Wastewater Treatment Optimization: Research to Practice

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Wastewater Treatment Challenges and Opportunities

- Evolving regulatory requirements
  - Effluent water quality requirements may change during the design life of a treatment facility

- Climate change adaptation and mitigation
  - Increased frequency and intensity of precipitation events, duration of drought conditions
  - Increased consideration for emissions

Wastewater System Effluent Regulations

Purpose: Decrease the level of deleterious substances deposited into waters

Timeline: *Into Force:* 2012; *Compliance:* 2015; *Transitional Authorization:* 2020, 2030, 2040

Key Element: Set national effluent quality standards

Wastewater System Effluent Regulations

- Average carbonaceous biochemical oxygen demand (CBOD)
  - ≤ 25 mg/L
- Average total suspended solids (TSS)
  - ≤ 25 mg/L
- Average total residual chlorine (if chlorine compounds used in treatment process)
  - ≤ 0.02 mg/L
- Maximum concentration of un-ionized ammonia
  - ≤ 1.25 mg/L (as nitrogen)

Transitional Authorization establishes conditions under which operations can continue

CANADA

CONSOLIDATION

CODIFICATION

Wastewater Systems Effluent Regulations

Règlement sur les effluents des systèmes d'assainissement des eaux usées

SOR/2012-139

DORS/2012-139

Current to December 23, 2021

Last amended on January 1, 2015

À jour au 23 décembre 2021

Dernière modification le 1 janvier 2015

Published by the Minister of Justice at the following address: http://laws-lois.justice.gc.ca

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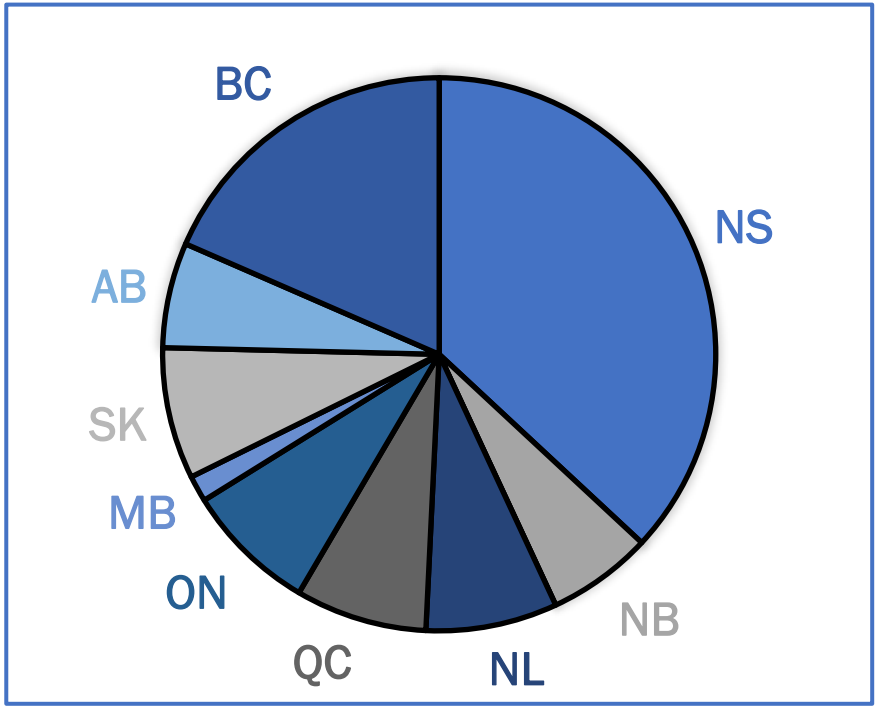
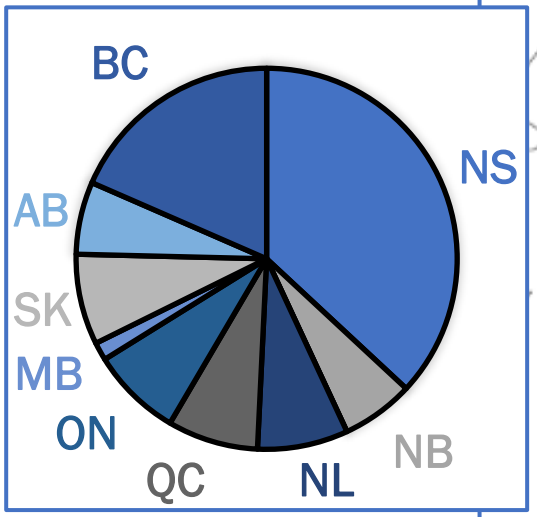
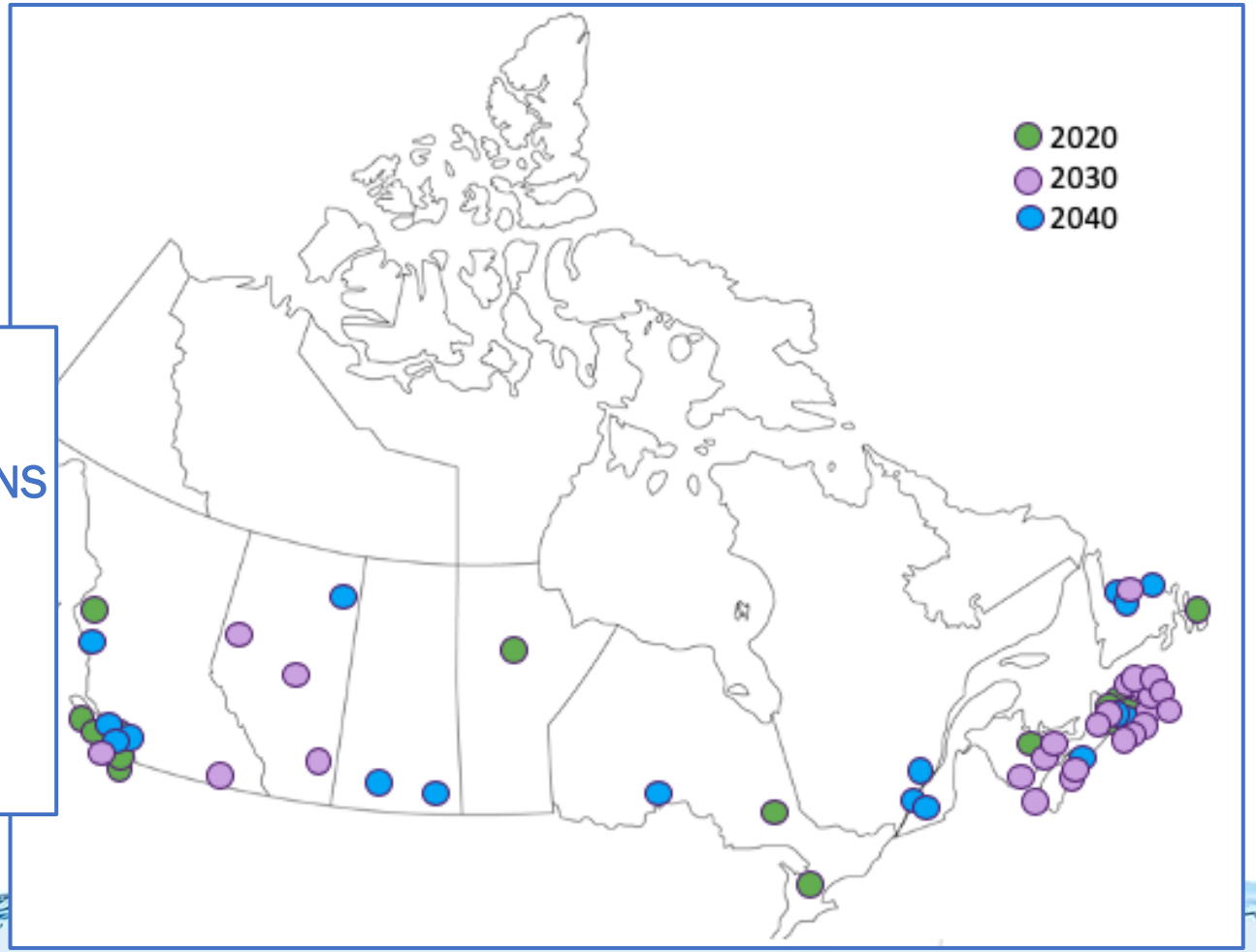
Transitional Authorization

- Establishes conditions under which operations can continue
- Sets deadline to meet national effluent guidelines
  - 2020, 2030 or 2040 depending on receiving water



Transitional Authorization





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Designed to be achievable through secondary wastewater treatment

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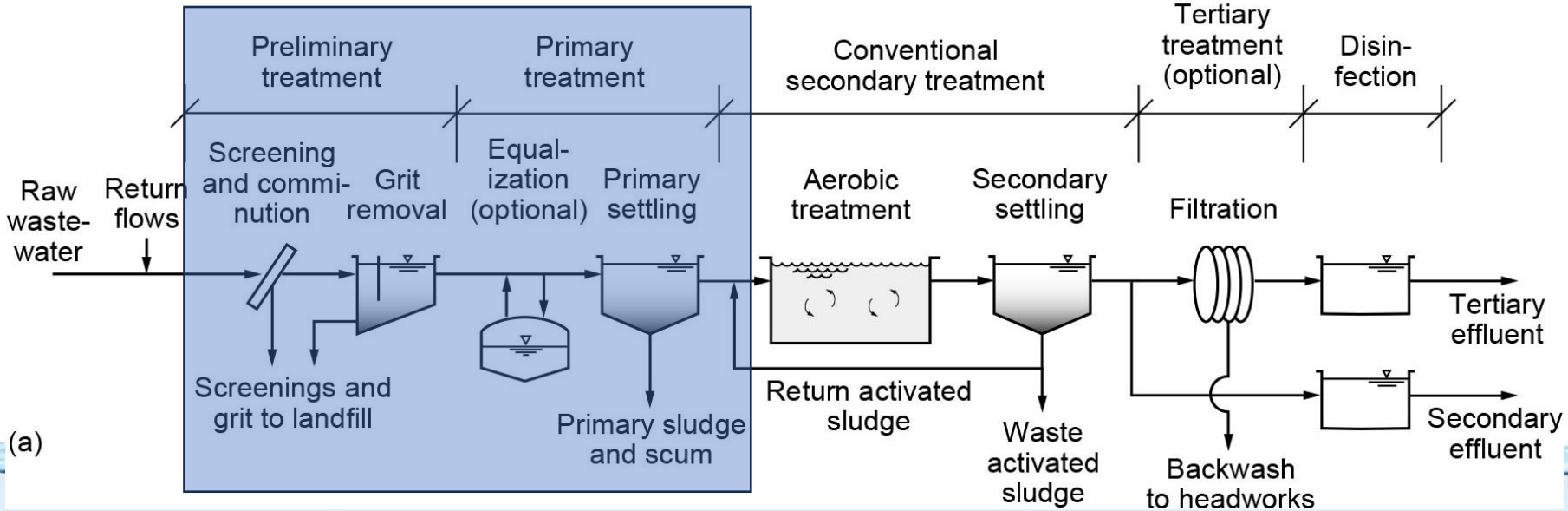
Classification of Wastewater Treatment

Preliminary and Primary Treatment

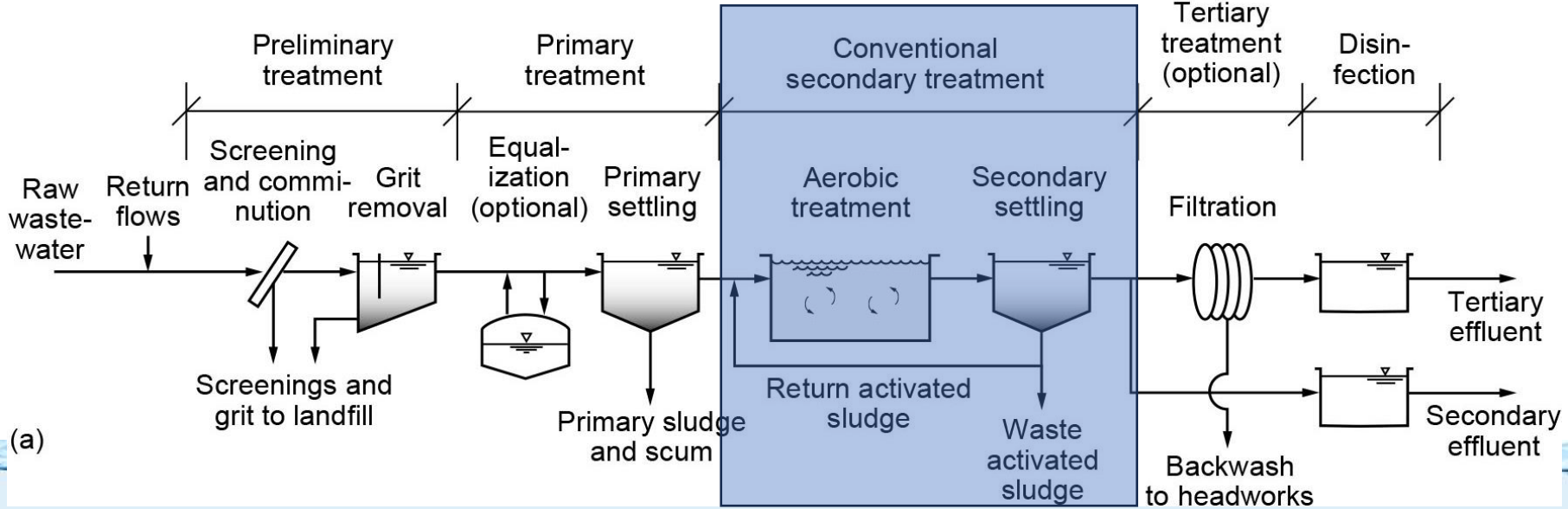
Screening, grit removal, primary settling



Classification of Wastewater Treatment

Secondary Treatment

Biological activity drives contaminant removal



Types of Biological Treatment Processes

1. Suspended Growth Processes

Microorganisms responsible for treatment are maintained in **liquid suspension** by mixing

2. Attached Growth (Biofilm) Processes

Microorganisms responsible for treatment are **attached** to media

Responses to Current Wastewater Treatment Challenges and Opportunities

Regulatory and Climate Change Adaptation

1. Optimize current treatment processes
2. Plan for additional treatment processes

Climate Change Mitigation

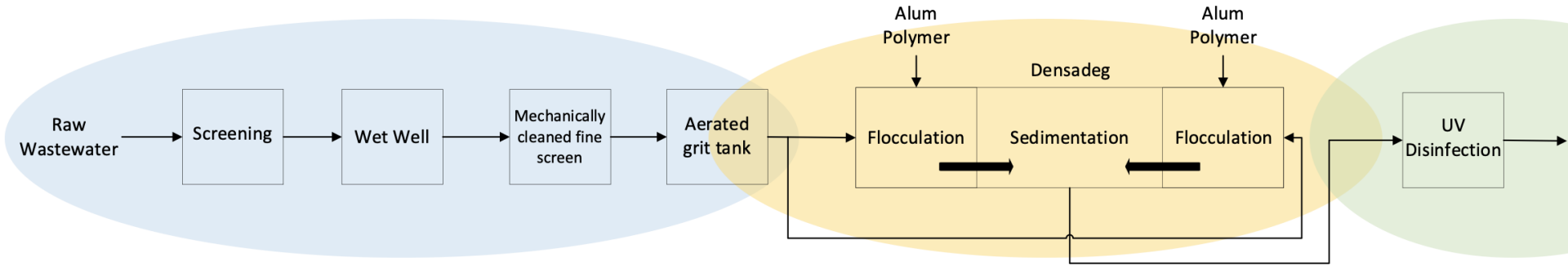
3. Innovative solutions

Optimization of Existing Treatment Processes and Planning for New Treatment Processes

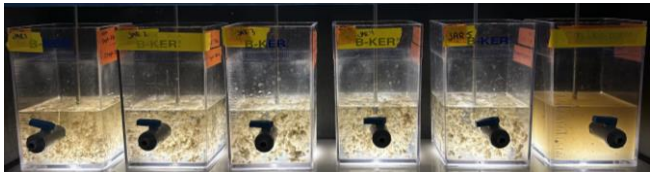
Bench-Scale

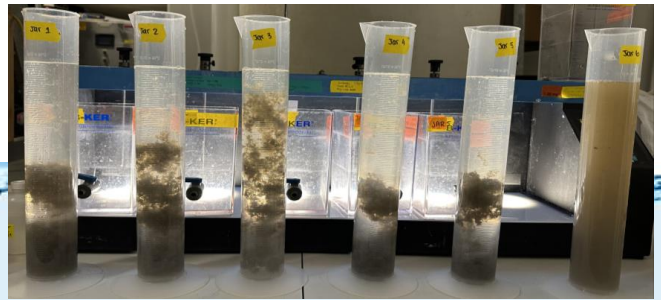
Pilot-Scale

1. Optimization of Existing Treatment: *Jar Testing to Improve Effluent TSS*



- Polymer dose
- Alum dose
- pH
- Mixing intensity
- Ballast concentration





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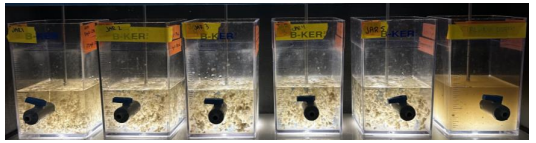

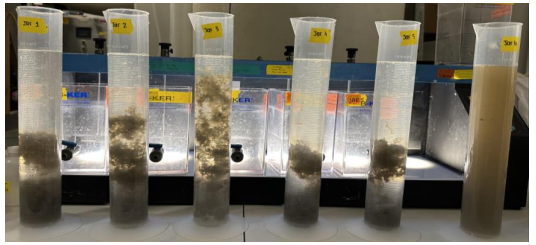

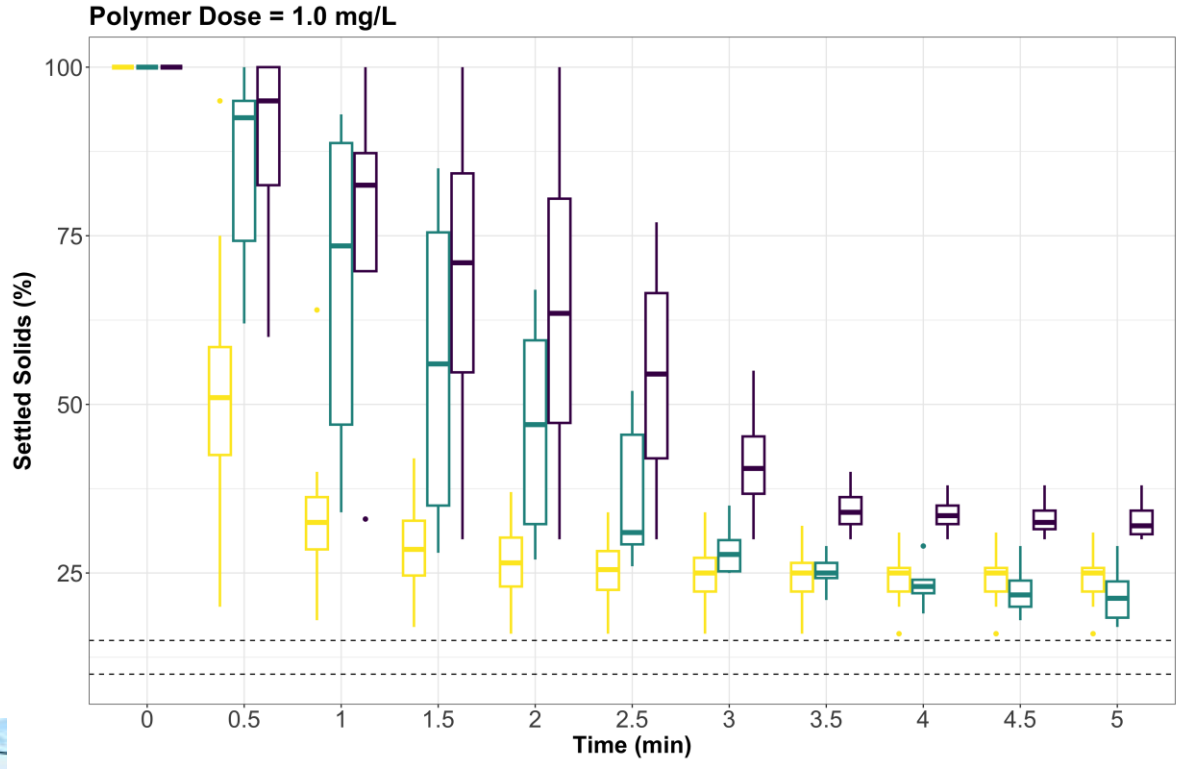

Settled TSS = 42 ± 22 mg/L

Settled TSS = 36 ± 16 mg/L

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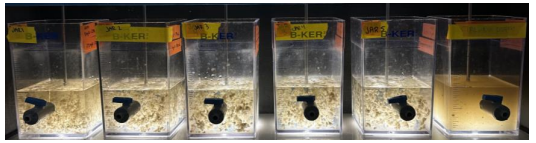
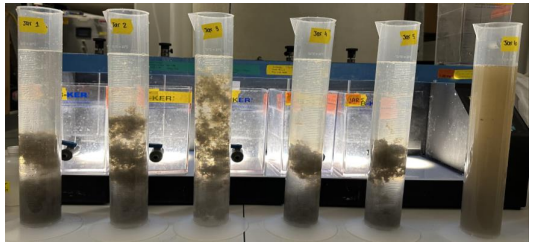
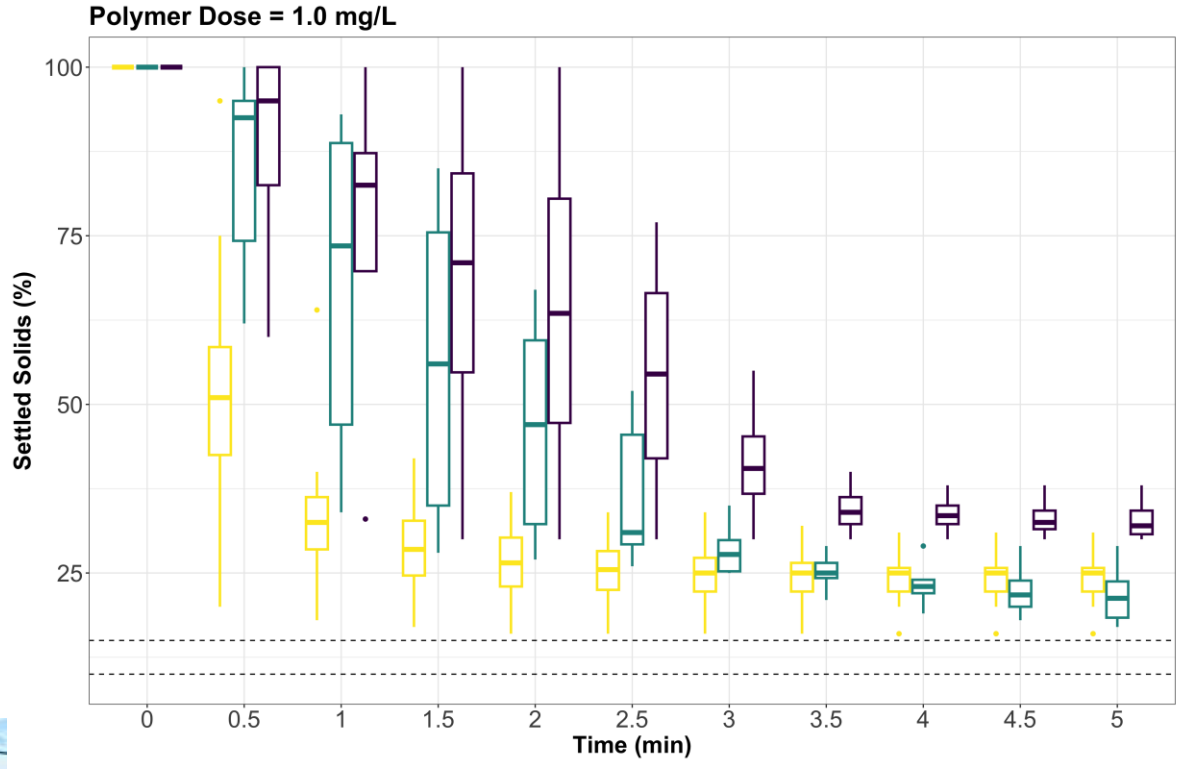
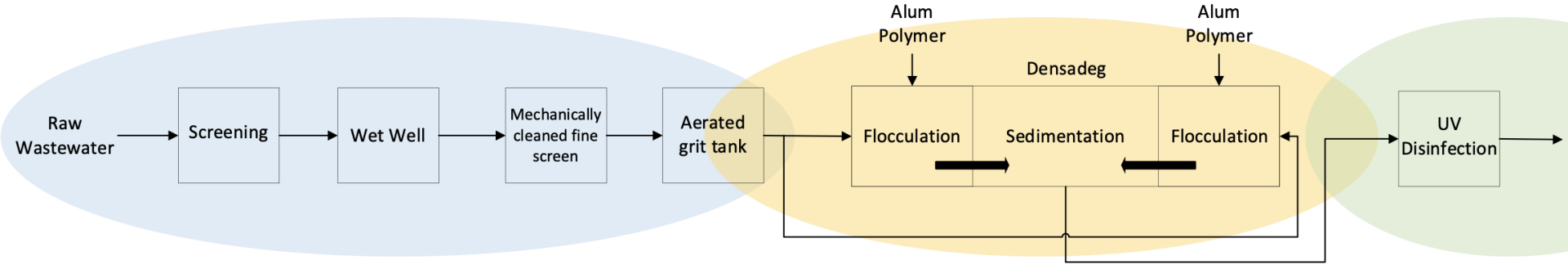






Settled TSS = 24 ± 15 mg/L

2. Planning for Additional Treatment Processes: *Investigation of Biologically Aerated Filtration (BAF)*



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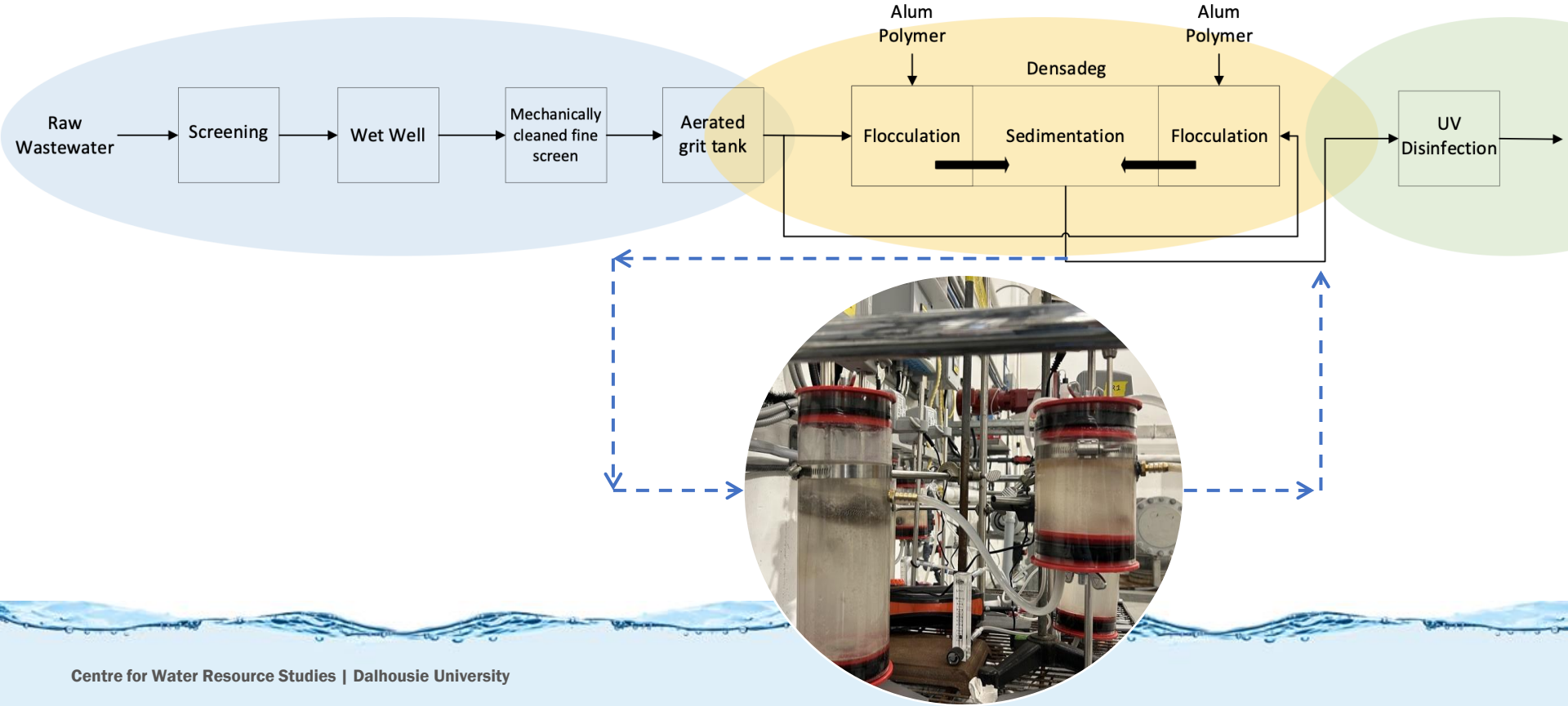

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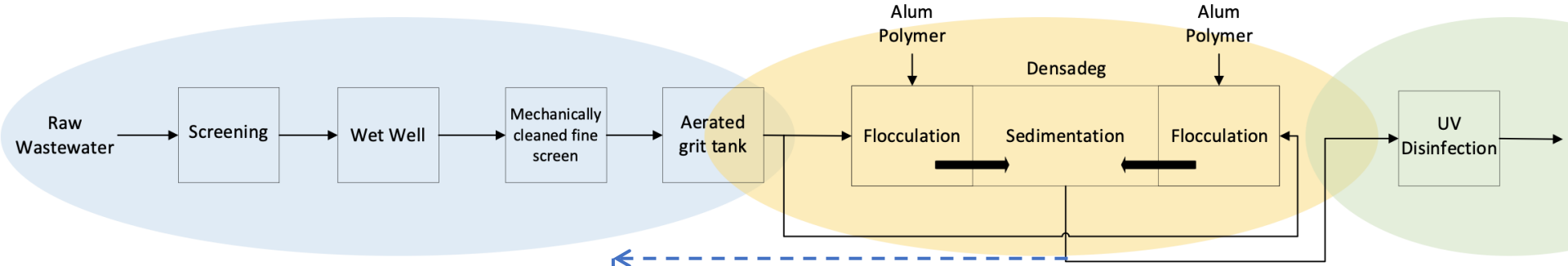
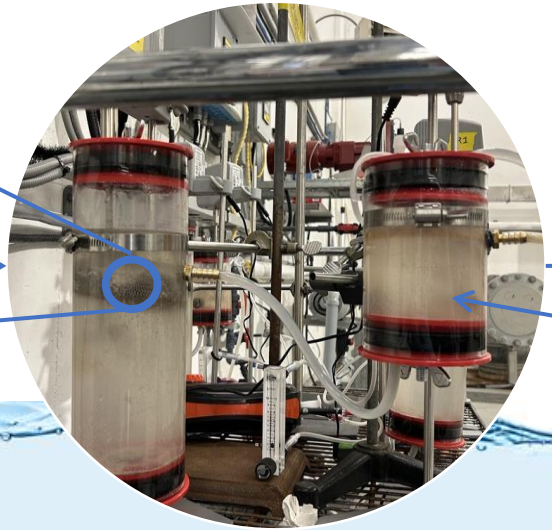
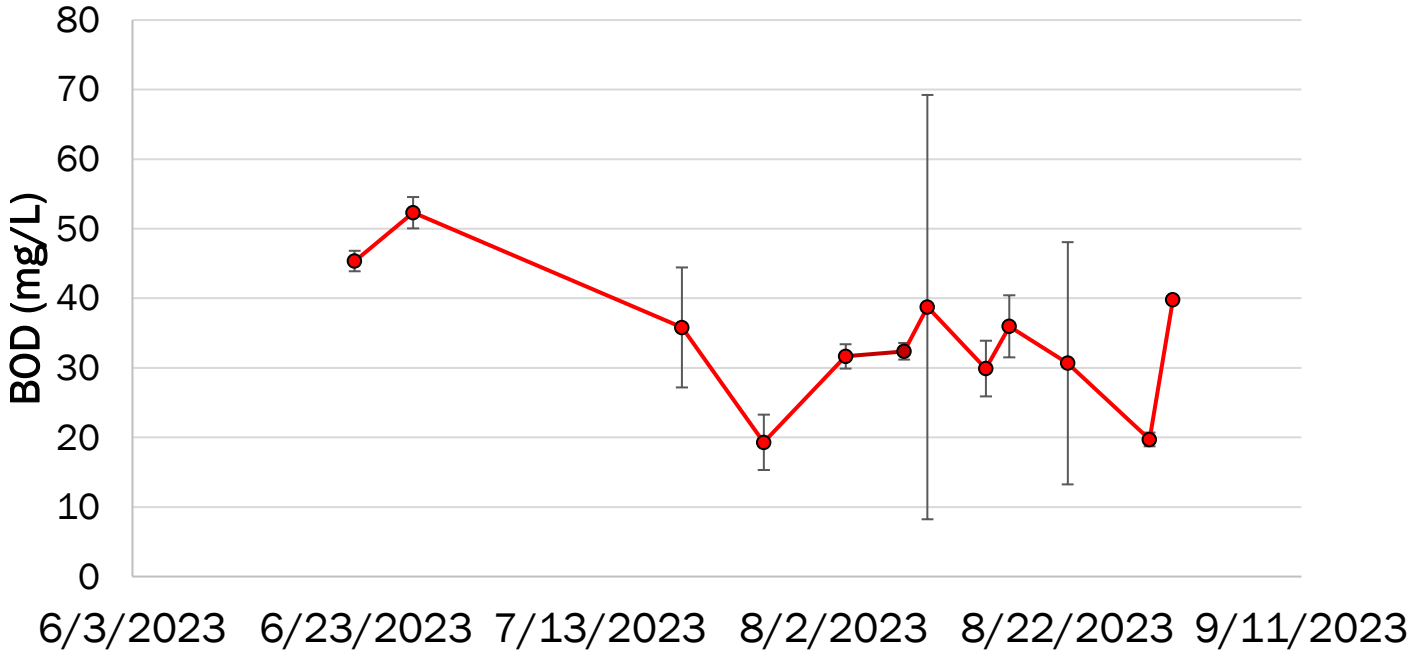


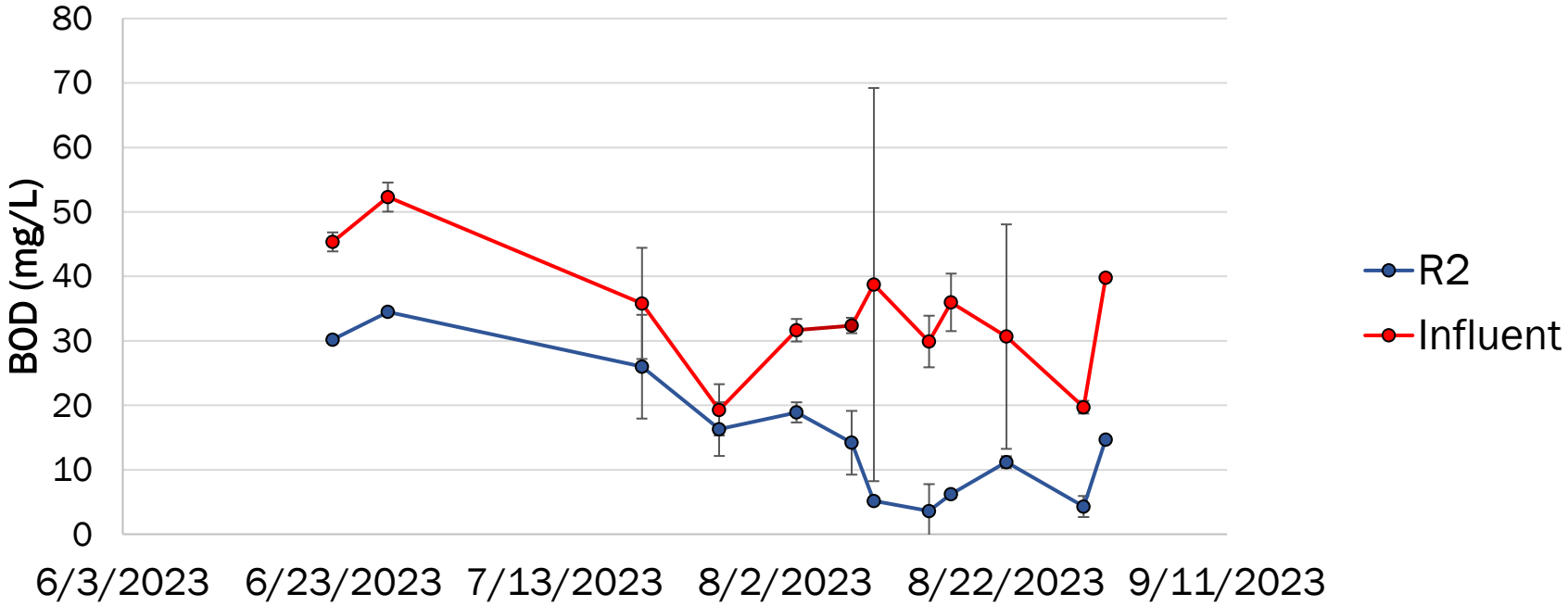


Aeration

2. Planning for Additional Treatment Processes: *Full-scale Plant Performance*



2. Planning for Additional Treatment Processes: *Bench-Scale BAF Performance*



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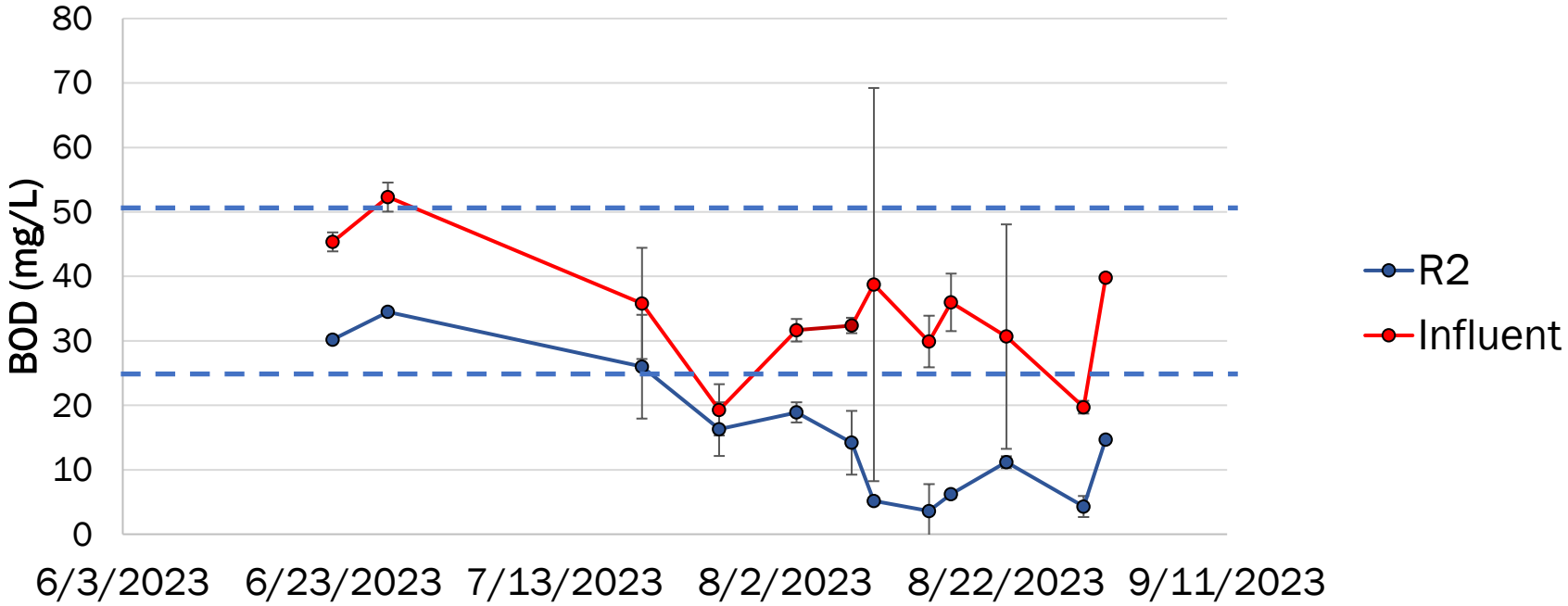
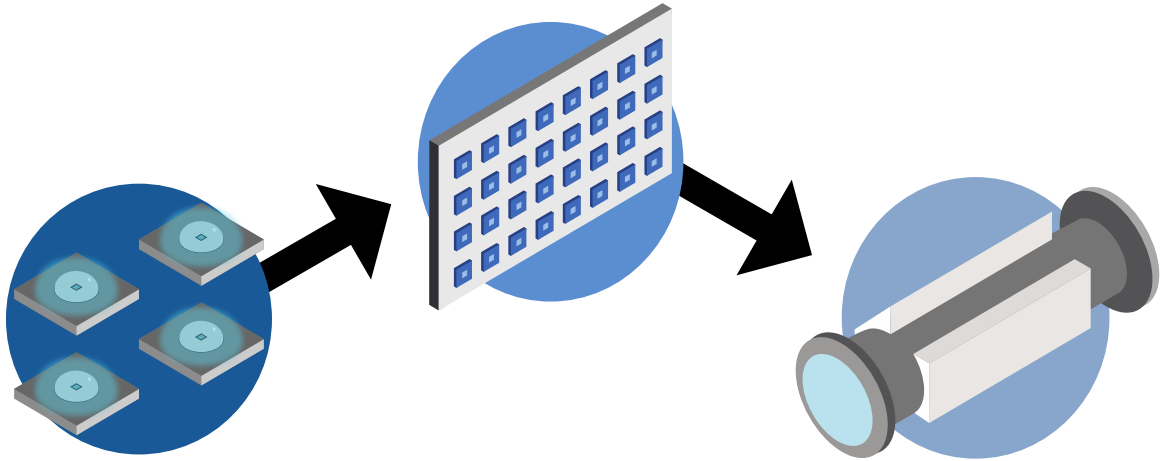
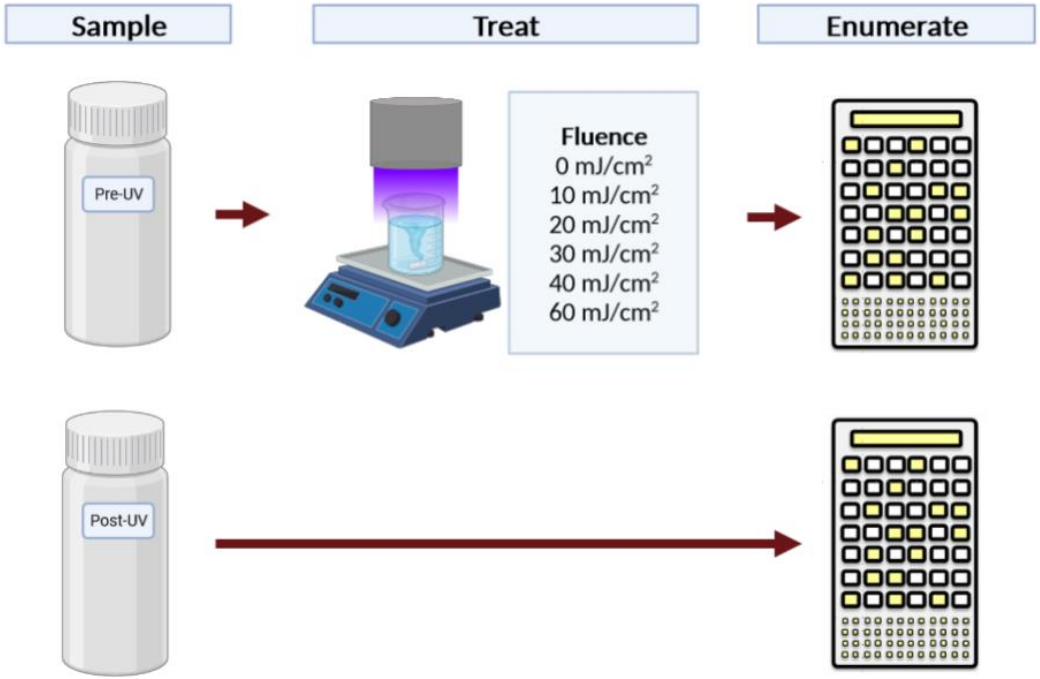


3. Climate Mitigation and Adaptation: *Innovative Solutions*

- Evaluate the effectiveness of UV LEDs for wastewater disinfection



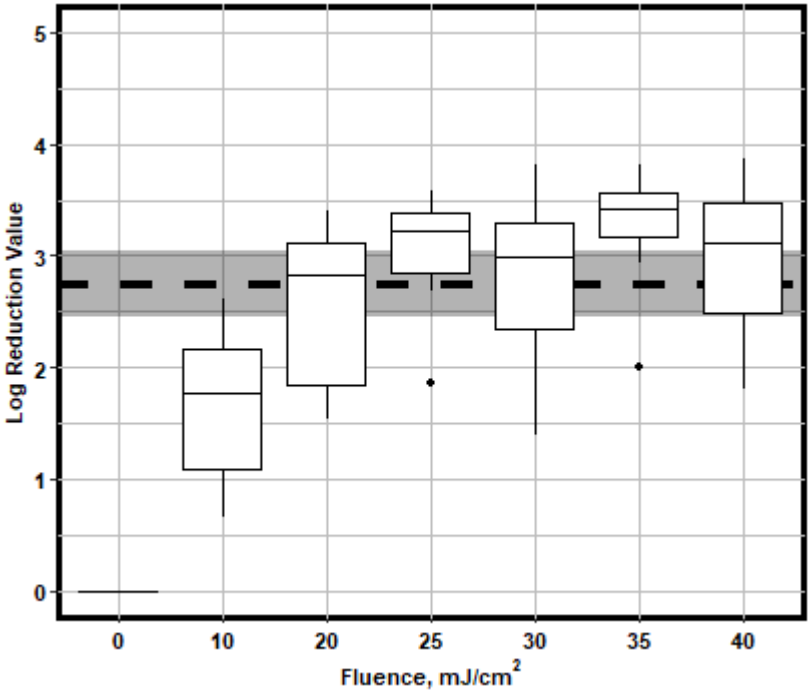
How to Assess Full-Scale UV Disinfection Systems?



UV audits can determine:

- Minimum fluence achieved
- Required dose for specific target reduction
- The upper limit of treatment

UV Audits for Disinfection Performance



UV audits are a powerful tool for estimating facility performance and understanding how new processes behave at scale

Contents lists available at ScienceDirect

Journal of Water Process Engineering

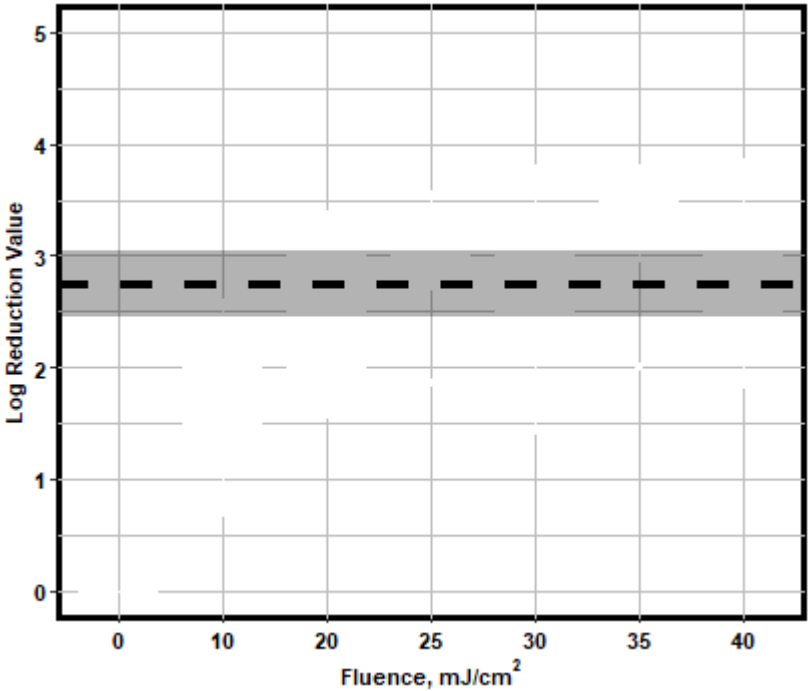
journal homepage: www.elsevier.com/locate/jwpe

UV disinfection audit of water resource recovery facilities identifies system and matrix limitations

Kyle D. Rauch, Sean A. MacIsaac, Amina K. Stoddart, Graham A. Gagnon *

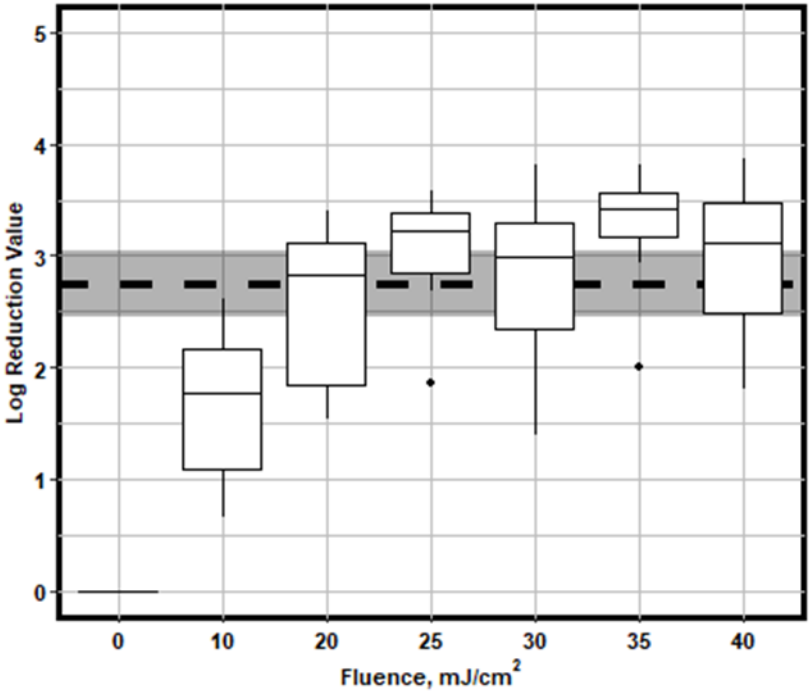
Centre for Water Resources Studies, Dalhousie University, B3H 4R2 Halifax, NS, Canada

UV Audits for Disinfection Performance



Plant performance mean and 95% CI

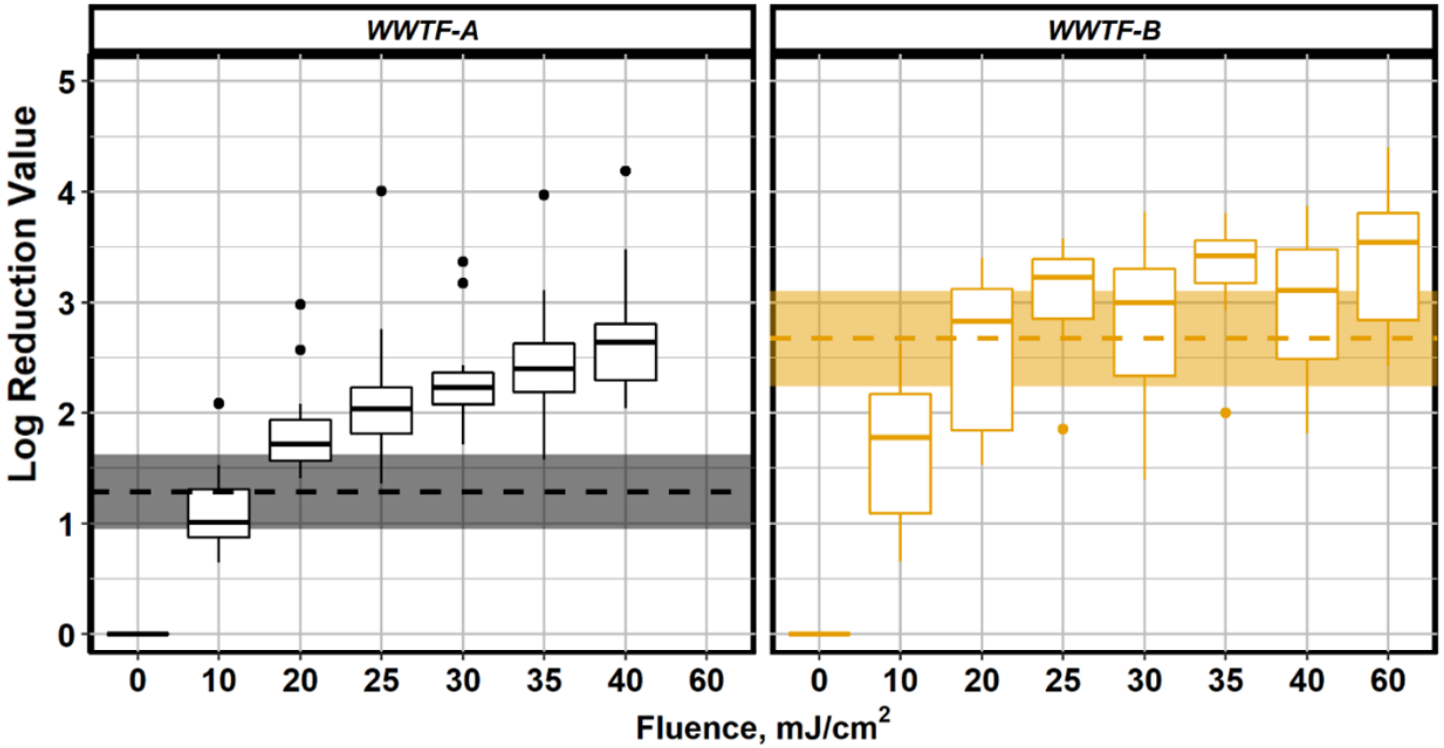
UV Audits for Disinfection Performance



Plant performance mean and 95% CI

Bench-scale treatment median and IQR

UV Audits for Disinfection Performance



Rauch, K. D., MacIsaac, S. A., Stoddart, A. K., & Gagnon, G. A. (2022). UV disinfection audit of water resource recovery facilities identifies system and matrix limitations. *Journal of Water Process Engineering*, *50*, 103167. https://doi.org/10.1016/j.jwpe.2022.103167

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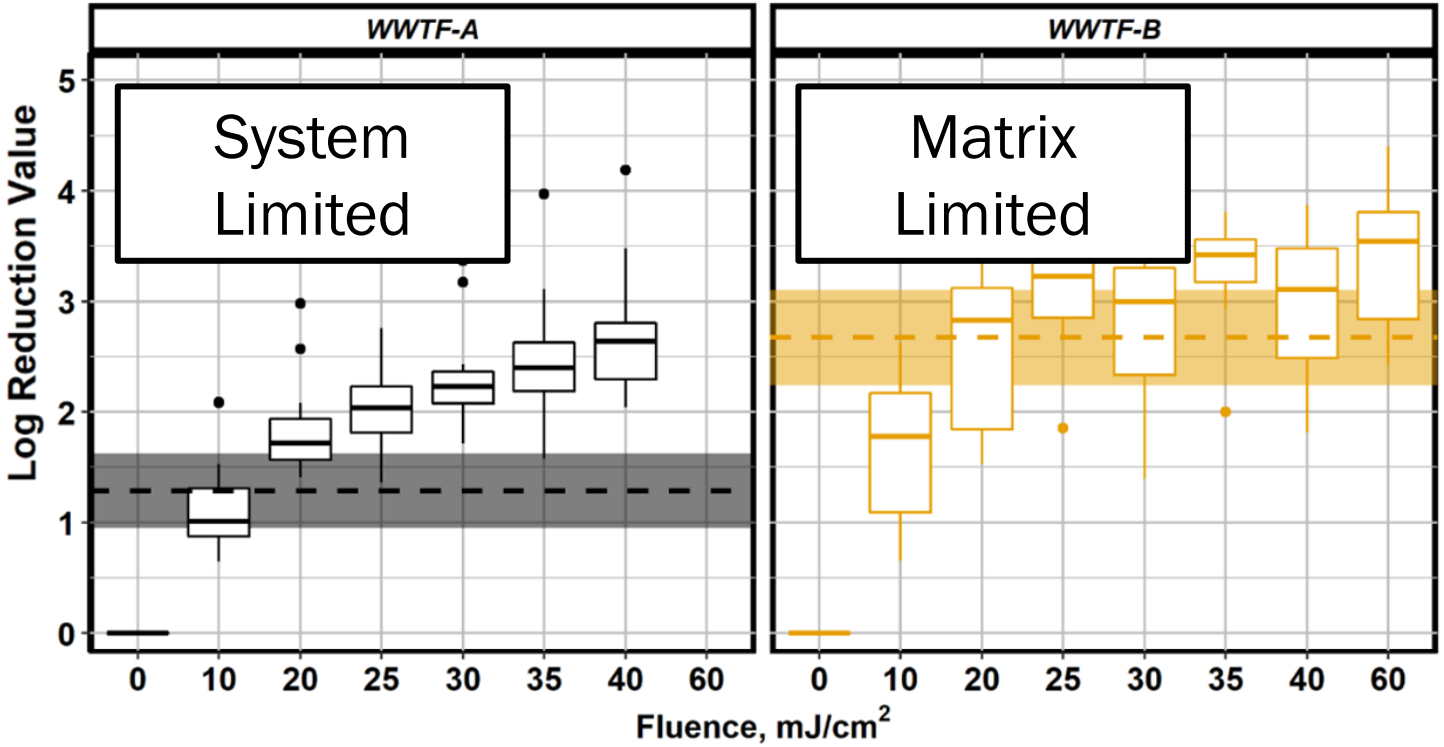

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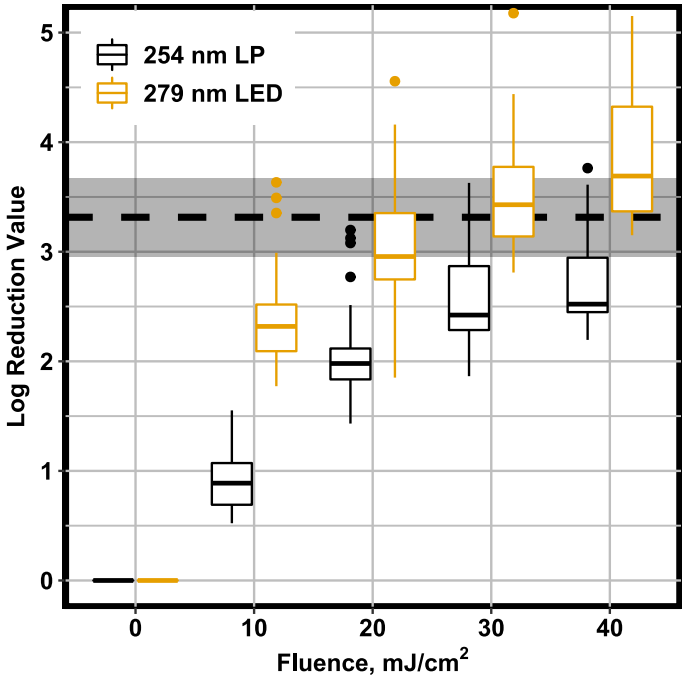
UV Auditing for LED systems



- LED treatment outperformed LP
  - Achieved plant performance at lower fluence
  - Reached higher upper level of treatment

scientific reports

OPEN

Improved disinfection performance for 280 nm LEDs over 254 nm low-pressure UV lamps in community wastewater

Sean A. MacIsaac[1,3], Kyle D. Rauch[1,3], Taylor Prest[1], Richard M. Simons[2], Graham A. Gagnon[1] & Amina K. Stoddart[1]

The research team acknowledges funding through the NSERC Alliance “Partnership for Innovation in Climate Change Adaptation in Water & Wastewater Treatment” and its member partners.