# Chapter 4A: STA Performance and Compliance

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## SUMMARY

Four of the six Stormwater Treatment Areas (STAs) are fully operational and are removing total phosphorus that otherwise would have gone into the Everglades Protection Area. During Water Year 2003 (WY2003) (May 1, 2002 to April 30, 2003), STA-1W, STA-2, STA-5, and STA-6 Section 1 treated more than 1,358 cubic hectometers (1,101,032 acre-feet) of water and removed more than 125 metric tons of total phosphorus (TP). This resulted in an overall 63-percent removal rate. Flows and total phosphorus concentrations into all the STAs increased from the previous water year. A summary is provided in **Table 4A-1**.

During WY2003, the STAs received greater flows and TP loads than the long-term average annual values anticipated during design. STA-1W received about three times the long-term average annual design volume and TP load; the 12-month flow-weighted discharge concentration increased to 53 parts per billion (ppb), up from 38 ppb in WY2002. Operations for STA-1W should be within the design ranges within the next 18 months, coinciding with the anticipated full operation of STA-1 East, scheduled for March 2005.

STA-2 received about 40 percent more inflow than the long-term average annual design volume. However, lower than expected inflow concentrations resulted in less total phosphorus load than anticipated. STA-5 received about 60 percent more inflow and phosphorus loading than the long-term average annual design volume; the 12-month flow-weighted discharge concentration increased to 136 ppb, up from 78 ppb in WY2002. Although the flow at the STA-6 inflow pump was about three times the average annual flow used in the design, STA-6 was not significantly overloaded, due primarily to lower than expected inflow TP concentrations; the WY2003 TP loading was within 25 percent of the long-term average used during design. As a result, STA-6 exhibited approximately 80-percent reduction in TP loads, exceeding the design assumption of about 75-percent reduction.

As of the end of Water Year 2003, the four operational STAs combined have reduced total phosphorus concentrations to about 40 parts per billion. Since the initiation of STA operation in 1994 through the end of April 2003, the STAs have reduced the total phosphorus load by 340 metric tons.

An overview of the STA operations, vegetation management, phosphorus performance, water quality monitoring, and permit compliance for each of the STAs is presented in this chapter. Water quality parameters that are addressed include nutrients; physical parameters including but not limited to pH, turbidity, and dissolved oxygen; pesticides; major ions; and mercury. This information is provided to document 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

**Table 4A-1.** Summary of Stormwater Treatment Area (STA) hydrology and total phosphorus (TP) removal for Water Year 2003 (WY2003).

| | STA-1W | STA-2 | STA-5 | STA-6 | All STAs |
|---|---|---|---|---|---|
| **Total Inflow volume** (ac-ft; $hm^3$) | 591,845 (730 $hm^3$ ) | 282,731 (349 $hm^3$) | 170,203 (210 $hm^3$) | 56,252 (69 $hm^3$) | 1,101,032 (1,358 $hm^3$) |
| **Hydraulic Loading Rate** (cm/d) | 7.41 | 3.67 | 3.45 | 5.40 | 5.74 |
| **Flow-weighted mean Inflow TP** (ppb) | 154 | 67 | 277 | 77 | 147 |
| **TP Loading Rate** ($g/m^2/yr$) | 4.16 | 0.90 | 3.48 | 1.52 | – |
| **Total Inflow TP load** (mt) | 112.1 | 23.4 | 58.1 | 5.4 | 199 |
| **Total Outflow volume** (ac-ft; $hm^3$) | 595,999 (735 $hm^3$) | 308,297 (380 $hm^3$) | 160,518 (198 $hm^3$) | 32,753 (40 $hm^3$) | 1,097,567 (1,353 $hm^3$) |
| **Flow weighted mean Outflow TP** (ppb) | 53 | 17 | 136 | 26 | 54 |
| **Total Outflow TP load** (mt) | 38.7 | 6.6 | 26.9 | 1.0 | 73.3 |
| **Hydraulic Residence Time** (d) | 8.2 | Not available | 12.6 | 9.5 | Not available |
| **TP Retained** (mt) | 73.5 | 16.8 | 31.2 | 4.3 | 126 |
| **TP Removal Rate** ($g/m^2/yr$) | 2.72 | 0.62 | 1.78 | 0.59 | 1.72 |
| **Load reduction** (%) | 66 | 72 | 54 | 80 | 63 |
| **TP retained to date** (mt) | 207 | 32.3 | 78.1 | 22 | 340 |

**Notes:** 1. "TP retained to date" is based on the period of record for each STA. The STA-1W record begins in WY1995. STA-2 record begins in WY2002; STA-5 in WY2001; STA-6 in WY1998.
2. Units used in this table are acre foot (ac-ft); cubic hectometer ($hm^3$); centimeter per day (cm/d); parts per billion (ppb); gram per square meter per year ($g/m^2/yr$); and metric ton (mt).

downstream of the STAs demonstrated that the four STAs in operation are in full compliance with state operating permits. A summary of STA operations and issues is presented in **Table 4A-2**. Appendices provide additional details of the monitoring program, as required by state operating permits.

**Table 4A-2**. Summary of STA operations and issues.

| STA | Operational Status | Other Issues |
|---|---|---|
| **STA-1 East** | Under construction by U.S. Army Corps of Engineers (USACE); scheduled for completion in 2004 | Working with USACE and the Florida Department of Environmental Protection (FDEP) to finalize operating permits |
| **STA-1 West** | Fully operational; in stabilization phase; in WY2003, there was a diversion of 12.6 $hm^3$ (10,218 ac-ft) and 2.5 mt of TP through G-300 and G-301 | Very high hydraulic and nutrient loading during WY2003 resulted from treatment of Lake Okeechobee releases |
| **STA-2** | Fully operational; in stabilization phase | Expanded mercury monitoring in this STA |
| **STA-3/4** | Under construction; scheduled for initial start-up in October 2003; construction scheduled for completion in 2004 | Three large construction contracts were taken over by a new company; District is reviewing recovery schedule |
| **STA-5** | Fully operational; in stabilization phase; in WY2003, there was a diversion of 48.2 $hm^3$ (39,070 ac-ft) and 13.7 mt of TP through G-406 | Very high hydraulic and nutrient loading during WY2003 |
| **STA-6** | Fully operational; in post-stabilization phase | Expanded mercury monitoring in this STA |

# STA-1 EAST UPDATE

The construction of STA-1 East is being managed by the U.S. Army Corps of Engineers (USACE). Construction of the inflow and outflow pump stations for STA-1 East began in May 2000 and September 2000, respectively, and is scheduled for completion in 2003. The Eastern Distribution Cell and Cells 1 and 2 could be completed as early January 2004. All the flow paths are scheduled to be complete by spring 2004, and flow-through operations should commence within 6–18 months of that date. To accelerate the start-up period, the South Florida Water Management District (SFWMD or District) and the USACE are currently discussing early hydration of treatment cells for vegetative establishment. A schematic of STA-1 East is presented in **Figure 4A-1**. Based on the 1979 through 1988 period of flow and total phosphorus (TP) data used during design, STA-1 East should receive approximately 94,000 acre-feet (ac-ft) from the C-51 West basin and approximately 31,000 ac-ft from the S-5A basin through the G-311 structure. Actual deliveries will vary based on hydrologic conditions in the basins. The District, the USACE, and the Florida Department of Environmental Protection (FDEP) are working to resolve the remaining issues associated with the operating permits for STA-1 East.

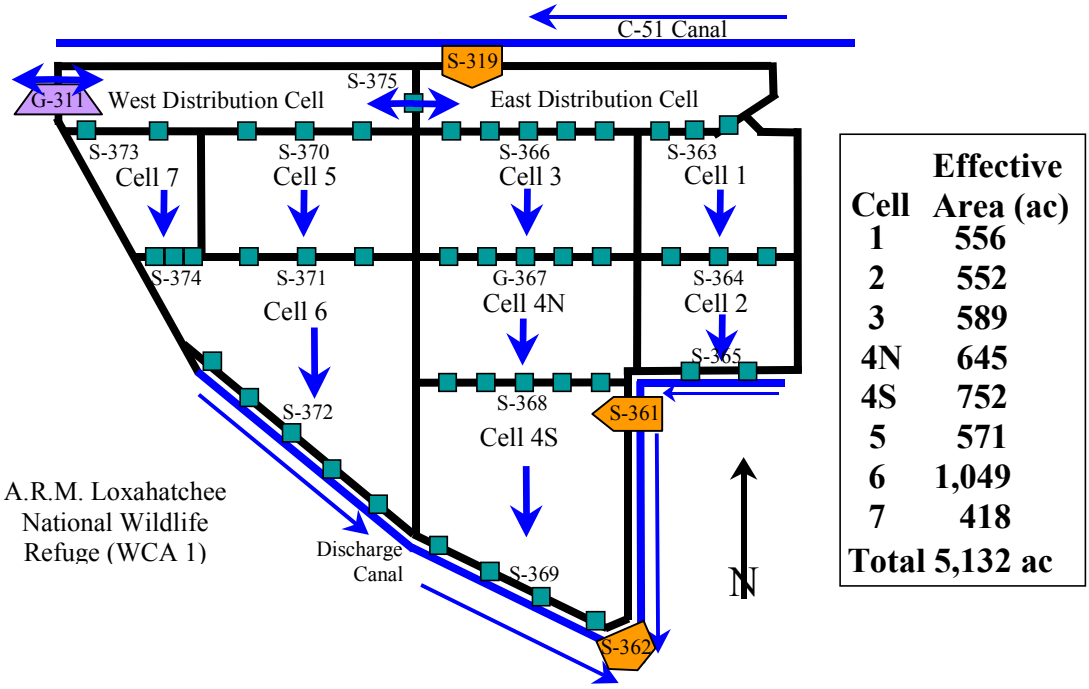



**Figure 4A-1.** Schematic of STA-1 East. The orange boxes denote pump stations; the green boxes represent culverts.

# STA-1 WEST

STA-1 West 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, which allow for tremendous operational flexibility. Based on the 1979 through 1988 period of flow, and on total phosphorus (TP) data used during design, STA-1W should receive an average annual flow of approximately 125,000 ac-ft from the S-5A basin, approximately 11,500 ac-ft from the C-51 West basin, approximately 4,300 ac-ft from the East Beach Water Control District, approximately 2,300 ac-ft of Lake Okeechobee regulatory releases, and Best Management Practice (BMP) replacement water from the lake. 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-304 (A–J) structures and into Cells 1 through 4 via the G-303 structure (**Figure 4A-2**). 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.

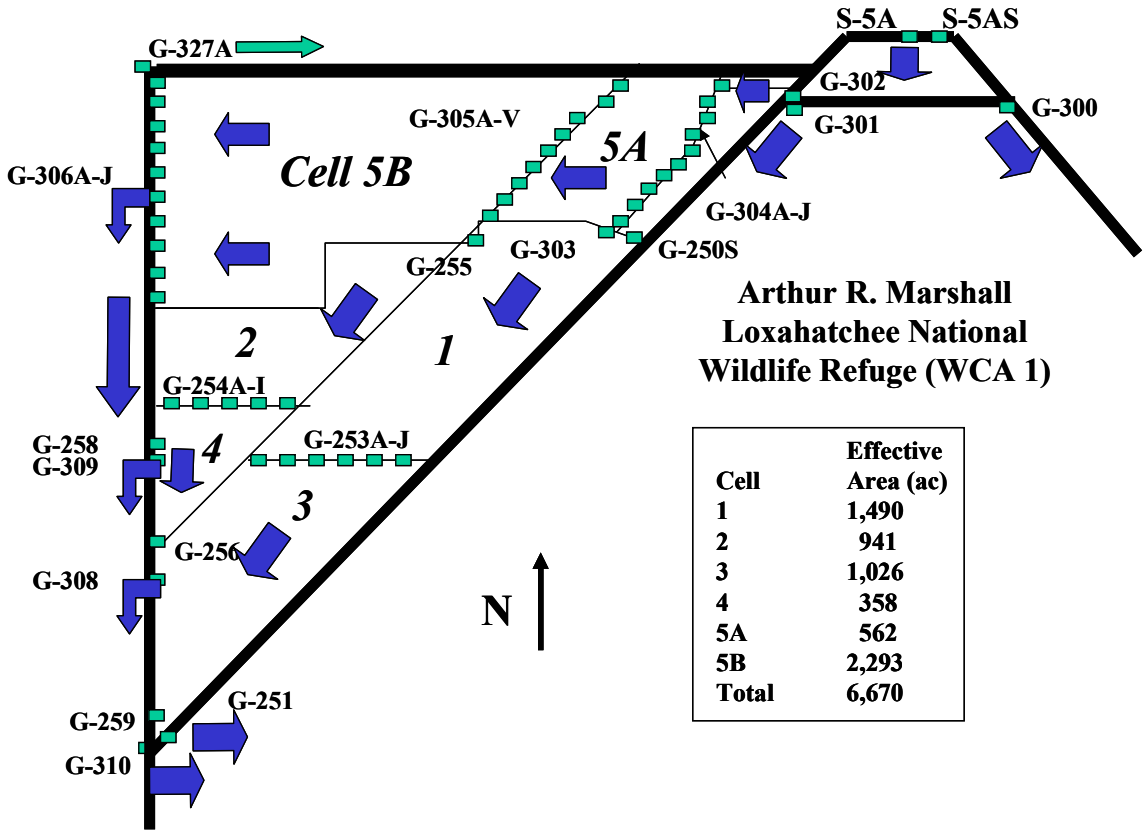


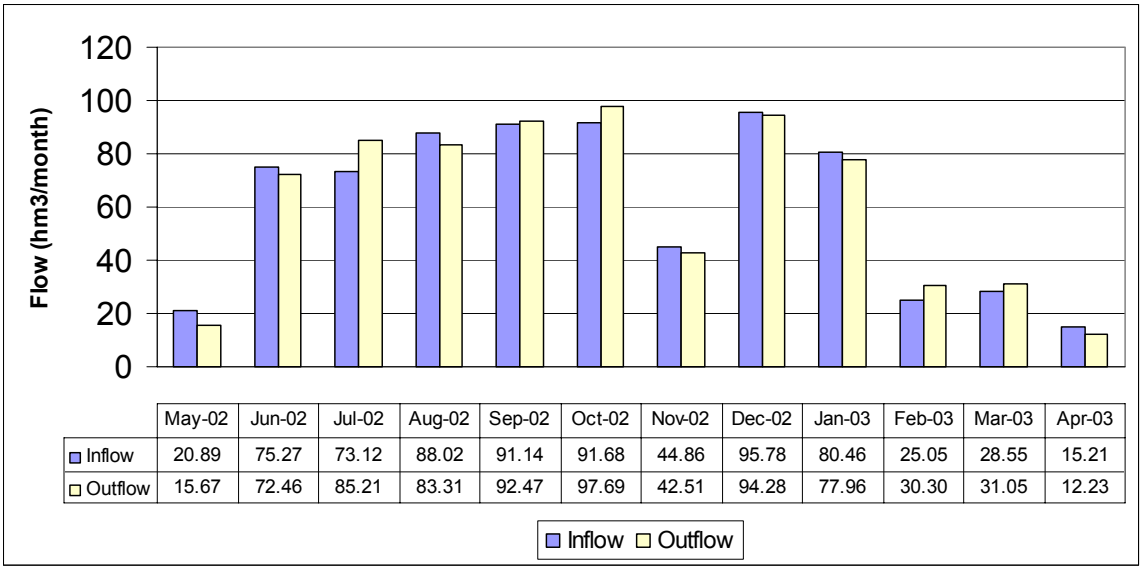

**Figure 4A-2.** Schematic of STA-1 West (not to scale).

## STA-1 WEST OPERATIONS

During WY2003, discharge to the STA-1W treatment cells via G-302 was approximately 730 cubic hectometers ($hm^3$) (591,845 ac-ft), equal to an average hydraulic loading rate of 7.4 cm/day over the effective treatment area of the STA. This annual inflow was approximately three times the long-term average annual volume contemplated during design, although the design anticipated a wide variability in inflows. The volume of treated water discharged from STA-1W to the Refuge was 735 $hm^3$ (595,999 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. A summary of monthly flows is presented in **Figure 4A-3**.

Until STA-1 East is fully operational, flows from the S-5A pump station that exceed the hydraulic capacity of STA-1 West will be diverted through the G-300 and G-301 structures into Water Conservation Area 1 (WCA-1), also referred to as the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge). During Water Year 2003 (WY2003), approximately 10,218 ac-ft (2.5 metric tons [mt]) of total phosphorus (TP) were diverted in this manner.

Between July 2002 and February 2003, approximately 329,607 ac-ft of Lake Okeechobee releases were diverted to STA-1W for treatment prior to discharge into the Refuge. These inflows accounted for almost one-third of the STA-1W inflows during WY2003. The decision to send lake releases to STA-1W was based on a federally authorized regulation schedule for the lake. This schedule, referred to as Water Supply and the Environment (WSE), is designed to balance regional factors by (1) controlling water levels and potential impacts to the lake and Everglades ecosystems, (2) minimizing damaging freshwater discharges to the Caloosahatchee Estuary and the St. Lucie Estuary, and (3) providing flood control and water supply of tributary basins. Because the Refuge was the only water conservation area where the water level was below its operating schedule for most of the year, the WSE schedule dictated sending the majority of the excess water to the Refuge. Generally, the District prefers to treat any water it sends to the Water Conservation Areas, so these lake releases were diverted to STA-1W. These deliveries were terminated in February 2003, when data indicated that the annual outflow concentrations of TP from STA-1W might exceed the target of 50 ppb. STA-3/4 was designed to capture and treat approximately 250,000 ac-ft per year of lake releases. When construction is completed, it is expected to handle the majority of any required lake releases. Also, the Everglades Agricultural Area (EAA) Storage Reservoir will provide system storage in the future. Finally, it is possible that STA-1E could have provided some additional storage and treatment capability had it been operational.




| | May-02 | Jun-02 | Jul-02 | Aug-02 | Sep-02 | Oct-02 | Nov-02 | Dec-02 | Jan-03 | Feb-03 | Mar-03 | Apr-03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 20.89 | 75.27 | 73.12 | 88.02 | 91.14 | 91.68 | 44.86 | 95.78 | 80.46 | 25.05 | 28.55 | 15.21 |
| Outflow | 15.67 | 72.46 | 85.21 | 83.31 | 92.47 | 97.69 | 42.51 | 94.28 | 77.96 | 30.30 | 31.05 | 12.23 |

**Figure 4A-3.** Summary of Water Year 2003 flow for STA-1W (Note: 1 $hm^3$ = 810.7 ac-ft).

## STA-1 WEST VEGETATION MANAGEMENT

Specific Condition 13(b) of the Everglades Forever Act (EFA) permit requires that the annual Everglades Consolidated Report (ECR) include information regarding the application of herbicides used to exclude and/or eliminate undesirable vegetation within the treatment cells. For this reporting period, the District applied a total of 707 gallons of the herbicide Glyphosate; 730 gallons of 2,4-D; and 1,050 gallons of Reward to control nuisance vegetation in the marsh. The District used both aerial and ground-based spray equipment to apply these herbicides.

## STA-1 WEST PERMIT WATER QUALITY MONITORING

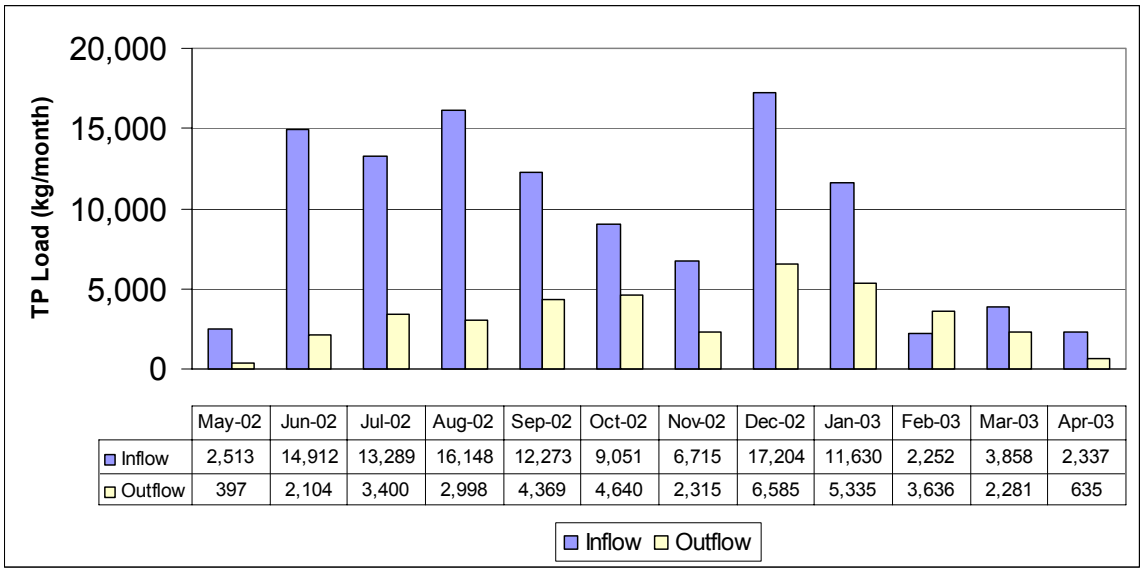
The data presented in this section demonstrate that STA-1W was in compliance with the EFA and the U.S. Environmental Protection Agency's (USEPA) National Pollution Discharge Elimination System (NPDES) operating permits for this reporting period and that discharges do not pose any known danger to public health, safety, or welfare. The EFA permits for 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 flow-through operations until 2004. Therefore, STA-1W currently remains in the stabilization phase.

## STA-1 WEST TOTAL PHOSPHORUS

During WY2003, STA-1W received more than twice the TP loading as the long-term average annual amount contemplated during design, although the design anticipated annual variability. Through the G-302 inflow structure, STA-1W received 112 metric tons (mt) of TP, equal to a nutrient loading rate of 3.15 grams/square meter. Approximately 74 mt of TP were removed by STA-1W during WY2003. Monthly discharge concentrations were usually considerably lower

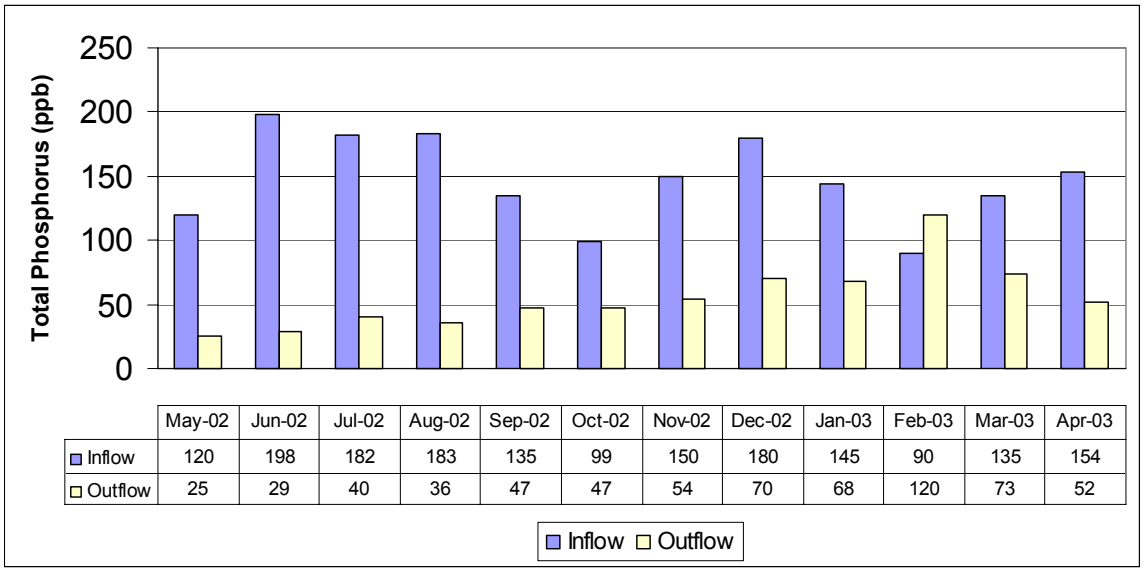
than inflow concentrations, except for discharges that occurred in February 2003. Between May 2002 and April 2003, STA-1W reduced TP discharge loads by 66 percent compared to inflow loadings measured at G-302. Summaries of monthly TP loads and flow-weighted mean TP concentrations are presented in **Figures 4A-4** and **4A-5**. The flow-weighted mean outflow concentration was 53 ppb, a 66-percent reduction from the inflow concentration of 154 ppb measured at G-302. For informational purposes, the geometric mean TP concentration of the discharge was calculated as 49 ppb, using auto sampler data from G-251 and G-310. The moving 12-month flow-weighted mean TP outflow concentration for STA-1W ranged from 34 to 53 ppb (**Figure 4A-6**). Although the annual flow-weighted mean concentration of TP in the outflow exceeded 50 ppb, this does not create a violation of the operating permits. The permit acknowledges that until STA-1E is fully operational, STA-1W may receive higher-than-normal inflows and therefore will remain in the stabilization phase. In addition, after STA-1W leaves the stabilization phase, the annual maximum discharge concentration allowed by the permit is 76 ppb, with no more than two successive years above 50 ppb.

Almost 61 percent of the TP inflows into STA-1W (approximately 68 mt) were associated with the diversion of Lake Okeechobee releases between July 2002 and February 2003. These deliveries were terminated in February when data indicated that the annual outflow concentrations from STA-1W might exceed the target of 50 ppb. Treating these lake releases in STA-1W prevented approximately 45 mt of phosphorus from otherwise entering the Refuge (and the Everglades Protection Area [EPA]).




| | May-02 | Jun-02 | Jul-02 | Aug-02 | Sep-02 | Oct-02 | Nov-02 | Dec-02 | Jan-03 | Feb-03 | Mar-03 | Apr-03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 2,513 | 14,912 | 13,289 | 16,148 | 12,273 | 9,051 | 6,715 | 17,204 | 11,630 | 2,252 | 3,858 | 2,337 |
| Outflow | 397 | 2,104 | 3,400 | 2,998 | 4,369 | 4,640 | 2,315 | 6,585 | 5,335 | 3,636 | 2,281 | 635 |

**Figure 4A-4.** Summary of Water Year 2003 phosphorus loads for STA-1W.




| | May-02 | Jun-02 | Jul-02 | Aug-02 | Sep-02 | Oct-02 | Nov-02 | Dec-02 | Jan-03 | Feb-03 | Mar-03 | Apr-03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 120 | 198 | 182 | 183 | 135 | 99 | 150 | 180 | 145 | 90 | 135 | 154 |
| Outflow | 25 | 29 | 40 | 36 | 47 | 47 | 54 | 70 | 68 | 120 | 73 | 52 |

**Figure 4A-5.** Summary of Water Year 2003 total phosphorus (TP) concentrations for STA-1W.

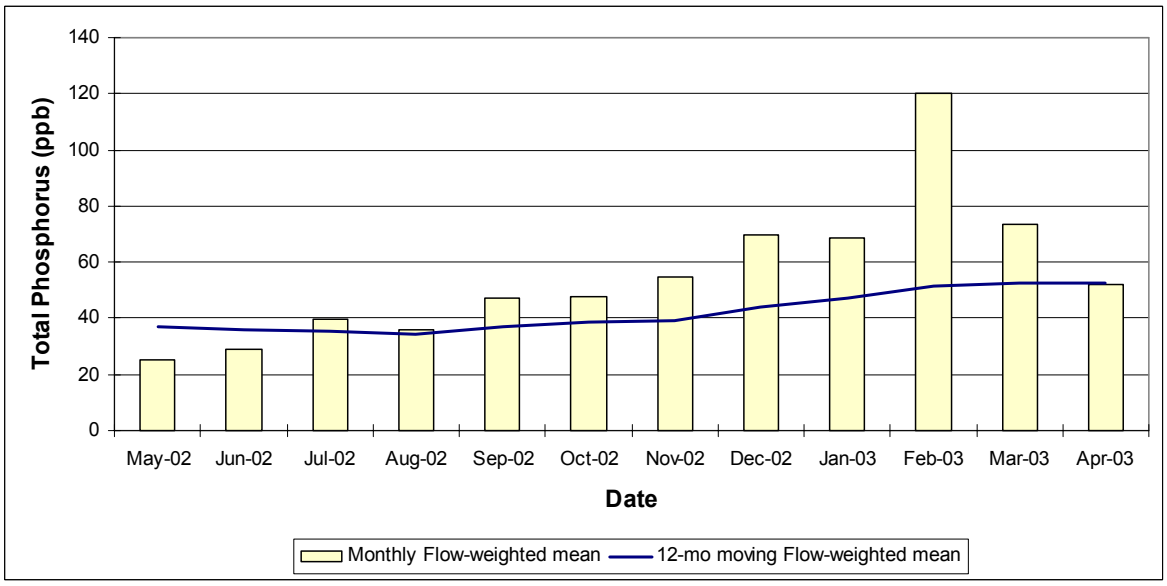



**Figure 4A-6.** Comparison of monthly to 12-month moving average phosphorus concentrations for Water Year 2003 for STA-1W outflow.

## STA-1 WEST OTHER WATER QUALITY PARAMETERS

Water quality parameters with Class III standards are identified in **Table 4A-3**. The monitoring data for non-phosphorus parameters at STA-1W during this reporting period are presented in Appendix 4A-1 and are summarized in **Table 4A-4**. Temperature, specific conductance, dissolved oxygen (DO), and pH values reported in this chapter are field measurements. While Ametryn and Atrazine 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:

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 number 1 (above) for all parameters other than phosphorus and dissolved oxygen with applicable numeric state water standards. Alkalinity and specific conductivity concentrations were higher at the outflow compared to the inflow, but these concentrations did not exceed the Class III numeric standards. Annual average concentrations of total dissolved solids, dissolved chloride, Ametryn, and Atrazine were also 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 a subsequent section.

**Table 4A-3.** Water quality parameters with 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 4A-4.** Summary of annual arithmetic averages and flow-weighted means for water quality parameters (other than total phosphorus) monitored in STA-1W. For the purpose of these comparisons, flow-weighted means are calculated as the ratio of the cumulative product of the instantaneous flow and the sample concentration divided by the cumulative flow values.

| Parameter | Arithmetic Means | | | Flow-Weighted Means | | | |
|---|---|---|---|---|---|---|---|
| | Inflow | Outflow | | Total Inflow | | Total Outflow | |
| | S5A | G251 | G310 | n | Conc. | n | Conc. |
| Temperature (°C) | 24.8 | 23.9 | 24.3 | -NA- | -NA- | -NA- | -NA- |
| Dissolved Oxygen (mg/L) | 4.4 | 2.7 | 3.8 | -NA- | -NA- | -NA- | -NA- |
| Specific Conductivity (µmhos/cm) | 871 | 981 | 896 | -NA- | -NA- | -NA- | -NA- |
| pH | 7.6 | 7.4 | 7.5 | -NA- | -NA- | -NA- | -NA- |
| Turbidity (NTU) | 21.9 | 1.3 | 5.3 | -NA- | -NA- | -NA- | -NA- |
| Total Dissolved Solids (mg/L) | 568 | 632 | 583 | 22 (26) | 582 | 40 (52) | 591 |
| Unionized Ammonia (mg/L) | 0.0062 | 0.0012 | 0.0017 | 22 (26) | 0.0063 | 40 (52) | 0.0014 |
| Orthophosphate as P (mg/L) | 0.078 | 0.018 | 0.035 | 39 (46) | 0.083 | 72 (91) | 0.035 |
| Total Dissolved Phosphorus (mg/L) | 0.083 | 0.025 | 0.044 | 36 (43) | 0.088 | 72 (90) | 0.043 |
| Sulfate (mg/L) | 66.3 | 61.4 | 62.0 | 22 (26) | 68.4 | 40 (52) | 64.3 |
| Alkalinity (mg/L) | 190 | 221 | 201 | 22 (26) | 203 | 40 (52) | 207 |
| Dissolved Chloride (mg/L) | 120 | 140 | 126 | 22 (26) | 119 | 40 (52) | 124 |
| Total Nitrogen (mg/L) | 2.53 | 1.87 | 1.97 | 22 (26) | 2.86 | 39 (50) | 1.95 |
| Total Dissolved Nitrogen (mg/L) | 2.14 | 1.78 | 1.82 | 22 (26) | 2.33 | 39 (50) | 1.83 |
| Nitrate + Nitrite (mg/L) | 0.438 | 0.042 | 0.130 | 22 (26) | 0.468 | 39 (50) | 0.148 |
| Ametryn (µg/L) | 0.049 | 0.052 | 0.067 | 4 (7) | 0.036 | 4 (8) | 0.049 |
| Atrazine (µg/L) | 1.033 | 1.036 | 1.413 | 4 (7) | 0.226 | 4 (8) | 0.638 |

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

The District has included the following documentation to satisfy the remaining monitoring requirements of the Everglades Forever Act (EFA) permit:

- The District has performed all sampling and analysis under the latest FDEP-approved CompQAP No. 870166G (June 1999).
- A signed copy of this statement is provided in Appendix 4A-2.

# STA-1 WEST DISSOLVED OXYGEN MONITORING

## Introduction

Dissolved oxygen (DO) concentrations fluctuate naturally in marsh environments such as the Everglades, routinely falling below the Class III water quality criterion of 5 mg/L. STAs also experience natural fluctuations in DO that routinely fall below 5 mg/L, as was observed in DO data collected in the Everglades Nutrient Removal Project (ENR Project Monitoring Report Appendices, 1995 to 1998) and as reported in the *Everglades Interim Report* (1999) and prior Everglades Consolidated Reports (2000 through 2003). 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 the District to 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 antidegradation 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 historic DO data from the Everglades Protection Area (EPA), including data from interior marsh stations within the Arthur R. Marshall Loxahatchee National Wildlife Refuge (receiving effluent from STA-1W), the Rotenberger 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 4A-2**).
- Downstream of the G-251 and G-310 discharge structures (**Figure 4A-2**).
- At sites along the X, Y, and Z transects in the periphery of the interior Arthur R. Marshall Loxahatchee National Wildlife Refuge marshes downstream of the combined discharges (**Figure 4A-7**).

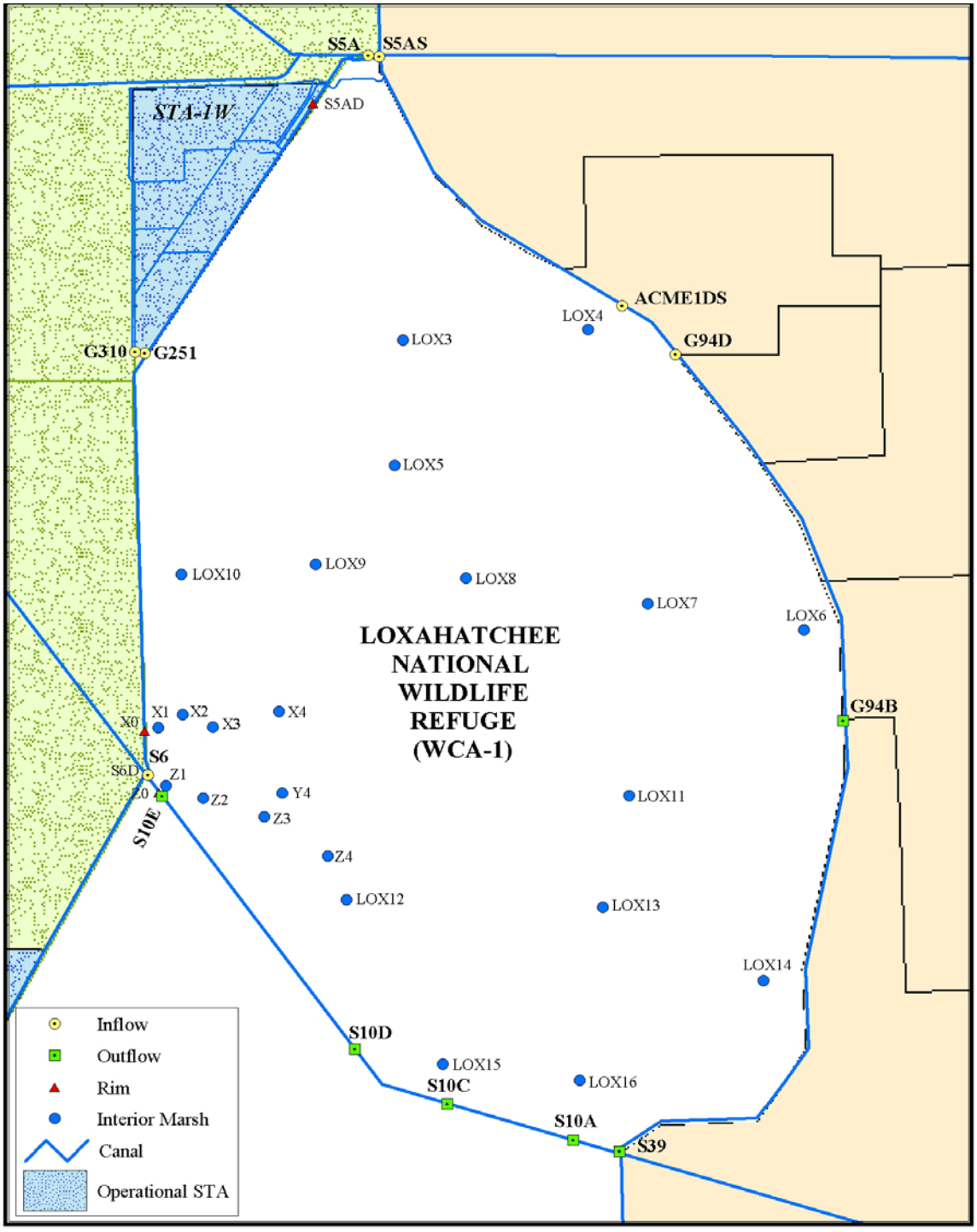



**Figure 4A-7.** Location and classification of water quality monitoring stations in the Arthur R. Marshall Loxahatchee National Wildlife Refuge.

## Sampling Dates

Diel oxygen measurement dates and sites for WY2003 are provided in **Table 4A-5**.

**Table 4A-5.** 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 | | |
| 07/08/2002 | 07/15/2002 | S5AU | G251D | G310 | x1, x2, x3, x4,Y4, Z1, Z2, Z3, Z4 |
| 09/30/2002 | 10/07/2002 | S5AU | G251D | G310 | ---------- |
| 01/13/2003 | 01/25/2003 | S5AU | G251D | G310 | X1, X3, X4, Y4, Z1, Z2, Z4 |
| 04/21/2003 | 04/25/2003 | S5AU | G251D | G310 | X1, X2, X3, X4, Y4, Z1, Z3 |

**Table 4A-6.** Statistical summary of diel dissolved oxygen at outflow stations G-251D and G-310 and at stations along the X, Y, Z transects in the Refuge during eight deployment periods.

| Location | Station | Number of Measurements | Mean | Minimum | Median | Maximum | Standard Deviation |
|---|---|---|---|---|---|---|---|
| **Outflow** | G251D | 941 | 3.31 | 0.33 | 2.85 | 9.52 | 2.07 |
| | G310 | 956 | 3.70 | 0.44 | 3.55 | 7.7 | 1.83 |
| **Transect X** | X1 | 544 | 2.16 | 0.48 | 2.085 | 8.05 | 0.95 |
| | X2 | 362 | 3.54 | 0.33 | 3.535 | 7.76 | 2.12 |
| | X3 | 558 | 4.56 | 0.33 | 3.535 | 7.76 | 2.12 |
| | X4 | 362 | 3.17 | 0.24 | 3.54 | 7.94 | 1.84 |
| **Transect Y** | Y4 | 545 | 3.58 | 0.46 | 3.66 | 7.25 | 1.61 |
| **Transect Z** | Z1 | 545 | 1.12 | 0.17 | 0.79 | 3.49 | 0.79 |
| | Z2 | 331 | 2.04 | 0 | 1.79 | 7.35 | 1.37 |
| | Z3 | 362 | 3.21 | 0.78 | 3.275 | 8.98 | 1.44 |
| | Z4 | 183 | 6.09 | 3.88 | 6.11 | 8.08 | 0.99 |
| **Mesocosm** | MESO01 | 0 | -- No measurements made due to low water levels -- | | | | |

See Appendix 4A-3, Table 1 for statistical summaries by event and diel parameter.

## Comparison of Dissolved Oxygen in STA-1 West Discharges with Dissolved Oxygen at Downstream Marsh Sites

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 4A-6**. Discharges from STA-1W structures G-251 and G-310 constitute the flow in the L-7 rim canal unless bypasses are made through G-301 or there are outflows from the interior Refuge marsh. The dissolved oxygen 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 greater than interior marsh stage, rim canal water will flow into the interior marsh. Rim canal water can penetrate into the marsh based on stage differential. Consequently, the STA-1W discharges do have an affect on water quality in the marsh.

Examination of the data in **Table 4A-6** and the notched box and whisker plots in **Figure 4A-8** 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, and Z2. This significance exists because the notches for the G-251 and G-310 plots, which represent the approximate 95-percent confidence intervals for the medians, do not overlap the notches for Z1, X1, and Z2. Non-overlapping notches indicate that data sets being compared are significantly different.

Further comparison of the medians and notches of dissolved oxygen concentrations in discharges indicates G-251 has significantly lower dissolved oxygen than the concentrations measured at transect sites X2, X3, Z3, Z4, Y4, and X4. Dissolved oxygen concentrations in G-310 discharges were not significantly different from concentrations measured at transect sites X2, Z3, Y4, and X4, but they were significantly lower than at sites X3 and Z4.

The complete DO data sets collected during WY2003 are presented in Appendix 4A-3.

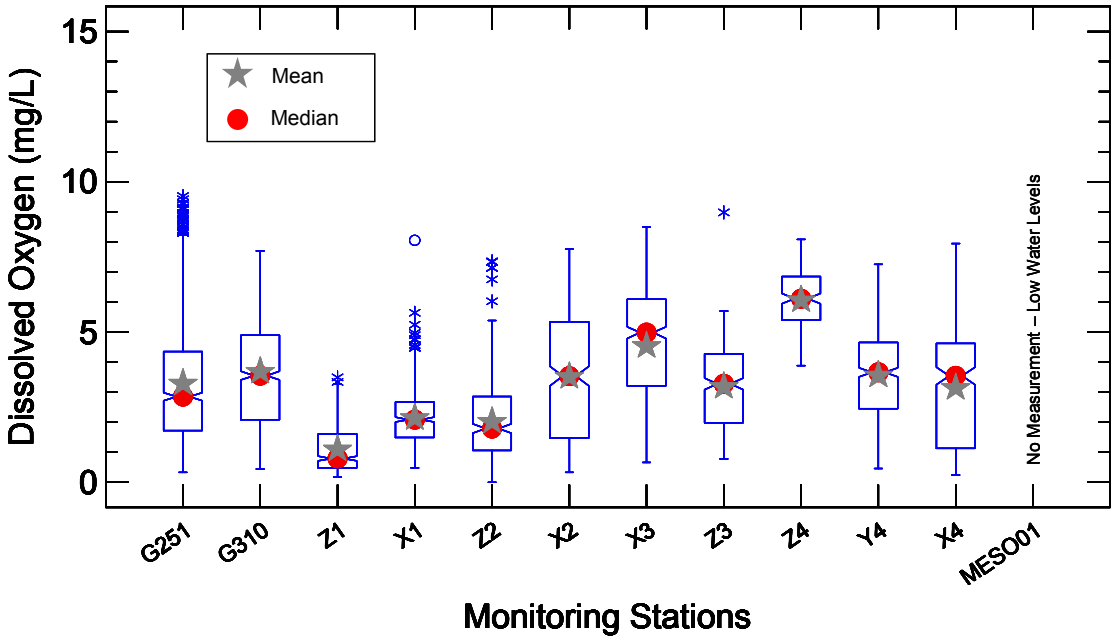



**Figure 4A-8.** Notched-box and whisker plots of diel dissolved oxygen measurements at STA-1W outflow stations (G-251D and G-310) and along transect sites in the Refuge during eight monitoring periods. The notch on a box plot represents the 95-percent confidence interval about the median, which is represented by the narrowest part of the notch. The top and bottom of the box represent the 75$^{th}$ and 25$^{th}$ 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-percent confidence level.

The STA-1W discharges must travel several km 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, and 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, and Z2 are largely due to the long-term effects of phosphorus (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 Refuge rim canals should improve DO conditions in the interior marsh fringe areas affected by rim canal water penetration.

## STA-1 WEST MERCURY

For each STA, the operating permits require the District to monitor total mercury (THg) and methylmercury (MeHg) in soils at six representative sites. These sites must be monitored biweekly prior to flooding, and triennially thereafter in start-up inflow and interior water from a representative site until the interior is not significantly greater than the inflow, and in representative inflows and outflows quarterly thereafter. In addition, THg is measured in mosquitofish collected semiannually and in sunfish and largemouth bass collected annually from representative inflow, interior, and outflow sites. These monitoring requirements are contained in Exhibit D of each state permit. The mercury performance of each STA for the reporting year is discussed in Appendix 4A-4.

During the monitoring period, there were no violations of the Florida Class III numerical Water Quality Standard (WQS) of 12 nanograms per liter (ng/L) for THg. The outflow THg and MeHg concentrations were consistently less than the inflow, suggesting that STA-1W – as with the ENR Project (Cells 1 through 4) that it subsumed in April 1999 – continues to remove both THg and MeHg from Everglades Agricultural Area (EAA) runoff and from Lake Okeechobee regulatory releases. The average THg concentrations in interior (Cell 3) and outflow mosquitofish, sunfish, and largemouth bass were also well below their corresponding Everglades averages. The average THg concentration in largemouth bass (standardized to age class 3 years) was also well below the Florida fish consumption advisory threshold of 0.5 ppm in fish flesh.

# STA-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 4A-9**. Based on the 1979 through 1988 period of flow, and based on TP data used during design, the STA should receive approximately 163,000 ac-ft from the S-6 and S-5A basins, approximately 8,300 ac-ft from the East Shore Water Control District and Closter Farms, approximately 3,000 ac-ft of Lake Okeechobee regulatory releases, and Best Management Practice (BMP) replacement water from the lake. 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.

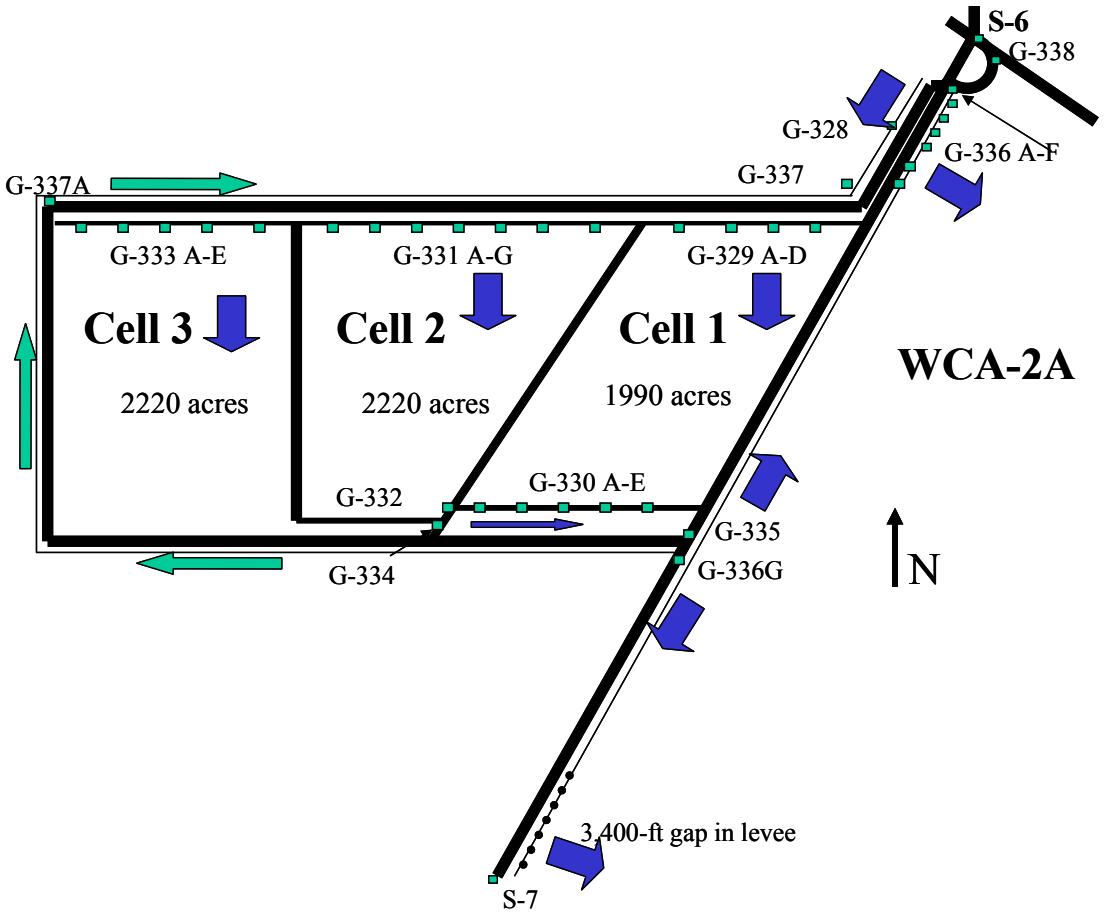


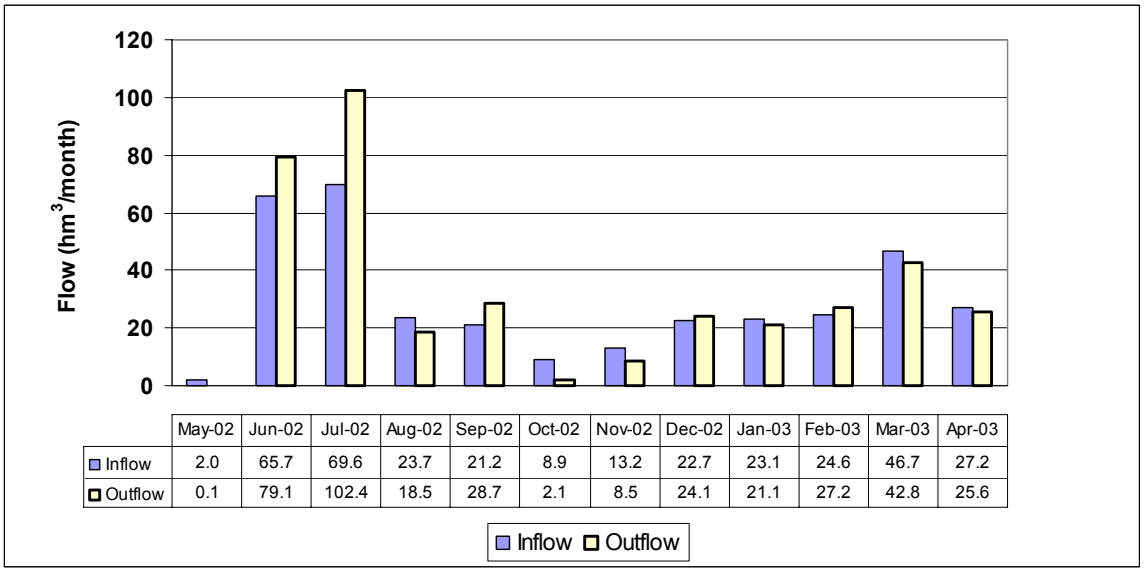

**Figure 4A-9.** Schematic of STA-2 (not to scale).

## STA-2 OPERATIONS

Startup 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-cubic feet per second (cfs) pump station. Construction of the 3,040-cfs outflow pump station (G-335) was completed in 2000, with final operational testing taking place 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.

During WY2003, approximately 349 $hm^3$ (282,731 ac-ft) of water were captured and treated by STA-2. This was about 40 percent more than the anticipated average annual flow contemplated during design, although annual variability was anticipated. This inflow loading was equal to an average hydraulic load of 3.67 cm/day over the treatment area. During WY2003, approximately 44,195 acre-feet of Lake Okeechobee regulatory releases were sent through STA-2. The annual volume of treated water discharged to WCA-2A was 380 $hm^3$ (308,297 ac-ft). The difference between the inflow and outflow volumes reflects the net contributions of direct rainfall, evapotranspiration (ET), seepage losses to adjacent lands, deep percolation, and flow

measurement error. A summary of monthly flows is presented in **Figure 4A-10**. No flows were diverted around STA-2 during WY2003.




| | May-02 | Jun-02 | Jul-02 | Aug-02 | Sep-02 | Oct-02 | Nov-02 | Dec-02 | Jan-03 | Feb-03 | Mar-03 | Apr-03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 2.0 | 65.7 | 69.6 | 23.7 | 21.2 | 8.9 | 13.2 | 22.7 | 23.1 | 24.6 | 46.7 | 27.2 |
| Outflow | 0.1 | 79.1 | 102.4 | 18.5 | 28.7 | 2.1 | 8.5 | 24.1 | 21.1 | 27.2 | 42.8 | 25.6 |

**Figure 4A-10.** Summary of Water Year 2003 flows for STA-2 (Note: 1 $hm^3$ = 810.7 ac-ft).

## STA-2 VEGETATION MANAGEMENT

Specific Condition 13(b) of the Everglades Forever Act (EFA) permit requires that the annual Everglades Consolidated Report include information regarding the application of herbicides to exclude and/or eliminate undesirable vegetation within the treatment cells. For this reporting period, the District applied a total of 235 gallons of the herbicide Glyphosate to control torpedograss (*Panicum repens*) and cattail (*Typha* spp.) in Cell 3. Both aerial and ground-based spray equipment were used to apply these herbicides.

## STA-2 PERMIT WATER QUALITY MONITORING

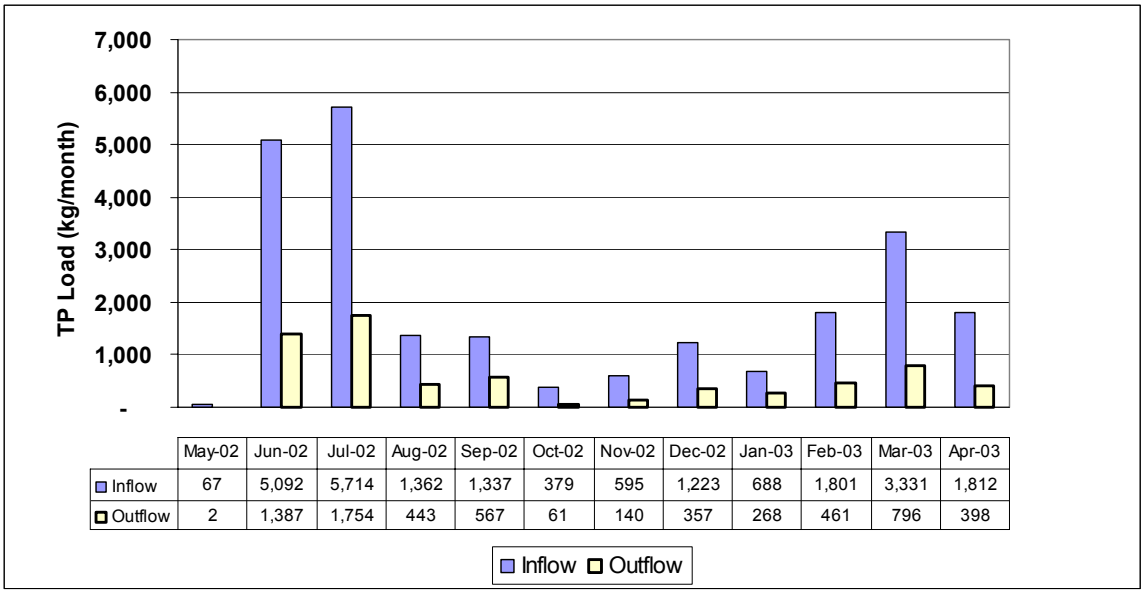
Monitoring data collected for STA-2 demonstrate that STA-2 was in compliance with the EFA and National Pollution Discharge Elimination System (NPDES) operating permits for WY2003 and that discharges do not pose any known danger to public health, safety, or welfare. The EFA and NPDES operating permits were issued for this project on September 29, 2000. Each treatment cell in STA-2 operates independently, and the permit authorizes discharges when net improvement in TP and mercury is demonstrated for each cell. STA-2 Cells 2 and 3 passed the net improvement start-up tests for TP and mercury on September 13 and November 9, 2000, respectively. Cell 1 was the last of the treatment cells to meet the start-up criteria described in the permit for mercury. After the FDEP, the U.S. Environmental Protection Agency (USEPA), and other agencies reviewed the Cell 1 mercury situation, it was determined that the most effective way to reduce mercury concentrations in Cell 1 was to move as much water through the cell as possible, both to increase sulfur levels and to keep the treatment cell hydrated. On August 9, 2001 a draft permit modification was issued to initiate flow-through operations for Cell 1. Data collected in December 2002 and January 2003 demonstrated that Cell 1 passed the start-up test

described in the permit, based on the stations identified for that purpose. Additional monitoring continues to increase the understanding of mercury in the STA. 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 flow-through operations. At this time, STA-1E and STA-3/4 are still in the construction phase and are not expected to begin flow-through operations until 2004, subject to vegetation grow-in and soil phosphorus stabilization.

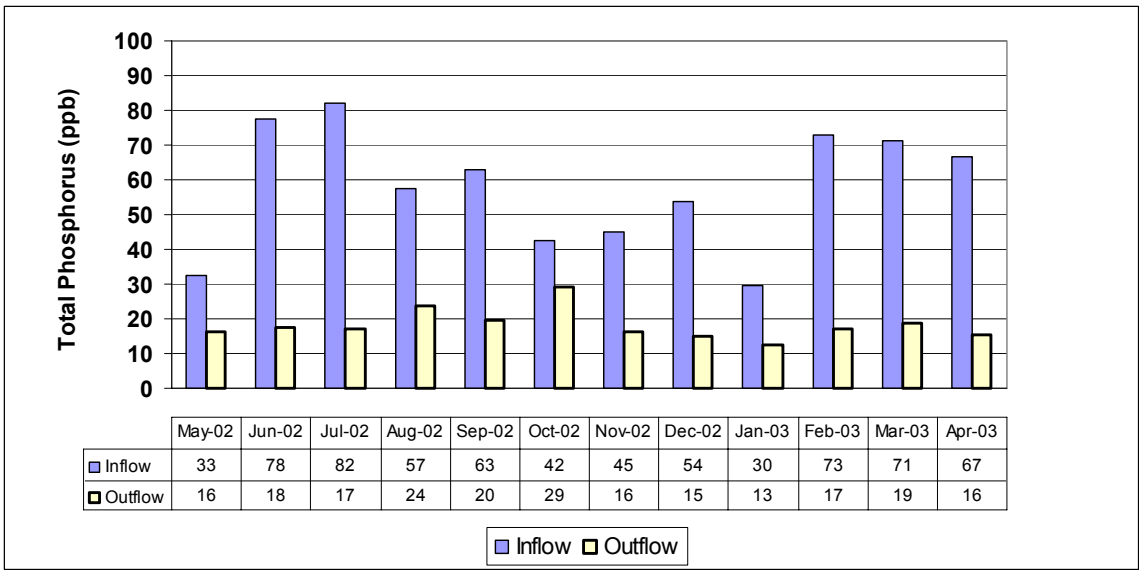
## STA-2 TOTAL PHOSPHORUS

Under the design objectives of the Everglades Forever Act, STA-2 is achieving its interim discharge goal of less than 50 ppb for total phosphorus (TP). Although the hydraulic loading to STA-2 was higher than the design criteria, the TP loading to the system was about 36 percent less than the design amount. During WY2003, the STA received 23.4 mt of TP, with 4.5 mt of TP from Lake Okeechobee. This loading is equal to a nutrient loading rate of 0.90 grams/square meter. STA-2 removed approximately 16.8 mt of TP during WY2003. Monthly discharge concentrations were considerably lower than inflow concentrations. For example, between May 2002 and April 2003, STA-2 reduced discharge loads of TP by 72 percent. Summaries of monthly TP loads and flow-weighted mean TP concentrations are presented in **Figures 4A-11** and **4A-12**. The annual flow-weighted mean outflow concentration was 17 ppb, a 74-percent reduction from the inflow concentration of 67 ppb. For informational purposes, the annual geometric mean discharge TP concentration for STA-2 was 19 ppb for WY2003. By virtue of achieving an outflow concentration of less than 50 ppb in accordance with the EFA permit for STA-2, 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 ranged from 16 ppb to 19 ppb (**Figure 4A-13**).




| | May-02 | Jun-02 | Jul-02 | Aug-02 | Sep-02 | Oct-02 | Nov-02 | Dec-02 | Jan-03 | Feb-03 | Mar-03 | Apr-03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 67 | 5,092 | 5,714 | 1,362 | 1,337 | 379 | 595 | 1,223 | 688 | 1,801 | 3,331 | 1,812 |
| Outflow | 2 | 1,387 | 1,754 | 443 | 567 | 61 | 140 | 357 | 268 | 461 | 796 | 398 |

**Figure 4A-11.** Summary of Water Year 2003 phosphorus loads for STA-2.




| | May-02 | Jun-02 | Jul-02 | Aug-02 | Sep-02 | Oct-02 | Nov-02 | Dec-02 | Jan-03 | Feb-03 | Mar-03 | Apr-03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 33 | 78 | 82 | 57 | 63 | 42 | 45 | 54 | 30 | 73 | 71 | 67 |
| Outflow | 16 | 18 | 17 | 24 | 20 | 29 | 16 | 15 | 13 | 17 | 19 | 16 |

**Figure 4A-12.** Summary of Water Year 2003 total phosphorus (TP) concentrations for STA-2.

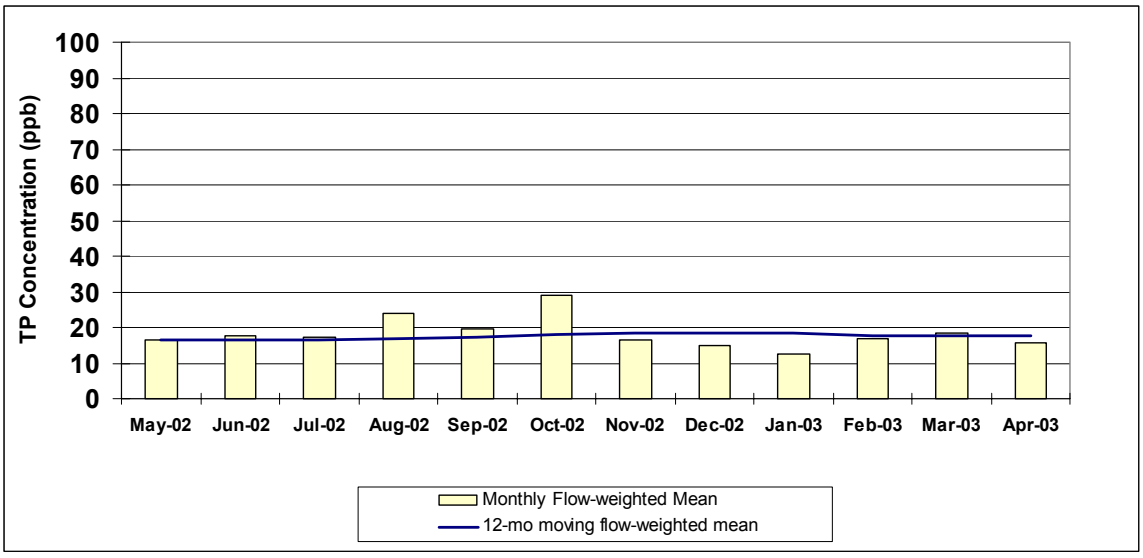



**Figure 4A-13.** Comparison of monthly to 12-month moving average phosphorus concentrations for Water Year 2003 for STA-2 outflow.

## STA-2 OTHER WATER QUALITY PARAMETERS

The monitoring data for non-phosphorus parameters at STA-2 during this reporting period are presented in Appendix 4A-5 and are summarized in **Table 4A-7**. Compliance with the EFA permit is determined based on the following three-part assessment:

1. If the annual average outflow concentration does not cause or contribute to violations of applicable Class III water quality standards, then STA-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 number 1 (above) for all parameters other than phosphorus and dissolved oxygen with applicable numeric state water standards. Annual average concentrations of dissolved chloride were slightly higher at the outflow compared to the inflow, although at this time it is not clear if this is due to groundwater interaction or not. However, because this parameter has no applicable numeric state water quality standard, STA-2 is deemed to be in full compliance with the permit. Additional requirements for dissolved oxygen are listed in Administrative Order AO-006-EV and are discussed below. Mercury monitoring results are also discussed below.

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 FDEP-approved CompQAP No. 870166G (June 1999).
- A signed copy of this statement is provided in Appendix 4A-2.

**Table 4A-7.** Summary of annual arithmetic averages and flow-weighted means for water quality parameters (other than total phosphorus) 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, flow-weighted means are calculated as the ratio of the cumulative product of the instantaneous flow and the sample concentration divided by the cumulative flow values.

| Parameter | Arithmetic Means | | | Flow-Weighted Means | | | |
|---|---|---|---|---|---|---|---|
| | Inflow | | Outflow | Total Inflow | | Total Outflow | |
| | S6 | G328 | G335 | n | Conc. | n | Conc. |
| Temperature (°C) | 25.2 | 25.2 | 25.0 | -NA- | -NA- | -NA- | -NA- |
| Dissolved Oxygen (mg/L) | 3.4 | 4.5 | 4.7 | -NA- | -NA- | -NA- | -NA- |
| Specific Conductivity (µmhos/cm) | 1,020 | 1,242 | 1,187 | -NA- | -NA- | -NA- | -NA- |
| pH | 7.5 | 7.5 | 7.6 | -NA- | -NA- | -NA- | -NA- |
| Turbidity (NTU) | 4.0 | 3.5 | 4.0 | -NA- | -NA- | -NA- | -NA- |
| Total Dissolved Solids (mg/L) | 665 | 765 | 752 | 15 (54) | 749 | 20 (27) | 709 |
| Unionized Ammonia (mg/L) | 0.0054 | 0.0059 | 0.0019 | 15 (54) | 0.0072 | 20 (27) | 0.0008 |
| Orthophosphate as P (mg/L) | 0.029 | 0.017 | 0.005 | 26 (92) | 0.047 | 35 (46) | 0.006 |
| Total Dissolved Phosphorus (mg/L) | 0.034 | 0.021 | 0.009 | 26 (92) | 0.052 | 35 (46) | 0.010 |
| Sulfate (mg/L) | 63.8 | 47.9 | 55.3 | 15 (54) | 76.2 | 20 (27) | 53.8 |
| Alkalinity (mg/L) | 257 | 298 | 281 | 15 (54) | 288 | 20 (27) | 261 |
| Dissolved Chloride (mg/L) | 136 | 187 | 176 | 15 (54) | 147 | 20 (27) | 162 |
| Total Nitrogen (mg/L) | 2.64 | 2.37 | 2.12 | 15 (52) | 3.61 | 20 (26) | 2.08 |
| Total Dissolved Nitrogen (mg/L) | 2.53 | 2.29 | 2.05 | 15 (52) | 3.48 | 20 (26) | 2.01 |
| Nitrate + Nitrite (mg/L) | 0.546 | 0.445 | 0.080 | 15 (52) | 1.107 | 20 (26) | 0.163 |

-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 dissolved oxygen (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 Hydrolab™, 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 for WY2003 are provided in **Table 4A-8**.

**Table 4A-8.** 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 | |
| 08/20/2002 | 08/23/2002 | ----- | ----- | ----- | C.25, C1, N.25 |
| 09/12/2002 | 09/19/2002 | S6 | G328 | G335 | ---------- |
| 12/02/2002 | 12/09/2002 | S6 | G328 | G335 | ---------- |
| 02/24/2003 | 02/28/2003 | ----- | ----- | ----- | C.25, C1, N.25, N1, S4 |
| 03/17/2003 | 03/20/2003 | S6 | G328 | G335 | ---------- |

## 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 cannot be made for WY2003, because Hydrolab™ deployment dates differed. (Monitoring sites are shown in **Figure 4A-14**.) However, to satisfy permit requirements, summary statistics for STA-2 outflows and WCA-2A marsh transect sites are presented in **Table 4A-9**. Notched box and whisker plots for the sites are presented in **Figure 4A-15**. The complete data sets collected at all sites during WY2003 are in Appendix 4A-6. The data indicate that diel DO concentrations in G-335 discharges are statistically greater than at marsh transect site C.25, not significantly different than at site N.25, and significantly lower than at sites N1, C1, and S4. In addition, the 25$^{th}$ percentile values for N.25 and C.25 are lower than that for G-335 discharges. This is likely the result of long-term phosphorus enrichment of these marsh areas, in which pre-daylight dissolved oxygen concentrations are frequently lowered to less than 2 mg/L due to excessive vegetative respiration.

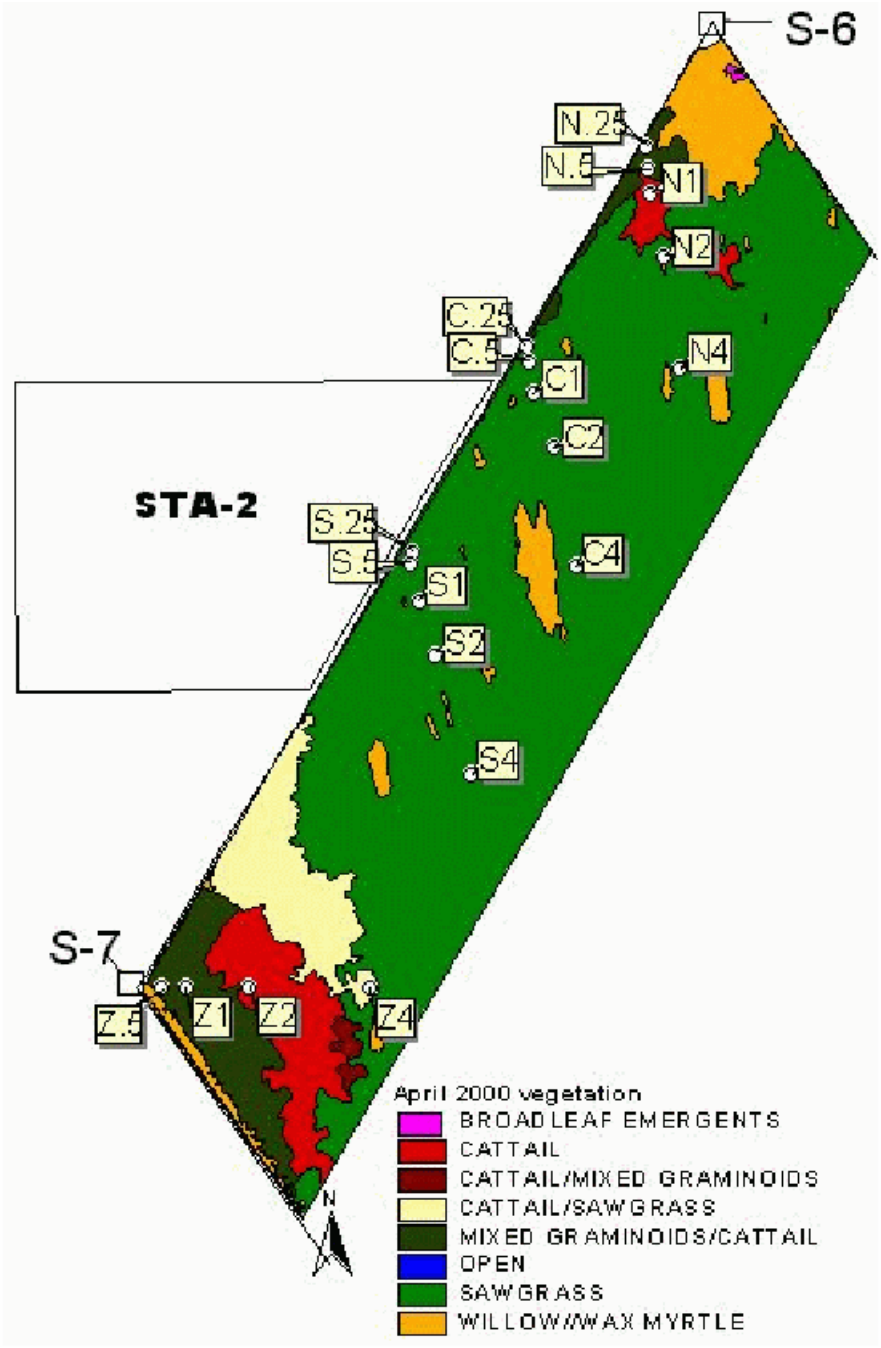



**Figure 4A-14.** Dissolved oxygen monitoring sites in WCA-2.

**Table 4A-9.** Statistical summary of diel dissolved oxygen at the outflow pump stations from STA-2 and marsh stations in WCA-2 during WY2003.

| Location | Station | Number of Measurements | Mean | Minimum | Median | Maximum | Standard Deviation |
|---|---|---|---|---|---|---|---|
| **Outflow** | G335 | 470 | 3.34 | 1.65 | 3.16 | 6.01 | 1.00 |
| **Transect C** | C.25 | 308 | 2.66 | 0.50 | 2.77 | 5.12 | 1.22 |
| | C1 | 310 | 4.75 | 0.72 | 4.56 | 10.11 | 2.40 |
| | C4 | 0 | -- No measurements made due to low water levels -- | | | | |
| **Transect N** | N.25 | 309 | 3.53 | 0.22 | 3.40 | 10.59 | 2.28 |
| | N1 | 179 | 4.63 | 2.24 | 4.54 | 7.24 | 1.36 |
| **Transect S** | S4 | 179 | 5.50 | 2.01 | 5.01 | 10.45 | 2.44 |
| **Transect Z** | Z.5 | 0 | -- No measurements made due to low water levels -- | | | | |
| | Z1 | 0 | -- No measurements made due to low water levels -- | | | | |
| | Z2 | 0 | -- No measurements made due to low water levels -- | | | | |
| | Z4 | 0 | -- No measurements made due to low water levels -- | | | | |

See Appendix 4A-6, Table 1 for statistical summaries by event and diel parameter.

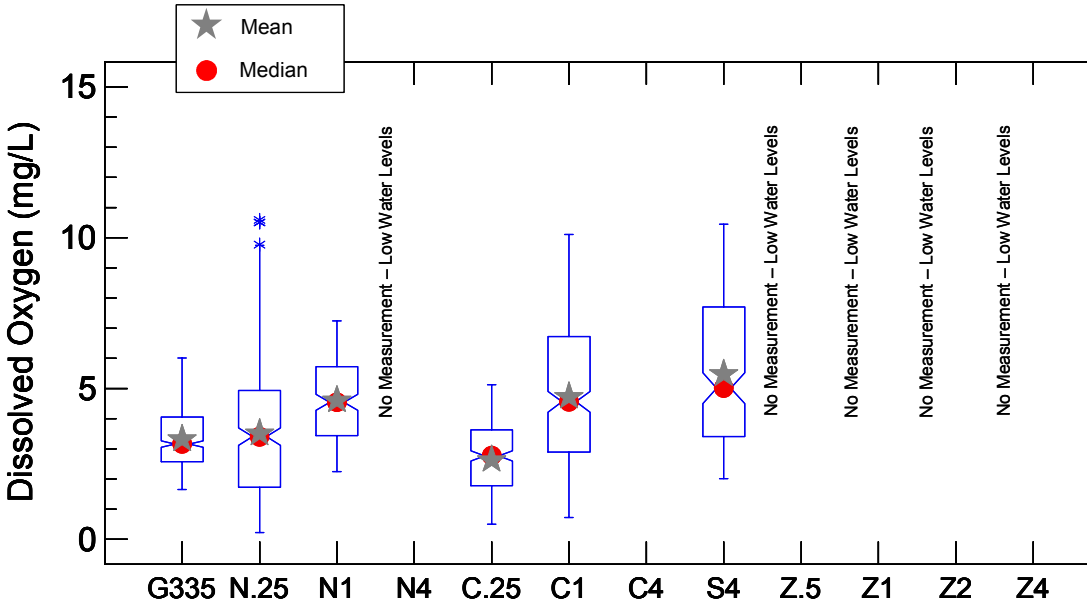



**Figure 4A-15.** Notched-box and whisker plots of diel dissolved oxygen measurements at the STA-2 outflow station (G-335) and along transect sites in Water Conservation Area 2 during three monitoring periods. The notch on a box plot represents the 95-percent confidence interval about the median, which is represented by the narrowest part of the notch. The top and bottom of the box represent the 75$^{th}$ and 25$^{th}$ 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-percent confidence level.

## STA-2 MERCURY

Exhibit D of each EFA permit issued by the FDEP to the District for the operation of the STAs requires pre-start, start-up, and routine mercury monitoring. Prior to start-up, six representative soil samples are analyzed for total mercury (THg) and methylmercury (MeHg) to establish baseline conditions. Soil monitoring continues triennially thereafter. During start-up, unfiltered water from the inflow and from a representative interior site are collected biweekly and analyzed for THg and MeHg until the interior is not significantly greater than the inflow. When all start-up requirements are met during routine operation, unfiltered water is collected quarterly at representative inflows and outflows and is then analyzed for THg and MeHg. In addition, THg is measured in mosquitofish collected semiannually and in sunfish and largemouth bass collected annually from representative inflow, interior, and outflow sites.

### Start-Up Monitoring Results

STA-2 Cells 3 and 2 met their mercury start-up requirements in September and November of 2000, respectively, but Cell 1 did not meet the requirements until recently. Based on data collected in November and December 2002, Cell 1 passed the start-up test described in the modified permit based on the stations identified for that purpose.

Pursuant to Condition 6.i of Exhibit D, following the first flooding of Cell 1 in the summer of 2000, the District notified the FDEP that STA-2 Cell 1 had experienced an anomalously high MeHg concentration spike in the fall of 2000. As an adaptive response, more intensive and extensive monitoring of water and fish was initiated in October 2000. A one-time soil study was also conducted in December 2000. Mosquitofish concentrations appeared to peak in March 2001 at more than 10 times the inflow concentration, but Cell 1 began to dry out in response to an emerging drought and was kept dry through July 2001. This also had the beneficial effect of precluding foraging by fish-eating birds.

### Permit Modification

As a consequence of the first MeHg anomaly, in July 2001 the District petitioned the FDEP for a permit modification that would allow flow-through operation of STA-2 Cell 1 to commence without meeting the mercury start-up criteria. This was intended to keep Cell 1 wet year-round while diluting the THg in rainfall and the internally produced MeHg. It was also hypothesized that the rate of internal MeHg production might be reduced by converting the excess sulfate in inflow water into inhibitory levels of sulfide in the peat soil porewater over time by maintaining a minimum of 15 cm (6 inches) of water at all times. The letter granting the permit modification was issued on August 9, 2001.

The modified permit requires the District to continue biweekly start-up monitoring while adding biweekly monitoring of combined discharge water, monthly monitoring of Cell 1 interior mosquitofish, and semiannual monitoring of interior sunfish. The modification also requires quarterly monitoring of mosquitofish and annual monitoring of sunfish at sites N4 and Z4 downstream of the discharge culverts from the L-6 levee into WCA-2A. An ecological risk assessment is also to be submitted to the FDEP at the end of one year of expanded monitoring – or immediately if both mosquitofish and sunfish have exceeded their respective 95$^{th}$ percentile upper bound THg concentrations for the Everglades as a whole. The purpose of the risk assessment is to quantify the likelihood of MeHg toxic effects in populations of fish-eating wading birds exposed to STA-2 fish. The results of the routine permit compliance monitoring are detailed in Appendix 4A-4. The results of modified permit mercury monitoring are detailed in Appendix 4A-7.

The modified permit monitoring requirements were instituted in August 2001. The modified permit is still in effect as of this writing. A second MeHg anomaly in STA-2 Cell 1 was detected in November 2001. After consulting with the FDEP, the District allowed Cell 1 to dry out in December 2001 to preclude build-up of this second MeHg pulse in the food chain. Thereafter, a laboratory study of the effect of drying and rewetting on Cell 1 soils was initiated in February 2002 by the U.S. Geological Survey (USGS) under a Cooperative Agreement between the District and the FDEP. The results of that study are contained in Appendix 2B-1 and are summarized in Appendix 2B-7. The results confirm that STA-2 Cell 1 soils are even more reactive to dryout and rewetting than the soils from the historical mercury "hot spot" in WCA-3A.

## Memorandum of Agreement

In August 2002, following another extended period of dryout, a "first flush" of excess MeHg was again observed in the interior and discharge from STA-2 Cell 1. As an adaptive management response, the District initiated special mercury studies in STA-2 to better understand and characterize these pulses and, if necessary, initiate appropriate corrective action. In STA-2, the special studies added monitoring of THg and MeHg in Cells 1, 2, and 3 outflows biweekly; interior water at three interior sites in each cell every four weeks; and mosquitofish, soil, and vegetation sampling at those same sites every four weeks, quarterly, and semiannually, respectively. Porewater sampling will commence using a modified in situ "sipper" method outside the reporting period in the early fall of 2003. The District commitment to conduct these studies was codified in a Memorandum of Agreement (MOA) with the FDEP. The MOA also commits the FDEP to fund research into the cause of and potential mitigative measures for these anomalies. The research will include modeling to predict the short- and long-term impacts of STA-2 discharges with and without these anomalies. The MOA was approved by the District's governing board in February 2003. The results of the District's special studies in STA-2 are summarized in Appendix 2B-7.

## Compliance Monitoring Results

Fortunately, immediate corrective action proved unnecessary, because the anomalous MeHg pulse was rapidly cleared from the system, as documented by the more frequent monitoring. Although the Cell 1 discharge exceeded the Florida Class III water quality standard (WQS) for THg of 12 ng/L in September 2002, the combined discharge from all three cells did not. Unfortunately, there is no WQS for MeHg, and the FDEP has declared the THg WQS deficient for purposes of protecting the sport fishery from MeHg bioaccumulation. This makes it difficult to evaluate the significance of the MeHg concentrations discharged from STA-2. Nevertheless, STA-2 was determined to be a net exporter of MeHg for the reporting period, based on the increased monitoring frequency. For perspective, the MeHg calculated to be discharged from STA-2 represented almost 50 percent of the total MeHg load from STA-1W, 2, 5, and 6 and from S-7, S-8, S-9, S-32, and S-140 combined. The individual loads were calculated as the annual average concentration multiplied by the annual total flow for the reporting period. For several structures, these estimates were compared to those based on quarterly monitoring with linear interpolation between sampling events and were found to be similar. For STA-2, these estimates were compared to those obtained using biweekly monitoring (every two weeks) and every other biweekly monitoring (every four weeks) and were found to produce results within 3 percent and 32 percent of the more accurate estimate, respectively. Nevertheless, the annual mass loads calculated in this way are for comparative purposes and should not be used in scientific, engineering, or regulatory application.

In STA-2 Cells 2 and 3, the interior and outflow mosquitofish, sunfish, and largemouth bass contained higher THg concentrations than the corresponding inflow fish, but the difference was not statistically significant at the 95$^{th}$ percentile confidence level. In STA-2 Cell 1, the

mosquitofish THg concentration exceeded the Everglades cumulative 95th percentile upper bound concentration in the Cell 1 interior beginning in August 2002, but the concentration declined to below that threshold in April 2003. The April 2003 mosquitofish THg concentration exceeded its Everglades-wide 95th percentile upper bound concentration at downstream site N4, but the average of sites N4 and Z4 did not. No sunfish could be collected at Site N4 because of the pre-existing degraded conditions of habitat quantity and quality. Sunfish collected in the Cell 1 interior in October 2002 and April 2003 did not exceed the Everglades-wide 95th percentile upper bound concentration, but sunfish collected at downstream site Z4 in April 2003 did. The sunfish concentrations at sites C1X and Z4 may be high enough to put some sensitive members of highly exposed wading bird populations at an increased risk of toxic effects from MeHg. In addition, the average largemouth bass THg concentration (adjusted to age class 3 years) in Cells 2 and 3 did not exceed the Florida fish consumption advisory level of 0.5 ppm wet weight. (No bass could be collected from the interior of Cell 1.) By contrast, the average age-adjusted THg concentration in bass in the STA-2 outflow canal was more than twice the 0.5 ppm advisory threshold value.

### Findings, Conclusions, and Recommendations

The mercury situation at STA-2 still must be considered problematic, although the trends in water, soil, and fish mercury concentrations are encouraging. Unlike STA-6 Cells 3 or 5, STA-2 Cell 1 requires many months to reach steady state conditions after a dryout MeHg anomaly. During this period, MeHg export and buildup in the food chain can be excessive. Efforts to prevent dryout in STA-2 Cell 1 – including raising the Cell 1 outflow weir heights – have been successful. Unfortunately, the present water reservation policy does not allow for the diversion of water to the STAs from higher-priority users during extended dry periods, so the eventual dryout of Cell 1 is inevitable. This complicates the District's efforts to manage water depths to minimize post-dryout MeHg anomalies. Further research is required into why STA-2 Cell 1 behaves so much differently than STA-6 Cells 3 and 5, for example. This research should also benefit CERP projects trying to avoid a first-flush mercury problem. Such studies need to include porewater sampling for MeHg and sulfide analysis to evaluate the degree to which sulfide inhibition of MeHg production is occurring in each treatment cell and to determine the influences of other soil constituents on that cause-effect relationship.

## STA-3/4

STA-3/4 will be the largest of the STAs, with approximately 16,600 acres of effective treatment area (**Figure 4A-16**). During an average year, STA-3/4 should receive approximately 350,000 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. Current projections of performance indicate that even without the planned enhancements, STA-3/4 should perform better than originally expected, reducing phosphorus to approximately 36 ppb with proportionately improved load reduction. Construction on STA-3/4 commenced in November 2000 with the award of the inflow pump stations equipment contract. The initial construction contracts (supply canal and L-5 enlargement) were awarded in January 2001. In July 2001, the interior works contract and the U.S. 27 bridges contract were awarded. The final construction contract was awarded in August 2001 for the construction of the inflow pump stations. All construction was scheduled to be completed by the October 1, 2003 date indicated in the Everglades Forever Act (EFA) and in the federal Everglades Settlement Agreement. STA-3/4 will use the existing S-7 and S-8 pump stations as the outflow facilities. Refurbishment of those stations is underway.

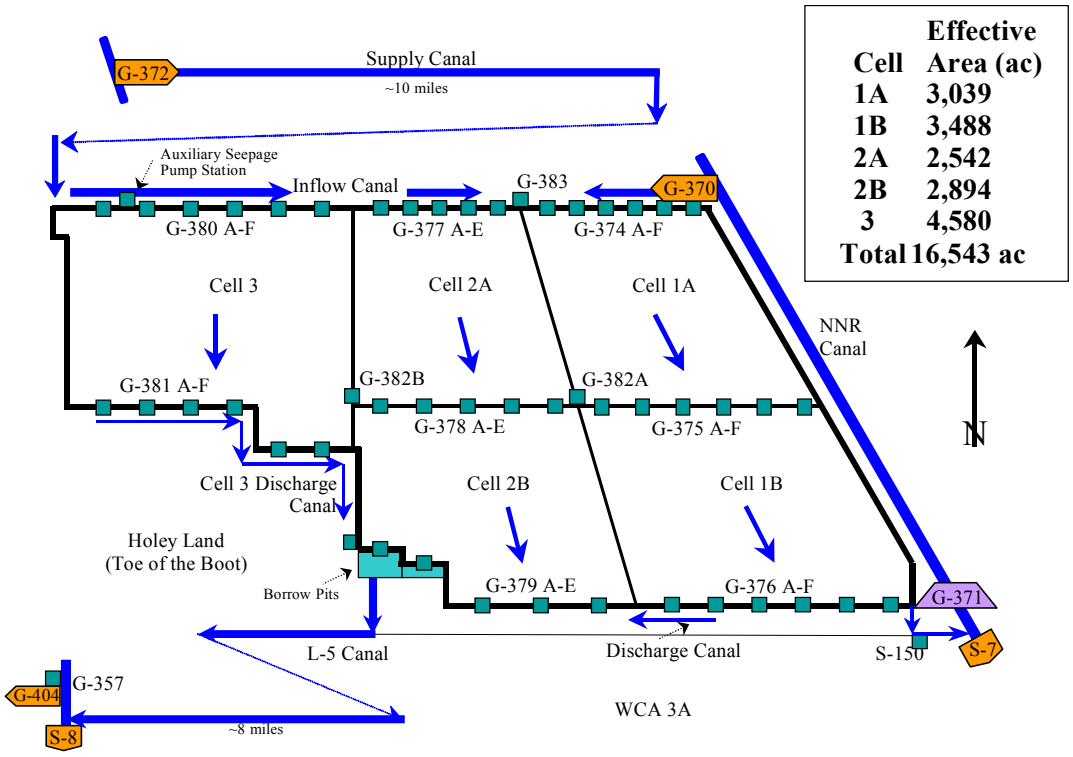



**Figure 4A-16.** Schematic of STA-3/4 (not to scale).

Construction is complete for the supply canal, the L-5 canal, and the U.S. 27 bridges projects. Three contracts remain to be completed: the contract for the interior levees and water control structures (referred to as the "Works contract"), and the pump station contracts for construction and for equipment. Management of construction dewatering and rainfall has been directed at developing vegetation in the interior cells to accelerate the start-up period prior to discharge.

Three of the construction contracts for STA-3/4 were awarded to the IT Corporation, which filed for bankruptcy in January 2002. Although work continued on the three contracts during the period of January through May 2002, progress was slow due to contractor financial issues. The Shaw Group purchased IT in May 2002 and assumed management of the three contracts. Two of the three Shaw Group contracts (the supply canal and L-5 canal projects) are now substantially complete, but the Works contract remains behind schedule. The Shaw Group has submitted a recovery schedule for the Works, contract showing completion by October 2003, but work has not accelerated sufficiently to meet that date. The most recent (July 10, 2003) schedule update shows the project to be about six months behind schedule. It is doubtful that the six months can be made up. However, a plan to achieve the beginning of the start-up operations phase (i.e., initial flooding of the cells) for each of the three flow-ways has been developed. The most current estimate is that flow-ways 1 and 2 will be flooded in October 2003, allowing start-up operations to begin.

The final completion of the Works contract and of separate contracts for power and telemetry are presently anticipated to be completed by June 2004. This coincides with the estimated

beginning of flow-through operations. The structures will be operated manually using a portable generator set in the start-up phase to allow regulation of flows to meet vegetation grow-in requirements.

The District is proceeding with the detailed design of the STA-3/4 enhancements, and construction should begin in 2004. The enhancements consist of an additional levee in Cell 3 to create two treatment cells in series, as well as conversion of emergent vegetation in Cells 1B and 3B into submerged aquatic vegetation (SAV). The District is also developing a plan to implement a Periphyton-Based Stormwater Treatment Area (PSTA) demonstration project in Cell 2B.

## STA-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 4A-17**. Based on the 1979 through 1988 period of flow, and on TP data used during design, it was assumed that STA-5 would receive a long-term average annual discharge of approximately 104,000 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 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*.

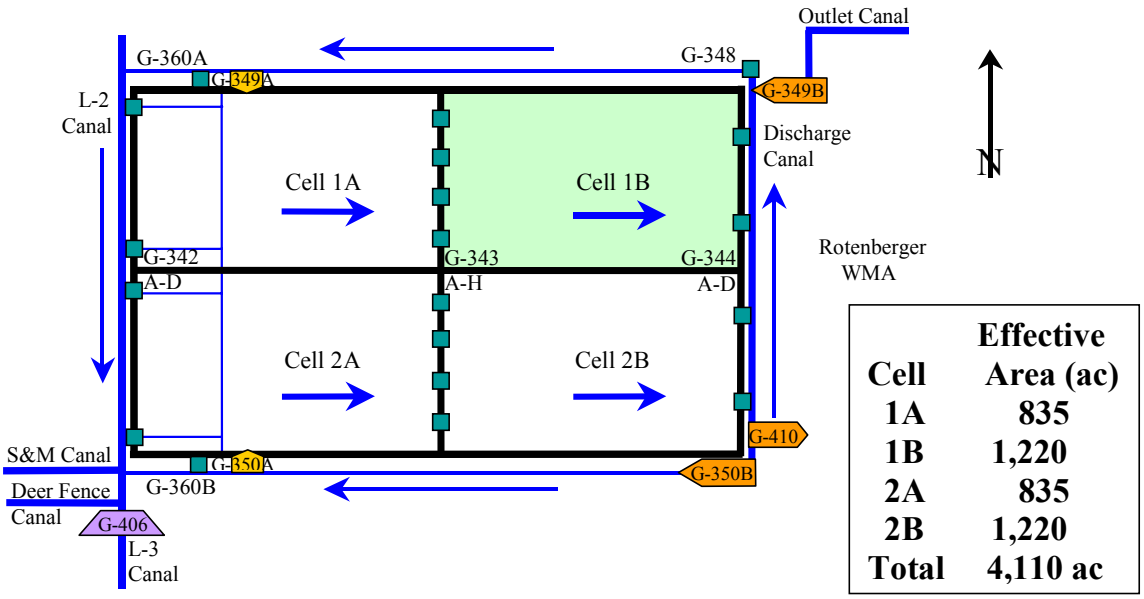
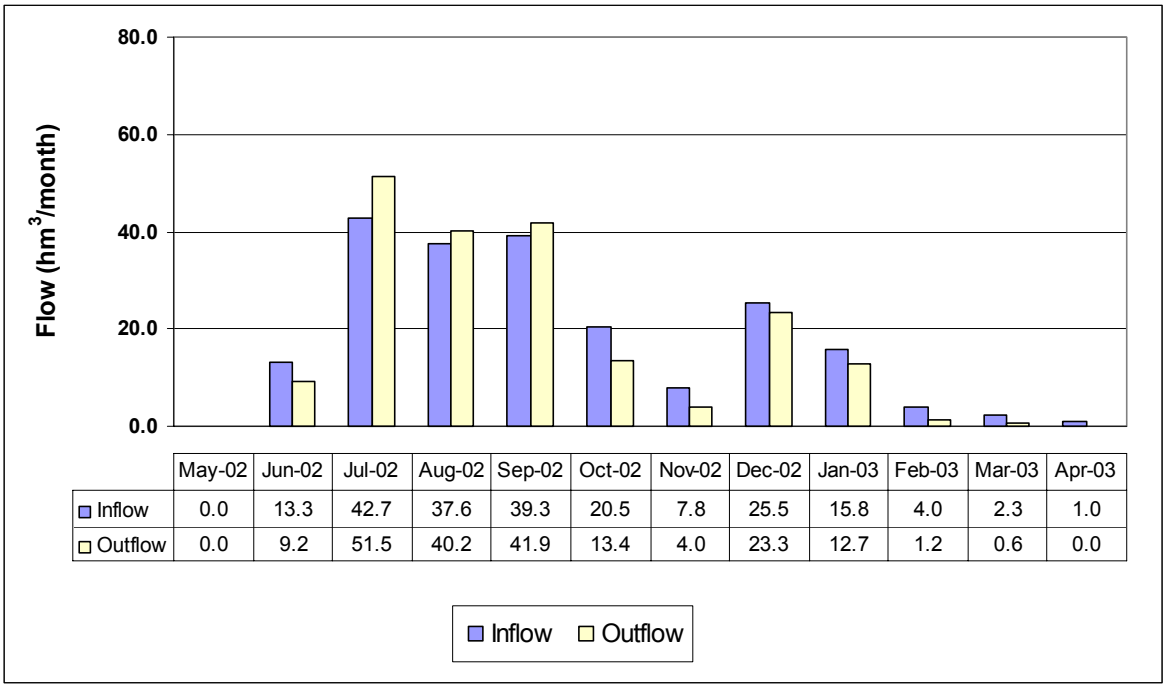



**Figure 4A-17.** Schematic of STA-5 (not to scale).

## STA-5 OPERATIONS

During WY2003, approximately 210 $hm^3$ (170,203 ac-ft) of water were captured and treated by STA-5. This is about 62 percent more than the anticipated average annual flow assumed during design, although the design anticipated annual variability. This surface inflow equates to an average hydraulic loading rate of 3.45 cm/day over the effective treatment area of the STA. During this reporting period, only Cell 2B in STA-5 experienced dryout conditions in May 2002. During WY2003, approximately 39,070 acre feet of C-139 basin runoff were 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 scheduled for completion by December 2006. A summary of monthly STA-5 flow is presented in **Figure 4A-18**.




| | May-02 | Jun-02 | Jul-02 | Aug-02 | Sep-02 | Oct-02 | Nov-02 | Dec-02 | Jan-03 | Feb-03 | Mar-03 | Apr-03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 0.0 | 13.3 | 42.7 | 37.6 | 39.3 | 20.5 | 7.8 | 25.5 | 15.8 | 4.0 | 2.3 | 1.0 |
| Outflow | 0.0 | 9.2 | 51.5 | 40.2 | 41.9 | 13.4 | 4.0 | 23.3 | 12.7 | 1.2 | 0.6 | 0.0 |

**Figure 4A-18.** Summary of Water Year 2003 flows for STA-5 (Note: 1 $hm^3$ = 810.7 ac-ft).

## STA-5 VEGETATION MANAGEMENT

Specific Condition 13(b) of the Everglades Forever Act (EFA) permit requires that the annual Everglades Consolidated Report include information regarding the application of herbicides used to exclude and/or eliminate undesirable vegetation within the treatment cells. For this reporting period, the District applied a total of 291 gallons of the herbicide Glyphosate, 965 gallons of 2,4-D, 1,635 gallons of Reward to the marsh area, and 10 gallons of Garlon 3A and 6 gallons of Arsenal to the levees and berms to control nuisance vegetation. Both aerial and ground-based spray equipment were used to apply these herbicides. Additional vegetation management was necessary in order to control undesirable floating aquatic vegetation to ensure favorable conditions for the development of submerged aquatic vegetation (SAV).

Dramatic improvement in the northern flow-way phosphorus removal performance was observed after the vegetation management activities.

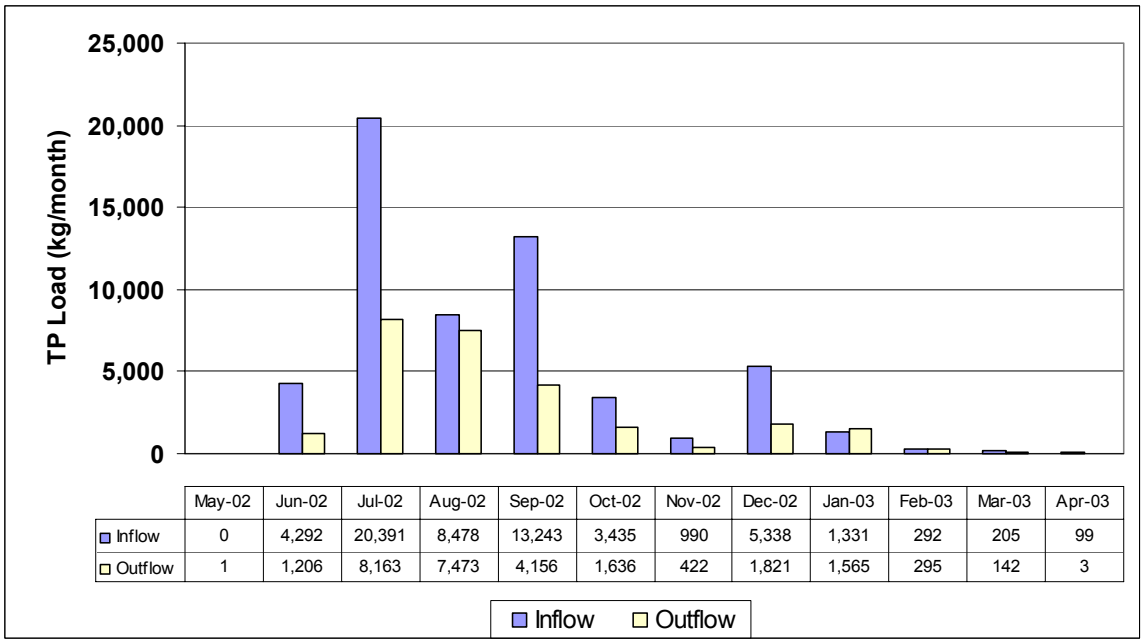
## STA-5 PERMIT WATER QUALITY MONITORING

The data presented in this section demonstrate that STA-5 was in compliance with the EFA and National Pollution Discharge Elimination System (NPDES) operating permits for WY2002, 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

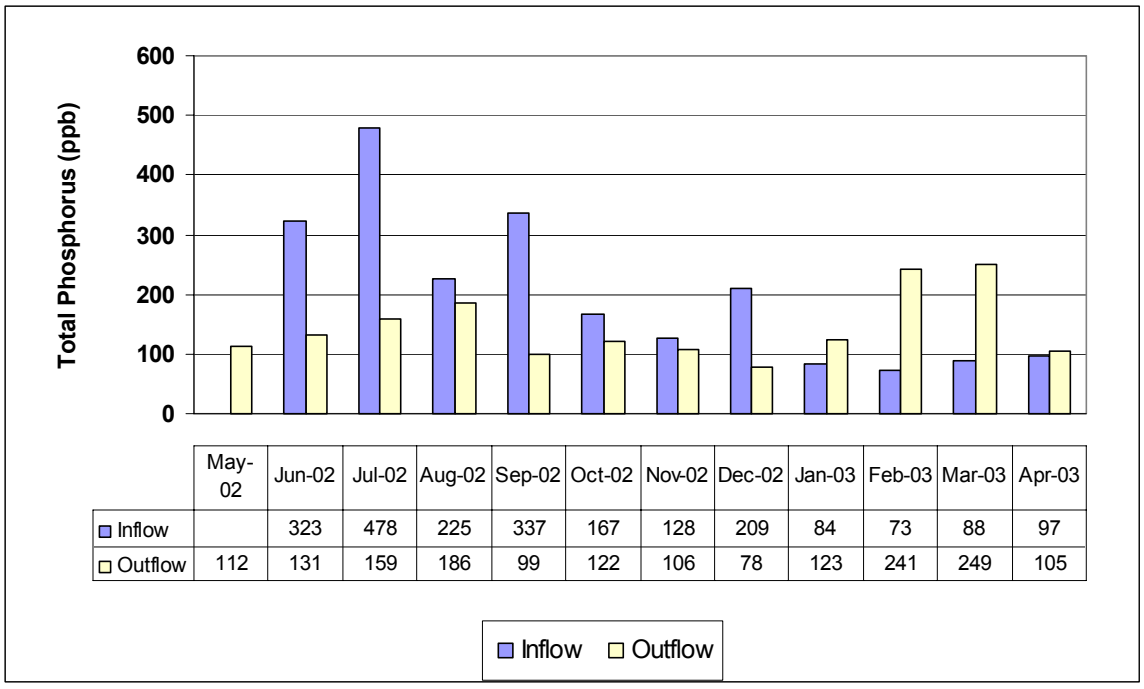
During WY2003, STA-5 received 58 mt of total phosphorus (TP). This nutrient load was approximately 70 percent more than the annual average load anticipated during the design of the treatment area. STA-5 removed approximately 31.2 mt of TP during WY2003, equal to a removal rate of approximately 3.48 grams per square meter per year. This removal rate exceeded the target removal rate of about 1.52 grams per square meter per year. As a result of above-normal runoff from the C-139 basin, approximately 39,070 ac-ft of stormwater carrying approximately 13.7 mt of TP was diverted around STA-5 through the G-406 structure.

During WY2003, STA-5 reduced outflow loads of TP by 54 percent compared to inflow loadings. Summaries of monthly TP loads and flow-weighted mean TP concentrations are presented in **Figures 4A-19** and **4A-20**. Monthly outflow TP concentrations from STA-5 from May through December 2002 were considerably lower than inflow concentrations. During the remainder of the water year, individual monthly outflow TP concentrations were higher than in the inflow due to reductions in flow volumes within the treatment areas. The flow-weighted mean outflow TP concentration was 136 ppb. This was a 51-percent reduction from the inflow concentration of 277 ppb. 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 Best Management Practice (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 flow-weighted mean TP outflow concentration for STA-5 increased from 78 to 136 ppb over the course of WY2003 (see **Figure 4A-21**). For informational purposes, the geometric mean discharge TP concentration for STA-5 was 134 ppb for WY2003.




| | May-02 | Jun-02 | Jul-02 | Aug-02 | Sep-02 | Oct-02 | Nov-02 | Dec-02 | Jan-03 | Feb-03 | Mar-03 | Apr-03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 0 | 4,292 | 20,391 | 8,478 | 13,243 | 3,435 | 990 | 5,338 | 1,331 | 292 | 205 | 99 |
| Outflow | 1 | 1,206 | 8,163 | 7,473 | 4,156 | 1,636 | 422 | 1,821 | 1,565 | 295 | 142 | 3 |

**Figure 4A-19.** Summary of Water Year 2003 phosphorus loads for STA-5.




| | May-02 | Jun-02 | Jul-02 | Aug-02 | Sep-02 | Oct-02 | Nov-02 | Dec-02 | Jan-03 | Feb-03 | Mar-03 | Apr-03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | | 323 | 478 | 225 | 337 | 167 | 128 | 209 | 84 | 73 | 88 | 97 |
| Outflow | 112 | 131 | 159 | 186 | 99 | 122 | 106 | 78 | 123 | 241 | 249 | 105 |

**Figure 4A-20.** Summary of Water Year 2003 total phosphorus (TP) concentrations for STA-5.

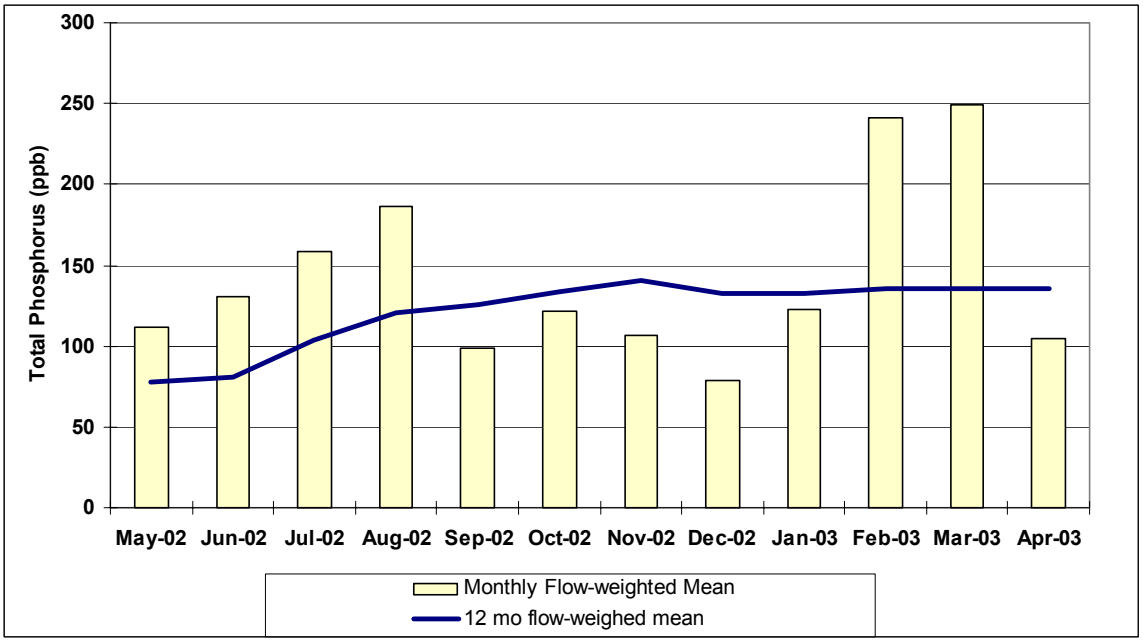



**Figure 4A-21.** Comparison of monthly to 12-month moving average phosphorus concentrations for Water Year 2003 for STA-5 outflow.

## STA-5 OTHER WATER QUALITY PARAMETERS

The monitoring data for non-phosphorus parameters at STA-5 during this reporting period are presented in Appendix 4A-8 and summarized in **Table 4A-10**. While Ametryn and Atrazine were detected in the outflow, this herbicide is not used within the 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-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 number 1 (above) for all parameters other than phosphorus and dissolved oxygen with applicable numeric state water standards. Alkalinity and un-ionized ammonia concentrations were higher at the outflow compared to the inflow, but these concentrations do not exceed the Class III numeric standards. Annual average concentrations of total dissolved solids, orthophosphate, total dissolved phosphorus, dissolved chloride, Ametryn, and Atrazine 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. It is interesting to note that inflow concentrations of sulfate are considerably lower for STA-5 than for the other STAs, and the percent reduction within the STA is higher. However, at this time the causes or significance are unclear. Additional requirements for dissolved oxygen are listed in Administrative Order AO-004-EV and are discussed below. Mercury monitoring results are also discussed below.

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 FDEP-approved CompQAP No. 870166G (June 1999).
- A signed copy of this statement is provided in Appendix 4A-2.

**Table 4A-10.** Summary of annual arithmetic averages and flow-weighted means for water quality parameters (other than total phosphorus) monitored in STA-5. For the purpose of these comparisons, flow-weighted means are calculated as the ratio of the cumulative product of the instantaneous flow and the sample concentration divided by the cumulative flow values.

| 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) | 25.5 | 25.2 | 25.2 | 24.9 | 23.2 | 23.5 | 23.2 | 23.4 | -NA- | -NA- | -NA- | -NA- |
| Dissolved Oxygen (mg/L) | 4.6 | 4.3 | 4.2 | 4.7 | 2.4 | 2.3 | 2.0 | 2.6 | -NA- | -NA- | -NA- | -NA- |
| Specific Conductivity (µmhos/cm) | 530 | 546 | 546 | 555 | 555 | 553 | 592 | 594 | -NA- | -NA- | -NA- | -NA- |
| pH | 7.4 | 7.4 | 7.4 | 7.5 | 7.3 | 7.3 | 7.2 | 7.3 | -NA- | -NA- | -NA- | -NA- |
| Turbidity (NTU) | 4.4 | 3.8 | 3.2 | 4.0 | 2.8 | 2.5 | 1.7 | 1.6 | -NA- | -NA- | -NA- | -NA- |
| Total Dissolved Solids (mg/L) | 352 | 361 | 357 | 352 | 361 | 360 | 381 | 388 | 81 (104) | 311 | 58 (104) | 310 |
| Unionized Ammonia (mg/L) | 0.0009 | 0.0010 | 0.0010 | 0.0009 | 0.0020 | 0.0016 | 0.0003 | 0.0003 | 77 (100) | 0.0014 | 55 (100) | 0.0015 |
| Orthophosphate as P (mg/L) | 0.052 | 0.075 | 0.093 | 0.094 | 0.092 | 0.114 | 0.129 | 0.088 | 138 (180) | 0.110 | 92 (178) | 0.102 |
| Total Dissolved Phosphorus (mg/L) | 0.064 | 0.086 | 0.105 | 0.106 | 0.115 | 0.132 | 0.143 | 0.099 | 138 (180) | 0.124 | 92 (180) | 0.114 |
| Sulfate (mg/L) | 8.8 | 9.6 | 9.2 | 9.2 | 4.3 | 4.5 | 4.9 | 5.3 | 81 (104) | 9.0 | 56 (102) | 4.4 |
| Alkalinity (mg/L) | 178 | 188 | 195 | 205 | 161 | 164 | 211 | 214 | 81 (104) | 154 | 58 (104) | 164 |
| Dissolved Chloride (mg/L) | 53 | 54 | 50 | 45 | 72 | 70 | 57 | 57 | 81 (104) | 42 | 58 (104) | 44 |
| Total Nitrogen (mg/L) | 1.60 | 1.49 | 1.47 | 1.42 | 1.99 | 1.90 | 1.56 | 1.52 | 76 (99) | 1.58 | 55 (98) | 1.54 |
| Total Dissolved Nitrogen (mg/L) | 1.33 | 1.28 | 1.25 | 1.17 | 1.72 | 1.67 | 1.41 | 1.39 | 76 (99) | 1.42 | 55 (98) | 1.40 |
| Nitrate + Nitrite (mg/L) | 0.065 | 0.041 | 0.037 | 0.030 | 0.036 | 0.023 | 0.013 | 0.022 | 76 (99) | 0.059 | 55 (98) | 0.022 |
| Ametryn (µg/L) | 0.005 | 0.005 | 0.005 | 0.005 | 0.015 | 0.014 | 0.010 | 0.009 | 12 (16) | 0.010 | 7 (16) | 0.010 |
| Atrazine (µg/L) | 0.075 | 0.054 | 0.050 | 0.051 | 0.163 | 0.200 | 0.090 | 0.104 | 12 (16) | 0.025 | 7 (16) | 0.012 |

-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 same dissolved oxygen (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-344A and G-344D, to provide representative data whether the discharge is to the Miami Canal, the Rotenberger Wildlife Management Area 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 Rotenberger Wildlife Management Area (**Figure 4A-22**), to measure effects of STA-5 discharges to the Rotenberger Wildlife Management Area.

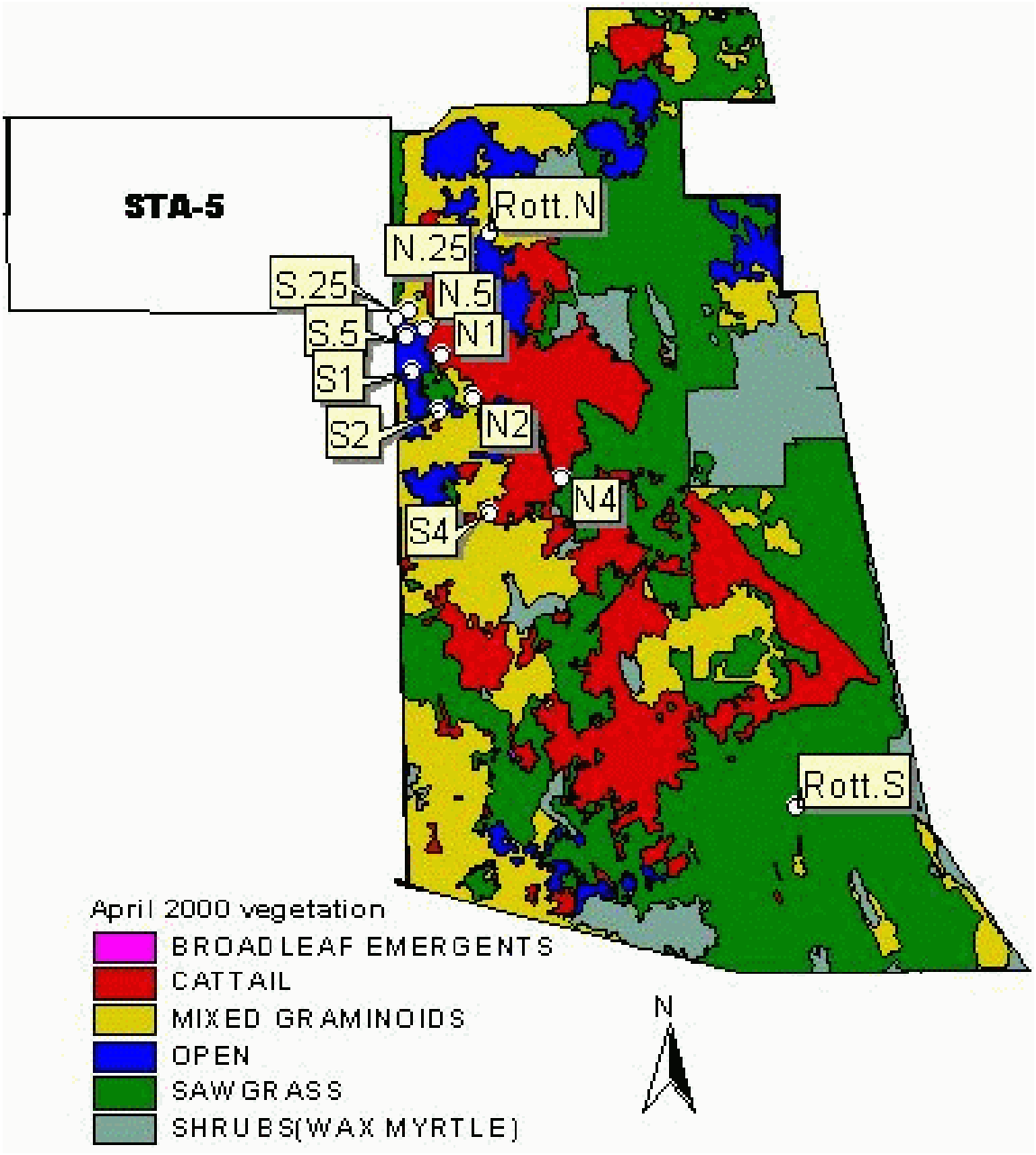



**Figure 4A-22.** Dissolved oxygen monitoring sites in the Rotenberger Tract.

## Sampling Dates

Diel oxygen measurement dates and sites for WY2003 are provided in **Table 4A-11**. No measurements were made in the Rotenberger tract marsh in WY2003 due to low water levels.

**Table 4A-11.** Deployment dates for diel oxygen measurement at STA-5 structures, sites in the Miami Canal, and Rotenberger Tract marsh sites

| Event Dates | | Structures | | Miami Canal Sites | | Sites Monitored in Rotenberger Tract |
|---|---|---|---|---|---|---|
| Start | End | Outflow | | | | |
| 06/17/2002 | 06/24/2002 | G344A | G344D | NMC | SMC | ---------- |
| 08/27/2002 | 09/03/2002 | G344A | G344D | NMC | SMC | ---------- |
| 12/19/2002 | 12/23/2002 | G344A | G344D | NMC | SMC | ---------- |
| 03/24/2003 | 03/27/2003 | G344A | G344D | NMC | SMC | ---------- |

## 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 oxygen cycle.

The summary statistics for STA-5 discharges and the downstream sites are presented in **Table 4A-12**. The complete data sets collected during WY2002 are presented in Appendix 4A-9. Examination of this table shows that median, mean, and maximum DO concentrations in discharges from G-344A are greater than those from G-344D. The notched box and whisker plots for these sites show that G-344A has a significantly higher median DO concentration than G-344D (**Figure 4A-23**). The north Miami Canal site (NMC) median and mean DO concentrations are higher than the south Miami Canal (SMC) values. The notched box and whisker plots show that G-334A is significantly greater than G-344D, NMC, and SMC. In addition, the NMC is significantly greater than the SMC (**Figure 4A-23**). This indicates that the STA discharges entering the Miami Canal have a significant decrease on Miami Canal DO concentrations, although the decrease was less than 0.5 mg/L. In addition, the 25th percentile value for the SMC was less than the NMC, indicating a somewhat negative influence of the STA-5 discharge on Miami Canal DO concentrations. There are no other inflows into the Miami Canal between the NMC and SMC monitoring sites that could be contributing to the lower dissolved oxygen conditions at SMC.

**Table 4A-12.** Statistical summary of diel dissolved oxygen at the outflow stations from STA-5, stations in the Miami Canal and marsh stations in the Rotenberger Tract during four deployment periods

| Location | Station | Number of Measurements | Mean | Minimum | Median | Maximum | Standard Deviation |
|---|---|---|---|---|---|---|---|
| **Outflow** | G344A | 478 | 4.86 | 2.76 | 4.83 | 7.65 | 1.08 |
| | G344D | 837 | 1.99 | 0.29 | 1.97 | 5.20 | 1.13 |
| **Miami Canal** | NMC | 814 | 3.62 | 0.10 | 3.20 | 9.64 | 1.70 |
| | SMC | 861 | 2.45 | 0.03 | 2.77 | 4.62 | 1.31 |
| **Transect N** | N.25 | 0 | -- No measurements made due to low water levels -- | | | | |
| | N1 | 0 | -- No measurements made due to low water levels -- | | | | |
| | N4 | 0 | -- No measurements made due to low water levels -- | | | | |
| **Transect S** | S.25 | 0 | -- No measurements made due to low water levels -- | | | | |
| | S1 | 0 | -- No measurements made due to low water levels -- | | | | |
| | S4 | 0 | -- No measurements made due to low water levels -- | | | | |

See Appendix 4A-9 Table 1 for statistical summaries by event and diel parameter.

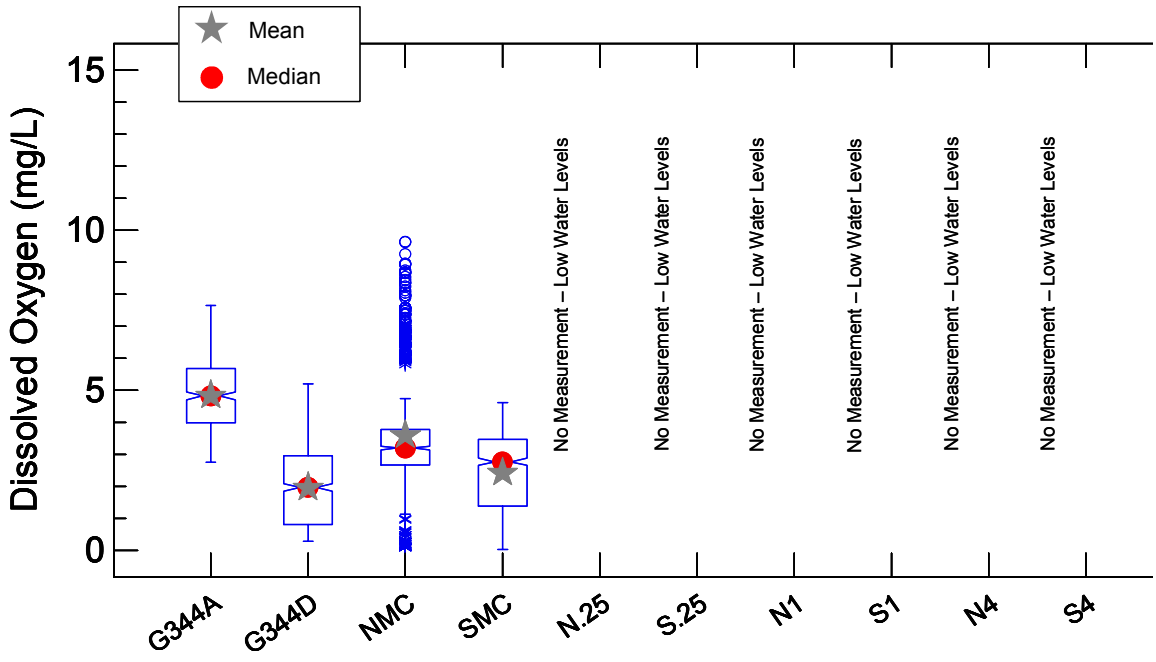



**Figure 4A-23.** Notched-box and whisker plots of diel dissolved oxygen measurements at the STA-5 outflow stations (G-344A and G-344D), at sites in the Miami Canal (NMC and SMC), and along transect sites in the Rotenberger tract during four monitoring periods. The notch on a box plot represents the 95-percent confidence interval about the median, which is represented by the narrowest part of the notch. The top and bottom of the box represent the 75$^{th}$ and 25$^{th}$ 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-percent confidence level.

## STA-5 MERCURY

For each STA, the operating permits require the District to monitor total mercury (THg) and methylmercury (MeHg) in soils at six representative sites. These sites are monitored biweekly prior to flooding, and triennially thereafter, in start-up inflow and interior water from a representative site, until the interior is not significantly greater than the inflow, and in representative inflows and outflows quarterly thereafter. In addition, THg is measured in mosquitofish collected semiannually and in sunfish and largemouth bass collected annually from representative inflow, interior, and outflow sites. These monitoring requirements are contained in Exhibit D of each state permit. The mercury performance of each STA for the reporting year is discussed in Appendix 4A-4.

During the monitoring period, there were no violations of the Florida Class III numerical water quality standard (WQS) of 12 ng/L for THg. In STA-5, the interior and outflow mosquitofish, sunfish, and largemouth bass contained higher THg concentrations than the corresponding inflow fish, but the difference was not statistically significant at the 95$^{th}$ percentile confidence level. In addition, the average largemouth bass THg concentration (adjusted to age class 3 years) did not exceed the Florida fish consumption advisory level of 0.5 ppm wet weight.

## 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 (Rotenberger WMA) 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 (**Figure 4A-24**) 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 Rotenberger WMA. This pump station distributes water through a 3.5 mile-long spreader canal located parallel to the west perimeter levee of the Rotenberger WMA. Discharges out of the Rotenberger WMA go into the Miami Canal through four gated culverts (G-402 A-D) along the eastern boundary of the Rotenberger WMA. There is a quarter-mile-long collection canal upstream of each outlet structure.

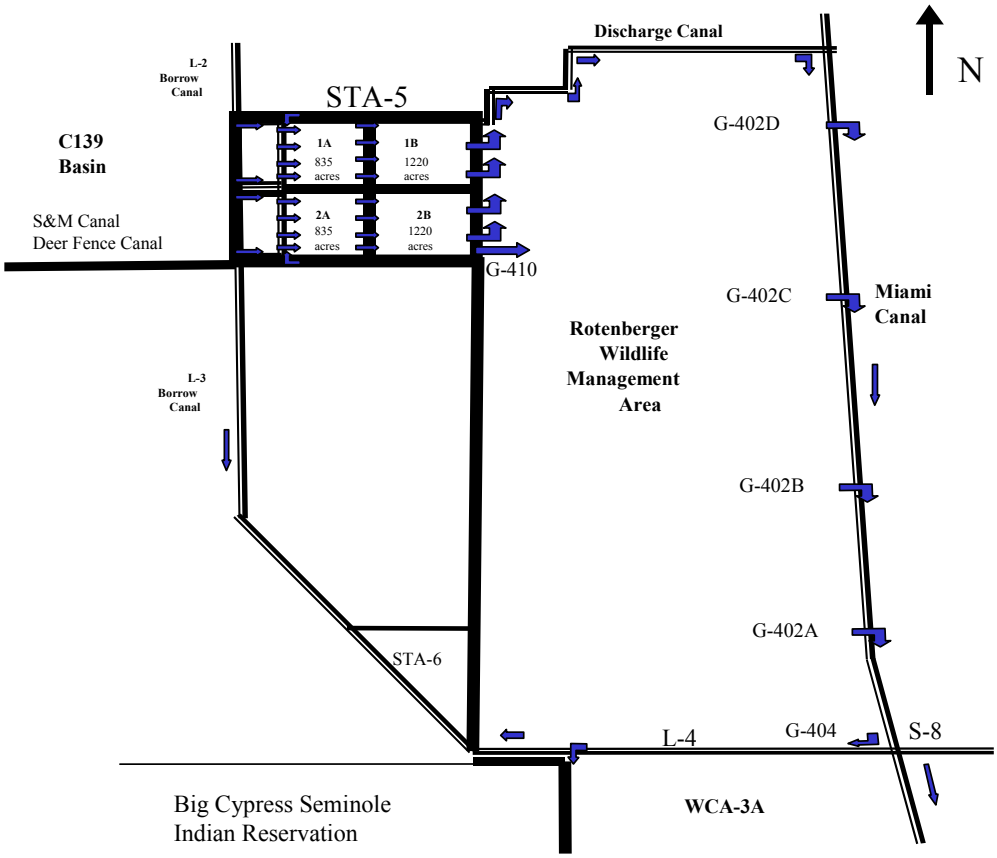



**Figure 4A-24.** Schematic of the Rotenberger Wildlife Management Area (not to scale).

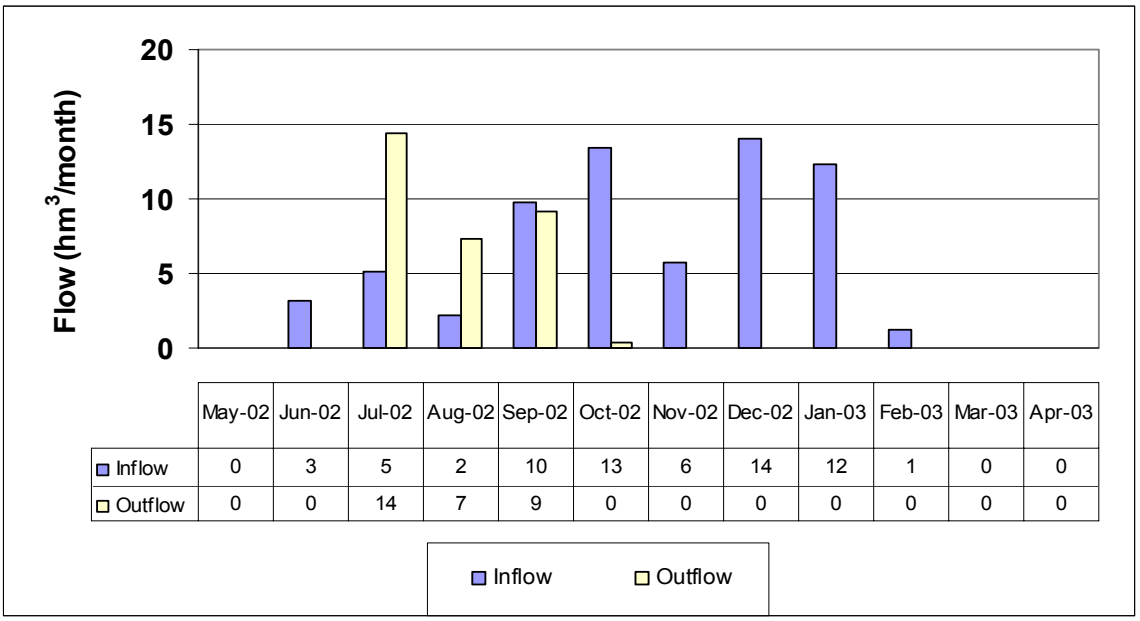
The FDEP issued a modification to the STA-5 EFA permit to include construction and operational authorization for the project in October 2000. This permit established a phased approach to restoration and recognizes an interagency group, including representatives from the FDEP, the Florida Fish and Wildlife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

Accordingly, this interagency group met on July 14, 2003. Representatives from the USACE, the FDEP, the FWC, the U.S. Fish and Wildlife Service, the Miccosukee Tribe of Indians, and the District were present. The purposes of this meeting were as follows: (1) update the interagency group on the latest ecological conditions within the Rotenberger WMA, (2) identify any effects the first two years of interim operations have had on the Rotenberger WMA, (3) determine if adverse impacts exceed environmental benefits, and (4) decide if modification of interim operations will be necessary.

In summary, it was agreed that in accordance with the phased approach toward restoration of the Rotenberger WMA, as recognized in the EFA permit, the first two years of project operation have provided initial downstream benefits. It was determined that the project should continue to follow the existing interim operational plan, with the addition of a water quality element. In brief, the new water quality element recommends limiting the operation of the G-410 inflow pump station when STA-5 discharge phosphorus concentrations (the source water for G-410) are equal to or less than 50 ppb for the vast majority of time. The new water quality element also recommends that only when water levels are critically low during the dry season should G-410 be allowed to operate for short intervals of time when STA-5 discharge phosphorus concentrations are above 70 ppb.

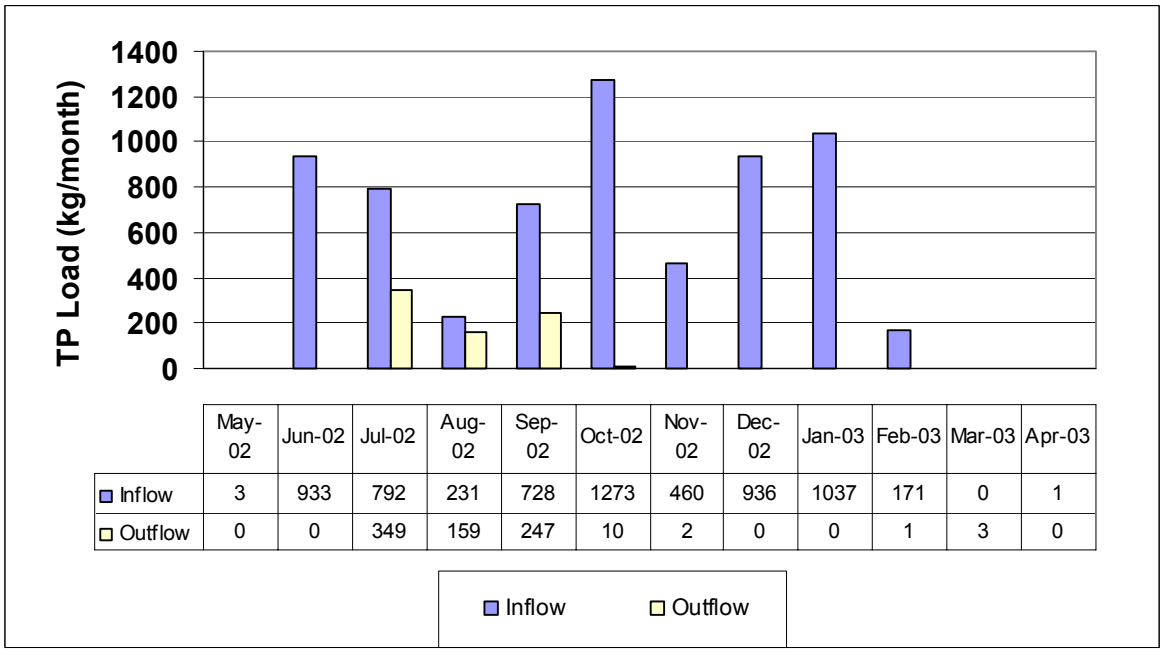
Interagency direction to the District was to continue project operations and monitoring and to provide annual updates on the progress being made toward ultimate restoration goals. The District will be conducting an analysis to determine if reductions in interior transect monitoring are appropriate. The next interagency update on the progress toward the Rotenberger WMA restoration will be in July 2004. At that time, interior vegetative coverage maps will be available for further evaluation of project benefits.

For WY2003, approximately 67 $hm^3$ (54,309 ac-ft) were directed into the Rotenberger WMA through G-410, while approximately 31 $hm^3$ (25,409 ac-ft) were discharged to the Miami Canal from the outlet structures (**Figures 4A-23** and **4A-24**). The flow-weighted mean inflow TP concentration was 98 ppb, yielding a total TP inflow load of about 6,566 kg (**Figures 4A-25** and **4A-26**). As the treatment system in STA-5 stabilizes, TP levels entering the Rotenberger WMA are anticipated to decrease. TP concentrations leaving the Rotenberger WMA averaged 25 ppb (**Figure 4A-27**).



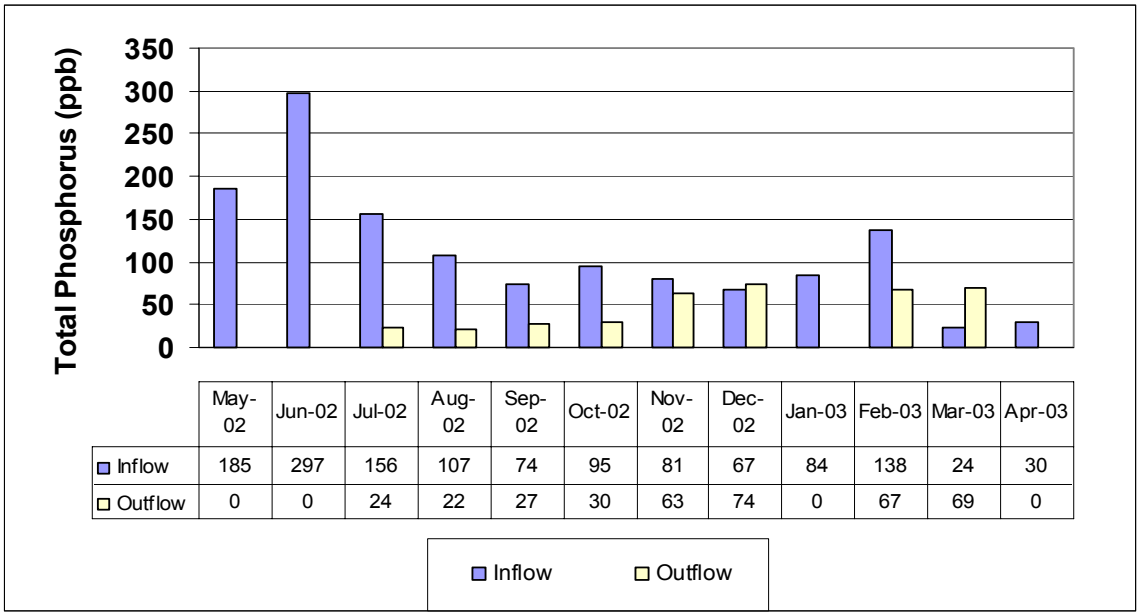

| | May-02 | Jun-02 | Jul-02 | Aug-02 | Sep-02 | Oct-02 | Nov-02 | Dec-02 | Jan-03 | Feb-03 | Mar-03 | Apr-03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 0 | 3 | 5 | 2 | 10 | 13 | 6 | 14 | 12 | 1 | 0 | 0 |
| Outflow | 0 | 0 | 14 | 7 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Figure 4A-25.** Summary of Water Year 2003 flows for the Rotenberger Wildlife Management Area (Note: 1 $hm^3$ = 810.7 acre feet).




| | May-02 | Jun-02 | Jul-02 | Aug-02 | Sep-02 | Oct-02 | Nov-02 | Dec-02 | Jan-03 | Feb-03 | Mar-03 | Apr-03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 3 | 933 | 792 | 231 | 728 | 1273 | 460 | 936 | 1037 | 171 | 0 | 1 |
| Outflow | 0 | 0 | 349 | 159 | 247 | 10 | 2 | 0 | 0 | 1 | 3 | 0 |

**Figure 4A-26.** Summary of Water Year 2003 total phosphorus (TP) loads for the Rotenberger Wildlife Management Area.




| | May-02 | Jun-02 | Jul-02 | Aug-02 | Sep-02 | Oct-02 | Nov-02 | Dec-02 | Jan-03 | Feb-03 | Mar-03 | Apr-03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 185 | 297 | 156 | 107 | 74 | 95 | 81 | 67 | 84 | 138 | 24 | 30 |
| Outflow | 0 | 0 | 24 | 22 | 27 | 30 | 63 | 74 | 0 | 67 | 69 | 0 |

**Figure 4A-27.** Summary of Water Year 2003 phosphorus concentrations for the Rotenberger Wildlife Management Area.

# STA-6 SECTION 1

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 4A-28**. Based on the 1979 through 1988 period of flow, and on total phosphorus (TP) data used during design, the STA should receive an annual average volume of approximately 18,300 ac-ft from the Everglades Agricultural Area (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 (operated by U.S. Sugar Corporation) 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, 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 approximately 35 percent of the water from the C-139 basin, as well as 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.

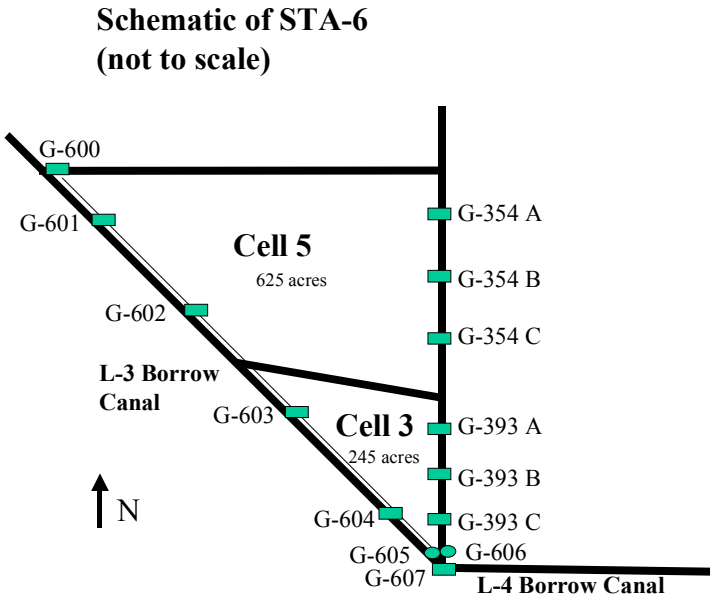
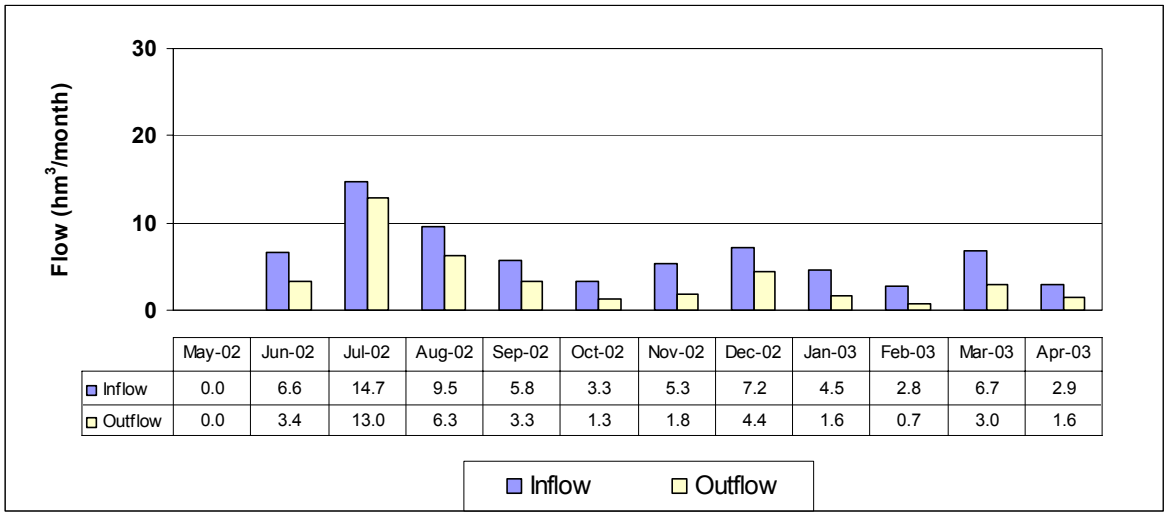



**Figure 4A-28.** Schematic of STA-6 (not to scale).

## STA-6 OPERATIONS

During WY2003, approximately 69.4 $hm^3$ (56,252 ac-ft) of water were captured and treated in STA-6, equating to a hydraulic load of 5.4 cm/day. This is about three times greater than the long-term average annual hydraulic loading rate of 1.75 cm/day contemplated during design, although the design anticipated a wide variability in inflows. Due to seepage losses, evapotranspiration (ET), and water supply deliveries from the STA, the net volume of treated water discharged from STA-6 during WY2003 was 40.4 $hm^3$ (32,753 ac-ft). A summary of monthly flow is presented in **Figure 4A-29**.

During WY2003, both treatment cells in STA-6 experienced dryout conditions from May through the middle of June 2002. No emergency water deliveries were required at STA-6, because the plant communities there are somewhat drought resistant.




| | May-02 | Jun-02 | Jul-02 | Aug-02 | Sep-02 | Oct-02 | Nov-02 | Dec-02 | Jan-03 | Feb-03 | Mar-03 | Apr-03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 0.0 | 6.6 | 14.7 | 9.5 | 5.8 | 3.3 | 5.3 | 7.2 | 4.5 | 2.8 | 6.7 | 2.9 |
| Outflow | 0.0 | 3.4 | 13.0 | 6.3 | 3.3 | 1.3 | 1.8 | 4.4 | 1.6 | 0.7 | 3.0 | 1.6 |

**Figure 4A-29.** Summary of Water Year 2003 flows for STA-6 (Note: 1 hm3 = 810.7 acre feet).

## STA-6 VEGETATION MANAGEMENT

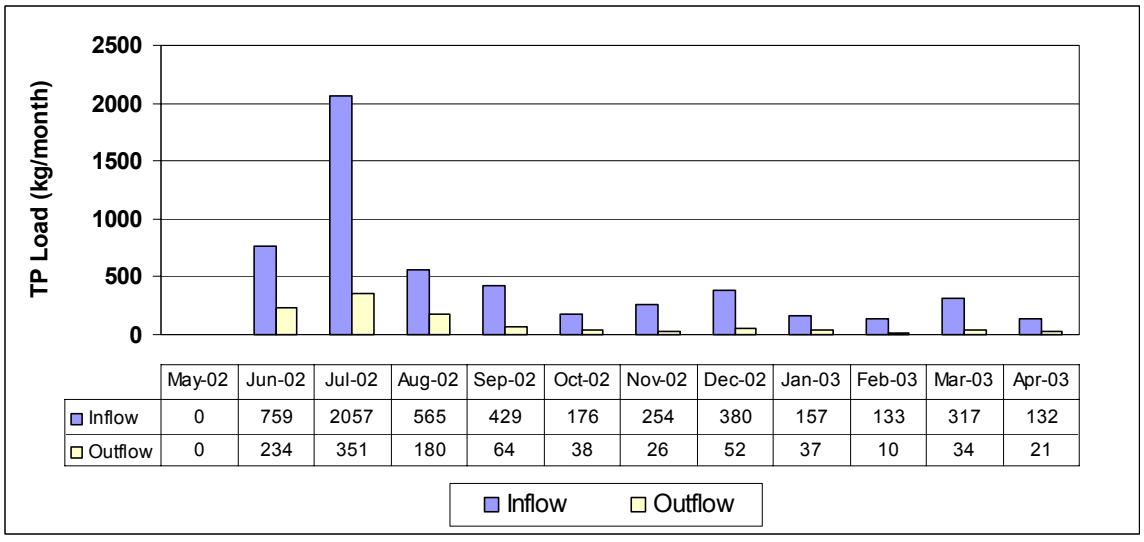
Specific Condition 13(b) of the EFA permit requires that the annual Everglades Consolidated Report include information regarding the application of herbicides used to exclude and/or eliminate undesirable vegetation within the treatment cells. For this reporting period, the District applied a total of 10 gallons of the herbicide Glyphosate, 10 gallons of Garlon 3A, and 3 gallons of Arsenal to the levees and berms to control nuisance vegetation. There was no herbicide treatment applied to the marsh area.

## STA-6 SECTION 1 PERMIT WATER QUALITY MONITORING

The District initiated a water quality monitoring program in STA-6 in December 1997 for the purpose of demonstrating compliance with the above-mentioned 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.

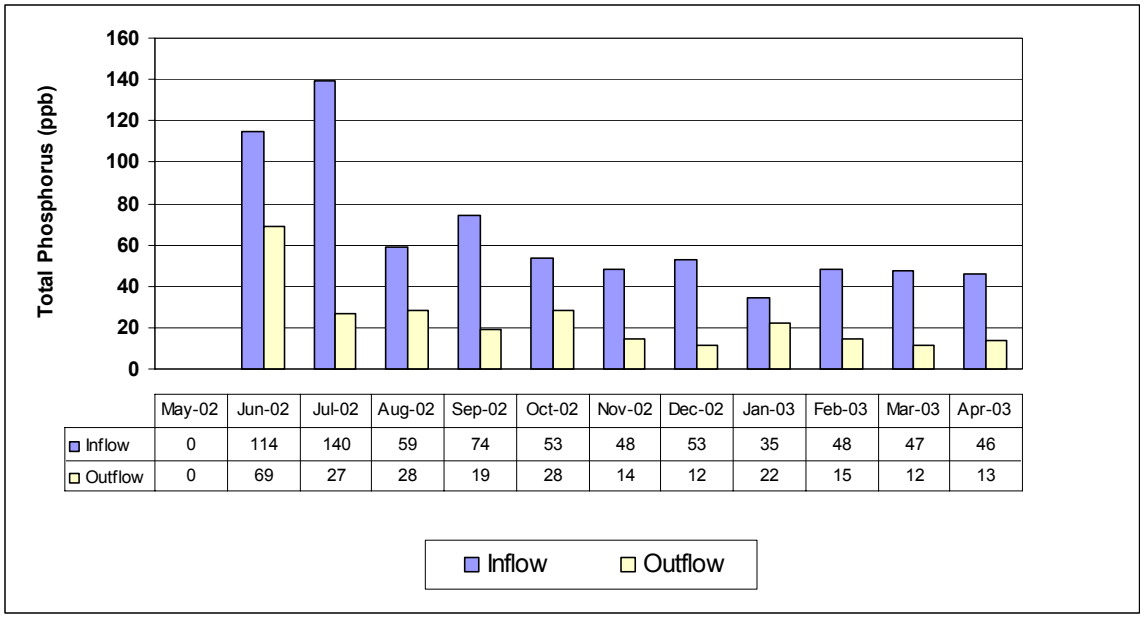
## STA-6 TOTAL PHOSPHORUS

STA-6 continues to achieve its interim discharge goal of less than 50 ppb for total phosphorus (TP). During WY2003, STA-6 received 5.4 mt of TP, equating to a nutrient loading rate of 1.5 g/square meter. Although STA-6 received about three times the long-term average inflow volume anticipated during design, because the inflow TP concentrations were lower than expected, the actual nutrient loading was only about 25 percent above the long-term average anticipated during design. Approximately 4.3 mt of TP were removed by STA-6 during WY2003. During WY2003, STA-6 experienced an 80-percent load reduction in TP (**Figure 4A-30**). Furthermore, monthly discharge concentrations were considerably lower than inflow concentrations (**Figure 4A-31**). The flow-weighted mean outflow concentration was 26 ppb, well below the EFA permit requirement of 76 ppb. This represents a 66-percent reduction from the inflow concentration of 77 ppb. For informational purposes, the geometric mean TP concentration of the discharge was 19 ppb. The moving 12-month, flow-weighted average outflow increased from 18 ppb to 28 ppb during the course of WY2003 (see **Figure 4A-32**).




| | May-02 | Jun-02 | Jul-02 | Aug-02 | Sep-02 | Oct-02 | Nov-02 | Dec-02 | Jan-03 | Feb-03 | Mar-03 | Apr-03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 0 | 759 | 2057 | 565 | 429 | 176 | 254 | 380 | 157 | 133 | 317 | 132 |
| Outflow | 0 | 234 | 351 | 180 | 64 | 38 | 26 | 52 | 37 | 10 | 34 | 21 |

**Figure 4A-30.** Summary of Water Year 2003 total phosphorus (TP) loads for STA-6.




| | May-02 | Jun-02 | Jul-02 | Aug-02 | Sep-02 | Oct-02 | Nov-02 | Dec-02 | Jan-03 | Feb-03 | Mar-03 | Apr-03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 0 | 114 | 140 | 59 | 74 | 53 | 48 | 53 | 35 | 48 | 47 | 46 |
| Outflow | 0 | 69 | 27 | 28 | 19 | 28 | 14 | 12 | 22 | 15 | 12 | 13 |

**Figure 4A-31.** Summary of Water Year 2003 total phosphorus (TP) concentrations for STA-6.

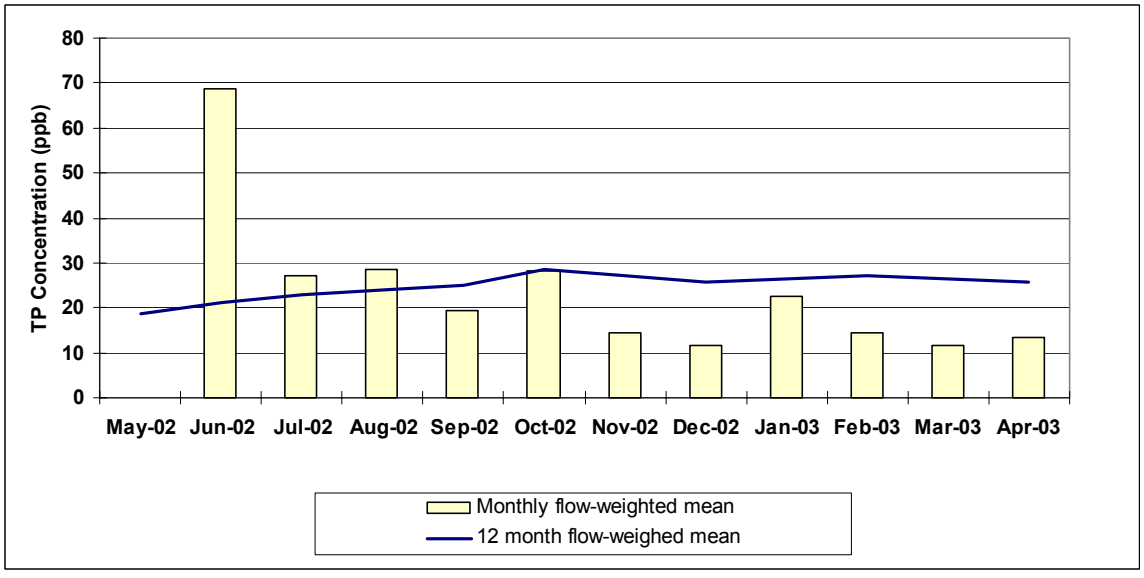



**Figure 4A-32.** Comparison of monthly with 12-month moving average phosphorus concentrations for Water Year 2003 for STA-6 outflow.

## STA-6 OTHER WATER QUALITY PARAMETERS

The monitoring data for non-phosphorus parameters at STA-6 during this reporting period are presented in Appendix 4A-10 and are summarized in **Table 4A-13**. 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 color, dissolved chloride, and dissolved sodium were slightly higher in the outflow compared to the inflow. However, 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 4A-13**). For STA-6, no downstream dissolved oxygen monitoring is required by the permits.

**Table 4A-13.** Summary of annual arithmetic averages and flow-weighted means for water quality parameters other than total phosphorus monitored in STA-6. For the purpose of these comparisons, flow-weighted means are calculated as the ratio of the cumulative product of the instantaneous flow and the sample concentration divided by the cumulative flow values.

| Parameter | Arithmetic Means | | | Flow-Weighted Means | | | |
|---|---|---|---|---|---|---|---|
| | Inflow | Outflow | | Total Inflow | | Total Outflow | |
| | G600 | G354C | G393B | n | Conc. | n | Conc. |
| Temperature (°C) | 25.1 | 23.3 | 22.4 | -NA- | -NA- | -NA- | -NA- |
| Dissolved Oxygen (mg/L) | 3.2 | 2.9 | 2.1 | -NA- | -NA- | -NA- | -NA- |
| Specific Conductivity (µmhos/cm) | 870 | 805 | 832 | -NA- | -NA- | -NA- | -NA- |
| pH | 7.3 | 7.4 | 7.3 | -NA- | -NA- | -NA- | -NA- |
| Turbidity (NTU) | 4.3 | 0.6 | 0.6 | -NA- | -NA- | -NA- | -NA- |
| Color (PCU) | 74 | 70 | 80 | -NA- | -NA- | -NA- | -NA- |
| Total Suspended Solids (mg/L) | 6.5 | 1.3 | 1.4 | 20 (27) | 4.9 | 38 (48) | 0.9 |
| Unionized Ammonia (mg/L) | 0.0027 | 0.0005 | 0.0002 | 20 (27) | 0.0029 | 37 (47) | 0.0003 |
| Total Kjeldahl Nitrogen (mg/L) | 1.76 | 1.49 | 1.40 | 20 (27) | 1.75 | 38 (48) | 1.34 |
| Orthophosphate as P (mg/L) | 0.016 | 0.004 | 0.008 | 35 (46) | 0.031 | 70 (85) | 0.007 |
| Total Iron (µg/L) | 270 | 57 | 61 | 9 (12) | 308 | 19 (22) | 76 |
| Silica (mg/L) | 9.87 | 8.81 | 9.14 | 9 (12) | 9.90 | 19 (22) | 9.36 |
| Sulfate (mg/L) | 27.3 | 23.2 | 22.3 | 11 (14) | 24.1 | 23 (26) | 21.4 |
| Alkalinity (mg/L) | 287.6 | 250.8 | 272.9 | 16 (20) | 272.6 | 32 (38) | 240.9 |
| Dissolved Chloride (mg/L) | 95.1 | 97.3 | 96.3 | 16 (20) | 87.0 | 32 (38) | 78.5 |
| Dissolved Sodium (mg/L) | 70.3 | 72.7 | 71.8 | 9 (12) | 73.0 | 18 (21) | 64.6 |
| Dissolved Potassium (mg/L) | 4.2 | 4.0 | 4.3 | 9 (12) | 4.2 | 18 (21) | 4.2 |
| Dissolved Calcium (mg/L) | 111.5 | 95.1 | 104.1 | 14 (18) | 114.3 | 27 (33) | 102.6 |
| Dissolved Magnesium (mg/L) | 10.3 | 9.8 | 9.7 | 9 (12) | 9.9 | 18 (21) | 9.2 |
| Ametryn (µg/L) | 0.016 | 0.016 | 0.010 | 4 (4) | 0.020 | 8 (8) | 0.016 |
| Atrazine (µg/L) | 0.138 | 0.071 | 0.076 | 4 (4) | 0.150 | 8 (8) | 0.074 |

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

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 FDEP-approved CompQAP No. 870166G (June 1999).
- A signed copy of this statement is provided in Appendix 4A-2.

## STA-6 MERCURY

For each STA, the operating permits require the District to monitor total mercury (THg) and methylmercury (MeHg) in soils at six representative sites. These sites must be monitored biweekly prior to flooding, and triennially thereafter, in start-up inflow and interior water from a representative site, until the interior is not significantly greater than the inflow, and in representative inflows and outflows quarterly thereafter. In addition, THg is measured in mosquitofish collected semiannually and in sunfish and largemouth bass collected annually from representative inflow, interior, and outflow sites. These monitoring requirements are contained in Exhibit D of each state permit. The mercury performance of each STA for the reporting year is discussed in Appendix 4A-4.

During the monitoring period, there were no violations of the Florida Class III numerical water quality standard (WQS) of 12 ng/L for THg. However, following an extended period of dryout, a "first flush" of excess MeHg was observed in the discharges from STA-6 Cell 5 in June 2002. As an adaptive management response, the District initiated special mercury studies in STA-6 to better understand and characterize these pulses and, if necessary, to initiate appropriate corrective action. In STA-6, inflow and outflow sampling were increased to every four weeks, and soil sampling was increased to quarterly. The results of these special studies are summarized in Appendix 2B-6.

Fortunately, immediate corrective action proved unnecessary, because the pulse was rapidly cleared from the system, as documented by the more frequent monitoring. Nevertheless, STA-6 was determined to be a net exporter of MeHg based on data from the increased monitoring. As noted at the outset, no STA discharge contained unfiltered THg in excess of the Florida Class III water quality standard (WQS) of 12 ng/L at any time during the reporting period. However, the Florida Department of Environmental Protection (FDEP) has determined that the THg WQS is deficient (see Chapter 2B in the *2002 Everglades Consolidated Report*). In December 2000, the U.S. Environmental Protection Agency (USEPA) published a new MeHg criterion based on THg in fish flesh of 0.3 ppm, and it is requiring adoption by all states within five years. Unfortunately, without a revised THg WQS, the District's ability to predict the adverse impacts from excess MeHg discharge is limited at this time. Nevertheless, for perspective, the approximately 40 g of MeHg calculated to be discharged from STA-6 (which was calculated based on sampling every four weeks) represents between 5 and 10 percent of the total MeHg load from STAs-1W, 2, and 5, S-7, S-8, S-9, S-32, and S-140 combined (which were calculated based on quarterly or annual average concentrations and corresponding total flows). However, due to the uncertainties associated with such calculations, these mass loads are presented for comparative purposes and should not be used in scientific, engineering, or regulatory application.

Regarding fish monitoring results, the average, age-adjusted THg concentration in bass in the STA-6 outflow canal exceeded the Florida advisory level of 0.5 ppm, although the THg concentration value is lower than the Everglades average. In addition, the average THg concentration in sunfish collected in the fall of 2002 in the STA-6 discharge canal is statistically significantly greater than the corresponding inflow canal value at the $95^{th}$ percentile confidence level.

In conclusion, the mercury situation at STA-6 bears watching. This STA has had both of its treatment cells undergo dryout over a large area and has undergone reflooding at least once during the reporting year. Unfortunately, the District has no control over the quantity of water released to STA-6 by U.S. Sugar Corporation. In addition, the present water reservation policy does not allow for the diversion of water to the STAs from higher-priority users during extended dry periods.

# STA PERFORMANCE SYNOPSIS

With multiple years of STA performance data available, a brief synopsis of phosphorus removal performance may be insightful. Of particular concern is the envelope of STA performance under high nutrient loading rates, as experienced during WY2003. **Figure 4A-33** summarizes the removal rate, expressed as grams per square meter per year ($g/m^2/yr$) in relation to the nutrient loading rate (also expressed as $g/m^2/yr$). Individual removal rates for each STA for each water year are compared to the associated loading rates. A very strong correlation is observed, with about 95 percent of the variance in removal rate explained by variance in the nutrient loading rate. Similar strong relations were observed for each STA, as summarized in **Table 4A-14**.

In addition to a linear regression, a logarithmic relationship was analyzed to examine whether the phosphorus removal rate dropped off at higher loading rates. However, at the higher loading rates the logarithmic relationship underpredicted the removal rate and resulted in a lower coefficient of determination than the linear regression. The strong linear relationship reflects the underlying first-order removal process that occurs in biological treatment systems. The proposed STA enhancements (discussed in Chapter 8A) have been designed using a forecast model based on this relationship. Additional discussion on the relationship between nutrient loading rates and outflow concentrations is provided in Chapter 4B.

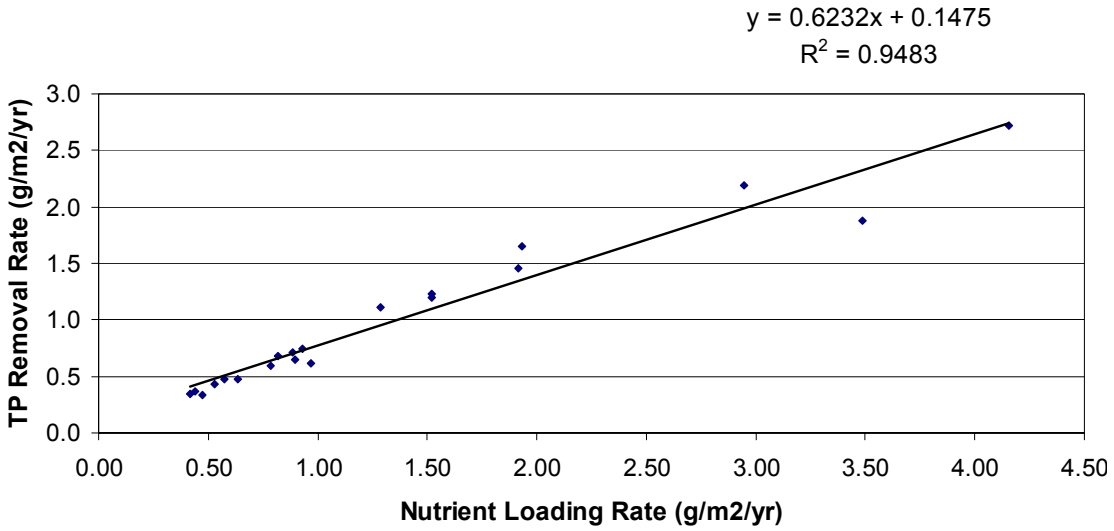



**Figure 4A-33.** Summary of STA total phosphorus (TP) removal rates and associated linear regression trend line.

**Table 4A-14.** Regression analysis of the TP loading rate ($g/m^2/yr$) versus TP removal rate ($g/m^2/yr$) for each STA using annual values.

| STA | Regression Intercept | Regression Slope | Coefficient of Determination ($r^2$) | Sample Size (number of water years) |
|---|---|---|---|---|
| **STA-1W** | 0.1125 | 0.6405 | 0.995 | 9 |
| **STA-2** | 0.2726 | 0.4133 | 1.000 | 2 |
| **STA-5** | 0.1346 | 0.5785 | 0.849 | 3 |
| **STA-6** | 0.0702 | 0.8744 | 0.992 | 6 |
| **Cumulative** | 0.1475 | 0.6232 | 0.948 | 20 |