Restoration Strategies

Science Plan Development and Approach

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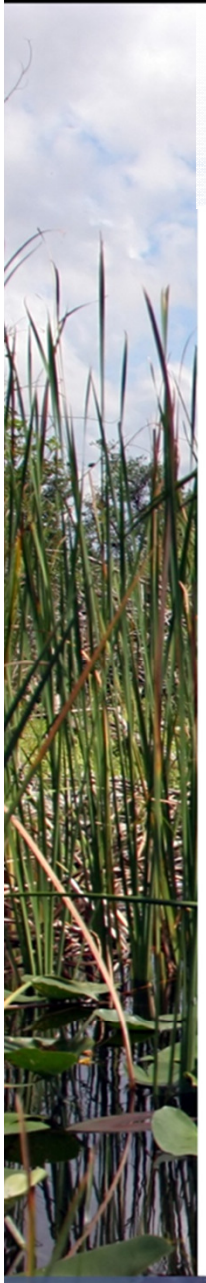
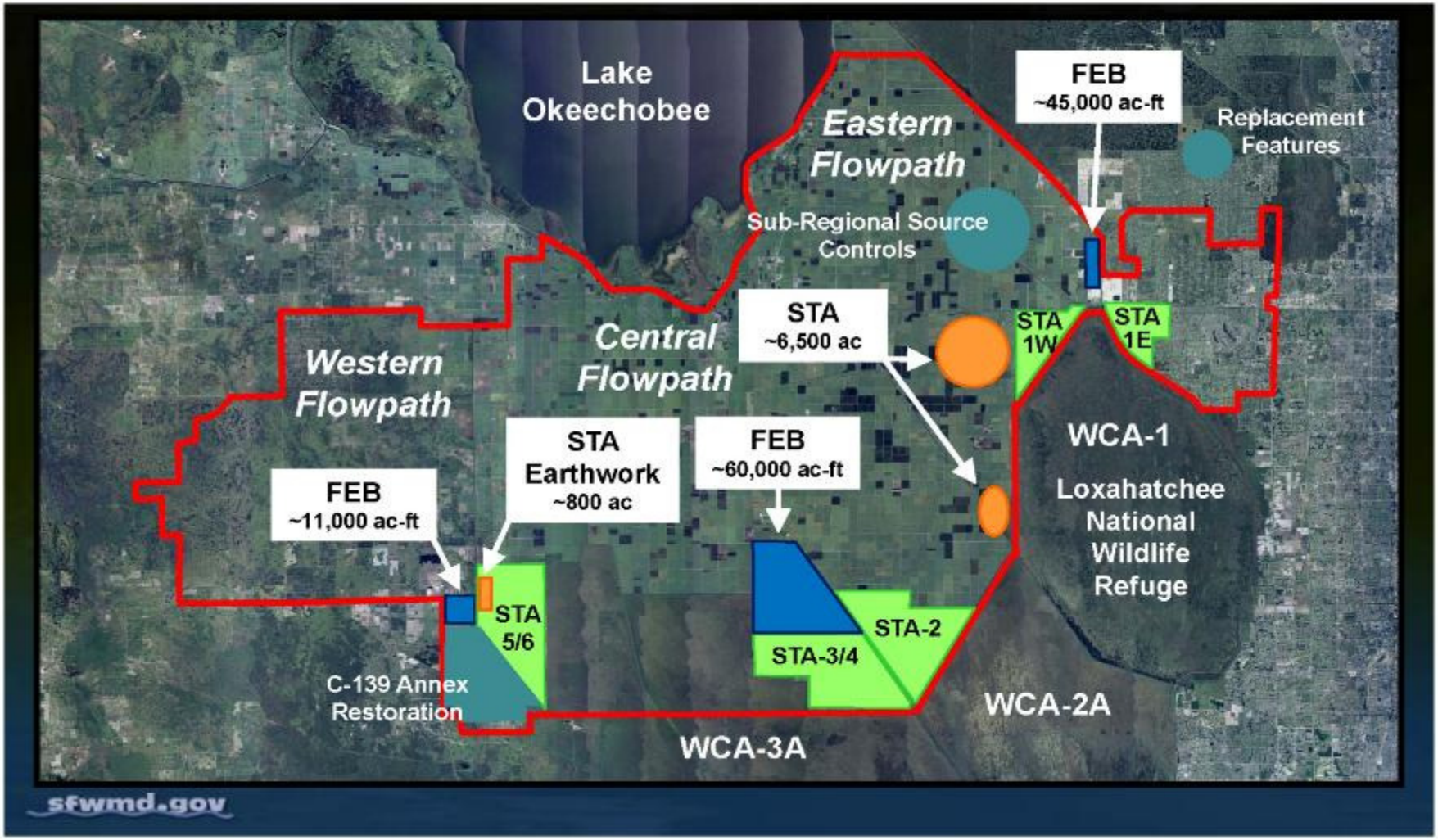
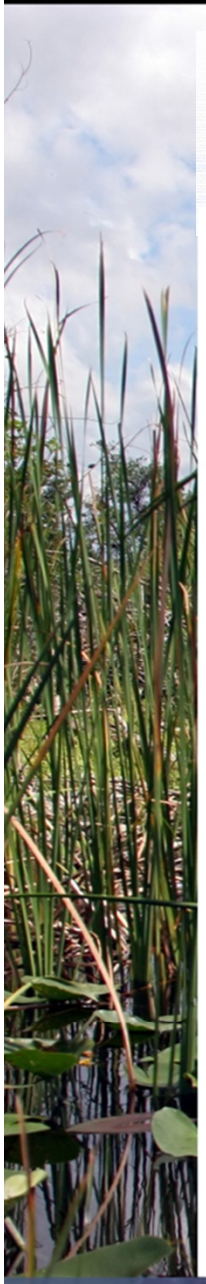


Background & Mandates

- The 1994 Everglades Forever Act (EFA)
- In 2012, the SFWMD, State of Florida, and USEPA reached agreement on consent orders and permits:
  - Consent Orders
    - Corrective actions and deadlines for STA expansions, **Flow Equalization Basins (FEBs)** and other improvements
    - Science plan to identify factors that collectively influence P reduction and treatment performance, in particular factors that affect performance at **low phosphorus concentrations <20 ppb (µg/L)TP**
  - Permits (EFA and NPDES)
    - Established Water Quality Based Effluent Limits (**WQBELs**) for TP in discharges from the STAs

Restoration Strategies – Key Projects





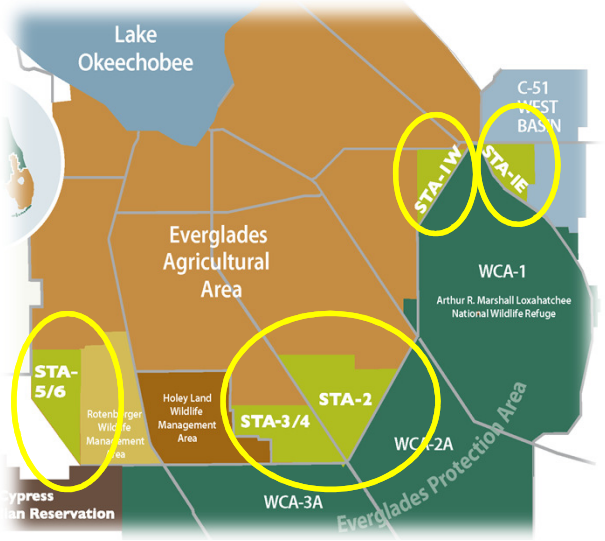
WQBEL:
Permit Compliance Test

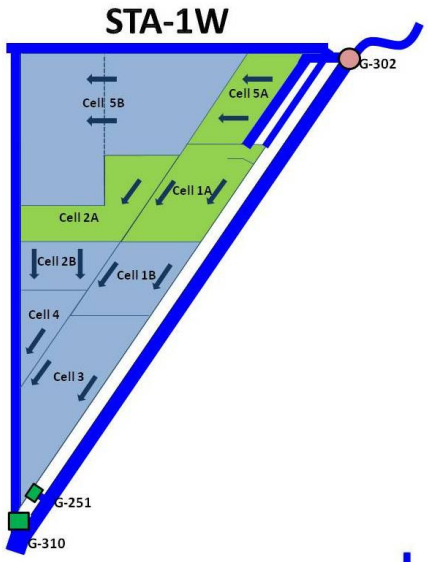
Two-part WQBEL compliance test takes effect after facilities are constructed/operating:

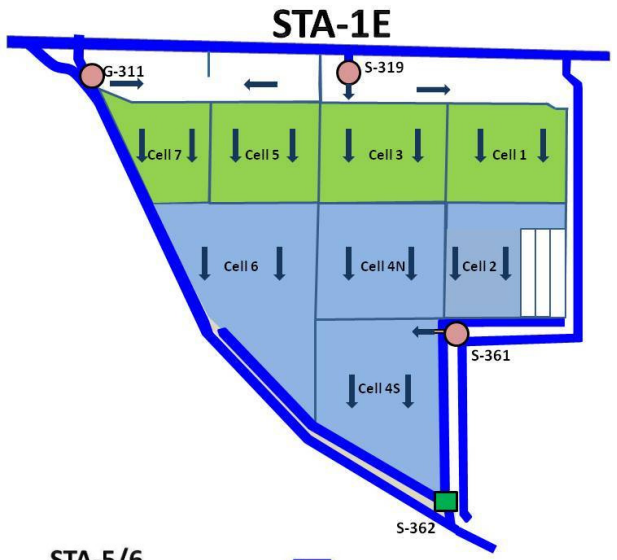
- Part I: Total phosphorus (TP) shall not exceed 13 parts per billion (ppb) as annual flow-weighted mean (FWM) more than 3 of 5 years on rolling basis

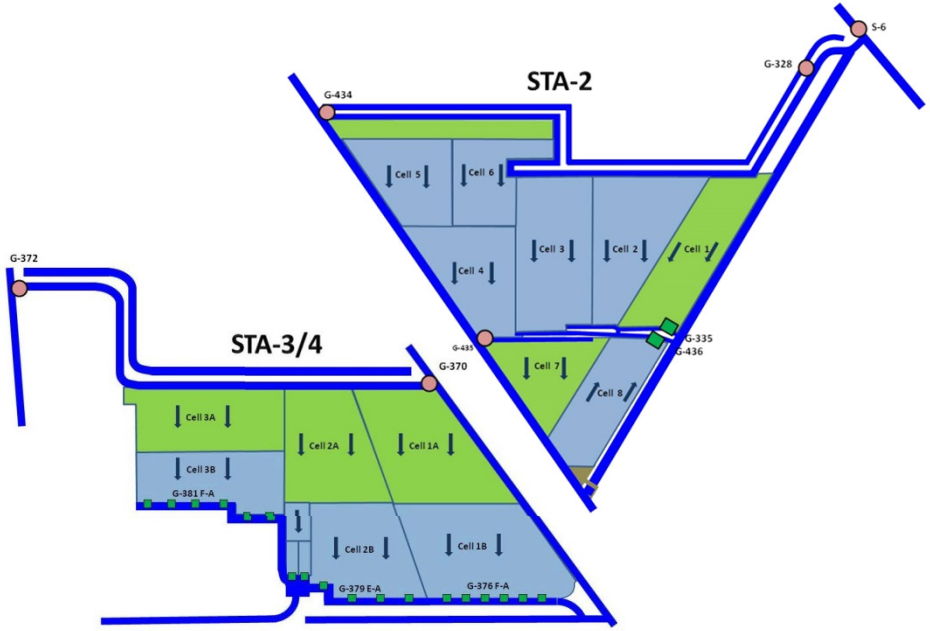
- Part II: TP shall not exceed 19 ppb as an annual FWM in any water year

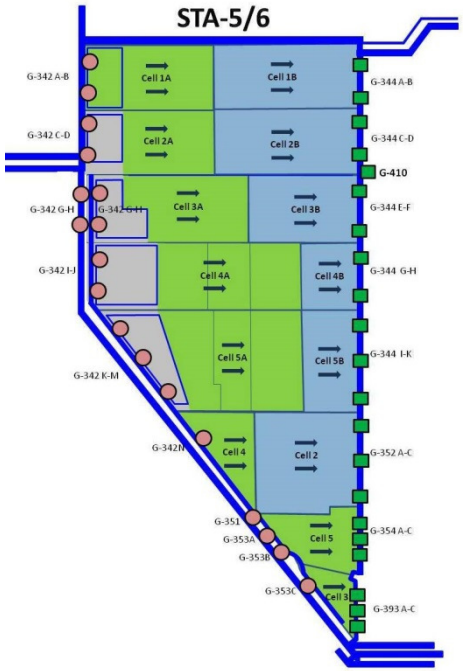
Stormwater Treatment Areas











Inflow Stations

Outflow Stations

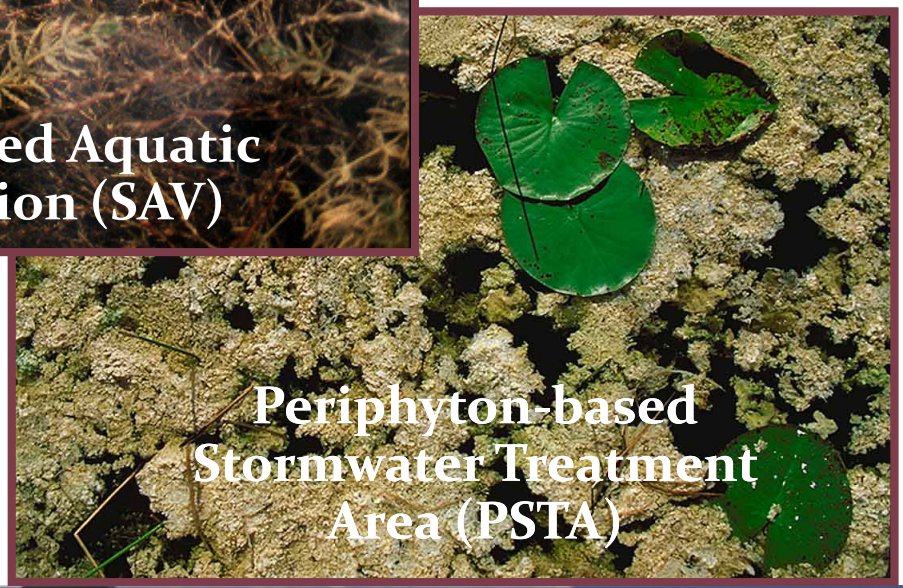
Emergent Aquatic Vegetation

Submerged Aquatic Vegetation

Flow Direction

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Stormwater Treatment Areas



Long-Term STA Performance

All STAs Combined

Period of Record 1994 – 2012

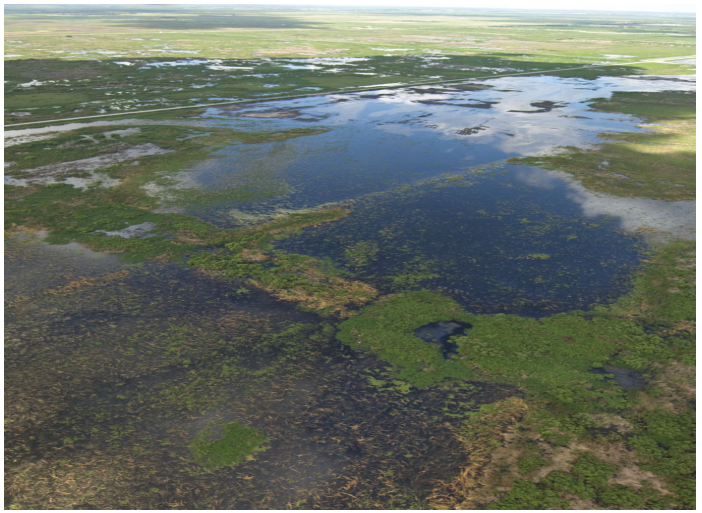
- Inflow, flow-weighted mean TP = 111 µg/L
- Outflow, flow-weighted mean TP = 19 µg/L

2013

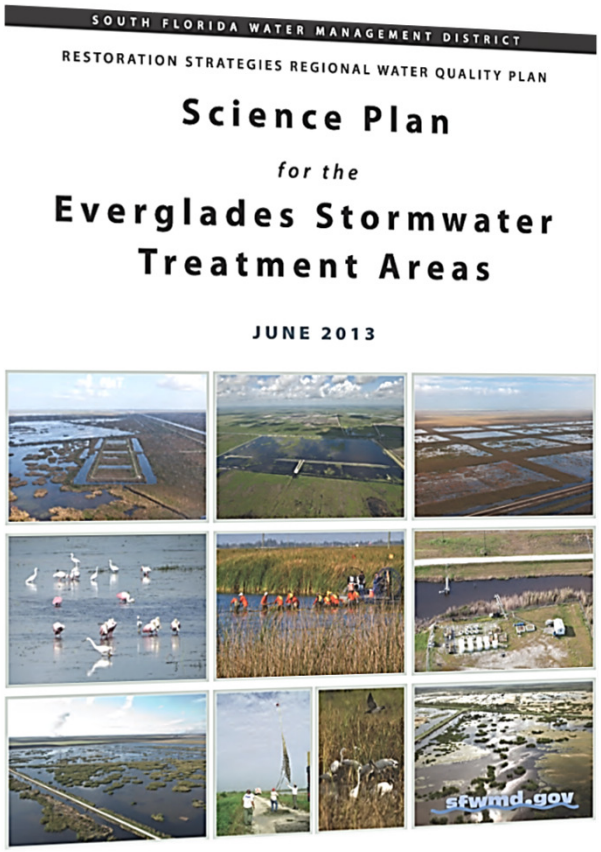
- Inflow: flow-weighted mean TP = 138 µg/L
- Outflow: flow-weighted mean TP = 21 µg/L

Ongoing Challenges

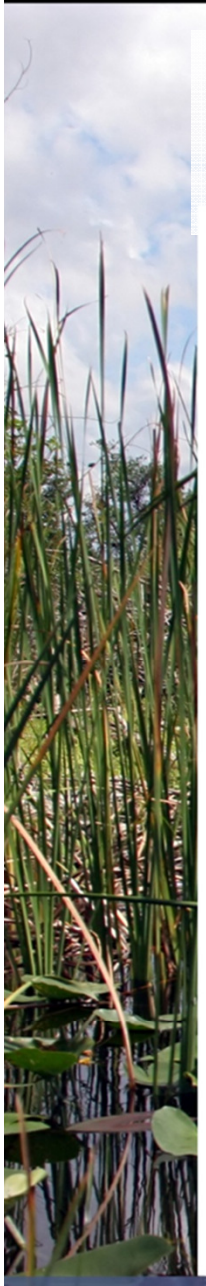
- Achieving ultra-low limits on Total Phosphorus concentrations in STA discharges
- STAs are integral components of a complex water management system with multiple objectives and cannot be operated in isolation
- Continued STA expansion requires more supplemental water in dry periods
- Science is advancing to better understand factors affecting STA sustainability and long-term performance



Science Plan: Progress to Date



- Initial Technical Representatives (Tech Reps) meetings (**November 2012 – May 2013**)
- Final Science Plan submitted to FDEP (**June 7, 2013**)
- Science Plan implemented **July 15, 2013** (ahead of September 10, 2013 deadline)
- Detailed Study Plan-focused workshops with Tech Reps, federal agency experts and their consultants (**July 2013 to July 2014)**



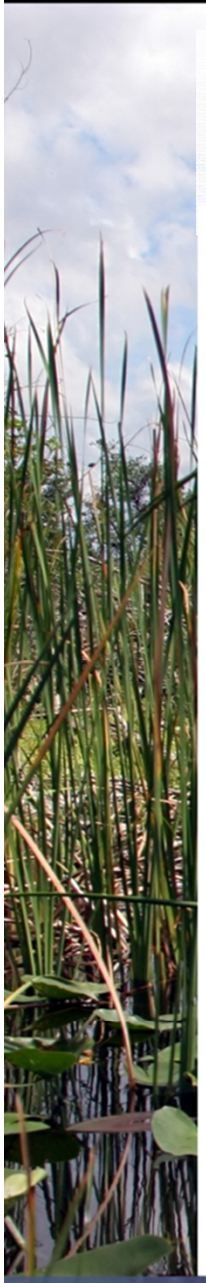
Science Plan

Science Plan Team Formulated 6 Key Questions

1. How can the FEBs be designed and operated to **moderate phosphorus concentrations and optimize phosphorus loading rates and hydraulic loading rates** entering the STAs, possibly in combination with water treatment technologies, or inflow canal management?

2. How can **internal loading of phosphorus** to the water column be reduced or controlled, especially in the lower reaches of the treatment trains?

3. What measures can be taken to enhance **vegetation-based treatment** in STAs and FEBs?



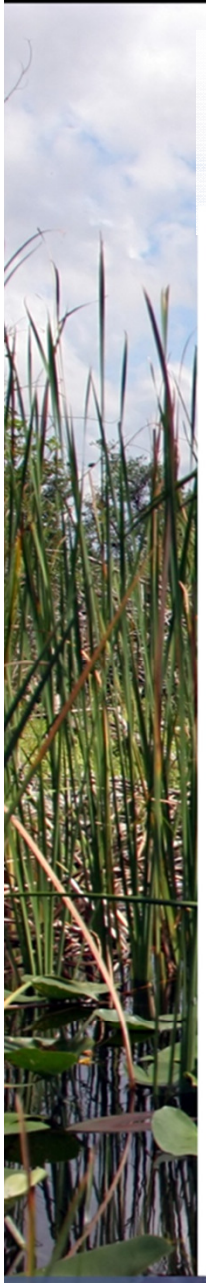
Science Plan

Key Questions (continued)

4. How can the biogeochemical or physical mechanisms be managed to further **reduce soluble reactive phosphorus (SRP), particulate phosphorus (PP), and dissolved organic phosphorus (DOP)** concentrations at the outflow of the STAs?

5. What **operational or design refinements** could be implemented at existing STAs and future features (i.e., STA expansions, FEBs) to improve and sustain STA treatment performance?

6. What is the **influence of wildlife and fisheries** on the reduction of phosphorus in the STAs?

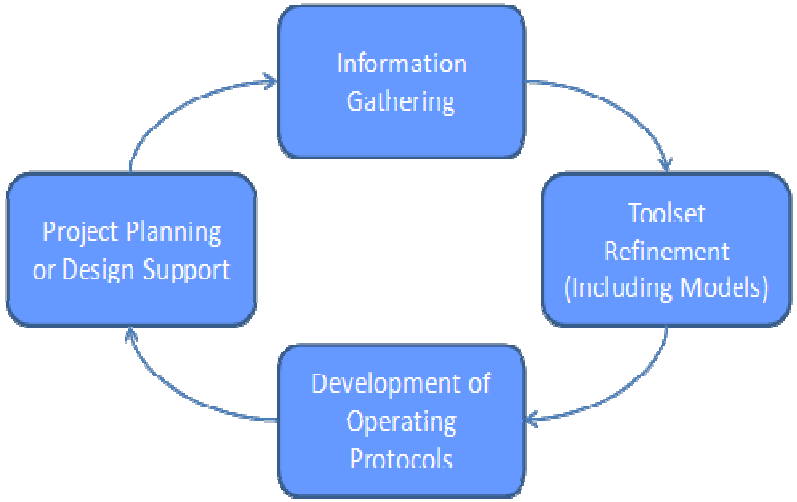


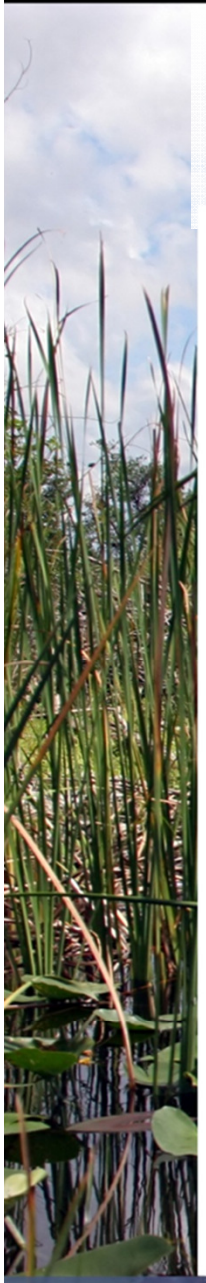
Initial Suite of Proposed Studies

1. Development of Operational Guidance for FEB and STA Regional Operation Plans
2. STA Water and Phosphorus Budget Improvements
3. Canal Conveyance Features on STA and FEB Inflow and Outflow TP Concentrations
4. Evaluation of Inundation Depth and Duration Threshold for Cattail Sustainability
5. Investigation of STA-3/4 PSTA Performance, Design and Operational Factors
6. Phosphorus Removal Efficacy of Alternative Vegetation in a Low Nutrient Environment in STAs
7. Use of Soil Amendments / Management to Control P Flux
8. Evaluate P Sources, Forms, Flux, and Transformation Processes in STAs
9. Evaluation of Sampling Methodologies for TP

Operational Guidance for FEB and STA Regional Operational Plans

- **Study Objectives/Purpose**
  - To develop modeling tools and operational protocols for FEBs/STAs to:
    - Manage storage in the FEBs to minimize dryout, deep water conditions, and bypass
    - Manage FEB outflow and STA inflows to minimize STA outflow phosphorus concentrations





STA Water & Phosphorus Budget Improvements

- **Issue**
  - Water budgets (WB) for many individual cells contain errors
  - WB analysis is important tool for understanding STA performance
  - Developing an accurate WB is not simple in wetland systems

- **Study Objective and Purpose**
  - Determine sources of error in WB and how they can be reduced
  - Develop improved water budgets for STA cells in a phased approach (Test case STA-3/4 Cells 3A and 3B) and based on Science Plan needs

Influence of Canal Conveyance Features on STA and FEB Inflow and Outflow TP Concentrations

- **Issue**
  - Changes in surface water TP concentration have been observed in canals of multiple STAs. Various factors that could potentially influence canal P concentrations include sediments, P speciation, flow velocities, dryout/re-wetting and seepage

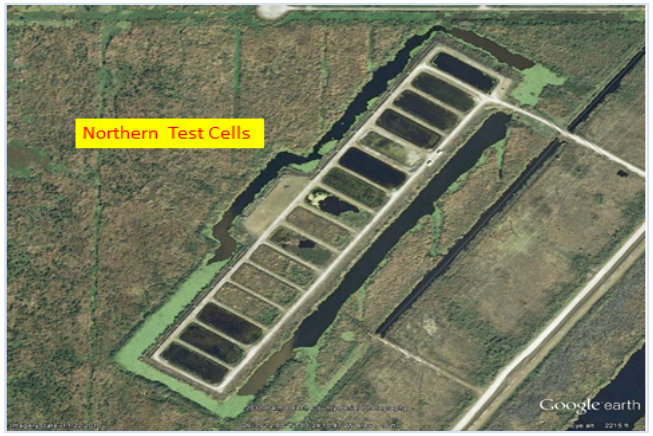
Study Objective/Purpose

- Determine whether phosphorus concentrations change when conveyed through STA inflow and outflow canals
- Evaluate sediments and seepage to and from canals

Evaluation of Inundation Depth and Duration Threshold for Cattail Sustainability

- **Issue**
  - Peak flows often occur in wet season and cause deep water in treatment cells which can adversely impact cattail and negatively affect treatment performance

- **Study Objective/Purpose**
  - Evaluate the influence of deep water pulsing on cattails
  - Assess impacts of cattail stress on STA performance
  - Provide recommendations for STA and FEB operations



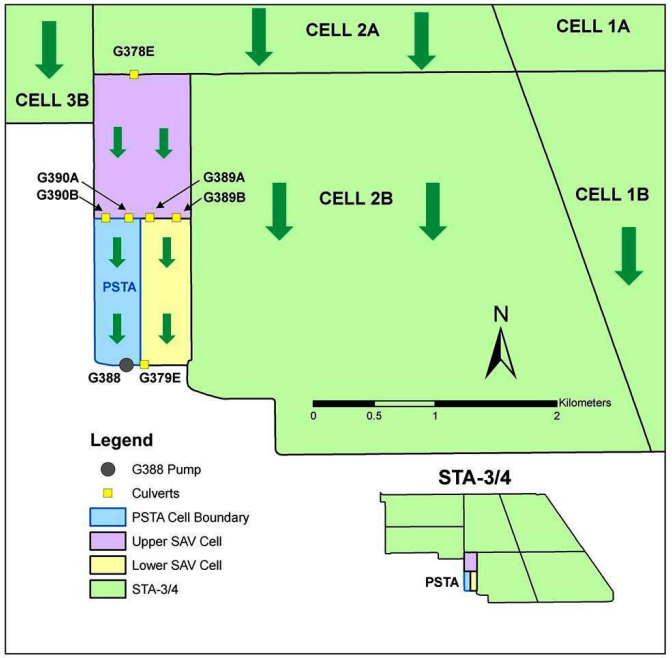
Periphyton-based Stormwater Treatment Area (PSTA): Performance, Design & Operational Factors

Issue

The STA-3/4 PSTA Cell has consistently achieved concentrations <12 ppb, but further investigation is needed to better assess performance & understand mechanisms and factors to achieve and sustain ultra-low TP concentrations at STA outflows

Study Objective/Purpose

Continue investigation of PSTA cell performance to determine design elements, operational factors, and biogeochemical characteristics that enable the PSTA cell to achieve ultra-low outflow TP levels



Phosphorus Removal Efficacy of Alternative Vegetation in a Low Nutrient Environment in STAs

- **Issue**
  - Preliminary studies indicate that water lily and may reduce TP concentrations in SAV cells
- **Study Objective and Purpose**
  - Evaluate nutrient removal efficacy of alternative vegetation under very low P conditions (downstream end of STAs) and examine major processes and mechanisms underlying P assimilation functions

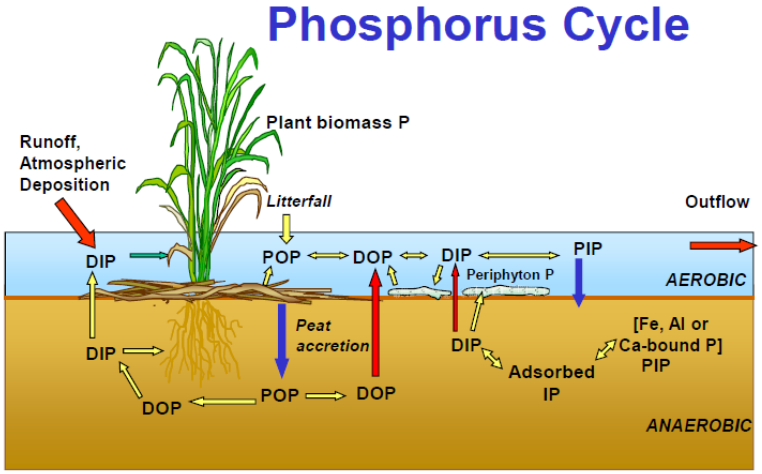
Use of Soil Amendments/Management to Control P Flux

- **Issue**
  - STA water column concentrations may increase through the flux of phosphorus from the soils
- **Study Objective /Purpose**
  - Determine if flux of P from the soil in an operating STA can be reduced with soil amendments or management techniques such as deep tilling or other management techniques or a limerock cap

Phosphorus Sources, Forms, Flux, and Transformation Processes in the STAs

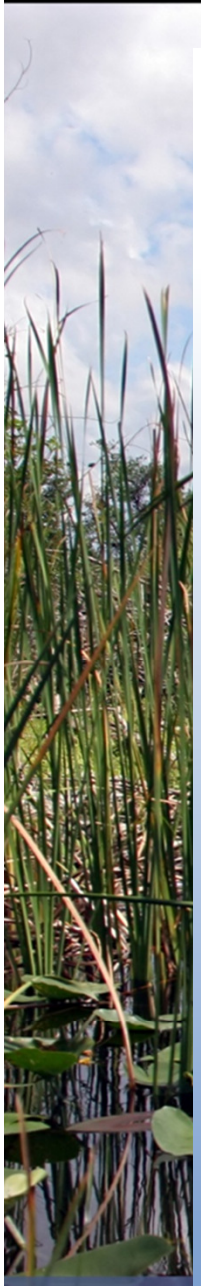
- **Issue**
  - A better understanding is needed of the biogeochemical factors and mechanisms controlling TP concentrations at the downstream end of the STA flow-ways

- **Study Objectives/Purpose**
  - Characterize P speciation, cycling and transport along STA gradients
  - Compare the findings with natural areas (Water Conservation Areas)
  - Develop recommendations to improve STA performance



Sampling Methods for Total Phosphorus

- **Issue**
  - Grab samples and auto-samplers, used for compliance sampling, show significant differences
  - Results from newer technology, the Remote Phosphorus Analyzer (RPA), show similar results to grabs and auto-samplers, but highlight issues that may impact the calculation of representative flow-weighted mean concentrations
- **Study Objective /Purpose**
  - To determine which sampling regime/ method provides most accurate representation of TP



Summary

- Restoration Strategies Science Plan Developed to optimize STA performance
- Nine initial studies under development and implementation
- Science Plan updates and subsequent results will be presented in the annual SFER