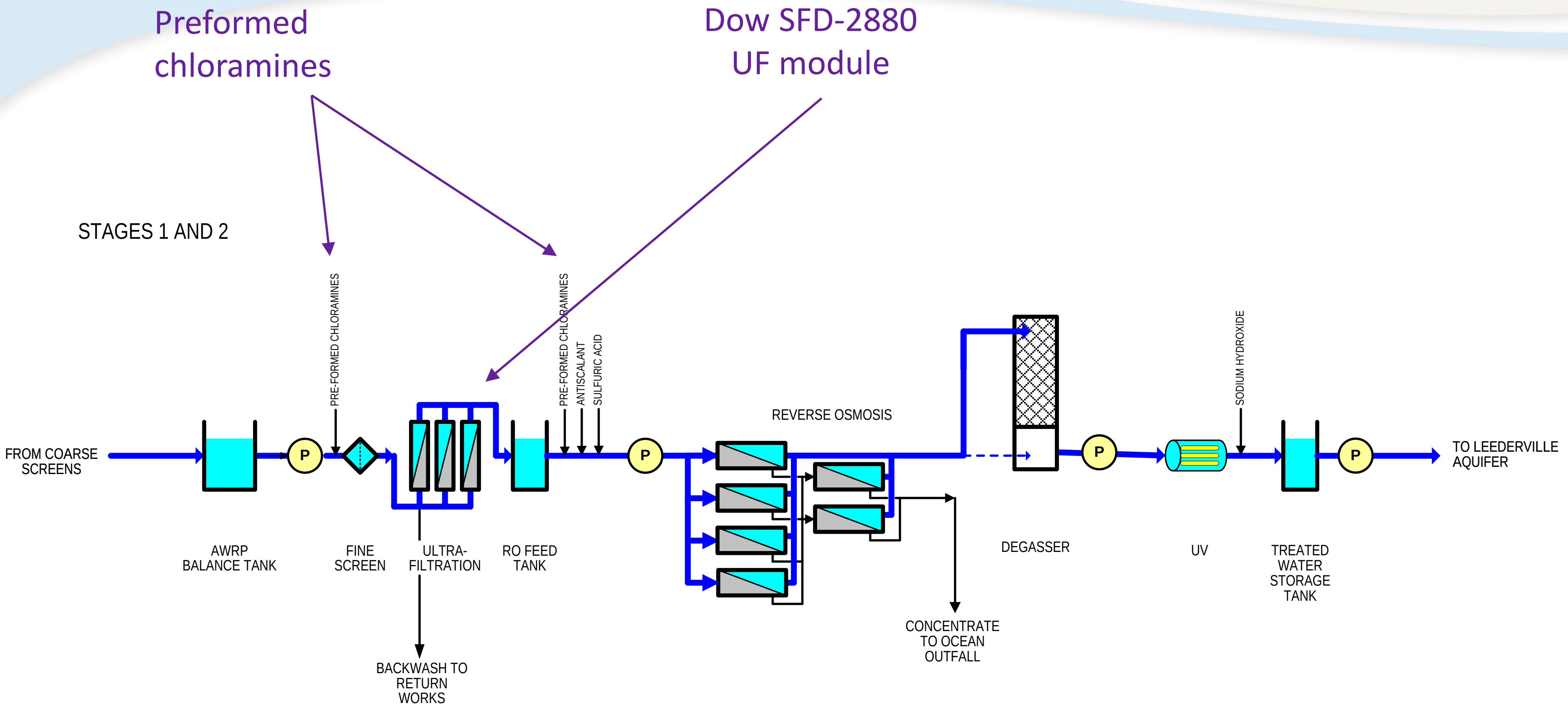
Advances in Treatment for Potable Reuse

- WateReuse LA Chapter
- December 6, 2016

- Steve Alt CH2M

Beenyup Advanced Water Recycling Plant (BAWRP) Process Schematic

- Plant is designed to be expanded from 10 to 20 MGD



BAWRP Level of Microbial Removal

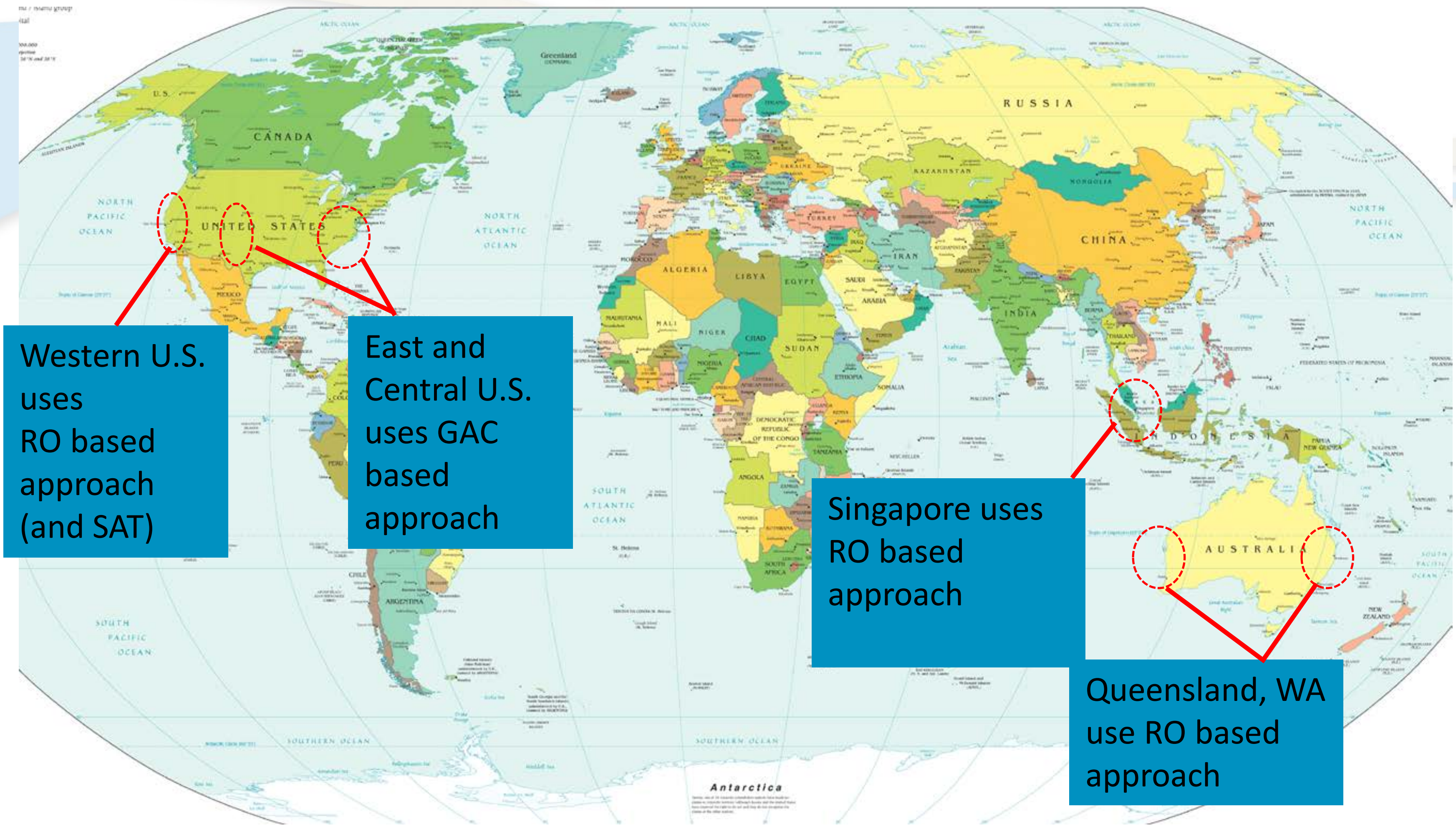
	Equivalent Log Reduction Credits		
	Bacteria	Virus	Protozoa
Wastewater Treatment	1	1	0.5
BAWRP Process Unit			
UF with chloramination >1.5 mg/L	3	**3**	3
Reverse Osmosis	3	**3**	3
UV Disinfection at 186 mJ/cm2	4	4	4
Total AWRP ELRC	10	10	10
Total (WWTP & BAAWRP)	11	11	10.5
DoH Requirement	8.5	9.5	8
Excess credits (safety factor)	2.5	1.5	2.5
California Requirement	NA	12	10/10

Additional Membrane Virus Credits

Total Process Virus Credits

Potable Reuse Plants

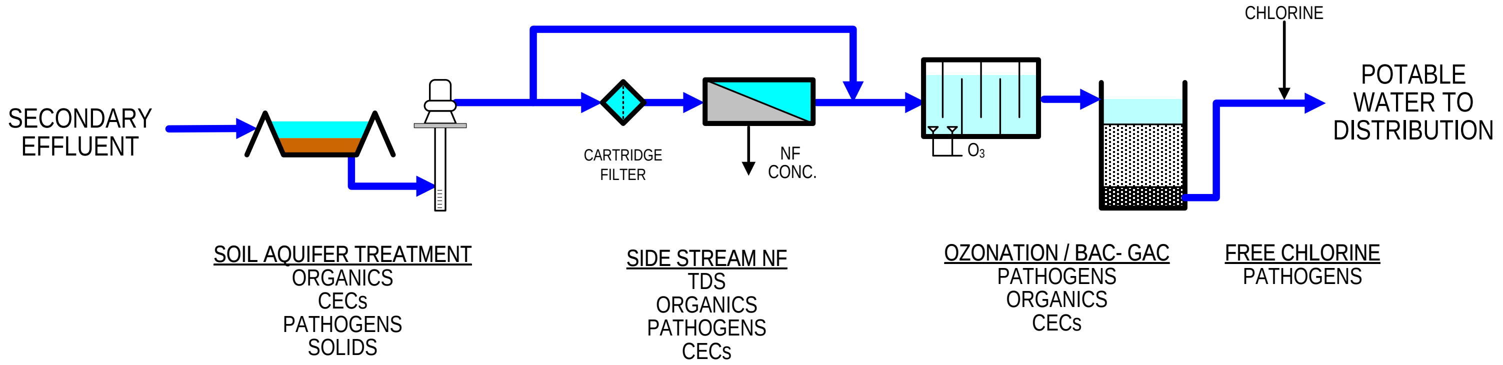
RO-Based (West U.S. and International) vs. GAC-Based (East and Central U.S)



- Fit for Purpose Water: The Cost of Overtreating Reclaimed Water (WRRF-10-01)

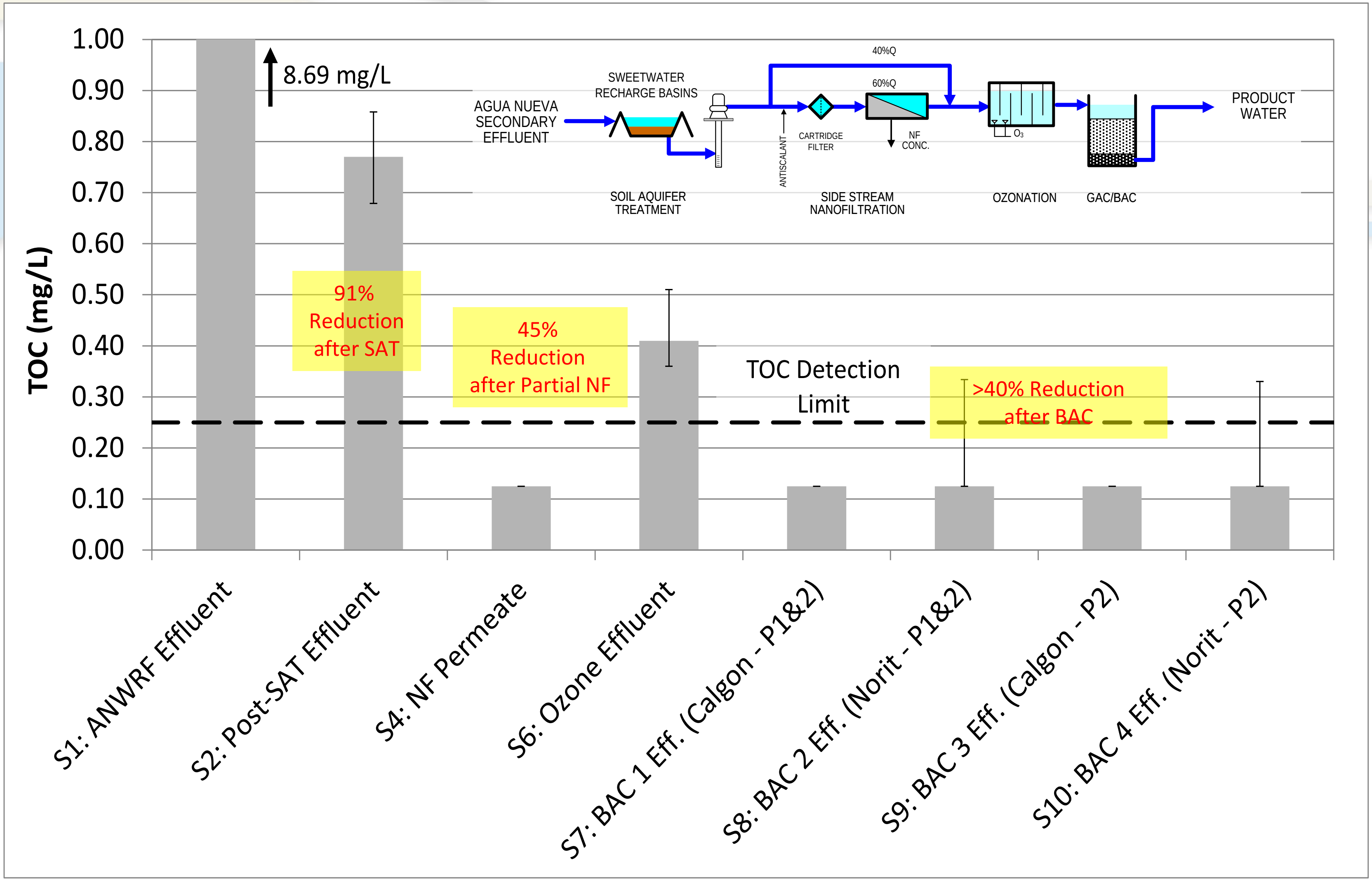
Tucson Water Pilot Testing

- Proposed treatment approach utilizes SAT, side stream NF, Ozone and BAC-GAC to provide multiple barriers required for potable reuse and TDS removal



- Pilot testing for WRRF 13-09 conducted at Tucson, AZ where reuse is being considered for the future

Tucson Water Total Organic Carbon



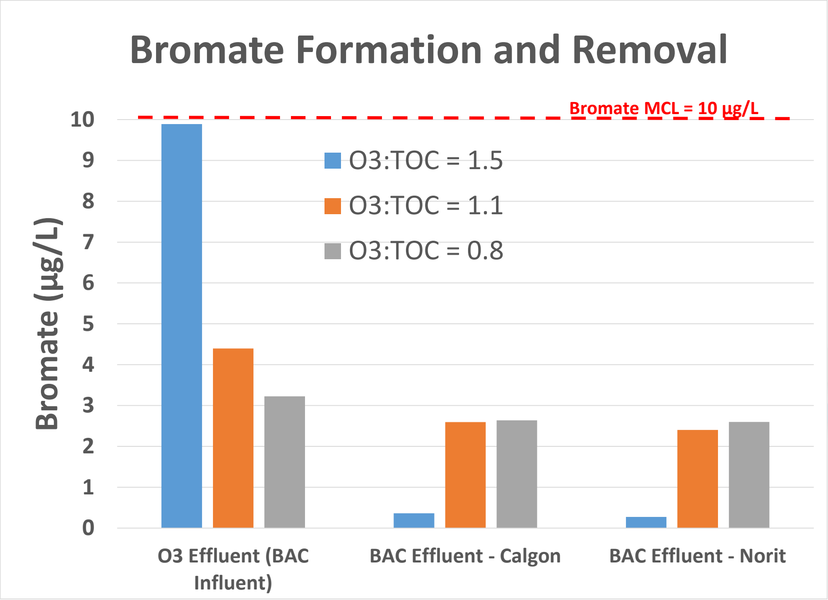
Tucson Water Total Contaminants of Emerging Concern

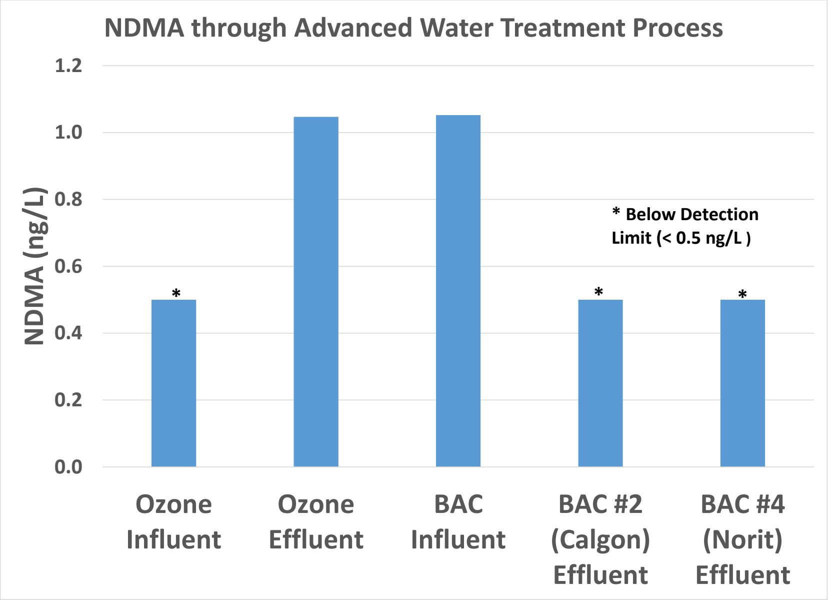
- 44 CECs monitored – **All below the detection limit in finished water**
- Some CECs are recalcitrant to certain treatment, so multiple barriers is important

2015/04/30	Concentration of Trace Organics in ng/L								
Compounds	**Category**	**Agua Nueva Effluent**	**Well 69B**	**Ozone Influent**	**Ozone Effluent**	**BAC C1 (Calgon) Effluent**	**BAC C2 (Calgon) Effluent**	**BAC C3 (Norit) Effluent**	**BAC C4 (Norit) Effluent**
Benzophenone	Industry (paint,	129	< 30	< 16	< 30	< 28	< 29	< 30	< 29
Benzotriazole	De-icing, inhibitor,	4236	4755	4051	2416	< 480	< 480	< 470	< 500
Caffeine	stimulant	< 4.0	< 5.2	< 4.4	< 5.6	< 3.9	< 4.1	< 3.7	< 3.8
Carbamezapine	Anit-epileptic	363	487	126	< 1.6	< 1.6	< 1.5	< 1.5	< 1.5
DEET	Insect repellant	172	7.0	14	< 6.0	< 4.1	< 4.0	< 3.8	< 3.6
Gemfibrozil	cholesterol drug	5.4	< 1.0	< 1.0	< 1.1	< 0.9	< 0.9	< 0.9	< 0.9
Ibuprofen	anti-inflamatory,	< 2.8	< 3.7	< 3.5	< 4.9	< 3.6	< 3.5	< 3.0	< 3.5
Iopamidol	Angiography	29677	3188	913	1395	< 27	< 28	< 26	< 31
Iopromide	x-ray contrast	5465	< 24	< 34	< 24	< 27	< 28	< 26	< 31
Meprobamate	tranquilizer	455	58	28	29	< 10	< 10	< 10	< 10
PFOA	cookware, textiles, clothing,	2.2	32.3	16.3	15.8	< 0.8	< 0.8	< 0.7	< 0.7
PFOS	Stain repellant	< 6.3	256	124	123	< 3.5	< 3.5	< 3.8	< 3.9
Primidone	Anit-epileptic	14	165	90	87	< 4.3	< 5.7	< 4.8	< 4.8
Sucralose	Artifical sweetner	51567	26702	7595	13459	< 220	< 240	< 240	< 250
Sulfamethoxazole	antibiotic	1903	36	15	< 8.0	< 5.0	< 4.9	< 4.5	< 4.9
TCEP	Flame retardant	128	181	31	125	< 22	< 22	< 23	< 23
TCPP	Flame retardant	715	< 24	129	83	< 22	< 22	< 23	< 23
Triclosan	soap	44	< 12	< 9	< 13	< 13	< 14	< 13	< 14

Ozone Disinfection Byproducts

- Ozone Dose = 0.3 – 1.0 mg/L
- Bromate
  - Bromide concentration in secondary effluent was relatively high (~0.3 mg/L)
  - Formation was significant at higher ozone doses, but
  - Bromate removal by BAC/GAC was significant
- NDMA
  - Very high in the secondary effluent (sometimes above 200 ng/L)
  - Excellent removal by SAT (< 10 ng/L)





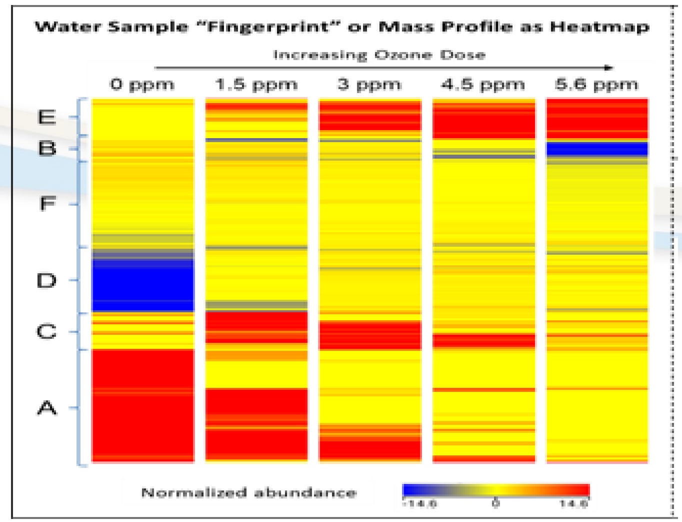
Tucson Water Conclusions

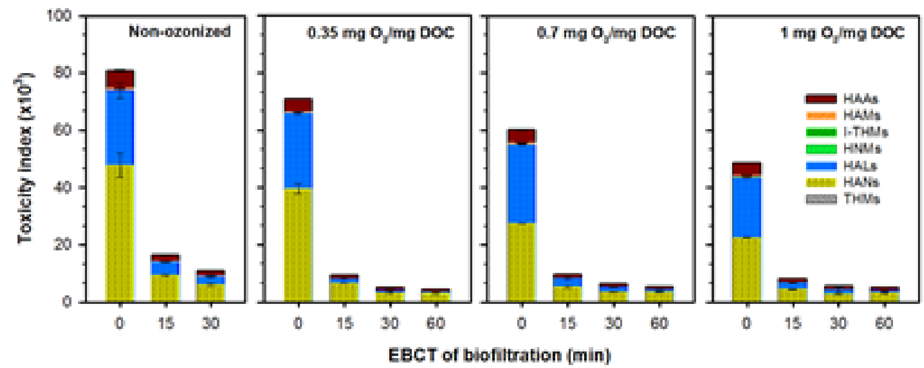
Issue	Answer
Do multiple organics barriers provide suitable water quality?	Yes; finished water quality: 1) TOC< 0.25 mg/L 2) All 44 CECs non-detect
Can TDS goal be met with sidestream NF treatment?	Yes, TDS < 500 mg/L consistently met
Can bromate and NMDA formation be controlled?	Yes, both were well below regulated limits: Bromate < 3 µg/L (MCL = 10 µg/L) NDMA < 0.5 ng/L (CA limit 10 ng/L)
Are pathogens adequately removed?	Yes, post-SAT water was non-detect for viruses and protozoa; >4-log removal of viruses by just SAT
Is GAC-based train suitable for potable reuse at Tucson?	Yes and costs are much lower than RO-based train

The Final Report for WRRF 13-09 is currently under review and will be published in 2016

WE&RF 15-04 Characterization and Treatability of TOC from DPR Processes Compared to Surface Supplies

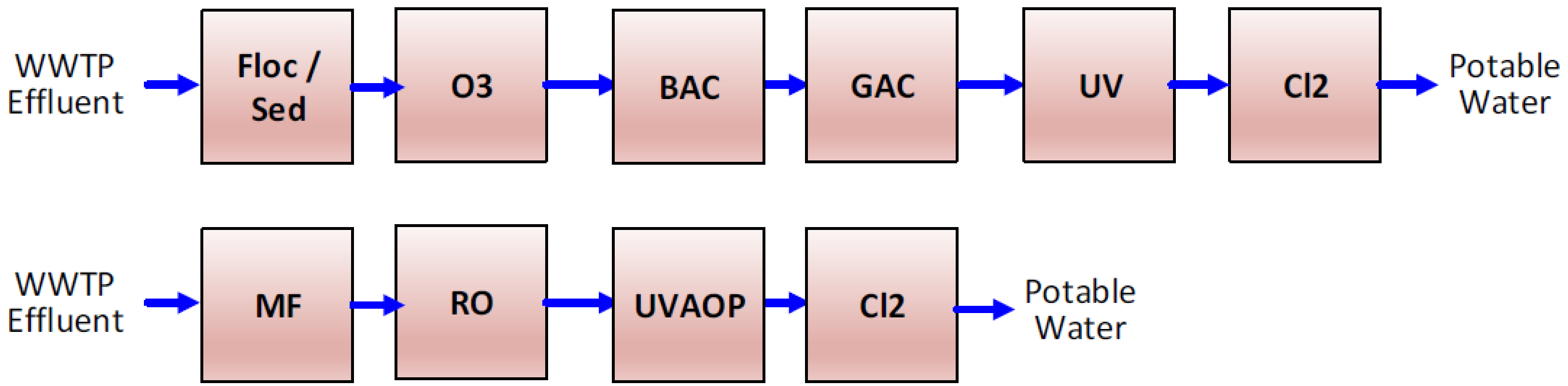
- The goal of the research is to develop a site-specific, feasible, and scientifically-defensible framework for organics removal for utilities pursuing direct potable reuse
  - TOC and COD alone are not able to properly reflect exposure to organics contaminants
  - Is a TOC goal of 0.5 mg/L appropriate? Is a COD goal of 10 mg/L appropriate?
- A framework will be develop to demonstrate if potable reuse water is comparable in safety to local drinking water based on the concept of *Chemical-Associated Toxicity (CAT)*
- PI: Larry Schimmoller/CH2M
- CO-PIs: Dr. Bill Mitch/Stanford; Dr. Shane Snyder/University of Arizona





Hampton Roads Sanitation District (Virginia)

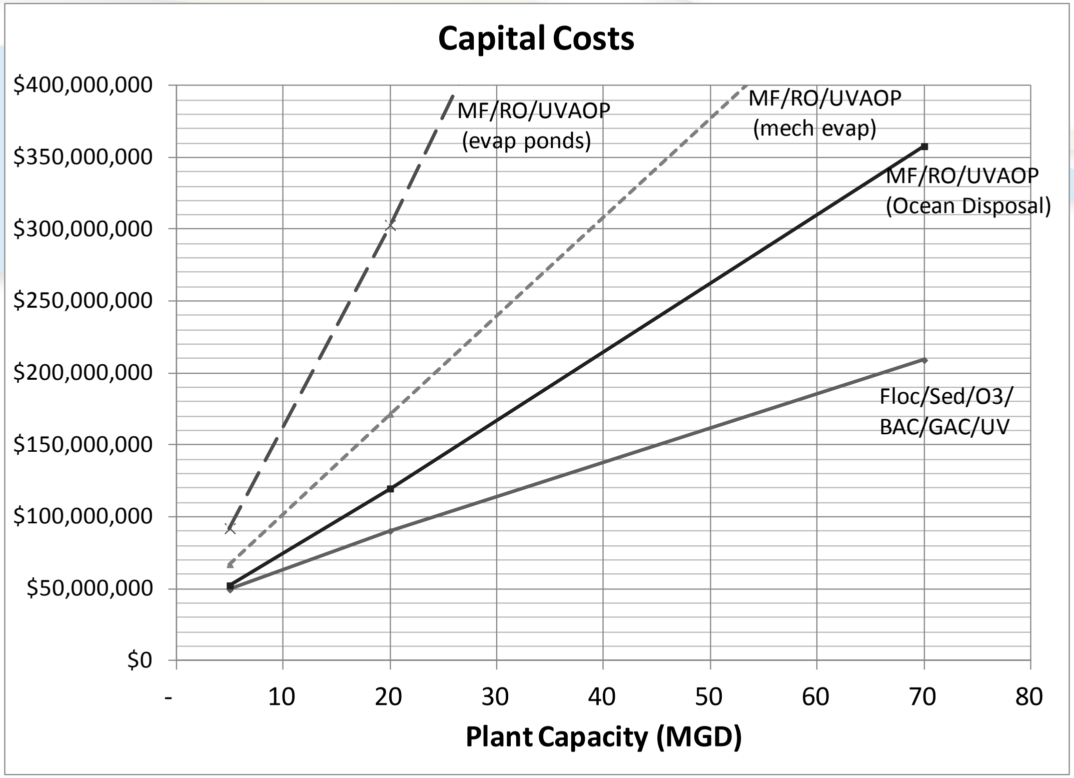
- HRSD is constructing pilot facilities that include parallel treatment trains for a direct comparison of RO and non RO based treatment



Thank You

- Questions=?

Potable Reuse Costs: RO-based vs. GAC-based



Source: Figure taken from WRRF 10-01. Figures are WateReuse Research Foundation's Intellectual Property

- GAC-based treatment less expensive
- High treatment cost for RO-based treatment due to costs for concentrate disposal, especially at inland locations
- Pretreatment to RO typically MF and also expensive
- SAT costs (not shown), are site specific but assumed to be reasonable with right geologic conditions