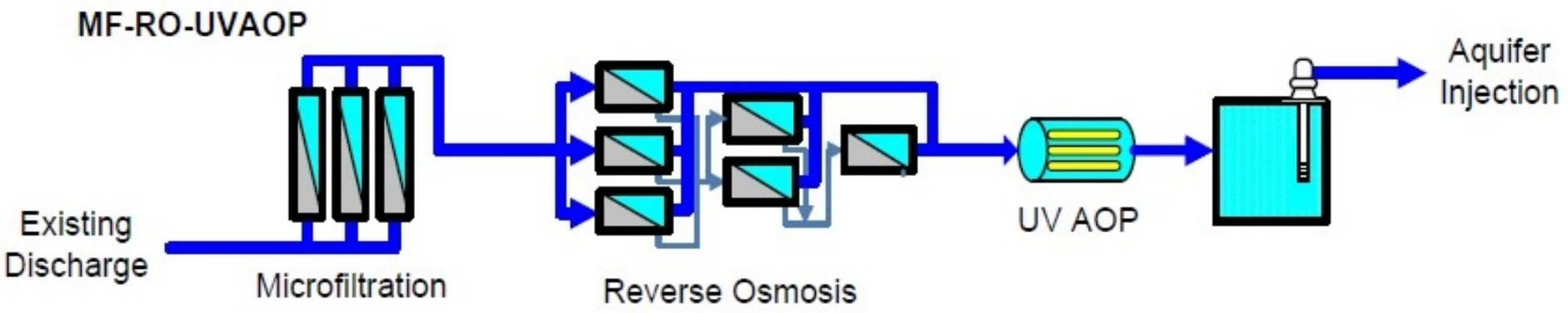
August 24, 2018

Xylem Reuse Solutions for the Modern Utility

PEDRO GOCHICOA – SENIOR SALES ENGINEER, WEDECO, A XYLEM BRAND
STEVE GREEN – BUSINESS DEVELOPMENT MANAGER, XYLEM

Traditional CA Potable Reuse Treatment Train



Source: Troy Walker, Hazen & Sawyer, East is East and West is West - Will the Twain Meet?

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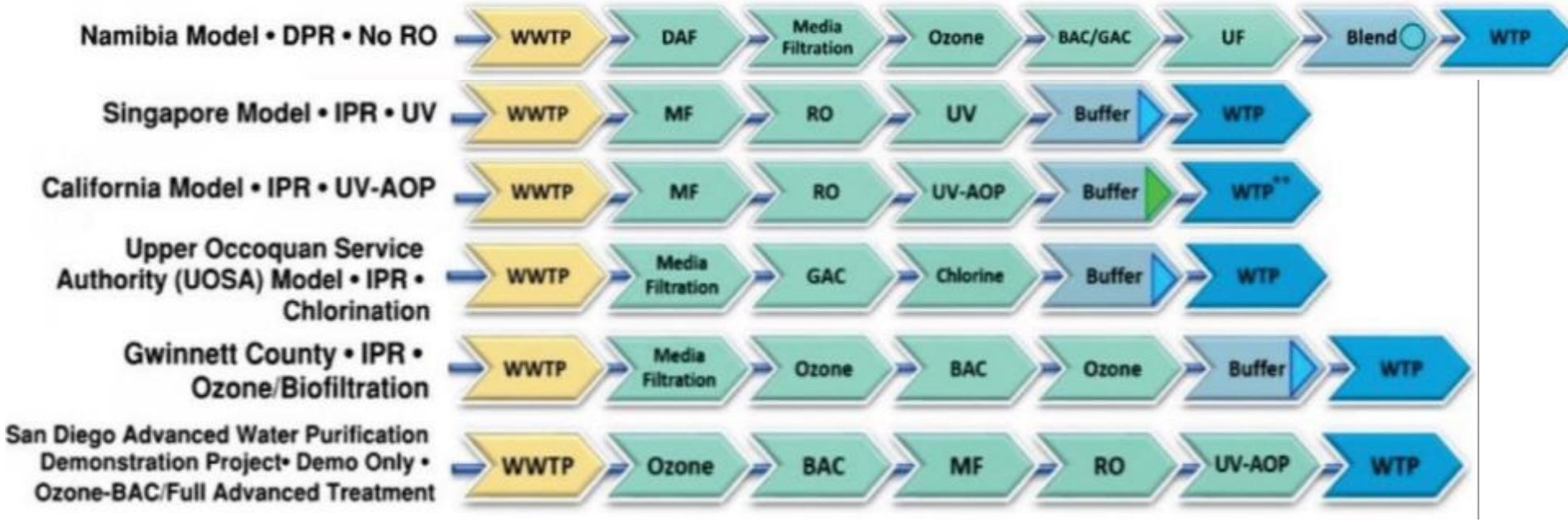
Potable Reuse Treatment Train Options



Source: US EPA 2017 Potable Reuse Compendium

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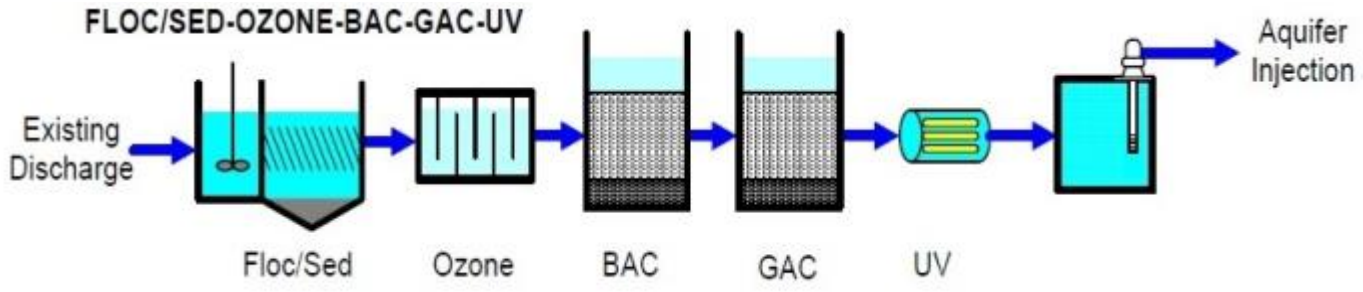
Challenges of RO Based PR Treatment Trains

- High Capital & Installation Costs
- Brine Disposal
- High Operational Costs – Primarily Due to High Energy Costs from Pumping
- Membrane Performance & Replacement Costs

Alternatives Exist for Potable Reuse Treatment



Source: Troy Walker, Hazen & Sawyer, East is East and West is West - Will the Twain Meet?

Parameter	Floc/Sed & BAF	Ozone	UV	Cl2	SAT	Total
Enteric Viruses	2	0 – 3	4	4	0 – 6	12 – 19
Cryptosporidium	4	0	4	0	0 – 6	10 – 14
Giardia	2.5	0 – 1.5	4	0	0 – 6	10 – 14

Source: Andrew Newbold, Hazen & Sawyer, Design of an Aquifer Recharge and Advanced Treatment Facility, Table 1

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Cost for O_3-BAF vs. RO

"RO-based treatment trains employ mechanically intensive processes, which result in 2.5 times as much electricity as the Ozone-BAF plants…"[1]

"Management of RO concentrate is a limiting factor for locations where sewer or ocean outfall options for brine disposal were not possible; concentrate handling and disposal significantly impacted the cost of the full advanced treatment alternative and approximately doubles the cost of providing treated water."[2]

Table 11-1. Cost of alternative treatment trains for a 20 MGD facility (adapted from WRRF, 2014d)

Process / Cost/Impact		Ozone-BAF	Full advanced treatment with RO Concentrate Disposal		
			Ocean Outfall	Mechanical Evaporation	Evaporation Ponds
Capital Cost (millions)		$91	$120	$172	$303
Annual O&M Cost (millions)		$4.2	$5.9	$10.9	$6.3
Annual Environmental Costs (millions)		$0.4	$1.6	$6.3	$2.2
Total TBL NPV (millions)		$173	$267	$533	$512
Cost of Water (including environmental costs)	$/AF	$386	$596	$1,190	$1,143
	$/1000 gal	$1.18	$1.83	$3.65	$3.51
	$/m^3	$0.31	$0.48	$0.96	$0.93
Power Consumption (MWh/year)		4,400	16,000	65,400	22,000
Chemical Consumption (dry tons/year)		1,770	1,860	3,020	1,860
Air Emissions (tons/year)	CO_2	2,900	13,400	44,200	17,200
	Other	11	30	150	49

[12]Source: US EPA Potable Reuse Compendium

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Oxelia™ Integrated Ozone-BAC System

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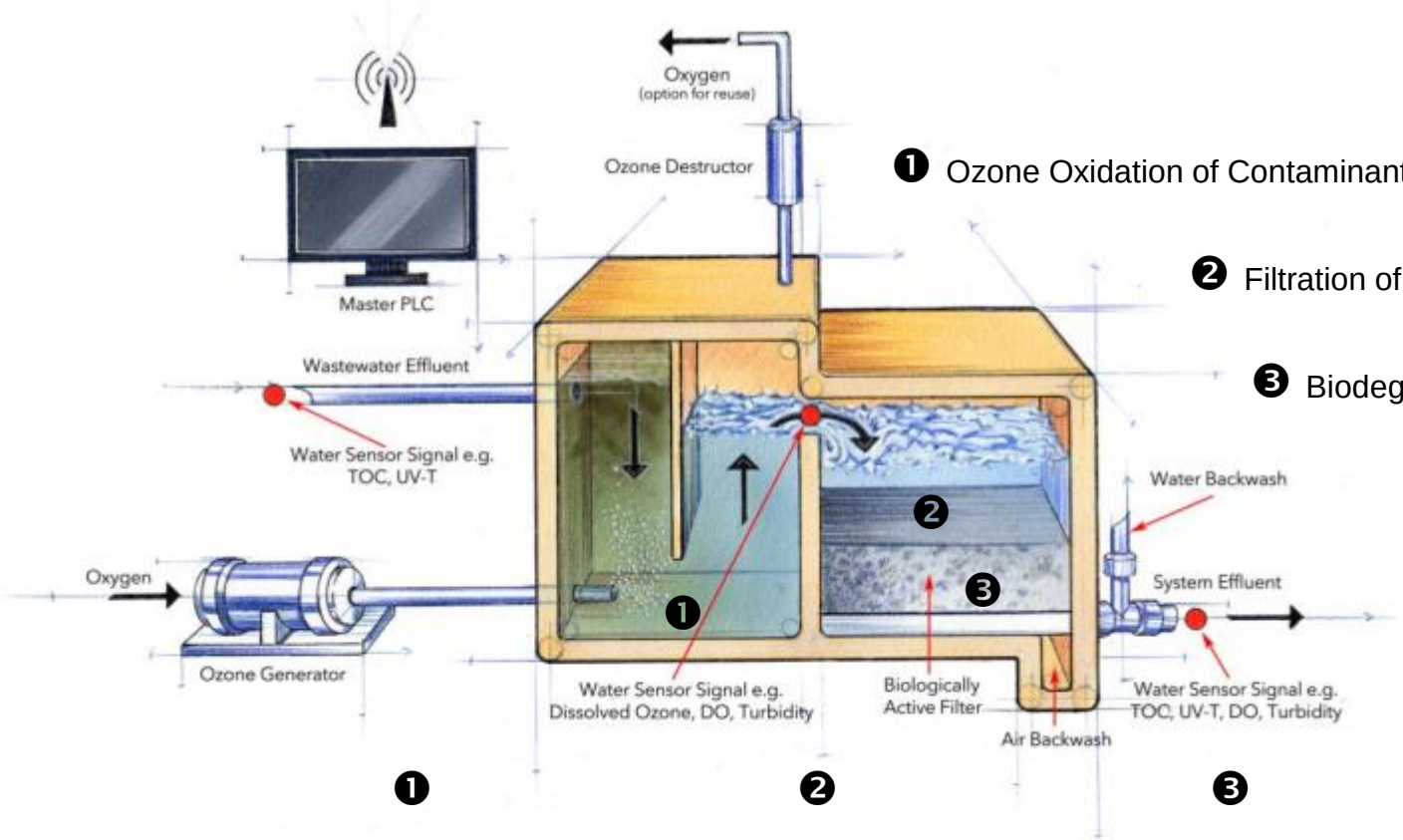
Can I Integrate These Processes?



1. Ozone Oxidation of Contaminants and Disinfection of Pathogens
2. Filtration of Turbidity and Suspended Solids
3. Biodegradation of Total Organic Carbon

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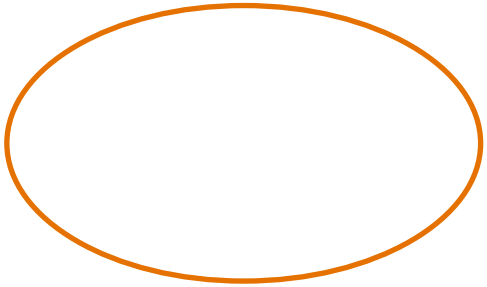
Comparison of O_3:TOC Ratio vs. TOC Effluent Control

O3+BAF Constant O_3:TOC	Oxelia™ Control Adjust O3:TOC ratio based on effluent TOC

Comparison of O_3:TOC Ratio vs. TOC Effluent Control



Control Strategy	Fixed O_3:TOC	Target Effluent TOC Control
Average Ozone Dose		
Average Eff. TOC		
Frequency of Exceedance (TOC>4 mg/L)		

~25% Ozone Savings

- **Fixed O3 dose has higher possibility for ineffective TOC or TOrC removal.**
- **With Effluent TOC control, Ozone/BAF effluent has more reliable TOC reduction**

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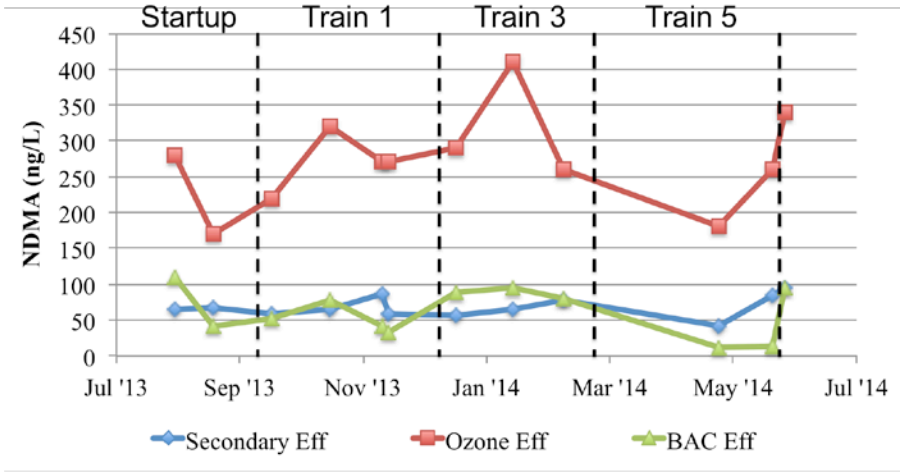
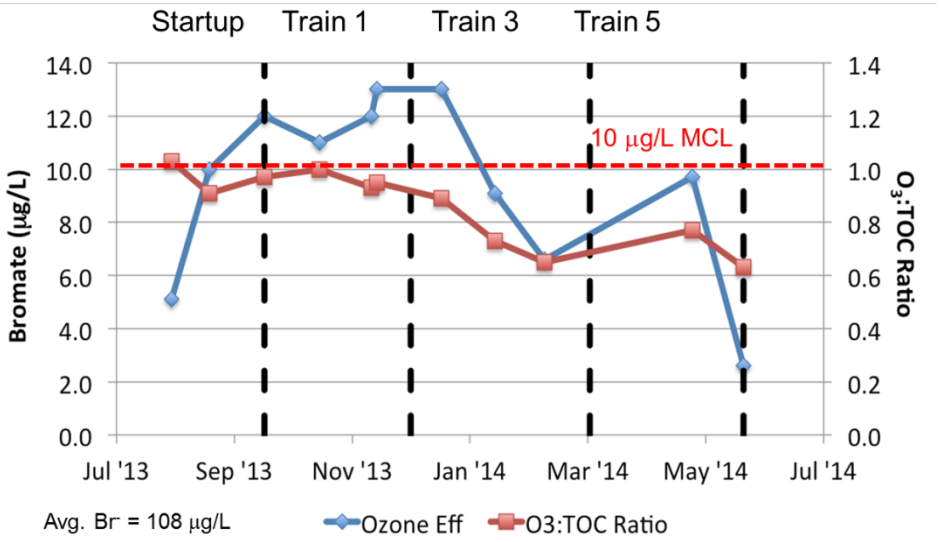
Oxelia Mitigates DBP Formation Concerns



NDMA formed by Ozone is removed by BAF



Ozone Dose Optimization Limits Bromate Formation

Ref: WRRF 11-02 Pilot Project

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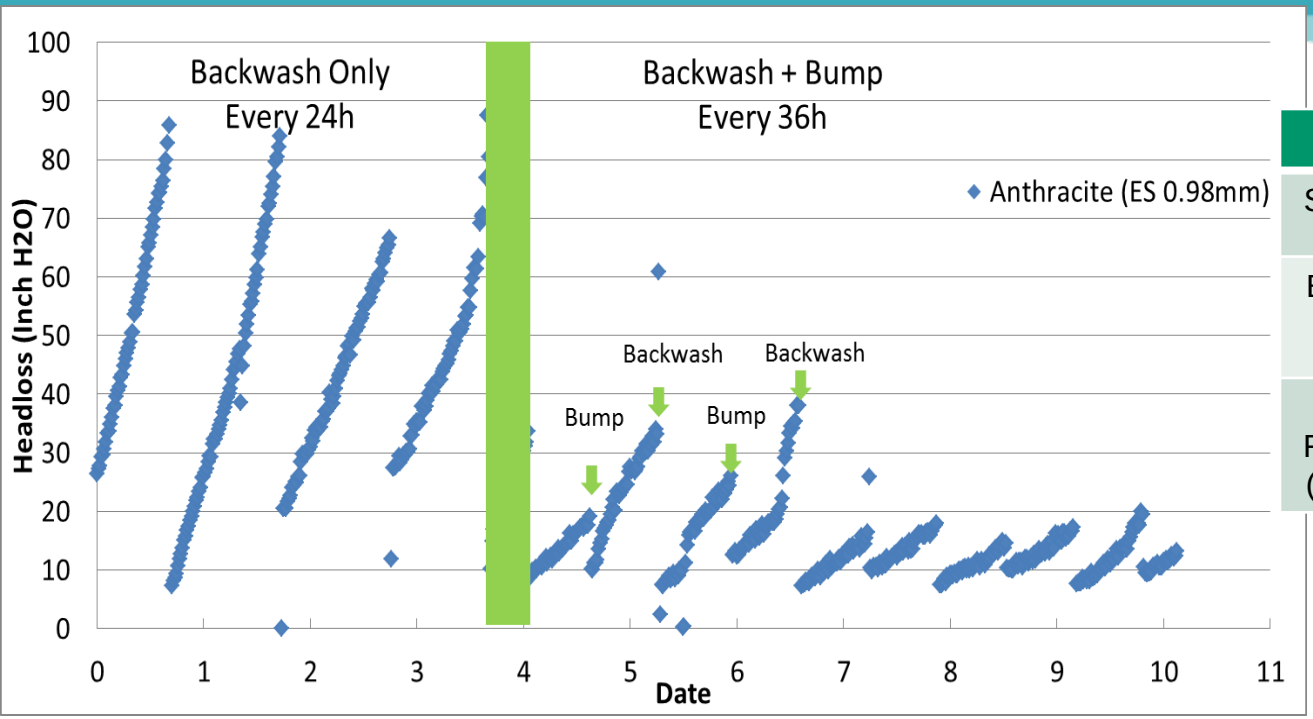
Optimized Filter Backwash & Bump



	Day 0-4	Day 4-10
Sequence		
BW water usage		
Annual Filter Cost (10 MGD)		

- Normal backwash sequence: Air scour + High rate water + Low rate water
- Bump: gentle water only backwash to breakdown cake layer at filter top and remove air
- **Bump is proven to reduce headloss and extend filter runtime.**
- **Save 28% of Filter OPEX**

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Clear Benefits for System Integration

An Ozone-BAF system with integrated on-line analytical and advanced control can be designed to achieve:

Better effluent quality control to achieve:

- More Consistent TOC at effluent
- Proven DBP control
- Reliable CEC removal
- Pathogen Log Reduction Credit

Lower operational cost:

- To save applied Ozone dose based on influent vs. effluent water quality
- To reduce backwash frequency

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Example OpEx Savings with Oxelia Control

Flow Rate	2 MGD	10 MGD	25 MGD	100 MGD
Ozone Dose with Decoupled Solution	7 mg/L	7 mg/L	7 mg/L	7 mg/L
Power Consumption with Decoupled Solution	40 kW	155 kW	435 kW	1,590 kW
Ozone Dose with Oxelia	5.3 mg/L	5.3 mg/L	5.3 mg/L	5.3 mg/L
Power Consumption with Oxelia	30 kW	130 kW	325 kW	1,275 kW
Power Savings for Your Facility	10 kW	25 kW	110 kW	315 kW
20-Year Present Worth of Savings	$109,169	$272,922	$1,200,857	$3,438,819

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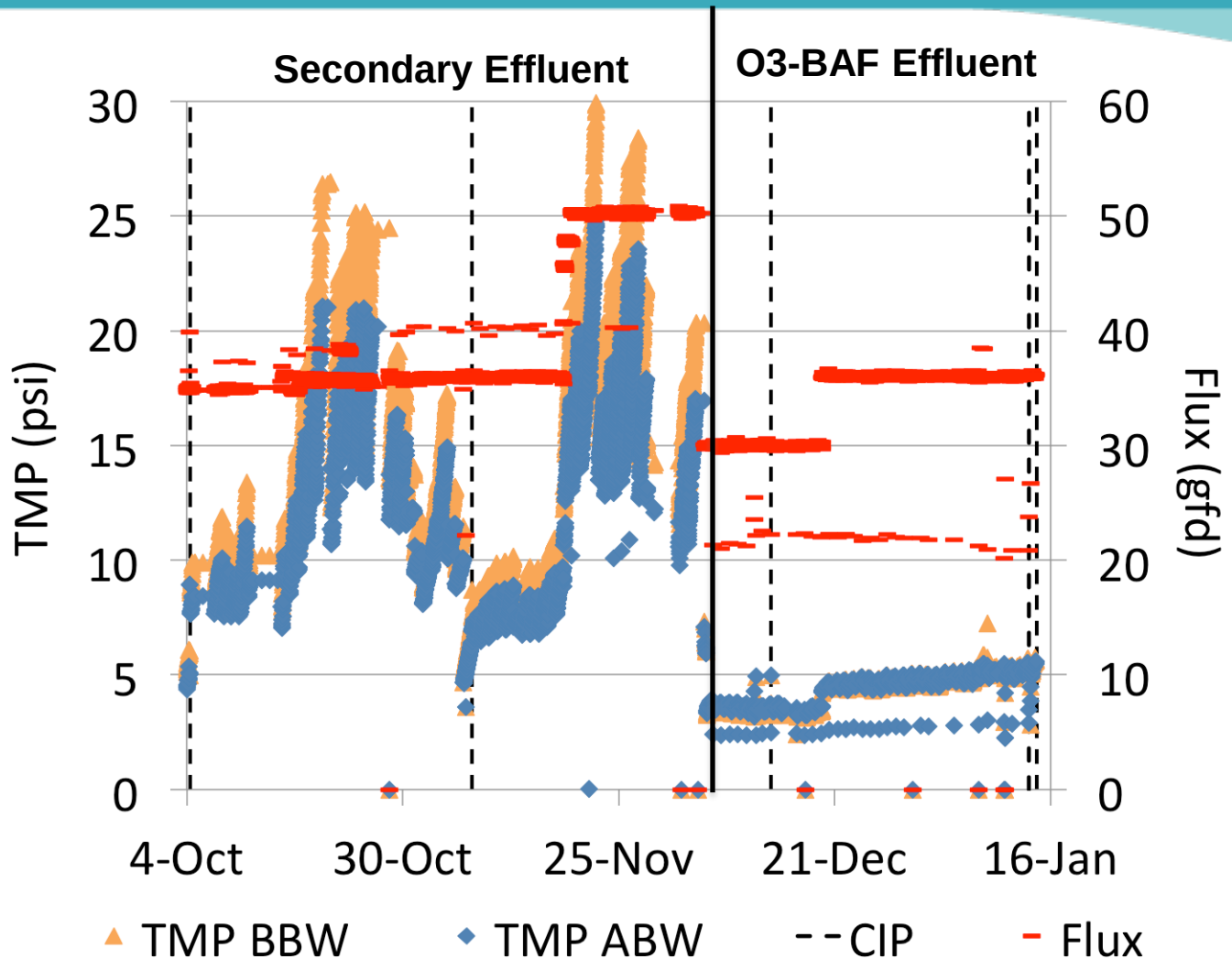
O3-BAF Benefits OpEx of Membranes



- **O3-BAF reduces organic fouling of membranes**
- **~ 3x reduction in Transmembrane Pressure Drop**
- **Reduces energy costs, CIP, and improves overall performance**

Ref: WRRF 11-02 Pilot Project

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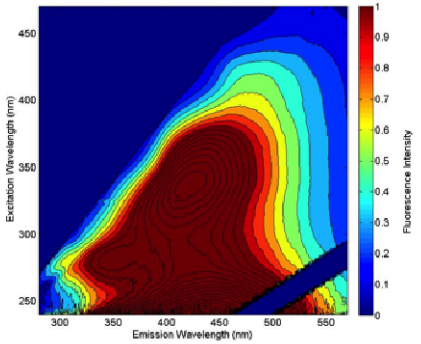
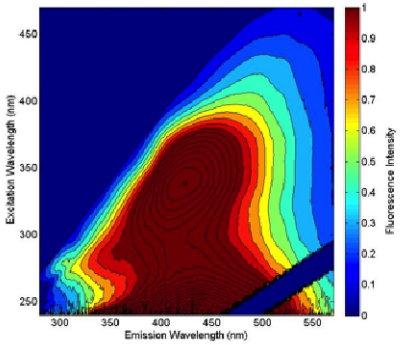
O3 BAF Reduces RO Brine Toxicity

(a) Without ozone/BAC pretreatment

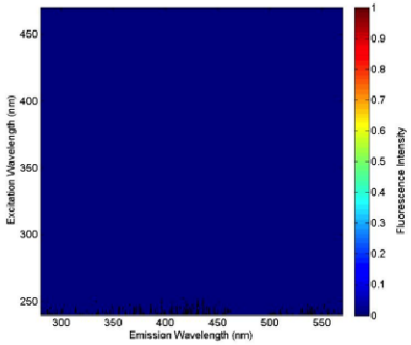
Tertiary Effluent



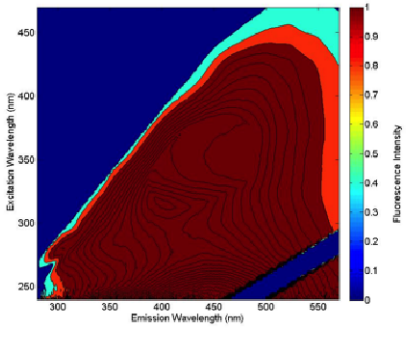
RO Feed



RO Permeate

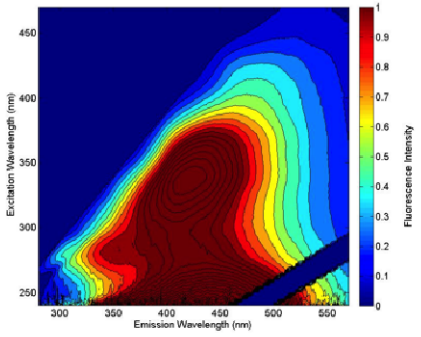


RO Concentrate

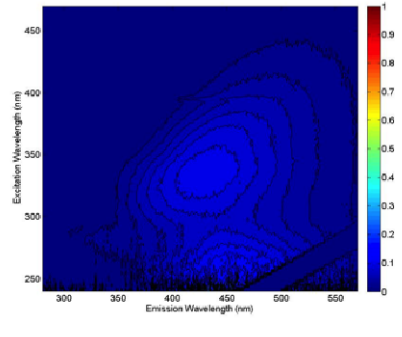


(b) With ozone/BAC pretreatment

Tertiary Effluent



RO Feed



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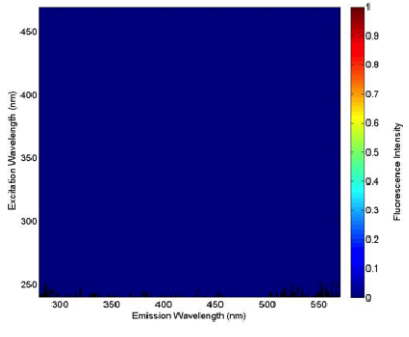
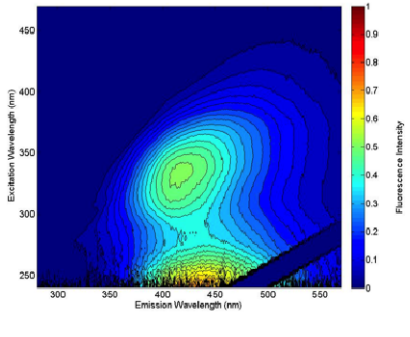


RO Concentrate



With O3-BAF pretreatment, RO concentrate shows less fluorescence than the feed water (tertiary effluent) and contains ~**40% less TOC**

Ref: Trussell Technologies IOA-PAG Dallas 2015

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Reuse Installations

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HRSD SWIFT Facility:
Oxelia – Integrated Ozone & BAF + UV

Winner of US Water Prize
1 MGD Design Flow
Oxelia System:

- 2 x SMOevo 610 Ozone Generators at 200 PPD Each
- 4 x Filter Cells with XA Underdrain

UV System:

- 2 x Spektron 2000e for 4-Log Virus Inactivation

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Pure Water Monterey

- Groundwater Recharge Project
- 5 MGD
- O3 and UV/AOP Provided by Xylem
  - 2 x PDOevo 900 Ozone Generators
    - Ozone Dose of up to ~20 mg/L
  - 6 x LBX 1500e UV Reactors with H_2O_2
    - UV Dose of 1,600 mJ/cm^2 and H_2O_2 Dose of up to 6 mg/L
- 2015 WateReuse Agricultural Project of the Year
- 2017 WateReuse CA Annual Conference Community Outreach and Public Education Project of the Year
- First indirect potable reuse project in Northern CA
- Installation in 2018 and Commission in 2019

Terminal Island UV-Chlorine AOP

- 2017 Best of the Best Water/Environment Project
- Terminal Island WRP – Owned and Operated by LASAN
- Indirect Potable Reuse
- 1st Greenfield MiPRO UV/Cl_2 AOP
  - Incl 2 x K143 12/17 UV Reactors
- 12 MGD Design Flow
- Partnered with LASAN, Trussell & Carollo to pilot test all AOP options and select the AOP which offered the best performance and cost.

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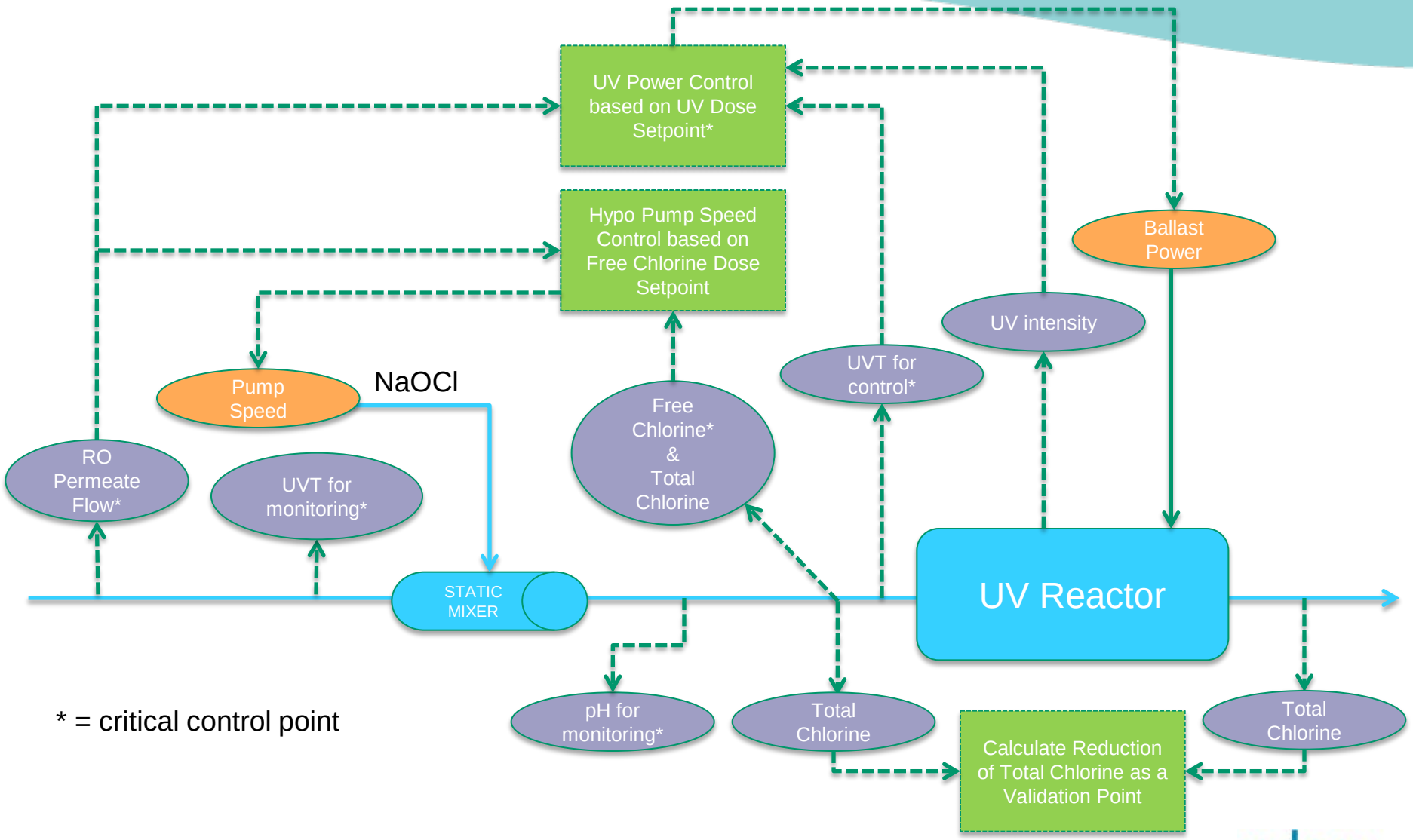
Xylem Approach to UV/Chlorine AOP Control



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Xylem's Partnership with SCVWD - Reuse

- Silicon Valley Advanced Water Purification Center (AWPC)
- Non-Potable Reuse for Silicon Valley Users
- Winner of 2015 Water Reuse Project of the Year
- 12 x LBX 1000e UV Units
- Variable Design & Control to Treat MF or RO effluent

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Xylem's Partnership with SCVWD - Reuse

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RO Brine Management at SCVWD

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Xylem's Partnership with SCVWD - Potable

Rinconada WTP

Penitencia WTP

Santa Teresa WTP

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Pilot & Bench Scale Capabilities

- Typical Flow Rates of
- UV doses up to XXX mJ/cm^2
- Ozone doses up to XX mg/L
- Hydrogen Peroxide doses up to XX mg/L
- Ability to link MiPRO AOP Process with Xylem Filter Columns for O_3 + BAF

*Note the information provided above is typical, but pilots can be configured for site specific conditions

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Come See Us at the WateReuse Symposium!

Kevin Flis, Sunday, September 9th 1:30 – 3 PM Moderator for Session 1, Track 3

Jens Scheideler, Sunday, September 9th 1:30 PM Speaker for Session 1, Track 3, Presentation Title, "*UV AOP Study at Singapore NEWater Factory*"

Patrick Decker, Monday, September 10th 8 – 10 AM Panelist for Plenary Discussion Title, "*Business Thought Leaders on Water Reuse*"

Lucinda Jooste, Monday, September 10th 1:45 PM Speaker for Session 1, Track 4, Presentation Title, "*Day Zero – The End or Beginning?*"

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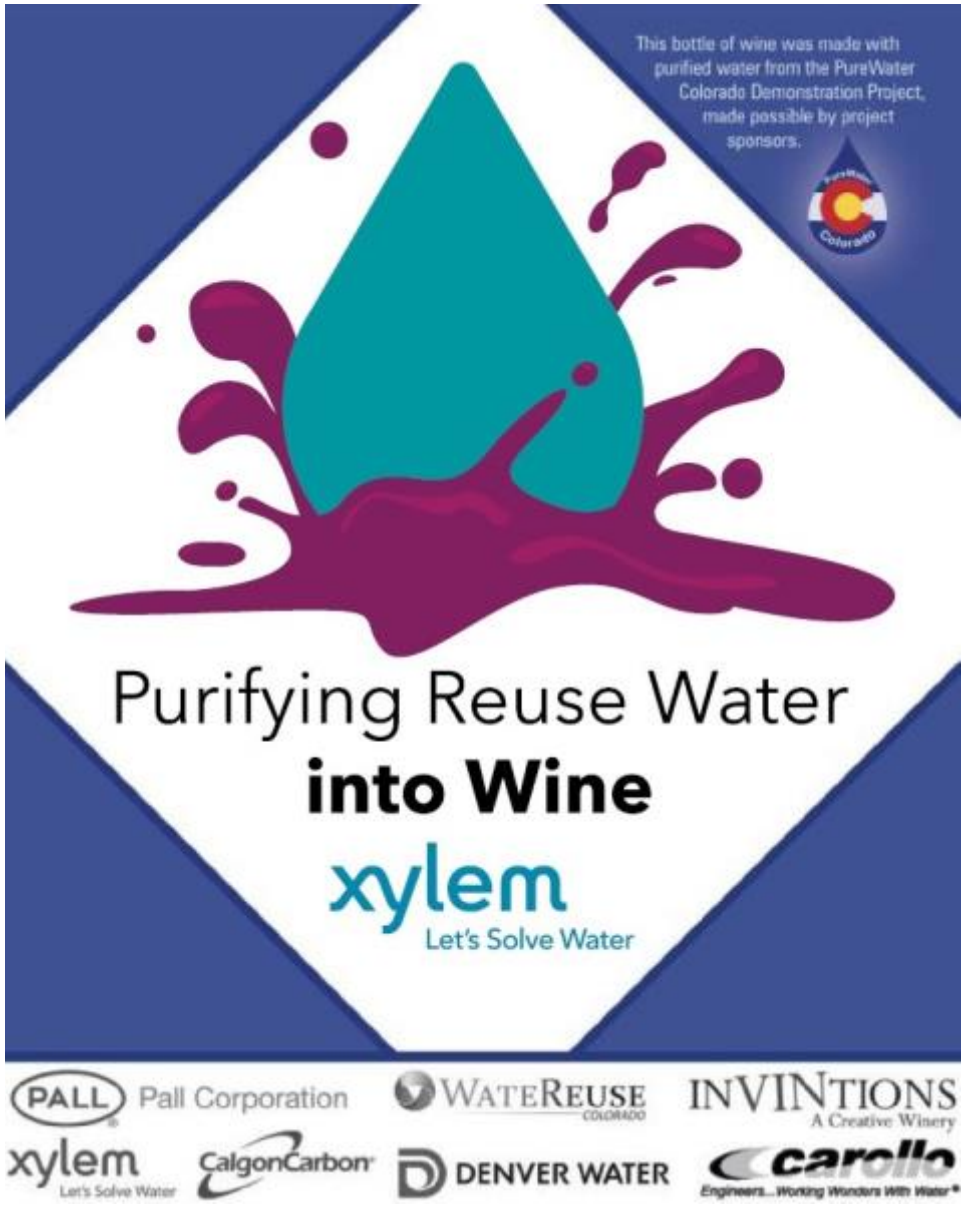
Come See Us at WEFTEC!



- Purified Water from WRCO Potable Reuse Demonstration into Wine
  - Distributed by Xylem at WEFTEC 2018
- Additionally, Xylem is Official Sponsor of the Biergarten
  - Biergarten will be Distributing Beer Made from Purified Water Monday & Tuesday Afternoon at WEFTEC

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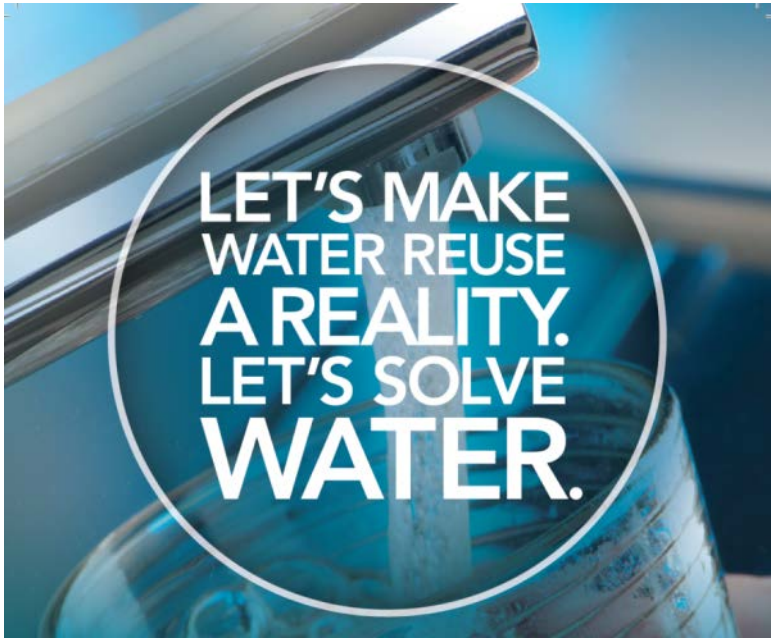
Thank you!



For questions please contact

Steve Green 503.396.2695 steve.green@xyleminc.com
Pedro Gochicoa 980.312.1365 pedro.gochicoa@xyleminc.com

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