HOW CAN WE MEET PATHOGEN REMOVAL REQUIREMENTS IN POTABLE REUSE PROJECTS IF MBR DOES NOT GET ANY PATHOGEN CREDITS?

Zeynep Erdal, Ph.D., PE

June 13, 2017

AECOM

Outline

- Background
- Objectives
- Approach
- Conclusions and Discussion
- Questions and Comments

AECOM

MBR vs. CAS

- Despite several benefits of MBR over CAS (sludge settling is no longer issue, smaller footprint, better removal efficiencies for metals, selected CECs, etc.), currently no pathogen credits are given to MBR in CA.
- Without direct integrity testing or an approved integrity assessment method, additional treatment processes needed for MBR trains to meet minimum 10-log G/C limits
  - Increases CAPEX and O&M costs

AECOM

Pathogen Credits and LRVs for CA IPR Projects

	CAS	MF/UF	RO	UVAOP	6-Month Retention in Ground	Total	GWR via Injection
Crypto	0	4	1-2	6	0	11-12	10
Giardia	0	4	1-2	6	0	11-12	10
Virus	1	0	1-2	6	6	14-19	12

	MBR	RO	UVAOP	6-Month Retention in Ground	Total	GWR via Injection
Crypto	0	1-2	6	0	7-8	10
Giardia	0	1-2	6	0	7-8	10
Virus	0	1-2	6	6	13-14	12

Objective

- To explore cost effective approaches to get 4-log Crypto and Giardia removal credits, if no pathogen credit is given to MBR in a potable reuse train

Approaches

1. Get better pathogen credit for RO
2. Get better pathogen credit for UVAOP
3. Consider adding a cost effective unit process if the above approaches do not work

AECOM

Get Better Pathogen Credit for UVAOP

AECOM

Current Regulatory Environment

- Final GWR Regulations – June 18, 2014

§60320.108. Pathogenic Microorganism Control.

(a) A project sponsor shall design and operate a GRRP such that the recycled municipal wastewater used as recharge water for a GRRP receives treatment that achieves at least 12-log enteric virus reduction, 10-log Giardia cyst reduction, and 10-log Cryptosporidium oocyst reduction. The treatment train shall consist of at least three separate treatment processes. Except as provided in subsection (c), for each pathogen (i.e., virus, Giardia cyst, or Cryptosporidium oocyst), a separate treatment process may be credited with no more than 6-log reduction, with at least three processes each being credited with no less than 1.0-log reduction.

- Given that UVAOP gets maximum 6-log credit for V/G/C

AECOM

UVAOP Design

- UVAOP is designed to meet <10 ng/L NDMA
- Minimum 0.5-log 1,4-dioxane removal
- UV doses >800 mJ/cm2 are needed depending on contaminant targets
- Multiple reactors/banks are operated in series to deliver the target UV dose
- Each reactor/bank is operated and monitored independently

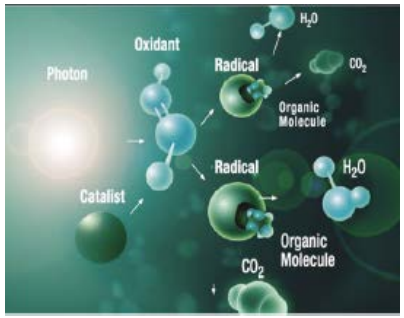


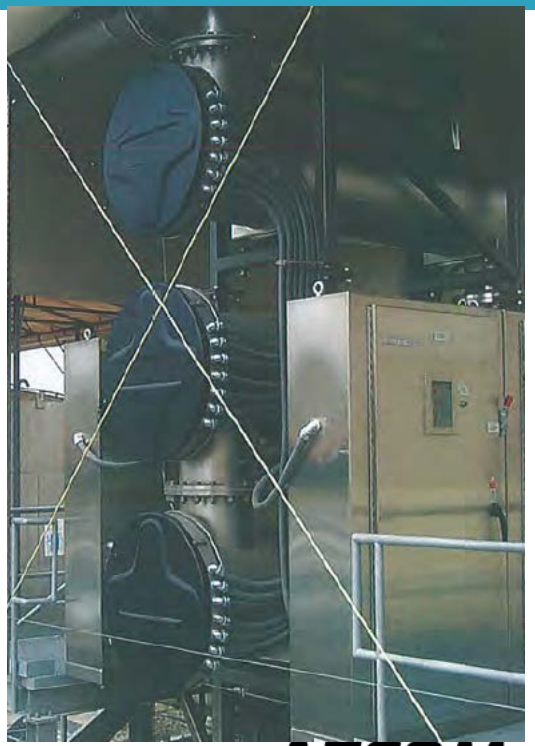
Table 1.4. UV Dose Requirements – millijoules per centimeter squared (mJ/cm^2) [1]

Target Pathogens	Log Inactivation							
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Cryptosporidium	1.6	2.5	3.9	5.8	8.5	12	15	22
Giardia	1.5	2.1	3.0	5.2	7.7	11	15	22
Virus	39	58	79	100	121	143	163	186

[1] 40 CFR 141.720(d)(1)

UVAOP Validation Studies- GWRS

- UVAOP was designed to meet
  - Minimum 1.2-log NDMA removal
  - Minimum 4-log MS-2 Inactivation
- Three chambers in series each has two reactors, (total of 6 reactors), each reactor has 72 lamps
- A Single reactor achieved minimum 4.4-log MS-2 inactivation at applied dose of 115 mJ/cm^2, 770 -3,600 gpm and UV reactor power level of 60-100%
- Four reactors in series can achieve
  - >16-log MS-2 inactivation
  - >>16-log Crypto and Giardia Inactivation



AECOM

Tired? Add a UV Disinfection System

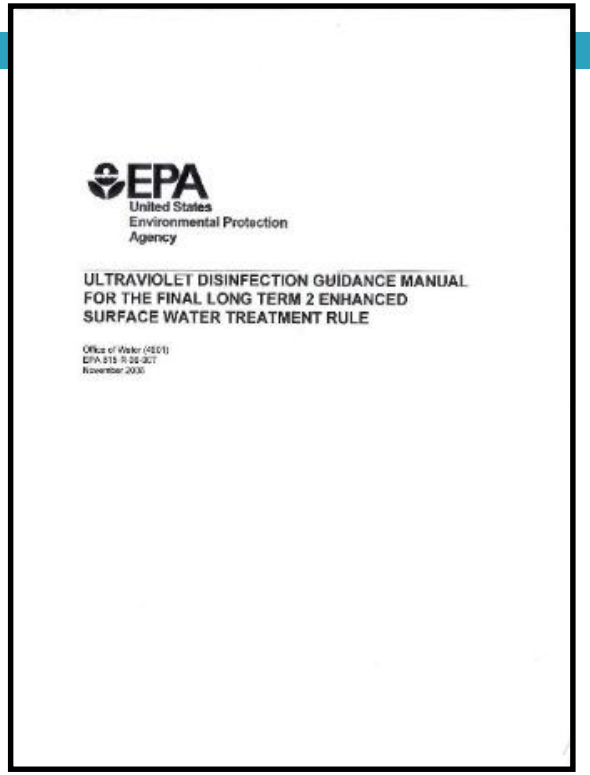
UV Dose Requirements for Pathogen Inactivation

Table 1.4. UV Dose Requirements – millijoules per centimeter squared (mJ/cm^2) [1]

Target Pathogens	Log Inactivation							
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Cryptosporidium	1.6	2.5	3.9	5.8	8.5	12	15	22
Giardia	1.5	2.1	3.0	5.2	7.7	11	15	22
Virus	39	58	79	100	121	143	163	186

[1] 40 CFR 141.720(d)(1)

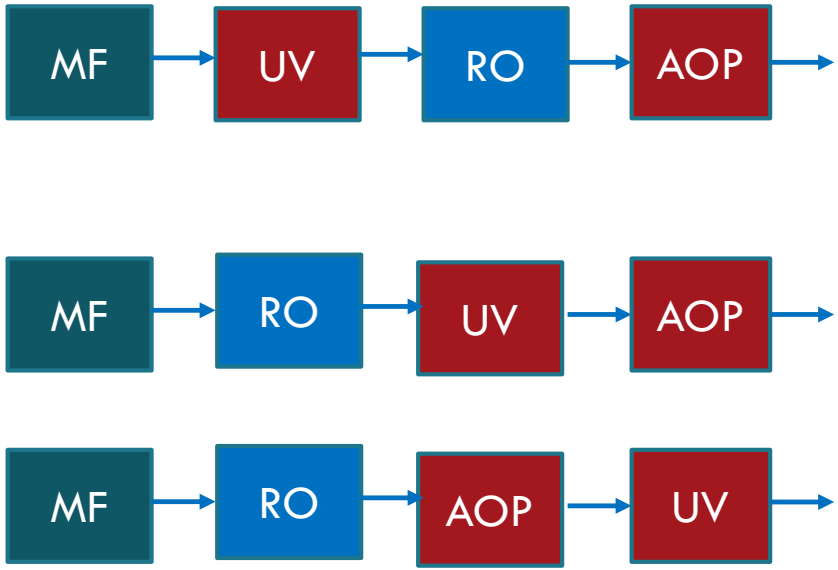
A validation factor must be applied to these UV doses for full-scale operation



AECOM

Where We Can Put UV Disinfection?

- After MF/UF (Before RO)
  - Lower UVT (typically 70-78%)
  - Without residual chlorine does not provide effective biological fouling control for RO
- After RO
  - Higher UVT (typically 95-98%)
    - Reduces both CAPEX and O&M Costs



AECOM

Discussion and Conclusions

- Using TRASAR, Rhodamine Dye, TOC, Sulfate may provide 2-log additional LRV for RO over conductivity monitoring
  - This may not be enough for reliably meeting minimum 10 log C/G requirements
- UV disinfection with <50 mJ/cm2 dose can provide 4-log Crypto and Giardia inactivation
  - Putting UV Disinfection after RO is advantageous for reducing CAPEX and O&M Costs

AECOM

Discussion and Conclusions

- Disinfection processes in series each may get up to 6 log pathogen credit (up to 12-log total)
- Systems with multiple UVAOP reactors in series may deserve credit for each reactor if all the monitoring requirements are met?

- UVAOP + Free Chlorine
- Ozone + UV
- Ozone + UVAOP
- UVAOP+ Low Dose UV
- Chlorine + UVAOP

Are these disinfection processes in series different than UVAOP reactors in series?

AECOM

Questions and Comments

Thanks for your participations

AECOM