CITY OF VENTURA

LA CHAPTER WATEREUSE MEETING

August 2016

Direct Potable Reuse in Ventura?

Project Team

Elisa Garvey
Lydia Holmes
Andrew Salveson
Justin Sutherland

Shana Epstein (Ventura)
Gina Dorrington (Ventura)

carollo
Engineers...Working Wonders With Water®

Stillwater Sciences

City of Ventura is planning to implement potable reuse within next 10 years

- Original drivers for reuse
  - Potential limitation on effluent discharge to SCRE
  - Settlement agreement with NGOs
- Drivers for potable reuse
  - Water supply and demand
  - Increased vulnerability of highest quality water supplies and water rights
  - Drought conditions

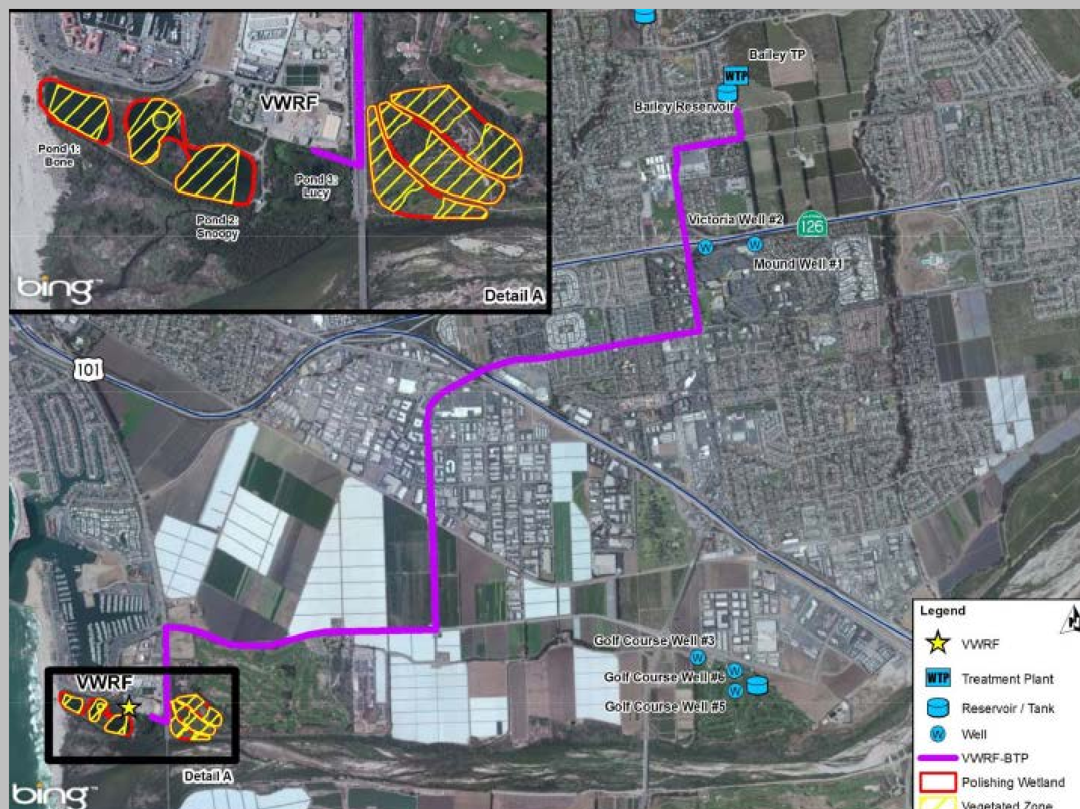
Many reuse alternatives were identified and evaluated by stakeholders…

Reuse Alternative	Reliable Reduction of Effluent Flow	Water Supply Benefit	Potential to Offset other Projects	Treatment Costs
Urban Irrigation	○	◒	○	Low
Agricultural Irrigation	◒	○	○	Medium
Groundwater Recharge	●	●	◒	High
Direct Potable Reuse	●	●	●	High

… potable reuse preferred by most

Indirect and Direct Potable Reuse alternatives are being considered and further developed

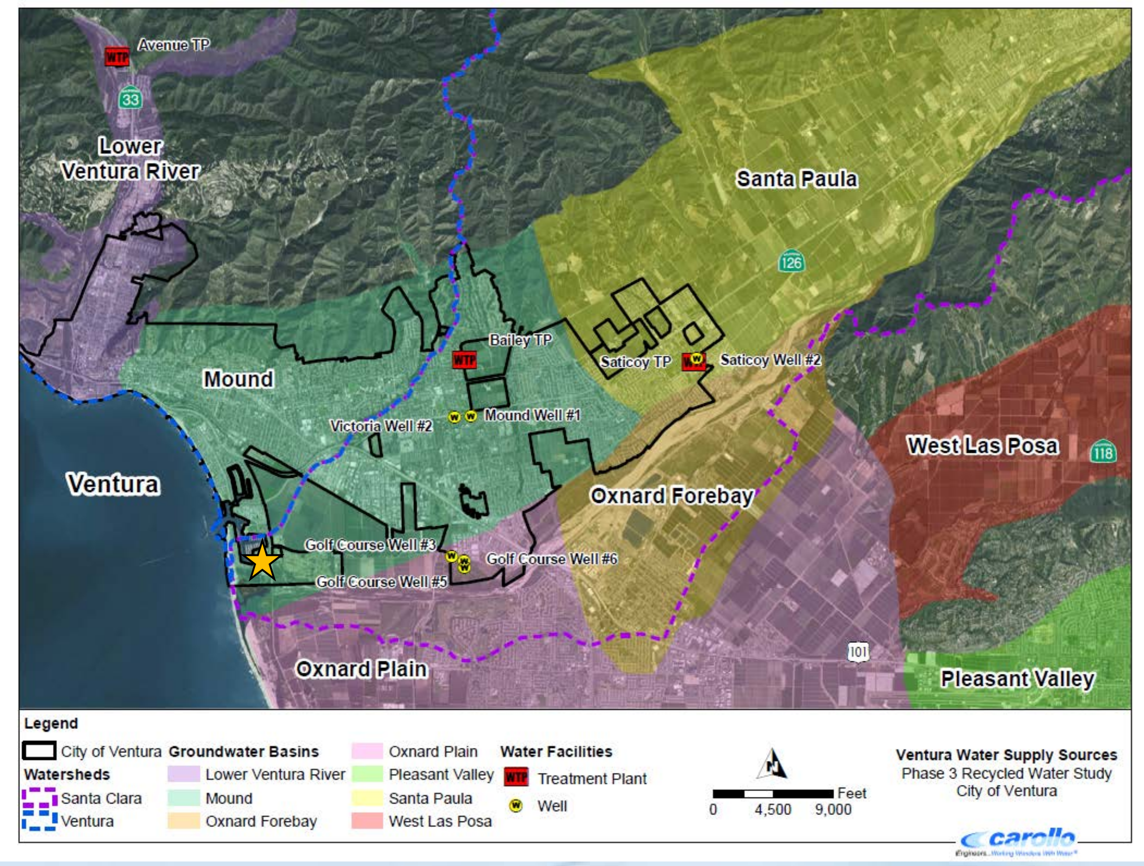
Raw Wastewater → VWRF (Tertiary Treatment) → Advanced Treatment → Environmental Buffer or Engineered Storage → Indirect or Direct Potable Reuse



Direct Potable Reuse

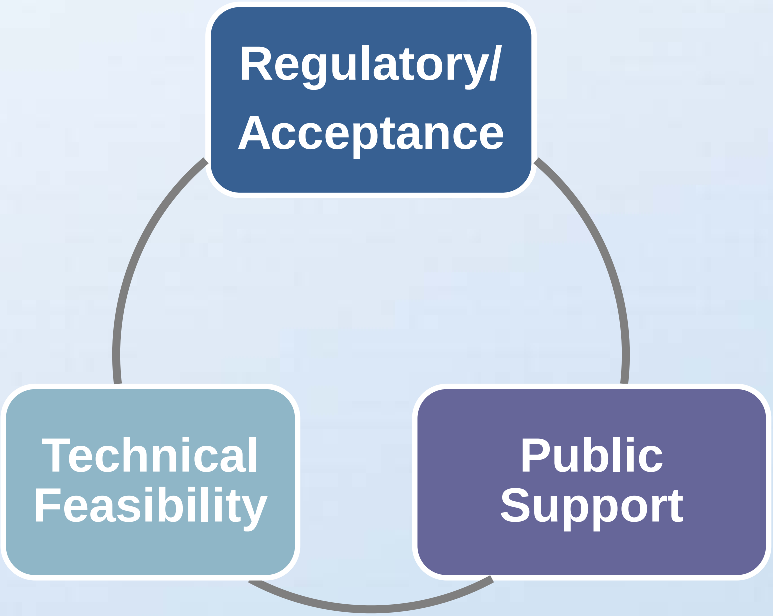
City interest in direct potable reuse based on a few key issues

- Environmental buffer is a compromised groundwater aquifer (high TDS)
- Capacity of groundwater aquifer
- Incomplete recovery of purified water from aquifer



City developed a strategy for implementing potable reuse

- Feasibility Study
  - DPR treatment train
  - Costs
- Potable Reuse Demonstration Facility
  - Regulatory Demonstration and Confidence
  - Internal Demonstration and Confidence
  - Public Education and Outreach (Tours and Survey)
  - Design Criteria
  - O&M Issues
  - Novel R&D



DPR treatment train - multiple barriers for water purification

Advanced Disinfection

Pasteurization

Kills *A LOT* of Pathogens

Tertiary Filtration

Pressure Filters

Removes turbidity and TSS

Secondary Effluent

Membrane Processes

Ultrafiltration

Filters Pathogens, Pretreats ahead of RO

Reverse Osmosis

Removes Pathogens, Removes Salt, Removes Trace Pollutants

Disinfection and Advanced Oxidation

NaOCl or H_2O_2

UV

Kills Pathogens, Destroys NDMA and Trace Pollutants

Engineered Storage

Finished Water

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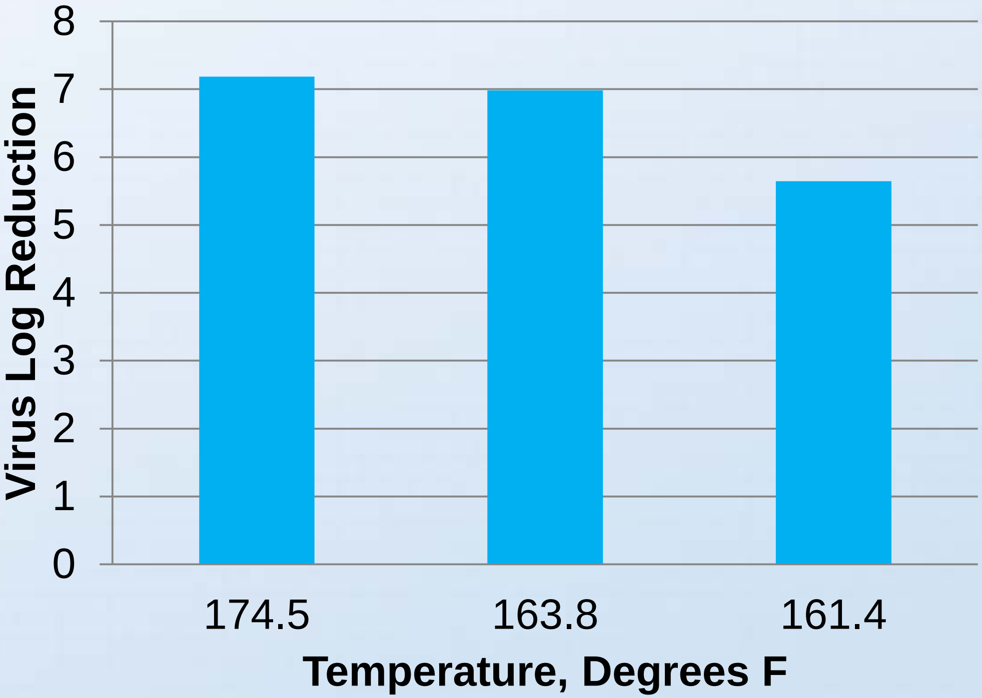
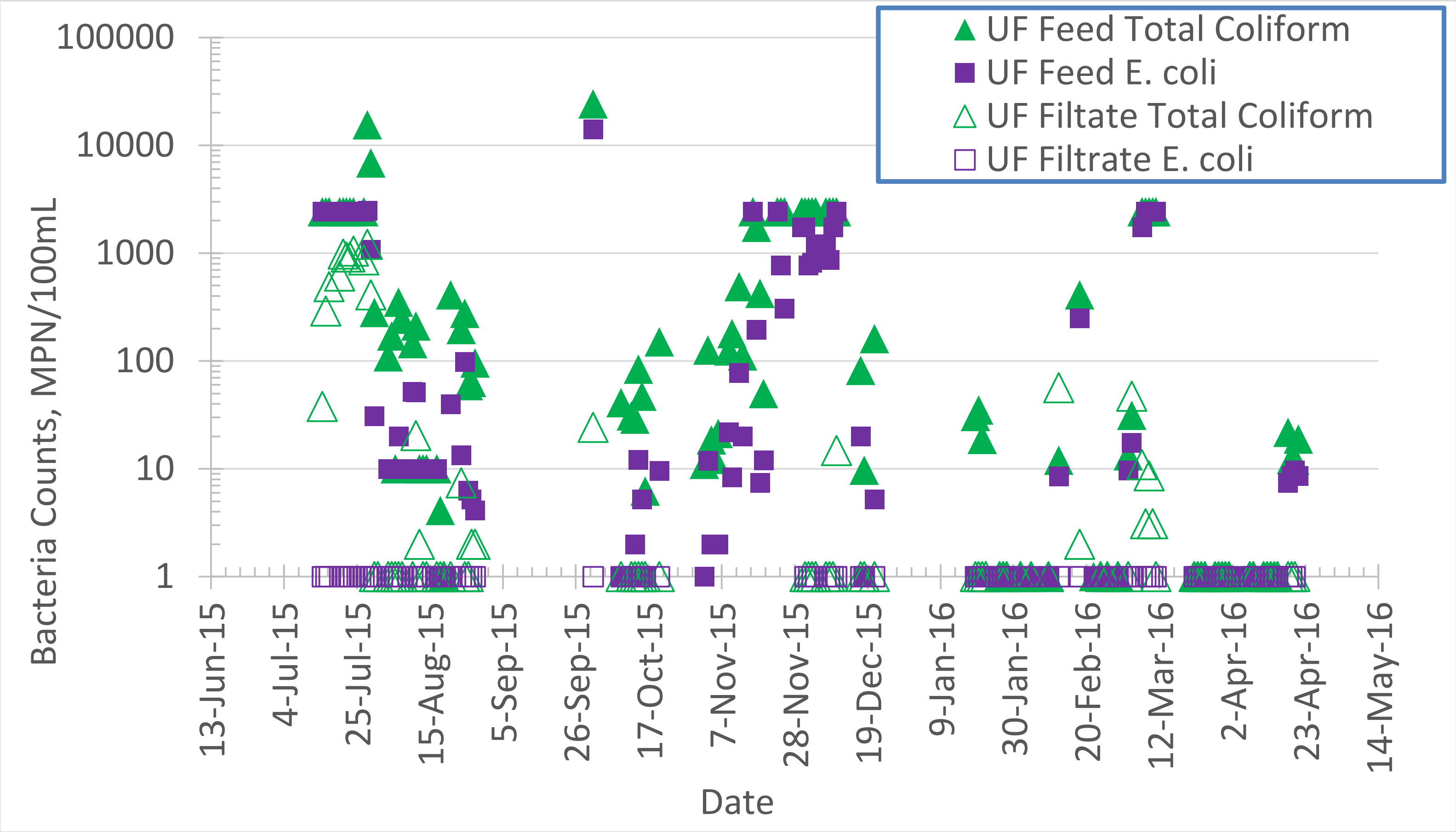
Pasteurization Provides Robust Disinfection



Pasteurization provides 5+ LRV of all known pathogens

UF Provided Robust Protozoa and Bacteria Removal



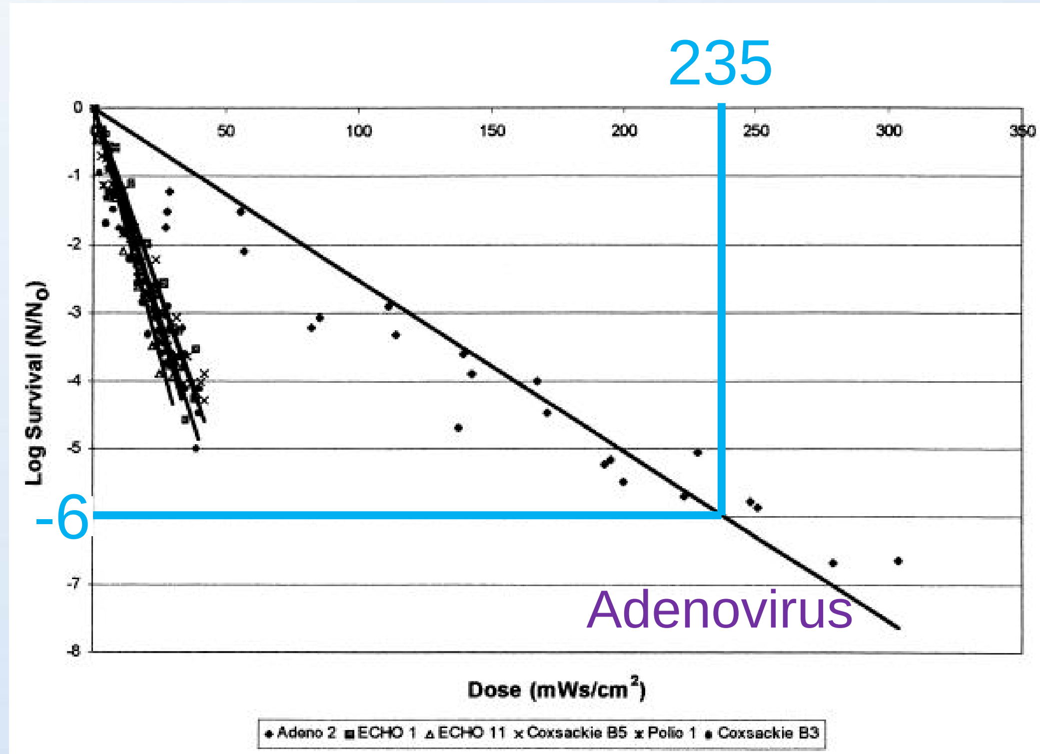
RO Removes both TOC and Salt…

- Monitoring Data
  - Feed TDS – 1350 to 1600 mg/L
  - Permeate TDS – 20 to 70 mg/L
  - Feed TOC – 5 to 9 mg/L
  - Permeate TOC <0.5 mg/L …likely <0.05

…And Pathogens

- Novel R&D on RO
  - Pathogen removal and improved system monitoring

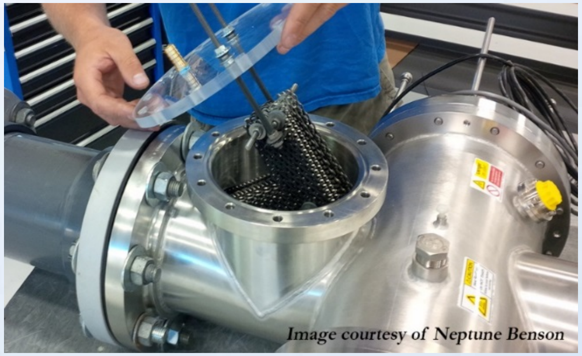
UV AOP Provides Very High Dose, Resulting in Destruction of Pathogens and Pollutants

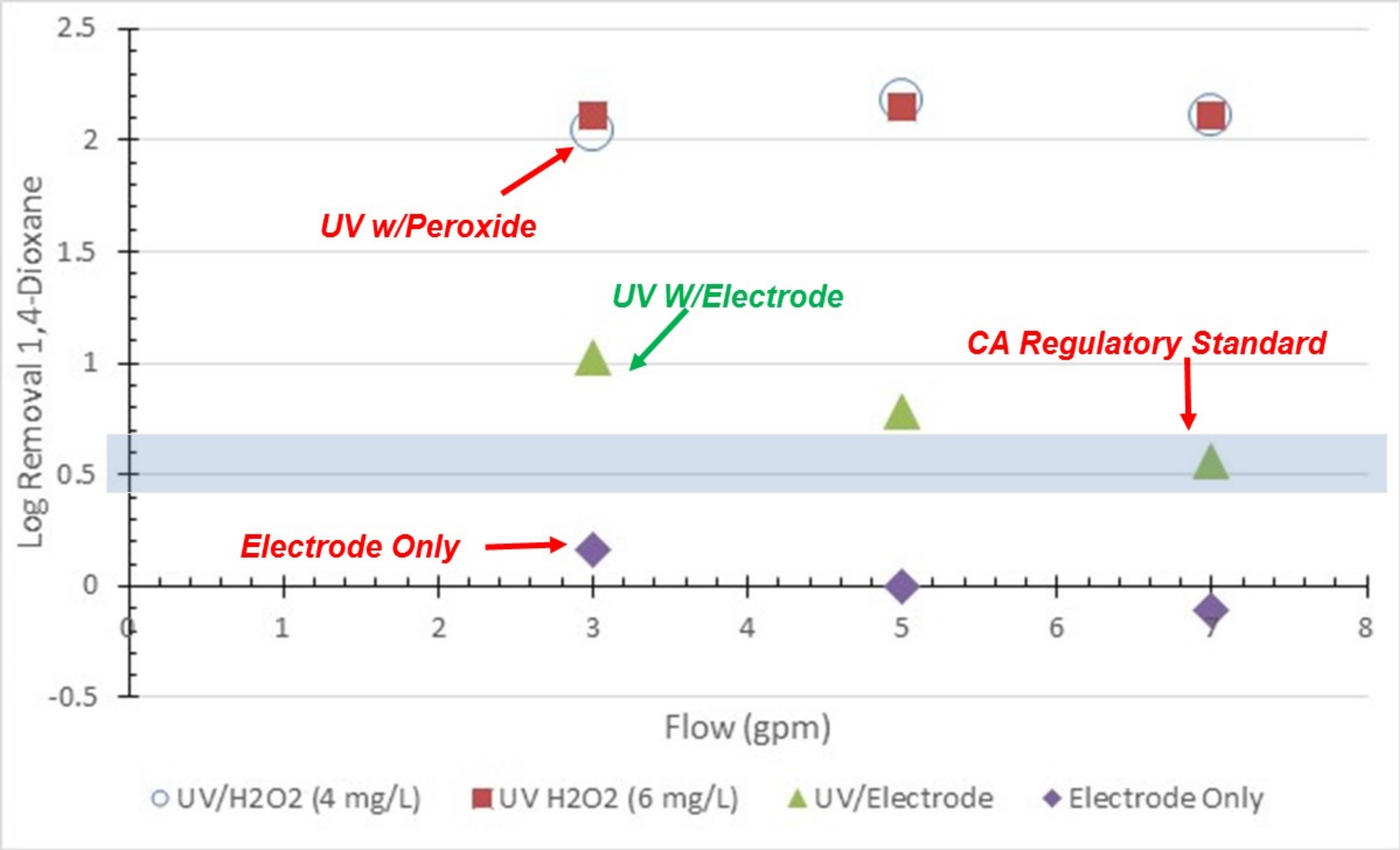


- Dose of 235 mJ/cm2 needed for 6-log broad pathogen removal
- Dose of ~900 mJ/cm2 needed for 90% NDMA reduction

Innovative UV AOP Without Oxidants

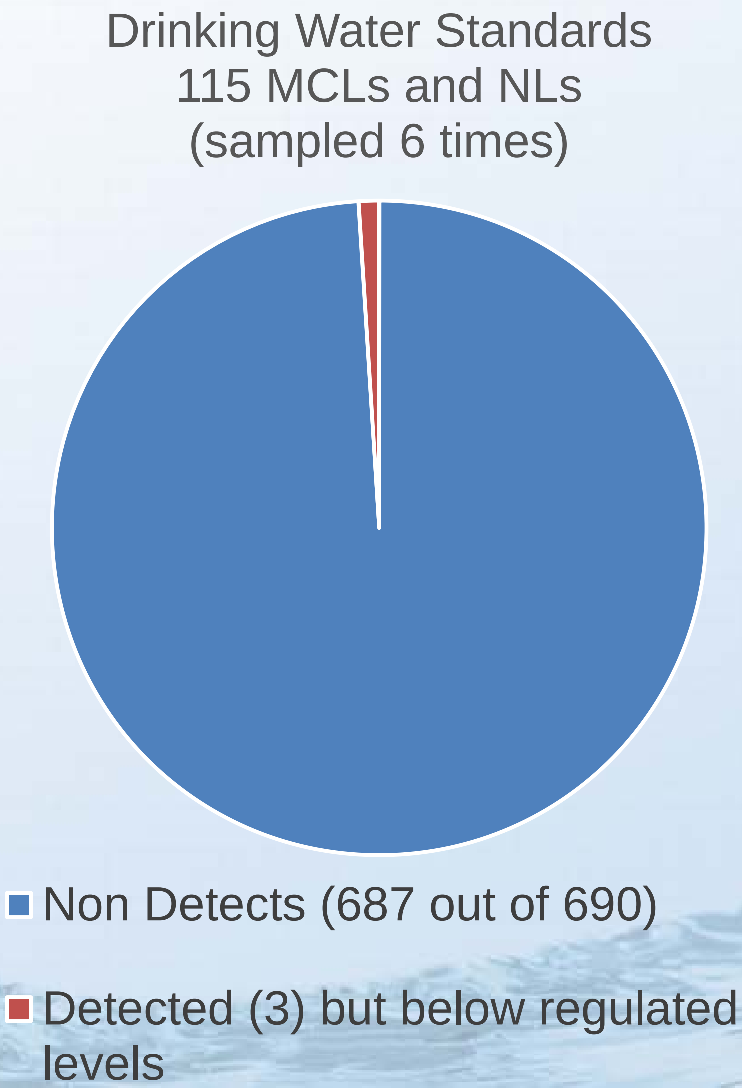
Patented electrode system for in-situ radical generation (for UV AOP)

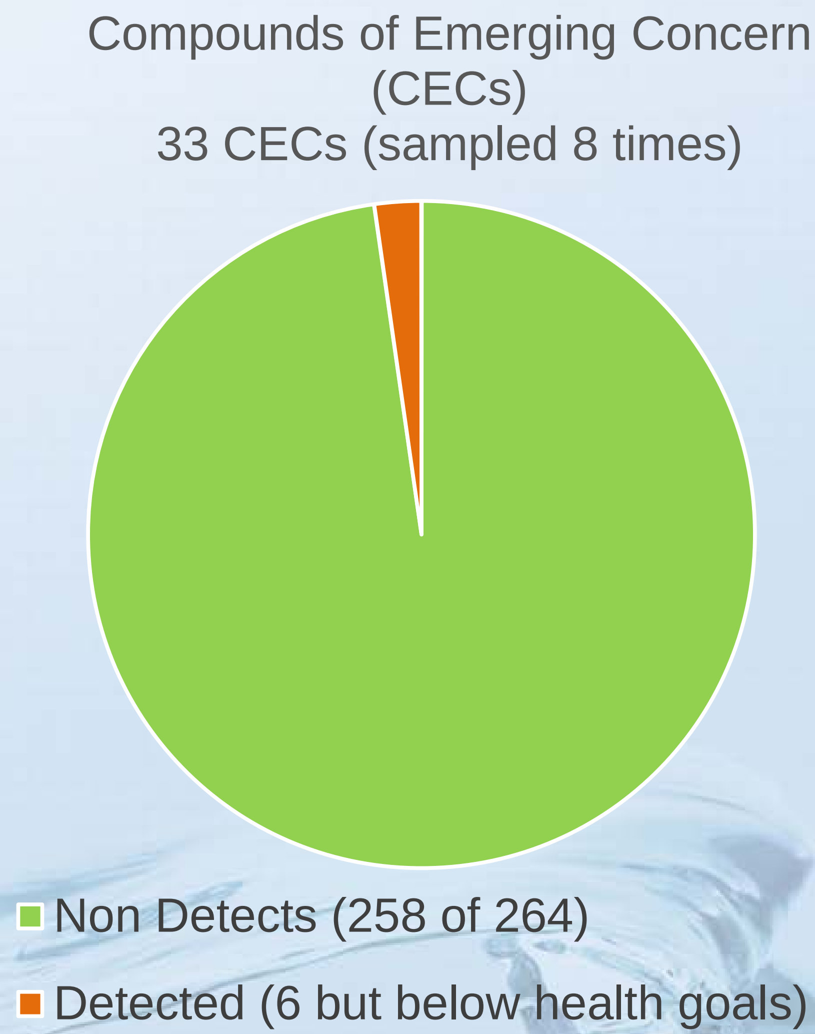




UV AOP Meets DDW Criteria Without Peroxide

Finished water meets all drinking water standards with very few detections of regulated chemicals





Ventura continues to be involved in research to address emerging concerns

- WRF “Blending Blending Requirements for Water from Direct Potable Reuse Treatment Facilities” (WRF #4536)
  - Antibiotic resistant genes (ARGs)
  - Opportunistic premise plumbing pathogens (OPPPs)
  - Inorganic corrosion
  - Biological corrosion

Thank you

egarvey@carollo.com

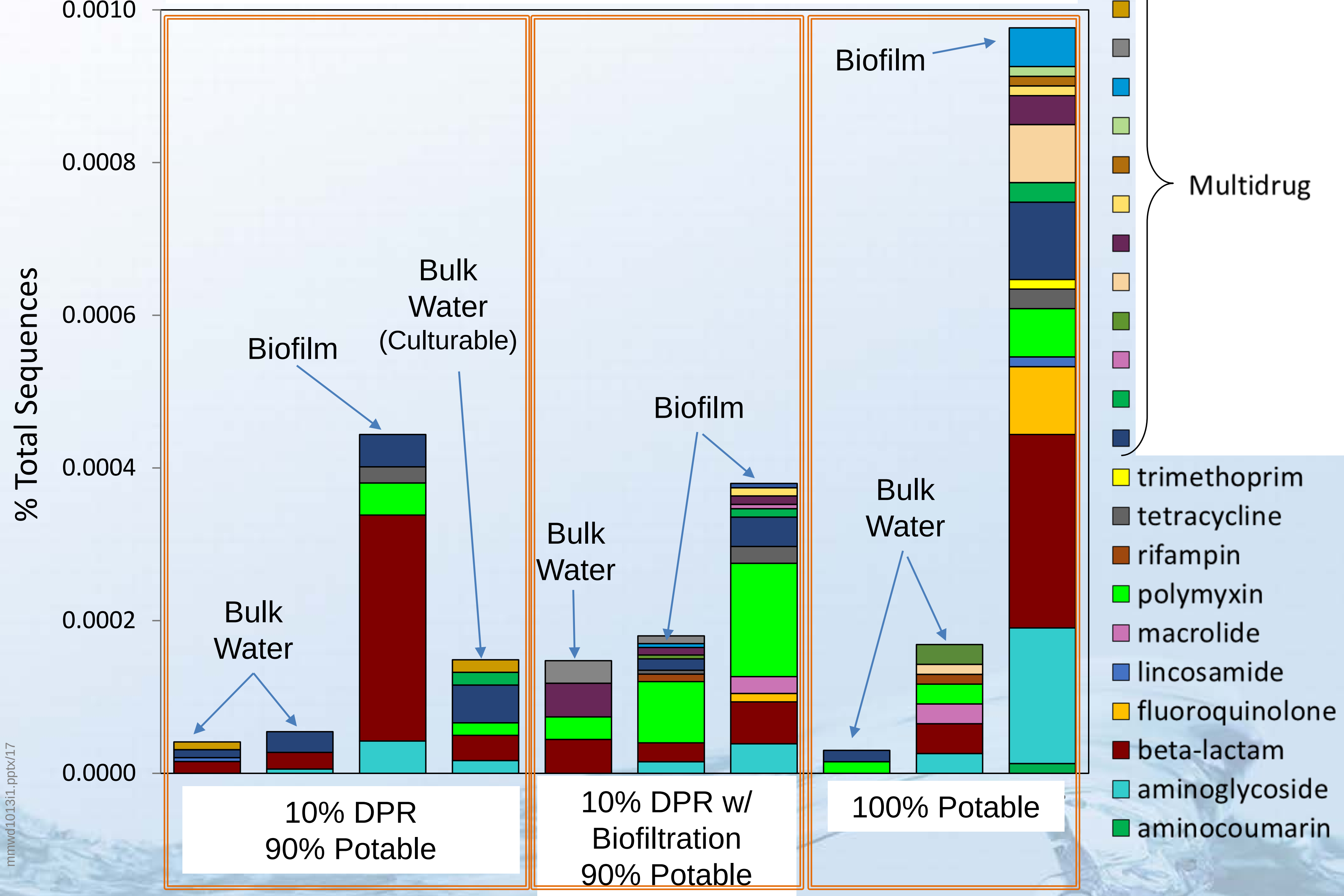
Existing condition – 6.4 mgd permeate

Table 10 Existing 100% Diversion Flow Cost Estimate
Diversion Infrastructure Projects Study
City of Ventura

Cost Component	Alternative 1 (DPR Bailey and IPR Mound)	Alternative 2 (DPR Bailey and DPR Saticoy)
Treatment Cost	$93 M to $102 M	$93 M to $102 M
Brine Disposal	$13 M to $22 M	$13 M to $22 M
Conveyance	$32 M	$20 M
Pond Recirculation and Lining (if required)	$10 M	$10 M
Total	$148 M – $166 M	$136 M – $154 M

- Notes:
  (1) Brine disposal cost range based on potential range of costs for new outfall or tying into the Calleguas SMP. Costs presented at November 2014 Stakeholder workshop. A separate memorandum is being prepared for developing brine disposal alternatives.

WRF 4536 Tackling ARGs in Finished Water Supplies (including DPR)



Multiple Barrier Treatment Train for Water Purification

Process	Pathogen Removal	Pollutant Removal	Salt Removal
Pasteurization	X		
Membrane Filtration	X		
Reverse Osmosis	X	X	X
Ultraviolet Light Advanced Oxidation	X	X	
Engineered Storage	X	X	

Final Water Quality Results Show High Quality Water that is Protective of Public Health

Table XX: UF/RO/UV AOP Finished Water Quality for CECs

Date Collected		10/21/2015	10/21/2015	11/17/2015	11/17/2015	12/1/2015	12/1/2015	12/7/2015	3/30/2016
Location		Finished	Finished	Finished	Finished	Finished	Finished	Finished	Finished
Sub Location			Duplicate		Duplicate		Duplicate		
Tap Location	Units	UV/AOP	UV/AOP	UV/AOP	UV/AOP	UV/AOP	UV/AOP	UV/AOP	UV/AOP
Gemfibrozil	ng/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	0.33
Naproxen	ng/L	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Triclosan	ng/L	1.6	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ibuprofen	ng/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Acetaminophen	ng/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Sucralose	ng/L	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25
Triclocarban	ng/L	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Sulfamethoxazole	ng/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	0.32
Atenolol	ng/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trimethoprim	ng/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	0.38
Caffeine	ng/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Fluoxetine	ng/L	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Meprobamate	ng/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25
Carbamazepine	ng/L	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Primidone	ng/L	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
DEET	ng/L	< 1.0	< 1.0	< 1.0	< 1.0	1.6	< 1.0	< 1.0	< 1.0
TCEP	ng/L	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
PFBA	ng/L	< 5.0	< 5.0	< 5.0	< 5.0	11	< 5.0	< 5.0	< 5.0
PFHxS	ng/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	<0.25
PFHxA	ng/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	<0.5
PFOA	ng/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	<0.5
PFOS	ng/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	<0.5
PFNA	ng/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	<0.5
PFDA	ng/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	<0.5
PFUdA	ng/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	<0.5
PFDoA	ng/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	<0.25
PFPnA	ng/L	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	<2
PFHpA	ng/L	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	<0.5
Estrone	ng/L	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Estradiol	ng/L	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Ethynylestradiol	ng/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Testosterone	ng/L	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Progesterone	ng/L	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50

DPR Treatment Train	Virus	Giardia	Crypto
Potable Goals	12-log	10-log	10-log
Primary and Secondary Treatment	1.9-log	0.8-log	1.2-log
Pasteurization	5+ log	3.8+ log	3.8+ log
Ultrafiltration		4-log	4-log
RO *Advanced Fluorescent Monitoring* *CEC Treatment and Salt Removal*	4-log	4-log	4-log
GAC (if needed) *CEC Treatment*			
UV (high-dose) AOP *CEC Treatment*	6-log	6-log	6-log
Engineered Storage with Chlorine (future) *CEC Treatment* *Failure & Response Time*	4-log	0.5-log	
Subtotal	20.9-log	19.1-log	19.0-log

Safety Factor of 100,000,000 to 1,000,000,000

ARGs

- Wastewater treatment plants are interfaces between different environments and, therefore, provide an opportunity for mobile elements (including resistance) to mix between pathogens, opportunistic pathogens, and environmental bacteria.[68] The presence of antibiotics in sewage selects for resistance markers that are able to spread through the microbial community and as a result, antibiotic-resistant bacteria can potentially disseminate their resistance genes widely among members of the endogenous microbial community (Figure 6). The sludge products of urban and rural wastewater treatment plants are increasingly used to fertilize agricultural crops, dispersing unknown amounts of resistance genes and antibiotics that withstand standard sewage treatment.

OPPPs

- The successful mitigation of microbiological hazards in drinking water represents one ofthe 10 greatest engineering achievements of the 20th century. Widespread implementation ofwater treatment and disinfection have virtually eliminated incidence of diseases such as typhoid in the United States. In 2008, however, the U.S. Centers for Disease Control and Prevention acknowledged that a greater incidence of waterborne disease outbreaks are attributable to microbes that persist and grow in premise plumbing (especially Legionella pneumophila) versus traditional fecal-borne pathogens leaving the treatment plant. “Premise plumbing” refers to the portion of potable water distribution systems beyond the property line and in buildings (e.g., businesses, schools, private homes, apartments). Addressing these OPPPs poses a logistical challenge because community water systems are designed and regulated to control pathogens leaving the water treatment facility, whereas OPPPs reside and multiply in building water systems. The five model OPPPs that were the focus of this study were: Legionella pneumophila,
- Mycobacterium avium Complex (MAC), Pseudomonas aeruginosa, Acanthamoeba spp., and
- Naegleria fowleri. In particular, addressing these OPPPs is challenged by research gaps in four
- key areas: 1.) Epidemiology. Increasing incidence of infection and outbreak and broad, nontraditional
- susceptibility groups suggest that OPPPs are more than “opportunistic” in that a
- significant and increasing portion of the population is at risk. However, because L. pneumophila
- is the only reportable OPPP, and only on a voluntary basis, there is very little information on the
- actual incidence of diseases caused by OPPPs.