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# Research on Trace Contaminants in Wastewater and Biosolids

**5<sup>th</sup> Canadian Residuals & Biosolids  
Conference**

**Niagara Falls ON**

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# Trace Contaminants in Wastewater and Biosolids -- partners

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- M Payne, Ontario Ministry of Agriculture, Food, and Rural Affairs
- C Metcalfe, Trent University
- E Topp, Agriculture and Agri-Food Canada
- Municipalities



# Outline

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- Terminology
- What are emerging contaminants?
- Effects of emerging contaminants
- Environment Canada research
- CMP wastewater monitoring
- Future needs



# Terminology

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- **Legacy contaminants** – metals, PCBs, PAHs, pesticides.
- **Emerging contaminants or contaminants of emerging concern** – flame retardants, perfluorinated compounds, endocrine disrupting compounds, pharmaceuticals, personal care products.....
- **Microconstituents** – natural and manmade substances detected in water and the environment, for which a prudent course of action is suggested for the continued assessment of the potential effect on human health and the environment (WEF).
- **Trace contaminants** – parts per billion, parts per trillion.



# Emerging Contaminants

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- Analgesics
- Lipid regulators
- Bronchodilators
- Antidepressants
- Antibiotics
- Antiseptics/antimicrobials
- Fragrances
- UV filters
- Surfactants
- Preservatives
- Siloxanes
- Flame retardants
- Fluorinated compounds
- Plasticizers
- Nanomaterials
- Anticorrosives
- Degradation products
- DEET
- Sucralose
- Illicit drugs



# Where do Chemical Substances come from?

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- Manufacturing uses
- Byproducts of chemical processes
- Residues from consumer products:
  - Personal care and household cleaning products flushed down the drain after use
  - Insect repellent, sunscreen, perfume, deodorant, etc. washed off skin
  - Flame retardants and perfluorinated compounds may enter wastewater from household cleaning
  - Many pharmaceuticals pass through the body unchanged from ingestion to excretion



# Emerging Contaminants in the Environment

- Biota
- Sediments
- Surface water
- Human tissue
- Human milk



# Effects of Chemical Substances in the Environment

- Chronic lifetime exposure
- Subtle, long-term, multi-generational effects
- Physiological end points for toxicology
- Environmentally relevant concentrations



# Drivers for EC Research

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Canadian Environmental Protection Act 1999

Canada-Ontario Agreement Respecting  
the Great Lakes Basin Ecosystem 2007

Virtual elimination of compounds that are:

- Persistent
- Bioaccumulative
- Toxic
- Primarily the result of human activities



# Study Goals

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- Occurrence and fate of emerging contaminants during municipal wastewater treatment (liquid and solids): degradation, partitioning
- Removal capabilities of conventional and innovative wastewater and sludge treatment technologies



# EC Wastewater Research Results to date

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- PPCPs are present in municipal wastewater at ppb to ppt levels.
- Relationship between PPCP removal and process retention time for mechanical plants is unclear.
- Facultative lagoons show >99% removal of PPCPs.
- Musk compounds are removed from water to a greater extent at warm process temperatures.
- Musk compounds partition to sludge.
- Musk compounds appear to degrade during aerobic sludge digestion, but not during anaerobic digestion.
- Nature of WWTP inputs and operation may influence removal of trace contaminants.



# Trace contaminants in Biosolids

- Hydrophobic
- Partition to solids
- Persist through sludge treatment?
- Applied to agricultural land
- Then what?



# Sludge Digestion and Dewatering Processes

- Aerobic  
warm/cold
  - Anaerobic
  - Centrifuge
  - Filter press
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- Sampling done  
Feb to Aug 2008



# Fate of Trace Contaminants during Digestion and Dewatering

- Flame retardants
- Pharmaceuticals
- Musk fragrances
- Antimicrobials
- Pathogens



# Sludge Storage and Further Treatment

- Liquid storage
- Dewatered storage
- Geotubes
- Lystek
- N-viro
- Pelletization



Planning stage



# Fate of Trace Contaminants during Sludge Storage and Further Treatment

- Flame retardants
- Pharmaceuticals
- Musk fragrances
- Antimicrobials
- Nonylphenol ethoxylates
- Bisphenol A
- Pathogens



Planning stage



# Chemicals Management Plan

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## Wastewater Monitoring Program



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# Rationale and Objectives

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- Wastewater effluents and residuals (solids) may be important sources of a variety of chemical substances to the environment.
- Occurrence and temporal trends of substances in influents (warm, cold).
- Fate of substances during typical Canadian wastewater treatment processes: disappearance, partitioning to solids.
- Concentrations entering the environment from effluents and biosolids.
- Baseline data to evaluate future **\*\*control\*\*** measures.



# Criteria for Selection of WWTPs

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- Upstream of water quality monitoring sites
- Discharge to shellfish monitoring sites
- Collaborate with Arctic wastewater working group
- Accommodate risk assessment recommendations
- Representative of typical Canadian treatment processes
- Representative of geographical variations
- Large volume discharges

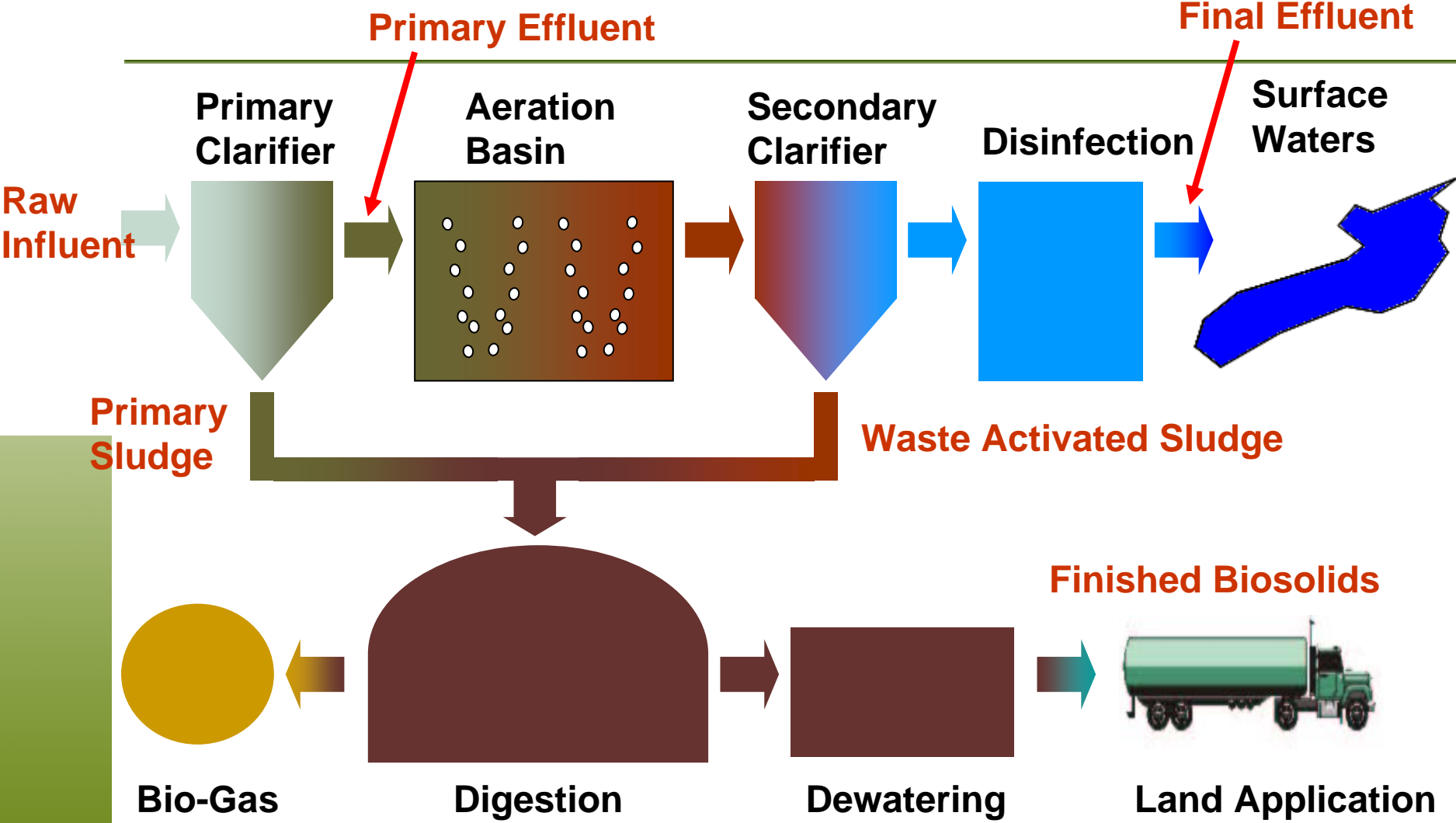


# Criteria for Selection of WWTPs

- 20 WWTPs
- At least 1 per province and territory
- 1 aboriginal
- 1 “federal house”
- Primary, secondary, advanced, and lagoon treatment
- About 10% of the Canadian population



# Sampling Plan



# Sludge Treatment Processes

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- Not a criterion for WWTP selection
- Digestion: none, aerobic, mesophilic and thermophilic anaerobic
- Dewatering: none, rotary press, filter press, plate-and-frame, centrifuge
- Other treatment: alkaline stabilization, composting
- Final destination: land application, forest fertilization, mine reclamation, landfill, incineration



# Substances to be Analyzed

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- Phenols and pharmaceuticals, including Bisphenol A and triclosan
- Perfluorinated compounds
- Polybrominated diphenyl ethers (flame retardants)
- Volatile methyl siloxanes
- Heavy metals
- Conventional wastewater parameters to provide context for observations of trace substances



# Future Needs for Trace Contaminants

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- Environmental effects research
- Risk assessments
- More affordable analytical methods
- Toxicity identification and evaluation



# Thank you!

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