



SAWEA Workshop, 2005

ZeeWeed MBR Technology Update

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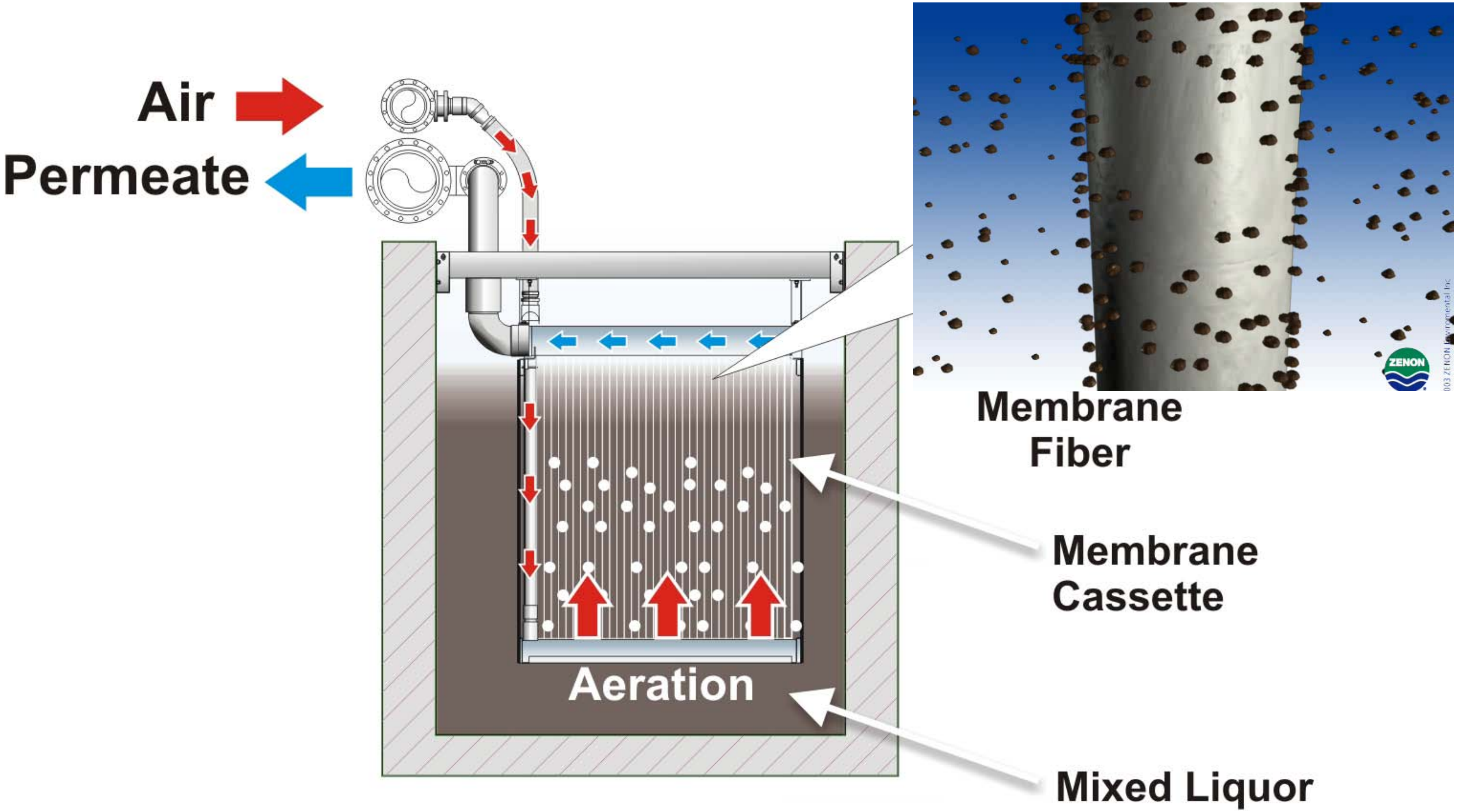
Presentation Outline

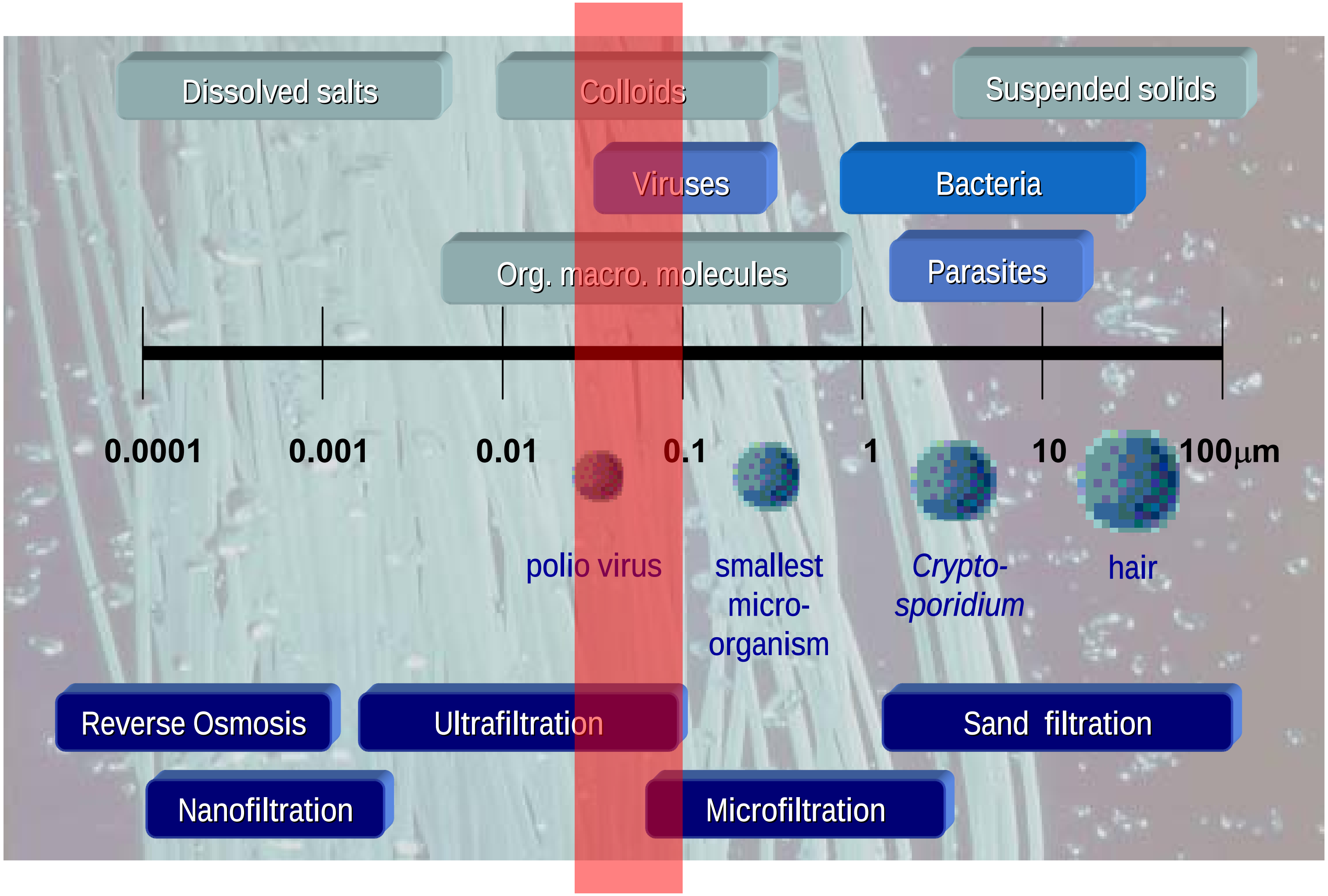
- ZeeWeed® MBR Technology
- ZENON MBR Technology Update
- New ZENON Projects
- Q & A

ZeeWeed® MBR Technology

Principles of ZeeWeed® Immersed Membranes



Membrane Filtration



ZENON membrane range

ZeeWeed® 500 – Robust Membrane

- Reinforced for maximum strength and maximum life
- Failure proof / double barrier
- High solids tolerance

ZeeWeed® Cassette Scale-Up

Larger Plants = Larger Cassettes

ZW-500d (2002)

16,300 ft^2
326,000 gpd

ZW-500c (2000)

5,500 ft^2
110,000 gpd

ZW-500a (1997)

4,000 ft^2
80,000 gpd

ZeeWeed® 500d – Cassette

Optimized Building Block

- Compact
  - High packing density = small footprint
  - Low energy costs
- Accessible
  - Easy to remove modules and cassettes
- Simple
  - Fewer connections, valves = higher reliability
  - Lower capital costs


ZENON
Water for the World
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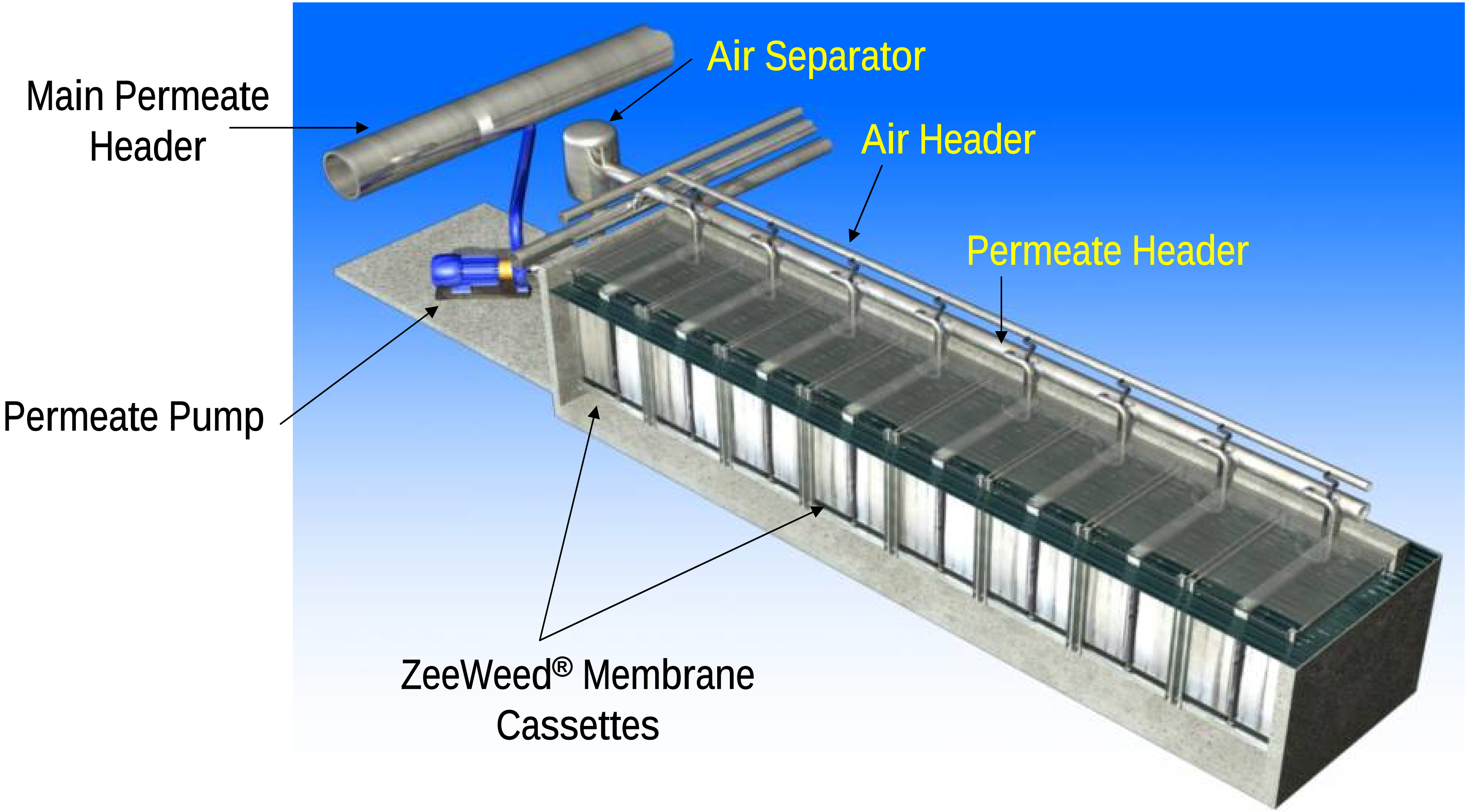
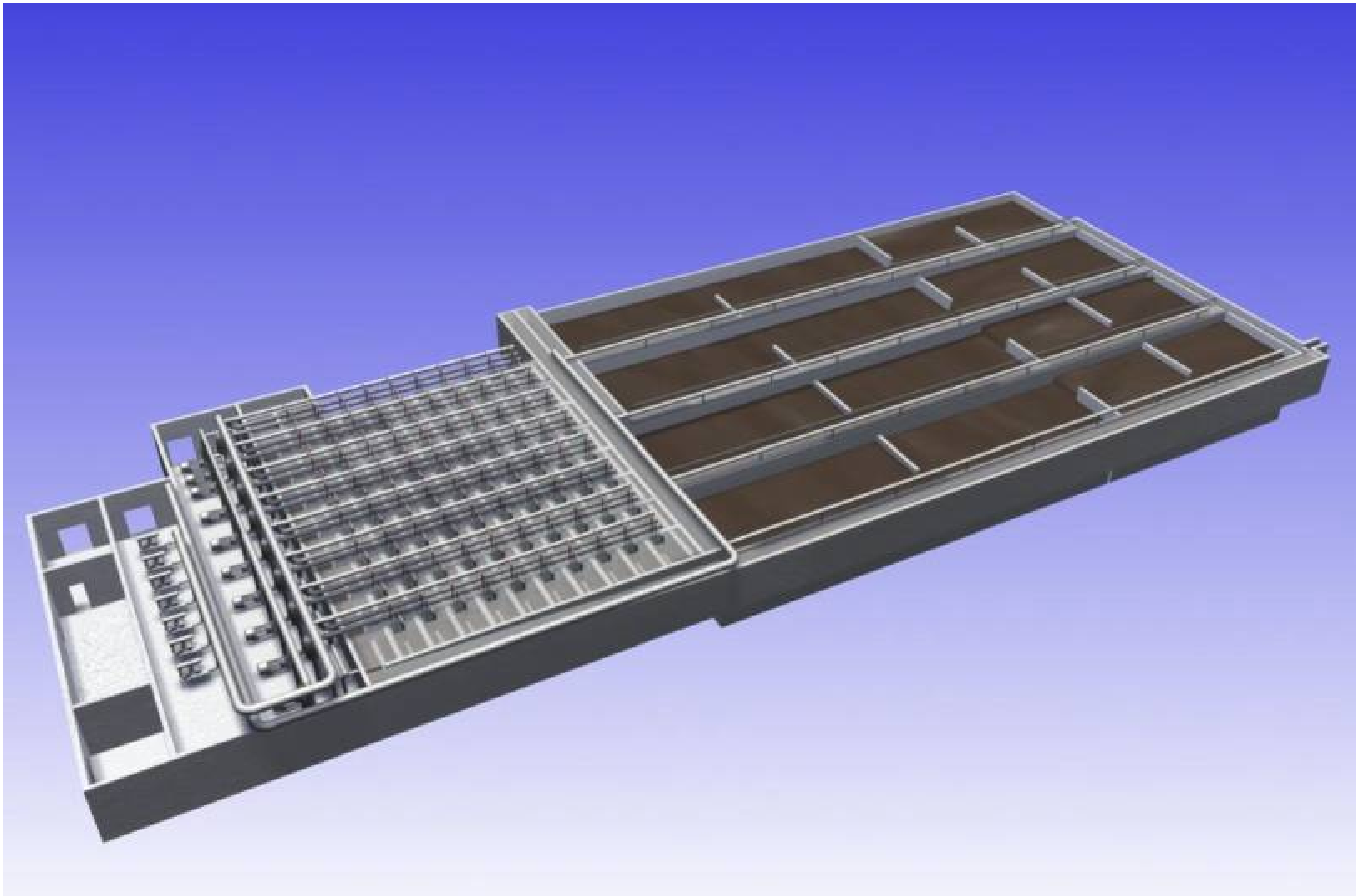
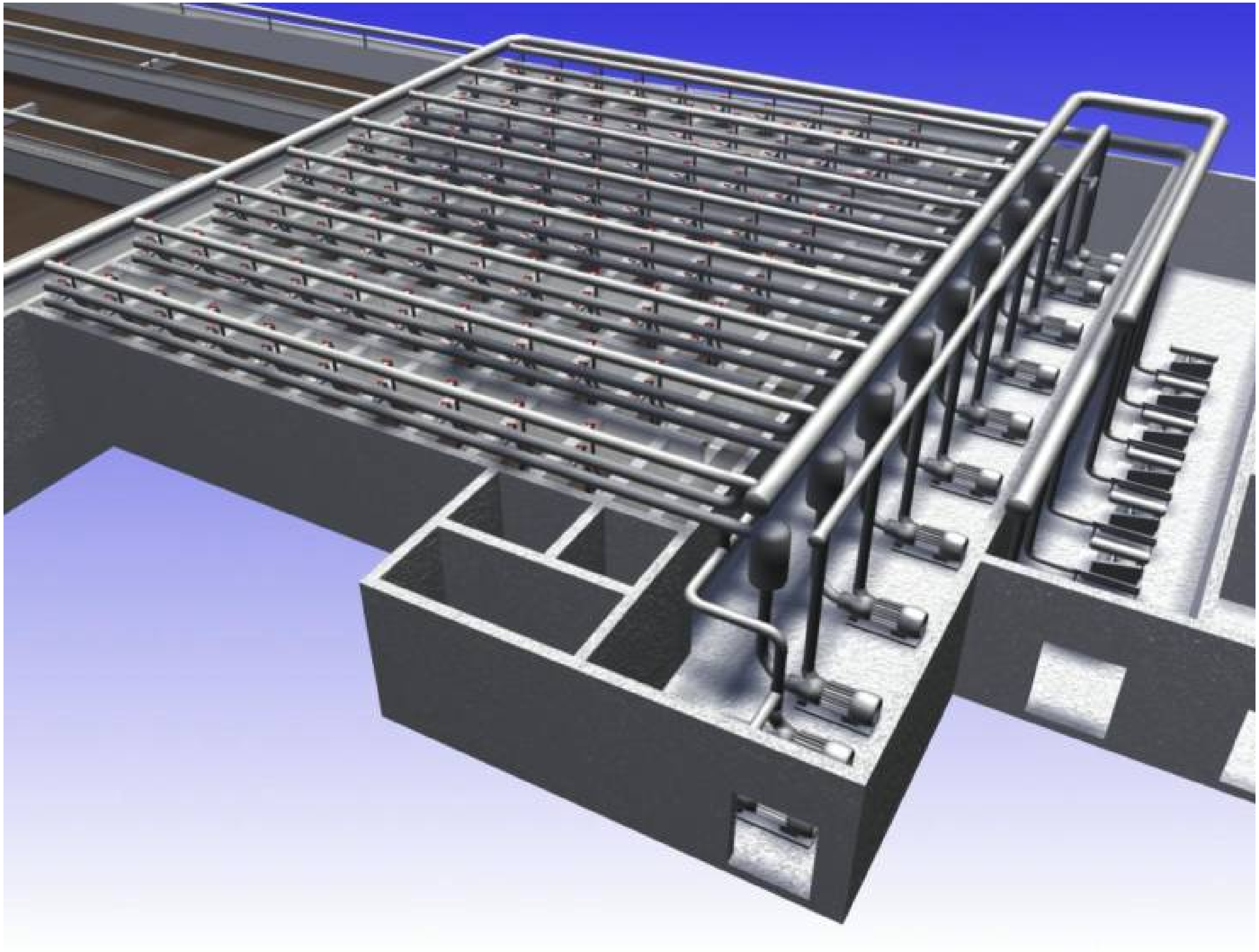
ZeeWeed® 500d – Train



Overall ZeeWeed® MBR Design



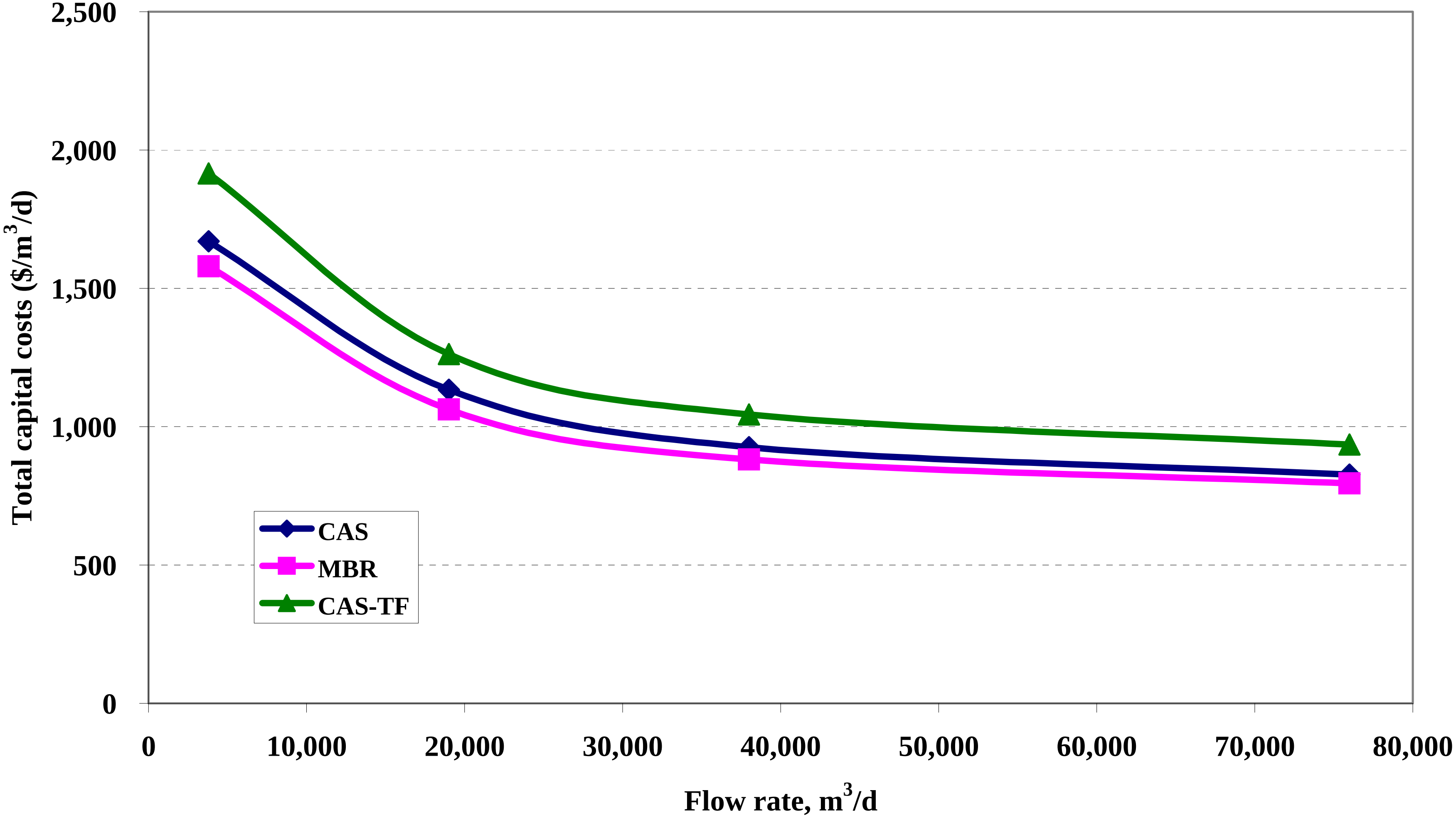
Simple, Modular ZeeWeed® Design



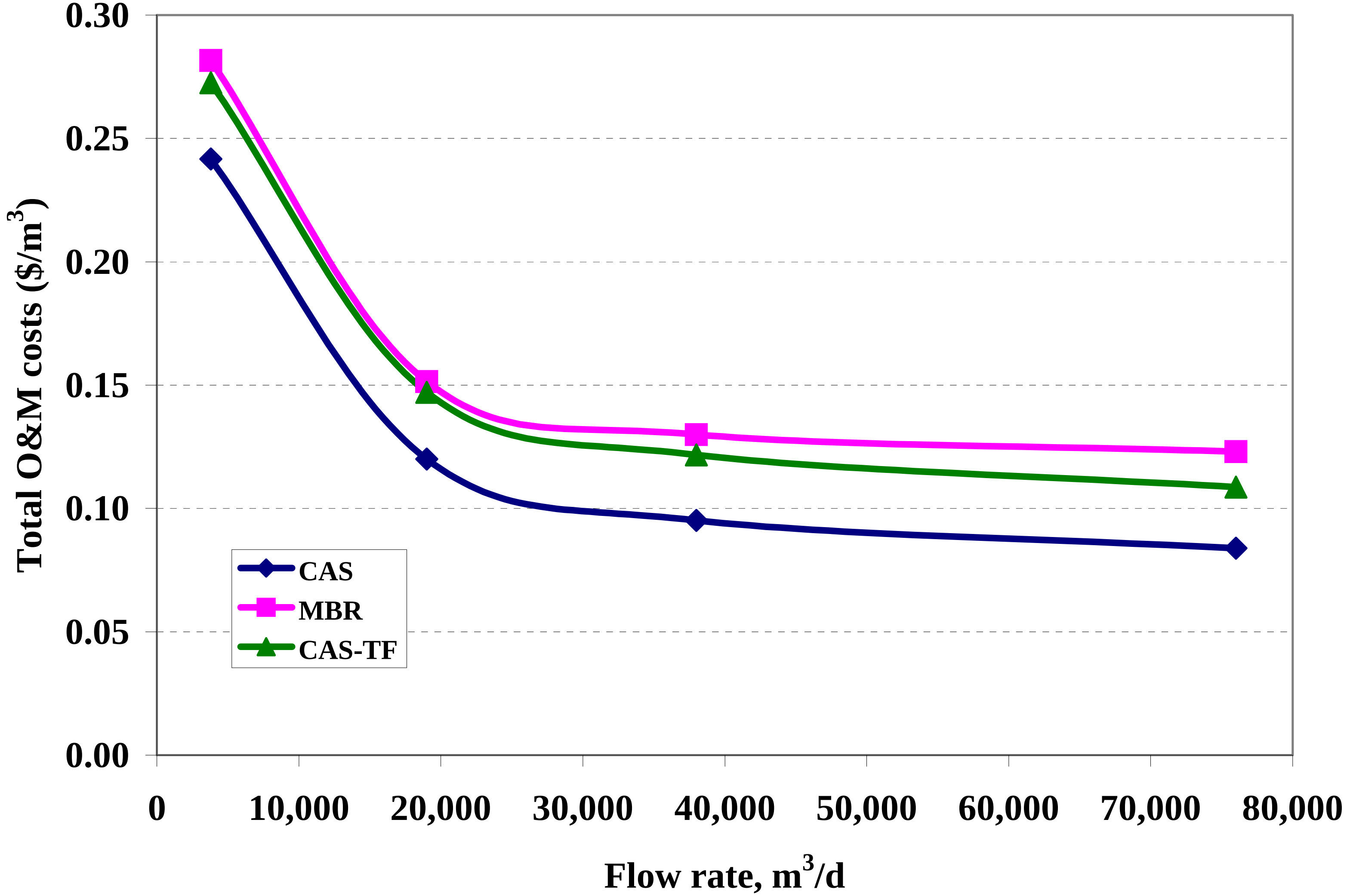
ZW MBR Technical Update

1. Drivers for Change - Efficiency
2. Effective Pre-Treatment
3. Simplified System Design
4. Comprehensive Cleaning Toolbox
5. Optimized Life Cycle Costs - Energy
6. Membrane Life and Warranty
7. Chemical Conditioning

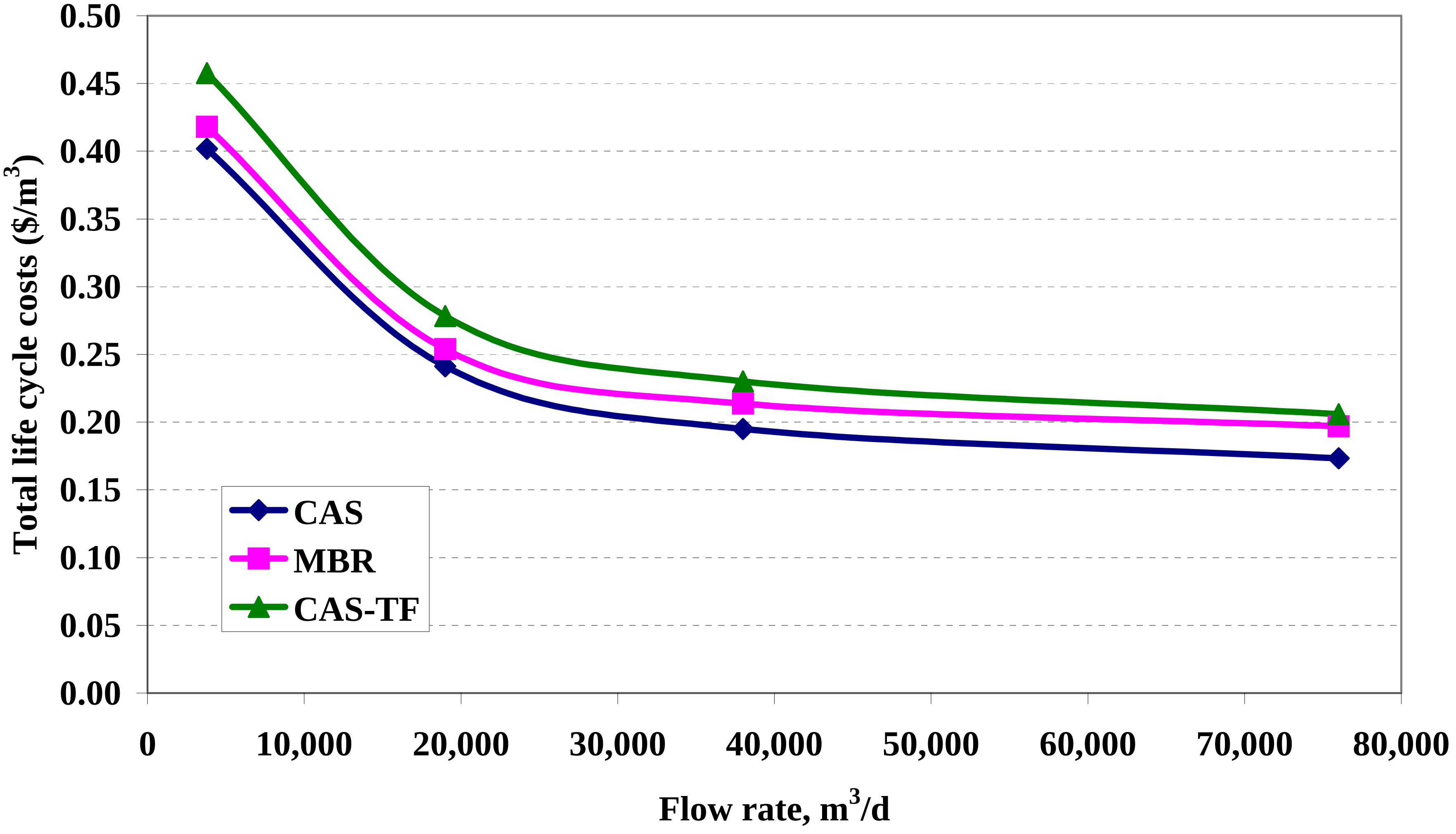
Total Capital Costs



Total O&M Costs



Total Life-Cycle Costs



Pre Screening Experience & Recommendation

Hollow Fibre

Flat Sheet

Acceptable Screen Types

- Internally-fed rotary drum screen
- In-channel rotary drum screen
- Rotating brush screen
- Travelling band screen

Screening Requirement

- **≤2 mm mesh or punched hole, with no possibility of screenings carry-over or bypass**

- **Preferred: ≤1 mm mesh or punched hole screening**

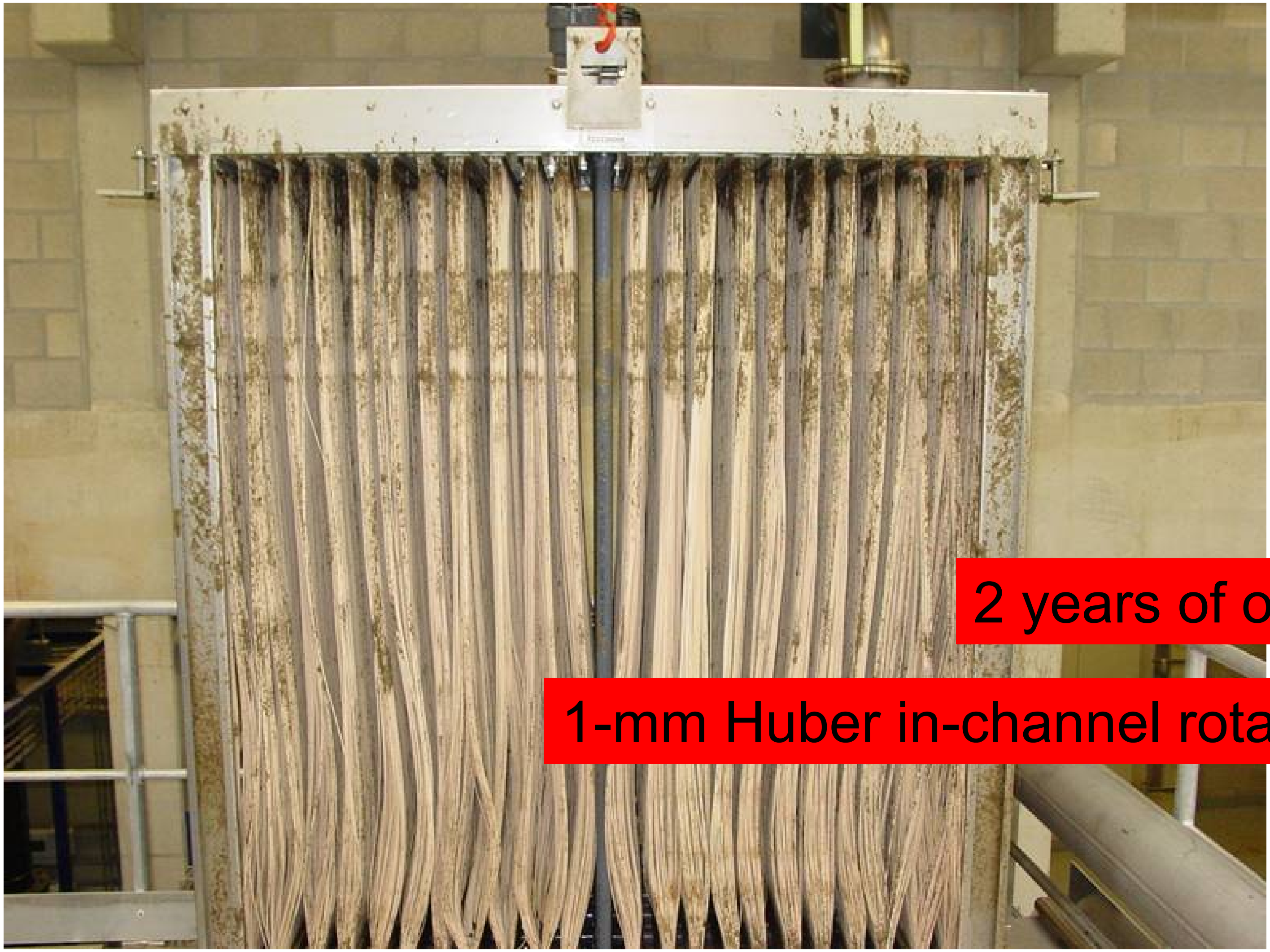
- European market is well on the way to acceptance of ≤1 mm screens

Brescia, Italy

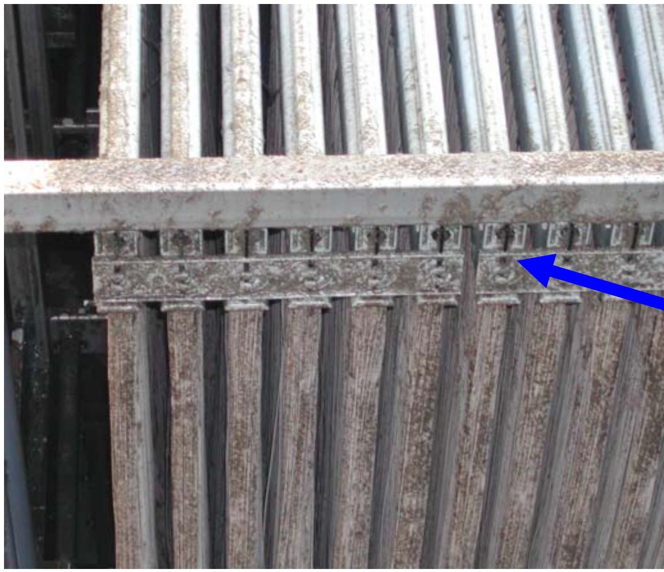
2.5 years of operation

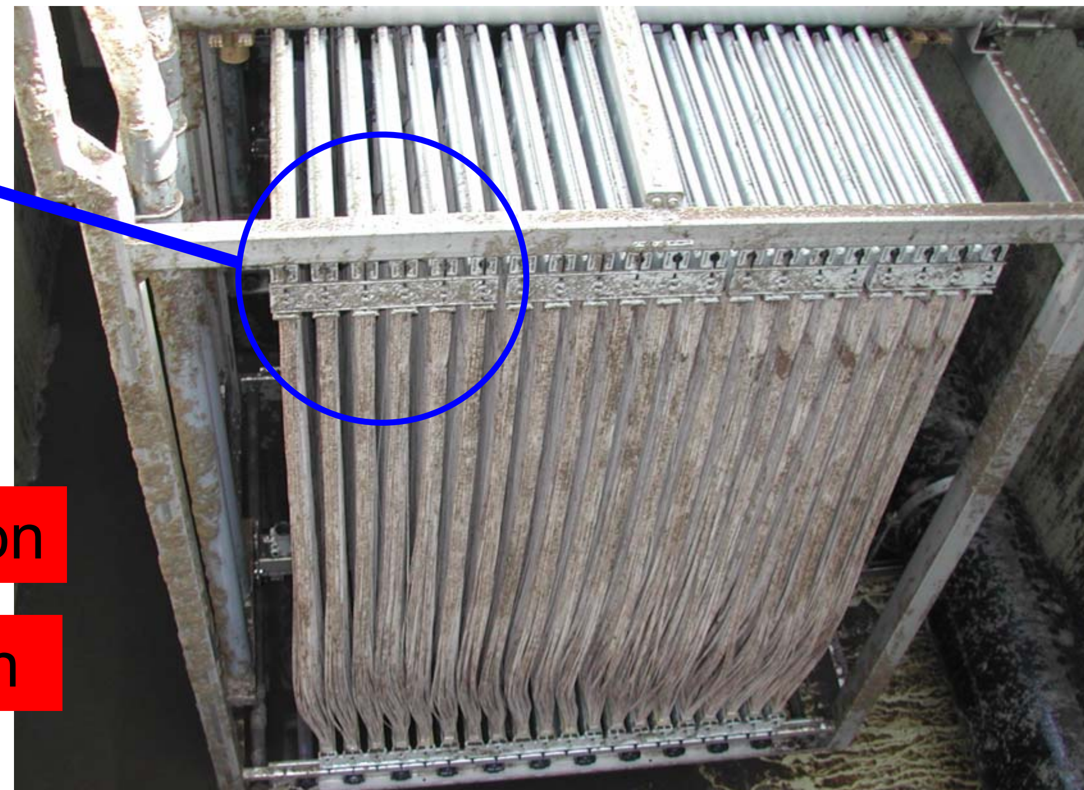
2-mm Huber in-channel rotary drum

Schilde, Belgium



Varsseveld, Netherlands





5 months of operation

0.8-mm rotating brush

Benefits of Fine Screening

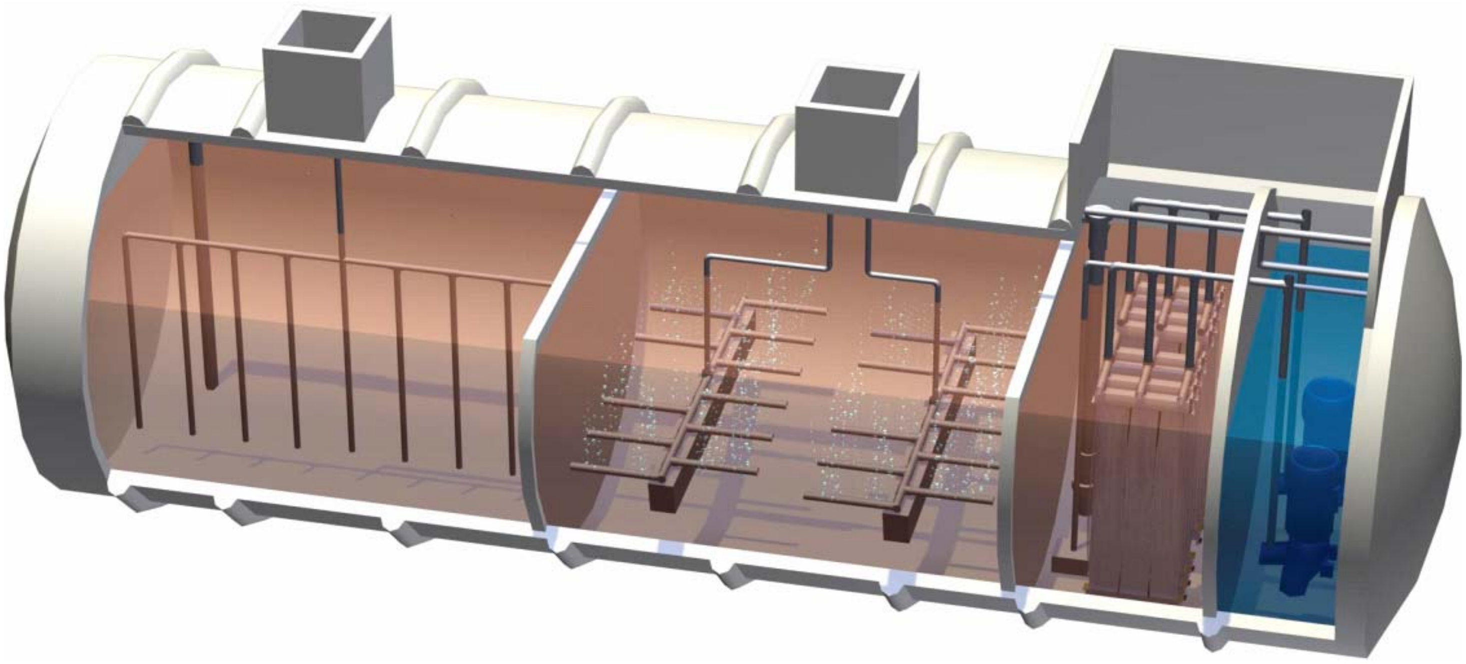
- Higher sustainable flux
- Longer membrane life
- Longer cleaning intervals
- Less equipment maintenance
- Insurance: protection of most valuable asset!

Membrane Filtration System Design

Filtration Package Plants

- Standard MWW units
- ZENON Standard components
- Cost savings due to pre-engineering

Full Scope Package Plants



Custom Membrane System Design

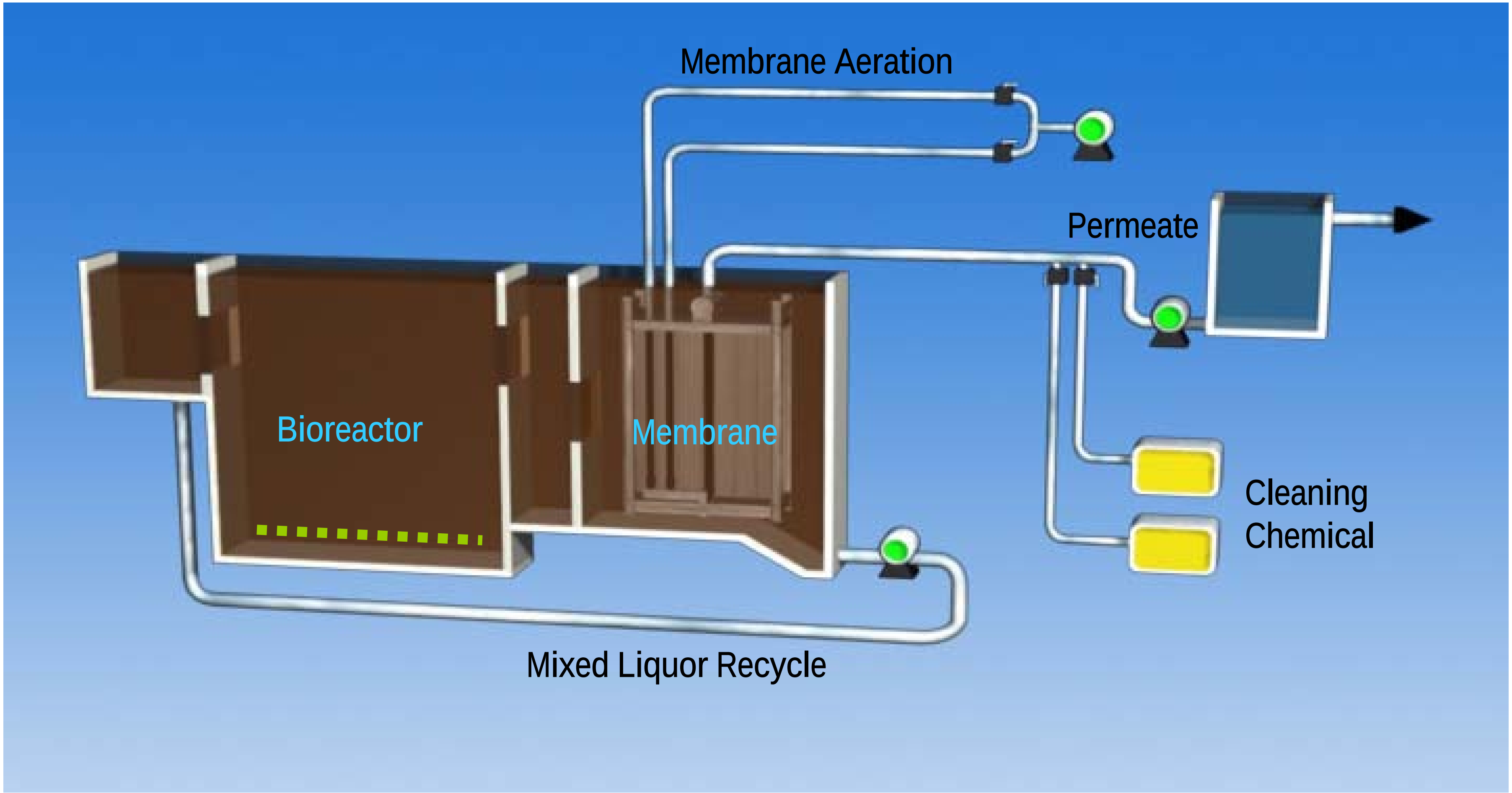
- Reversible pumps
- Removal of air separator
- Siphon designs
- Redundancy

Not So Simple Design

Creemore

Cauley Creek

Simple Design – Reversible Pump



Simple Design using Reversible Pumps

Woodstock

NordKanal

Permeate by Gravity / Siphon

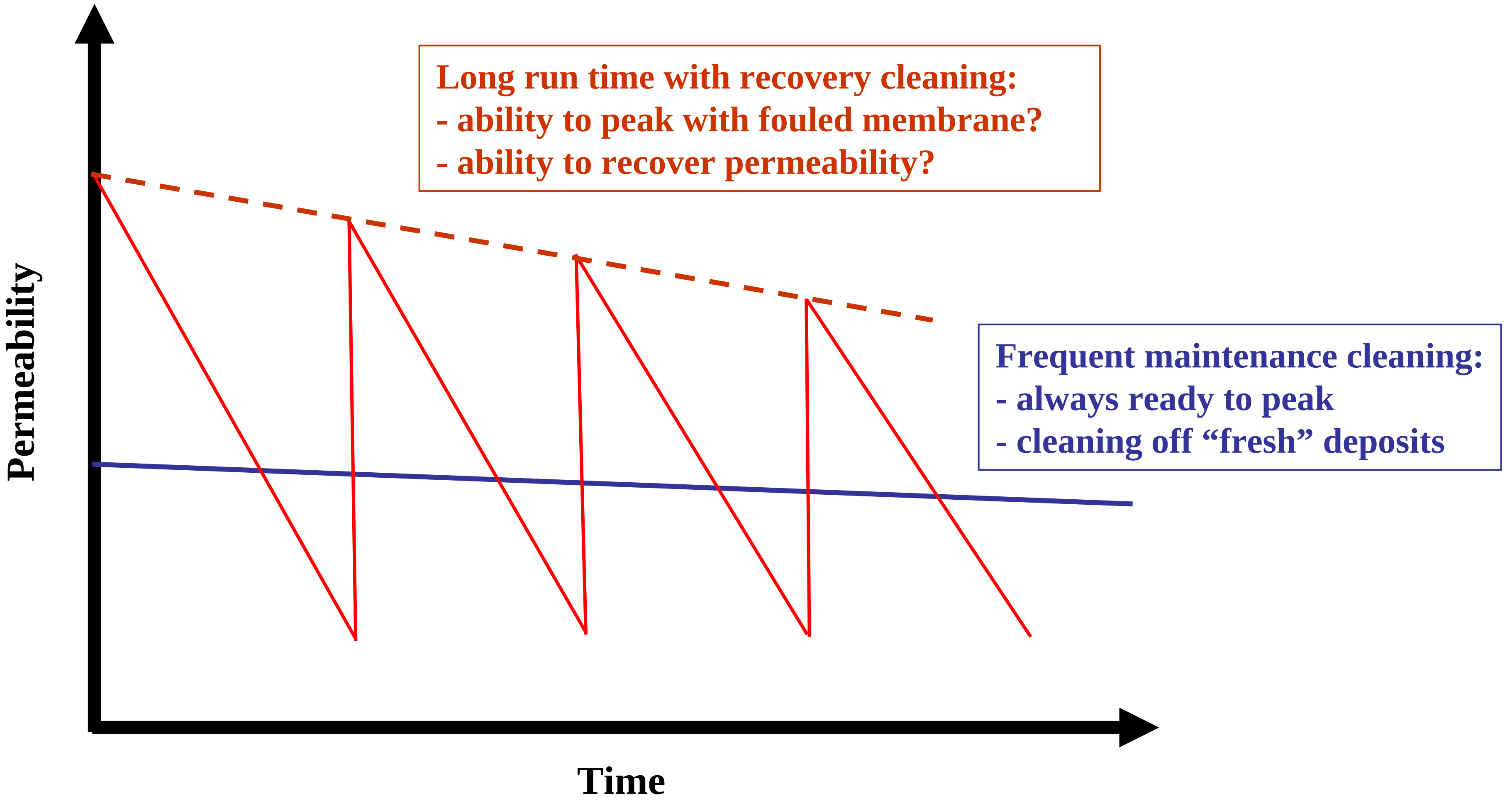
- **ZENON uses a Controlled Siphon** – control valve
- **25 ft minimum head**
- **ZeeWeed® MBR plants**
  - Lowestof, UK
  - Buxton, UK - **4.4 mgd**
  - Linwood, GA – 7 mgd under design

Membrane Cleaning

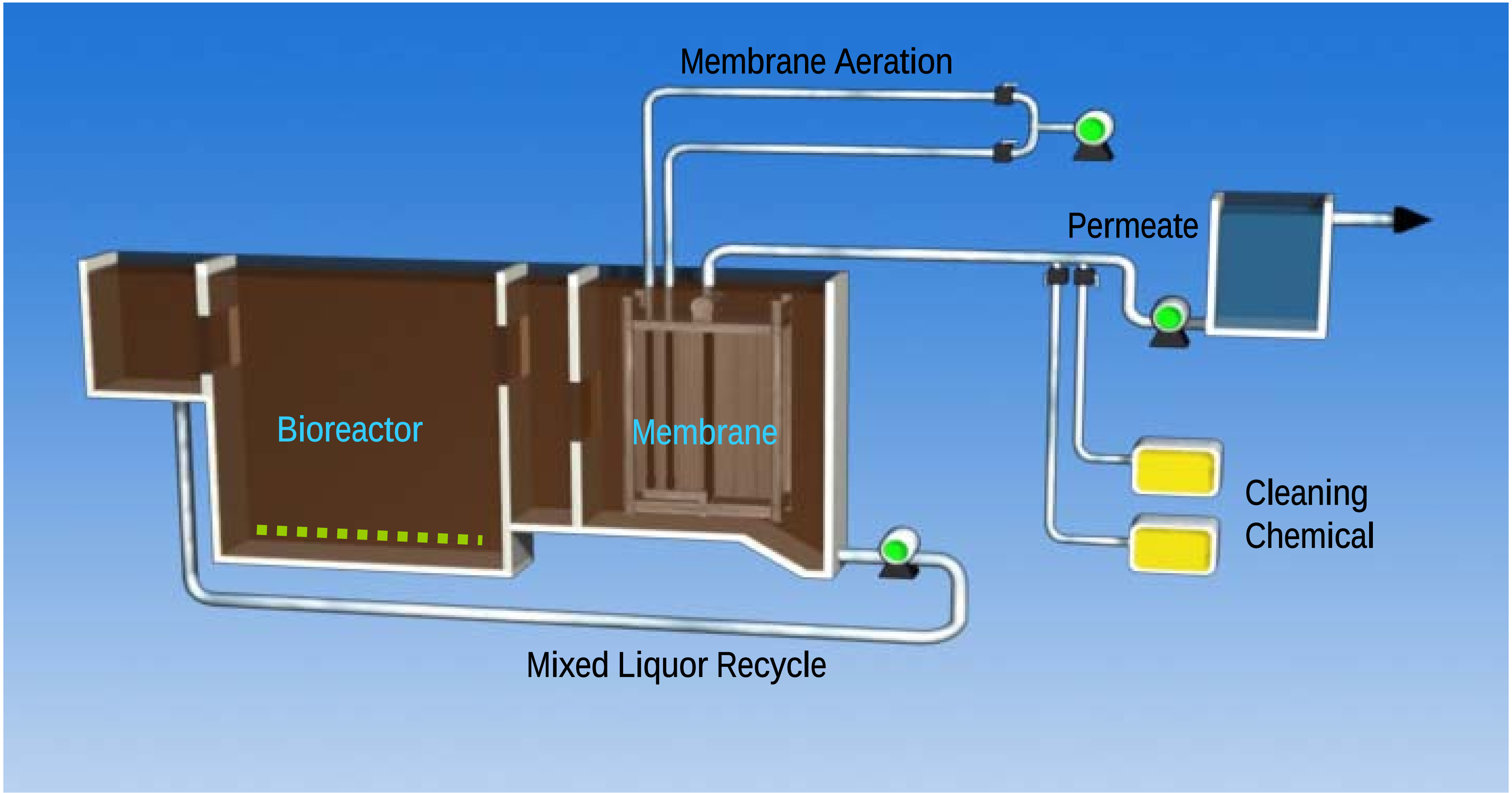
ZENON Cleaning Toolbox

- In-situ membrane cleaning
  - Reduce handling of membranes
- Fully automated cleaning procedure
  - Reduce operator requirements
- Regular, less intense cleaning
  - Maintain a higher membrane permeability
- Backpulse cleaning chemicals
  - Improved cleaning effectiveness

MBR Operation Philosophies

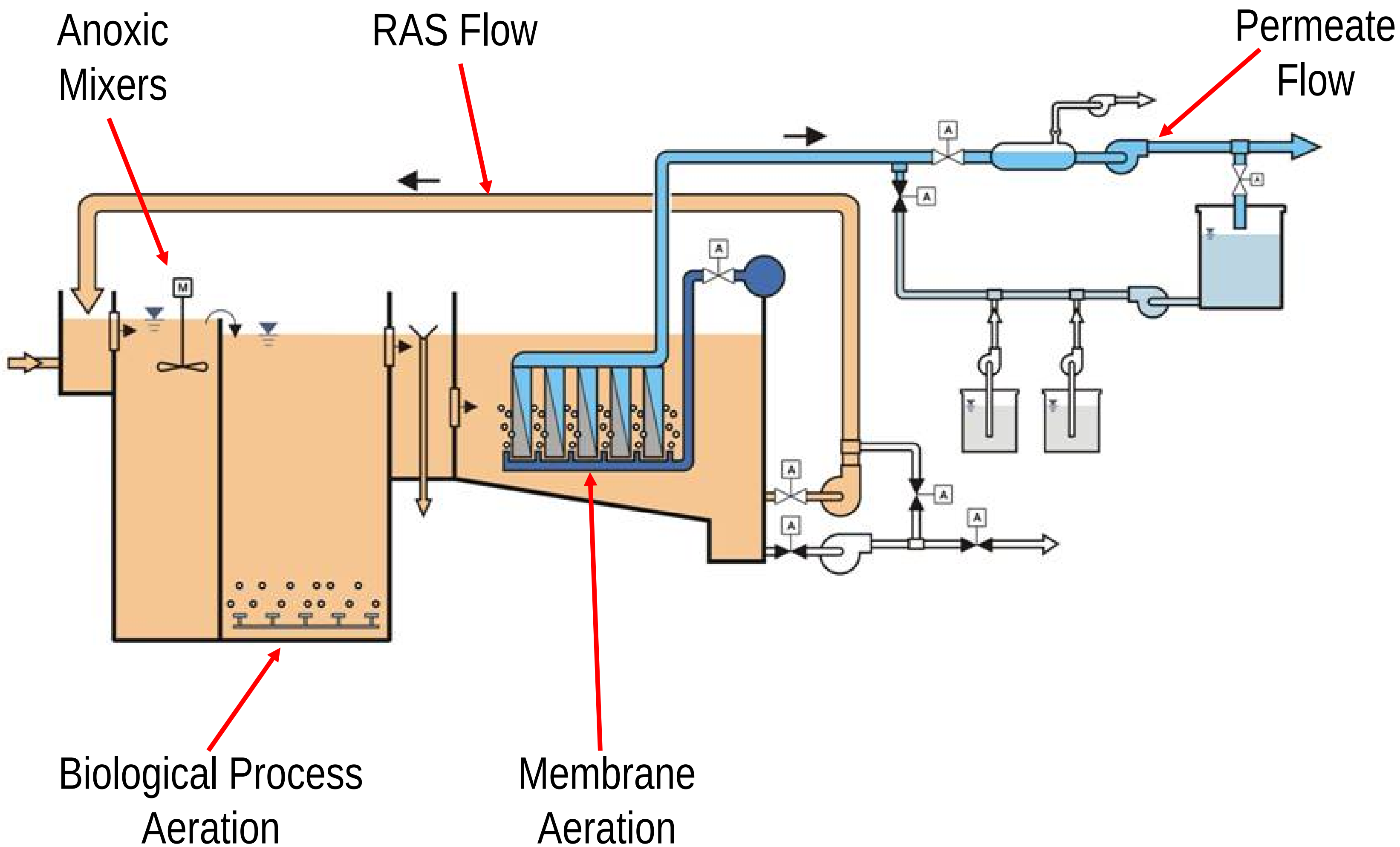


Automated Membrane Cleaning

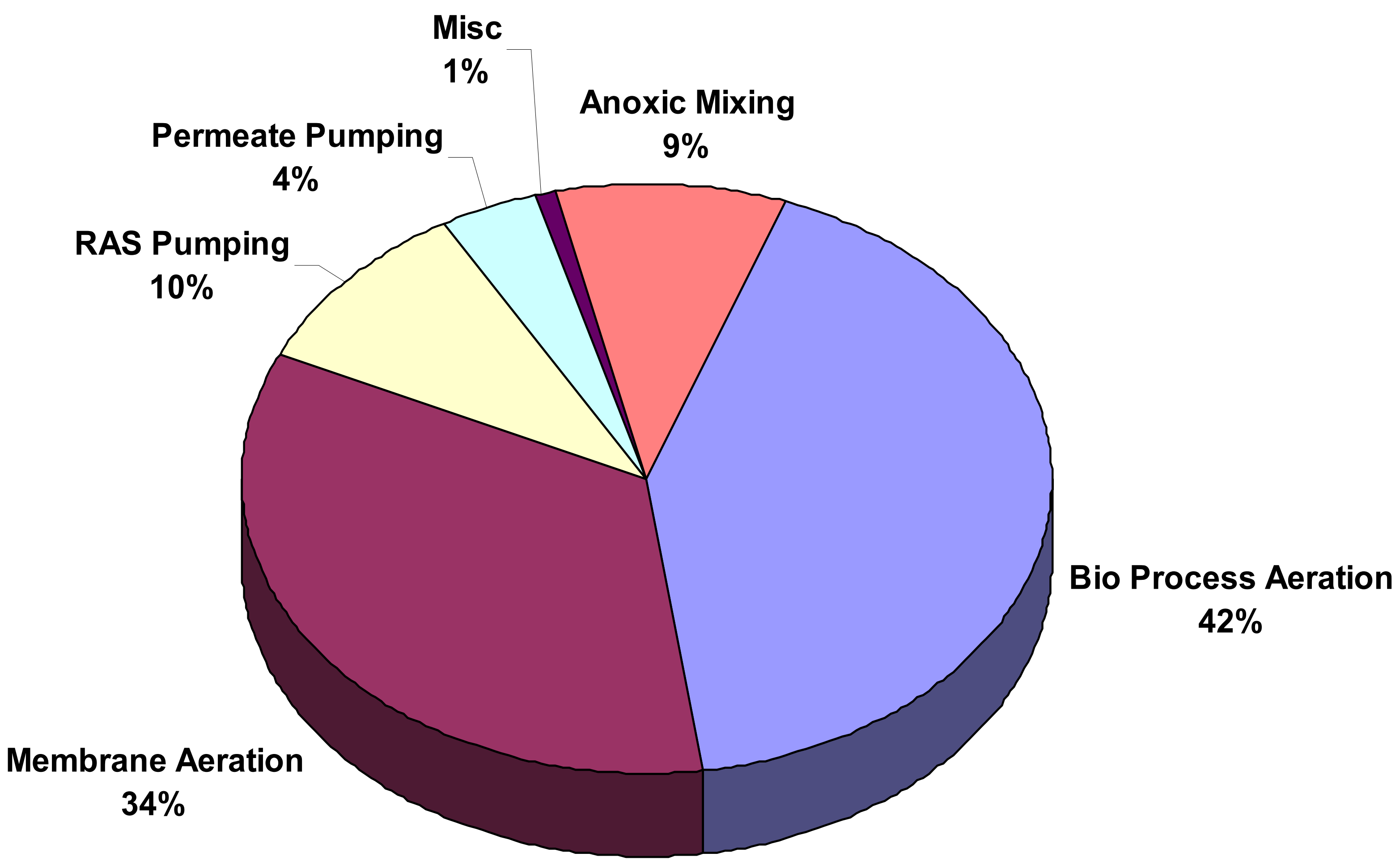


Energy Optimization

MBR Energy Users

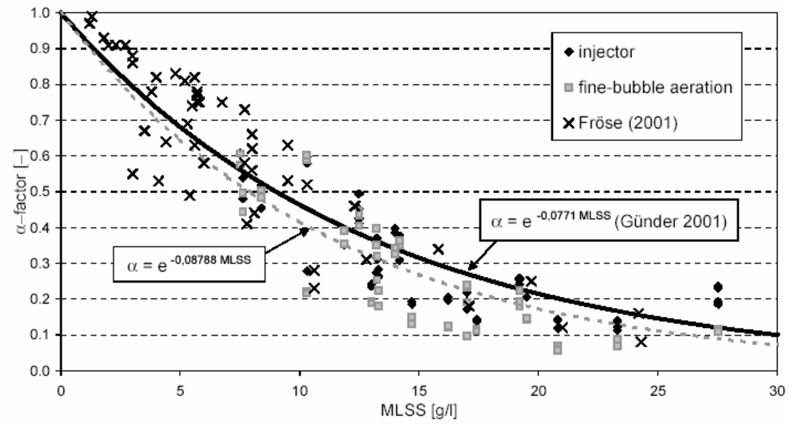


MBR Energy Users

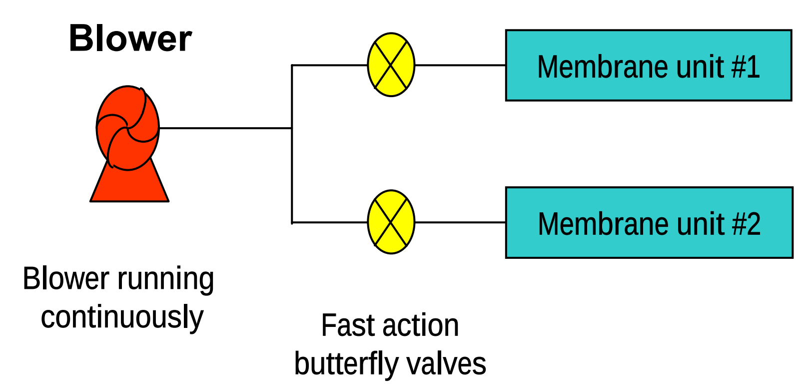


Optimizing Energy Efficiency

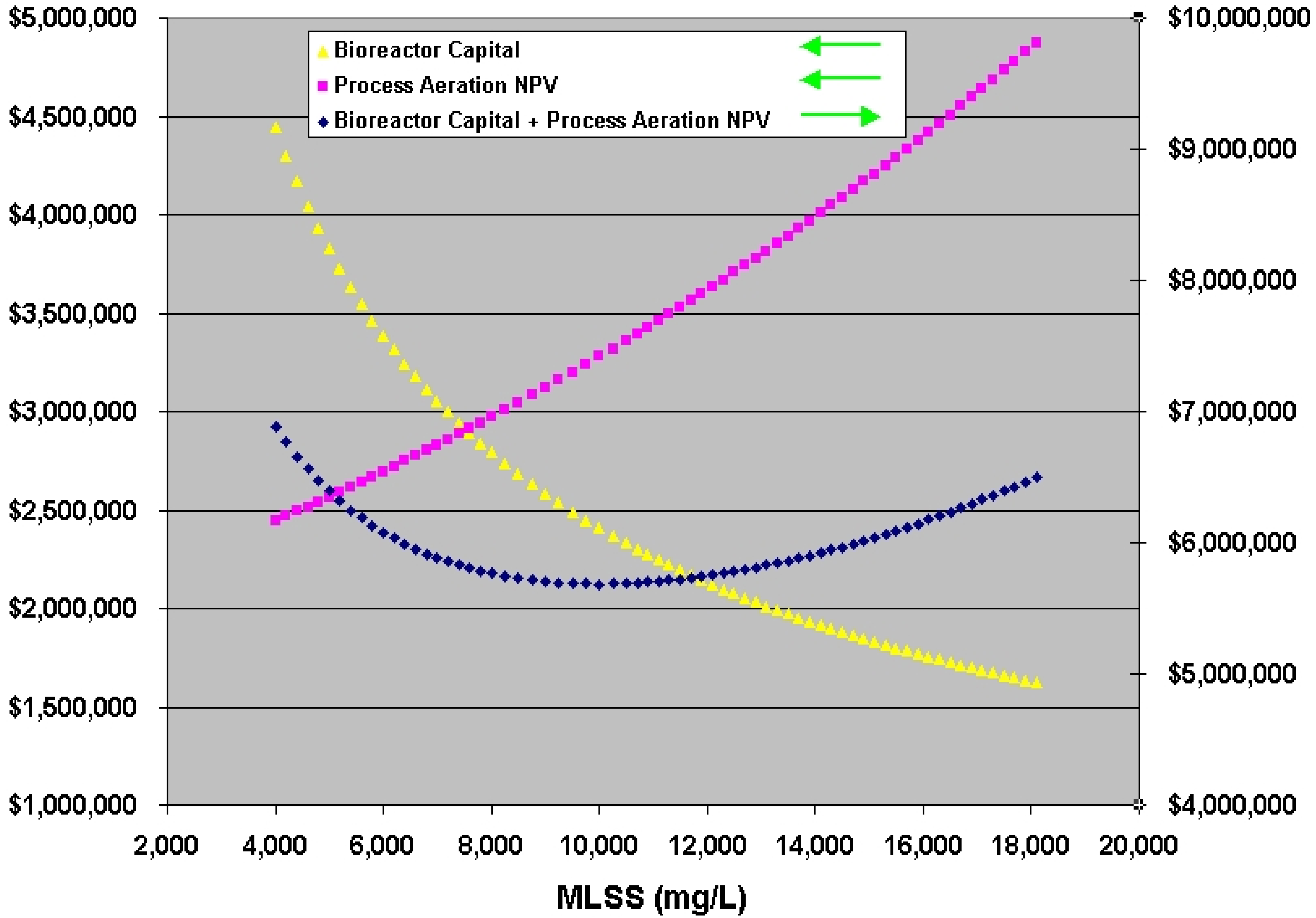
- **Biological process aeration**
  - Select MLSS to optimize OTE
    - Alpha factor decreases at higher MLSS
    - Limitation on OUR at higher MLSS
  - Nit/DeNit recovers energy and alkalinity
  - Fine bubble aeration in bioreactor



- **Membrane aeration**
  - Optimize membrane depth
  - Cyclic aeration

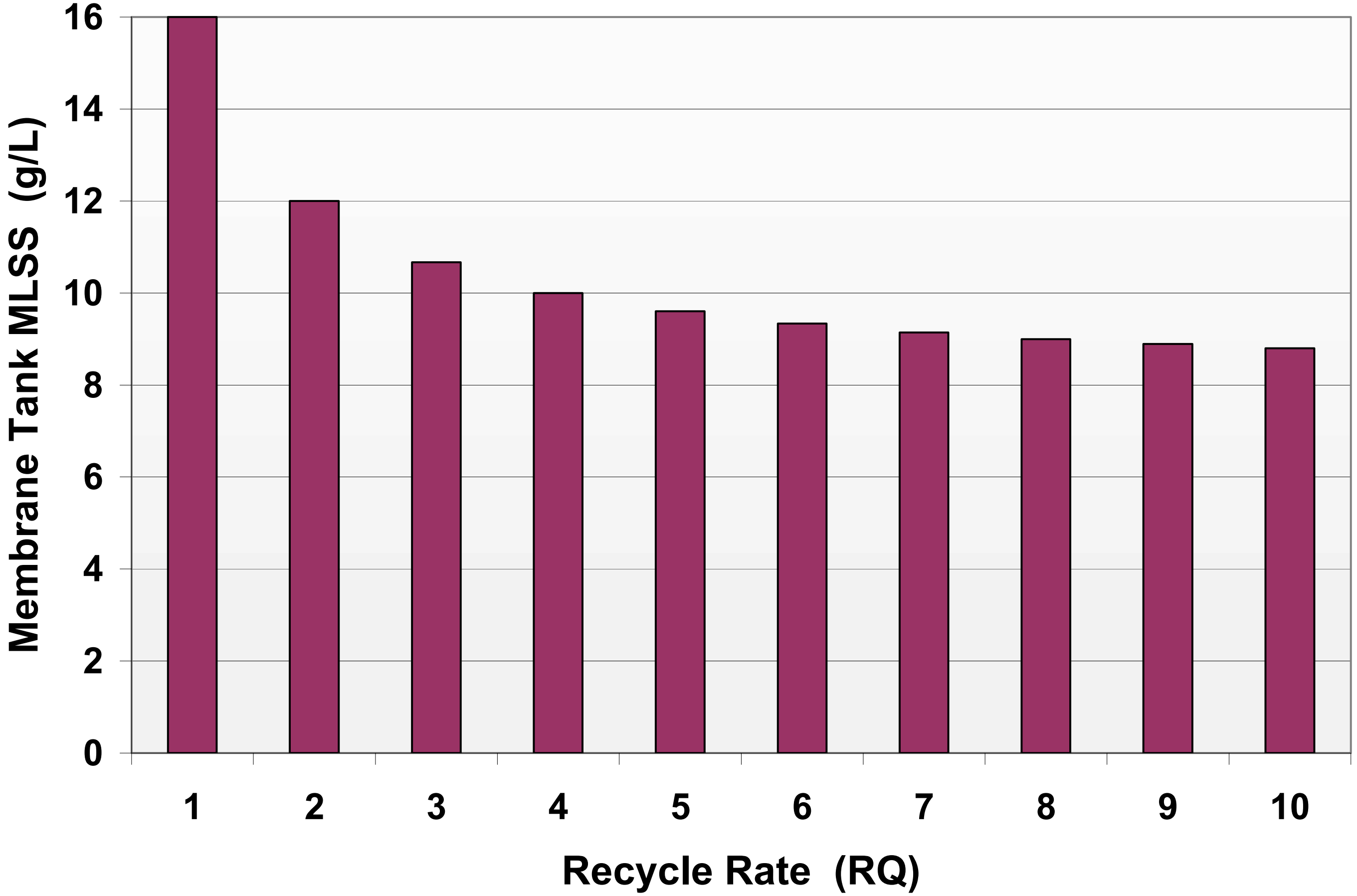


Bio-Process NPV vs. MLSS Concentration



MLSS Distribution

$$MLSS_{membrane\ tank} = \frac{(R+1)}{R} \times MLSS_{bioreactor}$$



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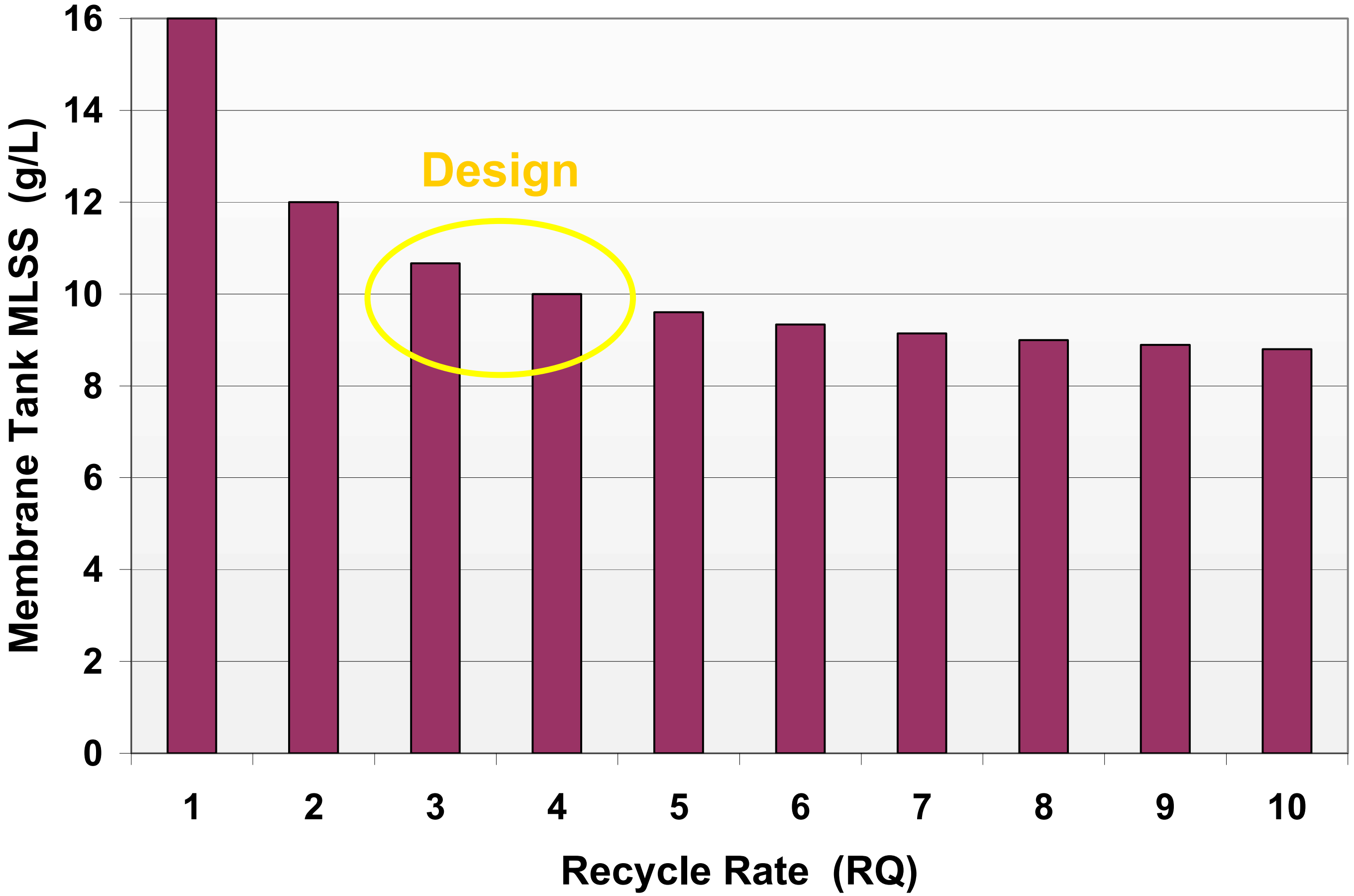
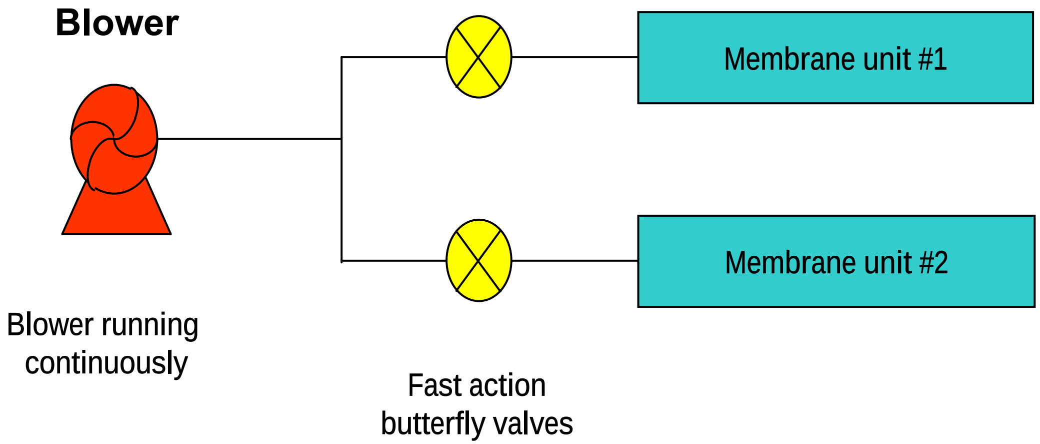


Membrane Aeration

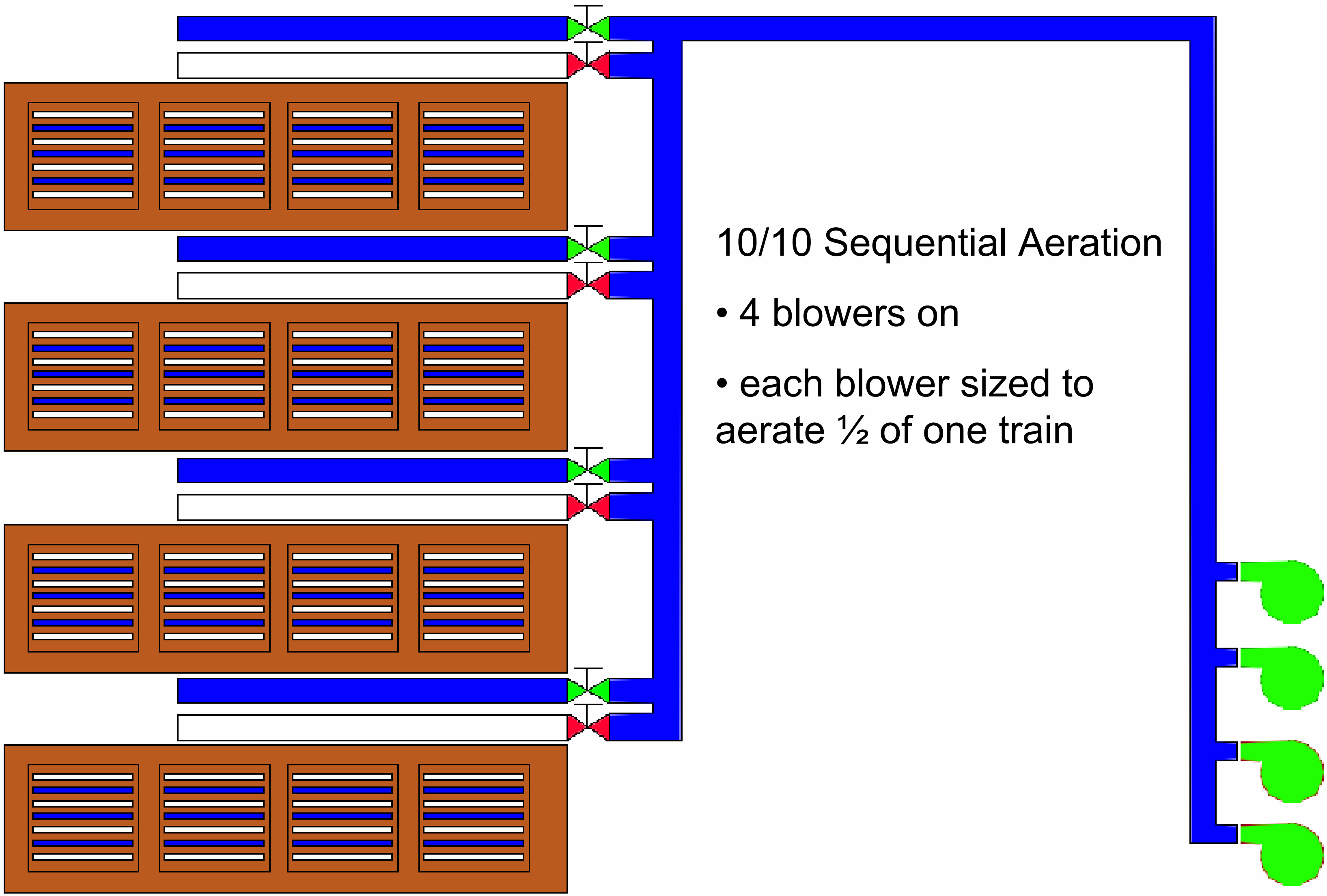
- Optimize membrane submergence to reduce blower discharge pressure
- Effective scouring with course bubble aeration
- Optimized cyclic aeration based on flow



US Patent 6,245,239

10/30 Aeration at ADF

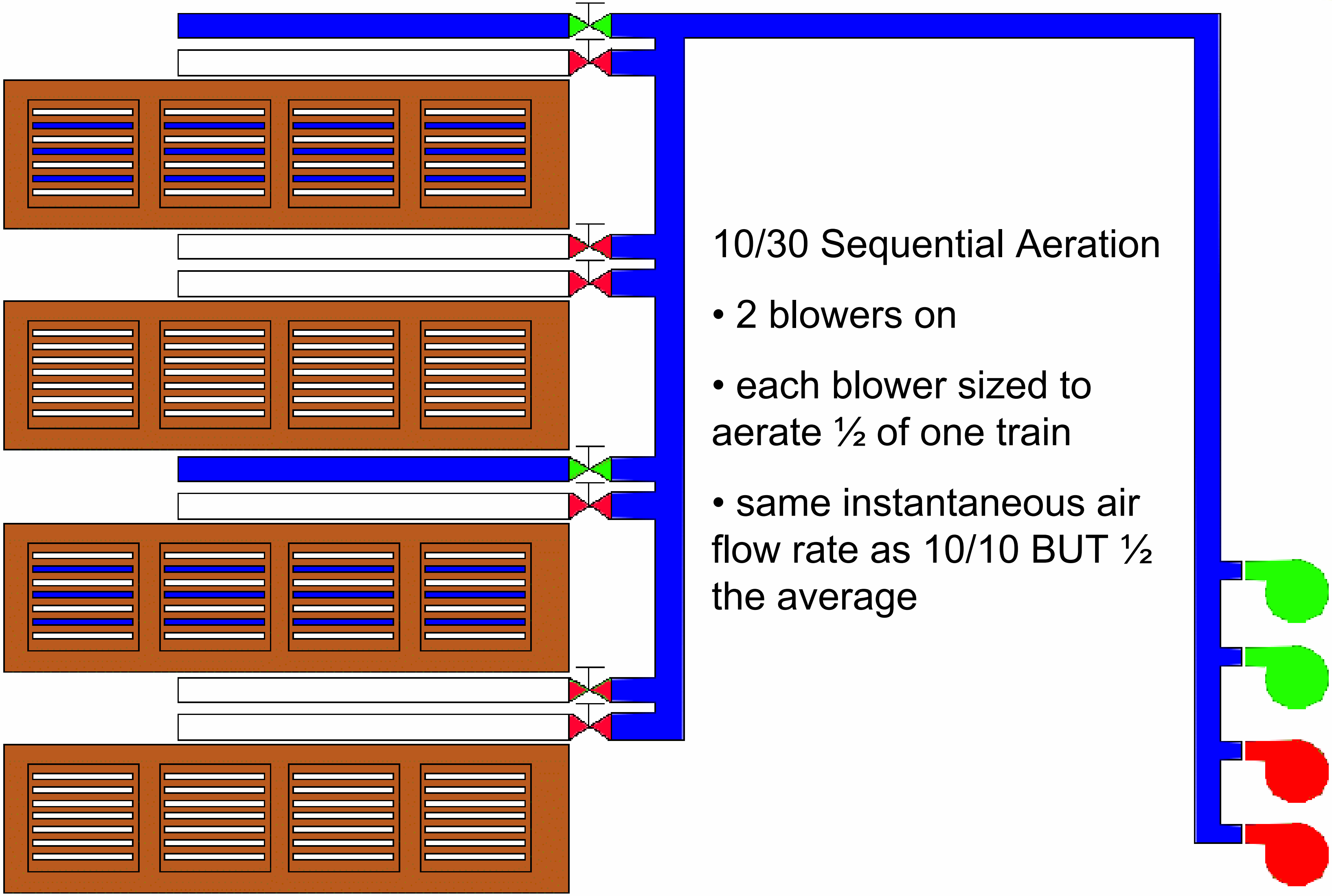
- Optimized cyclic aeration based on flow
- Maintain 10/10 Aeration at or above ADF
- Run at 10/30 Aeration below ADF
- 50% Savings compared to 10/10 = 7-10% LCC



10/10 Sequential Aeration

- 4 blowers on
- each blower sized to aerate ½ of one train

Note – Airflow is blue

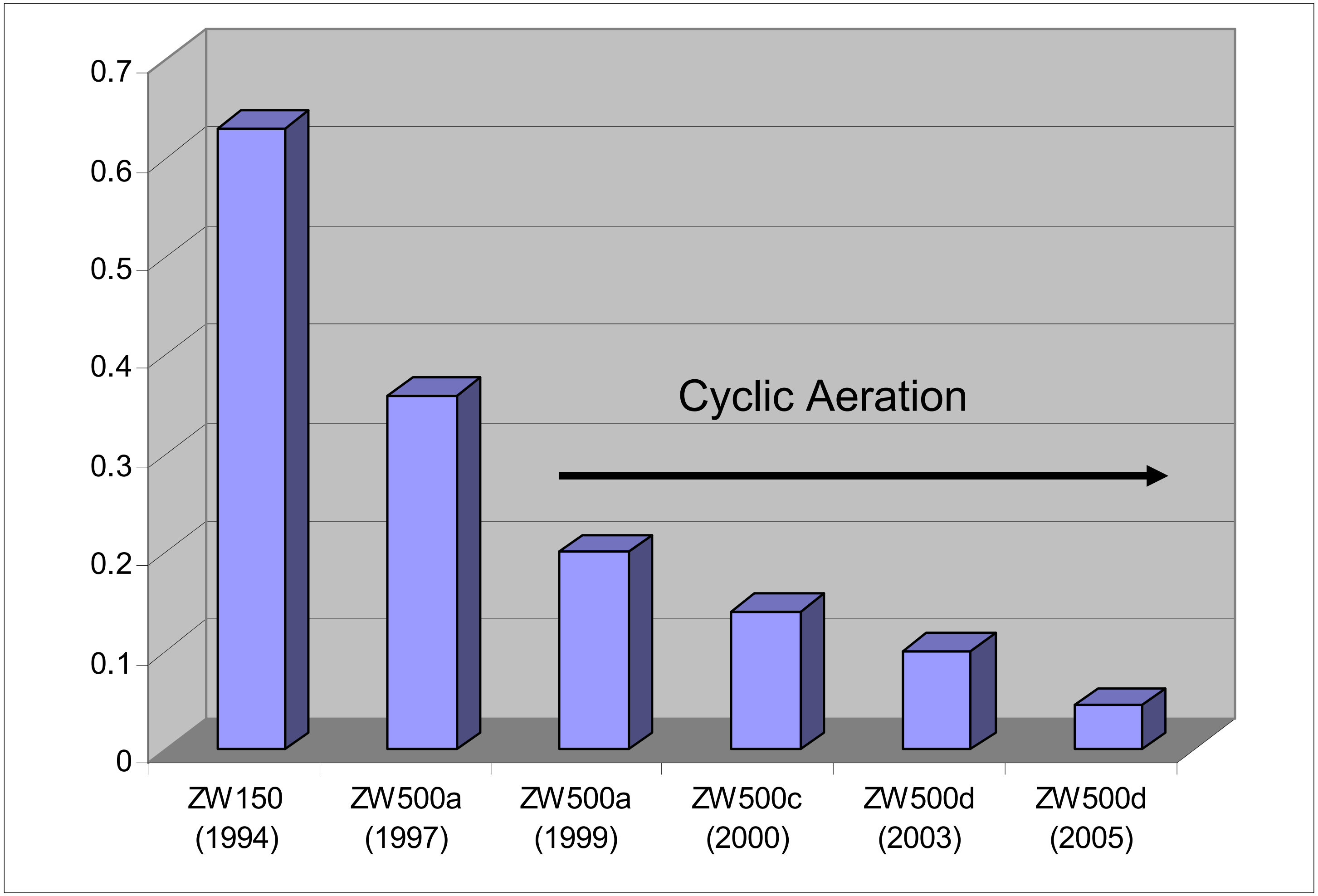


10/30 Sequential Aeration

- 2 blowers on
- each blower sized to aerate ½ of one train
- same instantaneous air flow rate as 10/10 BUT ½ the average

Note – Airflow is blue

Evolution of ZeeWeed Membrane Aeration



ZeeWeed® Cassette Scale-Up

Larger Cassettes = Lower Capital + O&M Costs

ZW-500a (1997)

4,000 ft^2
80,000 gpd

ZW-500c (2000)

5,500 ft^2
110,000 gpd

ZW-500d (2002)

16,300 ft^2
326,000 gpd

ZW-500d (2005)

21,800 ft^2
436,000 gpd

Increasing Size
Decreasing $ / gal

Membrane Life and Warranty

Key Factors for Extended Membrane Life

- Select a robust membrane
- Protect the membrane
- Keep the membrane clean
- Design with a conservative flux
- Finite life time capacity

Design Flux Selection

- Based on long-term, full-scale experience, rather than short-term data or pilot studies
- Design based on limiting hydraulic conditions
  - Maximum Flow
  - Minimum Temperature
  - Performance Beyond 5 Years
  - Minimum Safety Factor

Recommend Specifying

Minimum Membrane Area **or** Maximum Peak Flux

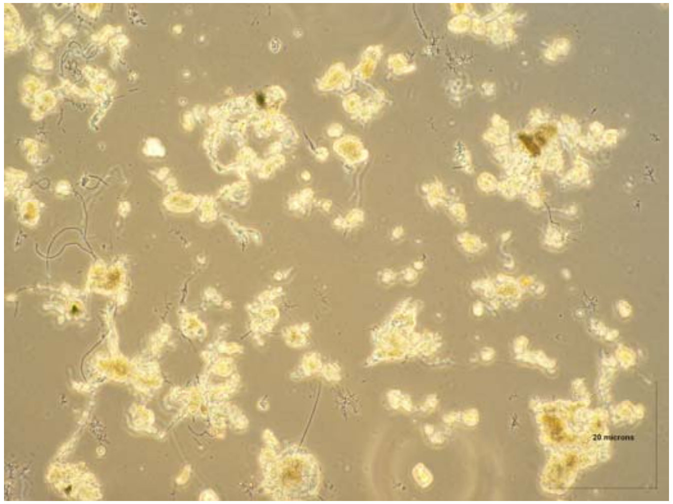
Life Time Membrane Capacity

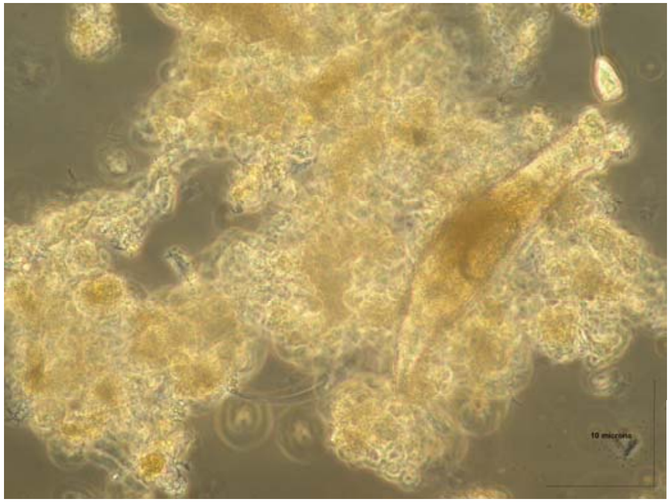
Operating Flux [gfd]	5 yrs [gal/ft2]	8 yrs [gal/ft2]	10 yrs [gal/ft2]	15 yrs [gal/ft2]
5	9,125	14,600	18,250	27,375
10	18,250	29,200	36,500	54,750
15	27,375	43,800	54,750	82,125

Chemical Conditioning

Sludge Quality?

- Settleability not important
- Sludge Quality is a factor
- How do we measure?





Which of the following parameters are more important for MBR fouling

- TTF
- DSVI
- MLSS
- Specific cake resistance
- Silt density index (SDI)
- Fouling index (FI)
- Modified fouling index (MFI)
- Particle size distribution (>1.5 µm)

- Colloidal TOC
- Soluble EPS
- Soluble carbohydrate
- Soluble protein
- Soluble humic acid

- Temperature
- Bound EPS
- Zeta-potential

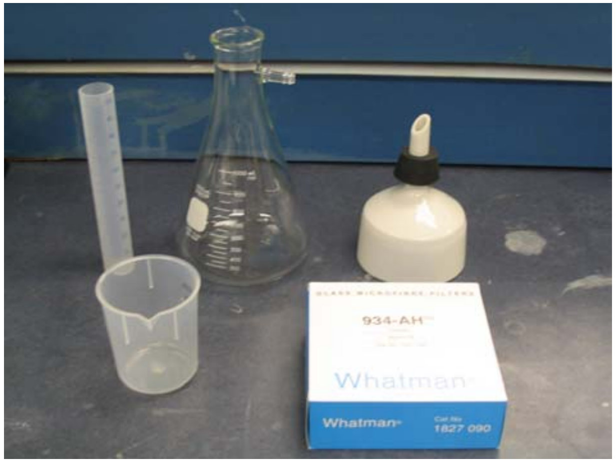
Which of the following parameters are more important for MBR fouling

- **TTF**
- DSVI
- MLSS
- Specific cake resistance
- Silt density index (SDI)
- Fouling index (FI)
- Modified fouling index (MFI)
- Particle size distribution (>1.5 µm)

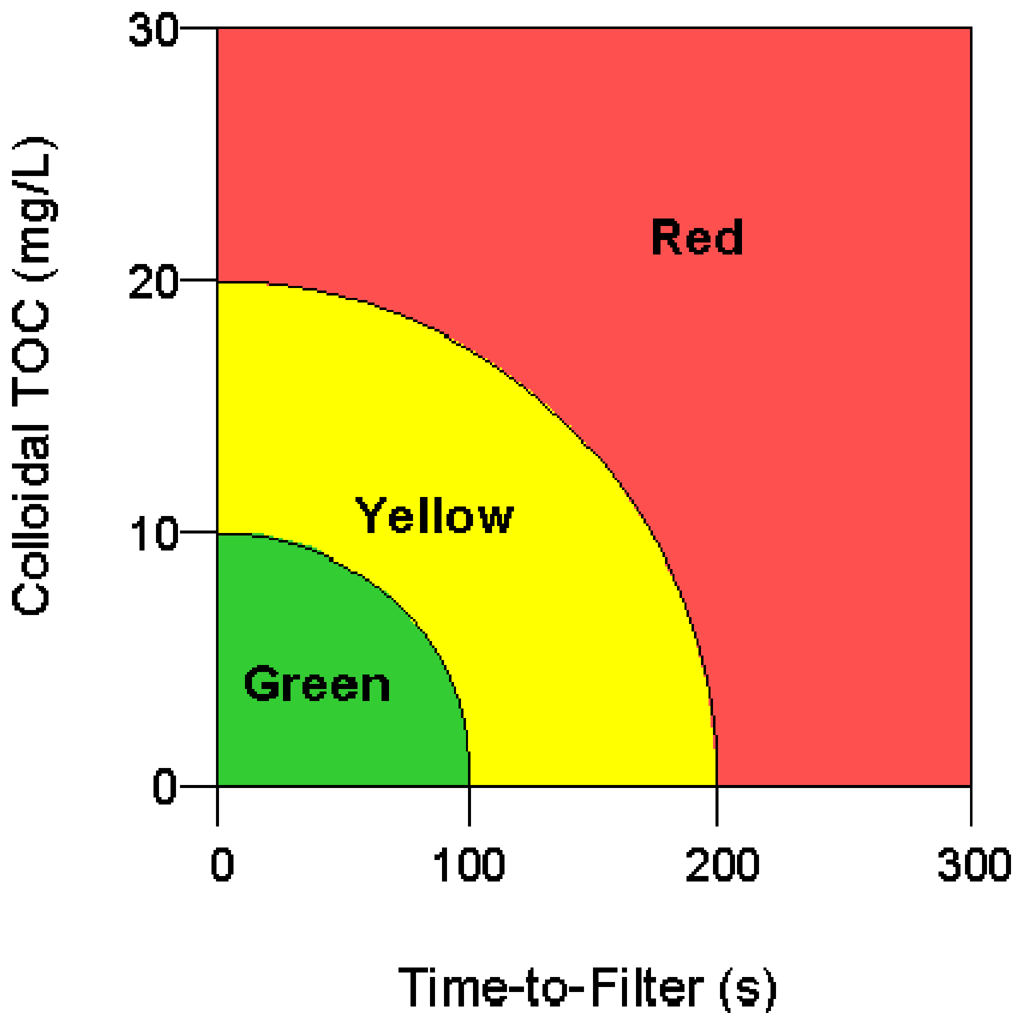
- **Colloidal TOC**
- Soluble EPS
- Soluble carbohydrate
- Soluble protein
- Soluble humic acid

- Temperature
- Bound EPS
- Zeta-potential

Sludge Quality - TTF

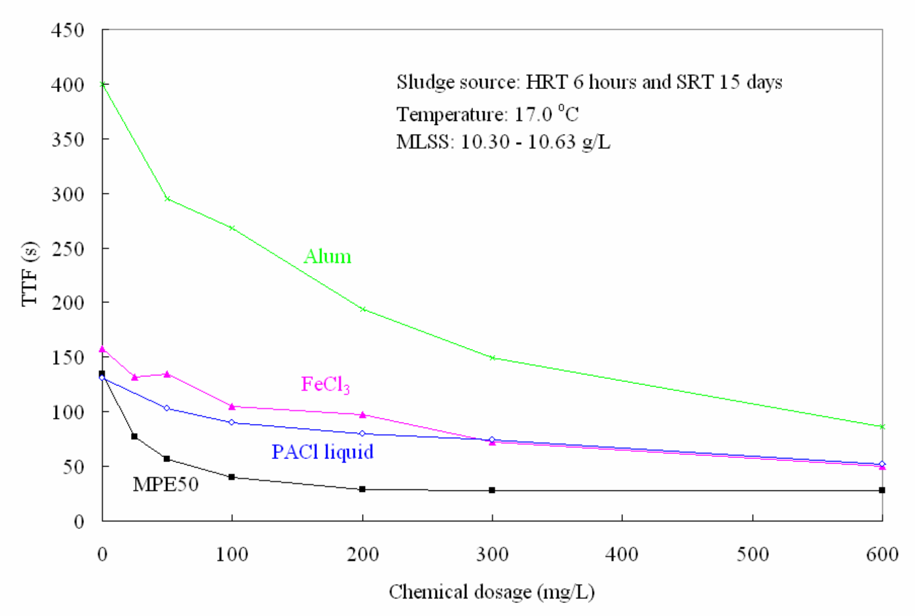


Sludge Quality?



Chemical Conditioning

- Coagulants, Polymers
- Significant Improvements
- Reliability
- Design Implementation

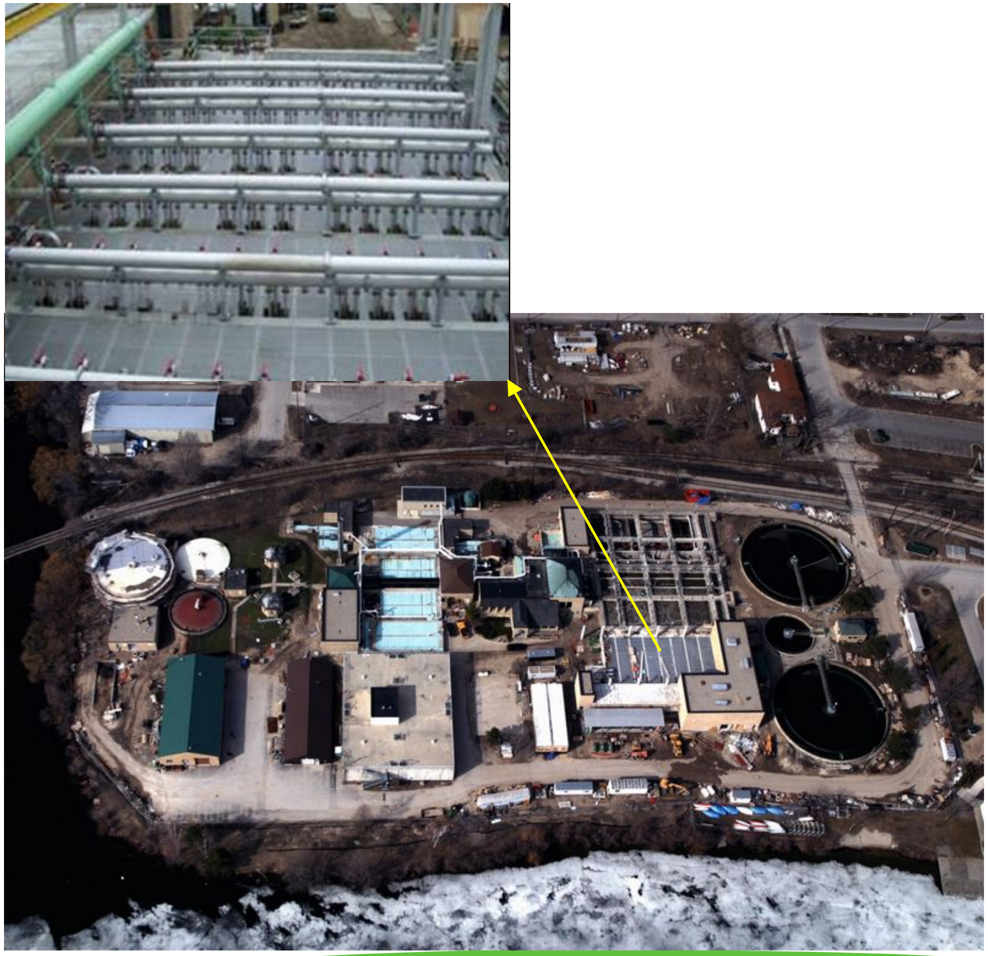


New Projects

Traverse City, MI

ADF: **7.1 MGD (26,500 m^3/d)**

Commission Date: **Summer 2004**

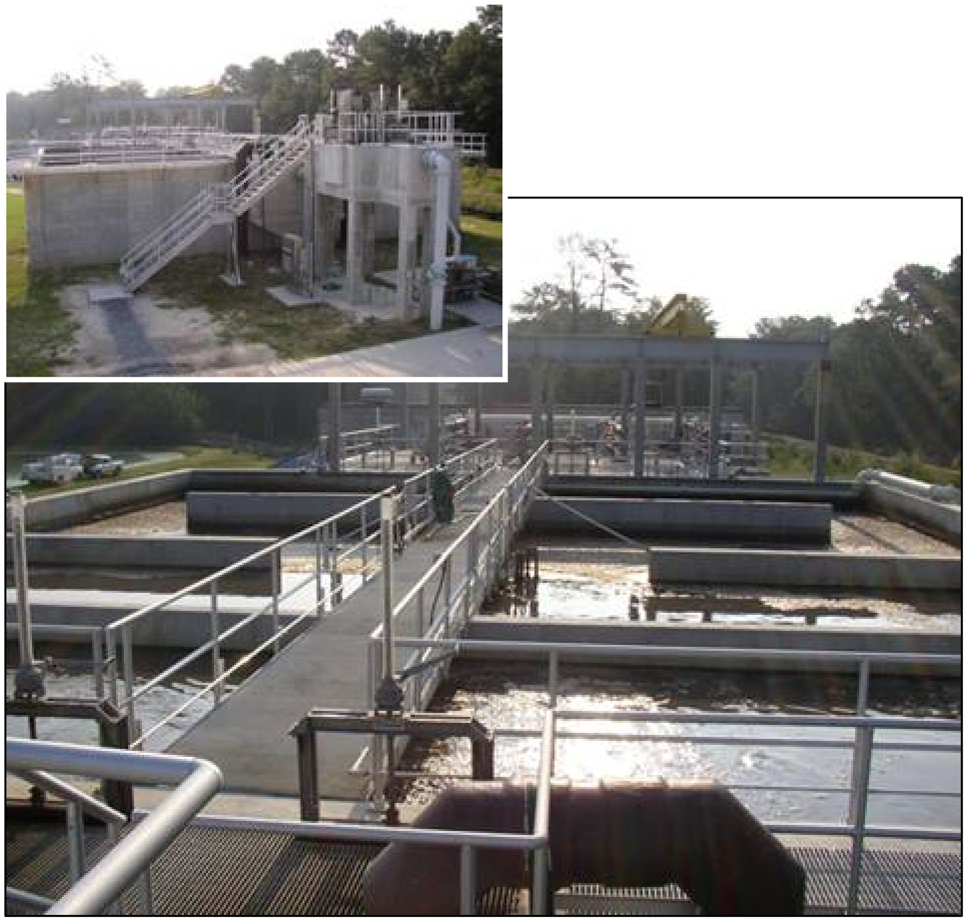


- Largest operating MBR based on peak flow
- Peak flow 17.2 mgd (65,000 m^3/d)
- Primary Clarifier + Fine Screen
- 8 ZW500 trains
- Bio-P Removal

Pooler, Georgia

ADF: **2.5 MGD (9,463 m^3/d)**

Commission Date: **November, 2004**

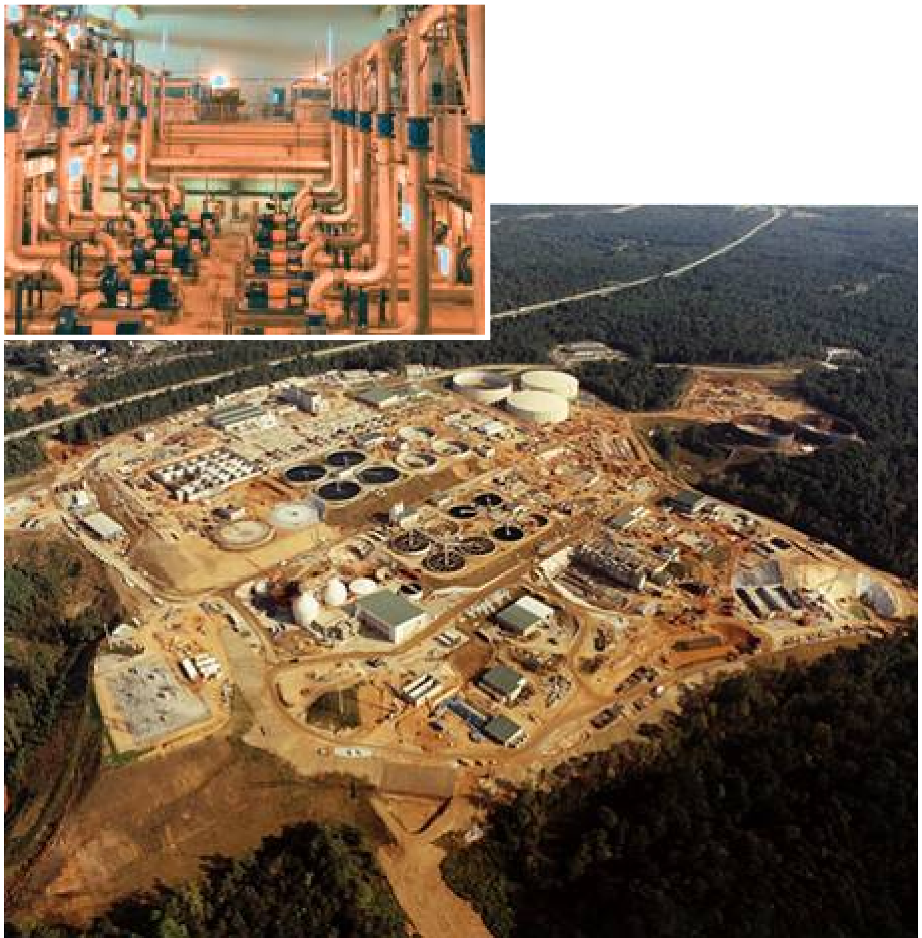


- Located near Savanna, GA
- 4 ZW500d trains with reversible pumps
- Simple, cost effective layout & construction
- Process optimization for flows < design

F. Wayne Hill Water Resources Center

ADF: **47 MGD (177,914 m^3/d)**

Commission Date: **Summer 2005**



- Largest membrane tertiary filtration plant
- 16 ZW500 Trains
- Very strict effluent limits
  - Turbidity < 0.1 NTU
  - Particle Count < 10#/ml
- Discharges to Lake Lanier
  - Recreational and indirect potable reuse

Jackson, Ohio

ADF: **2 MGD (7,571 m^3/d)**

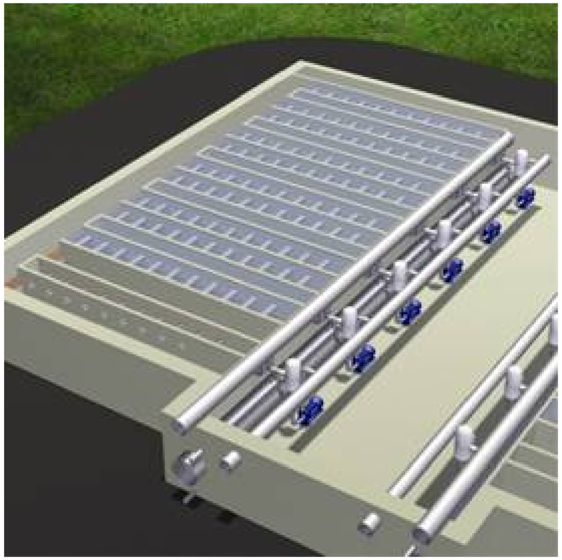
Commission Date: **2006/2007**

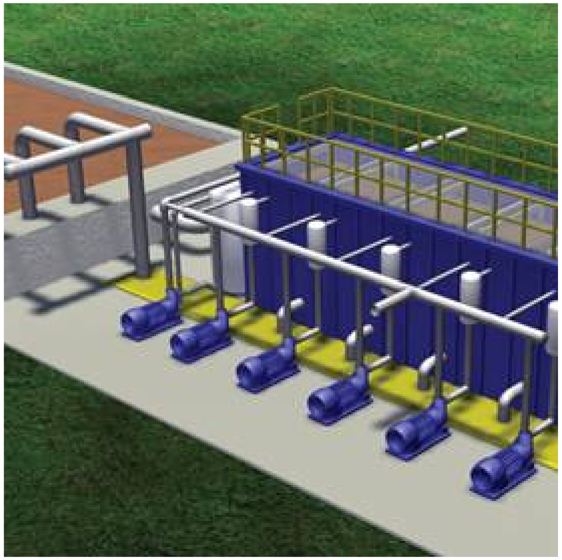
- Retrofit of old aeration tanks
- Will operate in parallel with existing ox ditches
- 4 trains, reversible pumps
- Zenon evaluated against other MBRs
- Selected based on experience and costs

Brightwater WWTP

ADF: **31 MGD (117,347 m^3/d)**

Commission Date: **Expected 2009/10**





- World's Largest MBR awarded
- Phase 1 peak hour flow 44 mgd
- Phase 2 peak hour flow 57 mgd
- 10 trains at buildout
- 24 mgd of Class A Reclaimed Water
- Evaluated Bid

Marco Island, Florida

ADF: **3 MGD (11,356 m³/d)**

Commission Date: **June, 2006**

- Largest skid mounted system
- 5 mgd Peak Hour Flow
- 3+1 train - Fully redundant train (tank & skid)
- Skid includes:
  - Process pump
  - RAS pump
  - Membrane blower
  - PLC
  - MCC
  - All values and wiring
- Negotiated

Peoria, Arizona

ADF: **10 MGD (37,854 m^3/d)**

Commission Date: **2007**

Courtesy of B&V and City of Peoria

- One of the fastest growing cities in the US
- Initial peak to 20 mgd
- Build-out to 13/26 mgd
- 10 membrane trains
- MBR evaluated against conventional
- Zenon evaluated against other MBRs
- Selected based on experience and costs

Henderson South Wastewater Reclamation Facility

ADF: **8 MGD (30,283 m^3/d)**

Commission Date: **July, 2009**

Courtesy of CH2M Hill and City of Henderson

- Fast growing community outside of Las Vegas
- Peak hour flow 13.6 mgd
- 8 membrane trains
- Evaluation based on defined lifecycle costs
- Zenon lowest LLC

Thank You!

Questions and Answers