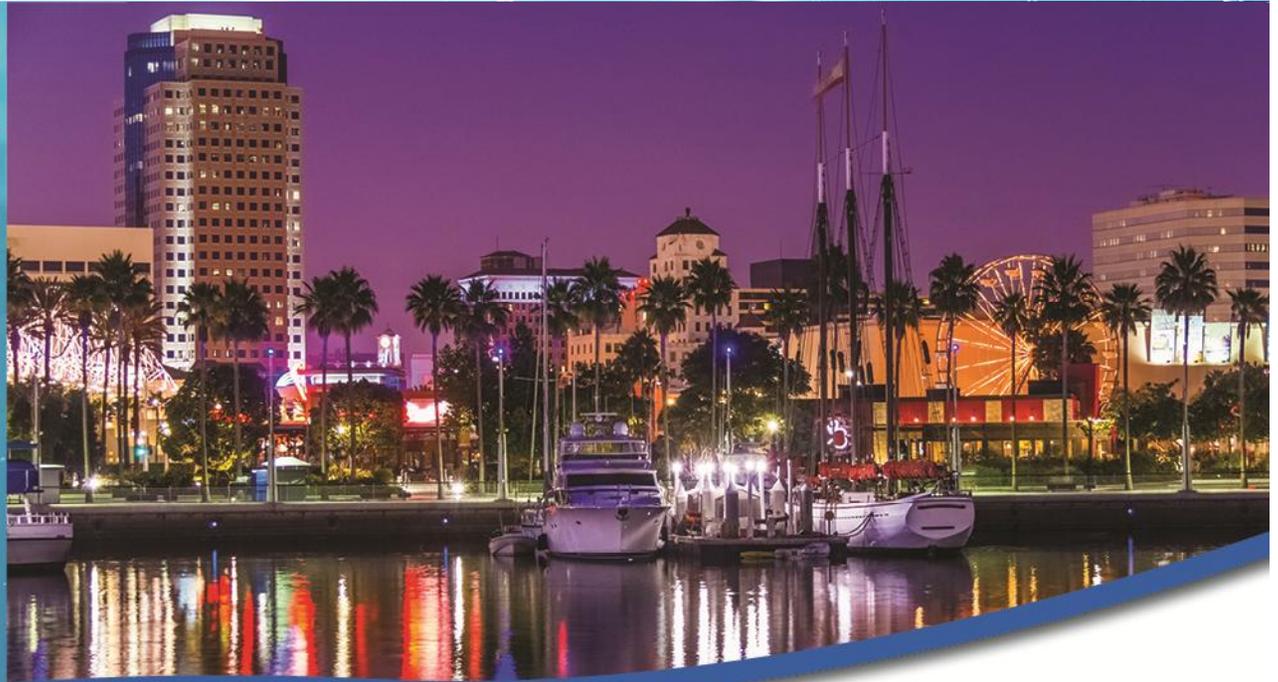


2017
**Membrane
Technology**
CONFERENCE & EXPOSITION



City of Scottsdale Water Campus Adopted Nanocomposite RO Membranes for Indirect Potable Reuse



Dian Tanuwidjaja



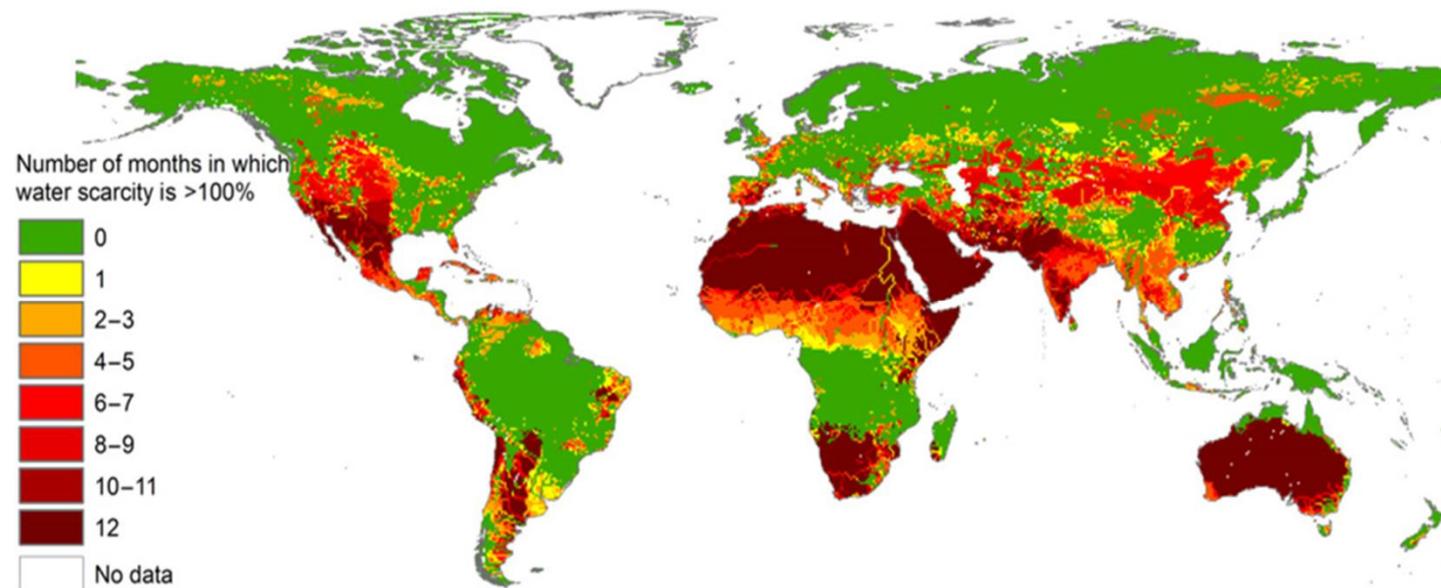
Outline of Presentation

- Introduction.
- Thin Film Nanocomposite (TFN) Membrane Technology.
- Scottsdale Water Campus.
 - Advanced Water Treatment (AWT) Facility.
- TFN Membrane Performance.
- TFN vs. Non-TFN Comparison Data.
- Conclusion.

Introduction

Global Water Scarcity Issue

- Globally half a billion population experience severe water scarcity all year round.
- By 2050, at least 25% of world's population is likely to live in a country affected by fresh water shortage.



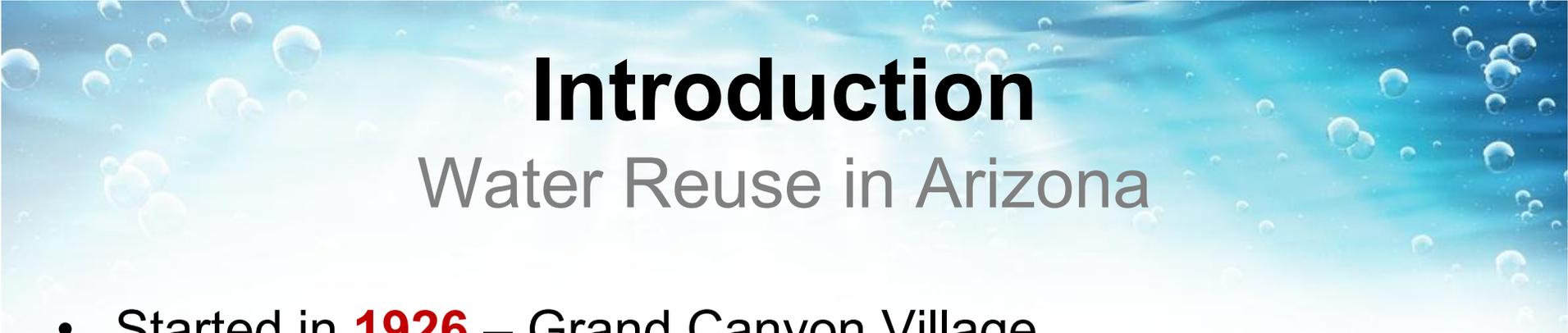
* The number of months per year in which water scarcity occurs¹⁾

¹⁾ Mesfin M. Mekonnen, and Arjen Y. Hoekstra Sci Adv 2016; 2:e1500323

Introduction

Water Reuse in United States

- Texas – No WQ standards for IPR, DPR permitted on case by case basis during emergency.
- New Mexico – Both IPR and DPR are permitted on case by case basis.
- Florida – Regulation based on applications (subsurface vs. surface).
- California – DPH is using Regulation Related to Recycled Water based on CCR title 17 and 22.
 - Subsurface application - direct injection.
 - Surface application - recharge to a spreading area.
 - **Application includes Soil-Aquifer Treatment (SAT).**
 - **Assume Recycled Municipal Wastewater Contribution (RWC) = 1.0 for worst case scenario. TOC limit = 0.5 mg/L/RWC= 0.5 mg/L.**



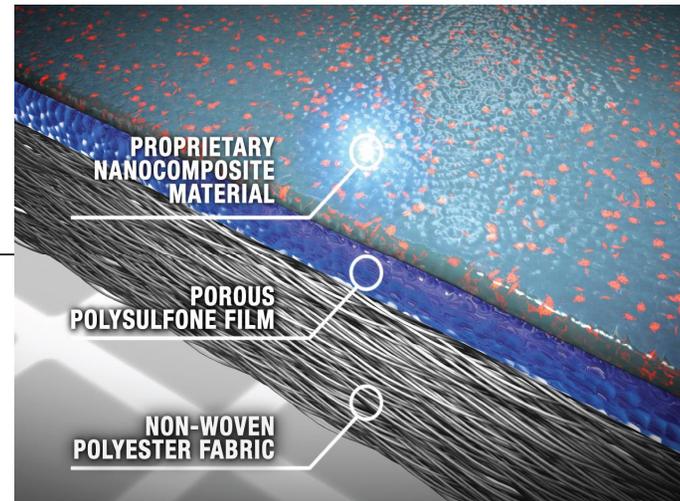
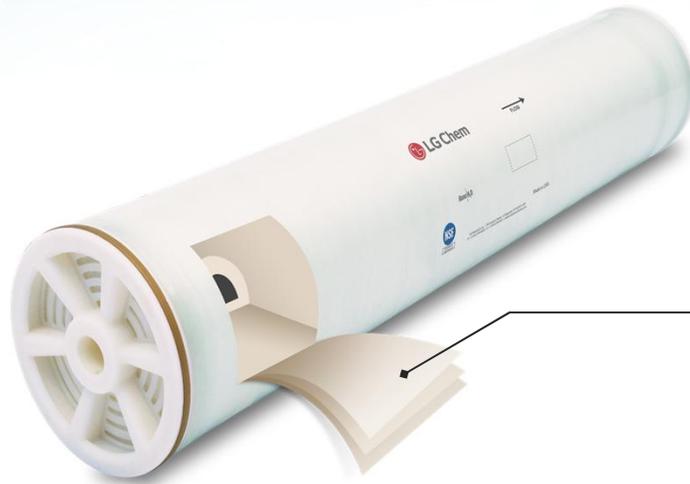
Introduction

Water Reuse in Arizona

- Started in **1926** – Grand Canyon Village.
 - 0.13 MGD reuse for toilet flushing and boiler feed.
- In 2010 – Blue Ribbon Panel (BRP) on Water Sustainability.
- In 2012 – the Steering Committee for Arizona Potable Reuse (SCAPR).
 - Specifically **prohibits** the use of reclaimed water for **direct potable reuse (DPR)**.
 - IPR can be implemented **under a set of other water regulation**.
- In 2016 – Arizona Department of Environmental Quality (ADEQ) begun revising Arizona’s rules governing reuse.

TFN Membrane Technology

Core Competencies



- 01 **Increase** Water Production.
- 02 **Highest** Salt Rejection in the Industry.
- 03 **74 patent** from 10 Countries (128 Patent-Pending).

All the NanoH₂O™ membranes are developed based on innovative ***Thin Film Nanocomposite (TFN)*** technology to improve membrane performance by incorporating benign nanoparticles.

Scottsdale Water Campus

Site Location



Scottsdale Water Campus is located in Scottsdale, AZ, north east of Phoenix, AZ.



Scottsdale Water Campus

Plant History

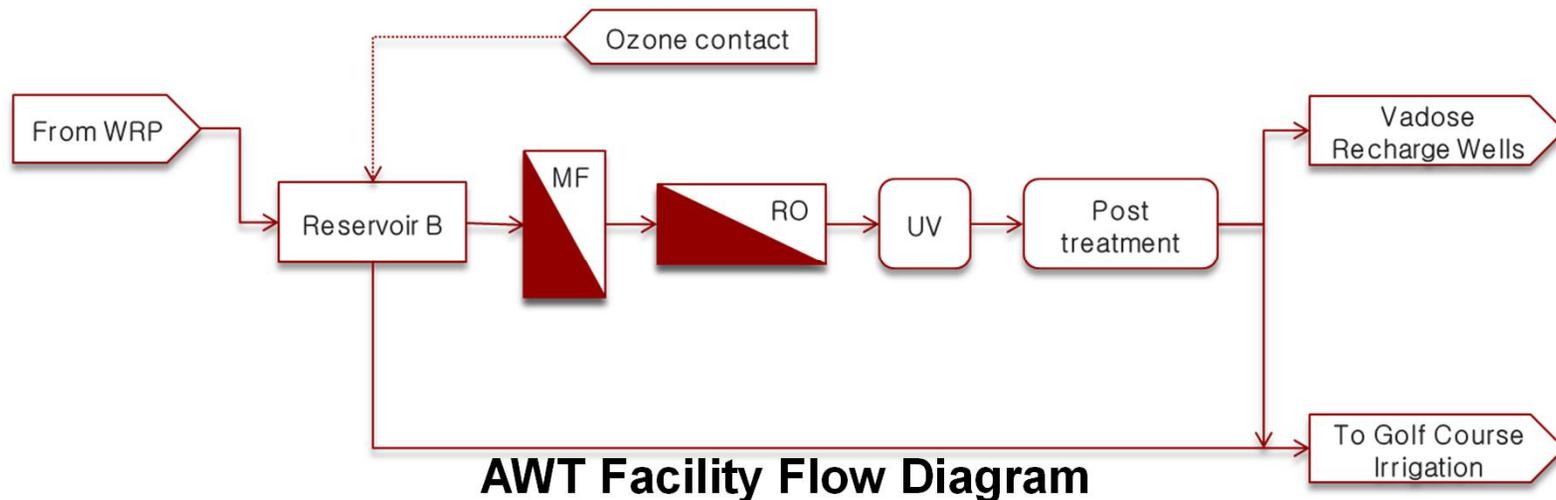
- Commissioned in 1999 with initial capacity of 6 MGD.
- One of the first plants to use MF and RO to treat waste water effluent.
- Currently produce 20 MGD of treated water for ground water aquifer injection.



Scottsdale Water Campus

Treatment System

- Scottsdale Water Campus consists of two facilities:
 - Water Reclamation Plant (WRP).
 - Advanced Water Treatment (AWT) Facility.
- AWT treats excess effluent from WRP for groundwater aquifer recharge.
- Target level to meet or surpass WQ established by ADEQ.



Scottsdale Water Campus

BWRO System Configuration

- Fourteen (14) 8-inch RO trains.
 - 1 MGD per train.
 - 20:10:5 or 24:10:5 array configuration.
 - 6 elements per PV.
 - 85% Recovery.
- Three (3) 16-inch RO trains.
 - 2.8 MGD per train.
 - 13:7 array configuration.
 - 7 elements per PV.
 - 85% Recovery.

Scottsdale Water Campus

TFN BWRO Membrane Installation

 Start-Up Date	Phase 1: March 2016. Phase 2: January 2017.
 Application	Ground Water Recharge and Golf Course Irrigation.
 Pretreatment	Chloramine, Ozone, and MF.
 Total Capacity of membrane replaced	Three (3) 1-MGD Trains per Phase.
 Number of Elements replaced	Phase 1: Total 630 Elements; 210 Elements per Train with 20:10:5-Array Configuration. Phase 2: Total 702 Elements; 234 Elements per Train with 24:10:5-Array Configuration.
 3-Year Permeate Quality Target	TDS = 70 ppm, Na = 17 ppm, and Cl = 20 ppm.

Scottsdale Water Campus

Existing Non-TFN BWRO Operation

- Membranes installed in 2010.
- Operating condition:
 - Feed pH: 6.1 – 6.3.
 - Average Flux: 9.0 gfd (15.3 l/mh).
 - Feed Pressure: 130 – 240 psi (9.0 – 16.6 bars).
 - Feed Temperature: 25 – 32 °C.

Non-TFN BWRO Membrane Specifications

Product Type	Flow Rate, m ³ /d (GPD)	Minimum NaCl Rejection, %	Stabilized NaCl Rejection, %	Active area, m ² (ft ²)
Low Fouling BWRO	38.6 (10,200)	99.0	99.7	37 (400)

Standard test condition: 2,000 mg/L NaCl, 225 psi (15.5 bar), 25 °C (77 °F), pH 7, 15% recovery.

Scottsdale Water Campus

TFN BWRO Operation

- Operating Condition:
 - Feed pH: 6.1 – 6.3.
 - Average Flux: 10.0 gfd (17.0 l/mh).
 - Feed Pressure: 106 – 120 psi (7.4 – 8.3 bars).
 - Feed Temperature: 25 – 32 °C.
- During seven (7) months of operation, one CIP was performed on **Train 19** only.

TFN BWRO Membrane Specifications

Product Type	Flow Rate, m ³ /d (GPD)	Minimum NaCl Rejection, %	Stabilized NaCl Rejection, %	Active area, m ² (ft ²)
Low Fouling BWRO	39.7 (10,500)	99.5	99.6	37 (400)

Standard test condition: 2,000 mg/L NaCl, 225 psi (15.5 bar), 25 °C (77 °F), pH 7, 15% recovery.

TFN Membrane Performance

Water Quality

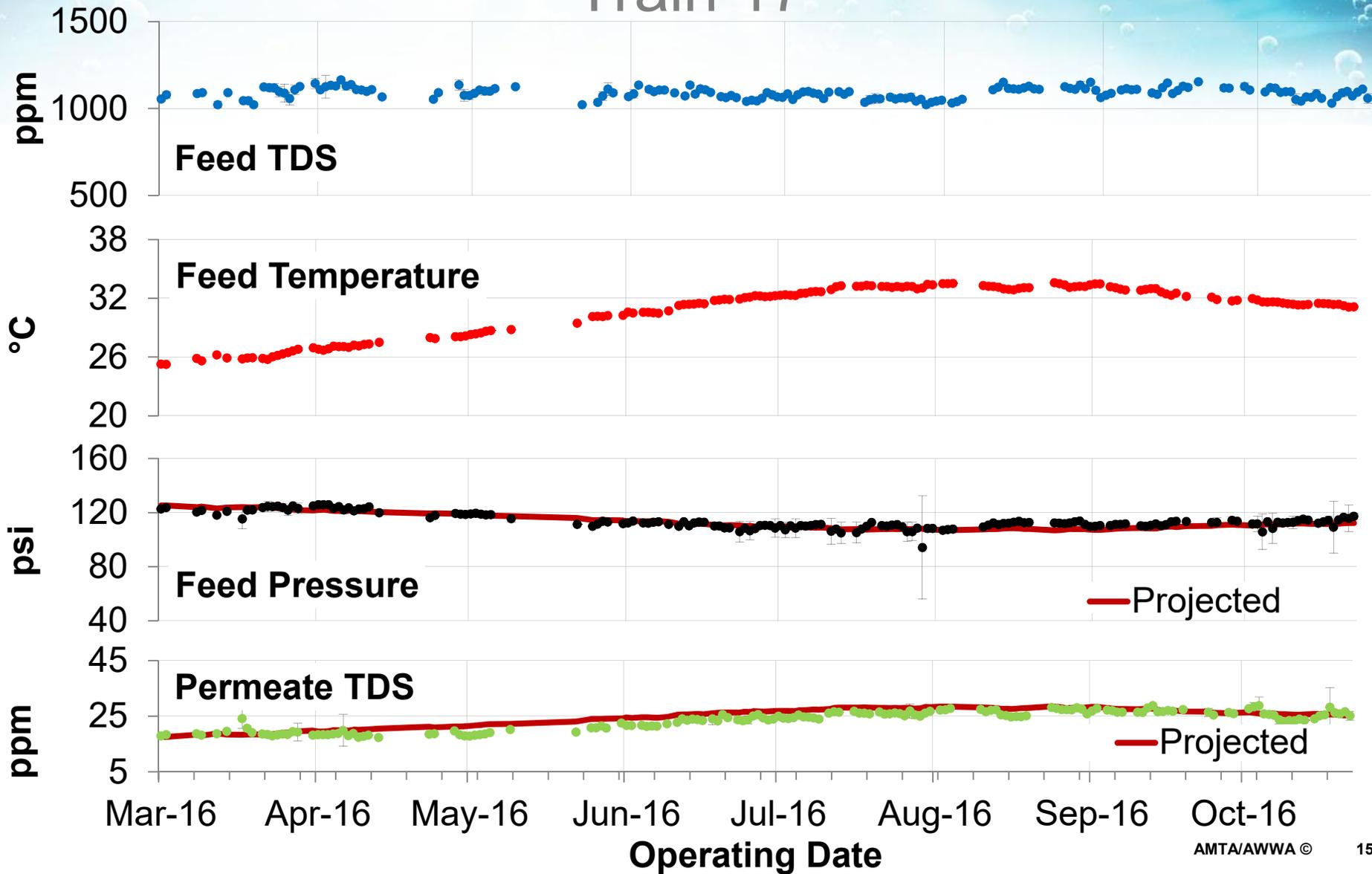
Parameters	Average ⁽¹⁾ Feed Ion Concentration (mg/L)	Average ⁽¹⁾ Permeate Ion Concentration (mg/L)	Average ⁽¹⁾ Ion Rejection	Standard Deviation
Bromide	0.0765	0.0113	84.62%	3.48%
Barium	0.0822	ND ⁽²⁾ (0.0002)	>99.76%	
Calcium	89.8	ND ⁽²⁾ (0.0375)	>99.96%	
Magnesium	31.2	ND ⁽²⁾ (0.0300)	>99.90%	
Potassium	28.2	0.620	97.85%	1.24%
Silica (Calculated)	8.44	0.0909	98.92%	0.25%
Sodium	283	7.50	97.35%	0.22%
Strontium	1.16	ND ⁽²⁾ (0.0020)	>99.83%	
Total Alkalinity	123	12.3	90.09%	1.51%
Chloride	422	4.55	98.92%	0.18%
Fluoride	0.447	ND ⁽²⁾ (0.0400)	>91.04%	
Nitrate as N	7.80	0.535	93.19%	1.22%
Ammonia as N	1.16	0.217	81.88%	5.29%
Nitrite as N	0.0141	ND ⁽²⁾ (0.0080)	>42.64%	
Sulfate	293	ND ⁽²⁾ (0.200)	>99.93%	
TDS (calculated)	1,285	26.3	97.96%	0.23%
TOC	6.81	0.268	96.06%	0.42%

(1). Average of four (4) independent sample analyses.

(2). Rejection for parameters with ND results was calculated using MDL values.

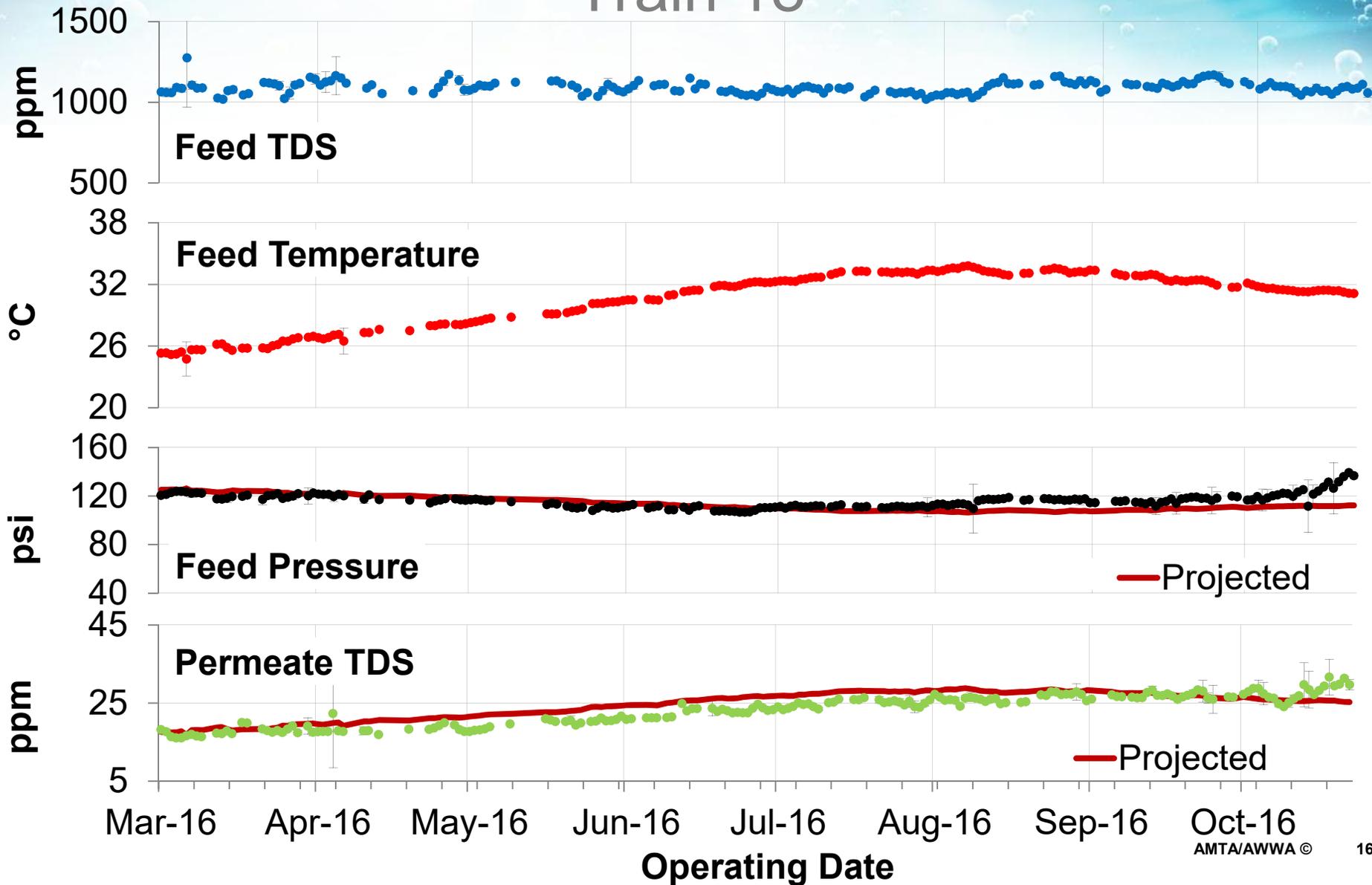
TFN Membrane Performance

Train 17



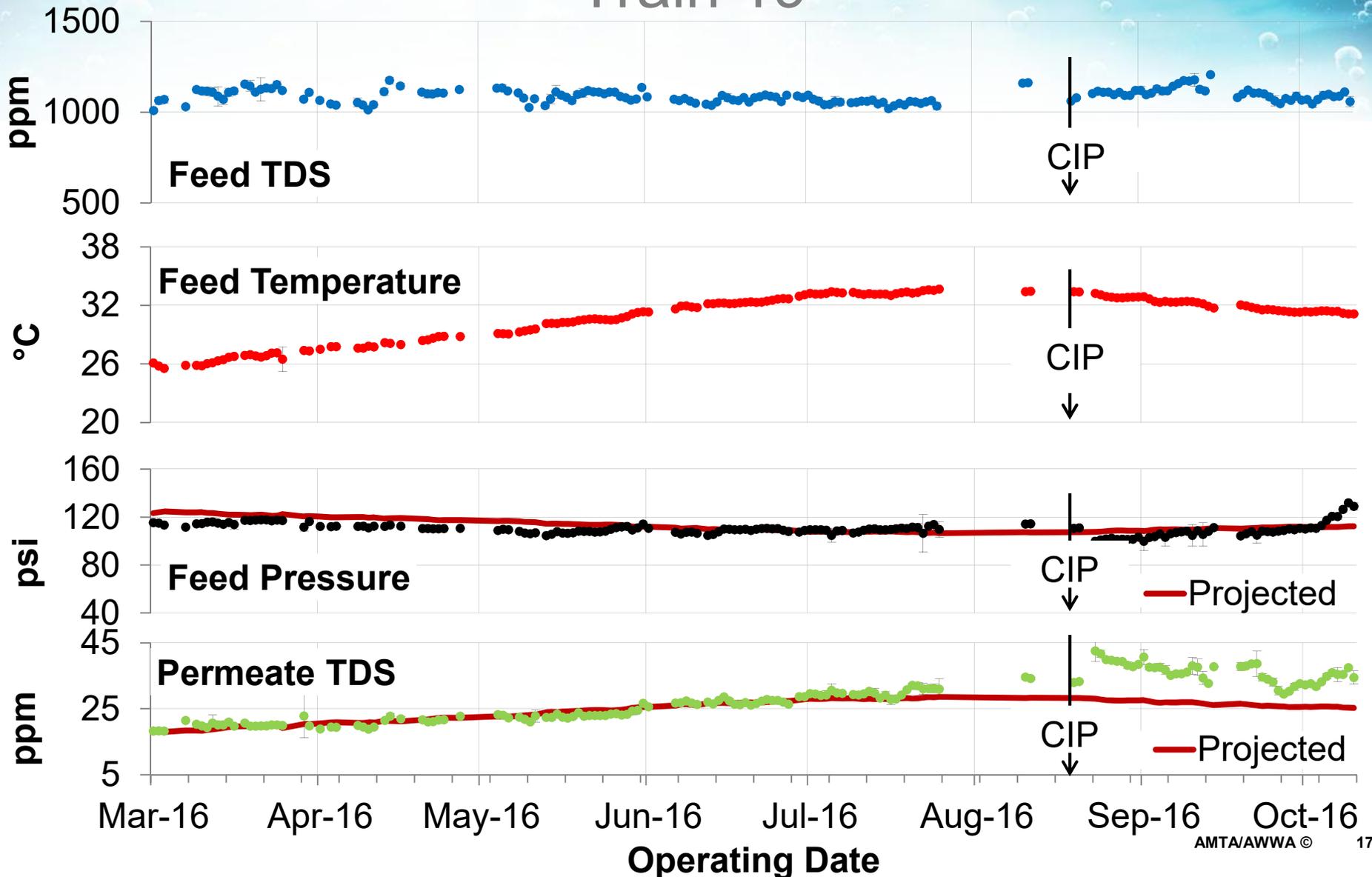
TFN Membrane Performance

Train 18

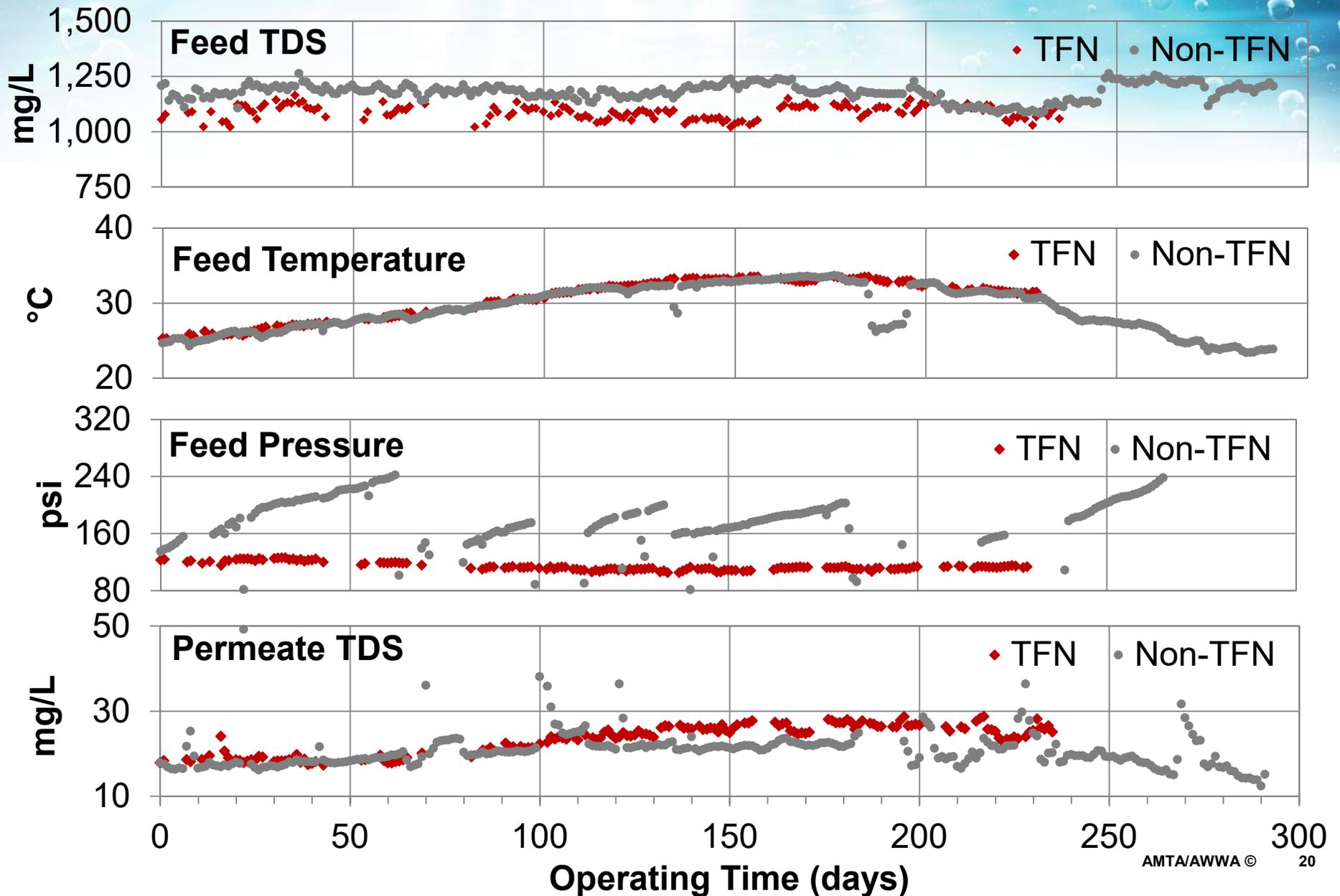


TFN Membrane Performance

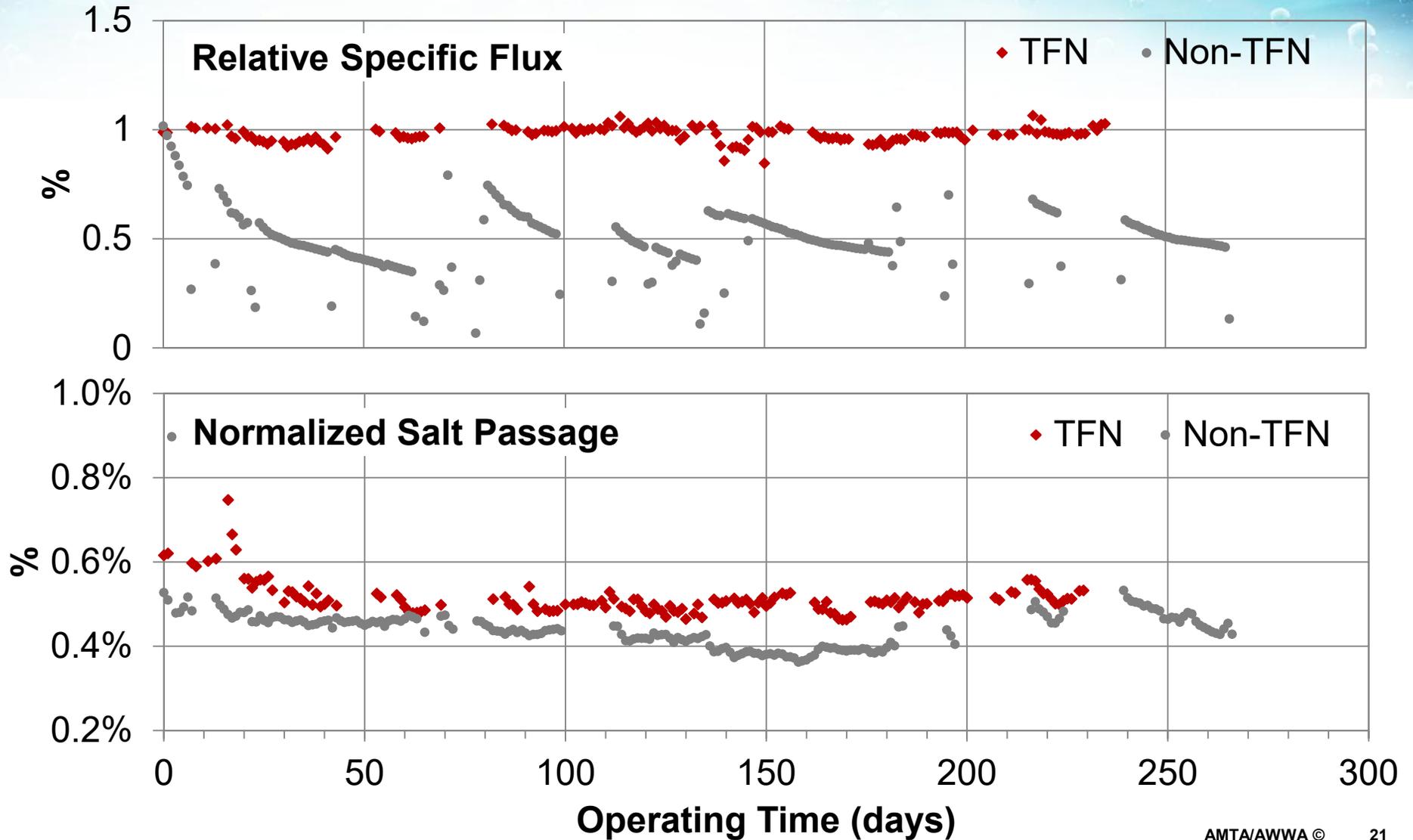
Train 19



TFN vs. Non-TFN RO Membranes



TFN vs. Non-TFN RO Membranes



Conclusion

During the stable operation of the TFN membrane in Scottsdale Water Campus for 7 months,

- TFN membrane shows high rejection on most ions.
- Permeate WQ is well within the three-year target set by Water Campus.
- Stable Permeate TOC concentration and well within California's 0.5 mg/L target for SAT application.
- The TFN membrane generally performs better than the non-TFN membrane.

Thank You

- Scottsdale Water Campus
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