DRAFT

OPERATIONS PLAN
FOR THE
STA-1E CELLS 1-2 PSTA/SAV
FIELD-SCALE DEMONSTRATION PROJECT

PALM BEACH COUNTY, FLORIDA

Prepared for

US Army Corps of Engineers®

JACKSONVILLE DISTRICT

CONTRACT NO. DACA-21-02-D-0004
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SEPTEMBER 2005

SAIC®

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SEPTEMBER 2005

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1 PROJECT DESCRIPTION

The C-51/STA-1E Project is part of the Everglades Construction Project to treat urban/agricultural drainage and to provide additional water to the Everglades. As a macrophyte stormwater treatment area (STA), represented in **Figure 1.1**, its purpose is to treat the water so that total phosphorus in the discharge waters is 50 parts per billion (ppb) or less. Natural levels of total phosphorus (TP) within the waters of the Everglades are generally below 10 ppb. Traditional wetlands-based STA technologies cannot reduce phosphorus concentrations to these natural levels. Thus, the C-51/STA-1E Project is designed to demonstrate an innovative treatment technology at a field-scale to improve the water quality by reducing the total phosphorus concentrations in the discharge to levels approaching 10 ppb so that it may be diverted to Water Conservation Area (WCA) 1 in the Loxahatchee National Wildlife Refuge (LNWR), located in Palm Beach County, Florida.

The U.S. Army Corps of Engineers (USACE), Jacksonville District, has been pilot testing a biotechnology known as periphyton stormwater treatment area (PSTA) to achieve a greater reduction in phosphorus. These tests have successfully demonstrated the ability of PSTA to produce effluent water TP concentrations at or below 10 ppb.

Due to the success of the pilot testing, the USACE Jacksonville District is planning to conduct a field demonstration of the PSTA technology within the existing footprint of STA-1E in what is known as Cell 2. Demonstration cells will evaluate three different alternatives for the development of activated PSTA. The field demonstration, expected to be conducted over a 24-month operation period, will be used to determine the optimum design parameters, operational parameters, and recommendations for full-scale implementation of PSTA for STA-1E.

The conceptual treatment train for the field-scale demonstration of PSTA in STA-1E (Cells 1 and 2) will use floating aquatic vegetation (FAV) in the Eastern Distribution Cell (EDC), emergent aquatic vegetation (EAV) in Cell 1 and a submerged aquatic vegetation (SAV) area and cyanobacteria-dominated periphyton cells in Cell 2, as represented in **Figure 1.2**. A conceptual layout and a flow diagram of the floating aquatic vegetation, emergent aquatic vegetation, and EAV/SAV/PSTA treatment train in Cells 1 and 2 are shown in **Figure 1.3**.

The overall project objective is to obtain TP removal to 10 ppb or less at the outflow of the PSTA cells in Cell 2. The objective of the demonstration cells is to demonstrate and evaluate up to three different substrates for the development of activated PSTA. The objective of the operations is to evaluate and demonstrate PSTA conditions providing water quality treatment to 10 ppb of phosphorous concentration or better while emulating flows representative of the 10 year period of record.

The purpose of this plan is to present information on the operations planned for the treatment train.

Schematic of STA-1 East (Not to Scale)

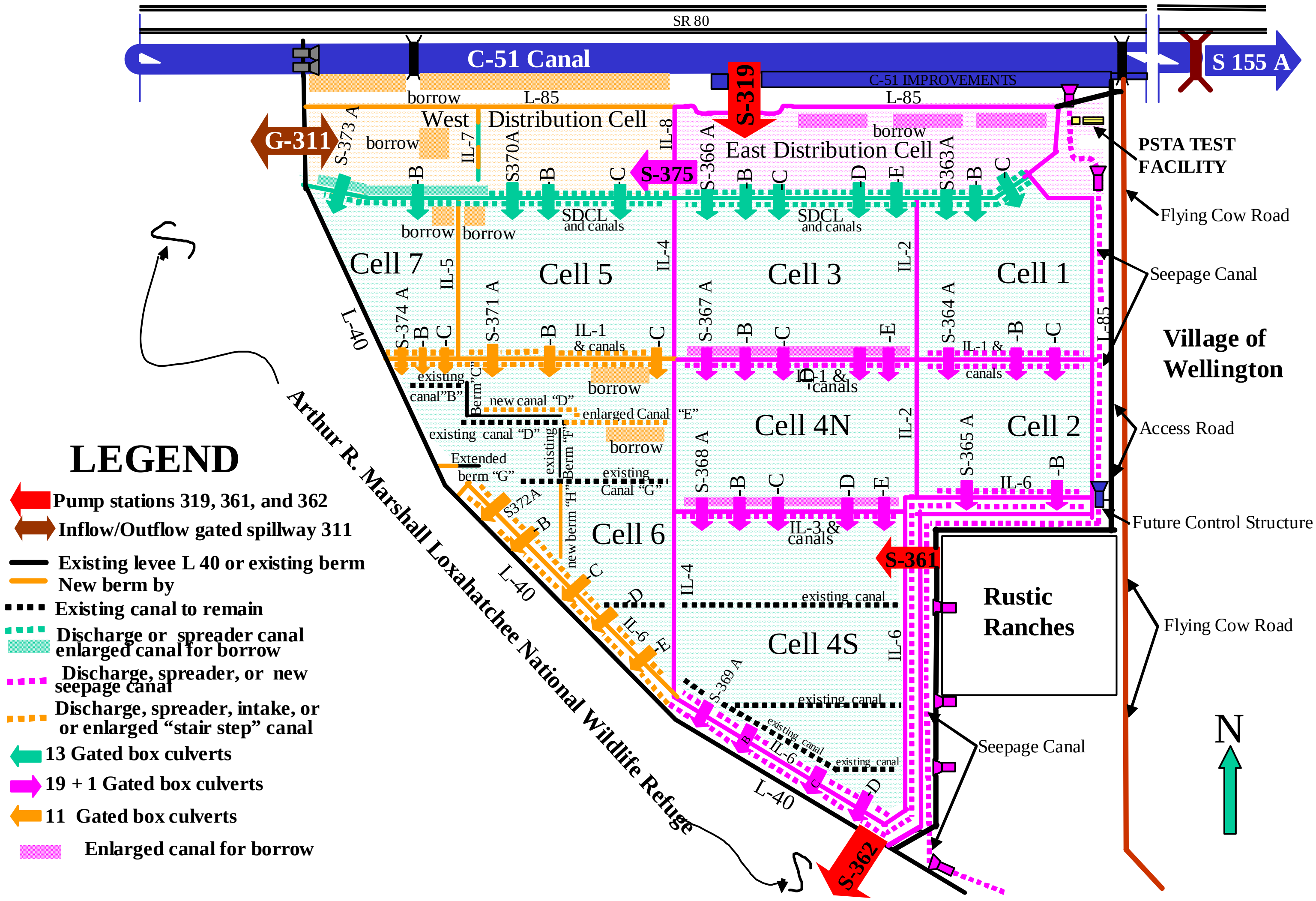


Figure 1.1. STA-1E Schematic Layout (USACE)

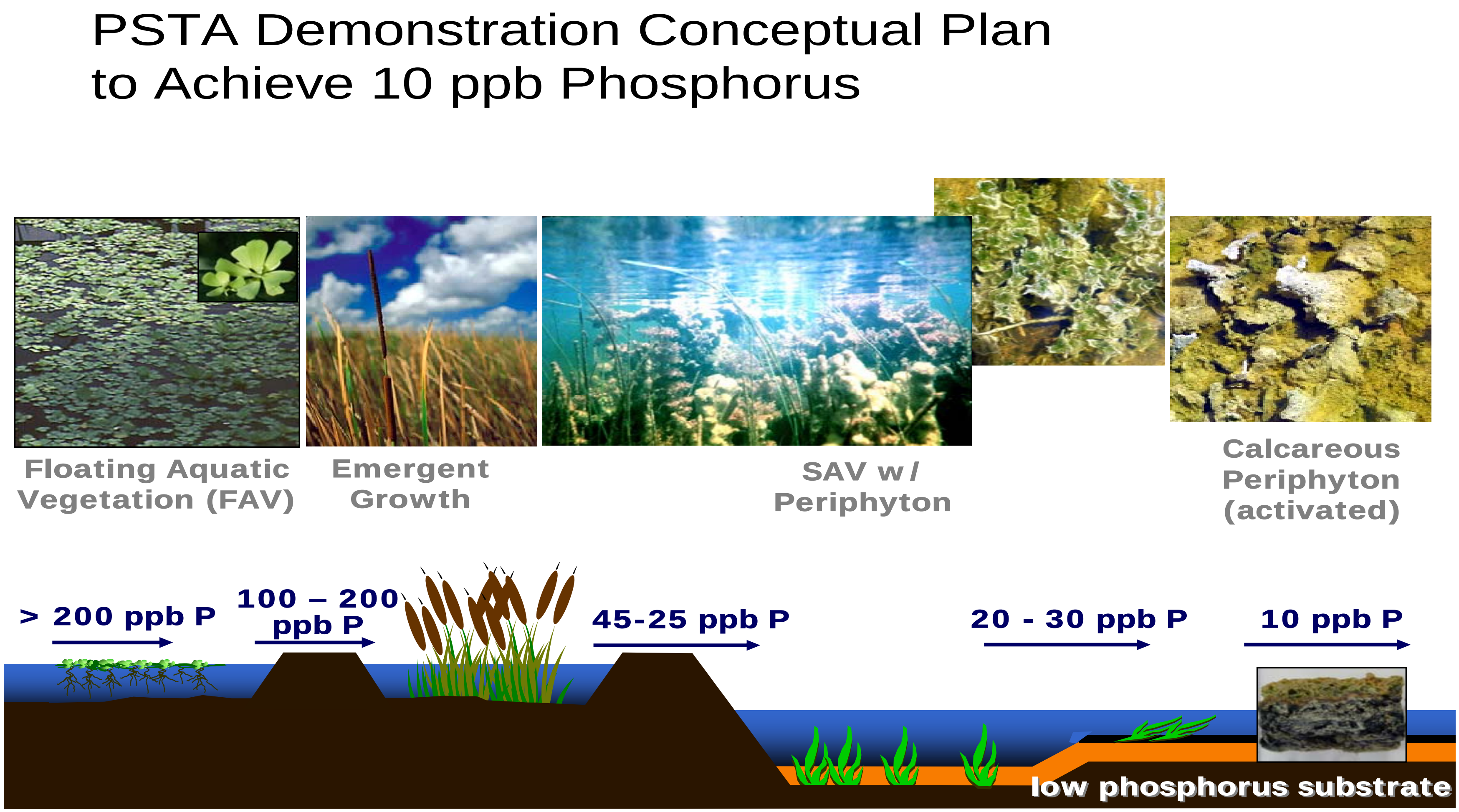


Figure 1.2. STA-1E Conceptual Treatment Train (USACE 2005)

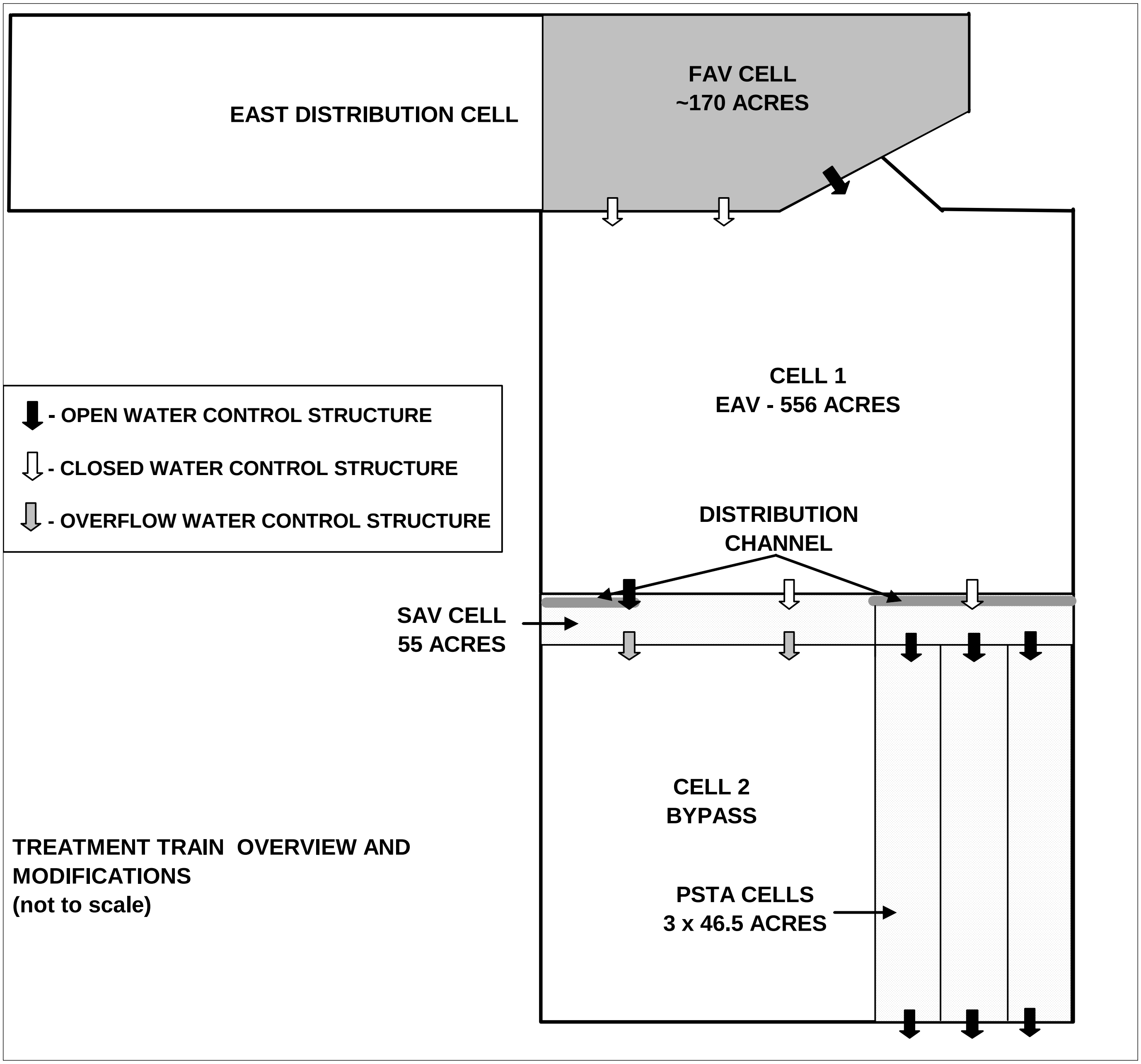


Figure 1.3. Flow Diagram for the STA-1E PSTA/SAV Field Scale Demonstration Project

2 TREATMENT TRAIN OVERVIEW

2.1 TREATMENT TRAIN OVERVIEW

Sustainable PSTA operations to achieve a long-term 10 ppb TP outflow concentration require inflow water concentrations equal to or less than 50 ppb. Since the inflow concentrations into STA-1E from the C-51 Canal range from 100 to 200 ppb (with even higher spikes), water treatment prior to PSTA cells' inflow is required. No distinct element of the EDC - Cell 1-2 treatment train can provide enough treatment to lower the phosphorous concentrations to 50 ppb TP or below required by PSTA. However, DMSTA modeling has shown that a multi-tiered treatment train will accomplish this objective. Hence, this Operations Plan has been developed to manage a system consisting of FAV in the Eastern EDC, EAV in Cell 1, and in Cell 2 an SAV cell leading to PSTA cells. The treatment train and the associated Dynamic Model for Stormwater Treatment Areas (DMSTA) FAV/EAV/SAV modeling results are shown in **Figures 1.3 and 2.1**, respectively. The DMSTA modeling approach and detailed results are presented in the September 2005 Design Analysis Report (**SAIC 2005**).

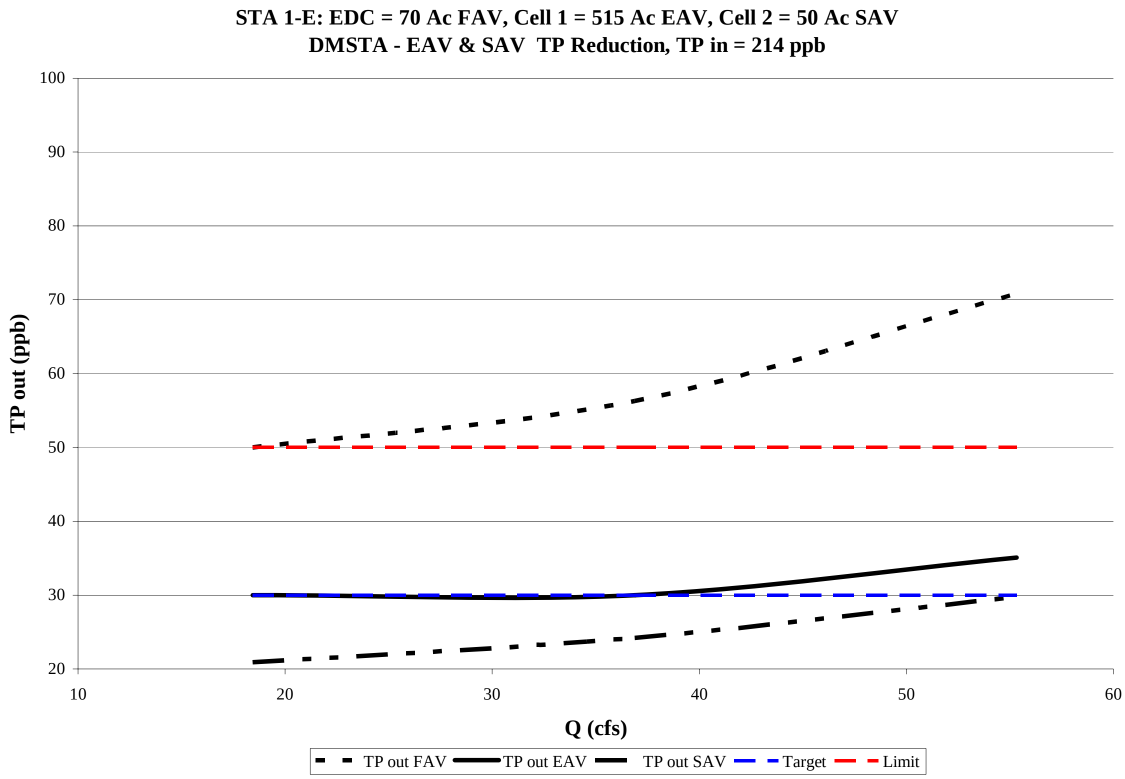


Figure 2.1. Phosphorus Removal in FAV, EAV and SAV Prior to PSTA Cells

2.2 TREATMENT TRAIN COMPOSITION

At the head of the treatment train, in the eastern part of the EDC is, a yet to be built, approximately 170 Ac FAV Cell, supplied with water from the C-51 Canal and covered with *Pistia stratoites* (water lettuce). The FAV cell is expected to treat water from the 100 ppb to 200 ppb TP range to about 70 ppb TP. Following the FAV, there is the already completed and inundated Cell 1 with EAV. Cell 1 is expected to discharge at about 50 ppb TP into a yet to be constructed SAV cell in Cell 2. The SAV cell is designed to deliver flow in the eastern direction toward the inflow points of the three PSTA cells at about 30 ppb TP, which are to discharge to the Cell 2 collection channel and then ultimately discharged from the STA through the S-365B.

2.3 TREATMENT TRAIN ELEMENTS

<u>EDC FAV Cell</u>
The purpose of the FAV Cell is to provide initial treatment of the C-51 Canal source water prior to entering the EAV cell. Water surface elevations within the FAV Cell should be maintained at 19-20 ft NGVD. The water source for the FAV Cell will depend on water conditions within the remainder of the EDC and the C-51 Basin and Canal. If water levels are sufficient the source will be the Eastern EDC and if required the source water will be augmented by or solely supplied by pumps dedicated to the FAV Cell. Water from the FAV cell will exit via the S-363C into the Cell 1 EAV Cell.

<u>Cell 1 EAV</u>
Cell 1 is 556-acre treatment cell that is the second step in the PSTA treatment train designated for EAV growth.

<u>Cell 2 SAV Cell</u>
The SAV Cell is a 55-acre treatment cell located along the northern extreme of Cell 2. This cell is both the third step in the PSTA treatment train and provides the hydraulic head to provide the flows into the PSTA Demonstration Cells. The ground surface elevation of the SAV Cell within Cell 2 has been designed to be 15.0 ft NGVD.

<u>PSTA Cells</u>
The PSTA Cells are the final step within this treatment train and consists of three 46.5-acre cells comprising a total area of 139.5 acres. The ground surface elevation of these cells has been designed to 16.25 ft NGVD. The remainder of the cell that is referred to as Cell 2 by pass has a slightly irregular ground surface but is expected to be approximately 15.75 ft NGVD.

<u>Cell 2 Bypass</u>
The Cell 2 Bypass is 364 acres located on the western side of Cell 2 and is used for both passing water through the cell and minimizing the head difference between the PSTA

Cells and the remainder of Cell 2. Eight in line risers with 48 inch culverts connect the SAV Cell to the Cell 2 Bypass and the outfall is the S-365A structure.

3 PSTA FIELD SCALE DEMONSTRATION OPERATIONS

3.1 BASIS AND OBJECTIVES FOR OPERATIONS

The operational objective of the PSTA field scale demonstration project in STA-1E Cell 2 has four sub-objectives. These are:

1. **Startup (abiotic) Operations, Establishment of the Periphyton Mat, and Activation of the Periphyton Mat:** The objective of this phase will be to operate the cells in a manner that will result in an activated periphyton mat that can be used in the Phase 2 treatment technology known as PSTA. Flows and depths, including periods of dry-out and no inflow other than that necessary to maintain a specific depth will be necessary to grow and select for organisms that can both establish the periphyton mat and be "activated" so that they can be maintained in the conditions that will occur under the additional three operational objectives.

2. **Fixed Scenarios**: Operations of the PSTA demonstration cells under the conditions that result in the depths, inflows, hydraulic loading rates (HLR)s and hydraulic retention times (HRT)s which duplicate the test conditions of the Flying Cow Road Test Facility (FCRTF).

3. **Period of Record (POR) Operations**: Operations of the PSTA demonstration cells under conditions experienced during the 10 year POR used for the design of the demonstration project. These conditions were determined using the Burns and McDonnell Dry-Out Analysis and the antecedent rainfall at the S-5A during the POR excluding all flows that resulted in a HRT of 21 days or greater. This operational phase consists of 53 weekly conditions ranked into "wet" and "dry" season conditions. This phase of the PSTA demonstration includes 3 artificially created 24 hour dry season events (8 cfs per cell for 24 hrs) occurring near the beginning middle and end of the dry season; and 3 artificially created wet season events (18 cfs per cell for 24 hrs) occurring as 2 events in one month during the middle and 1 event near the end of the wet season.

4. **Extreme Conditions**: Operation of the PSTA demonstration test cells under extreme conditions (maximum input flow of 55.0 CFS, maximum HLR of 23.8 cm/day, maximum output depth of 2.75 ft and minimum HRT of 3.5 days) for a period of 7 days. This operational condition will cause a condition that would not have occurred naturally during either the 10 or 31 year PORs.

3.2 SEQUENCE OF OPERATIONS

The planned operations of the PSTA cells assume USACE control of Cells 1 and 2 of the STA-1E and that the remainder of cell 2 will be used only as bypass to limit seepage into and out of the PSTA cells. As indicated above, the operations consist of three main phases, which are Start Up and Activation, Fixed Scenario Operations, and POR Operations.

These phases are further described in the following sections. Upon completion of the start up operations, the exact sequence of operations will be made adaptable to weather conditions and the season of the year that the operations begin.

FAV Operations

During most of the operations water levels within the FAV cell will be controlled to remain between 19 and 20 ft NGVD. During high water conditions in EDC west of the FAV levee, water surface elevations within the FAV cell will mimic those of the west side of the EDC. The operational window of the EDC exceeds the height of the FAV levee. Since the levee is not to be a flood control structure it may be overtopped in emergency conditions.

3.3 START UP AND ACTIVATION OPERATIONS

Due to the uncertainties of the construction schedules and the antecedent conditions caused by the wet and dry seasons in South Florida, the start up operations for all of the components of the EDC, Cell 1, Cell 2, and PSTA may need to be adjusted to compensate for these differences. The sequence of PSTA startup operations (steps A-G in Appendix A) cannot be adjusted and will have to be conducted as a first step in order to ensure an activated periphyton mat for the additional portions of the demonstration.

East Distribution Cell FAV Cell

Prior to startup activities, *Pistia stratiotes* should have been installed within the FAV Cell. The length of start up operations will be dependant on seasonality and the initial amount of *Pistia stratiotes* placed in the cell during construction. Additionally, actions should be taken if emergent vegetation has recolonized to the degree that it is excluding *Pistia stratiotes* from large portions of the cell.

Prior to normal operations monitoring of the efficiency of the FAV Cell should be conducted to determine if changes to the operational flows are required to meet the target phosphorus concentrations.

Cell 1 EAV Cell

Start up activities within Cell 1 have been initiated and should be completed at the time of the commencement of operations. These activities have been guided by the *Stormwater Treatment Area 1E Vegetation Management Plan* (Serbesof-King 2004).

Cell 2 SAV Cell

Prior to start non-desirable species of existing vegetation should be removed.

Water surface elevations will be increased incrementally within the SAV Cell to maximize light reaching the vegetation. The initial water surface elevation within the cell should be 16.5 ft NGVD and increased by 0.25 ft when 50% of the vegetation has reached the water surface or is within 2 inches of the surface. Water levels will be increased until an elevation of 18 ft NGVD is reached.

Use of contact herbicide might be required within the SAV Cell if a significant coverage/density of FAV species, *Brachiara mutica*, *Panicum sp.*, or *Typha sp.* colonize the cell. The potential need for transplanting of desirable SAV species may be required; this activity depends on seasonality, schedule, cost, and availability.

Cell 2 PSTA Cells

The expectation is that startup activities will commence immediately after the emplacement of the PSTA cell substrates and the cells will be nominally free of vegetation.

PSTA start up activities will be the most intensive of the treatment train in regards to the manipulation of water levels. The steps in **Table 3.1** are conducted to foster the environment that encourage the growth of a calcareous periphyton community, limit the initial growth of emergent vegetation and non-desirable periphyton communities. Visual inspection of the emerging periphyton community should be conducted on a regular basis (weekly) to determine if water control operations require modification to prevent the establishment of undesirable communities.

Water quality, biomass and substrate monitoring will be conducted prior to and during start-up operations and will be further elaborated on within the monitoring plan.

Table 3.1 Schedule of Water Surface Elevations during Startup Operations

	Water Surface Elevation (NGVD ft.)				PSTA Cells
Day	EDC	Cell 1	SAV Cell	PSTA Cells	HRT (Days)
1-15	19.75	19.25	18.75	18.25	Static
16-30	19.25	18.75	18.25	16.75	Draining
31-45	19.25	18.75	18.25	16.25	Draining
46-60	19.25	18.75	18.25	16.75	Filling
61-90	19.25	18.75	18.25	16.75	14
91-105	19.25	18.75	18.25	16.25	Draining
106-120	19.25	18.75	18.25	16.75	Filling
121-150	19.25	18.75	18.25	16.75	14
151-165	19.25	18.75	18.25	16.25	Draining
166-180	19.25	18.75	18.25	16.75	Filling
181-195	19.25	18.75	18.25	16.75	14

Cell 2 Bypass

This area will be primarily used to provide water surface equalization in order to limit seepage into and out of the PSTA cells; hence the water elevations will mimic the PSTA cell elevations. The operational needs of the PSTA demonstration only require maintaining the surface water elevation of the bypass within three inches of the PSTA Cell water surface elevation when PSTA Cell elevations are at or below 17.75 ft NGVD. The other scenarios occur too quickly to allow for equalization of the Cell 2 bypass. The flow requirements to meet these needs will be quantified when the amount of seepage loss from this area is determined during operations startup. The potential of this area to pass additional flows during normal operations should be more easily quantifiable once the effectiveness of the treatment train in reducing phosphorus concentrations is better known.

The following assumptions have been made on the best available data prior to the aforementioned seepage tests. Three 30 cfs pumps will transfer water from the C-51 canal to the northwestern corner of the FAV cell. The high operating flow required for PSTA cells is 55 cfs to achieve 2.75 ft depth and the desired hydraulic detention time. Given the minimum operating depth of 0.5 ft, the flow required would be about 10 cfs. To account for seepage and ET losses in the system, based on SFWMD comments at the August 8, 2005 meeting in West Palm Beach, FL, Cell 1 requires approximately 10 cfs. Based on the combined areas for the EDC and SAV cells we can conservatively assume similar ET and seepage losses as for Cell 1 but for smaller areas, so about 5 cfs. From DAR calculations, PSTA cells should experience about 1-5 cfs in seepage losses. Therefore, the minimum flow requirement for 0.5 ft PSTA cell water depth would be about 26 to 30 cfs, while the high flow would require 71 to 75 cfs. Hence, one 30 cfs pump operating continuously should maintain the required flow regime for 0.5 ft PSTA cell water depth. When more flow is required, a second pump would be cycled on and off. However, two 30 cfs pumps will not be sufficient for high flow conditions, while having three pumps will provide the required high flow capacity with a prudent safety factor.

3.4 FIXED SCENARIOS

The fixed condition operations which complement the FCRTF conditions can be operated in a variable sequence depending on the availability of water. However, since they are considered as part of the initial part of the demonstration they must be conducted immediately following the startup, periphyton establishment and activation phase.

The fixed scenarios will consist of the following depth/flow/HLR/HRT characteristics:

A. 0.5 ft, 2.6 CFS, 1.1 cm/day, 14 days.
B. 1.0 ft, 5.0 CFS, 2.2 cm/day, 14 days.
C. 1.0 ft, 10.7 CFS, 4.6 cm/day, 7days.

D. 2.0 ft, 11.7 CFS, 5.1 cm/day, 7 days.

PSTA input stoplog elevations will depend on antecedent SAV water elevations. Output stoplog elevations will be: 16.75, 17.25, 17.25 and 18.25 ft NGVD respectively.

3.5 PERIOD OF RECORD OPERATIONS

The *Stormwater Treatment Area No. 1 East Period of Record Dry-Out Analysis* model (Burns & McDonnell 2000) was used to simulate the flows encountered during the 1979 to 1988 base period used for STA sizing process. **Figure 3.1** displays the projected flows into STA-1E for this time period scaled to the combined size of the three PSTA Cells and reordered to account for rainfall. This represents the base POR for Operations.

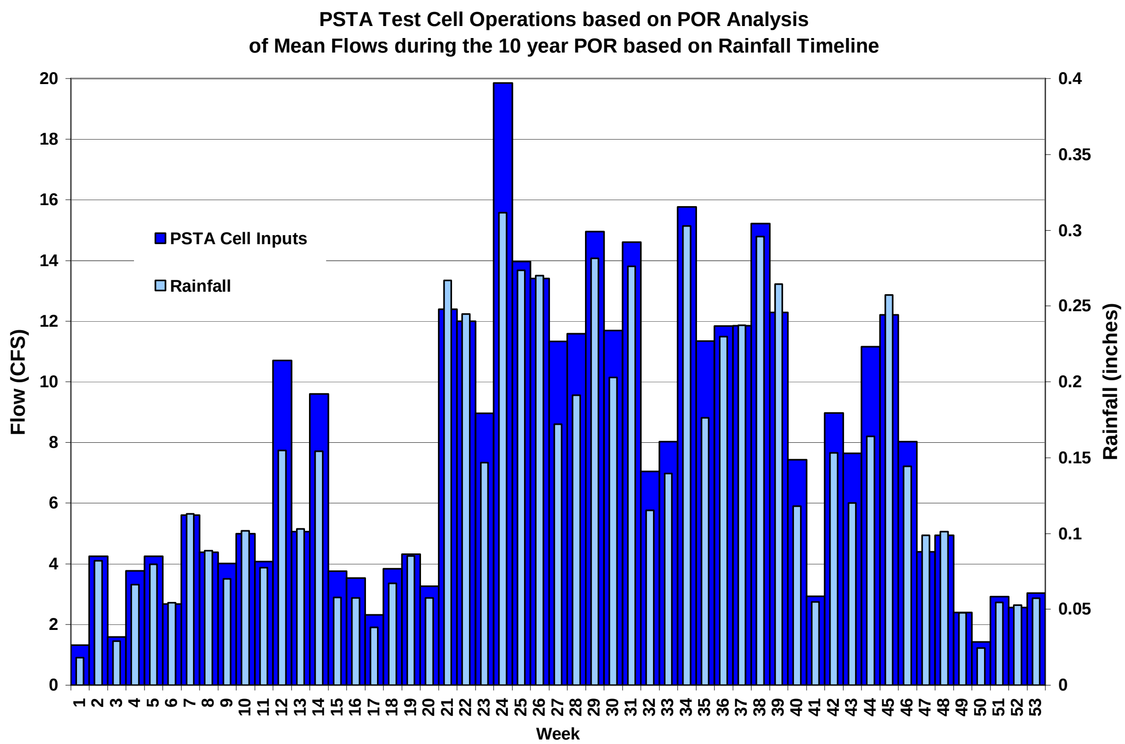


Figure 3.1. Scaled Mean Weekly S-319 Flows Reordered to S-5A Rainfall From 1979 to 1988

In addition to the base flows provided in Figure 3.1, high flow events associated with tropical storms and other high rainfall events needed to be accounted for to test the effectiveness of PSTA. To account for these events the largest wet season and dry season flows during the period of record were interjected within the base flows three times per season (**Figure 3.2**). This Figure represents the POR flows to be tested during PSTA Demonstration Operations. In order to configure the appropriate PSTA cell input and output water control structure settings the POR-based HRTs also needed to be established. **Figure 3.3** shows the flow and depth dependencies in the PSTA cells, where the targeted PSTA inflow is the POR-based flow and depth is the planned PSTA Cell depth for a given test scenario. The depth and flow information from Figure 3.3 was then used to establish the PSTA cell HRTs (**Figure 3.4**) to be tested. In Figure 3.4, in order to fit as many tests as possible into the two-year demonstration schedule, the HRT coditions longer than 21 days (depth < 0.5 ft) have been eliminated.

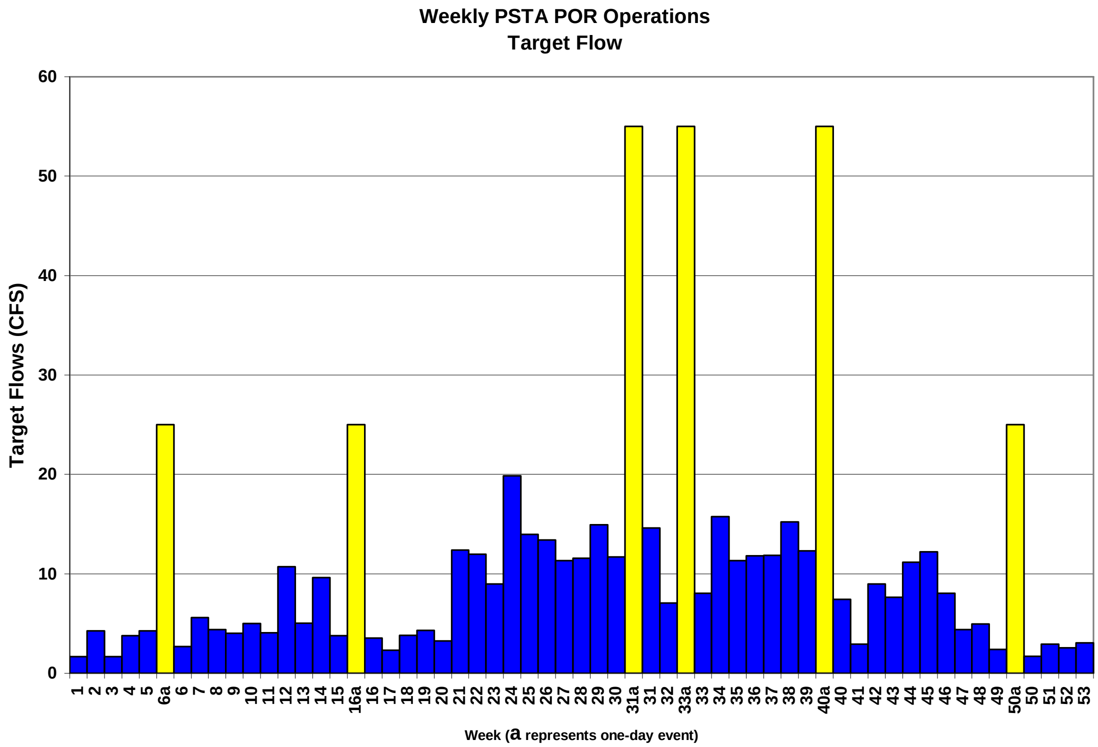


Figure 3.2. Target Flows with Storm Events for PSTA Cells

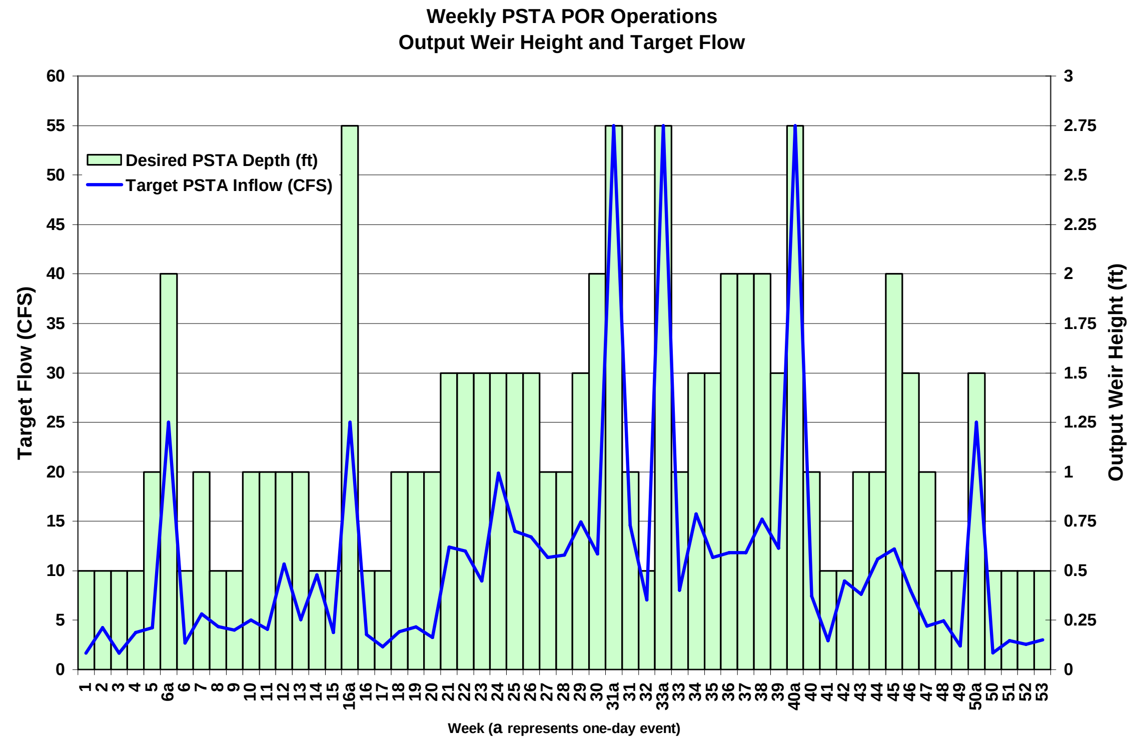


Figure 3.3. Target Flows and Depths Within the PSTA Cells

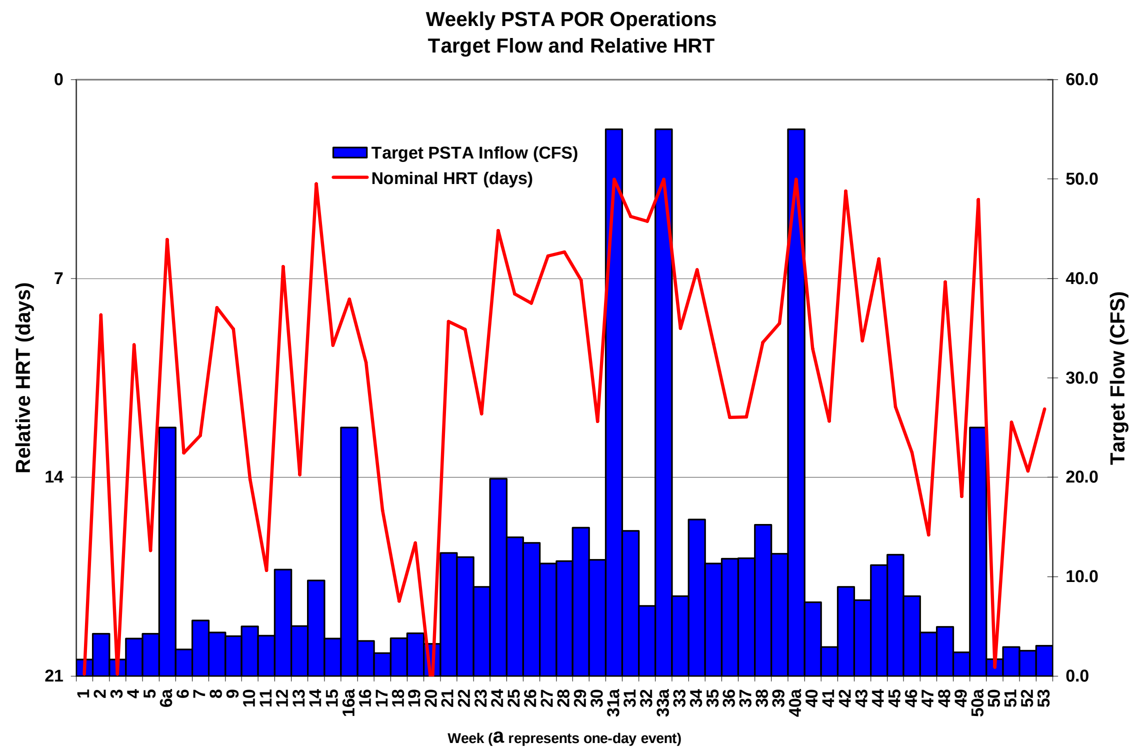


Figure 3.4. Target PSTA Flows and Resulting HRT

To achieve the desired PSTA cell flow conditions presented above, the SAV Cell operations needed to be established, as it's the SAV cell elevations that provide the hydraulic head for the PSTA system. In addition, it was important to limit the water level fluctuations in the SAV cell since they could cause short-circuiting above the SAV. This was done by using stop logs as the main flow controls into the PSTA cells. Nevertheless, large changes in SAV cell depths proved necessary during the highest flow events. This is acceptable as it reflects the reality of the reduced treatment capacity during these types of events and provides a PSTA test condition that needs to be included in the operations. **Figure 3.5** shows the SAV cell water surface elevations with respect to targeted PSTA flows.

The SAV cell water surface elevations combined with the targeted PSTA cell inflows were utilized to establish the required stop log setting and are shown in **Table 3.2**. The exact flows will be calibrated during start up operations. In the Table, PSTA Cell elevations and depths are provided to determine weir settings. Weir and SAV Cell elevations will be changed weekly and will not be readjusted to account for rainfall and operations in Cell 3 and Cell 4N that will impact seepage; however, elevations will be monitored to back calculate depths and flows. Similar accounting will occur at the outflow weir. HRT calculations use the desired PSTA depth column and are expected to be shorter than shown but can not be pre-calculated due to the unpredictability associated with seepage and rainfall. The HLR in **Table 3.2** (also shown in **Figure 3.6**) has been provided in both ft/day and cm/day to be compliant both with the units of measure of this report and those provided in the South Florida Water Management District (SFWMD) generated STA reports. For comparison purposes the average HLR within the operating STAs for WY2004 was 3.4 cm/day (**Figure 3.7**) (SFWMD, 2005).

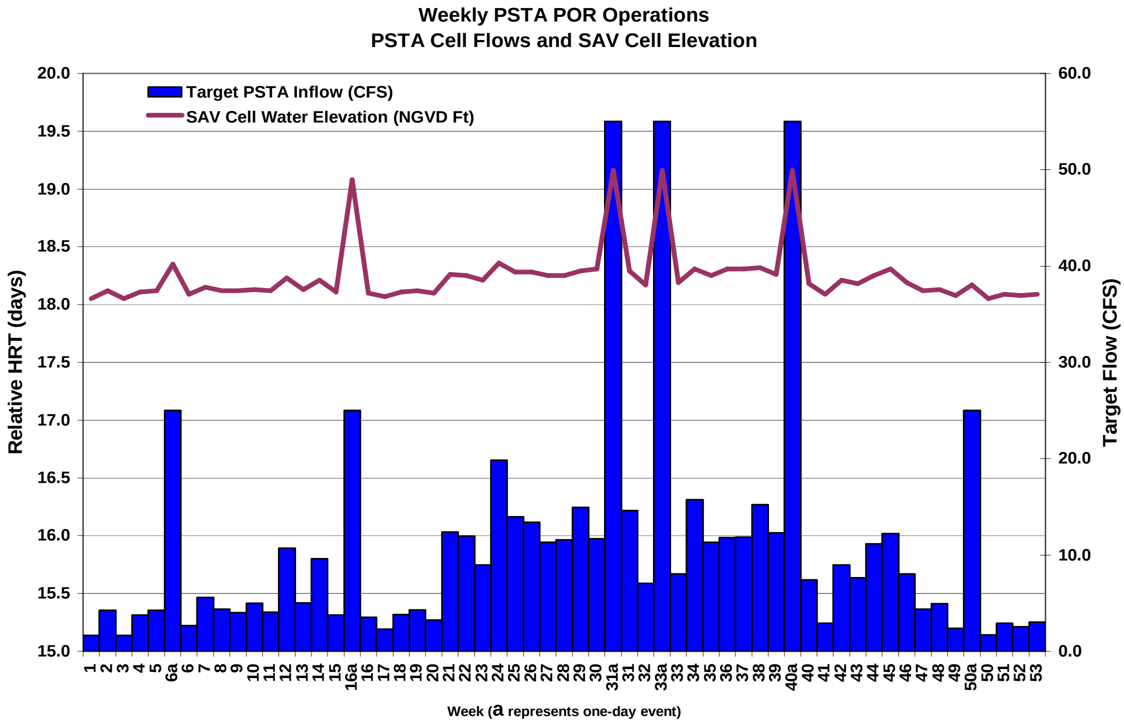


Figure 3.5. SAV Cell Water Surface Elevations

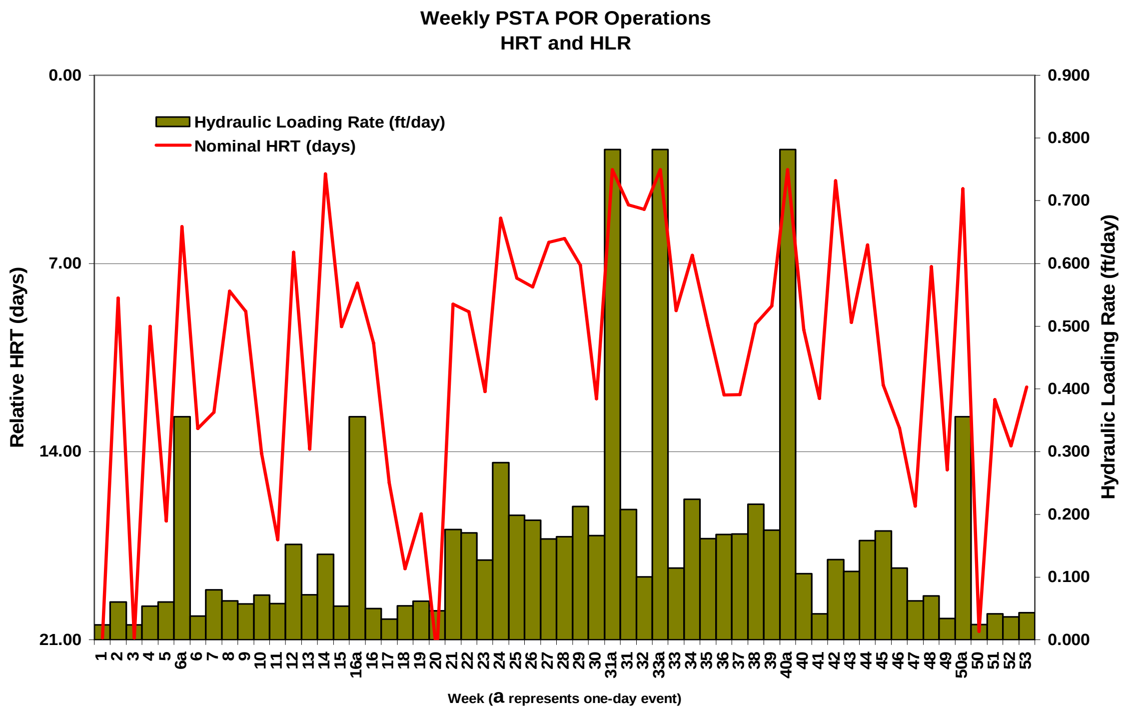


Figure 3.6. Estimated HLR and HRT for PSTA Cells During POR Operations

Table 3.2 Period of Record Operations Summary Table

Week	Target PSTA Inflow (CFS)	SAV Cell Water Elevation (NGVD ft)	PSTA Input Stoplogs One Test Cell Elev (Ft NGVD)			Desired PSTA Depth (ft)	Desired PSTA Elev (ft)	PSTA Seepage (CFS)	Target PSTA Outflow (CFS)	PSTA Output Stoplogs One Test Cell Elev (ft NGVD)			Potential PSTA Outflow (CFS)	Nominal HRT (days)	HLR (ft/day)	HLR (cm/day)
1	1.7	18.05	18.00	18.00	18.00	0.5	16.75	1.00	0.68	16.75	16.75	16.75	0.72	20.9	0.024	0.7
2	4.2	18.12	18.00	18.00	18.00	0.5	16.75	1.00	3.24	16.75	16.75	16.75	3.24	8.3	0.060	1.8
3	1.7	18.05	18.00	18.00	18.00	0.5	16.75	1.00	0.68	16.75	16.75	16.75	0.72	20.9	0.024	0.7
4	3.8	18.11	18.00	18.00	18.00	0.5	16.75	1.00	2.77	16.75	16.75	16.75	2.79	9.3	0.054	1.6
5	4.2	18.12	18.00	18.00	18.00	1	17.25	2.00	2.24	17.25	17.25	17.25	2.25	16.6	0.060	1.8
6a	25.0	18.35	17.00	17.00	17.00	2	18.25	4.00	21.00	18.00	18.00	18.00	20.97	5.6	0.355	10.8
6	2.7	18.09	18.00	18.00	18.00	0.5	16.75	1.00	1.67	16.75	16.75	16.75	1.71	13.1	0.038	1.2
7	5.6	18.15	18.00	18.00	18.00	1	17.25	2.00	3.61	17.25	17.25	17.25	3.60	12.5	0.080	2.4
8	4.4	18.12	18.00	18.00	18.00	0.5	16.75	1.00	3.38	16.75	16.75	16.75	3.42	8.0	0.062	1.9
9	4.0	18.12	18.00	18.00	18.00	0.5	16.75	1.00	3.01	16.75	16.75	16.75	2.97	8.8	0.057	1.7
10	5.0	18.13	18.00	18.00	18.00	1	17.25	2.00	3.00	17.25	17.25	17.25	2.97	14.1	0.071	2.2
11	4.1	18.12	18.00	18.00	18.00	1	17.25	2.00	2.07	17.25	17.25	17.25	2.07	17.3	0.058	1.8
12	10.7	18.23	18.00	18.00	18.00	1	17.25	2.00	8.70	17.25	17.25	17.25	8.73	6.6	0.152	4.6
13	5.1	18.13	18.00	18.00	18.00	1	17.25	2.00	3.05	17.25	17.25	17.25	3.06	13.9	0.072	2.2
14	9.6	18.21	18.00	18.00	18.00	0.5	16.75	1.00	8.61	16.75	16.75	16.75	8.64	3.7	0.137	4.2
15	3.8	18.11	18.00	18.00	18.00	0.5	16.75	1.00	2.76	16.75	16.75	16.75	2.79	9.4	0.053	1.6
16a	25.0	19.08	12.00	12.00	12.00	2.75	19.00	5.00	20.00	18.75	18.75	18.75	19.98	7.7	0.355	10.8
16	3.5	18.10	18.00	18.00	18.00	0.5	16.75	1.00	2.53	16.75	16.75	16.75	2.52	10.0	0.050	1.5
17	2.3	18.07	18.00	18.00	18.00	0.5	16.75	1.00	1.32	16.75	16.75	16.75	1.35	15.2	0.033	1.0
18	3.8	18.11	18.00	18.00	18.00	1	17.25	2.00	1.83	17.25	17.25	17.25	1.80	18.4	0.054	1.7
19	4.3	18.12	18.00	18.00	18.00	1	17.25	2.00	2.31	17.25	17.25	17.25	2.34	16.3	0.061	1.9
20	3.3	18.10	18.00	18.00	18.00	1	17.25	2.00	1.27	17.25	17.25	17.25	1.26	21.5	0.046	1.4

Week	Target PSTA Inflow (CFS)	SAV Cell Water Elevation (NGVD ft)	PSTA Input Stoplogs One Test Cell Elev (Ft NGVD)			Desired PSTA Depth (ft)	Desired PSTA Elev (ft)	PSTA Seepage (CFS)	Target PSTA Outflow (CFS)	PSTA Output Stoplogs One Test Cell Elev (ft NGVD)			Potential PSTA Outflow (CFS)	Nominal HRT (days)	HLR (ft/day)	HLR (cm/day)
21	12.4	18.26	18.00	18.00	18.00	1.5	17.75	3.00	9.40	17.75	17.75	17.75	9.36	8.5	0.176	5.4
22	12.0	18.25	18.00	18.00	18.00	1.5	17.75	3.00	8.99	17.75	17.75	17.75	9.36	8.8	0.171	5.2
23	9.0	18.21	18.00	18.00	18.00	1.5	17.75	3.00	5.97	17.75	17.75	17.75	5.94	11.8	0.127	3.9
24	19.9	18.36	17.50	18.00	18.50	1.5	17.75	3.00	16.85	17.50	17.50	17.50	16.83	5.3	0.282	8.6
25	14.0	18.28	17.00	17.00	17.00	1.5	17.75	3.00	10.97	17.50	17.50	17.50	10.98	7.6	0.199	6.1
26	13.4	18.28	17.00	17.00	17.00	1.5	17.75	3.00	10.41	17.50	17.50	17.50	9.90	7.9	0.191	5.8
27	11.3	18.25	18.00	18.00	18.00	1	17.25	2.00	9.33	17.25	17.25	17.25	9.36	6.2	0.161	4.9
28	11.6	18.25	18.00	18.00	18.00	1	17.25	2.00	9.58	17.00	17.00	17.00	9.36	6.1	0.165	5.0
29	14.9	18.29	18.00	18.00	18.00	1.5	17.75	3.00	11.95	17.50	17.50	17.50	12.06	7.1	0.213	6.5
30	11.7	18.31	17.00	17.00	17.00	2	18.25	4.00	7.69	18.25	18.25	18.25	7.65	12.0	0.166	5.1
31a	55.0	19.16	12.00	12.00	12.00	2.75	19	5.00	50.00	18.50	18.50	18.50	50.00	3.5	0.782	23.8
31	14.6	18.29	18.00	18.00	18.00	1	17.25	2.00	12.60	17.00	17.00	17.00	12.60	4.8	0.208	6.3
32	7.0	18.17	18.00	18.00	18.00	0.5	16.75	1.00	6.05	16.75	16.75	16.75	6.03	5.0	0.100	3.1
33a	55.0	19.16	12.00	12.00	12.00	2.75	19	5.00	50.00	18.50	18.50	18.50	50.00	3.5	0.782	23.8
33	8.0	18.19	18.00	18.00	18.00	1	17.25	2.00	6.03	17.25	17.25	17.25	6.03	8.8	0.114	3.5
34	15.8	18.31	18.00	18.00	18.00	1.5	17.75	3.00	12.76	17.50	17.50	17.50	12.78	6.7	0.224	6.8
35	11.3	18.25	18.00	18.00	18.00	1.5	17.75	3.00	8.34	17.75	17.75	17.75	8.37	9.3	0.161	4.9
36	11.8	18.31	17.00	17.00	17.00	2	18.25	4.00	7.83	18.25	18.25	18.25	7.83	11.9	0.168	5.1
37	11.8	18.31	17.00	17.00	17.00	2	18.25	4.00	7.85	18.25	18.25	18.25	7.83	11.9	0.168	5.1
38	15.2	18.32	17.00	17.00	17.00	2	18.25	4.00	11.22	18.00	18.00	18.00	11.25	9.2	0.216	6.6
39	12.3	18.26	18.00	18.00	18.00	1.5	17.75	3.00	9.29	17.75	17.75	17.75	9.27	8.6	0.175	5.3
40a	55.0	19.16	12.00	12.00	12.00	2.75	19	5.00	50.00	18.00	18.00	19.00	50.00	3.5	0.782	23.8
40	7.4	18.18	18.00	18.00	18.00	1	17.25	2.00	5.43	17.25	17.25	17.25	5.40	9.5	0.106	3.2
41	2.9	18.09	18.00	18.00	18.00	0.5	16.75	1.00	1.93	16.75	16.75	16.75	1.89	12.0	0.042	1.3

Week	Target PSTA Inflow (CFS)	SAV Cell Water Elevation (NGVD ft)	PSTA Input Stoplogs One Test Cell Elev (Ft NGVD)			Desired PSTA Depth (ft)	Desired PSTA Elev (ft)	PSTA Seepage (CFS)	Target PSTA Outflow (CFS)	PSTA Output Stoplogs One Test Cell Elev (ft NGVD)			Potential PSTA Outflow (CFS)	Nominal HRT (days)	HLR (ft/day)	HLR (cm/day)
42	9.0	18.21	18.00	18.00	18.00	0.5	16.75	1.00	7.98	16.75	16.75	16.75	8.01	3.9	0.128	3.9
43	7.6	18.18	18.00	18.00	18.00	1	17.25	2.00	5.65	17.25	17.25	17.25	5.67	9.2	0.109	3.3
44	11.2	18.25	18.00	18.00	18.00	1	17.25	2.00	9.16	17.25	17.25	17.25	9.18	6.3	0.159	4.8
45	12.2	18.31	17.00	17.00	17.00	2	18.25	4.00	8.21	18.25	18.25	18.25	8.19	11.5	0.174	5.3
46	8.0	18.19	18.00	18.00	18.00	1.5	17.75	3.00	5.03	17.75	17.75	17.75	5.04	13.1	0.114	3.5
47	4.4	18.12	18.00	18.00	18.00	1	17.25	2.00	2.39	17.25	17.25	17.25	2.43	16.0	0.062	1.9
48	4.9	18.13	18.00	18.00	18.00	0.5	16.75	1.00	3.94	16.75	16.75	16.75	3.96	7.1	0.070	2.1
49	2.4	18.08	18.00	18.00	18.00	0.5	16.75	1.00	1.40	16.75	16.75	16.75	1.44	14.7	0.034	1.0
50a	25.0	18.17	17.75	17.75	17.75	1.5	17.75	3.00	22.00	17.50	17.50	17.50	21.96	4.2	0.355	10.8
50	1.7	18.05	18.00	18.00	18.00	0.5	16.75	1.00	0.70	16.75	16.75	16.75	1.71	20.7	0.024	0.7
51	2.9	18.09	18.00	18.00	18.00	0.5	16.75	1.00	1.92	16.75	16.75	16.75	1.89	12.1	0.041	1.3
52	2.6	18.08	18.00	18.00	18.00	0.5	16.75	1.00	1.55	16.75	16.75	16.75	1.53	13.8	0.036	1.1
53	3.0	18.09	18.00	18.00	18.00	0.5	16.75	1.00	2.03	16.75	16.75	16.75	2.07	11.6	0.043	1.3

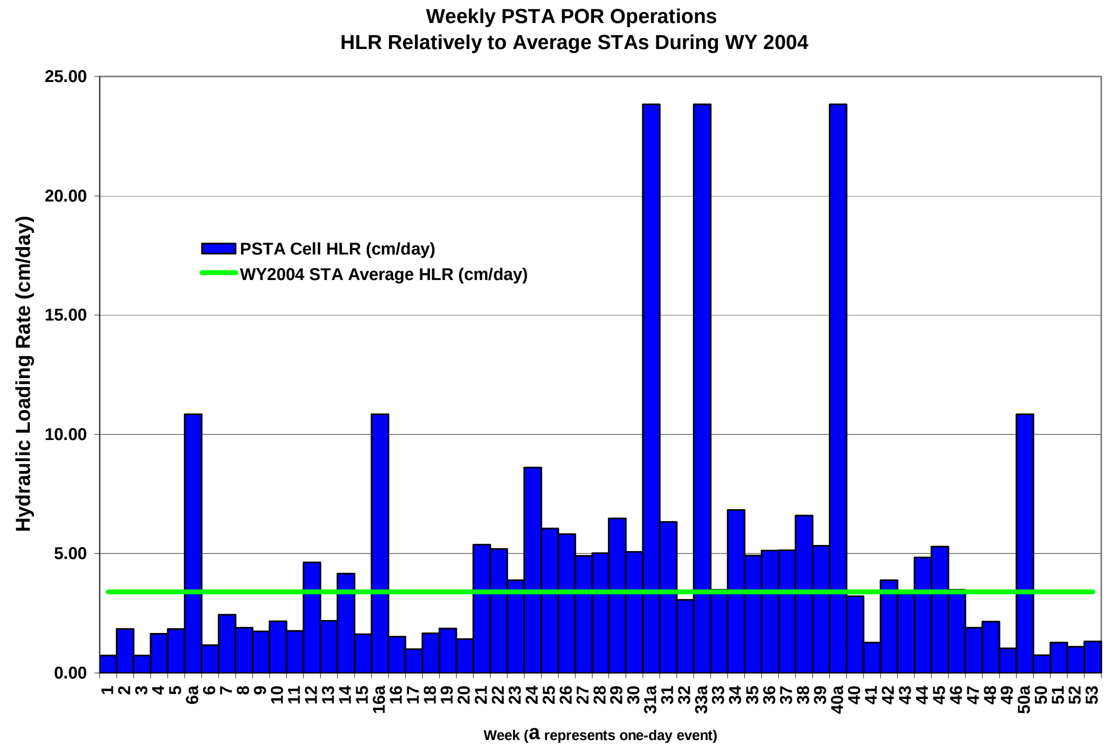


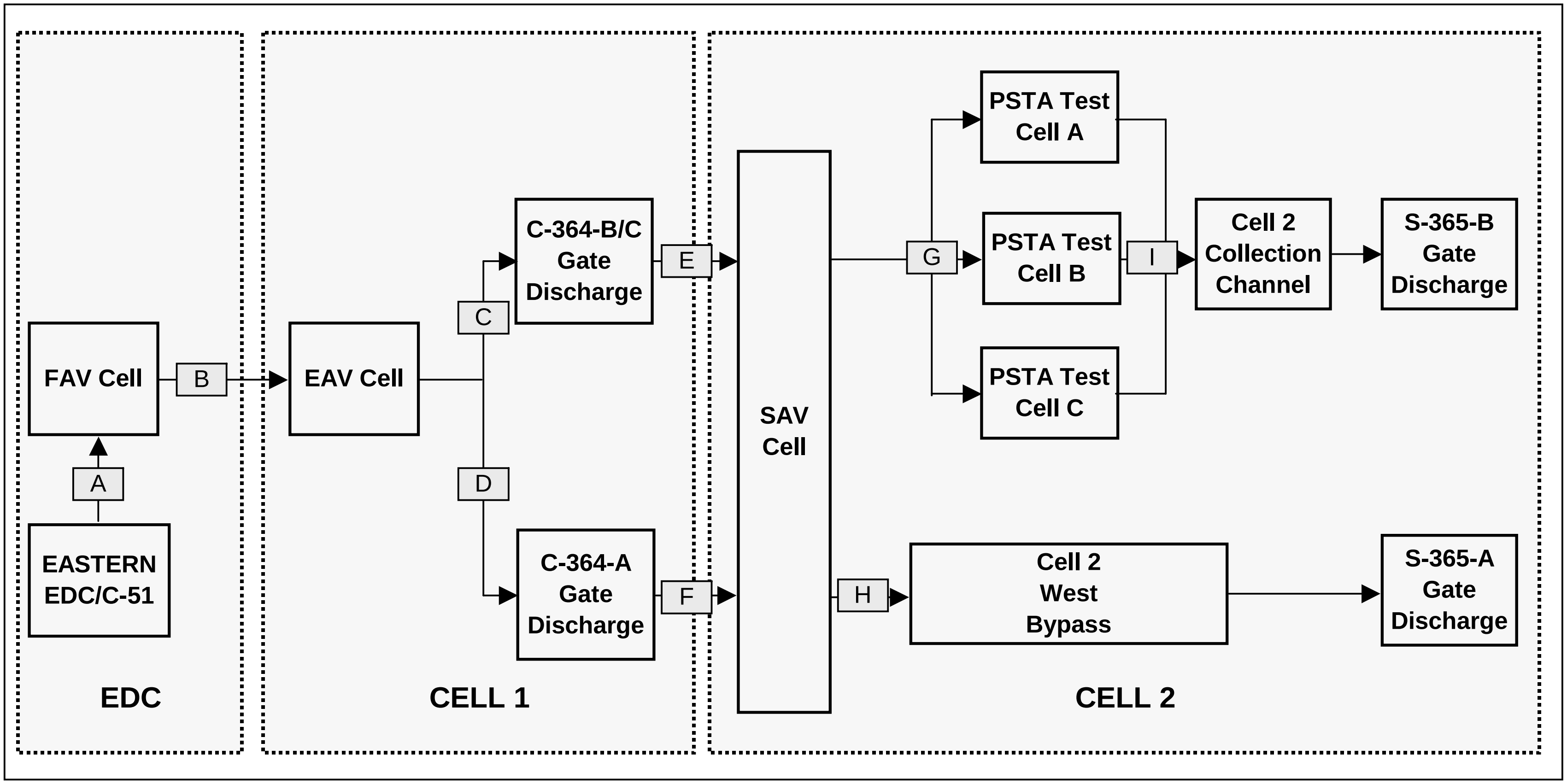
Figure 3.7. Average WY2004 South Florida STA HLR and proposed HLRs for PSTA Cells

3.6 EXTREME CONDITIONS OPERATIONS

PSTA cells will be operated under extreme conditions with maximum input flow of 55.0 CFS, maximum HLR of 23.8 cm/day, maximum output depth of 2.75 ft, and minimum HRT of 3.5 days for a period of 7 days. This operational condition will cause a situation that would not have occurred naturally during either the 10 or 31 year PORs. However, the purpose of this condition will be to examine PSTA behavior under flood situations.

3.7 SUMMARY OF OPERATIONS

The treatment train operations can be summarized in the following process flow diagram shown in Figure 3.8.



Location	Approximate Flow Range (cfs)		Approximate TP Range (ppb)	
	Minimum	Maximum	Minimum	Maximum
A	<19	>55	<214	214
B	<19	>55	50	71
C	<19	>55	30	35
D	<19	>55	30	35
E	<19	>55	30	35
F	0	55	30	35
G	<19	>55	30	35
H	0	55	30	35
I	<19	>55	<10	10

Figure 3.8 Process Flow Diagram for PSTA Demonstration Treatment Train

4 PARTNERING WITH SFWMD

Continued collaboration between USACE and the SFWMD will be one of the keys to successful operations of the PSTA Field-Scale Demonstration. SFWMD expertise in operations and advice in operation of the STAs will be a valuable asset to the USACE in its work with the PSTA treatment train. Moreover, the SFWMD will continue to operate all of the existing S-363, S-364 and S-365 structures. The USACE will be relying on SFWMD's cooperation and commitment to the success of PSTA to operate the structures as the demonstration operations require. In addition, the USACE will be counting on the SFWMD to assist with maintaining water elevation in the FAV portion of the EDC to no less than 18.25 ft, and increase as needed, to keep structures S-364 B and C closed for PSTA Demonstration duration, and work together to establishing the criteria for and notification of expected flood conditions and planned operations. In the future, the USACE would like to have its contractor operating the PSTA demonstration to participate in the USACE/SFWMD/DOI weather response conference calls during which the parties decide if and when to respond to developing storm conditions.

The process of collaboration has already begun, as the parties on August 3 of 2005 at the STA-1E site to discuss the PSTA Demonstration needs.

5 MONITORING OVERVIEW

It is anticipated that there will be 12 monitoring points necessary for the operation of the EDC, Cell 1, and Cell 2 treatment train. These locations can be found in **Figure 5.1**. The parameters to be measured and their frequency of collection can be found in Table 5.1. The parameters to be measured are a combination of parameters necessary to fulfill permit requirements and provide information requested by the LNWR staff. The locations of the designated points were chosen primarily for the need to fulfill permit requirements and compliance monitoring. It has been assumed that the permits will require influent and effluent measurements and that for the PSTA cells that an intermediate point in the channels should be measured to determine variation in the designated parameters that may occur in the application of this Phase 2 treatment technology.

The anticipated parameters and the frequency of measurement have also been selected based on the need to fulfill permit and compliance requirements. In addition additional parameters such as Calcium, Total Nitrogen, Total Organic Carbon, Conductivity, pH, and Alkalinity have been added to address the concerns of the LNWR staff scientists. Other parameters associated with the YSI measurements are included as they are part of the standard package of parameters supplied with the probes.

These parameters along with additional parameters and sampling points will be supplied in greater detail as part of the Monitoring Plan.

Table 5.1 Operations Plan Monitoring Parameters Necessary for Compliance with NPDES and FDEP Permit Requirements

CONTINUOUS PARAMETERS	
Stage Recorders with Data Logging	
Stage/depth	hourly
Physiochemical Measurements	
Temperature	hourly
pH	hourly
Dissolved oxygen	hourly
Conductivity	hourly
Turbidity	hourly
Color	hourly
Surface Water Auto Samplers	
Total Phosphorus	weekly composites and diel discrete samples
INTERMITTENT PARAMETERS	
Grab Samples	
Total Phosphorus	weekly
Total Nitrogen	weekly
Total Organic Carbon	weekly
Total Suspended Solids	weekly
Alkalinity	weekly
Calcium	monthly
Total Mercury	as required
Methyl Mercury	as required

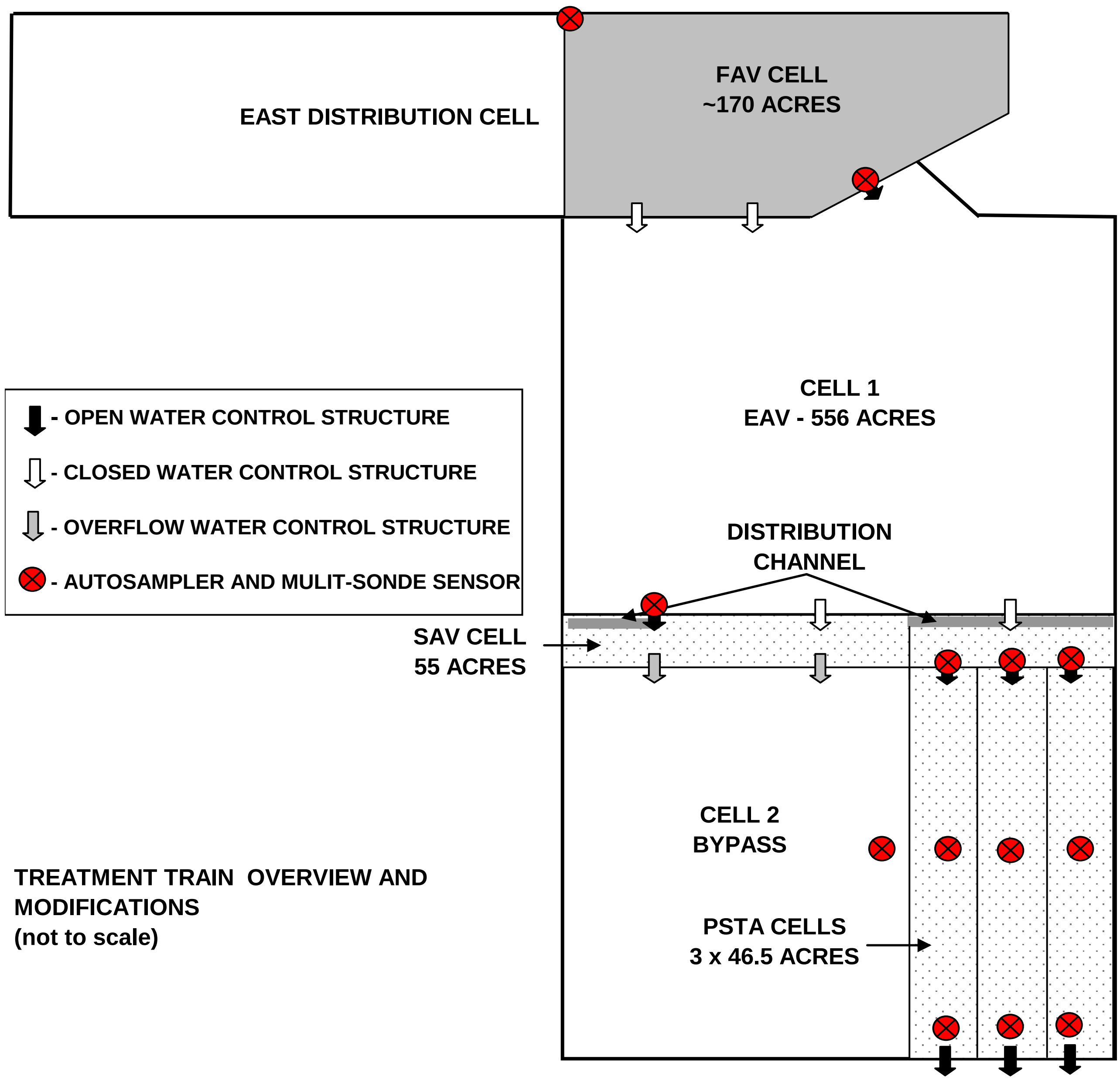


Figure 5.1. Monitoring Point Locations

6 MAINTENANCE REQUIREMENTS

This section provides an overview of the maintenance activities required during the operation the PSTA Demonstration Cells and the treatment train preceding it. Maintenance activities associated with monitoring will be addressed within the monitoring plan. Activities are arranged those specific to a treatment train component and then by items that can be addressed universally.

East Distribution Cell FAV Cell

FAV Cell Pumps: The specifications for the three 30 CFS pumps have yet to be developed. It is recommended that these pumps be maintained to manufactures specifications and started bi-weekly to ensure that they are in working order.

Emergent Vegetation: Herbicide might be required if emergent vegetation has recolonized the cell to the degree that it is excluding *Pistia stratiotes* from significant portions of the cell.

FAV Levee: Inspection of FAV levee should be conducted when: 1) a significant head difference exists between the FAV Cell and the EDC, 2) water surface elevations exceed 20 ft NGVD, 3) monthly.

Cell 1 EAV Cell

Maintenance activities beyond coordination with SFWMD are not envisioned within this cell.

Cell 2 SAV Cell

Vegetation Control: Use of contact herbicide might be required within the SAV Cell if a significant coverage/density of FAV species, *Brachiara mutica*, *Panicum sp.*, or *Typha sp.* colonize the cell. A similar approach to *Stormwater Treatment Area 1E Vegetation Management Plan* (Serbesoff-King 2004).

Cell 2 PSTA Cells

In-Line Weir Riser: Inspect stop logs for warping that could cause excessive leakage. Visually inspect gasketed joints for failure on a weekly basis and more frequently when a large head difference exists between SAV and PSTA cells. Visually inspect weir inputs for obstructions and clear if required.

PSTA Cell Levees: Visually inspect levees for failure of sloughing on a weekly basis. Additional inspections are required during times of high water surface elevations (greater than 18.25 NGVD) or after incidences of high winds.

Vegetation Control: It is anticipated that the PSTA cells will be populated with sparse EAV and SAV marsh species that are adapted to low water and soil TP concentrations. In addition, the high calcium carbonate content of the demonstration project substrates should ensure that only EAV and SAV species that can compete with the periphyton mat will be the long term successors. However, due to the presence of a seed bank in the soils being covered by the three test substrates and the presence of undesirable species such as *Typha sp., Pistia sp.,* and *Panicum sp.* in adjacent cells and on the levees that it may be necessary to use contact herbicides to eliminate these species as they could decrease the performance of the PSTA cells. Although the STA-1E Vegetation Management Plan prepared by the SFWMD does not address PSTA directly, it is believed that the same undesirable species presented in Table 7 of that document for SAV will be identical to that of PSTA (Serbesoff-King 2004)

STA 1-E Levees

Coordinate with SFWMD regarding levee maintenance and vegetation control.

STA 1-E Structures

Coordinate with SFWMD regarding structure maintenance and status.

7 HEALTH AND SAFETY

A project specific Safety and Health Plan will be developed as prior to initiation of field operations activities. It will sets forth the basic procedures required to protect SAIC and subcontractor personnel involved in the field phase of this project. The SHP will establish practices to protect the public and the immediate environment from hazards, if any, caused by this work. SAIC's formal policy, stated in the Environmental Compliance and Health and Safety Program, is to take every reasonable precaution to protect the health and safety of SAIC employees, the public, and the environment. SAIC personnel and subcontractors will be required to review this plan prior to on-site project participation. SAIC subcontractors are further required to verify that the hazard controls contained in this plan are sufficient to protect their employees, and if not, to supplement this plan with additional and sufficient controls. Standard procedures will be used to minimize the potential for personnel injury or illness. These will include on-site training, routine inspections, visual and instrument surveillance for hazards, and enforcement of the health and safety requirements by project management.

This document is designed to satisfy the requirements of EM 385-1-1, *U.S. Army Corps of Engineers Safety and Health Requirements Manual*, relevant Occupational Safety and Health Administration regulations and the SAIC Environmental Compliance and Health and Safety Manual.

8 STRUCTURE DESCRIPTIONS

Weir Structures

This section describes the in-line weir risers controlling the flow of water through the PSTA Cells and Cell 2 Bypass. A total of 26 in-line weir risers exist within Cell 2. Eighteen of these weirs provide for flow in and out of the PSTA Cells and have 36 in. culverts on each side of the weir, see **Figure 8.1**. The remaining eight weirs allow for flow into the Cell 2 Bypass and are served by 48 in. culverts. The operations of these structures are identical except for the greater flow capacity of the Cell 2 bypass culverts and are described jointly in the remainder of this section unless otherwise noted.

Flow through these structures is controlled by head/tail-water elevations and weir elevations. Weir elevation is controlled by the number of 6 in stop logs within each structure. Access to the stop logs is gained through the top of the 48 in. weir risers which are located on the upstream side of the levee 2 ft from the flat drivable surface of the levee. Removal of plywood cover overlaying the riser will provide access to the stop logs via a 10 ft long hook which is kept within the riser structure. The structures allow for the weir to be adjusted from 12 to 21 ft NGVD. Water flowing from these structures is discharged into either existing or project-related distribution canals via a culvert bottom elevation of 12 ft NGVD.

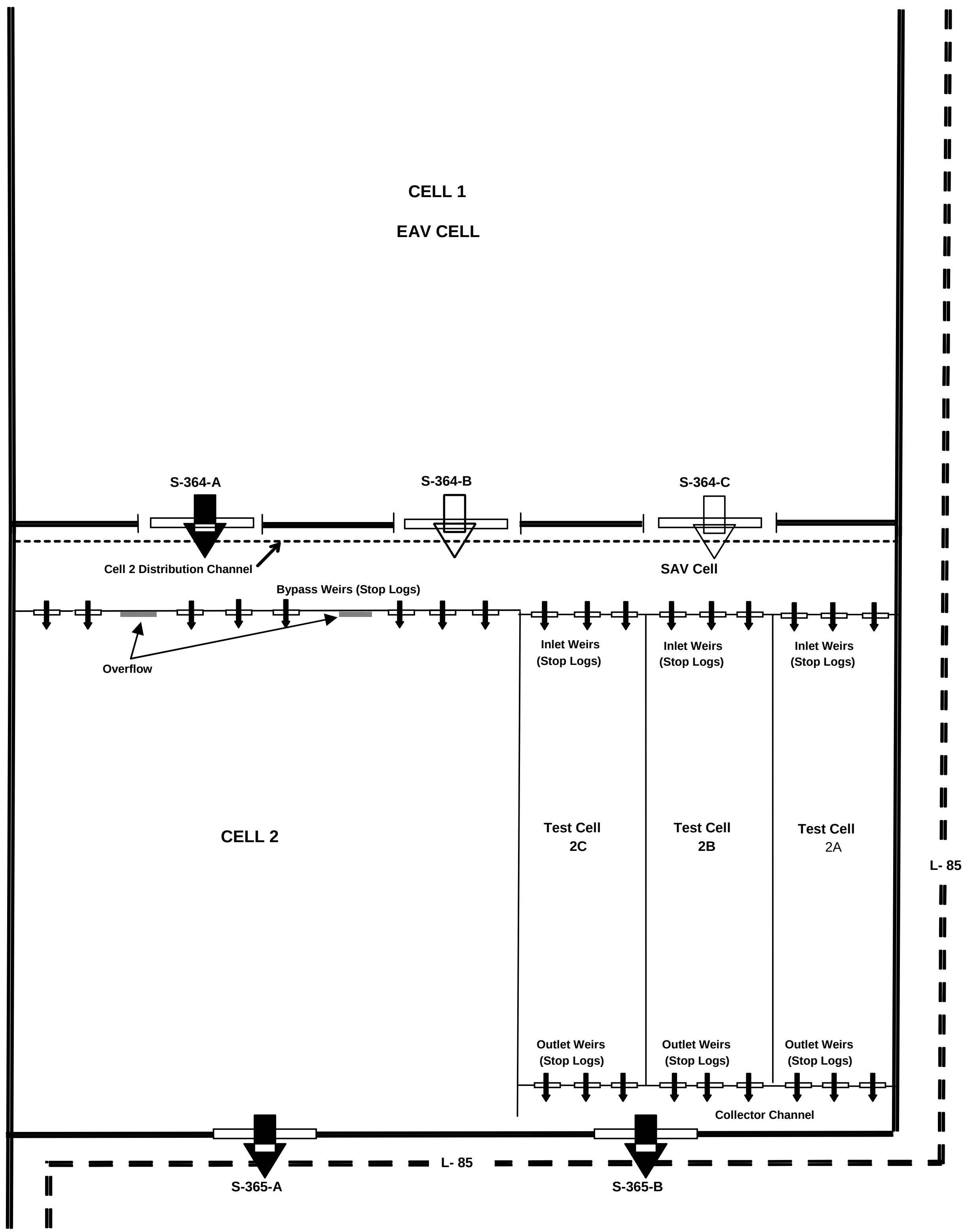


Figure 8.1 Cell 2 Weirs and Stop Log Structures

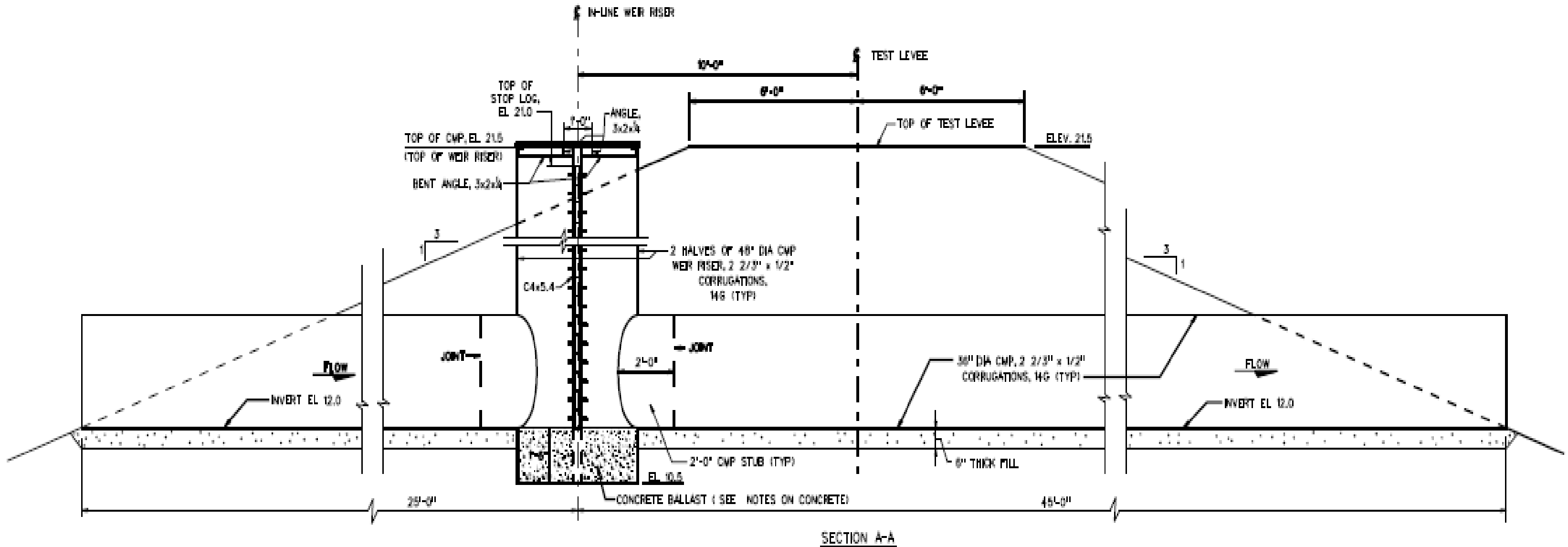


Figure 8.2 Cross Section of PSTA Cell In Line Riser

Acronyms

CFS	cubic feet per second
DMSTA	Dynamic Model for Stormwater Treatment Areas
HLR	hydraulic loading rate
HRT	hydraulic residence time
LNWR	Loxahatchee National Wildlife Refuge
POR	Period of Record
PPB	parts per billion
PSTA	periphyton stormwater treatment area
SAV	submerged aquatic vegetation
SFWMD	South Florida Water Management District
STA	stormwater treatment area
STA-1E	Stormwater Treatment Area 1-East
TP	total phosphorus
USACE	U.S. Army Corps of Engineers
WCA	Water Conservation Area

References

SAIC 2005, Design Analysis Report

Serbesoff-King 2004. Stormwater Treatment Area 1E Vegetation Management Plan, June 23, 2004

Burns & McDonnell 2000. *Stormwater Treatment Area No. 1 East Period of Record Dry-Out Analysis*, U.S. Army Corps of Engineers, Jacksonville District, 99-822-1-001, March.

SFWMD, 2005. *South Florida Environmental Report 2005.*

APPENDIX A

OPERATIONS SUMMARY SCHEDULE

24 MONTHS PSTA DEMONSTRATION CELL OPERATIONS SCHEDULE

ALL SCENARIOS ASSUME COE CONTROL OF CELLS 1 AND 2 AND THAT THE REMAINDER OF CELL 2 WILL BE USED ONLY TO LIMIT SEEPAGE INTO AND OUT OF THE DEMONSTRATION CELLS, AND IF POSSIBLE TO OPTIMIZE CELL 1 (EAV) TP REMOVAL

A. 0-0.5 months – flood all cells to 2.0 ft with no outflow and input Q necessary to maintain depth to remove non wetland emergent vegetation.

B. 0.5-1.0 months – drain cells to a 6 inch ponding depth with no outflow and an input Q necessary to sustain this depth

C. 1.0-1.5 months – dry out all cells and allow them to remain dry for 0.5 months.

D. 1.5-2.0 months – flood all cells over a 0.5 month period to an operational depth of 0.5 ft.

E. 2.0-3.0 months – operate all cells for 1.0 months at 0.5 ft and a 14 day HRT.

F. 3.0-3.5 months – dry out all cells and allow them to remain dry for 0.5 months.

G. 3.5-5.5 months – repeat steps D-F.

H. 5.5-6.0 months – flood all cells over a 0.5 month period to an operational depth of 0.5 ft.

I. 6.0-6.5 months – operate cells at 0.5 ft and a 14 day HRT.

J. 6.5-7.0 months – flood all cells over a 0.5 month period to an operational depth of 1.0 ft.

K. 7.0-8.0 months – operate cells at 1.0 ft and a 14 day HRT.

L. 8.0-9.0 months – operate cells at 1.0 ft and a 7 day HRT.

M. 9.0-9.25 months – raise depth of cells to 2.0 ft maintaining a 7 day HRT.

N. 9.25-10.0 months – operate cells at 2.0 ft and a 7 day HRT.

O. 10.0-22.0 months (12 months) – POR operations (see Figure 3.1 and Table 3.1).

P. 22.0-2.25 months – pulse cell with an input Q equivalent of a 3.5 day HRT for 7 days and increase depth to 2.75 ft.

Q. 22.25-22.75 months – return Q to that necessary for a 7 day HRT and allow the depth to return to 2.0 ft.

R. 22.75- 24.0 months – return Q to that necessary for a 14 day HRT and allow the depth to return to 1.0 ft.

APPENDIX B

SFWMD VEGETATION CONTROL PLAN

Stormwater Treatment Area 1E
Vegetation Management Plan
June 23, 2004
Prepared by Kristina Serbesoff-King

I. INTRODUCTION

The development and successful management of vegetation plays an important role in optimizing the phosphorous reduction abilities of stormwater treatment areas (STA). The objectives of this vegetation management plan (hereafter referred to as this Plan) are to provide the methods and schedules required to successfully and cost effectively maintain the desired vegetation communities within STA-1E, as prescribed in the *Everglades Protection Project, Conceptual Design*, 1994 (1994 Conceptual Design) and in the *Everglades Protection Area Tributary Basins, Long-Term Plan for Achieving Water Quality Goals*, 2003 (Long-Term Plan).

STA-1E is a dynamic system, subject to natural variation in rainfall, hydraulic and nutrient loading, inflow water quality, seepage and interior vegetative conditions. With such a varying natural system, it is impossible to determine all possible scenarios and factors influencing operation. As a result, this Plan is only intended to provide the general strategy for establishing and maintaining target vegetation in STA-1E. It is imperative that this Plan have built in operational flexibility to allow for needed adjustments and refinements as STA operation commences. The SFWMD will operate and maintain STA-1E in accordance with the final operation plan and this Plan. SFWMD will confer with the USACE regarding any major variations to the plans necessary to meet the goals of STA-1E.

This Plan also recognizes that operation may fluctuate outside of the optimal range for targeted vegetation communities with the treatment cells. For example, extreme storm events could result in inflows to the STA which exceed the system's hydraulic and treatment capacity and may result in excessive depths within treatment cells designed for emergent mixed marsh. As a result, this Plan, the STA-1E Operation Plan and the Pollution Prevention Plan describe measures that may be taken by operators to minimize potential adverse impacts to the targeted vegetative communities under adverse circumstances.

II. BACKGROUND

A. STA-1E

The Everglades Forever Act (EFA) enacted by the Florida Legislature in April 1994, identified that the United States Government, acting through the United

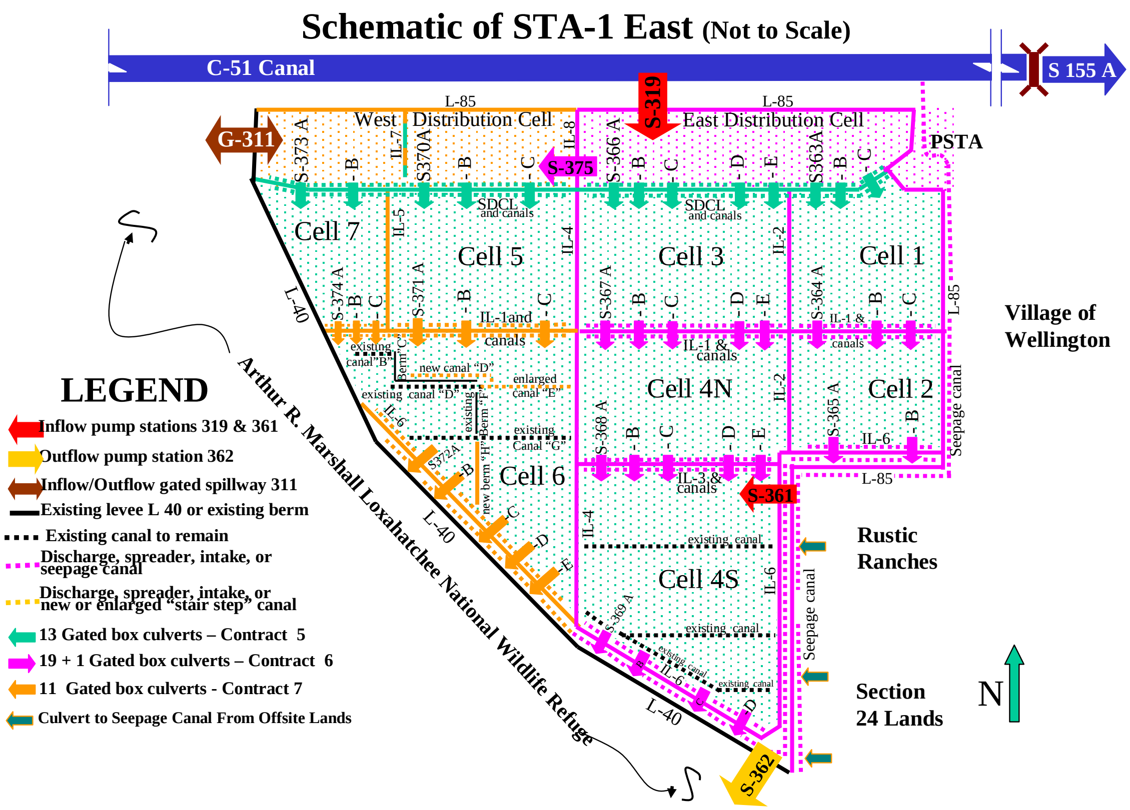
States Army Corps of Engineers (USACE), would construct Stormwater Treatment Area No 1 East (STA-1E) in conjunction with the currently authorized C-51 Flood Control Project, by July 1, 2002. Congress authorized Federal participation in the design and construction of STA-1E in Section 315 of Public Law 104–303, dated October 31, 1996 (the Water Resource Development Act of 1996). That authorized legislation directed the USACE to complete STA-1E in general conformance with the design intent of the Everglades Forever Act and the Conceptual Design of the Everglades Protection Project, completed by Burns & McDonnell on February 15, 1994.

STA-1E is located in Palm Beach County, immediately south of the C-51 Canal and northeast of Water Conservation Area No. 1 (the Arthur R. Marshall Loxahatchee National Wildlife Refuge), outside of the Everglades Agricultural Area. STA-1E is intended to improve the quality of waters discharged to the Everglades Protection Area from the C-51 West basin, together with lesser inflows from other interconnected hydrologic basins.

STA-1E is designed to provide a total effective treatment area of 5,132 acres for stormwater runoff. The eastern and western distribution cells, approximately 1,046 acres in size, although not specifically designed as effective treatment area, will provide some level of additional water quality treatment. The total area of STA-1E including levees and interior canals is approximately 6500 acres. A more detailed description of the operation of this facility can be found in the Operation Plan for STA-1E.

The overall treatment area (**Figure 1**) is divided into eight cells forming four parallel flow paths. The general direction of flow in each path is from north to south. Those flow paths are preceded by two distribution cells, which receive inflows from Pump Station S-319. When discharges at the existing S-5A pumping station exceed the hydraulic capacity of STA-1E, the excess flows can be diverted to WCA-1 through structure G-311 or partially to the east through structure S-155A. The distribution cells run the entire length of the northern portion of STA-1E, and are bounded by C-51 on the north, existing Levee 40 on the west, Flying Cow Road on the east, and Cells 1,3,5, and 7 on the south.

Figure 1. STA-1E Treatment Cell Locations.



B. Prior Land Use

Prior land uses within the STA-1E boundary included various agricultural activities including sugar cane, vegetable or row crops, citrus grove farming, small scale nurseries and homesteads (**Appendix 1**). The Macklen parcel (280 ac.) was operated as a citrus grove and ceased operations in 2000. The McArthur Davis parcel (1,463 ac.) was historically used for vegetable crops with the northern section being operated up until 1999 and the southern section having been abandoned for some time and overgrown with vegetation. The John B. Kennelly parcel (824 ac.) was used to grow citrus up until 1999. The South Florida Industries parcel (935.8 ac.) was used up until 1999 as a satellite farm for the cultivation of sugar cane. The Mayo and Associates (aka FDIC) parcel (900 ac.) was also used as a satellite farm for the cultivation of sugar cane and ceased operations in 1996. The Daystar/Camero Farms parcel (992 ac.) was actively being used for the cultivation of sugar cane up until the property was turned over for construction of STA-1E. The Busbee and Wilkins parcel (816 ac.) was utilized as citrus grove up to 1999. The remaining parcels (Doug Mills, Grove owners Co-op, Palm Beach County, and Bobby Reagan) were used for small nurseries, green houses, citrus and homesteads.

C. Present Land Use

All sections of STA-1E now exist as fallow agricultural fields and/or regenerating wetland areas. Substantial re-contouring of these fallow fields during STA construction has left much of the soil disturbed. This intensive soil disturbance has likely altered the seed bank and soil chemistry in many areas. As a result, much of the vegetation profile is composed of ruderal upland species. The eastern cells, Cells 1, 2, 3, 4N and 5 are primarily composed of mineral (sand) soils, while the western cells, Cells 4S, 6 and 7 are primarily organic (muck) soils.

Existing vegetation coverage is variable within the STA, but is generally composed of dogfennel (*Eupatorium capillifolium*), paragrass (*Brachiaria mutica*), Bermuda grass (*Cynodon dactylon*), sugarcane (*Saccharum* cultivars), cattail (*Typha spp.*) and other mixed upland herbaceous species. Ground elevations generally decline from the northeast to the southwest. resulting in increased dominance of wetland emergent vegetation in the southwestern cells. Cell 6 is currently dominated by cattail and other emergent wetland macrophytes. The eastern cells are dominated by upland species but contain scattered wetland vegetation growing in low depressions. Remnant sugarcane from abandoned fields is most prevalent in the distribution cells and the northwestern treatment cells

III. VEGETATION MANAGEMENT PLAN

A. Overview of Plan Objectives

The objective of this plan is to provide a flexible planning document for implementation of a comprehensive vegetation management program in STA-1E. The following sections provide information for the establishment of desirable vegetation in each treatment cell of STA-1E as well as a normal operations maintenance plan for each of these cells. Timelines for establishment phase and normal operations maintenance events are outlined. Due to construction delays and other unplanned events, actual dates for these events may be shifted. It is important to maintain the timing of vegetation management events in relation to the expected date of initial flooding.

It is imperative that vegetation management staff and STA site managers plan joint site visits followed with management discussions on a routine basis to ensure open communication and coordination of available resources to achieve long-term maintenance success in STA-1E. Operational flexibility in all STAs is key to successful desirable vegetation maintenance.

Detailed information regarding the establishment phase for this Plan is included in Section B – Startup/Implementation Phase. Information on the normal operations maintenance phase is included in Section C – Management and Maintenance Practices during Normal Operations.

B. Startup/Implementation Phase

1. Establishment Phase Events

The vegetation management strategies for this Plan were established to meet the following goals: 1) establish emergent marsh vegetation within Cells 1, 3, 5, and 7 and 2) establish SAV marsh in Cells 2, 4N, 4S and 6. The tables below identify individual treatment cells and establishment phase vegetation management events (**Table 1**), the tentative schedule during the establishment phase (**Table 2**), and the proposed operational water depths during the establishment phase of the vegetation plan (**Table 3**).

Table 1. Treatment Cells and Vegetation Management Events during Establishment Phase

Cell	Area (Acres)	Existing Vegetation	Target Vegetation	Treatment Methodology
1	556	Mixed old field vegetation with scattered areas of wetland species[1]	Emergent	1) Herbicide undesirable vegetation[2] if necessary 2) Flood, 3) Maintenance Herbicide[3]
2	552	Mixed old field vegetation with scattered areas of wetland species	SAV	1) Herbicide paragrass and other undesirable vegetation if necessary 2) Flood 3) Maintenance Herbicide[4]
3	589	Mixed old field vegetation with scattered areas of wetland species	Emergent	1) Herbicide undesirable vegetation if necessary 2) Flood, 3) Maintenance Herbicide
4N	645	Mixed old field vegetation with scattered areas of wetland species	SAV	1) Herbicide paragrass and other undesirable vegetation if necessary 2) Flood 3) Maintenance Herbicide
4S	752	Mixed old field vegetation with scattered areas of wetland species	SAV	1) Herbicide paragrass and other undesirable vegetation if necessary 2) Flood 3) Maintenance Herbicide
5	571	Sugarcane, mixed field vegetation	Emergent	1) Herbicide undesirable vegetation if necessary 2) Flood, 3) Maintenance Herbicide
6	1049	Cattail, sugarcane, mixed herbaceous	SAV	1) Herbicide 2) Burn 3) Flood 4) Maintenance Herbicide
7	418	Sugarcane	Emergent	1) Herbicide undesirable vegetation if necessary 2) Flood, 3) Maintenance Herbicide

[1] Dominant vegetation types include: dog fennel, paragrass, cattail, Bermuda grass, caesar weed, milkpea, alligator flag, and day-flower. Other species include: torpedograss, foxtail grass, crowfoot grass, broomsedge, beggartick, Whitehead broom, and Napier grass.

[2] Undesirable vegetation are known to be poor performers at phosphorous removal and interfere with the establishment or maintenance of desirable vegetation.

[3] Maintenance herbicide applications in emergent cells will focus on controlling undesirable species and promotion of desirable emergents.

[4] Maintenance herbicide applications in SAV cells will focus on controlling undesirable emergent and floating aquatic species and promotion of desirable SAV.

Table 2. Tentative Schedule during Establishment Phase				
Cell	**Initial flooding date**	**Vegetation Mgmt. Inspection**	**Vegetation Mgmt. Event**	**Comments**
1	7/21/04	6/1/04	If needed 7/14/04	Burrowing owls present
2	7/21/04	6/1/04	7/14/04	Burrowing owls present, waiting on new elevations from USACE. Possible location for PSTA
3	7/21/04	6/1/04	If needed 7/14/04	Burrowing owls present
4N	7/21/04	6/1/04	7/14/04	Burrowing owls present, possible grading, waiting on new elevations from USACE
4S	7/21/04	6/1/04	7/14/04	Possible location for PSTA, possible grading
5	10/1/04	9/1/04	If needed, 9/15/04	Burrowing owls present, Dependent on completion of grading (assuming 3 months post owl nesting)
6	10/1/04	8/15/04	1) 9/1/04 - herbicide emergents in cell (see plan) 2) 9/15/04 – burn entire cell	Dependent on completion of grading of 5 and/or 7 -if possible, may delay timing of herbicide treatment and burn to occur during dry season (after November 2004)
7	10/1/04	9/1/04	If needed, 9/15/04	Dependent on completion of grading

Table 3. Proposed Cell Stages during Vegetation Establishment Phase

Cell	Design ground elevations (ft NGVD)	Target water levels (ft above ground elev.)	Target Stage[1] (ft NGVD)	Measured At Structure
1	17.00	~1.0'	18.00'	S-364A-C
2	15.75	2.0'	17.75'	S-365A-B
3	15.00	~1.0'	16.00'	S-367A-E
4N	14.50	2.0'	16.50'	S-368A-E
4S	12.75	2.0'	14.75	S-369A-D
5	14.00	~1.0'	15.00	S-371A-C
6	11.90	2.0'	13.90	S-372A-E
7	12.75	~1.0'	13.75	S-374A-C

[1] Target stages assume a flat pool (static), meaning that the inflow elevation and the outflow elevations are the same during normal operations. Proposed target stages also assume design elevations of all cells. Currently, cells 4N, 4S, 5 and 7 are 0.5 to 1 foot lower.

2. EMERGENT MARSH CONVERSION: CELLS 1, 3, 5 AND 7

Emergent vegetation is a community of plant species that have roots anchored to the bottom of the marsh and leaves that grow up through the water and emerge above the surface. **Table 4** lists the most common desirable emergent vegetation expected to be found in STA-1E. Successful establishment of desirable emergent vegetation will be dependent on various factors including abundance of existing emergent vegetation, relative abundance of undesirable vegetation, and the ability to control water levels. If appropriate environmental conditions exist after initial flooding, emergent vegetation is expected to expand fairly rapidly into the flooded areas. The critical management issues during the initial vegetation establishment period are:

- Ability to maintain minimum water stages following initial inundation
- Control of floating aquatic vegetation
- Ability to manipulate water elevations to promote natural recruitment
- Ability to import desirable emergent vegetation if natural recruitment fails

Pre-treatment Activities

Initial operations within Cells 1 and 3 are expected to begin in mid-July 2004 and within Cells 5 and 7 in the beginning of October 2004 (see **Table 2** above). Cells 1, 3, 5 and 7 are to be managed for the establishment of emergent marsh vegetation. Water levels within these cells are proposed to be held at 1.0' (average depth across cells) during the first several months of inundation. Although it is desirable to hold stages lower during this period of recruitment of emergent vegetation, a higher target elevation is necessary to maintain a minimum average stage of 2.0' in the downstream submerged aquatic vegetation (SAV) cells (Cells 2, 4N, 4S and 6) through a gravity flow system (see SAV Establishment section for details). Once a sufficient period of inundation has passed in the downstream SAV cell, levels in the upstream emergent cell may be lowered such that the average water depth is closer to the optimal depth 0.5'. This lower elevation of surface water is expected to maximize the recruitment rate of emergent species.

Based on preliminary vegetation surveys, Cells 1 and 3 are dominated by dogfennel, paragrass (approximately 15 acres in Cell 1 and 530 acres in Cell 3 based on May 18, 2004 flight), and mixed upland herbaceous cover. Establishment phase vegetation treatments for Cells 1 and 3 will include herbicide treatments, if necessary, for large concentrations of undesirable vegetation prior to the initial flooding of the cells. A vegetation management inspection of undesirable vegetation in Cells 1 and 3 is scheduled for June 1, 2004, with an herbicide treatment for Cells 1 and 3 scheduled for July 14, 2004, if necessary. If it is observed during the June 1, 2004 survey that the upland vegetation has reached a height that rapid decline post flooding is not likely to occur, site managers and vegetation management staff may decide burn, mow or herbicide this upland vegetation.

Preliminary vegetation surveys in Cells 5 and 7 found primarily mixed upland herbaceous cover and some paragrass (approximately 400 acres in Cell 5 and 20 acres in Cell 7 based on May 18, 2004 flight). Establishment phase vegetation treatments for Cells 5 and 7 will include herbicide treatments, if necessary, for large concentrations of undesirable vegetation prior to the initial flooding of the cells. A vegetation management inspection of undesirable vegetation in Cells 5 and 7 is scheduled for September 1, 2004, with an herbicide treatment for Cells 5 and 7 scheduled for September 15, 2004, if necessary. If it is observed during the September 1, 2004 survey that the upland vegetation has reached a height that rapid decline post flooding is not likely to occur, site managers and vegetation management staff may decide burn, mow or herbicide this upland vegetation.

Establishment of Desired Emergent Vegetation

Unlike other STAs, construction of STA-1E has required substantial re-contouring of the land to be used for treatment cells. This construction activity has probably radically disturbed, or even eliminated the native emergent wetland plant seed source that is usually present. In other STAs, this native emergent wetland plant seed source has played a major role in establishing the appropriate, desired treatment cell vegetation. Loss of this seed source through construction activities, coupled with poor plant nutrition levels in the soil could make rapid establishment of appropriate wetland vegetation a challenge.

Manipulations of water levels within Cells 1, 3, 5 and 7 will play an important role in the establishment of desirable emergent vegetation. Periodic drawdowns of water elevations below 0.5 feet during periods of seedling establishment may increase the rate of expansion of many species. Extended periods of deep water (>1.5 feet) during periods of seed germination and/or seedling establishment are likely to decrease recruitment rates within emergent cells. For these reasons, it is critical that plant phenologies (seed dispersal, season of maximal growth, etc.) be considered in management decisions involving stage manipulations. Site managers and vegetation management staff, during establishment phase inspections, should make observations of plant phenologies to assist in vegetation management decisions.

Table 4. Desirable Plants in an Emergent Marsh

Cattail	*Typha* spp.
Sawgrass	*Cladium jamaicens*e
Spikerush	*Eleocharis interstincta*, *E. baldwinii*
Soft rushes	*Juncus* spp. (esp. *J. marginatus*, *J. megacephalus*)
Bulrushes	*Scirpus* spp.(esp. *S. californicus)*
Leather fern	*Acrostichum danaeifolium*
Pickerelweed	*Pontederia cordat*a
Duck potato	*Sagittaria lancifolia*
Switch grass	*Panicum virgatum*,
Panic grasses	*Panicum* spp.
Arrowhead	*Sagittaria latifolia*
Maidencane	*Panicum hemitomon*
Barnyard grass	*Echinochloa* spp.
Flat Sedge	*Cyperus* spp.
Giant reed	*Phragmites australis*
Wax myrtle	*Myrica cerifer*a
Elderberry	*Sambuca canadensi*s
Primrose willow	*Ludwigia* spp.
Smartweed	*Polygonum* spp.
Alligator flag	*Thalia geniculata*

Initial Control of Undesirable Vegetation

Species-level control of vegetation will be in accordance with the desirable and undesirable species listed in **Tables 4 and 5**.

During the startup operational phase, diligent monitoring of vegetation change will be necessary to keep all undesirable species under control. Immediately after initial flooding, vegetation inspections should be conducted bi-weekly to assess growth of both desirable and undesirable species and to assess site conditions. Post-flooding herbicide work will occur based on bi-weekly inspection results.

Scattered patches of torpedograss have been observed in all cells. This non-native grass is an especially invasive plant that can rapidly displace native wetland plant species. This species is a threat both to successful establishment of emergent vegetation as well as SAV. Flooding will not kill torpedograss. However, because no large areas of dense torpedograss have been identified, initial treatment of torpedograss may not be feasible.

Paragrass (*Brachiaria mutica*) has been found throughout the treatment cells in STA-1E. Paragrass is a non-native grass that can aggressively invade wetland systems. At this time, there is no empirical data to conclude whether or not paragrass is efficient at removing phosphorous from the water column. At the time of the writing of this Plan, it has been decided that paragrass will not be treated as an undesirable species in the emergent cells. However, the expansion of paragrass should be evaluated during the routine inspections of this STA by vegetation management staff. STA site managers will follow the effectiveness of phosphorous removal by this STA and coordinate with vegetation management staff on future management of this species.

Table 5. Undesirable Plants in an Emergent Marsh

Water Lettuce	*Pista stratiotes*
Water Hyacinth	*Eichhornia crassipe*s
Torpedograss	*Panicum repen*s
Frogs-bit	*Limnobium spongia*
Old World climbing fern	*Lygodium microphyllum*
Brazilian pepper	*Schinus terebinthifoliu*s
Melaleuca	*Melaleuca quinquenervia*

3. SAV MARSH CONVERSION CELLS 2, 4N, 4S, 6

Submerged aquatic vegetation (SAV) is a community of macrophytic plant species found in the water column but do not emerge above the water surface. These species may be rooted or unrooted to the bottom substrate of the marsh. **Table 6** lists the most common desirable SAV expected to be found in STA-1E. Successful establishment of desirable SAV vegetation will be dependent on various factors including, but not limited to, abundance of SAV propagules, relative abundance of undesirable vegetation, ability to control water levels, abundance of aboveground SAV “anchors”, turbidity, and water quality. If appropriate environmental conditions exist after initial flooding, SAV is expected expand fairly rapidly into the flooded areas. Therefore, the critical management issues during the initial vegetation establishment period are:

- Removal of aggressive emergent vegetation prior to flooding
- Maintenance of high water stages for initial 2-3 month flooding period
- Maintenance of minimum water stages following initial inundation
- Minimization of turbidity levels
- Control of floating aquatic vegetation

- Minimization of nutrient loading during the establishment period
- Ability to import SAV vegetation if natural recruitment is inadequate
- Ability to stabilize SAV vegetation

Pre-treatment Activities

Initial operations within Cells 2, 4N and 4S are expected to begin in mid-July 2004 and within Cell 6 in the beginning of October 2004 (see **Table 2** above). Cells 2, 4N, 4S and 6 will be managed for the establishment of submerged aquatic vegetation (SAV). Water levels within these cells are proposed to be held at 2.0' (average depth across cells) during the first 2-3 months of inundation. This target elevation is necessary in order to drown out existing upland herbaceous vegetation and to encourage establishment of SAV.

Based on preliminary vegetation surveys, Cells 2 and 4S are dominated by upland herbaceous vegetation and some paragrass (approximately 10 acres in Cell 2 and 35 acres in Cell 4S based on May 18, 2004 flight). Preliminary vegetation surveys in Cell 4N found upland herbaceous vegetation, mixed wetland emergent vegetation and large mats of paragrass (approximately 150 acres based on May 18, 2004 flight). Establishment phase vegetation treatments for Cells 2, 4N and 4S will include herbicide treatments of paragrass and, if necessary, other undesirable vegetation prior to the initial flooding of the cells. A vegetation management inspection of undesirable vegetation in Cells 2, 4N and 4S is scheduled for June 1, 2004, with an herbicide treatment for Cells 2, 4N and 4S scheduled for July 14, 2004. If it is observed during the June 1, 2004 survey that the upland vegetation has reached a height that rapid decline post flooding is not likely to occur, site managers and vegetation management staff may decide burn, mow or herbicide this upland vegetation.

Preliminary vegetation surveys of Cell 6 found a mixture of emergent wetland vegetation, sugarcane and paragrass (approximately 315 acres based on May 18, 2004 flight). Establishment phase vegetation treatments for Cell 6 will include herbicide treatments for all emergent vegetation (leaving strips of emergent vegetation along existing perpendicular field ditches where present or as identified by STA site manager) and conducting a prescribed burn of the entire cell prior to the initial flooding of this cell. This method has been successful in other constructed wetlands in removing emergent vegetation (Mark Sees, City of Orlando, *personal communication*). A vegetation management inspection date to survey the condition of Cell 6 is scheduled for August 15, 2004, the herbicide treatment is scheduled for September 1, 2004, and the subsequent burn is scheduled for September 15, 2004. The burn must occur no more than 2 weeks prior to the initial flooding of Cell 6 to avoid re-establishment of the remaining emergent seed-bank.

Pre-treatment activities of Cell 6 will likely result in a flux of released phosphorus in the water column after burning. Considerations for ameliorating this negative effect could include stopping the releases of water from this cell until such time as the downstream phosphorous level water readings have dropped (as measured at structures S-372,A-E) or by delaying the burn until the dry season when offsite discharge from the cell is less likely and internal biological and sedimentation processes can resequester the phosphorous. Nuisance smoke from the prescribed fire may be a concern of nearby residential communities, thereby limiting the timeframes or size of the burn.

Establishment of Desired SAV Vegetation

Some of the interior agricultural field ditches will not be filled during construction. Although some SAV within these ditches will expand into other areas after cell flooding, preliminary field inspections indicate minimal SAV within these ditches. Therefore, inoculation of SAV from donor sites may be necessary to ensure rapid expansion of desirable SAV species.

Previous experience has shown some success in introducing SAV by harvesting vegetation from STA donor sites and placing the harvested material in the new SAV cell. To maximize success of this procedure, it is important to identify appropriate sites for depositing the propagules. Placement of the imported SAV in inappropriate or stressful locations may substantially limit success. The ongoing SAV demonstration project within STA 3/4 is expected to evaluate the efficacy and cost effectiveness of the SAV inoculation procedure. As information becomes available from this study, site managers will consider the benefits of an inoculation program at STA-1E. At this time, no inoculation procedures are recommended within STA-1E.

Turbidity during the initial flooding should be monitored to discourage establishment of hydrilla (able to grow at lower light levels). In high levels of turbidity are observed, water levels should be reduced in all SAV cells to an appropriate level to increase light penetration to encourage establishment of desirable SAV vegetation until turbidity levels have dropped. Operational flexibility in all cells is key to successful desirable vegetation establishment.

No disking within any SAV cells is proposed, since rapid inundation after disking results in turbid conditions which can limit sunlight to developing SAV. Also, disking removes remnant vegetation stubble, which may help to provide substrate for SAV establishment and periphyton attachment.

Table 6. Desirable Plants in a SAV marsh:

Coontail	*Ceratophyllum demersum*
Southern naiad	*Najas quadalupensis*
Macroalga	*Chara spp*.

Duckweed	*Lemna valdivianna*
Water fern	*Salvinia minima*
Pondweeds	*Potamogeton* spp. (esp. *P. illinoensis*, *P. pusillus*)
Bladderwort	*Utricularia* spp.
Fragrant water lily	N*ymphaea odorata*
Carolina fanwort	*Cabomba caroliniana*
Spatter–dock	*Nuphar lutea*
Periphyton	Various microscopic plant/fungal taxa

Initial control of undesirable vegetation

Species-level control of vegetation will be in accordance with the desirable and undesirable species listed in **Tables 6 and 7**.

During the startup operational phase, diligent monitoring of vegetation change will be necessary to keep all undesirable species under control. Immediately after initial flooding, vegetation inspections should be conducted bi-weekly to assess growth of both desirable and undesirable species and to assess site conditions. Post-flooding herbicide work will occur based on bi-weekly inspection results.

To reduce movement of floating aquatic vegetation during periods of high water, it is recommended that several vegetation “strips,” oriented perpendicular to flow, be cultivated within the SAV cells. Site managers will identify “no-spray zones” at intervals of 500-1000’. These emergent strips can be located over the existing lateral field ditches, which were not filled during construction. These ditches typically have spoil berms at the top of bank that will provide shallow zones for more vigorous emergent growth. Establishment phase herbicide activity in all SAV cells must take into consideration the establishment of these emergent strips.

Scattered patches of torpedograss have been observed in all SAV cells. This non-native grass is an especially invasive plant that can rapidly displace native wetland plant species. If torpedograss is already established in an area where SAV marsh creation is desired, flooding will not kill it and the subsequent colonization of SAV plants becomes very difficult and expensive. However, since no large areas of dense torpedograss have been identified, initial treatment of torpedograss may not be feasible.

Table 7. Undesirable Plants[1] in a SAV marsh:

Water Lettuce	*Pista stratiotes*
Water Hyacinth	*Eichhornia crassipe*s
Frogs-bit	*Limnobium spongia*[2]
Torpedograss	*Panicum repen*s

Paragrass	*Brachiara mutica*
Water Pennywort	*Hydrocotyle spp.*
Cattail	*Typha* spp.[3]

[1] All floating aquatic vegetation and aggressive emergent vegetation are considered undesirable; this list includes those most likely to be found in STA-1E

[2]Frogs-bit is a native floating aquatic plant similar in appearance to water hyacinth. This species should be controlled in SAV cells to reduce shading of desirable SAV.

[3]Cattail may be encouraged in certain areas within SAV cells as buffers for wave action reduction and compartmentalization of SAV beds.

4. GENERAL VEGETATION CONVERSION CONSIDERATIONS

PSTA Demonstration Project

A Periphyton-based Stormwater Treatment Area (PSTA) demonstration project is planned for a 300-acre area either in the western portion of Cell 4S or in Cell 2 (Figure 1). The construction timeline for this project has not yet been determined. The vegetation management plan for this area is not presented in this Plan and will be outlined in a separate document.

C. Management and Maintenance Practices during Normal Operations

1. WATER LEVELS DURING NORMAL OPERATIONS

Emergent cells (Cells 1, 3, 5 and 7) will be held at 1.25 ft above ground level during normal operations. SAV cells (Cells 2, 4N, 4S and 6) will be held at 1.5 ft above ground level during normal operations (see **Table 8**). Changes in these water levels may be necessary in response to disturbances (see III.C.3).

The timeline for transitioning to year-round target stages will be approximately three months after the initial flooding of cells (see **Table 2**). The STA site managers and the vegetation management staff will make the decision for the implementation of the year-round target stages. This decision will be based on the success of establishing target vegetation during the establishment phase.

Table 8. Cell Stages during Normal Operations (Year-round Target Stage)				
Cell	**Design ground elevations (ft NGVD)**	**Target water levels (ft above ground elev.)**	**Target Stage[1] (ft NGVD)**	**Measured At Structure**
1	17.00	1.25’	18.25’	S-364A-C
2	15.75	1.50’	17.25’	S-365A-B
3	15.00	1.25’	16.25’	S-367A-E
4N	14.50	1.50’	16.00’	S-368A-E
4S	12.75	1.50’	14.25’	S-369A-D
5	14.00	1.25’	15.25’	S-371A-C
6	11.90	1.50’	13.40’	S-372A-E
7	12.75	1.25’	14.00’	S-374A-C

[1] Target stages assume a flat pool (static), meaning that the inflow elevation and the outflow elevations are the same during normal operations. Proposed target stages also assume design elevations of all cells. Currently, cells 4N, 4S, 5 and 7 are 0.5 to 1 foot lower.

2. Maintenance of Vegetation during Normal Operations

Emergent Cells (Cells 1, 3, 5 and 7)

Maintenance in emergent cells during normal operations will include herbicide treatments of undesirable vegetation (Table 5) on a routine schedule. Quarterly maintenance events are proposed (more or less herbicide maintenance may be necessary based on observations of undesirable species during monthly flights or ground inspections). At this time paragrass will not be treated in the emergent cells of STA-1E. Expansion of paragrass should be evaluated during the routine inspections of this STA by vegetation management staff. STA site managers will follow the effectiveness of phosphorous removal by this STA and coordinate with vegetation management staff on future management of this species.

In the emergent cells there may be deep pockets where SAV will colonize and emergent vegetation will encroach much slower. Previous observations in other STA’s suggest that the leading edge of emergent vegetation growing on muck soils may uproot and form floating mats during periods of sustained above average stages. These floating mats may then disturb the adjacent SAV. It is therefore recommended that large areas of low elevation (deeper water) be managed for SAV rather than emergent vegetation. Vegetation management would include treating floating aquatic vegetation and encroaching emergent vegetation in these areas. STA site managers and vegetation management staff will identify these areas and recommend management activities accordingly.

SAV Cells

Maintenance in SAV cells during normal operations will include routine herbicide treatments of undesirable species (**Table 7**) with exception of emergent strips (see discussion in III.B.2). Quarterly maintenance events are proposed (more or less herbicide maintenance may be necessary based on observations of undesirable species during monthly flights or ground inspections).

Structures/Samplers

Structures should be inspected continuously and any vegetation that threatens the performance of the structure will be managed (either herbicide or physical removal). Auto-sampler intakes also should be inspected regularly and kept free of any vegetation. Control of algae at these intakes may also be necessary to reduce sample contamination.

Prescribed Burning

If prescribed burning is recommended as part of vegetation management, burns should occur at the beginning of the dry season to minimize offsite discharge of released phosphorous following the burn and allow for sequestration and sedimentation of phosphorus through the dry season. Prior to initiating any prescribed burns in the STA, it is recommended that a comprehensive prescribed fire plan be developed to address the specific goals of burning STA vegetation as well as monitoring and permitting needs.

Maintenance Control

Once the appropriate type of marsh vegetation is established within a treatment cell, significant effort must be made to maintain the targeted plant community while controlling undesired vegetation. Unfortunately, the same environmental conditions that promote the growth and development of the desired vegetation also promote the growth and development of undesirable vegetation. It is therefore critical to the overall success of STA performance to sustain diligent monitoring and "maintenance control" of the vegetation to avoid costly and ecologically stressful "large-scale control." Maintenance control is an integrated management approach that coordinates several vegetation control methods (i.e. harvesting, herbicide and burning) on a continuous basis such that undesirable vegetation plant populations are reduced and maintained at the lowest practicable levels. Such an approach results in less herbicide use, less organic matter inputs from plant biomass decomposition, reduced management costs, and improves system readiness.

To achieve maintenance control, regular monitoring, coordination between responsible parties, and rapid completion of recommended actions is critical. Anticipation of problems (e.g., rapid expansion of undesirable species) is important and is developed by staff through experience. A minimum of monthly inspections to observe vegetation and turbidity and to determine need for vegetation management and/or water level manipulations are recommended. Observations and herbicide events are especially important prior to the wet season to reduce floating aquatic vegetation and to reduce possibility of clogging structures.

3. VEGETATION MANAGEMENT CONSIDERATIONS AND WATER LEVEL OPERATIONS AS RESULT OF DISTURBANCES

High turbidity

Certain conditions (i.e. high inflows or high winds) may cause high turbidity in the cells. In SAV cells this may encourage the growth of the undesirable hydrilla because it can grow at lower light levels than desirable SAV. To discourage hydrilla and to encourage desirable SAV, water levels in SAV cells with high turbidity should be reduced to allow for light penetration to maintain established desirable SAV vegetation until turbidity levels have dropped.

Drought

In a short drought, no vegetation management activities are anticipated. Target water level elevations should be re-established.

In a long drought causing complete vegetation die-off it will be necessary to return to establishment phase procedures (see III.B). Herbicide treatments may be needed in SAV cells if emergent vegetation has become established during the drought event. It may be necessary to plant emergent vegetation (to include scattering of cattail rhizomes and desirable emergent species seeds and keeping water levels fairly low) in emergent cells, and inoculate SAVs in SAV cells.

During a drought, the priority should be to hold water in SAV cells.

Storm events

Vegetation management activities and operational responses will occur depending on the duration of deep flooding (2.5 to 4.5’ water levels above ground elevation across all cells).

In short term flooding event, no vegetation management activities are anticipated. Following the storm event, aerial or ground inspections should be conducted to assess the growth of floating species in cells and against structures. If necessary, floating aquatic vegetation will be treated with herbicide or removed mechanically.

In a long term flooding event, it will be necessary to first re-establish target water elevations. Following the event, aerial or ground inspections should be conducted to assess the growth of floating species in cells and against structures. It is anticipated that herbicide treatments will be required for floating aquatic vegetation. It is expected that revegetation will occur through natural recruitment. It may be necessary to plant emergent vegetation (to include scattering of cattail rhizomes and desirable emergent species seeds and keeping water levels fairly low) in emergent cells, and inoculate SAVs in SAV cells.

During a storm event, it is recommended that the mineral (sand) soil cells (Cells 1, 3, 4N and 5) be used to pulse storm water rather than the organic (muck) soil cells (Cells 4S, 6 and 7). It is suggested to hold water in the western distribution cell then slowly bleed the water through Cells 5 and 7 to reduce the chance of tussock formation due to increased water depth. It is also suggested to hold water in Cells 1, 3 and 4N and slowly bleed into cell 4S to reduce chance of tussock formation. Tussock formation in mucky soils is more likely because roots of emergent vegetation will tend to break away from a muck substrate more readily than on a mineral substrate. Rapid fluctuations during storm events will exacerbate this problem.

Wildfire

A wildfire is most likely during the dry season and especially during drought. Please see drought vegetation management above. Prioritization of flows should occur into STA-1E to keep soils wet and to prevent muck fires.

Tussocks

If tussocks are observed in a cell, the cell will need to be taken off-line, and mechanical harvesting and removal of tussock material should occur as soon as possible.

Tussocks are often produced after rapid increases in water stages within treatment cells with emergent vegetation. Emergent vegetation may float to the surface in mats or floating dead plant matter may accumulate after large-scale herbicide applications. These floating mats (tussocks) are detrimental to STA performance, primarily due to scouring of bottom sediments, reductions in SAV, and clogging of water management structures. The formation of floating tussocks is not anticipated to be a major concern in the eastern cells due to the mineral substrate in these areas. Cells 4S, 6, and 7, which contains more widespread muck soils may begin to form tussocks earlier. Several techniques may be employed to remove these mats, including herbicide treatments, mechanical harvesting, and muck removal. These control methods may also be detrimental to STA performance by increasing turbidity and sediment loading in the water column. Therefore, management practices that reduce the formation of tussocks should be emphasized. These include minimizing pre-flood densities of emergent vegetation, minimizing rapid fluctuations in water elevations, limiting periods of deep water (> 3 feet), and periodic maintenance events (muck removal).

IV. APPENDICES AND ATTACHMENTS

- Appendix 1 – Summary of Phase I /Phase II, Environmental Assessment Activities/Corrective Actions, STA-1 East – Palm Beach County, Response to DEP Comments
- Appendix 2 - Preliminary STA Vegetation Maintenance SOP document

APPENDIX C

SETTLEMENT AGREEMENT EXECERPTS

Settlement Agreement, United States of America, et al., Plaintiffs, vs. South Florida Water Management District, et al.; Florida Department of Environmental Regulation et al., Defendants. 88-1886-CIV-HOEVELER.

COMMIMENT TO RESTORING AND MAINTAINING WATER QUALITY

4. In recognition of the serious and potential devastating degradation threatening the Park and the Refuge as a result of nutrient-laden waters, and to further a process that resolves ongoing litigation, the Parties commit themselves to guarantee **water quality** (emphasis added) and **water quantity** (emphasis added) needed to preserve and restore the unique flora and fauna of the Park and Refuge. p. 9, Exhibit B.

TOTAL PHOSPHORUS CONCENTRATION LEVELS AND DISCHARGE LIMITS FOR THE REFUGE

8. C. Inflows to the Refuge must result in compliance with the Class III water quality criteria or long-term concentration levels, whichever are lower by December 31, 2006, as set forth in Appendix B. Research and monitoring will be conducted under this Agreement to interpret what phosphorus concentration levels comply with Class III water quality criteria. pp. 11-12, Exhibit B.

Comment: The water quality criteria was approved by the ERC and adopted by the State (FDEP) and is 10 ppb TP. The EPA reviewed the water quality criteria and associated standard and gave its approval. While the criteria have not been challenged in court, the standard has. However, the Settlement Agreement and Consent Decree use criterion and thus the Class III water quality criterion of 10 ppb TP has been used for this project.

WATER QUANTITY REQUIREMENTS

9. Quantity, distribution and timing of water flow to the Park and Refuge must be sufficient for maintaining and restoring the full abundance and diversity of the native floral and faunal communities throughout the Park and Refuge. The Parties shall take all actions within their authority necessary to provide adequate flows to meet the water quantity, distribution and timing needs of the Park and the Refuge. The District shall implement mitigation measures to offset fowl reductions to the EPA resulting from efforts to the water quality in the EPA. Additionally, the Parties through the TOC shall jointly develop specific elements of these actions as part of a basin-wide Everglades ecosystem restoration plan. Nothing in this Agreement shall limit or prejudice any rights of the Park or Refuge under State or Federal law to obtain greater or more specific water quantity. pp. 12-13, Exhibit B.

IMPLEMENTATION OF STORMWATER TREATMENT AREAS

10. A. The primary strategy to remove nutrients from agricultural runoff is the construction and operation o STAs, which are large scale wetland treatment systems constructed by the District **and the Corps.** These STAs will mainly receive stormwater directly from the primary agricultural drainage canals and process it for the removal of nutrients through **intensive management** (emphasis added). Deliveries may be made to the STAs from Lake Okeechobee or other sources. These areas will be designed, operated and managed primarily to purify the water before it enters the WCAs, the Park

and the Refuge. In addition, their size and location may allow significant improvement in the manner in which water is introduced into the natural areas. By allowing the reintroduction of sheet flow into tens of thousands of acres of Everglades, the completion of these projects has **<u>the potential for improving Everglades hydroperiod</u>** (emphasis added). p. 13, Exhibit B.

10. B. …The size of each STA is based on the assumption that the volume of flows experienced during the 1979 to 1988 base period from each tributary basin would be treated with no hydraulic bypass…. p. 14, Exhibit B.