

Ceramic Microfiltration Allows Reuse of Challenging Wastewaters at Two U.S. Locations

Dave Holland
Senior Process Engineer



AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

Presentation Outline

Membrane Description

System Features

Performance

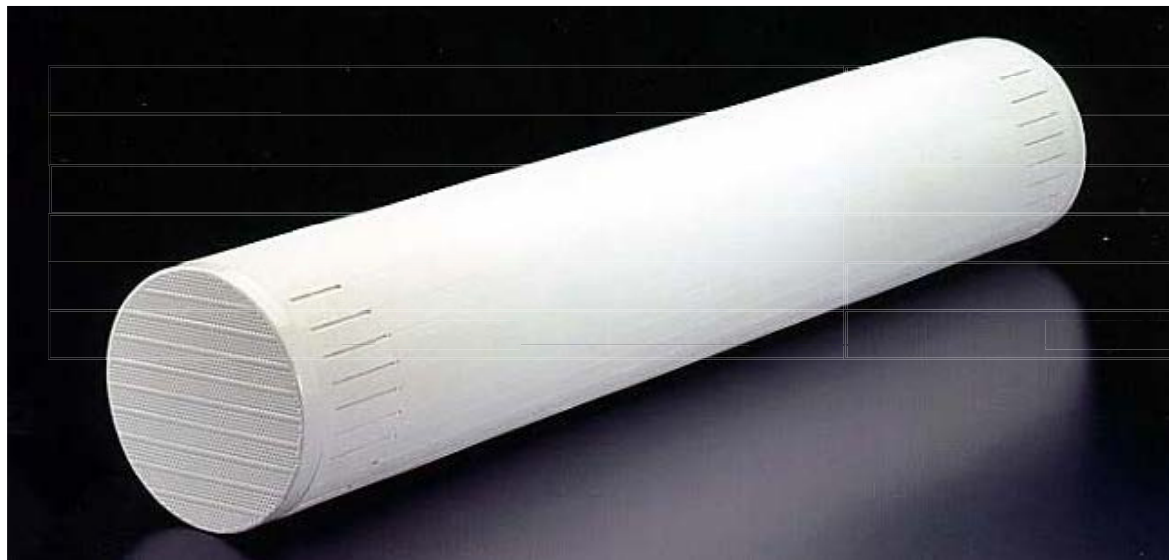
Experience

Flowback Water Application

Blended Wastewater Application

Membrane Specifications

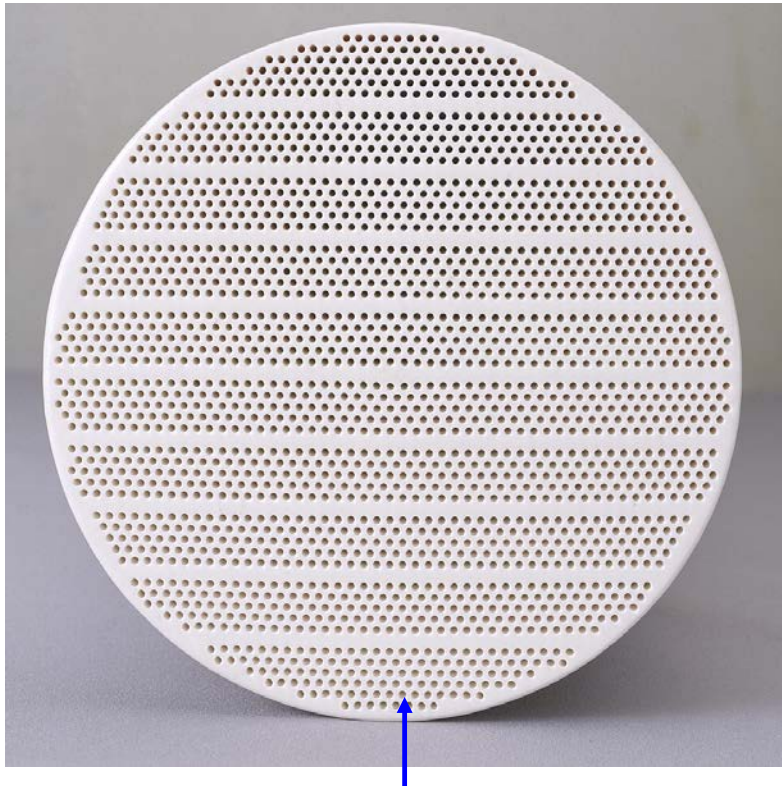
Material	Modified aluminum oxide
Nominal Pore Size	0.1 micron
Dimension	180 mm OD x 1,500 mm L (7 inch OD x 4.9 ft L)
Surface Area	25 m ² (269 ft ²)



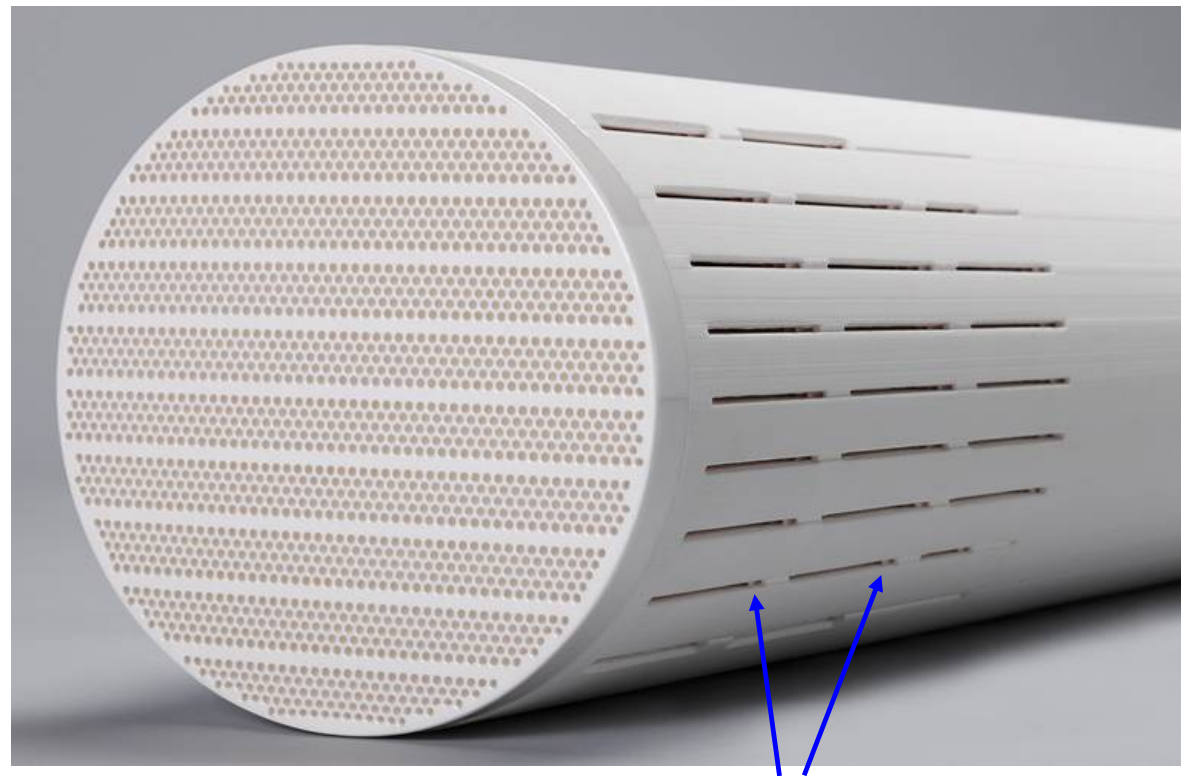
Membrane Material

- **Single piece of ceramic**
 - No glue or epoxy
 - Won't delaminate
- **High chemical and temperature resistance**
 - 1-13 pH
 - 0 – 50°C
- **Low fouling potential**
 - Many cleaning options
 - Highly hydrophilic (more resistant to fouling)

Membrane Construction

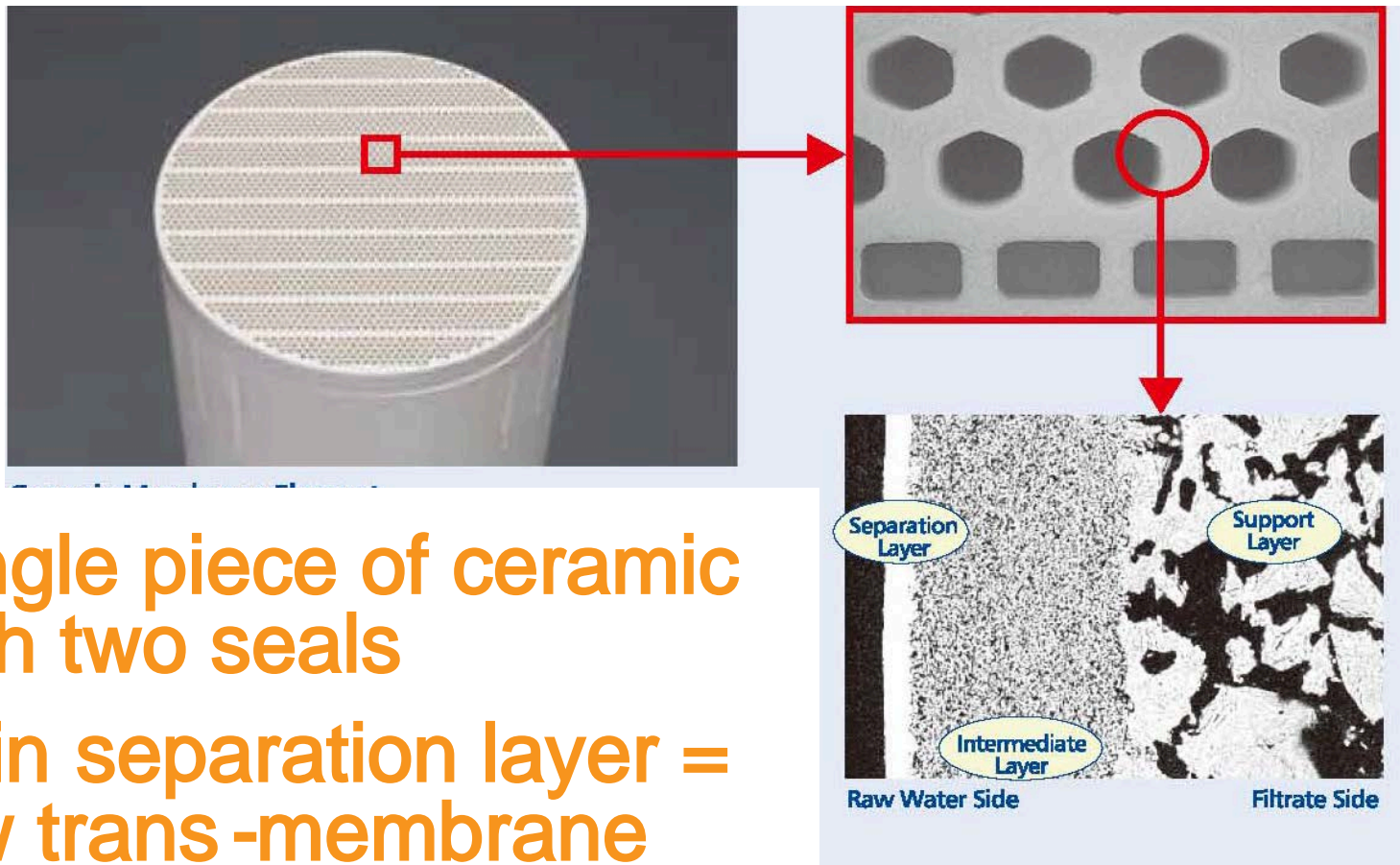


Raw Water Channels



Filtrate Collection Slits

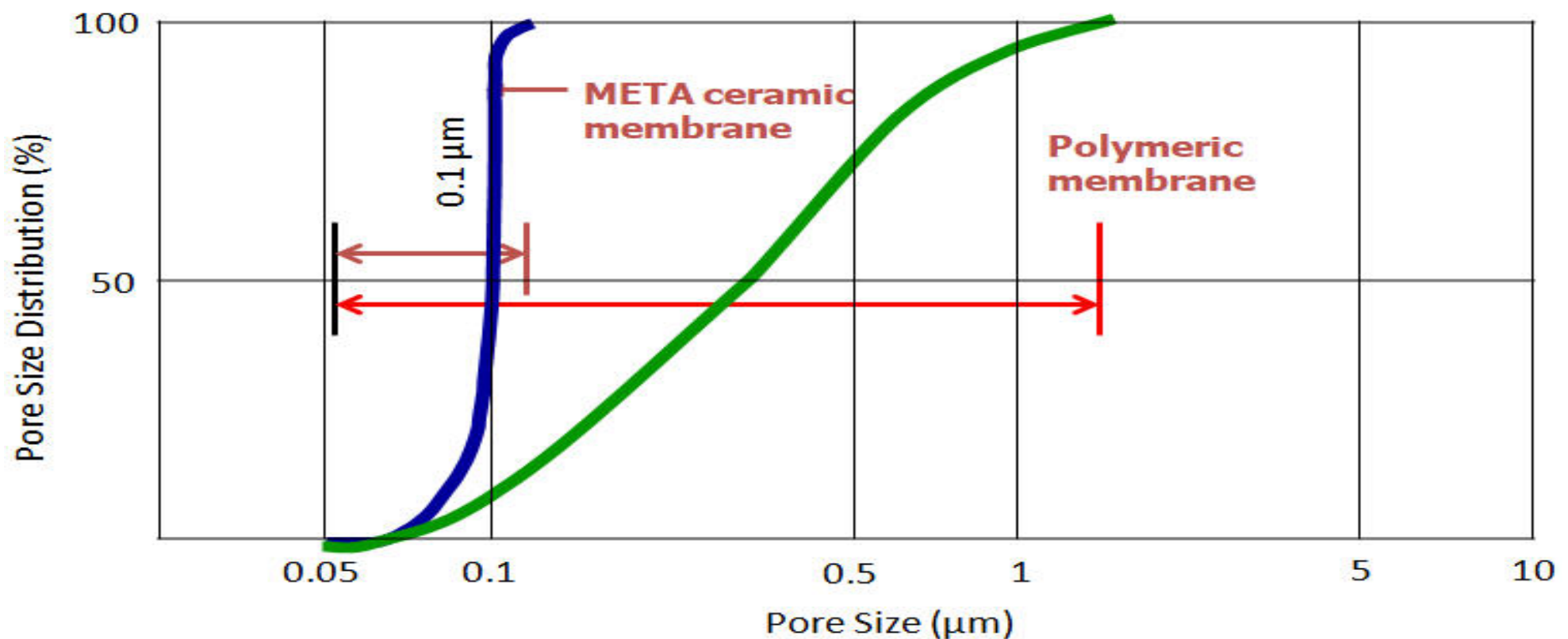
Membrane Construction



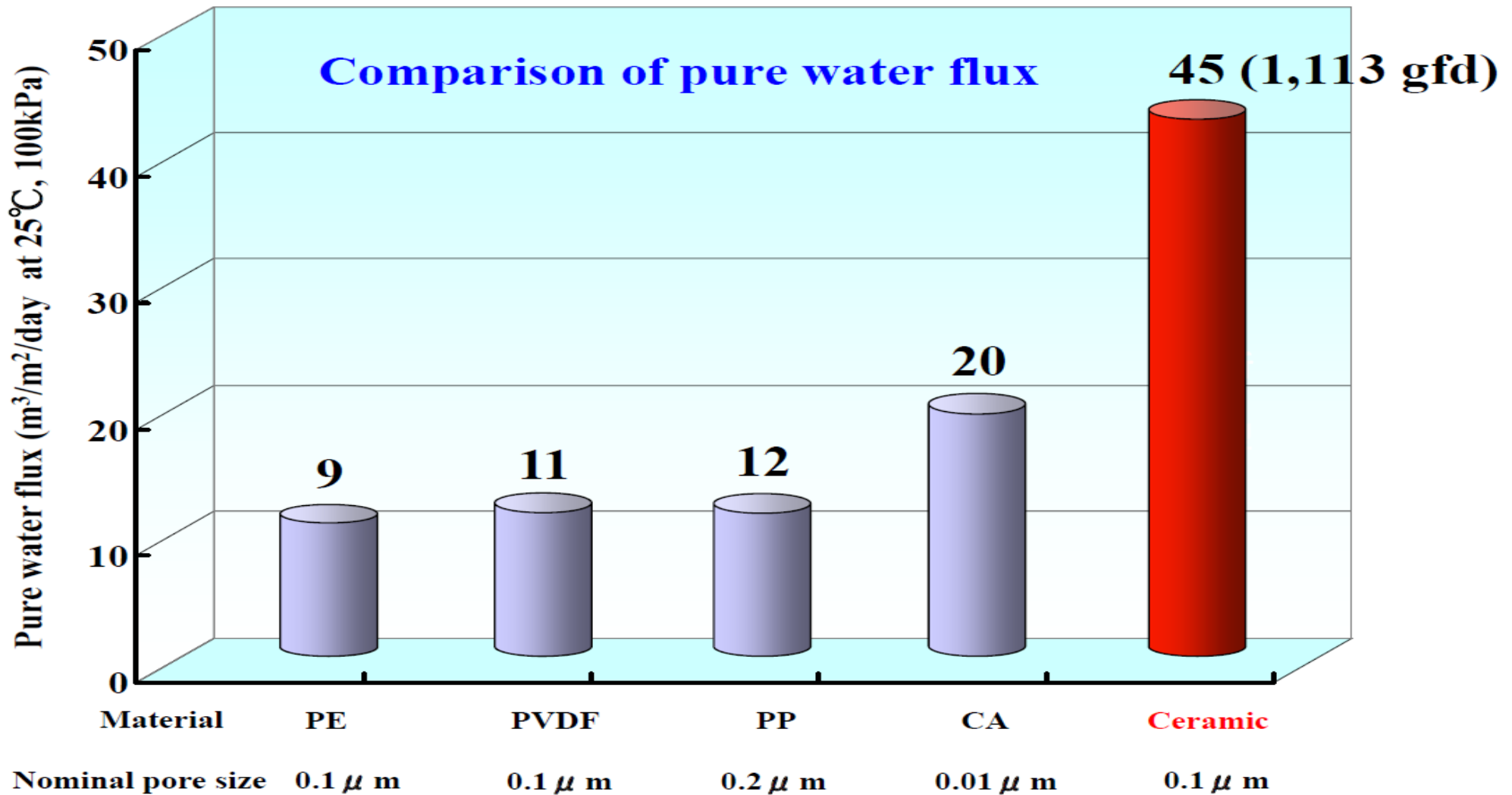
- Single piece of ceramic with two seals
- Thin separation layer = low trans-membrane pressure (TMP)

Narrow Pore Distribution

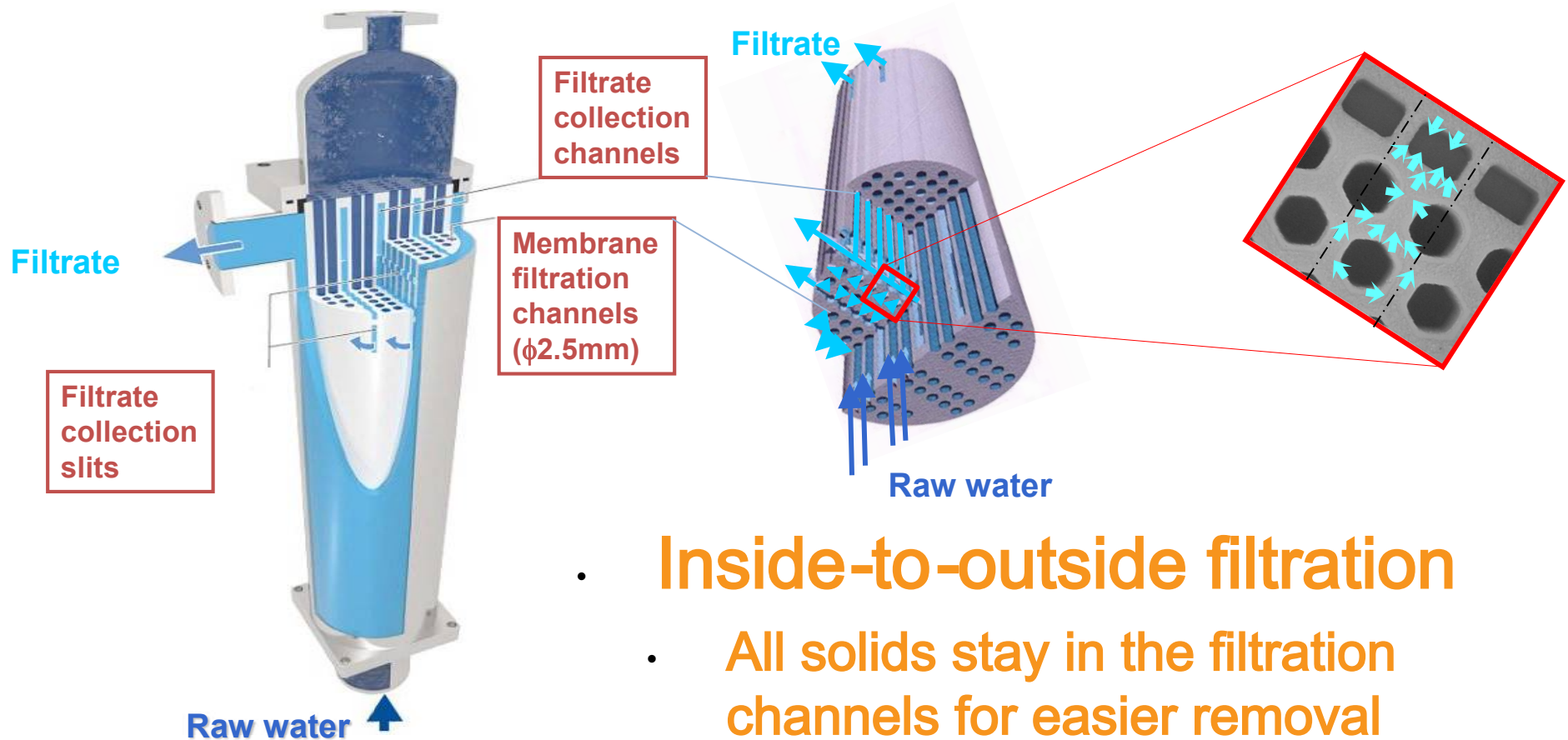
- Pores are closer to each other, further lowering TMPs



Higher Flux

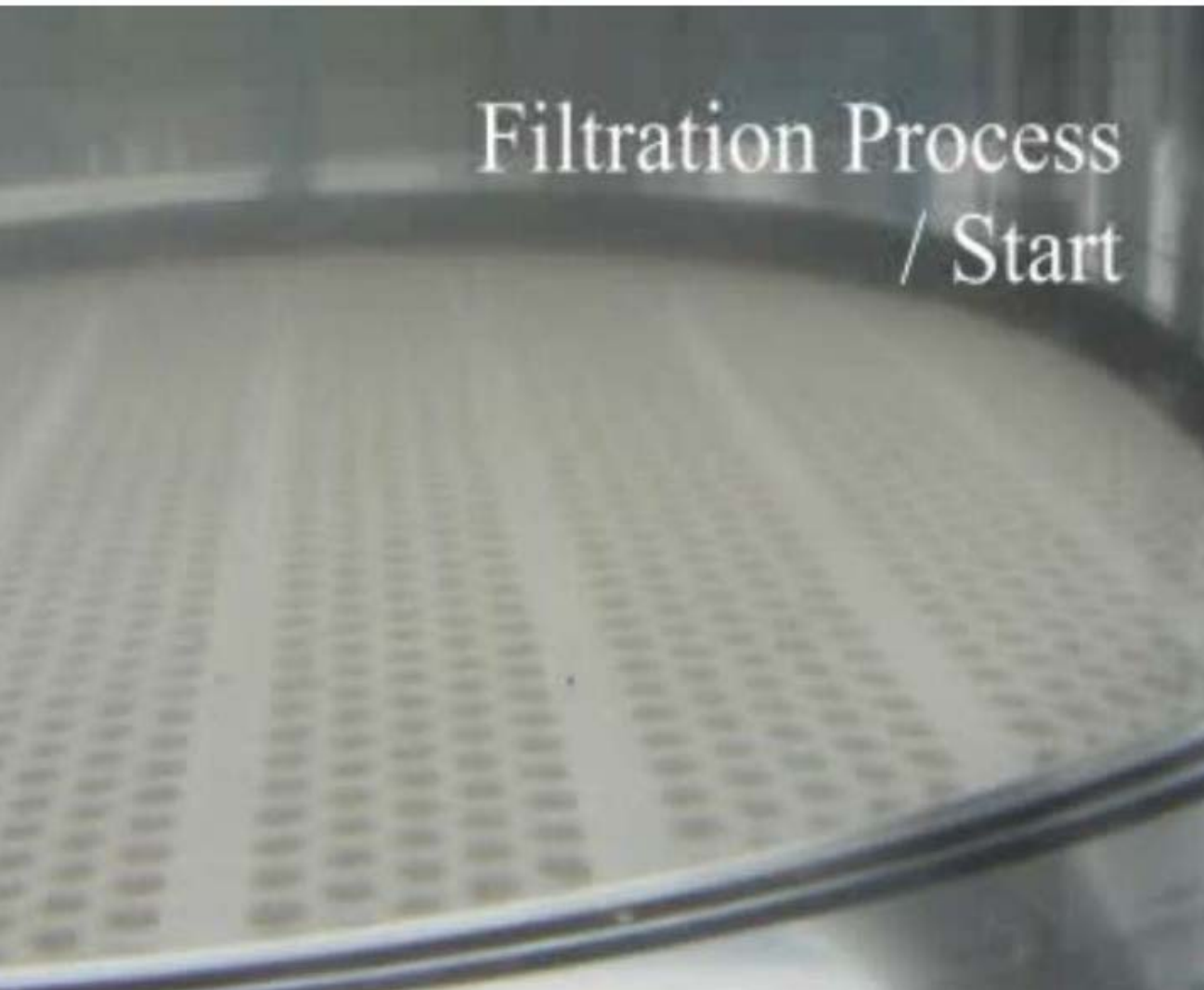


Membrane Flow Path



- **Inside-to-outside filtration**
 - All solids stay in the filtration channels for easier removal
 - Enables higher velocity for better cleaning

Unique Backwash



- **Small backwash water volume**
- **Low air usage**
- **Less chemical required**
- **= 98+ % recovery**

High-Pressure Housings and Piping

- Can handle pressures up to 100 psig
- Ideal for direct filtration of higher -elevation water sources
 - Can discharge directly to downstream systems or distribution lines
 - No need for break tanks or booster pumps
 - Saves overall power consumption



Compact, External Skids

- **Easily expanded**
 - Higher fluxes than submerged units
 - No basins or lifting equipment
 - Highly accessible



Standard Single-Element Modules

- Each row consists of 1 – 10 modules
 - Backwashes only 1 row at a time
 - Minimizes the size of the backwash system
- Each train consists of 1 – 10 rows (1-100 modules)
 - Has its own set of valves
 - Full redundancy with the least number of modules

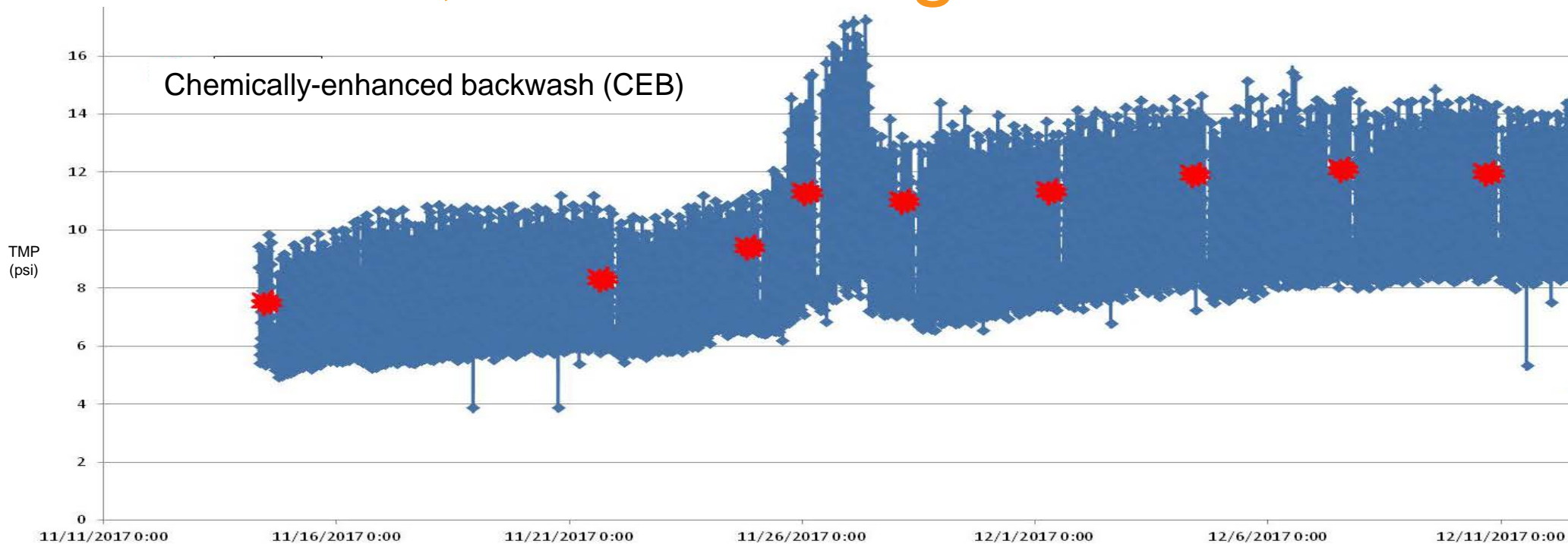


Optional Multi-Element Modules

- Each housing has up to 90 elements
 - Only one set of valves per one or more housings
- Requires extra housings for full redundancy



Ashland, OR Drinking Water Pilot



- Surface water w/ 0.6 -3 NTU & 2.2–2.9 mg/l TOC
- 150 gfd, 1.5-hr cycles
- CEB every 3 days at 2 pH & 100 mg/L NaOCl, 1 mg/L Al⁺³

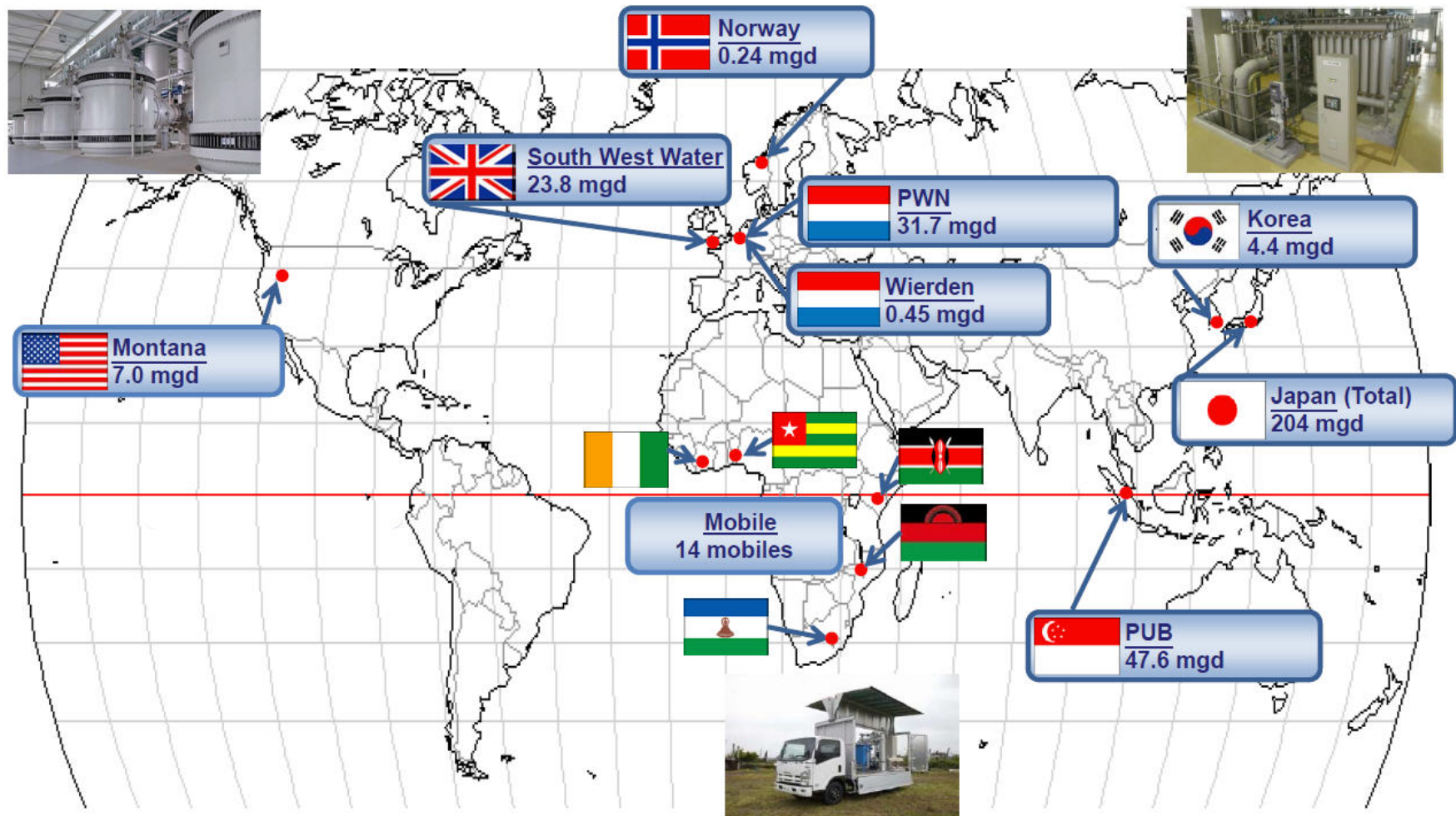
Performance – Shibaura WWTP

- 1.8 MGD reuse plant in operation for 12 years
- Up to 2.8 NTU and 7 mg/L TOC
- 103 gfd avg, 135 gfd max
- 2-hour cycles, 10 mg/L NaOCl every 3-7 days, annual CIP
- Uses 5-7 mg/L O₃ and 5–17 mg/L Al
- 99.8% total recovery



Experience: >190 Installations in 23 Years

- >20,000 elements with only 5 replaced



Flowback Water Application

- 6,000 bpd ceramic membrane demonstration plant
- Existing system used settling/separation tanks
 - 6.5–25% TDS, 20-900 mg/L oil and grease; 50-950 mg/L TSS
- Effluent is re-injected into well
- Minimizes fresh water makeup



Flowback Water Treatment

Fresh Water Storage Basin (44%)

Treated Water Storage Basins (56%)



Aeration Tank for Initial
Oxidation of Heavy Metals

Chlorine Dioxide to
Complete Oxidation

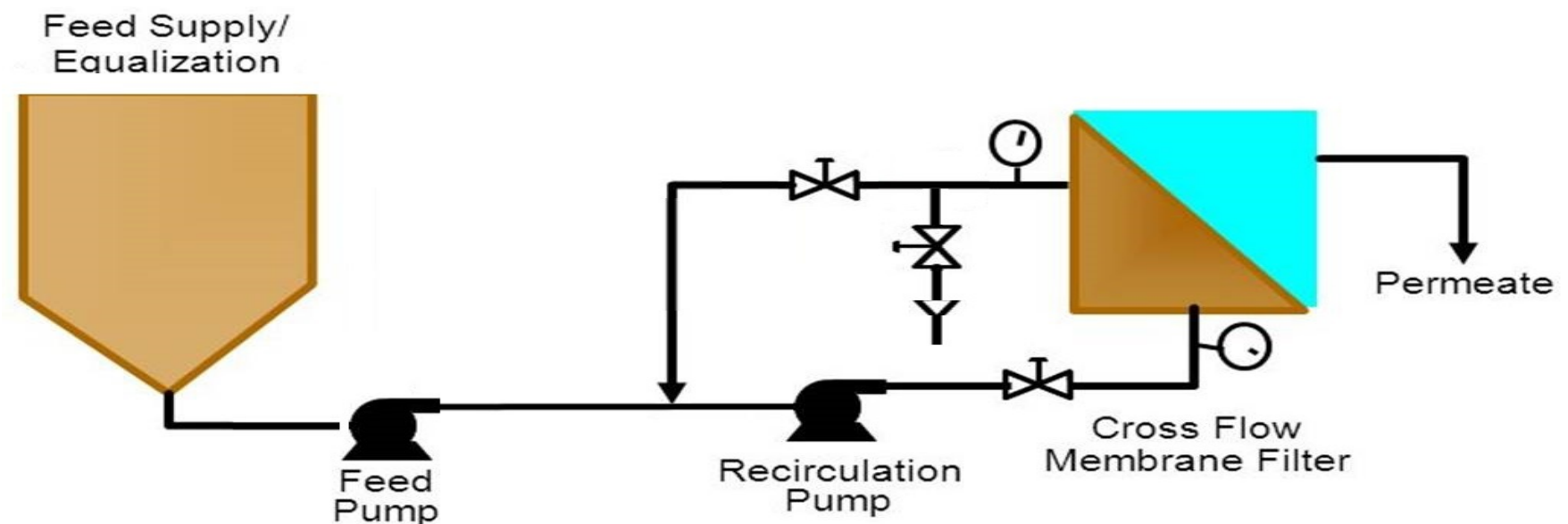
Settling/Separation
Tanks

Produced Water Storage Tanks
for Equalization and Oil separation

- **Membrane system replaces Settling/
Separation Tanks**

Flowback Water Treatment

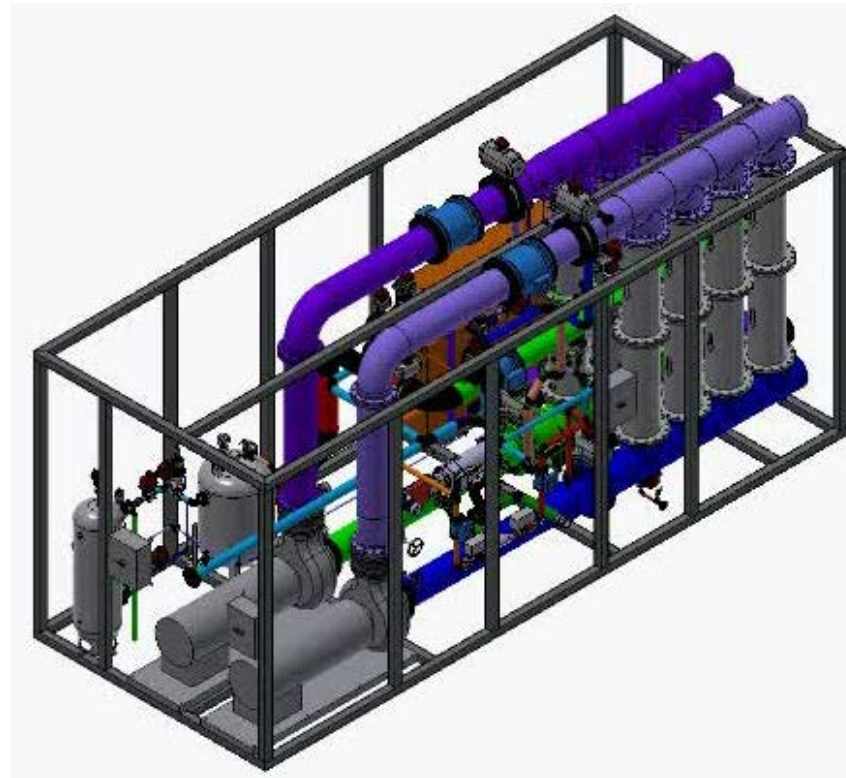
- 80 l/mh (47 gfd), 30-minute filtration
- 3 m/s cross-flow concentrates TSS 10-50 times for 4 hours before wasting
- At 30 psi TMP, CIP with 12.5 pH caustic, 3,000 mg/L citric acid



Flowback Treatment – Mobile System

Membrane skid with (2) two independent trains of 250 m² of membranes

Explosion-proof
feed pump skid



Compressor/CIP skid



Flowback Treatment – Performance

Sample ID	Total Fe	TDS	pH	TSS >0.7micron	TSS >8 micron	O&G
Untreated	76.8	101,120	7.36	528.0	332.0	67.2
Filtrate 10min	<1	102,656	7.03	22.0	12.6	3.2
Concentrate 1hr	145.6	100,992	7.53	868.0	540.0	315.0
Concentrate 4hr	249.7	100,416	7.66	1,668.0	1,268.0	423.8
%Concentration 4hr	325%	-	-	316%	382%	631%
Filtrate 4hr	<1	101,376	6.94	9.8	<5	<1
Removal % 4hr	<98.7	-	-	98.1	>98.5	>98.5

- TSS depositing on membrane at nearly twice the rate of O&G
- More than 98% removal of iron, TSS, and O&G after 4 hours
- TMP increased from 7.8 – 9 psi

Flowback Treatment – Performance



Blended Wastewater Treatment

- 2002 wastewater plant designed for 15 MGD
- Currently treating 60% industrial and 40% domestic
- Conventional activated sludge (CAS), sand filters, MF, reverse osmosis (RO), advanced oxidation process (AOP)
 - MF feed: 2–7 mg/L BOD₅, 1–21 NTU, 3,100–4,840 mg/L TDS
- Potable and non-potable reuse



Blended Treatment– High Maintenance

- MF system required frequent fiber pinning
- Want a system with a more robust membrane

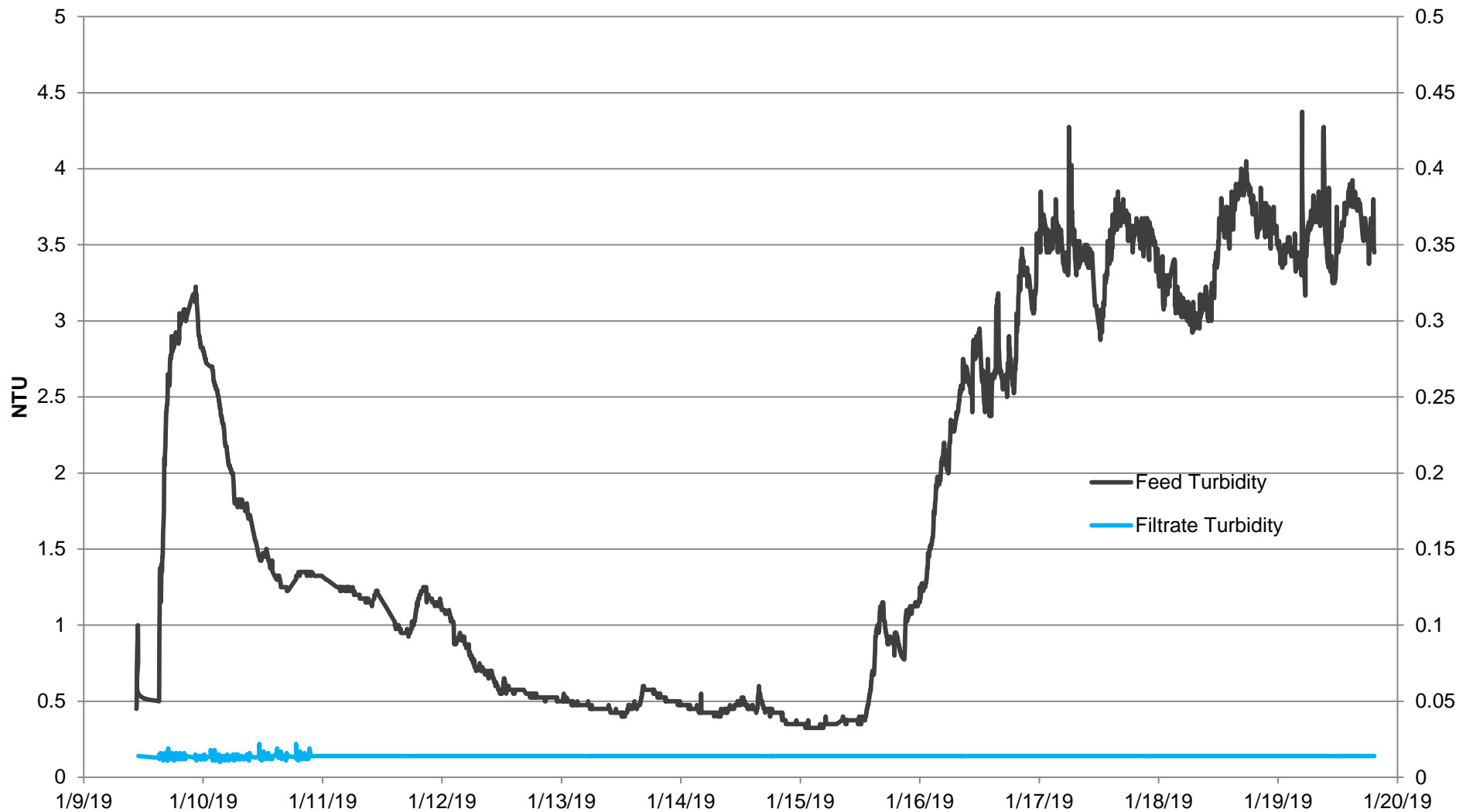


Blended Treatment – Ceramic Pilot

- **Piloted on both tertiary and secondary effluent**
 - Prefer using secondary effluent to eliminate sand filters
- **Ran at 100 gfd and 98.6% recovery**
 - 30-minute filtration times with 8.5 mg/L Al⁻³
 - Daily 30-minute CEBs at 100 mg/L NaOCl and 300 mg/L citric acid
 - Monthly 4-hour CIPs at 1,000 mg/L NaOCl and 3,000 mg/L citric acid

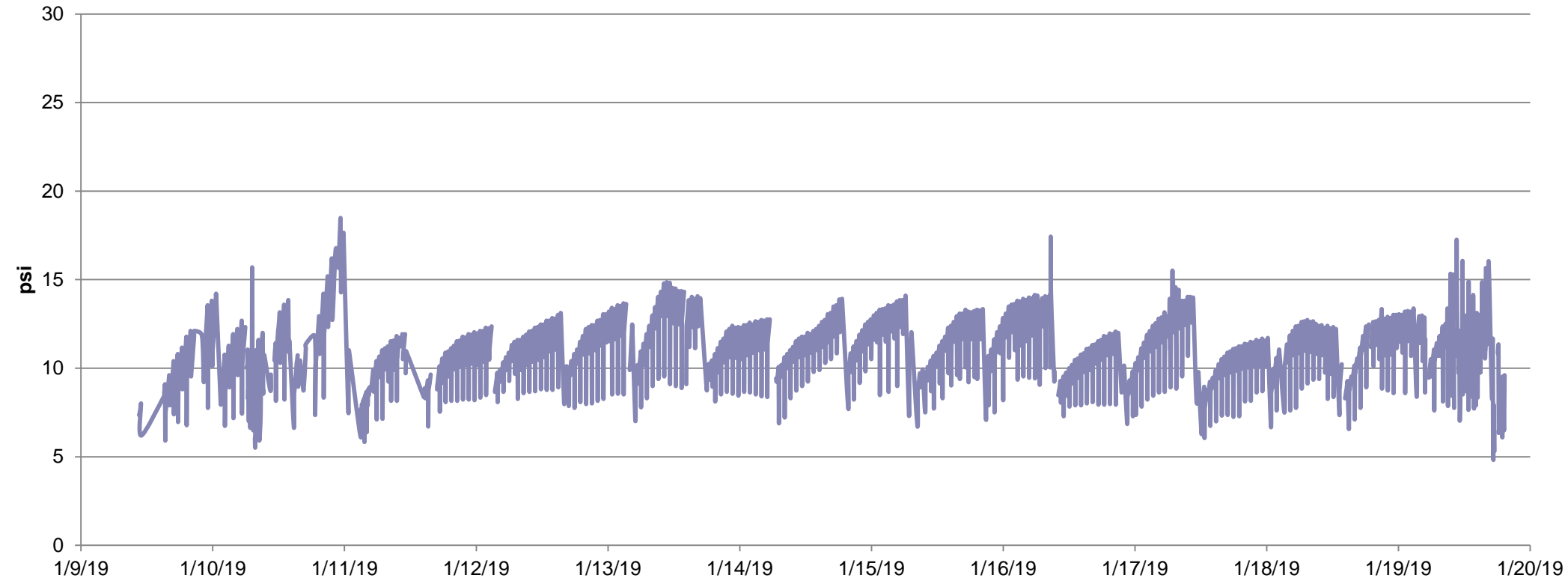


Blended Treatment–Performance



Blended Treatment–Performance

- **TMPs on secondary effluent at 100 gfd:**



Blended Treatment–Performance



Summary

- **Aqua MultiBore C-Series Ceramic Membranes have a proven long life with high recoveries and fluxes**
- **Ideal for flowback water treatment**
 - Demonstration system at TX well removed >98% iron, TSS, and oil & grease
- **Perfect for blended wastewaters**
 - Pilot for CA wastewater plant ran at 100 gfd and 98.6% recovery

Contact Information

Dave Holland

Senior Process Engineer

(815) 639-4470

dholland@aqua-aerobic.com

www.aqua-aerobic.com



AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company