# Algae to Enhance Water Recovery for Future Space Habitats

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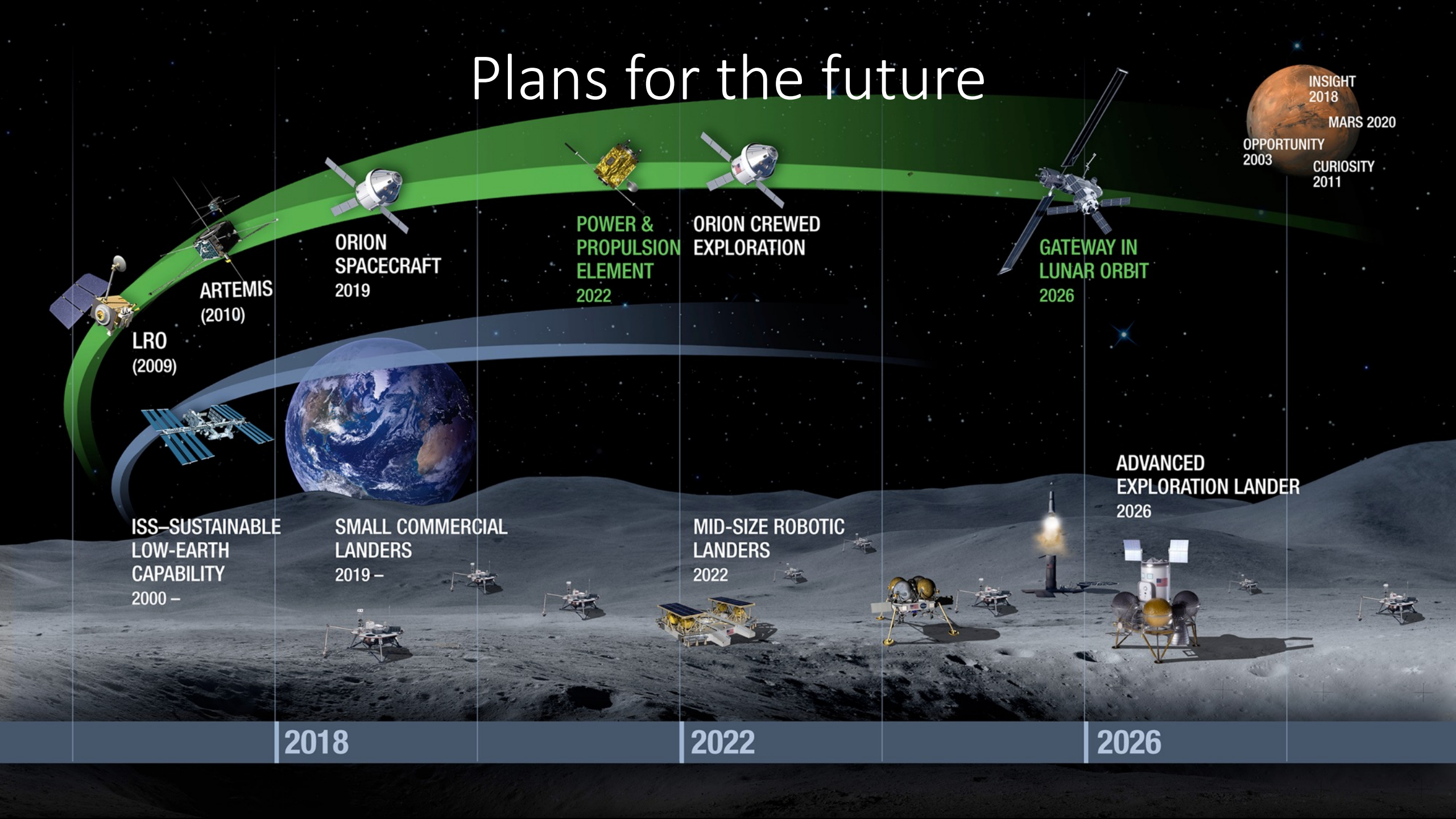
# NASA Kennedy Space Center Post-doc


# Plans for the future

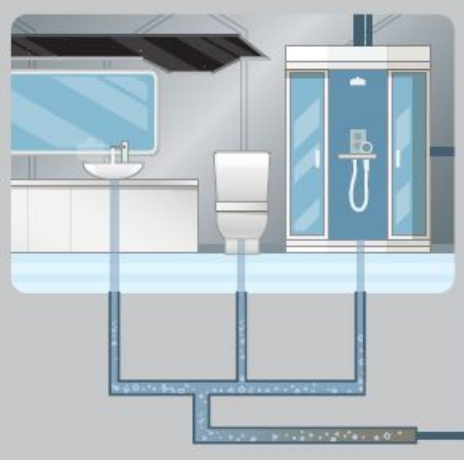


National Aeronautics and Space Administration

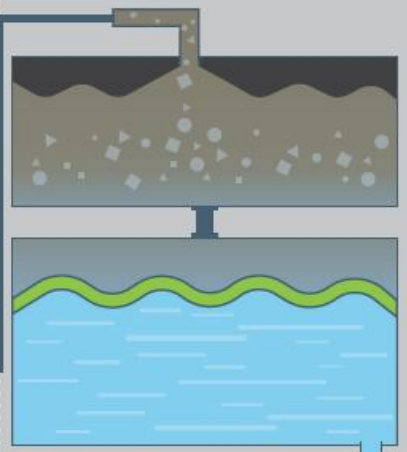
# WATER: SUSTAINING LIFE ON THE MOON

Sustainably exploring the Moon will require a safe habitat for the crew. To stay on the Moon, new technology is needed to simulate Earth's environment that will reliably regenerate water, air, and food. Smart water recycling within the habitat will treat wastewater, provide necessary fertilizers and water for food crops, and create safe drinking water for our explorers. Proving these technologies will then take us to Mars and beyond.

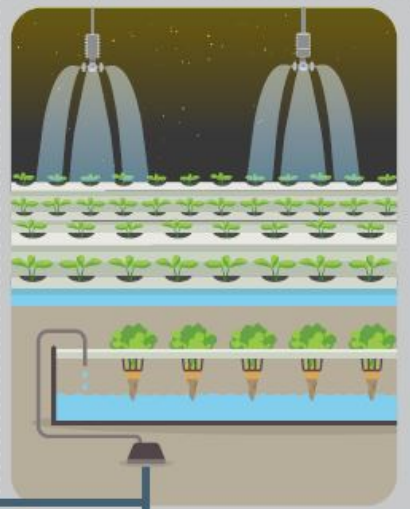
## 1 Waste Water Collection




## 2 Waste Water Treatment




## 3 Water & Fertilizer for Plants




## 4 Clean Water & Food for Humans


www.nasa.gov/centers/kennedy/exploration/researchtech

# High Strength Space Wastewater

## Municipal Wastewater

*No restriction on water usage:*

- Toilets with flush water (1-3gal)
- Long showers
- Laundry
- Dishwashers

| | Municipal | Space |
|---|---|---|
| Nitrogen | 40 ppm | 850 ppm |
| Phosphorus | 10 ppm | 120 ppm |

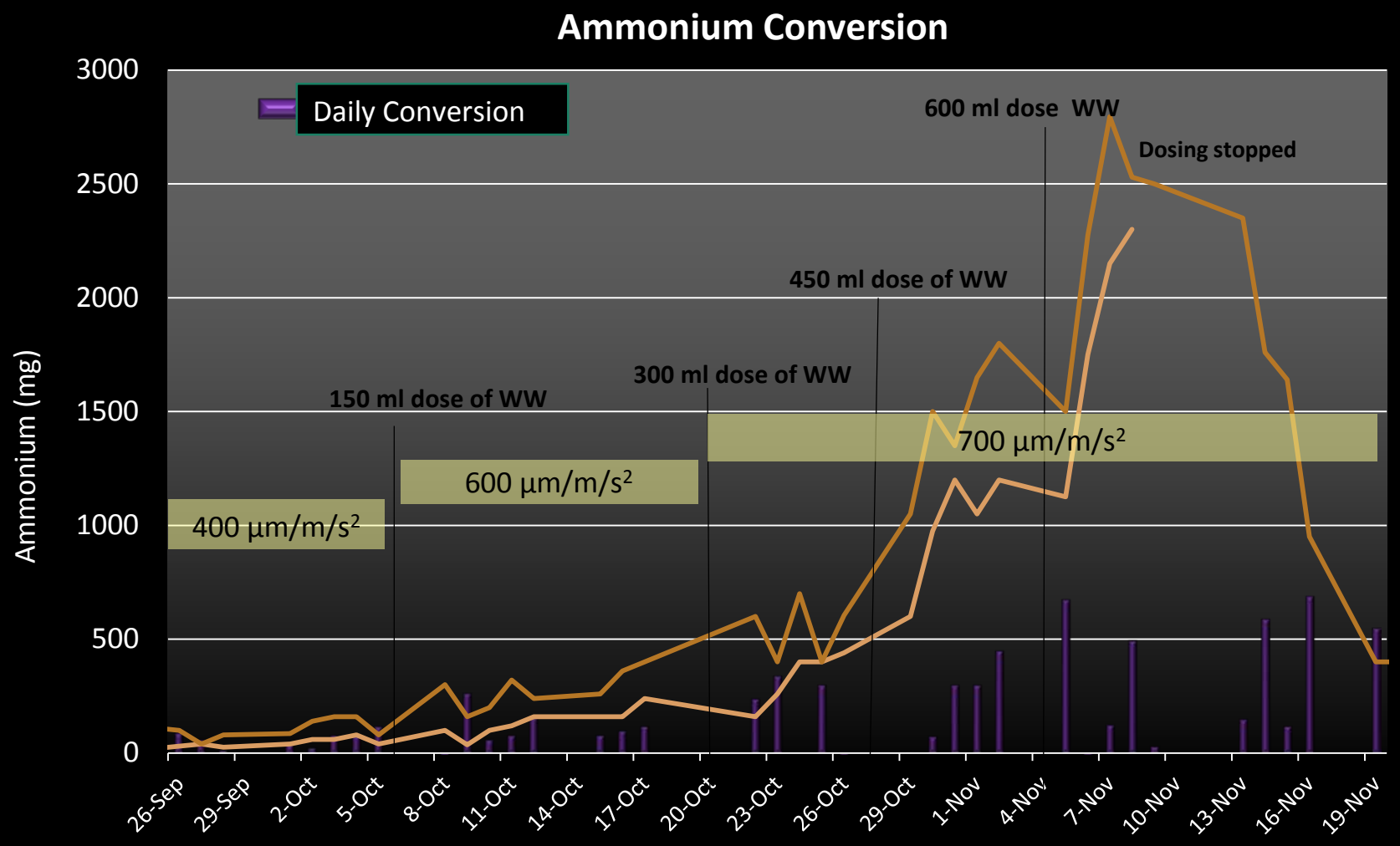
## Space Wastewater

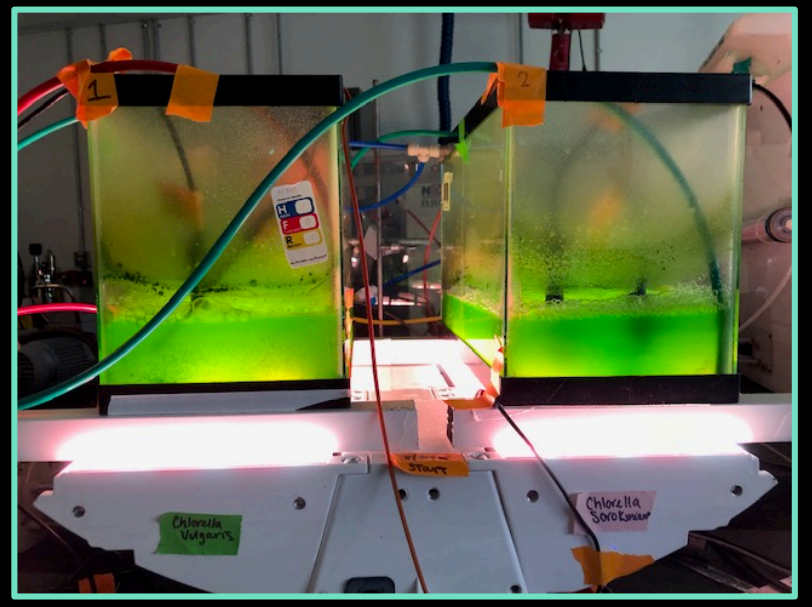
*Major water usage restrictions*:

- Urine + 300mL flush water
- No/limited showers and laundry
- No dishes in general

NASA astronaut Serena Auñón-Chancellor performs plumbing duties inside the ISS toilet, also known as the Waste and Hygiene Compartment, located in the U.S. Tranquility module.

# Preliminary Batch Testing




2 month Batch Study at KSC

Synthetic Space WW:

850 mg/L $NH_4^+$, 50mg/L COD

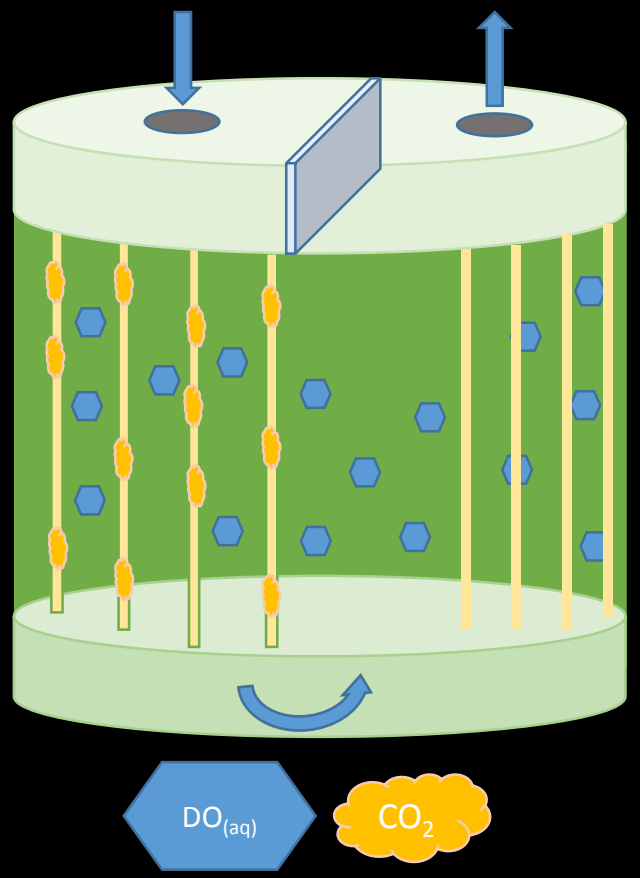
1g/L algal density, 700 umol/$m^2$-s

**30% $NH_4^+$ removal efficiency**

# Flow Dynamics in Zero-G

# Experimental Plan Overview

- Axenic cultures (testing multi-species)
  - Robustness, high ammonium tolerance
- Elevated $CO_2$ (3000 ppm)
  - Simulating ambient habitat concentrations
- Membrane solids separation
  - Smaller footprint, higher liquid throughput
- Continuous flow
  - Minimized stabilization tanks required
- Membrane gas delivery
  - No gas diffusion stones in reduced gravity
- Artificial lighting (testing lighting regime)




Silicone Membrane Tubing for Reduced Gravity Gas Delivery

# Current Status


- Optimize Gas Delivery
- Ramping acclimation to Syn Wastewater

Future Plans

- Incorporate real urine
- Subsystem integration with solid waste bioreactor

# Questions?

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