



14th
IWA International Conference on
**WATER RECLAMATION
& REUSE**

HOSTED BY



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IN ASSOCIATION WITH



water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA



CITY OF CAPE TOWN
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WATER PARTNERSHIP OFFICE
A PARTNERSHIP BETWEEN WPO, DSDM AND SALGA

Non-target screening of trace organic compounds and targeted monitoring of contaminants in diverse parts of the Cape Flats Aquifer.

A collaboration between the University of Cape Town Future Water Research Institute (FW)¹, the French Geological Survey (BRGM)², and the City of Cape Town (CoCT)³, with funding from the French Development Agency (AFD).

R. Schneuwly¹, C. Bryan², K. Carden¹, N. Baran², H. Thouin², C. Soulier², V. Parry¹, P. Msimango³, A. Gutierrez²



In partnership with



About the project

BRGM support to the City of Cape Town for Water Management:

- Task 1: Development of a decision-making aid tool with groundwater water level forecasting
- Task 2: Training for CoCT officials on the decision-making aid tool
- **Task 3: Contaminants of Emerging concern (CECs) in infiltrated water and groundwater in the Cape Flats Aquifer**

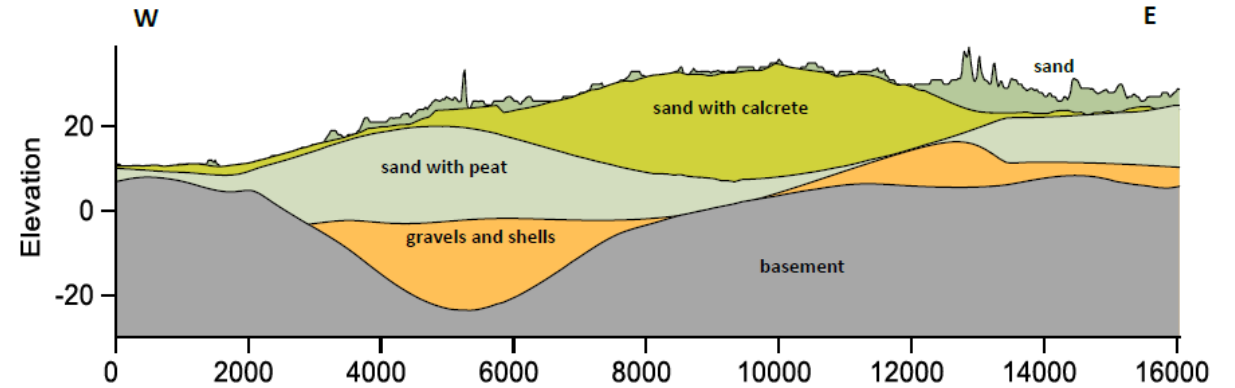
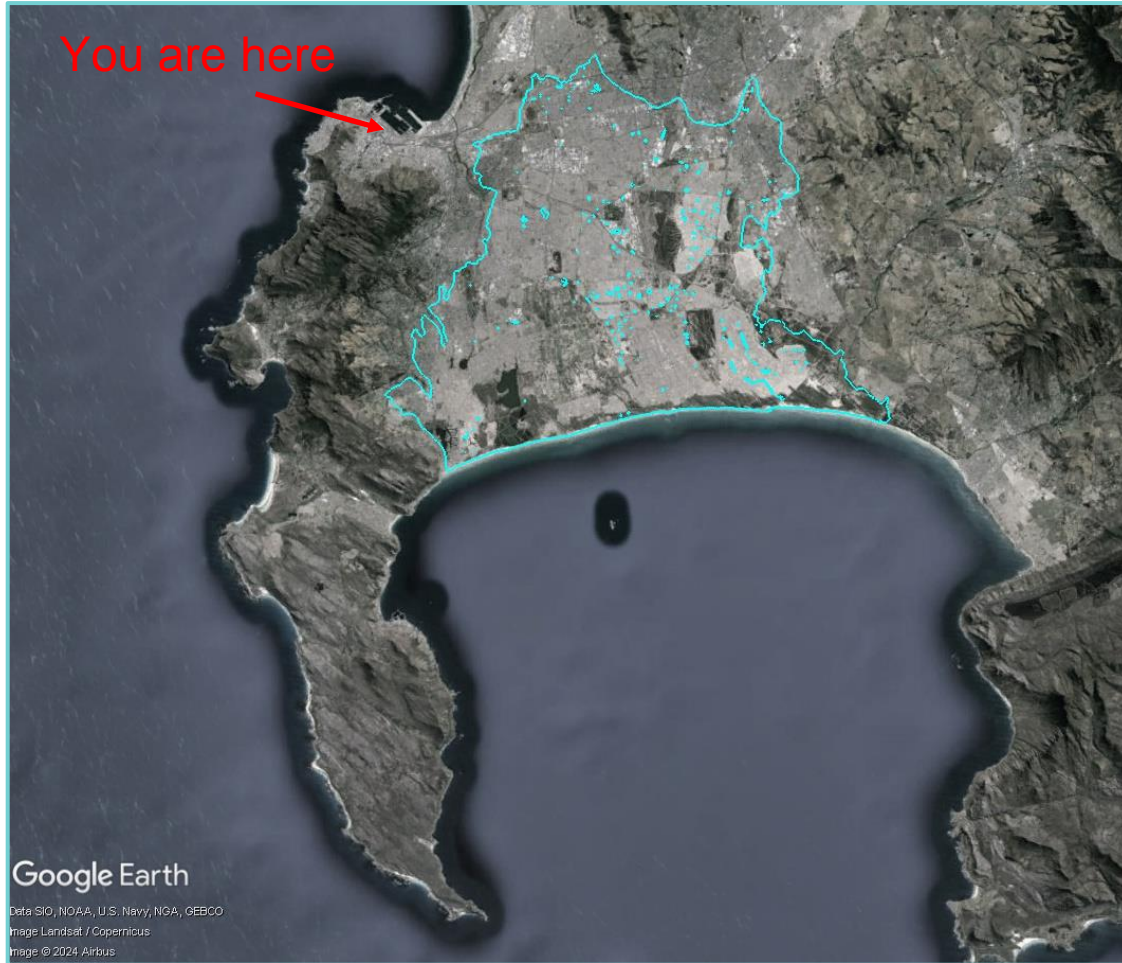


Pathways to water resilient South African cities (PaWS) project:

Ongoing transdisciplinary research at Future Water with a stormwater infiltration study site in Mitchell's Plain



The Cape Flats Aquifer



- Layers of sand on top of shale basement bedrock
- In the sand: calcrete, peat, clay, shells
- Gravel in parts

Vulnerable to contamination from the surface

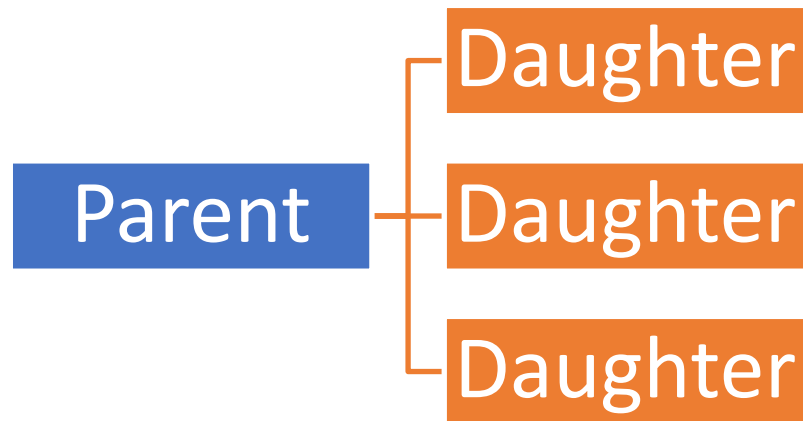
Full range of land use activities occur

Planned source of potable water for CoCT

(Cross-section from CoCT, 2020)

CECs in urban surface and groundwater

- These include organic compounds such as pharmaceuticals, personal care products, industrial products, pesticides and more (an ever-growing list!)
- Present in low concentrations in aquatic environments (ng/L)
- Pose a variety of risks such as ecotoxicity, antimicrobial resistance, endocrine disruption...



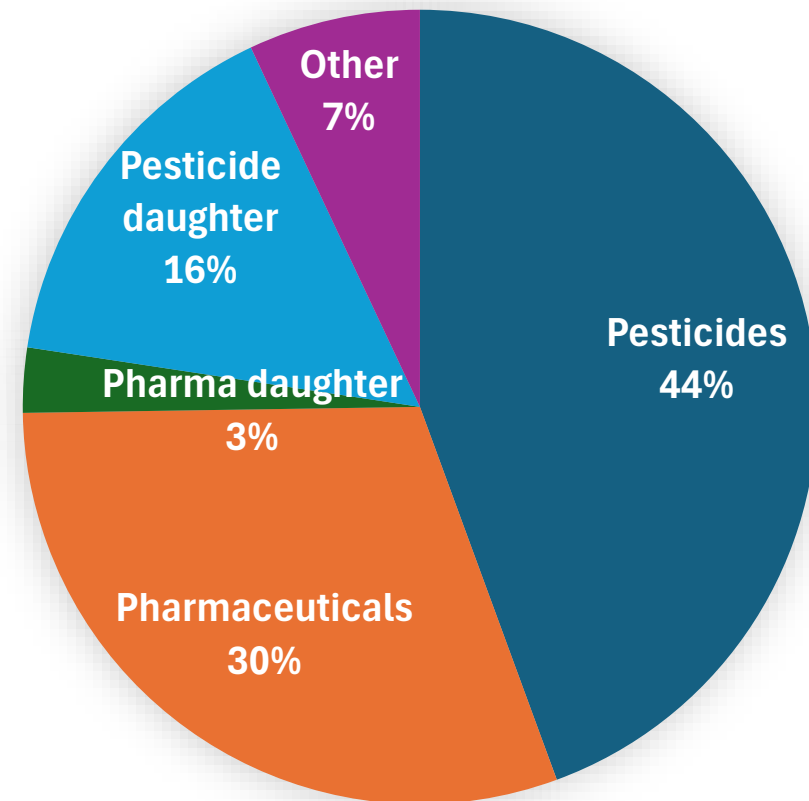
- Metabolites and transformation products
- Known or unknown compounds
- Can more toxic or have worse adverse effects
- May be less biodegradable or more mobile
- Not often looked for

Current multi-lab monitoring approach

New Water Programme – Cape Flats Aquifer Management Scheme
Contaminants of Emerging Concern Report 2021

204 contaminants analysed across
5 local and international labs
Only a few select daughter products

BRGM propose non-target screening

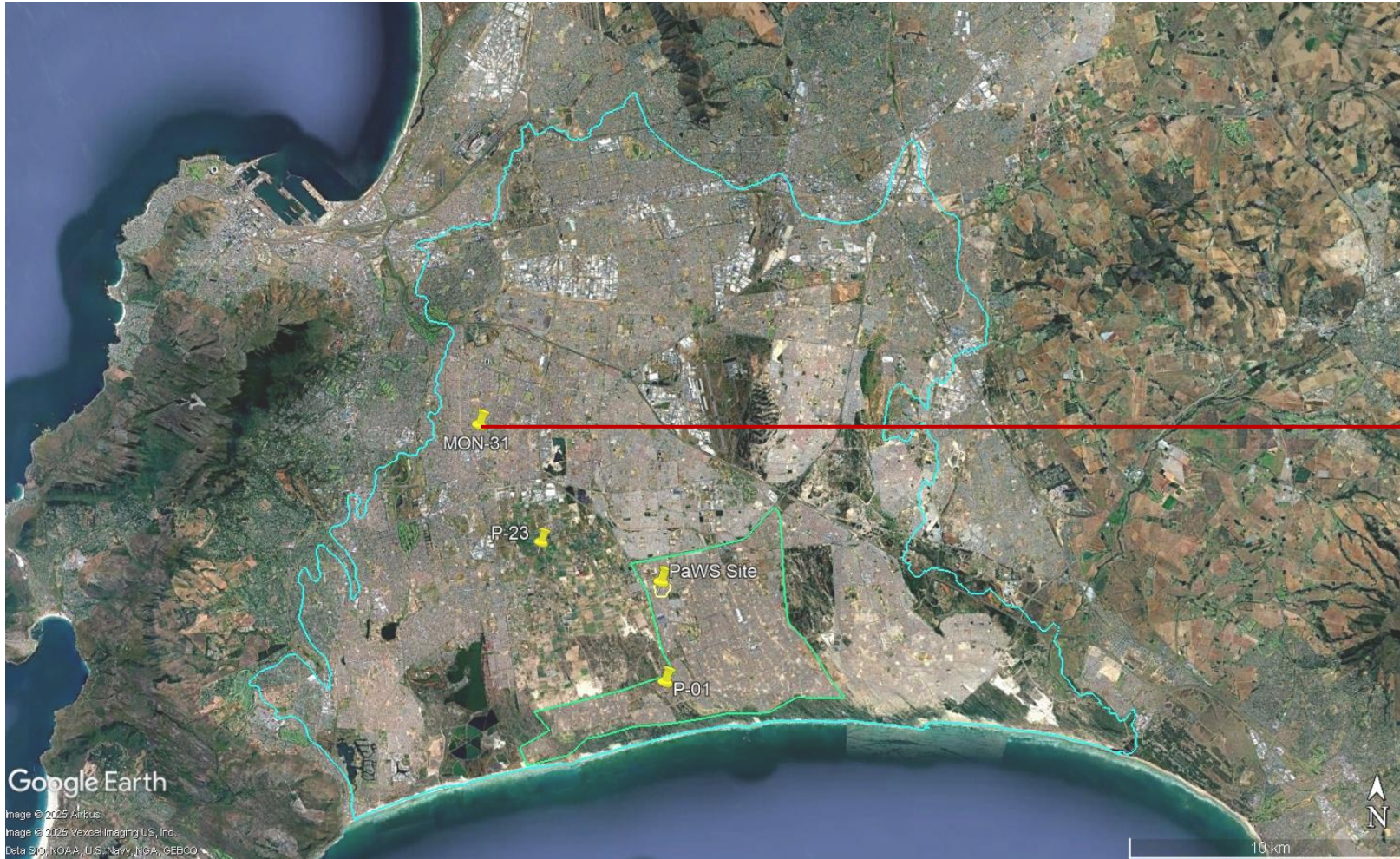


Database total 520 compounds

Aims:

- Assess the usefulness of non-target screening for water quality monitoring compared to a multi-lab approach
- Monitor the temporal variation of CECs in the CFA over 1 year period

Four sampling sites



MON-31: Groundwater monitoring well.
165 mm casing
Total depth: 10 m
Sample depth: 3 m
Lithology around screened section:
Coarse sand.
Formal residential area.
Away from planned injection and
abstraction areas.

MON-31

Four sampling sites



P-23: Drilled as production well, used as monitoring well. 305 mm casing
Total depth: 48 m
Sample depth: 38 m (below a 9 m thick clay layer)
Lithology around screened section:
Course and very coarse sand with clay.
Philippi horticultural area.

P-23

Four sampling sites



P-01: Drilled as production well, used as monitoring well. 305 mm casing
 Total depth: 50 m
 Sample depth: 26 m
 Lithology around screened section: Fine sand with shells and coarse sand.
 Near Mitchells Plain WWTW down gradient of sludge ponds

P-01

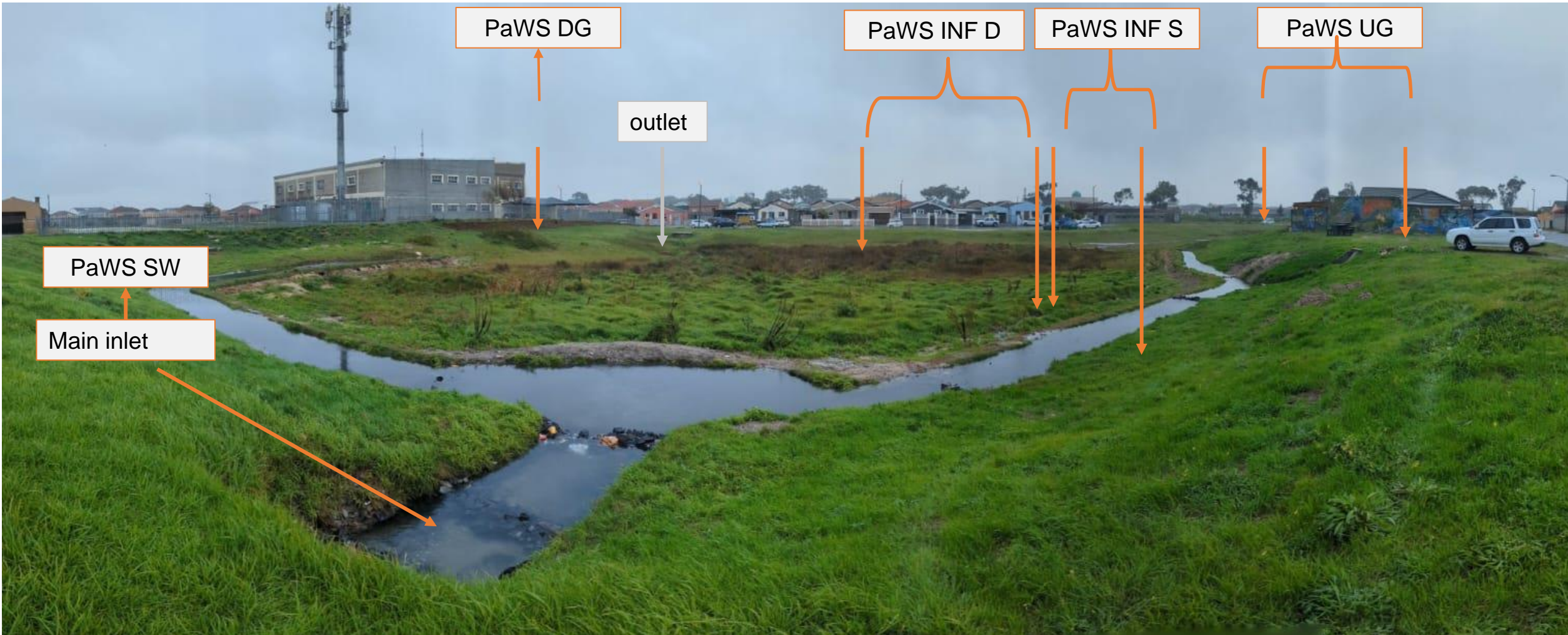
Four sampling sites



PaWS: Stormwater infiltration study site with monitoring wells. 63 mm casing
Total depth: 1.5 to 5.4 m
Sample depth: 0.25 m from well bottom
Lithology: Fine and medium sand with clay in some areas
Formal residential catchment

PaWS

PaWS site and sample points



Sample collection and analysis



- Stormwater grab samples on 5 occasions
- CoCT monitoring wells sampled 4 times
- Groundwater at PaWS site in all 8 sampling rounds
- CEC monitoring: samples sent to Stellenbosch University analyzed using LC-QqQ-MS (Archer et al 2021)
- One batch of samples went to BRGM for non-target screening

Sample analysis

CEC monitoring

Samples sent to
Stellenbosch
University

Target list of 21 CECs
Detection and
quantification

All sampling rounds

Other contaminants

Nitrogen,
phosphorous and
organic carbon

Geochemical
parameters

All sampling rounds

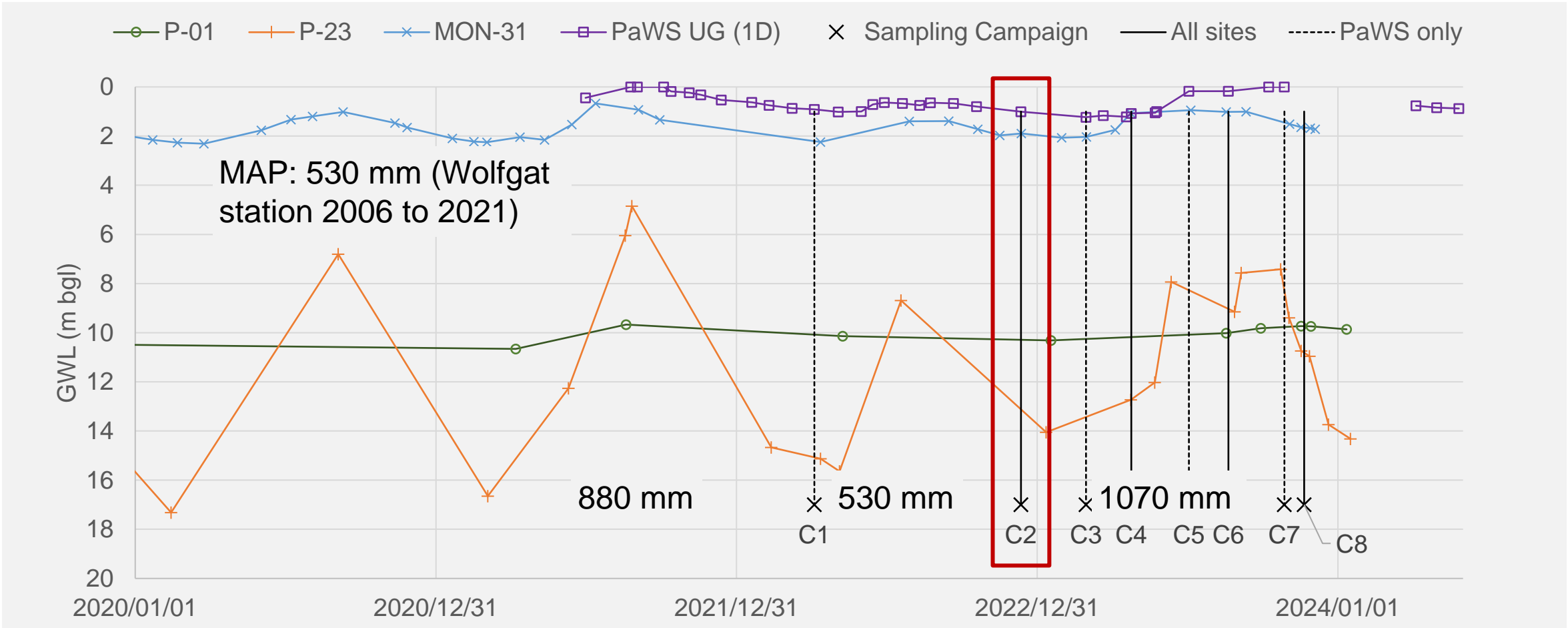
Non-target screening

Samples sent to
BRGM (France)

NTS using LC Q-ToF
MS

One sampling round

Sampling campaigns and groundwater levels



Results: Non-target screening results

Results: Non-target screening (NTS)

Food Additive / Body Care Products / Sweetener	Acesulfam	X		X	X	X	
	Cyclamate			X			X
	Sucralose	X	X	X	X	X	X
Industrial / Corrosion Inhibitor	5,6-dimethyl-1H-benzotriazole				X		
	Benzotriazole	X		X	X	X	X
	Tolyltriazole	X	X	X	X		X
Industrial / Phenol	Bisphenol S	X					X
Parabens / Preservatives / Body care products	Ethylparaben		X				
	Methylparabene		X				
Pesticides / Fungicide / Benzimidazole	Carbendazim	X			X		X
	2 Aminobenzimidazole	X			X		
Pesticides / Fungicide / Imidazole	Imazalil = enilconazole			X			
Pesticides / Fungicide / Methoxyacrylate	Azoxystrobine			X			
	Azoxystrobine R234886			X			
Pesticides / Fungicide / Morpholine	Fenpropimorphe						X
Pesticides / Fungicide / Morpholine	Spiroxamine			X			
Pesticides / Fungicide / Oximinoacetate	Trifloxystrobine						X
Pesticides / Fungicide / Pyridinecarboxamide	Boscalide				X		
Pesticides / Fungicide / Triazole	Epoxiconazole			X			

Pesticides / Herbicide	Choridazon						
	Chloridazon Desphenyl						X
	Chloridazon Methyl Desphenyl						X
Pesticides / Herbicide	Iodosulfuron						
	Iodosulfuron IN A4098 triazine amine		X				
Pesticides / Herbicide	Metazachlore						
	Metazachlore ESA						X
Pesticides / Herbicide	Metolachlore						
	Metolachlore ESA						X
Pesticides / Herbicide	Simazine	X	X	X			
	Simazine 2-Hydroxy	X	X	X	X		X
Pesticides / Herbicide	Terbutylazine						
	Terbutylazine Desethyl		X				
	Terbutylazine-2-hydroxy	X	X	X	X		X
Pesticides / Herbicide	Prosulfocarb			X	X	X	
Pesticides / Herbicide	Propazine	X	X	X			
Pesticides / Herbicide	Terbutryne	X		X	X		
Pesticides / Insecticide	N,N-Diethyltoluamide (DEET)	X			X	X	
Pesticides / Insecticide	Diazinon	X		X			
Pesticides / Insecticide	Fipronil	X					
	Fipronil sulfone	X	X		X		
Pesticides	Dimetachlor						
	Dimethachlor CGA-369873						X

Results: Non-target screening (NTS)

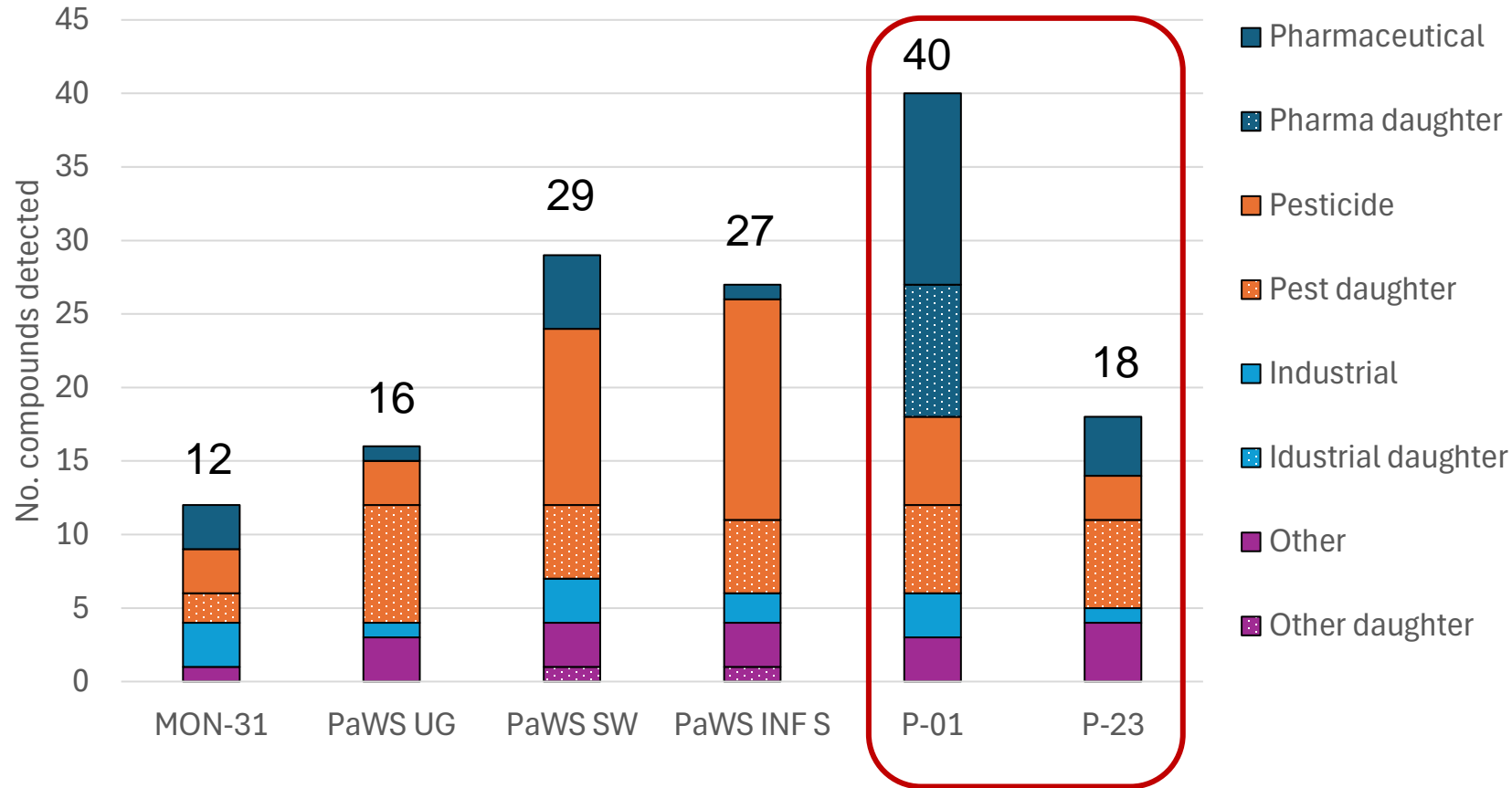
Pharmaceutical / Analgesic / Anti-inflammatory / Anilide / RAS	Paracetamol (acetaminophen)	X		
Pharmaceutical / Analgesic / Anti-inflammatory / Corticosteroids	Diclofenac		X	
Pharmaceutical / Analgesic / Anti-inflammatory / Opioid	Tramadol	X		
Pharmaceutical / Anesthetic / Anti-Arrhythmic	Lidocaine		X	
Pharmaceutical / Antibiotic / Sulphonamide	Sulfamethazine		X	X
Pharmaceutical / Antiepileptic	Carbamazepine		X	X
	10,11 dihydrocarbamazepine		X	
	2 hydroxy carbamazepine		X	
	Carbamazepine 10,11 epoxide		X	
	Iminostilbene (=dibenzazepine)		X	
Pharmaceutical / Antiepileptic	Lamotrigine		X	
Pharmaceutical / Antifungal	Fluconazole		X	
Pharmaceutical / Antihistamine	Cetirizine			
	rac Cetirizine N-Oxide		X	
Pharmaceutical / Antihypertensive	Valsartan			
	Valsartan acid		X	
Pharmaceutical / Antineoplastic / Alkylating Agent	Cyclophosphamide			X
Pharmaceutical / Antiviral	Nevirapine	X	X	

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Pharmaceutical / Antifungal	Fluconazole		X	
Pharmaceutical / Antihistamine	Cetirizine			
	rac Cetirizine N-Oxide		X	
Pharmaceutical / Antihypertensive	Valsartan			
	Valsartan acid		X	
Pharmaceutical / Antineoplastic / Alkylating Agent	Cyclophosphamide			X
Pharmaceutical / Antiviral	Nevirapine	X	X	
Pharmaceutical / Benzodiazepine	Benzodiazepine			
	2-Quinazolinecarboxylic acid, 6-chloro-4-phenyl		X	
Pharmaceutical / Dihydropyridines / Cardiovascular agent	Amlodipine		X	
Pharmaceutical / Psycholeptic / Anxiolytic	Diazepam		X	
Pharmaceutical / Psycholeptic	Venlafaxine			
	O-desmethylvenlafaxine		X	
Body care products	Cafeine	X	X	X
Body care products	Nicotine			
	Cotinine	X	X	

Note: compounds in red text indicate only the daughter compound/s was/were detected; green cases indicate greater confidence in compound identification than orange cases.

Results: Non-target screening (NTS)

79 compounds detected out of a possible 520 present in the database

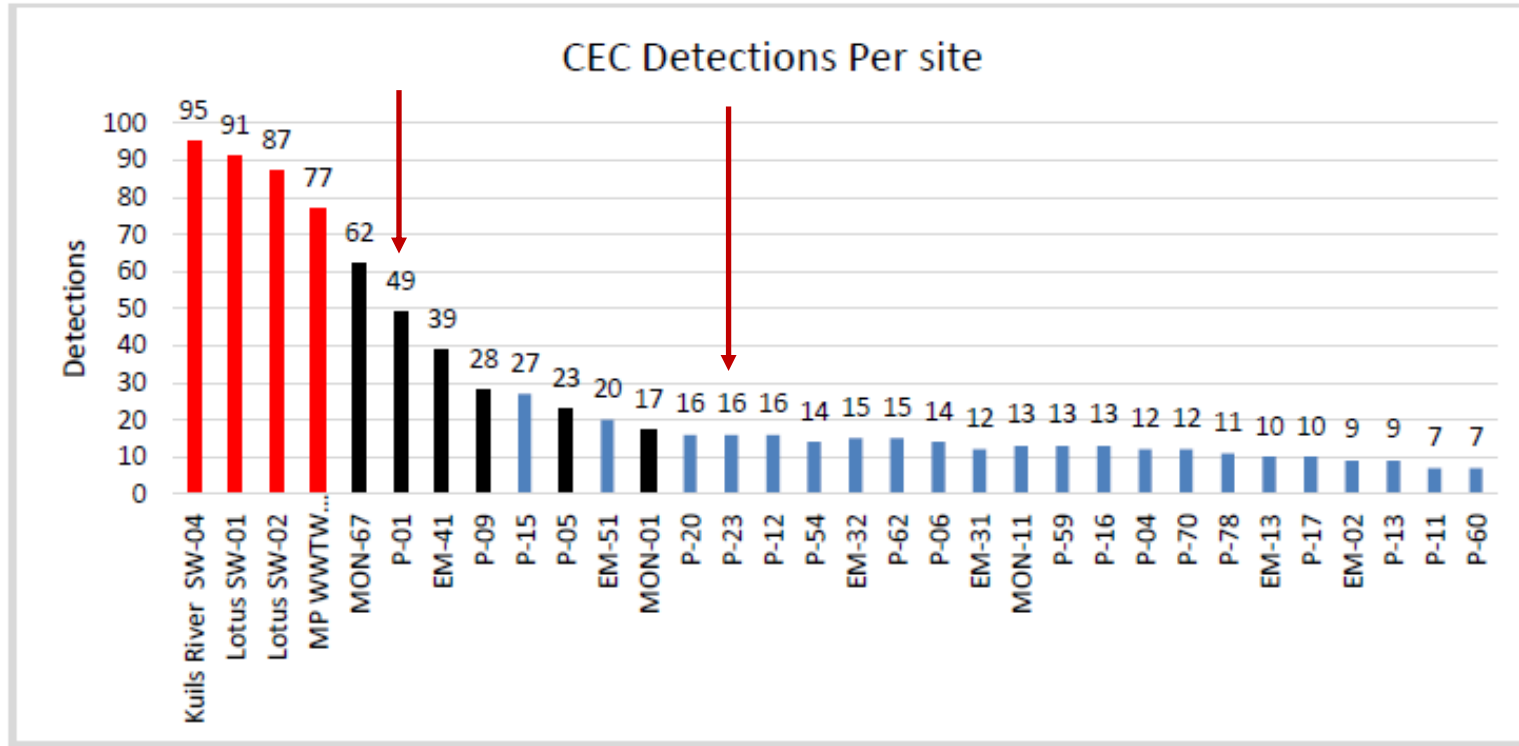


Some drugs specific to the SA context, notably **ARVs Emtricitabine and Efavirenz** and **illicit drugs** – not looked for but could be added to database.

Also missing: PAHs, organophosphate pesticides.

Results: Multi-lab monitoring (CoCT)

CoCT: 204 unique contaminants analysed across 5 laboratories



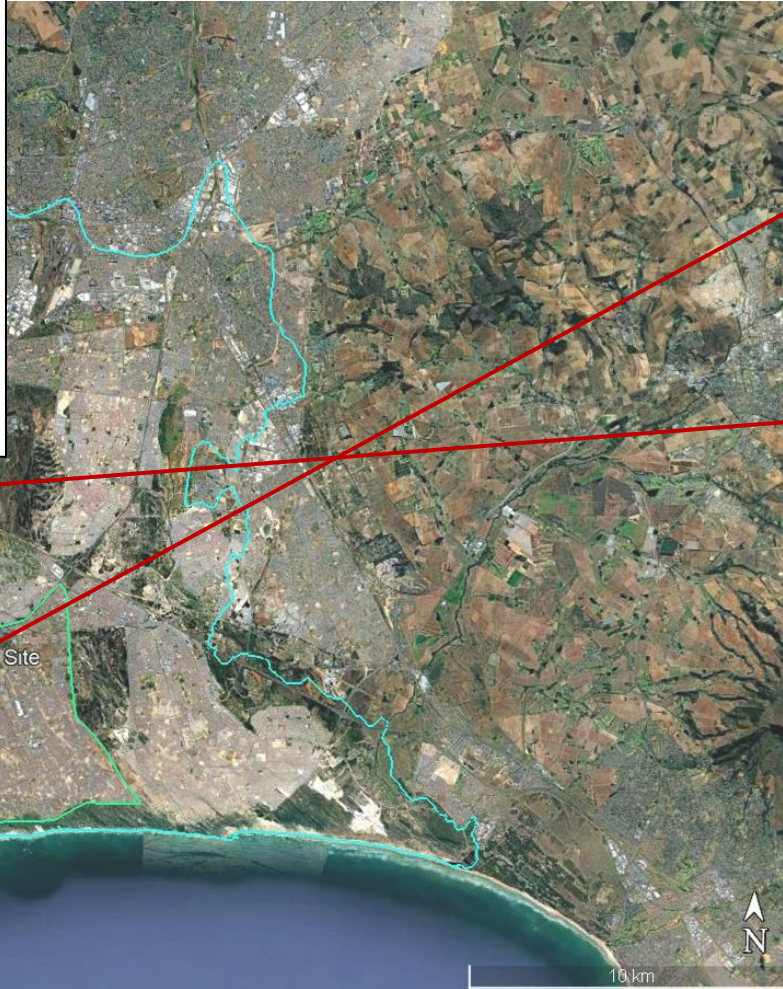
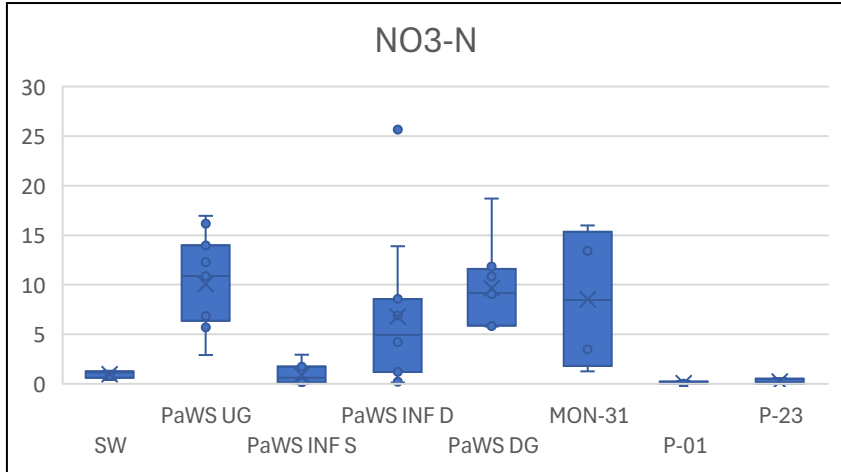
Only a few metabolites are included

Similar no. compounds detected at P-01 and P-23

Figure 3-1 CEC detections per sampling site (red represents surface water, black represents groundwater sites adjacent to surface water bodies and blue represents the remaining groundwater sites).

Targeted chemical monitoring results

Geochemical differences



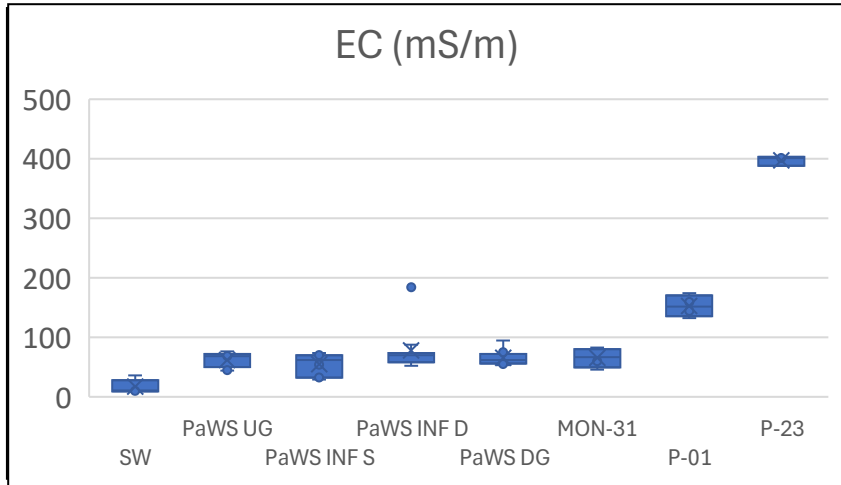
PaWS:
 Background GW: 5 to 15 mg/L nitrate as N
 SW: NH4-N and TP typical of residential SW (0.5 and 0.4 mg/L), TOC 5-25 mg/L

MON-31: Nitrate similar to PaWS site

Google Earth

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 Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Geochemical differences



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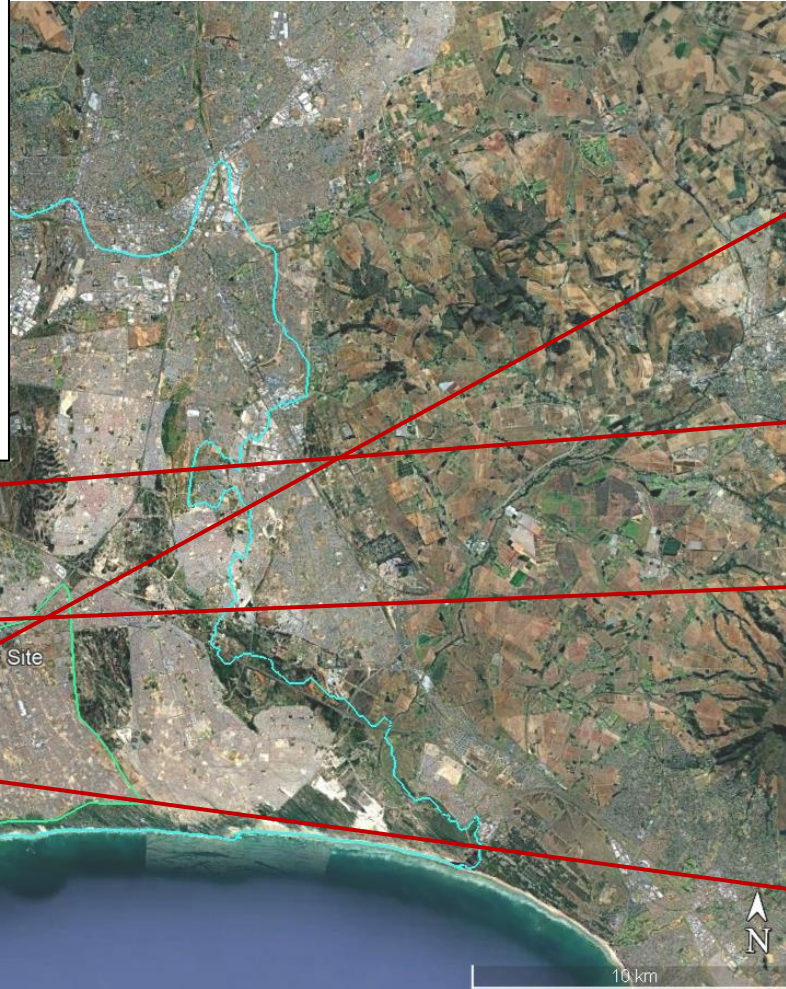
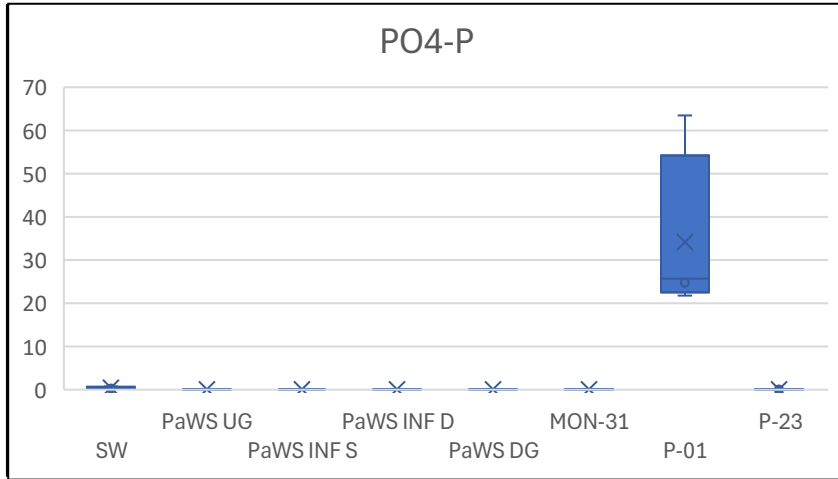
MON-31: Nitrate similar to PaWS site

P-23: High salinity (EC = 400 mS/m), high dissolved ferrous iron (9 mg/L), high TOC (18 mg/L)

Google Earth

Image © 2025 Airbus
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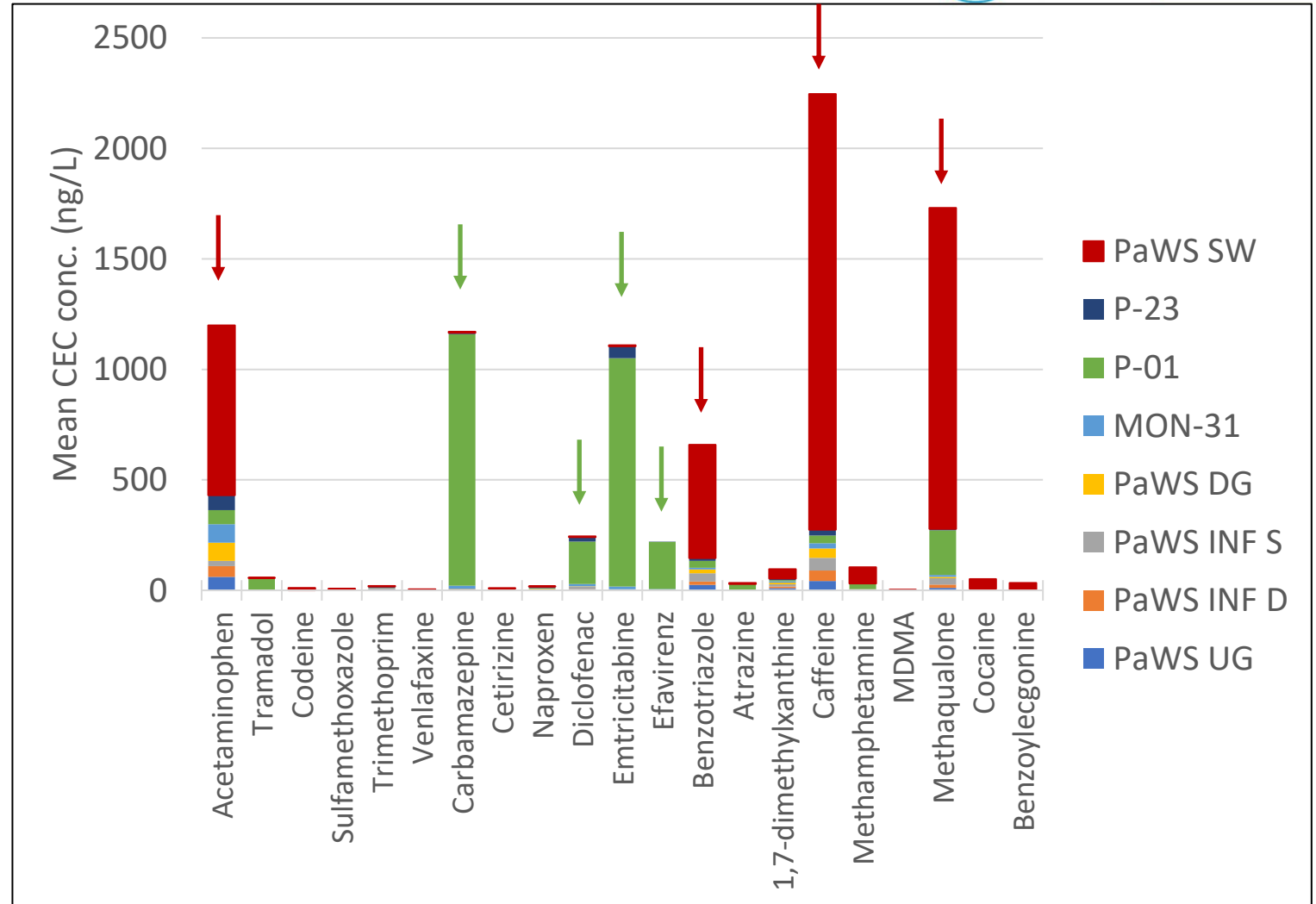
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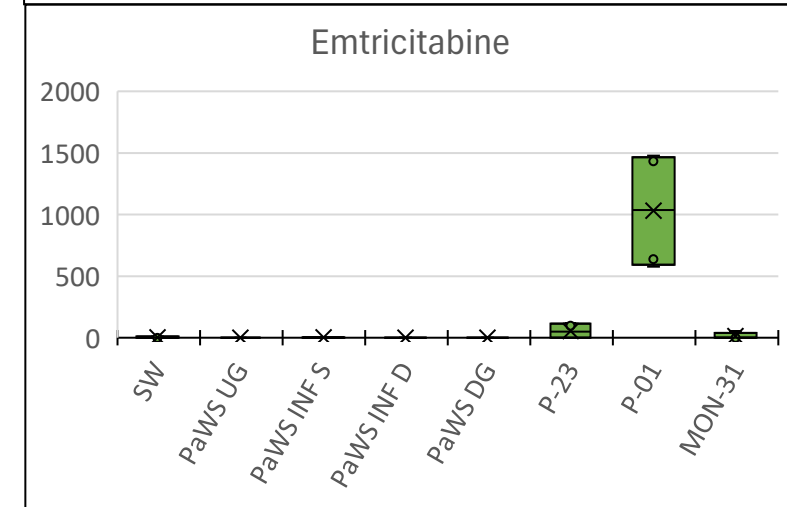
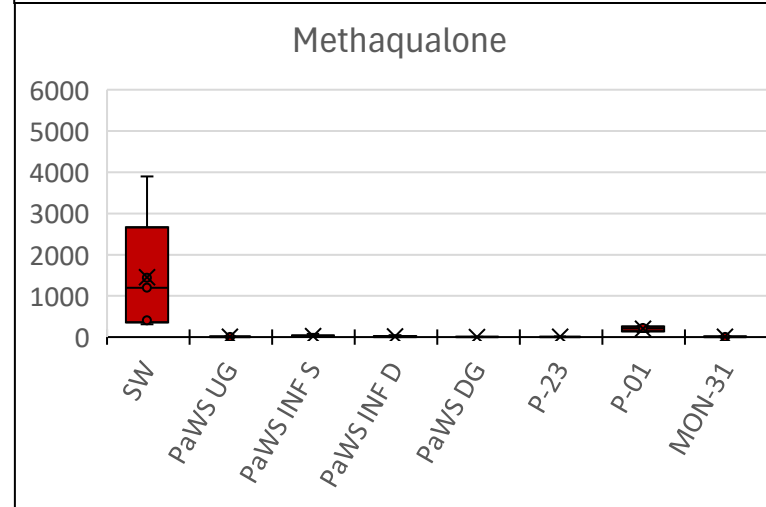
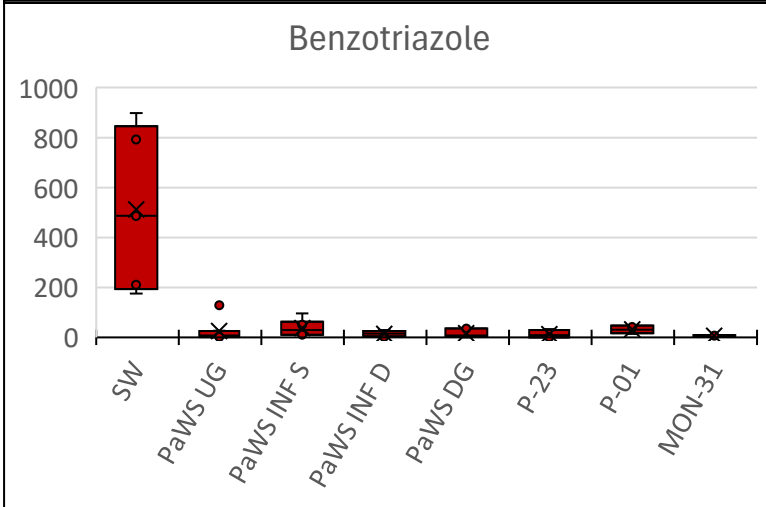
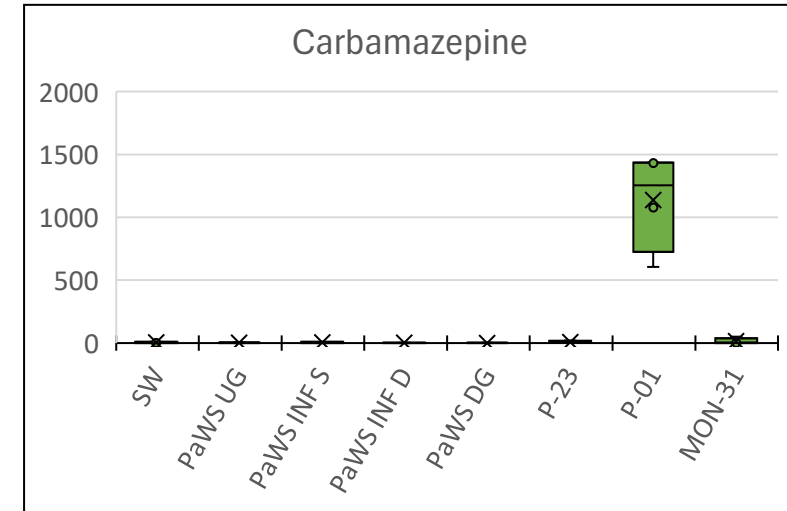
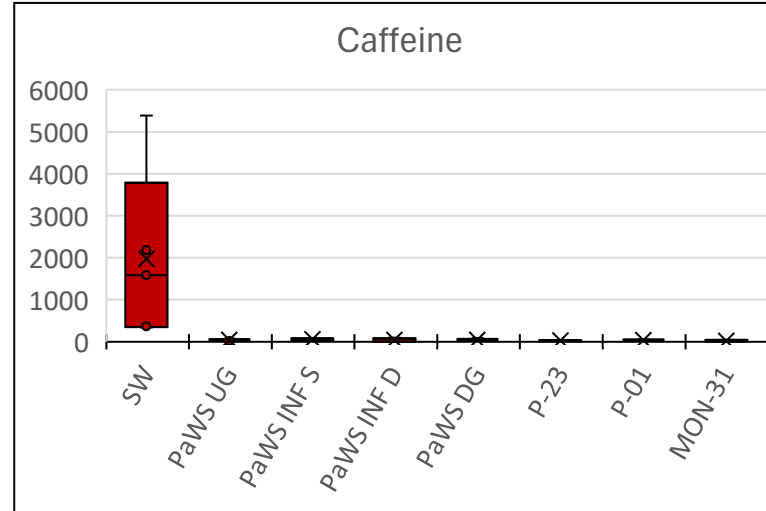
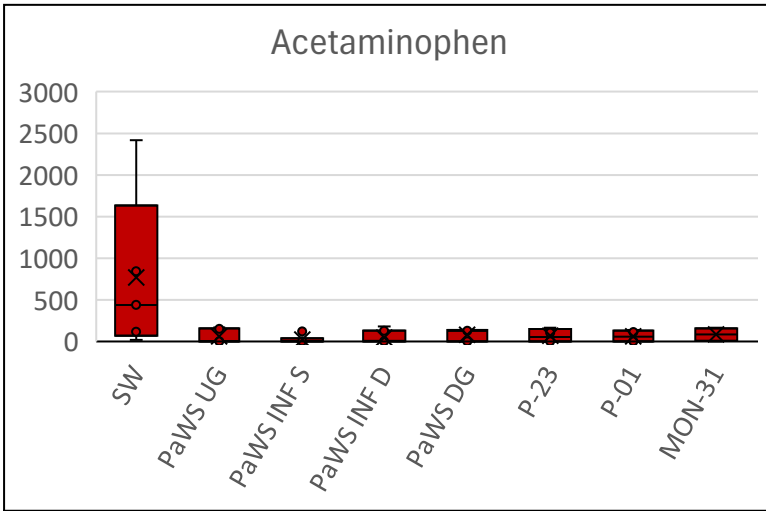
P-01: High TP (35 mg/L), high NH4-N (30 mg/L) and ammonia, relatively high TOC (16 mg/L)

Target CECs (top 8)

Compound	Category	Detections
→ Acetaminophen	Analgesic	98%
Tramadol	Analgesic/Opioid	59%
Codeine	Analgesic/Opioid	9%
Sulfamethoxazole	Antibiotic	28%
Trimethoprim	Antibiotic	39%
Venlafaxine	Anti-depressant	37%
→ Carbamazepine	Anti-epileptic	76%
Cetirizine	Antihistamine	43%
Naproxen	Anti-inflammatory	72%
→ Diclofenac	Anti-inflammatory	80%
→ Emtricitabine	Anti-retroviral	50%
→ Efavirenz	Anti-retroviral	39%
→ Benzotriazole	Corrosion inhibitor	100%
Atrazine	Herbicide	24%
1,7-dimethylxanthine	Human marker	93%
→ Caffeine	Human marker	100%
Methamphetamine	Illicit drug	93%
MDMA	Illicit drug	11%
→ Methaqualone	Illicit drug	98%
Cocaine	Illicit drug	72%
Benzoyllecgonine	Illicit drug metabolite	33%



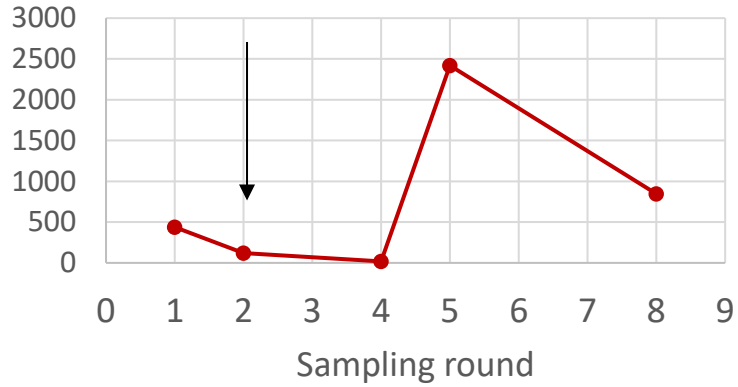
Target CECs (top 6)



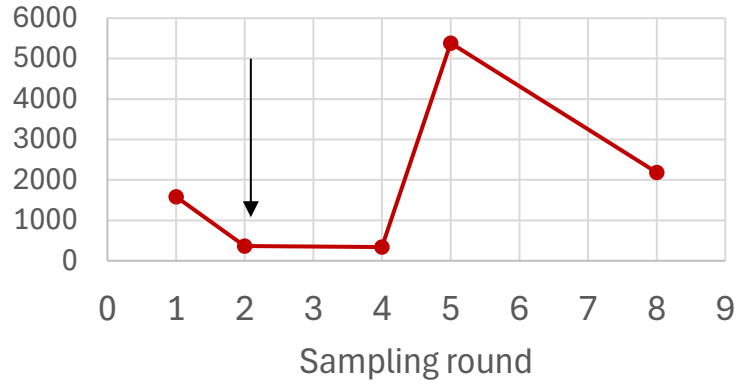
(Units: ng/L)

Target CECs (top 6)

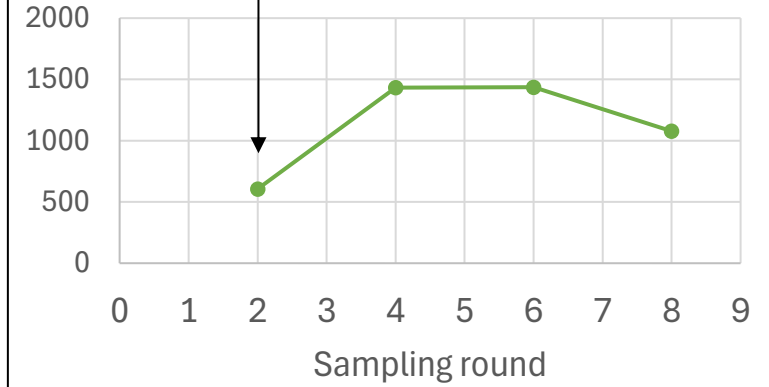
Acetaminophen



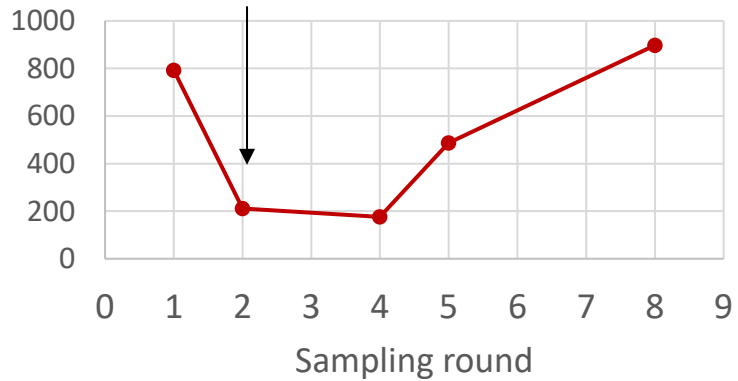
Caffeine



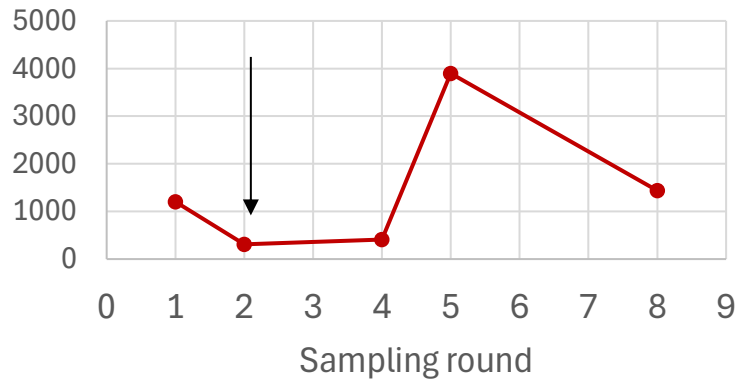
Carbamazepine



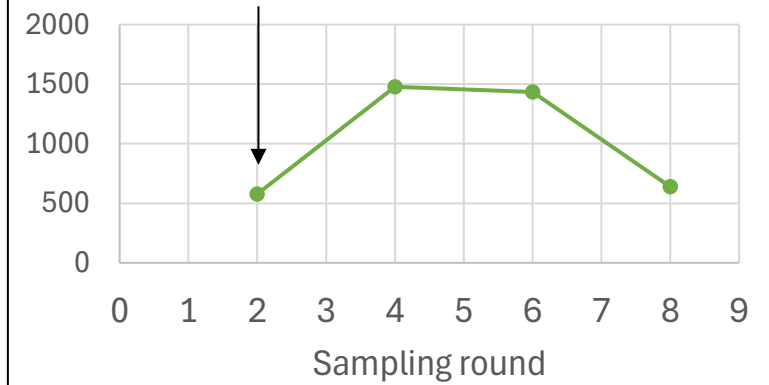
Benzotriazole



Methaqualone



Emtricitabine



Red = SW; Green = P-01 (Units: ng/L)

Conclusions and recommendations

- NTS could complement a targeted monitoring program to identify possible “new” CECs including daughter products
- Frequent monitoring for a selected target list would allow for determination of temporal trends
- Sampling for NTS analysis should then be done at times when CEC concentrations are expected to be highest

Acknowledgements



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