Monitoring Chemical Substances in Canadian Municipal Wastewater

ISO Technical Committee 275
Burlington ON
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8 September 2014
Outline

• The Chemicals Management Plan (CMP)
• Monitoring & Surveillance in support of the CMP
• Wastewater monitoring program
• Results to date
• For the future
What is the Chemicals Management Plan?

• Launched by the Government of Canada in 2006 as a commitment to protect human health and the environment from the risks of harmful chemicals

• Designed to:
  – Take action on the highest priority substances
  – Provide transparency and predictability through
    ▪ clear priorities and timelines
    ▪ ongoing engagement with stakeholders and the public
  – Promote international collaboration
  – Invest in research and monitoring
  – Align work on chemicals across regulatory programs
CMP Monitoring and Surveillance

• Generate Science-based information:
  – Feed decision making during Risk Assessments
  – Inform Risk Management action by identifying exposure pathways and vulnerable areas

• Performance Measurement:
  – Develop baseline data and milestone data for performance measurement
  – Demonstrate overall effectiveness of risk management action
  – Indicate if additional risk management action is required
CMP Monitoring and Surveillance

• Environment Canada’s activities:
  – Monitoring in environmental media
    ▪ Water
    ▪ Air and Precipitation
    ▪ Sediment
    ▪ Aquatic biota (fish)
    ▪ Terrestrial biota (birds)
  – Monitoring outputs from wastewater sector
Rationale for CMP Wastewater Monitoring Program

• Wastewater effluents and residuals (solids) may be important sources of a variety of chemical substances to the environment, through consumer products.

• Wastewater sector has no control over what enters its treatment systems.

• Very little field information available to verify or calibrate model predictions for removal and fate.
CMP Wastewater Monitoring Program

Objectives

• Temporal trends in influents (warm, cold)
• Fate of compounds during wastewater treatment: disappearance, partitioning to solids
• Concentrations entering environment
• Baseline data to evaluate future upstream control measures
Wastewater Treatment in Canada

- Facultative lagoon
- Aerated lagoon
- Chemically-assisted primary treatment *
- Secondary biological treatment *
- Advanced treatment *

* produce solids which then need treatment
Wastewater Solids Treatment

- Stabilize, reduce volume, inactivate pathogens
- Digestion (aerobic, anaerobic)
- Methane production
- Dewatering
- Alkaline stabilization
- Composting
Sampling Techniques

• Raw Influent, Final Effluent
  – 24-hour composite
  – Refrigerated
  – Equal volume
  – Stainless steel
  – 3 days per season

• Treated Biosolids
  – Grab
  – Stainless steel
  – 3 days per season

Temperatures:
< 5°C to > 20°C
Selection of Analytes

- Risk assessment and risk management priorities
- Availability of analytical methods and capacity
- Availability of $$$
What have we monitored so far?

- Polybrominated diphenyl ethers (PBDEs)
- 5 other brominated flame retardants (HBCD, BTBPE, PBE, HBB, DBDPE)
- Perfluoroalkyl substances (PFOS, PFOA +11)
- Bisphenol A
- Metals (20)
- Triclosan
- Tetrabromobisphenol A
- Chlorinated alkanes
- Organotins
- Parabens
- Nonylphenol and ethoxylates
- Siloxanes
- Polyaromatic hydrocarbons (PAHs)
- Pharmaceuticals and personal care products (PPCPs)
Results – brominated flame retardants in biosolids

- PBDEs: 420 to 6000 ng/g in treated biosolids
  - Increased by digestion, decreased by alkaline treatment
- BTBPE, PBEB, HBB, DBDPE: up to 32 ng/g
- HBCD: up to 45 ng/g
- Do not degrade, partition to solids
- Maximize removal from liquid by optimizing operational conditions
Results – pharmaceuticals and personal care products

• Analgesics/anti-inflammatory: biodegradation
  – Ibuprofen max 490 ng/g
  – Naproxen max 150 ng/g

• Antibiotics/antifungal: partitioning to solids
  – 4-Epitetracycline max 1700 ng/g
  – Azithromycin max 850 ng/g
  – Ciprofloxacin max 16,000 ng/g
  – Norfloxacin max 3300 ng/g
  – Triclocarban max 8900 ng/g
  – Triclosan max 11,000 ng/g
Results – Perfluorinated compounds (PFOS, PFOA +)

- PFOS and PFOA concentrations increase during wastewater treatment!
- PFOS sorbs to sludge to a greater extent than PFOA
- PFOS median 13 ng/g
- Higher concentrations in anaerobically digested biosolids
Results – Bisphenol A

- Used in manufacture of polycarbonate and epoxy resins
- Ubiquitous in environment
- Endocrine disruptor
- Canadian prohibition 2010

- Monitoring in wastewater 2009 to 2012, 25 WWTPs
- Wastewater effluents median 150 ng/L
- Removal dependent on treatment type
- Treated biosolids median 460 ng/g
- Baseline for comparison with future monitoring
Results – Nonylphenol Ethoxylates

- Surfactants
- NP2EO, NP1EO, NP
- Use restrictions imposed in 2004 to reduce NPEs in wastewater and biosolids
- Follow-up wastewater monitoring in 2010-2012

- 12 WWTPs including 5 types
- High removal from wastewater by partitioning to solids
- Increased concentration in biosolids after anaerobic digestion, median NP 62,900 ng/g
- 70%+ reductions in concentrations compared to 10 years ago!
References – just ask me!

Future Wastewater and Biosolids Monitoring

• Phase 3 of CMP 2016-2020
• Method development and data generation
• Follow-up monitoring for high priority substances