Emerging Organic Contaminants: What Are They And Should We Be Concerned?

Dr Becky Macdonald (Beca Limited)

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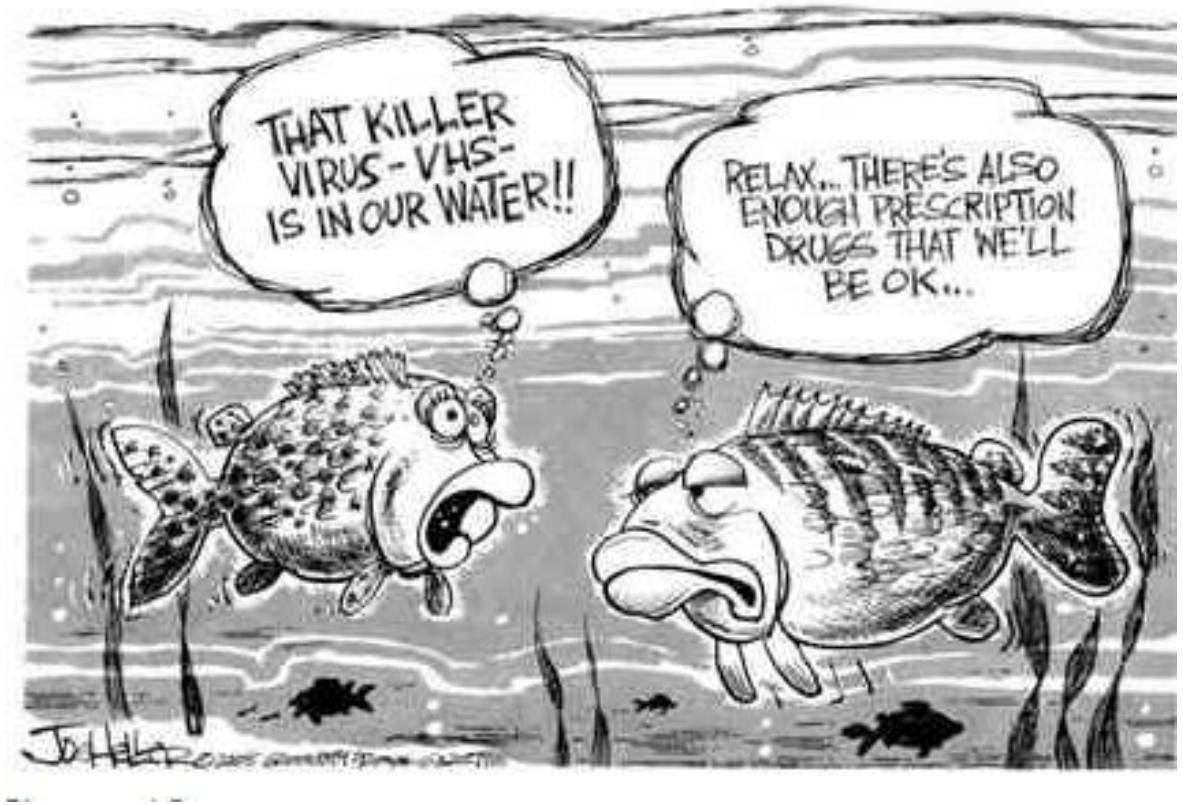
Emerging Organic Contaminants (EOCs)

- What are they?
- Where do they come from?
- Should we be concerned?
- Is treatment effective?
- What is a design engineer to do?



EOCs – What are they?

- Commonly accepted definition – US Geological Survey (USGS) 2011 :

  "any synthetic or naturally occurring chemical or any microorganism that is not commonly monitored in the environment but has the potential to enter the environment and cause known or suspected adverse ecological and (or) human health effects. In some cases, release of emerging chemicals …. to the environment has likely occurred for a long time, but may not have been recognised until new detection methods were developed. In other cases, synthesis of new chemicals or changes in use and disposal of existing chemicals can create new sources of emerging contaminants"

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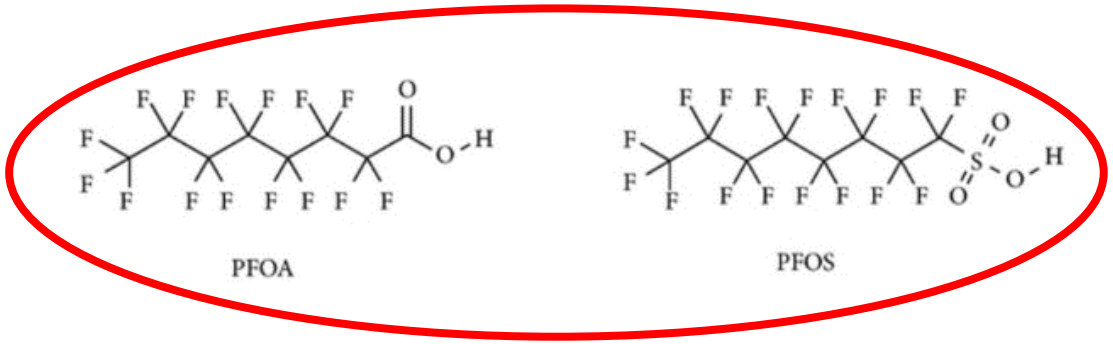
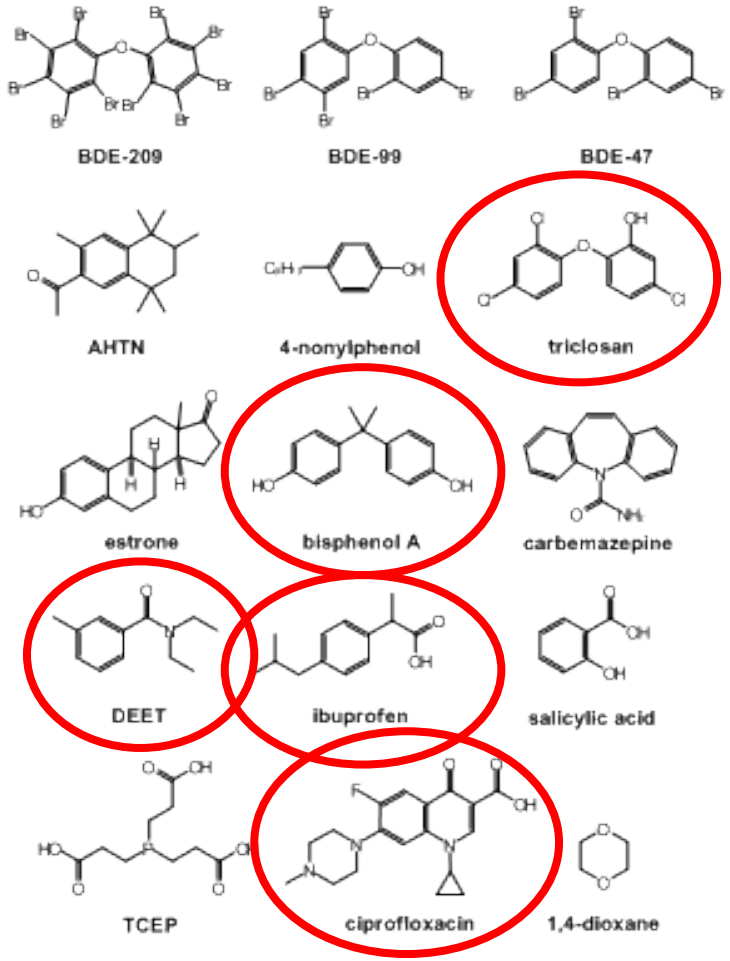
- Previously:
  - Not detected
  - Not considered harmful
  - Only recently used

EOCs – What are they?

- A wide range of chemicals
  - Antimicrobials
  - Plasticisers
  - Personal care products (PPCPs)
  - Flame retardants
  - Drugs





EOCs – Where do they come from?

- Personal care
  - Surfactants
  - Antimicrobials
  - Fragrances
  - Sunscreens
- Health
  - Antibiotics
  - Painkillers
  - Anaesthetics
  - Steroids and hormones

Personal Care	Examples
Surfactant	Quarternary ammonium compounds (QAC)
Surfactant	Polyoxyethylene glycol alkylphenol ether
Surfactant	Sodium lauryl ether sulfate (SLES)
Fragrances	Galalxolide
Preservative	Parabens (methyl, ethyl, propyl etc)
Preservative	Triclosan
Sunscreen	Oxybenzone
Sunscreen	Octisalate
Insect repellent	N,N-Diethyl-meta-toluamide (DEET)

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Health	Examples
	moxicillin
	etrinidazole
	xycodone
	uprofen
	clofenac
	etamine
	ocaine
	estradiol
	ldenafil
	heophylline
	abapentin

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Wastewater drug testing shows cocaine on the rise in Auckland, high meth use in Whangarei

Last updated 14:19, November 28 2017

CARYS MONTEATH/STUFF

Aucklanders are taking more cocaine, a report from the National Drug Intelligence Bureau shows (file photo).

Cocaine use is increasing in Auckland, according to new figures from a Police wastewater drug testing initiative.

Wastewater testing in Christchurch and Auckland began in December 2016, with testing in Whangarei starting in August this year.

EOCs – Where do they come from?

- Manufacturing
  - Flame retardants
  - Plasticisers
  - Surfactants
  - Antimicrobials
- Farming
  - Pesticides
  - Insecticides
  - Herbicides

Manufacturing	Examples
Flame retardant	Perflorinated chemicals (PCFs)
Flame retardants	Polybrominated diphenyl ether (PBDEs)
Plasticiser	Bisphenol A
Plasticiser	Phthalate ester (PAE)
Surfactant	Polyoxyethylene glycol sorbitan alkyl esters
Surfactant	Dioctyl sodium sulfosuccinate
Antimicrobial	2-thiazol-3(2H)-one (DCOIT)

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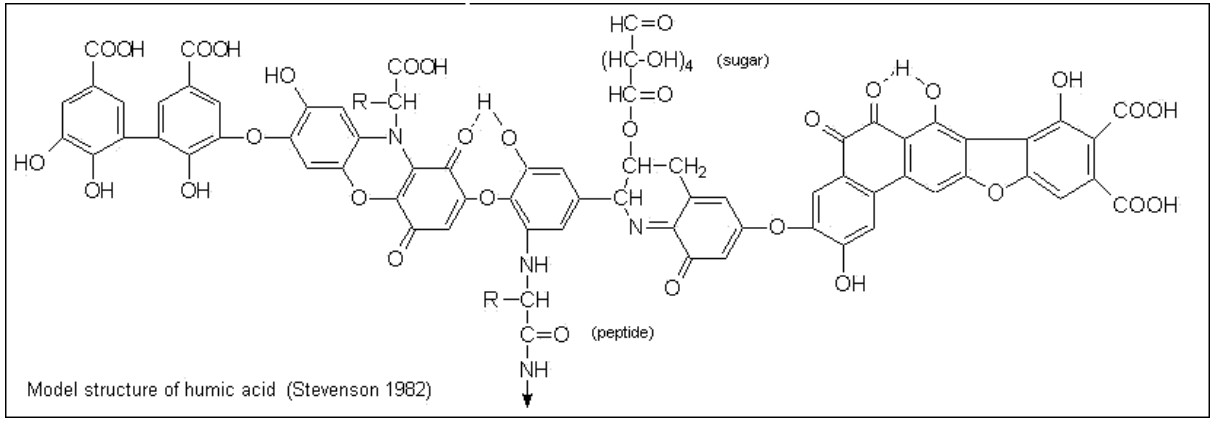
Farming	Examples
Insecticide	Bifenthrin
Insecticide	Permethrin
Insecticide	Imidacloprid
Pesticide	Glyphosates
Herbicide	Terbuthylazine
Hormone	Somatotrophin



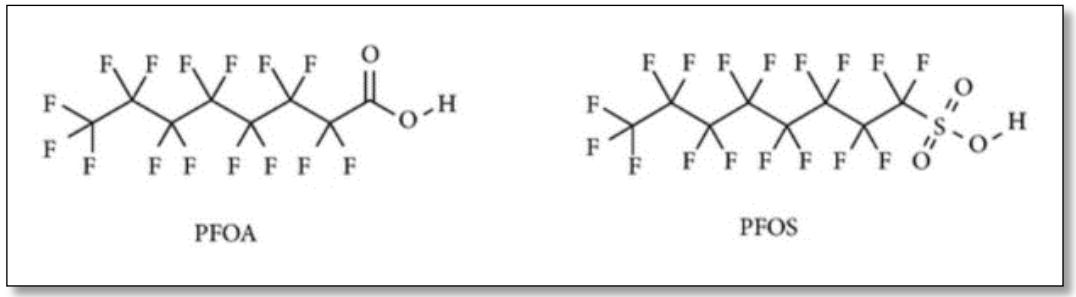
Model structure of humic acid (Stevenson 1982)

EOCs – Should we be concerned?

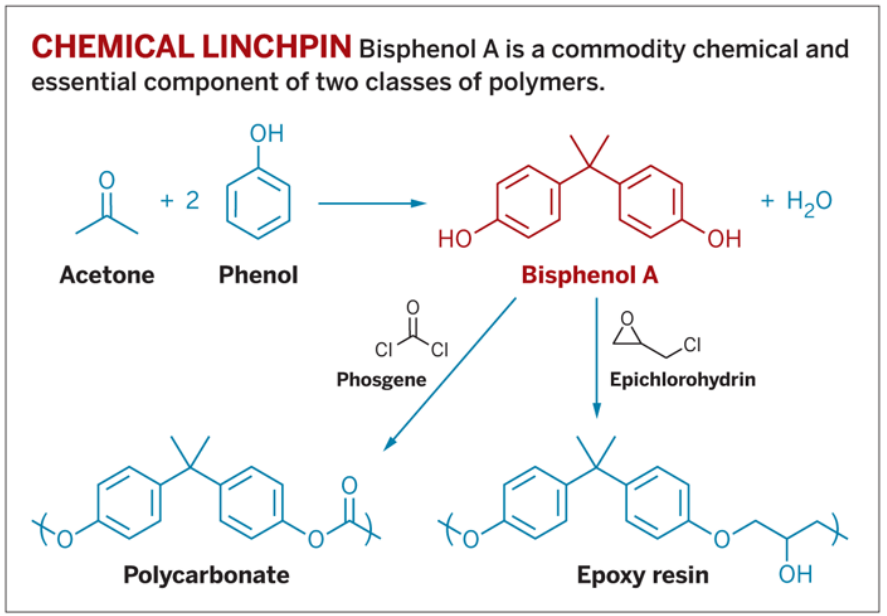
- Many EOCs are used in a wide range of everyday applications
- Some EOCs may pose harm to the environment, or human health

EXAMPLES:

- Bisphenol A, chemical precursor, and common plasticiser
- PFCs and PBDE's, were widely used fire retardants



- Endocrine disruptors
- Neurodevelopmental defects with environmental exposure

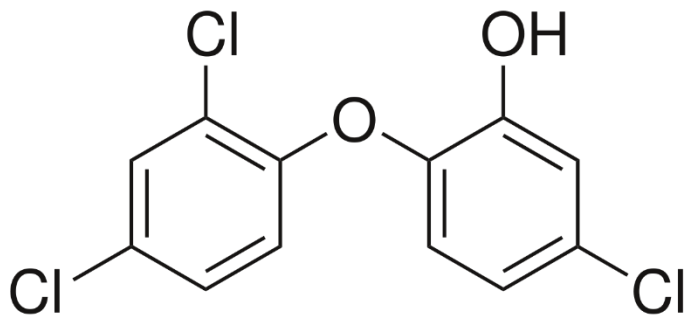


EOCs – Should we be concerned?

- Antimicrobials (bacteria, yeast, virus)

  EXAMPLES:

  - Ciprofloxacin commonly prescribed anti bacterial
  - Triclosan widely used in liquid soaps, also used in medical applications



  - Population resistance
  - Persistence in soils
  - High specificity
  - USEPA prohibited the used of “consumer antiseptic washes" containing triclosan

EOCs – When do they show up?

Variability

- Hourly
- Weekly
- Annually
- Special occas

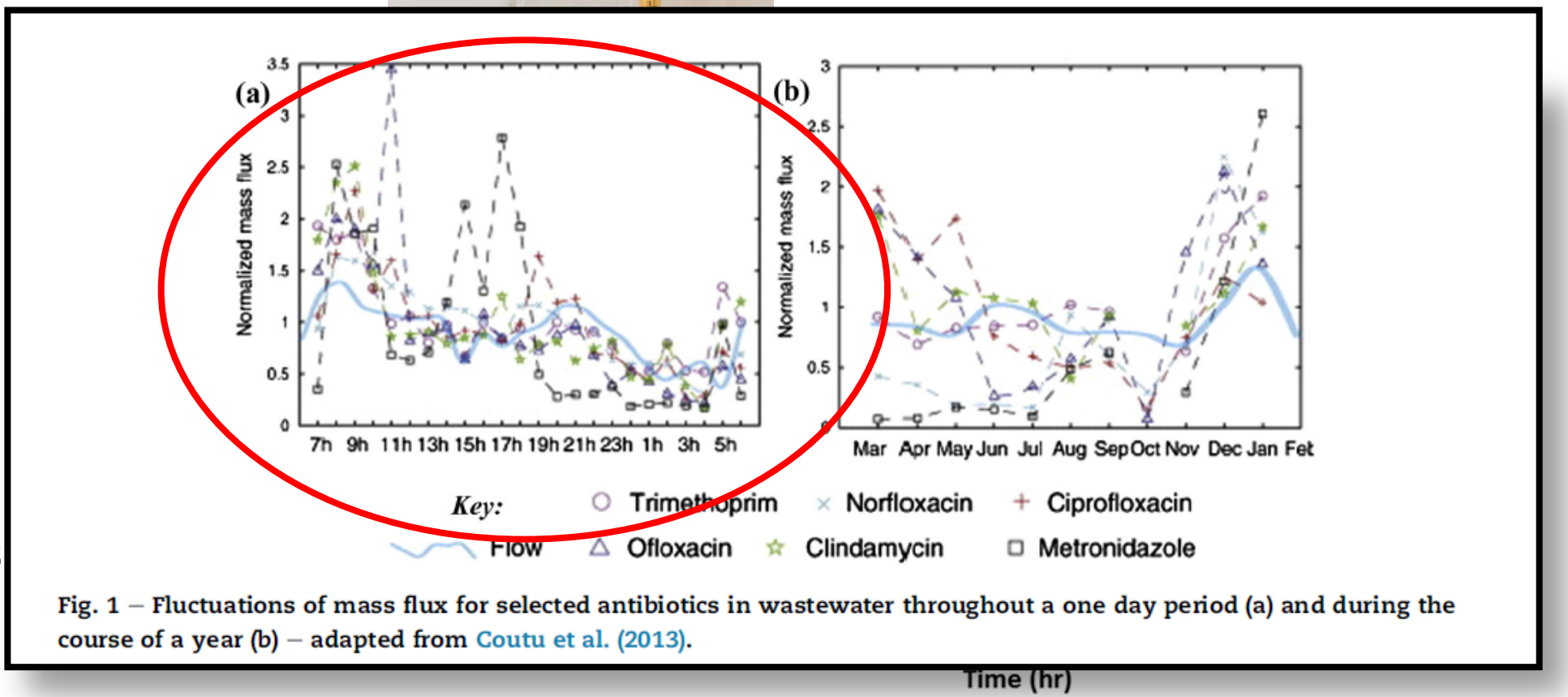


Fig. 1 – Fluctuations of mass flux for selected antibiotics in wastewater throughout a one day period (a) and during the course of a year (b) – adapted from Coutu et al. (2013).

EOCs – When do they show up?

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- Weekly
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- Special occasions

Fig. 2 – Inter-day variation in cocaine (COC) and MDMA consumption calculated from a European wide study profiling wastewater of 19 cities – adapted from Thomas et al. (2012).

EOCs – When do they show up?

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- Hourly
- Weekly
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- Special occasions

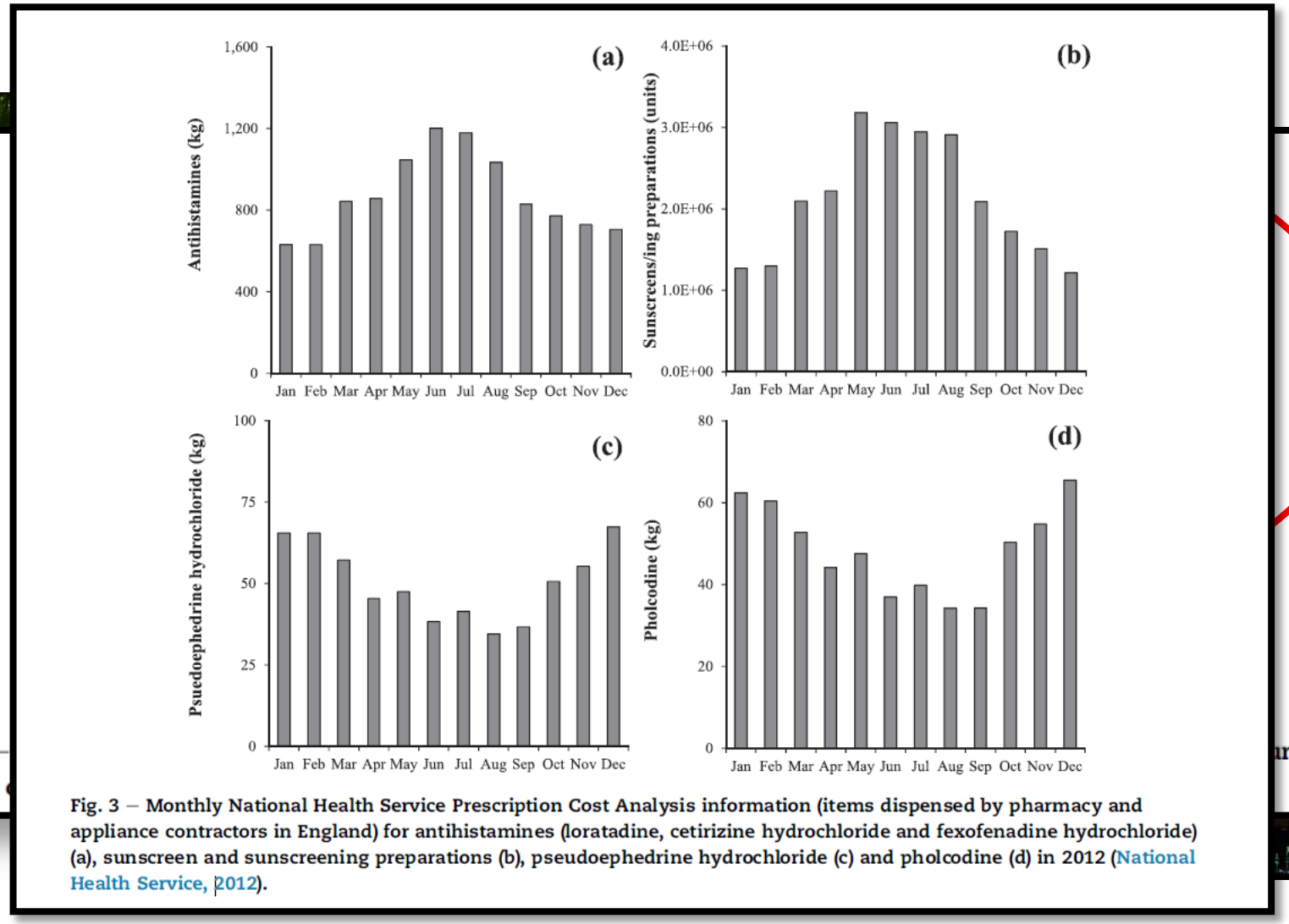


Fig. 3 – Monthly National Health Service Prescription Cost Analysis information (items dispensed by pharmacy and appliance contractors in England) for antihistamines (loratadine, cetirizine hydrochloride and fexofenadine hydrochloride) (a), sunscreen and sunscreening preparations (b), pseudoephedrine hydrochloride (c) and pholcodine (d) in 2012 (National Health Service, 2012).

EOCs - Is treatment effective?

Treatment technology	Removal Effectiveness
Constructed wetland	42%
Aeration basin	62%
Rotating biological contactor	63%
Waste stabilisation pond	82%

Compound	Removal Efficiency
Clotrimazole (antifungal)	-55%
Diclofenac (NSAID)	-71%
Erthromycin (antibiotic)	79%
Ibuprofen (NSAID)	-89%
Mefenamic acid (NSAID)	67%
Paracetamol (pain killer)	100%
Tamoxifen (cancer drug)	30%
Trimethoprim (antibiotic)	3%

EOCs – What is a design engineer to do?

Guidance:

- Solids Stream:
  - NZ Biosolids Guidelines – Draft
- Liquid stream:
  - …….?

Organic Contaminant Limits

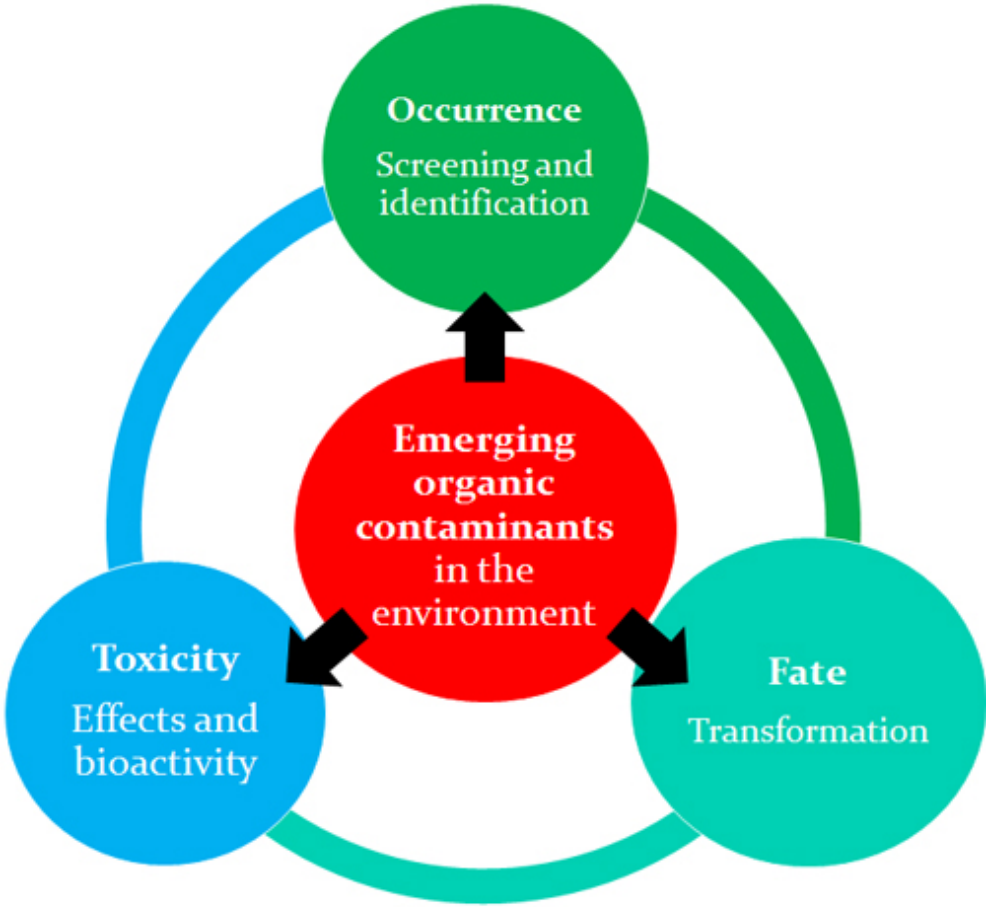
Parameter	Concentration limit (mg/kg dry weight)
Perfluoro compounds (PFOS and PFOA)	0.01
Absorbable organic halogens (AOX)	450
Polycyclic aromatic hydrocarbons (PAH sum)	5
Nonyl phenol and ethoxylates (NP/NPE)	25
Phthalate (DEHP)	75
Linear alkydbenzene sulphonates (LAS)	1500
Musks – Tonalide	15
Musks – Galaxolid	10

water NEW ZEALAND

EOCs – What is a design engineer to do?

EOCs of interest

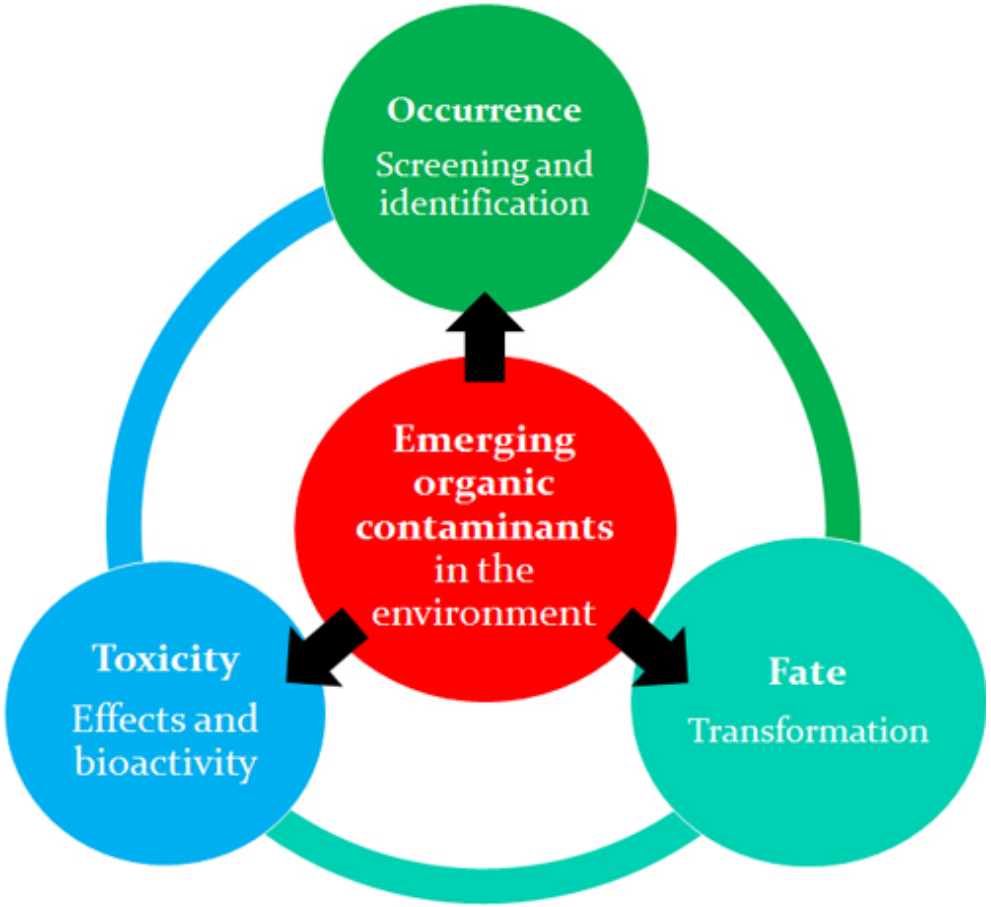
- Develop a short list of "indicator" EOCs based on:
  - Environmental Effects
  - Relevance to NZ
  - Solid v's liquid treatment
  - Disposal route solids v's liquid disposal



EOCs – What is a design engineer to do?

Sampling

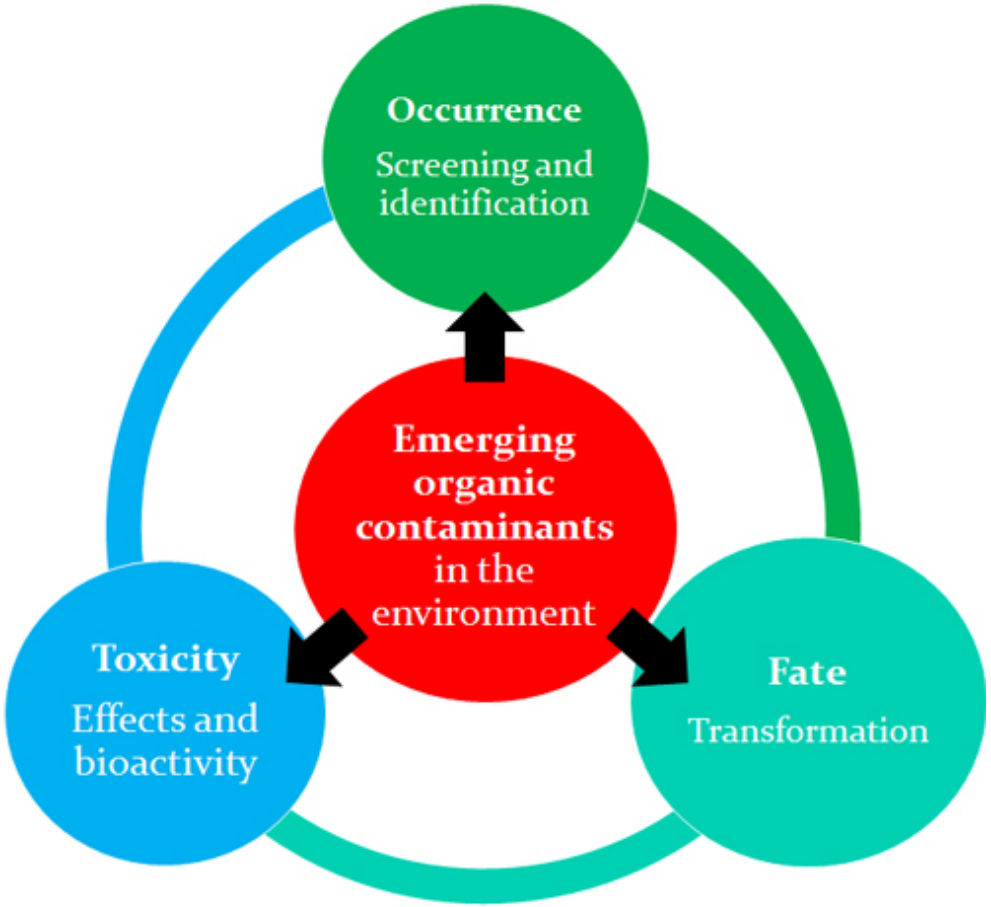
- Location : network, treatment plant, disposal
- Source: water, wastewater, land
- Timing: hourly, daily weekly
- Method: continuous, grab



EOCs – What is a design engineer to do?

Analysis techniques

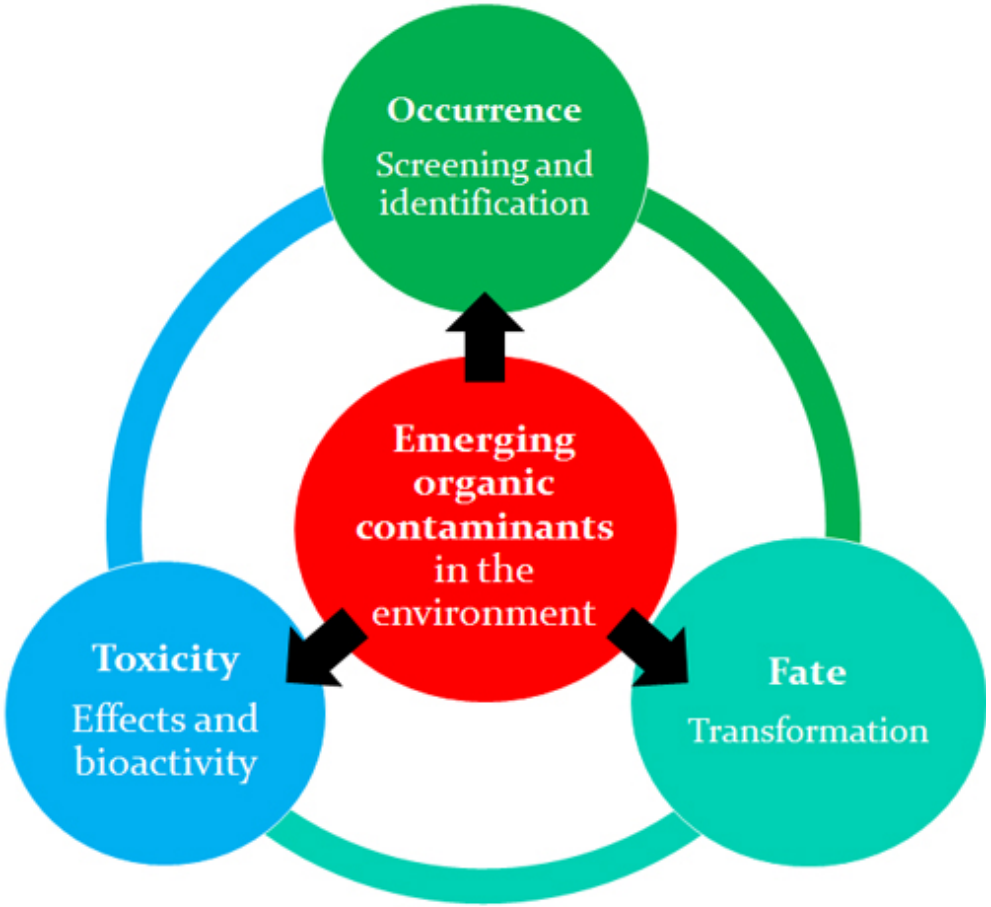
- Information that is consistent, comparable and useful
- Cost that is not prohibitive
- Testing time that provides data in a useful timeframe



EOCs – What is a design engineer to do?

My wish list:

- Useful data for design
  - Consistent list of EOCs of interest
  - Consistent sampling and analysis techniques
  - Reasonable cost



Questions?

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