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Synopsis of the Everglades Stormwater Treatment Areas, Water Year 1996–2012

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Purpose and Scope

This synopsis document was prepared to consolidate various information related to Stormwater Treatment Area (STA) performance, condition, construction, and management activities for the period of record from Water Year (WY) 1996 to 2012 (May 1, 1995, through April 30, 2012). The construction of the STAs occurred in a phased approach so not all of the STAs have been operational for the same period. Timelines have been created for each STA to indicate major construction, vegetation management or extreme weather events (*Synopsis of the Major Operational Events* section). In addition to listing the major events that have occurred in the STAs, operating guidelines and the difficulties in interpreting the STA performance data are also discussed.

Additional information can be found in various documents including:

1. South Florida Environmental Reports (http://www.sfwmd.gov/sfer).
2. STA History (Chimney and Goforth, 2006)
3. STA Historical Vegetation Information Analysis (Malcolm Pirnie, 2008; Chimney 2009)

Introduction

The South Florida Water Management District (District) is operating and maintaining six Everglades Stormwater Treatment Areas (STAs), totaling about 45,000 acres (ac) of effective treatment area as of WY2012 (**Figure 1; Figures 12–16**). An additional 12,000 ac of treatment area have been completed in Compartments B and C and will become operational in WY2013. The STAs were constructed to remove excess phosphorus from surface waters before they enter into the Everglades Protection Area. From 1996 to May 2012 these large constructed wetlands have retained approximately 1,560 metric tons (mt) of total phosphorus (TP), reducing inflow loads by 73 percent and lowering phosphorus concentrations from an overall annual TP flow-weighted mean (FWM) concentration of 140 parts per billion (ppb) to 37 ppb. Annual outflow TP concentrations differ among the STAs and from year to year (**Figure 2**). All of the STAs have shown an annual reduction in inflow TP loads, with most achieving annual retentions greater than 50 percent and as high as 90 percent (**Figure 2**). During their operational period, the STAs have experienced variable loadings, extreme weather conditions, and construction or vegetation management or rehabilitation activities to enhance performance (**Figures 3** and **4**).

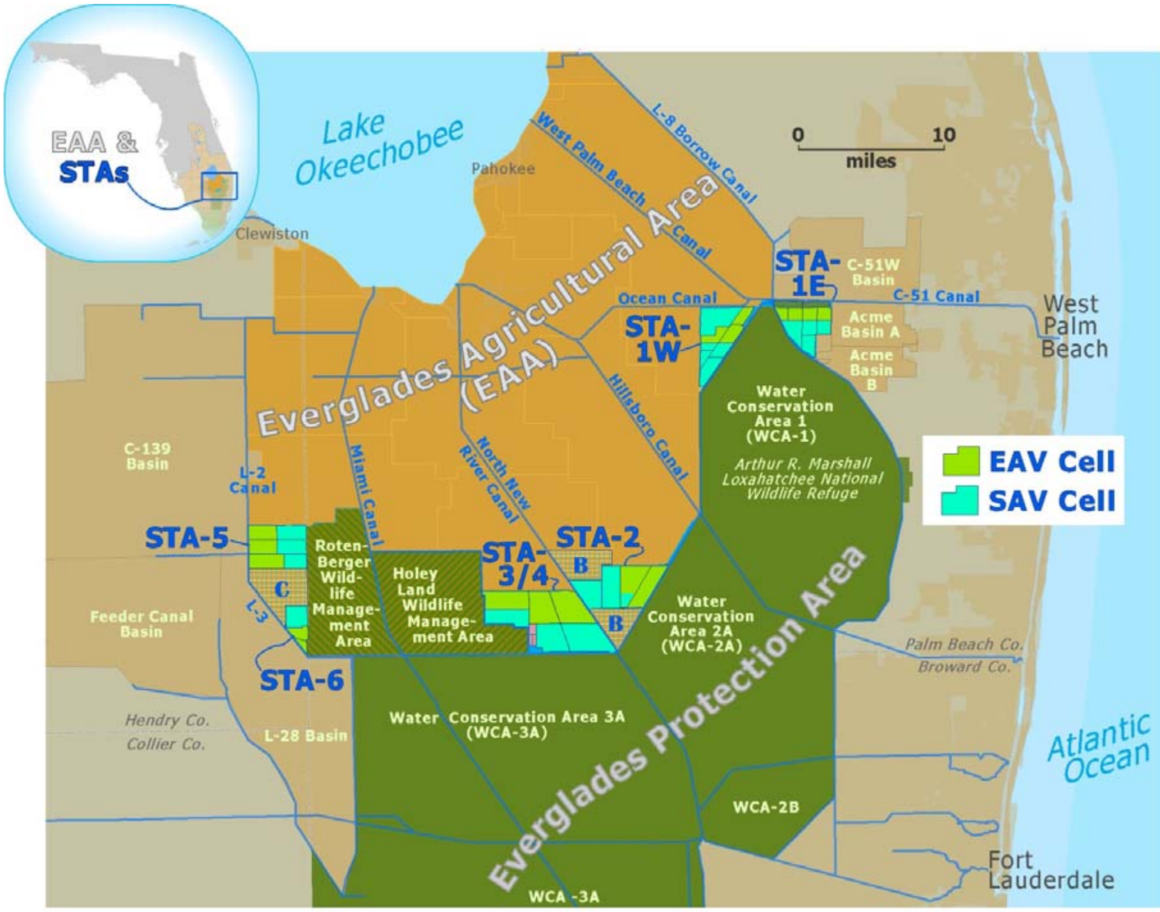


Figure 1. Location of the six Everglades Stormwater Treatment Areas (STAs) – STA-1E, STA-1W, STA-2, STA-3/4, STA-5, and STA-6. The letters "B" and "C" indicate the Compartment B and Compartment C Buildout areas under construction to create additional STA treatment acreage. The olive green color indicates treatment cells dominated by emergent aquatic vegetation (EAV) and the turquoise color indicates treatment cells dominated by submerged aquatic vegetation (SAV).

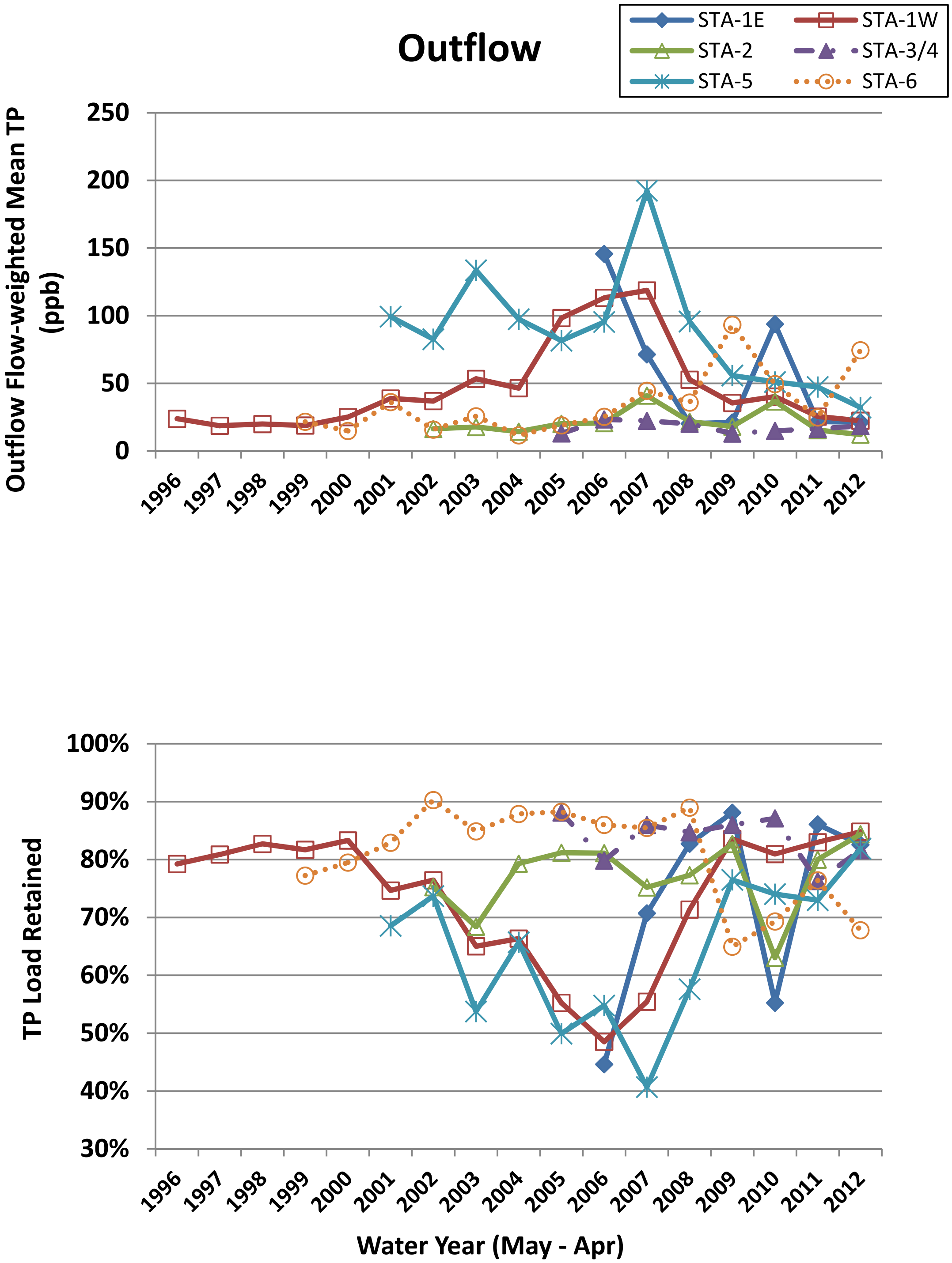


Figure 2. Top: the total phosphorus (TP) flow-weighted mean outflow concentration and (bottom) proportion of inflow TP load retained for the six Everglades Stormwater Treatment Areas (STAs) for the period of record through Water Year 2012. Plots show only complete water years of operation.

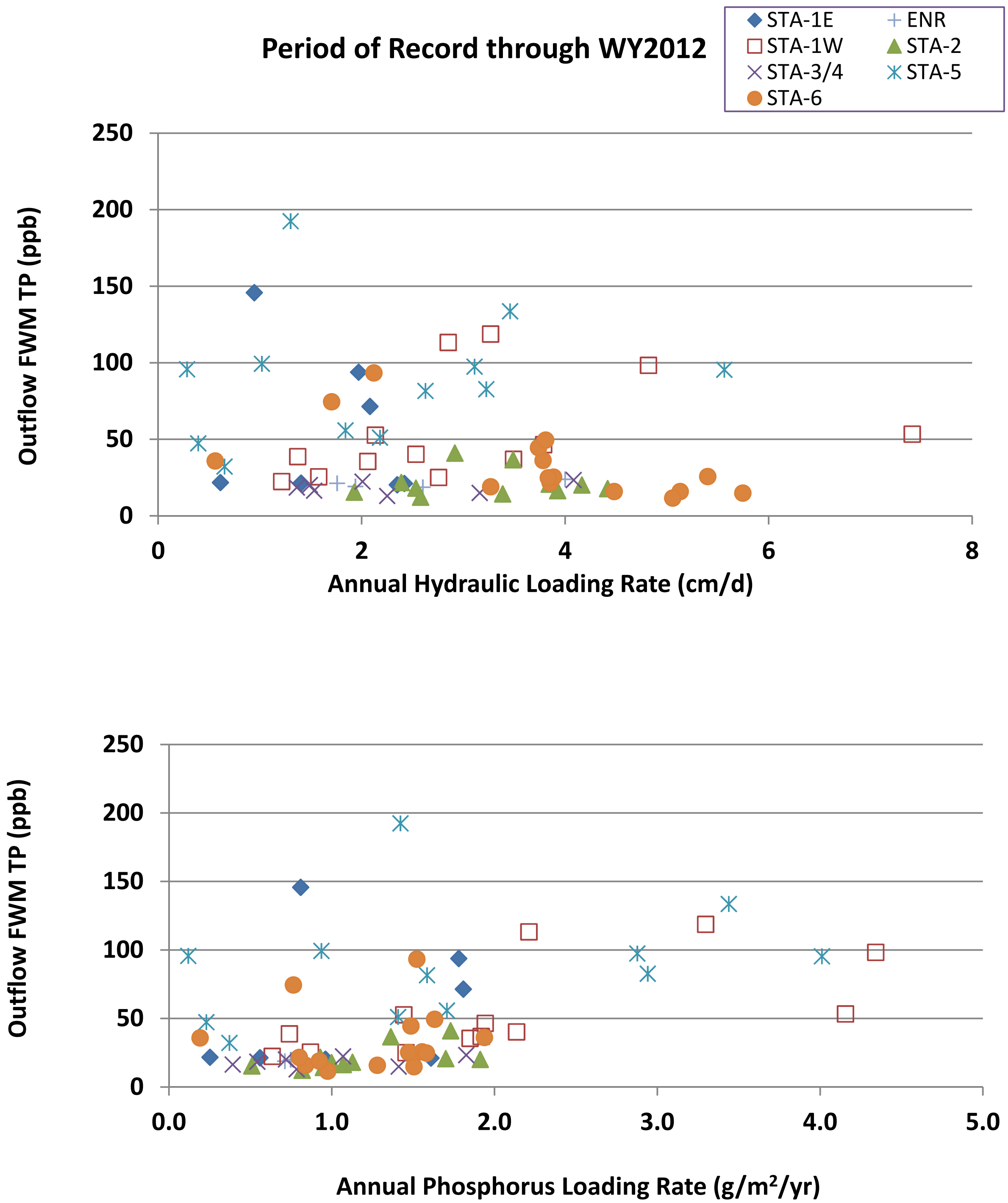


Figure 3. Relationship of outflow flow-weighted mean total phosphorus (FWM TP) concentration compared to annual inflow hydraulic loading rates (cm/day) and phosphorus loading rates (g/m^2/year). Plots show only complete water years of operation.

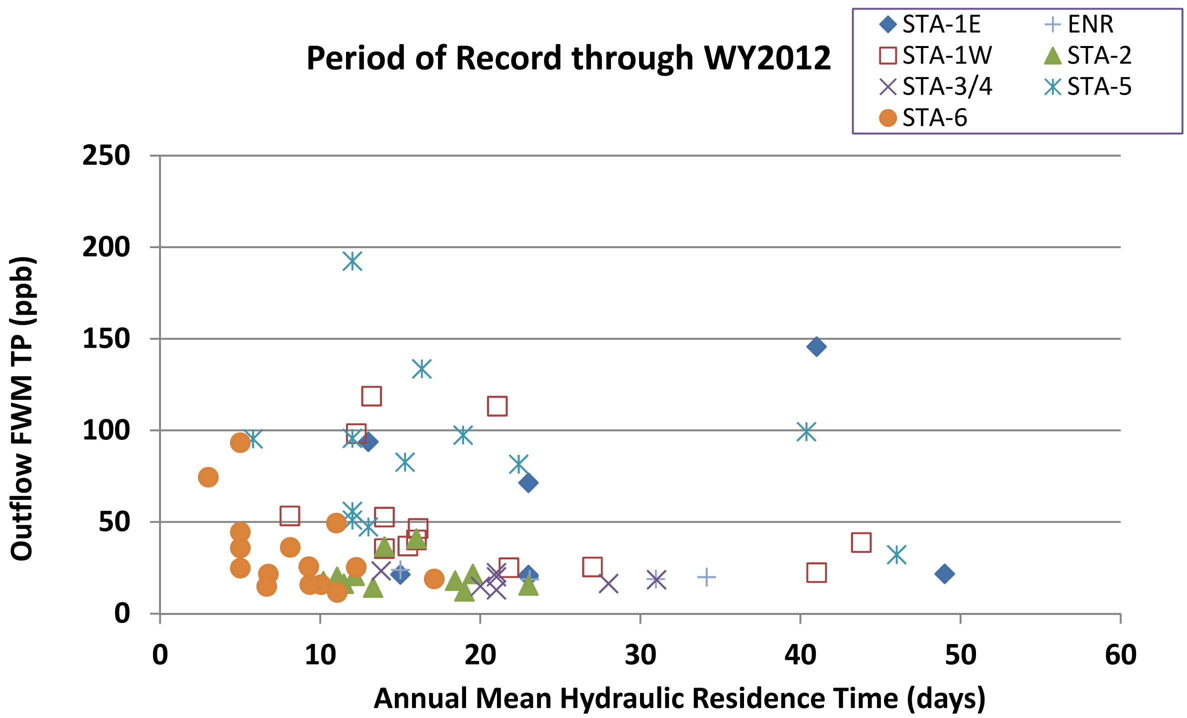


Figure 4. Relationship of outflow flow-weighted mean total phosphorus (TP) concentration compared to mean annual hydraulic residence time (HRT). Plots show only complete water years for period of record data through Water Year 2012.

The STAs are highly managed systems. The operation of the STAs involves various personnel for routine operations and maintenance of pumps, gates, structures, and vegetation maintenance. Scientists and engineers provide the technical information and evaluation to help ensure proper operation and optimized management, including collecting and analyzing water quality data, soil and vegetation data, flow data, and performance data. Cross-disciplinary teams participate in weekly, bi-weekly and monthly communication and coordination meetings. The flows and loads to each flow-way are examined weekly and this data is used to assist in operational decision-making. Water depths in each cell are monitored and target stages are set from average ground elevations depending on the dominant vegetation community and condition of the treatment cell. When desired performance is not being achieved, the technical team examines potential causes and implements corrective actions when feasible. Corrective actions can be operational in nature, such as reducing inflow loading to one flow-way by redirecting flows to another flow-way, or reducing target stages to allow vegetation to rejuvenate. Corrective actions can also include structural enhancements such as adding new structures or constructing divide levees to increase compartmentalization, or major rehabilitation activities such as the earthwork that was completed in STA-1W in 2007 and in STA-5 in 2009.

Challenges and Constraints Related to STA Operations

The STAs are biological treatment systems therefore treatment performance is inherently variable and is affected by a host of external and internal factors. External factors include wet and dry weather cycles, inflow phosphorus concentrations and loads, variable water delivery rates that result in changing water depths and flow rates, and wildlife utilization and associated state and federal wildlife protection laws. Treatment performance is also affected by internal biogeochemical factors including the health of submerged and emergent vegetation communities, algal, periphyton and bacterial communities, and soil phosphorus dynamics and flux. The STAs cannot be operated in isolation because they are integral components of a complex water management system with multiple objectives, particularly flood control and phosphorus removal performance expectations. Some of the challenges and constraints in operating the STAs are presented in **Table 1**.

The STAs receive stormwater runoff, resulting in variable inflow volumes and TP loads and concentrations. Since the goal is to treat all of the stormwater before it enters into the Everglades Protection Area, high loadings and extended periods of deep water conditions can occur, which in turn can negatively impact STA performance. In general, the STAs are maintained at a target depth of about 1.25 feet between flow events. As a result of storm events and associated stormwater inflows, water depths in the treatment cells can rise 2 to 3 feet within a short amount of time. As upstream basin runoff and stages decline, and STA inflows correspondingly subside, discharges from the STAs are made until water depths in the STAs are returned to the target depth. Until all of the regional infrastructure improvements are in place, it is expected that some of the STAs will continue to receive flows and loads higher than those anticipated during the original design phase. Another challenge related to STA operations occurs during the dry season and in particular during drought periods, when there is not always sufficient water to keep the cells hydrated and some cells dry out. Prolonged dryout conditions have been found to cause elevated outflow TP concentrations upon rehydration as observed historically most often at STA-5 and STA-6 (**Table 2**, **Figure 5**). Over the years, the District has implemented a drought contingency strategy to try to minimize the impacts of drought on STA performance. STA operations are also impacted by wildlife use, in particular species protected under the Migratory Bird Treaty Act, Endangered Species Act, and Bald Eagle Protection Act. STA water depths and flow conditions have been modified at times as a result of the presence of protected species in the STAs.

Table 1. The constraints and challenges related to operating the Stormwater Treatment Areas (STAs).

Constraints and Challenges Related to STA Operations and Phosphorus Removal Performance
Variable inflow volumes & total phosphorus (TP) loads/concentrations
Maintain compliance with all state and federal permits
Goal of avoiding diversion of untreated water into the Everglades Protection Area
Costs involved in additional compartmentalization levees and water control structures and major maintenance activities that can impact operations
Phased implementation of regional infrastructure components
Regional drought resulting in dryout conditions
Restrictions on operations due to presence of state or federally protected wildlife
Rapid increases in water depths in response to storm events
Variable topography resulting in short-circuiting and in some cases, inability to maintain desired vegetation communities
Limitations in moving water within the STA and watershed
Limited ability to take flow-ways off-line for maintenance, particularly during high rainfall events
Potential issues with stability of accrued sediment, particularly areas dominated by submerged aquatic vegetation
Internal nutrient flux from underlying substrate into the water column
Complexities in removing residual TP (mostly dissolved organic and particulate phosphorus) at the end of the treatment train
Limited ability to re-circulate water in the STA before discharging
Recovery time following extreme events, such as dryout or high water conditions and following vegetation conversions
Challenges in encouraging establishment of desired species and coverage
Elimination of large floating cattail tussocks (damages treatment cell vegetation and may cause internal loading due to sediment scouring)
Errors/uncertainties associated with flow measurements

Table 2. The impact on outflow TP of prolonged dryout conditions in the treatment cells at STA-5 and STA-6.

STA	Cell	Start Date (Depth <= 0)	End Date (Depth >= 0)	Dryout Duration (days)	Maximum TP Following Rehydration (ppb)
STA-5	Cell 1A	15-Mar-08	18-Apr-08	48	No Discharge
		2-May-08	18-Jun-08	43	302
		17-Dec-08	13-Jun-09	167	1325
		20-Mar-11	2-Jul-11	90	742
STA-5	Cell 2A	4-May-08	22-Jun-08	50	259
		25-Feb-09	27-May-09	88	279
		19-Dec-10	21-Jan-11	34	No Discharge
		26-Feb-11	7-Jul-11	132	2239
STA-6	Cell 3	16-May-08	21-Jun-08	37	162
		19-Feb-09	21-May-09	91	313
		28-Dec-10	4-Jul-11	192	370
		24-Feb-12	31-May-12	97	0
STA-6	Cell 5	12-May-08	21-Jun-08	40	59
		17-Feb-09	19-May-09	89	46
		25-Dec-10	3-Jul-11	191	458

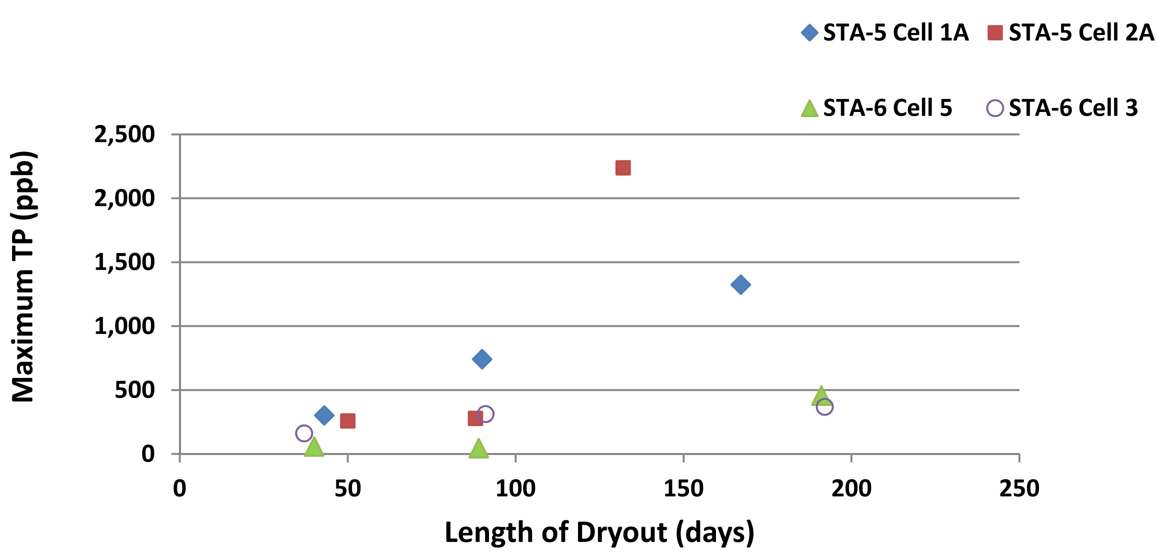


Figure 5. Maximum outflow flow-weighted mean TP concentrations at STA-5 and STA-6 from 2008–2012 following prolonged periods of dryout conditions. Elevated outflow TP concentrations have occurred following periods of dryout conditions.

In addition to hydrologic and nutrient loading, STA performance is affected by various other factors, some of which are outside of the STA managers' control such as extreme weather events and protected species nesting (**Table 1**). Some of the STA cells have highly variable topography that results in short-circuiting or conditions that may not be conducive for successful establishment of desired vegetation. The expenses involved in completely leveling the uneven topography are high; therefore strategic grading is the more routinely implemented option. The stability of the accrued sediment layer, along with establishment of plant communities is crucial for treatment sustainability. The feasibility (and effectiveness) of adding soil amendments to stabilize the sediments and improve phosphorus removal performance at this large scale is uncertain. Maintaining desired plant communities is also a challenge and much effort is expended in vegetation management activities.

General Operating Principles

The general operating principle for the STAs is to try to balance the inflows (flow volume and TP loads) between STA flow-ways and among nearby STAs if possible, and to try to maintain the water depths at target stages between flow events. The target water depths are kept shallow enough to avoid long periods of inundation that are too deep for the vegetation. Under extended deep water conditions, rooted macrophytes may float up and form tussocks that move around in the treatment cell scouring sediments. The tussocks can damage the vegetation communities and cause internal phosphorus re-suspension. Deep water can also limit light penetration and the light limitation can damage the submerged aquatic vegetation (SAV) community. Research conducted in deep mesocosms has shown that damage is done to the photosynthetic apparatus of cattail (*Typha domingensis*) under extended periods of high water conditions (Chen, et al., 2010). The treatment cells also have to be kept wet enough to minimize sediment drying and reduce the amount of subsequent oxidative remobilization of stored nutrients. As of result of these issues, target water depths are established to avoid dryout (low target stages are set to achieve a minimum depth of 0.5 feet), to avoid water depths that are too deep for too long (avoid 4.0 feet for more than 3 days, 3.5 feet for more than 7 days, and 3.0 feet for more than 10 days), and to maintain depths between storm events of about 1.25 feet. Frequent field visits are made to the STAs by the site managers and scientists. Following extreme weather conditions, such as drought or storm events, assessments of the STA plant communities and infrastructure components are conducted.

Extreme Weather Conditions Impacting the STAs, 2000–2012

Since WY2000, the STAs have been impacted by extreme weather conditions ranging from regional droughts to tropical storms and hurricanes. Timelines of extreme events impacting the STAs and annual performance are shown in **Figures 6–11** and **Tables 3–8**. During regional drought years, some of the STAs received decreased hydraulic loadings, with treatment cell water levels dropping below-ground for brief to prolonged periods (considered to by dried out) even though they were being operated in water conservation mode for most of the year. Hurricanes impacted the STAs in WY2000, WY2005 and WY2006 and tropical storms impacted the STAs in WY2007 and WY2009, during which the STAs received large inflow volumes and TP loads and deep water conditions persisted. Severe storms have led to physical damage to the STA infrastructure, prolonged power outages (Hurricane Wilma), and wind and wave damage especially to the SAV-dominated cells. To the other extreme, the region experienced drought conditions in WY2000–WY2001, WY2007, WY2008, WY2009, WY2011, and WY2012, during which flows and loads were reduced and more sporadic. When available, supplemental water was supplied to the treatment cells to help maintain SAV growth. A drought contingency strategy document was developed in WY2008 and continues to be utilized when drought conditions are experienced. Although WY2007 was considered to be a drought year, the STAs were impacted in late August and early September 2006 by Tropical Storm Ernesto. Tropical Storm Fay in August 2008, which arrived in the midst of the third consecutive year of regional drought conditions, also increased inflows to the STAs.

In WY2010, the STAs experienced an unusual extended period of cold weather, with minimal temperatures below 13° Celsius experienced sporadically from October 2009−April 2010. The cold extremes during the winter resulted in large-scale die-offs of exotic fish in all the STAs, leaving large amounts of decomposing fish biomass within the treatment cells, collection canals, and structures. Declines in SAV communities were observed in STA-1E, STA-1W, and STA-5, perhaps due to the cold conditions. Also in WY2010, the region had above average annual rainfall amounts and the dry season was considered to be relatively wet.

Long-Term Plan Enhancements and Rehabilitation Activities

The difficulty in understanding performance trends due to the natural variability of the biological systems receiving variable flows and loads is confounded by management activities, such as enhancements or rehabilitation activities. In addition to experiencing extreme weather, all the STAs have undergone one or more major change such as expansion, vegetation conversion, compartmentalization, and rehabilitation. A list of the construction and other enhancement activities associated with the Long-Term Plan (LTP) is shown in **Table A1**. Construction of the LTP enhancements and expansions typically resulted in taking flow-ways off-line to install divide levees or improve water control structures. Major rehabilitation activities have occurred at STA-1W and STA-5 such as earth-moving activities to improve hydraulics, remove cattail tussocks or high phosphorus content accrued sediments, and encourage desired plant establishment (Pietro et al., 2009; Pietro et al., 2010).

STA inflow and outflow TP concentrations, as well as individual flow-way TP concentrations, are monitored and when performance issues are observed, more in-depth data analysis and field observations are used together to understand the potential causes and implement activities aimed at improving performance. These activities include reducing loading to the affected treatment cells by moving water to other cells or STAs when feasible, inoculating with SAV, planting emergent aquatic vegetation (EAV), removing accrued sediments high in phosphorus, and modifying water depths to encourage healthy plant communities. An innovative method to stabilize sediment and encourage SAV growth as part of the 2006 STA-1W Cell 5 rehabilitation effort involved planting rice to stabilize the sediments and to provide a substrate for SAV establishment.

The optimization efforts include a large vegetation management component. Giant bulrush (*Schoenoplectus californicus*) has been planted in open water areas, deep areas, and in areas where hydraulic short-circuiting has been observed, such as in STA-1W Northern Flow-way, STA-1E (Cell 6 and Cell 7), STA-3/4, and STA-5. To fortify and protect the SAV-dominated treatment cells from wind and wave action, vegetation strips consisting of EAV have been created.

Factors to Consider when Evaluating STA Phosphorus Removal Performance

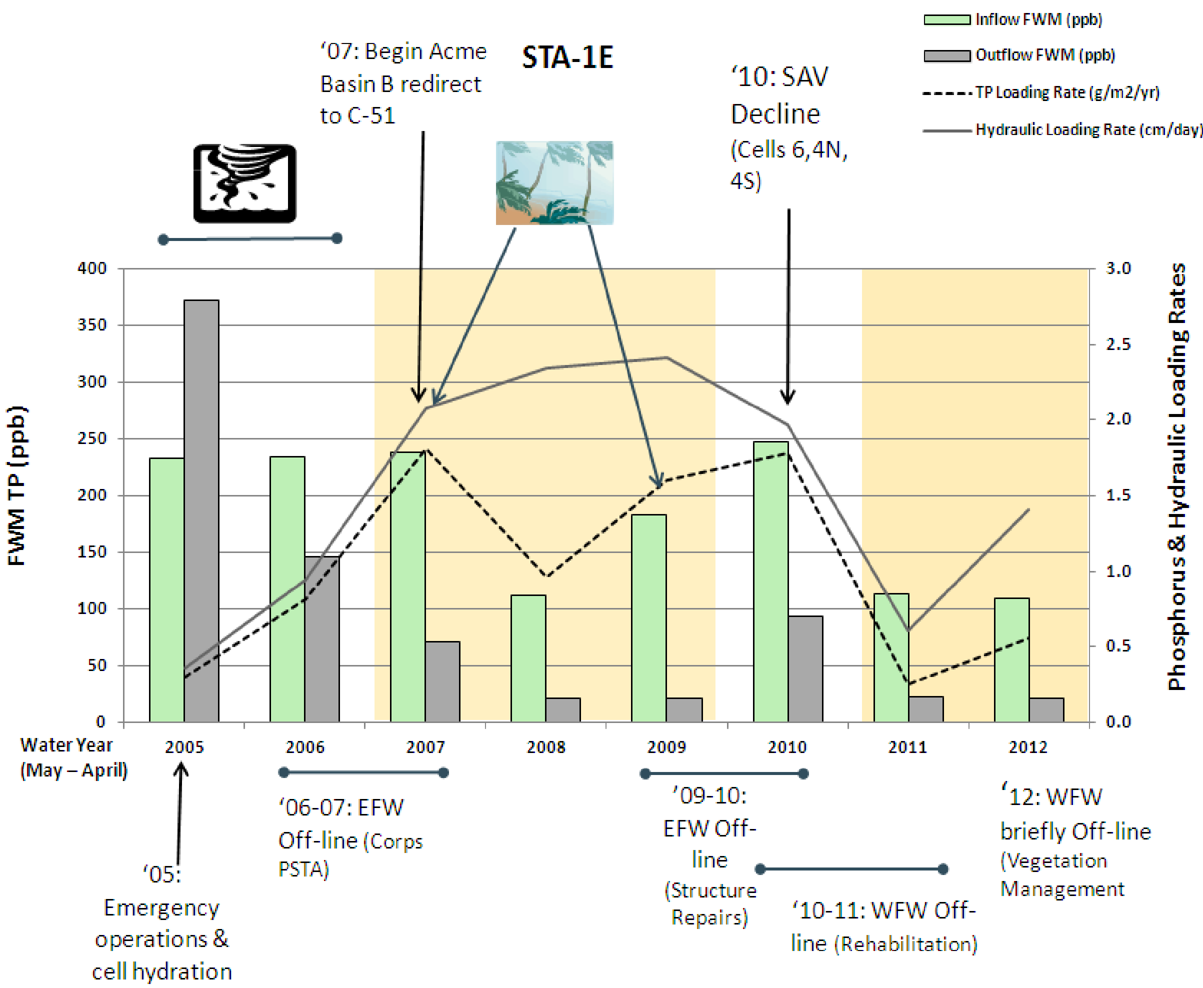
The outflow FWM TP concentrations are different among the STAs and from year to year (**Figures 2, 3, 4, 6-11**). In general, STA-1E, STA-2, STA-3/4, and STA-6 achieved the lowest outflow concentrations, below 50 ppb and often below 25 ppb, while historically STA-5 and STA-1W in some years had the highest outflow concentrations. The lowest annual outflow TP concentrations have been observed consistently at STA-3/4, where maximum outflow was 23 ppb and lowest outflow was 13 ppb over an eight year period. STA-2 has also shown consistently low outflow TP concentrations, ranging from 12 ppb to 41 ppb over an 11 year period. Improvements in TP removal efficiency have been observed at STA-5 beginning in WY2009. The improvements are likely a result of a number of related and independent factors, including reduced inflow loadings, L-3 Canal dredging, C-139 Basin BMP improvements, LTP enhancements, vegetation management activities, rehabilitation activities in Cell 1A and increased SAV coverage in the downstream cells. STA-1W (an expanded version of the Everglades Nutrient Removal [ENR] Project) outflow concentrations were below 55 ppb until WY2004, where they rose to above 100 ppb beginning in WY2005. Within the last few water years (following rehabilitation activities in WY2007), establishment of the desired plant communities and reduction in outflow TP concentrations have been observed at STA-1W and in WY2012, outflow concentration at STA-1W was 22 ppb. At STA-6, the performance has significantly declined in recent years mainly due to extended periods of little to no inflows and resulting dryout conditions. Low inflow volumes in recent years are attributed to regional drought conditions, Compartment C construction activities, and changes in the inflow conveyance features. Even when TP removal efficiency declined, the STAs showed TP removal efficiencies mostly above 50 percent (**Figure 2**). Over the period of operation, variability in the annual loadings to the STAs and hydraulic residence times (HRT) and wide ranges in outflow concentrations have been observed (**Figures 3** and **4**), with STA-1W and STA-5 showing the greatest range in hydraulic loading rate (HLR), phosphorus loading rate (PLR), and outflow FWM TP concentrations. In general, STA-1W and STA-5 have received the highest PLRs compared to the other STAs and STA-6 has received the highest HLRs. Time series plots show the annual trends in loadings and outflow TP concentrations (**Figures 6-11**).

The amount of time that the STAs have been operating is not solely a predictor of STA performance. Loading rates, which are adjusted for the actual amount of treatment area that is available, might provide a better indication of the impact of loading on treatment performance, regardless of the activities that occur within the STA. However, an examination of **Figures 2**, **3**, **4**, and **6-11** would indicate that there are no clear trends in the relationship of outflow TP to HLR, PLR, and HRT. This is likely because phosphorus removal can be affected by many other factors in addition to HLR, PLR and HRT. The STAs are biological systems that are subjected to flood and drought conditions; therefore, annual variability in performance is to be expected. The variability in STA performance can also be influenced by antecedent land use, inflow sources of water (with different chemistry), inflow water TP concentrations, vegetation composition, soil type, cell topography, cell size and shape, water depths, extreme weather conditions (hurricanes, droughts), enhancement activities (**Table A1**), and regional operations (i.e., flood control or water supply deliveries). The various management activities or operating events have different impacts on the TP removal performance and details and timelines of events by STA are listed in the "Synopsis of the Major Events by STA" section and in **Tables 3–8**.

For all the STAs, hydrologic extremes are exemplified by periods of high volumes of runoff in wet years and water shortages in drought years. Extreme weather affects the plants and loading characteristics. Performance has been found to be impacted by dryout as well as large loading events. Large flow events may be coupled with elevated TP concentrations, resulting in increased TP loads to the STAs. Annual values can be skewed by these large flow events with associated high TP values. Conversely, outflow TP concentrations following periods of dry conditions are usually associated with elevated TP after rehydration, referred to as the first flush (Pietro et al., 2010, Appendix 5-3). For example, FWM TP outflow concentrations have been recorded as high as 2,239 ppb in STA-5 after rehydration following prolonged periods of dryout conditions (**Table 2, Figure 5**). Thus, the frequency and duration of flooding and drought events influences performance. The marsh treatment cells show resilience but the impact of multiple events and the duration of events on vegetation communities and phosphorus removal warrant further investigation.

Following extreme weather conditions, major construction, or rehabilitation efforts, a recovery period is required. Management actions have been needed in some of the treatment cells following extreme weather events (i.e., STA-1W Cell 5 and STA-2 Cell 3 following Hurricane Wilma). The recovery time for treatment cells that undergo vegetation conversions or vegetation reestablishment following rehabilitation or construction events can be 1 to 3 years. The vegetation communities also change due to community maturity and invasion by undesirable species, such as willow. Water level manipulations as well as periodic and selective herbicide application are used to create and maintain desired vegetation communities.

Understanding the factors controlling long-term performance continues as the STAs are operated. Analysis of the performance on a shorter time step and in relation to high flow events, rapid increases in water depth, dryout, and vegetation coverage may provide further insight into STA performance. The STA optimization research program focuses on sustaining and optimizing the performance of the STAs, with studies pertaining to cattail flood tolerance, cattail drought response, and phosphorus removal efficiency of PSTA and other wetland plants (**Table A2**). Ongoing activities include implementation of vegetation management strategies based on field trials of different types of vegetation to develop sustainability, pre- and post-rehabilitation monitoring, post-storm monitoring, and post-dryout monitoring. Tracer studies have been conducted in various treatment cells (STA-1W Cells 1, 2, 4, and 5; STA-2 Cell 3; and STA-3/4 PSTA Implementation Project) to assess hydraulic characteristics. Other management options that require additional study, such as achieving optimal plant communities and management of unconsolidated accrued sediment floc layer, may aid in further improving the performance of the STAs. The Water Depth Assessment Tool (WDAT) is one of the tools being developed to understand water depth and vegetation community dynamics within the treatment



cells.

Figure 6. Inflow and outflow flow-weighted mean total phosphorus (FWM TP), hydraulic and phosphorus loading rates (HLR and PLR, respectively) for Stormwater Treatment Area 1 East (STA-1E) by water year (May–April) with major weather and operational events depicted. Plots show only complete water years and partial water years of operation are not included. Orange shading indicates regional drought years, funnel cloud icon indicates hurricane impacts, and palm tree icon indicates tropical storms. LTP refers to Long-Term Plan enhancements. Refer to the *Synopsis of the Major Operational Events* section for STA schematics and additional details regarding the operational timeline.

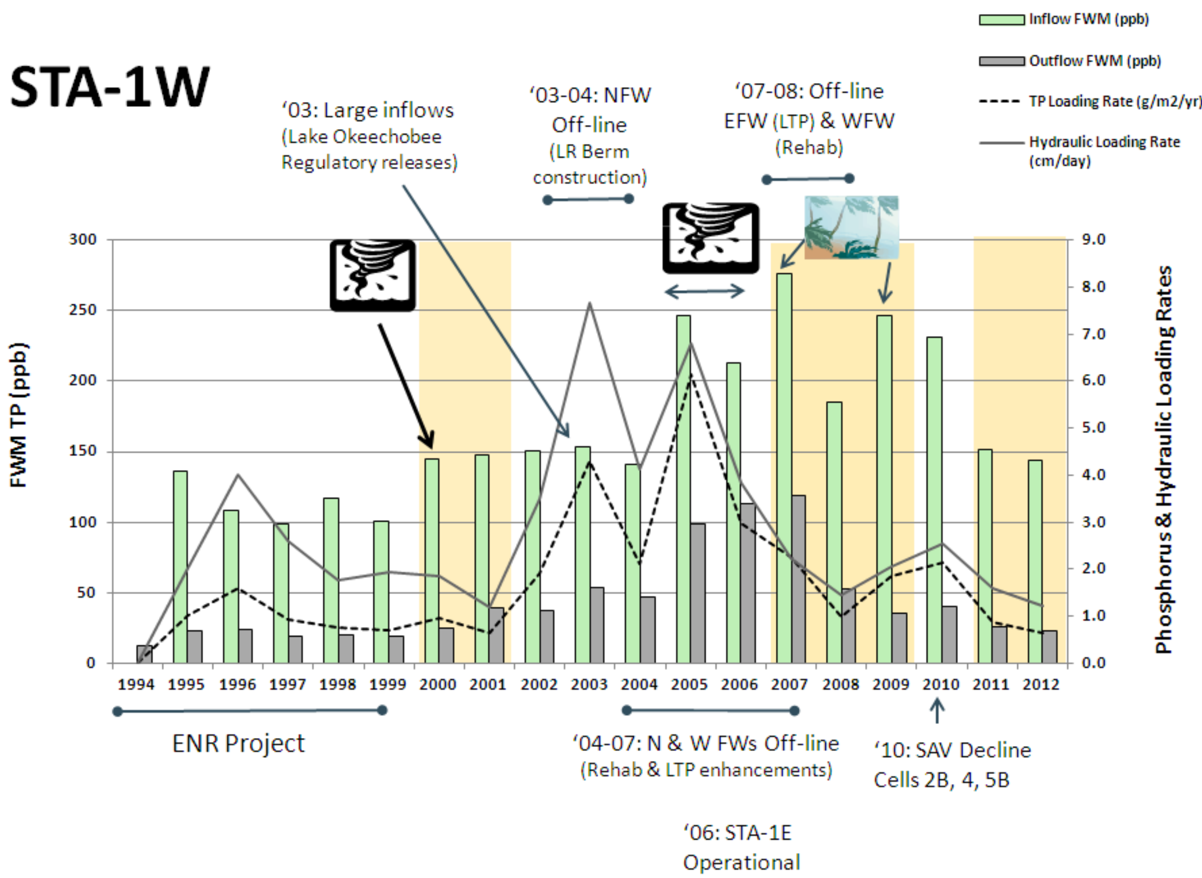


Figure 7. Inflow and outflow flow-weighted mean total phosphorus (FWM TP), hydraulic and phosphorus loading rates (HLR and PLR, respectively) for Stormwater Treatment Area 1 West (STA-1W) by water year (May–April) with major weather and operational events depicted. Plots show only complete water years and partial water years of operation are not included. Orange shading indicates regional drought years, funnel cloud icon indicates hurricane impacts, and palm tree icon indicates tropical storms. LTP refers to Long-Term Plan enhancements. Refer to the *Synopsis of the Major Operational Events* section for STA schematics and additional details regarding the operational timeline.

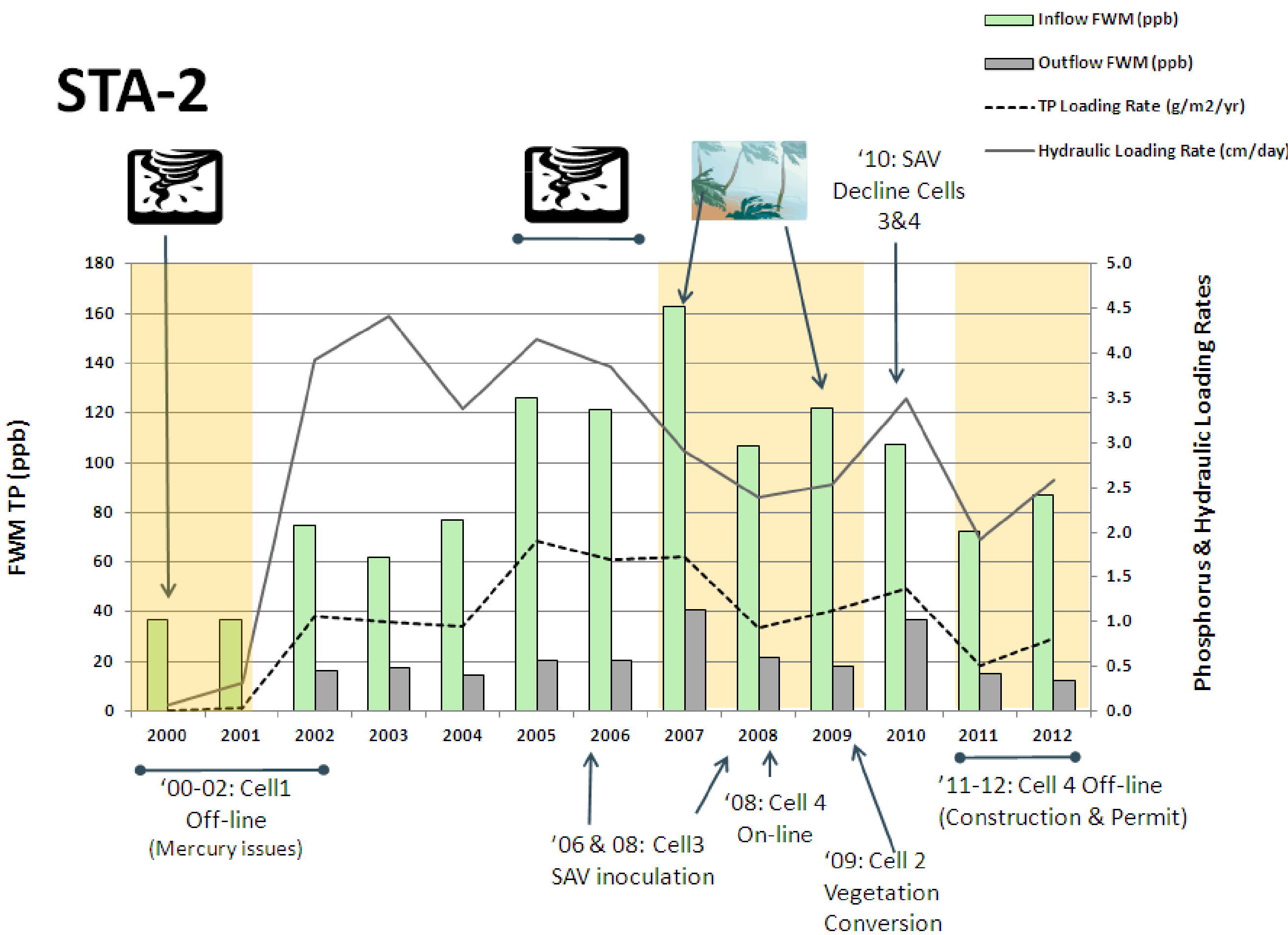


Figure 8. Inflow and outflow flow-weighted mean total phosphorus (FWM TP), hydraulic and phosphorus loading rates (HLR and PLR, respectively) for Stormwater Treatment Area 2 (STA-2) by water year (May–April) with major weather and operational events depicted. Plots show only complete water years and partial water years of operation are not included. Orange shading indicates regional drought years, funnel cloud icon indicates hurricane impacts, and palm tree icon indicates tropical storms. LTP refers to Long-Term Plan enhancements. Refer to the *Synopsis of the Major Operational Events* section for STA schematics and additional details regarding the operational timeline.

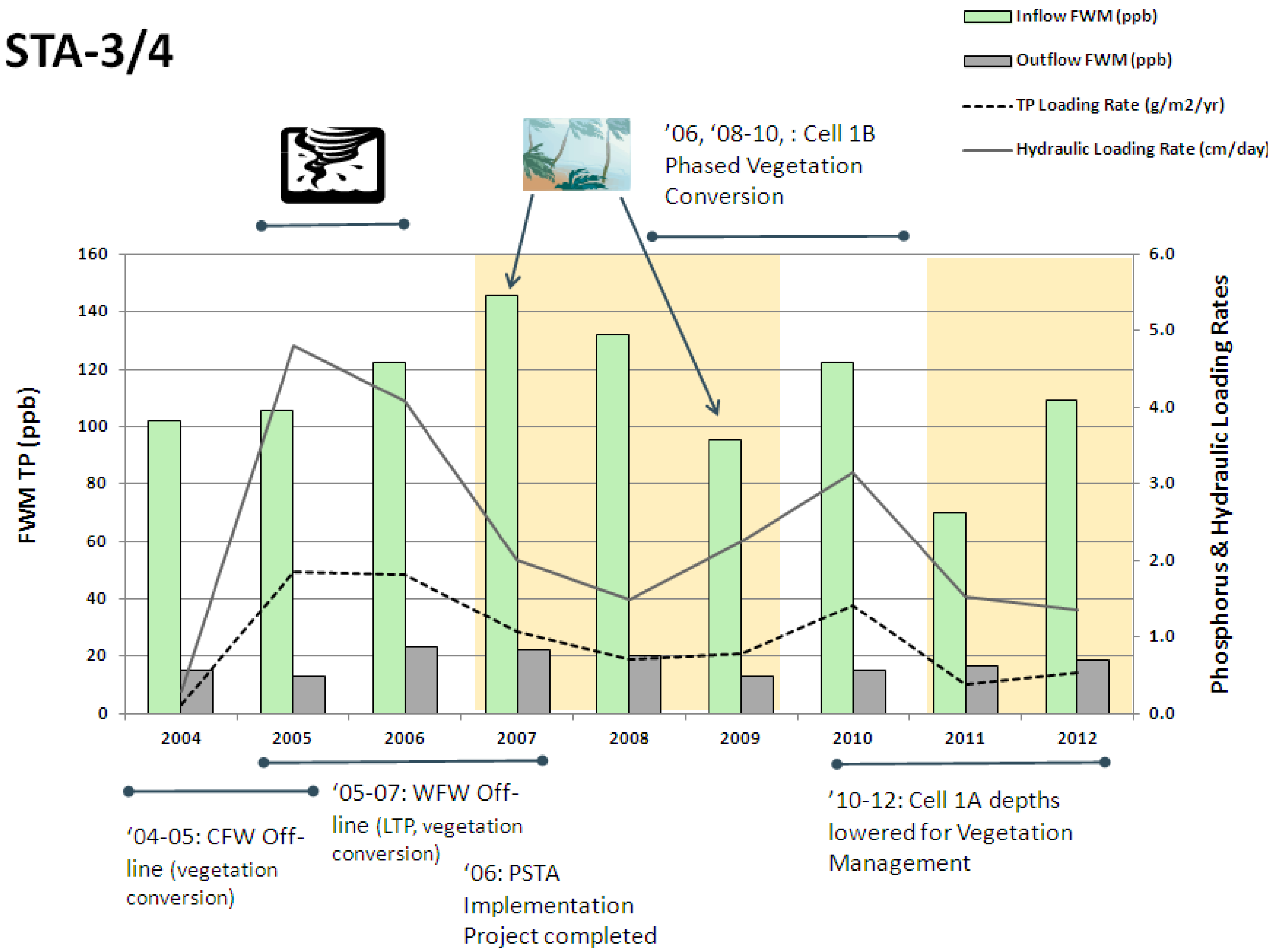


Figure 9. Inflow and outflow flow-weighted mean total phosphorus (FWM TP), hydraulic and phosphorus loading rates (HLR and PLR, respectively) for Stormwater Treatment Area 3/4 (STA-3/4) by water year (May–April) with major weather and operational events depicted. Plots show only complete water years and partial water years of operation are not included. Orange shading indicates regional drought years, funnel cloud icon indicates hurricane impacts, and palm tree icon indicates tropical storms. LTP refers to Long-Term Plan enhancements. Refer to the *Synopsis of the Major Operational Events* section for STA schematics and additional details regarding the operational timeline.

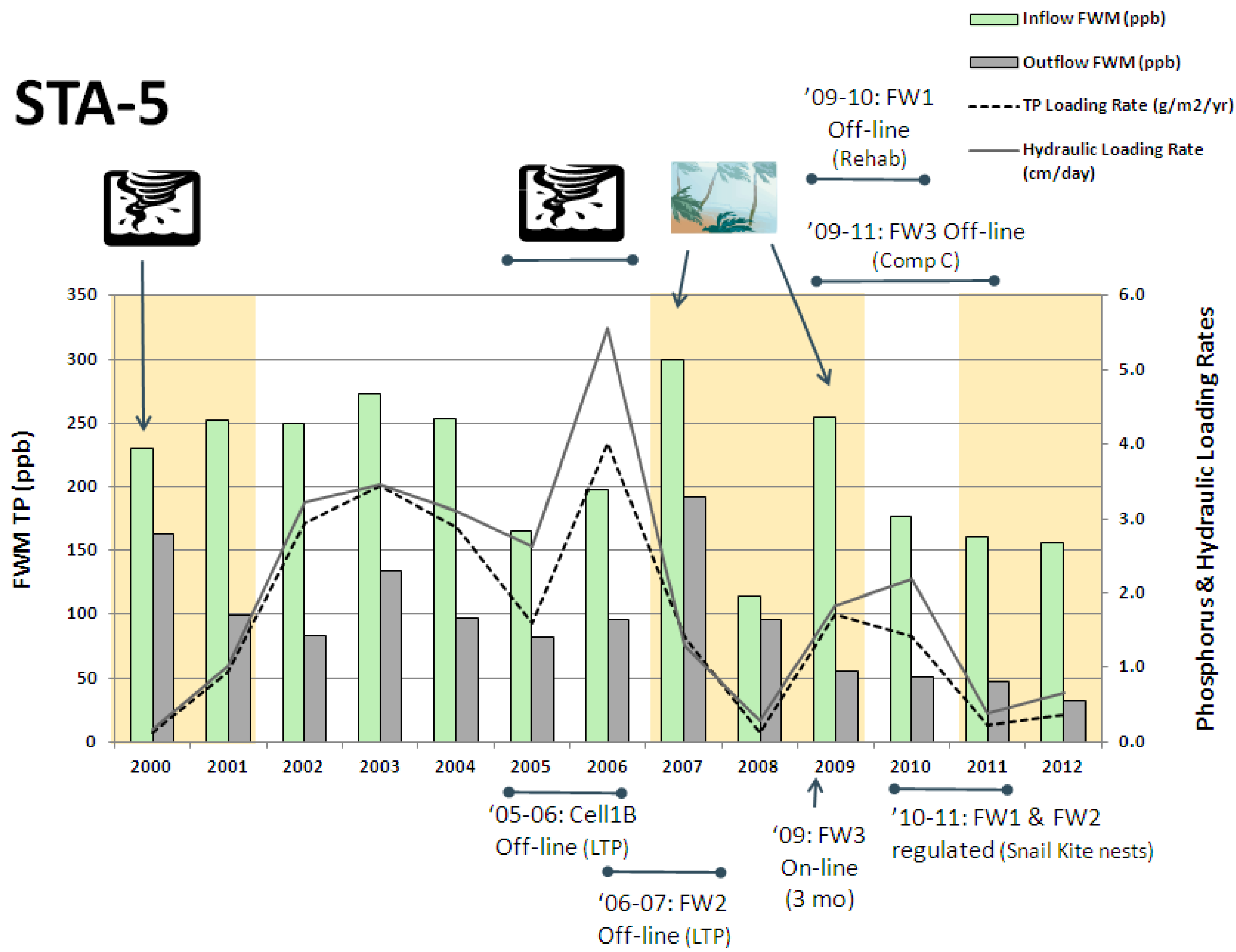


Figure 10. Inflow and outflow flow-weighted mean total phosphorus (FWM TP), hydraulic and phosphorus loading rates (HLR and PLR, respectively) for Stormwater Treatment Area 5 (STA-5) by water year (May–April) with major weather and operational events depicted. Plots show only complete water years and partial water years of operation are not included. Orange shading indicates regional drought years, funnel cloud icon indicates hurricane impacts, and palm tree icon indicates tropical storms. LTP refers to Long-Term Plan enhancements. Refer to the *Synopsis of the Major Operational Events* section for STA schematics and additional details regarding the operational timeline.

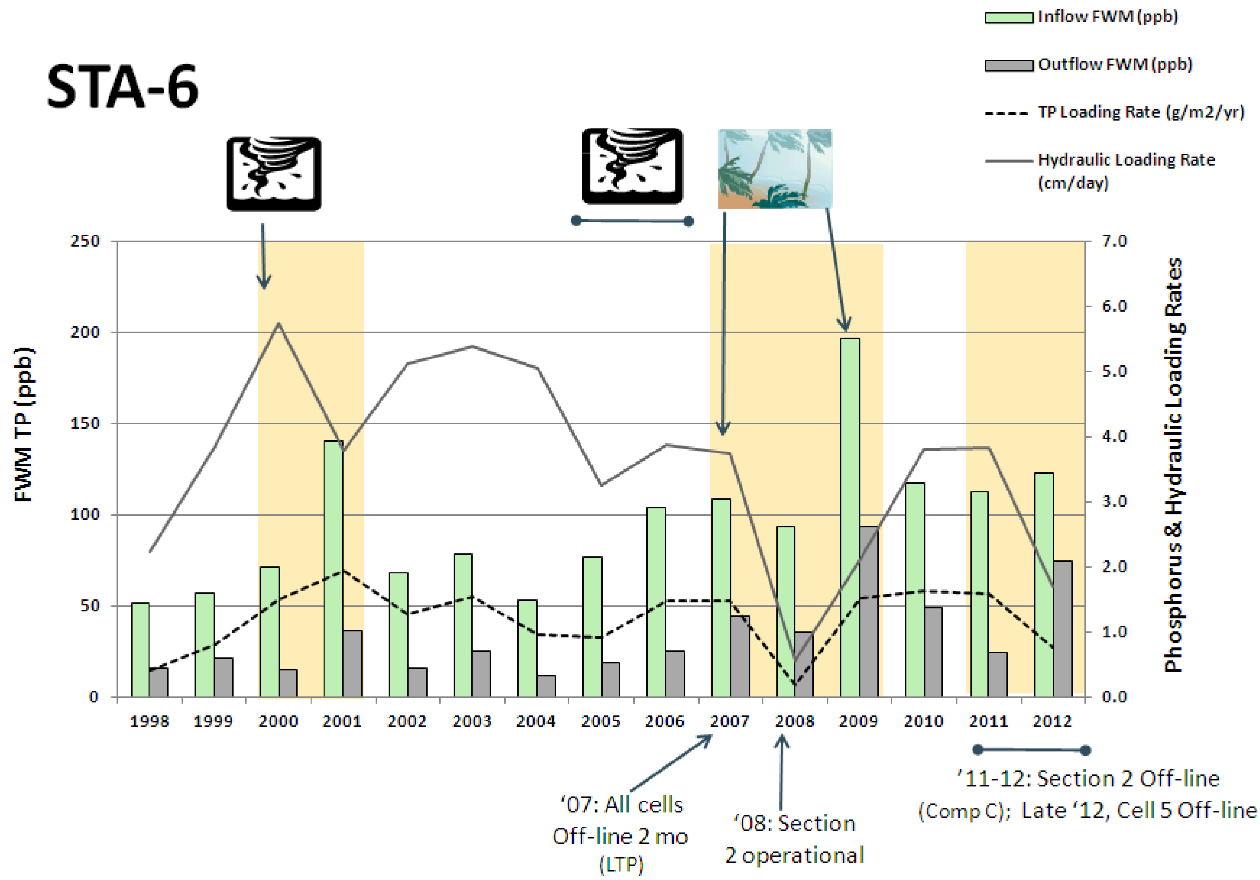


Figure 11. Inflow and outflow flow-weighted mean total phosphorus (FWM TP), hydraulic and phosphorus loading rates (HLR and PLR, respectively) for Stormwater Treatment Area 6 (STA-6) by water year (May–April) with major weather and operational events depicted. Plots show only complete water years and partial water years of operation are not included. Orange shading indicates regional drought years, funnel cloud icon indicates hurricane impacts, and palm tree icon indicates tropical storms. LTP refers to Long-Term Plan enhancements. Refer to the *Synopsis of the Major Operational Events* section for STA schematics and additional details regarding the operational timeline.

Synopsis of the Major Operational Events by STA

STA-1E (Figure 12, Table 3)

The design and construction of STA-1E, which was completed in June 2004, was managed by the U.S. Army Corps of Engineers (USACE). In WY2005, prior to receiving an operating permit, STA-1E was authorized for emergency operations in response to flooding conditions from Hurricanes Frances and Jeanne (Pietro et al., 2006). The winds and rain from both hurricanes impacted STA-1E, including damage to vegetation and erosion damage on the interior levees in Cells 4N, 4S, and 6. Hurricane Wilma (WY2006) caused minor damage to the southern levee in Cell 4N and eastern levee in Cell 4S, and minor damage to the SAV and emergent plants, particularly in Cell 4N (Pietro et al., 2007). Resulting power outages, lasting about two weeks, impacted structure operation, specifically necessitating manual operation of structures.

In WY2006, the Central and Western flow-ways were operational. The Eastern Flow-way was operated under restricted conditions through WY2012 due to the USACE's Periphyton-dominated Stormwater Treatment (PSTA) demonstration project. A large flow and TP loading event occurred in the Western Flow-way in February 2006. In WY2007, STA-1E started receiving inflows from an additional source (runoff from Wellington Acme Basin B). Challenges in vegetation establishment and endurance have been experienced in the Western Flow-way, prompting rehabilitation activities beginning in the later part of WY2010 and continuing into WY2013. The rehabilitation activities included lowering water levels to encourage natural recruitment of cattail, planting bulrush in open water areas, and removing five small sections of a berm area upstream of the Cell 5 outflows (about 600 feet total of degraded berm). A pilot bio-enhancement project was implemented in Cell 5 consisting of placing bales of cattail, created by mowing and harvesting cattails, across a short circuit to try to divert flow from the open water channel and newly planted bulrush. A major decline in SAV (hydrilla) in Cell 6 was observed in May 2009 and plant export was massive enough to stop the outflow pump station from operating. A major decline in SAV in Cells 4N and 4S was also observed in February/March 2010 and the decline was attributed to the low winter season temperatures. At the beginning of WY2009, it became evident that some of the water control structures were failing and/or having structural issues. The S-375 structure moves water from east to west in the inflow distribution cell and was the first structure to undergo repairs. Repairs started in March 2008 and continued through WY2012. Between April 2009 and January 2010 the Cell 2 outflow structures S-365 A-B were repaired, followed by repairs to structures S-367B, S-370C, S-373B, and S-374A starting in May 2011 through WY2012. Other culvert repairs are under way throughout STA-1E, and the PSTA project is scheduled to be removed by the USACE by mid-2013.

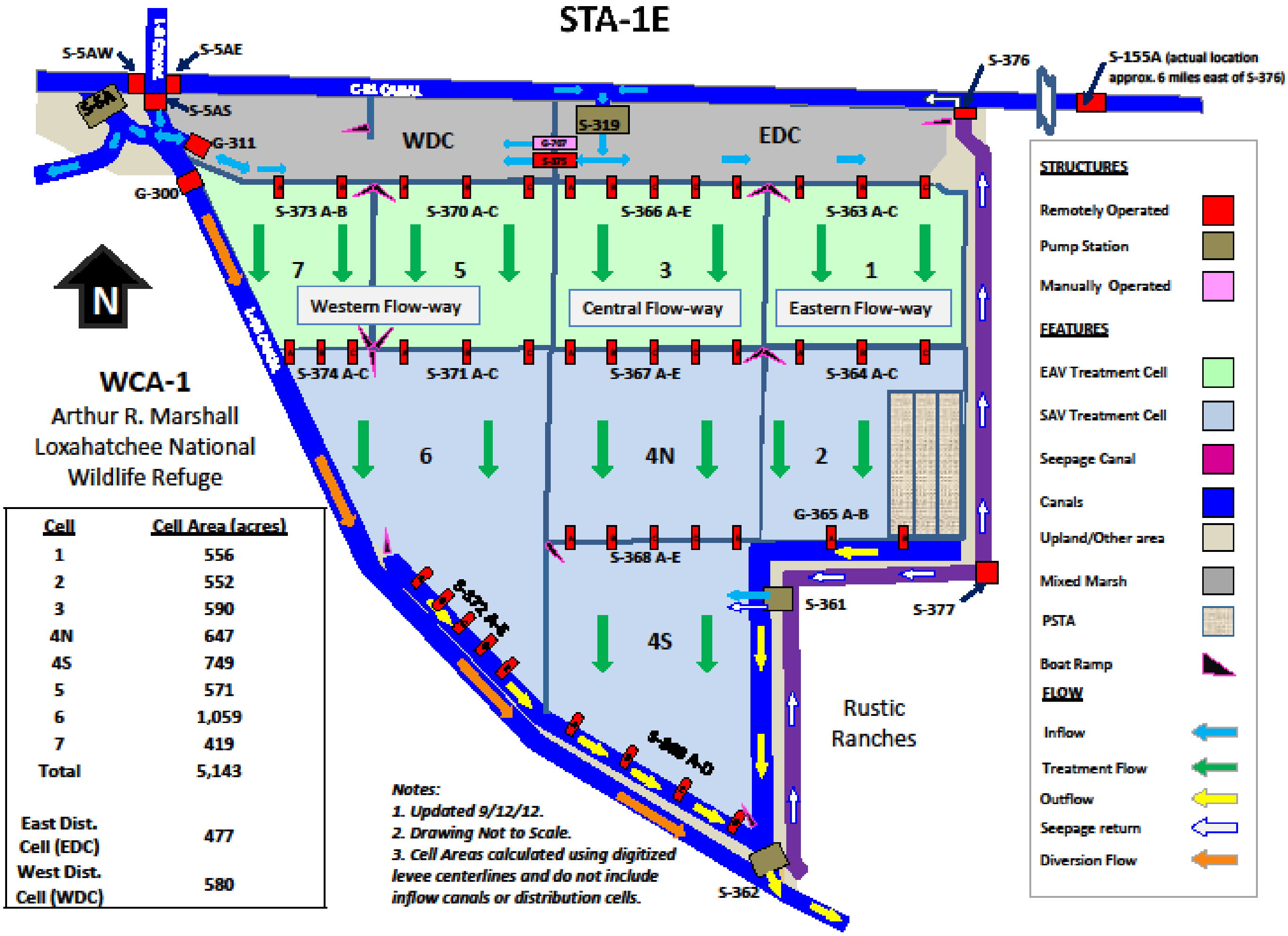


Figure 12. Schematic of Stormwater Treatment Area 1 East (STA-1E) showing the major water control structures, treatment cell acreage, infrastructure components, and direction of flow.

Table 3. Stormwater Treatment Area 1 East (STA-1E) operational timeline through Water Year 2012 (WY2012).

STA-1E Operational Timeline

Calendar Year	2004			2005					2006					2007				2008				
Water Year (May - Apr)	WY2005 (Hurricane Impacts)				WY2006 (Hurricane Impacts)					WY2007 (Regional Drought)					WY2008 (Regional Drought)				WY2009 (Regional Drought)			
Month	Jul - Aug	Sep *Hurricanes Frances & Jeanne*	Oct - Dec	Jan - Apr	May - Jul	Aug - Sep	Oct *Hurricane Wilma*	Nov - Dec	Jan - Apr	May - Jul	Jul - Dec	Aug *Tropical Storm Ernesto*	Sep - Dec	Jan - Apr	May	Jun - Sep	Sep - Dec	Jan - Apr	May - Jun	Jun - Jul	Aug *Tropical Storm Fay*	Sep - Dec
Eastern Flow-way (EFW) Cells 1/2		Emergency Operations, cell hydration																				
Central Flow-way (CFW) Cells 3/4N/4S		Emergency Operations, cell hydration																				
Western Flow-way (WFW) Cells 5/6/7		Emergency Operations, cell hydration																				
Details:																						
On-line	Prior to operation	EFW, CFW, WFW temporarily on-line in response to hurricane flood conditions					CFW & WFW on-line									CFW & WFW on-line; EFW hydrated and passed WQ start-up in Sep 2007	All FW's on-line (EFW restricted capacity due to USACOE PSTA project)		CFW & WFW on-line	All FW's on-line (EFW w/restrictions)		
Notes													Acme Basin B discharge redirected from WCA1 to C-51 Dec 2006									
Off-line							EFW off-line for USACE PSTA project (construction completed Feb 2007, FW off-line until Jun 2007)												EFW off-line (5/1/08 - 6/9/08)			

Indicates Off-line
Indicates Restricted Flow
Indicates On-line
Indicates Construction Activities
Indicates Vegetation Management Activities
Indicates Rehabilitation Activities

Notes: FW = Flow-way, EFW = Eastern Flow-way, CFW = Central Flow-way, WFW = Western Flow-way, PSTA = Periphyton Stormwater Treatment Area

Table 3. STA-1E operational timeline (Continued)

STA-1E Operational Timeline

Calendar Year	2009				2010			2011			2012
Water Year (May - Apr)	WY2009 (Regional Drought)		WY2010			WY2011 (Regional Drought)			WY2012 (Regional Drought)		
Month	Jan - Mar	Apr	May-Oct	Nov-Dec	Jan-Apr	May - Jun	Jul - Dec	Jan - Apr	May-Oct	Nov-Dec	Jan - Apr
Eastern Flow-way (EFW) Cells 1/2											
Central Flow-way (CFW) Cells 3/4N/4S											
Western Flow-way (WFW) Cells 5/6/7											
Details:											
On-line	All FW's on-line (EFW w/restrictions)	CFW & WFW On-line		CFW on-line	EFW (with restrictions) & CFW on-line		All FW's on-line (EFW restricted due to PSTA)			EFW (restricted due to PSTA) & CFW on-line	All FW's on-line (EFW & WFW with restrictions)
Notes				Decline in SAV (hydrilla) in Cell 6 in May 2009	Decline in SAV in Cells 4N & 4S in Feb/Mar 2010				Structure repairs @ S-367B, S-375, S-370C, S-373B, S-374A; coffer dams @ S-370C, S-373B, S-374A		
Off-line		EFW off-line for S-365A & B structure repairs (4/25/09 - 1/24/10)		EFW off-line structure repair (S-365 A&B); WFW off-line 10/13/09 - 6/14/10 for rehabilitation activities	WFW off-line for rehabilitation activities (10/13/09 - 6/14/10)					WFW off-line (11/29 - 12/19/11) vegetation enhancements in Cell 7	
	S-375 repairs (off-line starting Mar08)										

Indicates Off-line

Indicates Restricted Flow

Indicates On-line

Indicates Construction Activities

Indicates Vegetation Management Activities

Indicates Rehabilitation Activities

Notes: FW = Flow-way, EFW = Eastern Flow-way, CFW = Central Flow-way, WFW = Western Flow-way, PSTA = Periphyton Stormwater Treatment Area

STA-1W (Figure 13, Table 4):

The Everglades Nutrient Removal (ENR) Project, consisting of the Eastern Flow-way (Cells 1 & 3) and the Western Flow-way (Cells 2 & 4) was operational from 1994 through 1999. In March 1999, the ENR project was expanded with the construction of the Northern Flow-way (Cells 5A and 5B), which nearly doubled the size of the STA. The Northern Flow-way passed permit start-up criteria in February 2000. From start-up, Cell 5B was hydrated to encourage SAV growth. All of the STA-1W treatment cells were built on former agricultural land (sugar cane, corn, rice, vegetables). In WY2000, earthen plugs were installed in Cell 4 in several of the deeper canals oriented parallel to flow in an attempt to distribute flow more evenly in the cell.

In mid-October 1999, Hurricane Irene produced heavy rainfall which increased stages in the treatment cells (Abtew and Huebner, 2000). These high stages decreased about two weeks following the storm. During WY2003, STA-1W received an unusually high amount of inflow (~600,000 ac-ft) in response to the high water levels in Lake Okeechobee during summer 2002 (July 2002 through February 2003) that required the District and the USACE to institute extreme operational measures to protect the lake ecosystem and the integrity of the surrounding levee (Goforth et al., 2005). This resulted in the inadvertent overload of flow and phosphorus loads to the STA. In February 2003, operational changes were implemented to minimize the long-term adverse impacts of the overload event.

In March 2003, the Northern Flow-way was taken off-line for installation of a limerock berm in Cell 5B. Construction of the berm was completed in August 2003. The berm was installed as a demonstration project to study the benefits of improved hydraulics through increased cell compartmentalization on phosphorus removal.

By December 2003, after about nine months of effort to reduce flows and loads to STA-1W, TP removal performance began to improve. In early 2004, the Western Flow-way was taken off-line to allow vegetation recovery. The Western Flow-way remained off-line until August 2004 when it was returned to online status for five months.

In September 2004, strong winds and heavy rainfall from Hurricanes Frances and Jeanne impacted STA-1W. STA-1W experienced physical damage as a result of the hurricanes. Specifically, there was erosion at the inflow structure G-302 and at the Cell 5 G-305 culverts, erosion on the north levees (especially severe in Cells 5A and 5B), and erosion of the limerock berm in Cell 5B. Extensive damage was also done to the SAV community in Cell 5B, with most of the SAV becoming uprooted and pushed up onto the northern levee bank. Some movement of the floating cattail tussocks in Cells 1 and 2 was observed and the water within Cell 5B was highly turbid (Pietro et al., 2006). Power outages following Hurricane Frances caused the shutdown of outflow pump station G-251. During Hurricane Jeanne, outflow pump station G-310 had to be shut down to remove mud that had been deposited in the area.

In December 2004, after previous unsuccessful attempts to rehabilitate the vegetation in the Northern and Western flow-ways and in response to multiple hurricanes, the STA-1W Recovery Plan was initiated. The plan included continued reduction in flows and TP loads to the STA, operational changes to encourage vegetation recovery (such as diversion to other STAs when possible), removal of floating cattail tussocks in Cell 2, construction of the Western Flow-way LTP enhancements projects (i.e., the new divide levee in Cell 2), and postponement of the Eastern Flow-way LTP enhancements projects. In January 2005 the District requested approval from the Florida Department of Environmental Protection (FDEP) to lower the top elevation of the limerock berm by about 1 to 1.5 feet. This request was made as a result of recent survey information indicating that the average ground elevation in the Northern Flow-way was 6 to 12 inches lower than was assumed during the design of the limerock berm (based on information from the original design phase of Cells 5A and B). The change in the assumed average ground elevation resulted in the decision to lower the average operating stage of the Northern Flow-way to provide a more appropriate water depth for SAV; therefore, more of the top of the limerock berm was exposed making it susceptible to scouring and washouts, as well as making it an attractive nesting area for federally protected birds. The FDEP approved the request to lower the top elevation of the limerock berm and construction was completed in April 2005 (Piccone, 2006).

Heavy rains experienced in March 2005 impacted STA-1W, especially because only Cells 1 and 3 were operating. Also during this timeframe, the Western Flow-way enhancements projects dewatering water was also being delivered to Cells 1 and 3. From January through August 2005, the only flow-way online was the Eastern Flow-way (Cells 1 and 3).

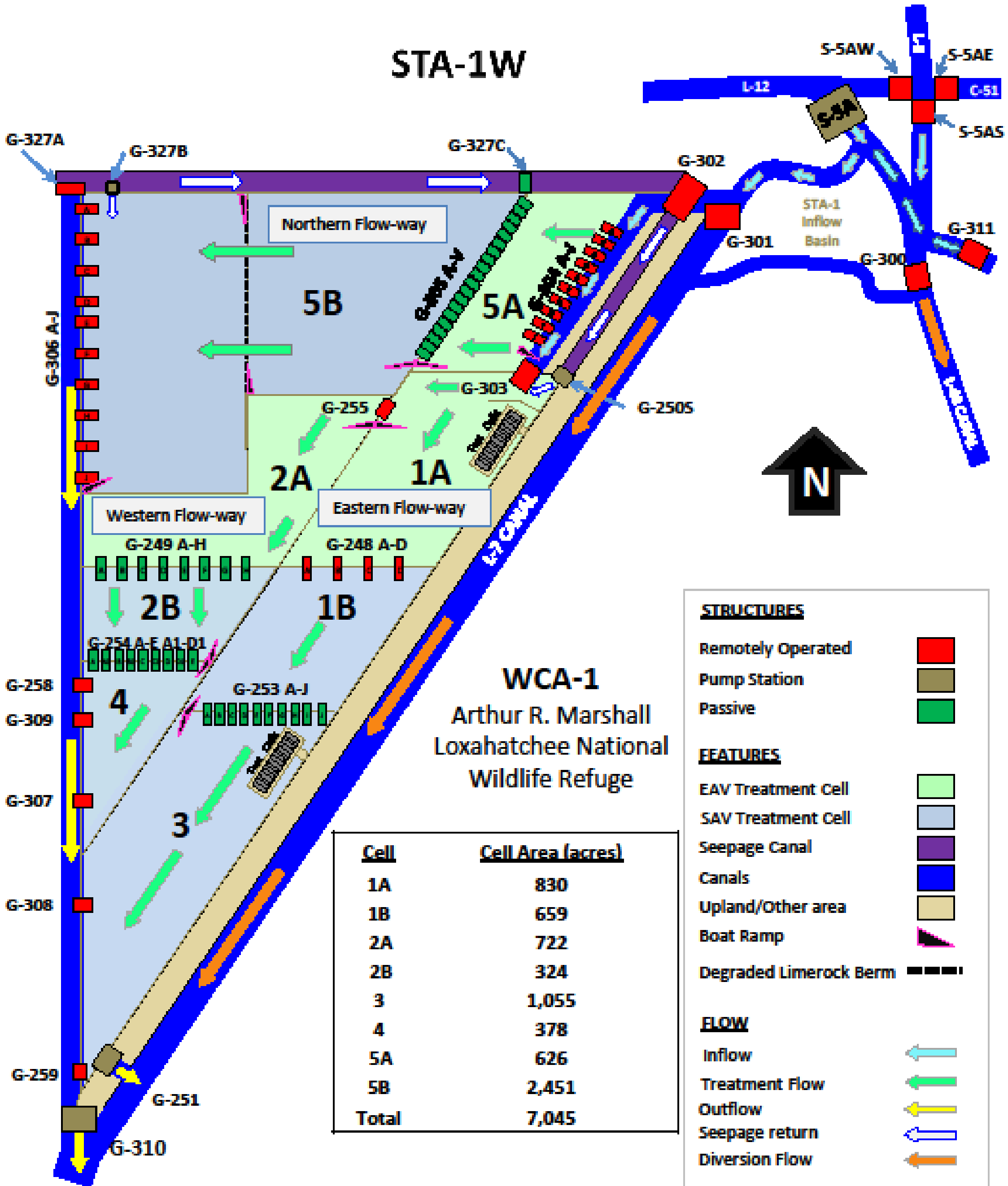
Although water depths were lowered in WY2005 in Cell 5B, in an effort to reduce turbidity and encourage SAV growth, recovery did not progress quickly and in July 2005, preparation of a recovery plan for STA-1W was initiated. In October 2005, Hurricane Wilma negatively impacted STA-1W. The northern and western levees in Cell 5 sustained minor to moderate damage, the water control structure buildings for G-255 and G-306 were damaged as well as culvert G-254C and the water quality auto-sampler intakes at the outflows G-251 and G-310. The hurricane also impacted the vegetation, with minor damage observed in the emergent vegetation communities and widespread damage observed in the SAV communities, particularly in Cell 5B (Pietro et al., 2007).

As a result, in WY2006, the Cell 5 Sediment Reconsolidation Plan was initiated, which included drawdown of Cell 5B for sediment consolidation, rice planting, removal of high berm areas near structures, removal of sediments from the Cell 5 outflow distribution canal, planting of vegetation strips, and scraping down marl in northern sections of Cell 5. This effort was concluded in June 2006.

Once the Northern Flow-way showed signs of recovery, efforts turned again to the Eastern and Western Flow-ways. From September 2006 to August 2007, a divide levee with associated water control structures was constructed, dividing Cell 1 into Cell 1A and Cell 1B., Vegetation conversion from EAV to SAV was initiated in Cell 3. In addition, taking advantage of the dry conditions during this period, rehabilitation activities were conducted in Cells 1B, 2B and 4. Activities included removal of tussock material in Cell 1, removal of phosphorus enriched soil on the bottom region of Cell 1B, and removal of the floc and accrued soil layer in Cell 4. Activities also included removal of silt in canals and filling in canals parallel to flow in Cells 1B and 4, and shallow disking of soil in Cell 2B. During the enhancements and rehabilitation activities, dry conditions in the cells allowed upland vegetation to proliferate resulting in the need to apply herbicide and mow. By September 2007, enhancements and rehabilitation efforts were completed in all three flow-ways and the entire STA-1W was returned to online status. For a brief period, while cattail residue was decomposing in Cell 3, water was recirculated from the Eastern Flow-way to the Northern Flow-way via G-327A.

In WY2010, SAV communities (particularly hydrilla and musk grass) in Cells 2B, 4, and 5 exhibited a noticeable decline (July–October 2009). The Western Flow-way outflow concentrations gradually increased to a peak of 132 ppb in October 2009, following the hydrilla community decline and subsequent decomposition. There were similar observations in the Northern Flow-way, where outflow concentrations rose to about 90 ppb in October 2009. The system showed some signs of recovery during periods of low to no flow, but phosphorus levels spiked again during March and April 2010 when STA-1W received high flows and nutrient loading as a result of heavy rainfall events. On a positive note, an April 2010 SAV survey indicated that southern naiad had taken over most open areas where hydrilla once dominated in Cells 2B, 4, and 5B.

In WY2011 (April 2011), to promote water movement through Cell 3 and reduce hydraulic short-circuiting, an earthen plug was installed in the discharge canal upstream of the G-259 structure. To increase compartmentalization and establishment of vegetation in open water areas, bulrush plantings in Cells 5A and 5B started in April 2011 and continued through WY2012.



Cell	Cell Area (acres)
1A	830
1B	659
2A	722
2B	324
3	1,055
4	378
5A	626
5B	2,451
Total	7,045

Notes:
1. Updated 9/12/12.
2. Drawing Not to Scale.
3. Cell Areas calculated using digitized levee centerlines and do not include inflow canals.
4. Cell Areas include utility easements and test cells located in Cells 1A, 1B, and 3.

Figure 13. Schematic of Stormwater Treatment Area 1 West (STA-1W) showing the major water control structures, treatment cell acreage, infrastructure components, and direction of flow.

Table 4. Stormwater Treatment Area 1 West (STA-1W) operational timeline

STA-1W Operational Timeline

Calendar Year	1994 - 1998	1999 - 2002					2003				2004			
Water Year (May - Apr)	WY1994 - WY1999	WY2000 - WY2001 (Regional Drought: 10/99 - 8/01)			WY2002 Regional Drought: 10/99 - 8/01)	WY2003			WY2004				WY2005 (Hurricane Impacts)	
Month		Oct 1999 Hurricane Irene				May -Dec	Jan - Feb	Mar - Apr	May-Aug	Sep-Dec	Jan-Feb	Mar-Apr	Apr - Jun	Jul - Jul
Northern Flow-way (NFW) Cells 5A/5B	Not Constructed													
Eastern Flow-way (EFW) Cells 1/3														
Western Flow-way (WFW) Cells 2/4														
Details:														
On-line	Everglades Nutrient Removal (ENR) Project on-line starting 8/94 (EFW & WFW)	NFW, EFW, & WFW on-line. ENR Project ceased to exist as a separate entity when new NPDES & EFA permits were issued in 5/99. NFW flooded 3/99, passed start-up 2/00, and discharged in 7/00; G-310 did not discharge until 7/00 (see ECR 2000, ECR 2001, ECR 2002).						EFW & WFW on-line		All FW's on-line		NFW & EFW on-line		
Notes						Large Lake Okeechobee regulatory releases received 7/02 - 2/03								
Off-line								NFW off line for limerock berm construction (3/03 - 8/14/03)				WFW off-line to remove cattail tussocks in Cell 2 and plant rehabilitation in Cell 4		

Indicates Off-line
Indicates Restricted Flow
Indicates On-line
Indicates Construction Activities
Indicates Vegetation Management Activities
Indicates Rehabilitation Activities

Notes: FW = Flow-way, EFW = Eastern Flow-way, NFW = Northern Flow-way, WFW = Western Flow-way

Table 4. STA-1W operational timeline (Continued)

STA-1W Operational Timeline

Calendar Year	2004					2005						
Water Year (May - Apr)	WY2005 (Hurricane Impacts)							WY2006 (Hurricane Impacts)				
Month	Aug	Sep *Hurricanes Frances & Jeanne*	Oct	Nov	Dec	Jan	Feb - Apr	May - Jun	Jul - Aug	Sep	Oct *Hurricane Wilma*	Nov - Dec
Northern Flow-way (NFW) Cells 5A/5B												
Eastern Flow-way (EFW) Cells 1/3												
Western Flow-way (WFW) Cells 2/4												
Details:												
On-line	All FW's on-line (NFW restricted capacity (150 cfs) 11/04 - 12/04 because of hurricane damage)			EFW & WFW on-line	All FW's on-line (NFW restricted capacity (150 cfs) 11/04 - 12/04 because of hurricane damage)	NFW & EFW on-line	EFW on-line		NFW & EFW on-line (NFW restricted flow in 11/05 - 12/05 because of hurricane damage)			
Notes												
Off-line				NFW off-line; Limerock Berm repaired from hurricane damage (washout areas) 11/04		Initiate STA Recovery Plan dated 12/04. WFW off-line (Cell 2 divide levee, water control structures; vegetation conversion Cell 2B)	WFW off-line (Cell 2 divide levee and water control structures, vegetation conversion Cell 2B), NFW off-line to degrade the Limerock Berm (2/05 - 4/05) and allow for hurricane repairs and plant re-establishment		WFW re-hydrated, off-line for plant re-establishment			

Indicates Off-line
Indicates Restricted Flow
Indicates On-line
Indicates Construction Activities
Indicates Vegetation Management Activities
Indicates Rehabilitation Activities

Notes: FW = Flow-way, EFW = Eastern Flow-way, NFW = Northern Flow-way, WFW = Western Flow-way

Table 4. STA-1W operational timeline (Continued)

STA-1W Operational Timeline																		
Calendar Year	2006				2007			2008				2009		2010		2011		2012
Water Year (May - Apr)	WY2006 (Hurricane Impacts)	WY2007 (Regional Drought)				WY2008 (Regional Drought)			WY2009 (Regional Drought)				WY2010		WY2011 (Regional Drought)		WY2012 (Regional Drought)	
Month	Jan - Apr	May - Jul	Aug *Tropical Storm Ernseto*	Sep - Dec	Jan - Apr	May - Aug	Sep - Dec	Jan - Apr	May - Jul	Aug *Tropical Storm Fay*	Sep - Dec	Jan - Apr	May-Dec	Jan-Apr	May - Dec	Jan - Apr	May - Dec	Jan - Apr
																		
Northern Flow-way (NFW) Cells 5A/5B																		
Eastern Flow-way (EFW) Cells 1/3																		
Western Flow-way (WFW) Cells 2/4																		
Details:																		
On-line	EFW on-line			NFW on-line (7/06 - 8/06 restiricted to 200 cfs and 10.7 target, 9/06 restricted to 500 cfs, 10/06 - 2/07 restricted to 750 cfs, 3/04 - 7/07 stage restricted to 10.8 during flow)			NFW on-line, WFW restricted to 400 cfs, EFW restricted to 450 cfs	All FW's on-line (EFW restricted to 225 cfs)	All FW's on-line									
Notes													SAV decline (hydrilla, chara) observed in Cells 2B, 4, & 5B in 9/09 - 10/09			Earthen plug installed in Cell 3 discharge canal upstream G259 (4/11); Bulrush planting Cell 5A/5B starts 4/11 - WY2012		
Off-line	Initiate Sediment Consolidation Plan. NFW off-line (LTP enhancements construction and sediment and plant rehabilitation) and WFW restricted flow 200 cfs, 10.7 stage in 7/06 - 8/06 then off-line (for plant re-establishment)			EFW off-line for LTP enhancements construction (Cell 1 divide levee) & vegetation conversion (Cell 3), WFW off-line for rehabilitation														

Indicates Off-line
Indicates Restricted Flow
Indicates On-line

Indicates Construction Activities
Indicates Vegetation Management Activities
Indicates Rehabilitation Activities

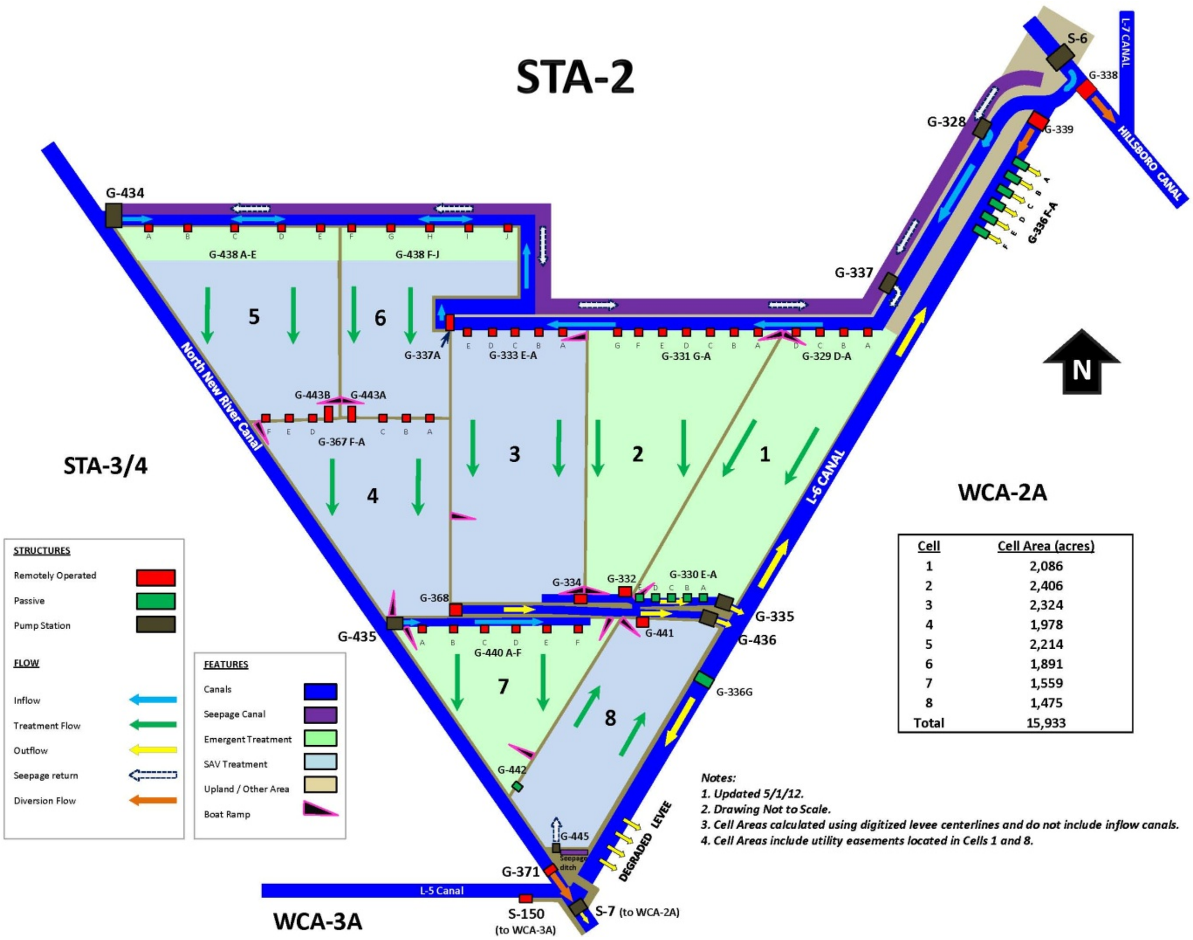
Notes: FW = Flow-way, EFW = Eastern Flow-way, NFW = Northern Flow-way, WFW = Western Flow-way

STA-2 (Figure 14, Table 5):

STA-2 became operational in WY2000 and consisted of Cells 1–3. Prior to becoming an STA, Cell 1 and 75 percent of Cell 2 land was remnant Everglades that had been partially drained but never cultivated, while most of Cell 3 was cultivated. Cells 2 and 3 passed the permit start-up criteria for phosphorus and mercury in September and November 2000 respectively, however, high mercury concentrations in STA-2 Cell 1 surface water measured during start-up monitoring in September 2000 delayed its startup. Due to extreme drought conditions, Cell 1 dried out from the fall of 2000 through July 2001. Although net reduction in methyl mercury (MeHg) was still not achieved, in August 2001 the Florida Department of Environmental Protection (FDEP) granted flow-through operations for Cell 1 to accelerate stabilization of MeHg by creating conditions designed to reduce productivity (2003 ECR, Goforth et al., 2003). An expanded monitoring and reporting program was also put in place at this time. In October 2001, another anomalous mercury event was observed in Cell 1. Because the dry season was starting and there was no certainty that the water levels in the cell could be maintained deep enough to discourage wading bird foraging, Cell 1 was dried down in December 2001. Upon rehydration in August 2002, high mercury concentrations were again observed but the fluctuations and concentrations of MeHg decreased following the dry-down event. To minimize the frequency and magnitude of dryout events, the outlet weir crests were raised in Cell 1. The District worked closely with FDEP during this period and developed three initiatives to better understand the causes of the excessive MeHg production. These initiatives included increasing the monitoring program, modeling the production, bioaccumulation, export and potential downstream impacts, and establishing a cooperative agreement with the U. S. Geological Survey and Academy of Natural Sciences Environmental Research Laboratory to study the effects of dryout duration. Cell 1 passed start-up for mercury in December 2002 (2004 ECR, Goforth et al., 2003).

Hurricane Irene made land-fall in southern Florida in mid-October 1999 at the end of the STA-2 start-up phase and the impacts from the hurricane were considered to be minimal. In WY2005, Hurricanes Frances and Jeanne impacted STA-2. During Hurricane Frances, a large amount of SAV (mostly hydrilla) was piled onto the northern levee banks of Cells 2 and 3 along with some of the cattails. During Hurricane Jeanne, the outflow pump station G-335 was shut down for 12 hours due to electrical problems and damage was done to the northeastern levee of Cell 3 (Pietro et al., 2006). In WY2006, Hurricane Wilma caused moderate damage to the northwest levee in Cells 2 and 3 and electrical power was out for almost two months. The SAV in Cell 3 suffered severe damage, especially in the northern section of the cell (Pietro et al., 2007). Flows and loads were reduced to this cell to allow for plant reestablishment and energy dissipaters were added downstream of the inflow culverts in Cell 2 and Cell 3 to reduce the turbulent flows through the structures under high flow conditions. In December 2006 (WY2007), as part of the initial expansion of STA-2 in Compartment B, Cell 4 became flow-capable. Due to regional drought conditions, this cell did not become operational until WY2008 and it was taken off-line starting in November 2010 through the end of WY2012 for construction activities associated with the Compartment B Build-out project.

Vegetation conversion from EAV to SAV in the southern section of Cell 2 started in April 2009 and an aerial inoculation to promote SAV establishment took place in July 2010. A decline in SAV (hydrilla) was observed in parts of Cell 3 and Cell 4 in December 2009, and this decline was attributed to the low temperatures. The construction of the Compartment B Buildout area commenced in May 2009 and continued through WY2012. Failures at the inflow pump station S-6 were observed in mid-March 2011 and repairs continued until the end of September 2011.



Cell	Cell Area (acres)
1	2,086
2	2,406
3	2,324
4	1,978
5	2,214
6	1,891
7	1,559
8	1,475
Total	15,933

Figure 14. Schematic of Stormwater Treatment Area 2 (STA-2) showing the major water control structures, treatment cell acreage, infrastructure components, and direction of flow.

Table 5. Stormwater Treatment Area 2 (STA-2) operational timeline

STA-2 Operational Timeline

Calendar Year	1999	2000	2001		2002				2003			2004				2005				
Water Year (May - Apr)	WY2000 - WY2002 (Regional Drought: 10/99 - 8/01)					WY2003				WY2004			WY2005 (Hurricane Impacts)				WY2006 (Hurricane Impacts)			
Month	Jun - Dec (Oct '99 Hurricane Irene)	Jan - Dec	Jan - Oct	Nov - Dec	Jan - Apr	May - Sep	Oct - Nov	Dec	Jan - Apr	May - Oct	Nov - Dec	Jan - Apr	May - Aug	Sep *Hurricanes Frances and Jeanne*	Oct - Dec	Jan - Apr	Apr - Sep	Oct *Hurricane Wilma*	Nov - Dec	Jan - Apr
Cell 1	Water quality issues																			
Cell 2																				
Cell 3																				
Cell 4	Not constructed																			
Details:																				
On-line	Cells 2 and 3 hydrated Jun 1999; passed startup Sep/Nov 2000 respectively)							All Cells on-line (Cells 1 - 3)												
Notes	Inflow pump station G-328 operational 6/99; outflow pump station G335 completed 10/00, Inflow pump station S-6 connected dry season 2001			20 acre PSTA Field-scale test facility operational 11/01 - 10/03; Cell 1 passed mercury start-up 12/02																SAV inoculation in N section Cell 3 using SAV collected from S part of cell (Apr 2006) following hydrilla die-off in summer 2005 and H. Wilma
Off-line	Cell 1 off-line due to high mercury levels																			

Indicates Off-line
Indicates Restricted Flow
Indicates On-line
Indicates Construction Activities
Indicates Vegetation Management Activities
Indicates Rehabilitation Activities

Notes: PSTA = Periphyton Stormwater Treatment Area; SAV = Submerged Aquatic Vegetation

Table 5. STA-2 operational timeline (Continued)

STA-2 Operational Timeline

Calendar Year	2006			2007			2008				2009		2010			2011				2012
Water Year (May - Apr)	WY2007 (Regional Drought)				WY2008 (Regional Drought)			WY2009 (Regional Drought)				WY2010		WY2011 (Regional Drought)				WY2012 (Regional Drought)		
Month	May - Jun	Aug *Tropical Storm Ernesto*	Sep - Dec	Jan - Apr	May - Nov	Dec	Jan - Apr	May - Jul	Aug *Tropical Storm Fay*	Sep - Dec	Jan - Apr	May-Dec	Jan-Apr	May - Oct	Nov - Dec	Jan - Feb	Mar-Apr	May - Sep	Oct - Dec	Jan - Apr
Cell 1	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line
Cell 2	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line
Cell 3	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line	On-line
Cell 4							On-line	On-line	On-line	On-line	On-line	On-line	On-line	Restricted Flow	Off-line (Construction)	Off-line	Off-line	Off-line	Off-line	Off-line
Details:																				
On-line	All Cells on-line (Cells 1 - 3)						All Cells on-line (Cells 1-4)							All Cells on-line (Cell 4 w/restrictions)	Cells 1 - 3 on-line					
Notes					Large SAV inoculation effort, July/August 2007 in Cell 3							Compartment B Buildout flow-capable Dec 2010; construction (on-going through WY2012); southern Cell 2 vegetation conversion to SAV started in Apr 2009; SAV (hydrilla) decline observed in parts of Cell 3 & Cell 4 Dec 2009		Aerial SAV inoculation in Cell 2 in Jul 2010			S-6 pump failures (3/11-9/26/11)			
Off-line			Cell 4 Flow-capable Dec 2006, non-operational (for WQ start-up compliance passed on 9/21/07; vegetation establishment until Dec 2007)												Cell 4 off-line starting 11/22/10 through end of WY2012 related to Compartment B buildout & permit issues					

Indicates Off-line
Indicates Restricted Flow
Indicates On-line
Indicates Construction Activities
Indicates Vegetation Management Activities
Indicates Rehabilitation Activities

Notes: PSTA = Periphyton Stormwater Treatment Area; SAV = Submerged Aquatic Vegetation

STA3/4 (Figure 15, Table 6).

Start-up of STA-3/4 treatment cells occurred in a phased approach and the Eastern Flow-way was the first to be operational starting in January 2004. Operation of the Central Flow-way was delayed to allow a vegetation conversion in Cell 2B from EAV to SAV. An aerial inoculation of SAV occurred in mid-August 2004 to aid in establishment of desired plant communities and the flow-way became operational in September 2004. Although mercury levels in the Western Flow-way were elevated at the outflow compared to the inflow, flow-through was initiated in March 2004 to reduce levels and net improvement was observed in August 2004. While there were no violations of mercury in WY2005, the STA had higher concentrations measured in the outflow surface water as compared to the inflows but the levels were comparable to water column concentrations observed elsewhere. In WY2004, the Eastern and Western Flow-ways were operational while the Central Flow-way was off-line for vegetation conversion from EAV to SAV in Cell 2B.

Hurricanes Francis and Jeanne in WY2005 impacted STA-3/4 with strong winds and heavy rainfall, although no damage was observed in the wetland (Pietro et al., 2006). In WY2006, Hurricane Wilma caused minor damage to the levees, moderate damage to SAV in Cell 2B, and moderate damage to the emergent vegetation (Pietro et al., 2007).

In WY2005 and WY2006, the Western Flow-way (Cell 3) was off-line for construction of an internal divide levee and vegetation conversion from EAV to SAV in Cell 3B as part of the LTP enhancements effort. The Periphyton-based Stormwater Treatment Area (PSTA) Project located in the western section of Cell 2B was completed and hydrated in March 2005. A phased vegetation conversion approach, where sections of the treatment cell were treated with herbicide instead of the entire cell, was initiated in Cell 1B in July 2007 and herbicide application continued in October–November 2008 and September 2009.

Although water conservation activities were initiated in WY2011, the regional drought conditions were so severe that the SAV-dominated treatment Cells 1B, 2B, and 3B dried down and damage to the SAV community was observed.

A decline in cattail coverage, attributed to high water conditions, was observed in Cell 1A and water levels were lowered periodically in WY2010–WY2012 to encourage cattail reestablishment and planting of bulrush. Shallow conditions are expected to revitalize the cattail stands by providing for seed germination and colonization of seedlings, clonal expansion, and potential elimination of floating tussocks. As a result of a regional drought and delayed start of the 2012 wet season, the water level in the entire STA-3/4 began receding quickly and water levels were below minimum levels toward the end of WY2012.

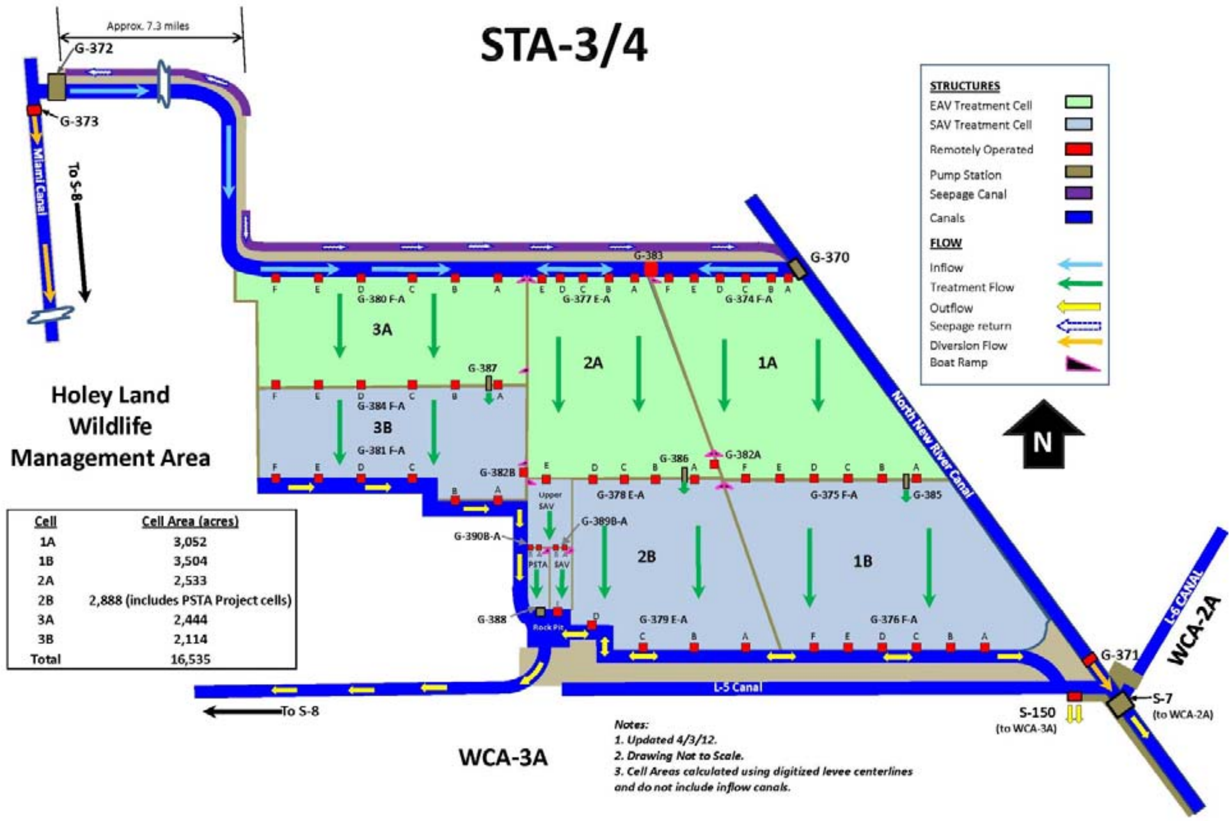


Figure 15. Schematic of Stormwater Treatment Area 3/4 (STA-3/4) showing the major water control structures, treatment cell acreage, infrastructure components, and direction of flow.

Table 6. Stormwater Treatment Area 3/4 (STA-3/4) operational timeline

STA-3/4 Operational Timeline

Calendar Year	2003	2004					2005					2006					2007			
Water Year (May - Apr)	WY2004		WY2005 (Hurricane Impacts)					WY2006 (Hurricane Impacts)					WY2007 (Regional Drought)					WY2008 (Regional Drought)		
Month	Oct - Dec	Jan - Apr	May	Jun - Aug	Sep *Hurricanes Frances and Jeanne*	Oct - Dec	Jan - Apr	May - Jun	Jul - Sep	Oct *Hurricane Wilma*	Nov - Dec	Jan - Apr	May	Jun - Jul	Aug *Tropical Storm Ernesto*	Sep - Dec	Jan - April	May - Dec	Jan - Apr	May - Jul
Eastern Flow-way (EFW) Cells 1A/1B																				
Central Flow-way (CFW) Cells 2A/2B																				
Western Flow-way (WFW) Cells 3A/3B																				
Details:																				
On-line		EFW on-line (passed start-up 1/15/04)		EFW & WFW on-line	All FW's on-line	EFW & CFW on-line			All FWs on-line (WFW restricted)			EFW and CFW on-line		All FWs on-line						
Notes	Phased start-up operations begin Oct 2003	CFW not yet operational (vegetation conversion Cell 2B; aerial SAV inoculation mid-Aug 2004); Cell 3 had elevated surface water mercury concentrations at the outflow compared to inflow; flow-through initiated in Mar 2004 to reduce levels and net improvement observed in Aug 2004					Cell 2B PSTA Implementation Project levee construction completed & area hydrated Mar 2005; outflow pump station completed Jul 2005		WFW re-hydrated, partial operation for plant re-establishment; begin phased approach to vegetation conversion in Cell 1B in Nov. 2005									Phased vegetation conversion in Cell 1B activities: aerial inoculation in Jul 2007 & herbicide application in Dec 2007		
Off-line						WFW off-line for LTP enhancements construction (divide levee; vegetation conversion Cell 3B)						WFW off-line for vegetation conversion								

Indicates Off-line
Indicates Restricted Flow
Indicates On-line
Indicates Construction Activities
Indicates Vegetation Management Activities
Indicates Rehabilitation Activities

Notes: FW = Flow-way, EFW = Eastern Flow-way, CFW = Central Flow-way, WFW = Western Flow-way, PSTA = Periphyton Stormwater Treatment Area, SAV = Submerged Aquatic Vegetation

Table 6. STA-3/4 operational timeline (Continued)

STA-3/4 Operational Timeli

Calendar Year	2008			2009		2010		2011				2012
Water Year (May - Apr)	WY2009 (Regional Drought)				WY2010		WY2011 (Regional Drought)		WY2012 (Regional Drought)			
Month	Aug *Tropical Storm Fay*	Sep	Oct - Dec	Jan - Apr	May-Dec	Jan-Apr	May - Dec	Jan - Apr	May-Jun	Jul - Aug	Sep - Dec	Jan - Apr
												
Eastern Flow-way (EFW) Cells 1A/1B												
Central Flow-way (CFW) Cells 2A/2B												
Western Flow-way (WFW) Cells 3A/3B												
Details:												
On-line	All FWs on-line								All FW's on-line, EFW (restricted)	All FW's on-line under restricted operations	All FWs on-line	
Notes			Phased vegetation conversion in Cell 1B; herbicide application in Oct/Nov 2008		Phased vegetation conversion in Cell 1B; herbicide application in Sep 2009. SAV (Chara) decline in Cell 3A.	Cell 1A water levels lowered to allow for vegetation establishment & planting		Cell 1A water levels lowered to allow for vegetation establishment & planting	EFW restricted for vegetation management activities 5/1 - 8/23/2011; water levels lowered in Cell 1A through end of WY2012 to encourage cattail reestablishment and planting	All FW's restricted to allow for vegetation re-establishment following dryout where much of the SAV was lost in SAV cells		
Off-line												

Indicates Off-line
Indicates Restricted Flow
Indicates On-line

Indicates Construction Activities
Indicates Vegetation Management Activities
Indicates Rehabilitation Activities

Notes: FW = Flow-way, EFW = Eastern Flow-way, CFW = Central Flow-way, WFW = Western Flow-way, PSTA = Periphyton Stormwater Treatment Area, SAV = Submerged Aquatic Vegetation

STA-5 (Figure 16, Table 7):

Flow-way 1 (Cell 1A & Cell 1B) and Flow-way 2 (Cell 2A & 2B) became operational in WY1999; Flow-way 3 (Cell 3A & 3B) was flow-capable in December 2006 and operational in September 2008. Due to high ground elevations along the western side of the STA, these areas were not considered to be effective treatment area.

The impact of Hurricane Irene in WY2000 was minimal in STA-5 and only a slight increase in water levels was observed (Abtew and Huebner, 2000). In WY2005, strong winds and heavy rainfall from Hurricanes Francis and Jeanne impacted STA-5, although no damage was observed in the wetland (Pietro et al., 2006). Hurricane Wilma in WY2007 caused minor damage to the SAV and moderate damage to the emergent vegetation and power to the STA was lost for approximately two months (Pietro et al., 2007).

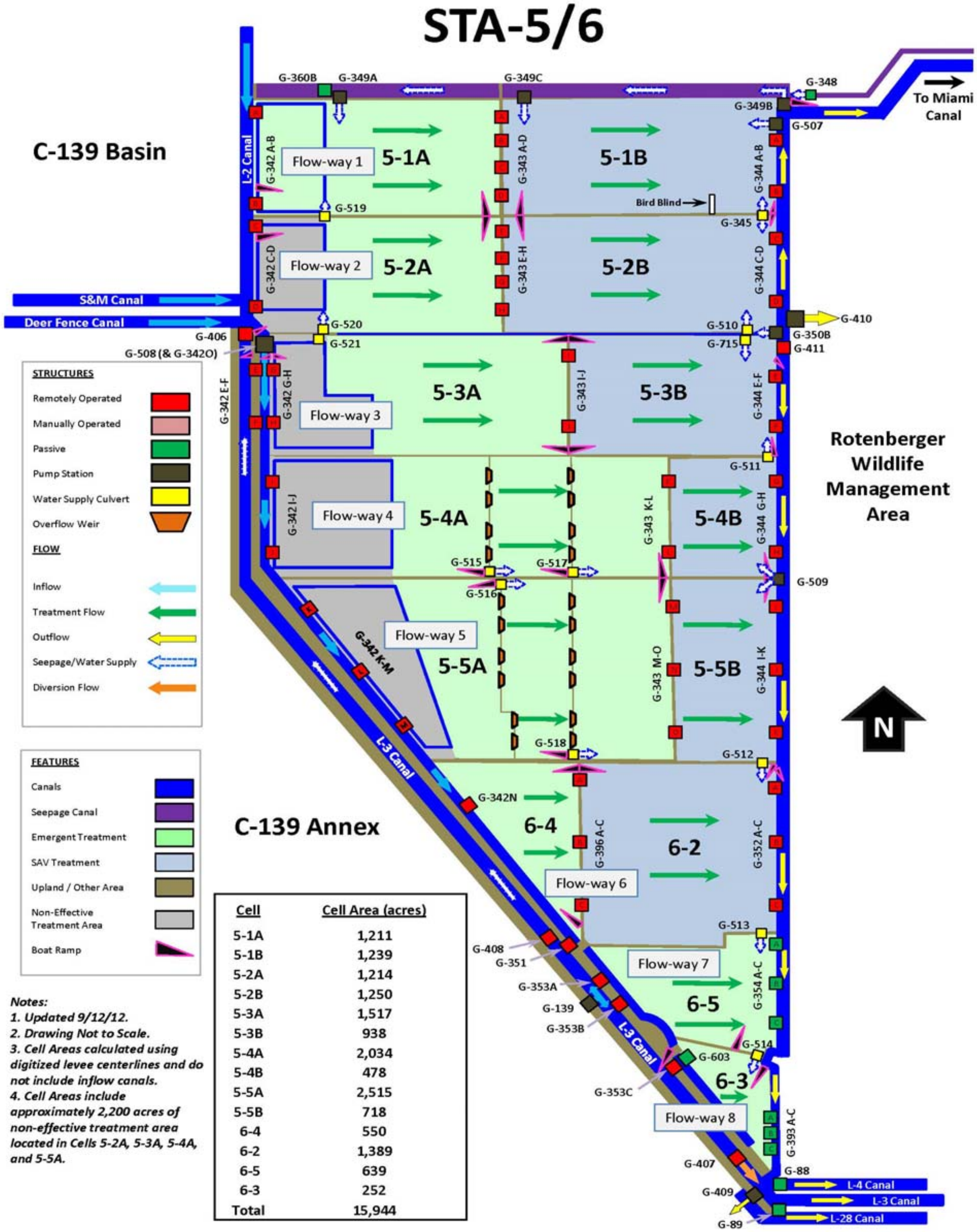
In WY2006, LTP enhancements were implemented including retrofits to the internal divide levee (G-343) structures in the Northern Flow-way (Flow-way 1) and degrading of high ground areas. Similar work was done to the G-343 structures in the Central Flow-way (Flow-way 2) in WY2007. Additionally, a vegetation conversion from EAV to SAV was initiated in Cell 2B in WY2006. In WY2008, the L-3 inflow canal upstream of G-342 A–D was dredged and improvements were made to the internal distribution canals in Cells 1A and 2A.

By WY2009, phosphorus removal performance continued to be problematic in STA-5, so a team of scientists and engineers focused their efforts toward examining the condition and causes of poor performance in this STA. High nutrient loadings, topographic issues, short circuiting, and periodic dryout were identified as likely causes. Due to budget constraints, rehabilitation efforts were limited to Flow-way 1, specifically, to fill a deep slough area on the southern portion of Cell 1A to reduce hydraulic short-circuiting, distribute flow more evenly along the flow path, and promote conditions favorable for EAV sustainability. Soil from high ground areas located on the western side of Cell 1A (formerly referred to as “non-effective treatment area” [NETA]) and southwestern side of Cell 3A was used to fill nearly half of the deep slough area in Cell 1A. Approximately 407,240 cubic yards of fill material was used and the work lasted from late December 2008 to May 2009. Following the earthwork, a variety of wetland plants were planted in the western and southern section of the treatment cell. As a consequence of taking fill material (~1 foot deep) from the former NETA of Cell 1A, the ground elevation in this area was lowered to a level that is conducive to more routine flow and hydration and is considered to be part of the effective treatment area footprint of the cell. Subsequent field observations indicated successful establishment of planted vegetation within the cell and the former NETA.

Endangered snail kite nests were found in Flow-way 1 and Flow-way 2 in April 2010. To avoid impacts to the nests, water depths were maintained at levels appropriate to protect the nests.

In February/March 2010, a cell-wide decline in SAV (hydrilla) was observed in Cells 1B and 2B. Construction of Compartment C Buildout to create Cells 5-4A, 5-4B, 5-5A, 5-5B, and 6-4 began in WY2009. As a result of this construction, Flow-way 3 was taken off-line in parts of WY2010 and

WY2011. The Compartment C Buildout was flow-capable December 2010 and construction was substantially completed in WY2012 and vegetation management activities to begin clearing the area of undesirable vegetation such as willows were initiated.



Cell	Cell Area (acres)
5-1A	1,211
5-1B	1,239
5-2A	1,214
5-2B	1,250
5-3A	1,517
5-3B	938
5-4A	2,034
5-4B	478
5-5A	2,515
5-5B	718
6-4	550
6-2	1,389
6-5	639
6-3	252
Total	15,944

Figure 16. Schematic of Stormwater Treatment Area 5 (STA-5) and Stormwater Treatment Area 6 (STA-6) showing the major water control structures, treatment cell acreage, infrastructure components, and direction of flow.

Table 7. Stormwater Treatment Area 5 (STA-5) operational timeline

STA-5 Operational Timeline

Calendar Year	1998 - 1999	1999 - 2001	2001-2003	2004				2005					2006					2007		
Water Year (May - Apr)	WY1999	WY2000 - WY2001	WY2002 - WY2004	WY2005 (Hurricane Impacts)					WY2006 (Hurricane Impacts)					WY2007 (Regional Drought)					WY2008 (Regional Drought)	
Month		Oct 1999 *Hurricane Irene*		Apr - Jun	Jul - Aug	Sep *Hurricanes Frances & Jeanne*	Oct - Dec	Jan - Apr	Apr - Jun	Jul - Sep	Oct *Hurricane Wilma*	Nov - Dec	Jan - Apr	May- Jun	Jul	Aug *Tropical Storm Ernesto*	Sep - Dec	Jan - Apr	May - Dec	Jan - Apr
Flow-way 1 (FW1) Cells 1A/1B																				
Flow-way 2 (FW2) Cells 2A/2B																				
Flow-way 3 (FW3) Cell 3A/Cell 3B	Not constructed																			
Details																				
On-line	All FW's on-line							FW2 on-line and Cell 1A restricted		All FW's on-line (Cell 1B restricted for plant establishment)			FW1 on-line		FW1 & FW2 on-line					
Notes								During construction of Cell 1A G343s, a 100' cut was made in the levee between Cell 1A & Cell 2A just west of the boat ramps. This allowed flow from 1A to be treated in FW2. Pumps were used to move water out of Cell 2A during this period.									FW3 flow-capable Dec. 2006			
Off-line								Cell 1B off-line; LTP Enhancements construction in FW1 (Cell 1A and 1B) to improve divide levee structures (G-343 A-D), remove obstructions to flow					FW2 off-line LTP Enhancements construction to improve divide levee structures (G 343 E-H), remove obstructions to flow, & vegetation conversion Cell 2B					FW3 off-line (drought, unable to hydrate)			

Indicates Off-line
Indicates Restricted Flow
Indicates On-line
Indicates Construction Activities
Indicates Vegetation Management Activities
Indicates Rehabilitation Activities

Notes: FW = Flow-way, FW1 = Cells 1A & 1B, FW1 = Cells 2A & 2B, FW1 = Cells 3A & 31B, SAV = Submerged Aquatic Vegetation

Table 7. STA-5 operational timeline (Continued)

STA-5 Operational Timeline

Calendar Year	2008		2009						2010					2011		2012
Water Year (May - Apr)	WY2009 (Regional Drought)				WY2010							WY2011 (Regional Drought)			WY2012 (Regional Drought)	
Month	May - Aug (in Aug, *Tropical Storm Fay*)	Sep - Dec	Jan - Apr	Apr	May	Jun-Sep	Oct	Nov-Dec	Jan - Feb	Feb -Mar	Apr	May - June	Jul-Aug	Sep - Dec	Jan - Apr	May - Dec	Jan - Apr
																	
Flow-way 1 (FW1) Cells 1A/1B																	
Flow-way 2 (FW2) Cells 2A/2B																	
Flow-way 3 (FW3) Cell 3A/Cell 3B	Not constructed																
Details																	
On-line	FW1 & FW2 on-line	All FW's on-line (Flow-ways 1,2, & 3)	FW2 & FW 3 on-line	FW2 on-line		All FW's on-line FW1 (w/restrictions)	FW1 (restricted) & FW2 on-line	FW2 on-line		FW1 (restricted) & FW2 on-line		FW1 & FW2 on-line	All FW's on-line (FW3 on-line 7/19/10 and restricted)			All FW's on-line	
Notes									SAV decline (hydrilla) observed in Feb/March		Snail Kite nests in FW1 & FW2, stages regulated to optimize nesting success until Oct 27, 2020 for Cell 1A & Nov 9, 2010 for Cell 2A			Compartment C Build-out flow-capable Dec 2010; construction on-going until 2012			Herbicide application in Compartment C
Off-line	FW3 off-line; hydrated, passed start-up on 8/28/08.		FW1 off-line for Cell 1A rehabiliation (start 12/2/08)	FW1 & FW3 off-line for Cell 1A rehabilitation (end 6/9/09)			FW3 off-line for Compartment C Buildout construction (10/1/09 - 7/10/10)	FW1 off-line 10/28/09 - 2/10/10 (vegetation establishment) & FW3 off-line		FW3 off-line (until 7/10/10)							

Indicates Off-line
Indicates Restricted Flow
Indicates On-line

Indicates Construction Activities
Indicates Vegetation Management Activities
Indicates Rehabilitation Activities

Notes: FW = Flow-way, FW1 = Cells 1A & 1B, FW1 = Cells 2A & 2B, FW1 = Cells 3A & 31B, SAV = Submerged Aquatic Vegetation

STA-6 (Figure 16, Table 8)

Cell 3 (Cell 6-3) and Cell 5 (Cell 6-5) became operational in WY1998; Section 2 (Cell 6-2) was flow-capable in December 2006 and operational in August 2007. Prior to becoming STA-6, Cells 3 and 5 served as a water detention area for the U.S .Sugar Corporation. From WY1998 to WY2006, STA-6 received stormwater runoff solely from the U.S. Sugar Corporation farming activity on the land subsequently referred to as Compartment C. When farming activities ended on Compartment C, the source of runoff to STA-6 was changed to the C-139 Basin, as part of the overall STA-5/6 complex. From WY1998 to WY2000, quarterly sampling indicated that on several occasions, the surface water outflow concentrations of total mercury (THg) and MeHg were significantly higher than inflow concentrations (Jorge et al., 2002). Concentrations of both THg and MeHg spiked briefly in 2001 following a dry-down and re-wetting event and in June 2002 upon rehydration following another extended period of dryout, excess MeHg was observed in outflows, which prompted the initiation of special mercury studies by the District as an adaptive management response (Goforth et al., 2003; Goforth et al., 2004). The high concentrations of THg decreased rapidly within the Florida Class III water quality standard but STA-6 was still determined to be a net exporter of MeHg based on the data from the increased monitoring. In WY2005, the STA dried out again and a spike was observed in THg and MeHg but the spikes were not as high as observed in previous years.

In mid-October 1999, Hurricane Irene produced heavy rainfall that significantly increased stages in Cells 3 and 5. These high stages decreased about two weeks following the storm (Abtew and Huebner, 2000). STA-6 received high inflow volumes as a result of Hurricanes Francis and Jeanne in WY2005, but there was no damage observed to the wetland (Pietro et al., 2006). Hurricane Wilma in WY2006 caused structural damage to the G-600 inflow pump station building and minor damage to SAV and emergent vegetation (Pietro et al., 2007).

In February 2001, the outflow structure was changed from G-606 to Cell 3 and Cell 5 outflows. Section 2 became flow-capable in WY2007 and was operational in WY2008. Gated inflow structures were installed to replace the original Cell 3 and Cell 5 inflow weirs. In WY2010, STA-6 received high rainfall volumes.

Compartment C Buildout became flow-capable in December 2010 and construction continued into WY2012. During the construction of Compartment C Buildout, Section 2 was taken off-line starting in WY2011 through WY2012. In April 2012, the redundant inflow levee that was left in place after the construction of the new inflow structures was degraded and the fill was used to confine the environmentally sensitive areas identified in STA-5/6 Cell 5B. During the droughts in WY2011 and WY2012, STA-6 dried out for extended periods of time (191 days in WY2011, 97 days in Cell 3 and 206 days in Cell 5 respectively during WY2012 and remained dry into WY2013).

Table 8. Stormwater Treatment Area 6 (STA-6) operational timeline

STA-6 Operational Timeline

Calendar Year	1997 - 1999	1999 - 2000	2000	2001	2002-2003	2004				2005				2006			
Water Year (May - Apr)	WY1998 - WY1999	WY2000 (Regional Drought: 10/99 - 8/01)	WY2001 (Regional Drought: 10/99 - 8/01)		WY2002 - WY2004		WY2005 (Hurricane Impacts)				WY2006 (Hurricane Impacts)				WY2007 (		
Month		Oct 1999 Hurricane Irene	May-Dec	Jan-Apr	May-Dec	Jan - Apr	May - Aug	Sep *Hurricanes Frances and Jeanne*	Oct - Dec	Jan - Apr	May - Sep	Oct *Hurricane Wilma*	Nov - Dec	Jan - Apr	May - Jul	Aug *Tropical Storm Ernesto*	Sep - Dec
Cell 3																	
Cell 5																	
Section 2 (Cell 6-2)	Not constructed																
Details:																	
On-line	All Cells on-line																
Notes	Cell 3 & Cell 5 operational starting Oct 1997			Outflow structure changed from G-606 to Cell 3 and Cell 5 outflows starting Mar 2001													
Off-line																	

Indicates Off-line
Indicates Restricted Flow
Indicates On-line

Indicates Construction Activities
Indicates Vegetation Management Activities
Indicates Rehabilitation Activities

Table 8. STA-6 operational timeline (Continued)

STA-6 Operational Timeline

Calendar Year	2006	2007					2008				2009		2010			2011		2012	
Water Year (May - Apr)	WY2007 (Regional Drought)				WY2008 (Regional Drought)			WY2009 (Regional Drought)				WY2010		WY2011 (Regional Drought)			WY2012 (Regional Drought)		
Month	Dec	Jan	Feb - Mar	Apr	May - Jul	Aug - Dec	Jan - Apr	May - Jul	Aug *Tropical Storm Fay*	Sep - Dec	Jan - Apr	May - Dec	Jan - Apr	May - Oct	Nov-Dec	Jan - Apr	May - Dec	Jan - Mar	Apr
Cell 3																			
Cell 5																			
Section 2 (Cell 6-2)	Water Quality issues																		
Details:																			
On-line	Cell 3 & Cell 5 on-line			Cell 3 & Cell 5 on-line		All Cells on-line									Cell 3 & Cell 5 on-line				Cell 3 on-line
Notes					In WY2008 Section 2 on-line but not hydrated due to drought; Inflow changed from G-600 to G-396ABC, G353A,B, C starting 10/2007							Compartment C Buildout construction dewatering through G-600; increased stage in L-3 canal			Compartment C Build-out flow-capable Dec 2010; construction on-going until 2012				Cell 5 off-line to degrade redundant inflow levee (began Apr 11, 2012); fill used for CompC Cell 5B cultural sensitive areas & L-3 boat ramp
Off-line	Section 2 flow-capable Dec 2006, but off-line for start-up WQ compliance		Cell 3 & Cell 5 off-line for LTP Construction, Section 2 off-line (start-up compliance)	Section 2 off-line (start-up WQ compliance passed Aug 14, 2007)											Section 2 off-line (from 11/5/10 through end of WY12) related to Compartment C Buildout & permit issues				Section 2 & Cell 5 off-line

Indicates Off-line
Indicates Restricted Flow
Indicates On-line

Indicates Construction Activities
Indicates Vegetation Management Activities
Indicates Rehabilitation Activities

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Appendix A:

Contents:

- Listing and status of Stormwater Treatment Area (STA) Long-Term Plan Enhancement Activities

- Chronology of Key Events and Projects Associated with the Everglades Stormwater Treatment Areas

Listing and status of Stormwater Treatment Area (STA) Long-Term Plan Enhancement Activities

Table A1. Listing of the Long-Term Plan construction, enhancement or expansion projects in the Everglades Stormwater Treatment Areas (STAs) and status of completion as of Water Year 2012.

Stormwater Treatment Area (STA) Long-Term Plan (LTP) Enhancement Activities	
STA-1E	• Convert emergent cells to SAV Cells 2, 4N, 4S, and 6 (complete except Cell 2 - start after PSTA project removal) • PSTA demonstration project operated by USACE (complete but be removed)
STA-1W	• Construct a new levee across Cell 1, together with a series of culverts for improved flow distribution (complete) • Convert Cell 1B from EAV to SAV (complete) • Construct a divide levee in Cell 2 (w/ culverts for improved flow distribution (G-249 structures), (complete) • Replace existing Cell 2 inflow structure G-255 with a fully operable control structures (complete) • Remove vegetation tussock material from Cell 2 (complete) • Excavate cuts in remnant farm road along north end of Cell 2A (complete) • Convert Cell 2B from EAV to SAV (complete) • Earthwork for improved flow distribution, Cell 3 (C-6 canal), (complete) • Convert Cell 3 from EAV to SAV (complete) • Addition of a 150-cfs structure (G-307) to replace G-256 as the primary discharge for Cell 4 (complete) • Demolish Cell 4 original outflow G-256 structure and restore levee section (complete) • Excavate cuts in berm along the C-7 Canal within Cell 4 (complete) • Improve G-308 collection canal within Cell 4 (complete) • Replace five existing galvanized culvert pipes along the G-254 levee (complete) • Construct seepage pump station (G-327B) NW Cell 5B to provide irrigation to SAV Cell 5B (complete) • Earthwork for improved flow distribution, Cell 5 (G-304 and G-306 berms) (complete) • Automate Cell 5 G-304 structures (complete)
STA-2	• Convert emergent vegetation to SAV in the new downstream cells (internal levees postponed/eliminated) • Initial expansion of STA-2 includes the construction of an additional 2,015-acre treatment cell (new Cell 4) on Compartment B (complete) • Expand STA-2 on the remainder of Compartment B (complete) • Convert southern Cell 2 from EAV to SAV (partially implemented/underway)
STA-3/4	• Construct about 3.3 miles of interior levee, subdividing Cell 3 into Cells 3A and 3B (complete) • Construct additional water control structures through divide levee in Cell 3 (complete) • Extend an overhead power distribution line (total length of approximately 3.6 miles), (complete) • Construct small forward-pumping stations along the interior levees between cells to permit withdrawal from upstream EAV to maintain stages in the downstream SAV cells. Supplemental flows can be transferred from Cell 2A to Cell 1A through structure G-382A, and between Cell 2A and Cell 3B through structure G-382B (complete) • Herbicide treatment of Cells 1B, 2B, and 3B for removal of emergent macrophyte vegetation to allow establishment of SAV (complete for Cells 2B & 3B, but underway for Cell 1B) • Convert Cell 1B from EAV to SAV (underway) • Convert Cell 2B from EAV to SAV (complete) • Convert Cell 3B from EAV to SAV (complete) • Inoculate SAV to accelerate vegetation recruitment (complete) • Construct and operate the full-scale PSTA Implementation Project (underway)
STA-5	• Modify the G-343 structures (complete) • Construct an additional seepage return pump station NW Cell 1B (complete) • Convert Cell 2B from EAV to SAV (complete) • Remove obstructions to flow, Cells 1B and 2B (complete) • Construct and operate an additional 2,560-acre treatment cell (Flow-way 3), (complete) • Expand STA-5 on remainder of Compartment C (complete)
STA-6	• Construct and operate additional 1,440-acre treatment cell (new STA-6 Section 2), (complete) • Improve inflow weir structures to Cells 3 and 5 (complete) • Convert southern Cell 5 from EAV to SAV (deleted from LTP, i.e., levee and SAV conversion in Cell 5 eliminated)

Notes: SAV = submerged aquatic vegetation, EAV = emergent aquatic vegetation, PSTA = Periphyton Stormwater Treatment Area

Chronology of Key Events and Projects Associated with the Everglades Stormwater Treatment Areas

Table A2. Chronology of the key events and projects associated with the Everglades Stormwater Treatment Areas (STAs), including major research initiatives (excerpt from table compiled by Michael Chimney, September 2012). WCA denote Water Conservation Areas.

Annotated Chronology of Key Events/Projects Associated With Everglades Water Quality Treatment Technologies and STA Optimization

Year	Event/Project Description
1975	The first in a series of studies to evaluate retention of phosphorus in regional wetlands was initiated by the District. In all, seven regional wetlands were monitored: Boney Marsh, Armstrong Slough, Ash Slough, Chandler Slough, WCA-1, WCA-2A and WCA-3A. Data collection in Boney Marsh and all the slough wetlands ended by 1989; data collection in the WCAs is ongoing.
1993	Two final reports published that evaluated alternative treatment technologies (i.e., alternative to the STAs) that had a demonstrated capability to achieve the phosphorus reduction requirements of the District's Everglades SWIM Plan: Phase I Evaluation of Alternative Treatment Technologies and Phase II Evaluation of Alternative Treatment Technologies by Brown and Caldwell Consultants.
1996	Publication of an updated evaluation of 24 alternate treatment technologies identified in the 1993 screening reports as potentially "superior" technologies applicable to the STAs. See Tables 1 and 2 in Desktop Evaluation of Alternative Technologies Final Report by PEER Consultants, P.C./BROWN and CALDWELL for a complete list of these technologies.
1996	The U.S. Army Corps of Engineers (USACE) Section 404 permit for constructing the STAs required the District to investigate nine treatment technologies: wetlands, managed wetlands, low-intensity chemical dosing, submerged aquatic vegetation (SAV)/limerock, periphyton-basted stormwater treatment areas (PSTA), chemical addition/microfiltration, chemical addition/direct filtration, chemical addition/dissolved-air floatation and chemical addition/high-rate settling. The research projects that resulted from this mandate were initially referred to as "supplemental technologies" and later became known collectively as the Advanced Treatment Technology (ATT) Research Program.
1997	Research was initiated for the following ATT Research Program projects: chemical addition/ microfiltration (by the Florida Department of Environmental Protection [FDEP]), low-intensity chemical dosing (by the Everglades Protection District [EPD]) and the other three chemical addition technologies (by the District). These studies were conducted at sites (mesocosms, Test Cells and Treatment Cells) within the ENRP.
1997	The District initiated development of the Supplemental Technology Standard of Comparison (STSOC) for the ATT Research Program projects. The STSOC set up data collection guidelines so comparable treatment performance and design information was collected from each ATT Program project. The STSOC also devised an evaluation methodology to compare the various technologies.
1998	Rebuilding of the north and south bank of Test Cells in the ENRP was completed and all cells were flooded to promote the establishment of wetland vegetation. Each Test Cell was 0.5 ac in size and fully lined so it was hydrologically isolated from adjacent cells.
	Research projects were initiated by the District for the following ATT Research Program projects at sites (mesocosms and Test Cells) within the ENRP: managed wetlands, SAV/limerock and PSTA .
	The District initiated the Marsh Dry Out Study (MDOS) to quantify the role of P loading, length of dryout and influence of macrophytes on sediment P-flux to the water column. This 2-year study was conducted in mesocosms (1m x 5.9m) located at the north and south ENRP Research Sites

Table A2. Chronology of STA Key Events and Research continued**.**

Year	Event/Project Description
1999	A 3-year study (the STA Optimization Experiments) was initiated in select ENRP Test Cells (north cells 6, 7, 8 and 9; south cells 2 and 14) to examine the influence that hydraulic loading rate (both increasing and decreasing), water depth and flow pulsing had on treatment efficacy; a total of seven different hydraulic manipulation experiments were conducted. This research was mandated by the FDEP operating permit for the ENRP and the USACE 404 permit to construct the STAs and was partially funded by a U. S. Environmental Protection Agency (USEPA) grant.
	The District conducted a dye tracer study of STA-1W Treatment Cell 4. This study was partially funded by FDEP and conducted by DB Environmental Laboratories, Inc (DB Labs).
2000	The District initiated construction of the Field-scale PSTA Facility adjacent to STA-2. This project had four 5-acre cells managed to promote a SAV/periphyton community in each cell. Research conducted at this site was an adjunct, although at a larger scale, to the PSTA studies in the ENRP.
	The District initiated a 9-month follow-on study of the low-intensity chemical dosing technology in three of the north Test Cells in STA-1W.
2001	Final report submitted to USEPA that summarized results from the STA Optimization Experiments conducted in the ENRP Test Cells. This report was later republished as a District Tech Pub in 2006 - Technical Publication ERA #438.
	The District initiated a study of the sediment and SAV community in Lake Panasoffkee to assess the long-term viability of phosphorus storage in aquatic systems. The objectives of this study were to use paleolimnological techniques to reconstruct the history of SAV abundance in the lake, to identify the dominant sources of organic matter in the sediment, and to evaluate how sediment P accumulation has changed over time relative to SAV abundance. This study was contracted to the University of Florida.
2002	The District initiated a 1-year study (winter and summer sampling) of vegetation biomass and nutrient content at a number of sampling sites in STA-1W. This study was conducted by DB Labs.
	The District conducted a mesocosm study on the efficacy of various soil amendments to enhance treatment performance of peat-based wetland systems. This study was conducted by CH2MHill at the PSTA Field-scale facility.
2003	The District conducted a literature survey of Florida lakes and rivers to assess the long-term viability of phosphorus storage in aquatic systems. The objective of this study was to analyze data from selected SAV-dominated systems and determine if (1) these systems had effectively removed phosphorus on a long-term basis and at what rates, and (2) how did these systems responded to changes in phosphorus loading, hydraulic loading and changes in the species composition of the SAV community. This study was contracted to Wetland Solutions, Inc.
2005	The District conducted a dye tracer study of STA-2 Treatment Cell 3. This study was conducted by DB Labs.
2006	Publication of a special issue of Ecological Engineering containing eight papers dealing with research conducted by the District in the ENRP - Ecological Engineering 27(4): 1-379.
	The District, in collaboration with the EPD, began co-funding a STA research program conducted by DB Labs.

Table A2. Chronology of STA Key Events and Research continued**.**

Year	Event/Project Description
2008	The District initiated a 6-month study of cattail tolerance to drought conditions utilizing mesocosms at the South Research site in STA-1W. The objectives of this study were to quantify the survivorship and physiological response of cattail to varying intensities of soil dryout.
	The District initiated a 3-month study of cattail tolerance to deep water conditions utilizing mesocosms at the South Research site in STA-1W. The objectives of this study were to quantify the survivorship and physiological response of cattail to varying depths and duration of flooding conditions.
2009	The District conducted a dye tracer study of the PSTA Cell within STA-3/4. This study was conducted by DB Labs.
	The District initiated a multi-year study to examine the response of cattail and soil porewater phosphorus concentrations to long-term deepwater conditions in the STAs. This study is being conducted in plots set up within STA-1E Treatment Cell 7.
2010	The District initiated a 3-year study to evaluate the treatment efficacy of six different wetland plant communities. This study, the STA-1W Mesocosm P Study, is being conducted in mesocosms located at the South Research site in STA-1W.
	In addition to the 9 technologies specified in the USACE 404 permit for construction of the STAs, the ATT Research Program from 1996 through 2010 evaluated 34 other commercial treatment technologies for possible use in Everglades restoration and responded to inquires from 17 additional vendors/scientists.
2011	The District initiated a drawdown of STA-3/4 Cell 1A in an effort to rehabilitate this cell's cattail vegetation. Study plots were set-up and vegetation recovery was monitored to evaluate the success of vegetation re-establishment. Initial findings indicate positive effects on vegetation density and growth.
	The District initiated the New Alternative Treatment Assessment (NATA) Program to provide an opportunity for interested parties to demonstrate potential alternative technologies for the reduction of nitrogen and/or phosphorus loads in water and/or sediments emanating from the Everglades watershed. To date, we have conducted small projects to test four products: Phoslock, STI, ViroPhos and WP1 and have one upcoming project (Ferrate).