QUARTERLY PROGRESS REPORT #3

March 1, 2019 – June 1, 2019

PROJECT TITLE: Evaluation and optimization of floating aquatic treatment wetlands for phytoremediation pre-treatment of municipal landfill leachate employing saline-tolerant plants natural to South Florida

PRINCIPAL INVESTIGATOR: Ashley Danley-Thomson, Ph.D., P.E.

AFFILIATION: Florida Gulf Coast University

COMPLETION DATE: September 2019 **PHONE NUMBER:** 239.745.4390

PROJECT WEB SITE: https://www.fgcu.edu/eng/environmental-civil/floating-aquatic-treatment-wetlands.aspx

Work accomplished during this reporting period:

Objective 1: Using bench-scale, discontinuous batch reactors filled with landfill leachate from a closed, Class 1 landfill, identify at least three saline-tolerant floating, floating-leaved, or emergent plants natural to South Florida that could survive on a floating wetland in a landfill leachate storage pond.

Tasks completed this reporting period: This objective was completed in Quarter 2.

Objective 2: Determine effectiveness of phytoremediation to reduce COD and inorganic nitrogen concentrations in landfill leachate using floating, floating-leaved, and/or emergent plants natural to South Florida (from Objective 1) using bench-scale, discontinuous batch reactors.

Tasks completed this reporting period:

- The average parameters of the influent leachate are: 3,169 + 35.7 mg/L of ammonium, 3.3 + 0.2 mg/L of nitrite, 6.8 + 0.2 mg/L of nitrate, 12.5 + 3.8 mg/L of phosphate, and the pH is 7.1.
- Sawgrass, Mangrove Spider Lily, Giant Leather Fern, Water Hyssop, White Mangrove, Red Mangrove, Black Mangrove, White Mangrove, Pond Apple, and Seaside Oxeye have been evaluated for their ability to pre-treat leachate in terms of COD, ammonium, nitrate, nitrite, and phosphate.
- Determining the reasons for plant chlorosis and death in order to improve survivability of plants and increase their treatment efficacy
- Partial treatment of the leachate by plants is observed.
- The biomass of each plant before and after treatment of leachate is being measured to determine the overall plant health and the treatment capacity per mass of the plant.
- Top contenders to move onto Objective 3 and 4 are:
    - White Mangrove
    - Black Mangrove
    - Red Mangrove
    - Mangrove Spider Lily
    - Sea oxeye
    - Sawgrass
    - Pond Apple

    - Giant Leather Fern
- White and Black Mangrove salt removal mechanisms can be witnessed:

- Data analysis will be conducted in Quarter 4, but preliminary results indicate:
    - Mangrove spider lily (1/25/19 – 2/1/19 – 4 trials) has 195% less COD than the control and 6900% less NH4+ than the control after 7 days.
    - Sawgrass (2/04/19 – 2/08/19 – 4 trials) has 56% less COD than the control after 7 days.
    - Sea oxeye (3/13/19 – 3/20/19 – 4 trials) has 142% less NH4+ than the control after 7 days.
    - Giant leather fern (3/20/19 – 3/27/19 – 4 trials) has 427% less NH4+ than the control after 7 days.
    - Mangrove spider lily (3/27/19 – 4/3/19 – 4 trials) has 31% less COD than the control and 103% less NH4+ than the control after 7 days.
    - Sawgrass (4/3/19 – 4/10/19 – 4 trials) has 7% more COD than the control after 7 days.
    - Pond apple (4/10/19 – 4/17/19 – 4 trials) has 1900% less COD than the control and 109% less NH4+ than the control after 7 days.
    - White mangrove (4/17/19 – 4/24/19 – 4 trials) has 35% less COD than the control and 37% less NH4+ than the control after 7 days.
    - Black mangrove (4/24/19 – 5/01/19 – 4 trials) has 231% less COD than the control and 52% less NH4+ than the control after 7 days.
    - Bull rush (4/26/19 – 5/03/19 – 1 trial) has 46% more COD than the control and 168% less NH4+ than the control after 7 days.

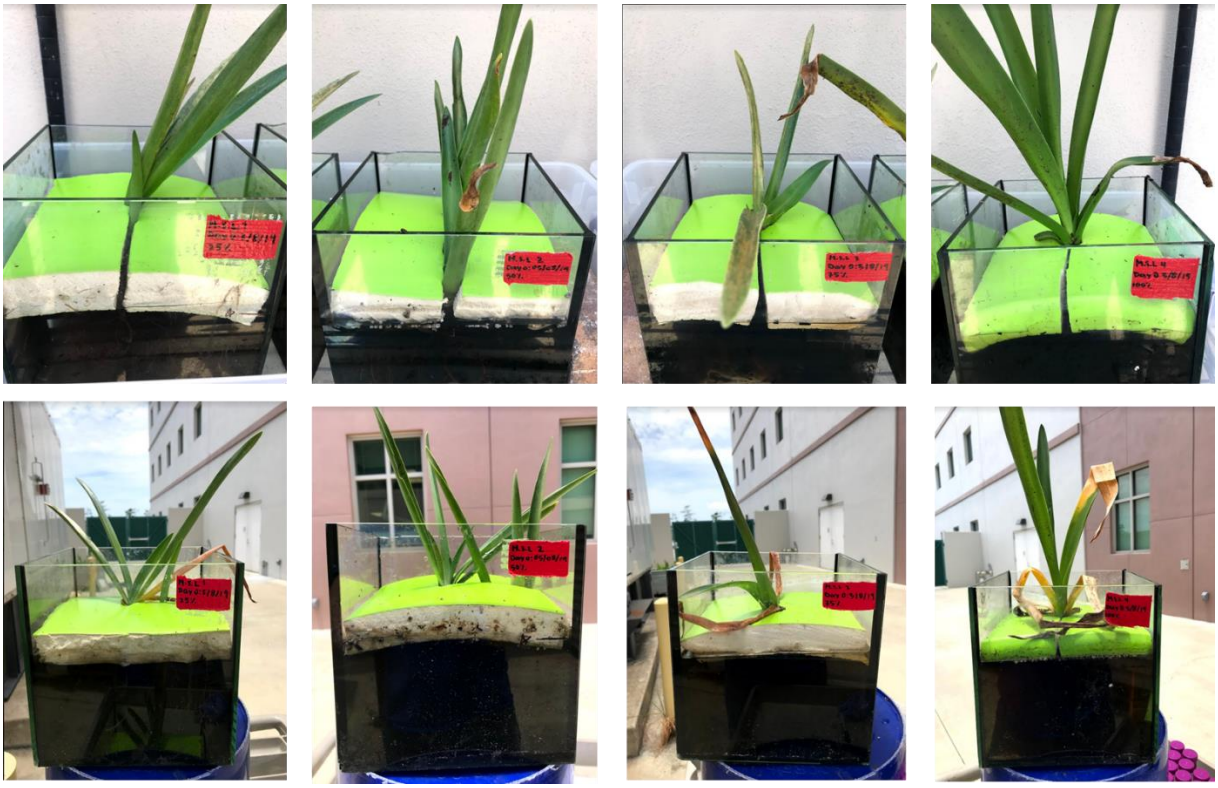
- Sea oxeye (4/26/19 – 5/03/19 – 1 trial) has 27% less COD than the control and 207% less NH4+ than the control after 7 days.
- Giant leather fern (4/26/19 – 5/03/19 – 1 trial) has 111% less COD than the control and 213% less NH4+ than the control after 7 days.

Objective 3: Quantify effect of dissolved oxygen concentration and pH on the ability of phytoremediation to reduce COD and inorganic nitrogen concentrations in bench-scale, discontinuous batch reactors.

Tasks completed this reporting period: Reactors were fit with aerators in order to work on this Objective after Objective 4 is complete.

Objective 4: Dilute leachate with septic tank effluent to evaluate the extent co-treatment reduces salinity levels and improves phytoremediation efficacy. Perform cost-benefit analysis to determine at what point the increased volume due to co-treatment is more expensive than the improved discharged quality accomplished by phytoremediation.

Tasks completed this reporting period: This setup was complete and four plants have completed 14 day trials of floating in distinct leachate and lake water mixes (25% leachate and 75% lake water, 50% leachate and 50% lake water, 75% leachate and 25% lake water, and 100% leachate, v/v). The four plants were mangrove spider lily, sawgrass, sea oxeye, and giant leather fern. Various parameters are measured every two days to analyze the plants ability to reduce constituents (ammonium, nitrate, nitrite, phosphate, and chemical oxygen demand, as well as pH and salinity. The other plants will be tested in Quarter 4. The setup is shown below, using the mangrove spider lily as an example.



Information Dissemination Activities this Quarter:

- Research presentation to the Board of Directors for the Hinkley Center for Solid and Hazardous Waste, Orlando, Florida, May 2019.
- Invited "Special Speaker" at the Solid Waste Seminar by SCS Engineers, March 28, 2019, Fort Myers, Florida. "Phytoremediation Pre-Treatment of Municipal Landfill Leachate Employing Saline-tolerant Plants Natural to South Florida".
- "Evaluation and optimization of floating aquatic treatment wetlands for phytoremediation pre-treatment of municipal landfill leachate employing saline-tolerant plants natural to South Florida". Research Day, April 11, 2019, Florida Gulf Coast University, Fort Myers, Florida.

Metrics:

1. List graduate or postdoctoral researchers who were funded by this Hinkley Center project.

Last Name, First Name	**Rank**	**Department**	**Professor**	**Institution**
Stauring, Sarah	Masters	Environmental and Civil Engineering	Dr. Danley-Thomson	Florida Gulf Coast University

2. List undergraduate students who worked on this Hinkley Center project.

Last Name, First Name	**Rank**	**Department**	**Professor**	**Institution**
Un Jan, Sandra	Senior	Environmental and Civil Engineering	Dr. Danley-Thomson	Florida Gulf Coast University
Humphrey, Morgan	Junior	Environmental and Civil Engineering	Dr. Danley-Thomson	Florida Gulf Coast University
Bayes, Cassandra	Junior	Bioengineering	Dr. Danley-Thomson	Florida Gulf Coast University
Nunez, Jorge	Senior	Environmental and Civil Engineering	Dr. Danley-Thomson	Florida Gulf Coast University
Cornelius, Jackson	Senior	Environmental and Civil Engineering	Dr. Danley-Thomson	Florida Gulf Coast University
Velosa, Andres	Senior	Environmental and Civil Engineering	Dr. Danley-Thomson	Florida Gulf Coast University
Wise, Austin	Junior	Environmental and Civil Engineering	Dr. Danley-Thomson	Florida Gulf Coast University
Soares, Marilia	Junior	Environmental and Civil Engineering	Dr. Danley-Thomson	Florida Gulf Coast University

3. List research publications resulting from this Hinkley Center project.

None.

4. List research presentations resulting from this Hinkley Center project.

- "Evaluation and optimization of floating aquatic treatment wetlands for phytoremediation pre-treatment of municipal landfill leachate employing saline-tolerant plants natural to South Florida". Research Day, April 11, 2019, Florida Gulf Coast University, Fort Myers, Florida.
- "Evaluation and optimization of floating aquatic treatment wetlands for phytoremediation pre-treatment of municipal landfill leachate employing saline-tolerant plants natural to South Florida". Florida Undergraduate Research Conference, February 22 – 23, 2019, University of North Florida, Jacksonville, Florida.
- "Evaluation and optimization of floating aquatic treatment wetlands for phytoremediation pre-treatment of municipal landfill leachate employing saline-tolerant plants natural to South Florida". Florida Collegiate Honors Council Conference, February 8 – 10, 2019, Altamonte Springs, FL

5. How have the research results from this Hinkley Center project been leveraged to secure additional research funding?

- Funding from the FGCU Honors Program was awarded to Dr. Danley-Thomson to support undergraduate student, Austin Wise, to work on Objective 4 of this project over the summer semester.

6. What new collaborations were initiated based on this Hinkley Center project?

- FGCU is now assisting at Hinkley-funded project at the University of South Florida with treatment wetland plant selection based on the findings of this work.
- FGCU is now working with several consulting firms and municipalities with whom FGCU did not previously have contact.
- We are collaborating with Sarasota County Public Utilities Solid Waste Division to further this work and other leachate treatment research projects.

7. How have the results from this Hinkley Center funded project been used (not will be used) by the FDEP or other stakeholders?

- None have been used.

Technical Awareness Group List

- Ashley Danley-Thomson, Ph.D., P.E., Florida Gulf Coast University, Fort Myers, FL.
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TAG Meeting Attendee List (10/17/18)

- Ashley Danley-Thomson, Ph.D., P.E., Florida Gulf Coast University, Fort Myers, FL.
- Isaac Holowell, CDM Smith, Fort Myers, FL.
- Ryan Holzem, Ph.D., P.E., ENV SP, University of Wisconsin, Green Bay, WI.
- Thomas Worley-Morse, Ph.D., P.E., Hazen and Sawyer, Lakewood, CO.
- Junos Reed, P.E., Volusia County Solid Waste, Port Orange, FL.
- Viraj deSilva, Ph.D., P.E., BCEE, SCS Engineers, Tampa, FL.
- Wes Henderson, Hinkley Center, Gainesville, FL.