BUILDING A BORLD OF DIFFERENCE

EFFECTIVE *REGULATIONS* TO MANAGE CECS IN WASTEWATER TREATMENT

WATEREUSE NORTHERN CALIFORNIA CHAPTER MEETING AUGUST 19, 2018



MICROCONSTITUENTS AND EMERGING CONTAMINANTS

- Endocrine disrupting compounds
- Pharmaceuticals
- Personal Care Products
- Persistent Organic Pollutants
- Nanoparticles

Ibuprofen













CECs HAVE DELETERIOUS ENVIRONMENTAL IMPACTS



From Ruiz A.M et. al, *Environ. Sci. Technol.* 2010, 44, 4862-4868.

ENVIRONMENTAL FATE OF CECS





Regulation

1 A rule or directive made and maintained by an authority



2 The action or process of regulating or being regulated



WHERE CAN WE "REGULATE" THE SYSTEMS?



EXAMPLES OF 'INNOVATIVE'^(A) COMPONENTS OF SOME SOURCE CONTROL PROGRAMS

FROM WRRF 13-12: EVALUATION OF SOURCE WATER CONTROL OPTIONS AND THE IMPACT OF SELECTED STRATEGIES ON DIRECT POTABLE REUSE

• Denmark

- *Mobile* activated sludge unit to pinpoint toxic discharges;
- *autotrophs* (i.e the nitrifiers) are more sensitive to toxic upset than heterotrophs;

• Singapore

- use of VOC analysers at nodal points in the collection system to identify high VOC discharges;
- some 40 units installed and in operation;

• Australia

• sensors for real-time data acquisition within a collection system.

(A) Included in regular monitoring programs focusing on illegal discharges

WRRF REGULATION TO MANAGE CEC REMOVAL



FACTORS WHICH INFLUENCE CEC REMOVAL









Leu et. al., 2012



BIOLOGICAL PROCESS SRT & CEC REMOVAL



Removal → biodegradation coupled with sorption in all systems

SRT to achieve MC removal

- compound specific (Ternes et. al., 2004; Clara et. al., 2005; Stephenson and Oppenheimer, 2007)
- in the range of 10+ days (Ternes et. al., 2004; Clara et. al., 2005; Stephenson and Oppenheimer, 2007)

SRT & PhAC REMOVAL



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SUSPENDED GROWTH OR MBR FOR CEC REMOVAL?



SUSPENDED GROWTH VS. MBR FOR PHAC REMOVALS

- •When operated at similar SRTs:
 - no statistically significant differences in PhAC removal performance

•Certain compounds are poorly removed in both (e.g., CBZ)



Sathyamoorthy, preliminary data (work product – not for distribution/copy)

FATE OF CECS DURING BIOLOGICAL TREATMENT





Evaluating the degradation of selected beta blockers during nitrification

Sathyamoorthy et. al, Environmental Science and Technology, 2013 Sathyamoorthy et. al, Environmental Modeling and Software, 2014

ATENOLOL BIODEGRADES & APPEARS LINKED TO AMMONIA OXIDATION



Sathyamoorthy et. al, Environmental Science and Technology, 2013

THE ROLE OF AOB IN PhAC BIODEGRADATION





WHAT ABOUT ATN BIODEGRADATION IN THE ABSENCE OF NITRIFICATION?



"TOOLS" (I.E., FUNCTION) REQUIRED FOR BIODEGRADATION

Atenolol



COMMUNITY DIVERSITY AND POTENTIAL BIODEGRADATION "TOOLS"



SUMMARY

Are CECs removed or degraded?

What processes can we regulate?

What are they key research needs?

yes, many are removed or transformed

But, to differing degrees

MC dependant, process dependant

Robust Source Control

- Effective pretreatment program
- Drug takeback programs
- Outreach & Education
- In WRRFs, effective management of
 - biological treatment
 - AWP processes (AOP, activated carbon, etc.)

 Develop mechanistic understanding of CEC attenuation in biological process
Enhance predictive modeling of CEC biodegradation

BLACK & VEATCH CURRENT CEC RESEARCH



Sandeep Sathyamoorthy **Black & Veatch** Walnut Creek, CA 925-949-5913 SathyamoorthyS@bv.com

Science News -March 19, 2008

Estrogenic chemicals change birds' tunes

Wild birds sing more complex melodies when exposed to endocrine disrupters.

Both natural and synthetic chemicals that mimic estrogen can change how male birds sing by enlarging sections of their brains responsible for creating songs. Researchers have taken these findings to the field for the first time, showing that the more complex songs these birds sing attract more females. But the males' immune systems and their overall reproductive success may be compromised by exposure to the contaminants.



DAVE MENKE/U.S. RSH AND WILDLIFE SERVICE European startings in the U.K. are exposed to endoor he disrupte is when they feed on contaminated worms.

QUESTIONS

