Characterizing the removal of microplastics by California wastewater treatment plants: Implications for management strategies

Charles S. Wong Ph.D.

Department Head Chemistry

Southern California Coastal Water Research Project Authority

Things we'll discuss in this presentation

- Background
- Study plan
- How study findings might be used

Overall project objectives

- Determine emissions and removal efficiencies of microplastics for POTWs representative of discharge into California coastal waters

- Evaluate efficiency of microplastic removal from different processes within treatment systems

Why this study?

- In 2018, State of California passed two pieces of legislation involving microplastics

- In particular, SB 1263 requires development of management plan for microplastic contamination in State's coastal waters

This study within SB 1263

- California Ocean Protection Council published a draft document in December 2022
- This has undergone public comment period
- Part of this plan is research to address data gaps on microplastics
- What role does wastewater discharge have on microplastics fluxes to coastal waters?
  - Compared to other sources, such as stormwater
  - In a statewide context, compared to SF Bay (SFEI study)

Specific project objectives

- Determine emissions and removal efficiencies of microplastics for POTWs representative of discharge into California coastal waters
  - How much microplastics entering CA coastal water POTWs?
  - How much being discharged?
  - Composition of microplastic load?

- Evaluate efficiency of microplastic removal from different processes within treatment systems
  - How much removal by various levels of POTW treatment (primary, secondary, tertiary)?
  - How much removal for different types of treatment within a level (e.g., tertiary)?
  - How much winds up in biosolids (i.e., media to which microplastics removed from wastewater)?

Study Plan

- Three sampling campaigns
  - Pilot study
  - Main sampling 1
  - Main sampling 2

- Collaboration amongst partner organizations
  - SCCWRP
  - SFEI
  - CASA (and member POTWs)

Purpose of pilot study

- To evaluate and refine study plan
  - Many new things being tried, from sampling, to extraction, to analysis
  - Results used to streamline main sampling

- To provide training and familiarization to study participants
  - POTWs involved in pilot study
  - POTWs interested in main sampling

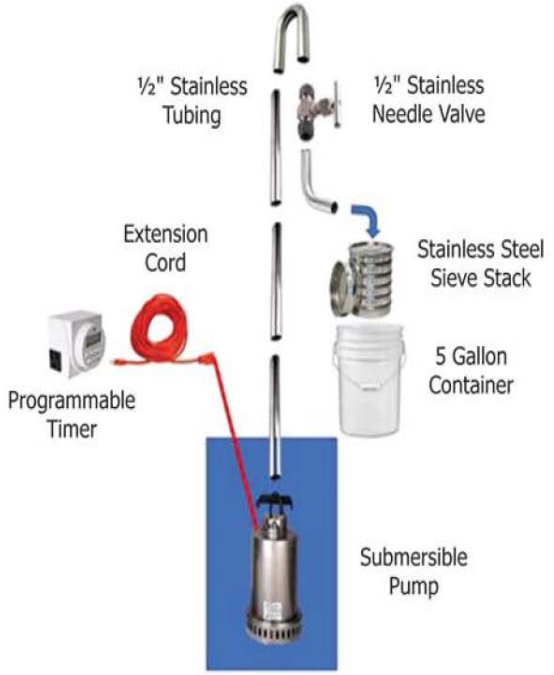
Pilot study POTWs

- Four POTWs involved, with mix of major state metro areas
  - Two in Northern CA
  - Two in Southern CA
- Mix of secondary and tertiary facilities
  - Sampling at selected locations (e.g., primary and secondary effluent, or secondary and tertiary effluent)
- Mix of treatment capacities (7-108 MGD)

Highlights of pilot study sampling achievements

- ASTM D8332-20 online filtration method modified to fit each POTW
  - 20—125 μm, 125-335 μm, >335 μm
- Equipment tested and verified
- QA samples tested (e.g., field blanks to evaluate background levels)
- Video produced for training POTWs for this sampling
- Initial evaluation of potential use of autosamplers vs. ASTM D8332-20

ASTM 8332-20: Collecting samples via in-line sieving



1) Pump capable of providing 20' of head and up to 3 gpm flow
2) Stainless steel transfer tubing
3) Adjustable valve for flow control
4) Programmable timer (for 24-hour diurnal flow)
5) 8" dia Sieve Stack (minimum – 20 µm)
6) Container for sieves with drainage

FIG. 1 Water Sampling Apparatus for Non-Pressurized Systems

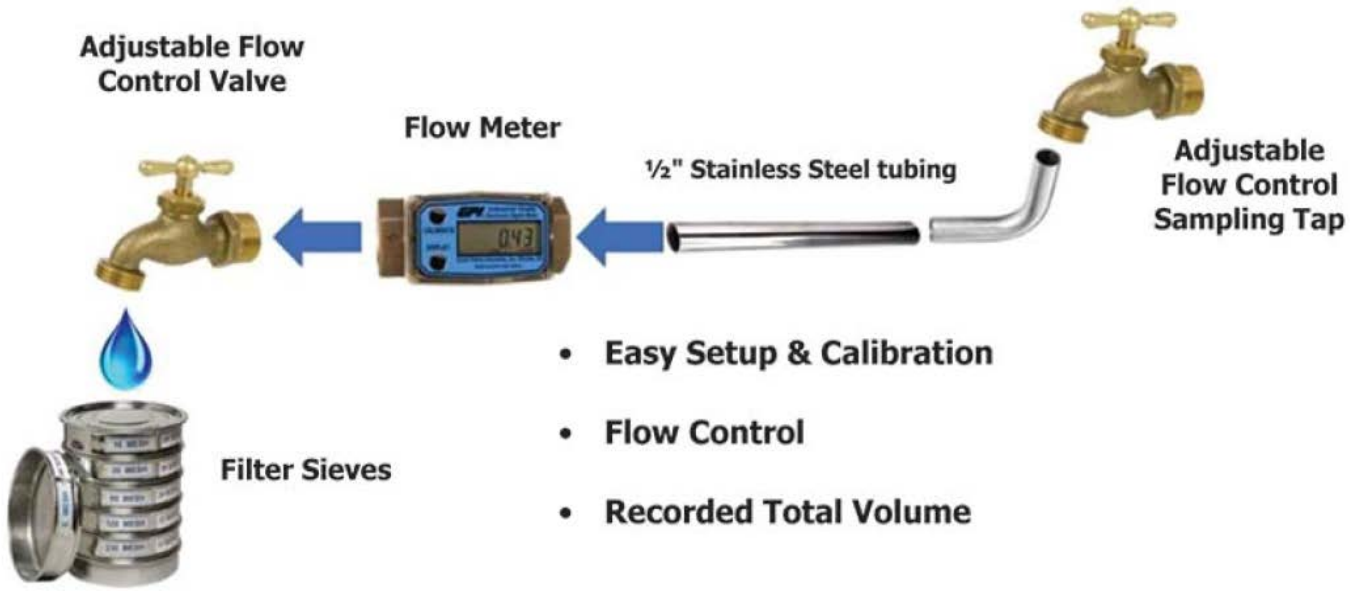


FIG. 2 Water Sampling Apparatus for Pressurized Systems

Non-pressurized

Pressurized

Highlights of pilot study extraction/analysis achievements

- ASTM D8333-20 lab processing method refined
  - Original method has wet peroxide oxidation + enzymatic digestion as needed
  - SCCWRP modifications add additional steps as needed
    - destroy applicable interferences (natural organic matter)
    - include QA/QC (surrogate standards)

- Analysis and quantification method streamlined
  - Visual microscopy and FTIR spectroscopy for particle material confirmation
  - SCCWRP modifications provide time-saving enhancements
    - Batch spectroscopy
    - Automated particle counting

What's next?

- Results briefing of pilot study participants
  - To occur over next several weeks

- Refinement of main sampling for study plan based on pilot lessons learned
  - Main sampling to take place late spring/early summer, and fall/winter
  - Sampling at points within treatment plant to evaluate removal efficiencies
  - Biosolids sampling to evaluate levels in major POTW microplastics sink

What will this study produce?

- Refinements to sampling and processing for microplastics of wastewater-derived materials
  - Of value internationally
  - Builds upon completed SCCWRP international interlaboratory measurements study for drinking water

- Data on microplastics levels in State's coastal POTWs
  - Input levels
  - Output levels
    - Effluent
    - Biosolids
  - Removal efficiencies
    - By treatment level
    - Within a treatment level

How can study findings be used?

- Improvements in sampling, measurement, and analysis of microplastics in extremely challenging matrices

- Insights into wastewater contributions for OPC coastal microplastics strategy
  - Do results from previous SFEI study hold beyond SF Bay?
  - A major piece of puzzle for overall microplastics sources to coastal waters (in conjunction with work to characterize stormwater, atmospheric inputs)