Summary of applied scientific studies in the Stormwater Treatment Areas (STAs) during May 1, 2011 – April 30, 2012

Ref. #	Study	Description and Objective	Finding and Status (as of 12/31/2012)
2012-1	STA-3/4 PSTA Project	This project, which began in WY2007, is a field implementation of PSTA technology aimed at further lowering outflow TP concentrations in STA discharges. The outflow concentrations to date have been promising, but further evaluation of the data will aid in a better understanding of the P removal mechanisms of PSTA technology and allow a more accurate assessment of its performance.	The STA-3/4 PSTA project structures and operations were modified in WY2012 to improve flow data accuracy. A more in-depth scientific evaluation also began in WY2012. *Status: ongoing.*
2012-2	STA-1W Phosphorus Mesocosm	This is a three-year study to investigate whether several species of native aquatic macrophytes (sawgrass, water lily, spikerush, and water lily + spikerush) can be used to enhance the treatment performance (TP removal) of the STAs. The TP removal capability of these species is being compared to that of cattail and SAV, plant communities that currently dominate the STAs. The study is being conducted at the STA-1W South Research Site.	This is the second year for the mesocosm study, the first year being a grow-in period, and a period of adjustment of controls and instrumentation. Initial findings are presented in this section. Data collection is continuing in WY2013. *Status: ongoing; expected completion: March 2013.*
2012-3	Potential Water Quality Benefits and Constraints of "Front-end" FAV communities in the STAs	This test cell-scale study, initiated in 2008, and mesocosm-scale study, initiated in 2010, are being performed to document the TP removal effectiveness of floating aquatic vegetation (FAV) as a front-end vegetation for the STAs, as well as to evaluate the influence of herbicide applications to FAV on water quality. Duplicate test cells were maintained with the following vegetation: cattail, cattail + FAV mix, and FAV.	Biweekly water quality sampling for soluble reactive phosphorus (SRP), TP, total soluble P, and pH was conducted at the test cell inflow and outflow until April 2011. Sampling for pH and TP at S-5A facility mesocosms was initiated in February 2011. Data collection continues and findings are planned to be reported in future SFERs. *Status: waiting for final report.*
2012-4	STA Vegetation Monitoring: Aerial Imagery	Aerial photographs (using high-contrast infrared film) of the STAs are taken annually during the summer to document vegetation coverage (emergent vegetation versus SAV+open water areas) in accordance with the STA operating permits. Specific areas of interest in the STAs are mapped in more detail on an as-needed basis. Aerial photographs, together with ground-truthing data, have been used to evaluate vegetation density on a relative basis in selected areas. Vegetation maps and GIS interpretation efforts are associated with this project, and findings are reported annually in the SFER.	Results of the 2011 imagery are presented in this chapter (STA Conditions, under each STA subheading). The 2012 imagery is being processed and will be presented in the future. Further analysis of the vegetation density index for selected areas in the STA is under way and results will be presented in a future SFER. *Status: recurring, annual.*
2012-5	STA Vegetation Monitoring: Ground Surveys	Ground surveys are conducted to assess SAV species coverage and relative abundance. Surveys are also conducted as part of extreme event assessments. Spatial species distributions are mapped and reported annually in the SFER and as needed for performance-related evaluations.	Results for STA-1E are presented in the chapter. Additional SAV maps are expected to be presented in future SFERs. *Status: recurring, ongoing.*
2012-6	STA-3/4 Cell 1A Drawdown Evaluation	Evaluate baseline and post-drawdown condition of vegetation in STA-3/4 Cell 1A, which has been negatively impacted by extended periods of deep water (e.g., greater than 2ft). Results were compared with data from the adjacent cell (Cell 2A), which was not drawn down. Monitoring includes site surveys and vegetation analysis. Results from this study will help in determining if water-level drawdown can be incorporated as a routine management strategy to maintain healthy emergent vegetation in the STAs.	Results to date are discussed in this section. Additional measurements and surveys, including evaluation of biomass and tissue nutrient concentrations, is planned to be done in WY2013. *Status: Field study complete, data analysis and report writing is on-going.*

Ref. #	Study	Description and Objective	Finding and Status (as of 12/31/2012)
2012-7	STA Water Quality Internal Transects Evaluation	Evaluate phosphorus removal from the water column along transects of selected flow-ways in STA-1E, STA-1W, STA-2 and STA-5. Data are being used to monitor P cycling within STA flow-ways under various operational and environmental conditions. Over time, these data may provide insight about key processes such as internal P transformations and spatial relationships between vegetation type/health and P retention or sediment P release.	Data from STA-5 transects are presented in this section. Previous results have also been utilized to help characterize particulate P (PP) transformations in STA-2 Cell 3 (Dierberg and DeBusk, 2008) and as evidence of background TP concentrations in SAV-dominated wetlands constructed on previously farmed muck soils (Juston and DeBusk, 2011). *Status: recurring, on-going.*
2012-8	STA-2 Cell 2 Partial SAV Conversion Evaluation	Emergent vegetation in the southern portion of STA-2 Cell 2 was treated with herbicide in April 2009 to allow for conversion of this area to SAV. Several different efforts are linked to this project, including SAV surveys, sampling along water quality transects and water level monitoring.	An update on the SAV establishment in the initial vegetation conversion area is presented in this chapter under each STA's *Maintenance and Enhancements* section. *Status: Field evaluation is complete, progress reported in the SFER.*
2012-9	Impacts and Benefits of Dryout on Cattail Communities	This mesocosm-scale study, which was concluded in WY2009, originally aimed at determining early signs of cattail stress due to dryout conditions because during periods of low rainfall, there are many emergent vegetation cells in the STAs that are prone to dryout. During the course of the study, it appeared that short periods of dryout may be beneficial to cattail health by allowing new growth to occur. Final evaluation of the study includes determining both the impacts and benefits of dryout conditions on cattail growth and survival.	An initial discussion of study results is included in this section. *Status: Study complete, initial draft of report has been prepared and undergoing revision.*
2012-10	Investigation of Factors Influencing SAV Performance and Sustainability in STAs	A better understanding is needed of the factors (e.g., water chemistry, soil chemistry, soil physical characteristics, herbivory) and their interactions that influence SAV species distribution, persistence, and colonization/recovery in STAs. This investigation includes (1) SAV distribution and speciation as a function of water depth; (2) an investigation on the potential impacts of bird herbivory on SAV communities; (3) a mesocosm study to determine the effects of mixed EAV and SAV communities on water quality and stability of sediment P; and, (4) a large sediment core evaluation study to assess impacts of sediment treatments (dry down, floc removal, etc.) on SAV recruitment and water column turbidity.	SAV surveys were conducted on potential bird herbivory study sites. Exclosures were installed at STA-1E Cell 4S and STA-1W Cell 5B in January 2011. Initial findings indicate that birds were actively feeding in and around the plot areas and that SAV beds exhibited damage caused by grazing. The density of hydrilla and naiad in the exclosures increased relative to the biomass density in the open plots whereas musk grass exhibited a decline in density in the enclosed plots. Data analysis for this effort continued in WY2012; results are expected to be presented in future SFERs. *Status: Ongoing in WY2013; herbivory study was discontinued due to difficulty in field assessment.*
2012-11	Characterization of Hydraulic Resistance of Emergent Macrophytes in STA-2 Cell 2	Many of the emergent macrophyte-dominated STA cells now contain dense vegetation stands, consisting of both living and dead plant material. Under high flow events, hydraulic resistance by the dense vegetation could be contributing to the high water depths in the front-end of many STA flow-ways. For this effort, water stage monitoring devices were deployed throughout an EAV cell in 2008 to help characterize internal stage changes as a function of flow rate and vegetation community type and condition.	A synopsis of the results from this study is presented in this section. Journal publication on this topic is also in review process. *Status: completed; report included in the SFER; publication is in review.*

Ref. #	Study	Description and Objective	Finding and Status (as of 12/31/2012)
2012-12	Effects of Deep Water Condition on Cattail	This was a multi-component study. A mesocosm study was conducted primarily to determine the eco-physiologic indicator of stress in cattail growing in different inundation conditions of 40, 91, and 137 cm for six weeks and the post-flooding recovery of the stressed cattail growing in 40-cm inundation for four weeks. The second component was a field study in STA-1E Cell 7. Study plots were established and periodic plant measurements were conducted to assess plant growth, photosynthesis, nutrient uptake, and propagation in relation to P reduction.	The mesocosm study concluded in 2009. Two peer reviewed publications summarized the findings. The STA-1E field study was concluded in 2009. A draft manuscript summarizing the findings is currently under internal review.

How Current and Recently Completed Studies Relate to Restoration Strategies Science Plan Sub Questions

Ref. #	Study	Restoration Strategies Science Plan Sub Questions (SQ) Being Addressed
2012-1	STA-3/4 PSTA Project	**SQ1** – This study partially addresses the soil management part of the sub question. Soil was removed from the PSTA cell for two reasons: discourage EAV growth, and reduce flux from the substrate.
		SQ3, SQ5, SQ6 – This study partially addresses these sub questions. We are comparing the condition and treatment pattern of the PSTA cell versus STA-3/4 Cells 2B and 3B. We are evaluating the major components of P cycling: vegetation, accreted soil, seepage (lateral and groundwater), particulate P, enzyme activities, and P species. Additional study that may help in full understanding of P mass balance in this cell is the use of stable isotope (carbon and nitrogen) analysis to determine the fate and flux of P into, within, and out of the cell. This is not currently being done due to funding issues.
		SQ14 – This study addresses this sub question partially, and without the interference of soil layer. We are collecting groundwater well samples at varying depth and seasonal periods. Current need for this project is an in depth hydrogeologist's interpretation of our measurements and findings.
2012-2	STA-1W Phosphorus Mesocosm	**SQ2** – This study directly answers this sub question, at a mesocosm scale. To test scalability, this study should be continued at field or test-scale.
		SQ6 – This study partially address these questions.
2012-3	Potential Water Quality Benefits and Constraints of "Front-end" FAV communities in the STAs	**SQ13, SQ16, SQ22, SQ 23** – This study partly address these sub questions, although the species studied (water lettuce) was not one of the specific species discussed during science plan question formulation. Discussions related to FAV focused on deeper rooted floating leaved species such as *Nelumbo lutea and Nuphar lutea*; however this study that just concluded tested for shallow-rooted species (e.g. water lettuce).
2012-4	STA Vegetation Monitoring: Aerial Imagery	**Routine Monitoring** – This effort does not directly address any of the specific sub questions. The infrequency of image acquisition (annual) limits its usability for detecting short-term changes in EAV species and coverage. Results of this effort, however, can be utilized for long-term speciation and coverage of EAV. The image acquired does not allow for assessment of SAV species or actual coverage.
2012-5	STA Vegetation Monitoring: Ground Surveys	**SQ2; Routine Monitoring** – This effort partly addresses this sub question for SAV speciation and for assessing temporal changes in SAV species. However, since it is not a controlled study, it does not address the TP uptake performance part of the question.
2012-6	STA-3/4 Cell 1A Drawdown Evaluation	**SQ17** – This study, which concluded in 2012, partially addresses this sub question. The study focused on cattail recovery, and was not designed nor controlled to enable assessment of effects on P uptake.
2012-7	STA Water Quality Internal Transects Evaluation	**SQ3, SQ5** – This study partially addresses these sub questions in terms of P treatment pattern and forms of P along the inflow-outflow transects. Additional parameters such as Ca are also tested, but not consistently. The frequency of sampling and testing also does not allow for reducing temporal variability. The forms of P studied are limited to measurements of SRP, TDP, and TP and the study is not designed to identify sources.
2012-8	STA-2 Cell 2 Partial SAV Conversion Evaluation	**SQ2** – This evaluation partly addresses this sub question; however, the nature of the evaluation does not allow for assessment of performance as a result of vegetation change alone, due to influence of other variables.
2012-9	Impacts and Benefits of Dryout on Cattail Communities	**SQ17, SQ21, SQ28, SQ29** – This study, which currently is in report preparation phase, partially addresses these sub questions. The study focused on effects on cattail, and was not designed nor controlled to enable assessment of effects on P uptake.
2012-10	Investigation of Factors Influencing SAV Performance and Sustainability in STAs	**SQ6, SQ15, SQ24, SQ26** – This series of studies and surveys partially address these sub questions. The study is on-going and other factors, such as turbidity is being added to the factors that are being investigated.
2012-11	Characterization of Hydraulic Resistance of Emergent Macrophytes in STA-2 Cell 2	**SQ12, SQ14** – This study partially addresses these sub questions. However, due to the topographic issues and flow bias in the front end of the study area (STA-2 Cell 2), the applicability of results to other areas maybe questionable.
2012-12	Effects of Deep Water Condition on Cattail	**SQ21** – The studies (mesocosm and field scale) partly address this sub question. The mesocosm treatments were limited to three levels (including the control), was not able to address optimum duration at specific depths, and was not able to capture other impacts observed under field condition, such as cattail dislodge and formation of floating tussocks.