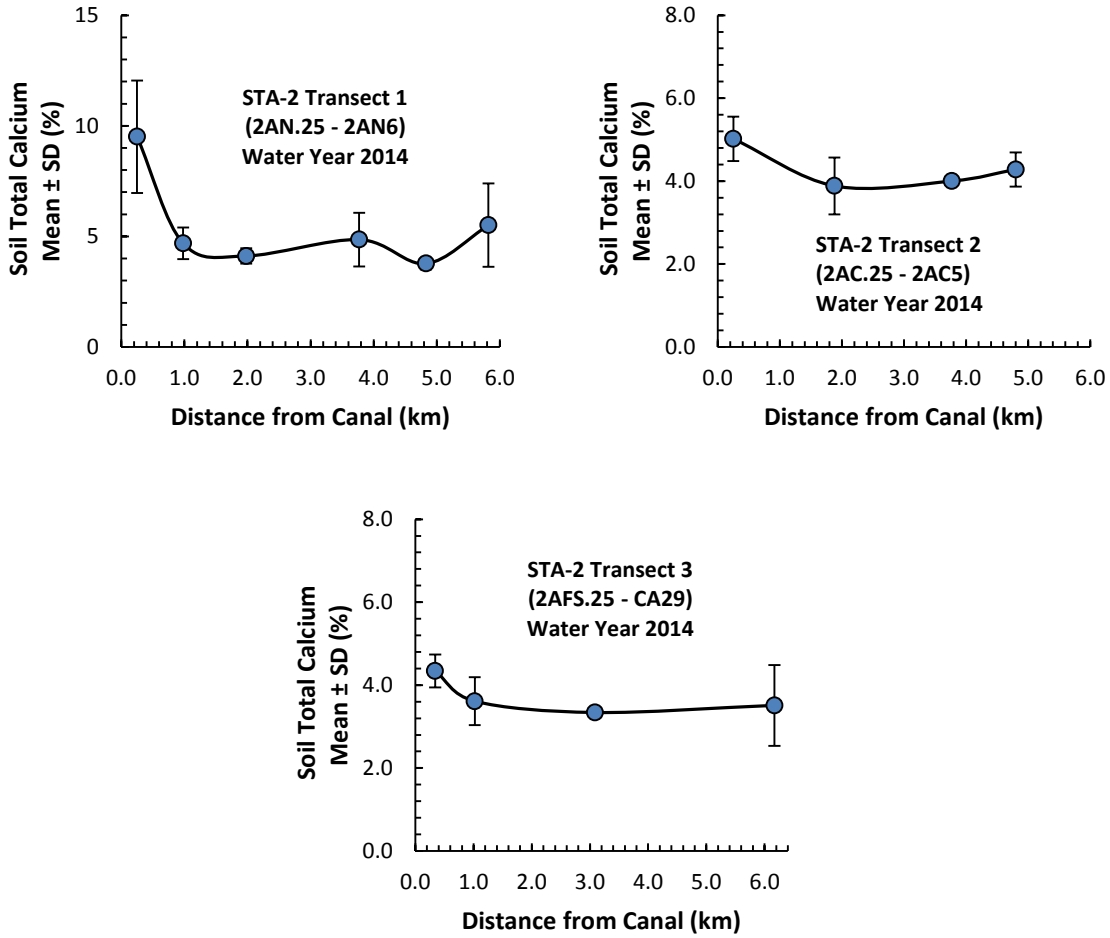


Figure D-23. Plots of mean soil Ca (± standard deviation) content for WY2014 as a function of distance for three transects in WCA-2A.

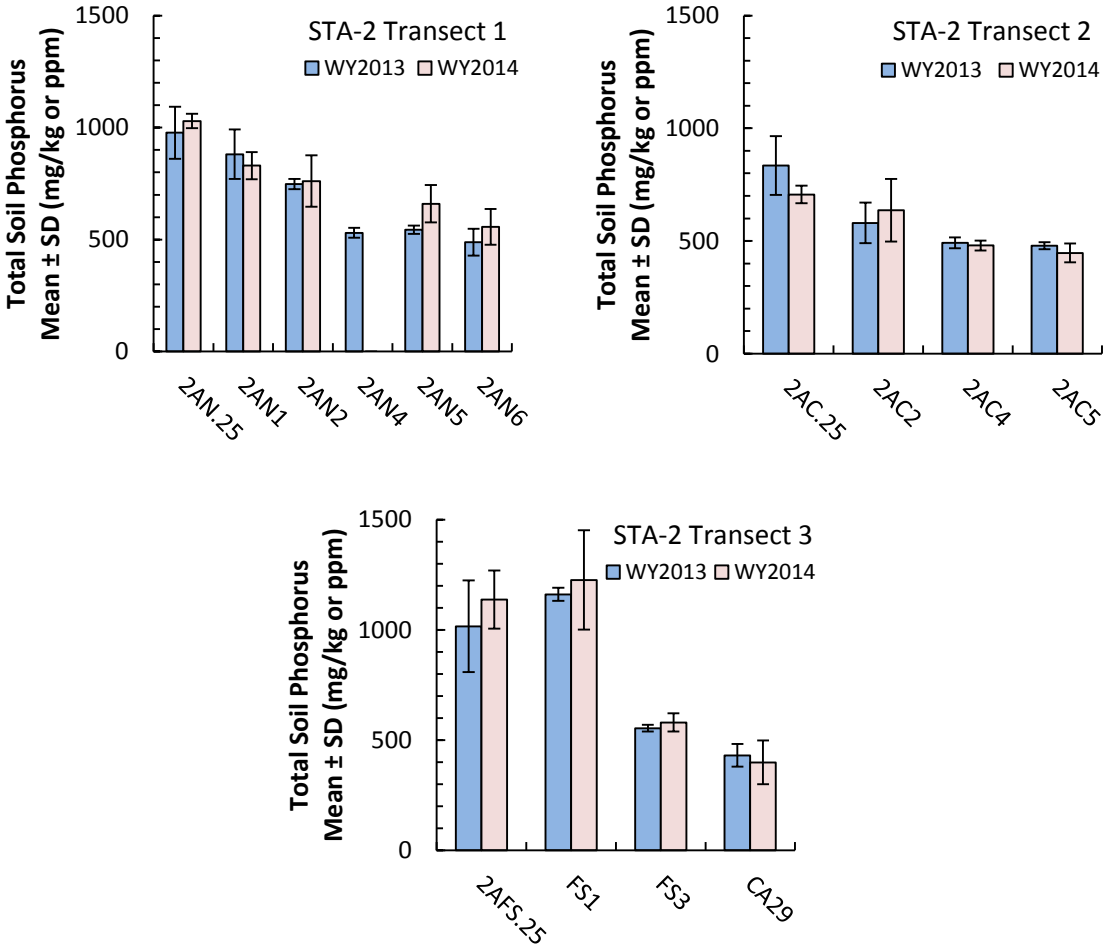


Figure D-24. Bar plots comparing mean soil P (± standard deviation) content measured during WY2013 and WY2014 at monitoring stations along three transects in WCA-2A

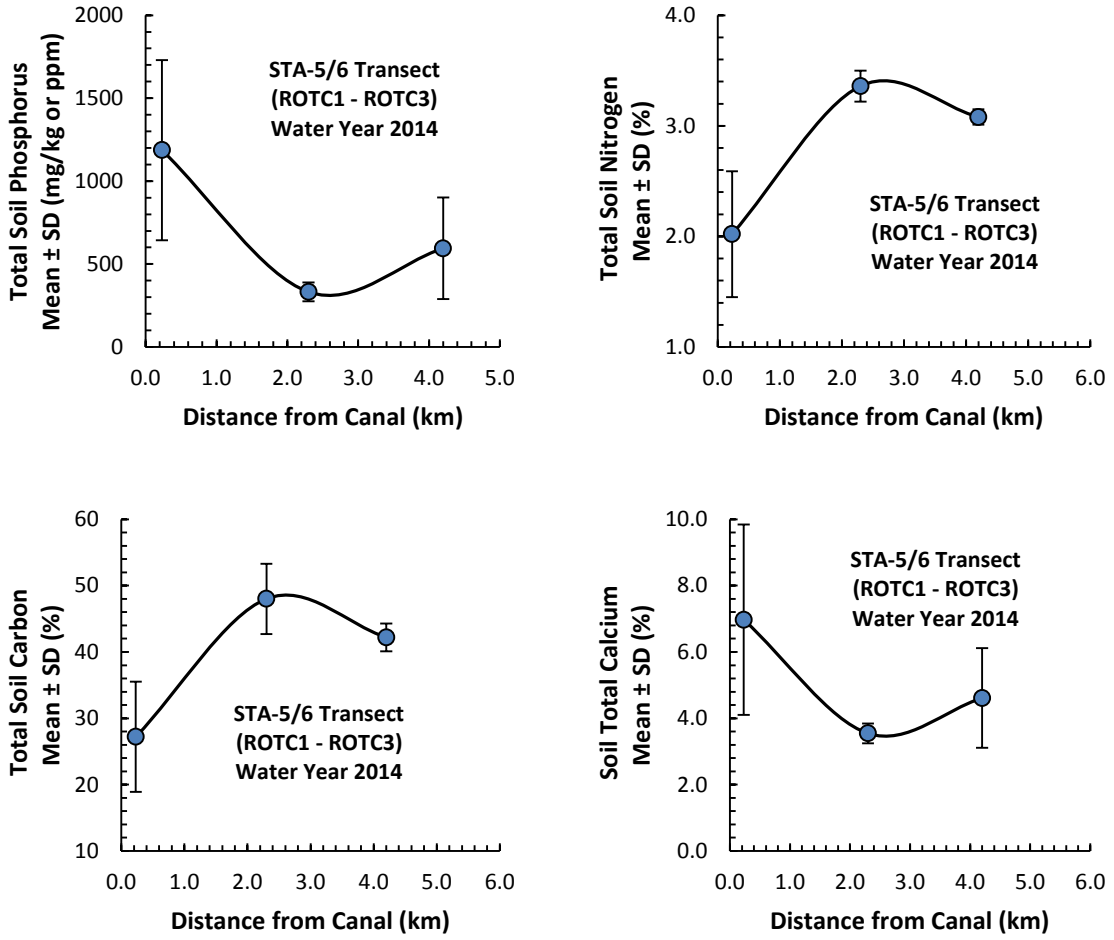


Figure D-25. Plots of mean soil P, N, C and Ca (± standard deviation) content for WY2014 as a function of distance for three transects in RWMA.

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Attachment E: STA Herbicide Application Summary for Water Year 2014

Louis Toth

Table E-1 summarizes herbicide treatments (acres treated and gallons of herbicides used) in the Everglades Stormwater Treatment Areas (STAs) during Water Year 2014 (WY 2014) (May 1, 2013– April 30, 2014). No pesticides were applied within the Everglades STAs during WY 2014.

Herbicides were used to control three species of floating plants, water lettuce (*Pistia stratiotes*), water hyacinth (*Eichhornia crassipes*), and crested floating heart (*Nymphoides cristata*), five species of emergents, cattail (*Typha domingensis* and *Typha latifolia*), alligator weed (*Alternanthera philoxeroides*) and pennywort (*Hydrocotyle umbellata* and *Hydrocotyle ranuculoides*), four species of grasses, torpedo grass (*Panicum repens*), paragrass (*Urochloa mutica*), bermudagrass (*Cynodon dactylon*) and napier grass (*Pennisetum purpureum*), three species of shrubs, Brazilian pepper (*Schinus terebinthifolius*), primrose willow (*Ludwigia peruviana*), and Carolina willow (*Salix caroliniana*), one tree species, melaleuca (*Melaleuca quinquenervia*), and the submerged exotic hydrilla (*Hydrilla verticillata*).

Large aerial herbicide treatments were needed to reduce cover of willow in Cells 5 (205 acres) and 6 (257 acres) in the north build-out of STA-2, and willow, primrose willow and water lettuce in Cells 1A (138 acres), 2A (109 acres), 3A (850 acres), 4A (641 acres) and 5A (1220 acres) of STA-5/6, to reduce cover of cattail in submerged aquatic vegetation (SAV) Cells 1B (150 acres) and 2B (100 acres) of STA-3/4, and to convert Cell 8 (225 acres) of STA-2 and Cell 5B (463 acres) of STA-5/6 to SAV. Herbicide applications also were used regularly to control floating plants near the inflow and outflow structures of all cells and in SAV cells. Frequent treatments were needed for water lettuce and water hyacinth in Cell 4N (826 acres) of STA-1E, Cell 5B (560 acres) of STA-1W, and Cells 1B (293 acres) and 2B (435 acres) of STA-5/6.

APPLICATION RATE

Water lettuce, water hyacinth, and crested floating heart were treated with either diquat dibromide (37.3% solution) at a rate of 1 quart per acre, 2,4D (46.3%) at 2 quarts per acre, or with a mix of diquat and imazapyr (28.7%) at 2 quarts per acre. Two new growth-regulating herbicides also were used to treat floating plants, particularly in locations where giant bulrush was planted. Flumioxazin (51%) was particularly effective in eliminating water lettuce at 6 ounces per acre. Penoxsulam (21.7%) was applied at 4-6 ounces per acre alone and in a mix with flumioxazin at 6-10 ounces per acre to treat water hyacinth and pennywort. Applications of triclopyr (44.4%) at a rate of 1-2 gallons per acre or a mix of glyphosate (53.8%) at 7.5 pints per acre and imazapyr (28.7%) at 2 quarts per acre were applied to willow, primrose willow, and Brazilian pepper. Cattails were treated with glyphosate or with a mix of glyphosate and imazapyr. Glyphosate or the glyphosate/imazapyr mix also was used to treat torpedograss, paragrass, napier grass, bermudagrass, and pennywort. Endothall (40.3%) was used at a rate of 2.6 gallons per acre foot to treat Hydrilla.

APPLICATION CERTIFICATION STATEMENT

The South Florida Water Management District ensures that all herbicide applications are carried out in accordance with label specifications and in compliance with NPDES regulations.

Table E-1. Acres of vegetation treated with herbicides during WY2014.

Cell	Acres	Diquat (gallons)	Imazapyr (gallons)	Glyphosate (gallons)	2,4 D (gallons)	Triclopyr (gallons)	Flumioxazin (pounds)	Penoxsulam (gallons)	Endothall (gallons)
STA 1E									
1	23.3	2.25	5	7.5	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	259.49	36.75	24	31.5	0	0	1.13	0	0
4N	826.65	145.25	0	0	2.5	0	3.38	0	0
4S	123.57	19.25	0	0	0	0	4.88	0	0
5	294.83	20.38	27.25	36	0	0	29.25	0.94	0
6	229.04	30.75	0	0	0	0	35.75	1.24	0
7	67.82	7.25	8.25	8.25	3.25	0	2.5	0	0
STA 1W									
1A	332.83	45.25	0	19.69	16	0	16.76	1.8	0
1B	20.52	4	0	0	0	0	0	0	0
2A	74.56	13.75	2.5	9.38	5	0	0	0	0
2B	60.99	6.5	0	0	0	0	5.75	0	0
3	12.54	0	0	4.69	0	2	0	0	0
4	0	0	0	0	0	0	0	0	0
5A	188.02	23.75	0	0	11.5	0	16	0.98	0
5B	560.53	87.88	6	22.51	5	0	1.5	0	0
STA 2									
1	22.41	3.5	1.25	4.69	0	1	0	0	0
2	100.86	3.5	3	70.31	0	0	0	0	0
3	41.04	5	2.25	8.44	0	0	0	0	0
4	174.62	0	1.25	71.82	0	4	0	0	0
5	178.92	4.75	40	129.31	0	0	0	0	0
6	257.56	2.63	44.5	138.64	2	59.5	2.5	0	0
7	0	0	0	0	0	0	0	0	0
8	225.4	0	120	215	0	0	0	0	0

Cell	Acres	Diquat (gallons)	Imazapyr (gallons)	Glyphosate (gallons)	2,4 D (gallons)	Triclopyr (gallons)	Flumioxazin (pounds)	Penoxsulam (gallons)	Endothall (gallons)
STA 3/4									
1A	278.79	50	0	0	47.75	0	46.13	4.21	0
1B	252.71	9	83.12	172.23	0	1.5	9.75	0	0
2A	141.93	14	0	3.13	8.25	1.25	15	1.05	0
2B	100	0	50	93.75	0	0	0	0	0
3A	85.19	15.88	0	8.91	0	0	2.13	0	0
3B	0	0	0	0	0	0	0	0	0
PSTA	1.72	0	0	0	0	1.5	0	0	0
STA 5/6									
5-1A	216.91	27.69	60	132.66	1.5	0	0.88	0	0
5-1B	293.03	58.44	0.31	3.09	0	0	20.31	0	0
5-2A	174.8	21.13	55.25	111.44	0	0	5.44	0	0
5-2B	435.11	90.32	0.09	1.43	0	0	77.5	0	0
5-3A	920.6	17	289.63	588.85	0	100	0	0	0
5-3B	137.73	0	30.56	114.61	0	0	3.28	0	6.82
5-4A	642.28	12.97	145.31	338.17	0	30	75	0	0
5-4B	38.21	0.38	2.44	9.14	0	0	45	0	93.5
5-5A	1252.55	16	610	1143.5	8	0	0	0	0
5-5B	463.85	0	229.75	439.31	0	0	0	0	0
6-3	29.4	0	15	28	0	0	0	0	0
6-5	29.4	0	15	28	0	0	0	0	0
6-2	7.2	2	0	0	0	0	0	0	0
6-4	304.38	2.25	125	233.75	0	25	0	0	0

Attachment F: Annual Permit Compliance Monitoring Report for Other Toxicants in the STAs

Richard Pfeuffer

EXECUTIVE SUMMARY

The Everglades Forever Act Permit Number 0311207 (Specific Condition 23 and Table 2) for the Everglades Construction Project, issued to South Florida Water Management District (District and SFWMD) in September 2012 requires the SFWMD "to monitor mercury in accordance with the Department [Florida Department of Environmental Protection] approved mercury monitoring plan." The Florida Department of Environmental Protection (FDEP) approved the plan on September 18, 2012. This document, *STA-1W, STA-1E, STA-2, STA-3/4 and STA-5/6 Mercury and Other Toxicants Monitoring Program*, referred to as the Monitoring Plan, contains sampling locations, frequency and types of monitoring for mercury and other toxicants required by the permit (SFWMD, 2012). This document is referred to as the Monitoring Plan throughout the rest of this document.

Specific Condition 23 also requires that the Monitoring Plan be developed in accordance with the publication *A Protocol for Monitoring Mercury and Other Toxicants* (FDEP and SFWMD, 2011). This document, referred to as the Protocol throughout the rest of this document, is a guide for design of monitoring and assessment plans for mercury, pesticides, and other toxicants for SFWMD projects.

INTRODUCTION

The SFWMD constructed two new flow-ways in Stormwater Treatment Area (STA)-2 known as the Everglades Agricultural Area (EAA) Compartment B Buildout Project. Compartment B (**Figure F-1**) includes Cells 4, 5, and 6, referred to as the North Buildout (NBO), and cells 7 and 8, referred to as the South Buildout (SBO). The Monitoring Plan (page 9) states that based on the prevailing status of Compartment B and guidance contained in the Protocol, the SFWMD would conduct Phase 2 – Tier 1 Routine Monitoring during Stabilization Period for all cells (4-8) of Compartment B. **Figure F2** shows the cells and flow-ways within STA-2.

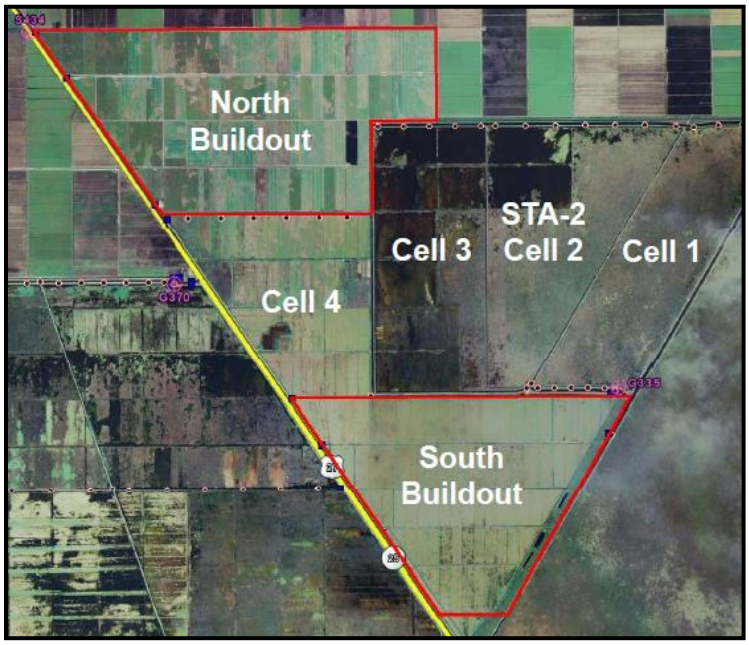

Figure F-1. Map showing Compartment B including the location of the NBO and SBO in relation to STA-2.

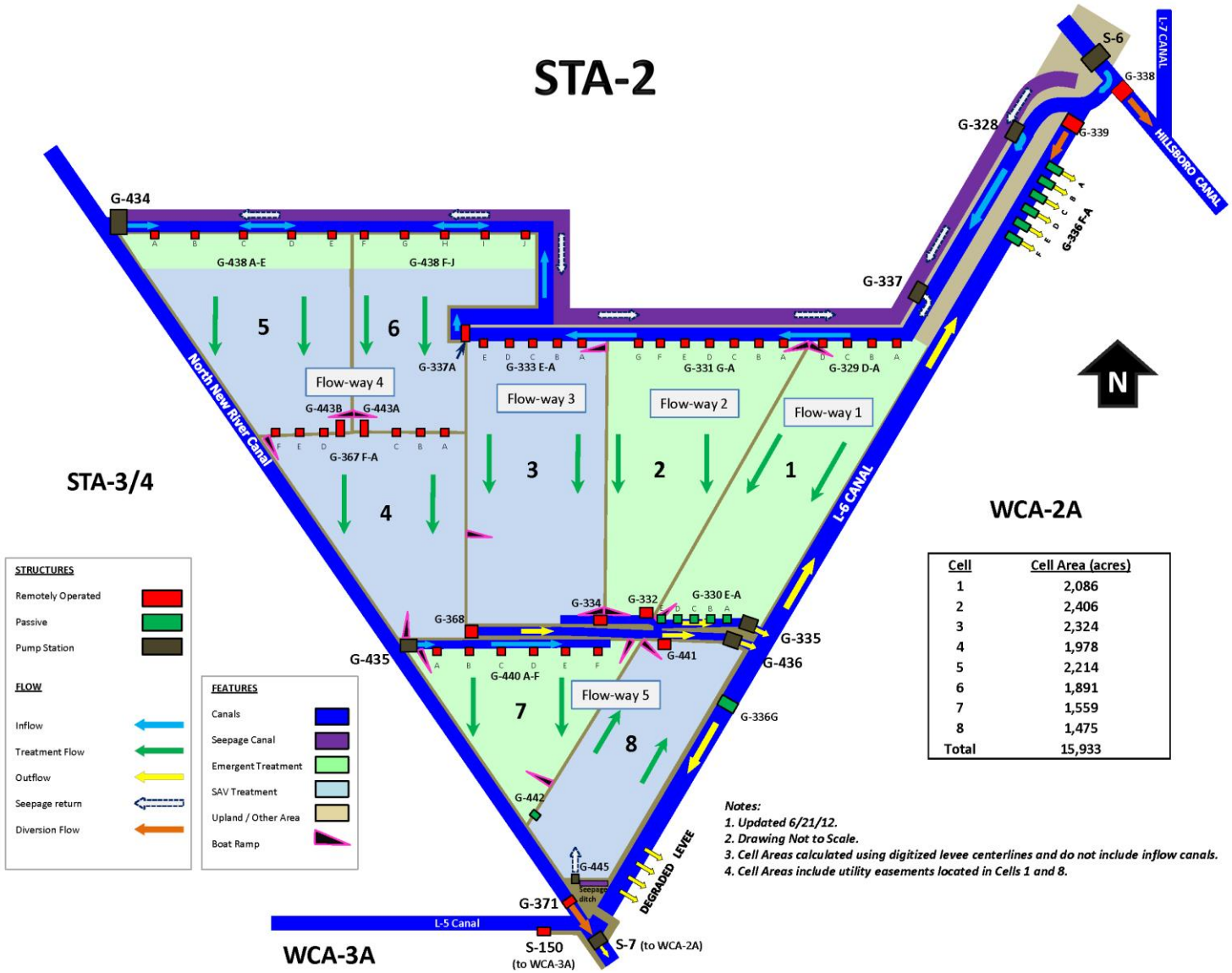

Figure F-2. Map of STA-2 showing cells and flow-ways.

OTHER TOXICANTS MONITORING REQUIREMENTS

The Monitoring Plan lists the Phase 2 – Tier 1 collection matrix (surface water and fish tissue), along with locations, method, frequency and parameters for Compartments B. **Table F-1** summarizes these monitoring requirements. Analysis of other toxicants from surface water or fish tissue samples in Compartment C was deemed not necessary based on results of an environmental site assessment. Initially, the operation plan for STA-2 and Compartment B only allowed STA-2 Cells 1–3 to discharge through the G-335 structure and Compartment B NBO and SBO to discharge through G-436. After start-up monitoring was completed, however, a plug was removed from the levee that segregated original STA-2 discharge from Compartment B discharge and the operation plan was changed to reflect this. Structure G-335 was subsequently added to the Compartment B monitoring plan.

Table F-1. Compartment B Phase 2 – Tier 1: Routine Monitoring during Stabilization Period.

Matrix	Location	Collection Method	Frequency	Parameter[a]
Mosquitofish (*Gambusia* spp.)	Within each flow-way of NBO and SBO	net or trap	quarterly	cis-chlordane, trans-chlordane, o,p'-DDD, p,p'-DDD, o,p'-DDE, p,p'-DDE, o,p'-DDT, p,p'-DDT, cis-nonachlor, trans-nonachlor, and toxaphene
Surface water	G-328, S-6, G-434 G-435, G-335, G-436	grab	quarterly	chlordane, p,p'-DDD, p,p'-DDE, p,p'-DDT, and toxaphene

a. Key to parameters:
o,p'-DDD – ortho para dichlorodiphenyldichloroethane
o,p'-DDE – ortho para dichlorodiphenyldichloroethylene
o,p'-DDT – ortho para dichlorodipheyltrichloroethane
p,p'-DDD – para para dichlorodiphenyldichloroethane
p,p'-DDE – para para dichlorodiphenyldichloroethylene
p,p'-DDT – para para dichlorodipheyltrichloroethane.

OTHER TOXICANTS MONITORING DATA

Surface water and fish sampling events were performed under project codes ST2G and ST2F, respectively. Surface water sampling occurred in May and August 2013. Mosquitofish sampling occurred in July 2013. Samples were analyzed for pesticide compounds listed in **Table F-1**.

Surface water samples were collected from six different sites (**Table F-1** and **Figure F-2**). All of the compounds were below detection level.

The only compound detected during the mosquitofish sampling was p,p'-DDE (**Table F-2**). However, the analytical lab, FDEP Central Laboratory, did not properly preserve the samples collected during this sampling event. The data are presented for informational purposes only.

A request to terminate the other toxicant monitoring was approved by FDEP on October 2, 2013 after the required monitoring met evaluation criteria.

Table F-2. Summary of fish other toxicant analysis.

Collection Date	Station / Fish	p,p'-DDE[a] (µg/kg wet weight)
7/22/2013	STA2NBO / Mosquitofish	1.1 T[b]Y[c]
	STA2SBO / Mosquitofish	0.95 TY

a. Key:
µg/kg – micrograms per kilograms.
p,p'-DDE: para, para dichlorodiphenyldichloroethylene

b. T – Value reported is less than the criterion of detection

c. Y – Laboratory analysis was from an improperly preserved sample; data may not be accurate.

REFERENCES

FDEP and SFWMD. 2011. A Protocol for Monitoring Mercury and Other Toxicants. Florida Department of Environmental Protection, Tallahasee, FL, and South Florida Water Management District, West Palm Beach, FL.

SFWMD. 2012. STA-1W, STA-1E, STA-2, STA-3/4 and STA-5/6 Mercury and Other Toxicants Monitoring Program. South Florida Water Management District, West Palm Beach, FL. September 18, 2012.