The Life Cycle Analysis of Onsite Wastewater Treatment and Disposal Systems Used in The Alabama Black Belt

Rachel Chai, Sean Walker, Kevin White, Kaushik Venkiteshwaran

Department of Civil, Coastal, and Environmental Engineering, University of South Alabama

UNIVERSITY OF SOUTH ALABAMA

1. Introduction

The Alabama Black Belt is a region in central Alabama (Figure 1) consisting of the Blackland Prairie. This is a 17- county site is characterized by its rural population, low econômic basis, and clay soils (Figure 3) with high percolation rates: **200min/inch+.** Due to this condition, in this region, 11 out of 17of these counties have significant issues with onsite wastewater, even causing onsite system failure (Figure 4). Many of these residents currently use straight pipes (Figure 2), an unacceptable form of wastewater disposal. This is a public health concern for diseases like Salmonella, Hepatitis A, and Hookworm.

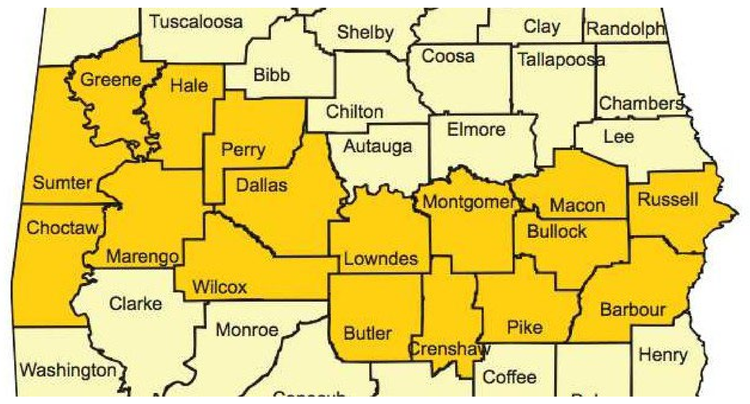

Figure 1. 17 Counties of the Alabama Black Belt

Figure 2. Straight Pipes

Figure 3. Vertisol Clay Soils

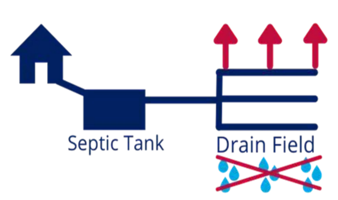

Figure 4. Septic Tank Failure

2. Process

Life cycle assessment studies the environmental aspects and potential impacts throughout a product's life from raw material acquisition through production, use and disposal.

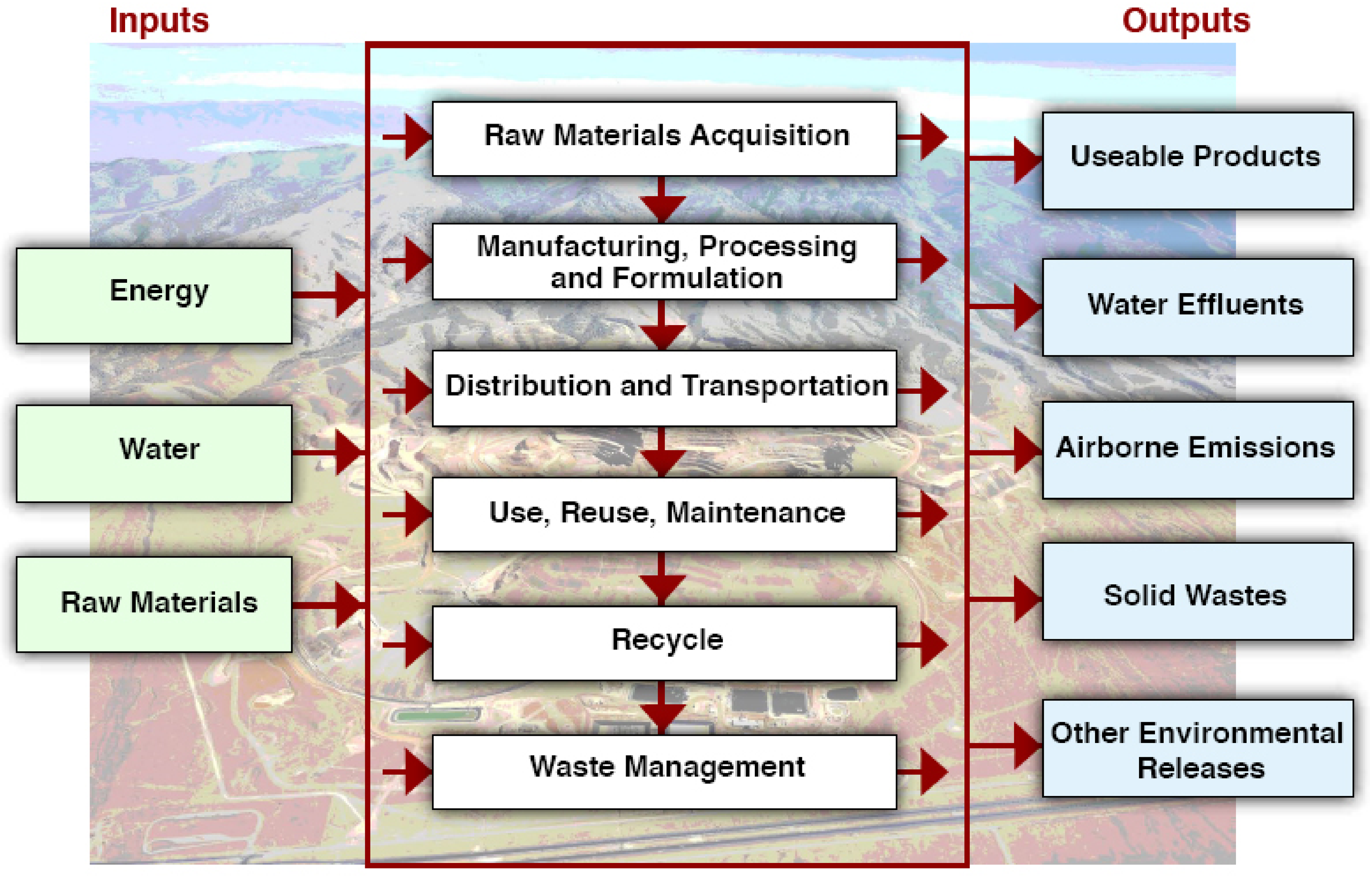

Figure 5. LCA Process

3. Parameters

Using the LCA Process specific are found. The desired parameters for the outputs of my LCA study are carbon footprint, energy usage, environmental impact, and costs (Figure 6).

Figure 6. Research Parameters

4. Methodology

OpenLCA and GREET are open-source life cycle assessment software's which contain databases and have tools used to form process models used to perform LCA (Figure 7). RSMeans is a lifecycle cost costing software which can be used in forming the LCI cost inventory (Figure 8).

Figure 7. LCI Inventories

Figure 8. Cost Inventory

The following LCA will cover the use cases within the specified boundaries of construction, treatment, and disposal. System Boundaries are highlighted by a box with a boundary of a red dotted and green solid lines as seen in Figure 9.

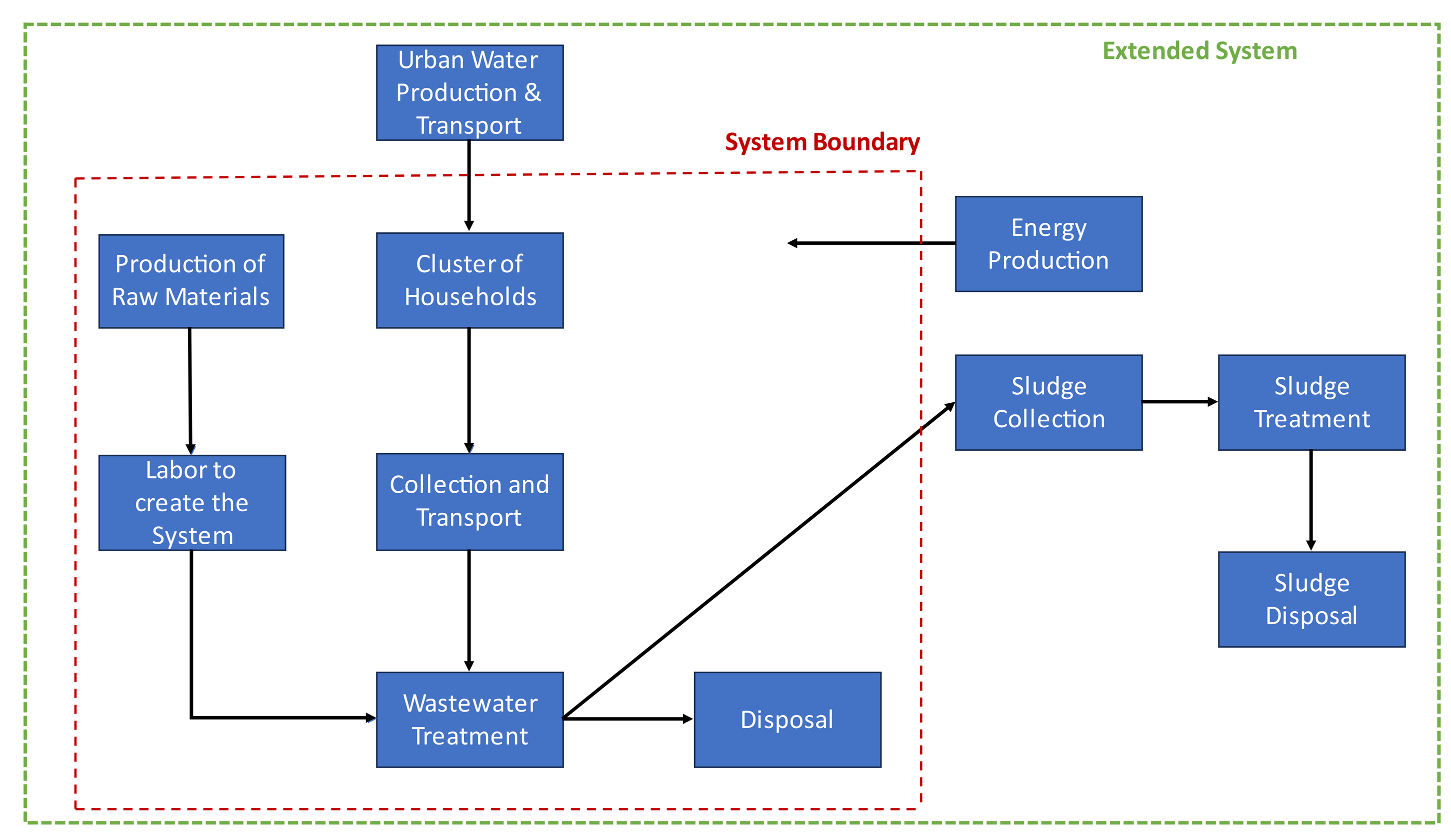

Figure 9. Use Case: Construction, Treatment, and Disposal

Future LCAs will find specified parameters for the following systems:

Wastewater Treatment Systems
1. Lagoon
2. Membrane Bioreactor
3. Aerobic Treatment Unit
4. Recirculating Sand Filter (Figure 10)
5. Constructed Wetland (Figure 11)

Wastewater Collection Systems
1. Gravity Collection
2. Septic Tank Effluent Pressure (Figure 12)
3. Pressure Sewer: Grinder Pump (Figure 13)

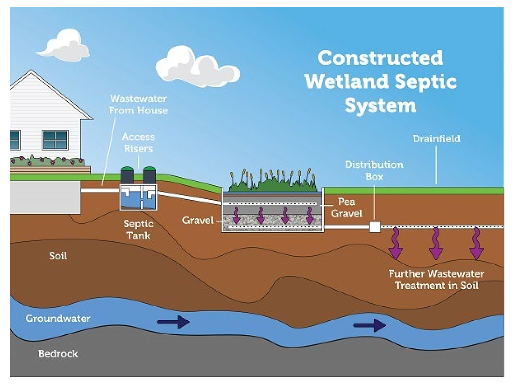

Figure 10. Constructed Wetland

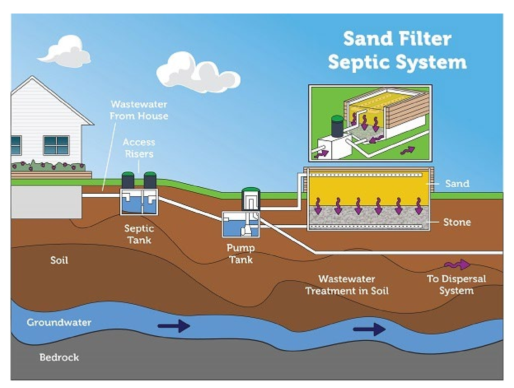

Figure 11. Recirculating Sand Filter

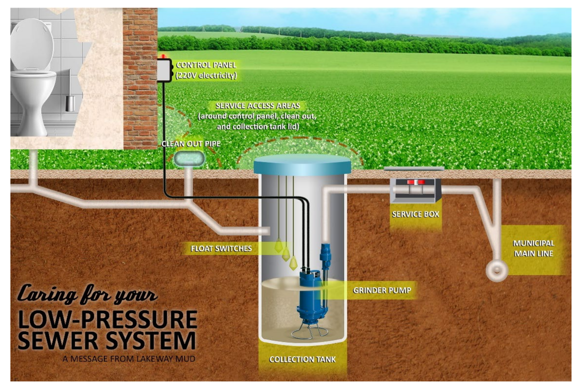

Figure 12. Pressure Sewer Grinder Pump

Figure 13. STEP Collection

5. Results

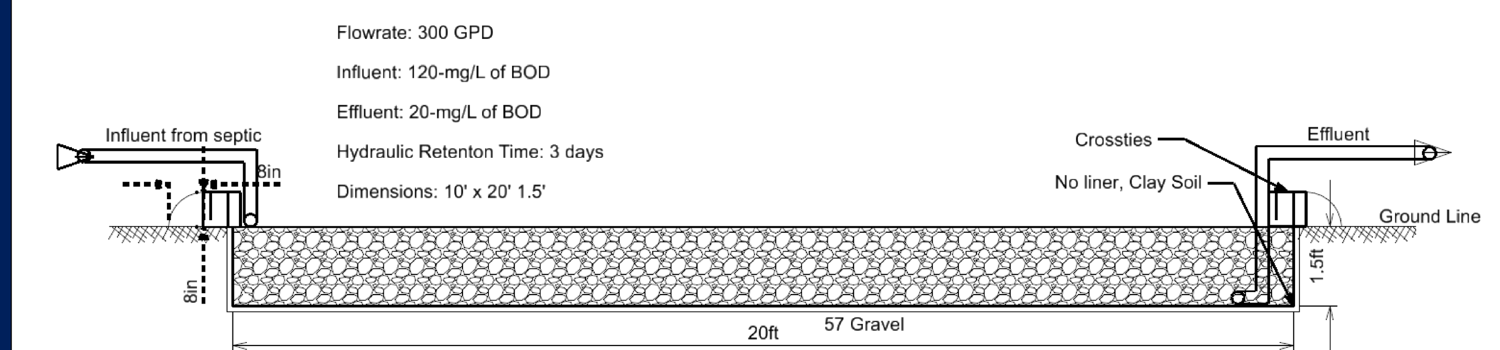

Figure 14. Design Constructed Wetland

A constructed wetland (10' x 20'x 1.5')was designed for a single home with a flow rate of 300 gpd and retention time of 3 days (Figure 14) and was broken down into materials to perform and LCA. An itemized lists of those materials can be seen in Table 1, with corresponding carbon footprint emissions, as well as the electricity consumption used to collect and manufacture those parts.

Table 1. LCA of Constructed Wetland: Construction

Material	Quantity	Carbon Footprint (kg-CO2-eq)	Energy for production (MJ)	Energy for production (kWh)
Concrete Septic Tank	100ft3	598	3372	936.7
Turbine Pump	1 Pump	122.0	407.7	113.3
Plants (Wetland Plants i.e. cattails)	50 (2 feet spacing)	-540		
#57 Gravel	300 ft3 (~18 tons)	107.4	1387	385.3
PVC pipes & elbows	247.9lb (~40ft)	401.2	6621	1839.2
control station (timer)	3 (replacements)	10.79	34.2	9.5
Butyl rubber liner	290 ft2	139.48	1779	494.2
wood frame (treated)	290 ft2	95.8	193.95	53.9
railroad crossties	7.5 crossties	-9	1,055	293.1
	Total	**926**	**14850**	**4125**

6. Conclusions & Next Steps

Conclusions:
- Determining carbon footprint for constructed wetlands and other systems is possible
- Concrete septic tank had the highest contribution for carbon footprint
- PVC piping and elbows had the highest electricity contribution
- Any plant growth will decrease the carbon footprint

Next Steps:
- Cost of materials
- Operation and Disposal
- Moving on to the next systems

This work was funded by the environmental Protection Agency: EPA Gulf of Mexico Program Cooperative Agreements. The statements in this work have not been formally reviewed by the EPA and are solely the views of the authors. References available up request. The comments and opinions made on this poster are those of the presenter and not of NOWRA or the Mega-Conference sponsors