Diffuse soil contamination of emerging contaminants along highways in Flanders

Exploratory measurement campaign

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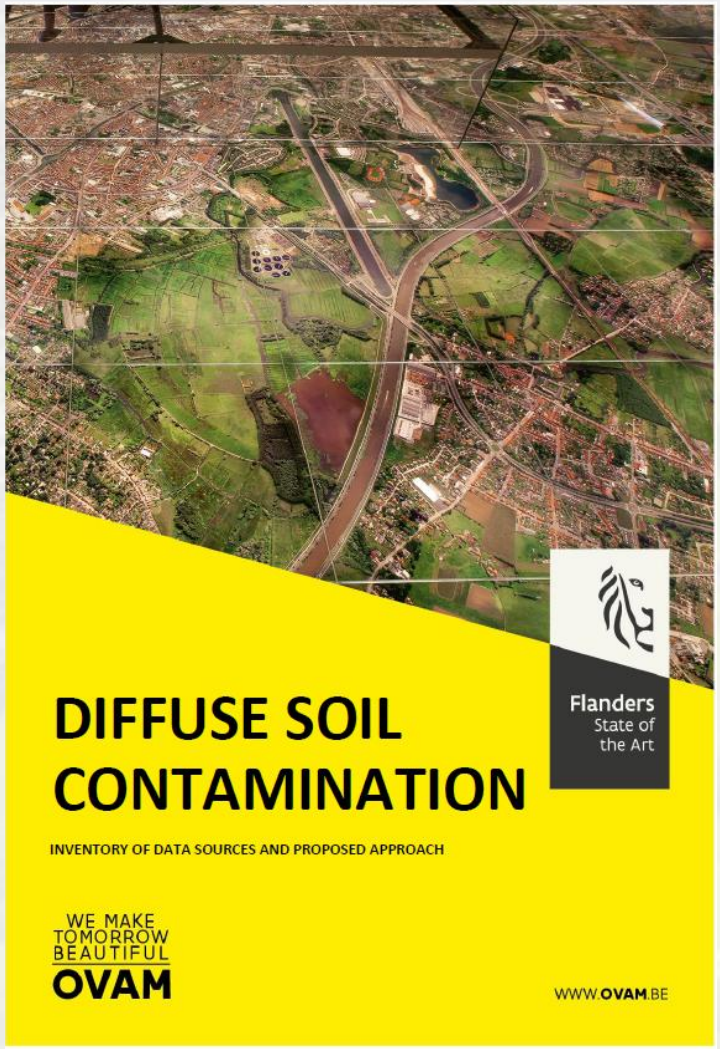


2021: policy study diffuse soil contamination

1. Inventory all existing data:
   - possible sources / substances of diffuse contamination
   - available measurement data
   - supporting data (e.g. emission data, cartographic data)

2. Estimate the potential impact

3. Overview of European policies

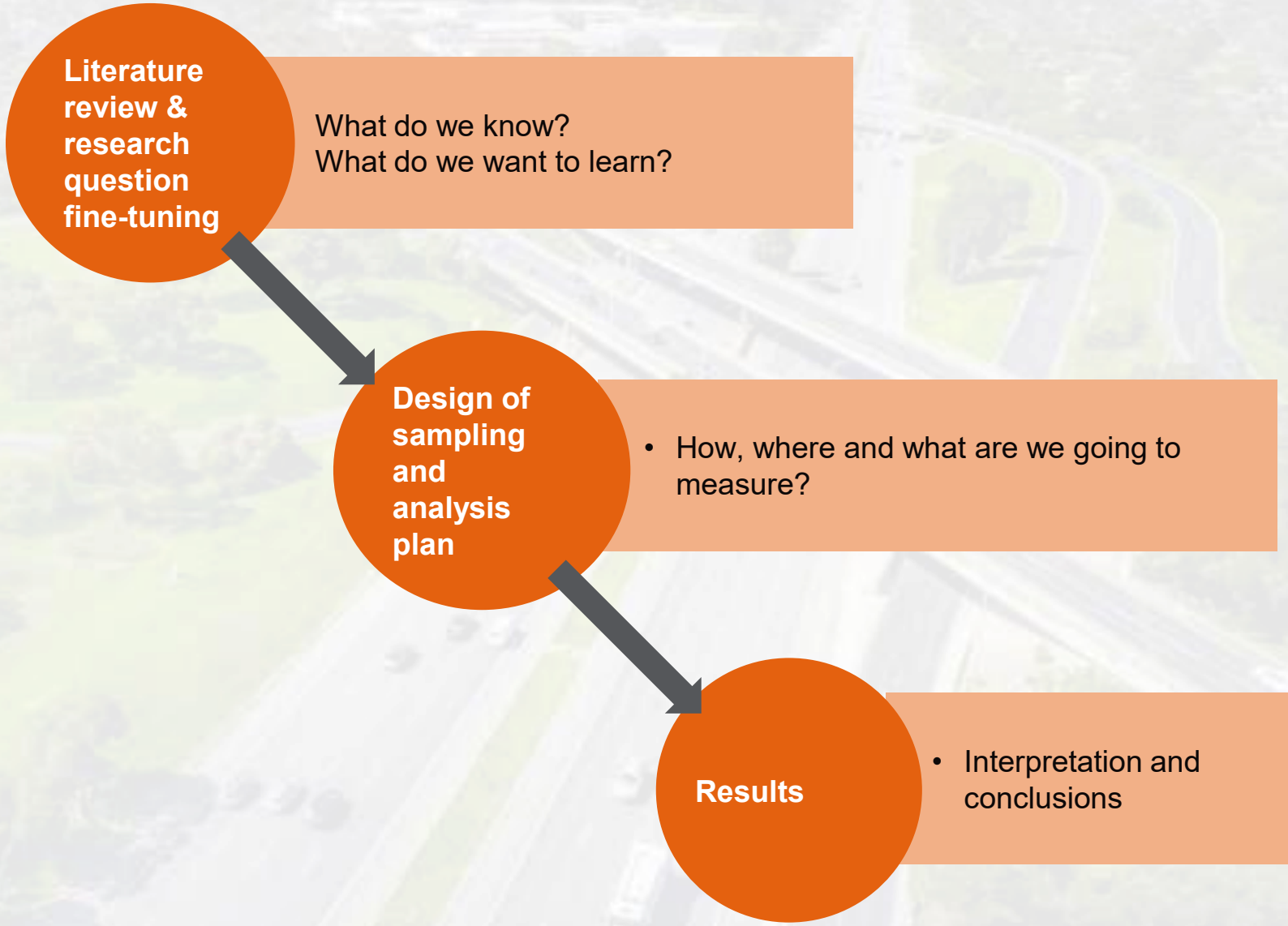
4. Proposal for a policy in Flanders, including a prioritization

→ Need to gain more insight in sources and substances causing diffuse soil pollution - such as transport (roadtraffic, railways,..)

Exporatory measurement campaign

- Roads and railways

→ focus presentation on roads



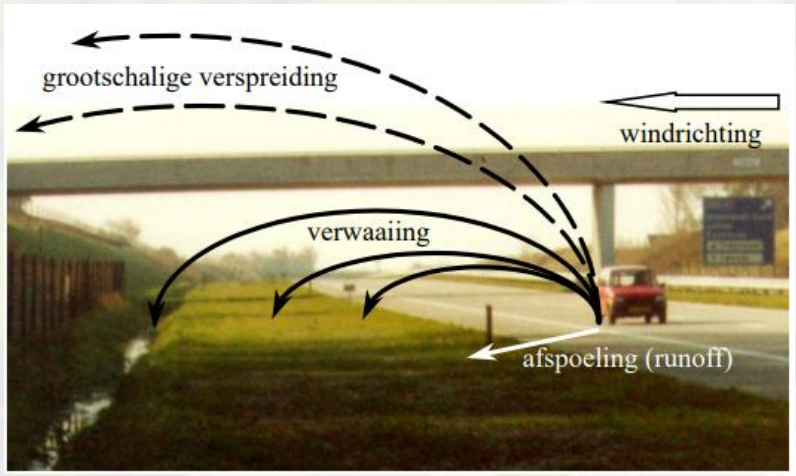
Literature review

Relevant Substances

- Heavy metals
- PAH
- phenols
- TPH
- Pesticides
- PCB
- Dioxines
- PFAS
- Asbestos
- Cyanide
- Chlorides
- Microplastics and rubber
- Flame retardants
- Tyre additives
  - Thiazoles
  - triazoles
  - Diphenylguanidine (DPG)
  - Mercaptobenzothiazole (MBT)
  - p-pheynlenediamane (PPD's)
  - Imidazoles
  - Phatalates
  - Bisfenol A
  - …
- …

Pathways to soil

- Run off
- Aerial dispersion
- Atmospheric deposition
- Roadside incidents
- Direct application to soil (e.g. pesticides, de-icing salts, accidents, littering)



CIW, 2002

Properties of the road and environment

- Age of the road
- Materials used
- Traffic volume, traffic congestion
- braking/acceleration events
- Presence of sewer system, infiltration ditches,..
- Position of the road (higher/lower) to the surrounding landscape
- Activities near the road
- Origin of the soil used in the roadside verges
- …

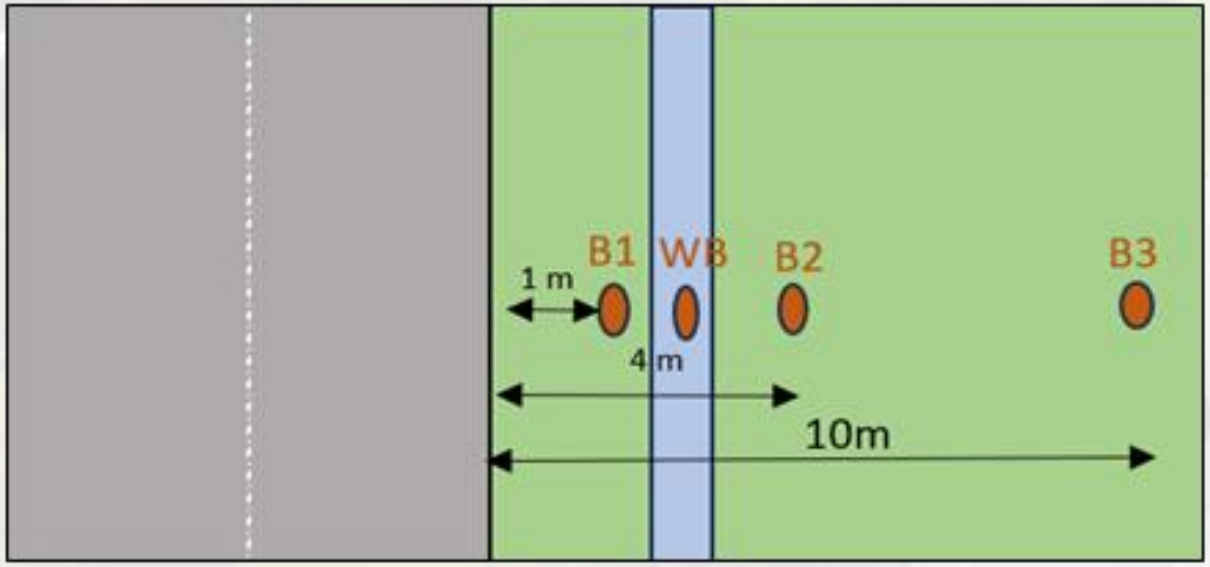
many variables to consider

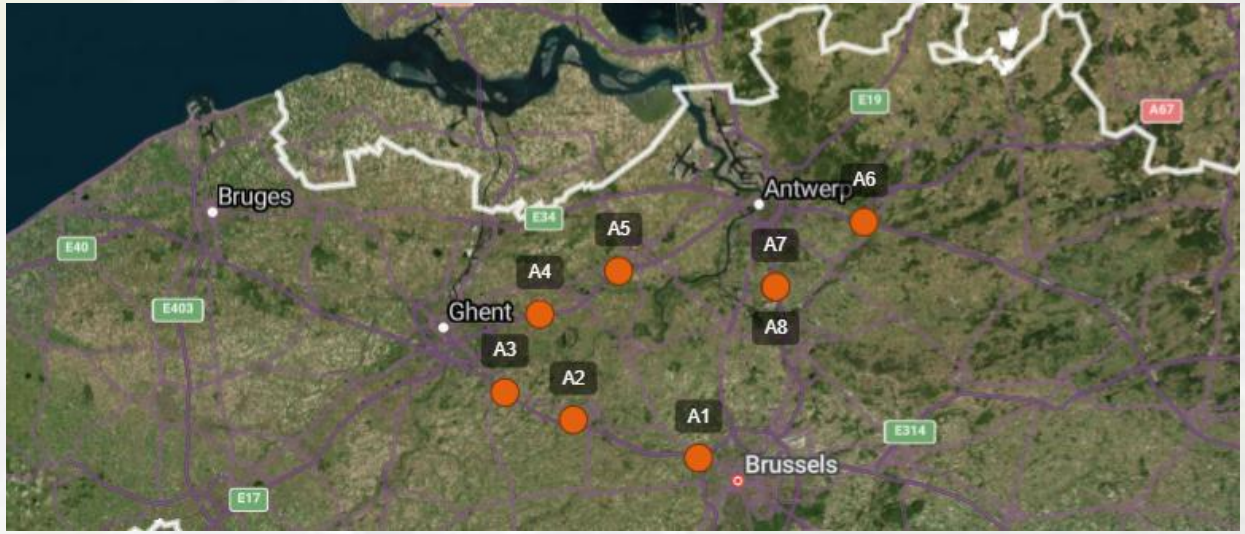
Focus: are emerging contaminants associated with roads and tyres present in the soil along highways in Flanders?

Sampling plan

- Highways with heavy traffic (high volume and congestion)
- Avoid other known contamination sources (industrial area's, landfills,..)
- Top 10 cm & 10-30 cm-bgl of soil sampled

AIM: select locations most likely to detect highway related emerging contaminants





Analysis plan

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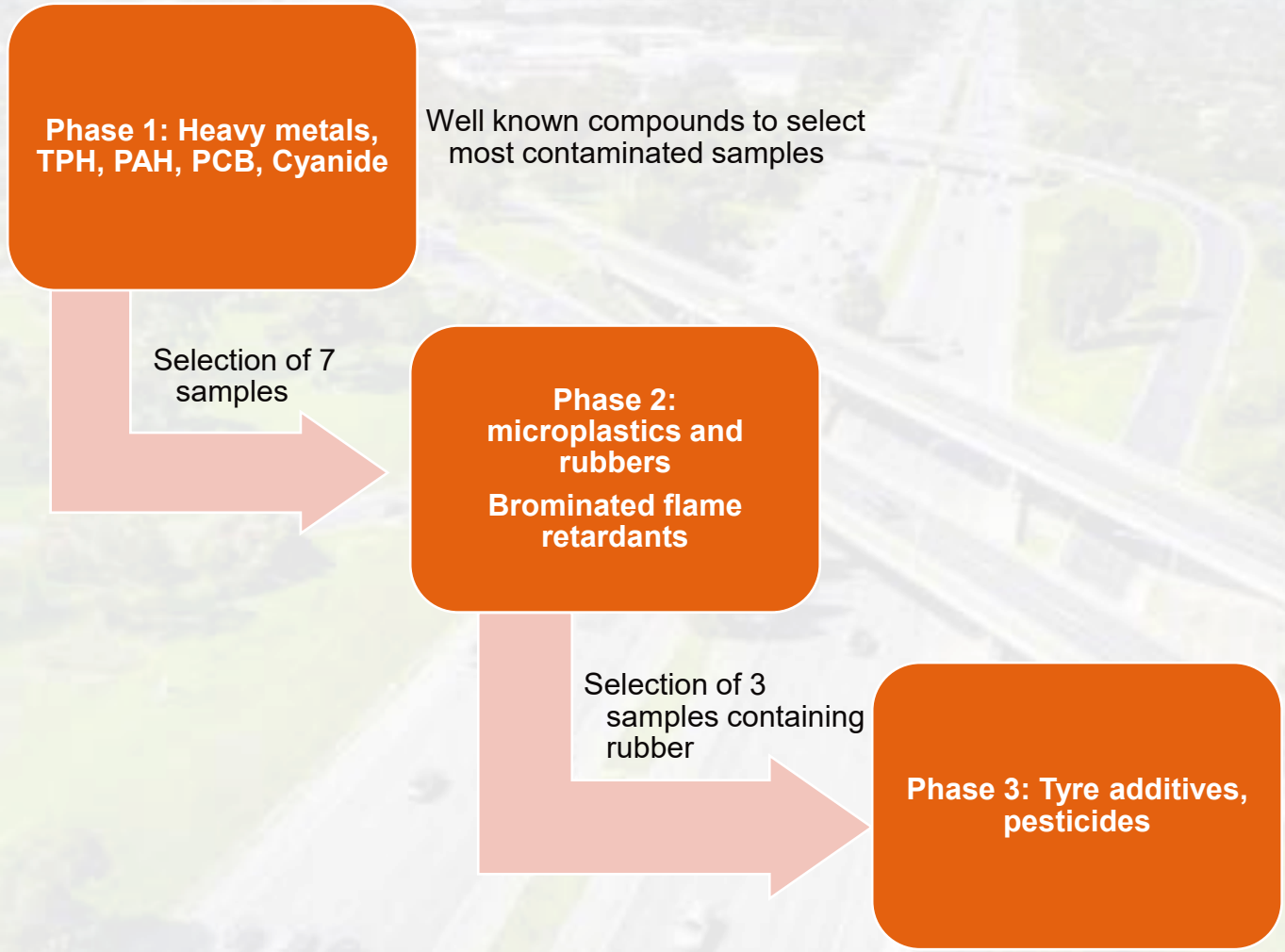
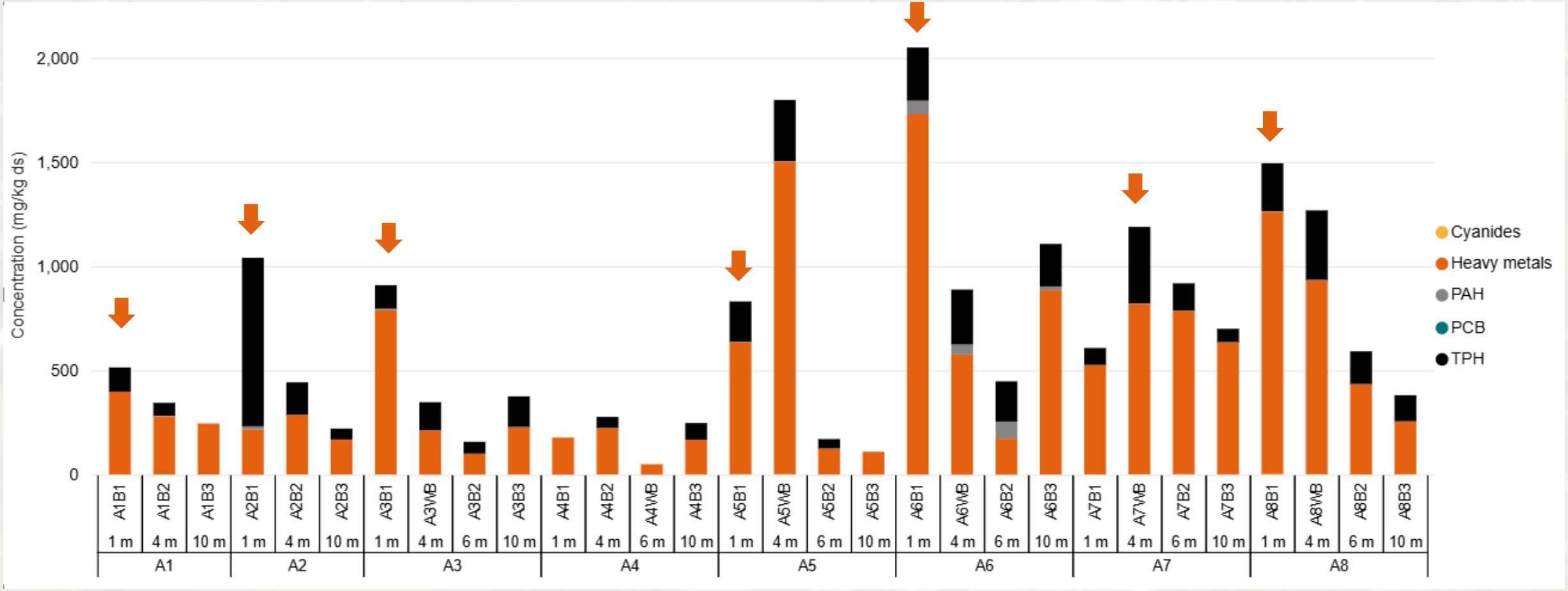
Target analysis

Analysis plan – target analysis

Selection based on analytical possibilities and available resources



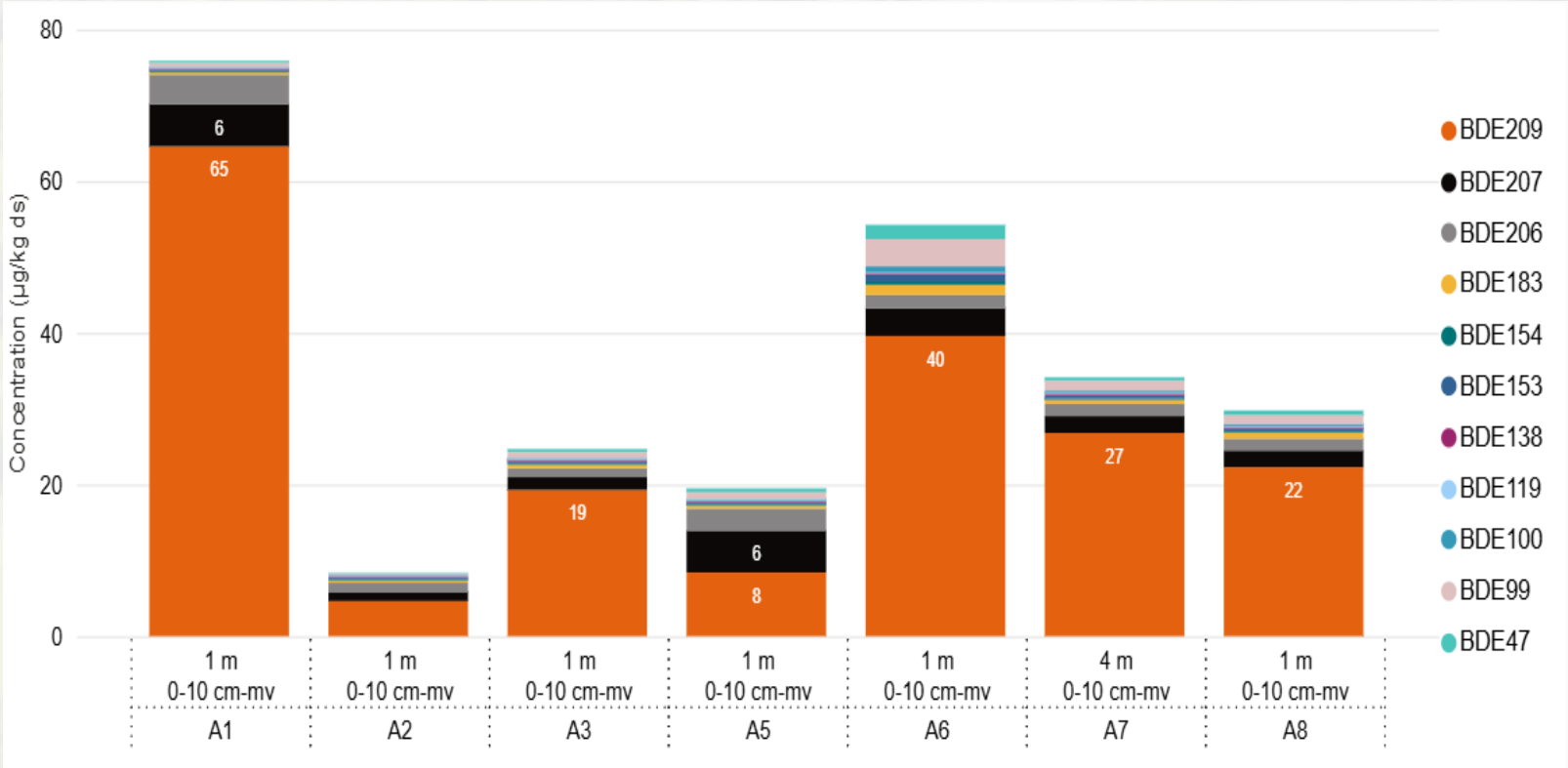
Target analysis Phase 1



Target analysis Phase 2

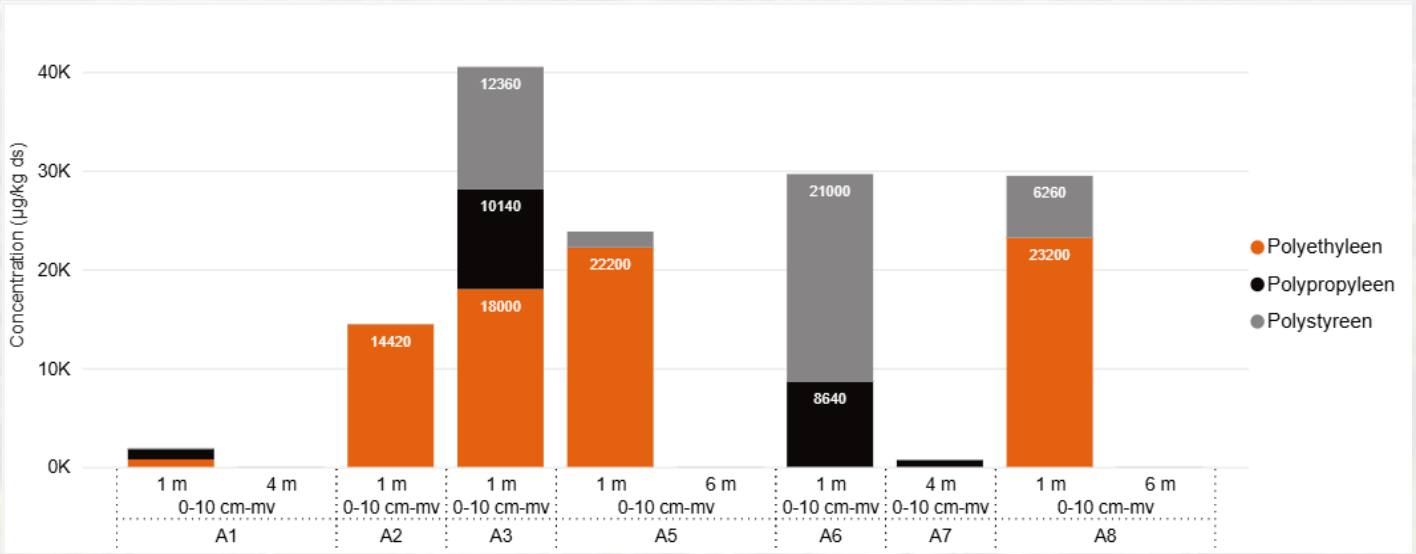
Brominated flame retardants

- Detected in every analysed sample
- Mainly BDE209, BDE207, BDE206

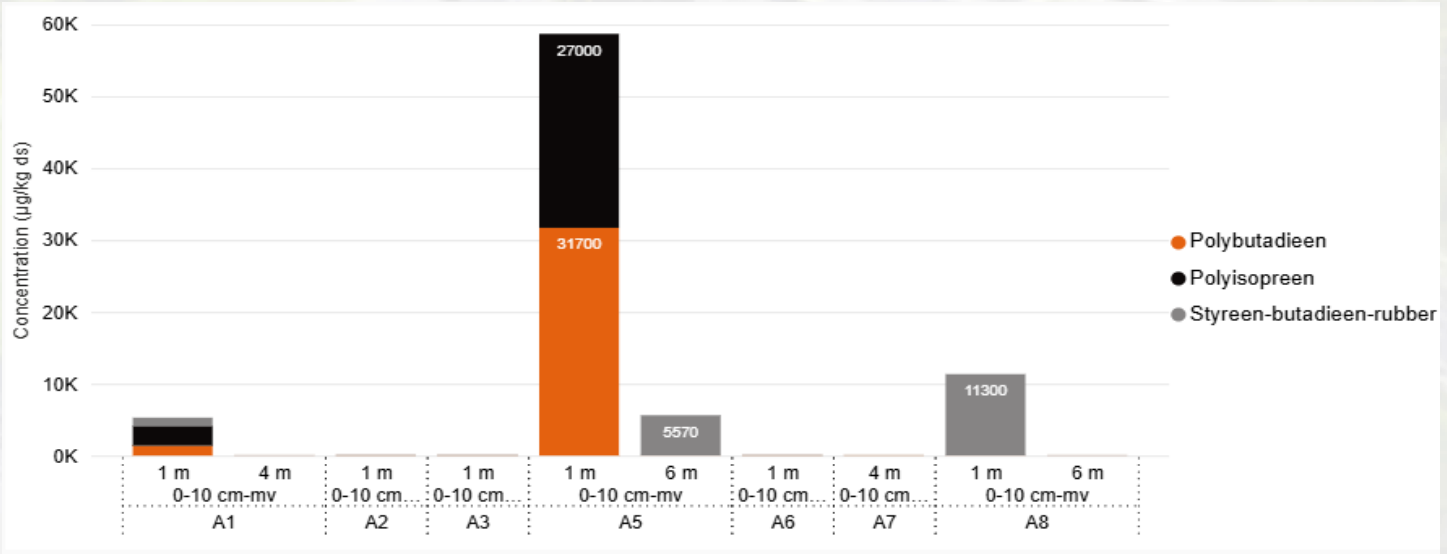


Target analysis – Phase 2

Microplastics & rubber



- Pyrolysis GC-MS
- Microplastics detected in every sample closest to highway
- Rubber particles found at 3/7 sites
- Greater distance to highway: lower concentations or non detected.

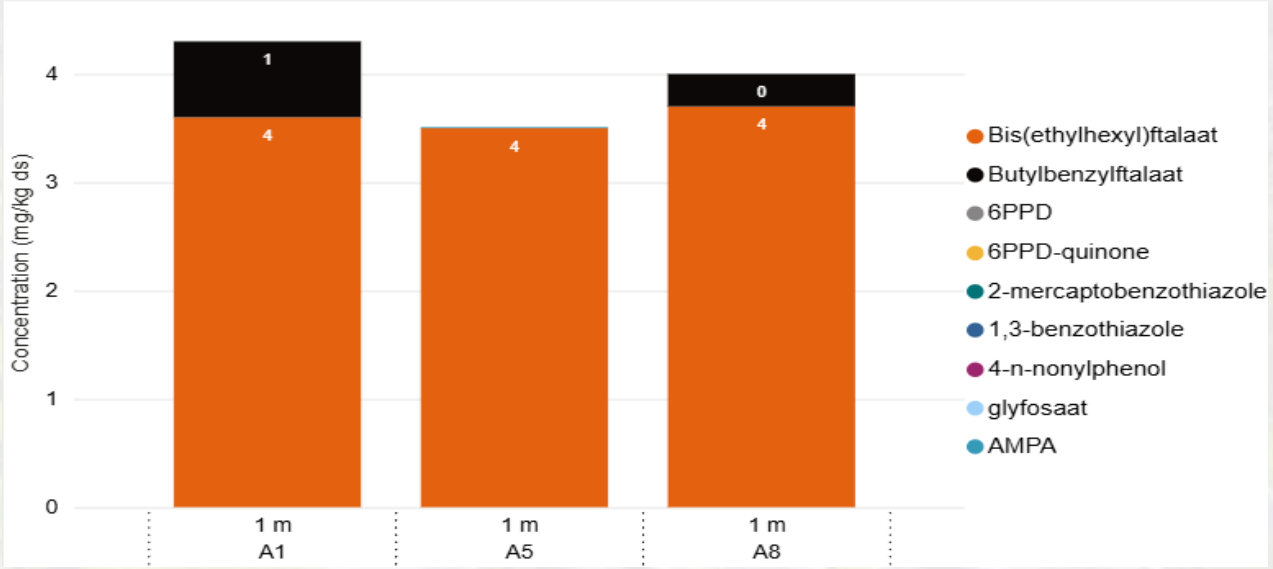


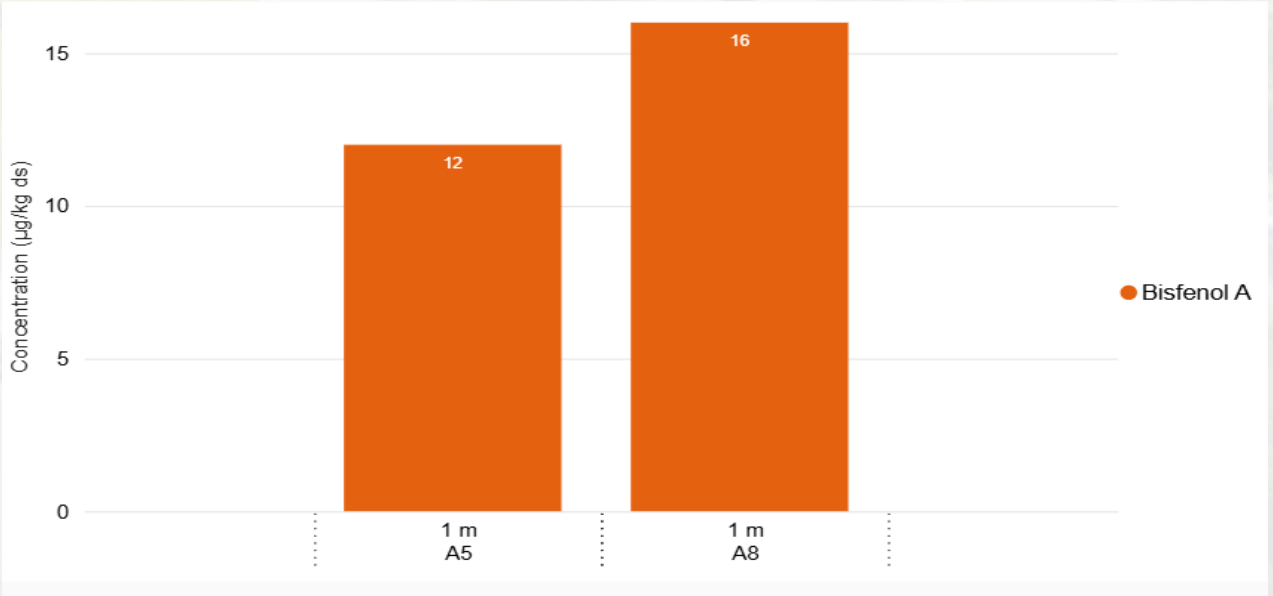
Target analysis – Phase 3

Tyre additives

- Phtalates
- Bisphenol A
- 6-PPD, 6-PPD-Q
- 2-mercaptobenzothiazole (MBT) , 1,3-benzothiazole (BTH)
- 4-nonylphenol

Pesicides: Glyphosate, AMPA





Phtalates detected in every sample with rubber

Bisphenol A found in 2/3 samples with rubber

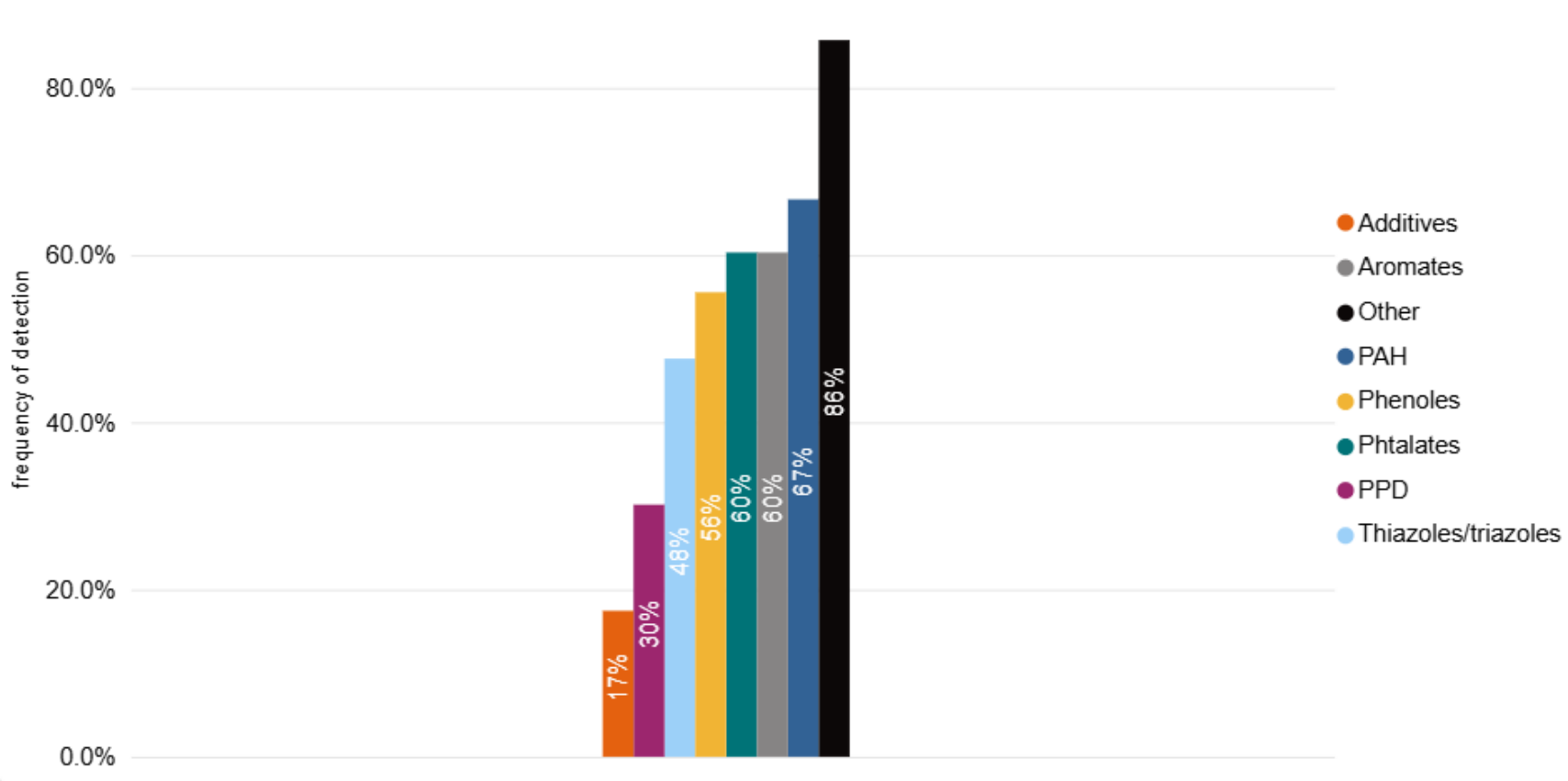
AMPA found in 1 sample

6-PPD, 6-PPD-Q, MBT, BTH, 4-nonylphenol, glyphosate: not detected

Suspect screening/non Target (DART + LC MS)

Results DART – suspect screening

- Chromatograms compared to list of 114 tyre-related compounds (Tirechem)
- Qualitative assesment: compound detected / not detected



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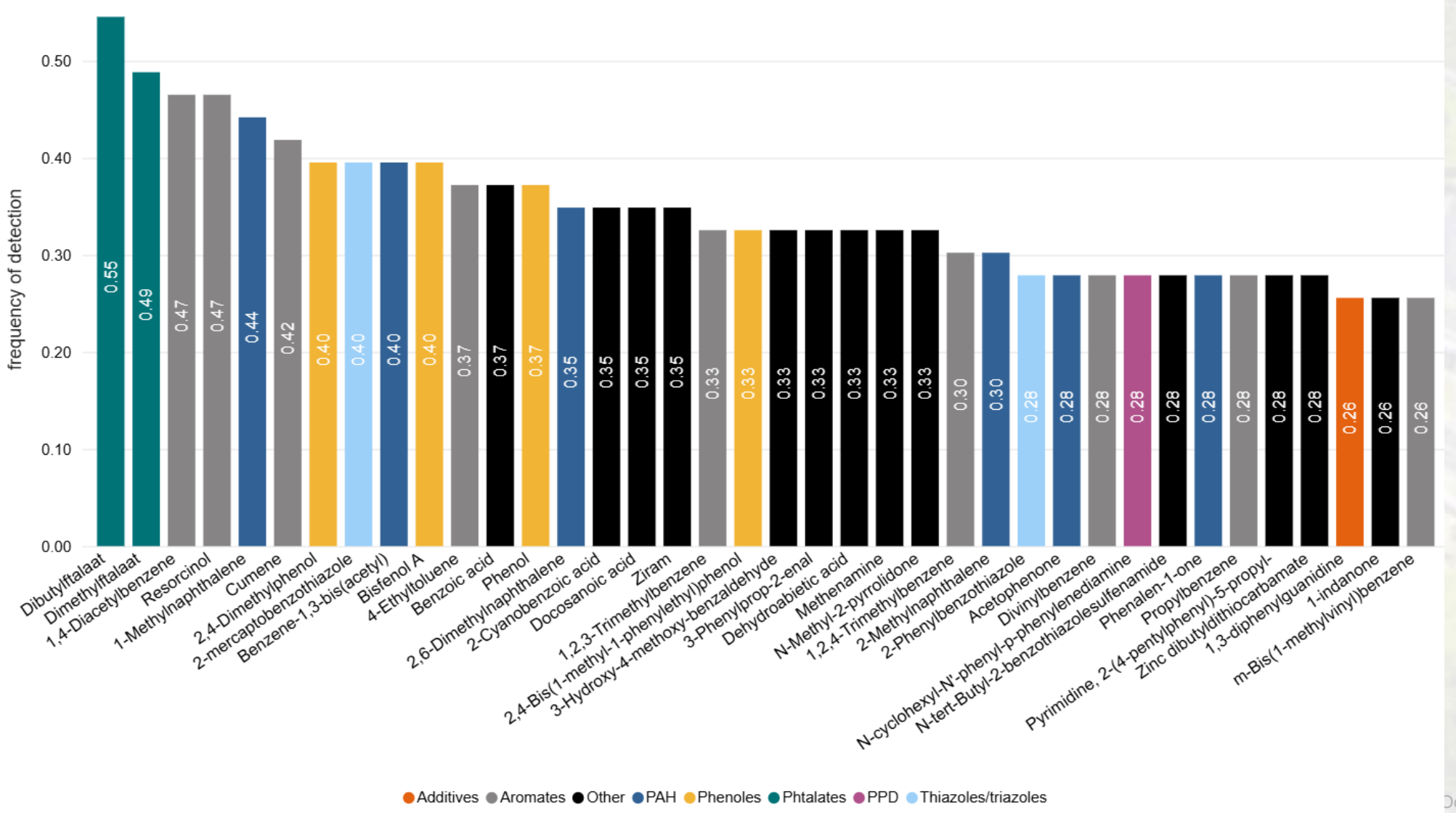
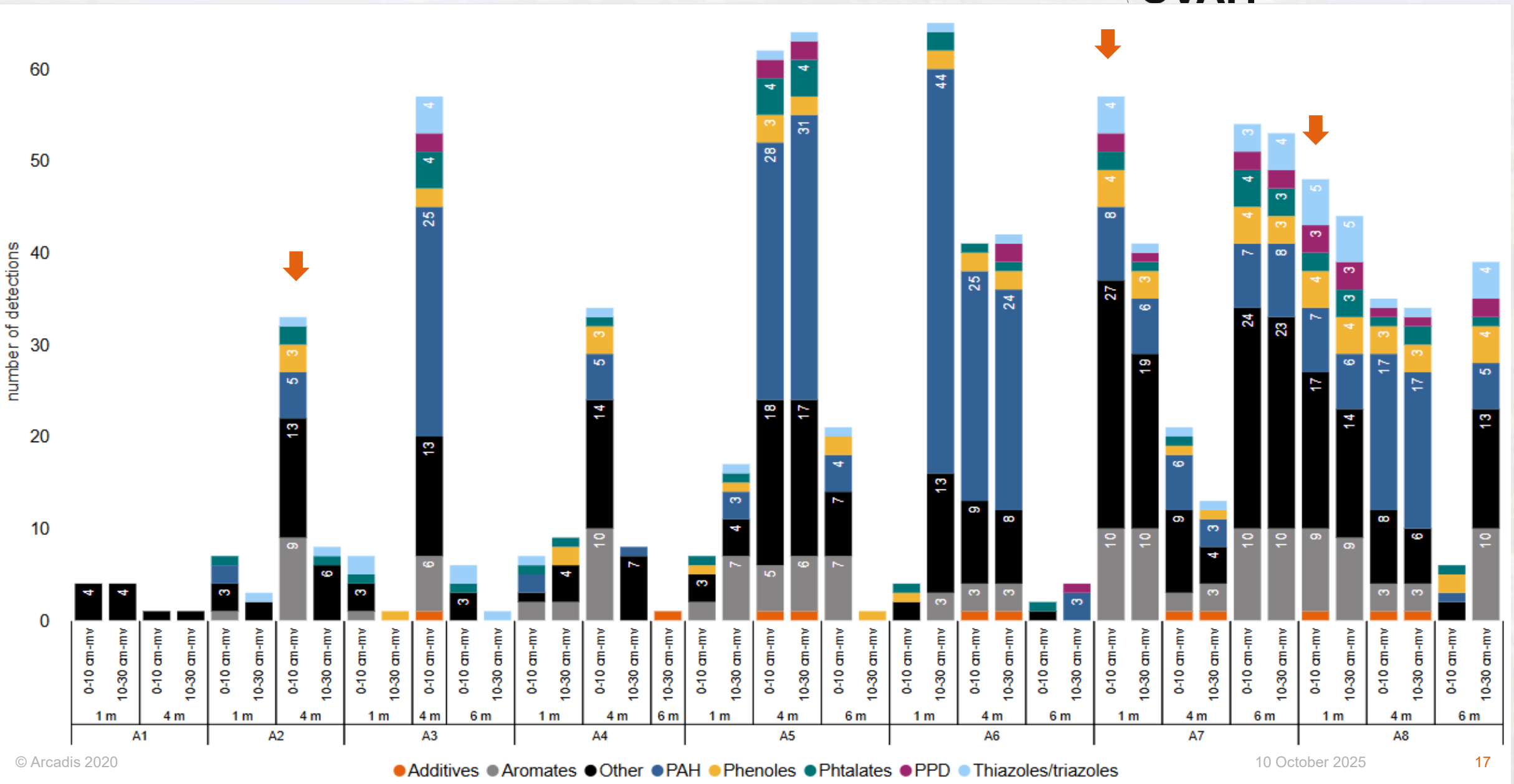
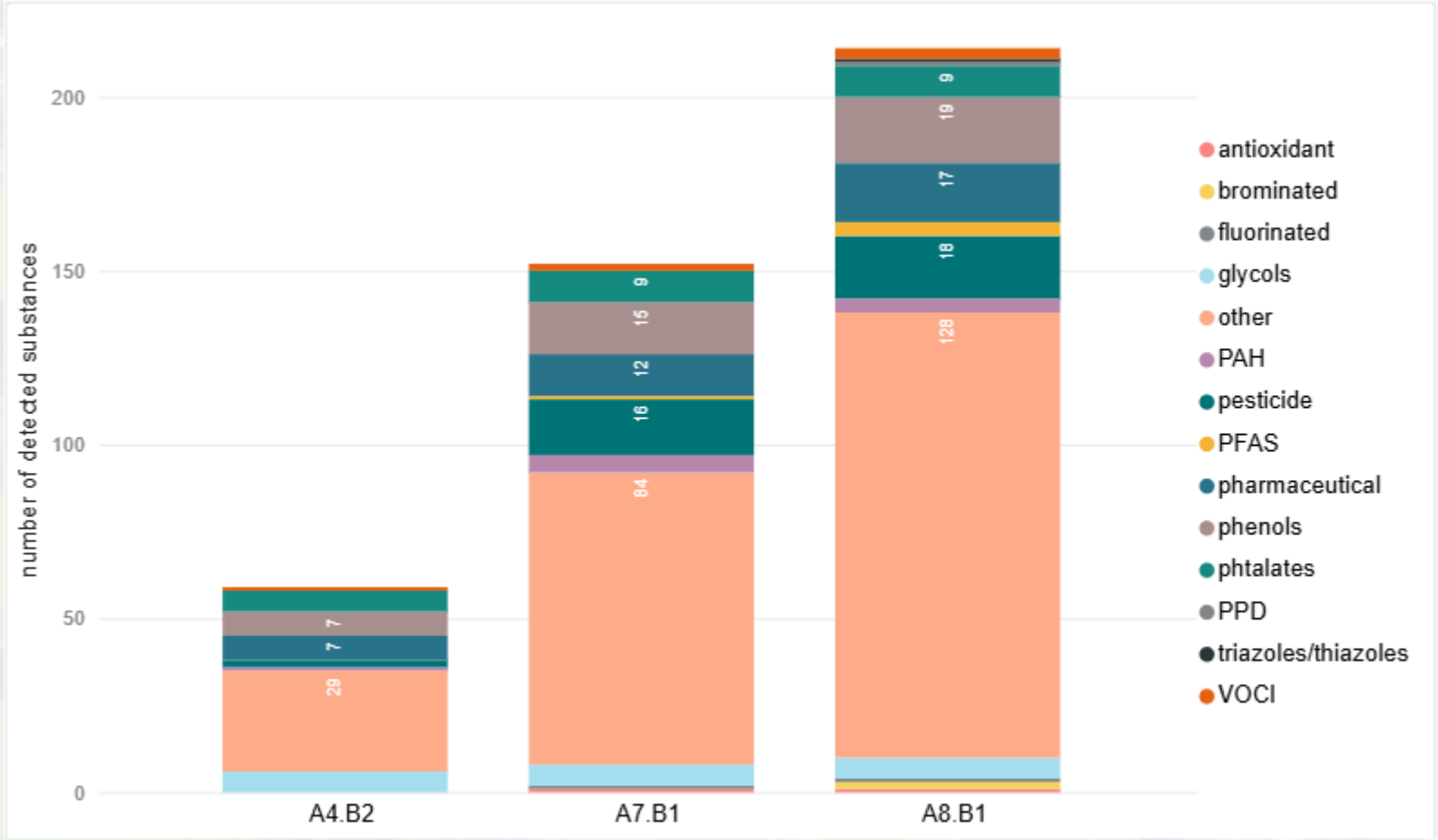


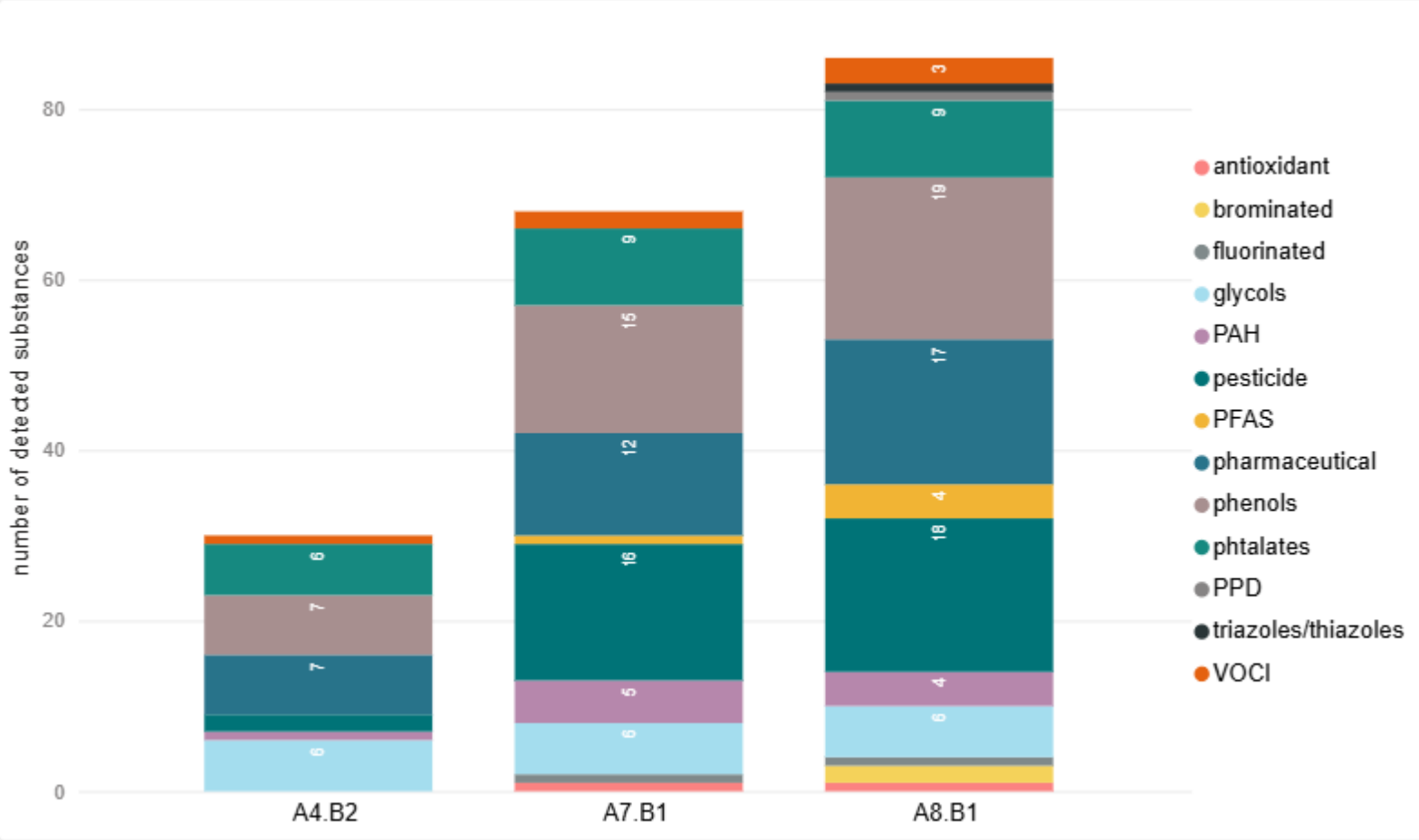


LC- MS screening

- 246 different compounds detected



LC- MS screening



LC- MS screening

- Compounds found in all 3 samples

Pharmaceutical		phenols	phtalates	glycolen	pesticide
alprenolol	Beta blocker	2,2'-Methylenebis(4-methyl-6-tert-butylphenol)	benzyl butyl phthalate	heptaethylene glycol	Fipronil
cholecalciferol	vitamin D3	4-(3,5,7-Trimethylnonyl)phenol	dibutyl phthalate	hexaethylene glycol	
Dexamisole	antidepressant	4,4'-Methylenebis(2,6-DI-tert-butylphenol)	diisooctyl phthalate	HOOCCH2O-peg7-CH2COOH	
Irbesartan	blood pressure lowering agent		Phthalic acid, heptyl undecyl ester	HO-Peg6-CH2COOH	
Olmesartan	blood pressure lowering agent		phthalic anhydride	octaethylene glycol	
Tramadol				Peg6-(CH2CO2H)2	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Overview

Group	expected	Quantitative analyses		DART (FOD) - Tirechemlijst	LC-MS - (tirechem list + library van stoffen)
		contaminant	Max concentration		
Microplastics and rubber	**Yes**	• PE, PS en PP • SBR, polybutadieen en polyisopreen	• Som 10 MP: 29.400 µg/kg • Som rubbers: 58.700 µg/kg		
Phthalates	**Yes**	• DEHP in 3/3 stalen • Butylbenzylftalaat in 2/3 stalen	• 3,6 mg/kg ds • 0,7 mg/kg ds	• DEHP: 16% • Benzylbutylftalaat: 7% • Dibutylftalaat: 55% • …	• DEHP (1/3) • Benzylbutylftalaat (3/3) • Dibutylftalaat (3/3) • …
Thiazoles/triazoles	**Yes**	0/3 stalen		• MBT: 40% • BTOH: 20% • …	• 5-methylbenzotriazol (1/3)
PPD (p-phenylenediamine)	**Yes**	0/3 stalen		• 6PPD: 9% • DPPD: 23% • CPPD: 28%	• 6PPD (1/3)
Phenols	**Yes**	**4-n-nonylfenol:** 0/3 stalen **Bisfenol A** 2/3 stalen	• 16 µg/kg ds	• Dimethylfenol:: 40% • Bisfenol A: 40% • ..	• Bisfenol A en Bisfenol F (2/3) • Desoxon M (1/3) • 4-octylfenol (1/3) • ….
Other additives (e.g., DPG)	**Yes**			• DPG: 26%	• “Santowhite” - antioxidant
Pesticides	**Yes**	**AMPA** 1/3 stalen	• 0,01 mg/kg ds		Amethrin,afbraakproducten Chloridazon, allethrin,benomyl, diflufenican, diuron, linuron, … (1/3) Altrazine, dinoseb, fluconazole, warfarin,.. (2/3) Fipronil (3/3)
Brominated flame retardants		7/7 stalen	• Som 24 BDE: 75 µg/kgds		
Pharmaceutical products	**No**				Betablokker, UV-filters, cannbiodiol, antidepressant, fentanyl, levonorgestrel, blood pressure lowering agents, tramadol,..
Glycols	**No**				polyethyleneglycols
VOCl (volatile organic chlorides)	**No**				Tetrachloroethane, dichloroethane, vinylchloride, (2/3)
PFAS (per- and polyfluoroalkyl substances)	**No**				Heptadecafluorocataansulfonate, henicosafluoroundecanoic acid, … (1/3)

Conclusions

Focus: are emerging contaminants associated with roads and tyres present in the soil along highways in Flanders?

Conclusions

- Emerging contaminants detected along highways and ditches.
- Lower levels and fewer contaminants at sites with drainage/sewer system (A1, A2).
- Some contaminants (phthalates, rubbers) linked to road use.
- LC-MS screening found additional unexpected components (source unclear).
- Suspect screening: no concentration data, so severity unknown

Recommendations

- Conduct additional measurements at various sites/land uses in Flanders to distinguish general vs. highway-specific contaminants (e.g., pharmaceuticals, pesticides, flame retardants).
- Investigate groundwater for confirmed components
- Develop standardized methods for analyzing rubbers and microplastics in soil

Contact us

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