Evaluation and optimization of pilot-scale floating aquatic treatment wetlands for phytoremediation pre-treatment of municipal landfill leachate employing saline-tolerant plants native to South Florida

Emily Lutter and Dr. Ashley Danley-Thomson*

Department of Environmental and Civil Engineering, Florida Gulf Coast University, 10501 FGCU Blvd S, Fort Myers, Florida 33965, United States

*Corresponding Author: Phone: 239-745-4390. Fax: 239-590-7304. E-mail: athomson@fgcu.edu.

Abstract

This research was the continuation (Phase III) of the evaluation and optimization of pilot-scale floating aquatic treatment wetlands for phytoremediation pre-treatment of municipal landfill leachate employing saline-tolerant plants native to South Florida. Pre-treatment of leachate (liquid that has percolated through the garbage within a landfill) by means of floating wetlands and phytoremediation is viewed as a viable option since it is a low-cost, low-maintenance option, with the potential of lowering costs for landfill operators. If leachate is sent to a wastewater treatment plant (WWTP), managers often pay a discharge fee based on the concentrations of certain parameters, particularly chemical oxygen demand (COD) and nitrogen, in addition to leachate volume discharged. Any pre-treatment that can occur prior to discharge to a WWTP will lower discharge costs. During Phase III of this research, a polyculture of plants was planted in a floating wetland and placed within leachate storage ponds located at the Lee and Hendry Regional Solid Waste Disposal Facility. Sampling has occurred biweekly since the site set up and samples acquired have been frozen until analysis in the laboratory.

Objectives

To provide design criteria for floating treatment wetlands so that landfill managers can reduce leachate management costs by pre-treating leachate using floating aquatic treatment wetlands.

To remove toxins such as heavy metals and COD within the leachate via phytoremediation prior to the leachate being discharged for treatment, either by deep well injection or sent to a WWTP.

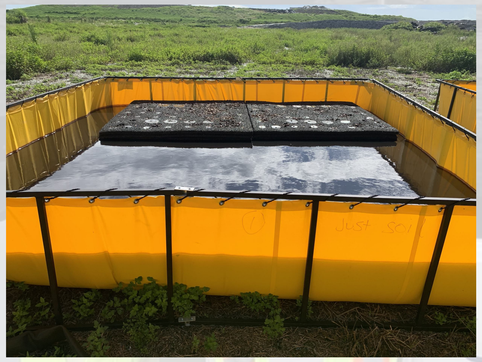

Figure 1: Container 1, control pond with floating mats and soil only.

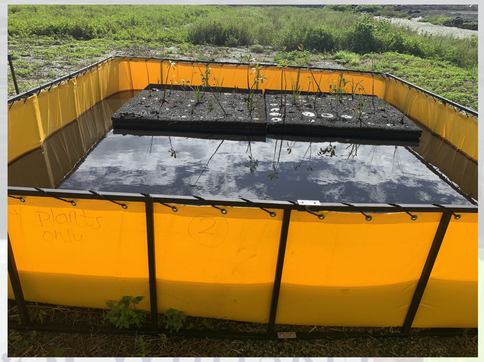

Figure 2: Container 2, pond with floating mats, soil, and plants.

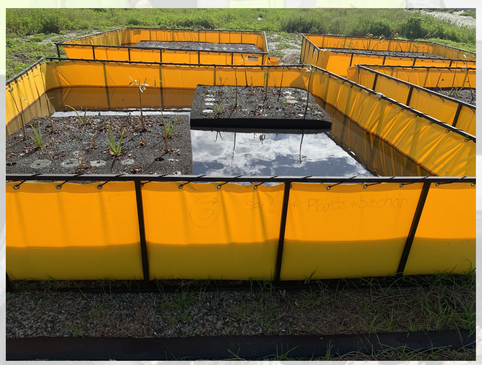

Figure 3: Container 3, pond with floating mats, soil, biochar, and plants.

Figure 4: Container 4, pond with floating mats, soil, biochar, plants, and bioaugmentation.

Methods and Materials

Based off Phase I and II of this research, twelve monocultures each placed in a batch reactor and four polyculture filled floating wetlands placed in leachate holding containers, modifications were made for Phase III. Research was conducted on leachate holding containers, floating wetlands, soil, biochar, and microorganisms to utilize for this project. The research site set up occurred on July 26th, 2021, at the Lee and Hendry Regional Solid Waste Disposal Facility. Four 2,500-gallon leachate holding containers were placed in a landfill cell and filled approximately halfway with leachate. Each container had a floating wetland filled with soil placed within. Container 1 (Figure 1) was the control and only contained the wetland and soil. Container 2 (Figure 2) had the addition of plants (red/black/white mangroves and mangrove spider lilies). Container 3 (Figure 3) had the addition of biochar. Finally, Container 4 (Figure 4) had the addition of microorganisms including salt and metal tolerant, and epiphyte. Since the initial site set up, sampling has occurred biweekly with the samples acquired frozen until analysis in the laboratory. As laboratory analysis of samples begin, ammonia, phosphate, chemical oxygen demand (COD), nitrite, nitrate, and heavy metals will be analyzed.

Acknowledgements

This work was made possible by the Blair Foundation Scholarship, U.A. Whitaker College of Engineering, and landfill operators at the Lee and Hendry Regional Solid Waste Disposal Facility. Special thanks to you all.