Soil and Water Science
Research Brief
University of Florida Institute of Food and Agricultural Sciences

Hydraulic performance evaluation of Periphyton treatment cells for the removal of phosphorus from surface waters entering the Everglades

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The primary objective of the Comprehensive Everglades Restoration Plan (CERP) is the reduction of nutrient inflows to the Everglades. Phosphorus has been identified as the nutrient most responsible for detrimental impacts on this ecosystem. Passive treatment technologies currently used have not proven capable of reaching the potential regulatory limit of 10 parts per billion (ppb) total P in the water entering the northern Everglades. Wetland-based storm water treatment areas (STAs) are being constructed in agricultural areas north of the Everglades to decrease phosphorus concentration in runoff entering the Everglades (Figure 1).

The South Florida Water Management District (SFWMD) is investigating advanced treatment technologies (ATTs) to further reduce P levels.

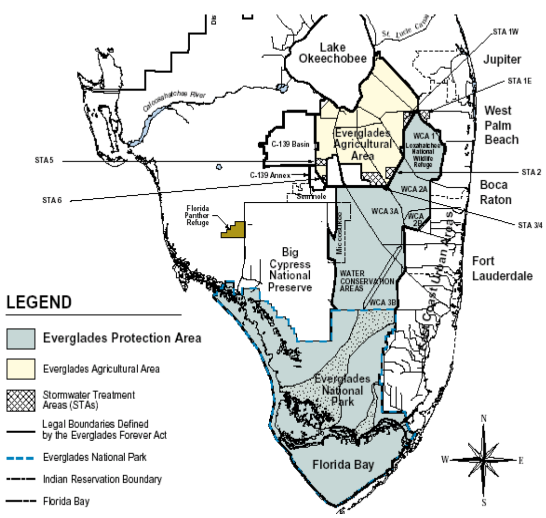

Figure 1. Map of south Florida indicating locations of STAs and other Everglades compartments.

Small-scale mesocosm and pilot-scale studies have shown that a periphyton-based treatment system achieved phosphorous removal rates of 7 to 43 percent, with mean outflow concentrations less than 15 ppb, and below 10 ppb on a periodic basis (*2001 Everglades Consolidated Report,* SFWMD). Follow-up studies are being conducted by the SFWMD in 5-acre field-scale treatment cells (Figure 2). Treatment performance evaluation at this scale, however, has been confounded by water and nutrient mass loss via infiltration into the subsurface and leakage through the surrounding berms.

Figure 2. Aerial photograph of PSTA wetlands.

In order to address these issues, this study, conducted with cooperation of SFWMD, focused on performing a dye tracer test to identify flow paths and quantify extent of water/nutrient leakage.

Lithium as a tracer was injected into two treatment cells and samples were collected over a period of 10 days. Water samples were analyzed for tracer and phosphorus concentrations. Figure 3 shows a schematic diagram of PSTA treatment cells and transect locations.

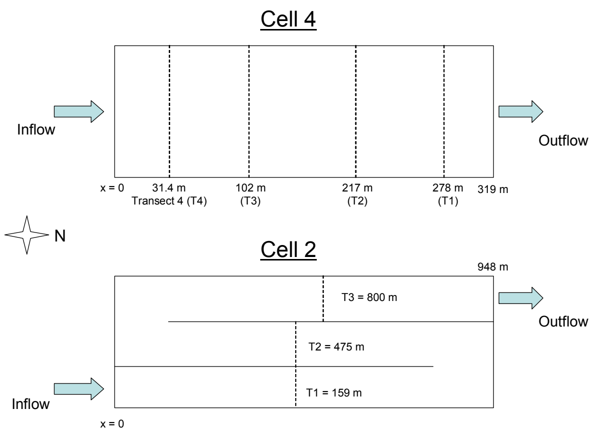

Figure 3. PSTA treatment cells 2 and 4.

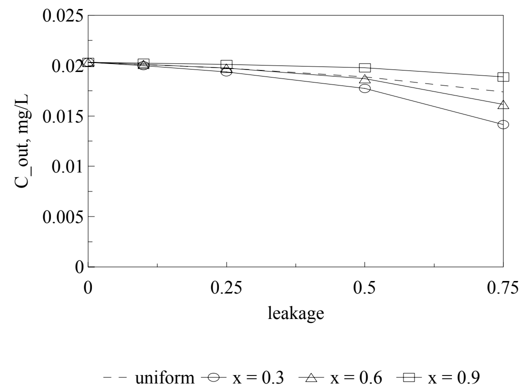

Figure 5. Results of leakage model, indicating that P concentrations and therefore, treatment efficiency, are not greatly affected by leakage location or amount.

The results of the measured tracer (lithium) concentrations and cumulative time from tracer release were plotted to generate arrival time distributions, or breakthrough curves (BTCs). Site access limitations resulted in periods of no data, so estimates of the complete moments were obtained from a fitted model. An example of a fitted BTC for cell 2 is shown in Figure 4.

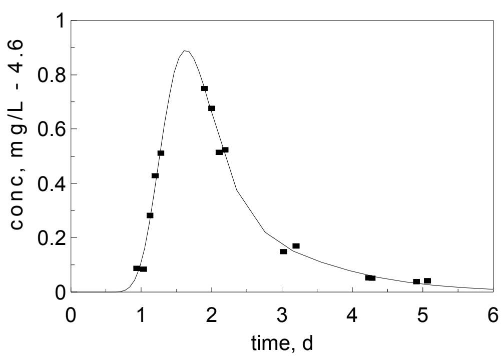

Figure 4. Model fit for cell 2.

Leakage. The effects of PSTA cell leakage location and amount on apparent treatment effectiveness were investigated using the superposition of one-dimensional analytical solutions for solute transport and decay in a plug-flow reactor. Leakage from the PSTA field-scale cells occurs through the wetland beds and the surrounding berms. Five leakage ratios I = {0.10, 0.25, 0.50, 0.75, 0.90} were evaluated. Seven different leakage scenarios were modeled for each leakage rate including uniform leakage throughout as well as non-uniform leakage occurring in several locations in the wetland.

The results of the leakage modeling analysis (Figure 5) indicated that leakage is not likely a major factor in evaluating the performance of these systems. The phosphorus concentrations were not greatly affected by leakage location or amount. It was recommended that the resources be directed away from measuring leakage from the system and towards improving phosphorus removal capabilities to further slow degradation of the Everglades ecosystem.

References: *2001 Everglades Consolidated Report*, "Chapter 8: Advanced Treatment Technologies for Treating Stormwater Discharges into Everglades Protection Area", ed. G. Redfield, South Florida Water Management District.

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