

The Flexcrevator:

Development and Field Testing of Mechanized Pit Emptying with Trash Exclusion

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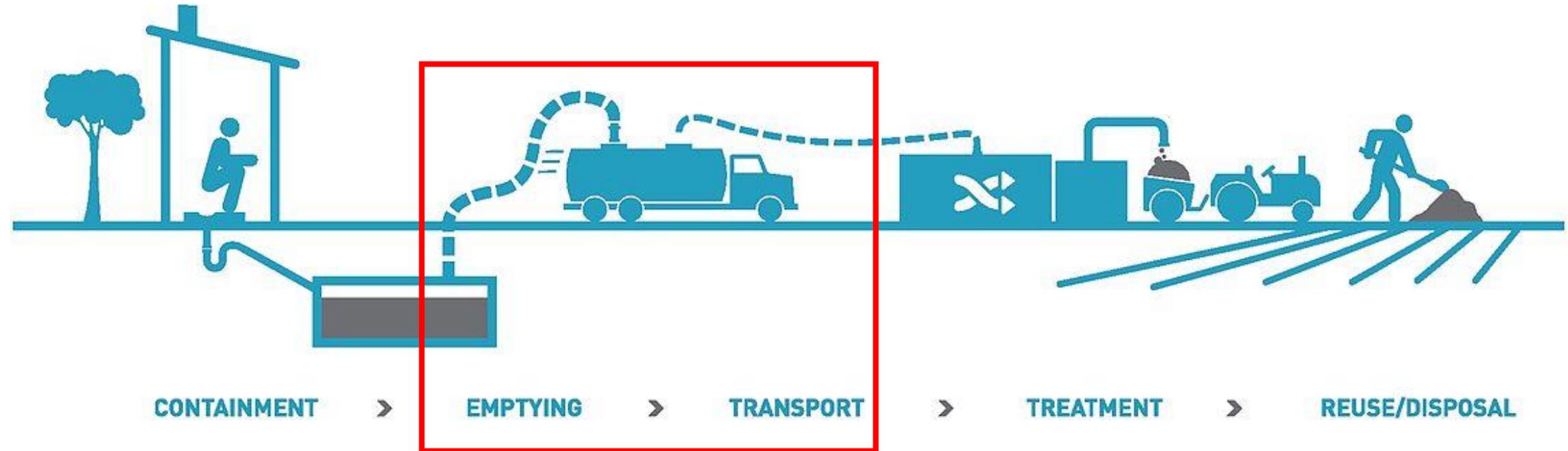
1.77 billion people use pit latrines for basic sanitation¹



¹ Graham, Jay P. and Polizzotto, Matthew L., "Pit latrines and their impacts on groundwater quality: A systematic review" (2013). *Environmental and Occupational Health Faculty Publications*. Paper 36. http://hsrc.himmelfarb.gwu.edu/sphhs_enviro_facpubs/36

Safe and efficient FS collection is a key part of the solution

Sanitation Value Chain



- Until waste is seen to be moving, **this issue remains invisible**
- A PE technology **enables the pit emptying industry to gain legitimacy**
- A PE technology is a **stimulant** for the FSM industry at large

Why is it so difficult?



- More efficient emptying – no more FISHING

- Closed system from pit to transfer tank

- Enables efficient downstream processing

TRASH EXCLUSION: Leave the trash behind!

- New business opportunities

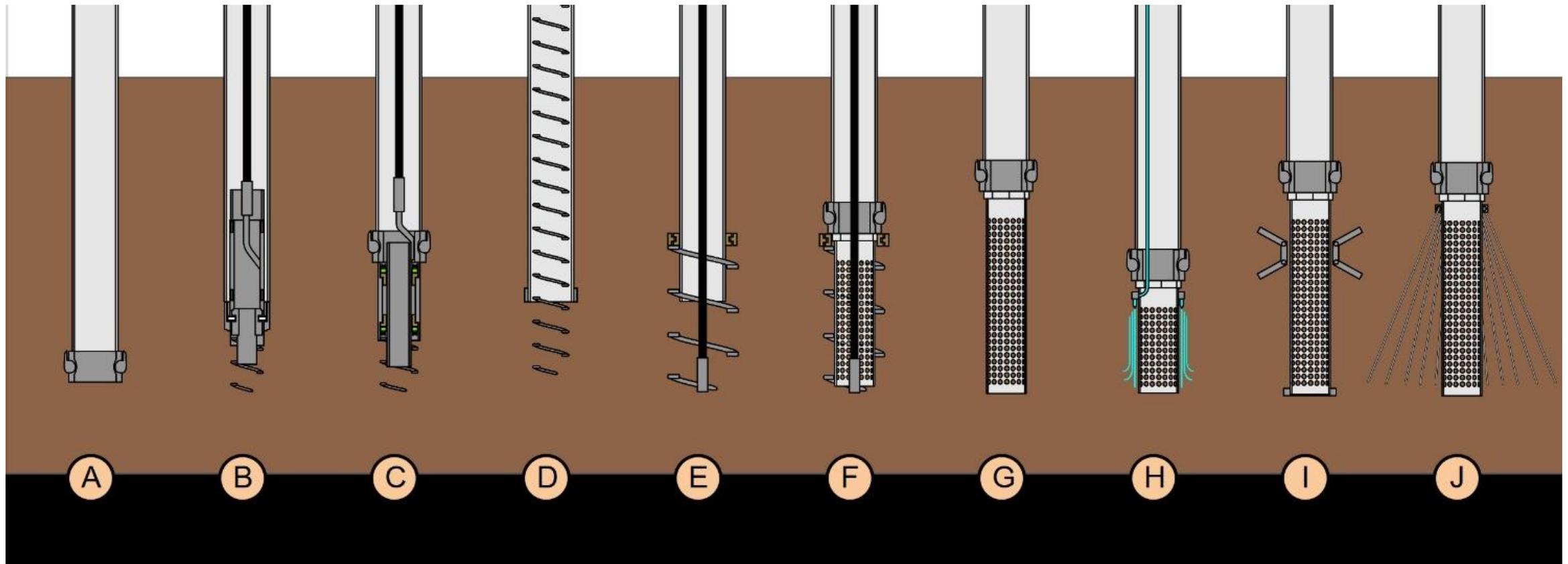
- Service is contracted for fecal sludge removal

- Incentive for behavioral change

Imagine this



Development of New Design Concepts



Deflection mechanism

Clearing mechanism

2017 Prototype – System Layout

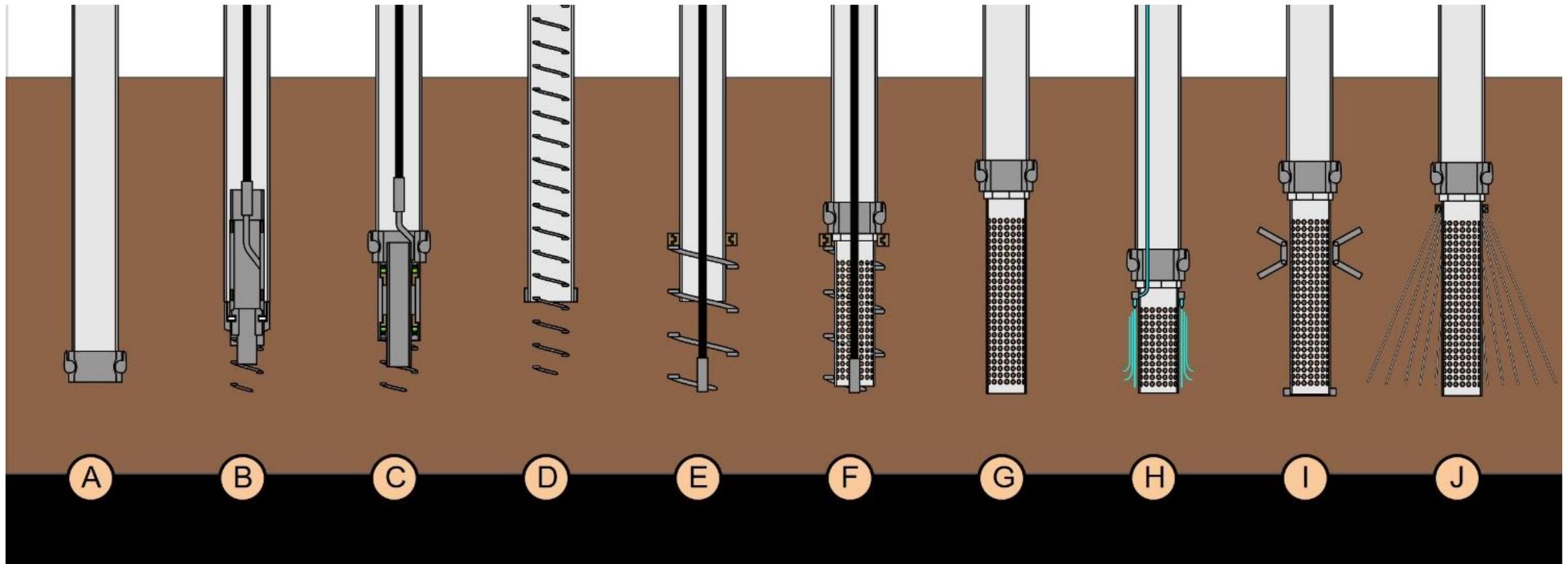


2017 Prototype – Field Testing Challenges (Lusaka, Zambia)

- Frequent clogs due to plastic bags and hair strands
- Flexible shaft did not withstand field conditions
- Ergonomic issues



Testing New Design Concepts



Worked in the lab, but had issues in the field

Had issues in the lab, not tested in the field

Deflection and Clearing Methods

Perforated Pipe + Auger

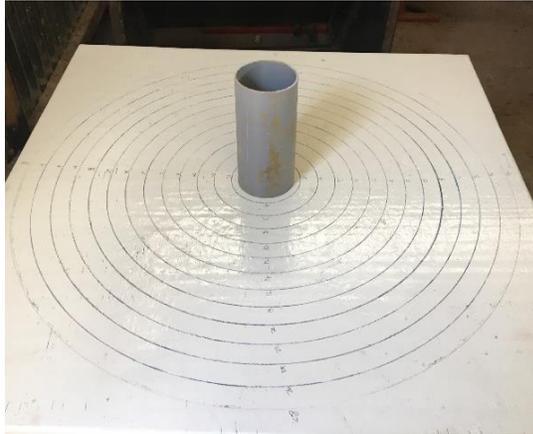
- Deflection Mechanism



- Clearing Mechanism

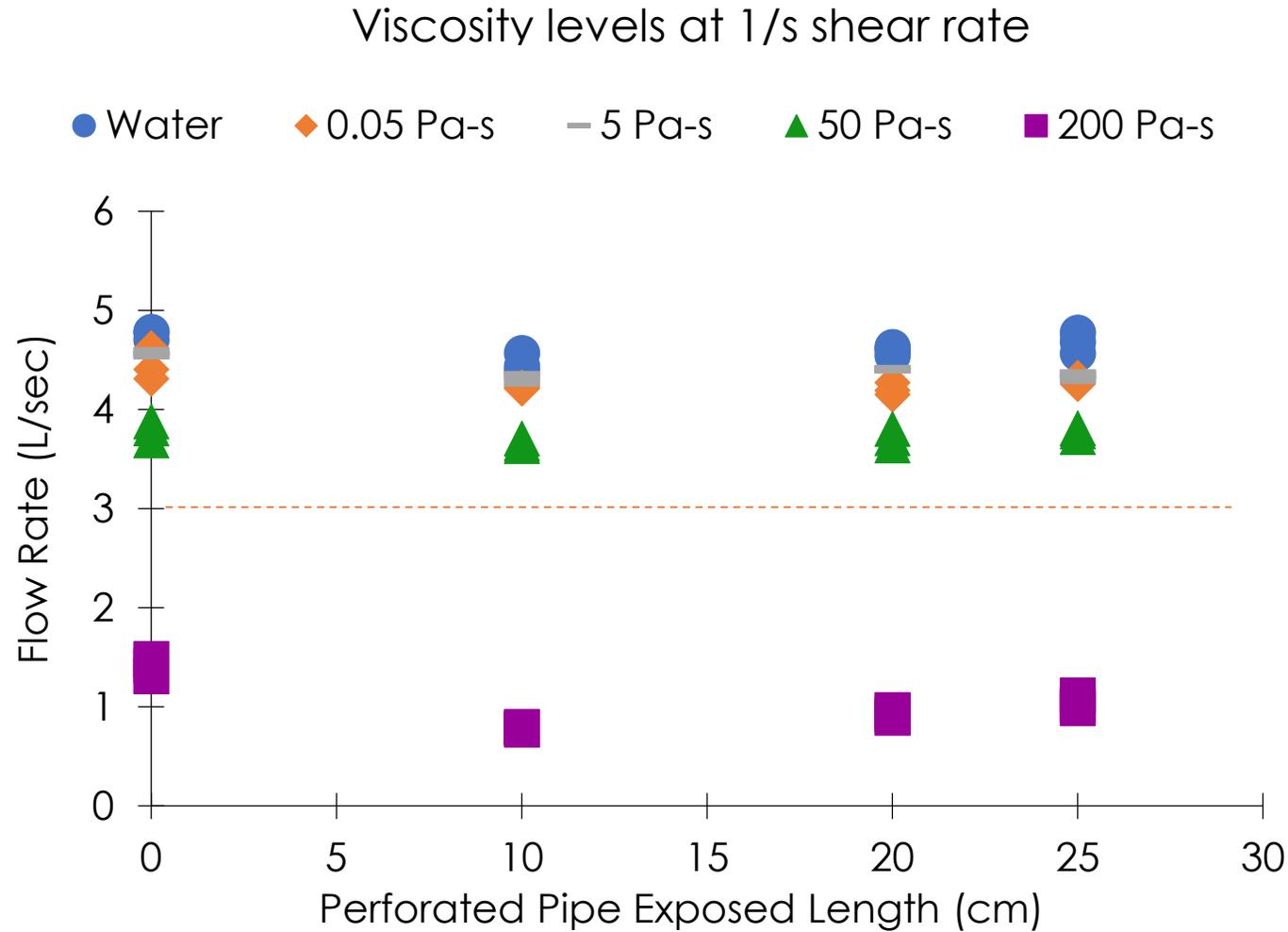


Simulating Pit Latrines in the Laboratory



Pipe length does not significantly affect flow rate

Fecal sludge viscosity: 10 – 1000 Pa-s
At 1/s shear rate



- Reached the pumpability limit above 50 Pa-s (10.5% bentonite)

Hole size can be used as a tool for trash exclusion



- Flow rate is mainly a function of material viscosity and pipe friction

Deflecting and Clearing mechanism prototypes were tested in the field (Kisumu, Kenya)



The clearing method successfully emptied wet pit latrines

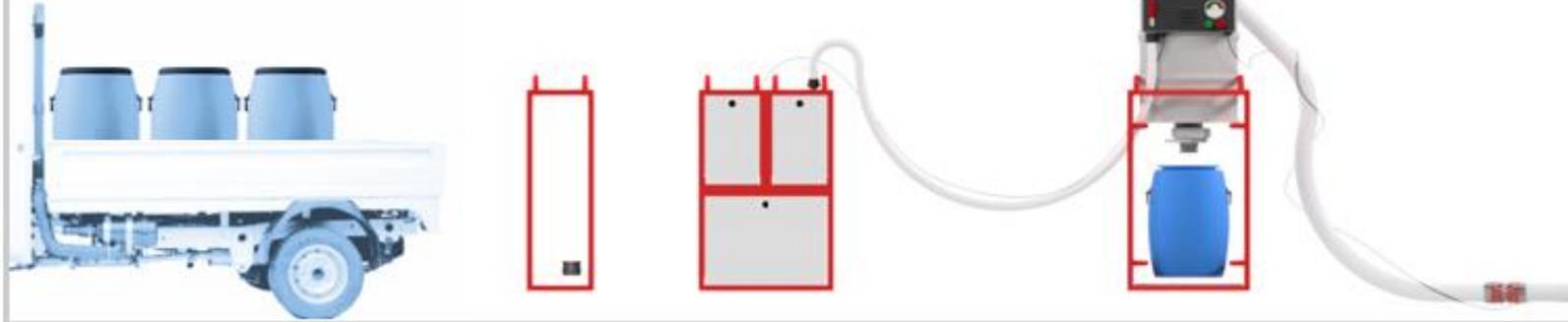
Pit No.	Sludge Type	% Solids in Sludge	Trash Excluder	Amount of Water Used for Fluidization (L)	Maximum Flow Rate (L/sec)	Average Flow Rate (L/sec)	Amount of Sludge Emptied (m ³)
1	Wet	<1%	Clearing	none	3	2	2.88
2	Wet	N/A	Clearing	none	4.3	2.3	2.5
3	Dry	14.8%	Clearing, Deflecting and Improved Clearing	90	1.5	N/A	0.95
4	Wet	<1%	Improved Clearing	none	4.3	4.1	0.9
			Improved Clearing w/ Vac Truck	none	N/A	5.6	4.7
5	Dry	10.5%	Improved Clearing	260	0.5	0.2	0.3

Less than 5 minutes active pumping time

System Configuration	Set-up Time (min)	Active Pumping Time for 0.81 m ³ (min)	Barrel Management Time (min)	Cleaning Time (min)	Total Process Estimated Time (min)	Maximum Volume per trip to the treatment plant (m ³)
Trash Excluder and Vacuum System	11	3.4	27	16	57.4	0.81
Trash Excluder and Vacuum Truck	7	2.4	none	8	17.4	8

The Flexcrevator can be adapted to three different scenarios

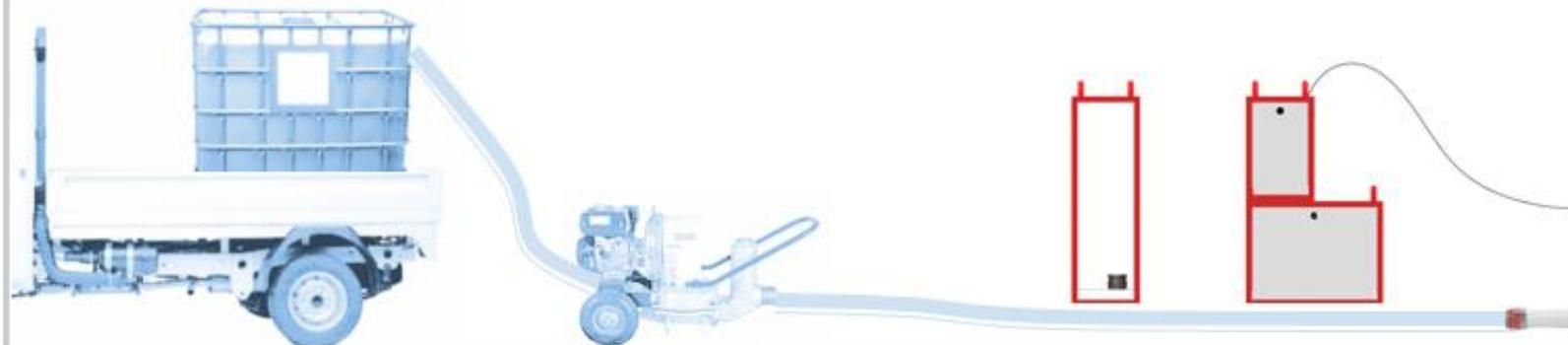
1 - Custom Vacuum System



2 - Vacuum Truck System



3 - Trash Pump System

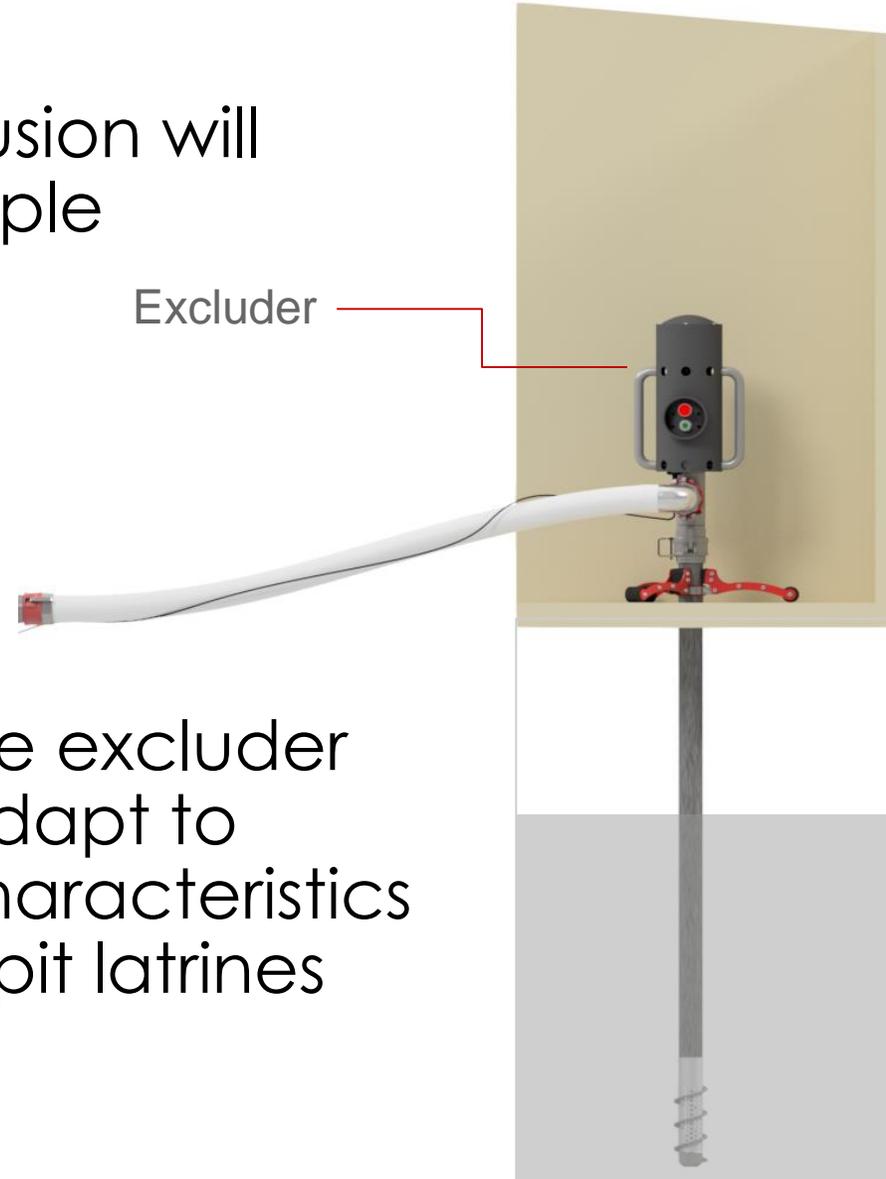


The Excluder can operate with 3 different vacuum based pit latrine emptying systems.



Summary: Trash Exclusion mechanism worked in the field; new design ready

- Trash exclusion will bring multiple benefits



- Swappable excluder head to adapt to specific characteristics of various pit latrines

- The clearing mechanism proved to be efficient in simulated and real pit latrines

- Opportunity to use the excluder head in conjunction with vacuum trucks (and basic pumps)

Next steps

- Field testing in Rwanda and Madagascar
- Partners to take to market

“Business case and market study for improved pit emptying”
Nicola Greene, Wednesday, 11:30 AM, Meeting Rm. 2.4.1.

