Chapter 4: STA Performance, Compliance and Optimization

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SUMMARY

The creation of wetlands to remove excess total phosphorus (TP) from surface waters entering into the Everglades Protection Area is a crucial component of the Everglades restoration program. Over 35,000 acres of wetlands have been built by the South Florida Water Management District (District or SFWMD) and over 6,000 acres have been built by the U.S. Army Corps of Engineers (USACE) in the Everglades area (**Figure 4-1**). 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 600 metric tons (mt). In Water Year 2005 (WY2005) (May 1, 2004 through April 30, 2005), the STAs combined received a total of 1,482,754 acre-feet of inflow, equating to an average hydraulic loading rate of 3.6 cm/day and an average nutrient loading rate of 1.9 $g/m^2/yr$ (**Table 4-1**). Overall, the flow-weighted total phosphorus entering into the STAs was 147 parts per billion (ppb) and the TP load was 268 mt. The STAs retained 189 mt of TP, reducing the inflow TP load by 71 percent and the inflow TP concentration down to 41 ppb.

An overview of the STA operations, vegetation management, phosphorus performance, water quality monitoring, and permit compliance for each of the STAs (STA-1E, STA-1W, STA-2, STA-3/4, STA-5, and STA-6) for WY2005 is presented in this chapter, along with an update of the progress of the STA enhancement projects that were identified in the Long-Term Plan for Achieving Water Quality Goals, the Everglades Protection Area Tributary Basins (Long-Term Plan) (Burns and McDonnell, 2003). Information about the Long-Term Plan is also presented in Chapter 8 of this volume and in the *2005 South Florida Environmental Report – Volume I*. The water quality parameters that are addressed include nutrients and physical parameters including but not limited to pH, turbidity, dissolved oxygen, pesticides, major ions, and mercury. This information documents compliance with appropriate conditions of the Everglades Forever Act and the U.S. Environmental Protection Agency's National Pollution Discharge Elimination System permits. Water quality monitoring within and downstream of the treatment areas demonstrated that the five STAs in operation are in full compliance with state operating permits. The District has performed all sampling and analysis under the latest Laboratory Quality Assurance Manual (SFWMD, dated January 3, 2005) and a Field Quality Assurance Manual (SFWMD, dated January 3, 2005). A signed copy of these statements is provided in Appendix 4-3 of this volume. A summary of STA operations and issues is presented in **Table 4-2**. The appendices presented with this chapter provide additional details of the monitoring program, as required by state operating permits, as well as plots showing the annual flow, TP load, and TP

required by state operating permits, as well as plots showing the annual flow, TP load, and TP concentrations for the inflow and outflow of each STA for the years that they have been operating.

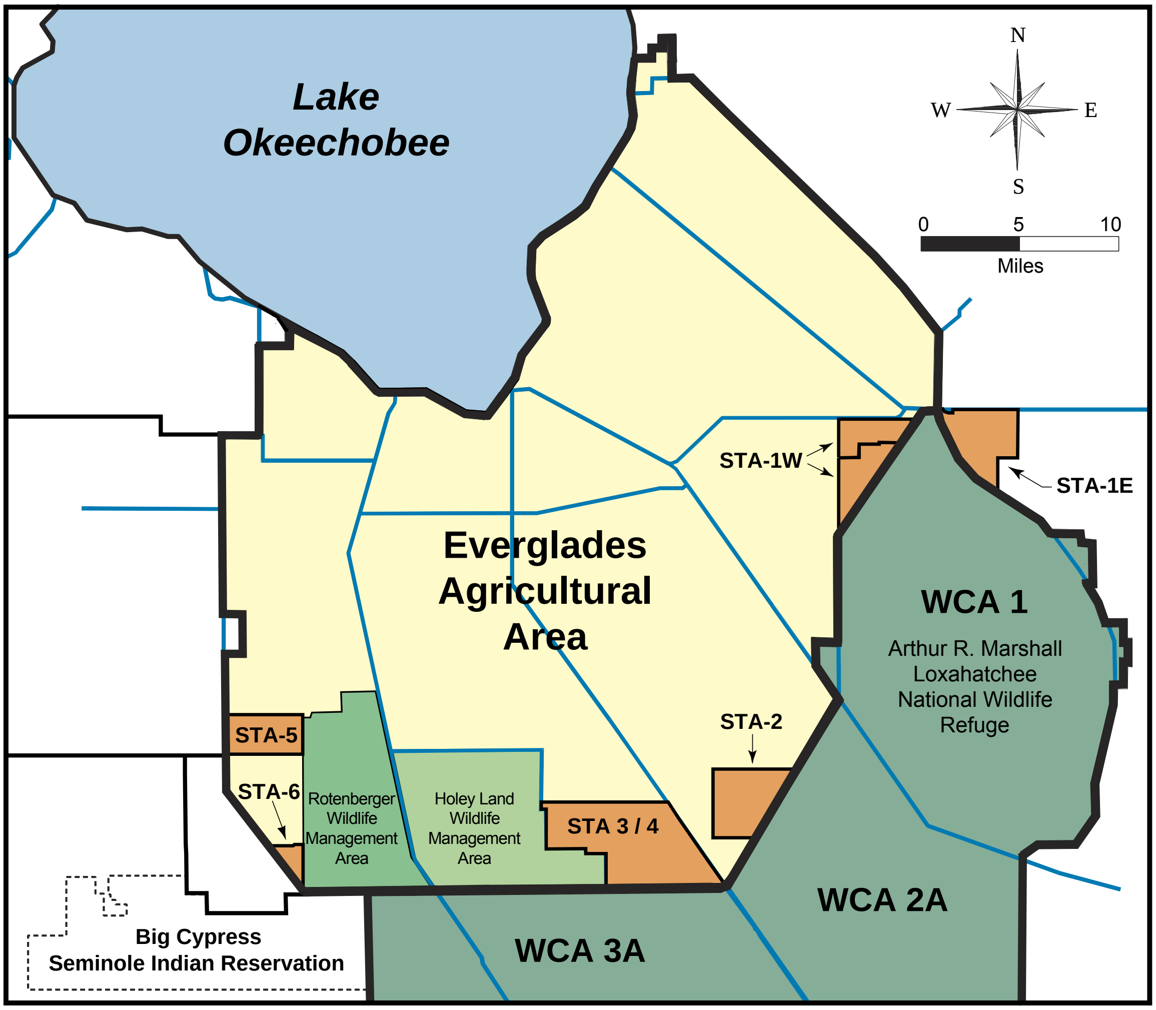


Figure 4-1. Location of the Stormwater Treatment Areas (STAs).

Table 4-1. STA hydrology and total phosphorus (TP) removal for Water Year 2005 (WY2005). Refer to each STA section for details regarding the operation of each STA, such as treatment cell start-up and flow-through status and temporary loss of effective treatment area due to vegetation rehabilitation or implementation of the Long-Term Plan enhancements.

	STA-1W	STA-2	STA-3/4	STA-5	STA-6	All STAs
Total Inflow Volume (ac-ft)	341,094	316,273	671,442	119,910	34,035	1,482,754
Hydraulic Loading Rate (cm/d)	5.2	4.1	4.0	2.9	3.2	4.1
Flow-weighted Mean Inflow TP (ppb)	247	126	105	165	78	147
TP Loading Rate (g/m2/yr)	*** 4.7	1.9	*** 1.6	*** 1.8	0.9	2.2
Total Inflow TP Load (mt)	103.9	49.1	87.4	24.4	3.3	268.0
Total Outflow Volume (ac-ft)	383,663	371,023	648,872	121,427	22,187	1,547,172
Flow-weighted Mean Outflow TP (ppb)	98	20	13	81	19	41
Total Outflow TP Load (mt)	46.5	9.2	10.4	12.2	0.5	78.9
Hydraulic Residence Time (d)	10	9	NA	15	14	
TP Retained (mt)	57.3	39.9	77.0	12.2	2.7	189.2
TP Removal Rate (g/m2/yr)	2.61	1.53	1.37	0.89	0.75	1.56
Load Reduction (%)	55%	81%	88%	50%	84%	71%
TP Retained to Date (mt)	297	91	78	122	28	617
TP Flow-weighted Mean Outflow to Date (ppb)	48	17	13	100	19	41

Note: "TP retained to date" based on the period of record for each STA. The STA-1W record begins in WY1995; the STA-2 record begins in WY2002; the STA-5 record begins in WY2001; and the STA-6 record begins in WY1998. STA-3/4 begins in October of WY2005. *** = loadings are based on the estimated effective treatment area for the STAs, taking into account loss of treatment area due to treatment cells taken off-line at times during the water year (refer to individual STA sections in this chapter).

Table 4-2. 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	Operational Status	Other Issues
STA-1E	In start-up phase. EFA and NPDES final permits were issued by the FDEP on August 30, 2005. On September 20, 2005 FDEP officially concurred with the District's submittal which documented that the start-up compliance tests for phosphorus and mercury, as outlined in the EFA and NPDES permits, was achieved for the western (Treatment Cells 5, 6, and 7) and central flow ways (Treatment Cells 3, 4N, and 4S) of STA-1E. Accordingly, flow-through operations for these flow ways was authorized. Treatment Cells 1 and 2 remain off-line for construction of the PSTA demonstration project. The PSTA demonstration project is currently scheduled for expected completion of construction in October 2006.	Partially operational: Treatment Cells 1 and 2 remain off-line for construction of the PSTA demonstration project; Hurricane damage to interior levees in Cell 4N.
STA-1W	In stabilization phase. In WY2005, there was a diversion through structures G-300 and G-301 of 69,064 ac-ft and 27 mt of TP with a flow-weighted mean TP average of 317 ppb into the Refuge because the capacity of the STA-1W was exceeded.	Partially operational; Northern flow-way (Cells 5A and 5B) temporarily under restricted flow of 150 cfs inflow when S-5A pumping for vegetation rehabilitation; off-line temporarily from January–April 2005 to degrade the limerock berm. Western flow-way (Cells 2 and 4) temporarily off-line from May 2004–July 2004 for vegetation management and from January 2005 to present for Long-Term Plan enhancement construction. Hurricane damage to G-302, Cell 5 northern levees; vegetation up-rooting.
STA-2	In stabilization phase until STA-1E reaches full capacity flow-through operations There was no diversion around STA-2.	Fully operational; Hurricane damage to northern levee in Cell 3; vegetation up-rooting.
STA-3/4	In stabilization phase. Eastern Flow-way 1 (Cells 1A and 1B) showed net improvement for phosphorus on 12/24/03 and for mercury on 1/15/04; Central Flow-way 2 (Cells 2A and 2B) showed net improvement for phosphorus on 8/5/04 and for mercury on 8/11/04 and has been in flow-through since 9/16/04; Western Flow-way 3 (Cell 3) showed net improvement for phosphorus on 12/24/03 and for mercury on 6/29/04, through a permit modification, flow-through operations was authorized on 3/19/04. In WY2005, there was diversion through structures S-7, S-150, S-8, and G-404/G-357 of 212,361 ac-ft and 8.9 mt of TP with a flow-weighted mean TP average of 34 ppb.	Partially operational; Western Flow-way 3 (Cell 3) temporary off-line from October 2004–June 2005 for Long-Term Plan enhancement construction and was returned to operation on 6/13/05 with a partial flow capacity of 800 cfs.
STA-5	In stabilization phase. In WY2005, there was a diversion through structure G-406 of 30,165 ac-ft and 10.5 mt of TP with a flow-weighted mean TP average of 282 ppb.	Partially operational; Cell 1B temporarily off-line from January 2005 –July 2005 for Long-Term Plan enhancement construction.
STA-6	Fully operational; in post-stabilization phase.	Fire at the inflow pump station G-600 in October 2004 destroyed the telemetry, pumps partially operational. District took over ownership of G-600 from U.S. Sugar Corporation in April 2005.

During WY2005, a series of events occurred that affected STA performance. These events ranged from the impact of multiple hurricanes in 2004 to the short-term reduction of treatment area due to construction of Long-Term Plan enhancements. The STAs experienced months of high rainfall, hydraulic overloading, and high TP inflows. The STAs have received stormwater runoff, lake releases, and water supply demand waters. Rainfall was variable, with some months having over two inches more rainfall than the average (Figure 5-34). The hurricanes caused physical damage to the wetlands, degrading levees and structure banks and uprooting submerged aquatic vegetation (SAV), especially at STA-1E, STA-1W, and STA-2. In January 2005, some sections of STA-1W, STA-3/4, and STA-5 were taken out of operation in order to construct Long-Term Plan enhancement elements, such as divide levees and improved water control structures. Those elements of the Long-Term Plan projects that have been started in the STAs are listed in this chapter, identified by the budget code and cross-referenced in Chapter 8 of this volume.

Because of the integrative nature of the regional system, the management of the STAs has been based on using an adaptive approach and real-time data interpretation tools. The focus of the STA operations team has been to implement adaptive management by utilizing real-time data evaluation tools which compare actual data to the long-term average annual value anticipated during design or to the established operations guides. During this reporting period, weekly communication meetings were held, real-time data evaluation was generated, a recover plan was prepared for STA-1W, vegetation management activities have occurred, and site managers continue to be assigned to the STAs. The real-time data evaluation tools use both data regarding stages and water quality information as presented by the site managers to the operations staff, as well as a graphical output that compares the actual flow and TP loads to the long-term average annual values that were anticipated for each STA (Goforth, 2004; www.sfwmd.gov/org/ema/toc/archives/docs/design_envelope_STA_051004.pdf). The recover plan developed for STA-1W was written to encompass both short and long-term projects aimed at reestablishing the vegetation and water flow patterns (www.sfwmd.gov/org/erd/longtermplan/documents.shtml). Weekly communication meetings and the involvement of the site managers and construction engineers and other technical working group meetings have contributed to the operation and management of the STAs.

As part of the adaptive implementation process envisioned by the District's STA optimization program, it is anticipated that further refinements to the recommended water quality improvement measures would be made at the earliest achievable dates as more scientific and engineering information is obtained. Investigations are under way in each STA, which are summarized in later sections of this chapter. General operational principles that are currently performed in the STA operations are as follows:

- Try to ensure inflows (flows and TP loads) are within the design envelope
- Avoid dryout and maintain a minimum of 15 cm depth of water
- Avoid keeping the water stage too deep for too long by limiting depth to a maximum of 137 cm for 10 days
- Maintain target depths between storm events:
    - Emergent vegetation: 38 cm
    - Submersed aquatic vegetation (SAV): 45 cm
- Frequent field observations by site managers

A complete set of references regarding STA operations can be found on the District's web site at www.sfwmd.gov/org/ema/everglades/consolidated_00/ecr2000/intro.pdf, and the 1995 Basis for Design paper is available online at http://wwwalker.net/pdf/stadesign.pdf.

Vegetation management activities in the STAs have both operational as well as research components. Activities include a large-scale plant inoculation to accelerate SAV recruitment, research studies to evaluate the best methods to treat undesirable vegetation, and percent coverage estimates. The water depth within the treatment cells along with herbicide application and the use of fire are used to manage the vegetation communities. In general, emergent vegetation is encouraged at the beginning of the treatment train where nutrient concentrations are higher and SAV is encouraged in areas further down the flow path. Overall, vegetation management focuses on keeping floating aquatic vegetation at maintenance control levels. The floating aquatic vegetation "shades out" or impedes beneficial submersed and emergent vegetation, which is necessary for proper STA performance. Additionally, emphasis was also placed on controlling expanding emergent vegetation, mainly torpedograss (*Panicum repens*) and cattail (*Typha*, spp.), which appears in SAV cells. Research experiments using varying dosages of herbicide along with different water depths and fire regimes have been conducted in WY2005. The final report on the torpedograss control experiment conducted in STA-3/4 can be found on the District's web site at www.sfwmd.gov/org/erd/longtermplan/documents.shtml. To accelerate the SAV recruitment in STA-3/4, a huge inoculation was conducted by helicopter, using plant material from STA-2 Cell 3. A summary of the vegetation management activities as well as a listing of the herbicides used in the STAs during WY2005 is presented in **Table 4-3** as well as under each STA section in this chapter.

Table 4-3. Summary of the amount of herbicides applied to the STAs during WY2005. The active ingredient within the herbicide is listed. Floating vegetation, such as water hyacinth and water lettuce, was controlled using herbicide containing diquat. Emergent vegetation, such as cattail, torpedograss, and para grass, was controlled using herbicides containing glyphosate or imazapyr. The submersed plant hydrilla was controlled using herbicide containing endothall.

STA	Acres	Herbicide containing Glyphosate (gallons)	Herbicide containing Imazapyr (gallons)	Acres	Herbicide containing Diquat (gallons)	Acres	Herbicide containing Endothall (gallons)
STA-1E	1,917.5	1,796.6	479.40	60.0	15.00	-	-
STA-1W	161.0	150.75	40.25	635.5	159.25	-	-
STA-2	7.0	6.5	1.75	268.0	67.00	151.0	285.0
STA-3/4	2,749.0	2,576.1	687.25	1,117.0	279.25	-	-
STA-5	758.0	710.6	189.50	639.25	159.80	-	-
STA-6	17.0	15.9	4.25	5.0	1.25	-	-

As part of the adaptive management activities, the STAs are evaluated using real-time data as compared to how they were designed. **Table 4-4** lists the average long-term design values that were anticipated during design, the actual values for WY2005, and longer-term averages, if the STAs have been in operation for awhile. The long-term average annual design values anticipated during design are presented as guidelines; they are not an annual maximum limit nor are they expected to occur each year. In WY2005, STA-1W, STA-2, and STA-3/4 received inflow and TP loads that were higher than the long-term average annual design values (**Table 4-4** and under each STA section of this chapter). STA-1W was the most overloaded and received about two times more flow and almost four times more TP load than the long-term average design value. During August and September 2004, all of the STAs received very high inflow and TP loads. In those two months, STA-1W received more flow than the long-term annual average design amount; STA-2 received about 78 percent more flow, and STA-2, STA-3/4, and STA-5 received about 50 percent more flow than the annual average long-term design amount. Time series plots showing monthly data for WY2005 are found under the individual STA sections in this chapter and plots showing annual data over the entire period of operation for each STA are found in Appendix 4-15. Analysis of the flows and TP loads on a regional scale are presented in Chapters 2 and 3 of this volume.

Table 4-4. STA long-term average annual design parameters along with data collected in WY2005. The actual effective treatment area is based on all treatment cells being operational within the STA. In STA-1W, STA-3/4, and STA-5, the effective treatment area is less due to cells being temporarily off-line for Long-Term Plan enhancements or vegetation rehabilitation.

STA	Parameter	Effective Treatment Area (acres)	Average Annual Inflow (ac-ft)	Hydraulic Loading Rate (cm/day)	Average Annual Load (kg)	Nutrient Loading Rate (g/m2/yr)	Flow-weighted Mean TP (ppb)
STA-1E	Long-Term Average Design	5,130	32,288	2.06	28,759	1.33	176
	WY2005 Actual	N/A	N/A	N/A	N/A	N/A	N/A
STA-1W	Long-Term Average Design	6,670	159,985	2.00	27,372	1.01	139
	WY2005 Actual	5,436	341,094	4.27	103,872	3.85	247
	WY2001–WY2005	---	319,661	4.20	67,131	2.66	170
STA-2	Long-Term Average Design	6,430	232,759	3.02	28,800	1.11	100
	WY2005 Actual	6,430	316,273	4.11	49,121	1.89	126
	WY2002–WY2005	---	267,188	4.91	29,277	1.79	89
STA-3/4	Long-Term Average Design	16,543	657,168	3.32	71,591	1.07	88
	WY2005 Actual	13,871	671,442	3.39	87,368	1.30	105

Table 4-4. Continued.

STA	Parameter	Effective Treatment Area (acres)	Average Annual Inflow (ac-ft)	Hydraulic Loading Rate (cm/day)	Average Annual Load (kg)	Nutrient Loading Rate (g/m2/yr)	Flow-weighted Mean TP (ppb)
STA-5	Long-Term Average Design	4,118	129,083	2.62	28,209	1.69	177
	WY2005 Actual	3,398	119,910	2.43	24,420	1.46	165
	WY2001–WY2005	---	130,582	2.75	39,045	2.40	242
STA-6	Long-Term Average Design (w/ Section 2)	2,370	37,442	1.32	3,999	0.42	87
	WY2005 Actual	870	34,035	3.27	3,255	0.92	78
	WY1999–WY2005	---	47,966	5.26	4,549	1.48	77

STA-1E

The construction of Stormwater Treatment Area 1 East (STA-1E) was managed by the U.S. Army Corps of Engineers (USACE). Construction of the STA was completed in June 2004. The Everglades Forever Act (EFA) and National Pollution Discharge Elimination System (NPDES) final permits were issued by Florida Department of Environmental Protection (FDEP) on August 30, 2005. On September 20, 2005 the FDEP officially concurred with the District's submittal which documented that the start-up compliance tests for phosphorus and mercury, as outlined in the EFA and NPDES permits, was achieved for the western (Treatment Cells 5, 6, and 7) and central flow-ways (Treatment Cells 3, 4N, and 4S) of STA-1E. Accordingly, flow-through operations for these flow ways was authorized. The USACE is currently designing a Periphyton-Based Stormwater Treatment Area (PSTA) demonstration project in Cell 2 and Treatment Cells 1 and 2 will remain off-line until the demonstration project is finished. A schematic of STA-1E is presented in **Figure 4-2**. The amount of discharge flow and TP load is listed in Table 2C-3.

Based on the 1979–1988 period of flow and total phosphorus (TP) data used during design, STA-1E should receive approximately 94,000 acre-feet (ac-ft) from the C-51 West basin, and approximately 31,000 acre-feet (ac-ft) from the S-5A basin through the G-311 structure. Actual deliveries will vary based on hydrologic conditions in the basins. An updated water quality analysis for the C-51 West basin indicates that the total phosphorus (TP) concentrations and loads to STA-1E were about 38 percent less than previously anticipated (Pietro and Goforth, 2004). This document is listed as the District Technical Publication ERA #430 and also on the Long-Term Plan web site at www.sfwmd.gov/org/erd/longtermplan/documents.shtml. Plans are under way to divert untreated stormwater from Acme Basin B that currently enter the Water Conservation Area 1 (WCA-1) to C-51 for treatment in STA-1E, with a scheduled completion around September 2007. Upon initial operation of STA-1E, though, there will be no Acme Basin B contributing to STA-1E.

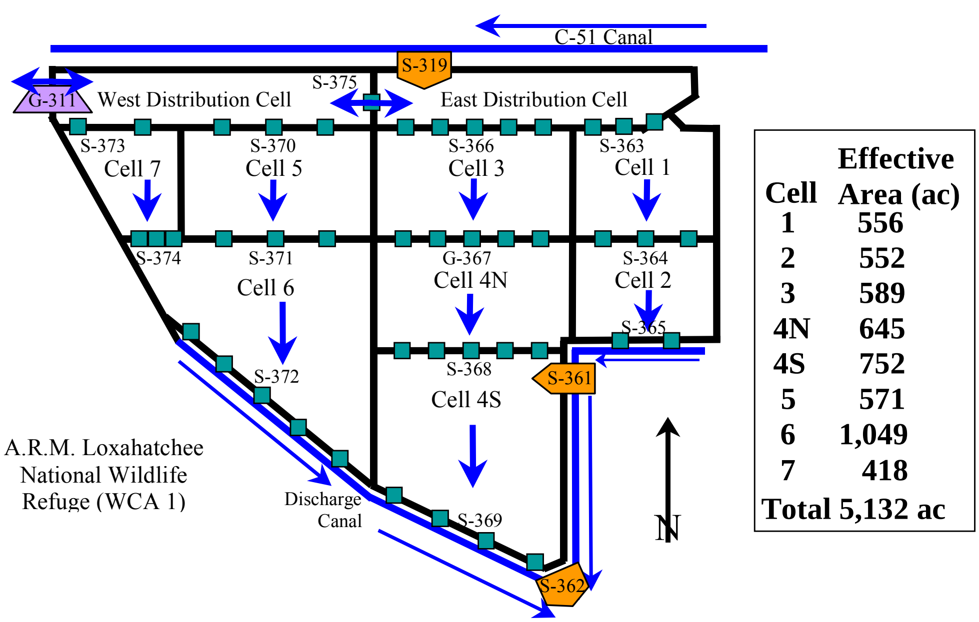


Figure 4-2. Schematic of STA-1E (not to scale). The orange boxes denote pump stations. Green boxes represent culverts.

STA-1E HURRICANE IMPACTS

The winds and rain from both hurricanes Frances and Jeanne impacted STA-1E. Hurricane Frances also temporarily caused emergency conditions affecting public health that necessitated an Emergency Authorization and Order to operate STA-1E. During Hurricane Jeanne, water was put into STA-1E beginning on September 26, 2004. Erosion damage was found on the interior levees in Cells 4N, 4S, and 6 and repairs are currently under way.

STA-1E VEGETATION MANAGEMENT

Vegetation management at STA-1E focuses on keeping floating aquatic vegetation (FAV) at maintenance control levels. FAV "shades out" or impedes beneficial submersed and emergent vegetation which is necessary for proper STA performance. Along with the FAV treatments, emphasis was placed on controlling expanding emergent vegetation, mainly torpedo grass (*Panicum repens*) and cattail (*Typha* spp.), which appear in submersed aquatic vegetation (SAV) cells. In addition to herbicide application, the water level within the treatment cells is manipulated to encourage vegetation growth. In Water Year 2005 (WY2005) (May 1, 2004 through April 30, 2005), 15 gallons of the herbicide containing the active ingredient diquat was used in STA-1E to treat 60 acres to control floating vegetation in the marsh and 1,917.5 acres of emergent vegetation (cattail, torpedo grass, para grass, etc.) was treated with 150.75 gallons of herbicide containing the active ingredient glyphosate and 479.4 gallons of herbicide containing the active ingredient imazapyr.

Four of the eight treatment cells within STA-1E are intended to be "start-up" SAV cells but are dominated by upland terrestrial vegetation. Plans include treating 1,000 acres of terrestrial vegetation and then burning the entire cell prior to flooding. Other projects include the treatment of hardwood invasives, consisting primarily of Brazilian pepper (*Schinus terebinthifolius*) and melaleuca (*Melaleuca quinquenervia*).

STA-1E WILDLIFE AND RECREATION

Before STA-1E was flooded, a total of four burrowing owl (*Athene cunicularia floridana*) nests were found in Cells 1, 2, 4N, and 5. The District received a permit from the Florida Fish and Wildlife Conservation Commission (FWC) to mitigate, and activities included removing the nests after the breeding season, creating another nesting site outside of the STA effective treatment area, and providing starter burrows.

Recreational facilities are proposed to provide public access to STA-1E. The proposed recreational facilities include an asphalt parking area, road improvements, a composting toilet, landscaping and an information kiosk. Pedestrian gates, signage and fencing as needed to define public access areas and to protect sensitive equipment are also proposed.

STA-1E ENHANCEMENTS

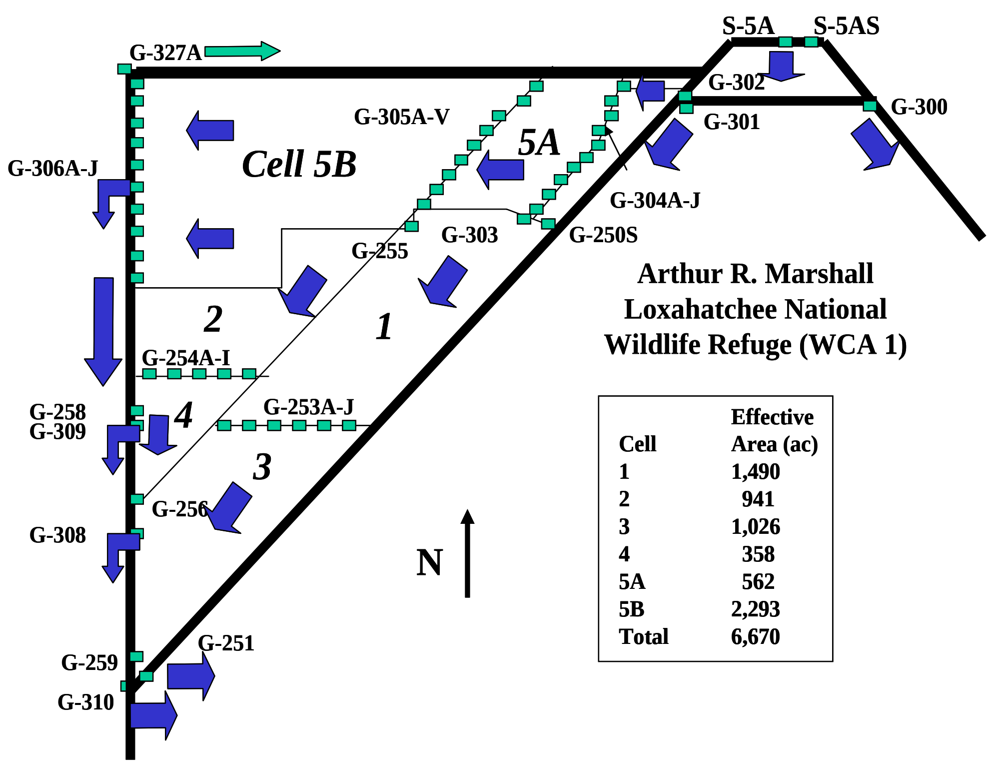
The STA-1E Enhancements project listed in the Long-Term Plan for Achieving Water Quality Goals in the Everglades Protection Area (Long-Term Plan) (Burns & McDonnell, 2003) was for herbicide treatment of Cells 2, 4N, 4S, and 6 and for the conversion from emergent (cattail dominant) to SAV vegetation communities. In the revised Part 2 of the Long-Term Plan dated November 2004, it was also recommended that the SFWMD coordinate with the USACE regarding its proposed PSTA demonstration project in Cell 2.

The current start-up plan for STA-1E has included efforts to establish Cells 6, 4N, and 4S as SAV cells from the beginning. Therefore, activities in these three cells during FY2005 included vegetation management activities such as herbicide application of emergent vegetation and less desirable vegetation. Also, as recommended in the Long-Term Plan, the SFWMD has been coordinating with the USACE regarding the PSTA demonstration project in Cell 2 including revision of the vegetation management activities in that cell for consistency with the demonstration project plan.

STA-1W

Stormwater Treatment Area 1 West (STA-1W) contains approximately 6,670 acres of effective treatment area arranged in three flow-ways. The eastern flow-way contains Cells 1 and 3, with a combined effective treatment area of approximately 2,516 acres. The western flow-way contains Cells 2 and 4, with a combined effective treatment area of approximately 1,300 acres. The northern flow-way (Cell 5) consists of approximately 2,855 acres. In addition, STA-1W includes the STA-1 inflow basin consisting of inflow pump station S-5A, and four gated spillways (S-5AS, G-311, G-300, and G-301), which allow for tremendous operational flexibility. Based on the simulated 1965–1995 period of flow utilized in developing the 2003 Long-Term Plan, STA-1W should receive an average annual flow of approximately 159,985 ac-ft (Goforth, 2004). Actual deliveries will vary based on hydrologic conditions in the basins.

Inflows to STA-1W from the STA-1 inflow basin are directed into STA-1W via the G-302 structure. Flow then moves into the northern flow-way (Cell 5) via the G-302 and G-304A–J structures and into Cells 1 through 4 via the G-303 structure (**Figure 4-3**). 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. Full flow-through operations through Cell 5 have occurred since July 2000. A limerock berm was constructed in Cell 5 during Water Year 2004 (WY2004) to improve the distribution of flow, thereby enhancing phosphorus removal.



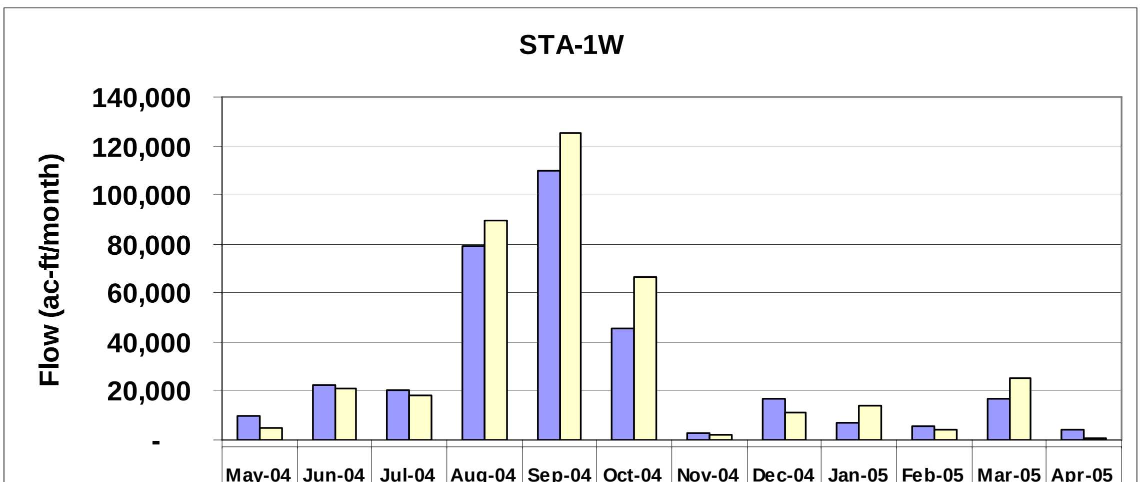
Cell	Effective Area (ac)
1	1,490
2	941
3	1,026
4	358
5A	562
5B	2,293
Total	6,670

Figure 4-3. Schematic of STA-1W (not to scale).

STA-1W OPERATIONS

During WY2005, discharge to the STA-1W treatment cells via G-302 was 341,094 ac-ft, equal to an average hydraulic loading rate of 5.2 centimeter per day (cm/d) over the effective treatment area of the STA. These inflows were about 113 percent higher than the long-term average annual simulated inflow for this STA, although annual variability was anticipated (**Table 4-4**). Had STA-1E been in flow-through operation, these inflows would have been reduced. The volume of treated water discharged from STA-1W to the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) was 383,663 ac-ft. The difference between the inflow and outflow volumes reflects the net contributions of direct rainfall, evapotranspiration (ET), seepage from the Refuge, seepage losses to adjacent lands, deep percolation, and flow measurement error. In WY2005, STA-1W received 17,829 ac-ft from Lake Okeechobee. A summary of monthly flows during WY2005 is presented in **Figure 4-4**.

Until STA-1E is fully operational, flows from the S-5A pump stations that exceed the hydraulic capacity of STA-1W will be diverted through the G-300 and G-301 structures into WCA-1. During WY2005, about 69,064 ac-ft (27 mt TP with a mean TP average of 317 parts per billion, or ppb) was diverted in this manner. A detailed breakdown of the diverted flow and loads are presented in the STA-1W Recovery Plan found on the District's web site at www.sfwmd.gov/org/erd/longtermplan/documents.shtml.



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Inflow	9,991	22,226	19,951	79,329	109,912	45,777	2,784	17,104	6,946	5,937	17,134	4,003
Outflow	5,118	20,752	18,219	89,672	125,419	66,613	2,126	11,424	14,034	4,280	25,534	471

Figure 4-4. Summary of WY2005 flow for STA-1W. Cells 1 and 3 were operational for the entire water year; Cell 5 was under restricted flow beginning in November 2004 for plant rehabilitation due to hurricane damage, was off-line in March 2005 to degrade the limerock berm, then was again operated under restricted flow; Cells 2 and 4 were taken off-line beginning in January 2005

Until STA-1E is fully operational, flows from the S-5A pump station that exceed the hydraulic capacity of STA-1W will be diverted through the G-300 and G-301 structures into Water Conservation Area 1 (WCA-1). These structures may also have been used to augment water displaced due to water supply demands. During WY2005, 69,064 ac-ft (27 metric tons, or mt) of TP were diverted in this manner.

The operation of STA-1W over the water year has focused on plant recovery in the treatments cells, response to multiple hurricanes, and implementation of major construction activities in Cells 2, 4, and 5B. To accomplish these tasks, sections of the wetland were taken off-line. To aid in mechanical removal of the floating cattail tussocks in Cell 2 and to encourage SAV growth in Cells 2 and 4, the western flow-way was closed to inflow during the dry season. During WY2003, STA-1W received an enormous amount of inflow (almost 600,000 ac-ft) in response to the high water levels in Lake Okeechobee during summer 2002 that required the District and the USACE to institute extreme operational measures to protect the lake ecosystem and the integrity of the surrounding levee. Thus, from July 2002 through February 2003, deliveries to WCA-1 were passed through STA-1W for treatment prior to discharge to the Refuge (Goforth et al., 2005). This resulted in the inadvertent overload of flow and phosphorus loads to the STA. Immediate management activities were implemented to minimize the long-term adverse impacts of this overload event.

Continuing with the management operational guidelines presented in Chapter 4 of the *2005 South Florida Environmental Report – Volume I* (SFER) (Goforth et al., 2005), loading into the STA was reduced and the western flow-way consisting of Cells 2 and 4 was closed to inflow until August 2004. Positive responses were observed, with SAV coverage increasing in Cells 4 and 5 and STA outflow flow-weighted mean (FWM) TP concentrations low, ranging from 29–32 parts per billion (ppb) during May–July 2004. The western flow-way was returned to flow-through operations in August 2004 to reduce the potential for untreated water to go to the Refuge. At this point, all treatment cells were operating. In August 2004, there was a large amount of rainfall at STA-1W. In September 2004, two major hurricanes (Hurricane Frances, a Category 2 hurricane); Hurricane Jeanne, a Category 3 hurricane) impacted STA-1W, delivering high winds and a very large amount of rainfall, about two times the average (Figure 5-34). In response to the heavy rains, STA-1W received more flow in two months than that anticipated for the entire year. Inflows into STA-1W in August–September 2004 totaled 199,241 ac-ft compared to the annual average design of 159,985 ac-ft per year. Simultaneously, the inflow TP concentrations were high, resulting in TP loads also much higher than the design amounts. In August 2004, the TP load was 26,030 kilograms (kg), close to the design average of 27,372 kg per year, and then rose up to 40,150 kg in September 2004. The high TP concentrations measured in early August occurred simultaneously with an internal breach at the Palm Beach Aggregates, which released water into the C-51 canal. TP measured at the auto-sampler at G-302 during this time was 540 ppb. Construction activities were also occurring at the S-5A pump station.

As soon as possible after the hurricanes, inflows to STA-1W were reduced. To help reestablish the SAV communities that were disrupted from the hurricanes and improve the water clarity, inflow into Cell 5 during November 2004 was restricted to a maximum of only 150 cubic feet per second (cfs) of flow when S-5A was pumping. In January 2005, the western flow-way (Cells 2 and 4) was closed down in order to build a divide levee with water control structures in Cell 2 and replace the outflow structure in Cell 4 (Long-Term Plan enhancements). The next month, because the TP concentrations measured at the Cell 5 outflow were high, the water was rerouted through STA-1W using the seepage pump (G-327A) instead of being discharged into the Refuge. The northern flow-way (Cell 5) was closed to inflow during late February 2005 in order to degrade the limerock berm to improve water flow through the cell. Heavy rains experienced in March 2005 impacted STA-1W, especially because only Cells 1 and 3 were operating. The western flow-way dewatering water was also put into Cells 1 and 3.

STA-1W HURRICANE IMPACTS

The strong winds and heavy rainfall from hurricanes Frances and Jeanne impacted STA-1W. Power outages were experienced a few days following the storms. The power outages experienced during Hurricane Frances caused the shut down of the outflow pump station G-251 during that storm event. During Hurricane Jeanne, the outflow pump station G-310 had to be shut down in order to remove mud that had been deposited in the area. There was physical damage done to STA-1W as a result of the hurricanes. Specifically, erosion at the inflow structure G-302 and at the Cell 5 G-305 culverts, erosion on the north levees, especially severe in Cells 5A and 5B, and erosion of the limerock berm in Cell 5B. Extensive damage was also done to the SAV community in Cell 5B, with most of the SAV uprooted and pushed up onto the northern levee bank. Some movement of the floating cattail tussocks in Cells 1 and 2 was observed. The water within the treatment cell was highly turbid. Repairs were completed in June 2005, and the SAV communities in Cell 5B are slowly reestablishing.

STA-1W MANAGEMENT ACTIVITIES IMPLEMENTED SINCE THE 2002 OVERLOAD EVENT

1. Deliveries from Lake Okeechobee to STA-1W were terminated as of February 15, 2003. This was done despite the continuing need to lower the stage in the lake, and the effort to minimize harmful freshwater releases to the estuaries. Deliveries resumed in WY2005 at a fraction of the WY2003 amount.
2. Weekly operations meetings between STA managers, construction engineers, and operations staff have been conducted to ensure the most efficient and effective coordination of STA operations. Graphics of real-time data compared to the average long-term design envelope estimates and recommendations from the site managers and research regarding operations based on stage and treatment performance are used to aid in decision making. A recovery plan for STA-1W has been prepared and is presently being implemented.
3. Cells 2 and 4 were taken off-line for the balance of the 2004 dry season in order to give this flow-way a period of recovery. In addition, water depths were lowered in order to facilitate increased submerged vegetation growth. The cells were returned to flow-through operation in mid-August 2004 to minimize the potential for diversion of untreated water to the Refuge. Observations indicate a good recovery of SAV vegetation at that time. Cells 2 and 4 were again taken off-line in January 2005 to begin construction of a divide levee in Cell 2, a new outflow structure in Cell 4, cuts in the mid canal berm in Cell 4, and replacement of the G-254 culverts.
4. Vegetation management activities have been completed in STA-1W, including herbicide application and physical removal (floating cattail tussocks in Cell 2, SAV in collection outflow canals in Cell 3).
5. Cell 5 was taken off-line in November 2004. Prior to that, inflows into Cell 5 were reduced in October 2004 to encourage SAV regrowth.
6. A limerock berm was constructed in Cell 5 from February–August 2004. In March 2005, the elevation of the berm was lowered to improve water flow through the cell.
7. The District has increased the coordination with the USACE to expedite the completion of STA-1E. This STA was designed to work in concert with STA-1W to treat a portion of the stormwater runoff from the upstream EAA basin. The District is considering alternative operations until STA-1E is fully operational, the preferable choice being diversion to tide rather than alternatively diverting the extra untreated runoff to the Everglades.
8. The District successfully experimented with delivering water around the Refuge rather than through the Refuge to meet the water supply demands of the local Water Control District.

9. The District expedited the commencement of flow-through operations of STA-3/4, designed to capture and treat approximately 250,000 ac-ft per year of lake water. On February 26, 2004, flow-through operations began for the 6,500-acre eastern flow-way. On June 8, flow-through operations began in the 4,500-acre western flow-way and, on September 16, 2004, flow-through operation began in the central flow-way. It is anticipated that all future Lake Okeechobee releases, whether they are pursuant to the Water Supply and Environment (WSE) regulation schedule, Best Management Practices (BMPs) replacement water, or for water supply to downstream receiving areas, will be directed to STA-3/4 prior to discharge to the Everglades Protection Area (EPA), when practical.

STA-1W VEGETATION MANAGEMENT

The treatment cells at STA-1W are managed to encourage emergent plant growth in Cells 1A, 2A, and 5A and SAV communities in the remaining cells. The target water stages are listed in the operations plan for each treatment cell to encourage the dominant vegetation types. Vegetation management focuses on keeping FAV at maintenance control levels in all STAs. FAV "shades out" or impedes beneficial submersed and emergent vegetation which is necessary for proper STA performance. Along with the FAV treatments, emphasis is also placed on controlling expanding emergent vegetation, mainly torpedograss and cattail, which appears in SAV cells.

Specific Condition 13(b) of the EFA permit requires that the annual Everglades Consolidated Report (currently known as the South Florida Environmental Report) include information regarding the application of herbicides used to exclude and/or eliminate undesirable vegetation within the treatment cells. In WY2005, the District treated a total of 796.5 acres to control vegetation in the marsh, using 159.25 gallons of diquat to treat the floating vegetation and 150.75 gallons of glyphosate and 40.25 gallons of imazapyr to control emergent vegetation (**Table 4-3**). The District used both aerial and ground-based spray equipment to apply these herbicides.

The hurricanes in September 2004 uprooted most of the SAV in Cell 5B and much plant material was pushed to the northern levee bank. The debris started to decompose and had to be manually removed. Within the treatment cells, the water depths were lowered in order to encourage SAV regrowth and improve water clarity.

STA-1W CELL 5 LIMEROCK BERM [FDEP GRANT AGREEMENT (BC25)]

In FY2003, the District, with funding assistance from the FDEP and the USEPA through FDEP Grant Agreement No. G0040, completed the construction of a limerock berm in STA-1W, Cell 5B. The purpose of the limerock berm project is to demonstrate the benefits of improved hydraulics through compartmentalization at full scale. The monitoring phase of the limerock berm project was initiated in FY2003 and continued in FY2004 and FY2005. In FY2004, a tracer project was initiated in Cell 5 to document the ability of the limerock berm to improve hydraulic distribution within the treatment cell. A description of the tracer project, including the results, is available on the South Florida Water Management District's web site at www.sfwmd.gov/org/erd/longtermplan/pdfs/STA1W%20Cell5b%20Tracer.pdf. The following is an excerpt from the Executive Summary of this report:

> This study revealed that Cell 5B displays remarkably efficient hydraulic characteristics. For example, the tanks-in-series (TIS) value calculated for Cell 5B using the method of moments was 10.6, an extraordinarily high value when compared to previous assessments (TIS range of 1.3 – 3.4 for other STA-1W wetlands). This high hydraulic efficiency was depicted by the "near-plug flow" shape of Cell 5B's outflow tracer response curve, as well as the comparable export, on a mass basis, of lithium from the wetland's 10 outflow

> culverts. Cell 5B's high hydraulic efficiency is probably due to effective distribution of inflows among the 22 culverts at G-305, as well as the absence of pronounced short-circuit pathways. The limerock berm undoubtedly also plays a role in enhancing hydraulic performance of the wetland, but its exact contribution cannot be elucidated from the findings of this study.

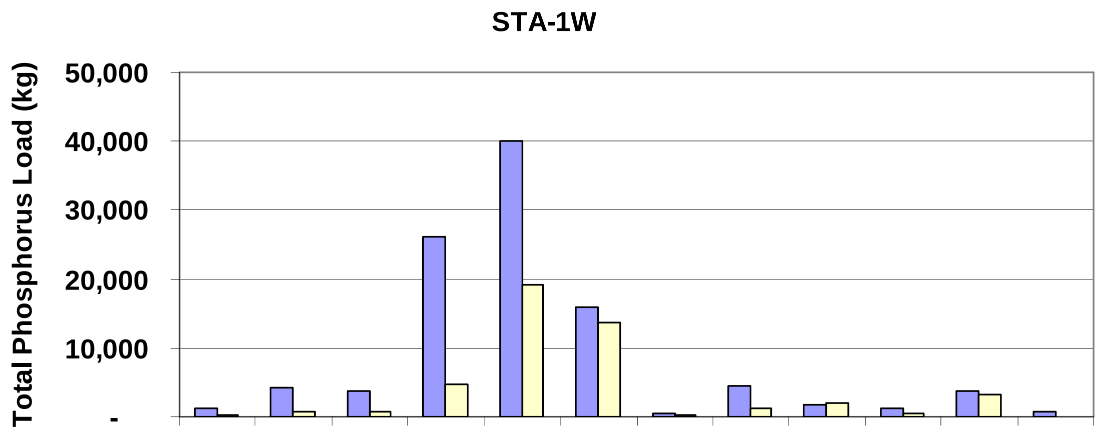
In fall 2004, the limerock berm sustained damage both from hurricanes Frances and Jeanne. The damage, consisting of washouts in various locations along the length of the berm, was repaired in late 2004. Subsequently, on January 3, 2005 the District requested approval from the FDEP to lower the top elevation of the limerock berm by about 1 to 1.5 feet. This request was made as a result of recent survey information indicating that the average ground elevation in Cell 5 was 6–12 inches lower than was assumed during the design of the limerock berm (based on information from the original design phase of Cell 5). The change in the assumed average ground elevation resulted in the decision to lower the average operating stage of Cell 5 to provide a more appropriate water depth for SAV; therefore, more of the top of the limerock berm was exposed making it susceptible to scouring and washouts. The FDEP approved the request to lower the top elevation of the limerock berm via e-mail on January 4, 2005. The lowering of the limerock berm was completed in April 2005. The monitoring of the limerock berm and the water quality associated with the treatment cell continued in FY2005. It is anticipated that the final reporting on the monitoring phase of this demonstration project will occur in next year's SFER.

STA-1W PERMIT STATUS

The data presented in this section demonstrates that STA-1W was in compliance with the EFA and the USEPA's NPDES operating permits for this reporting period and that discharges do not pose any known danger to public health, safety, or welfare. The EFA permits for the STAs acknowledge that until all the STAs are fully operational, certain STAs may receive higher than normal inflows. Specifically, Specific Condition 14(c) of the STA-1W EFA permit states that STA-1W will remain in the stabilization phase of operation until STA-1E and STA-2 begin flow-through operations. At this time, STA-2 has begun flow-through operations, but STA-1E is not expected to begin full capacity flow-through operations until the PSTA demonstration project is completed (expected completion date is October 2006). Therefore, STA-1W currently remains in the stabilization phase.

STA-1W TOTAL PHOSPHORUS

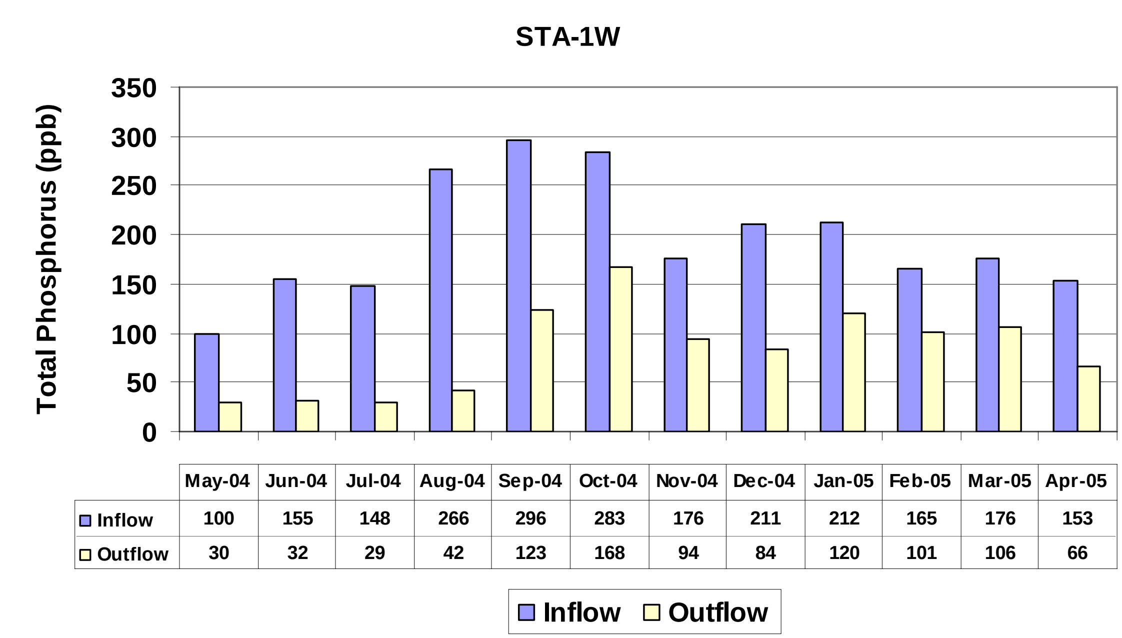
During WY2005, STA-1W received 103.9 mt of TP, equal to a nutrient loading rate of 4.7 grams per square meter (g/m^2) (**Table 4-4**). The TP loading to the system was about 3.8 times greater than the long-term design amount. During WY2005, STA-1W received approximately 6.6 mt of TP from Lake Okeechobee. Approximately 57.3 mt of TP were removed by STA-1W during WY2005. From May 2004 through April 2005, STA-1W reduced TP discharge loads by 55 percent, compared to inflow loadings measured at G-302. Summaries of monthly TP loads and FWM TP concentrations are presented in **Figures 4-5** and **4-6**. The FWM outflow concentration was 98 ppb, a 66 percent reduction from the inflow concentration of 247 ppb measured at G-302. For informational purposes, the geometric mean TP concentration of the discharge was calculated as 67 ppb, using auto-sampler data from G-251 and G-310. The moving 12-month FWM TP outflow concentration for STA-1W ranged from 41–98 ppb (**Figure 4-7**).



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Inflow	1,233	4,254	3,641	26,030	40,150	15,997	603	4,461	1,814	1,209	3,725	754
Outflow	191	823	657	4,620	19,063	13,776	246	1,187	2,078	531	3,324	38

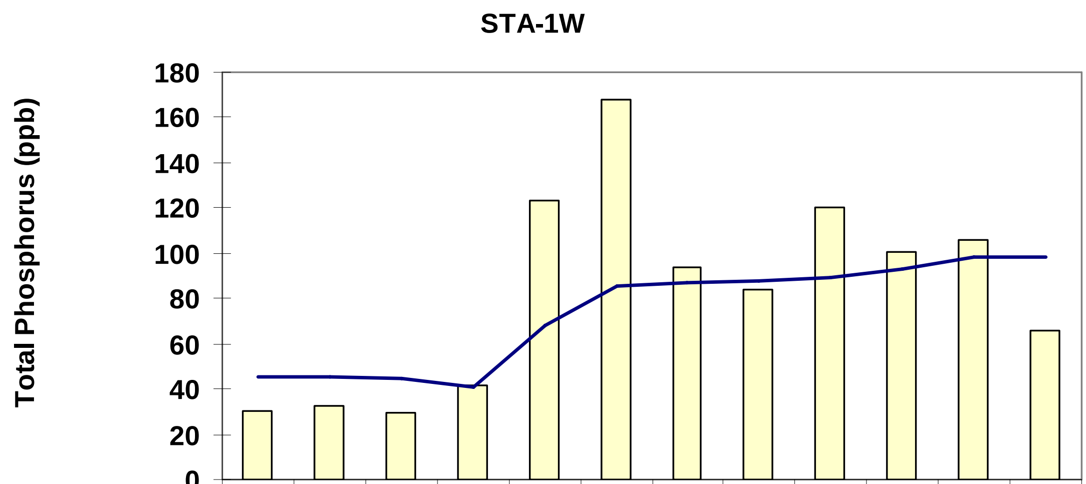
Inflow Outflow

Figure 4-5. Summary of WY2005 TP loads for STA-1W. Cells 1 and 3 were operational for the entire water year; Cell 5 was under restricted flow beginning in November 2004 for plant rehabilitation due to hurricane damage, was off-line in March 2005 to degrade the limerock berm, then was again operated under restricted flow; Cells 2 and 4 were taken off-line beginning in January 2005 for Long-Term Plan Enhancement construction.



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Inflow	100	155	148	266	296	283	176	211	212	165	176	153
Outflow	30	32	29	42	123	168	94	84	120	101	106	66

Figure 4-6. Summary of WY2005 TP concentrations for STA-1W. Cells 1 and 3 were operational for the entire water year; Cell 5 was under restricted flow beginning in November 2004 for plant rehabilitation due to hurricane damage, was off-line in March 2005 to degrade the limerock berm, then was again operated under restricted flow; Cells 2 and 4 were taken off-line beginning in January 2005 for Long-Term Plan Enhancement construction.



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Outflow	30	32	29	42	123	168	94	84	120	101	106	66
12 mo. Moving FWM	45	46	45	41	68	85	87	88	90	93	98	98

Figure 4-7. Comparison of monthly to 12-month moving average TP concentrations for WY2005 for STA-1W outflow. Cells 1 and 3 were operational for the entire water year; Cell 5 was under restricted flow beginning in November 2004 for plant rehabilitation due to hurricane damage, was off-line in March 2005 to degrade the limerock berm, then was again operated under restricted flow; Cells 2 and 4 were taken off-line beginning in January 2005 for Long-Term Plan Enhancement construction.

STA-1W OTHER WATER QUALITY PARAMETERS

Water quality parameters with Florida Class III standards are identified in **Table 4-5**. The monitoring data over the water year for non-phosphorus parameters at STA-1W during this reporting period are presented in Appendix 4-1 of this volume, and are summarized in **Table 4-6**. Temperature, specific conductance, dissolved oxygen (DO), and pH values reported in this chapter are field measurements. Ametryn concentrations were higher in the outflow than the inflow, although these herbicides are not used within this STA. 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 it 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 it also exceeds the annual average concentration at the inflow station, then STA-1W shall be deemed out of compliance.

Discharges from STA-1W 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 quality standards. Both inflow and outflow DO concentrations were lower than the Class III numeric standard. Annual average concentrations of total dissolved solids and dissolved chloride were slightly higher at the outflow compared to the inflow. However, because these parameters have no applicable numeric state water quality standards, STA-1W is deemed to be in full compliance with the permit. Additional requirements for DO are listed in Administrative Order AO-002-EV and are discussed below. Mercury monitoring results are also discussed in Chapter 2B, and the annual permit compliance monitoring report for mercury in the STAs is in Appendix 4-2 of this volume.

The District has included the following documentation to satisfy the remaining monitoring requirements of the EFA permit.

- The District has performed all sampling and analysis under the latest Laboratory Quality Assurance Manual (SFWMD, dated January 3, 2005) and a Field Quality Assurance Manual (SFWMD, dated January 3, 2005).
- A signed copy of these statements is provided in Appendix 4-3 of this volume.

Table 4-5. Water quality parameters with Florida Class III criteria specified in Section 62-302.530, Florida Administrative Code (F.A.C.).

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

Table 4-6. Summary of annual arithmetic averages and flow-weighted means (FWM) over the water year for all parameters other than TP monitored in STA-1W. For the purpose of these comparisons, FWMs are calculated as the quotient of the cumulative product of the mean daily flow and the sample concentration divided by the corresponding cumulative daily flows.

Parameter	Arithmetic Means			Flow-Weighted Means			
	Inflow	Outflow		Total Inflow		Total Outflow	
	S5A	G251	G310	n	Conc.	n	Conc.
Temperature (°C)	24.7	23.5	24.4	-NA-	-NA-	-NA-	-NA-
Dissolved Oxygen (mg/L)	4.8	1.9	4.1	-NA-	-NA-	-NA-	-NA-
Specific Conductivity (µmhos/cm)	859	955	935	-NA-	-NA-	-NA-	-NA-
pH	7.6	7.4	7.6	-NA-	-NA-	-NA-	-NA-
Turbidity (NTU)	24.1	2.6	5.0	-NA-	-NA-	-NA-	-NA-
Total Dissolved Solids (mg/L)	554	612	609	17 (26)	678	29 (52)	621
Unionized Ammonia (mg/L)	0.007	0.002	0.004	32 (49)	0.010	28 (51)	0.004
Orthophosphate as P (mg/L)	0.096	0.040	0.059	34 (52)	0.148	60 (104)	0.086
Total Dissolved Phosphorus (mg/L)	0.103	0.048	0.069	33 (51)	0.158	57 (100)	0.098
Sulfate (mg/L)	63.1	54.0	60.8	17 (26)	74.7	29 (52)	68.0
Alkalinity (mg/L)	206	239	220	17 (26)	255	29 (52)	222
Dissolved Chloride (mg/L)	104	120	126	17 (26)	115	29 (52)	114
Total Nitrogen (mg/L)	3.19	2.11	2.57	33 (51)	4.49	29 (51)	2.91
Total Dissolved Nitrogen (mg/L)	2.76	1.99	2.46	17 (26)	3.92	29 (51)	2.78
Nitrate + Nitrite (mg/L)	0.759	0.056	0.329	33 (51)	0.977	29 (51)	0.538
Ametryn (µg/L)	0.033	0.047	0.057	5 (7)	0.022	7 (8)	0.048
Atrazine (µg/L)	0.559	0.471	0.476	5 (7)	0.192	7 (8)	0.255

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

STA-1W DISSOLVED OXYGEN MONITORING

Introduction

DO concentrations fluctuate naturally in marsh environments, such as the Everglades, routinely falling below the Class III water quality criterion of 5 milligrams per liter (mg/L). STAs also experience natural fluctuations in DO that routinely fall below 5 mg/L, as observed in DO data collected in the Everglades Nutrient Removal Project (ENR Project Monitoring Report Appendices, 1995–1998), and as reported in the 1999 Everglades Interim Report, and in the 2000–2004 Everglades Consolidated Reports. The FDEP recognized the phenomenon of fluctuating DO concentrations in the EFA permit issued to the District for STA-1W (Administrative Order No. AO-002-EV in Exhibit C of Permit No. 503074709, April 13, 1999). To address DO in STA discharges, Section II of the Administrative Orders 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. The analysis is based on the following:

- Comparison of DO levels in STA discharges with background conditions in receiving waters
- 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
- Evaluation of whether discharges are necessary or desirable and are otherwise in the public interest
- Depiction of the daily and seasonal diel cycles for STA DO discharges during the period covered by the STA annual report
- Comparison of STA effluent with other historical DO data from the EPA, including data from interior marsh stations within the Refuge (receiving effluent from STA-1W), the Rotenberger Wildlife Management Area (RWMA) tract (receiving effluent from STA-5), and any other locations downstream of the STA discharges
- Consideration of the influences of temperature, seasonal weather conditions, aquatic community type, and hydropattern on the diel cycle of the STA discharges

The District developed the following plan to comply with the DO requirements of the Administrative Orders for STA-1W. Under the plan, DO concentrations are measured quarterly with Hydrolab™, DataSonde®, or MiniSonde® probes at 30-minute intervals for four consecutive days at the following locations:

- On the south side of the C-51 canal upstream of S-5A (**Figure 4-3**)
- Downstream of the G-251 and G-310 discharge structures (**Figure 4-3**)
- At sites along the X, Y, and Z transects in the periphery of the interior Refuge marshes downstream of the combined discharges (**Figure 4-8**)

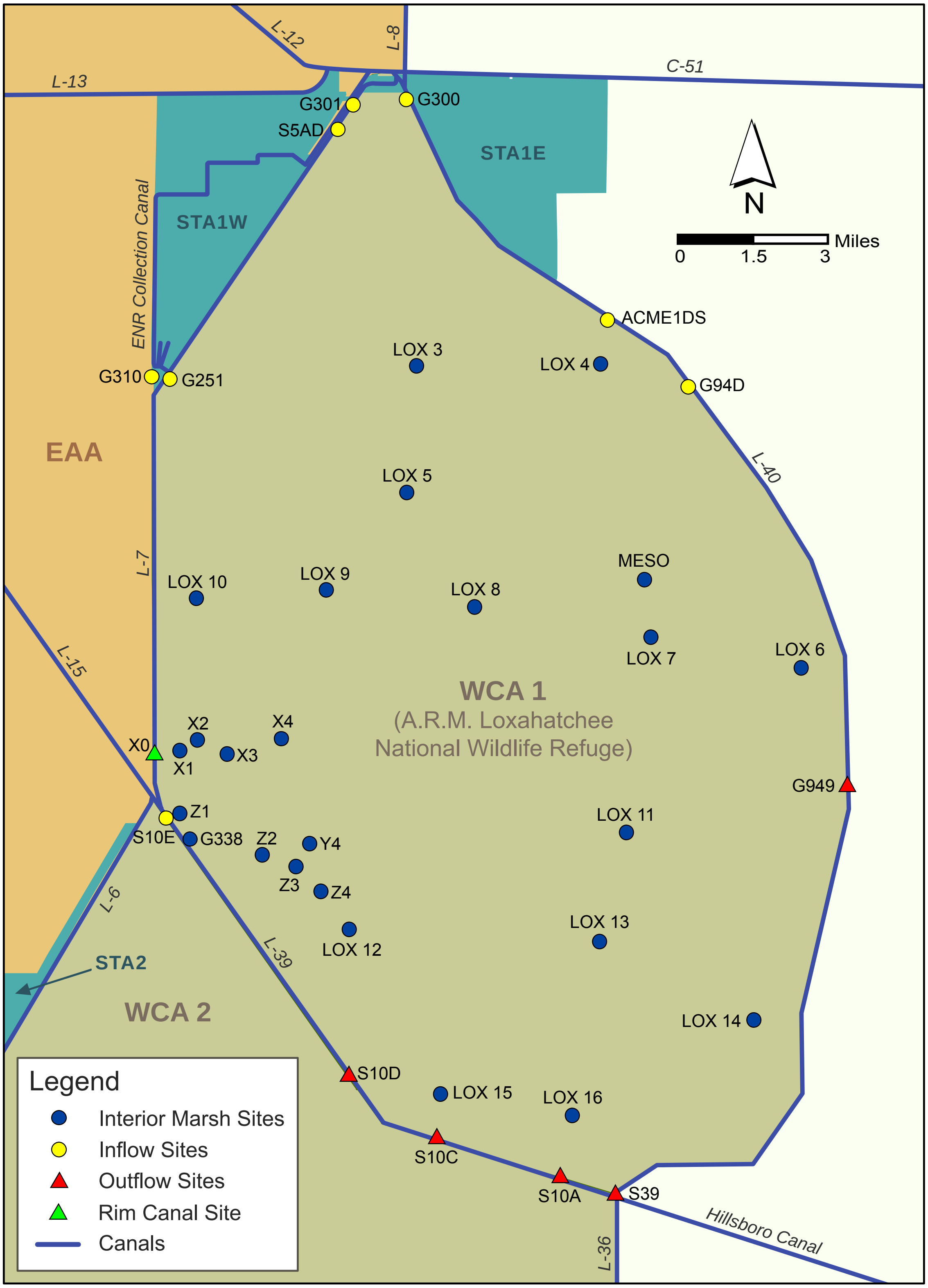


Figure 4-8. Location and classification of water quality monitoring stations in the Refuge.

Sampling Dates

Diel oxygen measurement dates and sites associated with STA-1W for WY2005 are provided in **Table 4-7**.

Table 4-7. Deployment dates for diel oxygen measurements at STA-1W structures and associated downstream marsh sites.

Event Dates		Structures			Sites Monitored in Refuge
Start	End	Inflow	Outflow		
06/21/2004	06/24/2004	S5AU	G251D	G310	----------------------------------
06/28/2004	06/30/2004	----	----	----	Y4*, Z1, Z3, Z4
09/23/2004	09/27/2004	S5AU	G251D	G310	----------------------------------
10/04/2004	10/08/2004	----	----	----	X1, X2, X3, X4, Y4, Z1, Z2, Z3*, Z4
12/13/2004	12/16/2004	S5AU	G251D	G310	----------------------------------
01/03/2005	01/07/2005	----	----	----	X1, X2, X3, X4, Z3, Z4
03/07/2005	03/11/2005	S5AU	G251D	G310	X1, X2, X3, X4, Y4, Z1, Z2*, Z3*, Z4

* Dissolved oxygen data collected at these sites were flagged.

Comparison of Dissolved Oxygen in STA-1W Discharges with Dissolved Oxygen at Downstream Marshes

Comparisons of DO in STA-1W discharges with DO at downstream marsh sites in the Refuge provide an indication of whether the discharge is affecting the marsh DO concentration or the diel oxygen cycle. The summary statistics for STA-1W outflows and Refuge marsh transect sites are presented in **Table 4-8**. Discharges from STA-1W structures G-251 and G-310 constitute the flow in the L-7 rim canal unless diversions are made through G-301, or there are outflows from the interior Refuge marsh. The DO concentration and concentrations of other constituents in the discharges affect water quality and vegetation along the fringe of the interior marsh. At times when rim canal stage is higher than interior marsh stage, rim canal water has the potential to flow into the interior marsh. The extent of this penetration is dependent on stage differential. Consequently, STA-1W discharges can affect the quality of water in the interior marsh up to several kilometers from the rim canal.

Examination of the data in **Table 4-8** and the notched box and whisker plots in **Figure 4-9** indicates that the median diel DO values in discharges from G-251 and G-310 were significantly greater than the values at transect sites Z1, X1, Z2, and X2. This significance is illustrated on **Figure 4-9** because the notches for the G-251 and G-310 plots, which represent the approximate

95-percent confidence interval (95% C.I.) for the medians, do not overlap the notches for Z1, X1, Z2, and X2. Non-overlapping notches indicate that data sets being compared are significantly different.

Further comparisons of medians and notches indicates G-251 had significantly lower DO concentrations than concentrations measured at sites X3, Z3, Z4, Y4 and X4. Site X3 is not significantly different from G-251. DO concentrations in G-310 discharges were significantly greater than concentrations measured at transect sites X3, Z4 and Y4. Sites Z3 and X4 were significantly different from both G251 and G-310, as well as significantly greater than the other marsh sites.

The STA-1W discharges must travel several kilometers down the L-7 canal before reaching the transect locations. Analysis of the data indicates that diel DO concentrations in the STA-1W discharges do not negatively affect the low DO concentrations observed at marsh transect stations Z1, X1, Z2, the closest to the canal, or the more interior marsh sites X2, X3, Z3, Z4, Y4, and X4. The diel DO patterns observed at Z1, X1, Z2 and X2 maybe largely due to the long-term effects of TP loading to the rim canal. Diel oxygen patterns at the more interior marsh transect sites, which are rainfall dominated, are the result of water depth and habitat vegetation differences. Ultimately, TP load reductions to the rim canal of the Refuge should improve DO conditions in the marsh fringe areas affected by canal water penetration. The complete DO data sets collected during WY2005 are presented in Appendix 4-4 of the 2005 SFER – Volume I.

Table 4-8. Statistical summary of diel DO at outflow stations (G-251D and G-310) and transect stations (X, Y, and Z) in the Refuge during six deployment periods.

Location	Station	Number of Measurements	Mean	Minimum	Median	Maximum	Standard Deviation
Outflow	G251D	613	3.82	0.83	4.22	7.62	1.72
	G310	610	4.78	2.61	4.66	6.62	0.88
Transect X	X1	523	0.75	0.01	0.66	3.65	0.69
	X2	362	2.17	0.28	1.31	8.58	1.78
	X3	542	4.07	0.35	3.77	10.96	2.42
	X4	541	5.37	2.11	4.76	9.81	2.12
Transect Y	Y4	360	5.09	1.03	5.19	10.20	2.51
Transect Z	Z1	475	2.26	0.01	1.96	5.96	1.74
	Z2	179	1.94	0.01	1.62	5.99	1.74
	Z3	477	6.33	0.91	6.68	9.52	1.98
	Z4	480	4.47	0.66	4.64	8.64	2.32

Note: See Appendix 4-4, Table 2 for statistical summaries by event and diel parameter.

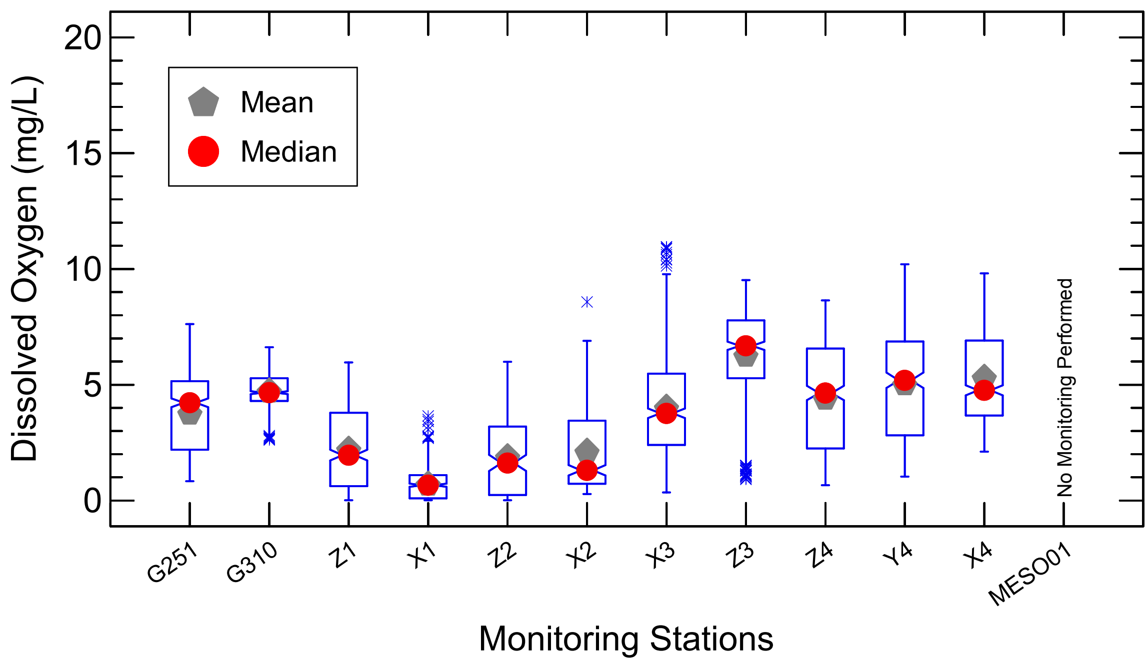


Figure 4-9. Notched box and whisker plots of diel DO measurements at STA-1W outflow stations (G251D and G310) and along transect sites in the Refuge during eight monitoring periods. The notch on a box plot represents the 95% C.I. about the median, which is represented by the narrowest part of the notch. The top and bottom of the box represent the 75th and 25th percentiles, respectively. The whiskers represent the highest and lowest data values that are within two standard deviations of the median. Values above and below the whiskers are greater than two standard deviations form the median. Notches that do not overlap indicate that the data represented by the boxes being compares are significantly different at the 95% C.I.

Note: See Appendix 4-4, Table 2 for statistical summaries by event and diel parameter.

STA-1W RECREATION AND WILDLIFE

STA-1W was opened to water fowl hunts in 2004. Bird watching tours were also conducted. Black-necked stilts (*Himantopus mexicanus*) were found nesting in Cells 2 and 5B in March 2005. The number of birds nesting interfered with the ability for flow-through in Cell 5. District staff worked with the U.S. Fish and Wildlife Service (USFWS) and several improvements have been initiated in order to prevent the excess nesting. The improvements include (1) degrading the limerock berm in Cell 5 to eliminate exposed fill material, (2) conducting migratory bird surveys (USFWS), and (3) posting signs around the areas of concern to increase awareness of the bird presence.

Recreational facilities are proposed to provide public access to STA-1W. The proposed recreational facilities include an asphalt parking area on the south side of CR 880 and associated road improvements such as an acceleration and deceleration lane in the vicinity of the entrance to the parking lot. The proposed facilities include a canoe launching site and a boardwalk for access to the seepage canal north of the STA. A footbridge is also proposed across the seepage canal to provide pedestrian access to the existing leveled area adjacent to the north end of the limerock berm in Cell 5B. An information kiosk,, a composting toilet, a boardwalk, and landscaping are proposed at this location. Pedestrian gates, signage and fencing as needed to define public access areas and to protect sensitive equipment are also proposed.

STA-1W ENHANCEMENTS [BC20]

STA-1W enhancements (**Figure 4-10**) consist of the following component elements:

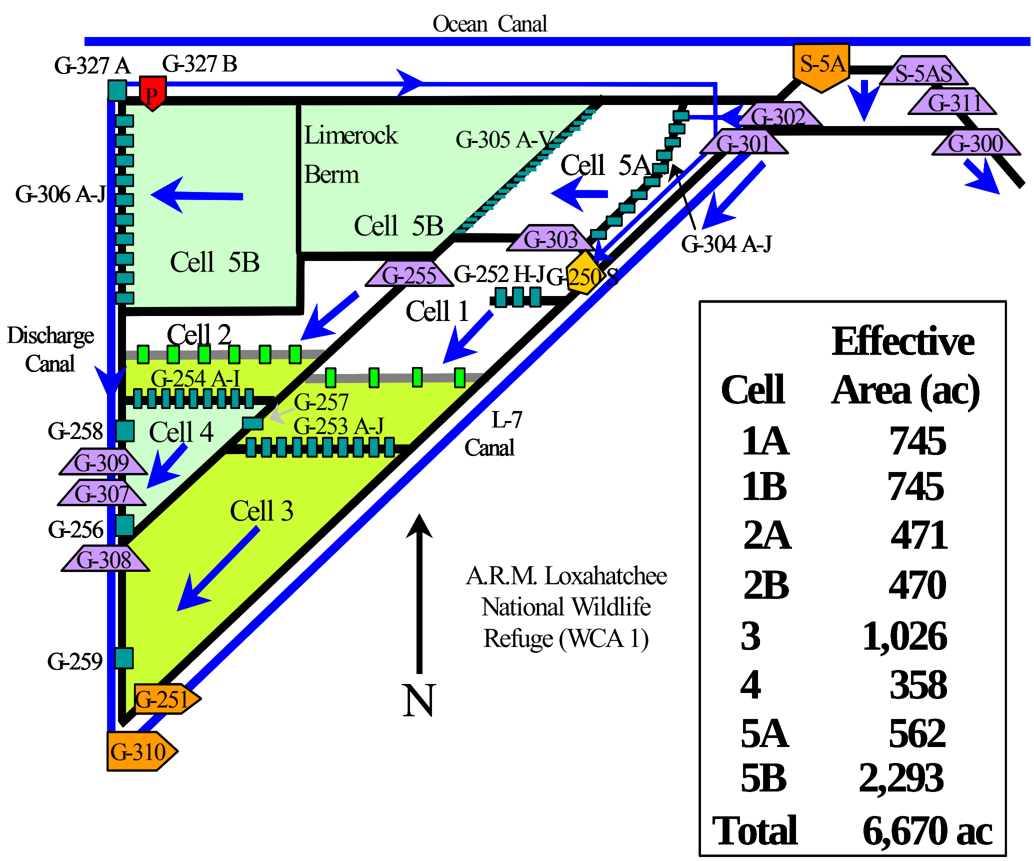
Scheduled for Completion in FY2005

- Replacement of existing structure G-255 with a fully operable control structure (nominal capacity of approximately 585 cubic feet per second, or cfs) [Status: G-255 is flow capable]
- Construction of a new levee across Cell 2, together with a series of culverts for improved flow distribution (G-249 structures) [Status: G-249 structures are flow capable]
- Construction of a small seepage pumping station (designated as G-327B) near the northwest corner of Cell 5B, included in the design to permit withdrawal from the seepage canal to maintain stages in the SAV Cell 5B [Status: construction to begin November 2005]
- Addition of a 150-cfs structure (G-307) to replace G-256 as the primary discharge for Cell 4 [Status: construction to begin November 2005]
- Demolition of G-256 structure and restoring levee section [Status: completed]
- Removal of tussock material from Cell 2 [Status: completed]
- Excavation of flow way cuts along the C-7 canal, within Cell 4 [Status: completed]
- Excavation of flow way cuts along north end of Cell 2A (submerged remnant farm road) [Status: completed]
- Replacement of five existing galvanized pipes along the G-254 levee [Status: construction to begin in late September 2005]

- Excavation of G-254 distribution and collection canals [Status: completed]
- Installation of overhead power line, beginning at Northeast corner of Cell 5A and continuing along the G-304 levee, providing power to G-255 structure (and future power to G-304 structures) [Status: completed]

Scheduled for Completion in FY2006

- Construction of a new levee across Cell 1, together with a series of fully operable control structures (G-248 structures)
- Herbicide treatment in those parts of Cells 1 and 2 to be converted to SAV
- Herbicide treatment of Cell 3 for removal of emergent macrophyte vegetation to permit development of SAV
- Addition of electric motors and telemetry equipment to allow remote operations of the gates at the G-304 inflow structures to Cell 5
- Enlarging C-6 canal cross section
- Power distribution to G-327B pump station and to G-248 structures



Cell	Effective Area (ac)
1A	745
1B	745
2A	471
2B	470
3	1,026
4	358
5A	562
5B	2,293
Total	6,670 ac

Figure 4-10. STA-1W enhancements (not to scale).

STA-2

Stormwater Treatment Area 2 (STA-2) contains approximately 6,430 acres of effective treatment area arranged in three parallel flow-ways. The eastern flow-way (Cell 1) consists of approximately 1,990 acres of effective treatment area. The center flow-way (Cell 2) consists of approximately 2,220 acres of effective treatment area. The western flow-way (Cell 3) consists of approximately 2,220 acres of effective treatment area. A schematic of STA-2 is presented in **Figure 4-11**. Based on the simulated 1965–1995 period of flow, the STA should receive a long-term average of approximately 232,759 ac-ft. Actual deliveries will vary based on hydrologic conditions in the basins.

Water enters STA-2 from the S-6 and G-328 pump stations, is distributed by the inflow canal across the north end of the treatment cells, and flows via gravity south through the three treatment cells. Treated water is collected and discharged to WCA-2A via the G-335 outflow pump station. Discharges are directed to areas within WCA-2A that are already impacted by elevated nutrient levels.

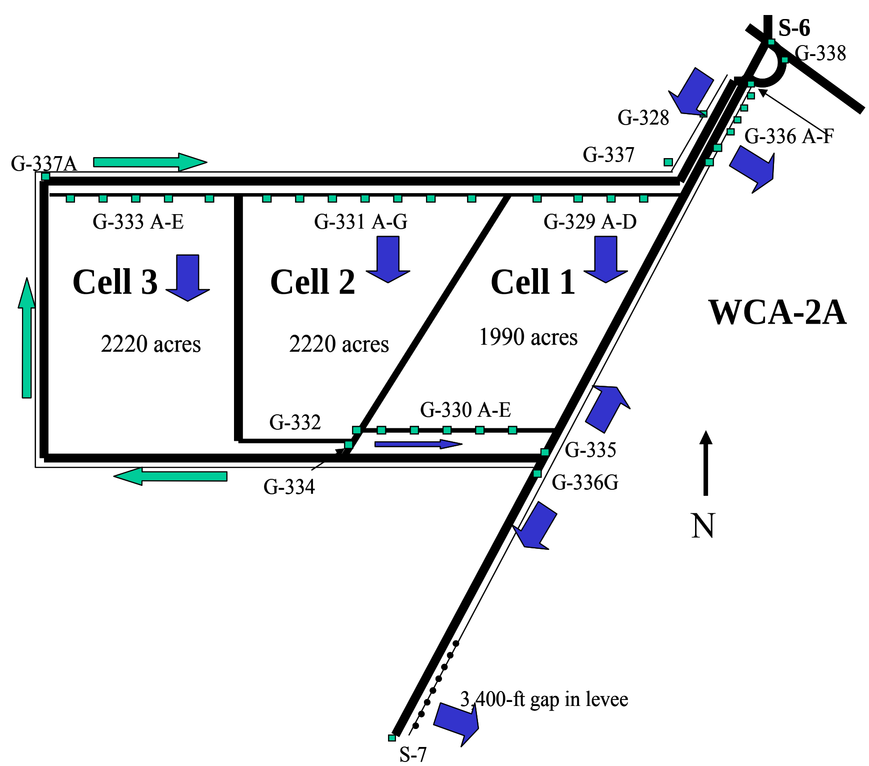
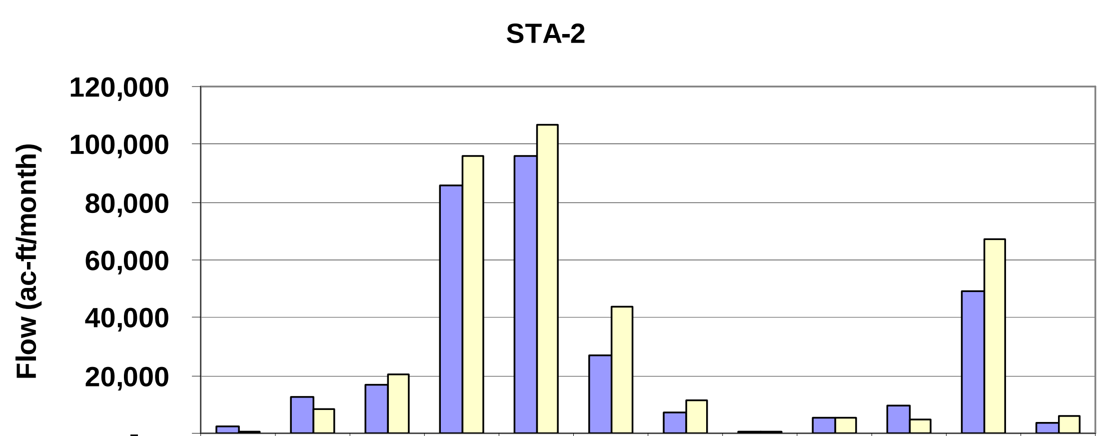


Figure 4-11. Schematic of STA-2 (not to scale).

STA-2 OPERATIONS

Start-up operations for STA-2 began upon the completion of the three treatment cells in 1999. At that time, water levels were maintained for optimal growth of desired vegetation. Inflow to STA-2 began in June 1999 from G-328, the 450-cfs pump station. Construction of the 3,040-cfs outflow pump station G-335 was completed in 2000, with the final operational testing completed in October 2000. The final construction component (connection of the S-6 pump station to the inflow canal) was completed during the dry season of 2001, a schedule that minimized the potential downtime of pump station S-6. The outflow structures in Cell 1 (G-330s) were retrofitted with weir plates to increase water depths in the cell, which should reduce the frequency and duration of drydowns within the cell.

All treatment cells were operational during WY2005. During WY2005, 316,273 ac-ft of water was captured and treated by STA-2 (**Table 4-4**). This was about 36 percent greater than the anticipated long-term average annual flow contemplated during design, although annual variability was anticipated. This inflow loading was equal to an average hydraulic load of 4.1 cm/d over the treatment area. The annual volume of treated water discharged to WCA-2A was 371,023 ac-ft. 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 is presented in **Figure 4-12**. During WY2005, STA-2 received 11,994 ac-ft from Lake Okeechobee. There was not any flow diverted around STA-2 during WY2005.



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Inflow	2,104	12,866	16,609	85,647	95,858	27,053	7,074	784	5,282	9,740	49,437	3,818
Outflow	388	8,268	20,338	96,114	107,053	43,575	11,307	803	5,197	4,661	67,433	5,885

Figure 4-12. Summary of WY2005 flows for STA-2. All treatment cells were operational during WY2005.

STA-2 HURRICANE IMPACTS

Both hurricanes Frances and Jeanne had an impact on STA-2. During Hurricane Frances, a large amount of SAV (mostly hydrilla, *Hydrilla verticillata*) was piled onto the northern levee banks of Cells 2 and 3 along with some of the cattails. Minor damage was done to some of the plastic covers for the structure stems. During Hurricane Jeanne, G-335 was shut down for 12 hours due to electrical problems. Damage was also done to the northeastern levee of Cell 3.

STA-2 VEGETATION MANAGEMENT

At STA-2, Treatment Cells 1 and 2 are managed for emergent vegetation and Cell 3 is managed as a SAV dominated cell. The water depth within the treatment cells, along with herbicide application are used to manage the vegetation types. The target water stages to encourage the dominant vegetation types are listed in the operations plan for each treatment cell. In Cell 3, although a majority of the cell is SAV, 500 acres of emergent cattail marsh exists in the southeastern section. It has been identified in the Long-Term Plan that this emergent portion be converted to SAV. Due to the performance of this cell and the pending results of the STA-3/4 demonstration project, this conversion will be deferred. To accelerate and encourage SAV establishment, the SAV in Cell 3 was used to inoculate treatment in STA-3/4, Cell 2B. A harvester was used to gather up the SAV, and helicopters were used to transport the plant material and drop it into 50 different locations within the treatment cell at STA-3/4. Research monitoring was performed to document plant growth. Vegetation coverage maps from December 2003 are found in Appendix 4-12 of the 2005 SFER – Volume I.

Specific Condition 13(b) of the EFA permit requires that the annual report include information regarding the application of herbicides to exclude and/or eliminate undesirable vegetation within the treatment cells. In WY2005, the District treated 275 acres and applied a total of 6.5 gallons of an herbicide containing the active ingredient glyphosate and 1.75 gallons of an herbicide containing the active ingredient imazapyr to control torpedograss and cattail, and 67 gallons of an herbicide containing the active ingredient diquat to control FAV and cattail in Cells 2 and 3. Both aerial and ground-based spray equipment were used to apply these herbicides. Additionally, to study the effectiveness of varying herbicide dosages in reducing hydrilla coverage, one treatment was conducted in STA-2, Cell 3 using 285 gallons of an herbicide containing the active ingredient endothall.

STA-2 PERMIT STATUS

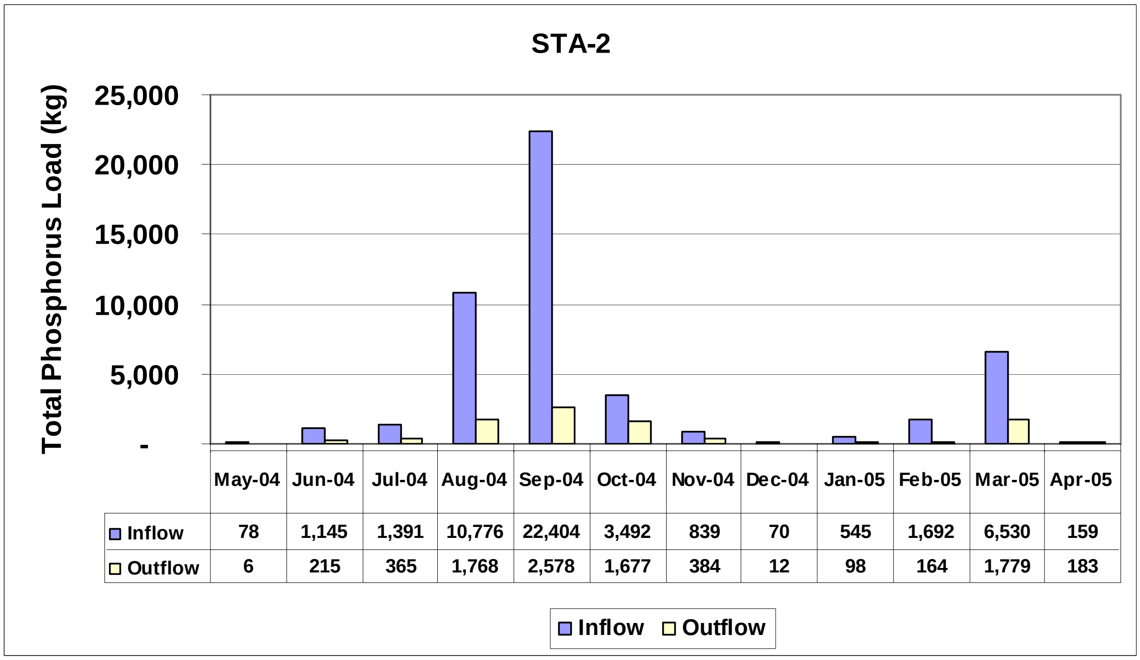
Monitoring data collected for STA-2 demonstrates that this treatment area was in compliance with the EFA and NPDES operating permits for WY2005 and that discharges do not pose any known danger to public health, safety, or welfare. The EFA and NPDES operating permits were issued for this project on September 29, 2000. Each treatment cell in STA-2 operates independently, and the permits authorize discharges when net improvement in TP and mercury is demonstrated for each cell.

Currently STA-2 is in the stabilization phase, having demonstrated net improvement in TP and mercury. In addition, Specific Condition 14(B) of the EFA permit states that STA-2 will remain in the stabilization phase of operation until STA-1E and STA-3/4 begin full capacity flow-through operations. STA-3/4 is in flow-through operations. STA-1E received a permit to discharge from all treatment cells except for Cells 1 and 2. These cells will remain off-line until construction of the PSTA demonstration project is completed (expected completion date is

October 2006). Until STA-1E is in full capacity flow-through operations,, STA-2 will remain in the stabilization phase of operation.

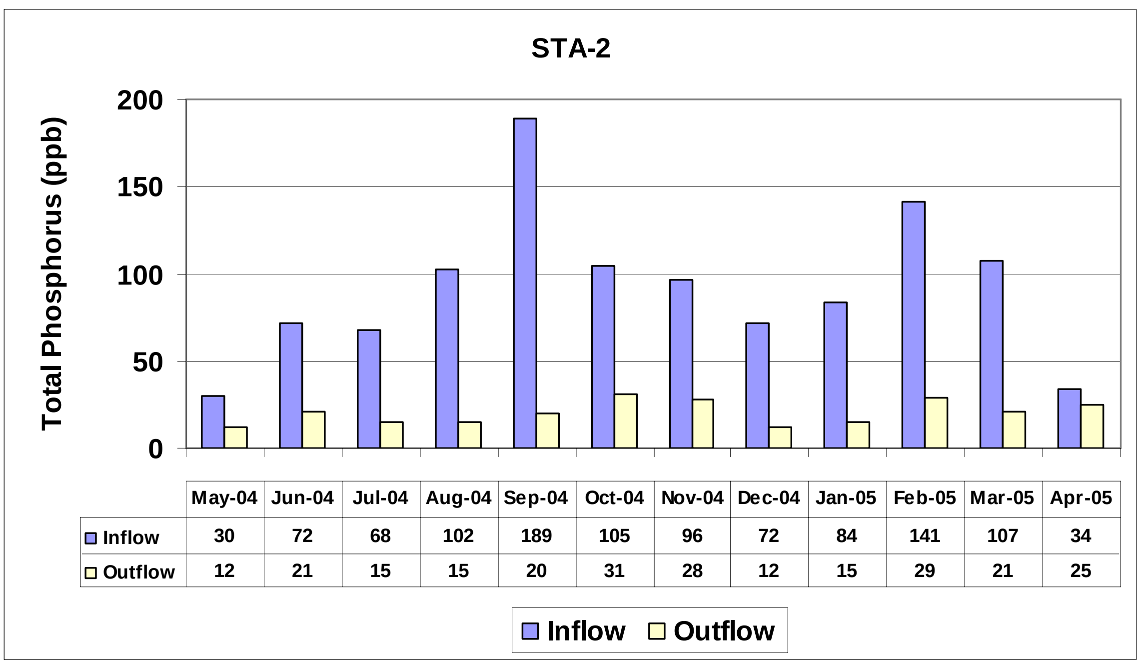
STA-2 TOTAL PHOSPHORUS

Under the design objectives of the EFA, STA-2 is achieving its interim discharge goal of less than 50 ppb for TP. The hydraulic loading to STA-2 was 1.4 times greater than the long-term design criteria and the TP loading to the system was about 1.7 times greater than the long-term design amount. During WY2005, the STA received 49.1 mt of TP, equal to a nutrient loading rate of 1.9 g/m^2 (**Table 4-4**). During WY2005, STA-2 received approximately 2.5 mt of TP from Lake Okeechobee. STA-2 removed approximately 39.9 mt of TP during WY2005. Monthly discharge concentrations were considerably lower than inflow concentrations. Summaries of monthly TP loads and FWM TP concentrations are presented in **Figures 4-13** and **4-14**, respectively. The annual FWM outflow concentration was 20 ppb, an 84 percent reduction from the inflow concentration of 126 ppb. For informational purposes, the annual geometric mean discharge TP concentration for STA-2 was 19 ppb for WY2005. If an outflow concentration of less than 50 ppb in accordance with the EFA permit for STA-2 had been achieved, then Cells 2 and 3 would have passed the stabilization phase if not for the requirement that STA-2 should remain in the stabilization phase until STA-1E and STA-3/4 begin full flow-through operation. The 12-month moving average TP concentration from STA-2 increased from 14–20 ppb during the course of WY2005 (**Figure 4-15**).



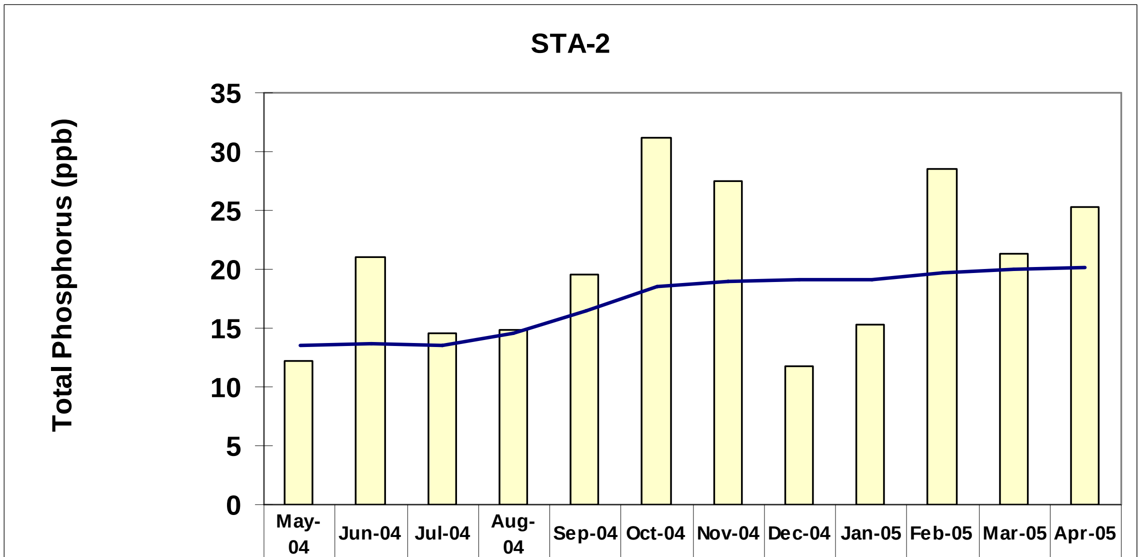
	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Inflow	78	1,145	1,391	10,776	22,404	3,492	839	70	545	1,692	6,530	159
Outflow	6	215	365	1,768	2,578	1,677	384	12	98	164	1,779	183

Figure 4-13. Summary of WY2005 TP loads for STA-2.
All treatment cells were operational during WY2005.



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Inflow	30	72	68	102	189	105	96	72	84	141	107	34
Outflow	12	21	15	15	20	31	28	12	15	29	21	25

Figure 4-14. Summary of WY2005 TP concentrations for STA-2.
All treatment cells were operational during WY2005.



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Outflow	12	21	15	15	20	31	28	12	15	29	21	25
12 mo. Moving FWM	14	14	14	15	16	19	19	19	19	20	20	20

Figure 4-15. Comparison of monthly to 12-month moving average TP concentrations for WY2005 for STA-2 outflow. All treatment cells were operational during WY2005.

STA-2 OTHER WATER QUALITY PARAMETERS

The monitoring data for the water year for non-phosphorus parameters at STA-2 during this reporting period are presented in Appendix 4-5 and are summarized in **Table 4-9**. Compliance with the EFA permit is determined based on the following three part assessments:

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

Discharges from STA-2 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. Additional requirements for DO are listed in Administrative Order AO-006-EV and are discussed below. Annual average concentrations of sulfate were slightly higher at the outflow than at the combined inflow. However, because this parameter has no applicable numeric state water quality standard, STA-2 is deemed to be in full compliance with the permit. Mercury monitoring results are discussed in Chapter 2B. An updated ecological risk assessment of mercury at STA-2 as it pertains to the bald eagle, wood stork, and snail kite is in Appendix 4-6, and the annual permit compliance monitoring report for mercury in the STAs is in Appendix 4-2.

The District has included the following documentation to satisfy the remaining monitoring requirements of the EFA permit:

- The District has performed all sampling and analysis under the latest Laboratory Quality Assurance Manual (SFWMD, dated January 3, 2005) and a Field Quality Assurance Manual (SFWMD, dated January 3, 2005).
- A signed copy of these statements is provided in Appendix 4-3 of this volume.

Table 4-9. Summary of annual arithmetic averages and flow-weighted means for the water year for water quality parameters (other than TP) monitored in STA-2. Note that monitoring for the pesticides ametryn and atrazine is not required under the routine permit. For the purpose of these comparisons, FWMs are calculated as the quotient of the cumulative product of the mean daily flow and the sample concentration divided by the corresponding cumulative daily flows.

Parameter	Arithmetic Means			Flow-Weighted Means			
	Inflow		Outflow	Total Inflow		Total Outflow	
	S6	G328	G335	n	Conc.	n	Conc.
Temperature (°C)	24.5	24.9	24.3	-NA-	-NA-	-NA-	-NA-
Dissolved Oxygen (mg/L)	3.9	4.0	4.8	-NA-	-NA-	-NA-	-NA-
Specific Conductivity (µmhos/cm)	1,112	1,500	1,208	-NA-	-NA-	-NA-	-NA-
pH	7.5	7.5	7.6	-NA-	-NA-	-NA-	-NA-
Turbidity (NTU)	3.4	3.8	1.2	-NA-	-NA-	-NA-	-NA-
Total Dissolved Solids (mg/L)	707	914	754	21 (52)	807	26 (26)	735
Unionized Ammonia (mg/L)	0.005	0.008	0.003	19 (50)	0.008	25 (25)	0.002
Orthophosphate as P (mg/L)	0.053	0.008	0.009	46 (102)	0.099	50 (51)	0.014
Total Dissolved Phosphorus (mg/L)	0.057	0.010	0.012	42 (96)	0.104	47 (47)	0.016
Sulfate (mg/L)	61.5	44.7	55.5	19 (50)	72.3	25 (25)	62.8
Alkalinity (mg/L)	282	359	292	19 (50)	325	25 (25)	287
Dissolved Chloride (mg/L)	138	241	171	19 (50)	145	25 (25)	150
Total Nitrogen (mg/L)	3.09	2.69	2.30	19 (49)	4.34	23 (23)	2.38
Total Dissolved Nitrogen (mg/L)	2.98	2.60	2.26	19 (49)	4.12	23 (23)	2.35
Nitrate + Nitrite (mg/L)	0.766	0.461	0.128	19 (49)	1.211	23 (23)	0.200

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

STA-2 DISSOLVED OXYGEN MONITORING

Introduction

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. The District developed the following plan to comply with the DO requirements of the Administrative Orders for STA-2. Under the plan, DO concentrations are measured quarterly with HydrolabTM, DataSonde®, or MiniSonde® probes at 30-minute intervals for four consecutive days at the following locations:

- At the inflow side of the S-6 pump station
- At the inflow side of the G-328 pump station
- At sites along the N, C, S, and Z transects in the northwest section of WCA-2A, located downstream of culverts distributing flow from discharge pump station G-335

Sampling Dates

Diel oxygen measurement dates and sites associated with STA-2 for WY2005 are provided in **Table 4-10** and Appendix 4-7.

Table 4-10. Deployment dates for diel oxygen measurement at STA-2 structures and associated downstream marsh sites.

Event Dates		Structures			Sites Monitored in Water Conservation Area 2
Start	End	Inflow		Outflow	
06/07/2004	06/10/2004	S6	G328	G335	----------------------------------
08/23/2004	08/27/2004	S6	G328	G335	C.25, C1, N.25*, N1*, N4*, S4
10/19/2004	10/22/2004	----	----	----	C.25, C1, N.25*, N1*, N4*, S4
12/17/2004	12/20/2004	S6	G328	G335	----------------------------------
03/14/2005	03/17/2005	S6	G328	G335	----------------------------------

* Dissolved oxygen data collected at the N transects were flagged.

Note: See Appendix 4-4, Table 3 for statistical summaries by event and diel parameter.

Comparison of Dissolved Oxygen in STA-2 Discharges with Dissolved Oxygen at Downstream WCA-2A Sites

Direct comparisons of DO in STA-2 discharges with DO at downstream marsh sites in WCA-2A (**Figure 4-16**) cannot be made for all monitoring events in WY2005 because Hydrolab™ deployment dates differed. However, to satisfy permit requirements, summary statistics for STA-2 discharges and WCA-2A marsh transect sites are presented in **Table 4-11**. Notched box and whisker plots for the sites are presented in **Figure 4-17**. The complete data sets collected at all sites during WY2005 are found in Appendix 4-6 of the 2005 SFER – Volume I.

The data indicate that diel DO concentrations in G-335 discharges were statistically greater than DO concentrations at all of the marsh transect sites. DO at site S4 was significantly greater than at the other marsh sites.

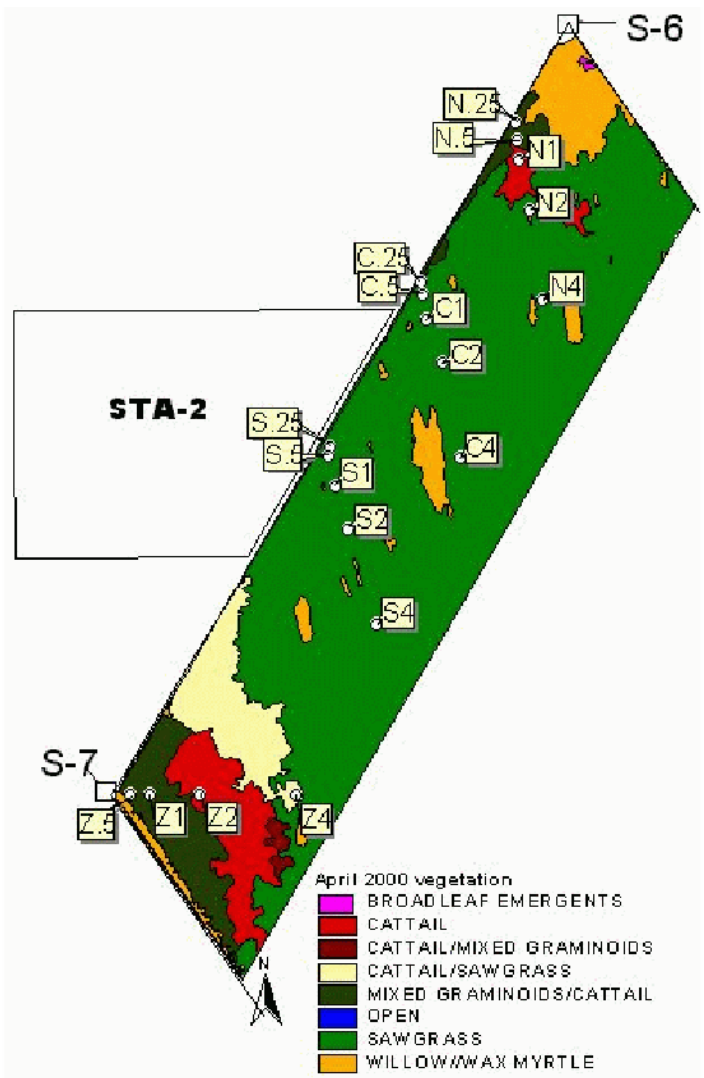


Figure 4-16. DO monitoring sites in WCA-2.

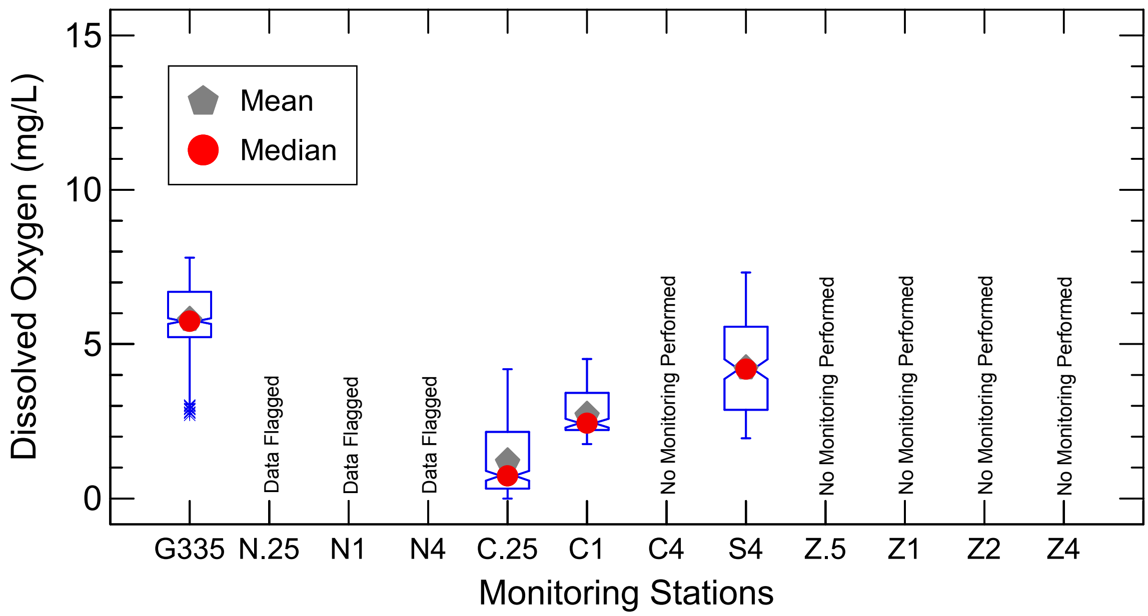


Figure 4-17. Notched-box and whisker plots of diel DO measurements at the STA-2 outflow station (G-335) and along transect sites in WCA-2 during three monitoring periods. The notch on a box plot represents the C.I. about the median, which is represented by the narrowest part of the notch. The top and bottom of the box represent the 75th and 25th percentiles, respectively. The whiskers represent the highest and lowest data values that are within two standard deviations of the median. Values above and below the whiskers are greater than two standard deviations from the median. Notches that do not overlap indicate that the data represented by the boxes being compared are significantly different at 95% C.I.

Table 4-11. Statistical summary of diel DO at the outflow pump station from STA-2 and marsh stations in WCA-2 during WY2004.

Location	Station	Number of Measurements	Mean	Minimum	Median	Maximum	Standard Deviation
Outflow	G335	574	5.84	2.69	5.75	7.80	1.16
Transect C	C.25	340	1.26	----	0.74	4.19	1.20
	C1	179	2.76	1.76	2.44	4.52	0.72
Transect N	N1	----	----	----	----	----	----
	N4	----	----	----	----	----	----
Transect S	S4	179	4.27	1.95	4.19	7.32	1.51
Transect Z	Z.5	----	----	----	----	----	----
	Z1	----	----	----	----	----	----
	Z2	----	----	----	----	----	----

HYDROLOGIC AND HYDRAULIC ASSESSMENT [BC84(3)] AND INTERNAL MEASUREMENTS [BC84(4)]

The steady-state performance model used in the design of the STAs (Burns & McDonnell, 1993) assumed plug-flow hydraulics. However, tracer studies conducted in STA-1W, Cells 1 and 4, have documented that flow patterns can depart markedly from ideal plug-flow conditions and that large short-circuits may exist (DBEL, 2000; 2003). It is thought that hydraulic inefficiency can reduce TP removal in the STAs (Kadlec, 2000). These non-ideal flow patterns typically will persist until flow is redistributed by some structural means, such as the addition of a levee perpendicular to the direction of flow that subdivides the treatment cell into two smaller areas.

The objective of the Hydrologic and Hydraulic Assessment Project [BC84(3)] is to conduct tracer studies to characterize the hydraulics (i.e., retention time and flow distribution) of Cell 3 in STA-2 both before and after the construction of an internal levee. The objective of the Internal Measurements Project [BC84(4)] is to document the spatial variability of TP concentrations in surface water within Cell 3 based on synoptic grab samples collected during both tracer studies. Work on both projects is being administered through a single contract, which began in October 2004. The final report documenting the first tracer project and associated synoptic internal measurements was submitted in October 2005 and is reprinted in Appendix 4-8 of this volume (also, see the District's web site at www.sfwmd.gov/org/erd/longtermplan/documents.shtml.)

Approximately 8,524 liters of lithium chloride (LiCl) tracer were distributed among the five inflow culverts of STA-2, Cell 3, a large (2,220-acre) SAV-dominated wetland. Lithium concentrations were monitored at the outflow structure in addition to synoptic monitoring of a network of internally located sampling stations to characterize the internal profiles of both lithium and phosphorus.

Wetland inflow volumes exceeded outflows for much of the study, resulting in increasing stages during the tracer assessment. A water balance was performed to confirm the accuracy of the District's inflow and outflow data. Approximately 90 percent of inflows were accounted for with measured outflows or stage change. The remaining 10 percent was thought to be due to a combination of seepage and measurement errors.

The lithium tracer reached the outflow structure around six days after tracer injection with the peak outflow lithium concentration (220 micrograms per liter, or µg/L) being observed one day later. Internal monitoring demonstrated that the tracer proceeded most rapidly along the western and central portions of the cell that were regions dominated by SAV. There was a lag in tracer passage through the eastern portion of the cell, which is dominated by cattail and sawgrass. However, both the outflow tracer response curve and the internal tracer profiles generally depicted relatively efficient hydraulic characteristics.

Internal sampling of water column phosphorus species during the study revealed TP levels exceeding 100 µg/L near the inflow region of the cell, but dropped markedly in the downstream half of the wetland. Declines in soluble reactive phosphorus were even more rapid with distance from the inflow location.

Tracer recovery, based on comparing the mass of lithium injected with that recovered at the cell outflow, was 96.6 percent. Lithium concentrations in the seepage return canal remained near background levels during the study. The measured Cell 3 hydraulic retention time (HRT), based on the tracer data, was determined to be 10.8 days, which was identical to the nominal HRT calculated for the varying flow and stage conditions that prevailed during the study. The tracer data indicated that Cell 3 was hydraulically efficient; it had a tank-in-series value of 5.5.

STA-2 RECREATION

Recreational facilities are proposed to provide public access to STA-2**.** The proposed recreational facilities include a parking area along the east side of U.S. Highway 27, an information kiosk, a composting toilet, landscaping, and a canoe launching site for access to canals and deepwater areas outside the treatment footprint of the STA. Pedestrian gates, vehicle gates, signage and fencing as needed to define public access areas and to protect sensitive equipment are also proposed The proposed recreational facilities will be located just east of the Okeelanta property bridge that will provide access from U.S. Highway 27

STA-2 EXPANSION & ENHANCEMENTS [BC30]

Expansion of STA-2 includes the construction of a 1,813-acre treatment cell (i.e., a new Cell 4) that will operate in parallel with existing Cells 1, 2, and 3. The design of the new Cell 4 is scheduled to be completed in October 2005. Construction of the new Cell 4 is scheduled to begin in early FY2006 and be completed in July 2007, with the cell being flow-capable by December 31, 2006. The design and construction of Cell 4 is being implemented under the District's Acceler8 program as part of the Everglades Agricultural Area (EAA) STA Expansion Project. For additional information on the status of the Acceler8 program, see Chapter 7A of this volume.

Enhancements to STA-2 (**Figure 4-18**) include construction of interior levees and associated water control structures in each of the three existing treatment cells (Cells 1, 2 and 3), as well as conversion of emergent vegetation to SAV in the new downstream cells. The new interior levees, water control structures, and vegetation conversion in existing Cells 1, 2, and 3 are scheduled to occur in a phased approach following commencement of flow-through operation in Cell 4. It is anticipated that the status of these additional enhancement projects will be included in future South Florida Environmental Reports.

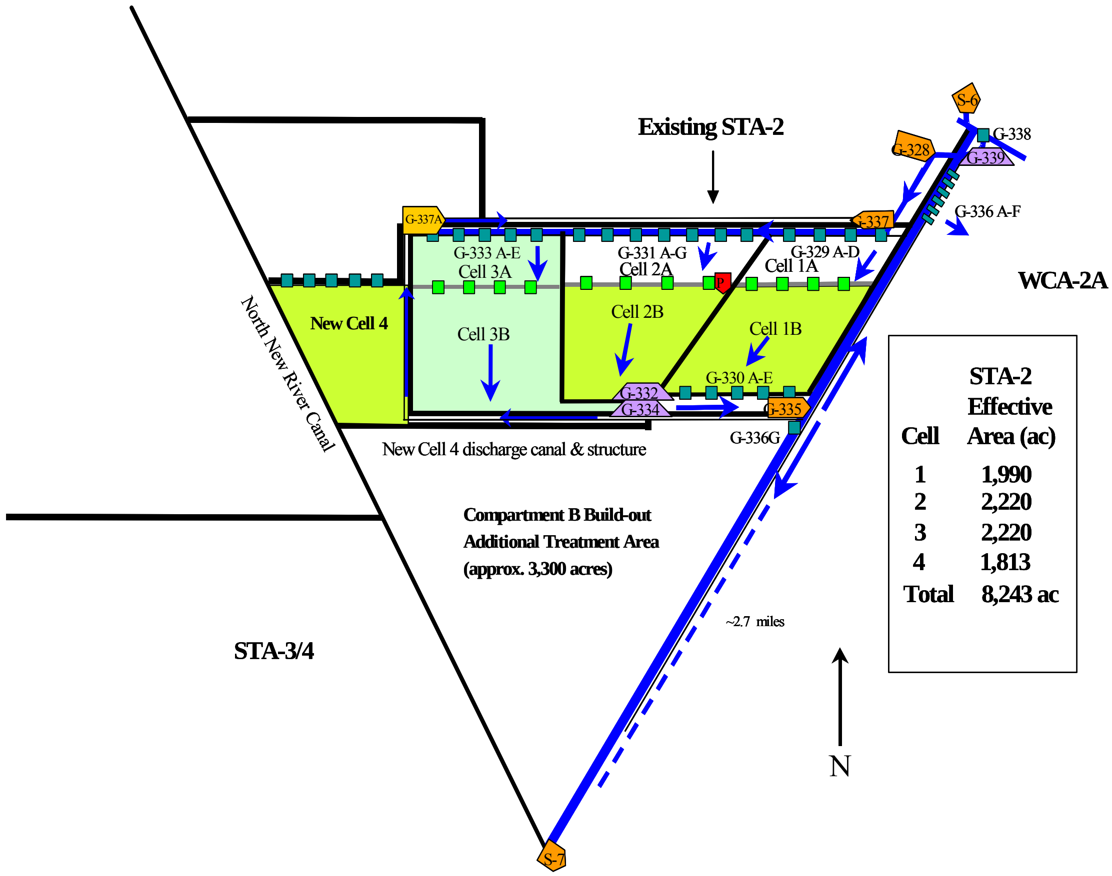
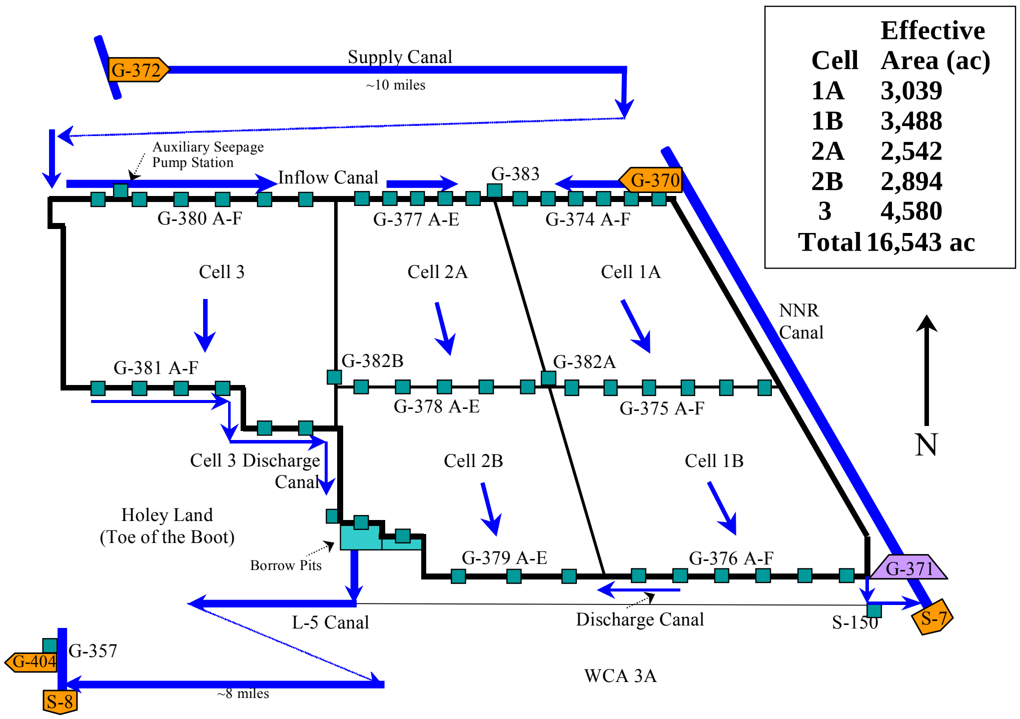


Figure 4-18. STA-2 enhancements (not to scale).

STA-3/4

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 4-19**. During an average year, STA-3/4 should receive approximately 400,000 ac-ft of runoff from upstream basins, and approximately 250,000 ac-ft of Lake Okeechobee releases. At the design performance of 50 ppb, the STA should remove more than 50 tons of phosphorus. STA-3/4 uses the existing S-7 and S-8 pump stations as the outflow facilities. Refurbishment of those stations is under way.

STA-3/4 achieved full flow-through operation on September 16, 2004. Although construction was not wholly complete by the October 1, 2003 target date, the facilities were sufficiently complete to begin start-up operations by October 1, 2003. During the start-up period, some of the water control structures were manually operated. Full electrical operation of all structures was achieved on May 20, 2004, at which time the STA treatment works was deemed complete. Flow-way 1 (Cells 1A and 1B) has been in flow-through since February 2004. The Western Flow-way (Cell 3) began flow-through in June 2004, was temporarily taken off-line between October 2004 through June 2005 to implement Long-Term Plan enhancements (construction of a compartmentalization levee with associated canals and water control structures and conversion of about 2,427 acres of emergent vegetation to SAV), then was returned to service with a partial flow capacity of about 800 cfs around June 13, 2005. A 200-foot gap was put into the western end of the Cell 3 levee to allow flow-through while the Long-Term Plan construction is completed. Flow-way 2 was intentionally kept off-line until after performance enhancements (conversion of vegetation in the southern cell from emergent to SAV from fall 2003 through the summer 2004. In order to minimize flow velocities in the area that was transplanted with vegetation in Cell 2B (see *Vegetation Management Demonstration Project in STA-3/4, Cell 2B (BC25)* section), discharges did not occur until September 16, 2004. The 2,542-acre Cell 2A was inundated in October 2003 and presently is fully vegetated. The 2,894-acre Cell 2B is the site of the new 400-acre demonstration project of periphyton-based STA (PSTA) and is also the location of a massive vegetation conversion to SAV. On September 16, 2004, the remaining 5,436 acre Flow-way 2 (Cells 2A and 2B) began discharging.



Cell	Effective Area (ac)
1A	3,039
1B	3,488
2A	2,542
2B	2,894
3	4,580
Total	16,543 ac

Figure 4-19. Schematic of STA-3/4 (not to scale).

STA-3/4 OPERATIONS

During WY2005, inflow to STA-3/4 through G-370 and G-372 was 671,442 ac-ft, equal to an average hydraulic loading rate of 4.1 cm/d over the effective treatment area of the STA (**Table 4-4**). These inflows were slightly higher (2 percent) than the long-term average annual simulated inflow for this STA, although annual variability was anticipated. The volume of treated water discharged from STA-3/4 was 648,872 ac-ft. A summary of monthly flows during WY2005 is presented in **Figure 4-20**.

The construction of diversion structures G-371 and G-373 is also part of STA-3/4. These structures, located outside the treatment area, will improve the hydraulic diversion of flows into the STA, prevent recirculation of treated water from south of the structures; allow water supply deliveries to the Water Conservation Areas, the Lower East Coast, and the Big Cypress Basin Seminole Indian Reservation; and allow diversion of storms from upstream basins. Before these structures were completed, the District installed earthen plugs across the North New River Canal on September 1, 2004 by the G-371 structure and in the Miami Canal on January 8, 2005 by the G-373 structure. The earthen plugs were removed on June 13, 2005 in response to heavy rains and high storm flows to allow diversion for flood control purposes. However, the gates at G-371 were able to be lowered and there was no diversion around STA-3/4 along the North New River Canal. On July 8, 2005, the gates in G-373 were installed, blocking all flow through the structure and there was no diversion around STA-3/4 along the Miami Canal after that time. The plug in the North New River Canal was reinstalled in early September 2005 (around September 3, 2005) and the plug in the Miami Canal was reinstalled in early January 2005 (around January 8, 2005). During the construction of G-371 and G-373 and before the plugs were reinstalled, there was diversion around STA-3/4 through structures S-7, S-150, S-8, and G-404/G-357 of 212,361 ac-ft (8.9 mt of TP with a flow-weighted mean TP average of 34 ppb) in WY2005.

STA-3/4 HURRICANE IMPACTS

Strong winds and heavy rainfall impacted STA-3/4, although no damage was observed in the wetland.

STA-3/4 VEGETATION MANAGEMENT

At STA-3/4, Treatment Cells 1A, 2A, and 3A are managed as emergent vegetation. Cell 2B underwent a massive conversion from emergent vegetation to SAV, and Cells 1B and 3B will be converted to SAV within the next few years. Water depths within the treatment cells, along with herbicide applications and the use of fire (see BC25 below) are tools used to manage the vegetation communities. The target water stages to encourage the dominant vegetation types are listed in the operations plan. Specific Condition 13(b) of the EFA permit requires that the annual report include information regarding the application of herbicides to exclude and/or eliminate undesirable vegetation within the treatment cells. In STA-3/4, 3,866 acres were treated and 279.25 gallons of diquat was used to control floating vegetation and 2,576.1 gallons of glyphosate and 687.25 gallons of imazapyr were used to treat emergent grasses and cattail (**Table 4-3**).

VEGETATION MANAGEMENT [BC84(2)]

In STA-3/4, emphasis will be placed on controlling expanding emergent vegetation, mainly torpedograss and cattail, which appears in SAV cells. In addition to these proposed maintenance treatments, vegetation management have plans to treat the hardwood non-target species, consisting primarily of Brazilian pepper and melaleuca in STA-3/4.

VEGETATION MANAGEMENT DEMONSTRATION PROJECT IN STA-3/4, CELL 2B (BC25)

In FY2004, with funding assistance from the same FDEP grant associated with the limerock berm in STA-1W, Cell 5B, a vegetation management demonstration project was initiated in STA-3/4, Cell 2B. The purpose of the vegetation management demonstration project was to evaluate methods for eliminating undesirable emergent vegetation and establishing SAV in the STAs. The main focus of this effort was to determine the most effective method for eliminating torpedograss and other emergent vegetation from STA treatment cells and to evaluate large scale inoculation of SAV in the same treatment cells. The torpedograss and emergent removal portion of the project was conducted in a 313-acre area in the southwest portion of Cell 2B, and involved applications and evaluation of combinations of two types of herbicides, fire, and flooding. Results indicate torpedograss is controlled most effectively by burning prior to herbicide applications and that elimination of torpedograss accommodated rapid colonization by SAV. A final report on the torpedograss control component of this project was completed in May 2005, and is available on the District's web site at www.sfwmd.gov/org/erd/longtermplan/documents.shtml.

The SAV inoculation plan, completed in summer 2004, involved harvesting SAV from a donor site in STA-2 and transporting the harvested plants via helicopter to STA-3/4, Cell 2B. Initial monitoring of the success of these inoculations was conducted in spring 2005. Forty-nine point samples were taken at 5-m centers within a 30 m x 30 m grid at each of the 50 inoculation sites. Presence of submerged aquatic plants (southern naiad, *Chara*, pondweed) was documented within a one-meter radius of each point sample location by visible observation and bottom grab samples using a hand cultivator. Natural colonization of SAV was evaluated using this sampling methodology (grab samples within a 900 m2 grid) at 50 randomly selected locations in the cell. Site selection was determined by a random compass direction and distance from each of the inoculation sites.

Preliminary data from spring 2005 indicate beds of SAV had become established at 85 percent of inoculation sites and that natural colonization of SAV had occurred in the portion of the cell that had previously been used for sod farming and a tree nursery but not in areas that were formerly sugar cane. The monitoring phase of this component of the vegetation management demonstration project is scheduled to be completed in spring 2006. It is anticipated that the final reporting on the monitoring phase of this demonstration project will occur in next year's SFER. The information gleaned from this research project will be applied to other large-scale vegetation conversions from emergent vegetation to SAV.

STA-3/4 PERMIT STATUS

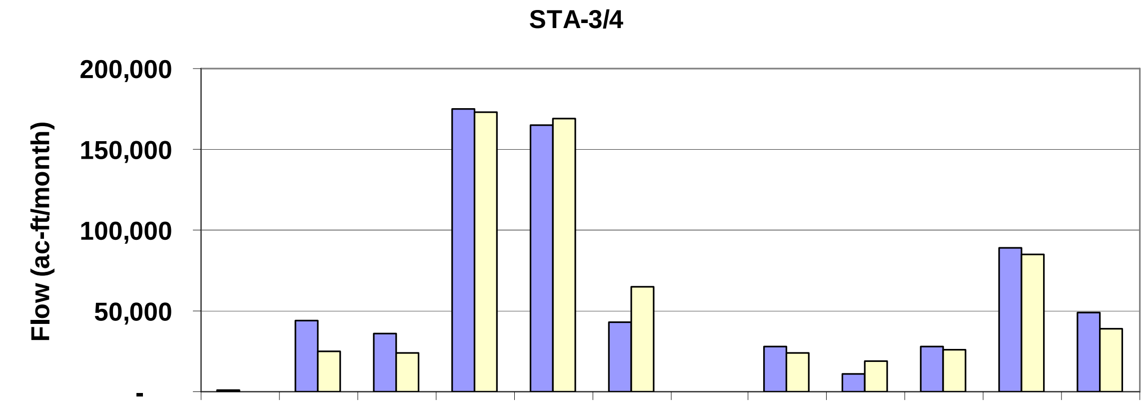
Although construction was not fully complete by the October 1, 2003 target date, the facilities were sufficiently complete to begin start-up operations on October 1, 2003. The FDEP operating permits were received on January 9, 2004, and by January 15, 2004, Flow-way 1 had passed the start-up tests for phosphorus and mercury. Due to dry season conditions, flow-through did not begin until February 26, 2004 for Flow-way 1. On March 19, 2004, the District received a permit modification to allow flow-through operation for Flow-way 3 in spite of elevated mercury conditions relative to the inflow levels. The modification was based on the hypothesis that flow-through conditions will lower outflow concentrations, as was demonstrated in STA-2, Cell 1. Due to dry season conditions, flow-through did not begin until June 8, 2004 for Flow-way 3. Flow-way 3 demonstrated net improvements in mercury in August 2004. Start-up operations also began in Cell 2A in October 2003. Cell 2B was kept off-line to allow for vegetation management activities designed to convert the emergent vegetation to SAV through herbicide and fire. In late June 2004, Cell 2B was inundated. Over 60,000 pounds of SAV were successfully transplanted from STA-2 into Cell 2B in mid-August, and Flow-way 2 began discharging on September 16, 2004. In December, Cell 3 was taken off-line for construction of the divide levee as a Long-Term Plan enhancement. Dewatering water was put into Cell 2A. Restricted flow-through of Cell 3 was started in June 2005.

To summarize, STA-3/4 is in the stabilization phase. Although construction was not wholly complete, the STA-3/4 facilities were sufficiently complete to begin start-up operations by October 1, 2003.

- Eastern Flow-way 1 (Cells 1A and 1B) showed net improvement for phosphorus on December 24, 2003 and for mercury on January 15, 2004; Flow-through operations began on February 10, 2004 and on February 25, 2004, the first discharges of treated water from this STA began.
- Central Flow-way 2 (Cells 2A and 2B) showed net improvement for phosphorus on August 5, 2004 and for mercury on August 11, 2004 and has been in flow-through since September 16, 2004.
- Western Flow-way 3 (Cell 3) showed net improvement for phosphorus on December 24, 2003 and for mercury on June 29, 2004, through a permit modification, flow-through operations was authorized on March 19, 2004.

STA-3/4 TOTAL PHOSPHORUS

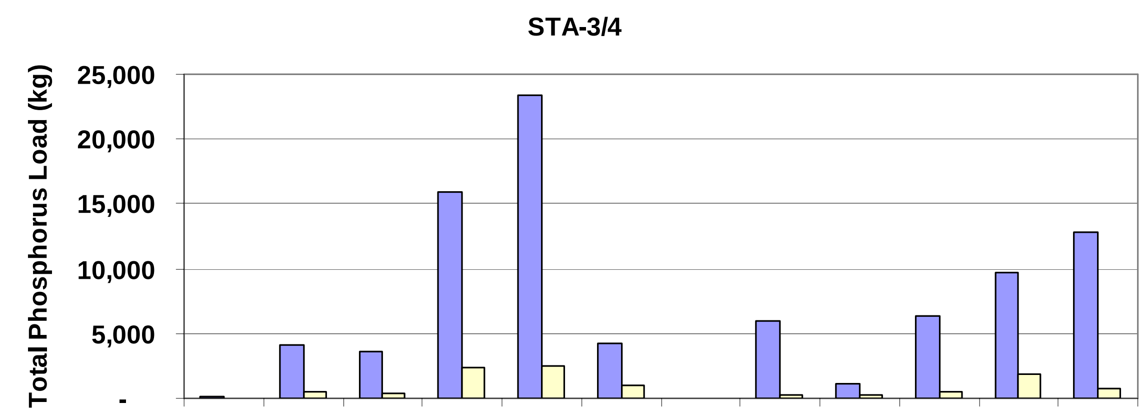
STA-3/4 has demonstrated better than anticipated phosphorus removal performance. In WY2005, beginning in October 2003, STA-3/4 received 671,442 ac-ft of water with an average inflow of 105 ppb and a TP load of 87.4 mt (**Table 4-4**). During this time frame, the STA discharged 648,872 ac-ft and a TP load of 10.4 mt, with an average concentration of 13 ppb (**Figures 4-20** through **4-23**). Approximately 77.0 mt of phosphorus was removed, and average TP was reduced from 105 ppb down to 13 ppb, resulting in an 88 percent load reduction. For the entire period of record, from October 1, 2003 through April 2005, STA-3/4 received 694,745 ac-ft inflow water and a TP load of 89 mt and discharged 676,580 ac-ft and a TP load of 11 mt.



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Inflow	1,400	44,163	36,323	175,200	165,241	43,367	-	28,073	11,235	28,269	89,378	48,793
Outflow	-	24,860	24,401	172,881	169,039	64,549	-	24,090	19,385	26,074	84,832	38,763

Inflow Outflow

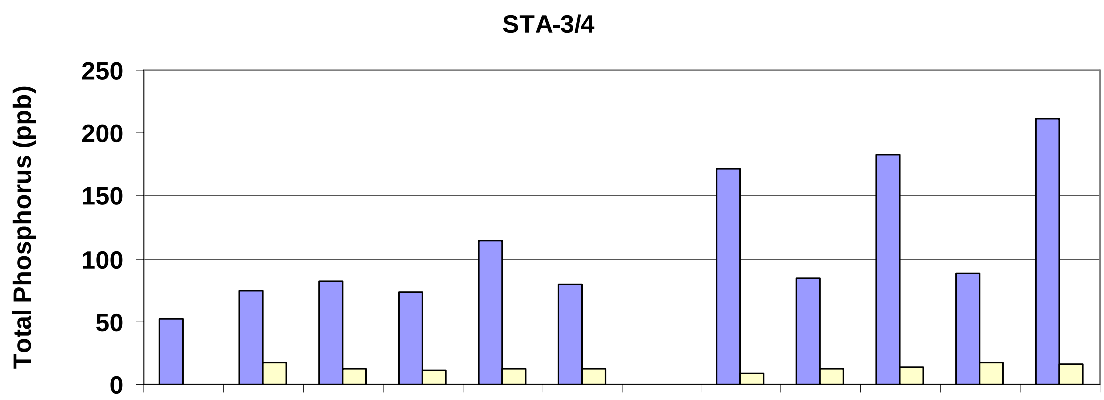
Figure 4-20. Summary of WY2005 flow for STA-3/4. Flow-way 1 was in operation during this entire period, Flow-way 2 began flow-though in September 2005, and Flow-way 3 was off-line for Long-Term Plan enhancement construction.



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Inflow	90	4,098	3,669	15,976	23,327	4,241	-	5,933	1,180	6,362	9,742	12,752
Outflow	-	530	368	2,368	2,534	1,001	-	254	289	441	1,845	781

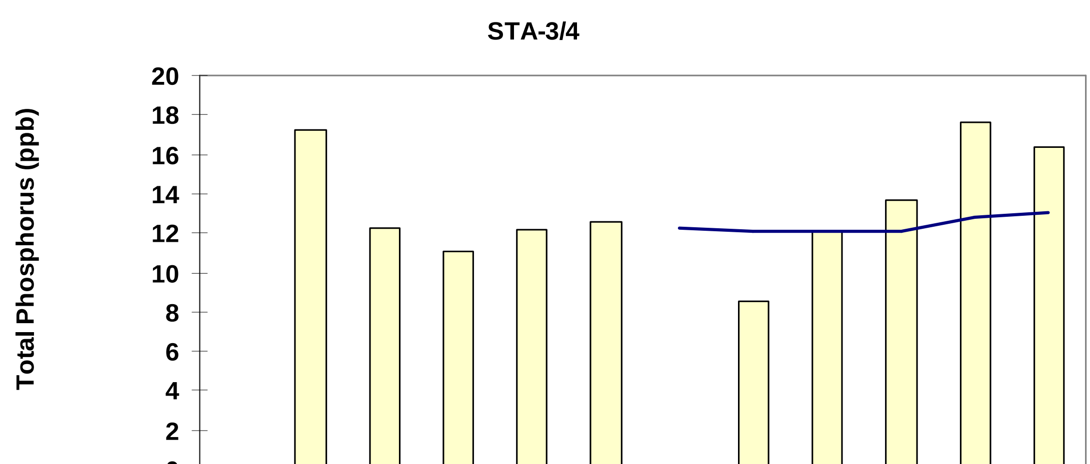
Inflow Outflow

Figure 4-21. Summary of WY2005 TP loads for STA-3/4. Flow-way 1 was in operation during this entire period, Flow-way 2 began flow-though in September 2005, and Flow-way 3 was off-line for Long-Term Plan enhancement construction.



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Inflow	52	75	82	74	114	79		171	85	182	88	212
Outflow		17	12	11	12	13		9	12	14	18	16

Figure 4-22. Summary of WY2005 TP concentrations for STA-3/4. Flow-way 1 was in operation during this entire period, Flow-way 2 began flow-though in September 2005, and Flow-way 3 was off-line for Long-Term Plan enhancement construction.



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Outflow		17	12	11	12	13		9	12	14	18	16
12 mo. Moving FWM							12	12	12	12	13	13

Figure 4-23. Comparison of monthly to 12-month moving average TP concentrations for STA-3/4. Flow-way 1 was in operation during this entire period, Flow-way 2 began flow-though in September 2005, and Flow-way 3 was off-line for Long-Term Plan enhancement construction.

STA-3/4 OTHER WATER QUALITY PARAMETERS

The monitoring data for non-phosphorus parameters at STA-3/4 for the water year are presented in Appendix 4-16 and are summarized in **Table 4-12**. Compliance with the EFA permit is determined based on the following three part assessments:

1. If the annual average outflow concentration does not cause or contribute to violations of applicable Class III water quality standards, then STA-3/4 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 it does not exceed or is equal to the annual average concentration at the inflow stations, then STA-3/4 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 it also exceeds the annual average concentration at the inflow station, then STA-3/4 shall be deemed out of compliance.

In WY2005, Flow-way 1 was operated for the entire water year, although the water quality data shown in **Table 4-12** is for all monitoring sites. The annual permit compliance measurements are applied only to the outflow from Flow-way 1 because it was the only treatment train in operation for the entire water year. Discharges from STA-3/4 were determined to be in compliance with the permit by satisfying criterion one above for all non-phosphorus with applicable numeric state water standards. Additional requirements for DO are listed in Administrative Order AO-006-EV will be implemented in WY2006. Annual average concentrations of total dissolved solids and dissolved chloride were slightly higher at the outflow that at the combined inflow. However, because these parameters have no applicable numeric state water quality standard, STA-3/4 is deemed to be in full compliance with the permit.

Table 4-12. Summary of annual arithmetic averages and flow-weighted means for the water year for water quality parameters (other than TP) monitored in STA-3/4. Note that only Flow-way 1 was operational for the entire water year; Flow-way 2 began flow-through on 9/16/04 and Flow-way 3 was in flow-through from May – October 2004, then taken off-line for Long-Term Plan enhancement construction. For the purpose of these comparisons, FWMs are calculated as the quotient of the cumulative product of the mean daily flow and the sample concentration divided by the corresponding cumulative daily flows.

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)	24.4	25.0	23.9	23.9	24.2	24.0	25.8	25.7	-NA-	-NA-	-NA-	-NA-
Dissolved Oxygen (mg/L)	5.4	5.5	3.0	3.4	5.9	6.7	3.8	3.5	-NA-	-NA-	-NA-	-NA-
Specific Conductivity (µmhos/cm)	908	685	870	866	742	746	736	715	-NA-	-NA-	-NA-	-NA-
pH	7.6	7.7	7.5	7.5	7.9	8.0	7.5	7.5	-NA-	-NA-	-NA-	-NA-
Turbidity (NTU)	8.8	11.0	1.4	1.1	2.0	2.0	2.1	2.4	-NA-	-NA-	-NA-	-NA-
Total Dissolved Solids (mg/L)	615	437	562	555	500	510	476	453	28 (52)	609	41 (115)	553
Unionized Ammonia (mg/L)	0.003	0.002	<0.001	<0.001	0.004	0.002	0.001	0.001	28 (50)	0.004	41 (110)	<0.001
Orthophosphate as P (mg/L)	0.055	0.034	0.005	0.004	0.003	0.003	0.003	0.004	28 (52)	0.058	41 (116)	0.005
Total Dissolved Phosphorus (mg/L)	0.062	0.041	0.008	0.008	0.011	0.009	0.007	0.007	26 (49)	0.068	36 (100)	0.008
Sulfate (mg/L)	70.7	36.9	50.4	51.3	29.0	27.9	28.5	27.3	28 (52)	66.3	41 (116)	51.2
Alkalinity (mg/L)	263	187	252	251	227	236	228	223	28 (52)	259	41 (115)	247
Dissolved Chloride (mg/L)	97	73	91	89	92	93	74	72	28 (52)	89	41 (116)	85
Total Nitrogen (mg/L)	2.70	2.29	1.77	1.77	2.10	2.13	1.66	1.60	28 (52)	3.47	41 (116)	1.77
Total Dissolved Nitrogen (mg/L)	2.43	2.08	1.72	1.70	1.94	2.04	1.58	1.51	28 (52)	3.14	41 (116)	1.76
Nitrate + Nitrite (mg/L)	0.608	0.656	0.016	0.026	0.039	0.124	0.020	0.024	28 (52)	1.028	41 (116)	0.035
Total Arsenic (µg/L)	-NA-	-NA-	2.35	-NA-	4.65	-NA-	2.45	-NA-	-NA-	-NA-	2 (6)	2.35
Total Copper (µg/L)	-NA-	-NA-	<1.2	-NA-	<1.2	-NA-	<1.2	-NA-	-NA-	-NA-	2 (6)	<1.2
Total Lead (µg/L)	-NA-	-NA-	<0.8	-NA-	<0.8	-NA-	<0.8	-NA-	-NA-	-NA-	2 (6)	<0.8
Total Zinc (µg/L)	-NA-	-NA-	<4.0	-NA-	<4.0	-NA-	<4.0	-NA-	-NA-	-NA-	2 (6)	<4.0
Atrazine (µg/L)	-NA-	-NA-	0.318	-NA-	0.059	-NA-	0.349	-NA-	-NA-	-NA-	2 (6)	0.318
Chlordane (µg/L)	-NA-	-NA-	<0.0200	-NA-	<0.0200	-NA-	<0.0190	-NA-	-NA-	-NA-	2 (6)	<0.0200
DDD (µg/L)	-NA-	-NA-	<0.0048	-NA-	<0.0048	-NA-	<0.0048	-NA-	-NA-	-NA-	2 (6)	<0.0048
DDE (µg/L)	-NA-	-NA-	<0.0040	-NA-	<0.0040	-NA-	<0.0038	-NA-	-NA-	-NA-	2 (6)	<0.0040
DDT (µg/L)	-NA-	-NA-	<0.0060	-NA-	<0.0060	-NA-	<0.0057	-NA-	-NA-	-NA-	2 (6)	<0.0060
Simazine (µg/L)	-NA-	-NA-	<0.0100	-NA-	<0.0100	-NA-	<0.0095	-NA-	-NA-	-NA-	2 (6)	<0.0100
Toxaphene (µg/L)	-NA-	-NA-	<0.1000	-NA-	<0.1000	-NA-	<0.0950	-NA-	-NA-	-NA-	2 (6)	<0.0100

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

STA-3/4 RECREATION

STA 3/4 has public roads along the east and south borders that allow development of multiple public access sites. Using more than one site allows the public to visit different portions of the STA and will minimize public access past the water control structures and data equipment. The proposed recreational facilities near the Griffin Pits include road improvements, an asphalt parking area, an information kiosk, landscaping, a multi-purpose bridge and a composting toilet. This site also proposes two boat ramps (one in the rock pits located south and downstream of treatment cell 2B and one in the stub end of the L-5 canal). A second proposed site will be at the southeast corner and will include a small asphalt parking area, an information kiosk, landscaping, and a composting toilet. A third proposed site along Hwy 27 may be located where guard rails and turning lanes exist that would allow protected parking if allowable by FDOT. This site will have a small asphalt parking area and landscaping.

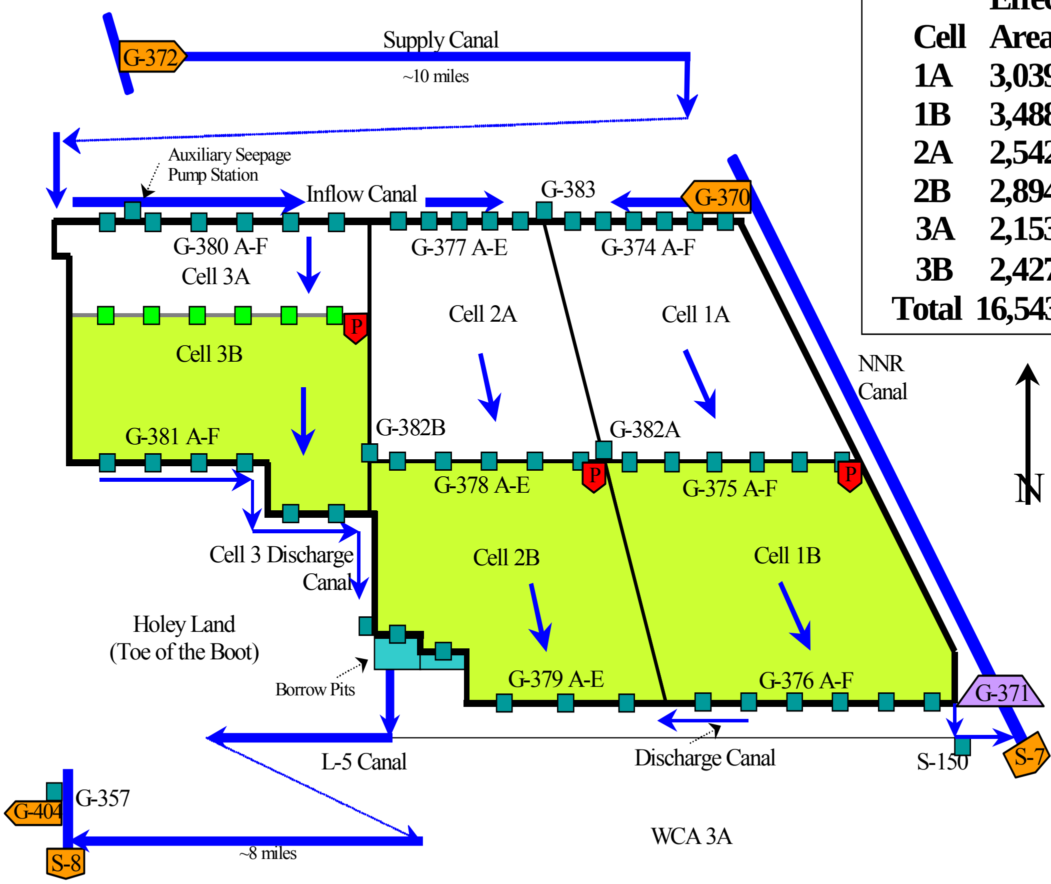
At each site pedestrian gates, vehicle gates, signage and fencing as needed to define public access areas and to protect sensitive equipment are also proposed.

STA-3/4 ENHANCEMENTS

Enhancements to STA-3/4 (**Figure 4-24**) include the following features:

- Construction of approximately 3.3 miles of interior levee, subdividing Cell 3 into Cells 3A and 3B
- Construction of additional water control structures through the new levee subdividing Cell 3 into Cells 3A and 3B
- Extension of an overhead power distribution line from the intersection of Interior Levee 3 and Interior Levee 4, extending north along Interior Levee 4 to the new levee across Cell 3, and then west along the new levee across Cell 3 (total length of approximately 3.6 miles)
- Small forward-pumping stations along the interior levees between cells in series to permit withdrawal from upstream emergent marsh cells to maintain stages in the downstream SAV cells. Supplemental flows can be transferred from Cell 2A to Cell 1A through structure G-382A, and between Cell 2A and Cell 3B through structure G-382B
- Herbicide treatment of Cells 1B, 2B, and 3B for removal of emergent macrophyte vegetation to permit development of SAV
- Inoculation of SAV from STA-2 into STA-3/4 by helicopter to accelerate vegetation recruitment
- Construction of the full-scale PSTA demonstration project (see *PSTA Investigations [BC83(3)]* and *PSTA Demonstration Project in STA-3/4 [BC83(4)]* sections for additional details)

During FY2005, the Cell 3 interior levee construction was substantially completed. Work on the water control structures through the new Cell 3 levee was also under way in FY2005 and is scheduled for completion in February 2006. Power distribution for the new Cell 3 levee is scheduled to be completed in mid-2006. The vegetation conversion activities were implemented in Cells 2B and 3B in FY2005. Work on the three forward-pumping stations was initiated in FY2005 and is scheduled to be completed in February 2006.



Cell	Effective Area (ac)
1A	3,039
1B	3,488
2A	2,542
2B	2,894
3A	2,153
3B	2,427
Total	16,543 ac

Figure 4-24. STA-3/4 enhancements (not to scale).

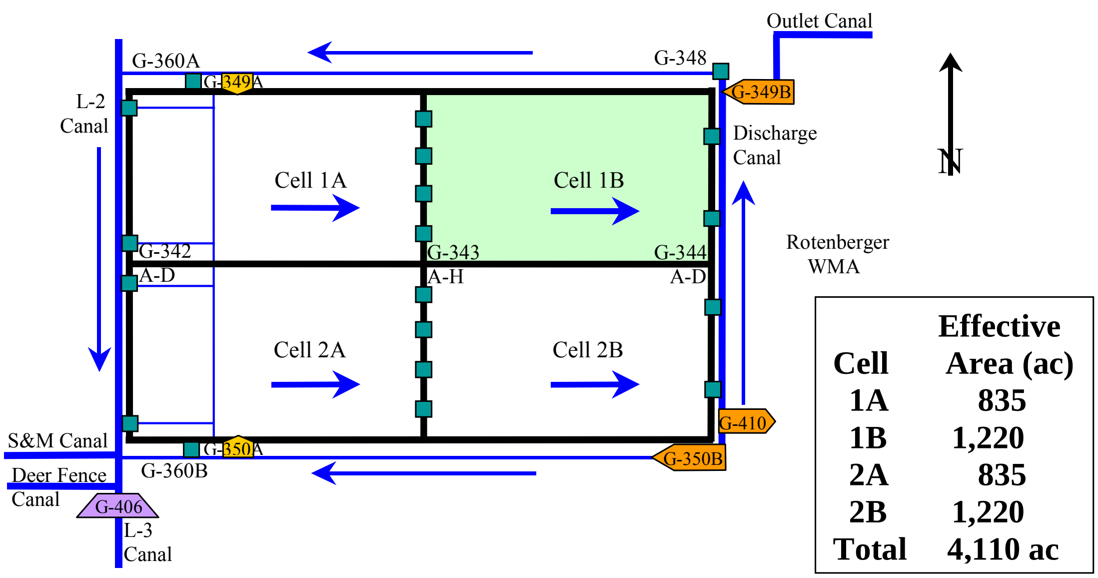
STA-3/4 PSTA Implementation Project [Bc83(4)]

The STA-3/4 PSTA Implementation Project is a 400-acre section in one of the treatment cells in STA-3/4 (Cell 2B) that was isolated by constructing internal levees to form an upstream, 200-acre cell and two adjacent downstream 100-acre cells. The upstream cell is being managed for SAV. SAV is being established in one of the downstream cells and a periphyton community in the other. The downstream cells will receive a hydraulic load that is proportionate to the load on the entire STA and consistent with its flood control mission. The project is described further in Chimney et al. (2004). Construction of the levees and interior water control structures was essentially complete by March 2005. Construction of the outflow pump station was completed in July 2005. Installation of the telemetry needed to operate the system is scheduled for completion by August–September 2005. The project was flooded in spring 2005 to begin establishing periphyton and SAV. Experience with other District PSTA and SAV projects indicated that it can take from 6–18 months to develop mature plant communities. A temporary outflow pump was installed in late June 2005 to lower water levels within the project and to help promote the SAV growth. Water quality monitoring at this single outflow was initiated at this time. After periphyton and SAV grow-in is substantially complete, the District will begin flow-through operation and initiate water quality monitoring throughout the project to compare treatment performance of the PSTA and SAV cells.

STA-5

Stormwater Treatment Area 5 (STA-5) contains approximately 4,110 acres of effective treatment area arranged in two parallel flow-ways. The northern flow-way (Cells 1A and 1B) consists of approximately 2,055 acres of effective treatment area. The southern flow-way (Cells 2A and 2B) consists of approximately 2,055 acres of effective treatment area. A schematic of STA-5 is presented in **Figure 4-25**. Based on the simulated 1965–1995 flow period utilized in developing the 2003 Long-Term Plan, it was assumed that STA-5 would receive a long-term average annual discharge of approximately 129,083 ac-ft per year from the C-139 basin. Actual deliveries will vary based on hydrologic conditions in the basin. Runoff that exceeds the hydraulic capacity of STA-5 will be diverted through G-406.

Water enters STA-5 from the west and flows by gravity through the treatment area to the east. Treated water is collected and discharged either to the Rotenberger Wildlife Management Area (RWMA) or the Miami Canal, where the majority of the water moves south to the northwest corner of WCA-3A. A complete description of STA-5 is contained in Chapter 6 of the 2000 Everglades Consolidated Report.

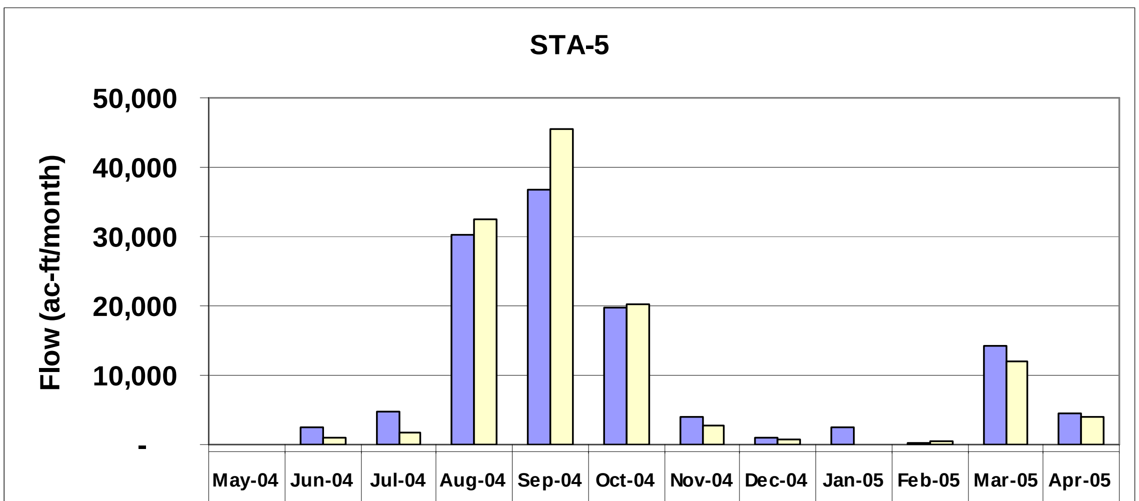


Cell	Effective Area (ac)
1A	835
1B	1,220
2A	835
2B	1,220
Total	4,110 ac

Figure 4-25. Schematic of STA-5 (not to scale). Not shown is the water supply pump G-507, which is located on the northeast corner of Cell 1B, and the two barrel culverts (G-345), located at the midpoint between the north and south flow-ways that were installed in the levee in order to transfer water from Cell 1B to Cell 2B.

STA-5 OPERATIONS

Since January 2005, Cell 1B was taken off-line in order to improve the water control structures (G-343A–D) and degrade a berm located by the outflow culverts, as part of a Long-Term Plan enhancement. During WY2005, 119,910 ac-ft of water was captured and treated by STA-5 (**Table 4-4**). This is about 7 percent more than the long-term average annual flow assumed during design, although the design anticipated annual variability. This surface inflow equates to an average hydraulic loading rate of 3.0 cm/d over the effective treatment area of the STA. During WY2005, approximately 30,165 ac-ft (10.5 mt of TP with a flow-weighted mean TP average of 282 ppb) of C-139 basin runoff was diverted around STA-5. In the future, flows and loads that are diverted around STA-5 will be captured and treated in STA-6 Section 2, which is currently scheduled for completion by December 2006. The water supply pump, G-507 was used for only two days (June 1 and 2, 2004) in the water year, and 22.4 ac-ft were pumped during this period. A summary of monthly STA-5 flow is presented in **Figure 4-26**.



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Inflow	0	2,425	4,728	30,142	36,759	19,652	3,959	914	2,413	286	14,180	4,453
Outflow	20	998	1,781	32,523	45,489	20,365	2,872	809	2	556	11,952	4,060

Figure 4-26. Summary of WY2005 flows for STA-5. In WY2005, Cell 1B was temporarily taken off-line for long-Term Plan construction beginning in January 2005; all other treatment cells were operational.

STA-5 HURRICANE IMPACTS

Strong winds and heavy rainfall impacted STA-5, although no damage was observed in the wetland.

STA-5 VEGETATION MANAGEMENT

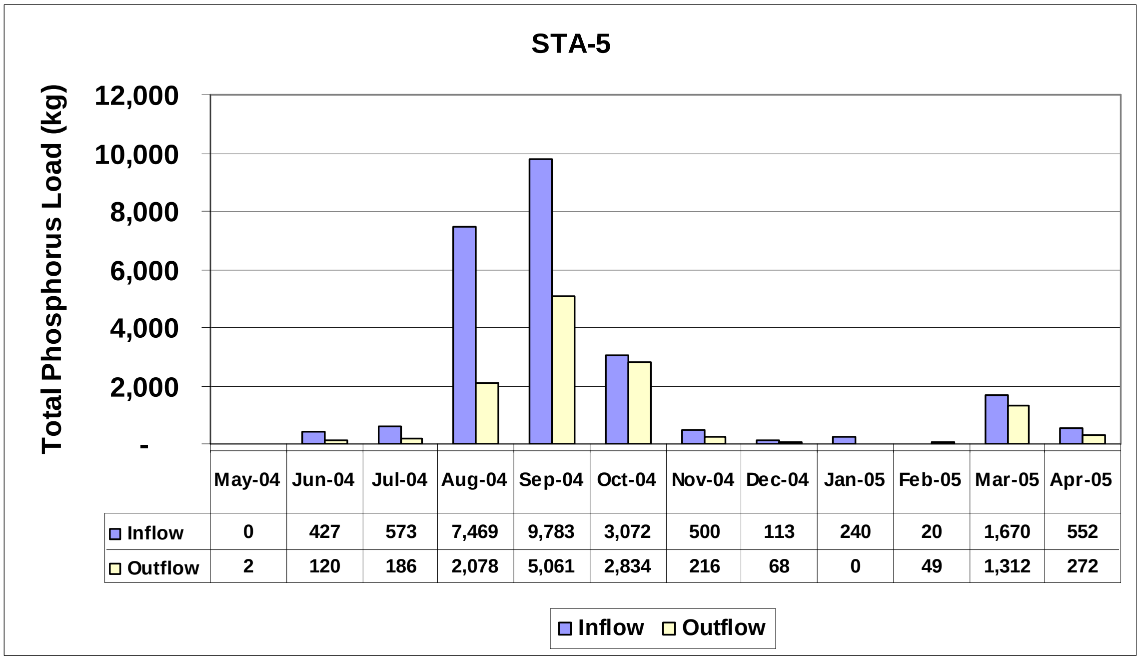
At STA-5, Treatment Cells 1A, 2A, and 2B are managed for emergent vegetation and Cell 1B is managed as a SAV cell. Next year, Cell 2B will be converted to a SAV cell as part of a Long-Term Plan enhancement. The target water stages are listed in the operations plan for each treatment cell to encourage the dominant vegetation types. Specific Condition 13(b) of the EFA permit requires that the annual report include information regarding the application of herbicides used to exclude and/or eliminate undesirable vegetation within the treatment cells. For this reporting period, about 1,397.25 acres of marsh was treated in STA-5 to control emergent and FAV. A total of 159.8 gallons of diquat was applied to treat the FAV, and 710.6 gallons of glyphosate and 189.5 gallons of imazapyr was used to control emergent and ditch bank vegetation (**Figure 4-3**). Both aerial and ground-based spray equipment were used to apply these herbicides. Vegetation coverage maps from December 2003 are found in Appendix 4-13 of the 2005 SFER – Volume I.

STA-5 PERMIT STATUS

Except for DO, the data presented in this section demonstrates that STA-5 was in compliance with the EFA and NPDES operating permits for WY2005, and that discharges do not pose any known danger to public health, safety, or welfare. The EFA permit states that STA-5 will remain in the stabilization phase of operation until STA-6 Section 2 begins flow-through operations.

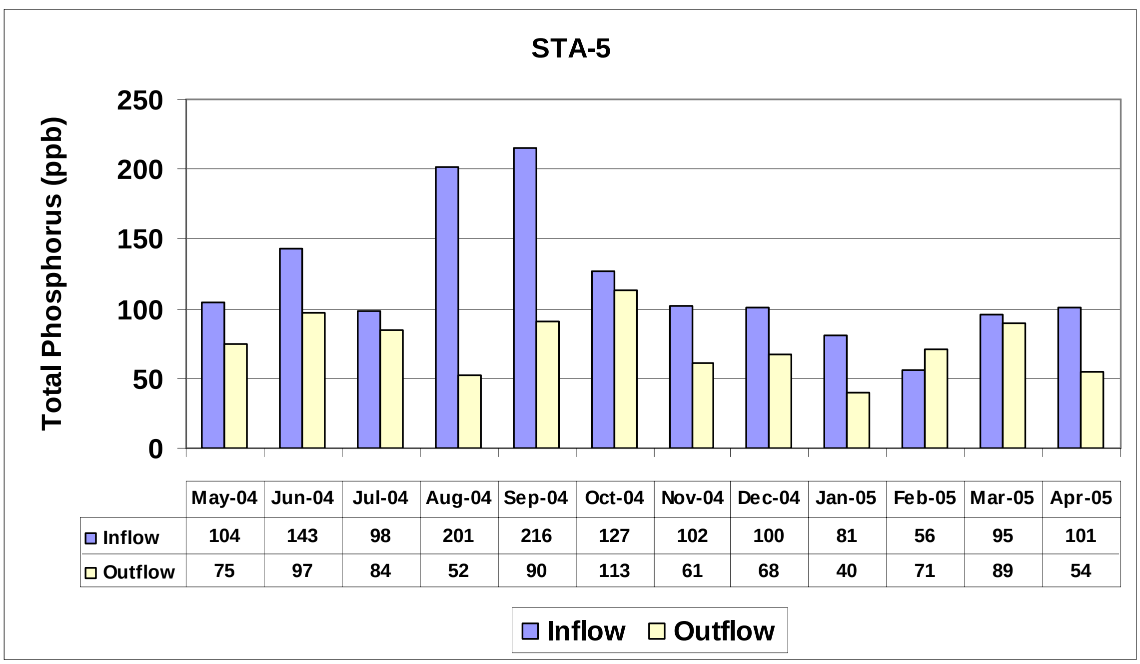
STA-5 TOTAL PHOSPHORUS

During WY2005, STA-5 received 24.4 mt of TP. STA-5 removed approximately 12.2 mt of TP during WY2005, equal to a removal rate of approximately 0.89 $g/m^2/yr$ (**Table 4-4**). Summaries of monthly TP loads and FWM TP concentrations are presented in **Figures 4-27** and **4-28**. The FWM outflow TP concentration was 81 ppb, a 51 percent reduction from the inflow concentration of 165 ppb. The inflow FWM TP during WY2005 is about 1.5 times lower than the FWM TP during WY2004. While the outflow concentration was above the 50-ppb interim target, this does not create a violation of the operating permits, as the STA is still in the stabilization phase. 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 moving 12-month FWM TP outflow concentration for STA-5 ranged from 81–100 ppb over the course of WY2005 (see **Figure 4-29**). For informational purposes, the geometric mean discharge TP concentration for STA-5 using auto-sampler data was 74 ppb for WY2005.



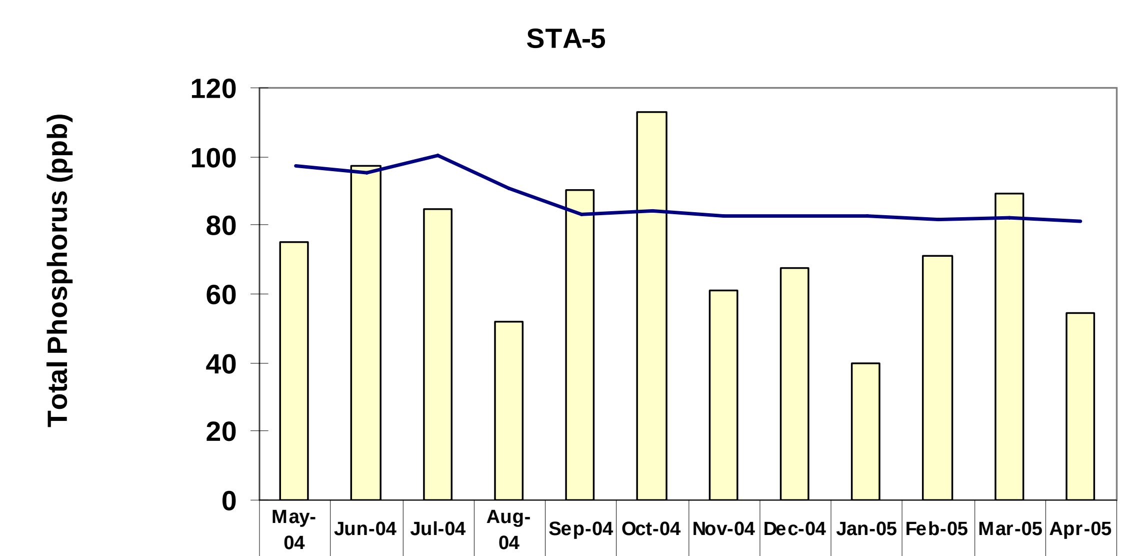
	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Inflow	0	427	573	7,469	9,783	3,072	500	113	240	20	1,670	552
Outflow	2	120	186	2,078	5,061	2,834	216	68	0	49	1,312	272

Figure 4-27. Summary of WY2005 TP loads for STA-5. In WY2005, Cell 1B was temporarily taken off-line for long-Term Plan construction beginning in January 2005; all other treatment cells were operational.



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Inflow	104	143	98	201	216	127	102	100	81	56	95	101
Outflow	75	97	84	52	90	113	61	68	40	71	89	54

Figure 4-28. Summary of WY2005 TP concentrations for STA-5. In WY2005, Cell 1B was temporarily taken off-line for long-Term Plan construction beginning in January 2005; all other treatment cells were operational.



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Outflow	75	97	84	52	90	113	61	68	40	71	89	54
12 mo. Moving FWM	97	95	100	91	83	84	83	83	83	82	82	81

Figure 4-29. Comparison of monthly to 12-month moving average TP concentrations for WY2005 for STA-5 outflow. In WY2005, Cell 1B was temporarily taken off-line for long-Term Plan construction beginning in January 2005; all other treatment cells were operational.

STA-5 OTHER WATER QUALITY PARAMETERS

The monitoring data for non-phosphorus parameters at STA-5 for the water year are presented in Appendix 4-9 and summarized in **Table 4-13**. While ametryn and atrazine concentrations were detected in the outflow, these herbicides are not used within the STA. Compliance with the EFA permit is determined based on the following three-part assessment criterion:

1. If the annual average outflow concentration does not cause or contribute to violations of applicable Class III water quality standards, then STA-5 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 it does not exceed or is equal to the annual average concentration at the inflow stations, then STA-5 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 it also exceeds the annual average concentration at the inflow station, then STA-5 shall be deemed out of compliance.

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. Concentrations of unionized ammonia, dissolved chloride, total nitrogen, and total dissolved nitrogen were slightly higher at the outflow 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. Of interest is that inflow concentrations of sulfate are considerably lower for STA-5 than for the other STAs. However, at this time the causes or significance are unclear. Additional requirements for DO are listed in Administrative Order AO-004-EV and are discussed below. Mercury monitoring results are also discussed in Chapter 2B, and the annual permit compliance monitoring report for mercury in the STAs is in Appendix 4-2 of this volume.

The District has included the following documentation to satisfy the remaining monitoring requirements of the EFA permit:

- The District has performed all sampling and analysis under the latest Laboratory Quality Assurance Manual (SFWMD, dated January 3, 2005) and a Field Quality Assurance Manual (SFWMD, dated January 3, 2005).
- A signed copy of these statements is provided in Appendix 4-3 of this volume.

Table 4-13. Summary of annual arithmetic averages and flow-weighted means for the water year for all parameters (other than TP) monitored in STA-5. Note that Cell 1B was taken out of operation in January 2005 for Long-Term Plan enhancement construction. Therefore, only Flow-way 2 was functional for the entire water year. For the purpose of these comparisons, flow-weighted means are calculated as the quotient of the cumulative product of the mean daily flow and the sample concentration divided by the corresponding cumulative daily flows.

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)	25.3	25.0	25.1	24.9	21.8	22.4	22.6	22.4	-NA-	-NA-	-NA-	-NA-
Dissolved Oxygen (mg/L)	5.1	5.3	5.4	5.9	2.1	2.6	2.1	2.1	-NA-	-NA-	-NA-	-NA-
Specific Conductivity (µmhos/cm)	621	603	592	580	507	509	568	548	-NA-	-NA-	-NA-	-NA-
pH	7.6	7.6	7.6	7.7	7.6	7.7	7.4	7.4	-NA-	-NA-	-NA-	-NA-
Turbidity (NTU)	2.8	2.9	3.0	3.2	1.2	1.4	1.9	1.2	-NA-	-NA-	-NA-	-NA-
Total Dissolved Solids (mg/L)	387	368	371	362	310	320	366	347	49 (104)	327	42 (96)	308
Unionized Ammonia (mg/L)	0.001	0.001	0.001	0.001	0.002	0.002	0.001	<0.001	43 (96)	0.001	38 (88)	<0.001
Orthophosphate as P (mg/L)	0.040	0.054	0.060	0.064	0.020	0.035	0.061	0.057	100 (204)	0.101	77 (188)	0.057
Total Dissolved Phosphorus (mg/L)	0.052	0.067	0.068	0.074	0.032	0.049	0.072	0.070	94 (198)	0.112	72 (183)	0.068
Sulfate (mg/L)	11.2	10.1	9.8	9.7	11.6	11.1	8.4	7.5	49 (104)	10.4	42 (96)	7.1
Alkalinity (mg/L)	198	207	211	217	130	132	165	165	49 (104)	158	42 (96)	152
Dissolved Chloride (mg/L)	66	57	54	47	69	67	71	67	49 (104)	51	42 (96)	51
Total Nitrogen (mg/L)	1.50	1.45	1.45	1.28	1.50	1.56	1.63	1.54	45 (100)	1.63	38 (92)	1.32
Total Dissolved Nitrogen (mg/L)	1.25	1.17	1.15	1.07	1.39	1.43	1.51	1.41	45 (100)	1.42	38 (92)	1.25
Nitrate + Nitrite (mg/L)	0.047	0.036	0.032	0.020	0.012	0.009	0.009	0.008	45 (100)	0.058	38 (92)	0.010
Ametryn (µg/L)	0.005	0.005	0.005	0.005	0.007	0.009	0.010	0.007	6 (20)	0.010	9 (20)	0.010
Atrazine (µg/L)	0.155	0.088	0.115	0.039	0.428	0.254	0.260	0.186	6 (20)	0.010	9 (20)	0.050

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

STA-5 DISSOLVED OXYGEN MONITORING

Introduction

STA-5 Administrative Order No. AO-004-EV in Exhibit C of Permit No. 0131842, February 29, 2000, specifies the DO monitoring requirements as STA-1W.

The District developed the following plan to comply with the DO requirements of the Administrative Orders for STA-5. Under the plan, DO concentrations are measured quarterly with Hydrolab™, DataSonde®, or MiniSonde® probes at 30-minute intervals for four consecutive days at the following locations:

- In the discharge canal near structures G-344 and G-344D, to provide representative data whether the discharge is to the Miami Canal, to the RWMA through pump station G-410, or to both sites simultaneously
- On the west bank of the Miami Canal about 100 meters upstream of the confluence of the canal and the STA-5 discharge canal, to measure background conditions in the Miami Canal
- On the west bank of the Miami Canal, about 100 meters downstream of the confluence of the canal and the STA-5 discharge canal, to measure effects of STA-5 discharges to the Miami Canal
- Sites along the north and south transects within the RWMA (**Figure 4-30**) to measure effects of STA-5 discharges to the RWMA

Sampling Dates

Diel oxygen measurement dates and sites associated with STA-5 for WY2005 are provided in **Table 4-14** and Appendix 4-10.

Table 4-14. Deployment dates for diel oxygen measurement at STA-5 structures and sites in the Miami Canal.

Event Dates		Structures		Miami Canal Sites		Sites Monitored in Rotenberger Tract
Start	End	Outflow				
06/14/2004	06/17/2004	STA5DC	G344D	NMC	SMC	----------------------------------
08/16/2004	08/20/2004	------	------	------	------	N.25, N1
09/20/2004	09/23/2004	STA5DC	G344D	NMC	SMC	----------------------------------
10/25/2004	10/29/2004	------	------	------	------	N.25, N1, S4
12/06/2004	12/09/2004	STA5DC	G344D	NMC	SMC	----------------------------------
03/14/2005	03/17/2005	STA5DC	G344D	NMC	SMC	----------------------------------

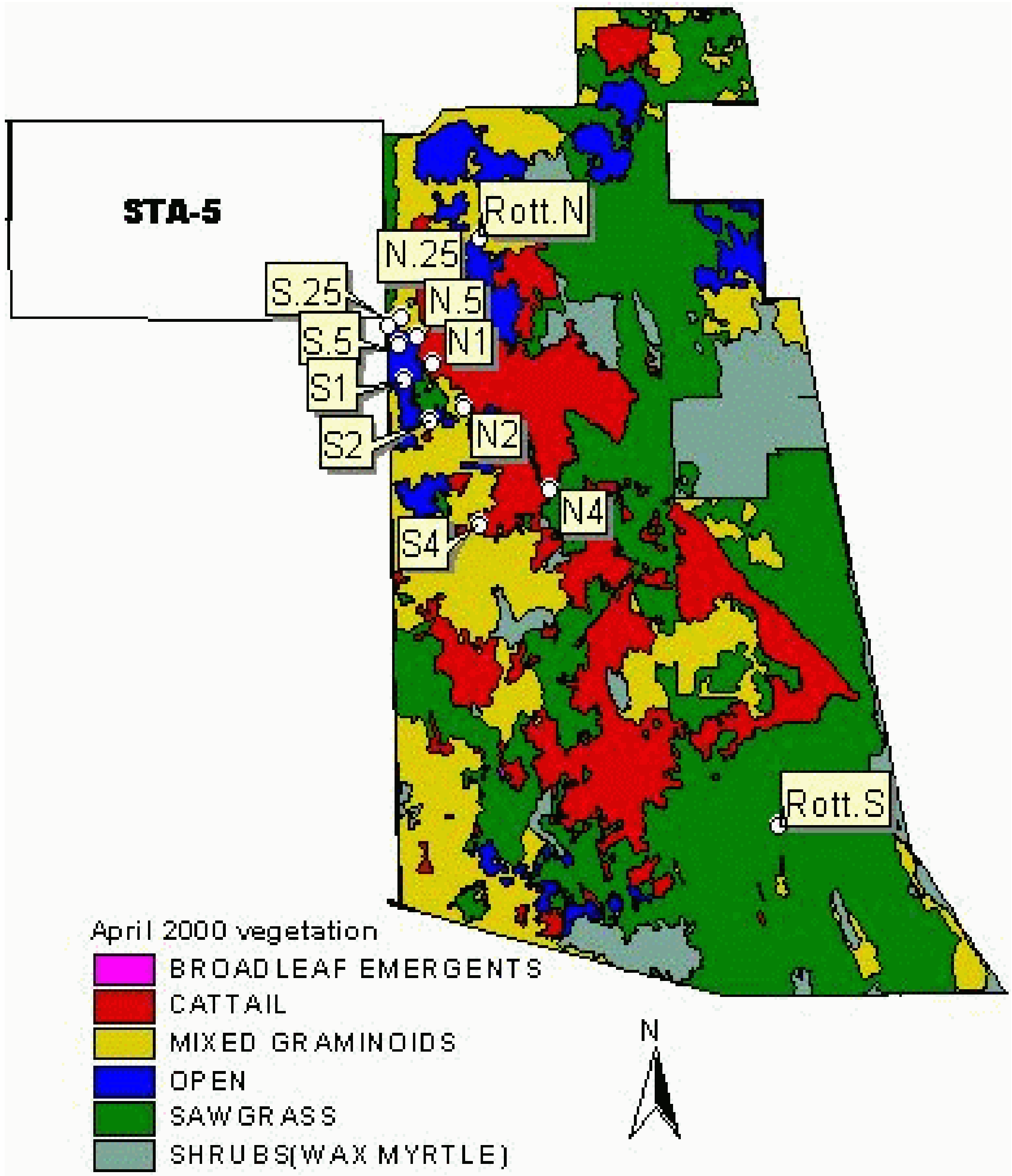


Figure 4-30. DO monitoring sites in the Rotenberger Wildlife Management Area (RWMA).

Comparison of Dissolved Oxygen in STA-5 Discharges with Dissolved Oxygen at Miami Canal Sites

Comparisons of DO in STA-5 discharges with DO in the Miami Canal provide an indication of whether the discharge is affecting the canal DO concentrations or the diel cycle. The summary statistics for STA-5 discharges and the downstream sites are presented in **Table 4-15**. Examination of this table and **Figure 4-31** shows that DO concentrations at the Miami Canal sites are statistically significantly greater than the DO concentrations in the discharged waters immediately downstream of the discharge structures. The average of the DO concentrations in the discharge canal ranges from 2.18 to 4.50 mg/L in the Miami Canal. Although the discharge canal intersects the Miami Canal between Miami Canal north and south (NMC and SMC, respectively) monitoring sites, the discharged waters do not appear to have an impact on the downstream site in the canal. No statistically significant difference was observed between the dissolved oxygen data collected at NMC and SMC sites. The complete data sets collected during WY2005 are presented in Appendix 4-9 in this volume.

Due to differences in Hydrolab™ deployment dates, direct comparisons of DO in STA-5 discharges with DO measured in the RWMA cannot be made. However, to satisfy permit requirements, summary statistics for STA-5 discharges and RWMA marsh transect sites are presented in **Table 4-15** and **Figure 4-31.** The data indicate that both STA5DC and G344D exhibited significantly higher DO concentrations than marsh station N.25. In addition, DO levels at STA5DC were significantly higher than either at N1 or S4 in the RWMA (**Figure 4-31**).

Table 4-15. Statistical summary of diel DO at the outflow stations from STA-5 and stations in the Miami Canal during three deployment periods. No monitoring was done in the RWMA.

Location	Station	Number of Measurements	Mean	Minimum	Median	Maximum	Standard Deviation
Outflow	STA5DC	696	3.57	0.09	3.41	8.21	2.12
	G344D	552	2.18	0.12	1.17	6.51	2.02
Canal	NMC	699	4.41	2.77	4.21	7.45	1.25
	SMC	558	4.50	1.63	4.45	7.30	1.45
Transect N	N.25	181	0.71	0.21	0.52	2.47	0.43
	N1	358	1.93	0.64	1.79	5.00	0.87
Transect S	S.25	----	----	----	----	----	----
	S1	----	----	----	----	----	----
	S4	177	1.71	1.18	1.63	2.81	0.29

Note: Statistical summaries by event and diel parameter can be found in Appendix 4-4, Table 3.

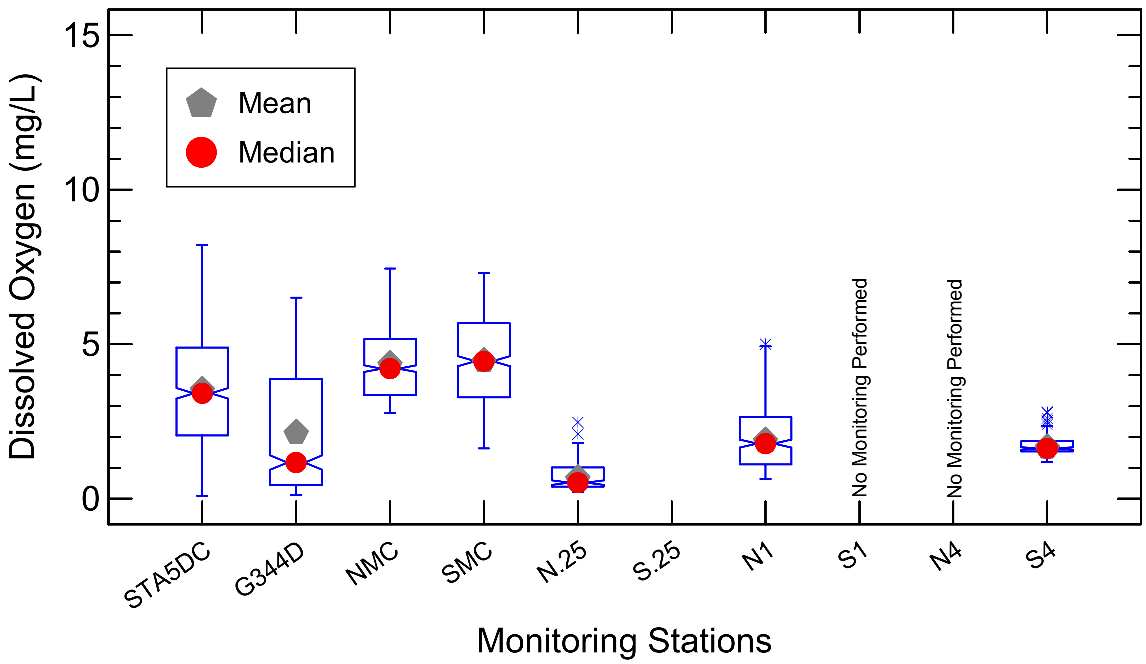


Figure 4-31. Notched box and whisker plots of diel DO measurements at STA-5 outflow stations STA5DC (formally G344A) and G344D and at sites in the Miami Canal north (NMC) and Miami Canal south (SMC) during three monitoring periods. The notch on a box plot represents the approximate (95%) C.I. about the median, which is represented by the narrowest part of the notch. The top and bottom of the box represent the 75th and 25th percentiles, respectively. The whiskers represent the highest and lowest data values that are within two standard deviations of the median. Values above and below the whiskers are greater than two standard deviations from the median. Notches that do not overlap indicate that the data represented by the boxes being compared are significantly different at the 95% C.I.

STA-5 RECREATION AND WILDLIFE

STA-5 was opened for the third year for water fowl hunts. Black-necked stilt nests were found on the levee roads but not within the treatment cells and did not impact STA operations.

Recreational facilities are proposed to provide public access to STA-5. The proposed recreational facilities include an asphalt parking area, a composting toilet, landscaping and an information kiosk. Pedestrian gates, signage and fencing as needed to define public access areas and to protect sensitive equipment are also proposed.

STA-5 ENHANCEMENTS

The recommended enhancements to STA-5 include the conversion of Cell 2B from emergent macrophyte vegetation to SAV, modification of existing structures, and expanded treatment area (**Figure 4-32**). The improvements are discussed below.

Modification of G-343 Structures. The G-343 structures are situated in the north-south interior levee subdividing Cells 1A and 2A from Cells 1B and 2B. Those structures originally consisted of reinforced concrete box culverts controlled by simple weir crests set at the design static water surface elevation in Cells 1A and 2A. The nature of those structures inhibited the District's ability to control proper flow distribution across the STA. The limited flexibility in operation of the G-343 structures has also contributed to a higher-than-intended frequency and volume of diversion. To address these limitations and afford the District increased flexibility in the operation of STA-5, the existing G-343 structures are being modified through the addition of operable gates and the removal of the upstream weir controls. This modification also require the addition of telemetric control to the structures, coupled with the addition of stilling wells for water level data acquisition in the upper ends of Cells 1B and 2B. Stilling wells presently exist in Cells 1A and 2A upstream of the G-343 structures. It will also be necessary to extend an overhead power transmission line along the interior levee to service the modified water control structures.

In FY2005, the structural modifications to the G-343A–D structures were substantially completed. Telemetry and power distribution for these four structures are scheduled to be completed by May 2006. The G-343E–H structural modifications are scheduled to be completed by May 2006. Power and telemetry for the final for structures are scheduled to be completed by mid-2006.

Additional Seepage Control Facilities. In order to minimize the induced loading on STA-5, it was recommended that an additional seepage return pumping station be constructed near the northwest corner of Cell 1B. This pump station will provide a nominal capacity of 45 cfs, similar to the capacity of existing pumping stations G-349A and G-350A. This seepage pump station is scheduled to be completed by May 2006.

Removal of Obstructions to Flow. Field observations indicated obstructions to flow existed in Cells 1B and 2B. These were likely a result of relatively high ground elevations, possibly an old road bed in the case of Cell 2B. These flow obstructions are being removed as part of the STA-5 enhancements. Cell 1B flow obstructions were removed in FY2005. The Cell 2B flow obstructions are scheduled to be completed by May 2006.

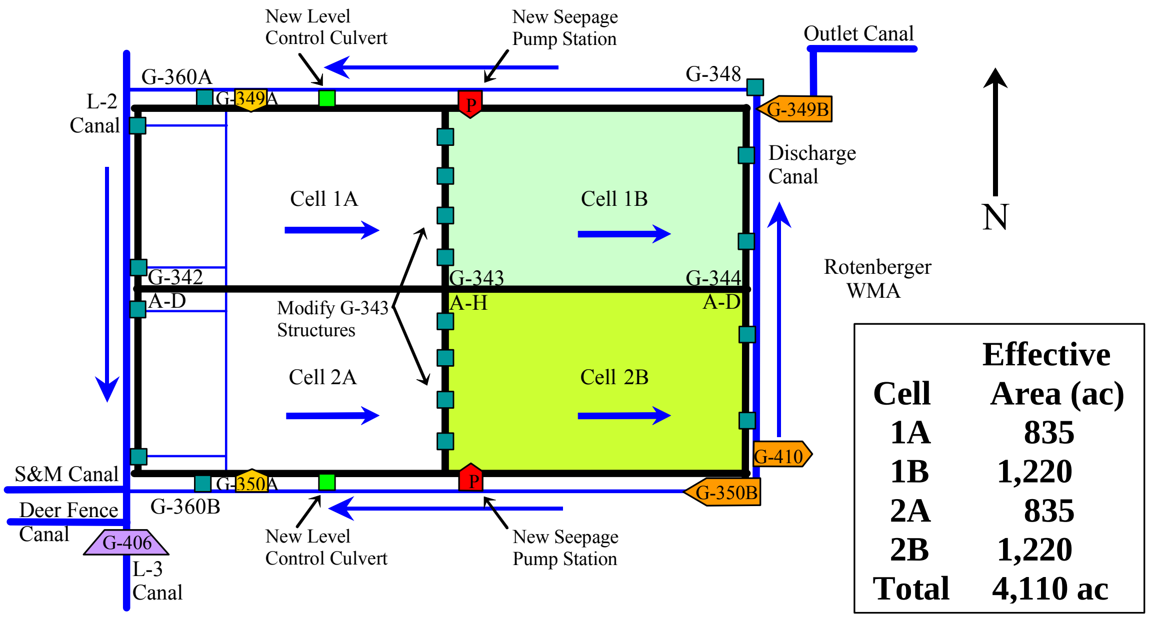


Figure 4-32. STA-5 enhancements (not to scale).

STA-5 EXPANSION

STA-5 enhancements include the construction of a 2,560-acre treatment cell (i.e., a new Flow-way 3) that will operate in parallel with existing Flow-ways 1 and 2. The design of the new Flow-way 3 is scheduled to be completed in October 2005. Construction of the new Flow-way 3 is scheduled to begin in January 2006 and be completed by March 2007, with the new cell being flow-capable by December 31, 2006. The design and construction of Flow-way 3 is being 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.

ROTENBERGER WILDLIFE MANAGEMENT AREA

The Rotenberger Hydropattern Restoration Project is a component of the larger Everglades Construction Project (ECP). The goal of the project is to restore a more natural hydroperiod to slow, alter, and eventually reverse the ecosystem degradation within the Rotenberger Wildlife Management Area caused by drought and seasonal fires, soil oxidation and compaction, and the release of ambient nutrients from soils. 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. 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–D) 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, FWC, USACE, and Friends of the Everglades. The permit requires the interagency group to periodically evaluate the progress the project is making toward achieving its restoration goals.

For WY2005, approximately 44,414 ac-ft were directed into the RWMA through G-410, while approximately 34,048 ac-ft were discharged to the Miami Canal from the outlet structures (**Figure 4-33**). The FWM inflow TP concentration was 71 ppb, yielding a total TP inflow load of about 3,905 kg (**Figures 4-34** and **4-35**). As the treatment system in STA-5 stabilizes, TP levels entering the RWMA are anticipated to decrease. TP concentrations leaving the RWMA averaged 21 ppb, although the total load was only 897 kg (**Figure 4-36**). Information about the Rotenberger hydropattern restoration is presented in Chapter 6 of this volume.

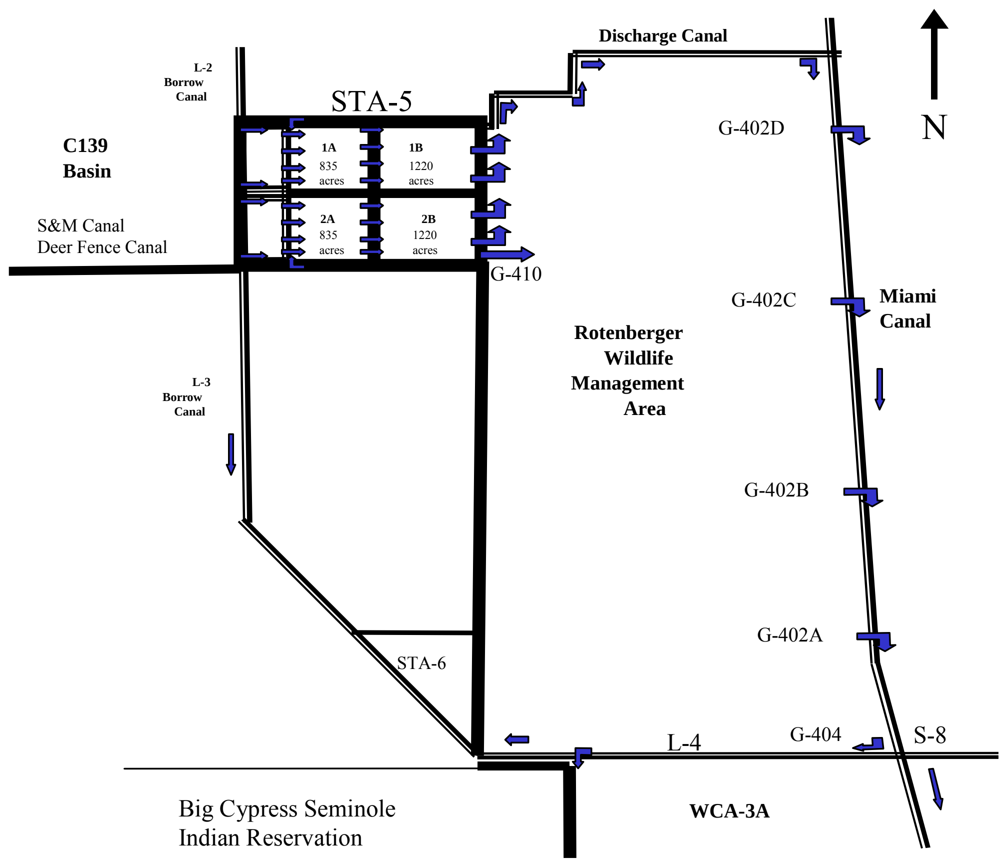
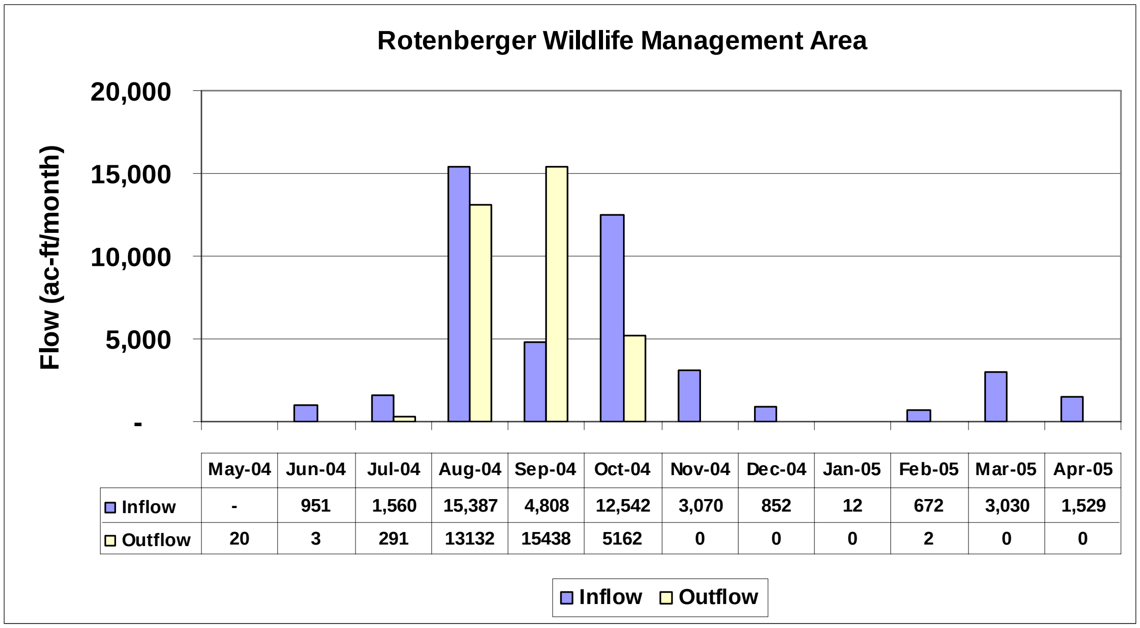
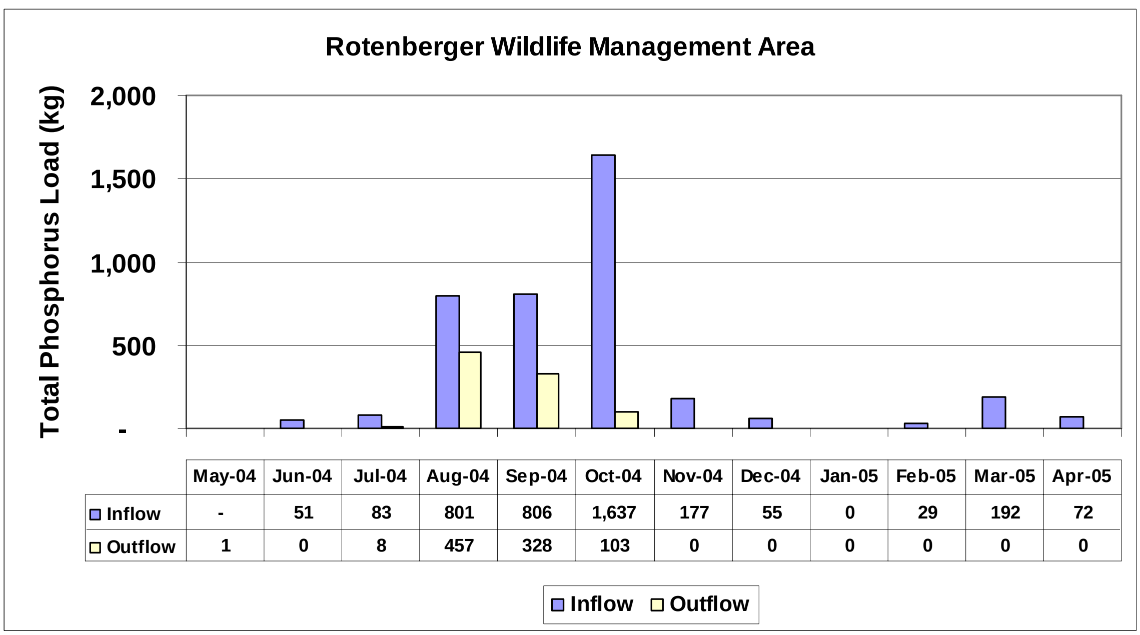


Figure 4-33. Schematic of the RWMA (not to scale).



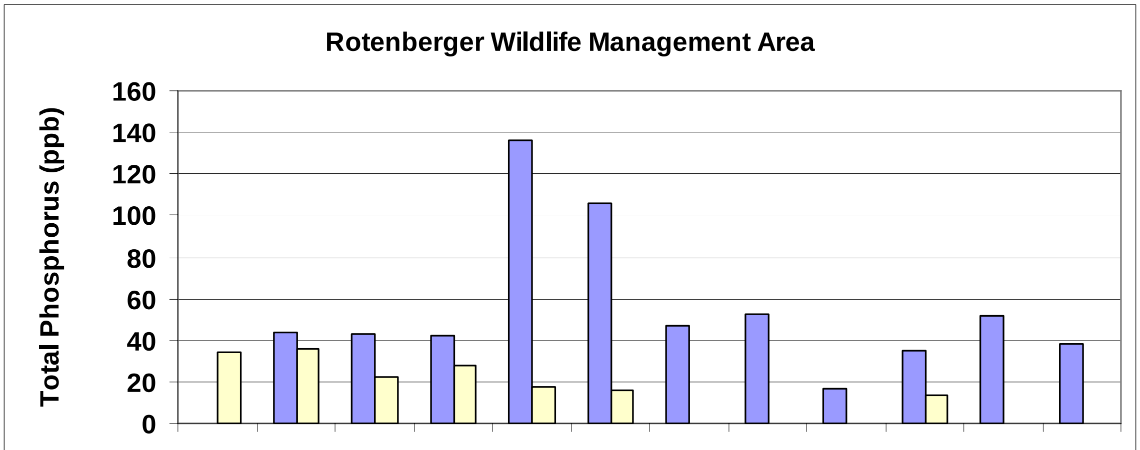
	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Inflow	-	951	1,560	15,387	4,808	12,542	3,070	852	12	672	3,030	1,529
Outflow	20	3	291	13132	15438	5162	0	0	0	2	0	0

Figure 4-34. Summary of WY2005 flows for the RWMA.



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Inflow	-	51	83	801	806	1,637	177	55	0	29	192	72
Outflow	1	0	8	457	328	103	0	0	0	0	0	0

Figure 4-35. Summary of WY2005 TP loads for the RWMA.



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Inflow		44	43	42	136	106	47	53	17	35	51	38
Outflow	34	36	22	28	17	16				13		

Figure 4-36. Summary of WY2005 TP concentrations for the RWMA.

STA-6 SECTION 1

Stormwater Treatment Area 6 (STA-6) Section 1 contains approximately 870 acres of effective treatment area, arranged in two parallel flow-ways. The northern flow-way (Cell 5) consists of approximately 625 acres of effective treatment area. The southern flow-way (Cell 3) consists of approximately 245 acres of effective treatment area. A schematic of STA-6 is presented in **Figure 4-37**. Based on the simulated 1965–1995 period of flow, the STA should receive a long-term average annual volume of approximately 37,442 ac-ft from the EAA basin, although annual variability is anticipated. Actual deliveries will vary based on hydrologic conditions in the basins.

Water enters the STA from the G-600 pumping station, and travels southeast in the supply canal. Water enters the treatment cells through three broad-crested weirs (G-601, G-602, and G-603), flows by gravity east through the treatment cells, and is discharged through several combination box weir/culvert structures (G-393 and G-354). The treated water is then collected in the discharge canal and flows to the L-4 borrow canal, where the majority of the water moves east to the northwest corner of WCA-3A.

STA-6 Section 2 will add about 1,400 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. STA-6 Section 2 is scheduled to be completed by December 31, 2006.

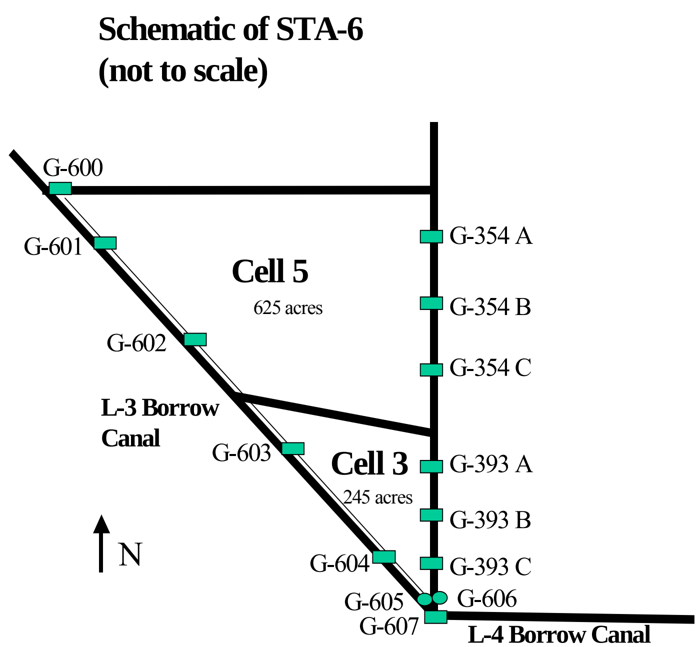
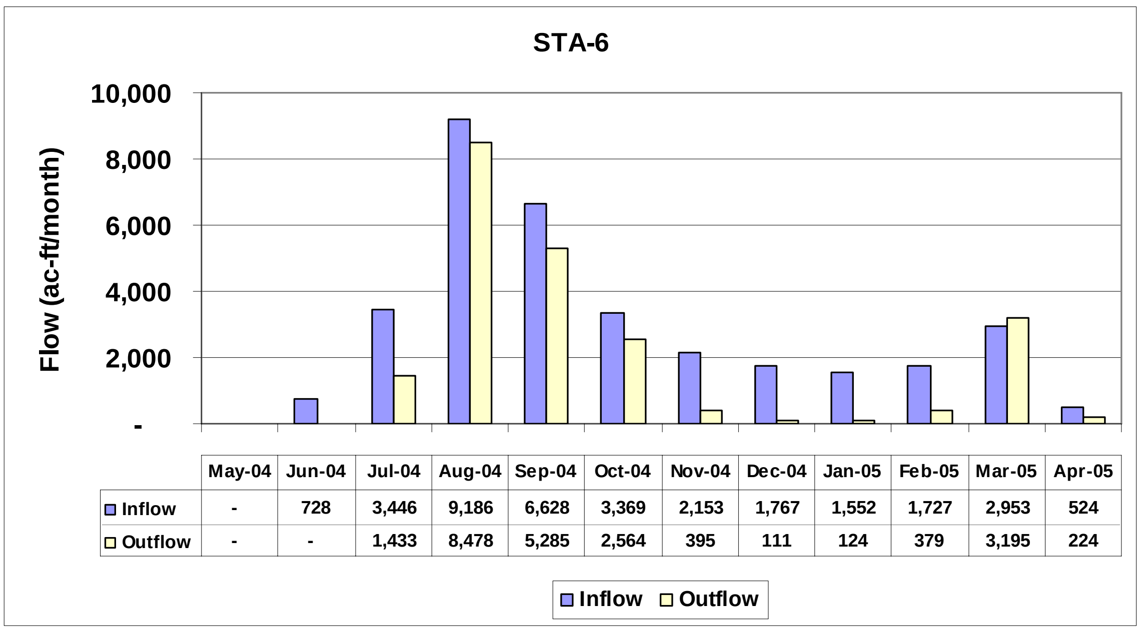


Figure 4-37. Schematic of STA-6 (not to scale). Note that structure G-606 is no longer operational.

STA-6 OPERATIONS

A fire occurred at the inflow pump station G-600 in October 2004, damaging some of the pumps, the pump house, and the telemetry. Manual readings were used to estimate flow. At the end of March 2005, the U.S. Sugar Corporation moved out of Unit 2 and formally transferred the inflow pump station G-600 to the District. Since that time, G-600 has not been used and water in the marsh is solely from rainfall. Dry out conditions were observed in May 2004. During WY2005, 34,035 ac-ft of water was captured by the inflow pump station for STA-6 (**Table 4-4**), although there existed some undetermined amount of losses to irrigation water supply, and the net flow into the treatment area was less. The inflow was about 9 percent greater than the long-term average assumed during design. Due to seepage losses, ET, and water supply deliveries from the STA, the net volume of treated water discharged from STA-6 during WY2005 was 22,187 ac-ft. A summary of monthly flow is presented in **Figure 4-38**.



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Inflow	-	728	3,446	9,186	6,628	3,369	2,153	1,767	1,552	1,727	2,953	524
Outflow	-	-	1,433	8,478	5,285	2,564	395	111	124	379	3,195	224

Figure 4-38. Summary of WY2005 flows for STA-6.
All treatment cells were operational in WY2005.

STA-6 HURRICANE IMPACTS

STA-6 received high inflow volumes as a result of the hurricanes, but here was no damage observed to the wetland.

STA-6 VEGETATION MANAGEMENT

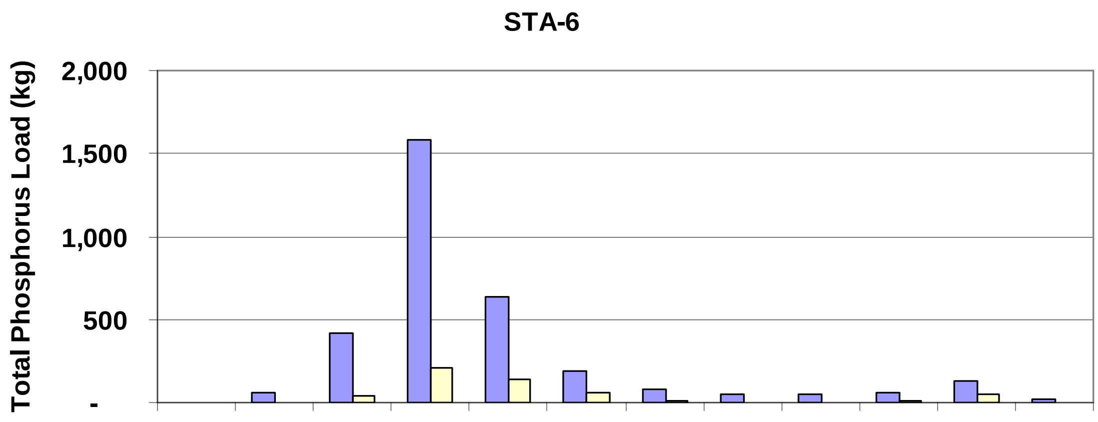
At STA-6, both treatment cells have emergent vegetation, with sawgrass and willow dominating in Cell 3 and cattail and grasses dominating in Cell 5. Specific Condition 13(b) of the EFA permit requires that the annual report include information regarding the application of herbicides used to exclude and/or eliminate undesirable vegetation within the treatment cells. For this reporting period, 22 acres were treated using 1.25 gallons of herbicide containing the active ingredient diquat to treat floating aquatic vegetation and 15.9 gallons of herbicide containing the active ingredient glyphosate and 4.25 gallons of herbicide containing the active ingredient imazapyr was used to control emergent vegetation (**Table 4-3**). Vegetation coverage maps from December 2003 are found in Appendix 4-13 of the 2005 SFER – Volume I.

STA-6 SECTION 1 PERMIT STATUS

The District initiated a water quality monitoring program in STA-6 in December 1997 for the purpose of demonstrating compliance with the above referenced conditions of the operating permit. Presently, STA-6 is in a post-stabilization phase. STA-6 discharges do not pose any known danger to the public health, safety, or welfare. Compliance with Specific Conditions 7(a)(i) and 7(a)(ii) was achieved.

STA-6 TOTAL PHOSPHORUS

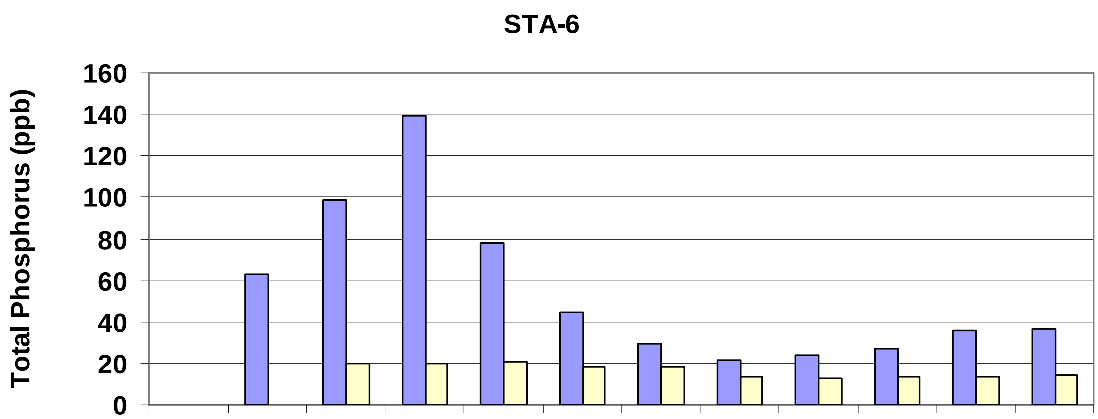
STA-6 continues to achieve its interim discharge goal of less than 50 ppb for TP. During WY2005, STA-6 received 3.3 mt of TP, equating to a nutrient loading rate of 0.9 g/m^2 (**Table 4-4**). The TP load was about 19 percent greater than the long-term average anticipated during design. Approximately 2.7 mt of TP was removed by STA-6 during WY2005. During WY2005, STA-6 experienced an 84 percent load reduction in TP (**Figure 4-39**). Furthermore, monthly discharge concentrations were considerably lower than inflow concentrations (**Figure 4-40**). The FWM outflow concentration was 19 ppb, well below the EFA permit requirement of 50 ppb. This represents a 76 percent reduction from the inflow concentration of 78 ppb. For informational purposes, the geometric mean TP concentration of the discharge was 17 ppb. The moving 12-month, flow-weighted average outflow ranged from 12–20 ppb during the course of WY2005 (see **Figure 4-41**).



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Inflow	-	56	418	1,577	637	186	77	47	46	58	129	24
Outflow	-	-	35	209	137	57	9	2	2	6	52	4

Inflow Outflow

Figure 4-39. Summary of WY2005 TP loads for STA-6.
All treatment cells were operational in WY2005.



	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Inflow	0	63	98	139	78	45	29	21	24	27	35	37
Outflow			20	20	21	18	19	14	13	13	13	14

Inflow Outflow

Figure 4-40. Summary of WY2005 TP concentrations for STA-6.
All treatment cells were operational in WY2005.

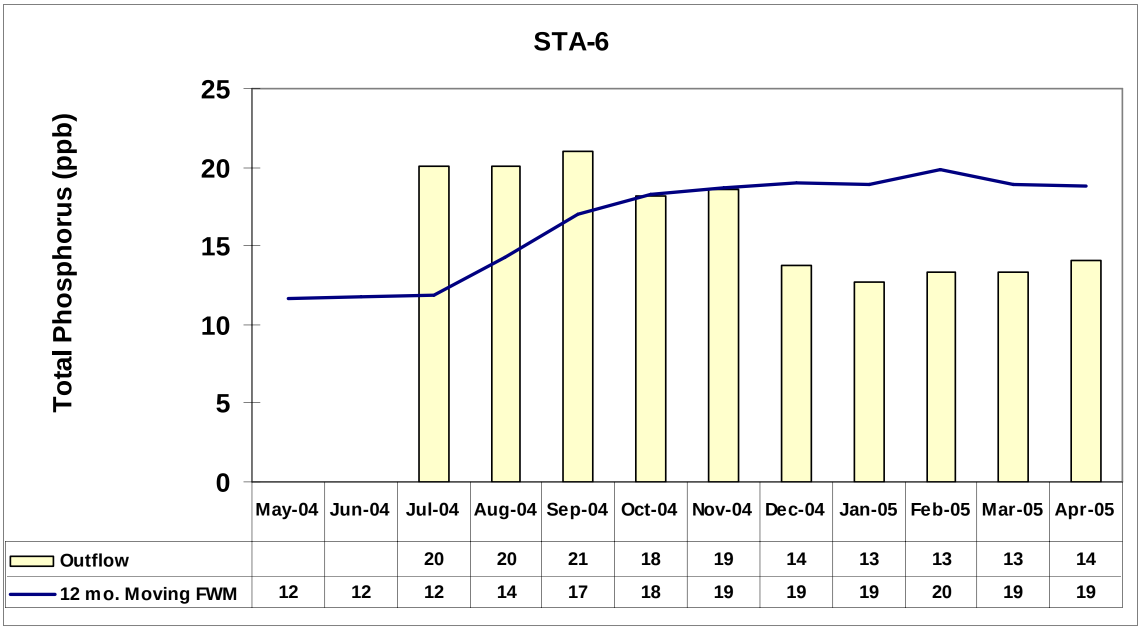


Figure 4-41. Comparison of monthly to 12-month moving average TP concentrations for WY2005 for STA-6 outflow. All treatment cells were operational in WY2005.

STA-6 OTHER WATER QUALITY PARAMETERS

The monitoring data for non-phosphorus parameters at STA-6 for the water year are presented in Appendix 4-11 of this volume and are summarized in **Table 4-16**. 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-6 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 it does not exceed or is equal to the annual average concentration at the inflow stations, then STA-6 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 it also exceeds the annual average concentration at the inflow station, then STA-6 shall be deemed out of compliance.

Annual average concentrations of ametryn and atrazine were detected in both the inflow and outflow at STA-6 and outflow values for color, total Kjeldahl nitrogen, sulfate, dissolved chloride, dissolved sodium, dissolved potassium, and dissolved magnesium were slightly higher than inflow values, but because these parameters have no applicable numeric state water quality standards, discharges from STA-6 are deemed to be in full compliance with the permit (see **Table 4-16**). For STA-6, downstream DO monitoring is not required by the permits. Mercury monitoring results are also discussed in Chapter 2B, and the annual permit compliance monitoring report for mercury in the STAs is in Appendix 4-2 of this volume.

The District has included the following documentation to satisfy the remaining monitoring requirements of the EFA permit:

- The District has performed all sampling and analysis under the latest Laboratory Quality Assurance Manual (SFWMD, dated January 3, 2005) and a Field Quality Assurance Manual (SFWMD, dated January 3, 2005).
- A signed copy of these statements is provided in Appendix 4-3 of this volume.

Table 4-16. Summary of annual arithmetic averages and flow-weighted means for the water year for all parameters (other than TP) monitored in STA-6. For the purpose of these comparisons, flow-weighted means are calculated as the quotient of the cumulative product of the mean daily flow and the sample concentration divided by the corresponding cumulative daily flows.

Parameter	Arithmetic Means			Flow-Weighted Means			
	Inflow	Outflow		Total Inflow		Total Outflow	
	G600	G354C	G393B	n	Conc.	n	Conc.
Temperature (°C)	24.5	22.8	21.6	-NA-	-NA-	-NA-	-NA-
Dissolved Oxygen (mg/L)	2.4	3.5	2.6	-NA-	-NA-	-NA-	-NA-
Specific Conductivity (μmhos/cm)	871	752	805	-NA-	-NA-	-NA-	-NA-
pH	7.3	7.5	7.3	-NA-	-NA-	-NA-	-NA-
Turbidity (NTU)	2.2	1.0	1.0	-NA-	-NA-	-NA-	-NA-
Color (PCU)	77	78	87	-NA-	-NA-	-NA-	-NA-
Total Suspended Solids (mg/L)	3.1	1.7	2.3	13 (25)	2.6	29 (46)	1.5
Unionized Ammonia (mg/L)	0.003	0.003	<0.001	13 (24)	0.002	29 (46)	<0.001
Total Kjeldahl Nitrogen (mg/L)	1.76	1.82	1.49	13 (25)	1.81	29 (46)	1.46
Orthophosphate as P (mg/L)	0.014	0.005	0.006	32 (50)	0.030	57 (92)	0.007
Total Iron (μg/L)	259	104	107	2 (5)	352	6 (10)	131
Silica (mg/L)	10.83	9.33	8.27	1 (4)	10.60	4 (8)	10.13
Sulfate (mg/L)	19.3	23.4	22.3	1 (4)	21.8	4 (8)	17.0
Alkalinity (mg/L)	282.2	206.2	258.5	13 (25)	278.2	29 (46)	232.8
Dissolved Chloride (mg/L)	94.6	96.5	93.6	13 (25)	89.2	29 (46)	70.6
Dissolved Sodium (mg/L)	62.4	66.5	62.1	1 (4)	72.0	4 (8)	64.5
Dissolved Potassium (mg/L)	4.2	4.6	5.0	1 (4)	4.1	4 (8)	4.8
Dissolved Calcium (mg/L)	105.7	74.1	96.4	13 (25)	104.6	29 (46)	87.0
Dissolved Magnesium (mg/L)	8.6	8.4	8.7	1 (4)	10.2	4 (8)	8.6
Ametryn (μg/L)	0.005	0.012	0.005	3 (5)	0.010	3 (9)	0.013
Atrazine (μg/L)	0.039	0.105	0.051	3 (5)	0.026	4 (10)	0.034

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

STA-6 RECREATION

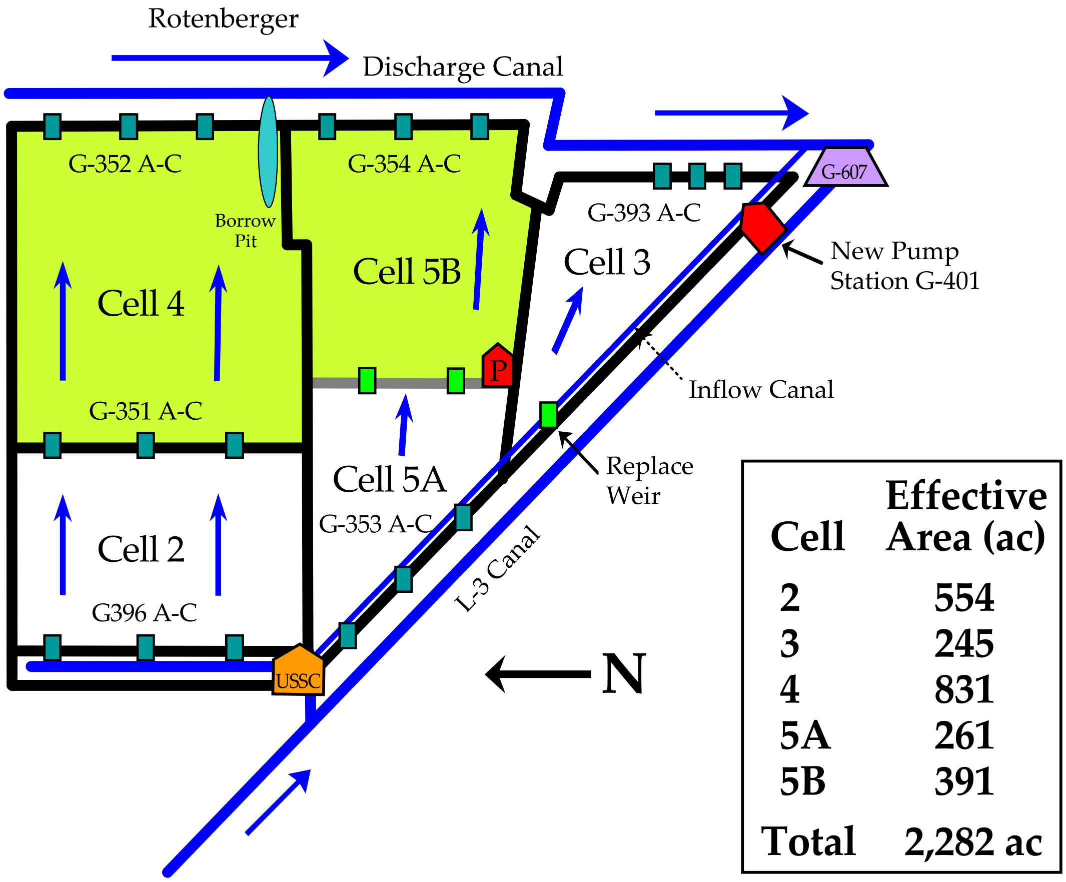
Recreational facilities are proposed to provide public access to STA-6. The proposed facilities include an asphalt parking area, landscaping, pedestrian gates, signage and fencing as needed to define public access areas and to protect sensitive equipment.

STA-6 ENHANCEMENTS AND STA-6 SECTION 2 [BC60]

Enhancements to STA-6 proposed in the revised Part 2 of the Long-Term Plan dated November 2004 included construction of an interior levee and associated water control structures in Cell 5, as well as conversion of emergent vegetation to SAV in the new downstream cell and construction of STA-6 Section 2 (**Figure 4-42**). The Long-Term Plan also recommended a review of the proposed enhancements to STA-6 Section 1 to asses whether these revisions were justified to improve performance or system efficiency, or to avoid redundant or unnecessary features. This assessment was conducted to predict outflow phosphorus concentrations with the full expansion of the STA into the Compartment C (build-out) area. Based on this evaluation, it was determined that the interior levees and associated water control structures were not required to improve performance in the build-out condition. However, some structural modifications to STA-6 Section 1 are still required to optimize the operation of the STA-5/STA-6 system.

STA-6 Section 2 will add about 1,400 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.

The design of the STA-6 enhancements and STA-6 Section 2 is scheduled to be completed in October 2005. Construction is scheduled to begin in January 2006 and be completed by March 2007, with STA-6 Section 2 being flow-capable by December 31, 2006. The design and construction of STA-6 Enhancements and STA-6 Section 2 is being implemented under the District’s Acceler8 program as part of the Everglades Agricultural Area STA Enhancement project. For additional information on the status of the Acceler8 program, see Chapter 7A of this volume.



Cell	Effective Area (ac)
2	554
3	245
4	831
5A	261
5B	391
Total	2,282 ac

Figure 4-42. STA-6 enhancements (not to scale).

STA PERFORMANCE SYNOPSIS

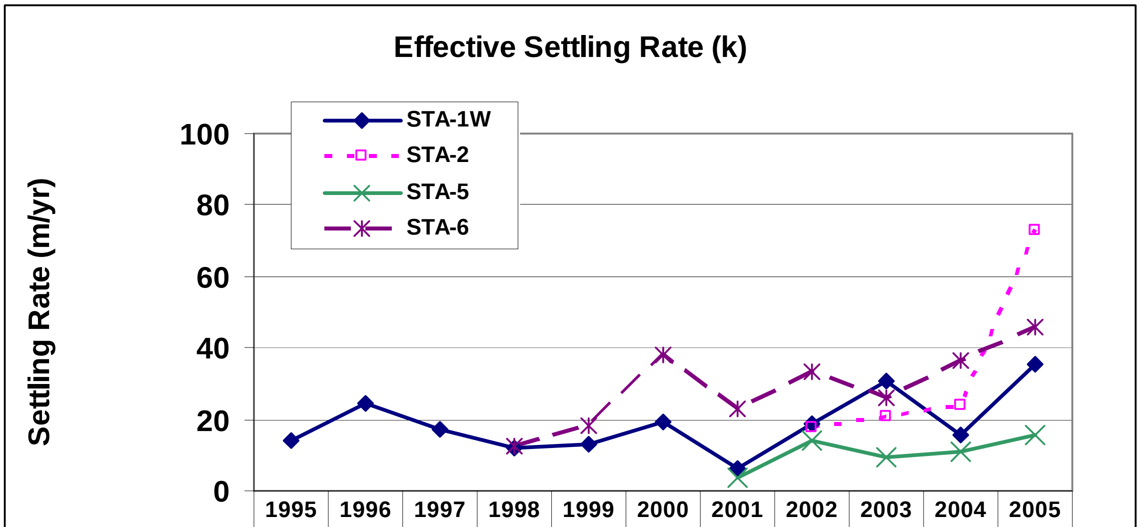
A brief synopsis of phosphorus removal performance may be insightful, as multiple years of STA performance data are available. The flows, TP loads, and FWM TP concentrations going into and out of each STA are presented in Appendix 4-2. The water budgets and phosphorus mass balance calculations for each treatment cell for each STA (excluding STA-3/4) are presented in the *Analysis and Interpretation [Bc82(4)]* section. The concentrations of the other nutrient parameters measured within the STAs are also presented in that section, along with soil nutrient data.

During WY2005, some of the effective treatment area was temporarily taken off-line for Long-Term Plan enhancements or plant rehabilitation. At STA-1W, Cells 1 and 3 were operational for the entire water year; Cell 5 was under restricted flow beginning in November 2004 for plant rehabilitation due to hurricane damage, was off-line in March 2005 to degrade the limerock berm, then was again operated under restricted flow; Cells 2 and 4 were taken off-line beginning in January 2005 for Long-Term Plan Enhancement construction. At STA-5, Cell 1B was temporarily taken off-line for long-Term Plan construction beginning in January 2005 and all other treatment cells were operational.

In WY2005, STA-1W had higher inflows and much higher TP loading than WY2004. The inflow FWM TP concentration of 247 ppb and outflow concentration of 98 ppb was the highest measured since start-up (Appendix 4-2). STA-2 also experienced higher inflows and much higher TP loads and inflow concentrations in WY2005 compared to prior water years (126 ppb compared to less than 80 ppb) (Appendix 4-2). Although the loading was high going into STA-2, the FWM outflow TP concentration remains low (20 ppb). STA-5 and STA-6 experienced the opposite type of loadings, with inflow flow and TP loads being lower than most prior water years.

Comparisons of the STA performance over the period of operation demonstrate long-term trends. Performance plots of the annual STA settling rates (**Figure 4-43**) indicate spatial and temporal variability within and among STAs, with all STAs at or above the design settling rate estimate of 10 m/yr. STA-2 had a steep rise in settling rate from prior water years, increasing from 24 m/yr up to 73 m/yr, probably due to the relatively large inflow load being reduced down by 81 percent. Time series plots of the load removal (**Figure 4-44**) also show variance between the STAs, as well as annual variability within the STAs. Outflow TP concentrations from STAs with low inflow TP concentrations (< 100 ppb) appear to be fairly insensitive to inflow concentrations, suggesting that greater performance can be achieved with improvements due to BMPs in those basins with higher inflow concentrations (i.e., upstream of STA-1W and STA-5).

The STA combined cumulative load removal of 71 percent (**Figure 4-45**) is slightly higher than the 70 percent design assumption. The load removal was highest for STA-2, STA-3/4, and STA-6 (over 80 percent) and lowest for STA-1W (55 percent) and STA-5 (50 percent). Much variability between the STAs, as well as within an STA, is also observed when comparing the STA TP load removal to inflow loading rate (**Figure 4-46**). Both STA-1W and STA-5 had Long-Term Plan enhancement construction projects that started during this water year and the reduction of the effective treatment area and the damage sustained to the plant communities within STA-1W due to the hurricane and large floating cattail tussocks impacted the removal efficiencies.



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
STA-1W	14.26	24.32	17.29	12.06	13.20	19.16	6.17	18.69	30.49	15.61	35.40
STA-2								17.95	20.73	23.78	72.76
STA-5							3.64	14.21	9.17	11.18	15.62
STA-6				12.50	18.47	37.87	22.92	33.26	25.82	36.40	45.89

Figure 4-43. Effective settling rates for STA-1W, STA-2, STA-5, and STA-6 for the period of record. In WY2005, STA-1W and STA-5 had short-term reduced effective treatment areas due to Long-Term Plan enhancements or vegetation rehabilitation.

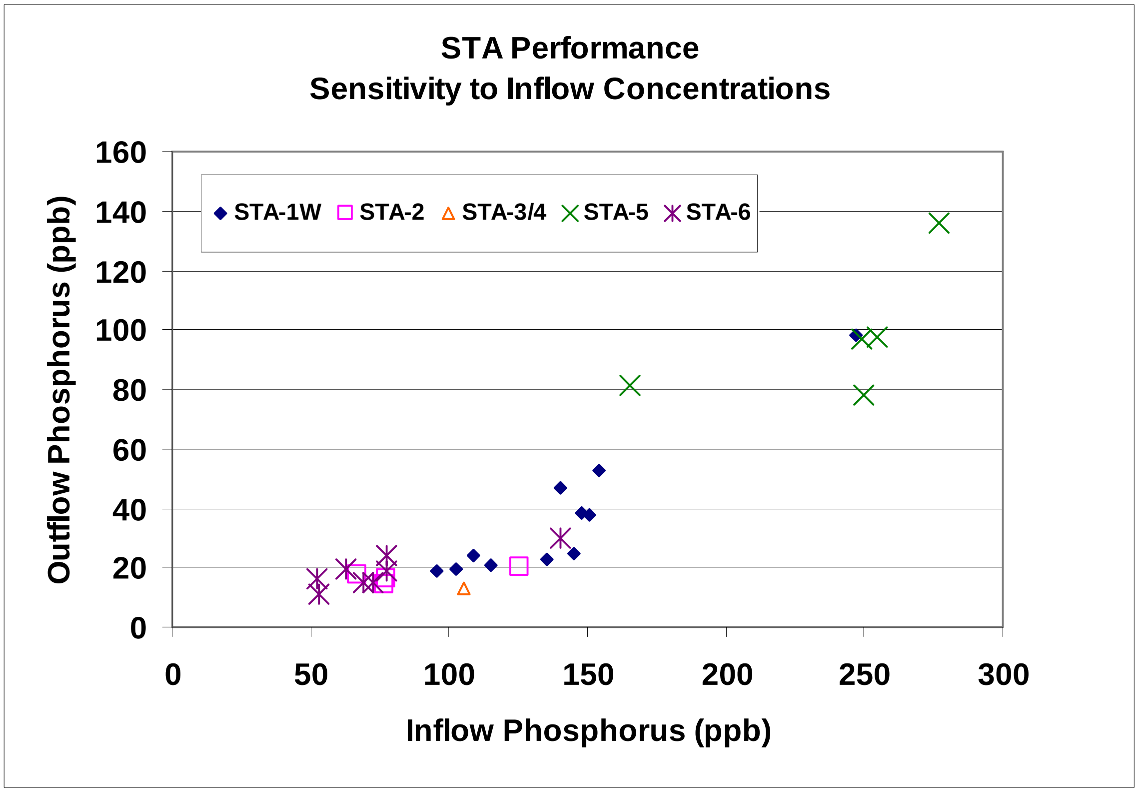


Figure 4-44. STA outflow TP concentration compared to STA inflow concentration. In WY2005, STA-1W and STA-5 had short-term reduced effective treatment areas due to Long-Term Plan enhancements or vegetation rehabilitation.

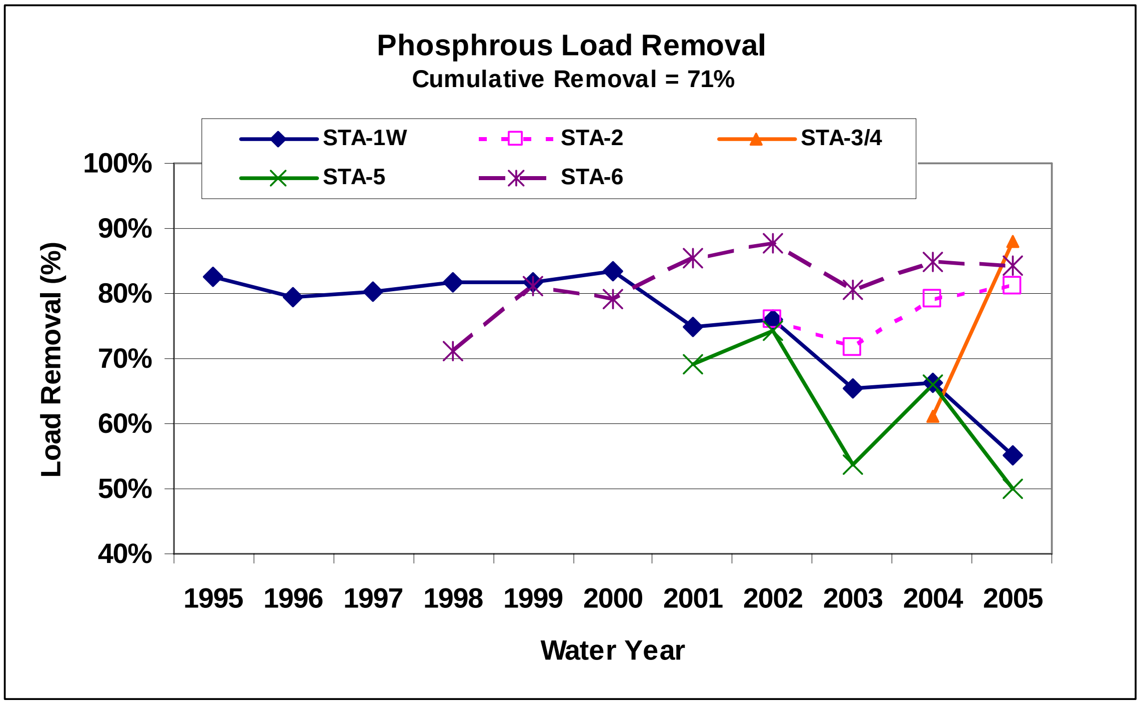


Figure 4-45. STA phosphorus load removal for the period of record. In WY2005, STA-1W and STA-5 had short-term reduced effective treatment areas due to Long-Term Plan enhancements or vegetation rehabilitation.

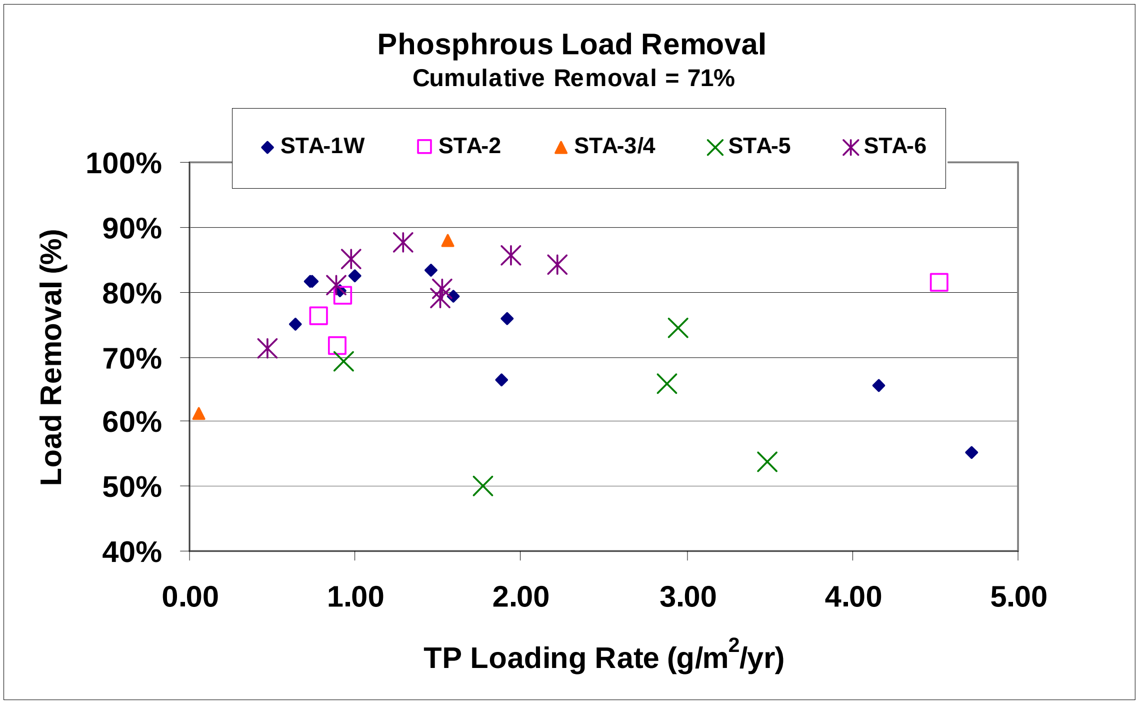


Figure 4-46. STA TP load removal compared to STA inflow loading rate. In WY2005, STA-1W and STA-5 had short-term reduced effective treatment areas due to Long-Term Plan enhancements or vegetation rehabilitation.

ANALYSIS AND INTERPRETATION [Bc82(4)]

One of the major objectives of the Process Development and Engineering (PD&E) 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. Project BC82(4) contributes to this goal by monitoring a number of water quality parameters at the inflow and outflow and developing water and TP budgets for individual STA treatment cells or flow-ways[1]. Project BC82(4) also is collecting and analyzing sediment cores from each STA to estimate the phosphorus stored in the accumulated detrital material (floc layer). It is our intent to incorporate the change in sediment phosphorus storage over time in the evaluation of STA treatment performance.

Annual water budgets and estimates of annual and seasonal water depths and HRT for treatment cells in the STAs are presented in **Tables 4-17** and **4-18** for STA-1W, STA-2, STA-5, and STA-6. STA-3/4 was not included in the analysis because it has only been operational for one year. Treatment cell/flow-way water budgets have been dominated by surface water inflow and outflow over the period of record (POR) in most STAs. The other water budget components usually contributed ≤ 10 percent of total flow. Exceptions to this generalization occurred in the south flow-way of STA-5 and STA-6, Cells 3 and 5, respectively, where seepage losses ranged from 26–40 percent of outflow. The magnitude of water budget errors, in general, has been variable from year to year for any given cell and most cells have a history of both positive and negative errors. Only Cells 2 and 3 of STA-1W had water budget errors that were either all positive or negative, which suggests a consistent measurement bias (i.e., errors were not randomly distributed) in these cells. The annual mean HRT for most flow-ways in the STAs was ≥ 10 days. An exception to this was Cell 3 in STA-6 and the east (Cells 1 and 3) and west (Cells 2 and 4) flow-ways in STA-1W in WY2005, which had shorter HRTs.

The following water quality parameters were monitored at the inflow and outflow of each treatment cell: TP, soluble reactive phosphorus (SRP), total dissolved reactive phosphorus (TDRP), total Kjeldahl nitrogen (TKN), ammonia (NH_4), nitrate + nitrite (NO_x), chloride (Cl), calcium (Ca), and alkalinity. TP was collected by either auto-samplers (weekly basis) or biweekly grab samples. All other parameters were collected as biweekly grab samples. Dissolved organic phosphorus (DOP) was calculated as DOP = TDRP – SRP; particulate phosphorus (PP) was calculated as PP = TP - TDRP; total nitrogen (TN) was calculated as TN = TKN + NO_x. WY2005 data for TP, SRP, DOP, PP TN, TKN, NO4, NOx, Cl, Ca, and alkalinity have been summarized graphically for all sampling location along the flow-ways within each STA. Annual treatment cell TP budgets have been computed for the POR in each STA.

The WY2005 water quality data were evaluated based on changes observed in mean and median concentrations along each flow-way (**Figures 4-47** through **4-50**). The STAs processed nutrients and other parameters at various levels of efficiency. For example, almost all flow-ways to varying degrees exhibited a concentration reduction in TP, SRP, PP, NO_4, and NO_x from inflow to outflow (note that concentration decreases were not apparent for NH_4 in STA-5 and for SRP in STA-6, Cell 3). Reductions in TN and TKN were not as consistent; there was little net change in STA-1W, Cell 5 (TN and TKN); STA-2, Cells 2 and 3 (TKN); STA-5 (TN and TKN); and STA-6, Cell 5 (TN and TKN). Only STA-6 exhibited a decrease in DOP. The G-308 and G-309 gates in STA-1W create hydraulic short circuits within Cells 3 and 4, respectively, which

[1] The District conducts the monitoring of flow and water quality at the inflow and outflow to all the STA treatment cells under Project BC05.

caused some concern that not all water entering Cells 3 and 4 was receiving full treatment. However, the TP, SRP, and PP concentrations at these water control structures were comparable to levels at the cell outflow structures located further downstream. It appears that releasing water through these gates had minimal impact on the overall treatment performance of Cells 3 and 4. A new water control structure (G-307) is being built to replace the original Cell 3 outflow structure and should aid in alleviating this short-circuit. These data suggest little change or modest increases on Cl levels after passage through most treatment cells. A pronounced decrease in Ca and alkalinity levels occurred in some treatment cells (e.g., STA-1W; west flow-way; STA-2, Cell 3; STA-5; and STA-6, Cell 5) but not others; reduction of these constituents was attributed to photosynthetic activity by periphyton and SAV. It is well documented that intense photosynthesis can remove all free CO_2 from the water column resulting in a rise in pH. Plants and algae then begin to assimilate bicarbonate from the water as an alternative carbon source. Wetzel (2001; pg 543) summarizes the cascade of chemical reactions that lead to the precipitation of $CaCO_3$ on leaf surfaces and the subsequent disappearance of Ca from the water column. SAV in the STAs was often found heavily encrusted with Ca deposits.

As noted above for the water budgets, the treatment cell/flow-way TP budgets were dominated by surface water inflow and outflow over the POR in most STAs (**Table 4-19**). The other TP budget components generally accounted for ≤ 10 percent of the phosphorus mass. Exceptions to this generalization occurred in STA-2, Cell 3, both flow-ways of STA-5 and STA-6, Cells 3 and 5, respectively where seepage losses made up 14–54 percent of total outflow phosphorus. Annual phosphorus mass loading to individual treatment cells has increased dramatically during the last several years in STA-1W, STA-2, and STA-5 compared to TP loading at the beginning of the POR for each wetland; changes in annual TP loading in STA-6 have been more varied. Based on the percent phosphorus mass retained over the POR, the treatment cells in STA-2 have been the most efficient systems (71–87 percent retained), STA-5 and STA-6 had intermediate performance (43–54 percent retained), and STA-1W exhibited mixed results (12–55 percent retained).

The accretion of phosphorus to the sediments constitutes the long-term storage mechanism in the STAs. The District collected and analyzed surficial sediment (0-10 cm cores) and the floc layer samples from STA-1W, 3/4, 2, 5, and 6 in 2003 or 2004 (see field and laboratory methods in Appendix 4B-1 of the 2004 Everglades Consolidated Report). Collection and evaluation of the historic sediments from STA-1E is ongoing with completion expected by next year's SFER. Maps of spatial variation in sediment and floc layer bulk density, and TP content in STA-1W, 2, 5, and 6 are provided in Appendix 4-14 of this volume. Surficial sediment chemistry varied markedly among the STAs (**Figure 4-51**). Differences in total nitrogen and carbon content were inversely related to sediment bulk density; sulfur content was inversely related to iron content. The chemical and physical composition of the sandy soils in STA-1E is clearly distinct from the highly organic soils of the other STAs. It has been estimated that 62–123 percent of the inflow TP mass retained to date by the STAs was stored within the floc layer (**Table 4-20**). The floc TP storage value greater then 100 percent reflects the uncertainty associated with trying to reconcile the TP budget with sediment storage. Sediment nutrient storage in wetlands can be difficult to estimate accurately, hence values of sediment storage that exceed inflow nutrients loads are not uncommon. These data represent baseline conditions in the STAs and will be compared against future sediment/floc layer data when evaluating phosphorus storage in these treatment systems.

Table 4-17. Annual water budgets for flow-ways and treatment cells in the STAs.[a]

	Inflows[b]				Outflows[b]						
	I_s	I_g	P	Σinflow	O_s	O_g	ET	Σoutflow	ΔS	r	ε
STA-1W, Cell 1											
WY2000	177.1	4.0	7.5	188.5	148.5	6.7	7.6	162.8	0.8	24.9	14.2%
WY2001	126.5	1.8	5.2	133.4	95.0	7.5	8.3	110.9	-2.3	24.8	20.3%
WY2002	159.4	2.8	7.8	169.9	154.5	6.3	7.8	168.6	0.9	0.4	0.2%
WY2003	305.2	-	6.2	311.4	316.6	-	7.5	324.1	-	-12.7	-4.0%
WY2004	193.8	3.0	5.0	201.8	230.6	4.6	7.5	242.8	-3.2	-37.8	-17.0%
WY2005	205.0	2.3	6.2	213.5	280.7	2.6	7.5	290.8	-0.1	-77.3	-30.6%
TOTAL	1,167.0	13.8	37.9	1,218.6	1,226.0	27.7	46.3	1,300.0	-3.8	-77.6	-6.2%
% inflow	95.8%	1.1%	3.1%	*% outflow*	94.3%	2.1%	3.6%				
STA-1W, Cell 2											
WY2000	73.0	-	5.5	78.5	70.9	23.8	5.4	100.1	0.6	-22.2	-24.9%
WY2001	38.7	-	3.7	42.4	47.4	20.5	5.9	73.8	-1.8	-29.6	-50.9%
WY2002	66.7	-	5.5	72.2	61.7	17.1	5.6	84.3	0.8	-12.9	-16.5%
WY2003	146.7	-	4.5	151.2	152.1	-	5.4	157.4	-	-6.3	-4.1%
WY2004	109.1	-	3.6	112.7	165.5	12.4	5.4	183.2	-2.5	-68.1	-46.0%
WY2005	101.9	-	4.4	106.3	106.7	-	5.3	112.0	-	-5.7	-5.3%
TOTAL	536.2	-	27.1	563.3	604.3	73.7	33.0	710.9	-2.9	-144.8	-22.7%
% inflow	95.2%	-	4.8%	*% outflow*	85.0%	10.4%	4.6%				
STA-1W, Cell 3											
WY2000	89.9	5.2	5.4	100.4	77.6	8.0	5.4	91.0	0.5	8.9	9.3%
WY2001	92.2	2.3	3.6	97.1	80.3	7.6	5.8	93.7	-1.0	4.4	4.6%
WY2002	143.5	3.6	5.4	152.5	121.6	6.4	5.5	133.4	0.5	18.6	13.0%
WY2003	256.9	-	4.4	261.2	198.8	-	5.2	204.0	-	57.2	24.6%
WY2004	121.5	3.3	3.5	128.3	66.5	4.4	5.2	76.2	-1.1	53.2	52.0%
WY2005	178.9	2.5	4.3	185.6	164.2	2.3	5.2	171.6	0.1	13.9	7.8%
TOTAL	881.8	16.8	26.5	925.1	709.0	28.7	32.3	770.0	-1.0	156.2	18.4%
% inflow	95.3%	1.8%	2.9%	*% outflow*	92.1%	3.7%	4.2%				
STA-1W, Cell 4											
WY2000	70.9	-	1.9	72.8	71.9	8.9	1.9	82.8	0.1	-10.1	-13.0%
WY2001	47.4	-	1.3	48.7	38.8	7.7	2.1	48.5	-0.5	0.7	1.5%
WY2002	61.7	-	2.0	63.7	80.7	6.4	2.0	89.1	0.3	-25.7	-33.6%
WY2003	152.1	-	1.6	153.7	194.6	-	1.9	196.5	-	-42.9	-24.5%
WY2004	165.5	-	1.3	166.7	108.6	4.6	1.9	115.1	-0.8	52.4	37.2%
WY2005	106.7	-	1.6	108.2	75.7	-	1.9	77.6	-	30.6	33.0%
TOTAL	604.3	-	9.6	613.9	570.4	27.6	11.7	609.6	-0.9	5.1	0.8%
% inflow	98.4%	-	1.6%	*% outflow*	93.6%	4.5%	1.9%				

Table 4-17. Continued.

	Inflows				Outflows						
	I_s	I_g	P	Σinflow	O_s	O_g	ET	Σoutflow	ΔS	r	ε
STA-1W, Cell 5											
WY2000											
WY2001	217.8	-	10.3	228.1	15.4	-	16.4	31.9	-	196.2	150.9%
WY2002	641.5	-	15.4	656.9	252.7	-	15.5	268.2	-	388.8	84.1%
WY2003	402.8	-	12.4	415.2	555.2	-	15.0	570.2	-	-154.9	-31.4%
WY2004	124.7	2.0	10.6	137.3	139.1	4.3	16.0	159.4	4.7	-26.8	-18.1%
WY2005	145.9	-	13.1	159.0	154.0	-	15.8	169.8	-8.4	-2.4	-1.5%
TOTAL	1,532.6	-	61.8	1,596.5	1,116.4	-	78.7	1,199.4	-	397.1	28.4%
% inflow	96.0%		3.9%	*% outflow*	93.1%		6.6%				
STA-2, Cell 1											
WY2002	54.1	0.0	12.1	66.3	19.6	0.0	10.8	30.4	0.1	35.7	73.9%
WY2003	57.2	0.0	10.3	67.5	36.9	0.0	10.5	47.3	4.6	15.6	27.1%
WY2004	78.0	0.0	9.4	87.4	61.3	0.0	10.5	71.8	-0.2	15.8	19.8%
WY2005	67.8	0.0	8.9	76.8	70.6	0.0	10.4	81.0	0.1	-4.3	-5.4%
TOTAL	257.2	0.0	40.8	297.9	188.5	0.0	42.1	230.6	4.6	62.8	23.8%
% inflow	86.3%	0.0%	13.7%	*% outflow*	81.8%	0.0%	18.2%				
STA-2, Cell 2											
WY2002	77.0	1.6	13.5	92.2	110.2	0.2	12.0	122.4	0.3	-30.6	-28.5%
WY2003	149.3	2.0	11.5	162.8	123.8	0.1	11.7	135.5	0.3	26.9	18.1%
WY2004	111.6	2.0	10.4	124.0	110.8	0.1	11.7	122.6	-0.1	1.5	1.2%
WY2005	172.3	3.6	10.0	185.9	162.8	<0.1	11.6	174.4	-0.2	11.7	6.5%
TOTAL	510.2	9.2	45.5	564.9	507.6	0.4	46.9	554.9	0.3	9.6	1.7%
% inflow	90.3%	1.6%	8.0%	*% outflow*	91.5%	0.1%	8.5%				
STA-2, Cell 3											
WY2002	130.8	0.0	13.5	144.3	109.3	28.9	12.0	150.2	0.3	-6.2	-4.2%
WY2003	178.7	0.0	11.5	190.2	144.7	19.5	11.7	175.8	0.3	14.1	7.7%
WY2004	137.8	0.0	10.4	148.3	129.3	17.1	11.7	158.1	-0.5	-9.3	-6.1%
WY2005	173.2	0.0	10.0	183.1	155.9	12.9	11.6	180.4	<0.1	2.8	1.5%
TOTAL	620.5	0.0	45.5	665.9	539.2	78.4	46.9	664.5	0.1	1.4	0.2%
% inflow	93.2%	0.0%	6.8%	*% outflow*	81.1%	11.8%	7.1%				
STA-5, North Flow-way											
WY2001	43.3	0.0	8.1	51.4	25.4	11.9	11.9	49.2	-2.4	4.7	9.3%
WY2002	121.0	0.0	7.5	128.5	103.3	13.1	11.2	127.6	2.7	-1.8	-1.4%
WY2003	127.6	0.0	10.1	137.7	124.5	11.9	10.8	147.2	<0.1	-9.4	-6.6%
WY2004	135.7	0.0	9.6	145.3	121.7	12.8	10.8	145.3	1.3	-1.3	-0.9%
WY2005	114.6	1.1	8.0	123.7	90.2	5.7	10.7	106.6	-3.7	20.9	18.1%
TOTAL	542.1	1.1	43.4	586.6	465.1	55.4	55.4	575.8	-2.2	13.0	2.2%
% inflow	92.4%	0.2%	7.4%	*% outflow*	80.8%	9.6%	9.6%				

Table 4-17. Continued.

	Inflows				Outflows						
	I_s	I_g	P	Σinflow	O_s	O_g	ET	Σoutflow	ΔS	r	ε
STA-5, South Flow-way											
WY2001	57.4	0.1	8.1	65.6	23.9	36.4	11.9	72.2	-1.5	-5.0	-7.3%
WY2002	114.7	<0.1	7.5	122.2	52.3	38.1	11.2	101.6	3.6	17.1	15.3%
WY2003	119.6	0.0	10.1	129.7	73.5	44.9	10.8	129.2	-0.4	0.8	0.7%
WY2004	89.2	0.0	9.6	98.9	46.7	43.6	10.8	101.1	1.8	-4.1	-4.1%
WY2005	68.1	0.0	8.0	76.1	59.6	45.4	10.7	115.7	-1.5	-38.1	-39.7%
TOTAL	449.0	0.2	43.4	492.5	256.0	208.4	55.4	519.8	2.0	-29.3	-5.8%
% inflow	91.2%	0.0%	8.8%	*% outflow*	49.2%	40.1%	10.7%				
STA-6, Cell 3											
WY1999	18.5	0.4	1.2	20.1	11.2	6.7	1.5	19.4	<0.1	0.7	3.6%
WY2000	28.1	0.3	1.4	29.8	29.2	6.9	1.2	37.4	0.9	-8.4	-25.0%
WY2001	17.4	0.4	1.3	19.2	11.4	8.2	1.4	21.0	0.3	-2.2	-10.8%
WY2002	24.5	0.2	1.2	25.9	13.4	5.8	1.3	20.5	<0.1	5.4	23.1%
WY2003	30.9	0.6	1.2	32.7	17.7	4.0	1.3	23.1	0.8	8.8	31.6%
WY2004	24.1	0.1	1.2	25.4	20.8	5.8	1.3	27.9	-0.4	-2.0	-7.6%
WY2005	23.0	0.6	1.3	24.8	13.1	7.6	1.3	21.9	0.4	2.6	11.0%
TOTAL	166.5	2.7	8.7	178.0	116.8	44.9	9.4	171.1	2.0	4.9	2.8%
% inflow	93.6%	1.5%	4.9%	*% outflow*	68.3%	26.3%	5.5%				
STA-6, Cell 5											
WY1999	30.9	0.0	2.9	33.9	7.3	12.6	3.9	23.8	0.2	9.8	34.1%
WY2000	45.3	0.0	3.6	48.9	18.4	14.5	3.1	36.0	1.5	11.4	27.0%
WY2001	31.0	0.1	3.4	34.5	17.8	10.0	3.6	31.4	1.0	2.1	6.4%
WY2002	41.1	0.0	3.0	44.2	21.1	13.2	3.4	37.6	<0.1	6.5	15.9%
WY2003	34.7	<0.1	3.0	37.7	22.6	13.2	3.3	39.1	1.1	-2.5	-6.4%
WY2004	24.0	<0.1	3.2	27.2	23.1	12.2	3.3	38.5	-0.8	-10.5	-31.9%
WY2005	19.7	<0.1	3.2	23.1	14.3	4.7	3.3	22.3	0.2	0.6	2.8%
TOTAL	227.0	0.2	22.2	249.4	124.6	80.3	23.9	228.8	3.0	17.6	7.3%
% inflow	91.0%	0.1%	8.9%	*% outflow*	54.5%	35.1%	10.4%				

[a] All water budget terms expressed as hm^3 (= 1,000,000 m^3); 1 hm^3 = 810.713 acre-ft; data provided by W. Abtew and S. Huebner, SFWMD.

[b] I_s = surface water inflow; I_g = groundwater inflow; P = precipitation; O_s = surface water outflow; O_g = groundwater outflow; ET = evapotranspiration; ΔS = change in storage volume; r = water budget residual [= Σinflow –(Σoutflow +ΔS)]; ε = water budget error [= r/(Σinflow+Σoutflow)/2].

Table 4-18. Annual and seasonal mean depths and HRT for treatment cells in the STAs.[a]

	Annual		Wet Season		Dry season	
	Depth	HRT	Depth	HRT	Depth	HRT
	(m)	(d)	(m)	(d)	(m)	(d)
STA-1W, Cell 1						
WY2005	0.61	5.1	0.71	3.7	0.54	8.0
STA-1W, Cell 2						
WY2005	0.15	2.1	0.55	3.9	-0.14	NA
STA-1W, Cell 3						
WY2005	0.27	2.3	0.16	0.9	0.36	4.6
STA-1W, Cell 4						
WY2005	0.27	1.6	0.43	1.3	0.16	3.1
STA-1W, Cell 5						
WY2005	0.35	21.7	0.52	16.3	0.23	45.4
STA-2, Cell 1						
WY2002	-0.31	NA	0.03	0.8	-0.56	NA
WY2003	0.08	4.2	-0.05	NA	0.17	7.6
WY2004	0.41	15.1	0.46	10.3	0.37	25.8
WY2005	0.40	14.9	0.45	10.0	0.36	26.9
STA-2, Cell 2						
WY2002	0.46	31.0	0.54	18.2	0.40	99.1
WY2003	0.52	29.9	0.50	37.5	0.54	26.4
WY2004	0.57	23.3	0.57	14.2	0.56	44.0
WY2005	0.49	20.3	0.58	14.2	0.42	35.0
STA-2, Cell 3						
WY2002	0.63	19.6	0.65	12.2	0.62	36.8
WY2003	0.73	16.2	0.72	10.8	0.73	25.0
WY2004	0.66	17.9	0.64	9.9	0.67	40.9
WY2005	0.51	9.5	0.65	6.5	0.41	20.1
STA-5, Cell 1A (North Flow-way)						
WY2001	0.37	9.1	0.51	7.2	0.27	14.1
WY2002	0.53	5.2	0.68	3.7	0.43	9.8
WY2003	0.65	5.7	0.74	3.8	0.59	10.1
WY2004	0.65	5.6	0.82	3.6	0.53	13.4
WY2005	0.60	6.5	0.70	4.0	0.52	17.3
STA-5, Cell 1B (North Flow-way)						
WY2001	0.51	18.1	0.65	13.4	0.40	30.9
WY2002	0.54	7.7	0.49	3.8	0.58	19.4
WY2003	0.53	6.7	0.51	3.8	0.54	13.5
WY2004	0.59	7.4	0.60	3.9	0.59	21.4
WY2005	0.38	6.0	0.62	5.1	0.21	10.0

Table 4-18. Continued.

	Annual		Wet Season		Dry season	
	Depth (m)	HRT (d)	Depth (m)	HRT (d)	Depth (m)	HRT (d)
STA-5, Cell 2A (South Flow-way)						
WY2001	0.45	8.2	0.59	6.2	0.36	13.4
WY2002	0.61	6.7	0.70	4.7	0.54	11.4
WY2003	0.72	6.9	0.79	4.7	0.67	11.3
WY2004	0.70	8.8	0.82	5.6	0.62	18.5
WY2005	0.71	9.1	0.77	6.9	0.66	12.6
STA-5, Cell 2B (South Flow-way)						
WY2001	0.32	8.3	0.54	8.2	0.16	8.7
WY2002	0.34	5.5	0.39	3.8	0.30	9.3
WY2003	0.44	6.1	0.46	4.0	0.42	10.2
WY2004	0.46	8.3	0.56	5.6	0.38	16.5
WY2005	0.44	8.3	0.52	6.8	0.38	10.7
STA-6, Cell 3						
WY1999	0.25	4.8	0.31	4.2	0.21	5.5
WY2000	0.38	4.2	0.64	3.8	0.20	5.6
WY2001	0.34	6.2	0.45	5.1	0.25	8.5
WY2002	0.47	7.3	0.61	6.9	0.36	8.0
WY2003	0.47	6.2	0.56	5.6	0.40	7.0
WY2004	0.58	7.9	0.72	6.1	0.48	11.7
WY2005	0.48	7.7	0.58	6.4	0.41	9.7
STA-6, Cell 5						
WY1999	0.26	12.5	0.32	7.9	0.22	9.0
WY2000	0.38	10.6	0.65	7.6	0.19	10.7
WY2001	0.30	13.9	0.46	7.3	0.18	11.1
WY2002	0.48	19.4	0.60	9.7	0.40	12.7
WY2003	0.52	17.4	0.59	10.4	0.46	14.9
WY2004	0.55	19.3	0.71	12.4	0.44	22.4
WY2005	0.49	19.8	0.58	14.3	0.42	32.7

[a] Data provided by W. Abtew and S. Huebner, SFWMD.

Table 4-19. Annual TP budgets for flow-ways and treatment cells in the STAs.[a]

	Inflows			Outflows				
	I_s	P	Σinflow	O_s	O_g	Σoutflow	Retained	% Ret
STA-1W, Cell 1								
WY2000	23,814	53	23,867	10,942	1,025	11,967	11,900	49.9%
WY2001	13,441	27	13,468	6,281	597	6,878	6,590	48.9%
WY2002	16,533	43	16,576	9,489	436	9,925	6,651	40.1%
WY2003	47,352	75	47,427	31,970	-	31,970	15,457	32.6%
WY2004	23,409	60	23,469	22,459	549	23,008	461	2.0%
WY2005	43,995	74	44,069	64,154	585	64,739	-20,669	-46.9%
TOTAL	168,544	332	168,876	145,294	3,192	148,486	20,390	12.1%
% inflow	99.8%	0.2%	*% outflow*	97.9%	2.1%			
STA-1W, Cell 2								
WY2000	9,842	39	9,881	5,335	1,970	7,305	2,576	26.1%
WY2001	4,334	19	4,353	3,678	1,527	5,205	-852	-19.6%
WY2002	6,316	30	6,346	3,602	1,155	4,757	1,589	25.0%
WY2003	23,266	53	23,319	20,733	-	20,733	2,586	11.1%
WY2004	10,606	43	10,649	18,940	1,730	20,670	-10,021	-94.1%
WY2005	30,353	53	30,406	14,569	-	14,569	15,837	52.1%
TOTAL	84,717	237	84,954	66,856	6,382	73,238	11,715	13.8%
% inflow	99.7%	0.3%	*% outflow*	91.3%	8.7%			
STA-1W, Cell 3								
WY2000	1,730	39	1,769	1,477	158	1,635	134	7.6%
WY2001	2,735	19	2,754	2,141	673	2,814	-60	-2.2%
WY2002	4,272	30	4,302	3,206	278	3,484	818	19.0%
WY2003	12,928	52	12,980	8,222	-	8,222	4,758	36.7%
WY2004	14,140	42	14,182	6,330	291	6,621	7,561	53.3%
WY2005	36,258	52	36,310	17,871	334	18,205	18,105	49.9%
TOTAL	72,063	234	72,296	39,246	1,735	40,981	31,316	43.3%
% inflow	99.7%	0.3%	*% outflow*	95.8%	4.2%			
STA-1W, Cell 4								
WY2000	5,335	14	5,349	1,916	290	2,206	3,143	58.8%
WY2001	3,678	7	3,685	1,028	297	1,325	2,360	64.0%
WY2002	3,366	11	3,377	2,190	262	2,452	925	27.4%
WY2003	17,603	19	17,622	13,353	-	13,353	4,269	24.2%
WY2004	17,012	15	17,027	9,353	443	9,796	7,231	42.5%
WY2005	13,294	19	13,313	12,968	-	12,968	345	2.6%
TOTAL	60,288	85	60,372	40,807	1,292	42,099	18,273	30.3%
% inflow	99.9%	0.1%	*% outflow*	96.9%	3.1%			

Table 4-19. Continued.

	Inflows			Outflows				
	I_s	P	Σinflow	O_s	O_g	Σoutflow	Retained	% Ret
STA-1W, Cell 5								
WY2001	24,595	123	24,719	2,019	-	2,019	22,699	91.8%
WY2002	87,684	185	87,869	23,397	-	23,397	64,472	73.4%
WY2003	62,823	149	62,972	44,176	-	44,176	18,796	29.8%
WY2004	14,182	128	14,310	6,587	339	6,926	7,384	51.6%
WY2005	38,484	157	38,641	25,565	-	25,565	13,076	33.8%
TOTAL	227,769	742	228,511	101,744	339	102,083	126,428	55.3%
% inflow	99.7%	0.3%	*% outflow*	99.7%	0.3%			
STA-2, Cell 1								
WY2002	1,698	146	1,844	425	0	425	1,419	77.0%
WY2003	2,985	124	3,109	522	0	522	2,587	83.2%
WY2004	6,794	112	6,907	831	0	831	6,076	88.0%
WY2005	6,699	107	6,806	708	0	708	6,098	89.6%
TOTAL	18,177	489	18,666	2,486	0	2,486	16,181	86.7%
% inflow	97.4%	2.6%	*% outflow*	100.0%	0.0%			
STA-2, Cell 2								
WY2002	2,052	163	2,214	1,742	4	1,745	469	21.2%
WY2003	10,334	138	10,472	2,494	3	2,497	7,976	76.2%
WY2004	10,279	125	10,404	1,750	4	1,755	8,650	83.1%
WY2005	19,485	120	19,604	6,396	1	6,397	13,207	67.4%
TOTAL	42,149	546	42,695	12,382	12	12,394	30,301	71.0%
% inflow	98.7%	1.3%	*% outflow*	99.9%	0.1%			
STA-2, Cell 3								
WY2002	3,327	163	3,490	1,819	580	2,398	1,091	31.3%
WY2003	9,527	138	9,665	2,279	562	2,841	6,825	70.6%
WY2004	11,368	125	11,493	1,743	562	2,305	9,188	79.9%
WY2005	18,874	120	18,993	2,754	552	3,306	15,687	82.6%
TOTAL	43,096	546	43,642	8,595	2,255	10,850	32,791	75.1%
% inflow	98.7%	1.3%	*% outflow*	79.2%	20.8%			
STA-5, North Flow-way								
WY2001	5,608	98	5,705	3,610	1,618	5,228	477	8.4%
WY2002	23,748	90	23,838	8,715	1,683	10,397	13,441	56.4%
WY2003	23,431	121	23,552	17,965	1,928	19,892	3,660	15.5%
WY2004	21,015	116	21,131	8,406	1,326	9,733	11,398	53.9%
WY2005	15,037	96	15,133	5,638	516	6,154	8,979	59.3%
TOTAL	88,839	520	89,359	44,333	7,071	51,404	37,955	42.5%
% inflow	99.4%	0.6%	*% outflow*	86.2%	13.8%			

Table 4-19. Continued.

	Inflows			Outflows				
	I_s	P	Σinflow	O_s	O_g	Σoutflow	Retained	% Ret
STA-5, South Flow-way								
WY2001	10,883	98	10,981	1,289	3,659	4,948	6,033	54.9%
WY2002	26,165	90	26,255	4,327	4,958	9,285	16,970	64.6%
WY2003	35,291	121	35,412	8,486	8,296	16,783	18,629	52.6%
WY2004	28,556	116	28,671	8,000	10,218	18,219	10,453	36.5%
WY2005	10,951	96	11,047	6,558	6,023	12,581	-1,535	-13.9%
TOTAL	111,845	520	112,366	28,661	33,155	61,816	50,550	45.0%
% inflow	99.5%	0.5%	*% outflow*	46.4%	53.6%			
STA-6, Cell 3								
WY2000	1,461	17	1,478	114	136	250	1,228	83.1%
WY2001	616	16	632	512	312	824	-192	-30.4%
WY2002	861	14	876	285	153	438	438	50.0%
WY2003	974	14	988	496	116	612	376	38.1%
WY2004	802	15	817	275	117	392	425	52.0%
WY2005	1,768	15	1,783	239	284	523	1,260	70.7%
TOTAL	6,482	91	6,573	1,921	1,116	3,038	3,535	53.8%
% inflow	98.6%	1.4%	*% outflow*	63.3%	36.7%			
STA-6, Cell 5								
WY2000	2,247	43	2,290	120	299	419	1,870	81.7%
WY2001	907	40	948	477	410	887	61	6.4%
WY2002	1,243	36	1,280	330	216	546	734	57.4%
WY2003	1,108	36	1,144	644	362	1,007	138	12.0%
WY2004	898	38	936	284	249	533	403	43.0%
WY2005	1,422	38	1,460	276	174	450	1,010	69.2%
TOTAL	7,826	232	8,058	2,132	1,710	3,842	4,216	52.3%
% inflow	97.1%	2.9%	*% outflow*	55.5%	44.5%			

[a] All phosphorus budget terms expressed as kg TP; data provided by W. Abtew and S. Huebner, SFWMD .

[b] I_s = surface water inflow; P = precipitation; O_s = surface water outflow; O_g = groundwater outflow; Retained = Σinflow – Σoutflow; %Ret = (Retained/Σinflow)*100.

Table 4-20. Summary statistics for STA floc TP content, depth, and bulk density, and estimates of inflow TP mass retained in the floc layer during the period of operation for each STA.

STA	Beginning water year	Inflow TP retained by STA (kg)[a]	TP in floc (kg)	Inflow TP stored in floc (%)	Floc TP (mg/kg)			Floc depth (cm)		Floc bulk density (g/cm^3)	
					N	Mean	SE	Mean	SE	Mean	SE
STA-1W	WY1995[b] WY2003[c]	240,000	162,340	68%	91	721	30	18.6	0.8	0.083	<0.01
STA-2	WY2002	51,000	62,924	123%	74	812	35	5.0	0.2	0.079	0.01
STA-3/4	WY2004	900	-	-	-	-	-	-	-	-	-
STA-5	WY2001	110,000	68,610	62%	110	873	41	8.8	0.4	0.074	0.01
STA-6	WY1998	25,000	15,570	62%	33	1072	103	8.3	0.5	0.048	0.01

[a] TP retained from beginning water year through WY2004, as reported in Chapter 4 of the 2005 SFER – Volume I.

[b] Cells 1– 4

[c] Cell 5B only; Cell 5A not sampled for floc.

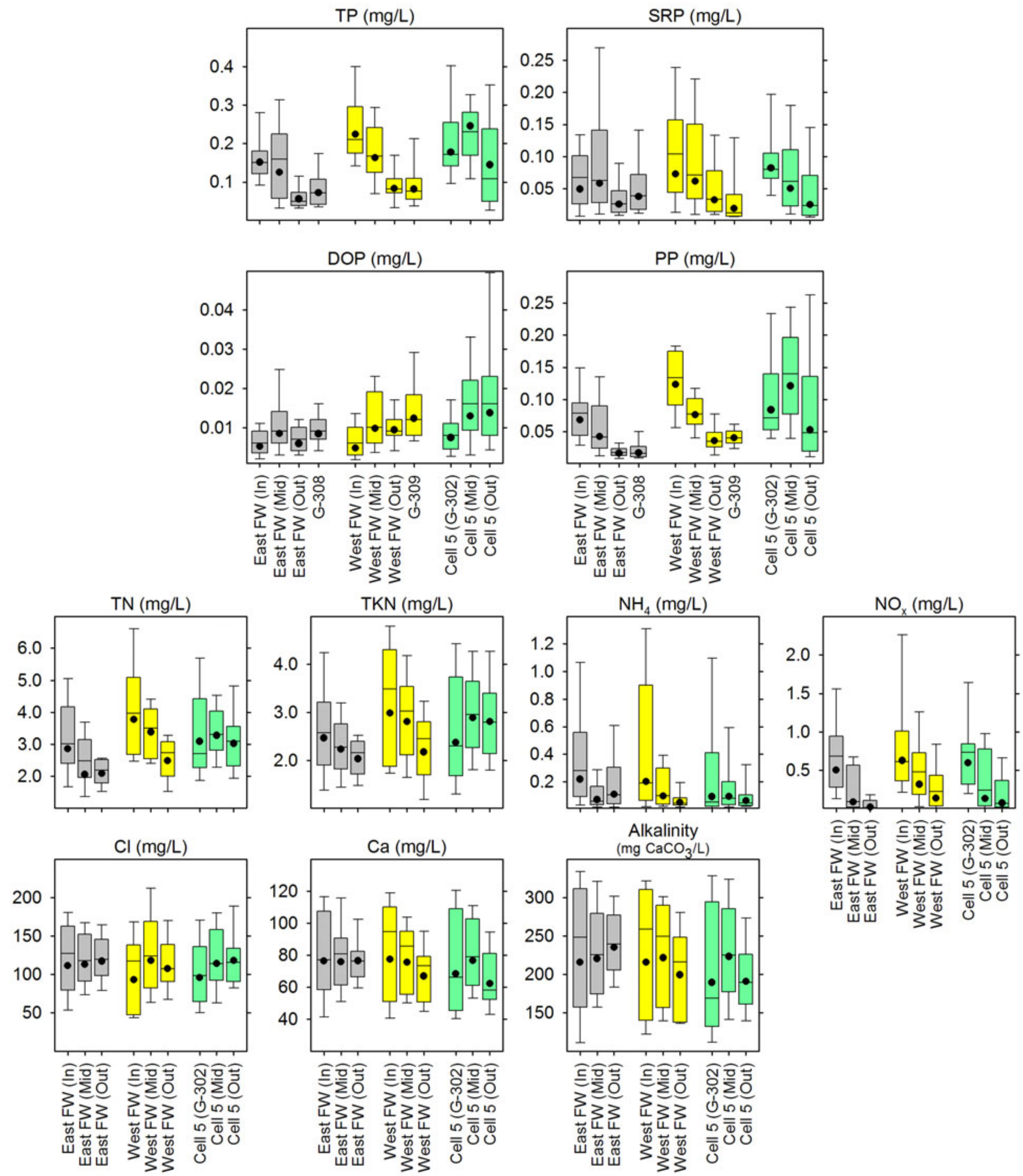


Figure 4-47. Summary of water quality parameters monitored at inflow, mid and outflow locations in the east flow-way, west flow-way, and STA-1W, Cell 5, during WY2005. Phosphorus concentrations in outflow through G-308 and G-309 also are depicted. TP = total phosphorus; SRP = soluble reactive phosphorus; DOP = dissolved organic phosphorus; TN = total nitrogen; TKN = total Kjeldahl nitrogen; NH_4 = ammonia-nitrogen; NO_x = nitrite+nitrate-nitrogen; Cl = chloride; Ca = calcium. Top and bottom of box represent interquartile range; line within each box is the median; top and bottom of whiskers represent 90th and 10th percentiles, respectively; solid circles are geometric means.

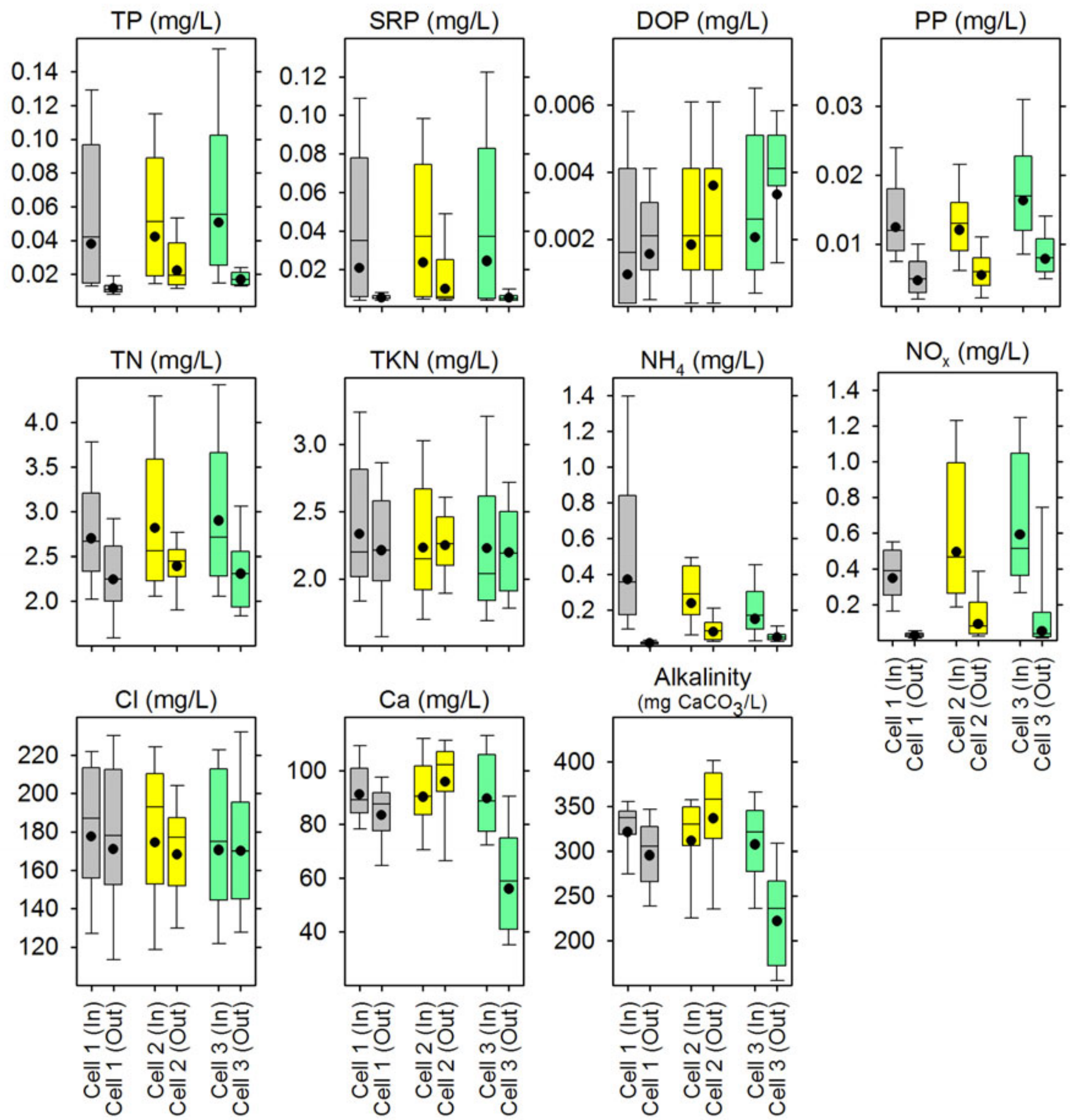


Figure 4-48. Summary of water quality parameters monitored at inflow and outflow locations in Cells 1, 2 and 3 of STA-2 during WY2005.

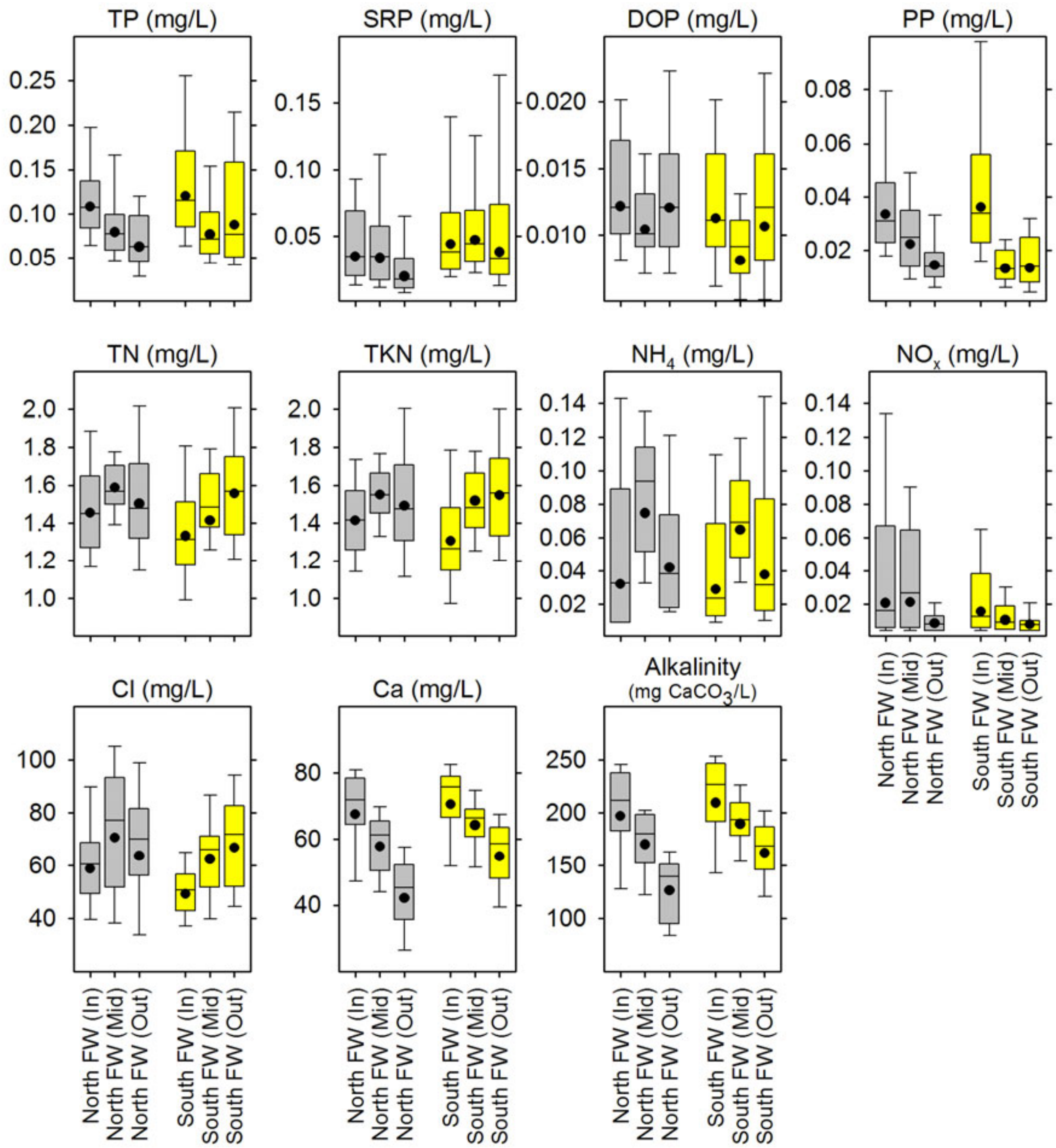


Figure 4-49. Summary of water quality parameters monitored at inflow, mid, and outflow locations in the north and south flow-ways of STA-5 during WY2005.

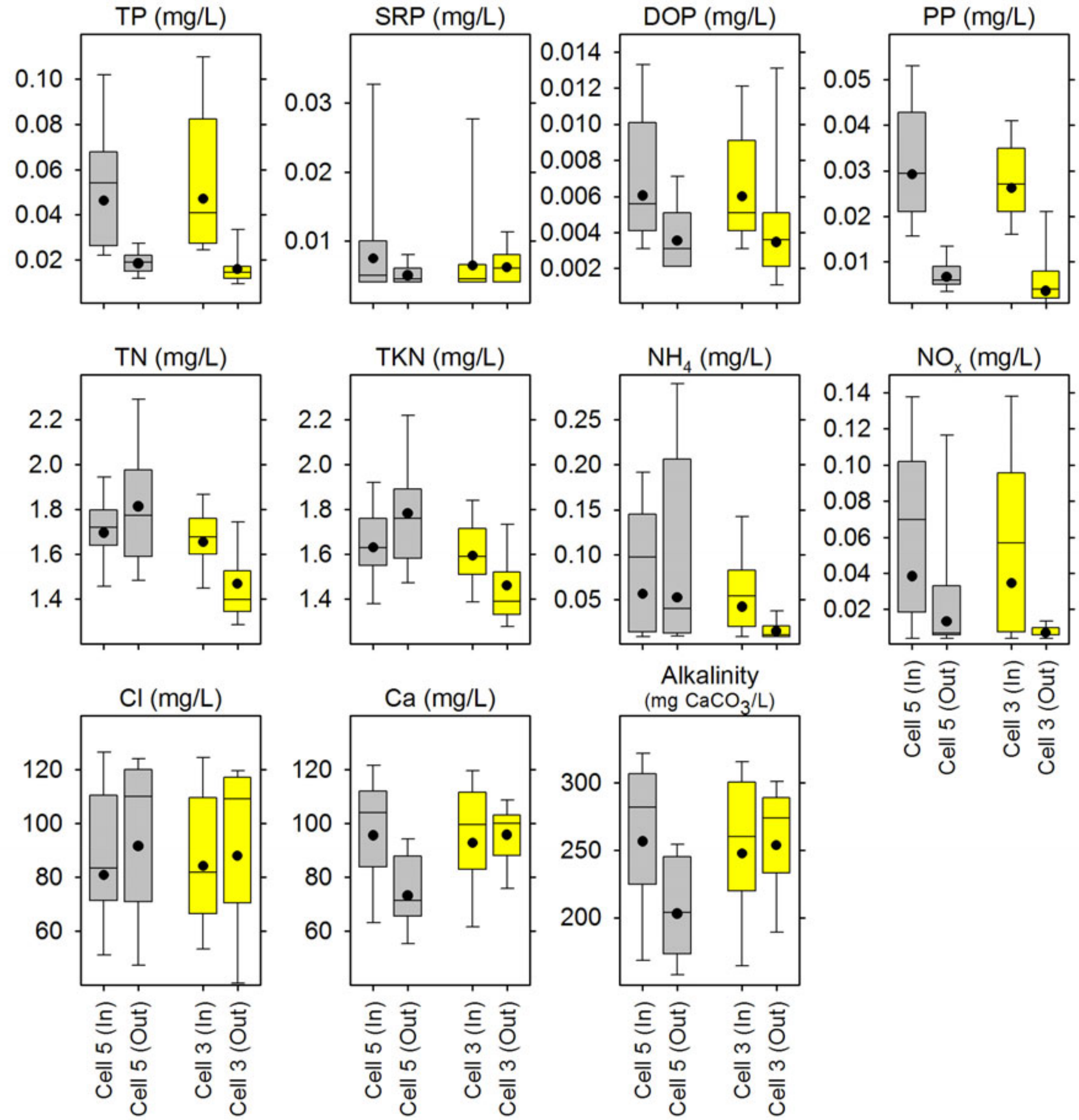


Figure 4-50. Summary of water quality parameters monitored at inflow and outflow locations in STA-6, Cells 3 and 5, during WY2005.

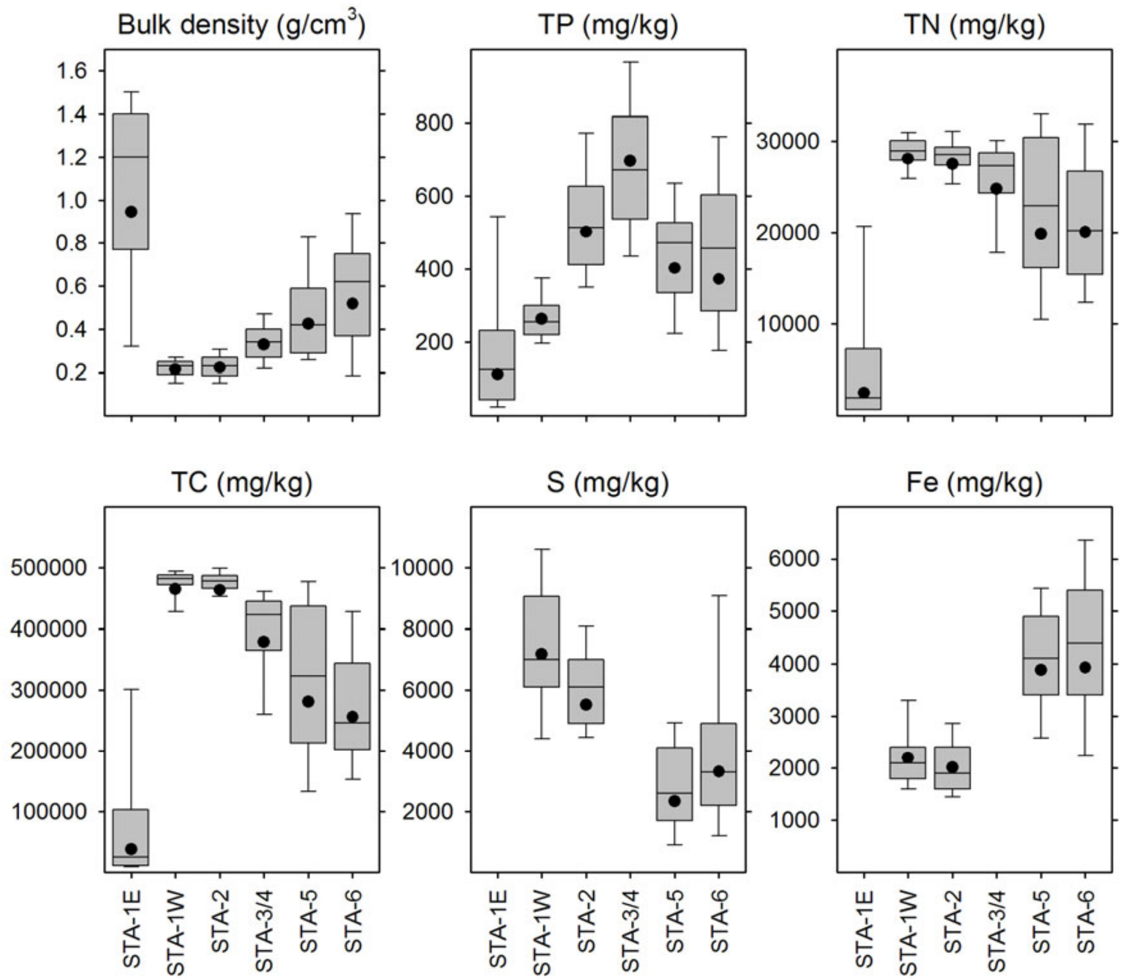


Figure 4-51. Summary of surficial sediment chemistry in the STAs based on analysis of 0-10 cm cores collected in 2003. TP= total phosphorus; TN = total nitrogen; TC = total carbon; S = sulfur; Fe = iron.

PSTA INVESTIGATIONS [BC83(3)]

A Periphyton-Based Stormwater Treatment Area (PSTA) is generally defined as a constructed wetland with a sparse emergent macrophyte community that provides structure to support a dominant periphyton assemblage. PSTA wetlands were studied extensively as part of the District's Advanced Treatment Technology (ATT) Program and are currently envisioned to be a post-STA technology that is operated at inflow TP concentrations of 50 µg/L (or ppb) or less. The primary nutrient removal mechanisms in a PSTA wetland are direct phosphorus uptake by the periphyton and algal-mediated co-precipitation of phosphorus with calcium carbonate. The objective of the PSTA Investigations Project [BC83(3)] is to track the performance of the District's ongoing PSTA research projects. During WY2005, the District operated one PSTA research site: the STA-1W south PSTA test cells. The PSTA field-scale test facility discussed in previous reports was decommissioned in October 2004. Construction of the full-scale implementation PSTA project in Cell 2B of STA-3/4 [Project BC83(4)] continued during WY2005. The status of projects BC83(3) and BC83(4) is discussed below.

STA-1W South PSTA Test Cells

The EFA required the District to optimize the treatment performance of the STAs. To comply with this mandate, the District initiated research projects in the STA-1W test cells to evaluate the efficacy of several different treatment technologies, one of which was PSTA. The STA-1W test cells are 30 0.2-hectare (0.5-acre) constructed wetlands designed to be hydrologically isolated from each other. One set of 15 test cells is located in STA-1W, Cell 1 (north test cells), and the other is in STA-1W, Cell 3 (south test cells). The test cells and the ATT research projects conducted in these cells are described in Chimney et al. (2000). All work associated with the ATT Program was concluded in January 2002. Results from the ATT projects have been summarized in previous Everglades Consolidated Reports and in final project reports that can be found on the District's web site at www.sfwmd.gov/org/erd/ecp/etweb/main_template/report.html.

The District continued monitoring the three south PSTA test cells on a reduced basis after the ATT Program ended to document long-term trends in TP removal in these systems. Two of the south PSTA cells were constructed with 30 cm of shellrock placed over 30 cm of peat (shellrock cells), while the remaining cell only had a peat substrate (peat cell). This section provides an overview of TP removal in the south PSTA test cells for the period from May 1, 2002 through April 30, 2005, which is referred to as the period of extended monitoring.

The south PSTA test cells were operated at a constant hydraulic loading rate of 2.6 cm/d throughout the period of extended monitoring. Water depth averaged 30 cm in all cells in WY2003 (Year 1), 60 cm in WY2004 (Year 2), and 30 cm in WY2005 (Year 3). Grab samples were collected biweekly at the common inflow to the south test cells and at the outflow from each individual PSTA test cell and analyzed for TP. It was apparent that the shellrock cells had substantially better treatment performance than the peat cell; sampling of the peat cell was discontinued in October 2004. Means values discussed in this section are geometric means. Differences in inflow and outflow TP concentrations were compared using analysis of variance analysis (ANOVA) of $\log_{10}$-transformed data pooled over all sampling dates followed by post hoc mean comparison tests (Tukey-Kramer HSD) using SAS JMP®, version 5.

Mean outflow TP concentrations from the shellrock cells (both 13 µg/L) were significantly lower than the mean inflow TP concentration (51 µg/L) and the peat cell outflow (31 µg/L) (**Figure 4-52**). Differences in water depth between Year 1 (30 cm) and Year 2 (60 cm) did not significantly affect treatment performance of the shellrock cells (see Figure 4-47 in Goforth et al., 2005). Mean inflow TP concentrations to the south test cells increased substantially after the two hurricanes in September 2004 (pre-hurricane = 39 µg/L; post-hurricane = 128 µg/L). However, outflow from the shellrock cells (pre-hurricane = 13 and 13 µg/L; post-hurricane = 15 and 13 µg/L) was little affected by the change in inflow TP levels. Note that while none of the south PSTA test cells achieved a long-term mean outflow TP concentration of 10 µg/L, individual biweekly values were occasionally at or below this threshold level.

PSTA Field-scale Test Facility

The PSTA field-scale test facility was a 20-acre site located immediately west of STA-2 that consisted of four 5-acre constructed wetlands. Treatment performance in these wetlands was monitored from November 2001–October 2003. Descriptions of the facility and its operation and a summary of phosphorus treatment results can be found in Newman et al. (2003), Chimney et al. (2004), and Goforth et al. (2005). The site was decommissioned in October 2004 and is being incorporated into the footprint of the STA-2, Cell 4, expansion project. No research was conducted in WY2005 at this facility. Summary reports from the two contractors that operated the facility are presented in Appendices 4-13 and 4-14, respectively.

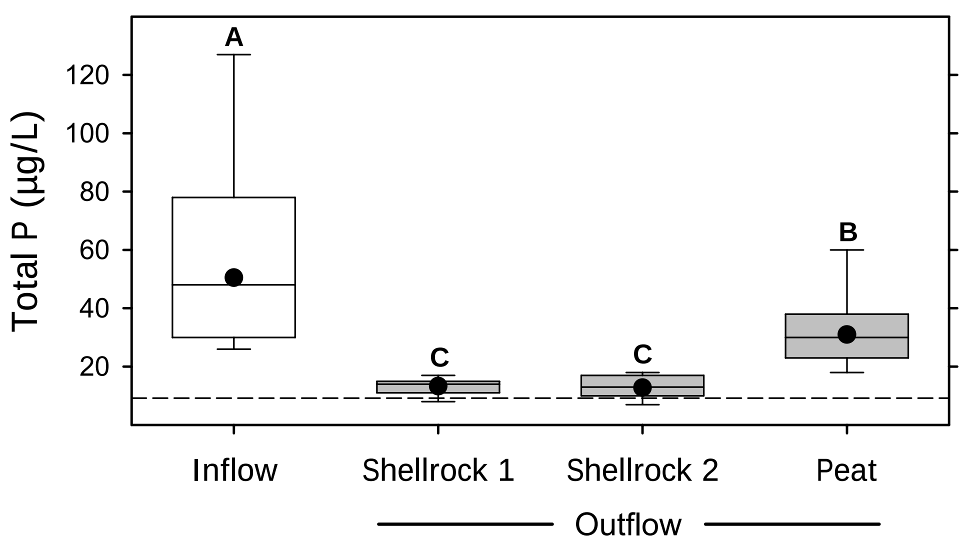


Figure 4-52. Summary of total phosphorus removal in the three STA-1W south PSTA test cells over the entire period of extended monitoring (May 1, 2002 through April 30, 2005). Closed circles represent geometric mean concentrations. Top and bottom of box = 75th and 25th percentile of the data distribution, respectively; mid-line in box = 50th percentile; ends of whiskers = 10th and 90th percentiles, respectively. Means with different letters are significantly different from each other at a probability level (α) < 0.05. The dashed line indicates a total phosphorus concentration of 10 µg/L.

STATUS OF OTHER LONG-TERM PLAN PROJECTS

ECP OPERATIONS MONITORING (Bc05)

The objective of the ECP Operations Monitoring Project (Bc05) is to collect water quality samples and monitor flow at inflow and outflow locations of all treatment cells within the STAs that are not covered under existing operating permits. Most of the ECP operations monitoring structures are currently being monitored, while additional monitoring stations are scheduled to come on-line by FY2006, as outlined in the Long-Term Plan. Flow is monitored on a continuous basis. Water quality samples analyzed for TP are collected weekly; all other parameters are monitored biweekly. These data will be used to assess the performance of each treatment cell and will contribute to the development of strategies for improving TP removal efficiency in the STAs as a whole.

During WY2005, water quality and flow monitoring in the STAs continued at the ECP operations monitoring stations listed in **Table 4-21**. As of August 2005, there are no ECP operations monitoring in STA-1E, as this STA is not in flow-through operations. Routine ECP operations monitoring of this facility is projected to begin in FY2006. The installation of monitoring stations in STA-3/4 is largely complete and water quality collection was initiated at the end of WY2005. All ECP operations monitoring in STA-1W is ongoing with the exception of the structures in the western flow-way, (Cells 2 and 4) and in Cell 5, which were closed for construction of the Long-Term Plan recommended enhancements. All ECP operations monitoring in STA-2, STA-5, and STA-6 is ongoing.

Table 4-21. Operational status of new and existing flow and water quality monitoring sites at interior treatment cells within the STAs during WY2005.

Location	Description	# Sites	Status
STA-1E (not including groundwater monitoring)	New: None	0	STA not in operation, no monitoring in WY2005
	Existing: None	0	STA not in operation, no monitoring in WY2005
STA-1W	New: None		--
	Existing: 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, ENR305, ENR306, G-250S, G-258, G259	19	Routine monitoring ongoing in Cells 1, 3 and 5. Cells 2, 4 and 5 were off-line during WY2005 for construction of Long-Term Plan recommended enhancements.
STA-2	New: None	0	---
	Existing: G-337	1	Routine monitoring ongoing at all water quality stations. G-337A is scheduled to be replaced with a new structure as part of the STA-2 expansion; this site will not be instrumented.
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	STA-3/4 has completed start-up phase; routine water quality monitoring was initiated at most sites by the end of WY2005.
STA-5	New: None	0	---
	Existing: G-343 (B,C,F,G), G-349A, G-350A	6	All water quality stations on-line and routine monitoring ongoing
STA-6	New: None	0	---
	Existing: G-602, G-603	2	All water quality stations on-line and monitoring ongoing

STA SITE MANAGEMENT [Bf81]

The District's Operations and Maintenance Department, Environmental Operations Section, currently staffs three STA site managers (one for STA-1W and STA-1E, one for STA-2 and STA-3/4, and one for STA-5 and STA-6). 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 [Bc82(1)]

The Acquisition of Survey Data project ([Bc82(1)] includes completing topographic surveys within the footprints of the STAs to more clearly delineate ground surface elevations between interior levees and control structures. These topographic surveys are being used by another Long-Term Plan project referred to as Update and Maintenance of Hydraulic Models [Bc82(5)]. To date, contractors have completed topographic surveys in STA-1E, STA-1W, STA-2, STA-5, and STA-6. There are two kinds of surveys done. A complete third order run was made to all the structures. Precision is 0.05 times the square root of the distance in miles. An RTK survey was done for the STA-1E topographic work, generally to 0.1 of a foot.

In addition, the Acquisition of Survey Data project includes conducting vertical control surveys at flow measurement stations to confirm, and correct gauge datum elevations, where necessary. As of the end of FY2005, surveys at the following structures have been completed:

- Spillway Structures G-302, G-301, and G-303
- Culvert Structures G-304A–J, G-306A–J, and G-327A
- Culvert Structures G-255 and G-305A–V
- Culvert Structures G-330A–E
- Culvert Structures G-329A–D
- Culvert Structures G-331A–G
- Culvert Structures G-333A–E
- Spillway Structures G-332 and G-334
- Pump Stations G-335, G-337, and G-337A
- STA-5 and STA-6 Structures

Surveying of the STA-1E structures is scheduled to begin in FY2006.

ADDITIONAL FLOW AND WATER QUALITY MONITORING STATIONS [Bc82(2)]

This project consists of establishing 47 new flow and water quality monitoring stations in the STAs. These additional monitoring efforts focus on STA-3/4 (two seepage pumps and nine culverts) and STA-1W (two culverts) in FY2004 and on STA-1E in FY2005 (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 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 the calibrated equations developed for STA-5 inflow/outflow culverts. 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.

Stilling wells have been installed at the following 19 stations in STA1-E: S-363B, S-364B, S-365A and B, S-366B and D, S-367B and D, S-368B and D, S-369A and D, S-370, S-371B, S-372B and D, S-373B, S-374B, and S-375. Certification and validation of these stage sensors and replacement of the gate sensors are in progress, and are expected to be completed by December 2005. Sensors at structures G-380B and E and G-381B and E are under construction, and are to be completed by August 2005.

REVIEW AND CORRECTION OF FLOW MEASUREMENT ANOMALIES [Bc82(3)]

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. The project was intended to improve the accuracy of flow data at 32 stations in FY2004 and 48 stations in FY2005. In FY2005, the District performed 18 flow measurements in STA-1W, 26 measurements in STA-2, and 24 measurements in STA-3/4. Calibrated flow equations have been completed and implemented at 100 percent in STA-5 and STA-6, and at 95 percent in STA-1W and STA-2. Theoretical flow equations and flow computation have been implemented 100 percent in STA-1W, STA-2, STA-3/4, STA-5 and STA-6. Due to delays in instrumentation in STA-1E, theoretical flow equations and flow computation will be implemented in this STA in FY2006. The District plans to perform over 200 field flow measurements to complete flow rating calibration analyses at 50 percent of the water control structures in STA-3/4 and STA-1E by the end of FY2006.

UPDATE AND MAINTENANCE OF HYDRAULIC MODELS [Bc82(5)]

In February 2004, a 23-month work order was issued to Sutron Corporation, Inc., for the performance of two-dimensional (2-D) hydraulic modeling of the STAs. In FY2005, linked cells models were developed for STA-2, STA-6 Section 1, STA-1W, and STA-5. For each of these STAs, Existing Conditions models were developed and three flow conditions were simulated: Low Flow, Design Flow, and Peak Flow.

Reports describing the 2-D models developed by Sutron Corporation, Inc., including reports describing models developed in FY2004, is available on the District's web site at www.sfwmd.gov/org/erd/longtermplan/documents.shtml.

According to the current work order schedule, 2-D models will be developed for STA-1E and STA-3/4 during the last three months of FY2005 and the first three months of FY2006.

OPERATIONAL STRATEGY [Bc84(1)]

No activities were scheduled or completed for this project in FY2005.

VEGETATION MAINTENANCE [Bc84(2)]

This project covers vegetation maintenance activities in STA-2, Cell 3, only. As stated on page 5-27 of the Long-Term Plan, invasion by emergents or other "less desirable" species should be controlled in order to optimize SAV performance of STA-2, Cell 3. Accordingly, patches of emergent cattail and torpedograss were routinely treated with herbicides during the past year. Introduction of biocontrol agent for hydrilla is planned for August 2005. The planned conversion of 500 acres of emergent vegetation that remains from the former Brown's Farm Wildlife Management Area has been postponed due to continuing good performance of the cell.

RECREATIONAL ACTIVITIES

Recreational facilities are proposed to provide public access to all six of the ECP STAs. The proposed facilities will include components such as boardwalks, bird watching blinds, parking areas, canoe launching sites, boat ramps, composting toilets, information kiosks, landscaping, pedestrian gates, road improvements, signs, and fencing as needed to define public access areas and to protect sensitive equipment.

As recommended in the Revised Part 2 of the Long-Term Plan dated November 2004, the design and engineering of the various recreational facilities is to occur in FY2005 and FY2006, and construction is to occur in FY2006 and FY2007. The District is currently evaluating a proposal to modify the schedule for some of the recreational facilities to allow better coordination between the proposed recreational facilities at STA-2, STA-5, and STA-6 and the proposed Compartments B and C Build-out projects. An update on the status of the design, engineering and construction of the various STA recreational facilities will be provided in next year's SFER.

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