Stormwater Treatment Area-1 West Recover Plan

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 1994 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 water quality standards, including phosphorus. The use of Stormwater Treatment Area (STA) 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), located 25 km west of the city of West Palm Beach, borders the northwest corner of Water Conservation Area 1 (WCA-1) in western Palm Beach County, is a large (6,670 acres) treatment wetland operated by the District (Figure 1). There are three flow-ways in the STA-1W: the east flow-way consists Cells 1 and 3 with an effective treatment area of 2,516 acres; the west 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. The east and west flow-ways were originally constructed as a prototype STA, formerly known as the Everglades Nutrient Removal Project (ENR Project) and operated from August 1994 through April 1999. The northern flow-way began flow-through operation in July 2000.

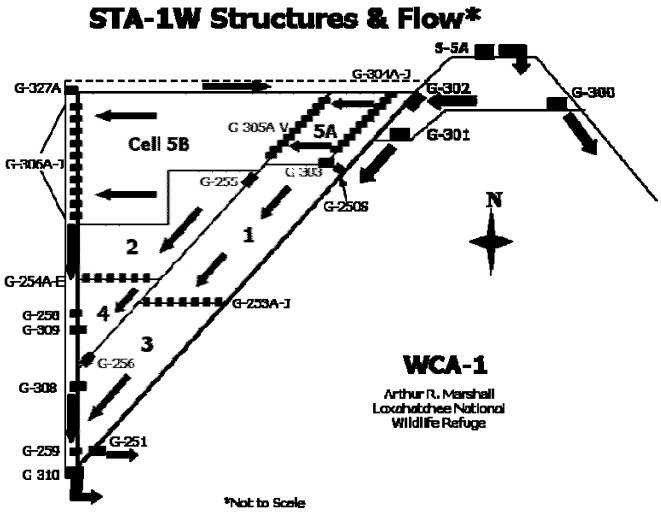

Figure 1. Site map for STA-1W showing flow-ways and flow structures.

Design Envelope vs. Operational Data

Design parameters are summarized in Table 1 and are described in relation to the operational data as follows:

Effective Treatment Area: STA-1W was designed to provide an effective treatment area of 6,670 acres, with the original ENR (Cells 1 through 4) comprising 3,815 acres and the remaining 2,855 acres contained in the northern flow-way (Cell 5A and 5B).

Flow Pattern: STA-1W receives inflow from pump station S-5A via structure G-302. The inflow is distributed to the three treatment flow-ways through respective structures or culverts and the outflow is discharged into WCA-1 via G-251 and G-310. While the inflow volume exhibits significant variability from year-to-year, the long-term average annual inflow volume anticipated during the design of the enhancements was approximately 160,000 acre-feet (221 cfs), based on key assumptions utilized during design:

1. STA-1E would be fully operational and receiving a portion of S-5A basin runoff;
2. a portion of the S-5A Basin runoff would be diverted to STA-2;
3. there would be a 20% reduction in S-5A Basin runoff volumes and loads as a result of BMP implementation;
4. there would be minimal deliveries from Lake Okeechobee for water supply or regulatory purposes;
5. runoff from the L-8 basin would be diverted away from the S-5A complex as delineated in the L8 Basin- Interim Operations of STA-1E and C-51 Canal (Draft May 24, 2005);
6. there would be a small increase in the volume of water from the East Beach Water Control District; and
7. the District South Florida Water Management Model accurately predicted runoff from the S-5A Basin.

These assumptions were inaccurate, and additional estimates of flows and loads to STA-1W are being developed.

During the past year, the 365-day cumulative flow to STA-1W had generally exceeded the maximum design envelope, and the 30-day cumulative inflow volume had experienced a sharp increase beginning in August 2004, the hydrologic loading in September 2004 alone was 109,912 acre-feet, which accounted for more than 65% of the average annual design inflow.

Operation depth: The current target water depth between storm events varies across the treatment cells with a range of 1.25 – 1.75 ft. The long-term average depth is 1.9 ft and the original design operational depth was 2.0 ft.

Total phosphorus loading: Although the annual TP load going into the STA will vary from year-to-year, the average annual TP loading to STA-1W applied during the

design of the enhancements was approximately 27,372 kg, and assumes a mean inflow concentration of approximately 139 ppb (Table 1).

From May 1994 through September 2004, the actual monthly flow-weighted mean inflow TP concentration was 151 ppb at inflow (G-250 and G-302). Preliminary assessment of more recent data indicates that beginning about June 2004, the weekly measured concentrations at G-302 often exceeded 150 ppb, with a peak monthly mean TP inflow concentration during September 2004 of about 296 ppb. This elevated TP concentration, combined with the elevated flows, resulted in 365-day cumulative TP loading rates greater than design. However, the 30-day cumulative loading rates between November 2003 and late August 2004 have generally been at or below the mean design loading rates, but experienced a sharp increase beginning September 2004, primarily as a result of hurricanes Francis and Jeanne.

Table 1. Revised design parameters for STA-1W.

	Peak Flow cfs	Average Flow acre-feet/yr	TP Conc ppb	Average Hydraulic Loading Rate cm/d	Peak Hydraulic Loading Rate cm/d	Average Nutrient Loading Rate $g/m^2/yr$
Inflow	3,250	159,985	139	2.00	29.46	1.01
Outflow	3,490	188,100	24-30			

Performance

Preliminary results, as reported in the 2004 Everglades Consolidated Reports, indicate that STA TP removal performance is related to TP inflow concentrations and areal loading rates. More recent data indicates that if loading rates are reduced, the STA TP percent load reduction will increase as the system recovers (Figure 2). Since about November 2003, the monthly TP loading rate into STA-1W has been at or below the mean design envelope and the STA-1W TP reduction performance had been increasing since about December 2003 until September 2004. This most recent decline, beginning in September 2004, may be mainly attributed to the effects of hurricanes Francis and Jeanne. In addition to the increased TP loading, the severe winds and heavy rainfalls during the hurricanes may have reduced plant coverage in some flow-ways, especially in the northern flow way Cell 5B.

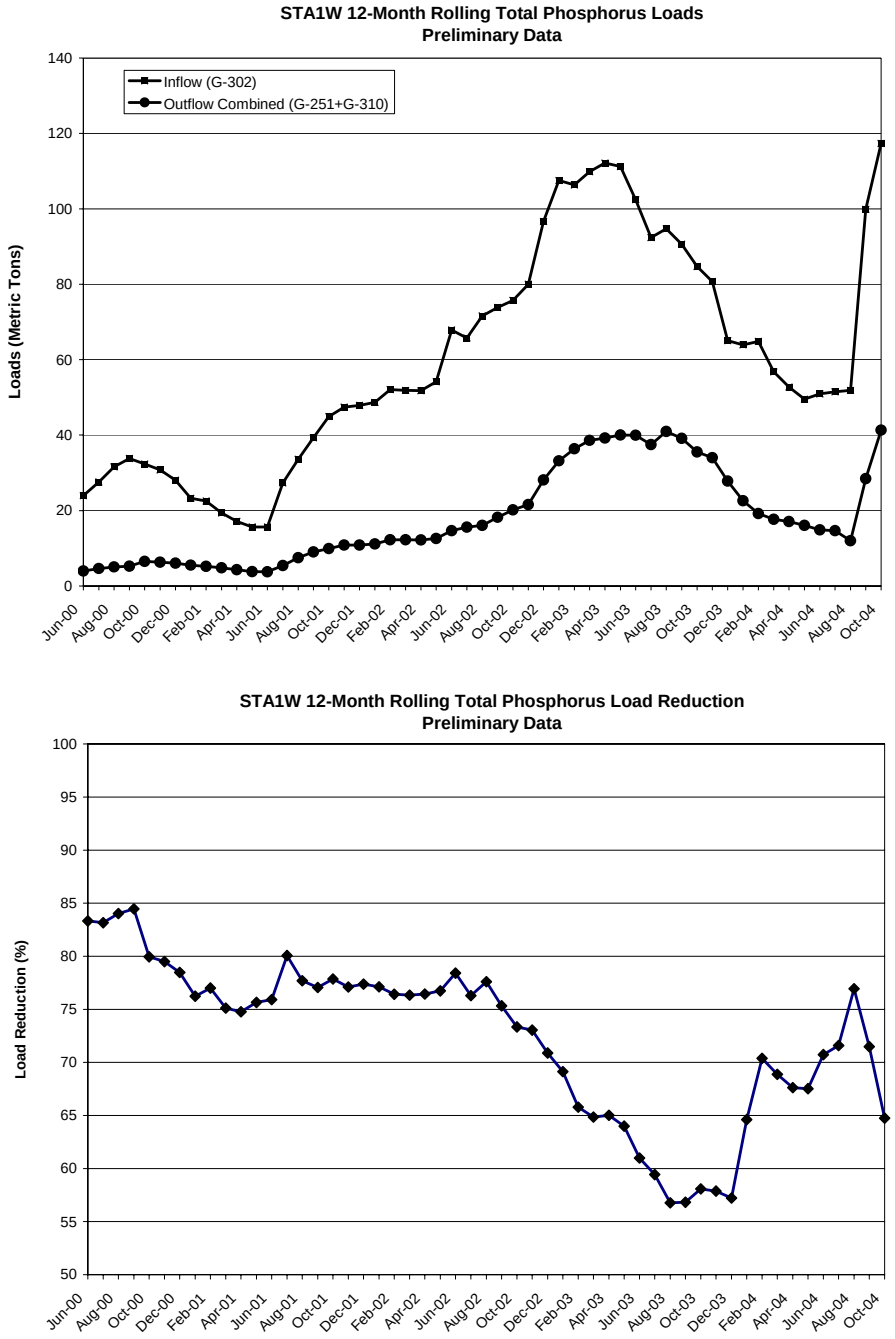

Figure 2. Inflow and outflow TP loads (upper panel) and load reduction (lower panel) in STA-1W.

Objective

The ultimate objective of this recovery plan is to provide a methodology to restore and enhance the nutrient removal performance of the STA-1W. This objective will be accomplished through hydrologic operation control, construction of enhancements, vegetation management, monitoring and assessment, and continued communication with stakeholders. A major effort will be the restoration of a robust vegetation

community that was degraded due to either overloading, alteration due to implementation of LTP enhancement projects, or decline due to natural processes such as hurricanes, drought or natural life cycles. Monitoring and assessment of the performance data will occur throughout this recovery period in order to provide operational guidelines and promote adaptive management decisions throughout the recovery process.

Summary

The major driving force in restoring the TP removal efficiency of STA-1W is the ability to maintain inflow TP loads at or below design levels (see Operations bullet 1.c). Comparisons of actual inflow loads to the design envelope projection of loads are discussed at weekly meetings with the Operations Department. In addition to controlling the loading, it is imperative that the appropriate vegetative community be established during this recovery period. Several efforts regarding the establishment of the vegetation communities have begun and discussions regarding additional strategies are ongoing and detailed in Table 1. Table 2 presents the monthly volumes, loads and flow-weighted means of TP diverted through the G-300 and G-301 structures during the recovery period. Tables 1 and 2 will be updated at least every 6 months.

It is anticipated that full recovery is not a short-term effort, and will not be fully realized until sometime following the completion of the LTP enhancements and a robust vegetative community is established.

Table 1. Timeline of STA-1W recovery efforts, start date and status.

Overall Efforts	**Participants**	**Start date**	**Status**
1 No limit at G-302, except as resulting from keeping Cell 5 offline	Operation	12/1/2004	Ongoing
2. Weekly assess 30-day load to adjust operation plan (assess all STAs weekly)	Operation	12/1/2004	Ongoing
3. Reduce water depth to between 1.25 to 1.5 ft	Operation	10/13/2004	**Completed This is the between storm event target.**
4. Divert flows to STA-2 as practicable	Construction	Jan-05	**Completed**
5. Accelerate STA-1E flow-through operations	Operation	10/13/2004	Ongoing
6. L-8 – move as much water to C-51W as possible	Operation	underway	Ongoing
7. Conduct vegetation reconnaissance in all cells to assess hurricane damage	STA/Site Mgmt.	10/27/2004	**Completed**
8. Prepare vegetation maps from aerial photos	STA	Dec-04	Ongoing (STAs 2, 5, and 6 completed for 2003; STA6 completed for 2004)
9. Continue inflow/outflow collection of water samples	STA/WQM	Previous effort	Ongoing
10. Conduct annual vegetation survey	STA	Previous effort	Ongoing (annually in summer)
11. G300/G301 collection of biweekly grab samples.	STA/WQM	10/27/2004	Ongoing
12. Installation of flow-proportional autosamplers at G300, G301 and G302	WQM/SIMS	July 2005	Ongoing
13. DMSTA modeling of STA-1W	District/Walker	2003	Ongoing
14. Provide monthly volume and load estimates entering G-300 and G301 as a result of STA-1W diversions.	District	8/23/05	Ongoing
15. Collaborate with Refuge on WCA-1 analysis of internal sampling data collected during and following diversion events. Refuge will analyze data and meet with District staff to discuss results.	STA/Refuge	2004	Ongoing
Eastern flow path, Cells 1 and 3	**Participants**	**Start Date**	**Status**
1. Remove G256 structure that connects eastern and western flow paths	Construction	2005/2006	Scheduled 2005/2006, but is currently sealed off and will not be operated
2. Review past Cell 1 tracer test to further assess hydraulic need for an additional levee	STA	August 2005	Note: review by STA staff will begin in mid August 2005. This is underway to see if results will also support delay of Cells 1-3 LTP enhancements.
Western flow path, Cells 2 and 4	**Participants**	**Start date**	**Status**
1. Cells 2 and 4 off line for levee installation in Cell 2 and vegetation conversion	Construction	2004/2005	Ongoing (expected completion of construction by mid July 2005

2. Repair/replace the G255 inflow structure to Cell 2	Construction	2004/2005	**Completed**
3. Install new G255 gate	Construction	2004/2005	**99% complete, telemetry needed**
4. Install electricity and telemetry to gate for remote operation	Construction	2004/2005	Scheduled to be installed by 11/2005
5. Clean out 4 aluminum G254 structures	Construction	2005	Ongoing – need to assess if are sufficiently clear
6. Replace the galvanized G254 structures	Construction	2005	Cost estimates requested as of 6/28/05
7. Considered floc removal in Cell 4 by hauling and burning	Construction/Site Mgmt /STA	2005	**Hauling was not feasible and too wet to burn. Continued discussion for other cells**
8. Reshape berm adjacent to center canal	Construction	2005	**Completed**
9. Construct new outflow structure for Cell 4 (G307) that will reduce need to use G309, which short-circuits flow path	Construction	2005	Not started, scheduled for Phase 2 (eastern flow path enhancement contract) construction, begin 8/2005
10. Removal of upland vegetation that resulted from dry out for construction in Cell 4. Several methods being tried, it was too wet to burn.	Site Mgmt.	2005	Ongoing
11. Promote grow in of vegetation in western flow-path after re-flooding - lowering depth if needed	Site Managers/Veg Mgmt/STA	2005-2006	7/2005 turned off dewatering pumps, and allowed seepage water to flood western flow-way. We are writing the contract for cattail/bulrush planting within Cell 2A.
12. Remove floating cattail tussocks	Construction	2005	**Completed**
13. Install distribution canal on north side of G254 structures	Construction	2004/2005	30% complete
14. Install/clean out distribution canal on south side of G254 structures	Construction	2004/2005	**Completed**
Northern flow path, Cells 5A and 5B	**Participants**	**Start date**	**Status**
1.DBE to provide District with depth/vegetation data	DBE/STA group	As soon as possible	not yet received
2. Lower crest of limerock berm by 6-12 inches to reduce flow obstruction	Construction	2005	**Completed**
3. Automation of G304 gates	Construction	2005/2006	Still planned
4. Encourage emergent (cattail) vegetation growth in Cell 5A and SAV growth in cell 5B by lowering water depth to 1 foot	Site Mgmt/STA/Op	2005	**Completed** As of 8/2005 we have seen no cattail growth along the edges. We will therefore move forward to plant some cattail within this cell.
5. Slowly flow water through Cells 5A and 5B to reduce possible stagnation (200 to 400 cfs)	Site Mgmt/STA/Op	2005	Ongoing
6. Plant emergent (cattail) vegetation	STA/Veg	2005	Ongoing. Contract initiated,

within Cell 5A.	Mgmt./Site Mgmt/Op		will plant perimeter with cattail.
Suggestions/Topics under general discussion	**Participants**	**Start date**	**Status**
1. Removal of accumulated floc within Cells 1 and 3 while off-line for construction (fire/hauling/dry out)			Table discussion, because requesting delay of LTP scheduled enhancements (see item 1 in Cells 1-3 section)
2. Additional levees/berms/vegetation strips to protect Cell 5 from damage that may result from additional hurricanes			Internal discussion with internal STA Leadership Team
3. Additional 2D hydrodynamic modeling of Cell 5 through contractual agreement			Internal discussions with STA Leadership Team.
45. The southwest corner of Cell 5 currently contains the only dense stand of SAV in the wetland. Under current low flow regime, the best cell outflow water quality might be achieved by closing all but the three southernmost culverts (G306 H, I, J) so that flow is diverted through this SAV community.			Internal discussions with STA Leadership Team.
5. Continued discussion on treating hydrilla in STAs, especially STA1W, Cell5 with different herbicide applications and rates.		August 2005	Note: 1.Vegetation management, site managers, STA research and DB Environmental, Inc, have had discussions regarding potential research proposals with UF aquatic weed experts regarding this subject. *A MOA is being written for various experiments to be conducted by UF in the STA-1W south site test cells.* 2, Vegetation management along with USDA has released hydrilla eating fly larvae into STA-2, Cell 3 in an experimental effort to contain the growth of hydrilla.
Suggestions/Topics to promote vegetation growth in the northern and western flow-paths	**Participants**	**Start date**	**Status**
1. In Cell 2A plant cattail propagules. Get cattail plants from either Cells 2B or 4.			**Current Status as of 8/12/05:** 2A has cattail sprouts appearing **STA Leadership Team Recommendation (8/16/05):**1. The Team does not support this

			recommendation at this time, because cattail growth is occurring under current conditions, and therefore, we recommend maintaining the current operating conditions. Everglades Division currently has a contractor scheduled to conduct a vegetation assessment of Cell 2A by mid 10/2005 and the extent of growth and spread can be reassessed at that time. *Action will not be implemented at this time.*
2. Spray Cell 2A with a low treatment dose of 2,4,D to defoliate the primrose willow plant, which may allow the canopy to open up and promote cattail expansion.	Veg. Mgmt./Site Mgmt	September 2005	**Current Status as of 8/12/05:** A heavy growth of primrose willow extends along the central to east side of cell. **STA Leadership Team Recommendation (8/16/05):** The Team supports the recommendation to spray the primrose willow to allow for further cattail growth into this area. The Team also recommends a reassessment to follow a few months after spraying the willow to determine if some cattail some cattail planting is needed in 2A. *Spraying will move forward in September 2005 if current work orders can be used, or work will be initiated in October at the start of FY06.*
3. In Cell 2B apply herbicide to emergent vegetation in Cell 2B to create alternating open water/vegetation habitat, and inoculate with SAV harvested from the Cell 3 finger canals.	Veg. Mgmt./Site Mgmt	September 2005	**Current Status as of 8/12/05:** Has dense stands of cattail, grasses, upland plants but none to little SAV. **STA Leadership Team Recommendation (8/16/05):** The Team supports the recommendation to apply herbicide to the emergent vegetation in addition to applying some inoculation of SAV if the Cell 3 finger canals can serve as donor sites.

			The consensus from discussions was that vegetation strips in Cell 2B may not be required because it is a relatively small area compared to Cell 5B. It was reasoned that perhaps STA-1W, Cell 4 did not require vegetation strips because it also was a smaller cell and did not have the large open areas found in Cell 5B. *Herbicide application to emergent vegetation to open the areas for SAV growth was implemented in September 2005.* *Currently selective spraying to promote vegetation strips will not be implemented.* *Currently SAV harvesting and inoculation is not planned.*
4. In Cell 4 apply herbicide to emergent vegetation to create alternating open water/vegetation habitat.	Veg. Mgmt./Site Mgmt	September 2005	**Current Status as of 8/12/05:** Cell 4 had dense stands of cattail, upland plants but none to little SAV. **STA Leadership Team Recommendation (8/16/05):** The Team supports the recommendation to apply herbicide to the emergent vegetation in addition to applying some inoculation of SAV if the Cell 3 finger canals can serve as donor sites. The consensus from discussions was that vegetation strips in Cell 4 were not previously required and therefore, may not be necessary at this time. *Herbicide application to emergent vegetation to open the areas for SAV growth was implemented in September 2005.* *Currently selective spraying to promote vegetation strips will not be implemented.*

			Currently SAV harvesting and inoculation is not planned.
5. In Cell 5A plant cattail propagules in along edge areas and interior areas where water depths are lower than 1 ft. Get cattail plants from either Cells 2B or 4.	Veg. Mgmt./Site Mgmt./STA	September 2005	**Current Status as of 8/12/05:** 5A has little plant growth except along southern edge and in shallow areas, and has many areas where local depths equal or exceed 2 ft. **STA Leadership Team Recommendation (8/16/05):** The Team supports the recommendation to plant cattail plants (previously collected from donor sites) along the exposed periphery of the cell and on internal sites that are currently exposed or under less than 1 foot of water. *Plans have begun to implement cattail planting at peripheral and internal sites with water depths conducive to cattail growth.*
6. In Cell 5A inoculate with SAV in areas deeper than 1 ft in effort to promote varied habitat and populate with some vegetation.	Veg. Mgmt./Site Mgmt./STA	September 2005	**Current Status as of 8/12/05:** Cell 5A has extremely varied topography and even with reduced water levels, a large area of this cell has depths greater than 1.5 ft.. **STA Leadership Team Recommendation (8/16/05):** The Team recognizes that that due to the deeper than expected conditions and extremely variable topography found in Cell 5A, it would be unreasonable to expect cattail growth to persist in these deeper areas during periods of full-scale operations when depths in some of these local areas may exceed 3 ft. The team supports the recommendation to promote SAV growth in these deeper areas. Some inoculation may be needed and should be tried.

			Beginning in FY06, the STA research, site managers, and vegetation management teams will coordinate to encourage SAV growth through the inoculation of SAV in those localized areas of Cell 5A were water depths are greater than 1.5 ft.
7. In Cell 5B herbicide the cattail/grass growth in the western area.	Veg. Mgmt./Site Mgmt.	September 2005	**Current Status as of 8/12/05:** Cell 5B had some moderate growth of SAV in the west, east, and southern borders. The middle of the cell is still void of vegetation. The south/western section has about 500 acres of grass/cattail. **STA Leadership Team Recommendation (8/16/05):** The Team supports the recommendation to use herbicide to remove the cattail/grass growth in the western area (the boot) of the cell. *Herbicide application to emergent vegetation to open the areas for SAV growth was implemented in September 2005.*
8. In Cell 5B establish emergent vegetation strips alternating with open water areas. Get cattail plants from either Cells 2B or 4.			**Current Status as of 8/12/05:** The south/western section has about 500 acres of grass/cattail. **STA Leadership Team Recommendation (8/16/05):** The Team did not discuss the creation of vegetation strips through a selective spraying effort in Cell 5B.
9. In Cell 5B inoculate open-water areas with SAV test plots.			**Current Status as of 8/12/05:** The middle of the cell is still void of vegetation. **STA Leadership Team Recommendation (8/16/05):** The Team supports the

			recommendation that some inoculation techniques should be tried in the larger un-vegetated areas of Cell 5B. *Beginning in FY06, the STA research, site managers, and vegetation management teams will coordinate to encourage SAV growth through the inoculation of SAV into Cell 5B.*
10. Propose to hydraulically isolate Cells 2A and 2B to keep depths deeper in Cell 2B (to promote SAV growth) and very shallow to only dry sediment in 2A (to promote cattail growth). a. Need to closing of the new G249 structures with bulk heads. b. Open connecting structure (G257) between Cells 1 and 2B to enable water input without having to flood cell 2A. c. Close off G255. d. Install dewatering pumps in 2A to keep water levels at minimum e. Isolation is estimated to be needed for at least 6 months, probably one year. f. Drop cattail seeds from helicopter into 2A onto moist sediment to encourage cattail growth.			**Current Status as of 8/12/05:** 2A has cattail sprouts appearing 2B has dense stands of cattail, grasses, upland plants but none to little SAV. **STA Leadership Team Recommendation (8/16/05):** At this time the Team does not support this recommendation as cattail growth is occurring in Cell 2A and it is our opinion that water depths are high enough in Cell 2B to grow SAV if the emergent plants are treated through herbicide applications. *Action will not be implemented at this time.*
11. Propose to hydraulically isolate Cells 5A and 5B to keep depths deeper in Cell 5B (to promote SAV growth) and very shallow to only dry sediment in 5A (to promote cattail growth). a. Close off the G305 structures with coffer dams. b. Install two 100 cfs pumps on Cells 1 and 5B levee to pump water from Cell 1 into 5b to hydrate and promote some flow through Cell 5B. c. Close off G304 structures. d. Install dewatering pumps in 5A to keep water levels at minimum. e. Isolation is estimated to be needed for at least 6 months, probably one year. f. Drop cattail seeds from helicopter into 5A onto moist sediment to encourage cattail			**Current Status as of 8/12/05:** 5A has little plant growth except along southern edge and in shallow areas. Cell 5B had some moderate growth of SAV in the west, east, and southern borders. The middle of the cell is still void of vegetation. The south/western section has about 500 acres of grass/cattail **STA Leadership Team Recommendation (8/16/05):** At this time the Team does not support this the water depths in Cell 5A are so varied and deep

			in areas that even if enough pumps were applied to lower Cell 5A and cattail growth promoted throughout the cell, under full-scale operations, many of these areas would be exceed 3 feet in depth and would not support sustained cattail growth. *Action will not be implemented at this time.*
12. Install forward pumps in 5A and 2B to assist with maintaining depths due to mean elevation differences.			Note: this was proposed at an internal meeting and construction and operation were asked to provide a cost analysis; will check progress **STA Leadership Team Recommendation (8/16/05):** The Team did not discuss this proposal.

Table 2. Monthly flows, total phosphorus (TP) loads and flow-weighted mean (FWM) TP concentrations diverted into structures G-300 and G-301beginning in January 2004. Dates indicate start and end of diversion. Single dates indicate diversion extent of one day or less. Pumping generally is not over a 24-hour period, but occurs during an 8-hour shift beginning at 8 am.

Year	Month	Dates (Beg-End)	Flow (ac-ft)	Load (metric tons)	FWM (ug/L)	Dates (Beg-End)	Flow (ac-ft)	Load (metric tons)	FWM (ug/L)
		G-300				G-301			
2004	Jan		0.00	0.00000		1/29	42.60	0.00478	91.000
2004	Feb		0.00	0.00000		2/25	22.29	0.00250	91.000
2004	Mar		0.00	0.00000		3/29	0.42	0.00005	91.000
2004	Apr		0.00	0.00000			0.00	0.00000	
2004	May		0.00	0.00000			0.00	0.00000	
2004	Jun	6/21	0.95	0.00017	147.000	6/29	0.12	0.00003	220.795
2004	Jul	7/14-7/17	4877.77	0.83699	139.112		0.00	0.00000	
2004	Aug	8/4	1.07	0.00066	503.000		0.00	0.00000	
2004	Sep	9/6-9/12 9/21-9/23 9/26-9/30	18473.65	8.10022	355.477	9/7-9/11	22365.24	9.32102	337.876
2004	Oct	10/1-10/4 10/7 10/22	3517.94	1.38087	318.222	10/1-10/4 10/22	7396.24	3.19899	350.646
2004	Nov		0.00	0.00000			0.00	0.00000	
2004	Dec		0.00	0.00000			0.00	0.00000	
2005	Jan		0.00	0.00000			0.00	0.00000	
2005	Feb		0.00	0.00000			0.00	0.00000	
2005	Mar	3/10-3/11 3/18-3/20	4977.08	1.76472	287.454	3/10-3/11 3/18-3/20	7454.18	2.42851	264.124
2005	Apr		0.00	0.00000			0.00	0.00000	
2005	May	5/5-5/6	1150.47	0.53396	376.272	5/5-5/6	2368.96	1.02903	352.159
2005	Jun	6/1-6/8 6/11-6/12 6/28-6/30	17824.46	4.92322	223.924	6/1-6/9 6/11-6/12 6/30	20247.39	5.56776	222.935
2005	Jul	7/1	1009.98	0.26535	213.000	7/18	0.05	0.00001	212.000