Chapter 5B: Performance and Operation of the Everglades Stormwater Treatment Areas

Edited by Michael Chimney

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SUMMARY

The construction and operation of large freshwater treatment wetlands, known as the Everglades Stormwater Treatment Areas (hereafter referred to as "STAs"), are mandated by the Everglades Forever Act (EFA) (Section 373.4592, Florida Statutes) and are an integral part of state and federal efforts to preserve the remaining Everglades ecosystem. These wetlands (STA-1 East [STA-1E], STA-1 West [STA-1W], STA-2, STA-3/4, and STA-5/6) are located south of Lake Okeechobee and are designed to reduce total phosphorus (TP) concentration in surface water runoff prior to discharging this water into the Everglades Protection Area (EPA) (**Figure 5B-1**). The STAs are operated by the South Florida Water Management District (SFWMD or District). The total area of the STAs, including infrastructure components, is roughly 68,000 acres (ac)[2], with 57,000 ac of treatment area currently permitted to operate including the expansions of STA-2 and STA-5/6. This chapter and its appendices (Appendices 5B-1 through 5B-5 of this volume) summarize short- and long-term STA treatment performance and document any environmental conditions that may have adversely affected treatment performance, the status of these

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[2] Chapter 5B is an annual report on the condition and performance of the STA treatment facilities. It combines a report of routine operations, construction activities, vegetation maintenance, and effects of extreme weather conditions or other unusual events. The primary target readers for the chapter are regulatory personnel and various other STA stakeholders. The reported values are linked to other documents, including Restoration Strategies documents, permits and consent orders, operation plans, weekly reports to stakeholders, and electronic programs that are used to track and manage the STAs. To preserve the continuity of understanding with the stakeholders and agreement with these documents and electronic programs, results reported in Chapter 5B include a mixture of International System of Units (SI) and non-SI units. Non-SI units used in this chapter include wetland surface area as acres (ac), flow rate as cubic feet per second (cfs), water volume as acre-feet (ac-ft), and TP mass as metric tons (t). Conversion factors to express these values in SI units are as follows: 1 ac = 0.40468 hectare or 4,046.8 square meters; 1 cfs = 0.02832 cubic meters per second; 1 ac-ft = 1,233.5 cubic meters; and 1 t =1,000 kilogram.

facilities, and operational challenges during Water Year 2017 (WY2017; May 1, 2016–April 30, 2017). An analysis of annual STA treatment performance relative to compliance with the STA operating permit is reported in Volume III, Appendix 3-1. A status update on implementing the Long-Term Plan for Achieving Water Quality Goals in the Everglades Protection Area (hereafter the Long-Term Plan) (Burns & McDonnell 2003) is covered in Appendix 5B-2 of this volume. This chapter also reports on information on facility status and operational issues, including relevant maintenance activities, vegetation conditions, and wildlife issues. Research activities conducted as part of the Restoration Strategies *Science Plan for the Everglades Stormwater Treatment Areas* (Science Plan; SFWMD 2013) are presented in Chapter 5C of this volume. More information about the STAs is available on the District's website[3].

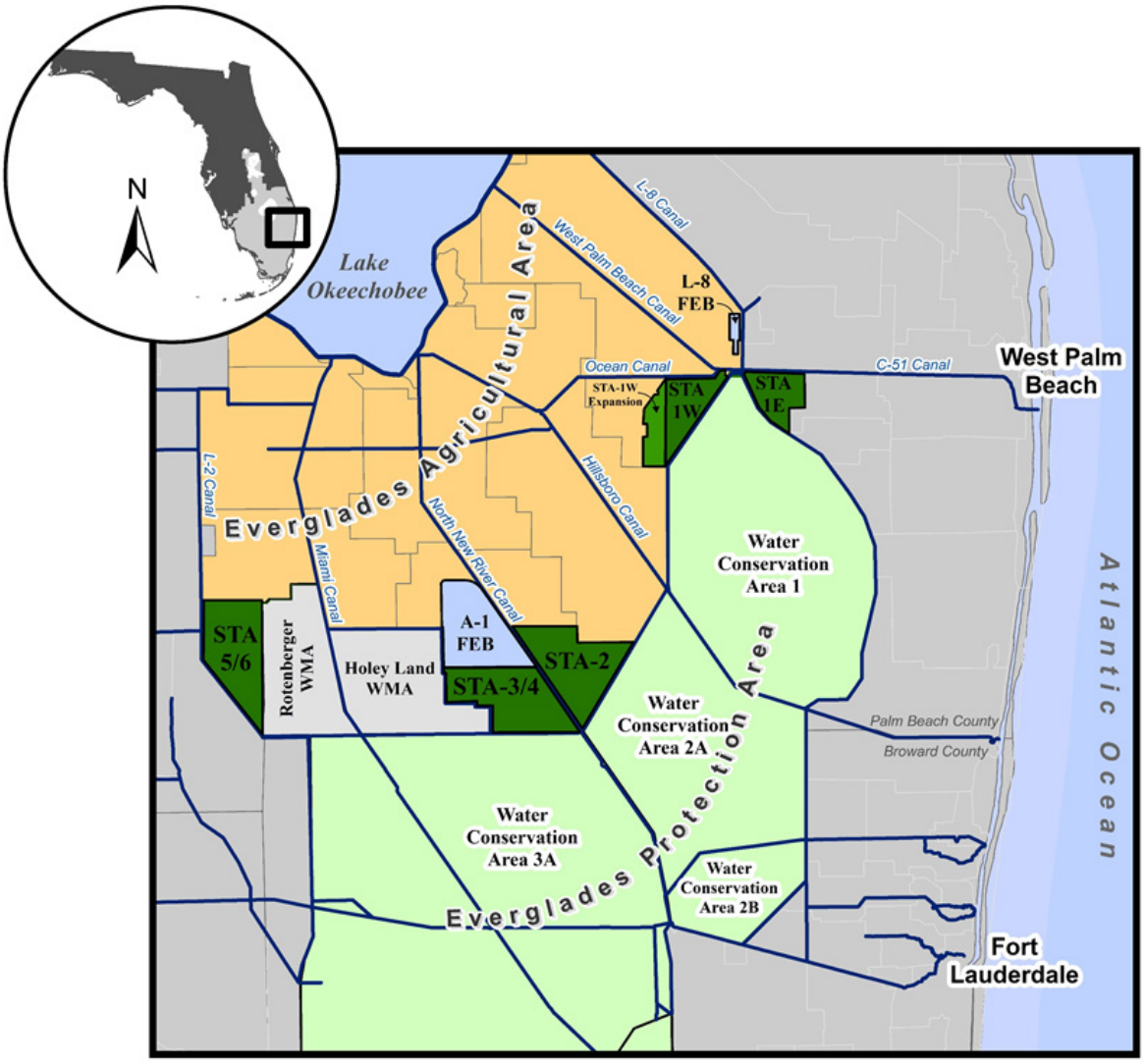


Figure 5B-1. Location of the STAs (STA-1E, STA-1W, STA-2, STA-3/4, and STA-5/6), the STA-1W Expansion Area, and the flow equalization basins (FEBs; A-1 and L-8) in relation to Lake Okeechobee, the EPA, and other landscape features of South Florida.
(Note: WMA – Wildlife Management Area.)

[3] https://www.sfwmd.gov/our-work/restoration-strategies

A summary of findings for the STAs for WY2017 is as follows:

- Over the past 23 years, the STAs in combination have treated approximately 18.6 million acre-feet (ac-ft) of water (~ 6.0 trillion gallons) and retained 2,329 metric tons (t) of TP with a 77% TP load reduction. The overall outflow flow-weighted mean (FWM) TP concentration from these treatment wetlands during this period has been 31 micrograms per liter (µg/L).
- In WY2017, the STAs treated a combined 1.1 million ac-ft of water and retained 108 t of TP, which equated to an 84% TP load reduction and produced an outflow FWM TP concentration of 15 µg/L. This is the lowest combined annual outflow FWM TP concentrations achieved in the STAs to date.
- The outflow FWM TP concentrations from individual STAs in WY2017 were 20, 23, 14, 11, and 18 µg/L in STA-1E, STA-1W, STA-2, STA-3/4, and STA-5/6, respectively. The percent TP load retained ranged from 80 (STA-3/4) to 87% (STA-1E and STA-5/6).
- STA-3/4, over its 14-year operational history has treated the most water (~ 5.9 million ac-ft), retained the most TP load (651 t), achieved the highest percent TP load retained (85%), and discharged water at the lowest outflow FWM TP concentration (16 µg/L) of all the STAs.
- All STAs were operational throughout WY2017. However, some flow-ways in all the STAs had operational restrictions for at least part of this water year for various reasons including protection of nesting birds, vegetation maintenance, structure repairs, and operation requirements of Restoration Strategies Science Plan research projects.
- Three hundred and five (305) black-necked stilt (*Himantopus mexicanus*) nests were observed across all the STAs. Collectively, 53 active Everglade snail kite (*Rostrhamus sociabilis*) nests were found in STA-1E, STA-2, and STA-5/6. Operational priorities were adjusted in the STAs, as needed, to avoid disturbing active nests. No active burrowing owl (*Athene cunicularia floridana*) nests were found in any STA this year.
- Approximately 239,000 ac-ft of Lake Okeechobee water releases were directed to the STAs in WY2017. Prior to delivery south to the EPA, 143,000 ac-ft of these releases were treated in the STAs, while 96,000 ac-ft were delivered as supplemental water to maintain cell water levels at target stages in STA-1E, STA-1W, STA-2, and STA-3/4.
- With the exception of Cells 1 and 2 in STA-1E and numerous cells in STA-5/6, all other cells in the STAs remained hydrated throughout WY2017, due in part, to the timely delivery of supplemental water.

INTRODUCTION

A major component of Everglades restoration efforts, the STAs are freshwater treatment wetlands built and operated to reduce TP concentration in surface runoff prior to these waters entering the EPA. The STAs were constructed primarily on former agricultural lands and retain nutrients through plant and microbial uptake, particulate settling, chemical sorption, and ultimately accretion of plant and microbial biomass to the sediments. This chapter describes the treatment performance and status of the five STAs (STA-1E, STA-1W, STA-2, STA-3/4, and STA-5/6; **Figure 5B-1** and Appendix 5B-1 of this volume) and the operational challenges related to maintaining treatment performance in them. The District operates and maintains all the STAs.

Varying in size, configuration, and length of operation, the STAs are divided into cells by interior levees to form "flow-ways" (i.e., cells arranged in series) within the STAs (see STA maps in Appendix 5B-1 of this volume). Water flows through these systems via water control structures, i.e., pump stations, gated

spillways, weirs, and culverts. The STAs are part of the District's regional flood control system and inflow is primarily from basin runoff. The STAs were constructed in a phased approach; the first STA (STA-1W) became operational in 1994. The STAs currently have a combined treatment area of 57,000 ac and occupy a total area, including infrastructure, of about 68,000 ac. Construction of the A-1 Flow Equalization Basin (FEB) was completed in WY2016 adding approximately 60,000 ac-ft of water storage capacity upstream of STA-3/4 and STA-2. Construction of the L-8 FEB was completed June 21, 2017, and adds approximately 45,000 ac-ft of water storage capacity upstream of STA-1E and STA-1W. The District is currently expanding STA-1W as part of the *Restoration Strategies Regional Water Quality Plan* (SFWMD 2012 and see Chapter 5A and Appendix 5B-2 of this volume).

Aquatic plants in the STAs are categorized based on their growth habit: emergent aquatic vegetation (EAV), submerged aquatic vegetation (SAV), or floating aquatic vegetation (FAV). While all STA cells contain a mixture of these vegetation types, cells are classified based on their target vegetation community, i.e., either SAV or EAV. Periphyton, the community of attached algae and other microorganisms growing on substrates in aquatic systems, is ubiquitous throughout the STAs.

Reduction in TP concentration and load has varied temporally within each STA and spatially among STAs and may be influenced by factors such as weather conditions, antecedent land use, soil type, cell topography, condition of the vegetation community, nutrient and hydraulic loading, hydropattern (continuously flooded versus periodic dryout), maintenance activities, and regional flood control operations. The District attempts to maximize STA treatment performance by balancing TP loading to these wetlands through adaptive management that prioritizes the distribution of water delivered to individual STAs and among flow-ways within each STA. These decisions are based on a weekly evaluation of interior stage (i.e. water levels), outflow TP concentrations, previous hydraulic and TP loading, vegetation condition, maintenance/rehabilitation activities, and any operation restrictions.

This chapter reports on STA treatment performance, information on facility status and operational issues, relevant maintenance activities, vegetation conditions, and wildlife issues. Discussion of recreational facilities and implementation of the Long-Term Plan is provided in Appendix 5B-2 of this volume. Supporting information on protected birds, EAV coverage, and SAV coverage in the STAs is presented in Appendices 5B-3, 5B-4, and 5B-5 of this volume, respectively. Details on the District's Restoration Strategies Program and Science Plan for the STAs are provided in Chapters 5A and 5C of this volume, respectively. Details on permit monitoring for TP that is mandated for the STAs are presented in Volume III, Appendix 3-1.

FLOW-WAY OPERATIONAL STATUS

Short-term and long-term operation of the STAs and individual flow-ways is critical in achieving and sustaining desired performance for the STAs. The District has established a comprehensive system that includes weekly review of individual flow-ways' treatment performance and condition, and discussions to prioritize operation of available flow-ways. Operation of an STA flow-way may be suspended entirely (operational status: offline) in response to environmental conditions that may adversely affect phosphorus (P) uptake, to allow for construction activities, or to allow the completion of critical rehabilitation activities. Operation of a flow-way may also be flow and stage-restricted (operational status: online with restrictions [ONR]) for a number of reasons, such as to protect vulnerable vegetation or to avoid and minimize impacts to nests of bird species protected under the Migratory Bird Treaty Act or the Endangered Species Act. Flow-ways designated as ONR would be in full operation mode only during emergencies, such as large storm events. During moderate storms, stormwater may be partially or entirely routed to other STAs or flow-ways for treatment.

ADJUSTMENT OF THE EFFECTIVE TREATMENT AREA VALUES

The effective treatment area in each STA was used to calculate the hydraulic loading rate (HLR), P loading rate (PLR), and P removal rate values (see **Table 5B-1** in the *Overview of Water Year 2017* section). Effective treatment areas are adjusted, if needed, using the following equation based on the operational period of each flow-way during the water year:

$$Adjusted\ Effective\ Treatment\ Area = Total\ Area \times \frac{\sum_1^n Daily\ Online\ Percentage}{\#\ days\ in\ year} \quad (1)$$

CALCULATION OF ANNUAL LOADS AND FLOW-WEIGHTED MEAN CONCENTRATIONS

Annual TP loads and FWM TP concentrations were calculated based on weekly measurements (sample size [n] = 52) of surface water inflow to and outflow from the STAs over the entire water year as follows:

$$Load = \sum_1^n (C_i V_i + C_{i+1} V_{i+1} + \ldots\ C_{i+n} V_{i+n}) \quad (2)$$

$$FWM\ Concentration\ = Load / \sum_1^n (V_i + V_{i+1} + \ldots\ V_{i+n}) \quad (3)$$

where

C_i = TP concentration for the ith sampling interval during the water year
V_i = Water volume for the ith sampling interval during the water year

VEGETATION MANAGEMENT AND RESTORATION

Vegetation management and restoration efforts in the STAs include herbicide applications and limited mechanical or manual removal to control undesired FAV, SAV, and emergent herbaceous and woody species[4]. Controlling non-rooted FAV, such as water lettuce (*Pistia stratiotes*) and water hyacinth (*Eichhornia crassipes*), is necessary in SAV cells where these species can form dense beds that shade out the SAV underneath. Dense non-rooted FAV can also hinder the growth of EAV, impede flow through cells, and lead to hydraulic short-circuiting. Woody plant species, such as primrose willow (*Ludwigia* spp.), are controlled because they tend to displace cattail (*Typha* spp.) and do not provide the same level of P removal as cattail or sawgrass (*Cladium jamaicense*). The District uses United States Environmental Protection Agency-registered herbicides applied by licensed applicators at the dosages recommended by the manufacturers. None of these products bioaccumulate, all are registered for use in aquatic systems, and none are restricted category herbicides. While these products are certainly toxic to plants, toxicity is negligible to non-plant organisms at the application rates used in the STAs. The District's vegetation management program is regulated by the Florida Department of Protection (FDEP) and fully complies with STA operating permit regulations. An accounting of herbicide application rates and quantities used, the acreage treated in each STA, and the species targeted during WY2017 is provided in Volume III, Appendix 3-1, Attachment E.

Vegetation management and restoration efforts also include planting select species, primarily giant bulrush (*Schoenoplectus californicus*), alligator flag (*Thalia geniculata*), and American lotus (*Nelumbo lutea)* plus inoculations of SAV, such as southern naiad (*Najas guadalupensis*), spiny naiad (*Najas marina*),

[4] Widespread harvesting often has been suggested as a way to manage vegetation in the STAs. However, harvesting is not under consideration for a number of reasons, including (1) mechanical removal is very labor intensive and would be disruptive to the STAs if done on a large scale, (2) the lack of local disposal sites for the collected plant biomass and high transportation costs to reach more distant disposal locations, (3) a viable market for plant byproducts, such as conversion into biofuel, has not materialized in South Florida, and (4) harvesting removes carbon from the system that may be critical to some nutrient removal processes (e.g. nitrogen). A synthesis of the potential benefits and liabilities of harvesting wetland vegetation by Kadlec (2011) influenced the District's decision not to pursue harvesting in the STAs.

eelgrass (*Vallisneria americana)*, pondweed (*Potamogeton illinoensis*) and muskgrass (*Chara* sp.). Giant bulrush and alligator flag are normally planted in linear strips (i.e., vegetation strips) to eliminate hydraulic short-circuits, buffer other plants against high wind and flow events, or provide plant cover at locations where the water is too deep for sustained growth of cattail. Alligator flag and American lotus are also planted to secure unstable sediments and minimize the effects of non-rooted FAV damage in areas where SAV and cattail are difficult to establish. The compartmentalization of SAV cells with vegetation strips is thought to provide some redundancy in nutrient uptake capacity to maintain treatment performance in the event of SAV loss[5]. In EAV cells, the most desired species are cattail, giant bulrush, alligator flag, and sawgrass. Other desirable native species that thrive in certain areas of the STAs are arrowhead (*Sagittaria latifolia*), duck potato (*S. lancifolia*), and spikerush (*Eleocharis* sp.). In SAV cells, the most desired species are coontail (*Ceratophyllum demersum*), muskgrass, pondweed, southern naiad, and spiny naiad. Another species commonly found in the STAs is hydrilla (*Hydrilla verticillata*); however, despite this species' ability to remove P, it is not desirable due to its invasive nature and tendency for sudden population crashes. Hydrilla, which thrives in areas of high water column TP concentrations, was a common SAV species in STA-1E and STA-5/6 during WY2017.

VEGETATION SURVEYS

The areal coverage of EAV and SAV (+ open water[6]) was estimated based on analysis of digital aerial imagery captured for each STA from fixed-wing aircraft flying at an altitude of approximately 4,770 meters (15,650 feet). Vegetation coverage based on aerial imagery taken in May 2016 is presented in this chapter as the percent of EAV coverage relative to the entire cell area and compared with EAV coverage in previous water years. Because there were only two vegetation classes in these analyses, a positive or negative change in EAV coverage would be balanced by the opposite percent change in SAV coverage. A description of the mapping methodology used and vegetation coverage maps for each STA produced from these data are provided in Appendix 5B-4 of this volume.

Ground surveys were conducted by airboat within STA cells designated as SAV cells on a periodic basis to map the areal coverage of SAV taxa. Assessments were made at a network of fixed geo-referenced sites established within each cell where the areal coverage of each SAV species was assessed by visual inspection in the field. The coverage of all SAV taxa considered together was also assessed. Details on the sampling methodology used and SAV coverage maps made from these surveys are provided in Appendix 5B-5 of this volume.

Helicopter surveys of the STAs were conducted on a monthly basis to assess condition of the vegetation community. This anecdotal information was used primarily to guide vegetation maintenance and restoration activities but also supplemented the ground surveys to track any notable changes in SAV coverage that occurred during the water year.

DRYOUT IMPACTS

One of the challenges in managing the STAs is dealing with periodic dryout. During the dry season in South Florida (approximately October to May), and particularly during prolonged droughts, portions of or entire STA cells can dry out. This is especially problematic for cells that have a higher ground elevation than surrounding areas (due to water loss through seepage) and cells that are not capable of receiving

[5] Based on lessons learned from managing and operating the STAs, the District has allowed EAV cover to expand outside of the vegetation strips to create a mixed-marsh vegetation community in some SAV-designated cells where periodic large-scale loss of SAV cover has occurred previously. The expansion of EAV in these cells is monitored and controlled as necessary based on cell treatment performance.

[6] It was often difficult, if not impossible, to distinguish between open water areas with no SAV in the water column and areas that contained SAV from the aerial imagery; therefore, some portion of areas mapped as SAV using aerial imagery may have been open water without SAV.

supplemental water to keep them hydrated. Dryout is known to affect STA treatment performance and the health of SAV and EAV communities, as well as encourage bird nesting that can result in conflicts with the operation of flow-ways. Dry conditions promote the rapid oxidation of soil organic matter and subsequent reflooding results in outflow P spikes due to the flux of mineralized soil P to the water column (Bostic and White 2007, DeBusk and Reddy 2003, Martin et al. 1996). The impact of dryout on outflow TP concentrations from the STAs is influenced by factors such as the spatial extent and duration of dry conditions, soil characteristics, type of vegetation, and the lag time between reflooding and cell discharge following the dryout. Operational experience indicates that brief dryout periods in peat-based STA cells usually do not result in large outflow TP spikes, likely due to the ability of the peat material to retain water within the soil matrix. However, in areas where the substrate has a higher mineral content, such as the soil found in some of the cells in STA-5/6, the upper soil column dries out much more quickly upon loss of surface water and is prone to fluxing soil P upon rewetting. For example, the impact of annual cycles of dryout and reflooding on treatment performance in Cells 6-3 and 6-5 of STA-5/6 is discussed in Chapter 5 of the *2010 South Florida Environmental Report – Volume I* (Pietro et al. 2010).

While prolonged dryout conditions in SAV cells can be detrimental to the plant community, dryout in EAV cells for short periods does not appear to have negative impacts and may benefit the plants. For example, managed water level drawdowns have been effective in encouraging recruitment of new of cattail in STA-3/4. Extended periods of dryout, however, have visibly affected EAV communities causing die-off of wetland vegetation and invasion of terrestrial plant species. When dried cells are rehydrated, EAV generally recovers more quickly than SAV. Operation plans for the STAs set the minimum target stages in EAV and SAV cells during drought conditions at 15 centimeters (cm; 6 inches) below and 15 cm above the average ground elevation, respectively, to maintain the vegetation community in a healthy condition.

The District has implemented the *South Florida Water Management District Everglades Construction Project (ECP) Stormwater Treatment Areas (STAs) Drought Contingency Recommendations and Considerations*, or simply the Drought Contingency Plan (DCP), since 2008 to minimize dryout during periods of drought (SFWMD 2008). When dry conditions are anticipated, the DCP provides guidance regarding raising cell target stages before the end of the wet season to increase storage volume in SAV cells, the use of temporary pumps to deliver water to the STAs from nearby sources when available, and the delivery of supplemental water when available from Lake Okeechobee to the STAs. The DCP prioritizes hydration of SAV cells over EAV cells to minimize impact to the SAV community. FEBs located adjacent to STA-1E and STA-1W (L-8 FEB) and STA-2 and STA-3/4 (A-1 FEB) (**Figure 5B-1**), and the future C-139 FEB that will be adjacent to STA-5/6, are anticipated to increase the supply of water available to the STAs during the dry season. In addition, the capacity of the FEBs to store spring stormwater runoff may allow the District, to some extent, to hold water longer in the STAs at the onset of the wet season without discharging from flow-ways that have dried out and therefore allow more of the flux of soil P to be reassimilated before water is released.

MIGRATORY BIRD AND SNAIL KITE NESTING

The District, in cooperation with the United States Fish and Wildlife Service (USFWS), finalized the *Avian Protection Plan for Black-necked Stilts and Burrowing Owls Nesting in the Everglades Agricultural Area Stormwater Treatment Areas*, or simply the Avian Protection Plan (APP), in 2008 for the STAs (Pandion Systems 2008). The black-necked stilts and burrowing owls are afforded protected status under the Migratory Bird Treaty Act of 1918. Additional protected status has been given to the burrowing owl since it is also listed as a species of special concern in the State of Florida. In accordance with the APP, the District conducts surveys within the STA cells for nests of these two bird species during their nesting seasons. The APP provides the District with a framework to modify STA operations to minimize potential impacts to active nests of either species. This is accomplished by diverting water around cells with nests or

regulating inflow to these cells to avoid raising water levels and flooding nests[7]. Although the District is committed to mortality reduction measures, there may be situations where bird mortality is unavoidable as the District fulfills its flood control and water quality treatment responsibilities. Specifically, during storm events, the District seeks to minimize sending untreated water directly to the water conservation areas (WCAs). Operation of the STAs at these times may result in the inadvertent taking of migratory birds or nests. Standardized black-necked stilt nesting surveys were conducted in all the STAs during the 2017 nesting season[8] following protocols outlined in the APP. The number of black-necked stilts, a groundnesting species, attracted to the STAs each year is a function of available nesting habitat, which can vary from year to year. This species prefers mudflats and areas near shallow water for nesting. Low water levels in the STAs can expose portions of the bottom, which creates ideal nesting habitat. To the extent practicable, the District attempts to keep the STAs completely flooded during the spring to discourage nesting. However, keeping the STAs flooded is subject to the availability of water in the basin, which in turn is a function of rainfall patterns. In addition, EAV coverage in many treatment cells has increased as the STAs have matured, which has further limited the habitat that black-necked stilts find suitable for nesting. Survey results are summarized in each STA section of this chapter and reported in more detail in Appendix 5B-3 of this volume.

In addition to the District's nest surveys for black-necked stilts and Florida burrowing owls, the University of Florida conducts Everglade snail kite nest surveys annually in the STAs. The Everglade snail kite has federal status as an endangered species. The USFWS is consulted and the District follows a set of voluntary guidelines (SFWMD 2016) on modifying construction, maintenance activities, and STA operations to avoid disturbing any active nests. Survey results are summarized in each STA section of this chapter and reported in more detail in Appendix 5B-3 of this volume.

OVERVIEW OF WATER YEAR 2017

The STAs, over their 23 years of operation, have treated approximately 18.6 million ac-ft of water (~6.0 trillion gallons) and retained 2,329 t of TP or 77% of the TP load that entered these facilities. The increase in the combined inflow water and TP loads to the STAs that began in WY2000 reflected an increase in treatment capacity as additional STAs came online (**Figure 5B-2**). The period of record (POR) inflow FWM TP concentration for all the STAs up through WY2017 is 133 µg/L, while the POR outflow FWM TP concentration is 31 µg/L (**Table 5B-1**).

All the STAs received a combined 1.1 million ac-ft of inflow during WY2017 (**Table 5B-1**). Of this total water volume, approximately 239,000 ac-ft were Lake Okeechobee releases directed to the STAs. Prior to delivery south to the EPA, 143,000 ac-ft of these releases were treated in the STAs, while 96,000 ac-ft were delivered as supplemental water to maintain water levels at target stages in STA-1E, STA-1W, STA-2, and STA-3/4.

The STAs retained a combined 108 t of TP during WY2017 (**Table 5B-1**), which represented an 84% load reduction. The overall annual inflow and outflow FWM TP concentrations in the STAs decreased from 96 to 15 µg/L, respectively. This was among the highest annual percent TP loads retained and the lowest overall annual outflow FWM TP concentration achieved to date (**Figure 5B-2**). The combined water and TP loads received by all the STAs this water year were comparable in magnitude to inflow water and TP

[7] The District is not required to alleviate flooding in cells with nests that is due to direct rainfall onto the STA. The District, to the extent practicable, maintains the STAs at a stage sufficient to keep all cells completely flooded, especially during the dry season. This dissuades black-necked stilts from using the STAs as nesting areas. In cases where black-necked stilts have nested in the STAs, the District maintains inflow to the affected cells at a restricted stage to prevent any further cell dry out, which would attract more nesting birds.

[8] Survey results for the 2017 nesting season are reported in this chapter even though the 2017 nesting season extended into May and June 2017, which was after the end of WY2017.

loads in recent water years. Inspection of the POR time-series data revealed a fairly consistent increase in the annual percent TP load retained over the past 15 water years from the lowest retention in WY2003 (63%) to the highest observed values in recent water years (84 to 86%).

STA-2, STA-3/4, and STA-5/6 all had annual outflow FWM TP concentrations less than or equal to 19 µg/L in WY2017 (11 to 18 µg/L), while annual outflow FWM TP concentrations in STA-1E and STA-1W were 20 and 23 µg/L, respectively (**Table 5B-1**). STA-3/4 received the largest inflow water volume and STA-2 the largest TP load this water year, while STA-1W received both the lowest inflow water volume and TP load (**Figure 5B-3**). HLRs in all the STAs during WY2017 were greater than or equal to 1.4 centimeters per day (cm/d) except for STA-5/6, which had a HLR of only 0.7 cm/day (**Figure 5B-3**). The corresponding PLRs were 1.2 and 0.7 grams per square meter per year ($g/m^2/yr$) in STA-1E and STA-1W, respectively, and 0.5, 0.4, and 0.4 $g/m^2/yr$ in STA-2, STA-3/4, and STA-5/6, respectively.

None of the STA effective treatment areas were adjusted in computations for WY2017 because no flow-ways were taken offline during the water year (**Table 5B-2**). However, most flow-ways were ONR for at least a portion of WY2017. Details of the operational status of each flow-way are provided in the individual STA sections that follow.

During WY2017, 305 black-necked stilt nests were observed across all the STAs, while no active burrowing owl nests were detected in any STA. Collectively, 53 active Everglade snail kite nests were found in STA-1E, STA-2, and STA-5/6 this water year. Operational priorities were adjusted in the STAs as needed to avoid disturbing active nests; any such adjustments are discussed under each STA section in Appendix 5B-3.

Table 5B-1. Summary of treatment performance in each STA and all STAs combined for WY2017 and the POR.

Parameter (unit [a])	STA-1E	STA-1W	STA-2	STA-3/4	STA-5/6	All STAs
Effective Treatment Area (ac)	4,994	6,544	15,495	16,327	13,685	57,045
Adjusted Effective Treatment Area (ac) [b]	4,994	6,544	15,494	16,327	13,685	57,045
WY2017 Inflow						
Inflow Water Volume (ac-ft)	162,000	109,000	325,000	377,000	118,000	1,090,000
Inflow TP Load (t)	25	18	33	28	24	129
FWM Inflow TP (µg/L)	126	136	82	61	164	96
Hydraulic Loading Rate (cm/d)	2.7	1.4	1.8	1.9	0.7	1.6
Phosphorus Loading Rate ($g/m^2/yr$)	1.2	0.7	0.5	0.4	0.4	0.6
WY2017 Outflow						
Outflow Water Volume (ac-ft)	134,000	102,000	316,000	403,000	141,000	1,100,000
Outflow TP Load (t)	3	3	6	6	3	20
FWM Outflow TP (µg/L)	20	23	14	11	18	15
TP Retained (t)	22	15	27	23	21	108
TP Removal Rate ($g/m^2/yr$)	1.1	0.6	0.4	0.3	0.4	0.5
TP Load Retained (%)	87%	84%	83%	80%	87%	84%
POR						
Start Date	Sep 2004 [c]	Oct 1993 [d]	Jun 1999	Oct 2003	Dec 1997	WY1994–WY2017
Inflow Water Volume (ac-ft)	1,390,000	4,050,000	4,740,000	5,940,000	2,420,000	18,600,000
TP Inflow Load (t)	285	871	566	770	549	3,041
FWM Inflow TP (µg/L)	166	174	97	105	184	133
Outflow Water Volume (ac-ft)	1,310,000	4,170,000	5,050,000	6,020,000	2,120,000	18,700,000
TP Outflow Load (t)	65	238	125	119	165	712
FWM Outflow TP (µg/L)	40	46	20	16	63	31
TP Retained (t)	220	633	440	651	385	2,329
% TP Retained	77%	73%	78%	85%	70%	77%

a. Conversion factors: 1 ac = 0.40468 hectares or 4,046.8 square meters; 1 ac-ft = 1,233.5 cubic meters; 1 metric ton (t) =1,000 kilograms; and 1 cm/d = 0.39370 inches per day.

b. Adjusted effective treatment area is time and area weighted to exclude any cells that were temporarily off-line; refer to **Table 5B-2**.

c. STA-1E was operated in WY2005 for emergency flood control purposes and to establish wetland vegetation; it became fully operational in WY2006.

d. Flow-through operations in STA-1W did not begin until August 1994.

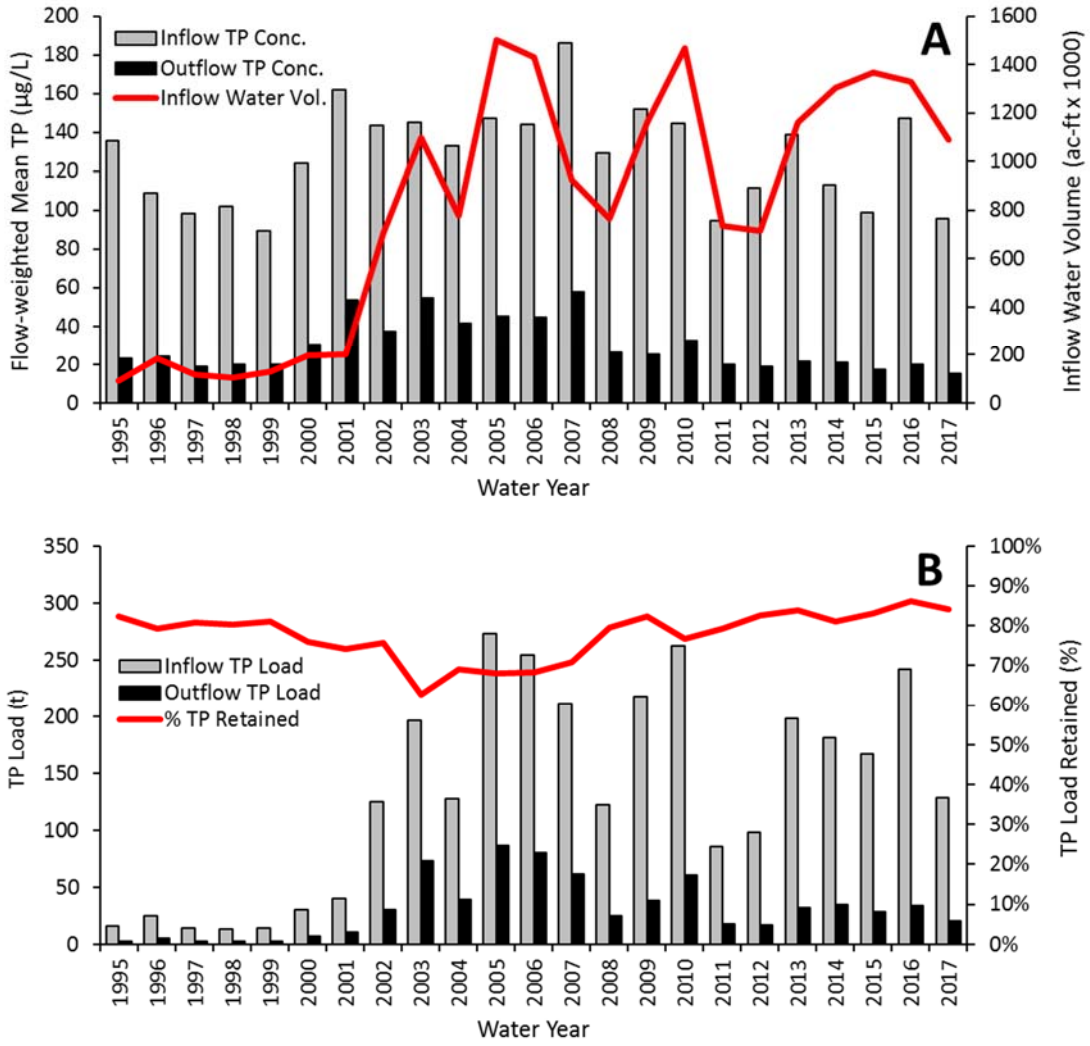


Figure 5B-2. POR time series in all the STAs combined for (A) annual inflow and outflow FMW TP concentrations (Conc.) with corresponding inflow water volumes (Vol.) and (B) annual inflow and outflow TP loads with the percent TP load retained.

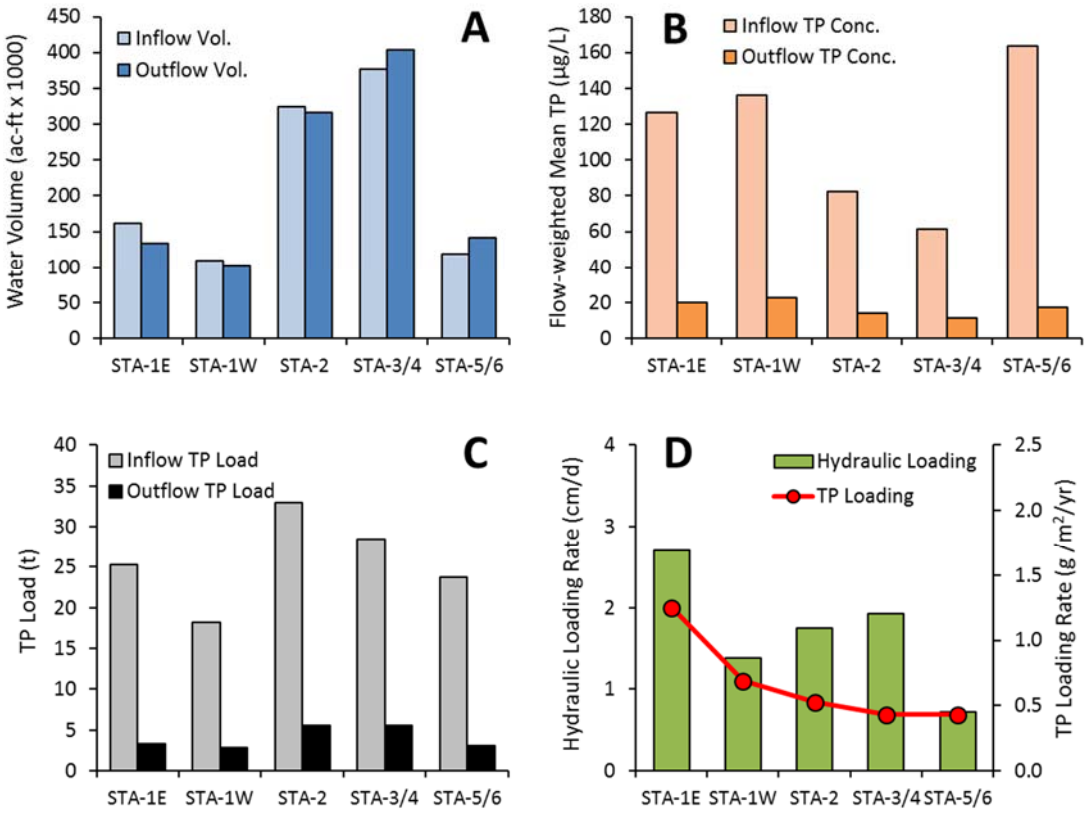


Figure 5B-3. Comparison of (A) inflow and outflow water volumes (Vol.), (B) inflow and outflow FWM TP concentrations (Conc.), (C) inflow and outflow TP loads, and (D) hydraulic and TP loading rates in the STAs during WY2017.

Table 5B-2. Operational status of STA flow-ways during WY2017.

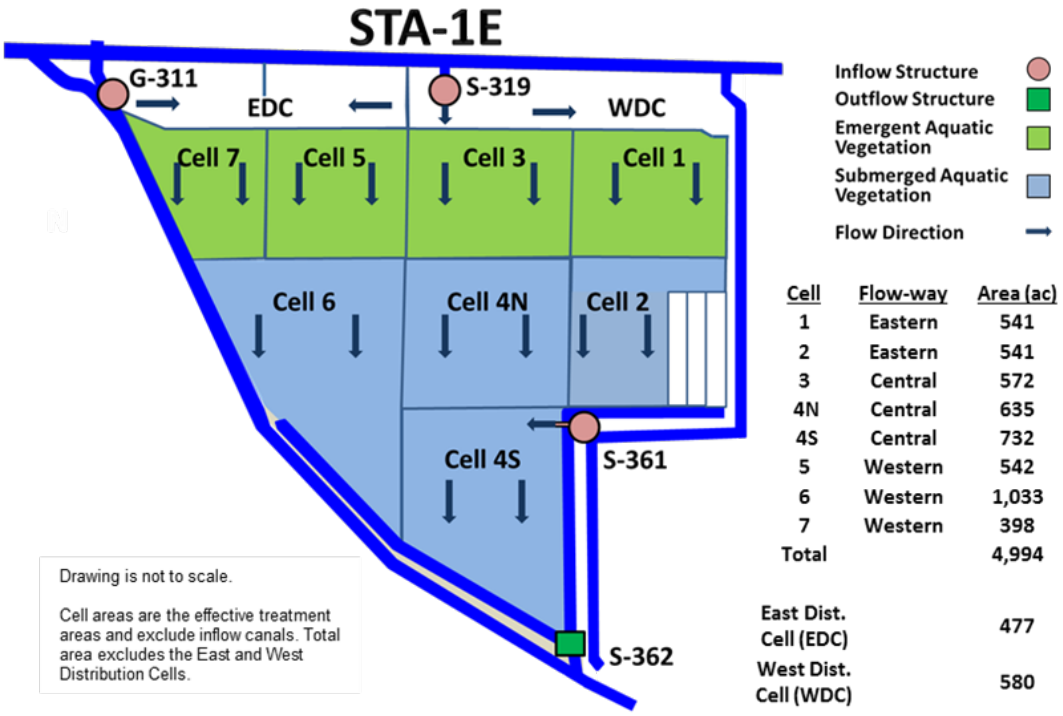
STA	Flow-way [a]	Effective Treatment Area (ac) [b]	Operational Status [c]	Comments [d]	% Time Online
STA-1E	Entire STA	4,994			100
	Eastern FW	1,082	ONR: 12/2016 to 04/2017 ONR: 05/2016 to 07/2016 ONR: 03/2017 to 04/2017	Structure repairs SK nesting [e] BNS nesting	100
	Central FW	1,939	ONR: WY2017 ONR: 05/2016 to 09/2016 ONR: 08/2016 to 09/2016	Structure repairs SK nesting RSSP research project	100
	Western FW	1,973	ONR: WY2017 ONR: 05/2016 to 06/2016 & 04/2017	Deep water due to topography, structure repairs, vegetation maintenance BNS nesting	100
STA-1W	Entire STA	6,544			100
	Eastern FW	2,171	ONR: 05/2016 to 08/2016 ONR: 05/2016 to 06/2016	Vegetation maintenance BNS nesting	100
	Western FW	1,369	ONR: 05/2016	BNS nesting	100
	Northern FW	3,004	ONR: 02/2017 to 04/2017 ONR: 05/2016 to 07/2016	STA-1W expansion construction BNS nesting	100
STA-2	Entire STA	15,494			100
	Flow-way 1	1,840	ONR: 01/2017 to 02/2017	RSSP research project	100
	Flow-way 2	2,373			100
	Flow-way 3	2,296	ONR: 05/2016 to 08/2016, 10/2016, & 01/2017 to 02/2017 ONR: 05/2016 to 06/2016	RSSP research project BNS nesting	100
	Flow-way 4	5,990	ONR: 05/2016 to 06/2016 & 04/2017 ONR: 05/2016	BNS nesting SK nesting	100
	Flow-way 5	2,995	ONR: 05/2016 to 06/2016	BNS nesting	100
STA-3/4	Entire STA	16,327			100
	Eastern FW	6,476	ONR: 05/2016 to 07/2016	Vegetation maintenance	100
	Central FW	5,349			100
	Western FW	4,502	ONR: 02/2017	RSSP research project	100
STA-5/6	Entire STA	13,685			100
	Flow-way 1	2,418	ONR: 05/2016 to 06/2016 DO: 03/2017 to 04/2017	Vegetation maintenance Cell dryout (Cell 1A)	100
	Flow-way 2	2,068	ONR: 05/2016 to 06/2016 DO: 03/2017 to 04/2017	Vegetation maintenance Cell dryout (Cell 2A)	100
	Flow-way 3	1,922	ONR: 05/2016 to 08/2016 DO: 03/2017 to 04/2017	SK and/or BNS nesting Cell dryout (Cell 3A)	100
	Flow-way 4	1,871	ONR: 05/2016 to 09/2016 ONR: 03/2017 to 04/2017	Vegetation maintenance Cell dryout (Cell 4A)	100
	Flow-way 5	2,642	ONR: 05/2016 to 07/2016 ONR: 05/2016 to 09/2016 & 04/2017 DO: 03/2017 to 04/2017	Vegetation maintenance SK and/or BNS nesting Cell dryout (Cell 5A)	100
	Flow-way 6	1,900	ONR: 04/2017 DO: 03/2017 to 04/2017	BNS nesting Cell dryout (Cells 6-4 & 6-2)	100
	Flow-way 7	621	DO: 01/2017 to 04/2017	Cell dryout (Cell 6-5)	100
	Flow-way 8	242	DO: 01/2017 to 04/2017	Cell dryout (Cell 6-6)	100

a. FW: flow-way.
b. Conversion factor: 1 acre = 0.40468 hectares or 4,046.8 square meters.
c. DO: dryout; OFF: offline; and ONR: online with restrictions.
d. BNS: black-necked stilt; RSSP: Restoration Strategies Science Plan; SK: Everglade snail kite; and USACE: United States Army Corps of Engineers.
e. STA operations and maintenance activities modified during WY2017 due to bird nesting are detailed in Appendix 5B-3 of this volume.

STA-1E

STA-1E is located in Palm Beach County approximately 32 kilometers (km; ~ 20 miles) west of West Palm Beach, south of State Road 80 and the C-51 canal, adjacent to the northeast boundary of the Arthur R. Marshall Loxahatchee National Wildlife Refuge (LNWR), and directly east of the STA-1 Inflow and Distribution Works (referred to as the STA-1 Inflow Basin) (**Figure 5B-1**). This facility was flooded in WY2005 to establish wetland vegetation. STA-1E provides a total treatment area of 4,994 ac arranged into three parallel treatment trains, or flow-ways, that contain eight cells (Piccone et al. 2013; **Figure 5B-4**). The East and West distribution cells are not considered part of the STA-1E treatment area. STA-1E receives inflow primarily from the C-51 West basin and smaller water volumes from the L-8 and S-5A basins, Lake Okeechobee regulatory releases, and the Rustic Ranches subdivision. In WY2007, STA-1E started receiving runoff from Wellington Acme Basin B. During the dry season, supplemental water is delivered from Lake Okeechobee, when available, to maintain hydration in priority cells, i.e., cells dominated by SAV. The flow-way nomenclature for STA-1E is as follows:

- Eastern Flow-way = Cells 1 and 2
- Central Flow-way = Cells 3, 4N, and 4S
- Western Flow-way = Cells 5, 6, and 7



Cell	Flow-way	Area (ac)
1	Eastern	541
2	Eastern	541
3	Central	572
4N	Central	635
4S	Central	732
5	Western	542
6	Western	1,033
7	Western	398
Total		4,994
East Dist. Cell (EDC)		477
West Dist. Cell (WDC)		580

Figure 5B-4. Simplified schematic of STA-1E showing major inflow and outflow water control structures, the treatment area of each cell, flow direction, and dominant/target vegetation types. Treatment areas do not include pump stations, levees, roads, or other upland areas. A detailed structure map of STA-1E is provided in Appendix 5B-1 of this volume. [Note: Dist. – distribution.)

A number of issues have affected STA-1E operations over its POR, including high hydraulic loadings during large storm events (particularly Hurricane Wilma in 2005, an unnamed storm in February 2006, and Tropical Storm Isaac in 2012), the repair of internal water control structures by the United States Army Corps of Engineers (USACE), uneven ground topography that results in excessively deep water and hydraulic short-circuiting (particularly in Cells 5 and 7 of the Eastern Flow-way), dryout of cells during droughts, and vegetation die-off (i.e., the gradual decline of cattail in Cell 7 over time, the mass uprooting of hydrilla in Cell 6 during a high flow event in WY2010, and the complete removal of SAV in Cell 4S from herbivory by the exotic island applesnail [*Pomacea maculata*] in July 2013).

STA TREATMENT PERFORMANCE

Over its 13-year POR, STA-1E has treated approximately 1.4 million ac-ft of water and retained 220 t of TP or 77% of the inflow TP load (**Table 5B-1**). The POR inflow FWM TP concentration to this facility is 166 µg/L, while the POR outflow FWM TP concentration is 40 µg/L.

STA-1E received a high inflow water volume during WY2017 (162,000 ac-ft) compared to previous water years (**Figure 5B-5**). Of this total water volume, approximately 50,800 ac-ft were Lake Okeechobee releases directed to STA-1E via the S-319 and G-311 structures. Prior to discharge to WCA-1, 42,100 ac-ft of these releases were treated in STA-1E, while 8,600 ac-ft were delivered as supplemental water to maintain the vegetation communities in STA-1E. Lake Okeechobee water was received in all months this water year.

STA-1E retained 87% of the inflow TP load this water year (22 of 25 t) (**Table 5B-1**). Percent TP retention has been fairly constant over the past seven water years. Annual inflow and outflow FWM TP concentrations were 126 and 20 µg/L in WY2017, respectively, while the HLR and PLR were 2.7 cm/d and 1.2 $g/m^2/yr$, respectively.

FACILITY STATUS AND OPERATIONAL ISSUES

All three flow-ways in STA-1E were operational throughout WY2017, although each flow-way was ONR during a portion of the water year when stage and/or flow were restricted due to one or more one of the following: the presence of nesting Everglade snail kites and black-necked stilts, structure repairs, STA operation requirements of a Restoration Strategies Science Plan research project[9], or deep water conditions promoted by a steep topographic gradient in some cells (**Table 5B-2**).

The USACE continued with repairs to water control structures in the Western and Central flow-ways during WY2017. All structure repairs were scheduled to be completed by May 2017. In addition, construction of G-716, a new triple-gated spillway that connects the East and West distribution cells, was completed in June 2016.

Dryout Impacts

In April 2017, Cells 1 and 2 dried out and FDEP was notified accordingly, as required by permit. All other cells in STA-1E were hydrated throughout WY2017.

[9] *Evaluation of the Role that Rooted Floating Aquatic Vegetation have in Lowering STA TP Discharge Concentrations* study, otherwise referred to as the "rFAV Study".

Migratory Bird and Snail Kite Nesting

Black-necked stilts nests were observed in Cell 5 between May and June 2016. Stilt nests were also observed in Cell 2 in March 2017 and in Cells 2 and 5 in April 2017. Active Everglade snail kite nests were present in Cell 1 from May through July 2016 and in Cell 4N from May through September 2016. Information on STA-1E operational and maintenance adjustments made to protect bird nests during WY2017 is presented in Appendix 5B-3 of this volume.

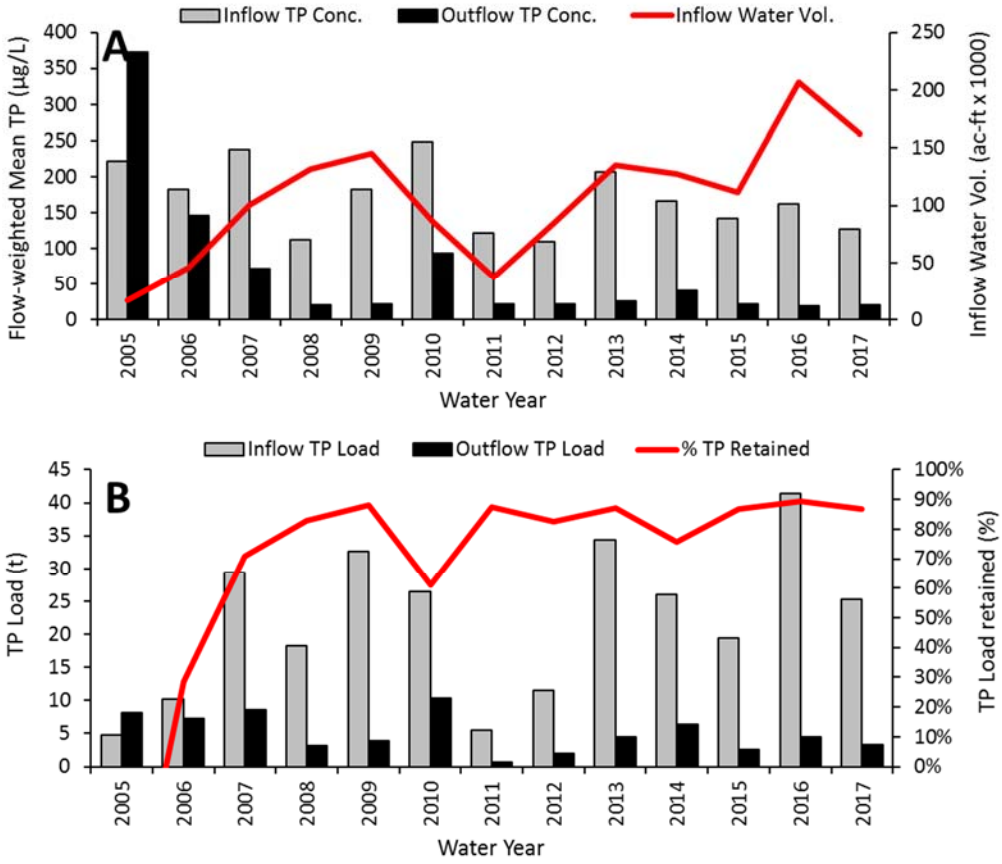


Figure 5B-5. POR time series in STA-1E for (A) annual inflow and outflow FWM TP concentrations (Conc.) with corresponding inflow water volumes (Vol.) and (B) annual inflow and outflow TP loads with the percent TP load retained.

VEGETATION MAINTENANCE AND RESTORATION

STA-1E vegetation management activities in WY2017 were largely focused on controlling FAV and preparing impacted cells for future rehabilitation efforts. Approximately 700 ac of FAV were treated in the Eastern and Western distribution cells to prevent FAV species from encroaching on water control structures and limit their spread to downstream treatment cells. Rehabilitation of the plant community in the Eastern Flow-way continued after the decommissioning of the USACE Periphyton-based Stormwater Treatment Area (PSTA) Project in WY2015. Cell 1 had approximately 75% EAV coverage by the end of the water year. FAV invading Cell 1 was a threat to the establishment of EAV cover; in response, 196 ac of FAV were treated during the water year. The coverage of muskgrass that has recolonized the Cell 2 fluctuated over the past two water years due to seasonal die-offs and unplanned cell dry outs. Invasive and nuisance

species treatments in this cell included 50 ac of FAV to protect maturing vegetation strips and encourage the spread of SAV.

In the Central Flow-way, willow (*Salix* spp.), primrose willow, and FAV coverage continued to expand in Cell 3, and 226 ac of these species were treated to limit their spreading to the downstream SAV cells. At the beginning of WY2017, SAV coverage in Cells 4N and 4S was relatively sparse but increased steadily over the course of the water year. One thousand four (1,004) ac of FAV were treated in Cell 4N.

In the Western Flow-way, 36 ac of alligator flag and 3 ac of giant bulrush were planted in Cell 5 to repair hydraulic short circuits and prepare harvest sites for more extensive plantings in the future. Willow, primrose willow, and pennywort (*Hydrocotyle umbellata*) were observed throughout this cell and will be controlled before extensive rehabilitation efforts can begin. In Cell 7, 687 acres of FAV were treated. Most of the cattail in this cell was rooted in soil that delaminated during the water year, leading to cattail die-off. Efforts are under way to sink the floating muck and reestablish EAV cover with a species that has a deeper root system that can help stabilize the remaining cattail. By the end of WY2017, sufficient FAV and floating muck had been controlled in Cell 7 to start replanting and 28 ac of alligator flag and 6 ac of giant bulrush were planted along with inoculations of SAV in deeper portions of the cell; planting with multiple species will continue in this cell over the next two to three years. In Cell 6, 745 acres of FAV were treated. SAV coverage in this cell averaged around 70% during the water year. Thirty-six (36) ac of alligator flag were planted in the northern portion of Cell 6 for vegetation strips and hydraulic short-circuit repairs and provide plant harvest sites for future restorations.

VEGETATION SURVEYS

Vegetation Coverage Estimates Based on Aerial Imagery

There has been relatively little net change in EAV coverage in Cells 3 and 5 over the last 10 years (2007 to 2016; Appendix 5B-4, Table 6 and Figure 6); the POR average EAV coverage in these two cells is 87 and 84%, respectively, while annual coverage values over this period generally ranged from 80 to 90%. EAV coverage in Cell 1 followed this same pattern except that EAV coverage in 2015 declined markedly to 27% (from 95% in the previous year) and then increased to 59% in 2016. Annual EAV coverage in Cell 7 typically had been around 60% up through 2013, increased to 80% in 2014 and 2015, and decreased to 68% this year. EAV coverage in the Cells 4N, 4S, and 6 has gradually increased from less than 7% in all cells in 2007 to 51 to 65% this year.

Cell 1 was dry for an extended period when the Eastern Flow-way was taken offline in WY2014 and WY2015 to allow the USACE to remove their PSTA Project from Cell 2. This allowed terrestrial vegetation to replace much of the pre-existing EAV throughout the flow-way. The terrestrial vegetation subsequently died back when the flow-way was reflooded at the end of WY2015. The vegetation community in these two cells is still transitioning from terrestrial vegetation to an assemblage of aquatic plant species.

Ground Surveys for SAV

Ground surveys were conducted on three occasions in WY2017 to map SAV coverage in STA-1E: on September 27, 2016, in Cells 4N and 4S, and on September 20, 2016, and October 26, 2016, in Cell 6. Surveys found SAV taxa distributed throughout these cells (Appendix 5B-5, Figures 1 and 2). Total SAV coverage ranged from dense or very dense at approximately one-quarter of the survey sites and moderately dense to nonexistent at the remaining sites. The following SAV taxa were identified in STA-1E this water year: coontail (*Ceratophyllum demersum*); bladderwort (*Utricularia* sp.); hydrilla (*Hydrilla verticillata*); muskgrass (*Chara* sp.); southern naiad (*Najas guadalupensis*); and spiny naiad (*Najas marina*). Hydrilla was the most abundant SAV taxon in Cells 4N and 4S, while southern naiad was most abundant in Cell 6. Coontail, muskgrass, southern naiad, and spiny naiad were present in lesser quantities in STA-1E this water year.

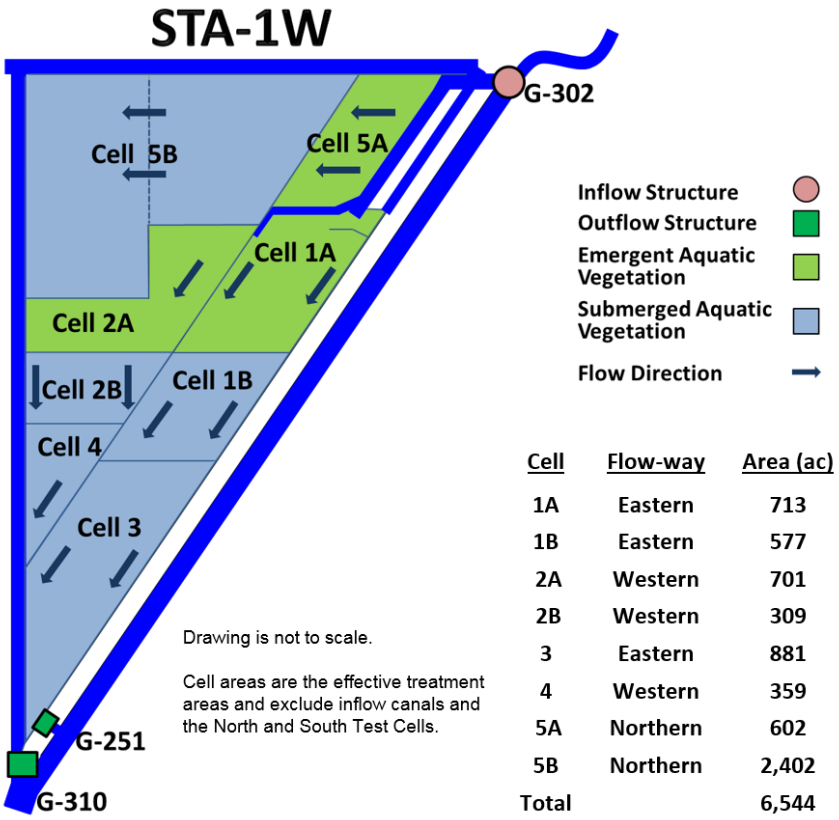
STA-1W

STA-1W, which began operation in 1994 as the Everglades Nutrient Removal (ENR) Project, is located in Palm Beach County northwest of LNWR (**Figure 5B-1**). This STA encompasses 6,544 ac of treatment area arranged into three flow-ways with eight treatment cells (Piccone et al. 2013; **Figure 5B-6**). The Eastern and Western flow-ways comprised the ENR Project and the Northern Flow-way was added to the facility in 1999. Compartmentalization of former Cells 1 and Cell 2 was completed in 2007 with the construction of two new interior levees that created Cells 1A, 1B, 2A, and 2B. This STA receives inflow primarily from the S-5A drainage basin and East Beach Water Control District, as well as Lake Okeechobee regulatory releases. During the dry season, supplemental water is delivered from Lake Okeechobee, when available, to maintain hydration in cells dominated by SAV. The flow-way nomenclature for STA-1W is as follows:

Eastern Flow-way = Cells 1A, 1B and 3

Western Flow-way = Cells 2A, 2B, and 4

Northern Flow-way = Cells 5A and 5B



Cell	Flow-way	Area (ac)
1A	Eastern	713
1B	Eastern	577
2A	Western	701
2B	Western	309
3	Eastern	881
4	Western	359
5A	Northern	602
5B	Northern	2,402
Total		6,544

Figure 5B-6. Simplified schematic of STA-1W showing major inflow and outflow water control structures, the treatment area of each cell, flow direction, and dominant/target vegetation types. Treatment areas do not include pump stations, levees, roads, or other upland areas. A detailed structure map of STA-1W is provided in Appendix 5B-1 of this volume.

Over its operational history, STA-1W has been affected by extreme weather events (regional droughts and large storms), maintenance activities that included water level drawdowns and construction, and high hydraulic and nutrient loadings. Major rehabilitation activities were implemented in STA-1W between 2005 and 2007 to reestablish the vegetation communities that were damaged by hydraulic overloading in previous water years and restore treatment performance to all cells.

STA TREATMENT PERFORMANCE

Over its 23-year POR, STA-1W has treated approximately 4.1 million ac-ft of water and retained 633 t of TP or 73% of the total inflow TP load (**Table 5B-1**). The POR inflow FWM TP concentration is 174 µg/L, while the POR outflow FWM TP concentration is 46 µg/L.

In WY2017, STA-1W treated approximately 109,000 ac-ft of runoff (**Table 5B-1**). Of this total water volume, approximately 30,500 ac-ft were Lake Okeechobee releases directed to STA-1W via G-302. Prior to discharge to WCA-1, 22,900 ac-ft of these releases were treated in STA-1W, while 7,600 ac-ft were delivered as supplemental water to maintain the vegetation communities in STA-1W. Lake Okeechobee water was received in all months this water year.

STA-1W had an inflow and outflow FWM TP concentrations of 136 and 23 µg/L, respectively, this water year (**Table 5B-1**). STA-1W retained 15 t of TP or 84% of the inflow TP load and had a HLR and a PLR of 1.4 cm/d and 0.7 $g/m^2/yr$, respectively. Treatment performance in STA-1W has fully recovered from the dramatic decline that occurred from WY2002 through WY2006 when the facility was hydraulically overloaded (**Figure 5B-7**). The percent TP load retained in STA-1W has been fairly constant at 80% or greater since WY2009, which is comparable to the level of treatment performance in the water years preceding WY2001.

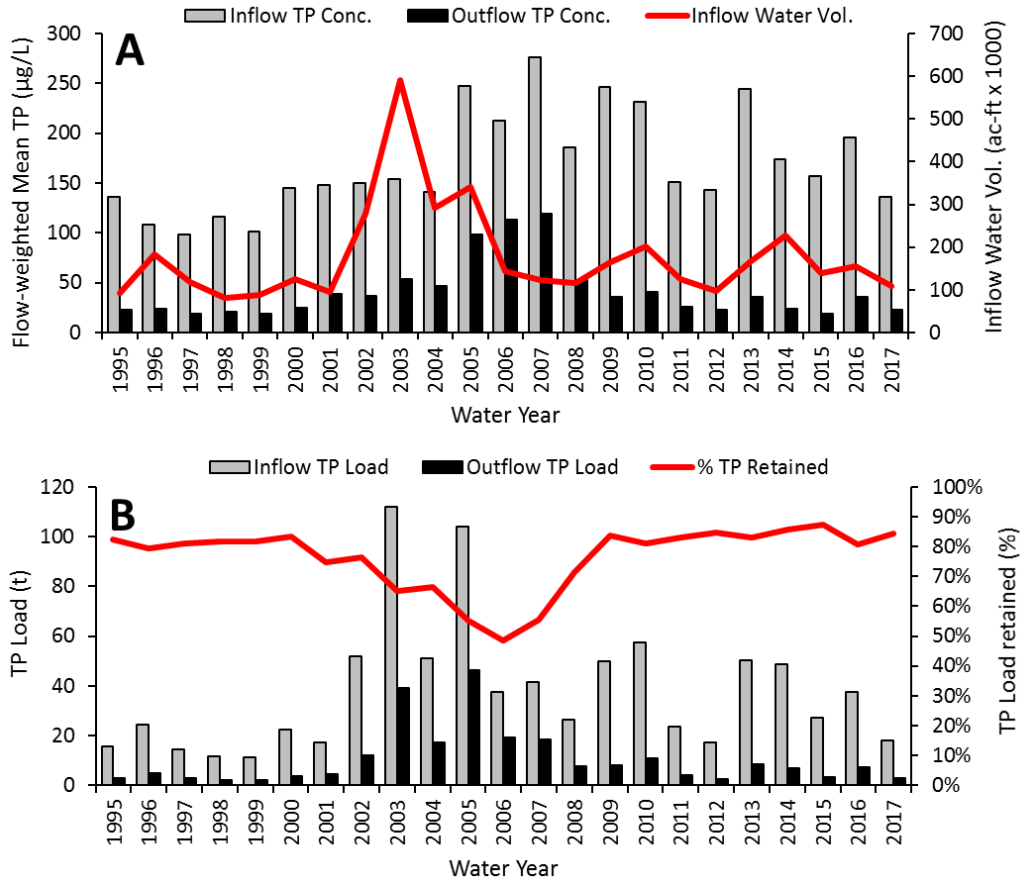


Figure 5B-7. POR time series in STA-1W for (A) annual inflow and outflow FWM TP concentrations (Conc.) with corresponding inflow water volumes (Vol.) and (B) annual inflow and outflow TP loads with the percent TP load retained.

FACILITY STATUS AND OPERATIONAL ISSUES

All three flow-ways in STA-1W were operational throughout WY2017, although each flow-way was ONR during a portion of the water year when stage and/or flow were restricted due to one or more one of the following: the presence of nesting black-necked stilts, vegetation maintenance, or activities associated with the expansion of STA-1W[10]. (**Table 5B-2**). As part of the STA-1W expansion, construction of the new G-727A overflow weir on the western levee of Cell 5B was initiated in February 2017. The G-306E-H outflow structures along this levee will remain closed until the new structure is completed. Power to G-258, G-309, G-307, and G-308 along the western levee was shut off from June to August 2016 to accommodate the construction; these structures were operated via backup generators during this period.

Dryout Impacts

All cells in STA-1W were hydrated throughout WY2017.

[10] Construction of a 6,500-ac addition to the treatment area in STA-1W (see **Figure 5B-1**) was initiated in April 2015 and is scheduled for completion by December 2018.

Migratory Bird and Snail Kite Nesting

Black-necked stilt were observed nesting in Cells 1A, 1B, 2B, 3, and 5B in May 2016, in Cells 1A and 5B in June 2016, and in Cell 5B in July 2016. No Everglade snail kite nests were found in STA-1W this water year. Information on STA-1W operational and maintenance adjustments made to protect bird nests during WY2017 is presented in Appendix 5B-3 of this volume.

VEGETATION MAINTENANCE AND RESTORATION

The primary focus of vegetation management in STA-1W during WY2017 was the rehabilitation of Cell 1A. Prior to this water year, Cell 1A had been impacted by the spread of primrose willow, pennywort, and floating cattail tussocks. Eight hundred fifty-six (856) ac of FAV were treated and 107 ac of alligator flag planted in this cell during this water year. In Cell 1B, 100 ac of cattail were treated as part of converting EAV stands to SAV. In the Western Flow-way, 100 ac of FAV were treated in Cell 2A to maintain conveyance capacity in the inflow and outflow spreader canals. Dense beds of Mexican water lily (*Nymphaea mexicana*) continued to expand in Cell 2B during WY2017 and 88 ac of FAV were treated to protect the SAV community. One hundred fifty (150) ac of cattail were treated in Cell 3 to convert more of this cell to a SAV community. In the Northern Flow-way, 261 and 672 ac of FAV were treated in Cells 5A and 5B, respectively, and a total of 187 ac of alligator flag were planted in the inflow regions of these cells to protect them from sediment erosion during high flow events

VEGETATION SURVEYS

Vegetation Coverage Estimates Based on Aerial Imagery

There has been relatively little net change in EAV coverage in the Cells 2A and 5A from 2007 to 2016 (Appendix 5B-4, Table 7 and Figure 7); their average EAV coverages are 86 and 62%, respectively. EAV coverages in Cells 1A, 1B, 2B, 3, and 4 were close to 100% in 2007 shortly after these cells were reflooded after rehabilitation of their aquatic plant communities. Subsequently, Cells 1B, 2B, 3, and 4 were converted from EAV to SAV communities. The EAV coverage in Cells 1B, 2B, and 4 decreased to 15% or less by 2008 and then varied from 5 to 28% through 2013. In the following years, EAV coverage in these cells increased, sometimes markedly, and now ranges from 27 to 32%. In contrast, EAV coverage in Cell 3 decreased to only 42% by 2008, varied little through 2013, and now stands at 46%. EAV coverage in Cell 5B was 5% in 2007 and has gradually risen to 21% by this year. Conversely, EAV coverage in Cell 1A increased from 59% in 2008 to approximately 80% from 2010 through 2014 and then decreased to 35% by this year.

Ground Surveys for SAV

Ground surveys were conducted on two occasions during WY2017 to map SAV coverage in STA-1W: on May 12, 2016, in Cells 2B and 4; and on October 27, 2016, in Cell 5B. (Appendix 5B-5, Figures 3 and 4). Total SAV areal coverage was dense to very dense at 50% or more of sites in these three cells. The SAV communities in Cells 2B and 4 were dominated by muskgrass while the community in Cell 5B was dominated by southern naiad. Other SAV taxa observed in lesser quantities in STA-1W this water year included coontail, spiny naiad, and bladderwort.

STA-2

STA-2 is located in Palm Beach County immediately west of WCA-2A (**Figure 5B-1**). STA-2 originally consisted of three treatment cells (Cells 1, 2, and 3) that began operation in 2000. This facility was expanded with the construction of Cell 4, which was flow capable by December 2006. Cell 4 then went offline in WY2010 during the construction of Cells 5, 6, 7, and 8, which were completed by WY2013. STA-2 now has five flow-ways with a total treatment area of 15,495 ac (Piccone et al. 2013; **Figure 5B-8**). STA-2 receives agricultural runoff from three Everglades Agricultural Area basins: runoff primarily comes from the S-6 and a portion of the S-2 basins but also can come from the S-7 and the remaining portion of the S-2 basins. STA-2 also receives runoff from the East Shore Water Control District, the Closter Farms Drainage System, and a portion of the S-5A basin. During the dry season, supplemental water is delivered from Lake Okeechobee, when available, to maintain hydration in cells dominated by SAV. The flow-way nomenclature for STA-2 is as follows:

Flow-way 1 = Cell 1

Flow-way 2 = Cell 2

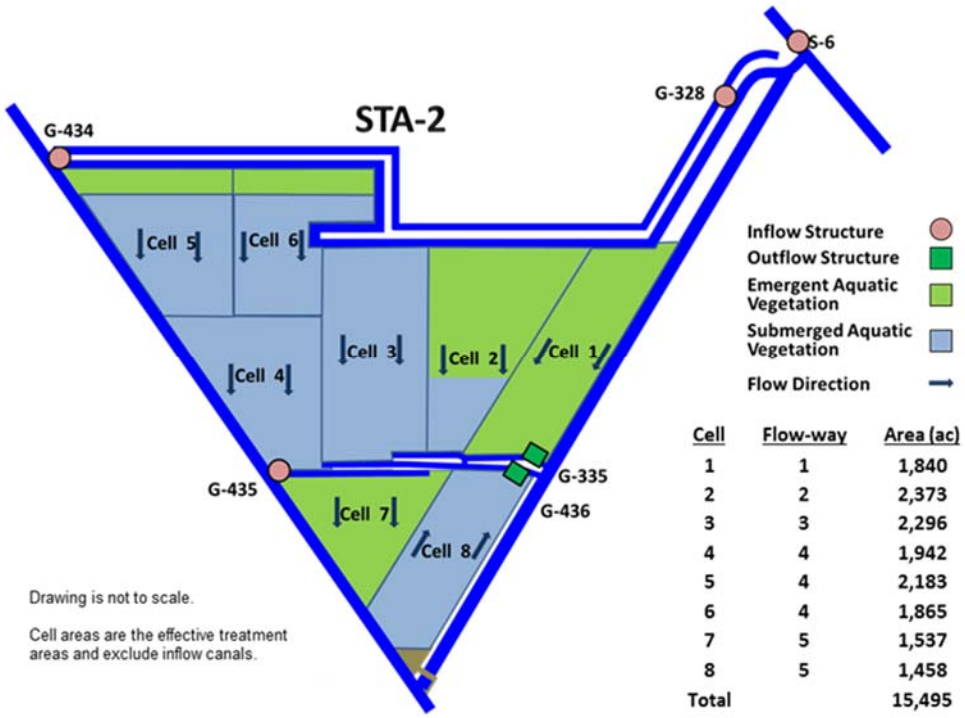
Flow-way 3 = Cell 3

Flow-way 4 = Cells 4, 5, and 6

Flow-way 5 = Cells 7 and 8

The A-1 FEB (**Figure 5B-1**), a 15,000-ac aboveground storage reservoir and a critical component of the *Restoration Strategies Regional Water Quality Plan* (SFWMD 2012), was completed and started operation in WY2016. STA-2 began receiving outflows from this facility in November 2015. The primary purpose of the A-1 FEB is to temporarily store stormwater runoff and thereby attenuate peak inflows to STA-2 to help improve its treatment performance. Secondarily, the A-1 FEB may provide a source of water during the dry season and reduce the frequency of dryout conditions in STA-2. For additional information on the A-1 FEB, see the following section on STA-3/4 and Volume III, Appendix 3-3.

Like the other STAs, STA-2 has been affected by regional droughts and large storm events over its POR. For example, Cells 1 and 2 have dried out, either partially or entirely, during past droughts when the supply of supplemental water was limited. Starting in WY2011, as a proactive measure, stage throughout STA-2 was increased to hold more water in the system in advance of the dry season, which has helped minimize dryout. One feature of STA-2 thought partly responsible for its historically good treatment performance is that all of Cell 1 and a portion of Cell 2 were never farmed prior to these areas becoming part of the STA. The hypothesis has been that there is reduced P flux from these unfarmed soils back to the water column, which leads to lower outflow TP concentrations from these cells. However, Cells 1 and 2 now comprise only 27% of the total treatment area in STA-2 (compared to 65% of the initial total treatment area of STA-2) and receive a proportionately similar amount of the inflow TP load to this STA. This suggests that Cells 1 and 2 are currently less important to the overall treatment performance of STA-2 than they were in the past.



Cell	Flow-way	Area (ac)
1	1	1,840
2	2	2,373
3	3	2,296
4	4	1,942
5	4	2,183
6	4	1,865
7	5	1,537
8	5	1,458
Total		15,495

Figure 5B-8. Simplified schematic of STA-2 showing major inflow and outflow water control structures, the treatment area of each cell, flow direction, and dominant/target vegetation types. Treatment areas do not include pump stations, levees, roads, or other upland areas. A detailed structure map of STA-2 is provided in Appendix 5B-1 of this volume.

STA Treatment Performance

Over its 16-year POR, STA-2 has treated approximately 4.7 million ac-ft of water and retained 440 t of TP or 78% of the TP load that entered this facility (**Table 5B-1**). The POR inflow FWM TP concentration to this facility is 97 µg/L, while the POR outflow FWM TP concentration is 20 µg/L.

STA-2 treated approximately 325,000 ac-ft of runoff in WY2017 (**Table 5B-1**). Of this total water volume, approximately 34,200 ac-ft were Lake Okeechobee releases directed to STA-2 via S-6, G-434, and G-435 throughout WY2017 except in September 2016. Prior to delivery south to WCA-2, 8,800 ac-ft of these releases were treated in STA-2, while 25,400 ac-ft were delivered as supplemental water to maintain the vegetation communities in STA-2.

STA-2 had an inflow and outflow FWM TP concentrations of 82 and 14 µg/L, respectively, this water year (**Table 5B-1**). This facility retained 27 t of TP, or 83% of the inflow TP load, and had a HLR and PLR of 1.8 cm/d and 0.5 g/m^2/yr, respectively. The treatment performance of STA-2 in WY2017 and previous water years, as measured by the percent TP load retained, has been fairly consistent over the POR (~ 75 to 84%; **Figure 5B-9**).

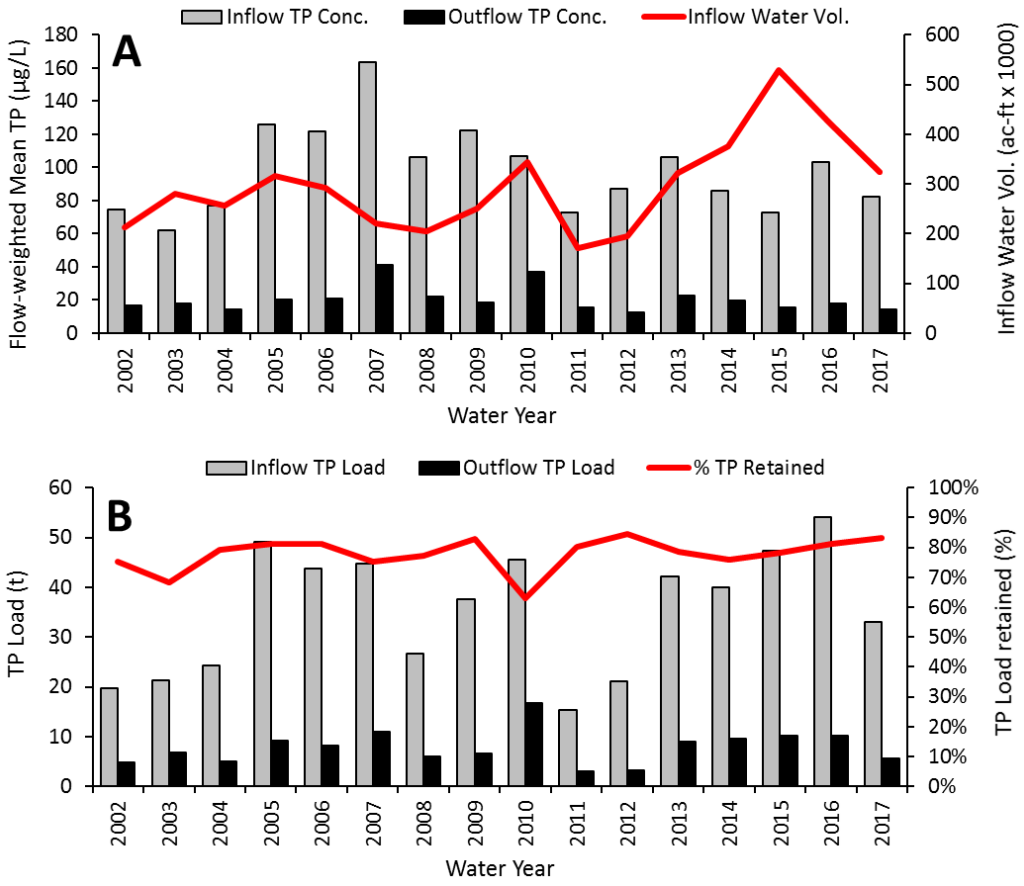


Figure 5B-9. POR time series in STA-2 for (A) annual inflow and outflow FWM TP concentrations (Conc.) with corresponding inflow water volumes (Vol.) and (B) annual inflow and outflow TP loads with the percent TP load retained.

FACILITY STATUS AND OPERATIONAL ISSUES

All five flow-ways in STA-2 were operational throughout WY2017, although Flow-ways 1, 3, 4, and 5 were ONR during a portion of the water year when stage and/or flow were restricted due to the presence of nesting Everglade snail kites and black-necked stilts or STA operation requirements of a Restoration Strategies Science Plan research project[11] (**Table 5B-2**).

Dryout Impacts

All cells in STA-2 were hydrated throughout WY2017.

[11] *Evaluation of Phosphorus Sources, Forms, Flux and Transformation Processes in the Stormwater Treatment Areas* study, otherwise known as the "P Flux Study".

Migratory Bird and Snail Kite Nesting

Black-necked stilts were observed nesting in Cells 3, 5, 6, and 8 in May 2016, in Cells 3 and 8 in June 2016, and in Cell 5 in April 2017. A single nest was present in Cell 6 in May 2016. Everglade snail kite nests were found in Cell 6 in May 2016. Information on STA-2 operational and maintenance adjustments made to protect bird nests during WY2017 is presented in Appendix 5B-3 of this volume.

VEGETATION MAINTENANCE AND RESTORATION

Vegetation management activities in STA 2 during WY2017 primarily were focused on preparing Cells 5 and 6 for rehabilitation by treating FAV (525 ac in Cell 5 and 703 ac in Cell 6) and the gradual conversion of cattail-dominated portions of Cells 2, 4, 5, 6, and 8 to a SAV community. As part of this process, cattail was treated in Cells 4 (200 ac), 5 (124 ac), and 6 (236 ac). Southern naiad was inoculated in portions of Cells 2 and 8 that were treated with herbicide last year as part of the EAV to SAV conversion.

VEGETATION SURVEYS

Vegetation Coverage Estimates Based on Aerial Imagery

The composition of the aquatic plant community in Cell 1 has been almost entirely EAV over the past 10 years; the average EAV coverage is 95% (Appendix 5B-4, Table 8 and Figure 8). Cell 2 had 75% EAV coverage from 2007 to 2009, which was reduced to 58 to 65% coverage in the following years after the conversion of the cell's outflow region to SAV. The EAV coverage in Cell 3 has increased steadily from 24% in 2007 to 41% by this year. The extent of EAV coverage in Cell 4 decreased from its maximum in 2007 (72%) to 5% in 2008 after the cell was converted to SAV. Cell 4 was then taken offline and dewatered in 2010 for the construction of additional treatment cells in STA-2. Subsequently, EAV coverage in this cell increased in the following years to 56% by 2011, declined through 2014, and then increased again to 52% by this year. The plant communities in the recently added cells, Cells 5, 6, 7, and 8, are largely dominated by EAV, where the percent EAV cover ranged from 48 to 93% this water year.

Ground Surveys for SAV

Ground surveys were conducted during two periods to map SAV coverage in Cells 3, 4, 5, 6, and 8: from August 11 to October 13, 2016, and from February 9 to March 27, 2017 (Appendix 5B-5, Figures 5 through 14). Total SAV areal coverage was widespread and often dense (high or medium coverage) in Cells 3 and 4, dense at less than one-half of the survey sites in Cells 5 and 6, and dense only at the inflow of Cell 8. The SAV communities in Cells 3 and 4 were dominated by muskgrass, while spiny naiad was the dominant taxon in Cells 5 and 6. Cell 8 primarily contained southern naiad and bladderwort; SAV coverage in this cell is increasing as it is converted to a primarily SAV community. Other SAV taxa observed in lesser quantities in STA-2 this water year included hydrilla, coontail, and pondweed.

STA-3/4

STA-3/4 is located in Palm Beach County northeast of the Holey Land Wildlife Management Area and north of WCA-3A (**Figure 5B-1**). This STA became operational in WY2004 and a new interior levee was constructed in WY2006 to create Cells 3A and 3B. STA-3/4 is comprised of six treatment cells arranged into three flow-ways with a total treatment area of 16,327 ac (Piccone et al. 2013; **Figure 5B-10**). A 445-ac section of Cell 2B is the site of the District's STA-3/4 PSTA Project, constructed as the first phase of implementing the PSTA treatment technology in this STA. The STA-3/4 PSTA Project has been described in past South Florida Environmental Reports and is discussed in Chapter 5C of this volume. STA-3/4 treats stormwater runoff from the S-2/S-7, S-3/S-8, S-236, and C-139 basins, the South Shore Drainage District, and the South Florida Conservancy District, and releases from Lake Okeechobee. During the dry season, supplemental water is delivered from Lake Okeechobee, when available, to maintain hydration in cells dominated by SAV. The flow-way nomenclature for STA-3/4 is as follows:

Eastern Flow-way = Cells 1A and 1B

Central Flow-way = Cells 2A and 2B

Western Flow-way = Cells 3A and 3B

Figure 5B-10. Simplified schematic of STA-3/4 and the A-1 FEB showing major inflow and outflow water control structures, treatment area of each cell, flow direction, and dominant/target vegetation types. Treatment areas do not include pump stations, levees, roads, or other upland areas. Detailed structure maps of STA-3/4 and the A-1 FEB are provided in Appendix 5B-1 of this volume.

The A-1 FEB (**Figure 5B-10**) is a 15,000-ac aboveground storage reservoir located immediately north of STA-3/4, and a critical component of the *Restoration Strategies Regional Water Quality Plan* (SFWMD 2012**)**. This facility was completed and started operation in WY2016. STA-3/4 began receiving outflows from the reservoir in November 2015. The primary purpose of the A-1 FEB is to temporarily store stormwater runoff and thereby attenuate peak inflows to STA-3/4 to help improve its treatment performance. Secondarily, the A-1 FEB may provide a source of water during the dry season and reduce the frequency of dryout conditions in STA-3/4. See Volume III, Appendix 3-3 for additional information on the A-1 FEB.

Similar to the other STAs, STA-3/4 has been affected by extreme weather events such as regional droughts and large storms. High hydraulic loads during and following storms have resulted to excessively deep water for extended periods in cells at the top of the flow-ways. Chronic deep-water conditions have stressed the cattail populations in Cells 1A and 2A causing widespread mortality, especially at the inflow regions of these cells.

STA TREATMENT PERFORMANCE

STA-3/4 over its 14-year POR has treated the largest volume of water (5.9 million ac-ft) and retained the most TP (651 t) with the greatest treatment efficiency, based on its percent TP load retained (85%), of all the STAs (**Table 5B-1**). The POR inflow FWM TP concentration STA-3/4 is 105 µg/L, while the POR outflow FWM TP concentration is 16 µg/L, which is the lowest POR outflow TP concentration among the STAs. Based on these metrics, STA-3/4 has been the best performing STA over its POR. The good POR treatment performance of STA-3/4 can be attributed, in part, to its relatively low POR inflow TP concentration (only STA-2 had a lower POR inflow TP concentration [97 µg/L]; see **Table 5B-1**) and TP areal loading rate compared to the other STAs. Past annual reports have documented moderate regression relationships between annual or POR outflow TP concentration with inflow TP concentration and areal TP loading. Depending on the averaging period, inflow TP concentration generally accounted for 50 to 60% of the variability in outflow TP concentration in these analyses. The remaining variability in outflow TP concentration is attributed to other biogeochemical differences among the STAs. A fuller explanation of why treatment performance varies among the STAs is one of the objectives of the ongoing Restoration Strategies Science Plan study *Evaluate Phosphorus Sources, Forms, Flux, and Transformation Processes in the Stormwater Treatment Areas* (see Chapter 5C in this volume).

STA-3/4 treated approximately 377,000 ac-ft of runoff in WY2017 (**Table 5B-1**). Of this total water volume, approximately 124,000 ac-ft were Lake Okeechobee releases sent to the STA-3/4-A1 FEB system. This water was received in all months except September 2016. Prior to delivery south to WCA-2A and WCA-3A, 69,600 ac-ft of these releases were treated in STA-3/4, while 54,100 ac-ft were delivered as supplemental water to maintain the vegetation communities in this STA.

STA-3/4 had an inflow FWM TP concentration of 61 µg/L and produced an outflow FWM TP concentration of 11 µg/L this water year, which is the lowest annual outflow concentration recorded in any STA to date (**Table 5B-1**). This facility retained 23 t of TP, or 80% of the inflow TP load and had a HLR and PLR of 1.9 cm/d and 0.4 $g/m^2/yr$, respectively. The annual percent TP load retained in STA-3/4 has been relatively constant throughout much of its POR (~ 80 to 88%; **Figure 5B-11**).

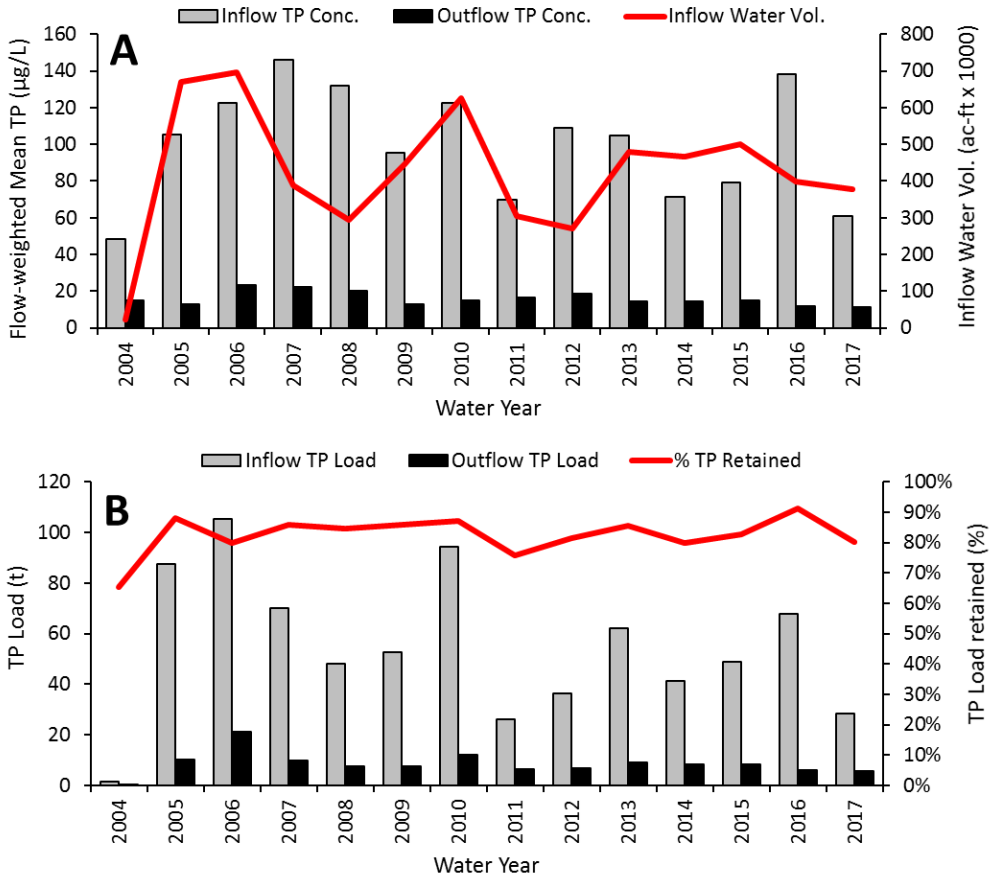


Figure 5B-11. POR time series in STA-3/4 for (A) annual inflow and outflow FWM TP concentrations (Conc.) with corresponding inflow water volumes (Vol.) and (B) annual inflow and outflow TP loads with the percent TP load retained.

FACILITY STATUS AND OPERATIONAL ISSUES

All three flow-ways in STA-3/4 were operational in WY2017, although the Eastern and Western flow-ways were ONR for a portion of the water year for vegetation maintenance or STA operation requirements associated with the *Evaluation of Phosphorus Sources, Forms, Flux and Transformation Processes in the Stormwater Treatment Areas* (P Flux Study), respectively (**Table 5B-2**).

Dryout Impacts

All the cells in STA-3/4 were hydrated throughout WY2017 and did not experience dryout impacts.

Migratory Bird and Snail Kite Nesting

Black-necked stilts nested in Cell 1 in May 2016. No Everglade snail kite nests were observed in STA-3/4 during WY2017. Information on STA-3/4 operational and maintenance adjustments made to protect bird nests during WY2017 is presented in Appendix 5B-3 of this volume.

VEGETATION MAINTENANCE AND RESTORATION

Most of the vegetation maintenance activities in STA 3/4 during WY2017 was focused on controlling FAV in EAV cells and the gradual conversion of EAV to SAV in SAV Cells. Fourteen (14) ac of alligator flag and 13 ac of giant bulrush were planted, and 188 ac of FAV were treated in Cell 1A this water year. Plant community conversion efforts continued in Cell 1B with the treatment of 430 ac of cattail. In the Central Flow-way, 503 ac of FAV were treated in Cell 2A and 20 ac of cattail were treated in Cell 2B. In the Western Flow-way, 25 and 0.5 ac of FAV were treated in Cells 3A and 3B, respectively.

VEGETATION SURVEYS

Vegetation Coverage Estimates Based on Aerial Imagery

There has been little change in EAV coverage within Cell 3A from 2007 to 2016 (Appendix 5B-4, Table 9 and Figure 9); the average EAV coverage for this cell is 95%. EAV coverage in Cells 1A and 2A has risen from initial values of 62 and 81%, respectively, in 2007 to 86 and 83%, respectively, by this year. EAV coverage in Cells 1B, 2B, and 3B in 2007 varied widely, ranging from 16 to 73%. In the years following, EAV coverage in Cells 2B and 3B remained fairly constant up through 2012, while coverage in Cell 1B decreased markedly during this period. EAV coverage in all three cells then increased steadily after 2012 to values this year that ranged from 40 to 59% by this year.

Ground Surveys for SAV

Ground surveys were conducted on four occasions during WY2017 to map SAV coverage in STA-3/4: September 15, 2016, in Cell 1B; September 7, 2016, in Cell 2B; and October 12, 2016, and March 29, 2017, in Cell 3B (Appendix 5B-5, Figures 15 through 18). Total SAV areal coverage was dense to very dense at the majority of survey sites in all three cells. The SAV communities in Cells 1B and 3B were dominated by muskgrass, while southern naiad was the dominant taxon in Cell 2B. Other SAV taxa observed in lesser quantities in STA-3/4 this water year included hydrilla, bladderwort, pondweed, spiny naiad, and coontail.

STA-5/6

STA-5/6 is located in Hendry County and is bordered by the C-139 and C-139 Annex basins on the west and the Rotenberger Wildlife Management Area on the east (**Figure 5B-1**). This STA was created by merging what had been two separate STAs: STA-5 and STA-6. The original STA-5 (Cells 5-1A, 5-1B, 5-2A, and 5-2B) and STA-6 (Cells 6-3 and 6-5) (**Figure 5B-12**) began operation in 2000 and 1997, respectively. STA-5 received inflow primarily from the C-139 Basin and STA-6 treated agricultural runoff from the former United States Sugar Corporation's Southern Division Ranch, Unit 2[12]. In 2006, Cells 5-3A and 5-3B were added to STA-5 and Cell 6-2 (formerly known as Section 2) was added to STA-6. Construction of additional treatment cells was completed by 2012 on the remaining portion of the STA-5/6 complex, which now has 14 cells arranged into eight flow-ways with a total treatment area of 13,685 ac (Piccone et al. 2013). STA-5/6 is operated as an integrated facility to treat runoff from the C-139 Basin. Performance measures that were reported individually for STA-5 and STA-6 in past annual reports have been recalculated for the integrated STA-5/6 complex in this water year's analysis.

The flow-way nomenclature for STA-5/6 is as follows:

Flow-way 1 = Cells 5-1A and 5-1B (former STA-5 Northern Flow-way)

Flow-way 2 = Cells 5-2A and 5-2B (former STA-5 Central Flow-way)

Flow-way 3 = Cells 5-3A and 5-3B (former STA-5 Southern Flow-way)

Flow-way 4 = Cells 5-4A and 5-4B

Flow-way 5 = Cells 5-5A and 5-5B

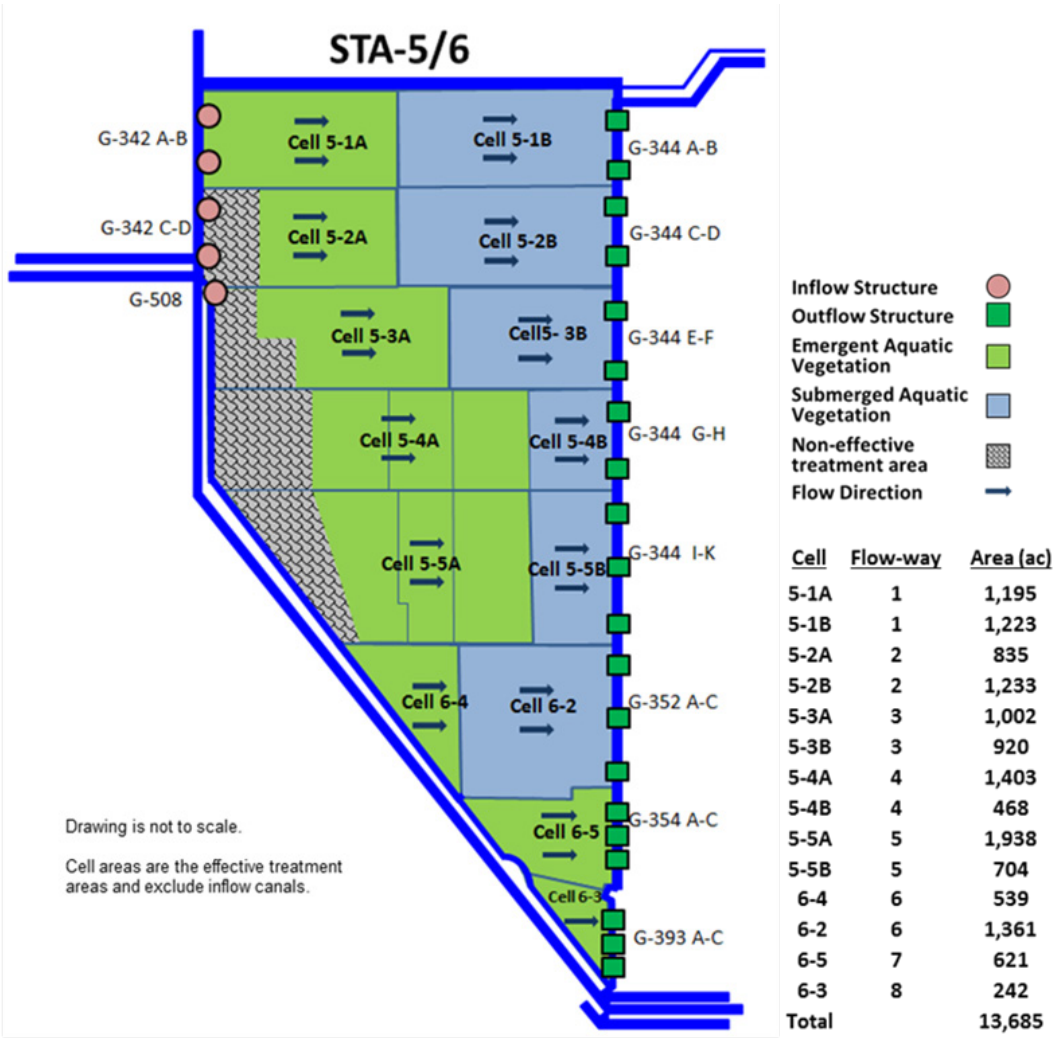
Flow-way 6 = Cells 6-4 and 6-2

Flow-way 7 = Cell 6-5

Flow-way 8 = Cell 6-3

As with the other STAs, STA-5/6 over its POR has been affected by high inflow TP concentrations and extreme weather events, such as regional droughts and large storms. The EAV cells in this STA have dried out to some extent in almost every dry season, and WY2017 was no exception. High soil P flux has followed rehydration of these cells, usually resulting in temporary spikes in outflow TP concentration.

[12] The footprint of the Southern Division Ranch, Unit 2 was incorporated into STA-5/6 when the treatment area of this STA was expanded.



Cell	Flow-way	Area (ac)
5-1A	1	1,195
5-1B	1	1,223
5-2A	2	835
5-2B	2	1,233
5-3A	3	1,002
5-3B	3	920
5-4A	4	1,403
5-4B	4	468
5-5A	5	1,938
5-5B	5	704
6-4	6	539
6-2	6	1,361
6-5	7	621
6-3	8	242
Total		13,685

Figure 5B-12. Simplified schematic of STA-5/6 showing major inflow and outflow water control structures, treatment area of each cell, flow direction, and dominant/target vegetation types. Treatment areas do not include pump stations, levees, roads, or other upland areas. A detailed structure map of STA-5/6 is provided in Appendix 5B-1 of this volume.

STA TREATMENT PERFORMANCE

STA-5/6 over its combined 20-year POR has treated approximately 2.4 million ac-ft of water and retained 385 t of TP or 70% of the total inflow TP load (**Table 5B-1**). The POR inflow FWM TP concentration is 184 µg/L, while the POR outflow FWM TP concentration is 63 µg/L. Based on the rank order of its overall outflow FWM TP concentration and percent TP load retained, STA-5/6 has been the poorest performing STA over its operational history. However, treatment performance in recent water years has improved (see below).

STA-5/6 treated approximately 118,000 ac-ft in WY2017 and retained 21 t of TP, which corresponded to 87% of the inflow TP load retained (**Table 5B-1**). The inflow FWM TP concentration this water year was 164 µg/L while the outflow FWM TP concentration was 18 µg/L. This was among the lowest annual outflow TP concentration and highest annual treatment efficiency recorded in STA-5/6 (**Figure 5B-13**). The HLR and PLR in STA-5/6 this water year were low (0.7 cm/d and 0.4 g/m^2/yr, respectively), compared

to the other STAs (**Figure 5B-3**). STA-5/6 usually has had the lowest HLRs and PLRs of all the STAs in recent water years, which is attributed, in part, to the large increase in STA-5/6 treatment area once Flow-ways 3, 4, and 5 came online. The percent TP load retained in STA-5/6 over the last seven water years (~ 76 to 91%), has been on par with treatment performance observed in the other STAs.

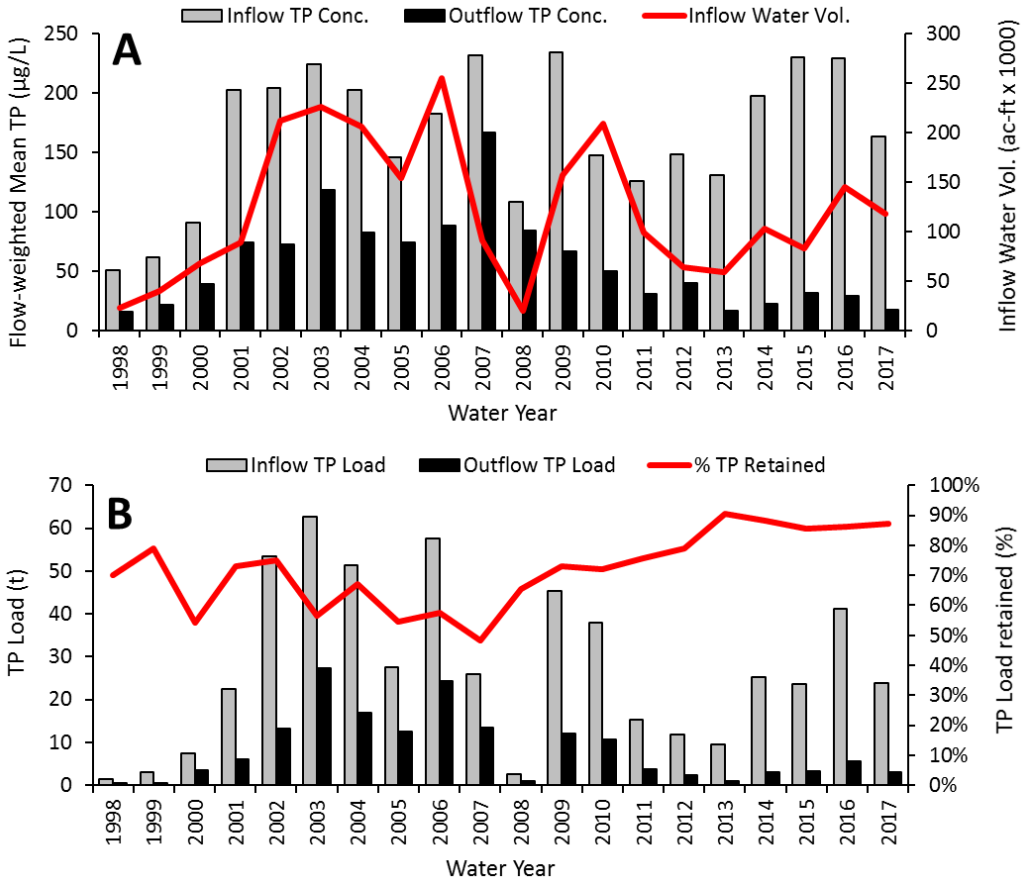


Figure 5B-13. POR time series in STA-5/6 for (A) annual inflow and outflow FWM TP concentration (Conc.) with corresponding inflow water volumes (Vol.) and (B) annual inflow and outflow TP loads with the percent TP load retained.

Due to conveyance limitations of the regional canal system, STA-5/6 cannot receive Lake Okeechobee regulatory releases. Supplemental water can be pumped from the STA-5/6 discharge canal and delivered as needed through the G-305B, G-507, G-509, and G-510 structures into Cells 1B, 2B, 3B, and 4B to keep these cells flooded.

FACILITY STATUS AND OPERATIONAL ISSUES

All eight flow-ways in STA-5/6 were operational during WY2017, although Flow-ways 1, 2, 3, 4, 5, and 6 were ONR for a portion of the water year due to the presence of nesting Everglade snail kites and black-necked stilts, vegetation maintenance, or cell dryout (**Table 5B-2**). All the EAV cells in this STA were dry at the conclusion of the water year, while supplemental water pumped from the STA-5/6 discharge canal was used to keep most of the SAV cells hydrated.

Dryout Impacts

A number of cells in STA-5/6 experienced dryout conditions during WY2017: Cells 6-3 and 6-5 from January through April 2017 and Cells 5-1A, 5-2A, 5-3A, 5-4A, 5-5A, 6-4, and 6-2 from March through April 2017. The District notified FDEP of these developments accordingly. All other cells in STA-5/6 were hydrated throughout WY2017 and had no dryout impacts this water year.

Migratory Bird and Snail Kite Nesting

Black-necked stilts were observed nesting in Cells 5-1A, 5-3B, 5-4A, 5-5A, and 5-5B in May 2016, in Cell 5-5B in June 2016, and in Cells 5-5B and 6-2 in April 2017. Active Everglade snail kite nests were present in Cell 5-3B from May through August 2016, in Cell 5-5A from May through September 2016, and in Cell 5-5B from May through August 2016. Information on STA-5/6 operational and maintenance adjustments made to protect bird nests during WY2017 is presented in Appendix 5B-3 of this volume.

VEGETATION MAINTENANCE AND RESTORATION

Historically, STA-5/6 has had chronic problems with willow and primrose willow encroachment in EAV cells and FAV invasion in all cells. WY2017 was no different and a combined total of 1,103 ac of primrose willow were treated in Cells 5-1A, 5-2A, 5-4A, 5-4B, 5-5B, and 6-4, while 300 ac of willow were treated in Cells 6-2, 6-3, and 6-5. The District also treated a combined 1,504 ac of FAV in Cells 5-1A, 5-1B, 5-2A, 5-2B, 5-3A, 5-4A, 5-4B, 5-5A, 6-2, 6-3, and 6-5. Restoration work this water year consisted of planting 89 ac of alligator flag in Cell 5-1A to repair a hydraulic short circuit and serve as a harvest site for expanded plantings next year. The nursery plots of alligator flag and giant bulrush that were started throughout STA-5/6 last year are growing in and should be ready for harvest by next year.

VEGETATION SURVEYS

Vegetation Coverage Estimates Based on Aerial Imagery

There was relatively little net change in EAV coverage in Cells 5-2A, 5-3A, 6-3, and 6-5 of STA-5/6 from 2007 to 2016 (Appendix 5B-4, Table 10 and Figure 10); their average EAV coverages ranged from 80 to 98%, respectively. EAV coverage in Cell 5-1A increased from 70 to 95% during this period. Cells 5-1B and 5-2B experienced gradual increases in EAV coverage from 5 and 20% coverage, respectively, in 2007 to 38 and 60%, respectively, by 2016. Conversely, coverage in Cell 6-2 has been largely EAV in most water years (average = 78%) while EAV coverage in Cell 5-3B was 80% or greater from 2008 through 2012, declined to 26% by 2014, and then increased to 61 percent by this year. EAV coverage in the recently created EAV cells (5-4A, 5-5A, and 6-4) and SAV cells (5-4B and 5-5B) has been comparable to EAV coverages in the older EAV and SAV cells, respectively.

Ground Surveys for SAV

Ground surveys were conducted during two periods to map SAV coverage in STA-5/6 Cells 5-1B, 5-2B, 5-3B, 5-4B, and 5-5B: from September 15 to November 10, 2016, and from March 2 to April 13, 2017 (Appendix 5B-5, Figures 19 through 27). Total SAV areal coverage was dense (high or medium coverage) at most survey sites in Cell 5-1B, and often dense at approximately one-third to one-half of the survey sites in Cells 5-2B, 5-3B, 5-4B, and Cell 5-5B. Hydrilla was the dominate taxon in Cells 5-1B, 5-2B, and 5-4B, while southern naiad or coontail was dominant in Cells 5-3B and 5-5B. Other SAV taxa observed in lesser quantities in STA-5/6 this water year included bladderwort, pondweed, and muskgrass.

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