Appendix 5-1: Annual Permit Report for the Loxahatchee River Watershed Restoration Project, G-160 and G-161 Components

Permit Report (January 1, 2011–December 31, 2011)
Permit Numbers: EI 50-0128848 and EI 50-0244327

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SUMMARY

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

Table 1. Key permit-related information.

Project Name	G-160 / G-161
Permit Number	EI 50-0128848 and EI 50-0244327
Issue and Expiration Dates EI 50-0128848 EI 50-0244327	 Issued: 3/7/2003; Expires: N/A (in Operation Phase) Issued: 5/15/2006; Expires: N/A (in Operation Phase)
Project Phase	Operation
Permit Specific Condition Requiring Annual Report	10
Relevant Period of Record	January 1, 2011–December 31, 2011
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Table 2. Attachments included with this report.

Attachment	Title
A	Specific Conditions and Cross-References
B	Hydrologic Data
C	Loxahatchee Slough Restoration and G-160 Monitoring Plan, Third Post-Operational Field-Based Vegetation Monitoring Report
D	Vegetation Communities in the Loxahatchee Slough Natural Area: A 2011 GIS-Based Analysis of Vegetation Associated with the G-160/161 Structures
E	L-8 Reservoir Pilot Test Water Quality Results

INTRODUCTION

Environmental Resource Permits EI 50-0128848 and No. EI 50-0244327 issued by the Florida Department of Environmental Protection (FDEP) to the South Florida Water Management District (District or SFWMD) authorized the District to construct and operate the C-18 Canal Control Structure (G-160) Project and the G-161 Water Control Structure Phase II Project. Modified Specific Conditions 7 and 10, respectively, require the District to submit an annual report within 75 days of the end of each year of operation. The reporting period for this report is Calendar Year 2011 (January 1, 2011–December 31, 2011). Because both structures are able to be operated concurrently and are designed to restore a more natural hydroperiod to the Loxahatchee Slough while increasing the flows to the Northwest Fork (NW Fork) of the Loxahatchee River, the two reports are unified into this single document. This G-160/G-161 Projects Annual Report presents the results of the permit-mandated monitoring for the G-160 and G-161 structures during Operation Year 2011.

The G-160 structure allows stages in the C-18 canal to be increased in accordance with specific hydraulic conditions and zones to meet the recommended target stages within the Loxahatchee Slough that are necessary to maintain the ecological integrity of the slough vegetative communities. The Loxahatchee Slough is a historical tributary component to the Loxahatchee River, providing important base and wet season flows. When supplemental water is available from the CERP project, G-160 will allow the maintenance of a permanent water pool in the Loxahatchee Slough, between 15.5 and 17.5 feet National Geodetic Vertical Datum (ft NGVD), with maximum water levels up to 17.8 ft NGVD for rainfall driven conditions. The structure is to be effectively operated so that during rainfall events, when stages upstream of the G-160 structure rise to elevation 16.8 ft NGVD, the structure is opened to allow the stages to recede and is closed once they reach elevation 16.2 ft NGVD. Gradual reduction of the stage upstream of G-160 should occur through the dry season to compensate for gradual drawdown of the slough to 15.5 ft NGVD toward the end May.

The G-161 structure allows water to be released from the Grassy Waters Preserve (GWP) under Northlake Boulevard into a constructed flow-way through the triangle formed by the area to the west of the intersection of Northlake Boulevard and Beeline Highway (SR 710). The water flows northward to a culvert that discharges under Beeline Highway to the C-18 Canal upstream of G-160.

The Environmental Resource Permit issued by the FDEP to the co-permittees, the District and Palm Beach County, for the construction and operation of the G-160 structure requires hydrologic and vegetation monitoring (vegetation monitoring is only required in the Loxahatchee Slough). The G-161 structure Environmental Resource Permitting (ERP) requires water quality, stage, and flow monitoring, as well as an expansion of the G-160 vegetation monitoring program into areas potentially impacted by the operation of the G-161 Project. Collectively, this report focuses on the monitoring outlined in the 5-Year Operation Monitoring Plan (Plan) for the G-161 Water Control Structure Phase (G-161 Project) to implement Specific Condition 9 (I)–(IV) of permit EI 50-0244327. The G-160 vegetation monitoring report, prepared under separate cover by the Palm Beach County Department of Environmental Resources Management, is also included with this document.

The purpose of the G-161 monitoring program is to evaluate the results of the G-161 Project in achieving the desired objectives of restoring a more natural hydroperiod and flow to downstream wetlands, sloughs, ponds, floodplains, and rivers, without impacting water quality relative to baseline conditions. It is also anticipated that restoring a more natural timing, magnitude, duration, and frequency of flow in the downstream flowing waters will also restore a more natural salinity gradient in the downstream system, with associated benefits for estuarine and marine flora and fauna. However, contribution of the G-161 Project to the restoration of natural hydroperiod to this system, individually or together with the related G-160 Project, is constrained by regional water availability. Operating schedules may still be controlled or influenced by other local government regulations or permits. Full benefits of the G-160 and G-161 structures are not anticipated to be realized until regional water is available in amounts adequate to provide restorative flows to the NW Fork of Loxahatchee River.

To the extent practicable and appropriate, the G-161 Project monitoring program is carried out in coordination with the adjacent G-160 Project using the same methods, procedures, and reporting format. This is intended to ensure comparability of results and continuity of data interpretation, while avoiding duplicative efforts.

Specifically, the Monitoring Plan provides for:

1. Continuous water level monitoring during operations at locations upstream and downstream of the G-161 structure via stage gauges with telemetry to support the calculation of the flow rate through the G-161 structure;
2. Expansion of the wet and dry season ground-level vegetation monitoring in Loxahatchee Slough under the G-160 ERP into the wetland areas of interest to evaluate the effect of project-related hydrological changes on the vegetation community;
3. Upland, wetland, and aquatic wildlife observations incidental to ground-level vegetation monitoring;
4. Vegetation monitoring of the entire system via aerial photography in 2011,with ground truthing using those vegetation plots compared to the pre-construction baseline aerial photograph taken in 2005; and
5. Monthly water quality monitoring during periods of flow via grab sampling upstream of the G-161 structure and the Control 2 Pump Station to evaluate the status of and trends in post-operational water quality relative to pre-operational baseline.

The permit requires monitoring in areas that are expected to have an altered or enhanced hydroperiod as a result of regular operation of the G-161 structure. The District has monitored stage and flow per G-161 ERP Specific Condition 9(I) and monthly water quality monitoring per 9(IV) on the few occasions over the last four years when water was flowing through the G-161 structure. However, the general lack of availability of regional water has precluded regular operation of the G-161 structure. Consequently, the co-permittees have been unable to monitor interior stages per 9(II), or vegetation per 9(III), and it was not possible to associate long-term changes in water stage, flow, or quality or vegetation in potentially impacted areas. Altered or enhanced hydroperiods have not been realized. Until the reservoir is fully operational and able to consistently deliver water from the regional system to maintain hydroperiod depths and durations as well as provide restorative flows to the river, it is unlikely that significant vegetative changes or changes in wildlife usage will be realized.

On February 18, 2011, the SFWMD submitted an application to the FDEP requesting temporary relief from Specific Condition 22 of CERPRA Permit 0188365, under an exemption pursuant to Subsection 373.406(6), Florida Statutes, in order to conduct a dry season operational pilot test. The test utilized the L-8 Reservoir as an alternative water supply source for the delivery of water to the GWP and NW Fork of the Loxahatchee River during the 2011 dry season (February–April).

On February 28, 2011, the FDEP authorized a temporary deviation from the permit requirement to allow water from the L-8 Reservoir to be delivered eastward into the GWP for eventual delivery north to the NW Fork of the Loxahatchee River for a limited period of time (30 consecutive or non-consecutive days). This included the G-161 structure which was also monitored during this pilot test. On March 29, 2011, the District provided the FDEP with initial water quality results from the pilot operational test and requested an additional 30-day (consecutive or non-consecutive) extension of the test to collect additional information necessary for the design and planning aspects associated with the Loxahatchee River Watershed Restoration Project. In accordance with the requirements of Section 373.406(6), Florida Statutes, the FDEP reviewed this information on April, 4, 2011, and granted the District an extension of the operational test for an additional 30 days. On June 3, 2011, the District submitted the final Water Quality Report on the L-8 Pilot Test to the FDEP (see Attachment E).

MONITORING STATION LOCATIONS

Table 3 summarizes the locations of the water quality and flow monitoring sites used in this report. **Figure 1** shows the monitoring locations in the GWP and Loxahatchee Slough areas. This figure also shows the natural areas to be restored by the operation of these structures in conjunction with the availability of regional water of sufficient quantity and quality to provide for restorative flows. Other relevant structures and environmental features include the G-92 culvert, S-46 spillway, water catchment area (Grassy Waters Preserve), Loxahatchee Slough, NW Fork of the Loxahatchee River, and Loxahatchee Estuary.

Table 3. G-160/161 monitoring locations.

Sampling Station	Station Location	Coordinates	
		Latitude	Longitude
G-161	North Lake Blvd west of SR 710 Outflow for Grassy Waters	264836.386	800923.390
G-160	C-18 Canal Loxahatchee Slough	265245.8	801035.6
S-46	Coastal Structure on the C-18 Canal	265603.203	800830.147
L8.M CNL	City of WPB Control 2 pump station on M-Canal	264519.710	802044.450

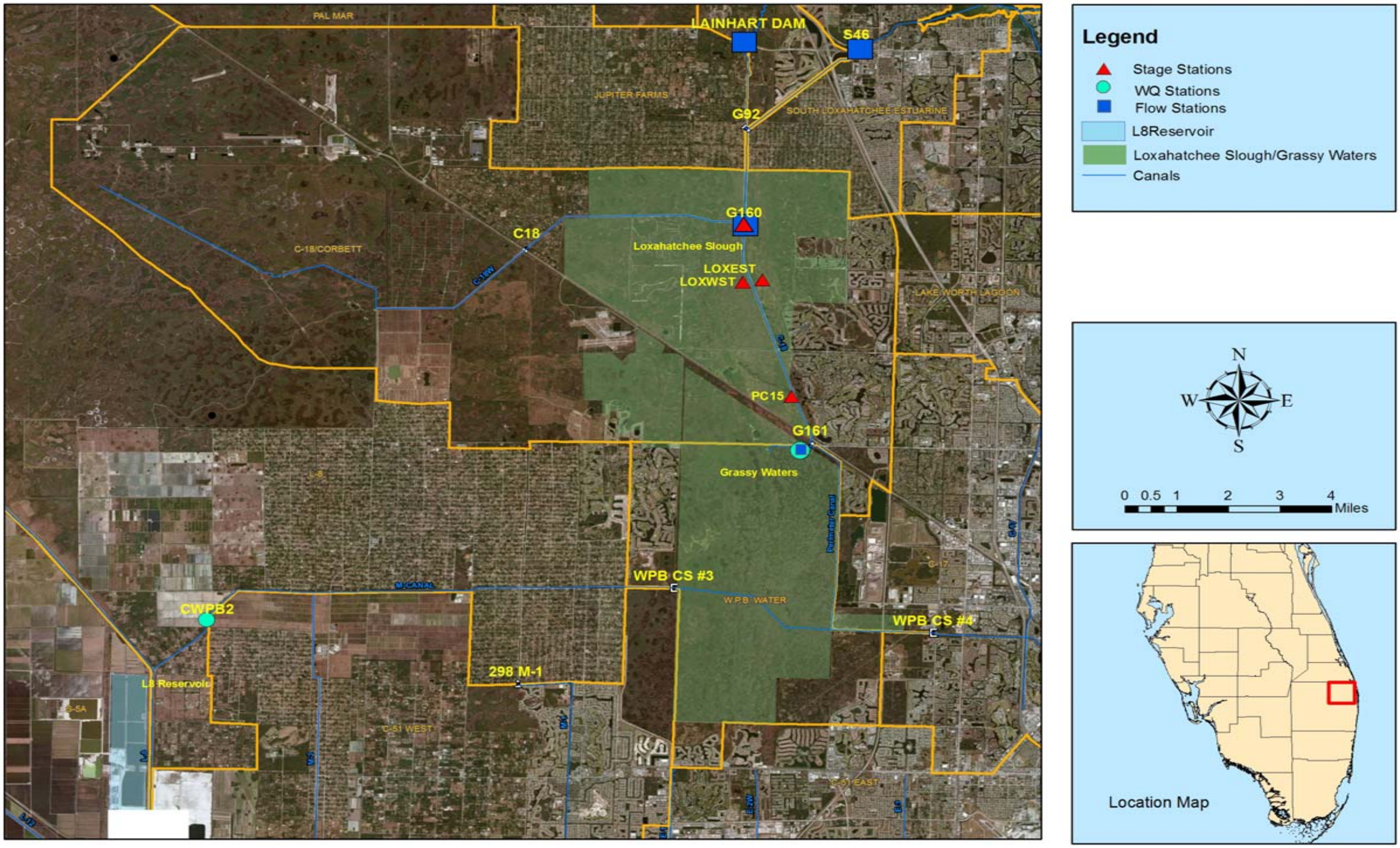


Figure 1. Location of G-160/161 monitoring sites.

2011 OPERATION OF G-160, G-161 AND S-46

In 2009, the FDEP directed the SFWMD to begin incrementally raising the G-160 structure in compliance with the interim operating plan that was component to the permit. The SFWMD responded by indicating that the G-160 headwater would be increased to 16.5 ft NGVD at the beginning of the 2009 wet season. The District also agreed to install and monitor seepage wells adjacent to the communities for a period of two years following the increase in stage to determine if seepage concerns were valid. The representative agencies (SFWMD, Northern Palm Beach County Improvement District, Southern Indian River Water Control District, and City of Palm Beach Gardens) met over several months in late 2009 to determine the location and number of wells to be installed. As a result, fourteen groundwater monitoring wells were installed (six shallow/deep pairs at strategic locations near community boundaries north of PGA Boulevard and two individual shallow wells in Palm Beach Gardens adjacent to the GWP) (see **Figure 2**) between January and March 2010. Data collection began in April 2010 and is planned to continue until September 2012. A preliminary analysis and interim report that reviews data collected through June 2011 is anticipated to be completed by late 2012. A final report that incorporates these data is expected to be completed in 2013.

The flashboard riser elevations for the project culverts on the east and west sides of the C-18 canal are currently set at 16.9 ft NGVD. In late 2010, slough elevations were at or slightly below the target. Although there were opportunities to lower the boards early in the 2010–2011 dry season to provide supplemental dry season flows to the NW Fork, this would have accelerated the slough drydown and further compromised the slough hydroperiod for the duration of the dry season. Any potential future changes to the operational protocol in the absence of adequate regional water available from the L-8 reservoir needs to consider maintaining slough levels within the target hydroperiod to the greatest extent possible.

The City of West Palm Beach routinely monitors apple snail (*Pomacea* sp.) populations; however, because of the lack of regional water availability, which has resulted in inconsistent and irregular operation of the G-161 structure, vegetation plot data were not collected by the city during this reporting period because vegetation changes are not expected until full operation of the system. However, a formal request to suspend the monitoring jhas not been submitted to date. In the future, the SFWMD proposes that landscape-level monitoring should offset the need for localized vegetation monitoring. Aerial photography was collected in early 2011, and a landscape level of analysis was conducted that can be used as a baseline for future operation.

During the 2011 dry season (November 2010–April 2011), the District experienced below average rainfall (9.33, 9.47, and 9.62 inches) at each of the three rainfall recorders in the area (SIRG_R, C-18W_R, and S46_R, respectively). The period of record rainfall average for these three sites is 16.01 inches.

Graphic representation of G-160 operation and associated slough stages are shown in **Figure 3**. Flows through G-161, G-160, S-46, and at Lainhart Dam are shown in **Figure 4**. Relevant data are included in Attachment B. G-160 was operated beginning in November 2010 to compensate flows through G-92 in an effort meet Minimum Flows and Level criteria for the NW Fork of the Loxahatchee River. This resulted in a 4-foot reduction in the stage upstream of G-160, and, from January through June 2011, stages upstream of the G-160 structure were limited to between 12 and 13 ft NGVD. Stages were allowed to increase with the onset of the wet season; however, due to relatively low rainfall levels in the basin, the G-160 stage did not rise above 16 ft NGVD until mid-August 2011.

Water quality samples were collected at G-161 and the City of West Palm Beach Control 2 Pump Station in association with the structure operation to comply with Specific Condition 9(IV) of the G-161 ERP which requires collection and analysis of water quality samples monthly during periods of flow for the following parameters:: temperature, dissolved oxygen, specific conductance, pH, and turbidity in the field using electro-physicochemical methods; and total suspended solids, ammonia, total Kjeldahl nitrogen, total nitrogen, orthophosphorus, total phosphorus, nitrite-nitrate, chlorides, calcium, and sulfate using a National Environmental Laboratory Accreditation Conference-certified laboratory and quantitative analytical methods approved by the FDEP for this purpose.

Figure 2. Groundwater monitoring wells in the vicinity of G-160/161.

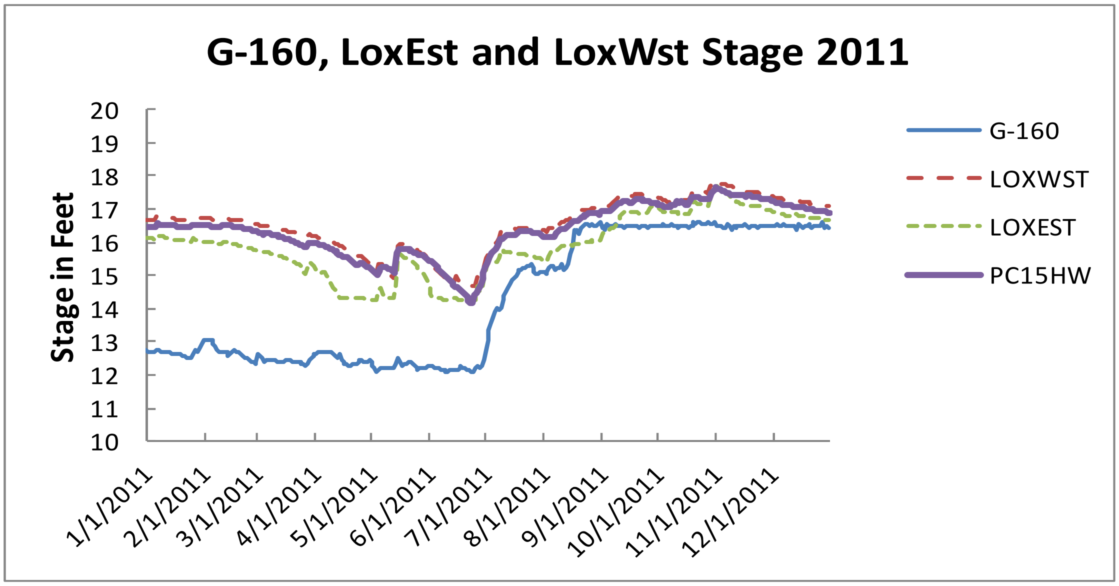


Figure 3. G-160 operation and Loxahatchee Slough stages (at LoxWst and LoxEst).

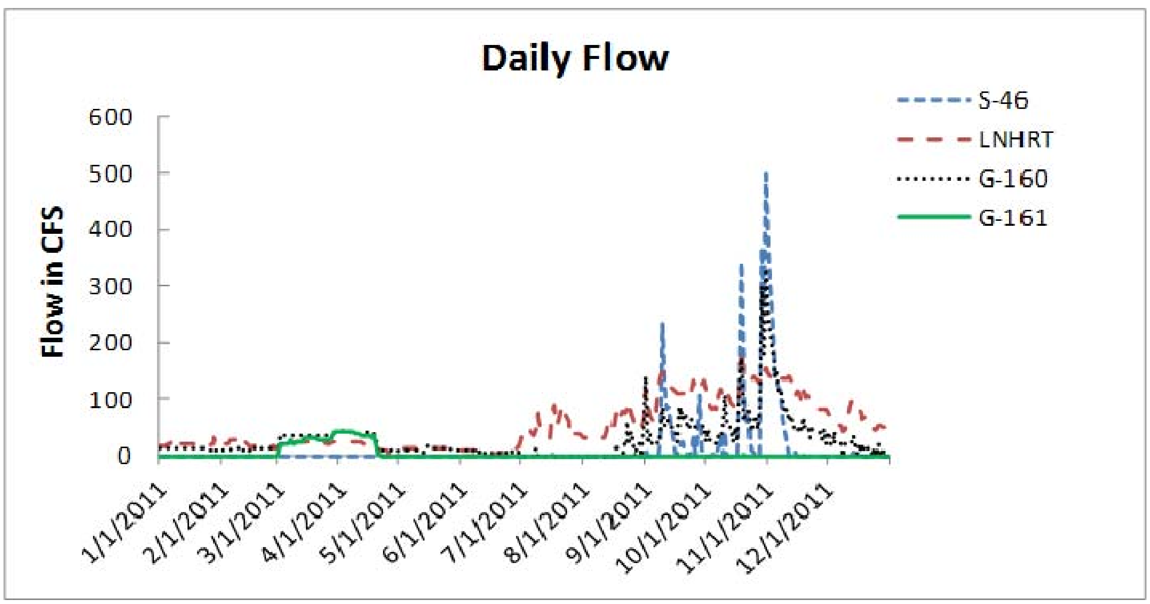


Figure 4. Daily flow at G-160, G-161, Lainhart Dam, and S-46.

Specific Condition 6 of Environmental Resource Permit EI 50-0128848 requires that the District evaluate the effect of operating the G-160 structure on flow at S-46, G-160, G-161, and LNHRT, for the reporting period (see **Figure 4)**. Specific Condition 9.IV of Environmental Resource Permit EI 50-0244327 requires that the District report flow through G-161 and Control 2 Pump Station as average, minimum, and maximum monthly flows (**Table 4)**.

Table 4. Monthly flow data in cubic feet per second (cfs) for 2011.

Month	G161 Avg	G161 Min	G161 Max	CWPB2 Avg**	CWPB2 Min**	CWPB2 Max
Jan	0	0	0.02	116.89	0	145.36
Feb	0.01	0	0.38	114.13	69.23	144.83
Mar	26.42	0	41.52	126.14	72.24	142.85
Apr	23.35	0	41.41	83.35	0	142.4
May	0	0	0.05	29.56	0	99.93
Jun	0	0	0	22.38	0	103.39
Jul	0	0	0.09	30.10*	0	68.22*
Aug	0	0	0	64.99	0	102.12
Sep	0	0	0	116.22	0	144.03
Oct	0.02	0	0.52	132.63	103.43	152.78
Nov	0	0	0	142.09	65.56	152.41
Dec	0.01	0	0.2	147.53	115.56	151.79

* Some daily flow data is not available for July 2011 for CWPB2

** Due to sensor problems, an average tail water reading of 18.5 ft was used to estimate the flow from January through June

VEGETATION MONITORING

The pre-operational baseline vegetation conditions in the Loxahatchee Slough were defined by the semiannual monitoring conducted in the wet and dry seasons from 2002–2007 by Palm Beach County. The annual reports, the Baseline Report, and 5-Year Report have been previously submitted to the FDEP for purposes of defining pre-operational baseline vegetation conditions in the Loxahatchee Slough, taking into account seasonal and interannual variability. Concurrently with the increase in stage elevation at the G-160 structure beginning June 1, 2009, Palm Beach County reinitiated the wet and dry season monitoring of vegetation in the Loxahatchee Slough (see Attachment C). The data collected by the county during the 2011 wet season monitoring event is shown in **Table 5**. As specified in the FDEP-approved 5-Year Operation Monitoring Plan for the G-161 Project, semiannual vegetation monitoring and apple snail egg cluster observations within the GWP will be initiated when regional water of adequate quantity and quality is available to be delivered through the G-161 structure. This will meet the intent of the monitoring plan to ensure that changes in water quality or quantity brought about by the delivery of regional water through the GWP and G-161 for deliveries to the NW Fork of the Loxahatchee River are not adversely affecting the preferred prey of the endangered snail kite. The Geographic Information Systems (GIS)-based analysis of the vegetation associated with the G-160/G-161 structures was conducted in March and April 2011; the results and analysis are presented in the report in Attachment D.

Table 5. Summary of 2011 wet season survey in the Loxahatchee Slough (Note: data provided by Palm Beach County).

Monitoring Station	Vegetative Community Type	Dominant Plant Species	Average Number of Individuals per Quadrat (Sample Standard Deviation=s)	Cover Class (DAUB)[1]	Average Depth of Water at Station (in inches)
1	Swale	Herbaceous 1. *Eleocharis cellulosa* Shrub 1. *Cephalanthus occidentalis* Canopy No canopy layer	 184 (**s**=74.3) 1 (**s**=1.7) n/a	 1.7 0.3 n/a	21.7
2	Swale	Herbaceous 1. *Eleocharis cellulosa* 2. *Rhynchospora tracyi* Shrub 1. *Taxodium distichum* Canopy No canopy layer	 227 (**s**=43.6) 6 (**s**=5.5) 0.3 (**s**=0.6) n/a	 2 0.7 0.3 n/a	18.3
3	Swale	Herbaceous 1. *Eleocharis cellulosa* 2. *Fuirena scirpoides* Shrub No shrub layer Canopy No canopy layer	 260 (**s**=133.2) 11 (**s**=19.1) n/a n/a	 2 0.3 n/a n/a	10.3
4	Hydric Hammock	Herbaceous 1. *Blechnum serrulatum* 2. *Vitus rotundifolia* Shrub 1. *Psychotria nervosa* 2. *Rapanea punctata* Canopy 1. *Sabal palmetto* 2. *Psychotria nervosa*	 4 (**s**=3.5) 3 (**s**=4.2) 10 (**s**=14.6) 2 (**s**=2.1) 6 (**s**=3.8) 5 (**s**=7.6)	 0.7 0.7 1 0.7 1.7 1	dry
5	Wet Flatwoods	Herbaceous 1. *Dichanthelium erectifolium* 2. *Rhychospora* sp. Shrub 1. *Myrica cerifera* 2. *Rapanea punctata* Canopy 1. *Pinus elliottii* var. *densa* 2. *Rapanea punctata*	 7 (**s**=7.0) 2 (**s**=4.0) 1 (**s**=0.6) 4 (**s**=6.4) 4 (**s**=3.0) 18 (**s**=19.5)	 0.7 0.3 0.7 0.3 1.3 1.3	saturated

[1] Daubenmire method

WATER QUALITY

The G-161 permit requires that the District collect and analyze water quality at the Control 2 Pump Station (L8.M CNL) and G-161 structure monthly during periods of flow. Water quality results are shown in **Table 6**. Only results for chloride and specific conductance exceeded any state surface water criteria at the Control 2 Pump Station (L.8N CNL), which was due to the pilot test pumping water from the L-8 Reservoir during March and April 2011. [Note that the L-8 Reservoir contained higher levels of these two parameters; see Attachment E for further results and information about the pilot test.] The only exceedance of state surface water criteria at G-161 was dissolved oxygen. Overall, there is a marked difference in the results between the Control 2 Pump Station and G-161 (which are 15.3 miles apart), with G-161 having much lower concentrations for nearly all the measured parameters (see **Table 6**). This may be partially attributable to natural physical, chemical, and biological processes of assimilation during water passage through the M Canal and the perimeter canal, and due to the dilution of flow of Control 2 Pump origin with overflow from the GWP into the perimeter canal.

Table 6. Water quality results from G-161 and Control 2 Pump Station (March–April 2011).

Station ID	Date	Temp °C	D.O. mg/L	Sp. Cond µS/cm	pH Units	Turb NTU
G161	3/3/2011	23.2	4.77	140	6.6	0.8
G161	4/7/2011	25.2	3.99	439	6.9	0.6
L8.M CNL	3/3/2011	22.5	8.06	1422	8.3	10
L8.M CNL	4/7/2011	24.3	7.35	1653	8.1	15.6

Station ID	Date	TSS mg/L	NOx mg/L	TKN mg/L	NH4 mg/L	TN mg/L
G161	3/3/2011	-3	-0.005	0.9	0.009	0.9
G161	4/7/2011	-3	-0.005	0.93	0.008	0.93
L8.M CNL	3/3/2011	12	0.082	1.06	0.046	1.142
L8.M CNL	4/7/2011	20	0.153	1.37	0.108	1.523

Station ID	Date	SO4 mg/L	OPO4 mg/L	TPO4 mg/L	CL mg/L	Ca mg/L
G161	3/3/2011	5.2	-0.002	0.012	30.4	15.5
G161	4/7/2011	13.5	0.002	0.009	63.5	23.1
L8.M CNL	3/3/2011	104	-0.002	0.055	267	79.4
L8.M CNL	4/7/2011	127	0.002	0.071	333	87.8

Note:
ID - Identification
^{0}C - Degrees Centigrade
D.O. - Dissolved Oxygen
Sp.Cond - Specific Conductance
µS/cm - microsiemens per centimeter
Turb - Turbidity
NTU – nephelometric turbidity units
mg/L - milligrams per liter
TSS - Total Suspended Solids
NOx - Nitrate plus Nitrite
TKN - Total Kjeldahl Nitrogen
NH4 - Ammonia
TN - Total Nitrogen
SO4 - Sulfate
OPO4 - Orthophosphorus
TPO4 - Total Phosphorus
CL - Chloride
Ca - Calcium

Attachment A: Specific Conditions and Cross-References

Table A-1. Specific conditions, actions taken, and cross-references presented for the G-160 Project (Environmental Resource Permit: EI 50-0128848) in this report.

Specific Condition	Description	Applicable Phase	Action & Frequency	Reported in the 2013 SFER – Volume III			
				Narrative	Figure	Table	Attachment
1	Authorized Construction	Construction	N/A	App. 5-1-3			
2	Interim Operation	Operation	N/A	App. 5-1-3,4,7,11	1		
3	Stage Control Elevations	Operation	Operated as required	App. 5-1-3,4,5,7,11	1		
4	Continuous Stage Monitoring	Operation	Stage monitoring was conducted as required	App. 5-1-3, 4, 7	1, 3		
5	Vegetation Monitoring for Loxahatchee Slough	Operation	Veg. monitoring was conducted as required	App. 5-1-3, 4,11		5	C, D
6	Operational Monitoring of S-46 & Annual Operational Evaluation Report	Operation	Report developed and included as part of annual permit report (see specific condition 7, below)	App. 5-1-5, 7,10	4		
7	Annual Monitoring Reports	Operation	Report developed and submitted on time	App. 5-1-2, 3			
8	Water Reservation/Allocation	Operation	Complied with, as required	App. 5-1-5			
9	Construction Best Management Practices: Turbidity & Erosion Control	Construction	N/A				
10	Drawings and Attachments	Operation	N/A	App. 5-1-2		2	A, B, C, D, E
11	Compliance with Specific Conditions	Operation	Complied with as required	App. 5-1-3			A
12	Compliance with General Conditions	Operation	Complied with as required				

Table A-2. Specific conditions, actions taken, and cross-references presented for the G-161 Project (Environmental Resource Permit: EI 50-0244327) in this report.

Specific Condition	Description	Applicable Phase	Action & Frequency	Reported in the 2013 SFER – Volume III			
				Narrative	Figure	Table	Attachment
1	Authorized Construction	Construction	N/A	App. 5-1-3			
2	Authorized Interim Operation	Operation	N/A	App. 5-1-3, 4,5,7,8	1		
3	Construction Limits	Construction	N/A	App. 5-1-3			
4	Fencing off Wetlands	Construction	N/A				
5	Construction Best Management Practices: Turbidity & Erosion Control	During Construction	N/A				
6	Turbidity Monitoring	During Construction	N/A	App. 5-1-8			
7	Turbidity Monitoring Reports	During Construction	N/A				
9	5-Year Operation Monitoring Plan	Operation	Monitoring was conducted as required	App. 5-1-4			
9 I	Continuous Water Level Monitoring	Operation	Monitoring was conducted as required	App. 5-1-3,4			
9 II	Hydrological Monitoring	Operation	N/A	App. 5-1-3,4,5,7,10	3,4	2,4,5	B
9 III	Vegetative Monitoring	Operation	Monitoring was conducted as required	App. 5-1-3, 4,7,11,12			C,D
9 IV	Water Quality Monitoring at G-161 and at Control 2 Pump Station	Operation	Monitoring was conducted as required	App. 5-1-4,5,13,14	1	3,6	B
10	Annual Monitoring Reports	Operation	Report developed and submitted on time	App. 5-1-2,3,11			
11	Water Reservation/Allocation	Operation	Complied with as required				
12	Drawings and Attachments	Operation	N/A	App. 5-1-2		2	A,B,C,D,E
13	Compliance with Specific Conditions	Operation	Complied with as required	App. 5-1-3			A
14	Compliance with General Conditions	Operation	Complied with as required				

Attachment B:
Hydrologic Data

This project information is required by Specific Condition 7 of the G-160 permit (EI 50-0128848) and Specific Condition 10 of the G-161 permit (EI 50-0244327), and is available upon request.

Attachment C: Loxahatchee Slough Restoration and G-160 Monitoring Plan, Third Post-Operational Field-Based Vegetation Monitoring Report

Note: This document, dated February 2012, was prepared by the Palm Beach County Department of Environmental Resources Management for the South Florida Water Management District and Florida Department of Environmental Protection.

Loxahatchee Slough Restoration and G-160 Monitoring Plan
Third Post Operation Field-based Vegetation Monitoring Report

Prepared for:

The South Florida Water Management District

and

The Florida Department of Environmental Protection

February 2012

Prepared by:

Palm Beach County
Department of Environmental Resources Management

Executive Summary

A mutually agreeable arrangement was reached between Palm Beach County‟s Department of Environmental Resources Management (County) and the South Florida Water Management District (SFWMD) with regard to the execution of the Loxahatchee Slough Restoration and G-160 Monitoring Plan (Plan). The Plan requires that the County conduct baseline (current) and post-construction/operation (G-160 Structure) vegetation and hydrological monitoring within the Loxahatchee Slough Natural Area (Slough). The purpose of the monitoring plan is to determine the effectiveness of the first tier improvements completed under the North Palm Beach County Comprehensive Water Management Plan and to provide a measure of success in achieving restoration targets. The results are expected to provide the SFWMD with beneficial information that will allow adjustments to the operation of the G-160 Structure to most effectively meet the Plan‟s objectives. The work includes two approaches to monitoring vegetation, a field-based site-specific component and a GIS-based landscape-level analysis. This report presents the findings from the field-based component of the vegetation surveys and hydrological monitoring data collected during the dry season (between February 1 and March 15) and wet season (between August 1 and September 15) of 2011. It represents the third year of post operation monitoring that will be combined with the landscape-level monitoring summary report prepared by the SFWMD.

The field-based vegetation and hydrological monitoring involves the collection of data from a total of five field stations. At each station, three rectangular nested vegetation quadrats, one staff gauge, and one photopoint were established. Vegetation parameters measured within the quadrats are species composition, density (total/unit area), cover [Daubenmire Cover Class (1-6)], and qualitative descriptions. The staff gauges are used to obtain water elevations relative to sea level (NGVD). The depth of the water within the quadrats is also measured. The photopoints were established to take a composite panoramic photograph of the vegetation at each station from the same location, angle, and perspective during each survey event.

Stations 1-3 are situated in swale communities dominated by spikerush (*Eleocharis cellulosa*) with very little shrub layer and virtually no canopy layer. Station 4 is a mature hydric hammock dominated by wild coffee (*Psychotria nervosa*) and swamp fern (*Blechnum serrulatum*) in the understory, and cabbage palm (*Sabal palmetto*) and laurel oak (*Quercus laurifolia*) in the canopy layer. The herbaceous layer is very sparse and severely damaged (tilled) by feral hogs (*Sus scrofa*). Station 5 is comprised of wet flatwoods where the herbaceous layer is highly variable, the shrub layer is dominated by wax myrtle (*Myrica cerifera*), saw palmetto (*Serenoa repens*) and myrsine (*Rapanea punctata*), and the canopy is dominated by slash pine (*Pinus elliottii* var. *densa*). Surface water is generally not present at Stations 4 and 5 during the wet or dry seasons, however Station 4 was saturated in 2009 and Station 5 had standing water at one of the plots in 2009 and 2010 and was saturated in 2011.

Panoramic photographs were taken at each of the five stations. One change to note is in the photos of Station 4 (Hydric Hammock), there is a surge in shrub vegetation after Sept. 2004. This is attributed to the loss of canopy after the hurricanes of 2004 (Frances and Jeanne) and 2005 (Wilma) that affected Palm Beach County.

Another point of note is that the 2011 dry season was longer and drier than normal which resulted in the water levels reaching seasonal low levels in the month of June. Stations 1-3 averaged 5 inches of surface water in the 2011 dry season and 16 inches in the 2011 wet season. Station 4 was dry during both 2011 monitoring events and Station 5 was dry during the 2011 dry season but the soil was saturated during the 2011 wet season. The wet season monitoring events of 2009 and 2010 were the only years that Station 5 (Wet Flatwoods) had any measurable standing water. Although station 5 did not have standing water during the 2011 wet season, the soil was saturated. This is notable since dry season conditions extended later into the wet season and there were no tropical storms or large low pressure systems affecting the region.

Since June 2009, when the wet season control elevation of the G-160 was increased from 15.5 ft. NGVD to 16.5 ft. NGVD, the eastern part of the Loxahatchee Slough Natural Area has become wetter and the oak hammock ridge more saturated. At this time, there does not appear to be any detrimental effects on the oak hammock ridge vegetation due to the wetter conditions. Also, during the 2011 dry season, the rusted out PC-17 water control structure in the western Loxahatchee Slough was replaced and the backfilling of the internal drainage ditches was completed. This will result in the western Loxahatchee Slough storing more water than in the past, although how this might affect seasonal high water levels is dependent on the efficacy of the new PC-17 (A and B) structures.

Introduction

The extant areas of the Loxahatchee Slough are comprised of approximately 16,000 acres of pine flatwoods, swale, wet prairies, hydric hammock, strand swamp, slough, dome swamp, depression marsh, and disturbed areas within the County-owned Hungryland Slough Natural Area (approximately 3,000 acres) and the Loxahatchee Slough Natural Area (approximately 12,836 acres) (Figure 1). The Loxahatchee Slough contains the headwaters of the Loxahatchee River, one of Florida‟s two federally designated Wild and Scenic Rivers. The site is one of the most ecologically diverse tracts of protected land in Palm Beach County, including nine distinct habitat types, the largest oak hammock and swale/slough in the County, and 63 federally or state-listed species of plants and animals (Gann *et al.*, 2001). The hydrology of the Loxahatchee Slough has been severely altered through the construction of drainage canals, flood protection berms, and increased anthropogenic water consumption. Overdrainage and hydroperiod alterations have contributed to the establishment of invasive exotic plant species such as melaleuca (*Melaleuca quinquenervia*), Old-world climbing fern (*Lygodium microphyllum*), and Brazilian pepper (*Schinus terebinthifolius*), which has led to decreases in habitat quality for native flora and fauna.

In 2003, in order to increase water control and restore the historic hydroperiod to the Slough, the G-160 structure was constructed in the C-18 canal immediately south of the intersection with its western leg, the C-18W (Figure 2). The structure will allow water managers operational flexibility for the purposes of water supply, flood protection, and environmental restoration, including hydrologic restoration of the Loxahatchee Slough to provide water to meet the base flow requirements for the Northwest Fork of the Loxahatchee River. From August 10, 2005 until June 1, 2009, the SFWMD operated the gates on the G-160 at 15.5 ft. NGVD during the dry season and 15.0 ft. NGVD during the wet season because of difficulties reaching an agreement between the SFWMD and Northern Palm Beach County Improvement District, the City of Palm Beach Gardens and the South Indian River Water Control District. The 15.0 ft./15.5 ft. NGVD operating schedule that started in 2005 was so low that it had no effect on increasing water elevations within the Loxahatchee Slough. Because the G-160 structure was not operated above 15.5 ft. NGVD, the County ceased monitoring in September 2006.

During the spring of 2009, the Florida Department of Environmental Protection mandated the SFWMD to begin to raise the elevation of the water in the C-18 canal by June 1, 2009 to 16.5 ft. NGVD during the wet season and 15.5 ft. NGVD during the dry season. When the SFWMD began to raise the elevation to 16.5 ft. NGVD in June 2009, the County resumed monitoring by performing the fall, wet season monitoring event. The monitoring plan was developed to assess the effects of the operation of the G-160 water control structure (and subsequent raising of water elevations) on the vegetation communities within the Loxahatchee Slough and to determine if restoration goals are being met. During the 2011 dry season, the rusted out PC-17 water control structure in the western Loxahatchee Slough was replaced with two new structures (PC-17 A and B) and the backfilling of the internal agricultural drainage ditches was completed.

Methods

A total of five permanent vegetation and hydrological monitoring stations were established in the Loxahatchee Slough Natural Area at pre-determined locations both east and west of the C-18 canal (see Figure 2). The selected locations are representative of major habitat types found within the Loxahatchee Slough, which are anticipated to be affected by the operation of the G-160 structure. At each of these five locations, three nested vegetation quadrats, one staff gauge, and one photopoint were established. The vegetation plots were positioned within the given community type using random compass directions and distances that were selected from a random numbers table and paced off as described in the SFWMD Save Our Rivers Environmental Monitoring Protocols (Van Horn and Van Horn 1993). The staff gauge and photopoint were then positioned centrally between the three vegetation quadrats at each station. The vegetation plots, staff gauges, and photopoints are monitored twice a year, once during the wet season (between August 1- September 15) and once during the dry season (between February 1 and March 15).

The vegetation plots are a nested design that includes a small (0.25m x 3m) herbaceous quadrat within a medium sized (1m x 12m) shrub quadrat, which is in turn contained within a larger (3m x 24m) canopy quadrat. The quadrat dimensions were permanently established in the field by installing four foot pieces of rebar (1/2 inch diameter) approximately two feet into the ground and covering them with a five-foot long PVC pipe (3/4 inch diameter) at each quadrat corner. The methods and monitoring definitions of herbaceous, shrub, and canopy are included as Attachment A. Vegetation parameters measured within the quadrats included species composition, density (total/unit area), cover [Daubenmire Cover Class (1-6)], and qualitative descriptions. Within the herbaceous quadrat, each individual plant was counted and recorded by species. An estimate of the vegetative cover (total surface area of the 0.25m x 3m quadrat covered by vegetation) was then recorded by species. This estimate was recorded as a particular Daubenmire Cover Class (1-6), each of which represents a range of percentages of vegetative cover (Attachment B). The qualitative observations (e.g. vigor of plant, overall appearance), and any other relevant observations (e.g., plant alive/dead, no herbaceous layer) were also recorded. Within the shrub quadrat and canopy quadrat, the same parameters were recorded as in the herbaceous quadrat.

The staff gauges were permanently established by installing 10 ft. painted signposts approximately four feet into the ground at each station. The elevations of the tops of these posts have been surveyed only at Stations 1 and 2 at this time. The readings are used to obtain water elevations relative to sea level (NGVD). The depth of the water within the quadrats was also measured.

The photopoints were established to take a composite panoramic photograph of the vegetation at each station from the same location, angle, and perspective during each survey event. The photopoint was permanently marked in the field with a 4 ft. long piece of rebar (3/4 inch diameter) and covered with a 5 ft. piece of PVC pipe (3/4 inch diameter). The photos were taken at the five photomonitoring stations using the method described in „Photomonitoring Protocol for Palm Beach County Natural Areas" (Attachment C). A Photomonitoring Record Form for each photostation described the purpose of the photopoint, location, direction of photos, and other information important for future monitoring events.

Data

Tables 1 and 2 summarize the results of the vegetation monitoring quadrats during the dry and wet season surveys conducted in March 2011 and September 2011. For more detailed information about vegetation structure and composition, the individual station quadrat data sheets for the 2011 surveys are included in Attachment B. The panoramic photos in Attachment D compare stations (1-5) from 2003 and 2006 (baseline events) to the third post operational monitoring event in 2011. Attachment E includes water level data, rainfall data and stage data from 2006-2011. The monitoring locations for all of the hydrological data are shown in Figure 3. Attachment F includes a summary of the vegetation data collected from 2006-2011.

Table 1: Summary of Dry Season 2011 Survey

Monitoring Station	Vegetative Community Type	Dominant Plant Species	Average Number of Individuals per Quadrat (Sample Standard Deviation=*s*)	Cover Class (DAUB)	Average Depth of Water at Station (in inches)
1	Swale	Herbaceous 1. *Eleocharis cellulosa* Shrub 1. *Cephalanthus occidentalis* Canopy No canopy layer	 177 (***s***=66.2) 1 (***s***=1.7) n/a	 1.3 0.3 n/a	10
2	Swale	Herbaceous 1. *Eleocharis cellulosa* Shrub 1. *Taxodium distichum* Canopy No canopy layer	 269 (***s***=59.1) 0.3 (***s***=0.6) n/a	 2 0.3 n/a	5.3
3	Swale	Herbaceous 1. *Eleocharis cellulosa* 2. *Fuirena scirpoides* Shrub No shrub layer Canopy No canopy layer	 97 (***s***=26.4) 17 (***s***=24.7) n/a n/a	 1 0.7 n/a n/a	1
4	Hydric Hammock	Herbaceous 1. *Blechnum serrulatum* 2. *Vitus rotundifolia* Shrub 1. *Psychotria nervosa* 2. *Rapanea punctata* Canopy 1. *Sabal palmetto* 2. *Psychotria nervosa*	 3 (***s***=2.3) 2 (***s***=1.5) 4 (***s***=4.5) 2 (***s***=2.1) 5 (***s***=4.0) 10 (***s***=11.2)	 0.7 0.7 0.7 0.7 1.7 1	Dry
5	Wet Flatwoods	Herbaceous 1. *Rhynchospora colorata* 2. *Eleocharis baldwinii* Shrub 1. *Rapanea punctata* 2. *Serenoa repens* Canopy 1. *Pinus elliottii* var. *densa* 2. *Rapanea punctata*	 4 (***s***=5.1) 3 (***s***=5.8) 3 (***s***=4.9) 2 (***s***=3.5) 4 (***s***=3.0) 13 (***s***=13.6)	 0.7 0.3 0.7 0.3 1.3 1.3	Dry

Table 2: Summary of Wet Season 2011 Survey

Monitoring Station	Vegetative Community Type	Dominant Plant Species	Average Number of Individuals per Quadrat (Sample Standard Deviation=*s*)	Cover Class (DAUB)	Average Depth of Water at Station (in inches)
1	Swale	Herbaceous 1. *Eleocharis cellulosa* Shrub 1. *Cephalanthus occidentalis* Canopy No canopy layer	184 (*s*=74.3) 1 (*s*=1.7) n/a	1.7 0.3 n/a	21.7
2	Swale	Herbaceous 1. *Eleocharis cellulosa* 2. *Rhynchospora tracyi* Shrub 1. *Taxodium distichum* Canopy No canopy layer	227 (*s*=43.6) 6 (*s*=5.5) 0.3 (*s*=0.6) n/a	2 0.7 0.3 n/a	18.3
3	Swale	Herbaceous 1. *Eleocharis cellulosa* 2. *Fuirena scirpoides* Shrub No shrub layer Canopy No canopy layer	260 (*s*=133.2) 11 (*s*=19.1) n/a n/a	2 0.3 n/a n/a	10.3
4	Hydric Hammock	Herbaceous 1. *Blechnum serrulatum* 2. *Vitus rotundifolia* Shrub 1. *Psychotria nervosa* 2. *Rapanea punctata* Canopy 1. *Sabal palmetto* 2. *Psychotria nervosa*	4 (*s*=3.5) 3 (*s*=4.2) 10 (*s*=14.6) 2 (*s*=2.1) 6 (*s*=3.8) 5 (*s*=7.6)	0.7 0.7 1 0.7 1.7 1	dry
5	Wet Flatwoods	Herbaceous 1. *Dichanthelium erectifolium* 2. *Rhychospora* sp. Shrub 1. *Myrica cerifera* 2. *Rapanea punctata* Canopy 1. *Pinus elliottii* var. *densa* 2. *Rapanea punctata*	7 (*s*=7.0) 2 (*s*=4.0) 1 (*s*=0.6) 4 (*s*=6.4) 4 (*s*=3.0) 18 (*s*=19.5)	0.7 0.3 0.7 0.3 1.3 1.3	saturated

Discussion of Findings

In Tables 1 and 2, the data from each of the three vegetation quadrats at each of the five vegetation monitoring stations were averaged by herbaceous layer, shrub layer, and canopy layer. The detailed data sheets in Attachment B reflect the species composition and structure of each of the three layers within the specific nested quadrats. Only the two species with the dominant vegetation cover percentage in each of the five stations were included. The data in this report represents the third collection of post operation data. For comparison purposes, the 2006 data was used as the final baseline. Attachment F includes a summary of all of the vegetation monitoring events. Stations 1-3 (Swale) had some minor changes in the herbaceous layer and the shrub layer. *Rhynchospora tracyi* disappeared from the herbacecous layer in Station 1 in 2009 and was replaced by *Furiena scirpoides* in Station 3 in 2010. In 2009, *Hypericum fasiculatum* disappeared from the shrub layer in Station 2 and *Cephalanthus occidentalis* disappeared from the shrub layer in Station 3. In Station 4, *Blechnum serrulatum* continues to dominate the herbaceous layer, the shrub layer had *Rapanea punctata* and *Psychotria nervosa*, and the canopy layer had *Sabal palmetto* and *Psychotria nervosa*. In Station 5, *Blechmum serrulatum* disappeared from the herbaceous layer in 2011, the shrub layer shifted dominance from *Urena lobata* and *Sabal palmetto* to *Rapanea punctata* and *Serenoa repens* in 2009, and the canopy layer lost some *Sabal palmetto* so that *Pinus elliottii* var. *densa* became the dominant species in 2009. Most of the changes in Stations 4 and 5 can be attributed to the extensive hog rooting in those plots. The 2006 Baseline conditions will continue to be compared with post-operation data in future reports.

The panoramic photographs taken at each of the photopoints give both quantitative (shrub and herbaceous layer heights) and qualitative representations of the vegetative community types described above (Attachment D). One change to note is in the photos of Station 4 (Hydric Hammock), there is a surge in shrub vegetation after Sept. 2004. This is attributed to the loss of canopy after the hurricanes of 2004 (Frances and Jeanne) and 2005 (Wilma) that affected Palm Beach County.

Another point of note is that the 2011 dry season was longer and drier than normal which resulted in the water levels reaching seasonal low levels in the month of June. Stations 1-3 averaged 5 inches of surface water in the 2011 dry season and 16 inches in the 2011 wet season. Station 4 was dry during both 2011 monitoring events and Station 5 was dry during the 2011 dry season but the soil was saturated during the 2011 wet season. The wet season monitoring events of 2009 and 2010 were the only years that Station 5 (Wet Flatwoods) had any measurable standing water. Although station 5 did not have standing water during the 2011 wet season, the soil was saturated. This is notable since dry season conditions extended later into the wet season and there were no tropical storms or large low pressure systems affecting the region that year. Surface water is generally not present at Stations 4 and 5 during the wet or dry seasons, however Station 4 was saturated during the 2009 wet season and Station 5 had standing water at one of the plots during the 2009 and 2010 wet seasons and was saturated during the 2011 wet season. The saturated soil may be attributed to the operation of the G-160. While the dry season was drier and longer than normal in 2011, the hydroperiod fluctuated naturally and the area was able to maintain surface water elevations at levels high enough to keep soils saturated. At this time, there does not appear to be any detrimental effects to the oak hammock ridge vegetation due to the wetter conditions.

Literature Cited

Gann, G., K. Bradley and S. Woodmansee. 2002. Habitats in South Florida. The Institute for Regional Conservation. Miami, Florida.

Van Horn, M. and K. Van Horn . 1993. „Save Our Rivers" Environmental Monitoring Protocols. South Florida Water Management District. West Palm Beach, Florida.

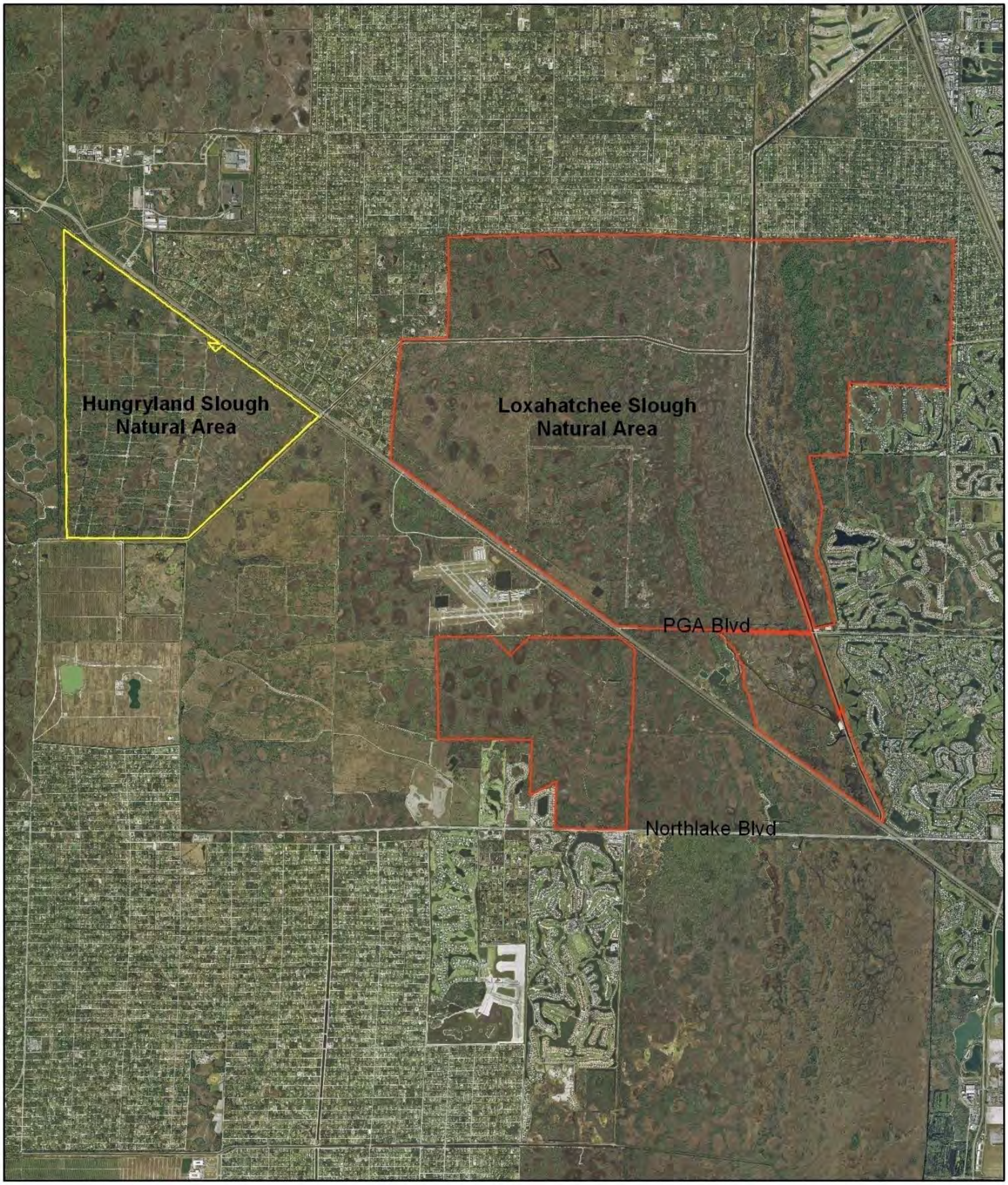


Figure 1: Hungryland Slough and Loxahatchee Slough Natural Areas Location Map

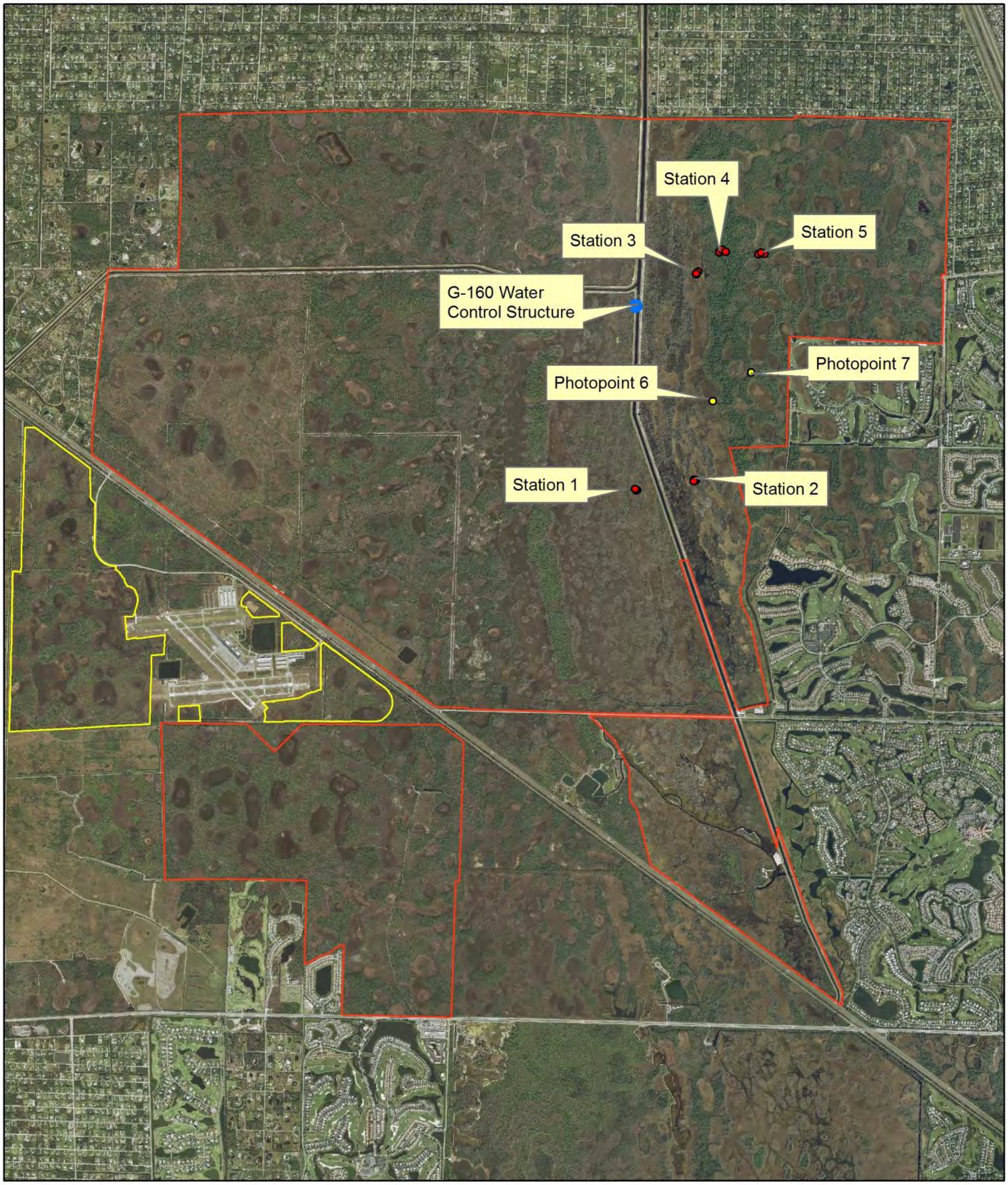
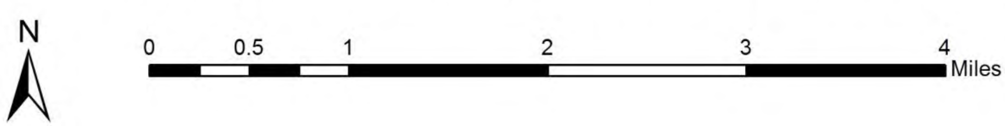
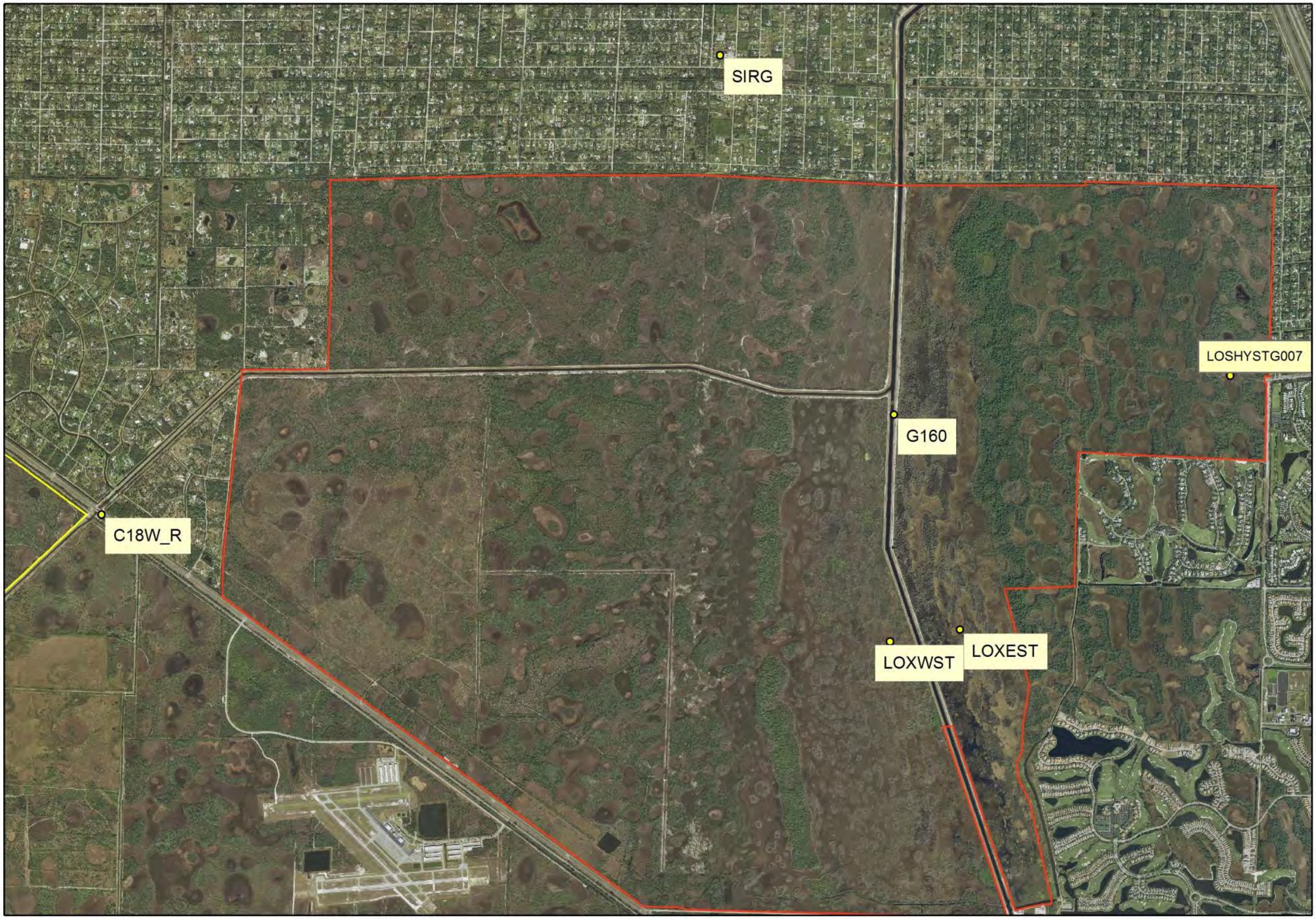


Figure 2: G-160 Vegetation Monitoring Stations in the Loxahatchee Slough Natural Area





N

Figure 3: Hydrological Monitoring Stations in the Vicinity and Within the Loxahatchee Slough Natural Area

0 0.5 1 2 3 4 Miles

ATTACHMENT A

Definitions for G-160 Vegetation Monitoring Stations at the Loxahatchee Slough Natural Area

Herbaceous layer = any *non-woody* plants, *excluding* seedlings of woody species that are presently non-woody (e.g. *Sabal palmetto*, *Hypericum* spp.), but *including* vines (e.g. *Vitis* spp., *Toxicodendron radicans).* Only count plants with at least half of their roots *within* the plot.

Shrub layer = any *woody* plant above the ground and *less* than, or equal to, 2.5 meters (8.2 feet) tall, excluding vines (which will *only* be recognized in the herbaceous plot canopy cover). Count *all Hypericum* spp. and *all* seedlings of potentially woody species in this plot. Shrub canopy cover class will be determined using trees rooted *both* inside *and* outside the plot.

Canopy layer = any *woody* plant greater than 2.5 meters tall, excluding vines. Only count the number of trees with more than half their root system within the plot. *Do not* count *seedlings* of canopy species; these will be counted within the shrub layer plot. Canopy cover class will be determined using trees rooted *both* inside *and* outside the plot.

Note: Always use the *first three letters* of both the genus and species names in the **Species** column on the Veg. Plot Data Sheets.

ATTACHMENT B

Vegetation Quadrat Data Sheets
For the Loxahatchee Slough Natural Area

March & September 2011

Loxahatchee Slough Restoration and G-160 Monitoring Plan
Vegetation Quadrat Data Sheet (Station 1, Swale)

Note: See "Rules for Vegetation Monitoring Plots at the Loxahatchee Slough Natural Area" prior to conducting the surveys.
Observer (s): Melissa Tolbert, Harper Carroll
Date: 3 / 3 / 11
Station #: 1 A, B, C
GPS Location: See attached aerial photo for exact locations Management Unit: n/a
General Comments: Cover Class (DAUB) is determined using the Daubenmire Cover Scale:

Cover Class	Cover (%)
1	0-5
2	6-25
3	26-50
4	51-75
5	76-95
6	96-100

Note: String needs to be placed around the herbaceous plots to delineate their perimeters

Depth of water in plots: **11" (A), 9" (B), 10" (C)** Staff Gauge Reading: **16.45 ft NGVD** (SFWMD gauge)

Species	# of individuals per quadrat	Cover Class (DAUB)	Comments (alive, dead,etc.)
Quadrat A **Herbaceous Plot (0.25x3 meters)**			
Ele cel	102	1	
Shrub Plot (1x12 meters)			no shrub layer
Seedlings of shrub or canopy species within plot			
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Quadrat B **Herbaceous Plot (0.25x3 meters)**			
Ele cel	228	2	

Shrub Plot **(1x12 meters)**			
Cep occ	3	1	stressed
Seedlings of shrub or canopy species within plot			
Canopy Plot **(3x24 meters)**			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
<u>Quadrat C</u> **Herbaceous Plot** **(0.25x3 meters)**			
Ele cel	200	1	
Shrub Plot **(1x12 meters)**			no shrub layer
Seedlings of shrub or canopy species within plot			
Canopy Plot **(3x24 meters)**			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			

Loxahatchee Slough Restoration and G-160 Monitoring Plan
Vegetation Quadrat Data Sheet (Station 2, Swale)

Note: See "Rules for Vegetation Monitoring Plots at the Loxahatchee Slough Natural Area" prior to conducting the surveys.

Observer (s): Melissa Tolbert, Harper Carroll
Date: 3 / 3 / 11
Station #: 2 A, B, C
GPS Location: See attached aerial photo for exact locations Management Unit: n/a
General Comments: Cover Class (DAUB) is determined using the Daubenmire Cover Scale:

Cover Class	Cover (%)
1	0-5
2	6-25
3	26-50
4	51-75
5	76-95
6	96-100

Depth of water in plots: **5" (A), 5" (B), 6" (C)** Staff Gauge Reading: **15.72 ft NGVD** (SFWMD gauge)

Species	# of individuals per quadrat	Cover Class (DAUB)	Comments (alive, dead,etc.)
Quadrat A **Herbaceous Plot (0.25x3 meters)**			
Ele cel	251	2	
Shrub Plot (1x12 meters)			
Seedlings of shrub or canopy species within plot			
Tax dis	1	1	
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Quadrat B **Herbaceous Plot (0.25x3 meters)**			
Ele cel	221	2	

Shrub Plot **(1x12 meters)**			no shrub layer
Seedlings of shrub or canopy species within plot			
Canopy Plot **(3x24 meters)**			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Quadrat C **Herbaceous Plot** **(0.25x3 meters)**			
Ele cel	335	2	
Shrub Plot **(1x12 meters)**			
			no shrub layer
Seedlings of shrub or canopy species within plot			
Canopy Plot **(3x24 meters)**			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			

Loxahatchee Slough Restoration and G-160 Monitoring Plan
Vegetation Quadrat Data Sheet (Station 3, Swale)

Note: See “Rules for Vegetation Monitoring Plots at the Loxahatchee Slough Natural Area” prior to conducting the surveys.

Observer (s): Melissa Tolbert, Harper Carroll, Lee Lietzke
Date: 3 / 15 / 11
Station #: 3 A, B, C
GPS Location: See attached aerial photo for exact locations Management Unit: n/a
General Comments: Cover Class (DAUB) is determined using the Daubenmire Cover Scale:

Cover Class	Cover (%)
1	0-5
2	6-25
3	26-50
4	51-75
5	76-95
6	96-100

Depth of water in plots: **saturated (A), 2" (B), 1" (C)**

Species	**# of individuals per quadrat**	**Cover Class (DAUB)**	**Comments (alive, dead,etc.)**
Quadrat A **Herbaceous Plot (0.25x3 meters)**			
Ele cel	89	1	
Fur sci	45	1	
Shrub Plot (1x12 meters)			
Cep occ	1	1	
Seedlings of shrub or canopy species within plot			
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Quadrat B **Herbaceous Plot (0.25x3 meters)**			
Ele cel	75	1	
Fur sci	5	1	

Shrub Plot **(1x12 meters)**			no shrub layer
Seedlings of shrub or canopy species within plot			
Canopy Plot **(3x24 meters)**			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
<u>Quadrat C</u> **Herbaceous Plot** **(0.25x3 meters)**			
Ele cel	126	1	
Shrub Plot **(1x12 meters)**			no shrub layer
Seedlings of shrub or canopy species within plot			
Canopy Plot **(3x24 meters)**			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			

Loxahatchee Slough Restoration and G-160 Monitoring Plan
Vegetation Quadrat Data Sheet (Station 4, Hydric Hammock)

Note: See "Rules for Vegetation Monitoring Plots at the Loxahatchee Slough Natural Area" prior to conducting the surveys.

Observer (s): Melissa Tolbert, Harper Carroll, Lee Lietzke

Date: 3 / 15 / 11

Station #: 4 A, B, C

GPS Location: See attached aerial photo for exact locations Management Unit: n/a

General Comments: Cover Class (DAUB) is determined using the Daubenmire Cover Scale:

Cover Class	Cover (%)
1	0-5
2	6-25
3	26-50
4	51-75
5	76-95
6	96-100

Note: String needs to be placed around these plots to permanently delineate the perimeters

Depth of water in plot: **N/A** inches

Species	# of individuals per quadrat	Cover Class (DAUB)	Comments (alive, dead,etc.)
Quadrat A			
Herbaceous Plot (1x3 meters)			
Ble ser	4	1	
Dic com	3	1	
Par qui	1	1	
Tox rad	4	1	
Shrub Plot (1x12 meters)			
Ure lob	12	1	
Psy ner	9	1	
Psy sul	2	1	
Seedlings of shrub or canopy species within plot			
Ure lob	100	1	
Que lau	15	1	
Sab pal	1	1	
Psy sul	3	1	
Canopy Plot (3x24 meters)			
Trees *rooted* within plot			
Sab pal	9	2	
Eug axi	2	1	
Psy ner	7	1	
Cal ame	1	1	
Fic mic	1	1	
Per bor	1	1	
Mor rub	1	1	
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Mor rub		1	
Sab palm		2	

Quadrat B **Herbaceous Plot** **(1x3 meters)**			
Vit rot	3	1	
Shrub Plot **(1x12 meters)**			
Psy ner	4	1	
Rap pun	3	1	
Chr ica	1	1	
Sab pal	1	1	
Seedlings of shrub or canopy species within plot			
Sab pal	7	1	
Que lau	5	1	
Ure lob	2	1	
Rap pun	3	1	
Psy ner	200	2	
Canopy Plot **(3x24 meters)**			
Trees *rooted* within plot			
Sab pal	6	2	
Psy ner	22	2	
Per bor	1	1	
Bac hal	1	1	
Chr ica	1	1	
Ace rub	1	1	
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Que lau		2	
Sab pal		1	
Quadrat C **Herbaceous Plot** **(1x3 meters)**			hog damage
Smi sp	4	1	
Ble ser	4	1	
Til set	2	1	
Phy ame	3	1	
Tox rad	3	1	
Vit rot	2	1	
Shrub Plot **(1x12 meters)**			
Rap pun	4	1	
Ser rep	1	1	
Cal ame	1	1	
Seedlings of shrub or canopy species within plot			
Ure lob	23	1	
Que lau	18	1	
Sab pal	2	1	

Canopy Plot (3x24 meters)			
Trees *rooted* within plot			
Sab pal	1	1	
Que vir	1	1	
Rap pun	6	1	
Que lau	2	1	
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Pin ell var. *den*		1	

Loxahatchee Slough Restoration and G-160 Monitoring Plan
Vegetation Quadrat Data Sheet (Station 5, Pine Flatwoods)

Note: See “Rules for Vegetation Monitoring Plots at the Loxahatchee Slough Natural Area” prior to conducting the surveys.
Observer (s): Melissa Tolbert, Harper Carrol, Lee Lietzke
Date: 3 / 15 / 11
Station #: 5 A, B, C
GPS Location: See attached aerial photo for exact locations   Management Unit: n/a
General Comments: Cover Class (DAUB) is determined using the Daubenmire Cover Scale:

Cover Class	Cover (%)
1	0-5
2	6-25
3	26-50
4	51-75
5	76-95
6	96-100

Note: String needs to be placed around these plots to permanently delineate the perimeters

Depth of water in plots: **N/A (A), N/A (B), N/A (C)**

Species	# of individuals per quadrat	Cover Class (DAUB)	Comments (alive, dead,etc.)
Quadrat A			
Herbaceous Plot (1x3 meters)			hog damage
Smi sp	1	1	
Ble ser	6	1	
Rhy col	3	1	
Dic ere	7	1	
Tox rad	4	1	
Vit rot	1	1	
Shrub Plot (1x12 meters)			
Rap pun	1	1	
Ser rep	6	1	
Ile gla	2	1	
Sab pal	1	1	
Bac hal	1	1	
Seedlings of shrub or canopy species within plot			
Ure lob	5	1	
Pin ell var. *den*	5	1	
Bac hal	8	1	
Que lau	1	1	

Canopy Plot (3x24 meters)			
Trees *rooted* within plot			
Pin ell var. *den*	1	1	
Sab pal	3	1	
Myr cer	1	1	
Rap pun	2	1	
Ile cas	1	1	
Ser rep	2	1	
Lyo fru	1	1	
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Quadrat B			
Herbaceous Plot (1x3 meters)			
Cla jam	2	1	
Lud rep	1	1	
Rhy sp	7	1	
Ele bal	10	1	
Rhy col	10	1	
Smi sp	1	1	
Shrub Plot (1x12 meters)			
Seedlings of shrub or canopy species within plot			
Sab pal	4	1	
Pin ell var. *den*	4	1	
Chr ica	3	1	
Rap pun	1	1	
Canopy Plot (3x24 meters)			
Trees *rooted* within plot			
Pin ell var. den	4	1	
Sab pal	3	1	
Rap pun	28	2	
Chr ica	1	1	
Myr cer	2	1	
Ile cas	1	1	
Bac hal	1	1	
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Myr cer		1	
Sab pal		1	
Pin ell var. den		1	

Quadrat C Herbaceous Plot (1x3 meters)			
Smi sp	1	1	
Dic com	5	1	
Shrub Plot (1x12 meters)			
Rap pun	9	1	
Myr cer	2	1	
Sab pal	4	1	
Ile gla	1	1	
Seedlings of shrub or canopy species within plot			
Rap pun	3	1	
Sab pal	4	1	
Ure lob	1	1	
Pin ell var. den	3	1	
Ile gla	1	1	
Cas cha	7	1	
Canopy Plot (3x24 meters)			
Trees *rooted* within plot			
Pin ell var. den	7	2	2 dead pine trees not included
Sab pal	4	1	
Rap pun	8	1	
Ile cas	2	1	
Myr cer	2	1	
Per bor	1	1	
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Pin ell var. den		1	
Ile cas		1	
Sab pal		1	

Loxahatchee Slough Restoration and G-160 Monitoring Plan
Vegetation Quadrat Data Sheet (Station 1, Swale)

Note: See "Rules for Vegetation Monitoring Plots at the Loxahatchee Slough Natural Area" prior to conducting the surveys.
Observer (s): Melissa Tolbert, Harper Carroll
Date: 9 / 15 / 11
Station #: 1 A, B, C
GPS Location: See attached aerial photo for exact locations Management Unit: n/a
General Comments: Cover Class (DAUB) is determined using the Daubenmire Cover Scale:

Cover Class	Cover (%)
1	0-5
2	6-25
3	26-50
4	51-75
5	76-95
6	96-100

Note: String needs to be placed around the herbaceous plots to delineate their perimeters

Depth of water in plots: **21" (A), 22" (B), 22" (C)** Staff Gauge Reading: **17.390 ft NGVD** (SFWMD gauge)

Species	# of individuals per quadrat	Cover Class (DAUB)	Comments (alive, dead,etc.)
Quadrat A **Herbaceous Plot (0.25x3 meters)**			Cannot see bottom of plot due to standing water, therefore, our ability to see plants that are completely under water is limited. A large amount of Bacopa sp. observed in area.
Ele cel	100	1	
Utr sp		1	Not able to count
Shrub Plot (1x12 meters)			no shrub layer
Seedlings of shrub or canopy species within plot			
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Quadrat B **Herbaceous Plot (0.25x3 meters)**			Cannot see bottom of plot due to standing water, therefore, our ability to see plants that are completely under water is limited.
Ele cel	240	2	
Nym odor	1	1	

Shrub Plot (1x12 meters)			
Cep occ	3	1	stressed
Seedlings of shrub or canopy species within plot			
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
<u>Quadrat C</u> **Herbaceous Plot (0.25x3 meters)**			Cannot see bottom of plot due to standing water, therefore, our ability to see plants that are completely under water is limited.
Ele cel	213	2	
Shrub Plot (1x12 meters)			no shrub layer
Seedlings of shrub or canopy species within plot			
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			

Loxahatchee Slough Restoration and G-160 Monitoring Plan
Vegetation Quadrat Data Sheet (Station 2, Swale)

Note: See "Rules for Vegetation Monitoring Plots at the Loxahatchee Slough Natural Area" prior to conducting the surveys.
Observer (s): Melissa Tolbert, Harper Carroll
Date: 9 /15 / 11
Station #: 2 A, B, C
GPS Location: See attached aerial photo for exact locations Management Unit: n/a
General Comments: Cover Class (DAUB) is determined using the Daubenmire Cover Scale:

Cover Class	Cover (%)
1	0-5
2	6-25
3	26-50
4	51-75
5	76-95
6	96-100

Depth of water in plots: **19" (A), 18" (B), 18" (C)** Staff Gauge Reading: **16.94 ft NGVD** (SFWMD gauge)

Species	# of individuals per quadrat	Cover Class (DAUB)	Comments (alive, dead,etc.)
Quadrat A **Herbaceous Plot (0.25x3 meters)**			Cannot see bottom of plot due to standing water, therefore, our ability to see plants that are completely under water is limited.
Ele cel	197	2	
Utr sp	--	1	not able to count
Pan hem	3	1	
Shrub Plot (1x12 meters)			
Seedlings of shrub or canopy species within plot			
Tax dis	1	1	
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Quadrat B **Herbaceous Plot (0.25x3 meters)**			Cannot see bottom of plot due to standing water, therefore, our ability to see plants that are completely under water is limited.
Ele cel	207	2	
Rhy tra	6	1	
Utr spp	--	1	not able to count

Shrub Plot (1x12 meters)			no shrub layer
Seedlings of shrub or canopy species within plot			
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
<u>**Quadrat C**</u> **Herbaceous Plot (0.25x3 meters)**			Cannot see bottom of plot due to standing water, therefore, our ability to see plants that are completely under water is limited.
Ele cel	277	2	
Rhy tra	11	1	
Utr sp	--	1	not able to count
Shrub Plot (1x12 meters)			
			no shrub layer
Seedlings of shrub or canopy species within plot			
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			

Loxahatchee Slough Restoration and G-160 Monitoring Plan
Vegetation Quadrat Data Sheet (Station 3, Swale)

Note: See "Rules for Vegetation Monitoring Plots at the Loxahatchee Slough Natural Area" prior to conducting the surveys.
Observer (s): Melissa Tolbert, Harper Carroll, Dave Witmer
Date: 9 /7 / 11
Station #: 3 A, B, C
GPS Location: See attached aerial photo for exact locations Management Unit: n/a
General Comments: Cover Class (DAUB) is determined using the Daubenmire Cover Scale:

Cover Class	Cover (%)
1	0-5
2	6-25
3	26-50
4	51-75
5	76-95
6	96-100

Depth of water in plots: 9**" (A), 10" (B), 12" (C)** Staff Gauge Reading: **N/A** feet from top of gauge

Species	# of individuals per quadrat	Cover Class (DAUB)	Comments (alive, dead,etc.)
Quadrat A **Herbaceous Plot (0.25x3 meters)**			Cannot see bottom of plot due to standing water, therefore, our ability to see plants that are completely under water is limited.
Ele cel	119	2	
Fur sci	33	1	
Utr sp	--	1	not able to count
Shrub Plot (1x12 meters)			
			no shrub layer
			Cep occ from previous data not found
Seedlings of shrub or canopy species within plot			
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Quadrat B **Herbaceous Plot (0.25x3 meters)**			Cannot see bottom of plot due to standing water, therefore, our ability to see plants that are completely under water is limited.
Ele cel	276	2	
Rhy tra	10	1	
Utr sp	--	1	not able to count

Shrub Plot (1x12 meters)			no shrub layer
Seedlings of shrub or canopy species within plot			
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
<u>Quadrat C</u> **Herbaceous Plot (0.25x3 meters)**			Cannot see bottom of plot due to standing water, therefore, our ability to see plants that are completely under water is limited.
Ele cel	384	2	
Utr sp	---	1	not able to count
Shrub Plot (1x12 meters)			no shrub layer
Seedlings of shrub or canopy species within plot			
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			

Loxahatchee Slough Restoration and G-160 Monitoring Plan
Vegetation Quadrat Data Sheet (Station 4, Hydric Hammock)

Note: See "Rules for Vegetation Monitoring Plots at the Loxahatchee Slough Natural Area" prior to conducting the surveys.
Observer (s): Melissa Tolbert, Harper Carroll, Dave Witmer
Date: 9 / 7 / 11
Station #: 4 A, B, C
GPS Location: See attached aerial photo for exact locations   Management Unit: n/a
General Comments: Cover Class (DAUB) is determined using the Daubenmire Cover Scale:

Cover Class	Cover (%)
1	0-5
2	6-25
3	26-50
4	51-75
5	76-95
6	96-100

Note: String needs to be placed around these plots to permanently delineate the perimeters

Depth of water in plot: **Dry** inches   Staff Gauge Reading: **N/A (no staff gauge)** feet NGVD

Species	# of individuals per quadrat	Cover Class (DAUB)	Comments (alive, dead,etc.)
Quadrat A			
Herbaceous Plot (1x3 meters)			
Ble ser	6	1	
Dic com	2	1	
Tox rad	5	1	
Par qui	2	1	
Shrub Plot (1x12 meters)			
Ure lob	1	1	
Psy ner	4	1	
Psy sul	1	1	
Phy ame	1	1	
Seedlings of shrub or canopy species within plot			
Ure lob	217	1	
Que lau	1	1	
Canopy Plot (3x24 meters)			
Trees *rooted* within plot			
Sab pal	9	2	
Eug axi	2	1	
Ile cas	1	1	
Fic mic	1	1	
Per bor	1	1	
Mor rub	2	1	
Psy ner	2	1	
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Mor rub	1	1	
Sab pal	2	1	
Chr oli	1	1	
Que lau	2	1	

Quadrat B **Herbaceous Plot** **(1x3 meters)**			
Vit rot	8	1	
Par qui	1	1	
Shrub Plot **(1x12 meters)**			
Psy ner	27	2	
Rap pun	1	1	
Chr ica	1	1	
Seedlings of shrub or canopy species within plot			
Sab pal	1	1	
Que lau	10	1	
Rap pun	4	1	
Psy ner	287	2	
Canopy Plot **(3x24 meters)**			
Trees *rooted* within plot			
Sab pal	8	2	
Psy ner	14	2	
Acr rub	2	1	
Chr ica	1	1	
Bac hal	2	1	
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Que lau	1	2	
Quadrat C **Herbaceous Plot** **(1x3 meters)**			
Smi sp	1	1	
Ble ser	6	1	
Til set	1	1	
Tox rad	2	1	
Vit rot	2	1	
Shrub Plot **(1x12 meters)**			
Rap pun	4	1	
Ser rep	1	1	
Cal ame	1	1	
Bac hal	1	1	
Seedlings of shrub or canopy species within plot			
Ure lob	10	1	
Cal ame	30	1	
Que lau	1	1	

Canopy Plot (3x24 meters)			
Trees *rooted* within plot			
Sab pal	2	1	
Que vir	1	1	
Rap pun	14	1	
Que lau	2	1	
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Pin ell var. *den*	1	1	
Que lau	2	2	
Ile cas	1	1	
Sab pal	1	1	

Loxahatchee Slough Restoration and G-160 Monitoring Plan
Vegetation Quadrat Data Sheet (Station 5, Pine Flatwoods)

Note: See "Rules for Vegetation Monitoring Plots at the Loxahatchee Slough Natural Area" prior to conducting the surveys.

Observer (s): Melissa Tolbert, Harper Carroll, Dave Witmer

Date: 9 / 7 / 11

Station #: 1 A, B, C

GPS Location: See attached aerial photo for exact locations   Management Unit: n/a

General Comments: Cover Class (DAUB) is determined using the Daubenmire Cover Scale:

Cover Class	Cover (%)
1	0-5
2	6-25
3	26-50
4	51-75
5	76-95
6	96-100

Note: String needs to be placed around these plots to permanently delineate the perimeters

Depth of water in plots: **moist (A),sa'd (B), sat'd (C)** Staff Gauge Reading: _____feet from top of gauge

Species	# of individuals per quadrat	Cover Class (DAUB)	Comments (alive, dead,etc.)
Quadrat A **Herbaceous Plot (1x3 meters)**			
Smi sp	1	1	
Ble ser	6	1	
Dic ere	6	1	
Vitus sp	1	1	
Tox rad	2	1	
Shrub Plot (1x12 meters)			
Ser rep	3	1	1 dead
Ile gal	1	1	
Myr cer	1	1	
Seedlings of shrub or canopy species within plot			
Ure lob	20	1	
Pin Ell Var. Den	7	1	
Rap pun	1	1	
Chr Ica	2	1	
Bac hal	6	1	
Que Lau	1	1	

Canopy Plot (3x24 meters)			
Trees *rooted* within plot			
Pin ell var. den	1	1	
Sab pal	3	1	
Myr cer	6	1	
Rap pun	3	1	
Ile cas	2	1	
Ser rep	2	1	
Lyo Fru	1	1	
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Sab pal	1	1	
Pin ell	3	1	

Quadrat B

Herbaceous Plot (1x3 meters)			
Cla jam	3	1	
Amp muh	1	1	
Rhy sp	7	1	
Ele bal	4	1	
Shrub Plot (1x12 meters)			
Seedlings of shrub or canopy species within plot			
Pin ell var. den	3	1	
Chy ica	2	1	
Rap pun	1	1	
Canopy Plot (3x24 meters)			
Trees *rooted* within plot			
Pin ell var. den	4	1	
Sab pal	3	1	
Rap pun	40	2	
Chr ica	1	1	
Myr cer	2	1	
Per bor	1	1	
Ile cas	1	1	
Bac hal	2	1	
Psy ner	1	1	
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Myr cer	1	1	
Pin ell	1	1	

Quadrat C			
Herbaceous Plot (1x3 meters)			hog damage
Dic ere	14	1	
Shrub Plot (1x12 meters)			
Rap pun	11	1	
Myr cer	1	1	
Sab pal	5	1	
Chy ica	1	1	
Cha fas	1	1	
Seedlings of shrub or canopy species within plot			
Sab pal	1	1	
Rap pun	2	1	
Cha fas	1	1	
Canopy Plot (3x24 meters)			
Trees *rooted* within plot			
Pin ell var. den	7	2	2 dead pine trees not included
Sab pal	5	1	
Rap pun	11	1	
Ile cas	3	1	
Myr cer	3	1	
Ile gla	1	1	
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Pin ell var. den	1	1	
Ile cas	1	1	

ATTACHMENT C

Photomonitoring Protocol for Palm Beach County Natural Areas

(Updated 10/7/02)

The following is to be used as a guideline for site managers for establishing photopoints and taking the photographs at each photomonitoring station required per the site management plan. The standards established here are to be treated as minimum requirements. It is assumed here that all photopoints shall always be established in accordance with the appropriate site management plan in addition to the standards set below. Individual site managers may decide additional photopoints are necessary to adequately monitor a particular event (e.g. extreme high water conditions, wildfire, etc.), or more comprehensive photos (e.g. a photo encompassing a 180 degree field of view photo instead of only approximately 110 degrees) are necessary to assess the success of a particular management activity. Note: See the appropriate management plan and the Burn Monitoring Protocol Memo for appropriate timing of photomonitoring events.

Objective:
To obtain a qualitative, long-term visual record of changes in vegetative structure and/or condition over time, including the effects of planned management activities. The visual record can become semi-quantitative with the use of a density board and/or range pole.

Equipment Required for Establishing Photopoints:

- Photopoint monitoring record form (see attachment)
- Aerial photograph of site
- GPS unit
- Measuring tape
- Monument stakes (rebar and PVC)
- Compass
- Camera
- Tripod (must have compass degree increments of at least 45 degrees on camera mount for horizontal movement left and right (our Mangrotto 3030 tripod has this))
- Range pole and/or density board

Methods:

1) Location Selection:
Establish permanent photopoints in areas where planned management activities are anticipated to occur and in areas where natural vegetation succession (of management interest) is expected to occur. Examples of planned management activities include the following:

- prescribed burns
- exotic vegetation removal/herbiciding
- mechanical cutting of vegetation (e.g. Hydro-axe, Brontosaurus, roller-chopping, mowing, logging. etc.)
- construction of public use facilities and/or management roads
- wetland/upland restoration
- volunteer events

- tree plantings
- construction of water control structures on-site
- adjacent property owner activities (construction)

Examples of areas of natural vegetation succession of management interest include the following:

- known listed species populations being outcompeted
- early (e.g. post-wildfire) or late (e.g. fire-suppressed) successional vegetation communities
- new invasions of exotic species
- insect pest (e.g. pine beetles, Mexican bromeliad weevils) or plant disease outbreaks

Site management plans may dictate the number and general locations of photopoints (e.g. one photo point per management unit), but the abovementioned conditions shall be considered in the micrositing of the photopoints.

At a minimum, each* management/burn unit *shall contain at least one photopoint within a vegetation community that is expected to carry fire during a wildfire or prescribed burn.

In addition, <u>if practical</u>, every* vegetation community *on-site shall contain at least one representative photopoint which captures at least one of the abovementioned planned management activities and/or vegetation conditions.

Additional photopoints may be deemed necessary (to be determined by the site manager) in order to appropriately represent the vegetation conditions on site.

2) Establishing the Photopoint:
The location from which the photograph is taken shall be permanently marked by placing rebar in the ground and covering it with a PVC tube. The rebar shall be placed *at least* 2 feet into the ground (or until completely stable) and the PVC covering should stand *at least* 4 feet above the ground (or until it is readily visible). The PVC can be left off if the point is in an area with a significant chance of being vandalized/removed or, the point can be easily encountered in the field in the future by ERM staff. Another rebar shall be placed in the ground at a reference point 15 feet from the photopoint in the direction of the central photo (i.e. one of four cardinal directions N, E, S, or W). This rebar should be *no more than* 3 feet above the ground and covering it with PVC will be optional. Both of these points can then be GPS‟d with the Trimble Backpack unit (or other unit w/ sub-meter accuracy) and their location clearly described on the photopoint monitoring record form. Describing additional reference points (e.g. trees, structures, other unique features) may also make the point easier to re-locate in the future (e.g. photopoint is 28 meters at 114 degrees from 20" d.b.h. slash pine).

3) Taking the photo:
(<u>Note:</u> If the photopoint was established prior to this protocol, evaluate the significance of the difference between the previously taken photos and photos taken according to this protocol before initiating this methodology. If the site manager determines that significant information will be lost by adopting this protocol, continue to take the photos according to the previously written instructions, otherwise, initiate this methodology during the next photo session.)

Take 3 photos to compose a panoramic image of the target vegetation. Each of the 3 photos will be taken at 45 degree intervals (use the degree graduation marks on the tripod to make this alignment). Set the tripod up so that the camera mount is at 4.5 feet above the ground directly over top of the rebar and at a 90 degree angle to the ground (bring a level if the photopoints are on excessively uneven terrain). In addition, set up the tripod so that the “0" on the dial with the degree graduations (below the camera mount on top of the tripod) is facing the center point of your 3 photo panorama. The center point of the middle photo should be in line with one of four cardinal directions N, E, S, or W (place the compass on top of the camera to assist with this alignment). Holding the bottom tripod handle and progressing from right to left, or left to right, take a photo at “45" degrees (middle dot between “0" and “90"), “0", and end at “45" on the other side from where you started (total of three photos). The range pole or density board shall be placed at the reference point 15 feet from the photopoint and included in the middle photograph. The range pole can be placed directly over top of the rebar.

Note: Always take your photos using the widest angle “zoom” possible (on either camera). Press the “w” on the zoom lever until the image stops zooming out. This will give sufficient overlap between the photos in order to arrange a composite panorama if needed. In addition, always take photos using the 1600x1200 image size (if using the Sony Cybershot, open “Menu” and select “File/Image Size/1600x1200", if using the Nikon, select “Medium” quality) for optimum image clarity and practical storage capacity.

4) Image Storage:
Using Adobe Photoshop Elements, compile the three photos into a panoramic photo and save as a single file (JPEG) with the name of the site, management unit, and photopoint number within the unit (if applicable), and the date it was taken. This file can then be viewed and printed as needed. Save copies of this file to the “Master” photomonitoring CD under the appropriate site folder and year.

In addition, save *each* of the three individual photos taken at each photopoint individually, including the degree angle at which each photo was taken in the name of each file. These will be saved as back-up files of the panoramic mosaic if needed in the future.

ATTACHMENT D

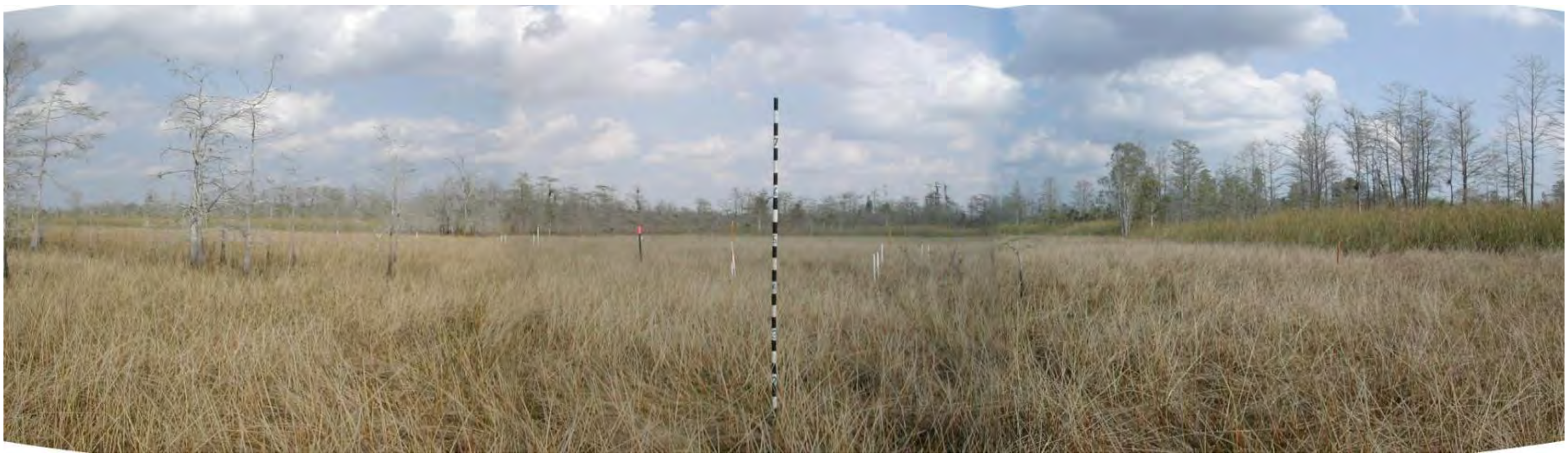
Photomonitoring in the Loxahatchee Slough Natural Area

March and September 2011

ATTACHMENT D - Panoramic Photos

Photostation 1 - Swale

March 2003



March 2006

March 2011

ATTACHMENT D - Panoramic Photos (cont'd)

Photostation 2 - Swale

March 2003

March 2006

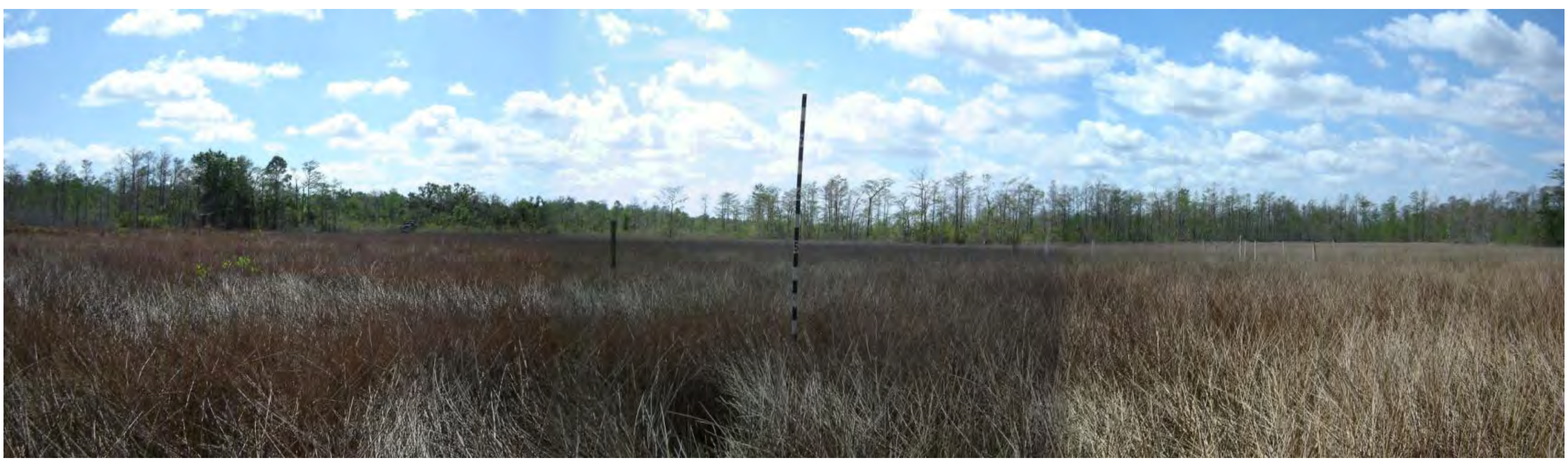
March 2011

ATTACHMENT D - Panoramic Photos (cont'd)

Photostation 3 - Swale

March 2003

March 2006



March 2011

ATTACHMENT D - Panoramic Photos (cont'd)

Photostation 4 – Hydric Hammock

March 2003

March 2006

March 2011

ATTACHMENT D - Panoramic Photos (cont'd)

Photostation 5 – Wet Flatwoods

March 2003

March 2006

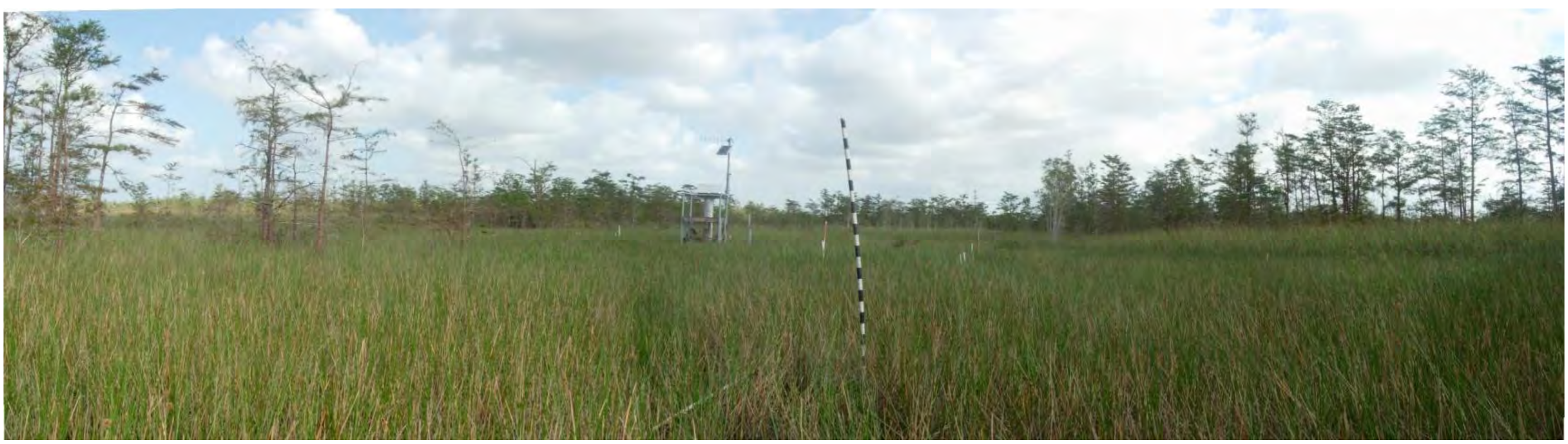
March 2011

ATTACHMENT D - Panoramic Photos

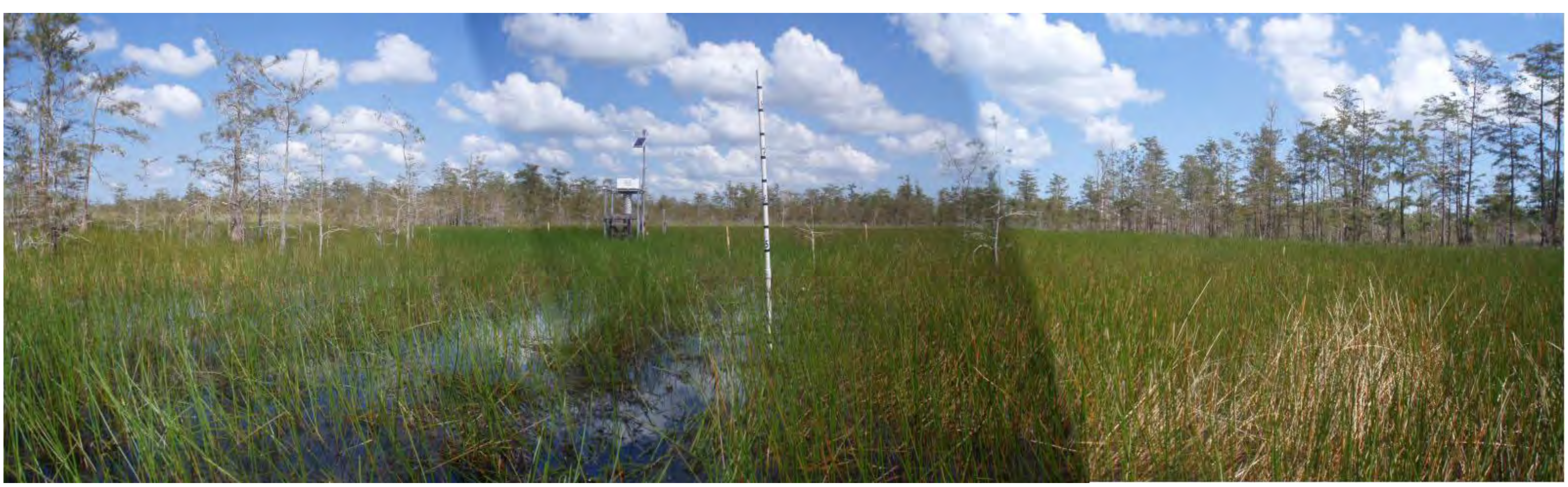
Photostation 1 - Swale

September 2003

September 2006



September 2011



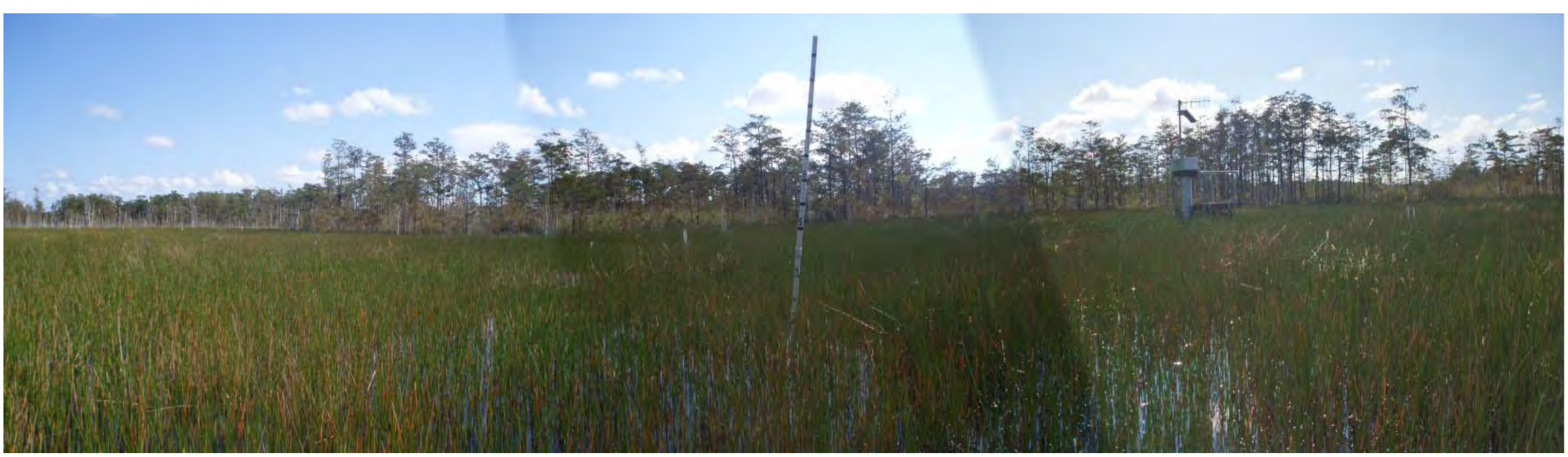
ATTACHMENT D - Panoramic Photos (cont'd)

Photostation 2 - Swale

September 2003

September 2006

September 2011



ATTACHMENT D - Panoramic Photos (cont'd)

Photostation 3 - Swale

September 2003

September 2006

September 2011

ATTACHMENT D - Panoramic Photos (cont'd)

Photostation 4 – Hydric Hammock

September 2003

September 2006

September 2011

ATTACHMENT D - Panoramic Photos (cont'd)

Photostation 5 – Wet Flatwoods

September 2003

September 2006

September 2011

ATTACHMENT E

Water Levels, Rainfall and Stages
In the Loxahatchee Slough Natural Area

2006-2011

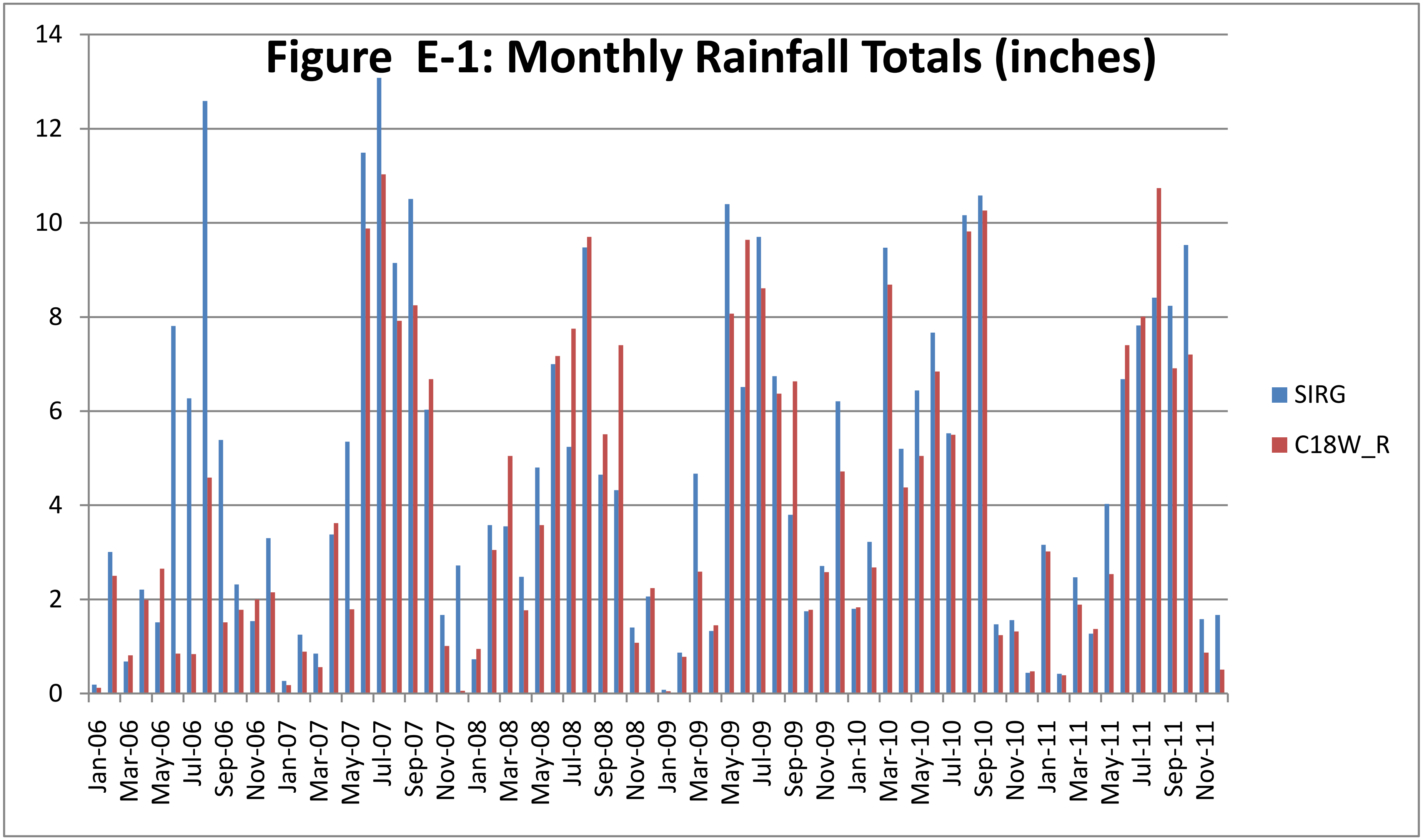


Figure E-1: Monthly Rainfall Totals (inches)
0
2
4
6
8
10
12
14
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Sep-08
Nov-08
Jan-09
Mar-09
May-09
Jul-09
Sep-09
Nov-09
Jan-10
Mar-10
May-10
Jul-10
Sep-10
Nov-10
Jan-11
Mar-11
May-11
Jul-11
Sep-11
Nov-11
SIRG
C18W_R

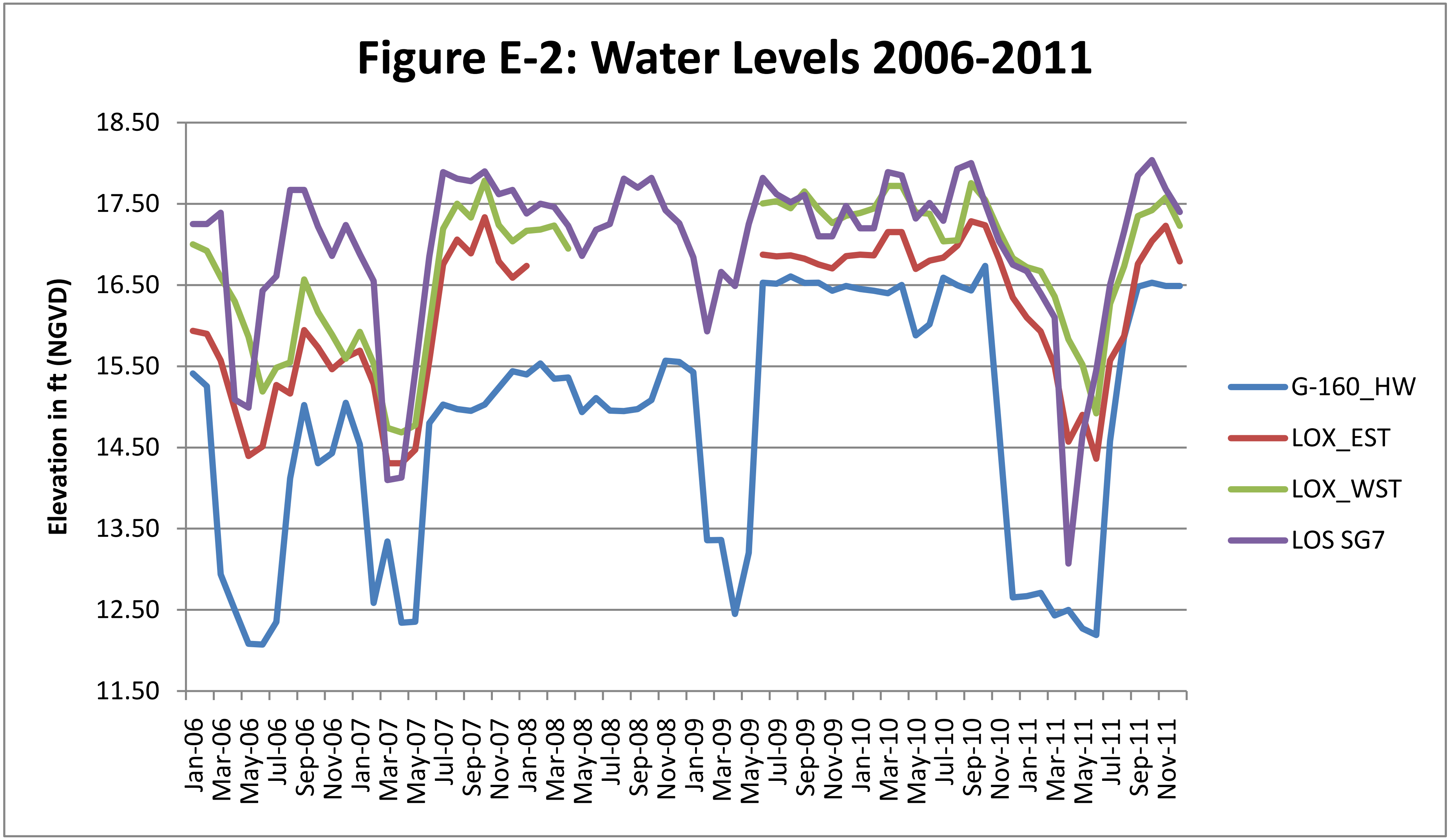


Figure E-2: Water Levels 2006-2011
18.50
17.50
16.50
15.50
14.50
13.50
12.50
11.50
Elevation in ft (NGVD)
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Sep-08
Nov-08
Jan-09
Mar-09
May-09
Jul-09
Sep-09
Nov-09
Jan-10
Mar-10
May-10
Jul-10
Sep-10
Nov-10
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Mar-11
May-11
Jul-11
Sep-11
Nov-11
G-160_HW
LOX_EST
LOX_WST
LOS SG7

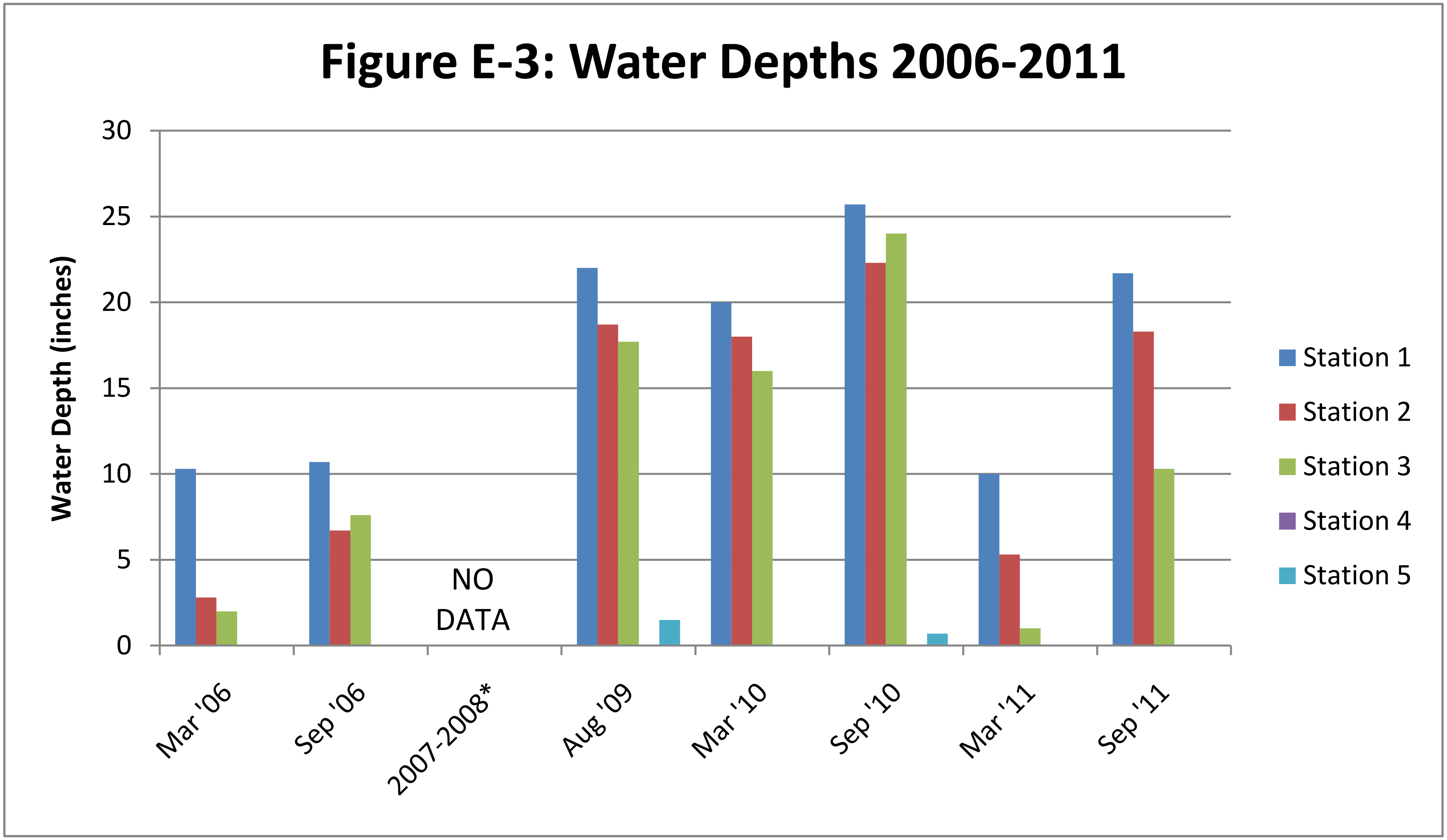
Figure E-3: Water Depths 2006-2011
Water Depth (inches)
30
25
20
15
10
5
0
NO
DATA
Mar '06
Sep '06
2007-2008*
Aug '09
Mar '10
Sep '10
Mar '11
Sep '11
Station 1
Station 2
Station 3
Station 4
Station 5

ATTACHMENT F

Summary of Vegetation Data
For the Loxahatchee Slough Natural Area

2006-2011

Vegetation Monitoring: nested plots		Station 1 (Swale community dominated by Eleocharis cellulosa, little shrub, no canopy				Station 2 (Swale community dominated by Eleocharis cellulosa, little shrub, no canopy				Station 3 (Swale community dominated by Eleocharis cellulosa, little shrub, no canopy				Station 4 - Mature Hammock dominated by Psychotria nervosa, Blechnum serrulatum in understory, Quercus laurifolia, sabal palmetto in canopy				Station 5 Pine flatwoods, variable understory, dominated by Pinus elliottii var. densa and Myrsine floridana			
		Species Composition	Density (total unit/area)	Cover Class 1-6	Water Depth (inches)	Species Composition	Density (total unit/area)	Cover Class 1-6	Water Depth (inches)	Species Composition	Density (total unit/area)	Cover Class 1-6	Water Depth (inches)	Species Composition	Density (total unit/area)	Cover Class 1-6	Water Depth (inches)	Species Composition	Density (total unit/area)	Cover Class 1-6	Water Depth (inches)
BASELINE MONITORING																					
Dry Season - March 2006	Herbaceous	*Elecharis cellulosa*	90 (s=50.5)	1.3	10.3	*Eleocharis cellulosa*	62 (s=24.0)	1	2.8	*Eleocharis cellulosa*	60 (s=40.0)	1	2.0	*Blechnum serrulatum*	9 (s=4.4)	1.3	Dry	*Blechnum serralatum*	2 (s=4.0)	0.3	Dry
		Rhynchospora tracyi	8 (s=7.5)	0.7		*Rhynchospora tracyi*	9 (s=4.5)	1		*Rhynchospora tracyi*	18 (s=16.7)	0.7		*Dichantheleum commutatum*	2 (s=1.7)	1		*Dichanthelium erectifolium*	4 (s=6.9)	0.3	
	Shrub					*Melaleuca quinquinervia*	0.7 (s=0.6)	0.7						*Psychotria nervosa*	33 (s=53.2)	1.7		*Rapanea punctata*	8 (s=10.8)	1	
		Cephalanthus occidentalis	1 (s=1.7)	0.3		*Taxodium distichum*	0.3 (s=0.6)	0.3		*Cephalanthus occidentalis*	0.3 (s=0.6)	0.3		*Urena lobata*	50 (s=74.2)	1		*Sabal palmetto*	3 (s=4.6)	0.7	
	Canopy													*Sabal palmetto*	5 (s=2.6)	2		*Sabal palmetto*	5 (s=3.8)	1.3	
		n/a (no canopy)	n/a	n/a		N/a (no canopy)	n/a	n/a		No canopy	n/a	n/a		*Rapanea punctata*	4 (s=6.9)	0.7		*Rapanea punctata*	8 (s=8.4)	1.3	
Wet Season - Sept. 2006	Herbaceous	*Elecharis cellulosa*	200 (s=106.2)	1	10.7	*Eleocharis cellulosa*	125 (s=50.7)	1	6.7	*Eleocharis cellulosa*	223 (s=281.2)	1.3	7.6	*Blechnum serrulatum*	10 (s=5.5)	1	Dry	*Dichanthelium commutatum*	4 (s=6.4)	0.3	Dry
		Rhynchospora tracyi	43 (s=35.4)	1		*Rhynchospora tracyi*	72 (s=30.3)	1		*Rhynchospora tracyi*	47 (s=40.8)	0.7		*Erechtites hieraciifolius*	12 (s=20.2)	0.3		*Chamaecrista fasciculata*	5 (s=8.1)	0.3	
	Shrub					*Hypericum fasciculatum*	0.3 (s=0.6)	0.3						*Psychotria nervosa*	52 (s=79.9)	1.7		*Urena lobata*	13 (s=21.9)	0.3	
		Cephalanthus occidentalis	1 (s=1.7)	0.3		*Taxodium distichum*	0.3 (s=0.6)	0.3		*Cephalanthus occidentalis*	0.3 (s=0.6)	0.3		*Urena lobata*	142 (s=99.9)	1.3		*Sabal palmetto*	22 (s=22.5)	1.3	
	Canopy													*Sabal palmetto*	6 (s=2.5)	1.7		*Sabal palmetto*	5 (s=2.0)	1.3	
		n/a (no canopy)	n/a	n/a		*N/a (no canopy)*	n/a	n/a		No canopy	n/a	n/a		*Psychotria nervosa*	2 (s=1.5)	0.7		*Rapanea punctata*	20 (s=23.1)	1.3	
POST OPERATION MONITORING																					
Wet Season - Sept. 2009	Herbaceous	*Elecharis cellulosa*	216 (s=81.5)	1.7	22	*Eleocharis cellulosa*	180 (s= 50.5)	1.3	18.7	*Eleocharis cellulosa*	167 (s=85.6)	1.3	17.7	*Psychotria nervosa*	78 (s=122.9)	0.7	Saturated	*Dichantheleum erectifolium*	4 (s=6.4)	0.3	1.5
						Rhynchospora tracyi	6 (s= 5.5)	0.7		*Rhynchospora tracyi*	21 (s=18.1)	0.7		*Blechnum serrulatum*	4 (s=2.0)	1		*Blechnum serrulatum*	2 (s=4.0)	0.3	
	Shrub					*Taxodium distichum*	0.3 (s=0.6)	0.3						*Psychotria nervosa*	21 (s=28.4)	0.7		*Rapanea punctata*	7 (s=9.8)	1	
		Cephalanthus occidentalis	1 (s=1.7)	0.3						*No shrub layer*	n/a	n/a		*Urena lobata*	14 (s=20.9)	0.7		*Serenoa repens*	2 (s=2.9)	0.3	
	Canopy													*Sabal palmetto*	5 (s=3.6)	1.7		*Pinus elliottii var. densa*	3 (s=2.5)	1.3	
		n/a (no canopy)	n/a	n/a		N/a (no canopy)	n/a	n/a		No canopy	n/a	n/a		*Rapanea punctata*	3 (s=3.8)	0.7		*Rapanea punctata*	12 (s=13.2)	1.3	
Dry Season - March 2010	Herbaceous	*Elecharis cellulosa*	259 (s=83.2)	1.3	20	*Eleocharis cellulosa*	244 (s=53.2)	1.3	18	*Eleocharis cellulosa*	136 (s=78.1)	1.3	16	*Psychotria nervosa*	9 (s=15.0)	0.3	Dry	*Dichanthelium commutatum*	1 (s=2.3)	0.3	Dry
						Rhynchospora tracyi	3 (s=3.1)	0.7		*Fuirena scirpoides*	18 (s=31.2)	0.3		*Blechnum serrulatum*	7 (s=7.0)	0.7		*Blechnum serrulatum*	3 (s=4.6)	0.3	
	Shrub					*Taxodium distichum*	0.3 (s=0.6)	0.3						*Psychotria nervosa*	17 (s=19.3)	0.7		*Rapanea punctata*	5 (s=5.7)	0.7	
		Cephalanthus occidentalis	1 (s=1.7)	0.3						*No shrub layer*	n/a	n/a		*Urena lobata*	6 (s=6.7)	0.7		*Serenoa repens*	2 (s=2.9)	0.3	
	Canopy													*Sabal palmetto*	5 (s=4.0)	1.7		*Pinus elliottii var. densa*	4 (s=3.1)	1.3	
		n/a (no canopy)	n/a	n/a		N/a (no canopy)	n/a	n/a		No canopy	n/a	n/a		*Psychotria nervosa*	3 (s=5.8)	0.3		*Rapanea punctata*	12 (s=13.2)	1.3	
Wet Season - Sept. 2010	Herbaceous	*Elecharis cellulosa*	198 (s=33.5)	2	25.7	*Eleocharis cellulosa*	294 (s=55.9)	2.3	22.3	*Eleocharis cellulosa*	179 (s=41.8)	2	24	*Psychotria nervosa*	9 (s=15.6)	0.3	Dry	*Dichanthelium commutatum*	10 (s=10.3)	0.7	0.7
						Rhynchospora tracyi	3 (s=3.5)	0.7		*Fuirena scirpoides*	15 (s=18.9)	0.7		*Blechnum serrulatum*	6 (s=6.0)	0.7		*Blechnum serrulatum*	3 (s=4.9)	0.3	
	Shrub					*Taxodium distichum*	0.3 (s=0.6)	0.3						*Psychotria nervosa*	12 (s=13.9)	1		*Rapanea punctata*	4 (s=5.8)	1	
		Cephalanthus occidentalis	1 (s=1.7)	0.3						No shrub layer	n/a	n/a		*Urena lobata*	6 (s=10.4)	0.3		*Serenoa repens*	1 (s=2.3)	0.3	
	Canopy													*Sabal palmetto*	6 (s=3.8)	1.7		*Pinus elliottii var. densa*	4 (s=3.1)	1.3	
		n/a (no canopy)	n/a	n/a		n/a (no canopy)	n/a	n/a		n/a (no canopy)	n/a	n/a		*Psychotria nervosa*	4 (s=5.5)	0.7		*Rapanea punctata*	16 (s=17.6)	1.3	

Vegetation Monitoring: nested plots		Station 1 (Swale community dominated by Eleocharis cellulosa, little shrub, no canopy				Station 2 (Swale community dominated by Eleocharis cellulosa, little shrub, no canopy				Station 3 (Swale community dominated by Eleocharis cellulosa, little shrub, no canopy				Station 4 - Mature Hammock dominated by Psychotria nervosa, Blechnum serrulatum in understory, Quercus laurifolia, sabal palmetto in canopy				Station 5 Pine flatwoods, variable understory, dominated by Pinus elliottii var. densa and Myrsine floridana			
		Species Composition	Density (total unit/area)	Cover Class 1-6	Water Depth (inches)	Species Composition	Density (total unit/area)	Cover Class 1-6	Water Depth (inches)	Species Composition	Density (total unit/area)	Cover Class 1-6	Water Depth (inches)	Species Composition	Density (total unit/area)	Cover Class 1-6	Water Depth (inches)	Species Composition	Density (total unit/area)	Cover Class 1-6	Water Depth (inches)
YEAR 3: POST OPERATION MONITORING																					
Dry Season - March 2011	Herba-ceous	*Elecharis cellulosa*	177 (s=66.2)	1.3	10	*Eleocharis cellulosa*	269 (s=59.1)	2	5.3	*Eleocharis cellulosa*	97 (s=26.4)	1	1	*Blechnum serrulatum*	3 (s=2.3)	0.7	Dry	*Rhynchospora colorata*	4 (s=5.1)	0.7	Dry
										Fuirena scirpoides	17 (s=24.7)	0.7		*Vitus rotundifolia*	2 (s=1.5)	0.7		*Eleocharis baldwinii*	3 (s=5.8)	0.3	
	Shrub					*Taxodium distichum*	0.3 (s=0.6)	0.3						*Psychotria nervosa*	4 (s=4.5)	0.7		*Rapanea punctata*	3 (s=4.9)	0.7	
		Cephalanthus occidentalis	1 (s=1.7)	0.3						*No shrub layer*	n/a	n/a		*Rapanea punctata*	2 (s=2.1)	0.7		*Serenoa repens*	2 (s=3.5)	0.3	
	Canopy													*Sabal palmetto*	5 (s=4.0)	1.7		*Pinus elliottii var. densa*	4 (s=3.0)	1.3	
		n/a (no canopy)	n/a	n/a		n/a (no canopy)	n/a	n/a		n/a (no canopy)	n/a	n/a		*Psychotria nervosa*	10 (s=11.2)	1		*Rapanea punctata*	13 (s=13.6)	1.3	
Wet Season - Sept. 2011	Herba-ceous	*Elecharis cellulosa*	184 (s=74.3)	1.7	21.7	*Eleocharis cellulosa*	227 (s=43.6)	2	18.3	*Eleocharis cellulosa*	260 (s=133.2)	2	10.3	*Blechnum serrulatum*	4 (s=3.5)	0.7	Dry	*Dichanthelium erectifolium*	7 (s=7.0)	0.7	Saturated
						Rhynchospora tracyi	6 (s=5.5)	0.7		*Fuirena scirpoides*	11 (s=19.1.)	0.3		*Vitus rotundifolia*	3 (s=4.2)	0.7		*Rhychospora sp.*	2 (s=4.0)	0.3	
	Shrub					*Taxodium distichum*	0.3 (s=0.6)	0.3						*Psychotria nervosa*	10 (s=14.6)	1		*Myrica cerifera*	1 (s=0.6)	0.7	
		Cephalanthus occidentalis	1 (s=1.7)	0.3						No shrub layer	n/a	n/a		*Rapanea punctata*	2 (s=2.1)	0.7		*Rapanea punctata*	4 (s=6.4)	0.3	
	Canopy													*Sabal palmetto*	6 (s=3.8)	1.7		*Pinus elliottii var. densa*	4 (s=3.0)	1.3	
		n/a (no canopy)	n/a	n/a		n/a (no canopy)	n/a	n/a		n/a (no canopy)	n/a	n/a		*Psychotria nervosa*	5 (s=7.6)	1		*Rapanea punctata*	18 (s=19.5)	1.3	

Attachment D: Vegetation Communities in the Loxahatchee Slough Natural Area: A 2011 GIS-Based Analysis of Vegetation Associated with the G-160/161 Structures

Note: This document, dated February 29, 2011, was prepared by the South Florida Water Management District and submitted to the Florida Department of Environmental Protection.

VEGETATION COMMUNITIES IN THE LOXAHATCHEE SLOUGH NATURAL AREA:

A 2011 GIS-Based Analysis of Vegetation Associated with the G-160/161 Structures

February 29, 2011

G-160 Structure
FDEP ERP PERMIT NO. EL-50-128848-004
USACE PERMIT NO. 200100551 (IP-TKW)

G-161 Structure
FDEP ERP PERMIT NO. EL-026854-001
USACE PERMIT NO. SAJ-2005-4004 (IP-TKW)

sfwmd.gov

Rick Householder, Senior Geographer
Water Quality Bureau
South Florida Water Management District
West Palm Beach, Florida

CONTENTS

Summary

For the 2010–2011 study period, the ground truthing results and Geographic Information Systems (GIS) analysis of the major vegetation community types in the Loxahatchee Slough Natural Area that are influenced by the South Florida Water Management District's (SFWMD or District) G-160 and G-161 structures indicate that the largest land use was wetlands and pine flatwoods. Based on this analysis, the distribution of vegetation communities in both 2005 (previous study) and 2010–2011 indicates that there was an increase in the extent of wetlands and pine uplands over this period. These results follow the upward trend for wetland communities from the initial study (2000 to 2005) and reverse the downward trend for upland pine communities for the same period.

Introduction

The Loxahatchee Slough Natural Area is the most ecologically diverse tract of protected land in Palm Beach County. The area is approximately 16,000 acres and includes distinct habitats of pine flatwoods, swale, wet prairies, hydric hammock, strand swamp, slough, cypress swamp, depression marsh, and disturbed areas. Within these habitats, 63 federally or state-listed threatened or endangered species of plants and animals may be found. The site also includes the largest oak hammock and swale/slough in the county. Palm Beach County owns and manages the area, and the slough represents the headwaters of the Loxahatchee River, federally designated in 1985 as Florida's first National Wild and Scenic River (Zahina and Kramp, 2008).

The historic hydrology of the slough has been altered over time. Construction of drainage canals, flood protection berms, and roads has fragmented the watershed. The resulting overdrainage and hydroperiod alterations have supported the establishment of invasive exotic plant species, such as melaleuca (*Melaleuca quinquenervia*), Old World climbing fern (*Lygodium microphyllum*), and Brazilian pepper (*Schinus terebinthifolius*), as well as the encroachment of upland or transitional species into wetland areas. The presence of these exotic species, as well as the encroachment of upland species into wetland areas, decreases habitat quality for native flora and fauna.

The G-160 structure was proposed and constructed to address some of these issues. The structure allows water managers to increase the stage within the C-18 canal adjacent to the site in an effort to meet hydroperiod targets within Loxahatchee Slough. The structure also serves as a part of a larger water control system that provides for improved conveyance of water within the region to areas that have been isolated from historical flow paths by the construction of drainage features and roadways. The G-160 Project was also implemented, in part, to mitigate adverse wetland impacts that were expected to result from the construction of the Mirasol Project (a development located east of the C-18 canal), as authorized under District permit #50-04118-P and the corresponding U.S. Army Corps of Engineers permit (Zahina and Kramp, 2008).

In 2002, a vegetation monitoring plan was developed and agreed upon between the SFWMD and Palm Beach County's Department of Environmental Resources Management (ERM) to monitor changes in vegetative communities within the Loxahatchee Slough Natural Area that would result from construction and operation of the G-160 structure in the C-18 canal. As part of the monitoring plan, the SFWMD is responsible for assessing landscape-level changes to vegetation communities and ERM is responsible for transect and quadrat-based field studies within the Loxahatchee Slough Natural Area. The SFMWD is required to conduct an aerial photography-based analysis of vegetation communities utilizing the Florida Land Use, Cover, and Forms Classification System (FLUCCS) developed by the Florida Fish and Wildlife Conservation Commission (Kawula, 2009). The SFWMD completed a baseline analysis of the historical (1995) and then-present (2000) extent of major vegetation community types in the preserve (Zahina and Kramp, 2004). As part of the original agreement, the SFWMD consented to update the map of vegetation communities in 2010. This report provides the results of that update in compliance with the monitoring agreement. It should be noted that the GIS-based analysis of the vegetation associated with the G-160/161 structures was not completed in 2010 due to budget and personnel constraints. However, it was conducted in March and April 2011, and the results are expected to be included in the next annual permit report.

Construction of the G-160 structure was completed in January 2004. Subsequent to full operation of the structure and, in order to address concerns raised by adjacent communities, a four-party agreement was executed between the SFWMD, Northern Palm Beach County Improvement District (NPBCID), South Indian River Water Control District (SIRWCD), and City of Palm Beach Gardens, limiting G-160 stage operations to 15 feet National Geodetic Vertical Datum (ft NGVD) in the wet season and 15.5 ft NGVD in the dry season for a period of five years, while executing a second agreement between the District and the NPBCID to assess the issues of concern and determine if seepage related impacts would occur resulting in the need for specific mitigation measures. In 2009, the FDEP directed the SFWMD to begin incrementally raising the G-160 structure in compliance with the interim operating plan that was component to the permit. Beginning in June 2009, the G-160 headwater was increased to

16.5 ft NGVD. The SFWMD allowed the four-party agreement to expire in 2010, while agreeing to install and monitor 14 groundwater seepage wells in areas adjacent to the east slough. Average seasonal water levels are being gradually increased each year; however, the ability to meet environmental targets has been challenged by drought conditions from 2006 to 2008 and most recently 2010.

The G-161 structure and flow-way is a shallow flow path that was constructed as part of a larger restoration effort to provide supplemental flow to the C-18 canal to meet proposed environmental enhancement targets for the Loxahatchee Slough Natural Area and the Northwest Fork of the Loxahatchee River. Construction of this shallow flow-way was anticipated to impact approximately 1.58 acres of existing wetlands through dredge and fill activities. After completion, a mitigation planting area was established along the flow-way littoral zone, as described in Environmental Resource Permit No. El-026854-01.

Project Location

The project site is located in western Palm Beach County in the area known as the Loxahatchee Slough and includes the northern section of the City of West Palm Beach's Grassy Waters Preserve (GWP), also known as the Water Catchment Area. The site includes SFWMD structures G-160, located in the C-18 canal just south of the confluence with the C-18 W canal, and G-161, located at the north end of Grassy Waters Preserve at North Lake Boulevard, just south of the area known as the "triangle" (**Figure 1**).

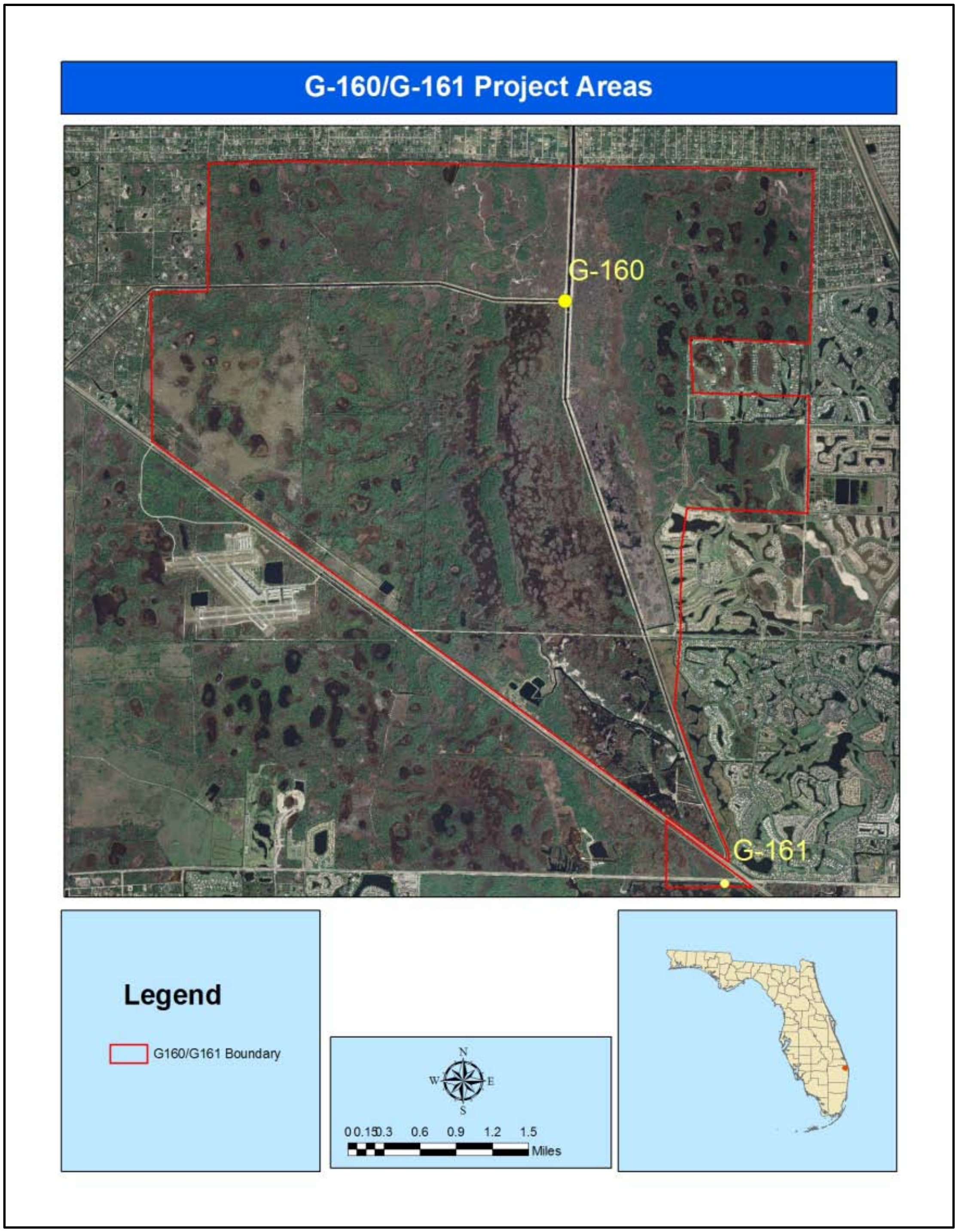

Figure 1. G-160/G-161 Project location areas.

Methodology

GIS Layers and Aerial Imagery

GIS vegetation layers for the project area were obtained from the Palm Beach County ERM and analyzed using ArcGIS software (ESRI, Redlands, CA). ERM's GIS layer was developed based on field surveys conducted during 2010 by ERM staff. The vegetation classification used for the survey is based on the 2010 Florida Natural Area Inventory (FNAI) system. After extensive review of the SFWMD's 2005 vegetation report classification (Zahina and Kramp, 2008), it was determined that the vegetation classes mapped by ERM were better suited for current and future vegetation analysis. The color infrared imagery used for this project was obtained through SFWMD contract and was collected in December 2010.

Imagery Classification and Vegetation Class Determination

Several unsupervised and supervised image classifications were created using ERDAS imagery processing software (ERDAS, Atlanta, GA). In an unsupervised classification, any individual pixel is compared to each discrete cluster to determine to which one it is most comparable. A map of all pixels in the image, classified as to which cluster each pixel is most likely to belong, is produced (in black and white or more commonly in colors assigned to each cluster). Then, this is interpreted by the user as to what the color patterns may represent in terms of vegetation classes that are actually present in the real world scene; this requires some knowledge of the scene's feature/class/material content from general experience or personal familiarity with the area imaged. In a supervised classification, the interpreter knows beforehand what classes are present and where each is in one to perhaps many locations within the scene. These are located on the image, areas containing examples of the class are circumscribed (making them training sites), and the statistical analysis is performed on the multiband data for each such class. Then, instead of clusters, one has class groupings with appropriate discriminate functions that distinguish each (note that it is possible that more than one class will have similar spectral values but this is unlikely when more than three bands are used because different classes/materials seldom have similar responses over a wide range of wavelengths). All pixels in the image lying outside training sites are then compared with the class discriminates derived from the training sites, with each being assigned to the class it is closest to—this makes a map of established classes (with a few pixels usually remaining unknown), which can be reasonably accurate (but some classes present may not have been set up; or some pixels are misclassified (Short, 2011).

The objective of the classifications was to roughly identify the dominant vegetation classes/communities based on 2005 and 2010 imagery and compare the results to the vegetation classifications and GIS layers provided by ERM (2011). After numerous attempts to identify the specific classes through this process, it was determined that the vegetation subtypes of disturbed and non-disturbed classes could not be accurately separated for identification. Based on these results it was decided to merge the two subclasses for field-based identification and final analysis.

Ground Truthing Points and Vegetation Sampling Locations

Based on ERM's established vegetation classes and the newly merged subclasses derived from running the unsupervised classifications, subsequently in early 2011, 233 ground truthing points were established over all the main vegetation categories to aid the ground/aerial survey. Of the 233, roughly 10 percent, or 25 points, were overlaid on each vegetation class and distributed throughout the study site. The survey points were each given unique ID numbers and quadrant designations (**Figure 2**).

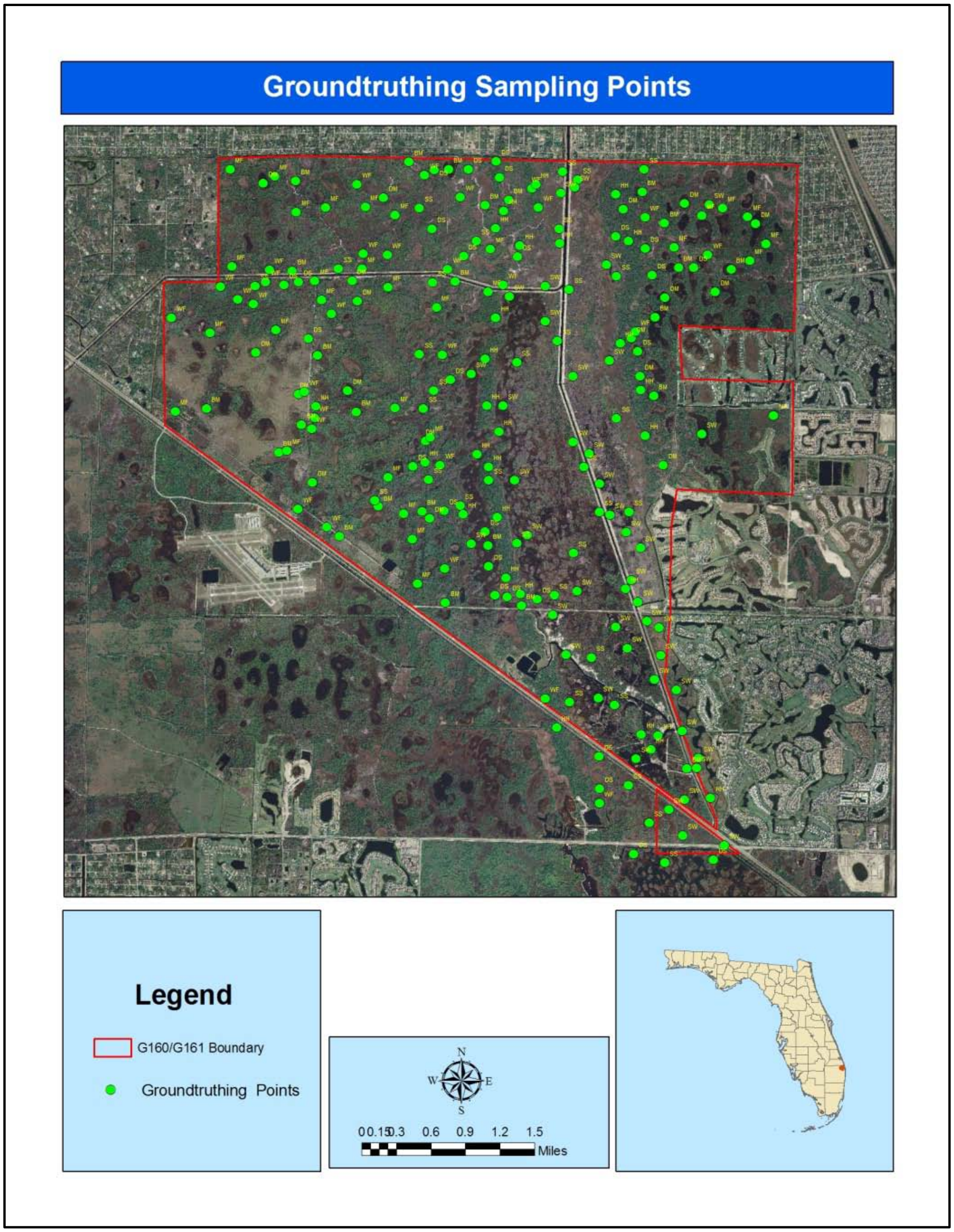

Figure 2. Ground truthing and vegetation sampling points.

Vegetation Field Surveys

For the first phase of the field-based surveys in February–March 2011, SFWMD staff conducted a ground-based survey utilizing navigation-grade GPSmap60SCx units (Garmin, Olathe, KS) to locate the established ground truthing points. Upon arriving at each point, staff identified the dominant vegetation class within a 10m x 10m plot. The identification was aided by the use of vegetation community reference guides created specifically for the project based on the established general vegetation classes. A site worksheet was also created to better facilitate data collection in the field (**Table 1**). The worksheet provided fields for the Palm Beach County ERM map class, dominant vegetation community, quad designation, point x/y coordinates, and latitude/longitude coordinates. Once the dominant community was identified, then a dry erase board with the sampling point designation number was held up and photographed with a digital camera.

Table 1. Data worksheet for 2011 vegetation field surveys.

BM = Basin Marsh; DM = Depresion Marsh; DS = Dome Swamp; HH = Hydric Hammock; MF = Mesic Flatwood; SS = Strand Swamp; WF = Wet Flatwoods

ID	Photo Y/N	Q	PBCMapClas	VegClass -Circle One	Observed prolific plants	POINT_X	POINT_Y	Long_	Lat
0		2	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		912214.5564	931739.7738	-80.214403	26.89484
1		2	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		917416.8678	932599.0842	-80.198426	26.897114
2		2	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		919228.387	932250.7151	-80.192875	26.896124
3		1	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		920900.5585	930624.9928	-80.187777	26.891623
4		2	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		908113.5291	921261.9959	-80.227181	26.866088
5		2	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		915001.509	921102.9049	-80.206057	26.865533
6		2	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		914794.8978	927143.8852	-80.206575	26.882154
7		2	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		920273.4942	922867.9749	-80.189853	26.870297
8		1	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		928123.2198	931228.8325	-80.165607	26.893155
9		1	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		931212.0922	930648.2174	-80.156143	26.891502
10		1	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		932210.7502	927675.468	-80.15314	26.883306
11		1	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		933195.2934	931915.1502	-80.150033	26.89495
12		1	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		929145.1024	929788.907	-80.162501	26.889176
13		1	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		928703.8349	925469.1306	-80.163942	26.877301
14		1	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		929795.3913	927745.1418	-80.160548	26.883542
15		4	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		921039.7154	914994.8339	-80.187657	26.848626
16		4	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		922572.5393	912231.106	-80.183011	26.840996
17		3	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		916000.2716	916800.3908	-80.203077	26.853681
18		2	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		911435.7363	919271.0467	-80.217029	26.860555
19		3	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		914218.943	915421.3484	-80.208566	26.849918
20		3	BASIN MARSH	BM - DM - DS - HH - MF - SS - WF		919088.8486	912347.229	-80.193692	26.841377

Due to the remoteness of many of the ground truthing points (vegetation sampling locations), more than half of the points were investigated by helicopter. With the aid of Global Positioning System (GPS) units and SFWMD staff, the pilot was guided to the select ground truthing point within the four quadrants. Upon arrival, the helicopter hovered while staff photographed the site, identified vegetation, and logged information on the worksheet.

Results

G-160 Vegetation Communities

Based on the field survey results and information provided by Palm Beach County ERM, eight distinct vegetation communities were identified for the G-160 study area. As previously noted, the vegetation classification used for the ground truthing survey was based on the 2010 FNAI and converted to the modified Florida Land Use Cover Classification System (FLUCCS) in order to compare to the previous 2005 study. The resulting communities are (1) basin marsh, (2) depression marsh, (3) wet flatwoods, (4) dome swamp, (5) mesic flatwoods, (6) strand swamp, (7) hydric hammock, and (8) swale (glades marsh). Photographs of each class and the FNAI descriptions are provided in **Figure 3**.

<table>
<tr>
<td></td>
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<tr>
<td>Basin Marsh

Basin with peat or sand substrate; seasonally inundated; statewide excluding Keys; occasional fire; largely herbaceous; maidencane, sawgrass, bulltongue arrowhead, pickerelweed, Baker's cordgrass, white water lily, coastalplain willow.</td>
<td>Depression Marsh

Small, isolated, often rounded depression in sand substrate with peat accumulating toward center; surrounded by fire-maintained community; seasonally inundated; still water; statewide excluding Keys; frequent or occasional fire; largely herbaceous; maidencane, sawgrass, pickerelweed, longleaf threeawn, sand cordgrass, peelbark St. John's wort.</td>
</tr>
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<td>Wet Flatwoods

Flatland with sand substrate; seasonally inundated; statewide except extreme southern peninsula and Keys; frequent fire (2-4 years for grassy wet flatwoods, 5-10 years for shrubby wet flatwoods); closed to open pine canopy with grassy or shrubby understory; slash pine, pond pine, large gallberry, fetterbush, sweetbay, cabbage palm, wiregrass, toothache grass.</td>
<td>Dome Swamp

Small or large and shallow isolated depression in sand/marl/limestone substrate with peat accumulating toward center; occurring within a fire-maintained community; seasonally inundated; still water; statewide excluding Keys; occasional or rare fire; forested, canopy often tallest in center; pond cypress, swamp tupelo.</td>
</tr>
</table>

Descriptions are from FNAI 2010.

Figure 3. Vegetation communities identified in the G-160 study area.

Mesic Flatwoods

Flatland with sand substrate; mesic; statewide except extreme southern peninsula and Keys; frequent fire (2-4 years); open pine canopy with a layer of low shrubs and herbs; longleaf pine and/or slash pine, saw palmetto, gallberry, dwarf live oak, wiregrass.

Strand Swamp

Broad, shallow channel with peat over mineral substrate; situated in limestone troughs; seasonally inundated; slow flowing water; vicinity of Lake Okeechobee and southward; occasional or rare fire; closed canopy of cypress and mixed hardwoods; cypress, pond apple, strangler fig, willow, abundant epiphytes.

Hydric Hammock

Lowland with sand/clay/organic soil over limestone or with high shell content; mesic-hydric; primarily eastern Panhandle and central peninsula; occasional to rare fire; diamond-leaved oak, live oak, cabbage palm, red cedar, and mixed hardwoods.

Swale (Glades Marsh)

Broad, shallow channel with peat/marl substrate directly overlying limestone; seasonally inundated; stagnant or slow flowing water; Everglades basin, Big Cypress region, and Keys; frequent to occasional fire (3-10 years); sawgrass, spikerush, maidencane, beaksedges, mixed emergents.

Descriptions are from FNAI 2010.

Figure 3. Continued.

GIS Mapping and Analysis

Upon completion of the ground- and aerial-based vegetation survey, SFWMD staff analyzed the field data results, converted analysis results to polygons, and compared them to both the 2011 image and the ERM GIS vegetation map. Staff then modified and digitized new GIS polygons for each vegetation community based on ground truthing results using ArcGIS. The extent of the vegetation communities within the study area of the Loxahatchee Slough Natural Area and specifically around structure G-160 is shown in **Figure 4** and **Table 2**.

The most extensive land use types were wetlands and pine flatwoods. Within the natural area, hydric and mesic pine coexist within a matrix of landforms elevations. As in 2005, it is very challenging to definitively categorize an area as one or the other since much of this landscape appears to be intermediate between the two land use types, especially during the extreme dry conditions in all areas of the site. Hence, significant areas that were interpreted as wet flatwoods (a wetland community type) in one year were interpreted as mesic pine (an upland community type) in another year (Zahina and Kramp, 2008). These may be considered the same community that has changed little, if any, since the previous (2005) study period. Another factor that made interpretation problematic was the 2005 analysis did not specify individual vegetation classes as was done in the current study (**Figure 5**).

Overall, the extent of non-coniferous wetlands and uplands slightly increased since the previous study (**Table 2** and **Figure 3**). As with the 2005 analysis, comparison of coniferous forested wetlands is confounded by the difficulty in determining wet and mesic pine communities.

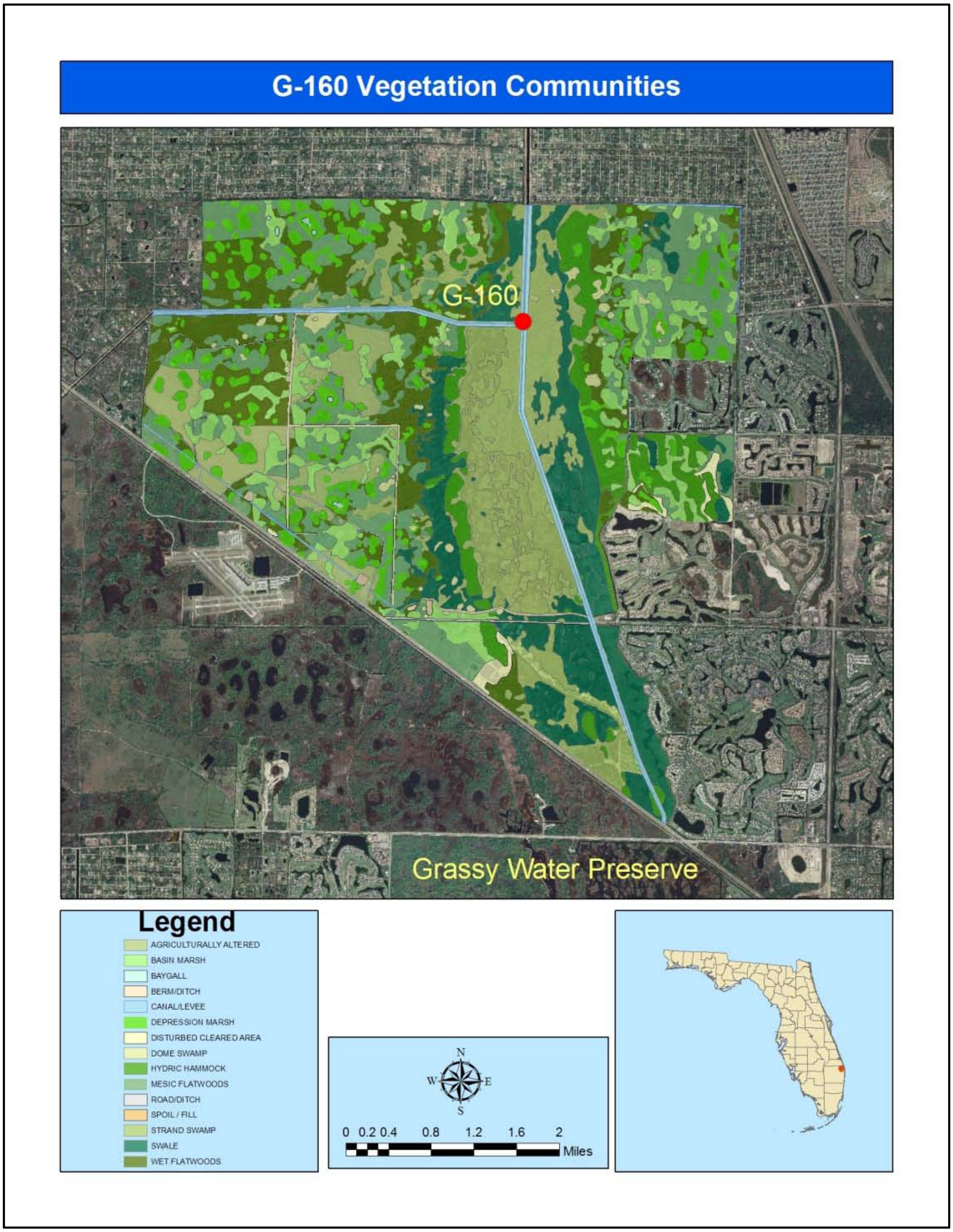

Figure 4. G-160 vegetation communities.

Table 2. Major vegetation communities near the G-160 structure.

Vegetation Community Name Based on FNAI*	FLUCCS Code	FNAI Code	Area		
			2000	**2005**	**2010**
Wetlands	6000	2000	3427 (total)	3523 (total)	3661 (total)
Basin Marsh	6410	2122	N/A	N/A	452
Dome Swamp	6215	2213	N/A	N/A	57
Depression Marsh	6410	2121	N/A	N/A	389
Hydric Hammock	6170	2232	N/A	N/A	344
Swale (Glades Marsh)	6410	2126	N/A	N/A	726
Strand Swamp	6216	2215	N/A	N/A	921
Wet Flatwoods	6250	2221	N/A	N/A	750
Baygall	6220	2231	N/A	N/A	4
Upland Forests	400	1000	1096	754 (total)	866 (total)
Mesic Flatwoods		1311	N/A	754	866

* FNAI 2010

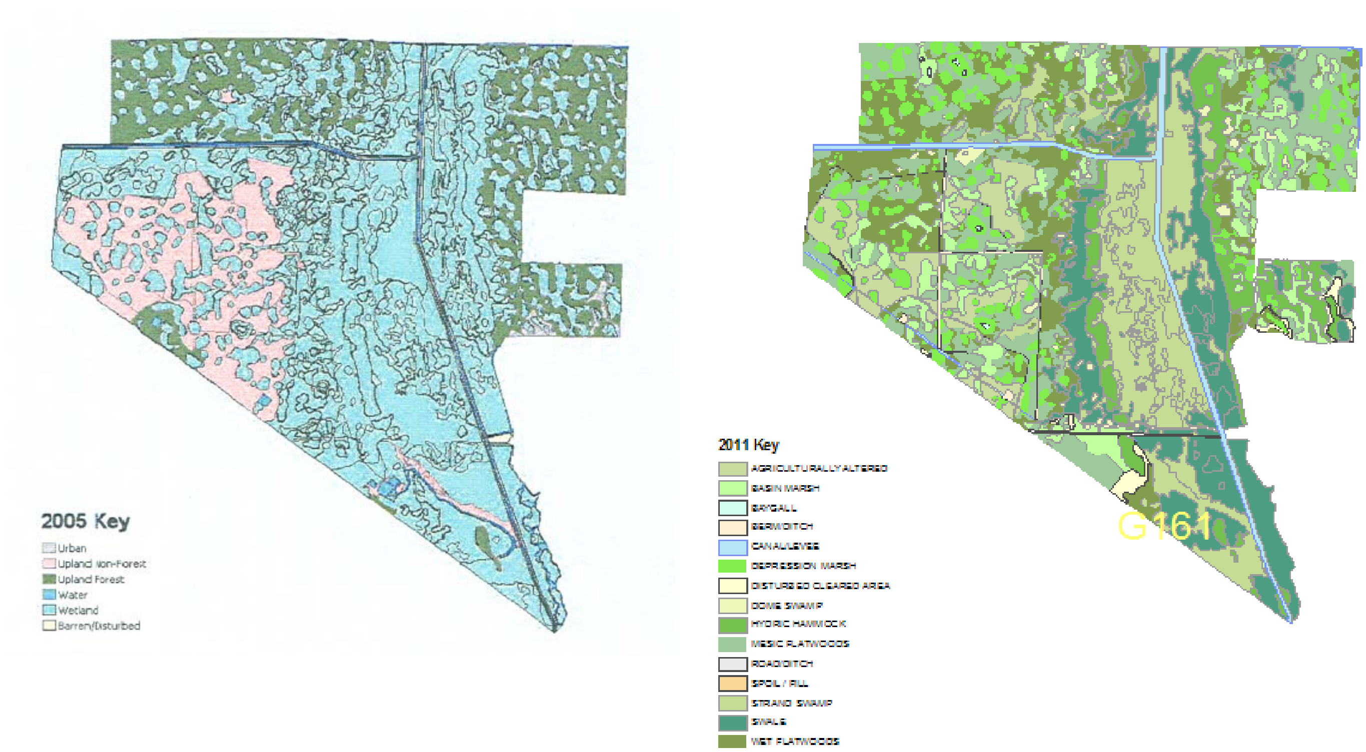

Figure 5. 2005 and 2011 vegetation comparison of the G-160 study area.

G-161 Structure Vegetation Communities

The G-161 structure and flow-way is a shallow flow path that was constructed as part of a larger restoration effort to provide supplemental flow to the C-18 canal to meet proposed environmental enhancement targets for the Loxahatchee Slough Natural Area and the Northwest Fork of the Loxahatchee River. The extent of the vegetation classes within the study area of the G-161 flow-way is shown in **Figure 6**. The area around the G-161 flow-way is dominated by two main vegetation classifications: the eastern section is dominated by glades marsh and the western section is dominated by strand swamp (**Figure 7**).

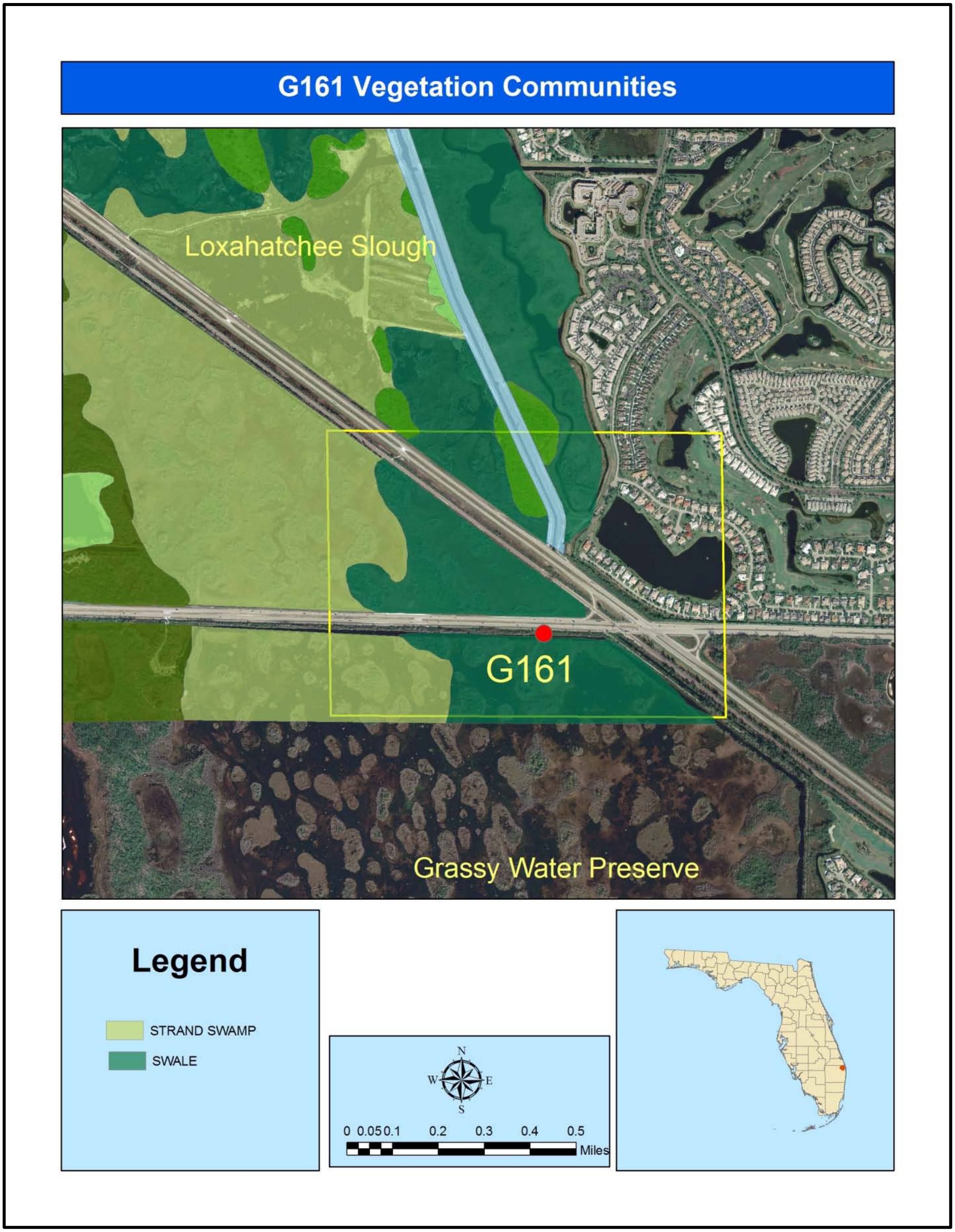

Figure 6. G-161 vegetation communities.

Glades Marsh (Swale)	Strand Swamp
Broad, shallow channel with peat/marl substrate directly overlying limestone; seasonally inundated; stagnant or slow-flowing water; Everglades basin, Big Cypress region, and Keys; frequent to occasional fire (3-10 years); sawgrass, spikerush, maidencane, beaksedges, mixed emergents.	Broad, shallow channel with peat over mineral substrate; situated in limestone troughs; seasonally inundated; slow flowing water; vicinity of Lake Okeechobee and southward; occasional or rare fire; closed canopy of cypress and mixed hardwoods; cypress, pond apple, strangler fig, willow, abundant epiphytes.

Descriptions are from FNAI 2010.

Figure 7. Vegetation communities identified in the G-161 study area.

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ERM. 2011. Loxahatchee Slough Restoration and G-160 Monitoring Plan Second Post Operation Field-based Vegetation Monitoring Report. Palm Beach County Department of Environmental Resource Management, West Palm Beach, FL.

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Attachment E: L-8 Reservoir Pilot Test Water Quality Results

Note: This document, dated June 3, 2011, was prepared by the South Florida Water Management District and submitted to the Florida Department of Environmental Protection.

L-8 Reservoir Pilot Test Water Quality Results

June 3, 2011

Prepared for:
Florida Department of Environmental Protection

By:
South Florida Water Management District

Table of Contents

L-8 Reservoir Pilot Test Water Quality Results

1. Introduction

On 2/18/11 the South Florida Water Management District (District) submitted an application to the Florida Department of Environmental Protection (FDEP) requesting temporary relief from Specific Condition 22 of CERPRA Permit No. 0188365-012, in the form of an exemption pursuant to Subsection 373.406(6), Florida Statues for the purpose of conducting a dry season operational pilot test. The test utilized the L-8 Reservoir as an alternative water supply source for the delivery of water to the Grassy Waters Preserve and Northwest Fork of the Loxahatchee River during the dry season (February – April) of 2011.

On 2/28/11, the FDEP authorized a temporary deviation from the permit requirement to allow water from the L-8 Reservoir to be delivered eastward into the Grassy Waters Preserve for eventual delivery north to the Northwest Fork (NW Fork) of the Loxahatchee River for a limited duration of time (30 consecutive or non-consecutive days).

On 3/29/11, the District provided the FDEP with initial water quality results from the pilot operational test and requested an additional 30-day (consecutive or non-consecutive) extension of the test to collect additional information necessary for the design and planning aspects associated with the Loxahatchee River Watershed Restoration Project. In accordance with the requirements of Section 373.406(6), Florida Statutes, the FDEP reviewed this information on 4/4/11 and granted the District an extension of the operational test for an additional 30 days.

2. Project Description

The L-8 Reservoir project, located in western Palm Beach County, Florida, is a component of the larger Loxahatchee River Watershed Restoration Project (formerly known as CERP North Palm Beach County-Part 1). The 46,000 acre-foot capacity reservoir is expected to capture, store and treat excess water from the L-8 basin that is currently discharged to the Lake Worth Lagoon. This captured water will be used for the environmental enhancement of the Loxahatchee River, Loxahatchee Slough and Grassy Waters Preserve.

The L-8 Reservoir Pilot Test included the water storage and conveyance features currently owned by the District and the City of West Palm Beach, including but not limited to the L-8 Reservoir, the L-8 Canal, L-8 Tieback Canal, the City of West Palm Beach's Control 2 Pump Station (WPB-CS2), the M-Canal, Grassy Waters Preserve and SFWMD structures G-161, G-160, and G-92 and Lainhart Dam located in northern Palm Beach County as well as the NW Fork of the Loxahatchee River (**Figure 1**).

The pilot test was a collaborative effort between multiple agencies (District, City of West Palm Beach, Palm Beach County and Loxahatchee River District) that resulted in the development of an operational plan for delivering water to the NW Fork of Loxahatchee River during the 2011 dry season. The pilot test utilized the existing 75 cubic feet per second (cfs) pump located within the L-8 reservoir to send flows north within the L-8 Canal to the L-

8 Tieback Canal where it mixed with gravity inflows from Culvert C-10A located at the head of the L-8 Canal on Lake Okeechobee. This mixed water was pumped eastward by the City of West Palm Beach's Control 2 pump station (150 cfs pumping capacity) to the M-Canal for a distance of 9.4 miles east into the Grassy Waters Preserve (20 sq. miles). The water continued to flow eastward through Grassy Waters Preserve (GWP) via the M-Canal with some this water mixing with GWP water before being delivered either north through G-161, G-160 and G-92 to the NW Fork of the Loxahatchee River, or eastward through the City of West Palm Beach's Control 4 structure to Lake Mangonia and Clear Lake to provide water supply for the City of West Palm Beach.

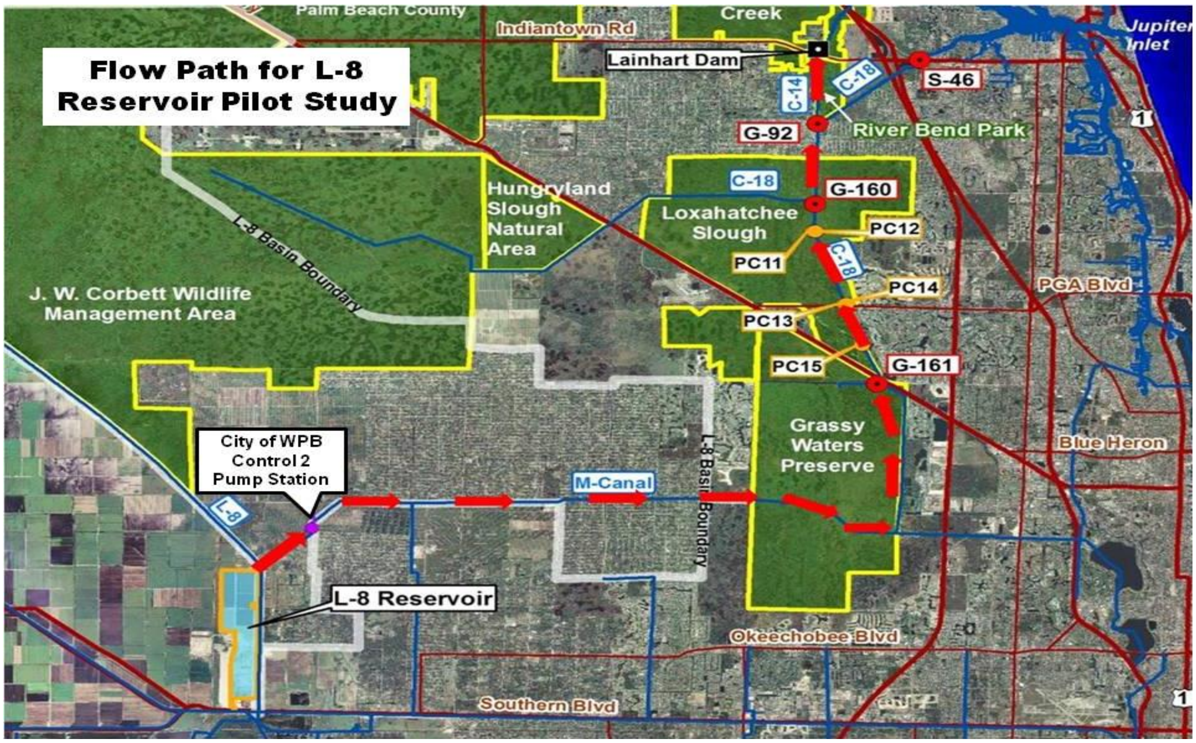

Figure 1. Flow path for the delivery of L-8 Reservoir water to Grassy Waters Preserve and the NW Fork of the Loxahatchee River

Objectives of the Pilot Test were to (1) obtain a broader understanding of the operational complexities involved in routing L-8 Reservoir water to the Loxahatchee River during extreme dry conditions as experienced during the dry season of 2011, (2) obtain data on water conveyance losses associated with making these deliveries to better enable scientists and engineers working on the Loxahatchee River Watershed Restoration Project determine the appropriate size of pump needed to make the L-8 Reservoir fully operational, and (3) provide an opportunity to "exercise" the L-8 Reservoir by lowering water levels during the dry season so that it can be refilled the following wet season to reduce chloride concentrations within the reservoir.

The L-8 Reservoir was originally a limestone quarry (mine) prior to its conversion to a reservoir. The quarry was mined primarily under dry conditions which required water levels to be lowered about 30 feet with the dewatering effluent retained on site. Cycling of this effluent water through the mine's geological formations resulted in contact with ancient connate seawater resulting in elevated chloride levels within the reservoir. As a result of these mining operations, the reservoir chloride concentrations are elevated above the Class I/Class III state water quality standard of 250 mg/L. These elevated chloride concentrations prevent the reservoir from being directly used for its intended purpose – environmental restoration, unless there is a source of dilution water available. Under current conditions, discharges from the reservoir must be diluted to meet Class III water quality standards to maintain chloride levels below 250 milligrams per liter (mg/L) when discharged outside of the L-8 Canal mixing zone. District efforts to reduce chloride levels within the reservoir by replacing it with freshwater over the past several years have shown promising results. **Figure 2** shows a strong, steady decline over the past four years in reservoir chloride concentrations. During the 2011 pilot test, chloride concentrations within the reservoir averaged about 354 mg/L.

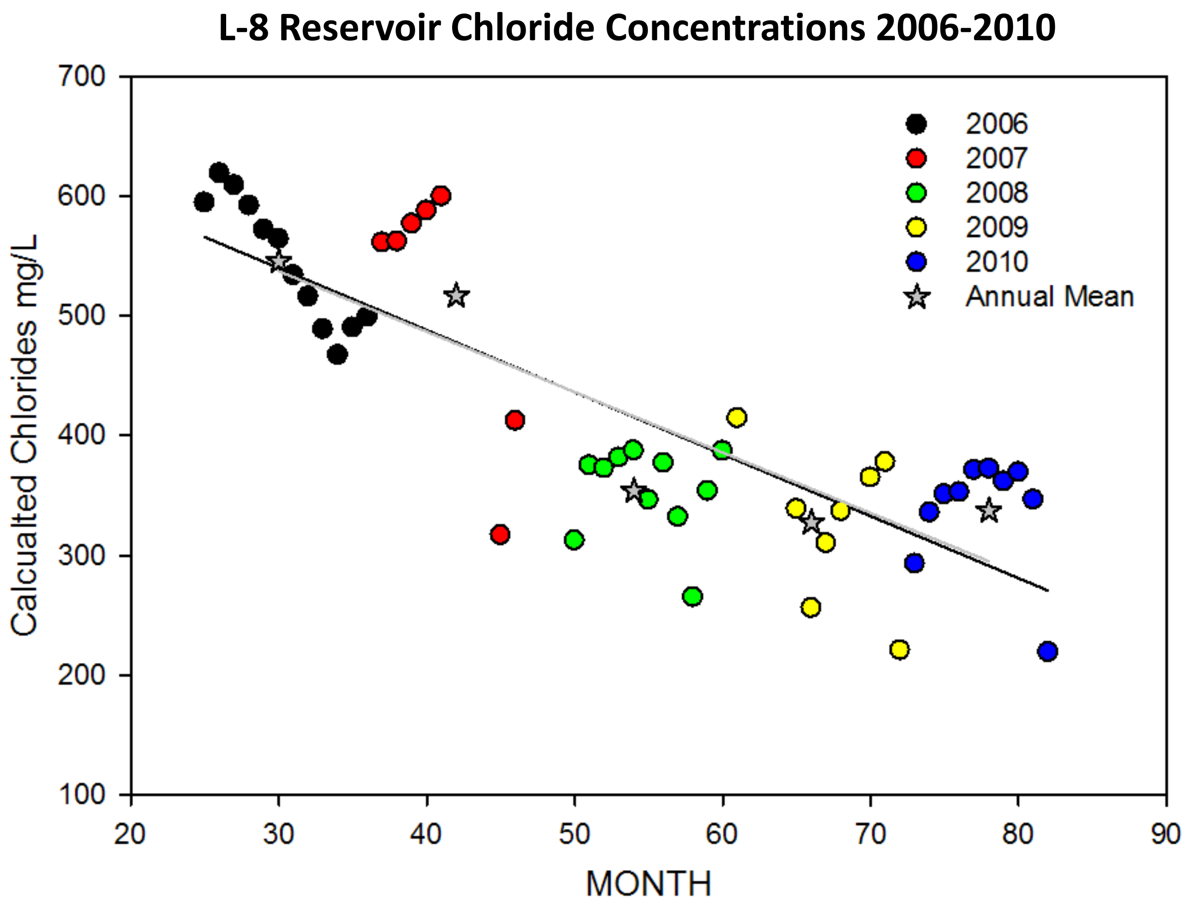

Figure 2. L-8 Reservoir Chloride Levels 2006-2010

Pumping from the L-8 Reservoir occurred for a total of 50 days during the pilot test. The permit exemption has still remaining 12 consecutive or non-consecutive days of pumping which may be implemented once sufficient dilution water becomes available during the wet season. This water quality report is being submitted in the event that the 12 days of additional pumping are not utilized in the future. Assuming that no additional pumping occurs, the permit exemption requires that a water quality report be submitted to FDEP no later than 6/3/11. If additional pumping occurs as authorized by the exemption, additional water quality monitoring data will be collected to supplement this report.

3. Terms of FDEP Permit Exemption

The 4/4/11 permit exemption required that "during the operational test, water quality monitoring data shall be provided [by the District] to the Department as it becomes available. All monitoring data shall be provided, along with an analysis of the data, to the Department within 45 days of completion of the operational test." Pumping operations for the pilot test were initiated on 3/1/11 and terminated on 4/19/11. Based on the requirements of the permit exemption, a water quality report must be submitted to FDEP no later than 6/3/11.

4. Water Quality Monitoring Methods

The L-8 Reservoir Pilot Project Test established 11 water quality monitoring stations as shown in **Figure 3**. **Table 1, Appendix A** provides the station names and GPS coordinates for each monitoring station.

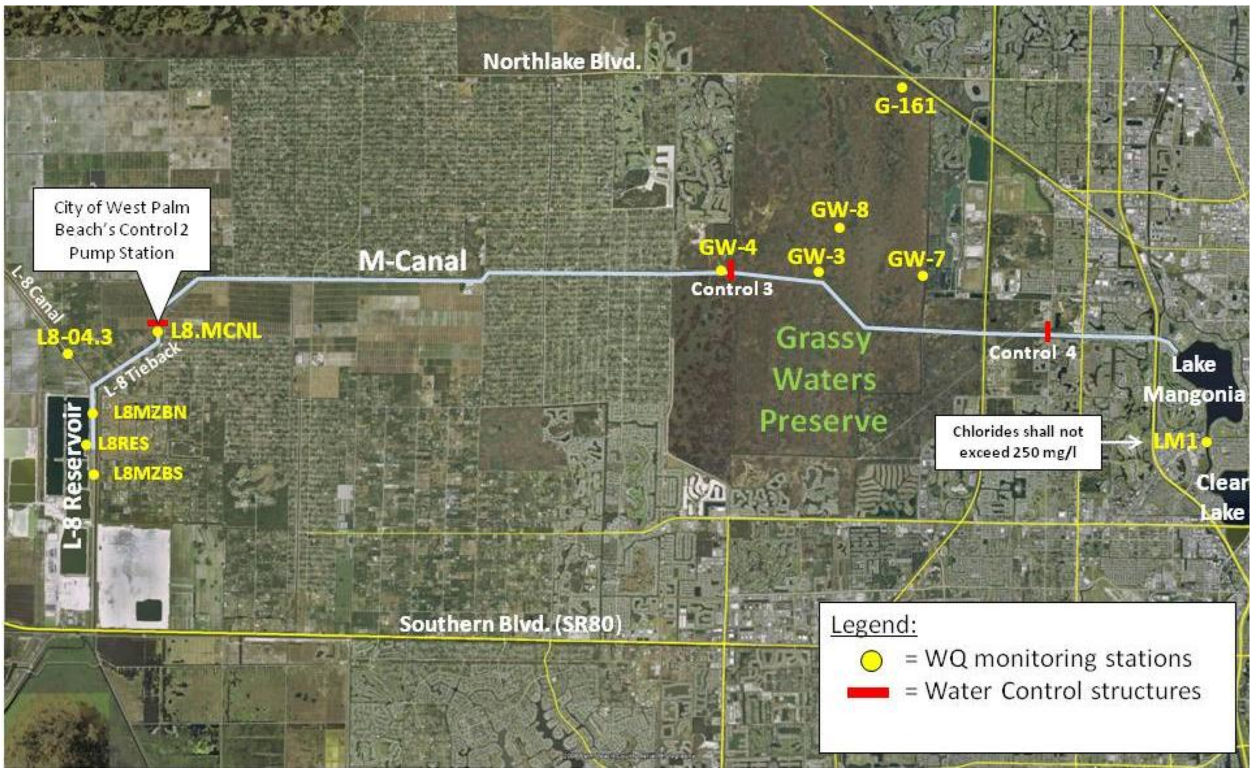

Figure 3. Location of water quality sampling stations for the L-8 Reservoir Pilot Test

Water quality samples, including field testing and field quality control samples were collected in accordance with the FDEP Quality Assurance Rule, 62-160 F.A.C. and the current version of the District's Field Sampling Quality Manual. Multi-parameter sondes were deployed at all stations to collect Specific conductance data. The sondes were maintained on a weekly time interval with data retrieval, calibration, and cleaning done prior to redeployment. All sondes had a recording frequency of 60 minutes except the permanently deployed sondes at L8RES, L8MZBN and L8MZBS. These sondes collect data every 15 minutes. Grab samples for Total Phosphorus (TP) were collected weekly at all stations (**Table 2, Appendix A**).

5. Results and Discussion

Chlorides

Chloride data were calculated from continuous Specific conductance data measured in the field using a newly revised second order polynomial regression equation. **Appendix B** provides a detailed summary of how this equation was derived for use in this study where:

$$\textit{Chlorides (mg/l)} = 0.0000455(\textit{Specific conductance})^2 + 0.0845(\textit{Specific conductance}) + 6.634$$

Monitoring for Specific conductance (calculated chloride concentrations) began on 2/25/11, four days prior to initiation of the pilot test for 11 stations shown in **Figure 2.** Pilot test pumping began on 3/1/11 and ended on 4/19/11; however, additional sampling was conducted for 17 days after the test was completed to capture potential residual effects and determine the time that it takes for the system to return to background levels. Calculated chloride values are depicted in **Figures 4 and 5** below and in **Table 4, Appendix A**.

The mixing zone requirements of the permit exemption dictated that the chloride concentrations located at the south end of Lake Mangonia shall not exceed 250 mg/L at monitoring station LM1. The purpose of this requirement was to ensure protection of public water supply for the City of West Palm Beach.

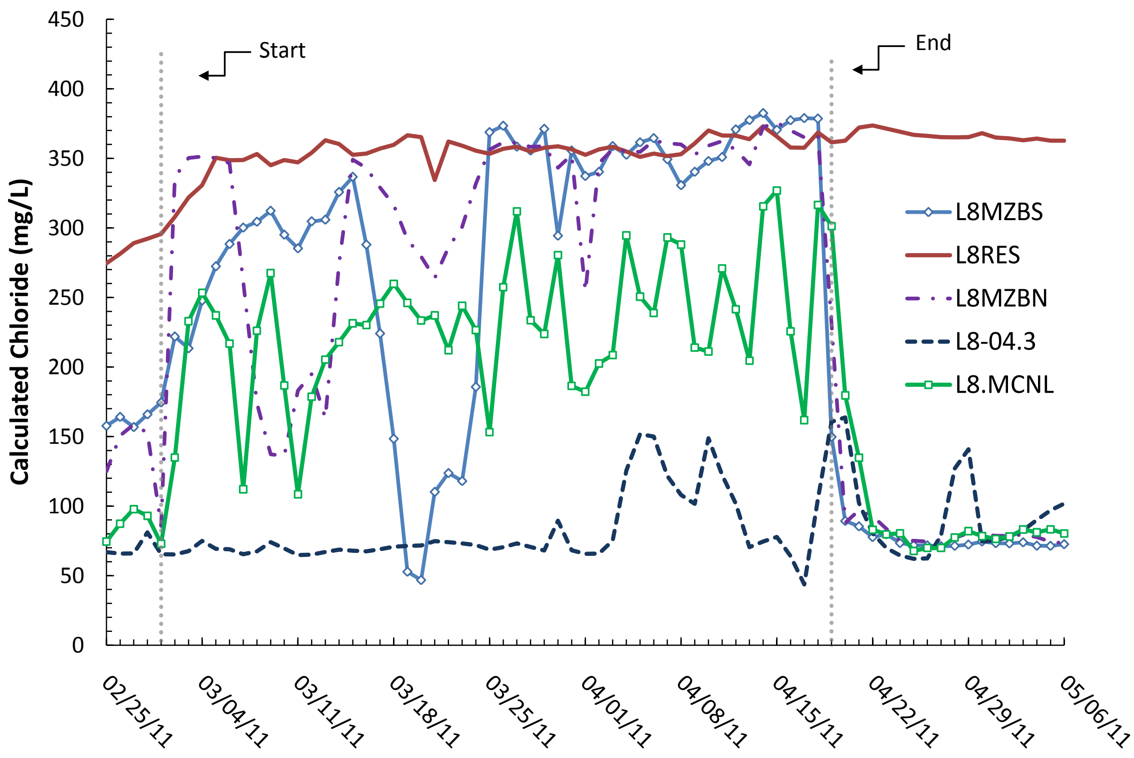

Figure 4. Calculated chloride concentrations observed before, during and after the L-8 Reservoir Pilot Test (L-8 Reservoir [L8RES], L-8 Canal mixing zone [L8MZBN and L8MZBS], Control 2 pump station (L8MCNL) and within the L-8 Canal located north of the L-8 Canal Tieback levee (L804.3). Dashed vertical grey lines denote the start and end of the pilot test.

Prior to the test, chloride concentrations within the L-8 Reservoir (L8RES) averaged about 284 mg/L. During the test, chloride levels within the Reservoir averaged 354 mg/L peaking at 373 mg/L on 4/14/11. **Figure 4** demonstrates that the L-8 Reservoir represents the primary source of elevated chloride levels that were discharged into the L-8 Canal and subsequently pumped by the Control 2 pump station into Grassy Waters Preserve during the test.

In contrast, inflows from Lake Okeechobee via Culvert C-10A represented an important source of dilution water for reducing elevated chloride concentrations in water pumped from the L-8 Reservoir. For example, chloride concentrations recorded at the L804.3 station (located north of the L-8 Tieback Canal) during the first four weeks of the test averaged about 70 mg/L. The gradual increase in chloride concentrations at this station near the end of test (**Figure 4)** most likely can be attributed due to (1) reduced dilution water as inflows from Lake Okeechobee via Culvert C-10A to the L-8 Canal decreased, and (2) increased withdrawals from permitted users north of the L-8 Tieback Canal located within the L-8 basin.

Chloride values (**Figure 4**) recorded at the Control 2 pump station (L8.MCNL) illustrate the dilution effect that inflows from Lake Okeechobee (via Culvert C10A) have on elevated chloride concentrations measured within the L-8 Canal mixing zone (L8MZBN and L8MZBS stations). Specifically, chloride concentrations were observed to fluctuate widely at the Control 2 pump over the course of the pilot test largely in response to whether the pump was operating or shut down for brief periods or the result of a brief rainfall event. Overall chloride concentrations calculated for the Control 2 pump station ranged from 73 and 327 mg/L, averaging about 228 mg/L over the course of the pilot test. These values are about 2.7 times higher than inflow water from Lake Okeechobee (via Culvert C-10A) and about 60 percent less than what is pumped from the L-8 Reservoir.

Of the five water quality stations sampled within Grassy Waters Preserve, the GW4 site appeared most affected by pumping water from the Control 2 pump station. This is a result of this station being located on the M-Canal directly downstream from the Control 2 pump station (the so-called "end of the pipe" location). Prior to the test, chloride concentrations at GW4 averaged about 69 mg/L. These values increased 3 fold during the test, averaging about 220 mg/L, ranging between 80-323 mg/L **(Figure 5).**

Chloride concentrations at GW4 and the Control 2 pump station were highly correlated (R= 0.97) as shown in **Figure 6**. Based on this information a time lag was calculated from the mean flow rate at the Control 2 pump station during the 50-day test period (109 cfs), and length of the M-Canal (9.4 miles) as occurring over a two-day period. Chloride concentrations peaked at GW 4 reaching 372 mg/L on 4/22 about two days after pumping from the L-8 Reservoir was terminated (**Figure 5**) Increased chloride values observed after the test are accentuated in **Figure 5** by a rainfall event that temporarily reduced chloride concentrations from 4/16-4/18. Previous to this rain-induced decline, chloride concentrations at GW4 steadily increased nearly equivalent to those discharged from the L-8 Reservoir. Although a rainfall event may have temporarily reduced chloride levels at GW4, these inputs were not large enough to overcome the rising chloride trend. The elevated chloride concentrations observed at GW4 after completion of the test were largely the result of the two-day lag time that it takes for water pumped from Control 2 to travel 9.4 miles downstream to GW4 (**Figures 5 and 6**).

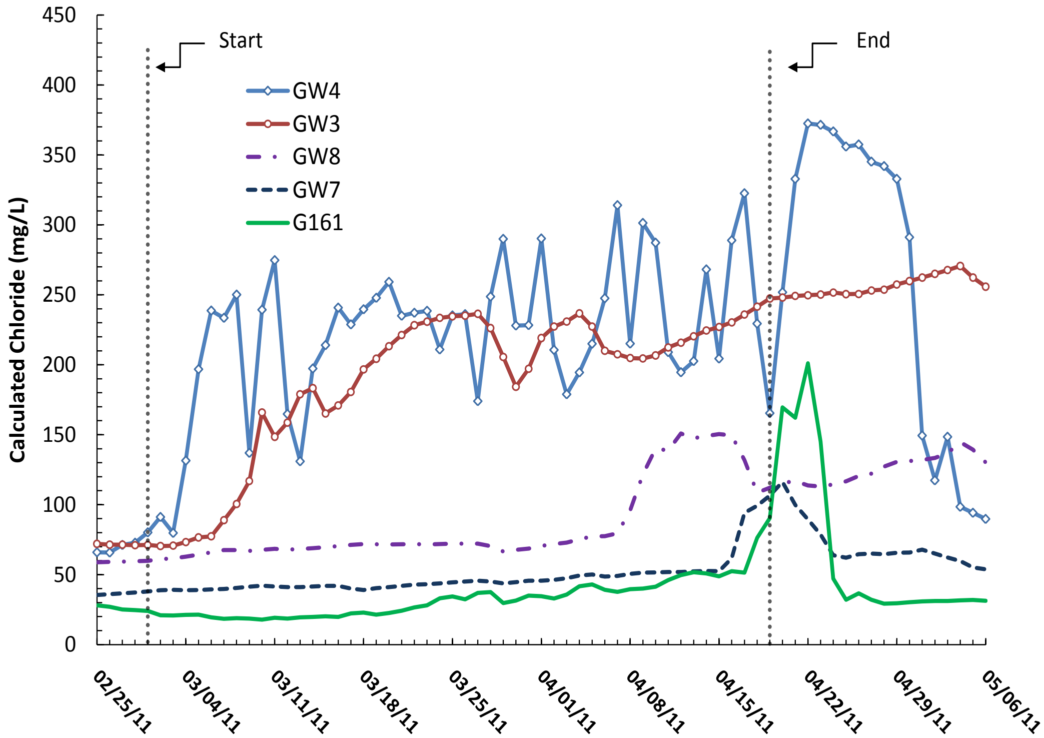

Figure 5. Calculated chloride concentrations observed before, during and after the L-8 Reservoir Pilot Test within Grassy Waters Preserve (GW3, GW4, GW7, GW8 and the G-161 structure) and Lake Mangonia/Clear Lake (LM1) monitoring stations. Dashed vertical grey lines denote the start and end of the pilot test.

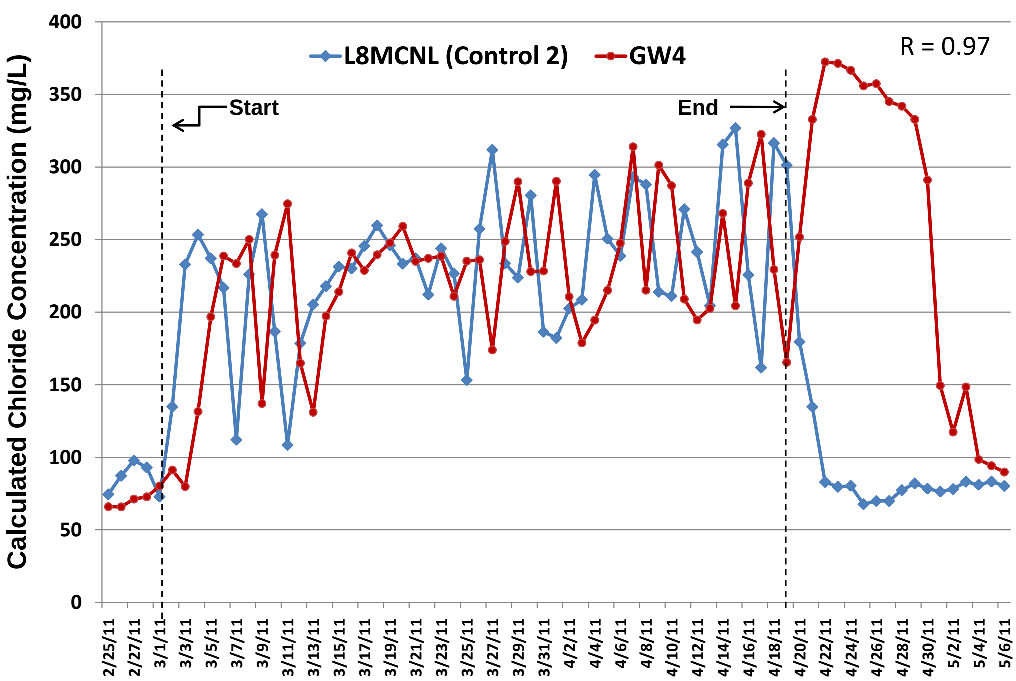

Figure 6. Chloride lag time response between GW 4 and the Control 2 pump station from 2/25/11 to 5/6/11. Lag time response is about 2 days (R=0.97). Dashed vertical grey lines denote the start and end of the pilot test.

In contrast, the GW3 station is located in a small slough immediately north of the M-Canal. Chloride concentrations at this station averaged 71 mg/L prior the test and steadily increased during the test reaching 247 mg/L on 4/19, the last day of the test. Unlike GW4, this station did not display a response that could be attributed to Control 2's pumping schedule. Instead, chloride concentrations at this station showed a gradual increase in chloride levels beginning about one week after the pilot test was initiated. Chloride concentrations at GW3 continued to increase at a steady rate beyond the conclusion of the test reaching a maximum daily mean of 271 mg/L on 5/4/11 (**Figure 5).**

The GW8 station is located within the interior of Grassy Waters Preserve and is thought to represent water quality conditions characteristic of a rainfall-driven system. Background chloride concentrations at GW8 averaged about 59 mg/L prior to the test. The maximum chloride concentration observed at GW8 was 151 mg/L on 4/15/11. GW8 was much slower to respond than either GW4 or GW3 with no observed increase in chloride concentration until about 10 days prior to termination of the test on 4/19/11 (**Figure 5).**

The lowest chloride concentrations observed within Grassy Waters preserve during the pilot test occurred at GW7 and the G-161 structure. Prior to the test, chloride levels averaged 36 and 26 mg/L respectively at GW7 and G-161. These values increased very gradually until near the end of the test period (**Figure 5**). The highest chloride concentrations recorded at GW7 and G-161 occurred after completion of the pilot test with concentrations of 116 mg/L (GW7 on 4/20/11) and 201 mg/L (G-161 structure on 4/21/11).

From an operations standpoint, closure of the City of West Palm Beach's Control 4 structure on 4/16/11 played an important role in increasing chloride concentrations at GW7 and the G-161 sampling locations during the test. Flow measurements performed on 4/17/11 confirmed that more than half the M-Canal inflow water delivered to Grassy Waters Preserve was diverted north either through the marsh or along the eastern perimeter canal when the Control 4 structure was closed. As a result of this closure, some water with elevated chloride concentrations made its way to GW7 and the G-161 structure (**Figure 5**) as flows routed through Grassy Waters Preserve's eastern perimeter canal or as sheet flow through the interior of Grassy Waters Preserve. Re-opening the Control 4 structure on 4/19/11 coupled with the closure of G-161 on 4/22/11 resulted in the redirection of elevated chloride water away from GW7 and G-161 and into the eastern perimeter canal.

A specific condition of the permit exemption was that if chloride concentrations at the Lake Mangonia/Clear Lake station (LM1) exceeded 250 mg/L, the pilot test would have to be terminated. Results presented in **Figure 7** show that chloride concentrations at the LM1 station never exceeded 135 mg/L, well below the 250 mg/L limit. The highest chloride concentration recorded at the LM1 site was 134 mg/L which occurred 16 days after the pilot test was completed (**Figure 7**).

An additional water quality sampling station was added to the study after the pilot test was completed to monitor the residual effects of the pilot test at the City of West Palm Beach's Control Structure 4 (CS4). This structure is located about 3.9 miles upstream from the LM1 station. **Figure 2** shows the location of this station, while **Figure 7** provides the chloride monitoring results.

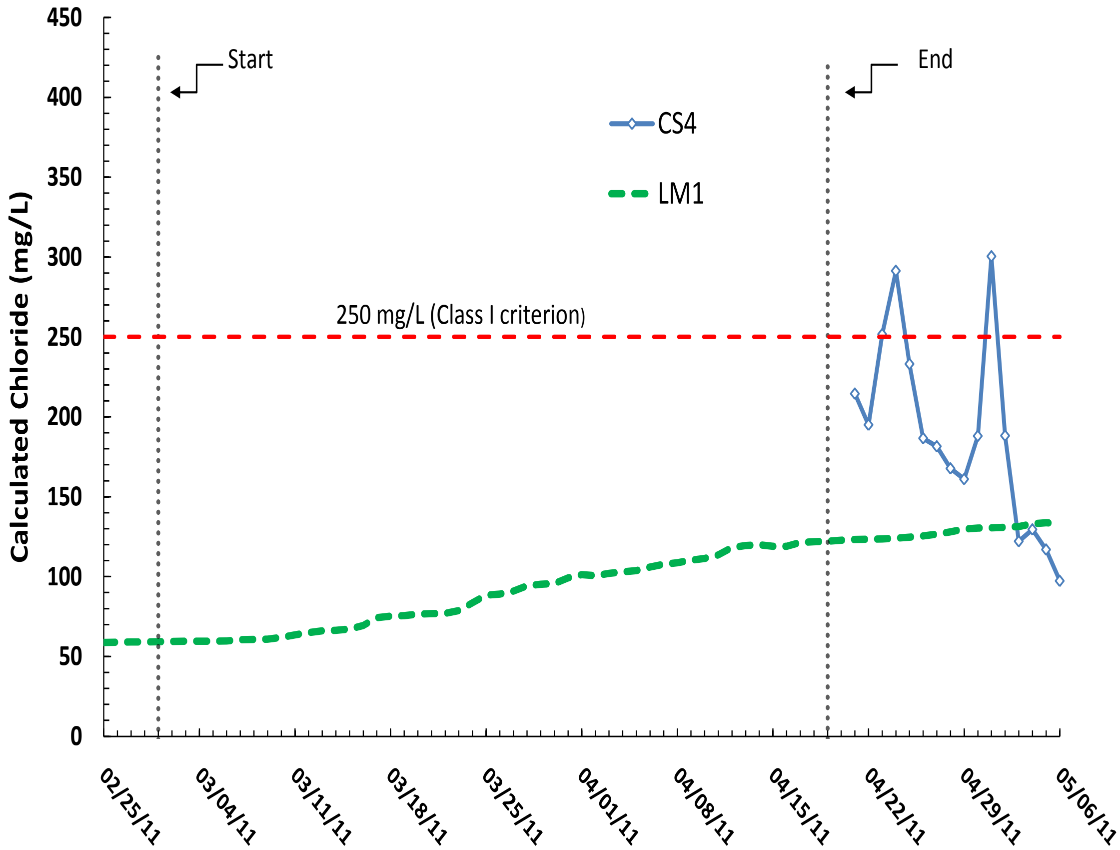

Figure 7. Calculated chloride concentrations during the L-8 Reservoir Pilot Test at the City of West Palm Beach's Control 4 structure (CS4) and at the Lake Mangonia/Clear Lake monitoring site (LM 1).

Total Phosphorus

Water quality sampling began on 2/25/11; four days prior to the start of the pilot test at all 11 monitoring stations (**Figure 3**) with grab samples collected weekly. Total Phosphorus (TP) data collected during the pilot test were consistent with results reported by the District for the past several years for the L-8 Reservoir and surrounding canals (SFER 2010). As shown in **Figure 8**, TP concentrations within the L-8 Reservoir were comparatively low with concentrations during the test ranging from 14 to 29 micrograms per liter (μg/L) with a mean concentration of 18 μg/L. The routine mixing zone stations (L8MZBN and L8MZBS) located 800 meters north and south of the L-8 Reservoir discharge point also showed the dilution effect that the L-8 Reservoir has on TP levels within the L-8 Canal (**Figure 8**).

In contrast, the L8-04.3 station located north of the L-8 Tieback Canal which receives inflows from Lake Okeechobee via Culvert C10A, recorded an average TP concentration of 95 μg/L, the highest concentration of all stations sampled during the pilot test. This is a reflection of the high concentrations of TP that have historically been documented in Lake Okeechobee waters (FDEP 2001, SFWMD 2002, SFWMD/FDEP/FDACS, 2011).

Prior to the initiation of the pilot test, TP values at the Control 2 pump station (L8MCNL) were typical of Lake Okeechobee water (mean = 98 µg/L) as the water flowing through this structure was derived from the L-8 Canal. However during the pilot test, TP values at the Control 2 pump station showed a marked reduction with values ranging between 54 and 82 µg/L and mean of 61 µg/L over the 50-day test period (**Figure 8**). Again, another example of the dilution effect of L-8 Reservoir water on L-8 Canal water whose sources are typically higher in TP.

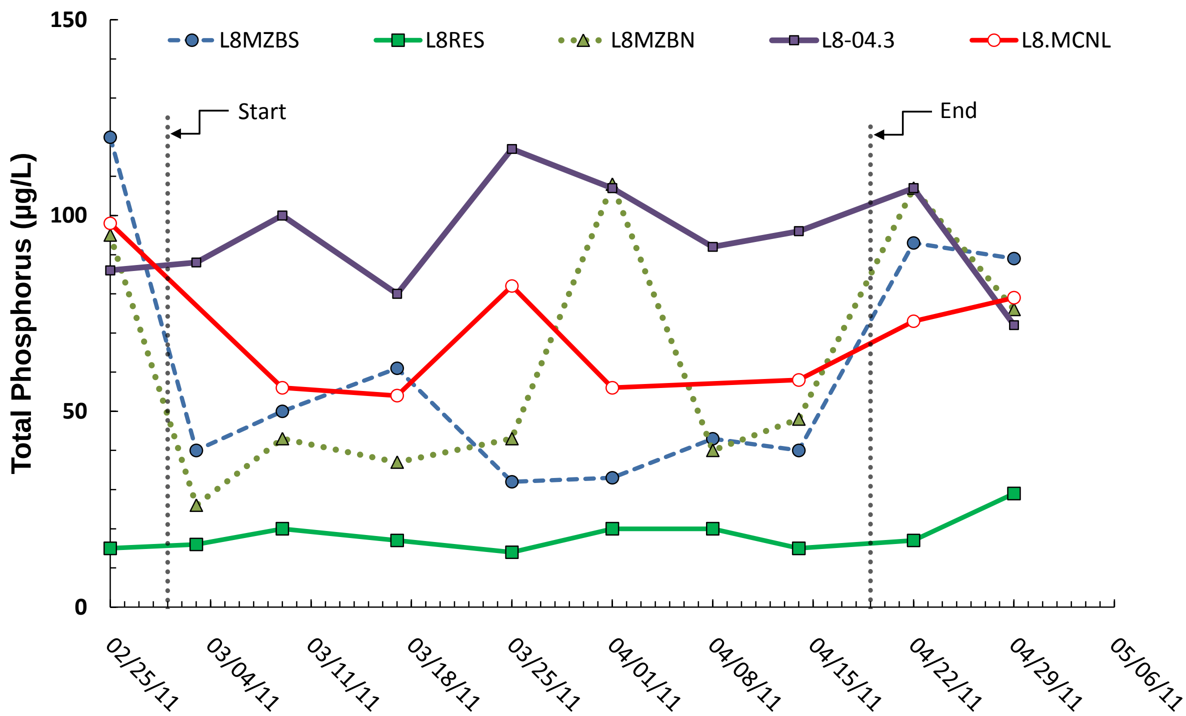

Figure 8. Total Phosphorus concentrations observed before, during and after the L-8 Reservoir Pilot Test (includes L-8 Reservoir (L8RES), L-8 Canal mixing zone (L8MZBN. L8MZBS) Control 2 pump station (L8MCNL) and within the L-8 canal located north of the L-8 Canal Tieback levee (L804.3)

The TP results from Grassy Waters Preserve interior marsh water quality monitoring stations (GW3, GW7, GW8, and the G-161 structure) were much lower than those recorded within the L-8 Canal or at the Control 2 pump station, with the lowest mean concentration of 6 µg/L recorded at GW7 and GW8 (**Figure 9** and **Table 3, Appendix A**). The dilution effect that L-8 Reservoir water has on Grassy Waters Preserve was most noticeable at GW4 (**Figure 9**).

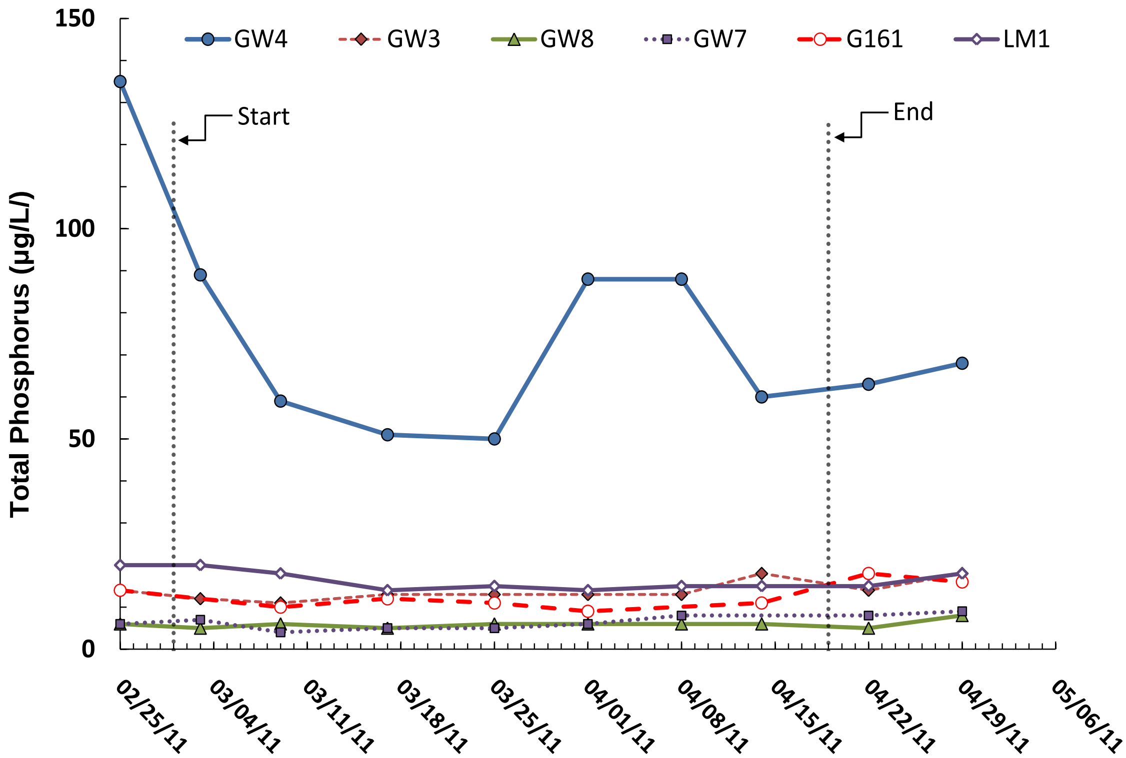

Figure 9. Total Phosphorus concentrations observed before, during and after the L-8 Reservoir Pilot Test within Grassy Waters Preserve (GW3, GW4, GW7, GW8, and G-161) and Lake Mangonia/Clear Lake monitoring site (LM 1)

6. Summary

1. The pilot test was a collaborative effort between multiple agencies (District, City of West Palm Beach, Palm Beach County and Loxahatchee River District) working together to develop an operational plan for delivering water to the NW Fork of Loxahatchee River during the 2011 dry season.
2. The FDEP granted the District an Exemption (0188365) to conduct a dry season operational pilot test to deliver water from the L-8 Reservoir to the NW Fork of the Loxahatchee River. The 30-day period (consecutive or non-consecutive days) pilot test began on 3/1/11. An additional 30 consecutive or non-consecutive days to continue the pilot test was granted to the District based on preliminary water quality data submitted to FDEP on 4/1/11.
3. The pilot test was terminated on 4/19/11 leaving a balance of 12 (consecutive or non-consecutive) days that could be used to move water from the Reservoir to the NW Fork of the Loxahatchee River. If sufficient dilution water becomes available during the wet season, the remaining balance of days may be utilized. This report is being submitted under the assumption that no additional pumping will be done. However, if pumping resumes as authorized in the exemption, additional water quality monitoring data will be collected and this report will be supplemented and re-submitted to FDEP.

4. The permit exemption mixing zone requirements dictated that chloride concentrations at the Lake Mangonia/Clear Lake station (LM1) shall not exceed 250 mg/L to ensure protection of the City's public water supply. This limit was never exceeded with highest chloride concentrations recorded at LM1 being less than 135 mg/L.

5. The test utilized the existing pump located at the L-8 Reservoir to pump water into the L-8 Canal where it was mixed with inflows from Lake Okeechobee delivered through Culvert C10A. This mixed water was pumped eastward through the City of West Palm Beach's Control 2 pump station and the M-Canal traversing 9.4 miles into the Grassy Waters Preserve and then routed northward to the NW Fork of the Loxahatchee River.

6. Specific conductance data (converted to chloride concentrations) and total phosphorus samples were collected from 11 water quality monitoring stations located within the L-8 Reservoir, L-8 canal, M-Canal, Grassy Waters Preserve and Lake Mangonia/Clear Lake before, during and after the pilot test.

7. During the pilot test, the highest chloride concentrations were recorded within the L-8 Reservoir with a mean concentration of 354 mg/l, peaking at 373 mg/L on 4/14/11. In contrast, water sampled at the L8-04.3 station, which represents inflows from Lake Okeechobee averaged about 70 mg/L during the first four weeks of the test. This water represents an important source of dilution water for the L-8 Reservoir.

8. Chloride values calculated for the Control 2 pump station show the dilution effect that Lake Okeechobee water had on L-8 Reservoir water. Specifically, chloride levels at the Control 2 pump station were highly dynamic (values ranged from between 73 and 327 mg/L) during the pilot test in response to pumping operations.

9. Within Grassy Waters Preserve, water quality at the GW4 showed a direct response to Control 2 pumping operations, due to its location on the M-Canal 9.4 miles downstream from Control 2. Chloride levels calculated at GW4 were highly correlated ($R= 0.97$) with those recorded at the Control 2 pump station when the observed two-day time lag was accounted for at GW4. Chloride levels increased 3 fold at the GW4 station with chloride levels ranging between 80 and 323 mg/L during the pilot test.

10. Based on stream gauging measurements, a two-day travel time was calculated as the time it takes water pumped from Control 2 to travel 9.4 miles downstream to the GW4 site. This two day time lag was observable in the chloride concentration dynamics observed at GW4 two days following termination of the pilot test.

11. The GW3 station did not display a chloride concentration dynamic that could be attributed to a direct response to operation of the Control 2 pump station. Instead this station showed a gradual increase in chloride levels during and after the pilot test reaching a maximum value of 271 mg/L.

12. Water quality conditions at the GW8 station located within the interior of Grassy Waters Preserve generally represents interior marsh water quality conditions. GW8 was much slower to respond to pumping from Control 2 with no observed increase in chloride levels until about 10 days prior to termination of the test on 4/19/11.

13. Lowest chloride levels observed during the pilot test study occurred at GW7 and the G-161 structure. Prior to the pilot test, chloride levels averaged 36 and 26 mg/L respectively at these two stations reaching concentrations of 116 mg/L and 201 mg/L several days

after the pump test was completed. Operationally, closure of the City of West Palm Beach's Control 4 structure on 4/16/11 may explain the observed increase in chloride levels at GW7 and the G-161 structure during and after the pilot test.

14. A specific condition of the permit exemption stated that if chloride concentrations at the Lake Mangonia/Clear Lake (LM1) station exceeds 250 mg/L, the pilot test would be terminated. Results presented in this report illustrate that chloride concentrations at LM1 never exceeded 135 mg/L during the test, well below the 250 mg/L limit.
15. Water quality monitoring results indicated that TP concentrations were comparatively low within the L-8 Reservoir as compared to the L8-04.3 station, which reflects historically high TP laden waters delivered from Lake Okeechobee through Culvert C10A.
16. TP values recorded at the Control 2 pump station and within the L-8 Canal mixing zone exhibited the dilution effect that discharges from the L-8 Reservoir had on TP concentrations within the L-8 Canal.
17. TP values recorded within Grassy Waters Preserve and Lake Mangonia/Clear Lake were much lower than those recorded in the L-8 Canal. Lowest TP values recorded during the pilot test occurred at the GW8 and GW 7 with a mean TP concentration of 6 μg/L.

References:

FDEP, 2001. Total Maximum Daily Load for Total Phosphorus Lake Okeechobee, Florida. Report prepared by the Florida Department of Environmental Protection and submitted to the U.S. Environmental Protection Agency, Region IV, Atlanta, Ga. August 2001.

South Florida Environmental Report (SFER) 2010. Appendix 7A-4. L-8 Reservoir Project: Annual Water Quality Assessment Report for Water Year 2009, South Florida South Florida Water Management District, West Palm Beach, FL.

SFWMD 2002. Surface Water Improvement and Management Plan for Lake Okeechobee. South Florida Water Management District, West Palm Beach, FL.

SFWMD, FDEP and FDACS. 2011. Lake Okeechobee Protection Program Update 2011, Lake Okeechobee Protection Plan Evaluation Report, South Florida Water Management District, West Palm Beach, FL.

Appendix A

Table 1. Project WQM Surface Water Monitoring Sites and GPS Coordinates

Station	Latitude	Longitude	Description
L8RES	26.7276	80.3651	Located at the L-8 Reservoir pump (SW6OUT)
L8MZBN	26.7346	80.3631	L-8 Reservoir mixing zone B north
L8MZBS	26.7204	80.3635	L-8 Reservoir mixing zone B south
L8 0.43	26.7480	80.3689	Located in the L-8 Canal ~1000 m upstream of the M-Canal tieback
L8 M.CNL	26.7553	80.3456	City of WPB Control pump station #2 located on M-Canal
GW3	26.7646	80.1759	Grassy Waters Preserve interior site
GW4	26.7657	80.1978	City of WPB Control Structure 3 located on M-Canal; Gated Weir
GW7	26.7634	80.1493	Grassy Waters Preserve interior site
GW8	26.7748	80.1700	Grassy Waters Preserve interior site
CS4*	26.7510	80.1186	City of WPB Control Structure 4 located on M-Canal; Gated Weir located at Haverhill Road
G161	26.8101	80.1565	Gated Culvert located at Northlake Blvd
LM1	26.7279	80.0774	Located between Lake Mangonia and Clear Lake ~300 m north of Palm Beach Lakes Blvd

The standard positional goal for site coordinates is ±1 meter as obtained with a professional grade DGPS system. The coordinates are relative to NAD83 HARN horizontal datum and reported in decimal degrees.

**Added on Day 56 of pilot test*

Table 2. Project WQM Sampling Parameters and Frequencies

Station	Sample Type	Frequency	Parameters
L8RES	Grab/In-situ	Weekly/15 min	TP04/Specific Conductance
L8MZBN	Grab/In-situ	Weekly/15 min	TP04/Specific Conductance
L8MZBS	Grab/In-situ	Weekly/15 min	TP04/Specific Conductance
L8 0.43	Grab/In-situ	Weekly/60 min	TP04/Specific Conductance
L8 M.CNL	Grab/In-situ	Weekly/60 min	TP04/Specific Conductance
GW3	Grab/In-situ	Weekly/60 min	TP04/Specific Conductance
GW4	Grab/In-situ	Weekly/60 min	TP04/Specific Conductance
GW7	Grab/In-situ	Weekly/60 min	TP04/Specific Conductance
GW8	Grab/In-situ	Weekly/60 min	TP04/Specific Conductance
CS4	Grab/In-situ	Weekly/60 min	TP04/Specific Conductance
G161	Grab/In-situ	Weekly/60 min	TP04/Specific Conductance
LM1	Grab/In-situ	Weekly/60 min	TP04/Specific Conductance

Table 3. Total Phosphorus concentrations at 11 sites located within the L-8 Reservoir, L-8 Canal. M-Canal, Grassy Waters Preserve and Lake Mangonia/Clear Lake (micrograms per liter)

Date	L8RES	L8MZBS	L8MZBN	L8-04.3	L8MCNL	GW4	GW3	GW8	GW7	G-161	LM1
02/25/11	15	120	95	86	98	135	14	6	6	14	20
03/03/11	16	40	26	88	---	89	12	5	7	---	20
03/09/11	20	50	43	100	56	59	11	6	4	10	18
03/17/11	17	61	37	80	54	51	13	5	5	12	14
03/25/11	14	32	43	117	82	50	13	6	5	11	15
04/01/11	20	33	108	107	56	88	13	6	6	9	14
04/08/11	20	43	40	92	---	88	13	6	8	---	15
04/14/11	15	40	48	96	58	60	18	6	---	11	15
04/22/11	17	93	107	107	73	63	14	5	8	18	15
04/29/11	29	89	76	72	79	68	18	8	9	16	18
Average	*17*	*43*	*49*	*97*	*61*	*69*	*13*	*6*	*6*	*11*	*16*
Minimum	*14*	*32*	*26*	*72*	*54*	*50*	*11*	*5*	*4*	*9*	*14*
Maximum	*29*	*120*	*108*	*117*	*98*	*135*	*18*	*8*	*9*	*18*	*20*

Appendix A (Continued)

Table 4. Calculated Chloride Concentrations within the L-8 Reservoir, L-8 Canal and M-Canal for the L-8 Reservoir Pilot Test

Calculated Chloride Concentrations (mg/L)					
Date	**L8MZBS**	**L8RES**	**L8MZBN**	**L8043**	**L8MCNL**
02/25/2011	157.7	274.5	125.0	66.9	74.5
02/26/2011	164.1	281.4	150.7	65.8	87.3
02/27/2011	156.8	289.0	158.6	65.9	97.8
02/28/2011	165.9	292.2	152.7	81.1	93.0
03/01/2011	174.5	295.7	85.8	65.3	72.9
03/02/2011	221.9	307.9	336.5	65.2	134.9
03/03/2011	213.4	321.9	350.3	67.6	232.9
03/04/2011	247.8	330.7	351.4	75.0	253.4
03/05/2011	272.4	350.4	350.3	69.3	237.1
03/06/2011	288.4	348.6	346.5	68.9	216.8
03/07/2011	300.2	348.8	261.4	65.3	112.1
03/08/2011	304.4	353.2	173.7	67.5	226.1
03/09/2011	312.3	345.0	137.2	74.1	267.5
03/10/2011	295.1	348.8	136.1	69.5	186.7
03/11/2011	285.3	347.1	183.1	64.7	108.5
03/12/2011	304.7	354.0	194.9	65.0	178.6
03/13/2011	305.9	363.1	163.3	67.0	205.3
03/14/2011	325.8	360.4	274.6	68.6	217.9
03/15/2011	336.7	352.5	349.1	67.9	231.4
03/16/2011	288.0	353.5	343.1	67.5	230.1
03/17/2011	224.1	357.1	329.1	68.9	245.6
03/18/2011	148.4	359.7	316.4	70.7	259.8
03/19/2011	52.8	366.7	291.6	71.4	246.1
03/20/2011	46.8	365.3	279.3	71.6	233.4
03/21/2011	110.2	334.4	263.9	74.8	237.1
03/22/2011	123.7	362.1	285.9	74.0	212.1
03/23/2011	118.0	359.1	300.7	73.1	244.0
03/24/2011	185.7	355.5	331.7	72.0	226.6
03/25/2011	368.8	353.3	356.3	68.7	153.2
03/26/2011	373.4	356.9	361.6	70.5	257.4
03/27/2011	358.4	358.4	361.3	73.1	311.9
03/28/2011	355.6	354.9	358.2	70.6	233.6
03/29/2011	371.2	357.6	358.9	68.1	223.8
03/30/2011	294.4	358.7	343.2	89.5	280.5
03/31/2011	355.6	356.5	352.5	68.2	186.4
04/01/2011	337.3	352.6	254.4	65.7	182.2

Calculated Chloride Concentrations (mg/L)					
Date	**L8MZBS**	**L8RES**	**L8MZBN**	**L8043**	**L8MCNL**
04/02/2011	340.3	356.5	346.5	65.8	202.5
04/03/2011	358.8	358.4	356.5	75.1	208.6
04/04/2011	352.6	355.0	355.4	125.6	294.6
04/05/2011	361.5	351.1	354.6	151.8	250.6
04/06/2011	364.5	353.4	362.7	150.0	238.8
04/07/2011	349.3	351.7	360.9	121.7	293.1
04/08/2011	330.7	353.0	360.0	108.1	288.0
04/09/2011	340.3	360.8	352.7	101.6	214.0
04/10/2011	348.0	370.0	359.1	148.8	211.1
04/11/2011	350.9	366.5	362.4	122.2	270.9
04/12/2011	370.8	366.4	356.0	101.6	241.5
04/13/2011	377.5	363.8	345.6	70.5	204.5
04/14/2011	382.5	373.1	372.5	74.5	315.5
04/15/2011	370.5	365.7	375.8	77.8	326.9
04/16/2011	377.4	357.8	370.0	64.0	225.7
04/17/2011	378.9	357.7	365.1	43.6	161.8
04/18/2011	378.6	368.6	365.4	105.5	316.5
04/19/2011	149.8	361.6	231.6	160.6	301.3
04/20/2011	89.3	362.7	87.9	163.7	179.6
04/21/2011	85.4	372.2	96.9	102.2	134.8
04/22/2011	77.7	373.7	92.7	80.3	83.0
04/23/2011	79.7	---	83.6	69.8	79.7
04/24/2011	73.4	---	75.1	64.4	80.4
04/25/2011	71.8	366.9	75.1	62.1	67.7
04/26/2011	71.7	366.2	74.5	62.3	69.9
04/27/2011	71.1	365.3	75.8	79.1	69.9
04/28/2011	71.4	365.1	77.0	127.1	77.4
04/29/2011	72.3	365.3	80.6	140.9	82.0
04/30/2011	74.5	368.2	79.7	74.5	78.4
05/01/2011	73.3	365.0	78.7	75.3	76.4
05/02/2011	73.1	364.4	78.5	78.1	78.1
05/03/2011	73.9	363.1	79.4	82.6	83.2
05/04/2011	71.5	364.3	77.7	90.0	81.1
05/05/2011	71.4	362.8	74.3	96.9	83.3
05/06/2011	72.6	362.7	73.3	101.7	80.3

Appendix A (Continued)

Table 5. Calculated Chloride Concentrations within Grassy Waters Preserve and Lake Mangonia/Clear Lake during the L-8 Reservoir Pilot Test

Calculated Chloride Concentrations (mg/L)							
Date	GW4	GW3	GW8	GW7	G-161	CS4	LM1
02/25/2011	66.0	72.0	58.8	35.4	28.0	---	58.8
02/26/2011	65.8	71.4	59.1	36.0	27.0	---	58.9
02/27/2011	71.2	71.4	59.3	36.6	25.1	---	59.1
02/28/2011	72.8	71.0	59.6	37.2	24.6	---	59.1
03/01/2011	80.2	71.2	59.9	37.9	24.1	---	59.2
03/02/2011	91.2	70.4	61.0	38.9	21.0	---	59.4
03/03/2011	79.8	70.7	61.7	39.1	20.8	---	59.5
03/04/2011	131.5	73.3	62.8	38.8	21.3	---	59.5
03/05/2011	196.8	76.6	64.3	39.0	21.4	---	59.5
03/06/2011	238.7	77.4	65.9	39.4	19.5	---	59.8
03/07/2011	233.5	88.9	67.6	39.8	18.4	---	60.5
03/08/2011	250.1	100.5	67.6	40.5	18.8	---	60.7
03/09/2011	137.0	116.9	66.9	41.4	18.6	---	60.8
03/10/2011	239.3	165.9	67.7	42.1	17.8	---	62.0
03/11/2011	274.7	148.5	68.4	41.5	19.1	---	63.5
03/12/2011	164.8	158.7	67.9	41.0	18.6	---	64.9
03/13/2011	131.0	178.9	68.3	41.0	19.4	---	66.0
03/14/2011	197.3	183.3	68.9	41.5	19.8	---	66.3
03/15/2011	214.0	165.2	69.6	41.9	20.2	---	67.1
03/16/2011	240.8	170.9	70.4	42.0	19.8	---	69.4
03/17/2011	228.8	180.6	71.3	40.1	22.3	---	74.3
03/18/2011	239.6	196.7	71.8	39.0	22.9	---	75.2
03/19/2011	247.8	204.3	71.7	40.3	21.4	---	75.5
03/20/2011	259.2	213.3	71.5	41.1	22.5	---	76.5
03/21/2011	235.0	221.3	71.7	42.0	24.2	---	76.8
03/22/2011	237.1	228.3	71.8	42.9	26.5	---	77.0
03/23/2011	238.5	230.8	71.5	43.2	28.0	---	78.8
03/24/2011	210.9	233.5	71.9	43.8	33.1	---	83.6
03/25/2011	235.2	234.6	72.2	44.5	34.4	---	88.4
03/26/2011	236.1	235.1	72.2	45.1	32.4	---	89.1
03/27/2011	174.0	236.4	72.1	45.6	36.9	---	90.9
03/28/2011	248.7	226.2	70.4	45.1	37.5	---	94.2
03/29/2011	289.9	205.6	66.6	43.7	29.7	---	95.2
03/30/2011	228.0	184.3	67.7	44.6	31.4	---	95.7
03/31/2011	228.3	197.1	68.6	45.6	35.0	---	99.1
04/01/2011	290.2	219.1	70.5	45.6	34.5	---	101.2

Calculated Chloride Concentrations (mg/L)							
Date	GW4	GW3	GW8	GW7	G-161	CS4	LM1
04/02/2011	210.6	227.3	71.9	46.2	32.9	---	100.6
04/03/2011	178.9	230.9	72.9	47.5	35.7	---	102.0
04/04/2011	194.5	236.7	75.3	49.4	41.6	---	103.0
04/05/2011	215.0	227.3	77.3	50.1	43.0	---	103.8
04/06/2011	247.5	210.0	77.5	48.6	39.1	---	106.0
04/07/2011	314.0	207.5	79.6	49.1	37.6	---	107.7
04/08/2011	215.1	204.8	95.8	50.6	39.6	---	108.6
04/09/2011	301.3	204.5	121.8	51.4	40.1	---	110.3
04/10/2011	287.2	206.7	140.1	51.6	41.4	---	111.4
04/11/2011	209.0	212.4	138.8	51.9	46.1	---	113.6
04/12/2011	194.6	215.8	150.9	51.9	49.6	---	118.2
04/13/2011	202.6	220.4	147.5	52.3	51.8	---	119.5
04/14/2011	268.1	224.5	149.1	52.6	50.8	---	119.9
04/15/2011	204.4	227.0	150.5	52.4	48.8	---	119.0
04/16/2011	288.9	230.3	149.6	61.7	52.5	---	118.9
04/17/2011	322.5	235.9	131.8	94.2	51.5	---	121.3
04/18/2011	229.4	241.5	108.5	99.3	76.3	---	121.9
04/19/2011	165.4	247.4	112.1	106.5	90.3	---	122.1
04/20/2011	251.8	248.0	115.5	116.3	169.6	---	122.7
04/21/2011	332.8	249.2	116.8	99.8	162.2	214.5	123.2
04/22/2011	372.4	249.7	113.7	89.5	201.1	195.0	123.4
04/23/2011	371.4	250.2	113.0	78.7	145.1	251.7	123.6
04/24/2011	366.7	251.6	114.5	63.8	47.2	291.4	124.1
04/25/2011	355.9	250.5	116.7	62.1	32.1	233.1	124.6
04/26/2011	357.4	250.6	120.6	64.6	36.7	186.6	125.5
04/27/2011	345.1	253.1	122.1	65.1	32.1	181.5	126.5
04/28/2011	341.9	253.7	127.2	64.6	29.3	167.7	128.0
04/29/2011	332.8	257.4	130.6	65.7	29.6	161.0	129.7
04/30/2011	291.1	259.8	131.2	65.8	30.2	188.0	130.3
05/01/2011	149.4	262.3	132.0	67.9	30.8	300.5	130.6
05/02/2011	117.4	265.0	133.4	65.0	31.2	188.2	130.8
05/03/2011	148.5	267.7	136.8	62.2	31.1	122.1	131.4
05/04/2011	98.5	270.6	144.6	59.7	31.6	129.5	133.1
05/05/2011	94.2	262.3	139.3	55.2	31.9	116.9	133.7
05/06/2011	89.8	255.8	130.1	53.8	31.3	97.3	133.3

APPENDIX B

In 2007, the South Florida Water Management District (SFWMD), working with the Florida Department of Environmental Protection (FDEP), derived a relationship between specific conductance and chloride for the L-8 Reservoir. The purpose of the equation was to estimate chloride levels in waters discharging from the reservoir into the L-8 canal and to monitor changes in chloride levels in the established mixing zone in the canal. The original data used to derive the relationship was collected at stations located in the L-8 canal and in the reservoir over 12 months. A total of 1,118 data pairs from 9 monitoring locations were used in the derivation. This relationship for these two parameters fits a 1st order polynomial regression and is summarized in **Figure B-1** below. The equation was adopted by the FDEP in the L-8 Reservoir Permit in August 2007 through a permit modification.

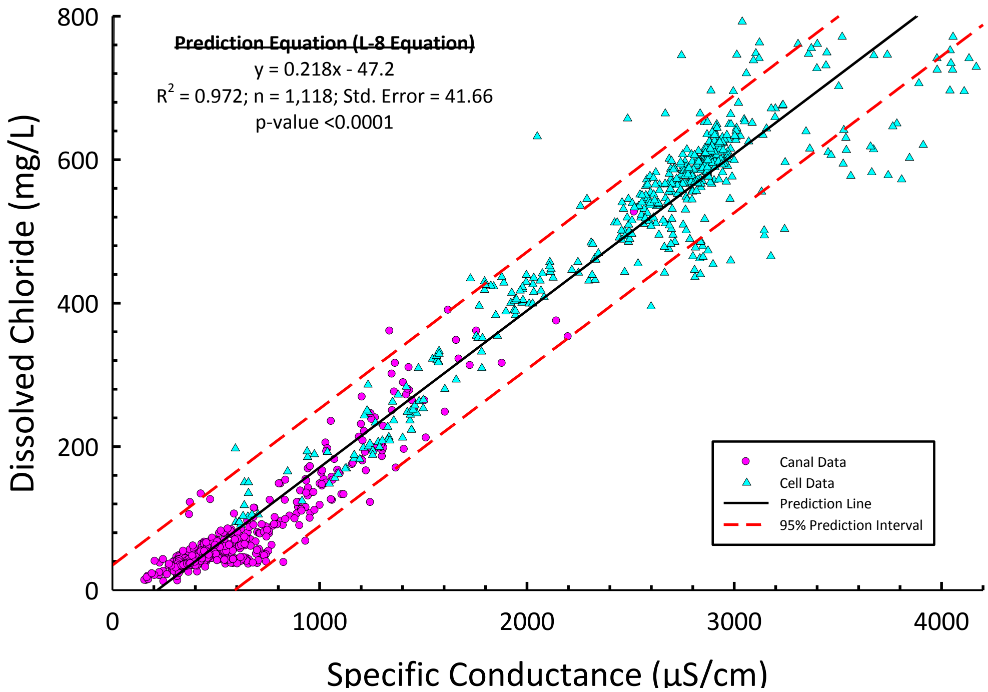

Figure B-1. Relationship between measured chloride and specific conductance data (**L-8 Equation**) collected at 121 reservoir stations and 997 canal stations (n = 1,118). The data were collected weekly for the period from October 2005 to September 2006.

Although the original relationship between chloride and specific conductance (L-8 Equation) was acceptable for discharges from the reservoir with when specific conductance levels ranged between 400 and 4000 microSiemens per centimeter (µS/cm), it poorly predicted chlorides when specific conductance was less than 400 µS/cm.

An L-8 Reservoir pilot test was conducted between March 2011 and April 2011 to better understand the effects of L-8 Reservoir discharges on the NW Fork of the Loxahatchee River during dry conditions as defined in the Loxahatchee Watershed Restoration Project (a.k.a. CERP

North Palm Beach County Part I). During the pilot test, continuous specific conductance measurements were collected at 11 monitoring locations at 15-minute to 60-minute intervals. An additional water quality sampling station was implemented after the pilot test was completed to monitor the chloride residual effects at Control Structure 4 (CS4) as shown in Figure 8.

At six of the 12 monitoring locations, background specific conductance levels were less than 400 µS/cm. As a result, the L-8 Equation was found to be unsuitable to predict chloride levels at these low specific conductance levels. Therefore, a new relationship between chloride and specific conductance that would include data below the 400 µS/cm was derived.

The new derivation produced a 2nd order polynomial regression and was limited to specific conductance levels of 3000 µS/cm or less. The data used in the new relationship was taken from the L-8 Equation derivation with additional data retrieved from DBHYDRO. The total number of data pairs used in the new derivation was 12,742. This new relationship (QUAD2) between chloride and specific conductance is summarized in **Figure B-2.**

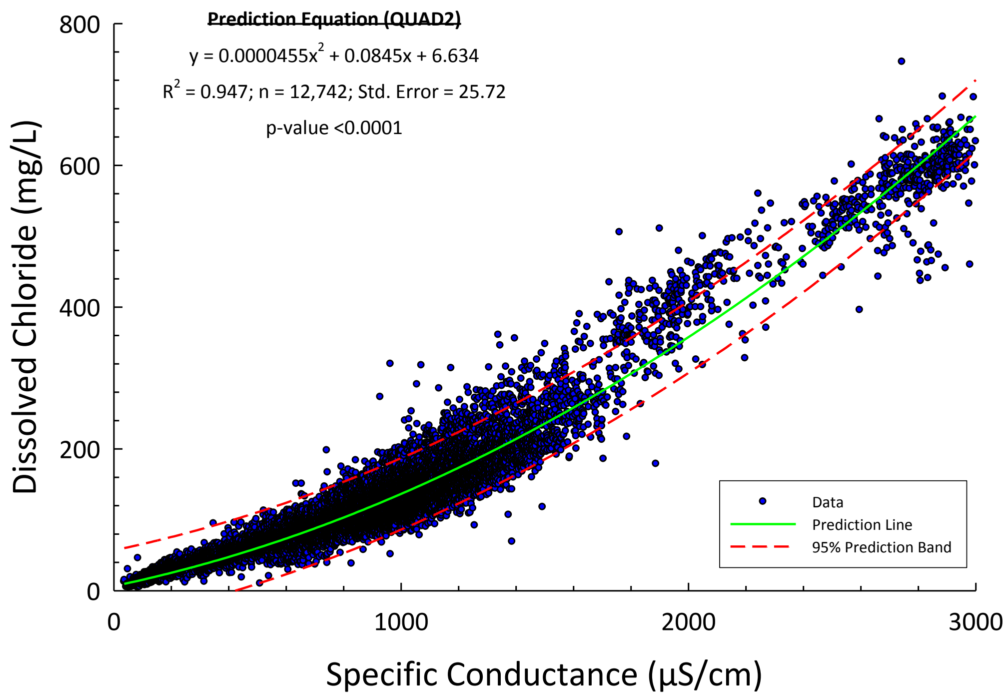

Figure B-2. New relationship between chloride and specific conductance (**QUAD2**). The 2nd order polynomial regression was derived from 12,742 data pairs that included data from the L-8 Reservoir.

Data screening was performed to remove obvious data outliers (e.g., when chloride levels were greater than 200 mg/L and specific conductance was less than or equal to 100 µS/cm or when chloride levels are less than 20 mg/L with specific conductance greater than 1000 µS/cm).

After the QUAD2 equation was derived, a validation data set containing paired chloride and specific conductance values was assembled. The L-8 Equation and the QUAD2 equation were used to predict chloride values from measured specific conductance values. These predicted values were compared with corresponding measured values. Figures B-3 summarizes these comparisons.

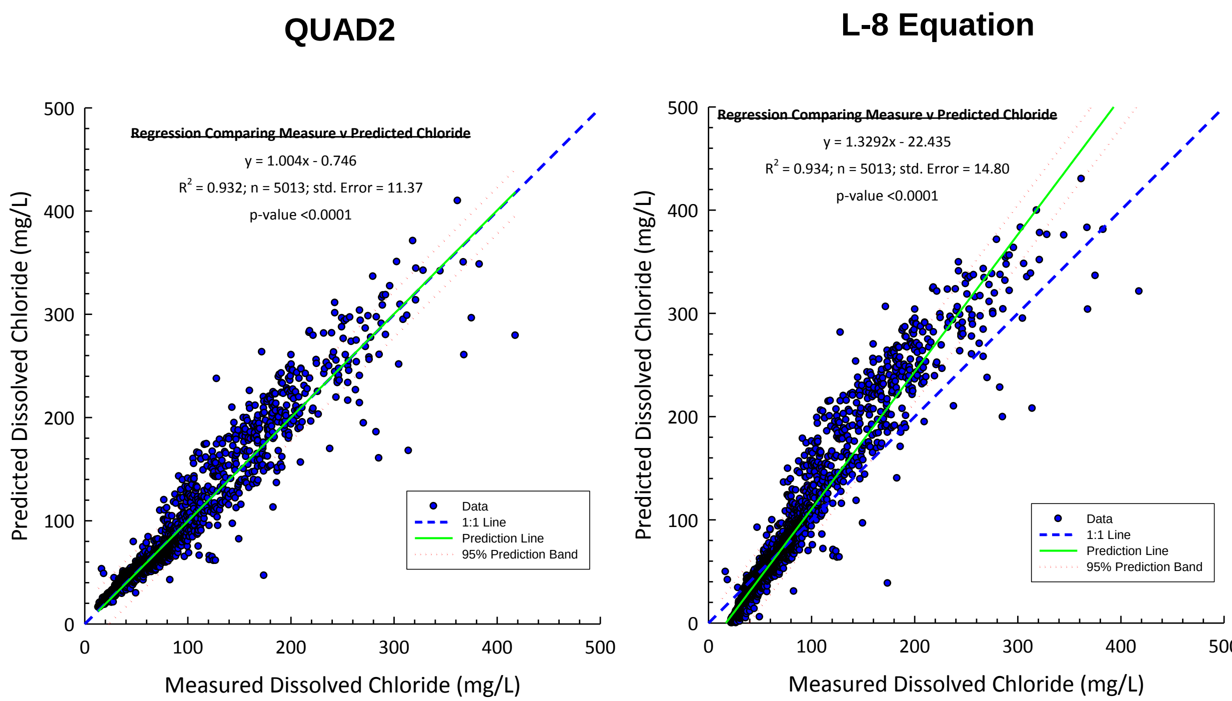

Figure B-3. Comparison of predicted chloride values (using the **QUAD2** and **L-8 Equation**) to the measured chloride values at the corresponding specific conductance used to predict chloride.

When predicted values are equivalent the measure chloride values, the data points (when plotted) should be aligned along a theoretical 1:1 line (**Figure B-3**; blue dashed line). Deviations from the theoretical 1:1 line indicate inaccuracies in the predictions. From the two plots in **Figure B-3**, it is evident that the QUAD2 regression equation predicts chloride values more accurately (over the 0 to 3000 µS/cm range) than the original L-8 Equation. The regression line for the relationship of measured chloride and predicted chloride (using QUAD2) does not appear to deviate from the 1:1 line (intercept is close to 0 and slope is 1). Predicted chloride values using the L-8 Equation exhibit a positive deviation from the 1:1 line. This means that the L-8 Equation over predicts chloride values based on specific conductance levels.

Therefore, based on these analyses, it is recommended that the QUAD2 Equation is used for predicting chloride levels from measured specific conductance. The data suggests that this equation can also be used to predict chloride levels for discharges from the L-8 Reservoir if the upper range in specific conductance does not exceed 3000 µS/cm. The prediction equation is provided below:

While the QUAD2 regression equation appears to be more robust than the original L-8 Equation, its application is limited to freshwater systems (i.e., lakes or reservoirs, canals, streams, marshes) with specific conductance levels at or below 3000 µS/cm. The equation should not be used to predict chloride levels in estuarine, marine or brackish waters.