MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

2025 Great Lakes Microplastics Summit

VIRTUAL EVENT | OCTOBER 22

Profiling WTPs for Microplastics Removal

Brent Alspach, PE, BCEE

Presenter Bio

ARCADIS

Brent Alspach holds both BS and MS degrees in Civil and Environmental Engineering from Cornell University. Brent joined Arcadis in 1997 and is a Vice President & the Director of Applied Research. He currently serves on the AWWA Technical and Education Council, as well as on the editorial boards for *Opflow* and *AWWA Water Science*. He is the PI / Co-PI on three Water Research Foundation projects on microplastics in drinking water, a subject on which he recently testified before the US Congress. His contributions to the water field were honored with the WRF's 2025 Pankaj Parekh Research Innovation Award.

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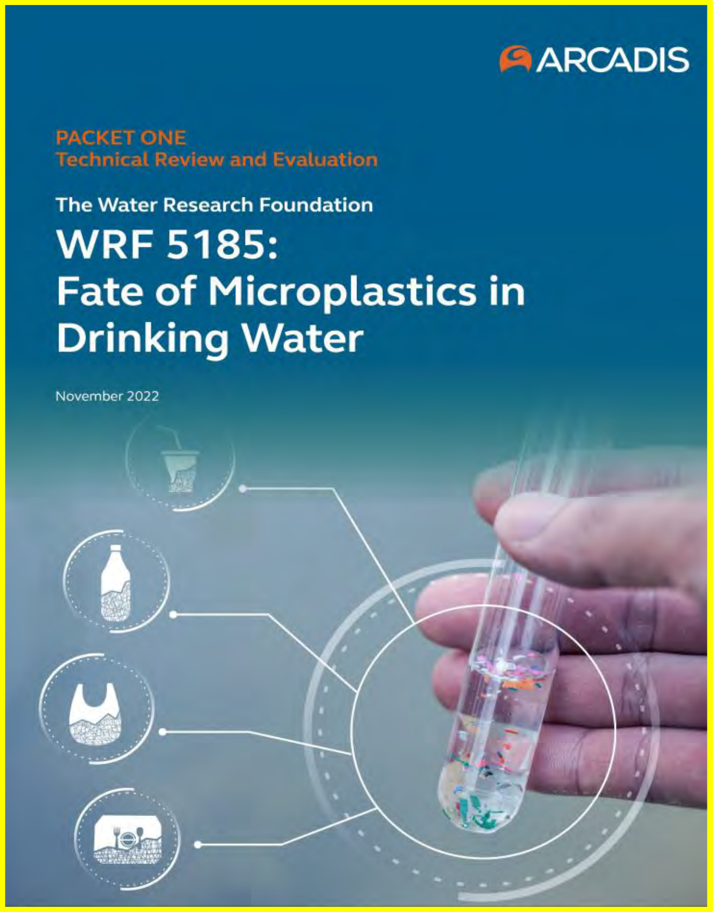
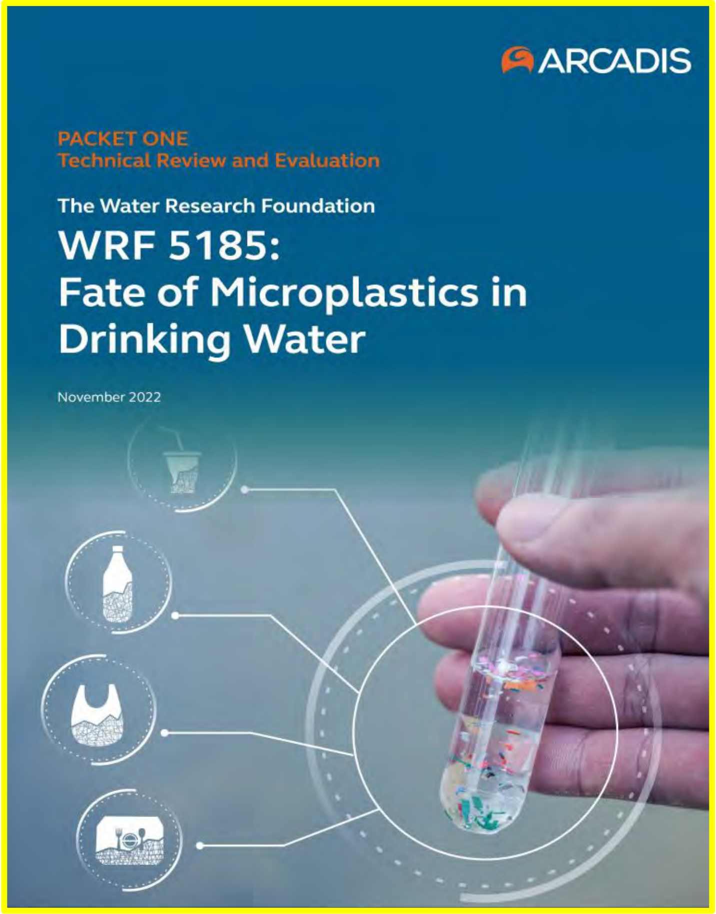


Brent Alspach, **Principal Investigator**
VP & Director of Applied Research
ARCADIS

Dr. Nicole Fahrenfeld, **Co-PI**
Professor
RUTGERS

WRF 5185: Fate of MPs in Drinking WTPs

Brent Alspach, PE, BCEE



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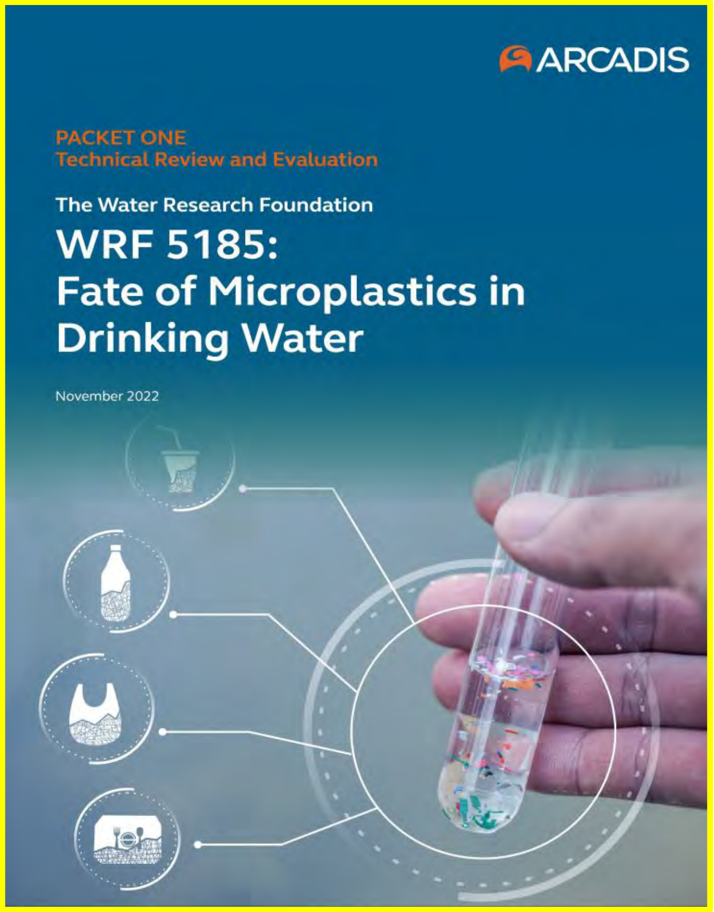

WRF 5185: Fate of MPs in Drinking WTPs

Brent Alspach, PE, BCEE

WRF 5185 Collaboration Team

Water Research Foundation

Sydney Samples, RPM
Valerie Roundy, Coordinator

Project Advisory Committee

Cayla Cook, Hazen & Sawyer
Andrew DeGraca, SFPUC
Peter Goodmann, Louisville Water Co.
Lucy Li, MWDSC

Expert Advisory Panel

Dr. Scott Coffin / Dr. Hélène Baribeau,
California SWRCB
Alignment with CA Monitoring Program

Shelly Walther,
LA County Sanitation Districts
Sampling and Analytical Methods

Dr. Vijay Bhatia,
Philadelphia Water Dept.
Water Utility Perspective

Principal Investigator

Brent Alspach, PE, BCEE

Co-Principal Investigator

Nicole Fahrenfeld, PhD

ARCADIS

Brent Alspach, PE, BCEE
Alma Beciragic, PhD
Francesca DePrima

RUTGERS

Nicole Fahrenfeld, PhD
Georgia Arbuckle-Keil, PhD
Jenny Cruz

Participating Utilities

THANKS!

American Water
City of Minneapolis
City of Sacramento
Dallas Water Utilities
Fairfax Water
Greater Cincinnati WW
Louisville Water Company
Manitowoc Public Utilities

Middlesex Water Company
Milwaukee Water Works
MWA of Westmoreland County
Orange County Utilities
Philadelphia Water Dept.
San Jose Water
So. Nevada Water Authority
Valley Water

Research Objective

Rising consumer concern over microplastics has prompted studies of occurrence in both raw and treated drinking water supplies, but treatment plants exhibit varying degrees of removal, and individual processes are not well-characterized. Thus, the objective of this research is to help close this knowledge gap by profiling key unit processes and correlating treatment efficacy with microplastics attributes, water quality data, design criteria, and operational parameters, thereby informing facility optimization.

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Research Objective

profiling
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Presentation Objective

Educate about the challenges of understanding and characterizing microplastics removal

Overview of Utility Partners

Agency	State	Source Water(s)	Treatment Facility Unit Processes
American Water	NJ	Canoe Brook Reservoir & Wells	Coagulation; flocculation, dissolved air flotation, media filters, chlorination
City of Minneapolis	MN	Mississippi River	Coagulation; flocculation, settling; MF & media filters (in parallel), chlorination
City of Sacramento	CA	Sacramento River	Coagulation; flocculation; settling; media filters, chlorination
Dallas Water Utilities	TX	Multiple lakes and rivers	Ozone, coagulation, flocculation, settling, biofiltration, chlorination
Fairfax Water	VA	Potomac River	Coagulation, flocculation, settling, ozone, media filters, chlorination
Greater Cincinnati Water Works	OH	Ohio River	Coagulation, flocculation, settling (2-stage), biofiltration, GAC, UV, chlorination
Louisville Water Company	KY	Ohio River	Coagulation, flocculation, settling, chlorination, lime softening, media filters
Manitowoc Public Utilities	WI	Lake Michigan	MF (direct filtration from Lake Michigan), chlorination
Middlesex Water Company	NJ	Delaware & Raritan Canal	Coagulation, flocculation, high-rate clarifiers, ozone, media filters
Milwaukee Water Works	WI	Lake Michigan	Ozone, coagulation, flocculation, settling, media filters, chlorination
MA of Westmoreland County	PA	Youghiogheny River	Coagulation; flocculation; settling; media filters, chlorination
Orange County Utilities	FL	Floridan Aquifer	Forced draft aeration, settling, chlorination
Philadelphia Water Dept.	PA	Delaware River	Coagulation; flocculation; settling; media filters, chlorination
San Jose Water Company	CA	Los Gatos Watershed	Coagulation; flocculation; settling; UF, chlorination
Southern Nevada Water Authority	NV	Lake Mead	Ozone, coagulation flocculation, media filters, chlorination
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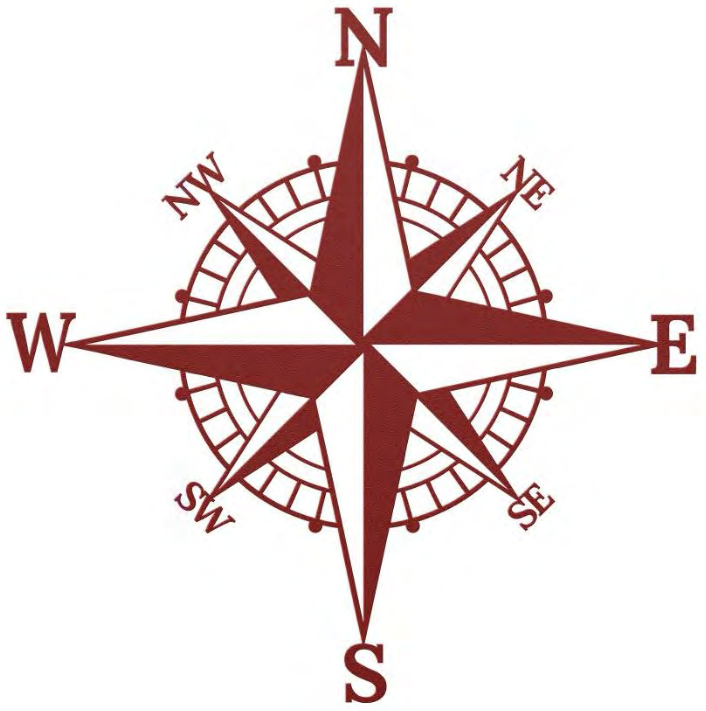

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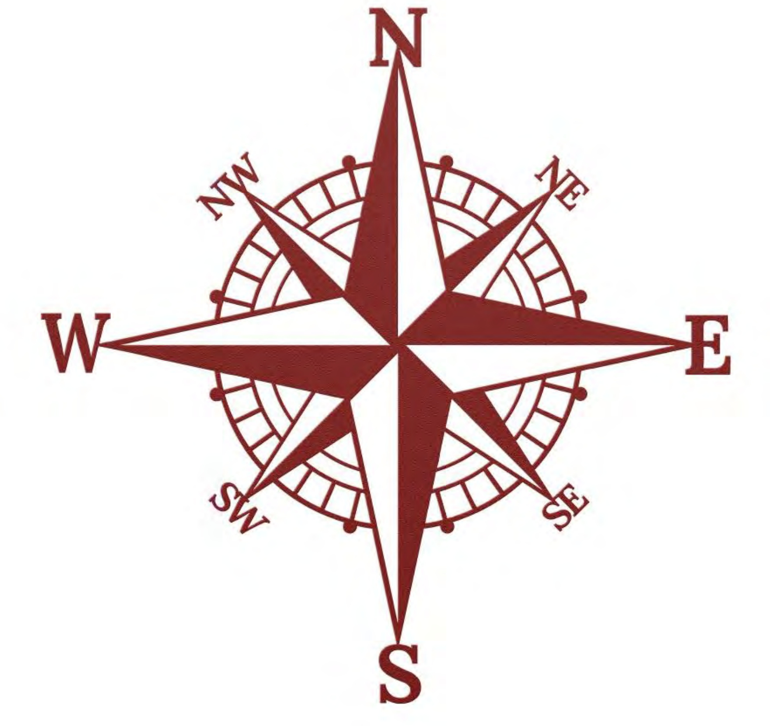

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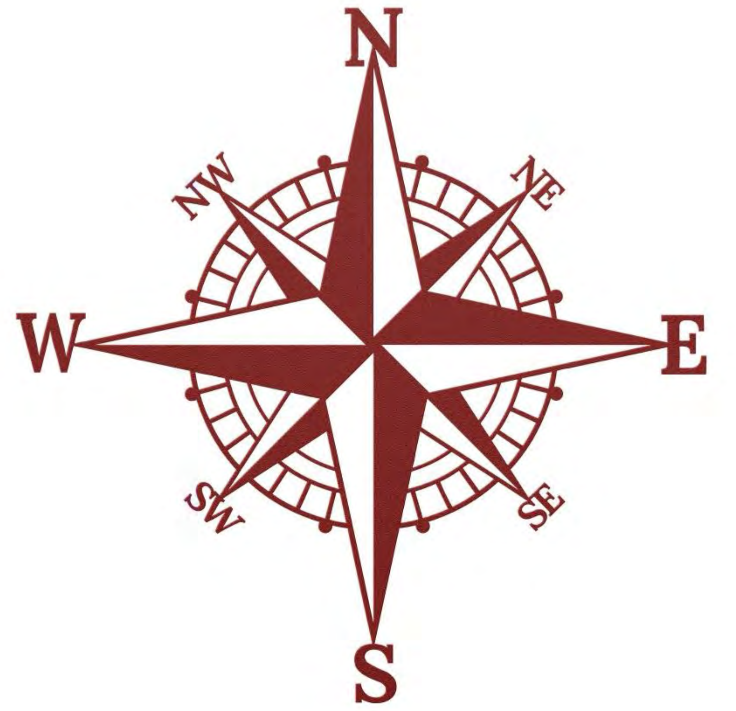

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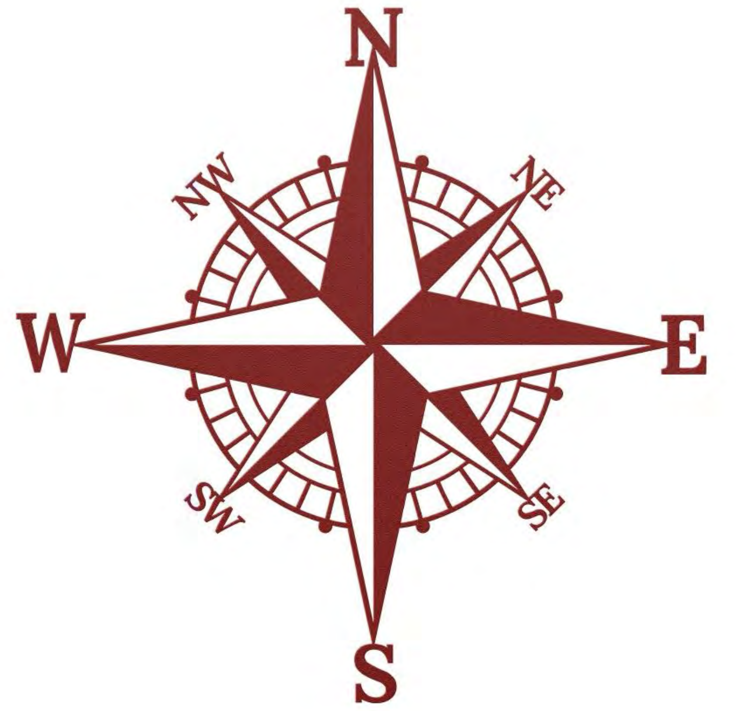

Importance...?

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Optics

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Groundwater Supply

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Conventional Pretreatment:

12 Facilities

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Media Filtration:

13 Facilities

(including biofilters)

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Chlorination:

15 Facilities

Overview of Unit Processes

Process	No.	Key Context / Notes
Conventional Pretreatment	12	Wide variety of coagulants and doses
Dissolved Air Flotation (DAF)	1	
High-Rate Clarification	1	
Forced Draft Aeration	1	
Ozone	6	Potential for microplastic embrittlement…?
Media Filtration	10	Various types and configurations
Biofiltration	3	
Microfiltration (MF)	2	Nominal pore size = 0.1 µm (100 nm barrier)
Ultrafiltration (UF)	1	Nominal pore size = 0.01 µm (10 nm barrier)
Granular Activated Carbon (GAC)	1	
Lime Softening	1	
UV Disinfection	1	Potential for microplastic embrittlement…?
Chlorination	15	Potential for microplastic embrittlement…?

Sample Regime

- 16 water treatment plants
- **13 unit processes**
- Strategic replicates
- Blanks
- Matrix spikes

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153 Samples Prescribed

* Not included

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Acknowledged that not every process at every WTP will be sampled

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Potential Constraints

- No sample tap
- No access to prescribed sample location
- Time / resource limits
- Others…?

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Presentation Objective

Educate about the challenges of understanding and characterizing microplastics removal

Presentation Objective

Educate about the **challenges** of understanding and characterizing microplastics removal

Dissecting the Difficulties

Three Core Sets of Challenges

1. Cumbersome sampling
2. Time- and labor-intensive analysis (for enumeration methods)
3. Extensive array of variables

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Sampling Challenges

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- Determining appropriate sampling depth (as applicable)
- Unwieldy apparatus for field filtration (current best practice)

Microplastics field filtration sampling apparatus assembled in a WTP lab

Apparatus deployed for sampling in a designated WTP location

Sampling Challenges

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- Specialized training required:
  - Working with the apparatus
  - QA/QC practices

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- QA/QC Practices:
  - Limit use of plastic materials, components, and equipment
  - Wear clothes made of non-synthetic textiles
  - Prevent potential for deposition of ambient airborne microplastics
  - Incorporate strategic blanks

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- Time required to collect appropriate sample volume

Sampling Challenges

- Unwieldy apparatus for field filtration (current best practice)

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Sampling Challenges

Reminiscent of early *Cryptosporidium* field filtration sampling…

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Sampling Challenges

Reminiscent of early *Cryptosporidium* field filtration sampling…

- **Unwieldy apparatus for field filtration (current best practice)**

…combined with rigorous PFAS-scale QA/QC requirements.

- **QA/QC Practices:**
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Dissecting the Difficulties

Three Core Sets of Challenges

1. Cumbersome sampling
2. **Time- and labor-intensive analysis** (for enumeration methods)
3. Extensive array of variables

Intensive Analysis

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Intensive Analysis

- QA/QC Practices:
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- Sample prep (“clean-up”)‡

‡ Enumeration methods

Intensive Analysis

- QA/QC Practices:
  - Limit use of plastic materials, components, and equipment
  - Wear clothes made of non-synthetic textiles
  - Prevent potential for deposition of ambient airborne microplastics
  - Incorporate strategic blanks
- Sample prep ("clean-up")‡
- Particulate counting‡

‡ Enumeration methods

Intensive Analysis

- QA/QC Practices:
  - Limit use of plastic materials, components, and equipment
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- **Sample prep ("clean-up")‡**
- **Particulate counting‡**

Time- and labor-intensive

Intensive Analysis

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Sample Regime

- 16 water treatment plants
- 13 unit processes
- Strategic replicates
- Blanks*
- Matrix spikes*

153 Samples Prescribed

* Not included

Acknowledged that not every process at every WTP will be sampled

Intensive Analysis

- QA/QC Practices:
  - Limit use of plastic materials, components, and equipment
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- 16 water treatment plants
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153 Samples Prescribed

* Not included

Assume 4 hours per sample for analysis

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- Particulate counting‡

Sample Regime

- 16 water treatment plants
- 13 unit processes
- Strategic replicates
- Blanks*
- Matrix spikes*

153 Samples Prescribed

* Not included

Assume 4 hours per sample for analysis

Probably an ambitious assumption (on average)

‡ Enumeration methods

Intensive Analysis

- QA/QC Practices:
  - Limit use of plastic materials, components, and equipment
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Sample Regime

- 16 water treatment plants
- 13 unit processes
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- Blanks*
- Matrix spikes*

153 Samples Prescribed

* Not included

Assume 4 hours per sample for analysis

=

15+ weeks

‡ Enumeration methods

Intensive Analysis

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Sample Regime

- 16 water treatment plants
- 13 unit processes
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- Matrix spikes*

153 Samples Prescribed

* Not included

Cost…?

Intensive Analysis

Static exercise that cannot account for the wide potential for variability

Sample Regime

- 16 water treatment plants
- 13 unit processes
- Strategic replicates
- Blanks*
- Matrix spikes*

153 Samples Prescribed

✓ **Time-intensive**

✓ **Cost-intensive**

Dissecting the Difficulties

Three Core Sets of Challenges

1. Cumbersome sampling
2. Time- and labor-intensive analysis (for enumeration methods)
3. **Extensive array of variables**

Dissecting the Difficulties

3. Extensive array of variables

Process Design Criteria & Information

Process Operational Parameters

Water Quality Parameters

Potential Points of Variability

Unit Process(es)	Operational Parameters	Design Criteria / Information	Water Quality Parameters
Conventional Pretreatment	• Coagulant Type • Coagulant Dose • Polymer Use (Y/N) • Polymer Type • Polymer Dose • Zeta Potential • Pre-Oxidant Use • Pre-Oxidant Type • Pre-Oxidant Dose	• Mixing Intensity (G) • Detention Time • Settling Rate	• Coagulation pH • Humic Acid • Calcium • Temperature • UV254 • Specific UV Abs. (SUVA)

Potential Points of Variability

Unit Process(es)	Operational Parameters	Design Criteria / Information	Water Quality Parameters
Conventional Pretreatment	• Coagulant Type • Coagulant Dose • Polymer Use (Y/N) • Polymer Type • Polymer Dose • Zeta Potential • Pre-Oxidant Use • Pre-Oxidant Type • Pre-Oxidant Dose	• Mixing Intensity (G) • Detention Time • Settling Rate	• Coagulation pH • Humic Acid • Calcium • Temperature • UV254 • Specific UV Abs. (SUVA)
Dissolved Air Flotation	• Bubble Surface Modification Agents • Air Saturation Pressure	• Mixing Intensity (G) • Detention Time • Settling Rate	

Potential Points of Variability

Unit Process(es)	Operational Parameters	Design Criteria / Information	Water Quality Parameters
Media Filtration	• Pre-Oxidant Use • Pre-Oxidant Type • Pre-Oxidant Dose	• Filter Media Type(s) • Filter Bed Depth(s) • Filter Bed L/d Ratio • Filtration Rate • Abiotic vs. Biological	

Potential Points of Variability

Unit Process(es)	Operational Parameters	Design Criteria / Information	Water Quality Parameters
Media Filtration	• Pre-Oxidant Use • Pre-Oxidant Type • Pre-Oxidant Dose	• Filter Media Type(s) • Filter Bed Depth(s) • Filter Bed L/d Ratio • Filtration Rate • Abiotic vs. Biological	
Membrane Filtration	• Backwash Practices • Chemical Cleaning Practices	• Pore Size Distribution	

Potential Points of Variability

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Membrane Filtration	• **Backwash Practices** • **Chemical Cleaning Practices**	• Pore Size Distribution	

Because these are intermittent practices, WHEN sampling occurs is important.

Potential Points of Variability

Unit Process(es)	Operational Parameters	Design Criteria / Information	Water Quality Parameters
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Membrane Filtration	• Backwash Practices • Chemical Cleaning Practices	• Pore Size Distribution	
General / Overall	• Flow	• Open Air Intakes • Upstream Pumping • Upstream Oxidants	

Dissecting the Difficulties

3. Extensive array of variables

Process Design Criteria & Information

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Water Quality Parameters

Dissecting the Difficulties

3. Extensive array of variables

Process Design Criteria & Information

Process Operational Parameters

Water Quality Parameters

Microplastics Attributes

Microplastics Attributes

Aspects of Interest

- Enumeration
- Mass concentration

Just one or both of these apply to almost every other contaminant

Microplastics Attributes

Aspects of Interest

- Enumeration
- Mass concentration
- Morphology
- Polymer type
- Surface roughness
- Surface charge
- Surface area
- Size

But there are many other potentially applicable attributes of microplastics

Microplastics Attributes

Aspects of Interest

- Enumeration
- Mass concentration
- Morphology
- Polymer type
- Surface roughness
- Surface charge
- Surface area
- Size

Any of these attributes could potentially influence treatment or health effects.

Microplastics Attributes

Aspects of Interest

- Enumeration
- Mass concentration
- Morphology
- Polymer type
- Surface roughness
- Surface charge
- Surface area
- Size

Microplastics are unlike any other contaminant.

Dissecting the Difficulties

Three Core Sets of Challenges

1. Cumbersome sampling
2. Time- and labor-intensive analysis (for enumeration methods)
3. Extensive array of variables

Dissecting the Difficulties: Implications

Three Core Sets of Challenges

1. Cumbersome sampling
2. Time- and labor-intensive analysis (for enumeration methods)
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Dissecting the Difficulties: Implications

- ✓ Studying microplastics is inherently challenging.

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Dissecting the Difficulties: Implications

- ✓ Studying microplastics is inherently challenging.
- ✓ There is a lot to learn about microplastics fate, transport, and removal efficacy in water treatment systems.
- ✓ WRF 5185 represents a significant step toward this goal…
  …but many more steps will ultimately be necessary.

Dissecting the Difficulties: Implications

- ✓ Studying microplastics is inherently challenging.
- ✓ There is a lot to learn about microplastics fate, transport, and removal efficacy in water treatment systems.
- ✓ WRF 5185 represents a significant step toward this goal… …but many more steps will ultimately be necessary.
- ✓ The drinking water community will need to be cleverer about characterizing microplastics removal and associated regulations (if/when applicable) than for any other contaminant.

Thank you for your attention!

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