MicroPoP, MagPi and Misty:

How to eliminate waste activated sludge for dewatering and disposal and recover phosphorus and ammonia

Dr. Rob Stephenson and Erik Rehtlane

EAGLERIDGE INNOVATIONS CORP.

604.817.4351 www.eagleridgeinnovation.com

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Hot buttons

Technical

- Squeeze more capacity out of existing assets
- “Beneficial use of Biosolids” – but less is better

Regulatory

- Meet tightening phosphorus, nitrogen concentrations
- GHG reduction

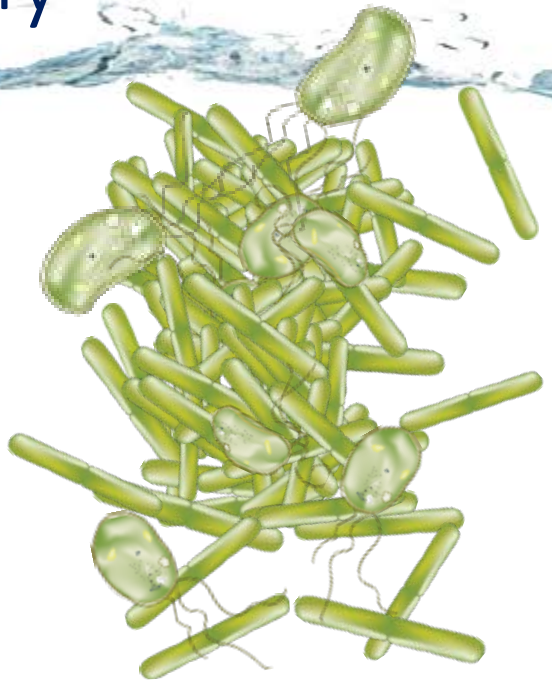
Economic

- Minimize capital expenditures
- Increase efficiencies to do more with less

Waste Activated Sludge

- Digests slowly and incompletely
- Dewaters poorly
  - High polymer demand for thickening and dewatering
  - Lowers solids content of dewatered sludge
    - Increases fuel requirement for incineration
    - Increases volume of sludge for disposal
- Contains nitrogen and phosphorus

Why WAS digests poorly



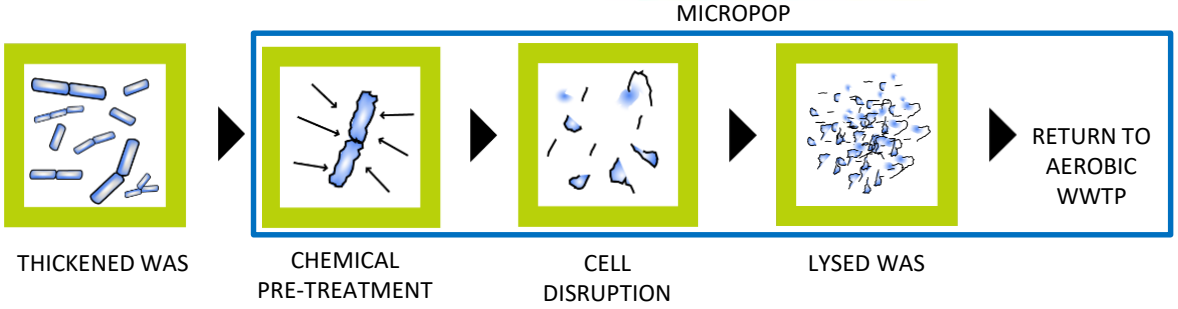
Bacteria eat liquids, not solids

- Extremely tough cell membranes limit microbiological breakdown aerobically or anaerobically

Destroy cell membranes

- Release cytoplasm as “fast food”

MicroPoP



1. Rupture microbial cell membranes in WAS
2. Return lysed cells to:
   a) Anaerobic digesters (optional), and/or
   b) Aerobic activated sludge treatment for co-digestion with wastewater

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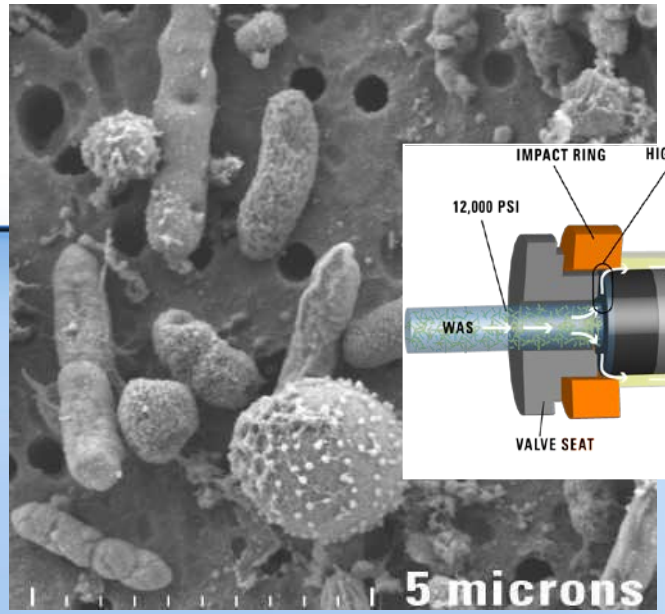
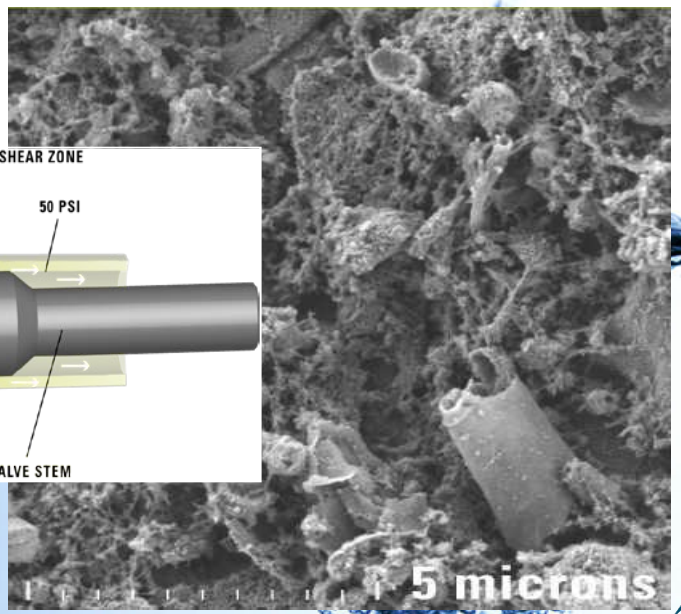
MicroPoP breaks cells

BEFORE MICROPOP



AFTER MICROPOP



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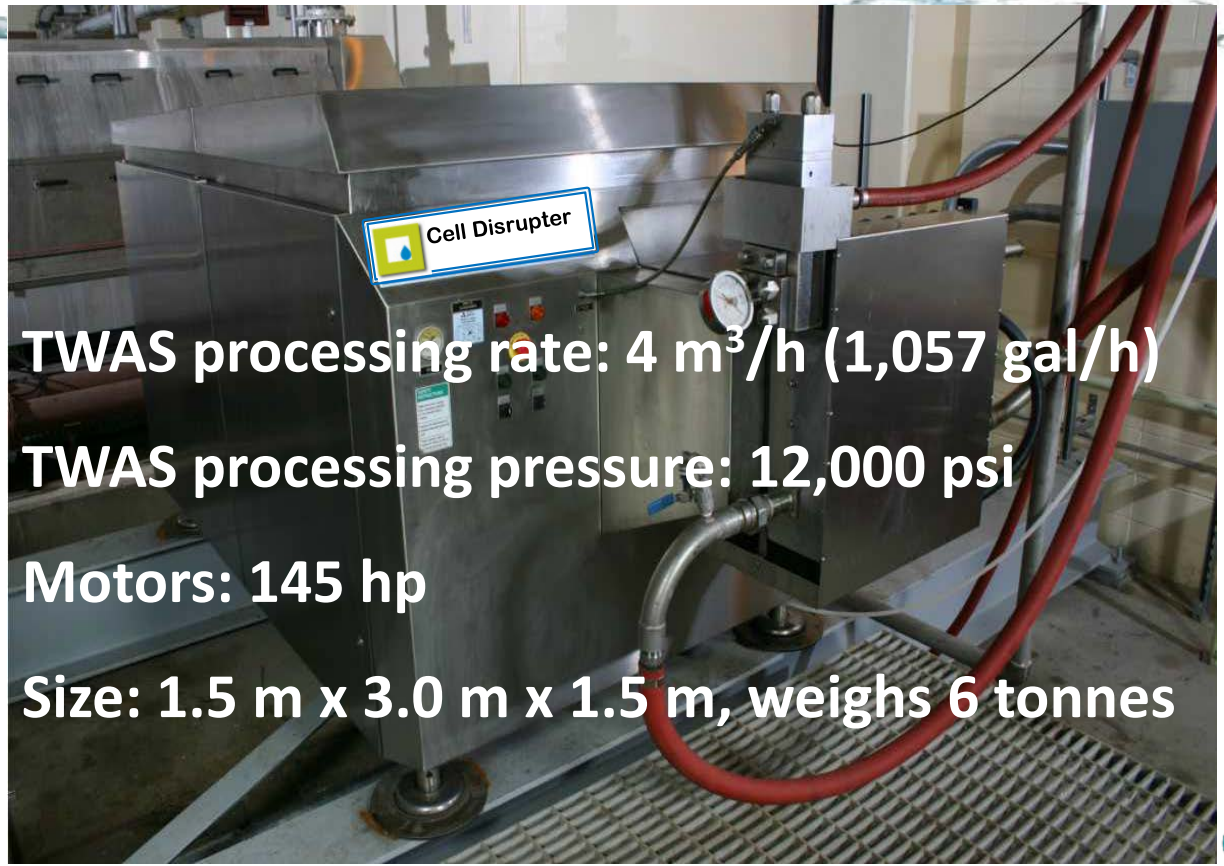
MicroPoP cell disrupter



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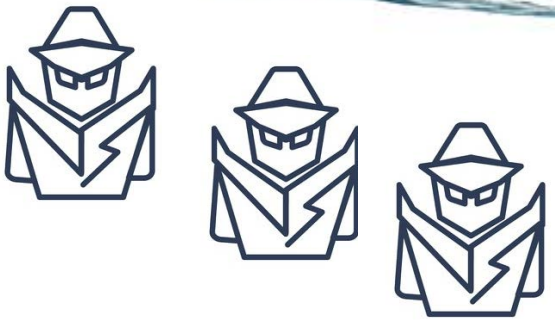
Why MicroPoP works



Three agents of WAS destruction:

1. Cell lysis
2. Anaerobic digester and/or
3. Aerobic digestion in effluent treatment plant

Liquefy enough WAS so:

Mass of WAS produced = Mass of WAS destroyed

Results:

≈ Eliminate WAS for dewatering and disposal

* But increased phosphorus and nitrogen

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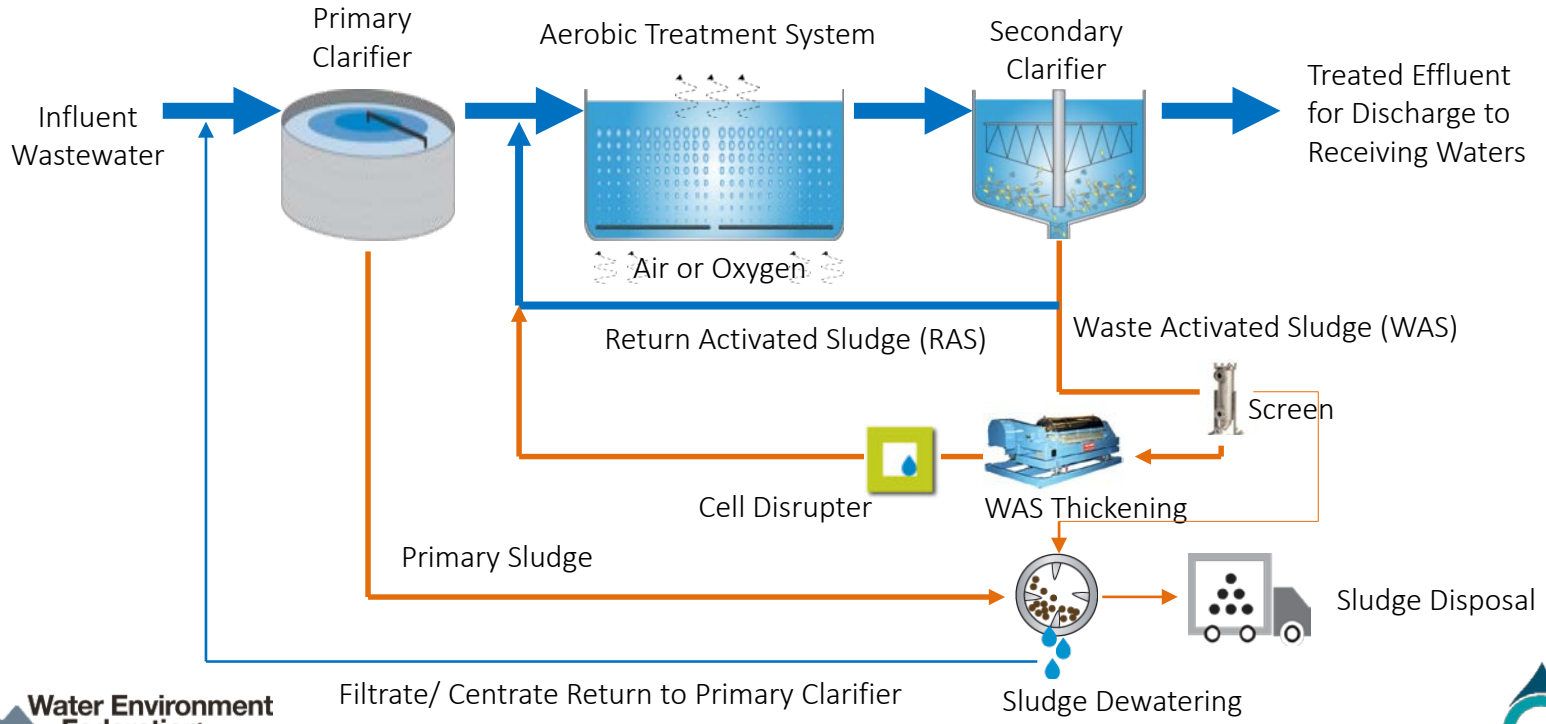
MicroPoP WWTP: No Digester



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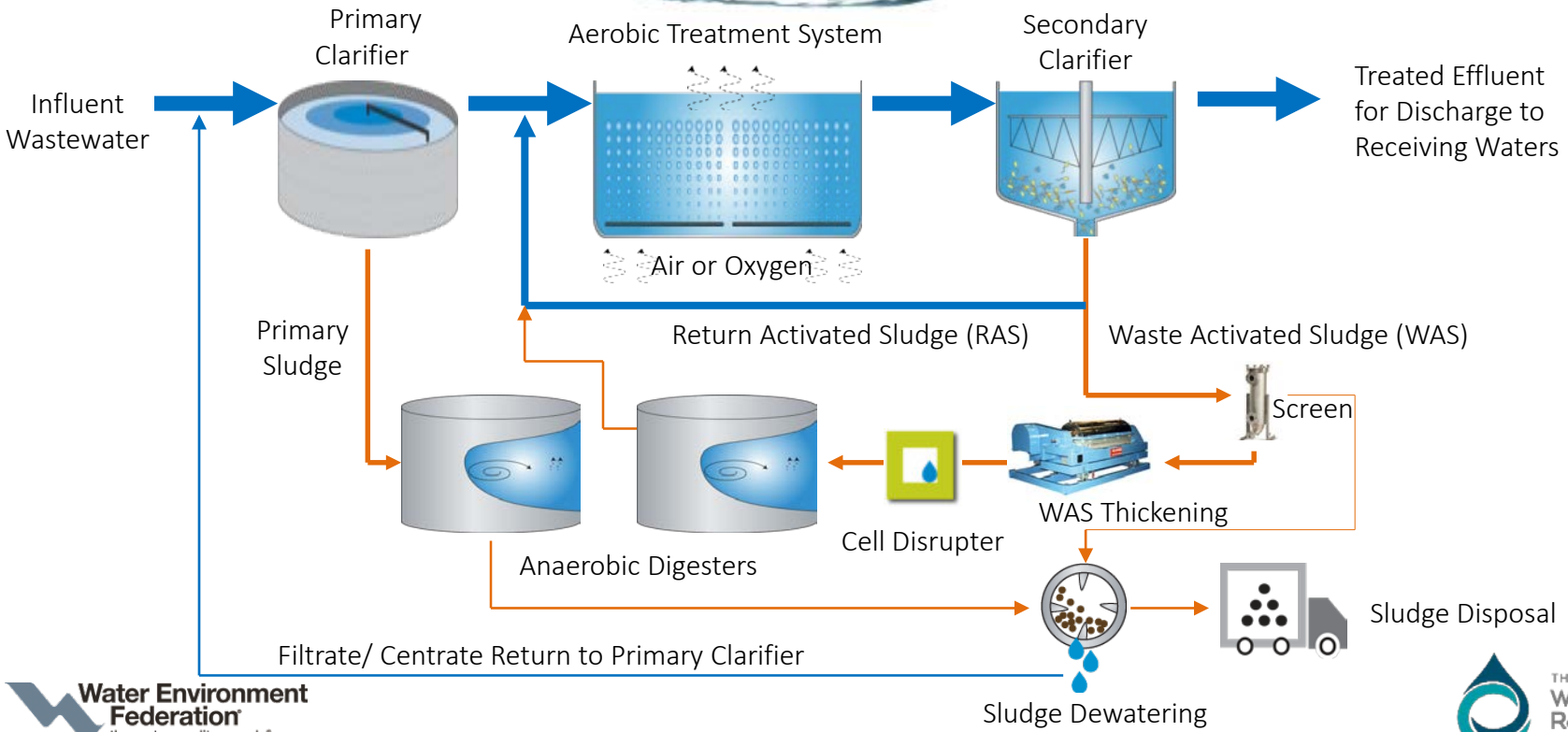
MicroPoP + Anaerobic Digestion



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Why MicroPoP?

- Cell lysis is key to WAS digestion, anaerobically and/or aerobically
- High pressure cell disruption is the most energy efficient, effective, and lowest cost cell lysis technology

MicroPoP

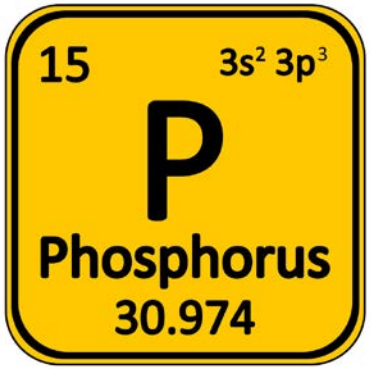
- Increases anaerobic digester performance
- Exploits un-used capacity of WWTP's activated sludge system to co-digest lysed WAS with in-coming wastewater

Enables elimination of WAS with/ without anaerobic digestion

Cell lysis releases nutrients

Cytoplasm “fast food” contains phosphorus and nitrogen

- Impacts nutrient levels in treated effluent



Nutrient Management Goals:

1. Remove P, N nutrients
2. Recover nutrients for reuse, not waste for disposal
3. Minimize cost

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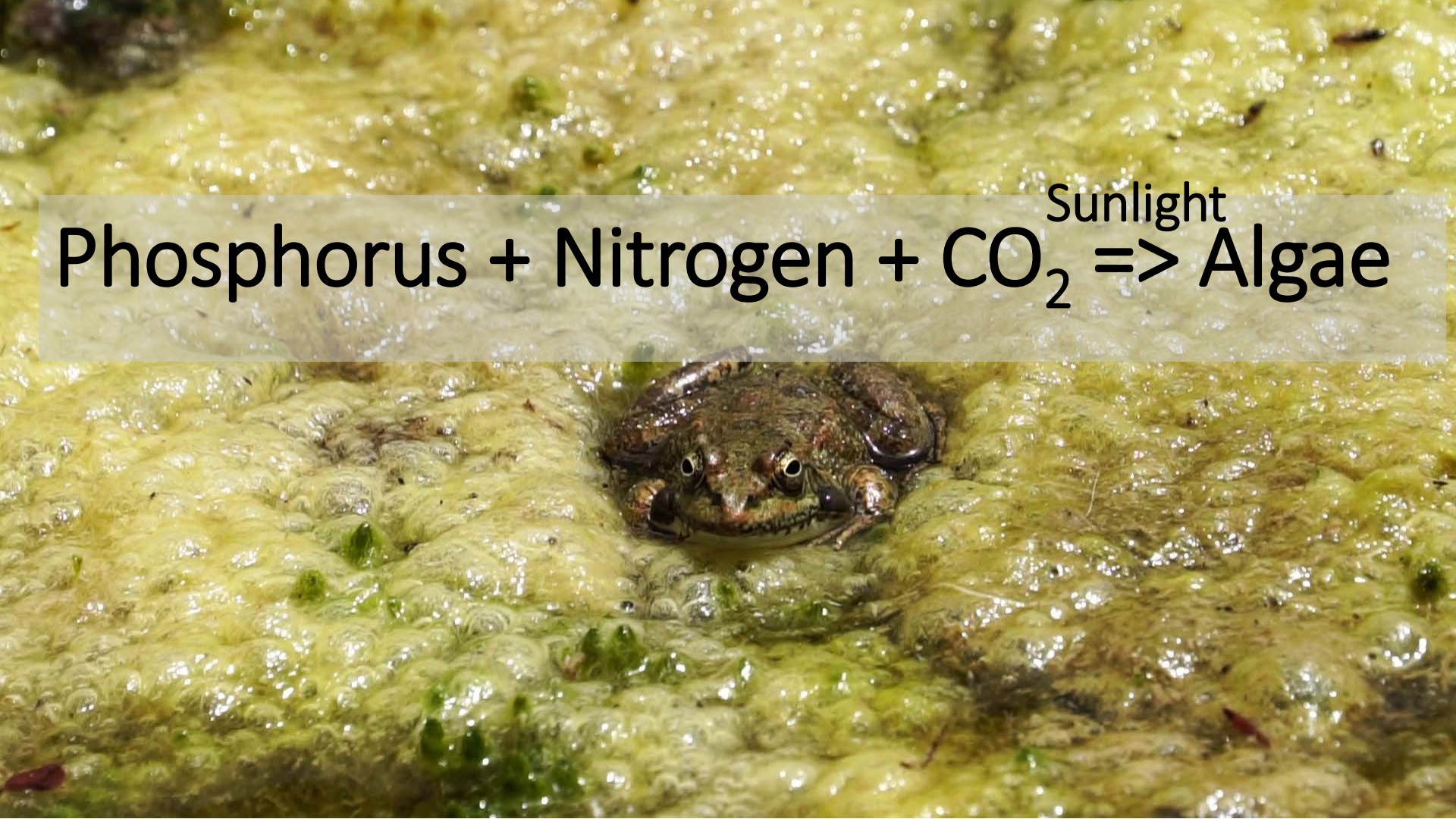
Phosphorus + Nitrogen + CO_2 $\xrightarrow{\text{Sunlight}}$ Algae

MagPi: Magnesium Phosphorus Innovation

$$Mg_{(aq)} + NH_4^+{}_{(aq)} + PO_{4(aq)} \Rightarrow MgNH_4PO_{4(s)}$$

Checklist

- ✓ Mechanically simple
- ✓ Useful fertilizer
- ✓ Low capital cost
- ✓ Small footprint

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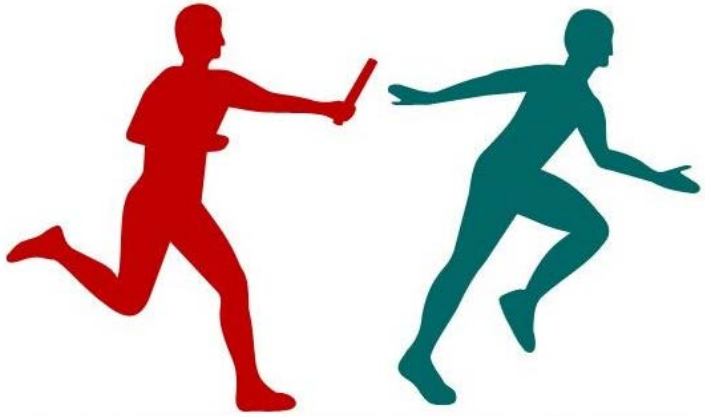
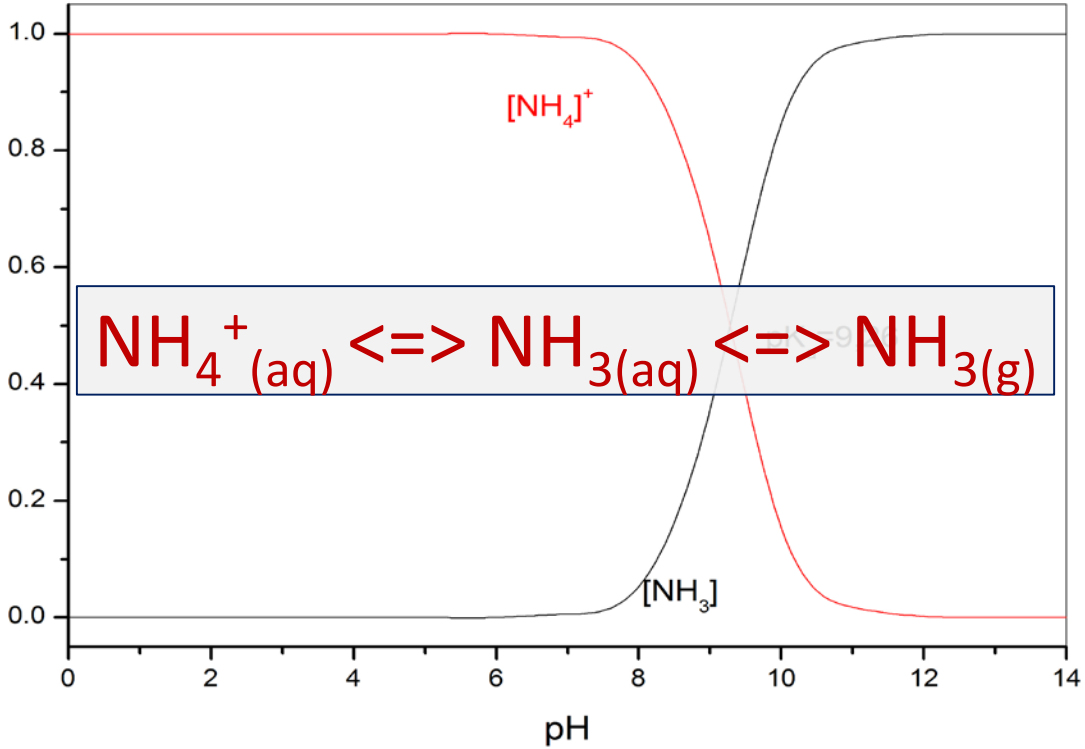
MagPi and Misty teamwork



MagPi

- Forms OH^- to raise pH
- Enables NH_3 stripping by Misty
- No added chemical cost



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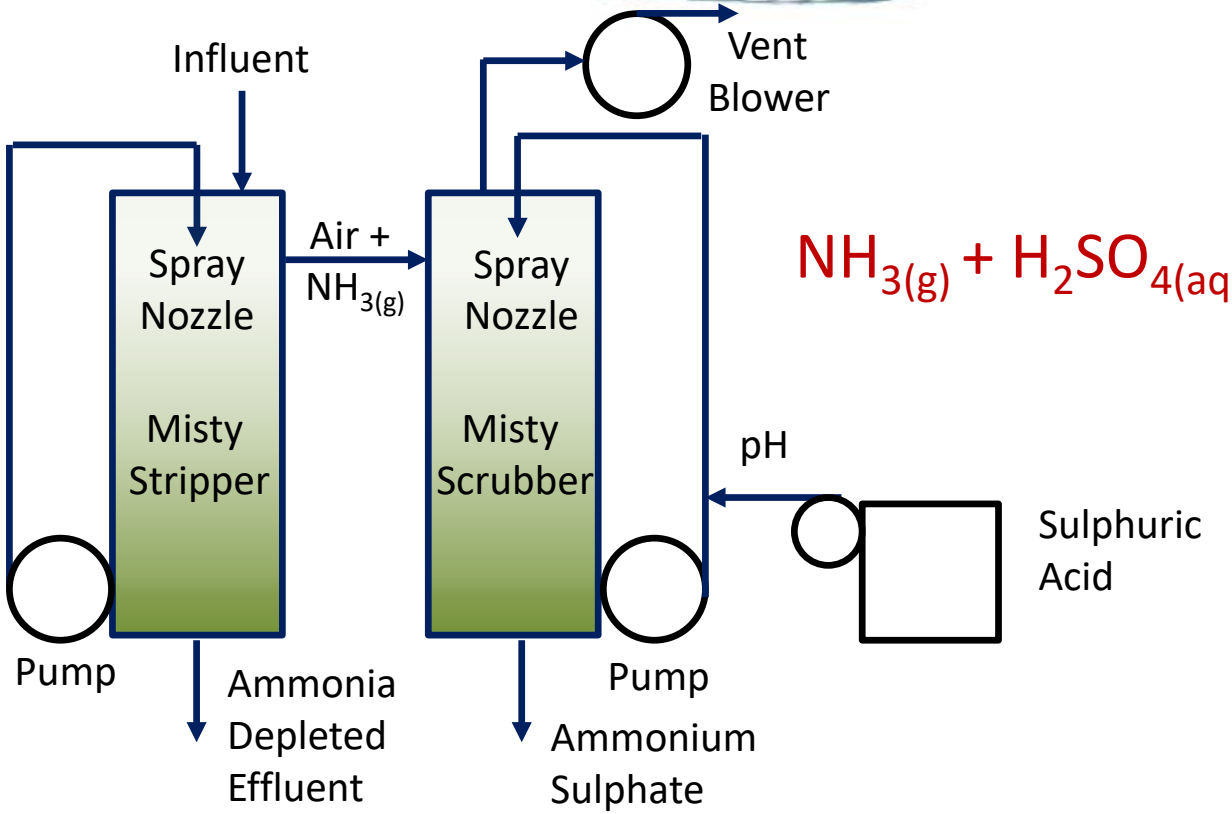
Misty: Ammonia stripping and scrubbing



$$NH_{3(g)} + H_2SO_{4(aq)} => (NH_4)_2SO_{4(aq)}$$

Misty: Ammonia stripping and scrubbing

Maximize gas: liquid ratio
=> stripping, scrubbing

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MicroPoP in 4 Steps

1. Remove and dewater non-degradable debris:

Dewatering relatively large particles is easy

2. Cell disruption liquefies WAS:

Quickly and almost completely biologically degradable

3. MicroPoP returns treated WAS to WWTP:

Complete destruction of WAS aerobically/anaerobically

4. MagPi + Misty:

Recovery of phosphorus and ammonia

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Financial impacts

Less sludge for disposal

- Cost savings for polymer, sludge storage, sludge hauling, sludge disposal

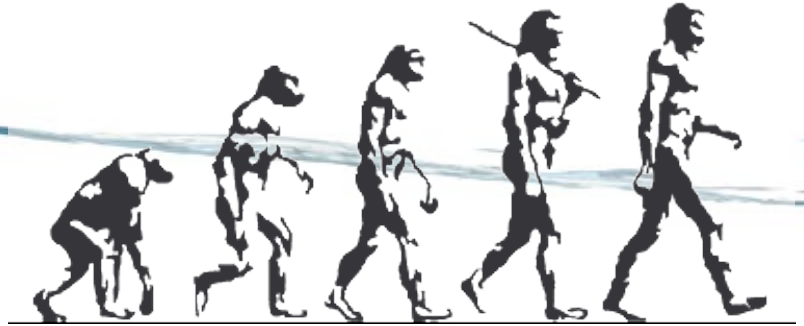
Anaerobic digester capacity

- Anaerobic digesters not essential for WAS destruction – avoided capital costs
- Increased throughput (thicker, faster) avoids costs to build more digesters
- Revenues or cost avoidance with increased biogas generation

Environmental

- GHG credits for RNG, reduced GHG emissions
- Low cost nutrient removal via MagPi and Misty

Technology Evolution



Scale	MicroSludge	MicroPoP	MagPi	Misty

Year	'99	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19	'20	'21
Bench	▶																▶	▶		▶	▶		
Pilot		▶	▶	▶	▶							▶	▶	▶	▶	▶			▶	▶	▶	▶	▶
																					▶	▶	
Full						▶	▶	▶	▶	▶	▶												

34,000 h (3.9 years)
of full scale operations

Landfill leachate ▶
Mine water ▶

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MicroPoP next steps

Dr. Bruce Rittman
ASU

Melissa Meeker
WaterTower

Dr. Glenn Daigger
MSU

Technology validation

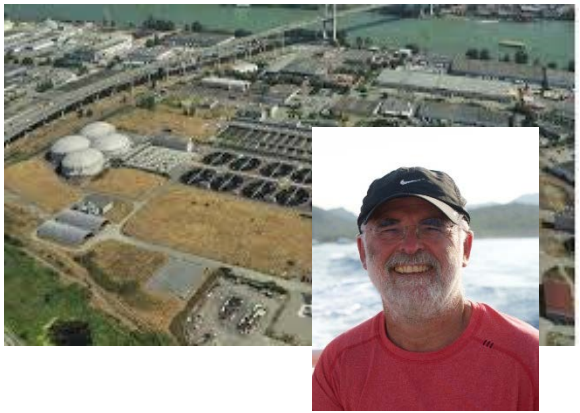
- MicroPoP, MagPi, and Misty at municipal WWTP

Types of partners

- Customer/host site
- Funding, Commercialization partner

In-kind support

- Demonstration site to install MicroPoP at full scale
- Leading experts: guide test plan, evaluate performance



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Muddy River Technologies

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