Inter-Agency Agreement to Conduct Scientific Studies Relevant to the Stormwater Treatment Areas

Agreement No. 4600003125
Appendix A

10/2/2015

Relationship of the Research Activities to the Detailed Study Plan Hypotheses

The PSTA Detailed Study Plan (DSP) was developed in February 2014 with a primary objective of determining design and operational factors that contribute to the PSTA cell's superior performance, in order to facilitate large-scale replication of the success of this technology. Data gathered from the PSTA Cell will provide needed information on the effects of muck removal, as well as operational factors (water depth and hydraulic and P loading), on treatment performance. Alternate approaches to immobilize soil P, and specific mechanisms contributing to sustainable low-level TP removal, were to be tested in replicated mesocosm studies. These data were considered critical to any future feasibility analysis of using PSTA technology to improve STA back-end P removal performance.

In addition to the primary objective described above, the following questions were posed in the DSP to address gaps in the current understanding of the PSTA technology related to design, operations, and sustainability. For each question, several research hypotheses are provided that are being tested by the experimental and monitoring efforts described in this Study Plan. A table subsequently is provided that shows the association between research activities and the DSP hypotheses.

What are the important design elements that enable the PSTA Cell to achieve ultra-low outflow TP levels? (muck removal, compartmentalization)

Hypothesis #1: Removal of muck soils in the downstream portion of an STA flow-way reduces or eliminates the flux of P from the soil to the water column, which in turn contributes to conditions favorable to low outflow TP concentrations.

Hypothesis #2: The removal of muck soils, or the reduction of bioavailable P levels in muck soils through the use of limerock or other soil amendments, will decrease soil P availability to macrophytes, resulting in reduced growth rates, decreased tissue nutrient content and biomass turnover, and in turn, a shift towards periphyton dominance and lower outflow surface water TP concentrations.

Hypothesis #3: The compartmentalization provided by vegetated strips has resulted in strong internal gradients in sediment accumulation by decreasing turbulence in the water column, and minimizing resuspension and transport of flocculent sediments

What are the key operational ranges that enable the PSTA Cell to achieve ultra-low outflow TP levels? (P Loads, HLR, and water depth)

Hypothesis #4: Low outflow TP concentrations have resulted from the moderation of hydraulic loads and P loading to the PSTA cell. Higher P loads will compromise treatment efficacy and result in increased outflow TP concentrations.

Hypothesis #5: Stable and shallow water depths have contributed to the superior performance of the PSTA cell, due to factors such as enhanced UV penetration throughout the water column; increased operational water depths will result in higher outflow TP concentrations.

Hypothesis #6: Shallow water depths (and a low surface water level compared to surrounding water levels) increase groundwater interaction, which in turn has led to low outflow TP concentrations for the STA-3/4 PSTA cell.

What management practices are required to sustain the PSTA Cell's good performance? (sediment management, vegetation management)

Hypothesis #7: Over time, accrued sediments in a PSTA Cell become a source of P to the water column and result in increased outflow TP concentrations compared to the initial condition when the cell bottom was mainly comprised of limerock substrate. Accumulation of sediment will result in elevated outflow TP concentrations, compared to a bare limerock substrate.

Hypothesis #8: Periodic drawdown will benefit PSTA cell performance by consolidating sediments, and helping maintain low macrophyte densities.

In Table 1, we provide a quick cross-reference between the above Hypotheses and the monitoring and experimental efforts described in the report.

Table 1. Summary of monitoring efforts in the STA-3/4 PSTA Cell and experimental efforts using water, plants, and soils from the PSTA Cell to examine the DSP hypotheses.

Hypotheses from Detailed Study Plan		**Section 4 - PSTA Cell Monitoring**			**Section 5 - Mesocosm and Microcosm Studies**				
		4.3 Water	**4.4 Sediments**	**4.5 Vegetation**	**5.1 Operational Boundaries**	**5.2 Sediment Effects on Vegetation and WQ**	**5.3 Substrate-Macrophyte Interactions**	**5.4 LR Cap on Low-P Muck**	**5.5 LR Cap on High-P Muck**
#1	**Removal of muck soils affects P flux**					X	X		X
#2	**Reduction of bioavailable soil-P affects macrophyte growth and nutrient content**					X	X	X	X
#3	**Compartmentalization results in strong internal gradients**	X	X	X	X				
#4	**Low outflow P results from moderate hydraulic and P loading**	X			X			X	
#5	**Stable and shallow depths improve performance**	X			X				
#6	**Shallow depths increase groundwater interaction**								
#7	**Sediment accrual will result in elevated outflow P concentrations**	X	X				X		X
#8	**Periodic drawdown will benefit performance**							X	