

QUARTERLY PROGRESS REPORT

August 2019-November 2019

PROJECT TITLE: Cost-Effective Hybrid Constructed Wetlands for Landfill Leachate Reclamation

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PROJECT WEBSITE: <http://constructed-wetlands.eng.usf.edu/>

Work accomplished during this period:

During this first quarter progress was made on the following objectives: adsorption isotherm studies, lab-scale sequencing batch reactor (SBR) design and operation, and preliminary research on water reuse applications.

Batch Adsorption Tests: Adsorption studies for NH_4^+ removal by clinoptilolite and soluble COD and color removal by biochar were carried out. Natural zeolite minerals have a high cation exchange capacity and selectivity for NH_4^+ and K^+ . Clinoptilolite is the most abundant and commonly used form of zeolite. Biochar has a high surface area, cation exchange capacity, and high moisture holding capacity. Fig. 1 shows the removal of ammonia by clinoptilolite and COD by biochar in landfill leachate. These measurements will inform the design of the pilot constructed wetlands (CWs).

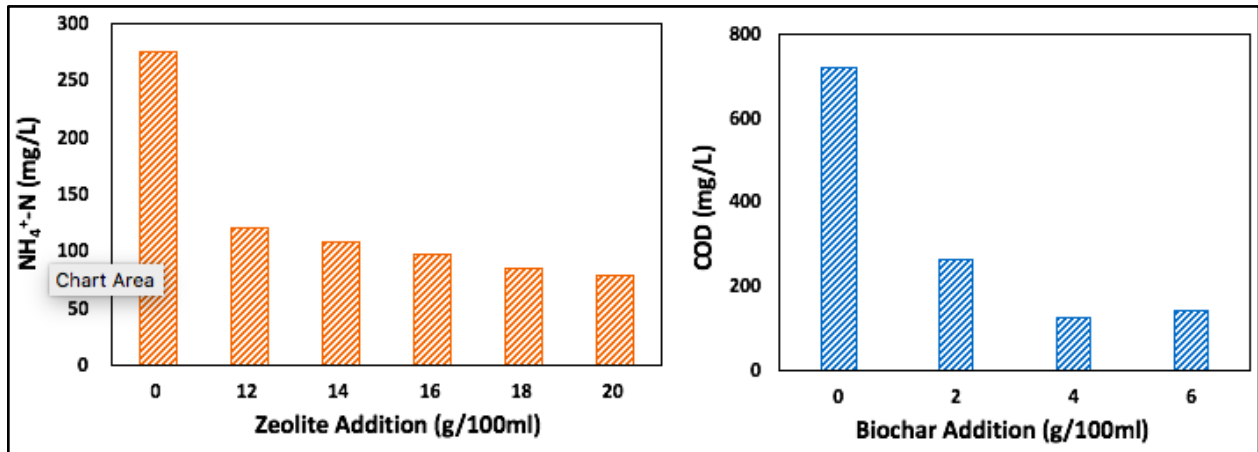


Figure 1: Removal of ammonia and COD in landfill leachate

Laboratory-Scale Sequencing Batch Reactors: Three SBRs were set up (Fig. 2) to test the effect of adsorbent addition on COD, total ammonia nitrogen (TAN) and color removal from landfill leachate. Reactor 1 (control) contains lightweight expanded clay aggregate (LECA)

media. Reactor 2 contains LECA and zeolite (in the form of clinoptilolite) to enhance TAN removal. Reactor 3 contains LECA, zeolite, and biochar to enhance TAN, COD and color removal. SBRs were inoculated with mixed liquor suspended solids (MLSS) from the Valrico Advanced Wastewater Treatment Plant and are operated with the following stages: 1) feed, 2) anoxic react (to promote denitrification), 3) aerobic react (to promote BOD oxidation and nitrification), 4) settle, 5) partial decant, and 6) idle. The overall cycle is 3.5 days.

Samples are collected at the end of the anoxic and aerobic stages to test the removal of COD (Fig. 3), TAN (Fig. 4), and color (Fig. 5). Reactor 3 had the highest COD, UV254 and UV456 removal efficiencies. All three SBRs showed high ammonia removal, indicating good nitrification efficiency at the low loading rates applied during the start-up phase.

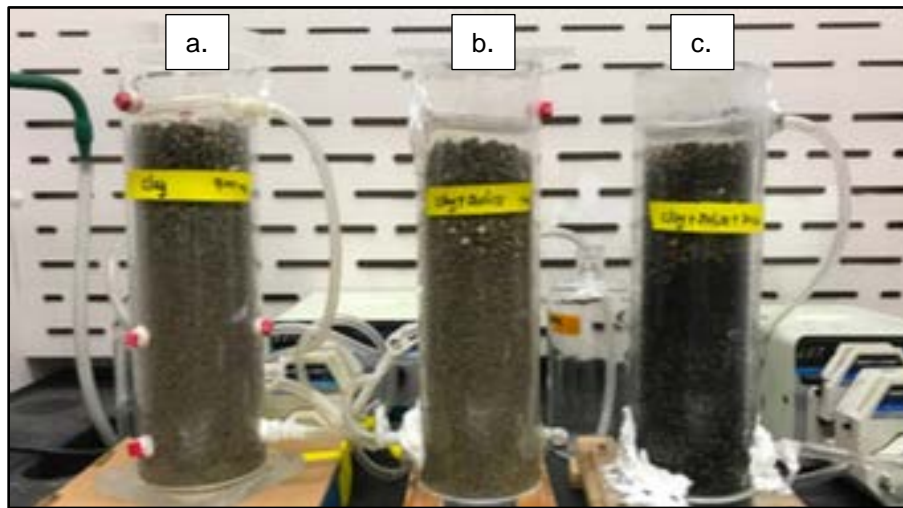


Figure 2: Lab-scale SBRs: a) LECA, b) LECA + clinoptilolite, c) LECA, clinoptilolite + biochar.

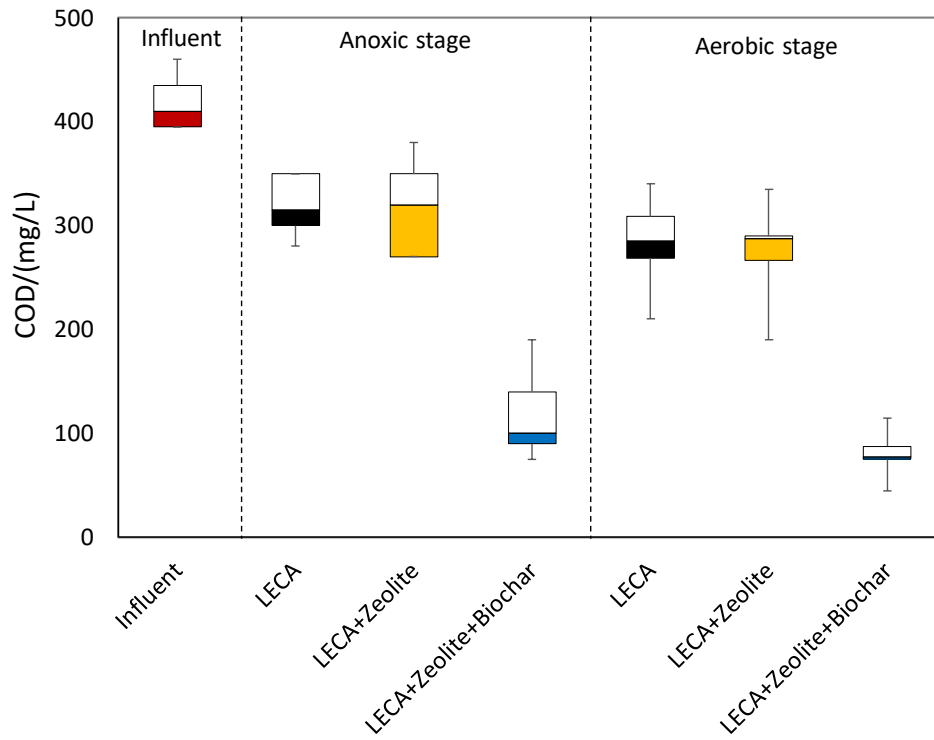


Figure 3: Soluble COD removal in laboratory-scale SBRs.

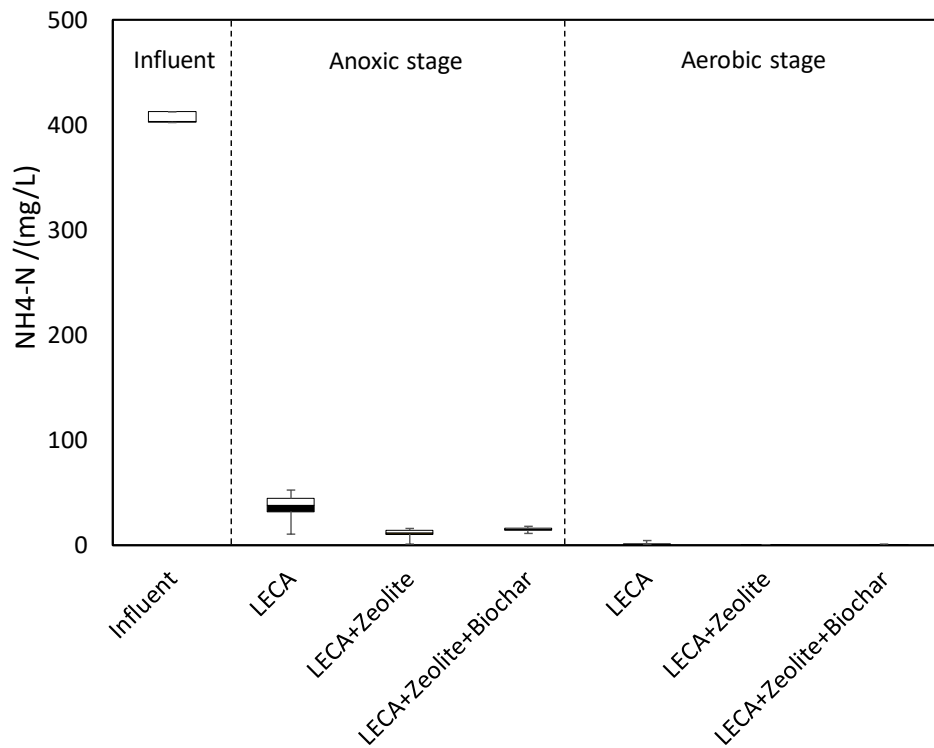


Figure 4: Total ammonia nitrogen removal in laboratory-scale SBRs.

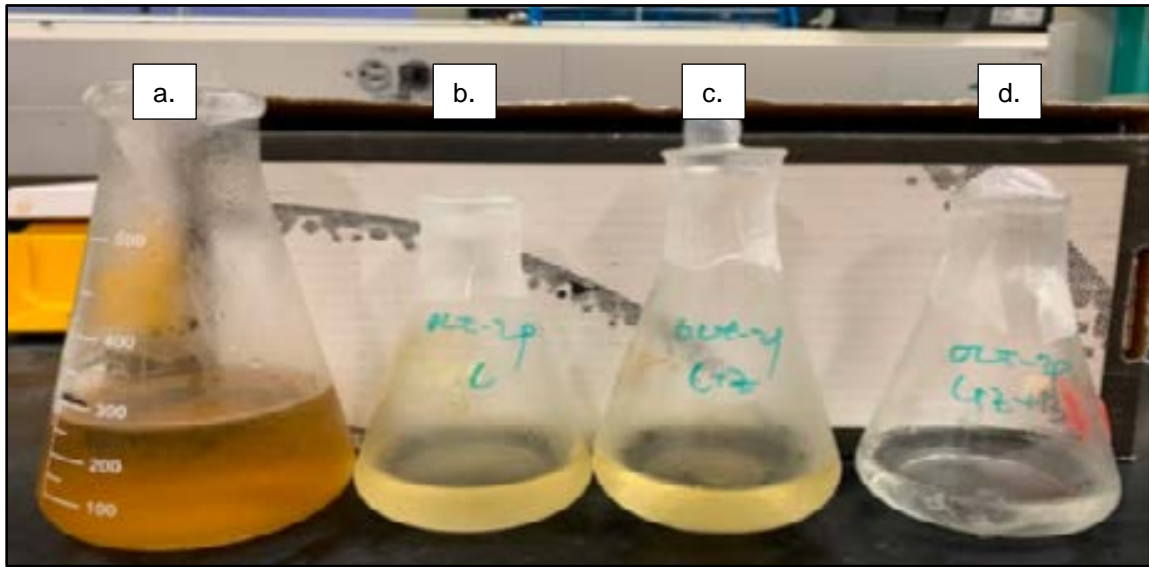


Figure 5: Color removal results: a) raw leachate, b) LECA effluent, c) LECA + clinoptilolite effluent, d) LECA + clinoptilolite + biochar effluent.

Water Reuse Applications: Potential water reuse applications for treated landfill leachate include urban and agricultural irrigation, cooling water, and aquifer recharge. Water quality requirements are shown in Table 1. Based on our preliminary results and literature on CW performance for leachate treatment, additional treatment would be required, especially for conductivity and metals.

Table 1: Regulations and recommendations for water reuse

Water Quality Parameter	Urban reuse	Agricultural reuse	Industrial reuse	Aquifer recovery
Example	Municipal irrigation	Agricultural irrigation	Cooling	Groundwater recharge
BOD ₅ (mg/L ann avg)	20	20	20	20
pH	NS	7 ~ 8	7.9 ~ 8.7	6.5 ~ 9.2
Conductivity (µs/cm)	NS	< 1,360	< 1,120	< 1,000
Total N (mg/L)	< 10	NS	< 2.3	NS
NO ₃ – N (mg/L)	NS	< 9.34	< 0.1	< 15
NH ₄ – N (mg/L)	NS	< 0.02	< 0.25	< 1.5
Heavy metals	As (mg/L)	< 0.1	NS	< 0.006
	Cu (mg/L)	< 0.2	< 0.003	< 0.003
	Pb (mg/L)	< 5	NS	< 0.003
	Zn(mg/L)	< 2	NS	< 0.021

NS= not specified by the Florida state's reuse regulation; avg = average; ann = annual

TAG Meeting: The first TAG meeting was held on November 21, 2019. Participants included the PIs, graduate students, TAG members, and other interested parties.

Graduate students:

Name	Rank	Department	Institution	Email
Xia Yang	PhD	Civil & Environmental Engineering	USF	xiayang@mail.usf.edu
Bisheng Gao	MS	Civil & Environmental Engineering	USF	bisheng@mail.usf.edu
Lillian Mulligan	MS	Civil & Environmental Engineering	USF	lillianm@mail.usf.edu
Xufeng (Alex) Wei	MS	Civil & Environmental Engineering	USF	xufengw@mail.usf.edu

TAG member attendees:

Name	Position/Affiliation	Email
James S. Bays	Technology Fellow, Jacobs Engineering	Jim.Bays@jacobs.com
Kimberly A. Byer	Solid Waste Management Division Director, Hillsborough County	ByerK@hillsboroughcounty.org
William J. Cooper	Prof. Emeritus, UC Irvine (Courtesy Prof. UF)	wcooper@uci.edu
Ashley Evans	Market Area Engineer, Waste Management, Inc., Florida	aevans19@wm.com
Melissa Madden-Mawhir	Senior Program Analyst, FDEP	Melissa.Madden@FloridaDEP.gov
Larry E. Ruiz	Landfill Operations Manager Hillsborough County	RuizLE@hillsboroughcounty.org

Additional attendees:

Name	Position/Affiliation	Email
Wester Henderson	Research Coordinator, Hinkley Center	Wester.henderson@essie.ufl.edu
Kristen Waksman	Process Control Engineer, Hillsborough County	WaksmanK@hillsboroughcounty.org
Luke Mulford	Water Quality Manager, Hillsborough County	MulfordL@HillsboroughCounty.ORG
Marcus Moore	Plant Supervisor, Valrico Advanced WWTP, Hillsborough County	MooreM@hillsboroughcounty.org

TAG members unable to attend:

Name	Position/Affiliation	Email
Stephanie Bolyard	Research and Scholarship Program Manager, EREF	sbolyard@erefdn.org
Ashley Danley-Thomson	Assistant Professor, Florida Gulf Coast University	athomson@fgcu.edu

Link to TAG presentation: TAG presentation slides are posted at <http://constructed-wetlands.eng.usf.edu/>. The recorded presentation will be posted when it is made available from the Hinkley Center.

Metrics:

1. List research presentations resulting from (or about) this Hinkley Center Project.

Nothing to report yet.

2. List who has referenced or cited your publications from this project.

Nothing to report yet.

3. How have the research results from this Hinkley Center project been leveraged to secure additional research funding? What additional sources of funding are you seeking or have you sought?

USF departments of Integrative Biology, Geoscience, and Civil & Environmental Engineering recently received a funding from the NSF for an S-STEM scholarship grant. The grant will fund MS students who are interested in the broad topic of “managing the nitrogen cycle.” Lillian Mulligan has applied for an S-STEM scholarship.

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

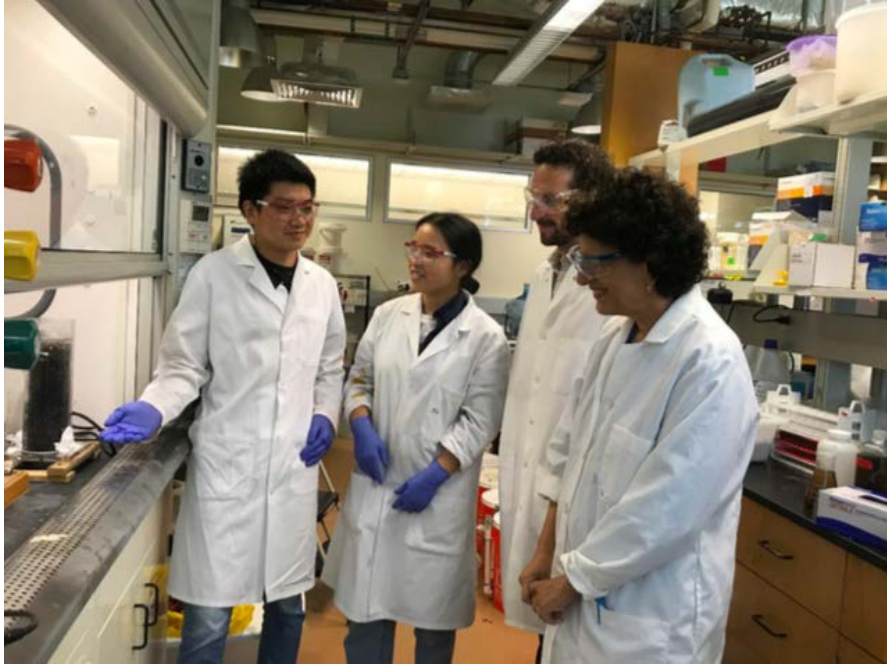
Scott Knight is the co-owner and VP of Wetland Solutions (<http://www.wetlandsolutionsinc.com/>), has been involved in a number of large treatment wetlands in Florida. He visited our laboratory and discussed potential collaborations.

Andre Dieffenthaler, P.E., Vice President, Hazen and Sawyer, is currently leading a complimentary study on the impact of landfill leachate on Hillsborough County’s Valrico Advanced Wastewater Treatment Plant. The team has been in touch with him to discuss potential synergies between the two studies.

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

Nothing to report yet.

Photographs:



Bisheng Gao and Xia Yang showing Dr. Arias and Dr. Ergas their lab setup.



Dr. Arias and Bisheng Gao visiting a constructed wetland in Lakeland FL.