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

Permit Report (January 1, 2013–December 31, 2013)
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 attachments included with this report. **Tables A-1** and **A-2** in Attachment A list the specific pages, tables, graphs, and attachments where project status and annual reporting requirements are addressed. This annual report satisfies the reporting requirements specified in the permit.

Under the terms of permit EI-50-0128848-004 (Specific Condition 5 and Exhibit C, Sections 4.0 to 4.2) and permit EI-50-0244327 (Specific Condition 9-III and monitoring and reporting requirements in Appendix 3), an annual ground survey-based vegetation monitoring report is required and is provided in Attachment D**.** This is the final annual vegetation monitoring report, and it fulfills the annual vegetation monitoring requirements in the permit.

In addition, under the same permit conditions listed above, a GIS-based, landscape-level vegetation monitoring report is required every 5 years, for a total of two reports, covering the periods 2000–2005 and 2005–2010. The first GIS-based, landscape-level vegetation monitoring report (covering 2000–2005) was completed and submitted in 2008. The second report (covering 2005–2010) was completed and submitted in 2011. These two vegetation reports satisfied the permit requirements, and are the final ones to be submitted. Permit-required stage, flow, and water quality monitoring data associated with the operation of the G-160 and G-161 structures will continue to be reported.

Table 1. Key permit-related information.

Project Name:	G-160 / G-161
Permit Numbers:	EI 50-0128848 and EI 50-0244327
Issue and Expiration Dates: Permit # EI 50-0128848: Permit # 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
Reporting Period:	January 1, 2013–December 31, 2013
Report Lead:	Guy Germain ggermain@sfwmd.gov 561-682-6732
Permit Coordinator:	Laura Reilly lreilly@sfwmd.gov 561-682-6875

Table 2. Attachments included with this report.

Attachment	Title
A	Specific Conditions and Cross-References
B	Water Quality Data
C	Hydrologic Data
D	Loxahatchee Slough Restoration and G-160 Monitoring Plan, Fifth Post-Operational Field-Based Vegetation Monitoring Report

INTRODUCTION

Environmental Resource Permits EI 50-0128848 and EI 50-0244327, issued by the 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 2013 (January 1, 2013–December 31, 2013). 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 consolidated into this single document. This annual report presents results of permit-mandated monitoring for the G-160 and G-161 structures during Operation Year 2013.

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 necessary to maintain the ecological integrity of the slough's vegetative communities. The Loxahatchee Slough is a historical tributary component of the Loxahatchee River, providing important base and wet season flows. When supplemental water is available from the Comprehensive Everglades Restoration Plan (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 an elevation of 16.8 ft NGVD, the structure is opened to allow stages to recede, and is closed once they reach an elevation of 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 towards the end of May.

The G-161 structure allows water to be released from 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 the Beeline Highway (SR 710). The water flows northward to a culvert that conveys it under the Beeline Highway to the C-18 canal upstream of G-160.

The Environmental Resource Permit (ERP) 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 ERP issued by the FDEP to the co-permittees, the District and City of West Palm Beach, requires water quality, stage, and flow monitoring, as well as an expansion of the G-160 vegetation monitoring program into areas potentially impacted by 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 separately by the Palm Beach County Department of Environmental Resources Management, is also included with this report (Attachment D).

The purpose of the G-161 monitoring program is to evaluate results of the G-161 Project in achieving the desired objectives of restoring a more natural hydropattern to downstream wetlands, sloughs, ponds, floodplains, and rivers, without impacting water quality, relative to baseline conditions. It is anticipated that restoring a more natural hydropattern will result in a more natural salinity gradient in the downstream system, with associated benefits for estuarine and marine flora and fauna. However, the contribution of the G-161 Project to the restoration of a more natural hydropattern in this system, individually or together with the 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 the following:

- 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
- 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
- Upland, wetland, and aquatic wildlife observations incidental to ground-level vegetation monitoring
- Monthly water quality monitoring during periods of flow by grab sampling upstream of the G-161 structure and Control 2 Pump Station to evaluate the status of and trends in post-operational water quality relative to the pre-operational baseline

The permit requires monitoring in areas that are expected to have an altered or enhanced hydropattern 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 in past 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, quality, or vegetation in potentially impacted areas. An altered or enhanced hydropattern has not yet been realized.

In 2012, the L-8 Reservoir was identified as a key component in the Restoration Strategies Regional Water Quality Plan, to be used as a flow equalization basin (FEB) for the eastern flow path to improve water quality discharged to the Everglades Protection Area. Prior to completion of the eastern flow path projects, water deliveries are expected to be available from the reservoir to the Loxahatchee River. However, alternative storage sites need to be identified to provide a more permanent source of regional water. Until alternative storage sites are identified and able to consistently deliver water from the regional system to maintain an acceptable hydropattern that provides restorative flows to the river, it is unlikely that significant vegetative changes or changes in wildlife usage will be realized.

MONITORING STATION LOCATIONS

Table 3 summarizes the locations of water quality and flow monitoring sites used in this report. **Figure 1** shows monitoring sites in GWP and Loxahatchee Slough. The figure also shows the natural areas to be restored by 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, GWP, Loxahatchee Slough, NW Fork of the Loxahatchee River, and Loxahatchee Estuary.

Table 3. G-160/G-161 monitoring locations.

Station ID	Station Location	Coordinates	
		Latitude	Longitude
G-161	Northlake Boulevard West of SR-710 Outflow for Grassy Waters Preserve	264836.386	800923.390
G-160	C-18 Canal Loxahatchee Slough	265245.800	801035.600
S-46	Coastal Structure on the C-18 Canal	265603.203	800830.147
L8.M CNL	City of West Palm Beach Control 2 Pump Station on M-Canal	264519.710	802044.450

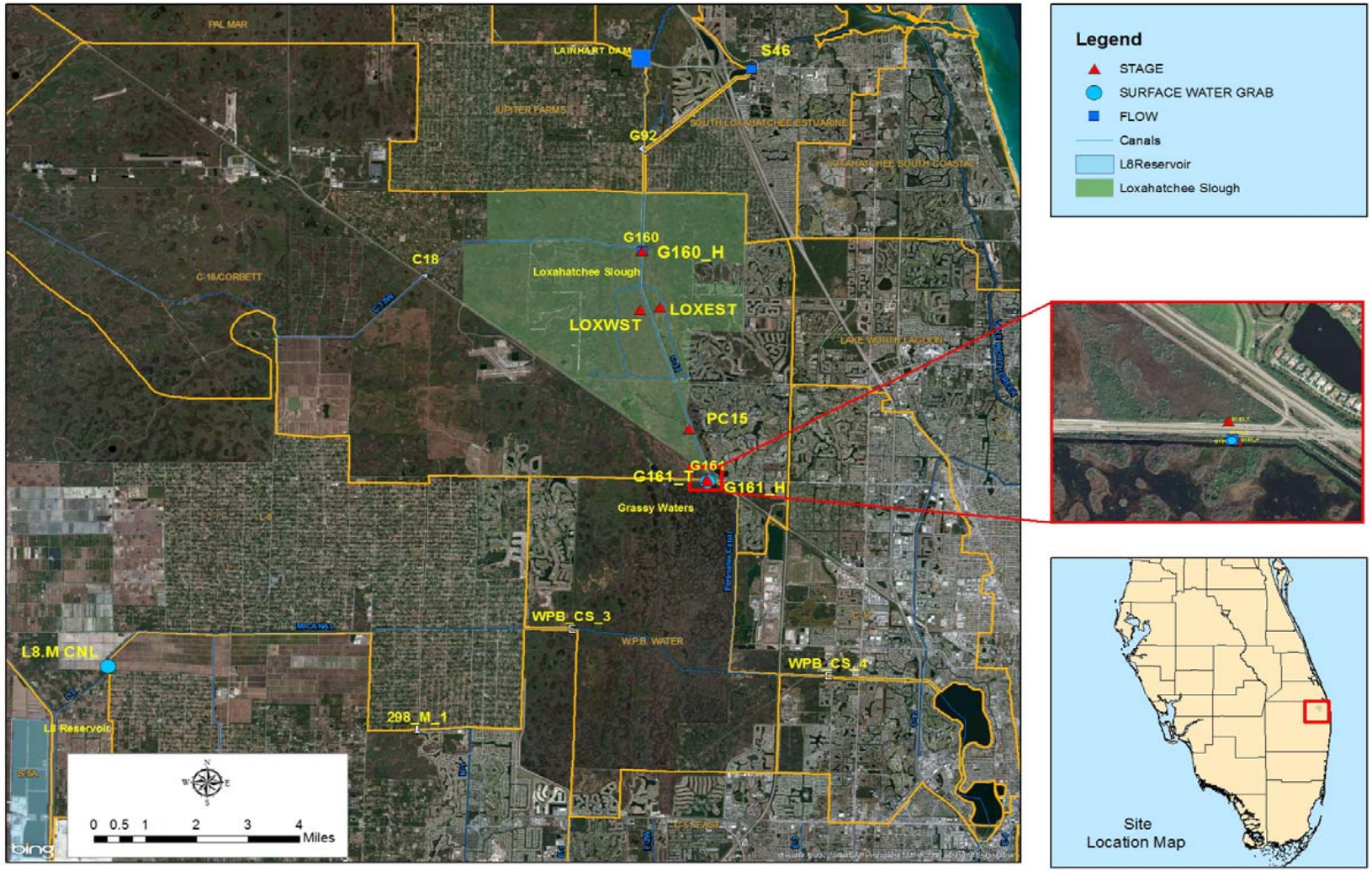


Figure 1. Location of G-160/G-161 monitoring sites.

2013 OPERATION OF G-160, G-161 AND S-46

In 2009, the FDEP directed the District to begin incrementally raising water levels upstream of the G-160 structure in compliance with the interim operating plan that was a component of the permit. The District responded by indicating that the G-160 headwater would be increased to 16.5 ft NGVD at the beginning of the 2009 wet season, and agreed to install and monitor seepage wells adjacent to the communities for two years following the increase in stage, to determine if seepage concerns were warranted. The participating agencies (SFWMD, Northern Palm Beach County Improvement District, Southern Indian River Water Control District, and the 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) (**Figure 2**) between January and March 2010. Data collection began in April 2010, and was completed in March 2013. The full data set has undergone quality assurance/quality control validation and has been loaded into the District's DBHYDRO database. Analysis of the full data set is continuing.

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.

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 infrequent operation of the G-161 structure, and because vegetation changes are not expected until the system is in full operation, vegetation plot data were not collected by the city during this reporting period.

During the 2013 dry season (November 2012–May 2013), the District experienced above average rainfall (24.2, 22.51, and 23.59 inches) at each of the three rainfall recorders in the area (SIRG, C18W_R, and S46_R, respectively). The dry season period of record (November–May each year from 1997–2013) rainfall average for these three sites is 18.99 inches. From January 17 through April 15, 2013, supplemental flows were discharged through G-161 to aid in meeting Minimum Flows and Levels criteria for the NW Fork of the Loxahatchee River. An average of 17 cubic feet per second (cfs) was discharged through G-161. Without this supplemental water, flows at Lainhart Dam would have been less than 35 cfs for a total of 55 non-consecutive days, and one period of 22 days, which would have resulted in an MFL exceedance, as shown in **Figure 5**.

Stages at G-161, and G-160 and associated sloughs are shown in **Figure 3**. Flows through G-161, G-160, S-46, and at Lainhart Dam are shown in **Figures 4** and **5**. Average, minimum, and maximum flow results are presented in **Table 4**. The average daily dry season flow over Lainhart Dam was 74 cfs. Wet season average daily flow over the dam was 211 cfs. Relevant data are included in Attachment C. Water quality samples were collected at G-161 and the City of West Palm Beach Control 2 Pump Station, in association with structure operation, to comply with Specific Condition 9(IV) of the G-161 ERP. This condition requires collection and analysis of water quality samples monthly during periods of flow for temperature, dissolved oxygen, specific conductance, pH, and turbidity in the field using electro-physicochemical methods; and for total suspended solids, ammonia, total Kjeldahl nitrogen, total nitrogen, ortho phosphorus, total phosphorus, nitrite-nitrate, chlorides, calcium, and sulfate using a National Environmental Laboratory Accreditation Conference certified laboratory and quantitative analytical methods that have been approved by the FDEP for this purpose (Attachment B).

Figure 2. Groundwater monitoring wells near G-160/G-161.

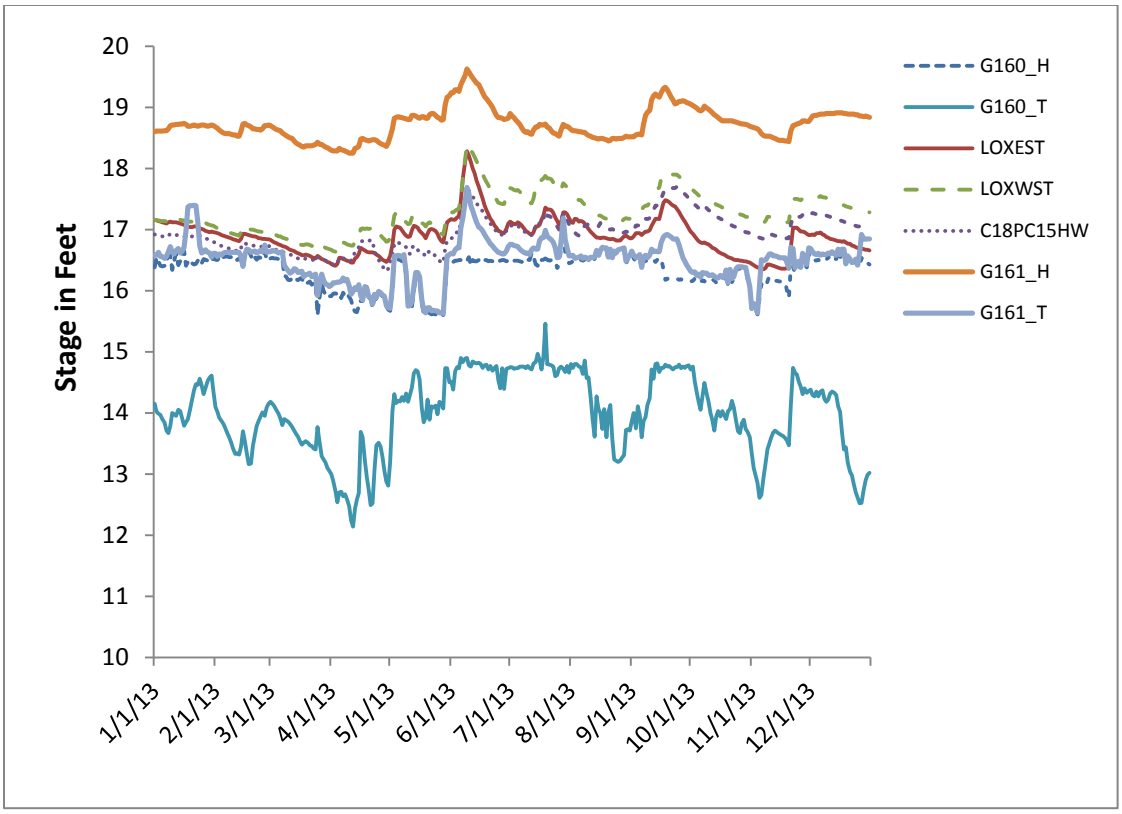


Figure 3. 2013 daily stages at stations G160_H, G160_T, LOXEST, LOXWST, C18PC15HW, G161_H, and G161_T.

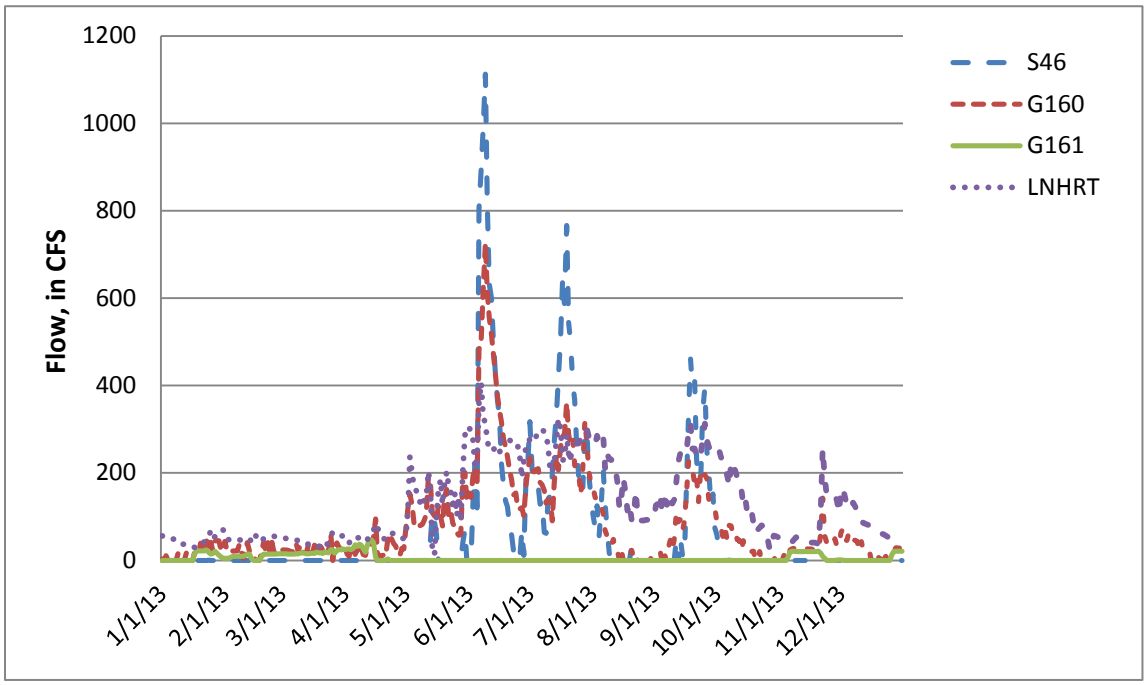


Figure 4. 2013 daily flows at structures S-46, G-160, and G-161, and Lainhart Dam.

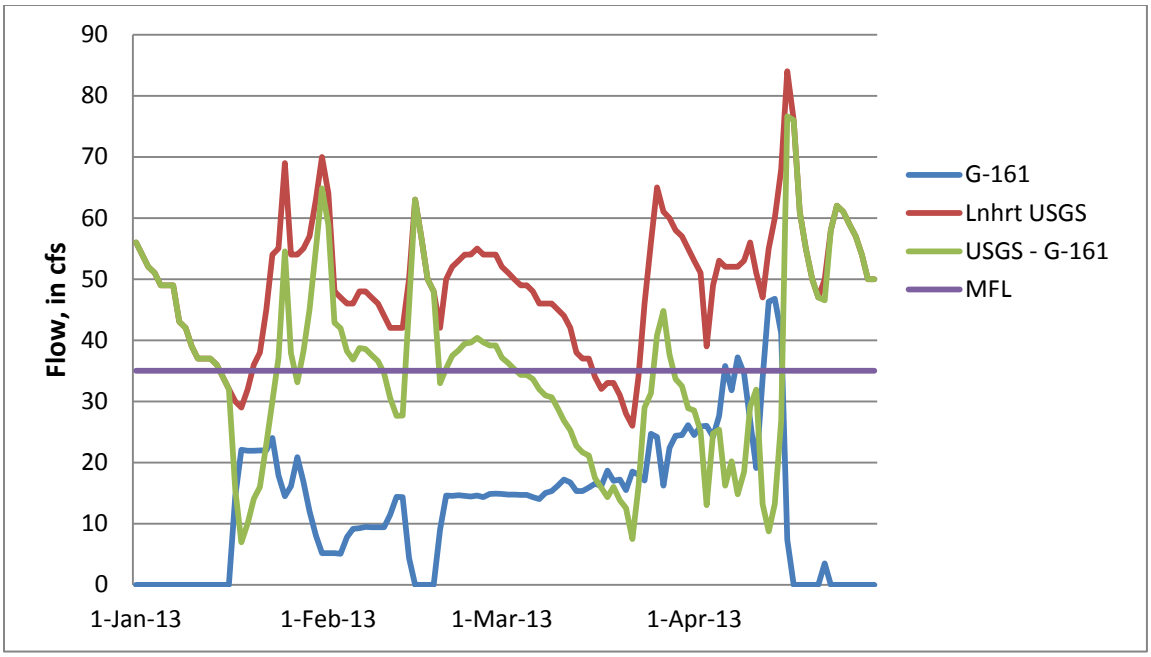


Figure 5. Lainhart flows with and without G-161 contributions.

Table 4. Monthly flow data in cfs for 2013.

Month	G-161 Avg	G-161 Min	G-161 Max	G-160 Avg	G-160 Min	G-160 Max	S-46 Avg	S-46 Min	S-46 Max	LNHRT Avg	LNHRT Min	LNHRT Max	L8.M CNL Avg	L8.M CNL Min	L8.M CNL Max
January	11.54	0	19.41	15.98	0	25.09	0	0	0	58.74	32.31	63.85	117.03	0	150.26
February	7.9	0	23.51	14.84	0	46.47	0	0	0.06	73.74	53.39	133.89	81.9	0	149.64
March	1.89	0	8.25	6.89	0	17.88	0.02	0	0.38	50.84	35.26	74.03	94.55	0	148.59
April	22.28	8.06	27.36	27.41	18.25	49.92	0	0	0.04	48.9	30.08	60.71	139.6	72.32	148.16
May	17.93	8.37	28	32.69	19.22	43.95	0	0	0	60.84	41.38	81.63	76.61	0	154.02
June	3.51	0	9.81	37.4	18.32	139.36	2.27	0	54.44	75.34	46.75	201.46	0	0	0
July	2.88	0	8.84	35.46	0	177.63	0	0	0.13	80.82	46.15	159.3	14.35	0	148.82
August	20.13	0	147.23	249.61	0	1069.17	298.62	0	2077.4	225.36	54.95	461.08	0.01	0	0.32
September	101.13	0	167.9	401.12	88.49	732.57	511.01	111.91	1242.85	257.96	67.39	324.99	0.01	0	0.19
October	0	0	0	84.26	0	175.7	147.37	5.38	341.75	156.58	61.06	255.27	32.08	0	147.3
November	0	0	0.08	14.92	0	54.28	0.1	0	2.88	127.1	52.72	230.49	120.42	0	144.12
December	0	0	0.01	13.76	0	116.2	1.09	0	31.1	104.62	58.37	252.38	75.25	0	145.08

Note:
Blue highlighted rows indicate wet season (June – October)
Avg – Average, Max – Maximum, and Min – Minimum.

VEGETATION MONITORING

Pre-operational baseline vegetation conditions in the Loxahatchee Slough were defined by the semiannual monitoring conducted in the wet and dry seasons from 2002 to 2007, by Palm Beach County. The baseline report, annual reports, and 5-year reports have previously been submitted to the FDEP for purposes of defining pre-operational baseline vegetation conditions in the Loxahatchee Slough, taking into account seasonal and annual variability. In 2009, the stage elevation at the G-160 structure was increased from 15.5 ft NGVD to 16.5 ft NGVD. On June 1, 2009, Palm Beach County reinitiated wet and dry season monitoring of Loxahatchee Slough vegetation. The fifth (final) annual vegetation monitoring report is presented in Attachment D. This area experienced an extremely wet dry season in 2009–2010, and a very dry wet season in 2011. In August 2012, an exceptional amount of rainfall from Tropical Storm Isaac (estimated to have been up to 20 inches during a one-week period) fell on the area.

Based on the LOXEST and LOXWST post-2009 stage data, and the staff gage data provided by Palm Beach County, the portion of Loxahatchee Slough on the east side of the C-18 canal is tracking closer in elevation to the western portion of the site. This is a strong indication that restoration goals for the slough are being met. The western Loxahatchee Slough is storing more water than in the past. How this might affect seasonal high water levels is dependent on several factors: the effect of the 2011 backfilling project; how efficiently the new PC-17 structures function; and how increased water levels at the northern border of the parcel (adjacent to the C-18 West Leg) affect seepage rates. It is difficult to determine the effects of the G-160 stage increases on water levels in Loxahatchee Slough, particularly in the portion west of the C-18 canal due to erratic weather patterns and the construction work (ditch filling and relocation of PC-17 structures) in the period following the increased control elevation. It is clear, though, that the cumulative effects of the raised G-160 control elevation and the referenced construction activities have increased water level duration and frequency. There also do not appear to be any detrimental effects to vegetation on the oak hammock ridges due to the wetter conditions. County staff believe that maintaining a control elevation above 16.5 ft NGVD could have detrimental effects and increase the frequency of flooding on PGA Boulevard during extreme high water periods (Attachment D).

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 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 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 most recent GIS-based analysis of vegetation associated with the G-160/G-161 structures was conducted in March and April 2011. Results of this analysis were presented in the 2012 South Florida Environmental Report – Volume III, Appendix 5-1 (Germain, 2012).

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 summarized in **Table 6** and included in Attachment B. Surface water quality criteria specified in Chapter 62-302.530, Florida Administrative Code are shown in **Table 5**. 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**). The average TP concentration observed at G-161 was 9 parts per billion (ppb), and the average observed at the M-canal was 164 ppb. Nutrient levels observed at the G-161 discharge structure appear low, and compare to levels expected in the interior marsh. The average dissolved oxygen (DO) level at G-161 was also low (3.49 milligrams per liter [mg/L]), typical of natural conditions in the marsh. In the seven DO samples analyzed during the reporting period from G-161, dissolved oxygen levels ranged from 2.0 to 4.8 mg/L. These values are below the Class III Criterion (≥ 5.0 mg/L). Turbidity at L8.M CNL was higher than usual, ranging from 15.7 to 69.7 nephelometric turbidity units (NTUs), with an average of 44.5 NTUs during the reporting period. However, since the state standard is "≤ 29 NTUs above background conditions", and background conditions have not been defined, it is not known whether there was an exceedance. The higher turbidity and nutrient levels observed in the M-canal compare to water quality in the L-8 canal, which receives discharges from Lake Okeechobee. This was the main difference between water quality within GWP and the regional water quality.

Table 5. Surface water quality criteria specified in Chapter 62-302.530, Florida Administrative Code.

Parameter	Units	Florida Class III Criteria [a]
Dissolved Oxygen	mg/L	≥ 5.0 mg/L
Specific Conductance	µS/cm	Not > 50 percent of background or > 1,275 µS/cm, whichever is greater
pH	SU	Not < 6.0 or > 8.5
Turbidity	NTU	≤ 29 NTUs above background conditions
Chlorides	mg/L	≤ 250

mg/L – milligrams per liter; µS/cm – microsiemens per centimeter; SU – standard units; NTU – nephelometric turbidity units.

[a] Because this is a freshwater system, the background concentration for specific conductance is assumed to be less than 1,275 µS/cm, and the background concentration for turbidity cannot exceed 29 NTUs.

Table 6. Water quality results from G-161 and Control 2 Pump Station (January–December 2013).

Parameter	Number of Observations	Mean ± Standard Deviation	Minimum	Median	Maximum
Station			**G161**		
Water Temperature (°C)	7	22.2 ± 2.2	18.9	21.4	25.3
Dissolved Oxygen (mg/L)	7	3.5 ± 1.1	2.0	3.7	4.8
Specific Conductance (µS/cm)	7	259.0 ± 102.6	149	222	429
Water pH	7	7.0 ± 0.3	6.6	6.9	7.6
Turbidity (NTU)	7	0.8 ± 0.3	0.5	0.7	1.2
Total Suspended Solids (mg/L)	7	<3.0 ± 0.0	<3.0	<3.0	<3.0
Calcium (mg/L)	7	19.8 ± 8.3	11.2	17.0	34.9
Chloride (mg/L)	7	39.3 ± 15.8	20.7	38.8	61.1
Sulfate (mg/L)	7	4.6 ± 5.4	0.5	3.5	16.1
Ammonia (mg/L)	6	0.010 ± 0.005	<0.005	0.007	0.019
Nitrate+Nitrite (mg/L)	7	0.006 ± 0.003	<0.005	<0.005	0.013
Total Kjeldahl Nitrogen (mg/L)	7	0.76 ± 0.12	0.63	0.75	0.95
Total Nitrogen (mg/L)	7	0.77 ± 0.12	0.63	0.75	0.96
Soluble Reactive Phosphorus (mg/L)	7	<0.002 ± 0.000	<0.002	<0.002	<0.002
Total Phosphorus (mg/L)	7	0.009 ± 0.003	0.005	0.010	0.014
Station			**L8.M CNL**		
Water Temperature (°C)	6	21.2 ± 1.8	18.8	20.8	23.5
Dissolved Oxygen (mg/L)	6	7.5 ± 0.7	6.9	7.3	8.5
Specific Conductance (µS/cm)	6	547.2 ± 196.6	427	471	943
Water pH	6	7.7 ± 0.2	7.4	7.7	7.9
Turbidity (NTU)	6	44.5 ± 20.8	15.7	42.0	69.7
Total Suspended Solids (mg/L)	6	34.0 ± 13.5	12	37.5	48
Calcium (mg/L)	6	45.1 ± 7.4	39.6	42.0	59.3
Chloride (mg/L)	6	72.6 ± 39.4	47.7	57.8	152.0
Sulfate (mg/L)	6	35.6 ± 12.6	25.3	32.2	60.3
Ammonia (mg/L)	6	0.068 ± 0.058	0.036	0.046	0.186
Nitrate+Nitrite (mg/L)	6	0.392 ± 0.172	0.176	0.393	0.668
Total Kjeldahl Nitrogen (mg/L)	6	1.49 ± 0.20	1.18	1.55	1.71
Total Nitrogen (mg/L)	6	1.88 ± 0.34	1.45	1.94	2.27
Soluble Reactive Phosphorus (mg/L)	6	0.059 ± 0.004	0.051	0.059	0.063
Total Phosphorus (mg/L)	6	0.164 ± 0.037	0.112	0.172	0.204

Note:
°C – Degrees Celsius
µS/cm – microsiemens per centimeter
NTU – nephelometric turbidity units
mg/L – milligrams per liter

REFERENCES

Germain, G. 2012. Appendix 5-1: Annual Permit Report for the North Palm Beach County – Part 1 Project, G-160 and G-161 Components. In: *2012 South Florida Environmental Report – Volume III*, South Florida Water Management District, West Palm Beach, FL.

Attachment A: Specific Conditions and Cross-References

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

Specific Condition	Description	Applicable Phase	Action Taken	Reported in 2015 SFER Vol. III, App. 5-1 in:			
				Narrative (page #s)	Figure	Table	Attachment
1	Authorized Construction	Construction	Not applicable	3			
2	Interim Operation	Operation	Not applicable	7			
3	Stage Control Elevations	Operation	Operated as required	7			
4	Continuous Stage Monitoring	Operation	Stage monitoring conducted as required	3, 7	1, 3		C
5	Vegetation Monitoring for Loxahatchee Slough	Operation	Vegetation monitoring conducted as required	3 - 4, 12			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)	7	4		
7	Annual Monitoring Reports	Operation	Report developed and submitted on time				
8	Water Reservation/Allocation	Operation	Complied with as required				
9	Construction Best Management Practices: Turbidity & Erosion Control	Construction	Not applicable				
10	Drawings and Attachments	Operation	Not applicable	2		2	A - D
11	Compliance with Specific Conditions	Operation	Complied with as required	2, 4 - 5, 8			A
12	Compliance with General Conditions	Operation	Complied with as required				

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

Specific Condition	Description	Applicable Phase	Action Taken	Reported in 2015 SFER Vol. III, App. 5-1 in:			
				Narrative (page #s)	Figure	Table	Attachment
1	Authorized Construction	Construction	Not applicable				
2	Authorized Interim Operation	Operation	Not applicable	7			
3	Construction Limits	Construction	Not applicable				
4	Fencing off Wetlands	Construction	Not applicable				
5	Construction Best Management Practices: Turbidity & Erosion Control	Construction	Not applicable				
6	Turbidity Monitoring	Construction	Not applicable				
7	Turbidity Monitoring Reports	Construction	Not applicable				
9	5-Year Operation Monitoring Plan	Operation	Monitoring was conducted as required	3, 12			
9 I	Continuous Water Level Monitoring	Operation	Monitoring was conducted as required	3 - 4, 7	1, 3		
9 II	Hydrological Monitoring	Operation	Not applicable	3 - 4, 7	3 – 5	4	C
9 III	Vegetative Monitoring	Operation	Monitoring was conducted as required	12			D
9 IV	Water Quality Monitoring at G-161 and at Control 2 Pump Station	Operation	Monitoring was conducted as required	3 - 4, 7, 13	1	6	B
10	Annual Monitoring Reports	Operation	Report developed and submitted on time				
11	Water Reservation/Allocation	Operation	Complied with as required				
12	Drawings and Attachments	Operation	Not applicable	2		2	A - D
13	Compliance with Specific Conditions	Operation	Complied with as required	2, 4 - 5, 8, 13			A
14	Compliance with General Conditions	Operation	Complied with as required				

Attachment B: Water Quality Data

This project information is required by Specific Condition 7 of the G-160 permit (EI 50-0128848), and Specific Conditions 9 and 10 of the G-161 permit (EI 50-0244327), and is available upon request.

Attachment C: Hydrologic Data

This project information is required by Specific Conditions 4 and 7 of the G-160 permit (EI 50-0128848), and Specific Conditions 9 and 10 of the G-161 permit (EI 50-0244327), and is available upon request.

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

Note: This document, dated February 2013, was prepared by the Palm Beach County Department of Environmental Resources Management for the South Florida Water Management District and the Florida Department of Environmental Protection.

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

Prepared for:

The South Florida Water Management District

and

The Florida Department of Environmental Protection

February 2014

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 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 2013. It represents the fifth 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 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 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 saw palmetto (*Serenoa repens*) and myrsine (*Rapanea punctata*), and the canopy is dominated by slash pine (*Pinus elliottii* var. *densa*).

Panoramic photographs were taken at each of the five stations as well as three additional locations that lie west and east of the hammock to give both quantitative (shrub and herbaceous layer heights) and qualitative representations of the vegetative community types. 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.

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 approximately 14 miles of drainage ditches was completed. The western Loxahatchee Slough is storing more water than in the past, although how this might affect seasonal high water levels is dependent on the following: the efficacy of the new PC-17 (A and B) structures, effects of the backfilled ditch project, and potential seepage rate changes due to higher water levels along the northern border of the parcel due to the lower control elevation of the west leg of the C-18 Canal. It is difficult to quantify the extent of observed hydrologic improvement which is directly attributed to the C-18 stages.

With the current operational schedule of the G-160 structure and project culverts along the C-18 Canal, County staff believes the restoration goals are being met without causing detrimental effects to the oak hammock vegetation. County staff will continue to coordinate with SFWMD staff to manage water levels in the Loxahatchee Slough and monitor the effects of the operational schedule.

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. There were concerns from surrounding land owners that increased water levels in the Loxahatchee Slough would increase flooding potential and affect roads and other infrastructure. 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 approximately 14 miles of agricultural drainage ditches was completed.

Methods

A total of five permanent vegetation and two 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 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 photopoint was positioned centrally between the three vegetation quadrats at each station. The vegetation plots 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.

Two automatic gauges monitored with telemetry were established by SFWMD at Stations 1 and 2. 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. Three additional photopoints were established outside of the vegetation plots to capture potential changes west (photopoint 6) and east (photopoints 7and 8) of the hammock.

Data

Tables 1 and 2 summarize the results of the vegetation monitoring quadrats during the dry and wet season surveys conducted in March 2013 and September 2013. For more detailed information about vegetation structure and composition, the individual station quadrat data sheets for the 2013 surveys are included in Attachment B. The panoramic photos in Attachment D compare stations (1-5) from 2003 and 2006 (baseline events) to the fifth post operational monitoring event in 2013. Attachment D also includes three additional photopoints (6, 7 and 8) that compare the pine density in 2002, 2012 and 2013. Attachment E includes water level data, rainfall data and stage data from 2006-2013. 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 2006-2013.

Table 1: Summary of G-160 Vegetation Monitoring During Dry Season 2013

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	 210 (***s***=47.1) 1 (***s***=1.7) n/a	 2.3 0.3 n/a	11.2
2	Swale	Herbaceous 1. *Eleocharis cellulosa* Shrub No shrub layer Canopy No canopy layer	 379 (***s***=117.6) n/a n/a	 4 n/a n/a	12.8
3	Swale	Herbaceous 1. *Eleocharis cellulosa* 2. *Fuirena scirpoides* Shrub No shrub layer Canopy No canopy layer	 265 (***s***=19.1) 8.3 (***s***=10.4) n/a n/a	 2.3 0.7 n/a n/a	12.0
4	Hydric Hammock	Herbaceous 1. *Blechnum serrulatum* 2. *Toxicodendron radicans* Shrub 1. *Psychotria nervosa* 2. *Rapanea punctata* Canopy 1. *Sabal palmetto* 2. *Psychotria nervosa*	 4 (***s***=1.7) 2 (***s***=1.5) 3 (***s***=4.2) 1 (***s***=1.5) 6 (***s***=3.6) 13 (***s***=14.2)	 1 0.7 0.7 0.7 1.7 1	Dry
5	Wet Flatwoods	Herbaceous 1. *Dichanthelium commutatum* 2. *Ludwigia repens* Shrub 1. *Rapanea punctata* 2. *Ilex glabra* Canopy 1. *Rapanea punctata* 2. *Pinus elliottii* var. *densa*	 14 (***s***=23.7) 7 (***s***=11.5) 3 (***s***=5.2) 1 (***s***=1.0) 16 (***s***=13.8) 4 (***s***=3.5)	 0.3 0.3 0.7 0.7 1.3 1.3	Moist

Table 2: Summary of G-160 Vegetation Monitoring During Wet Season 2013

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* 2. *Bacopa monnieri* Shrub 1. *Cephalanthus occidentalis* Canopy No canopy layer	 289 (***s***=67.9) 3 (***s***=5.8) 1 (***s***=1.7) n/a	 2.3 0.3 0.3 n/a	20.3
2	Swale	Herbaceous 1. *Eleocharis cellulosa* Shrub No shrub layer Canopy No canopy layer	 273 (***s***=38.9) n/a n/a	 2.7 n/a n/a	18.8
3	Swale	Herbaceous 1. *Eleocharis cellulosa* 2. *Fuirena scirpoides* Shrub No shrub layer Canopy No canopy layer	 148 (***s***=27.0) 7 (***s***=7.0) n/a n/a	 1.7 0.7 n/a n/a	20.2
4	Hydric Hammock	Herbaceous 1. *Blechnum serrulatum* 2. *Smilax sp.* Shrub 1. *Psychotria nervosa* 2. *Rapanea punctata* Canopy 1. *Sabal palmetto* 2. *Psychotria nervosa*	 3 (***s***=1.5) 1 (***s***=1.2) 3 (***s***=4.9) 1 (***s***=1.2) 6 (***s***=3.6) 16 (***s***=16.6)	 1 0.7 1 0.7 1.7 1	dry
5	Wet Flatwoods	Herbaceous 1. *Eleocharis baldwinii* 2. *Dichanthelium commutatum* Shrub 1. *Rapanea punctata* 2. *Myrica cerifera* Canopy 1. *Rapanea punctata* 2. *Pinus elliottii* var. *densa*	 4 (***s***=2.0) 2 (***s***=3.5) 3 (***s***=5.2) 1 (***s***=1.5) 16 (***s***=14.0) 4 (***s***=3.5)	 0.3 0.3 0.7 0.7 1.3 1.3	moist

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 fifth 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) are dominated by *Eleocharis cellulosa*, but 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 Station 2 in 2012, 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, while the shrub layer had *Rapanea punctata* and *Psychotria nervosa*, and the canopy layer had *Sabal palmetto* and *Psychotria nervosa*. Most of the changes in the herbaceous layers of Stations 4 and 5 can be attributed to the hog rooting in those plots. Station 5 was consistent with *Rapanea punctata* in the shrub and canopy layers.

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 September 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. Photopoint 6 shows the early stages of pine and wax myrtle mortality. These species would have moved into the wetlands during periods of lower water levels and are expected to be drowned out as water depths and/or hydroperiod increase.

During the period from 2006 to 2008, most of the deteriorated C-18 project culverts (9 through 15) were replaced, which were contributing to overdraining the Loxahatchee Slough. The G-160 began effectively controlling water levels behind it in June of 2009, when the wet season control elevation was raised to 16.5' NGVD (from the 15.0'NGVD elevation in 2005). Since June of 2009, the area has experienced an extreme wet 2009-2010 dry season, an awfully dry 2011 wet season, and the exceptional amount of rainfall (up to 20" in a week) from Tropical Storm Isaac in August 2012. Also in 2011, approximately 14 miles of drainage ditches were backfilled in the western portion of the property, and the four rusted out PC-17 culverts were replaced at two locations, with two culverts moved west of the original location (PC-17B) and two moved east (PC-17A). The ineffective PC-17 culverts prior to their repair, made some of the western portion of the site controlled at the 14.8' NGVD wet season elevation of the C-18 West leg. This allowed a significant amount of 'back door' drainage prior to 2011. Based on the water elevation data post 2009 (Figures E-2 and E-4), the portion of the Loxahatchee Slough on the east side of the C-18 Canal (LOXEST) is tracking closer in elevation to the western portion of the site (LOXWST), which is a good sign that our restoration goals will be met.

Following Tropical Storm Issac in August 2012, County staff observed record high water levels as water flowed from the west to the east through wetlands and sloughs through the newly installed culverts in the restoration area associated with backfilling of the 14 miles of agricultural ditches in the west-central

portion of the site. County staff observed over two feet of water in the hammock islands in the central part of the slough with the project culvert's levels at 18' NGVD. Also, PGA Blvd was flooded and one lane had to be temporarily closed. The high water levels caused a blowout just north of PC-9. South Indian River Water Control District contacted SFWMD and requested that the boards be temporarily removed to drop water levels enough to make the necessary repairs. Since the extremely high water levels were temporary, there appears to be no damage to the hammock vegetation. However, County staff believes that maintaining a control elevation above 16.5' NGVD could have detrimental effects to the oak hammock vegetation and increase the frequency of flooding on PGA Blvd. during extreme high water periods. County staff observed similar problems after the 2004 and 2005 hurricanes which occurred prior to the operation of the G-160 structure, replacement of the PC-17, and the restoration of the western Loxahatchee Slough.

On July 30, 2013 an interagency meeting was held to discuss the wet/dry season and pre-storm settings for the project culverts along the C-18 Canal. Table 3 below summarizes the operational schedule and board settings.

C-18 Canal Recommended Board Settings (NGVD) as of August 16, 2013				
C-18 Leg	**C-18 PC #**	**Wet Season (June 1st)**	**Dry Season (April 1st)**	**Comment**
C-18W	19	21.5'	21.5'	(aka Youth Camp (YC)) - SFWMD to contact FFWCC (Corbett)
C-18W	18B	TBD	TBD	(pending Vavrus parcel permit app)
C-18W	18A	20.5'	20.5'	
C-18W	18	fully open	fully open	culvert in disrepair
C-18W	17B	17'	16'	
C-18W	17A	17'	16'	
C-18	15	17'	16'	
C-18	14A	16.5'	15.5'	
C-18	14	15'	14'	Lower to 14.0 ft per permit during dry conditions (Seacoast Utilities water supply)
C-18	13	17'	16'	
C-18	12	16.5'	15.5'	
C-18	11	17'	16'	
C-18	10	---	---	Non-functional (SIRWCD control upstream is 14.0 ft)
C-18	9	17'	16'	
C-18	8A	16'	16'	

The western Loxahatchee Slough is storing more water than in the past, although how this might affect seasonal high water levels is dependent on the following: the efficacy of the new PC-17 (A and B) structures, effects of the backfilled ditch project, and potential seepage rate changes due to higher water levels along the northern border of the parcel due to the lower control elevation of the west leg of the C-18 Canal. It is difficult to determine the effects of the G-160 on the water levels in the Loxahatchee Slough, particularly the larger western portion of the site, due to these changes within this area and the erratic weather patterns during the period since the control elevation of it was raised. It is apparent

though, that the cumulative affects of the raised G-160 control elevation and the replacement of the rusted out PC culverts, along the C-18 and C-18W canals bordering the Loxahatchee Slough, have increased water level duration and frequency within the Natural Area. There also does not appear to be any detrimental effects to the vegetation on the oak hammock ridges due to the wetter conditions. County staff will continue to coordinate with SFWMD staff to manage water levels in the Loxahatchee Slough and monitor the effects of the operational schedule.

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.

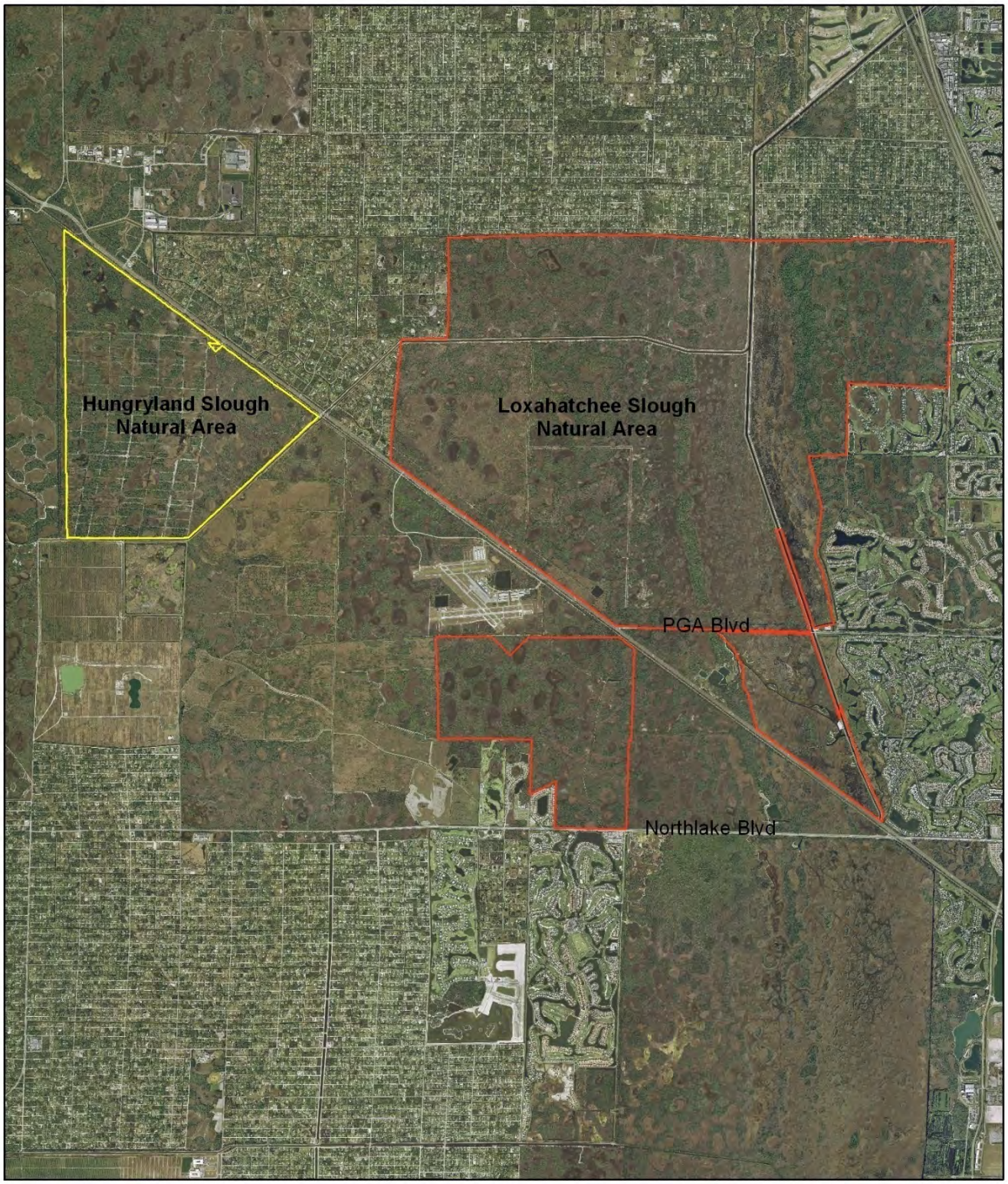


Figure 1: Hungryland Slough and Loxahatchee Slough Natural Areas Location Map

N

0 0.5 1 2 3 4 Miles

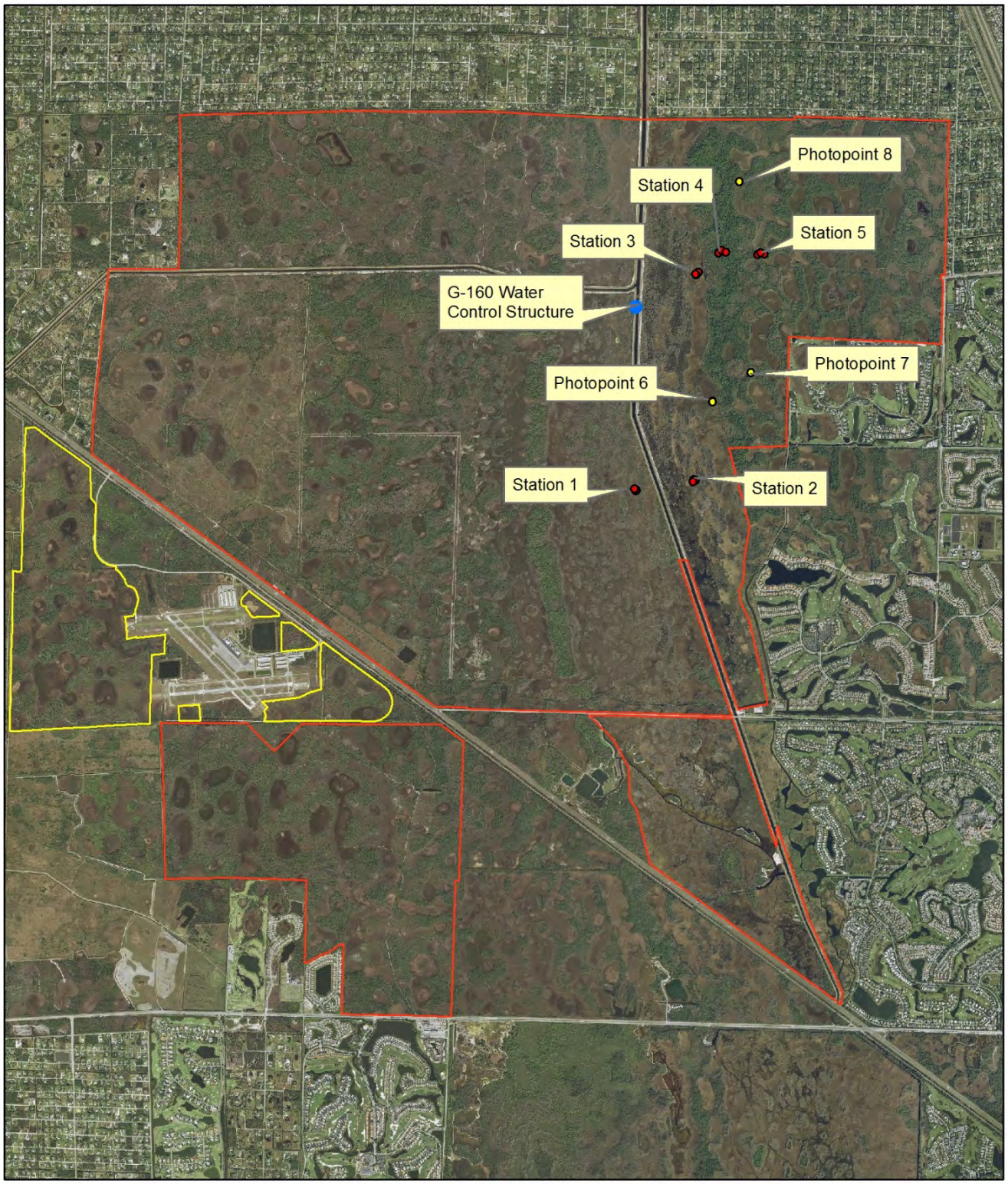


Figure 2: G-160 Vegetation Monitoring Stations in the Loxahatchee Slough Natural Area

N

0 0.5 1 2 3 4 Miles

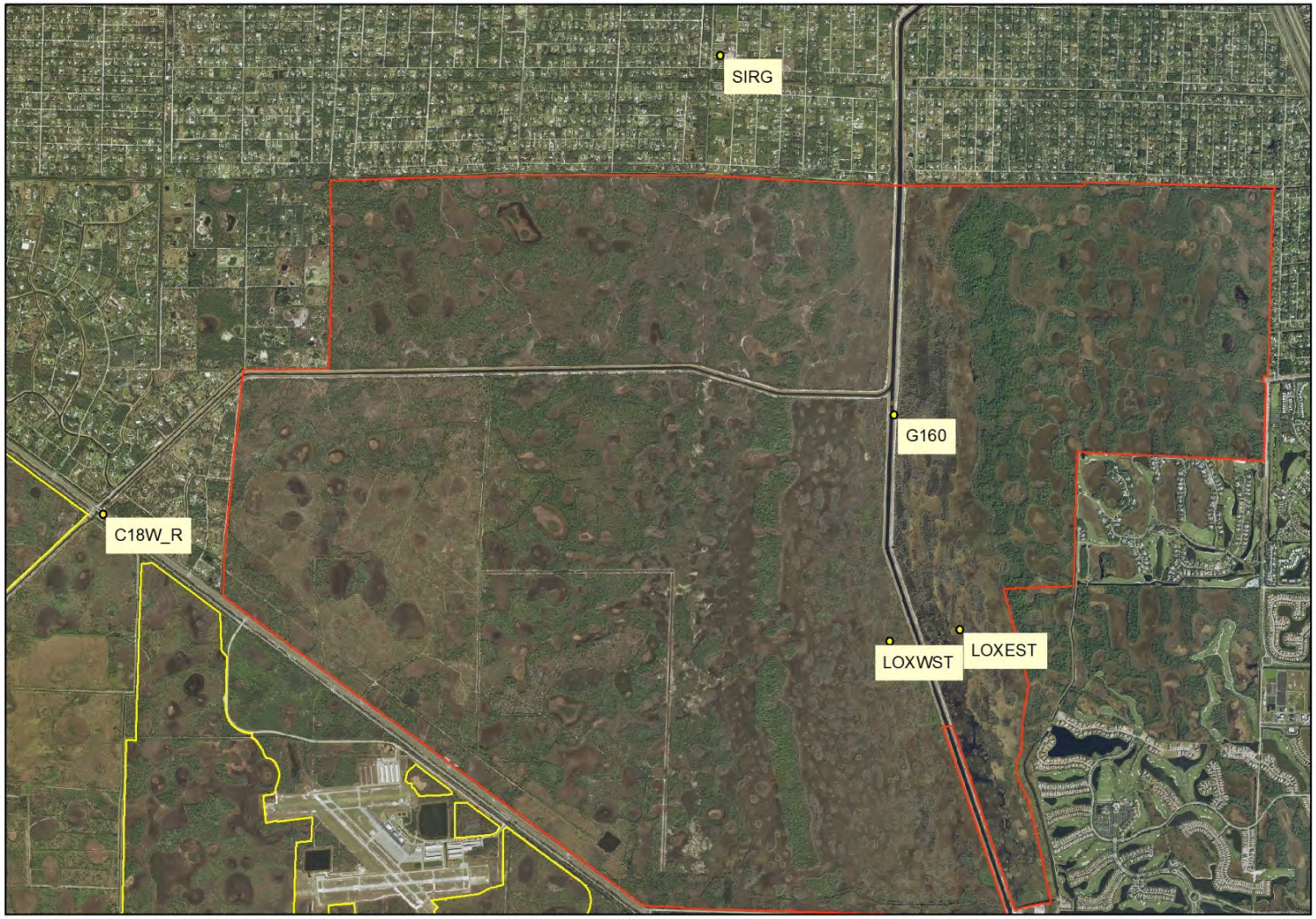


Figure 3: Hydrological Monitoring Stations in the Vicinity and Within the Loxahatchee Slough Natural Area

N

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 2013

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
- 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

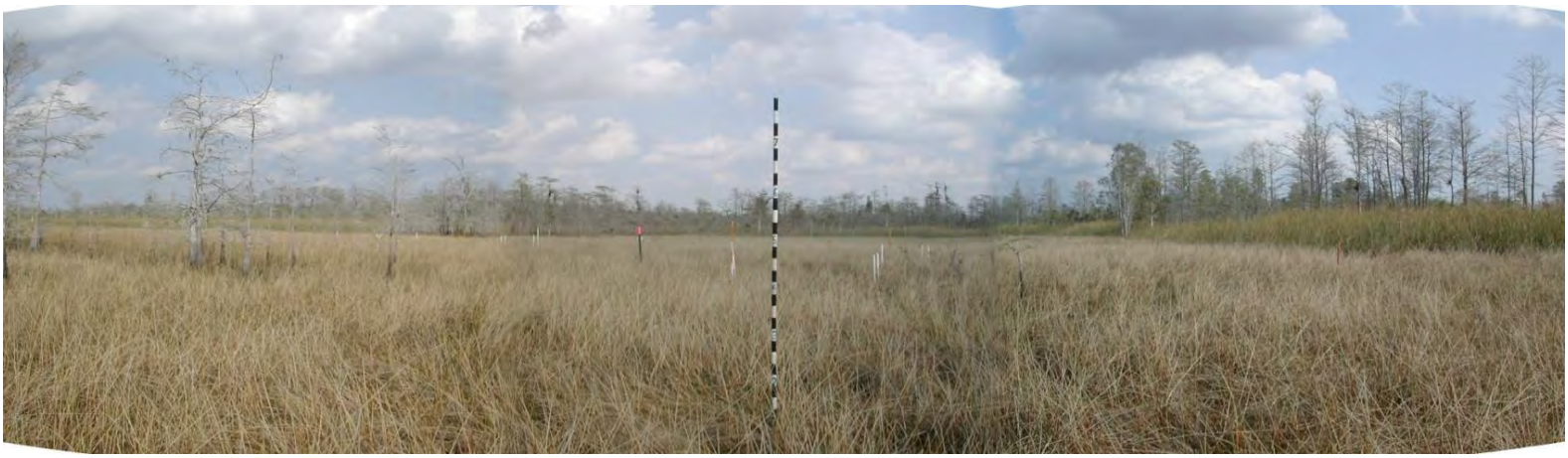
Photomonitoring in the Loxahatchee Slough Natural Area

March and September 2003-2013 Comparisons

ATTACHMENT D - Panoramic Photos

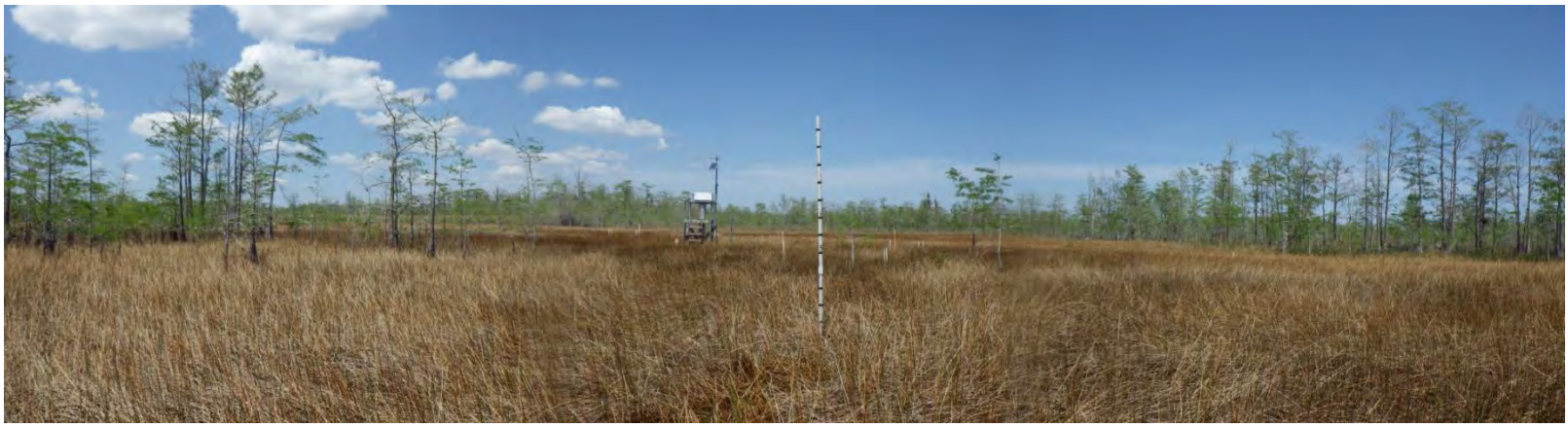
Photostation 1 - Swale

March 2003



March 2006

April 2013



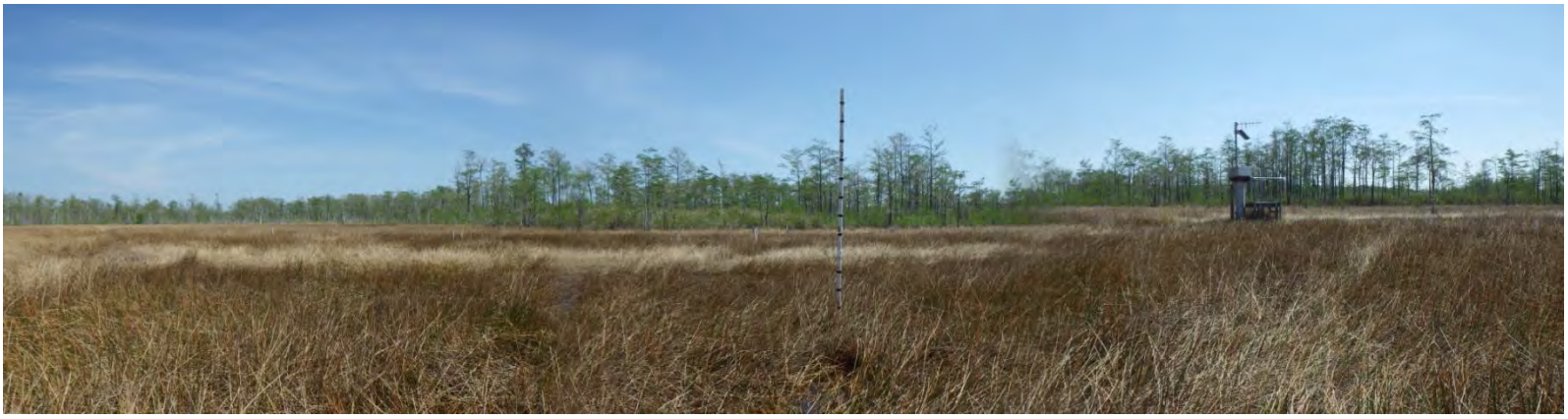
ATTACHMENT D - Panoramic Photos (cont'd)

Photostation 2 - Swale

March 2003

March 2006

April 2013

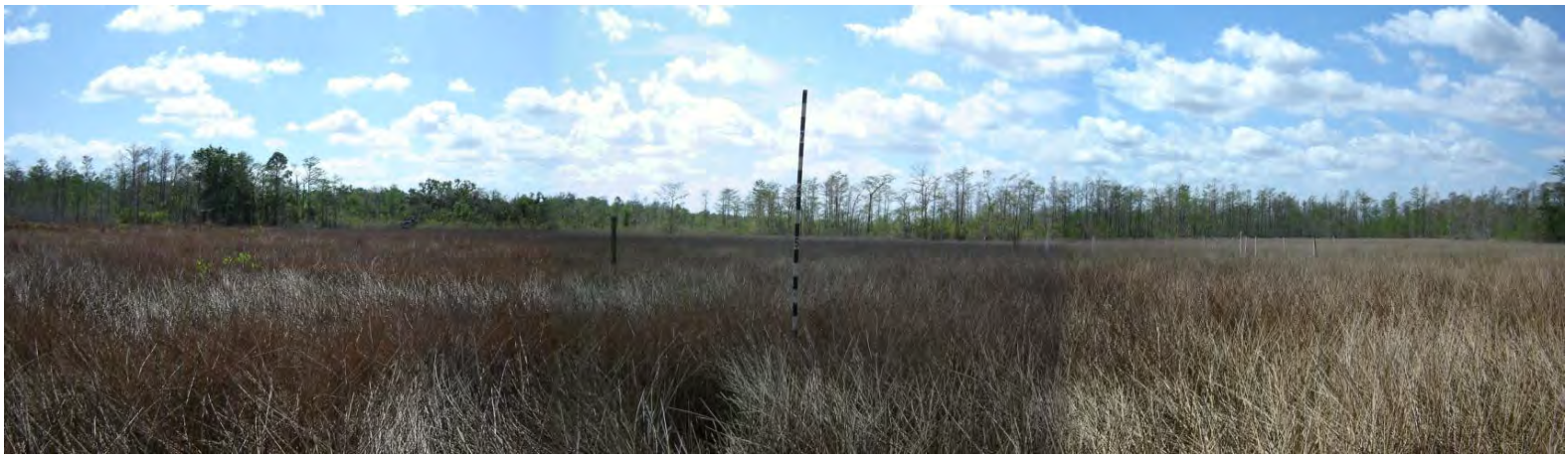


ATTACHMENT D - Panoramic Photos (cont'd)

Photostation 3 - Swale

March 2003

March 2006



April 2013

ATTACHMENT D - Panoramic Photos (cont'd)

Photostation 4 – Hydric Hammock

March 2003

March 2006

April 2013

ATTACHMENT D - Panoramic Photos (cont'd)

Photostation 5 – Wet Flatwoods

March 2003

March 2006

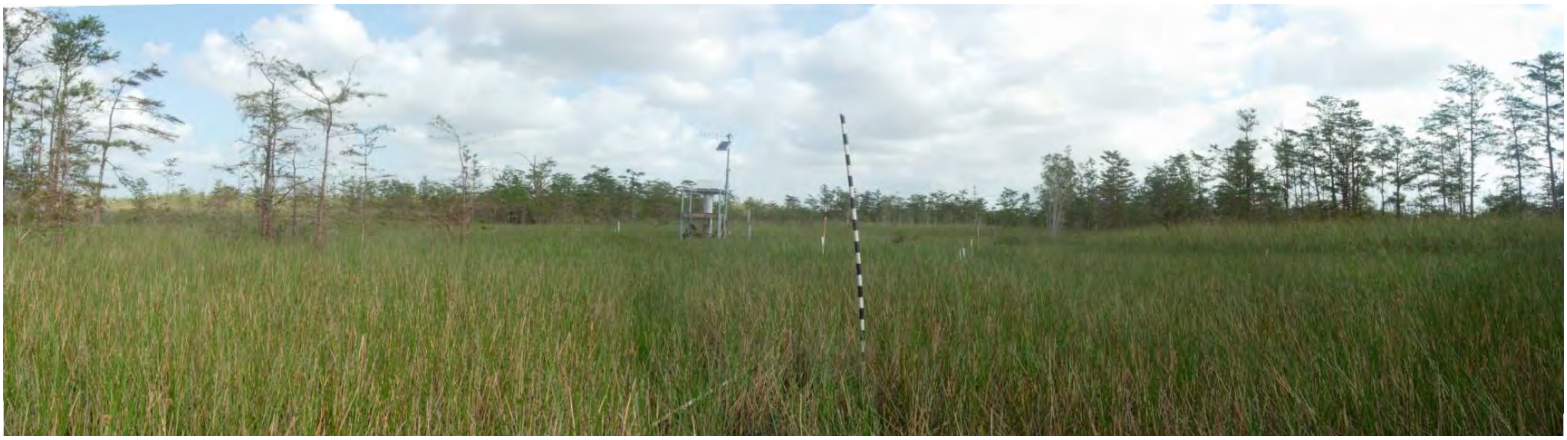
April 2013

ATTACHMENT D - Panoramic Photos

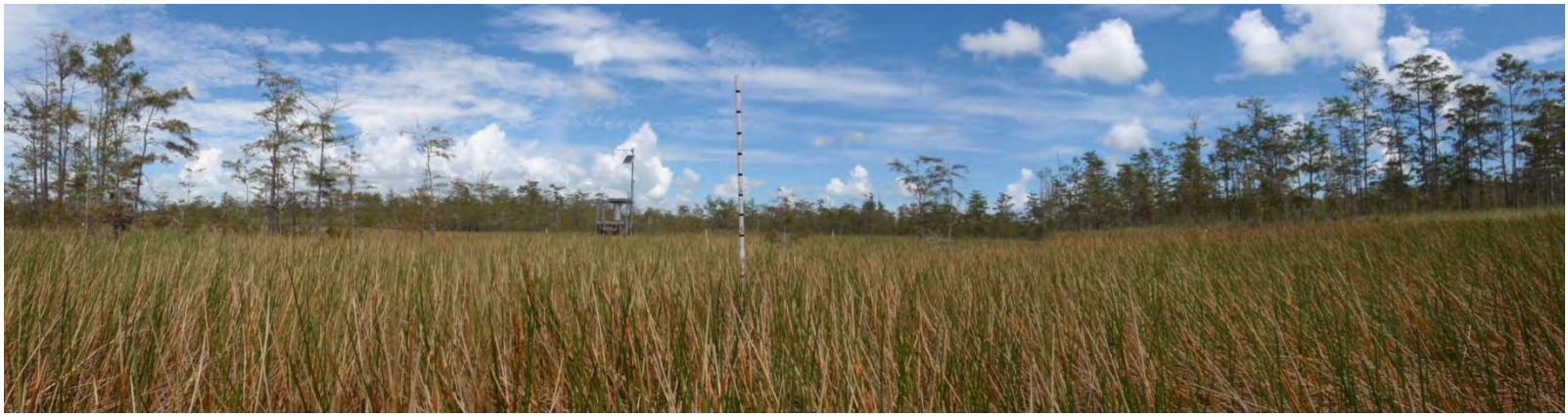
Photostation 1 - Swale

September 2003

September 2006



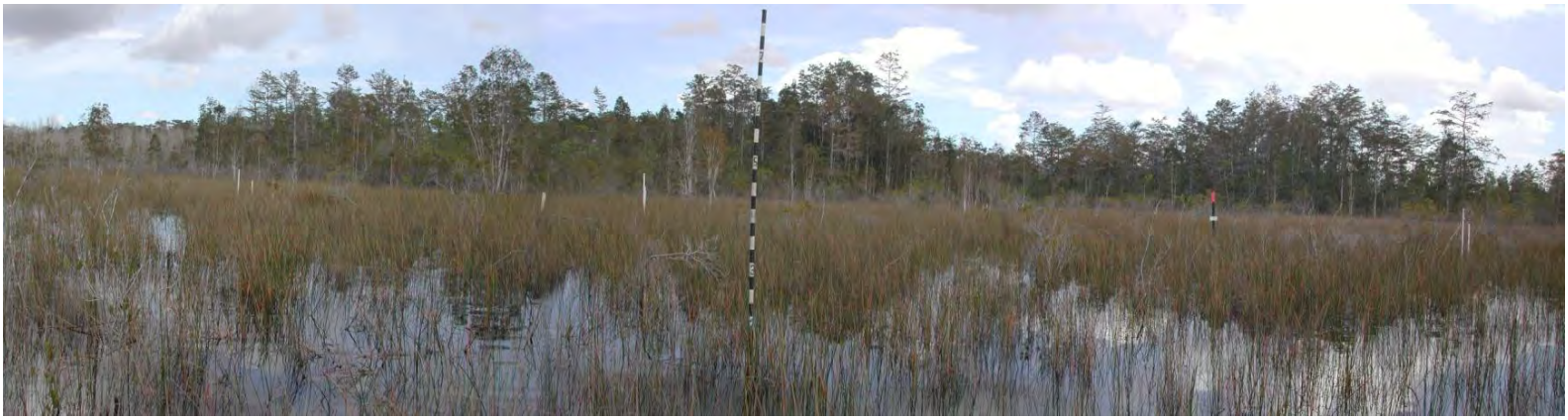
September 2013



ATTACHMENT D - Panoramic Photos (cont'd)

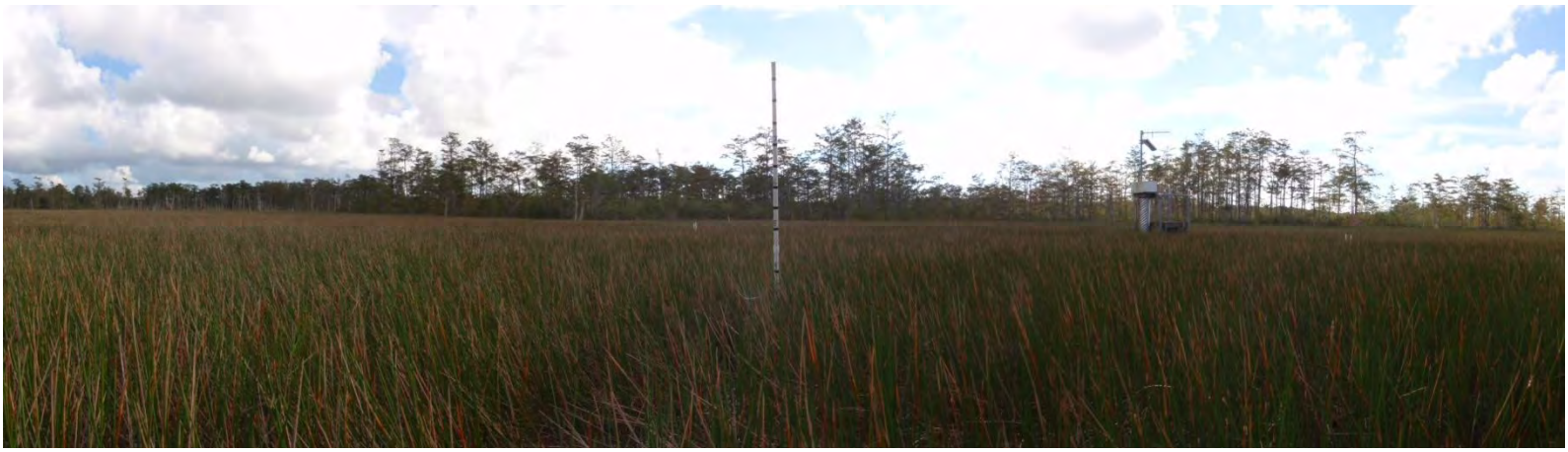
Photostation 2 - Swale

September 2003



September 2006

September 2013



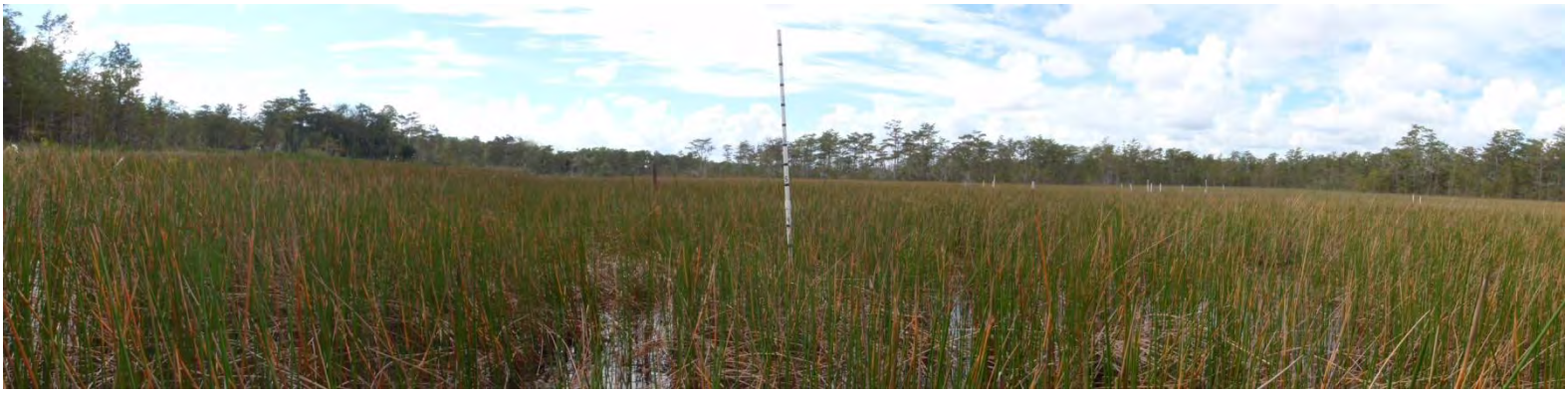
ATTACHMENT D - Panoramic Photos (cont'd)

Photostation 3 - Swale

September 2003

September 2006

September 2013



ATTACHMENT D - Panoramic Photos (cont'd)

Photostation 4 – Hydric Hammock

September 2003

September 2006

September 2013

ATTACHMENT D - Panoramic Photos (cont'd)

Photostation 5 – Wet Flatwoods

September 2003

September 2006

September 2013

Photostation 6 – Pine Invasion

October 2002

September 2010

September 2013

Photostation 7 – Pine Invasion

October 2002

September 2010

September 2013

Photostation 8 – Pine Invasion

October 2002

September 2012* (no photo taken in 2010)

September 2013

ATTACHMENT E

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

2006-2013

ATTACHMENT F

Summary of Vegetation Data
For the Loxahatchee Slough Natural Area

2006-2013