

# ***Algal-Sludge Granules as a Novel Technique for Wastewater Treatment***

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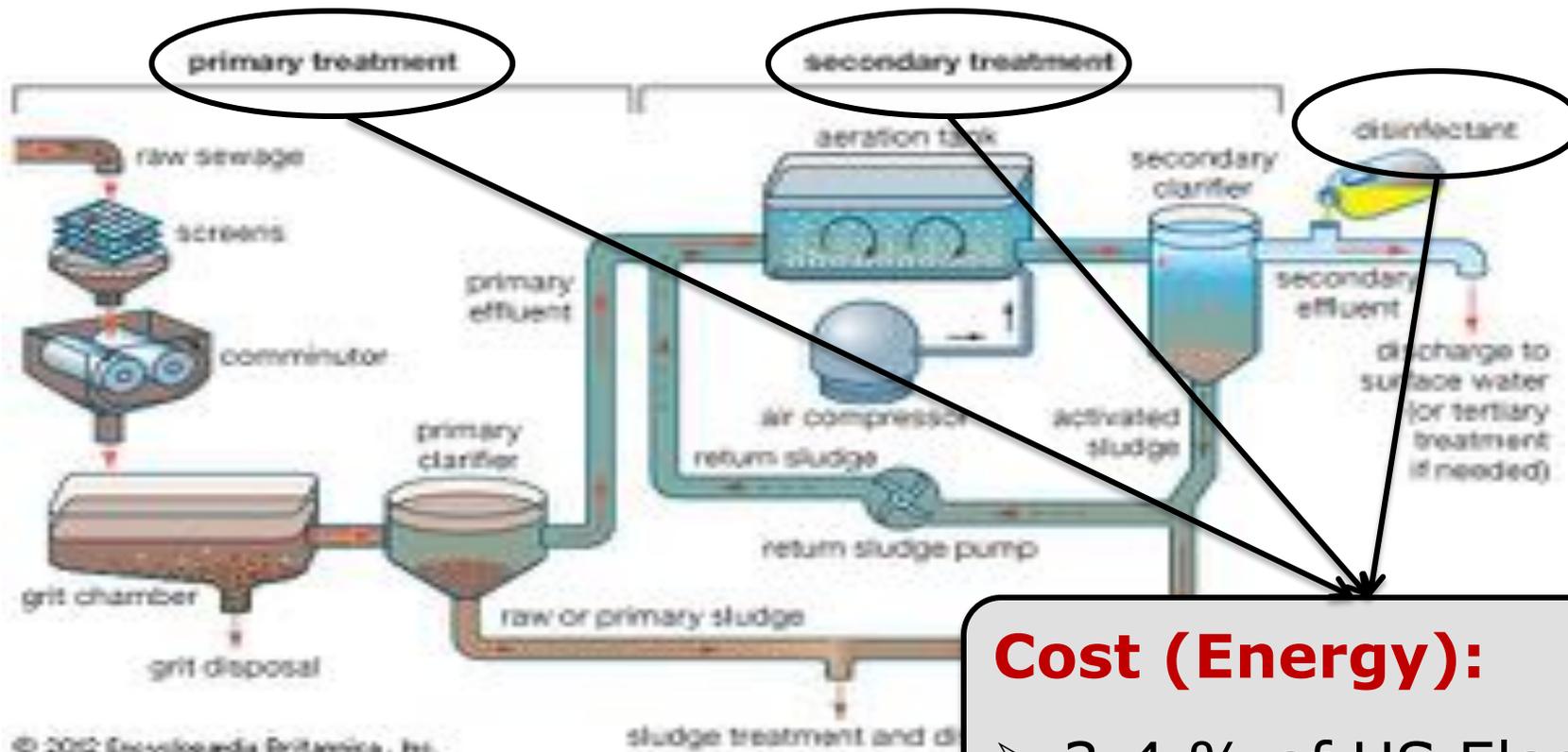
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<sup>2</sup> *Marine Pollution Lab., NIOF, Egypt*

*The Northeast Residuals And Biosolids Symposium,  
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## Background

- Conventional Wastewater Treatment Process

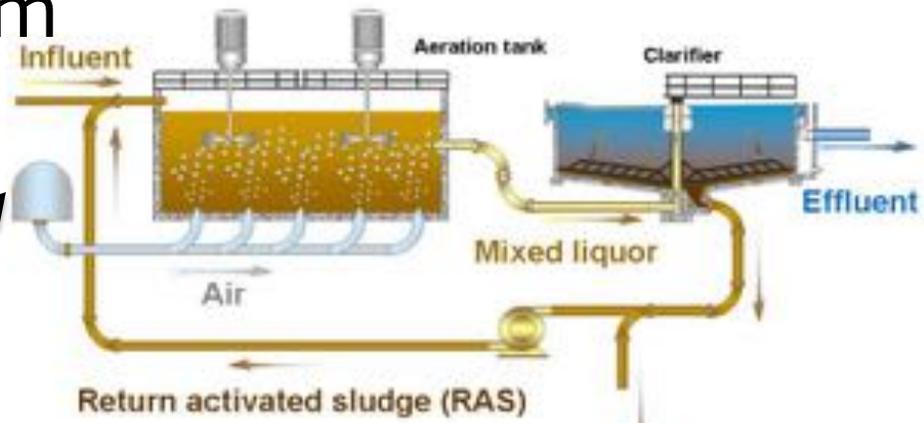
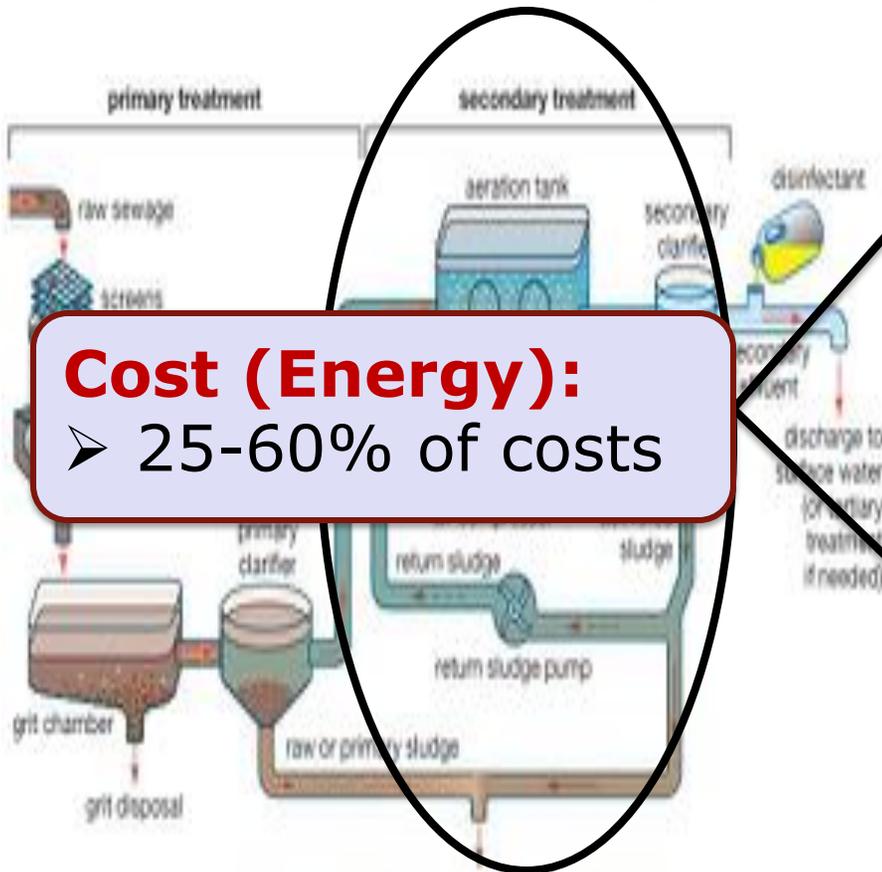


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<https://www.britannica.com/technology/wastewater-treatment/images-videos>

# Secondary Treatment

- Activated Sludge System



<http://www.evisa.co.za/misc/wastewater/defaultas1.htm>



**Cost (Energy):**  
➤ 25-60% of costs

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## Wastewater as a Significant Energy Source

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➤ **Chemical energy in wastewater**

- *Based on COD;  $1 \text{ m}^3 = 6-8 \text{ MJ}$*

➤ **Energy used for treatment**

- *$1 \text{ m}^3 = 0.6 \text{ kW h} = 2.16 \text{ MJ}$*

**Wastewater holds about 2-5 times the energy used to treat it.**

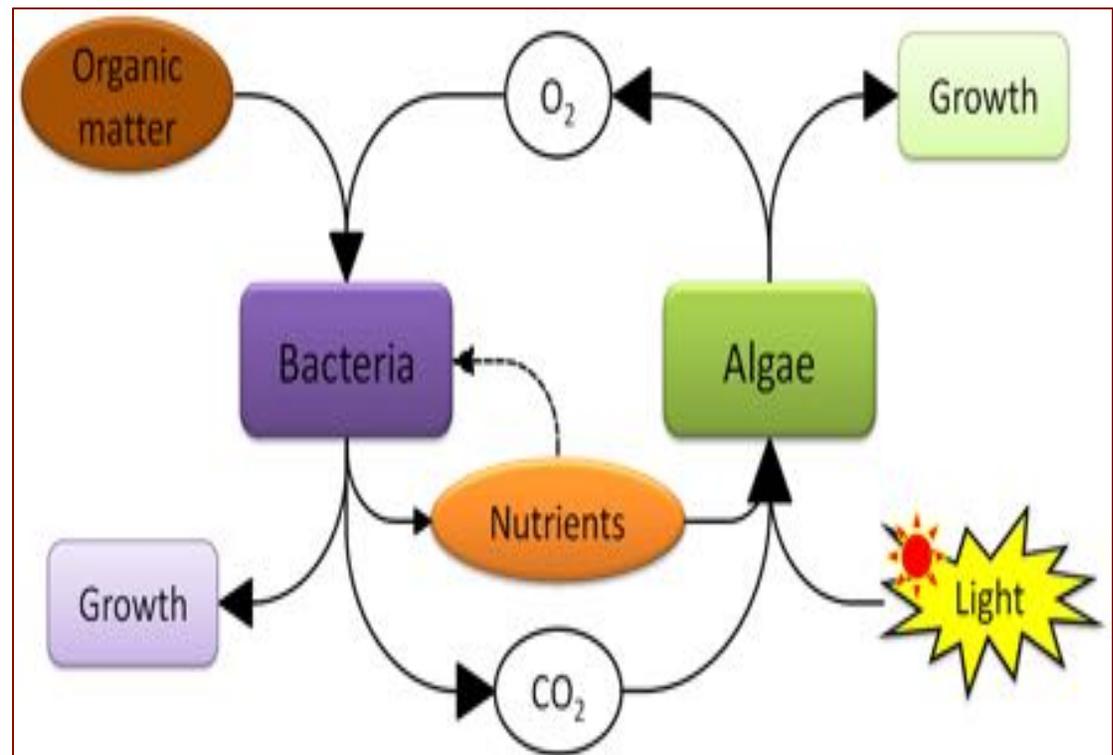
- ***The Question: How to Recover This Energy?***

## Alternative Technologies

- Algal-based Wastewater Treatment Technologies

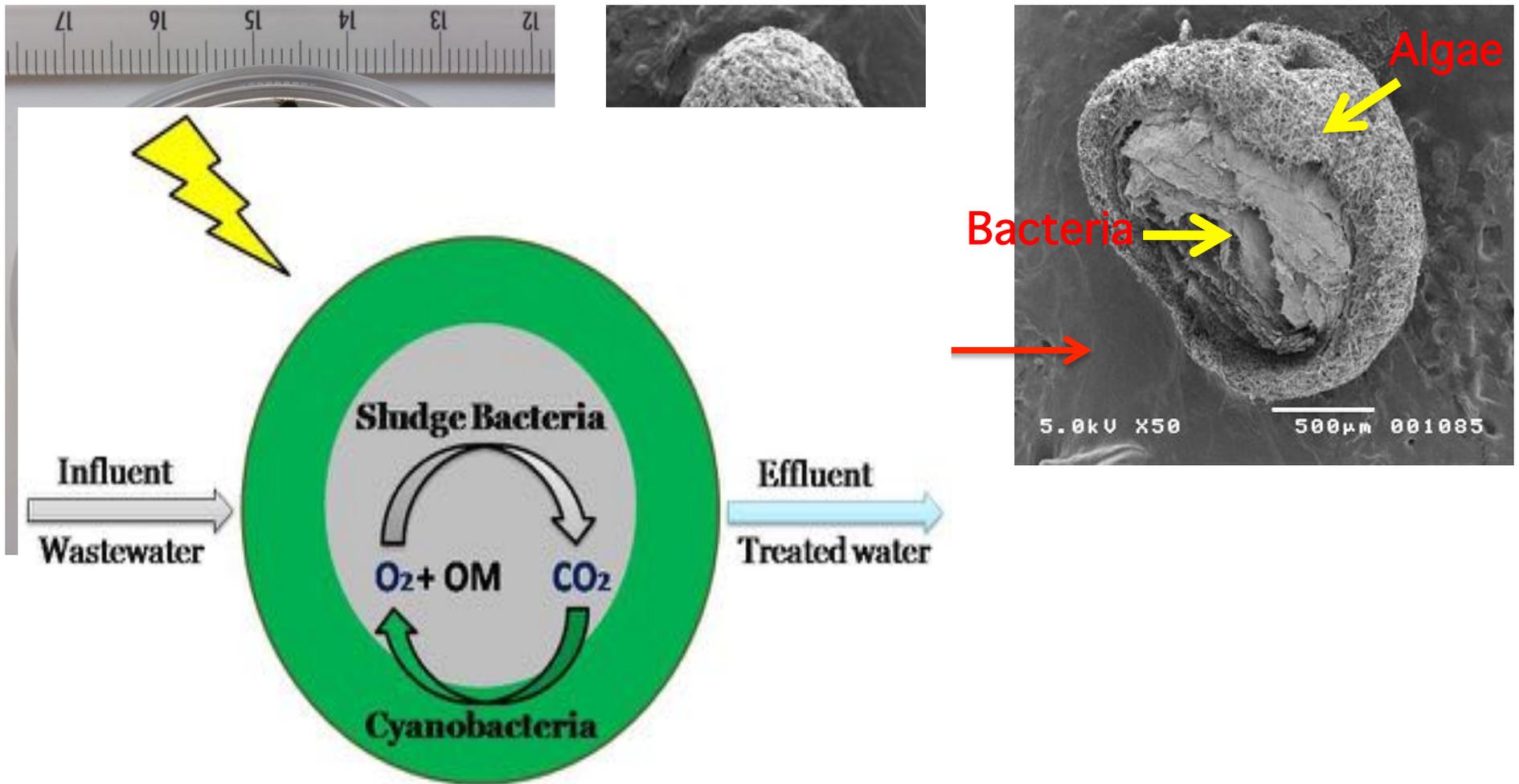


➤ Most wastewater treatment lagoons in the U.S. do not harvest algae biomass.

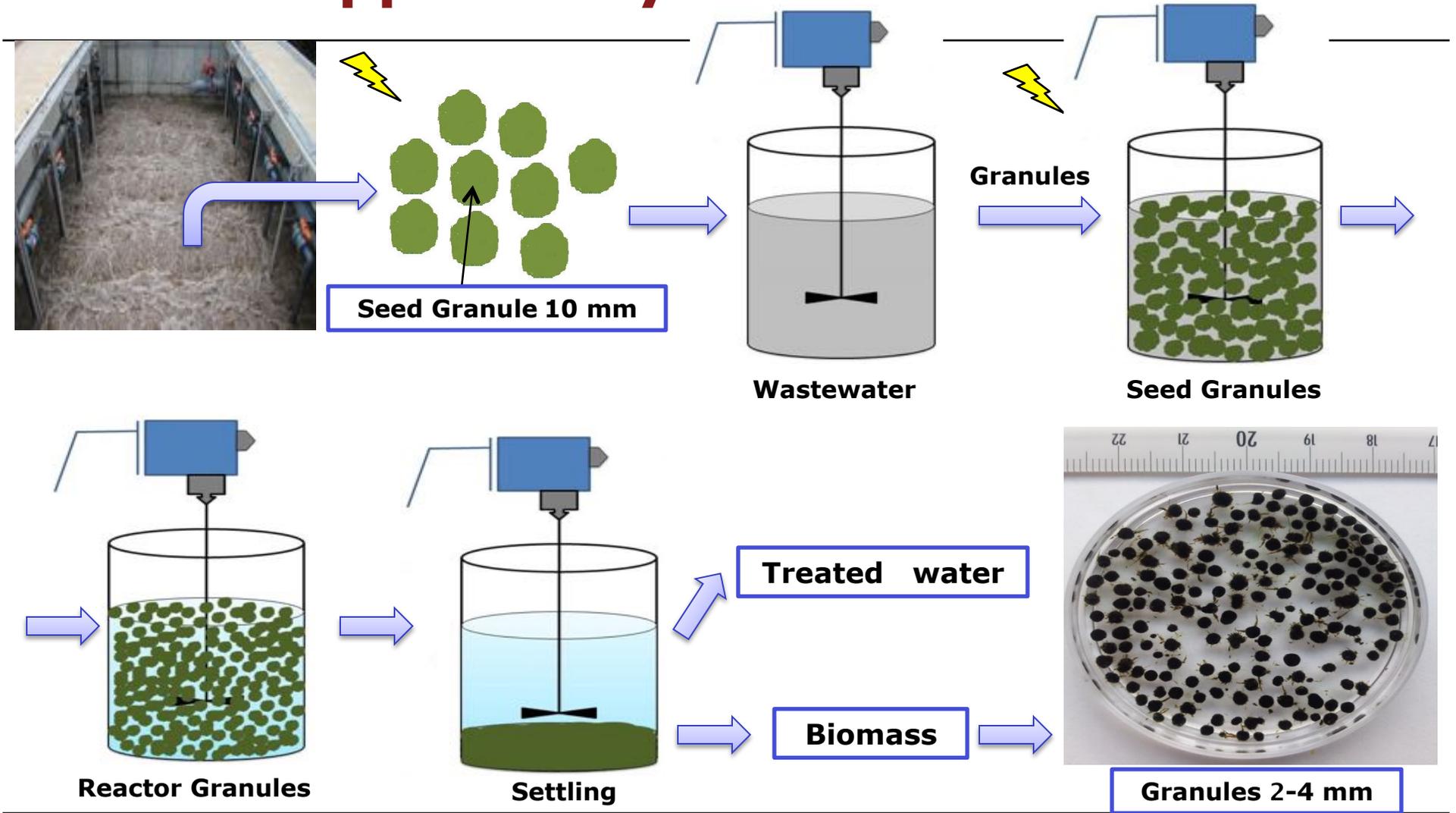


[http://algaebiogas.eu/algal\\_bacterial\\_wwt](http://algaebiogas.eu/algal_bacterial_wwt)

# The Novel Technology: Algae-Sludge Granules



# How the opportunity was identified?



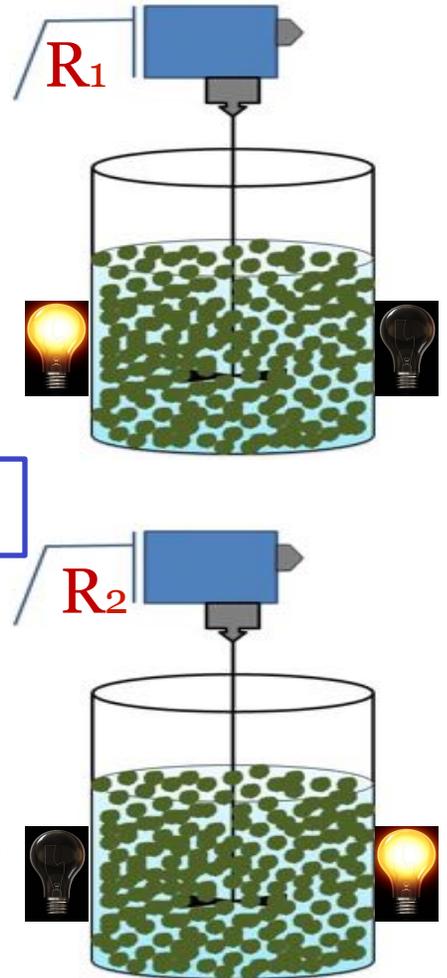
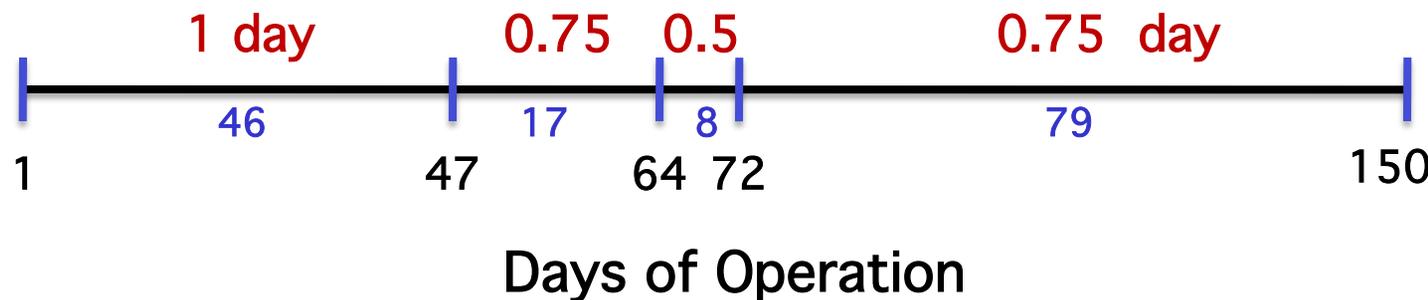
# Application: Sequenced Batch Reactors

- ❑ 2 SBRs (1.5 L each) by 4- 6 hrs cycles/day.
- ❑ The WW is the primary effluent of AWWTP.
- ❑ 150 days of operation.
- ❑ 2 Light sequences were studied;

**R<sub>1</sub>**: 3.5 hr l- 2.5 h d

**R<sub>2</sub>**: 2.5 hr d- 3.5 h l

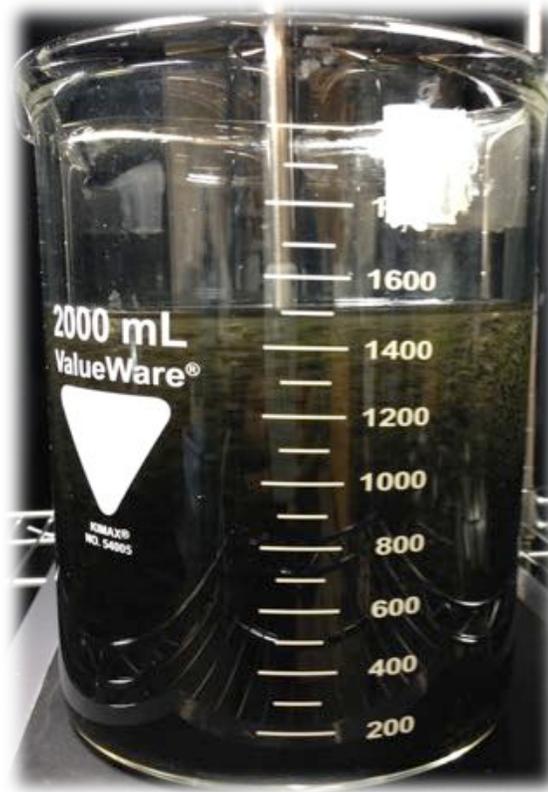
❑ **HRT:**



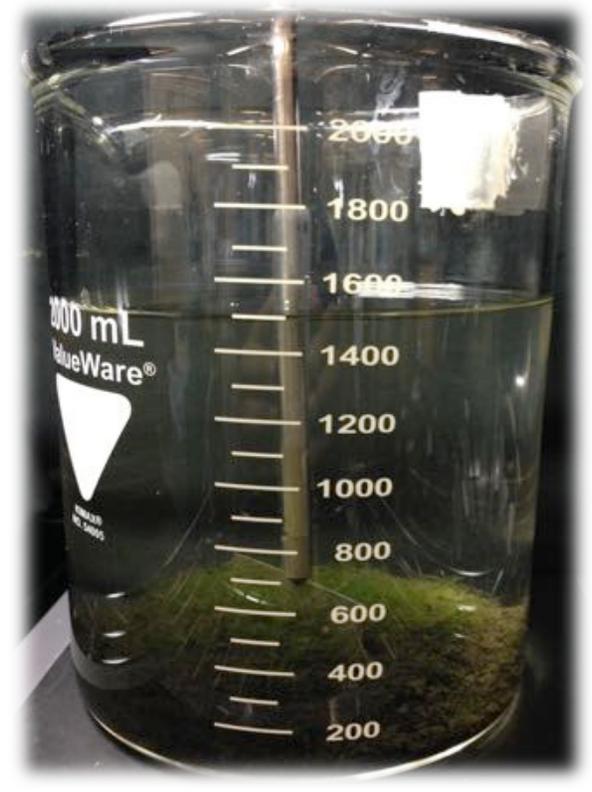
# Potential Impact of Treatment Process



**Influent WW**



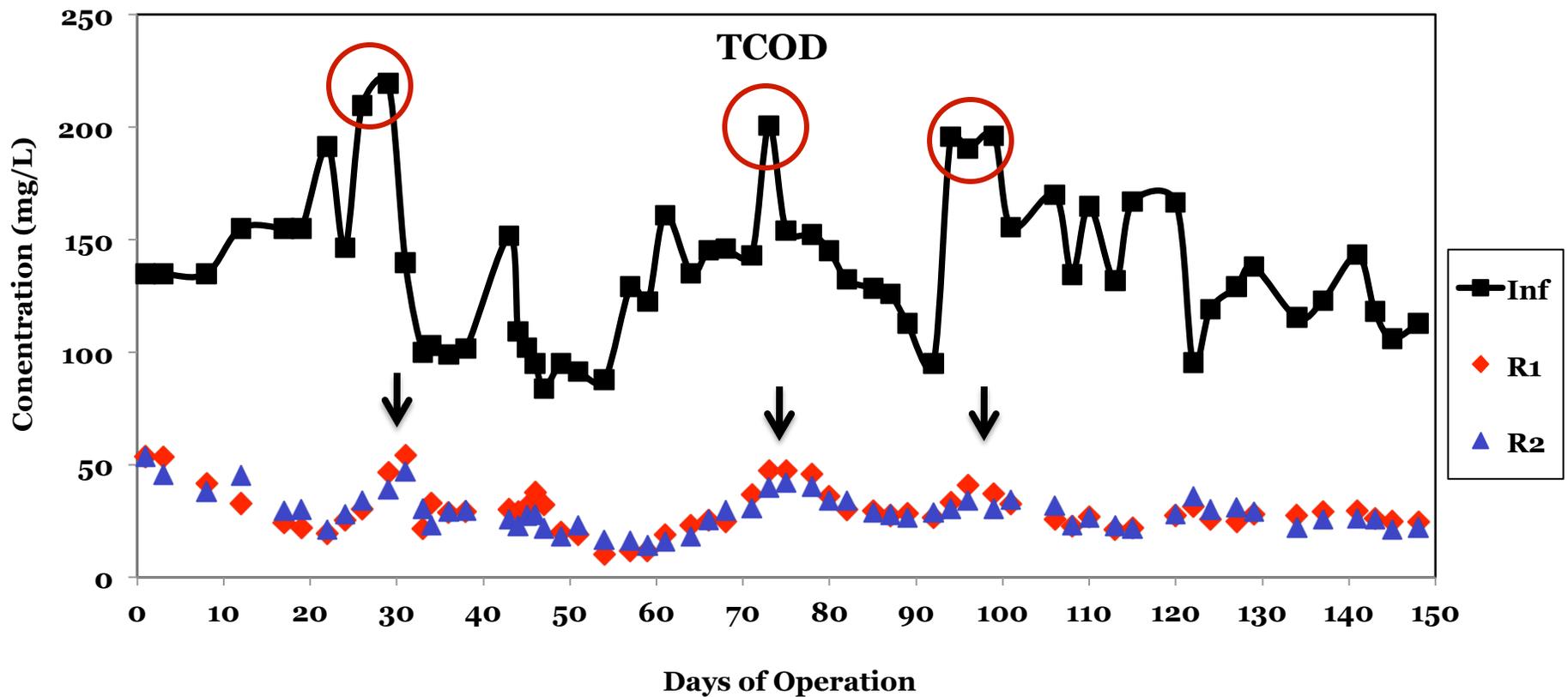
**Cycling and Mixing**



**After 15 min Settling**

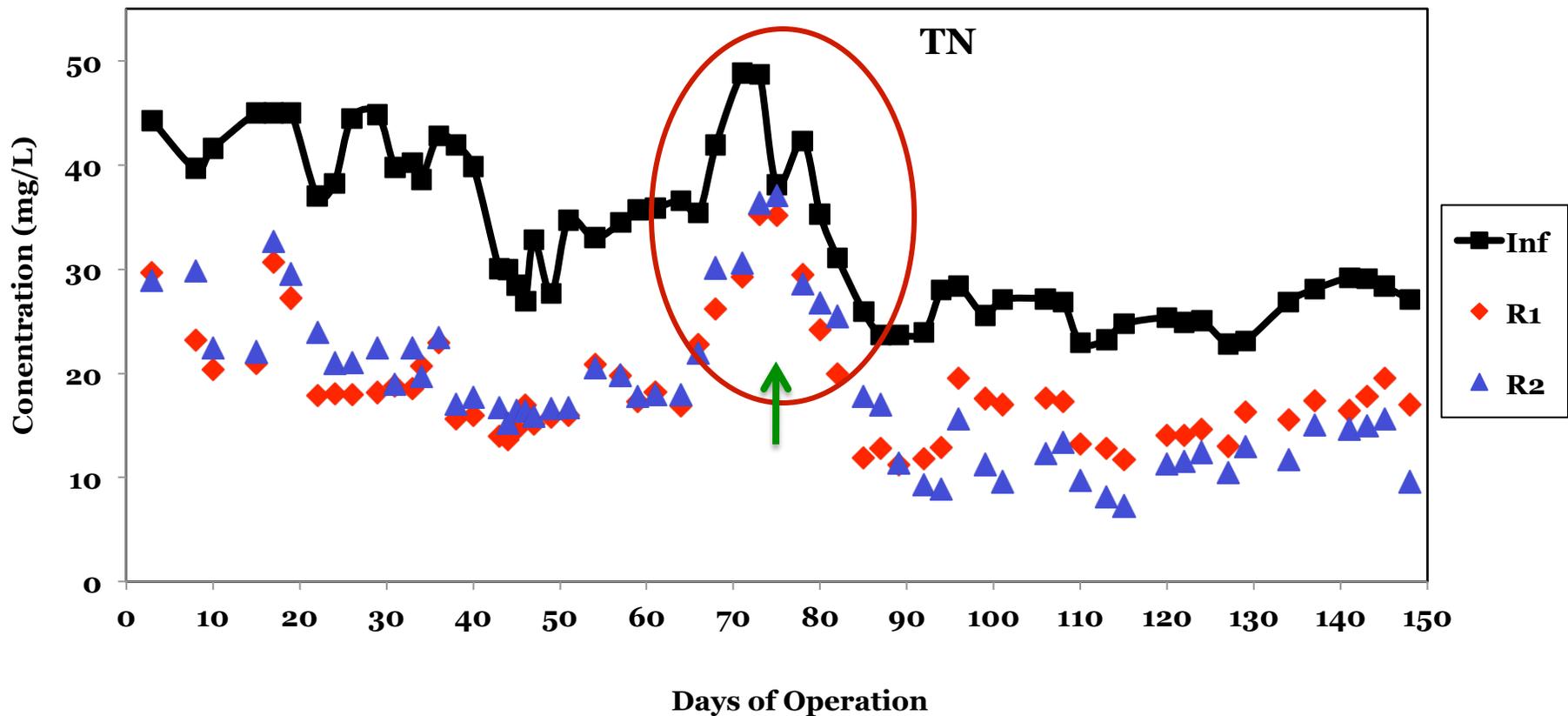
# Effluent Quality

## ■ COD Removal



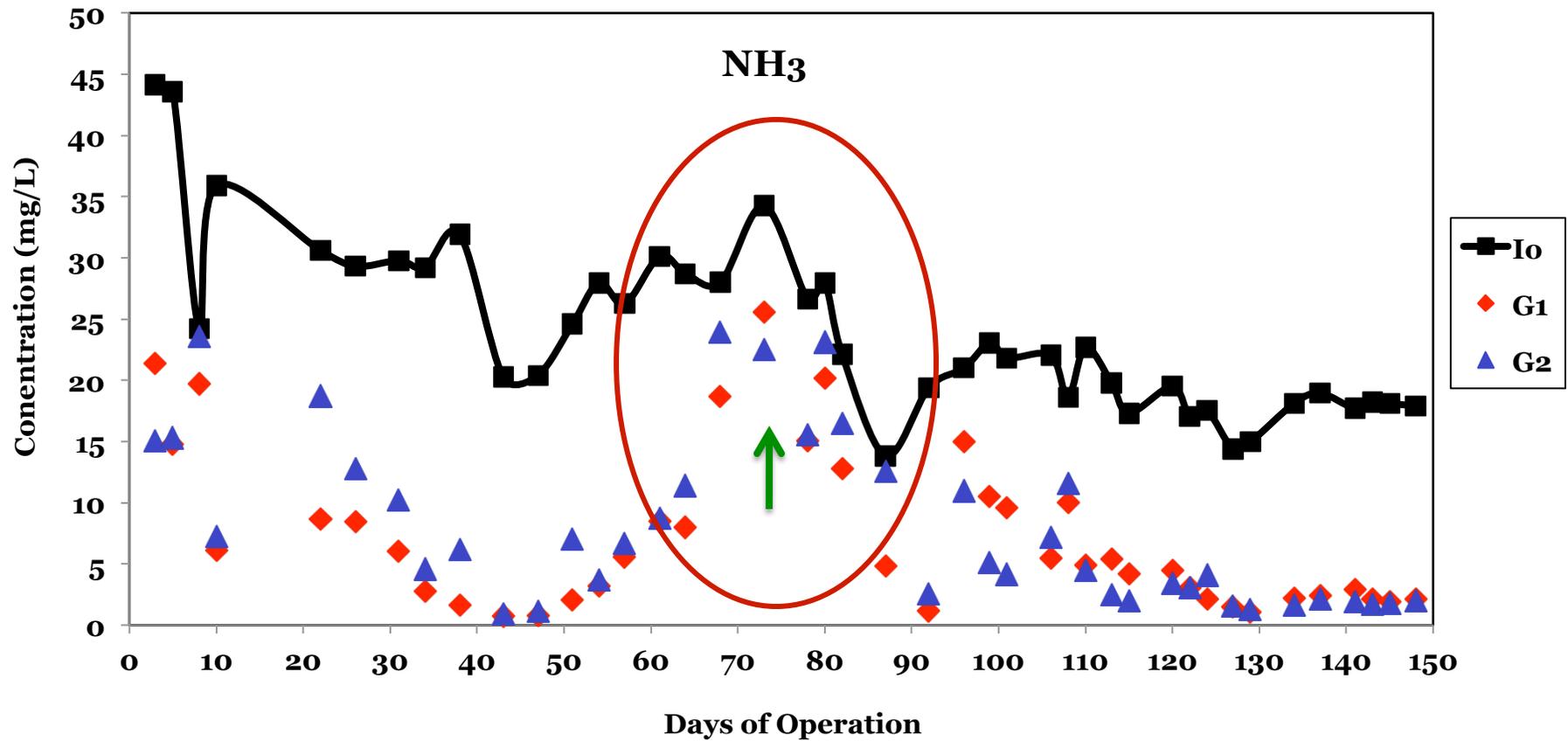
# Effluent Quality

- **Total Nitrogen (TN)**



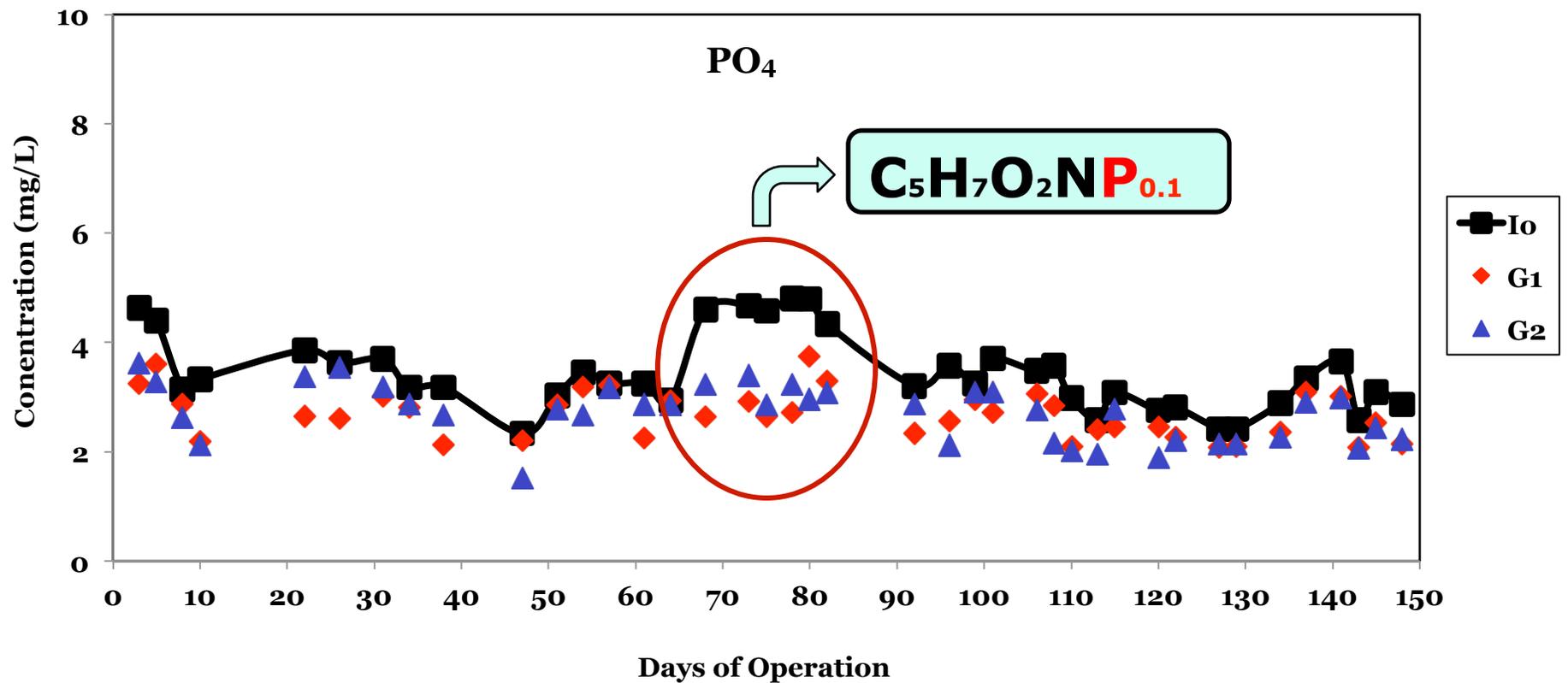
# Effluent Quality

## Ammonia (NH<sub>3</sub>)



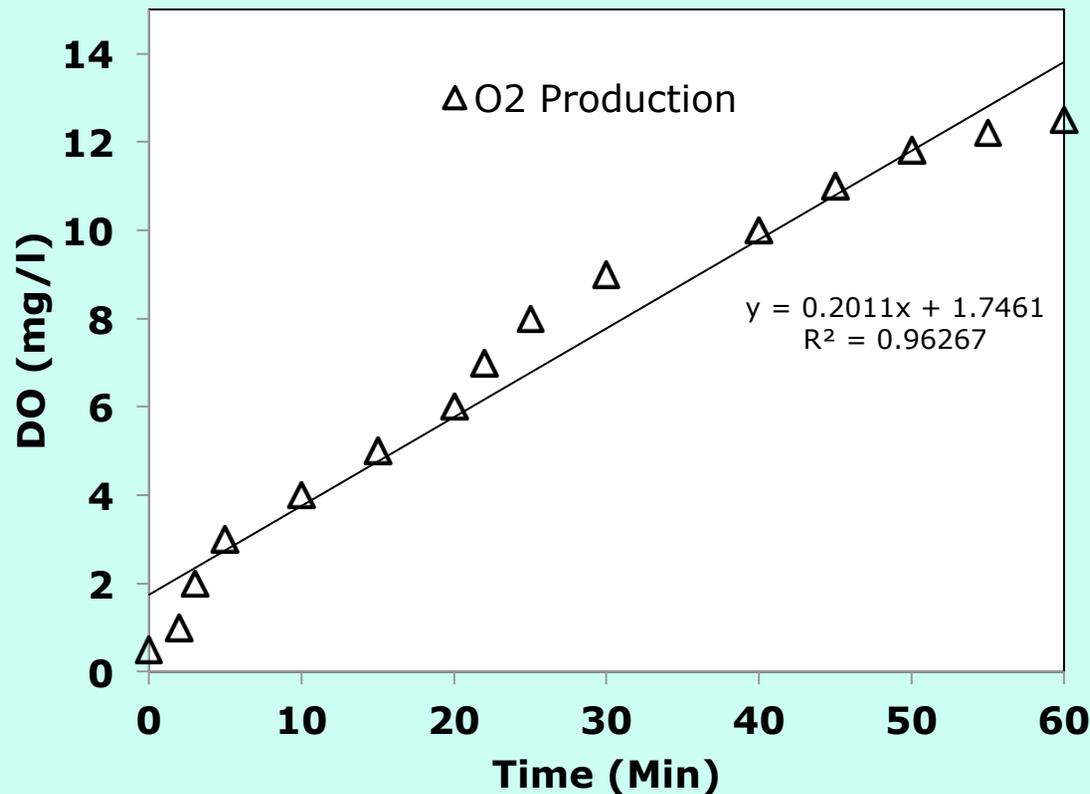
# Effluent Quality

## ■ Phosphate ( $\text{PO}_4$ )



# Self Aeration : Natural Oxygenation

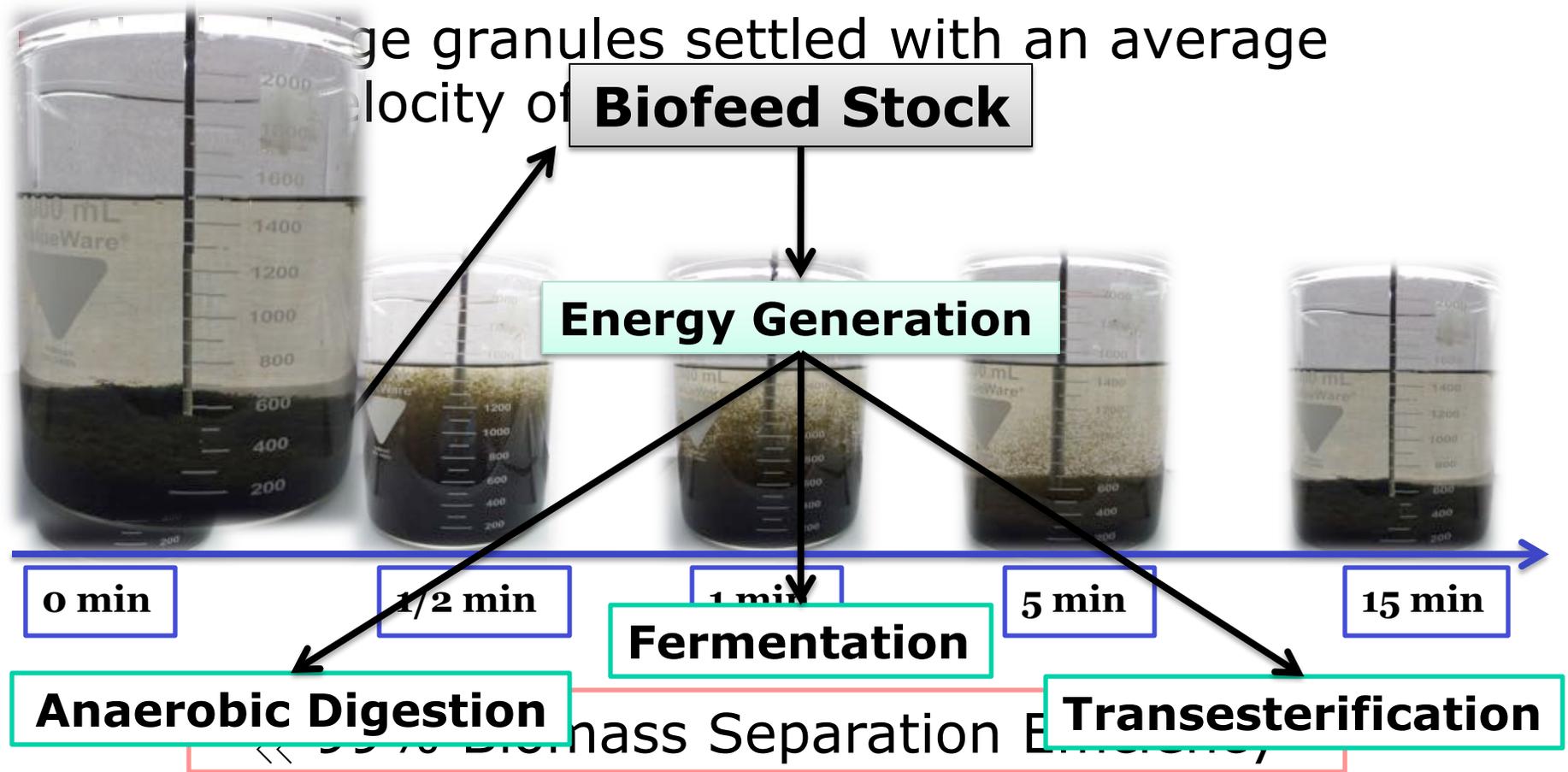
## O<sub>2</sub> Production Rate



**Specific Oxygen  
Production Rate:**

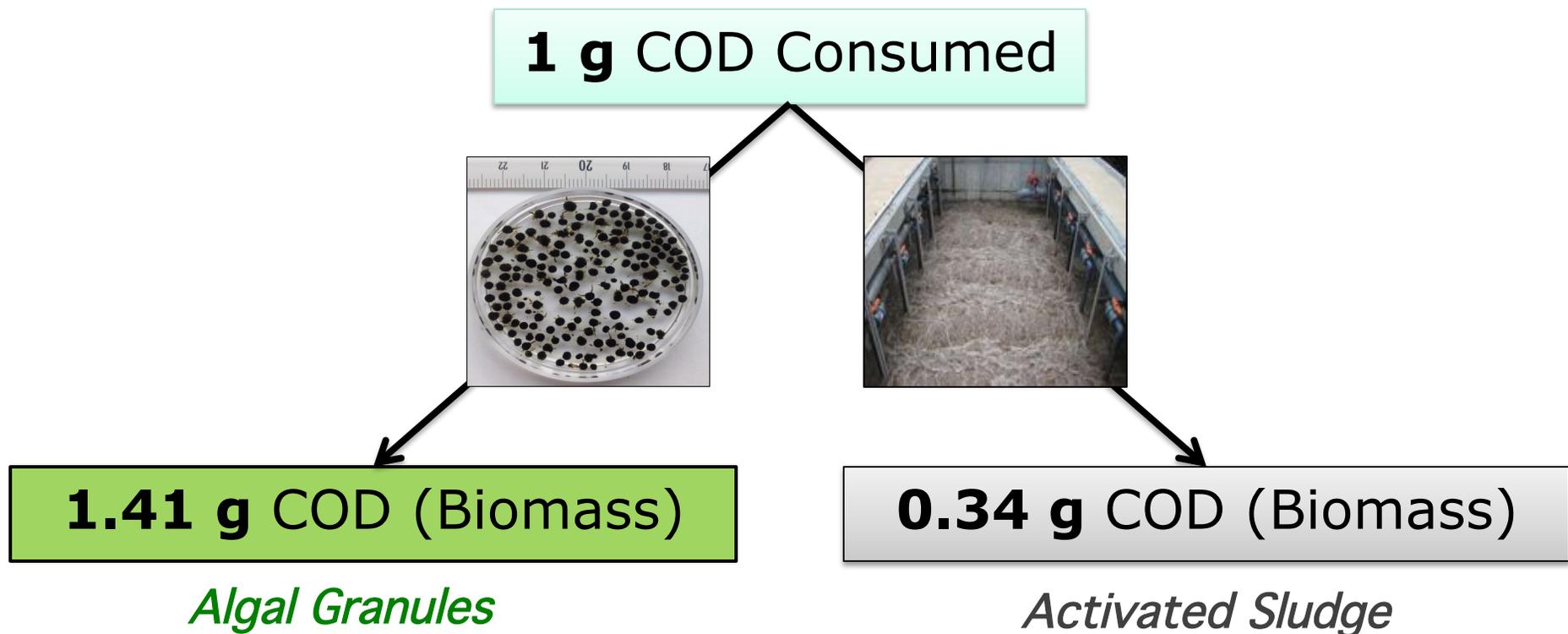
**8.0 (mg/gVSS)/hr**

# Biomass Separation and Energy Production



## The Yield (Biomass-Energy Conversion)

- The biomass yields were up to 400% higher than typical activated sludge:



## Conclusion

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### **Algae-Sludge Granules Technology**

- Demonstrated wastewater treatment without external aeration.
- Allows for recovery of energy laden in WW in the form of harvestable biomass and leads to substantial cost reduction in WW treatment.
- Achieves environmental benefits reducing the green house gases emitted into the atmosphere
- The successful application could provide an alternative to the activated sludge process.

## Current and Future Research

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- Operating a pilot ASG unit at AWWTP:
  - \* Now; 30 L reactor as SBR
  - \* Our goal: 1000-2000 L System
- Investigation on several others
  - ✓ Pathogens
  - ✓ Heavy metals
- Anaerobic digestion of ASG biogranules.

# Acknowledgement

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# Questions

