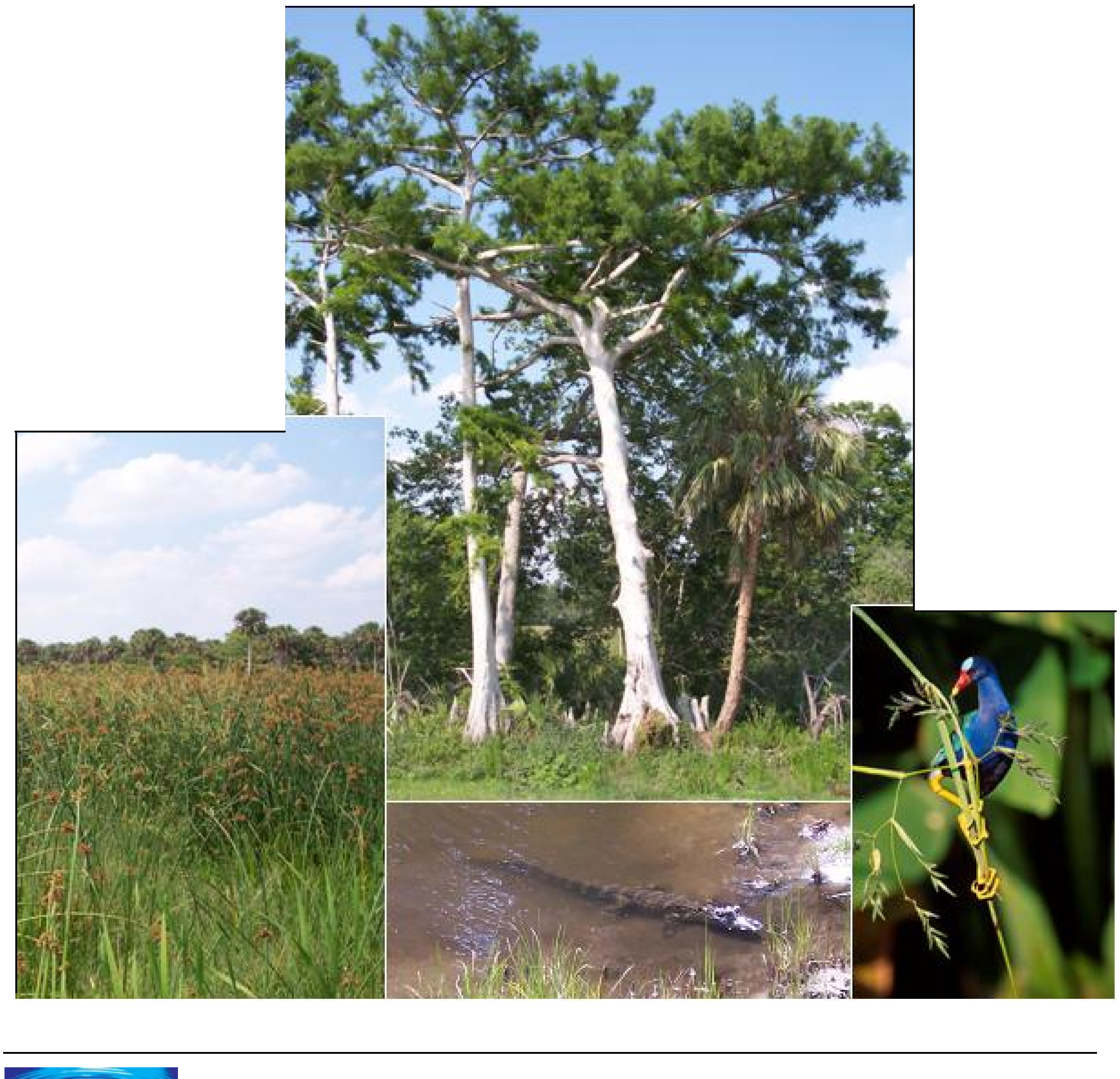
SOUTH FLORIDA WATER MANAGEMENT DISTRICT

OPERATION PLAN

TAYLOR CREEK / GRASSY ISLAND

STORMWATER TREATMENT AREA



August 2005

Gary Goforth, Inc.

CERTIFICATION

I hereby certify, as a Professional Engineer in the State of Florida, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by the South Florida Water Management District or others without specific verification or adaptation by the Engineer. This certification is made in accordance with the provisions of the Laws and Rules of the Florida Board of Professional Engineers under Chapter 61G15-29, Florida Administrative Code.

____

Gary F. Goforth, P.E. Florida P.E. # 35525

Date:________________________

(Reproductions are not valid unless signed, dated and embossed with Engineer's seal)

STRUCTURE REFERENCE

Structure Identification	Description	Operations
S-390	12	23
S-391	14	25
S-392	16	25
Emergency overflow sections	17	
Seepage control	19	
Airboat ramp and crossover	19	

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PLEASE NOTE

During the preparation of this *Operation Plan*, two critical hydraulic issues that need attention to ensure that maximum phosphorus removal of the STA can be achieved were discussed with the District and the Corps of Engineers.

1. **Operating thresholds for the inflow pump station.** The S-390 pump operating set points were discussed with Dan Miller of Stanley Consultants, Inc., who agreed that the set point triggering the sequencing of the pumps on should be lowered from the current elevation of 20.0 ft NGVD to around 18.0 ft. This set point is referred to as the "Taylor Creek Stage High level" in Table 3 (page 24). It is recommended that the District or Corps revise this set point and its associated reset elevation as soon as possible after field testing to ensure that maximum phosphorus removal of the STA can be achieved.

2. **Capacity of S-391 and S-392.** After review of the rating curves for S-391 and S-392 and discussion with Dan Miller of Stanley Consultants, Inc., it was determined that the hydraulic capacity of the interior structure (S-391) and outlet structure (S-392) may be smaller than stated in the design documents, which was to pass the peak flow of 24 cfs with a head loss of less than 1.0 ft. This reduced capacity may increase the stage above the design pool elevation at peak flow through the STA, which in turn may reduce the design freeboard on the levee. The effect of this reduced capacity is partially compensated for by conservative estimates of the hydraulic roughness coefficient and pump station energy losses which reduce the peak flow under design conditions to approximately 21.5 cfs. It is recommended that the District pursue resolution of this issue with the Corps, perhaps through additional hydraulic modeling or flow calibrations after the STA is in flow through mode, to ensure that maximum phosphorus removal of the STA can be achieved. Until this issue is resolved, the Corps and District should consider an appropriate operational remedy such as limiting the number of pumps operating at one time during the rainy season.

Several tables and discussions within this document rely on the implementation of the recommendations above in order to achieve the design flows and stages described in the *Design Documentation Report* and *Design Analysis Report*. Depending upon the resolution of these issues, this Operation Plan will need to be revised accordingly.

Summary of Start up phase operations

- Revise the STA High-high level set point that shuts off the pumps to 23.6 ft
- Limit the number of pumps operating simultaneously to two (2) to allow the cypress trees to acclimate to higher water levels
- The target depth is between 0.5 - 1.0 ft (23.1-23.6 ft in Cell 1 and 22.1-22.6 ft in Cell 2)
- With the gate at S-392 closed, and the gate at S-391 open fully, raise the water level in Cell 2 to an average of 22.6 ft, then close the S-391 gate and raise the water level in Cell 1 to an average of 23.6 ft
- Once flow-through operations begin, reset the number of pumps operating simultaneously back to 4 and reset the STA High-high level set point back to 26.5 ft.

Summary of Normal Operations:

- Wet season
  - The S-390 pumps will operate automatically to supply water to the STA based on stage in Taylor Creek
  - Leave the gates at S-391 and S-392 fully open when pumps are running
  - Partially close the gates 0.5 ft when no pumps are running
    - S-391 gate closed to elevation 23.1 ft
    - S-392 gate closed to elevation 22.1 ft
- Dry season
  - The S-390 pumps will operate automatically to supply water to the STA based on stage in Taylor Creek
  - Leave the gates at S-391 and S-392 fully open when pumps are running
  - Partially close the gates 0.75 ft when no pumps are running
    - S-391 gate closed to elevation 23.35 ft
    - S-392 gate closed to elevation 22.35 ft

Summary of Extreme Flow Operations:

- Prior to extreme events,
  - the trash rack should be checked to ensure it is clear and working properly, and
  - the gates at S-391 and S-392 should be checked to see that they are fully open.
- As soon as safety permits after extreme events,
  - check the operating status of all the pumps and gates,
  - make repairs if needed, and clear debris if needed

Summary of Drought Operations:

- S-392 should be closed and S-391 opened as needed to allow water depths in both cells to rise up to 2-2.5 feet, if water is available.
- Maintain a minimum depth of 0.5 ft if water is available; this may necessitate a small portable pumping unit to hydrate Cell 2.
- Following a dry out
  - keep S-392 closed for a period following reflooding to a stage of 22.1 ft, depending on the severity of dry out and the status of the treatment vegetation
    - if the vegetation is robust, the recommended period of closure following reflooding is approximately two weeks
    - if the vegetation is damaged, the period of closure will likely be greater, to be determined by field conditions and phosphorus levels

1 PROJECT DESCRIPTION

1.1 BACKGROUND

The South Florida Water Management District (SFWMD), the U. S. Army Corps of Engineers (Corps), the Florida Department of Environmental Protection (FDEP), other agencies and private landowners are cooperating on efforts to improve water quality in the Lake Okeechobee watershed, and through the south Florida ecosystem. This cooperation includes studies and capital projects composing the Lake Okeechobee Protection Program, the Comprehensive Everglades Restoration Plan (CERP), and Critical Restoration Projects. The Lake Okeechobee Water Retention / Phosphorus Removal Project consists of two shallow stormwater treatment areas – the Taylor Creek Stormwater Treatment Area (STA) and the Nubbin Slough STA – designed to remove phosphorus loads from the Taylor Creek and Nubbin Slough watersheds. High phosphorus loads have been implicated in excessive eutrophication of Lake Okeechobee that have resulted in algal blooms, high oxygen demand, and loss of fisheries and recreational benefits provided by the lake.

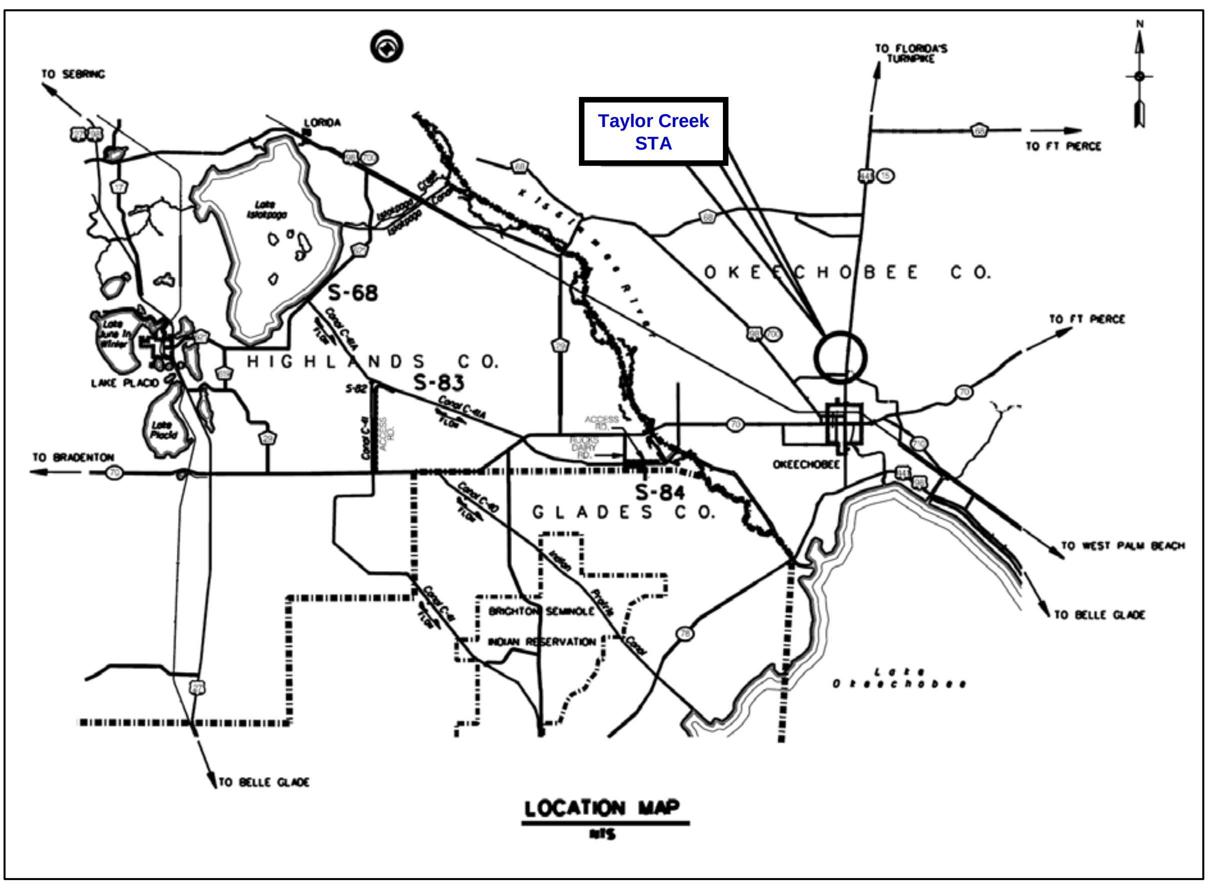
The Taylor Creek STA is one of the Critical Restoration Projects authorized by Congress through Section 528 of the Water Resources Development Act of 1996. The project was designed by Stanley Consultants, Inc. working under contract to the Corps, who was responsible for construction. Construction is presently underway with completion scheduled for summer 2005. The SFWMD is the sponsor for the project and assisted in the funding of the capital works and will be responsible for operation and maintenance of the STA. The anticipated long-term average phosphorus reduction within the STA was estimated during the design phase to be approximately 38% (2 tons per year), or about 9% of the phosphorus load of Taylor Creek at the project location.

The Taylor Creek STA is approximately 2 miles north of the city of Okeechobee (Figure 1), adjacent to Taylor Creek and immediately northwest of the U.S Highway 441 bridge that spans Taylor Creek. A gated driveway will provide access to the project site, and the water control structures can be reached by traveling along the top of the levee. The southern end of this project is approximately 7 miles from the edge of Lake Okeechobee. The Taylor Creek Site habitat is situated between large areas of pasture, upland forested areas, cypress stand, depressions, and forested wetlands. The Florida Natural Areas Inventory designated the very southern end of the Taylor Creek Site as an area of conservation interest, in connection with the larger forested wetlands system in the slough along Taylor Creek (Corps 2005). According to the Fish and Wildlife Coordination Act report of the U.S. Fish and Wildlife Service (USFWS), the adjacent lands, open pastures with scattered cabbage palms are prime foraging and nesting habitat for Audubon's crested caracara. The open pasture is also habitat for turkey vulture, sandhill crane, meadowlark, mourning dove, and white-eyed vireo. In addition, the wooded areas (wetland and upland) provide habitat for migratory and resident birds.

1.2 OPERATIONAL OBJECTIVES

The goal of the Taylor Creek STA is to capture and reduce the mass of total phosphorus from the Taylor Creek Basin prior to discharge back into Taylor Creek and on to Lake Okeechobee. The phosphorus concentration in Taylor Creek runoff exhibits considerable variability, with an average of approximately 500 parts per billion (ppb) (Stanley Consulting, Inc. 2003). This greatly exceeds the phosphorus concentration of Lake Okeechobee, which averages just over 100 ppb. Emergent wetland vegetation (bulrush, *sagitaria, pontedaria*, etc.) has already begun to colonize the treatment areas, and average depths of less than 2 feet should be conducive to sustaining these communities. The long-term phosphorus storage mechanism within the STA will be through accretion of new organic sediment, and for this reason it is important to operate the STA to avoid dry out, which could release nutrient through remineralization of these sediments. The anticipated long-term average phosphorus reduction within the STA was estimated during the design phase to be approximately 38% (2 tons per year), or about 9% of the phosphorus load of Taylor Creek at the project location. In addition to the reduction of phosphorus loads, the Taylor Creek STA will provide additional water quality and quantity benefits to downstream waters, including the removal of suspended solids, nitrogen, metals, and pesticides that would otherwise flow into the lake.

Figure 1. Taylor Creek / Grassy Island STA location map.



The Taylor Creek STA is a long, narrow enclosure that parallels Taylor Creek (shown in Figure 2). An inflow pump station lifts water from Taylor Creek at the north end of the STA. Treatment occurs through natural biogeochemical processes as the water slowly flows by gravity southeasterly through the 49-acre Cell 1 and subsequently through the 93-acre Cell 2 before being discharged back to Taylor Creek. Water levels and flow rates through the treatment cells are controlled by individual gated structures located at the southerly end of each cell. The predominant grade within the STA creates flow northwest to the southeast but the general slope of each cell is from east to west, making the water on the west side of the cells deeper than on the east. The southeast corner of Cell 2, containing a strand of cypress and other wetland hardwoods, ranges from 1-2 feet higher than the remainder of the cell and will remain dry most of the time (subject to verification after as-built surveys). This wooded area was included in the STA to avoid constructing the perimeter berm through the cypress stand. Deep zone trenches at the inflow and outflow of each cell are designed to help distribute flow evenly throughout the cell.

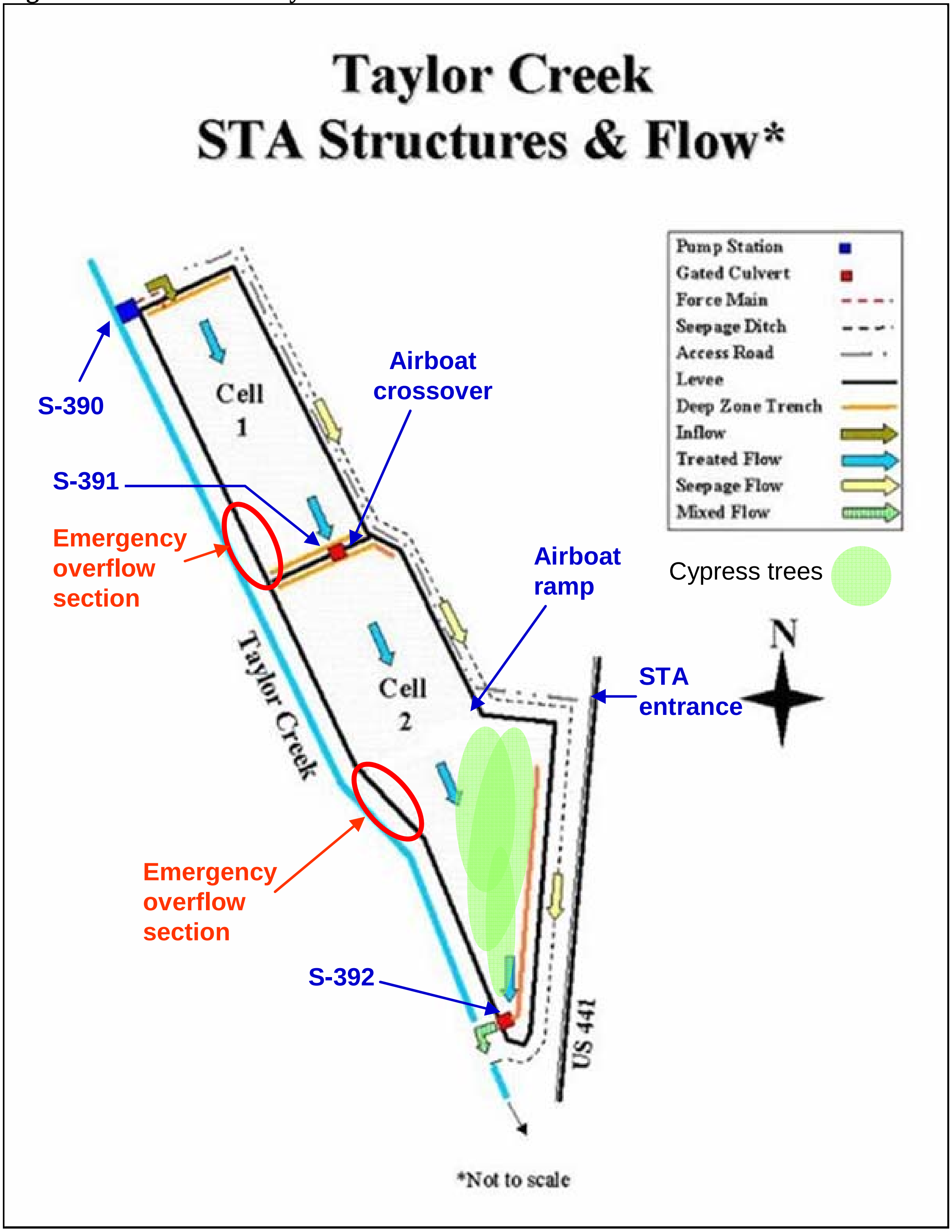
References. This *Operation Plan* for the Taylor Creek STA was developed based upon the following documents:

1. Stanley Consultants, Inc., Lake Okeechobee Water Retention / Phosphorus Removal Project, Final Design Analysis Submittal, June 2003

2. Stanley Consultants, Inc., Lake Okeechobee Water Retention / Phosphorus Removal Project, Final Design Document Report Submittal, June 2003

3. U. S. Army Corps of Engineers, Draft Lake Okeechobee Water Retention / Phosphorus Removal Project – Taylor Creek (Grassy Island) Stormwater Treatment Area (STA) Water Control Plan (June 2005)

Figure 2. Schematic of Taylor Creek STA.



A summary of the key operational parameters is presented in Table 1.

Table 1. Summary of Taylor Creek STA Operational Parameters

Design Parameter	Cell 1	Cell 2	Entire STA
Treatment Area			
Effective Treatment Area (acres)	41	77	118
Total Area (acres)	49	93	142
Average ground elevation (ft NGVD)	22.6 +/-	21.6 +/-	21.9 +/-
Nominal Length (feet)	2,300	4,200	6,500
Nominal Width (feet)	775	795	785
Aspect Ratio (length:width)	3.0	5.3	8.3
Flow			
Average flow (cfs)	12	12	12
Average annual inflow (acre feet)	8,674	8,674	8,674
Mean depth at average flow (ft)	1.25 +/-	1.25 +/-	1.25 +/-
Average hydraulic loading rate (ft/yr)	213	113	74
Volume at average depth (AF)	51	96	147
Nominal hydraulic residence time at average flow (days)	2.1	4.0	6.0
Nominal linear velocity at average flow (ft/day)	1071	1043	
Minimum depth (ft)	0.5	0.5	
Minimum stage (ft NGVD)	23.1 +/-	22.1+/-	
Nominal peak flow from DAR (cfs)	24	24	
Design depth at nominal peak flow (ft)	2.0 +/-	2.0 +/-	
Design stage at peak flow (ft NGVD)	24.6	23.6	
Peak flow from pump curves (cfs)	21.4	21.4	
Emergency Overflow Section			
Perimeter levee crest (ft NGVD)	28.0	27.0	
Emergency overflow crest (ft NGVD)	27.0	26.0	
Maximum depth at emergency overflow	4.4	4.4	
Length of emergency spillway (ft)	500	500	

Note: During the preparation of this *Operation Plan,* it was determined that the hydraulic capacity of the interior structure (S-391) and outlet structure (S-392) may be less than stated in the design documents, which may decrease the peak, and therefore the average, flows through the STA. If so, the values in this table would need to be revised.

All ground and water surface elevations are referenced to the 1929 NGVD.

2 STRUCTURE AND CANAL DESCRIPTIONS

The following sections describe the associated project water control structures, canals and related features.

2.1 INFLOW CONTROL FACILITY

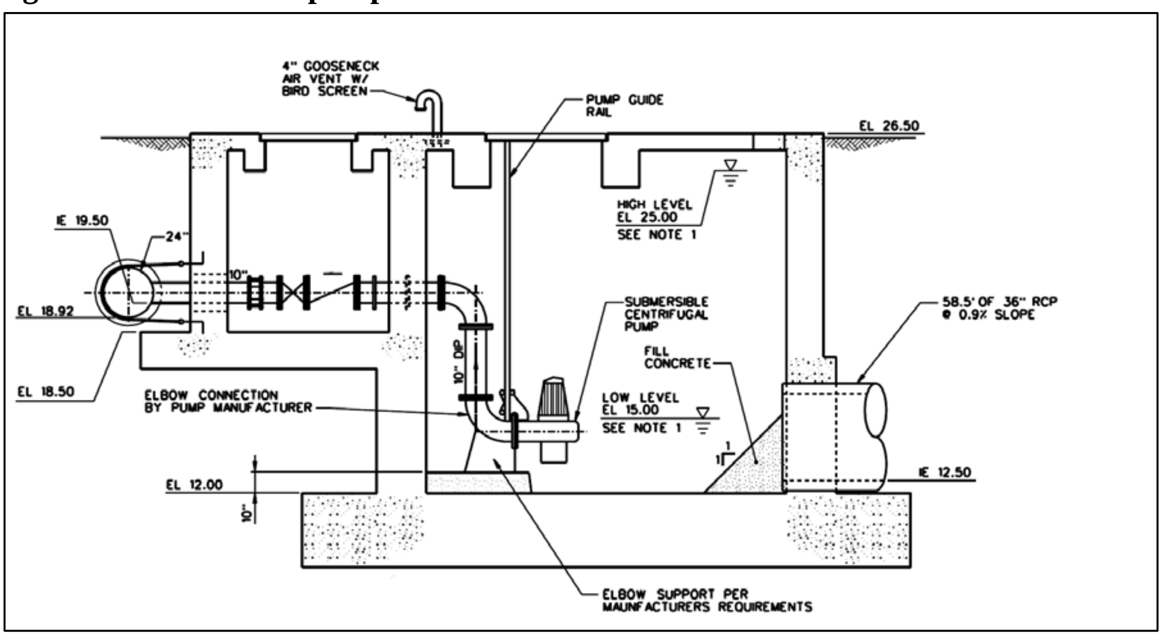
Structure S-390 is the inflow pump station for the Taylor Creek STA and is located at the northwest corner of the STA (see Figures 2 and 3). The pump station has four (4) submersible 10-inch diameter centrifugal pumps with 14-horsepower electric powered motors. Each pump has a nominal discharge capacity of approximately 6 cfs pumping against a static head of 9 ft; however, friction and other energy losses within the piping system reduce the pump capacity (see Section 3 for operational details). The four pumps' outlet pipes enter a common 24-inch diameter 111-ft long concrete pipe that conveys the intake water into the deep zone trench that serves as a distribution canal at the upstream end of Cell 1 (Figure 4). A cross section of the pump station wet well is shown in Figure 5. The performance curves and additional manufacturer's information for these pumps are presented in Appendix A.

Figure 3. Photograph of S-390 Trash rack and pump station control building shortly before construction completion.

Figure 4. Pump Station S-390 control building, end of discharge pipe and inflow distribution canal (deep zone trench) shortly before construction completion.

Trash Rack. The S-390 pump station is equipped with a self cleaning trash rack, as shown in Figure 3. The trash rack is driven by a chain that is activated by a preset pressure differential across the rack. Trash removed from the rack is deposited on a concrete pad for subsequent removal and disposal. Additional information is provided in Appendix A.

Figure 5. Schematic of pump station S-390 wet well.



NOTE 1. High level elevation for float switch provides alarm to field off. Low level elevation for float switch provides pump shut-off.

Pump Station S-390 Information:

Number of pumps:	4
Discharge capacity (each pump):	6 cfs at a static head of 9.0 ft
Design headwater elevation:	9.0 ft NGVD
Design low water (headwater) elevation:	17.0 ft NGVD
Design tailwater elevation:	26.0 ft NGVD
Nominal pump operating speed:	1160 rpm
Normal "on elevation":	When Taylor Creek (pump HW) is 20.0 ft NGVD
Normal "off elevation":	When Cell 1 (S-391 HW) is 26.5 ft NGVD
Motor size:	14 Hp
Centerline of 24-in discharge culvert:	22.0 ft (invert elevation 21.0 ft NGVD)
Pump station wet well floor elevation:	12.0 ft NGVD
Intake floor elevation:	12.17 ft NGVD

Data Acquisition and Telemetry:
Presently the pumps are designed to work in automatic mode depending on local stage readings and set points. Telemetry control for remote operation and real-time status of each pump is planned for completion in the fall of 2005. Headwater and tailwater sensors provide stage data to the pump operation controls, and eventually, to remote operator at the S-127 control center and at the West Palm Beach operations control center. Headwater and tailwater staff gages are available for manual/local operation.

Water Quality Sampling:
Flow proportional, automatic sampling equipment has been installed at the wet well for the purpose of monitoring inflow water quality. Please refer to the Water Quality Monitoring Plan (SFWMD 2005) for updated details.

2.2 INTERIOR CONTROL STRUCTURE

Structure S-391 controls flow from Cell 1 into Cell 2. S-391 is a combination structure consisting of an inlet box fitted to a 60-ft long 3 ft. diameter reinforced concrete pipe (see Figure 6). The inlet box has a 5-ft wide by 2-ft high downward opening slide gate for water control (see Figure 7). This structure is located in the separation levee between Cells 1 and 2. As shown in Figure 6, the gate is manually operated by means of a pedestal mounted gate operator that synchronizes the movement of the twin gate stems. A detailed schematic with construction elevations and manufacturers information on the gate and operator are presented in Appendix B.

Figure 6. Structure S-391 just prior to construction completion (May 2005).

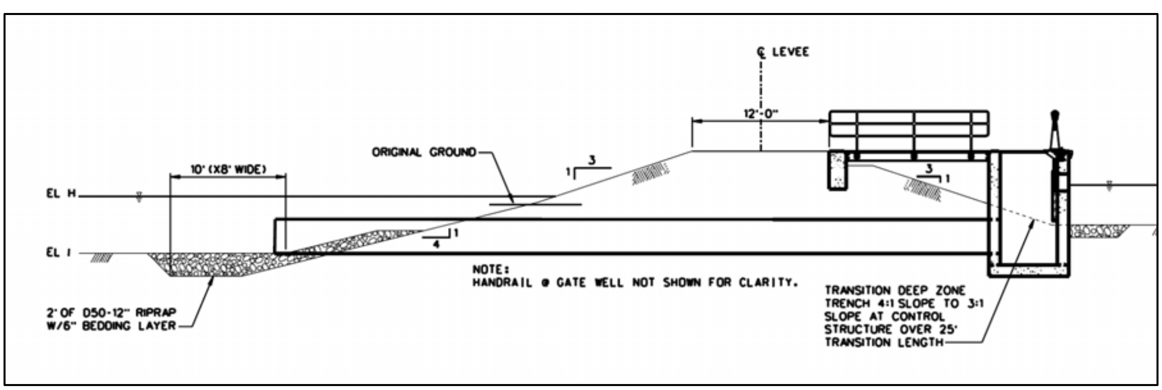
Data Acquisition and Telemetry

A headwater stage sensor and a gate position indictor sensor are available to monitor the status remotely, while a headwater staff gage is available for local operation. District staff are looking into the possibility of installing a tailwater staff gage.

Water Quality Sampling

At the present time, there is no automatic sampling equipment installed at S-391 for the purpose of monitoring water quality. Please refer to the Water Quality Monitoring Plan (SFWMD 2005) for updated details. The District may want to consider a weekly grab sample for phosphorus to assist in better understanding the performance of the STA.

Figure 7. Cross section of S-391 through the separation levee between Cells 1 and 2.



S-391 structure information

Gate opening invert:	22.6 ft NGVD
Height of Gate:	2.0 ft
Width of gate:	5.0 ft
Invert of culvert:	18.5 ft NGVD
Diameter of culvert:	3.0 ft
Length of culvert:	60 ft

2.3 OUTFLOW CONTROL STRUCTURE

Structure S-392. Water control structure S-392 controls flow from Cell 2 into Taylor Creek. S-392 is a combination structure consisting of an inlet box fitted to a 3 ft. diameter reinforced concrete pipe culvert (Figure 8). This structure is located in the perimeter levee at the southwest corner of Cell 2. The inlet box has a 5-ft wide by 2.5-ft high downward opening slide gate for water control as shown in Figure 8. When S-392 is open, the treated water will flow over the gate and through the inlet box into a 72-ft long culvert and return to Taylor Creek. As shown in Figure 6, the gate is manually operated by means of a pedestal mounted gate operator that synchronizes the movement of the twin gate stems. A detailed schematic with construction elevations and manufacturers information on the gate and operator are presented in Appendix B.

Data Acquisition and Telemetry:
Headwater and tailwater sensors, as well as a gate position indictor sensor, are available to monitor the status remotely, while headwater and tailwater staff gages are available for local operation.

Water Quality Sampling:
Flow proportional, automatic sampling equipment has been installed at S-392 for the purpose of monitoring water quality. Please refer to the Water Quality Monitoring Plan (SFWMD 2005) for updated details.

Figure 8. Structure S-392 just prior to construction completion (May 2005).

Structure information

Gate opening invert:	22.0 ft NGVD
Height of Gate:	2.5 ft
Width of gate:	5.0 ft
Invert of culvert:	17.5 ft NGVD
Diameter of culvert:	3.0 ft
Length of culvert:	72 ft

2.4 EMERGENCY OVERFLOW

Each treatment cell contains a 500-ft long emergency overflow section on the southwest perimeter levee, with the crest elevation 12 inches lower than the cells' perimeter levee. When the water elevation increases above 27.0 ft. in Cell 1, water will flow over the emergency overflow section to Taylor Creek. When the water level increases above 26.0 ft. in Cell 2, water will flow over the emergency overflow section to Taylor Creek. The transition between the perimeter levee and each section, from inside the treatment cell, over the levee, and across the downstream face of the levee, is armored with articulated concrete block overlaying geotextile (Figures 9 and 10).

Figure 9. Plan section of emergency overflow section.

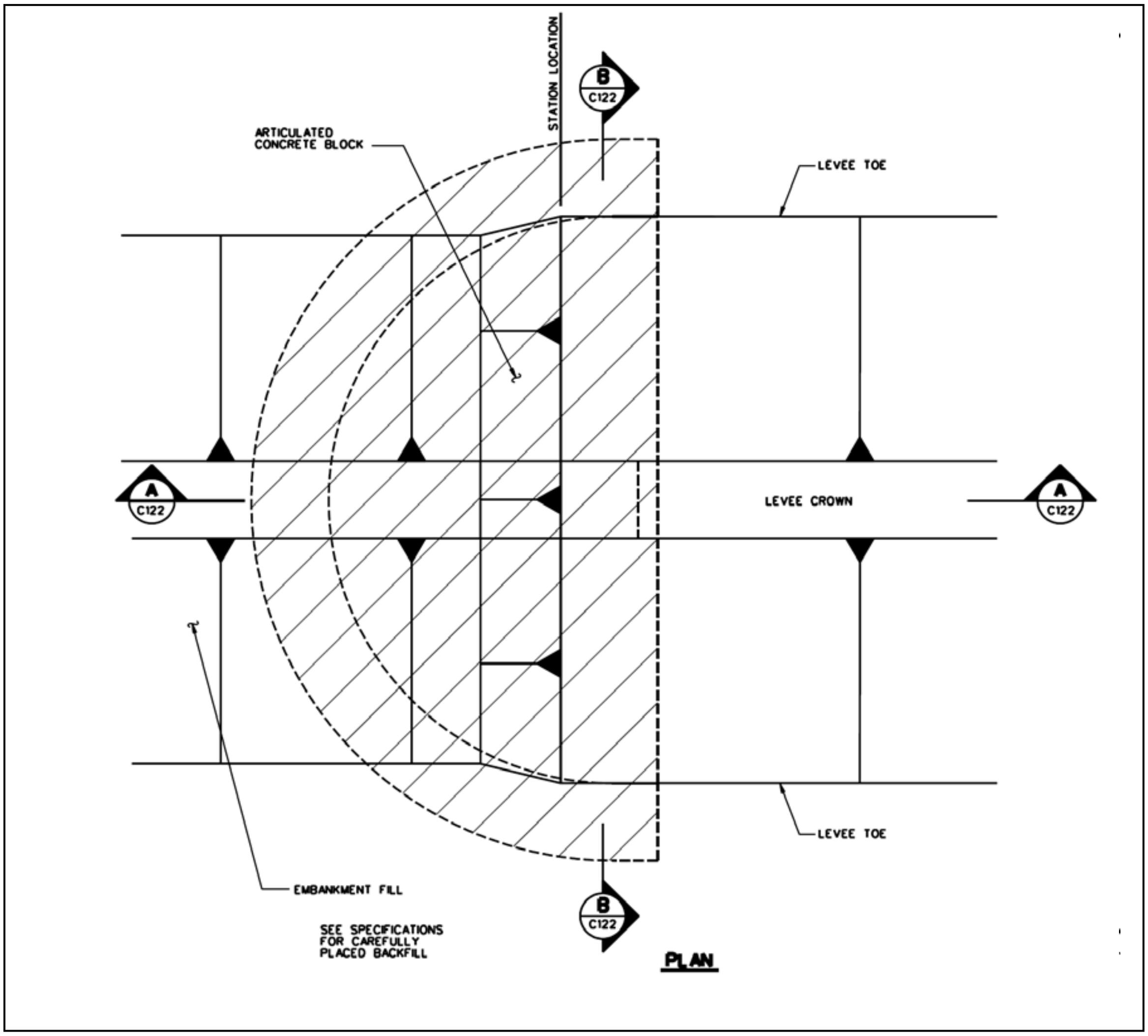
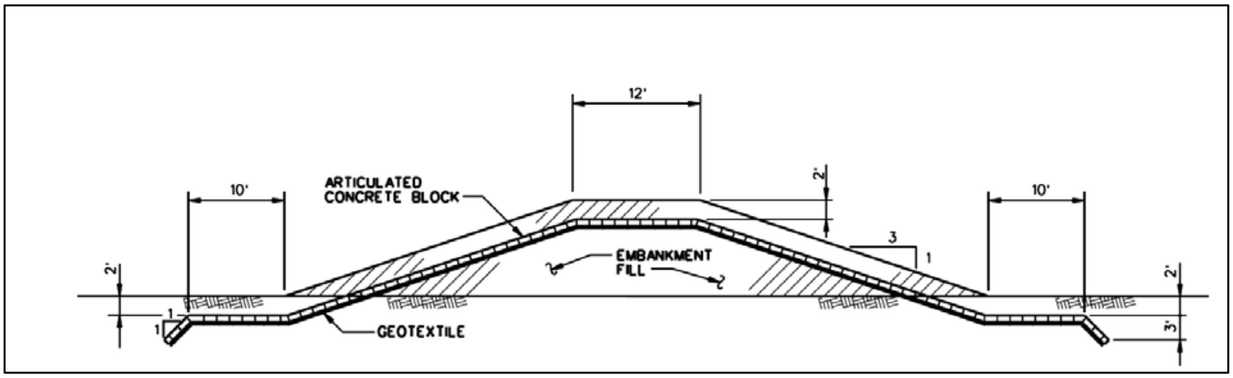


Figure 10. Cross section B-B through the transition to the emergency overflow section.



2.5 SEEPAGE CONTROL FACILITIES

A seepage collection ditch is located on the eastern side of the STA. This ditch collects seepage from the STA and runoff from upstream areas and conveys it to Taylor Creek through an existing un-gated culvert southeast of S-392. The bottom elevation of this ditch slopes from elevation 20.45 ft adjacent to Taylor Creek up to 23.8 ft at the north end of the STA. The bottom width is 8 ft, and the side slopes are 3:1. There is no seepage ditch on the western side of the STA; any seepage to the west will flow to Taylor Creek. A seepage analysis conducted during design of this project estimated a total seepage of less than 1 cfs at the design pool elevations. A double-barrel set of 24-in diameter and 40-ft long reinforced concrete pipes is located beneath the access road crossover of the seepage collection ditch.

2.6 RELATED FACILITIES

Deep Zone Trenches. Each treatment cell has deep zone trenches located immediately downstream of the inflow structure and immediately upstream of the outlet structure. The deep zone trench at the inflow of each cell is designed to distribute the inflow across the entire width of the cell. The deep zone trench at the outfall collects flow from across the entire width of the cell. They average 3 ft in depth with a 50 ft. bottom width and 4H to 1V side slopes.

Levees. The STA is bounded on all sides by a perimeter levee with a separation levee across the mid section of the site providing a separation of Cell 1 and 2. The levee crest elevation is set by the design pool elevation within each cell plus a 3-ft freeboard allowance to accommodate the 10-year, 24-hour precipitation event, wind shear surge, and wave run-up. The 3 ft freeboard allowance consists of 6 inches for a 10-year 24-hour event, an estimated 4 inches surge, 1.5 ft. for wave run-up and 8 inches for backwater effects (Stanley Consultants 2003). The design pool elevation for Cells 1 and 2 are 24.6 ft and 23.6 ft, respectively, and the crest elevations were set at Cell 1 and 2 are 28.0 and 27.0 ft, respectively. The levee top width is 12 ft, and the side slopes are 3H to 1V. Each cell has an emergency overflow section on the southwest levee (as discussed in Section 2.4 above).

Airboat ramp and crossover. An airboat ramp is located on the east perimeter levee of Cell 2 just west of the entrance to the STA project site. An airboat crossover is located adjacent to S-391 on the separation levee to facilitate airboat movement between the treatment cells (Figure 11).

Figure 11. Airboat crossover located adjacent to S-391.

Cell Grade. The predominant grade within the STA creates flow northwest to the southeast, but the general slope of each cell is from east to west, making the water on the west side of the cells deeper than on the east. Extensive grading during construction leveled out a majority of the prior existing ditches, with a resulting average ground elevation of approximately 22.6 ft +/- in Cell 1 and 21.6 +/- ft in Cell 2. As-built surveys will verify these elevations after construction is completed. Some portions of the southeast corner of Cell 2 will remain dry most of the time.

Cypress Trees Acclimation. A cypress tree stand is located within the boundaries of Cell 2. Alternatives to protect these trees, including a ring levee to separate the surface waters from the treatment cell, were evaluated during the design, with the resulting decision made to leave the trees without a structural barrier. A gradual initial inundation rate (1-2 inches per day) is recommended in order to minimize stress to the cypress trees.

3 OPERATIONS

PLEASE NOTE

During the preparation of this *Operation Plan,* two critical hydraulic issues that need attention to ensure that maximum phosphorus removal of the STA can be achieved were discussed with the District and the Corps of Engineers.

3. **Operating thresholds for the inflow pump station.** The S-390 pump operating set points were discussed with Dan Miller of Stanley Consultants, Inc., who agreed that the set point triggering the sequencing of the pumps on should be lowered from the current elevation of 20.0 ft NGVD to around 18.0 ft. This set point is referred to as the "Taylor Creek Stage High level" in Table 3 (page 24). It is recommended that the District or Corps revise this set point and its associated reset elevation as soon as possible after field testing to ensure that maximum phosphorus removal of the STA can be achieved.

4. **Capacity of S-391 and S-392.** After review of the rating curves for S-391 and S-392 and discussion with Dan Miller of Stanley Consultants, Inc., it was determined that the hydraulic capacity of the interior structure (S-391) and outlet structure (S-392) may be smaller than stated in the design documents, which was to pass the peak flow of 24 cfs with a head loss of less than 1.0 ft. This reduced capacity may increase the stage above the design pool elevation at peak flow through the STA, which in turn may reduce the design freeboard on the levee. The effect of this reduced capacity is partially compensated for by conservative estimates of the hydraulic roughness coefficient and pump station energy losses which reduce the peak flow under design conditions to approximately 21.5 cfs. It is recommended that the District pursue resolution of this issue with the Corps, perhaps through additional hydraulic modeling or flow calibrations after the STA is in flow through mode, to ensure that maximum phosphorus removal of the STA can be achieved. Until this issue is resolved, the Corps and District should consider an appropriate operational remedy such as limiting the number of pumps operating at one time during the rainy season.

Several tables and discussions within this document rely on the implementation of the recommendations above in order to achieve the design flows and stages described in the *Design Documentation Report* and *Design Analysis Report*. Depending upon the resolution of these issues, this Operation Plan will need to be revised accordingly.

Introduction. This section describes the general operations associated with the Taylor Creek STA. Operations are classified in the following modes:

1. Start-up operations
2. Normal operations
3. Extreme flow operations
4. Drought operations, and
5. Operations to take one or more treatment cells out of service

The Initial Operational Testing and Monitoring Period of the construction phase of the project consists of two activities: Pre-Discharge and Flow-Through (Discharge) Activities. Because of the overlap in operations with those discussed below, no separate discussion of this Period is necessary.

3.1 START-UP OPERATIONS

General. The goal during STA startup is to provide hydrologic conditions conducive to wetland vegetation growth, while avoiding release of total phosphorus and mercury. The STA permits preclude flow-through operations until phosphorus and mercury concentrations demonstrate a net improvement compared to the source water in Taylor Creek. In addition, the FDEP permit requires that pesticide samples be taken in the water column and sediment at the inflow and outflow structures before discharges are to occur from the STA. A complete description of the permit and performance conditions can be found in the associated *Performance Plan for the Taylor Creek / Grassy Island STA.*

Operations During Startup. The STA outlet structure, S-392, should remain closed during the startup phase. The inflow pump station, S-390, should be operated to maintain approximately 1.0 ft water depth in Cells 1 and 2. **This will require the operating set points to be revised during the start-up phase from the values identified in the design documents, specifically the "High-high STA level" that shuts down the pumps needs to be set to 23.6 ft.** Since the ground elevation in Cell 2 is about 1.0 ft lower than in Cell 1, synchronized operation of S-390 and S-391 will be required to achieve these target depths. In general, S-391 should be open entirely during the initial operations while Cell 2 is inundated to a stage of 22.6 ft (i.e., a depth of 1.0 ft). With two pumps operating, S-390 should be able to raise water elevations across the entire STA in just under a week at a rate of about 2 inches per day, assuming seepage and ET losses of about 1/2-inch per day; rainfall will increase the rate of net increase in depth. When the average stage in Cell 2 (determined by the arithmetic average of the tailwater stage of S-391 and the headwater stage of S-392) is approximately 22.6 ft (i.e., a depth of 1.0 ft), S-391 should be partially closed to an elevation of 23.6 ft, and water depths in Cell 1 should be allowed to rise until the average stage in Cell 1 (determined by the arithmetic average of the tailwater stage of S-390 and the headwater stage of S-391) is approximately 23.6 ft (i.e., a depth of 1.0 ft). With two pumps at S-390 operating, Cell 1 should be close to the target depth roughly two days after closing S-391. S-390 can be shut off when the average stage in Cell 1 is 23.6 ft (i.e., a depth of 1.0 ft). Periodic pumping of S-390 and opening S-391 may be necessary to maintain a desired depth of approximately 1.0 foot in the treatment cells. ***It is critical to keep depths between 0.5 and 1.0 ft during the start up phase to ensure proper growing conditions with minimal high-water damage to the young vegetation***.

The cypress tree stand located in Cell 2 should be inundated slowly to minimize shocking the trees with raising water levels too quickly. These trees have historically grown in a shallow depressional area, however the presence of numerous knees indicate that the trees are accustomed to periodic inundation and they should be able to tolerate a moderate rate of inundation of approximately 2 inches per day; this can be accomplished with 2 pumps operating at S-390. **Limiting the inundation rate during start up to allow acclimation of the cypress trees will require revising the pump motor controls to a limit of two (2) pumps operating at one time.**

Once net improvement for phosphorus and mercury removal is demonstrated, and the pesticide samples are collected, the S-392 slide gate can be opened to allow the treated water to flow into Taylor Creek; the project structures can now be operated based on the normal operations in the following section. Once flow-through operations begin, the pump motor controls that limited the number of pumps operating during the start up phase should be reconfigured to allow all four pumps to operate simultaneously as conditions warrant, and revise the STA High-high level set point back to 26.5 ft.

Summary of Start up phase operations

- Revise the STA High-high level set point that shuts off the pumps to 23.6 ft
- Limit the number of pumps operating simultaneously to two (2) to allow the cypress trees to acclimate to higher water levels
- The target depth is between 0.5 ft and 1.0 ft
- With the gate at S-392 closed, and the gate at S-391 open fully, raise the water level in Cell 2 to an average of 22.6 ft (i.e., a depth of 1.0 ft), then close the S-391 gate and raise the water level in Cell 1 to an average of 23.6 ft (i.e., a depth of 1.0 ft).
- Once flow-through operations begin, reset the number of pumps operating simultaneously back to 4 and reset the STA High-high level set point back to 26.5 ft.

3.2 NORMAL OPERATIONS

Normal operations are defined as flow-through operations for flows up to and including the design peak pumping rate of 24 cfs. The operational goal is to capture and treat as much water through the STA as possible, subject to water availability in Taylor Creek and maintaining appropriate water depths in the STA. Analyses conducted during the design suggest an average flow of approximately 12 cfs will result from the inflow pump operations. This should yield average water depths of approximately 1.5 ft in the STA, although actual conditions may vary. Water levels in the STA will be adjusted through operation of the inflow pump and adjustment of the gates on the interior and outlet structures. Initial operating guidelines are provided below, however, as the STA vegetation matures the target water levels and gate openings will likely need to be refined based on actual operating experience.

3.2.1 S-390 Operations

During normal operations, the S-390 pumps will primarily operate based on a Taylor Creek water level sensor located approximately 150 feet upstream of the pump station. The pumps will begin sequencing on when the water level in the Taylor Creek rises above 20.0 ft [Note: It is recommended to lower the set point (and associated reset elevation) triggering the

sequencing of the pumps from the current elevation of 20.0 ft NGVD to around 18.0 ft. to ensure that maximum phosphorus removal of the STA can be achieved.] If the stage in Cell 1 exceeds 26.5 ft, which is 0.5 ft below the crest of the emergency overflow section, the S-390 pumps will cease pumping. Table 2 shows the percentage of time that the available flow in Taylor Creek at Grassy Island historically exceeded the pump capacities of the STA. Analyses conducted during the design indicated that approximately 95% of the time, there is sufficient flow in Taylor Creek to keep at least one pump running (Stanley Consulting, Inc.).

Table 2. Flow availability in Taylor Creek.

Number of pumps operating	Pumping capacity against 9 ft head (cfs)	Percentage of days flow is available in Taylor Creek
1	5.8	95%
2	11.5	88%
3	16.5	84%
4	21.4	74%

During normal operations, the pumps are set to run in automatic mode based on the operating breakpoints identified in Table 3 below. The pumps will be electronically rotated in an attempt to equalize the total running time among the pumps. A lag of 10 minutes is set between subsequent pump starts. Pump operating breakpoints were established during the design of the STA with the intent to operate S-390 as often as possible. Therefore, minimal intervention should be required. Local operation of this pump station is also possible, and remote operation and monitoring is scheduled to be made available in the future by the District.

Table 3. Pump operating points for S-390.

Pump operating points	**Water Level**	**Reset elevation**	**Purpose for operating point**	**Purpose for reset point**
Taylor Creek Stage, measured 150 ft upstream of S-390 intake				
Low level	Drops <17.0	Rises >17.5	Pumps start sequencing off	Pumps stop sequencing off
High level	Rises >20.0	Drops <19.5	Pumps start sequencing on	Pumps stop sequencing on
S-390 Pump Station, measured at wet well				
Low-low level	Drops <15.0	Rises >15.5	All pumps stop	Restart pump sequencing
High-high level alarm	Rises >25.0	N/A	Sends an alarm to field office	N/A
STA, measured at S-390 tailwater at northeast end of distribution canal				
High-high level	Rises >26.5	Drops <26.0	All pumps stop	Restart pump sequencing

3.2.2 Wet Season Operation

Structure S-391. According to the design documents, the peak flow through the STA is anticipated to be 24 cfs, which should yield a design pool elevation of 24.6 ft NGVD at the headwater of S-391 with the gate fully open (Stanley Consultants, Inc., 2003), however the capacity of S-391 may be less at this design pool elevation, as explained in the note at the beginning of Section 3. An analysis conducted during the design indicated that an average flow of 12 cfs is anticipated through the STA. With the gate at S-391 fully open, the rating curve developed during the design indicates this flow should result in a headwater stage at S-391 between 23.5 ft and 24 ft, yielding an average depth in Cell 1 of approximately 1.25 +/- ft.

Ideally, the gate opening at S-391 would be controlled electronically by the number of pumps running at S-390 to ensure ideal flows and water levels in the STA. However, cost considerations precluded electric gate operators and telemetry connection, necessitating manual monitoring and gate operation.

Until the issue of the hydraulic capacity is resolved, the recommended operation for S-391 during normal operations in the wet season is to keep the gate wide open to allow maximum flow through the treatment area during days when the pumps are on without exceeding the design pool elevation. To minimize dry out, it is recommended to partially close the gate 0.5 ft (to an elevation of 23.1 ft) during the wet season when no pumps are running. This initial guidance should be revisited periodically and revised based on field observations.

Structure S-392. According to the design documents, the peak flow through the STA is anticipated to be 24 cfs, which should yield a design pool elevation of 23.6 ft NGVD at the headwater of S-392 with the gate fully open (Stanley Consultants, Inc., 2003), however the capacity of S-392 may be less at this design pool elevation, as explained in the note at the beginning of Section 3. With the gate at S-392 fully open, the anticipated average flow of 12 cfs should result in a headwater stage at S-392 of approximately 22.5 ft – 23 ft, yielding an average depth in Cell 2 of approximately 1.25 +/- ft.

Until the issue of the hydraulic capacity is resolved, the recommended operation for S-392 during normal operations in the wet season is to keep the gate wide open to allow maximum flow through the treatment area during days when the pumps are on. To minimize dry out, it is recommended to partially close the gate 0.5 ft (to an elevation of 22.1 ft) during the wet season when no pumps are running. This initial guidance should be revisited periodically and revised base on field observations.

3.2.3 Dry Season Operation

An important aspect of the STA operation is avoiding treatment cell dry out, as dry out typically results in a release of phosphorus. To minimize the duration and frequency of dry out, the gates in S-391 and S-392 will need to be partially closed as the number of pumps in operation decrease. However, gate closure reduces the flow capacity of the treatment area at design peak flow, and since the gates are not operated remotely (i.e., they are not operated electronically in connection with the number of pumps in operations), more frequent manual gate changes will be required during the dry season. The ideal minimum water depth is 0.5 ft in both cells, suggesting the gates would be closed to an elevation of 23.1 ft at S-391 and 22.1 ft at S-392. However, to compensate for evapotranspiration and seepage losses, for the initial year it is recommended to close the gates to an elevation of 23.35 ft and 22.35 ft, which should establish a water depth of 0.75 ft during the dry season.

Subject to water supply conditions in the Taylor Creek basin, there may be times when S-390 should be operated outside the normal operating set points described in Table 3, specifically, turning on the pumps at Taylor Creek stages below 20 ft in order to prevent the STA from drying out.

Should the STA dry out, please refer to section 3.4.1 for operations following dry out.

Summary of Normal Operations:

- Wet season
  - The S-390 pumps will operate automatically to supply water to the STA based on stage in Taylor Creek
  - Leave the gates at S-391 and S-392 fully open when pumps are running
  - Partially close the gates 0.5 ft when no pumps are running
    - S-391 gate closed to elevation 23.1 ft
    - S-392 gate closed to elevation 22.1 ft
- Dry season
  - The S-390 pumps will operate automatically to supply water to the STA based on stage in Taylor Creek
  - Leave the gates at S-391 and S-392 fully open when pumps are running
  - Partially close the gates 0.75 ft when no pumps are running
    - S-391 gate closed to elevation 23.35 ft
    - S-392 gate closed to elevation 22.35 ft

3.3 EXTREME FLOW OPERATIONS

Discretion in the operation of the STA structures is reserved by the District Operations staff to account for excess precipitation and upstream and downstream conditions. The Taylor Creek STA has been designed to accommodate a peak flow of 24 cfs with the estimated rainfall resulting from the 10-yr 24-hr storm; depending on the wind and wave effects and the slope of the backwater profile, the stage in the cells may exceed the crest of the emergency overflow section and flow may occur to Taylor Creek over these sections. Flows and stages resulting from precipitation events smaller than this event should fall under "Normal Operating Conditions" for the STA.

To minimize the occurrence of emergency overflow resulting from extreme rainfall events, the inflow pumps at S-390 are set to shut off should the water level rise to an elevation of 26.5 ft at the upstream end of Cell 1 (equal to 0.5 ft below the emergency overflow crest elevation). Should water levels continue to rise above elevation 27.0 ft due to extreme rainfall, discharges will occur over the emergency overflow section in Cell 1. Should water levels in Cell 2 continue to rise due to extreme rainfall, discharges will occur over the emergency overflow section that has a crest elevation of 26.0 ft.

Summary of Extreme Flow Operations:

- Prior to extreme events,
    - the trash rack should be checked to ensure it is clear and working properly, and
    - the gates at S-391 and S-392 should be checked to see that they are fully open.
- As soon as safety permits after extreme events,
    - the operating status of all the pumps and gates should be checked,
    - repairs made if needed, and
    - debris cleared if needed

3.4 DROUGHT OPERATIONS

Subject to water availability, operations of the STA should maintain water depths 0.5 feet above the average ground elevation in the treatment cells to minimize potential negative effects of dry out on project performance. The ability to maintain this minimum water elevation is determined primarily by the availability of water from the upstream watershed and on local rainfall. In the extreme case that there is no water available from the upstream watershed and/or from rain, the treatment cells may dry out. The severity and duration of the dry conditions that may lead to reduced project performance is currently unknown, as is the magnitude and duration of the potential depression of project performance. Analysis of the monthly compliance monitoring data collected at the project outflow monitoring station will be useful in making these determinations.

To minimize dry out, the gates in S-391 and S-392 will need to be closed down as the number of pumps in operation decreases. The ideal minimum water depth is 0.5 ft in both cells, suggesting the gates would be closed to a static water surface of 23.1 ft at S-391 and 22.1 at S-392. However, to compensate for evapotranspiration and seepage losses, for the initial year it is recommended to close the gates to an elevation of 23.35 ft for S-391 and 22.35 ft for S-392 during the dry season, yielding a water depth of approximately 0.75 ft.

Once it is suspected a drought is imminent, to the extent possible, water should be conserved within the treatment cells at higher than normal depths in anticipation of a decrease in future flows. S-392 should be closed and S-391 opened as needed to allow water depths in both cells to rise up to 2-2.5 feet if water is available. Should drought conditions persist and prevent the inundation of Cell 2 using S-390, the use of a small temporary pump (e.g., an 8-inch diameter unit) may be considered for maintaining a minimum depth of 0.5 feet in Cell 2. A temporary pump could be placed outside of the west perimeter levee and draw water from Taylor Creek to hydrate the vegetation in Cell 2.

3.4.1 Operations Following STA Dry Out

There will be times when there are insufficient flows and/or stages in Taylor Creek to operate the S-390 inflow pump for long enough durations to keep the treatment cells from drying out. Following reflooding after a dry out, treatment wetlands typically exhibit a spike in outflow concentrations, a result of phosphorus remineralization processes that occur with exposed sediment. To minimize the magnitude of this flux leaving the Taylor Creek STA, it is recommended to keep S-392 closed for approximately two weeks after dry out and following reflooding to a stage of 22.1 ft measured at S-392 headwater. This recommendation should be revisited periodically to ensure it is achieving water quality goal of annual net improvement. The severity and duration of the dry conditions that may lead to reduced project performance is currently unknown, as is the magnitude and duration of the potential depression of project performance. Analysis of the monthly compliance monitoring data collected at the project outflow monitoring station will be useful in making these determinations.

Management activities following a dry out will vary depending on the severity of the drought and the attendant loss of vegetation. For mild to moderate loss of vegetation, the inundation regime described in Section 3.1 above can be followed (i.e., slowly raising depths to 1.0 ft). For severe loss of vegetation, it may be necessary to limit the initial depth to 0.5 ft to promote re-establishment desirable emergent vegetation. The length of time to retain water in the STA before initiating flow-through should be based on achieving a net reduction in the weekly phosphorus concentrations. This recommendation should be revisited periodically to ensure it is achieving water quality goal of annual net improvement. Table 4 provides an estimate of time required for reflooding the cells.

Table 4. Estimated time required to raise water levels following dry out.

Pumps Operating	Flow (cfs)	Rise per day (ft)	Days to Raise Water 0.5 ft	Days to Raise Water 1 ft
1	5.8	0.06	8.9	17.7
2	11.6	0.15	3.2	6.5
3	16.5	0.24	2.1	4.2
4	21.4	0.32	1.6	3.1

Assumes 1/2 inch of ET and seepage losses per day

Summary of Drought Operations:

- S-392 should be closed and S-391 opened as needed to allow water depths in both cells to rise up to 2-2.5 feet, if water is available.
- Maintain a minimum depth of 0.5 ft if water is available; this may necessitate a small portable pumping unit to hydrate Cell 2.
- Following a dry out
    - keep S-392 closed for a period following reflooding to a stage of 22.1 ft, depending on the severity of dry out and the status of the treatment vegetation
        - if the vegetation is robust, the recommended period of closure following reflooding is approximately two weeks
        - if the vegetation is damaged, the period of closure will likely be greater, to be determined by field conditions and phosphorus levels

3.5 TREATMENT CELLS OUT OF SERVICE

After flow-through operations begin, the STA may be taken off-line for vegetation management or other activities in order to improve the phosphorus removal performance. Pumping at S-390 may be reduced or stopped during activities for performance enhancement, and S-391 may be adjusted to reduce or stop flow to Cell 2 depending on the management activities underway (please refer to the associated Taylor Creek STA Vegetation Management Plan for additional details). Depending on the severity of the management operations, the reflooding operations may or may not require similar actions as in the start-up phase, i.e., demonstrating a 4-week net improvement in phosphorus.

3.6 DEVIATIONS FROM THE OPERATION PLAN

This initial Operation Plan for the Taylor Creek STA is meant to be updated regularly based on field observations of stage-flow relationships, structure flow calibrations, and other factors. Discretion in the operation of the STA structures is reserved by the District Operations staff to deviate from these guidelines to account for flood protection, excess precipitation and upstream and downstream conditions. It is anticipated that after the first year of flow-through operation, and annually thereafter, this operation Plan will be reviewed to identify any needed revisions.

3.6.1 Deviations from the Water Control Plan

The Corps of Engineers developed a Water Control Plan for the Taylor Creek STA and this Operation Plan will be added to the Water Control Plan as an appendix. Deviations from that Plan may require advanced notification and approval from the Corps, as discussed below.

3.6.2 Deviation from Normal Operation.

The United States Army Corps of Engineers (USACE), Jacksonville District Engineer is occasionally requested to deviate from the normal regulation of the project. Prior approval for a deviation is to be obtained from the Jacksonville District Office (SAJ) except as noted below. The Jacksonville District Office will in turn obtain the necessary approvals from the South Atlantic Division (SAD) except as noted below. Deviation requests usually fall into the following categories:

3.6.2.1 **EMERGENCIES.** Some emergencies that can be expected include drowning and other accidents, failure of project facilities, and flushing of pollutants. Antecedent conditions, as well as forecasted storm events, may result in SFWMD declaring an Emergency Authorization Order which would result in an Emergency Deviation. Necessary action under emergency conditions is taken immediately, unless such action would create an equal or worse condition. The Jacksonville District Office should be informed as soon as practicable. Written confirmation should be furnished after the incident. SAJ will report these deviations to SAD.

3.6.2.2 **UNPLANNED MINOR DEVIATIONS**. There are unplanned instances where there is a temporary need for a minor deviation from normal regulation, although they are not considered emergencies. A change in releases is sometimes necessary for construction, maintenance, or inspection. These requested deviations are usually for duration of a few hours to a few days. Each request is analyzed on its own merits. Consideration is given to upstream watershed conditions, potential flood threat, conditions of lakes, and possible alternative measures. In the interest of maintaining good public relations, the request is complied with, providing there are no adverse effects on the overall project regulation for authorized project purposes. Approval for minor deviations will normally be obtained from the Jacksonville District by telephone. A written confirmation will be furnished after the deviation is completed. SAJ will report these deviations to SAD.

3.6.2.3 **PLANNED DEVIATIONS.** Each condition should be analyzed on its own merits. Sufficient data on flood potential, lake and watershed conditions, possible alternative measures, benefits to be expected, and probable effects on other authorized and useful purposes will be presented to the Jacksonville District along with recommendations for review and approval. SAJ will report these deviations to SAD and obtain approval.

In light of the uncertainty in specifying operating criteria necessary to optimize phosphorus removal in the Taylor Creek STA, the SFWMD has the authority to refine the operations described in this plan without seeking Corps approval, as long as those operations are within the overall range of water depths and flows anticipated in the project design documents.

4 OPERATIONAL PERMITS

4.1 LAKE OKEECHOBEE PROTECTION ACT PERMITS

On September 15, 2003, the Florida Department of Environmental Protection (FDEP) issued Lake Okeechobee Protection Act (LOPA) permit 0194485-001-GL to the Corps for the construction of the Taylor Creek STA.

Presently the FDEP and the SFWMD are negotiating the operations, maintenance and monitoring permit for the project (0194485-002-GL). Accordingly, the STA Operation Plan must be consistent with the requirements of those permits.

Additional information on the permits is found in the *Performance Plan for the Taylor Creek / Grassy Island STA.*

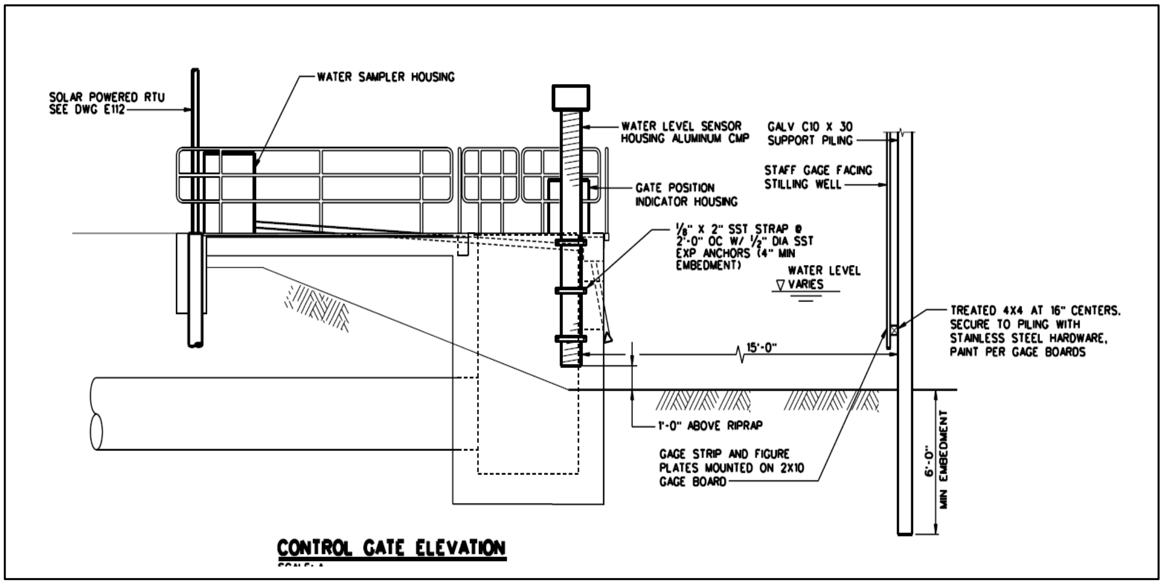
4.2 MONITORING

Data will be collected to monitor flow rates and phosphorus removal rates within the STA, as well to gather other water quality information. Inflow to the system will be determined by the manufacturer's pump curves and head determined from water levels transmitted from sensors upstream of the pump station and at the inflow distribution canal (deep zone trench) located inside Cell 1. At S-391, a gate level sensor, monitored in conjunction with the headwater level sensor will provide discharge information from Cell 1 to Cell 2. A similar arrangement of water and gate level sensors at the outfall of Cell 2 will provide total effluent discharge. The three flow measurements, one at the inflow, one at the separation levee, and one at the discharge end of the STA, in conjunction with local rainfall measurements, will enable the calculation of quantities of water treated and combined losses from seepage and evapotranspiration. Stage readings across the STA will also be helpful in assessing static and dynamic surface water profiles, allowing verification of estimates developed during design. A schematic of the hydraulic and water quality sampling arrangement for S-392 is shown in Figure 12.

A detailed water quality monitoring plan has been developed for the Taylor Creek STA. Contact W. Patrick Davis (SFWMD) for more information.

Additional information on the project evaluation and reporting can be found in the associated *Performance Plan for the Taylor Creek / Grassy Island STA.*

Figure 12. Stage and water quality sampling at control structure S-392.



5 COORDINATION

As with most large water resource projects, effective coordination within the agency and among the various agencies will be critical to ensure the STA operational objectives are achieved. The nature of this coordination will change as the project goes through the initial operational and testing period, and is then transferred to the District by the Corps.

5.1 Initial Operational Testing and Monitoring Period

In accordance with the Project Cooperation Agreement executed between the Corps and the District, prior to turnover of the project to the District, the Corps will conduct an **initial operational testing and monitoring period**. During this period, data will be collected to demonstrate that the project achieves the designated benefits. This period is further divided into two phases – a start-up phase (no discharge) and a flow-through phase once discharge commences. Prior to initiating flow-through (discharge) activities, phosphorus and mercury will be monitored to demonstrate that the STA is achieving a net improvement in both constituents. In addition, pesticide sampling will occur as a condition for moving into the flow-through phase. Once the District Engineer determines that the project is performing as designed, the Corps will transfer the project to the District for subsequent operations, maintenance, repair, replacement and rehabilitation, commencing the **operations phase.**

5.1.1 On-going data review and operational feedback

In accordance with the project PCA, the operation of the STA during start-up will be a joint effort of the Corps and the District. A **Project Coordination Team** consisting of Corps and District staff was established in accordance with the Project Cooperation Agreement, and this team will establish a protocol for communicating the start up operations between the agencies prior to the initiation of start up. Key aspects are to identify who will be the respective tactical contact points, and the appropriate type and frequency of start up communication. The frequency of telephone conferences and meetings will likely be weekly at first as issues surrounding structure operations may arise; experience in other new systems suggests that the frequency will likely decrease to approximately once per month by the end of the start-up phase.

Once flow-through operations begin, the weekly/monthly communications will include operational feedback (pump operations, gate openings, flow rates and water levels) in addition to the performance discussion. By that time, the criteria for project transfer from the Corps to the District should be finalized.

5.1.2 Interagency coordination

In addition to the day-to-day project coordination, by virtue of the fact that the Taylor Creek STA is a feature of an integrative set of water quality protection projects, project staff will necessarily be communicating and coordinating with other District staff (e.g., Lake Okeechobee Division), the Corps (CERP and related activities), FDEP (for permitting and other wetland protection purposes), and the Florida Department of Agriculture and Consumer Services (DACS, e.g., for implementation of watershed BMPs).

An initial list of potential contact persons from these agencies is presented below.

STA Project Manager: Lisa Kreiger, Staff Environmental Scientist, (863) 462-5280 x 3026 lkreiger@sfwmd.gov; South Florida Water Management District, Okeechobee Service Center, 205 N Parrott Ave, Suite 201, Okeechobee, FL 34972.

Program Manager: Dave Unsell, Lead Project Manager, (561) 686-8800 x 6888; dunsell@sfwmd.gov; South Florida Water Management District; 3301 Gun Club Road; West Palm Beach, FL 33406

Okeechobee Field Station: Terry Peters, Interim Director, 863-462-5280 x 3102; rpeters@sfwmd.gov; and Bruce Chesser, Interim Director of Field Operations, x 3114; bchesser@sfwmd.gov; Okeechobee Field Station, Okeechobee, FL

Operations Department: Tom Kosier, Environmental Operations Section (561) 682-6533; tkosier@sfwmd.gov; South Florida Water Management District; 3301 Gun Club Road; West Palm Beach, FL 33406

Water quality monitoring: W. Patrick Davis **Field Project Manager** (863) 462-5280 x 3171; wpdavis@sfwmd.gov; Okeechobee Water Quality Field Section, 1000 NE 40 Avenue, Okeechobee, FL 34972.

U. S. Army Corps of Engineers: Stephanie Jenkins; Hydraulic Engineer (904) 232-1612; Stephanie.L.Jenkins@saj02.usace.army.mil; US Army Corps of Engineers, Jacksonville District, ENHW, 701 San Marco Blvd, Jacksonville, Florida 32207 and Chuck Wilburn, Civil Engineer (863) 471-1741; Charles.R.Wilburn@usace.army.mil; Sebring Project Office, 6406 U.S. Hwy 27 S, Sebring, Florida 33876

Florida Department of Environmental Protection: Kim Shugar, Program Administrator, (561) 681-6706; kimberly.shugar@dep.state.fl.us; FDEP-Southeast District, 400 N. Congress Avenue, Suite 200, West Palm Beach, Florida 33401

Florida Department of Agricultural and Consumer Services: Bo Griffin, Environmental Manager, (863) 462-5883; griffid@doacs.state.fl.us; 305 E.N. Park Street, Suite C, Okeechobee, Florida 34972.

5.2 Operations Phase

Once the Corps transfers the project over to the District, the **Operations Phase** commences. Most, if not all, of the same degree of communication and coordination that began in the **initial operational testing and monitoring period** will continue.

5.2.1 On-going data review and operational feedback

The frequency and type of the weekly/monthly meetings during the Operations Phase may not differ from the earlier phases, depending on the status of the STA and whether or not there are significant refinements to the operations based on previous experience or permit requirements. During the summer, the performance evaluation for the previous water year should be drafted for including in the draft of the annual South Florida Environmental Report.

5.2.2 Interagency coordination

Depending on the Corps continued role and responsibilities after the project is turned over to the District, their involvement in the weekly/monthly coordination conferences may change in the Operations Phase. There may or may not be a shift in the other agency contacts shown in section 5.1.2 above, depending on the status of the STA and other needs.

5.3 COORDINATION WITH OTHER PLANS

The South Florida Water Management District (SFWMD), the U. S. Army Corps of Engineers (Corps), the Florida Department of Environmental Protection (FDEP), other agencies and private landowners are cooperating on efforts to improve water quality in the Lake Okeechobee watershed, and throughout the south Florida ecosystem. This cooperation includes studies and capital projects composing the Lake Okeechobee Protection Program, the Comprehensive Everglades Restoration Plan (CERP), and Critical Restoration Projects. The operations, monitoring and reporting associated with the Taylor Creek STA will be coordinated with several other plans, including:

1. The Lake Okeechobee Protection Plan
2. Draft Lake Okeechobee Water Retention / Phosphorus Removal Project – Taylor Creek (Grassy Island) Stormwater Treatment Area (STA) Water Control Plan
3. Operations, Maintenance, Repair, Replacement, and Rehabilitation Manual (USACE), as required by the Project Cooperation Agreement between the Corps and SFMWD
4. Vegetation Management Plan for the Taylor Creek / Grassy Island STA (Gary Goforth, Inc. 2005)
5. Performance Plan for the Taylor Creek / Grassy Island STA (Gary Goforth, Inc. 2005)

6 REFERENCES

Gary Goforth, Inc., Vegetation Management Plan for the Taylor Creek / Grassy Island STA, July 2005

Gary Goforth, Inc., Performance Plan for the Taylor Creek / Grassy Island STA, July 2005

Stanley Consultants, Inc., Lake Okeechobee Water Retention / Phosphorus Removal Project, Final Design Analysis Submittal, June 2003

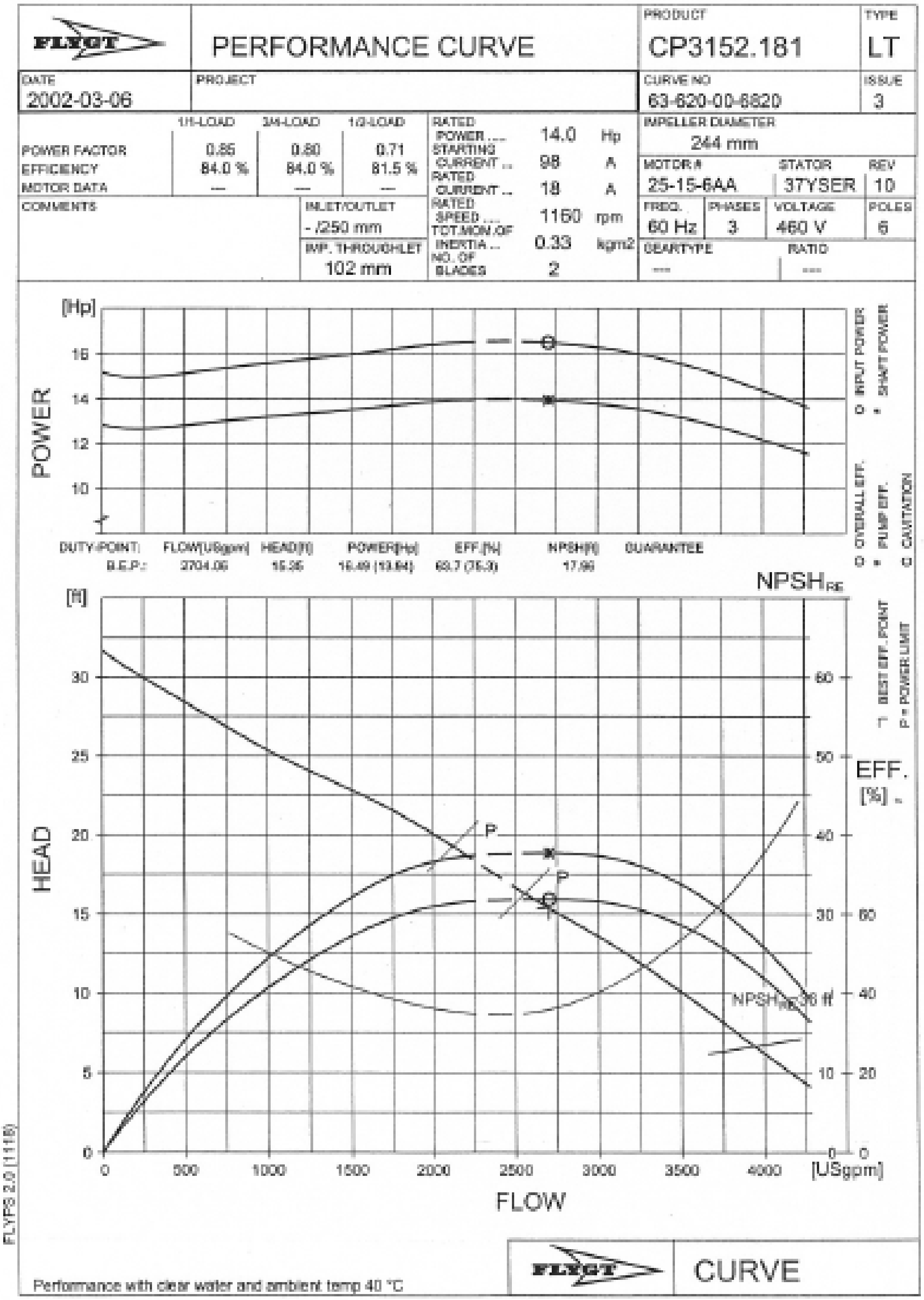
Stanley Consultants, Inc., Lake Okeechobee Water Retention / Phosphorus Removal Project, Final Design Document Report Submittal, June 2003

South Florida Water Management District, WQ Monitoring Plan For Taylor Creek Storm Water Treatment Area (STA), April 2005.

U. S. Army Corps of Engineers, Draft Lake Okeechobee Water Retention / Phosphorus Removal Project – Taylor Creek (Grassy Island) Stormwater Treatment Area (STA) Water Control Plan (June 2005)

APPENDIX A – ADDITIONAL PUMP STATION INFORMATION

PUMP PERFORMANCE CURVES

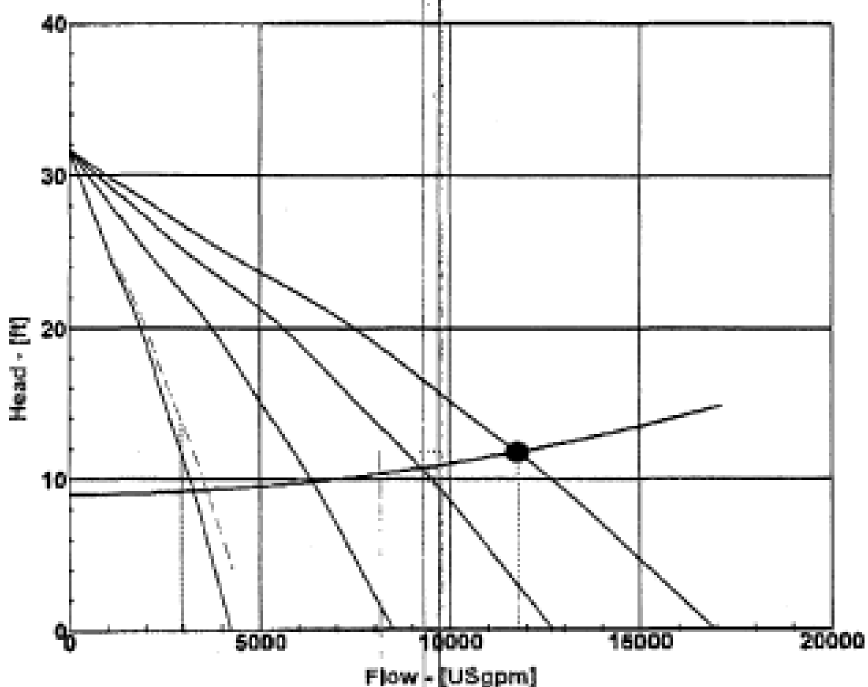


FLYGT

Duty Analysis - Duty conditions

Project: Taylor Creek

Created by:: Thomas Miller



Reduced curve

Pump curve

4 CP 3152 63-620-00-6820

PRODUCT DATA

Rtd. pwr.: 14 hp

Imp. diam.: 243.5 mm

Vanes: 2

Throughlet: 4 inch

DUTY CONDITIONS

No of pumps: 4

Flow: 11779.2 USgpm

Head: 13.9 ft

Reduced head: 11.7 ft

Shaft power: 55.2 hp

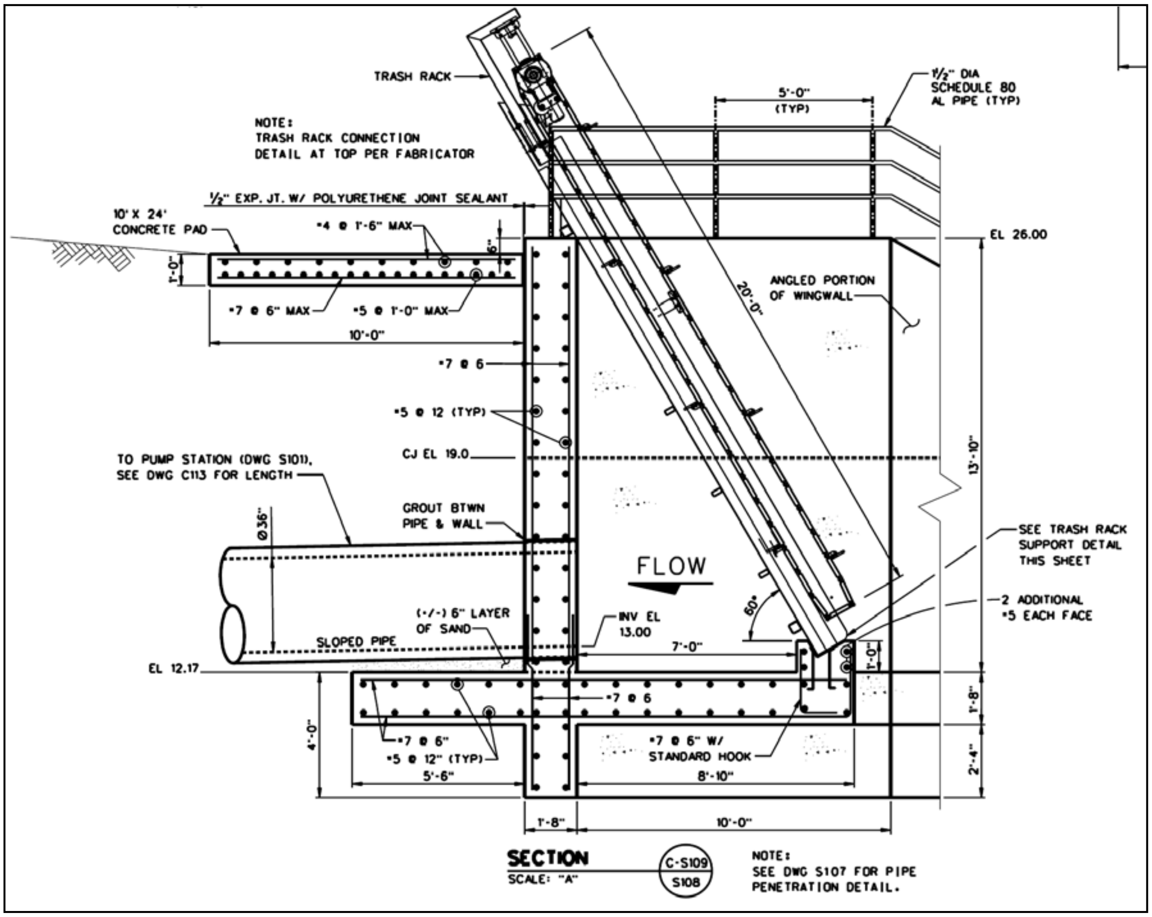
Pump efficiency: 74.9 %

Specifc energy: 68.8 kWh/mg

Flygt

ITT Industries

Schematic of the trash rack at S-390.



S-390 System Pumping Characteristics

Calculate Pump Head;
Taylor Creek

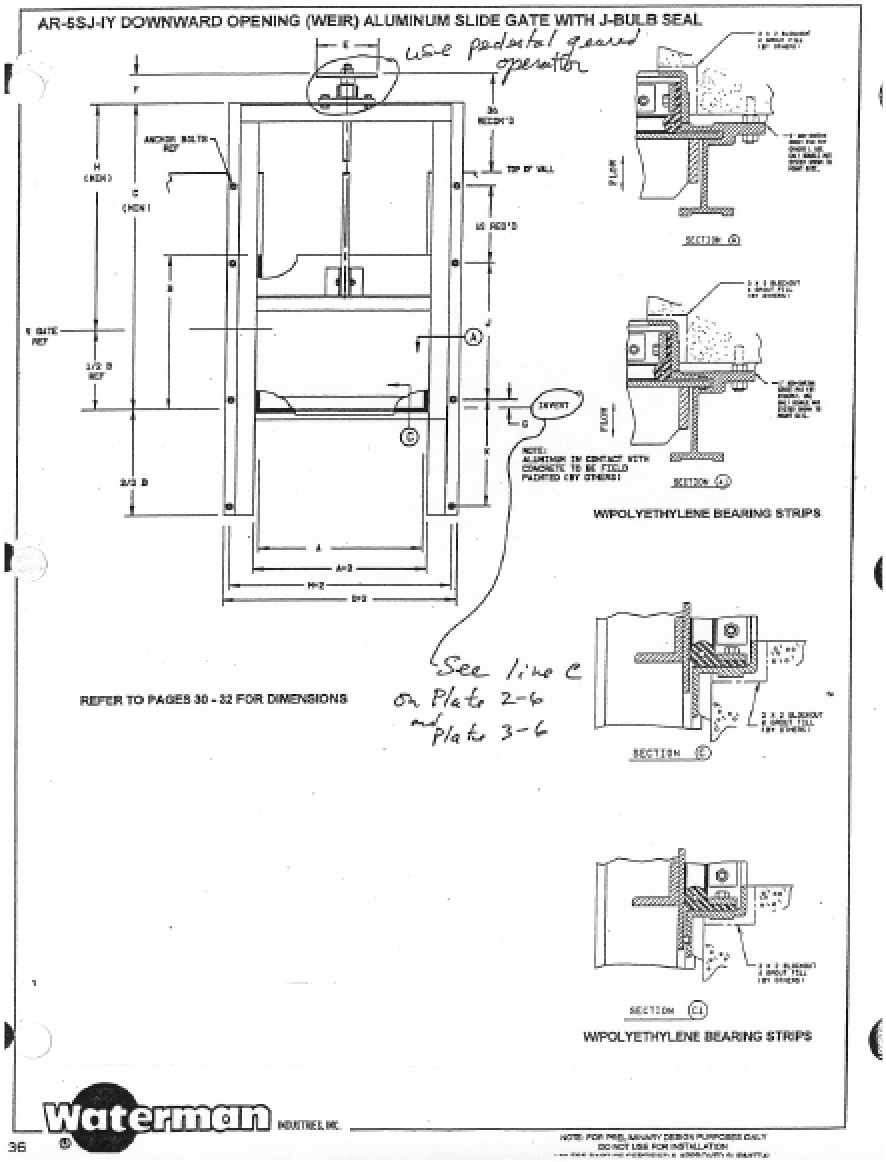
Static Head

WS.El In [ft]	WS. El. Out [ft]	Hs [ft]
17	26	9

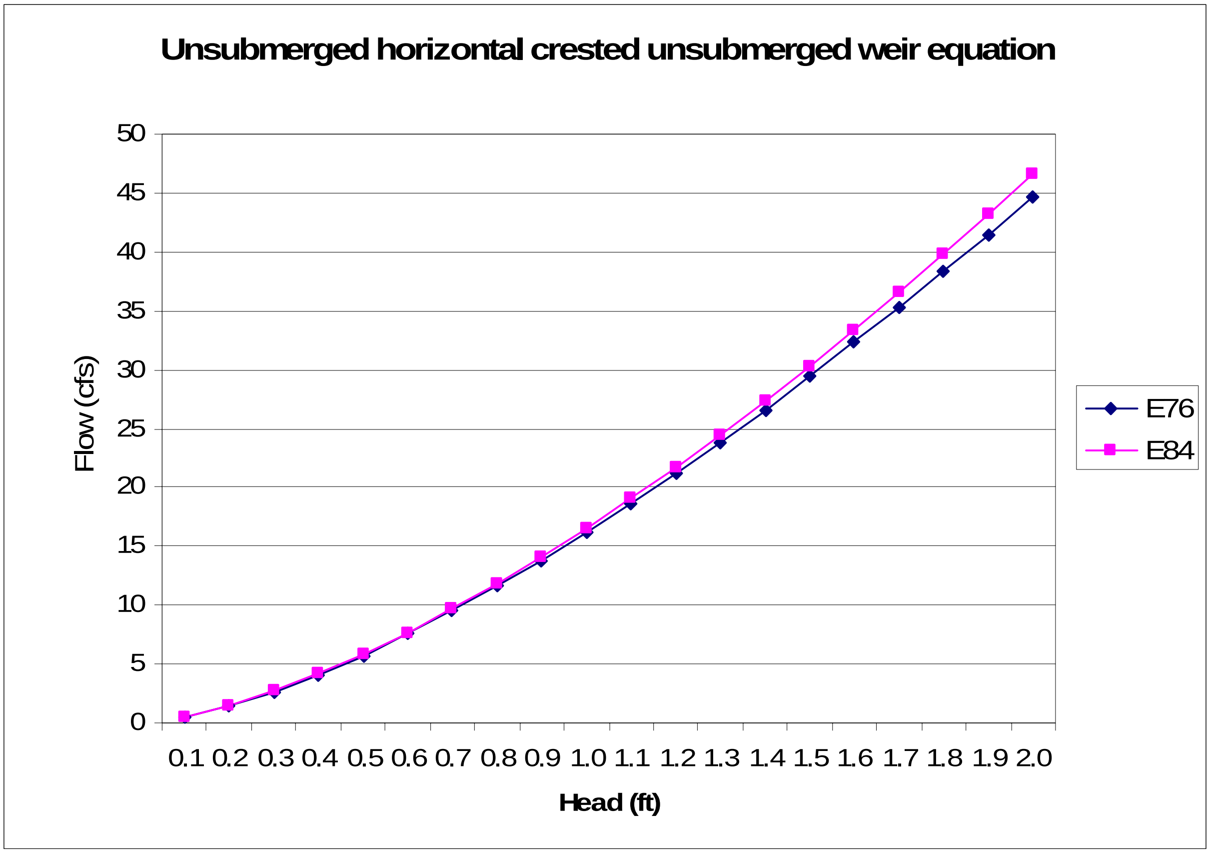
63-620-00-6820
Pump Cw 3152-181-LT-243

Friction Head Length [ft]	Diameter [ft]	Area [sf]	FM - Q [gpm]	cfs	FM - V [fps]	HW Coefficient	Hf [ft]	No. of Pumps	Dia. Dischge	Avg HPS	HtPS [ft]	HtFM [ft]	Hs [ft]	Htotal [ft]	1 Pump [ft]	eff.	2pmps	3pmps	4pmps
370	2	3.14	2000	4.5	1.42	140	0.10	1	10	6	4.04	0.03	9	13.18	20.1	56.1			
370	2	3.14	2200	4.9	1.56	140	0.12	1	10	6	4.89	0.04	9	14.05	18.7	59.2			
370	2	3.14	2400	5.3	1.70	140	0.14	1	10	6	5.82	0.04	9	15.01	17.3	61.6			
370	2	3.14	2600	5.8	1.84	140	0.17	1	10	6	6.83	0.05	9	16.05	16.0	63.4			
370	2	3.14	2800	6.2	1.99	140	0.19	1	10	6	7.92	0.06	9	17.17	14.8	64.7			
370	2	3.14	3000	6.7	2.13	140	0.22	1	10	6	9.10	0.07	9	18.38	13.5	65.5			
370	2	3.14	3200	7.1	2.27	140	0.24	1	10	6	10.35	0.08	9	19.67	12.2	65.9			
370	2	3.14	3400	7.6	2.41	140	0.27	1	10	6	11.68	0.09	9	21.05	10.8	65.9			
370	2	3.14	3600	8.0	2.55	140	0.30	2	10	6	3.27	0.10	9	12.68	9.3	65.5			
370	2	3.14	3800	8.5	2.70	140	0.33	2	10	6	3.65	0.11	9	13.09	7.7	64.6			
370	2	3.14	4000	8.9	2.84	140	0.37	2	10	6	4.04	0.12	9	13.53	6.2	63.3	20.1		
370	2	3.14	4200	9.4	2.98	140	0.40	2	10	6	4.46	0.14	9	14.00	4.7	61.5	19.4		
370	2	3.14	4400	9.8	3.12	140	0.44	2	10	6	4.89	0.15	9	14.48			18.7		
370	2	3.14	4600	10.2	3.26	140	0.47	2	10	6	5.35	0.17	9	14.99			18.0		
370	2	3.14	4800	10.7	3.40	140	0.51	2	10	6	5.82	0.18	9	15.52			17.3		
370	2	3.14	5000	11.1	3.55	140	0.55	2	10	6	6.32	0.20	9	16.07			16.7		
370	2	3.14	5200	11.6	3.69	140	0.60	2	10	6	6.83	0.21	9	16.64			16.0		
370	2	3.14	5400	12.0	3.83	140	0.64	2	10	6	7.37	0.23	9	17.23			15.4		
370	2	3.14	5600	12.5	3.97	140	0.68	2	10	6	7.92	0.24	9	17.83			14.8		
370	2	3.14	5800	12.9	4.11	140	0.73	2	10	6	8.50	0.26	9	18.49			14.2		
370	2	3.14	6000	13.4	4.26	140	0.78	2	10	6	9.10	0.28	9	19.13			13.5	20.1	
370	2	3.14	6200	13.8	4.40	140	0.83	3	10	6	4.32	0.30	9	14.44			12.9	19.6	
370	2	3.14	6400	14.3	4.54	140	0.87	3	10	6	4.60	0.32	9	14.79			12.2	19.2	
370	2	3.14	6600	14.7	4.68	140	0.93	3	10	6	4.89	0.34	9	15.16			11.5	18.7	
370	2	3.14	6800	15.2	4.82	140	0.98	3	10	6	5.19	0.36	9	15.53			10.8	18.2	
370	2	3.14	7000	15.6	4.96	140	1.03	3	10	6	5.50	0.38	9	15.92			10.1	17.8	
370	2	3.14	7200	16.0	5.11	140	1.09	3	10	6	5.82	0.40	9	16.31			9.3	17.3	
370	2	3.14	7400	16.5	5.25	140	1.14	3	10	6	6.15	0.43	9	16.72			8.5	16.9	
370	2	3.14	7600	16.9	5.39	140	1.20	3	10	6	6.49	0.45	9	17.14			7.7	16.4	
370	2	3.14	7800	17.4	5.53	140	1.26	3	10	5	6.83	0.48	9	17.57			7.0	16.0	
370	2	3.14	8000	17.8	5.67	140	1.32	3	10	6	7.19	0.50	9	18.01			6.2	15.6	20.1
370	2	3.14	8200	18.3	5.82	140	1.38	3	10	6	7.55	0.53	9	18.46			5.5	15.2	19.8
370	2	3.14	8400	18.7	5.96	140	1.45	3	10	6	7.92	0.55	9	18.92			4.7	14.8	19.4
370	2	3.14	8600	19.2	6.10	140	1.51	4	10	6	4.67	0.58	9	15.76				14.4	19.1
370	2	3.14	8800	19.6	6.24	140	1.58	4	10	6	4.89	0.60	9	16.07				13.9	18.7
370	2	3.14	9000	20.1	6.38	140	1.64	4	10	6	5.12	0.63	9	16.39				13.5	18.4
370	2	3.14	9200	20.5	6.53	140	1.71	4	10	6	5.35	0.66	9	16.72				13.1	18
370	2	3.14	9400	20.9	6.67	140	1.78	4	10	6	5.58	0.69	9	17.05				12.6	17.7
370	2	3.14	9600	21.4	6.81	140	1.85	4	10	6	5.82	0.72	9	17.39				12.2	17.3
370	2	3.14	9800	21.8	6.95	140	1.92	4	10	6	6.07	0.75	9	17.74				11.7	17.0
370	2	3.14	10000	22.3	7.09	140	2.00	4	10	6	6.32	0.78	9	18.10				11.3	16.65
370	2	3.14	10200	22.7	7.23	140	2.07	4	10	6	6.57	0.81	9	18.46				10.8	16.3
370	2	3.14	10400	23.2	7.38	140	2.15	4	10	6	6.83	0.84	9	18.83				10.3	16.0
370	2	3.14	10600	23.6	7.52	140	2.23	4	10	6	7.10	0.88	9	19.20				9.8	15.7
370	2	3.14	10800	24.1	7.66	140	2.30	4	10	6	7.37	0.91	9	19.58				9.3	15.4
370	2	3.14	11000	24.5	7.80	140	2.38	4	10	6	7.64	0.95	9	19.97				8.8	15.1
370	2	3.14	11200	25.0	7.94	140	2.46	4	10	6	7.92	0.98	9	20.37				8.2	14.8
370	2	3.14	11400	25.4	8.09	140	2.55	4	10	6	8.21	1.02	9	20.77				7.7	14.5
										Avg	6.38								

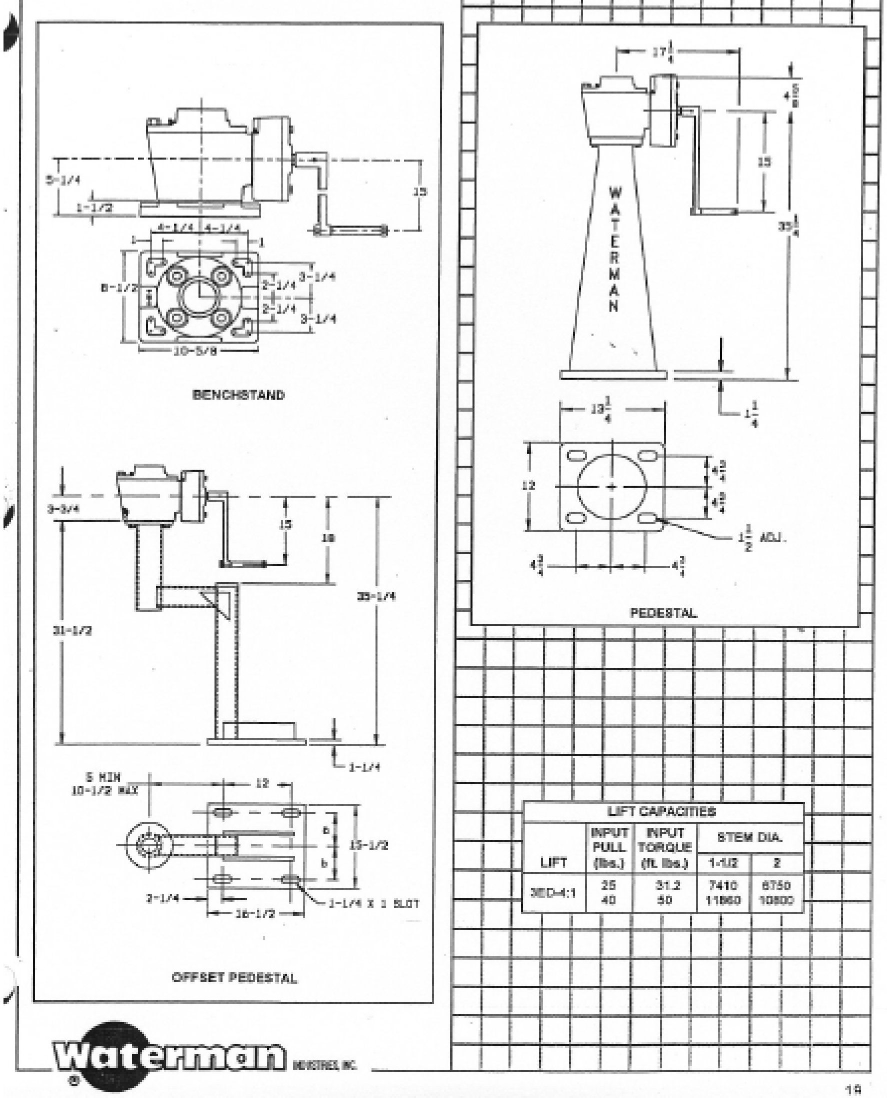
APPENDIX B – ADDITIONAL WATER CONTROL STRUCTURE INFORMATION



Rating curve for S-391 and S-392 gate orifices (Stanley Consultants, Inc)

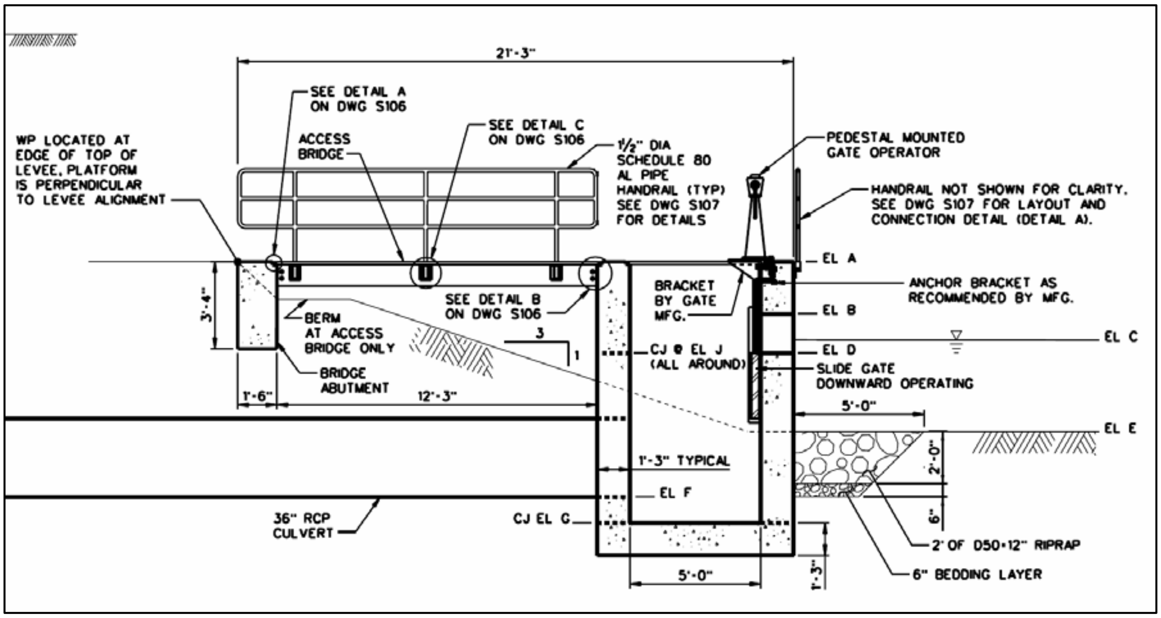


TYPE 3ED- 4:1 GEARED OPERATOR



LIFT CAPACITIES

LIFT	INPUT PULL (lbs.)	INPUT TORQUE (ft. lbs.)	STEM DIA. 1-1/2	STEM DIA. 2
3ED-4:1	25 40	31.2 50	7410 11860	6750 10800



CONTROL GATE ELEVATION TABLE			
LOCATION	ELEVATION	GATE ELEVATION	
		S-391	S-392
		WORKING POINT: X = 710476.722 Y = 1081342.548	WORKING POINT: X = 711786.049 Y = 1077652.381
TAYLOR CREEK	A	27.88	26.88
	B	24.60	24.50
	C	24.10	23.50
	D	22.60	22.00
	E	21.00	18.50
	F	18.50	17.50
	G	17.50	16.50
	H	23.50	N/A
	I	18.50	13.50
	J	24.00	22.00
	GATE SIZE	60X24	60X30

Downward opening slide gate at S-391.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

VEGETATION MANAGEMENT PLAN

TAYLOR CREEK / GRASSY ISLAND

STORMWATER TREATMENT AREA

Gary Goforth, Inc. *Wetland Consulting Services, Inc*

August 2005

Table of Contents

LIST OF FIGURES

1. Introduction

The South Florida Water Management District (SFWMD), the U. S. Army Corps of Engineers (Corps), the Florida Department of Environmental Protection (FDEP), other agencies and private landowners are cooperating on efforts to improve water quality in the Lake Okeechobee watershed and throughout the south Florida ecosystem. This cooperation includes studies and capital projects composing the Lake Okeechobee Protection Program, the Comprehensive Everglades Restoration Plan (CERP), and Critical Restoration Projects. The Lake Okeechobee Water Retention / Phosphorus Removal Project consists of two shallow stormwater treatment areas – the Taylor Creek Stormwater Treatment Area (STA) and the Nubbin Slough STA – designed to remove phosphorus loads from the Taylor Creek and Nubbin Slough watersheds. High phosphorus loads have been implicated in excessive eutrophication of Lake Okeechobee that have resulted in algal blooms, high sediment oxygen demand, and loss of fisheries and recreational benefits provided by the lake.

The Taylor Creek STA is one of the Critical Restoration Projects authorized by Congress through Section 528 of the Water Resources Development Act of 1996. The project was designed by Stanley Consultants, Inc. working under contract to the Corps, who was responsible for construction. Construction is presently underway with completion scheduled for summer 2005. The SFWMD, as the project sponsor, assisted in funding the capital works and is responsible for operation and maintenance of the STA. The anticipated long-term average phosphorus reduction within the STA was estimated during the design phase to be approximately 38% (2 tons per year), or about 9% of the phosphorus load of Taylor Creek at the project location.

The Taylor Creek STA is located approximately two miles north of the City of Okeechobee, adjacent to Taylor Creek and immediately northwest of the U.S Highway 441 bridge that spans Taylor Creek. A gated driveway will provide access to the project site, and the water control structures can be reached by traveling along the top of the levee. The southern end of this project is approximately seven miles from the edge of Lake Okeechobee. The Taylor Creek site originally consisted of pasture, upland forest, depressional marsh, and cypress/forested wetland habitats. The Florida Natural Areas Inventory designated the very southern end of the Taylor Creek Site as an area of conservation interest, in connection with the larger forested wetlands system in the slough along Taylor Creek (Corps 2005). According to the Fish and Wildlife Coordination Act report of the U.S. Fish and Wildlife Service (USFWS), the adjacent lands, open pastures with scattered cabbage palms are prime foraging and nesting habitat for Audubon's crested caracara. In addition, the wooded areas (wetland and upland) provide habitat for migratory and resident birds.

This document is intended to provide District vegetation management staff with the information necessary to maintain Taylor Creek STA in a manner that provides the greatest nutrient removal from the vegetation community within the perimeter levee. Appropriate management options are provided for each phase of operations and strategies for managing adverse conditions will be discussed. While this vegetation management plan (Plan) cannot predict the full range of conditions that may affect the STA or provide comprehensive solutions for every event, the information contained within should provide sufficient guidance to enable District staff to meet the project objectives.

2. Background

2.1 STA Background

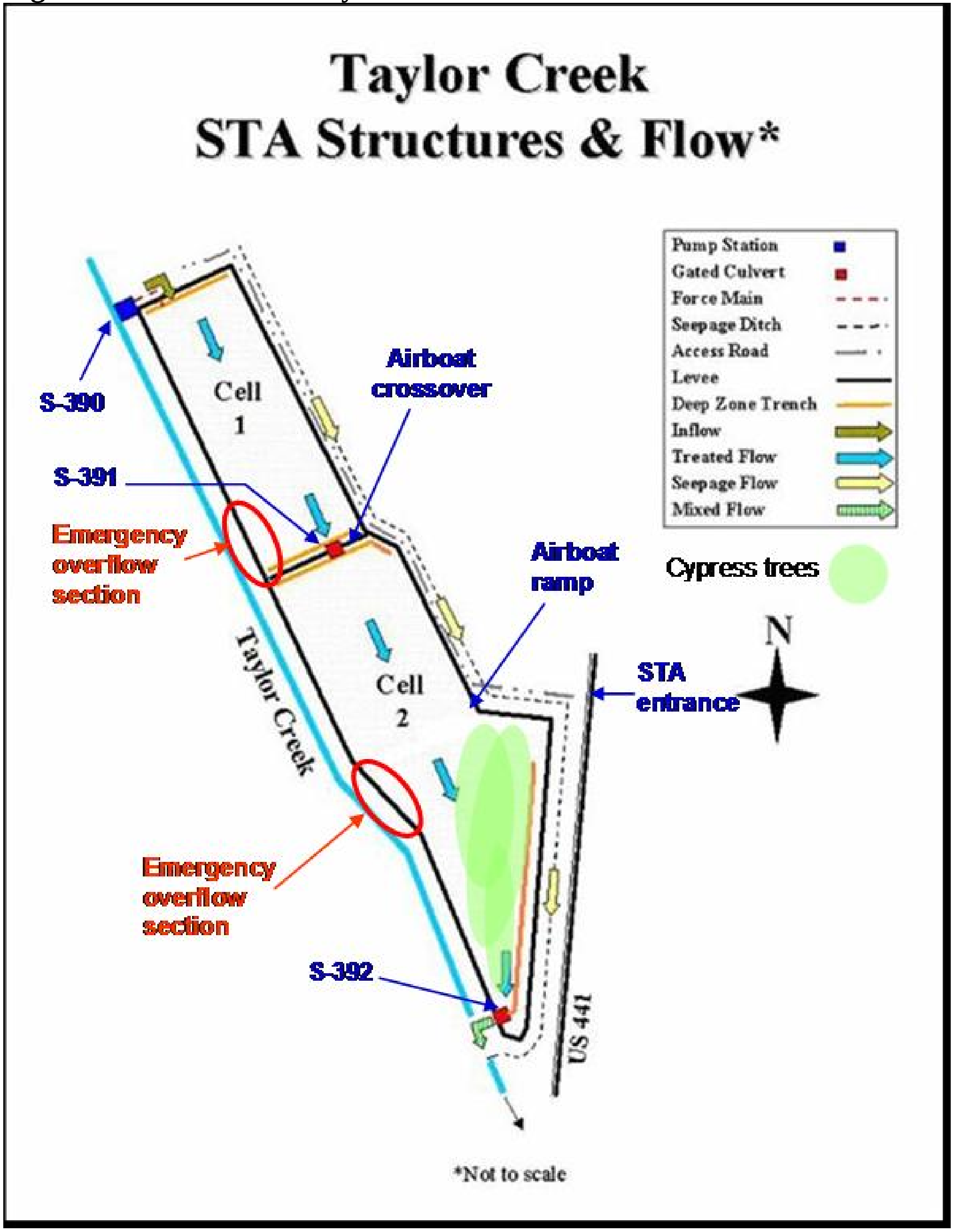
The land that the project occupies was most recently used for cattle operations before construction of the Taylor Creek STA began. Prior to construction, most of the property consisted of wet and dry pasture, a few small depressions, some upland forest and a large stand of cypress trees at the south end of the property.

Taylor Creek STA is a long, narrow enclosure that parallels Taylor Creek (shown in Figure 1). An inflow pump station lifts water from Taylor Creek at the north end of the STA and delivers it into the treatment area. Treatment occurs through natural biogeochemical processes as the water slowly flows by gravity southeasterly through the 49-acre Cell 1 and subsequently through the 93-acre Cell 2 before being discharged back to Taylor Creek. Water levels and flow rates through the treatment cells are controlled by individual gated structures located at the southeast end of each cell. The predominant grade within the Taylor Creek STA creates flow northwest to the southeast but the general slope of each cell is from east to west, making the water on the west side of the cells deeper than on the east. Some portions of the southeast corner of Cell 2 containing a stand of cypress and other wetland hardwood trees will remain dry most of the time. Deep zone trenches at the inflow and outflow of each cell are designed to help distribute flow evenly throughout the cell.

2.2 Vegetation History and Existing Conditions

Based on knowledge and experience gathered from the operation and maintenance of many large STAs, it was assumed during design that cattail (*Typha* sp.) would colonize the project early and eventually become the dominant plant species within the treatment cells. Initial observations of the two treatment cells just prior to construction completion (May, 2005) revealed the presence of cattail and a significant variety of other native wetland plant species, including bulrush, pickerelweed and maidencane, perhaps indicating that a viable source of seeds for these plants remains on the property. No planting activities are planned at Taylor Creek STA; wetland vegetation will colonize the treatment cells through natural recruitment. Also observed were several notable invasive exotic plants, such as torpedo grass, that may need to be treated (depending on its nutrient uptake ability and other factors) to help ensure optimal performance of the STA. This will be discussed in further detail in section 3.1.2.

Figure 1. Schematic of Taylor Creek STA.



2.3 Project Objectives

The goal of Taylor Creek STA is to capture and reduce the mass of total phosphorus from the Taylor Creek Basin prior to discharge back into Taylor Creek and on to Lake Okeechobee. The phosphorus concentration in Taylor Creek runoff exhibits considerable variability, with an average of approximately 500 parts per billion (ppb). This greatly exceeds the phosphorus concentration of Lake Okeechobee, which averages just over 100 ppb. Emergent wetland vegetation (bulrush, duck potato, cattail, pickerelweed, etc.) has already begun to colonize the treatment areas, and average depths of less than 2 feet should be conducive to sustaining these communities. The long-term phosphorus storage mechanism within the STA will be the accretion of new organic sediment, and for this reason it is important to operate the STA to avoid dry out, which could release nutrients through remineralization of these sediments. In addition to the reduction of phosphorus loads, Taylor Creek STA will provide additional water quality and quantity benefits to downstream waters, including the removal of suspended solids, dissolved and particulate oxygen-demanding materials, total nitrogen, metals, and pesticides that would otherwise flow into the lake.

The development and successful management of vegetation plays an important role in optimizing the phosphorous reduction abilities of stormwater treatment areas. The objectives of this Plan are to provide the methods required to successfully and cost effectively maintain the desired vegetation communities within the STA. The District will operate and maintain the STA in accordance with the final Operation Plan and this Plan. This District will also confer with the USACE regarding any major variations to the plans necessary to meet the goals of this project.

3. Vegetation Management Activities

3.1 Management Activities During Start-up Operations Phase

In order for an STA to perform in a manner consistent with its stated objectives, an appropriate plant community must first be established. The selection of an effective community can only result from the consideration of several factors, including the hydrology of the STA (water depths, velocity, hydroperiod), what wetland plants, if any, are/were present on the property, soil type(s), and basin water quality characteristics. Once the desired plant community has been identified, operations and maintenance activities will likely need to be concentrated during this initial grow-in phase to help ensure that it is established successfully and undesirable plants are controlled within the STA.

The Taylor Creek STA will be managed as a shallow, emergent marsh system intended to reduce nutrient loading to Lake Okeechobee. Depths will range from 0.5 to 3.0 feet but should average approximately 1.5 feet. Based on the hydrologic analyses conducted during the design, approximately 95% of the time the STA should have flow of approximately 6 cfs (Stanley Consultants, Inc. 2003), hence dryout is expected to be infrequent and limited to the dry season. The average hydraulic loading rate at the expected average flow of 12 cfs would be approximately 6.2 cm/day, which is 2-3 times greater than the average rate of the STAs constructed as part of the Everglades protection program. The average water velocity at 12 cfs is expected to be approximately 0.01 ft/sec or about 1100 ft per day. The resulting plant community is expected to be lentic (i.e., characterized by slowly moving water) in nature.

Much of the Grassy Island Ranch property has historically been saturated for part of the year and supported a variety of desirable wetland plant species. It was determined that Taylor Creek STA would not be planted with additional wetland plants, but rely on natural revegetation from internal and external sources. Previous experience with STA start-up has shown that initial vegetation growth will depend on the seed source found in STA soils and viable plants and seeds carried into the STA by wind, water and wildlife. Because of its proximity to Taylor Creek and low elevation, the portion of Grassy Island Ranch that Taylor Creek STA occupies contained a variety of wetland plants that would be appropriate for inclusion in an STA and could be reestablished through deliberate management of water levels.

The mature cypress tree stand located in Cell 2 should be inundated slowly to minimize shocking the trees with raising water levels too quickly. These trees have historically grown in a shallow depressional area, however the presence of numerous knees indicate that the trees are accustomed to periodic inundation and they should be able to tolerate a moderate rate of inundation, such as that recommended for STA start-up. Inundation rates during start-up are expected to be about 2 inches per day with 2 pumps operating. Specific operational details are contained in the Operation Plan for the Taylor Creek / Grassy Island STA.

Figure 2. Mature cypress tree stand in Cell 2.

Native soils at Taylor Creek STA consist mainly of fine sands of the Myakka and Immokalee Series, but also include other frequently flooded soils of the Floridana, Placid and Okeelanta Series, mainly in Cell 2 where the cypress and other wetland hardwood trees are growing. Fine sands provide appropriate substrate for virtually all desirable emergent wetland plants listed in Table 1 and should help resist the occurrence of floating plants and the creation of potentially damaging tussocks.

In terms of water quality, the characteristics most important to the vegetation community and ultimately the performance of an STA are perhaps nutrient loading and phosphorus in particular. Total Phosphorus (TP) concentrations in the Taylor Creek basin upstream of the STA have most recently averaged around 500 - 700 parts per billion (ppb), which will create hyper-eutrophic conditions within the STA. Plants that once naturally occurred in the area may be best suited to exist in this high-phosphorus environment, but several species of nuisance vegetation are also well-equipped to thrive here. Should additional varieties of vegetation be considered for planting in the future, they should be chosen based partly on their ability to compete with existing plants in a hyper-eutrophic setting.

3.1.1 Strategies to encourage desirable emergent vegetation

Effectively managing water levels in Cells 1 and 2 will be necessary to create a desirable emergent marsh plant community through synchronized operation of the inflow pump station (S-390) and the two water control structures, S-391 and S-392, to regulate depths within the treatment cells. The Operations Plan prescribes activities designed to establish a water depth of ***1.0 ft*** in both treatment cells to promote seed germination and young plant growth within the emergent marsh community. If the initial depth is allowed to exceed much more than 1.0 ft, plant growth may be hindered by reduced available sunlight, particularly if the water is turbid or tannin stained.

Table 1. Desirable Plants in an Emergent Marsh

Cattail	*Typha* spp.
Sawgrass	*Cladium jamaicense*
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 cordata*
Duck potato	*Sagittaria lancifolia*
Arrowhead	*Sagittaria latifolia*
Maidencane	*Panicum hemitomon*
Switch grass	*Panicum virgatum,*
Barnyard grass	*Echinochloa* spp.
Flat Sedge	*Cyperus* spp.
Giant reed	*Phragmites australis*
Wax myrtle	*Myrica cerifera*
Elderberry	*Sambuca canadensis*
Primrose willow	*Ludwigia* spp.
Smartweed	*Polygonum* spp.
Alligator flag	*Thalia geniculata*

3.1.2 Strategies to exclude invasive or non-desirable vegetation

Should non-desirable plants become established in either treatment cell during the start-up phase, it may be necessary to apply appropriate herbicides to eliminate or control their spread. Certain exotic plants may out-compete more desirable native species, sometimes displacing them entirely over time, and are suspected of reducing system performance. Additionally, Taylor Creek STA should be maintained in a manner that will not cause the spread of exotic plant species to downstream areas.

If undesirable plant species are observed within the treatment cells, particularly those listed in Table 2, a qualified vegetation management specialist should be consulted who can help develop an appropriate strategy for controlling the infestation. If deemed necessary, herbicides may be applied using several approved methods including aerial, vehicle, airboat or backpack based equipment. The size of the infested area will usually dictate the method of application, but in almost every case, herbicides must carry a label approving it for aquatic use to be applied within the STA. Care must be taken to reduce herbicide impacts to desirable plants while targeting potentially harmful species. Also, if applying herbicide to a large area within the treatment cell(s), the effects that a subsequent nutrient release may have on the start-up compliance test should be carefully considered.

Table 2. 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 terebinthifolius*
Melaleuca tree	*Melaleuca quinquenervia*
India cupscale grass	*Sacciolepis indica*

*Although a Category I invasive exotic, torpedo grass may be tolerated in some STA settings.

There are several species of non-rooted, floating plants that could retard emergent plant growth and reduce performance if they become established within the STA. The most effective management strategies to prevent this are keeping the trash rack clean and maintaining a maximum depth of ***1.0 ft*** within both treatment cells during start-up. A clean trash rack will reduce the chance of these plants entering the system and shallow cell depths will prevent their spread should some pass through the inflow pumps. Once a healthy emergent plant community is established in the STA, it will be less vulnerable to invasion by noxious floating plants.

3.2 Management Activities During Normal Operations

Upon completion of the Start-Up Operation Phase, Taylor Creek STA will enter normal operations and be subject to a wider variety of water depths, control structure settings, and possibly research and monitoring activity. Maintaining appropriate depths within the cells will be an important part of successful management because of the variety of plant species that occur in the STA. For example, maintaining depths in excess of the targets may eventually eliminate certain plant species, creating large unvegetated areas that are vulnerable to invasion by inappropriate plants. Likewise, allowing depths to fall below the targets or below ground surface may also create large vegetation die-offs and a subsequent invasion of undesirable plants.

Table 3. Treatment Cell Size, Vegetation and Estimated Target Depths/Stages

Cell	Cell Area (acres)	Target Vegetation	Design Ground Elevation ft NGVD	Target D/S Start-up ft/NGVD	Target D/S Normal Ops Ft/NGVD
1	49	Emergent Marsh	22.6	1.0 / 23.6	1.5 / 24.1
2	93	Emergent Marsh	21.6	1.0 / 22.6	1.2 / 22.8

Note: These stages and depths are estimates and will be revised based on actual observed conditions.

3.2.1 Strategies to maintain desirable emergent vegetation

Except for unusual events, Taylor Creek STA will always be managed in the normal operations mode. In this mode, District staff should seek to always maintain treatment cell depths within the target range to promote healthy plant communities and reduce the possibility of invasion by nuisance species. In both treatment cells, depths should range primarily between ***0.5*** and ***2.0 ft***, with higher levels during intense rainfall events.

Through experienced gained by operating other large STAs, a seasonal pattern of performance should be expected at this STA. Peak vegetation growth and system performance will likely occur during spring and summer, taper downward during autumn and reach their lowest levels during winter. As a result, the system will respond most quickly to operational changes such as varying depths and herbicide applications during the spring and summer, something to consider when planning any modifications or activities.

Also, physical disruption within the treatment area of the STA should be avoided to prevent damaging the plants. Appropriate airboat operation (non-recreational) will not likely have adverse impacts on the vegetation in either treatment cell, but the use of heavy equipment should be restricted to activities that are deemed necessary for operations or maintenance purposes. One possible form of impact to be avoided would be the accidental creation of furrows or ditches that could allow water to flow in a more direct fashion through the project, bypassing critical treatment area. This diversion from a sheet flow pattern is known as a 'short circuit' and can reduce STA performance.

3.2.2 Strategies to control invasive/non-desirables

Should non-desirable plants become established in either treatment cell during the normal operations phase, it may be necessary to apply appropriate herbicides to eliminate or control their spread. Again, a qualified vegetation management specialist should be consulted for their opinion on the severity of the infestation and potential treatment options.

Depending on the undesirable vegetation in question, it may be appropriate to delay treatment until hydrologic or seasonal conditions improve, particularly if an herbicide application is recommended. As discussed previously, seasonal variations can impact herbicide efficacy. Should mechanical harvest be recommended to eliminate an infestation, managers should carefully consider the compatibility of the equipment with the treatment area. For instance, to remove a hypothetical water lettuce invasion from the north deep zone trench in Cell 1, it may be possible for Operations Control to temporarily raise the water level in Cell 1 (particularly during the summer) to allow a mechanical harvester or tow boat access to the deep zone. This equipment would be otherwise unable to access the treatment cell without causing damage.

Spot treatment of undesirable vegetation has largely been considered ineffective in other STAs because of their great size. However, at less than 150 acres, Taylor Creek STA may be small enough for backpack or airboat based herbicide application, particularly for invasive shrubs and trees growing alone or in small stands. This treatment strategy may also work for undesirable herbaceous plants that are not yet spatially extensive enough for aerial applications. Again, qualified vegetation management specialists should be consulted for specific treatment remedies. Control of terrestrial invasive plants on the interior and perimeter levees should be left to qualified vegetation management technicians dispatched from the Okeechobee Field Station.

3.3 Management Activities During Drought

The potential for drought conditions to impact the vegetation viability and subsequent nutrient removal performance of an STA cannot be overstated. Even a drought considered moderate in severity could cause a significant shift in the vegetation community and excessive soil oxidation within an STA, leading to a reduction in performance upon returning to normal operations. While it is possible that a drought may not cause serious long-term damage to the treatment area, operations at Taylor Creek STA should be managed carefully during drought conditions to help ensure a prompt return to normal operations once the drought has passed. The Operations Plan describes control structure operations designed to minimize the adverse impacts of droughts.

3.3.1 Strategies to maintain native/desirable vegetation

Based on the availability of water in the Taylor Creek basin, S-390 will be operated to maximize the flow through the treatment area. To minimize the duration and frequency of dry out, the gates in S-391 and S-392 will need to be partially closed as the number of pumps in operation decrease (see Operations Plan for specific details). The Operations plan describes gate closings to maintain a minimum depth of 0.75 feet in the dry season of the initial year to protect the vegetation community from dry-out.

Once it is suspected a drought is imminent, to the extent possible, water should be conserved within the treatment cells at higher than normal depths in anticipation of a decrease in future flows. S-392 should be closed and S-391 opened as needed to allow water depths in both cells to rise up to 2 feet, and up to 3 feet if possible.

Subject to water supply conditions in the Taylor Creek basin, there may be times when S-390 should be operated outside the normal operating range described in the Operations Plan, specifically, turning on the pumps at stages below 17-20 ft in order to prevent the STA from drying out. Should drought conditions persist and prevent the inundation of Cell 2 using S-390, the use of a small temporary pump (e.g., an 8-inch diameter unit) may be considered for maintaining a minimum depth of 0.5 feet in Cell 2. A temporary pump could be placed outside of the west perimeter levee and draw water from Taylor Creek to hydrate the vegetation in Cell 2.

If it is not possible to maintain the 0.5 ft minimum depth, sufficient water should be provided to ensure that all treatment area soils are saturated to protect some of the emergent plant species. Certain plants, like cattail, can tolerate dry soils for short to moderate periods; however others, such as bulrush, may not survive as well without some standing water. However, if all STA soils are maintained in a saturated condition through the drought, a significant portion of the vegetation should survive.

Operations Following STA Dry Out. Management activities following a dry out will vary depending on the severity of the drought and the attendant loss of vegetation. For mild to moderate loss of vegetation, the inundation regime described in Section 3 above can be followed (i.e., slowly raising depths to 1.0 ft). For severe loss of vegetation, it may be necessary to limit the initial depth to 0.5 ft to promote re-establishment of desirable emergent vegetation. The length of time to retain water in the STA before initiating flow-through should be based on achieving a net reduction in the weekly phosphorus concentrations. This recommendation should be revisited after the first year of flow-through operation to ensure it is achieving a water quality goal of annual net improvement.

3.3.2 Strategies to control invasive/non-desirables

Maintaining water depths as described in Section 3.3.1 during drought conditions will help prevent invasion of undesirable vegetation. The onset of drought can provide invasive or undesirable plant species an opportunity to displace desirable wetland plants and cause a long-term shift in the vegetation of an STA that could affect system performance. A severe drought could cause a loss of part of the wetland plant community and allow upland grasses or shrubs to invade the treatment cells, which would delay the re-establishment of an effective wetland plant community when the drought subsides. Staff should remain vigilant against the invasion of undesirable plants during drought conditions and qualified vegetation management specialists should be consulted for herbicide treatment options when nuisance vegetation is observed.

3.4 Management Activities During High stage/flow conditions

During periods of heavy rainfall over the Taylor Creek basin and high water levels within the STA, impacts to the treatment cell plant communities should be carefully observed. Prolonged water depths in excess of 3.0 feet may damage certain components of the vegetation communities and reduce performance in both treatment cells.

3.4.1 Strategies to maintain native/desirables

The inflow pump and structure operations described in the Operations Plan should prevent prolonged periods of excessive depths. After a high stage/flow event, Taylor Creek STA should be inspected, the condition of the emergent plants noted as well as any other areas of concern. Should the stage inside the cells exceed the crest elevation of the emergency overflow sections, water will overtop the west perimeter levee and may carry with it some floating or uprooted plant material.

Figure 3. Headwater side of S-390 showing automatic trash rack

In the event of a catastrophic loss of vegetation during a storm (such as occurred in STA-1W following Hurricane Jeanne in September 2004), STA managers could consider lowering depths to 0.5 feet at Taylor Creek STA to help accelerate the restoration of the desired emergent marsh community. Once treatment cell vegetation is deemed to be in satisfactory condition, the operations described in Section 3.3.1 above should be followed.

3.4.2 Strategies to control invasive/non-desirables

A high stage/flow event may carry certain species of invasive vegetation into the STA, particularly floating plants such as water hyacinth or water lettuce. Prior to these extreme events, the automatic trash rack at S-390 should be checked and cleared if necessary. A mass of floating vegetation pressing against the trash rack could force plants through the bars and into Cell 1 where it could spread throughout the cell.

Operations staff should be aware of the possible effects of high stages and flows on the plant community at Taylor Creek STA. Protecting the desirable plants from disruption and stress caused by storm events will also help prevent subsequent invasion by nuisance plants, which can save significant maintenance dollars. The strategy described in Section 3.4.1 to discourage encroachment by invasive plant species should be considered following high stage/flow events.

4. Long-Term Management Activities

A regular quantitative analysis of STA vegetation should be performed by appropriate staff to help provide some insight to prevailing trends among the plant community within the STA treatment area. Monthly observations from the levees and from SFWMD helicopter overflights should be used to help manage vegetation within Taylor Creek STA.

Observations from the STA levees should be performed monthly and include permanent monitoring stations from which to record observations and digital color photographs. These monitoring stations should be located along the perimeter and separation levees at no greater that 0.25 miles apart. The plant species observed at each station, their approximate dominance, the proportion of open water or unvegetated area, and any other important information should be recorded. To balance accuracy and simplicity, a scale from 0 to 100% that includes five ranges (0-20, 20-40, 40-60, 60-80, and 80-100) should be used to quantify vegetation coverage. Over time, this information will assist the SFWMD in managing Taylor Creek STA successfully.

Observations by project staff from SFWMD helicopters should also be performed regularly, perhaps when seats are available on routine regulatory flights, and include digital color photographs that clearly show vegetation identifiable to the genus or species level.

4.1 Aerial Photography

SFWMD should consider purchasing aerial photography of Taylor Creek STA each year for a general analysis of vegetation coverage and species composition within each treatment cell. A series of annual photos will provide helpful insight regarding the increase or loss of specific vegetation species. The best format for this photography is color infrared (CIR) and should be shot at a scale of approximately 1:6000. This aerial perspective is an additional reference point that STA managers may find extremely helpful, rather than relying solely on brief helicopter overflights or limited views from the levees.

4.2 Vegetation Mapping

The current FDEP permit issued to the Corps of Engineers requires that a baseline vegetation coverage map for Taylor Creek STA be created to provide a detailed analysis of vegetation coverage and species composition within each treatment cell; however, negotiations are underway to modify the permit to remove this requirement. The procedure involves acquiring CIR photographs, digitizing them, field verifying their contents and finally, producing a fully georeferenced vegetation map of the STA. While these maps can be potentially useful in tracking vegetation coverage statistics, they are very expensive to produce, require extensive effort to interpret and may have limited management value.

4.3 Advanced techniques

Over a period of time, an STA will mature and may eventually need additional monitoring or maintenance not yet described in this Plan. By monitoring long-term changes in the STA and planning for possible 'regenerative' maintenance, the system can be understood in greater detail, enabling more successful and cost-effective management of Taylor Creek STA. After a period of several years to perhaps several decades, the vegetation within an STA may mature to a point where biomass becomes extremely high, sediment accretion has lowered hydraulic capacity, and/or performance significantly declines. If such a scenario arises at STA, it may be advisable to consider one or more of the 'regenerative' maintenance techniques listed below.

4.3.1 Prescribed Fire

The removal of emergent vegetation through a prescribed burn may help restore system performance in several ways. First, a controlled burn will enable new plant growth to occur where only mature and possibly senescent vegetation was found. Young vegetation grows more rapidly than mature plants and has a higher nutrient uptake rate (DeBusk, et al). Also, with more sunlight reaching the treatment cell substrate, periphyton biomass would likely be greater and capture more phosphorus. Perhaps as importantly, this technique requires no additional handling or disposal methods which make it quite cost effective to use on a large scale. While this technique has been used at the 1,220 acre Orlando Easterly Wetlands Project in Orange County, Florida to help restore project performance, the District may elect to study the effects of fire on vegetation succession and specific performance expected in this STA before proceeding, perhaps using a pilot study.

Water levels may need to be lowered in order for a prescribed burn to be successful, but not lowered so much that treatment cell soils become overly dry and lose too much organic material during the fire. Some other possible restrictions associated with prescribed burning at STA might include the proximity of US Highway 441 and reduced visibility for motorists due to smoke. The surrounding property should also be assessed for its vulnerability to fire should it escape from the treatment area. Should this technique be employed by STA managers, a permit will need to be acquired from the Florida Division of Forestry before proceeding.

Should performance decline significantly or the system becomes a consistent net exporter of phosphorus over several years, additional regenerative measures of a more intrusive nature could be investigated, such as vegetation or sediment harvesting. These two techniques, however, have not been attempted on the scale of a moderate to large STA and may not be feasible because of the scale of labor required and/or complications regarding the disposal of soil and plant material.

5. References

Stanley Consultants, Inc., Lake Okeechobee Water Retention / Phosphorus Removal Project, Final Design Analysis Submittal, June 2003

Stanley Consultants, Inc., Lake Okeechobee Water Retention / Phosphorus Removal Project, Final Design Document Report Submittal, June 2003

South Florida Water Management District, WQ Monitoring Plan for Taylor Creek Storm Water Treatment Area (STA), April 2005.

U. S. Army Corps of Engineers, Draft Lake Okeechobee Water Retention / Phosphorus Removal Project – Taylor Creek (Grassy Island) Stormwater Treatment Area (STA) Water Control Plan (June 2005)

DeBusk, Thomas A., Forrest E. Dierberg, John Juston. Phosphorus Removal in Treatment Wetlands. DB Environmental, Inc., Rockledge, FL. MS Powerpoint presentation, date unknown.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

PERFORMANCE PLAN

TAYLOR CREEK / GRASSY ISLAND

STORMWATER TREATMENT AREA

August 2005 ***Gary Goforth, Inc.***

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PLEASE NOTE

During the preparation of this *Operation Plan*, two critical hydraulic issues that need attention to ensure that maximum phosphorus removal of the STA can be achieved were discussed with the District and the Corps of Engineers.

1. **Operating thresholds for the inflow pump station.** The S-390 pump operating set points were discussed with Dan Miller of Stanley Consultants, Inc., who agreed that the set point triggering the sequencing of the pumps on should be lowered from the current elevation of 20.0 ft NGVD to around 18.0 ft. This set point is referred to as the "Taylor Creek Stage High level" in Table 3 (page 24). It is recommended that the District or Corps revise this set point and its associated reset elevation as soon as possible after field testing to ensure that maximum phosphorus removal of the STA can be achieved.

2. **Capacity of S-391 and S-392.** After review of the rating curves for S-391 and S-392 and discussion with Dan Miller of Stanley Consultants, Inc., it was determined that the hydraulic capacity of the interior structure (S-391) and outlet structure (S-392) may be smaller than stated in the design documents, which was to pass the peak flow of 24 cfs with a head loss of less than 1.0 ft. This reduced capacity may increase the stage above the design pool elevation at peak flow through the STA, which in turn may reduce the design freeboard on the levee. The effect of this reduced capacity is partially compensated for by conservative estimates of the hydraulic roughness coefficient and pump station energy losses which reduce the peak flow under design conditions to approximately 21.5 cfs. It is recommended that the District pursue resolution of this issue with the Corps, perhaps through additional hydraulic modeling or flow calibrations after the STA is in flow through mode, to ensure that maximum phosphorus removal of the STA can be achieved. Until this issue is resolved, the Corps and District should consider an appropriate operational remedy such as limiting the number of pumps operating at one time during the rainy season.

Several tables and discussions within this document rely on the implementation of the recommendations above in order to achieve the design flows and stages described in the *Design Documentation Report* and *Design Analysis Report*. Depending upon the resolution of these issues, this Operation Plan will need to be revised accordingly.

1 PROJECT DESCRIPTION

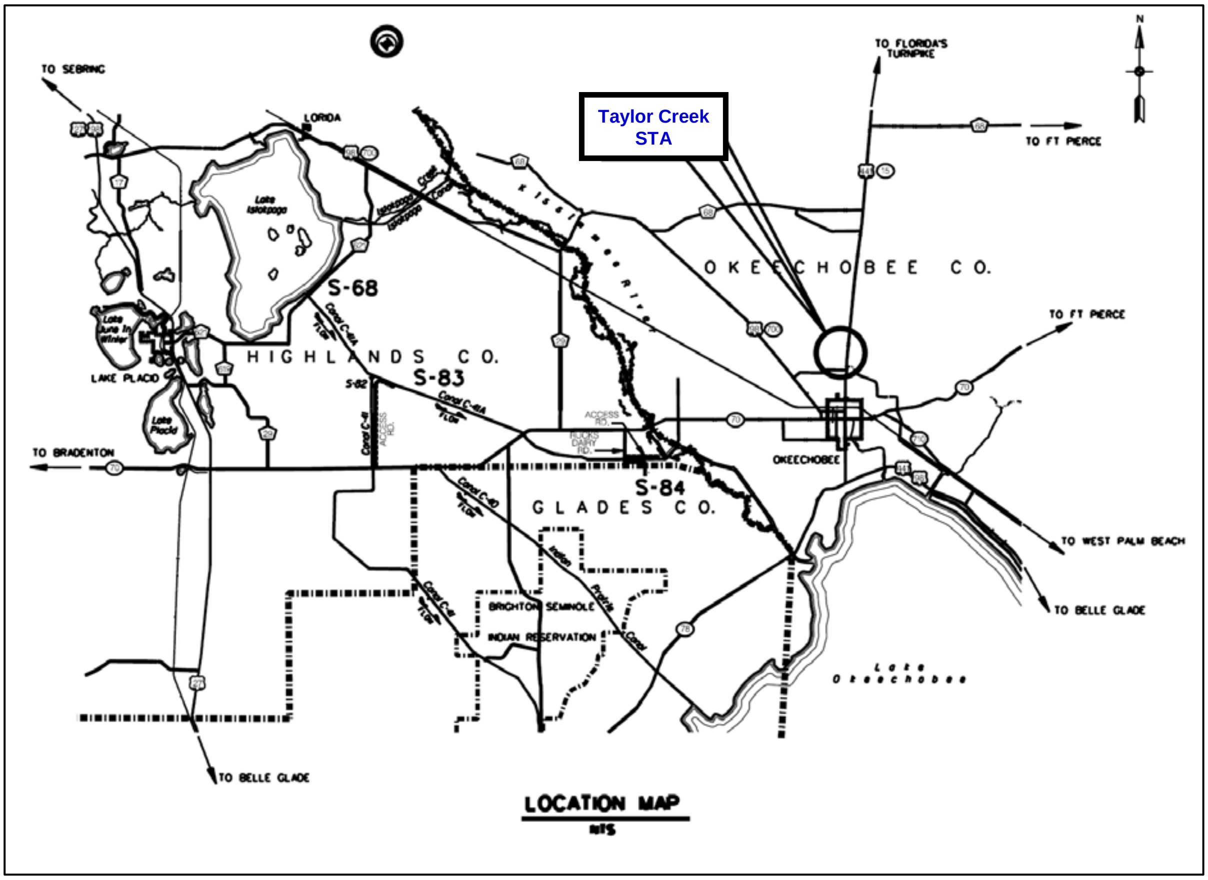
1.1 BACKGROUND

The South Florida Water Management District (SFWMD), the U. S. Army Corps of Engineers (Corps), the Florida Department of Environmental Protection (FDEP), other agencies and private landowners are cooperating on efforts to improve water quality in the Lake Okeechobee watershed, and through the south Florida ecosystem. This cooperation includes studies and capital projects composing the Lake Okeechobee Protection Program, the Comprehensive Everglades Restoration Plan (CERP), and Critical Restoration Projects. The Lake Okeechobee Water Retention / Phosphorus Removal Project consists of two shallow stormwater treatment areas – the Taylor Creek Stormwater Treatment Area (STA) and the Nubbin Slough STA – designed to remove phosphorus loads from the Taylor Creek and Nubbin Slough watersheds. High phosphorus loads have been implicated in excessive eutrophication of Lake Okeechobee that have resulted in algal blooms, high oxygen demand, and loss of fisheries and recreational benefits provided by the lake.

The Taylor Creek STA is one of the Critical Restoration Projects authorized by Congress through Section 528 of the Water Resources Development Act of 1996. The project was designed by Stanley Consultants, Inc. working under contract to the Corps, who was responsible for construction. Construction is presently underway with completion scheduled for summer 2005. The SFWMD is the sponsor for the project and assisted in the funding of the capital works and will be responsible for operation and maintenance of the STA. The anticipated long-term average phosphorus reduction within the STA was estimated during the design phase to be approximately 2 tons per year, or about 9% of the phosphorus load of Taylor Creek at the project location.

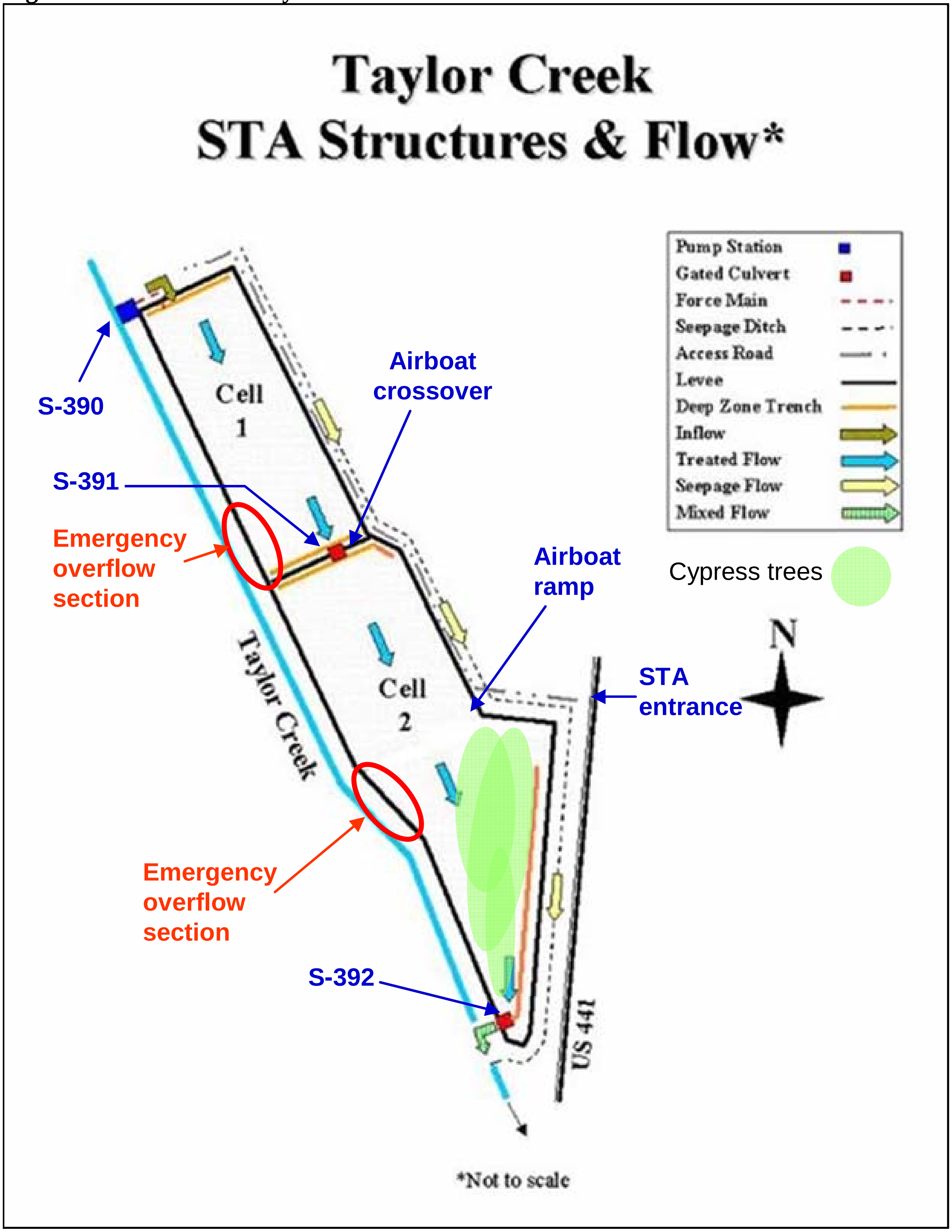
The Taylor Creek STA is approximately 2 miles north of the city of Okeechobee (Figure 1), adjacent to Taylor Creek and immediately northwest of the U.S Highway 441 bridge that spans Taylor Creek. A gated driveway will provide access to the project site, and the water control structures can be reached by traveling along the top of the levee. The southern end of this project is approximately 7 miles from the edge of Lake Okeechobee. The Taylor Creek Site habitat is situated between large areas of pasture, upland forested areas, cypress stand, depressions, and forested wetlands. The Florida Natural Areas Inventory designated the very southern end of the Taylor Creek Site as an area of conservation interest, in connection with the larger forested wetlands system in the slough along Taylor Creek (Corps 2005). According to the Fish and Wildlife Coordination Act report of the U.S. Fish and Wildlife Service (USFWS), the adjacent lands, open pastures with scattered cabbage palms are prime foraging and nesting habitat for Audubon's crested caracara. The open pasture is also habitat for turkey vulture, sandhill crane, meadowlark, mourning dove, and white-eyed vireo. In addition, the wooded areas (wetland and upland) provide habitat for migratory and resident birds.

Figure 1. Taylor Creek / Grassy Island STA location map.



The Taylor Creek STA is a long, narrow enclosure that parallels Taylor Creek (shown in Figure 2). An inflow pump station lifts water from Taylor Creek at the north end of the STA. Treatment occurs through natural biogeochemical processes as the water slowly flows by gravity southeasterly through the 49-acre Cell 1 and subsequently through the 93-acre Cell 2 before being discharged back to Taylor Creek. Water levels and flow rates through the treatment cells are controlled by individual gated structures located at the southerly end of each cell. The predominant grade within the STA creates flow northwest to the southeast but the general slope of each cell is from east to west, making the water on the west side of the cells deeper than on the east. The southeast corner of Cell 2, containing a strand of cypress and other wetland hardwoods, ranges from 1-2 feet higher than the remainder of the cell and will remain dry most of the time. This wooded area was included in the STA to avoid constructing the perimeter berm through the cypress stand. Deep zone trenches at the inflow and outflow of each cell are designed to help distribute flow evenly throughout the cell.

Figure 2. Schematic of Taylor Creek STA.



1.2 PERFORMANCE OBJECTIVES

The original performance objective was to design an STA that would produce a flow-weighted mean phosphorus concentration of approximately 50 parts per billion (ppb). However, due to limited size of the STAs that could be constructed for this Project, the revised objective is to maximize the total mass of phosphorus removal from the available treatment area. **As described below, the expected long-term phosphorus removal efficiency was estimated to be approximately 38% within the treatment area.**

Phosphorus removal performance for the Taylor Creek STA was estimated during the design by use of the Infiltrating/Exfiltrating model (Wetland Solutions, Inc.). No flow gauging stations are located within the Taylor Creek watersheds upstream of S-191. Based on relative watershed areas, analyses conducted during the design estimated that approximately 37% of the daily flows measured at S-191 pass adjacent to the Taylor Creek STA. Daily flows were estimated by interpolating flows from S-191 for the period 1973 – 2001 using this ratio (37%); the estimated average and median period of record flows of Taylor Creek at the STA were 51 cfs and 12 cfs, respectively. Daily flows equal to or less than the maximum inflow pump capacity (24 cfs) were averaged to estimate pumped inflow to the STA. Flows exceeding the maximum inflow pump capacity were averaged to estimate the amount of bypass. It was estimated that a long-term average flow of 12 cfs could be supplied to the Taylor Creek STA with the 4-pump configuration installed at S-390, with a stream bypass of approximately 39 cfs. The long-term average annual influent phosphorus concentration was estimated as approximately 500 parts per billion (ppb) at Taylor Creek, yielding a long-term average annual phosphorus load to the STA of approximately 5,265 kg/yr (Stanley Consulting, Inc. 2003). The long-term average annual outflow concentration was estimated to be approximately 303 ppb (Wetland Solutions, Inc. 2003). At these average values, the long-term average phosphorus removal for the Taylor Creek STA was estimated to be approximately 2 metric tons per year with a removal efficiency of approximately 38%. **Taking into account the balance of the Taylor Creek flows that bypassed the STA, the long-term average phosphorus load reduction within the STA resulted in an estimated total load reduction in Taylor Creek of approximately 9%. The actual annual performance within the Taylor Creek STA may vary significantly from these forecast long-term averages due to the variability in the flows and phosphorus levels within Taylor Creek, as well as the inherent variability in the biological removal processes within the STA.**

The fundamental phosphorus performance described above was independently verified with the first-order equation used for initial sizing of the STAs within the Everglades Construction Project (Walker 1995). That model neglects seepage and makes other simplifying assumptions, and yields a long-term average estimate of outflow concentration of approximately 316 ppb, within 5% of the estimate developed during the design.

With regard to performance, there are two distinct phases for the Taylor Creek STA. In accordance with the Project Cooperation Agreement executed between the Corps and the District, prior to turnover of the project to the District, the Corps will conduct an **initial**

operational testing and monitoring period. During this period, data will be collected to demonstrate that the project achieves the designated benefits. Once the District Engineer determines that the project is performing as designed, the Corps will transfer the project to the District for subsequent operations, maintenance, repair, replacement and rehabilitation, commencing the **operations phase.** The following sections describe the performance objectives specific to those two periods.

1.2.1 Initial Operational Testing and Monitoring Period

The initial operational testing and monitoring period consists of a start-up phase (pre-discharge) and a flow-through (discharge) phase. The operational goal during STA startup is to provide hydrologic conditions conducive to wetland vegetation growth, while avoiding release of total phosphorus and mercury. The performance objective during start-up is to demonstrate a net improvement in both phosphorus and mercury (see Section 2.1.1 below for details). The STA permits issued to the Corps by the FDEP preclude flow-through operations until phosphorus and mercury concentrations demonstrate a net improvement compared to the source water in Taylor Creek. In addition, the permit requires that a pesticide sample be taken in the water column and sediment at the inflow and outflow structures before discharges are to occur from the STA.

Once the phosphorus and mercury data demonstrate a net improvement, discharges will begin, and the second phase of the initial operational testing and monitoring period will begin. During this phase, the nutrient removal performance of the STA will be monitored through extensive water quality sampling. In addition, the FDEP permit requires monitoring and assessment of numerous other water quality constituents; the project permit and the *WQ Monitoring Plan For Taylor Creek Storm Water Treatment Area (STA)* (SWMD 2005) contains additional details.

During the **initial operational testing and monitoring period**, data will be collected to demonstrate that the project achieves the designated benefits. Once the District Engineer determines that the project is performing as designed, the Corps will transfer the project to the District for subsequent operations, maintenance, repair, replacement and rehabilitation, commencing the **operations phase.**

1.2.2 Operations Phase

The goal of the Taylor Creek STA is to maximize the phosphorus load reduction. The phosphorus concentration in Taylor Creek runoff exhibits considerable variability, with a long-term average of approximately 500 ppb (Stanley Consultants, Inc.). This greatly exceeds the phosphorus concentration of Lake Okeechobee, which averages just over 100 ppb. The long-term phosphorus storage mechanism within the STA will be through accretion of new organic sediment. Analyses conducted during the design of the project suggest that the long-term phosphorus load reduction within the STA would be modest, at approximately 38%, or approximately 2 metric tons per year. A summary of the performance characteristics developed during the design of the project are summarized in Table 1. In addition to the reduction of phosphorus loads, the Taylor Creek STA will provide additional water quality and quantity benefits to downstream waters, including the removal of suspended solids, nitrogen, metals, and pesticides that would otherwise flow into the lake.

References. This *Performance Plan* for the Taylor Creek STA was developed based upon the following documents:

1. South Florida Water Management District, WQ Monitoring Plan For Taylor Creek Storm Water Treatment Area (STA), April 2005.

2. Stanley Consultants, Inc., Lake Okeechobee Water Retention / Phosphorus Removal Project, Final Design Analysis Submittal, June 2003

3. Stanley Consultants, Inc., Lake Okeechobee Water Retention / Phosphorus Removal Project, Final Design Document Report Submittal, June 2003

4. U. S. Army Corps of Engineers, Draft Lake Okeechobee Water Retention / Phosphorus Removal Project – Taylor Creek (Grassy Island) Stormwater Treatment Area (STA) Water Control Plan (June 2005)

5. Wetland Solutions, Inc., 2003, Section 3.3 of the Design Analysis Report, Lake Okeechobee Water Retention / Phosphorus Removal Project, Final Design Analysis Submittal, June 2003.

Table 1. Summary of Taylor Creek STA Performance Parameters

Design Parameter	Cell 1	Cell 2	Entire STA
Treatment Area			
Effective Treatment Area (acres)	41	77	118
Total Area (acres)	49	93	142
Average ground elevation (ft NGVD)	22.6 +/-	21.6 +/-	21.9 +/-
Nominal Length (feet)	2,300	4,200	6,500
Nominal Width (feet)	775	795	785
Aspect Ratio (length:width)	3.0	5.3	8.3
Flow			
Average flow (cfs)	12	12	12
Average annual inflow (acre feet)	8,674	8,674	8,674
Mean depth at average flow (ft)	1.5	1.4	1.4
Average hydraulic loading rate (ft/yr)	213	113	74
Nominal hydraulic residence time at average flow (days)	2.6	4.4	7.0
Average rainfall (inches)			47.6
Average evapotranspiration (inches)			51.6
Phosphorus			
STA			
Average inflow concentration (ppb)			492
Average inflow load at 12 cfs (kg/yr)			5,265
Average inflow loading rate (g/m2/yr)			11.1
Average atmospheric deposition (equiv. ppb)			40
Effective settling rate (m/yr)			10.2
Estimated outflow concentration (ppb)			303
Estimated outflow load (kg/yr)			3,242
Estimated load removal (kg/yr)			2,022
Estimated STA phosphorus reduction (%)			38.4%
Taylor Creek			
Base flow before STA (AF/yr)			36,819
Base load before STA (kg/yr)			22,347
Estimated total load after STA (kg/yr)			20,324
Estimated concentration after STA (ppb)			447
Estimated load reduction (kg/yr)			2,022
Estimated overall load reduction (%)			9.0%

Note: During the preparation of this *Performance Plan,* it was determined that the hydraulic capacity of the interior structure (S-391) and outlet structure (S-392) may be smaller than stated in the design documents, which may decrease the peak, and therefore the average, flows through the STA without exceeding the design pool elevation. If so, the values in this table would need to be revised.

2 PERMIT INFORMATION AND REPORTING REQUIREMENTS

2.1 INITIAL OPERATIONAL TESTING AND MONITORING PHASE

On September 15, 2003, the Florida Department of Environmental Protection (FDEP) issued Lake Okeechobee Protection Act (LOPA) permit 0194485-001-GL to the Corps for the construction of the Taylor Creek STA. For the purpose of the permit, the construction phase includes the initial operational testing and monitoring period. The phosphorus performance-related monitoring requirements of the permit are discussed below.

2.1.1 Performance Monitoring Requirements for the Start-up (pre-discharge) Period

Net improvement in phosphorus concentrations. Figure 3 identifies the monitoring locations for water levels, flow and phosphorus samples. Total phosphorus will be sampled weekly at the inflow (S-390) and outflow (S-392) structure, via grab and automatic samples, for the duration of the pre-discharge period. The automatic sampler will be programmed to collect samples on a time composite basis during the period of pre-discharge.

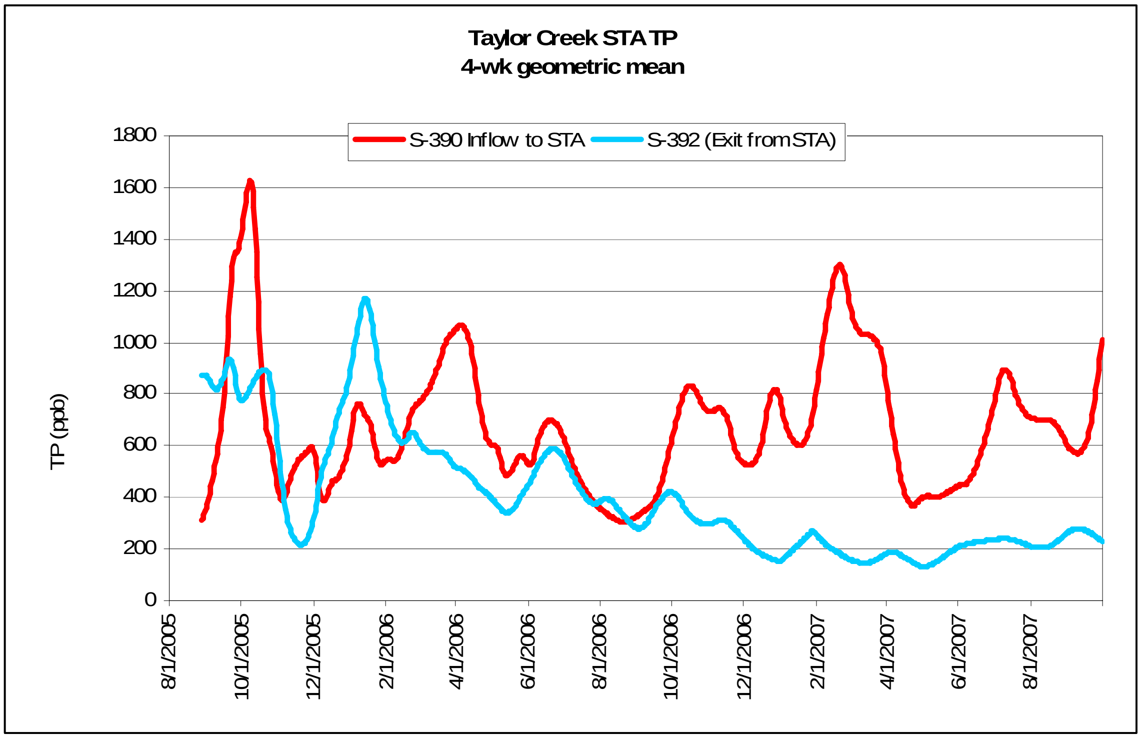
Prior to initiating flow-through (discharge) activities, phosphorus will be monitored to demonstrate that the STA is achieving a net improvement in phosphorus. This net improvement shall be deemed to occur when the 4-week geometric mean total phosphorus concentrations collected at the outflow structure (S-392) is less than the 4-week geometric mean collected at the inflow structure (S-390). If the project has not achieved a net improvement of phosphorus within two months after beginning pre-discharge activities, reports of the 4-week geometric mean differences will be transmitted to the FDEP. If net improvement has not been demonstrated after six months, the vegetation conditions shall be evaluated and strategies to achieve the net improvement are to be identified.

Figure 3 contains a hypothetical scenario of phosphorus levels for the Taylor Creek STA during this start-up period. Plotted in Figure 3 are the 4-week geometric mean phosphorus concentrations measured at the inflow (S-390) and the outlet structure (S-392). As shown in this example, net improvement of phosphorus was demonstrated approximately 6 weeks after the initiation of weekly grab sampling. While the values in Figure 3 are hypothetical, they represent potential trends, variations and relative magnitude of phosphorus levels that could be anticipated for Taylor Creek STA.

Mercury net improvement shall be demonstrated when the concentration of total mercury and methyl mercury at the mid-point of the STA are not significantly greater than the concentration of the corresponding species at the inflow to the STA. In addition, the permit requires that a pesticide sample be taken in the water column and sediment at the inflow and outflow structures before discharges are to occur from the STA.

Once the net improvement in phosphorus and mercury has been demonstrated, the FDEP shall be notified and discharges from the STA may commence.

Figure 3. Hypothetical phosphorus concentrations during initial operations.



The complete set of water quality constituents being monitored at the Taylor Creek STA is described in the *WQ Monitoring Plan For Taylor Creek Storm Water Treatment Area (STA)* (SFWMD 2005). Although not specifically required by the permit, it is recommended to also sample phosphorus at S-391 to gain a better understanding of the nutrient removal in Cell 1.

2.1.2 Performance Monitoring Requirements for the Flow-through (discharge) Period

During the Flow-through Period, the focus of the STA performance monitoring will be on establishing flow-weighted mean concentrations and loads entering and leaving the STA. Total water column phosphorus samples will be collected weekly at the inflow and outflow structures. Water quality data at the inflow location will be collected from a platform on the upstream side of the S-390 pump station. Samples will be collected by an automatic sampler and weekly grab samples. The pump station will be instrumented to trigger the automatic sampler when the pumps are running at speeds that will generate a sufficient flow; flow rates will be determined after the construction and exact specifications of the structure are known. Due to the small size of the STA, grab samples will be collected weekly. However, the data will be analyzed after a period of time to determine if the grab sampling frequency may be reduced.

Water quality data at the STA outlet will be obtained on the upstream side of the discharge structure, S-392. Samples will be collected by an automatic sampler and weekly grab samples. The S-392 will be instrumented to provide computed flow rates by using upstream and downstream stage in combination with gate opening information. A MOSCAD remote terminal unit will total the discharge and trigger the automatic sampler.

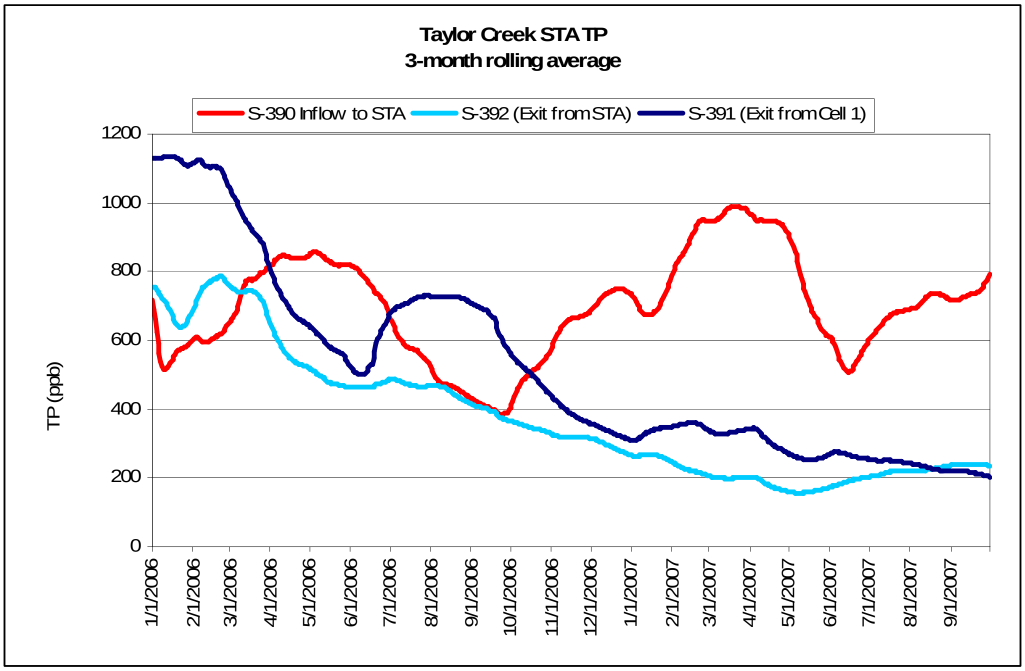
Data from these samples will be evaluated for the permit as follows:

1. Rolling 3-month flow-weighted mean total phosphorus concentrations for the STA shall be calculated for the outflow and inflow structures;
2. The flow-weighted mean outflow concentrations of total phosphorus for the STA at the outflow structure shall be compared to flow-weighted mean concentrations at the inflow structure using the student's t-test with a 95% confidence interval on log transformed data.

If the evaluation indicates that the flow-weighted mean outflow concentration is less than the flow-weighted mean inflow concentration, then the discharges from the project shall be deemed to be in compliance with Specific Condition 14A. If after six months, discharges from the STA are not achieving a net reduction in total phosphorus, the vegetation conditions shall be evaluated and strategies to achieve the net improvement are to be identified.

Figure 4 represents a hypothetical set of 3-month rolling average phosphorus concentrations during initial operations of an STA, assuming that discharge began on or about October 2005. Shown in the figure are hypothetical 3-month rolling phosphorus concentrations at the inflow (S-390), the exit from Cell 1 (S-391) and the outlet from the STA (S-392). Note that the initial 3-month comparison will not be available until 3 months after initial discharge began. This scenario achieves the permit-requires net reduction after approximately 6 months of flow-through. While the values in Figure 4 are hypothetical, they represent potential trends, variations and relative magnitude of phosphorus levels that could be anticipated.

Figure 4. Hypothetical phosphorus concentrations during initial flow-thru operations.



In addition to phosphorus, the permit contains conditions requiring either a net improvement in concentrations, or discharges to be at or below applicable criteria. For dissolved oxygen the permit requires demonstration that the STA is not responsible for degradation of dissolved oxygen in downstream receiving waters. Although not specifically required by the permit, it is recommended to also sample phosphorus at S-391 to gain a better understanding of the nutrient removal in Cell 1.

2.1.3 Reporting Requirements

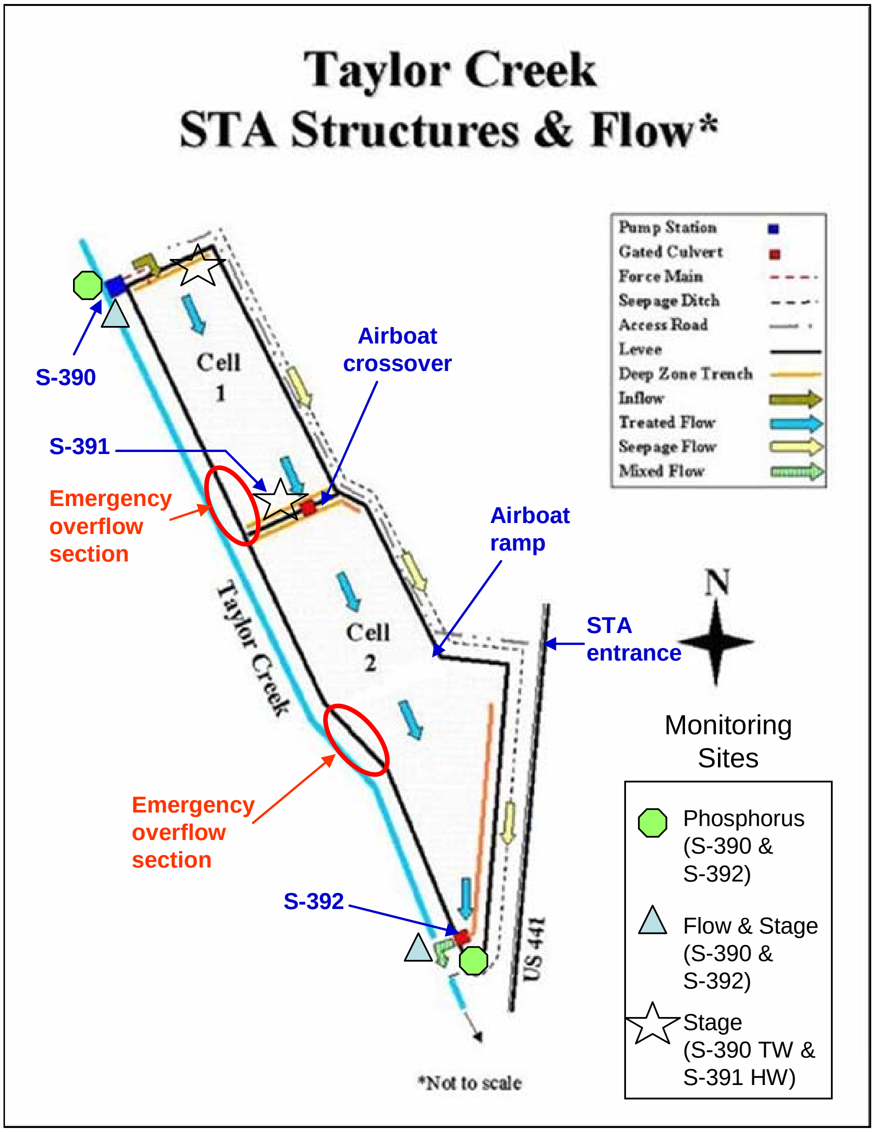
All water quality submittals required by the FDEP permit shall be transmitted to the FDEP in an Annual Report. Specific Condition 18 of the FDEP permit contains the minimum information to be contained in the Annual Reports.

A summary of the phosphorus-related monitoring requirements are shown in Table 2 and Figure 5.

Table 2. Summary of Phosphorus-related Performance Monitoring

Structure	Headwater Stage	Tailwater Stage	Flow	Phosphorus
S-390	Continuous	Continuous	Yes, based on pump curves	Autosampler and weekly grab
S-391	Continuous	No, but staff gage recommended	Calculated based on HW	No, but recommend weekly grab samples
S-392	Continuous	Continuous	Calculated	Autosampler and weekly grab

Figure 5. Monitoring locations.



2.2 OPERATIONS PHASE

At the time of this publication (June 2005), the FDEP and the SFWMD were negotiating the LOPA permit covering the operations, maintenance and monitoring permit for the project (permit No. 0194485-002-GL).

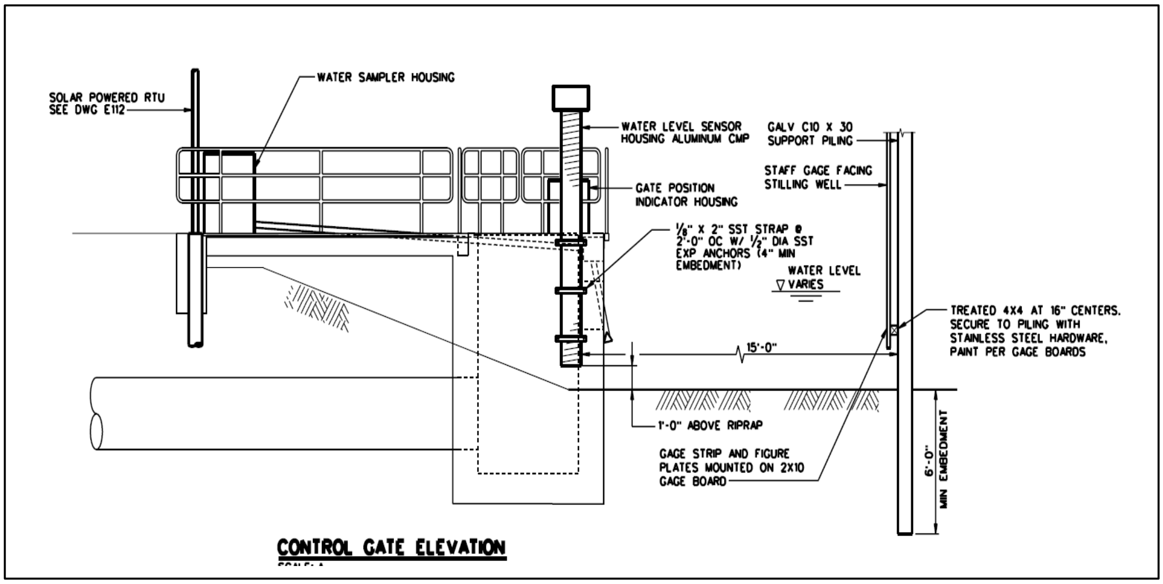
2.2.1 Performance Monitoring Requirements for the Operations Phase

It is anticipated that the phosphorus performance-related monitoring requirements will be similar to those described in Section 2.1.2 and shown in Table 1 and Figure 5 above. It is suggested that 12-month rolling means phosphorus concentrations be evaluated annually instead of 3-month rolling means.

Data will be collected to monitor flow rates and phosphorus removal rates within the STA, as well to gather other water quality information. Inflow to the system will be determined by the manufacturer's pump curves and head determined from water levels transmitted from sensors upstream of the pump station and at the spreader canal located inside Cell 1. At S-391, a gate level sensor, monitored in conjunction with the headwater level sensor will provide discharge information from Cell 1 to Cell 2. A similar arrangement of water and gate level sensors at the outfall of Cell 2 will provide total effluent discharge. The three flow measurements, one at the inflow, one at the separation levee, and one at the discharge end of the STA, in conjunction with local rainfall measurements, will enable the calculation of quantities of water treated and combined losses from seepage and evapotranspiration. Stage readings across the STA will also be helpful in assessing static and dynamic surface water profiles, allowing verification of estimates developed during design. A schematic of the hydraulic and water quality sampling arrangement for S-392 is shown in Figure 6.

At the present time, there is no plan to monitor phosphorus as S-391, however, a weekly grab sample for phosphorus at S-391 is recommended to provide valuable information on the performance of the STA.

Figure 6. Stage and water quality sampling at control structure S-392.



2.2.2 Reporting Requirements

It is anticipated that all water quality submittals required by the FDEP permit shall be transmitted to the FDEP in an Annual Report; furthermore, it assumed that the Taylor Creek STA performance report will be included in the South Florida Ecosystem Report, published annually by the District. The FDEP permit to be issued to the District for the STA will contain the minimum information to be contained in the Annual Reports.

An example of an annual report that was recently prepared for STA-2 of the Everglades Construction Project is reprinted in Appendix 1 (Goforth et al. 2005). The format of that report has evolved over the last several years with valuable input from the peer-review panel that annually reviews the draft document. The report contains a summary of the annual operations, vegetation management, phosphorus performance, mercury, as well as a summary of other water quality parameters monitored at the STA, and is based on a May 1 – April 30 water year. The Taylor Creek STA manager should review the report in Appendix 1 to identify which features may be relevant to the Taylor Creek STA.

3 PHOSPHORUS PERFORMANCE ANALYSES

In addition to the permit-required monitoring and reporting, there is a minimal amount of analyses and reporting that the District may wish to conduct to better understand the phosphorus removal capability of the Taylor Creek STA. This includes both a basic water budget and phosphorus mass budget information for each treatment cell and the STA as a whole. This information will be invaluable in developing appropriate adaptive management remedies should the phosphorus performance not achieve expectations. In addition, the information gained from this prototype STA can potentially be applied to many of the remaining 40,000 acres of STAs contained in the overall CERP program.

3.1.1 Performance Assessment

It is recommended that a weekly assessment of STA flows and phosphorus levels be performed by the Taylor Creek STA manager. The District has many good flow and nutrient load analytical tools that facilitate frequent evaluations, e.g., the Load Program developed by Environmental Resource Assessment. The Taylor Creek STA manager may want to discuss setting up a weekly automated batch file to generate the latest information.

In addition to the Load Program, a simple spreadsheet can be quickly created and maintained. For example, Table 3 and Figures 7-10 were developed using flows from the USGS gage near the STA site, along with phosphorus data from STA-1W, adjusted for the differences in inflow phosphorus concentrations. The table identifies the simple components of the water budget, although, estimates of rainfall, evapotranspiration and seepage could be added on an annual basis to complete the water budget. The table also outlines the basic components of the phosphorus budget for the STA, although the change in biomass and sediment storage of phosphorus, and loss through seepage, will need to be estimated through other means. Figure 7 depicts a two-year period of initial flows adjacent to the STA in Taylor Creek, and into the STA through the S-390 pump station. Figure 8 presents a hypothetical time series of flows into, through and out of the STA, demonstrating the step function (exaggerated) resulting from the pumped inflow. Figures 9 and 10 depict weekly and 12-month rolling mean phosphors concentrations at the STA. Table 4 summarizes the performance of the initial two years of flow-through operation at the hypothetical STA, and although the values are hypothetical, they represent potential trends and variability that may be observed at Taylor Creek STA. An important characteristic of the STA is the variability in short-term flows, loading and performance.

Taylor Creek STA

3

	Taylor Creek					S-390 (Inflow to STA)								S-391 (Exit from Cell 1)							
Date	Stage ft NGVD	Flow cfs	Flow AF	TP ppb	TP kg	# of pumps	Flow cfs	Flow AF	TP ppb	4-wk TP ppb	3-mo ppb	12-mo TP ppb	TP kg	HW	Flow AF	adj TP ppb	4-wk TP ppb	3-mo ppb	12-mo TP ppb	TP kg	TP Removed kg
1-Sep-07	17.57	96	190.4	495	116	4	21.5	43	495	598	718	746	26	23.8	43	238	206	221	287	13	14
2-Sep-07	17.56	68	134.9	520	87	4	21.5	43	520	592	717	746	27	23.8	43	234	208	221	286	12	15
3-Sep-07	17.48	52	103.1	545	69	4	21.5	43	545	586	717	746	29	23.8	43	229	210	221	286	12	17
4-Sep-07	17.42	46	91.2	570	64	4	21.5	43	570	582	717	746	30	23.8	43	224	211	221	285	12	18
5-Sep-07	17.44	44	87.3	595	64	4	21.5	43	595	578	717	746	31	23.8	43	220	213	220	284	12	20
6-Sep-07	17.38	36	71.4	620	55	4	21.5	43	620	575	717	746	33	23.8	43	215	214	220	284	11	21
7-Sep-07	17.32	36	71.4	645	57	4	21.5	43	645	573	718	747	34	23.8	43	210	215	220	283	11	23
8-Sep-07	17.28	58	115.0	670	95	4	21.5	43	670	572	721	747	35	23.8	43	206	216	220	282	11	24
9-Sep-07	17.24	40	79.3	695	68	4	21.5	43	695	571	723	747	37	23.8	43	201	217	220	282	11	26
10-Sep-07	17.42	90	178.5	720	159	4	21.5	43	720	571	725	748	38	23.8	43	197	218	220	281	10	28
11-Sep-07	17.83	326	646.6	745	594	4	21.5	43	745	571	727	748	39	23.8	43	192	218	219	280	10	29
12-Sep-07	17.86	350	694.2	803	688	4	21.5	43	803	574	729	748	42	23.8	43	191	218	219	280	10	32
13-Sep-07	17.86	224	444.3	861	472	4	21.5	43	861	578	730	749	45	23.8	43	189	218	218	279	10	35
14-Sep-07	18.03	180	357.0	920	405	4	21.5	43	920	585	731	749	48	23.8	43	188	218	218	279	10	38
15-Sep-07	18.03	214	424.5	978	512	4	21.5	43	978	594	733	750	51	23.8	43	187	218	217	278	10	42
16-Sep-07	17.92	166	329.3	1036	421	4	21.5	43	1036	604	734	751	55	23.8	43	186	217	216	278	10	45
17-Sep-07	17.95	118	234.0	1094	316	4	21.5	43	1094	617	735	753	58	23.8	43	184	216	216	277	10	48
18-Sep-07	18	128	253.9	1153	361	4	21.5	43	1153	632	736	754	61	23.8	43	183	215	215	276	10	51
19-Sep-07	18.06	102	202.3	1211	302	4	21.5	43	1211	650	737	756	64	23.8	43	182	213	214	276	10	54
20-Sep-07	18.2	102	202.3	1269	317	4	21.5	43	1269	670	738	758	67	23.8	43	180	212	213	275	9	57
21-Sep-07	18.12	80	158.7	1327	260	4	21.5	43	1327	693	739	759	70	23.8	43	179	210	212	275	9	60
22-Sep-07	18.08	64	126.9	1385	217	4	21.5	43	1385	718	742	762	73	23.8	43	178	208	211	274	9	64
23-Sep-07	18.13	50	99.2	1444	177	4	21.5	43	1444	747	746	764	76	23.8	43	177	206	210	273	9	67
24-Sep-07	18.29	40	79.3	1502	147	4	21.5	43	1502	779	751	766	79	23.8	43	175	203	209	273	9	70
25-Sep-07	18.25	30	59.5	1560	115	4	21.5	43	1560	815	756	769	82	23.8	43	174	201	208	272	9	73
26-Sep-07	18.28	26	51.6	1560	99	4	21.5	43	1560	854	762	772	82	23.8	43	174	198	207	272	9	73
27-Sep-07	18.35	24	47.6	1560	92	4	21.5	43	1560	893	769	775	82	23.8	43	174	196	206	271	9	73
28-Sep-07	18.46	20	39.7	1560	76	4	21.5	43	1560	932	776	777	82	23.8	43	174	193	205	271	9	73
29-Sep-07	18.37	24	47.6	1560	92	4	21.5	43	1560	971	783	780	82	23.8	43	174	191	204	270	9	73
30-Sep-07	18.43	26	51.6	1560	99	4	21.5	43	1560	1010	790	783	82	23.8	43	174	189	203	270	9	73
1-Oct-07	18.46	22	43.6	1560	84	4	21.5	43	1560	1049	798	785	82	23.8	43	174	187	202	269	9	73
Annual Average			42427	718	37605		4583	9090 21%	732				8208		9090	472				5288	2920

Table 3. Possible spreadsheet analysis for Taylor Creek STA

Taylor Creek STA 3

Date	HW	Flow	TW	adj TP	4-wk TP	3-mo TP	12-mo TP	TP	Cell 2 TP Removed	STA Total TP Removed	STA Total TP Removed	Taylor Creek after STA Flow	TP	TP	TP Removal
		S-392 (Exit from STA)										Taylor Creek after STA			
		AF		ppb	ppb	ppb	ppb	kg	kg	kg	%	AF	ppb	kg	%
1-Sep-07	22.8	42.6	17.6	292.2	265	237	233	15	-3	11	41%	190.4	450	106	9%
2-Sep-07	22.8	42.6	17.6	287.5	268	237	233	15	-3	12	45%	134.9	447	74	14%
3-Sep-07	22.8	42.6	17.5	282.9	271	238	233	15	-3	14	48%	103.1	437	56	20%
4-Sep-07	22.8	42.6	17.4	278.3	273	238	233	15	-3	15	51%	91.2	434	49	24%
5-Sep-07	22.8	42.6	17.4	273.7	275	239	232	14	-3	17	54%	87.3	438	47	26%
6-Sep-07	22.8	42.6	17.4	269.1	277	239	232	14	-3	18	57%	71.4	410	36	34%
7-Sep-07	22.8	42.6	17.3	264.5	278	240	232	14	-3	20	59%	71.4	418	37	35%
8-Sep-07	22.8	42.6	17.3	259.8	279	240	232	14	-3	22	61%	115.0	518	74	23%
9-Sep-07	22.8	42.6	17.2	255.2	279	241	231	13	-3	23	63%	79.3	459	45	34%
10-Sep-07	22.8	42.6	17.4	250.6	279	241	231	13	-3	25	65%	178.5	608	134	16%
11-Sep-07	22.8	42.6	17.8	246.0	279	241	231	13	-3	26	67%	646.6	712	568	4%
12-Sep-07	22.8	42.6	17.9	243.0	278	241	231	13	-3	29	70%	694.2	769	658	4%
13-Sep-07	22.8	42.6	17.9	240.0	277	241	231	13	-3	33	72%	444.3	802	439	7%
14-Sep-07	22.8	42.6	18.0	237.0	276	241	230	12	-3	36	74%	357.0	838	369	9%
15-Sep-07	22.8	42.6	18.0	234.0	274	241	230	12	-2	39	76%	424.5	903	473	8%
16-Sep-07	22.8	42.6	17.9	231.0	273	241	230	12	-2	42	78%	329.3	932	378	10%
17-Sep-07	22.8	42.6	18.0	228.0	271	241	230	12	-2	46	79%	234.0	936	270	14%
18-Sep-07	22.8	42.6	18.0	225.0	269	241	229	12	-2	49	80%	253.9	997	312	14%
19-Sep-07	22.8	42.6	18.1	222.0	266	240	229	12	-2	52	82%	202.3	1002	250	17%
20-Sep-07	22.8	42.6	18.2	219.0	264	240	229	12	-2	55	83%	202.3	1048	261	17%
21-Sep-07	22.8	42.6	18.1	216.0	261	240	229	11	-2	58	84%	158.7	1029	201	23%
22-Sep-07	22.8	42.6	18.1	213.0	258	239	228	11	-2	62	85%	126.9	992	155	28%
23-Sep-07	22.8	42.6	18.1	210.0	255	239	228	11	-2	65	85%	99.2	913	112	37%
24-Sep-07	22.8	42.6	18.3	207.0	251	238	228	11	-2	68	86%	79.3	806	79	46%
25-Sep-07	22.8	42.6	18.3	204.0	248	238	227	11	-2	71	87%	59.5	588	43	62%
26-Sep-07	22.8	42.6	18.3	204.0	244	238	227	11	-2	71	87%	51.6	439	28	72%
27-Sep-07	22.8	42.6	18.4	204.0	241	237	227	11	-2	71	87%	47.6	345	20	78%
28-Sep-07	22.8	42.6	18.5	204.0	238	237	227	11	-2	71	87%	39.7	102	5	93%
29-Sep-07	22.8	42.6	18.4	204.0	235	236	226	11	-2	71	87%	47.6	345	20	78%
30-Sep-07	22.8	42.6	18.4	204.0	232	236	226	11	-2	71	87%	51.6	439	28	72%
1-Oct-07	22.8	42.6	18.5	204.0	229	236	226	11	-2	71	87%	43.6	235	13	85%
Annual Average		9090	32	354				3966	1322	4242	52%	42427	637	33363	11%

Table 3. Possible spreadsheet analysis for Taylor Creek STA (concluded)

Figure 7. Time series of hypothetical flows in Taylor Creek and the STA

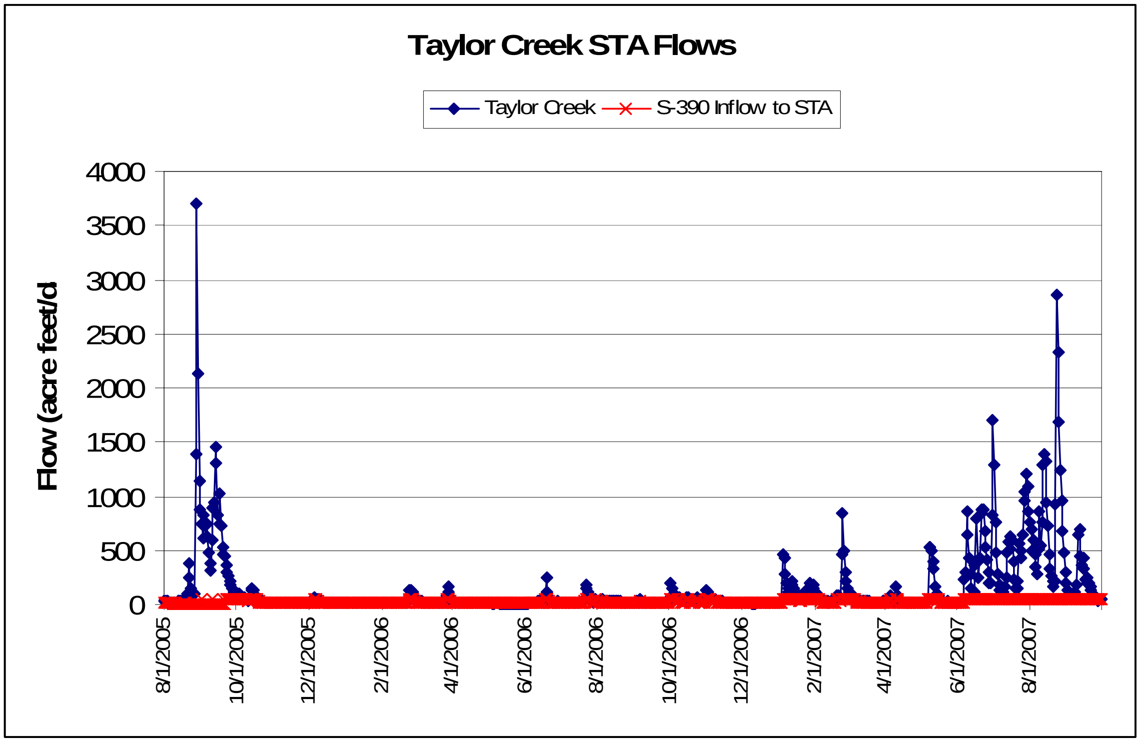


Figure 8. Time series of hypothetical flows into, through and out of the STA.

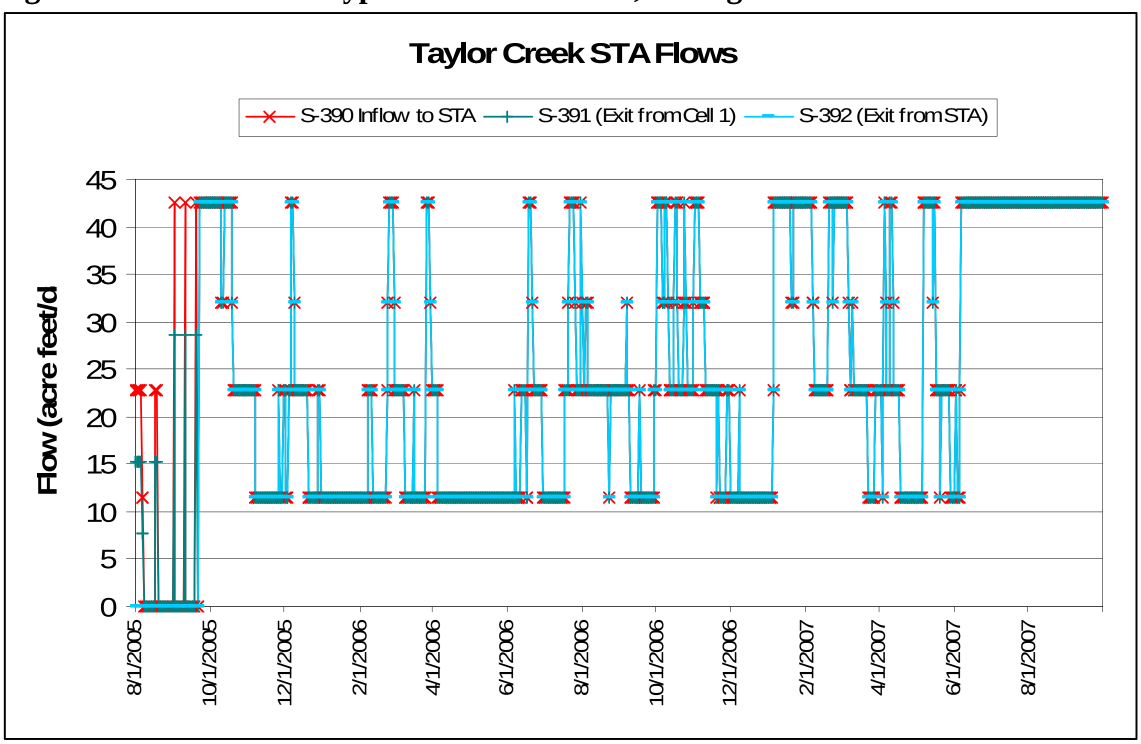


Figure 9. Weekly phosphorus concentrations at Taylor Creek STA.

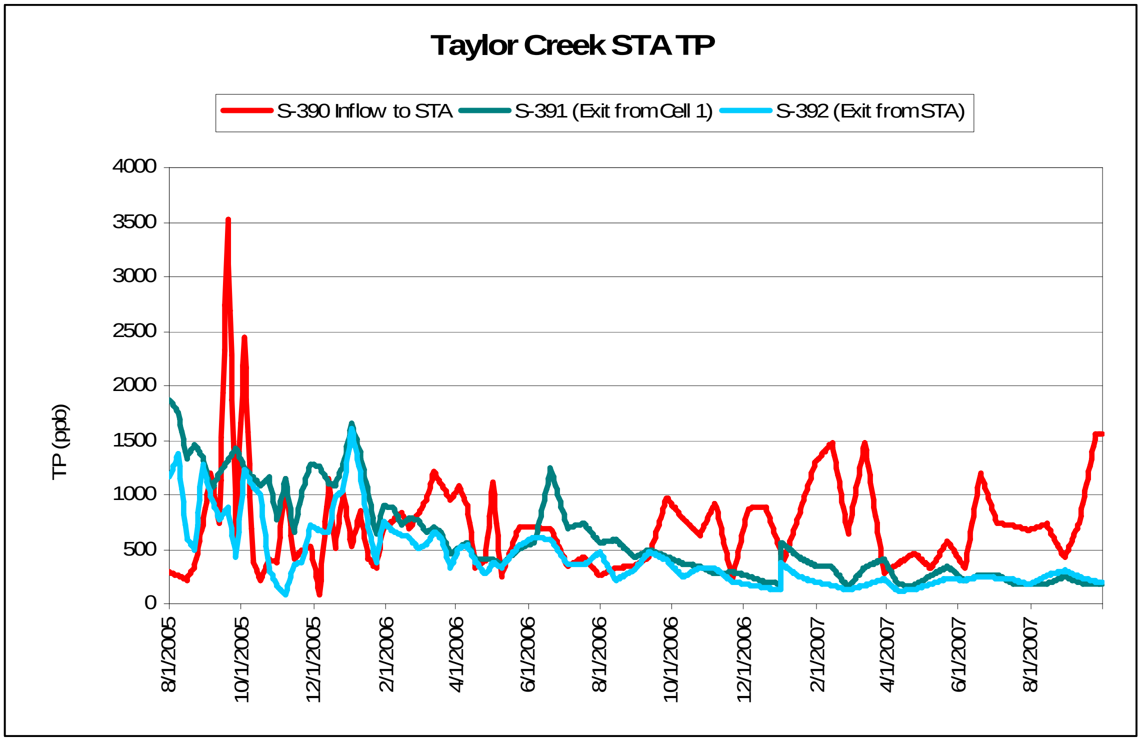


Figure 10. 12-month rolling phosphorus concentrations at Taylor Creek STA.

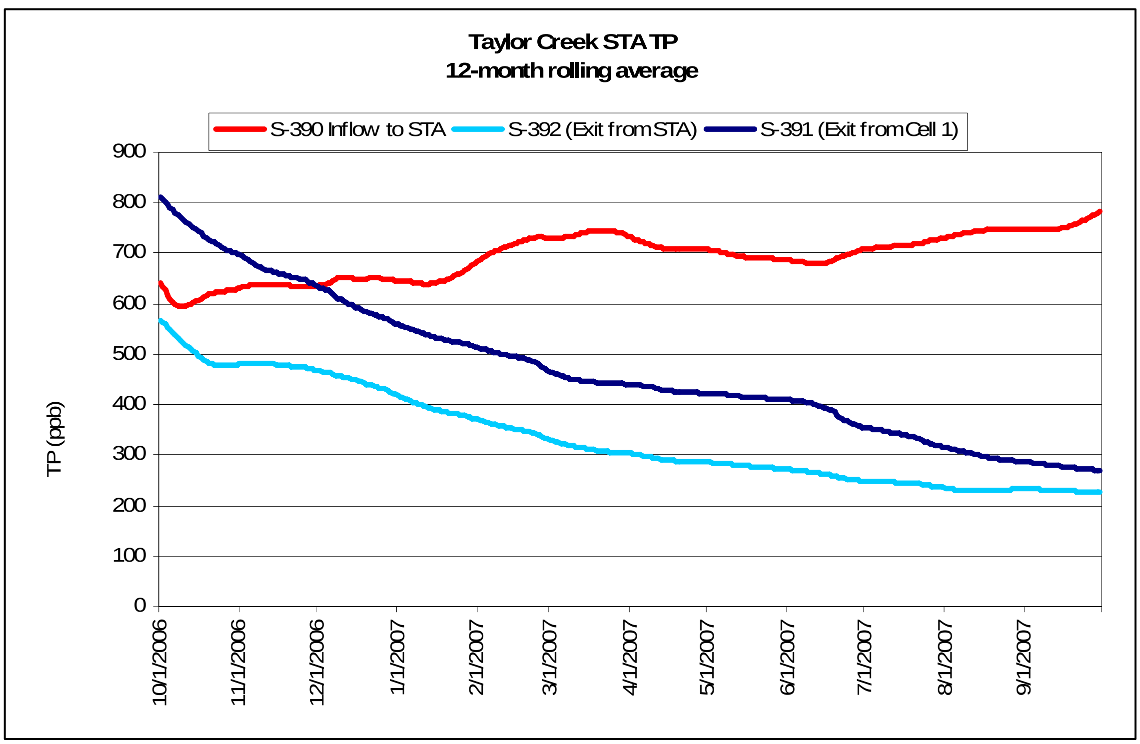


Table 4.
Summary of First Two Years of Performance of Taylor Creek STA

	Oct 2005 - Sep 2006	Oct 2006 - Sep 2007	2-Year Period
Inflow to STA			
Flow (AF/yr)	6,779	11,401	9,090
Percent of Taylor Creek	69%	15%	21%
TP Load (kg/yr)	5,370	11,046	8,208
TP Conc (ppb)	642	785	732
Cell 1			
Flow (AF/yr)	6,779	11,401	9,090
TP Load (kg/yr)	6,790	3,786	5,288
TP Conc (ppb)	812	269	472
Cell 2			
Flow (AF/yr)	6,779	11,401	9,090
TP Load (kg/yr)	4,755	3,176	3,966
TP Conc (ppb)	569	226	354
STA Reduction			
TP Load (kg/yr)	615	7,869	4,242
Removal Efficiency	11%	71%	52%
TP Conc (ppb)	74	560	378
Taylor Creek Reduction			
TP Load (kg/yr)	615	7,869	4,242
Removal Efficiency	8%	12%	11%
TP Conc (ppb)	51	85	81

4 COORDINATION

As with most large water resource projects, effective coordination within the agency and among the various agencies will be critical to ensure the STA performance objectives are achieved. The nature of this coordination will change as the project goes through the initial operational and testing period, and is then transferred to the District by the Corps.

4.1 Initial Operational Testing and Monitoring Period

In accordance with the Project Cooperation Agreement executed between the Corps and the District, prior to turnover of the project to the District, the Corps will conduct an **initial operational testing and monitoring period**. During this period, data will be collected to demonstrate that the project achieves the designated benefits. Once the District Engineer determines that the project is performing as designed, the Corps will transfer the project to the District for subsequent operations, maintenance, repair, replacement and rehabilitation, commencing the **operations phase.** This period is further divided into two phases – a start-up phase (no discharge) and a flow-through phase once discharge commences. Prior to initiating flow-through (discharge) activities, phosphorus and mercury will be monitored to demonstrate that the STA is achieving a net improvement in both constituents. In addition, pesticide sampling will occur as a condition for moving into the flow-through phase.

4.1.1 On-going data review and operational feedback

In accordance with the project PCA, the District will conduct the phosphorus, mercury and pesticide samples during the **initial operational testing and monitoring period**. A **Project Coordination Team** was established in accordance with the Project Cooperation Agreement, and this team will establish a protocol for communicating the start up operations between the District and Corps prior to the initiation of start up. Key aspects are to identify who will be the respective tactical contact points, and the appropriate type and frequency of start up communication. The frequency of telephone conferences and meetings will likely be weekly at first as issues surrounding structure operations may arise; experience in other new systems suggests that the frequency will likely decrease to approximately once per month by the end of the start-up phase. During this start-up phase, the format, data extraction and distribution list of the STA performance worksheets should be finalized

Once flow-through operations begin, the weekly/monthly communications will include operational feedback (pump operations, gate openings, flow rates and water levels) in addition to the performance discussion. By that time, the criteria for project transfer from the Corps to the District should be finalized.

4.1.2 Interagency coordination (District, FDEP, Corps, DACS)

In addition to the day-to-day project coordination, by virtue of the fact that the Taylor Creek STA is a feature of an integrative set of water quality protection projects, project staff will necessarily be communicating and coordinating with other District staff (e.g., Lake Okeechobee Division), FDEP (for permitting and other wetland protection purposes), the Corps (CERP and related activities) and DACS (e.g., for implementation of watershed BMPs).

An initial list of potential contact persons from these agencies is presented below.

STA Project Manager: Lisa Kreiger, Staff Environmental Scientist, (863) 462-5280 x 3026 lkreiger@sfwmd.gov; South Florida Water Management District, Okeechobee Service Center, 205 N Parrott Ave, Suite 201, Okeechobee, FL 34972.

Program Manager: Dave Unsell, Lead Project Manager, (561) 686-8800 x 6888; dunsell@sfwmd.gov; South Florida Water Management District; 3301 Gun Club Road; West Palm Beach, FL 33406

Okeechobee Field Station: Terry Peters, Interim Director, 863-462-5280 x 3102; rpeters@sfwmd.gov; and Bruce Chesser, Interim Director of Field Operations, x 3114; bchesser@sfwmd.gov; Okeechobee Field Station, Okeechobee, FL

Operations Department: Tom Kosier, Environmental Operations Section (561) 682-6533; tkosier@sfwmd.gov; South Florida Water Management District; 3301 Gun Club Road; West Palm Beach, FL 33406

Water quality monitoring: W. Patrick Davis **Field Project Manager** (863) 462-5280 x 3171; wpdavis@sfwmd.gov; Okeechobee Water Quality Field Section, 1000 NE 40 Avenue, Okeechobee, FL 34972.

U. S. Army Corps of Engineers: Stephanie Jenkins; Hydraulic Engineer (904) 232-1612; Stephanie.L.Jenkins@saj02.usace.army.mil; US Army Corps of Engineers, Jacksonville District, ENHW, 701 San Marco Blvd, Jacksonville, Florida 32207 and Chuck Wilburn, Civil Engineer (863) 471-1741; Charles.R.Wilburn@usace.army.mil; Sebring Project Office, 6406 U.S. Hwy 27 S, Sebring, Florida 33876

Florida Department of Environmental Protection: Kim Shugar, Program Administrator, (561) 681-6706; kimberly.shugar@dep.state.fl.us; FDEP-Southeast District, 400 N. Congress Avenue, Suite 200, West Palm Beach, Florida 33401

Florida Department of Agricultural and Consumer Services: Bo Griffin, Environmental Manager, (863) 462-5883; griffid@doacs.state.fl.us; 305 E.N. Park Street, Suite C, Okeechobee, Florida 34972.

4.2 Operations Phase

Once the Corps transfers the project over to the District, the **Operations Phase** commences. Most, if not all, of the same degree of communication and coordination that began in the **initial operational testing and monitoring period** will continue.

4.2.1 On-going data review and operational feedback

The frequency and type of the weekly/monthly meetings during the Operations Phase may not differ from the earlier phases, depending on the status of the STA and whether or not there are significant refinements to the permit requirements. During the summer, the performance evaluation for the previous water year should be drafted for including in the draft of the annual South Florida Environmental Report.

4.2.2 Interagency coordination (District, FDEP, Corps, DACS)

Depending on the Corps continued role and responsibilities after the project is turned over to the District, their involvement in the weekly/monthly coordination conferences may change in the Operations Phase. There may or may not be a shift in the other agency contacts shown in section 4.1.2 above, depending on the status of the STA and other needs.

5 REFERENCES

Goforth G., Pietro K., M. Chimney, J. Newman, T. Bechtel, G. Germain, and N. Iricanin, STA Performance, Compliance and Optimization, Chapter 4 in *2005 South Florida Env. Report*, 2005

South Florida Water Management District, WQ Monitoring Plan For Taylor Creek Storm Water Treatment Area (STA), April 2005.

Stanley Consultants, Inc., Lake Okeechobee Water Retention / Phosphorus Removal Project, Final Design Analysis Submittal, June 2003

Stanley Consultants, Inc., Lake Okeechobee Water Retention / Phosphorus Removal Project, Final Design Document Report Submittal, June 2003

U. S. Army Corps of Engineers, Draft Lake Okeechobee Water Retention / Phosphorus Removal Project – Taylor Creek (Grassy Island) Stormwater Treatment Area (STA) Water Control Plan (June 2005)

Walker W.W., Design basis for Everglades stormwater treatment areas. Wat. Res. Bull. 31(4), 671-685, 1995.

Wetland Solutions, Inc., 2003, Section 3.3 of the Design Analysis Report, Lake Okeechobee Water Retention / Phosphorus Removal Project, Final Design Analysis Submittal, June 2003.

APPENDIX 1. EXCERPT FROM 2005 SOUTH FLORIDA ENVIRONMENTAL REPORT

Chapter 4: STA Performance, Compliance and Optimization

Gary Goforth, Kathleen Pietro, Michael Chimney, Jana Newman,
Tim Bechtel, Guy Germain and Nenad Iricanin

SUMMARY

As of June 2004, over 35,000 acres of Stormwater Treatment Areas (STAs) have been constructed by the South Florida Water Management District (District or SFWMD) (**Figure 4-1)**. Almost 30,000 acres were in flow-through operation and removing total phosphorus (TP) that otherwise would have gone into the Everglades Protection Area (EPA). During Water Year 2004 (WY2004) (May 1, 2003 through April 30, 2004), Stormwater Treatment Areas 1 West, 2, 3/4, 5, and 6 Section 1 (STA-1W, STA-2, STA-3/4, STA-5, and STA-6) STA-1W, STA-2, STA-3/4, STA-5, and STA-6) treated more than 778,000 acre-feet (ac-ft) of water and removed more than 88 metric tons of TP. Inflow concentrations averaged 133 parts per billion (ppb), while the outflow concentrations averaged 41 ppb. This resulted in an overall 69-percent removal rate. STA performance varied, with outflow concentrations ranging from 12 to 14 ppb for STA-6 and STA-2, respectively, to almost 100 ppb for STA-5.

Since the initiation of STA operations in 1994 through the end of April 2004, the STAs have reduced the TP load by about 427 metric tons. A summary is provided in **Table 4-1**. The most significant milestone during this last reporting period was the completion of STA-3/4, the world's largest constructed wetland at over 16,500 acres. On January 15, 2004, the 6,500-acre Flow-way 1 of STA-3/4 passed the start-up requirements of the operating permits, and on February 25, 2004, the first discharges of treated water from this STA began. On June 7, 2004, the 3,500-acre Cell 3 began discharging. On September 16, 2004, the remaining 5,500 acre Flow-way 2 began discharging. The initial 12-month (October 1, 2003 to September 30, 2004) performance of STA-3/4 was exceptional, with over 445,000 ac-ft of water treated to an average outflow concentration of 14 ppb.

The SFWMD began the design and implementation of enhancements to STA-3/4, intended to further lower phosphorus levels. Key components include additional levees and water control structures, refined operations, and revisions to the vegetation communities, including a 400-acre demonstration Periphyton-Based Stormwater Treatment Area (PSTA) within the footprint of STA-3/4. These enhancements, along with enhancements to the other five STAs, will continue through the end of 2006. The construction of Stormwater Treatment Area 1 East (STA-1E) was substantially completed by the U.S. Army Corps of Engineers in June 2004. Initial flooding of STA-1E began in summer 2004. A 6-month to 18-month vegetation start-up period is anticipated before STA-1E is expected to discharge to the Arthur R. Marshall Loxahatchee National Wildlife Refuge, depending on growth of the vegetation.

The Everglades Protection Area Tributary Basins Long-Term Plan for Achieving Water Quality Goals (see Chapter 8 of the *2005 South Florida Environmental Report – Volume I*) recommends structural, vegetative and operational enhancements for each STA, and provides a

predicted range of long-term average outflow phosphorus concentrations once the enhancements are completed. Refinement of the operational strategies for the STAs is required to optimize their phosphorus removal performance and to ensure that they are not subject to overload from inflow volume or nutrients. In addition, assessment of annual or long-term performance is aided by a comparison of actual loading to the loading that was anticipated during the design of the treatment areas, and the subsequent design of the STA enhancements. A recent paper developed the "operational design envelope" for inflow volume and phosphorus loads that were anticipated for each STA (Goforth, 2004), and can be found on the District's Website at http://www.sfwmd.gov/org/ema/toc/archives/docs/design_envelope_STA_051004.pdf.

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

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

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

An overview of the STA operations, vegetation management, phosphorus performance, water quality monitoring, and permit compliance for each of the STAs is presented in this chapter. Water quality parameters that are addressed include nutrients, physical parameters including but not limited to pH, turbidity, dissolved oxygen (DO), pesticides, major ions, and mercury. This information documents compliance with appropriate conditions of the Everglades Forever Act and the U.S. Environmental Protection Agency's National Pollution Discharge Elimination System permits. Water quality monitoring within and downstream of the treatment areas demonstrated that the five STAs in operation are in full compliance with state operating permits. A summary of STA operations and issues is presented in **Table 4-2**. Appendices presented with this chapter provide additional details of the monitoring program, as required by state operating permits.

Table 4-1. Stormwater Treatment Area (STA) hydrology and total phosphorus (TP) removal for Water Year 2004 (WY2004). Start-up operations started in October 2003 and flow-through began in February 2004 for STA-3/4.

	STA-1W	STA-2	STA-3/4	STA-5	STA-6	All STAs
Total Inflow Volume (ac-ft)	292,690	256,938	23,303	153,080	52,674	**778,685**
Hydraulic Loading Rate (cm/d)	3.7	3.3	0.3	3.1	5.1	**3.4**
Flow-weighted Mean Inflow TP (ppb)	141	77	49	255	53	**133**
TP Loading Rate ($g/m^2/yr$)	1.9	0.9	0.05	2.9	1.0	**2.0**
Total inflow TP Load (mt)	50.7	24.3	1.4	48.1	3.4	**127.9**
Total Outflow Volume (ac-ft)	297,603	284,780	27,708	136,466	35,549	**782,106**
Flow-weighted Mean Outflow TP (ppb)	47	14	16	97	12	**41**
Total Outflow TP Load (mt)	17.1	5.0	0.55	16.4	0.5	**39.6**
Hydraulic Residence Time (d)	16.1	13.5	N/A	18.9	11.0	**15.4***
TP Retained (mt)	33.7	19.2	0.9	31.7	2.9	**88.3**
TP Removal Rate ($g/m^2/yr$)	1.25	0.74	0.03	1.90	0.83	**1.2**
Load Reduction (%)	66 %	79 %	61	66 %	85 %	**69%**
TP Retained to Date (mt)	240	51	0.9	110	25	**427**
TP Outflow to Date (ppb)	38	16	16	105	19	**40**

Note: "TP retained to date" is based on the period of record for each STA. The STA-1W record begins in WY1995; the STA-2 record begins in WY2002; the STA-5 record begins in WY2001; and the STA-6 record begins in WY1998. STA-3/4 begins in October of WY2004.

Table 4-2. Summary of STA operations and issues. Operational phases: (1) Start-up, inundate for vegetation growth. No discharge, phase ends when cell demonstrated net improvement in phosphorus and mercury. (2) Stabilization: discharge, phase ends when 12-month outflow TP ≤ 50 ppb. (3) Post-stabilization: after stabilization phase.

STA	Operational Status	Other Issues
STA-1E	Under construction by USACE. Substantially completed in June 2004. Initial flooding began in summer 2004	Working with USACE and FDEP to finalize operating permits
STA-1W	Fully operational; in stabilization phase; in WY2004, there was a diversion of 17,000 ac-ft and 3.1 mt of TP with a flow-weighted mean TP average of 148 ppb into the Refuge because the capacity of the STA-1W inflow structure was exceeded	Had STA-1E been operational, the TP loads and concentrations from the EAA prior to entering the Refuge would have been lower; performance enhancements are under way
STA-2	Fully operational; in stabilization phase	Design of an additional 2,015-acre flow-way is under way
STA-3/4	Start-up operations began in October 2003; construction was completed in 2004	Performance enhancements are under way, including vegetation conversion and construction of a PSTA demonstration project
STA-5	Fully operational; in stabilization phase; in WY2004, there was a diversion of 37,630 ac-ft and 17 mt of TP with a flow-weighted mean TP average of 367 ppb through G-406	Performance enhancements are under way; design of an additional 2,565-acre flow-way is under way
STA-6	Fully operational; in post-stabilization phase	STA-6 Section 2 is in final design

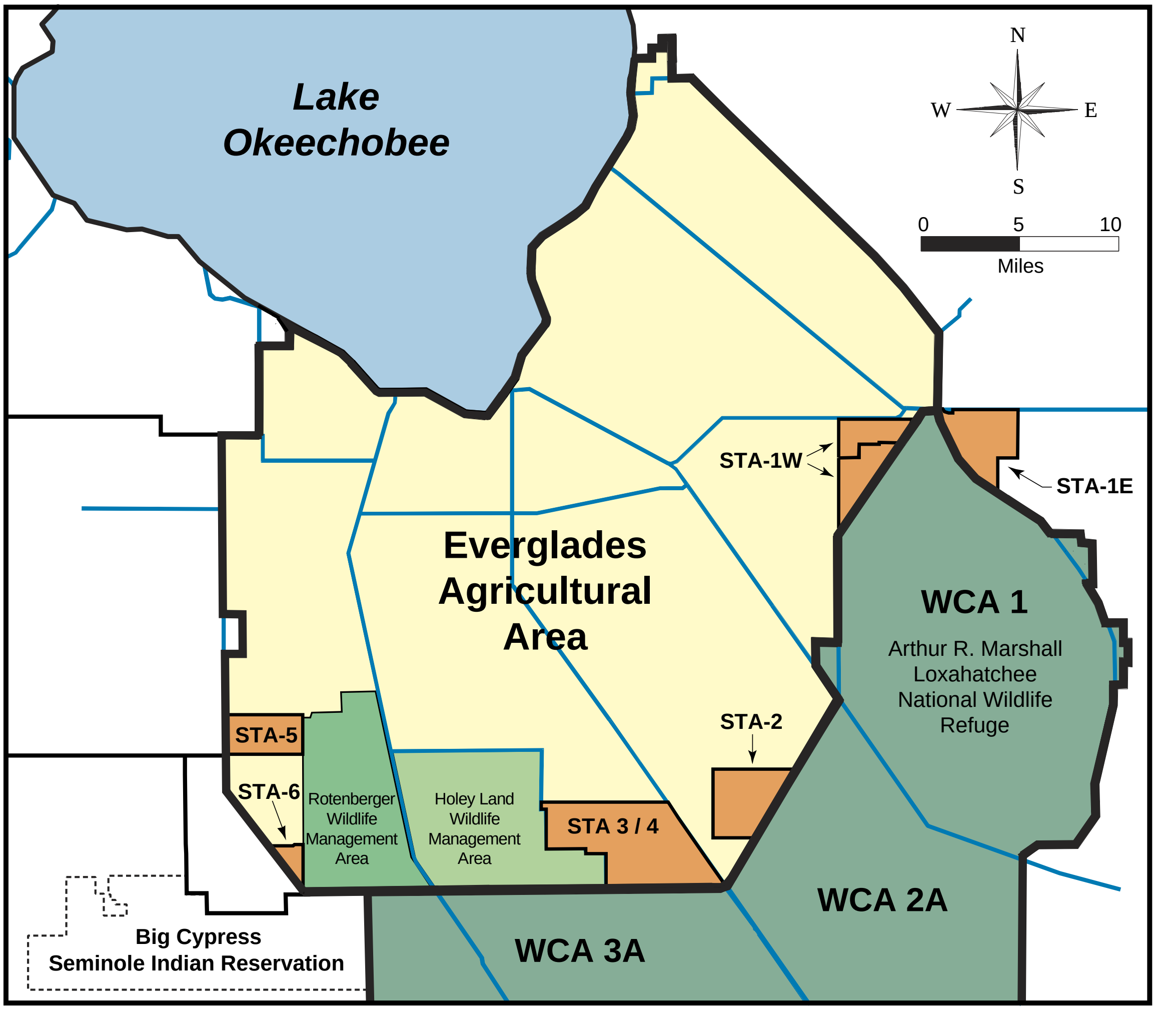


Figure 4-1. Location of STAs.

STA-2

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

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

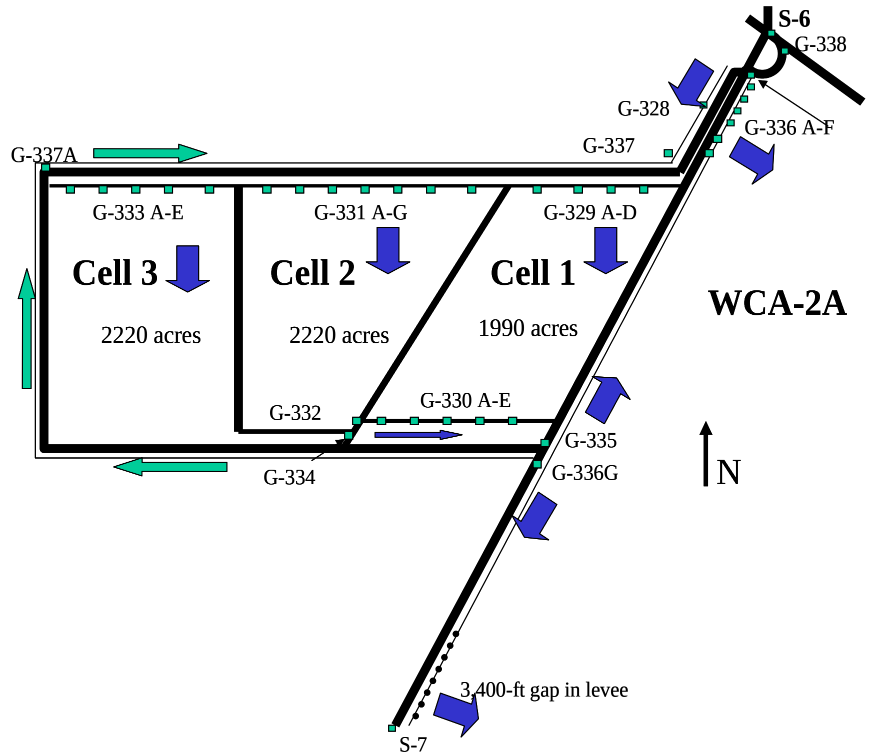
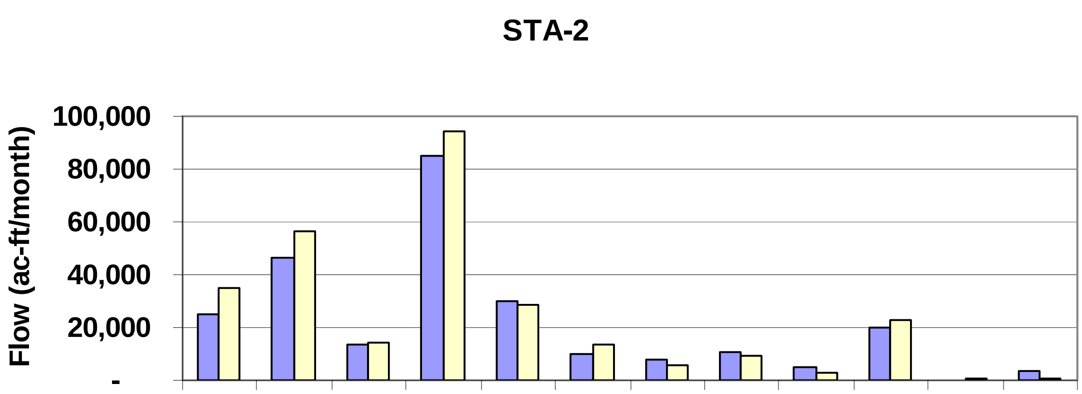


Figure 4-11. Schematic of STA-2 (not to scale).

STA-2 OPERATIONS

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

During WY2004, approximately 256,938 ac-ft of water was captured and treated by STA-2. This was about 25 percent more than the anticipated average annual flow contemplated during design, although annual variability was anticipated. This inflow loading was equal to an average hydraulic load of 3.3 cm/d over the treatment area. The annual volume of treated water discharged to WCA-2A was 284,780 ac-ft. The difference between the inflow and outflow volumes reflects the net contributions of direct rainfall, ET, seepage losses to adjacent lands, deep percolation, and flow measurement error. A summary of monthly flows is presented in **Figure 4-12**. No flows were diverted around STA-2 during WY2004.



	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04	Apr-04
Inflow	25,193	46,295	13,681	85,165	29,796	9,746	7,680	10,628	5,049	19,859	22	3,824
Outflow	35,060	56,764	14,086	94,120	28,571	13,815	5,808	9,078	2,874	23,080	907	615

Figure 4-12. Summary of WY2004 flows for STA-2 (Note: 1 hm^3 = 810.7 ac-ft).

STA-2 VEGETATION MANAGEMENT

Specific Condition 13(b) of the EFA permit requires that the annual report include information regarding the application of herbicides to exclude and/or eliminate undesirable vegetation within the treatment cells. For this reporting period, the District treated 782 acres and applied a total of 163.0 gallons of the herbicide glyphosate to control torpedograss and cattail, and 95.75 gallons of diquat to control FAV and cattail in Cells 2 and 3. Both aerial and ground-based spray equipment were used to apply these herbicides. Additionally, two submersed treatments were conducted on hydrilla (*Hydrilla verticillata*) in STA-2, Cell 3 using the active ingredient endothall. Two formulations were used: (1) 393 liquid gallons of Aquathol K, and (2) 2,571 granular pounds of Aquathol Super K.

STA-2, Cell 3 has a total area of 2,270 acres and is dominated by SAV; however, 500 acres of emergent cattail marsh exists in the south east section. Vegetation coverage maps from December 2003 are found in Appendix 4-12 of the 2005 SFER – Volume I. It has been identified in the Long-Term Plan that this emergent portion be converted to SAV. Due to the performance of this cell and the pending results of the STA-3/4 demonstration project this conversion will be deferred.

Vegetation management will focus on keeping FAV at maintenance control levels in all STAs. FAV "shades out" or impedes beneficial submersed and emergent vegetation which is necessary for proper STA performance. Along with the FAV treatments, emphasis will also be placed on controlling expanding emergent vegetation, mainly torpedograss and cattail, which appears in SAV cells.

STA-2 PERMIT WATER QUALITY MONITORING

Monitoring data collected for STA-2 demonstrate that STA-2 was in compliance with the EFA and NPDES operating permits for WY2004 and that discharges do not pose any known danger to public health, safety, or welfare. The EFA and NPDES operating permits were issued for this project on September 29, 2000. Each treatment cell in STA-2 operates independently, and the permits authorize discharges when net improvement in TP and mercury is demonstrated for each cell. STA-2 Cells 2 and 3 passed the net improvement start-up tests for TP and mercury on September 13 and November 9, 2000, respectively. Cell 1 was the last of the treatment cells to meet the start-up criteria listed in the permit for mercury. After the FDEP, the USEPA, and other agencies reviewed the Cell 1 mercury situation, it was determined that the most effective way to reduce mercury concentrations in Cell 1 was to move as much water through the cell as possible to increase sulfur levels. On August 9, 2001, a draft permit modification was issued to initiate flow-through operations for Cell 1. Data collected in December 2002 and January 2004 demonstrated that Cell 1 passed the start-up test listed in the permit based on the stations identified for that purpose. Additional monitoring continues to increase the understanding of mercury in the STA. Currently STA-2 is in the stabilization phase, having demonstrated net improvement in TP and mercury. In addition, Specific Condition 14(B) of the EFA permit states that STA-2 will remain in the stabilization phase of operation until STA-1E and STA-3/4 begin flow-through operations. Presently STA-1E is still in the construction phase and is not expected to begin flow-through operations until 2005, subject to vegetation grow-in and soil phosphorus stabilization.

STA-2 TOTAL PHOSPHORUS

Under the design objectives of the EFA, STA-2 is achieving its interim discharge goal of less than 50 ppb for TP. Although the hydraulic loading to STA-2 was higher than the design criteria, the TP loading to the system was less than the design amount. During WY2004, the STA received 24.3 mt of TP, equal to a nutrient loading rate of 0.90 g/m^2. During WY2004, STA-2 received approximately 0.8 mt of TP from Lake Okeechobee. STA-2 removed approximately 19.2 mt of TP during WY2004. Monthly discharge concentrations were considerably lower than inflow concentrations. For example, from May 2002–April 2004, STA-2 reduced discharge loads of TP by 79 percent. Summaries of monthly TP loads and flow-weighted mean TP concentrations are presented in **Figures 4-13** and **4-14**, respectively. The annual flow-weighted mean outflow concentration was 14 ppb, an 81-percent reduction from the inflow concentration of 77 ppb. For informational purposes, the annual geometric mean discharge TP concentration for STA-2 was 15 ppb for WY2004. If an outflow concentration of less than 50 ppb in accordance with the EFA permit for STA-2 had been achieved, then Cells 2 and 3 would have passed the stabilization phase if not for the requirement that STA-2 should remain in the stabilization phase until STA-1E and STA-3/4 begin full flow-through operation. The 12-month moving average TP concentration from STA-2 decreased from 18 ppb to 14 ppb during the course of WY2004 (**Figure 4-15**).

STA-2 OTHER WATER QUALITY PARAMETERS

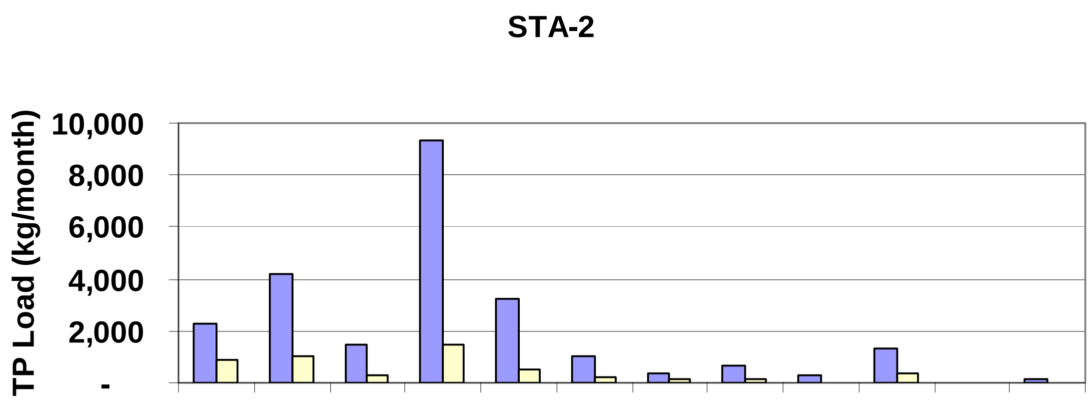
The monitoring data for non-phosphorus parameters at STA-2 during this reporting period are presented in Appendix 4-5 of the 2005 SFER – Volume I, and are summarized in **Table 4-7**. Compliance with the EFA permit is determined based on the following three part assessments:

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

Except for specific conductivity, discharges from STA-2 were determined to be in compliance with the permit by satisfying criterion one above for all non-phosphorus and non-DO parameters with applicable numeric state water standards. Additional requirements for DO are listed in Administrative Order AO-006-EV and are discussed below. Mercury monitoring results are discussed in Chapter 2B, and also in Appendix 4-7 of the 2005 SFER – Volume I.

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

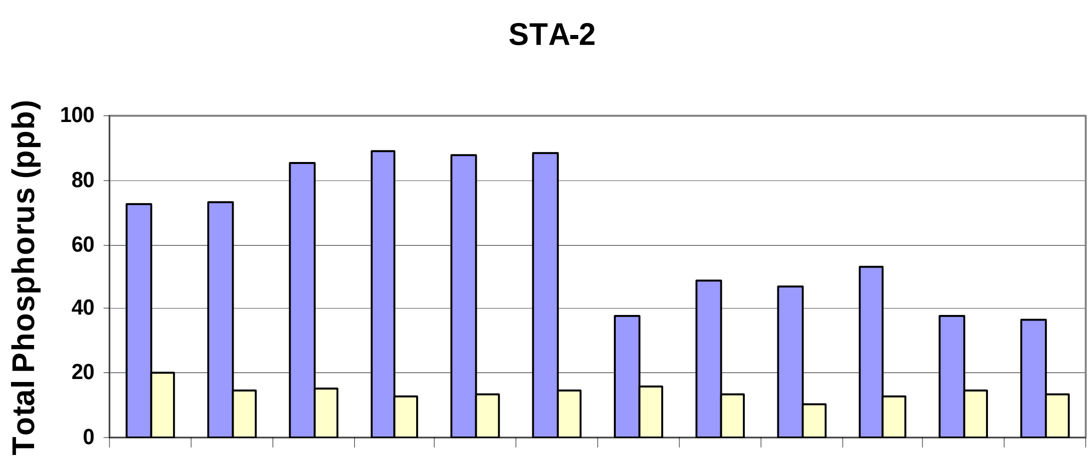
- The District has performed all sampling and analysis under the latest FDEP-approved CompQAP No. 870166G (June 1999).
- A signed copy of this statement is provided in Appendix 4-2 of the 2005 SFER – Volume I.



	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04	Apr-04
Inflow	2,254	4,176	1,438	9,362	3,219	1,059	358	639	293	1,304	1	173
Outflow	861	1,003	265	1,487	480	248	113	148	36	362	16	10

Inflow Outflow

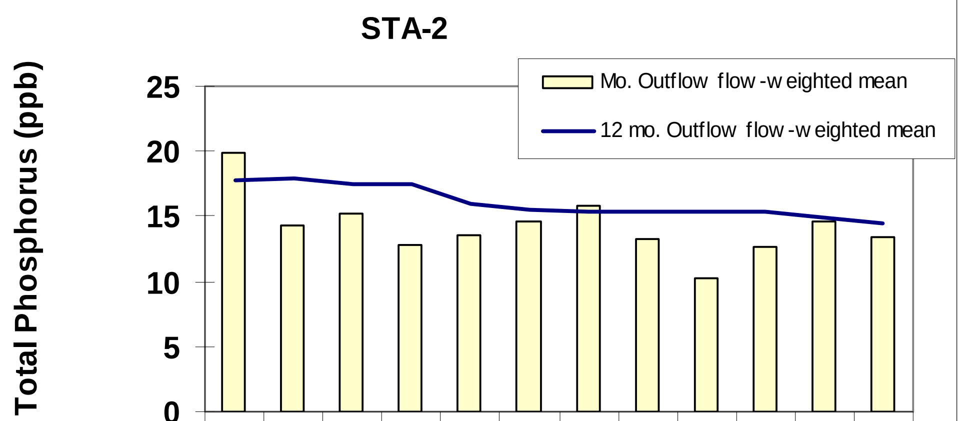
Figure 4-13. Summary of WY2004 TP loads for STA-2.



	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04	Apr-04
Inflow	73	73	85	89	88	88	38	49	47	53	38	37
Outflow	20	14	15	13	14	15	16	13	10	13	15	13

Inflow Outflow

Figure 4-14. Summary of WY2004 TP concentrations for STA-2.



	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04	Apr-04
Mo. Outflow flow-weighted mean	20	14	15	13	14	15	16	13	10	13	15	13
12 mo. Outflow flow-weighted mean	18	18	17	17	16	15	15	15	15	15	15	14

Figure 4-15. Comparison of monthly to 12-month moving average TP concentrations for WY2004 for STA-2 outflow.

Table 4-7. Summary of annual arithmetic averages and flow-weighted means for water quality parameters (other than TP) monitored in STA-2. Note that monitoring for the pesticides ametryn and atrazine is not required under the routine permit. For the purpose of these comparisons, flow-weighted means are calculated as the quotient of the cumulative product of the mean daily flow and the sample concentration divided by the corresponding cumulative daily flows.

Parameter	Arithmetic Means Inflow		Arithmetic Means Outflow	Flow-Weighted Means Total Inflow		Flow-Weighted Means Total Outflow	
	S6	G328	G335	n	Conc.	n	Conc.
Temperature (°C)	25.1	25.1	25.1	-NA-	-NA-	-NA-	-NA-
Dissolved Oxygen (mg/L)	3.1	4.3	4.6	-NA-	-NA-	-NA-	-NA-
Specific Conductivity (µmhos/cm)	1,305	1,557	1,261	-NA-	-NA-	-NA-	-NA-
pH	7.4	7.5	7.5	-NA-	-NA-	-NA-	-NA-
Turbidity (NTU)	3.8	3.1	1.2	-NA-	-NA-	-NA-	-NA-
Total Dissolved Solids (mg/L)	848	966	823	18 (52)	890	26 (26)	794
Unionized Ammonia (mg/L)	0.0061	0.0087	0.0032	18 (52)	0.0084	26 (26)	0.0013
Orthophosphate as P (mg/L)	0.034	0.012	0.006	32 (104)	0.068	52 (52)	0.007
Total Dissolved Phosphorus (mg/L)	0.041	0.015	0.007	31 (91)	0.073	43 (43)	0.008
Sulfate (mg/L)	82.0	54.4	69.2	18 (52)	102.5	26 (26)	77.4
Alkalinity (mg/L)	324	368	305	18 (52)	341	26 (26)	293
Dissolved Chloride (mg/L)	181	263	185	18 (52)	171	26 (26)	163
Total Nitrogen (mg/L)	3.09	2.68	2.34	18 (52)	4.14	26 (26)	2.34
Total Dissolved Nitrogen (mg/L)	2.98	2.57	2.29	18 (52)	3.94	26 (26)	2.29
Nitrate + Nitrite (mg/L)	0.542	0.378	0.107	18 (52)	1.051	26 (26)	0.185

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

STA-2 DISSOLVED OXYGEN MONITORING

Introduction

STA-2 Administrative Order No. AO-006-EV in Exhibit C of the EFA STA-2 Permit (Permit No. 0126704, September 29, 2000) specifies the same DO monitoring requirements as those for STA-1W. The District developed the following plan to comply with the DO requirements of the Administrative Orders for STA-2. Under the plan, DO concentrations are measured quarterly with HydrolabTM, DataSonde®, or MiniSonde® probes at 30-minute intervals for four consecutive days at the following locations:

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

Sampling Dates

Diel oxygen measurement dates and sites associated with STA-2 for WY2004 are provided in **Table 4-8**.

Table 4-8. Deployment dates for diel oxygen measurement at STA-2 structures and associated downstream marsh sites.

Event Dates		Structures			Sites Monitored in Water Conservation Area 2
Start	End	Inflow		Outflow	
06/02/2003	06/06/2003	----	----	----	C.25, N.25, N1, N4
08/25/2003	08/28/2003	S6	G328	G335	----------------------------------
10/20/2003	10/25/2003	----	----	----	C.25, C1, N.25, N1, N4, S4
12/15/2003	12/18/2003	S6	G328	G335	----------------------------------

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

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

Direct comparisons of DO in STA-2 discharges with DO at downstream marsh sites in WCA-2A (**Figure 4-16**) cannot be made for WY2004 because Hydrolab™ deployment dates differed. However, to satisfy permit requirements, summary statistics for STA-2 discharges and WCA-2A marsh transect sites are presented in **Table 4-9**. Notched box and whisker plots for the sites are presented in **Figure 4-17**. The complete data sets collected at all sites during WY2004 are found in Appendix 4-6 of the 2005 SFER – Volume I.

The data indicate that diel DO concentrations in G-335 discharges were statistically greater than DO concentrations at all of the marsh transect sites. DO at site N.25 was significantly greater than at the other marsh sites.

STA-2 ENHANCEMENTS

Enhancements to STA-2 (**Figure 4-18**) include construction of interior levees and associated water control structures in each of the three treatment cells, as well as conversion of emergent vegetation to SAV in the new downstream cells and construction of a 1,813-acre treatment cell.

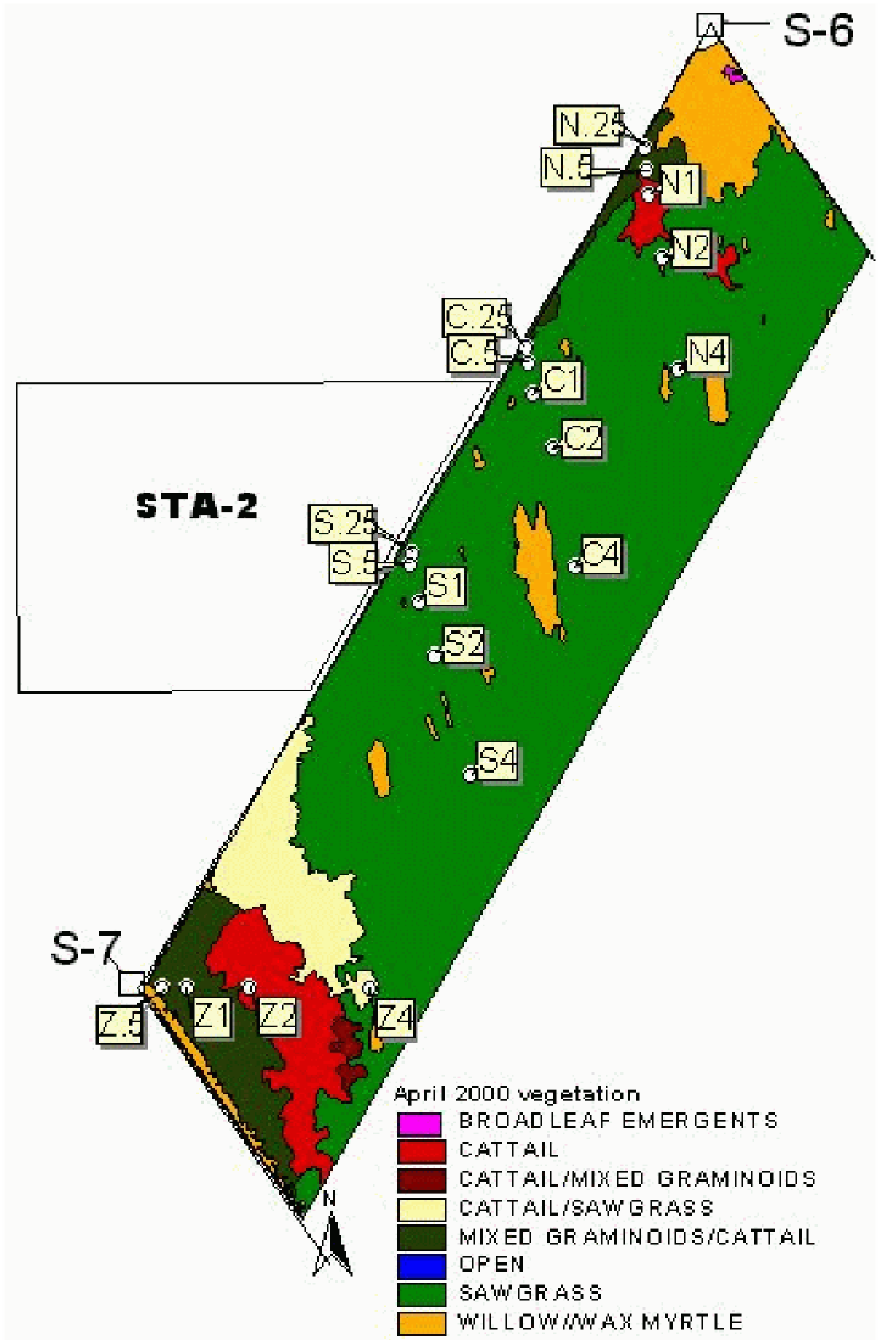


Figure 4-16. DO monitoring sites in WCA-2.

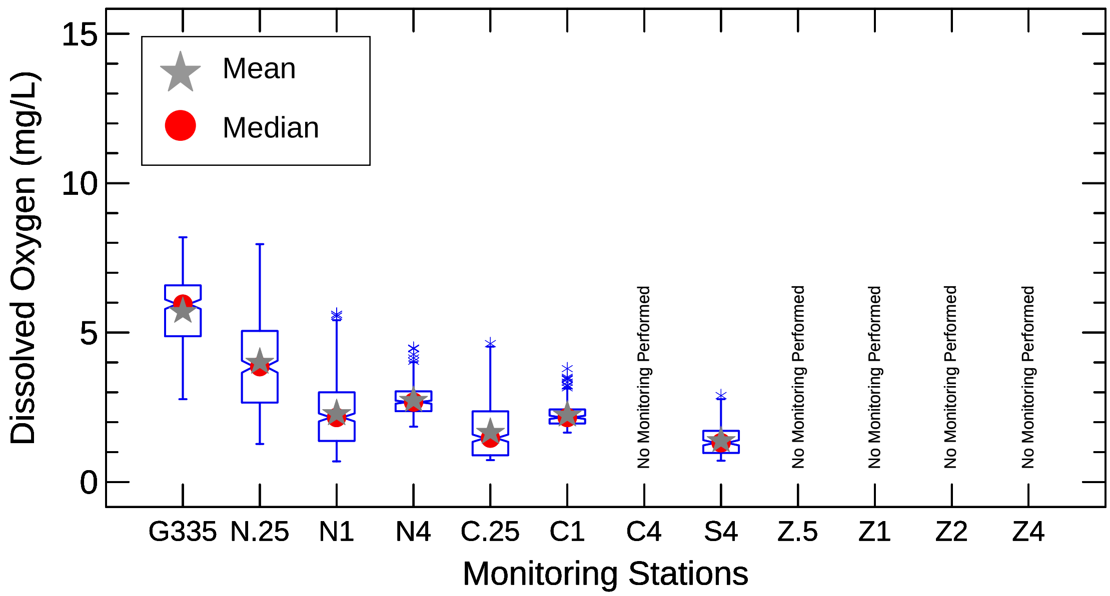
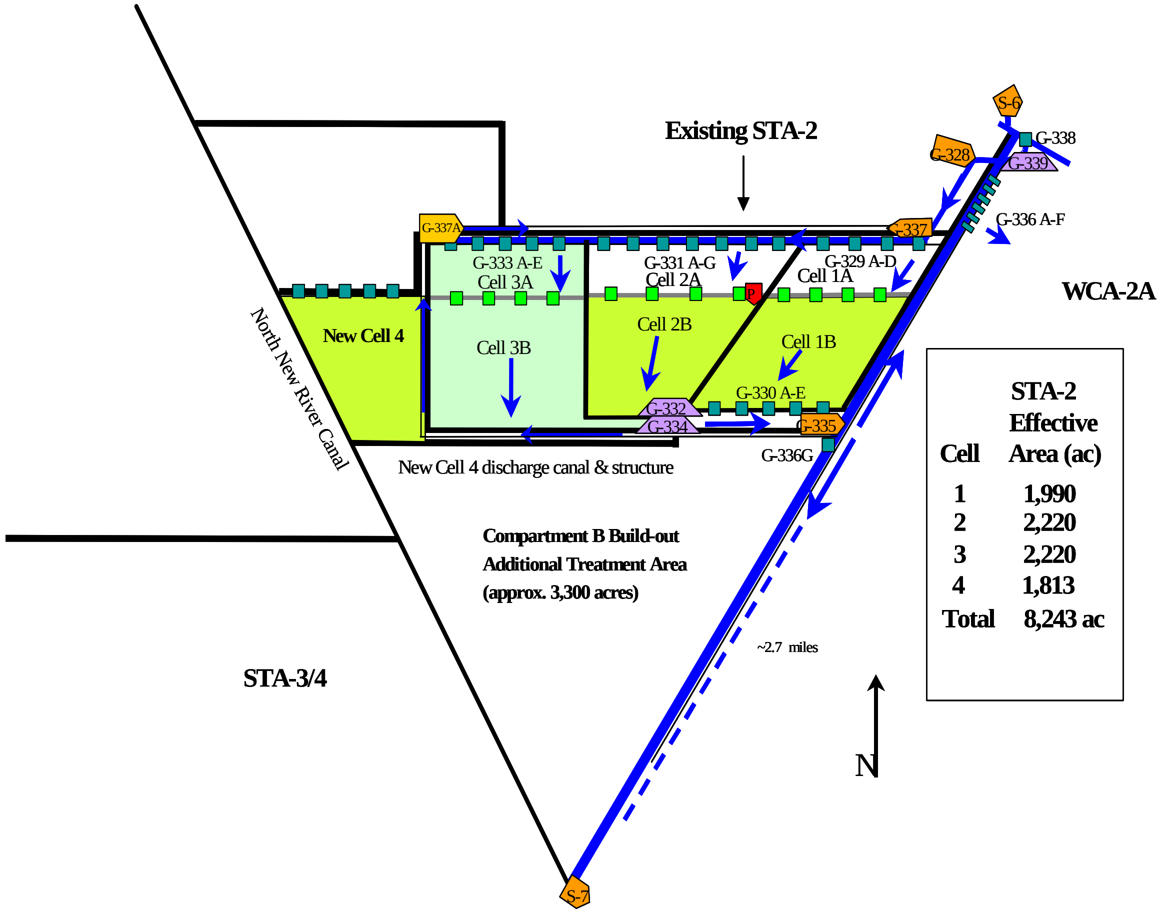


Figure 4-17. Notched-box and whisker plots of diel DO measurements at the STA-2 outflow station (G-335) and along transect sites in WCA-2 during three monitoring periods. The notch on a box plot represents the C.I. about the median, which is represented by the narrowest part of the notch. The top and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



Cell	STA-2 Effective Area (ac)
1	1,990
2	2,220
3	2,220
4	1,813
Total	8,243 ac

Figure 4-18. STA-2 enhancements.

Table 4-9. Statistical summary of diel DO at the outflow pump station from STA-2 and marsh stations in WCA-2 during WY2004.

Location	Station	Number of Measurements	Mean	Minimum	Median	Maximum	Standard Deviation
Outflow	G335	278	5.73	2.77	5.95	8.19	1.33
Transect C	C.25	360	1.68	0.73	1.47	4.63	0.88
	C1	181	2.26	1.65	2.16	3.79	0.41
	C4	----	----	----	----	----	----
Transect N	N.25	359	4.03	1.27	3.86	7.96	1.59
	N1	377	2.31	0.69	2.16	5.61	1.14
	N4	377	2.75	1.85	2.67	4.48	0.52
Transect S	S4	181	1.41	0.71	1.31	2.89	0.52
Transect Z	Z.5	----	----	----	----	----	----
	Z1	----	----	----	----	----	----
	Z2	----	----	----	----	----	----
	Z4	----	----	----	----	----	----