Emerging contaminants assessment 2019–20: Summary of results

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Summary report

EPA analysed samples of soils, water and sediment at 101 sites across Victoria for emerging and legacy contaminants (including PFAS).

The results for all emerging contaminants are consistent with concentrations EPA has observed in previous studies (Sardina et al. 2019; Sharp et al 2020; EPA publication 1870, May 2020). In soil and sediment, PFAS concentrations were mostly below guideline values. In water, concentrations of some PFAS exceeded ecological guideline values. Concentrations of pesticides were mostly below guidelines across all land use types with some exceptions, such as atrazine, simazine, p'p-DDE, DDT and dieldrin. Of the phthalates quantified, only DEHP and BBP were found above the limit of reporting. Metals were found in varying concentrations across all land use types in metropolitan and regional Melbourne.

This study enables EPA to further identify the extent and magnitude of emerging and legacy contaminants across Victoria, to inform where there may be priority areas, regulatory responses, and identify sectors to work with to prevent and reduce environmental pollution.

Definitions and methodology

Selection of sites

EPA selected sites representing five land use types: background, low-intensity agriculture (grazing), high-intensity agriculture (cropping, horticulture), urban residential, and urban industrial.

Background sites represented natural environments with no or minimal human impact. Background in this context does not necessarily mean pristine conditions, but rather conditions where diffuse sources of contamination, such as atmospheric drift, may be possible.

Water, sediment, and soil samples were collected at around 100 sites (97 – 107 depending on the matrix and analyte group) in October-December 2019. In addition, 145 sites were sampled for soil only to establish background conditions for PFAS.

Sampling methodology and laboratory analysis

The methodologies for sample collection, handling, transport, storing, and quality assurance and control were consistent with EPA publication IWRG 701 (2009) and PFAS National Environmental Management Plan (NEMP) (2018). Emerging contaminants were determined using USEPA 8270, USEPA 537 and USEPA-821-R-11-007, Pesticide Analytical Manual (1999), AS4479, USEPA 3050, 200.7, 6010, 200.8 and 6020 methods at the National Measurement Institute. Four groups of emerging contaminants were analysed: phthalate esters (phthalates), per and poly-fluorinated alkyl substances (PFAS), pesticides and total metals. Of 33 PFAS-compounds analysed the three most frequently detected were PFOS, PFHxS and PFOA.

Results

PFAS: PFOS, PFHxS, and PFOA

Concentrations of PFAS compounds in freshwaters, freshwater sediments, and soils samples across five land use types were found to be relatively low. The maximum concentration of PFOS + PFHxS is 0.149 μg/L in water (Table 1). PFOS and PFHxS are summed to benchmark against existing guideline values. Across land uses, PFOS, PFHxS and PFOA concentrations ranged from <0.0002 to 0.081 μg/L in water. In sediments, PFOS, PFHxS and PFOA concentrations were below the limit of reporting and ranged from <0.002 to 0.039 mg/kg across all land use types. In soil, PFOS, PFHxS and PFOA concentrations ranged from <0.001 to 0.029 mg/kg for PFOS and PFHxS across all land use types. Of the 145 soil samples taken to establish background concentrations, most were below the limit of detection (data not shown).

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Table 1. Minimum and maximum concentrations across all land use types for PFOS, PFHxS, and PFOA[#].

PFAS	Ambient					
	Water (*n* = 104)		Sediment (*n* = 102)		Soil (*n* = 107)	
	Range (μg/l)	Detected (%)	Range (mg/kg)	Detected (%)	Range (mg/kg)	Detected (%)
PFOS	<0.0002 – 0.081	88	<0.002 – 0.039	25	<0.002 – 0.029	25
PFHxS	<0.0002 – 0.068	86	<0.001 – 0.0011	2	<0.001- 0.0011	1
PFOA	<0.0005 – 0.036	82	<0.001 – 0.0015	1	<0.001	0

[#]The minimum concentration is the LOR for each PFAS compound. Number of ambient sites per land use type: background (16-17), low-intensity agriculture (19), high-intensity agriculture (11), urban residential (24-25), and industrial (31-35).

Pesticides

Concentrations of pesticides were mostly below guidelines across all land use types with some exceptions.

- In water, concentrations of pesticides detected ranged from 0.0074 to 1.42 μg/L across all land use types. For example, herbicide simazine was only detected in water (<0.01 – 1.3 μg/L, maximum concentration exceeds the ecological 99% species protection level), and most frequently in sites with urban industrial and urban residential land uses.
- In sediments, the insecticide bifenthrin, a key ingredient in termiticides for residential housing, was detected in 34% of sites from <1 up to 79 μg/kg. Currently, there are no guideline values for bifenthrin, however, the higher concentrations observed suggest toxicity to aquatic invertebrates. The insecticide DDT was detected from <1 to 200 μg/kg and its metabolite p'p-DDE was detected from <1 to 170 μg/kg, with ~ 50% of the detected concentrations exceeding the sediment quality guidelines. Dieldrin was detected at 26% of sites with concentrations ranging from <1 to 39 μg/kg, with the higher concentrations exceeding the sediment quality guideline value.
- In soils, insecticide p'p-DDE was detected from <1 up to 150 μg/kg, and dieldrin from <1 up to 38 μg/kg, concentrations of which were below human health and ecological guidelines (ASC NEPM, 2013) across all land use types.

Phthalates

Of six phthalates quantified, two phthalates were detected above the limit of reporting, but none exceeded the drinking water guideline values. Bis(2-ethylhexyl) phthalate (DEHP) was found in 26 sediment sites at concentrations ranging from 0.49 to 15 mg/kg (across different land use types), in 11 soil samples from 0.38 to 2.9 mg/kg (across different land use types) and in one water sample at concentration of 0.0064 mg/L (urban residential). Benzyl phthalate (BBP) was detected above limit of reporting (<1 mg/kg) in sediments at three different sites (1.2 mg/kg) located in metropolitan Melbourne.

Metals

Total metals (22 out of 23 sampled) were found across all land use types in metropolitan and regional Victoria, including those typically associated with toxicity (Ni, Zn, Cu, As, Cr, Pb, Cd, Hg in decreasing order of detection).

- In water, total metal concentrations frequently exceeded the ecological 95% species protection guidelines for Cu (60% of sites), Zn (38%) and Cr (30%), with concentrations ranging <1 to 7.2 μg/L for Cu, <1 to 130 μg/L for Zn and <1 to 13 μg/L for Cr. Further, detected concentrations exceeded the ecological 95% species protection guidelines only in a small number (2-5%) of sites for As, Cd, Pb and Ni.
- In sediments, concentrations exceeded sediment guidelines for Ni (57% of sites), for Zn (26%), with concentrations ranging from 2.5 to 160 mg/kg for Ni and from 6.9 to 1,420 mg/kg for Zn. In addition, concentrations exceeded the guidelines for As and Pb (13% of sites), for Cu (10%), for Hg (7%) and for Cr (5%).
- In soils, concentrations only exceeded ecological and human health guidelines for arsenic in 5% of sites, ranging from <0.5 to 380 mg/kg.

Limitations of the study

- Further spatial and temporal replication would provide a greater understanding of and confidence in the variation of concentrations of contaminants in the environment.
- Environmental samples (water, sediment, soil) should be combined with biota (fish, macroinvertebrate) samples to gain a better understanding of the ecosystem level impacts of emerging contaminants.