BLACK & VEATCH

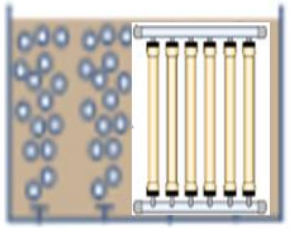
ReUSA

a State-by-State Comparison of Direct Potable Reuse Regulations

Scott Evan Miller, Ph.D., P.E.

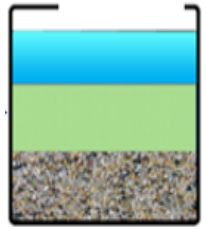
Reuse Regulatory Lead, Black & Veatch | April 16, 2025

Terminology



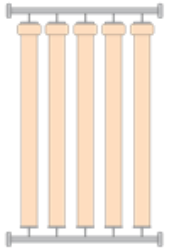
WWTP / WRF
Wastewater Treatment Plant
or Water Reclamation Facility

O3
Ozone

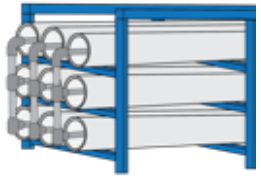


BAC
Biological Activated Carbon

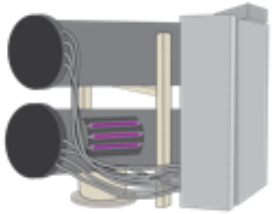
GAC
Granular Activated Carbon



MF
Membrane Filtration
(Micro- or Ultrafiltration)



RO
Reverse Osmosis



UVAOP
(Ultraviolet) Advanced
Oxidation Process

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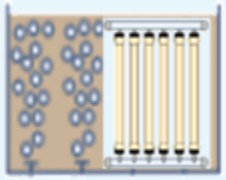
Terminology

“Log” values for treatment requirements in regulations due to some very high required reductions for contaminants.

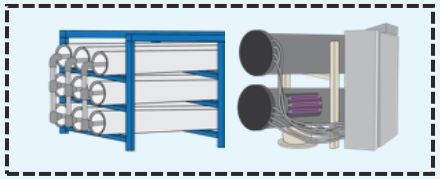
X Log	**= Y percent removal**
0.5 log	= 66%
1 log	= 90%
10 log	= 99.99999999%
20 log	= 99.9999999999999999%

Indirect Potable Reuse (IPR)

Groundwater Recharge

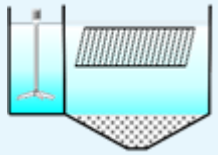


WWTP



Advanced Water Treatment Facility (AWTF)

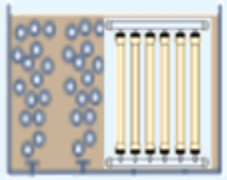
Environmental Buffer

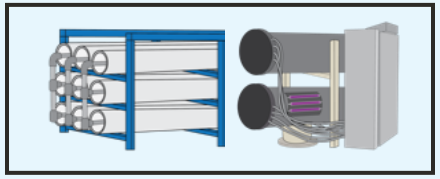


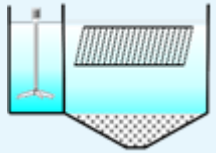
Drinking Water Treatment Plant

Distribution

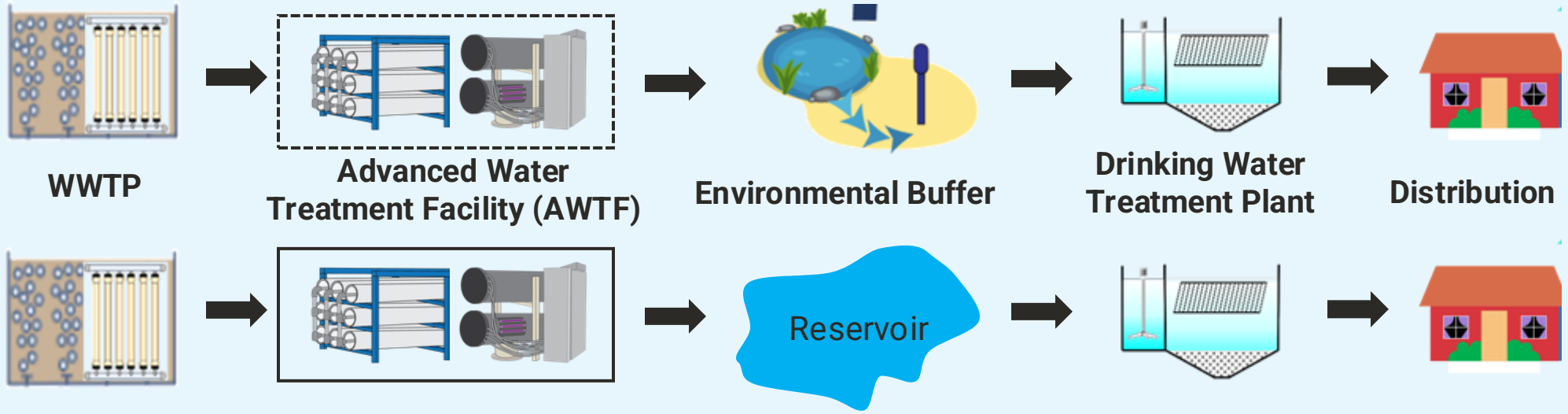
Surface Water Augmentation



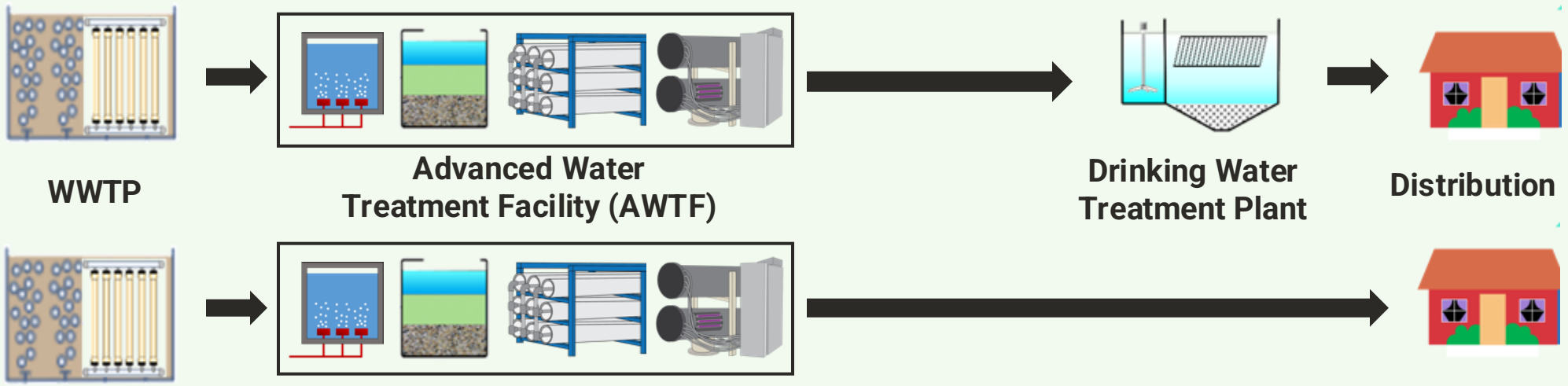


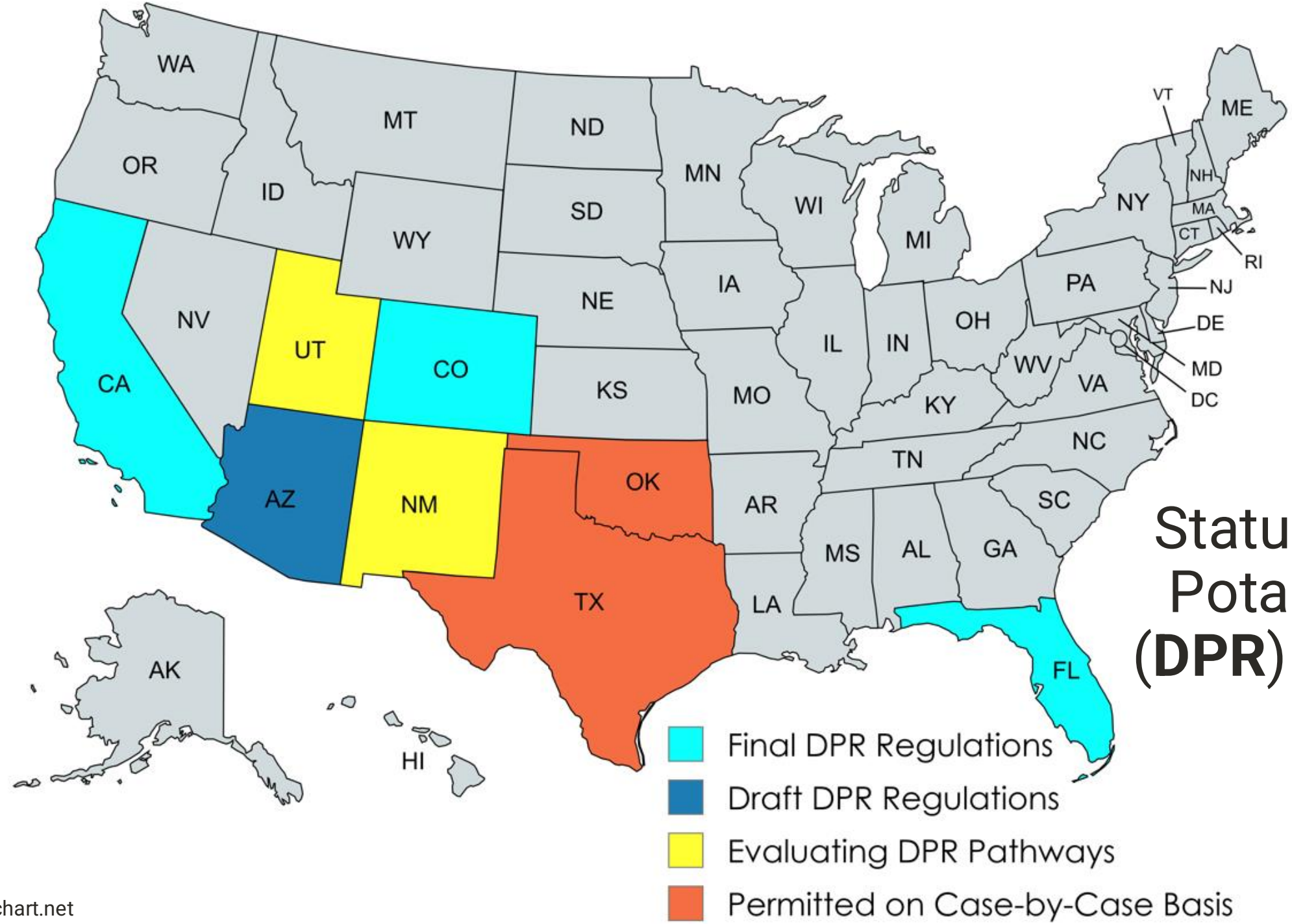


Indirect Potable Reuse (IPR)



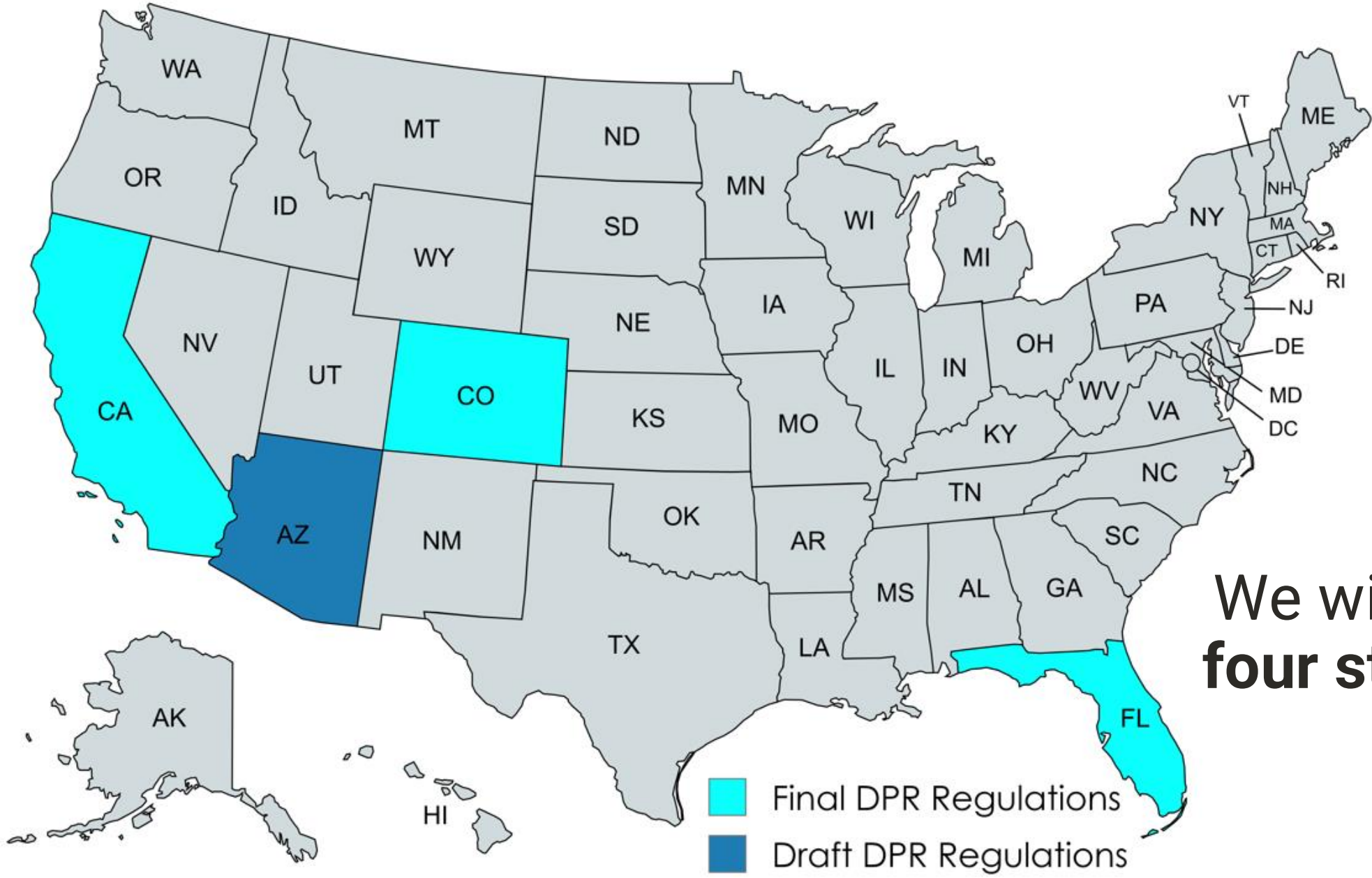
Direct Potable Reuse (DPR)





Status of Direct Potable Reuse (**DPR**) Regulation

mapchart.net



We will focus on **four states** today

mapchart.net

DPR regulations can be as different as the weather across these states.

Arizona

Colorado

California

Florida

Today we will compare four key topics of DPR regulations.

1. Chemical control
2. Treatment requirements
3. Pathogen control
4. Piloting

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Protecting Public Health
in Potable Reuse

CHEMICALS: differences from conventional drinking water.

Municipal wastewater is a soup of regulated and unregulated chemicals and contaminants.

- Treatment techniques to address “universe” of chemicals
- Routine water quality sampling to verify treatment performance.

Chemical “spikes” or “peaks”

PATHOGENS: differences from conventional drinking water.

Higher pathogen load = greater log reductions.

Greater scrutiny of validating treatment processes to demonstrate pathogen removal.

Chemical Control

Finished Water Quality Standards for DPR

- Primary Maximum Contaminant Levels (MCLs)
- Secondary MCLs
- Action Levels – lead /copper

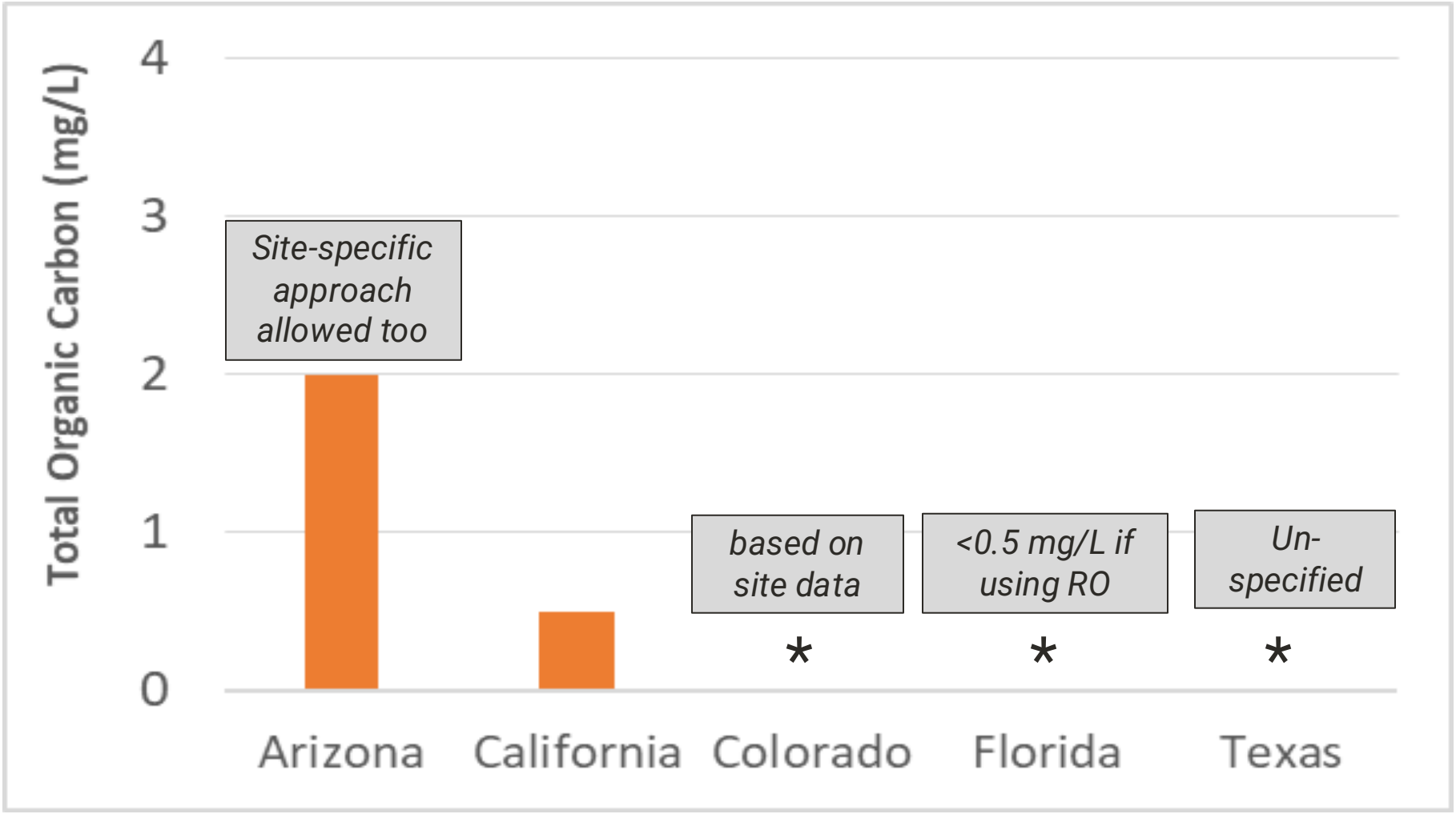
Existing drinking water standards

- Industrial pollutants
- Household and commercial wastes
- Personal care products, pharmaceuticals
- Total organic carbon (surrogate)

Not well addressed by existing drinking water standards

Maximum TOC in DPR Treated Waters

Typical Influent WW TOC = ~10-20 mg/L



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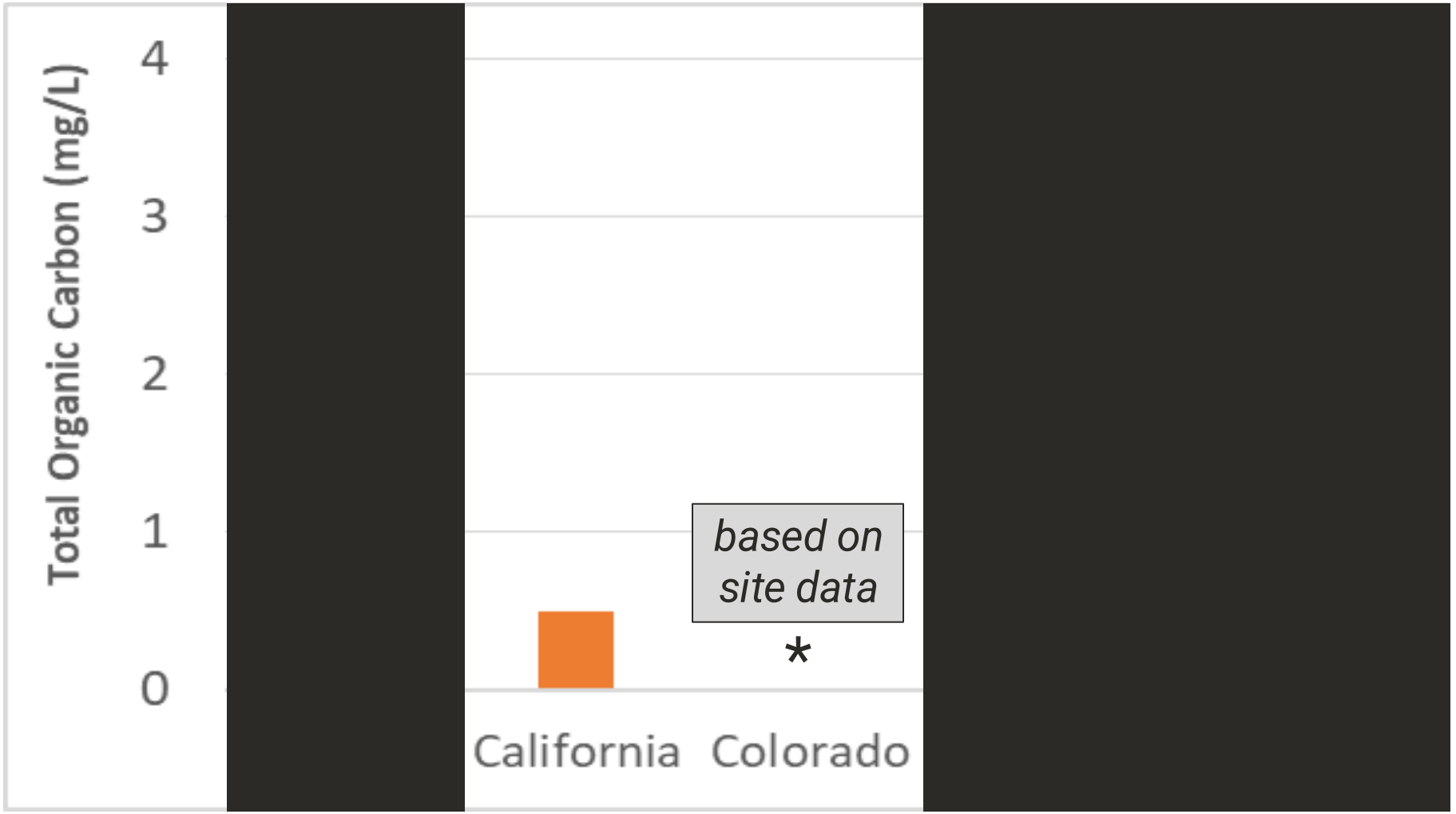
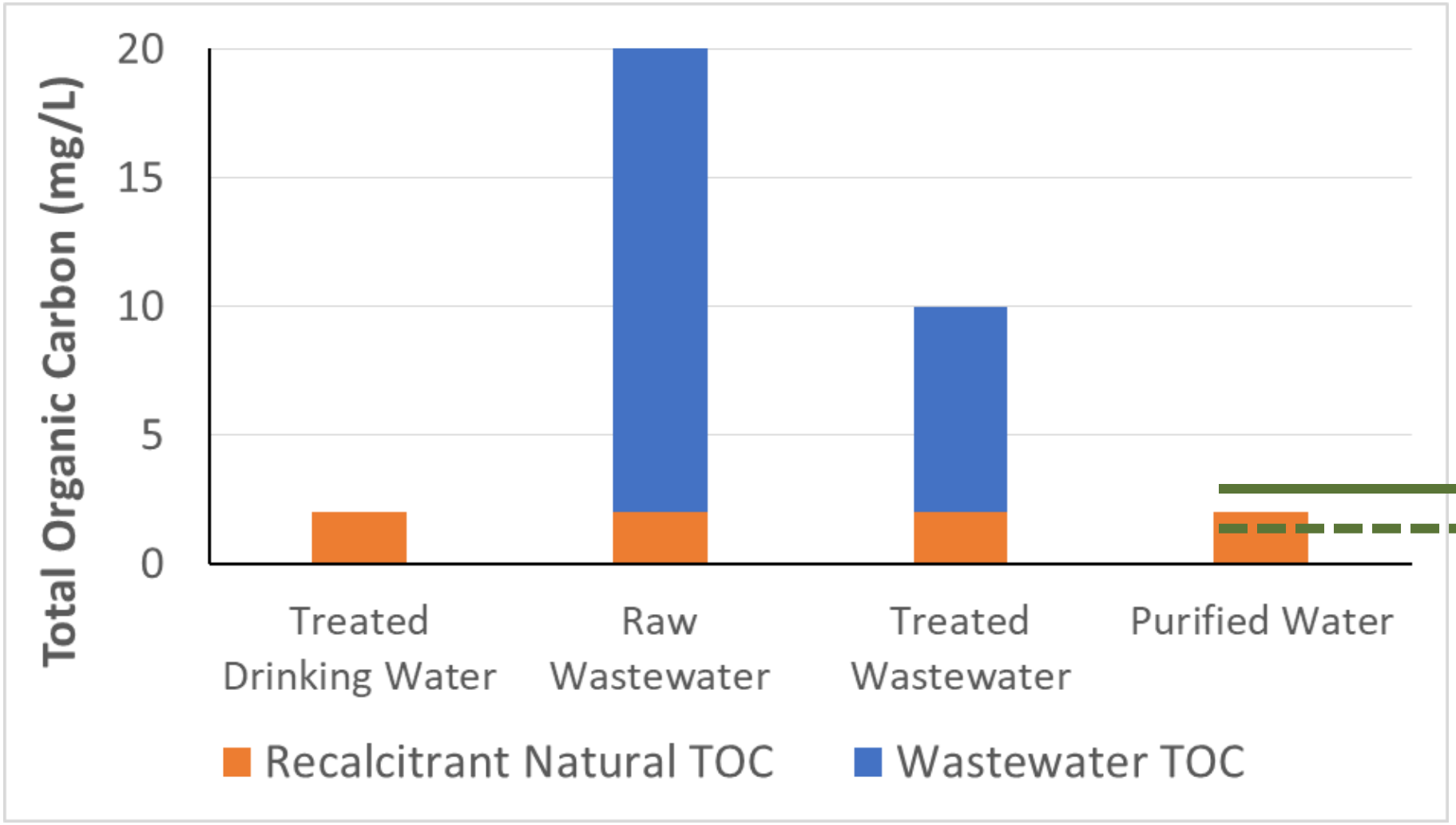


Case Study: **Colorado**

Site-specific TOC limits are developed based on **"Recalcitrant TOC"**

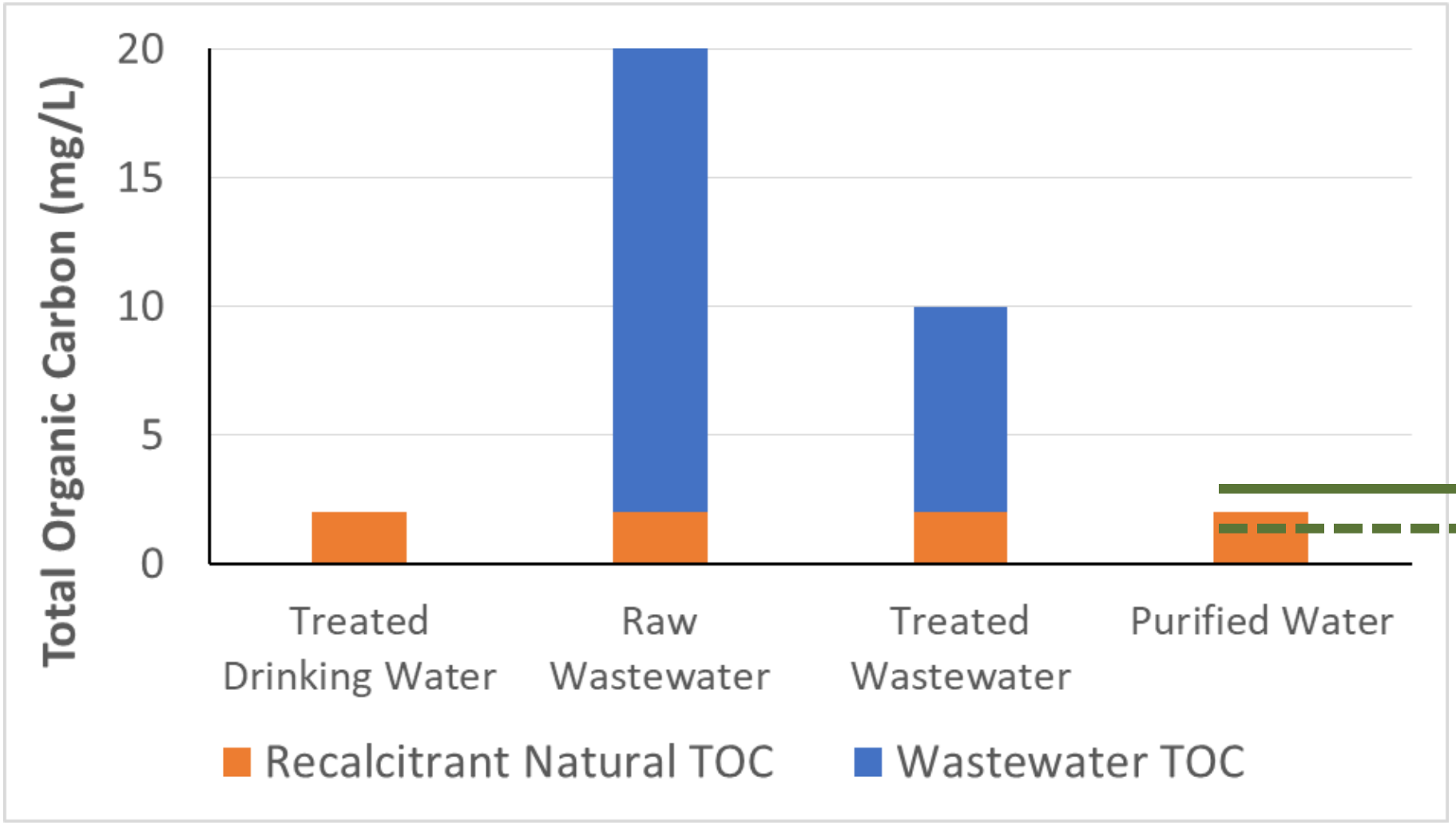


Action Limit
1.5 x 95th percentile TOC

Alert Limit
75th percentile TOC

Case Study: **Colorado**

Site-specific TOC limits are developed based on **"Recalcitrant TOC"**



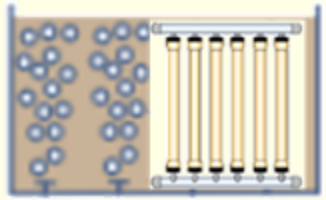
Also Unique:
Can correlate UVT with TOC and use UVT instead

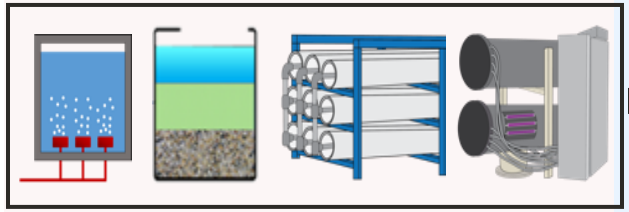
Action Limit
1.5 x 95th percentile TOC

Alert Limit
75th percentile TOC

Water Quality Monitoring

	Source Water	Inter-Process Monitoring at AWTF	Advanced Treated Water
Continuous TOC	*UVT	*RO only	*CO is only every 4 hours
Continuous NO_3/NO_2			
Continuous Ammonia*			





*CO can meet all of this at WRF

Treatment Requirements

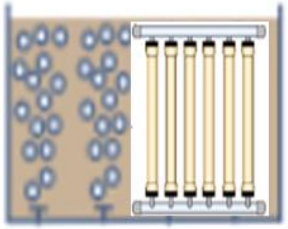
Is there a Specified Treatment Train?

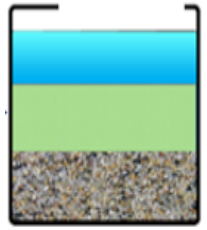
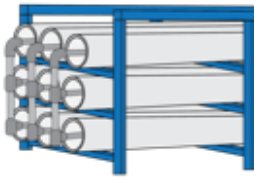
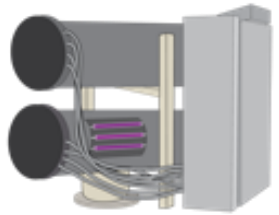
Yes – Ozone/BAC, RO, AOP. (Or alternative subject to approval)

No, but some technologies may be required.

Specified Treatment Technologies for California

*UV and AOP can be separate



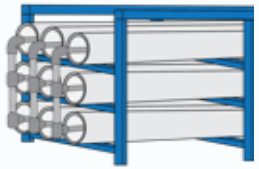




	Source Wastewater	Ozone	BAC	RO	UVAOP
Carbamazepine & Sulfamethoxazole		1-log reduction			
Acetone & Formaldehyde			1-log reduction		
TOC				< 0.5 mg/L	
1,4-dioxane					0.5-log reduction

Specified Treatment Technologies for [redacted] Colorado

Pathogens

Filtration



RO

---- OR ----

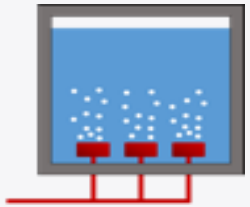
Conventional or Direct Filtration

---- OR ----

Alternative Tech

+

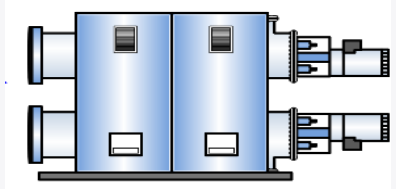
Disinfection



Ozone

---- OR ----

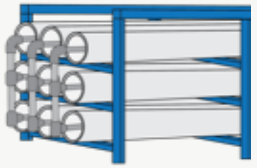
Ultraviolet (UV)



+

Chemicals

Either of these Options



Reverse Osmosis (RO)

---- ---- ---- OR ---- ---- ----

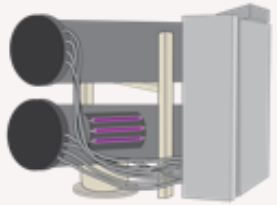
Adsorption-based Process

+

Second barrier approved by CO

+

Advanced Oxidation Process (AOP)



Specified Treatment Technologies for Arizona

Pathogens

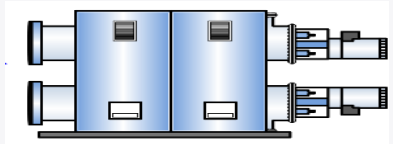
Filtration

A physical separation process

+

Disinfection

Ultraviolet (UV)



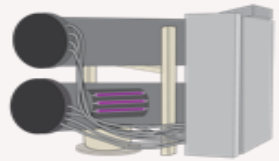
Chemicals

+

No others specified

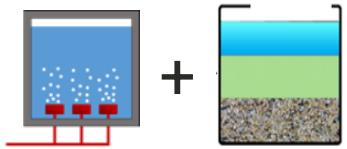
+

Advanced Oxidation Process (AOP)

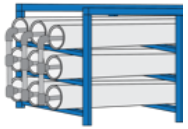


Arizona specifies treatment requirements **IF** you use these treatments

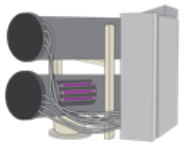
Ozone + BAC



RO



UVAOP

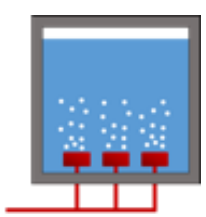


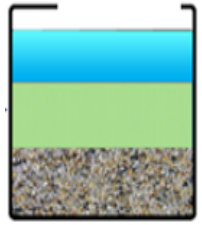
Specified Treatment Technologies for Florida

Pathogens			Chemicals
Filtration		**Disinfection**	
A filtration process	+	**A disinfection process**	+ *None specified*

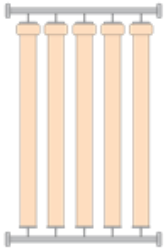
Florida specifies treatment requirements **IF** you use these treatment combinations:

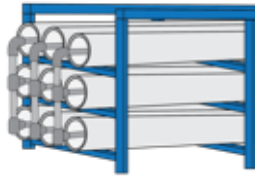
Ozone + BAC

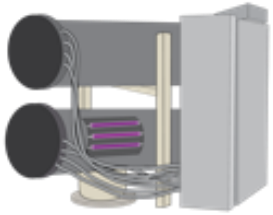


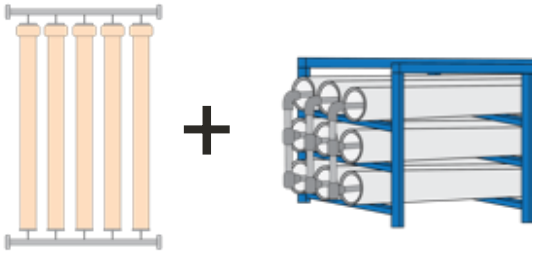
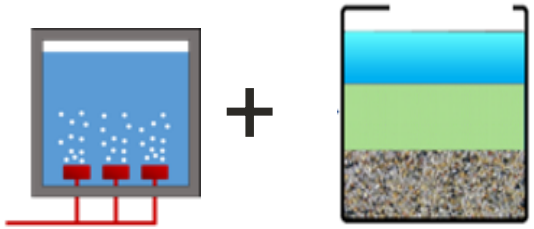


MF + RO + AOP

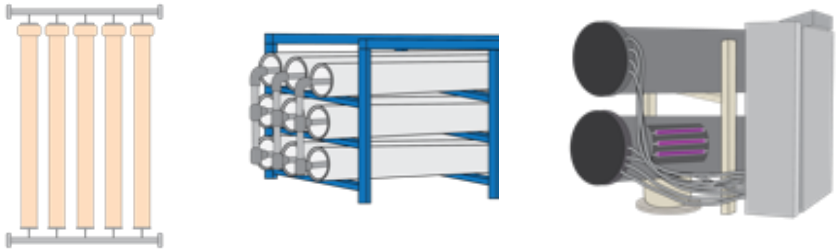


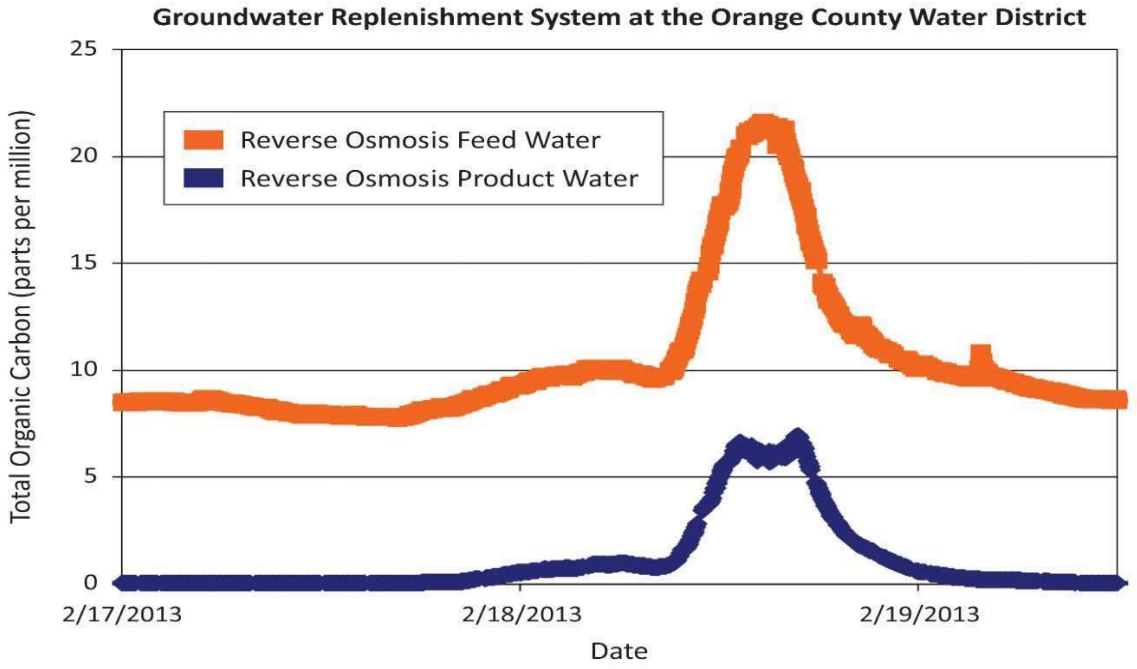




	Water recovery (%)	TOC reduction	TDS reduction	Brine disposal
	70-80	High	High	Yes
	97-99	Moderate	Low/None	No

MF + RO + UVAOP is very effective but not perfect

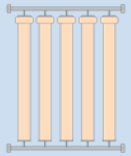
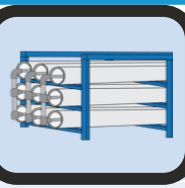
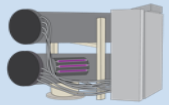
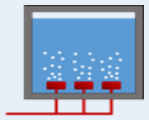
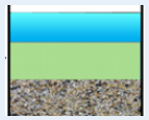
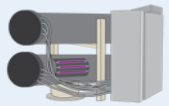
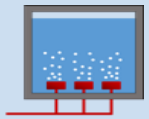
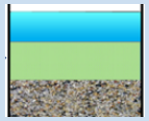
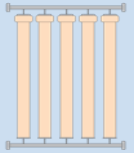
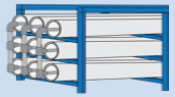
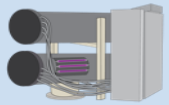




Bernados, 2017

Elicit acetone discharges to sewer system caused RO permeate TOC **>5 mg/L**
(10x the CA limit of 0.5 mg/L)

Example DPR Treatment Trains

Concept	Ozone	BAC	MF/UF	RO	GAC	AOP
MF-RO						
Ozone-BAC						
“Hybrid”						

Big Spring (TX)

PureWater Colorado (CO)

San Diego Pure Water (CA)

In non-RO trains, multiple processes are needed to “replace” RO’s broad-spectrum barrier for chemical contaminants.

BLACK & VEATCH

Treatment Case Study: **Ozone Requirements**

If I use Ozone or Ozone-BAC, are there Specified Requirements?

Yes – Ozone/BAC

Yes – Ozone and Ozone-AOP

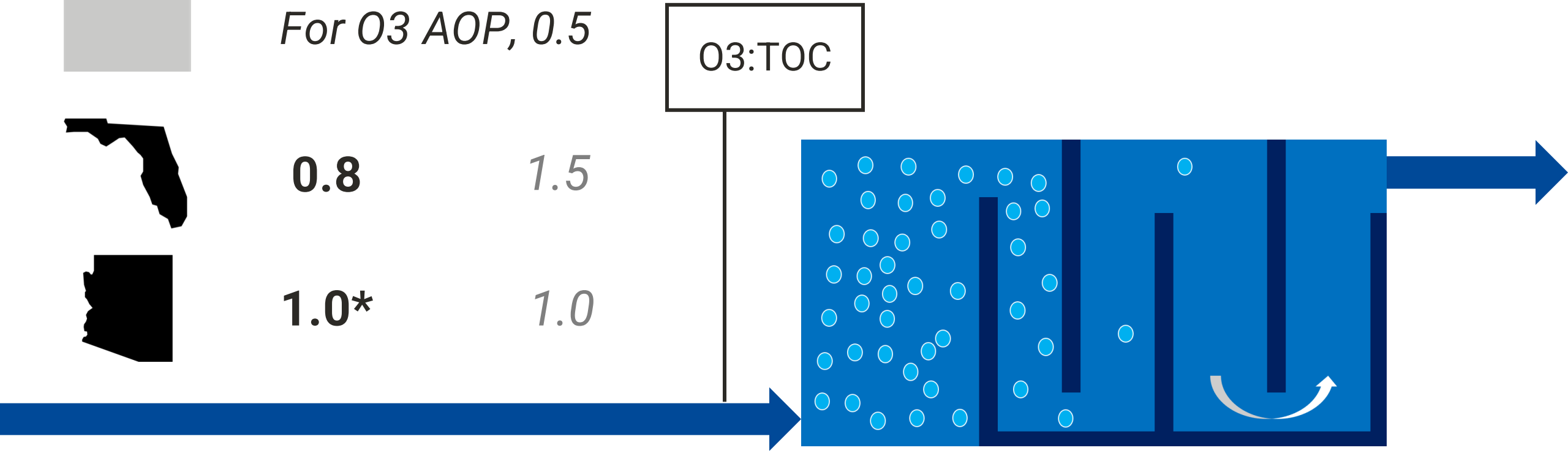
Yes – only if using Ozone/BAC

Yes – only if using Ozone/BAC

Operating O3:TOC Ratios

	Minimum Operating	Minimum Design
	**1.0***	*1.0*
	For O3 AOP, 0.5	
	0.8	*1.5*
	1.0*	*1.0*

**Alternative minimum O3:TOC ratio may be demonstrated.*



Ozone Validation Testing

	Specified Indicators	Minimum Reduction by Ozone	
	**Carbamazepine** **Sulfamethoxazole**	**1.0 log_{10}**	
	At least one based on source water	**0.4 log_{10}***	**Refer to CO DPR Policy*
	Select **two indicators** from pre-approved list of 12 (or alternatives)	**1.0 log_{10}**	
	**Carbamazepine** **Sulfamethoxazole**	**1.0 log_{10}**	

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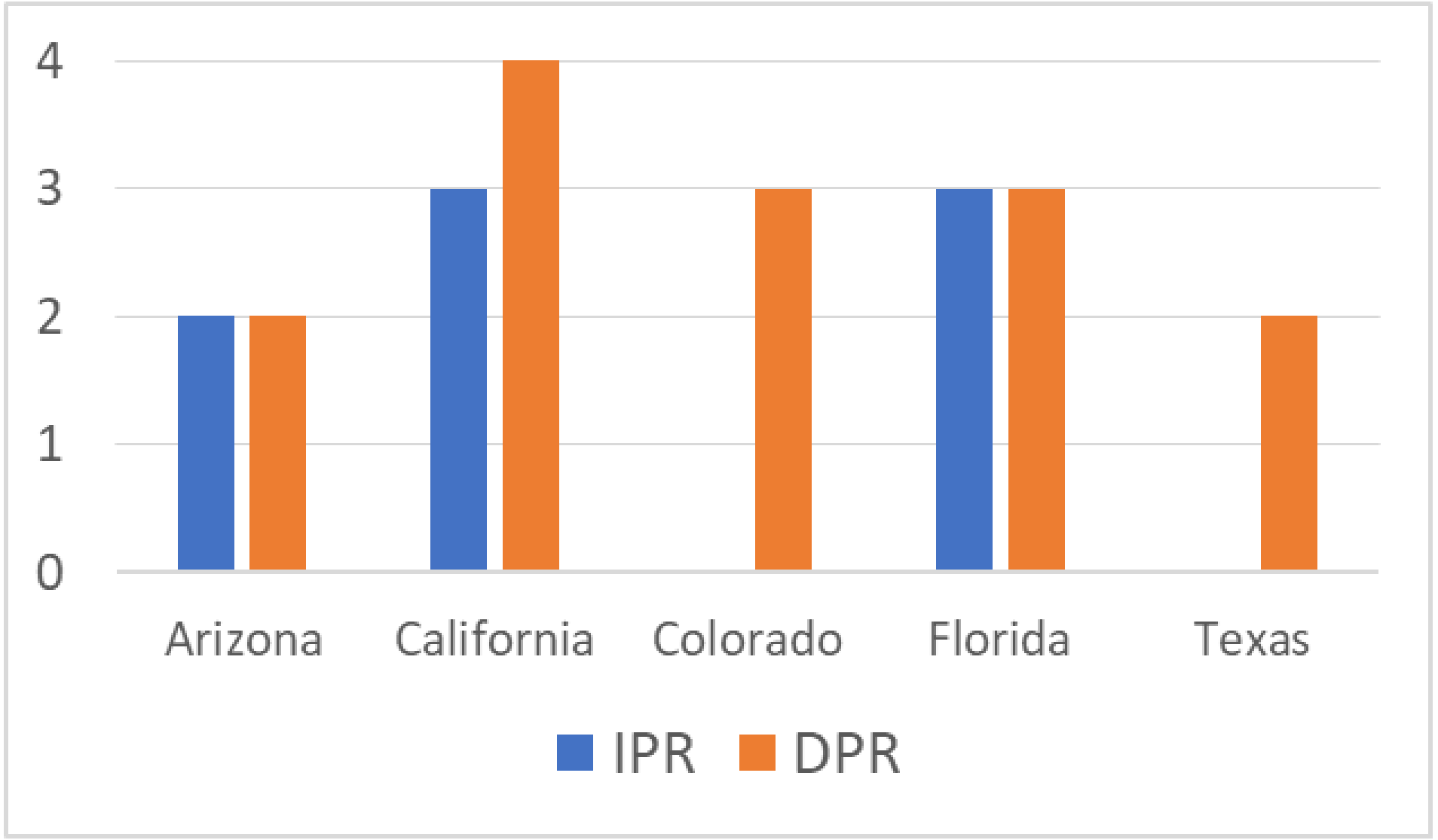
Pathogen Control

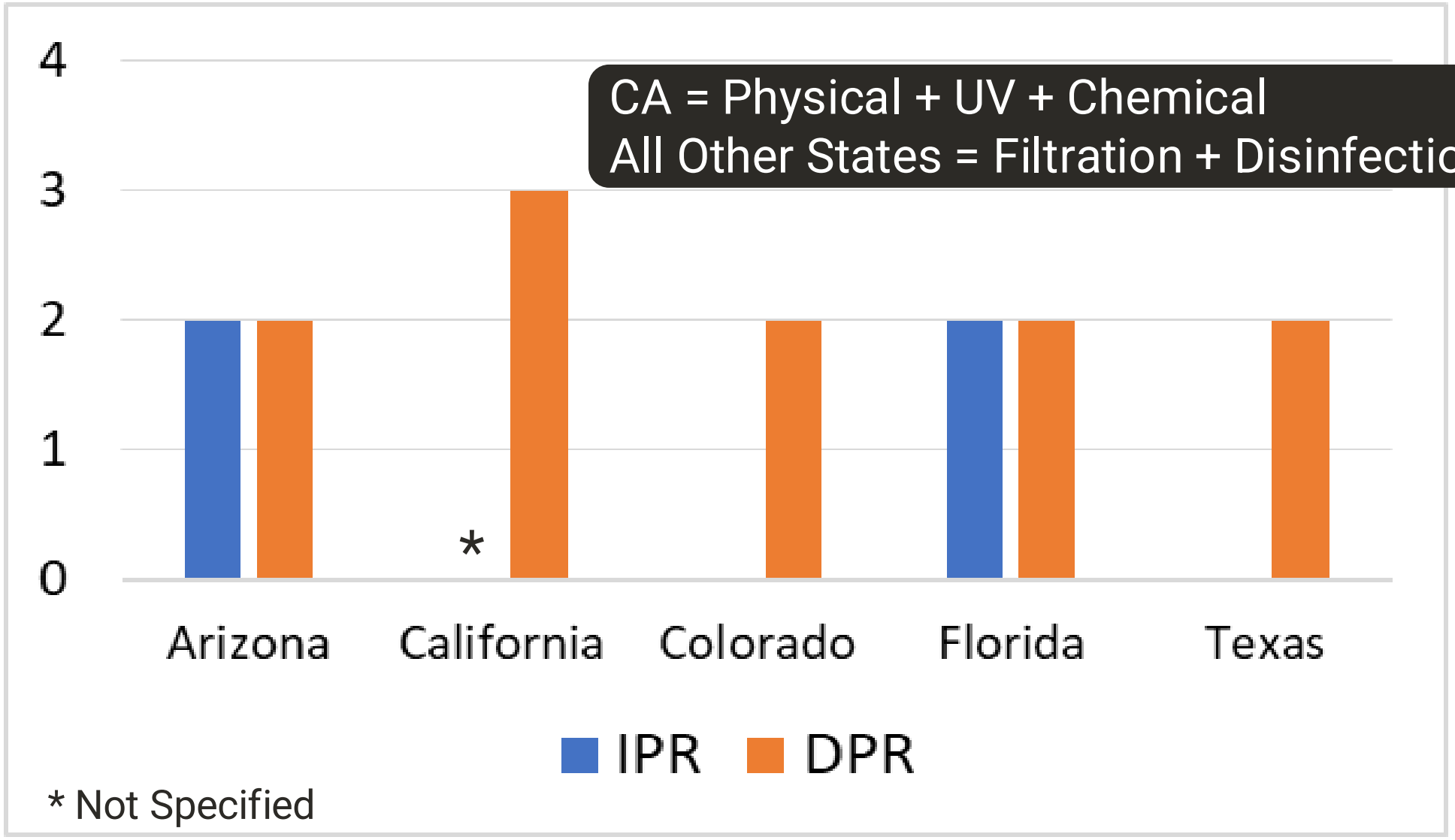
Comparison of IPR and DPR pathogen criteria

- **Colorado** and **Texas** do not have IPR criteria
- Some states require sampling for pathogens; no methods can detect pathogens at the levels in treated water and sampling is expensive and won’t catch peaks

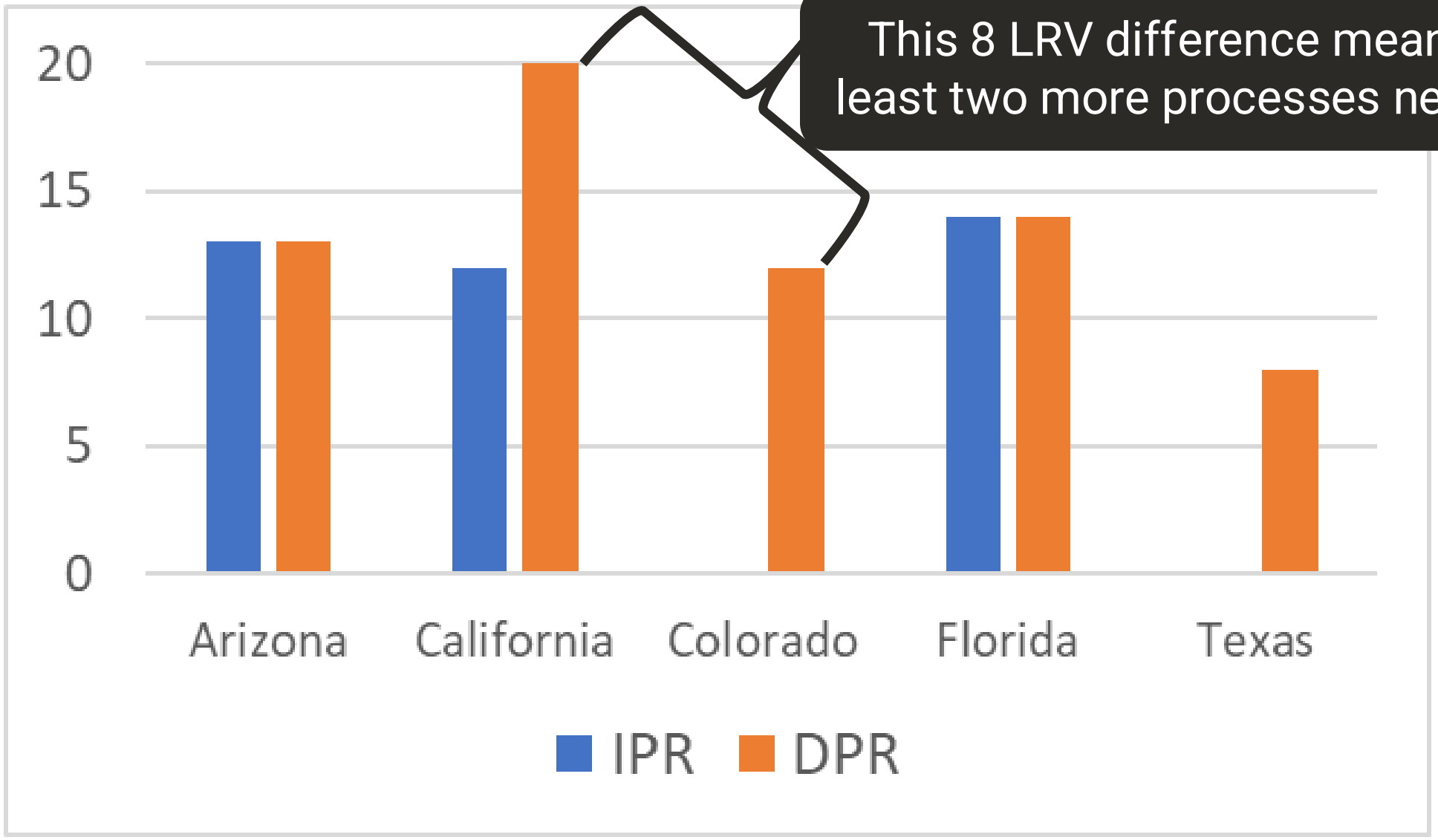
Minimum Number of Treatment Processes with at least 1 LRV for Each Pathogen



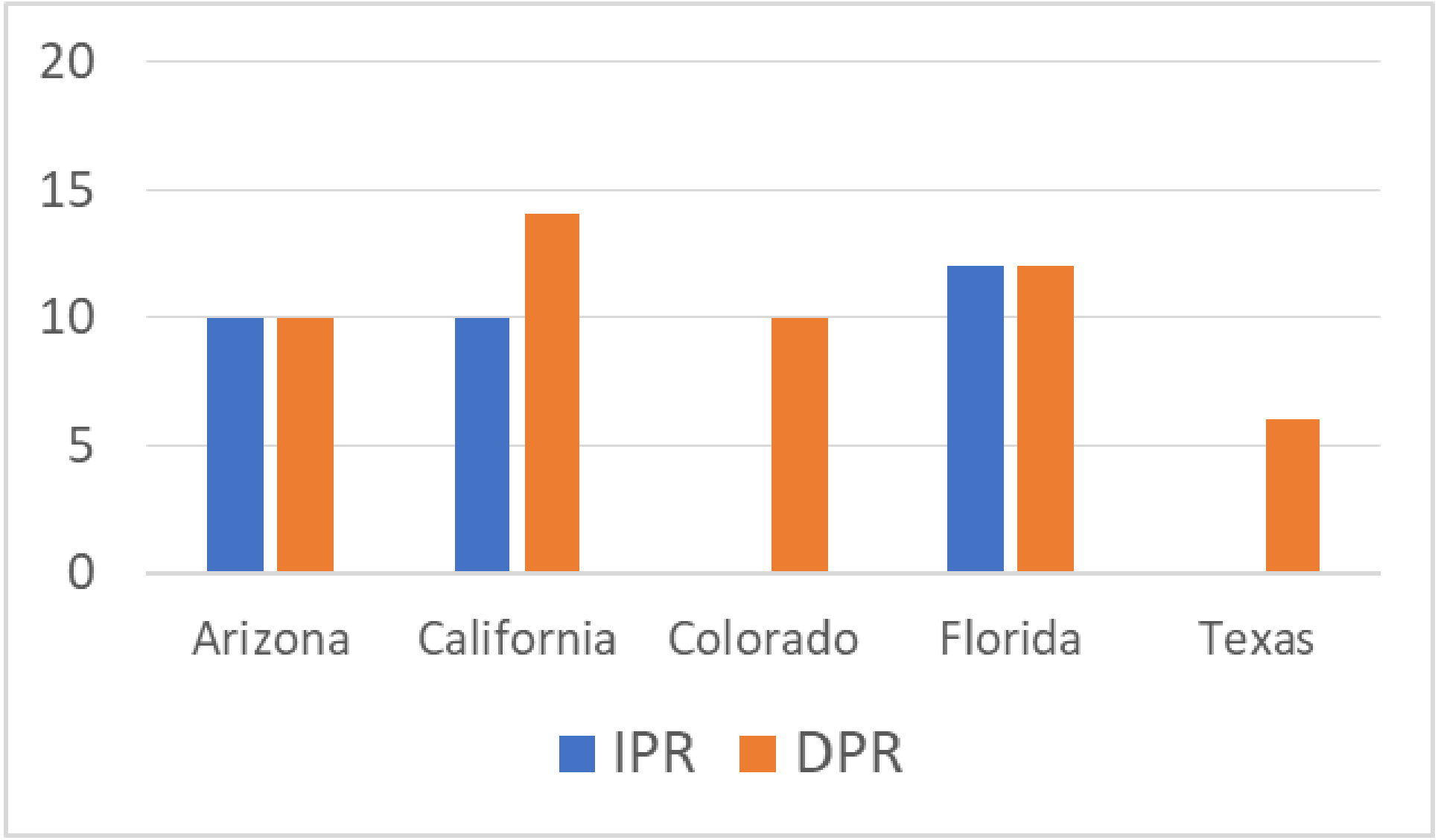
Minimum Number of Treatment Mechanisms for Each Pathogen



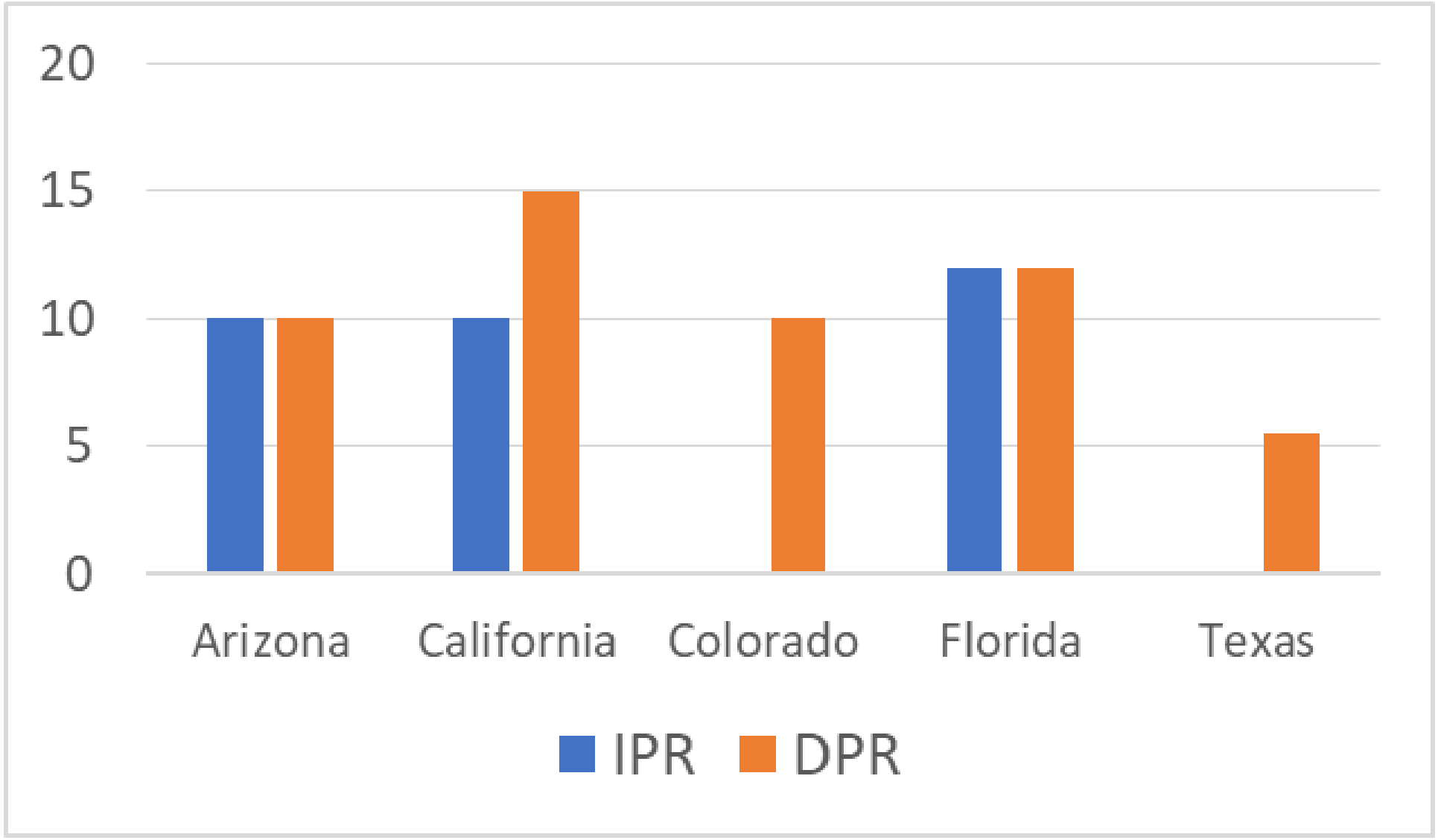
Minimum Number of LRVs for Virus



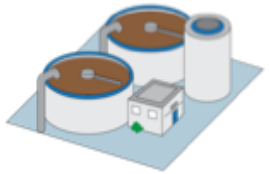
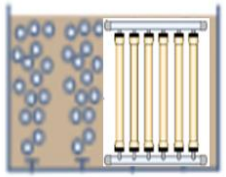
Minimum Number of LRVs for Giardia

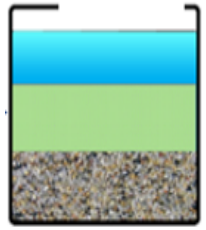
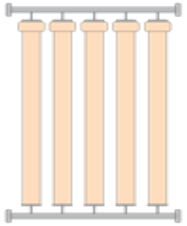
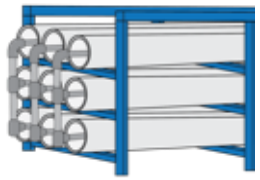
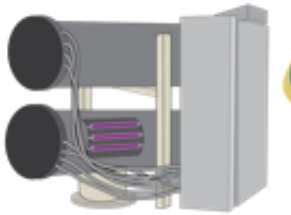
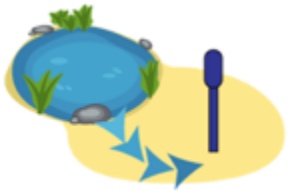


Minimum Number of LRVs for Cryptosporidium



All these LRVs… Where Can I Find Them?

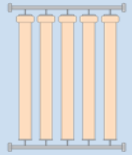
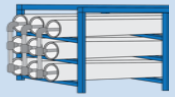
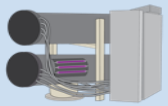
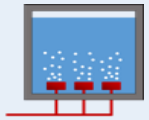
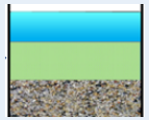
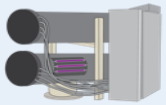
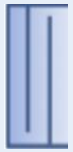
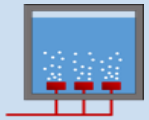
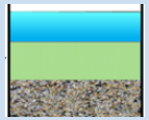
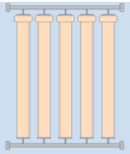
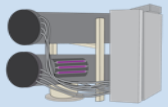



	WWTP Effluent	Ozone	Ozone	BAF	MF/UF	RO/NF	UV or UV/AOP	Env. Buffer
Virus	0-?	1+	1-6	0-2*	0	1-3	6	2-6
Giardia	0-?	2.5+	0-6	0-2*	4	1-3	6	0-?
Crypto	0-?	2.5+	0-1	0-3*	4	1-3	6	0-?

•

Piecing the LRV Train Together

Concept	Ozone	BAC	MF/UF	RO	GAC	AOP	Free Chlorine	Virus LRV	Giardia LRV	Crypto LRV
RO Base Train								14	12	12
Ozone-BAC								18	16	11
“Hybrid”								20	18	13

Piloting

Do I need a DPR Pilot?

No – can demonstrate concept at pilot- or full-scale.

No – can demonstrate concept at pilot- or full-scale.

Yes – 3 months minimum.

Yes – 1 year minimum, but can apply for less.

Takeaways

Takeaways

- There isn’t ONE way to address DPR.
- Regulatory understanding, standard permit requirements, and industry best practices are rapidly evolving.

Takeaways

- There isn’t ONE way to address DPR.
- Regulatory understanding, standard permit requirements, and industry best practices are rapidly evolving.
- Remember to pack your design appropriately for your state!

Arizona

Colorado

California

Florida

BLACK & VEATCH

Say hello!

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millerse@bv.com