How toxic is toxic?
(I) Toxic components in discharged water

Karen Louise Feilberg, DTU Offshore

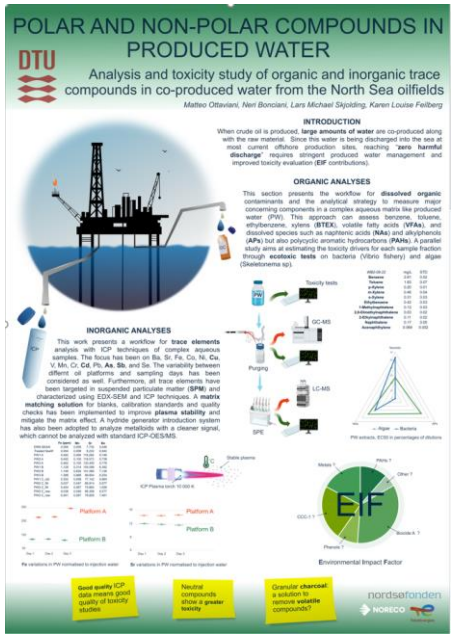
Project: Polar/non-polar species

Research team: Matteo Ottaviani; Neri Bonciani; Karen Feilberg

Objectives:

- Identify key species in PW
- Link components to toxicity
- Variation in samples
- Improve EIF calculation

Poster Yesterday!

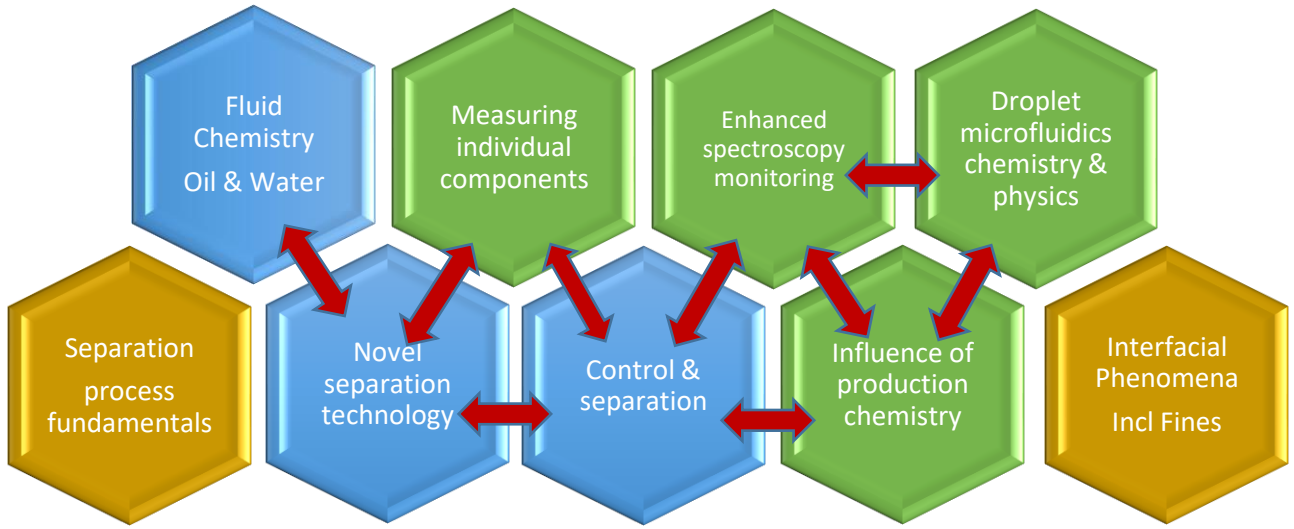


Envisaged application:

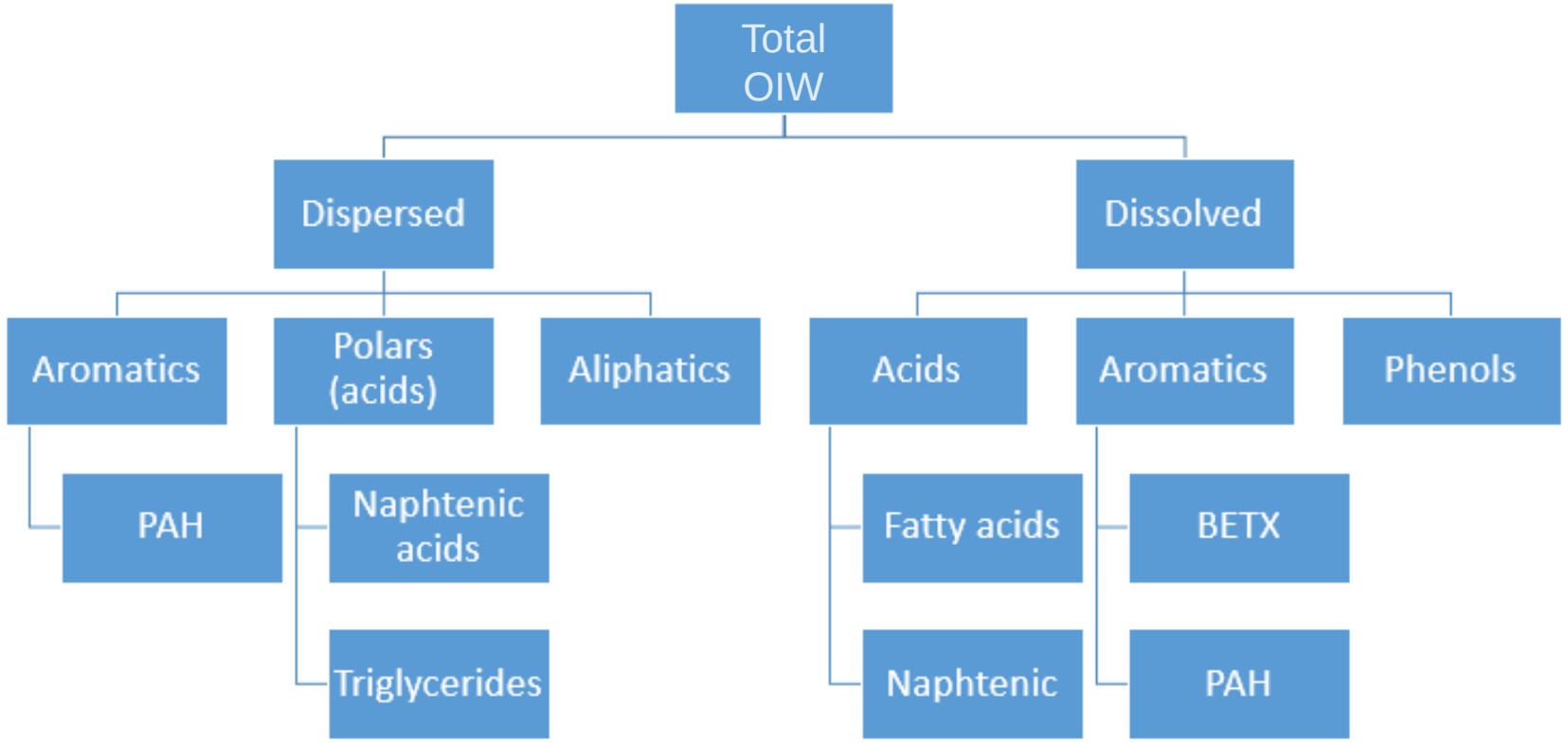
- Environmental monitoring
- Environmental reporting
- Additives management
- Environmental impact

Challenges:

- Sample procurement
- Sample quality
- Complexity of samples
- Salinity of samples

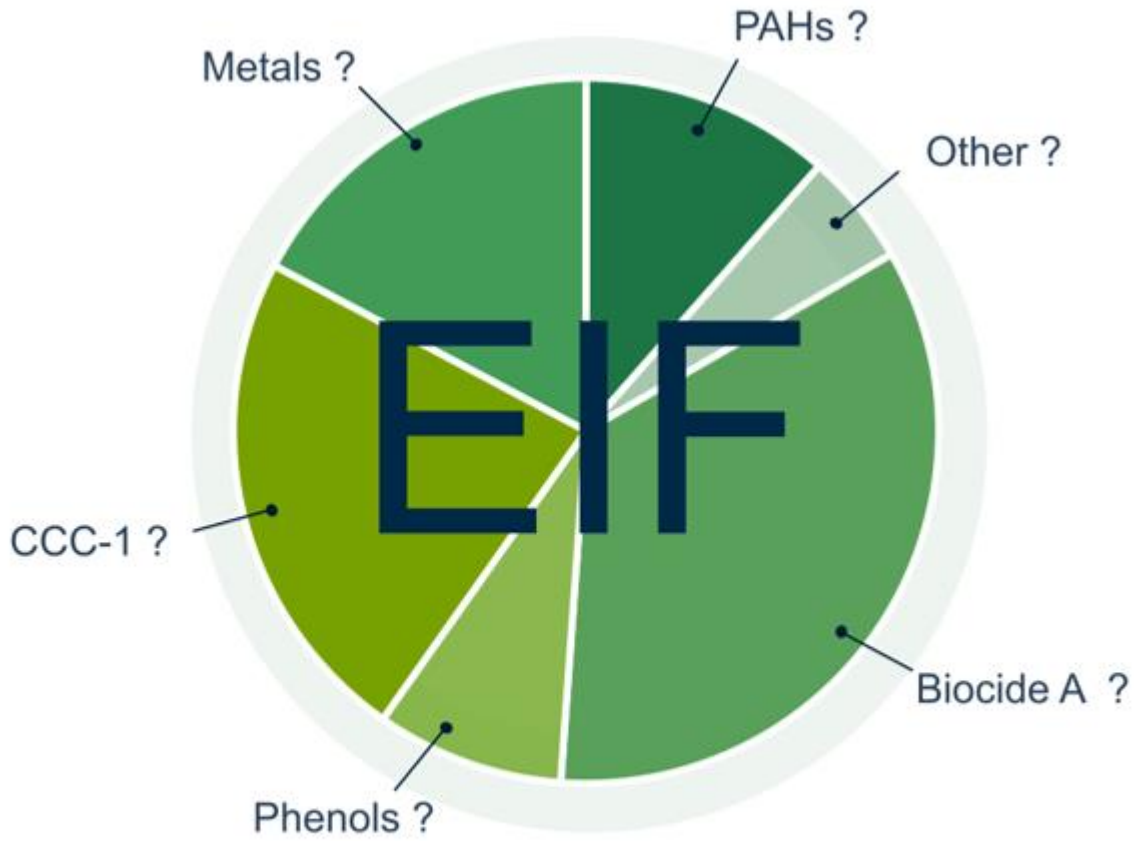


Produced Water – Polar/Non-Polar compounds



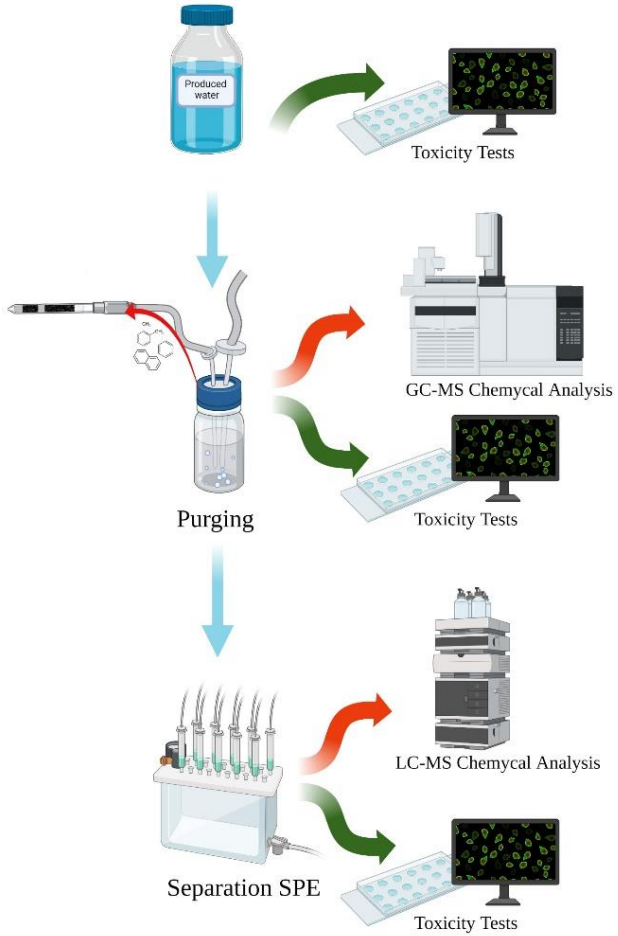
Trace metals in suspended solids

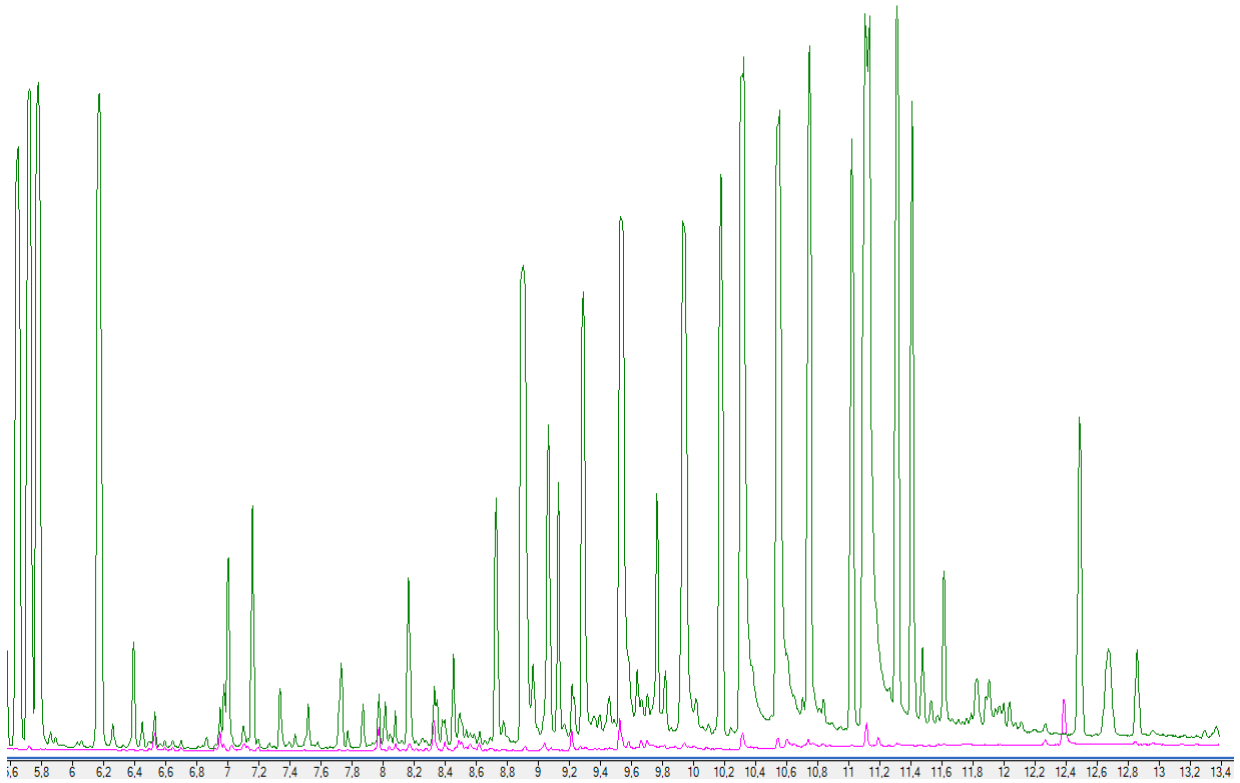
Main ions and trace metals



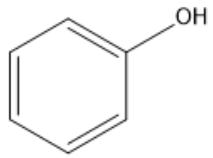
Environmental **I**mpact **F**actor

Workflow for extraction and analysis of organics

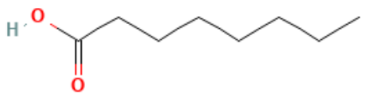




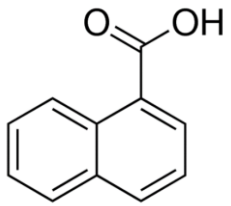
Naphtenic acids and Phenols



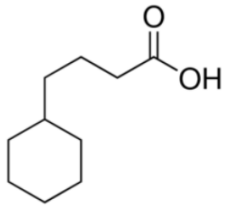
phenol



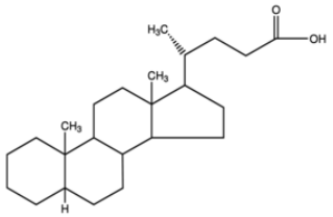
Octanoic acid



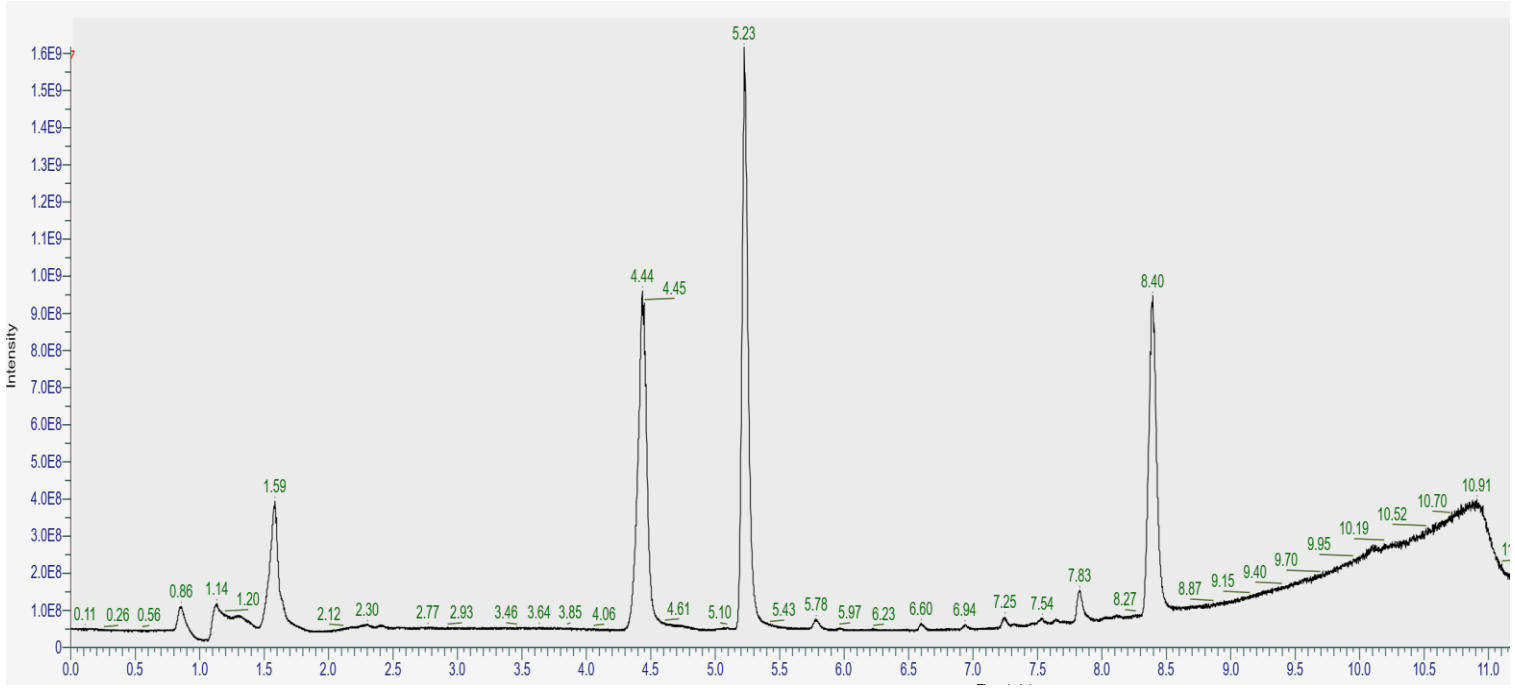
1-naphtoic acid

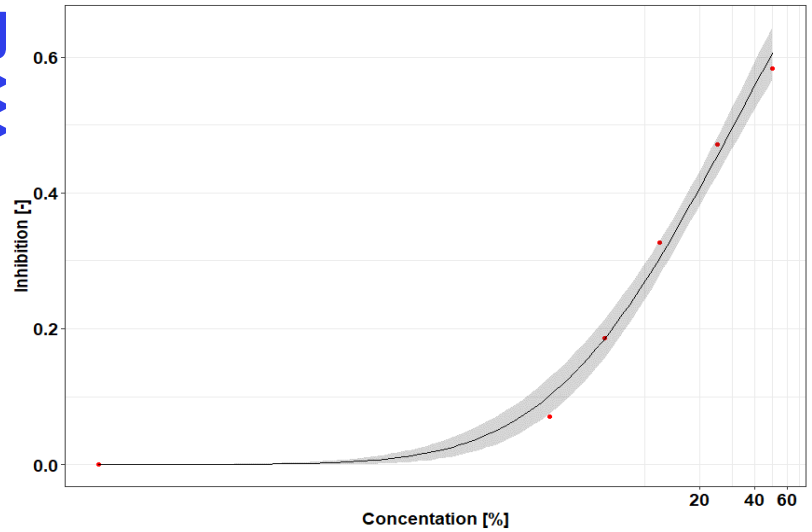


Cyclohexanebutyric acid

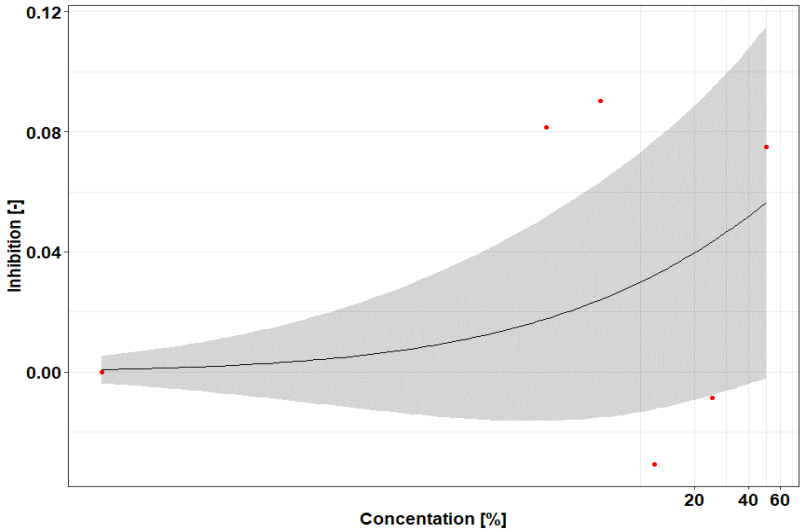


Fraction with 5% formic acid

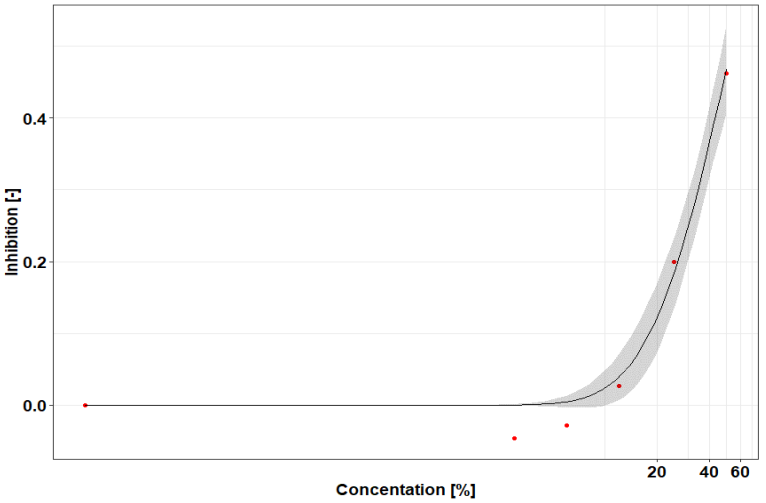




EC50 Naphthenic acids bacteria

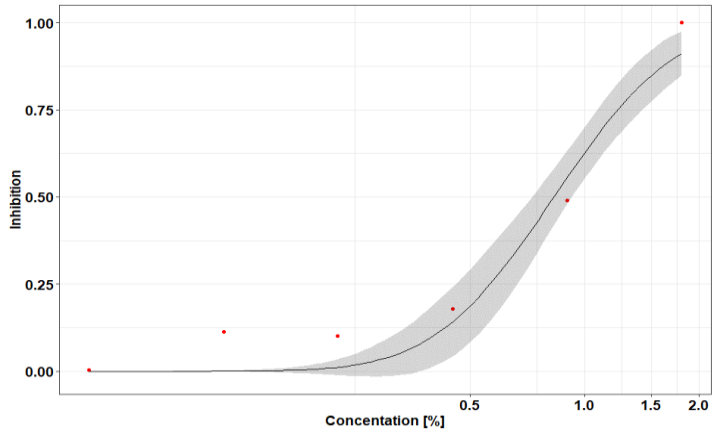


EC50 Phenols bacteria

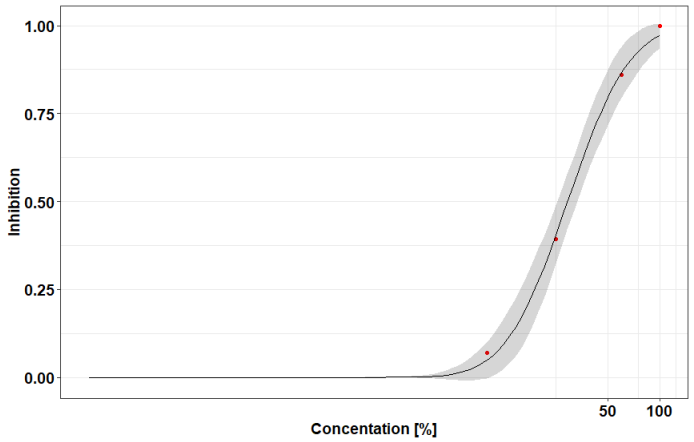


EC50 Neutrals bacteria

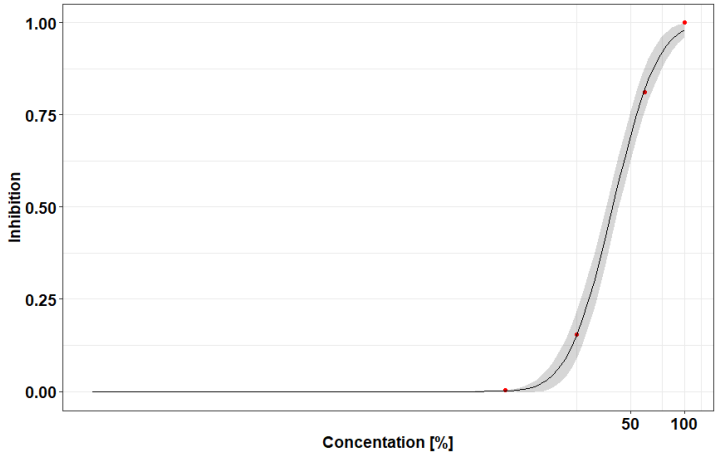
Results are normalized for the residual toxicity of the solvents and cartridges running a parallel toxicity test with blank samples!



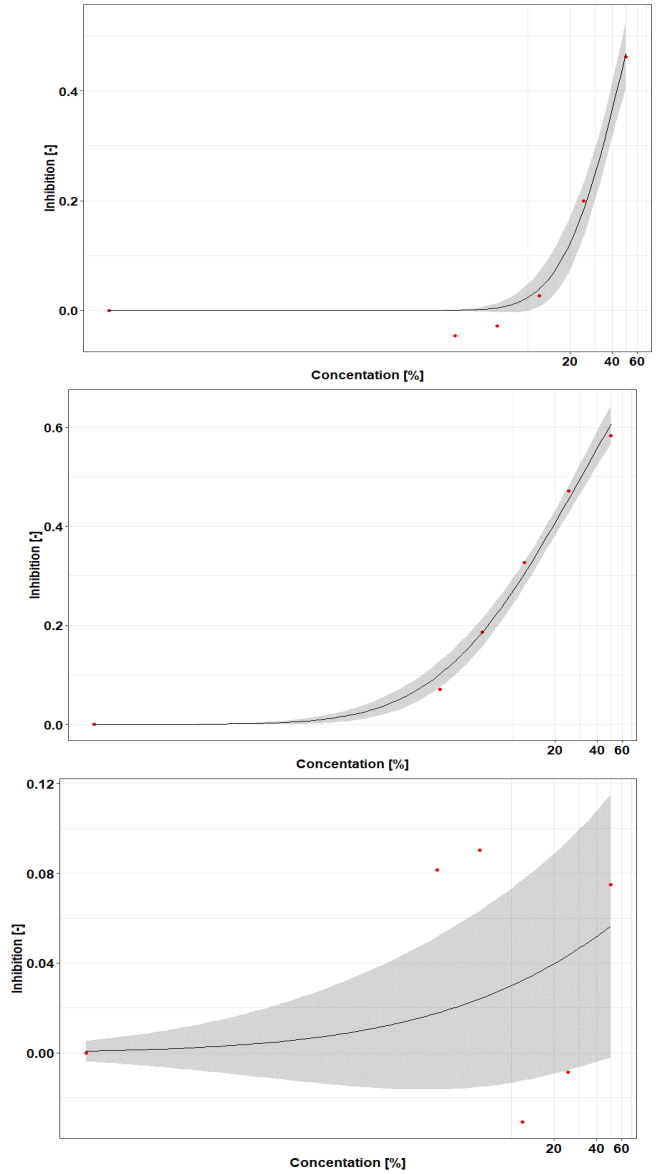
EC50 algae methanol

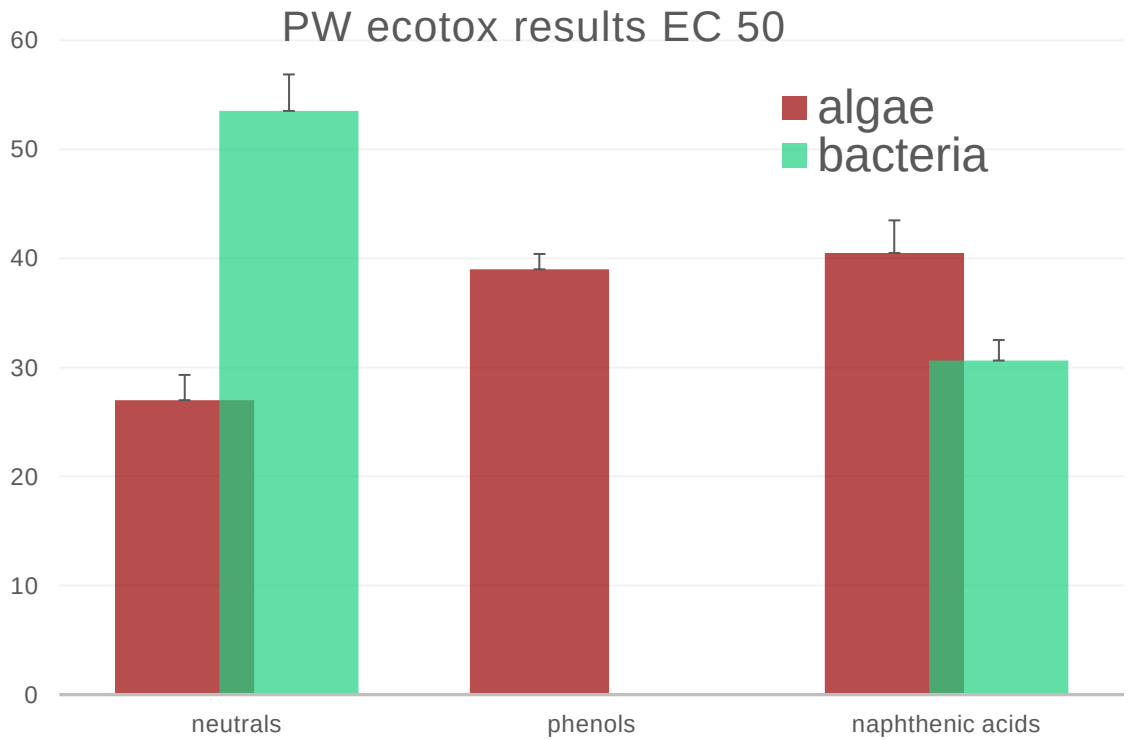


EC50 Algae phenols

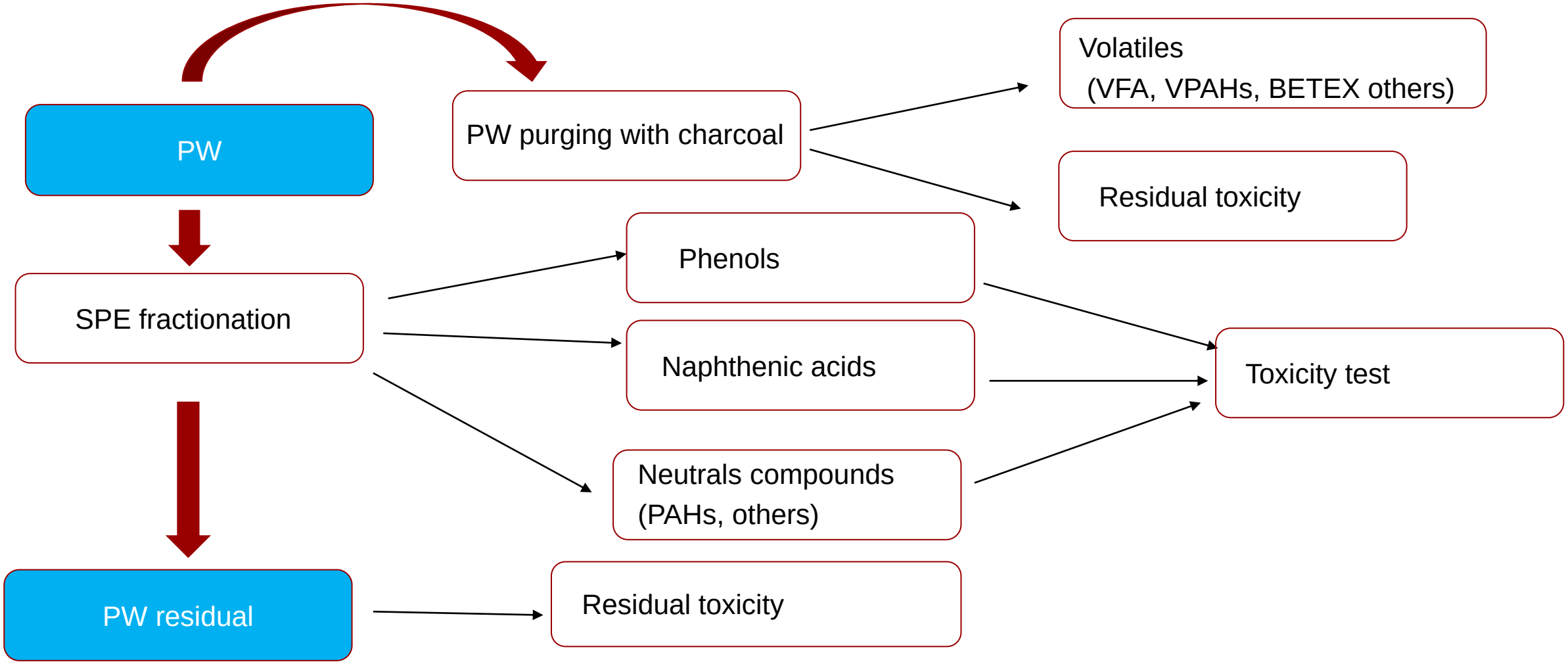


EC50 Algae phenols


Inhibition [-]
0.4
0.2
0.0
20
40
60
Concentation [%]
Inhibition [-]
0.6
0.4
0.2
0.0
20
40
60
Concentation [%]
Inhibition [-]
0.12
0.08
0.04
0.00
20
40
60
Concentation [%]

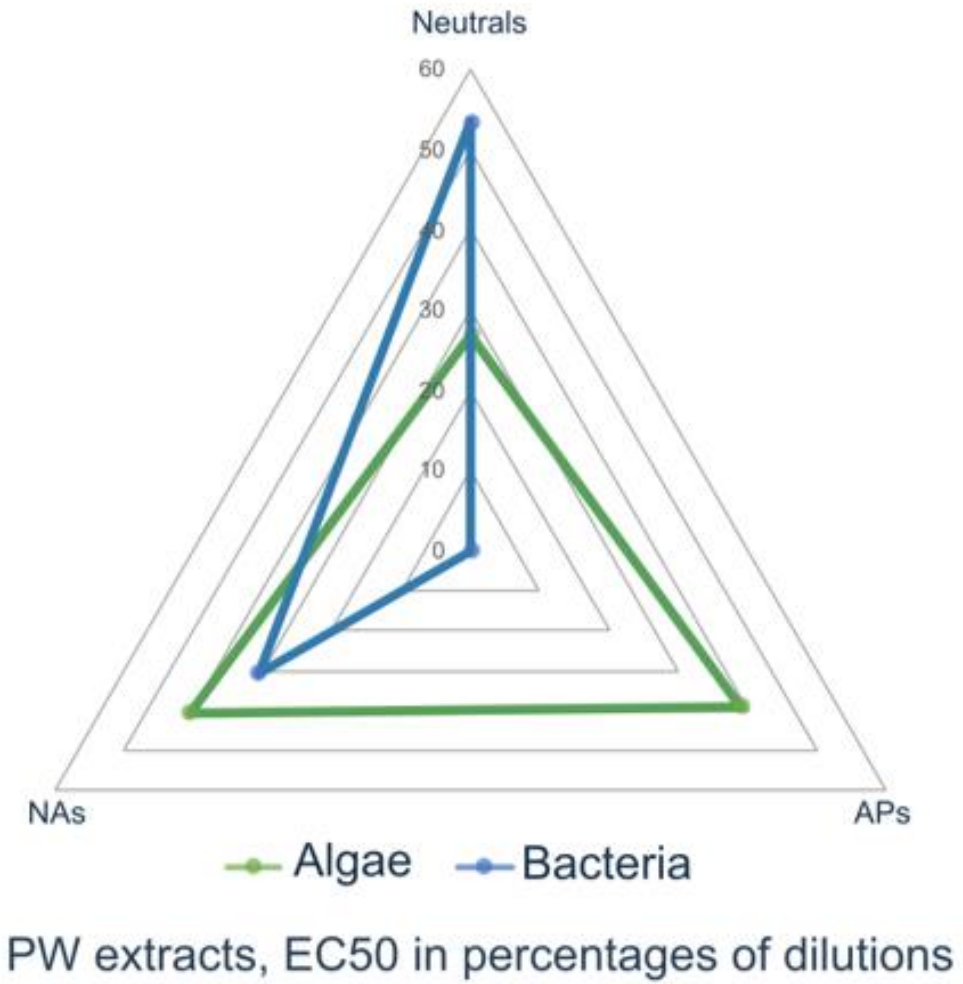

PW ecotox results EC 50
algae
bacteria
60
50
40
30
20
10
0
neutrals
phenols
naphthenic acids

PW scheme of analysis



Field B Sampling date: 31-07-22

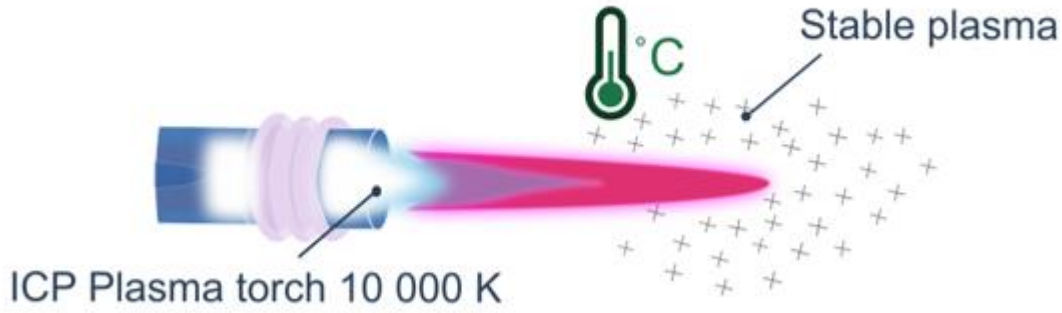
	mg/L	STD
Benzene	2.81	0.02
Toluene	1.83	0.07
P-xylene	0.20	0.01
m-xylene	0.46	0.04
o-xylene	0.31	0.03
Ethylbenzene	0.42	0.03
1-methylnaphtalene	0.13	0.03
2,6-dimethylnaphthalene	0.03	0.02
2-ethylnaphthalene	0.11	0.02
Naphthalene	0.17	0.05
Acenaphthylene	0.069	0.002
Acetic acid	167	10
Butyric acid	84	5
	ug/L	STD
4-terz-octylphenol	3.70	0.02
Octylphenol	8.91	0.04



PW extracts, EC50 in percentages of dilutions

Trace metals and major ions

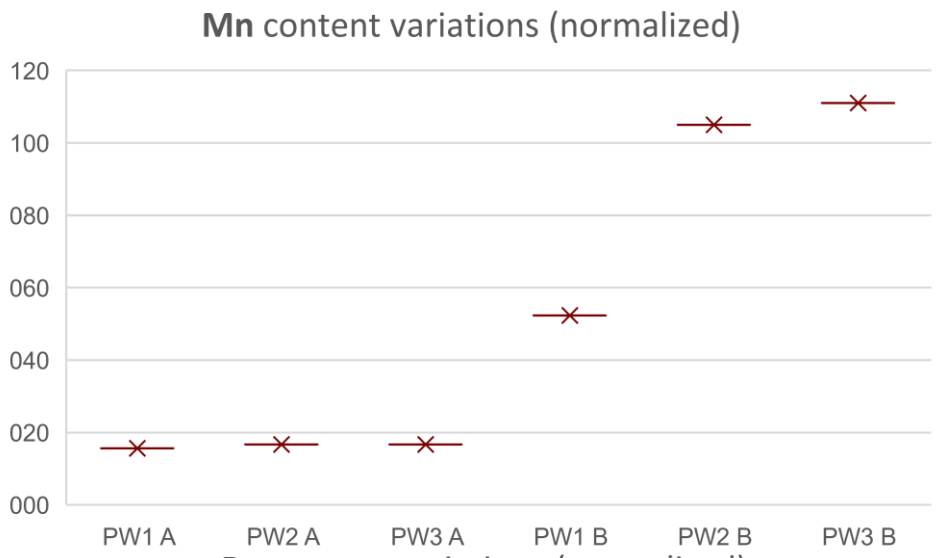
	SAMPLE	Fe (ppm)	Mn	Sr	Ba
Same day	PW1 C OLD	0,306	0,042	68,229	0,572
	PW2 C filtered	0,037	0,047	66,914	0,577
	PW3 C filtered	0,454	0,087	75,883	1,026
	PW2 C initial	0,038	0,046	66,308	0,577
	PW3 C initial	0,461	0,087	76,829	7,461
	Reference seaW	0,006	0,006	7,730	0,046
	Treated seaW	0,004	0,006	8,232	0,042
Different days	PW1 A	0,482	0,094	119,284	0,746
	PW2 A	0,492	0,100	118,572	0,738
	PW3 A	0,462	0,100	120,450	0,778
	PW1 B	1,128	0,314	104,098	6,392
	PW2 B	1,146	0,630	101,580	7,126
	PW3 B	1,388	0,666	99,804	6,254



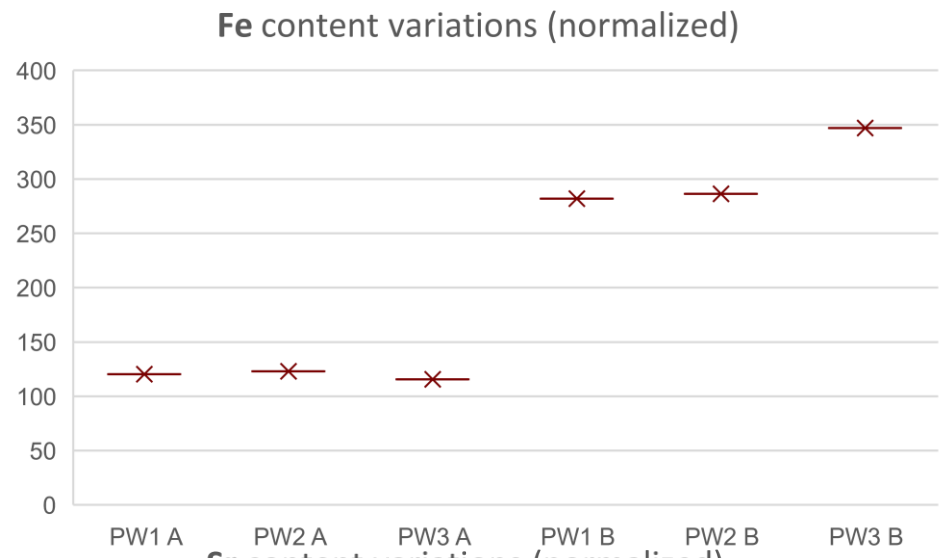
	Fluoride (mg/l)	Acetate	Chloride	Bromide	Nitrate	Sulfate	Sodium	Ammonium	Potassium	Magnesium	Calcium
Treated Sea Water	nd	nd	21310,3	< 1	nd	3718,4	10 698,56	nd	219,5	1230,8	379,4
PW A	1,0	349,7	34867,6	nd	64,7	1713,7	18 114,305	nd	97,429	665,707	863,709
PW C	nd	568,3	29837,0	nd	63,6	708,7					

Concentrations: daily variation

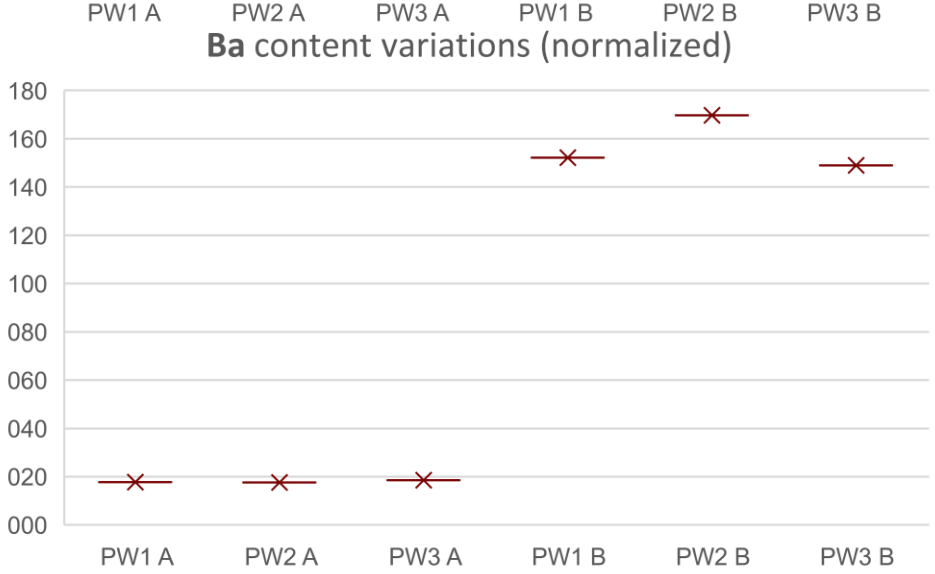
Mn



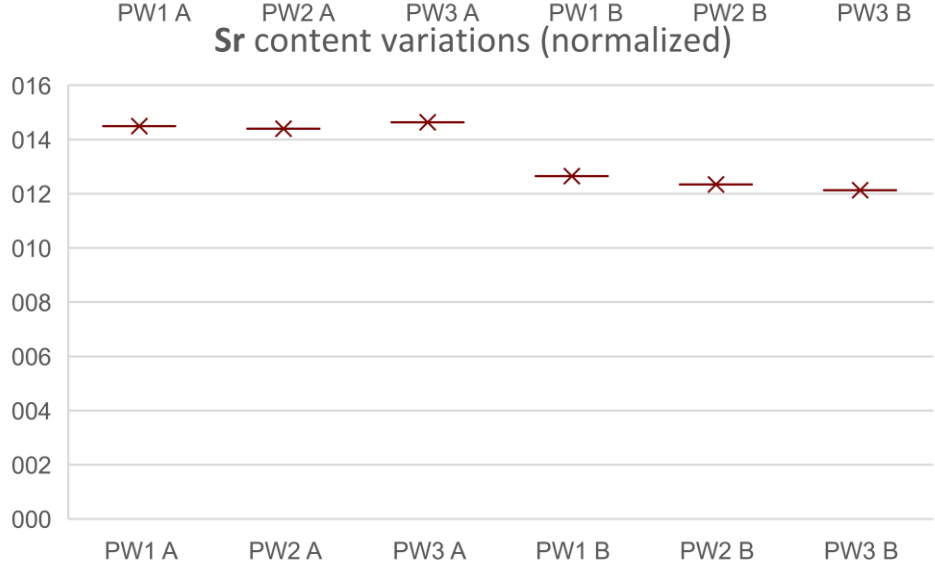
Fe



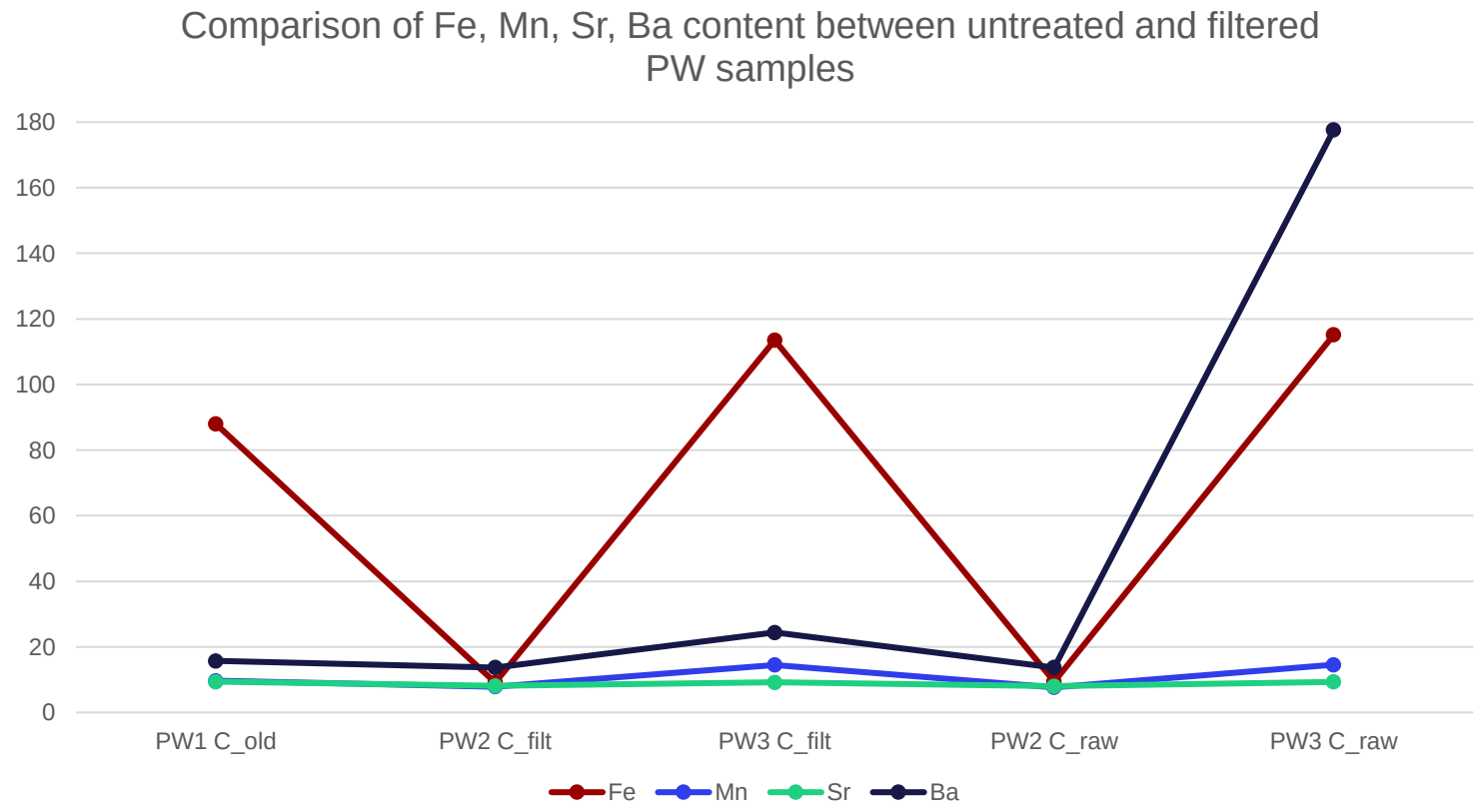
Ba



Sr



Normalized metal concentration values

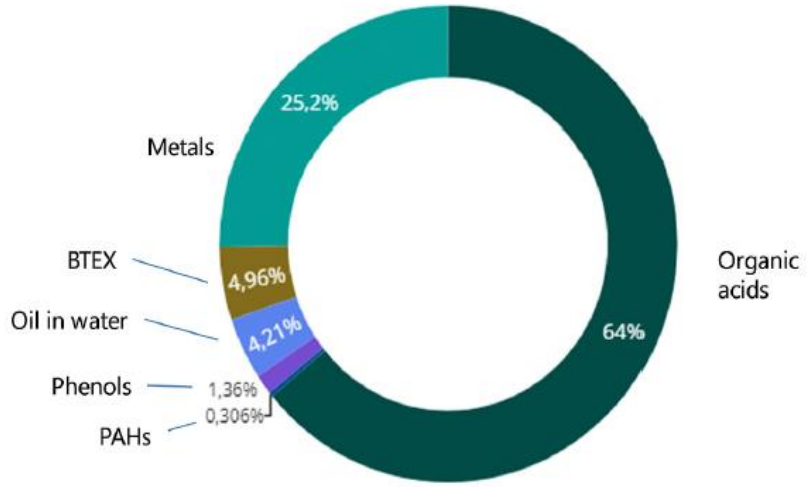


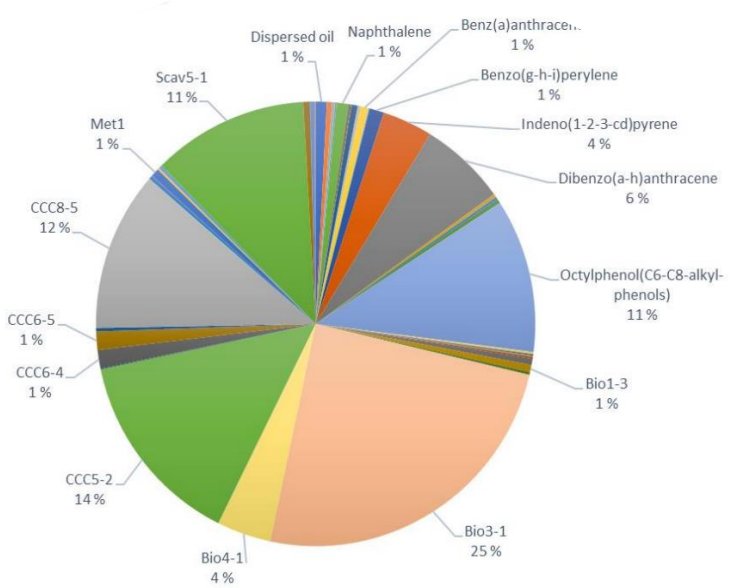
SPM rich in **Ba** species

Fe stays in aqueous phase

15:21

Higher in **Fe!** + Ba and Mn





- Illustration of EIF calculation PEC/PNEC => Risk
- Compounds of interest for further study:

  Heavy metals (detection limits?), specific acid compounds, surfactants, organometallics, structure dependence of PAH.
- Environmental impact based on linking chemistry directly to toxicity

1 Environmental effects of offshore produced water discharges: A review focused on the Norwegian continental shelf J. Beyer, , A. Goksøyr, D. Øystein, J. Klungsøyr

2 Risk Based Approach to Produced Water Management EIF Calculations Total E&P DK 2019 NORCEN Emily Lyng

Thank you for your attention!

Matteo Ottaviani

Neri Bonciani

Thanks to: Lars Michael Skjolding, Anders Baun, Simon Andersen, Charlotte Lassen, Jørgen Rentler Næumann

DTU Offshore
Danish Offshore Technology Centre

TotalEnergies

NORECO

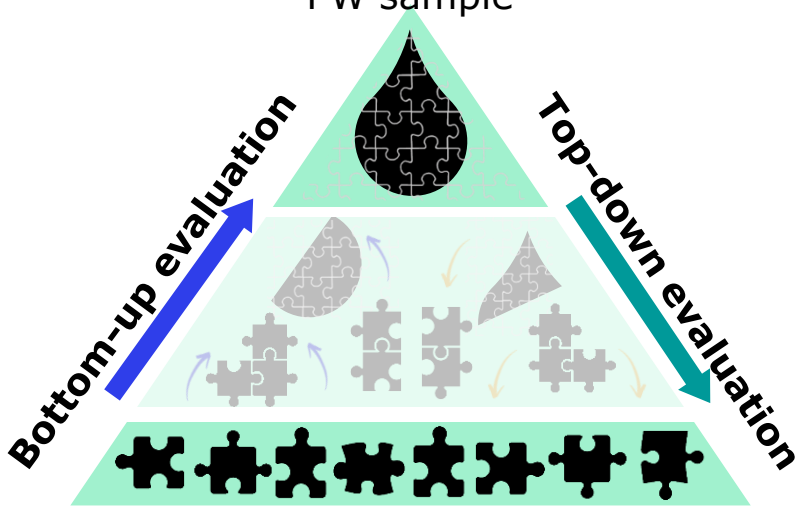
nordsøfonden

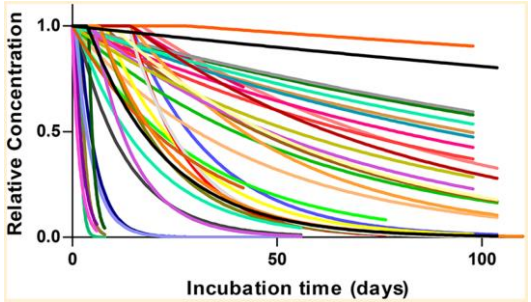
Topics

Legislation

§ Compliance §
???

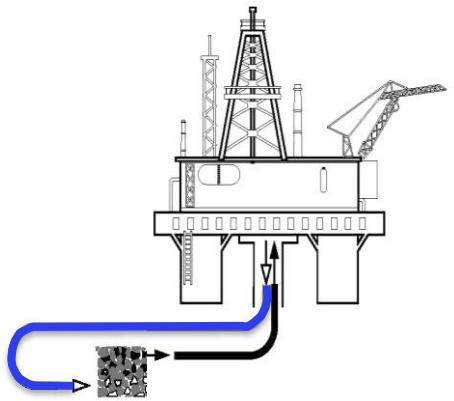
Assessing Environmental Impact
Proposing solutions





Action

One possible solution



Produced water RI