Stormwater Treatment Area-1 West, Cell 5 Sediment, Topographic and Vegetative Enhancements

Introduction

The Everglades is an internationally recognized ecosystem that covers approximately two million acres in South Florida and is the largest subtropical wetland in the United States. However, the biotic integrity of the Everglades ecosystem has been endangered by alterations of hydrologic and nutrient regimes due to urban and agricultural development. Reduction of total phosphorus (TP) from the Everglades Agriculture Area (EAA) runoff is a prerequisite to restoring and protecting the remaining Everglades natural resources. The Everglades Forever Act (EFA, Section 373.4592, Florida Statutes) requires that water released from the EAA into the Everglades Protection Area (EPA) achieve and maintain compliance with state water quality standards, including phosphorus. The use of Stormwater Treatment Areas (STAs) to intercept TP from the agricultural runoff is a key component of the South Florida Water Management District's (District) Everglades restoration program. Six STAs with a total effective treatment area of approximately 40,000 acres have been constructed in recent years.

Background

Stormwater Treatment Area-1West (STA-1W) is a large (6,670 acres) treatment wetland operated by the District, located 25 km west of the city of West Palm Beach and borders the northwest corner of Water Conservation Area 1 (WCA-1) in western Palm Beach County, (Figure 1). There are three flow-ways in the STA-1W: the eastern flow-way consists Cells 1 and 3 with an effective treatment area of 2,516 acres; the western flow-way consists of Cells 2 and 4 with an effective treatment area of 1,299 acres; the northern flow-way consists Cells 5A and 5B with an effective treatment area of 2,855 acres.

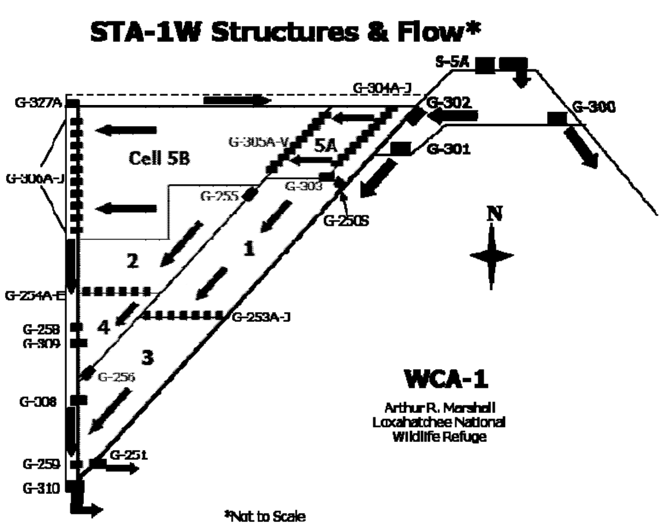

Figure 1. Site map for STA-1W showing flow-ways and flow structures.

The northern flow-way began flow-through operation in July 2000. The two cells are separated by a levee containing twenty-two culverts (G305A-V) that convey the water from Cell 5A to 5B. The vegetation management objective for this flow-way is to encourage emergent macrophyte vegetation (generally cattail) in Cell 5A (562 ac) and submerged aquatic vegetation (SAV) in Cell 5B (2,293 ac). In 2000 and 2001, various efforts were employed to encourage and promote the growth of vegetation within the cell and included such efforts as water depth management and stocking Cell 5B with SAV harvested from other areas in the STA. Despite these efforts, the SAV was slow to colonize and expand throughout the entire Cell 5B. Additionally, the large open water in Cell 5B, in excess of 2,000 ac, created favorable conditions for small waves that continually uprooted the SAV, and wind coming predominantly from the south-east would pile the SAV up near the northern and western boundaries of the system. Anecdotal observances indicated that SAV was becoming established on the lee side of cattail clumps; therefore plastic and wooden stakes were installed throughout Cell 5B to serve as an attachment site for the SAV. This effort may have been beneficial, as by August 2003 over 90% of the cell was vegetated with SAV with greater than 50% of the cell categorized as densely vegetated. Efforts to encourage the growth of emergent vegetation in Cell 5A were also problematic due to topographic inconsistencies in the cell which created excessively deep areas when attempting to maintain a target stage in the cell based on the average bottom elevation.

In January 2004 the density of SAV coverage in Cell 5B began to decline, but rebounded during the summer season, resulting in the hypothesis that the loss was seasonally related. As a direct result of the September 2004 hurricanes, the SAV in the eastern portion of Cell 5B was uprooted and a severe decline of the vegetation in the western portion of the cell was set in motion, ultimately resulting in virtually a complete loss of SAV in Cell 5B. The deterioration of the SAV was likely due to a combination of the following factors:

- Unconsolidated sediment that is easily suspended resulting in:
  - excessive turbidity, and
  - the inability to adequately secure vegetative roots
- Non-uniform depths, with north-eastern portions of the system much deeper than others, resulting in water depths higher than optimal for SAV growth in these areas
  - Due to the dark tannic water, the deeper areas resulted in poor light penetration and played a part in the poor SAV growth.
- Phosphorus loads about double the estimated design envelope
- Severe hurricane winds in September 2004 and October 2005 resulting in uprooted vegetation and re-suspension of sediment into the water column

In November 2004 the District implemented a series of measures designed to alleviate these, such as lowering the water depth and reducing the nutrient loading to the system, details of which are provided in the STA-1W Recovery Plan. Following Hurricane Wilma in October 2005, the vegetation and sediment were severely disrupted and the District recognized the need for a comprehensive plan to address the many issues specific to Cell 5. The following sections describe a plan that spans two dry seasons and is intended to accomplish the following:

- Extensive dry-out of Cell 5B to consolidate the sediment.
- Installation of several small berms in Cell 5B that will serve as high-ground and support the growth of emergent vegetation strips. The berms will serve to segment the large cell and may provide wind breaks and possibly preventing the uprooting of SAV during high-wind events.
- Transport and distribution of fill material in the extremely low areas in Cell 5A to establish shallow depths favorable for emergent vegetation.

Cell 5 Dewatering and Construction Plan – January 2006 to June 2006

- Cells 5A and 5B will be drawn down for dry out and consolidation of sediments, survey work, and planting strip construction.
- SFWMD will install a temporary earth plug in the STA-1W discharge canal near the south boundary of Cell 5. SFWMD has installed another temporary earth plug in the seepage canal near the east end of Cell 5A. *(Installed)*
- SFWMD will install 2-30", 50 CFS pumps in the reach of the discharge canal adjacent to Cell 5 and draw it down several feet below normal to allow Cell 5 to drain through the G-306 structures. A temporary water quality monitoring station will be set up down stream of the discharge points. *(Instituted)* After initial drawdown of surface water, approximately 4 to 6 weeks, one of the 30" pumps will be moved to the east end of the seepage canal to discharge to the old ENR Supply Canal. This pump will be operated only if Florida Crystals is unable to accept discharges due to high water levels on its lands. *(To date, Florida Crystals has accepted all discharges)*
- SFWMD will use 3 each - 12", 15 CFS pumps in the north end of the north-south farm canals in Cell 5 and discharge to the seepage canal. The pump will be located as shown on Figure 2. *(Installed)*
- Florida Crystals will route the discharges onto its lands utilizing existing farm canals as needed to route the water to fields requiring irrigation for rice cultivation. *(Instituted)*
- The balance of the water will be absorbed in the canals of the Gladeview DD in as much as practicable, and any excess water will be will be diverted through a 48" culvert to Shawano DD for use in irrigation or recharging the water table. *(To date the balance of the water has been absorbed by the canals of the Gladeview DD)*
- Should surface or ground water levels exceed those required for efficient agricultural operations; Shawano will operate the pump station on the

Hillsboro Canal to move water form Shawano to the Hillsboro Canal. *(To date, this has not been necessary)*

- SFWMD will operate the S-6 Pump Station as required and move the water to STA-2 for treatment.
- Planting strips will be located on top of the old north–south farm roads on the section and half section lines. The old farm roads were surveyed on 100 foot centers and it was determined that the existing road elevations would be suitable for planting and that no earthwork activities would be required.
- Planting strips will be planted with a mixture of five emergent plants, such as cattail, alligator flag, bull rush, and spike rush by contractor(s) employed by Vegetation Management. *(Planting scheduled for July 10, 2006)*
- Upon completion of sediment consolidation and planting strip planting, Cell 5B will be re-flooded to a depth suitable for SAV growth. Cell 5A will not be hydraulically isolated from Cell 5B.

Cell 5B G-306 Upstream Berm Removal

- High topographic areas upstream of the outflow structures G-306 F-I have been identified as areas that create high-flow short-circuits that could be leading to increased bed-load removal through the outflow structures. This material was scraped down and placed in deep areas in Cell 5B, including portions of the former ENR seepage canal. (completed)

Cell 5B G-305 Inflow Culverts

- Through a combination of normal operations and the Cell 5 drawdown, many of the G-305 Cell 5B inflow culverts (specifically G305 C-D and O-R) have become filled with silt.
- Removal of this material is planned to occur in the 2007 wet season.
    - A hydraulic dredge will be used to remove the material to a 50 acre spoil site located north of Cell 5A.

Cell 5A G-304 Inflow Culverts

- Automation and remote operation capability of the G-304 structures is scheduled to be completed by September 2006. This automation will allow maintenance of uniform allocation of flows and loads to each flow-way and maintenance of target water levels in Cell 5 that are lower than the target water levels in Cell 1. *(Underway)*

Cell 5A Topographic Enhancements and G-304 Downstream Berm

The existing farm road and/or berm located immediately downstream of the G-304 spreader canal has been surveyed and a review indicates the following:

- Much of the berm is above elevation 10.0 ft NGVD
- There is a 700 ft gap located on the northern end between stuctures G-304 A and B that has an elevation less than 10 ft NGVD, with one area between 7.6 ft and 8.0 ft NGVD
- A larger tract of land area in the southern end of Cell 5A, at the end of this high berm area was identified.

The District will level the berm to elevation 10.0 ft NGVD and move the spoil to a low section in the northern area. The scope will be as follows:

- Disk the area to be graded. The heavy vegetation will be chopped prior to grading in order to facilitate loading the berm material onto pan scrapers.
- Cut the elevated area of the berm down to an elevation below 10 ft NGVD and more the material to the lowest areas identified by the survey
- Complete the job by laser leveling the cut and fill areas.
- Some areas marginally less than the target elevation of 10 ft NGVD will be left undisturbed.
- The larger land area in the southern end of Cell 5A that was identified as having elevations greater than 10 ft NGVD will not be degraded at this time. A channel will be cut in this area to facilitate water movement through this area.

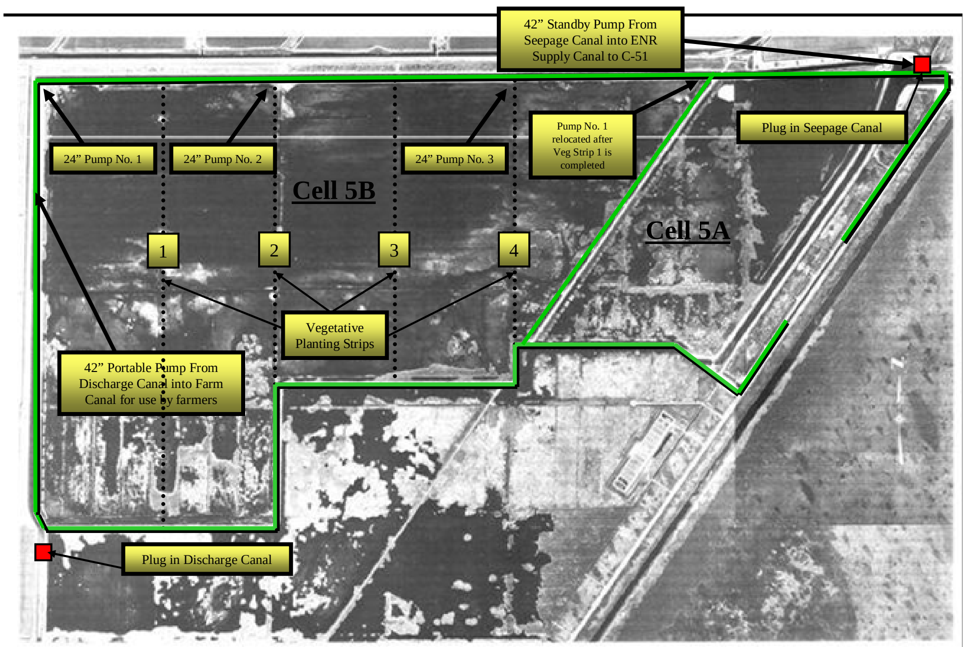

Figure 2. Site plan showing the details of the proposed dewatering and planting strip plan for STA-1W, Cells 5A and 5B.

Cell 5B Planting Strips *(Planting scheduled for July 10, 2006)*

- Planting strips will be created on top of the four former north-south farm roads located within Cell 5B (Figure 2). Note that the existing former farm roads were surveyed and a review of the data indicated that the elevation of these existing roads was adequate for the creation of the planting strips.
- The four former north-south farm roads will be planted with a mixture of emergent plants. Current design is to plant with nursery stock at 1-ft on center. The following plants (40,000 each) were ordered for delivery 7/10/06
    - *Scirpus californicus*; giant bulrush
    - *Scirpus americanus*; three-square
    - *Thalia geniculata*; alligator flag
    - *Eleocharis interstincta*; jointed spikerush
    - *Sagittaria lancifolia*; lance-leaf arrowhead
- Each existing former farm road has several cuts along its length which will not be planted with vegetation thereby leaving gaps in the planting strips to assist with the movement of water through the cell. The resulting gaps in the planting strips will be sufficiently staggered such that the gaps along the adjacent planting strips will not be in line with each other. This staggered gap arrangement will minimize hydraulic short circuiting in the cell.
- To ensure sufficient water for the growth of the emergent vegetation, prior to planting, the cell will be hydrated to partially submerge the planting strip locations.

Cell 5 Dewatering Monitoring Plan

- The dewatering monitoring plan will be implemented and conducted by the contractor on site as per the Everglades Regulatory Program Monitoring Program; Chapter 40E-63 Requirements for ECP Basins: Stormwater Treatment Area (STA) Dewatering Discharges Project: STA-1W, Cell 5 (Addendum 1). *(Underway)*

Cell 5B Planting, Re-wetting, and Grow-in Plan for Phase 1 (2006)

- About 967 net acres of Cell 5B has been dedicated for rice planting (*Oryza sativa* L., cv Wells) with the remaining area to be inoculated with SAV (Figure 4).
- Rice is being planted in an attempt to utilize the root structure to bind and bring cohesion to the unconsolidated peat upon re-flooding. Additionally, it is theorized that the rice may reduce turbidity by reducing wind fetch across the system and provide a temporary attachment site for epiphytic algae and SAV. (*Underway 4/10/06)*

- Two types of rice planting methods will be used to determine which may provide the better results for the purposes of this plan. A rice or grain drill will be utilized for a portion of the planting area. The balance of the area will be planted after light disking with an "Air-Max" seeder, followed by a drag board. Application rate about 80 lb/ac.
- Upon completion of planting, the dewatering pumps will be turned off and the cell will be allowed to re-wet with seepage.
    - The next step will be to remove the temporary earth plug located in the seepage canal near the east end of Cell 5A.
    - As a result of these activities the seepage canal will slowly return to the normal stage.
    - It is assumed that the low-lying areas of the cell will re-hydrate after 2-3 weeks. Additional water to replace ET losses and to achieve the necessary rice grow-in depths will likely be required and these possible sources are detailed in the following section.
- The remaining open water designated for SAV growth will remain unplanted at this time, but may be inoculated at a later date.
- The portions of Cell 5B that were planted with rice may also be inoculated with SAV if deemed necessary to accelerate the grow-in process.
- Cells 5A and 5B will be closely monitored and *Amaranthus palmeri* (pigweed) and will be chemically treated with 2,4-D, and if possible mowed and removed (following spraying).
    - To date, a total of 1,500 ac has been sprayed
    - To date, over 280 ac of pigweed have been harvested

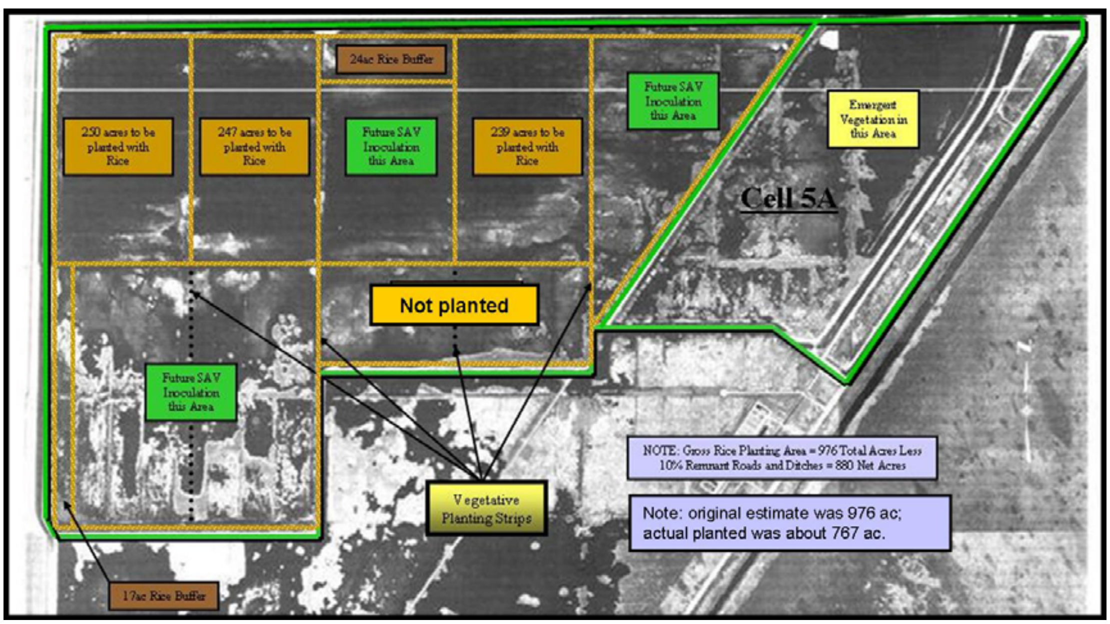

Figure 4. Site plan showing the details of the proposed block planting design for STA-1W, Cell 5B.

Source Water for the Re-wetting of Cell 5B: Phase 1 (2006)

In estimating the amount of water that will be needed to complete this re-hydration process, it was assumed that the total acreage of Cells 5A and 5B combined is 2,855 acres and that an average water depth of one foot will be needed or about 3,000 acre-feet. Following is a list of possible sources for the additional water necessary to re-hydrate Cell 5:

- G-327B Seepage Pumping and Temporary Pumping Option – Seepage from the seepage canal can be directed to Cell 5B by the newly constructed pump station G-327B which has a capacity of 65-cfs. Should seepage water in the canal not be adequate to maintain the desired stage in Cell 5B, a 50-cfs portable pump can be set up to pump C-51W Canal water from the former ENR Supply Canal to the seepage canal. G-327B can then lift the water into Cell 5B.
- Refuge Option– Depending on stage and wildlife conditions in the Refuge, and assuming approval from the Refuge Manager, the G-301 structure could be opened to allow the discharge of about 300-500 cfs out the Refuge into the STA-1 inflow distribution works. The STA-1W, G-302 inflow structure would then be opened to send the water into STA-1W. This procedure has been used on at least two previous occasions to add water to STA-1W, first when we conducted the dye tracer project in Cell 5, and second when we re-hydrated Cell 5 following the limerock berm scrape-down activities in the spring of 2005 (still confirming second event). Depending on stages in the Refuge and the receiving canal(s), the initial re-hydrating of the cell with 3,000 acre-feet of water could be accomplished in about 5 days assuming an inflow rate of 300 cfs per day, and in about 3 days assuming an inflow rate of 500 cfs per day.
- STA-1E Option – Assuming that a rain event occurs in the C-51W basin that triggers operation of the S-319 pump station and with the correct stages in the STA-1E distribution cells, it would be hydraulically possible to move water out of STA-1E through the G-311 over to G-302 and into STA-1W. To facilitate this, the STA-1E inflow gates for Cells 3, 5 and 7 would need to be closed and the S-375 divide structure separating the eastern and western distribution cells would need to be opened.
- Lake Okeechobee Option – Assuming 24-hour pumping of one 800-cfs pump at the S-5A pump station, the initial re-hydrating of the cell with 3,000 acre-feet of water could be accomplished in about 2 days. If 8-hour pumping shifts are used, the 3,000 acre-feet could be provided in about 6 days. If it is necessary to re-hydrate the cell in a more gradual manner to coincide with the rice growing process as opposed to adding all 3,000 acre-feet of water at once, then a series of 8-hour pumping events could be utilized over one or more weeks.
    - Although phosphorus levels in Lake O water being released through the S-352 structure are starting to decline to concentrations near 200 ppb, the water may be excessively turbid and therefore, not favorable for SAV growth. It is recommended that the phosphorus levels and

clarity of this source of water continue to be monitored and a determination made in the coming months (May-June) as to whether or not it should be utilized to re-hydrate Cell 5.

Cell 5B Monitoring Plan for Phase 1 (2006)

- In brief; the top 10 to 12 cm of peat has become unconsolidated and created two main problems.
    - Emergent vegetation and SAV with roots or holdfasts are unable to properly anchor within this unconsolidated peat.
    - The unconsolidated peat is constantly being re-suspended resulting in a very turbid water column that prevents light penetration down into the water column; thus deterring and/or inhibiting the growth of SAV.
- Therefore, the monitoring program should measure metrics that attempt to measure (answer) the two main questions.
    - Has the peat successfully reconsolidated?
    - Has the re-suspension of the unconsolidated peat been abated?
- In addition, other questions of interest have arisen.
    - Will the rice plant provide enough open areas to support SAV growth?
    - Will the roots of the rice plant provide a cohesive structure to the peat?
    - Will the rice plants reduce turbidity?
    - Will SAV growth be increased in the rice planted areas relative to the unplanted areas?
    - Which method of removing pigweed proved to be more successful, i.e., application of herbicide without mowing or application of herbicide in conjunction with mowing/harvesting?
- The monitoring plan will employ a stratified-random block sampling design, with the blocking design provided by the rice vs. SAV planted areas (Figure 4); thus resulting in 8 blocks.
- Randomized water quality sampling sites within each block will be established; utilizing previously established 1300 ft by 1300 ft sampling grid for Cell 5B (Figure 5).
    - Within each block, three water quality sampling stations will be randomly established; resulting in 24 water quality sample sites.
    - Sampling interval will be weekly at the beginning; with increased time-step if warranted.
- Water depth and percent cover of vegetation growth will be visually surveyed across each of the blocks; resulting in 68 sites.
    - Sampling interval will be biweekly at the beginning and once per month after growth slows.

  - Percent cover will be estimated using a previously proven method devised to quickly assess cover over a large area. At each site, coverage will be determined to be as follows:
    - No coverage (rating of 0)
    - Zero to one-third (33%) coverage (rating of 1)
    - One-third to two-thirds (66%) coverage (rating of 2)
    - Two-thirds to full coverage (100%) (rating of 3).
  - These estimates will then be graphically displayed with circles on a map, with increased circle size representing increasing coverage; thus allowing for a quick visual representation of the coverage and any possible patterns. Figure 6 is an example of this graphical display using data similarly collected in the STA-3/4 PSTA cells.
- Aerial flights may be needed for the initial assessments; depending on the initial water depths.
- Random sampling will be employed within each block (SAV vs. rice) to determine if SAV alone or rice has been more successful in reducing sediment re-suspension.
  - Three sites within each block will be randomly selected for this endeavor.
  - Monthly grab water samples will be collected from each site and analyzed for the following parameters:
    - Turbidity
    - Total suspended solids
    - Color
    - Phosphorus
- The study is expected to extend through the 2006 wet season; with the need for continued monitoring assessed in October 2006.

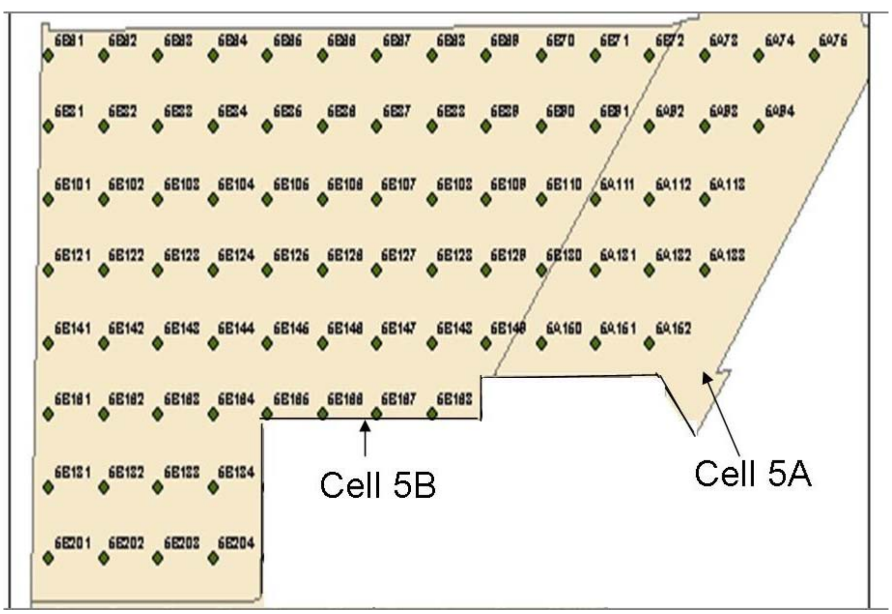

Figure 5. Schematic indicating previously established monitoring sites in STA-1W, Cell 5. The 68 sites in Cell 5B will serve as the basis for the stratified random sampling design to monitor factors related to the Cell 5 draw-down.

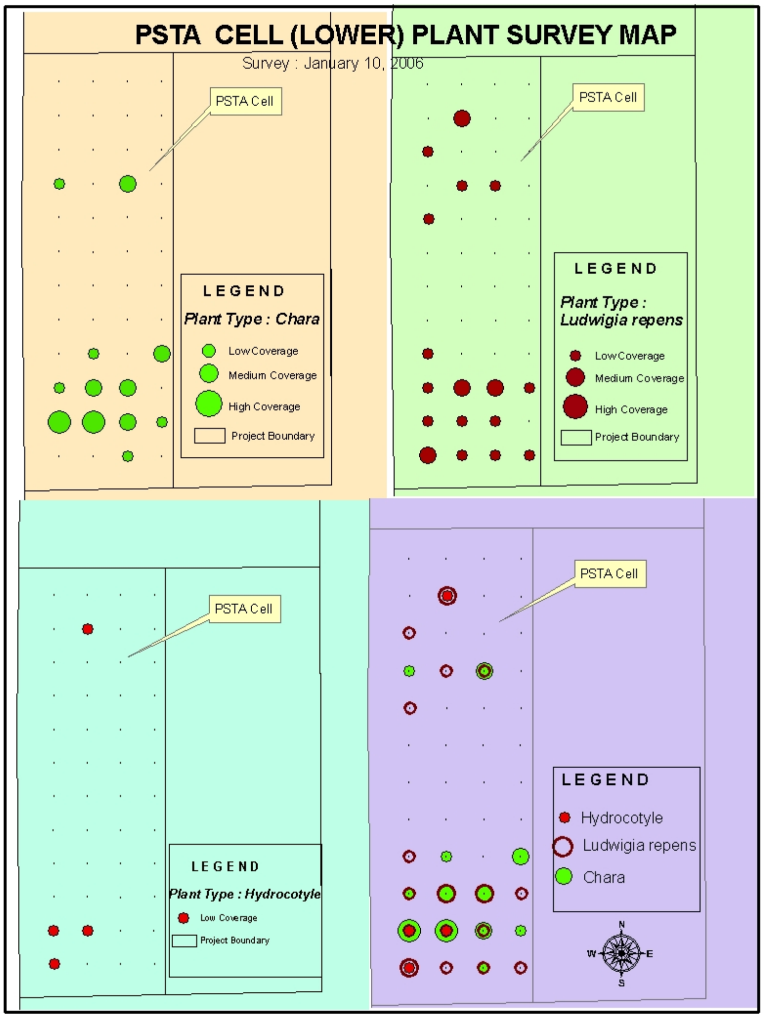

Figure 6. Maps from the STA-3/4 PSTA full-scale monitoring project depicting the relative density of the vegetation at each site along a set of transects. Dot size ranges across low, medium and high coverage resulting in a quick visualization of the vegetative coverage of the system.

Permit modifications

- Addendum II is a copy of FDEP by-pass response letter.

Addendum I: Everglades Regulatory Program Monitoring Program for Chapter 40E-63 Requirements for ECP Basins: Stormwater Treatment Area (STA) Dewatering Discharges Project: STA-1W, Cell 5

I. Minimum Requirements for Water Quality:

A. During periods of off-site discharge, water quality composite samples shall be collected by a time proportional automatic sampler and preserved. The composite sample shall be: a) **removed** from the sample collection site and delivered to the laboratory no later than 7 days from the time the individual first sample was drawn, and b) **analyzed** for total phosphorus no later than 28 days from the time the first individual sample was drawn. Each time there is discharge (e.g. the pump is operated) the automatic sampler must be turned on for the duration of the discharge event and turned off when the pump is turned off (unless an automated system is in place).

B. All field water quality sample collection, preservation, handling, transport and chain-of-custody documentation must be conducted in accordance with an FDEP-approved comprehensive quality assurance plan.

C. All phosphorus analyses shall be conducted by a laboratory certified by FDOH for nutrient analysis.

D. In the event that water quality automatic sampling equipment becomes inoperable for any reason, grab samples shall be taken on a daily basis and composited for a maximum of 7 days for total phosphorus analysis. Reasonable efforts must be made in that time period to render the automatic sampling equipment operable.

E. There may be other creative approaches to measure phosphorus. These alternative approaches need to be presented in writing and approved prior to implementation.

II. Requirements for Water Quantity:

A. Prior to any discharges occurring, instrumentation must be in place to provide reasonable assurance that the discharge quantity is accurately documented. In the case of a pump, a calibration approved in advance by the EREG Division is usually required. The field variables that must be recorded for the calibration equation include the head differential across the pump and the RPM. For the head differential, an upstream and a downstream staff gage are typically installed relative to the pump discharge centerline so that water elevations can be measured. The staff gages must be read and logged at least twice daily at approximately the same times each day during periods of discharge. If the potential to discharge with the pipe fully or partially submerged exists, the centerline of pipe elevation must be measured relative to the staff gages.

B. Prior to any discharges occurring, there must be some means to record the pump or engine RPM. If this is done using a hand-held tachometer, reflective tape should be placed on the appropriate pulley. A mounted tachometer shall be calibrated to the pump or engine speed depending on which is to be recorded for use in the calibration equation. While the pump is operating, the RPM must be recorded each time the site is visited (at least twice daily during periods of discharge). Any changes in the pump or engine configurations (such as new sheaves, impellers, etc.) which might impact the accuracy of the existing calibration should be reported immediately to determine if re-calibration is necessary.

C. One exception to A and B above, with prior District approval, is for pumps which are in place for less than 30 days. In this case the pump manufacturer's rated capacity along with the time pumped may be used to compute daily flows. Alternatively, the manufacturer's rating curves for the specific pumps may be submitted with the method for computing flow for approval. In this case, upstream and downstream staff gages are required to be logged twice daily to confirm applicability of pump curves. Pump logs shall be submitted with the monthly data submittals.

D. There may be other creative approaches to measure flow. These alternative approaches need to be presented in writing and approved prior to implementation.

III. Summary of Requirements for Reporting:

A. A monthly log must be kept for **each pump** (see the attached sample pump log).

B. Daily **rainfall** in inches must be **measured** at an on-site rain gage and logged on the pump log. If no rain occurred, zero should be reported.

C. Indicate on the log whether the pump was turned on or off or whether the speed was adjusted.

D. Log the **time of each visit** to the site when indicating on the log if the pump was turned on or turned off, or in the case of a continuous pumping event the time readings were taken.

E. Pump or engine **RPM must be read** during **each visit** if operating.

F. Each **staff gage must be read** at least **twice per day** during periods of discharge.

G. **Each day should have an entry** for flow as well as rainfall. Zeros should be reported for days where no rainfall or flow occurred.

H. Any **maintenance or repairs should be noted** on the back of the log (including the date), particularly if it affects the sheave ratio, impeller, etc.

I. The monthly water quality and quantity **data must be submitted** to the EREG Division in **electronic format**. To ensure consistency of data submittal, the District has developed an Electronic Data Deliverable (EDD) format to be used when submitting data. A web based application (EWOD) for data entry is also available upon request (see attached user's manual and refer to Appendix A for EDD format). All water quality and quantity data shall be submitted in accordance with this program.

J. A **map** depicting the location of the dewatering pump(s) and sampling location(s), accompanied with **photos** of each, must be submitted.

NOTE:
If discharge is by another means such as a culvert, open channel or weir, please contact the Everglades Regulation Division for specific monitoring requirements. These types of discharges typically require electronic water level sensors and recording of different site variables.

All questions should be directed to the Division Director, Everglades Regulation Division.

Addendum II: FDEP by-pass response letter for STA-1W, Cell 5