Chapter 5: STA Performance, Compliance and Optimization

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CHAPTER LAYOUT

A multitiered approach is used to organize the large amount of information related to the Everglades Construction Project Stormwater Treatment Areas (STAs) and Rotenberger Wildlife Management Area. An overview of the hydraulic and nutrient loadings, operations, vegetation management, phosphorus and nutrient removal performance, and permit compliance for each Everglades STA is presented in this chapter, along with an update of the progress of the STA Enhancements projects that were identified in the Everglades Protection Area Tributary Basins Long-Term Plan for Achieving Water Quality Goals (Long-Term Plan) (Burns and McDonnell, 2003) and subsequent revisions (see Chapter 8 of this volume). This chapter documents compliance with appropriate conditions of the Everglades Forever Act (EFA) and the U.S. Environmental Protection Agency's National Pollution Discharge Elimination System (USEPA's NPDES) operating permits.

The chapter starts with an executive summary, followed by highlights on individual STA performance, construction, maintenance, Long-Term Plan Enhancements, and research and optimization efforts. Further details about individual STA performance are presented, followed by the STA Performance Synopsis section that discusses loading rates and removal efficiencies and the Analysis and Interpretation section that provides a more detailed analysis of the performance of each treatment cell. The appendix contains period of record time series graphs for inflow and outflow volume, TP load, FWM TP, hydraulic loading rate, and phosphorus loading rate, the draft Avian Protection Plan, vegetation maps, the draft report on Hydropattern Restoration in WCA-2A, Black-Necked Stilt nest survey results, compliance monitoring for mercury in the STAs, the Operation Plan for the Periphyton Stormwater Treatment Area (PSTA) Project in STA-3/4, water and constituent mass balance budgets for the STAs, water quality data, and information on herbicide application in the STAs.

SUMMARY

The ability of wetlands to assimilate phosphorus is a crucial component of the Everglades restoration program. For this purpose, over 50,000 acres of freshwater wetlands have been constructed in the Everglades area (STA-1E, STA-1W, STA-2, STA-3/4, STA-5, and STA-6) (**Figures 5-1** and **5-2**) to remove excess total phosphorus (TP) from surface waters entering into the Everglades Protection Areas (EPA). Since 1994, these constructed wetlands, referred to as Stormwater Treatment Areas (STAs), have reduced the TP load that would have gone into the Everglades by over 950 metric tons (mt), reducing TP loads by 70 percent and overall annual flow-weighted mean (FWM) TP concentrations from 145 ppb down to 45 ppb (**Tables 5-1** through **5-3,** Appendix 5-1).

REPORTING MANDATES

The efforts to improve water quality in the Everglades watershed and throughout the South Florida ecosystem involve the cooperation of the South Florida Water Management District (SFWMD), the U.S. Army Corps of Engineers (USACE), the Florida Department of Environmental Protection (FDEP), other agencies and private landowners. The Everglades Forever Act (EFA) (Ch. 373.4592, F.S.) and the Everglades Settlement Agreement required the Everglades Construction Project (ECP), which consists primarily of six large constructed wetlands, referred to as the ECP Stormwater Treatment Areas (STAs), designed to reduce the levels of phosphorus from waters entering the Everglades Protection Area (EPA) (**Figure 5-1**). The STAs are operated under EFA and National Pollution Discharge Elimination System (NPDES) permits and this chapter serves as the reporting mechanism for performance over water year 2007 (WY2007), which covers the period from May 1, 2006 – April 30, 2007.

WATER YEAR OVERVIEW

This water year was marked by observed variable loadings, although the variability of inflows was not statistically measured. High inflow volumes occurred in late August and early September, partially in response to Tropical Storm Ernesto. During the last half of the water year, the STAs received very little inflow because of a regional drought (details in the *Drought Impacts* section of this chapter and in Chapter 2). This pattern of inflow volume is rather atypical and although southern Florida does experience wet and dry season variability, drought conditions are not usually experienced annually. The drought conditions decreased the amount of water flowing through and out of the STAs, which impacted performance. The low water conditions provided desirable habitat conditions for ground-nesting birds [Black-Necked Stilts (*Himantopus mexicanus*)]. The eggs of the Black-Necked Stilts are protected under the Migratory Bird Treaty Act and their nesting activity restricted operations.

This year's Long-Term Plan Enhancements construction activities also affected some of the STAs' operations, specifically STA-1W, where the Eastern and Western Flow-ways were taken offline, and STA-6 where inflow water into Section 1 was stopped temporarily to allow completion of Section 2 construction. New structures were built, and existing structures were automated for better operational management of individual cells. Large rehabilitation efforts were conducted in STA-1W and included soil and tussock removal, ground leveling to reduce flow constrictions and short-circuiting, and establishment of desired vegetation. Additional treatment areas (STA-2 Cell 4, STA-5 Flow-way 3, STA-6 Section 2) became flow-capable in December 2006. These newly constructed treatment areas, identified as one of the success indicators in the District's Strategic Plan 2006–2016, will provide more than 5,300 acres of additional treatment area. Because of the drought conditions, these areas did not receive inflow water until June and July 2007.

Nutrient uptake performance is affected by vegetation and soil conditions in the STAs. Research and optimization efforts continue to provide information for understanding the various factors affecting STA performance. Some of the studies include determining depth and duration thresholds related to vegetation health, studying drought effects on cattails, and periodic monitoring of soil conditions, water quality, and vegetation conditions within the treatment cells.

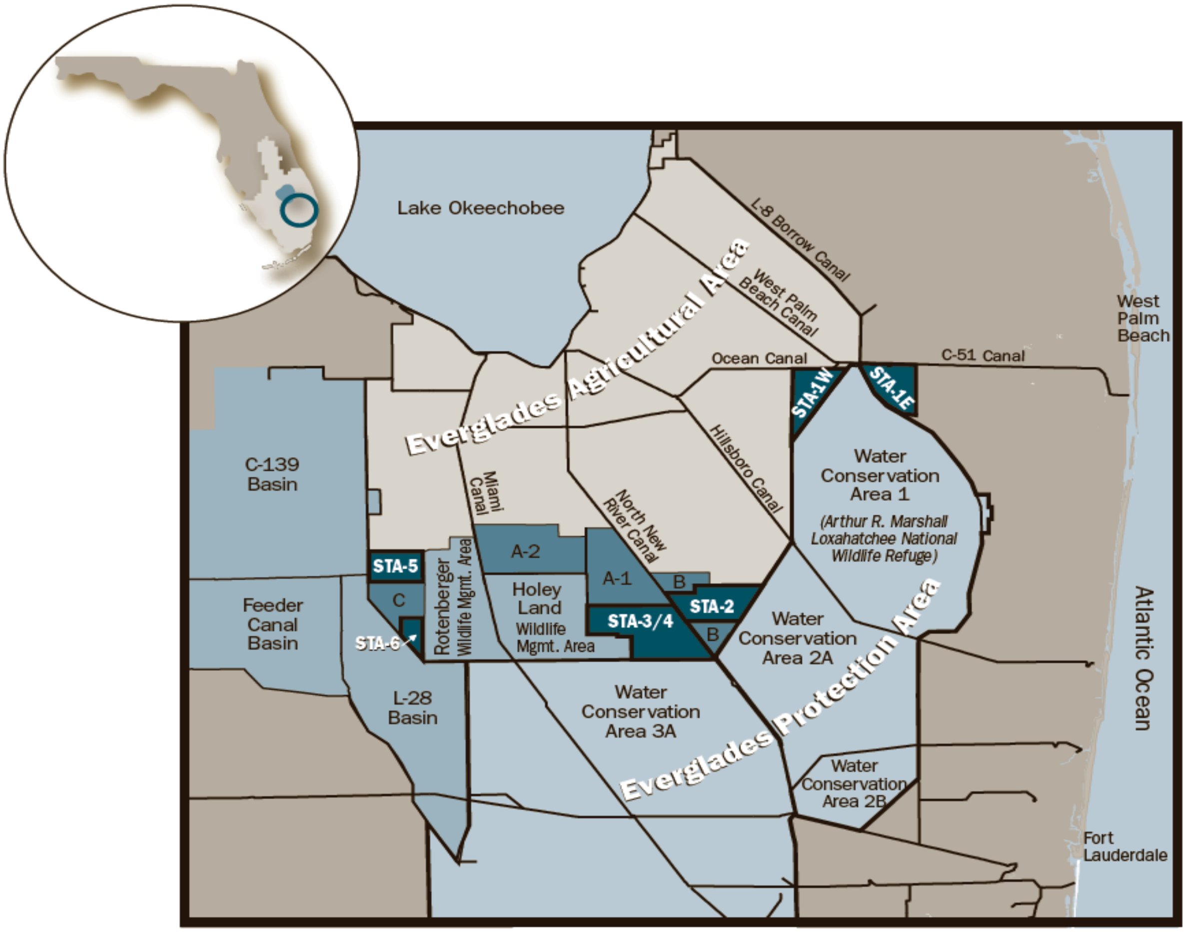


Figure 5-1. Location of the Everglades Stormwater Treatment Areas (STA-1E, STA-1W, STA-2, STA-3/4, STA-5, and STA-6).

Table 5-1. Sequencing of STA operational dates.

STA Operational Dates	Water Years (May - April)													
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
STA-1E (Central and Western Flow-way)											"	"	"	"
ENR Section of STA-1W	"	"	"	"	"	"								
STA-1W							"	"	"	"	"	"	"	"
STA-2							"	"	"	"	"	"	"	"
STA-3/4											"	"	"	"
STA-5 (Cells 1A, 1B, 2A, 2B)						"	"	"	"	"	"	"	"	"
STA-6 Section 1					"	"	"	"	"	"	"	"	"	"

Note: "ENR Section of STA-1W" refers to the Everglades Nutrient Removal Project, which consisted of Cells 1 through 4; after Cell 5 was constructed, the project was then named STA-1W.

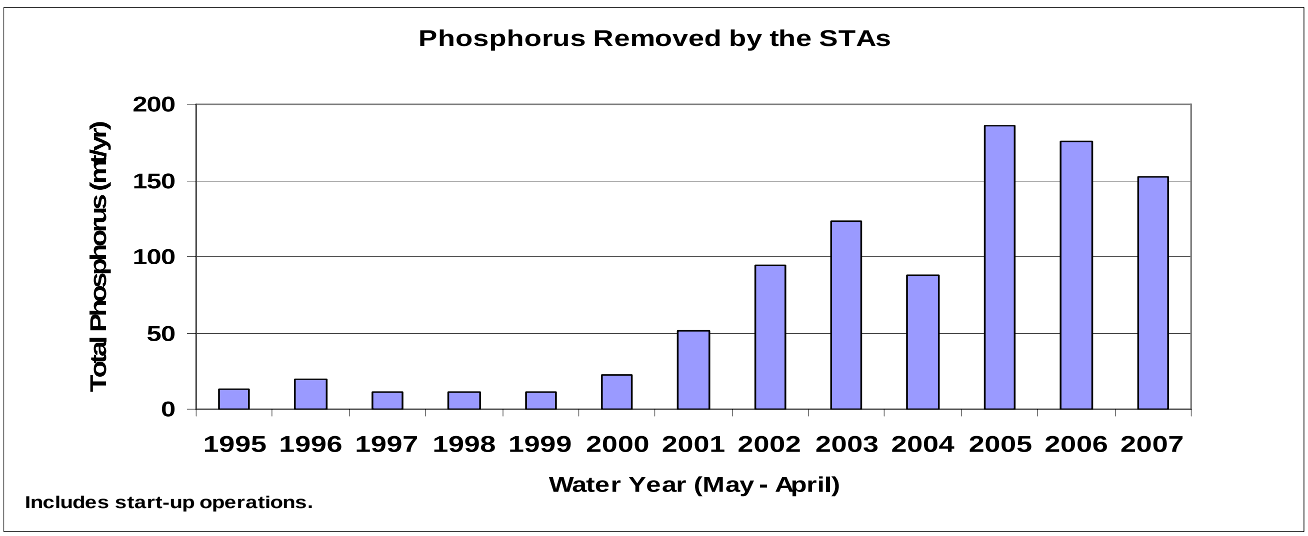


Figure 5-2. Annual phosphorus removal by the STAs. The STAs began operation at different times, and the timeline of start-up sequencing is found on **Table 5-1**.

Table 5-2. STA hydrology and TP removal for Water Year 2007 (WY2007). See also individual STA sections for further information. The hydraulic and phosphorus loading rates are calculated by dividing the inflow by the effective treatment area. These rates are affected when areas of the STAs are temporarily taken offline for construction or rehabilitation. The 31-yr average loading rates are based on simulated long-term average simulated inflows.

	STA-1E**	STA-1W	STA-2**	STA-3/4	STA-5	STA-6	All STAs ***WY2007***
Average Effective Treatment Area (acres)	4,024	3,168	6,338	16,161	3,768	748	34,207
Inflow:							
Total Inflow Volume (ac-ft)	108,311	121,698	218,566	388,471	58,690	32,443	928,178
Hydraulic Loading Rate (HLR) (cm/d)	2.25	3.21	2.88	2.01	1.30	3.62	2.41
31-yr average HLR (cm/d)	*2.06*	*2.00*	*3.02*	*3.32*	*2.62*	*1.32*	
Total Inflow TP Load (mt)	31.9	41.5	44.9	69.9	21.7	4.4	214.3
TP Loading Rate (PLR) ($g/m^2/yr$)	1.96	3.24	1.75	1.07	1.42	1.44	1.81
31-yr average PLR ($g/m^2/yr$)	*1.33*	*1.01*	*1.11*	*1.07*	*1.69*	*0.42*	
Flow-weighted Mean Inflow TP (ppb)	239	277	167	146	299	109	187
Outflow:							
Total Outflow Volume (ac-ft)	97,818	126,246	217,572	355,423	54,163	16,755	867,977
Total Outflow TP Load (mt)	8.6	18.5	11.0	9.8	12.9	0.9	61.7
Flow-weighted Mean Outflow TP (ppb)	71	119	41	22	192	45	58
Hydraulic Residence Time (d)	23	14	13	21	12	5	
TP Retained (mt)	23.3	23.0	33.9	60.1	8.8	3.4	152.6
TP Removal Rate (g/m2/yr)	1.43	1.80	1.32	0.92	0.58	3.41	1.10
Load Reduction (%)	73%	55%	76%	86%	41%	79%	71%
Period of Record:							
Start date	Sep-04	Oct-93	Jun-99	Oct-03	Oct-99	Oct-97	***1994 - 2007***
TP Retained to Date (mt)	24.3	338.5	181.0	222.1	158.4	35.6	959.9
TP Outflow to Date (ppb)	125	55	21	19	106	20	45

Note: average effective treatment areas reflect treatment cells temporarily off-line for plant rehabilitation or LTP enhancements.
Autosamplers samples are used to calculate TP loads and concentrations, if available.
Period of record calculations Include start-up data.
STA-1E** and STA-2**: see individual STA sections for details about inflow calculations.

Table 5-3. As part of the permit reporting requirement, the amount of water that was diverted around the STAs and the amount of water received from Lake Okeechobee as regulatory inflows in WY2007 is listed below. The volume of Lake Okeechobee water delivered to the STAs as a supplemental water source during the drought period is not included in this table, but is listed in **Table 5-5**.

	STA Diversion				Inflows from Lake Okeechobee			
STA	Structure	Volume (ac-ft)	TP Load (mt)	FWM TP (ppb)	Structure	Volume (ac-ft)	TP Load (mt)	FWM TP (ppb)
STA-1E		0	0.00		G-311	3,014	0.39	
					S-319	7	0.00	
Total		0	0.00			3,021	0.39	103
STA-1W	G-300	0	0.00		G-302	6,938	1.04	
	G-301**	0	0.00					
Total		0	0.00			6,938	1.04	122
STA-2	G-338	101	0.02		S-6	9,277	0.94	
	G-339	19	0.00					
Total		120	0.02	160		9,277	0.94	82
STA-3/4	G-371	11,912	1.35		G-370	2,746	0.21	
	G-373	17,866	2.32		G-372	9,413	1.18	
Total		29,778	3.67	100		12,159	1.39	93
STA-5	G-406	11,530	6.27					
Total		11,530	6.27	441				
STA-6	N/A				N/A			
Total								

** Although there was a very small amount of water flow measured entering into WCA-1 through G-301 (0.14 ac-ft, 0.05583 kg), this is not considered to be a diversion because the flow occurred as a result of stage differences during routine gate maintenance.

WY2007 STA Highlights

- Since 1994, the Everglades Construction Project (ECP) STAs have retained over 900 mt of TP that would have otherwise entered into the Everglades Protection Areas, reducing TP loads by 70 percent and phosphorus concentrations from an overall annual flow-weighted mean (FWM) TP of 145 ppb down to 45 ppb (**Figures 5-1** and **5-2**, **Tables 5-1** through **5-3,** Appendix 5-1).
- STA-1E, STA-1W, STA-2, STA-3/4, STA-5, and STA-6 are in compliance with the EFA and NPDES operating permits for this reporting period.
- During this water year, the STAs received a total of 928,178 acre-feet (ac-ft) of water, equating to an average hydraulic loading rate of 2.40 centimeters per day (cm/day). The TP load received was 214 metric tons (mt), equating to an average phosphorus loading rate of 1.80 grams per square meters per year ($g/m^2/yr$). An estimated 71 percent load reduction was achieved, with the STAs retaining 153

mt of TP and reducing FWM TP inflow concentrations from 187 ppb down to 58 ppb (**Table 5-2**).

- The regional drought impacted all the STAs. Minimal water stages occurred in most cells, and some of the cells experienced dry-out conditions, either due to low rainfall amounts (and lack of basin runoff), drawdown for plant reestablishment, rehabilitation, or Long-Term Plan Enhancements construction. Approximately 15,000 ac-ft of water was delivered from Lake Okeechobee to hydrate the treatment cells during the drought period.
- Long-Term Plan Enhancements construction and vegetation conversion (e.g., expansions, divide levees, water control structures, hydraulic improvements) occurred in STA-1W, STA-3/4, STA-5, and STA-6 this water year (**Figure 5-3**). Some of the STAs experienced temporary reduction of effective treatment area due to the construction and rehabilitation efforts.
    - STA-2 Cell 4, STA-5 Flow-way 3, and STA-6 Section 2 became flow-capable December 2006. The completion of STA-6 Section 2 marks the completion of construction of the original Everglades Construction Project (ECP).
    - The conversion of STA-1W Cells 1B and 3 to submerged aquatic vegetation (SAV) cells was initiated.
    - New structures and existing structures were automated for better operational control.
- Major efforts to rehabilitate STA-1W Cells 2, 4, 1B, and 5 were under way during WY2007. Rehabilitation efforts included removal of the phosphorus-rich accrued layer that includes highly flocculent material, removal of tussock material, ground leveling to reduce flow constriction or short-circuiting, and rice planting to stabilize the soils (**Figure 5-3**). In early WY2008, a major SAV inoculation effort was conducted using SAV harvested from STA-2 Cell 3 and deposited into STA-1W Cells 2B and 3.
- Issues pertaining to threatened, endangered, and migratory birds impacted STA operations. The District developed a draft Avian Protection Plan to use in conjunction with STA operations. Surveys were conducted during the nesting season to monitor for the presence of nests and eggs; information collected helped guide operations in hydrating individual cells.
- Vegetation management activities included SAV inoculation, exotic plant eradication, and creation and maintenance of emergent vegetation strips within the SAV treatment cells, in addition to routine vegetation management activities.
- Maps of the STA vegetation types (Appendix 5-2) compiled from March 2006 aerial imagery were completed. The preparation of vegetation maps is included as a goal in the District's Strategic Plan 2006–2016.
- Recreational opportunities, such as duck and alligator hunting, bird watching, and tours, continued to be offered in the STAs (**Figure 5-3**). Recreational areas, which will include kiosks and educational opportunities, are under construction at STA-3/4, STA-1E, and STA-1W. Public outreach continued this year with various recreational opportunities available. An overview of the STA research program and Long-Term Plan was also updated for use as educational and outreach materials.

- Generator hook-up receptacles were installed at major STA water control structures to allow for operation during power outages.
- Integrative STA management continues through coordination with multidisciplinary teams at various regularly scheduled communication meetings. A draft of the STA Research and Optimization Plan was prepared and efforts are under way to address priority questions and information gaps related to optimal and sustainable STA phosphorus removal performance.

Figure 5-3. During WY2007, some of the activities that occurred in the STAs included construction of additional treatment areas and water control levees with gated structures, removal of short-circuiting areas and soils high in phosphorus as part of the STA-1W restoration efforts, and duck and alligator hunting.

REHABILITATION EFFORTS

Major efforts continued this water year to restore the performance of STA-1W. The need for rehabilitation was caused by both natural conditions and high nutrient and hydraulic loading rates. Natural conditions such as hurricanes and drought have significantly impacted the status of STAs in recent years. Vegetation reestablishment in some of the treatment cells was very poor, primarily due to high water column turbidity (SFER, 2007). Applying the knowledge gained from the prior restoration efforts in STA-1W, the research team was opportunistic in initiating research or monitoring activities in the other treatment flow-ways to assist in understanding the response of the system to the rehabilitation activities in order to help guide future efforts. Taking advantage of the dewatering activities related to Long-Term Plan Enhancements construction as well as the drought conditions, an intensive rehabilitation effort was successfully completed in this STA. The *STA-1W* section of this chapter contains details about the recent restoration efforts as well as an evaluation of the prior restoration efforts.

STA MANAGEMENT

The operation of the STAs involves extensive coordinated efforts by multidisciplinary teams and the use of innovative technologies and integrative diagnostic tools. Research and optimization studies provide data used to guide operations. For example, guidance regarding water deliveries to the individual treatment flow-ways is based on information such as cumulative average annual inflow volumes and loads, treatment cell outflow concentrations, or the status of vegetation establishment within the treatment cells. During the recent drought, target water stages within the treatment cells were managed according to the dominant plant community. Also during the drought, the same team of scientists monitoring bird nesting activities worked collaboratively with the drought team to prioritize water deliveries to the STA treatment cells. An example of using research and optimization data for STA management decision making was the effort to remove the accrued soil layer from STA-1W Cell 1B. Vegetation management activities are coordinated with multidisciplinary teams, and meetings between STA management staff and operations staff occur frequently during the week to discuss STA operations related to performance and sustainability issues.

STA RESEARCH

The overall goal of the applied research conducted in the STAs is to provide short-term guidance in operational decision making, which leads to the long-term goal of sustainable and optimized STAs that achieve water quality goals with a minimum of rehabilitation activity. Scientists perform applied research and analyses that assist in decision making to optimize STA performance over time (**Table 5-4**). The scientists work closely with the District's Operations and Maintenance Department to help plan, implement, and maintain the proper hydrologic and vegetation conditions in the STAs. Critical information is reviewed, analyzed, and interpreted to form the basis for STA operation and optimization. Monitoring is conducted to determine success of the restoration efforts and the establishment of vegetation. A study was also conducted to evaluate the impact of exotics and terrestrial vegetation on SAV establishment (see the *Vegetation Management Research* section of this chapter). The STA research plan is updated to take into account STA performance and observations thus far, with the goal to address all key phases of STAs, including start-up, recovery, optimization, and sustainability.

Nutrient uptake performance depends on vegetation and soil conditions. Two research studies were started in summer 2007 to examine the physiological and molecular response of cattails to drought and high water conditions. These studies are intended to provide depth and duration information for cattails and threshold water depth requirements during drought conditions also for cattails. The first stage of the drought and high water related studies will focus on the physiological and molecular evaluation of the response of cattails to various water extreme regimes in order to better quantify the magnitude of the stress experienced by the plants. Another study that began in early 2007 involves biogeochemical characterization of floc formed in SAV cells. The ultimate goal of this study is to determine the factors affecting soil colloidal suspension in the STA SAV cells in order to develop cost-effective ways of restoring cells that have highly inorganic floc problems. To further assist in understanding the characteristics of vegetation communities found in the STAs, an intensive literature search on this topic was also completed this water year. The literature search provided important information focused mainly on cattails. The ongoing research projects use this information and will incorporate the findings into refining STA operations.

Table 5-4. Research projects conducted or initiated in WY2007 in the STAs.

Title	Brief Description
Analysis and Interpretation Project: Vegetation Surveys	As described in Part 5 of Long-Term Plan and subsequent FDEP approved revisions
Analysis and Interpretation Project: Soil Sampling	As described in Part 5 of Long-Term Plan and subsequent FDEP approved revisions
Analysis and Interpretation Project: Water Quality	As described in Part 5 of Long-Term Plan and subsequent FDEP approved revisions
Analysis and Interpretation Project: Monitoring for newly rehabilitated STA-1W cells	Water quality, vegetation, and soil monitoring to determine effectiveness of rehabilitation and also to monitor cell performance
Analysis and Interpretation Project: Data analysis	In-depth analysis of all data collected for entire period of record for each STA
Analysis and Interpretation Project: Drought study on cattails	Study effects of drought on cattail, identify stress indicators, and recovery pattern
Analysis and Interpretation Project: Flooding depth and duration study on cattails	Study effects of extended period of flooding on cattails, identify stress indicators, and recovery pattern
Analysis and Interpretation Project: Biomass effects on SAV establishment	Study effects of un-decomposed biomass on SAV establishment, determine SAV establishment patterns in rehabilitated or new cells with or without inoculation
Analysis and Interpretation Project: Floc soil biogeochemistry	In-depth examination of the floc material from SAV cells, including mineralogical testing; laboratory simulation studies to determine potential factors inhibiting SAV growth
STA-3/4 PSTA Project	Monitoring Phase
STA Compliance Monitoring Project and Downstream Monitoring Project (Vegetation and Periphyton)	Downstream vegetation and Periphyton survey (permit and non-permit locations)
STA Compliance Monitoring Project and Downstream Monitoring Project (Soils)	Downstream soil sampling (permit and non-permit locations)
Giant Bulrush (*Schoenoplectus*, spp.; formally known as *Scirpus*, spp.) study	Determine tolerance in deep water conditions

2006-2007 Project Summaries: SFWMD and EAA-EPD Jointly Funded STA Research

The SFWMD has partnered with the Everglades Agricultural Area Environmental Protection District (EAA-EPD) through DB Environmental, Inc., to conduct research and monitoring studies that could help in facilitating start-up and recovery of STAs and in improving STA performance and sustainability. Following are brief descriptions of the various studies associated with this jointly funded research effort.

Improving Sustainability of STAs

STA-2 Internal Water Quality: Internal water quality measurements are done in the three original flow-ways (Cells 1-3) in order to characterize water column phosphorus removal profiles as a function of vegetation type, flow, phosphorus loading, and season. Monitoring within Cell 3 has been performed since 2003, and monitoring in Cells 1 and 2 was initiated in 2007. Findings to date demonstrate that these internal profiles are useful for identifying regions of poor performance, and that they also help define the potential for selected flow-ways to achieve target (10 µg/L TP) outflow concentrations.

STA-2 Internal Phosphorus Storage and Stability Gradients: Soils are being sampled and characterized to assess spatial (inflow to outflow) differences and temporal changes in soil phosphorus accrual and chemistry. Findings to date indicate that Cell 3 inflow soils are enriched with TP, exhibit greater soil to water column P flux, and contain higher porewater soluble reactive phosphorus (SRP) concentrations than outflow region soils.

Factors Influencing Vegetation Stability in STAs: These studies consist of a series of assessments to define master factors that influence stability of emergent and SAV communities to develop design and operational guidelines for enhancing vegetation sustainability. Excessive water depths have been identified as a key factor that adversely impacts emergent communities, and hurricane wind/wave action has proven detrimental to submerged aquatic vegetation (SAV) communities. The SFWMD has addressed the former concern in STAs by modifying maximum stage/duration targets, and the latter by creating vegetated strips and earthen berms in the large SAV cells. A new research effort on this topic was initiated in 2007, involving characterization of drought tolerance of cattails.

Submerged Aquatic Vegetation Surveys in STA-2 and STA-3/4: Vegetation surveys have been conducted in STA-2 Cell 3 since 2003 to characterize spatial and temporal changes in SAV speciation and cover. Vegetation surveys performed in 2007 demonstrated that the SAV community has recovered since the die-off that resulted from Hurricane Wilma in 2005. The initial vegetation survey in STA-3/4 Cell 2B in 2007 demonstrated that this cell has widespread coverage by a diversity of native SAV species (e.g., *Najas, Potamogeton*).

During 2006–2007, scientists continued monitoring two mesocosm experiments related to the sustainability of STA communities. The *Sawgrass Mesocosm Assessment* compares the phosphorus removal performance of calcareous periphyton-based systems (PSTA) cultured on limerock with sawgrass cultured on muck. In natural stands, sawgrass has been able to achieve outflow concentrations of 10 µg/L and has proven resistant to hurricane winds. During the start-up period of this mesocosm study, sawgrass has exhibited mean outflow TP concentrations of approximately 15 µg/L.

In a second mesocosm experiment, the *Effects of SAV Species on Soil Accrual Rate and Soil P Stability,* scientists are comparing the soil accrual rate and soil phosphorus stability of *Chara*, *Potamogeton* and *Najas* (three common 'back-end' SAV species). The mesocosms have been in operation since July 2006 and are providing outflow TP concentrations in the range of 15 µg/L. Following two additional years of operation, the accrued soils within the mesocosms will be collected and compared with respect to stability of their associated phosphorus.

STA-1W Rehabilitation Efforts: During late 2006, scientists performed a spatial soil sampling effort in Cell 1 to identify regions containing deep, P-enriched soils. SFWMD personnel used this information to guide their soil removal efforts during the rehabilitation of this cell in early 2007. During July 2007, laboratory studies were initiated to evaluate internal phosphorus loadings from Cell 1 soils that had been subjected to differing management regimes (e.g., intact soils vs. excavated surficial soils) to confirm the effectiveness of SFWMD's soil rehabilitation efforts.

Impacts of Previously Enriched Soils on Outflow P Concentrations in a SAV Wetland: This mesocosm assessment was conducted to determine the effects of previously enriched soils on outflow P quality within SAV-dominated STA flow-ways. To date, the SAV communities cultured on native muck and Cell 4 outflow soils have provided lowest outflow TP concentrations, whereas SAV on Cell 4 inflow soils have provided only a slight reduction from inflow TP levels.

STA-1W Western Flow-way (Cells 2B and 4) Vegetation Surveys: During 2006–2007, two vegetation surveys were conducted within these cells and found only sparse, sporadic coverage of *Chara* in Cell 4 and just slightly greater coverage of *Chara* in Cell 2B. *Chara* is considered to be a desired type of SAV. Due to the slow observed rate of SAV proliferation in these cells in 2006, the SFWMD drained and rehabilitated these wetlands during early 2007.

STA-1E Internal Water Quality Transects and Vegetation Surveys: During 2006–2007, several internal water quality and vegetation surveys were performed within the Western and Central Flow-ways of STA-1E. Their monitoring efforts demonstrated effective water column phosphorus removal in the Central Flow-way, but much poorer performance (on an outflow TP concentration basis) in the Western Flow-way. In both flow-ways, the upstream emergent cells have exhibited only minor TP concentration reductions, with the bulk of the phosphorus removal being provided by the downstream SAV cells. Vegetation surveys demonstrate that SAV is gradually increasing in cover in the downstream cells, and is dominated primarily by *Hydrilla verticillata*.

STA Performance

Several mesocosm assessments are being conducted to characterize and optimize STA phosphorus removal performance. The *Low-Level Phosphorus Loading Rate Mesocosm Assessment* has been in operation since spring 2004, with the objective of determining if substantial improvements in outflow quality can be achieved by operating STAs at extremely low loading rates. Each treatment consists of an "optimized" treatment train of two SAV tanks in series, followed by a calcareous periphyton system cultured on limerock. To date, only marginal improvements in outflow TP concentrations (13 versus 11 µg TP/L) have been achieved by providing a twofold reduction in loading rates (from 0.61 to 0.31 g P/m^2·yr).

In the study *Effects of Water Column Calcium Concentrations on Phosphorus Removal by a Mesocosm – Scale STA Flow-way*, scientists are evaluating whether the approximately twofold higher calcium levels found in EAA farm runoff, as compared to Lake Okeechobee waters, can lead to lower outflow TP concentrations.

For the *Torpedograss Mesocosm Assessment*, the performance of torpedograss, a common emergent species in STA-3/4 and STA-1E, is being compared to that of cattail and SAV species. To date, outflow TP levels from cattail and torpedograss are comparable, and higher than those achieved by SAV communities.

In another project, *Assessing The Ability of STA Outflows to Support "Pristine" Everglades Flora,* the goal is to determine whether pristine species (e.g., calcareous periphyton and *Utricularia* spp.) can thrive downstream of the STAs at water column concentrations in excess of 10 µg TP/L. Much of the P in waters discharged from "well performing" STAs consists of particulate P and dissolved organic P (some of which is not readily bioavailable) and this appears to facilitate growth of the pristine species in STA outflows that do not quite achieve the 10 µg TP/L target.

DROUGHT IMPACTS ON THE STAs

During the extended drought period, the District's STA Management Division worked very closely with the Operations and Maintenance Department in order to set priorities and water delivery strategies. Drought target stages were developed with minimal water depths set at 6 in for SAV communities and 6 in below the ground surface for the emergent dominated treatment cells. The durations of low water stage and possible impacts on the vegetation were taken into account, along with likelihood of invasion by exotics. The general hierarchy of prioritization was established as follows: (1) existing SAV cell, (2) STA-2 Cell 2 to comply with permit-related restriction pertaining to mercury methylation, (3) existing emergent cell, (4) newly constructed cells. The STAs received about 15,000 ac-ft of water from Lake Okeechobee before the lake stage became too low for water to move through the control structures (**Table 5-5**). This water enabled the water levels within most of the STAs to stay close to the drought target stage.

A series of drought-related studies are currently under way to determine the optimum water depth for emergent vegetation survival, stress indicators, and recovery potential of drought-impacted plants.

Table 5-5. Supplemental water deliveries from Lake Okeechobee that were made to the STAs during the drought period in 2007. Regulatory water deliveries from Lake Okeechobee are listed in **Table 5-3** and are not included in this table.

STA Supplemental Water Deliveries (2007)

		3/12/07-3/18/07 (ac-ft)	3/19/07-3/25/07 (ac-ft)	3/26/07-4/01/07 (ac-ft)	4/2/07-4/8/07 (ac-ft)	Sum (ac-ft)	STA inflow estimate based on pump stations/spillways and/or water balance (ac-ft)
STA-1W	G-302	1,411	660	312	335	2,718	2,718
STA-1E	S-319	580	0	0	0	580	692
	G-311	0	112	0	0	112	
STA-2 *	S-6	1,597	2,270			3,867	3,372
	G328I_P	260	235			495	
STA-3/4	G-370	1,222	0	0	0	1,222	6,851
	G-372	3,392	2,237	0	0	5,629	
STA-5	G-507	298	628	317	0	1,243	1,243
						Total (ac-ft)	**14,876**

*Inflows into STA-2 were estimated by subtracting out the water used for irrigation through G328I_P

VEGETATION MANAGEMENT

Vegetation management activities in the STAs involve operational and research efforts. In general, emergent vegetation is encouraged at the beginning of the treatment system where nutrient concentrations are higher and SAV is encouraged further down the flow-way in areas where phosphorus concentrations are expected to be lower. Maps of the vegetation coverage found in the STAs as documented in a March 2006 aerial imagery can be found in Appendix 5-2. Vegetation strips, consisting of emergent vegetation, have been established and maintained in many of the SAV-dominated treatment cells to aid in reducing wave and wind damage to the plants (**Figure 5-4**). This water year, because of low water conditions due to the drought and due to taking cells offline for Long-Term Plan Enhancements construction or rehabilitation efforts, vegetation management activities have also focused on eliminating terrestrial plants.

In July and August 2007, the District transplanted 59,470 pounds of SAV in a three-day airlift to revitalize specific areas within STA-1W (Cells 2B and 4 following the rehabilitation effort), STA-2 and STA-3/4. Southern naiad, Illinois pondweed, and musk grass (*chara* spp.) were the SAV species involved in this large-scale SAV inoculation effort. Monitoring related to this effort will be reported in the 2009 SFER.

Specific Condition 13(b) of the EFA permit requires that the annual Everglades Consolidated Report (currently known as the *South Florida Environmental Report*) includes information regarding the application of herbicides used to exclude and/or eliminate undesirable vegetation within the treatment cells. In STA-3/4, STA-5, and STA-6, a new herbicide containing the active ingredient Metsulfuron was applied during the period when the STAs were dried out to treat willow. The acreage treated by STA and herbicide applied is found in Appendix 5-3. Specific vegetation management activities for each STA are found in the individual STA sections of this chapter.

Figure 5-4. Vegetation strips in SAV-dominated treatment cells aid in reducing wave and wind damage to the plants. Shown is one of the vegetation strips located in STA-1W Cell 5.

Vegetation Management Research

An experimental plot (3 ha) with dense torpedograss cover in Cell 2B of STA-3/4 was used to investigate potential impediments to planned conversions of emergent cells to SAV while maintaining flow-through operations and associated water quality treatment. Torpedograss is an exotic and common nuisance species in the STAs and forms dense mats that are difficult to control in South Florida wetlands. Study results indicate colonization of SAV following herbicide treatment of torpedograss in an operational STA occurred by the end of the first growing season (spring-summer) after treatment. The thick accumulation of dead torpedograss thatch that remained six months after herbicide treatment provided similar conditions as untreated torpedograss and temporarily prevented establishment of SAV. However, when the treated torpedograss sank below the water surface, the submerged litter became coated with periphyton, which can facilitate an important mechanistic pathway for co-precipitation and retention of phosphorus. Southern naiad subsequently colonized this submerged mat of partially decomposed litter and periphyton. Similarity between mean biomass of southern naiad beds that established 14-16 months after herbicide treatment and the standing crop of SAV after 12 months of growth at an adjacent reference site confirms the feasibility of rapid conversion of emergent STA cells.

A study was conducted to evaluate the potential of a new growth-regulating herbicide, imazamox, for controlling Hydrilla (an exotic SAV species) in submerged cells of the STAs. Following preliminary testing of imazamox in STA-1W test cells, which suggested that imazamox can be used to regulate growth of Hydrilla with little or no effect on southern naiad or Chara, imazamox was applied to a 15-acre plot in Cell 4S of STA-1E with both pure beds of Hydrilla and a mixed community of Hydrilla, southern naiad and small pondweed. Experimental results from this plot indicate this larger-scale imazamox treatment did not have the desired growth-regulating effect on Hydrilla.

Due to unknown causes, Hydrilla cover in the north end of Cell 3 of STA-2 began to decline in summer 2005 and was completely eliminated following Hurricane Wilma several months later. As the die-off of the Hydrilla left this northern portion (approximately 750 acres) of the cell devoid of vegetation, an attempt was made to establish native SAV species by transplanting Southern naiad, *chara,* and Illinois pondweed from the south end of the cell. Twelve 9 m^2 enclosures were inoculated with these three species in April 2006. However, this effort to establish native SAV failed as regrowth of Hydrilla from buried tubers began shortly thereafter and rapidly outcompeted the inoculated plants.

A study to determine which management options should be taken to allow for optimal SAV reestablishment in areas that had dense growth of terrestrial plants during the Cell 5 rehabilitation efforts is under way in Cell 5B (**Figure 5-5**). During the period when the cell was dried out to implement the Long-Term Plan Enhancements construction and rehabilitation work, the southern portion of Cell 5B became dominated by two different grass species: Sprangletop (*Leptochloa*, sp.) and Barnyard (*Echinochloa*, sp.), which died out when the cell was rehydrated. The biomass associated with the dead grasses is preventing the growth of SAV, the intended vegetation type for this cell. The objective of this study is to determine the presence/absence of SAV in the regions of Sprangletop and Barnyard grasses in STA-1W Cell 5B and to evaluate various types of management options to allow for SAV establishment. Additionally this study examines the viability of a seed source of SAV in order to determine whether SAV can be successfully transplanted into these regions. A total of 80 plots are being monitored on a monthly basis. Extensive field notes, photo documentation, and estimation of biomass of SAV using wet weight will be available at the end of the study, expected to be completed in early 2008.

Figure 5-5. Research study conducted in STA-1W Cell 5 to evaluate various management options necessary to establish SAV in areas previously dominated by dense terrestrial vegetation.

WILDLIFE ISSUES AND AVIAN PROTECTION PLAN

In WY2007, the key issues were the presence of a pair of bald eagles in STA-2, burrowing owls in STA-1E, snail kites in STA-3/4, and an abundance of Black-Necked Stilt nests throughout the STAs. The bald eagle pair has been sited in STA-2 since early spring 2007, but abandoned the nests shortly thereafter. In STA-1E, one burrowing owl nest was found in the southeastern portion of the bypass area of Cell 2. There was some activity observed in this nest around May 2007. The nest was observed and surveyed by the USACE and was deemed inactive and flooded shortly afterwards. Some snail kites have been seen foraging in Cell 1B of STA-3/4. Apple Snail egg clusters were also found in Cell 1B of STA-3/4. STA-1, STA-5, and STA-2 were also surveyed, but there was only one kite seen in these areas. Surveys were performed by the University of Florida under the Florida Fish and Wildlife Cooperative Research Unit.

In WY2007, many of the STAs had Black-Necked Stilts nesting within the treatment areas (**Figure 5-6**). Because the eggs are protected under the Migratory Bird Treaty Act, STA operations were restricted. Surveys to estimate the number of nests were conducted over the nesting season and results of this survey are found in Appendix 5-4.

Figure 5-6. A Black-Necked Stilt nesting in the STA.

Avian Protection Plan

The STAs provide high-quality wildlife habitat and are known to support more than 130 species of birds (Chimney and Gawlik, 2007), many of which are protected under federal law by the Endangered Species Act and/or the Migratory Bird Treaty Act. The potential impact to these birds in the STAs of greatest concern is the disturbance of nests or fledgling mortality (i.e., a "taking") of ground nesting species. The District in cooperation with the U.S. Fish and Wildlife Service (USFWS) has developed a draft Avian Protection Plan (APP) for the existing ECP STAs and their expansions that is focused on two representative ground nesting species, the Black-Necked Stilt (BNS) and the Florida Burrowing Owl (FBO) (*Athene cunicularia floridana*) (Appendix 5-5). The APP characterizes the risk to these species from STA construction, operation start-up, drought condition operations, routine maintenance, and enhancement activities and outlines a number of prophylactic measures intended to minimize the incidental taking of birds or nests due to these actions. These measures range from suspending routine levee and road maintenance (e.g., mowing, grading, etc.) to diverting stormwater runoff from those STA cells with active nests. All information collected as part of the APP (e.g., nesting records of BNSs and FBOs) and any District corrective action(s) will be reported annually in future SFERs.

STA RECREATIONAL ACTIVITIES

Hunting Program

Because of intensive management of areas leading to ideal habitat for waterfowl, these constructed wetlands have become magnets for migratory waterfowl. STA-5 was opened for duck hunting as an experiment in 2002 with 25 permits per hunt day. Because of its popularity and no apparent impact to the functioning of the treatment areas, the hunting program has grown many folds by expanding to other STAs. Three out of six STAs (STA-1W, STA- 3/4, and STA- 5) are now open for hunting. The duck hunters boast that STA-5 is one of the best waterfowl hunting sites in the nation.

Hunting is managed by the Florida Fish and Wildlife Conservation Commission (FWC). Hunting was open one weekend day per STA during the 2006-07 waterfowl hunting season. That accounted for 10 hunt days during regular hunting season and one youth hunt, totaling 11 hunt days from mid-November to the first week of February. STA-3/4 had 22 hunt days for the season as 11 of those hunt days were transferred to this STA from STA-1W because of maintenance work at STA-1W. In 22 hunt days, 2,661 hunters took out 9,228 ducks from STA-3/4 during the 2006-07 waterfowl hunting season. Similarly, in 11 hunt days 1,910 hunters took out 7,914 ducks from the STA-5.

Bird-watching program

Two of the STAs (STA-1E and STA-5) are now open for bird watching activities. The organized bird-watching tours were conducted by Hendry-Glades Audubon for STA-5 and Pine Jog Environmental Education Center of the Florida Atlantic University for STA-1E. These birding tours have been as popular as hunting, which is indicated by the participants reaching up to 105 people in a single tour. Fifteen birding tours during the period of September through April were conducted by Pine Jog Environmental Center for STA-1E and 407 bird-watchers participated (average 27 per tour; range 7-46). Similarly, Hendry-Glades Audubon conducted 16 birding tours to STA 5 during the period of September through May and had 771 bird enthusiasts participated (average 48 per tour; range 7-105).

These recreational programs were advertised through various media: the Florida Fish and Wildlife Conservation Commission web site, the District web site, the Everglades Audubon Society newsletter (The Kite), The Palm Beach Post, the Hendry-Glades Audubon web site, and local newspapers in the west coast.

Trailhead Construction

Recreational facilities or trailheads are under construction at three STAs to provide opportunities for the public to access these constructed wetlands. A trailhead at the southwest corner of STA-3/4 is being completed (**Figure 5-7**). This facility includes landscaping, a double-lane boat ramp, parking area, informational kiosks, a composting toilet, and a foot bridge to provide access to the treatment area. Similarly, a parking area with a composting toilet will be developed at north end of the STA-1E, across the existing bridge, over C-51 canal. For access to STA-1W, a trailhead with parking and a canoe launch site will be developed across the seepage canal at the north central portion of STA-1W. In addition, a foot bridge, landscaping, a boardwalk with viewing platforms, an information kiosk, and a composting toilet will be developed in this portion of STA-1W. A turn lane on CR 880 is constructed to provide access to the STA-1W parking area from the road.

STA-2 in Palm Beach County is being established as a public small game hunting area as part of the District's continuing commitment to broaden land access for public recreation. The Governing Board recently approved expanding hunting opportunities on District lands. Beginning in September, the FWC will manage hunts in STA-2, as it does for the hunts already allowed in STA-1W, STA-3/4, and STA-5.

Figure 5-7. Aerial view of the Harold S. Campbell Recreational Area recently constructed at STA-3/4.

ECP STA PERMIT STATUS

For WY2007, ECP STAs are in compliance with all requirements of the EFA and the NPDES operating permits.

The EFA permits for the STAs acknowledge that until all the STAs are fully operational, certain STAs may receive higher than normal inflows. The EFA permits also recognize that some of the STAs will remain in the stabilization phase of operation until other STAs are in full flow-through operations. Specifically, STA-1W will remain in the stabilization phase of operation until STA-1E and STA-2 begin full flow-through operations; STA-2 will remain in the stabilization phase of operation until STA-1E and STA-3/4 begin flow-through operations, and STA-5 will remain in the stabilization phase of operation until STA-6 Section 2 begins flow-through operations. In WY2007, STA-1E and STA-6 Section 2 were not in full flow-through operations. STA-1E is not expected to begin full flow-through until the PSTA demonstration project located in the Eastern Flow-way (**Figure 5-8)** is completed. The STA-1E PSTA demonstration project is expected to become operational in late 2007 and will be operated for a 24-month period. STA-6 Section 2 became flow-capable in December 2006, but initial hydration was delayed until July 2007 due to regional drought conditions. STA-6 Section 2 still has not met the start-up criteria of net reduction in phosphorus concentrations. In the interim, STA-1W and STA-5 remain in the stabilization phase of operation. During interim operations, the District has provided monthly reports documenting discharge phosphorus levels.

Table 5-6. Summary of STA operations and issues. Operational phases: (1) Start-up, inundate for vegetation growth. No discharge, phase ends when cell demonstrated net improvement in phosphorus and mercury. (2) Stabilization: discharge, phase ends when 12-month outflow TP ≤ 50 parts per billion (ppb). (3) Post-stabilization: after stabilization phase. The terms "fully operational" and "partially operational" refer to the status of the treatment cells.

STA-1E	**Operational Status**		**WY2007 Operational Issues**
	In Stabilization phase		• Partially operational: Cells 1 and 2 remain closed due to construction of the PSTA demonstration project by the USACE. • Operations restricted due to presence of federally protected birds. • Extremely low water conditions due to drought
Permit timeline: • Construction completed for Cells 3, 4N, 4S, 5, 6, 7: 6/04 • Start-up Operations began: September 2004 • Flow-through operations 9/30/05 (emergency discharges in Sept. and Oct, 2004 because of the hurricanes).			
STA-1W	**Operational Status**		**Operational Issues**
	In Stabilization Phase		• Partially operational, only Northern Flow-way (Cell 5) operational.: • LTP construction and rehabilitation in the Eastern Flow-way. • Rehabilitation in Western Flow-way • Operations restricted due to presence of federally protected birds. • Extremely low water conditions due to drought
Permit timeline: Initial 3,742 acres: • Start-up operations: 10/93 • Flow-through operations: 8/94			Additional 3,018 acres: • Construction completed 3/18/99 • Start-up operations began: 3/18/99 • Net improvement: 1/21/00 • Flow-through operations: 7/7/00
STA-2	**Operational Status**		**Operational Issues**
	In Post-stabilization Phase		• Operations restricted due to presence of federally protected birds. • Extremely low water conditions due to drought. Water was directed into the SAV dominated Cell 3 from the emergent Cell 2 or Cell 4
Permit timeline: Start-up operations began June 1999 • Demonstrated net improvement for phosphorus October 2000 • Flow-through operations began October 2000 as part of pump station commissioning, although drought prevent normal operations until summer 2001 • New Treatment Cell 4 flow-capable 12/06, start-up monitoring delayed until July 2007 due to drought conditions			
STA-3/4	**Operational Status**		**Operational Issues**
	In Post-stabilization Phase		• Operations restricted due to presence of federally protected birds. • Extremely low water conditions due to drought. Temporary pumps installed at divide levees to supply water to SAV dominated downstream cells.
Permit timeline: • Cells 1A/1B and 2A/2B began start-up October 2003 • Cell 3 began start up November 2003 • Cell 1 passed start-up January 2004, but lack of flow delayed flow-through until February 2004 • Cell 3 began flow-through June 2004 • Cell 2A/2B began flow-through September 2004			

Table 5-6. Continued.

STA-5	Operational Status		Operational Issues
	In Stabilization Phase		Operations restricted due to presence of federally protected birds. G-507 used to deliver water to SAV dominated cells, divide structure G-345 used to supply water from Cell 1B to Cell 2B.
Permit timeline: • Start-up began December 30, 1998 • Flow-through began October 6, 1999 • New Flow-way 3 flow-capable 12/06. start-up monitoring delayed until July 2007 due to drought conditions			
STA-6	**Operational Status**		**Operational Issues**
	In Post-stabilization Phase		• Operations restricted due to presence of federally protected birds. • Extremely low water conditions due to drought
Permit timeline: • Start-up Section 1 began October 1997 • Flow-through Section 1 began December 1997 •New Section 2 Treatment Cell flow-capable 12/06, start-up monitoring delayed until July 2007 due to drought conditions			

WATER QUALITY PERMIT REQUIREMENTS

Water quality parameters with Florida Class III standards are identified in **Table 5-7**. Compliance with the EFA permit is determined based on the following three-part assessment:

1. If the annual average outflow concentration does not cause or contribute to violations of applicable Class III water quality standards, then STA-1W shall be deemed in compliance.
2. If the annual average concentration at the outflow causes or contributes to violations of applicable Class III water quality standards but does not exceed or is equal to the annual average concentration at the inflow stations, then STA-1W shall be deemed in compliance.
3. If the annual average concentration at the outflow causes or contributes to violations of applicable Class III water quality standards and also exceeds the annual average concentration at the inflow station, then STA-1W shall be deemed out of compliance.

The District has performed all sampling and analysis in compliance with Chapter 62-160, Florida Administrative Code (F.A.C.), and the District's Laboratory Quality Manual (SFWMD, 2006) and Field Sampling Quality Manual (SFWMD, 2007). Certification statements as to the procedures used in collection and analysis are provided in Appendix 5-6 of this volume. The Annual Permit Compliance Monitoring Report for Mercury in the STAs is located in Appendix 5-7.

The STA flow volumes are based on surface water flow, and the TP loads are calculated using flow or time-proportional auto-sampler data. If auto-sampler data is not available, then TP data from grab samples collected during flow events are used instead. The permitting reporting requirements for water quality parameters are different for each STA. Each individual STA section shows a table of the annual values for those parameters required by the permit.

Modifications Made in TP Load Estimate Calculation

This water year, flow that moves in the opposite way than intended (termed negative flow) is included in the STA TP load estimates. This modification changes the TP load and FWM TP estimates, resulting in lower loading estimates. Some of the previous water year estimates have changed, mostly at the STA-3/4 outflows, STA-5 inflows, and STA-6 inflows. Also, the TP load and FWM TP estimates presented in this chapter are slightly different than those shown in Chapter 4 of this volume, *Phosphorus Source Controls for the Basins Tributary to the Everglades Protection Area*. Additionally, to account for water used for pass-through or irrigation, the flow data used to estimate inflows for STA-1E, STA-2, and STA-3/4 have been modified (see individual STA sections for details).

Mercury

For WY2007 there were no violations of the Florida Class III numerical water quality standard (WQS) of 12 nanograms (ng) of total mercury per liter (THg/L) during the reporting year at any of the STAs. Average annual outflow concentrations for THg and MeHg at all STAs were lower than inflow except for STA-IE. The average outflow MeHg concentration at STA-1E was statistically higher (Students t-test, $p < 0.001$) than inflow. Mercury levels in all monitored fish species for 2006 demonstrated a slight to moderate increase since 2005. However, this increase did not result in mercury concentrations in fish collected with the STAs to exceed the basin-wide action levels. Based on USFWS and USEPA predator protection criteria, fish-eating wildlife foraging within all STAs are at an overall moderate risk to mercury exposure. Of lowest concern is fish-eating wildlife foraging within STA-1W (Appendix 5-7). STA mercury performance criteria are evaluated on an annual basis. If respective actions levels are exceeded, corrective measures are taken in accordance with the FDEP approved monitoring plans.

Table 5-7. Water quality parameters with Florida Class III criteria specified in Section 62-302.530, Florida Administrative Code.

Parameter	Units	Class III Criteria
Dissolved Oxygen	mg/L	Greater than or equal to 5.0 mg/L
Specific Conductivity	µmhos/cm	Not greater than 50% of background or greater than 1,275 µmhos/cm, whichever is greater
pH	standard units	Not less than 6.0 or greater than 8.5
Turbidity	NTU	Less than or equal to 29 NTU above background conditions
Unionized Ammonia	mg/L	Less than or equal to 0.02 mg/L
Alkalinity	mg/L	Not less than 20 mg/L
Total Iron	µg/L	Less than or equal to 1,000 µg/L

DISSOLVED OXYGEN

Dissolved oxygen (DO) concentrations below 5.0 mg/L occur commonly throughout the EPA, including interior marsh sites minimally impacted by nutrient enrichment or cattail invasion. Frequent DO levels below 5.0 mg/L are typical in macrophytic-dominated wetlands where marsh processes of photosynthesis and respiration result in wide diel cycle swings in DO levels. Since low DO concentrations often measured in the EPA represent natural variability in this type of ecosystem, the FDEP, pursuant to Chapter 62-302.800(1), F.A.C., has promulgated a site-specific alternative criterion (SSAC) for DO in the Everglades. This SSAC addresses the wide-ranging natural daily (diel) fluctuations that influence natural background DO levels. Chapter 3A of the 2008 SFER (Weaver, 2008) contains a summary explanation of the SSAC, its development and its application in assessing DO excursions. A more detailed description of the derivation of the DO SSAC is found in Weaver (2004).

Previous reports (Jorge et al, 2002; Goforth et al., 2003; Goforth et al., 2004; Goforth et al., 2005; Pietro et al., 2006; and Pietro et al., 2007) provided monitoring results, comparisons, and evaluations with regards to diel DO for the STAs. These reports were used to assess the impact of STA discharges on the downstream Everglades ecological system or downstream water quality with respect to DO and pursuant the STA-1E, STA-1W, STA-2, STA-3/4 and STA-5 EFA permits and associated Administrative Orders. This effort also provided data to the FDEP for development of the DO SSAC.

Previous annual reports (Everglades Consolidated Report and *South Florida Environmental Report*) included the following information:

- A comparison of DO levels at STA discharges with background conditions in receiving waters
- An evaluation of DO levels at representative interior Everglades marsh stations, demonstrating that STA discharges fully maintain and protect the existing designated uses of the downstream waters and that the level of water quality is consistent with applicable anti-degradation requirements
- An evaluation of whether discharges are necessary or desirable and are otherwise in the public interest
- A depiction of the daily and seasonal diel cycles for STA DO discharges during the period covered by the STA annual report
- A comparison of STA effluent with other historical DO data from the EPA, including data from interior marsh stations downstream of the STA discharges within the Everglades Protection Area
- Consideration of the influences of temperature, seasonal weather conditions, aquatic community type, and hydropattern on the diel cycle of the STA discharges

The new STA permits that have been, or will be, issued this year have the site-specific alternative criterion (SSAC) requirement instead of the diel oxygen comparisons. The diel oxygen information collected in previous years was used to develop the SSAC. For the purposes of this report, DO levels measured at outflow stations from five STAs (STA-1E, STA-1W, STA-2, STA 3/4, and STA-5) will be assessed using the FDEP promulgated SSAC for the Everglades rather than diel DO evaluation as provided in previous reports. Since the STA-6 permit did not have diel requirements, no SSAC comparison will be performed for this STA for WY 2007.

A summary of annual DO levels at outflows for each STA and their comparisons with the SSAC is provided **Table 5-8**. If mean annual DO concentrations measured at the effluent compliance points are greater than the calculated mean annual lower limit using the SSAC equation, then the outflow values are above the SSAC limit. Biweekly dissolved oxygen levels measured at discharge stations from each STA are presented in Appendices 5-8 and 5-9.

A SSAC is presently included in the combined STA-1E/STA-1W EFA permit, the STA-1E NPDES permit and the STA-2, STA-5 and STA-6 EFA and NPDES permits. Additionally, the District has requested the SSAC be included in the future EFA and NPDES permits for STA 3/4 and the NPDES permit for STA-1W.

Table 5-8. Summary of annual dissolved oxygen levels at outflow stations for each STA and their comparison with the SSAC during Water Year 2007.

STA	Outflow Station	No. of Samples	Mean[a]	Standard Deviation	Minimum	Maximum	Mean Annual SSAC Limit[b]	SSAC Limit Classification[c]
STA-1E	S-362	51	5.95	2.00	2.16	10.10	3.88	Above
STA-1W	G-251	51	1.44	1.37	0.02	4.90	2.92	Below
	G-310	51	3.64	1.98	0.38	7.51	2.76	Above
STA-2	G-335	52	4.41	1.26	1.82	7.44	2.88	Above
STA-3/4	G-376B	52	3.19	1.68	0.43	6.54	2.95	Above
	G-376E	52	3.26	1.53	0.46	6.80	3.18	Above
	G-379B	52	4.21	1.73	0.38	7.64	3.41	Above
	G-379D	52	4.82	1.82	1.72	8.83	3.57	Above
	G-381B	45	5.18	1.56	1.49	7.72	3.84	Above
	G-381E	45	4.83	1.49	1.17	7.26	4.02	Above
STA-5	G-344A	50	3.04	2.48	0.20	8.44	3.34	Below
	G-344B	51	3.12	1.89	0.12	8.43	3.55	Below
	G-344C	41	4.53	2.41	0.29	10.40	3.72	Above
	G-344D	41	5.43	2.47	1.06	11.80	3.89	Above

Note: [a] Arithmetic mean

[b] SSAC limit derived using the equation derived by Weaver (2004) which calculates the limit using water temperature and time of day data recorded at each monitoring location during each monitoring event.

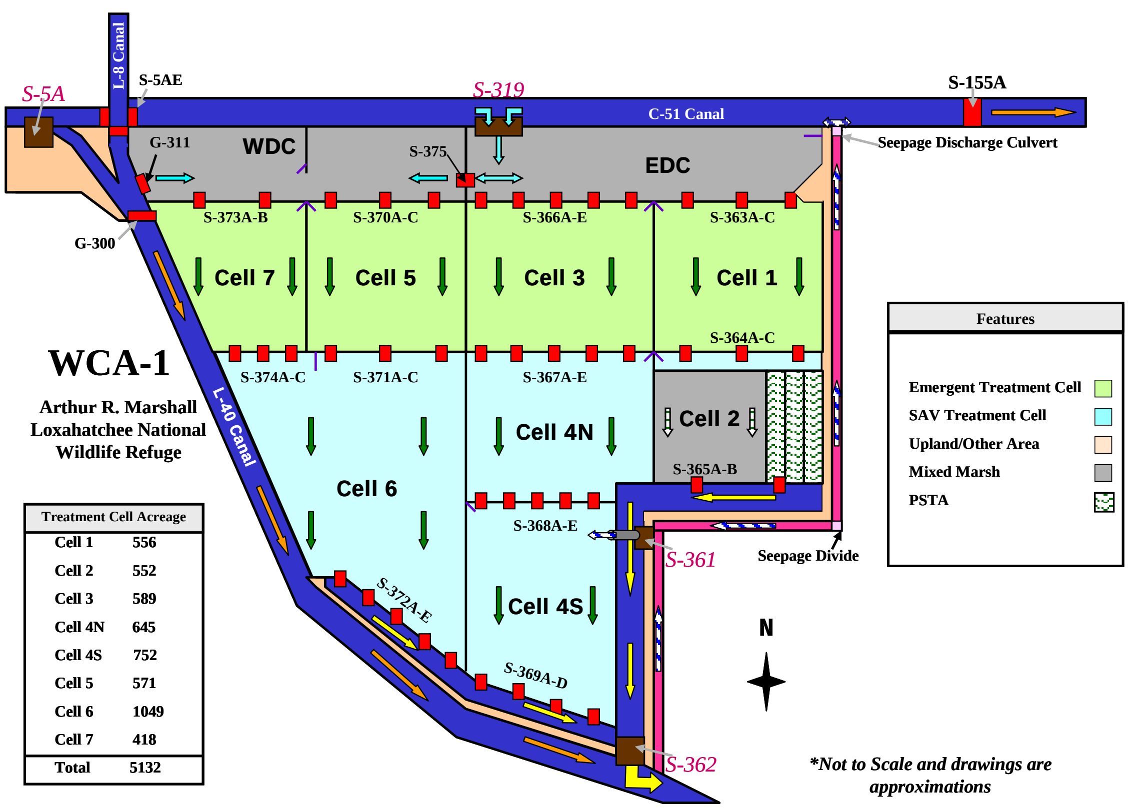
[c] SSAC limit indicates whether the mean annual DO level measured at an outflow station was above or below the SSAC limit. To be above the SSAC limit, mean annual DO must be equal to or greater than the mean annual SSAC limit.

STA-1E

STA-1E CONFIGURATION

STA-1E is the last of the six STAs to begin operation and is located about 20 miles west of West Palm Beach, Florida, adjacent to the northeast boundary of the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) and directly east of the STA-1 Inflow and Distribution Works (referred to as the STA-1 Inflow Basin). Inflow is received through the Pump Station S-319, the gated structure G-311, and the culvert structure S-361. Outflow from STA-1E is through the gated structure S-362 and discharges go into the Refuge (**Figure 5-8**).

STA-1E consists of three parallel treatment flow-ways, with eight treatment cells flowing from north to south. The Western (Treatment Cells 5, 6, and 7) and Central Flow-ways (Treatment Cells 3, 4N, and 4S) were operational in WY2007. The USACE has just recently completed construction of a Periphyton-Based Stormwater Treatment Area (PSTA) demonstration project in a portion of Cell 2 of the Eastern Flow-way (Treatment Cells 1 and 2). The Eastern Flow-way will remain offline until the PSTA demonstration project is finished and the cell is prepared for full flow-through operations. The PSTA demonstration project consists of three cells (45.5 acres each) preceded by a 556-acre cell (Cell 1), consisting of emergent vegetation and a 55-acre SAV cell. A map showing the major vegetation communities found in STA-1E, created from aerial imagery flown in March 2006, is found in Appendix 5-2.



Treatment Cell Acreage	
Cell 1	556
Cell 2	552
Cell 3	589
Cell 4N	645
Cell 4S	752
Cell 5	571
Cell 6	1049
Cell 7	418
Total	5132

Figure 5-8. Schematic of STA-1E (not to scale). Inflow and outflow sites are designated with red/bold/italic font.

STA-1E WY2007 HIGHLIGHTS

- STA-1E was in compliance with the EFA and NPDES operating permits for this reporting period and discharges do not pose any known danger to public health, safety, or welfare.
- During WY2007, Treatment Cells 3, 4N, 4S, 5, 6, and 7 were online. Treatment Cells 1 and 2 continued to be offline for construction of the USACE PSTA demonstration project and plant establishment (**Table 5-9**).
- The USACE PSTA demonstration project construction was completed in February 2007. The project, located in Cell 2, is under the control of the USACE. Soon after construction was completed, some water was delivered to the upstream SAV-dominated cells to encourage the plant growth, but these water deliveries could not be maintained because of regional drought conditions. Inflows to the upstream Cell 1 resumed in July 2007.
- Flow data for the inflow structure G-311 covering the period of June–October 2006 was updated in February 2007. The data adjustment was due to a stilling well malfunction.
- G-311 experienced reverse flow during this past water year (although the majority of flow was from west to east).
- Low water conditions were experienced in the treatment cells due to the drought. Cell 1 had been impacted the most compared to the other cells.
- During the summer 2006, Cell 7 experienced prolonged high water levels (> 3 ft).
- Wildlife issues included the presence of burrowing owls (*Athene cunicularia floridana*) in the bypass area of Cell 2 and abundance of Black-Necked Stilt nests in most of the other treatment cells (see *Wildlife Issues and Avian Protection Plan* section in this chapter and Appendix 5-4 for survey dates and estimated number of nests) which impacted operation options.

STA-1E OPERATIONS

Table 5-9. Operational status of the treatment cells in STA-1E. Major events, such as hurricanes, treatment areas temporarily offline or Long-Term Plan Enhancements construction are listed.

STA-1E Operational Treatment Cells

<table>
<tr><th colspan="5">2004</th><th colspan="5">2005</th><th colspan="3">2006</th></tr>
<tr><td>WY2004</td><td colspan="4"></td><td></td><td colspan="6">WY2006</td><td></td></tr>
<tr><td></td><td colspan="6">WY2005</td><td colspan="3"></td><td></td><td colspan="2">WY2007</td></tr>
<tr><td>Jan - Mar</td><td>Apr - Jun</td><td>Jul - Aug</td><td>Sep Hurricanes Frances and Jeanne</td><td>Oct - Dec</td><td>Jan - Mar</td><td>Apr - Jul</td><td>Aug - Sep</td><td>Oct Hurricane Wilma</td><td>Nov - Dec</td><td>Jan - Mar</td><td>Apr - Jun</td><td>Jul - Sep</td></tr>
<tr><td colspan="3">Prior to operation</td><td colspan="5">Emergency Operations, cell hydration</td><td colspan="5">Central and Western Flow-ways Operational</td></tr>
<tr><td colspan="8"></td><td colspan="5">Eastern Flow-way off-line for construction of PSTA project</td></tr>
</table>

STA-1E HYDROLOGY AND TOTAL PHOSPHORUS

During WY2007, 108,311 ac-ft of water, with a TP load of 31.9 mt and a FWM TP concentration of 239 ppb was captured and treated by STA-1E through structures S-319, G-311, and S-361 (**Tables 5-2** and **5-9, Figures 5-9** and **5-10**). The volume of water that passed through S-319 that was then immediately discharged through G-311 for delivery to STA-1W was subtracted out of the inflow loading calculations because this volume of water is not considered to have entered into the effective treatment area. Slightly different methods are used to estimate inflow and outflow flow in the water budgets. In the water budget estimates, water that moves through S-319 then out through G-311 is considered to be an outflow, whereas in the TP loading estimates this volume of water is not included. Additionally in the water budgets, flow measured at S-361 is not used. Instead, the contribution from this structure is calculated as 3 percent of the S-319 volume. The hydraulic loading was 2.25 cm/day, only slightly higher (9 percent) than the simulated long-term average annual simulated inflow for this STA and the phosphorus loading was equal to an average of 1.96 g/m^2 over the effective treatment area, about 47 percent more than the simulated long-term average annual load (**Table 5-2**). The hydraulic and phosphorus loading rates are calculated by dividing the inflow by the effective treatment area. These rates are affected when areas of the STAs are temporarily taken offline for construction or rehabilitation. Although drought conditions existed in the last part of the water year, STA-1E experienced high inflow volumes in July, August, September, resulting in an increase in the annual hydraulic loading rate (HLR). Compared to last water year, the inflow flow was about two times and the inflow load was about 2.8 times what was received last water year (**Table 5-10**). The diversion calculations and the amount of Lake Okeechobee regulatory releases received over the water year are found in **Table 5-3**.

The annual volume of treated water discharged to Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) was 97,818 ac-ft through structure S-362 with a TP load of 8.6 mt and the FWM TP outflow concentration of 71 ppb (geometric mean = 46 ppb), a 70 percent reduction from the inflow concentration. This is equivalent to 73 percent TP load reduction. The difference between the inflow and outflow volumes reflects the net contributions of direct rainfall, evapotranspiration (ET), seepage losses to adjacent lands, deep percolation, and flow measurement error. A summary of monthly flows and loads is presented in **Figure 5-9** and the monthly FWM TP concentrations, which ranged from 19 ppb to 105 ppb, compared to the moving 12-month FWM TP outflow concentration for STA-1E is presented in **Figure 5-10**. Graphs of annual flows, TP loads, FWM TP concentrations, and hydraulic and phosphorus loading rates for the period of record operations are found in Appendix 5-1.

Table 5-10. Summary Statistics of 12-month inflow and outflow flow, TP load, FWM TP concentration for each water year at STA-1E.

STA-1E Inflow												
	Flow Volume (ac-ft)				TP Load (mt)				FWM TP (ppb)			
Water Year	Sum	Avg.	Min.	Max.	Sum	Avg.	Min.	Max.	Arithmatic [1]	Geo. Mean [2]	Min.	Max.
2005	19,426	1,619	0	6,260	4.9	0.4	0	2.0	202	188	120	275
2006	52,132	4,344	1,196	12,277	11.5	1.0	0.2	3.5	179	151	98	253
2007	108,311	9,026	293	30,365	31.9	2.7	0.1	10.9	239	149	76	291

STA-1E Outflow												
	Flow Volume (ac-ft)				TP Load (mt)				FWM TP (ppb)			
Water Year	Sum	Avg.	Min.	Max.	Sum	Avg.	Min.	Max.	Arithmatic [1]	Geo. Mean [2]	Min.	Max.
2005	17,565	1,464	0.0	8,950	8.1	0.7	0.0	4.8	373	93	33	433
2006	40,572	3,381	0.0	10,756	7.3	0.6	0.0	3.1	146	91	55	237
2007	97,818	8,151	1.6	32,841	8.6	0.7	0.0	4.2	71	47	22	105

[1]Arithmatic FWM TP calculated using the annual load and flow.

[2]Geometric FWM TP calculated based on monthly FWM TP estimates.

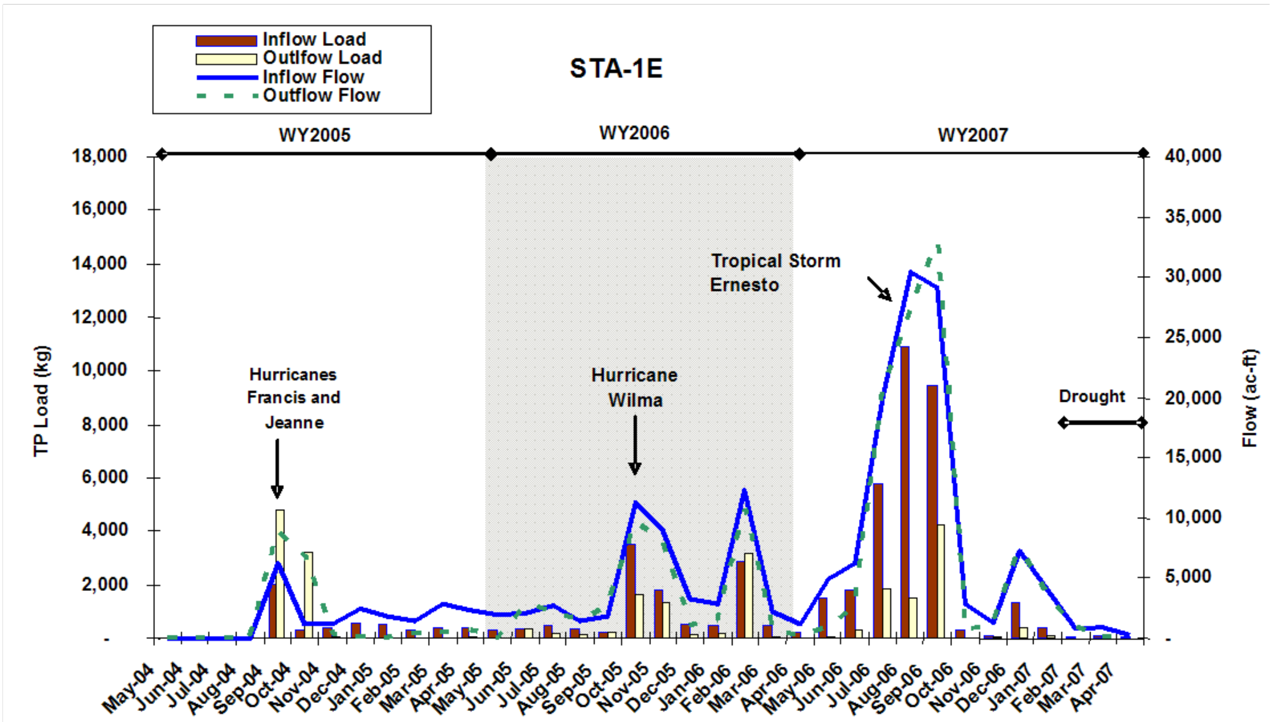


Figure 5-9. Monthly inflow and outflow flow and TP load from WY2005–WY2007. Labeling and gray shading were added to the plot to designate each water year and major climatic events are noted. The Central and Northern Flow-ways (Cells 3, 4N, 4S, 5, 6, 7) were operational for part of the water year; Cells 1 and 2 were offline for construction of the PSTA demonstration project and vegetation establishment.

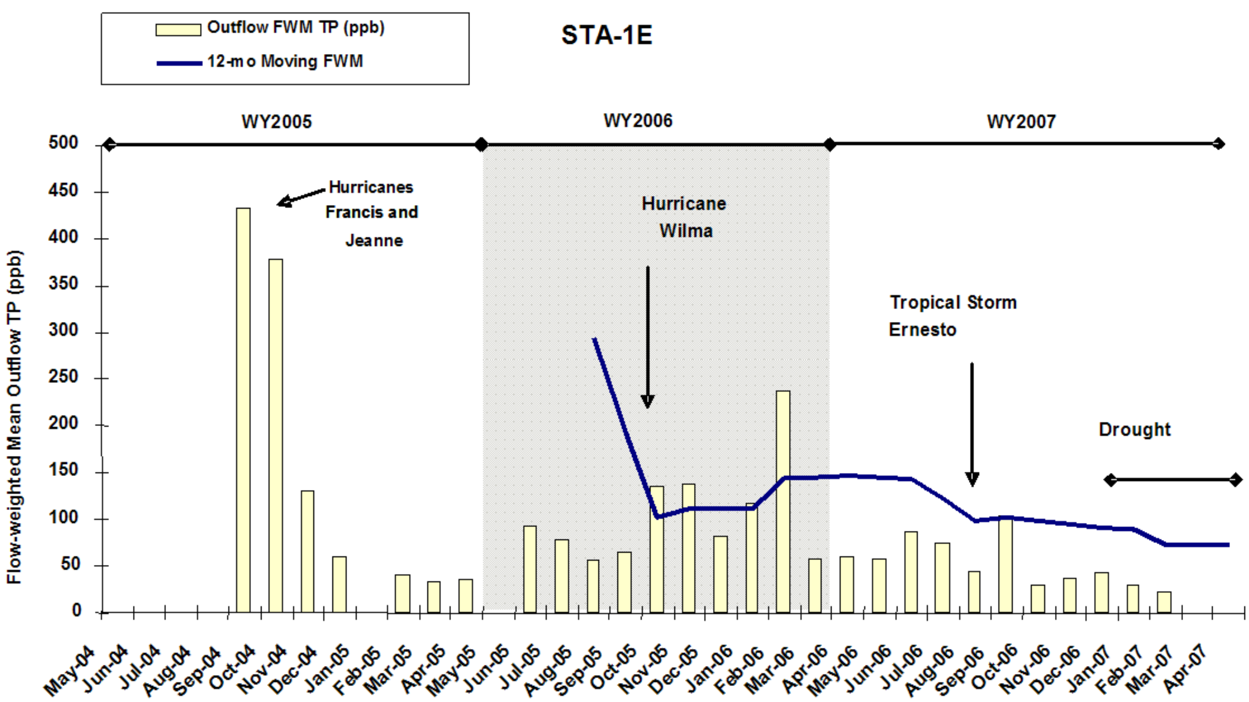


Figure 5-10. Comparison of monthly to 12-month moving average TP concentrations for STA-1E. from WY2005–WY2007. The Central and Northern Flow-ways (Cells 3, 4N, 4S, 5, 6, 7) were operational for part of the water year; Cells 1 and 2 were offline for construction of the PSTA demonstration project and vegetation establishment.

OTHER STA-1E WATER QUALITY PARAMETERS

Water quality parameters with Florida Class III standards are identified in **Table 5-7**. Compliance with the EFA permit is determined based on the three-part assessment presented in the *Water Quality Permit Requirements* section of this chapter. The monitoring data over the partial water year for all other water quality parameters at STA-1E during this reporting period are presented in Appendix 5-10 of this volume, and are summarized in **Table 5-11**. Temperature, specific conductance, dissolved oxygen (DO), and pH values reported in this chapter are field measurements. The annual permit compliance monitoring report for mercury in the STAs is in Appendix 5-7 of this volume.

Discharges from STA-1E were determined to be in compliance with the permit by satisfying criterion number 1 for all other water quality and non-DO parameters with applicable numeric state water quality standards. STA-1E is deemed to be in full compliance with the permit.

Table 5-11. Summary of annual arithmetic averages and FWM for all parameters other than TP monitored in STA-1E. Alkalinity is reported as mg/L $CaCo_3$ and Nitrite+ Nitrate is reported as mg/L N. Because these parameters are measured from grab samples and not flow-proportional samples, both the arithmetic of all the samples collected as well as the means for those samples collected only during flow events (flow-weighted means) are shown.

Parameter	Arithmetic Means Inflow			Arithmetic Means Outflow	Flow-Weighted Means Total Inflow		Flow-Weighted Means Total Outflow	
	G311	S319	S361	S362	n	Conc.	n	Conc.
Temperature (°C)	25.0	26.0	25.4	25.3	-NA-	-NA-	-NA-	-NA-
Dissolved Oxygen (mg/L)	4.5	6.0	4.6	6.0	-NA-	-NA-	-NA-	-NA-
Specific Conductivity (µS/cm)	776	734	955	988	-NA-	-NA-	-NA-	-NA-
pH	7.6	7.6	7.5	7.8	-NA-	-NA-	-NA-	-NA-
Sulfate (mg/L)	45.3	36.8	22.0	42.2	37 (78)	63.1	12 (26)	42.1
Alkalinity (mg/L)	210	204	281	202	37 (78)	254	12 (26)	189
Total Nitrogen (mg/L)	2.4	1.5	2.0	2.1	37 (77)	3.5	12 (26)	2.2

-NA- : Not Applicable
n: number of samples with flow (total number of samples)

STA-1E DISSOLVED OXYGEN MONITORING

The existing STA-1E permits require dissolved oxygen (DO) monitoring only at the inflow and outflow and redirection (G-311) structures. There is no diel cycle or downstream marsh DO monitoring requirements. The permits require the SSAC to be used for compliance analysis purposes at the outflow station (S-362) for STA-1E (**Figure 5-8**).

Based on the DO data collected at S-362, STA-1E was found to be incompliance with the SSAC limit based on mean annual average concentrations (**Figure 5-11** and **Table 5-8**).

Biweekly DO levels measured at S-362 for WY2007 are available in Appendix 5-8. In addition, a graphical depiction of the bi-weekly residual differences between measured DO levels and SSAC limits is provided in Appendix 5-9.

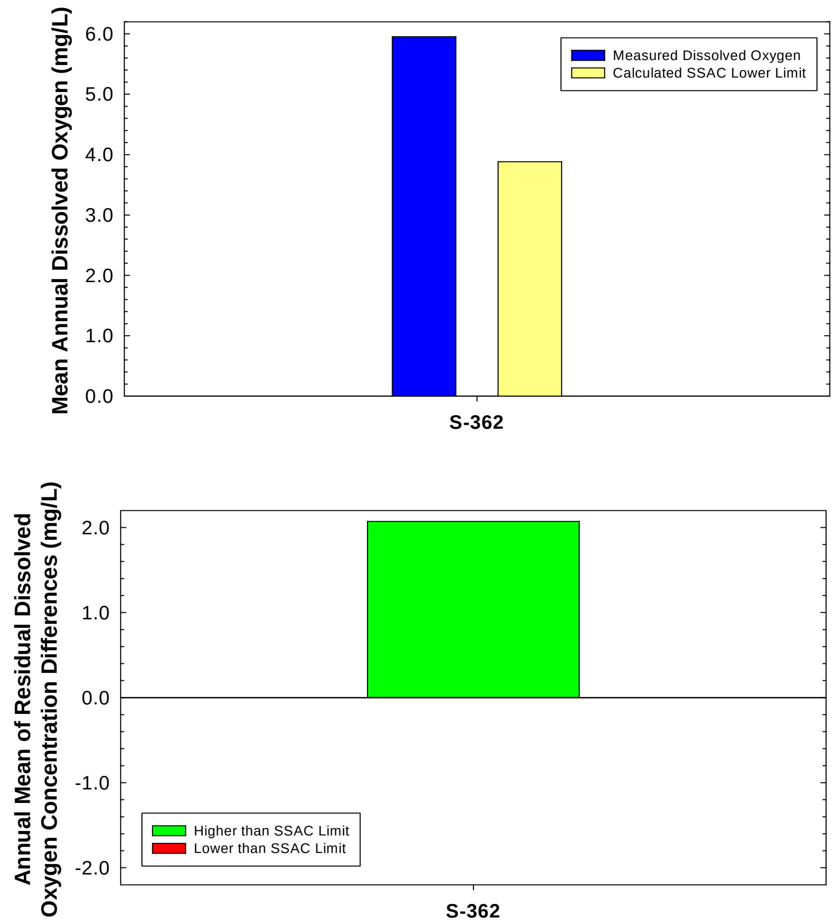


Figure 5-11. Comparison of mean annual DO measured at the outflow station (S-362) for STA-1E during WY2007 with the mean annual SSAC limit derived from the corresponding water temperature and time of day collected at the outflow station (top plot). The annual mean residual DO difference between the mean annual DO and mean annual SSAC indicates whether the station was above the SSAC limit (when greater than or equal to zero) or whether the station was below the limit (less than zero) (bottom plot).

STA-1E VEGETATION MANAGEMENT

Vegetation management activities in STA-1E included a herbicide treatment of 15 acres of hydrilla in Cell 4S and planting of Bulrush in Cell 7 late May 2007 as a study to see if this plant species can withstand the higher water conditions in that treatment cell. Also during the 2007 water year, vegetation management efforts in STA-1E focused mainly on the control of emergent vegetation in the SAV cells, Cells 4N, 4S, and 6. The 2006 and 2007 droughts compounded by wide variations in topography resulted in heavy emergent growth of grasses and cattail species in the SAV cells. Both aerial and ground crews were needed to resolve this problem. Floating aquatic vegetation, primarily water lettuce, were also a significant issue in the SAV cells and emergent cells. Vegetation management also targeted primrose willow in all emergent cells of the STA.

STA-1W

STA-1W CONFIGURATION

Stormwater Treatment Area 1 West (STA-1W) consists of three flow-ways (**Figure 5-12**): the Eastern Flow-way contains Cells 1 and 3, the Western Flow-way contains Cells 2 and 4, and the Northern Flow-way contains Cell 5. Water enters into the STA-1W Inflow Distribution either through the S-5A or G-311 structure and is then directed into STA-1W via the G-302 gated structure. Full flow-through operations in Cells 1 through 4 have occurred since August 1994, when these cells were part of the original Everglades Nutrient Removal (ENR) Project and full flow-through operations through Cell 5 have occurred since July 2000. Outflow is through Pump Stations G-251 and G-310 and discharge is directed into the western side of the Refuge. A map showing the major vegetation communities found in STA-1E, created from aerial imagery flown in March 2006, is found in Appendix 5-2.

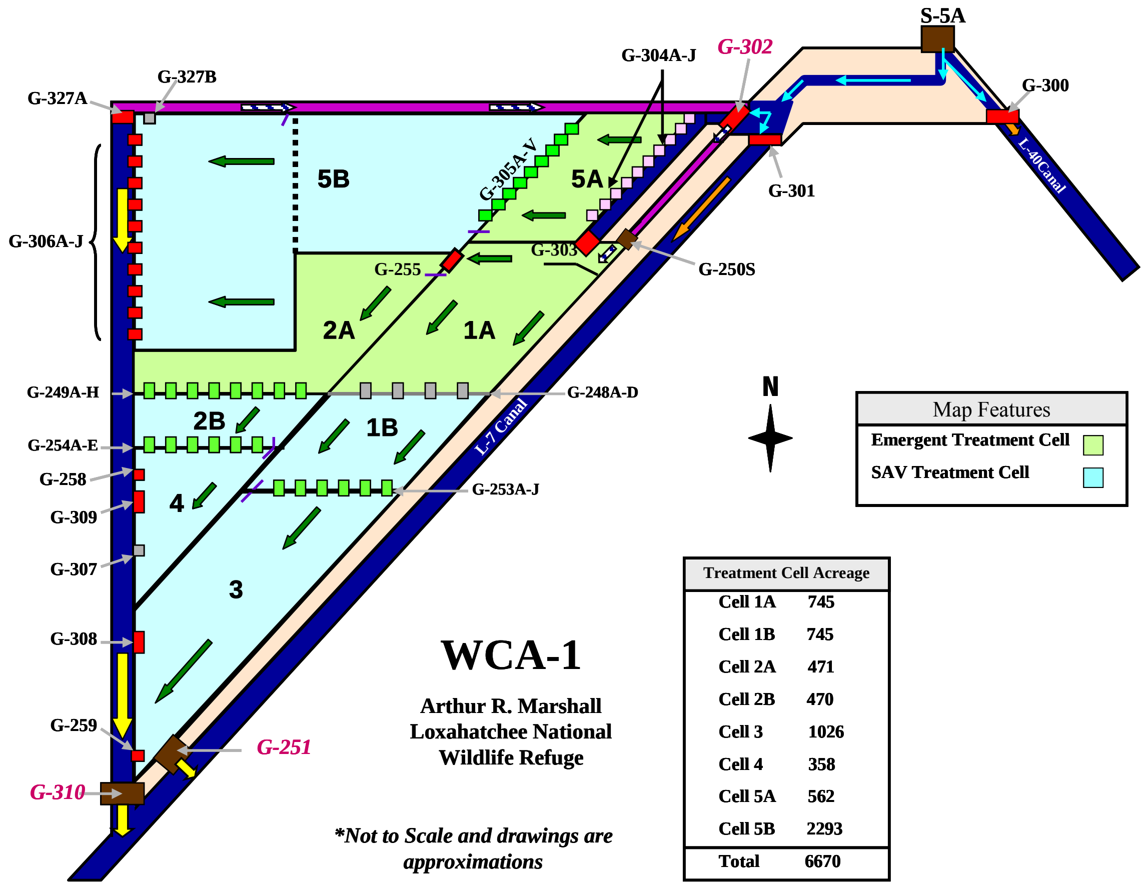


Figure 5-12. Schematic of STA-1W (not to scale). Inflow and outflow sites are designated with red/bold/italic font.

STA-1W WY2007 HIGHLIGHTS

- STA-1W was in compliance with the EFA and the USEPA NPDES operating permits for this reporting period. Detailed information about the permit status is found in **Table 5-6**.
- The Northern Flow-way (Cell 5) was operational under restricted flow during the entire water year for SAV reestablishment and the Eastern Flow-way (Cells 1 and 3) and Western Flow-way (Cells 2 and 4) were offline to allow for plant reestablishment following completion of Long-Term Plan Enhancements projects (**Table 5-12**).
- Major rehabilitation efforts were under way in Cells 2B and 4, and 5 throughout the water year (see the *STA-1W Rehabilitation* section of this chapter).
- Enhancements completed in the Eastern Flow-way included the cleanout of the G-253 distribution canal, creation of a divide levee in Cell 1, and installation of four new G-254 culverts. The treatment cell was gradually rehydrated in June 2007.
- Low water conditions were experienced in the treatment cells due to the drought.
- Wildlife issues included abundance of Black-Necked Stilt nests in Cell 5B (see the *Wildlife Issues and Avian Protection Plan* section in this chapter and Appendix 5-4 for survey dates and estimated number of nests) which affected operational options.
- Recreational opportunities, such as bird watching, continued. There was no duck hunting this water year, due to the construction projects and rehabilitation efforts in Cell 5.

STA-1W OPERATIONS

Table 5-12. Operational status of the treatment cells in STA-1W. Major events, such as hurricanes, treatment areas temporarily offline or Long-Term Plan Enhancements construction are listed.

STA-1W Operational Treatment Cells

2004						2005							2006		
WY2004							WY2006								
	WY2005													WY2007	
Jan - Mar	Apr - Jun	Jul - Jul	Aug	Sep *Hurricanes Frances and Jeanne*	Oct - Dec	Jan	Feb - Jun	Jul - Aug	Sep	Oct *Hurricane Wilma*	Nov	Dec	Jan - Mar	Apr - Jun	Jul - Sep
Northern and Eastern Flow-ways Operational			All Flow-ways Operational (Cell 5 restricted capacity (150 cfs) Nov. and Dec. because of hurricane damage).			Northern and Eastern Flow-way Operational	Eastern Flow-way Operational	Northern and Eastern Flow-ways Operational (Cell 5 restricted flow in Nov. and Dec. because of hurricane damage)					Eastern Flow-way Operational		
Western Flow-way off-line to remove cattail tussocks in Cell 2 and plant rehabilitation in Cell 4						Western Flow-way off-line (Cell 2 divide levee and water control structures), Northern Flow-way off-line (starting in Feb.) to degrade the Limerock Berm and allow for hurricane repairs and plant re-establishment.		Western Flow-way re-hydrated, off-line for plant re-establishment					Nothern Flow-way and Western Flow-way off-line (Cells 2/4 plant re-establishment, Cell 5 LTP enhancements construction and sediment and plant rehabilitation)		

STA-1W HYDROLOGY AND TOTAL PHOSPHORUS

During WY2007, 121,698 ac-ft of water, with a TP load of 42 mt and a FWM TP concentration of 277 ppb was captured and treated by STA-1W entering through structure G-302 (**Table 5-2** and **Table 5-13, Figures 5-13** and **5-14**). The hydraulic loading was 3.21 cm/day, about 60 percent higher than the simulated long-term average annual inflow for this STA. Phosphorus loading was 3.24 g/m^2 over the effective treatment area, about three times the average simulated long-term average annual load (**Table 5-2**). The diversion calculations and the amount of Lake Okeechobee regulatory releases received over the water year are found in **Table 5-3**.

The annual volume of treated water discharged to the Refuge through structures G-310 and G-251 was 126,246 ac-ft with a TP load of 19 mt and the FWM TP outflow concentration of 119 ppb (geometric mean 86 ppb), a 57 percent reduction from the inflow concentration. STA-1W reduced TP discharge loads by 55 percent compared to inflow loadings, retaining 23 mt of phosphorus. The hydraulic and phosphorus loading rates are calculated by dividing the inflow by the effective treatment area. These rates are affected when areas of the STAs are temporarily taken offline for construction or rehabilitation. During WY2007, the Northern and Eastern Flow-ways were temporarily offline (**Figure 5-12**). Although drought conditions existed in the last part of the water year, STA-1W experienced high inflow volumes in August, September, and October, resulting in an increase in the annual HLR. The difference between the inflow and outflow volumes reflects the net contributions of direct rainfall, evapotranspiration (ET), seepage losses to adjacent lands, deep percolation, and flow measurement error. A summary of monthly flows, loads, monthly and the moving 12-month FWM TP outflow is presented in **Figures 5-13** and **5-14**.

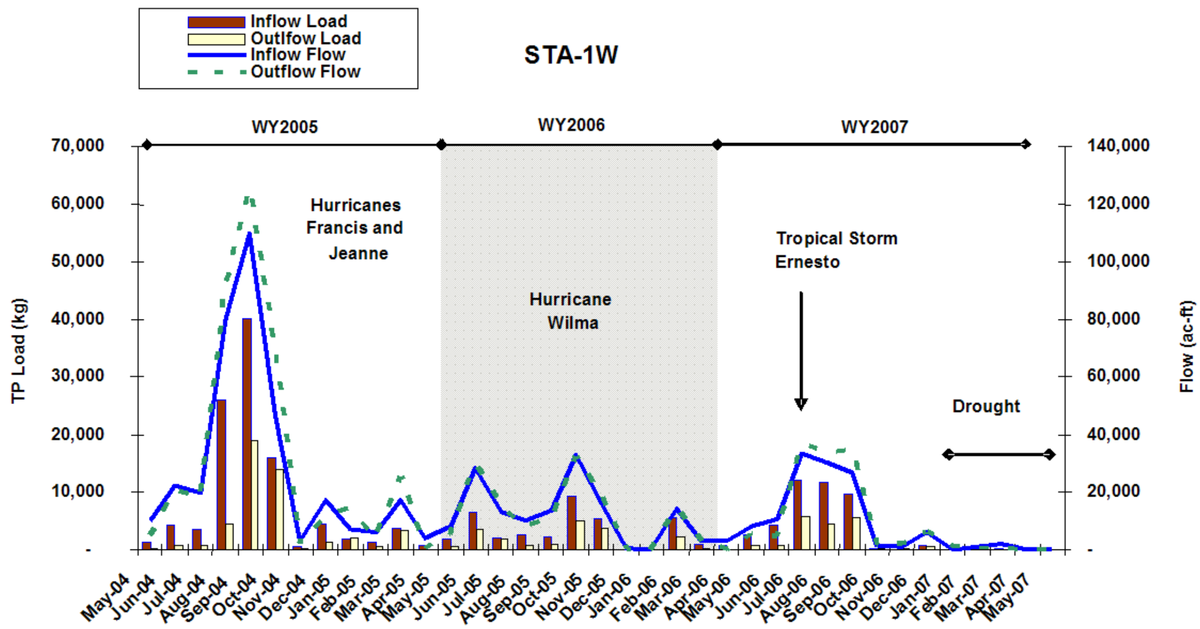


Figure 5-13. Summary of monthly flow and TP load for STA-1W for water years 2004-2007. In WY2007, some of the treatment cells were temporarily offline for Long-Term Plan Enhancement construction or rehabilitation (**Table 5-11**).

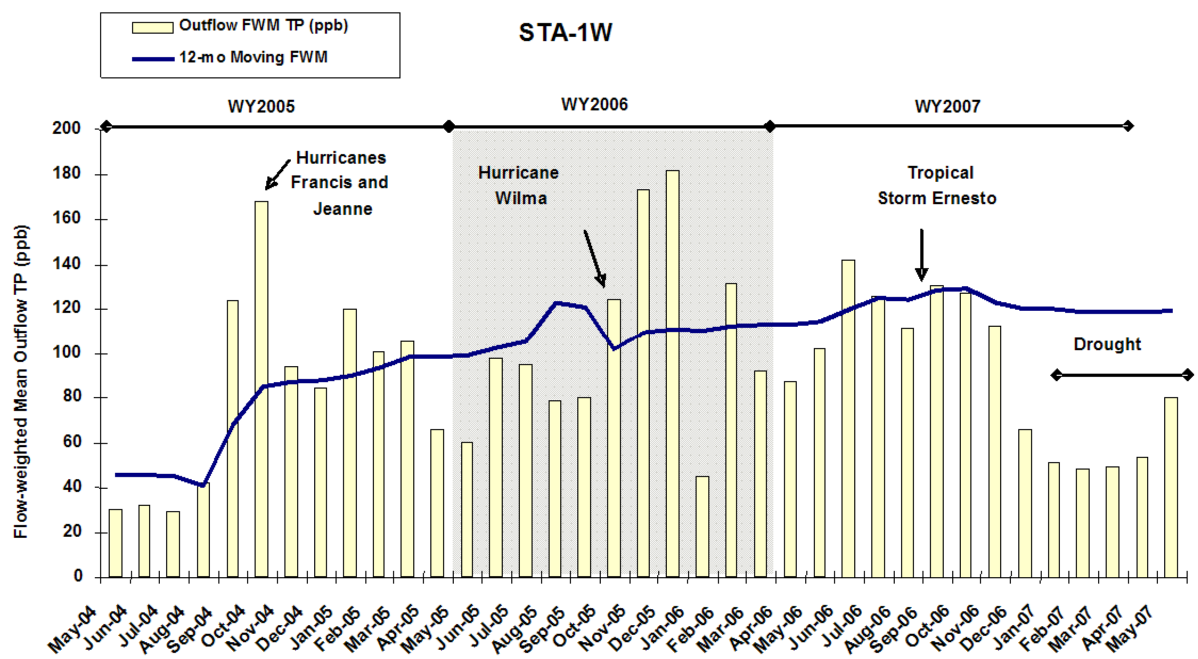


Figure 5-14. Comparison of monthly to 12-month moving average TP concentrations for STA-1W outflow.

Table 5-13. Summary Statistics of 12-month inflow and outflow flow, TP load, FWM TP concentration for each water year at STA-1W.

STA-1W Inflow												
	Flow Volume (ac-ft)				TP Load (mt)				FWM TP (ppb)			
Water Year	Sum	Avg.	Min.	Max.	Sum	Avg.	Min.	Max.	Arithmatic[1]	Min.	Max.	Geo. Mean[2]
2000	125,863	10,489	1	20,904	22.5	1.9	0.0	4.8	145	81	216	143
2001	94,522	7,877	0	20,884	17.2	1.4	-	4.3	147	72	178	120
2002	278,857	23,238	84	56,178	51.8	4.3	0.0	15.4	150	33	257	108
2003	591,845	49,320	12,327	77,651	112.2	9.3	2.3	17.2	154	90	198	144
2004	292,690	24,391	3,115	93,215	50.7	4.2	0.5	18.5	141	60	209	130
2005	341,094	28,425	2,784	109,912	103.9	8.7	0.6	40.1	247	100	296	187
2006	142,678	11,890	0	33,087	37.4	3.1	0.0	9.5	213	127	316	208
2007	121,698	10,142	0	33,263	41.5	3.5	0.0	12.2	277	42	326	155

STA-1W Outflow												
	Flow Volume (ac-ft)				TP Load (mt)				FWM TP (ppb)			
Water Year	Sum	Avg.	Min.	Max.	Sum	Avg.	Min.	Max.	Arithmatic[1]	Min.	Max.	Geo. Mean[2]
2000	121,229	10,102	3,968	18,829	3.8	0.3	0.1	0.6	25	17	43	24
2001	90,517	7,543	-	22,496	4.3	0.4	-	1.6	39	18	59	30
2002	267,624	22,302	-	57,103	12.2	1.0	-	2.5	37	16	62	33
2003	595,999	49,667	9,914	79,195	39.2	3.3	0.4	6.6	53	25	144	51
2004	297,603	24,800	840	102,284	17.1	1.4	0.0	6.5	47	25	68	41
2005	383,365	31,947	471	125,419	46.5	3.9	0.0	19.1	98	29	168	71
2006	137,890	11,491	64	32,499	19.3	1.6	0.0	5.0	113	45	182	96
2007	126,246	10,521	27	36,692	18.5	1.5	0.0	5.7	119	49	141	86

OTHER STA-1W WATER QUALITY PARAMETERS

Water quality parameters with Florida Class III standards are identified in **Table 5-7**. Compliance with the EFA permit is determined based on the three-part assessment presented in the *Water Quality Permit Requirements* section of this chapter. The monitoring data over the water year for all other water quality parameters at STA-1W during this reporting period are presented in Appendix 5-11 of this volume, and are summarized in **Table 5-14**. Temperature, specific conductance, DO, and pH values reported in this chapter are field measurements. The annual permit compliance monitoring report for mercury in the STAs is in Appendix 5-7 of this volume.

Discharges from STA-1W were determined to be in compliance with the permit by satisfying the criterion assessment for all other water quality and non-DO parameters with applicable numeric state water quality standards.

Table 5-14. Summary of annual arithmetic averages and FWM for all parameters other than TP monitored in STA-1W. Parameters that were measured higher at the outflow compared to the inflow are shaded in gray. Alkalinity is reported as mg/L $CaCo_3$ and Nitrite+ Nitrate is reported as mg/L N. Because these parameters are measured from grab samples and not flow-proportional samples, both the arithmetic of all the samples collected as well as the means for those samples collected only during flow events (flow-weighted means) are shown.

Parameter	Arithmetic Means Inflow	Arithmetic Means Outflow		Flow-Weighted Means Total Inflow		Flow-Weighted Means Total Outflow	
	S5A	G251	G310	n	Conc.	n	Conc.
Temperature (°C)	24.9	24.8	25.2	-NA-	-NA-	-NA-	-NA-
Dissolved Oxygen (mg/L)	4.5	1.4	3.6	-NA-	-NA-	-NA-	-NA-
Specific Conductivity (µS/cm)	856	1,121	1,069	-NA-	-NA-	-NA-	-NA-
pH	7.6	7.4	7.7	-NA-	-NA-	-NA-	-NA-
Turbidity (NTU)	11.5	5.8	4.5	-NA-	-NA-	-NA-	-NA-
Total Dissolved Solids (mg/L)	555	717	693	11 (26)	706	27 (52)	617
Unionized Ammonia (mg/L)	0.005	0.006	0.007	17 (41)	0.010	27 (52)	0.003
Orthophosphate as P (mg/L)	0.086	0.035	0.034	19 (52)	0.189	52 (104)	0.089
Total Dissolved Phosphorus (mg/L)	0.096	0.047	0.049	19 (51)	0.200	51 (102)	0.102
Sulfate (mg/L)	59.7	49.7	55.8	11 (26)	79.9	27 (52)	59.6
Alkalinity (mg/L)	211	296	263	11 (26)	276	27 (52)	241
Dissolved Chloride (mg/L)	105	143	148	11 (26)	121	27 (52)	114
Total Nitrogen (mg/L)	2.76	2.58	2.64	17 (40)	5.08	23 (47)	2.52
Total Dissolved Nitrogen (mg/L)	2.37	2.39	2.53	11 (26)	4.39	23 (46)	2.40
Nitrate + Nitrite (mg/L)	0.522	0.067	0.257	17 (41)	1.290	23 (48)	0.338

-NA- : Not Applicable
n: number of samples with flow (total number of samples)

STA-1W DISSOLVED OXYGEN MONITORING

Section II of the Administrative Order for STA-1W (Administrative Order No. AO-002-EV in Exhibit C of Permit No. 503074709, April 13, 1999) requires that the District provide the FDEP with an annual report consisting of an analysis demonstrating that DO levels in STA discharges do not adversely change the downstream Everglades ecology or the downstream water quality. Since the SSAC has been adopted by the FDEP, and formally approved by the USEPA

(Weaver, 2008), assessment on possible downstream impacts by the outflows from STA-1W during WY2007 will be performed by applying the SSAC limit with respect to DO at outflow stations G-251 and G-310 (**Figure 5-12**).

The G-310 and G-251 structures at STA-1W, where the DO was measured, are large outflow pump stations where velocities can be very high during pumping events. The annual assessment of DO at STA-1W during WY2007 indicates that G-251 is above the SSAC limit, while G-310 is below the limit (**Figure 5-15** and **Table 5-8**). Biweekly DO levels for WY2007 are available in Appendix 5-8. In addition, a graphical depiction of the biweekly residual differences between measured DO levels and SSAC limits is provided in Appendix 5-9.

During WY2007, the eastern and western treatment cells of STA-1W were offline for Long Term Plan enhancement construction and rehabilitation. This construction and rehabilitation may have contributed to G-251 being below the SSAC limit. Additionally, discharge at G-310 during WY2007 was six-fold higher than at G-251, which may have also contributed to the lower DO levels observed at this outflow station. From WY2004–WY2007, flow at G310 has been higher by approximately five times. This may also explain why G-251 has exhibited mean annual DO levels lower than the SSAC limit (Weaver and Payne, 2005, 2006; and Weaver et al., 2007). The District and the FDEP will continue to evaluate the reasons for DO depression at the G-251 pump station.

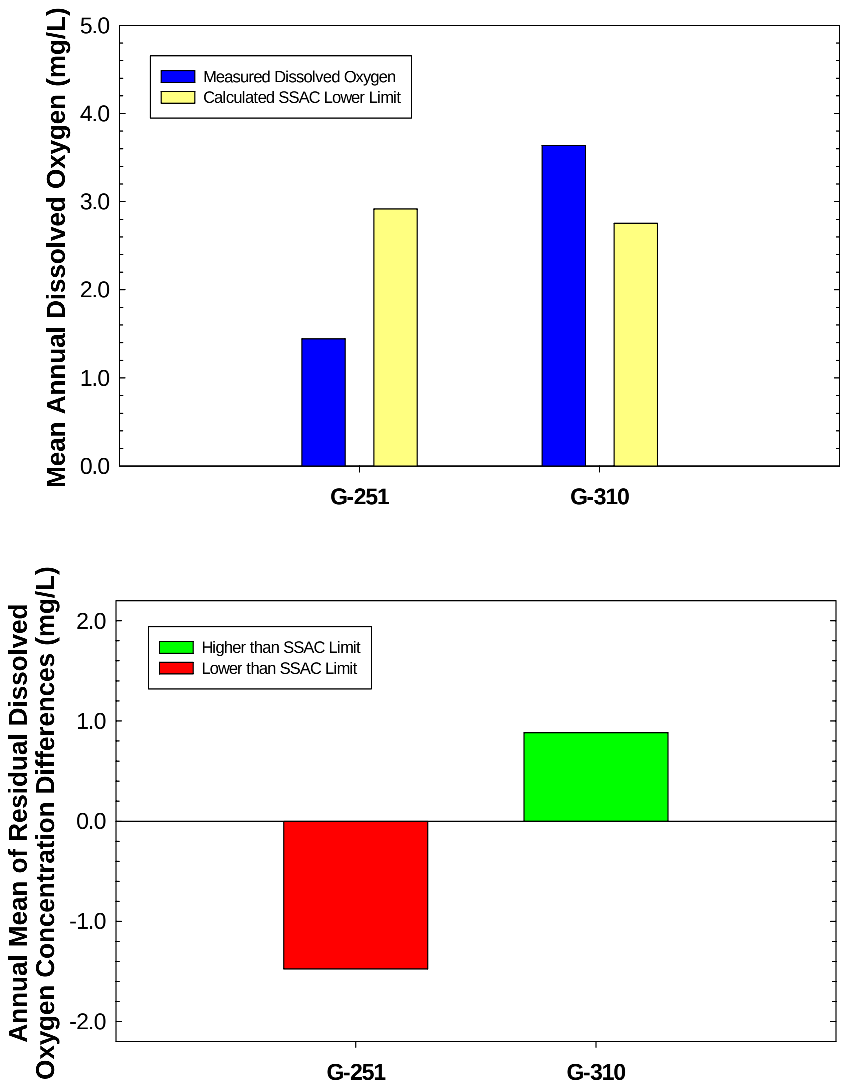


Figure 5-15. Comparison of mean annual DO measured at the outflow stations (G-251 and G-310) for STA-1WE during WY2007 with the mean annual SSAC limit derived from the corresponding water temperature and time of day collected at the outflow station (top plot). The annual mean residual DO difference between the mean annual DO and mean annual SSAC indicates whether stations were above the SSAC limit (when greater than or equal to zero) or whether stations were below the limit (less than zero) (bottom plot). Based on this analysis, G-251 was below the limit while G-310 was above it.

STA-1W REHABILITATION

A multifaceted rehabilitation plan was initiated in conjunction with the Long-Term Plan Enhancements construction (see *STA-1W Enhancements* section of this chapter) in order to reestablish desired vegetation communities and improve TP removal performance in all of the STA-1W treatment cells. The rehabilitation plan included planting rice in an effort to consolidate sediments and reduce overlying water turbidity, removing unconsolidated sediment at water control structures, degrading remnant farm roads, and planting emergent vegetation strips in one of the SAV dominated cells. A summary of the activities completed in STA-1W is presented in **Table 5-15**.

Table 5-15. Summary of rehabilitation efforts in STA-1W cells. The type and nature of the work performed in each cell varied depending on the condition prior to the enhancements and the desired vegetation.

Cell	Target Vegetation	Background Information and Rehabilitation Goal	2006–2007 Rehabilitation Activities
Cell 1A	Emergents	Cells 1A and 1B have been divided according to Long-Term Plan. In the earlier periods of the ENR, this cell was dominated by cattails. The goal was to restore cattails back in this cell.	The cell was dewatered. Tussocks were removed and hauled outside of the STA treatment footprint. There was no other earthwork done in this cell.
Cell 1B	SAV	Soil surveys over the past 6 years showed an increasing amount of TP accumulated in the accrued soil layer in this cell. The goal was to remove the accrued layer and convert this cell to SAV. High TP in the soil would likely make this cell less efficient as an SAV cell in removing TP from the water column.	This cell was dewatered. Tussocks were removed and hauled outside of the STA treatment footprint. The accrued soil layer with high TP levels was scraped and the material was hauled and placed along the FPL easement. The target elevation for scraping was 9.4' NGVD. Rice was planted using a mechanical spreader, then rolled and covered with a thin layer of peat soil. Water was brought back into the cell in controlled amounts to allow rice to establish.
Cell 2B	SAV	This cell was recently having problems with persistent high turbidity and SAV failed to establish. The goal of shallow disking was to incorporate the top layer with the subsurface material. Rice was planted to stabilize the soil and SAV inoculation will help to jumpstart the area with the target vegetation.	The cell was dewatered and shallow disking was done to incorporate the accrued layer with the historic peat layer. Rice was planted using a mechanical spreader, then rolled and covered with a thin layer of peat soil. Water was brought back into the cell in controlled amounts to allow rice to establish. SAV inoculation was completed July/August 2007.
Cell 3	SAV	This cell is being converted from emergent to an SAV community.	The cell was dewatered and cattail stands were chopped and left on the ground. Approximately 150 acres was not chopped due to the wet ground conditions. Neither earthwork nor rice planting was done in this cell. SAV inoculation was completed July/August 2007.

Table 5-15. Continued.

Cell	Target Vegetation	Background Information and Rehabilitation Goal	2006–2007 Rehabilitation Activities
Cell 4	SAV	This cell has had persistent high turbidity and SAV failed to establish. Scraping was done to remove the accrued material. Rice was planted to stabilize the soil and SAV inoculation will help to jumpstart the area with the target vegetation.	The cell was dewatered and scraped (to elevation of 9.3' NGVD) to remove the accrued soil layer. Rice was planted using a mechanical spreader, then rolled and covered with a thin layer of peat soil. Water was brought back into the cell in controlled amounts to allow rice to establish. SAV inoculation was completed July/August 2007.
Cell 5B	SAV	This cell experienced a decline in SAV and had persistent high turbidity. Some high berm areas within the cell were degraded and rice was planted to stabilize the sediments and encourage SAV reestablishment.	The cell was dewatered and rice was planted in some sections of the cell in May 2006. Water was brought in gradually to hydrate the rice in early June 2006. Vegetation strips were established perpendicular to water flow in July/August 2006. The cell was operated under flow and stage restrictions to allow for SAV regrowth.

ENHANCEMENTS, REHABILITATION, AND VEGETATION CONVERSION IN STA-1W Cells 1, 2, 3, and 4

After completion of the new Cell 2 interior levee and the extensive maintenance activities in 2005 (details about the Long-Term Plan Enhancements construction can be found in Chapter 5 of the *2007 South Florida Environmental Report*), the Western Flow-way was re-flooded to allow vegetation grow-in. The Long-Term Plan recommendation included establishing emergent vegetation in the new Cell 2A, reestablishing SAV in Cell 4, and converting the new Cell 2B to a SAV cell.

Conversion of Cell 2B from emergent vegetation to SAV was initiated in 2005. The effort included eradication of emergents, water-depth management, and stocking Cell 2B with SAV harvested from other areas in the STA. Despite these efforts, the SAV colonization was limited to *Chara* spp. which failed to expand throughout the entire cell. In both Cells 2B and 4, the expanse of the open water in Cell 2B created favorable conditions for small waves that continually suspended soils throughout the water column, which may have contributed to the lack of colonization of SAV. Floc was easily suspended in the water column, resulting in excessive turbidity, limiting light penetration, and the inability of SAV to adequately secure vegetative roots.

By early 2006, SAV had not grown in Cell 2B, nor was it reestablishing in Cell 4. A small-scale SAV inoculation effort was completed in STA-1W Cells 2B and 4 in early December 2006 to encourage establishment of SAV in these two cells. Small quantities of SAV were placed in corrals in these cells, but after a short time the plants died, and any small areas of SAV that did start to grow eventually died off. Subsequent vegetation surveys indicated that the inoculation effort was unsuccessful, likely due to issues with flocculent soils and poor water clarity.

In late 2006, rice was planted aerially in Cells 2B and 4 with the goal of reducing turbidity and stabilizing the soil to encourage SAV establishment. A large SAV inoculation effort was also done in these cells. The inoculation of SAV species consisted of primarily *Najas guadalupenisis* collected from STA-1E and introduced into STA-1W Cells 2B and 4.

The rice and SAV in these two cells were then monitored for the next couple of months. SAV colonization remained poor and was not present in many areas. Turbidity and floc resuspension persisted. Also, in Cell 2B, the rice that was planted did not survive.

In February 2007, the opportunity to perform earthwork and vegetation conversion in the Eastern and Western Flow-ways arose as a result of dewatering activities related to construction of the new Cell 1 levee and structures as part of the Long-Term Plan Enhancements construction. The lack of water during the extended drought period also aided this effort. In addition to the Long-Term Plan Enhancements construction, which consisted of constructing a divide levee between Cells 1A and 1B, installing water control structures (G-248 A–D), and excavating levee collection and distribution canals, the following were also completed: (1) canal silt removal, (2) ditches parallel to flow were filled to prevent short circuiting, (3) re-grading of various high spots, i.e., south of G-309, south of G-254, and along the NW section of Cell 2B. Other earthwork activities that were conducted were to remove tussock materials located in several areas throughout Cell 1, remove the accrued soil layer in Cell 1B, where high TP in the soils had been found, and remove the highly flocculent and calcareous layer from Cells 2B and 4.

The rehabilitation effort was launched with the understanding that factors outside the District's control, such as the weather and Black-Necked Stilt nesting season could impact the effort. Fortunately, due to severe and prolonged drought conditions throughout the entire region, the weather did not affect the earthwork schedule. However, once the earthwork was complete, the drought affected the project because the inability to re-flood the cells allowed the persistent infestation of pigweed and emergent grasses. Drought also prevented the planned burn of dead cattail stands in Cell 3. Dewatering some of the cells was a challenge. In addition to increasing the number of dewatering pumps already in place for the Long-Term Plan Enhancements construction project to expedite the dewatering process, it was necessary to clean some of the existing ditches and create new ones. Most areas were successfully drained, except small areas in Cells 1B and 3. Following the earthwork activities, the ditches created to facilitate the dewatering process were filled back in.

The Black-Necked Stilt nesting season also had to be factored into decision making during the rehabilitation efforts. It was anticipated that the presence of active nests would prevent the re-flooding of these cells in time to grow rice and other desired vegetation. Due to the cells being dry, this was not a problem during the construction, and nesting season was over by the time the cells were ready to be re-flooded.

Dry conditions resulted in proliferation of upland vegetation. Therefore, weed infestation became a problem during construction and after the rice was planted. Growth of pigweed became problematic in all cells. Mowing was necessary to prepare for cell scraping or disking. Herbicide spraying was used to control the pigweed in some of the cells. Prior to rice planting, the ground was scraped and disked again to control some of the new pigweed seedlings that were beginning to proliferate in these cells. There was also a proliferation of emergent grasses, such as barnyard grass, after the cells were planted with rice and moistened with the limited amount of water that could be brought into the cells. Infestation of barnyard grass was most problematic in Cell 2B.

The Long-Term Plan recommendation for Cell 3 was conversion from emergents to SAV; this cell had been primarily vegetated with cattail stands up to this time. Preparation for the Cell 3 conversion primarily involved removing the cattail stands to facilitate SAV establishment. Because the drought and the associated fire ban prevented the planned burn in Cell 3, it was necessary to use a mechanical chopper to bring the standing cattails down to ground level and prepare this cell for re-flooding and SAV conversion. The thick layer of dead biomass will likely slow down SAV establishment in this cell.

As of early summer 2007, all earthwork was completed and the desired vegetation had started to establish in each cell. There is good growth of cattails in Cell 1A, good coverage of SAV in Cells 1B and 4, and some SAV in Cells 2B and 3. SAV inoculation was completed in Cells 2B and 4 in July/August 2007. A post-rehabilitation monitoring effort has been initiated and results will be presented in the 2009 SFER.

ENHANCEMENTS, REHABILITATION, AND VEGETATION CONVERSION IN STA-1W Cell 5B

To address vegetation issues and associated poor TP removal performance of STA-1W Cell 5, rehabilitation efforts were initiated in WY2006 when the cell was offline for Long-Term Plan Enhancements construction. A comprehensive sediment reconsolidation plan was implemented and the recovery plan can be found on the District's website at www.sfwmd.gov under *Everglades, Long-Term Plan for Achieving Everglades Water Quality Goals* link. The goal of the plan, conducted during the 2006 dry season, was to rehabilitate the cell to encourage SAV growth, improve the sustainability of the plant community, and improve the TP removal performance of the cell. The cell was dried out, high areas immediately downstream of the inflow structures and upstream of the outflow structures were leveled, soil was tilled in some areas of the cell, rice was planted to help consolidate the floc material and promote SAV growth, and vegetation strips were planted to reduce the impact of wave and wind action on the vegetation.

About 967 acres of Cell 5B was planted with rice (*Oryza sativa* L., cv Wells) in an attempt to utilize the root structure to bind and bring cohesion to the unconsolidated peat upon re-flooding (**Figure 5-16**). It was also anticipated that the rice would reduce turbidity by reducing wind fetch across the system and provide a temporary attachment site for epiphytic algae and SAV strips were also planted in Cell 5B during in mid-July to the beginning of August, 2006 on remnant north-to-south farm roads. The plants used in the vegetation strips consisted of Giant Bulrush (*Schoenoplectus*, spp., formally known as *Scirpus* sp.), *Pontederia cordata*, *Sagittaria,* spp., *Eleocharis,* spp., and *Thalia geniculata*. In addition to the vegetation strips, Giant Bulrush, Sagittaria, and Eleocharis were planted in other areas of the cell, mainly at the southern end.

Re-flooding of the cell following the rehabilitation efforts occurred in June of 2006 and water quality and vegetation monitoring was conducted from July 2006 through May 2007 to evaluate the recovery of Cell 5B. Water column turbidity was measured and percent cover of vegetation growth was surveyed.

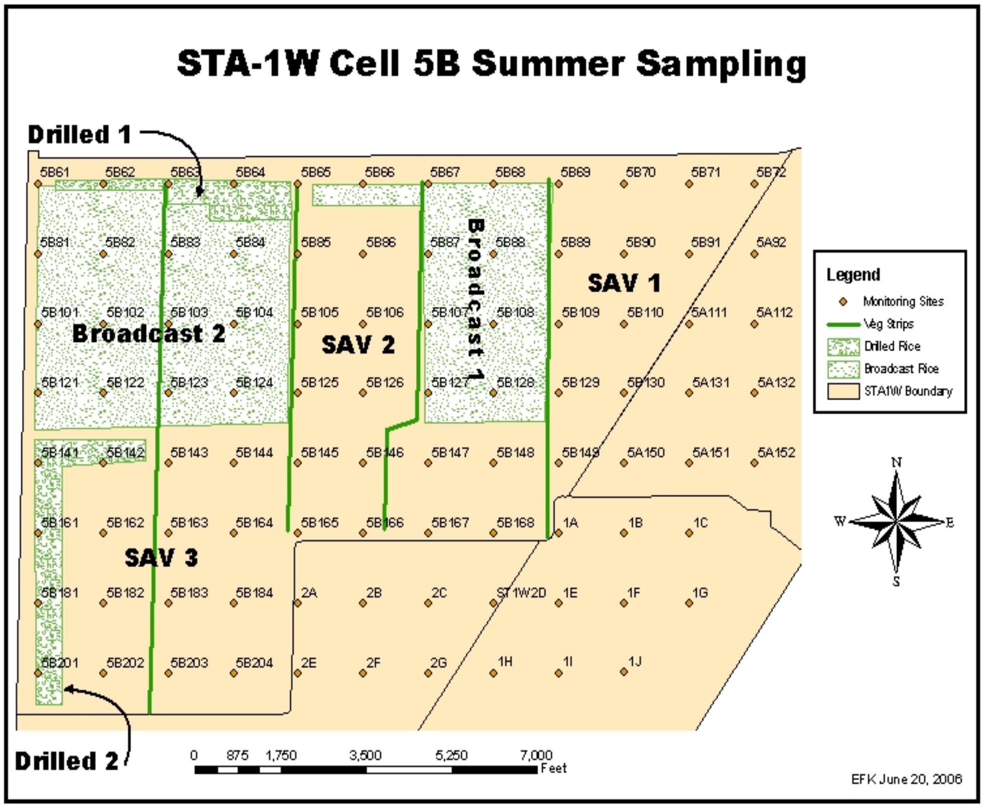


Figure 5-16. Rice planting, vegetation strips, and monitoring stations for STA-1W Cell 5B.

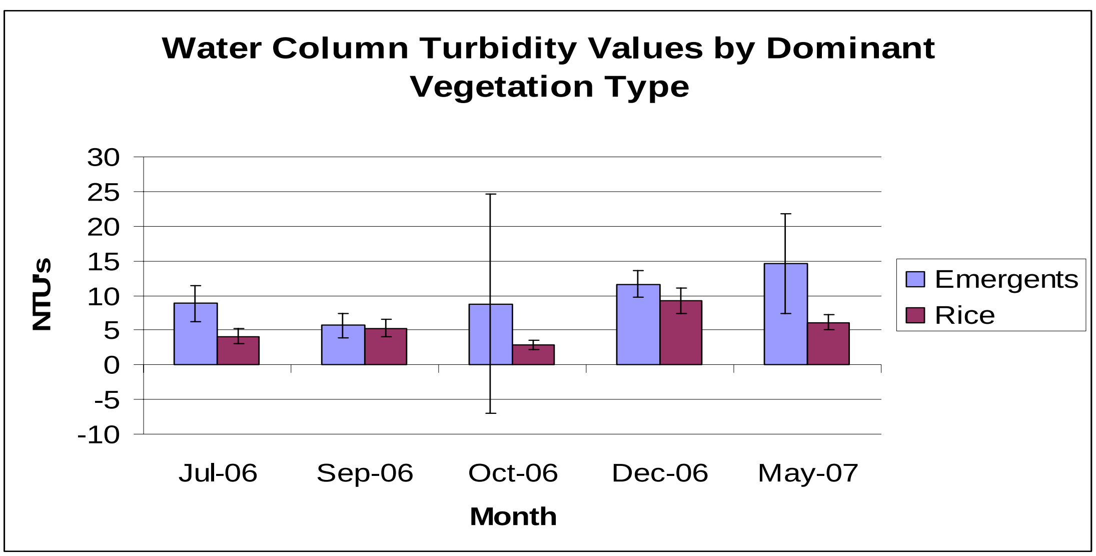


Figure 5-17. Water column turbidity in Cell 5B by dominant vegetation type expressed in NTUs.

Water column turbidity values were generally lower in areas planted with rice compared to areas not planted with rice (**Figure 5-17**). Data analysis is complicated by the fact that numerous emergent species, primarily Barnyard Grass and Sprangletop grass, dominated large portions of the cell outside areas planted with rice. No information regarding water column turbidity prior to this monitoring exists; therefore, no direct before and after comparisons can be made. The TP data (**Figure 5-18**) indicates that the rice planting appears to have helped to reduce TP concentrations coming out of Cell 5. Note that from September 2004 to May 2006, the outflows were either equal to or much higher than the inflow.

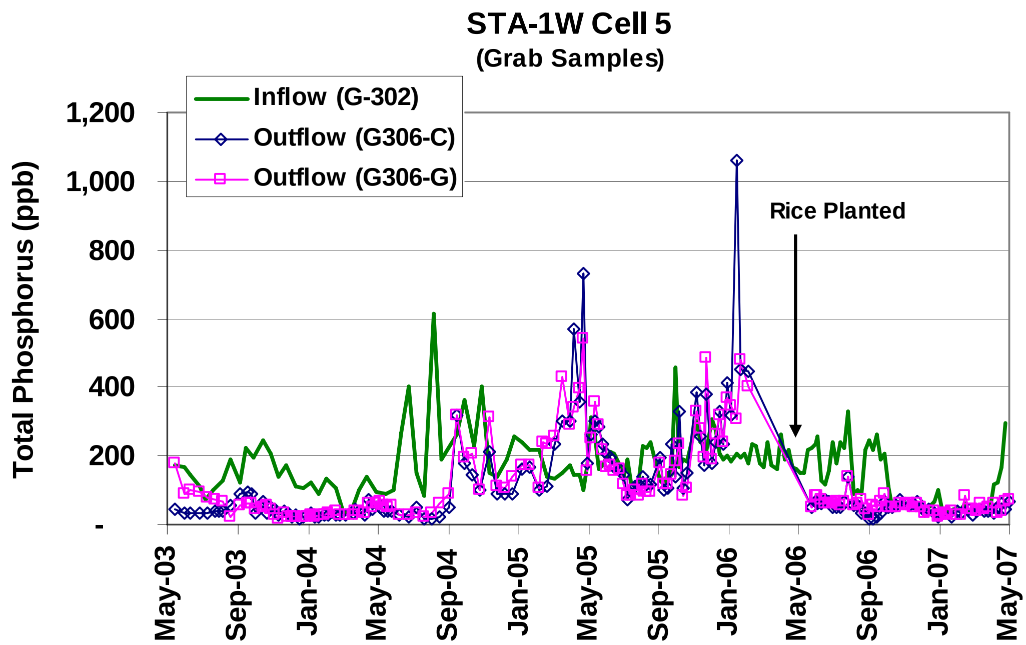


Figure 5-18. Total phosphorus inflow and outflow concentration data collected from Cell 5. Decreases in outflow TP concentrations were observed following the restoration efforts.

Rice density peaked in September of 2006 and started to decline in coverage through the balance of the water year (**Figures 5-19**). By May 2007, the rice crop had died. Dead rice biomass did not seem to inhibit SAV growth, and there was some evidence that this biomass promoted periphyton growth.

Initially after planting rice in May 2006, SAV was found in sparse quantities throughout the northern half of the cell, primarily in those areas planted with rice. By December of 2006, dense beds of Naiad, Chara, and Hydrilla were found throughout a majority of the cell (**Figures 5-19** and **5-20**). This trend continued through the first half of the dry season, where significant expansion of Naiad occurred throughout non-rice areas. This may be explained by the fact that increased water depths and subsequent decline in the coverage of emergent species in the southern half of the cell made conditions more favorable for SAV expansion.

The 2006 rehabilitation efforts provided conditions which encouraged the expansion of SAV throughout a majority of this cell (**Figure 5-21**). Water column turbidity values were slightly lower in areas where rehabilitation efforts were undertaken compared to areas where no significant effort was put forth. The parameters that are used as metrics of success are vegetation growth and reduced TP outflow concentrations. Internal monitoring of water column TP concentrations and plant coverage is ongoing. All of the emergent species in the vegetation strips are doing well a year later, and SAV has become well established in Cell 5B in both those areas that were planted with rice as well as in adjacent areas that were not planted (**Figures 5-21** and **5-22**). The decrease in water column turbidity, the re-colonization of SAV, and the decrease in outflow TP grab sample concentrations are indications the rice may have played a beneficial role in the reestablishment of the plant communities. The inflow concentrations measured from grab samples were about the same from November 2005–September 2006 (**Figure 5-18**) and improvements in the outflow concentrations were not observed until May 2006, following the rice planting and associated SAV grow-in, although the influent TP was low after November 2006, where inflow volumes were also greatly decreased due to the drought conditions.

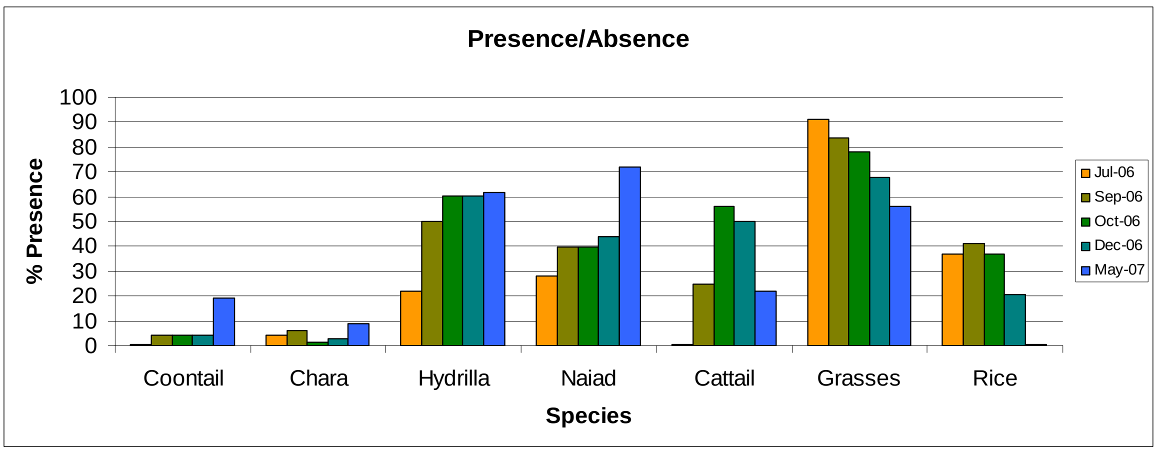


Figure 5-19. Presence or absence of SAV (N = 68).

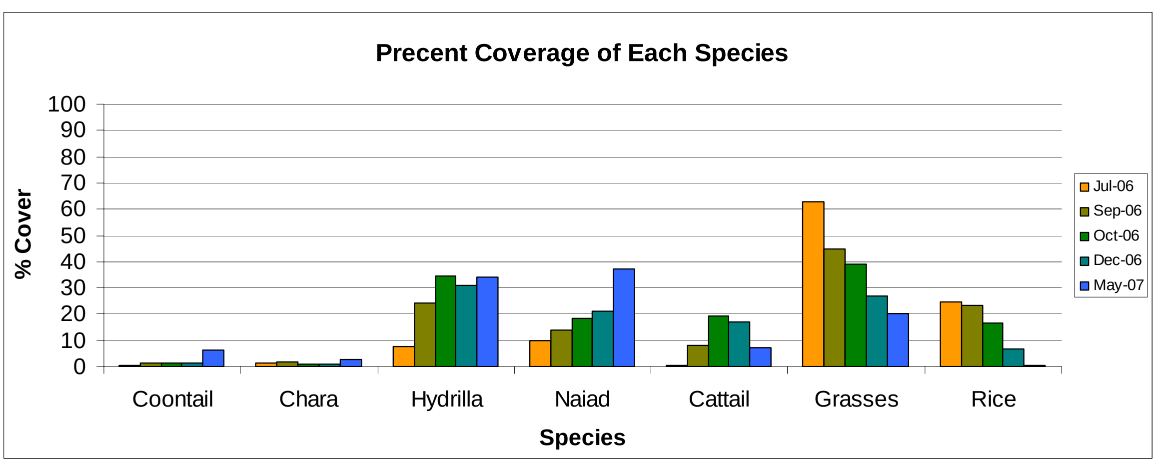


Figure 5-20. Average percent coverage of each species throughout Cell 5B.

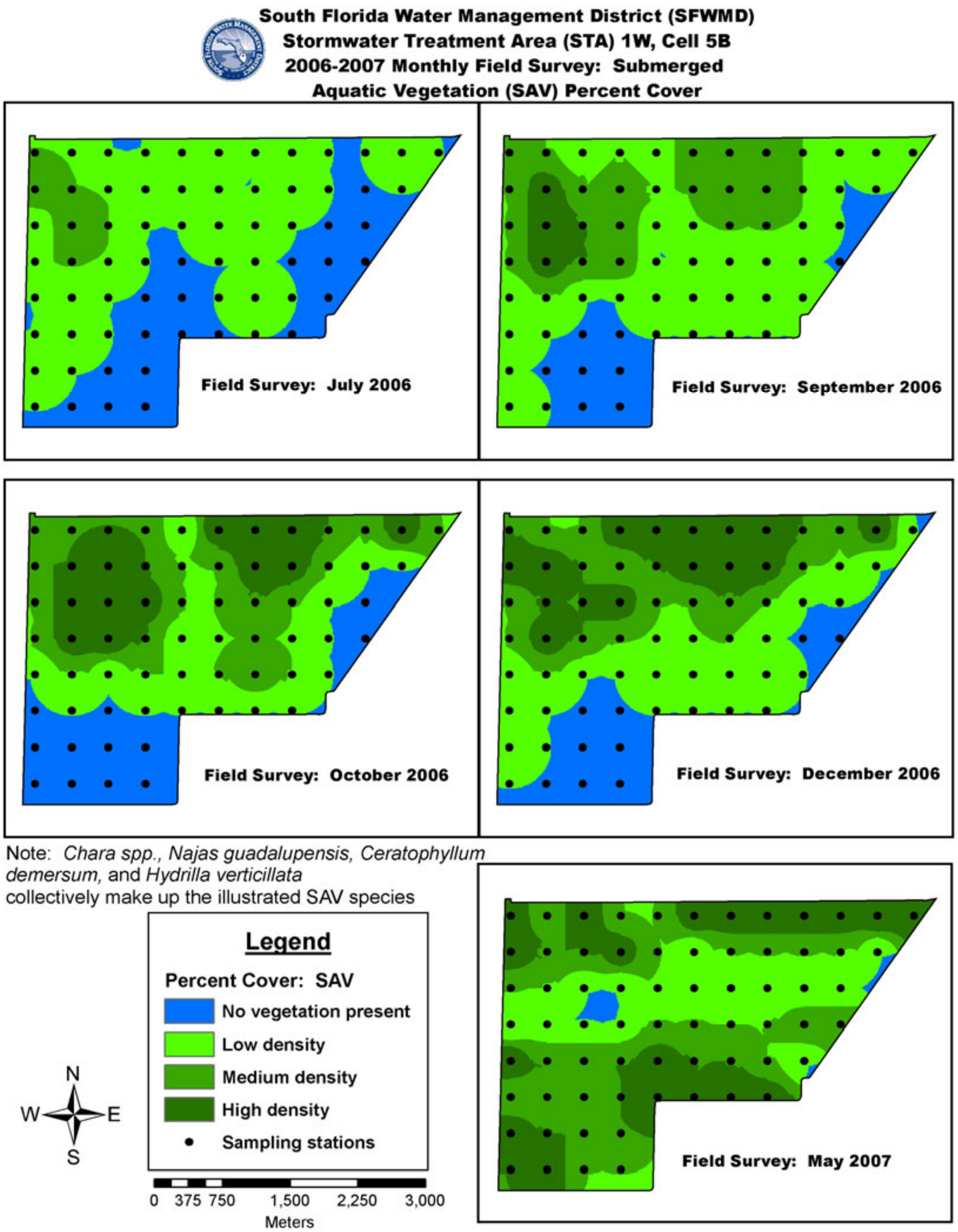


Figure 5-21. Vegetation surveys of the SAV reestablishment in STA-1W Cell 5B.

Figure 5-22. SAV community found in STA-1W Cell 5 (photo taken in spring 2007).

STA-1W VEGETATION MANAGEMENT

Vegetation Maintenance of Online Cells

During WY2007, vegetation management efforts in STA-1W focused mainly on the control of emergent vegetation. The only operational flow-way this water year was Cell 5 and as a consequence, the majority of maintenance vegetation control has occurred in this flow-way. Herbicide treatment for control of cattail, grasses, primrose willow, and willow in the SAV treatment cell occurred (Appendix 5-3). Ground applications of herbicide also targeted floating aquatics such as water lettuce and water hyacinth, but floating aquatics were not as much of a significant problem this year as emergent vegetation, mainly due to the low stages present in Cell 5 in 2006 and 2007. Within emergent cells, primrose willow was also a vegetation species targeted for control. At the end of this water year, Cell 5 once again had an abundance of emergent species requiring control. Long-term Plan Construction Enhancements construction occurred in STA-1W Cells 1 and 3. The areas of the treatment cells dried out for construction activities and tussock removal were conducive to proliferation of pigweed. Aerial herbicide treatments were performed.

STA-1W ENHANCEMENTS

The following construction activities were completed during WY2007:

- Constructed internal levee and culverts in Cell 1 over the 2006–2007 dry season. Levee collection and distribution canals were excavated.
- Converted Cells 1B and 3 to SAV.
- Conveyance capacity improvements were made to C-6 Canal in Cell 3.

STA-2

CONFIGURATION

STA-2 is located in Palm Beach County, situated in lands that were previously part of the Brown's Farm Wildlife Management Area as well as agricultural land. STA-2 is located immediately west of Water Conservation Area 2A (WCA-2A) and consists of four parallel treatment flow-ways, flowing from north to south (**Figure 5-23**). The original STA-2 consisted of Cells 1-3, which began operation in 2000; an additional 2,015-acre expansion of the STA (Cell 4) became flow-capable before December 31, 2006.

Pump Station S-6 serves as the primary inflow pump station to STA-2 with additional inflow through the agricultural pump station G-328. Outflow is through the G-335 Pump Station, which discharges to the L-6 Borrow Canal, where sheetflow across the L-6 Levee discharges into the northwesterly perimeter of WCA-2A via structures G-336A-F and into the southwestern portion of WCA-2A through a 3,400-foot gap in the L-6 levee located just north of the S-7 Pump Station.

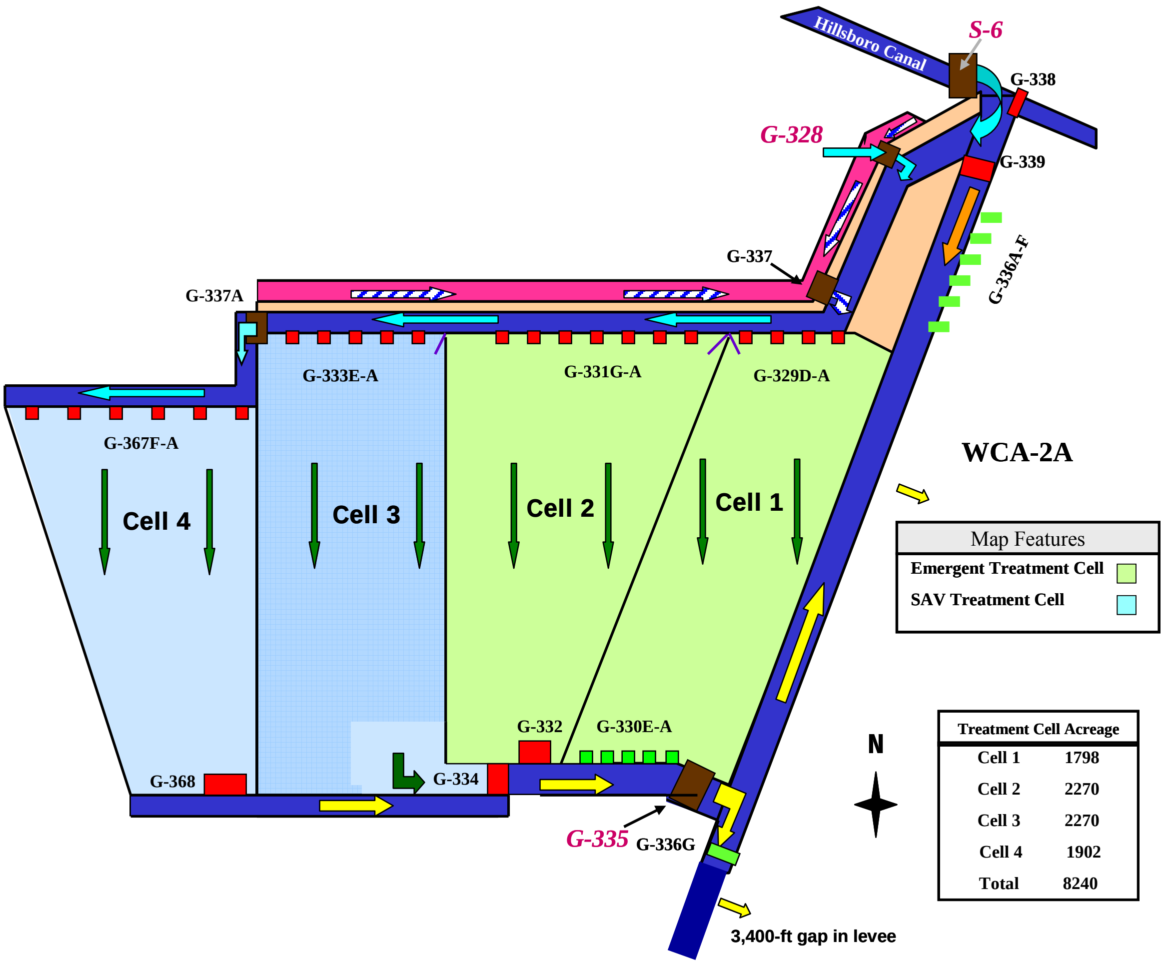


Figure 5-23. Schematic of STA-2 (not to scale). Inflow and outflow sites are designated with red/bold/italic font.

STA-2 WY2007 HIGHLIGHTS

- STA-2 was in compliance with the EFA and the USEPA NPDES operating permits for this reporting period. Detailed information about the permit status is found in **Table 5-6**.
- All treatment cells (Treatment Cells 1, 2, and 3) were operational during the water year (**Table 5-16**).
- Cell 4 became flow-capable in December 2006. Initial flooding of Cell 4 was delayed until June 8, 2007, because of the drought.
- Repairs in northern inflow sections damaged by erosion during Hurricane Wilma have been completed in Cell 3. Energy dissipaters were installed on the downstream side of the inflow structures to Cells 2 and 3 to help reduce the turbulent flows through the structures under high flow conditions.
- Wildlife issues included abundance of Black-Necked Stilt nests in the treatment cells (see the *Wildlife Issues and Avian Protection Plan* section in this chapter and Appendix 5-4 for survey dates and estimated number of nests), which affected operational options. Additionally, an active bald eagle (*Haliaeetus leucocephalus*) nest was found in Cell 2.
- There were no recreational opportunities in STA-2 in WY2007.
- Low water conditions were experienced in WY2007 and alternate methods of hydration were employed.
    - From October 20 to October 28/2006, water was back-siphoned from WCA-2A through G-335 into the STA-2 discharge canal to supply water to Cell 3 through the G-334 outflow gate. This was in response to extremely low water conditions and was successful in preventing the SAV in Cell 3 from drying out.
    - On February 25, 2007, water was added to Cell 1 from WCA-2A by opening the G339 gate. This operation was carried out to maintain at least 6 in of water in Cell 1 due to the potential for mercury methylation in this cell.
    - In April 2007, water was moved from Cell 2 (emergent cell) to Cell 3 (SAV) in order to keep Cell 3 hydrated.
    - During the drought in late spring 2007, a temporary pump was used to keep Cell 3 from drying out by pumping water from Cell 4 via the discharge canal.
- In January 2007, a leak in the Cell 3 inflow gate G-333E was discovered and fixed; the bottom seal had to be replaced.

STA-2 OPERATIONS

Table 5-16. Operational status of the treatment cells in STA-2. Major events, such as hurricanes, treatment areas temporarily off-line or Long-Term Plan Enhancements construction are listed.

STA-2 Operational Treatment Cells

2004					2005					2006		
Jan - Mar	Apr - Jun	Jul - Aug	Sep *Hurricanes Francis and Jeanne*	Oct - Dec	Jan - Mar	Apr - Jun	Jul - Sep	Oct *Hurricane Wilma*	Nov - Dec	Jan - Mar	Apr - Jun	Jul - Sep
WY2004						WY2006						
	WY2005										WY2007	
All Flow-ways Operational												

STA-2 HYDROLOGY AND TOTAL PHOSPHORUS

All three treatment cells were operational during WY2007. To account for the water used for irrigation in the adjacent farm area and not put into the STA, the inflow volume and load was estimated by the following method (the station names are as they appear in the District's hydrological database): Inflow Calculation = S6_P + G328_P – G328I_P – G328I_C – G338_C – G339_S. In previous years, inflows were estimated using only S-6 and G-328. During WY2007, 218,566 ac-ft of water, with a TP load of 45 mt and a FWM TP concentration of 167 ppb was captured and treated by STA-2 (**Tables 5-2** and **5-17, Figures 5-24** and **5-25**). The hydraulic loading was 2.88 cm/day, about 5 percent lower than the simulated long-term average annual inflow for this STA, and the phosphorus loading was equal to an average of 1.75 g/m^2 over the effective treatment area, about 60 percent more than the simulated long-term average annual load (**Table 5-2**). The diversion calculations and the estimates of the amount of Lake Okeechobee regulatory releases received over the water year are found in **Table 5-3**.

The annual volume of treated water discharged to WCA-2A through structure G-335 was 217,572 ac-ft with a TP load of 11 mt and the FWM TP outflow concentration of 41 ppb (geometric mean 38 ppb), a 75 percent reduction from the inflow concentration. STA-2 reduced TP discharge loads by 76 percent compared to inflow loadings, retaining 34 mt of phosphorus. The difference between the inflow and outflow volumes reflects the net contributions of direct rainfall, evapotranspiration (ET), seepage losses to adjacent lands, deep percolation, and flow measurement error. A summary of monthly flows, loads, and moving 12-month FWM TP outflow concentration is presented in **Figures 5-24** and **5-25**.

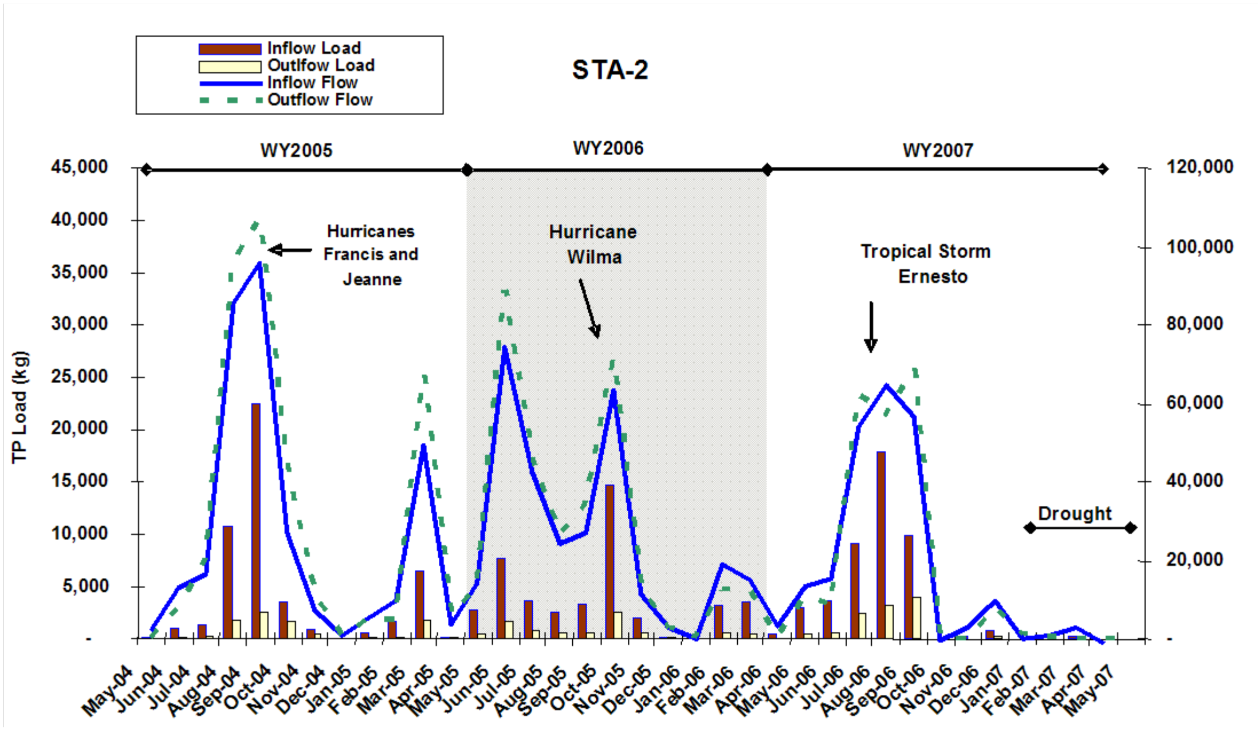


Figure 5-24. Summary of monthly flow and TP load for STA-2 for WY2004–WY2007. In WY2007, all of the treatment cells were operational (**Table 5-15**).

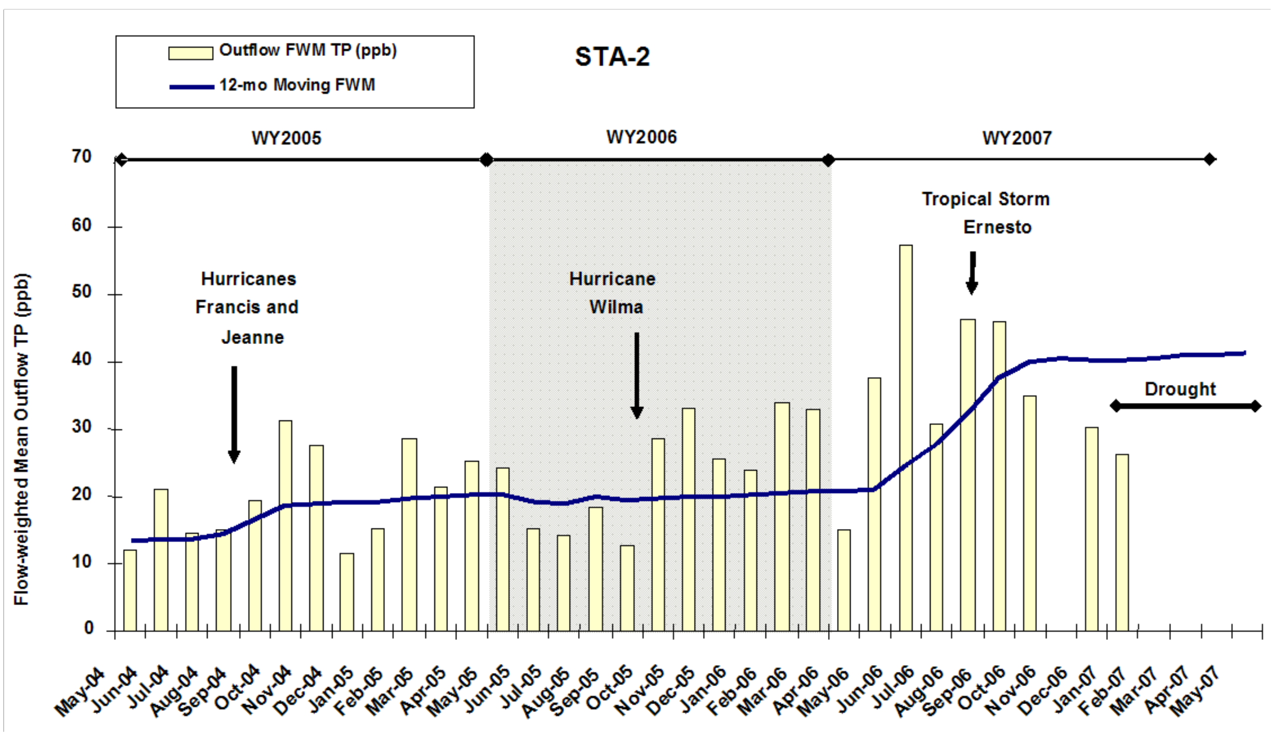


Figure 5-25. Comparison of monthly to 12-month moving average TP concentrations for STA-2 outflow.

Table 5-17. Summary statistics of 12-month inflow and outflow flow, TP load, FWM TP concentration for each water year at STA-2.

STA-2 Inflow												
	Flow Volume (ac-ft)				TP Load (mt)				FWM TP (ppb)			
Water Year	Sum	Avg.	Min.	Max.	Sum	Avg.	Min.	Max.	Arithmatic[1]	Min.	Max.	Geo. Mean[2]
2002	212,808	17,734	7	43,625	19.7	1.6	0.0	4.7	75	19	92	46
2003	282,731	23,561	1,660	56,393	21.8	1.8	0.1	5.2	62	30	75	54
2004	256,938	21,411	22	85,165	24.3	2.0	0.0	9.4	77	37	90	60
2005	316,273	26,356	784	95,858	49.0	4.1	0.1	22.4	126	30	189	81
2006	297,364	24,780	0	74,443	44.0	3.7	0.0	14.7	120	46	188	110
2007	218,566	18,214	-1,180	64,476	44.9	3.7	0.0	18.0	167	36	226	108

STA-2 Outflow												
	Flow Volume (ac-ft)				TP Load (mt)				FWM TP (ppb)			
Water Year	Sum	Avg.	Min.	Max.	Sum	Avg.	Min.	Max.	Arithmatic[1]	Min.	Max.	Geo. Mean[2]
2002	240,685	20,057	0	49,288	4.9	0.4	-	0.9	16	12	27	18
2003	308,297	25,691	84	83,035	6.8	0.6	0.0	1.8	18	13	31	18
2004	284,780	23,732	615	94,120	5.0	0.4	0.0	1.5	14	10	20	14
2005	371,023	30,919	388	107,053	9.2	0.8	0.0	2.6	20	12	31	19
2006	322,303	26,859	371	88,698	8.2	0.7	0.0	2.5	21	13	34	22
2007	217,572	18,131	12	69,048	11.0	0.9	-	3.9	41	26	57	38

OTHER STA-2 WATER QUALITY PARAMETERS

The WY2007 monitoring data for all other water quality parameters at STA-2 during this reporting period are presented in Appendix 5-12 and are summarized in **Table 5-18**. Discharges from STA-2 were determined to be in compliance with the permit. Additional requirements for DO are listed in Administrative Order No. AO-006-EV and are discussed in the following section. The annual permit compliance monitoring report for mercury in the STAs is in Appendix 5-7 of this volume.

Table 5-18. Summary of annual arithmetic averages and FWM for all parameters other than TP monitored in STA-2. Alkalinity is reported as mg/L $CaCo_3$ and Nitrite + Nitrate is reported as mg/L N. Because these parameters are measured from grab samples and not flow-proportional samples, both the arithmetic of all the samples collected as well as the means for those samples collected only during flow events (flow-weighted means) are shown.

Parameter	Arithmetic Means			Flow-Weighted Means			
	Inflow		Outflow	Total Inflow		Total Outflow	
	S6	G328	G335	n	Conc.	n	Conc.
Temperature (°C)	25.3	25.5	24.8	-NA-	-NA-	-NA-	-NA-
Dissolved Oxygen (mg/L)	3.7	5.1	4.4	-NA-	-NA-	-NA-	-NA-
Specific Conductivity (µS/cm)	1,061	1,225	1,146	-NA-	-NA-	-NA-	-NA-
pH	7.6	7.8	7.6	-NA-	-NA-	-NA-	-NA-
Turbidity (NTU)	4.3	5.8	1.8	-NA-	-NA-	-NA-	-NA-
Total Dissolved Solids (mg/L)	696	778	742	9 (51)	830	11 (25)	648
Unionized Ammonia (mg/L)	0.005	0.009	0.003	9 (50)	0.004	10 (25)	<0.001
Orthophosphate as P (mg/L)	0.042	0.015	0.007	25 (103)	0.126	27 (52)	0.023
Total Dissolved Phosphorus (mg/L)	0.054	0.024	0.015	25 (98)	0.138	25 (48)	0.033
Sulfate (mg/L)	56.4	47.7	45.5	9 (52)	77.4	11 (26)	54.0
Alkalinity (mg/L)	292	320	313	9 (52)	359	11 (26)	286
Dissolved Chloride (mg/L)	137	182	155	9 (52)	139	11 (26)	114
Total Nitrogen (mg/L)	2.86	2.44	2.21	9 (52)	4.06	11 (25)	2.26
Total Dissolved Nitrogen (mg/L)	2.58	2.32	2.16	9 (52)	3.71	11 (26)	2.26
Nitrate + Nitrite (mg/L)	0.512	0.368	0.076	9 (52)	0.629	11 (26)	0.076

-NA- : Not Applicable
n: number of samples with flow (total number of samples)

STA-2 DISSOLVED OXYGEN MONITORING

STA-2 Administrative Order No. AO-006-EV in Exhibit C of the EFA STA-2 Permit (Permit No. 0126704, September 29, 2000) specifies the same DO monitoring requirements as those for STA-1W. Since the SSAC has been adopted by the FDEP and formally approved by the USEPA (Weaver, 2008), assessment on possible downstream impacts by the outflows from STA-2 during

WY2007 will be performed by applying the SSAC limit with respect to DO at outflow station G-355 (**Figure 5-23**).

Based on the annual assessment of DO at the outflow from STA-2 using the SSAC limit, G-355 was above the SSAC limit by 1.53 mg/L (**Figure 5-26** and **Table 5-8**). Biweekly DO levels for WY2007 are available in Appendix 5-8. In addition, a graphical depiction of the biweekly residual differences between measured DO levels and SSAC limits is provided in Appendix 5-9.

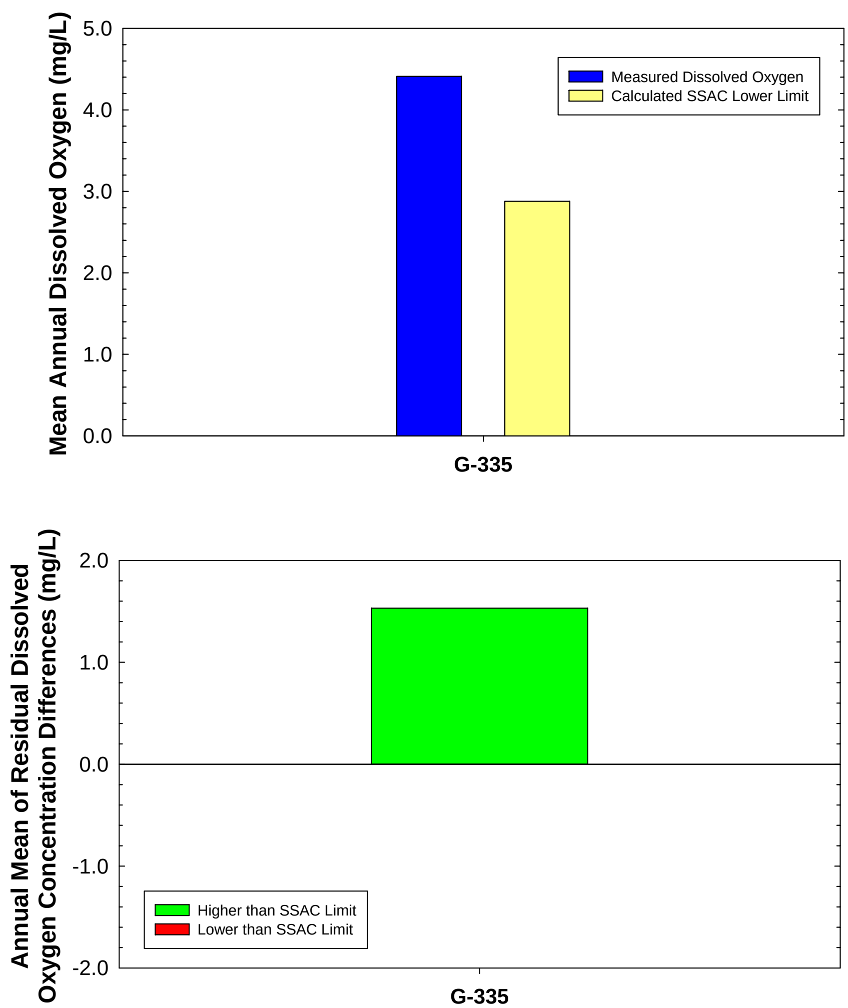


Figure 5-26. Comparison of mean annual DO measured at the outflow station (G-355) for STA-2 during WY2007 with the mean annual SSAC limit derived from the corresponding water temperature and time of day collected at the outflow station (top plot). The annual mean residual DO difference between the mean annual DO and mean annual SSAC indicates whether the station was above the SSAC limit (when greater than or equal to zero) or whether the station was below the limit (less than zero) (bottom plot).

STA-2 VEGETATION MANAGEMENT

Vegetation Management activities in WY2007 included:

- Herbicide treatment of the Torpedo grass in the south end of Cell 3 in October 2006.
- Small-scale inoculations of desirable SAV (Naiad, Chara, Pondweed) were made in the north end of Cell 3, where hydrilla is prevalent. Unfortunately, inoculation was unsuccessful and hydrilla reappeared as the dominant plant species.
- In June 2006, Brazilian red pepper, located along the north supply canal levee, was treated with herbicide.
- Three 200-foot-wide vegetation strips, orientated perpendicular to flow, were established using aerial spraying in Cell 4. Cell 4 is an SAV-dominated cell and herbicide was applied to eradicate the emergent vegetation, except in those areas where the vegetation strips were intended to be located.

Details about the vegetation management research studies conducted in STA-2 can be found the in the *Vegetation Management* section of this chapter, and the types and quantities of the herbicides that were used during the water year are listed in Appendix 5-3.

STA-2 EXPANSION AND ENHANCEMENTS

Construction of an additional 2,015-acre treatment cell (i.e., Cell 4) that will operate in parallel with existing Cells 1, 2, and 3 was substantially completed during WY2007 (**Figure 5-23**). The effective treatment area of the Cell 4 will be approximately 1,902 acres. Cell 4 was substantially completed and flow-capable in December 2006. Final completion of construction including telemetry and electrical hook-up is expected to be completed in early 2008. The design and construction of Cell 4 was implemented under the District's Acceler8 program as part of the Everglades Agricultural Area (EAA) STA Expansion Project.

STA-3/4

STA-3/4 CONFIGURATION

Stormwater Treatment Area 3/4 (STA-3/4) is the largest of the STAs, with approximately 16,543 acres of effective treatment area. A schematic of STA-3/4 is presented in **Figure 5-27**. STA-3/4 consists of three flow-ways; the Eastern Flow-way contains treatment Cells 1A and 1B, the Central Flow-way contains treatment Cells 2A and 2B, and the Western Flow-way contains treatment Cells 3A and 3B. Inflows are through the G-370 and G-372 structures and outflows are through the G-376, G-379, and G-381 structures. STA-3/4 uses the existing S-7 and S-8 Pump Stations to convey the STA discharges to the WCAs (S-7 discharges to WCA-2A and S-8 discharges to WCA-3A). Runoff that exceeds the hydraulic capacity of STA-3/4 can be diverted through the G-371 and G-373 structures.

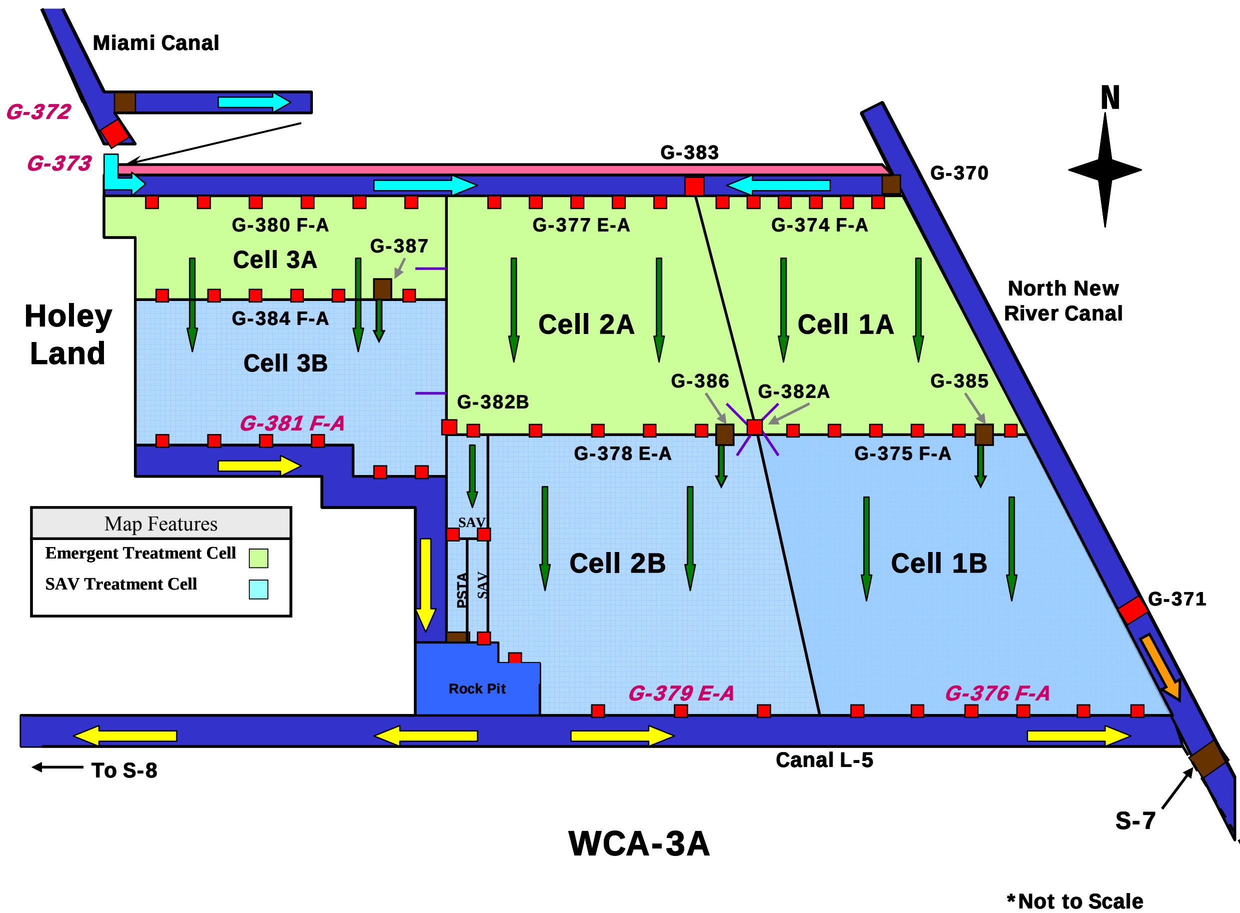


Figure 5-27. Schematic of STA-3/4 (not to scale). Inflow and outflow sites are designated with red/bold/italic font.

STA-3/4 WY2007 HIGHLIGHTS

- STA-3/4 was in compliance with the EFA and the USEPA's NPDES operating permits for WY2007. Detailed information about the permit status is found in *Permit Status* section of this chapter.
- The Western Flow-way (Cell 3) was offline from January 2006 through May 2006 to allow for Long-term Plan Enhancements construction and vegetation establishment. The Eastern and Central Flow-ways were operational in WY2007 (**Figure 5-19**).
- Low water conditions were experienced during the drought period. Small temporary pumps were installed in April 2007 at the mid-levee in all three treatment cells to hydrate downstream SAV communities. The pumps were dismantled in the first week of June.
- The full-scale PSTA implementation project located in Cell 2B is in the operations phase, and water quality sampling at the project continued.
- Vegetation management activities included converting Cells 1B and 3B to SAV. Emergent vegetation strips were allowed to establish in Cell 3B with a north to south orientation**.**
- Operations were restricted due to the nesting of federally protected black-necked stilt nests (additional details can be found in the *Wildlife* section of this chapter).
- A technical report describing the flow rating and mass balance analysis for STA-3/4 can be found on the District's web site at www.sfwmd.gov/sta under *Long-Term Plan for Achieving Everglades Water Quality Goals* link.

STA-3/4 OPERATIONS

Table 5-19. Operational status of the treatment cells in STA-3/4 from January 2004 through April 2007. Major events, such as hurricanes, treatment areas temporarily offline or Long-Term Plan Enhancements construction are listed.

STA-3/4 Operational Treatment Cells

2004					2005					2006		2007
WY2004							WY2006					
	WY2005											WY2007
Jan - Mar	Apr - Jun	Jul - Aug	Sep *Hurricanes Frances and Jeanne*	Oct - Dec	Jan - Feb	Mar - Jun	Jul - Sep	Oct *Hurricane Wilma*	Nov - Dec	Jan - May	Jun - Dec	Jan - April
Eastern and Western Flow-way Operational			All Flow-ways Operational	Eastern and Central Flow-way Operational			All Flow-ways Operational (Cell 3 restricted flow/stage)			Eastern and Central Flow-way Operational	All Flow-ways Operational	
Central Flow-way off-line for vegetation conversion				Western Flow-way off-line for LTP enhancements construction			Western Flow-way re-hydrated, partial operation for plant re-establishment			Western Flow-way off-line for LTP enhancemenets construction		

STA-3/4 HYDROLOGY AND TOTAL PHOSPHORUS

During WY2007, 388,471 acre-feet (ac-ft of water, with a TP load of 70 mt and a FWM TP concentration of 146 ppb was captured and treated by STA-3/4 through pump stations G-370 and G-372 (**Table 5-2** and **5-20, Figures 5-28** and **5-29**). The volume of water that entered into STA-3/4 through G-372 that was then routed into the Holey Land was subtracted out of the total inflow because the water did not enter into the effective treatment areas of the STA. The hydraulic loading was 2.01 cm/day, about 40 percent lower than the simulated long-term average annual inflow for this STA and the phosphorus loading was equal to an average of 1.07 g/m^2 over the effective treatment area, equal to the simulated long-term average annual load (**Table 5-2**). The diversion calculations and the estimates of Lake Okeechobee regulatory releases received over the water year are found in **Table 5-3**.

The annual volume of treated water discharged to S-8 was 355,423 ac-ft through structures G-376A-F, G-379A-E, and G-381A-F with a TP load of about 10 mt and the FWM TP outflow concentration of 22 ppb (geometric mean 25 ppb), an 85 percent reduction from the inflow concentration. STA-3/4 reduced TP loads by 86 percent compared to inflow loadings, retaining 60 mt of phosphorus. The difference between the inflow and outflow volumes reflects the net contributions of direct rainfall, ET, seepage losses to adjacent lands, deep percolation, and flow measurement error. A summary of monthly flows, TP loads and moving 12-month FWM TP outflow concentration is presented in **Figures 5-28** and **5-29**.

Table 5-20. Summary Statistics of 12-month inflow and outflow flow, TP load, FWM TP concentration for each water year at STA-3/4.

STA-3/4 Inflow												
	Flow Volume (ac-ft)				TP Load (mt)				FWM TP (ppb)			
Water Year	Sum	Avg.	Min.	Max.	Sum	Avg.	Min.	Max.	Arithmatic[1]	Min.	Max.	Geo. Mean[2]
2005	671,442	55953	0	175,200	87.4	7.3	0.0	23.3	105	52	212	101
2006	696,729	58,061	2,174	209,251	105.3	8.8	0.2	32.5	123	61	226	119
2007	388,471	32373	0	148,975	69.9	5.8	0.0	30.6	146	58	205	106

STA-3/4 Outflow												
	Flow Volume (ac-ft)				TP Load (mt)				FWM TP (ppb)			
Water Year	Sum	Avg.	Min.	Max.	Sum	Avg.	Min.	Max.	Arithmatic[1]	Min.	Max.	Geo. Mean[2]
2005	646,587	53,882	-	172,881	10.4	0.9	0.0	2.5	13	9	18	13
2006	736,422	61,369	1,467	186,689	21.2	1.8	0.1	4.9	23	17	41	24
2007	355,423	29,619	-	177,600	9.8	0.8	0.0	4.7	22	21	32	25

[1]Arithmatic FWM TP calculated using the annual load and flow.
[2]Geometric FWM TP calculated based on monthly FWM TP estimates.

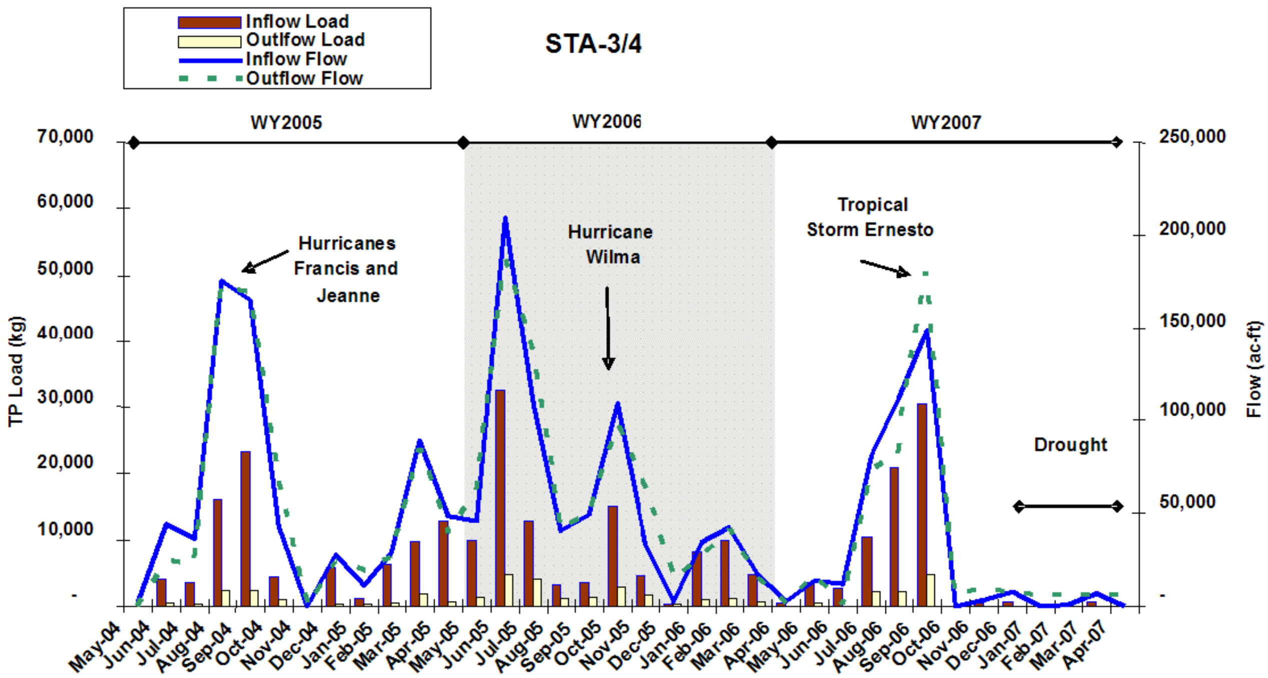


Figure 5-28. Summary of monthly flow and TP load for STA-3/4 for WY2004 through WY2007. Except for May 2006, all of the treatment cells were operational in WY2007. (**Table 5-19**).

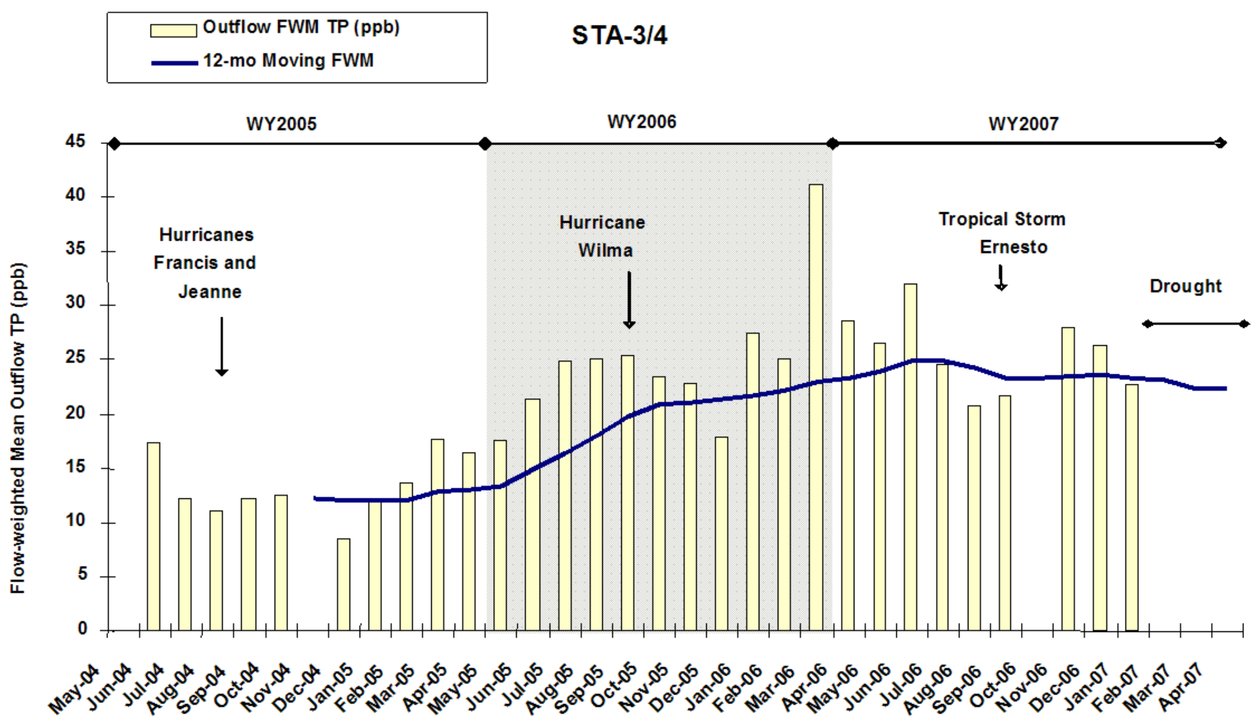


Figure 5-29. Comparison of monthly to 12-month moving average TP concentrations for STA-3/4 outflow. Except for May 2006, all of the treatment cells were operational in WY2007 (**Table 5-19**).

STA-3/4 OTHER WATER QUALITY PARAMETERS

Compliance with the EFA permit is determined based on the three-part assessment presented in the *Permit Requirements* section of this chapter. Water quality parameters with Florida Class III standards are identified in **Table 5-7**. The monitoring data for non-phosphorus parameters at STA-3/4 for the water year are presented in Appendix 5-13 and are summarized in **Table 5-21**. STA-3/4 is deemed to be in full compliance with the permit. The annual permit compliance monitoring report for mercury in the STAs is in Appendix 5-7 of this volume.

Table 5-21. Summary of annual arithmetic averages and flow-weighted means for all parameters other than TP monitored in STA-3/4. Alkalinity is reported as mg/L $CaCo_3$ and nitrite + nitrate is reported as mg/L N. Because these parameters are measured from grab samples and not flow-proportional samples, both the arithmetic of all the samples collected as well as the means for those samples collected only during flow events (flow-weighted means) are shown.

Parameter	Arithmetic Means								Flow-Weighted Means			
	Inflow		Outflow						Total Inflow		Total Outflow	
	G370	G372	G376B	G376E	G379B	G379D	G381B	G381E	n	Conc.	n	Conc.
Temperature (°C)	25.0	25.3	24.7	24.7	24.7	25.0	24.9	25.2	-NA-	-NA-	-NA-	-NA-
Dissolved Oxygen (mg/L)	5.4	5.3	3.2	3.3	4.2	4.8	5.2	4.8	-NA-	-NA-	-NA-	-NA-
Specific Conductivity (µS/cm)	969	701	925	914	762	744	828	788	-NA-	-NA-	-NA-	-NA-
pH	7.7	7.7	7.5	7.6	7.7	7.9	7.8	7.7	-NA-	-NA-	-NA-	-NA-
Turbidity (NTU)	6.2	8.3	1.9	2.4	3.1	2.8	2.5	3.2	-NA-	-NA-	-NA-	-NA-
Total Dissolved Solids (mg/L)	603	458	601	598	512	494	584	531	20 (54)	577	34 (148)	533
Unionized Ammonia (mg/L)	0.003	0.002	0.002	0.003	0.007	0.008	0.004	0.003	18 (51)	0.003	34 (136)	<0.001
Orthophosphate as P (mg/L)	0.027	0.031	0.002	0.002	0.003	0.003	0.002	0.002	32 (103)	0.068	73 (282)	0.004
Total Dissolved Phosphorus (mg/L)	0.037	0.042	0.010	0.013	0.015	0.014	0.014	0.017	33 (105)	0.080	73 (286)	0.010
Sulfate (mg/L)	46.0	40.2	42.7	36.9	28.5	27.1	23.2	21.0	20 (54)	61.4	34 (147)	52.2
Alkalinity (mg/L)	264	199	253	257	192	177	221	227	20 (54)	257	34 (148)	243
Dissolved Chloride (mg/L)	118	76	116	114	106	106	124	105	20 (54)	86	34 (147)	78
Total Nitrogen (mg/L)	2.10	2.23	2.26	2.37	2.95	2.77	2.94	2.60	20 (53)	3.51	34 (141)	1.99
Total Dissolved Nitrogen (mg/L)	1.93	1.98	2.15	2.23	2.75	2.61	2.79	2.47	20 (53)	3.11	34 (141)	1.95
Nitrate + Nitrite (mg/L)	0.267	0.516	0.047	0.053	0.084	0.061	0.051	0.058	20 (53)	1.066	34 (141)	0.028

-NA- : Not Applicable
n: number of samples with flow (total number of samples)

STA-3/4 DISSOLVED OXYGEN MONITORING

STA-3/4 Administrative Order No. AO-007-EV in Exhibit D of Permit No. 0192895, January 9, 2004, specifies the same DO monitoring requirements as STA-1W. Since the SSAC has been adopted by the FDEP and formally approved by the USEPA (Weaver, 2008), assessment on possible downstream impacts by the outflows from STA-3/4 during WY2007 will be performed by applying the SSAC limit with respect to DO at outflow stations G-376B, G-376E, G-379B, G-379D, G-381B, and G-381E (**Figure 5-27**).

All of the outflow stations exhibited mean annual DO levels greater than the mean annual SSAC limit (**Figure 5-30** and **Table 5-8**). Outflow stations at STA-3/4 were greater than the SSAC limit by 0.08 to 1.35 mg/L (**Table 5-8**). Biweekly DO levels for WY2007 are available in Appendix 5-8. In addition, a graphical depiction of the biweekly residual differences between measured DO levels and SSAC limits is provided in Appendix 5-9.

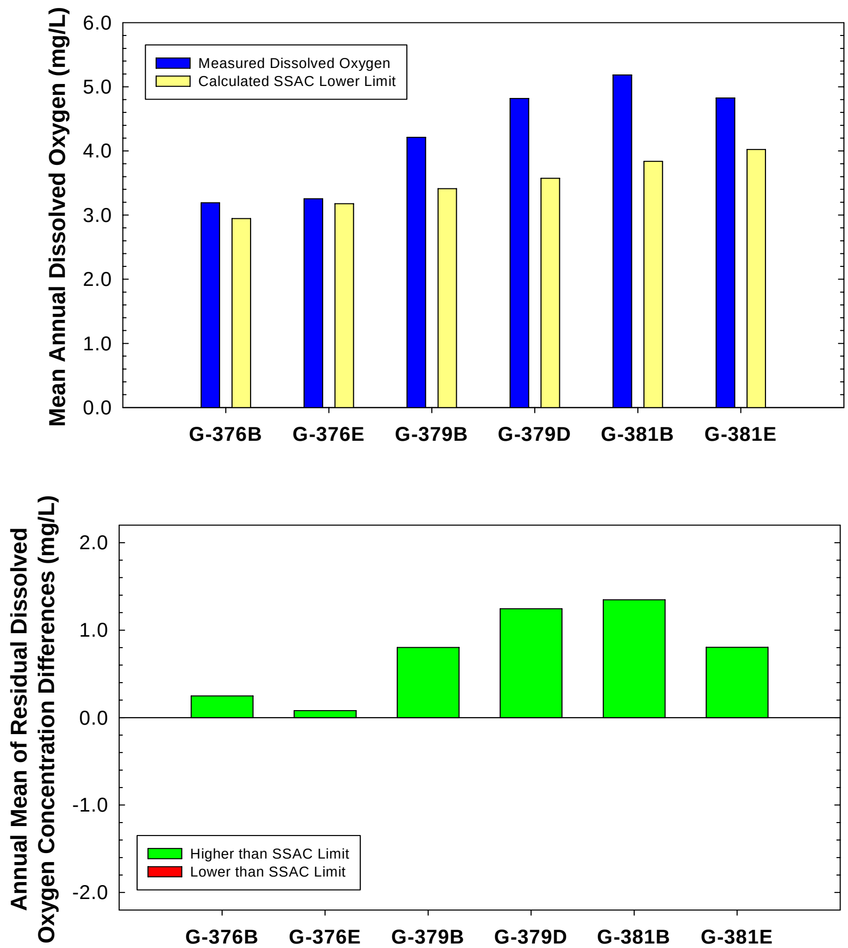


Figure 5-30. Comparison of mean annual DO measured at the outflow stations (G-376B, G-376E, G-379B, G-379D, G-381B, and G-381E) for STA-3/4 during WY2007 with the mean annual SSAC limit derived from the corresponding water temperature and time of day collected at the outflow station (top plot). The annual mean residual DO difference between the mean annual DO and mean annual SSAC indicates whether stations were above the SSAC limit (when ≥ zero) or whether stations were below the limit (< zero) (bottom plot).

STA-3/4 VEGETATION MANAGEMENT

STA 3/4, CELL 1B CONVERSION

Phased conversion of Cell 1B from emergent vegetation to SAV began in November 2005, when 650 acres of cattail and willow were treated with a herbicide. Colonization of SAV in the treated area has been occurring slowly and has likely been impeded by the accumulation of dead cattail litter. However, most of this litter is now submerged and an aerial inoculation of SAV was conducted in July and August 2007. Another 500 acres of emergent vegetation was to be treated with herbicide in fall 2007.

STA 3/4, CELL 2B

As documented in *2007 SFER–Volume I*, Chapter 5, establishment of SAV in Cell 2B was accomplished during start-up by herbicide treatment of existing vegetation prior to initial flooding followed by aerial inoculations of SAV. The report, which includes recommendations such as pretreatment (herbicide and/or fire) and preferred SAV species for successful implementation of future SAV inoculation efforts, can be found on the District's web site at www.sfwmd.gov/sta under the *Long-Term Plan, Documents* link. Dense beds of southern naiad, Illinois pondweed and *Chara* now cover most of the cell.

OTHER VEGETATION MANAGEMENT ACTIVITIES

Aerial applications were conducted in December 2006 and June 2007 in the SAV-dominated treatment Cell 3B in order to reconfigure and maintain vegetation strips (2007 SFER – Volume I, *STA-3/4 Vegetation Management* section). The vegetation strips consist of cattail that naturally recruited in the area. This cell contains 11 north-south vegetation strips (parallel to flow) and three east-west vegetation strips (perpendicular to flow). In December 2006, aerial herbicide treatments in Cells 1A and 1B were carried out due to the presence of a large amount (> 1,000 acres) of floating aquatic vegetation (Appendix 5-3). An aerial application was scheduled for the later part of summer or early fall 2007 (at the time of this writing) to treat willows that have been spreading into Cell 3A from the vegetation strips.

STA-3/4 PSTA Implementation Project

The STA-3/4 PSTA Implementation Project is a 400-acre portion of Cell 2B in STA-3/4 that was isolated by constructing new levees to form an upstream 200-acre cell (Upper SAV) and two adjacent downstream 100-acre cells (Lower SAV and PSTA) (**Figure 5-31**). All cells have been managed to promote a SAV community and its associated periphyton through repeated herbicide applications to suppress emergent aquatic plants. The primary difference in the construction of the PSTA versus the SAV cells is that the peat substrate in the PSTA Cell was scraped down to caprock level and removed, while the soil in the Upper and Lower SAV cells was not disturbed. Consequently, the floor elevation of the PSTA cell is approximately 60 cm lower than the adjacent SAV cells. The peat was removed from the PSTA cell because it provided a rooting medium for emergent plants and was a potential source of phosphorus that would flux back into the water column and reduce treatment efficiency. Design considerations and the project layout are described in greater detail in previous consolidated reports.

The District committed to building the project in May 2003. Construction of all infrastructure (levees, culverts, gates, and the outflow pump station) was substantially complete by spring 2005. The inflow and outflow gates, i.e., G-378E and G-379E, respectively, were kept closed at this time to impound water within the project and begin establishing periphyton and SAV. The project outflow pump station, i.e., G-388, began operating in August 2005 as a stand-alone facility to control water levels in the PSTA Cell; the two 100 cfs pumps (244,658 $m^3\ d^{-1}$) in this station are activated by a float switch located at the pump intakes. The telemetry system that is needed to operate the structures remotely became functional in July 2006. Unfortunately, equipment failure shut down G-388 in September 2006, and repairs were not completed until late in the year. By that time, water shortages associated with a severe regional drought forced the District to suspend operations in all of STA-3/4, including the restart of G-388, for the remainder of WY2007. Up to the end of WY2007, the G-378E and G-379E gates remained closed and the only inflows to the project were rainfall and seepage from adjacent treatment cells in STA-3/4.

A detailed operation plan for the project was finalized in February 2007 (Appendix 5-14). The Upper and Lower SAV cells will be operated in association with the rest of Cell 2B. The

PSTA Cell will be operated at a constant hydraulic retention time of 5 days by regulating flow into the cell through G-390A and B. The plan, at this time, ignores the potential contribution of seepage to the total water load entering the PSTA Cell; the plan will be modified when there is a better understanding of groundwater flow into this cell. The outflow pump station will be operated to maintain an average water depth in the PSTA Cell of approximately 60 ± 8 cm. As of July 2007, the District has resumed flow into STA-3/4 and has started operating the PSTA project in accordance with the Operation Plan.

The vegetation community throughout the project has been surveyed on a regular basis since September 2005. A geo-referenced grid of regularly spaced sampling stations was established for each cell (**Figure 5-32** and Appendix 5-15). The areal coverage of each SAV species at all sites is categorized as "low" (up to ⅓ coverage), "medium" (⅓ to ⅔ coverage), or "high" (> ⅔ coverage). The results of surveys conducted in August and November 2006, and February and June 2007, are presented in this report (**Figure 5-32**).

A water quality sampling program (grab samples only) was initiated at G-388 in August 2005. Sampling at the other six sites (G-378E, G-379E, G-389A, G-389B, G-390A, and G-390B) began in June 2006. Water temperature, dissolved oxygen (DO), specific conductance, and pH were measured *in situ* in conjunction with the collection of water samples. Soluble reactive phosphorus (SRP), total phosphorus (TP), and total dissolved phosphorus (TDP) were monitored weekly; nitrite + nitrate-nitrogen (NO_x), ammonia-nitrogen (NH_4), total Kjeldahl-nitrogen (TKN), calcium (Ca), chloride (Cl), and total suspended solids (TSS) were monitored monthly; and sodium (Na), potassium (K), magnesium (Mg), sulfate (SO_4), hardness, and alkalinity were monitored quarterly. Samples are collected at the upstream side of each structure. Summary statistics for all water quality parameters during WY2007 are presented in **Table 5-22**.

A total of 11 SAV taxa were observed in the project over the four sampling dates: *Chara* sp., *Ceratophyllum demersum*, *Egeria densa*, *Hydrilla* sp., *Ludwigia repens*, *Najas guadalupensis, Najas marinas, Nitella tenuissima, Potamogeton* sp., *Utricularia* sp., and *Vallisneria americana*. The most abundant species has continued to be *Chara* sp., during WY2006. In comparison, all other SAV taxa, including *Hydrilla*, had markedly lower areal coverages (Appendix 5-15). Composite distribution maps for each sampling date revealed that SAV has become established throughout the project (**Figure 5-32**). The apparent decrease in composite SAV areal distribution between November 2006 and February 2007, and the subsequent increase in June 2007, probably reflected a seasonal cycle in plant biomass with the lowest coverage occurring in winter and the highest in late summer/early fall.

The mean TP concentration at G-388 during WY2007 was 0.012 mg/L (**Table 5-22**). The corresponding mean TP concentration at this site in WY2006 was 0.015 mg/L (Table 5-22 in Pietro et al., 2007). There was no statistical difference in TP concentration at G-388 between the period when the pumps were in operation (May 1 through September 27, 2006) and after they were shut down (September 28, 2006 through April 30, 2007) (t-test: t = 0.9348, df = 48, $p = 0.3546$, $\alpha = 0.05$). Annual mean TP concentrations at the other stations ranged from 0.032 mg/L (G-389A & B, G-390A & B) to 0.044 mg/L (G-378E). The annual mean TP concentration at G-388 was significantly lower than at all the other sites based on a one-way ANOVA and a *post hoc* Tukey means comparison (F = 24.98, df = 332, $p = < 0.0001$, $\alpha = 0.05$). G-388 also had the highest annual mean DO concentration and the lowest annual means for temperature, NO_x, NH_4, TKN, SRP, TDP, Na, K Cl and hardness. Because the project did not operate in flow-through mode during WY2007, the treatment efficiency for each cell cannot be evaluated.

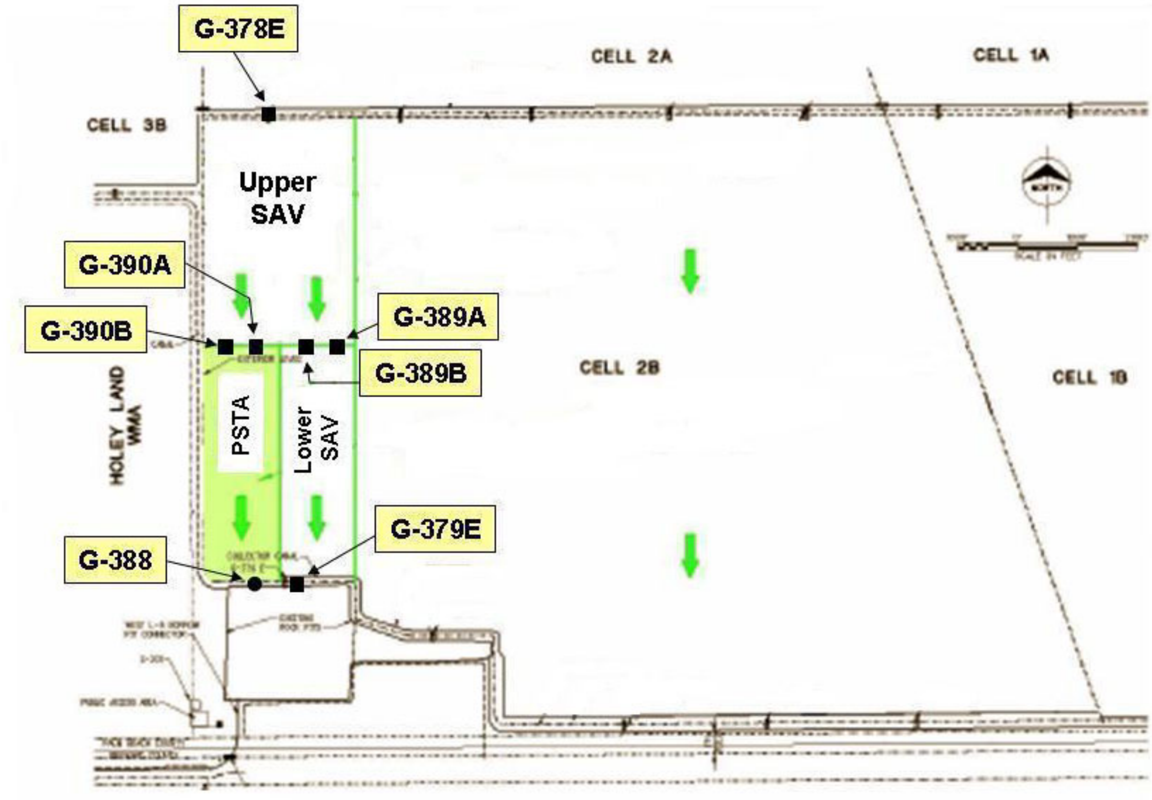


Figure 5-31. Map of the STA-3/4 PSTA Implementation Project showing the location of water control structures, the Upper SAV Cell, the Lower SAV Cell, and the PSTA Cell. Arrows indicate the direction of flow.

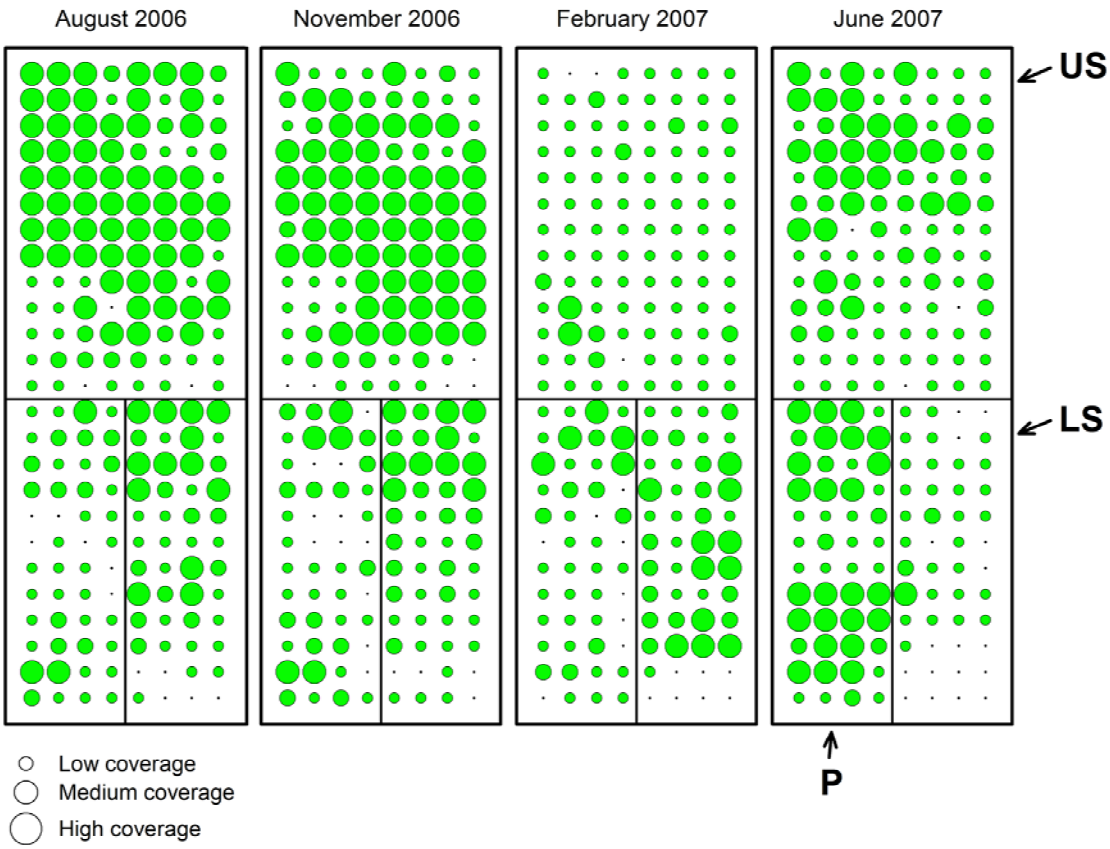


Figure 5-32. Composite distribution maps of submerged aquatic vegetation (SAV) in the Upper SAV Cell (US), Lower SAV Cell (LS) and PSTA Cell (P) of the STA-3/4 PSTA Implementation Project (see location of cells in Figure 5-31). Each closed circle represents the highest areal coverage level amongst all individual SAV species observed at that site (see Appendix 5-14).

Table 5-22. Summary statistics for water quality variables in grab samples collected weekly, monthly, and quarterly at monitoring sites in the STA-3/4 PSTA Project during WY2007. Summary statistics also are presented for the outflow pump station (G-388) during periods when the pumps were operational and not operational.

	Temp. Deg C	DO mg/L	Cond. µS/cm	pH s.u.	TSS mg/L	NO_x mg N/L	NH_4 mg N/L	TKN mg N/L	SRP mg P/L	TP mg P/L	TDP mg P/L	Na mg/L	K mg/L	Ca mg/L	Mg mg/L	Cl mg/L	SO_4 mg/L	Hard. mg/L	Alk. mg $CaCO_3$/L
G-378E																			
Minimum	18.4	0.6	531	7.3	3	0.006	0.010	1.950	0.002	0.022	0.007	37.9	4.6	62.8	12.9	69.6	19.3	249	148
Maximum	32.0	9.0	1090	8.1	10	0.186	0.936	3.770	0.017	0.110	0.030	88.2	12.6	106.2	24.9	130.0	43.4	355	284
Mean	25.5	4.3	848	7.6	4.3	0.077	0.191	2.640	0.005	0.044	0.018	65.9	10.0	83.5	20.1	103.8	28.9	307	223
Median	24.9	4.0	845	7.6	3.0	0.069	0.128	2.550	0.004	0.041	0.019	67.7	11.7	84.8	21.0	103.0	26.5	305	231
CV	15%	53%	14%	3%	54%	91%	142%	21%	60%	45%	34%	22%	28%	14%	17%	18%	31%	11%	23%
N	44	42	44	43	9	9	9	10	42	44	43	8	8	11	8	10	4	6	4
G-379E																			
Minimum	16.1	1.4	467.0	7.4	3.0	0.089	0.065	1.530	0.002	0.007	0.010	37.1	1.7	51.0	9.9	58.4	3.3	220	154
Maximum	32.0	8.6	1084.0	8.3	8.0	0.265	0.469	4.130	0.010	0.151	0.035	101.9	13.2	84.4	21.7	185.0	5.5	300	236
Mean	24.9	5.2	727.3	7.8	4.3	0.176	0.208	2.531	0.005	0.040	0.019	69.1	7.1	67.6	16.2	99.5	4.4	250	200
Median	24.3	5.0	687.5	7.8	3.0	0.184	0.139	2.340	0.004	0.033	0.020	61.0	6.4	65.8	15.5	89.7	4.4	236	205
CV	17%	36%	21%	3%	43%	35%	74%	28%	39%	60%	33%	33%	46%	13%	22%	39%	19%	13%	15%
N	44	42	44	43	10	9	9	9	41	59	42	8	8	11	8	9	4	6	4
G-388																			
Maximum	16.4	3.8	533.0	7.2	3.0	0.017	0.033	1.470	0.002	0.009	0.005	43.6	2.9	57.8	12.8	68.0	9.6	215	180
Max	31.4	11.2	926.0	8.7	3.0	0.051	0.106	3.260	0.004	0.019	0.012	78.3	7.8	81.9	20.1	137.0	14.8	248	209
Mean	24.7	6.6	732.2	7.8	3.0	0.031	0.064	2.023	0.004	0.012	0.007	59.0	5.4	65.4	16.9	97.1	11.4	231	196
Median	24.4	6.7	716.0	7.9	3.0	0.033	0.059	1.790	0.004	0.012	0.006	55.9	5.4	63.6	16.8	92.3	10.5	230	197
CV	16%	22%	13%	3%	<1%	32%	34%	27%	22%	20%	21%	18%	27%	9%	13%	24%	18%	5%	6%
N	52	50	52	51	12	10	10	11	51	50	45	8	8	13	8	11	4	6	4
G-388 – pumps operational (May 1 to September 27, 2006)																			
Maximum	23.2	3.8	533.0	7.2	3.0	0.017	0.046	1.540	0.004	0.009	0.005	43.6	2.9	57.8	12.8	68.0	10.6		180
Max	31.4	11.2	926.0	8.1	3.0	0.034	0.106	3.260	0.004	0.018	0.008	68.1	3.8	81.9	18.5	128.0	14.8		201
Mean	28.4	5.8	774.2	7.7	3.0	0.022	0.072	2.403	0.004	0.012	0.006	55.9	3.4	69.0	15.7	106.3	12.7		191
Median	28.5	5.3	742.6	7.7	3.0	0.019	0.067	2.405	0.004	0.012	0.006	55.9	3.4	68.2	15.7	114.5	12.7		191
CV	6%	25%	13%	3%	<1%	31%	36%	26%	<1%	16%	14%	22%	13%	13%	18%	23%	17%		6%
N	22	21	22	21	5	4	4	4	22	22	22	2	2	4	2	4	2	0	2
G388 – pumps not operational (September 28, 2006 to April 30, 2007)																			
Maximum	16.4	3.9	558.0	7.3	3.0	0.031	0.033	1.470	0.002	0.009	0.005	49.4	5.3	60.9	15.2	72.6	9.6	215	192
Max	26.8	8.8	863.0	8.7	3.0	0.051	0.084	2.570	0.004	0.019	0.012	78.3	7.8	68.6	20.1	137.0	10.4	248	209
Mean	22.1	7.2	701.5	7.9	3.0	0.036	0.059	1.806	0.003	0.012	0.007	60.0	6.1	63.8	17.3	91.8	10.0	231	201
Median	22.6	7.5	684.0	7.9	3.0	0.034	0.059	1.750	0.004	0.011	0.006	55.9	5.5	63.2	16.8	87.6	10.0	230	201
CV	12%	15%	10%	3%	<1%	19%	28%	18%	29%	22%	25%	17%	16%	4%	10%	22%	4%	5%	4%
N	30	29	30	30	7	6	6	7	29	28	23	6	6	9	6	7	2	6	2

STA-3/4 ENHANCEMENTS

Long-Term Plan Enhancements include the following features:

- Control of emergent vegetation in Cells 1B, 2B, and 3B to encourage establishment of SAV (see the *STA-3/4 Vegetation Management* section of this chapter)
- Operation of the full-scale PSTA demonstration project (see *PSTA Implementation Project* sections for additional details)

STA-5

STA-5 CONFIGURATION

Stormwater Treatment Area 5 (STA-5) contains approximately 6,190 acres of effective treatment area arranged in three parallel flow-ways (**Figure 5-33**). The Northern Flow-way (Cells 1A and 1B) consists of approximately 2,055 acres of effective treatment area. The Central Flow-way (Cells 2A and 2B) consists of approximately 2,055 acres of effective treatment area. Construction of the Southern Flow-way, with approximately 2,080 acres of effective treatment area, was substantially complete and became flow-capable in December 2006.

Water enters STA-5 from the west through the G-342 structures and flows by gravity through the treatment area to the east. Supplemental water can also be delivered to Cell 1B through the G-507 structure. The three flow-ways discharge into a common discharge canal via culverts G-344A-F. The discharge canal is located along the western and northern boundaries of the Rotenberger Wildlife Management Area (RWMA) and is connected to the Miami Canal. Discharge from the Miami Canal can enter into the northwest corner of WCA-3A. Through the end of WY2007, G-406 was the diversion structure used when runoff exceeded the hydraulic capacity of STA-5. Beginning in the 2009 SFER – Volume I, the revised operations of G-406, including the new diversion structure called G-407 will be described when the expanded flow-ways at STA-5 and STA-6 demonstrate net improvement in phosphorus and mercury and are in flow-through operation. In accordance with the guidance of the EFA, STA-5 and STA-6 will be operated to the maximum extent practical to improve the quality, timing, and distribution of water entering the northwest portion of WCA-3A.

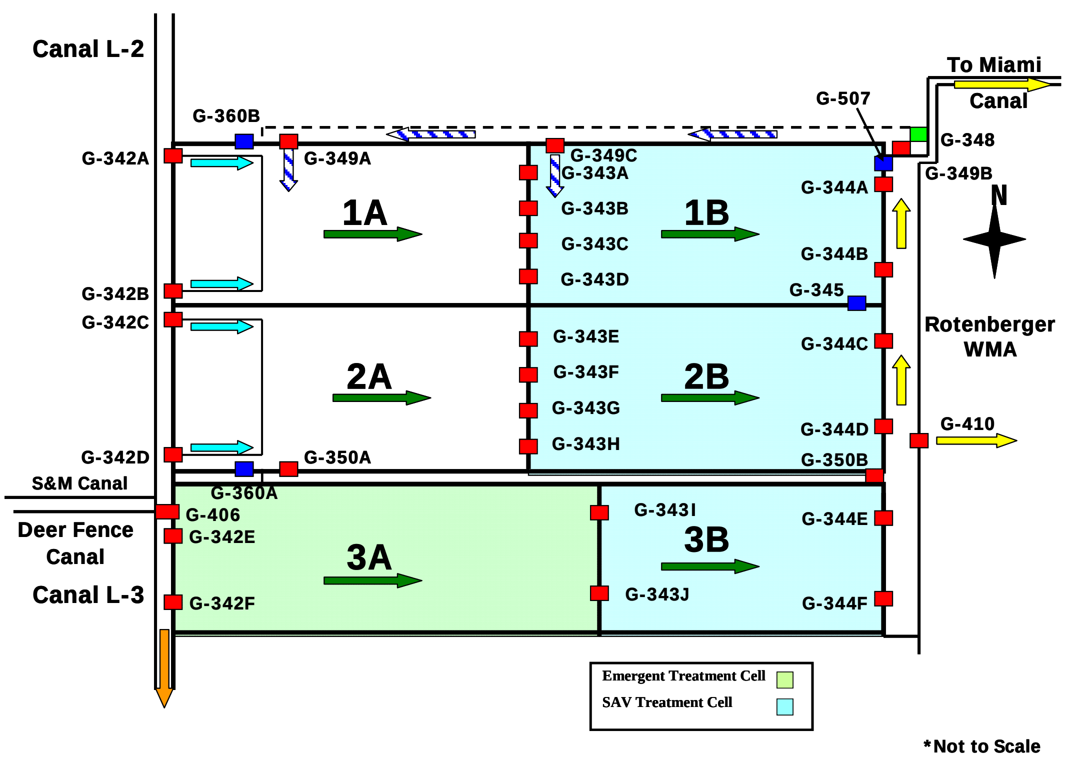


Figure 5-33. Schematic of STA-5 (not to scale). Arrows indicate the direction of flow.

STA-5 WY2007 HIGHLIGHTS

- STA-5 was in compliance with the EFA and the USEPA NPDES operating permits for WY2007. STA-5 is in the permit stabilization phase (details found in the *Permit Status* section of this chapter). In the stabilization phase, outflow concentrations above the 50-ppb interim target do not constitute a violation of the operating permits.
- Although STA-5 is in compliance with the EFA and NPDES permits, the TP removal performance has not been as expected. District scientists are analyzing flow, TP load and concentration, SRP, stage, vegetation coverage, and soil nutrients within the STA in order to understand the reasons why TP outflow concentrations are higher than anticipated (see the *STA Performance Synopsis* section of this chapter for evaluation).
- The Central Flow-way (Cells 2A and 2B) was offline in May–June 2006. The Northern Flow-way was operational the entire water year (**Table 5-23**).
- The Long-Term Plan Enhancements construction to improve the mid-levee water control structures has been completed. Telemetry on these structures is expected in late 2007.
- The Long-Term Plan vegetation conversion has been completed in Cell 2B and vegetation strips have been incorporated as part of the design in this SAV cell.
- Low water conditions were experienced during the drought. The water supply pump G-507 was used beginning in April 2006 to keep Cell 1B and 2B hydrated during the drought. G-345 was used to move water into Cell 2B. The G-345 culvert was closed in early 2007 and Cell 2B was allowed to dry out. Cells 1A and 2A dried out during the drought.
- Operations were restricted due to the nesting of federally protected black-necked stilt nests (additional details can be found in the *Wildlife* section of this chapter).
- Recreational opportunities in STA-5 included duck hunting and bird watching.

Table 5-23. Operational status of the treatment cells in STA-5 from January 2004 through May 2007. Major events, such as hurricanes, treatment areas temporarily offline, or Long-Term Plan Enhancements construction are listed.

STA-5 Operational Status of Treatment Cells

2004					2005					2006			2007
WY2004						WY2006							
	WY2005										WY2007		
Jan - Mar	Apr - Jun	Jul - Aug	Sep *Hurricanes Frances and Jeanne*	Oct - Dec	Jan - Mar	Apr - Jun	Jul - Sep	Oct *Hurricane Wilma*	Nov - Dec	Jan - Mar	Apr - Jun	Jul - Dec	Jan - May
Northern and Central Flow-ways Operational					Central Flow-way (Cells 2A and 2B) Operational; Cell 1A restricted capacity		Northern and Central Flow-ways Operational (Cell 1B restricted capacity to allow for plant establishment)			Northern Flow-way Operational		Northern and Central Flow-ways Operational. Southern Flow-way (Cells 3A and 3B) flow-capable Dec. 2006.	
					Cell 1B off-line; LTP Enhancements construction in Northern Flow-way (Cell 1A and 1B)					Central Flow-way (Cells 2A and 2B) off-line; LTP Enhancements construction			

STA-5 OPERATIONS

STA-5 Hydrology and Total Phosphorus

During WY2007, 58,690 acre-feet (ac-ft) of water, with a TP load of 21.7 mt and a FWM TP concentration of 299 ppb was captured and treated by STA-5 through the G-342 structures (**Tables 5-2** and **5-24, Figures 5-34** and **5-35**). The volume of water that entered into the STA was calculated by adding the four G-342 inflow structures together. The hydraulic loading was 1.30 cm/day, which was about 50 percent lower than the simulated long-term average annual simulated inflow for this STA. The phosphorus loading was equal to an average of 1.42 g/m^2 over the effective treatment area, which was about 16 percent less than the simulated long-term average annual load (**Table 5-2**). In WY2007, water was also delivered into Cell 1B through the G-507 pump (10,110 ac-ft of water, with a TP load of 1 mt and a FWM TP concentration of 43 ppb). The diversion calculations and the estimates of the amount of Lake Okeechobee regulatory releases received over the water year are found in **Table 5-3**.

The annual volume of treated water discharged through the G-344 structures was 54,163 ac-ft with a TP load of 12.9 mt and the FWM TP outflow concentration of 192 ppb (geometric mean 112 ppb), a 36 percent reduction from the inflow concentration. The STA reduced TP discharge loads by 41 percent compared to inflow loads, indicating retention of 8.8 mt of phosphorus. While the outflow concentration in WY2007 was above the 50-ppb interim target, this does not constitute a violation of the operating permits because the STA is still in the stabilization phase. One of the permit conditions for STA-5 states that it will remain in the stabilization phase of operation until STA-6 Section 2 begins full flow-through operations. This was added to the permit in recognition that STA-6 Section 2 would treat a portion of the water from the C-139 basin (the tributary basin for STA-5, **Figure 5-1**) and that until STA-6 Section 2 was done, STA-5 would be receiving inflows in excess of the intended long-term design capacity (more details found in the *Permit Status* section of this chapter). Improved TP reduction is anticipated in the future as BMP measures are implemented for the C-139 basin and as the benefits of vegetation management within the STA are realized. The difference between the inflow and outflow volumes reflects the net contributions of direct rainfall, ET, seepage losses to adjacent lands, deep percolation, and flow measurement error. Under low-stage conditions, outflow has occasionally occurred at the inflows, resulting in negative flow and load estimates. A summary of monthly flows, loads, and moving 12-month FWM TP outflow concentration is presented in **Figures 5-34** and **5-35**.

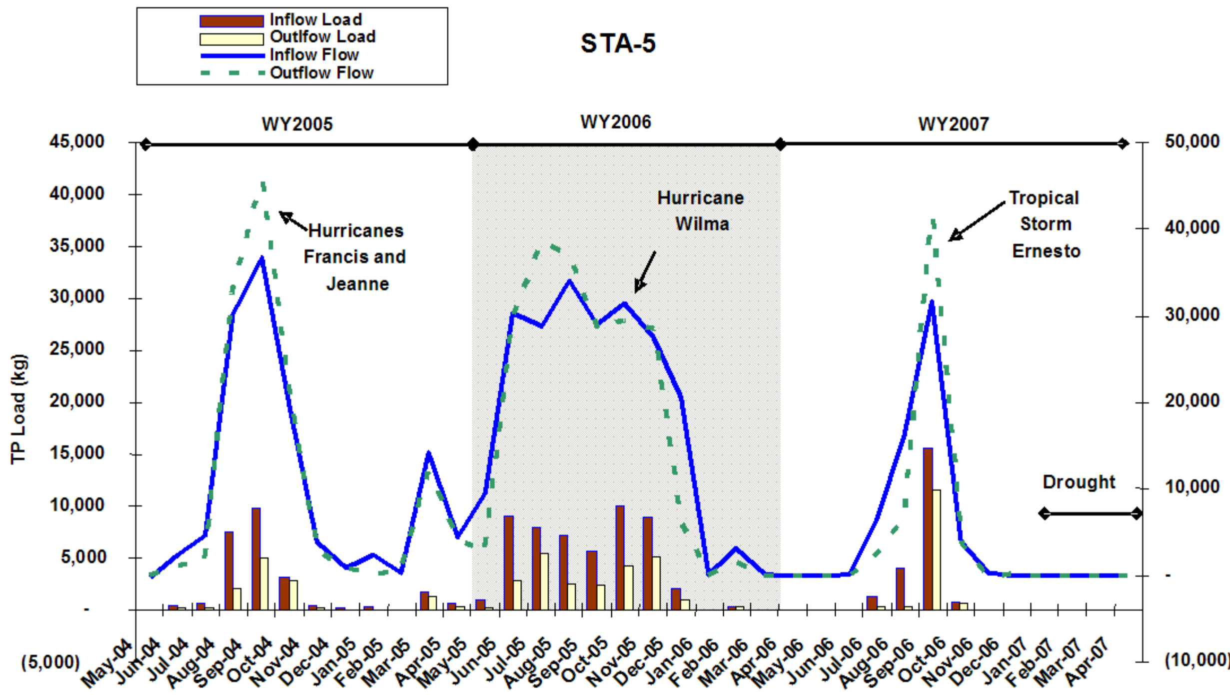


Figure 5-34. Summary of monthly flow and TP load for STA-5 for WY2004 through WY2007. In WY2007, some of the treatment cells were temporarily offline for Long-Term Plan Enhancements construction and vegetation establishment (**Table 5-23**).

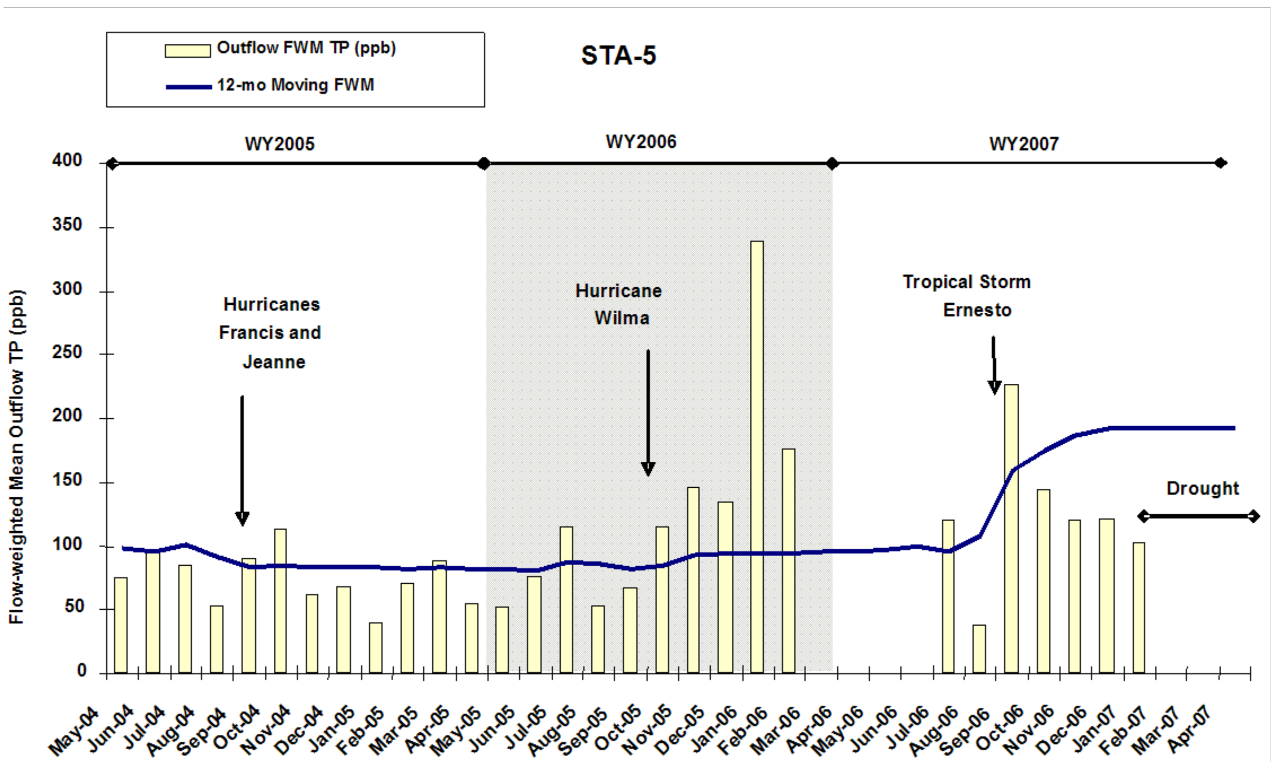


Figure 5-35. Comparison of monthly to 12-month moving average TP concentrations for STA-5 outflow.

Table 5-24. Summary Statistics of 12-month inflow and outflow flow, TP load, and FWM TP concentration for each water year at STA-5.

STA-5 Inflow												
	Flow Volume (ac-ft)				TP Load (mt)				FWM TP (ppb)			
Water Year	Sum	Avg.	Min.	Max.	Sum	Avg.	Min.	Max.	Arithmatic[1]	Min.	Max.	Geo. Mean[2]
2001	50,111	4,176	-9	16,912	15.6	1.3	0.0	6.3	252	36	411	152
2002	158,672	13,223	0	33,805	48.9	4.1	0.0	14.6	250	58	351	142
2003	170,176	14,181	-10	34,612	57.2	4.8	0.0	19.2	272	72	451	166
2004	152,984	12,749	-10	38,692	47.8	4.0	0.0	14.9	254	55	336	137
2005	119,665	9,972	-214	36,759	24.4	2.0	0.0	9.8	165	56	216	117
2006	214,621	17,885	0	34,146	52.3	4.4	0.0	10.0	198	70	263	135
2007	58,690	4,891	0	31,689	21.7	1.8	0.0	15.6	299	95	399	151

STA-5 Outflow												
	Flow Volume (ac-ft)				TP Load (mt)				FWM TP (ppb)			
Water Year	Sum	Avg.	Min.	Max.	Sum	Avg.	Min.	Max.	Arithmatic[1]	Min.	Max.	Geo. Mean[2]
2001	39,976	3,331	0	19,377	4.9	0.4	0.0	2.2	99	68	333	146
2002	126,180	10,515	0	36,323	12.9	1.1	0.0	3.7	83	38	127	70
2003	160,518	13,376	7	41,713	26.5	2.2	0.0	7.9	134	81	249	134
2004	136,466	11,372	12	35,719	16.4	1.4	0.0	4.4	97	58	148	93
2005	121,427	10,119	2	45,489	12.2	1.0	0.0	5.1	82	40	113	72
2006	200,872	16,739	-1	38,505	23.6	2.0	0.0	5.4	95	51	339	108
2007	54,163	4,514	0	41,288	12.9	1.1	0.0	11.5	192	39	226	112

[1]Arithmatic FWM TP calculated using the annual load and flow.

[2]Geometric FWM TP calculated based on monthly FWM TP estimates.

OTHER STA-5 WATER QUALITY PARAMETERS

Compliance with the EFA permit is determined based on the three-part assessment presented in the *Permit Requirements* section of this chapter. Water quality parameters with Florida Class III standards are identified in **Table 5-7**. The monitoring data for parameters other than phosphorus at STA-5 for the water year are presented in Appendix 5-16 and summarized in **Table 5-25**. Discharges from STA-5 were determined to be in compliance with the permit by satisfying criterion one above for all non-phosphorus and non-DO parameters with applicable numeric state water standards. The annual permit compliance monitoring report for mercury in the STAs is in Appendix 5-7 of this volume. In WY2007, total dissolved solids, orthophosphate, total dissolved phosphorus, and dissolved chloride concentrations were found to be higher at the outflow as compared to the inflow. However, because these parameters have no applicable numeric state water quality standards, STA-5 is deemed to be in full compliance with the permit.

Table 5-25. Summary of annual arithmetic averages and FWM for all parameters other than TP monitored in STA-5. Alkalinity is reported as mg/L $CaCo_3$ and nitrite + nitrate is reported as mg/L N. Because these parameters are measured from grab samples and not flow-proportional samples, both the arithmetic of all the samples collected, as well as the means, for those samples collected only during flow events (flow-weighted means) are shown.

Parameter	Arithmetic Means								Flow-Weighted Means			
	Inflow				Outflow				Total Inflow		Total Outflow	
	G342A	G342B	G342C	G342D	G344A	G344B	G344C	G344D	n	Conc.	n	Conc.
Temperature (°C)	25.9	25.4	24.7	24.4	23.2	23.6	23.4	23.5	-NA-	-NA-	-NA-	-NA-
Dissolved Oxygen (mg/L)	6.1	5.8	5.5	5.7	3.0	3.1	4.5	5.4	-NA-	-NA-	-NA-	-NA-
Specific Conductivity (µS/cm)	624	588	593	601	598	584	622	608	-NA-	-NA-	-NA-	-NA-
pH	7.8	7.8	7.7	7.7	7.6	7.7	7.9	8.0	-NA-	-NA-	-NA-	-NA-
Turbidity (NTU)	5.0	5.4	6.6	5.0	3.2	2.2	2.4	2.7	-NA-	-NA-	-NA-	-NA-
Total Dissolved Solids (mg/L)	*406*	*379*	*387*	*384*	*389*	*383*	*413*	*396*	10 (92)	***295***	8 (90)	***308***
Unionized Ammonia (mg/L)	0.002	0.002	0.001	0.001	0.002	0.002	0.003	0.003	10 (92)	0.002	8 (90)	<0.001
Orthophosphate as P (mg/L)	0.031	0.051	0.075	0.087	0.031	0.067	0.053	0.032	29 (183)	**0.177**	22 (179)	***0.182***
Total Dissolved Phosphorus (mg/L	0.050	0.070	0.094	0.105	0.049	0.087	0.086	0.065	30 (182)	**0.202**	21 (177)	***0.206***
Sulfate (mg/L)	13.0	11.4	10.7	11.5	18.8	15.6	9.4	8.5	10 (92)	11.1	8 (90)	10.9
Alkalinity (mg/L)	217	206	212	222	165	158	169	160	10 (92)	154	8 (90)	149
Dissolved Chloride (mg/L)	66	58	57	56	80	78	89	88	10 (92)	**35**	8 (90)	***41***
Total Nitrogen (mg/L)	1.58	1.62	1.75	1.46	1.87	1.93	2.31	2.23	10 (91)	2.05	8 (86)	1.48
Total Dissolved Nitrogen (mg/L)	1.28	1.25	1.29	1.21	1.68	1.70	2.09	2.07	10 (91)	1.69	8 (85)	1.34
Nitrate + Nitrite (mg/L)	0.039	0.048	0.051	0.037	0.074	0.073	0.045	0.024	10 (91)	0.132	8 (87)	0.030

-NA- : Not Applicable
n: number of samples with flow (total number of samples)

Parameters exhibiting excursions are highlighted in grey. Pursuant to EFA Permit Number 0131842, an excursion occurs when outflow flow-weighted mean concentrations exceed inflow FWM concentrations.

STA-5 DISSOLVED OXYGEN MONITORING

The STA-5 Administrative Order No. AO-004-EV in Exhibit C of Permit No. 0131842, February 29, 2000, specifies the DO monitoring requirements as for STA-1W. Since the SSAC has been adopted by FDEP and formally approved by the USEPA (Weaver, 2008), assessment on possible downstream impacts by the outflows from STA-5 during WY2007 will be performed by applying the SSAC limit with respect to DO at outflow stations G-344A, G-344B, G-344C, and G-344D (**Figure 5-33**).

Assessment of DO at STA-5 for WY2007 indicates that two outflow stations (G-344A and G-344B) were below the SSAC limits while the central STA outflow stations G-344C and G-344D were above the SSAC limits (**Figure 5-36** and **Table 5-8**). The annual mean DO levels for stations G-344A and G-344B (i.e, 3.04 and 3.12 mg/L, respectively) were lower than the mean annual SSAC limit by approximately 0.3 and 0.4 mg/L, respectively. The reasons for the lower DO levels at G-344A and G-344B are unclear. However, the District and the FDEP will continue to evaluate DO depression and possible influencing factors. The District and FDEP will continue to evaluate DO depression and possible influencing factors. All of the Northern Flow-ways (which include the G-344A and G-344B outflows) were operational during the entire WY2007. In contrast, the Central Flow-way cells (which include G-344C and G-344D) were not operational the entire year (due to Long-Term Plan Enhancements construction) and both outflows were greater than the SSAC limit.

Biweekly DO levels for WY2007 are available in Appendix 5-8. In addition, a graphical depiction of the biweekly residual differences between measured DO levels and SSAC limits is provided in Appendix 5-9.

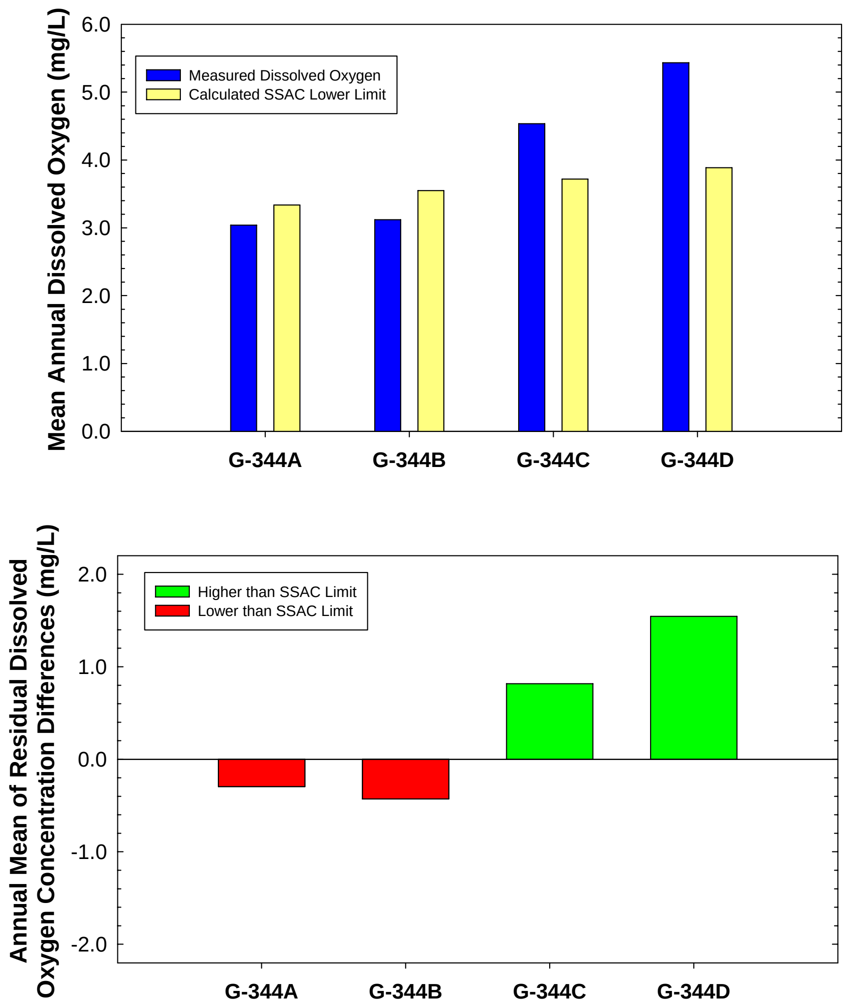


Figure 5-36. Comparison of mean annual DO measured at the outflow stations (G-344A, G-344B, G-344C, and G-344D) for STA-5 during WY2007 with the mean annual SSAC limit derived from the corresponding water temperature and time of day collected at the outflow station (top plot) (**Figure 5-33**). The annual mean residual DO difference between the mean annual DO and mean annual SSAC indicates whether stations were above the SSAC limit (when ≥ zero) or whether stations were below the limit (< zero) (bottom plot). Outflow stations G-344A and G-344C did not meet the SSAC limit for WY2007 while stations G-344C and G-344D did meet the SSAC limit.

STA-5 VEGETATION MANAGEMENT

An overview of the vegetation management activities that occurred in the STAs can be found in the *STA Vegetation Management* section of this chapter.

STA-5 EXPANSION AND COMPARTMENT C BUILDOUT

Expansion of STA-5 includes the construction of an additional 2,560-acre treatment cell, i.e., a new Flow-way 3 that will operate in parallel with existing Flow-ways 1 and 2 with an effective treatment area of approximately 1,985 acres and 6,395 acres for Compartment C Build-out (**Figure 5-1**). Flow-way 3 design was completed in October 2005, and it was flow-capable in December 2006. Final completion, including telemetry and electrical hook-up is scheduled to be completed by late 2007. The design and construction of Flow-way 3 was implemented under the District's Acceler8 program as part of the EAA STA Expansion Project. Additional information on the status of the Acceler8 program is presented in Chapter 7A of this volume.

The Compartment C Build-out, an Acceler8 project located in Hendry County between existing STA-5 and STA-6, will expand the size and enhance the performance of existing STAs created as part of the Everglades Construction Project. Compartment C Build-out, which involves STA construction into the remaining Compartment C areas, is scheduled to be flow-capable by the end of 2010.

STA-6

STA-6 CONFIGURATION

Stormwater Treatment Area 6 (STA-6) consists of Sections 1 and 2, totaling approximately 2,170 acres (**Figure 5-37).** Section 1 contains approximately 870 acres of effective treatment area, arranged in two treatment cells. Cell 5 consists of approximately 625 acres of effective treatment area and Cell 3 consists of approximately 245 acres of effective treatment area. Section 2, in which construction was substantially completed and became flow-capable in December 2007, adds about 1,300 acres of additional treatment area to the STA-5/STA-6 system. This expansion will allow for the capture and treatment of runoff from the C-139 Annex located just west of the L-3 borrow canal.

Previously, inflows into Section 1 were through the G-600 pump station. Currently, water from the L-3 canal enters into the distribution canal via the G-600 pump station, and then enters into Section 2 through the G-396 A-C structures and into Section 1 through the G-353 A-C structures. Flows move easterly by gravity through the treatment cells, and are discharged through several combination box weir/culvert structures (G-352A-C, G-393A-C, and G-354A-C). The treated water is then collected in the discharge canal and enters the L-3 canal downstream of the G-407 structure. Treated water can then move into the L-4 borrow canal and be discharged to the northwestern corner of WCA-3A through a cut in the L-4 and L-3 extension canal or can also be conveyed westerly in the L-4 canal to the Seminole Reservation water supply pump G-409. In accordance with the guidance of the EFA, STA-5 and STA-6 will be operated in a phased approach to achieve the maximum extent practical to improve the quality, timing, and distribution of water entering the northwest portion of WCA-3A.

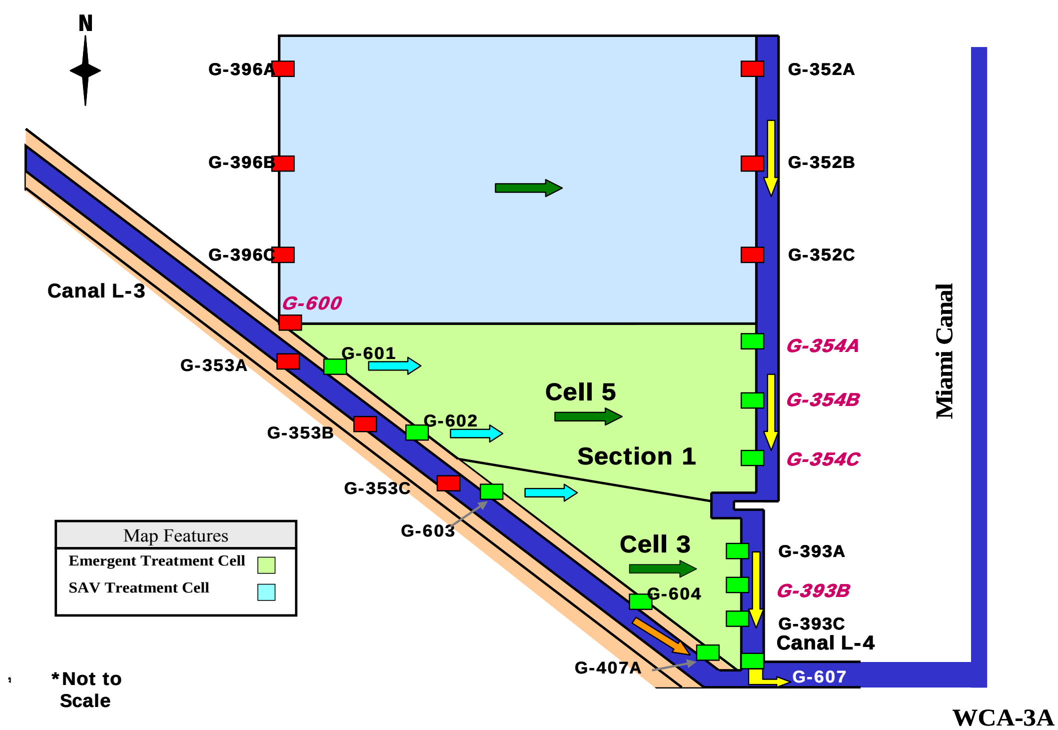


Figure 5-37. Schematic of STA-6 (not to scale). Inflow and outflow sites are designated with red/bold/italic font.

STA-6 WY2007 HIGHLIGHTS

- STA-6 was in compliance with the EFA operating permits for this reporting period. Detailed information about the permit status is found in the *Permit Status* section of this chapter.
- The Section 1 Flow-ways were temporarily offline in February and March 2007 for Long-Term Plan Enhancements and expansion construction (**Table 5-26**).
- Low water conditions were experienced during WY2007 due to the drought and Long-Term Plan Enhancements and expansion construction activities, resulting in dry conditions in Cells 3 and 5 for part of the year. Water delivery and loadings to STA-6 are different from previous years due to the drought, with more frequent inflows delivered through G-507. Additionally, in order to move water from Cell 1B to the Cell 2B, the culvert located in the divide levee (G-245) was opened to supply water to the SAV areas.

Table 5-26. Operational status of the treatment cells in STA-6 from January 2004 through May 2007. Major events such as hurricanes, treatment areas temporarily offline, or Long-Term Plan Enhancements construction are listed.

STA-6 Operational Treatment Cells

<table>
<tr><th colspan="3">2004</th><th colspan="3">2005</th><th>2006</th><th colspan="3">2007</th></tr>
<tr><td>WY2004</td><td colspan="2"></td><td colspan="3"></td><td colspan="4">WY2006</td></tr>
<tr><td colspan="7">WY2005</td><td colspan="2"></td><td>WY2007</td></tr>
<tr><td>Jan -Aug</td><td>Sep
Hurricanes Francis and Jeanne</td><td>Oct - Dec</td><td>Jan - Sep</td><td>Oct
Hurricane Wilma</td><td>Nov - Dec</td><td>Jan - Dec</td><td>Jan</td><td>Feb - Mar</td><td>Jan - May</td></tr>
<tr><td colspan="8">All Flow-ways Operational</td><td>Cell 3 and Cell 5 off-line for LTP Construction</td><td>All Flow-ways Operational</td></tr>
</table>

STA-6 OPERATIONS

STA-6 Hydrology and Total Phosphorus

During WY2007, 32,443 acre-feet (ac-ft) of water, with a TP load of 4.4 mt and a FWM TP concentration of 109 ppb was captured and treated by STA through the G-600 structure (**Tables 5- 2** and **5-27, Figures 5-38** and **5-39**). The hydraulic loading was 3.62 cm/day, which was about 2.7 times the simulated long-term average annual inflow for this STA, and the phosphorus loading was equal to an average of 1.44 g/m^2 over the effective treatment area, about 3.4 times the simulated long-term average annual load (**Table 5-2**). The diversion calculations and the estimates of Lake Okeechobee water received over the water year are found in **Table 5-3**.

The annual volume of treated water discharged through the G-393 and G-354 structures was 16,755 ac-ft with a TP load of 0.9 mt and the FWM TP outflow concentration of 45 ppb (geometric mean 28 ppb), a 59 percent reduction from the inflow concentration. STA-6 reduced TP loads by 79 percent compared to inflow loadings, retaining 3.4 mt of phosphorus. The difference between the inflow and outflow volumes reflects the net contributions of direct rainfall, ET, seepage losses to adjacent lands, deep percolation, and flow measurement error. A summary of monthly flows, loads, and moving 12-month FWM TP outflow concentration is presented in **Figures 5-38** and **5-39**.

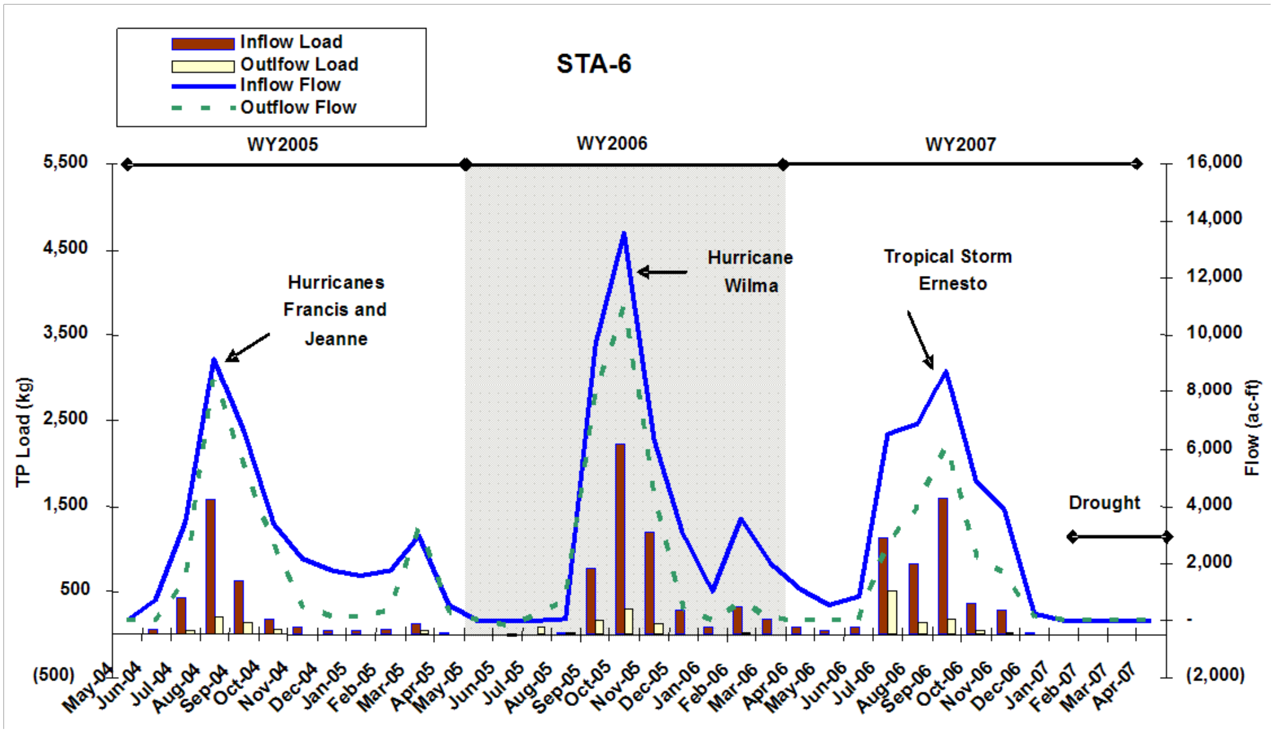


Figure 5-38. Summary of monthly flow and TP load for STA-6 for Water Years 2004–2007. In WY2007, some of the treatment cells were temporarily offline for Long-Term Plan Enhancement construction (**Table 5-26**).

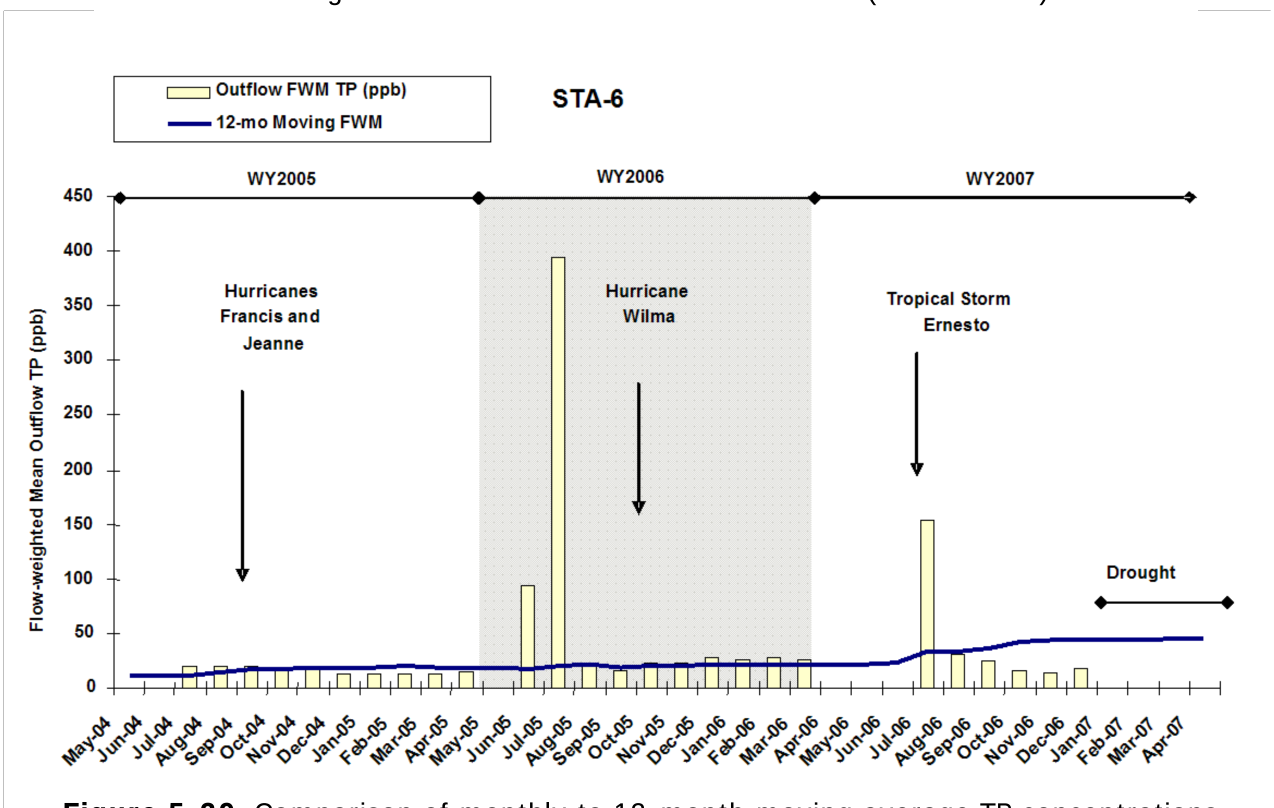


Figure 5-39. Comparison of monthly to 12-month moving average TP concentrations for STA-6 outflow. In WY2007, some of the treatment cells were temporarily offline for Long-Term Plan Enhancement construction (**Table 5-26**).

Table 5-27. Summary statistics of 12-month inflow and outflow flow, TP load, FWM TP concentration for each water year at STA-6.

STA-6 Inflow												
	Flow Volume (ac-ft)				TP Load (mt)				FWM TP (ppb)			
Water Year	Sum	Avg.	Min.	Max.	Sum	Avg.	Min.	Max.	Arithmatic[1]	Min.	Max.	Geo. Mean[2]
2000	59,848	4,987	283	14,734	5.4	0.4	0.0	2.2	73	41	122	60
2001	39,395	3,283	0	12,690	6.8	0.6	0.0	4.2	140	35	271	82
2002	53,437	4,453	239	8,895	4.5	0.4	0.0	1.0	68	32	223	62
2003	56,252	4,688	0	11,939	5.5	0.5	0.0	2.2	79	35	146	60
2004	52,674	4,389	0	10,645	3.4	0.3	0.0	0.9	53	30	74	49
2005	34,035	2,836	0	9,186	3.3	0.3	0.0	1.6	78	21	139	45
2006	40,467	3,372	0	13,592	5.2	0.4	0.0	2.2	104	65	152	90
2007	32,443	2,704	0	8,773	4.4	0.4	0.0	1.6	109	60	146	89

STA-6 Outflow												
	Flow Volume (ac-ft)				TP Load (mt)				FWM TP (ppb)			
Water Year	Sum	Avg.	Min.	Max.	Sum	Avg.	Min.	Max.	Arithmatic[1]	Min.	Max.	Geo. Mean[2]
2000	14,152	1,179	0	7,026	0.2	0.0	0.0	0.1	13	11	14	12
2001	25,866	2,155	0	13,465	1.0	0.1	0.0	0.5	31	14	91	28
2002	30,466	2,539	0	7,883	0.6	0.1	0.0	0.2	16	10	43	15
2003	35,615	2,968	0	11,463	1.1	0.1	0.0	0.4	26	12	69	20
2004	38,682	3,223	0	10,435	0.6	0.0	0.0	0.1	12	10	23	13
2005	22,187	1,849	0	8,478	0.5	0.0	0.0	0.2	19	13	21	16
2006	24,735	2,061	-213	10,958	0.7	0.1	0.0	0.3	23	16	394	36
2007	16,755	1,396	0	6,182	0.9	0.1	0.0	0.5	45	15	154	28

[1]Arithmatic FWM TP calculated using the annual load and flow.

[2]Geometric FWM TP calculated based on monthly FWM TP estimates.

STA-6 OTHER WATER QUALITY PARAMETERS

Compliance with the EFA permit is determined based on the three-part assessment presented in the *Permit Requirements* section of this chapter. Water quality parameters with Florida Class III standards are identified in **Table 5-7**. The monitoring data for non-phosphorus parameters are presented in Appendix 5-17.

Outflow values for silica were slightly higher than inflow values, but because this parameter does not have applicable numeric state water quality standard, discharges from STA-6 are deemed to be in full compliance with the permit (**Table 5-28**). The annual permit compliance monitoring report for mercury in the STAs is in Appendix 5-7 of this volume.

Table 5-28. Summary of annual arithmetic averages and FWM for all parameters other than TP monitored in STA-6. Alkalinity is reported as mg/L $CaCo_3$ and nitrite+ nitrate is reported as mg/L N. Because these parameters are measured from grab samples and not flow-proportional samples, both the arithmetic of all the samples collected as well as the means for those samples collected only during flow events (flow-weighted means) are shown.

Parameter	Arithmetic Means			Flow-Weighted Means			
	Inflow	Outflow		Total Inflow		Total Outflow	
	G600	G354C	G393B	n	Conc.	n	Conc.
Temperature (°C)	24.9	24.6	23.1	-NA-	-NA-	-NA-	-NA-
Dissolved Oxygen (mg/L)	4.3	3.4	1.6	-NA-	-NA-	-NA-	-NA-
Specific Conductivity (µS/cm)	842	786	838	-NA-	-NA-	-NA-	-NA-
pH	7.5	7.4	7.2	-NA-	-NA-	-NA-	-NA-
Turbidity (NTU)	12.8	1.1	1.2	-NA-	-NA-	-NA-	-NA-
Color (PCU)	68	91	96	-NA-	-NA-	-NA-	-NA-
Total Suspended Solids (mg/L)	13.2	2.1	2.1	14 (26)	18.3	20 (29)	1.7
Unionized Ammonia (mg/L)	0.003	<0.001	<0.001	14 (26)	0.003	20 (28)	<0.001
Total Kjeldahl Nitrogen (mg/L)	1.70	1.57	1.54	14 (26)	1.95	20 (29)	1.52
Orthophosphate as P (mg/L)	0.010	0.010	0.014	25 (50)	0.031	39 (55)	0.021
Total Iron (µg/L)	265	77	112	3 (4)	383	4 (5)	128
Silica (mg/L)	10.26	8.86	10.60	3 (4)	**11.06**	4 (5)	***12.55***
Sulfate (mg/L)	18.9	22.5	18.4	3 (4)	26.2	4 (5)	21.7
Alkalinity (mg/L)	295.1	244.3	269.9	13 (25)	293.2	18 (27)	253.8
Dissolved Chloride (mg/L)	81.5	95.4	94.6	14 (26)	87.1	20 (29)	75.7

-NA- : Not Applicable
n: number of samples with flow (total number of samples)

Parameters exhibiting excursions are highlighted in grey. Pursuant to EFA Permit Number 262918309, an excursion occurs when outflow flow-weighted mean concentrations exceed inflow flow-weighted mean concentrations.

STA-6 DISSOLVED OXYGEN MONITORING

The existing EFA permit requires dissolved oxygen to be monitored on a biweekly basis at the inflow (G-600) and outflow compliance points (G354C and G-393B) (**Table 5-28**). Since the STA-6 existing permit does not have diel requirements, no SSAC comparison was performed for this STA for WY2007.

STA-6 VEGETATION MANAGEMENT

Vegetation management involved herbicide application to control willow.

STA-6 EXPANSIONS AND ENHANCEMENTS

Section 2 became flow capable in December 2006. The 1,440-acre cell adds approximately 1,300 acres of effective treatment area to the STA-5/STA-6 system. This expansion will allow for the capture and treatment of runoff from the C-139 Annex located immediately west of the L-3 borrow canal.

The inflows to Cells 3 and 5 were upgraded and gated weirs were constructed by March 2007. Remaining construction, including electrical wiring and telemetry, is estimated to be completed by early 2008. The construction of the STA-6 Enhancements and Section 2 was implemented under the District's Acceler8 program as part of the EAA STA Expansion Project.

ROTENBERGER WILDLIFE MANAGEMENT AREA

ROTENBERGER CONFIGURATION

The Rotenberger Hydropattern Restoration Project is a component of the larger Everglades Construction Project (ECP). The goal of this project is to slow, alter, and eventually reverse the ecosystem degradation within the Rotenberger Wildlife Management Area (RWMA), primarily by restoring the area's natural hydroperiod. This degradation is predominantly caused by overly dry conditions that have resulted in repeated peat fires, soil oxidation and compaction, nutrient release from surface soils, and conversion of obligate wetland vegetative communities to upland-type communities. Anticipated benefits include the preservation of coverage of the remaining desired vegetative species, the encouragement of desirable wetland vegetation, and the initiation of the process of peat formation.

Project features include a 240-cfs electric pump station (G-410) to withdraw treated water from the STA-5 discharge canal for establishing a more natural hydroperiod within the RWMA (**Figure 5-40**). This pump station distributes water through a 3.5-mile-long spreader canal located parallel to the west perimeter levee of the RWMA. Discharges out of the RWMA go into the Miami Canal through four gated culverts (G-402A through G-402D) along the eastern boundary of the RWMA. There is a quarter-mile-long collection canal upstream of each outlet structure.

The FDEP issued a modification to the STA-5 EFA permit to include construction and operational authorization for the project in October 2000. This permit established a phased approach to restoration, and recognizes an interagency group including representatives from the District, FDEP, Florida Fish and Wildlife Conservation Commission (FWC), USACE, and the Friends of the Everglades. The permit requires the interagency group to periodically evaluate the progress the project is making toward achieving its restoration goals.

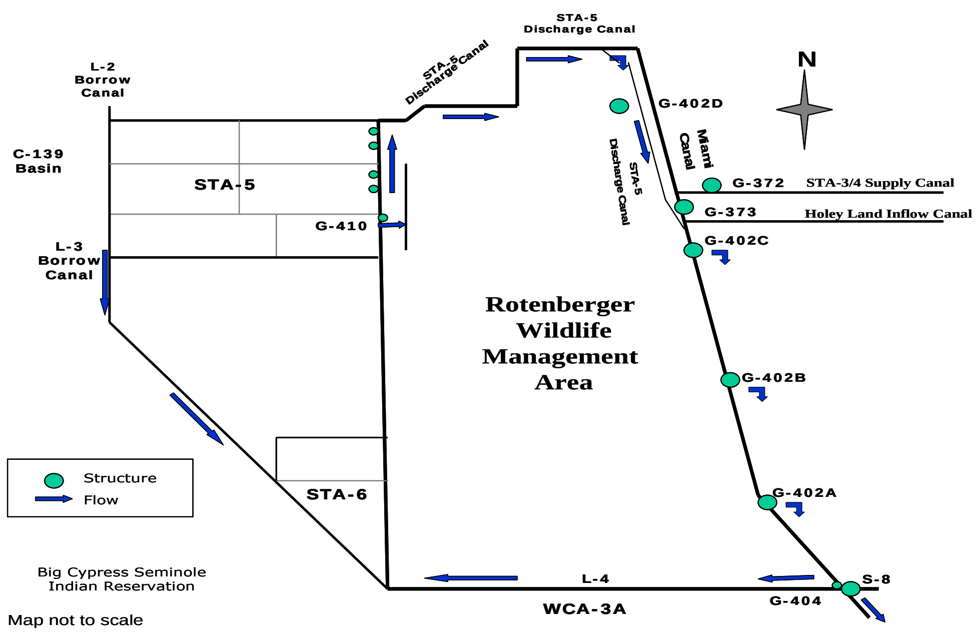


Figure 5-40. Schematic of the Rotenberger Wildlife Management Area (RWMA). Map not to scale.

HYDROLOGIC AND TOTAL PHOSPHORUS LOADS

In WY2007, approximately 16,195 ac-ft was directed into the RWMA through the G-410 structure, while approximately 4,630 ac-ft was discharged to the Miami Canal from the outflow structures (**Figure 5-41**). The difference between inflow and outflow volumes is attributed to high receiving capacity within the RWMA because of low water stages and water loss from a combination of high ET rates and seepage. During the drought period, the area had constantly increasing dense vegetation coverage, mostly *Eupatorium capillifolium* (dog fennel) and temperatures regularly exceeding 100°F within these vegetation stands. The FWM inflow TP concentration was 137 ppb, yielding a total TP inflow load of about 2.7 mt (**Figure 5-42**). As the treatment system in STA-5 stabilizes, TP levels entering the RWMA are expected to decrease. TP concentrations leaving the RWMA averaged 66 ppb, and the total outflow load was only 0.38 mt (**Figure 5-41**). In February 2007, there was a slight amount of inflow (52 ac-ft) entering through the outflow structures (not shown on **Figure 5-41**.)

HYDROPATTERN RESTORATION

The monthly target stages for the RWMA were determined by the Natural System Model (NSM). As noted in the 2007 *South Florida Environmental Report* (2007 SFER), the hydropattern restoration goal was generally achieved for the 2005 calendar year, although it fell short by approximately 0.4 ft at the end of the year (**Figure 5-43**). Rainfall during 2006 and early 2007 was well below average, and as a result, the stage dropped over 1 foot below NSM targets for most of 2006. By February 2007, the water level in northern RWMA (as measured by the Rott.N stage gauge) receded below the bottom of the stilling well. Therefore, the stage appeared to hold steady at 11.11 ft, but was likely substantially below 11 ft. The stage remained at this level through June 2007, and finally began to increase in July.

With drought conditions continuing well into the 2007, the threat of peat fires has been a concern. Beginning in February 2007, the District began evaluating sites throughout the Everglades region for calculated risks of peat fires occurring. It was determined that from February through June, RWMA (especially the northern region) was at a high risk for peat fires. While precipitation cannot be controlled, the District may be able to keep the RWMA tract hydrated longer by adjusting the current operation schedule of the outflow structures (the G-402 A–C). The way in which these structures are operated will be examined in the upcoming year, and a new optimal operating plan will be determined.

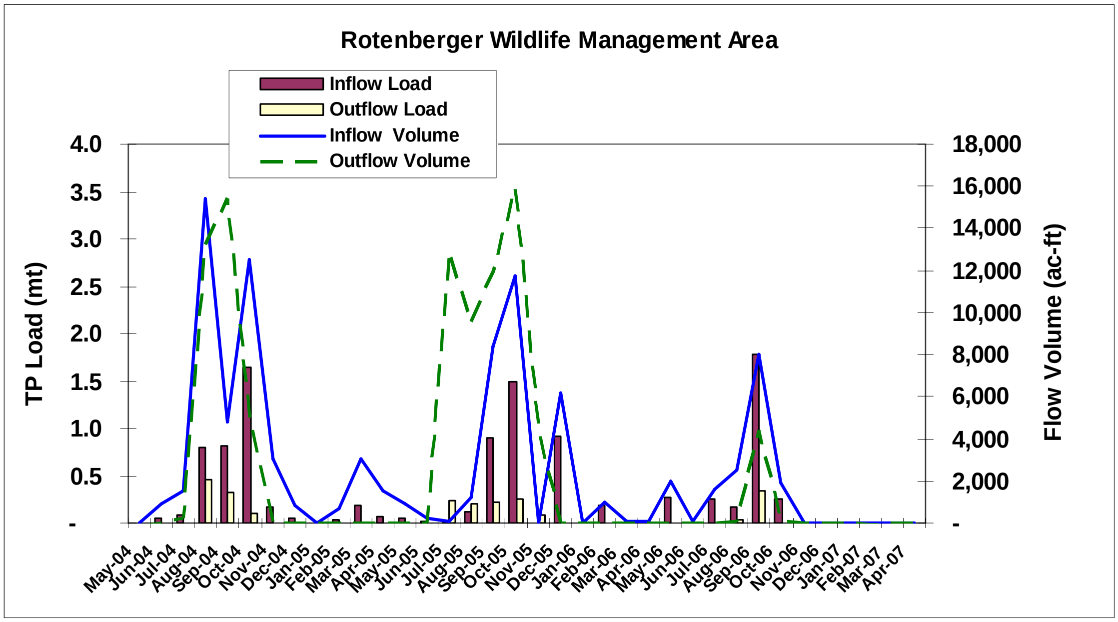


Figure 5-41. Summary of monthly flow and TP load for the Rotenberger Wildlife Management Area (RWMA) for WY2004 through WY2007.

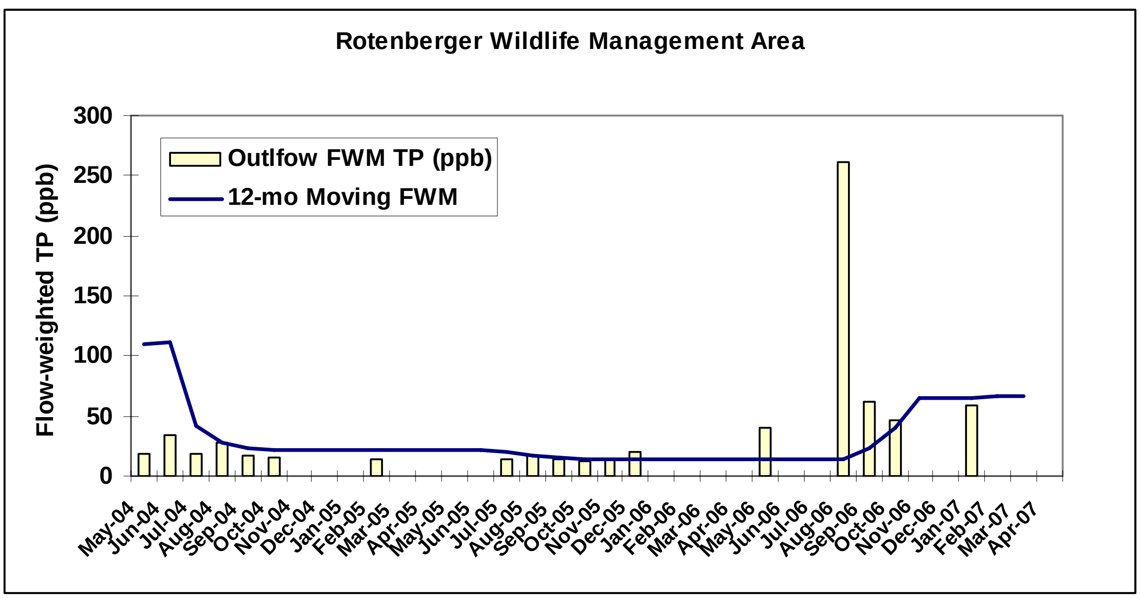


Figure 5-42. Comparison of monthly to 12-month moving average TP concentrations for the RWMA outflow.

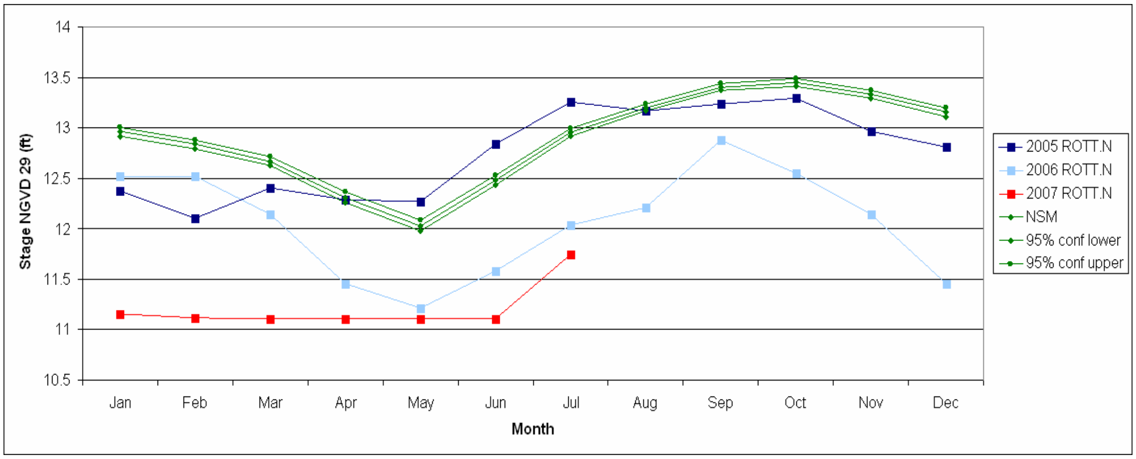


Figure 5-43. Hydrograph displaying the monthly mean target stages with 95% confidence intervals determined by the Natural System Model (NSM) for the RWMA, including a 0.25 foot offset. Also displayed are the mean stages measured at the Rott.N stage gauge within the RWMA for each month from January 2005 through July 2007.

SURFACE WATER QUALITY AND SOIL CHEMISTRY

Surface water quality samples were collected at 8 sites within the RWMA when sufficient water ($\geq$ 10 cm) was available. Mean surface water depth and mean TP were calculated for each station group, with sites closest to inflow displaying the greatest depth and TP concentrations (**Table 5-29**). During 2006, all sites displayed an increase in mean TP concentrations when compared to 2005 results (which can be found in the 2007 SFER – Volume I). This was likely a result of increased surface soil TP concentrations following the large-scale fire that occurred in May 2006.

Soil samples were collected at all 20 monitoring sites in March 2007, but results were not available in time for this report. Soil phosphorus results from 2005 can be found within the 2007 SFER – Volume I.

Table 5-29. Mean surface water TP concentrations (mg/L) and mean water depths (m) measured when water was collected in 2006.

Station Group	Mean SW TP (mg/L)	Mean Depth (m)	N
1 - RA1 & RC1	0.140 ± 0.028	0.31 ± 0.04	10
2 - RA2 & RC2	0.031 ± 0.003	0.16 ± 0.02	7
3 - RA3 & RC3	0.054 ± 0.013	0.15 ± 0.03	5
4 - RA4 & RC4	0.063 ± 0.026	0.18 ± 0.03	6

2006 FIRE ASSESSMENT: SOILS

As mentioned in the 2007 SFER, a severe fire occurred in May 2006, which burned approximately 95 percent of the RWMA. The fire occurred when soils were extremely dry, and as a result, peat fires occurred over portions of the area. Studies were conducted to determine the effect of surface and peat burns on soil nutrient flux after rehydration, and to document post-fire changes in vegetation composition and coverage.

For the nutrient-flux experiment, soil samples were collected immediately after the fire at three sites that experienced both surface and peat fires. Fifteen cores were collected from each burn type. Cores were placed into butyrate tubes and flooded with low phosphorus ambient marsh water. Water samples were collected from the cores 8 hours, 3 days, and 7 days after flooding, and analyzed for soluble reactive phosphorus (SRP). Surface and peat burned soil types displayed nearly identical phosphorus flux rates (13.5 mg SRP $d^{-1}m^{-2}$) during the initial 8-hr flooding period, likely due to flushing effect or quick release of porewater phosphorus and hydrolysis of weakly bonded phosphorus when the water was added. However, after the initial flooding period, the surface burned soils displayed significantly greater phosphorus flux than the peat burned soils ($p = 0.0033$ and < 0.0001 for 3 and 7 days, respectively). This result may be a consequence of an increase in phosphorus binding sites (e.g., calcium and magnesium) in the peat burned soils (Neary et al., 1999).

In addition to the phosphorus-flux soil collection, the 0-2 cm layer of soil was sampled from the same three sites immediately after the fire and analyzed for TP. The mean concentration was calculated for surface burn and peat burn soils, and results were compared to pre-fire conditions. While mean TP concentrations increased significantly in both surface burn and peat burn soils, they increased more than threefold within peat burned soils compared to pre-burn concentrations (**Figure 5-44**).

2006 FIRE ASSESSMENT: VEGETATION RECOVERY

To monitor any changes in vegetation composition and coverage as compared to pre-fire conditions, vegetation surveys were conducted at 20 permanent monitoring sites within the RWMA (**Figure 5-45**). Surveys were conducted using a line-intercept type methodology, i.e., each plant species intercepting the line at each meter along the 10-meter transect was recorded. Sampling sites were categorized and grouped based upon fire intensity along each survey transect: severe peat burn (≥ 50 percent of transect experienced peat fires), limited peat burn (< 50 percent of transect experienced peat fires), and surface burn (transect did not experience peat fires).

Vegetation recovery, as measured by plant density and species richness along the line intercept transects, occurred fastest in surface burn sites, and slowest in severe peat burn sites. The longer recovery time of the peat burned sites was likely due to the fact that seed banks and belowground root systems were destroyed in peat burned soils, while only aboveground vegetation was damaged in surface burn sites.

The relative abundance (RA) of species in surface burn sites remained relatively unchanged six months and one year after the fire, as compared to pre-fire conditions (**Figure 5-46**). A noticeable shift in RA occurred in limited peat burn sites. RA of *Cladium jamaicense* decreased from 52 percent to 40 precent six months after the fire, and decreased to 26 percent one year after the fire. RA of *Polygonum* spp., *Mikania scandens,* and other species, such as *Eupatorium capillifolium,* increased slightly post-fire. The most significant changes occurred in the severe peat burn sites. The RA of *C. jamaicense* decreased from 35 percent to 8 percent six months after the fire, and decreased to 4 percent one year after the fire. The RA of Carolina willow (*Salix caroliniana*) and maidencane *(Panicum hemitomon)* also decreased post-fire, while a variety of *Polygonum* species increased dramatically from < 1 percent of the vegetative community to 34 percent one year after the fire event. Other species (primarily *Cyperus odoratus*) also

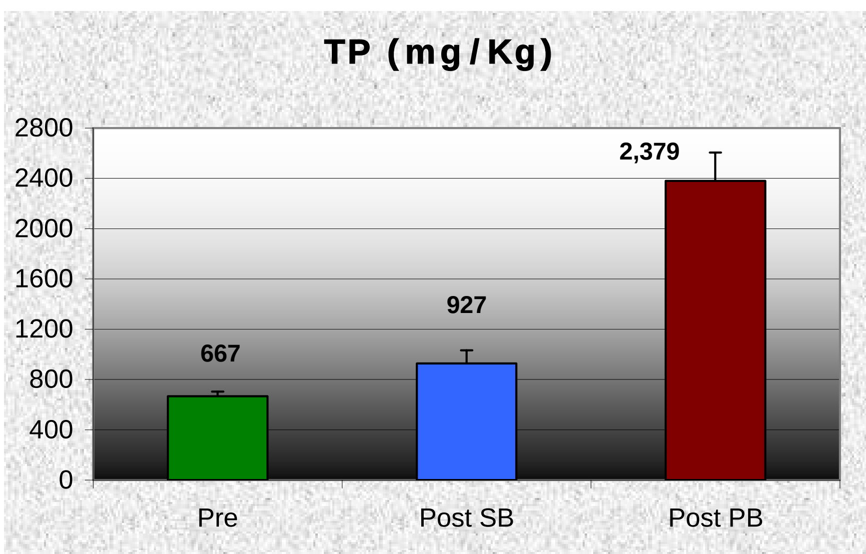


Figure 5-44. Mean pre- and post-fire TP concentrations of the 0-2 cm soil layer at the RC2, RC3, and RC4 sites within the RWMA. The post-fire soil cores were collected at sites that experienced both surface burns (SB) and peat burns (PB) in May 2006.

displayed large increases in RA post-fire in severe peat burn sites. RA of *Typha domingensis* increased in severe peat burn sites six months post-fire, but remained relatively constant in all burn designations one year post-fire, as compared to pre-fire conditions. Previous studies show evidence that the growth of *T. domingensis* may be enhanced by peat burn effects on soil properties (Smith and Newman, 2001). Based on field observations, *T. domingensis* appears stressed within the RWMA due to the drought conditions, and may still increase its overall coverage when the area becomes flooded during the 2007 wet season. Monitoring of these sites will continue through the next year.

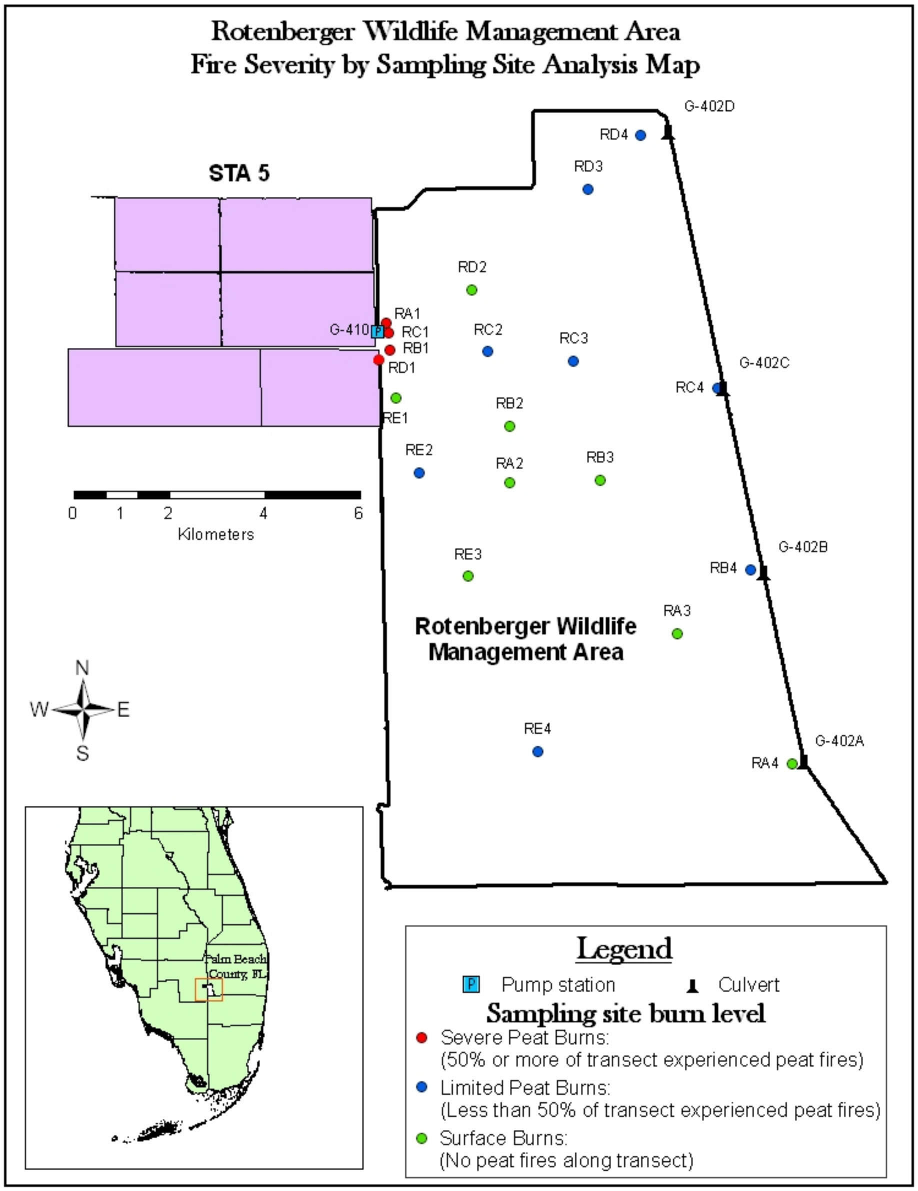


Figure 5-45. Map of sampling sites with the RWMA, color-coded to show fire intensity along vegetation transects.

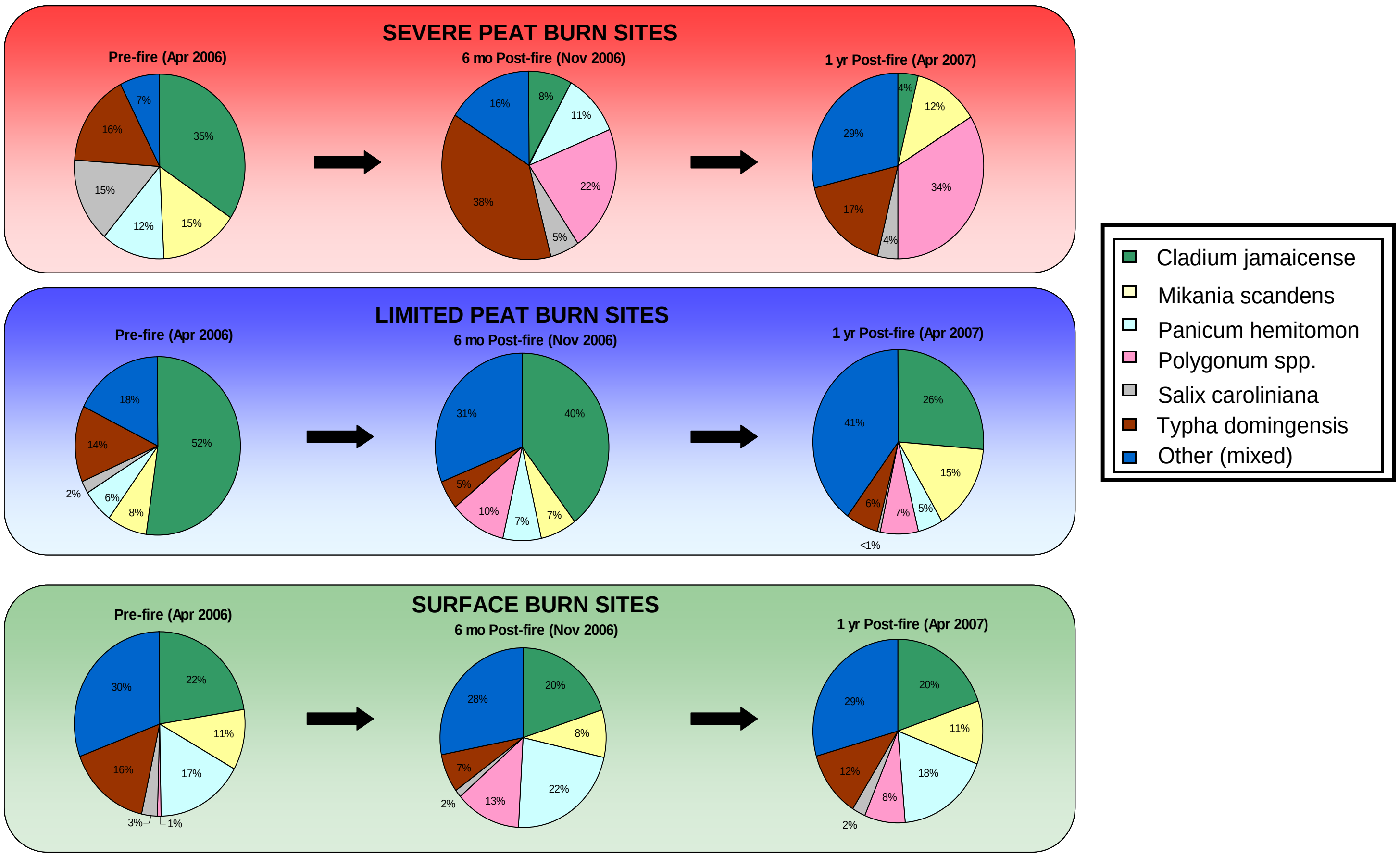


Figure 5-46. Relative abundance of plant species by burn designation: one month pre-fire, six months post-fire, and one year post-fire.

HYDROPATTERN RESTORATION WITHIN NORTHWESTERN WATER CONSERVATION AREA 2A

WATER CONSERVATION AREA 2A CONFIGURATION

In accordance with the Everglades Forever Act (EFA), the Army Corps Section 404, and the National Pollutant Discharge Elimination System (NPDES) permits, the District has been operating and monitoring water discharges from Stormwater Treatment Area 2 (STA-2) into the northwestern region of Water Conservation Area 2A (WCA-2A). The main objective of the STA discharge is to restore the hydropattern and ecological functionality of the marshes downstream of STA-2. These permits require the District to implement a monitoring and assessment program to evaluate ecological changes associated with STA-2 discharges within the northwestern region of WCA-2A by performing field monitoring, research, mapping, and reporting activities.

STA-2 primarily discharges into WCA-2A through six culverts (the G-336A-F structures) (**Figure 5-23**). Sampling stations were established in 1998 to capture environmental changes in this downstream region of WCA-2A. Additional STA-2 effluent is discharge via the G-336G structure into a discharge canal south of STA-2. Approximately one kilometer northeast of the S-7 pump station the levee separating this discharge canal from WCA-2A is degraded, allowing discharge passing through the G-336G to passively enter WCA-2A. In 2005, a new transect (FS-transect) was established to monitor this additional STA-2 discharge.

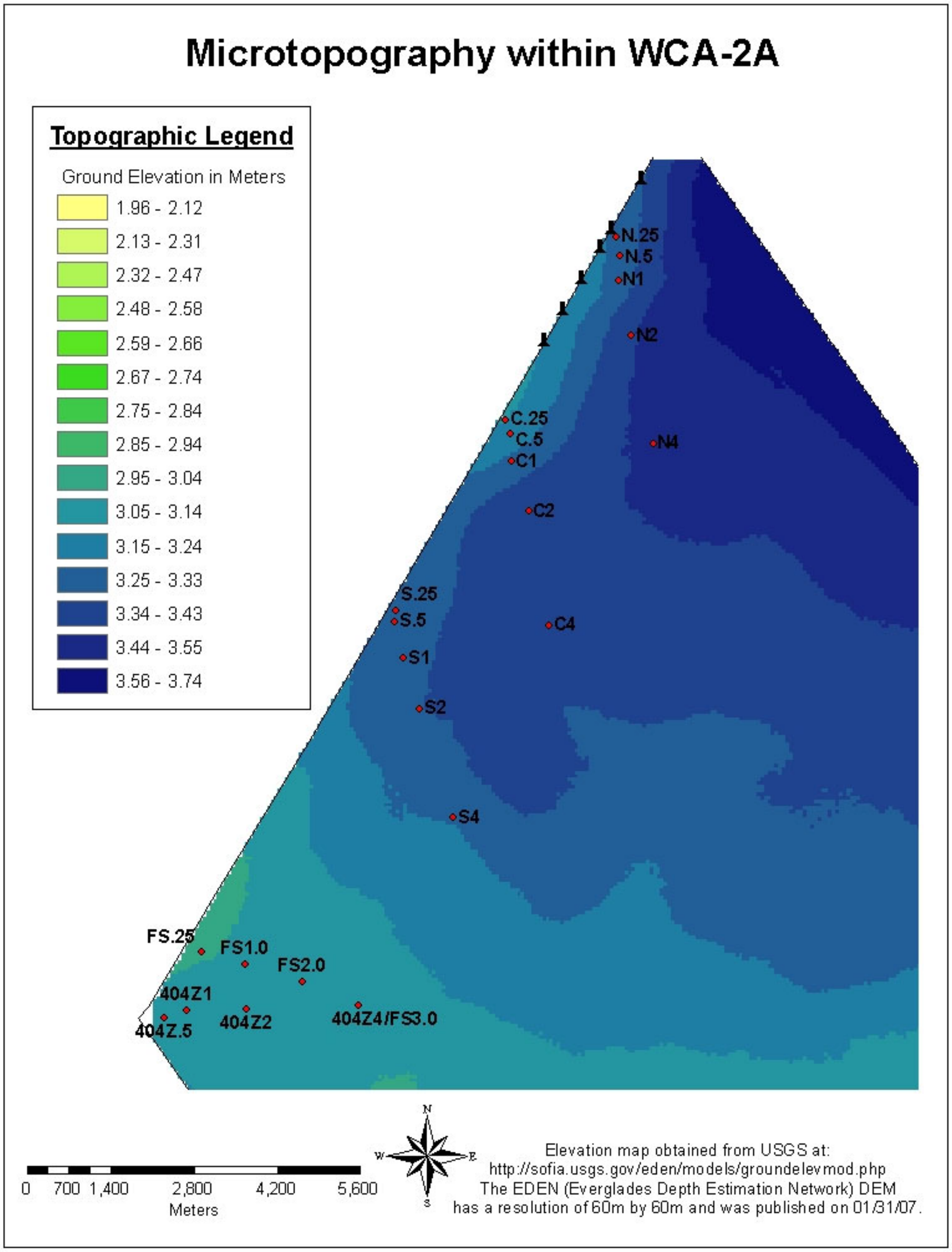


Figure 5-47. Map displaying the topographic contours along the northwestern section of WCA-2A (Source: USGS, 1/31/07).

HYDROPATTERN RESTORATION

Since treated water from STA-2 was released into this region beginning in July 2001, mean water depths have significantly increased ($p < 0.05$; **Table 5-30**), and hydroperiod has also increased from under five months to just less than 10 months. The increased hydroperiod benefits the area through decreased soil loss due to oxidation.

Table 5-30. Mean water depths (with standard deviations) at selected stations within WCA-2A, pre- and post-STA-2 discharge.

Station	Mean Water Depth (m) ± St Dev		Number of Water Measurements	
	Pre-Discharge Jul '98 - Jun '01	Post-Discharge Jul '01 - Jun '06	Pre-Discharge Jul '98 - Jun '01	Post-Discharge Jul '01 - Jun '06
$N_{0.25}$	0.12 ± 0.20	0.53 ± 0.28	35	58
$N_{1.0}$	0.10 ± 0.17	0.51 ± 0.30	35	58
$N_{2.0}$	0.04 ± 0.11	0.27 ± 0.22	35	56
$N_{4.0}$	0.07 ± 0.13	0.27 ± 0.19	35	57
$C_{0.25}$	0.14 ± 0.21	0.51 ± 0.27	35	58
$C_{1.0}$	0.08 ± 0.15	0.33 ± 0.20	35	57
$C_{2.0}$	0.05 ± 0.12	0.27 ± 0.23	35	57
$C_{4.0}$	0.07 ± 0.13	0.20 ± 0.15	35	56
$S_{2.0}$	0.08 ± 0.14	0.21 ± 0.18	35	56
$S_{4.0}$	0.19 ± 0.22	0.33 ± 0.21	34	57

SURFACE WATER QUALITY

Notched box and whisker plots were used to demonstrate surface water phosphorus concentrations before and after discharges began in 2001. Surface water total phosphorus decreased at most of the sampling locations (**Figures 5-47** and **5-48**). There were significant increases in surface water conductivity and major ions, including sulfate, in the area during the post-discharge period. However, it should be noted that the post-discharge sulfate concentration of 60.8 ± 1.0 mg/L is within the same range as what is found in the rest of WCA-2 and STA-2 discharge surface water (Gilmour et al., 2007). The apparent increase in conductivity and sulfate in WCA-2A is likely due to the fact that prior to receiving STA-2 discharge, the area's only source of hydration was rainwater. While the interior of WCA-2 had elevated sulfate concentrations prior to 2001, this northwestern corner had relatively low sulfate concentrations (ranging between 4.9 mg/L and 16.7 mg/L) likely due to the high elevation sawgrass ridge approximately 2 km from the L-6 levee extending from the N-2.0 station to the S-2.0 station which isolated the area from the interior marsh (**Figure 5-47**).

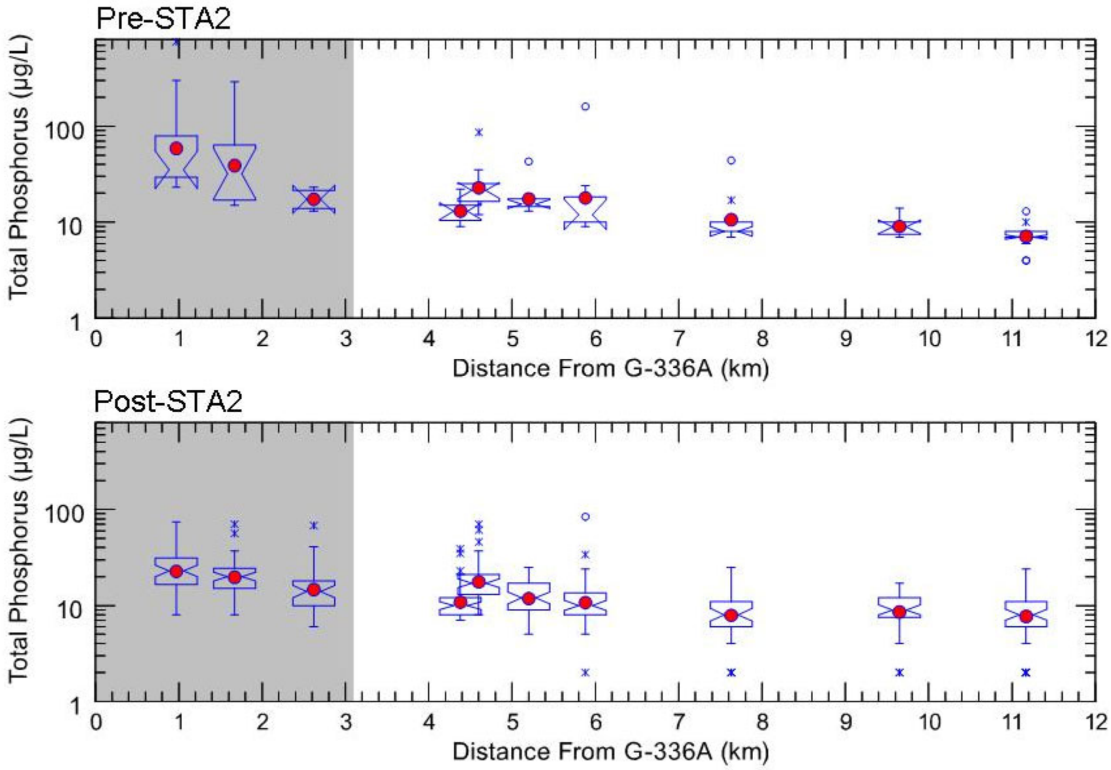


Figure 5-48. Pre- and post-discharge surface water total P (TP) concentrations representing all transect locations plotted against distance from G-336A (Grayed-out area represents the distance between Culvert A and F). The open circle represents data greater than four SDs above the median, the asterisk represents data greater than two SDs above the median, the upper whisker is the maximum data value or the highest value not outside two SDs, the top of the box is the 75th percentile, the filled circle represents mean concentration, the notch represents the 95% confidence interval around the median, the bottom of the box is the 25th percentile, and the lower whisker is the minimum data value or the lowest value not outside two SDs.

SOIL WATER QUALITY

There were significant increases in porewater dissolved phosphorus (**Figure 5-49**) observed at some of the stations, likely due to hydrolysis of soil TP and iron reduction resulting in release of TP. Soil TP displayed no significant changes between pre- and post-discharge periods except for one transect location. The C-4.0 station displayed the only significant increase in soil TP, although the mean post-discharge concentration still remained below the 500 mg/kg criteria for impacted sites (DeBusk et al., 1994; **Figure 5-50**).

PERIPHYTON

The nutrient content (TP, total nitrogen, and total carbon) of periphyton tissues decreased significantly between the pre- and post-discharge periods (**Figure 5-51**). Relative abundance of periphyton species associated with nutrient-poor environments increased and relative abundance of the species associated with nutrient-rich environments decreased. These changes likely indicate a beneficial effect of decreased surface water TP. Both the decrease in tissue nutrient content and changes in relative abundance results indicate an improvement in the area, possibly a result of STA-2 discharge.

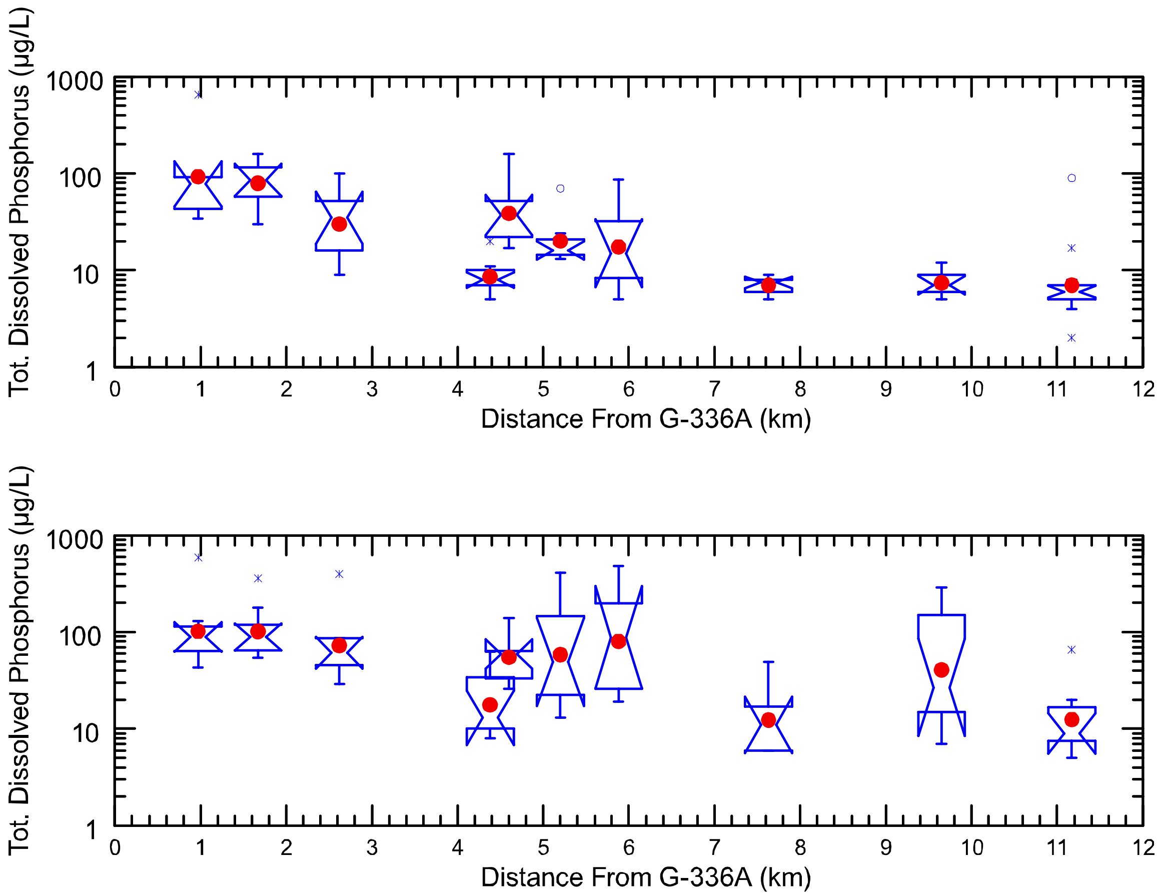


Figure 5-49. Porewater pre- and post-discharge total dissolved phosphorus (TDP) concentrations representing all transect locations and plotted against distance from G-336A. The box and whisker designations are described in the legend for **Figure 5-48**.

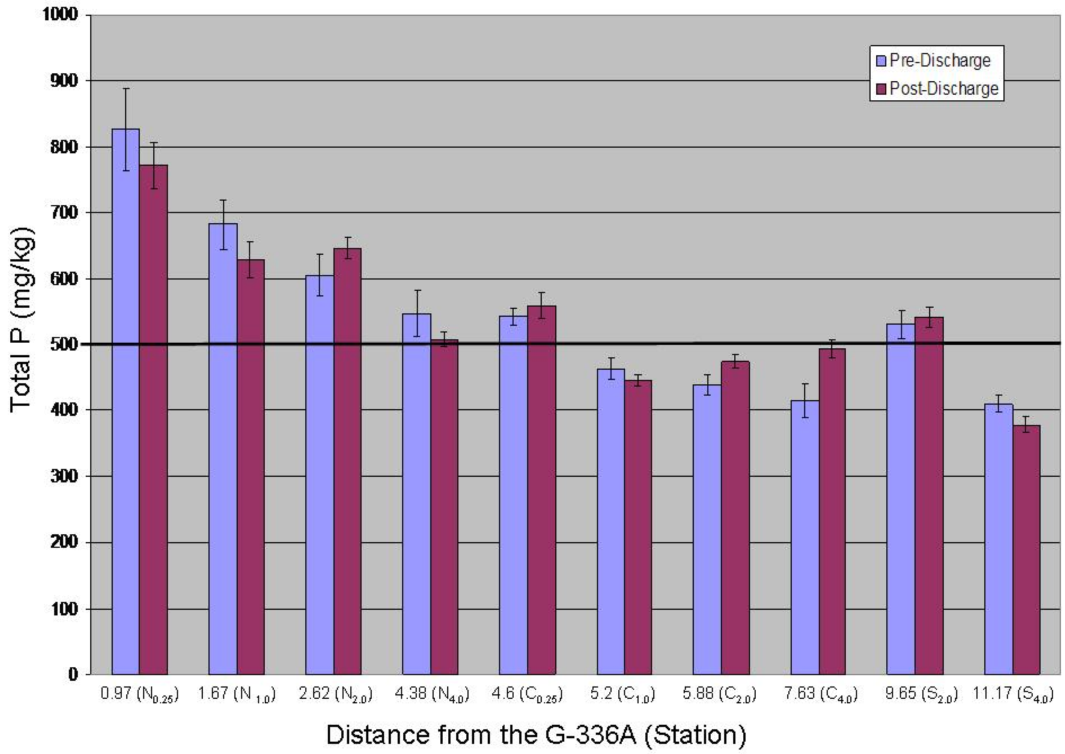


Figure 5-50. Mean total phosphorus concentrations (± standard error) within the 0-10 cm layer of soil before and after STA-2 discharge. Results are displayed from the 10 stations that were continuously sampled from 1998 through 2006. The 500 mg/kg concentration level has been presented in bold; those stations that exhibit soil phosphorus concentrations that are greater than 500 mg/kg are considered to be nutrient impacted. From each station, nine samples were collected over three sampling events during pre-discharge period and 12 samples were collected over four sampling events during the post-discharge period.

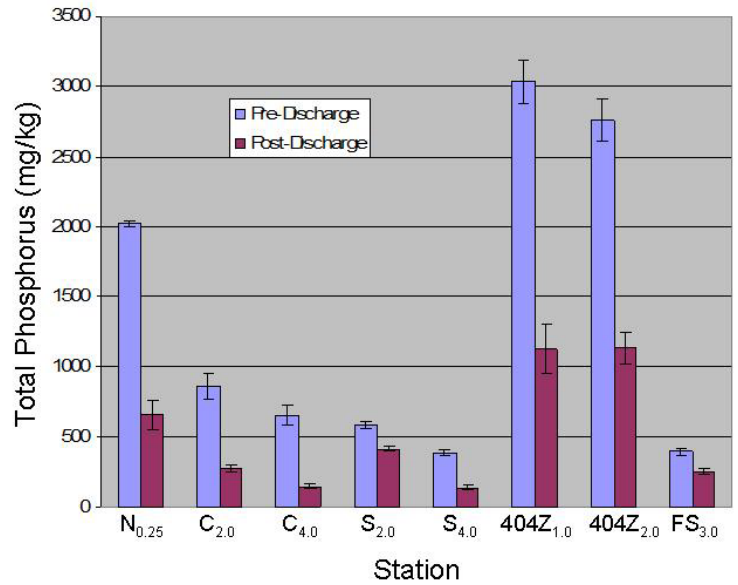


Figure 5-51. Mean total phosphorus concentrations (± standard error) within the periphyton tissues before and after STA-2 began discharging effluent into western WCA-2A during 2001.

VEGETATION

Sawgrass and cattail displayed mixed evidence of any significant changes in nitrogen and phosphorus concentrations within their root and leaf tissues. Sawgrass N:P ratios most accurately reflect the nutrient gradient that exists from the L-6 levee into the interior marsh; this gradient has changed little since STA-2 began operating in 2001.

SUMMARY

In summary, these results indicate that there have been improvements at several previously impacted sites and there was generally no negative impact at previously unimpacted sites in WCA-2A resulting from STA-2 discharge. The positive impacts include increased hydroperiod and hydropattern, decreased surface water TP, steady soil TP concentrations, increased relative abundances of low nutrient periphyton indicator species, decreased relative abundances of high nutrient periphyton indicator species, and decreased nutrient content in periphyton tissues. A more in-depth report describing the evaluation of WCA-2A before and after STA-2 discharges was scheduled to be available in late 2007.

ANALYSIS AND INTERPRETATION

One of the major objectives of the Process Development and Engineering component of the Long-Term Plan is to monitor the physical/chemical environment and nutrient sequestration in the STAs. This effort was included in the plan in the belief that a better understanding of wetland structure and function will assist the District in optimizing performance of these treatment systems. The Analysis and Interpretation Project contributes to this goal by analyzing water quality at interior sites throughout each STA and developing water and constituent mass balance budgets for individual STA treatment cells or flow-ways (hereafter collectively referred to as "cells"). The District conducts the field sampling and laboratory analyses associated with this effort under the ECP Operations Monitoring Project. The following water quality parameters were monitored at the inflow and outflow to each cell: TP, soluble reactive phosphorus (SRP), total dissolved reactive phosphorus (TDRP), ammonia-nitrogen (NH_4), nitrite + nitrate-nitrogen (NO_x), total kjeldahl nitrogen (TKN), chloride (Cl), calcium (Ca), and alkalinity. TP was collected as either flow- or time-proportioned composite samples plus separate grab samples on a weekly basis. All other parameters were collected as biweekly grab samples. Dissolved organic phosphorus (DOP) was calculated as TDRP – SRP; particulate phosphorus (PP) was calculated as TP – TDRP; total nitrogen (TN) was calculated as TKN + NO_x.

Annual water budgets were developed for STA-1E (Cells 3, 4N, 4S, 5, 6, and 7;), STA-1W (Cells 1, 2, 3, 4, and 5), STA-2 (Cells 1, 2, and 3), STA-3/4 (Cells 1A, 1B, 2A, 2B, and 3), STA-5 (North and South Flow-ways), and STA-6 (Cells 3 and 5) using data available for each STA over the period of record (POR) from WY2001 to WY2007 (Appendix 5-18, Table 1**)**. Surface flow was calculated using the flow equations developed for the structures. Groundwater outflow was not directly measured in the STAs. This component of water budgets was estimated as seepage through the perimeter levees and is based on head differences between the STA and outside water levels, levee length and a first-order seepage coefficient (cfs/mi/ft) optimized for each STA. Groundwater outflow was estimated on a daily basis and aggregated over longer periods. The STA cell by cell water budgets were developed using the best available data, some of which is preliminary and subject to revision. Future reports will reflect the updated data as it becomes available.

Annual mass balance budgets were developed for each cell for the following constituents: TP, SRP, DOP, PP, TN, NH_4, NO_x, Cl, Ca, and alkalinity (Appendix 5-18, Tables 2 through 11). The mass loads in surface water inflow and outflow were calculated using a Microsoft Excel application developed by the District (Reardon and Germain, 2005) and the same POR as the corresponding water budget. Both positive and negative flows at water control structures were used in these calculations. The mass load in precipitation was based on annual rainfall volume multiplied by the median water quality constituent concentration in rainfall monitored at STA-1W (site ENR308) from January 2000 through June 2006. The mass load in groundwater outflow was based on the annual groundwater outflow volume (where available) multiplied by the annual geometric mean of the inflow and outflow annual flow-weighted mean concentrations for each cell. Residuals to the mass balance budgets were regarded as mass retained within the cell. Flow-weighted mean concentrations, areal mass loading rates and removal coefficients, i.e., *k* values, were computed for all water quality constituents in each cell on an annual and/or POR basis. Removal coefficients were calculated as first-order rate constants following Kadlec and Knight (1996):

$$k = \ln\left(\frac{C_{in}}{C_{out}}\right) \times \left(\frac{(Q_{in} + Q_{out})/2}{A}\right) \times (12/\Delta t)$$ ***Equation 5.1***

where k is the removal coefficient (m/yr), C_{in} is the constituent flow-weighted mean inflow concentration (mg/L), C_{out} is the constituent flow-weighted mean outflow concentration (mg/L), Q_{in} is the inflow water load (m^3), Q_{out} is the outflow water load (m^3), A is the cell surface area (m^2), and Δt is number of months.

All cell water budgets were dominated by surface flow (Appendix 5-18, Table 1), which is consistent with the composition of water budgets in other treatment wetlands (Nungesser and Chimney, 2006). Groundwater and precipitation in the STAs usually made up less than 10 percent of the total inflow water volume, while surface outflow made up ≥ 80 percent of total outflow. Exceptions to this generalization occurred in the South Flow-way of STA-5 and STA-6 Cells 3 and 5, where seepage losses and evapotranspiration made up 33 to 40 percent of POR outflow. Except for STA-1E, all cells had both positive (i.e., more outflow than inflow) and negative (i.e., more inflow than outflow) water budget residuals, suggesting a random component to the uncertainty in these computations. More than one-third of annual water budgets (33 of 85 budgets) had errors ≥ 20 percent, which was attributed primarily to inaccuracies in measuring surface flow under low head conditions in the STAs. Flow computations at interior water control structures in the STAs are based on headwater and tailwater stage differences, which are often close to the measurement accuracy of the stage recorders [± 3 millimeters (mm)]. Small uncertainties associated with measuring stage cause error in flow estimates. Cell inflow was strongly correlated with outflow (**Figure 5-52**). There was a 10-fold difference among cells in mean annual inflow [19.8 to 208.5 hm^3 (~16,000 to 169,000 ac-ft]. The corresponding range of areal loading rates was approximately 1.5 to 10.9 cm/day, more than a seven-fold difference. Cells 1, 3, and 4 in STA-1W had markedly higher areal loading rates compared to the other cells. The STAs generally have treated much more water than was anticipated during design (see the *STA Performance Synopsis* section in this chapter).

Given the importance of surface water in the cell water budgets, it was not unexpected that the corresponding constituent mass budgets were also dominated by contributions from surface water. Precipitation made up 5 percent or more of the POR inflow mass load only in NH_4 and NO_x budgets for some cells in STA-1E, 3/4, 5, and 6. Likewise, POR outflow loads were dominated by surface water, although groundwater contributions were ≥ 10 percent of the outflow load in all mass budgets for STA-2 Cell 3, the North and South Flow-ways of STA-5 and STA-6 Cells 3 and 5. Cell outflow TP levels were correlated with TP inflow (**Figure 5-53**); higher inflow TP resulted in correspondingly higher outflow TP and reflects a characteristic response of treatment wetlands to increased P loading (Kadlec, 2006). The variance unaccounted for in the STA TP relationships can be attributed to among-cell differences in treatment efficiency and/or uncertainty in the flow and water quality data. A similar inflow-outflow response was evident for most other constituents (Appendix 5-18, Tables 1 and 2). The POR data (**Figure 5-53** and Appendix 5-19) support the observation of Juston and DeBusk (2006) that cells loaded at ~ 1.3 g TP/m^2·yr or less were likely to have outflow TP concentrations of 0.30 mg/L or less regardless of their vegetation community type.

Inspection of the time-series of annual percent TP mass retained indicated that all the cells in STA-2 and STA-6 Cell 5 consistently achieved at least 50 percent TP retention while the other cells surpassed this (arbitrary) benchmark only in some years and on a few occasions actually exported TP on a net basis, i.e., had negative mass retention (**Figure 5-54**). [Time-series for STA-1E and STA-3/4 are not included in **Figure 5-54** because as of this report there were only one and two years of data for the treatment cells in these STAs, respectively] STA-1W Cell 1 and STA-5 North Flow-way exhibited a steady decline in TP mass retention from WY2001 to WY2005 but recovered in WY2006 and WY2007. No other temporal trends were obvious in these data. Annual k values exhibited similar relationships; k values in all cells in STA-2 and STA-6 were generally at or above 10 m/yr, while k values in most other cells, with the exception of STA-1W Cell 4, were below this (arbitrary) benchmark (**Figure 5-55**). No consistent temporal trends were evident in these data. The POR for STA-1E (1 yr) and STA-3/4 (2 yr) is too short to detect temporal trends. Less then 50 percent of TP mass was retained in most cells of STA-1E (Appendix 5-19), while Cells 3, 4N, and 4S had k values greater than 10 m/yr and the remaining cells had lower values (Appendix 5-20, Table 3). Annual TP mass retained in STA-3/4 was quite variable with most cells exhibiting retention both well above and below 50 percent; k values were above 10 m/yr in all cells but Cells 2B and 3.

Two of the three cells with well-established SAV communities, STA-1W Cell 4 and STA-2 Cell 3 (note that STA-1W Cell 5b was not analyzed separately from Cell 5a for this report), had POR k values of 28.6 m/yr and 24.6 m/yr, respectively, which was markedly higher that k values for the other cells (1.2 m/yr to 18.3 m/yr) (Appendix 5-20 Table 3). STA-1W Cell 4 had the highest annual k value (82.5 m/yr in WY2003) which was comparable to previous TP removal coefficients calculated for this cell when it was operated as part of the Everglades Nutrient Removal Project from 1994 through 1999 (see Figure 6-26 in the *2000 South Florida Environmental Report – Volume I*).

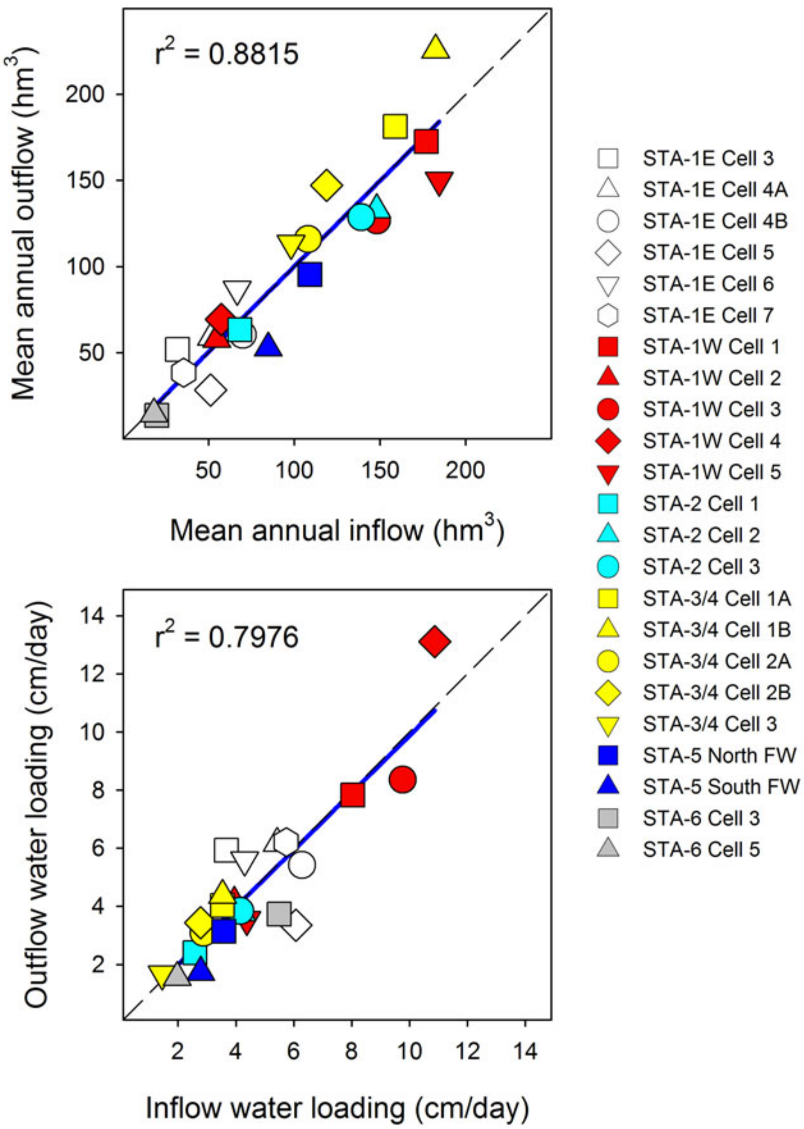


Figure 5-52. Comparison of period of record mean annual inflow and outflow water loads (top panel) and water loading rates (bottom panel) in the flow-ways and treatment cells of the Everglades Protection Area Stormwater Treatment Areas. Dashed lines represent a 1:1 relationship of inflow with outflow; heavy blue lines are linear fits through the data.

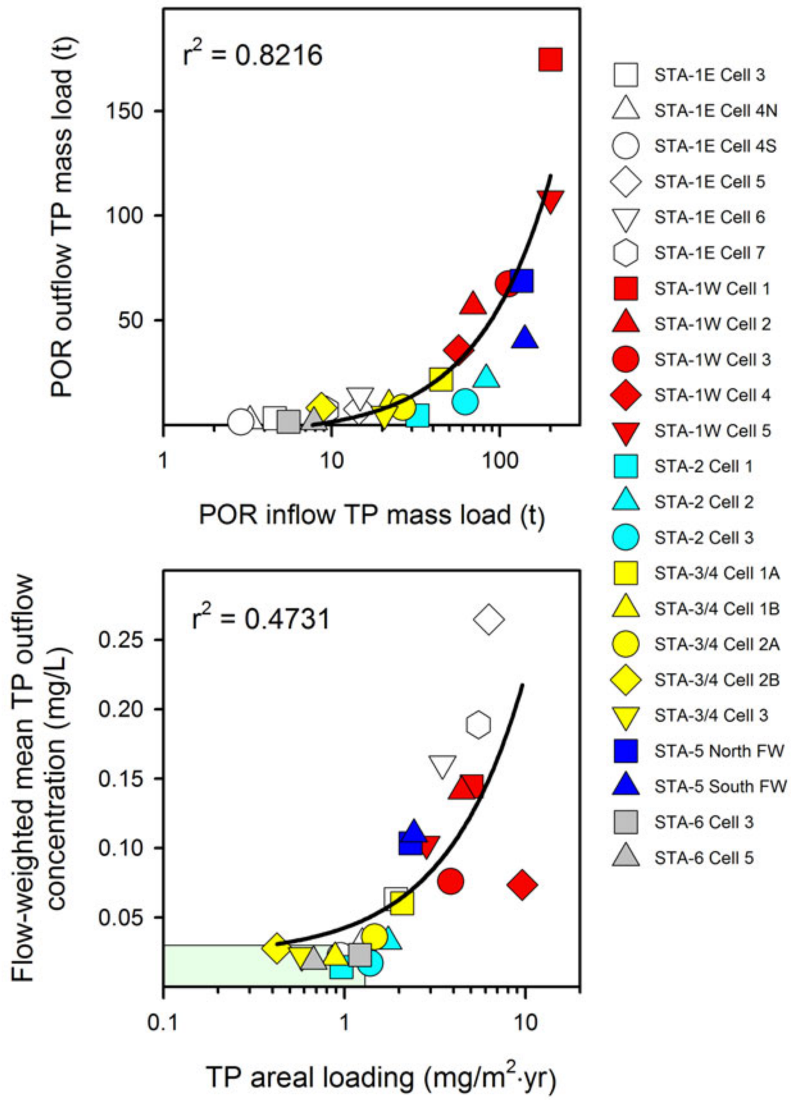


Figure 5-53. Period of record inflow versus outflow total phosphorus (TP) loads (top panel) and TP areal mass loading rate versus flow-weighted mean outflow concentration (bottom panel) in the flow-ways and treatment cells of the Everglades Protection Area Stormwater Treatment Areas. Lines are linear fits through the data. The shaded area in the bottom panel marks the region where areal loading is ≤ 1.3 $g/m^2 \cdot yr$ and outflow concentrations are ≤ 0.03 mg/L; see text for details.

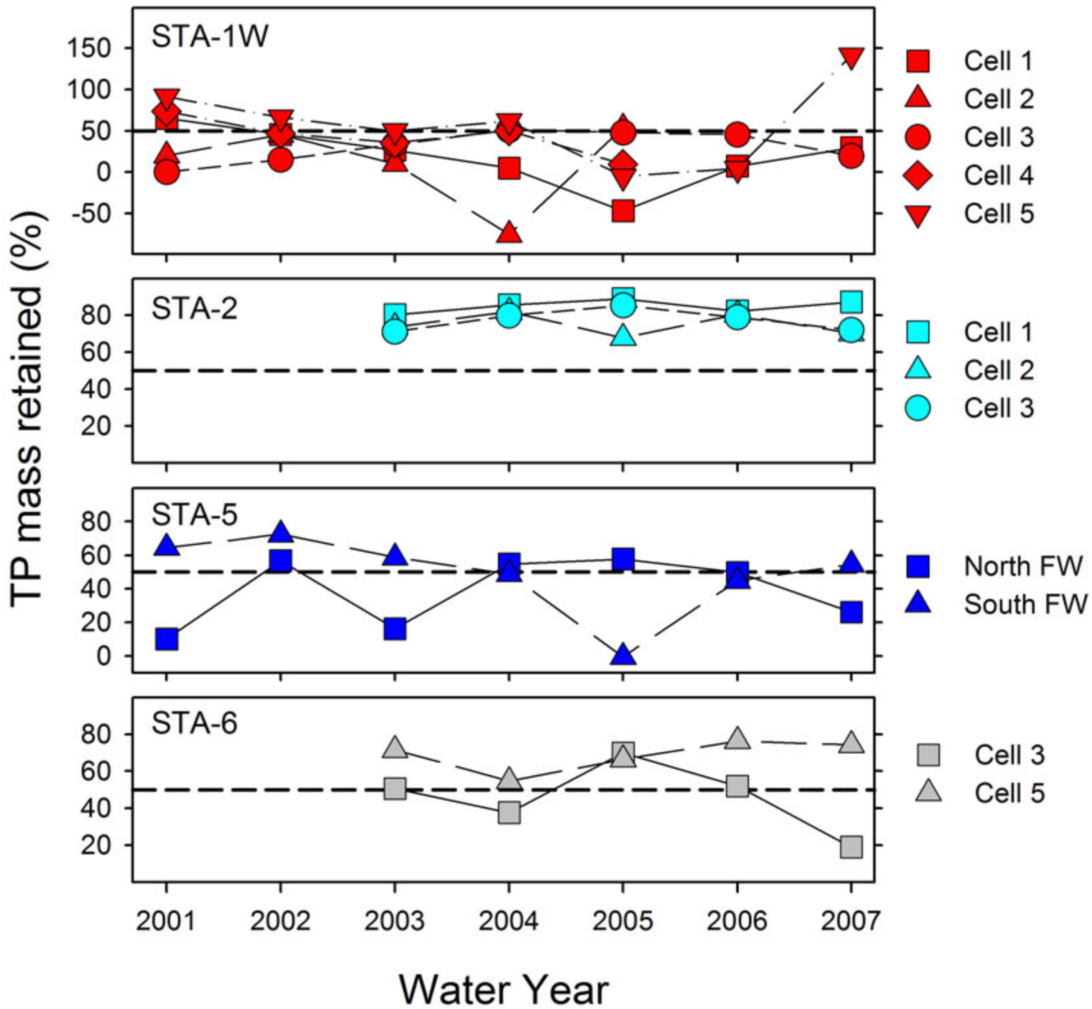


Figure 5-54. Temporal trends in the percent mass of total phosphorus retained in the flow-ways and treatment cells of Everglades Protection Area Stormwater Treatment Areas 1W, 2, 5, and 6. Dashed horizontal lines indicate the 50 percent mass retained benchmark described in the text.

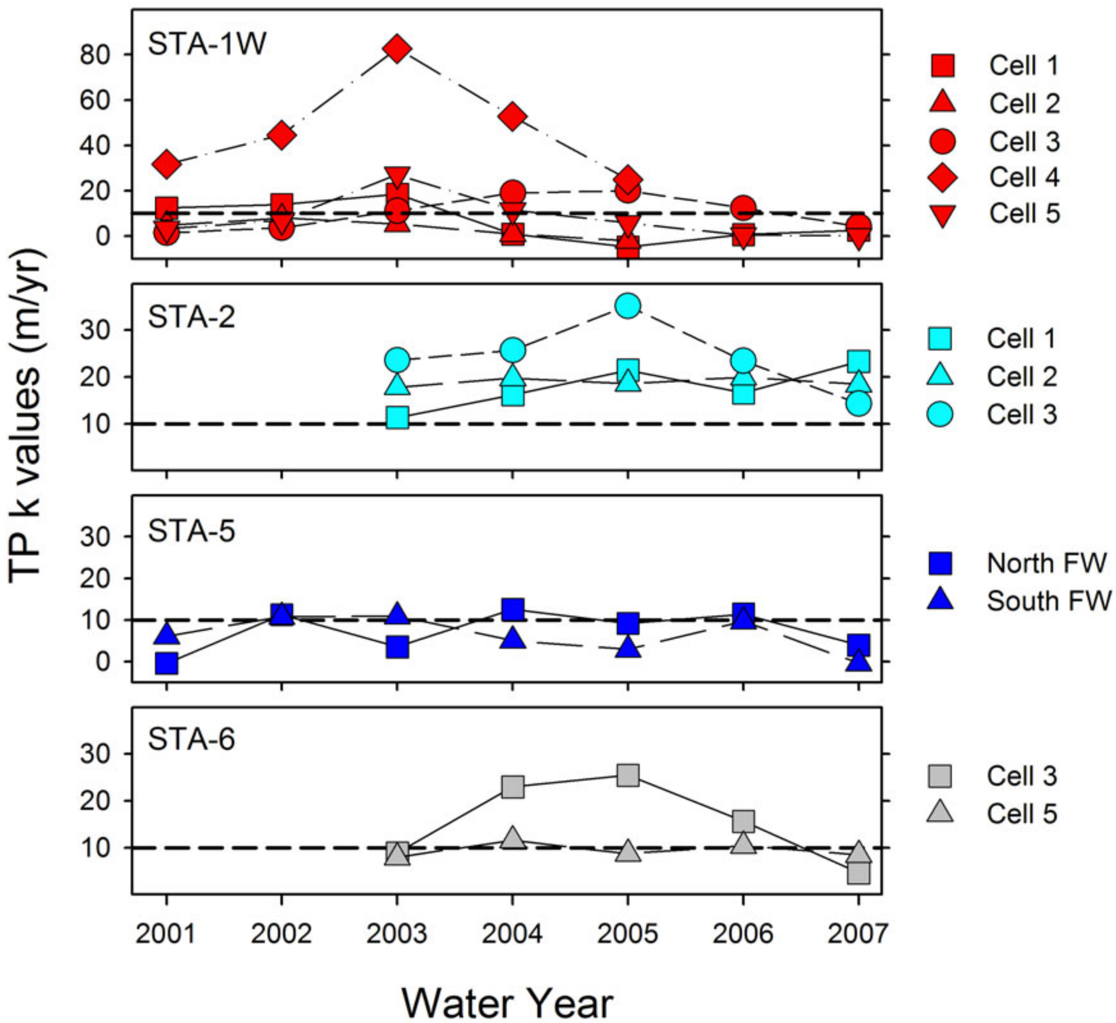


Figure 5-55. Temporal trends in k values for total phosphorus retention in the flow-ways and treatment cells of Everglades Protection Area Stormwater Treatment Areas 1W, 2, 5. and 6. Dashed horizontal lines indicate the 10 m/yr benchmark described in the text.

STA PERFORMANCE SYNOPSIS

The performance of the STAs beginning at start-up operations is shown in **Table 5-31,** and a timeline showing the water year of operation for the STAs is shown in **Table 5-1**. The flow and TP estimates are slightly different than those presented last year due to updates in the database as well as a change in the load calculation methodology. This water year, the STA TP load estimates have been calculated to take into account flow that moves in the opposite way than intended (termed negative flow). This modification changes the TP load and FWM TP estimates, resulting in lower loading estimates. Some of the previous water year estimates have changed, mostly at the STA-3/4 outflows, STA-5 inflows, and STA-6 inflows. Additionally, to account for water used for pass-through or irrigation, the flow data used to estimate inflows for STA-1E, STA-2, and STA-3/4 have been modified (see individual STA sections for details).

The annual flows, TP loads, and FWM TP concentrations going into and out of each STA are presented in Appendix 5-1, along with graphs of the outflow FWM TP concentration and estimated phosphorus and hydraulic loading rates. The water budgets and phosphorus mass balance calculations for each treatment cell for each STA (excluding STA-3/4) are presented in the *Analysis and Interpretation* section of this chapter. The concentrations of the other nutrient parameters measured within the STAs are also presented in that section. During WY2007, some of the effective treatment area was temporarily taken off-line for Long-Term Plan Enhancements construction or rehabilitation activities (see *Operations* sections for each STA).

Inflows into the STAs in WY2007 were not uniform. High inflows occurred in August and September 2006, followed by months of little to no inflow. The treatment cells experienced low water stages during in spring 2006, mainly due to regional drought conditions, or Long-Term Plan Enhancements construction at STA-1W and STA-6.

Phosphorus and hydraulic loadings into STA-1E were higher this water year, about double compared to WY2006. The amount of hydraulic and phosphorus loading to the STAs is variable and dependent upon conditions within the contributing basins, which are influenced by rainfall, land use, etc. The largest contributor to the STAs is the Everglades Agricultural Area (EAA), and the main source of irrigation water for the EAA is Lake Okeechobee. For this reason, an evaluation of the impact of the concentrations of the phosphorus from Lake Okeechobee on the Everglades Agricultural Area and the consequences to the receiving downstream areas is currently underway. For STA-1W, compared to the previous water year, the hydraulic and phosphorus loading rate received was higher, reflecting the temporary reduction in effective treatment area because of Long-Term Plan Enhancements construction or rehabilitation efforts. For STA-2, STA-3/4, and STA-5, the hydraulic and phosphorus loads were less, and for STA-6, the phosphorus loading rate was about the same as last water year but the hydraulic loading rate increased (**Figures 5-56** and **5-57**).

Time series plots of the TP load retained show an increase for STA-1E, STA-1W, and STA-3/4, and about a 6 percent decrease for STA-2, STA-5, and STA-6 (**Figure 5-58**). The percent TP load retained for STA-1E showed a large increase from 37 percent last water year to 73 percent this water year and is probably indicative of increased flow and loads going into the system and greater plant establishment. The percent TP load retained increased slightly for STA-1W from last water year, and for STA-2 and STA-6, remained relatively high, at 75 percent and 86 percent respectively. STA-5 continued to show a decline in the efficiency of TP load retained, in part due to decreased operational treatment area because of Long-Term Plan Enhancements construction, vegetation reestablishment, and limited flow events over the water year.

The annual STA total phosphorus removal coefficient rates (TP mass removal rate) (k) (equation 5.2) indicate spatial and temporal variability within and among STAs, with all STAs except for STA-5 at or above the initial design TP mass removal rate estimate of 10.2 m/yr (**Figure 5-59**). The TP mass removal rate was calculated as:

$$k = HLR \ln [(C_{in} - C^*) / (C_{out} - C^*)] \qquad \textit{Equation 5.2}$$

$$HLR = Q_{in}/\text{effective treatment area}/365*30.48 \qquad \textit{Equation 5.3}$$

where: HLR = hydraulic loading rate; C_{in} is the annual mean inflow TP concentration (ppb); C_{out} is the annual mean outflow TP concentration (ppb); C^* is the assumed background TP concentration of 4 ppb); Q_{in} = annual inflow volume (ac-ft); effective treatment area (acres).

The phosphorus TP mass removal rates have decreased from last water year, except for STA-1W where a slight increase was observed in WY2007. For most of the STAs, except for STA-1W, the effective TP mass removal rate is about half of what it was in WY2006. The lower TP mass removal rates may have been due to the decreased amount of flow-through due to drought conditions.

The comparison of outflow versus inflow TP concentrations (**Figure 5-60**) shows a wide range of inflow and outflow values, with STA-1E, STA-1W, and STA-5 having the highest inflow and outflow concentrations over the period of record. Much variability between the STAs, as well as within an STA, was also observed when comparing the STA TP load removal to inflow hydraulic loading rate (**Figures 5-61**) and inflow phosphorus loading rate (PLR) (**Figure 5-62**). The hydraulic and phosphorus loading rates are calculated by dividing the inflow by the effective treatment area. These rates are affected when areas of the STAs are temporarily taken off-line for construction or rehabilitation. The influence of hydraulic loading rate and phosphorus loading rate on the outflow TP concentration is shown in **Figures 5-61** and **5-62**. The long-term PLR is just one of many factors that influence the phosphorus removal performance of an STA; others include vegetation type, soil type, antecedent land use, phosphorus loading history, inflow concentrations, and hurricanes, droughts and other disturbances. STA-6 showed the highest HLRs, although little effect is observed on the outflow TP concentrations.

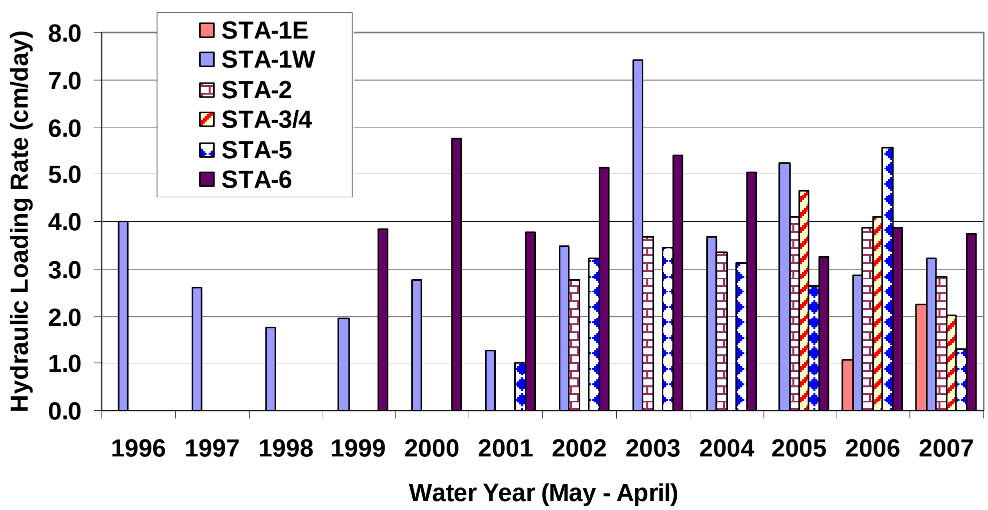


Figure 5-56. Hydraulic loading rates for the STAs when in flow-through mode. In STA-1E, STA-1W, and STA-6, the amount of the effective treatment area was temporary reduced because treatment cells were taken off-line for LTP Enhancements, construction, or rehabilitation activities. The data displayed is when the STA is in flow-through mode for entire water year; does not include partial water year start-up loadings.

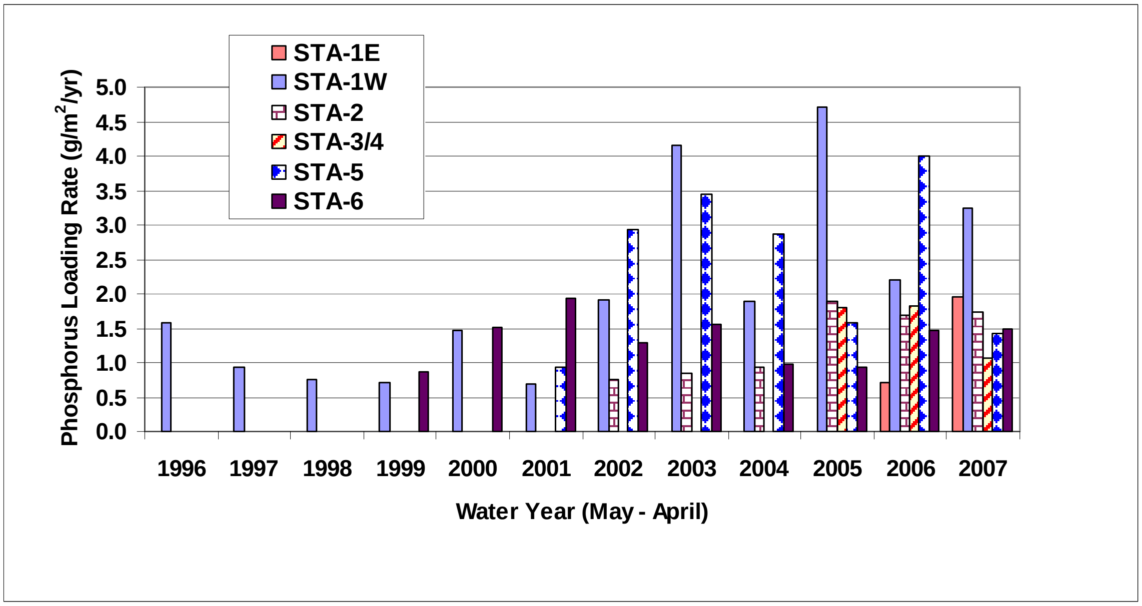
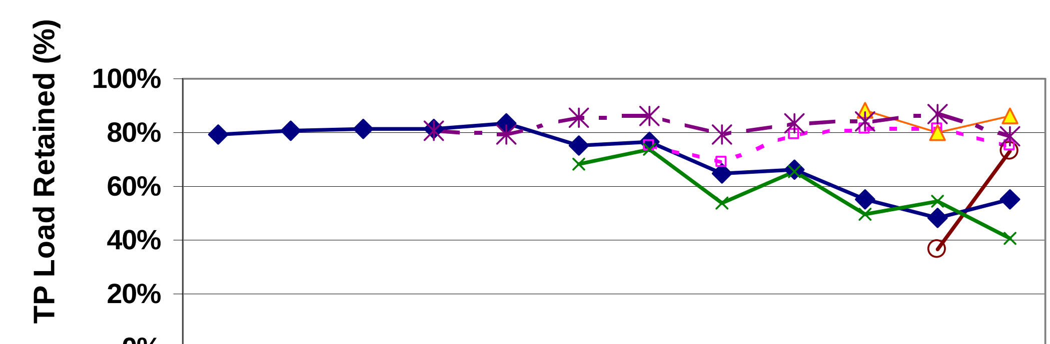
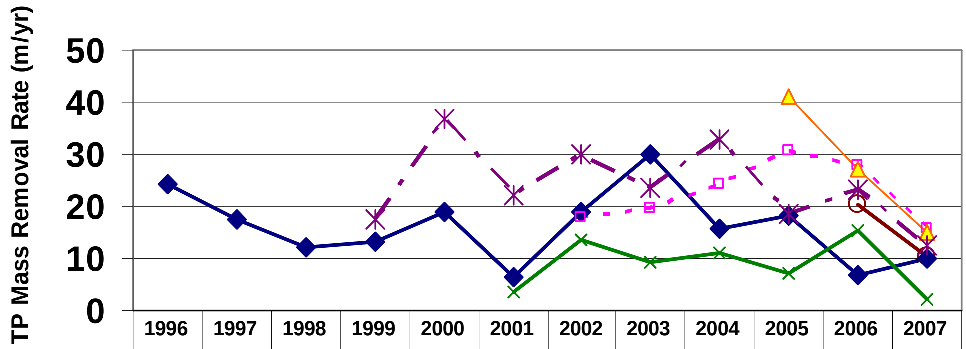


Figure 5-57. Phosphorus loading rates (PLR) for the STAs when in flow-through mode. In STA-1E, STA-1W, STA-5, and STA-6, the amount of the effective treatment area was temporary reduced because treatment cells were taken off-line for Long-Term Plan Enhancements, construction, or rehabilitation activities. The data displayed is when the STA is in flow-through mode for entire water year; does not include partial water year start-up loadings.



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
STA-1E											37%	73%
STA-1W	79%	81%	82%	82%	83%	75%	76%	65%	66%	55%	49%	55%
STA-2							75%	69%	79%	81%	81%	76%
STA-3/4										88%	80%	86%
STA-5						69%	74%	54%	66%	50%	55%	41%
STA-6				81%	79%	86%	86%	79%	84%	84%	87%	79%

Figure 5-58. STA TP load retained for the period of record (POR).



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
STA-1E											20	10
STA-1W	24	18	12	13	19	7	19	30	16	18	7	10
STA-2							18	20	24	31	28	16
STA-3/4										41	27	15
STA-5						4	13	9	11	7	15	2
STA-6				18	37	22	30	23	33	19	23	13

Figure 5-59. STA effective TP mass removal rates for the POR. In WY2007, STA-1E, STA-1E, STA-1W, and STA-5 had reduced effective treatment areas due to Long-Term Plan Enhancements, construction, or rehabilitation activities (refer to each individual STA section for details).

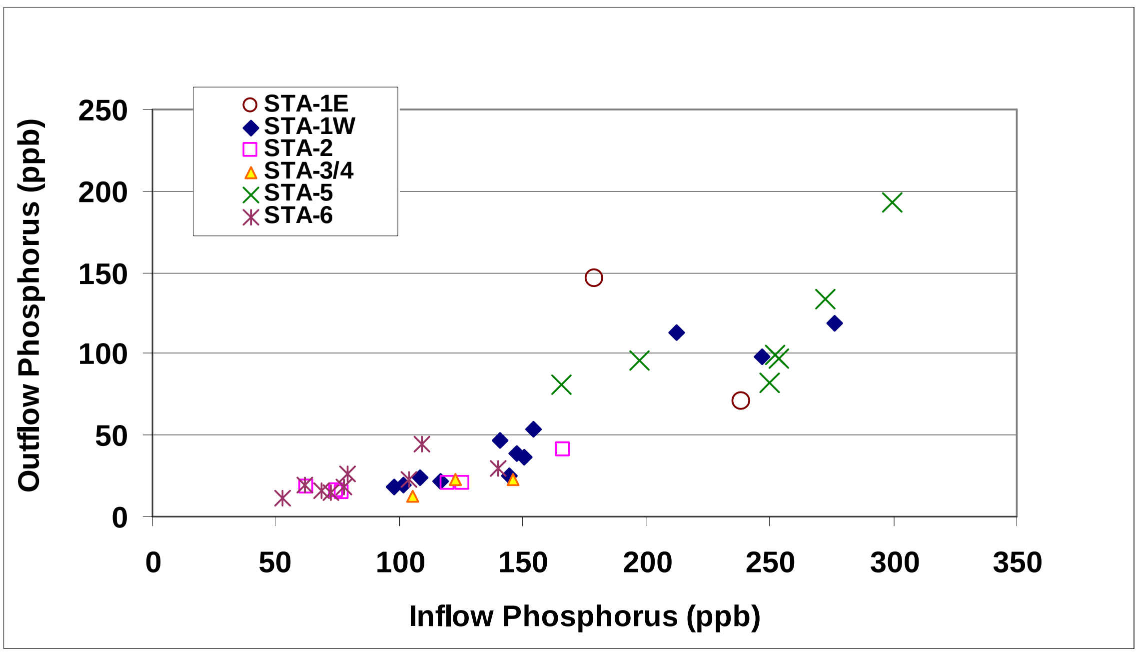


Figure 5-60. STA outflow TP concentration compared to STA inflow concentration by water year.

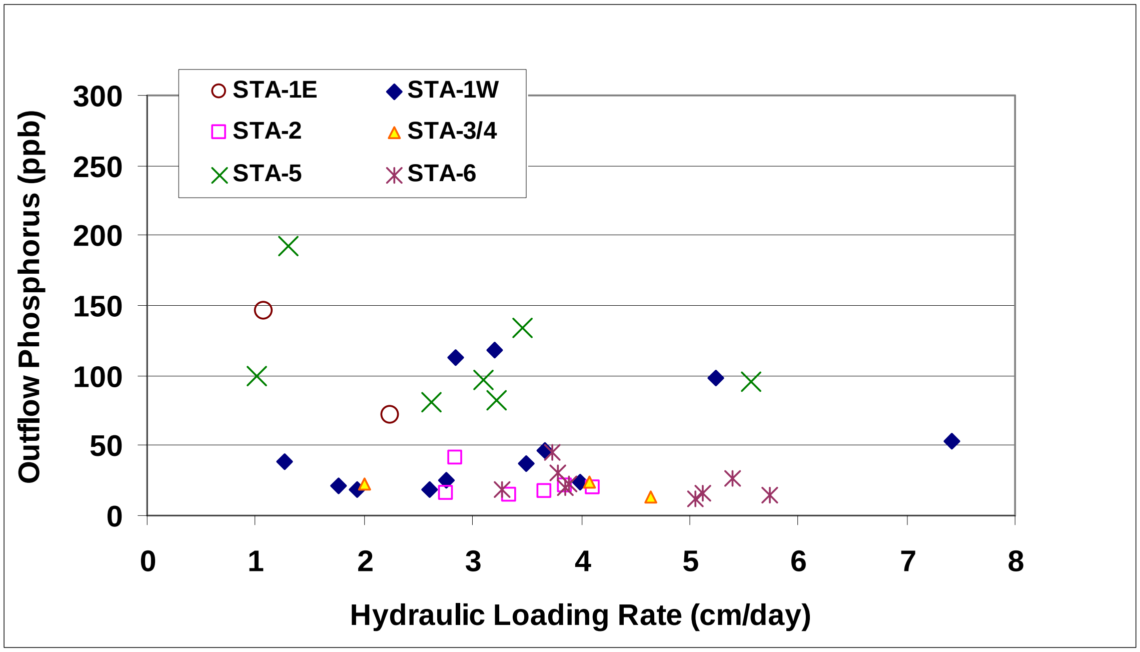


Figure 5-61. STA outflow TP concentrations compared to the inflow hydraulic loading rate (HLR) by water year for the STAs when in flow-through mode.

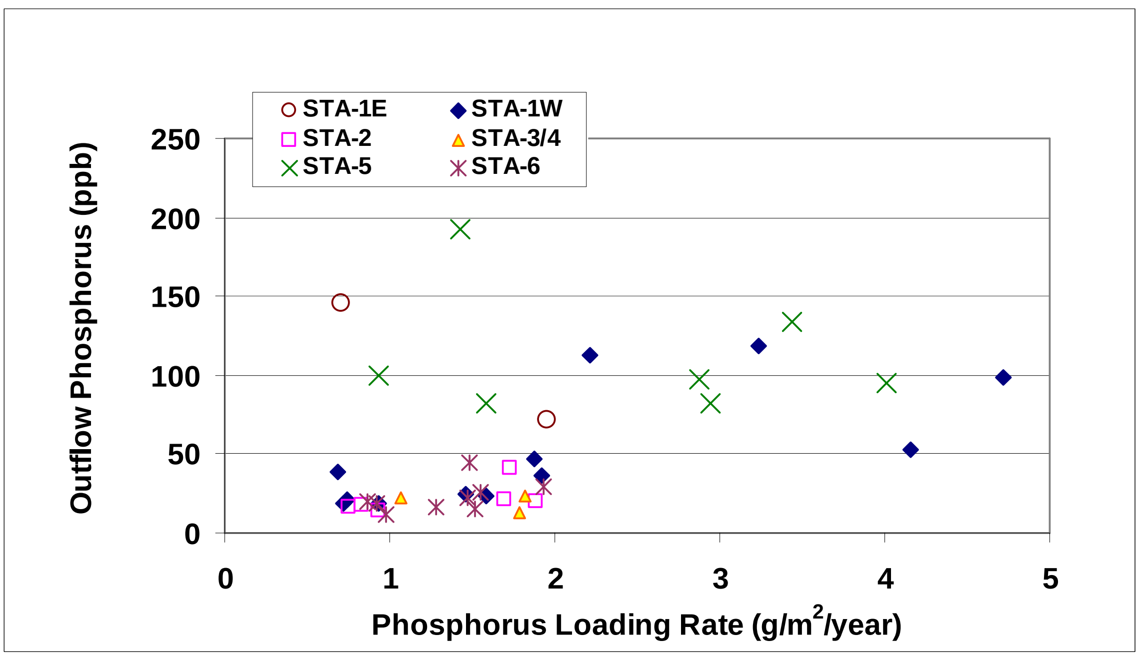


Figure 5-62. STA TP load removal compared to the inflow TP loading rate (PLR) by water year for the STAs when in flow-through mode. The long-term PLR is just one of many factors that influence the phosphorus removal performance of an STA; others include vegetation type, soil type, antecedent land use, phosphorus loading history, inflow concentrations, and hurricanes, droughts and other disturbances.

Hindcast of STA TP Treatment Performance

The STAs were designed using a simple steady-state model that predicted annual outflow TP concentration (Burns & McDonnell, 1994; Walker, 1999):

$$C_{out} = (rC_r) + (C_{in} - rC_r) \times (1 + aA) \exp - (1 + k/[R - ET]) \qquad \textbf{\textit{Equation 5.4}}$$

$$a = (R - ET)/Q_{in} \qquad \textbf{\textit{Equation 5.5}}$$

$$r = R/(R - ET + k) \qquad \textbf{\textit{Equation 5.6}}$$

where: C_{out} is the annual mean outflow TP concentration (µg/L); C_{in} is the annual mean inflow TP concentration (µg/L); C_r is the mean rainfall TP concentration (50 µg/L); R is annual rainfall (m); A is wetland treatment area (m^2); ET is annual evapotranspiration (m); Q_{in} is the annual inflow (hm^3); and k is the removal coefficient (10.2 m/y). **Equation 5.4** was used to hindcast STA treatment performance, i.e., predict annual outflow TP concentrations based on observed values for each model parameter, and these predicted values were then compared to observed annual mean outflow TP concentrations. With few exceptions, STA treatment performance has met or exceeded model predictions (and therefore design expectations) over the range of annual mean inflow TP concentrations (0.051mg/L to 0.300 mg/L) experienced by these wetlands (**Figures 5-63**). STA-5 was the only wetland that consistently underperformed. The reason(s) for this discrepancy is(are) not entirely clear at this time, although it does not appear to be directly related to excessive loading nor differences in sediment characteristics. STA-5 was not loaded more heavily than the other STAs based on a comparison of observed annual versus design water and TP loading rates (**Figure 5-64**) and examination of the period-of-record loading rates among the STAs (Table 2 in Appendix 5-20); all the STAs were overloaded in some if not all years and STA-5 was loaded at levels that were either equal to or less then design assumptions in two of the years when it failed to meet model predictions (**Figure 5-64**). Also, sediment characteristics (e.g. bulk density and TP, total carbon and iron content) in STA-5 were comparable to the range of values in the other STAs (see Figure 4B-12 in the 2002 Everglades Consolidated Report and Figure 4-51 in the 2006 South Florida Environmental Report). At this time, we suspect that the underperformance of STA-5 may be related to hydraulic inefficiencies. This will be the subject of future research.

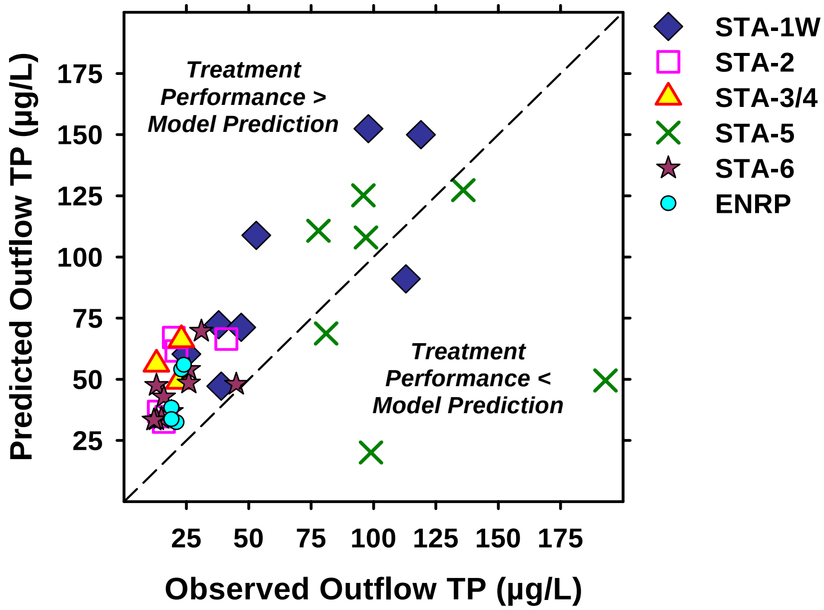


Figure 5-63. Comparison of observed versus predicted total phosphorus (TP) treatment performance in the STAs and the ENRP as measured by annual outflow TP concentration. Symbols above the dashed diagonal line indicate that observed treatment performance exceeded performance predicted by the original STA design model. The ENRP is the Everglades Nutrient Removal Project, a prototype treatment wetland that was incorporated into STA-1W.

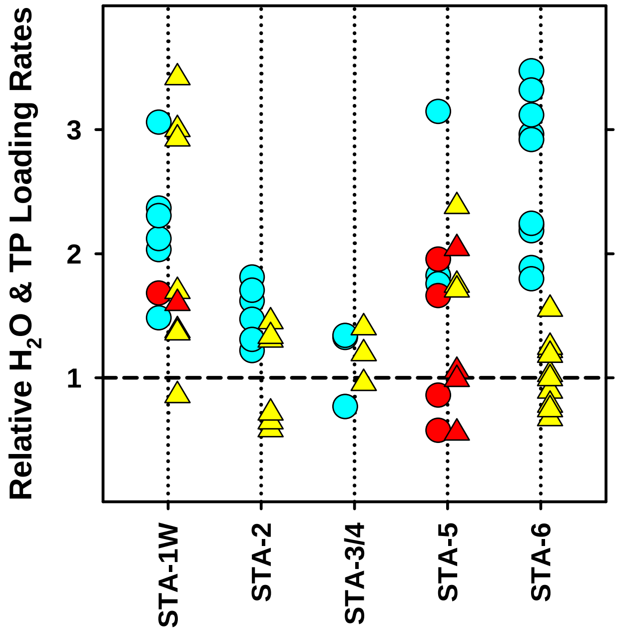


Figure 5-64. Relative annual water (○) and total phosphorus (TP) (△) loading rates in the STAs. Relative rates for each STA were computed by dividing observed annual TP and water loading rates by the rates assumed during design. Symbols above the dashed line indicate observed loading exceeded the design rate. Red symbols are the relative loading rates associated with those instances where observed TP treatment performance did not achieve the performance predicted the by original STA design model (see **Figure 5-63**).

Table 5-31. Estimates of STA performance.

STA-1E (Start-up 9/04, Permit issued 10/1/2005)																
	Inflow = S-319, G-311, S-361						Outflow = S-362									
	Inflow			**Inflow TP***	**HLR**	**PLR**	**Outflow**			**TP Removed**		**TP Removal**	**Average Annual Effective Treatment Area**	**Ave. depth**	**HRT**	**TP Mass Removal Co-efficient**
Water Year	**ac-ft**	**TP kg**	**TP ppb**	**ppb**	**cm/day**	**g/m2/yr**	**ac-ft**	**TP kg**	**TP ppb**	**kg**	**%**	**g/m2/yr**	**ac**	**cm**	**Days**	**m/yr**
Hurricane response, start Sept. 2004 through April 2005	19,426	4,853	202		0.69	0.51	17,565	8,071	373	-3,219	-66%		4,024			
2006	52,132	11,512	179	151	1.08	0.71	40,572	7,295	146	4,217	37%	0.26	4,024	29.2	41	21
2007	108,311	31,890	239	149	2.25	1.96	97,818	8,600	71	23,290	73%	1.43	4,024		**23**	10
Total	***179,869***	***48,254***	***217***				***155,955***	***23,966***	***125***	***24,288***	***50%***					

*Geometric Mean

Table 5-31. Continued.

STA-1W (ENR Start-up 10/93, Flow-through: 8/1994; STA-1W 2000)

Outflow = G-251 for Water Year 95-99, G-251 + G-310 for remainder.

	Inflow*			G.mean Inflow TP	HLR	PLR	Outflow	Outflow TP		TP Removed			TP Removal	Cm. Removal	Average Annual Effective Treatment Area	Ave. depth	HRT	TP Mass Removal Co-efficient
Water Year	**ac-ft**	**TP kg**	**TP ppb**	**ppb**	**cm/day**	**g/m2/yr**	**ac-ft**	**TP kg**	**ppb**	**kg**	**mt**	**%**	**g/m2/yr**	**kg**	**acres**	**cm**	**Days**	**m/yr**
1994*, partial, startup 10/93	0.00	0					0.53	0.01	20	0								
1995*, partial WY, start-up 5/94 - 7/94	0.60	0	0				0.00	0.00										
1995*, partial WY, start 8/94	92,364	15,542	136		3.47	1.73	95,333	2,718	23	12,824	13	83%	0.83	12,824	3,815	60	17.3	25
1996	182,670	24,464	109		4.00	1.58	172,414	5,079	24	19,385	19	79%	1.26	32,209	3,815	60	15.0	24
1997	118,780	14,391	98		2.60	0.93	119,198	2,750	19	11,642	12	81%	0.75	43,850	3,815	60	23.1	18
1998	80,304	11,536	116		1.76	0.75	80,986	2,125	21	9,410	9	82%	0.61	53,261	3,815	60	34.1	12
1999	88,532	11,096	102		1.94	0.72	86,376	2,045	19	9,051	9	82%	0.59	62,312	3,815	60	31.0	13
2000	125,863	22,477	145		2.76	1.46	121,229	3,753	25	18,724	19	83%	1.21	81,036	3,815	60	21.8	19
2001	94,522	17,171	147		1.27	0.68	90,517	4,319	39	12,852	13	75%	0.51	93,888	6,194	54	42.4	7
2002	278,857	51,767	150		3.49	1.92	267,624	12,200	37	39,567	40	76%	1.47	133,455	6,670	60	17.2	19
2003	591,845	112,172	154		7.41	4.16	595,999	39,234	53	72,937	73	65%	2.70	206,392	6,670	61	8.2	30
2004	292,690	50,733	141		3.66	1.88	297,603	17,073	47	33,661	34	66%	1.25	240,053	6,670	59	16.1	16
2005	341,094	103,872	247		5.24	4.72	383,365	46,489	98	57,384	57	55%	2.61	297,437	5,436	60	11.5	18
2006	142,678	37,415	213	208	2.85	2.21	137,890	19,265	113	18,150	18	49%	1.07	315,587	4,181	23	13.2	7
2007	121,698	41,511	277	155	3.21	3.24	126,246	18,493	119	23,019	23	55%	1.80	338,606	3,168		14.0	10
Total	***2,551,898***	***514,148***	***163***				***2,574,781***	***175,543***	***55***	***338,605***		***66%***						

*Inflow: G250 for WY1994–6/99, G302 for remainder

Table 5-31. Continued.

STA-2 (Start-up 6/99; Flow-through: 10/2000)

Inflow = S-6 + G-328 Outflow = G-335

Water Year	Inflow ac-ft	Inflow TP kg	Inflow TP ppb	Geo. Mean Inflow TP ppb	HLR cm/day	PLR g/m2/yr	Outflow ac-ft	Outflow TP kg	Outflow TP ppb	TP Removed kg	TP Removed mt	TP Removed %	TP Retained g/m2/yr	Cm. Retained kg	Average Annual Effective Treatment Area ac	Ave. depth cm	HRT Days	TP Mass Removal Coefficient m/yr
2001* Partial WY, flow start 7/99	158,012	22,355	115		4.16	1.74	0	0		22,355	22		0.86		6,338			
2002	212,808	19,656	75		2.80	0.77	240,685	4,871	16	14,786	15	75%	0.57	14,786	6,338	45	16.3	18
2003	282,731	21,765	62		3.73	0.85	308,297	6,757	18	15,008	15	69%	0.58	29,794	6,338	45	12.3	19
2004	256,938	24,330	77		3.39	0.95	284,780	5,036	14	19,294	19	79%	0.74	49,088	6,338	45	13.5	24
2005	316,273	49,048	126		4.17	1.91	371,023	9,228	20	39,821	40	81%	1.53	88,908	6,338	46	11.2	30
2006	297,364	44,038	120	110	3.92	1.72	322,303	8,238	21	35,800	36	81%	1.38	124,709	6,338	47	14.8	27
2007	218,566	44,930	167	108	2.88	1.75	217,572	11,010	41	33,920	34	75%	1.30	158,629	6,338		13.0	15
Total	***1,742,691***	***226,123***	***105***				***1,744,660***	***45,139***	***21***	***180,984***		***80%***						

STA-3/4 (E and C FW start-up 10/03, W FW start-up 11/03)

Flow-through: E FW 1/04, W FW 6/04, C FW 9/04 Inflow = G-370 + G-372

Water Year	Inflow ac-ft	Inflow TP kg	Inflow TP ppb	Geo. Mean Inflow TP ppb	HLR cm/day	PLR g/m2/yr	Outflow ac-ft	Outflow TP kg	Outflow TP ppb	TP Removed kg	TP Removed mt	TP Removed %	TP Retained g/m2/yr	Cm. Retained kg	Average Annual Effective Treatment Area ac	Ave. depth cm	HRT Days	TP Mass Removal Coefficient m/yr
2004* Partial WY, start 10/03	23,303	1,392	48		0.09	0.02	25,811	481	15	910	1	65%	0.03	910	6,500			
2005	671,442	87,368	105		4.65	1.79	646,587	10,375	13	76,993	77	88%	1.58	77,904	12,059			41
2006	696,729	105,310	123	119	4.08	1.83	736,422	21,241	23	84,069	84	80%	1.46	161,973	14,253	51.8	13.8	27
2007	388,471	69,921	146	106	2.01	1.07	355,423	9,810	22	60,111	60	86%	0.92	222,085	16,161		21.0	15
Total	***1,779,945***	***263,992***	***120***				***1,764,243***	***41,907***	***19***	***222,085***		***84%***		***240,787***				

Table 5-31. Continued.

STA-5 (Start-up 12/30/98; Flow-through: 10/1999)																			
Flow record starts in 9/99	Inflow = G-342 A-D						Outflow = G-344 A-D												
	Inflow	Inflow TP		Geo. Mean Inflow TP	HLR	PLR	Outflow	Outflow TP		TP Removed			TP Retained	Cm. Retained	Ave. Annual Effective Treatment Area	Ave. depth	HRT	TP Mass Removal Coefficient
Water Year	ac-ft	kg	ppb	ppb	cm/day	g/m2/yr	ac-ft	kg	ppb	kg	mt	%	g/m2/yr	kg	ac	cm	Days	m/yr
2000* Partial WY, start 9/99	7,792	2,212	230		0.16	0.13	11,840	2,376	163	-164	0	-7%			4,110			
2001	50,111	15,575	252		1.02	0.94	39,976	4,898	99	10,677	11	69%	0.64	10,677	4,110	41.1	40.4	4
2002	158,672	48,918	250		3.22	2.94	126,180	12,872	83	36,046	36	74%	2.17	46,723	4,110	49.3	15.3	13
2003	170,176	57,198	272		3.46	3.44	160,518	26,456	134	30,742	31	54%	1.85	77,465	4,110	56.5	16.3	9
2004	152,984	47,849	254		3.11	2.88	136,466	16,407	97	31,442	31	66%	1.89	108,907	4,110	58.8	18.9	11
2005	119,665	24,406	165		2.63	1.58	121,427	12,220	82	12,186	12	50%	0.79	121,092	3,805	58.8	22.4	7
2006	214,621	52,293	198	135	5.56	4.01	200,872	23,643	95	28,649	29	55%	2.20	149,742	3,222	41.7	5.8	15
2007	58,690	21,681	299	151	1.30	1.42	54,163	12,858	192	8,824	9	41%	0.58	158,565	3,768		12.0	2
Total	**932,711**	**270,132**	***235***				**851,442**	**111,731**	***106***	***158,401***		***59%***						

Table 5-31. Continued.

STA-6 (Start up 10/97, Flow-through Date: 12/97)

Inflow = G-600; Outflow = G-393 and G-354

Water Year	Inflow	Inflow TP		Geo. Mean Inflow TP	HLR	PLR	Outflow	Outflow TP		TP Removed			TP Retained	Cm. Retained	Ave. Annual Effective Treatment Area	Ave. depth	HRT	TP Mass Removal Coefficient
	ac-ft	kg	ppb	ppb	cm/day	g/m2/yr	ac-ft	kg	ppb	kg	mt	%	g/m2/yr	kg	ac	cm	Days	m/yr
1998* Partial WY, startup, 10/97	4,121	190	37															
1998* Partial WY, flow-through 12/97	26,101	1,631	51		2.43	0.45	23,984	481	16	1,150	1	71%	0.98	1,150	897	45.00	18.0	12
1999	40,120	3,052	62		3.73	0.84	24,035	588	20	2,464	2	81%	2.10	3,614	897	26.00	6.8	18
2000	59,848	5,353	73		5.57	1.47	59,261	1,115	15	4,238	4	79%	3.61	7,853	897	38.20	6.6	38
2001	39,395	6,821	140		3.67	1.88	26,718	986	30	5,835	6	86%	4.97	13,688	897	30.70	8.1	23
2002	53,437	4,506	68		4.97	1.24	30,466	615	16	3,891	4	86%	3.32	17,579	897	47.90	9.3	31
2003	56,252	5,474	79		5.24	1.51	35,615	1,139	26	4,335	4	79%	3.69	21,913	897	50.10	9.3	24
2004	52,674	3,424	53		4.90	0.94	38,682	561	12	2,863	3	84%	2.44	24,776	897	55.90	11.1	34
2005	34,035	3,255	78		3.17	0.90	22,187	515	19	2,740	3	84%	2.34	27,517	897	55.90	17.1	19
2006	40,467	5,183	104	90	3.77	1.43	24,735	692	23	4,491	4	87%	3.83	32,008	897	47.55	12.2	24
2007	32,443	4,360	109	89	3.62	1.44	16,755	925	45	3,435	3	79%	3.51	35,443	748		5.0	13
Total	***438,893***	***43,250***	***80***				***302,439***	***7,617***	***20***	***35,633***		***82%***						

Table 5-31. Continued.

TOTAL OF ALL STORMWATER TREATMENT AREAS																	
OPERATIONAL STAs	**WY**	**Inflow**	**Inflow TP**		**HLR**	**PLR**	**Outflow**	**Outflow TP**		**TP Removed**			**TP Retained**	**Cm. Retained**	**Ave. Annual Effective Treatment Area**	**Ave. Depth**	**HRT**
	May-April	**ac-ft**	**kg**	**ppb**	**cm/day**	**g/m2/yr**	**ac-ft**	**kg**	**ppb**	**kg/yr**	**mt**	**%**	**g/m2/yr**	**kg/yr**	**ac**	**cm**	**Days**
1994 (ENR Section of STA-1W)	1994	0.00	-				1	0	20	0	0						
1995 (ENR Section of STA-1W)	1995	92,364	15,452	136	3.47	1.72	95,333	2,718	23	12,735	13	82%	1.41	12,735	3,815	60	17.3
1996 (ENR Section of STA-1W)	1996	182,670	24,464	109	4.00	1.58	172,414	5,079	24	19,385	19	79%	1.26	32,120	3,815	60	15.0
1997 (ENR Section of STA-1W)	1997	118,780	14,391	98	2.60	0.93	119,198	2,750	19	11,642	12	81%	0.75	43,761	3,815	60	23.1
1998 (ENR Sec. of STA-1W, STA-6)	1998	110,527	13,357	98	1.85	0.70	104,970	2,606	20	10,751	11	80%	0.56	54,512	4,712	53	28.1
1999 (ENR Sec. of STA-1W, STA-6)	1999	128,652	14,148	89	2.50	0.75	110,411	2,633	19	11,516	12	81%	0.60	66,027	4,712	43	17.0
2000 (STA-1W, STA-5, STA-6)	2000	193,503	30,042	126	3.52	1.36	192,330	7,244	31	22,798	23	76%	0.64	88,826	8,822	49	13.7
2001 (STA-1W, STA-2, STA-5, STA-6)	2001	342,041	61,923	147	2.85	1.26	157,211	10,204	53	51,719	52	84%	0.73	140,545	17,539	42	14.8
2002 (STA-1W, STA-2, STA-5, STA-6)	2002	703,773	124,847	144	3.34	2.11	664,957	30,558	37	94,289	94	76%	1.29	234,834	18,015	51	15.2
2003 (STA-1W, STA-2, STA-5, STA-6)	2003	1,101,005	196,608	145	5.74	3.51	1,100,430	73,586	54	123,022	123	63%	1.69	357,856	18,015	53	9.3
2004 (STA-1W, STA-2, STA-3/4, STA-5, STA-6)	2004	778,589	127,728	133	3.44	2.03	783,342	39,558	41	88,170	88	69%	0.70	446,027	31,015	55	15.9
2005 (STA-1W, STA-2, STA-3/4, STA-5, STA-6)	2005	1,501,935	272,803	147	4.43	2.87	1,562,154	86,899	45	185,904	186	68%	1.61	631,931	28,536	55	12.5
2006 (ALL)	2006	1,443,991	255,751	144	4.03	2.25	1,462,794	80,373	45	175,377	175	69%	1.32	807,308	32,915	40	9.9
2007 (ALL)	2007	928,178	214,294	187	2.41	1.81	867,977	61,695	58	152,599	153	71%	1.10	959,907	34,207		
Grand Total		***7,626,007***	***1,365,809***	***145***			***7,393,520***	***405,902***	***45***	***959,907***		***70%***					

STATUS OF OTHER LONG-TERM PLAN PROJECTS

HYDROLOGIC AND HYDRAULIC ASSESSMENT AND INTERNAL MEASUREMENTS

No activities were scheduled or completed for this project in FY2007.

ECP OPERATIONS MONITORING PROJECT

The objective of the ECP Operations Monitoring Project is to collect water quality samples and monitor flow at inflow and outflow locations of all treatment cells within the STAs that are not specified as compliance sampling locations by the STA operating permits. Most of the ECP operations monitoring sites were sampled during WY2007 with the exception of some structures located in flow-ways undergoing Long-Term Plan Enhancements and/or rehabilitation efforts. Additional monitoring stations are scheduled to come online in WY2008 or thereafter when the expansions of STA-2, STA-5, and STA-6 come online.

Flow is monitored on a continuous basis. Water quality samples analyzed for flow-proportional TP concentrations are collected weekly; all other water quality parameters are monitored biweekly. The TP data are routinely used to assess the performance of each treatment cell and contribute to the development of strategies for improving the efficiency of the TP load retained in the STAs as a whole. The status of ECP operations monitoring for WY2007 is outlined in **Table 5-32**.

Table 5-32. Status of new and existing water quality monitoring sites at interior treatment cells within the STAs during WY2007. This table does not include compliance sites that are specified in the STA operating permits.

LOCATION	SITES	SITE NO.	STATUS
STA-1E	New: None	0	---
	Existing: S-366(B, D), S-367(B, D), S-368 (B, D), S-369(B, C), S-370(A, C), S-371(A, C), S-372(B, D), S-373(A, B), S-374(A, C)	18	All sites monitored.
STA-1W	New: None	0	---
	Existing: G-302, G-303, G-305 (G, N), G-306(C, G), G-255, G-254(B, D), G-253(C, G), G-256, G-308, G-309, G-327A, G-250S, G-258, G-259	1	Cells 1, 3, and 5 operated only part of the year. Cells 2 and 4 were off-line all year for construction of Long-Term Plan enhancements or rehabilitation efforts.
STA-2	New: None	0	---
	Existing: G-329(B), G-330(A), G-331(D), G-332, G-333(C), G-334	6	All sites monitored.
STA-3/4	New: None	0	---
	Existing: G-374(B, E), G-375(B, E), G-377(B, D), G-378(B, D), G-370 Seep, G-372 Seep, G-383	11	All sites monitored. Cell 3 passed start-up criteria to begin flow-through operation in Aug. 2006.
STA-5	New: None	0	---
	Existing: G-343(B, C, F, G), G-349A, G-350A	6	All sites monitored. Station G-350A removed as part of STA-5 expansion construction.
STA-6	New: None	0	---
	Existing: G-602, G-603	2	All sites monitored.

STORMWATER TREATMENT AREA SITE MANAGEMENT

The District's Operations and Maintenance Department, Environmental Operations Section, currently staffs three STA site managers (one for both STA-1W and STA-1E, one for both STA-2 and STA-3/4, and one for both STA-5 and STA-6). In addition to these three site managers, for the past year, the STA Site Management division included the addition of technical support through a contract employee. The primary responsibility of the STA site managers is to coordinate among various departments, divisions, and external stakeholders to facilitate resolution of day-to-day STA management and operation issues. Site managers maintain an onsite presence at STAs to ensure objectives of the STA program are met.

Site managers routinely report observations of changing environmental and site conditions, maintenance concerns, or infrastructure problems to appropriate District staff. Significant additional coordination between the District's Construction Department and the site managers has been and will be required during the build-out of the Long-Term Plan components. Additionally, site managers coordinate monthly vegetation management surveys with Vegetation Management and Field Operations staff to identify priorities and strategies to meet the overall vegetation goals of the STA program. Site managers also monitor daily stormwater operations and confirm that these operations are consistent with the established STA operation plans.

ACQUISITION OF SURVEY DATA

The Acquisition of Survey Data Project as described in the October 27, 2003, the Long-Term Plan was completed in FY2005. As new STA facilities and structures are completed, acquisition of any necessary survey data will be collected on an as needed basis.

ADDITIONAL FLOW AND WATER QUALITY MONITORING STATIONS

This project consists of establishing 47 new flow and water quality monitoring stations in the STAs. These additional monitoring stations are in STA-3/4 (two seepage pumps and nine culverts), STA-1W (two culverts), and STA-1E (19 stations). The instrumentation has been completed, and flow computation has been implemented at G-258 and G-259 culverts in STA-1W. The registration in the District's hydrometeorologic database, DBHYDRO, has been completed for G-374B and E, G-375B and E, G-377B and D, G-378B and D, G-383, and seepage pumps G-370, and G-372 in STA-3/4. Currently, flow is computed at all STA-3/4 culverts using calibrated flow-rating equations. Flow is also computed at the inflow pumps G-370, G-370S (seepage), G-372, and G-372S (seepage) using the pump manufacturers' curves at these sites.

For FY2007, streamgauging access platforms are planned to be built at G-304 (STA-1W) and G-376E (STA-3/4). The platforms will be used for accurate flow measurements at these sites and testing to determine the most suitable flow meters for STA flow monitoring. The data to be collected will also be used for flow rating improvement at STA culverts.

REVIEW AND CORRECTION OF FLOW MEASUREMENT ANOMALIES

The goal of this project is to address flow estimate uncertainties and to provide good quality flow data at all major flow stations in the STAs. Calibrated flow equations have been completed and implemented at 100 percent in STA-1W, STA-2, STA-3/4, STA-5, and STA-6. Theoretical flow equations for flow computation have been implemented at 100 percent in STA-1E. Water balance analysis was conducted for six storm events for STA-3/4. Improved flow rating equations have been developed for G-300, G-301, G-302, G-303, G-308, G-309, G-311, G-332, G-334, G-371, G-372, S-155A, G-335, G-328, G-388, G-349C, G-600, S-382, S-383, S-385, and S-390. A stream-gauging plan was completed for STA-1W, STA-2, STA-5, and STA-6. In the first part of FY2007, 81 streamflow measurements were completed in STA-1W, STA-1E, STA-2, STA-3/4, and STA-5. About 50 additional streamflow measurements in the same STAs are planned to be completed by the end of FY2007.

UPDATE AND MAINTENANCE OF HYDRAULIC MODELS

The two-dimensional (2-D) modeling effort for the STAs continued during FY2007 through a contract with Sutron Corporation. An 2-D model was developed for STA-2 including the new Cell 4. The STA-5 model was updated to include the new Flow-way 3, and the STA-6 model was updated to include the new Section 2. These updated models are intended to assist in operational decision-making for the STAs with the initial expansions. As these new treatment areas begin start up and flow-through operations, actual flow and stage data can be obtained and the models can be refined for long-term operational decision-making.

Also completed during FY2007 as part of Sutron's contract was the STA-1E Distribution Cells and Discharge Canal Water Balance Analysis. The main purpose of this effort was to analyze the water balance in the East and West Distribution Cells and to evaluate the flow distributions. This effort also included analyzing the water balance in the Discharge Canal and evaluating the flow distributions. This information is intended to assist the District in optimizing operations of the STA-1E inflow and outflow facilities and structures.

Reports describing the above efforts are available on the District's website at www.sfwmd.gov/sta.

OPERATIONAL STRATEGY

This project is complete; no activities were scheduled or completed for this project in FY2007.

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