Field study on intermittent mixing of septic tank fecal sludge

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Introduction

- Previous work: design and important findings

- Motivation for septic study

- "Septic Mixer"

- Next steps: proof of concept

- Characterizing septic tank contents – field study

- Expected outcomes

- Questions & comments
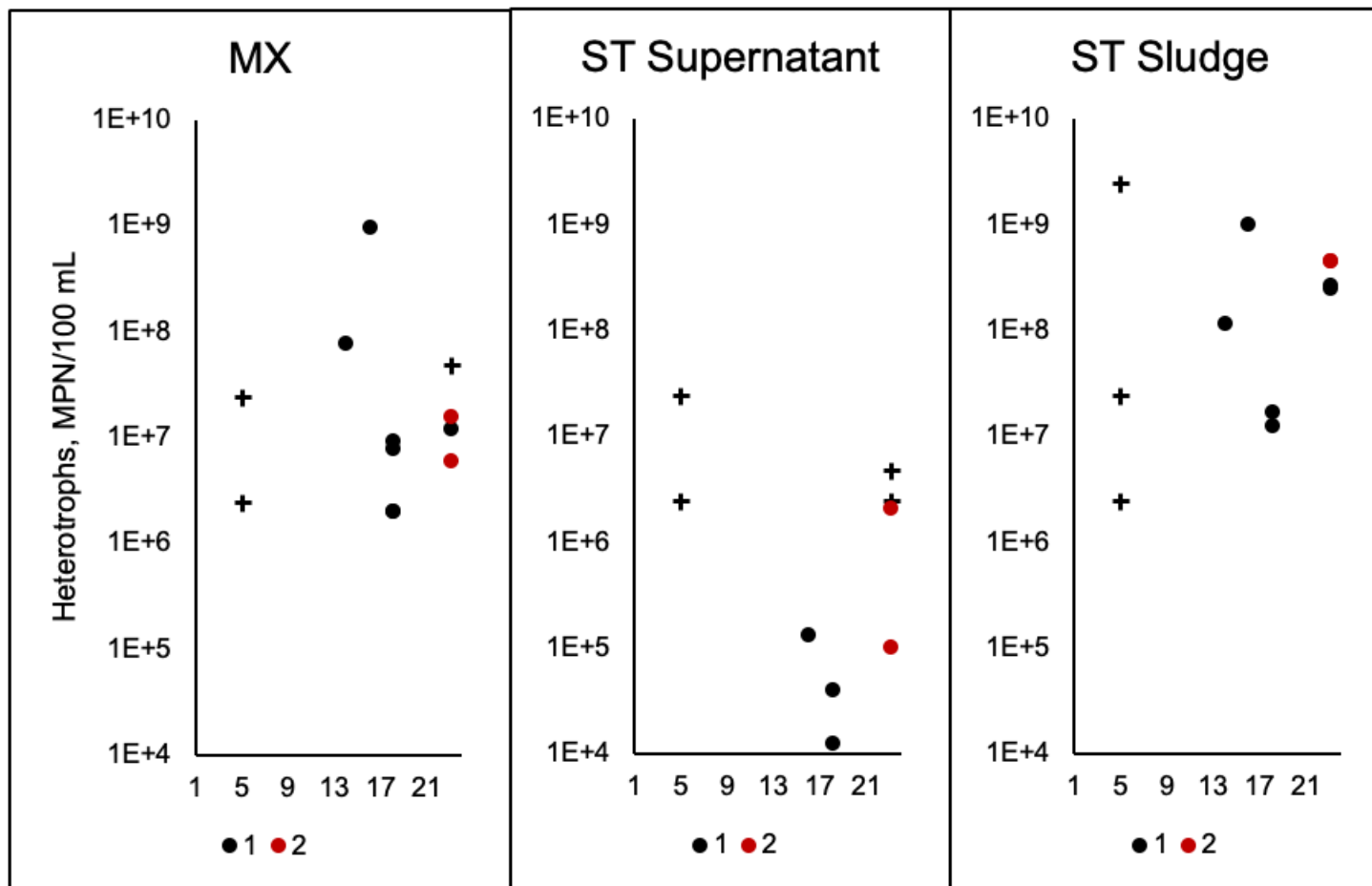
Previous work – bench-scale anaerobic digesters

- **Non-dilute waste products**

    - Dog feces
    - Commercial grade toilet paper
    - Synthetic urine

- **Intermittent mixing**

- **725 days operation (~2 years)**

- **Monitoring chemical, physical, bacterial characteristics**
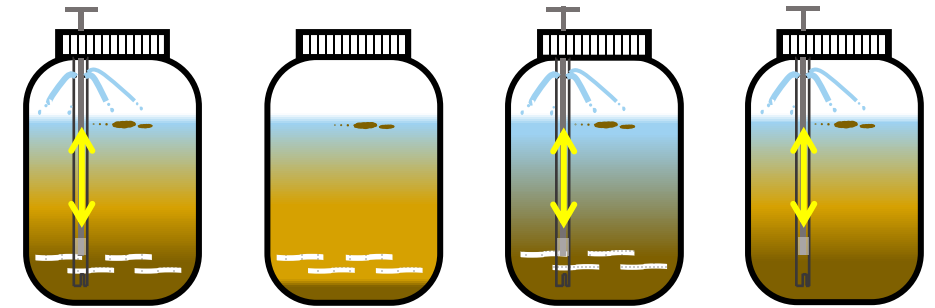
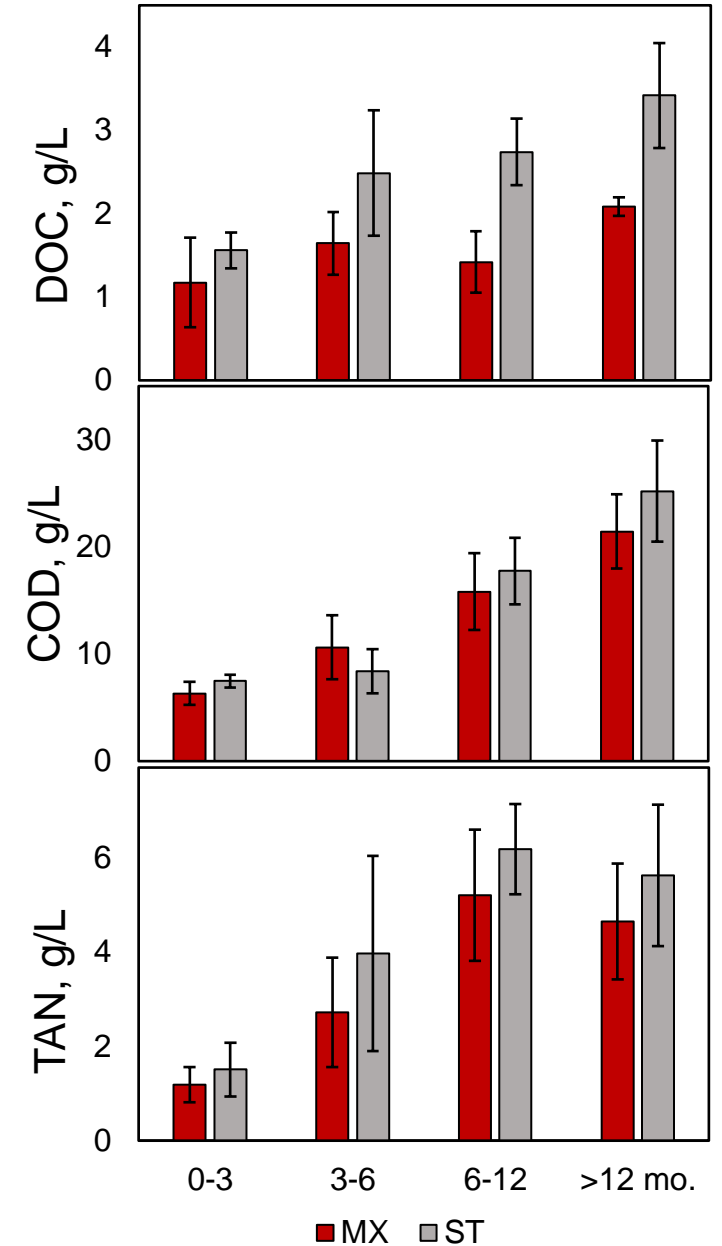| Waste	MX	ST	UD	NO TP
Mixing	•		•	•
Feces	•	•	•	•
Urine	•	•		•
Toilet Paper	•	•	•	

Previous work – important findings

Heterotrophs
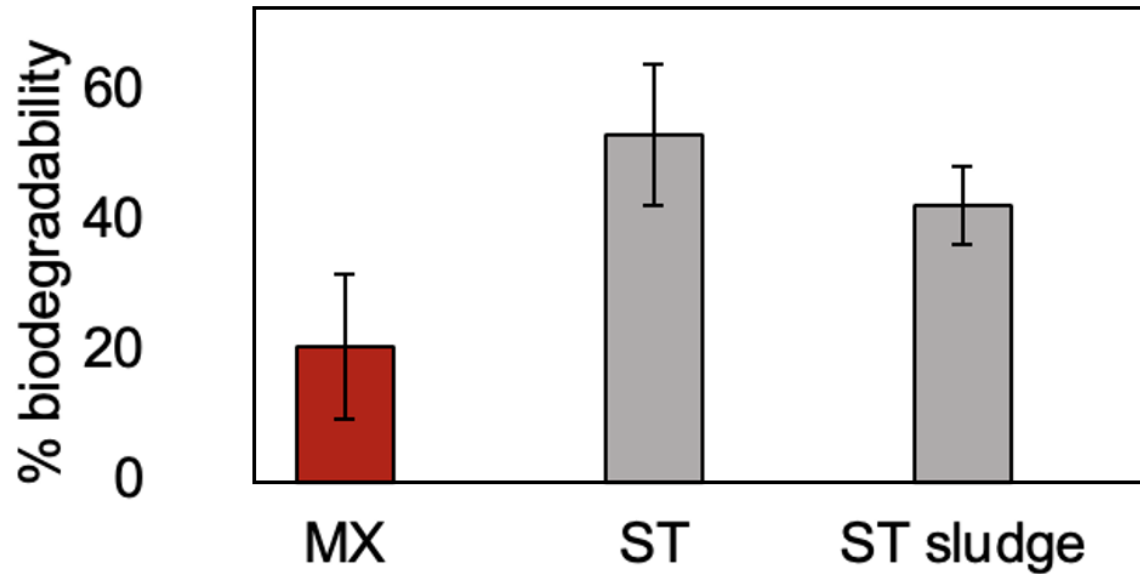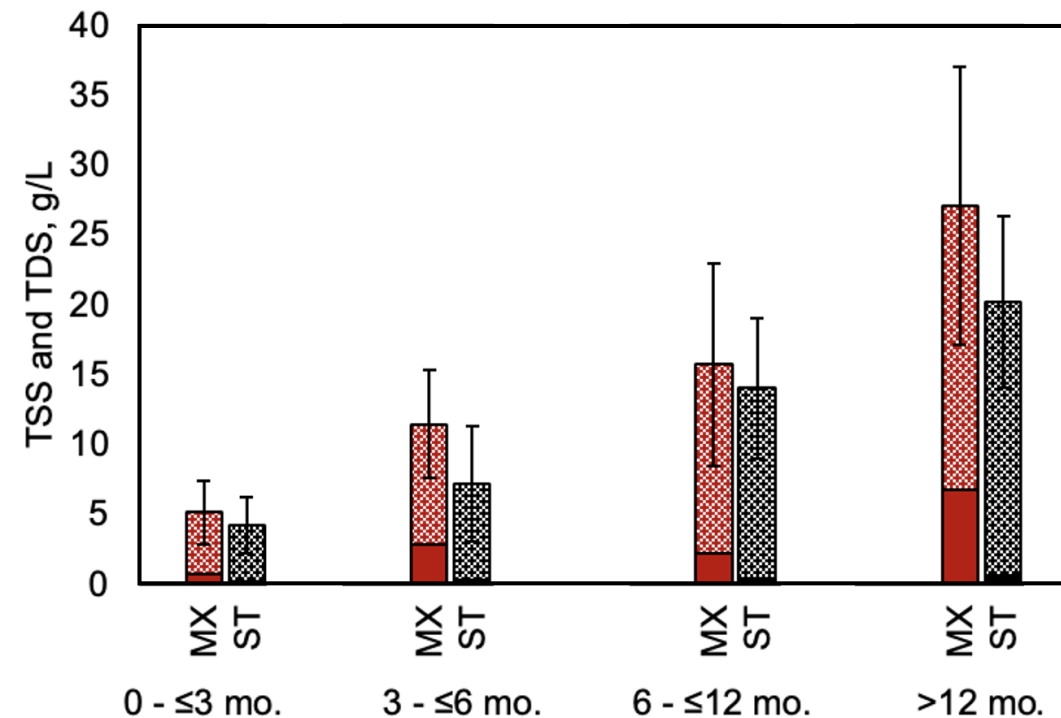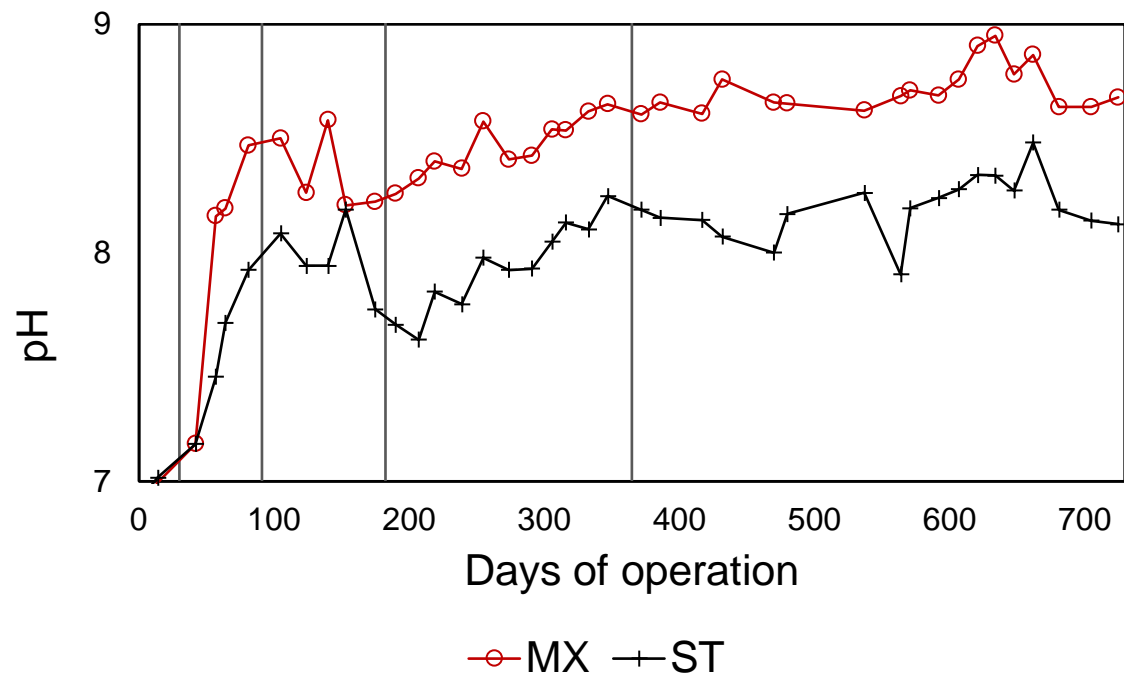
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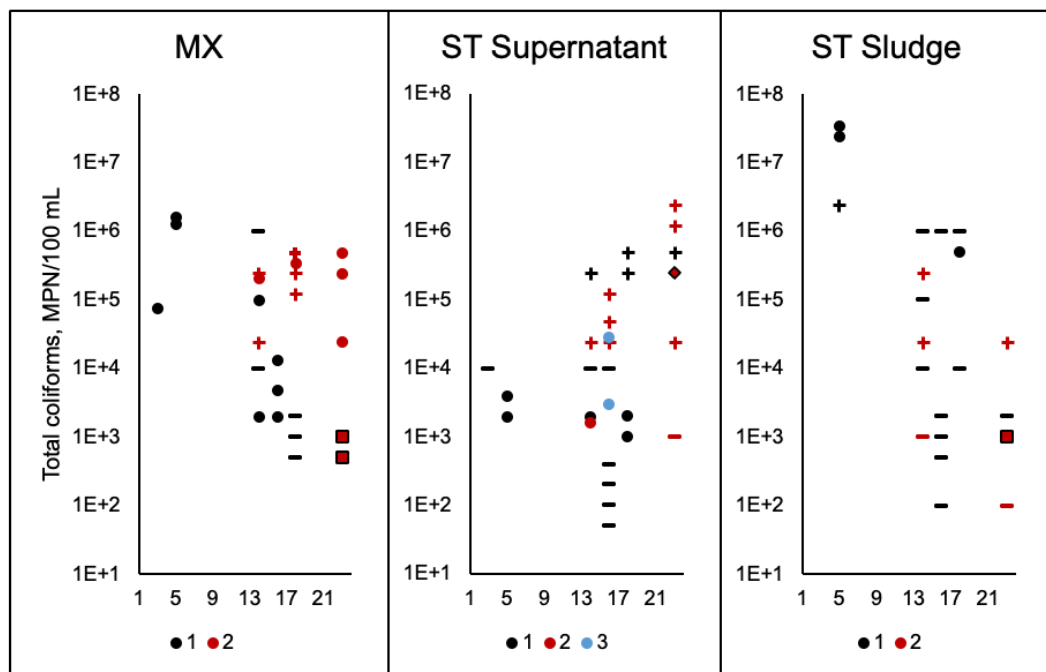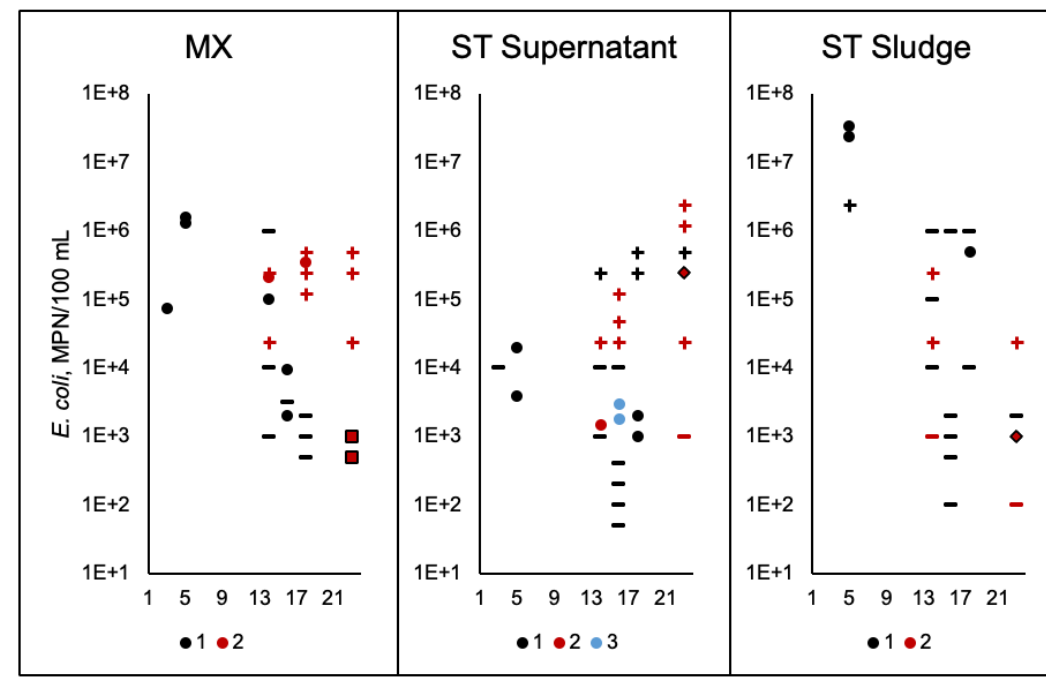
Previous work – important findings

Motivation for study

Mixing in anaerobic digesters and latrines → increased stabilization

Mixing of settled sludge in septic tanks → system sustainability?
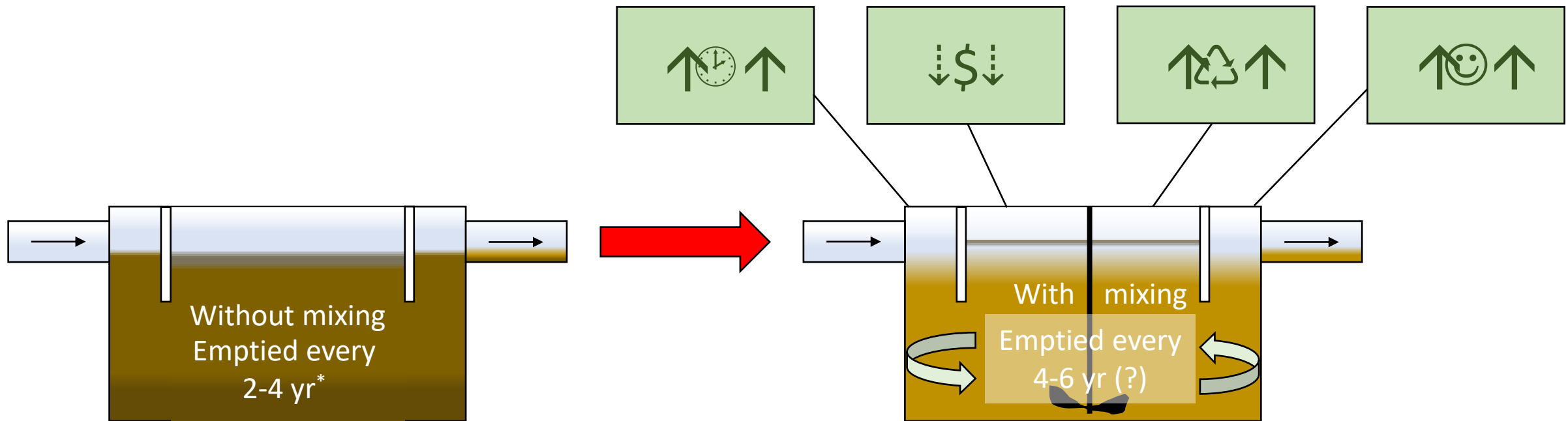
*Based on interviews with septic system owners and maintainance providers in San Diego, CA.

"Septic Mixer"

- Prototype

    - Access port configurations (with and without risers)
    - Best mixing method (paddle, pump)
    - Physical operation (clogging, tangling)
    - Power requirements

- Comparison

    - Without mixing (normal use, 12 months)
    - With mixing (prototype installed, 12 months)
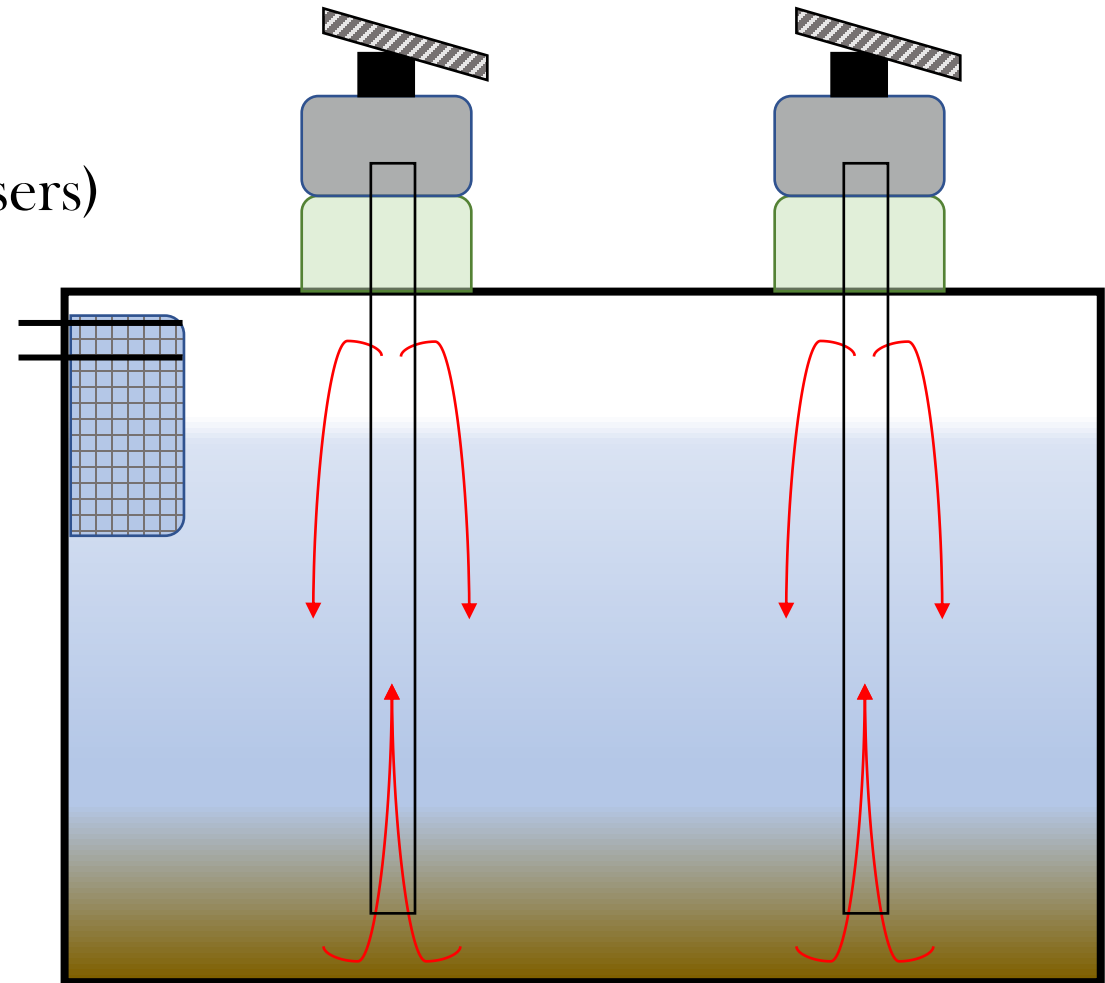
* Patent pending

Next steps – proof of concept

Site evaluation → **Preliminary data** → **Site selection** → **Pilot study** →

Interviews

Monitoring

As-is

With prototype

Evaluation

- Is longer use of septic systems implied when mixed?
- Are there environmental implications to mixing?
- Do benefits of mixer outweigh costs of operation?
- Were prototype operational obstacles present?

Characterizing septic tank contents – field study

https://www.jtplumbing.co.nz/tank-systems/septic-tanks/
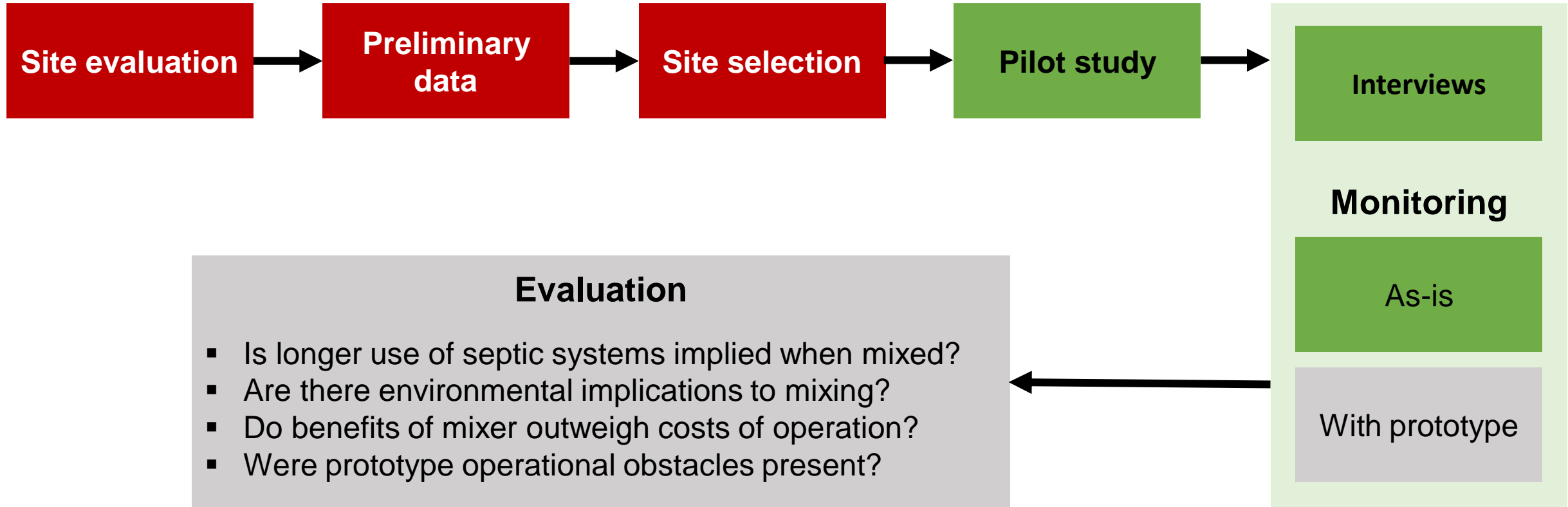
Composite samples:

	Chamber 1		Chamber 2	
	Surface	**Sludge**	**Surface**	**Sludge**
pH	7.09	6.98	7.11	7.22
Turbidity, NTU	181.72		107.31	
Conductivity, mS/cm	4.29	7.15	4.50	6.73
Total solids, mg/L	890	26,860	750	11,520
Volatile solids, %	56.85	77.08	54.47	56.55
Chemical oxygen demand, mg/L	720	16,860	590	9,160
Total coliforms, log CFU/100 mL	5.42		5.09	
Phosphorus, mg/L	17.77	80.08	18.46	23.15
Ammonia, mg/L	60.25	140.69	70.19	93.93
Nitrate, mg/L	0.44	1.88	0.41	0.45
Nitrite, mg/L	0.02	0.07	0.02	0.03

Characterizing septic tank contents – field study

high pH

1.4 years, use "green" products

high COD
high %VS

1.3 years, well maintained

low COD
low %VS

2.5 years, backup issues

Total solids Ch1 ~ Ch2

3.5 years, functional issues

low pH

0.5 years, fire station with high usage
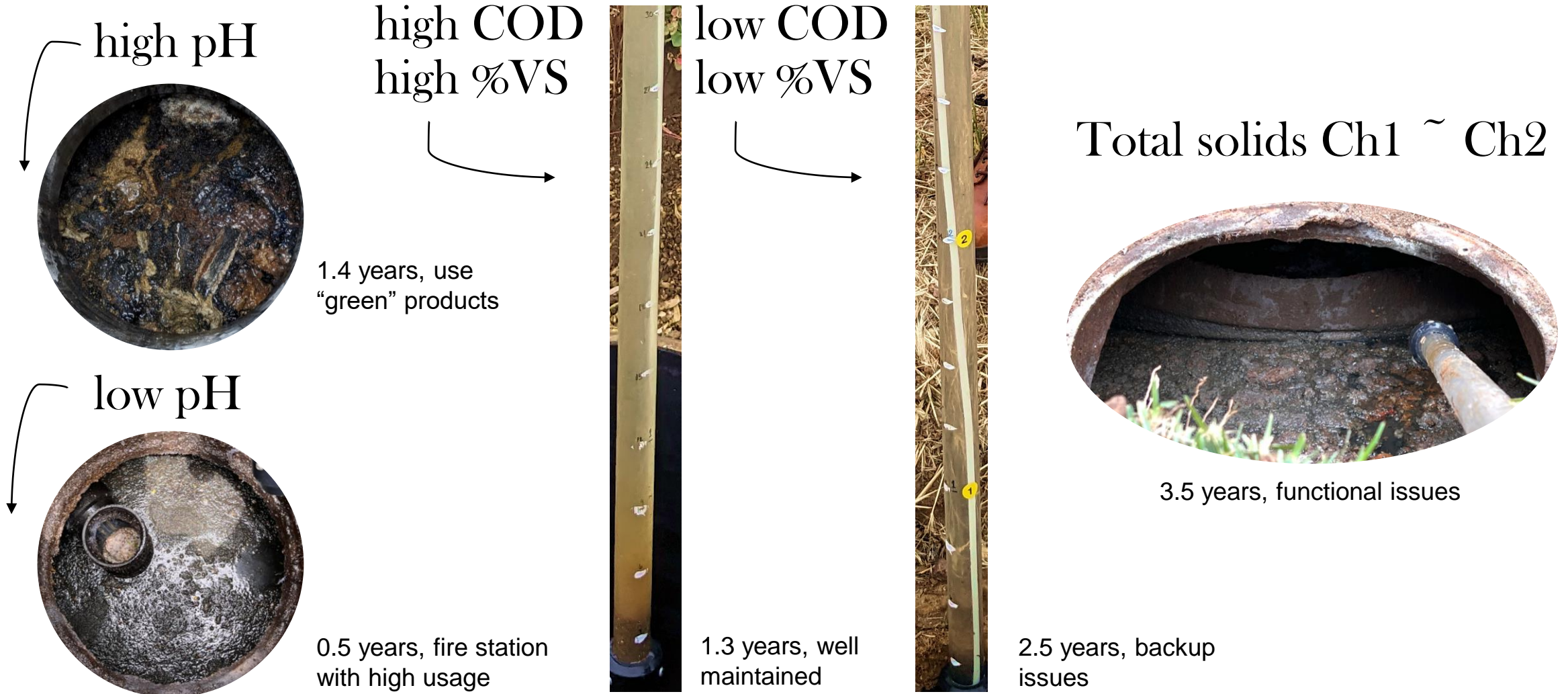
Characterizing septic tank contents

Unknowns:

- How does number of users affect filling rates?

- How does diet influence septic tank contents?

- What types of household products influence internal processes?

Expected outcomes

- pH
  - Increase with mixing, organic degradation
  - Surface and sludge congruence

- Nutrients
  - Consumption = reduction

- Chemical oxygen demand
  - Stabilization = reduction

- Solids
  - Distributed across water column

- Biodegradability test
  - Stabilization = reduction

- Microbial consortia
  - Changes to community
  - Roles of bacteria

- Volatile fatty acids
  - Degradation = increase

- Interviews
  - Unmet needs of users

Questions?

Comments?