

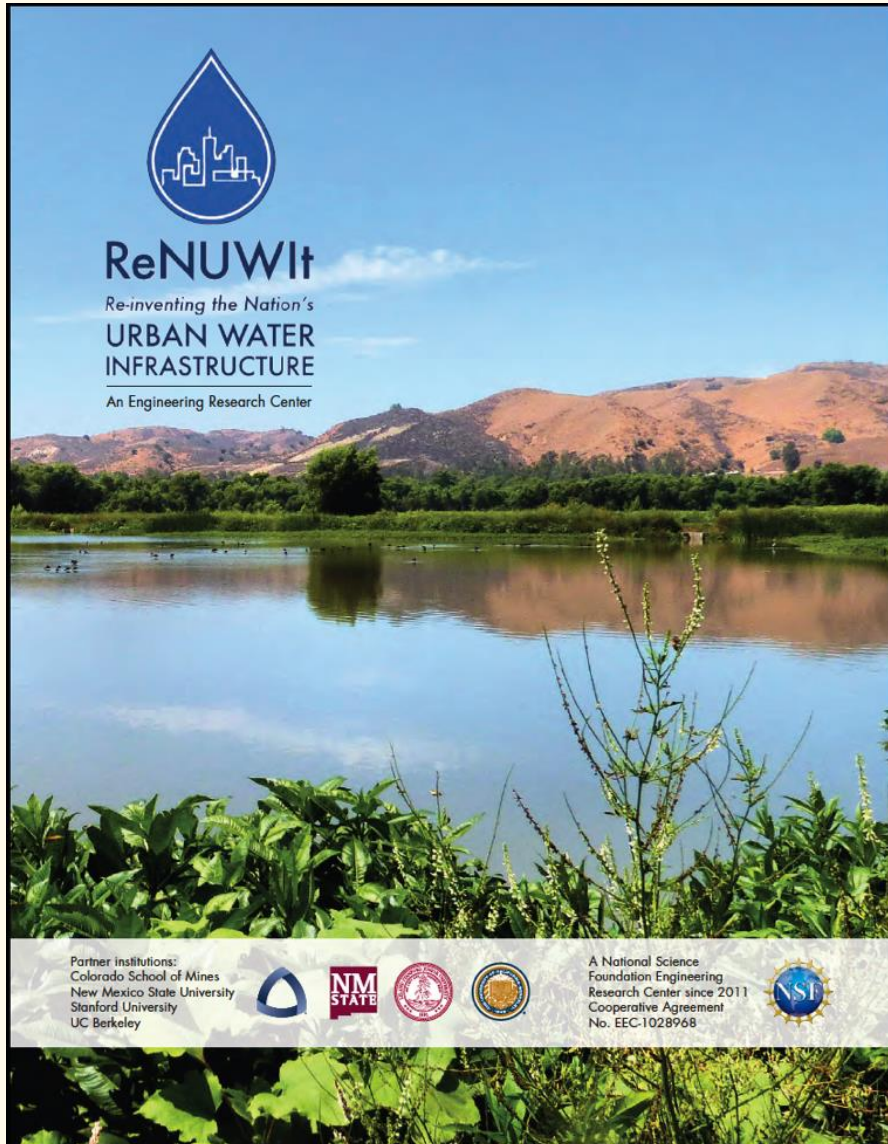


***The Anaerobic Fluidized Bed
Membrane Bioreactor for
Energy-Efficient Wastewater Reuse***

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Re-inventing the Nation's Urban Water Infrastructure

NSF Engineering Research Center



Research Issues

- Compact water recycling systems
- Distributed treatment system planning
- Energy-positive wastewater treatment
- Open water unit process wetlands
- Ecosystem rehabilitation

ReNUWIt Leadership Team

Stanford, UC Berkeley, New Mexico State, Colorado Sch. of Mines



Seeking Sustainable Solutions



Economic & social benefits

Save energy & water

Increase resiliency & resource recovery

Enhance acceptance & the urban environment



Codiga Resource Recovery Center

Stanford's Pilot-scale test bed facility



Director
Craig
Criddle



*Wastewater
and Waste
Organics*



*High Value
Products*

**Chungheon
Shin**

**Prof.
Jaeho
Bae**

**Prof.
Jon
Kim**

INHA University, Korea, World Class University Research Team

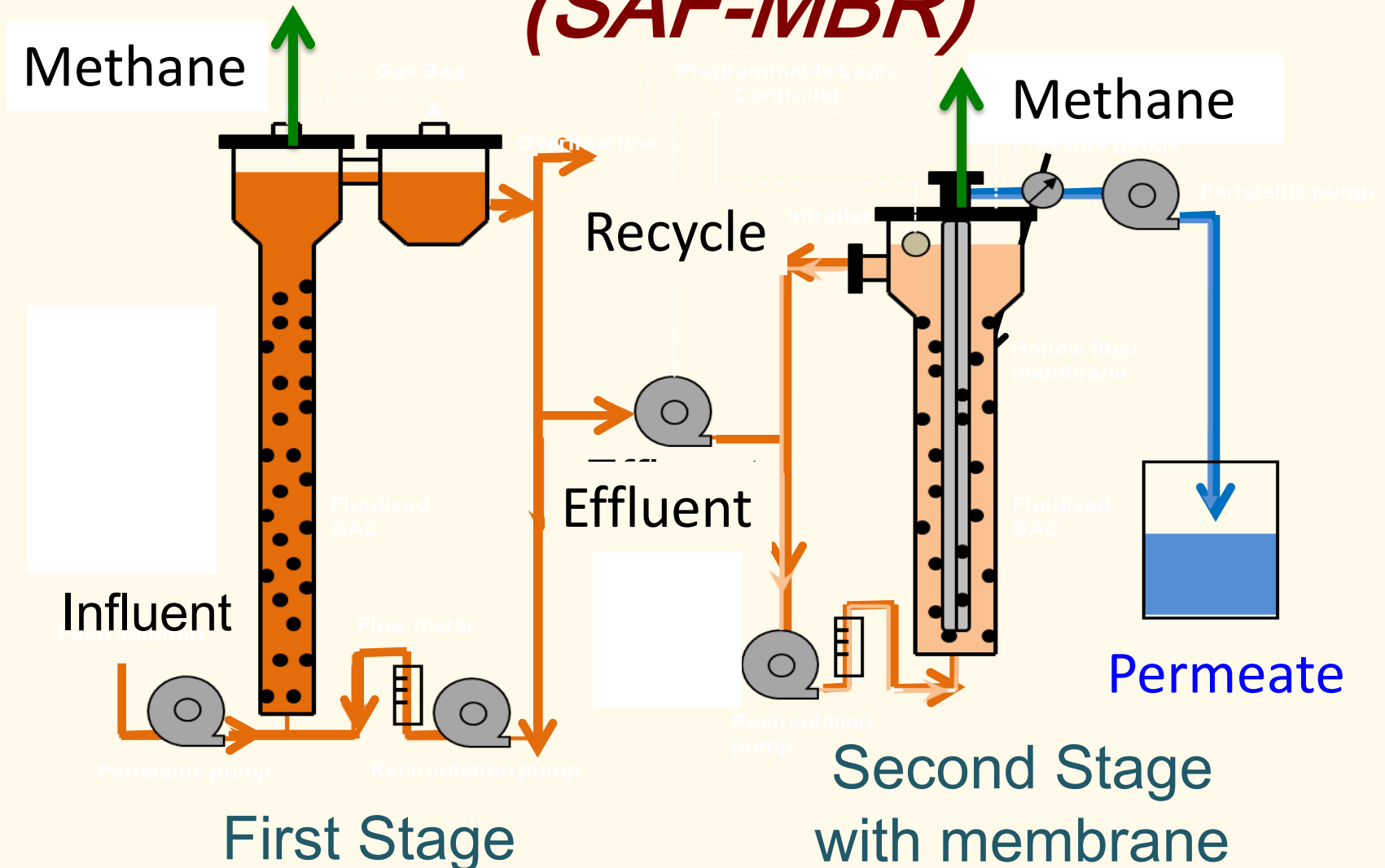
Question

- Can we treat municipal wastewater 100% anaerobically to achieve net energy production while meeting effluent quality standards, and at lower cost than by conventional aerobic treatment ?

Fluidized Bed Anaerobic Treatment of Industrial Wastewaters Objective – High SRT and short HRT



Staged Anaerobic Fluidized MBR (SAF-MBR)



**12 m³/day (6 h HRT)
SAF-MBR Pilot Plant
Treating South Korea
Primary Effluent**



Fluidized Bed Reactor



**Membrane
Bioreactor**

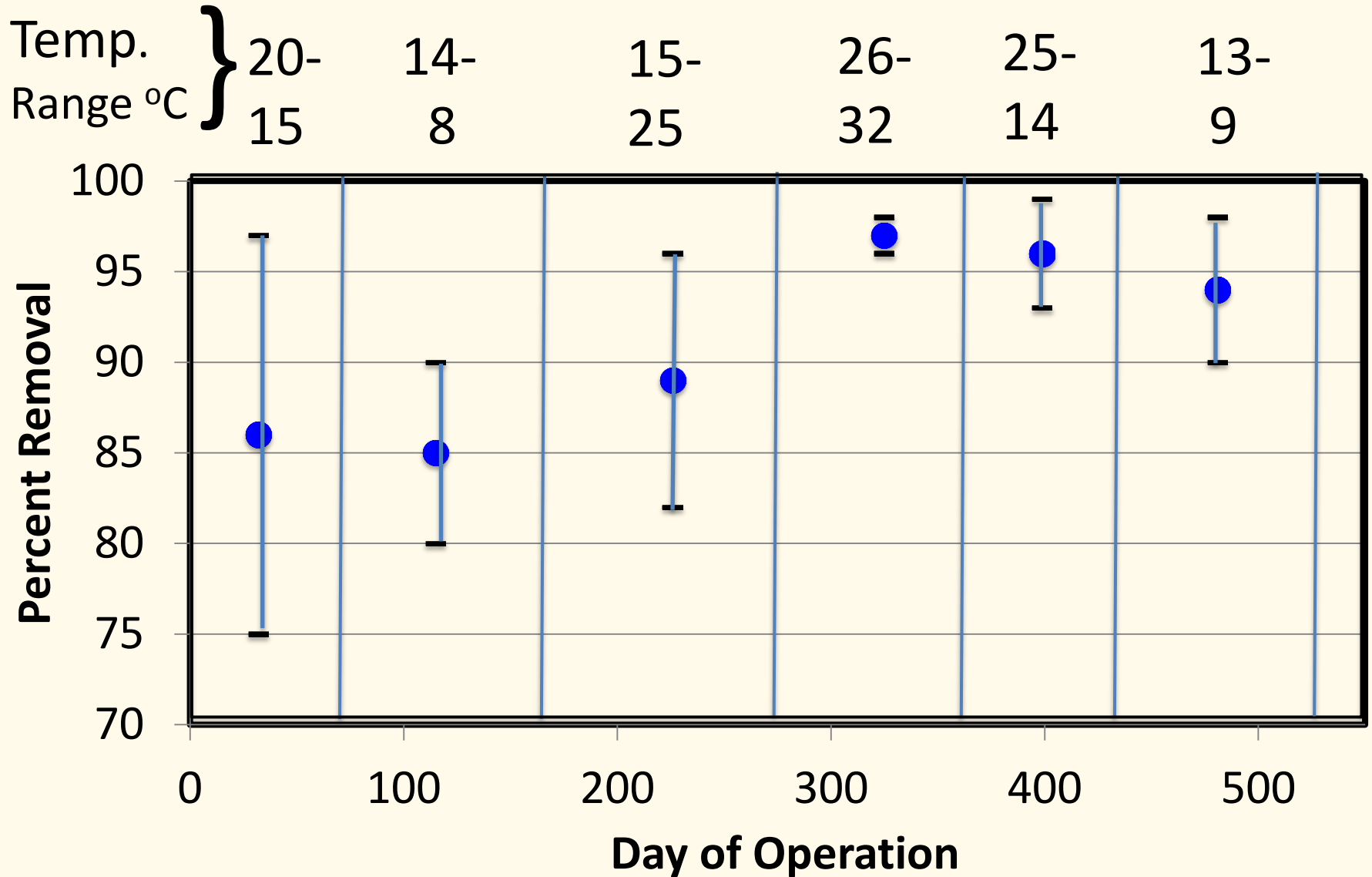


Membranes

Pilot SAF-MBR Operation

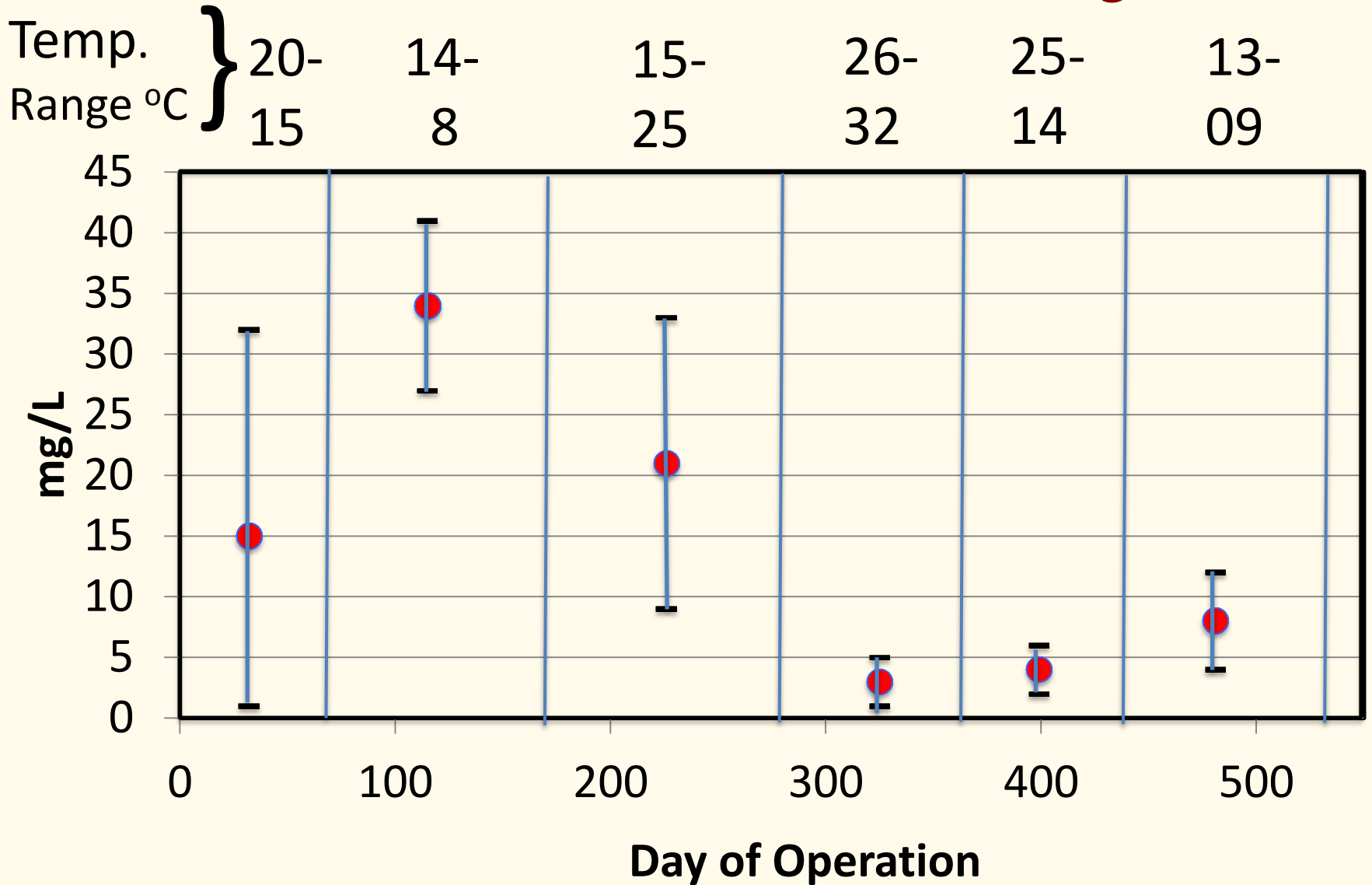
- **Wastewater characteristics**
 - COD 300 ± 60 mg/L
 - BOD₅ 160 ± 45 mg/L
- **Hydraulic Retention Time**
 - AFBR 2 hours
 - AFMBR 2.6 to 4.8 hours
 - Total 4.6 to 6.8 hours
- **AFMBR Flowrate** 4 to 7 m³/d

Percent BOD₅ Removal



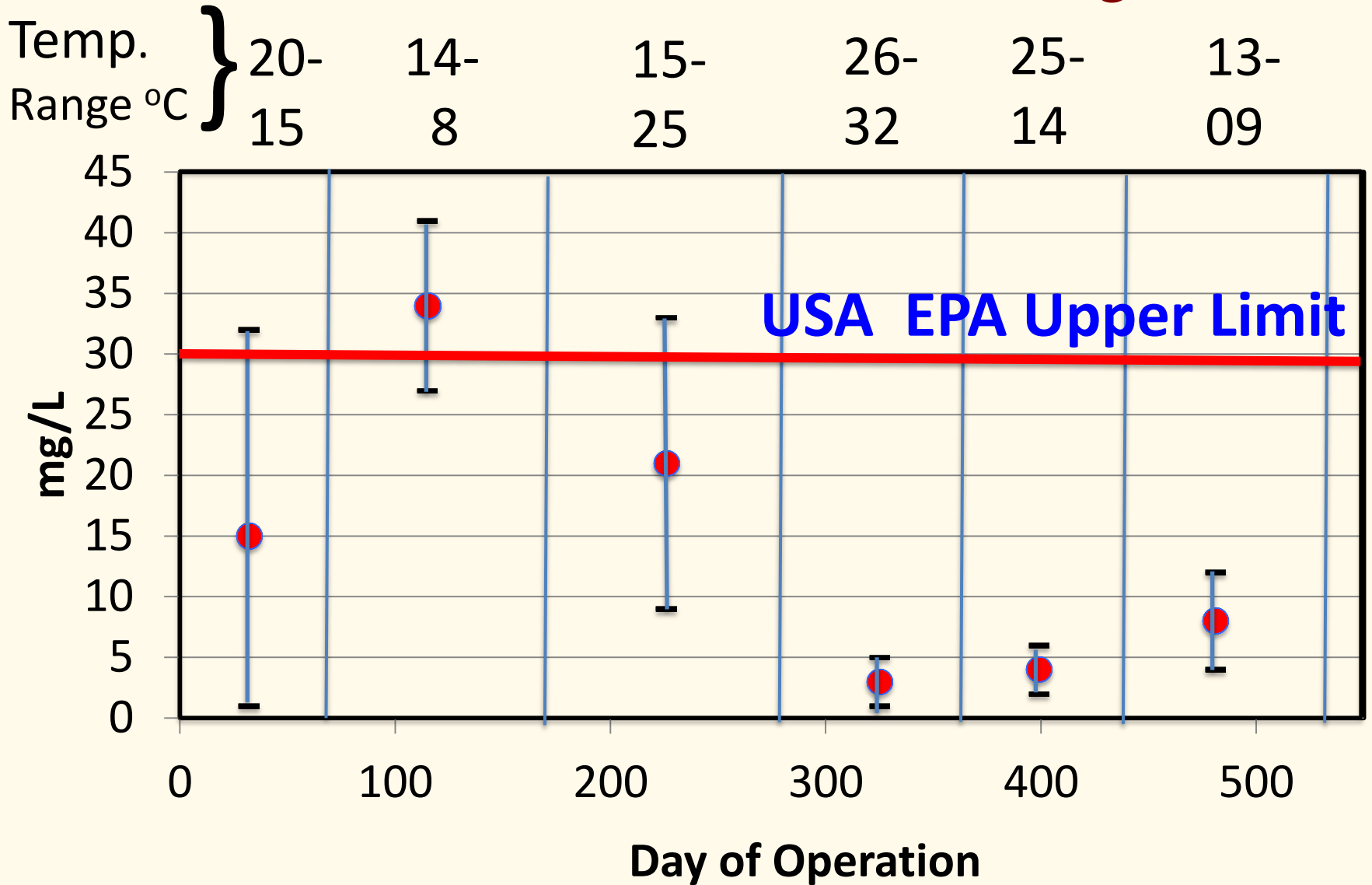
Shin et al., *Bioresource Technology*, **159**, 95-103 (2014)

SAF-MBR Effluent BOD₅



Shin et al., *Bioresource Technology*, **159**, 95-103 (2014)

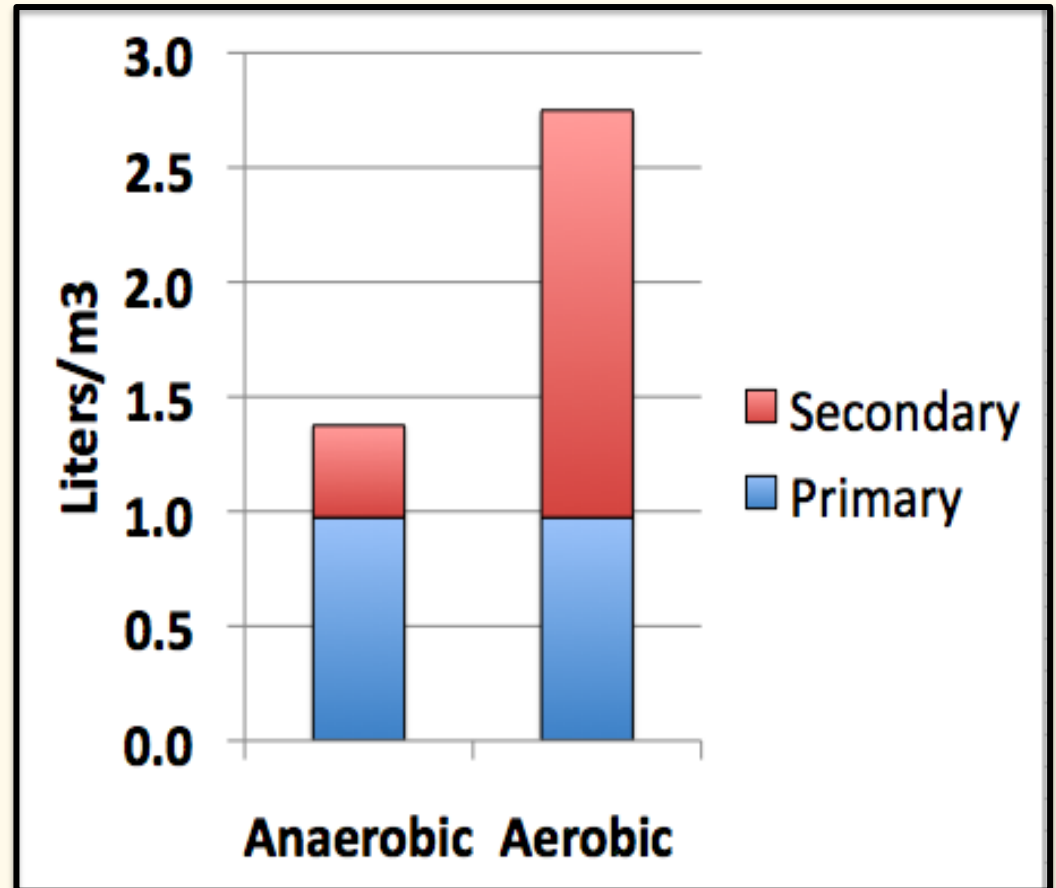
SAF-MBR Effluent BOD₅



Shin et al., *Bioresource Technology*, **159**, 95-103 (2014)

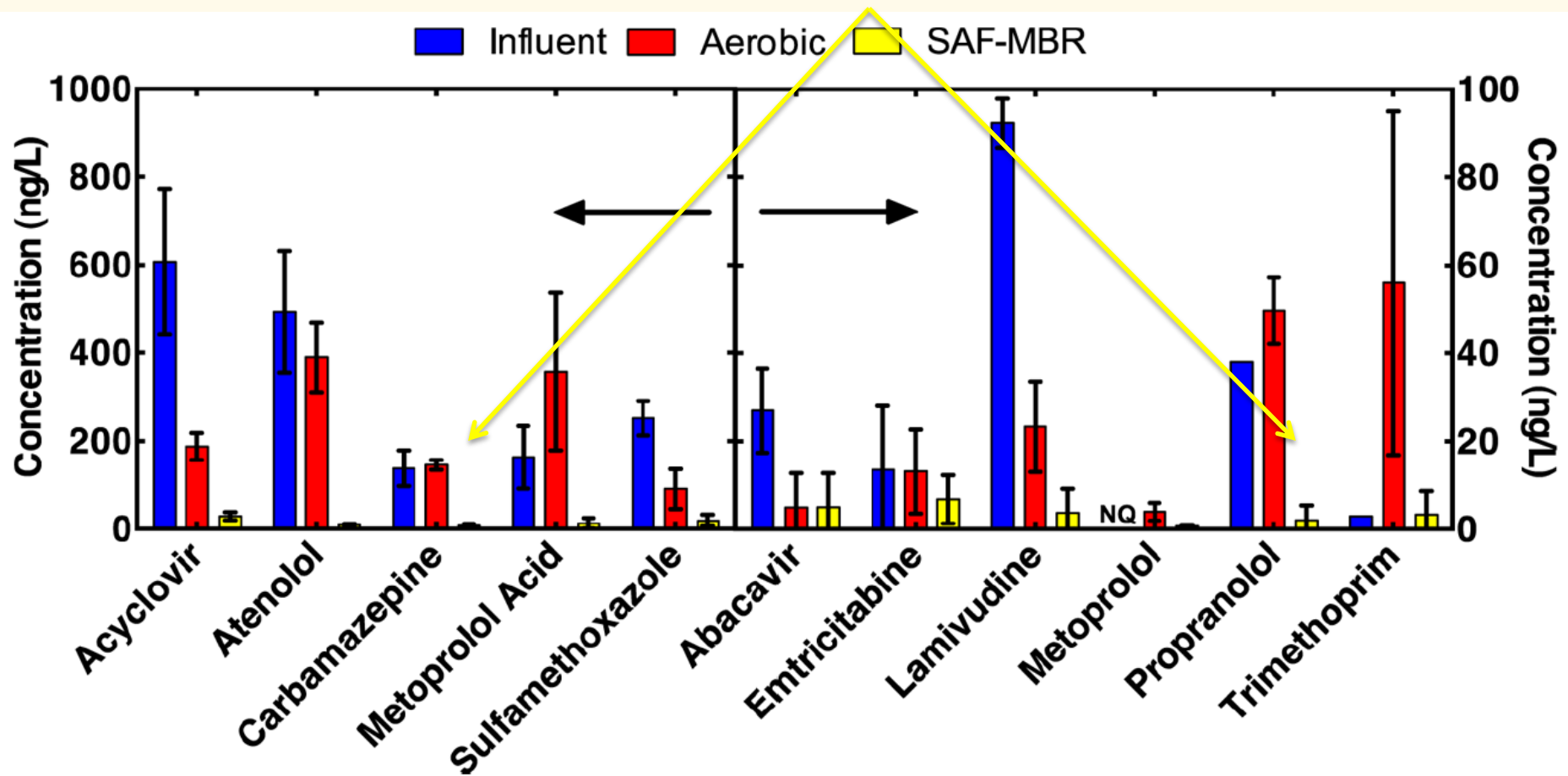
Biosolids Production

0.05 kg VSS/kg COD
and
already digested
and
less than half
that from aerobic
treatment



Shin et al., *Bioresource Technology*, **159**, 95-103 (2014)

Superior removal of pharmaceuticals: Anaerobic (SAF-MBR) vs aerobic treatment





Irrigated land

**Monterey County Water
Recycling Project**

Water Reclamation Plant

Monterey Regional Water Pollution Control Agency Recovers Water, Energy, and Nutrient Resources

- Largest irrigated crop wastewater recycle in U.S.
- Produces 76,000 m³/day recycled water
- Irrigates 5,000 hectares
- Through anaerobic biosolids treatment and cogeneration, produces 50% of WWTP's energy needs
- No energy wasted for nitrogen oxidation – all is used as plant fertilizer

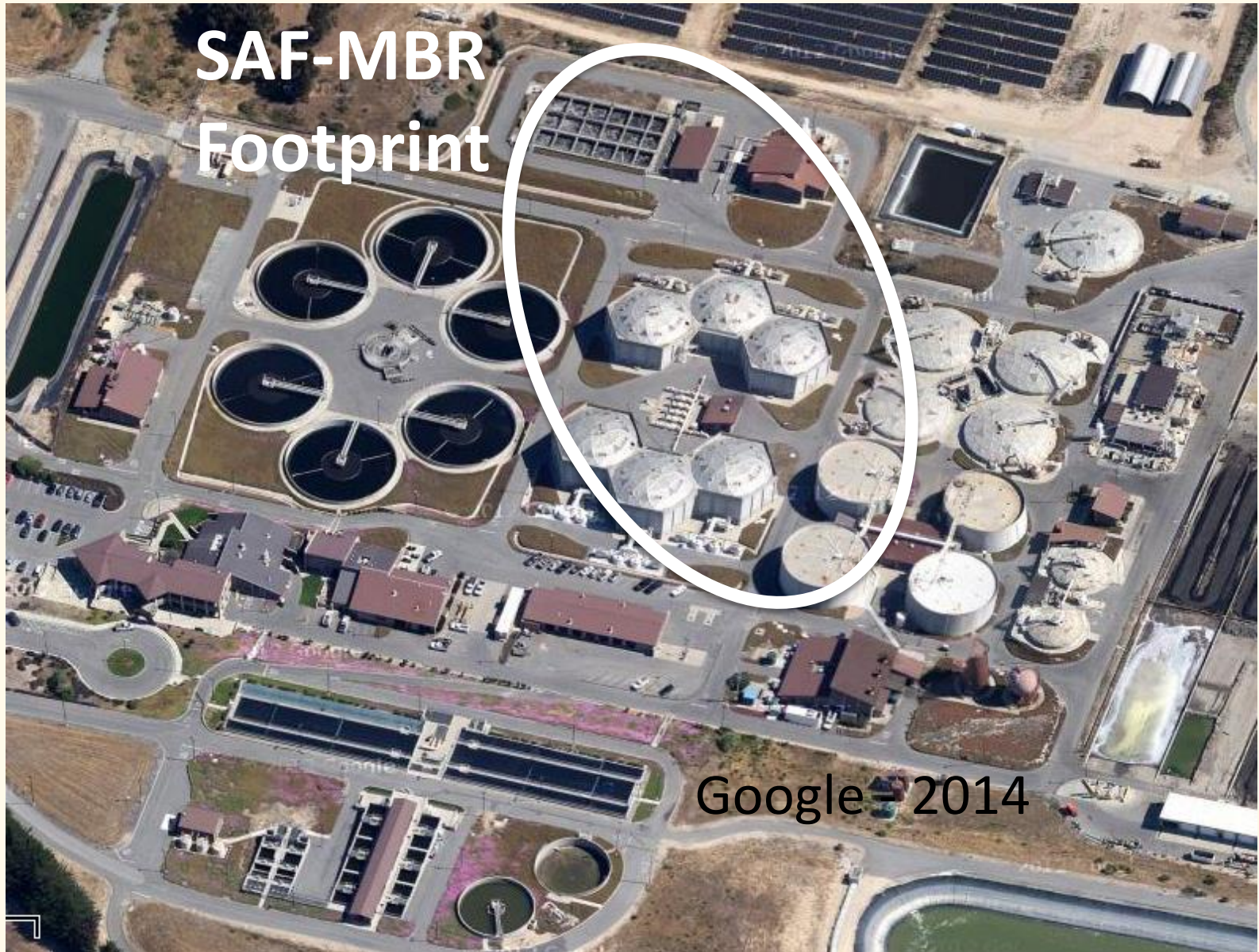


Monterey Water Reclamation Plant



Google - 2014

Monterey Water Reclamation Plant



Thank you!

