Appendix 5-3: Biennial Permit Report for the C-4 Emergency Detention Basin

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SUMMARY

Based on Florida Department of Environmental Protection (FDEP) permit reporting guidelines, **Table 1** lists key permit-related information associated with this report. **Table 2** lists the attachments included with this report. Table A-1 in Attachment A lists 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, and is the final report required by the permit.

Table 1. Key permit-related information.

Project Name:	C-4 Emergency Detention Basin
Permit Numbers:	EI 13-0192729-001 and EI 13-0192729-004
Issue and Expiration Dates:	
EI 13-0192729-001	Issued: 9/10/2002; Expires: 9/9/2002
EI 13-0192729-002	Issued: 2/14/2003
EI 13-0192729-003	Issued: 3/4/2003
EI 13-0192729-004	Issued: 9/26/2003; Expires: 9/25/2008
EI 13-0192729-008	Issued: 2/3/2005
EI 13-0192729-010	Issued: 7/2/2007
EI 13-0192729-011	Issued: 9/25/2008
Project Phase:	I & II
Permit Condition Requiring Annual Monitoring Report:	8 (in EI 13-0192729-001) 11 (in EI 13-0192729-004)
Relevant Period of Record:	May 1, 2009 – April 30, 2011
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Table 2. Attachments included with this report.

Attachment	Title
A	Specific Conditions and Cross-References
B	Water Quality Data Summary (May 1, 2010 – April 30, 2011)
C	Water Quality Data (May 1, 2009 – April 30, 2011)
D	Hydrological Data (May 1, 2009 – April 30, 2011)
E	Intensive Vegetation Survey Results
F	Vegetation Monitoring Report: Stereo-Imagery Rectification Accuracy (MATCH-AT log)
G	Vegetation Monitoring Report: Ground-Truthing Results
H	Vegetation Monitoring Report: GIS Habitat Maps 2011, 2009, 2007 and 2005
I	Vegetation Monitoring Report: Change Detection Maps and Table
J	Field Notes
K	Workshop Presentation

INTRODUCTION

The South Florida Water Management District (SFWMD or District) was issued Environmental Resource Permit 13-0192729-001 and 13-0192729-004 by the Florida Department of Environmental Protection (FDEP) to construct and operate Phases I and II, respectively, of the C-4 Emergency Detention Basin (C-4 EDB, **Figure 1**). This report provides an estimate of the total phosphorus (TP) mass budget on an event basis and cumulatively for the fifth and sixth years of operation of the C-4 EDB. This fulfills the TP mass budget reporting requirement in Specific Condition 11 of the permit modification (13-0192729-008) issued on February 3, 2005, for the third biennial reporting period (May 2009–April 2011).

The C-4 EDB is in the Miami-Dade County Lake Belt Area and includes projects within jurisdictional wetlands in the North Trail Wetland Basin, located adjacent to and immediately north of the C-4 canal and west of the Dade-Broward Levee (Section 4, Township 54 South, Range 39 East). The C-4 EDB provides improved flood protection for the city of Sweetwater and surrounding areas during extreme events by providing 3,264 acre-feet (ac-ft) of aboveground storage for floodwaters. During a major storm event, the C-4 EDB pumps convey floodwaters from the C-4 canal into the storage detention basins (both Phase I and Phase II), which helps reduce flooding of the area further east. After the event and stages in the C-4 canal have returned to normal, the floodwaters discharge from the EDB back to the C-4 canal and eventually to tide. Construction of the water management infrastructure was certified complete in May 2005, and the facility became administratively operational in November 2006 after stage monitoring equipment was relocated and recalibrated to maximize accuracy and minimize siltation.

BACKGROUND

The C-4 EDB is in the North Trail Wetland Basin in southwestern Miami-Dade County between SW 137th Avenue and Krome Avenue and accessible via Tamiami Trail (SW 8th Street, U.S. 41), which runs along the facility's southern border. It was constructed to reduce the magnitude, duration, and frequency of flooding of low-lying areas within the jurisdictions of the cities of Sweetwater, West Miami, and western Miami-Dade County (the "Flagami District"). Such flooding occurred during intense rainfalls accompanying several unnamed (2000) and named tropical storms and Hurricane Irene (1999) in the previous decade. A naturally low-lying, high-seepage area was chosen for the facility between the Dade-Broward Levee and Canal to the west and an abandoned orange grove to the east and between a mining operation to the north and the C-4 canal to the south. On the other side of the Dade-Broward Levee is the Pennsuco Wetlands Area, portions of which are owned by the District.

The C-4 EDB was constructed in phases. Phase I includes the northern section and encompasses 415 acres. The remaining 416 acres is Phase II. Together, the two areas total 831 acres. Construction of the Phase I levees, seepage canal, and the G-420 and G-420S pumps was completed in March 2002. Phase II was completed in May 2005. The G-420S pump was replaced in April 2006.

The Phase I and Phase II lands were both owned by private and public entities. The District obtained a 50-year easement from the State of Florida for Phase I. Phase II lands were obtained by using funds from the Federal Emergency Management Agency (FEMA) and the Florida Department of Community Affairs (DCA), as well as funds from the Conservation and Recreation Lands Trust Fund (CARL). Phase I will eventually become part of the East Coast Buffer Project. CEMEX, Inc., has mineral extraction rights for a substantial portion of the Phase I parcel for the next 50 years, but the start date and duration of mining are not yet known. During extraction operations, the Phase I section can only be flooded to a maximum depth of 2 feet (ft) rather than the designed 4 ft. The District has been reimbursed for the entire cost of the project by FEMA. Pump and weir construction for Phase I and II were completed in July 2004 and May 2005, respectively.

Figure 1. Overview of the C-4 Emergency Detention Basin (C-4 EDB).

PERMIT CONDITIONS

In applying for the permit, the District agreed to remediate wetlands degraded by construction and remove all exotic trees. Both efforts have been successful. The District also assured the issuing authorities that the risk of adverse impacts to native, short hydroperiod wetland vegetation and wildlife would be *de minimis* if the facility was operated infrequently and in such a manner as to minimize the stage-duration by emptying the accumulated rain, groundwater, and inflow water rapidly following a pumping event.

The permits from the U.S. Army Corps of Engineers (USACE) and Miami-Dade County Department of Environmental Resources Management cross-referenced the FDEP permit general and specific conditions, but the USACE permit added a focus on the eradication of primrose willow (*Ludwigia peruviana*), as well as melaleuca (*Melaleuca quinquenervia*). The effectiveness of the exotic plant eradication program is documented annually pursuant to Specific Conditions 8 and 12 of the Phase I and II permits, respectively.

In September 2008, the FDEP issued permit modification #EI 13-012729-011, which amended specific conditions 8 and 11 for the Phase 1 and 2 monitoring in permit modifications #EI 13-0192729-001 and 13-0192729-004. This allowed biennial vegetation monitoring via aerial photography and quarterly monitoring of wildlife from the levees in conjunction with water quality monitoring.

A six-year biennial monitoring program was established to detect, quantify, and report significant changes in vegetation habitat, wildlife utilization, water quality, and periphyton growth within the Phase I (north) and Phase II (south) basins of the C-4 EDB.

ACTIVE MANDATES AND PERMIT

The original Environmental Resource Permit (ERP) and all major modifications issued to the SFWMD are:

- #EI 13-0192729-001; issued September 10, 2002, with the expiration of the construction phase on September 9, 2007 (Phase 1)
- #EI 13-0192729-004; issued September 26, 2006, with the expiration of the construction phase on September 25, 2008 (Phase 2)
- #EI 13-0192729-008; issued on February 3, 2005, to modify the project's monitoring requirements by reducing the frequency of monitoring the wetlands within the Phase 1 and Phase 2 Detention Basins.
- #EI 13-012729-010; issued on July 2, 2007, to modify the project's monitoring requirements, which reduced the frequency of wildlife observations from quarterly to semi-annually, periphyton monitoring will coincide with the biennial aerial survey, the Biennial Environmental Impact Evaluation Workshop will be conducted in September instead of July, and the evaluation report is due in November instead of July.
- #EI 13-012729-011; issued on September 25, 2008, to modify the project's monitoring requirements (wildlife observations shall be implemented once every other year incidental to ground-truthing for vegetation monitoring via aerial photography for the period 2005 through 2011).

ERP #EI 13-0192729-001 and ERP #EI 13-0192729-004 were issued for the construction of the Phase 1 and Phase 2 detention basins, levees and seepage canals respectively. In addition, these permits granted approval for the construction of the G-420 and G-422 pump stations, the G-421 spillway, C-4 inflow canal, G-420S seepage pump, and the G-423 divide structure.

On November 8, 2006, the FDEP approved the As-Built Certification of the C-4 EDB and concurred that this facility was constructed in accordance with the FDEP's permits.

WATER QUALITY

To monitor the water quality entering and leaving the C-4 EDB, the SFWMD, in cooperation with the FDEP, has established a water quality monitoring plan. This plan has been implemented by the SFWMD since the C-4 EDB project inception. This plan has been altered by several permit modifications throughout the project's life, most recently by a letter modification approving a switch from auto-samplers to grab samples. This letter modification occurred February 8, 2010, and the following methodology reflects the water quality monitoring plan since that most recent modification.

METHODOLOGY

Three water quality monitoring stations, G-420, G-421 and G-422, are in the C-4 EDB. The G-420 and G-422 stations are located just upstream of pump stations and G-421 is a gate structure that allows water in or out of the basin (**Figure 2**). If flow occurred at a station, the station was sampled within 72 hours of the flow event and then on a weekly basis thereafter. If no flow occurred at a station during the quarter, a quarterly grab sample was collected at G-420. Samples were analyzed for total phosphorus (TPO4), orthophosphate (OPO4), total dissolved phosphorus (TDPO4), total Kjeldahl nitrogen (TKN), total dissolved Kjeldahl nitrogen (TDKN), nitrate+nitrite (NOx), and temperature (TEMP). Sample stations, parameters, and frequency of sampling are summarized in **Table 3**. All samples were collected using the grab method outlined

in the SFWMD's Field Sampling Quality Manual (FSQM) (SFWMD, 2011) and in accordance with FDEP standard operating procedures (SOPs). To satisfy requirements of the FSQM, quality control (QC) samples were collected along with the sample. The QC samples consisted of a single equipment blank and two replicate samples each quarter.

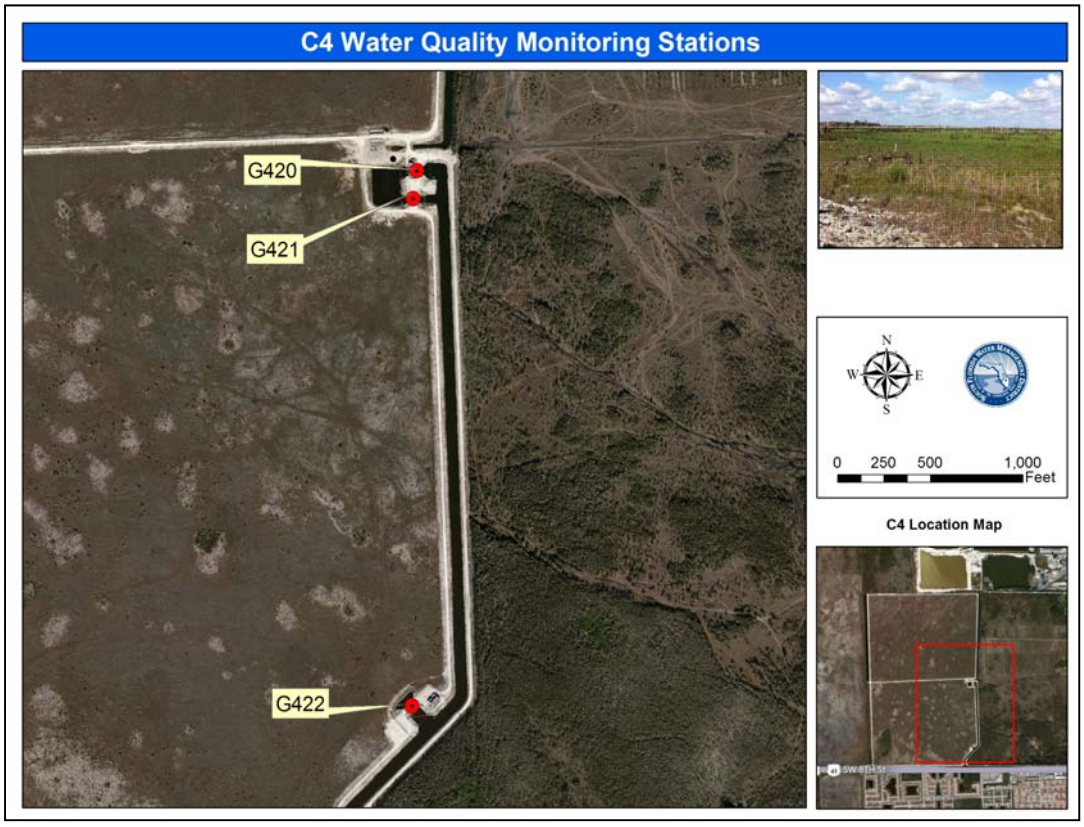


Figure 2. Water quality monitoring stations associated with the C-4 EDB.

Table 3. C-4 EDB water quality stations, parameters, and frequencies.

Station	Coordinates	Parameters	Frequency
G-420	25°46'18"N -80°26'02"W	TPO_4, OPO_4, $TDPO_4$, TKN, TDKN, NOx, TEMP	Weekly when flow, otherwise quarterly
G-421	25°46'17"N -80°26'02"W	TPO_4, OPO_4, $TDPO_4$, TKN, TDKN, NOx, TEMP	Weekly when flow
G-422	25°45'49"N -80°26'03"W	TPO_4, OPO_4, $TDPO_4$, TKN, TDKN, NOx, TEMP	Weekly when flow

TPO_4: total phosphorus
OPO_4: orthophosphate
$TDPO_4$: total dissolved phosphorus
TKN: total Kjeldahl nitrogen
TDKN: total dissolved Kjeldahl nitrogen
NOx: nitrate+nitrite
TEMP: temperature

RESULTS

Six sampling events occurred during the reporting period (**Table 4**). Of these sampling events, only one was triggered by flow into the C-4 EDB. This flow event occurred on September 30, 2010, in response to Tropical Storm Nicole. All other sampling events were considered quarterly and were required to meet the permit condition that there is at least one sampling event every quarter. Additional water quality data are provided in Attachments B and C.

Table 4. Water quality sampling results.

Station	Date Collected	TDKN (mg/L)	TKN (mg/L)	NOX (mg/L)	TDPO4 (µg/L)	OPO4 (µg/L)	TPO4 (µg/L)	TEMP (C)
G-420	3/29/10	1.2	1.2	0.014	2	2	6	24.2
	5/27/10	1.1	1.1	0.011	2	2	6	25.6
	9/01/10	1.2	1.2	0.005	5	3	7	26.1
	9/30/10	1.3	1.3	0.059	5	2	7	25.8
	12/01/10	1.3	1.3	0.005	3	2	9	25.9
	3/01/11	1.2	1.3	0.005	2	2	9	24.7

mg/L: milligrams per liter
µg/L: micrograms per liter
C: degrees Celsius

PERIPHYTON

METHODOLOGY

Two periphyton stations were reestablished at G-421P and G-423P. G-423P was located approximately 100 ft north of the G-423 structure that separates Phase I from Phase II. G-421P was located within the G-420 pump station retention pond 30 ft west of the G-421 structure (**Figure 3**).

Periphyton sampling was conducted according to the SFWMD's Taxonomic and Nutrient Periphyton SOP (SFWMD, 2010) and FDEP FS 7000, Quantitative Periphyton Sampling SOP (FDEP, 2008). Eight glass slides were housed in each of the three periphytometers and were deployed for 28 days. Periphytometers were deployed on June 2, 2011, and retrieved on June 30, 2011. Upon retrieval the glass slides were placed in reclosable plastic bags and transported in ice-filled coolers. The slides were scraped into 15 milliliter centrifuge tubes, fixed with a formalin solution, and shipped to the FDEP laboratory for analysis.

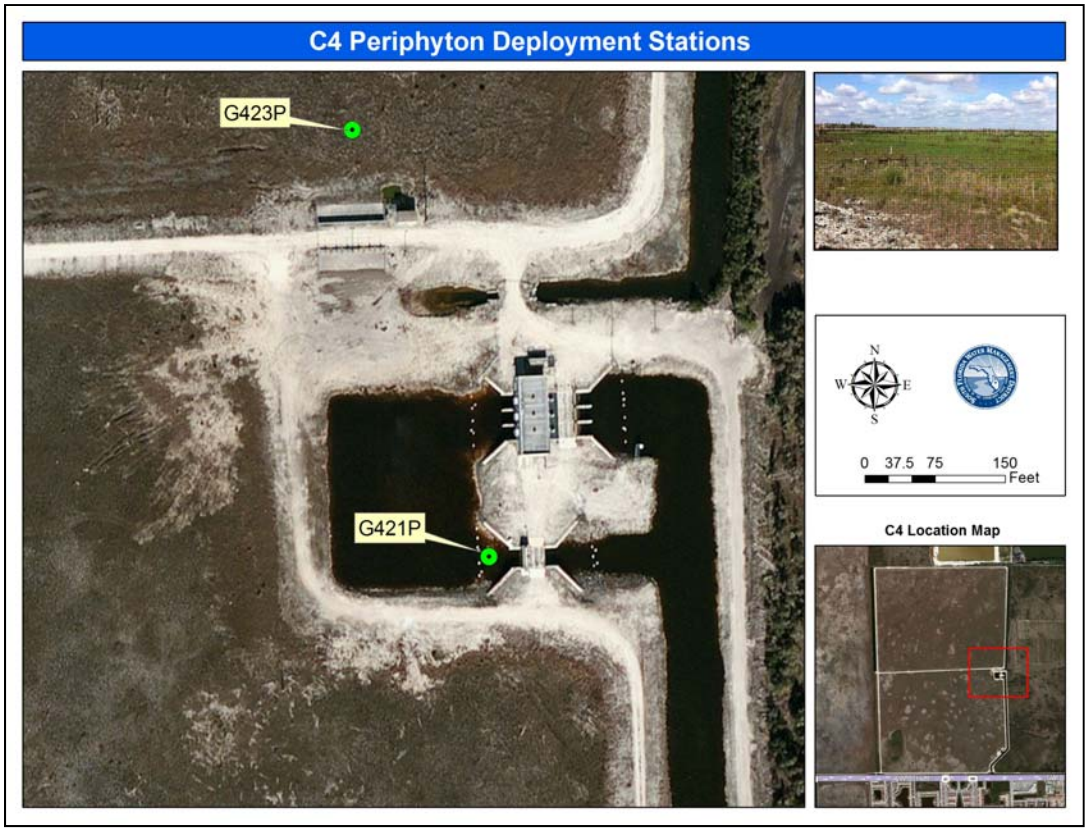


Figure 3. Periphyton monitoring station locations.

RESULTS

During the periphytometer deployment period, the G-423P sampling station within the Phase I basin was dry (**Figure 4**); therefore no periphyton was collected.

The Phase II basin was also dry during the deployment period (**Figure 5**); however, sufficient water was present within the G-421P sample station (**Figure 6**). This site is located in the retention pond of the G-420 pump station and is not representative of typical basin conditions. This site represents conditions near the G-420 pump station, which experiences much longer periods of inundation (see **Figure 3**), but are not within the scope of this project. Therefore, the resulting periphyton samples were not submitted to the FDEP laboratory for analysis.

See Attachment A for field notes recorded during periphyton monitoring.

Figure 4. Periphytometers in Phase I of the C-4 EDB (June 2, 2011).

Figure 5. Location of the G-421 pump station retention pond in Phase II of the C-4 EDB.

Figure 6. G-421P retention pond surrounded by dry Phase II on June 2, 2011.

TOTAL PHOSPHORUS

INTRODUCTION

Water quality monitoring was used to determine the TP mass budget within the C-4 EDB. The SFWMD has conducted six years (beginning in May 2005) of monitoring to identify water quality changes caused by operation of the C-4 EDB as required by the related permits.

The data collected were used to:

- Determine overall nutrient load into and out of the C-4 EDB and document changes that result from operational and management decisions
- Provide environmental information for management of the C-4 EDB to monitor and document physical and chemical characteristics of source and receiving environments
- Provide the data necessary to identify potential environmental and ecological impact shifts resulting from management decisions

DESCRIPTION OF THE FACILITIES

Water Management Infrastructure

G-420

Structure G-420 pumps are operated remotely following direction from the Miami-Dade County Flood Mitigation Program C-4 EDB Operating Plan. The structure is a three-unit pump station located north of the C-4 canal at the junction of U.S. 41 and S.W. 137th Avenue in Miami-

Dade County. The three pumps have a combined rating capacity of 700 cubic feet per second (cfs) and are used to move water from the C-4 canal into the C-4 EDB for flood control.

G-421

Water flows out of Phase I of the C-4 EDB into the supply canal and then to the C-4 canal via the G-421 spillway. The operation of the C-4 EDB is governed by the Interim Seasonal Operation Plan. G-421 pumps are turned on progressively if the T5 (C-4 canal at Tamiami Trail at Coral Gables) stage exceeds 5.00 feet in relation to the National Geodetic Vertical Datum of 1929 (ft NGVD 29), and all inflow impellers will be turned on if the T5 stage exceeds 5.20 ft NGVD 29. Pumping ceases when the stage in the C-4 EDB reaches 8.0 ft NGVD 29 and the T5 begins to recede below 5.90 ft NGVD 29, or the stage in the C-4 EDB exceeds the maximum elevation of 10.00 ft NGVD 29.

G-422

G-422 consists of a set of seven electric pumps powered by diesel generators. Together, the pumps have a total capacity of 700 cfs and move a maximum of 585 cfs with a 4-ft head difference. Inflow pumps are only operated when the stage in the C-4 canal meets the trigger criterion. Water gravity-flows from Phase I into the supply canal and then to the C-4 canal via the G-421 weir. Discharge occurs only after the flood-stage peak has passed. The structure was registered on March 11, 2006.

G-420S

A 100-cfs submersed electric pump (G-420S) located just to the northeast of G-420 is used to recirculate water collected in the seepage collection canal, which runs north-south along the east levee, back into Phase II.

G-423

Water enters and leaves Phase I through the G-423 weir, which will remain permanently, open until CEMEX, Inc. exercises its mineral extraction option. After the mining operation begins, G-423 will be closed and Phase I will be operated independently of Phase II. The maximum depth of Phase I will be 2 ft, while Phase II will be able to be filled to a maximum of 4 ft. No flow is monitored at this structure.

Operation

The only reportable flood control pumping event during the biennial reporting period (May 1, 2009–April 30, 2011) occurred during Tropical Storm Nicole (September 29–30, 2010). Additional flow occurred during extended pumping tests in June 2009 and May 2010.

Monitoring

In addition to authorizing the operation and maintenance of certain structures, the permit requires a routine water quality monitoring program to characterize the quality of water discharged through G-420, G-422, and G-421.

Monitoring is performed during periods of flow. Upon the start of pumping operations, sample collection by auto-samplers is initiated. Grab sample collection occurs within 48 hours after pumping. Monitoring is conducted at the designated sites until the inflow and outflow operations cease. The monitoring plan recommends collecting samples on a weekly basis during operations; however, other frequencies (for example, daily) could be collected if determined

necessary by the Field Project Manager. The Field Project Manager determined the dates for all sampling events.

Only one operation event sampling (September 29–30, 2010, Tropical Storm Nicole) occurred from May 1, 2009, to April 30, 2011. The sample was collected on September 30, 2010.

Flow was monitored at two inflows to the C-4 EDB at G-420 and G-422; outflow was monitored at G-421; seepage flow was monitored at pump G-420S. The wetland stage was monitored at C4SW1, C4SW2, and C4SW3 (**Figure 7**).

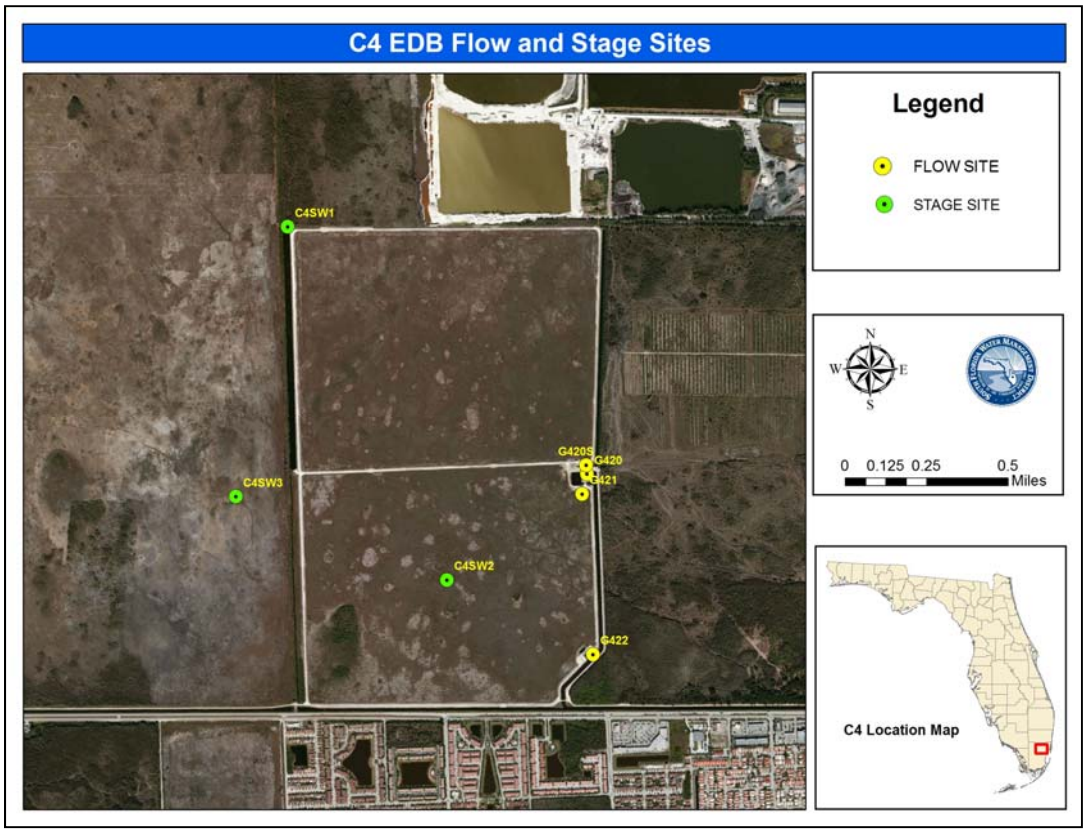


Figure 7. Flow and stage stations for the C-4 EDB.

Monitoring Frequencies by Site and Parameters

The C-4 EDB monitoring schedule specified in the monitoring plan is shown in **Table 3**. Samples are collected through a grab and auto-sampler collection program. Grab samples are collected weekly if flowing for the inflow and outflow structures.

Monitoring of Initiation Conditions and Storm Event

Construction of the C-4 EDB project was completed in May 2005 and the first biennial monitoring period started in May 2005. This is the third biennial monitoring period. The only event monitoring trip occurred on September 29–30, 2010, to monitor the condition at G-420 (**Table 5**). The auto-sampler at G-420 was not triggered during Tropical Storm Nicole. No monitoring occurred at the G-421 outflow structure because there was no flow and no water quality monitoring is required for seepage pump G-420S.

Table 5. Water quality monitoring sites with C-4 EDB discharge structures.

STRUCTURE CATEGORY	C-4 EDB STRUCTURE	WATER QUALITY SAMPLING SITE	Comments
Inflow	G-420	G420	Six grab samples were collected; no sample was collected by auto-sampler.
	G-422	G422	No grab or auto-sampler was collected.
Outflow	G-421	G420	Same water as G-420.

Notes: Water quality sampling sites are located on the upstream side of the structure.

Maintenance of Water Quality Equipment

Monitoring equipment located at the water control structures within the C-4 EDB was fully functional prior to and during flow events. Equipment calibration and general maintenance were performed monthly regardless of flow. More specific equipment maintenance, such as changing tubing for the auto-sampler, was performed quarterly regardless of flow.

METHODOLOGY

Water Quality and Hydrologic Data

The sampling collection, preservation, storage, and chain-of-custody for grab and auto-samplers are listed in the Water Quality Monitoring Plan, and are based on the Field Sampling Quality Manual (SFWMD, 2011). The chemical analysis procedures and QA/QC procedures are specified in the Chemical Laboratory Quality Manual (SFWMD, 2010).

The standards used to evaluate the accuracy of the rating for flow calculations are consistent with the SFWMD Standard Operating Procedures (SOP) for Flow Data Management in the District Hydrologic Database (Akpoji et al., 2003) and the U.S. Geological Survey approach as outlined by Novak (1985). Four classifications are adopted to assess a rating's accuracy. The rating is classified as (1) "excellent" when about 95 percent of the predicted flow rates are within ±5 percent of the measured discharges, (2) "good" if they are within ±10 percent, (3) "fair" if they are within ±15 percent, and (4) "poor" when they are not within ±15 percent.

Water Budget and TP Mass Budget Methods

The water budget and TP mass budget were calculated from May 1, 2009, to April 30, 2011. The water budget and TP mass budget were also calculated for the reportable event during Tropical Storm Nicole (September 29–30, 2010).

Water Budget

The water budget was calculated as follows:

$\Delta S = I+R-ET\pm Se -O-GW(out)$

Where:

- ΔS = change in water storage=$Stage_t$ - $Stage_{t-1}$, $Stage_t$ is the final stage and $Stage_{t-1}$ is the initial stage
- I = inflow structure flows
- R = rainfall
- ET = evapotranspiration loss
- Se = seepage
- O = outflow weir volume
- GW = Groundwater GW(out) = I+R-ET -O- ΔS(when ± Se=0)

TP Mass Budget

The TP mass budget was calculated as:

$\Delta S_{tp} = I_{tp} + D_{tp} \pm Se_{tp} - O_{tp} - GW_{tp(out)}$

Where:

- ΔS_{tp} = change in TP storage=TP storage change in soil, water, vegetation, unknown
- I_{tp} = TP coming in through inflow pumps
- O_{tp} = TP leaving out of system through outflow pumps
- Se_{tp} = TP pump into system through seepage pumps, no TP measurements and TP seeping out through seepage
- D_{tp} = Deposition estimate based on literature review (Redfield, 2002)
- GW_{tp} = GW losses or gains, unknown

Retained plus lost through groundwater flow $= \Delta S_{tp} + GW_{tp} = I_{tp} + D_{tp} - O_{tp}$

Daily rainfall measurements were obtained from the nearest station available at S-335, evapotranspiration (ET) was estimated using potential evapotranspiration (ET) data at S-331W (**Figure 8**), and TP load was calculated by multiplying the TP concentration with the corresponding flow. TP inflow and outflow loads were calculated using the SFWMD's Nutrient Load Program. TP atmospheric deposition was calculated by multiplying the area and deposition rate (36 $mg/m^2/yr$ from literature compiled by Redfield [2002]). The missing outflow TP concentration (auto-sampler was not triggered) at G-421 was conservatively estimated as equal to the inflow concentration at G-420, because both structures represent the same body of water.

Figure 8. Rainfall and evapotranspiration stations and detention areas.

RESULTS

Flow and Water Budget

The monitoring data for the biennial period (May 1, 2009–April 30, 2011) are presented in Attachment B. Water quality data for all parameters monitored at inflow stations G-420 and G-422 are summarized in Table B-1.

The flows at each structure (**Figure 9**) were as follows:

- Peak flow at G-420_P was 285 cfs and total flow was 1,642 ac-ft
- Peak flow at G-422P was 26 cfs and total flow was 454 ac-ft
- Very little outflow, 25 ac-ft, went through G-421_S
- Peak flow at seepage pump G-420S_P was 3.5 cfs

Total flow volumes in the C-4 EDB for the reporting period are summarized in **Table 6.**

The water budget components including the rainfall (**Figure 10**), ET (**Figure 11**), and storage change (**Figure 12**) are used for water budget calculation. It should be noted from **Figure 12** that the storage changed very fast during Tropical Storm Nicole due to high seepage rates in the C-4 EDB. Little water was continuously stored in the system. The water budget is summarized in **Table 7**. The inflow was the highest in September 2010, which was consistent with the rainfall input to the system.

The stage time series are shown in **Figure 13**. The stage was high during the wet season around October. The water depth reached about 1 ft (stage level 6.3 ft – ground elevation 5.1 ft) during Tropical Storm Nicole.

As shown in **Table** Table**7**, the major inflow components to the water budget is precipitation, and minor inflow component is surface inflow; the major outflow components are ET and groundwater loss (GW).

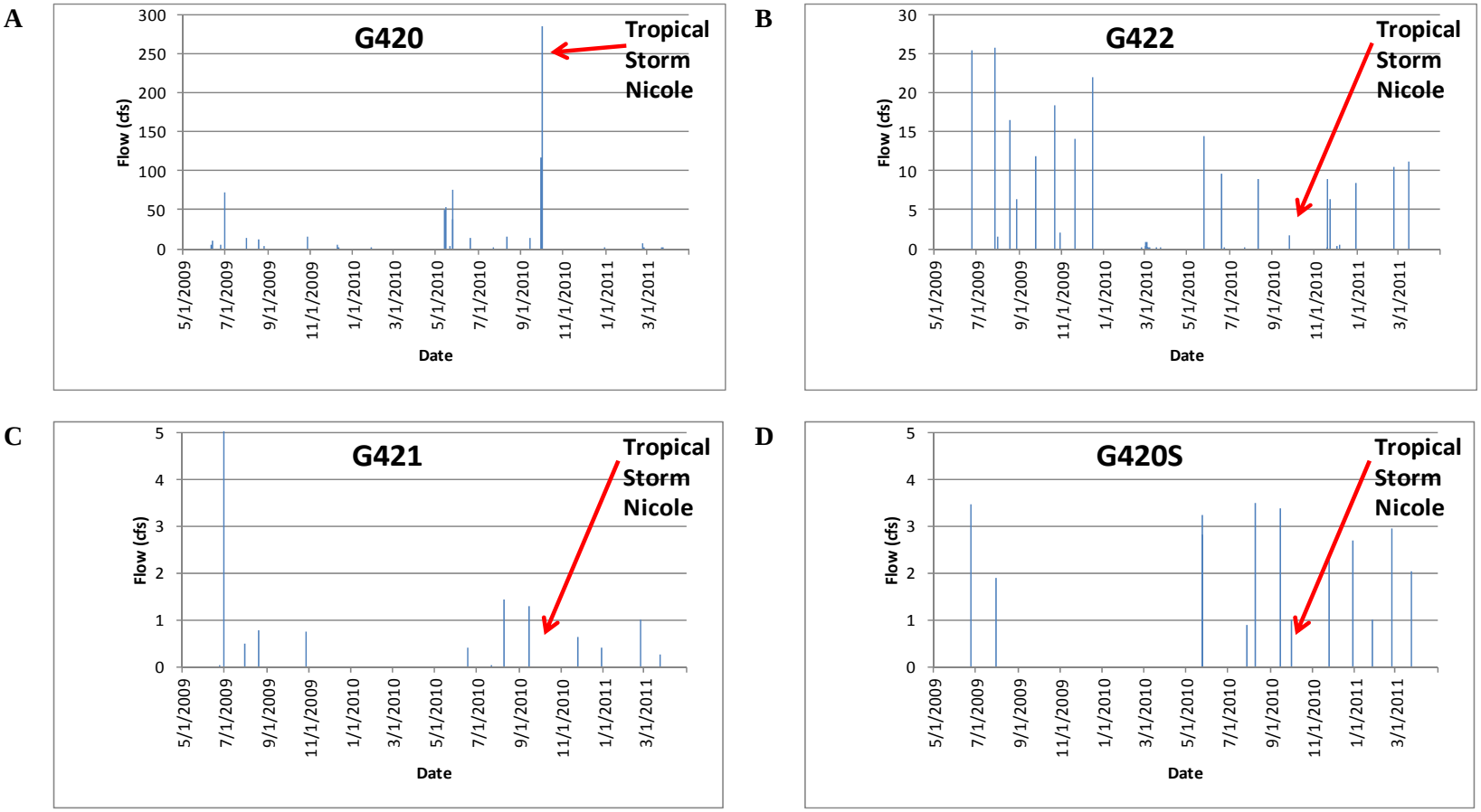


Figure 9. Flow for the C-4 EDB, (A) G-420_O, (B) G-422_P, (C) G-421_S, and (D) G-420S_P.

Table 6. Flow volume and flow-weighted mean total phosphorus concentrations for the C-4 EDB structures (collected May 1, 2009–April 30, 2011).

Type	C-4 EDB STRUCTURE	WATER QUALITY SAMPLING SITE	FLOW		Water Year Flow Vol (Ac-ft)		Total Flow Volume (acre-ft)	Flow weighted TP Concentration (ppb)		TP Load (kg)		Total Load (kg)
			STATION	DBKEY	WY2010	WY2011		WY2010	WY2011	WY2010	WY2011	
inflow	G-420	G420	G420	T0997	295	1,347	1,642	6	7	2.3	11.1	13
	G-422	G422	G422	TS006	291	162	454	6	8	2.2	1.5	4
Outflow	G-421	G421[1]	G421	TA779	15	11	25	6	8	0.1	0.1	0.2

1) Water year 2011 is defined as from May 1, 2010 to April 30, 2011

2) Outflow water quality data were not available, G-420 inflow water quality data were used for G-421 outflow concentration..

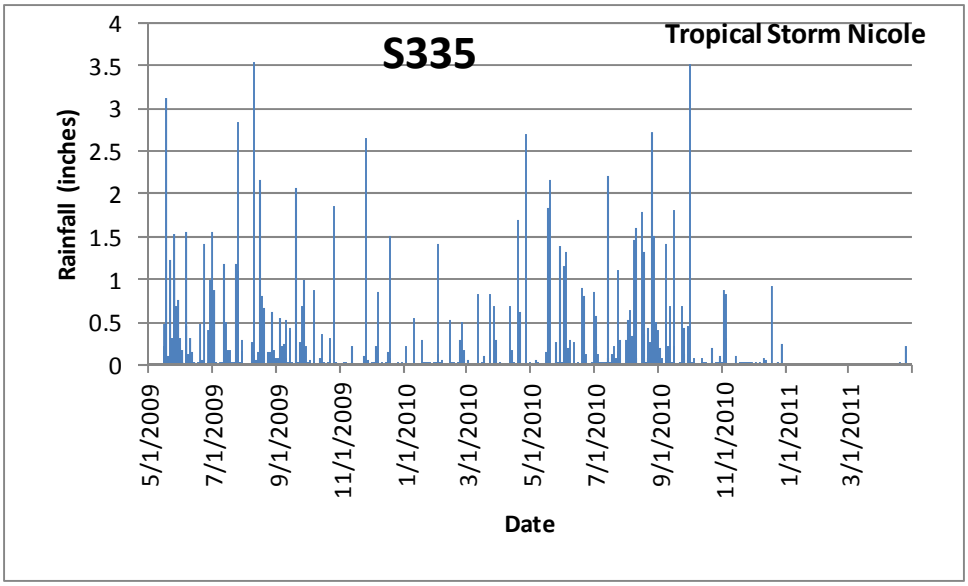


Figure 10. Rainfall for the C-4 EDB.

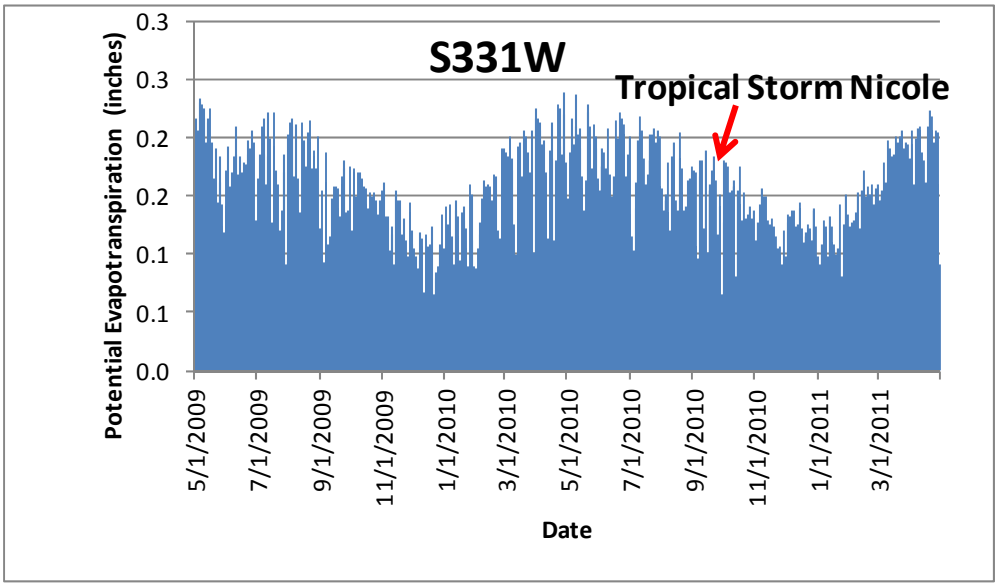


Figure 11. Evapotranspiration for the C-4 EDB.

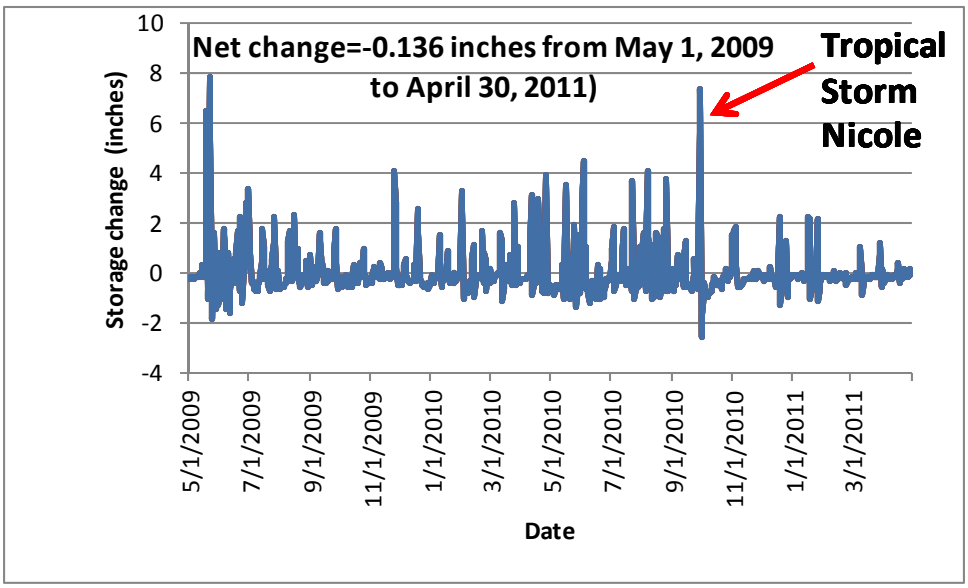


Figure 12. Storage change for the C-4 EDB.

Table 7. Water budget for the C-4 EDB (May 1 2009–April 30 2011).

WY2010		WY2011
66.9	Precipitation (inches)	47.2
51.3	ET (inches)	52.3
8.6	Inflow (inches)[1]	22.2
0.2	Outflow (inches)[1]	0.2
0.2	Seepage recycle (inches)	0.8
24.7	Storage change (inches)	-26.6
-0.7	*GW**	43.5

WY2010 is defined as from May 1, 2009–April 30, 2010

GW(out) =I + R – ET- O - ΔS

[1] Calculated by flow volume divided by total detention area (816 acre).

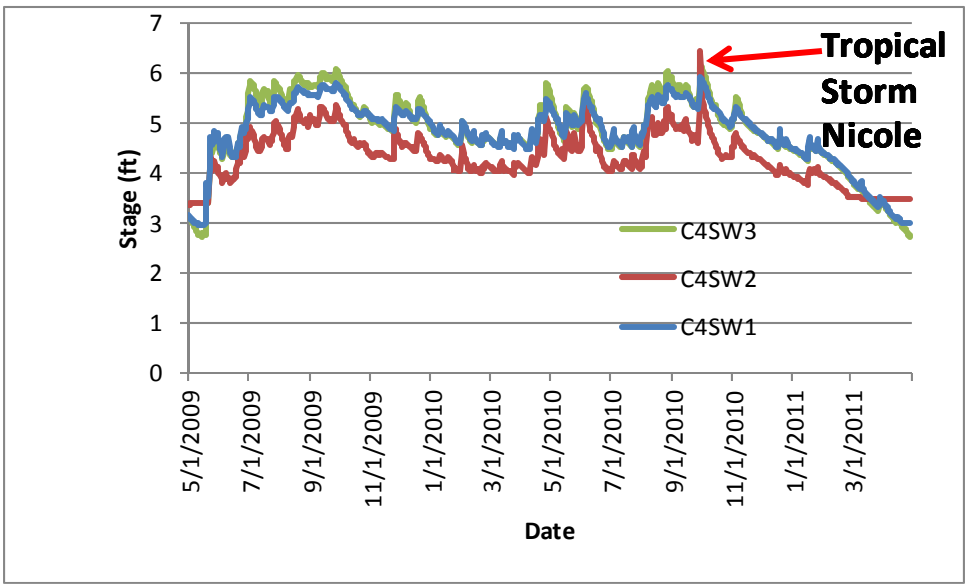


Figure 13. Stage for the C-4 EDB (ground elevation is about 5.1 ft).

TOTAL PHOSPHORUS MASS BUDGET

The TP mass budgets are shown in **Table 8**. During Water Year 2010 (May 1, 2009–April 30, 2010) and WY2011 (May 1, 2010–April 30, 2011), auto-samplers collected no TP sample at the inflow structure G-420 pump station. As shown in **Table 5**, six grab samples were collected at the inflow detention areas (G-420), and there were no TP samples collected at the outflow structure (G-421). The TP data from inflow structure G-420 were used to estimate the outflow concentration in the mass budget calculation, because no outflow TP concentration data were available at G-421 and both structures represent the same water body.

As shown in Table B-1 of Attachment B, TP concentrations at the G-420 monitoring site were 7 ppb for the grab sample. No sample was collected at the G-422 site. The TP concentrations varied from 6 to 9 ppb with a mean TP concentration of 7 ppb, all TP concentrations were less than 10 ppb, the numerical TP Water Quality Criterion for the Everglades, for the biennial reporting period. The TP load to the C-4 EDB was 17.1 kg from inflow structures G-420 and G-422. Since TP data were not available at outflow structure G-421, the outflow TP load was calculated using the inflow TP concentration. The estimated outflow TP load was 0.2 kg. The actual outflow TP load could be less than 0.2 kg because of plant uptake of TP within the C-4 EDB. As shown in **Table 8**, the estimated atmospheric deposition (238.0 kg) is much higher than the inflow TP load (17.1 kg). It is assumed that most of the TP was retained (254.9 kg) in the C-4 EDB or lost through groundwater.

Table 8. TP mass budget in the C-4 EDB (May 1, 2009-April 30, 2011).

	WY2010	WY2011	Total	Tropical Storm Nicole (Sept. 2010)
Atmospheric Deposition (kg)	119.0	119.0	238.0*	0.7
Inflow (kg)	4.5	12.6	17.1	6.9*
Outflow (kg)	0.1	0.1	0.2	0
Retained plus lost through groundwater flow (kg)*	123.4	131.5	254.9	7.5
Percentage			93%	91%

Where retained plus lost through groundwater flow $=\Delta S_{tp+}$ $GW_{tp} = I_{tp} + D_{tp} - O_{tp}$

The event-based (Tropical Storm Nicole) TP mass budgets are illustrated in **Figure 14** and the biennial TP mass budget is illustrated in **Figure 15**. On an event basis, surface water inflow from G-420 and G-422 for the September 2010 storm was the major TP contributor (6.9 kg) to the C-4 EDB compared to atmospheric deposition (0.7 kg) and outflow TP (0 kg). The retained TP plus the amount lost through groundwater accounted for 7.5 kg. As shown in **Figure 15**, from May 2009 through April 2011, atmospheric deposition was the major (238 kg) contributor to the TP load compared to the surface water inflow from G-420 and G-422 (17.1 kg) and outflow pump (0.2 kg). The retained TP plus the amount lost through groundwater accounted for 254.9 kg.

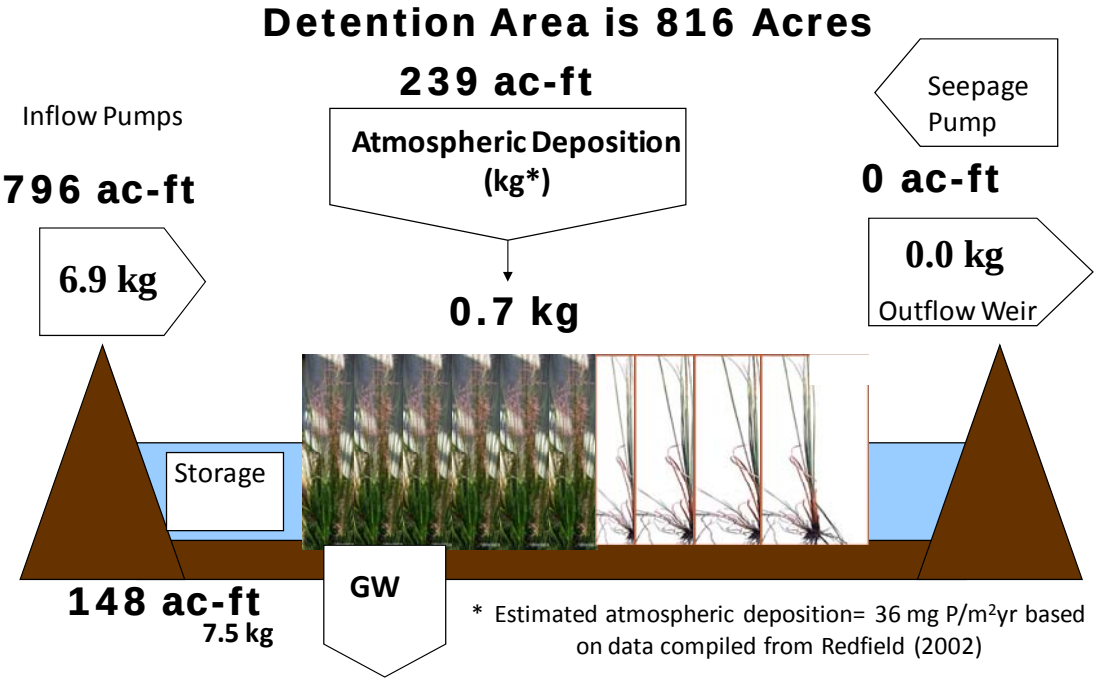


Figure 14. TP mass budget for Tropical Storm Nicole flood control pumping event in the C-4 EDB.

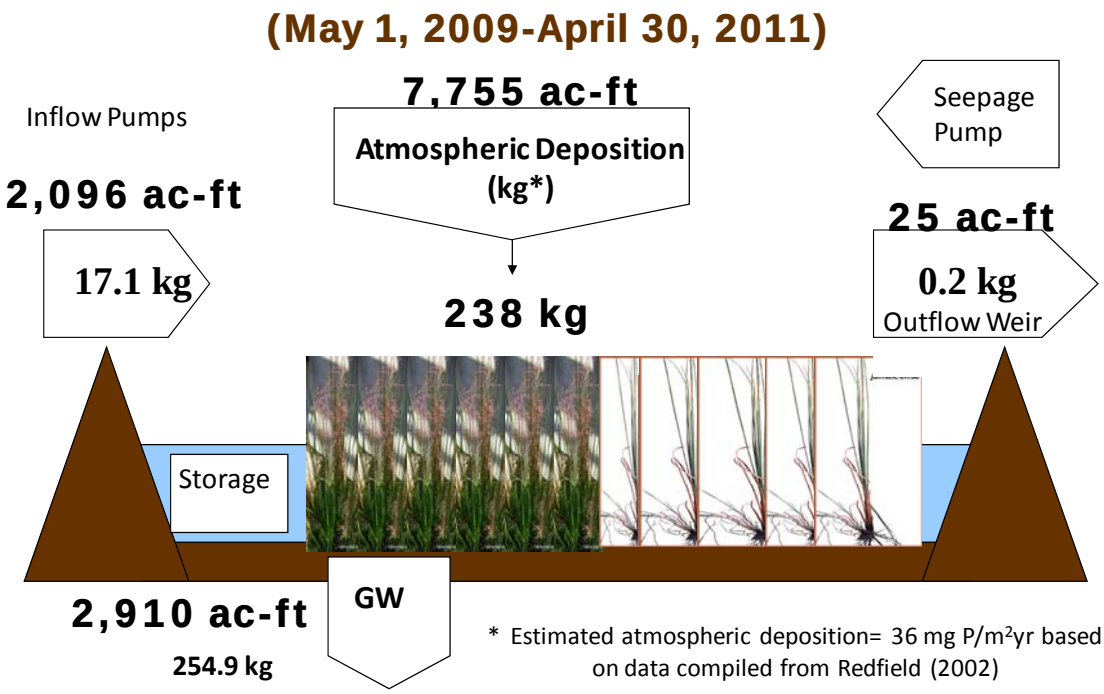


Figure 15. TP mass budget for May 1, 2009–April 30, 2011, in the C-4 EDB.

HIGHLIGHTS

The water budget and total phosphorus mass budget calculations indicate that:

- The major inflow component to the water budget was precipitation and the minor inflow component was surface inflow; the major outflow components were ET and groundwater loss.
- The C-4 EDB was a net sink for TP for the one reportable event associated with Tropical Storm Nicole, with 91 percent TP retention plus loss through groundwater.
- The C-4 EDB was a net sink for TP for the biennial reporting period (May 1, 2010–April 30, 2011), with more than 93 percent TP retention plus loss through groundwater.
- Surface water inflow loads predominated on an event basis, but atmospheric deposition predominated for the biennial reporting period.
- The outflow TP mass load from C-4 EDB was very small (less than 0.2 kg).
- Mean TP concentrations of 7 ppb in the C-4 EDB were less than 10 ppb, which is the numerical TP Water Quality Criterion for the Everglades for the biennial reporting period.

INCIDENTAL WILDLIFE

METHODOLOGY

Incidental to the ground-truthing of the aerial photographs (Task 3.2 of the statement of work), qualitative wildlife utilization observations were recorded in a field notebook. Both direct and indirect observations were recorded, including tracks, burrows, and eggs. Field observations were made at each ground-truthing station. In addition, any incidental faunal observations made while traveling between and to stations was documented. The field notebook was reviewed by the field supervisor within seven calendar days of the field event. The entries were uploaded to a Microsoft Excel spreadsheet. The page(s) from the field book was also electronically scanned into the computer (Attachment J).

RESULTS

Widespread wildlife was not observed at the C-4 EDB at the time of the 2011 incidental wildlife surveys (**Table 9**). This paucity of wildlife may be attributed to fire. On March 4, 2011, a wildfire occurred in the Phase II basin. A prescribed burn was also conducted in the Phase I basin on April 4, 2011. At the time of the surveys, vegetation had not sufficiently recovered and did not provide good habitat for fauna. Much of the basin remained bare and offered little to no protection from predation. Animals capable of travel outside of the C-4 EDB were dominant (i.e., birds) within the basin. Additionally, lubber grasshoppers (*Romalea microptera*) were common within 21 days of the prescribed burn. Other evidence of animal use includes large quantities of burrows used by the southern toad (*Anaxyrus terrestris*) and multiple turtle carapaces that likely burned in the fires. Live turtles were also observed in the canal surrounding the detention basin.

A previous survey (2009 Vegetative Monitoring Report) shows that this region is widely used by megafauna including deer, raccoon, and alligators. The absence of these taxa further suggests that fire may have negatively impacted habitats of this region.

Table 9. Incidental wildlife observations.

Name		Date			
Common	**Scientific**	**4/25/11**	**4/26/11**	**4/27/11**	**4/28/11**
Common nighthawk	*Chordeiles minor*		✓		
Eastern meadowlark	*Sturnella magna*		✓		
Northern mockingbird	*Mimus polyglottos*		✓		
Killdeer	*Charadrius vociferus*		✓		
Turkey vulture	*Cathartes aura*	✓	✓	✓	✓
Halloween pennant dragonfly	*Celithemis eponina*		✓		
Southern Toad	*Anaxyrus terrestris*			✓	✓
Lubber	*Romalea microptera*	✓	✓	✓	✓
Golden Silk Orb Spider	*Nephila* sp.		✓		
Turtle	Unknown	✓	✓	✓	✓

WETLAND RAPID ASSESSMENT PROCEDURE

INTRODUCTION

The Wetland Rapid Assessment Procedure (WRAP; Miller, 1997) is a rating index developed by the District to assist the regulatory evaluation of mitigation sites (created, restored, enhanced, or preserved) that are permitted through the SFWMD's Management and Storage of Surface Waters or Environmental Resource Permit processes. The objectives of WRAP are to (1) establish an accurate, consistent, and timely regulatory tool, (2) track trends over time (land use versus wetland impacts), and (3) offer guidance for environmental site plan development.

WRAP analysis for the C-4 EDB has been completed every other year starting in 2005 and has been used to track ecological trends over time. WRAP has been used consistently with its overall objectives to utilize as much information as possible and organize it in a simple but accurate rating.

METHODOLOGY

WRAP scores a wetland on wildlife utilization, wetland overstory/shrub canopy, wetland vegetative ground cover, adjacent upland/wetland buffer, field indicators of wetland hydrology, and water quality input and treatment systems. Each variable is evaluated and scored between 0 (severely impacted) and 3 (best ecosystem function). Variables not applicable to the wetland are excluded from the final analysis. The variables are scored, totaled, and then divided by the maximum possible total score. When properly done, each variable will result in a score between zero and one. The final score is expressed as:

WRAP Score = V/Vmax

Where: V: sum of the scores for the rated variables

Vmax: sum of maximum possible scores for the rated variables

The wildlife utilization variable is a measure of observations and signs such as scat and tracks of wildlife, primarily wetland-dependent species. In addition, potential wildlife use through the presence of wildlife food sources, nesting areas, roosting areas, den trees, protective cover and landscape position is also considered. To receive a score of 3, a wetland must provide habitat for multiple trophic levels within a food chain associated with that particular system and strong evidence of wildlife utilization must be present. This evidence includes proof of use by large mammals and reptiles and abundant cover for wildlife within the wetland.

The wetland overstory/shrub canopy variable is a measure of the health and appropriateness of the wetland shrub and overstory canopy. The assessment of the canopy variable is objectively evaluated based on food resources, cover, nesting potential, and appropriateness of the vegetative community. The canopy stratum is evaluated based on the habitat type. This variable may not be applicable to freshwater marsh and wet prairie habitats where overstory/shrub canopy is typically not present (less than 20 percent).

The vegetative ground cover variable is a measure of the presence, abundance, appropriateness, and condition of vegetative ground cover within the wetland. To achieve a score of 3 for this variable, the wetland must have less than 10 percent nuisance and inappropriate plant species with no exotic species.

The adjacent upland/wetland buffer variable is a measure of the area adjacent to the subject wetland and the landscape setting of the wetland. This variable is evaluated based on the adjacent buffer size and the ecological attributes (e.g., cover, food source, roosting areas for wildlife) that

the area provides in association with the wetland that is being assessed. WRAP guidelines recommend a score of 3 for adjacent lands that are less than 10 percent nuisance species and a 2 for adjacent lands that are 75 percent or more undesirable noninvasive plant species.

The wetland hydrology variable is a measure of the hydrologic regime based on observed field indicators for the subject wetland including hydroperiod duration and magnitude. Wetland hydrology is generally interpreted using vegetative indicators. In addition, hydrologic indicators such as lichen lines, algal mats, adventitious roots, and basal scarring are also utilized. Signs of altered hydrology may include encroachment of upland and transitional plant species into the wetland. WRAP requires conditions "adequate to maintain a viable wetland system although external features may affect wetland hydrology" (Miller, 1997). To receive a score of 3, a wetland must have a natural hydroperiod and cannot be adjacent to canals, swales, berms, or wellfields.

The water quality variable of the rating index is a measure of the quality of the surface water flowing into the subject wetland from adjacent land uses (LU). The percent and type of surrounding land uses as well as any on-site pretreatment (PT) of surface waters prior to the discharge into wetlands is considered. If the wetland is totally isolated from the surrounding area by a berm or levee and water budget consists only of rainfall, a score of 2.75 should be given (Miller, 1997).

RESULTS

A score of 1.5 was given for the wildlife utilization variable. This represents a 50 percent functional loss in this wetland. Incidental wildlife monitoring at the C-4 EDB did not find evidence of any large mammals; however, use by small birds, small reptiles, burrowing amphibians, and insects was apparent. These data suggests that the C-4 EDB score should range between 1 (minimal wildlife usage) and 2 (moderate wildlife usage). At the time of the incidental wildlife surveys and WRAP analysis, the C-4 EDB was recovering from a prescribed burn in Phase I and wildfire in Phase II. These fires dramatically reduced the habitat and food resources for wildlife. It is likely that this score would have been higher had the surveys occurred after a longer recovery period.

The wetland overstory/shrub canopy was not scored. Wet prairie covers more than 95 percent of the C-4 EDB (see the *Vegetative Monitoring Report* section). The WRAP guidelines recommend that wetlands that typically lack canopies such as wet prairies not be scored for this variable.

The wetland vegetative ground cover was given a score of 2.5. The presence of the nuisance species melaleuca and *Typha* spp. prevented a score of 3. The C-4 EDB contains less than 25 percent undesirable ground cover plant species and has had limited human impacts to the wetland; therefore the basin does exceed the WRAP requirements for a score of 2. A score of 2.5 was given for the wetland since the wetland exceeded requirements for a score of 2, but failed to meet requirements for a 3.

The adjacent upland/wetland buffer was given a score of 1.56. The C-4 EDB is bordered to the north by a large active quarry and U.S. Highway 41 (Tamiami Trail) to the south. These areas offer no ecological value to the basin as a buffer. Conversely, there are undeveloped natural areas to the east and west that provide ecological value as a buffer but are dense with melaleuca and other undesirable species. The east and west boundaries are between the two guidelines and thus were given a score of 2.5. To calculate the total score, each buffer type was multiplied by the adjoining percentage and then summed to give a total adjacent upland/wetland buffer score of 1.56.

The C-4 EDB was given of score of 2 for hydrology. The WRAP criteria met included a healthy wetland plant community and little evidence of soil subsidence. However, the C-4 EDB hydrology is controlled artificially and is surrounded by canals and berms, so it failed to meet the more stringent criteria for a score of 3.

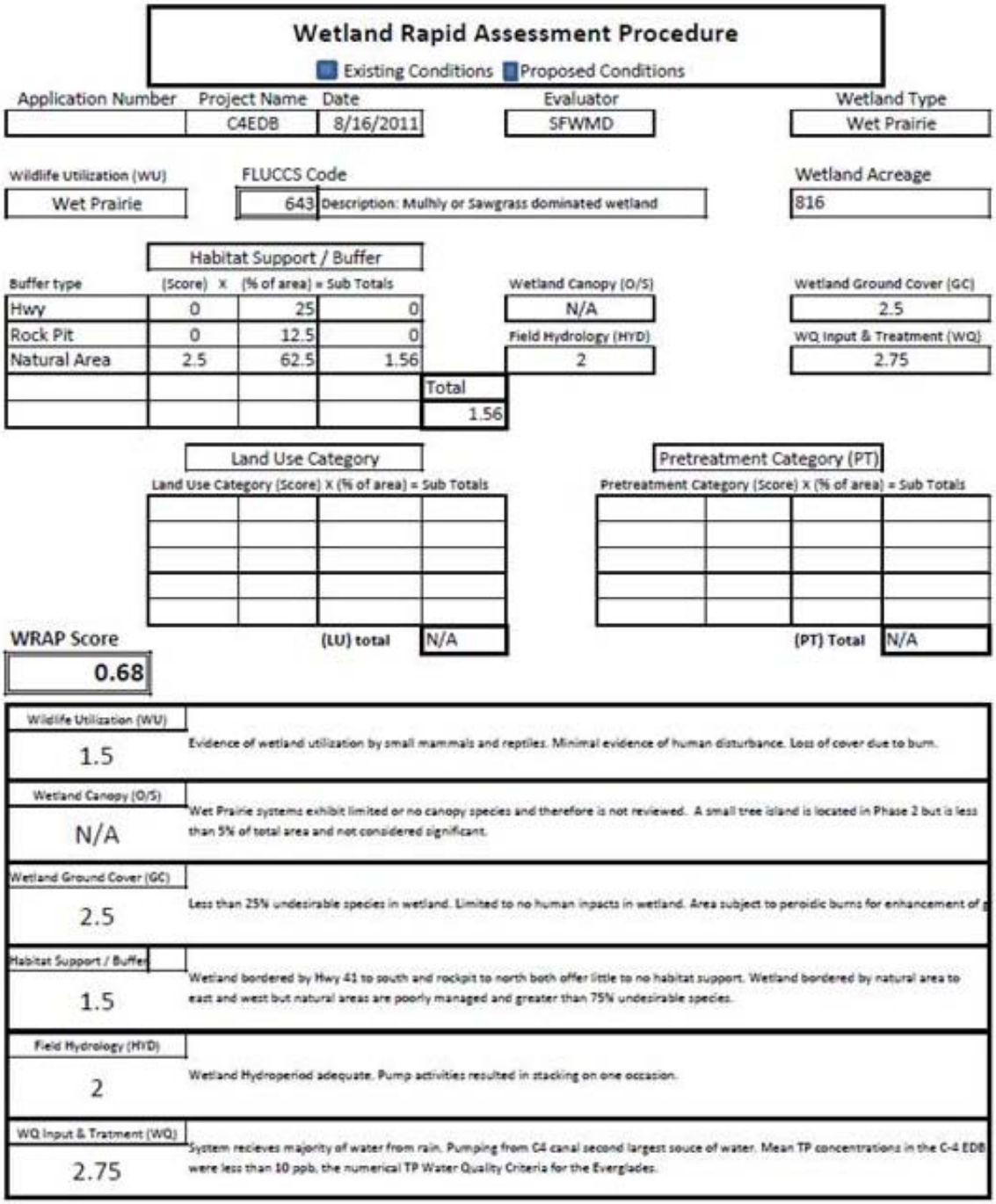
The WRAP guidelines recommend using a score of 2.75 when the wetland is isolated and rainfall driven. C-4 EDB is not solely driven via rainfall; however, rain made up the majority of the water budget for WY2010 and WY2011. The remaining 21 percent of the water budget is flow in as surface water from the C-4 canal. Phosphorus concentrations and quantities from surface water flow were lower than the phosphorus that entered as rainfall (see the *Total Phosphorus* section). Because of the inconsequential phosphorus input from surface flow relative to rainfall, surface flow was not factored into the WRAP score for this variable.

The total WRAP score for the C-4 EDB was 0.68 (**Table 10** and **Figure 16**). In previous years, Phase I and Phase II of the C-4 EDB were evaluated separately; however, the 2011 evaluation combined both because of similarities. Mean results of Phase I and Phase II scores from previous years (2009, 2007, 2005, and baseline studies) were compared to the 2011 score. As noted in previous reports, there may be some discrepancies due to subjective influences of the different reviewers.

The 2011 score was lower than in years past, which is attributed to lower scores in two variables. First, the C-4 EDB experienced a wildfire and prescribed burn that had a deleterious effect upon the wildlife utilization score. Second, the lower score for the adjacent upland/wetland buffer may in part be explained by natural factors such as by expansion of exotics in adjacent areas and in part by differing judgments of the analysts when evaluating this variable.

Table 10. Comparison of Wetland Rapid Assessment Procedure (WRAP) scores for the C-4 EDB.

	Baseline	2005	2007	2009	2011
WRAP Score	0.74	0.79	0.81	0.82	0.68



Wetland Rapid Assessment Procedure

Existing Conditions Proposed Conditions

Application Number	Project Name	Date	Evaluator	Wetland Type
	C4EDB	8/16/2011	SFWMD	Wet Prairie

Wildlife Utilization (WU)	FLUCCS Code		Wetland Acreage
Wet Prairie	643	Description: Mulhly or Sawgrass dominated wetland	816

Habitat Support / Buffer

Buffer type	(Score) X	(% of area) = Sub Totals		Wetland Canopy (O/S)	Wetland Ground Cover (GC)
Hwy	0	25	0	N/A	2.5
Rock Pit	0	12.5	0	Field Hydrology (HYD)	WQ Input & Treatment (WQ)
Natural Area	2.5	62.5	1.56	2	2.75
			Total		
			1.56		

Land Use Category

Land Use Category (Score) X	(% of area) = Sub Totals		
		(LU) total	N/A

Pretreatment Category (PT)

Pretreatment Category (Score) X	(% of area) = Sub Totals		
		(PT) Total	N/A

WRAP Score

0.68

Wildlife Utilization (WU)	
1.5	Evidence of wetland utilization by small mammals and reptiles. Minimal evidence of human disturbance. Loss of cover due to burn.
Wetland Canopy (O/S)	
N/A	Wet Prairie systems exhibit limited or no canopy species and therefore is not reviewed. A small tree island is located in Phase 2 but is less than 5% of total area and not considered significant.
Wetland Ground Cover (GC)	
2.5	Less than 25% undesirable species in wetland. Limited to no human inpacts in wetland. Area subject to peroidic burns for enhancement of p
Habitat Support / Buffer	
1.5	Wetland bordered by Hwy 41 to south and rockpit to north both offer little to no habitat support. Wetland bordered by natural area to east and west but natural areas are poorly managed and greater than 75% undesirable species.
Field Hydrology (HYD)	
2	Wetland Hydroperiod adequate. Pump activities resulted in stacking on one occasion.
WQ Input & Tratment (WQ)	
2.75	System recieves majority of water from rain. Pumping from C4 canal second largest souce of water. Mean TP concentrations in the C-4 EDB were less than 10 ppb, the numerical TP Water Quality Criteria for the Everglades.

Figure 16. WRAP scoresheet for the 2011 C-4 EDB survey.

INTENSIVE VEGETATION SURVEY

METHODOLOGY

To monitor the changes in vegetation habitat in the C-4 EDB, the SFWMD conducts biennial intensive vegetation surveys. These surveys have been conducted since the inception of the C-4 EDB. Vegetation is surveyed at 11 sites in the basin (**Figure 17**). Each survey site was established during project baseline surveys. Before the 2011 surveys, the site had to be reestablished using GPS because the location markers had fallen into disrepair. Once the locations were reestablished, a 10x10-meter quadrate was marked. Each quadrate was surveyed for vegetative percent cover and species presence. Species were identified in the field when possible; otherwise, they were taken to the SFWMD botanist for identification. Results were recorded and compared to previous surveys to evaluate trends over time. For each site, the 2011 percent vegetative coverage was compared with the 2009 percent vegetative coverage. In addition, the change from 2009 to 2011 in the presence or absence of a species was noted. These changes were examined to look for trends in vegetation habitat of the C-4 EDB.

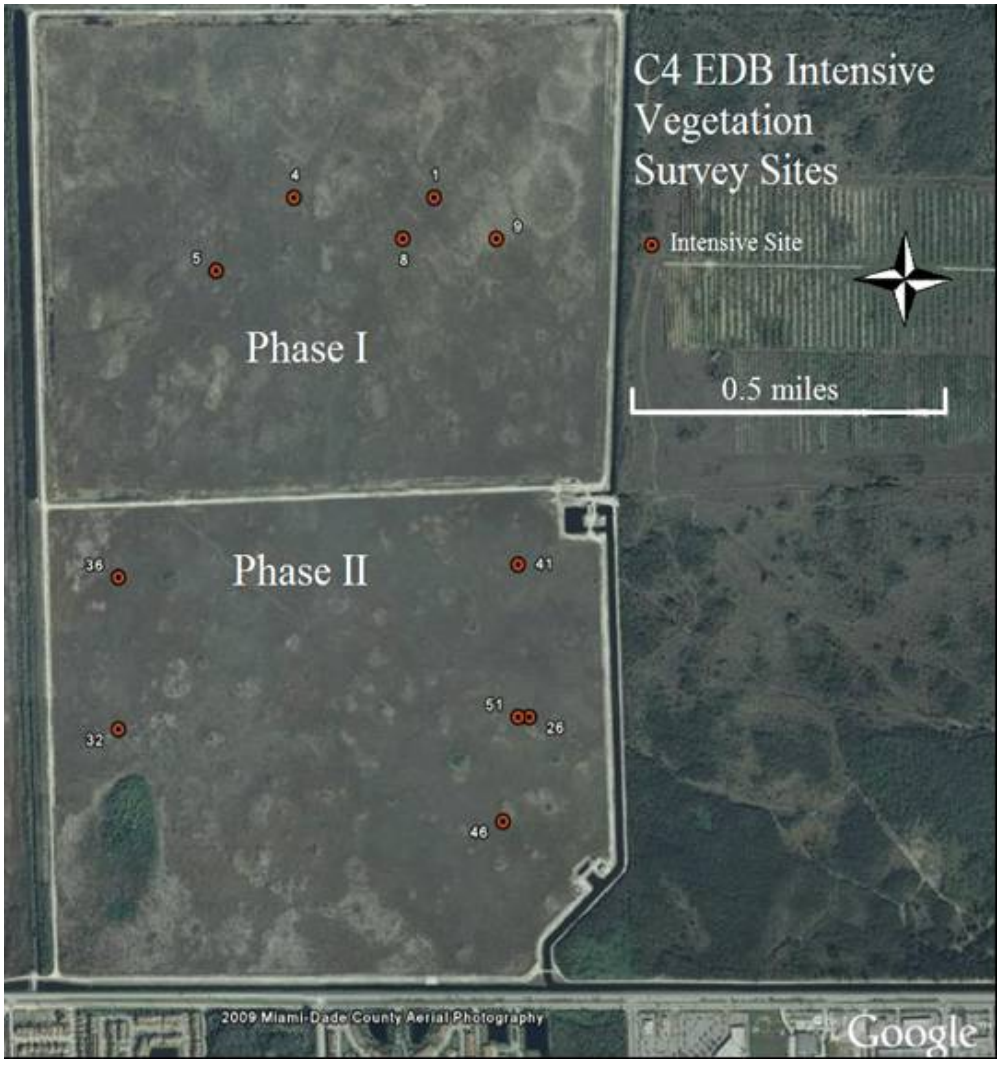


Figure 17. Intensive vegetation survey sites.

RESULTS

Prior to the intensive vegetation surveys, a prescribed burn occurred in Phase I and a wildfire in Phase II of the C-4 EDB. The wildfire and prescribed burn happened approximately two months and one month, respectively, before intensive surveys were completed. These fires affected the vegetative percent cover. As a result, the largest increase in a category for all sites was Open Dead/Periphyton/Algae.

The low vegetative percent cover result is not a negative development for the C-4 EDB natural community. Fire is a natural part of the wet prairie ecosystem and although the percent coverage is temporarily lower, the species that were recovering were species that are expected to form such a habitat. If the intensive surveys were completed at a time when species had more time to recover, the percent vegetative cover would be much higher and in line with the previous years' surveys.

A more useful metric than percent vegetative cover may be species presence. The list of species present in the past years' surveys is almost unchanged for the 2011 survey and the dominant species in 2011 were the same as 2009 and 2007. For example, muhly grass (*Muhlenbergia capillaris*) and sawgrass (*Cladium jamaicense*) were found at all sites in 2011, an increase for muhly grass of one site and two additional sites for sawgrass in comparison with 2009. The largest decrease in plant species presence was coastal plain St. John's wort (*Hypericum brachyphyllum*), which decreased 75 percent from 2009 to 2011 and bluestem (*Andropogon* sp.), which decreased 87 percent in the same period. The largest increases in species were for spadeleaf (*Centella asiatica*), which increased 50 percent since 2009, and needleleaf witchgrass (*Dichanthelium aciculare*) and fingergrass (*Eustachys* sp.), which increased 54 percent.

Witchgrass and fingergrass are both facultative upland (FACU) plants and their presence could be explained by the dryer conditions in the C-4 EDB than in previous reporting periods. Spadeleaf is a facultative wetland (FACW) plant; its greater prevalence may be due to reduction of other species caused by fire. As other species, such as muhly grass and sawgrass mature, they will likely block further growth of spadeleaf. Melaleuca, which is listed as a category one noxious weed by the U.S. Department of Agriculture and the Florida Exotic Pest Plant Council, was found at four sites in 2011, an increase of one from 2009.

Additional intensive vegetation survey data are provided in Attachment E.

VEGETATIVE MONITORING REPORT[1]

INTRODUCTION

A six-year biennial monitoring program was established to detect, quantify, and report significant changes in vegetative communities within the Phase I (north) and Phase II (south) basins of the C-4 EDB. This section presents the results for the fourth post-construction vegetation monitoring event. As with previous studies, density and percent coverage of vegetative species within the impoundment basins were assessed and mapped. However, as a result of burns in C-4 EDB on March 5, 2011 (Phase II) and April 4, 2011 (Phase I), other parts of the project had to be scaled back. At the time of image acquisition (March 7, 2011), Phase II had already been burned, so only Phase I was compared to the previous monitoring events, which occurred in 2009, 2007, 2005 and to the pre-construction baseline studies conducted in 2003 and 2002.

The major findings from the fourth post-construction vegetation monitoring event are as follows:

- As with 2009, no living melaleuca trees were noticeable in either the aerial imagery or field photo transects. However, a field survey revealed melaleuca saplings and immature trees in the northeast half of the Phase I basin. These occurrences are isolated, surrounded by healthy wetland species, but will increase in dominance with time. The recent burns in the Phase I and Phase II raises some concern over melaleuca propagation, as it is a fire-adapted species that responds well to post fire conditions.
- Recovery from areas identified as treated for melaleuca continues, although significant relic treated melaleuca stands persist. Between 2009 and 2011, there appears to be significant increase in shrub species occupying treated areas, particularly wax myrtle (*Myrica cerifera*). A field survey conducted post fire (May 25, 2011) indicated that these species were only modestly affected by the burns on March 5, 2011 (Phase II) and April 4, 2011 (Phase I). Plants observed were already showing signs of new growth.
- In Phase I, muhly-dominated wet prairie has expanded more than any other community, and is the second largest community behind mixed wet prairie. The increase in muhly-dominated wet prairie is consistent with the 2009 trend. Low density wet prairie continues to decrease in areas adjacent to recovering wet prairie in treated melaleuca, evolving into denser wet prairie communities. As observed in previous studies, the low density wet prairie is largely associated with past overspray from melaleuca treatment. Open areas appear most persistent in wetter areas adjacent to sawgrass prairie. As noted in 2009, these open areas contained an abundance of periphyton. General patterns of Phase I, however, have not significantly changed.
- As a result of an accidental fire, over 90 percent of Phase II was burned on May 5, 2011, with the areas showing greatest effects to be those previously identified as recovering wet prairie in treated melaleuca. This is likely the result of higher fuel loading. The unburned areas were the majority of the tree island in the southwest corner (burned only around its perimeter) and muhly grass wet prairie in the northeast corner.

[1] Adapted from a report prepared by Boodjamap, Inc., West Palm Beach, FL

Upon completion of the program, there will have been a total of four monitoring events over the six-year monitoring program. Monitoring is scheduled to occur every other year, with the first monitoring having been completed in 2005. This section summarizes the results of the fourth vegetation monitoring event, which occurred in 2011, and is the final event in the series. This work is being performed under South Florida Water Management District work order #4500059544.

This monitoring effort complies with the monitoring conditions as identified in the permits, and subsequent permit modifications, issued by the FDEP, USACE, and Miami-Dade County Department of Environmental Resource Management (DERM).

The primary vegetation monitoring objectives include:

- Monitor the density and percent cover of vegetation at the habitat level within the impoundment areas, as compared to previously reported levels
- Detect and monitor the presence, increase, or decrease of invasive exotic or nuisance species, as compared with previously reported levels

The total area of the impoundment basins is approximately 806 acres (ac). Vegetative monitoring was conducted to determine and report changes in the vegetative communities within these basins associated with activities such as water impoundment and melaleuca eradication. Original baseline (i.e., pre-construction) studies were conducted in 2002 and 2003 in accordance with original permit requirements. Since that time, a revised monitoring methodology has been developed to detect, quantify, and report potential changes in the vegetative communities. The new vegetative monitoring methodology involves the use of high resolution aerial imagery, photo interpretation, and field ground-truthing to produce a map illustrating the habitat composition within each basin. The first monitoring effort using the new methodology was completed in July 2005 and the results were documented in the Vegetative Monitoring Report dated July 2005 (SFWMD Work Order No.: C19902P-WO 05). Each subsequent report has followed the same methodology. This report, however, represents significant differences from prior studies due to recent burns in the project area. The method was altered, incorporating high-resolution photo transects as part of the ground-truthing process. Further, the scope was altered, focusing on Phase I, and removing WRAP analysis and field plot sampling (to be completed at a later date). Unlike the 2009 study, in 2011 only Phase I was compared to the prior year results to determine the types and magnitude of vegetation changes.

Figure 18. Project location of the C-4 EDB Phase I and Phase II. The C-4 EDB is composed of a north basin (Phase I) and a south basin (Phase II).

METHODOLOGY

Aerial Imagery

Aerial imagery for the project was collected by Aerial Cartographics of America, Inc under work order 4600000942-WO07 on March 7, 2011. Collection involved obtaining large format RGB Infrared (IR) aerial imagery over the entire project area using an UltraCam X, S/N UCX-SX-1-10817438 camera at a 16-inch ground resolution, on one strip of 25 exposures, with 90 percent overlap between exposures along the track. The mapping limits were contained within 23 stereo models (see **Figure 19**).

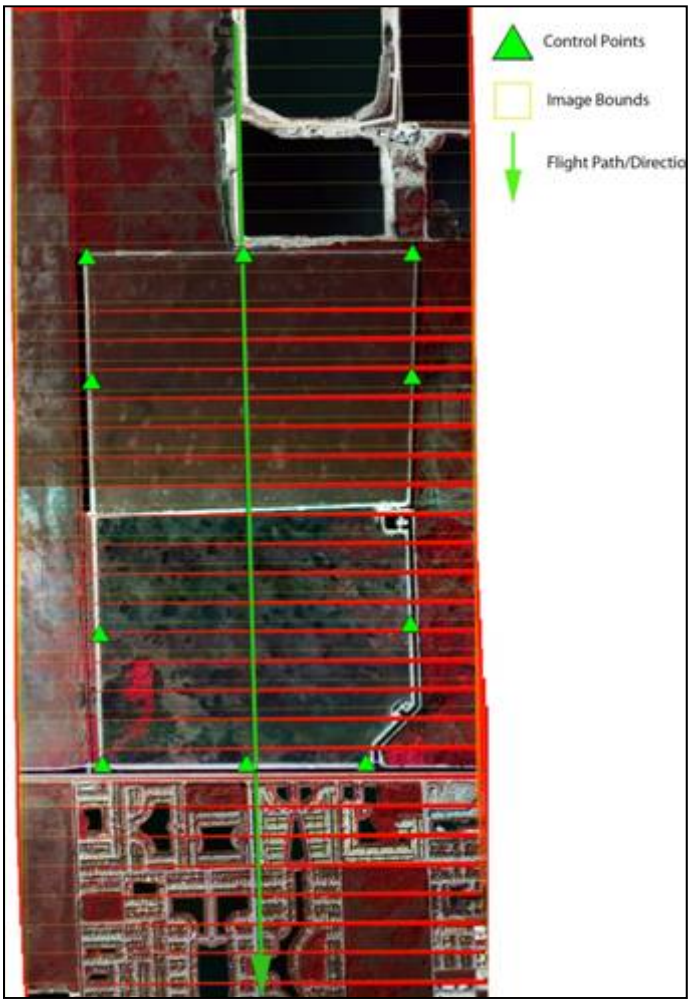


Figure 19. Aerial image bounds/control layout.

Ten ground control points were used within the project area to support the photogrammetric compilation of two-dimensional (2-D) polygons. Since the flight layout was the same as that used in 2005, 2007, and 2009, the same survey control stations were used. Each point was targeted (8x8x2-ft) prior to aerial imagery acquisition. This was completed by the SFWMD on March 2, 2011. Targets were verified and repaired where necessary.

Geo-referencing of the imagery was accomplished via direct referencing using post processed airborne global positioning systems (ABGPS) and inertial measurement unit (IMU) data and

included aero-triangulation with additional targeted ground control. Digital aero-triangulation to develop stereo models was performed by the SFWMD using Inpho Match AT software. At less than 1 ft, the aero-triangulation met the required horizontal positional accuracy of 9.84 feet at the 95 percent confidence interval (Accuracy = 1.7308 * $RMSE_h$ so $RMSE_h$ = 5.77 feet) as specified in the Federal Geodetic Data Committee (FGDC) Geospatial Positioning Accuracy Standards, Part 3: National Standard for Spatial Data Accuracy (FGDC-STD-007.3-1998) and resulted in parallax-free stereo imagery suitable for three-dimensional (3-D) feature extraction. More detailed information about Stereo-Imagery Rectification Accuracy can be found in Attachment F.

Aerial Photo-transects

In 2009, to assist in the visual interpretation of the aerial imagery, pre-flight ground targets were set in the field to provide a visual reference for the varying habitats. This process was altered in 2011. On March 7, 2011 [the same acquisition date as that of large format RGB Infrared (IR) aerial imagery], environmental scientists of Boodjamap, Inc., in conjunction with the SFWMD, flew four high resolution oblique photo helicopter transects over Phase I and Phase II (see **Figure 20**). Almost 700 oblique photos were collected at a height of between 5 m and 25 m above ground, by two photographers using Canon EOS 20D SLR digital cameras (8.2MP with EF-S 18-55mm f/3.5-5.6 Lens). Simultaneously, GPS coordinates were collected at one-second intervals with a Trimble ProXR differential GPS (1 meter accuracy before differential correction) and a Dell Laptop installed with ArcPad 7.1 acting as a data logger. Using the 'time' attributes in the GPS trackfile and the image time stamp in the XML header of the image files, each photo was assigned spatial coordinates based on when the photo was taken. Further, using the GPS trackfile 'course of ground' attribute, and the known position of helicopter photographers (front left hand side and front right hand side), a compass bearing was calculated for each showing its relative direction.

The resolution and coverage of high resolution oblique photo helicopter transects can provide unparalleled field data for developing community level vegetation maps. If the Environmental Scientist/GIS Specialist is familiar with the region's ecology, high resolution oblique photo helicopter transects offer an easy means to positively identify Florida Land Use, Cover and Forms Classification System (FLUCFCS) to higher order levels (III and IV) at any given location along their path. When these data are viewed at the same time as stereo imagery, they can be used to determine the unique spectral and spatial characteristics of each habitat class, making delineation more efficient and accurate. All relevant trackfiles, field photographs, and spatial data are contained in the digital files accompanying this document.

As a result of the April 4, 2011 (Phase I) burn, it was apparent that data from the high resolution oblique photo helicopter transects would be necessary to accuracy check the habitat classification. Points used to perform the accuracy check were not used as part of the mapping process. These data are discussed in the *Quality Control* section of this appendix.

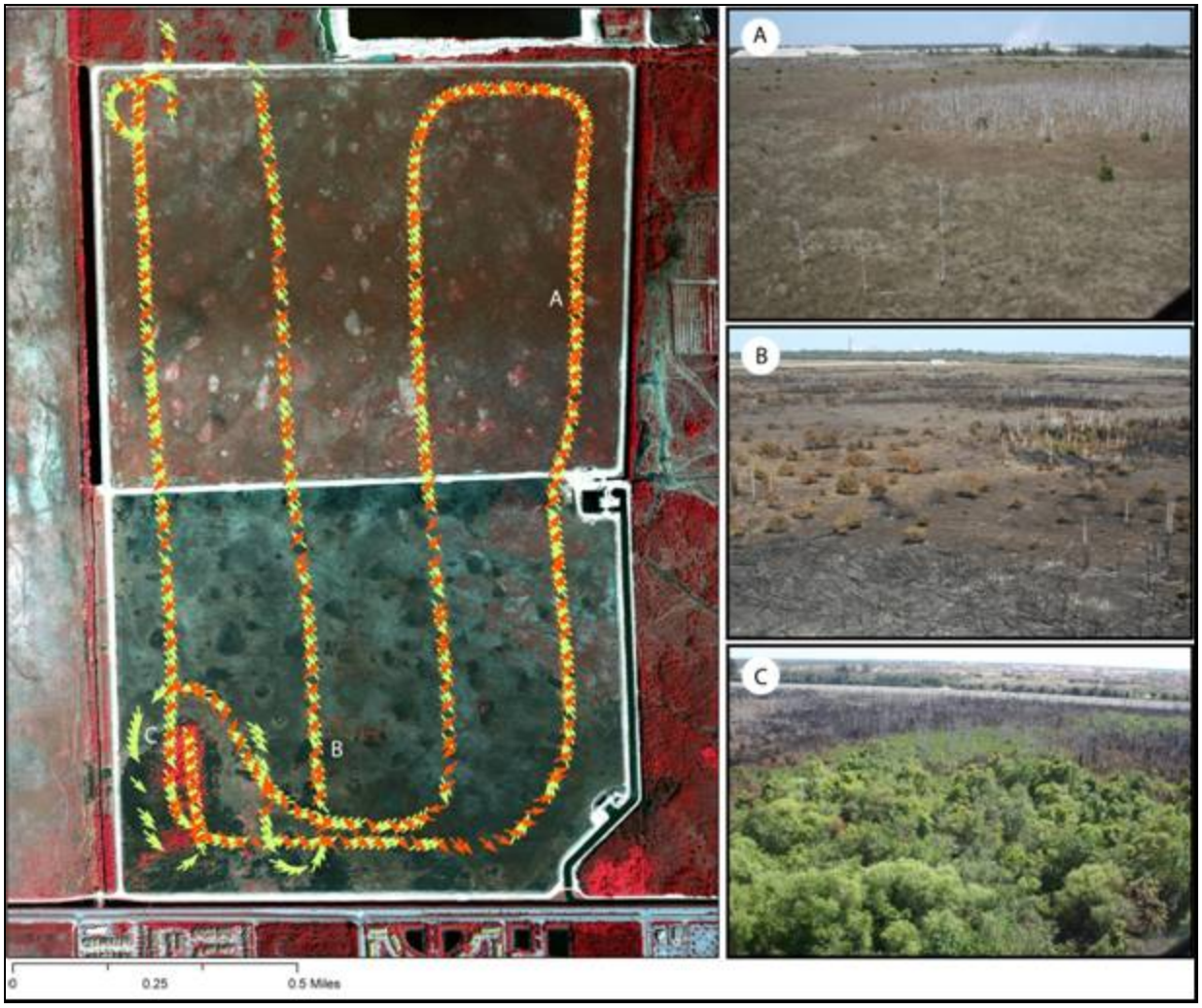


Figure 20. High resolution oblique photo transects. (A) Patchy muhly wet prairie adjacent mixed/recovering prairie, Phase I; (B) burned recovering wet prairie adjacent burned prairie with sparse wax myrtle, Phase II; (C) tree island, surrounded by burned recovering wet prairie, Phase II.

Ground Survey

Although the project scope was scaled back as a result of burns, a simple field assessment was deemed necessary to develop a better prospective of C-4 EDB's topography, hydrology, wildlife, and returning community vegetation. On May 25, 2011, a tour was made of both Phase I and Phase II. Using a Canon EOS Rebel T3i Digital SLR Camera (18 MP with EF-S 18-55mm f/3.5-5.6 IS Lens) attached with a JOBO photoGPS tracking logger (~10m horizontal accuracy). More than 450 field photos were taken as part of an area assessment (**Figure 21**). The imagery was not formally collated, but ground-based field photographs and associated spatial information are contained on the digital files accompanying this report.

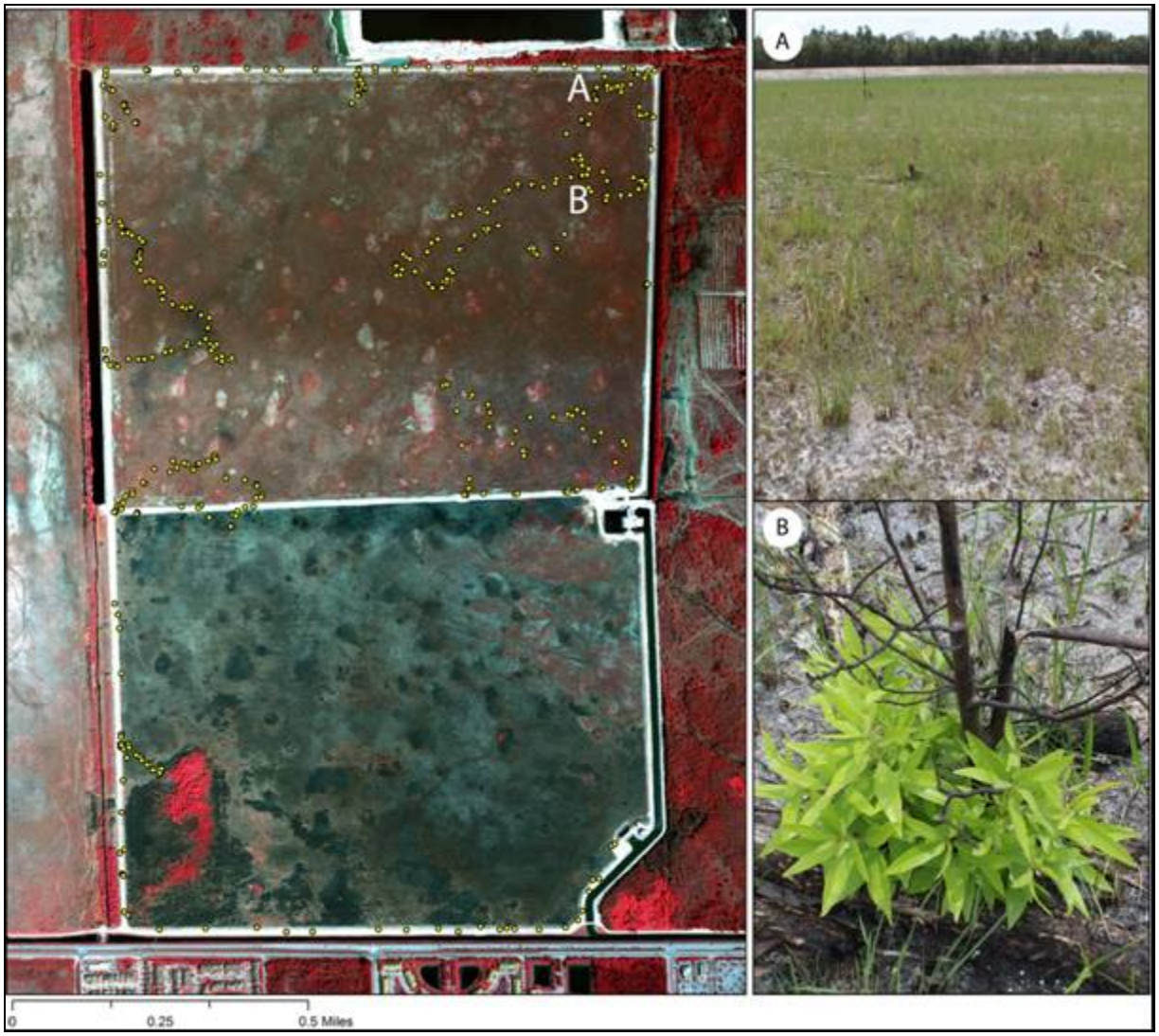


Figure 21. Field ground survey points.

Mapping

Data gathered from the previous monitoring events, helicopter transects, and the ground survey, combined with the FLUCFCS, provided a generalized list of habitat types for the C-4 basin, which were used in the mapping process. For this project, the minimum mapping unit is 10 x10 m (~32.8x32.8 ft or roughly 0.01 hectares). A softcopy photogrammetric workstation was used for the initial mapping. This workstation is a PC-based dual processor system running on Windows 7. The compilation software used was DATEM Summit Professional, which operates on top of AutoCAD Map 3D. Each habitat polygon on the map was captured stereoscopically using CIR imagery, and attributed in AutoCAD as 2-D vectors in accordance with the FLUCFCS National Map Accuracy Standards for 1-inch to 100-foot mapping. Subsequent to the vector collection, the data were combined into a single AutoCAD DWG file type and exported to ArcGIS 9.3. This file was incorporated into an ArcGIS geodatabase for final editing and topology clean up.

Many of the ecotones or habitat breaks observed in the field were distinct when viewing the imagery stereoscopically and in normal 2-D view. For example, low density recovering wet

prairie, recovering wet prairie within treated melaleuca heads, the scraped area of the perimeter of Phase I, and the native tree islands in Phase II were all visually distinct. Some ecotones, however, were more complex and not easily delineated. High heterogeneity of sawgrass-dominated wet prairie, mixed wet prairie, and to some extent lower percentage muhly-dominated wet-prairie, often displayed a gradual blending of adjacent communities rather than a hard boundary. To separate these blended ecotones, high resolution oblique photo helicopter transects were used to develop unique spectral and spatial signatures. Spectral and spatial characteristics are discussed in the *Customizing the FLUCFCS Code* section.

Customizing the FLUCFCS Code

The FLUCFCS was used to classify the vegetation communities present in the C-4 EDB and to identify the habitat types during the mapping process. A modified FLUCFCS code system (**Table 11**) was used to account for the variations in the observed wet prairie communities. As in 2009, a pre-existing 3rd order classification was used where appropriate (e.g., 617-Mixed Wetland Hardwoods). For 4th order classification and above, letters were used in place of numbers for ease of utilization and quick interpretation. Consistent with 2009, the letters used in this higher order classification followed counterparts from the RECOVER codes (Rutchey and Schall, 2005). An illustration of this coding can be examined by viewing the various wet prairie communities and their photos in **Table 12**.

Five different habitat classes were added to the FLUCFCS codes used in 2009. The class 643rms (recovering wet prairie/shrub in treated melaleuca) was added to account for the emerging co-dominance of shrubs in recovering areas. The class 641t (cattail marsh) was added as it was now possible, with aid of 2011 imagery and field data, to positively identify *Typha* sp. The final three changes were added to accommodate for the burned vegetation in Phase II. Classes 643rm (recovering wet prairie in treated melaleuca), 643s (mixed wet prairie) and 631 (wetland shrub), all had the suffix 'burn' added where appropriate (e.g., 643rmburn for burned recovering wet prairie in treated melaleuca). It should be noted that in 2005 there were thirteen FLUCFCS used, ten classes in 2007, nine in 2009 and thirteen in 2011. **Table 11** summarizes the FLUCFCS codes used in 2005, 2007, 2009 and 2011.

Table 11. FLUCFCS code comparison for 2005–2011.

FLUCFCS Code	Description	2005	2007	2009	2011	Notes
617	Tree Island	X	X	X	X	
619m	Melaleuca	X	X			None observed in 2011
619mca	Melaleuca-Casuarina Mix	X				None observed in 2011
619mt	Treated Melaleuca	X	X	X		
631	Wetland Scrub	X		X	X	
631burn	Wetland Scrub				X	Limited to Phase II in 2011
641t	Cattail Marsh				X	
643cs	Sawgrass Wet Prairie	X	X	X	X	
643ms	Muhly Wet Prairie	X	X	X	X	
643rm	Recovering Wet Prairie in Treated Melaleuca		X	X	X	
643rmburn	Burned Recovering Wet Prairie in Treated Melaleuca				X	Limited to Phase II in 2011
643rms	Recovering Wet Prairie /Shrub in Treated Melaleuca				X	Areas showing co-dominant prairie/shrub mix in 2011
643s	Mixed Wet Prairie	X	X	X	X	Combined 643s and 643xs into one class in 2007, took name of Mixed WP
643sburn	Burned Wet Prairie	X	X		X	Limited to Phase II 2011
643sl	Scraped Wet Prairie	X	X	X	X	
643t	Treated Wet Prairie	X				None observed in 2011
643xs	General Wet Prairie	X				Code became 643s description changed
643xsl	Low Density Wet Prairie	X	X	X	X	

Table 12. FLUCFCS codes used for 2011 mapping, habitat descriptions, and representative habitat photos.

	(617) Mixed Wetland Hardwoods This category is reserved for those wetland hardwood communities which are composed of a large variety of hardwood species like ficus and pond apple (*Annona glabra*) tolerant of hydric conditions. The tree islands occurring in the southwest corner of Phase II have been given this designation. This code has been used since the 2005 mapping.
	631 Wetland Shrub This new emerging community has woody vegetation less than 6 m (20 ft) tall with no true canopy. The species include shrubs like wax myrtle (*Myrice cerifera*), young trees like pond apple and red bay (*Persea borbonia*). This type of wetland shrub mixture has been known to represent a successional stage leading to 617 Mixed Wetland Hardwoods. Spectrally, shrub areas have distinctly high IR values.
	(643s) Mixed Wet Prairie Wet prairie (643) is defined as predominately grassy vegetation on hydric soils and usually distinguished from marshes by having less water and shorter herbage. The "s" designation used here signifies that there is a shrubby component to the community with densities varying between 1 and 49 percent, but more typically between 1 and 10 percent. The main shrub components are wax myrtle with a high percentage of other vegetation species. The other species generally include muhly grass and/or sawgrass in amounts not exceeding 50 percent. Dog fennel and bluestem are also prevalent in this habitat type. This generalized classification of 643s was used on a significant portion of the mapping in Phase I and Phase II. This class was broken into two separate classes in 2005 and merged into the 643s in the 2007 mapping effort. Spectrally mixed prairie can vary greatly dependent on the species composition, but typically it is highly textured due to its high heterogeneity. Spatially it often occupies a transitional zone between the wetter sawgrass dominant wet prairie and higher elevation muhly dominant wet prairie.

Table 12. Continued.

	(643cs) Sawgrass Wet Prairie This variation of 643s is dominated by sawgrass (50 percent or greater cover). This code been used since the 2005 mapping effort. In 2009, dormant sawgrass interspersed with some living sawgrass in Phase I was identified as produced a unique bluish hue. This could not be supported with 2011 data. Typically, sawgrass has a mid-range IR signature for a marsh grass. It is higher in absorption than sedges (*Juncus* sp.), bluestem (*Andropogon* sp.) and muhly (*Muhlenbergia capillaris*), because of its broader leaves, but pails when compared to fleshier leaved plants like dog-fennel (*Eupatorium capillifolium*) and coinwort (*Centella asiatica*). Texturally, sawgrass dominant wet prairie varies almost as much as mixed wet prairie, primarily because dominance tends to be not much greater than 50 percent. Spatially it is located at lower, wetter elevations.
	(643ms) Muhly Wet Prairie This variation of 643s is dominated by muhly grass (50 percent or greater cover). This code has been used since the 2005 mapping effort. Spectrally, muhly wet prairie varies dependent on percentage dominance. In areas where muhly is highly dominant (>75 percent), it has a tall, textured, white appearance (high reflectance). In locations where dominance falls to below 75 percent (often lower and wetter), only the peaks are white, with the majority being grey or very dark.
	(643rm & 643rms) Recovering Wet Prairie in Treated Melaleuca Stands & Recovering Wet Prairie /Shrub in Treated Melaleuca This is a relatively new wet prairie community that is arising in areas that were treated melaleuca. This class is defined by standing and fallen dead melaleuca within the site, which is contributing to the unique vegetation mix in these areas. As a result of this, there is a high percent cover of dog fennel and bluestem with shrubby vegetation like wax myrtle. Where shrubby vegetation approaches co-dominance with herbaceous species (talller, high IR), the code becomes 643rms.

Table 12. Continued.

	(643sl) Scraped Wet Prairie This area is a variation of 643s and is a result of earthworking activities in the basin. As a result of being scraped it is significantly lower in elevation than other areas and has a high tendency to be wetter than anywhere else in the project area. It has high amounts of open space with only 10-20 percent of plant coverage, which is mostly herbaceous.
	(643xsl) Low-Density Wet Prairie This low-density and lower stature variation of 643s generally occurs in areas that had been treated wet prairie, although is also present in lower, wetter elevations adjacent to sawgrass wet prairie. In 2011, as with 2009 and 2007, this class is defined by having at least 15–30 percent of open space composed of bare ground or periphyton. The class was used in the 2005 mapping to designate areas with 41 percent or greater open space. In addition there is a mix of low stature vegetation like southern breakrush (*Rhynchospora microcarpa*), spreading breakrush (*Rhynchospora divergens*), dog fennel (*Eupatorium capillifolium*), coinwort (*Centella asiatica*), and narrowleaf yellowtops (*Flaveria linearis*).
	(641t) Cattail Marsh Marsh (641) contrasts wet prairie (643) in that it has a longer hydroperiod. Cattail dominated marsh has a greater than 50 percent coverage of *Typha* sp. These areas are located exclusively adjacent to levees, where earthworking activities have often created marsh like habitat.
	(643rmburn, 643sburn, 631burn) Burn suffix The 'burn' suffix designates those areas in Phase II that have been burned. Intuitively, burned areas are dark to black in all bands. The darkest areas are where relic treated melaleuca have burned 'hot' due to high fuel loads.

Quality Control

In prior analyses (2005, 2007, and 2009) the scope of work required that all vegetation categories delineated in the final maps must be classified at 90 percent accuracy or higher. However, due to an accidental burn in Phase II on March 7, 2011, and a controlled burn in Phase I on April 4, 2011, the Quality Control method for accuracy had to be modified as it was not possible to create a quantitative Confusion Matrix. As a compromise, the SFWMD agreed to a qualitative assessment using high-resolution oblique photo transects collected on March 7, 2011 (see *Methodology* section). Prior to classification points were selected from the transects, representing community vegetation at approximately 200 yard intervals, and held back for qualitative assessment. Once the first draft of the habitat mapping was completed, a total of 106 field photos were described and classified using FLUCFCS codes, visited spatially in GIS using the corresponding field point (**Figure 22**), and assessed as to determine whether the map product accurately represented the true landscape (**Table 13**). Of the 106 points surveyed, 222 unique habitat locations were identified from field photos, spanning all 13 available FLUCFCS codes. Detailed information about ground-truthing results using the high-resolution helicopter photos can be found in Appendix G.

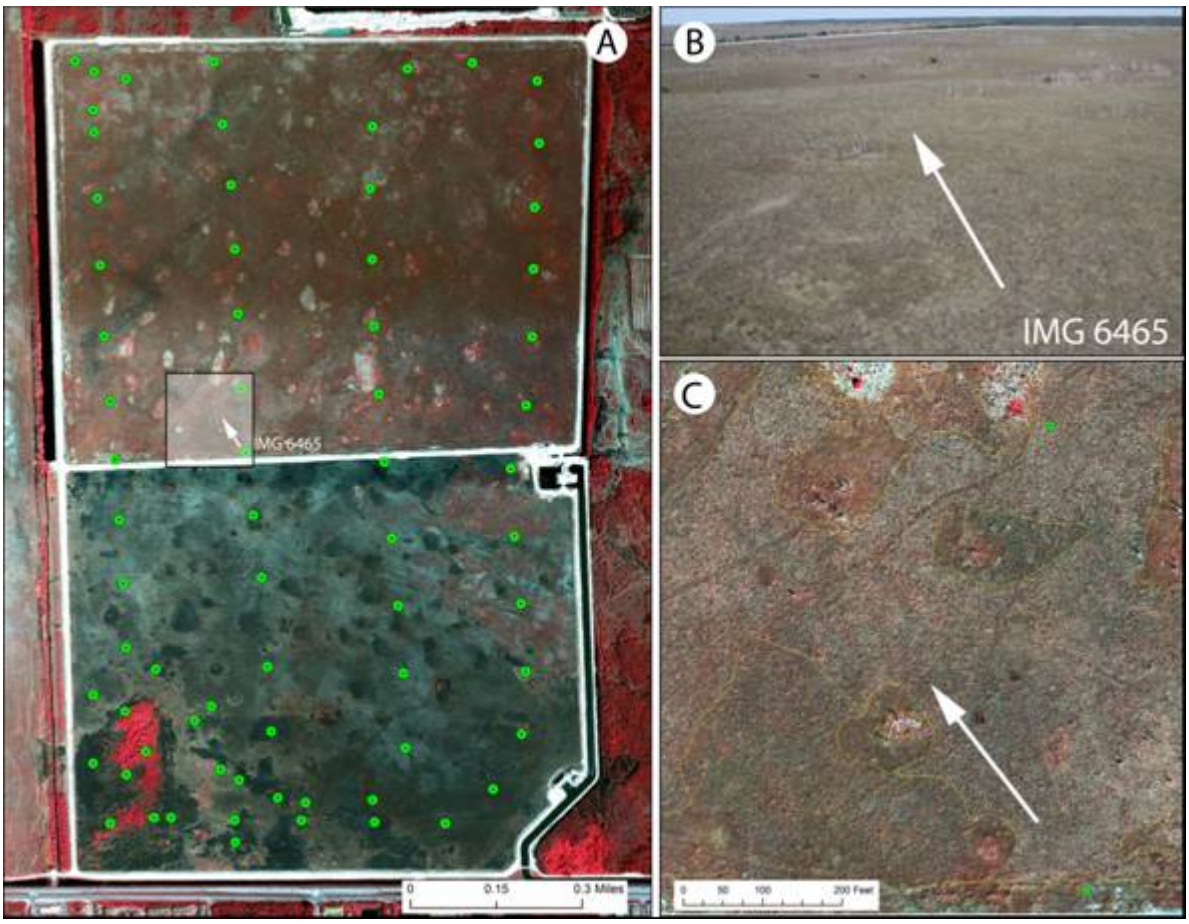


Figure 22. High resolution transect ground controls and photo point example. (A) Transect quality point overview, (B) photo example of muhly wet prairie and interface between mixed prairie and muhly, (C) close-up of ortho-image inset, including class boundaries.

Table 13. FLUCFCS codes observed in 2011 in transect ground controls.

FLUCFCS Code	Description	Incidences
617	Tree Island	10
631	Wetland Scrub	1
631burn	Burned Wetland Scrub	1
641t	Cattail Marsh	3
643cs	Sawgrass Wet Prairie	10
643ms	Muhly Wet Prairie	33
643rm	Recovering Wet Prairie in Treated Melaleuca	18
643rmburn	Burned Recovering Wet Prairie in Treated Melaleuca	37
643rms	Recovering Wet Prairie /Shrub in Treated Melaleuca	4
643s	Mixed Wet Prairie	36
643sburn	Burned Wet Prairie	48
643sl	Scraped Wet Prairie	10
643xsl	Low Density Wet Prairie	11

Post Classification Quality Control

In addition to accuracy quality control, the final mapping product was evaluated to ensure there were no slivers, overlaps, gaps, and that each polygon had its own centroid. Topology was evaluated and corrected using topology and editing tools in ArcGIS 9.3.

RESULTS

Vegetative Monitoring Accuracy

As described previously, 13 different FLUCFCS codes were developed for the habitat mapping effort based on aerial interpretation and ground-truthing activities. The habitat map developed for this monitoring event is presented in Attachment H. Habitats are delineated with colored, semi-transparent polygons corresponding to their respective FLUCFCS code. The color schemes used are similar to those used in 2007–2009. Color-infrared ortho-images created from the stereo aerials are used as a backdrop for the map so their texture, shape, etc. can be seen due to the transparency of the polygons.

Many techniques have been developed to measure the uncertainty in mapping land classifications based on remotely sensed data. Common practice to select a sample of locations and to compare the classes assigned to each location with some source of higher accuracy, is usually field plots. As stated previously, vegetation burns made traditional accuracy assessment via in-field assessment impossible. Fortunately, high resolution oblique photos (high resolution oblique photo transects) were collected by Boodjamap, Inc. and the SFWMD from a helicopter along a traverse on March 7, 2011 (post Phase II burn, pre Phase I burn). These oblique photos were used to positively identify FLUCCS habitat coverage.

Of the 106 transect ground-truthing stations, all but 2 were found to match well with the designated habitat classification. These two are related to the classification of low density wet prairie (FLUCFCS 643xsl). Problems with classifying 643xsl were due to high IR in low statue species like coinwort (*Centella asiatica*) in recovering prairie. This was corrected post quality assessment and the map updated.

Habitat Quantification

The second portion of the mapping analysis was quantification of the habitats. Habitat polygon layers were separated by basin (Phase I and II) in ArcMap 9.3 and the acreage calculated on the dissolved habitat classes. The attribute tables were then transferred to Microsoft Excel to compute percent coverage for comparison to 2009 Habitat Quantification values. The total acreage of each habitat type and percent of the total impoundment area is given in **Table 14**. **Table 15** provides a comparison showing the percent coverage of each habitat in Phase I from 2011 and 2009. As previously stated, only Phase I was calculated because the March 5, 2011burn in Phase II.

Most noteworthy is the continued increase of muhly wet prairie in Phase I. This trend has continued from 2007. Conversely, there has been a reduction in wetter sawgrass wet prairie and mixed prairie classes. Recovering wet prairie/shrub in treated melaleuca has seen a modest decrease in coverage, as some areas have transitioned to the higher shrub component class 643rms. In Phase II, most dramatic is the percentage of area burned. Burned classes in Phase II account for more than 90 percent of the total area. Additional review of these changes is included in the *Discussion* section.

Table 14. 2011 FLUCFCS habitat area and percent coverage.

FLUCFCS CODE	HABITAT	PHASE I (ac)	PHASE I (% Cover)	PHASE II (ac)	PHASE II (% Cover)
617	Tree Island	-	-	8.15	2.10
619mt	Melaleuca-Treated	-	-	-	-
631	Wetland Shrub	0.44	0.11	0.94	0.24
631burn	Burned Wetland Scrub	-	-	0.09	0.02
641t	Cattail Marsh	1.75	0.42	-	-
643cs	Sawgrass-Wet Prairie	50.22	12.05	-	-
643ms	Muhly-Wet Prairie	88.37	21.20	26.33	6.76
643rm	Recovering Wet Prairie in Treated Melaleuca	25.43	6.10	1.43	0.37
643rmburn	Burned Recovering Web Prairie in Treated Melaleuca	-	-	78.57	20.18
643rms	Recovering Wet Prairie/Shrub in Treated Melaleuca	1.88	0.45	-	-
643s	Mixed Wet Prairie	136.69	32.78	3.15	0.81
643sburn	Burned Mixed Wet Prairie	-	-	270.16	69.40
643sl	Scraped-Wet Prairie	25.04	6.00	0.49	0.13
643xsl	Low Density	87.08	20.89	-	-
	TOTAL	**416.90**	**100**	**389.31**	**100**

Table 15. Phase I habitat acreage and percent cover for 2011 and 2009.

FLUCFCS CODE	HABITAT	2011 PHASE I		2009 PHASE I		
		(Acres)	(% Cover)	(Acres)	(% Cover)	(% Change)
619mt	Melaleuca-Treated	-	-	0.12	0.03	-0.03
631	Wetland Shrub	0.44	0.11	0.70	0.17	-0.06
641t	Cattail Marsh	1.75	0.42	-	-	+0.42
643cs	Sawgrass-Wet Prairie	50.22	12.05	86.00	20.57	-8.52
643ms	Muhly-Wet Prairie	88.37	21.20	38.13	9.12	+12.08
643rm	Recovering Wet Prairie in treated Melaleuca	25.43	6.10	26.54	6.35	-0.25
643rms	Recovering Wet Prairie/Shrub in treated Melaleuca	1.88	0.45	-	-	+0.45
643s	Mixed Wet Prairie	136.69	32.78	186.35	44.56	-11.78
643sl	Scraped-Wet Prairie	25.04	6.00	4.27	1.02	+4.98
643xsl	Low Density WP	87.08	20.89	76.04	18.18	+2.71
	TOTAL	**416.90**	**100**	**418.16**	**100**	

* Minor differences in the total area for each basin are due to variations in how the perimeter of the basin is mapped (i.e. from the levee road vs. from the bottom of the levee).

Change Detection between 2009 and 2011 in Phase I

Change detection is analysis of the same geographic area at different times to determine habitat change (Attachment I). To calculate change detection in Phase I from 2009 to 2011, an overlay union was performed in ArcGIS and the results were tabulated. Within Phase I, approximately 56 percent of the total area remains unchanged from 2009 to 2011 (**Table 16**). Of the remaining approximately 44 percent, about 36 percent can be attributed to seven class transitions (**Table 17**). The greatest transition is from mixed prairie in 2009 to muhly prairie in 2011 (~13 percent).

Table 16. Class agreement between 2011 Phase I and 2009 Phase I.

FLUCFCS 2011	FLUCFCS 2009	Acre	% Cover (2011)
643cs	643cs	36.15	8.67
643rm	643rm	17.74	4.26
643s	643s	93.50	22.43
643sl	643sl	3.39	0.81
643xsl	643xsl	35.82	8.59
643sl	643xsl	14.00	3.36
643ms	643ms	30.60	7.34
Total		**231.20**	**55.46**

Table 17. Class disagreement between 2011 Phase I and 2009 Phase I.

FLUCFCS 2011	FLUCFCS 2009	Acre	% Cover (2011)
643cs	643s	8.53	2.05
643ms	643s	52.97	12.71
643s	643cs	16.66	4.00
643s	643xsl	17.66	4.24
643sl	643s	6.45	1.55
643xsl	643cs	27.16	6.50
643xsl	643s	19.39	4.65
Other		36.90	8.84
Total		**185.72**	**44.54**

DISCUSSION

General Habitat Changes

As shown in Attachments H and I, in the Phase I basin, the general trend of wetter sawgrass prairie in the northwest to higher elevation mixed wet prairie and muhly wet prairie communities in the south/southeast is as it appeared in 2005, 2007, and 2009. The most significant changes to occur in Phase I appear to be (1) the expansion of muhly wet prairie at the exception sawgrass and mixed prairie, (2) the appearance of large patches of cattail (*Typha* sp.) in the scrapped areas adjacent to the levee, (3) increased colonization of shrubs in relic treated melaleuca stands, and overall increase in the density of shrubs, and (4) shrinkage of individual recovering wet prairie melaleuca patches as treated melaleuca decompose. Some of these changes are naturally occurring, yet some are the result of an improvement in interpretation through superior stereo image quality.

As over 90 percent of Phase II had burned on March 5, 2011 (shortly prior to image acquisition), no attempt was made to compare community changes with 2009 data. It is worth noting, however, that the tree island in the southwest part of Phase II only incurred minor fire damage at its periphery. Further, unburned muhly wet prairie in northeast Phase II shows no change from 2009.

Muhly Wet Prairie / Mixed Wet Prairie Transition

Phase I has undergone substantial muhly wet prairie expansion since 2009, creeping further northward. Overall, there was a net gain of 50.24 (88.37-38.13) acres of muhly wet prairie in Phase I, more than double the 2009 value (38.13 acres). Much of the area taken over by muhly wet prairie was previously classified as mixed wet prairie (52.97 acres), although 6.64 acres has transitioned from muhly wet prairie to mixed wet prairie. Gains and losses in other classes are minor and evenly distributed.

Based on the 2009 report, the transition of muhly to mixed, and mixed to muhly, appears to be in constant flux. In 2009, the emergence of other vegetation, like bluestem, sawgrass, and many other species, was attributed to creating a mixed wet prairie environment. In 2011, muhly wet prairie in the east of Phase I, although more mixed than muhly communities in the western half of Phase I, was clearly shown in photo transects to be composed of muhly percentages well in excess of the 50 percent threshold.

Sawgrass Wet Prairie Change

The expansion of sawgrass wet prairie observed from 2007 to 2009 was not repeated in 2011. Sawgrass wet prairie decreased by almost 36 acres in 2011, with the majority of losses occurring to low density prairie (27 acres) and mixed prairie (8 acres). If is difficult to determine if the reduction in sawgrass coverage is a real transition, or the result of improved classification through improved imagery and increased ground-truthing. A review of the original 2009 stereo images shows that there has been some shift to more open prairie in the north, but without knowing the disturbance patterns (e.g., fire) over the last two years, it is impossible to postulate a cause. The transition from sawgrass to mixed is less clear. Sawgrass wet prairie has a wide ecotone, transitioning gradually from east to west. Without the improved spectral characteristics of 2011 UltraCam X imagery (native 16-bit digital with IR, R, G, and B bands), and large volume of oblique images, identifying this interface would be extremely challenging.

Melaleuca Habitat

As with 2009, the only invasive species of immediate concern in the project area is melaleuca. Melaleuca chemical treatment appears to have been effective in removing almost all live trees, with no live trees identified in the stereo imagery. Field work on May 25, 2011, however, noted sporadic melaleuca saplings in treated melaleuca stands in the northeast corner of Phase I. Proximity to large live melaleuca stands to the north and west of Phase I, and west of Phase II, indicate that this melaleuca will require constant management. Further, recent burns could add to melaleuca propagation if soil contains an existing seed bank.

Recovering Wet Prairie in Treated Melaleuca

Since 2007, previous reports have shown a significant reduction in recovering wet prairie in treated melaleuca as these areas transition to low density or mixed prairie. **Table 15** appears to show that between 2009 and 2011, this trend had halted, with recovering wet prairie in treated melaleuca showing no appreciable decrease. Further examination in change detection maps, however, appears to show that the area map is misleading and that this trend is indeed continuing. The boundaries of the larger recovering wet prairie polygons have shrunk, but this has been counter balanced with increased delineation of smaller treated areas elsewhere. The greatest increase in recovering wet prairie is found to come from mixed prairie (4 acres). Examining these areas in the 2009 stereo imagery shows that these areas existed in 2009, but were not mapped.

Cattail Marsh

As already stated, cattail species (southern cattail, *Typha domingensis* and broadleaf cattail, *T. latifolia*) were mapped for the first time in 2011. These are not included on the FEPPC or noxious plant list, but must be monitored by the regulations of the permit. In the 2009 monitoring effort, small amounts of cattail were witnessed in the scraped down wet prairie areas (643sl) of Phase I. In 2011, 1.75 acres of cattail was identified, over 16 different locations. As with 2009, each occurrence was confined to the habitat class, 643sl. Field work on May 25, 2011, determined that like the 2009 study, that cattail was unlikely to extend beyond the edge of the levee. Scraped-down wet prairie is most likely subject to regular human disturbance, resulting in wetter conditions that do not extend into the open prairie.

CONCLUSIONS/RECOMMENDATIONS

Overall, the technique of remote sensing as a method of tracking vegetation in the C-4 EDB is highly successful, with stereoscopic aerial interpretation deemed effective in delineating the major communities. In 2011, the photo interpretation process was greatly enhanced by collecting high resolution oblique photo transects prior to classification. These photo transects offered an

unprecedented number of ground-truthing stations for the C-4 EDB, significantly reducing the amount of time needed for revision and improvement. Unlike 2009, many of the complex land cover questions did not require reassessment as often there was an available oblique image to guide the stereo delineation. Improved spectral characteristics of stereo imagery also contributed to an improved map product. The UltraCam X, S/N UCX-SX-1-10817438 camera, has superior spectral resolution over the film photography used in previous studies (IR, Red, Green and Blue spectra as opposed to just IR, Red and Blue). Further, since it is natively digital, uniformity of color is also greatly improved as it is not subject to loss of spectral sensitivity through film deterioration (i.e., IR film is fragile and deteriorates with increased temperatures) or analog to digital scanning.

As with 2009, there has been an increase in the density of muhly wet prairie (643ms) communities in Phase I. It is unclear if the expansion of muhly is a true sign of community change, or the result of a natural fluctuating system. Similarly attention should be also be paid to the contraction of sawgrass wet prairie (643cs) to see if this is a real change, or simply the result of improved delineation as a result of improved imagery and increased ground-truthing. It is possible that the increase in muhly, the increase in shrubs, and the decrease in sawgrass, indicate a drying out of Phase I and a transition to a Phase II-like community structure.

C-4 is located adjacent to live melaleuca stands. Although largely removed from Phase I, melaleuca saplings still persist, and windblown colonization is unavoidable without periodic retreatment. Fire has been identified as contributing to melaleuca seed propagation. Monitoring treated areas post-fire would give an indication to the level of the melaleuca seed bank, and whether fire should be carefully controlled.

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Attachment A: Specific Conditions and Cross-References

Table A-1. Specific conditions, actions taken, and cross-references presented for the C4 Emergency Detention Basin – Phase I & II Project, Permit #Phase 1: EI 13-0192729-001; Phase 2: EI 13-0192729-004; Modification by EI 13-012729-011.

Specific Condition	Description	Applicable Phase	Action Taken	Reported in 2012 SFER *(All references are to Volume III, unless otherwise noted)*			
				Table	Narrative	Figure	Attachment
Phase 1 EI 13-0192729-001							
8	Wetland Monitoring & Maintenance: Water Quality	Phase I	Conducted Water Quality Sampling	3, 4, B-1	pgs. 5-7	2	Attachment B
8	Wetland Monitoring & Maintenance: Periphyton	Phase I	Conducted Periphyton Sampling		pgs. 7-10	3, 4, 5, 6	Attachment J
8	Wetland Monitoring & Maintenance: Total Phosphorus	Phase I	Utilized Water Quality Monitoring Data to Determine TP Mass Budget	5, 6, 7, 8	pgs. 10-15, 20-22	7, 8, 9, 10, 11, 12, 13, 14, 15	
8	Wetland Monitoring & Maintenance: Incidental Wildlife	Phase I	Conducted Incidental Wildlife Observations	9	pg. 23		Attachment J
8	Wetland Monitoring & Maintenance: WRAP Assessment	Phase I	Conducted WRAP Assessment	10	pgs. 24-26	16	
8	Wetland Monitoring & Maintenance: Intensive Vegetation Monitoring	Phase I	Conducted Intensive Vegetation Survey		pgs. 28-29	17	Attachment E
8	Wetland Monitoring & Maintenance: Vegetation Monitoring	Phase I	Conducted Vegetation mapping	11, 12, 13, 14, 15, 16, 17	pgs. 30-37, 42-48	18, 19, 20, 21, 22	Attachment F, G, H, I
8	Biennial Workshop	Phase I	Held Biennial Workshop in September 2011				Attachment K
12	Operation	Phase 1	Conducted Operation During Storm Event		pg. 15	9	

Specific Condition	Description	Applicable Phase	Action Taken	Reported in 2012 SFER *(All references are to Volume III, unless otherwise noted)*			
				Table	Narrative	Figure	Attachment
Phase 2 EI 13-0192729-004							
11	Wetland Monitoring & Maintenance: Water Quality	Phase II	Conducted Water Quality Sampling	3, 4	pgs. 5-7	2	Attachment B
11	Wetland Monitoring & Maintenance: Periphyton	Phase II	Conducted Periphyton Sampling		pgs. 7-10	3, 4, 5, 6	Attachment J
11	Wetland Monitoring & Maintenance: Total Phosphorus	Phase II	Utilized water quality monitoring data to determine TP mass budget	5, 6, 7, 8	pgs. 10-15, 20-22	7, 8, 9, 10, 11, 12, 13, 14, 15	
11	Wetland Monitoring & Maintenance: Incidental Wildlife	Phase II	Conducted Incidental Wildlife Observations	9	pg. 23		Attachment J
11	Wetland Monitoring & Maintenance: WRAP Assessment	Phase II	Conducted WRAP Assessment	10	pgs. 24-26	16	
11	Wetland Monitoring & Maintenance: Intensive Vegetation Monitoring	Phase II	Conducted Intensive Vegetation Survey		pgs. 28-29	17	Attachment E
11	Wetland Monitoring & Maintenance: Vegetation Monitoring	Phase II	Conducted Vegetation mapping	11, 12, 13, 14, 15, 16, 17	pgs. 30-37, 42-48	18, 19, 20, 21, 22	Attachment F, G, H, I
11	Biennial Workshop	Phase II	Held Biennial Workshop in September 2011				Attachment K
12	Removal of Exotic Vegetation	Phase II	Treated and Survey Melaleuca	11, 15	pg. 47		
16	Operation	Phase 1I	Conducted Operation during storm event		pg. 15	9	

Attachment B: Water Quality Data Summary (May 1, 2010–April 30, 2011)

Attachment Note:

Table B-1 summarizes all water quality data collected from May 1, 2009, to April 30, 2011, for the C-4 EDB water quality monitoring sites.

Table B-1. Water quality data summary in C-4 EDB for WY2009 and WY2011.

STATION	TEST NAME	UNITS	TEST NUMBER	PERIOD OF RECORD	# OF SAMPLES	MEAN	STD	MIN	Q25	MEDIAN	Q75	MAX	# BELOW DETECTION LIMIT	# OF EXCURSIONS	% EXCURSIONS
G420	DIS. KJEL N	mg N/L	22	29MAR2010 - 21MAR2011	6	1.202	0.062	1.100	1.175	1.210	1.245	1.270	0	0	0.00%
G420	NOX	mg N/L	18;180	29MAR2010 - 21MAR2011	6	0.017	0.021	0.005	0.005	0.008	0.013	0.059	2	0	0.00%
G420	OPO4	mg P/L	23	29MAR2010 - 21MAR2011	6	0.002	0.000	0.002	0.002	0.002	0.002	0.003	4	0	0.00%
G420	TEMP	CENT	7	29MAR2010 - 21MAR2011	6	25.383	0.757	24.200	24.925	25.700	25.875	26.100	0	0	0.00%
G420	TKN	mg N/L	21	29MAR2010 - 21MAR2011	6	1.230	0.060	1.130	1.208	1.240	1.265	1.300	0	0	0.00%
G420	TN	mg N/L	80	29MAR2010 - 21MAR2011	6	1.247	0.072	1.141	1.219	1.245	1.270	1.359	0	0	0.00%
G420	TOT. DIS. P	mg P/L	26	29MAR2010 - 21MAR2011	6	0.003	0.001	0.002	0.002	0.002	0.003	0.005	0	0	0.00%
G420	TP	mg P/L	25	29MAR2010 - 21MAR2011	5	0.007	0.002	0.006	0.006	0.007	0.009	0.009	0	0	0.00%
G420	NO3	mg N/L	78	29MAR2010 - 27MAY2010	2	0.009	0.003	0.007	0.008	0.009	0.010	0.011	0	0	0.00%

Attachment C:
Water Quality Data
(May 1, 2009–April 30, 2011)

This project information is required by Specific Condition 11 of the permit for the C-4 Emergency Detention Basin, and is available upon request.

Attachment D: Hydrological Data (May 1, 2009 – April 30, 2011)

This project information is required by Specific Condition 11 of the permit for the C-4 Emergency Detention Basin, and is available upon request.

Attachment E: Intensive Vegetation Survey Results

C-4 Impoundment Multi Year Comparison		STA 6	Site 41:	Site 41:	Site 41:	Site 41	Site 41:	Site 41:	
	Date surveyed	Baseline	Apr-05	May-07	Apr-09	May-11	07 to '09	09 to '11	
	Latitude	25.7706					Change In Percent Coverage		Change in Presence
	Longitude	-80.436							
	FLUCCS Code		643s	643ms	643ms	643			
Species	**Common Name**								
Andropogon sp.	Bluestem	0	2	8	1	0.0	-7	-1	Present in 2009
Centella asiatica	Coinwort	0	2	1	2	5.3	1	3.3	Present
Cladium jamaicense	Sawgrass	4.25	2	6	2	3.2	-4	1.2	Present
Dichanthelium erectifolium	Erect-leaf witchgrass	0	1	3	0	3.5	-3	3.5	Present in 2011
Eupatorium capillifolium	Dog-fennel	0	0	1	0	1.7	-1	1.7	Present in 2011
Flaveria linearis	Narrowleaf yellowtops	0	1	1	0	0.8	-1	0.8	Present in 2011
Hypericum brachyphyllum	Coastal-plain St. John's-wort	0	1	1	1	2.6	0	1.6	Present
Ludwigia erecta	Red ludwigia	0.25	0	0	0	0.0	0	0	Absent
Melaleuca quinquenervia	Punk tree	0.25	1	1	1	0.2	0	-0.8	Present
Melaleuca quinquenervia - dead	Punk tree - dead	0	0	0	2	0.0	2	-2	Present in 2009
Mitreola sessilifolium	Miterwort	0	1	0	0	0.0	0	0	Absent
Mitreola petiolata	Miterwort	0	0	1	0	0.0	-1	0	Present in 2011
Muhlenbergia capillaris	**Muhly grass**	**58.25**	**79**	**65**	**83**	**22.0**	**18**	**-61**	Present
Myrica cerifera	Wax myrtle	0	0	2	2	0.0	0	-2	Present in 2009
Panicum dichotomum	Panic grass	1	0	0	0	0.0	0	0	Absent
Panicum hemitomon	Maidencane	0.25	0	0	0	0.0	0	0	Absent
Polygala sp.	Bachelors buttons	0	1	1	1	10.3	0	9.3	Present
Rhynchospora divergens	Spreading beakrush	0	0	5	1	0.0	-4	-1	Present in 2009
Rhynchospera colorata	White top sedge	0	1	0	1	0.0	1	-1	Present in 2009
Rhynchospora microcarpa	Southern beak rush	0.75	0	0	0	0.0	0	0	Absent
Sagittaria lancifolia	Lance-leaf arrowhead	0	0	2	0	0.0	-2	0	Absent
Samolus ebracteatus	Water pimpernel	0	3	0	1	0.1	1	-0.9	Present
Setaria parviflora	Knotroot foxtail	0	0	2	0	0.0	-2	0	Absent
Open Dead/Periphyton/Algae	**Periphyton/Open/Dead**	**35**	**5**	**0**	**2**	**49.0**	**2**	**47**	Present

Pink: greater than 10% loss of cover	Green: Greater than 10% gain in cover	Blue: Present in 2011 but not in 2009	Orange: Present in 2009 but not 2011

C-4 Impoundment Multi Year Comparison		STA 16	Site 36:	Site 36:	Site 36:	Site 36:			
	Date surveyed	Oct-03	Apr-05	May-07	May-09	May-11	07 to '09	09' to '11	
	Latitude	25.77028					Change in Percent Coverage		Change in Presence
	Longitude	-80.44611							
	FLUCCS Code		643ms		643ms	643			
Species	**Common Name**								
Agalinus linifolia	Flaxleaf foxglove	0	0	2	0	0.0	-2	0.0	Absent
Andropogon glomeratus	Broomsedge, Bushy bluestem	1.5	2	0	0	0.0	0	0.0	Absent
Aster sp.						0.1		0.1	Present in 2011
Centella asiatica	Coinwort	0.5	2	3	0	0.6	0	0.6	Present in 2011
Cladium jamaicense	Sawgrass	3	14	20	15	8.2	-5	-6.8	Present
Dichanthelium aciculare						0.3		0.3	Present in 2011
Dichanthelium erectifolium	Erect-leaf witchgrass	0	2	2	0	0.1	0	0.1	Present in 2011
Diodia virginiana	Buttonweed	0	0	0	1	0.0	1	-1.0	Present in 2009
Erigeron quercifolius						0.1		0.1	Present in 2011
Eupatorium capillifolium	Dog-fennel	0	0	0	1	0.0	1	-1.0	Present in 2009
Flaveria linearis	Narrowleaf yellowtops	0	3	3	0	4.4	0	4.4	Present in 2011
Hypericum brachyphyllum	Coastal-plain St. John's-wort	0	0	0	1	0.0	-1	-1.0	Present in 2009
Ipomoea sagittata	Everglades morning-glory	0	1	0	0	1.2	0	1.2	Present in 2011
Ludwigia erecta	Red ludwigia	0.5	0	0	0	0.0	0	0.0	Absent
Melaleuca quinquenervia	Punk tree	0	1	0	0	0.0	0	0.0	Absent
Muhlenbergia capillaris	**Muhly grass**	**73.75**	**60**	**40**	**75**	**25.1**	**35**	-49.9	Present
Polygala balduinii	Baldwin's milkwort	0	0	0	1	0.0	-1	-1.0	Present in 2009
Pluchea rosea	Rosy camphor weed	0	2	0	0	0.0	0	0.0	Present in 2011
Polygala balduinii	Bachelors buttons	0	1	3	0	0.0	-3	0.0	Absent
Rhynchospora microcarpa	Southern beak rush	0.5	4	3	0	0.0	-3	0.0	Absent
Rhynchospora divergens	Spreading beakrush	0	0	7	1	0.0	-6	-1.0	Present in 2009
Sabatia stellaris	Marsh pink	0	0	2	0	0.0	-2	0.0	Absent
Saccharum giganteum	Sugarcane plumegrass	0	3	0	0	0.0	0	0.0	Absent
Samolus ebracteatus	Water pimpernel	0	0	0	3	0.0	3	-3.0	Present in 2009
Teucrium canadense	Wood sage	0	0	0	1	0.5	1	-0.5	Present
Various algae/open/dead	**Periphyton/Open/Dead**	**20.25**	**5**	**15**	**0**	**54.4**	**-15**	54.4	Present in 2011
Unknown vine (arrow leaves)					1	0	1	-1	Present in 2009
Unknown Grass						0.1		0.1	Present in 2011

C-4 Impoundment Multi Year Comparison		STA 4	Site 46	Site 46	Site 46	Site 46	Site 46		
	Date surveyed	Baseline	Apr-05	May-07	May-09	May-11	07 to '09	09 to '11	
	Latitude	25.76493					Change in Percent Coverage		Change in Presence
	Longitude	-80.43623							
	Community		643ms	643ms	643ms	643			
Species	**Common Name**								
Agalinus linifolia	Flaxleaf foxglove	0	0	3	0	0	-3	0	Absent
Andropogon sp.	Bluestem	0	2	10	2	0	-8	-2	Present in 2009
Aster sp.						0.02		0.02	Present in 2011
Centella asiatica	Coinwort	0	4	5	5	1.8	0	-3.2	Present
Cladium jamaicense	Sawgrass	25.25	4	5	2	1.5	-3	-0.5	Present
Dichanthelium aciculare						0.02		0.02	Present in 2011
Dichanthelium erectifolium	Erect-leaf Witchgrass	0	2	5	1	0.3	-4	-0.7	Present
Eragrostis spectabilis	Purple lovegrass	0.75	0	0	0	0	0	0	Absent
Erigeron quercifolius	Oakleaf fleabane	0	1	0	0	0.06	0	0.06	Present in 2011
Eupatorium capillifolium	Dog-fennel	0	0	0	1	0.02	1	-0.98	Present
Eustachys						0.02		0.02	Present in 2011
Flaveria linearis	Narrowleaf yellowtops	0	2	0	1	0	1	-1	Present in 2009
Hypericum brachyphyllum	Coastal-plain St. John's-wort	1.25	4	0	2	0	2	-2	Present in 2009
Ludwigia erecta	Red luwigia	0.5	0	0	0	0	0	0	Absent
Melaleuca quinquenervia	Punk tree*	0.25	2	0	1	0.12	1	-0.88	Present
Mitreola petiolata	Stalked miterwort	0	0	3	1	0	-2	-1	Present in 2009
Muhlenbergia capillaris	Muhly grass	42	39	60	70	8.98	10	-61.02	Present
Panicum sp.	Panic grass	0.75	0	0	0	0.08	0	0.08	Present in 2011
Phyla Nodiflora						0.02		0.02	Present in 2011
Pluchea rosea	Rosy camphor weed	0	2	0	0	0.04	0	0.04	Present in 2011
Polygala balduinii	Bachelors buttons	0	1	0	1	0	1	-1	Present in 2009
Rhynchospora microcarpa	Southern beak rush	0.5	4	0	1	0	1	-1	Present in 2009
Rhynchospora divergens	Spreading beakrush	0	2	5	1	0	-4	-1	Present in 2009
Samolus ebracteatus	Water pimpernel	0	0	4	1	0	-3	-1	Present in 2009
Schizachyrium sp.						4.3		4.3	Present in 2011
Setaria parviflora	Knotroot foxtail	0	1	0	0	0	0	0	Absent
Various algae/Open	Periphyton/Open/Dead	28.75	30	0	10	82.5	10	72.5	Present
Unknown Grass						0.06		0.06	Present in 2011

C-4 Impoundment Multi Year Comparison		Site 8:	Site 8:	Site 8:	Site 8:	Site 8:		
	Date surveyed	Apr-05	May-07	Apr-09	May-11	'07 to '09	'09 to '11	
	Latitude	25.7777				Change in Percent Coverage		Change in Presence
	Longitude	-80.4388						
	FLUCCS Code	643xs	643s	643s	643			
Species	**Common Name**							
Andropogon sp.	Bluestem	1	0	10	0	10	-10	Present in 2009
Cladium jamaicense	**Sawgrass**	**20**	**35**	**20**	**3.2**	**-15**	**-16.8**	Present
Dichanthelium erectifolium	Erect-leaf witchgrass	1	3		0	-3	0	Absent
Eupatorium capillifolium	Dog-fennel		2		0	-2	0	Absent
Eustachys					0.12		0.12	Present in 2011
Hypericum brachyphyllum	Coastal-plain St. John's-wort	1	3	4	0	1	-4	Present in 2009
Melaleuca quinquenervia	Punk tree	20	2		0	-2	0	Absent
Melaleuca quinquenervia - dead	Punk tree - dead			5	0	5	-5	Present in 2009
Muhlenbergia capillaris	**Muhly grass**	**25**	**35**	**40**	**6.76**	**5**	**-33.24**	Present
Peltandra virginica	Green arum		2	1	0	-1	-1	Present in 2009
Rhynchospora microcarpa	Southern beak rush	1	3	1	0	-2	-1	Present in 2009
Rhynchospora divergens	Spreading beakrush		3		0	-3	0	Absent
Sagittaria lancifolia	Lance-leaf arrowhead	1	2	3	0.98	1	-2.02	Present
Setaria parviflora	Knotroot foxtail		3		0	-3	0	Absent
Unknown grass				1	0.18	1	-0.82	Present
Various algae	**Periphyton/Open/Dead**	**30**	**7**	**15**	**88.46**	**8**	**73.46**	Present

C-4 Impoundment Multi Year Comparison		Site 26:	Site 26:	Site 26:	Site 26:	Site 26:		
	Date surveyed	Apr-05	May-07	Apr-09	May-11	'07 to '09	'09 to '11	
	Latitude	25.76722				Change in Percent Coverage		Change in Presence
	Longitude	-80.43555						
	FLUCCS Code	643ms	643ms	643ms	643			
Species	**Common Name**							
Andropogon sp.	Bluestem	1	0	3	0	3	-3	Present in 2009
Andropogon glomeratus	Broomsedge, Bushy bluestem	0	10	0	0	-10	0	Absent
Aster sublatus	Annual saltmarsh aster	0	0	1	0	1	-1	Present in 2009
Centella asiatica	Coinwort	1	2	1	5.36	-1	4.36	Present
Cirsium horridulum	Thistle	1	0	0	0	0	0	Absent
Cladium jamaicense	Sawgrass	3	3	3	1.74	0	-1.26	Present
Dichanthelium aciculare		0	0	0	0.02		0.02	Present in 2011
Dichanthelium erectifolium	Erect-leaf Witchgrass	2	2	1	4.7	-1	3.7	Present
Eragrostis spectabilis	Purple lovegrass	0	0	0	0	0	0	Absent
Eupatorium capillifolium	Dog-fennel	0	3	0	0.08	-3	0.08	Present in 2011
Eustachys		0	0		0.34		0.34	Present in 2011
Flaveria linearis	**Narrowleaf yellowtops**	**3**	**3**	**1**	**11.4**	**-2**	**10.4**	Present
Hypericum brachyphyllum	Coastal-plain St. John's-wort	1	0	0	0.6	0	0.6	Present in 2011
Ludwigia erecta	Red ludwigia	0	0	0	0	0	0	Absent
Melaleuca quinquenervia	Punk tree	2	3	0	0.02	-3	0.02	Present in 2011
Melaleuca quinquenervia – dead	Punk tree – dead	0	0	3	0	3	-3	Present in 2009
Mitreola petiolata					0.04		0.04	Present in 2011
Muhlenbergia apillaries	**Muhly grass**	**73**	**60**	**80**	**26.58**	**20**	**-53.42**	Present
Myrica cerifera	Wax myrtle	2	0	1	0	1	-1	Present in 2009
Panicum dichotomum	Panic grass	0	0	0	0	0	0	Absent
Pluchea rosea	Rosy camphor weed	1	0	0	0.02	0	0.02	Present in 2011
Polygala sp.	Bachelor's buttons	0	0	1	2.2	1	1.2	Present
Rhynchospora microcarpa	Southern beak rush	1	0	0	0	0	0	Absent
Rhynchospora divergens	Spreading beakrush	0	2	0	0	-2	0	Absent
Saccharum giganteum	Sugarcane plumegrass	2	0	0	0.06	0	0.06	Present in 2011
Samolus ebracteatus	Water pimpernel	2	2	1	0.74	-1	-0.26	Present
Open Dead Algae	**Periphyton/Open/Dead**	**5**	**10**	**3**	**36.64**	**-7**	33.64	Present
Teucrium canadense				0	0.02		0.02	Present in 2011
Unknown grass				1	0.12	1	-0.88	Present

C-4 Impoundment Multi Year Comparison		Site 1:	Site 1:	Site 1:	Site 1:	Site 1:		
	Date surveyed	Apr-05	May-07	Apr-09	May-11	'07 to '09	'09 to '11	
	Latitude	25.7786				Change in Percent Coverage		Change in Presence
	Longitude	-80.438						
	FLUCCS Code	643xsl	643s	643ms	643			
Andropogon sp.	Bluestem	5	10	0		-10	0.00	Absent
Centella asiatica	Coinwort		2	2	1.40	0	-0.60	Present
Cladium jamaicense	Sawgrass	10	15	10	1.92	-5	-8.08	Present
Dichanthelium erectifolium	Erect-leaf witchgrass		3	0	0.02	-3	0.02	Present in 2011
Eustachys sp.	Fingergrass				0.02		0.02	Present in 2011
Hypericum brachyphyllum	Coastal plain St. John's wort	0	0	1		1	-1.00	Present in 2009
Melaleuca quinquenervia	Punk tree	5	2	5		3	-5.00	Present in 2009
Muhlenbergia capillaris	**Muhly grass**	**25**	**40**	**60**	**5.86**	**20**	**-54.14**	Present
Polygala balduinii	Bachelor's buttons		2	0		-2	0.00	Absent
Rhynchospora microcarpa	Southern beak rush	3	3	2		-1	-2.00	Present in 2009
Rhynchospora divergens	Spreading beakrush	0	3	0		-3	0.00	Absent
Sagittaria lancifolia	Lance-leaf arrowhead	2	0	0		0	0.00	Absent
Samolus ebracteatus	Water pimpernel	0	2	0		-2	0.00	Absent
Setaria parviflora	Knotroot foxtail	0	3	0		-3	0.00	Absent
Various algae	**Periphyton/Open/Dead**	**50**	**15**	**20**	**90.98**	**5**	**70.98**	Present
Unknown Grass	Unknown Grass				0.02		0.02	Present in 2011

C-4 Impoundment Multi Year Comparison		Site 5:	Site 5:	Site 5:	Site 5:			
	Date surveyed	Apr-05	May-07	Apr-09	May-11	'07 to '09	'09 to '11	
	Latitude	25.777				Change in Percent Cover		Change in Presence
	Longitude	-80.4436						
	FLUCCS Code	643xs	643cs	643cs	643			
Species	**Common Name**							
Andropogon sp.	Bluestem	1	0	3	0	3	-3.00	Present in 2009
Aster sublatus	Annual saltmarsh aster		0	2	0	2	-2.00	Present in 2009
Centella asiatica	Coinwort	3	0	0	0.06	0	0.06	Present in 2011
Cladium jamaicense	Sawgrass	30	60	60	5.14	0	-54.86	Present
Dichanthelium erectifolium	Erect-leaf witchgrass	1	5	1	0	-4	-1.00	Present in 2009
Erigeron	Fleabane			1	0	1	-1.00	Present in 2009
Eupatorium capillifolium	Dog-fennel	0	5	15	0	10	-15.00	Present in 2009
Eustachys					0.1		0.10	Present in 2011
Melaleuca quinquenervia	Punk tree	6	3	0	0	-3	0.00	Absent
Melaleuca quinquenervia - dead	Punk tree - dead	0	0	1	0	1	-1.00	Present in 2009
Mitreola petiolata	Stalked miterwort		3		0	-3	0.00	Absent
Muhlenbergia capillaris	Muhly grass	39			1.7	0	1.70	Present in 2011
Panicum sp.					11.16		11.16	Present in 2011
Peltandra virginica	Arum			1	0.2	1	-0.80	Present
Pluchea odorata	Sweetscent	0	0	1	0	1	-1.00	Present in 2009
Pluchea rosea	Rosy camphorweed	0	0	1	0	1	-1.00	Present in 2009
Rhynchospora microcarpa	Southern beak rush	2		1	0	1	-1.00	Present in 2009
Rhynchospora divergens	Spreading beakrush	1	5	1	0	-4	-1.00	Present in 2009
Saccharum giganteum	Sugarcane plumegrass	1			3.32	0	3.32	Present in 2011
Sagittaria lancifolia	Lance-leaf arrowhead	1	2	1	0.84	-1	-0.16	Present
Setaria parviflora	Knotroot foxtail		2	1	0	-1	-1.00	Present in 2009
Various algae/open	Periphyton/Open/Dead	15	15	10	74.9	-5	64.90	Present in 2011
Unknown Grass					1.66		1.66	Present in 2011

C-4 Impoundment Multi Year Comparison		Site4:	Site4:	Site4:	Site4:			
	Date surveyed	Apr-05	May-07	Apr-09	May-11	'07 to '09	'09 to '11	
	Latitude	25.7786				Change in Percent Cover		Change in Presence
	Longitude	-80.4416						
	FLUCCS Code	643xs	643cs	643cs	643			
Andropogon sp.	Bluestem	2	0	5	0	5	-5.00	Present in 2009
Aster sublatus	Annual saltmarsh aster	0	0	1	0	1	-1.00	Present in 2009
Centella asiatica	Coinwort	3	5	10	1.14	5	-8.86	Present
Cladium jamaicense	Sawgrass	35	65	30	4.92	-35	-25.08	Present
Cladium jamaicense - dead	Sawgrass - dead	0	0	15	0	15	-15.00	Present in 2009
Dichanthelium erectifolium	Erect-leaf witchgrass	1	2	1	0	-1	-1.00	Present in 2009
Eupatorium capillifolium	Dog fennel	0	0	10	0	10	-10.00	Present in 2009
Hypericum brachyphyllum	Coastal-plain St. John's-wort	1	2	1	0	-1	-1.00	Present in 2009
Ipomoea sagittata	Everglades morning-glory	1	0	0	0.82	0	0.82	Present in 2011
Melaleuca quinquenervia	Punk tree	10	5	0	0	-5	0.00	Absent
Melaleuca quinquenervia - dead	Punk tree - dead	0	0	5	0	5	-5.00	Present in 2009
Muhlenbergia capillaris	Muhly grass	20	5	10	2.28	5	-7.72	Present
Myrica cerifera	Wax myrtle	0	0	1	0.02	1	-0.98	Present
Panicum Sp.					5.62		5.62	Present in 2011
Pluchea rosea	Rosy camphorweed	1	0	0	0	0	0.00	Absent
Polygala balduinii	Bachelor's buttons	1	2	0	0	-2	0.00	Absent
Proserpinaca palustris	Marsh mermaid weed	1	0	0	0	0	0.00	Absent
Rhynchospora microcarpa	Southern beak rush	1	0	1	0	1	-1.00	Present in 2009
Rhynchospora divergens	Spreading beakrush	1	2	0	0	-2	0.00	Absent
Sagittaria lancifolia	Lance-leaf arrowhead	1	0	0	0.48	0	0.48	Present in 2011
Samolus ebracteatus	Water pimpernel	1	0	0	0	0	0.00	Absent
Setaria parviflora	Knotroot foxtail		2	0	0	-2	0.00	Absent
Various algae/Open	Periphyton/Open/Dead	20	10	10	85.2	0	75.20	Present
Unknown Grass					0.14		0.14	Present in 2011

C-4 Impoundment Multi Year Comparison		Site 51:	Site 51:	Site 51:	Site 51:			
	Date surveyed	Apr-05	May-07	Apr-09	May-11	'07 to '09	'09 to '11	
	Latitude	25.7786				Change in Percent Cover		Change in Presence
	Longitude	-80.4416						
	FLUCCS Code	643t	643rm	643h	643			
Andropogon sp.	Bluestem	0	20	30	0.26	10	-29.74	Present
Aristida sp.					0.34		0.34	Present in 2011
Aster braciae	Brace's aster	1	0	0	0	0	0.00	Absent
Blechnum serrulatum	Swamp fern	0	0	1	0	1	-1.00	Present in 2009
Brace's aster subulatus	Annual saltmarsh	1	0	0	0	0	0.00	Absent
Centella asiatica	Coinwort	3	3	0	0.48	-3	0.48	Present in 2011
Cladium jamaicense	Sawgrass	0	0	0	2.4	0	2.40	Present in 2011
Crinum americanum	Swamp-lily	3	0	0	0	0	0.00	Absent
Dichanthelium aciculare					0.2		0.20	Present in 2011
Dichanthelium erectifolium	Erect-leaf Witchgrass	1	5	0	0.84	-5	0.84	Present in 2011
Eupatorium capillifolium	Dog-fennel	3	10	15	0.24	5	-14.76	Present
Eustachys					1.24		1.24	Present in 2011
Flaveria linearis	Narrowleaf yellowtops	0	30	30	1.8	0	-28.20	Present
Hypericum brachyphyllum	Coastal-plain St. John's-wort	1	0	1	0	1	-1.00	Present in 2009
Ipomoea sagittata	Everglades morning-glory	1	0	0	0.06	0	0.06	Present in 2011
Justicia sp.		0	0	1	0	1	-1.00	Present in 2009
Melaleuca quinquenervia	Punk tree	3	0	0	0	0	0.00	Absent
Melaleuca quinquenervia - dead	Punk tree - dead	0	0	5	0	5	-5.00	Present in 2009
Mikania scandens	Climbing hempweed	1	1	1	0.04	0	-0.96	Present
Mitreola sessilifolium	Sessile miterwort	1	0	0	0.06	0	0.06	Present in 2011
Muhlenbergia capillaris	Muhly grass	0	0	2	5.1	2	3.10	Present
Myrica cerifera	Wax myrtle	0	0	2	0	2	-2.00	Present in 2009
Pluchea odorata	Saltmarsh fleabane	0	0	5	0.98	5	-4.02	Present
Pluchea rosea	Rosy camphor weed	2	0	1	0	1	-1.00	Present in 2009
Polygala balduinii	Bachelors buttons	1	2	2	0	0	-2.00	Present in 2009
Proserpinaca palustris	Marsh mermaid weed	2	0	0	0	0	0.00	Absent
Rhynchospora microcarpa	Southern beak rush	0	3	0	0	-3	0.00	Absent
Rhynchospora divergens	Spreading beakrush	2	3	0	0	-3	0.00	Absent
Saccharum giganteum	Sugarcane plumegrass	2	5	0	0	-5	0.00	Absent
Samolus ebracteatus	Water pimpernel	0	2	1	0	-1	-1.00	Present in 2009
Setaria parviflora	Knotroot foxtail	0	3	0	0	-3	0.00	Absent
Solidago gigantea	Giant goldenrod	0	2	0	0.08	-2	0.08	Present in 2011
Sonchus oleaceus	Common sow-thistle	1	0	0	0	0	0.00	Absent
Teucrium canadense	Wood sage	1	1	0	0	-1	0.00	Absent
Thelypteris kunthii	Shield fern	0	0	1	0	1	-1.00	Present in 2009
Thistle		0	0	1	0	1	-1.00	Present in 2009
Various algae	Periphyton/Open/Dead	70	10	0	85.16	-10	85.16	Present in 2011
Unknown herbaceous		0	0	1	0	1	-1.00	Present in 2009
Unknown Grass					0.04			Present in 2011

C-4 Impoundment Multi Year Comparison		Site 9:	Site 9:	Site 9:	Site 9:			
	Date surveyed	Apr-05	May-07	Apr-09	May-11	'07 to '09	'09 to '11	
	Latitude	25.7786				Change in Percent Cover		Change in Presence
	Longitude	-80.4416						
	FLUCCS Code	643t	643xsl	643xsl	643			
Andropogon sp.	Bluestem	0	0	10	0	10	-10.00	Present in 2009
Aster braciae	Brace's aster	1	0		0	0	0.00	Absent
Cephalanthus occidentalis	Buttonbush	1	0		0	0	0.00	Absent
Cladium jamaicense					1.08		1.08	Present in 2011
Dichanthelium aciculare					0.64		0.64	Present in 2011
Dichanthelium erectifolium	Erect-leaf witchgrass	1	3	3	0	0	-3.00	Present in 2009
Eupatorium capillifolium	Dog-fennel	1	30	5	0	-25	-5.00	Present in 2009
Eustachys					0.5		0.50	Present in 2011
Hypericum brachyphyllum	Coastal-plain St. John's-wort		2	1	0	-1	-1.00	Present in 2009
Ludwigia microcarpa	Little seedbox	1	0	0	0	0	0.00	Absent
Melaleuca quinquenervia	Punk tree	3	25	0	0	-25	0.00	Absent
Melaleuca quinquenervia - dead	Punk tree - dead			3	0	3	-3.00	Present in 2009
Muhlenbergia capillaris	Muhly grass	5		2	5.38	2	3.38	Present
Myrica cerifera	Wax myrtle		2	4	0	2	-4.00	Present in 2009
Panicum Hemitomon	Maidencane		2		0	-2	0.00	Absent
Rhynchospora microcarpa	Southern beak rush	1	5	5	0	0	-5.00	Present in 2009
Rhynchospora divergens	Spreading beakrush	1	5		0	-5	0.00	Absent
Saccharum giganteum	Sugarcane plumegrass	1			0	0	0.00	Absent
Setaria parviflora	Knotroot foxtail		3	1	0	-2	-1.00	Present in 2009
Unknown grass/other			3	1	0.14	-2	-0.86	Present
Various algae	Periphyton/Open/Dead	84	20	65	92.02	45	27.02	Present

C-4 Impoundment Multi Year Comparison		Site 32:	Site 32:	Site 32:	Site 32:			
	Date surveyed	Apr-05	May-07	Apr-09	May-11	'07 to '09	'09 to '11	
	Latitude	25.7786				Change in Percent Cover		Change in Presence
	Longitude	-80.4416						
	FLUCCS Code	643t	643xsl	643xsl	643			
Agalinus linifolia	Flaxleaf foxglove	0	3	1	0	-2	-1	Present in 2009
Andropogon sp.	Bluestem	0	20	2	0	-18	-2	Present in 2009
Andropogon glomeratus	Broomsedge, Bushy bluestem	3	0	0	0	0	0	Absent
Aster sublatus	Annual saltmarsh aster	0	0	1	0	1	-1	Present in 2009
Centella asiatica	Coinwort	2	0	1	3.02	1	2.02	Present
Cladium jamaicense	Sawgrass	24	5	7	10.14	2	3.14	Present
Dichanthelium aciculare					3.38		3.38	Present in 2011
Dichanthelium erectifolium	Erect-leaf witchgrass	3	3	1	2.32	-2	1.32	Present
Diodia sp.		0	0	1	0	1	-1	Present in 2009
Erigrostas chapmanii	Lovegrass	0	2	0	0	-2	0	Absent
Eupatorium capillifolium	Dog-fennel	3	3	1	1.14	-2	0.14	Present
Flaveria linearis	Narrowleaf yellowtops	3	3	0	0	-3	0	Absent
Hypericum brachyphyllum	Coastal-plain St. John's-wort	2	0	1	0	1	-1	Present in 2009
Ipomoea sagittata					0.3		0.3	Present in 2011
Juncus megacephalus	Big headed rush	0	0	1	0	1	-1	Present in 2009
Linum arenicola	Sand flax	0	0	1	0	1	-1	Present in 2009
Ludwigia erecta	Red ludwigia	0	0	0	0	0	0	Absent
Ludwigia microcarpa	Little seedbox	1	0	0	0	0	0	Absent
Melaleuca quinquenervia	Punk tree	1	0	0	0.04	0	0.04	Present in 2011
Muhlenbergia capillaris	Muhly grass	25	30	65	23.74	35	-41.26	Present
Oxypolis sp.	Cowbane	0	2	0	0	-2	0	Absent
Panicum	Panic grass	0	0	0	0	0	0	Absent
Pluchea rosea	Rosy camphor weed	1	0	0	0.4	0	0.4	Present in 2011
Polygala balduinii	Baldwin's milkwort	1	1	1	0	0	-1	Present in 2009
Rhynchospora microcarpa	Southern beak rush	2	10	5	0	-5	-5	Present in 2009
Rhynchospora divergens	Spreading beakrush	5	5	7	0	2	-7	Present in 2009
Rhynchospora colorata	White top sedge	0	2	1	0.4	-1	-0.6	Present
Rhynchospora sp.					4.78		4.78	Present in 2011
Sabatia stellaris	Marsh pink	1	0	1	0	1	-1	Present in 2009
Samolus ebracteatus	Water pimpernel	2	0	0	0	0	0	Absent
Setaria parviflora	Knotroot foxtail	1	5	0	0.04	-5	0.04	Present in 2011
Teucrium canadense	Wood sage	0	1	1	0.84	0	-0.16	Present
Various algae	Periphyton/Open/Dead	20	5	1	36.3	-4	35.3	Present

Attachment F: Vegetation Monitoring Report: Stereo-Imagery Rectification Accuracy (MATCH-AT log)

```
Start Post Processing: Tue Apr 05 17:11:56 2011
================================================

Active Block                                                    : complete Block
Number of photos                                                : 25
Number of strips                                                : 1

Photo scale                                                     : 1:20308
Mean terrain height [user]                                      : 9

Automatic blunder detection                                     : OFF


Use all adjusted points in project file
as control (absolute mode)                                      : OFF


Control parameter for block adjustment :
----------------------------------------

Selfcalibration                                                 : OFF
GNSS-Mode                                                       : OFF
Drift-Mode                                                      : OFF
IMU-Mode                                                        : OFF
Earth's curvature correction                                    : ON
Atmospheric correction                                          : ON
Do not eliminate manual points                                  : OFF

Standard deviations (a-priori) :
--------------------------------


Ground control (planimetry) [user]

    Set
     0 (=default)                                               :  0.100


Ground control (height) [user]

    Set
     0 (=default)                                               :  0.200


Automatic image points [mm]

    Set
     0 (=default)                                               :  0.002



Image points of ground control and manual measurements [mm]     :  0.002



Used Cameras in block:
----------------------

  1 UCX-SX-1-10817438
```

Distortion : No correction

Tie Point Generator
---

created 149 observations for photo 301_0027
created 158 observations for photo 301_0026
created 163 observations for photo 301_0025
created 160 observations for photo 301_0024
created 157 observations for photo 301_0023
created 148 observations for photo 301_0022
created 142 observations for photo 301_0021
created 137 observations for photo 301_0020
created 106 observations for photo 301_0019
created 75 observations for photo 301_0018
created 75 observations for photo 301_0017
created 70 observations for photo 301_0016
created 80 observations for photo 301_0015
created 81 observations for photo 301_0014
created 77 observations for photo 301_0013
created 81 observations for photo 301_0012
created 104 observations for photo 301_0011
created 106 observations for photo 301_0010
created 110 observations for photo 301_0009
created 118 observations for photo 301_0008
created 125 observations for photo 301_0007
created 130 observations for photo 301_0006
created 114 observations for photo 301_0005
created 109 observations for photo 301_0004
created 99 observations for photo 301_0003

total of 2874 measurements in 25 photos are used for adjustment (total 25 photos)

sigma naught 0.6 micron (17:11:59)
sigma naught 0.6 micron (17:11:59)

found 1 points connecting 2 photos
found 9 points connecting 3 photos
found 24 points connecting 4 photos
found 23 points connecting 5 photos
found 30 points connecting 6 photos
found 26 points connecting 7 photos
found 47 points connecting 8 photos
found 70 points connecting 9 photos
found 98 points connecting 10 photos
found 26 points connecting 11 photos

number of observations 5778
number of unknowns 1212
redundancy 4566

RMS automatic points in photo (number: 1598)
x 0.6 micron
y 0.4 micron

RMS control and manual points in photo (number: 1276)

x 0.6 micron
y 0.7 micron

RMS control points with default standard deviation set (number: 10)
x 0.081 [feet]
y 0.080 [feet]

RMS control points with default standard deviation set (number: 10)
z 0.082 [feet]

sigma naught 0.6 micron (17:12:00)
standard deviations of exterior orientation parameters (px, py, pz in [feet] omega,phi,kappa in [deg/1000])

photo ID	px	py	pz	omega	phi	kappa
301_0003	0.137	0.184	0.078	1.5671	1.0524	0.4094
301_0004	0.133	0.165	0.069	1.4021	1.0295	0.3706
301_0005	0.132	0.160	0.063	1.3567	1.0289	0.3422
301_0006	0.129	0.145	0.057	1.2220	1.0078	0.3142
301_0007	0.128	0.142	0.052	1.1926	1.0037	0.2955
301_0008	0.126	0.137	0.047	1.1497	0.9911	0.2769
301_0009	0.125	0.131	0.044	1.0942	0.9912	0.2609
301_0010	0.125	0.129	0.042	1.0676	0.9895	0.2491
301_0011	0.123	0.112	0.039	0.9177	0.9771	0.2349
301_0012	0.126	0.119	0.038	0.9789	1.0024	0.2355
301_0013	0.125	0.118	0.037	0.9664	0.9996	0.2310
301_0014	0.124	0.113	0.037	0.9175	0.9934	0.2235
301_0015	0.124	0.110	0.036	0.8968	0.9930	0.2216
301_0016	0.127	0.118	0.037	0.9635	1.0126	0.2272
301_0017	0.126	0.117	0.037	0.9618	1.0077	0.2275
301_0018	0.128	0.119	0.039	0.9821	1.0219	0.2356
301_0019	0.123	0.121	0.039	0.9982	0.9862	0.2396
301_0020	0.122	0.118	0.041	0.9801	0.9726	0.2464
301_0021	0.124	0.132	0.045	1.0989	0.9877	0.2622
301_0022	0.125	0.138	0.048	1.1609	0.9921	0.2783
301_0023	0.124	0.136	0.052	1.1430	0.9843	0.2919
301_0024	0.127	0.145	0.058	1.2294	1.0015	0.3157
301_0025	0.128	0.152	0.064	1.2853	1.0029	

0.3375

301_0026	0.130	0.161	0.070	1.3648	1.0105

0.3623

301_0027	0.131	0.168	0.078	1.4248	1.0152

0.3918

mean standard deviations of rotations
- omega 1.1 [deg/1000]
- phi 1.0 [deg/1000]
- kappa 0.3 [deg/1000]

max standard deviations of rotations
- omega 1.6 [deg/1000] at photo 301_0003
- phi 1.1 [deg/1000] at photo 301_0003
- kappa 0.4 [deg/1000] at photo 301_0003

mean standard deviations of translations
- x 0.127 [feet]
- y 0.136 [feet]
- z 0.050 [feet]

max standard deviations of translations
- x 0.137 [feet] at photo 301_0003
- y 0.184 [feet] at photo 301_0003
- z 0.078 [feet] at photo 301_0027

residuals horizontal control points in [feet]

control point ID	rx	ry
N-01	-0.115	0.051
N-02	0.026	0.063
N-03	-0.063	0.041
N-04	0.071	-0.012
N-05	-0.097	0.179
N-06	0.146	-0.072
N-07	0.051	-0.027
N-08	-0.022	-0.105
N-10	-0.064	-0.062
N-9R	0.067	-0.056

residuals vertical control points in [feet]

control point ID	rz
N-01	-0.091
N-02	-0.036
N-03	-0.034
N-04	0.078
N-05	0.124
N-06	-0.130
N-07	-0.076
N-08	0.030
N-10	0.031
N-9R	0.103

max standard deviations of terrain points
- x 0.262 [feet] at point 30000008

y 0.235 [feet] at point 20000001
z 0.876 [feet] at point 20000001

mean standard deviations of terrain points
x 0.046
y 0.032
z 0.140

exterior orientation parameters (px, py, pz in [feet] omega,phi,kappa in [deg])
rotations from terrain to photo (rotated axes)

photo ID	px	py	pz	omega	phi	kappa
301_0003	840068.051	528509.194	6700.796	-0.2239	0.1954	-179.4285
301_0004	840081.963	528068.745	6700.641	-0.2060	0.1922	-179.3462
301_0005	840093.481	527629.763	6700.253	-0.2016	0.2012	-179.3887
301_0006	840102.299	527194.060	6699.709	-0.1811	0.2020	-179.3760
301_0007	840109.040	526751.301	6699.073	-0.1528	0.1545	-179.4010
301_0008	840114.210	526317.118	6698.708	-0.2145	0.1637	-179.3847
301_0009	840117.867	525878.090	6698.144	-0.1835	0.2007	-179.3785
301_0010	840120.290	525437.383	6697.764	-0.1710	0.1852	-179.3904
301_0011	840121.732	524998.288	6697.397	-0.1775	0.1936	-179.4065
301_0012	840122.742	524560.966	6697.538	-0.1700	0.1961	-179.3790
301_0013	840123.219	524119.378	6698.632	-0.1869	0.2293	-179.3765
301_0014	840123.871	523682.887	6699.659	-0.1662	0.2397	-179.4302
301_0015	840125.182	523242.439	6700.368	-0.2116	0.1529	-179.3877
301_0016	840127.122	522804.012	6700.016	-0.1874	0.1964	-179.4159
301_0017	840129.502	522367.186	6699.544	-0.1579	0.2782	-179.3955
301_0018	840132.734	521925.934	6699.423	-0.1845	0.1605	-179.3418
301_0019	840136.924	521490.625	6699.642	-0.1685	0.1314	-179.4320
301_0020	840143.920	521051.016	6700.548	-0.1289	0.2105	-179.4288
301_0021	840153.840	520610.652	6702.862	-0.1586	0.2374	-179.3687
301_0022	840166.139	520172.769	6706.342	-0.1648	0.1937	-179.3627
301_0023	840182.666	519732.637	6712.131	-0.1343	0.1954	-179.4515
301_0024	840205.848	519293.422	6718.516	-0.1121	0.2071	-179.3829
301_0025	840234.330	518856.173	6724.731	-0.1192	0.2648	-179.5754
301_0026	840263.399	518416.291	6731.865	-0.1848	0.2310	

-179.4587
301_0027 840288.241 517980.792 6738.178 -0.1543 0.1706
-179.3392

==========

Sigma naught : 0.6 [micron] = 0.1 [pixel in level 0]

Elapsed time = 0 hour 0 min. 9 sec.

End of Post Processing: Tue Apr 05 17:12:03 2011

Attachment G: Vegetation Monitoring Report: Ground-Truthing Results

Accuracy ID	Image ID	Orientation	Description	FLUCFCS Code(s)	Match
10	IMG_6076.JPG	Left	*Cladium jamaicense* dominated prairie with sparse treated *Melaleuca quinquenervia.*	643c	Yes
21	IMG_6087.JPG	Left	Open areas with short stature mixed prairie and relic treated *Melaleuca quinquenervia.*	643l	Yes
6	IMG_8351.JPG	Right	Open areas with short stature mixed prairie and relic treated *Melaleuca quinquenervia;* adjacent *Cladium jamaicense* dominated prairie with sparse *Myrica cerifera*.	643xl; 643c; 643cs	Yes
23	IMG_6089.JPG	Left	Open areas with short stature mixed prairie and relic treated *Melaleuca quinquenervia.*	643l	Yes
31	IMG_6097.JPG	Left	Tall relic treated *Melaleuca quinquenervia* mixed with short stature mixed prairie.	643rm; 643	Yes
8	IMG_8353.JPG	Right	Tall relic treated *Melaleuca quinquenervia* mixed with short stature mixed prairie; adjacent *Muhlenbergia capillaris and Cladium jamaicense* mixed prairie with sparse relic treated *Melaleuca quinquenervia.*	643rm; 643	Yes
41	IMG_6107.JPG	Left	Open areas with short stature mixed prairie and relic treated *Melaleuca quinquenervia* and isolated swamp shrub.	643l; 643	Yes
12	IMG_8357.JPG	Right	*Cladium jamaicense* dominated prairie with sparse swamp shrubs and patchy short stature mixed prairie.	643c; 643cs; 643xsl	Yes
50	IMG_6116.JPG	Left	*Cladium jamaicense* dominated prairie with sparse treated *Melaleuca quinquenervia* and isolated *Myrica cerifera.*	643c	
16	IMG_8361.JPG	Right	*Cladium jamaicense*dominated prairie	643c	Yes
58	IMG_6124.JPG	Left	Open areas with short stature mixed prairie and relic treated *Melaleuca quinquenervia.*	643l; 643	Yes
20	IMG_8365.JPG	Right	*Cladium jamaicense* dominated prairie in foreground; adjacent *Muhlenbergia capillaris* and *Cladium jamaicense* mixed prairie; background treated *Melaleuca quinquenervia* mixed with short stature mixed prairie; scrapped wet prairie adjecent levy with large patch *Typha latifolia* inclusions.	643c; 643; 643m; 643xl; 641t	Yes
64	IMG_6130.JPG	Left	Mixed prairie and relic treated *Melaleuca quinquenervia*; small patch of *Cladium jamaicense* dominated prairie in near foreground; isolated *Myrica cerifera*; *Muhlenbergia capillaris* prairie ridge in background.	643l; 643; 643c; 643m	Yes
72	IMG_6138.JPG	Left	*Muhlenbergia capillaris* prairie in foreground; mixed prairie with sparse *Myrica cerifera* in background and relic treated *Melaleuca quinquenervia.*	643m; 643; 643s	Yes
78	IMG_6144.JPG	Left	Burned treated *Melaleuca quinquenervia* and burned prairie; center burned prairie.	643rmburn; 643burn	Yes
28	IMG_8373.JPG	Right	Burned treated *Melaleuca quinquenervia* and burned prairie.	643rmburn; 643burn	Yes

83	IMG_6149.JPG	Left	Burned prairie; isolated burned treated *Melaleuca quinquenervia.*	643burn	Yes
31	IMG_8376.JPG	Right	Burned treated *Melaleuca quinquenervia* and burned prairie.	643rmburn; 643burn	Yes
89	IMG_6155.JPG	Left	Burned prairie; isolated burned treated *Melaleuca quinquenervia.*	643burn	Yes
34	IMG_8379.JPG	Right	Burned prairie; small patch of swamp shrub.	643burn; 631burn	Yes
95	IMG_6161.JPG	Left	Burned prairie; burned treated *Melaleuca quinquenervia* and burned prairie; mixed hardwoods background.	643burn; 643rmburn; 617	Yes
37	IMG_8382.JPG	Right	Burned treated *Melaleuca quinquenervia* and burned prairie.	643rmburn; 643burn	
102	IMG_6168.JPG	Left	Mixed hardwoods.	617	Yes
40	IMG_8385.JPG	Right	Burned treated *Melaleuca quinquenervia* and burned prairie.	643rmburn; 643burn	Yes
108	IMG_6174.JPG	Left	Mixed hardwoods; burned treated *Melaleuca quinquenervia* and burned prairie.	617; 643rmburn	Yes
115	IMG_6181.JPG	Left	Burned treated *Melaleuca quinquenervia* and burned prairie; center burned prairie; patches of unburned mixed prairie; sparse burned treated *Melaleuca quinquenervia*.	643rmburn; 643burn; 643	Yes
120	IMG_6186.JPG	Left	Burned treated *Melaleuca quinquenervia* and burned prairie; burned prairie; sparse burned treated *Melaleuca quinquenervia*.	643rmburn; 643burn	Yes
53	IMG_8398.JPG	Right	Burned treated *Melaleuca quinquenervia* and burned prairie; sparse patches unburned mixed prairie; sparse swamp shrubs.	643rmburn; 643burn; 643sburn; 643; 643s	Yes
57	IMG_8402.JPG	Right	Burned treated *Melaleuca quinquenervia* and burned prairie with sparse swamp shrub.	643rmburn	Yes
131	IMG_6197.JPG	Left	Burned prairie; sparse burned treated *Melaleuca quinquenervi*; sparse *Myrica cerifera*.	643burn; 643sburn	Yes
61	IMG_8406.JPG	Right	Burned prairie with sparse *Myrica cerifera;* treated *Melaleuca quinquenervia* and burned prairie background.	643burn; 643sburn; 643rmburn	Yes
65	IMG_8410.JPG	Right	Burned prairie with sparse *Myrica cerifera*	643burn; 643sburn	Yes
69	IMG_8414.JPG	Right	Burned prairie; burned treated *Melaleuca quinquenervia* and burned prairie; sparse patches unburned *Muhlenbergia capillaris*; sparse *Myrica cerifera*.	643burn; 643sburn; 643rmburn; 643m	Yes
140	IMG_6206.JPG	Left	Burned prairie; patches of unburned *Muhlenbergia capillari* prairie; sparse burned treated *Melaleuca quinquenervia*.	643burn; 643m; 643rmburn	Yes

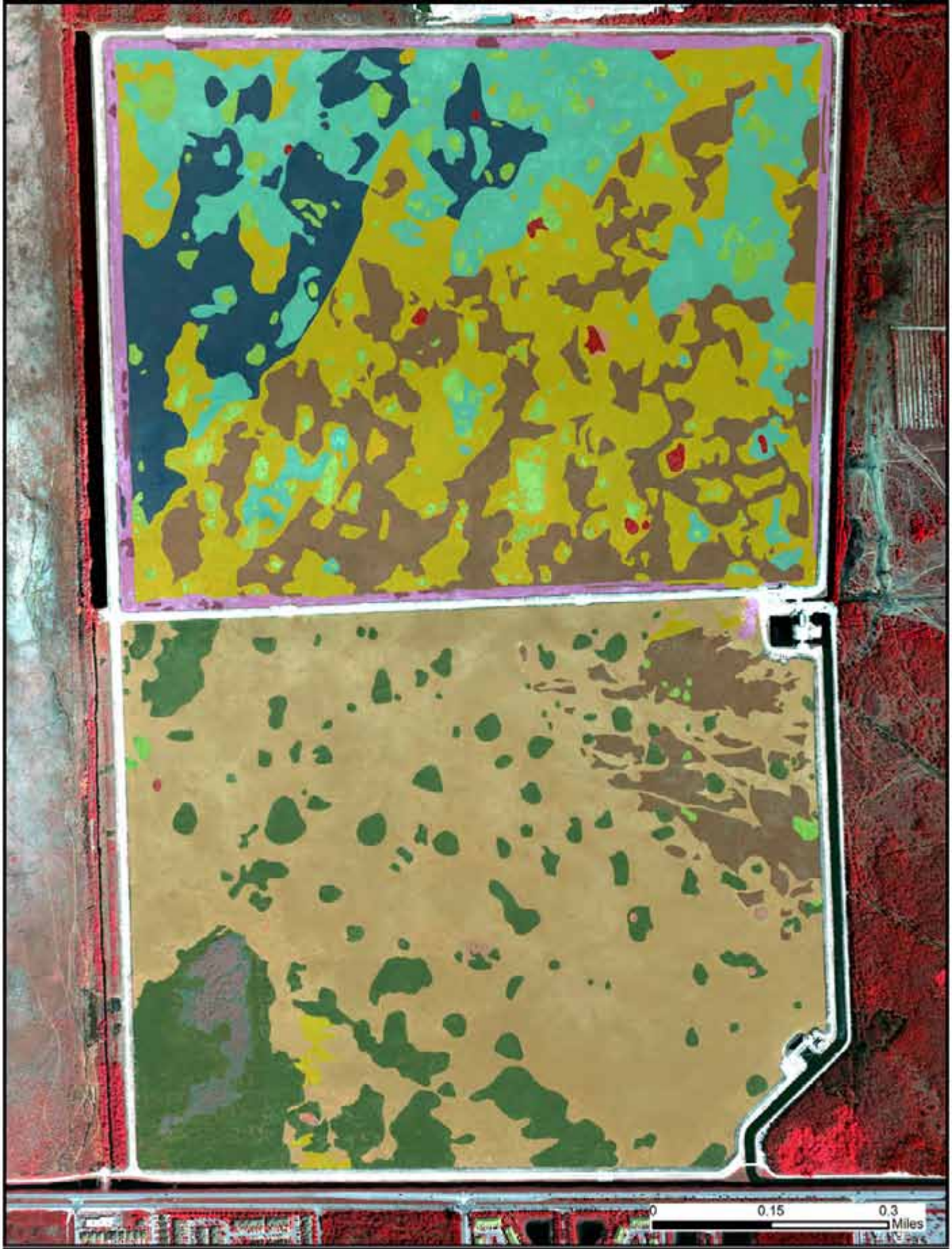
146	IMG_6212.JPG	Left	Unburned *Muhlenbergia capillari* prairie; burned prairie; sparse burned treated *Melaleuca quinquenervia*.	643m; 643burn; 643rmburn	Yes
153	IMG_6219.JPG	Left	Unburned *Muhlenbergia capillari* prairie; burned prairie; sparse burned treated *Melaleuca quinquenervia*.	643m; 643burn; 643rmburn	Yes
81	IMG_8426.JPG	Right	Unburned *Muhlenbergia capillaris* prairie; Burned prairie with sparse treated *Melaleuca quinquenervia*.	643ms; 643burn	Yes
160	IMG_6226.JPG	Left	Unburned *Muhlenbergia capillari* prairie.	643m	Yes
168	IMG_6234.JPG	Left	Scrapped wet prairie adjecent levy; *Muhlenbergia capillaris* prairie in background.	643xl; 643m	Yes
174	IMG_6240.JPG	Left	*Muhlenbergia capillari* prairie; patches mixed prairie.	643m; 643	Yes
180	IMG_6246.JPG	Left	Mixed prairie; patches *Muhlenbergia capillari* prairie; isolated *Myrica cerifera*.	643; 643m	Yes
93	IMG_8438.JPG	Right	Mixed short stature prairie foreground; *Muhlenbergia capillaris* prairie in foreground and alonghigher elevations; isolated patch treated *Melaleuca quinquenervia*; isolated swamp shrubs.	643xl; 643; 643m	Yes
187	IMG_6253.JPG	Left	Mixed prairie; patches *Muhlenbergia capillari* prairie; isolated *Myrica cerifera;* tall relic treated *Melaleuca quinquenervia* mixed with short stature mixed prairie.	643; 643m; 643rm	Yes
103	IMG_8448.JPG	Right	Tall relic treated *Melaleuca quinquenervia* mixed with short stature mixed prairie; adjacent mixed prairie; *Muhlenbergia capillaris* prairie in background.	643rm; 643xl; 643; 643ms	Yes
195	IMG_6261.JPG	Left	Tall relic treated *Melaleuca quinquenervia* mixed with short stature mixed prairie.	643rm	Yes
204	IMG_6270.JPG	Left	Tall relic treated *Melaleuca quinquenervia* mixed with short stature mixed prairie.	643rm	Yes
113	IMG_8458.JPG	Right	Mixed prairie with isolated open patches; relic treated *Melaleuca quinquenervia*; isolated *Myrica cerifera*; scrapped wet prairie adjecent levy with large patch *Typha latifolia* inclusions.	643; 643xl; 641t	Yes
213	IMG_6279.JPG	Left	*Muhlenbergia capillari* prairie; patches mixed prairie with sparse treated *Melaleuca quinquenervia* and sparse *Myrica cerifera.*	643m. 643, 643s	Yes
221	IMG_6287.JPG	Left	Tall relic treated *Melaleuca quinquenervia* mixed with short stature mixed prairie; sparse *Myrica cerifera*.	643rm; 643l; 643s	Yes
119	IMG_8464.JPG	Right	Tall relic treated *Melaleuca quinquenervia* mixed with swamp shrubs and short stature mixed prairie; adjacent mixed prairie; scraped wet prairie adjacent levy in background.	643rms; 643; 643xl	Yes
125	IMG_8470.JPG	Right	*Muhlenbergia capillaris and Cladium jamaicense* mixed prairie; sparse relic treated *Melaleuca quinquenervia*; isolated *Myrica cerifera*; scrapped wet prairie adjecent levy with large patch *Typha latifolia* inclusions.	643; 643xl; 641t	Yes
229	IMG_6295.JPG	Left	Mixed prairie; Tall relic treated *Melaleuca quinquenervia* mixed with short stature mixed prairie; sparse *Myrica cerifera*.	643; 643rms	Yes
131	IMG_8476.JPG	Right	Short stature mixed prairie with open patches in foreground; *Cladium jamaicense* dominated prairie with sparse patches *Muhlenbergia capillari,* sparse *Myrica cerifera* and sparse treated *Melaleuca quinquenervia*.	643l, 643c, 643cs	Yes

237	IMG_6303.JPG	Left	Mixed prairie; Tall relic treated *Melaleuca quinquenervia* mixed with short stature mixed prairie; sparse *Myrica cerifera*.	643; 643rms	Yes
244	IMG_6310.JPG	Left	Mixed prairie forground; *Muhlenbergia capillari* prairie center; dense *Myrica cerifera* in background.	643; 643m; 643s; 631	Yes
135	IMG_8480.JPG	Right	Mixed prairie with sparse *Myrica cerifera* and sparse treated *Melaleuca quinquenervia; Muhlenbergia capillari* prairie on horizon	643; 643s; 643m, 643rm	Yes
139	IMG_8484.JPG	Right	*Muhlenbergia capillari* prairie foreground, mixed prairie center; adjacent relic treated *Melaleuca quinquenervia* mixed with short stature mixed prairie; isolated *Myrica cerifera* and sparse treated *Melaleuca quinquenervia.*	643m; 643; 643rm	Yes
251	IMG_6317.JPG	Left	Mixed prairie surrounding *Muhlenbergia capillari* prairie; isolated *Myrica cerifera;* tall relic treated *Melaleuca quinquenervia* mixed with short stature mixed prairie.	643; 643m; 643rm	Yes
257	IMG_6323.JPG	Left	Mixed prairie; patches *Muhlenbergia capillari* prairie; isolated *Myrica cerifera;* sparse relic treated *Melaleuca quinquenervia.*	643; 643m; 643rm	Yes
143	IMG_8488.JPG	Right	Mixed prairie in foreground and background right; *Muhlenbergia capillari* prairie ridge through center; isolated *Myrica cerifera* and sparse treated *Melaleuca quinquenervia.*	643; 643s; 643m	Yes
263	IMG_6329.JPG	Left	*Muhlenbergia capillari* prairie; patches mixed prairie with sparse treated *Melaleuca quinquenervia*.	643m; 643; 643rm	Yes
270	IMG_6336.JPG	Left	Burned treated *Melaleuca quinquenervia* and burned prairie; burned prairie; sparse burned treated *Melaleuca quinquenervia;* patches unburned *Muhlenbergia capillari* prairie.	643rmburn; 643burn; 643m	Yes
150	IMG_8495.JPG	Right	Burned prairie with sparse treated *Melaleuca quinquenervia*; patch of unburned *Muhlenbergia capillari* prairie.	643burn; 643m	Yes
154	IMG_8499.JPG	Right	Burned treated *Melaleuca quinquenervia* and burned prairie with sparse *Myrica cerifera*.	643rmburn; 643burn; 643sburn	Yes
279	IMG_6345.JPG	Left	Burned treated *Melaleuca quinquenervia* and burned prairie; burned prairie; sparse burned treated *Melaleuca quinquenervia;* sparse *Myrica cerifera.*	643rmburn; 643burn; 643sburn	Yes
284	IMG_6350.JPG	Left	Burned prairie.	643burn	Yes
166	IMG_8511.JPG	Right	Burned prairie with treated *Melaleuca quinquenervia*.	643burn	Yes
291	IMG_6357.JPG	Left	Burned treated *Melaleuca quinquenervia* and burned prairie.	643rmburn	Yes
297	IMG_6363.JPG	Left	Burned treated *Melaleuca quinquenervia* and burned prairie; burned prairie; sparse burned treated *Melaleuca quinquenervia*; sparse *Myrica cerifera.*	643rmburn; 643burn; 643sburn	Yes
173	IMG_8518.JPG	Right	Burned treated *Melaleuca quinquenervia* and burned prairie with sparse *Myrica cerifera*.	643rmburn; 643burn; 643sburn	Yes
304	IMG_6370.JPG	Left	Burned prairie; patches of unburned mixed prairie; sparse burned treated *Melaleuca quinquenervia*.	643burn; 643	Yes

177	IMG_8522.JPG	Right	Burned treated *Melaleuca quinquenervia* and burned prairie with sparse *Myrica cerifera*.	643rmburn; 643burn; 643sburn	Yes
312	IMG_6378.JPG	Left	Mixed hardwoods; burned prairie; sparse burned treated *Melaleuca quinquenervia.*	617; 643burn	Yes
182	IMG_8527.JPG	Right	Burned treated *Melaleuca quinquenervia* and burned prairie.	643rmburn; 643burn	Yes
317	IMG_6383.JPG	Left	Mixed hardwoods; burned prairie; sparse burned treated *Melaleuca quinquenervia.*	617; 643burn	Yes
186	IMG_8531.JPG	Right	Burned treated *Melaleuca quinquenervia* and burned prairie with sparse *Myrica cerifera*.	643rmburn; 643burn; 643sburn	Yes
323	IMG_6389.JPG	Left	Burned prairie; burned treated *Melaleuca quinquenervia* and burned prairie; mixed hardwoods background.	643burn; 643rmburn; 617	Yes
329	IMG_6395.JPG	Left	Mixed hardwoods.	617	Yes
333	IMG_6399.JPG	Left	Mixed hardwoods; burned treated *Melaleuca quinquenervia* and burned prairie background.	617: 643rmburn	Yes
337	IMG_6403.JPG	Left	Mixed hardwoods; burned treated *Melaleuca quinquenervia* and burned prairie.	617; 643rmburn	Yes
189	IMG_8534.JPG	Right	Burned treated *Melaleuca quinquenervia* and burned prairie; background unburned mixed prairie with sparse treated *Melaleuca quinquenervia* and sparse swamp shrubs.	643rmburn; 643burn; 643; 643s	Yes
344	IMG_6410.JPG	Left	Mixed hardwoods.	617	Yes
194	IMG_8539.JPG	Right	Mixed Hardwoods foreground; background burned treated *Melaleuca quinquenervia* and burned prairie	617; 643rmburn; 643burn	Yes
352	IMG_6418.JPG	Left	Burned prairie; burned treated *Melaleuca quinquenervia* and burned prairie.	643burn; 643rmburn	Yes
198	IMG_8543.JPG	Right	Burned treated *Melaleuca quinquenervia* and burned prairie; unburned mixed prairie with sparse treated *Melaleuca quinquenervia.*	643rmburn; 643burn; 643	Yes
358	IMG_6424.JPG	Left	Burned treated *Melaleuca quinquenervia* and burned prairie; center burned prairie	643rmburn; 643burn	Yes
364	IMG_6430.JPG	Left	Burned treated *Melaleuca quinquenervia* and burned prairie; burned prairie; small patches of unburned mixed prairie.	643rmburn; 643burn; 643	Yes
371	IMG_6437.JPG	Left	Burned treated *Melaleuca quinquenervia* and burned prairie; burned prairie; sparse burned treated *Melaleuca quinquenervia*.	643rmburn; 643burn	Yes

205	IMG_8550.JPG	Right	Burned treated *Melaleuca quinquenervia* and burned prairie with sparse *Myrica cerifera*.	643rmburn; 643burn; 643sburn	Yes
382	IMG_6448.JPG	Left	Burned prairiesparse burned treated *Melaleuca quinquenervia*.	643burn	Yes
208	IMG_8553.JPG	Right	Burned treated *Melaleuca quinquenervia* and burned prairie with sparse *Myrica cerifera*.	643rmburn; 643burn; 643sburn	Yes
383	IMG_6449.JPG	Left	Burned prairie; sparse burned treated *Melaleuca quinquenervia*.	643burn	Yes
391	IMG_6457.JPG	Left	Burned prairie; sparse burned treated *Melaleuca quinquenervia*.	643burn	Yes
394	IMG_6460.JPG	Left	Burned prairie; sparse burned treated *Melaleuca quinquenervia*.	643burn	Yes
216	IMG_8561.JPG	Right	Burned praire; isolated burned treated *Melaleuca quinquenervia.*	643burn	Yes
219	IMG_8564.JPG	Right	*Muhlenbergia capillari* prairie; isolated relic treated *Melaleuca quinquenervia.*	643m	Yes
399	IMG_6465.JPG	Left	*Muhlenbergia capillari* prairie	643m	Yes
404	IMG_6470.JPG	Left	*Muhlenbergia capillari* prairie ridge between tall relic treated *Melaleuca quinquenervia* mixed with short stature mixed prairie; sparse open patches.	643m; 643rm; 643l	Yes
226	IMG_8571.JPG	Right	*Muhlenbergia capillari* prairie; treated *Melaleuca quinquenervia* with short stature mixed prairie and swamp shrubs on horizon; mixed prairie foreground left.	643m; 643rm 643rms; 643	Yes
410	IMG_6476.JPG	Left	*Muhlenbergia capillari* prairie; patches tall relic treated *Melaleuca quinquenervia* mixed with short stature mixed prairie.	643m; 643rm	Yes
415	IMG_6481.JPG	Left	Short *Muhlenbergia capillari* prairie ridge in foreground; mixed prairie center; *Cladium jamaicense* dominated prairie background; patches tall relic treated *Melaleuca quinquenervia* mixed with short stature mixed prairie.	643m; 643; 643c; 643rm	Yes
229	IMG_8574.JPG	Right	*Muhlenbergia capillari* prairie foreground; mixed prairie center; *Melaleuca quinquenervia* with short stature mixed prairie on horizon.	643m; 643; 643rm	Yes
232	IMG_8577.JPG	Right	Open areas with short stature mixed prairie and relic treated *Melaleuca quinquenervia* foreground right*;* Patch *Muhlenbergia capillari* prairie center; rest dominated by mixed prairie; isolated *Myrica cerifera.*	643l; 643m; 643	Yes
423	IMG_6489.JPG	Left	Open areas with short stature mixed prairie and relic treated *Melaleuca quinquenervia;* sparse *Myrica cerifera*; *Cladium jamaicense* dominated prairie background.	643xl; 643c; 643cs	Yes
235	IMG_8580.JPG	Right	Open areas with short stature mixed prairie; Relic treated *Melaleuca quinquenervia* with short stature mixed prairie; isolated *Myrica cerifera*.	643l, 643rm	Yes
429	IMG_6495.JPG	Left	Scrapped wet prairie adjecent levy with sparse *Typha latifolia.*	643xl	Yes

Attachment H:
Vegetation Monitoring Report:
GIS Habitat Maps
2011, 2009, 2007 and 2005



C-4 Emergency Drainage Basin
Miami-Dade County, FL
2011 Habitat Map

Boodjamap, Inc.
GIS & Vegetation Mapping Services

Customized FLUCFCS Codes

617	Mixed Wetland Hardwoods	643sburn	Burned Mixed Wet Prairie	643rmburn	Burned Recovering Wet Prairie in Treated Melaleuca Stands
631	Wetland Shrub	643cs	Sawgrass Wet Prairie	643rms	Recovering Wet Prairie/Shrub in Treated Melaleuca Stands
631burn	Burned Wetland Shrub	643sl	Scraped Wet Prairie	643xsl	Low-Density Wet Prairie
641t	Cattail Marsh	643ms	Muhly Wet Prairie		
643s	Mixed Wet Prairie	643rm	Recovering Wet Prairie in Treated Melaleuca Stands		

Phase I

Phase II

N

0 275 550

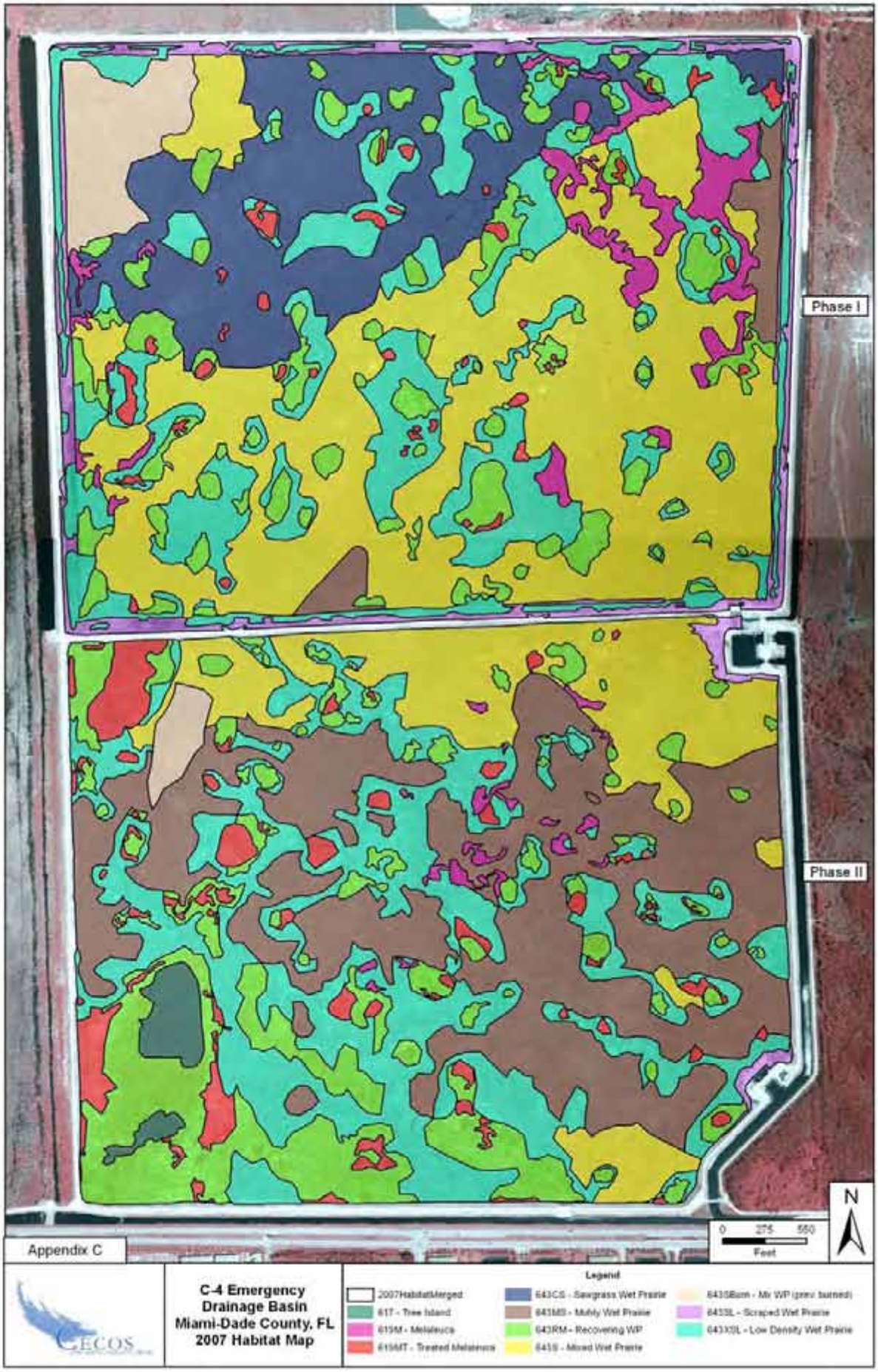
Feet

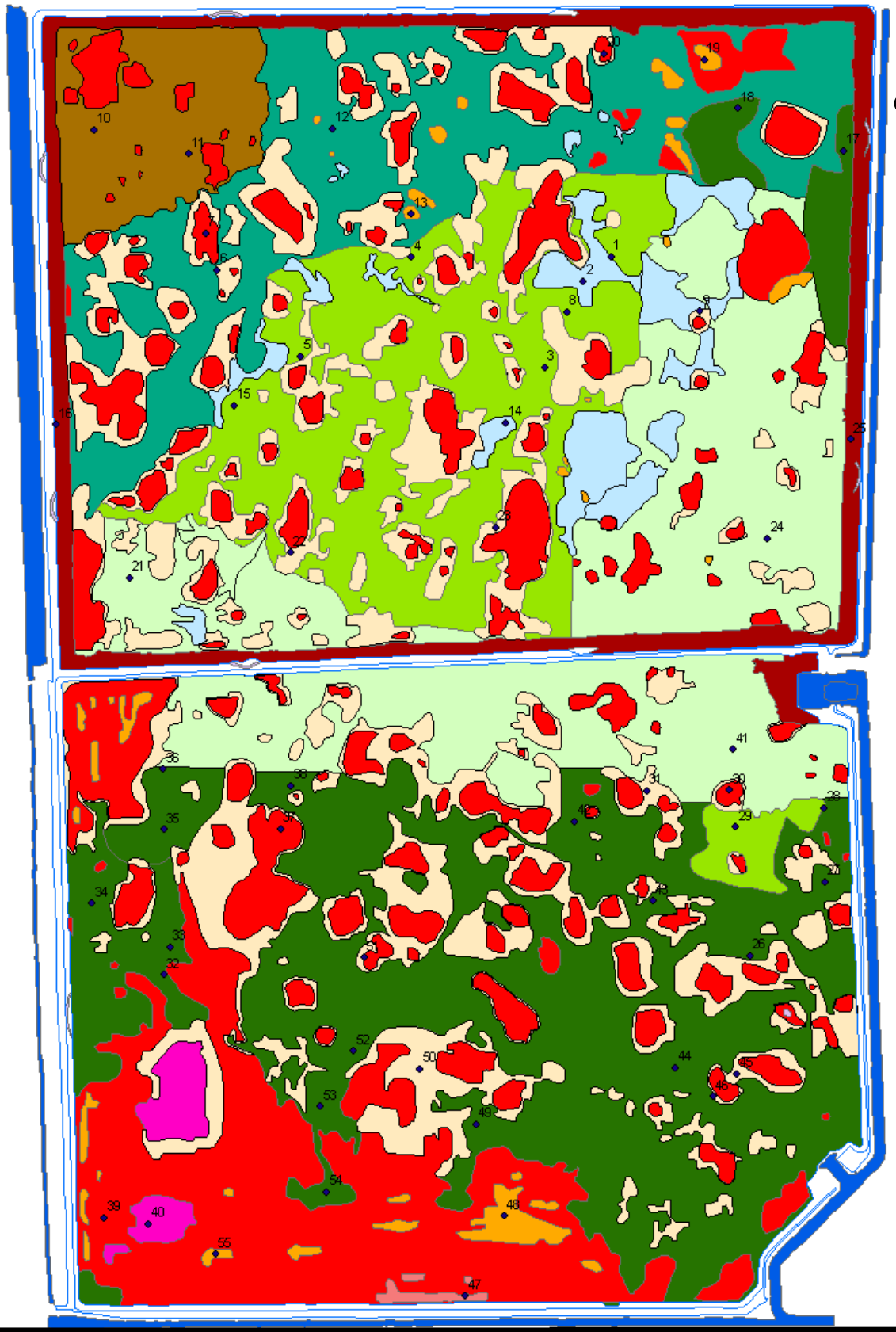
Appendix G

C-4 Emergency Drainage Basin Miami-Dade County, FL 2009 Habitat Map

Legend

- 617 - Tree Island
- 619MT - Treated Melaleuca
- 631 - Wetland Shrub
- 643CS - Sawgrass Wet Prairie
- 643MS - Muhly Wet Prairie
- 643RM - Recovering WP
- 643S - Mixed Wet Prairie
- 643SL - Scraped Wet Prairie
- 643XSL - Low Density Wet Prairie


Phase I
Phase II
N
0 275 550
Feet
Appendix C
C-4 Emergency Drainage Basin Miami-Dade County, FL 2007 Habitat Map
Legend
2007HabitatMerged
643CS - Sawgrass Wet Prairie
643Burn - Mx WP (prev burned)
61T - Tree Island
643MS - Muhly Wet Prairie
643SL - Scraped Wet Prairie
615M - Melaleuca
643RM - Recovering WP
643XL - Low Density Wet Prairie
615MT - Treated Melaleuca
643S - Mixed Wet Prairie

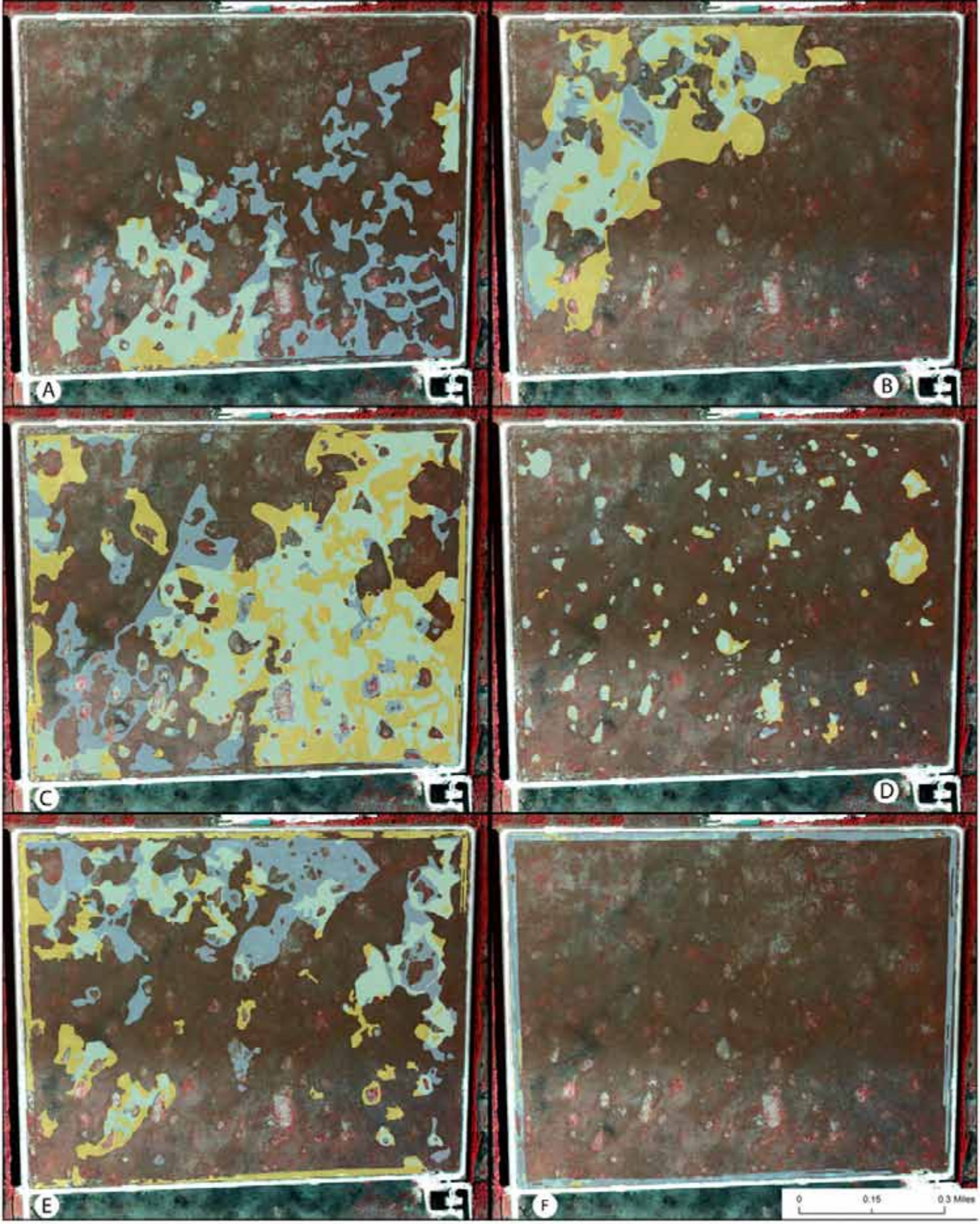


C4 EMERGENCY IMPOUNDMENT PROJECT
(Phase I & Phase II)
Miami-Dade County, FL

Appendix C:

2005 GIS HABITAT MAP

Attachment I:
Vegetation Monitoring Report:
Change Detection Maps and Table



Appendix F: Change Detection 2011-2009

2011
2011 & 2009
2009

A: Muhly Wet Prairie
B: Sawgrass Wet Prairie
C: Mixed Wet Prairie
D: Recovering Wet Prairie
E: Low-Density Wet Prairie
F: Scraped Wet Prairie

2011 FLUCFCS Change Detection 2011 - 2009

FLUCFCS 2011	FLUCFCS 2009	Acre	%
631	643cs	0.007	0.002
631	643rm	0.099	0.024
631	643s	0.334	0.080
641t		0.009	0.002
641t	643cs	0.084	0.020
641t	643ms	0.120	0.029
641t	643s	0.231	0.055
641t	643sl	0.587	0.141
641t	643xsl	0.723	0.173
643cs	643cs	36.154	8.672
643cs	643ms	0.001	0.000
643cs	643rm	0.753	0.181
643cs	643s	8.527	2.045
643cs	643sl	0.011	0.003
643cs	643xsl	4.771	1.144
643ms	643cs	3.744	0.898
643ms	643ms	30.592	7.338
643ms	643rm	0.017	0.004
643ms	643s	52.971	12.706
643ms	643sl	0.015	0.004
643ms	643xsl	1.028	0.247
643rm	619mt	0.065	0.016
643rm	643cs	2.074	0.498
643rm	643ms	0.063	0.015
643rm	643rm	17.739	4.255
643rm	643s	3.994	0.958
643rm	643xsl	1.493	0.358
643rms	643rm	1.295	0.311
643rms	643s	0.534	0.128
643rms	643xsl	0.052	0.013
643s		0.001	0.000
643s	619mt	0.055	0.013
643s	643cs	16.657	3.996
643s	643ms	6.642	1.593
643s	643rm	2.136	0.512
643s	643s	93.512	22.430
643s	643sl	0.032	0.008
643s	643xsl	17.655	4.235
643sl		0.296	0.071
643sl	631	0.181	0.043
643sl	643cs	0.125	0.030
643sl	643ms	0.598	0.144
643sl	643s	6.450	1.547
643sl	643sl	3.388	0.813
643sl	643xsl	13.998	3.358
643xsl	643cs	27.158	6.514
643xsl	643ms	0.102	0.024
643xsl	643rm	4.507	1.081
643xsl	643s	19.386	4.650
643xsl	643sl	0.115	0.028
643xsl	643xsl	35.820	8.592
	631	0.171	N/A
	643ms	0.010	N/A
	643s	0.414	N/A
	643sl	0.124	N/A
	643xsl	0.502	N/A

Attachment J:
Field Notes

Periphyton Monitoring Field Notes

PROJECT: C4IP Date Deployed: 6/2/11 Date Retrieved: 6/30/11 Page 1 of 1

Periphyton monitoring

Equipment

Pole: 6 periphytometers w/slides Palbga pole

Collectors and Tasks: MOP

Methods: Collection done according to SOP SFWMD-FIELD-SOP-025-01.

		Deployment			Retrieval			
Project	Site	Time	Tdepth (m)	Number of Periphytometers deployed	Time	Tdepth(m)	Number of periphytometers retrieved	Comments
C4IP	G423P	1048	0	3	1130	0	3	Site Dry
C4IP	G421P	1130	1.43	3	1100	71m	3	Retention Pond

6/30/11

Signature /Date

Reviewed By /Date

Incidental Wildlife Field Notes

4/25/11 MOP, NC 64IP 9, 32

Incidental Wildlife

Vulture (Turkey)

Rubbers

Dead Turtles

4/26/11 MSP, KAL CAIP Sites 8, 36, 1

Incidental Wildlife

vultures
Killdeer
Northern Mocking Bird
Lubber
turtles Dead
Eastern meadowlark
Common night hawk
Golden silk orb spider
Turtles live
Halloween pennant dragonfly

CHIP

4/27/11 MOP, MOB, JA, MF Sites 26, 46, 51

Incidental wildlife

Turkey Vulture

Burrows (Toad)

Lubbers

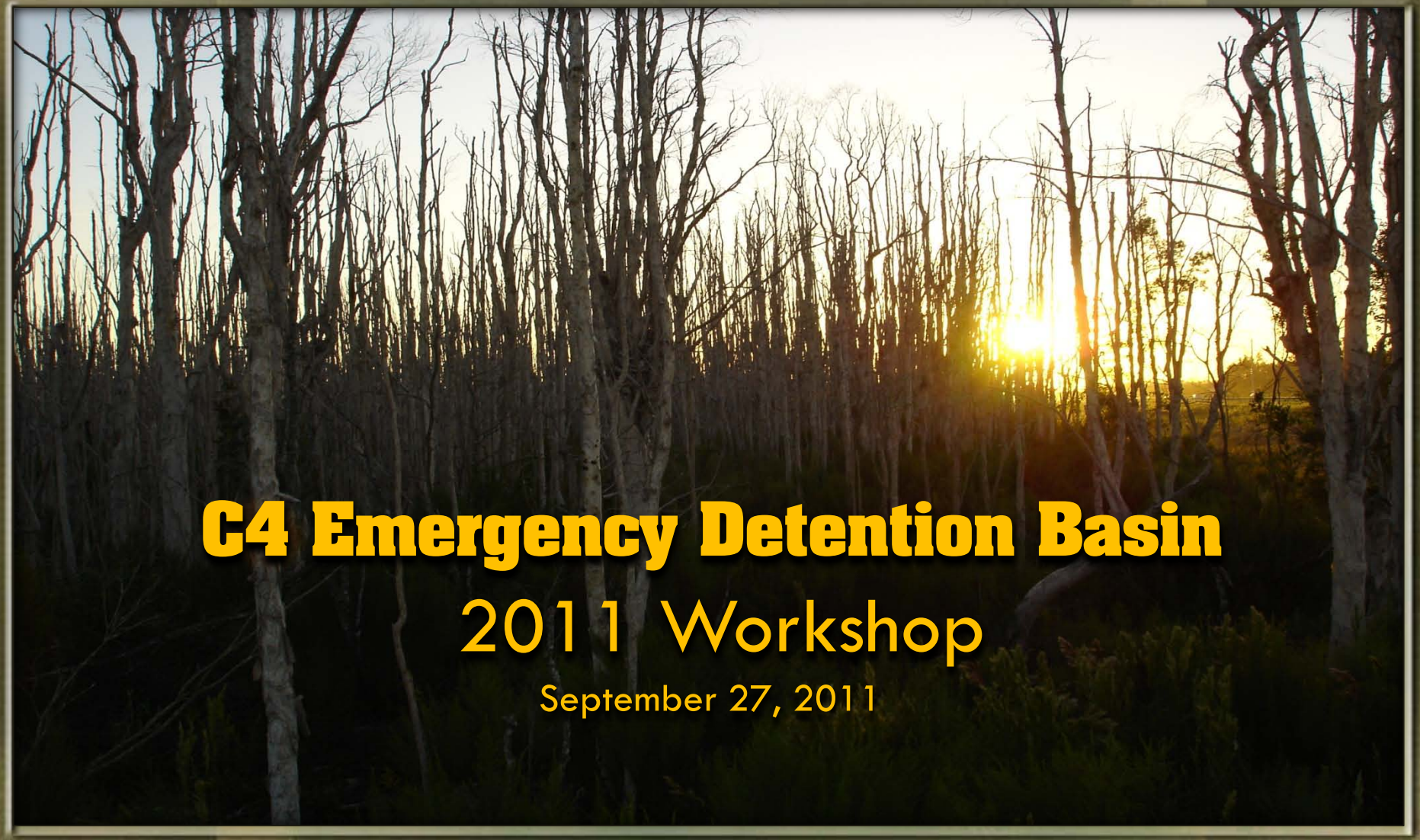
Dead turtles

4/28/11 MAP, JA

Incidental Wildlife

- Lubbers
- Dead Turtles
- Vultures
- Burrows

Attachment K: Workshop Presentation



C4 Emergency Detention Basin

2011 Workshop

September 27, 2011

Workshop Agenda

9:30 am 1	Introductions	Rick Householder
9:40 am 2	Overview of Permit Requirements and Past Reporting	John Leslie
10:00 am 3	Water Quality and Periphyton Methods	Matt Powers
10:20 am 4	Total Phosphorous Update	Shi Xue
10:30 am 5	Vegetation Monitoring Results • mapping (aerial photography and ground truthing) • incidental wildlife • WRAP scoring	Ken Chen & Matt Powers
11:20 am 6	Recommendations/Future Activities Discussion	Brad Robbins/ Group
12:00 pm	Adjourn	

Introduction

Purpose of Construction:

- To serve as an impoundment area which provides flood protection for City of Sweetwater and surrounding areas

- The impoundment area comprises 855 acres and is divided into two basins: Phase I (north) and Phase II (south)

Project Site Location

Project Site Map

Required Monitoring

Current Permit Required Monitoring	
Parameter	***Frequency***
Wildlife	Biennial
Water Quality	Weekly if Flowing (72 hr response) else Quarterly
Periphyton	Biennial
Vegetation (intensive)	Biennial
Vegetation (routine groundtruthing)	Biennial
Aerial Vegetation Surveys	Biannual
Reporting	Biennial
Workshop	Biennial

2 John Leslie

Project Timeline

October 16, 2006

Request to transfer from construction to operations

November 8, 2006

Approval of As-Built Certification for
C4 Emergency Detention Facility

July 2, 2007

Permit modification (13-0193739 -008)
Reduces frequency of wildlife observations in the C4 EDB

July 2007

Vegetation Monitoring Report

Project Timeline continued . . .

September 25, 2008

Permit modification for wildlife monitoring

July 2009

Vegetation Monitoring Report

October 2009

Biennial Comprehensive
Environmental Impact Evaluation Report

July 2011

Vegetation Monitoring Report

April 20, 2011

Corps of Engineers letter stating
no more monitoring is required for this project

Next Agenda Topic

3

Water Quality and Periphyton Methods

presented by

Matt Powers

C4 Emergency Detention Basin

2011 Workshop
September 27, 2011

Water Quality and Periphyton Monitoring Methods and Results

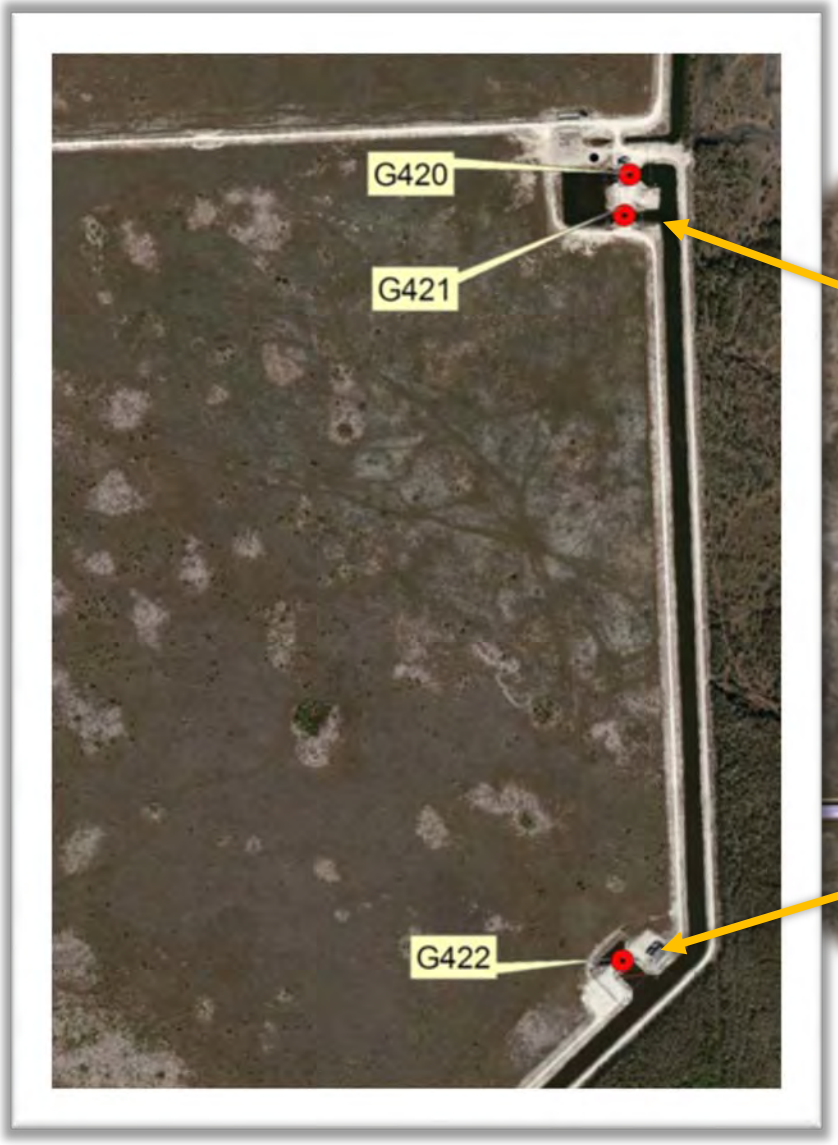
Matt Powers
Environmental Scientist
Water Quality Bureau

Water Quality Monitoring Overview

- Pumps Operate for Emergency Flood Protection
- Sampling Stations are at 3 Structures:

  G420, G421, and G422
- Sampling frequency is weekly if recorded flow, otherwise quarterly only at G420
- Sampling is conducted in accordance with SFWMD Field Sampling Quality Manual (FSQM) and in compliance with DEP SOPs

C4 Water Quality Monitoring Stations



Structures G420 and G421

Structure G422

Water Quality Parameters Monitored

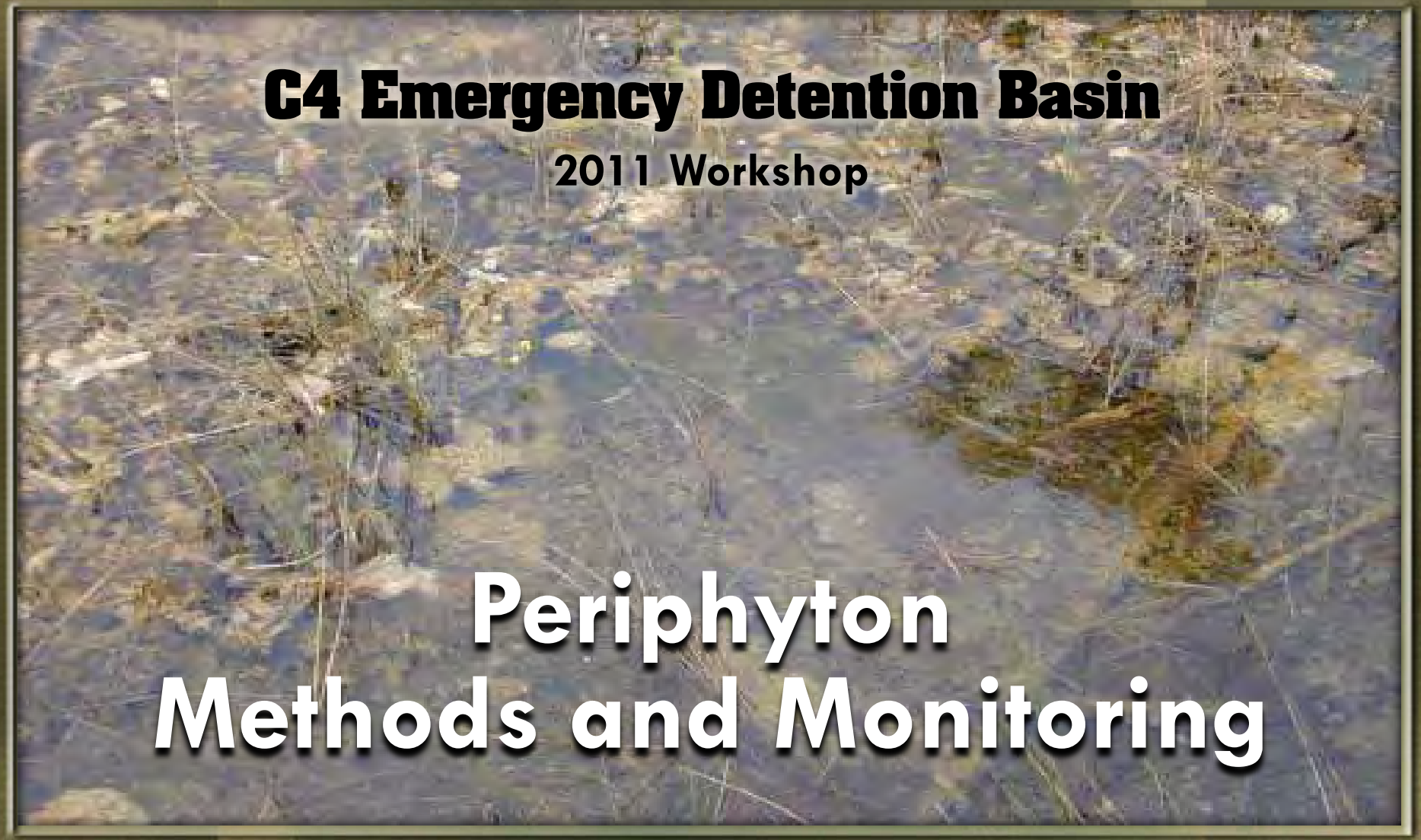
Parameter	Sample Type	PQL	MDL	Collection Frequency
TPO4	Grab	8 µg/l	2 µg/l	Within 72 hours of operation, then weekly
TDPO4		8 µg/l	2 µg/l	
OPO4		8 µg/l	2 µg/l	
TKN		0.200 mg/l	0.05 mg/l	
TDKN		0.200 mg/l	0.05 mg/l	
NOX		0.020 mg/l	0.005 mg/l	
Temp.	Field Parameter	n/a	n/a	

Water Quality Monitoring Results

9/1/09 to Present

Station	Date Collected	TDKN mg/l	TKN mg/l	NOX mg/l	TDPO4 µg/l	OPO4 µg/l	TPO4 µg/l	TEMP C
G420	3/29/2010	1.2	1.2	0.014	2	2	6	24.2
	5/27/10	1.1	1.1	0.011	2	2	6	25.6
	9/01/10	1.2	1.2	0.005	5	3	7	26.1
	9/30/10	1.3	1.3	0.059	5	2	7	25.8
	12/01/10	1.3	1.3	0.005	3	2	9	25.9
	3/01/11	1.2	1.3	0.005	2	2	9	24.7
	06/2/11	1.1	1.1	0.005	2	2	5	25.5

Collection in **red** indicates sample was triggered by flow event; all other samples collected as part of quarterly permit requirement. All Data from DBHYDRO



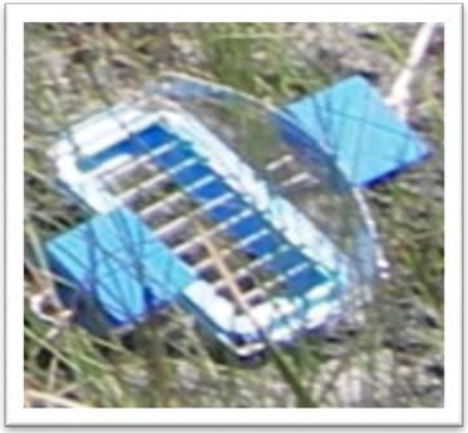
C4 Emergency Detention Basin

2011 Workshop

Periphyton Methods and Monitoring

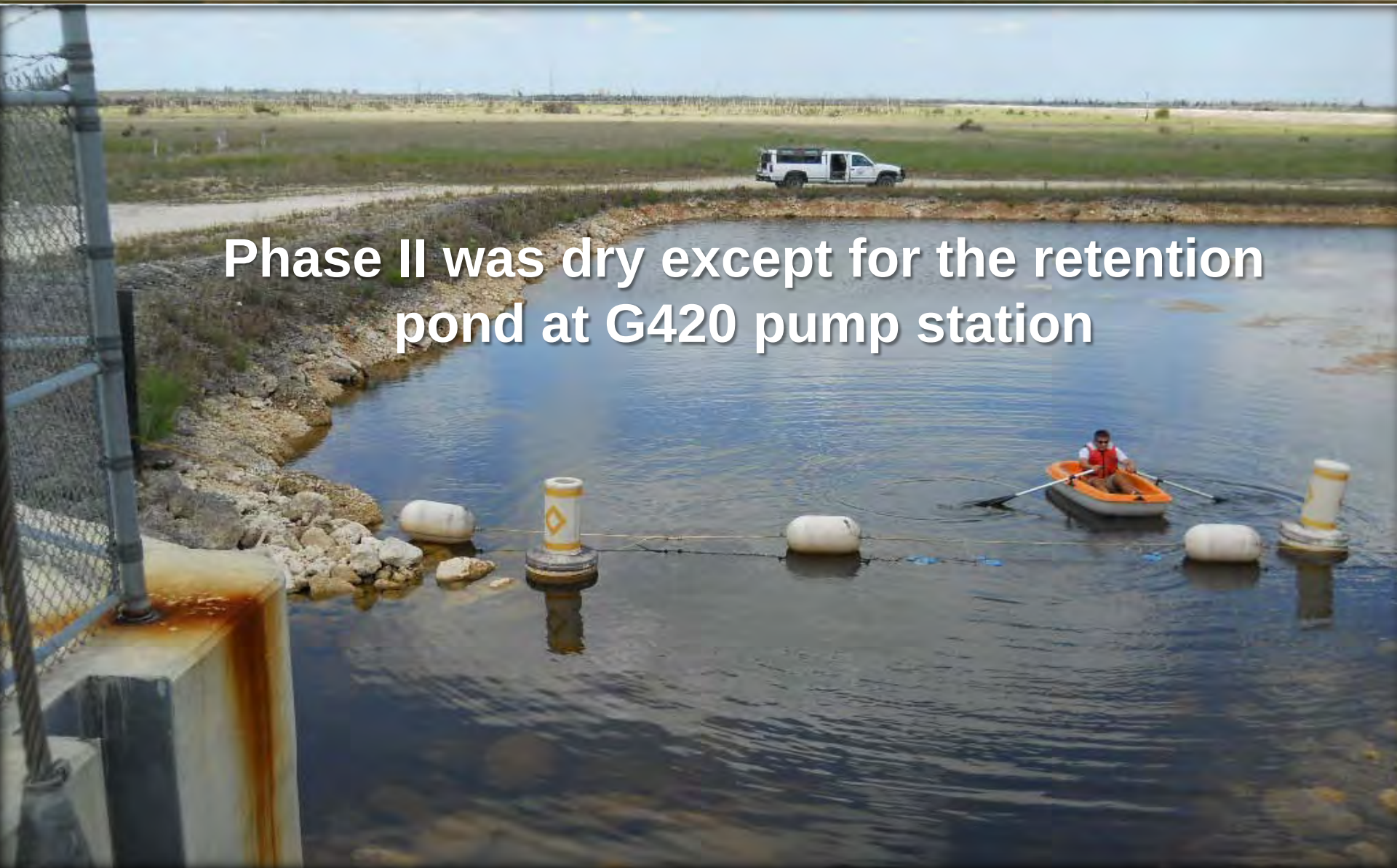
Periphyton Monitoring Overview

- Periphyton is collected biennially
  - June to July during odd years
- Sample stations G423P and G421P
- Deployment of periphytometers over a 28-day period

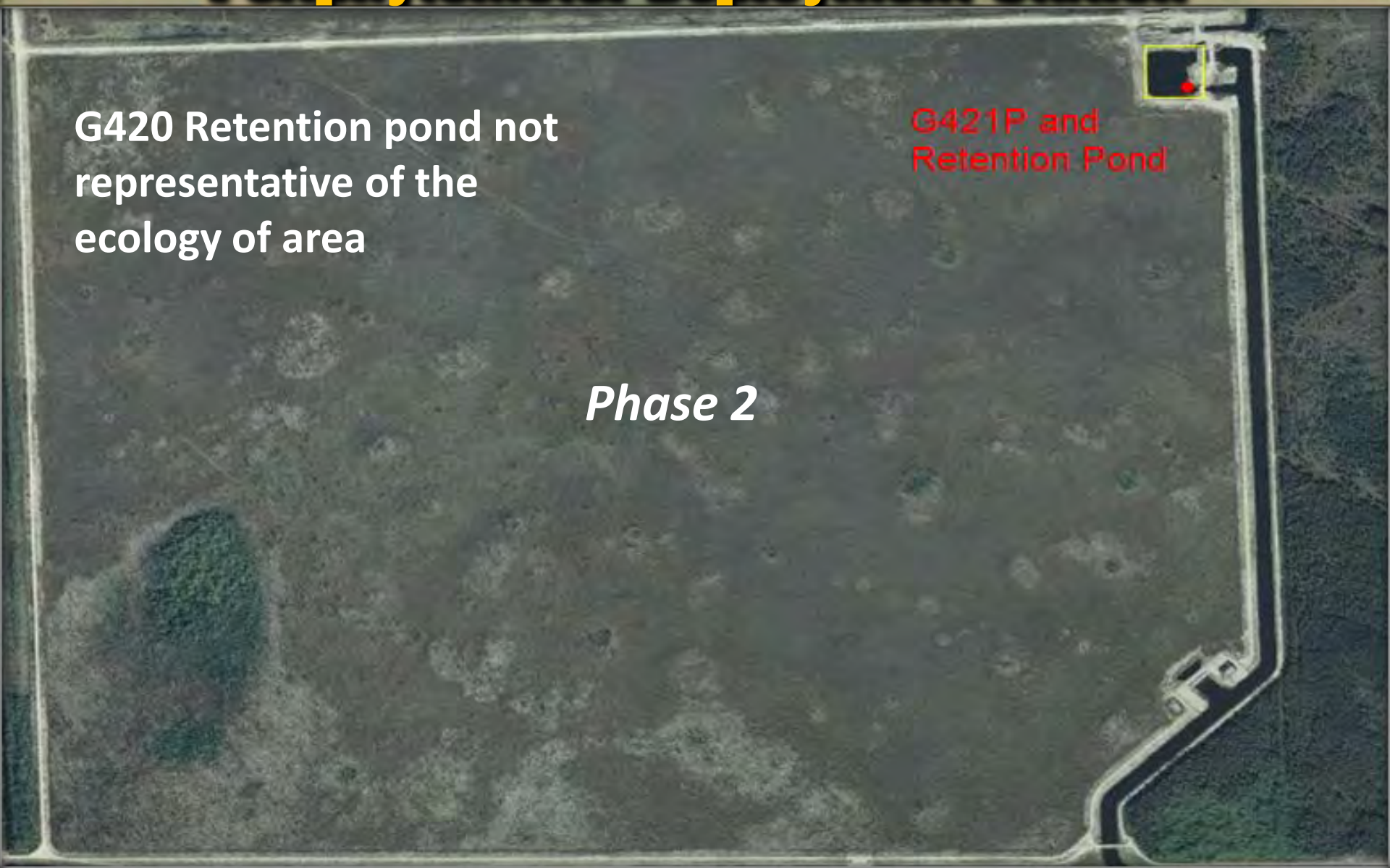


Phase I Periphytometer Deployment

Phase II Periphytometer Deployment



Phase II Retention Pond and Periphytometer Deployment Station



Phase II Conditions June 2011

Questions?

References

- DEP (Florida Department of Environmental Protection). 2004. Standard Operating Procedures for Field Activities. Available at: http://www.dep.state.fl.us/labs/qa/sops.htm
- SFWMD (South Florida Water Management District) Water Quality Monitoring Division. 2011. Field Sampling Quality Manual. 6/07/09.
- SFWMD (South Florida Water Management District). DBHYDRO Browser. 9/01/11. http://my.sfwmd.gov/
- SFWMD (South Florida Water Management District) Water Quality Monitoring Division. 2011. 025_Taxonomic and Nutrient Periphyton Sampling_SFWMD-FIELD-SOP-025-01

Next Agenda Topic

4

Total Phosphorus Update

presented by

Shi Xue

C4 Emergency Detention Basin

2011 Workshop

September 27, 2011

Total Phosphorus Mass Budget

May 1, 2009 - April 30, 2011

Shi Xue

Sr. Environmental Scientist

Water Quality Bureau

Flow Stations and Stage Sites

C4SW1
Phase 1
G420S
G420
G421
C4SW3
Phase 2
C4SW2
G422

Legend

- FLOW SITE
- STAGE SITE

Rainfall and ET Sites

C4 Detention Area Location Phase I & Phase 2

Legend

- ET
- Rainfall

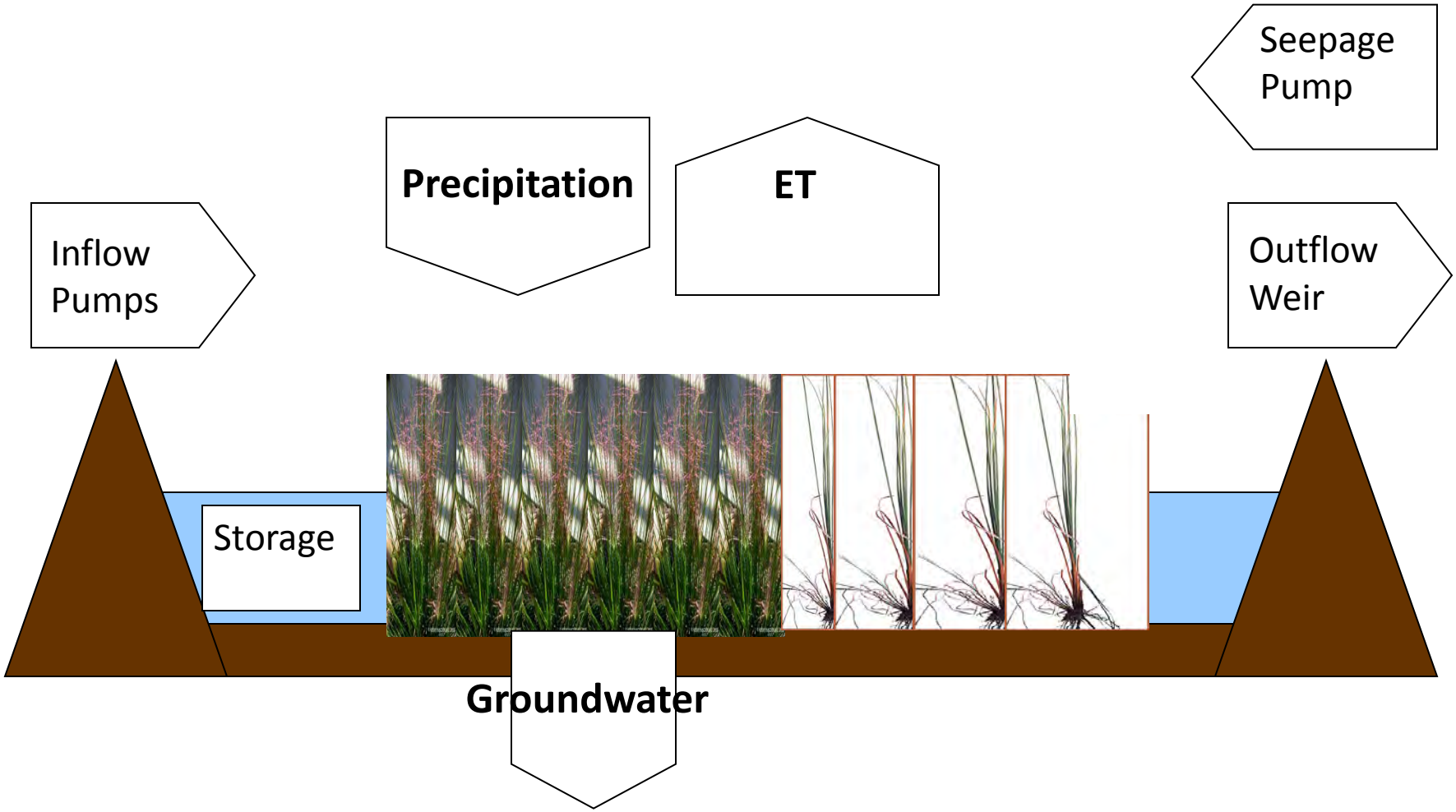
Project Objectives

- To determine overall water and nutrient load into and out of the impoundment on event and biennial basis
- To provide environmental information for management of the impoundment

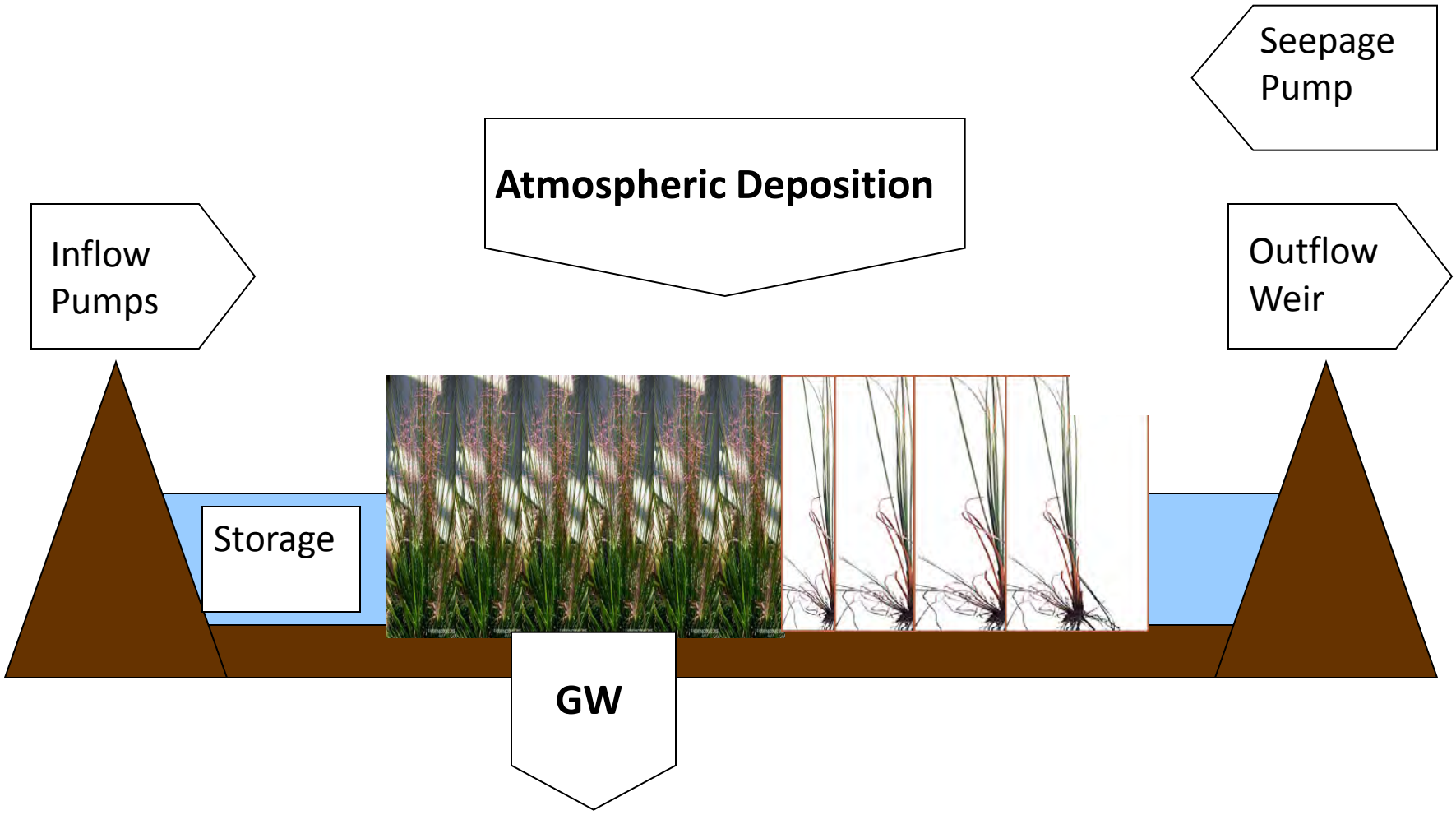
Background

- Area: Phases I and II total 816 acres
- Maximum storage depth = 4 ft
- G420 and G422 pumps rated at 700 cfs and 585 cfs respectively
- Inflow pumps only operated when stage in C4 canal meets trigger criterion
- Discharge occurs only after flood stage peak has passed
- Operated once during biennial reporting period (May 1, 2009 –April 30, 2011)

General Conceptual Model of Water Budget for C4 EDB



General Conceptual Model of Pollutant Mass Budget for C4 EDB



Methods

Where:

- I = inflow structure flows; loads
- R = rainfall volume
- ET = evapotranspiration loss
- Se = seepage (seepage water is offset water of recycle pump and can be set as 0)
- O = outflow weir volume; load
- D = atmospheric deposition of TP
- Δ S = change in water storage
- GW=groundwater
- ΔS_{tp} =*change in TP storage*

Water balance was calculated as:

$$\Delta S = I + R - ET \quad Se - O - GW\ (out)$$

$$\Delta S = Stage_t - Stage_{t-1}$$

$$GW\ (out) = I + R - ET \quad Se - O - \Delta S$$

$$GW\ (out) = I + R - ET - O - \Delta S \quad (when \quad Se = 0)$$

TP mass budget was calculated as:

Retained plus lost through groundwater flow:

$$\Delta S_{tp} + GW_{tp}\ (out) = I_{tp} + D_{tp} - O_{tp}$$

Methods

- Daily rain depths obtained from the nearest station S335
- ET estimated using ET_p data at S331W
- TP load calculated by multiplying TP concentration by corresponding water volume
- TP inflow and outflow loads calculated using Load Program
- TP atmospheric deposition calculated by multiplying area and deposition rate
- TP concentrations at G422 and G421 were estimated with concentration at G420 which was the only site measured for the period

Water Budgets (inches)

	WY2010	WY 2011	Total
Precipitation	66.9	47.2	114.0
ET	51.3	52.3	103.5
Inflow	8.6	22.2	30.8
Outflow	0.2	0.2	0.4
Seepage (recycles)	0.2	0.8	0.9
Hydrological (Storage change)	24.7	-26.6	-1.9
GW*	-0.7	43.5	42.8

**GW = I+R –ET -O-ΔS*

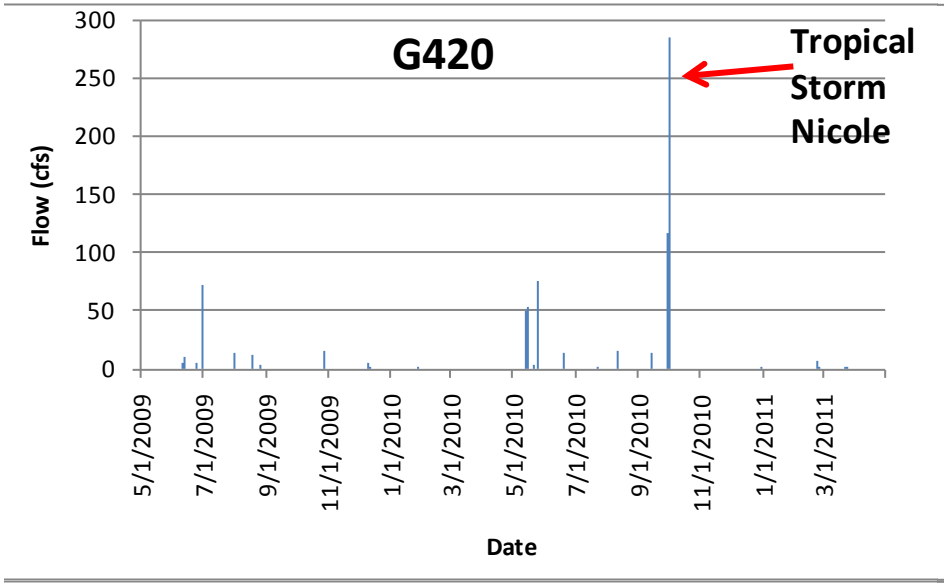
TP Mass Balance (Kg)

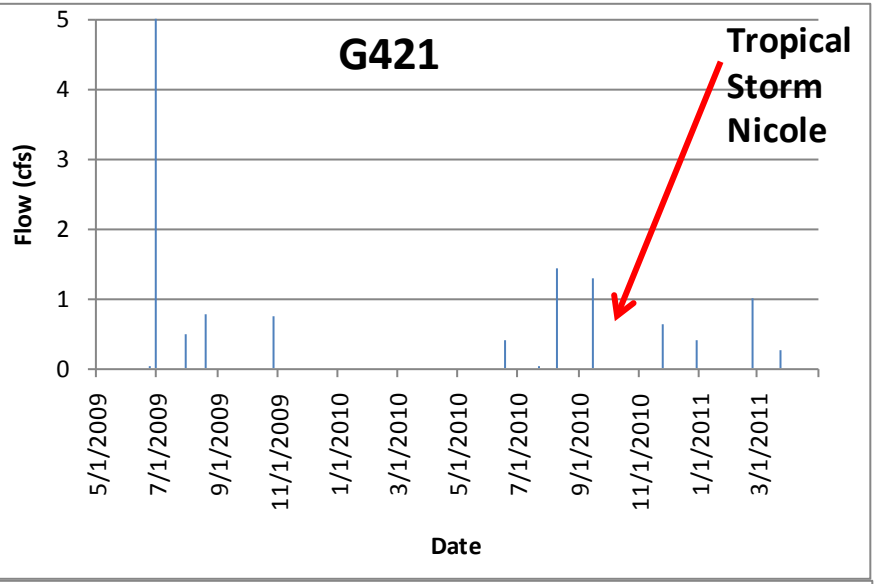
	WY2010	WY 2011	Total	Tropical Storm Nicole (September 29-30 2010)
Atmospheric Deposition	119.0	119.0	238.0	0.7
Inflow	4.5	12.6	17.1	6.9
Outflow	0.1	0.1	0.2	0
Retained plus lost through groundwater flow*	123.4	131.5	254.9	7.5
Percentage			93%	91%

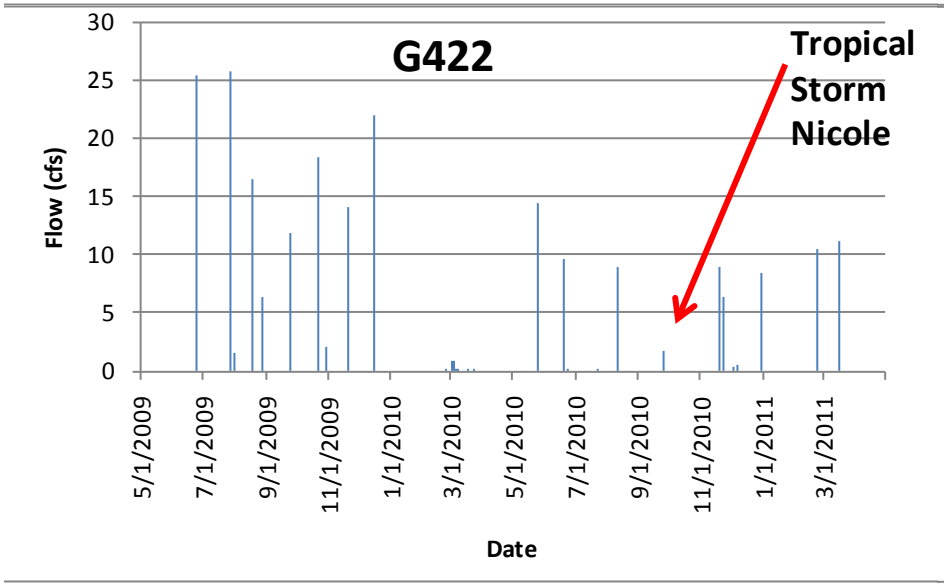
*Retained plus lost through groundwater flow

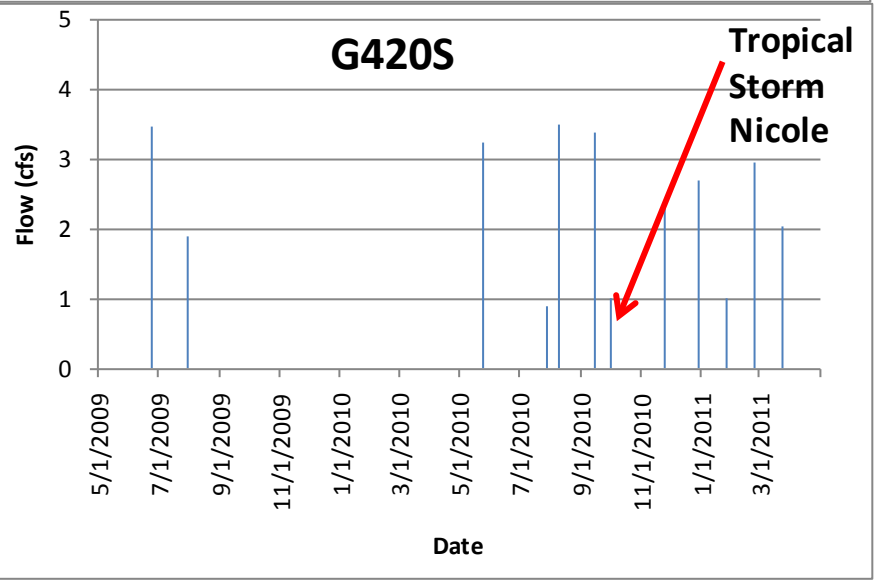
$= \Delta S_{tp} + GW_{tp} = I_{tp} + D_{tp} - O_{tp}$

Flows


G420
Tropical Storm Nicole
Flow (cfs)
300
250
200
150
100
50
0
5/1/2009
7/1/2009
9/1/2009
11/1/2009
1/1/2010
3/1/2010
5/1/2010
7/1/2010
9/1/2010
11/1/2010
1/1/2011
3/1/2011
Date

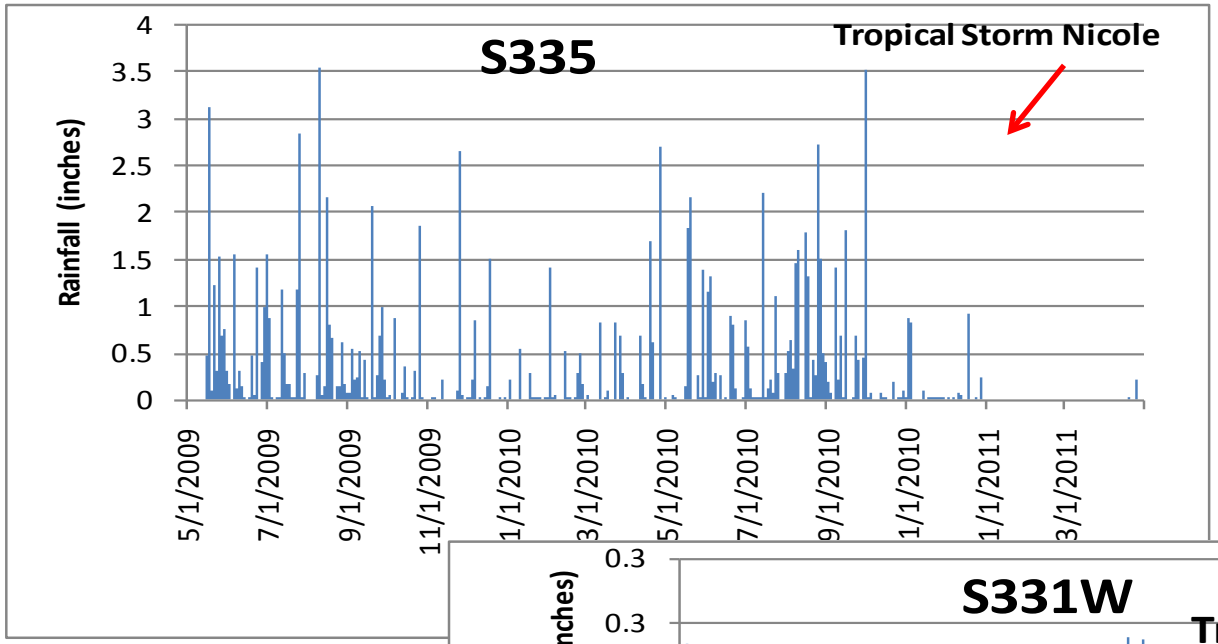

G421
Tropical Storm Nicole
Flow (cfs)
5
4
3
2
1
0
5/1/2009
7/1/2009
9/1/2009
11/1/2009
1/1/2010
3/1/2010
5/1/2010
7/1/2010
9/1/2010
11/1/2010
1/1/2011
3/1/2011
Date


G422
Tropical Storm Nicole
Flow (cfs)
30
25
20
15
10
5
0
5/1/2009
7/1/2009
9/1/2009
11/1/2009
1/1/2010
3/1/2010
5/1/2010
7/1/2010
9/1/2010
11/1/2010
1/1/2011
3/1/2011
Date

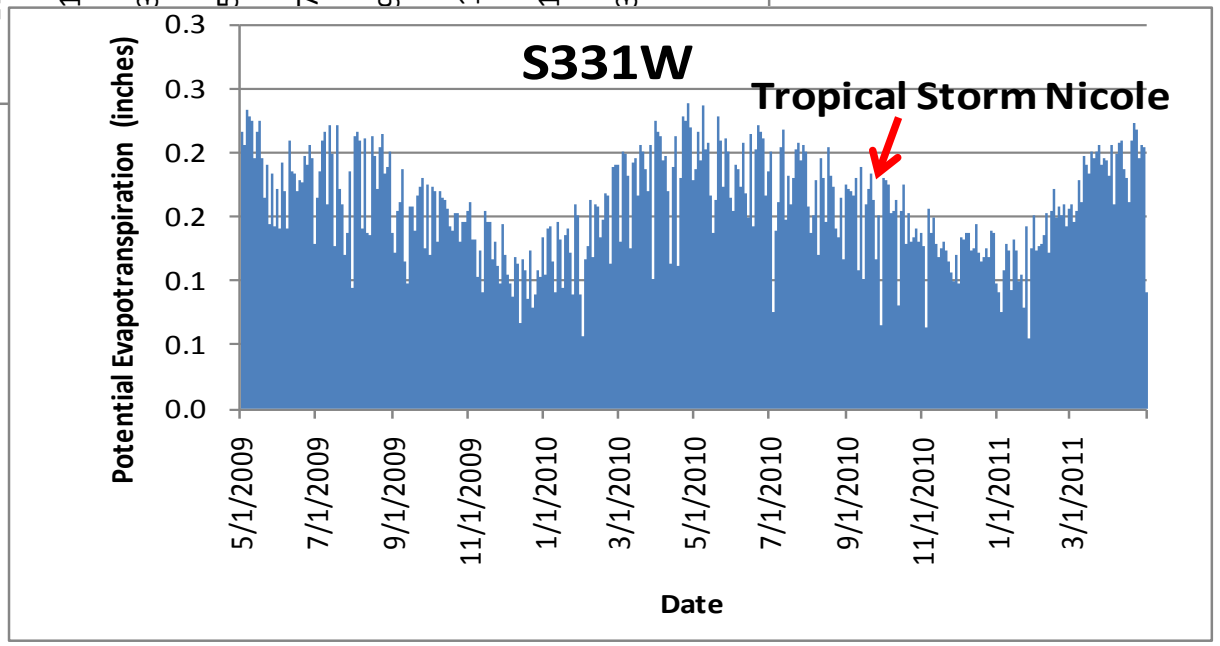

G420S
Tropical Storm Nicole
Flow (cfs)
5
4
3
2
1
0
5/1/2009
7/1/2009
9/1/2009
11/1/2009
1/1/2010
3/1/2010
5/1/2010
7/1/2010
9/1/2010
11/1/2010
1/1/2011
3/1/2011
Date

Rainfall at S335 (a) and Evapotranspiration at S331W (b)

(a)

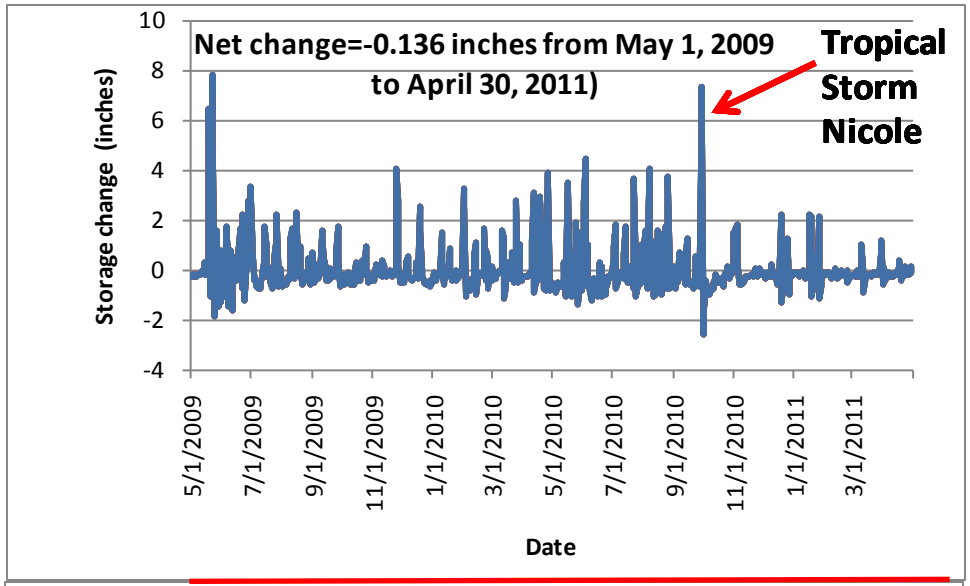


(b)

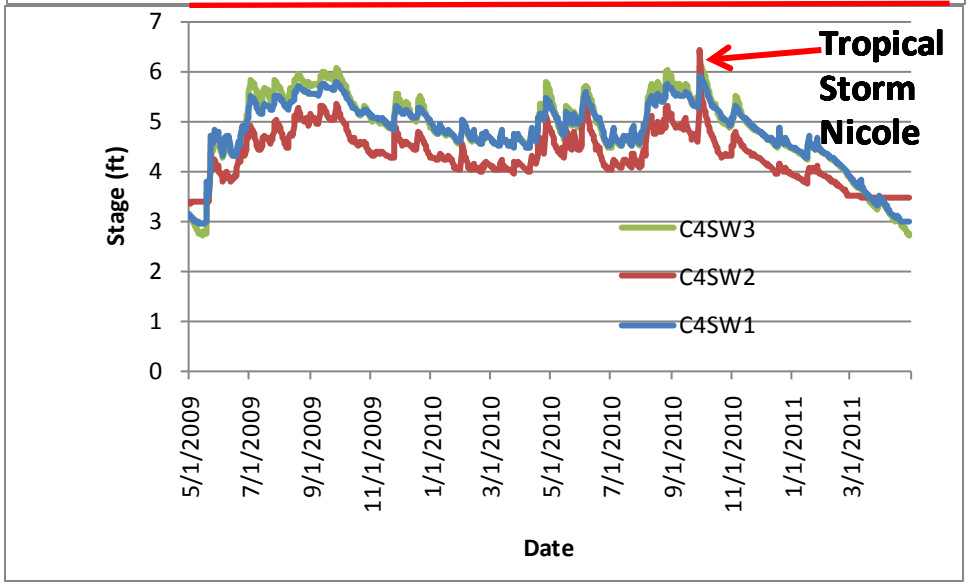


Water Storage Change (a) and Stage (b)

(a)



(b)



Ground elevation~ 5.1 ft*

Water and TP Budget Results

- Individual Event
- Biennial Reporting Period: May 2009 - April 2011

TP Mass Budget Diagram by Pumping Event

9/29-9/30, 2010 (Tropical Storm Nicole)

Detention Area is 816 Acres

239 ac-ft

Inflow Pumps

796 ac-ft

6.9 kg

Atmospheric Deposition (kg*)

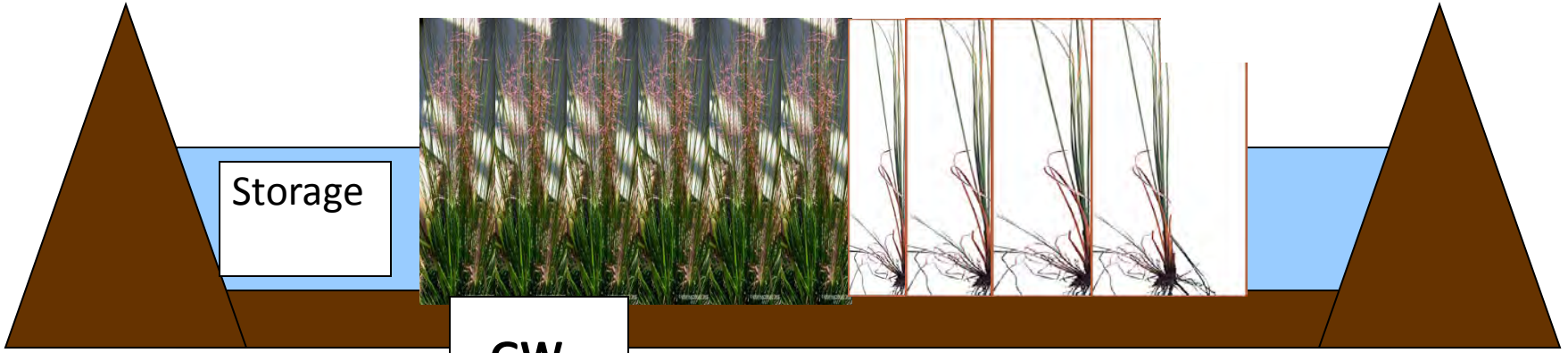
0.7 kg

Seepage Pump

0 ac-ft

0.0 kg

Outflow Weir



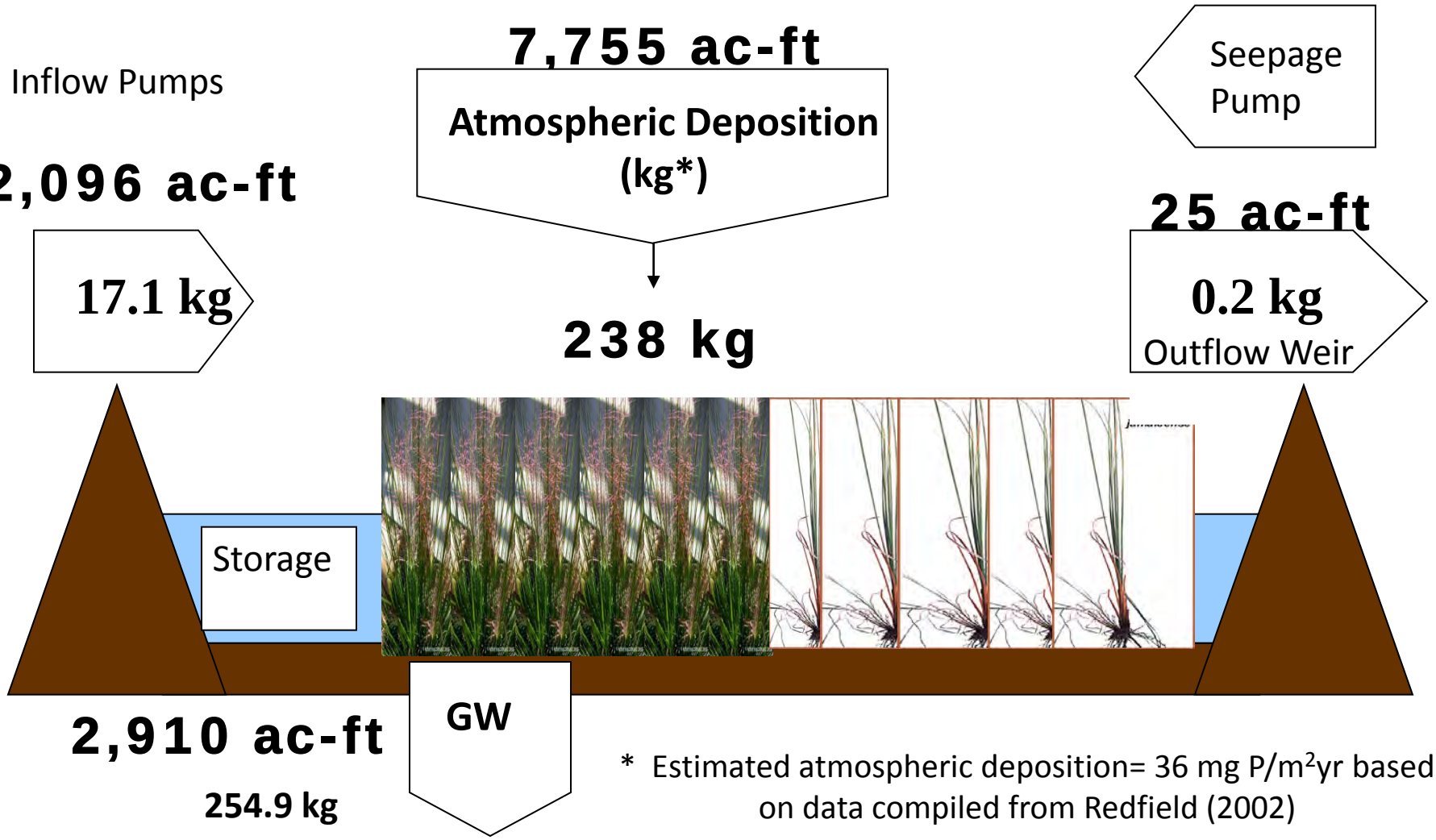
148 ac-ft

7.5 kg

* Estimated atmospheric deposition= 36 mg P/m^2yr based on data compiled from Redfield (2002)

TP Mass Budget Diagram for Biennial Reporting Period

(May 1, 2009-April 30, 2011)



* Estimated atmospheric deposition= 36 mg P/m^2yr based on data compiled from Redfield (2002)

Findings

- The major inflow components to the water budget were precipitation, and minor inflow component was surface inflow; the major outflow components are ET and groundwater loss (GW)
- The C4 EDB was a net sink for TP for the one reportable event associated with Tropical Storm Nicole, with 91% TP retention plus loss through groundwater
- The C4 EDB was a net sink for TP for the biennial reporting period (May 1, 2009–April 30, 2011), with more than 93% TP retention plus loss through groundwater
- Surface water inflow loads predominated on event basis, but atmospheric deposition predominated for biennium
- Mean TP concentrations were 7 ppb in the C4 EDB which is less than 10 ppb, the numerical TP Water Quality Criterion for the Everglades, for the biennial reporting period

Next Agenda Topic

5

Vegetation Monitoring Results

presented by

Ken Chen

C4 Emergency Detention Basin

2011 Workshop
September 27, 2011

Vegetation Monitoring Results

2011 Aerial Interpretation for Vegetation Mapping at the C4 Emergency Detention Basin (EDB)

Ken Chen, Ph.D.
Sr. Supervising Geographer
Water Quality Bureau

Project Location

C4 Emergency Detention Basin

Phase 1 & Phase 2,
Miami-Dade Co., Florida

Background

1. **C4 EDB biennial vegetation mapping involves two parts:**
   - Part 1: Aerial photointerpretation (veg. cover update and change analysis)
   - Part 2: Ground-survey based veg. mapping (11 intensive ground sites)
2. **Aerial photointerpretation includes (theoretically) several major components:**
   - Aerial photography collection & processing (e.g., aero-triangulation)
   - Photointerpretation using FLUCFCS code system
   - Groundtruthing to support photointerpretation
   - Creation of vegetation maps
   - Groundtruthing to quantitatively validate mapping results (i.e., mapping accuracy assessment)
   - Vegetation cover change detection (compare with previous years' vegetation maps)

Timetable of Events

1. **March 2, 2011: Pre-flight ground targets/ground control points set up**
2. **March 5, 2011: Uncontrolled burn (south cell/Phase 2)**
3. **March 7, 2011:**
   a) Aerial imagery acquisition
   b) High-resolution oblique photos of helicopter transects collection (taken 5-25m AGL, ~700 photos for all FLUCFCS communities, GPSed/registered)
4. **April 4, 2011: Controlled burn (north cell/Phase 1)**
5. **April 20, 2011: C4 field visit with FDEP staff regarding modifications to the groundtruthing methods used in previous years**
6. **May 25, 2011: Simple field assessment**

Burns in North and South Cells

Aerial IR Imagery Acquired 3/7/11

Ground photos taken 5/25/11

Helicopter oblique photo taken 3/7/11.
- Camera view direction

Ground photos taken 5/25/11

Helicopter oblique photo taken 3/7/11.
- Camera view direction

Rationale for Modifications to 2011 Vegetation Mapping Methods

GROUNDTRUTHING IN NORTH AND SOUTH CELLS WAS PLANNED FOR MAY 2011, BUT BURNS CHANGED EVERYTHING ……

SOUTH CELL:

- **landscape changes occurred from the 3/5/11 burn in south cell**
- **aerial photointerpretation of south cell, NOT meaningful for reporting vegetation conditions prior to burn**

NORTH CELL:

- **3/7/11 aerial imagery still valid, north cell not affected by 3/5/11 burn**
- **3/7/11 helicopter transects photos of can be used for "quasi-groundtruthing" or "air-truthing" of north cell**
  - the "air-truthing" method is inconsistent with the traditional method
  - change analysis (comparison between 2011 veg. maps with previous years') CANNOT be quantitatively done
  - Qualitatively only
- **landscape changes occurred from the 4/4/11 burn in north cell**
- **traditional groundtruthing, NOT meaningful/useful to support aerial photointerpretation of north cell**

Rationale for Modifications (continued)

CONSENSUS OF THE 4/20/11 JOINT (FDEP & SFWMD) C4 FIELD VISIT:

1. Vegetation mapping of the south cell is NOT needed
2. "Air-truthing" is an acceptable method to support aerial photointerpretation of north cell
3. Qualitative change analysis of vegetation conditions is acceptable
4. Continue the ground-survey based veg. mapping (11 intensive ground plots) as it could be a good baseline information for future reference/assessment

4/20/11 joint field tour by FDEP & SFWMD at C4 EDB

Scope of Work

1. **Task 1:** A Simple Ground Survey (north and south cells)

2. **Task 2:** Processing of Helicopter-based High Resolution Oblique Photographs (north cell)

3. **Task 3:** GIS Vegetation Mapping and Accuracy Assessment (north cell)
   - Photointerpret results and assign predominant veg. types to polygons
   - Develop GIS vegetation maps
   - Conduct GIS veg. map accuracy assessment

4. **Task 4:** Qualitative Vegetation Change (GIS Change) Analysis (north cell)

5. **Task 5:** Prepare and Submit Photointerpretation and Accuracy Assessment Report
   - Prepare and submit 2011 report
   - Prepare and submit vegetation analysis report based on the comparison of previous vegetation maps and the 2011 maps

6. **Task 6**: Vegetation Mapping of **South Cell** (optional)

7. **Task 7:** Vegetation Map Accuracy Assessment of **South Cell** (optional)

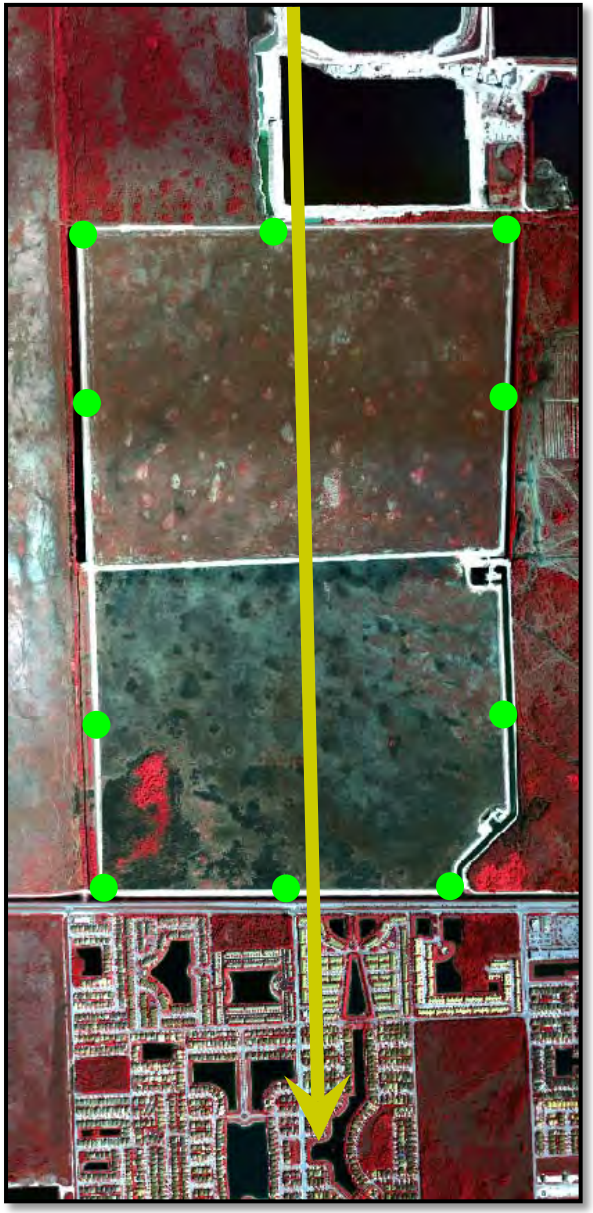
Aerial IR Imagery:

- <u>Imagery Acquisition</u>:
  - 2011 Aerial imagery collection: 3/7/2011
  - Flight: Single north-south line
  - Image Type: RGB Infrared (IR) Imagery
  - Ground Sampling Distance (GSD): 6”
  - Number of Exposures: 25
  - Overlap: 90% (along-track)

- <u>Ground Survey/Control Targets</u>:
  - Ground Survey/Control Targets: 10 stations (same as 2005, 2007 & 2009)
  - Each Target: 8’ x 8’ x 2’
  - Targets Deployment: completed by SFWMD prior to aerial imagery acquisition
  - Targets Maintenance: verified and repaired where necessary

Ground survey/control targets were set up on 3/2/2011

Aerial Image Flight and Control Layout



Ground Survey/ Control Points

Flight Path & Direction

Aerial IR Imagery Processing

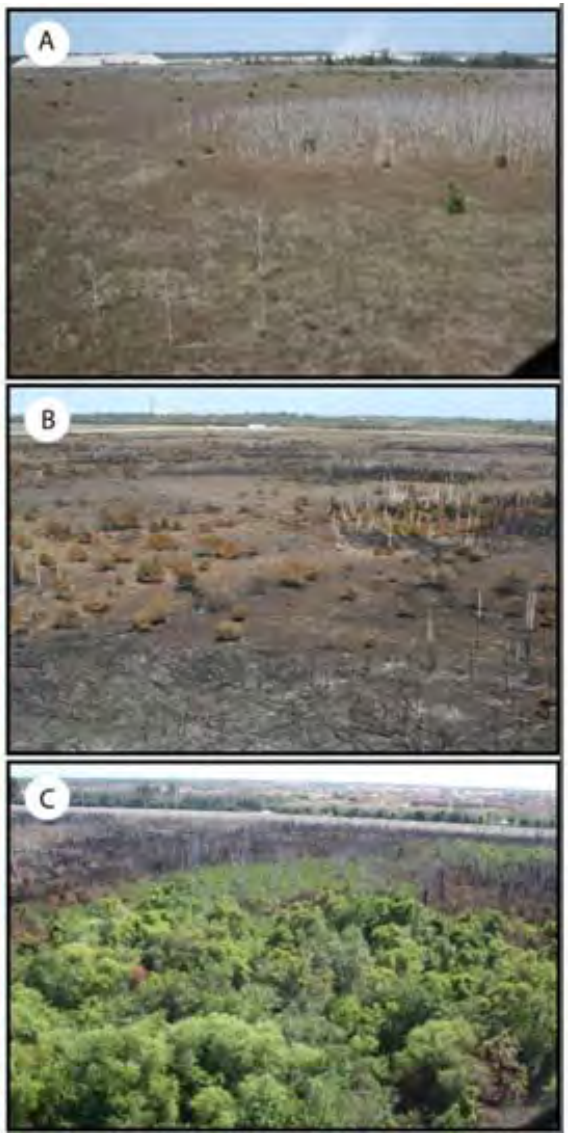
- **Geo-referencing:**
  - To correct geometric distortions and register geospatial information
  - Horizontal: NAD83/HARN, State Plane Coordinate System, Florida East Zone 0901
  - Units: U.S. survey feet
- **Digital Aero-triangulation (AT):**
  - to develop stereo models
- **Aero-triangulation accuracy:**
  - <1 ft (meeting the horizontal positional accuracy of 9.84 feet at 95% confidence interval)

Color infrared imagery developed from 2011 C4 stereo imagery – acquired March 7th, 2011

Aerial Oblique Photos of Helicopter Transects

Helicopter oblique photos taken 3/7/11

- Camera left-hand-side view
- Camera right-hand-side view



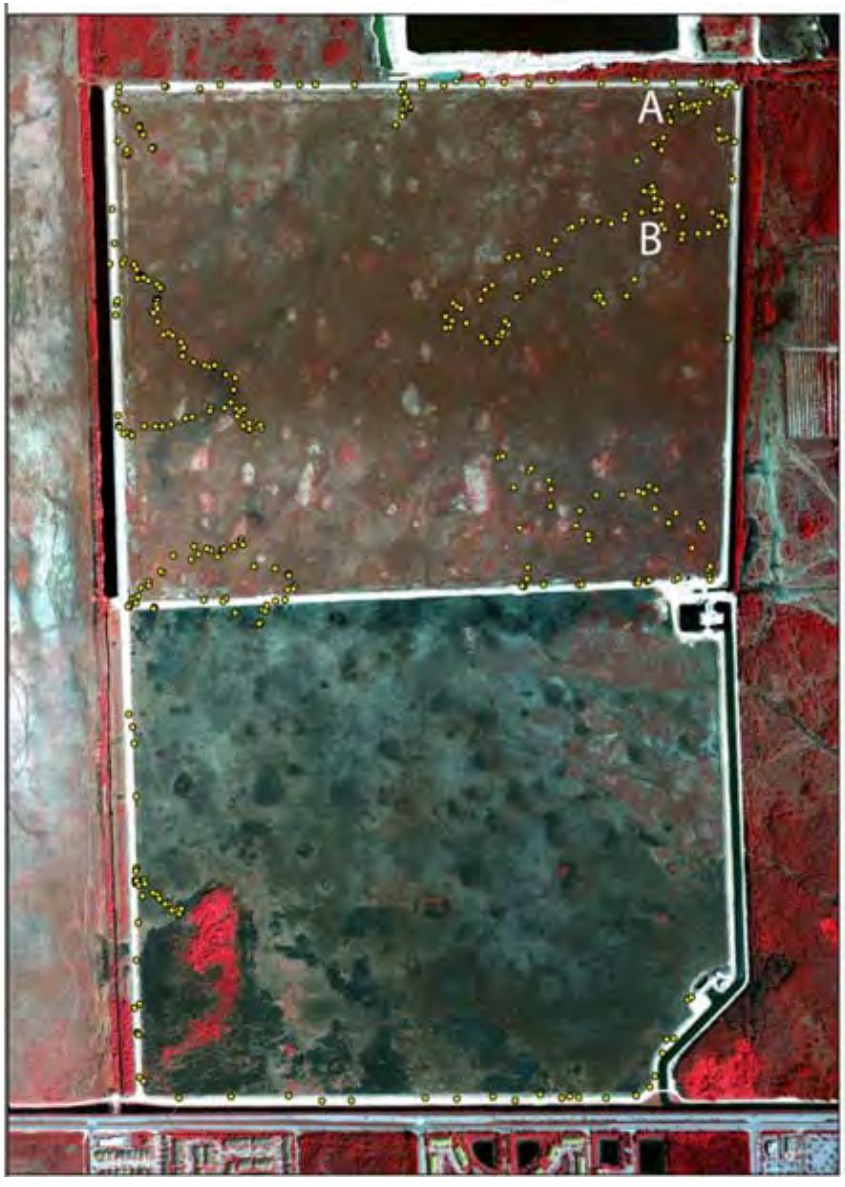
- **Collection: 3/7/2011**
- **High Resolution: taken 5-25m above ground**
- **GPSed and registered**
- **Nearly 700 photos for all FLUCFCS communities**

A - patchy muhly wet prairie adjacent mixed/recovering prairie, Phase 1

B – Burned recovering wet prairie adjacent burned prairie with sparse wax myrtle, Phase 2

C – tree island surrounded by burned recovering wet prairie, Phase 2

Simple Ground Survey



- **Field Survey: 5/25/2011**
- **Purpose: Although scaled back as a result of burns, a simple field assessment was deemed helpful to develop a better prospective of C4 EDB's topography, hydrology, wildlife and returning community vegetation.**
- **>450 field photos were taken to support vegetation mapping**

Vegetation (Habitat/Community) Mapping

- **Data from previous monitoring events, helicopter transects, and the simple ground survey, combined with FLUCFCS**
  - generate a list of habitat types to be used in mapping process
- **A softcopy photogrammetric workstation was used for the initial mapping**
- **Each habitat/community polygon was captured stereoscopically using CIR imagery**
- **Minimum mapping units: 10 m x 10 m**
- **High resolution oblique photo helicopter transects were used to develop unique spectral and spatial signatures**
  - to separate complex and blended ecotones (e.g., sawgrass dominated wet prairie, mixed wet prairie, muhly dominated wet prairie)

Florida Land Use Cover and Forms Classification System (FLUCFCS)

- **A modified FLUCFCS code system was used to account for the variations in the observed wet prairie communities**
- **Five different habitat classes were added to the FLUCFCS codes used in 2009:**
  - The class 643rms (recovering wet prairie/shrub in treated melaleuca) was added to account for the emerging co-dominance of shrubs in recovering areas
  - The class 641t (cattail marsh) was added as it was now possible, with aid of 2011 imagery and field data, to positively identify cattail (*Typha spp.)*
  - The final three (3) changes were added to accommodate for the burned vegetation in Phase II
- **Totally 13 FLUCFCS codes/habitat classes were used in 2011 vegetation mapping**

Florida Land Use Cover and Forms Classification System (FLUCFCS)

Comparison of FLUCFCS Codes Used in 2005 - 2011

FLUCFCS	Description	'05	'07	'09	'11	Notes
617	Tree Island	X	X	X	X	
619m	Melaleuca	X	X			None observed in 2011
619mca	Melaleuca-Casuarina Mix	X				None observed in 2011
619mt	Treated Melaleuca	X	X	X		
631	Wetland Shrub	X		X	X	
631burn	Burned Wetland Shrub				X	Limited to Phase II in 2011
641t	Cattail Marsh				X	
643cs	Sawgrass Wet Prairie	X	X	X	X	
643ms	Muhly Wet Prairie	X	X	X	X	
643rm	Recovering Wet Prairie in Treated Melaleuca		X	X	X	
643rmburn	Burned Recovering Wet Prairie in Treated Melaleuca				X	Limited to Phase II in 2011
643rms	Recovering Wet Prairie /Shrub in Treated Melaleuca				X	Areas showing co-dominant prairie/shrub mix in 2011
643s	Mixed Wet Prairie	X	X	X	X	Combined 643s and 643xs into one class in 2007, took name of Mixed WP
643sburn	Burned Mixed Wet Prairie	X	X		X	Limited to Phase II 2011
643sl	Scraped Wet Prairie	X	X	X	X	
643t	Treated Wet Prairie	X				None observed in 2011
643xs	General Wet Prairie	X				Code became 643s description changed
643xsl	Low Density Wet Prairie	X	X	X	X	

Note: the highlighted are 5 new classes added to the FLUCFCS codes used in 2009

2011 FLUCFCS Keys

(643s) Mixed Wet Prairie

(641t) Cattail Marsh

(643cs) Sawgrass Wet Prairie

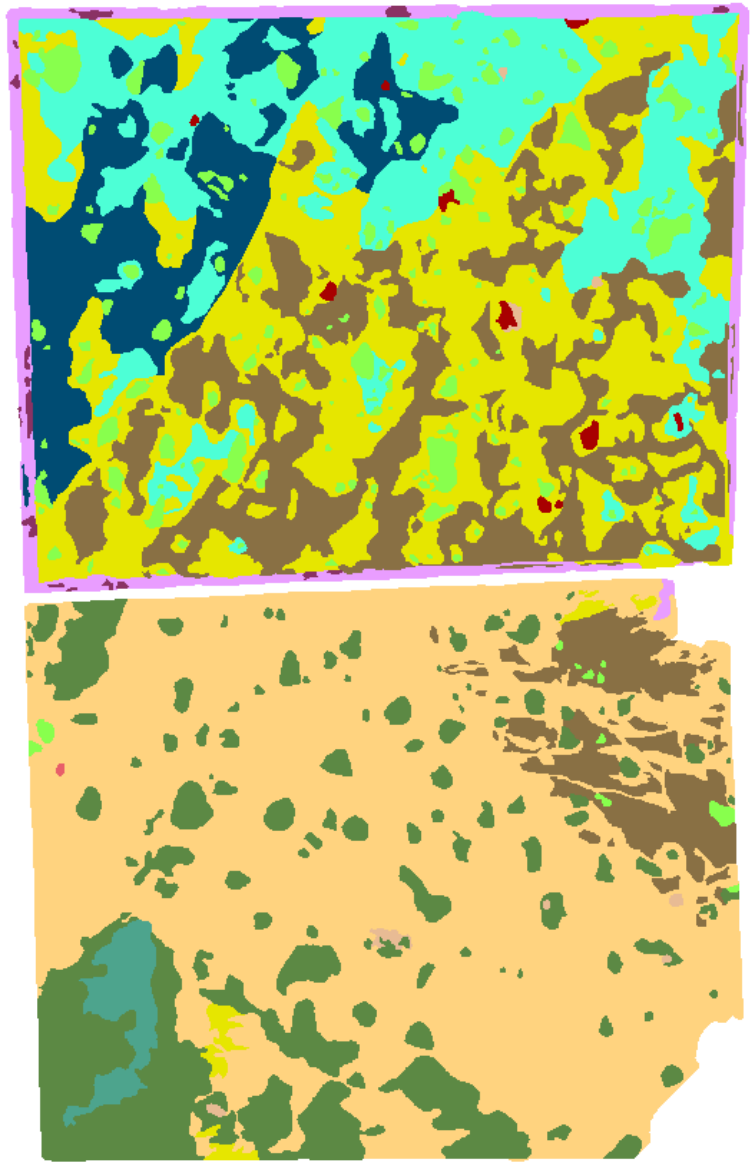
(643ms) Muhly Wet Prairie

(643rms) Recovering Wet Prairie in Treated Melaleuca Stands & Recovering Wet Prairie /Shrub in Treated Melaleuca

(643xsl) Low-Density Wet Prairie

2011 Customized FLUCFCS Codes

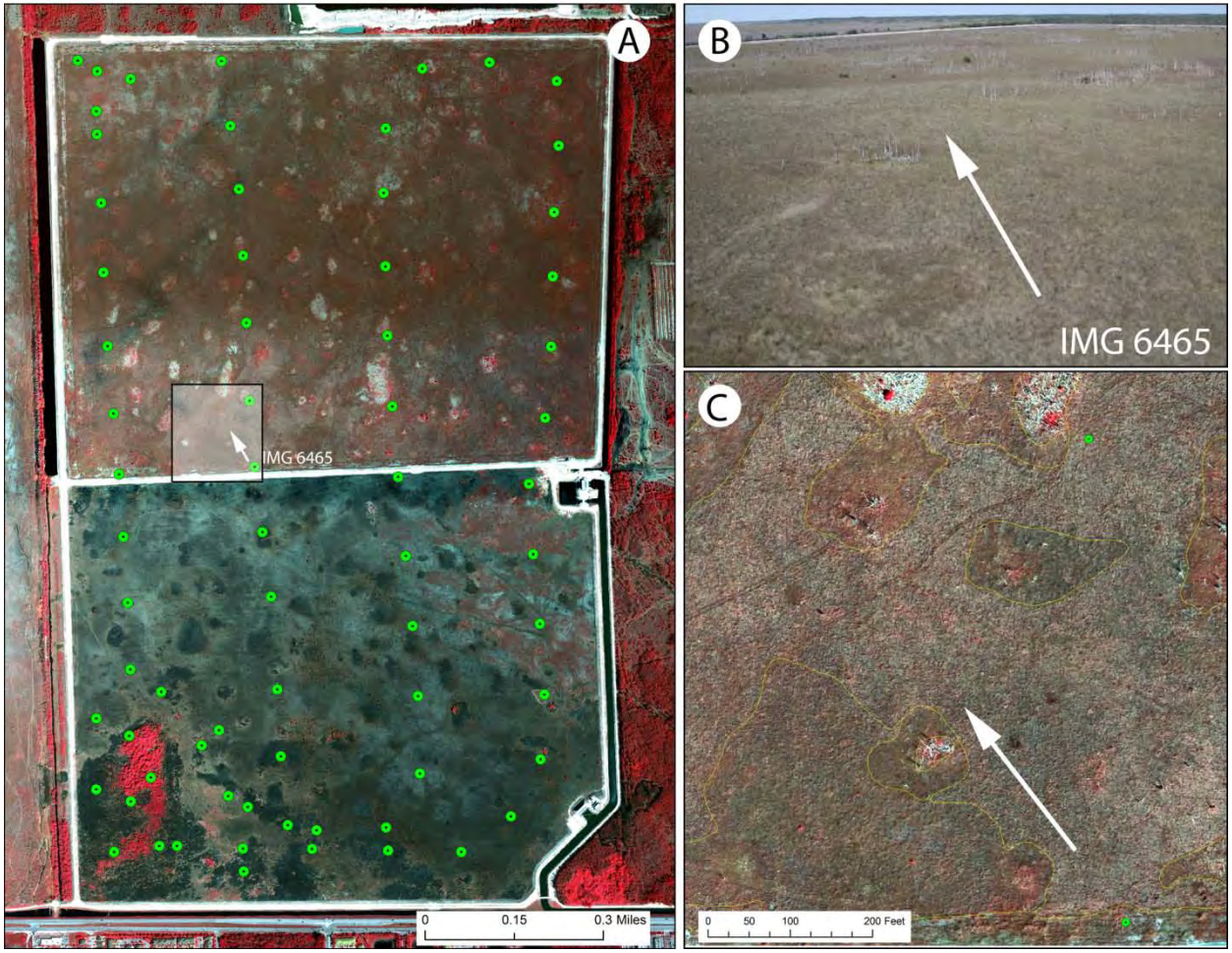
- 617 – Mixed Wetland Hardwoods
- 631 – Wetland Shrub
- 631burn – Burned Wetland Shrub
- 641t – Cattail Marsh
- 643cs – Sawgrass Wet Prairie
- 643ms – Muhly Wet Prairie
- 643rm – Recovering Wet Prairie in Treated Melaleuca
- 643rmburn – Burned Recovering Wet Prairie in Treated Melaleuca
- 643rms – Recovering Wet Prairie /Shrub in Treated Melaleuca
- 643s – Mixed Wet Prairie
- 643sburn – Burned Mixed Wet Prairie
- 643sl – Scraped Wet Prairie
- 643xsl – Low Density Wet Prairie



2011 GIS Vegetation Map

Vegetation Mapping Accuracy

Figure 5: High Resolution Transect Ground Controls and Photo Point Example



A) Transect Quality Point Overview. ~200-yard intervals between points (oblique photo locations). B) Photo example muhly wet prairie and interface between mixed prairie and muhly. C) Close-up of ortho-image inset, including class boundaries.

- 90+% mapping accuracy was required in prior years
- The Quality Control method for accuracy had to be modified as it was not possible to create a quantitative Confusion Matrix due to burns --> qualitative assessment using helicopter photo transects
- 106 points chosen for accuracy analysis. They were not used for veg. mapping
- Of the 106 oblique photos checked, a total of 222 unique habitat locations identified, spanning all 13 available FLUCFCS codes
- Of the 106 transect “air-truthing” stations, all but 2 were found to match well with the designated habitat classification in the GIS vegetation map

Habitat Quantification

FLUCFCS CODE	HABITAT	PHASE I (ac)	PHASE I (% Cover)	PHASE II (ac)	PHASE II (% Cover)
617	Mixed Wetland Hardwoods (Tree Island)	-	-	8.15	2.10
631	Wetland Shrub	0.44	0.11	0.94	0.24
631burn	Burned Wetland Shrub	-	-	0.09	0.02
641t	Cattail Marsh	1.75	0.42	-	-
643cs	Sawgrass Wet Prairie	50.22	12.05	-	-
643ms	Muhly Wet Prairie	88.37	21.20	26.33	6.76
643rm	Recovering Wet Prairie in treated Melaleuca	25.43	6.10	1.43	0.37
643rmburn	Burned Recovering Wet Prairie in treated Melaleuca	-	-	78.57	20.18
643rms	Recovering Wet Prairie/Shrub in treated Melaleuca	1.88	0.45	-	-
643s	Mixed Wet Prairie	136.69	32.78	3.15	0.81
643sburn	Burned Mixed Wet Prairie	-	-	270.16	69.40
643sl	Scraped Wet Prairie	25.04	6.00	0.49	0.13
643xsl	Low Density Wet Prairie	87.08	20.89	-	-
	TOTAL	**416.90**	**100**	**389.31**	**100**

Change Detection Between 2009 and 2011

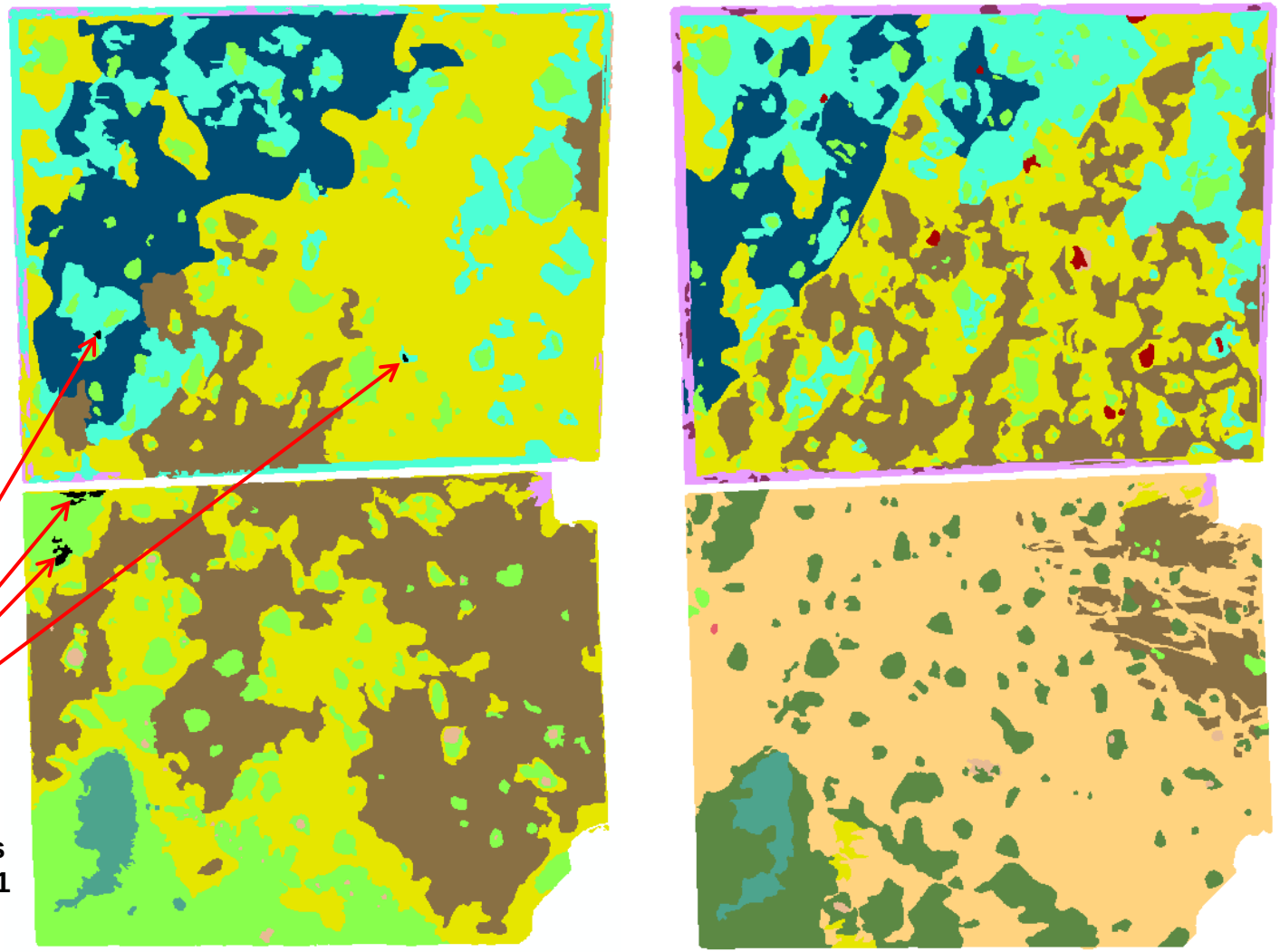
2009 Aerial Imagery of C4 EDB

2011 Aerial Imagery of C4 EDB

Change Detection Between 2009 and 2011

2009 GIS Vegetation Map of C4 EDB

2011 GIS Vegetation Map of C4 EDB



(619mt) – Treated Melaleuca class was not observed in 2011 GIS vegetation map

Change Detection Between 2009 and 2011

Class Agreement between 2011 Phase I and 2009 Phase I

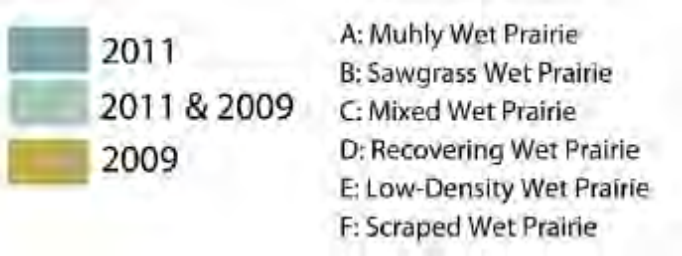
FLUCFCS 2011	FLUCFCS 2009	Acre	% Cover (2011)
643cs	643cs	36.15	8.67
643rm	643rm	17.74	4.26
643s	643s	93.50	22.43
643sl	643sl	3.39	0.81
643xsl	643xsl	35.82	8.59
643sl	643xsl	14.00	3.36
643ms	643ms	30.60	7.34
Total:		**231.20**	**55.46**

Class Disagreement between 2011 Phase I and 2009 Phase I

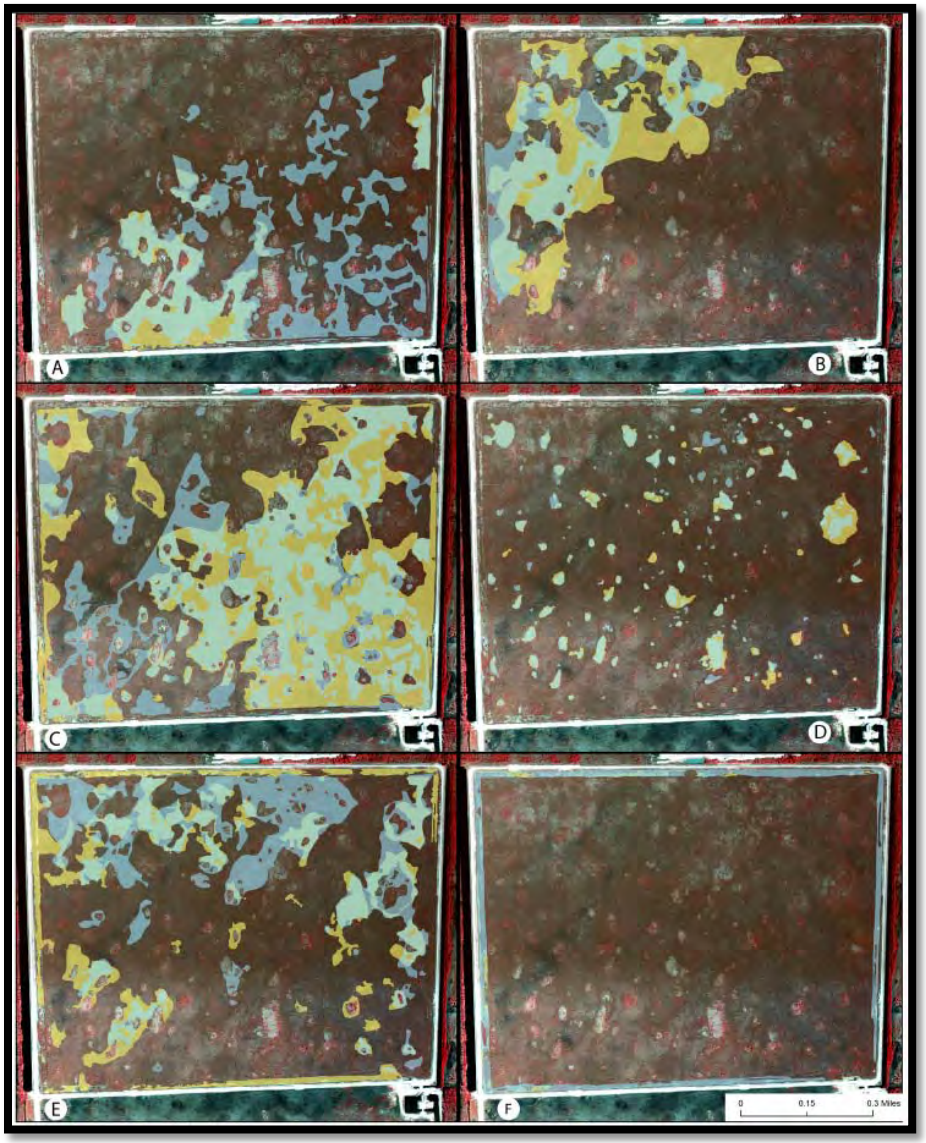
FLUCFCS 2011	FLUCFCS 2009	Acre	% Cover (2011)
643cs	643s	8.53	2.05
643ms	643s	52.97	12.71
643s	643cs	16.66	4.00
643s	643xsl	17.66	4.24
643sl	643s	6.45	1.55
643xsl	643cs	27.16	6.50
643xsl	643s	19.39	4.65
Other		36.90	8.84
Total:		**185.72**	**44.54**

Change Detection Between 2009 and 2011

- Change detection is analysis for the same geographic area at different times to determine habitat change
- Within Phase I, ~ 56% of the total area remains unchanged from 2011 to 2009
- Of the remaining ~44%, ~36% can be attributed to 7 class transitions
- The greatest transition is from mixed wet prairie in 2009 to muhly prairie in 2011 (~13%). Ref. to tables in previous slide



Change Detection 2011-2009: for each of the popular habitats/communities



Change Detection Between 2009 and 2011

CAUSE OF CHANGES:

1. NATURAL CHANGES
2. Different types of imagery between 2009 and 2011
3. Different weather conditions (drier in 2011???)
4. Different methods used in groundtruthing and validation (due to burns)
5. Different mapping units
   (2009 coarse??? - 10m x 10m in 2011 vs ??? in 2009)
6. Discrepancies in applying FLUCFCS codes

Matt Powers

Incidental Wildlife Sightings

- **Common nighthawk** (*Chordeiles minor*)
- **Eastern meadowlark** (*Sturnella magna*)
- **Northern mockingbird** (*Mimus polyglottos*)
- **Halloween pennant dragonfly** (*Celithemis eponina*)
- **Killdeer** (*Charadrius vociferus*)
- **Turkey vulture** (*Cathartes aura*)
- **Southern Toad** (Anaxyrus terrestris)
- **Lubber** (Romalea microptera)
- **Golden Silk Orb Spider** (Nephila sp)
- **Turtle** (unknown species)

Lubber (Romalea microptera)

WRAP Scoring

Wetland Rapid Assessment Procedure

Existing Conditions Proposed Conditions

Application Number	Project Name	Date	Evaluator	Wetland Type
	C4EDB	8/16/2011	SFWMD	Wet Prairie

Wildlife Utilization (WU)	FLUCCS Code		Wetland Acreage
Wet Prairie	643	Description: Mulhly or Sawgrass dominated wetland	800

Habitat Support / Buffer

Buffer type	(Score) X	(% of area) = Sub Totals	
Hwy	0	25	0
Rock Pit	0	12.5	0
Natural Area	2.5	62.5	1.56
			Total
			1.56

Wetland Canopy (O/S)	Wetland Ground Cover (GC)
N/A	2.5
Field Hydrology (HYD)	**WQ Input & Treatment (WQ)**
2	2.75

Land Use Category

Land Use Category (Score) X (% of area) = Sub Totals			
		(LU) total	N/A

Pretreatment Category (PT)

Pretreatment Category (Score) X (% of area) = Sub Totals			
		(PT) Total	N/A

WRAP Score

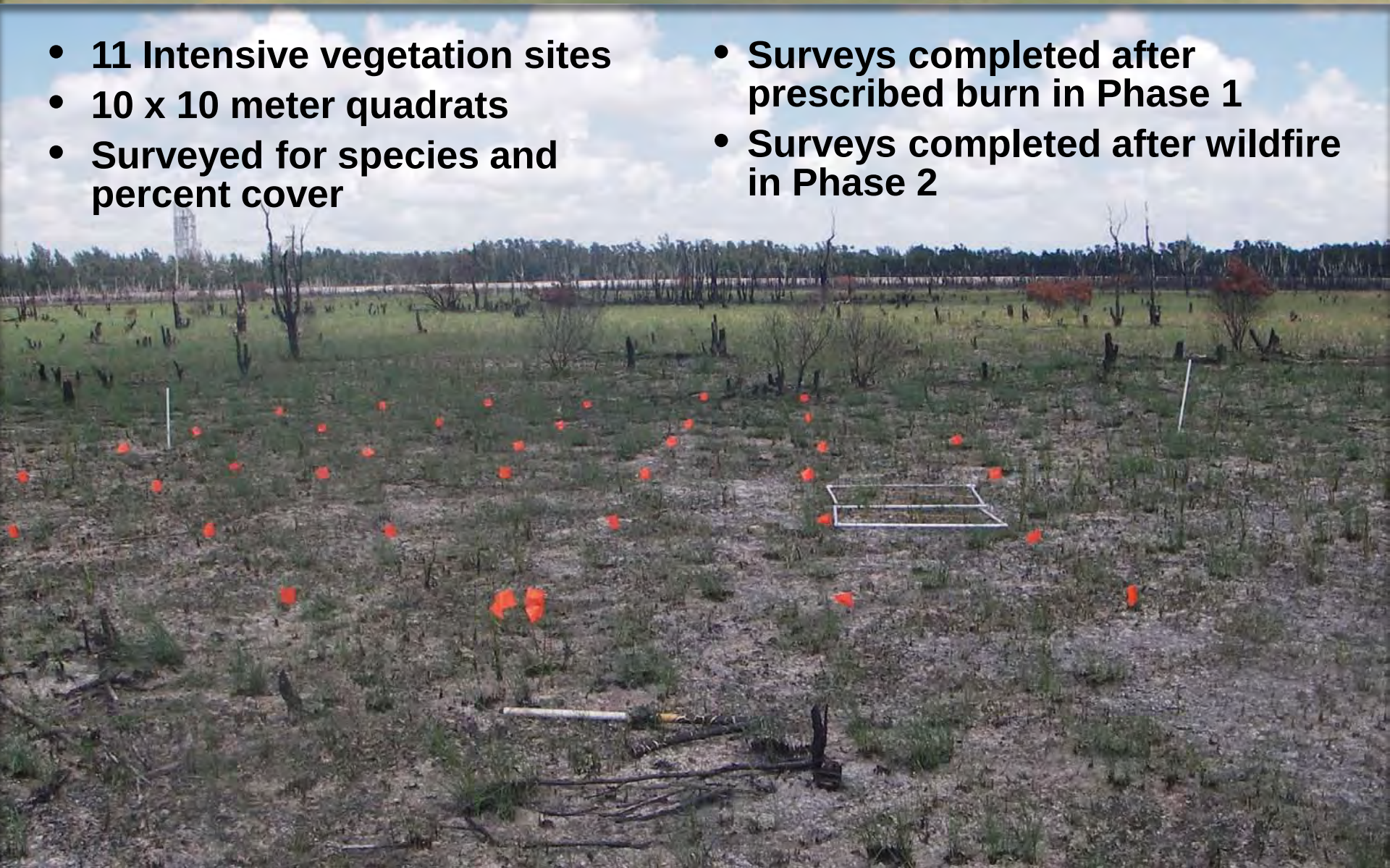
0.68

Wildlife Utilization (WU)	
1.5	Evidence of wetland utilization by small mammals and reptiles. Minimal evidence of human disturbance. Loss of cover due to burn.
Wetland Canopy (O/S)	
N/A	Wet Prairie systems exhibit limited or no canopy species and therefore is not reviewed. A small tree island is located in Phase 2 but is less than 5% of total area and not considered significant.
Wetland Ground Cover (GC)	
2.5	Less than 25% undesirable species in wetland. Limite to no human inpacts in wetland. Area subject to perooidic burns for enhavemnet of gr
Habitat Support / Buffer	
1.5	Wetland bordered by Hwy 41 to south and rockpit to north both offer little to no habitat support. Wetland bordered by natural area to east and west but natural areas are poorly managed and greater than 75% undesirable species.
Field Hydrology (HYD)	
2	Wetland Hydroperiod adequate. Pump activities resulted in stacking on one occasion
WQ Input & Tretment (WQ)	
2.75	System recieves majority of water from rain. Pumping from C4 canal second largest souce of water. Mean TP concentrations in the C-4 EDB were less than 10 ppb, the numerical TP Water Quality Criterion for the Everglades.

Intensive Vegetation Surveys

- 11 Intensive vegetation sites
- 10 x 10 meter quadrats
- Surveyed for species and percent cover

- Surveys completed after prescribed burn in Phase 1
- Surveys completed after wildfire in Phase 2



Intensive Vegetation Survey Results

- Decrease in percent coverage attributed to fire
- Species present at sites did not change with the most dominant species in 2009 most dominant in 2011
- Largest decrease: *Hypericum brachyphyllum* (75% 2009 to 2011), *Andropogon* sp. (87% 2009 to 2011)
- Largest Increase: *Dichanthelium aciculare* and *Eustachys sp*. (54% 2011 compared to 2009 (not present)), *Centella asiatica* (50% 2011 compared to 2009)

Notable Species

1. *Muhlenbergia capillaris* found at all sites in 2011 and 10 of 11 sites in ’09

2. *Cladium jamaicense* found at all sites in 2011 and 9 of 11 sites in ’09

3. *Melaleuca quinquenervia* found at 4 sites in 2011 and 3 sites in 2009

Next Agenda Topic

6

Recommendations/Future Activities Discussion

GROUP DISCUSSION

UPDATE (save this slide for detail discussion)

- As with 2009, no living melaleuca trees (*Melaleuca quinquenervia*) were noticeable in either the aerial imagery or field photo transects. These occurrences are isolated, surrounded by healthy wetland species, but will increase in dominance with time.
- Recovery from areas identified as treated melaleuca continues, although significant relic treated melaleuca stands persist. Between 2009 and 2011, there appears to significant increase in shrub species occupying treated areas, particularly wax myrtle (*Myrica cerifera*). A field survey conducted post fire (May 25th, 2011) indicated that these species were only modestly affected by the burns on March 5th, 2011 (Phase II) and April 4, 2011 (Phase I). Plants observed were already showing signs of new growth.
- In Phase I, muhly dominated wet prairie (FLUCFCS 643m) has expanded more than any other community, and is the second largest community behind mixed wet prairie (FLUCFCS 643). The increase in muhly dominated wet prairie is consistent with the 2009 trend. Low density wet prairie (FLUCFCS 643xsl) continues to decrease in areas adjacent recovering wet prairie in treated melaleuca (FLUCFCS 643rm), evolving into denser wet prairie communities. Open areas appear most persistent in wetter areas adjacent to sawgrass (*Cladium jamaicense*) prairie (FLUCFCS 643cs). General patterns of Phase I, however, have not significantly changed.
- As a result of an accidental fire, over 90% of Phase II was burned on May 5th, 2011, with the areas showing greatest effects to be those previously identified as recovering wet prairie in treated melaleuca (FLUCFCS 643rm). This is likely the result of higher fuel loading. The areas unburned were the majority of the tree island (FLUCFCS 617) in the south west corner (burned only around its perimeter) and muhly grass (*Muhlenbergia capillaries*) wet prairie (FLUCFCS 643m) in north east corner.

C4 Emergency Detention Basin

2011 Workshop
September 27, 2011

Recommendations
Future Activities

DISCUSSION

Recommended Changes

Current Permit Required Monitoring		Recommended Changes	Justification
Parameter	***Frequency***		
Wildlife	Biennial	Drop	Wildlife monitoring does not serve the purposes that C4 EDB was built and is not needed to evaluate the operational success of the project
Water Quality	Weekly if Flowing (72 hr response) else Quarterly	Change to biweekly if recorded flow. Change location of sampling station to bridge over C4EDB inflow canal	Gives District greater latitude to respond to the rare flow event while reducing the collection of samples that are not being used for compliance. Station relocation is upstream of both G420 and G422 reducing redundant sampling
Periphyton	Biennial	Drop	Area typically too dry to deploy periphytometers in areas representative of either Phase I or Phase II for the length of time necessary (28 days) to develop a periphyton community on artificial substrate
Vegetation (intensive)	Biennial	Drop	Vegetation monitoring does not serve the purposes that C4 EDB was built and is not needed to evaluate the operational success of the project
Vegetation (routine) groundtruthing)	Biennial	Drop	
Aerial Vegetation Surveys	Biannual	Drop	
Reporting	Biennial	Report as part of the District's SFER	
Workshop	Biennial	Drop	Including data summaries in the District's SFER report should suffice as the project rarely operates.

C4 Emergency Detention Basin

2011 Workshop