Microplastics research initiatives in California drinking water and coastal California wastewater treatment plants

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Microplastics in California's waters: what is the problem?

- Microplastics are of increasing concern
  - Ubiquitous in aquatic environment
  - From many potential pathways
  - Unknown levels, sources, fate, effects

- California taking action to address issues
  - SB 1422 requires monitoring for microplastics in drinking water (*first part of our discussion*)
  - SB 1263 requires strategy to manage microplastics contamination in coastal waters, which OPC has developed (*second part of our discussion*)

Microplastics in drinking water

- Methodology needed to be standardized for drinking water monitoring
  - Analysis methods
  - Collection methods

- Once standardized and vetted methods in place, pilot monitoring can take place as required by SB 1422
  - Completed for analysis methods
  - In progress for collection methods

Status of microplastics analysis

- Two methods now accredited by ELAP for drinking water
  - Infrared spectroscopy
  - Raman spectroscopy

- Based on SCCWRP's international intercomparison study
  - 40 participating laboratories in 6 countries
  - Analysis of blind samples with known amounts of microplastics with draft SOPs
  - Performance (accuracy, precision, costs in time and labor) quantified to refine SOPs
  - Detailed in Special Issue of Chemosphere (https://www.sciencedirect.com/journal/chemosphere/special-issue/1028DWKF0HR)

Status of microplastics collection

- Standardized methods also need to be developed to collect microplastics reliably
  - Very low concentrations (down to 10^{-3}-10^{-4} particles/L)
  - Need to collect up to thousands of L to have a representative sample!
  - How to do this reliably and without contamination?

- Current research to standardize approach and train users
  - SCCWRP in collaboration with Dr. Bob Andrews (U. Toronto)
  - Enclosed in-line filtration to protect from airborne particulates
  - Experiments to evaluate effectiveness at environmentally relevant levels currently in progress
  - SOP for collection and training courses/videos follow
  - Completion date: March 2025

Microplastics in wastewater

- Wastewater is one pathway to the aquatic environment
  - Important to quantify to support SB 1263 prioritization strategy
  - May be insignificant compared to other pathways due to wastewater treatment processes (e.g., tire wear is a much larger contributor in earlier SF Bay study)
  - Use best available methods and improve if needed

- Accordingly, wastewater study of microplastics initiated
  - Supported by Ocean Protection Council
  - Additional support from staff and members of the California Association of Sanitation Agencies

Wastewater microplastic project objectives

- Determine emissions of microplastics for POTWs typical of discharge into California coastal waters
  - How much being discharged?
  - What is particle composition?

- Evaluation removal efficiencies from different processes of treatment systems
  - How much removal by various treatment levels (primary, secondary, tertiary)?

How was study conducted?

- Seven POTWs in major urban coastal areas in state
  - Primary to tertiary
  - Large and small treatment facilities (tens to hundreds of MGD/day)

- Samples collected using with ASTM 24-hour online-filtration method
  - Only standardized collection method for wastewater currently available
  - Samples up to 5500 L of water

- Lab processing at SCCWRP

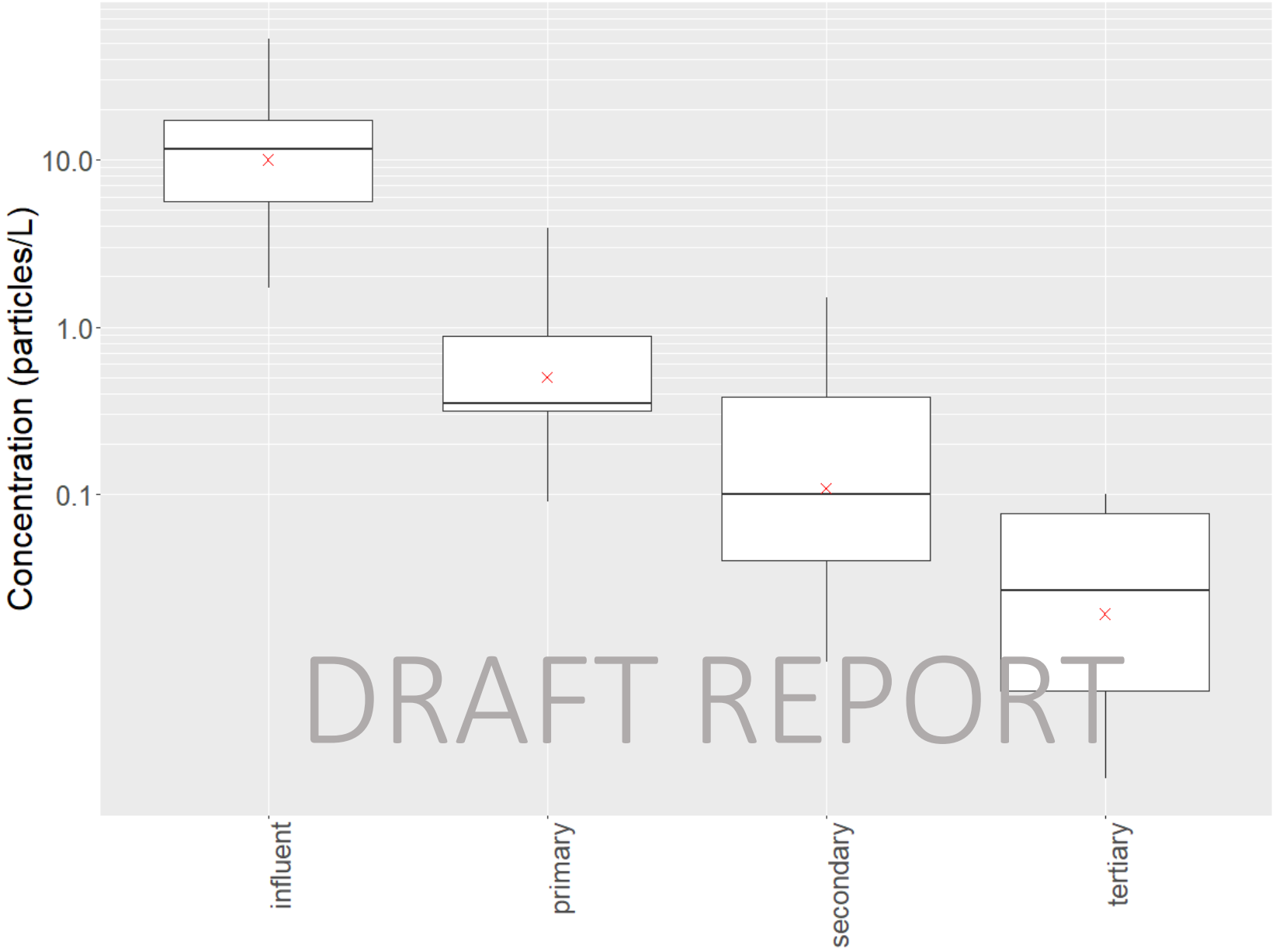
Synopsis of results

- Levels of microplastics in wastewater ranges from:
  - 1-52 particles/L in influent
  - 0.09-4 particles/L in primary effluent
  - 0.01-2 particles/L in secondary effluent
  - 0.002-0.1 particles/L in tertiary effluent

- Removal efficiencies between influent to final effluent are up to 99+%

- These observations in line with previous reports all over the world and earlier in state
  - POTWs efficient and effective at removing microplastic particles

Microplastics decrease with more treatment



>125 μm

POTW location	Effluent type	MP (particles/L)	Source
A	**primary**	**1-4**	**This study**
B	**primary**	**0.3-0.4**	**This study**
F	**primary**	**0.09-0.3**	**This study**
Globally (24 POTWs)	primary	0.2-12600 (median = 5)	Liu et al. (2021)
A	**secondary**	**001-0.1**	**This study**
B	**secondary**	**0.02-0.08**	**This study**
D	**secondary**	**0.07-0.1**	**This study**
E	**secondary**	**0.9-2**	**This study**
SF Bay	secondary	0.02-0.2	Sutton et al. (2019)
US (CA, NY, OH, WI)	secondary	0.004-0.2	Mason et al. (2016)
Globally (24 POTWs)	secondary	ND-7860 (median = 7)	Liu et al. (2021)
A	**tertiary**	**0.002-0.1**	**This study**
C	**tertiary**	**0.07-0.1**	**This study**
SF Bay	tertiary	0.008-0.4	Sutton et al. (2019)
Finland	tertiary	0.005-0.3	Talvitie et al. (2017)
Globally (24 POTWs)	tertiary	ND-297 (median = 0.4)	Liu et al. (2021)

How do concentrations compare?

- Comparisons complicated by widely variable POTW characteristics and methods used in different studies
- Still, concentrations in line with existing measurements

How do removal efficiencies compare?

POTW location	Treatment	%difference	Source
B (secondary)	**influent → secondary**	**88-99.4**	**This study**
F (secondary)	**influent → secondary**	**98-99.5**	**This study**
A (tertiary)	**influent → tertiary**	**99.9**	**This study**
Canada	influent → secondary	97-99	Gies et al. (2018)
Globally (24 POTWs)	influent → secondary	20-95 (median = 74)	Liu et al. (2021)
Finland	influent → tertiary	>95	Talvitie et al. (2017)
Korea	influent → tertiary	98	Lee and Kim (2018)
Globally (24 POTWs)	influent → tertiary	50-99.6 (median = 90)	Liu et al. (2021)

- Removal efficiencies for >125 μm particles in line with other POTWs elsewhere
- Most removal in primary, with addition removal further downstream

Biosolids

- Concentrations in biosolids from selected POTWs 3-48 particles/g
  - In line with literature estimates 4-240 particles/g
  - Many microplastics removed from wastewater end up in biosolids
  - Some solid wastes in sludges or scum landfilled or incinerated

Microbeads

- Only 6 plastic microspheres found in entire study
  - Previous study in San Francisco Bay (Sutton et al., 2019) found 111 microspheres in effluent

- Source control effective at keeping microplastics out of waste stream
  - California AB 888 and Congress HR 1321 in 2015 passed to ban sale of personal care products containing plastic microbeads
  - Legislative ban not yet fully implemented at sampling time of SFEI study in 2017
  - Toothpastes, shampoos, etc. containing microbeads no longer in use, as reflected in few microbeads in wastewaters

Take-home messages from wastewater study

- Concentrations are in line with those in POTWs elsewhere
- Decreases during treatment are high, and are also in line with literature
- Source control can be effective at keeping contaminants, such as microplastics, from entering wastewaters in the first place