Novel Application of the Membrane Technology for High End Reuse

Zeynep K. Erdal, PhD, PE

February 12, 2013

WateReuse LA Chapter Meeting
West Basin Municipal Water District

Outline

- Goals
- Technology Options
- Pilot Testing Conditions
- Progress and Status
- Q&A

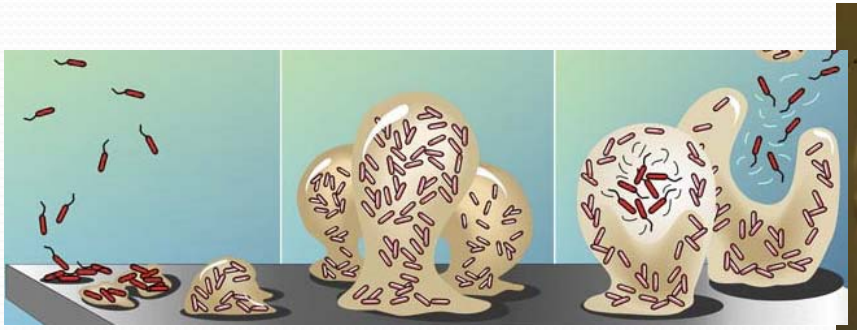
Goals

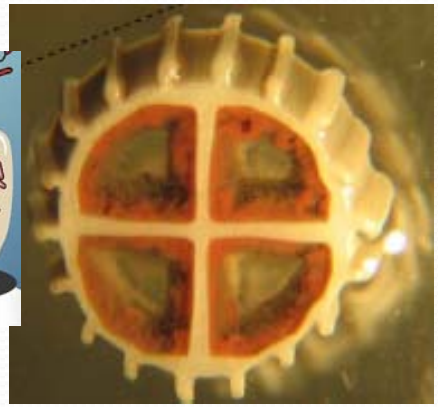
- Produce recycled water for use in
  - Cooling tower makeup water
  - Boiler makeup water
  - Irrigation
- Recycled water quality to be suitable for
  - Direct use – non-detectable ammonia N
  - Use as RO feed
- Waste streams to be
  - In compliance with discharge requirements
  - Minimized to reduce disposal costs

Nitrification Technologies

- Suspended growth

- Attached growth

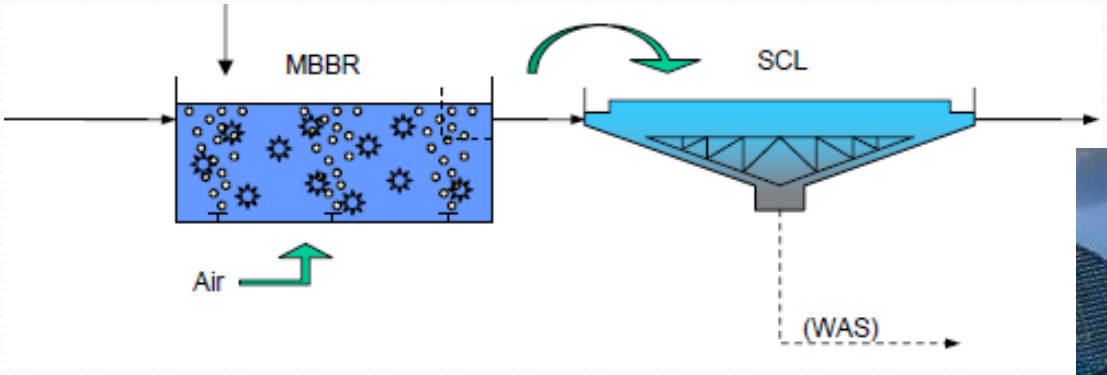


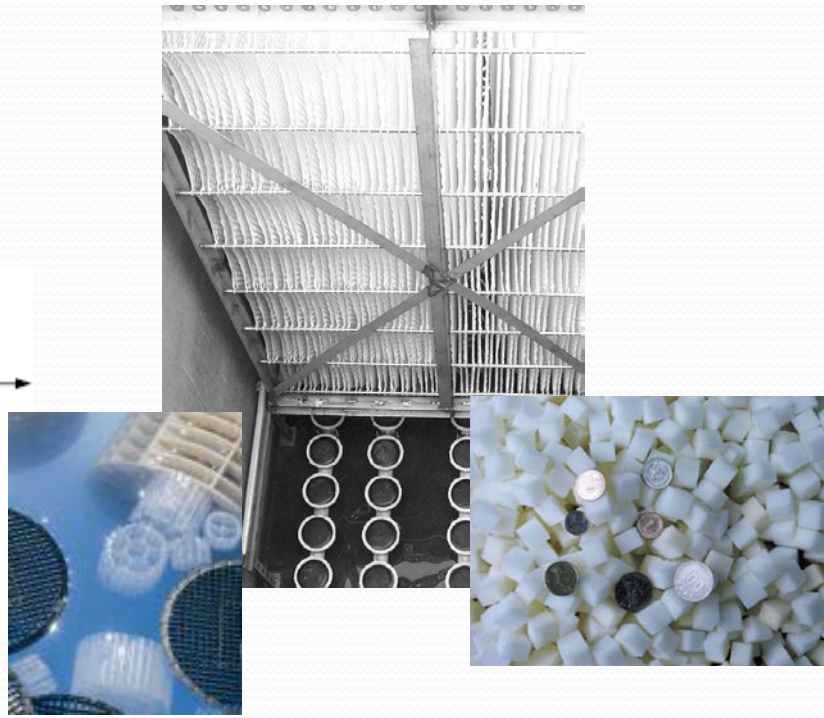


Attached Growth

- Clay or polystyrene media

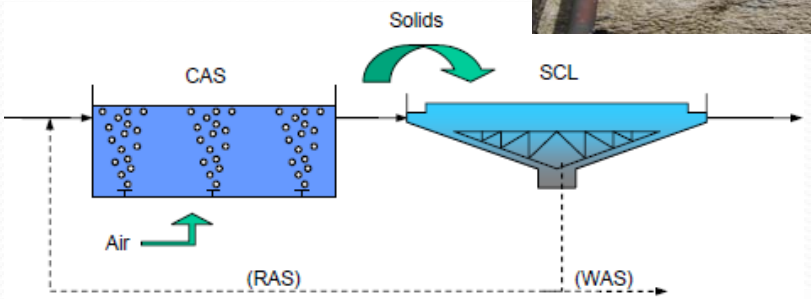
- Rope, chip, disks, sponges, etc. media



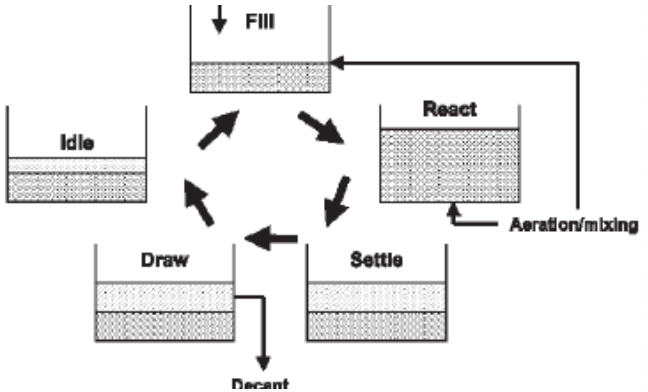


Suspended Growth

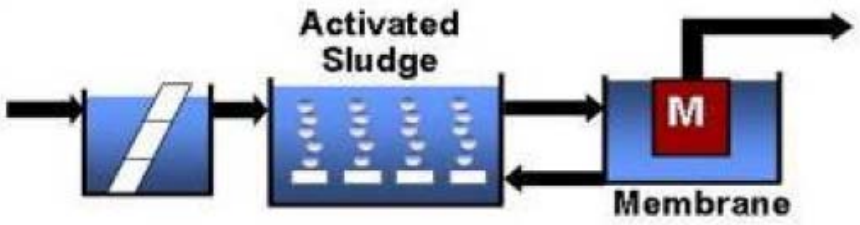
- Conventional activated sludge systems



- Sequencing batch reactors

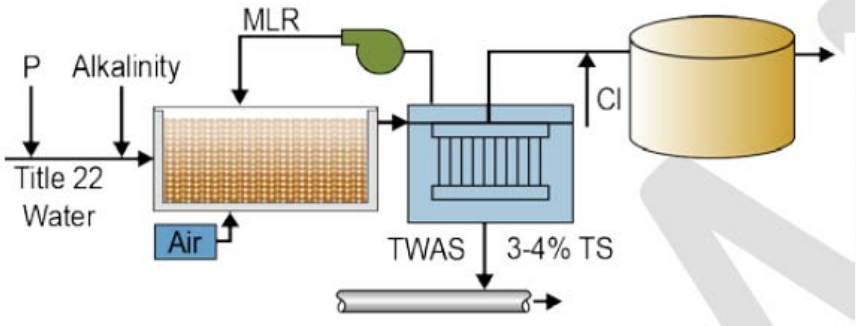


- Membrane bioreactors



Membrane Bioreactors (MBRs)

- Uses low-pressure membrane filtration system (e.g., microfiltration or ultrafiltration) and eliminates the need for clarifiers and filtration for solid-liquid separation
- Higher MLSS in smaller footprint
- To clean the exterior of the membranes, backpulsing and air scour is used
- Tertiary application is relatively new (Hamilton, Canada, CH2M HILL)



Membrane Bioreactors (MBRs)

Advantages

- Superior effluent quality
- Handle WQ variability
- Eliminates separate solids/liquid separation and tertiary filtration
- Pretreatment for NF/RO

Disadvantages

- Additional cleaning chemicals such as citric acid over other conventional technologies
- Proper maintenance of membranes required
- T-MBR new concept

T-MBR Pilot Testing Goals

- Provide proof of concept for use of a membrane bioreactor for nitrification on a tertiary treated wastewater.
- Verify the biological system capability to produce less than 1 mg/L ammonia nitrogen.
- Define and optimize the process design criteria.
- Take the system to failure and/or test the ability for recovery from failure.

T-MBR Feed Water Quality

Parameter	Average Feed Values	Product Water Requirements
pH, SU	6.8	6.5-7.5
Temperature, °C	20	
BOD, mg/L	1	
TOC, mg/L	12	
TSS, mg/L	3	
Turbidity, NTU	1.3	<0.2
Ammonia-N, mg/L	**53**	**<1**
Nitrate-N, mg/L	11	
Alkalinity, mg/L $CaCO_3$	230	
Ortho Phosphate-P, mg/L	0.1	
TDS, mg/L	1,560	Monitored

Product water is to be also suitable for use as RO feed.

Ammonia Oxidation Basics

- Nitrification (*Nitrosomonas* and *Nitrobacter*):

  $NH_4^+ + 2\ O_2 \rightarrow NO_3^- + 2H^+ + H_2O$

  $1.02NH_4^+ + 1.89\ O_2 + 2.02\ HCO_3^- \rightarrow 0.021\ C_5H_7O_2N + 1.06\ H_2O + 1.92\ H_2CO_3 + 1.00\ NO_3^-$

- Breakpoint chlorination:

  $2NH_4^+ + 3\ Cl_2 \rightarrow N_2\ (g) + 8H^+ + 6Cl^-$

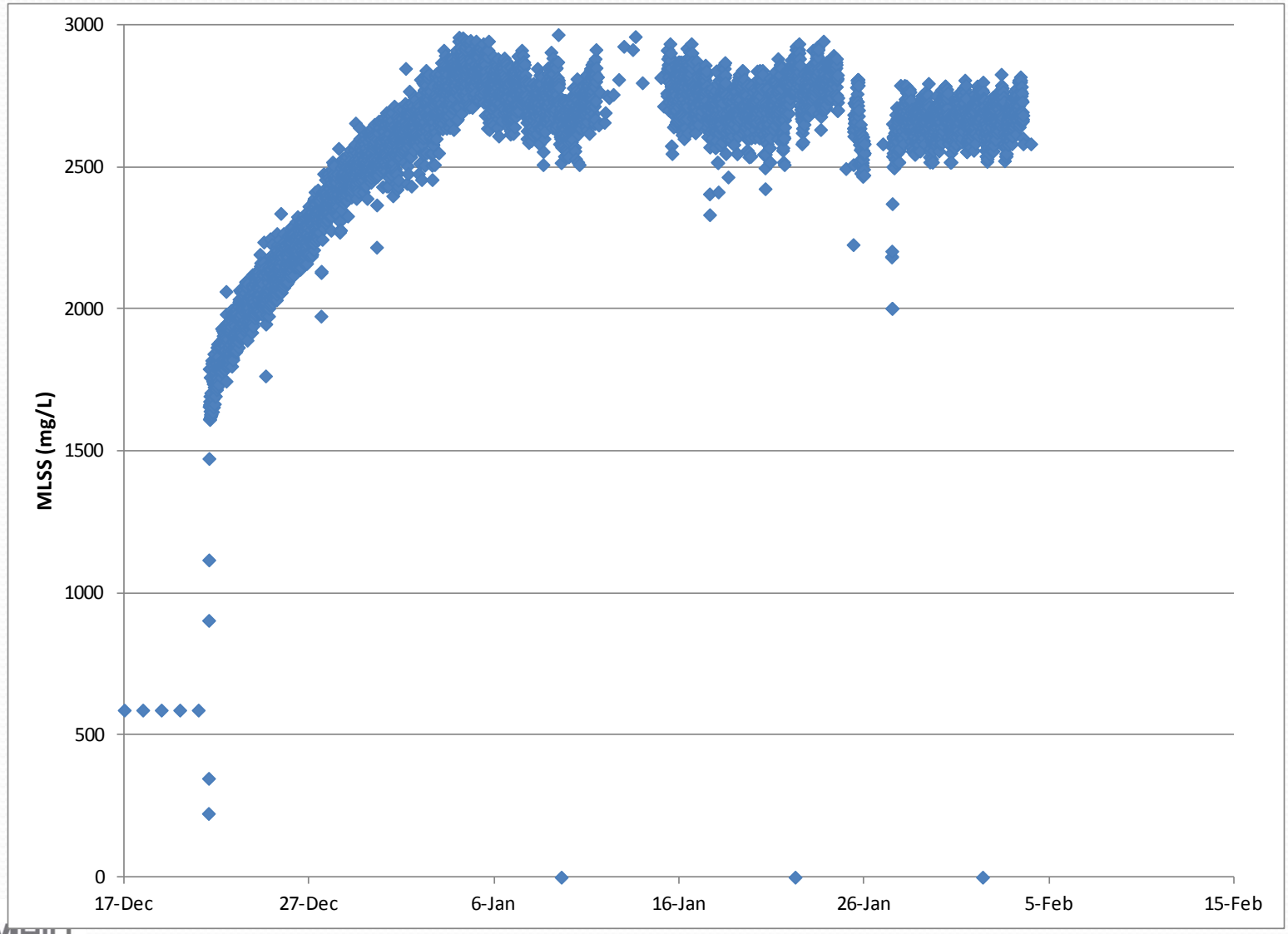
Pilot Unit Components

CH2MHILL

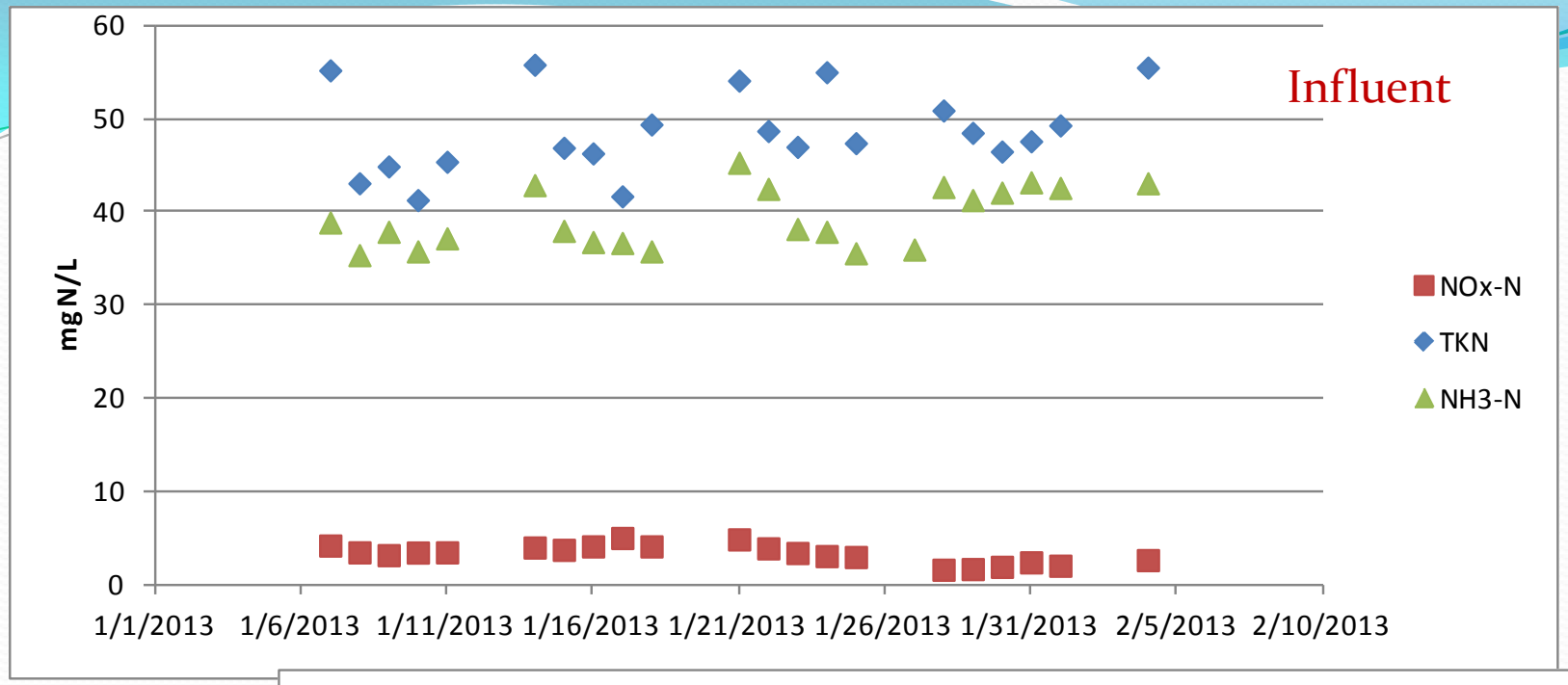
CH2MHILL

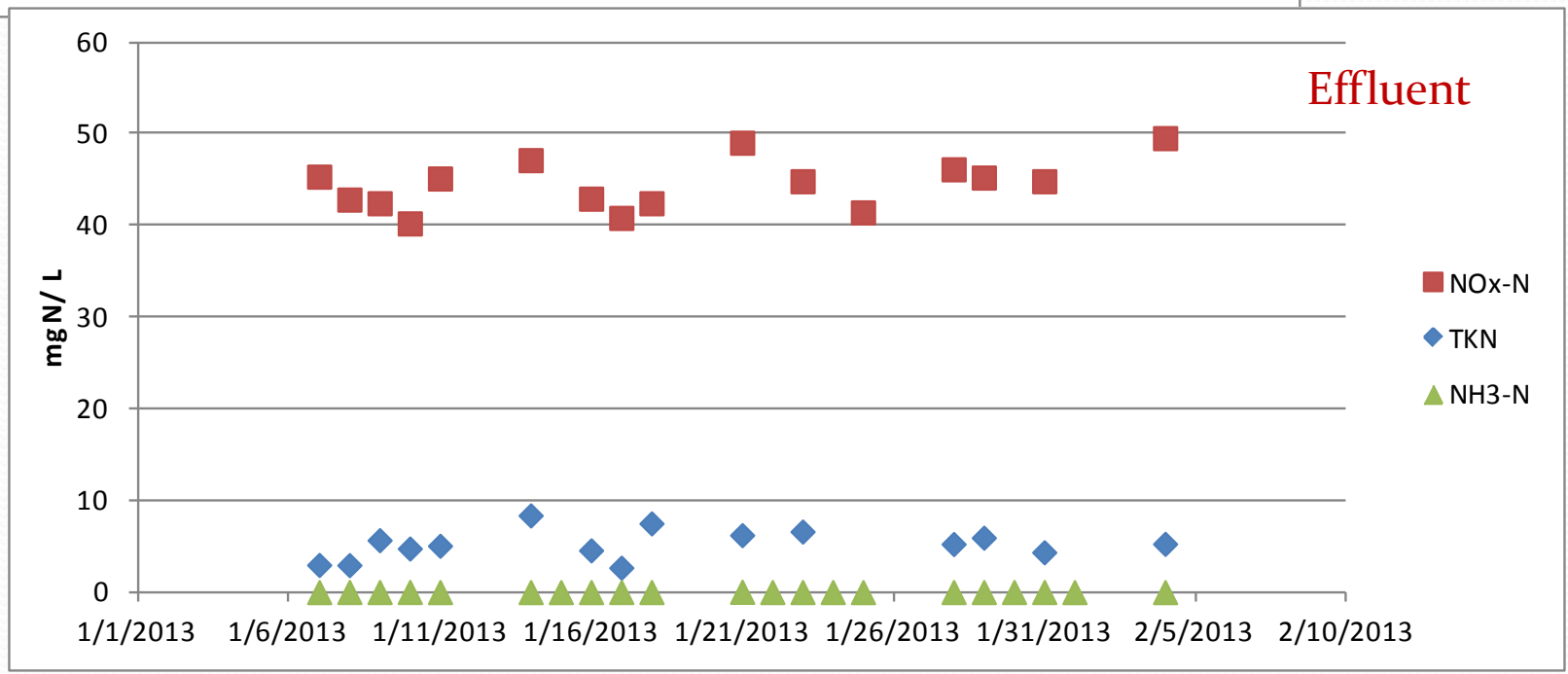
What does the MBR Mixed Liquor Look Like?

MBR System MLSS



CH2MHILL


Influent
60
50
40
30
20
10
0
mg N/L
1/1/2013
1/6/2013
1/11/2013
1/16/2013
1/21/2013
1/26/2013
1/31/2013
2/5/2013
2/10/2013
NOx-N
TKN
NH3-N


Effluent
60
50
40
30
20
10
0
mg N/ L
1/1/2013
1/6/2013
1/11/2013
1/16/2013
1/21/2013
1/26/2013
1/31/2013
2/5/2013
2/10/2013
NOx-N
TKN
NH3-N

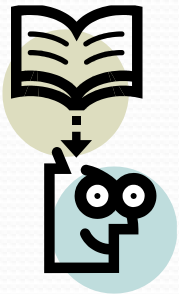
CH2MHILL

Next Steps

- Continue monitoring under steady state conditions
- Conduct challenge tests
- Develop design criteria for the 12-mgd full scale system

CH2MHILL

Questions



Comments

Zeynep.Erdal@ch2m.com

CH2MHILL