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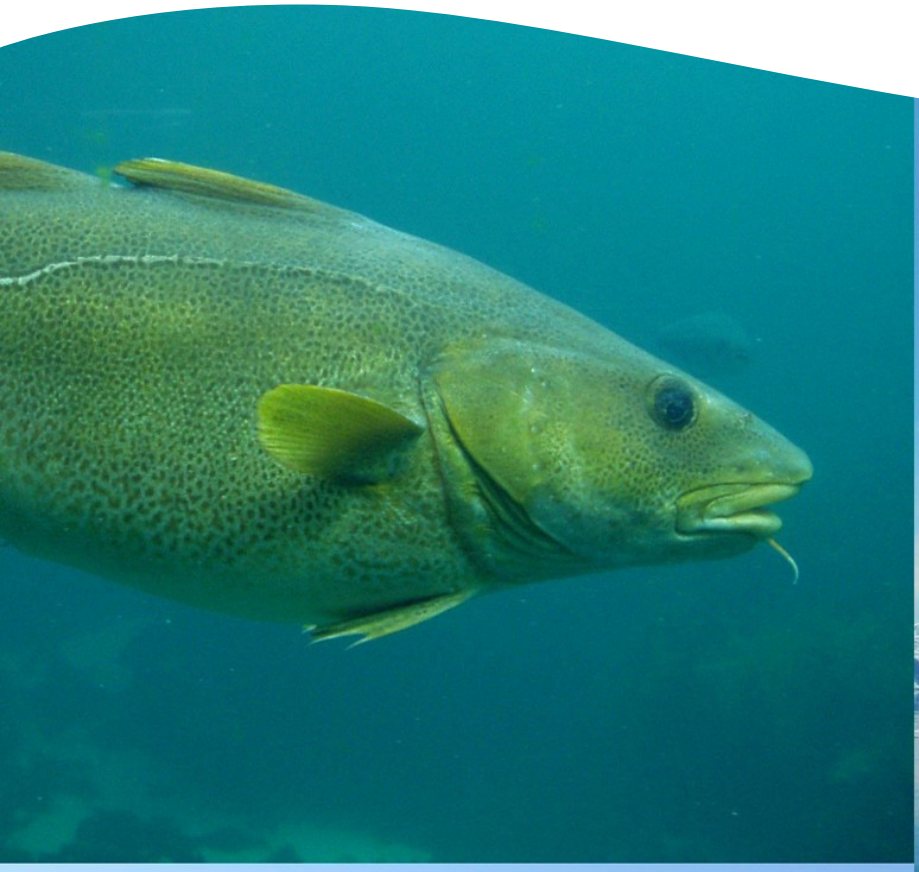
Screening Programme 2021

New Environmental Pollutants



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Summary

The Screening Programme 2021 was carried out by the Norwegian Institute for Water Research (NIVA) and NILU-Norwegian Institute for Air Research. The spotlight was placed on the occurrence and possible environmental problems of 218 chemicals. The selected substances may be included in numerous products and their usage patterns are not easily defined so an array of different locations and sample-types were investigated. The total number of results exceeds 26 000. Results are can be downloaded from the database Vannmiljø.

Four keywords	Fire emneord
1. Screening	1. Screening
2. Emerging contaminants	2. Nye miljøgifter
3. Environmental monitoring	3. Miljøovervåkning
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Screening Programme 2021:
New Environmental Pollutants

Preface

On behalf of the Norwegian Environment Agency (Miljødirektoratet), the Norwegian Institute for Water Research (NIVA) and the Norwegian Institute for Air Research (NILU) have carried out the 2021 screening programme.
Coordinator at the Norwegian Environment Agency (Miljødirektoratet) was Bård Nordbø, and the project manager was Bert van Bavel.

Sampling was carried out by Pernilla Bohlin-Nizzetto, Heidi Eikenes (NILU), Christian Vogelsang, Elisabeth Rødland and Bjørnar Beylich (NIVA). Coordination of sampling equipment and chemical data were carried out by Kine Bæk and Mona Eftekhar Dadkhah (NIVA).
Chemical analyses were performed by Vladimir Nikiforov, Michael Harju, Katrine Aspmo Pfaffhuber, Norbert Schmidbauer (NILU), Thomas Rundberget, and Kuria Ndungu (NIVA). The arctic biota samples were made available by the Norwegian Polar Institute (NP) with the help of Geir Gabrielsen.

Data analyses and reporting were executed by Martin Schlabach, Pernilla Bohlin-Nizzetto, Pawel Rostkowski, Malcolm Reid and Bert van Bavel. Quality assurance was performed by Malcolm Reid (NIVA). Reporting to Vannmiljø and the NORMAN Database was performed by Silje Winnem (NILU).

Oslo,

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Contents

Summary

For the Screening 2021 project more than 170 samples were analyzed for 218 compounds. Samples from indoor air at industrial facilities, tunnel wash run-off, waste recycling facilities and municipal wastewater treatment plants (WWTPs) were analyzed for specific compounds. Biological samples from the Oslofjord and the Arctic were also investigated.

If results are compared simply by reporting the compound with the highest measured concentration in each sample type, the list includes:

- Air - 2,2,4-Trimethyl-1,3-pentanediol diisobutyrate (TXIB, CAS 6846-50-0)
- Dust - 2-Methyl-9,10-Anthraquinone (MAQ, CAS 84-54-8)
- River Water - Trifluoroacetic acid (TFA, CAS 76-05-1)
- WWTP Effluent - 2-NitroAnisole (oNA, CAS 91-23-6)
- WWTP Sludge - Di(2-ethylhexyl) phosphate (HDEHP, CAS 298-07-7)
- Tunnel-wash Water - Monomethyl phthalate (MMP, CAS 4376-18-5)
- Arctic Biota - Bis[2-(perfluorohexyl)ethyl] phosphate (6:2 diPAP, CAS 57677-95-9)

Detection frequency is a useful measure when PNECs are not assigned or unreliable. By this measure perfluoro-1-octanesulfonate (PFOS, CAS 754-91-6) was found with the highest (summed) detection frequency across all sample types. This was followed (in descending order) by:

- 2-NitroAnisole (oNA, CAS 91-23-6)
- Carbazol (Cbzl, CAS 86-74-8)
- Di n-butyl phosphate (HDBP, 107-66-4)
- 2-Methyl-9,10-Anthraquinone (MAQ, CAS 84-54-8)
- 1,4-Dicyanobenzene (pBDN, CAS 623-26-7)
- 2,6-Dichlorobenzonitrile (26DCBN, CAS 1194-65-6)
- Diphenyl phosphate (DPP, CAS 838-85-7)
- 1,3-Dicyanobenzene (mBDN, CAS 626-17-5)

The latter resulted in just half the rate of detection of PFOS.

Of the PFAS compounds included in this investigation, the short chain PFAS such as TFA and Perfluorobutanesulfonate (PFBS, CAS 45187-15-3) were found in water samples, while longer chain PFAS (such as perfluoro-1-undecansulfonate, perfluoro-n-dodecanoic acid and perfluoro-n-tridecanoic acid) were found in sediments, sludges and biota. PFOS was the only example found in all environmental compartments. Such trends match expected partitioning properties of PFAS.
GenX (CAS 62037-80-3) was not found in any samples in this investigation. However perfluoro(perfluoro-ethyl)cyclohexanesulfonate (PFECHS, CAS 67584-42-3) which is an analog and replacement of PFOS was found in the effluent of the Bekkelaget WWTP. The telomer 10:2 Fluorotelomer sulfonic acid (10:2 FTS, CAS 120226-60-0) was measured in WWTP sludge samples and Herring Gulls from Oslo. The 8:2 and 12:2 telomers were also identified in Herring Gull. 6:2 DiPAP was also found in WWTP sludge and Arctic Mussels, but not in the mussel samples from the Olsofjord.

New technologies to screen samples for PFAS compounds were tested on a small selection of samples in this study. Total-Fluor (EOF) was successfully applied, and preliminary results indicate that the level of total-Fluor exceed the sum of targeted analysis. Such results are very useful for determining the proportion of known fluorinated substances with respect to the total.

Measured concentrations of all substances were compared with available PNEC values downloaded from the NORMAN network. While many substances may have unreliable PNECs, the well-studied compounds PFOA and PFOS were found in WWTP effluents and tunnel-wash water at concentrations exceeding their established PNEC values for marine water and /or fresh water. PFOSA (CAS 754-91-6), PFBS-amide (CAS 30334-69-1) and the fluorotelomer FTS 4:2 (CAS 757124-72-4) exceeded the PNEC for biota samples from Oslofjord. Also the levels for PFOS and PFOSA exceeded the PNEC for marine biota.

Several substances that were earlier identified by non-target screening in Arctic Air (Röhler et al. 2020), were also included in the present study as a follow up. This included:

- 2,6-Dichlorobenzonitrile (26DCBN, CAS 1194-65-6)
- 1,4-Dicyanobenzene (pBDN, CAS 623-26-7)
- 2,3,5,6-Tetrachloropyridine (TeCPY, CAS 2402-79-1)
- 2-Chloro-6-Trichloromethylpyridine (CTCMPY, CAS 1929-82-4)
- Diclofluanid (DCFd, CAS 1085-98-9)
- Carbazol (Cbzl, CAS 86-74-8)
- 6H-Benzo[c,d]pyren-6-one (BPon, CAS 3074-00-8)
- 2-Naphthalenecarbonitrile (NCN, CAS 613-46-7)
- 4-Nitroanisole (pNA, CAS 100-17-4)
- 1,3-Dicyanobenzene (mBDN, CAS 626-17-5)
- 1,2-Dicyanobenzene (oBDN, CAS 91-15-6)

These substances were subsequently observed in air and dust samples in the present study, albeit at very low sub-nanogram concentrations. The substances in this group have no common function or use. Several are potential bactericides, fungicides or herbicides (26DCBN, CTCMPY, DCFd). Cbzl occurs in tobacco smoke, while the remaining may be used in the manufacture of polymers.

The Volatile Organic Compounds (VOCs) Tetrafluoroethene (TFE, CAS: 116-14-3, C2F4), Chlorotrifluoroethylene (CTFE, CAS: 79-38-9, C2ClF3), Hexafluoropropene (HFP. CAS: 116-15-4, C3F6) and Freon-C-138 were analyzed by the Medusa method. This is a sample preconcentration and detector system for analysis of atmospheric trace halocarbons, hydrocarbons and sulfur compounds. All analytes were subsequently identified in all air samples except those from Ny-Ålesund.

Metilox (CAS 6386-38-5), Jasminal (CAS 122-40-7) and 1-methoxy-4-(4-propylcyclohexyl)cyclohexane (MPDcH, CAS 97398-80-6) were found in WWTP effluent. Cuminal (CAS 122-03-2), Jasminal and Diethyl 1,4-cyclohexane-dicarboxylate (DEcHDC, CAS 72903-27-6) were found in several of the biota samples including Arctic samples.
Several substances were found at concentrations exceeding PNEC values for marine water and /or fresh water in samples related to WWTP effluents and tunnel-wash water. This included Jasminal, MPDcH, TXiB, Monoethyl phthalate (MEP, CAS 2306-33-4) and Mono(2-ethylhexyl) phthalate (MEHP, CAS 4376-20-9).
Also Phenindione (iMAC-P, CAS 83-12-5), TXIB, HDBP and HDEHP in tunnel-wash exceeded (or were close to) the PNEC for sediment. Cuminal and Diethyl 1,4-cyclohexanedicarboxylate (DEcHDC, CAS 72903-27-6) exceeded PNECs for samples from both the Arctic and the Oslo fjord. oNA, pNA and Octachlorostyrene (OCSt, CAS 29082-74-4) were the only substances from the VOC Group III that exceeded or were close to the PNEC values for the Oslofjord. Concentrations in the marine mussels exceeded PNEC levels in both the Oslofjord and the Arctic for Cbzl and pNA.

Screening Programme 2021

1 Background on the selected compounds

The 2021 Screening Programme of the Norwegian Environment Agency aims at reducing knowledge-gaps for a multitude of chemicals. The compounds have been selected by the Norwegian Environment Agency's screening group on the basis of external and internal input to the screening program 2021. The substances were prioritized based on previous studies in the environment, their physical-chemical properties by QSAR modelling, and the use of these substances in Europe.

The 2021 Screening programme consist of long list of substances with wide-ranging physiochemical properties and fields of application. **See Appendix 1** for a full list of substances included in this investigation.

The set of compounds are mostly related to products with a very general area of use. There is no information indicating that the selected compounds are produced in Norway. Many of the compounds are included as one of several ingredients in various products and materials. These can be plastic, paint, car tires and other rubber products, car parts, electronics, textiles, household chemicals, as well as other products used in private households, crafts and industry, laundries, and leisure boats.

For a rational sampling-design and selection of the most cost-effective and accurate analytical methodology, this set of compounds has been divided into several groups including (i) Metals, (ii) PBT substances, (iii) New PFAS, (iv) Short PFAS, (v) Phos-Phtal, (vi) Anti-oxidants, (vii) Siloxanes, and (viii) MEDUSA-substances. See the Appendix for the full list of substances included in each group.

The grouping is based primarily on physiochemical properties of the substances. Such properties indicate the most appropriate sample-types and analytical method.
Note also that some groups are based on classifications made by the Norwegian Environment Agency during prioritization. This includes specific reference to substances found in Top Predators (no reference has been provided) which are in PBT Group I. Potential PBT substances identified by Zhang et al (2020) are represented in PBT Group II. Substances previously identified in non-target screening of air-samples (Röhler et al 2020, and Röhler et al 2021) are included as VOC Group III.
MEDUSA-substances are a small sub-set of compounds that are analysed by the MEDUSA method.
Further details on the most appropriate analytical methods are provided in §3 Chemical Analysis.

See the following §2 Sampling section for details of sampling scheme appropriate for each substance-group.

2 Sampling

2.1 Rationale for the sampling scheme

The selected substances may be included in numerous products and their usage patterns are not easily defined. As no known production is occurring in Norway, hotspots from factory emissions are unlikely. Waste disposal facilities are however included as potential hotspots in 2021.
The wide array of potential use scenarios for these substances also means that samples of municipal wastewater from a large city are useful. Samples of air and dust from both residential and commercial premises are also relevant.

Tyre-related products associated with vehicle transport, and polymer coatings associated with marine transport are very relevant. Sampling of water from tunnel washes, vehicle wash facilities and winter storage for leisure boats (marinas) were therefore selected as relevant for these substances.
Emissions from of cars in tunnels through tunnel wash samples, car scrapping, and handling of electrical and electronic waste are relevant for the group of rare metals used in car catalysts, batteries and other electronic items.

Emission of substances poorly soluble in water are largely released into the air. This applies siloxanes and similar substances which through their usage pattern end up in wastewater but have a tendency to leave the water phase

into the air. This is also a relevant hotspot for substances with similar physiochemical properties including volatile organic fluorine substances.

The following samples were therefore selected for analysis:

1. Water from the urban river Alna during heavy rain events and dry weather.
2. Wastewater effluent and sludge from Veas and Bekkelaget Wastewater Treatment Plants.
3. Tunnel wash water and sediment was sampled at a heavy-traffic tunnel in Oslo (Smestad tunnel).
4. Indoor air and settled dust from residential, public areas and equipment stores.
5. Air and dust from waste disposal and recycling facilities (potential hotspots).
6. Outdoor air from urban locations in Oslo and background monitoring stations in southern and Arctic Norway.
7. Herring gull eggs and blue mussels from the Inner Oslo Fjord that represent both a contaminated marine and terrestrial food chain (sampling under the auspices of the Urban Fjord project).
8. Liver of whiting and Arctic cod
9. Arctic bird eggs, Arctic mussel and plasma from polar bears

See Table 1 for details of the most appropriate sample-type for each group of substances.

NIVA performed sampling of all water-related and biota samples, while NILU carried out sampling of air and settled dust. The Norwegian Polar Institute (NP) was responsible for the biota samples from the arctic.

Sampling and handling of the samples was carried out in the cleanest possible way to minimize risk of contamination. One of the measures was to avoid the use of personal care products such as shampoos and creams one day before collection of samples. The guidelines for sampling to the Environmental Specimen Bank were used where possible (ESB 2021, https://miljoprovebanken.no/innsamling-og-provetaking). Field-blanks and laboratory-blanks are also analysed. This includes unexposed material (filters and passive samplers) for air samples, and well characterized samples of biota which are taken out and stored as blank samples.

Table 1.Summary of the selected sample-matrices most appropriate for each group of substances[¤]. Coloured squares indicate samples were analysed for the given group. White squares indicate analysis was not carried out for the given compound group in that sample-type.

[¤]*See Appendix 1 for the list of substances in each group. See §1 Background on the selected compounds for more information on groups*

		Me	PBTs			PFAS				VOCs			Other	
		Metals	PBT Group I	PBT Group II	PBT Group III	New PFAS	Short PFAS	Total-F	TOPA	MEDUSA	Siloxanes	VOC Group III	Phos-Phtal	AntiOx
Location	**Matrix**													
1.House dust														
Housing Industry buildings	Indoor Air													
	House dust													
2. WWTP														
Effluent WWTP Alna river	Effluent WWTP													
	Sludge													
	Water/Sediment													
	Air													
3. Hot spot														
Hotspot: Tunnel wash	Effluent													
	Sludge													
Hotspot: Waste treatment	Air													
	Dust													
4. Biota														
Oslofjord	Cod Liver													
	Gull Eggs													
	Blue Mussels													
Arctic	Polar Bear													
	Gull Egg													
	Mussels													
	Cod Lever													
5. Other relevant samples														
Air	Urban													
	Rural													
	Arctic													

2.2 Indoor air and dust samples

Sampling of indoor environments was carried out in both residential and public environments. In total, seven residential sites and seven public sites in the Oslo area were included. No specific criteria for the residential buildings were used for the selection in 2021. The public environments included equipment stores of furniture, electronics, clothes, and outdoor equipment, an indoor playland and a public garage. At the furniture store, samples were collected at two locations. The residential sites included terrace houses (TH), single-family houses (SFH) and apartments (AB).

The screening of indoor environments was performed by collecting settled dust samples and two types of air samples. The settled dust samples were collected from floors with a specially designed vacuum cleaner. Air samples were collected on ABN adsorbent for analyses of volatile to semi volatile chemicals and as grab samples in canisters for analyses of VOCs. The ABN adsorbents were deployed as active air samples with a pump sampling for 24 hrs. The sampling was conducted in the main living area of the residential sites, and in representative areas of the public sites. All samples were collected at 1-2 m height. Details on sampling sites are given in Table 2
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Table 2. Description of the residential and public indoor sites and samples collected at each site.

Site ID	Type*	Details	Dust	Air - SVOCs	Air - VOCs
Public 1	NRB	Shop	Floor dust	Active air sampling (24 hr), ABNx2	Grab sampling (few min), Canister
Public 2	NRB	Shop	Floor dust	Active air sampling (24 hr), ABNx2	Grab sampling (few min), Canister
Public 3	NRB	Garage	Floor dust	Active air sampling (24 hr), ABNx2	Grab sampling (few min), Canister
Public 4	NRB	Playland	Floor dust	Active air sampling (24 hr), ABNx2	Grab sampling (few min), Canister
Public 5	NRB	Shop	Floor dust	Active air sampling (24 hr), ABNx2	Grab sampling (few min), Canister
Public 6	NRB	Shop	Floor dust	Active air sampling (24 hr), ABNx2	Grab sampling (few min), Canister
Public 7	NRB	Shop	Floor dust	Active air sampling (24 hr), ABNx2	Grab sampling (few min), Canister
Private 1	TH		Floor dust	Active air sampling (24 hr), ABNx2	Grab sampling (few min), Canister
Private 2	TH		Floor dust	Active air sampling (24 hr), ABNx2	Grab sampling (few min), Canister
Private 3	SFH	Split	Floor dust	Active air sampling (24 hr), ABNx2	Grab sampling (few min), Canister
Private 4	SFH		Floor dust	Active air sampling (24 hr), ABNx2	Grab sampling (few min), Canister
Private 5	TH		Floor dust	Active air sampling (24 hr), ABNx2	Grab sampling (few min), Canister
Private 6	SFH	Split	Floor dust	Active air sampling (24 hr), ABNx2	Grab sampling (few min), Canister
Private 7	AB		Floor dust	Active air sampling (24 hr), ABNx2	Grab sampling (few min), Canister

*SFH: Single-Family House; TH: Terrace House; AB: Apartment Block; NRB: Non-residential building

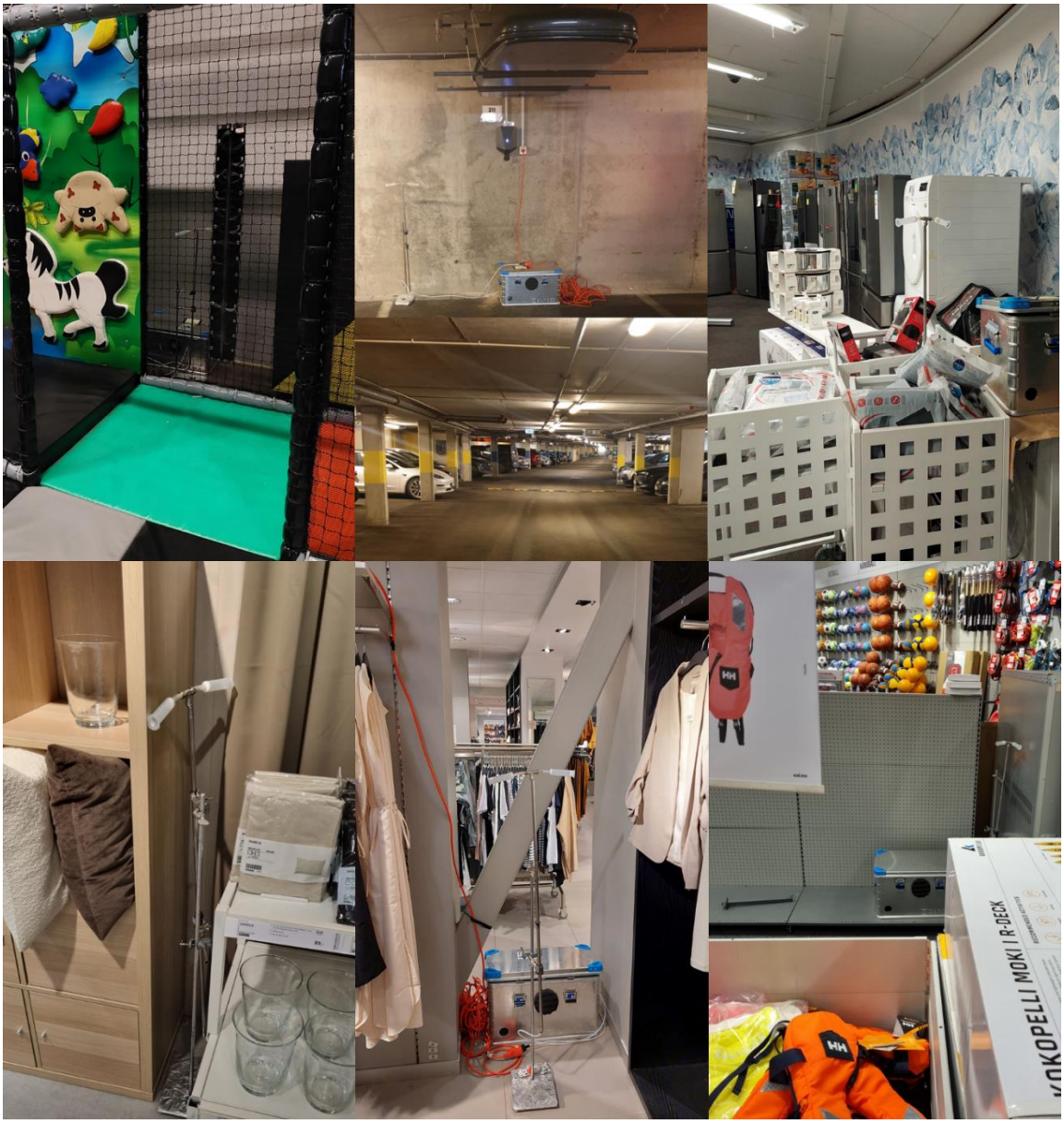


Figure 1. Indoor sampling at public locations. (Photo: Dorothea Schulze, Even Teigland, NILU.)

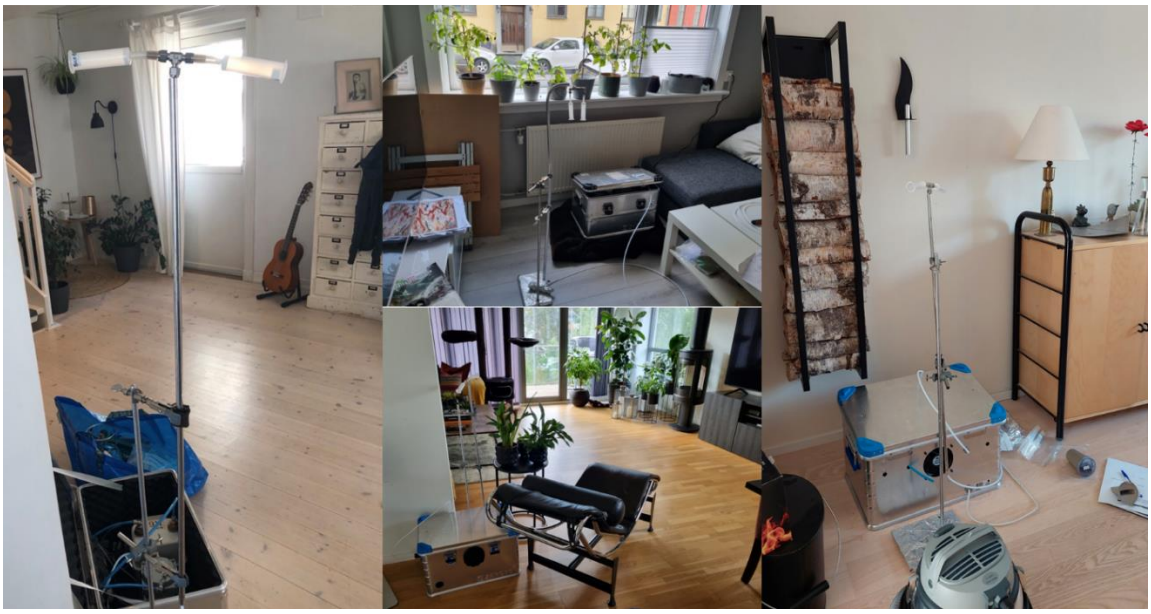


Figure 2. Indoor sampling at residential locations. (Photo: Heidi Eikenes, Dorothea Schulze, Even Teigland, NILU.)

2.3 Potential hotspot samples – waste disposal and recycling facilities

The selection of potential hotspots was based on the use categories for targeted chemicals. The sampling covered three waste disposal and recycling facilities, one car wrecking facility and one wastewater facility. Samples were taken indoors and outdoors at three of the facilities, resulting in total seven samples. See Figures 3 and 4.
Additional details on sampling sites are given in Tables 3 and 4.

The screening of potential hotspots was performed by collecting two types of air samples and settled dust. Settled dust samples were collected from the ground outdoors or floors indoors of the facilities with the specially designed vacuum used in indoor environments.
Airborne particles were collected on filters using low-volume active air samplers. The samples were collected over 24 hrs. Air samples for VOC analyses were collected as grab samples in Canisters.

Figure 3. Sampling locations at the WWTP at Bekkelaget, from left to right sample C1, sample C2 and C3-6, samples taken in March 2022 (Photo Vogelsang, NIVA).

Figure 4. Indoor and outdoor sampling at waste disposals and recycling, and car wrecking facilities. (Photo: Dorothea Schulze, Even Teigland, NILU.)

Table 3 Description of the potential hotspots sites and samples collected at each site.

Site ID	Details	Dust	Air - SVOCs	Air - VOCs	Air - Particles
Recycling facility 1	Indoor	Settled dust	-	Grab sampling (few min), Canister	Low-volume active air sampling (filter)
Recycling facility 1	Outdoor	Settled dust	-	Grab sampling (few min), Canister	Low-volume active air sampling (24 hr), filter
Recycling facility	Outdoor	Settled dust	-	Grab sampling (few min), Canister	Low-volume active air sampling (24 hr), filter
Recycling facility	Outdoor	Settled dust	-	Grab sampling (few min), Canister	Low-volume active air sampling (24 hr), filter
Recycling facility	Outdoor	Settled dust	-	Grab sampling (few min), Canister	Low-volume active air sampling (24 hr), filter
Car wrecking 1	Indoor with exhaust	Settled dust	-	Grab sampling (few min), Canister	Low-volume active air sampling (24 hr), filter
Car wrecking 1	Outdoor	Settled dust	-	Grab sampling (few min), Canister	Low-volume active air sampling (24 hr), filter
Car wrecking 1	Indoor without exhaust	Settled dust	-	Grab sampling (few min), Canister	Low-volume active air sampling (24 hr), filter

Table 4. Air sampling at the Bekkelaget wastewater treatment plant.

Sample	Date	Location at the waste water treatment facility
C1	2021-08-23	Right next to the hatch (closed) while I was putting on test 5
C2	2021-08-31	Right next to the hatch (closed) while I was putting on test 6
LV1	2021-06-28	Under the lid and grid in air tank Bio2 (rel. early in the pool)
LV2	2021-07-05	Under the lid and grid in air tank Bio2 (rel. early in the pool)
LV3	2021-08-16	Under the lid and grid in air tank Bio2 (rel. early in the pool)
LV4	2021-08-18	Under the lid and grid in air tank Bio2 (rel. early in the pool)
LV5	2021-08-23	Under the lid and grid in air tank Bio2 (rel. early in the pool)
LV6	2021-08-31	Under the lid and grid in air tank Bio2 (rel. early in the pool)
C1	18-03-2022	Above inlet channel
C2	18-03-2022	Through hatch when thrown into grating tank
C3	18-03-2022	Through the air hatch above the last part of the aerated tank (nitrification tank) – 36 m from the top of the tank
C4	18-03-2022	Through the air hatch above the middle part of the aerated tank (nitrification tank) - 15 m from the top of the tank
C5	18-03-2022	Through the air hatch above the first part of the aerated tank (nitrification tank) - 3 m from the top of the tank
C6	18-03-2023	Through air hatch above post-nitrification stage

LV = Large Volume sampling, C = Cannister grab sample.

2.4 Urban and background air samples

Air samples were collected at four urban sampling stations and two background sampling stations. All stations are used for continuous monitoring of other chemicals and/or air quality parameters in air. The two background monitoring stations are included in the national monitoring programme for Atmospheric contaminants (Birkenes and Zeppelin).

Air samples were collected using three sampling strategies depending on targeted chemicals and sample location. Details on sampling sites are given in Table 5. Air samples for VOCs in air were collected as grab samples in stainless steel Canisters in indoor environments, potential hotspots and urban air stations while using MEDUSA instrument at the background air stations.

i) Air samples for volatile to semivolatile chemicals were collected on ABN adsorbents using low-volume active air samples (flow rate of ~0.7 m3/hr, sampling times ~24 hrs). The ABN adsorbent is used for monitoring of siloxanes and volatile fluorinated and chlorinated substances in the Norwegian monitoring programme for Atmospheric contaminants (Bohlin-Nizzetto et al. 2022, Warner et al. 2020). It is also shown to provide clean extracts and low background for non-target screening analyses.

ii) Air-borne particles for analysis of REEs were collected on 47 mm Fluoropore PTFE membrane filters (Millipore) using low-volume active air samples (single-filter Kleinfiltergerät, Svein Leckel Ingenieurbüro GmbH) equipped with a PM10 inlet to discriminate against particles larger than 10 µm. Sampling times were ~24 hrs, the flow rate 50 m^3 per hour resulting in air volumes of 1200 m3.

Table 5. Description of the air samples at the urban and reference sites.

Site ID	Details	Air - SVOCs	Air - VOCs
Urban air 1	Bjørvika	Active air sampling (72 hr), ABNx2	Active air sampling (30 min), Tenax
Urban air 2	Bjørvika	Active air sampling (72 hr), ABNx2	Active air sampling (30 min), Tenax
Urban air 3	Sofienbergparken	Active air sampling (72 hr), ABNx2	Active air sampling (30 min), Tenax
Urban air 4	Bryn	Active air sampling (72 hr), ABNx2	Active air sampling (30 min), Tenax
Urban air 5	Kirkeveien	Active air sampling (72 hr), ABNx2	Active air sampling (30 min), Tenax
Urban air 6	Kirkeveien	Active air sampling (72 hr), ABNx2	Active air sampling (30 min), Tenax
Background air 1-6	Zeppelin	Active air sampling (72 hr), ABNx2	Active air sampling (30 min), Tenax
Background 7-12	Birkenes	Active air sampling (72 hr), ABNx2	Active air sampling (30 min), Tenax

2.5 Sampling of municipal wastewater and final treated sludge

Flow-proportional 24-hour composite samples of fully treated effluent were collected from VEAS and Bekkelaget wastewater treatment plants (WWTPs). The plants' own automatic composite samplers were used for sampling. Table 6 shows the time period for sampling, the total amount of wastewater that was treated at the two plants during each sampling campaign, the ratio of the wastewater that went through only partial treatment (bypassed the biological treatment step), as well as the suspended solids (SS) concentration in each individual water sample (measurements made by the plants themselves).

In addition, samples were collected of stabilized dewatered sludge; the same that is transported away from the plant at Bekkelaget WWTP but prior to addition of slaked lime at VEAS. At Bekkelaget WWTP the samples were taken as daily grab samples on weekdays from each of the centrifuges in use at the time of sampling. At VEAS the daily grab samples were taken from each of the sludge silos (storage tanks) during weekdays. Each subsample was frozen and

transported to NIVA where they were thawed before preparation of the composite sample, which was then frozen again. Table 7 shows the total sludge production at the plants as well as the solids content and organic content (loss on ignition; LOI) of the sludge during each sampling period (measurements made by the plants themselves).

Table 6. Period for sampling of treated effluent for analysis of environmental contaminants at VEAS and Bekkelaget WWTPs. The samples were taken as water flow-proportional samples with the plants' own automatic composite sampler. The concentrations of suspended solids (SS) (the plants' own measurements) and the amount of wastewater that was treated at the plant during each sampling campaign.

Start	End	SS mg/L	Total treated volume m^3	Ratio reduced treatment %
VEAS WWTP				
21.6.21 08:00	22.6.21 08:00	-	410 927	24*
22.6.21 08:00	23.6.21 08:00	-	325 754	8.8*
23.6.21 08:00	24.6.21 08:00	-	246 275	0
23.8.21 08:00	24.8.21 08:00	-	190 719	0
24.8.21 08:00	25.8.21 08:00	-	182 848	0
25.8.21 08:00	26.8.21 08:00	1.6	190 806	0
Bekkelaget WWTP				
21.6.21 07:30	22.6.21 07:30	0.51	281 769	0
24.6.21 07:30	25.6.21 07:30	1.02	121 924	0
25.6.21 07:30	28.6.21 07:30	2.00	310 136	0
16.8.21 07:30	17.8.21 07:30	1.50	114 800	0
19.8.21 07:30	20.8.21 07:30	1.94	100 358	0
20.8.21 07:30	23.8.21 07:30	3.88	310 083	0

*) Bypassed the biological treatment.

Table 7 Period for sampling of final treated sewage sludge taken at Bekkelaget WWTP. Total sludge production during the period that the sampling represented, as well as the sludge's dry matter content (TS) and organic content (loss on ignition; LOI) (both plants' own measurements).

Start	End	Sludge production ton TS VEAS	ton TS/d	TS %	LOI %
21.6.2021	25.6.2021	300	75	43,8	-
28.6.2021	2.7.2021	285	71	45,1	-
5.7.2021	9.7.2021	248	62	45,4	-
16.8.2021	20.8.2021	300	75	42,3	-
23.8.2021	27.8.2021	217	54	41,9	-
30.8.2021	3.9.2021	258	65	41,0	-
Bekkelaget WWTP					
21.6.2021	25.6.2021	47	47	29,9	49,6
28.6.2021	2.7.2021	82	82	30,6	50,8
5.7.2021	9.7.2021	92	31	29,2	50,5
16.8.2021	20.8.2021	14	14	25,3	51,4
23.8.2021	27.8.2021	60	60	31,7	51,2
30.8.2021	3.9.2021	83	28	32,3	50,3

2.6 Sampling of river water

Six water samples were collected at Breivoll, just downstream of the main part of the industrial area in the Alna area. See coordinates in Table 8 and further location in Figure 6. The samples were collected as time-proportional 24-hour composite samples (50 mL every 5 min) with an automatic composite sampler (ISCO). Four of the six samples were collected in connection with rainfall events. The reported water flow is at Oslo Municipality's measuring station "Kværnerristen" approx. 3.5 km further downstream. The stream Østensjøbekken enters along this stretch of river in addition to some smaller streams, so the indicated water flow probably overestimates the water flow at Breivoll (approx. 25% based on the relative sizes of the two catchment areas).

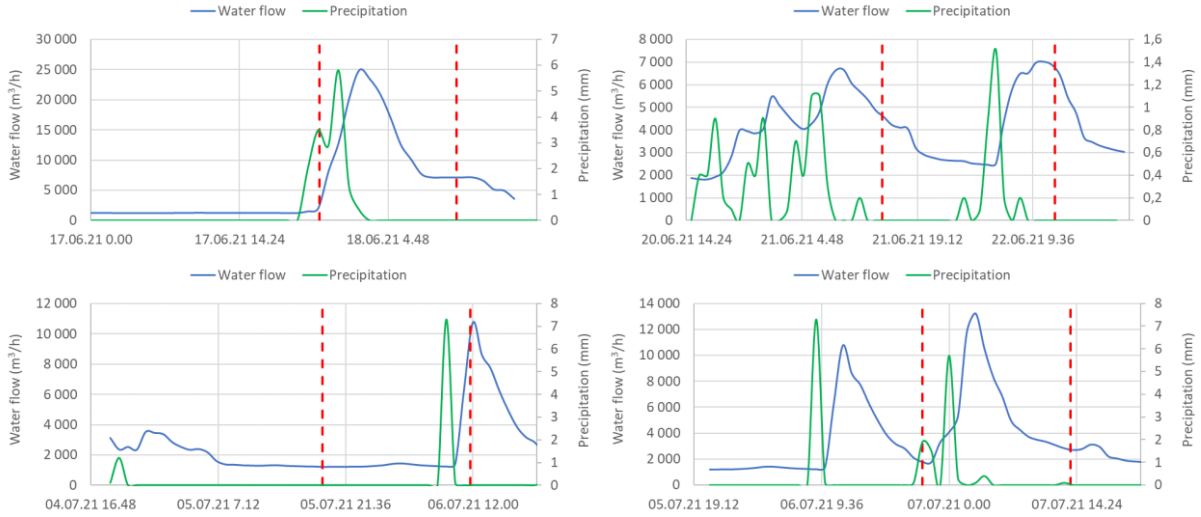


Figure 5. Precipitation and water flow from 24 hours prior to the start of each sampling event and through the sampling event. The start and end of each sampling are marked with red dotted lines.

Table 8. *Period for sampling at the station Breivoll along the river Alna. Rainfall before and during the sampling period (data from Frost API (met.no) at the weather station Brobekk), as well as the amount of water that had passed and the average water flow during each sampling campaign as measured at Oslo municipality's sampling station "Kværnerristen".*

Station	Start	End	Rainfall the week before mm	Rainfall 24 h before mm	Rainfall during mm	Amount of water m³	Amount of water m³/time
Breivoll (N6644277.7 Ø602599.79)	17.06.2021 22:08	18.06.2021 11:24	12.37	2.5	10.0	181 121	13 652
	21.06.2021 14:49	22.06.2021 12:21	28.10	7.7	3.1	89 156	4 140
	05.07.2021 19:00	06.07.2021 11:40	7.90	1.2	7.4	33 014	1 981
	06.07.2021 21:00	07.07.2021 13:40	17.30	9.4	8.1	92 772	5 566
	18.08.2021 09:37	19.08.2021 03:00	4.50	0.0	0.0	20 430	1 175
	23.08.2021 11:19	24.08.2021 03:54	2.80	0.0	0.0	17 795	1 073

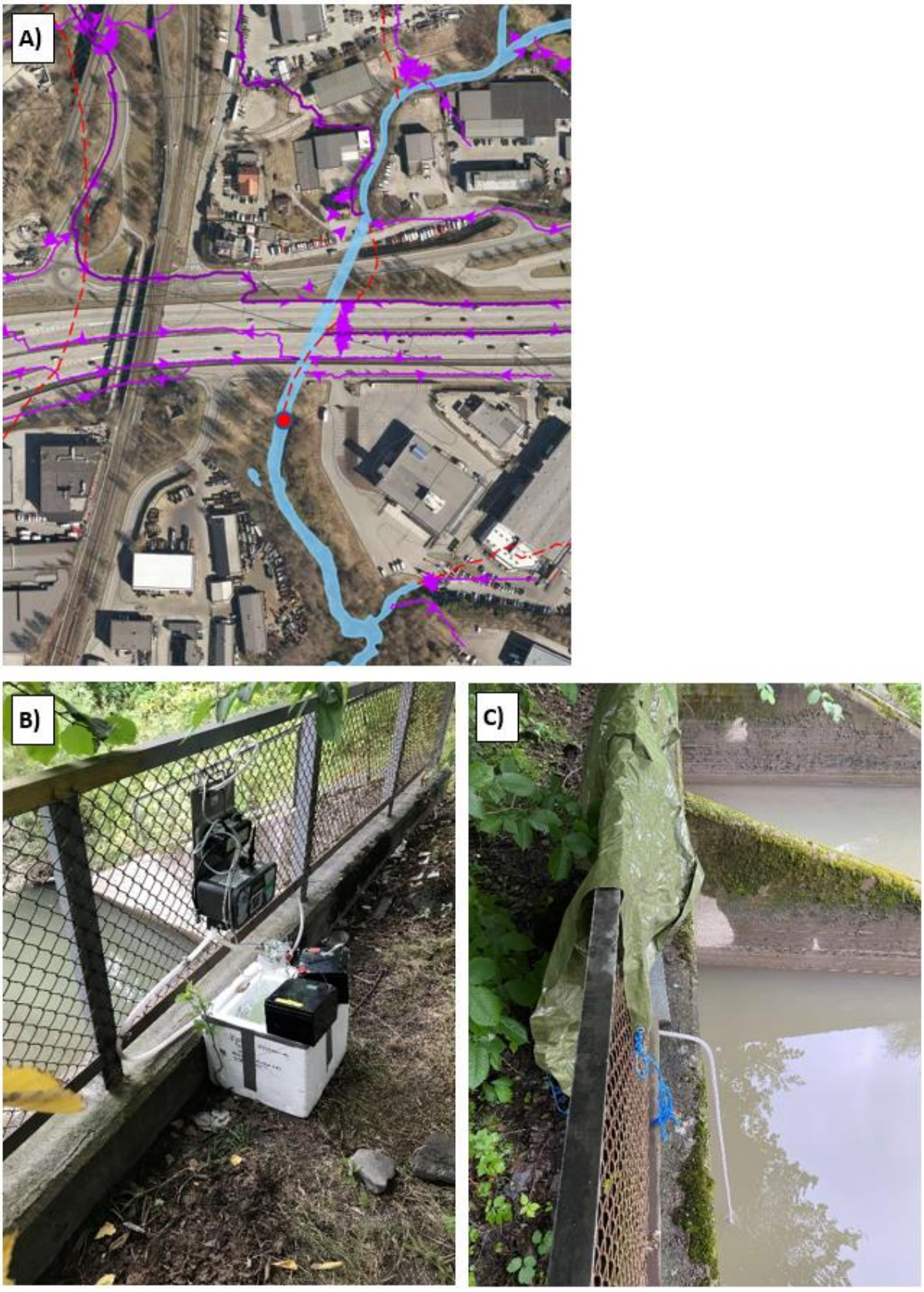


Figure 6. A) The location of the sampling stations Breivoll along Alna. The red dot indicates the sampling point. The purple lines indicate theoretical drainage lines in the area. B) The sampling equipment. C) The sampling line going into the river. (Photo Vogelsang).

2.7 Tunnel wash samples

Tunnel wash water and sediment from sand capture filters of a high-traffic tunnel in Oslo, the Smestad tunnel (59◦56'16" N, 10◦41'2" E). This tunnel is 500 m long. All samples are taken from the westbound course, which has an annual daily traffic (ADT) of 44,060 cars a day and 8% heavy vehicles. Before the wash started inside the tunnel, sediment samples were taken from three gully-pots. All samples were taken during a "full wash", where the entire tunnel including tunnel walls, the roof, the road surface and equipment inside the tunnel, is washed. The tunnel is first cleaned with a sweeper to remove gravel and dust from the roadway before the tunnel is washed. After this precleaning, soap is applied to the tunnel walls and the equipment before the washing begins. The whole procedure takes approx. 1-2 hours. Immediately after the wash procedure is started, water will flow from the tunnel surface into the gully-pots and from there led to the treatment system via a basin in the pump house. As the basin in the pump house fills up, the water is directed to the sedimentation basin. Sedimentation of the wash water was allowed for 3 weeks (21 days) before the treated water is pumped to a rain garden for infiltration through the vegetation. From here it will end up in the Smestad pond via infiltration.

The tunnel wash samples were taken throughout the washing episode, from the start of washing (from the first water arriving at the pump sump) and until the washing is finished. The tunnel wash water flow from the tunnel to the pump house basin lasted for 45 min. Triplicate samples were therefore taken at three different times; early (1 min in), middle (22 min in) and late (45 min in). A small sampling pump was used to fill the sample bottles which were stored cooled until analysis. Number of samples are given below. For the gully pots, triplicate samples in three different gully-pots located at 100 m, 250 m and 400 m in the tunnel were collected. Samples were collected using a small van Veen grab, collected in aluminum foil tins and then representative samples from this were taken with metal spoon and placed in muffle-furnace pre-cleaned glass jars. Samples were frozen after sampling.

Table 9 *The sampling plan for tunnel washing water and sediment samples from sand capture.*

Location	Info	Type
100 m	Sand capture inlet	Pooled sample
250 m	Sand capture center	Pooled sample
400 m	Sand capture outlet	Pooled sample
Pumpstation 1	Wash water start	Pooled sample
Pumpstation 2	Wash water halfway	Pooled sample
Pumpstation 3	Wash water end	Pooled sample

Figure 7. For left to right the 'Gully-put' samples, a tunnel wash water sample and the sampling of the wash water. (Photo Meland, Rødland)

2.8 Biota samples from Oslo fjord

The Herring Gull (Larus argentatus) eggs were collected at the small gull colony Raudskjera in Asker municipality 25 May 2021, position 59 ° 50'21 "N 010 ° 32'18" E. One egg was taken from each of ten different nests, where each nest had three eggs. It is not known which individuals have laid each individual egg as this colony consists of relatively few adult birds with colourings. But there are a few, and the Herring Gull female with ring JKP99, Figure 8, was ringed as an adult at the National Theatre in central Oslo on 16.01.2020.

Figure 8. The 'National Theatre' Herring Gull, an adult female from the sampled colony.

Blue mussels were sampled by snorkeling and simply picking the mussels by hand on the 21st and 22nd of August 2021. All mussels were rinsed three times in water from the sampling site. The mussels were kept in polyethylene bags and then frozen at -20 C. The mussels were later thawed and measured, and the soft tissue was sampled with a stainless-steel scalpel. 20 mussels from each station went into one sample that was again frozen until analysis.

Whiting was collected on October 15th by benthic trawling on F/F Trygve Braarud. The fish were frozen and kept in a polyethylene bag. The fish were later thawed, measured, weighed and the liver was sampled. A total of 14 fish were sampled, six as individual samples and the eight fish with the smallest livers were pooled to obtain a larger volume material for analysis. The liver was then frozen again until analysis.

Table10 Sample locations of the blue mussel samples from the Oslo fjord

Sample Code	Location		Latitude	Longitude	Quantity	Date
SC1	Hovedøya	Floating dock	59.8982	10.7372	20-30	21-aug
SC2	Frognerkilen	Floating dock	59.9102	10.7015	20-30	21-aug
SC3	Bekkelaget	Floating dock	59.8749	10.7549	20-30	21-aug
SC4	søndre Langøya	Floating dock	59.8681	10.7175	20-30	21-aug
SC5	Storøyodden	Floating dock	59.8881	10.5918	20-30	20-aug
SC6	Bunnefjorden	Stacked stone wall	59.8151	10.7004	20-30	21-aug
SC7	Fagerstrand	Floating dock	59.7318	10.5882	20-30	20-aug
SC8	Slemmestad VEAS	Floating dock	59.7830	10.5003	20-30	20-aug
SC9	Håøya	Floating dock	59.7071	10.5545	20-30	20-aug
SC10	lysaker	Floating dock	59.9115	10.6455	20-30	21-aug

2.9 Arctic biota samples

Collection of blood samples from polar bears was carried out in the spring of 2021. In connection with the on-going fieldwork on polar bears, 40-60 polar bears are anesthetized for sampling. For the screening project 6 extra blood samples were taken. The blood samples were labelled with the individual and date and are stored in glass and kept in a freezer (-20°C) until analyses were carried out (Routti, Lille-Langoy et al. 2016, Routti, Aars et al. 2017).

Collection of eggs from arctic gulls was carried out in connection with field work carried out in Kongsfjorden at the beginning of June 2021. One egg is collected from each nest (normally 3 eggs in the nest). A total of 6 eggs were transported in a shockproof box to the laboratory in Ny-Ålesund where the eggs were labelled and wrapped in aluminium foil before being placed in the freezer for storage and shipping to Tromsø/Oslo (Neerland, Bytingsvik et al. 2019, Sebastiano, Angelier et al. 2020).

Collection of polar cod was carried out on cruises (with Crown Prince Haakon) which were carried out north of Svalbard in June 2021. The polar cod were taken with nets/trawls in ice-filled waters. The polar cods (6 pieces) were weighed and measured before they were wrapped in aluminium foil. All polar cod samples were marked and stored frozen (-20°C) before being transported to Tromsø/Oslo.

Collection of "filter feeders" (mussels) was carried out in Kongsfjorden in June/July with the assistance from divers who carry out fieldwork in the fjord. Collection of clams took place at regular monitored locations in Kongsfjorden. The clams (6 pieces) were transported immediately after collection to the marine laboratory in Ny-Ålesund where the species was determined, and biological measurements performed before they were packed into aluminium foil. The shell samples will be stored in a freezer (minus 20 degrees) before shipping Tromsø/Oslo.

Permits for the collection of samples from polar gulls and polar bears was successfully obtained from the Governor on Svalbard and from the Norwegian Food Safety Authority. The collection of samples followed approved protocols for biological samples provided by Norway’s environmental test bank.

3 Chemical analysis

3.1 Medusa compounds

The **A**dvanced **G**lobal **A**tmospheric **G**ases **E**xperiment (AGAGE) has been measuring the composition of halogenated trace gases in global atmosphere since 1978, https://agage.mit.edu/ .
AGAGE's latest measurement upgrade is a preconcentration system called Medusa. For details - like flow schemes, temperature settings, pressure regimes, adsorbent and columns (see Miller 2008). At the heart of the Medusa is a cold plate which maintains a temperature of - 175 °C which cool two traps to about - 165 °C. Each trap can be independently heated resistively from - 165 °C to +200 °C. The use of two traps with wide programmable temperatures ranges, coupled with the development of appropriate trap absorbents, permits the desired analytes from 2-liter air samples to be effectively separated from more-abundant gases that would otherwise interfere with chromatographic separation or mass spectrometric detection, such as N_2, O_2, Ar, H_2O, CO_2, CH_4, Kr and Xe. Importantly, the dual traps also permit the analytes to be purified of interfering compounds by fractional distillation and re-focusing from the larger first-stage trap (T1) onto a smaller trap (T2) at very low temperatures, so that the resulting injections to the Agilent 5973 GC-MS are sharp and reproducible. A Linux operating system runs both the Medusa "front end" and the GC-MS in selective ion mode (SIM). This software includes the mass/charge ratio as a variable, as well as the many control and diagnostic parameters of the Medusa. Blanks and instrument linearities are measured routinely. An important advance in the Medusa is its ability to check its linearity by injecting a wide range of standard gas volumes. Such linearity and composition-independence are critical to accurate calibration, especially when propagating synthetic primary standards or when measuring samples spanning wide concentration ranges. The Medusa system uses a high precision integrating mass flow controller (MFC) for improved measurement of sample volumes. The Medusa systems are producing exceptional routine precisions. The practice of alternating ambient air and calibration gas analyses obtain the highest precision measurements. By using quantifier (target) and qualifier ions for each measured species, the Medusa also offers improved peak identification and reduced susceptibility to interference by co-eluting species.
Because of the high rate of standard gas consumption (24 litres/day), a quaternary level of whole-air calibration gas is added to the normal tertiary level of calibration. The quaternary working gases are calibrated over the course of their use in the field by analyses against the tertiary standards sent from Scripps Institution of Oceanography La Jolla, California, USA (SIO) for use with the Medusas. SIO has maintained the Central Laboratory for standards of halogenated gases within AGAGE for the last 4 decades and their scale together with the scale of NOAA (National Oceanic and Atmospheric Administration) are those scales which are used for reporting global atmospheric background concentrations.
Medusa measurements of the global atmospheric background concentrations of halogenated gases are very precise – usually within less than 1 % - and can deal with mixing ratios far lower than 1 ppt.

In this project, the Medusa measurements were chosen for the analysis of six different compounds:
1) Octafluorocyclobutane (CAS: 115-25-3, C4F8); ***2)*** Tetrafluoroethene (CAS: 116-14-3, C2F4), ***3)*** Hexafluoropropene (CAS: 116-15-4, C3F6), ***4)*** Chlorotrifluoroethylene (CAS: 79-38-9, C2ClF3), ***5)*** 1,2-dichloro-1,2,3,3,4,4-hexafluoro cyclobutene (CAS: 356-18-3, C4Cl2F6), ***6)*** 1,1,2-trichloro-1,2-difluoro-propane (CAS: 7126-04-7, C3H3Cl3F2). Of these, only Octafluorocyclobutane is routinely measured at all AGAGE sites and is also the only with an official calibration scale maintained by Scripps and NOAA.
Octafluorocyclobutane was chosen as internal reference standard. During the first step of the method development the ten most unique and dominant mass fragments were chosen to identify the retention times of the compound **2-5**. The five targeted compounds were well separated within the usual temperature program of the usual AGAGE method. All compounds showed exceptional good agreement with known mass spectra from different mass spectra libraries – except compound ***5)*** 1,2-dichloro-1,2,3,3,4,4-hexafluoro cyclobutene for which the two most heavy mass fragments did not show the proper intensity.
Compound ***2-4***; Tetrafluoroethene, Hexafluoropropene and Chlorotrifluoroethylene are all very reactive gases. As it is very difficult to make gas standards of non-stable compounds it has previously been tested to infer and calculate sensitivity relationships to more stable compounds in order to avoid the making of gas standards for reactive and short-lived halogenated compounds (Laube and Engel 2008). Therefore, for the calibration we chose mass fragments with similar intensity for the internal quantification standard Octafluorocyclobutane and compound ***2-4***.

3.2 OPFRs and phthalates

For the sample clean-up for metabolites of organophosphorus flame retardants and phthalates in dust, deuterated internal standards were added, and samples were extracted using acetone on a shaking table for 60min. Extracts were concentrated by centrifugal evaporation and an aliquot was taken, added water and filtered by a press PTFE filter of 0.2um before analysis.

Sediment/sludge samples were dried overnight in a clean cabinet, added deuterated internal standards, and extracted sequentially using acetone and methanol using a sonication bath for 10min. Extracts were concentrated by centrifugal evaporation to 1mL and diluted to 10mL with water and cleaned up on a glass Oasis HLB cartridge, washed, dried, and eluted using acidified (1% formic acid) methanol. The extract was concentrated again and transferred to analytical glass for analysis.

Water samples (50mL) were spiked with deuterated internal standard and extracted using glass Oasis HLB cartridges. The procedure was similar to that for sediment/sludge samples.

Air samples collected on Envi+ cartridges were extracted using acetone and methanol. Deuterated internal standard was added and extracts concentrated and transferred to analytical vials for analysis.

All extracts were concentrated and analyzed by UHPLC/MSMS with ESI (-).

3.3 PBT substances, siloxanes, Volatile Organic Compounds; and organophosphorus plasticizers

Extraction procedure for dust samples was the same as for organophosphorus flame retardants and phthalates. Deuterated internal standards were added, and samples were extracted using acetone on a shaking table for 60min. Extracts were concentrated to a desired volume by blowing dry pure nitrogen and injected into Q Exactive GC (GC-HRMS Orbitrap).
Sediment/sludge samples, as well as biota samples, were extracted wet. Deuterated internal standards were added first and then the samples were extracted with a mixture of acetonitrile and hexane. The hexane layer was analysed on Q Exactive GC (GC-HRMS Orbitrap) with or without preconcentration.
Air samples (ABN-cartridges) were extracted with acetone. Deuterated standards were added. Some extracts were pre-concentrated depending on expected levels of pollutants. Several samples contained significant amounts of moisture which was removed with sodium sulphate. Extracts were analysed on Q Exactive GC (GC-HRMS Orbitrap).
Water samples (200mL) were extracted with a mixture of dichloromethane and ethyl acetate on a shaking table for 24 hours, following addition of deuterated internal standards. The organic layer was separated, dried with sodium sulphate and concentrated in a flow of dry pure nitrogen. Extracts were analysed on Q Exactive GC (GC-HRMS Orbitrap).
Instrumental parameters of Q Exactive GC (GC temperatures, mass-resolution and ion injection time, mass range etc) were optimized to cover maximal range of analytes. All analyses were performed in positive ion mode with EI ionization. A standard 30m TGSIL5MS column was used in all cases for harmonization and for reliable calculation of retention indices and prediction of retention times. For a number of target compounds the authentic standards were not available. In such cases essential properties of analytes (retention times, characteristic ions and ion ratios, relative response factors) were deduced from those for available homologues/analogues, or from literature data.

3.4 Rare earth elements (REEs)

Aqueous samples
All samples were acidified with HNO3 to a total concentration of 1% (v/v).

Solid samples – Sludge and household dust
Samples were digested in a closed-vessel microwave technique system (UltraClave, Milestone, Italy). Approximately 0,5 g of the household dust and 0,1 g of the sludge were weighed accurately on a Mettler PG503 balance and 5 ml HNO3 (s.p.) and 3 ml deionized water was added. The samples were digested according to a 65 min. temperature

programme, with stepwise heating to 250°C and a holding time of 30 minutes at 250°C. After cooling, the digests were quantitatively transferred to polypropylene tubes and diluted to a total volume of 50 ml with deionized water.

Biota
Samples were digested in a closed-vessel microwave technique system (UltraClave, Milsetone, Italy). Approximately 0,6 g of the common mussel and clam samples were weighed accurately on a Mettler PG503 balance and 5 ml HNO3 (s.p.) and 3 ml deionized water was added. The samples were digested according to a 65 min. temperature programme, with stepwise heating to 250°C and a holding time of 30 minutes at 250°C. After cooling, the digests were quantitatively transferred to polypropylene tubes and diluted to a total volume of 50 ml with deionized water.

Air
Samples were digested in a closed-vessel microwave technique system (UltraClave, Milsetone, Italy). Approximately half of the air filters were added 1 ml HNO3 (s.p.) and 2 ml deionized water. The samples were digested according to a 65 min. temperature programme, with stepwise heating to 250°C and a holding time of 30 minutes at 250°C. After cooling, the digests were quantitatively transferred to polyethylene tubes and diluted to a total volume of 10 ml with deionized water.

Instrumental analysis
Determination of REEs were performed on an ICP-sector field-MS (Element2, Thermo Fisher Scientific, Bremen, Germany). From the digested samples, aliquots of 1.0 ml or 0.1 ml were diluted to 10 ml using deionized water or 2% HNO3 for a total acid matrix of 2%. For all samples, also aqueous samples, Rhenium (Re) were added as internal standard (IS) to the sample line at a constant rate of approximately 1 ng ml-1. Quantification was performed by external calibration using multi element mixtures delivered by Teknolab AS and Spectrascan all made from high purity NIST traceable primary element solutions of 99,99% or better. All calibration solutions were prepared in nitric acid solutions free of chloride to avoid common Cl molecular ions in the ICP-MS, at a nitric acid concentration of 2% to match the matrix of the samples. An analysis program containing the target elements was designed using appropriate resolutions for each element to avoid expected interferences such as polyatomic ions and doubly charged species. The strength of ICP-HR-MS is that most of the serious molecular ion problems encountered in classical quadrupole ICP-MS are removed when appropriate instrument resolutions of 4000 and 10000 are used. Additionally, to reduce risk of matric matrix interferences and signal suppression due to matrix effects the analytes were determined in diluted samples.

Quality control (QC) samples were used to check the external calibration and certified reference materials (BCR 176R (fly ash from Institute for Reference Materials and Measurements, IRMM, Belgium), MODAS-2 (bottom sediment from Institute of Nuclear Chemistry and Technology, IChTJ, Poland) and SRM1515 (apple leaves from National Institute of Standards and Technology, NIST, US)) were digested with the samples to check the efficiency of the digestion. Blank samples were run after highly concentrated samples to check for appropriate washout and carry-over between samples. All samples, standards, blanks, QC-samples and CRM used Re as internal standard added to the sample line at a constant rate of approximately 1 ng.ml-1 in a HNO3 acidified matrix of 2% (v/v). The uncertainties based on analysis of CRMs, measurement uncertainties for REEs are within 20% for all sample matrixes in this study.

3.5 New PFAS compounds

Before extraction, a mixture of isotopically labeled PFAS is added, which follows both extraction and processing and which is used in quantification of the analytes. Sediment, sludge, effluent from treatment plants and biota samples were extracted with organic solvents that ensure a good yield of the analytes. Buffers were used for pH control; this is particularly important for the extraction of the sediment samples. The extracts were purified using solid phase extraction (SPE) and fatty biota samples were also cleaned up using charcoal. The water samples were concentrated and purified on a SPE column. All the extracts were concentrated under nitrogen before they were analyzed.
Concentrated extract is analyzed with HPLC-ToF for new PFAS (Sun, Bossi et al. 2019, Langberg, Breedveld et al. 2020). At least one blank sample/series of samples is analyzed. At least one spiked sample (and one non-spiked) is analyzed for each type of material.

3.6 Short chain PFAS compounds

Before extraction, a mixture of isotopically labeled PFAS is added, which follows both extraction and processing and which is used in quantification of the analytes. Sediment, sludge, dust and effluent from treatment plant samples are extracted with organic solvents that ensure a good yield of the analytes. To control the pH a buffer is added, this is particularly important for the extraction of the sediment samples. The extracts are purified using solid phase extraction (SP). Canisters and adsorbents (TENAX and ABN) air samples are extracted and cleaned with SPE as described above.
All concentrated extracts are analyzed with SFC-MS/MS and GC-OrbitrapMS (Thermo Scientific) instrument (mass resolution 120000) or on GC-qTOF (Agilent) (Björnsdotter, Yeung et al. 2019).
At least one blank sample/series of samples is analyzed. At least one spiked sample (and one non-spiked) is analyzed for each type of material.

3.7 Extractable Organofluorine (EOF, Tot-F)

Wastewater and road runoff water
Water samples including blanks (distilled deionized water-DI) and spikes for EOF analysis were extracted using solid phase extraction (SPE) weak anion exchange cartridges (Oasis® WAX, Waters) as described in detail elsewhere (Aro et al. 2021). Briefly, frozen samples, were allowed to thaw overnight and then vigorously shaken prior to subsampling 50-100 mL. For spiked samples, appropriate amounts of either PFOA or inorganic fluorine (as NAF) were added prior to extraction. The subsamples were vigorously shaken and allowed to equilibrate overnight. Prior to loading the water subsamples, the SPE cartridges were first conditioned with sequential additions of 4 mL of 0.1% NH_4OH in MeOH, 4 mL of MeOH, and 4 mL of DI water. The subsample was then vigorously shaken prior to loading 50-100 mL onto the cartridges. The cartridges were then rinsed with 10 mL of 0.01% NH_4OH in DI to remove inorganic fluoride followed by a 4 mL DI. They were then allowed to dry uunder vacuum, dry cartridge and eluted with sequential additions of 4 mL MeOH followed by 4 mL 0.1% NH_4OH in methanol. The 8 mL eluents were vortexed and blown down under gentle stream of nitrogen to dryness. Finally, the sample was reconstituted to 1 mL with HPLC grade methanol vortexed and then heated sample for 40 minutes at 40°C prior to CIC analysis

Sediment, sludge and biota samples
Solid samples were extracted mainly using acetonitrile as described for targeted PFAS, but the final extract for CIC analysis was reconstituted in methanol and no internal standard was added.

Combustion ion chromatography (CIC analysis of EOF)
Extractable organofluorine (EOF) content was analyzed using combustion ion chromatography (CIC). The CIC system consists of a combustion module (Analytik Jena, Germany), a 920 Absorber Bodule and a 930 Compact IC Flex ion chromatograph (Metrohm, Switzerland). Separation of anions was performed on an ion exchange column (Metrosep A Supp5 – 150/4) using carbonate buffer (64 mmol/L sodium carbonate and 20 mmol/L sodium bicarbonate) as eluent in isocratic elution. In brief, the sample extract (0.1 mL) was set on a quartz boat and placed into the furnace at 1000–1050 °C for combustion, during which, all organofluorine was converted into hydrogen fluoride (HF); the HF was then absorbed into Milli-Q water. The concentration of F^- ions in the solution was measured using ion chromatography. Fluoride signal was observed in combustion blank even when no sample was analyzed. Prior to sample analysis, multiple combustion blanks were performed until stable fluoride signals were reached. The peak area of the standard solution was first subtracted with the peak area of a previous combustion blank before plotted against concentration for the external calibration curve. Six or seven-point calibration (20 -2000 µg-F/L) standards were run for every batch of 20 to 25 samples and exhibited good linearity with R2>0.999. Quantification of samples was based on an external calibration curve after the peak area of the sample had been subtracted from the previous combustion blank.

4 Results and discussion

In this study nearly 170 different environmental samples were taken and for some samples several sub-samples for the different analytical methods were taken. More than 210 different substances were chosen to be analysed in these samples. Even if not all samples were analysed for all substances the total number of results exceeds 26 000. All results are possible to download from the database Vannmiljø (Vannmiljø, 2022) which is managed by the Norwegian Environment Agency. It is not practical to discuss all results in detail. However, in the following chapter the results were summarized in a way which allows for the identification of the most relevant findings.

4.1 Significant Findings

This section present highlights. The aim is to showcase the substances that were detected most frequently, and in multiple environmental compartments.
For the complete list of detection frequencies for all substances and sample types, please see Appendix 2.

4.1.1 PBT Groups I, II and III

Table 11: Average measured concentration of PBT Group I, II, and III substances in each sample type. Selection of substances with greater than 50% detection frequency in at least two independent sample types or environmental compartments. Detection frequency represented by colour. Substances identified by only suspect screening are marked with *, and the letter "S" takes the place of the measured concentration.

Detection Frequency Scale	Air (ng/m3)					Water (ng/L)	Effluent (ng/L)			Sludge/Sediment (ng/g)			Biota (ng/g)			Arctic Biota (ng/g)				
100	Bekkelaget STP	Residential Building	Nonresidential Build.	Urban	Recycling Centre	Alna River - Water	VEAS STP	Bekkelaget STP	Smestad Tunnel	VEAS STP	Bekkelaget STP	Smestad Tunnel	Herring gull - Egg	Blue mussel	Whiting - Liver	Arctic cod - Liver	Arctic bird - Egg	Arctic mussel	Polar bear - Plasma
85																				
65																				
50																				
30																				
0																				
Metilox		1,7			0,0	2	2	2												
Cuminal		409,0		5,5						47	49			1	20	6		1		
Jasminal		30,0	12,0		2,1	76	65	68	179				9		210		6			
DEcHDC														3	175	21		7		
MPDcH						76	65	68										18		
TXIB		3666	1351	40	408	94	55	54	233	40		69								
ABA	0,2	1,8	0,5	0,5	0,5					753	555									
DABA		0,7		0,8	7,3					408	325									
DEHTP*						S	S	S	S				S	S						
Sylkolide*													S	S	S	S	S	S	S	
Serenolide*		S											S	S	S	S	S	S		
DiUnDP*									S	S	S	S		S			S	S	S	
DcHA*		S		S		S														

4.1.2 PFAS Substances

Table 12: Average measured concentration of PFAS substances in each sample type. Selection of substances with greater than 50% detection frequency in at least two independent sample types or environmental compartments. Detection frequency represented by colour.

Detection Frequency Scale	Air (ng/m3)					Water (ng/L)	Effluent (ng/L)			Sludge/Sediment (ng/g)			Biota (ng/g)			Arctic Biota (ng/g)			
100	Bekkelaget STP	Residential Building	Nonresidential Build.	Urban	Recycling Centre	Alna River - Water	VEAS STP	Bekkelaget STP	Smestad Tunnel	VEAS STP	Bekkelaget STP	Smestad Tunnel	Herring gull - Egg	Blue mussel	Whiting - Liver	Arctic cod - Liver	Arctic bird - Egg	Arctic mussel	Polar bear - Plasma
85																			
65																			
50																			
30																			
0																			
PFBS					0,01	0,6	1,1	2,9	1,4										
PFBA		0,01			0,03	4,3	6,0	8,6											
TFA		0,03	0,01	0,05	0,03	158,0	145,0	158,0											
PFPrA		0,04			0,22	8,4	7,6	25,0											
PFPeA						2,7	1,6	8,3	1,6										
PFHxA						3,0	3,1	7,0	2,7										
PFHA						1,5	1,7	1,5	2,1										0,5
PFOA					0,05	2,5	3,1	22,0	2,7				0,4						2,8
PFNA						0,5	0,6	0,6	0,8				0,5				0,6		17,0
PFDA									1,2	0,4	0,9		1,2		0,3		0,6		4,5
PFUA													1,1		0,6		1,2		7,9
PFDoA													1,5		0,4		0,3		1,0
PFTDA													1,3		0,3		1,0		2,2
PFBS					0,01	1,0	1,1	2,9	1,4										
PFHxS					0,03	0,3	0,2	0,6					0,6				0,1		20,0
PFHS													0,2						2,0
PFOS		0,01	0,07		0,01	2,1	1,2	1,6	1,6	0,5	1,7		30,0	0,1	2,0	0,4	3,3		57,0
PFDS													0,4		0,1				
PFOSA														0,4	13,0				
PFBS-amide							1,1	0,6							0,4				
6:2FTS						0,9	0,3	0,7								0,5			
10:2 FTS										0,7	0,4		1,0						
6:2 diPAP										1,2	0,7							405,0	
Tot-F						67	743	703		156	290	743							

4.1.3 VOC Substances

Table 13: Average measured concentration of VOC substances in each sample type. Selection of substances with greater than 50% detection frequency in at least two independent sample types or environmental compartments. Detection frequency represented by colour. Substances identified by only suspect screening are marked with *, and the letter "S" takes the place of the measured concentration

Detection Frequency Scale	Air (ng/m3)							Dust (ng/g)			Water (ng/L)	Effluent (ng/L)			Sludge/Sediment (ng/g)			Biota (ng/g)			Arctic Biota (ng/g)			
100	Bekkelaget STP	Residential Building	Nonresidential Build.	Urban	Recycling Centre	Birkenes	Ny-Ålesund	Residential Building	Nonresidential Build.	Recycling Centre	Alna River - Water	VEAS STP	Bekkelaget STP	Smestad Tunnel	VEAS STP	Bekkelaget STP	Smestad Tunnel	Herring gull - Egg	Blue mussel	Whiting - Liver	Arctic cod - Liver	Arctic bird - Egg	Arctic mussel	Polar bear - Plasma
85																								
65																								
50																								
30																								
0																								
TFE	0,29	1,40	0,12	0,10	0,09	0,90																		
CTFE	3,60	15,00	8,10	4,30	2,60	15,00																		
HFP	0,04	0,18			0,11	0,19																		
Freon-C-318	4,60	4,40	4,30	4,50	4,40	4,90																		
H-L3		0,09	0,39	0,01	0,02																			
26DCBN		0,01	0,01	0,00		0,01	0,00				0,2	4,5	5,7	0,2	0,1	0,1								
oNA		31,00	3,30	0,47	1,60	0,02	0,00	1,6	2,2	3,1	17,0	221,0	8,4	11,0					3,2					
pBDN		0,08	0,12	0,06	0,04	0,08	0,01	0,1	0,1	0,2				3,2										
MAQ				0,07				267,0	52,0	513,0	6,2	6,9	6,5	74,0	11,0	55,0	13,0							
CMP			62,00		12,00			260,0	55,0	8,9				5,7										
TeCPy		0,01	0,01	0,00		0,00	0,00							0,8										
CTCMPy			0,22	0,02	0,06	0,05	0,04																	
DCDMB				0,01		0,04					0,0	0,5	0,2											
BDMT				0,01		0,01						0,1	0,8											
DCFd		19,00	0,32	1,70	0,36	0,15	0,01	3580,0		11,0							1,5							
Cbzl		0,14	0,14	0,06	0,15	0,00		68,0	20,0	145,0	7,1	6,0	2,0				2,1	1,1	0,4	0,2		0,8	0,5	
BPon		0,01	0,03	0,06	0,10																			
NCN		0,77	0,98	0,59	0,71	0,09	0,00		0,7	1,0														
mNA		19,00	0,06			0,30		0,9	1,3	4,3														
pNA		2,70	0,02	0,87		0,08	0,02												1,4	0,1	0,2		0,5	0,1
mBDN		0,13	0,06	0,07	0,12	0,03	0,01	0,2		0,2				3,2										
oBDN		0,04	0,04	0,04	0,11				0,2	0,5				7,5										
iMAC-P								265	46	916														
iMAC-B					0,24	0,00	0,00																	
TCSt*																		S		S	S	S	S	
PCSt*																		S	S	S	S	S	S	

4.1.4 Phos-Phthal Substances

Table 14: Average measured concentration of Phos-Phthal substances in each sample type. Selection of substances with greater than 50% detection frequency in at least two independent sample types or environmental compartments. Detection frequency represented by colour.

Detection Frequency Scale	Air (ng/m3)				Dust (ng/g)			Water (ng/L)	Effluent (ng/L)			Sludge/Sediment (ng/g)	
100	Residential Building	Nonresidential Build.	Urban	Birkenes	Residential Building	Nonresidential Build.	Recycling Centre	Alna River - Water	VEAS STP	Bekkelaget STP	Smestad Tunnel	VEAS STP	Smestad Tunnel
85													
65													
50													
30													
0													
MMP	1,00	0,18	0,10	0,11	60	48	9,9				275		4,6
MEP	0,27	0,10			133	30	29		169				
MiBP/MnBP					83	63	75						2,0
MEOHP					3,5	1,1	8,3						
MEHHP					30	4,3	18						
MEHP					350	213	489	5,9	4,0	3,2	4,9	11	0,74
DPP	0,01	0,01			161	119	11	6,9	15	8,4	5,4	32	6,1
HDBP	0,12	0,05		0,01	1750	434	39	4,8	53	3,1	3,0	158	47
BDCPP					4,0	8,5			4,9	9,4			
BBOEP		0,03			184	1370	19	2,0	20	32	1,2	5,0	
HDEHP					1320	1910	737					1500	1240

4.2 Comparison with predicted no-effect concentrations

An appropriate tool for assessing the relevance of the reported results is the comparison of these concentrations with the corresponding predicted no-effect concentrations (PNEC) when available. To prioritize compounds, experts have set ecotoxicological limit values known as Lowest PNECs. These PNECs are obtained by applying an assessment factor to ecotoxicological endpoints (EC50 or NOECs) using organisms with different sensitivities to different types of chemicals. The assessment factor depends on the duration of the test (acute or chronic), the number of trophic concentrations tested, and the general uncertainties in predicting ecosystem effects from laboratory data. If no experimentally derived PNECs are available, QSAR-based prediction models are applied (Aalizadeh et al., 2017). These values are largely calculated for the freshwater environment and then translated into corresponding PNEC values for sediment, seawater and biota matrices (Dulio et al., 2018). It is obvious that the modelling of PNECs involves many oversimplifications and uncertainties. Furthermore, most of these lowest PNEC data are not fully reviewed and verified by experts. The following comparison tables are therefore only used for a first prioritization and cannot replace a more detailed risk assessment.

Table 15: Lowest PNEC {NORMAN, 2022 #4449} for marine water environment are compared to maximum concentrations measured in samples from STP effluent. Only PNECs close to or below the measured maximum values are shown (for colour code see bottom of the table). Compounds shown here are of some environmental concern and should be prioritized for further in-depth studies.

Group	Acronym	CAS#	Lowest PNEC Marine water	STP Effluent
			µg/L	
VOC Group III	oNA	91-23-6	0.193	0.41
	MAQ	84-54-8	0.064	0.014
	Cbzl	86-74-8	0.026	0.012
PBT Groups	Jasminal	122-40-7	0.010	0.13
	MPDcH	97398-80-6	0.012	0.13
	TXIB	6846-50-0	0.042	0.12
PFAS	PFOA	335-67-1	0.018	0.11
	PFOS	754-91-6	0.000065	0.0019
Phos-Phtal	MEP	2306-33-4	0.620	0.37
	MEHP	4376-20-9	0.019	0.0085
	At least one sample above PNEC (PNEC < MEC)			
	At least one sample close to PNEC (PNEC/5 < MEC < PNEC)			

Table 16: Lowest PNEC (NORMAN, 2022) for freshwater environment are compared to maximum concentrations measured in samples from STP effluent, Alna river surface water, and road tunnel wash water. Only PNECs close to or below the measured maximum values are shown (for colour code see bottom of the table). Compounds shown here are of some environmental concern and should be prioritized for further in-depth studies.

Group	Acronym	CAS#	Lowest PNEC Freshwater	STP Effluent	Alna River	Tunnel wash
			µg/L			
VOC Group III	oNA	91-23-6	1.93	0.41	0.03	0.02
	MAQ	84-54-8	0.64	0.014	0.014	0.13
PBT Group	Jasminal	122-40-7	0.10	0.13	0.14	0.33
	MPDcH	97398-80-6	0.12	0.13	0.14	<0,025
	TXIB	6846-50-0	0.42	0.12	0.23	0.46
PFAS	PFOA	335-67-1	0.18	0.11	0.0042	0.0032
	PFOS	754-91-6	0.00065	0.0019	0.0027	0.0018
	At least one sample above PNEC (PNEC < MEC)					
	At least one sample close to PNEC (PNEC/5 < MEC < PNEC)					

Table 17: Lowest PNEC (NORMAN, 2022) for freshwater sediments are compared to maximum concentrations measured in samples from STP effluent. Only PNECs close to or below the measured maximum values are shown (for colour code see bottom of the table). Compounds shown here are of some environmental concern and should be prioritized for further in-depth studies.

Group	Acronym	CAS#	Lowest PNEC Sediments	Tunnel wash sediment
			ng/g dw	
VOC Group III	iMAC-P	83-12-5	55	28
PBT Groups	TXIB	6846-50-0	14	69
Phos-Phtal	HDBP	107-66-4	132	84
	HDEHP	298-07-7	44	2 900
	At least one sample above PNEC (PNEC < MEC)			
	At least one sample close to PNEC (PNEC/5 < MEC < PNEC)			

Table 18: Lowest PNEC (NORMAN, 2022) for marine fish are compared to maximum concentrations measured in samples from fish liver from Oslofjord and the Arctic. Only PNECs close to or below the measured maximum values are shown (for colour code see bottom of the table). Compounds shown here are of some environmental concern and should be prioritized for further in-depth studies.

Group	Acronym	CAS#	Marine biota (fish)	Oslofjord	Arctic
			ng/g ww		
VOC Group III	oNA	91-23-6	0.97	5.5	<1
	OCSt	29082-74-4	1.32	0.44	<0,1
	pNA	100-17-4	1.10	0.61	0.22
PBT Group I	Cuminal	122-03-2	27.1	32	10
PBT Group I	DEcHDC	72903-27-6	16.9	370	38
PFAS	PFOSA	754-91-6	0.010	20	<0,1
	PFBS-amide	30334-69-1	0.23	0.8	<0,3
	4:2 FTS	757124-72-4	1.89	1.8	<0,3
	At least one sample above PNEC (PNEC < MEC)				
	At least one sample close to PNEC (PNEC/5 < MEC < PNEC)				

Table 19: Lowest PNEC (NORMAN, 2022) for marine mussels are compared to maximum concentrations measured in samples from mussels from Oslofjord and the Arctic. Only PNECs close to or below the measured maximum values are shown (for colour code see bottom of the table). Compounds shown here are of some environmental concern and should be prioritized for further in-depth studies.

Group	Acronym	CAS#	Marine biota (mussels)	Oslofjord	Arctic
			ng/g ww		
VOC Group III	Cbzl	86-74-8	0.86	1.0	1.6
	OCSt	29082-74-4	0.33	<0.1	0.10
	pNA	100-17-4	0.28	4.0	0.84
PBT Group I	Cuminal	122-03-2	6.78	1.70	1.20
PBT Group I	DEcHDC	72903-27-6	4.22	5.0	8.7
PBT Group I	MPDcH	97398-80-6	0.90	<10	71
PFAS	PFOS	754-91-6	0.0025	0.10	<0.1
	PFOSA	754-91-6	0.0025	0.60	<0.1
	At least one sample above PNEC (PNEC < MEC)				
	At least one sample close to PNEC (PNEC/5 < MEC < PNEC)				

4.3 Comprehensive Results, Tables and Discussion

4.3.1 PBT Groups I, II and III

4-Isopropyl-benzaldehyde (Cuminal) was found in indoor (residential buildings). Lower concentrations were also observed in outdoor air samples taken in Oslo, in sludge samples from STPs, and in mussel and fish liver samples from both Oslofjord and the Arctic. The maximum concentration measured in fish liver from Oslofjord exceeds the lowest PNEC estimated for marine fish). Cuminal is a fragrance and ECHA reports that Cuminal is used in the following products: air care products, perfumes, polishes and waxes, washing & cleaning products, cosmetics and personal care products, and biocides (e.g. disinfectants, pest control products) (ECHA, 2022).

Amylcinnamal (Jasminal) was found in all samples of air taken in residential and non-residential buildings, in some air samples taken at recycling facilities, frequently in effluent and water samples, and in biota samples. The maximum concentrations measured in STP effluents and water exceed both the lowest PNECs estimated for the marine and freshwater environment. Jasminal is a fragrance and ECHA reports that Jasminal is used in the following products: air care products, biocides (e.g. disinfectants, pest control products), perfumes and fragrances, polishes and waxes and cosmetics and personal care products (ECHA, 2022). This agency also reported that the majority of data submitters agree this substance is skin sensitising.

Diethyl 1,4-cyclohexanicarboxylate (DEcHDC) was detected in tunnel wash water and in different biological samples from Oslofjord and the Arctic. The measured average concentrations in tunnel wash water in marine mussels from Oslofjord and the Arctic were exceeding the lowest PNEC estimated for freshwater environment (water) and marine mussels. DEcHDC is a fragrance (raspberry dicarboxylate) and has the same use pattern as the other fragrances measured in this study (ECHA, 2022).

1-Methoxy-4-(4-propylcyclohexyl)cyclohexane (MPDcH) was detected in effluent from STPs and in surface water from Alna river. It was also detected in a few samples of Arctic mussels. The measured average concentration in effluent from STPs was exceeding the lowest PNEC estimated for marine environment. MPDcH is probably used in the production of liquid crystal displays.

4.4'-Dichlorodiphenyl sulfide (DCDPS) was detected in several residential buildings. DCDPS is a member of a class of chlorinated aromatic compounds structurally related to PCB and PBDE. They are used in different applications and are frequently found in environmental samples. In studies analyzing the complete congener group from non-chlorinated to the very high chlorinated hexa- and heptachloro diphenyl sulfides, the most prominent congener group was the tetrachloro diphenyl sulfides (Nian et al., 2022). In this study, DCDPS was only detected in the residential indoor environments. The measured concentrations of DCDPS in air (<0.015-0.047 ng/m^3) are comparable to concentrations of PCB-118, 138, 153 and 180 but significantly lower than PCB-28, 52 and 101 in households in Oslo (Sakhi et al. 2022)

Several substances were not available as chemical standards so suspect screening via high resolution mass spectrometry (HRMS) was performed. Identification was via exact mass, isotopic pattern and predicted chromatographic retention time. This provides confidence in assignment of the correct molecular formulae, but is inadequate for unequivocal confirmation of structure. Detections via this method included substances matching molecular formulae of Di(2-ethylhexyl) terephthalate (DEHTP), 2-(3,5-dimethylhex-3-en-2-yloxy)-2-methylpropyl cyclopropanecarboxylate (sylkolide), Ethyl 2-methyl-4-oxo-6-pentyl-cyclohex-2-ene-1-carboxylate (EMOPCC or calyxol), Serenolide, Decyl isoundecyl phthalate (DiUnDP), Dicyclohexyl adipate (DcHA) and Methyl 2,6,6-trimethylcyclohex-2-ene-1-carboxylate (MTCC).

Table 20: Concentration range, average (ng/m^3), and detection frequency (%) of the potential POP compound DCDPS in air samples from residential buildings.

	Res. Build. – Air
DCDPS	<0.015 - 0.047 0.02 43 %

Table 21: Concentration range, average (ng/m^3), and detection frequency (%) of PBT Group and other compounds in air samples from residential and non-residential buildings, and recycling facilities.

	Bekkelaget STP - Air	Res. Build. - Air	Nonres. Build. - Air	Urban - Air	Recycling - Air
Metilox	<0.5 - <0.5 <0.5 0 %	<5 - 2.9 1.7 29 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - 0.052 0.03 88 %
Jasmone	<0.05 - <0.05 <0.05 0 %	<25 - 75 34 57 %	na	<10 - <10 <10 0 %	na
Cuminal	<0.05 - <0.05 <0.05 0 %	3 - 2300 409 100 %	na	0.8 - 13 5.5 100 %	na
Jasminal	<0.05 - <0.05 <0.05 0 %	11 - 57 30 100 %	1.2 - 27 12 100 %	<0.3 - <0.3 <0.3 0 %	<1 - 7.4 2.1 33 %
Serenolide*	Suspect 0 %	Suspect 43 %	na	Suspect 0 %	na
DcHA*	Suspect 0 %	Suspect 100 %	na	Suspect 100 %	na
TXIB	<0.05 - <0.05 <0.05 0 %	760 - 6100 3666 100 %	55 - 4228 1351 100 %	14 - 97 40 100 %	4 - 2326 408 100 %
ABA	<0.05 - 0.5 0.18 33 %	<5 - 0.5 1.8 29 %	0.5 - 0.5 0.50 100 %	0.5 - 0.5 0.50 100 %	0.50 100 %
DABA	<0.5 - <0.5 <0.5 0 %	<0.5 - 2.1 0.68 57 %	<0.5 - <0.5 <0.5 0 %	<0.5 - 2 0.83 67 %	7.3 100 %

* No chemical standards or reference material available during the time of analysis. Detection via Suspect Screening. Identification by exact mass, isotopic pattern and predicted retention time.

Table 22: Concentration range, average (ng/L), and detection frequency (%) of PBT Group and other compounds in water/effluent samples from STPs, Alna river, and tunnel wash.

	VEAS STP - Effluent	Bekkelaget STP - Effluent	Alna River - Water	Smestad Tunnel - Effluent	VEAS STP - Sludge	Bekkelaget STP - Sludge	Smestad Tunnel - Sedimentt
DEHTP*	Suspect 67 %	Suspect 83 %	Suspect 100 %	Suspect 100 %	na	na	na
Metilox	1.7 - 2.7 2.1 100 %	1.7 - 2.8 2.3 100 %	1.4 - 1.9 1.7 100 %	<1 - <1 0.50 0 %	<5 - <5 <5 0 %	<5 - <5 <5 0 %	<5 - <5 <5 0 %
Cuminal	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	23 - 74 47 100 %	<5 - 140 49 33 %	<5 - <5 <5.0 0 %
Jasminal	<50 - 130 65 50 %	<50 - 120 68 67 %	<50 - 140 76 83 %	<50 - 330 179 83 %	<10 - <10 <10 0 %	<10 - <10 <10 0 %	<10 - <10 <10 0 %
MPT	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	<1 - 16 12 67 %	#N/A 2.7 67 %	<1 - <1 <1.0 0 %
DHEASA	<0.015 -<0.015 <0.015 0 %	<0.015 -<0.015 <0.015 0 %	<0.015 - 0.016 0.015 17 %	<0.015 -<0.015 <0.015 0 %	na	na	na
DiUnDP*	Suspect 0 %	Suspect 0 %	Suspect 0 %	Suspect 100 %	Suspect 100 %	Suspect 100 %	Suspect 100 %
DcHA*	Suspect 0 %	Suspect 0 %	Suspect 100 %	Suspect 0 %	na	na	na
MPDcH	<50 - 130 65 50 %	<50 - 120 68 67 %	<50 - 140 76 83 %	<25 - <25 <25 0 %	<10 - <10 <10 0 %	<10 - <10 <10 0 %	<10 - <10 <10 0 %
MTCC*	Suspect 0 %	Suspect 0 %	Suspect 0 %	Suspect 33 %	Suspect 33 %	Suspect 17 %	Suspect 50 %
TXIB	<55 - 92 55 50 %	<55 - 120 54 33 %	<55 - 230 94 50 %	<55 - 460 233 67 %	<50 - 59 40 33 %	<50 - <50 <50 0 %	<50 - 69 69 17 %
ABA	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	710 - 800 753 100 %	555 67 %	<5 - <5 <5.0 0 %
DABA	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	370 - 440 408 100 %	325 67 %	<5 - <5 <5.0 0 %
CHX*	Suspect 0 %	Suspect 0 %	Suspect 0 %	Suspect 0 %	Suspect 100 %	Suspect 67 %	Suspect 0 %

* No chemical standards or reference material available during the time of analysis. Detection via Suspect Screening. Identification by exact mass, isotopic pattern and predicted retention time.

Table 23: Concentration range, average (ng/g ww), and detection frequency (%) of PBT Group and other compounds in biota samples from.

	Herring gull - Egg	Blue mussel - Soft tissue	Whiting - Liver	Arctic cod - Liver	Arctic bird - Egg	Arctic mussel - Soft tissue	Polar bear - Plasma
DEHTP*	Suspect 30 %	Suspect 80 %	Suspect 0 %	Suspect 0 %	Suspect 0 %	Suspect 0 %	Suspect 0 %
Cuminal	<0.5 - <0.5 <0.5 0 %	0.8 - 1.7 1.1 100 %	<0.5 - 32 20 90 %	1.4 - 10 5.5 100 %	<0.5 - <0.5 <0.5 0 %	0.5 - 1.2 0.87 100 %	<0.5 - <0.5 <0.5 0 %
Jasminal	<5 - 26 9.1 50 %	<5 - <5 <5.0 0 %	27 - 500 210 100 %	<5 - <5 <5.0 0 %	5.3 - 14 6.0 50 %	<5 - <5 <5.0 0 %	<5 - <5 <5.0 0 %
Sylkolide*	Suspect 100 %	Suspect 100 %	Suspect 100 %	Suspect 100 %	Suspect 100 %	Suspect 100 %	Suspect 100 %
EMOPCC*	Suspect 0 %	Suspect 0 %	Suspect 60 %	Suspect 100 %	Suspect 0 %	Suspect 0 %	Suspect 0 %
Serenolide*	Suspect 100 %	Suspect 100 %	Suspect 100 %	Suspect 100 %	Suspect 100 %	Suspect 100 %	Suspect 0 %
DiUnDP*	Suspect 0 %	Suspect 100 %	Suspect 0 %	Suspect 0 %	Suspect 50 %	Suspect 33 %	Suspect 50 %
DEcHDC	<1 - <1 <1.0 0 %	1.6 - 5 3.2 100 %	<1 - 370 175 90 %	3.4 - 38 21 100 %	<1 - <1 <1.0 0 %	4.8 - 8.7 6.7 100 %	<1 - <1 <1.0 0 %
MPDcH	<10 - <10 <10 0 %	<10 - <10 <10 0 %	<10 - <10 <10 0 %	<10 - <10 <10 0 %	<10 - <10 <10 0 %	<10 - 71 18 17 %	<10 - <10 <10 0 %

* No chemical standards or reference material available during the time of analysis. Detection via Suspect Screening. Identification by exact mass, isotopic pattern and predicted retention time.

4.3.2 PFAS Compounds

The results from the PFAS analysis are given below, including both short chain PFAS, the more routinely analysed PFAS compounds.
Residential and non-residential buildings air samples contained PFOS, but also the short chain compound TFA. The residential building air samples in addition contained PFPrA, PFBA and N-MeFOSE.

In addition to the targeted PFAS, two new technologies to screen samples for PFAs compounds were tested. Total-Fluor (Tot-F, EOF) was successfully applied on a limited number of samples, and preliminary results indicate that the level of total-Fluor exceed the sum of targeted analysis.
Tot-F was detected in eight of the 12 wastewater effluent (i.e., above 0.3 ng-F/mL) and in all the 10 sludge samples (i.e., above 86 microgram-F/kg). The EOF concentration in all 10 of the analysed indoor samples was also above the detection limit of 0.5 microgram-F/gram-dust filter. However, we only detected EOF (i.e., above 86 microgram-F/kg) in one of the 10 fish samples analysed.

These measurements are consistent with recent work by Aro et al. 2021. In their study, Aro et al. 2021 preformed a fluorine mass balance from measurements of 37 targeted PFAS and EOF in fish sampled from Alna River and in wastewater sampled from treatment plants and in Oslo. In that study, over 70% of the EOF could not be accounted for by the 37 PFAS they measured in the study. They also noted that the flux of EOF to Alna River and from selected sewage pipes was an order or two higher than the flux of the measured PFAS. Aro et al. 2021`s observation, that most of the organic fluorine measured in environmental samples cannot be accounted for by known PFAS, is now well documented globally. It is therefore recommended that all targeted PFAS analysis is performed in parallel with EOF (Hagan & Harper, 1999).

Table 24: Concentration range, average (ng/m^3), and detection frequency (%) of PFAS compounds in air samples from residential and non-residential buildings, recycling facilities, and urban and remote air monitoring stations.

	Bekkelaget STP - Air	Res. Build. - Air	Nonres. Build. - Air	Urban - Air	Recycling - Air
TFA	<0.015 - <0.015 <0.015 0 %	<0.015 - 0.059 0.03 86 %	<0.015 - 0.044 0.01 14 %	0.016 - 0.09 0.05 100 %	<0.015 - 0.13 0.03 25 %
PFPrA	<0.5 - <0.5 <0.5 0 %	<0.05 - 0.1 0.04 14 %	<0.05 - <0.05 <0.05 0 %	<0.05 - <0.05 <0.05 0 %	<0.05 - 0.84 0.22 38 %
PFEtS	<0.1 - <0.1 <0.1 0 %	<0.05 - <0.05 <0.05 0 %	<0.05 - <0.05 <0.05 0 %	<0.05 - <0.05 <0.05 0 %	<0.05 - <0.05 <0.05 0 %
PFPrS	<0.1 - <0.1 <0.1 0 %	<0.05 - <0.05 <0.05 0 %	<0.05 - <0.05 <0.05 0 %	<0.05 - <0.05 <0.05 0 %	<0.05 - <0.05 <0.05 0 %
PFBS	<0.15 - <0.15 <0.15 0 %	<0.015 - <0.015 <0.015 0 %	<0.015 - <0.015 <0.015 0 %	<0.015 - <0.015 <0.015 0 %	<0.015 - 0.038 0.01 13 %
PFBA	<0.15 - <0.15 <0.15 0 %	<0.015 - 0.019 0.01 29 %	<0.015 - <0.015 <0.015 0 %	<0.015 - <0.015 <0.015 0 %	<0.015 - 0.046 0.03 75 %
PFOA	<0.05 - <0.05 <0.05 0 %	<0.05 - <0.05 <0.05 0 %	<0.05 - <0.05 <0.05 0 %	<0.05 - <0.05 <0.05 0 %	<0.05 - 0.077 0.05 63 %
PFBS	<0.15 - <0.15 <0.15 0 %	<0.015 - <0.015 <0.015 0 %	<0.015 - <0.015 <0.015 0 %	<0.015 - <0.015 <0.015 0 %	<0.015 - 0.038 0.01 13 %
PFHxS	<0.01 - <0.01 <0.01 0 %	<0.01 - <0.01 <0.01 0 %	<0.01 - <0.01 <0.01 0 %	<0.01 - <0.01 <0.01 0 %	<0.01 - 0.07 0.03 38 %
PFOS	<0.005 - <0.005 <0.005 0 %	<0.005 - 0.0066 <0.005 43 %	<0.005 - 0.11 0.07 86 %	<0.005 - <0.005 <0.005 0 %	<0.005 - 0.016 0.01 63 %
N-MeFOSA	<0.05 - <0.05 <0.05 0 %	<0.05 - 0.047 0.03 14 %	<0.05 - <0.05 <0.05 0 %	<0.05 - <0.05 <0.05 0 %	<0.05 - <0.05 <0.05 0 %
N-MeFOSE	<0.05 - <0.05 <0.05 0 %	<0.05 - 0.15 0.07 57 %	<0.05 - <0.05 <0.05 0 %	<0.05 - <0.05 <0.05 0 %	<0.05 - 0.27 0.10 25 %
N-EtFOSE	<0.05 - <0.05 <0.05 0 %	<0.05 - 0.18 0.09 57 %	<0.05 - <0.05 <0.05 0 %	<0.05 - <0.05 <0.05 0 %	<0.05 - <0.05 <0.05 0 %

Table 25: Concentration range, average (ng/L), and detection frequency (%) of PFAS compounds in water/effluent samples from STPs, Alna river, and tunnel wash.

	Alna River - Water	VEAS STP - Effluent	Bekkelaget STP - Effluent	Smestad Tunnel - Effluent	VEAS STP - Sludge	Bekkelaget STP - Sludge	Smestad Tunnel - Sedimentt
TFA	130 - 210 158 100 %	120 - 160 145 100 %	110 - 210 158 100 %	<1 - <1 <1.0 0 %	<0.2 - <0.2 <0.2 0 %	<0.2 - <0.2 <0.2 0 %	<0.2 - <0.2 <0.2 0 %
TFMeS	<0.1 - <0.1 <0.10.05 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - 5.3 3.5 67 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %
TFMS	<0.1 - <0.1 <0.10.05 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - 5.3 3.5 67 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %
PFPrA	5 - 15 8.4 100 %	5.1 - 10 7.6 100 %	5.1 - 85 25 100 %	<0.2 - <0.2 <0.2 0 %	<0.2 - <0.2 <0.2 0 %	<0.2 - <0.2 <0.2 0 %	<0.2 - <0.2 <0.2 0 %
PFBS	0.7 - 1.2 0.97 100 %	0.6 - 1.5 1.1 100 %	2.1 - 3.9 2.9 100 %	1.1 - 1.6 1.4 100 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %
PFPeS	<0.1 - <0.1 <0.10.05 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - 0.2 0.08 33 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %
PFBA	<0.2 - 5.3 4.3 83 %	<0.2 - 15 6.0 83 %	5.1 - 11 8.6 100 %	<0.2 - <0.2 <0.2 0 %	<0.2 - <0.2 <0.2 0 %	<0.2 - <0.2 <0.2 0 %	<0.2 - <0.2 <0.2 0 %
PFPeA	0.8 - 4.5 2.7 100 %	0.6 - 2.5 1.6 100 %	6.6 - 12 8.3 100 %	0.4 - 2.7 1.6 100 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %
PFHxA	1.5 - 5.9 3.0 100 %	2.1 - 4.6 3.1 100 %	4.9 - 8.6 7.0 100 %	1.5 - 3.6 2.7 100 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %
PFHA	0.7 - 3.1 1.5 100 %	1.1 - 2.4 1.7 100 %	0.9 - 2.2 1.5 100 %	1.1 - 3.3 2.1 100 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %
PFOA	1.6 - 4.2 2.5 100 %	1.5 - 4.4 3.1 100 %	3.5 - 110 22 100 %	1.9 - 3.2 2.7 100 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %
PFNA	<0.5 - 1.4 0.52 33 %	<0.5 - 0.9 0.60 50 %	<0.5 - 0.8 0.56 83 %	<0.5 - 0.8 0.75 67 %	<0.4 - <0.4 <0.4 0 %	<0.4 - <0.4 <0.4 0 %	<0.4 - <0.4 <0.4 0 %
PFDA	<0.4 - <0.4 <0.40.20 0 %	<0.4 - <0.4 <0.4 0 %	<0.4 - <0.4 <0.4 0 %	<0.4 - 1.6 1.2 83 %	<0.4 - 0.5 0.38 50 %	0.8 - 1.1 0.90 100 %	<0.4 - <0.4 <0.4 0 %
PFBS	0.7 - 1.2 0.97 100 %	0.6 - 1.5 1.1 100 %	2.1 - 3.9 2.9 100 %	1.1 - 1.6 1.4 100 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %
PFHxS	0.2 - 0.4 0.32 100 %	<0.1 - 0.3 0.15 67 %	0.5 - 0.6 0.55 100 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %
	1.7 - 2.7	0.8 - 1.7	1.4 - 1.9	1.4 - 1.8	0.4 - 0.6	1.6 - 1.9	<0.1 - <0.1

	Alna River - Water	VEAS STP - Effluent	Bekkelaget STP - Effluent	Smestad Tunnel - Effluent	VEAS STP - Sludge	Bekkelaget STP - Sludge	Smestad Tunnel - Sedimentt
PFOS	2.1 100 %	1.2 100 %	1.6 100 %	1.6 100 %	0.50 100 %	1.7 100 %	<0.1 0 %
N-MeFOSE	<1 - <1 <1.00.50 0 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	<0.3 - <0.3 0.15 0 %	1.4 - 1.9 1.6 100 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %
N-MeFOSAA	<0.3 - <0.3 <0.30.15 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	0.5 - 0.7 0.63 100 %	<0.3 - <0.3 <0.3 0 %
N-EtFOSAA	<0.3 - <0.3 <0.30.15 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	0.5 - 0.8 0.62 100 %	#N/A 1.6 100 %	<0.3 - <0.3 <0.3 0 %
PFBS-amide	<0.3 - <0.3 <0.30.15 0 %	0.7 - 1.4 1.1 100 %	0.5 - 0.7 0.58 100 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %
6:2FTS	<0.3 - 2.4 0.93 67 %	<0.3 - 0.7 0.32 33 %	0.4 - 1.1 0.67 100 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %
10:2 FTS	<0.3 - <0.3 <0.30.15 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	0.5 - 0.9 0.68 100 %	<0.3 - 0.4 0.40 75 %	<0.3 - <0.3 <0.3 0 %
6:2 diPAP	<0.3 - <0.3 <0.30.15 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	0.8 - 1.6 1.2 100 %	#N/A 0.70 100 %	<0.3 - <0.3 <0.3 0 %
PFECHS	<0.3 - <0.3 <0.30.15 0 %	<0.3 - <0.3 <0.3 0 %	0.9 - 2.6 1.7 100 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %
Tot-F	#N/A 67 na	#N/A 743 na	#N/A 703 na	#N/A na na	#N/A 156 na	#N/A 290 na	#N/A 743 na
TOPA	#N/A na na	#N/A na na	#N/A na na	#N/A na na	#N/A na na	#N/A na na	#N/A na na

Table 26: Concentration range, average (ng/g ww), and detection frequency (%) of PFAS compounds in biota samples.

	Herring gull - Egg	Blue mussel - Soft tissue	Whiting - Liver	Arctic cod - Liver	Arctic bird - Egg	Arctic mussel - Soft tissue	Polar bear - Plasma
PFHA	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - 1.1 0.48 50 %
PFOA	<0.5 - 0.8 0.40 20 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	1.7 - 4.6 2.8 100 %
PFNA	<0.4 - 1.3 0.54 40 %	<0.4 - <0.4 <0.4 0 %	<0.4 - <0.4 <0.4 0 %	<0.4 - <0.4 <0.4 0 %	0.5 - 0.9 0.55 50 %	<0.4 - <0.4 <0.4 0 %	11 - 22 17 100 %
PFDA	<0.4 - 3.1 1.2 90 %	<0.4 - <0.4 <0.4 0 %	<0.4 - 0.5 0.30 30 %	<0.4 - <0.4 <0.4 0 %	0.4 - 1.2 0.58 50 %	<0.4 - <0.4 <0.4 0 %	2.9 - 5.6 4.5 100 %
PFUA	<0.4 - 2 1.1 90 %	<0.4 - <0.4 <0.4 0 %	<0.4 - 1.2 0.59 60 %	<0.4 - <0.4 <0.4 0 %	0.6 - 2.9 1.2 100 %	<0.4 - <0.4 <0.4 0 %	4.7 - 12 7.9 100 %
PFDoA	<0.4 - 3.7 1.5 90 %	<0.4 - <0.4 <0.4 0 %	<0.4 - 1.1 0.41 40 %	<0.4 - <0.4 <0.4 0 %	0.6 - 0.6 0.30 17 %	<0.4 - <0.4 <0.4 0 %	0.6 - 1.3 0.97 100 %
PFTDA	0.5 - 3.4 1.3 100 %	<0.4 - <0.4 <0.4 0 %	<0.4 - 0.8 0.29 10 %	<0.4 - <0.4 <0.4 0 %	0.6 - 1.6 0.98 100 %	<0.4 - <0.4 <0.4 0 %	1.3 - 3.6 2.2 100 %
PFTA	<0.4 - 3.2 1.3 90 %	<0.4 - <0.4 <0.4 0 %	<0.4 - <0.4 <0.4 0 %	<0.4 - <0.4 <0.4 0 %	<0.4 - <0.4 <0.4 0 %	<0.4 - <0.4 <0.4 0 %	<0.4 - <0.4 <0.4 0 %
PFHxS	<0.1 - 4.2 0.64 70 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	0.1 - 0.1 0.09 67 %	<0.1 - <0.1 <0.1 0 %	7.3 - 30 20 100 %
PFHS	<0.1 - 0.6 0.21 80 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	1.1 - 2.9 2.0 100 %
PFOS	7.5 - 110 30 100 %	<0.1 - 0.1 0.07 20 %	1.1 - 3.1 2.0 100 %	0.3 - 0.6 0.43 100 %	1.2 - 8.3 3.3 100 %	<0.1 - <0.1 <0.1 0 %	41 - 83 57 100 %
PFDS	<0.1 - 1.1 0.41 70 %	<0.1 - <0.1 <0.1 0 %	<0.1 - 0.2 0.09 20 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %
PFOSA	<0.1 - <0.1 <0.1 0 %	0.2 - 0.6 0.38 100 %	7.2 - 20 13 100 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %
PFBS-amide	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - 0.8 0.40 70 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %
4:2 FTS	<0.3 - <0.3 <0.3	<0.3 - <0.3 <0.3	<0.3 - 1.8 0.43	<0.3 - <0.3 <0.3	<0.3 - <0.3 <0.3	<0.3 - <0.3 <0.3	<0.3 - <0.3 <0.3

	Herring gull - Egg	Blue mussel - Soft tissue	Whiting - Liver	Arctic cod - Liver	Arctic bird - Egg	Arctic mussel - Soft tissue	Polar bear - Plasma
	0 %	0 %	10 %	0 %	0 %	0 %	0 %
6:2FTS	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	0.4 - 0.7 0.47 100 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %
8:2 FTS	<0.3 - 0.5 0.22 10 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %
10:2 FTS	<0.3 - 4.5 1.0 10 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %
12:2 FTS	<0.3 - 0.6 0.24 10 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %
6:2 diPAP	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	<0.3 - <0.3 <0.3 0 %	140 - 820 405 100 %	<0.3 - <0.3 <0.3 0 %
Tot-F	#N/A na na	#N/A na na	#N/A na na	#N/A na na	- na na	#N/A na na	#N/A na na
TOPA	#N/A na na	#N/A na na	#N/A na na	#N/A na na	- na na	#N/A na na	#N/A na na

4.3.3 Medusa compounds

Table 27: Concentration range, average (ng/m^3), and detection frequency (%) of VOCs air samples from STPs, residential and non-residential buildings, recycling facilities, and urban and remote air monitoring stations.

AIR	Bekkelaget STP	Res. Build.	Nonres.Build.	Urban	Recycling	Birkenes
TFE	<0.05 - 0.62 0.29 50 %	<0.05 - 2.9 1.4 86 %	<0.05 - 0.59 0.12 14 %	<0.05 - 0.45 0.10 17 %	<0.05 - 0.44 0.09 11 %	<0.05 - 1.4 0.90 83 %
CTFE	2 - 5.9 3.6 100 %	4.6 - 38 15 100 %	5.1 - 15 8.1 100 %	2.7 - 5.7 4.3 100 %	1.3 - 4.1 2.6 100 %	2.8 - 42 15 100 %
HFP	<0.05 - 0.11 0.04 17 %	<0.05 - 0.51 0.18 86 %	<0.05 - <0.05 <0.05 0 %	<0.05 - <0.05 <0.05 0 %	<0.05 - 0.44 0.11 22 %	<0.05 - 0.39 0.19 83 %
Freon-C-318	4.4 - 4.8 4.6 100 %	4.3 - 4.6 4.4 100 %	4.3 - 4.4 4.3 100 %	4.4 - 4.6 4.5 100 %	4.3 - 4.5 4.4 100 %	4.8 - 5 4.9 100 %

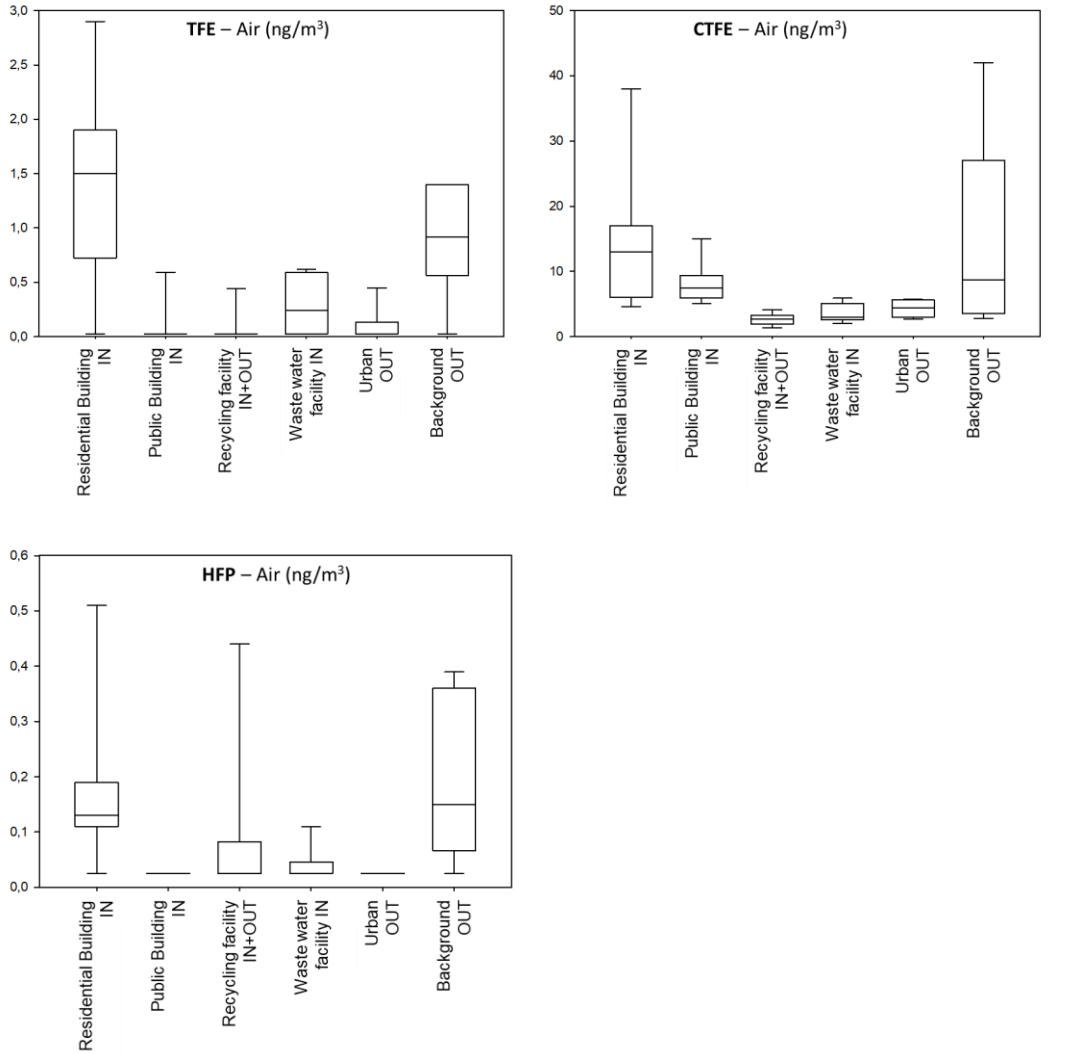


Figure 9. Box-plots of measured concentrations of three groups of VOCs (ng/m^3) in air at indoor and outdoor locations.

4.3.4 Siloxanes (Sil) and Antioxidants (AO)

The highest concentration of H-L3 was measured in a public garage (1.1 ng/m^3) followed by two stores (electronics and clothes: 0.56 and 0.50 ng/m^3, respectively)

Table 28: Concentration range, average (ng/m^3), and detection frequency (%) of siloxane compounds in air samples from residential and non-residential buildings, recycling facilities, and urban air monitoring station.

	Bekkelaget STP - Air	Res. Build. - Air	Nonres. Build. - Air	Urban - Air	Recycling – Air
H-L3	<0.05 - <0.05 <0.05 0 %	0.013 - 0.36 0.09 100 %	<0.005 - 1.1 0.39 100 %	<0.005 - 0.012 <0.01 17 %	<0.0076 - 0.035 0.02 67 %

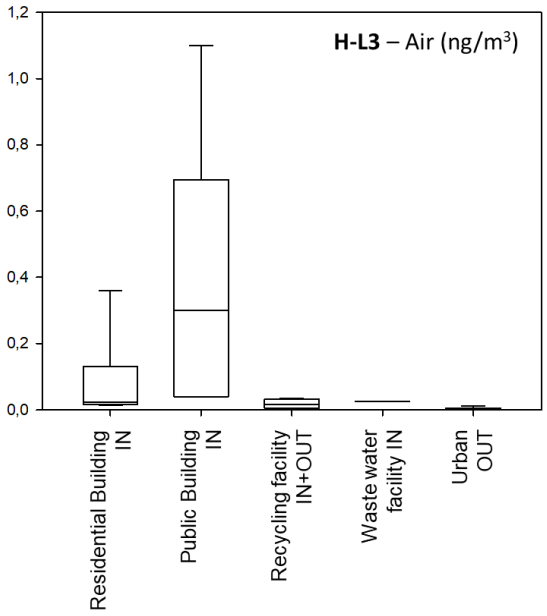


Figure 10. Box-plots of measured concentrations of H-L3 in air (ng/m^3). The box-plots represents a range from 25-75% confidence interval with the center line representing the median concentrations and the error bars the outliers, respectively.

4.3.5 Compounds earlier identified in the Arctic (VOC Group III)

Based on findings in a recent study of remote air samples from Birkenes and Ny-Ålesund some emerging compounds were tentatively identified by suspect and non-target screening (Röhler et al., 2021, Röhler et al., 2020). In order to confirm these tentative identifications in total 45 compounds were selected for further verification. These were 25 substances from the original tender (21 authentic standard available) and 20 additional substances (all 20 available) – isomers and suspected congeners. It was not possible to confirm all earlier findings, however, 21 out of 25 VOC Group III compounds were identified and quantified in at least one sample. Of the additional substances 17 out of 20 were detected. In several cases an additional congener was present in higher concentration than the original reported findings. This shows importance of using all available congeners for confirmation when available.

The nitroanisoles 2-nitroanisole (oNA), 3-nitroanisole (mNA), and 4-nitroanisoles (oNA) were frequently found in air, dust, water, and effluent samples. oNA and pNA were also found in biota samples. The source of the nitroanisoles might be the use as industrial chemicals, however, it might also be formed by nitration of aromatic precursors with airborne NO_2 (Pereira et al., 2015). For oNA both the maximum concentration and the average concentration measured in effluent from VEAS were exceeding the lowest PNEC estimated for the marine environment. ECHA predicted oNA as likely to meet criteria for category 1A or 1B carcinogenicity, mutagenicity, or reproductive toxicity (ECHA, 2022).

2-Methylanthraquinone (MAQ) is an oxygenated PAH, which most probably are generated by photo-oxidation of anthracene or other PAHs (Webb et al., 2006) or as a disinfection by-product (Onodera et al., 1994). It is found in all urban air samples, regularly in dust samples, in all water and effluent samples, and all sludge samples. Some of the maximum concentrations measured in effluent from STPs and tunnel wash water are close to the lowest PNEC estimated for the marine or freshwater environment.

Carbazole (Cbzl) was frequently found in a lot of different sample types, including biota samples. The maximum concentrations measured in effluent from STPs are close to the lowest PNEC estimated for the marine environment The maximum concentrations of carbazole measured in mussels from both Oslofjord and the Arctic were exceeding the estimated lowest PNEC for marine mussels. Carbazole is a heterocyclic PAH with the same main sources as other PAHs namely incomplete combustion processes. It is also found in crude oil and coal. It also used as intermediate in synthesis of dyes and other chemicals.

Octachlorostyrene (OCSt) was detected in some arctic air samples and in biota samples from both Oslofjord and the Arctic. The maximum concentration measured in Arctic mussels was close to the lowest PNEC estimated for this species. It should also be mentioned that the lower chlorinated styrenes tetra- and pentachlorostyrenes (TCSt and PCSt) were found regularly in fish liver in much higher concentrations than octachlostyrene, however, for these compounds no PNEC-values were listed.

Phenindione (iMAC-P) is found in dust samples from residential and non-residential buildings and in in dust from recycling facilities, and also in some samples of tunnel wash sediments. The maximum level measured in tunnel wash sediment was close to the estimated lowest PNEC for freshwater environment. Phenindione is a pharmaceutical (anticoagulant), but it is not listed in the Norwegian list of pharmaceuticals (felleskatalogen.no) and it is therefore hardly used as medicine in Norway. However, it is also acting as a rodenticide and might be used for this purpose (Hohenberger et al., 2022, Gomez-Canela et al., 2014). As it is not registered in the Norwegian biocide regulation also this application is not very likely, however other indanedione type rodenticides like chlorophacinone (CAS 3691-35-8) are registered (2017) and probably in use and phenindione might be a impurity in such products.

Dichlofluanid (DCFd) was detected in all air samples from residential buildings. In additions it was found in very high concentration in the dust of one residential building with a concentration of 21 µg/g. Dichlofluanid is registered as a fungicide and used in some outdoor wood preservation products as for example Jotun's Drygolin (Jotun, 2011) or Preventol A 4 of Lanxess (Lanxess, 2007). In the 80's and 90's a product containing DCFd (Rentolin) was marketed in Denmark for indoor use. This resulted in many cases of illnesses such as headaches, dizziness, eye and respiratory irritation, nausea and skin rash. However, the fungicide was assessed - based on the low concentrations measured in the indoor climate - to play a very small role for the vast majority of people, but allergic reactions cannot be ruled out. (Miljøstyrelsen, 2020). In a recent ECHA assessment of DCFd ((ECHA, 2016) Acceptable Exposure Limit (AEL) were

published: AEL $_{Acute}$ = 0.3 mg/kg bw/day, AEL $_{Long\ term}$ = 0.025 mg/kg bw/day US EPA recommend a dust ingestion value for children of 20 – 100 mg/day (US-EPA, 2017). Given a 6 month old baby with a body weight 8 kg, a measured concentration of 21 µg/g, and an uptake of 100 mg/day, the maximum uptake could be up to 0.26 µg/ kg bw/day. This is roughly a factor of 100 lower than the acceptable exposure limit for long term exposure and it can be assumed that there is no increased health risk due to this compound. Also other VOC Group III compounds, like 2- and 3-nitro anisole (oNA/mNA), 2-methyl-9.10-anthraquinone (MAQ), 4-chloro-2-methyl phenol (CMP), carbazole ((Cbzl), and phenin dione ((IMAC-P) showed maximum concentrations in the dust sample from residential building 5. However, when looking into air samples taken in the same buildings, house 5 does not show any elevated concentration.

Table 29: Concentration range, average (ng/m^3), and detection frequency (%) of VOC Group III compounds in air samples from residential and non-residential buildings, recycling facilities, and urban and remote air monitoring stations.

	Res. Build. - Air	Nonres. Build. - Air	Urban - Air	Recycling - Air	Birkenes - Air	Ny-Ålesund - Air
26DCBN	<0.008 - 0.022 0.009 29 %	<0.013 - 0.015 0.008 17 %	<0.003 - 0.009 0.003 50 %	<0.08 - <0.08 <0.08 0 %	0.0022 - 0.019 0.007 100 %	0.001 - 0.0066 0.004 100 %
oNA	9 - 86 31 100 %	<0.01 - 10 3.3 83 %	0.17 - 0.8 0.47 100 %	<0.01 - 5.2 1.6 83 %	0.011 - 0.036 0.02 100 %	0.0015 - 0.0022 0.00 100 %
pBDN	0.014 - 0.14 0.08 100 %	0.047 - 0.28 0.12 100 %	0.016 - 0.11 0.06 100 %	0.024 - 0.069 0.04 100 %	0.01 - 0.15 0.08 100 %	0.0018 - 0.031 0.01 100 %
MAQ	<0.04 - <0.04 <0.04 0 %	<0.13 - <0.13 <0.013 0 %	0.015 - 0.12 0.07 100 %	<0.01 - <0.01 <0.01 0 %	<0.015 - <0.015 <0.015 0 %	<0.1 - <0.1 <0.1 0 %
CMP	<0.4 - <0.4 <0.4 0 %	<4 - 150 62 83 %	<0.15 - <0.15 <0.15 0 %	<4 - 52 12 17 %	<0.15 - <0.15 <0.15 0 %	<0.1 - <0.1 <0.1 0 %
TeCPy	<0.008 - 0.0099 0.006 29 %	<0.01 - 0.024 0.009 17 %	<0.0025 - 0.0068 0.002 17 %	<0.005 - <0.005 <0.005 0 %	<0.0025 - 0.0025 <0.0025 50 %	<0.0015 - 0.0039 0.002 60 %
TCAP	<0.004 - 0.097 0.021 43 %	<0.1 - <0.1 <0.1 0 %	<0.0015 - 0.0079 0.002 17 %	<0.05 - <0.05 <0.05 0 %	<0.0015 - <0.0015 <0.0015 0 %	0.0006 - 0.0018 0.001 100 %
CTCMPy	<0.04 - <0.04 <0.04 0 %	<0.1 - 0.89 0.22 17 %	<0.015 - 0.044 0.02 33 %	<0.05 - 0.099 0.06 33 %	<0.015 - 0.15 0.05 67 %	0.02 - 0.06 0.04 100 %
DCDMB	<0.015 - <0.015 <0.015 0 %	<0.013 - <0.013 <0.013 0 %	0.001 - 0.034 0.013 100 %	<0.01 - <0.01 <0.01 0 %	<0.005 - 0.087 0.035 83 %	<0.003 - <0.003 <0.003 0 %
BDMT	<0.004 - <0.004 <0.004 0 %	<0.1 - <0.1 <0.1 0 %	<0.0015 - 0.015 0.006 67 %	<0.05 - <0.05 <0.05 0 %	<0.0012 - 0.014 0.005 83 %	<0.0008 - <0.0008 <0.0008 0 %
	6.5 - 32	<0.3 - 0.99	0.25 - 3.2	<0.2 - 0.63	0.08 - 0.25	0.005 - 0.014

	Res. Build. - Air	Nonres. Build. - Air	Urban - Air	Recycling - Air	Birkenes - Air	Ny-Ålesund - Air
DCFd	19 100 %	0.32 33 %	1.7 100 %	0.36 67 %	0.15 100 %	0.01 100 %
Cbzl	0.048 - 0.28 0.14 100 %	<0.13 - 0.32 0.14 33 %	0.015 - 0.11 0.06 100 %	<0.06 - 0.34 0.15 83 %	<0.005 - 0.0052 0.003 17 %	<0.003 - <0.003 <0.003 0 %
BPon	<0.008 - 0.039 0.01 14 %	<0.01 - 0.11 0.03 17 %	0.004 - 0.11 0.06 100 %	0.017 - 0.31 0.10 100 %	<0.0025 - <0.0025 <0.0025 0 %	<0.0015 - <0.0015 <0.0015 0 %
NCN	0.28 - 1.2 0.77 100 %	0.22 - 2 0.98 100 %	0.26 - 1.3 0.59 100 %	0.25 - 1.3 0.71 100 %	0.04 - 0.15 0.087 100 %	0.0008 - 0.0025 0.001 100 %
24DCBN	<0.008 - 0.017 0.007 29 %	<0.013 - <0.013 <0.013 0 %	<0.003 - <0.003 <0.003 0 %	<0.01 - <0.01 <0.01 0 %	<0.0025 - <0.0025 <0.0025 0 %	<0.0015 - <0.0015 <0.0015 0 %
ChrQ	<0.008 - <0.008 <0.008 0 %	<0.13 - <0.13 <0.13 0 %	<0.003 - 0.022 0.011 83 %	<0.008 - 0.02 0.008 17 %	<0.0025 - <0.0025 <0.0025 0 %	<0.0015 - <0.0015 <0.0015 0 %
BPQ-14	<0.008 - <0.008 <0.008 0 %	<0.13 - <0.13 <0.13 0 %	<0.003 - 0.011 0.005 67 %	<0.008 - <0.008 <0.008 0 %	<0.0025 - <0.0025 <0.0025 0 %	<0.0015 - <0.0015 <0.0015 0 %
BPQ-56	<0.008 - <0.008 <0.008 0 %	<0.13 - <0.13 <0.13 0 %	<0.003 - 0.005 0.002 33 %	<0.008 - 0.01 0.006 17 %	<0.0025 - <0.0025 <0.0025 0 %	<0.0015 - <0.0015 <0.0015 0 %
BBBF	<0.008 - <0.008 <0.008 0 %	<0.13 - <0.13 <0.13 0 %	<0.003 - 0.006 0.002 17 %	<0.008 - 0.014 0.009 33 %	<0.0012 - <0.0012 <0.0012 0 %	<0.0008 - 0.0009 0.001 20 %
35DCBN	<0.004 - 0.018 0.008 43 %	<0.008 - <0.008 <0.008 0 %	<0.0015 - <0.0015 <0.0015 0 %	<0.004 - <0.004 <0.004 0 %	<0.0012 - <0.0012 <0.002 0 %	<0.0008 - 0.0009 0.001 40 %
25DCBN	<0.004 - 0.009 0.004 29 %	<0.008 - <0.008 <0.008 0 %	<0.0015 - <0.0015 <0.0015 0 %	<0.004 - <0.004 <0.004 0 %	<0.0025 - <0.0025 <0.0025 0 %	<0.0015 - <0.0015 <0.0015 0 %
34DCBN	<0.008 - <0.008 <0.008 0 %	<0.008 - 0.01 0.005 17 %	<0.003 - <0.003 <0.003 0 %	<0.004 - <0.004 <0.004 0 %	<0.0025 - <0.0025 <0.0025 0 %	<0.0015 - 0.0016 0.001 20 %
mNA	<8 - 51 19 86 %	<0.008 - 0.12 0.06 67 %	<3 - <3 <3.0 0 %	<0.008 - <0.008 <0.008 0 %	<0.5 - 0.559 0.30 17 %	<0.3 - <0.3 <0.3 0 %
pNA	<1.5 - 7.9 2.7 43 %	<0.013 - 0.063 0.02 17 %	<0.5 - 1.2 0.87 83 %	<0.008 - <0.008 <0.008 0 %	0.008 - 0.14 0.08 100 %	0.0017 - 0.043 0.02 100 %
mBDN	0.045 - 0.28 0.13 100 %	0.025 - 0.1 0.06 100 %	0.022 - 0.14 0.07 100 %	<0.014 - 0.53 0.12 83 %	0.006 - 0.058 0.03 100 %	0.0011 - 0.014 0.01 100 %

	Res. Build. - Air	Nonres. Build. - Air	Urban - Air	Recycling - Air	Birkenes - Air	Ny-Ålesund - Air
oBDN	0.016 - 0.087 0.04 100 %	<0.013 - 0.12 0.04 67 %	0.014 - 0.089 0.04 100 %	<0.014 - 0.53 0.11 33 %	<0.015 - <0.015 <0.015 0 %	<0.008 - <0.008 <0.008 0 %
iMAC-B	<0.08 - <0.08 <0.08 0 %	<0.13 - <0.13 <0.13 0 %	<0.003 - <0.003 <0.003 0 %	0.11 - 0.62 0.242 100 %	<0.0025 - 0.0037 0.002 50 %	0.0012 - 0.0041 0.003 100 %
245TCPy	<0.008 - <0.008 <0.008 0 %	<0.08 - <0.08 <0.08 0 %	<0.003 - 0.0033 0.002 17 %	<0.05 - <0.05 <0.05 0 %	<0.00025 - 0.0002 0.0002 33 %	<0.00015 - 0.0004 0.0002 80 %
NCQ	<0.008 - <0.008 <0.008 0 %	<0.13 - <0.13 <0.13 0 %	<0.003 - 0.013 0.01 83 %	<0.08 - <0.08 <0.08 0 %	na na	na na

Table 30: Concentration range, average (ng/g dw), and detection frequency (%) of VOC Group III compounds in dust samples from residential and non-residential buildings, and recycling facilities, and sludge/sediment samples from STPs and tunnel wash.

	Res. Build. - Dust	Nonres. Build. - Dust	Recycling - Dust	VEAS STP - Sludge	Bekkelaget STP - Sludge	Smestad Tunnel - Sedimentt
26DCBN	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	0.06 - 0.11 0.09 100 %	<0.1 - 0.17 0.13 67 %	<0.1 - <0.1 <0.1 0 %
oNA	<0.5 - 8.1 1.6 29 %	<0.5 - 5.9 2.2 86 %	<0.5 - 14 3.1 33 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %
pBDN	<0.03 - 0.27 0.07 57 %	0.06 - 0.18 0.10 100 %	<0.03 - 0.51 0.15 89 %	<0.03 - <0.03 <0.03 0 %	<0.03 - <0.03 <0.03 0 %	<0.03 - <0.03 <0.03 0 %
MAQ	<2 - 1400 267 57 %	<2 - 250 52 86 %	7 - 2300 513 100 %	8 - 15 11 100 %	31 - 77 55 100 %	<2 - 13 13 17 %
CMP	2.4 - 1200 260 100 %	4.6 - 140 55 100 %	4 - 17 8.9 100 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %
DCFd	<1 - 21000 3 580 71 %	<1 - <1 <1.0 0 %	<1 - 53 11 22 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	<1 - 2.4 1.5 17 %
Cbzl	<2 - 310 68 57 %	<2 - 63 20 86 %	6 - 760 145 100 %	<2 - <2 <2.0 0 %	<2 - <2 <2.0 0 %	<2 - 2.1 2.1 17 %
NCN	<1 - <1 <1.0 0 %	<1 - 1.9 0.73 14 %	<1 - 3.2 0.95 11 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %
	<0.1 - <0.1	<0.1 - <0.1	<0.1 - 0.3	<0.1 - <0.1	<0.1 - <0.1	<0.1 - <0.1

	Res. Build. - Dust	Nonres. Build. - Dust	Recycling - Dust	VEAS STP - Sludge	Bekkelaget STP - Sludge	Smestad Tunnel - Sedimentt
23DCBN	<0.1 0 %	<0.1 0 %	0.09 11 %	<0.1 0 %	<0.1 0 %	<0.1 0 %
mNA	<0.1 - 3.4 0.85 86 %	0.13 - 3.2 1.3 100 %	<0.1 - 26 4.3 56 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %
mBDN	<0.2 - 0.39 0.19 29 %	<0.2 - <0.2 <0.2 0 %	<0.2 - 0.51 0.21 33 %	<0.2 - <0.2 <0.2 0 %	<0.2 - <0.2 <0.2 0 %	<0.2 - <0.2 <0.2 0 %
oBDN	<0.2 - <0.2 <0.2 0 %	<0.2 - 0.4 0.22 57 %	<0.2 - 1.3 0.53 56 %	<0.2 - <0.2 <0.2 0 %	<0.2 - <0.2 <0.2 0 %	<0.2 - <0.2 <0.2 0 %
iMAC-P	<20 - 1500 265 29 %	<20 - 150 46 57 %	<20 - 2400 916 89 %	<20 - <20 <20 0 %	<20 - <20 <20 0 %	<20 - 28 28 17 %

Table 31: Concentration range, average (ng/L), and detection frequency (%) of VOC Group III compounds in water/effluent samples from STPs, Alna river, and tunnel wash.

	VEAS STP - Effluent	Bekkelaget STP - Effluent	Alna River - Water	Smestad Tunnel - Effluent
26DCBN	1.1 - 8.3 4.5 100 %	4.7 - 6.9 5.7 100 %	0.07 - 0.56 0.22 100 %	0.1 - 0.32 0.18 100 %
oNA	91 - 410 221 100 %	<5 - 11 8.4 83 %	6 - 30 17 100 %	<5 - 17 11 67 %
pBDN	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - 6 3.2 83 %
MAQ	1.4 - 14 6.9 100 %	4.6 - 11 6.5 100 %	3.1 - 14 6.2 100 %	9.1 - 130 74 100 %
CMP	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	<1 - 8.4 5.7 67 %
TeCPy	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	0.25 - 1.7 0.77 100 %
DCDMB	0.05 - 1.1 0.46 100 %	0.07 - 0.38 0.21 100 %	<0.04 - 0.01 0.02 17 %	<0.04 - <0.04 <0.04 0 %
BDMT	<0.1 - 0.19 0.08 17 %	0.6 - 1 0.75 100 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %
Cbzl	1.9 - 12 6.0	1.1 - 3.8 2.0	<5 - 29 7.1	<5 - <5 <5.0

	VEAS STP - Effluent	Bekkelaget STP - Effluent	Alna River - Water	Smestad Tunnel - Effluent
	100 %	100 %	50 %	0 %
24DCBN	<0.015 - <0.015 <0.015 0 %	<0.015 - <0.015 <0.015 0 %	<0.015 - 0.016 0.01 17 %	<0.015 - <0.015 <0.015 0 %
mBDN	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - 6 3.2 83 %
oBDN	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %	0.8 - 16 7.5 100 %

Table 32: Concentration range, average (ng/g ww), and detection frequency (%) of VOC Group III compounds in biota samples from.

	Herring gull - Egg	Blue mussel - Soft tissue	Whiting - Liver	Arctic cod - Liver	Arctic bird - Egg	Arctic mussel - Soft tissue	Polar bear - Plasma
oNA	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	<1 - 5.5 3.2 70 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %	<1 - <1 <1.0 0 %
TCSt*	Suspect 10 %	Suspect 0 %	Suspect 90 %	Suspect 50 %	Suspect 50 %	Suspect 17 %	Suspect 0 %
PCSt*	Suspect 30 %	Suspect 10 %	Suspect 90 %	Suspect 100 %	Suspect 83 %	Suspect 17 %	Suspect 0 %
HCMBP*	Suspect 40 %	Suspect 10 %	Suspect 30 %	Suspect 17 %	Suspect 67 %	Suspect 0 %	Suspect 0 %
Cbzl	<0.5 - 1.8 1.1 80 %	<0.5 - 1 0.36 10 %	<0.5 - 0.06 0.20 20 %	<0.5 - <0.5 <0.5 0 %	0.53 - 1.9 0.82 83 %	<0.5 - 1.6 0.52 17 %	<0.5 - <0.5 <0.5 0 %
OCSt	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - 0.44 0.14 30 %	<0.1 - <0.1 <0.1 0 %	0.18 - 2.1 0.58 67 %	<0.1 - 0.1 0.06 17 %	<0.1 - <0.1 <0.1 0 %
pNA	<0.1 - <0.1 <0.1 0 %	<0.1 - 4 1.4 90 %	<0.1 - 0.61 0.14 10 %	<0.1 - 0.22 0.16 67 %	<0.1 - <0.1 <0.1 0 %	<0.1 - 0.84 0.46 67 %	<0.1 - 0.6 0.14 17 %

* no chemical standards or reference material available during the time of analysis. Detection via Suspect Screening. Identification by exact mass, isotopic pattern and predicted retention time.

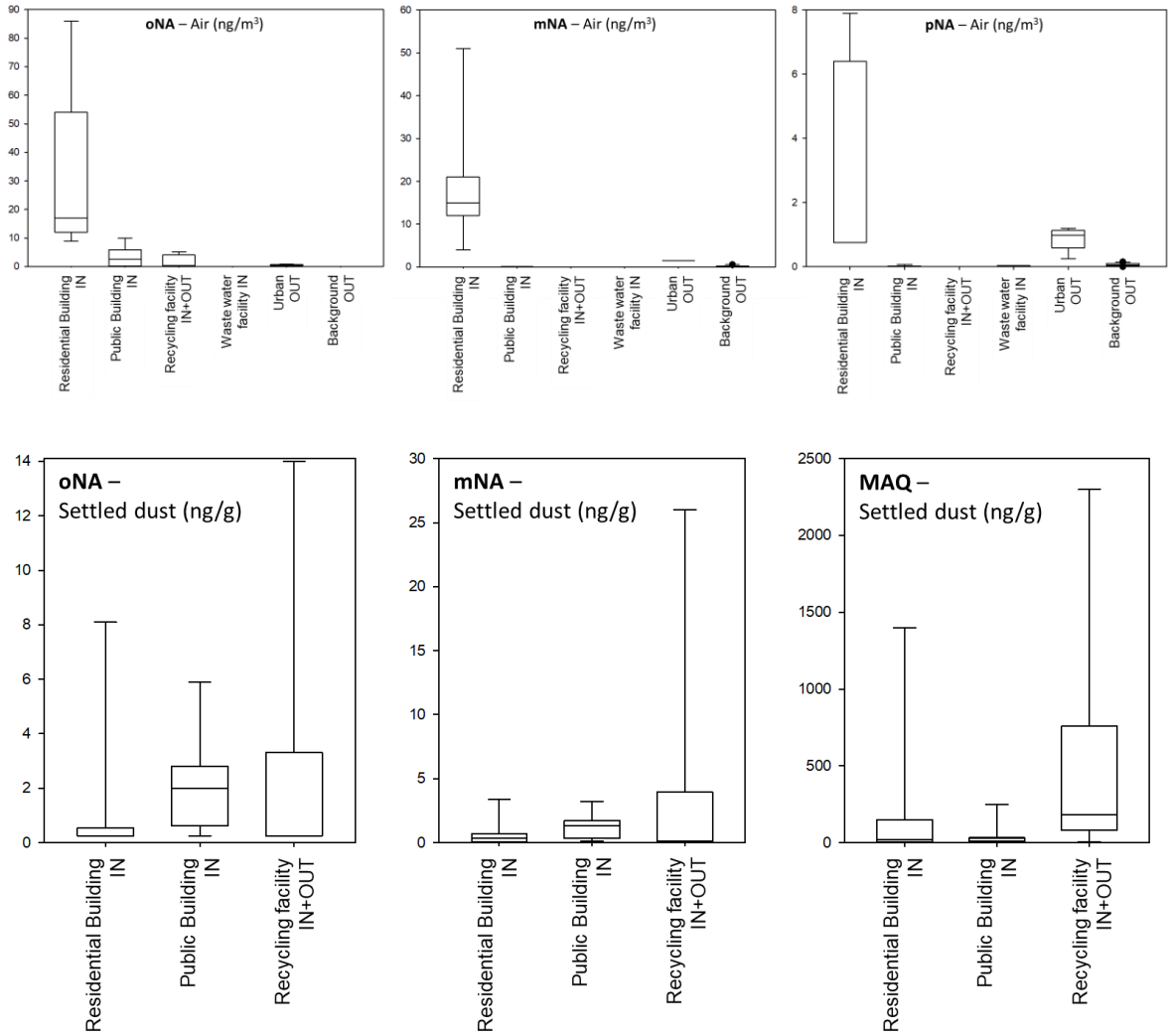


Figure 11. Box-plots of measured concentrations of oNA, mNA and pNA in air (ng/m^3) and oNA, mNA and MAQ in settled dust in residential and public indoor environments and recycling facilities (ng/g).

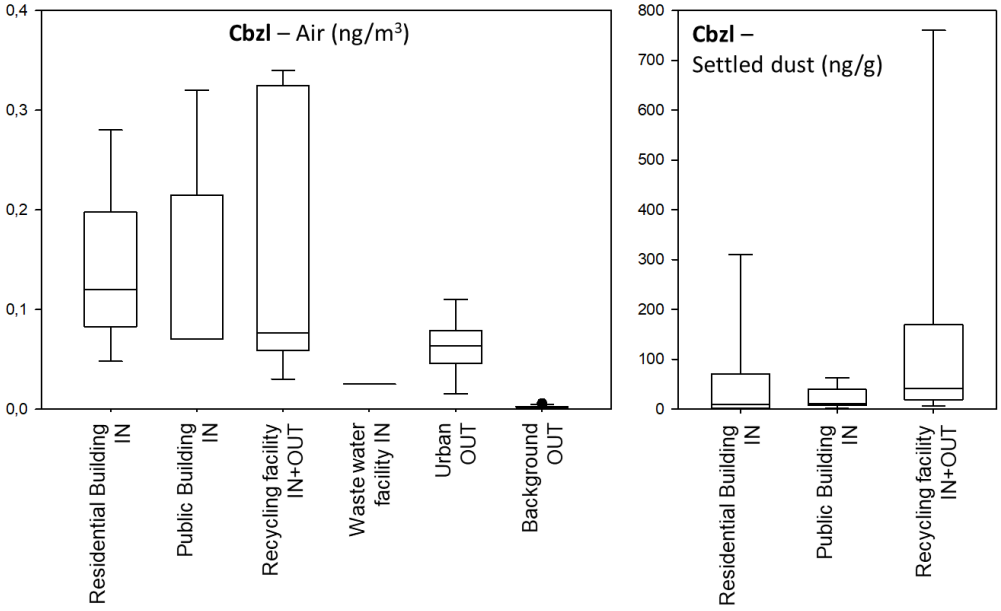


Figure 12. Box-plots of measured concentrations of Cbzl in air (ng/m^3) and settled dust (ng/g).

4.3.6 Metabolites of organophosphorous flame retardants and phthalates

Table 33: Concentration range, average (ng/m^3), and detection frequency (%) of OPFR/Phthalate degradation products in air and dust samples from residential and non-residential buildings, recycling facilities, and urban and remote air monitoring stations.

	Res. Build. - Air	Nonres. Build. – Air	Urban - Air	Birkenes - Air	Res. Build. - Dust	Nonres. Build. – Dust	Recycling - Dust
MMP	0.42 - 2.3 1.0 100 %	<0.05 - 0.55 0.18 86 %	<0.05 - 0.23 0.10 50 %	0.07 - 0.2 0.11 100 %	<1 - 180 60 86 %	6.7 - 140 48 100 %	<1 - 24 9.9 60 %
MEP	<0.1 - 0.87 0.27 67 %	<0.1 - 0.35 0.10 14 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	19 - 380 133 100 %	<1 - 69 30 83 %	<1 - 110 29 80 %
MiBP/ MnBP	<1.3 - <1.3 <1.3 0 %	<1.3 - <1.3 <1.3 0 %	<1.3 - <1.3 <1.3 0 %	<1.3 - <1.3 <1.3 0 %	29 - 140 83 100 %	9.4 - 110 63 100 %	10 - 310 75 100 %
MEOHP	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<1 - 7.9 3.5 57 %	<1 - 2.7 1.1 29 %	<1 - 32 8.3 60 %
MBzP	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<1 - 18 5.9 29 %	<1 - 11 3.1 43 %	<1 - 28 8.7 70 %
MEHHP	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<1 - 120 30 57 %	<1 - 8.1 4.3 71 %	<1 - 84 18 60 %
MEHP	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	42 - 840 350 100 %	23 - 490 213 100 %	16 - 1900 459 100 %
BCEP	<16 - <16 <16 0 %	<16 - <16 <16 0 %	<16 - <16 <16 0 %	<16 - <16 <16 0 %	na	na	na
BCPP	<0.05 - 1.1 0.40 67 %	<0.05 - 0.63 0.15 29 %	<0.05 - <0.05 <0.05 0 %	<0.05 - <0.05 <0.05 0 %	<1 - <1 <1.0 0 %	<1 - 110 25 43 %	<1 - 130 17 20 %
DPP	<0.01 - 0.03 0.01 17 %	<0.01 - 0.03 0.01 14 %	<0.01 - <0.01 <0.01 0 %	<0.01 - <0.01 <0.01 0 %	<1 - 890 161 57 %	<1 - 260 119 86 %	<1 - 46 11 80 %
HDBP	0.04 - 0.22 0.12 100 %	<0.01 - 0.09 0.05 71 %	<0.01 - <0.01 <0.01 0 %	<0.01 - <0.01 0.01 0 %	<1 - 12000 1 750 71 %	<1 - 1100 434 86 %	<1 - 300 39 90 %
BDCPP	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<1 - <1 <1.0 0 %	<1 - 18 4.0 14 %	<1 - 43 8.5 30 %
BBOEP	<0.01 - <0.01 <0.01 0 %	<0.01 - 0.1 0.03 43 %	<0.01 - <0.01 0.01 0 %	<0.01 - <0.01 <0.01 0 %	<1 - 870 184 57 %	<1 - 4500 1 370 71 %	<1 - 88 19 50 %
HDEHP	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	<0.1 - <0.1 <0.1 0 %	18 - 7500 1 320 100 %	12 - 8100 1 910 100 %	24 - 1600 737 100 %

Table 34: Concentration range, average (ng/L), and detection frequency (%) of of OPFR/Phthalate degradation products/metabolites in water/effluent samples from STPs, Alna river, and tunnel wash.

	VEAS STP - Effluent	Bekkelaget STP - Effluent	Alna River - Water	Smestad Tunnel - Effluent	VEAS STP - Sludge	Smestad Tunnel - Sedimentt
MMP	<20 - <20 <20 0 %	<20 - <20 <20 0 %	<20 - <20 <20 0 %	<20 - 350 275 67 %	<1 - <1 <1.0 0 %	<1 - 8.7 4.6 17 %
MEP	<3 - 370 169 50 %	<3 - <3 <3.0 0 %	<3 - <3 <3.0 0 %	<3 - <3 <3.0 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - <0.5 <0.5 0 %
MiBP/MnBP	<4.7 - <4.7 <4.7 0 %	<4.7 - <4.7 <4.7 0 %	<4.7 - <4.7 <4.7 0 %	<4.7 - <4.7 <4.7 0 %	<0.5 - <0.5 <0.5 0 %	<0.5 - 4 2.0 33 %
MEHP	<5 - 8.5 4.0 33 %	<5 - 6.4 3.2 17 %	<5 - 12 5.9 33 %	<5 - 12 4.9 17 %	6.4 - 19 11 100 %	<0.5 - 1.1 0.74 83 %
DPP	<0.8 - 40 15 67 %	2.1 - 13 8.4 100 %	<0.8 - 15 6.9 67 %	4.1 - 7.4 5.4 100 %	22 - 45 32 100 %	2 - 9.4 6.1 100 %
HDBP	11 - 130 53 100 %	1.6 - 4.4 3.1 100 %	2.5 - 7 4.8 100 %	2.1 - 3.7 3.0 100 %	47 - 370 158 100 %	20 - 84 47 100 %
BDCPP	<1.5 - 9.7 4.9 83 %	<1.5 - 19 9.4 83 %	<1.5 - <1.5 <1.5 0 %	<1.5 - <1.5 <1.5 0 %	#N/A na na	<1 - <1 <1.0 0 %
BBOEP	1.1 - 54 20 100 %	16 - 85 32 100 %	<0.4 - 4.7 2.0 67 %	<0.4 - 1.6 1.2 83 %	2.2 - 8.6 5.0 100 %	<2 - <2 <2.0 0 %
HDEHP	<10 - <10 <10 0 %	<10 - <10 <10 0 %	<10 - <10 <10 0 %	<10 - <10 <10 0 %	900 - 2900 1 500 100 %	480 - 2900 1 240 100 %

OPFRs and phthalates are frequently found in high concentrations in indoor and industrial environments and found mostly in settled dust which is shown in the results of this study where significant levels mostly can be found in dust, sludge and sediment and only non-detects to low levels in air and water. Parent compounds are mostly considered non-toxic but degradation products or metabolites are supposed to induce toxicity in humans (Katsikantami et al. 2016).

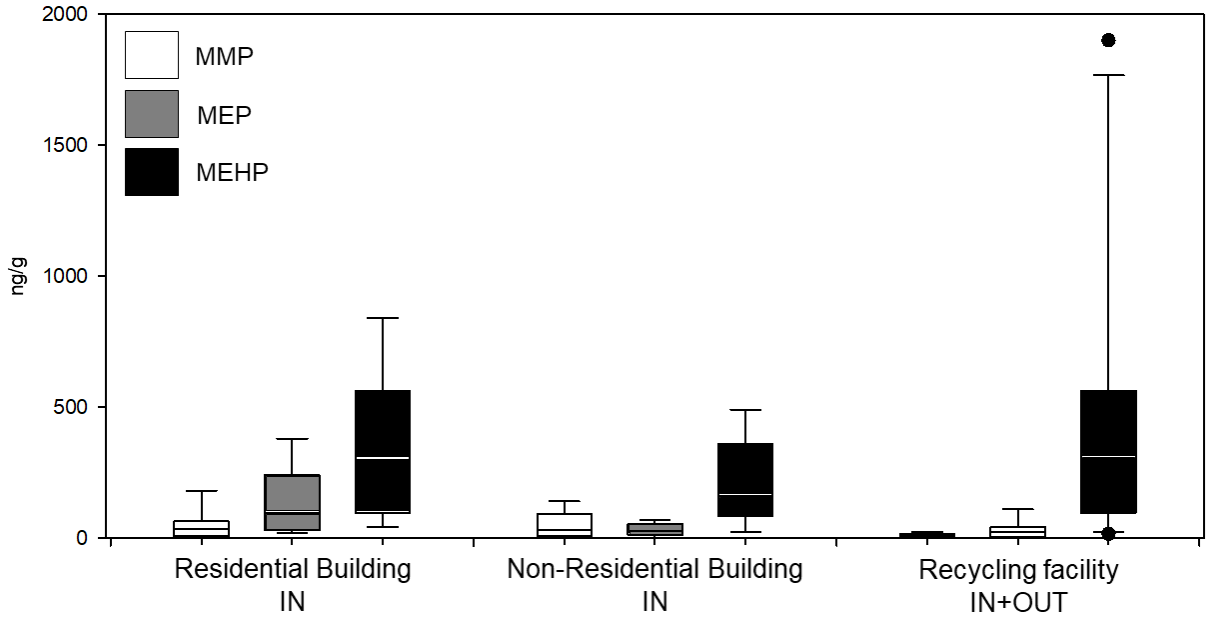


Figure 13. Box-plots of measured concentrations of three phthalates; MMP, MEP and MEHP, in settled dust (ng/g). The box-plots represents a range from 25-75% confidence interval with the center line representing the median concentrations and the error bars the outliers, respectively.

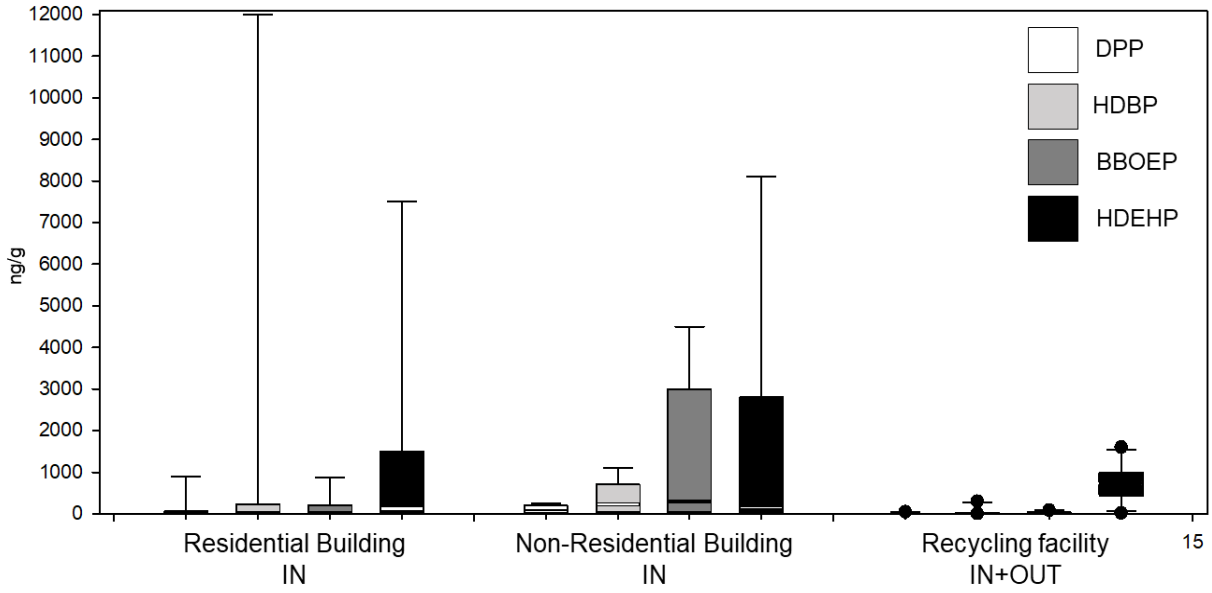


Figure 14. Box-plots of measured concentrations of four OPFRs; DPP, HDBP, BBOEP and HDEHP, in settled dust (ng/g). The box-plots represents a range from 25-75% confidence interval with the center line representing the median concentrations and the error bars the outliers, respectively.

4.3.7 Rare earth elements (REE)

All REEs were detected in all matrixes in all samples. The less abundant heavier REEs (Ho, Tm and Lu) were close to the detection limit in a few of the air samples.

Aqueous samples

Aqueous samples consist of wastewater from two different wastewater treatment plants, surface river water and collected water from tunnel cleaning. The sum REE in wastewater range from 193 to 806 ng/L (average 472 ng/L), whereas river water and tunnel cleaning water range from 726 to 34210 ng/L (average 11 600 ng/L) and 28 800 to 45 000 ng/L (average 35 700 ng/L) respectively. REEs are ubiquitous in natural waters, and they originate from rocks or sediments with which water interacts. Surface waters are an important pathway of transporting and distributing REEs among different environmental compartments. Most lake and river waters exhibit REE concentrations in the lower ng/L but can show substantial variation in different streams and rivers, and river water flow is a parameter that influence REE concentration. The river water concentrations found in this study are considerably higher than the concentrations found in 2018 (Schlabach et al., 2019). River water samples collected on days with high water flow in the river was consistently higher than samples collected when the water flow was low). High water flow leads to turbulence with washout of sediments on the riverbed and edges and turbid water, that in turn results in higher concentrations of REE in the river water. During summer 2018, the water flow in the river was generally lower compared to 2021. Low water flow leads to low turbidity and hence lower concentrations of REE. However, when the 2021 samples are normalized to reference shales, the REE distribution displays a rather flat curve, which means that no REE in the surface waters shows any anomaly. Normalized tunnel cleaning water, on the other hand, resembles the normalized pattern of sediments found in 2018 (Schlabach et al., 2019), with the heavier REEs slightly depleted comparted to the lighter REEs. In this study the wastewater samples showed the lowest concentrations of REEs of all aqueous samples. However, the normalized REE pattern was very different for the wastewater samples compared to river and tunnel cleaning water**Error! Reference source not found.**, with a general slight enrichment of the heavier REEs compared to the lighter, and anomalies for Eu, Gd and Yb. Eu anomalies/enrichment are explained by the different mobility of Eu^{2+} compared to the trivalent REEs. The Gd anomaly in wastewater ranges from moderate to significant (from 4.6 to 106, average 40.2) which most likely originates from the Gd-based MRI agent that passes through wastewater treatment plants (Telgmann et al., 2012). The Yb anomaly in wastewater samples is most likely associated with an analytical error due to low concentrations of Yb.

La, Ce and Nd displays no anomaly in any of the aqueous samples indicating that these elements are not influenced by anthropogenic activity or sources.

Sludge

Sludge samples from both wastewater treatment plants were collected in this study and the sum REE concentration in samples from Bekkelaget ranged from 55.5 to 76.6 µg/g dw (average 66.1 µg/g dw), whereas the sum REE in samples from VEAS were about half, ranging from 32.9 to 40.7 µg/g dw (average 36.6), which is comparable to what was found in a recent study (Kaegi et al., 2021). Shale normalized REE distribution reveals a pattern similar to the natural REE distribution (Haskin et al., 1968), with only a small Eu anomaly and no anomaly in Gd. Though the waters from the wastewater treatment plants in this study show moderately to high influence of anthropogenic activity, this is not visible in the sludge samples. La, Ce and Nd displayed no anomaly.

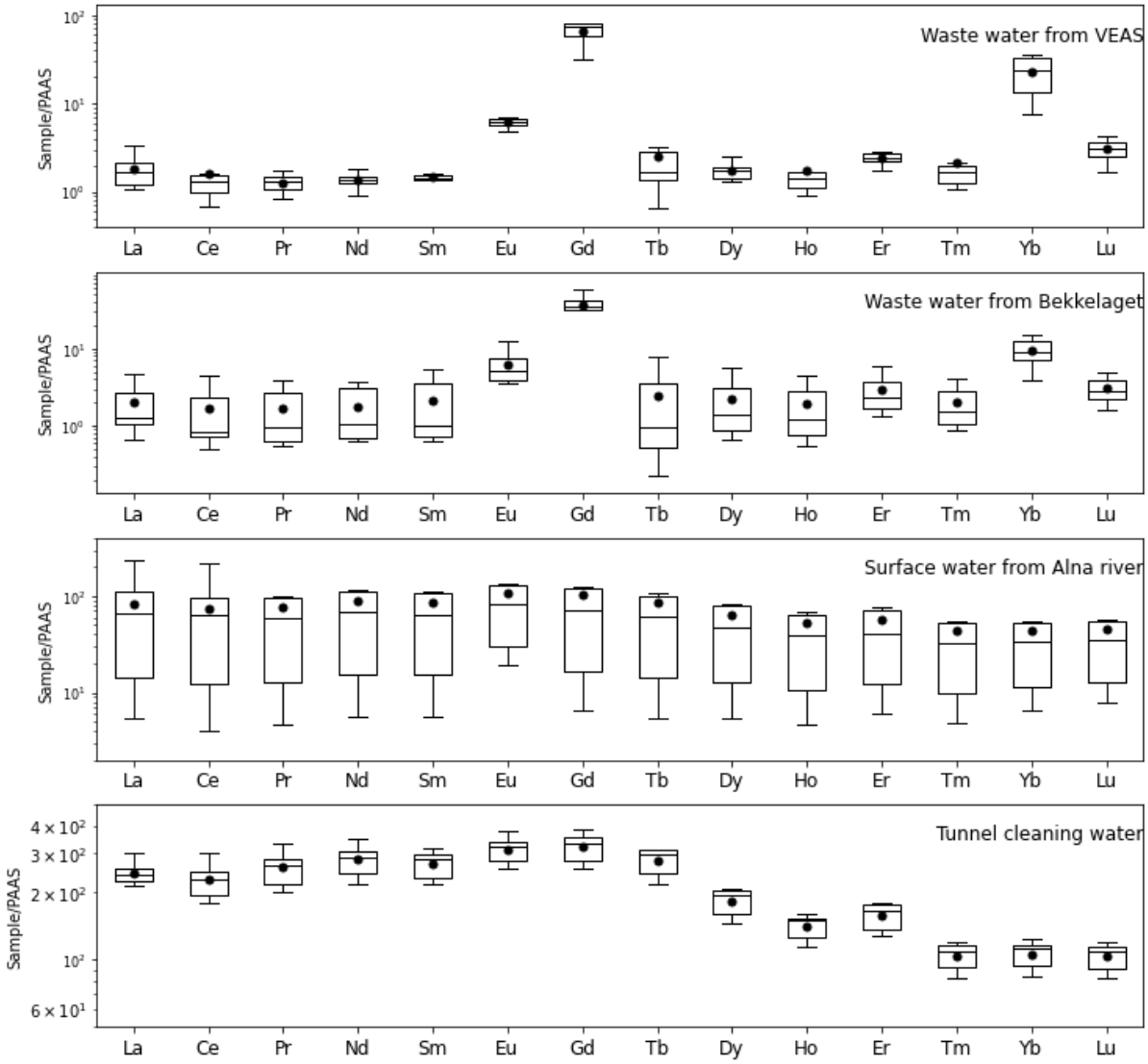


Figure 15: Box and whisker plots of PAAS normalized aqueous samples a) wastewater from VEAS, b) wastewater from Bekkelaget, c) surface water from Alna River and d) collected water from tunnel cleaning.

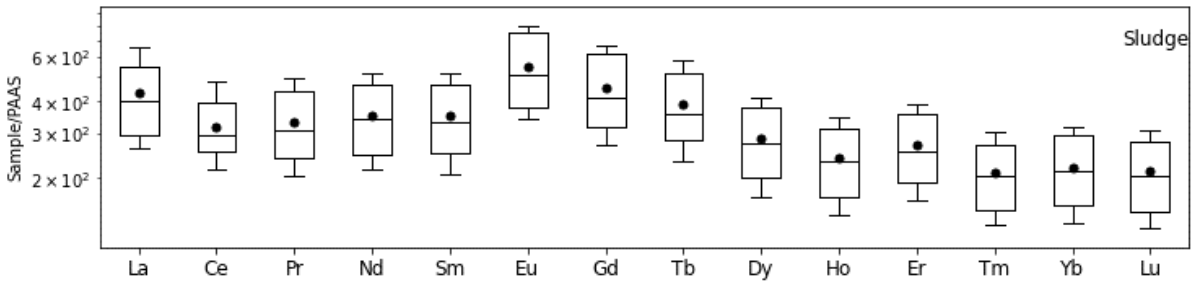
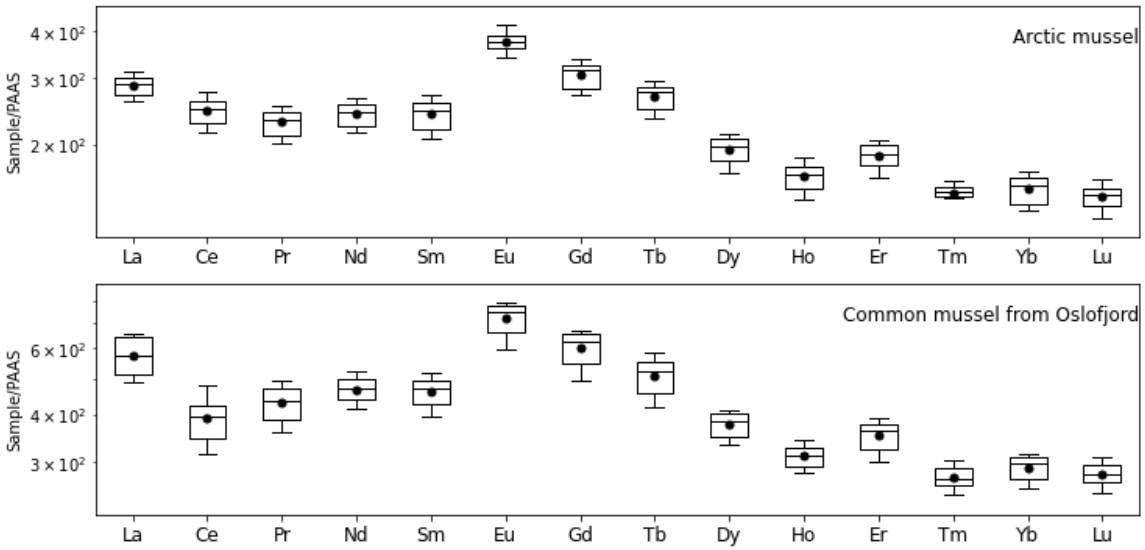


Figure 16: Box and whisker plots of PAAS normalized sludge samples from VEAS and Bekkelaget combined.

Biota

The sum REE concentrations in Arctic mussel and common mussel from Oslofjord ranged from 180 to 3122 ng/g ww (average 901 ng/g ww) and 129 to 486 ng/g ww (average 235 ng/g ww) respectively. One sample of the Arctic mussel is significantly higher than the rest, obscuring the mean. Apart from this one sample, there is no significant difference in concentration between the Arctic mussel and the Common mussel from Oslofjord. The concentration ranges are comparable to a recent study from the Portuguese coast (Figueiredo et al., 2022) analyzing the mussel Mytilus galloprovincialis. Shale normalized REE in the mussel samples reveal a pattern where the heavier REEs are slightly depleted compared to the lighter. In seawater the heavier REEs are almost entirely bound to stabile carbonate complexes while the lighter REEs are present with a greater proportion as free metal ion which makes the heavier

REEs more susceptible to removal from solution through adsorption processes (Cantrell and Byrne, 1987, Byrne and Kim, 1990, Sholkovitz et al., 1994). Eu is enriched in all samples whereas Ce is depleted in the Common mussel samples. The depletion in Ce is probably due to microbially mediates redox chemistry that result in lower relative concentrations compared to the neighboring REEs. La and Nd show no anomaly.



Household dust and air

Dust samples were collected from residential houses, businesses buildings and waste treatment sites. Sum REE ranged from 3.57 to 21.9 µg/g (average 10.4 µg/g), from 4.81 to 75.9 µg/g (average 40.7 µg/g) and from 19.0 to 157 µg/g (average 86.9 µg/g) in residential houses, business buildings and waste treatment sites, respectively. Generally, samples from business buildings and waste treatment sites show a higher distribution in the concentrations ranges as compared to residential houses. The normalized REE distribution form residential houses are similar to natural background, indicating that the source of REEs in household dust originated from outdoors most likely from soil and clay particles. Eu show the highest concentration variation and is most likely related to the origin of soil and clay particles. Non-residential houses show a positive Eu anomaly of varying degree. The reason for this in not clear but may be due to the application of Eu in low-energy light bulbs (Resende and Morais, 2015). Though the concentration variation between samples is high amongst dust samples from business buildings, the general normalized REE distribution pattern is similar to residential houses; enriched Eu and the heavier REEs depleted compared to the lighter REEs. The reason for this in not clear, but may be due to the application of Eu in low-energy light bulbs (Resende and Morais, 2015). La, Ce and Nd showed no anomaly in any of the dust samples.

The normalized REE distribution pattern for dust samples collected at waste treatment sites differ substantially from each other depending on the sampling location. Dust samples collected at a scrapyard showed a REE distribution pattern similar to natural background with no anomalies for any REE, whereas dust samples collected at re-cycling stations also handing E-waste displayed a REE distribution pattern enriched in Eu and Tb, and to some extent Lu.

Air samples were collected from waste re-cycling stations both indoors and outdoors, in addition to a scrapyard. Sum REE in samples collected outdoors ranged from 0.28 to 2.66 ng/m3 (average 1.42 ng/m3). Only two samples were collected indoors, however they were significantly higher (19.9 and 132 ng/m3). The normalized REE pattern in the air samples collected outdoors also resembles natural background, with a small enrichment in Eu (**Error! Reference source not found.**). La, Ce and Nd showed no anomaly in any of the air samples.

It is apparent that the REE distribution pattern is similar in dust and air. Air samples collected indoors and outdoors show the same pattern though the outdoors pattern is less pronounced. These samples are collected at re-cycling stations also handing E-waste. The REE distribution pattern is enriched in Eu and Tb, and to some extent Lu. Whether the Lu enrichment is due to an actual source or an analytical error due to low concentrations is unclear. However, the Eu and Tb enrichment in the dust samples is probably caused by broken fluorescent lamps containing Eu and Tb, and different phosphors producing red, blue and green light, in which Eu and Tb are applied. Data below also show that Eu and Tb to some extent is volatile as the pattern in dust and indoor air is similar.

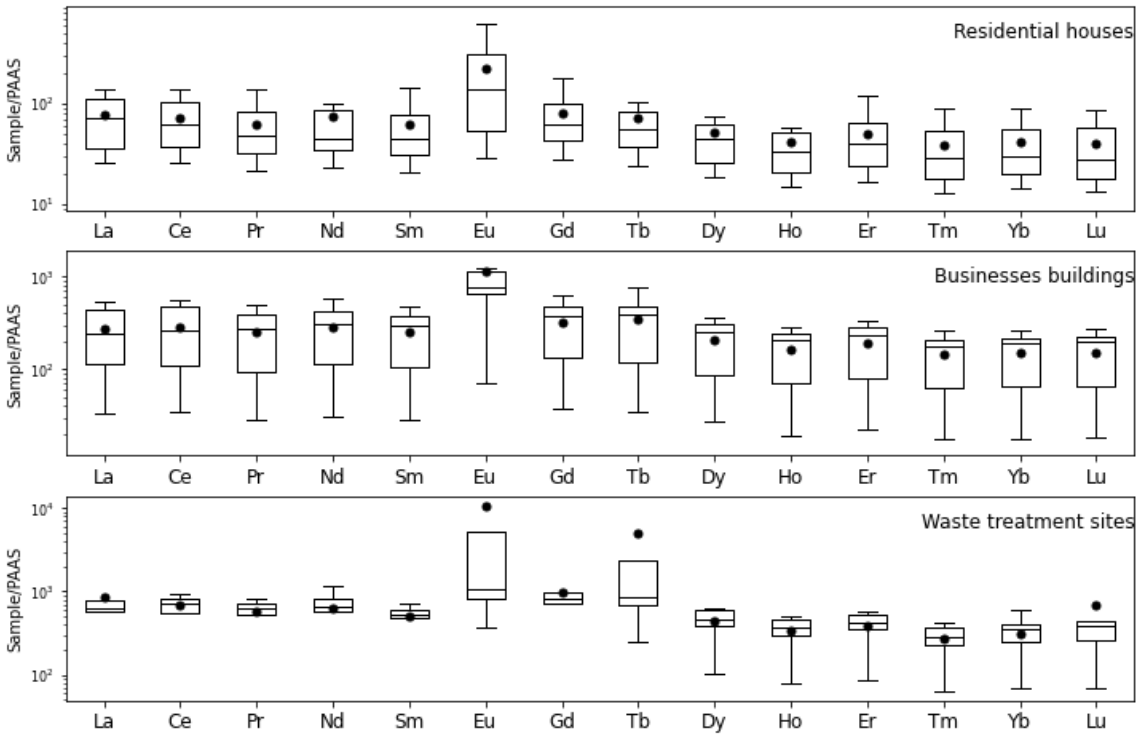


Figure 17: Box and whisker plots of PAAS normalized settled dust samples a) from residential houses, b) from businesses building and c) from waste treatment sites.

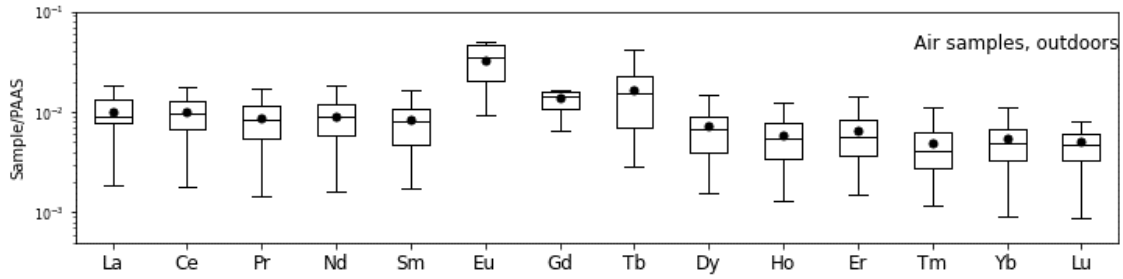


Figure 18: Box and whisker plots of PAAS normalized air samples.

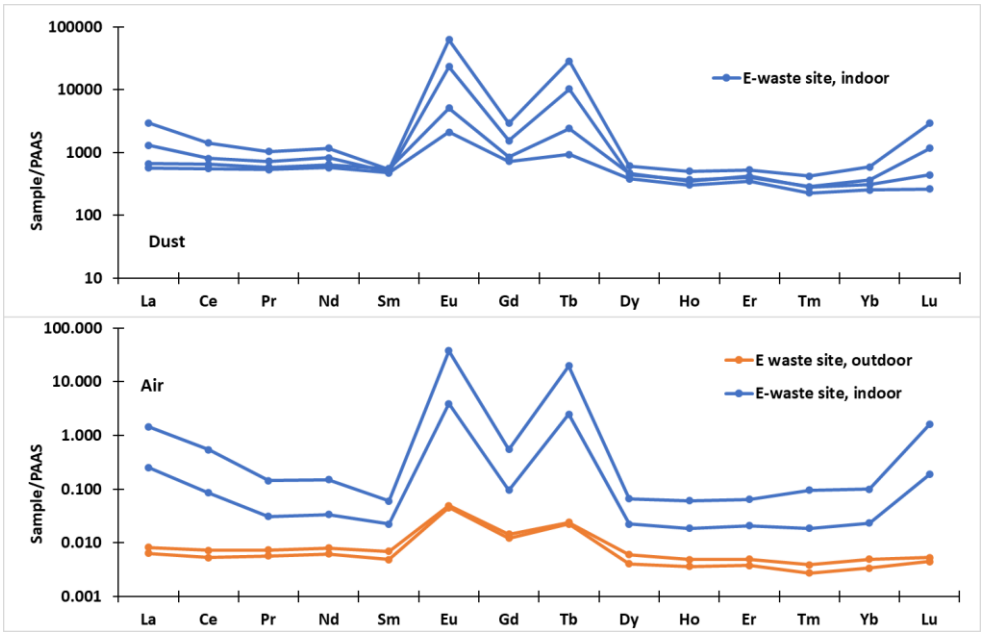


Figure 19: PAAS normalized dust and air samples.

5 Conclusion

In this study nearly 170 different environmental samples were taken and for some samples several sub-samples for the different analytical methods were taken. More than 210 different substances were chosen to be analysed in these samples. The total number of results exceeds 26 000.

Of the PFAS compounds included in this investigation, the short chain PFAS such as TFA and PFBS were found in water samples, while longer chain PFAS (such as PFUS, PFDoA and PFTDA) were found in sediments, sludges and biota. PFOS was the only example found in all environmental compartments. Such trends match expected partitioning properties of PFAS.

PFOA and PFOS were found in WWTP effluents and tunnel-wash water at concentrations exceeding the PNEC values for marine water and /or fresh water. PFOSA, PFBS-amide and the fluor telemer FTS 4:2 exceeded the PNEC for biota samples from Oslofjord. Also the levels for PFOS and PFOSA exceeded the PNEC for marine biota.

New technologies to screen samples for PFAS compounds were tested on a small selection of samples in this study. Total-Fluor (EOF) was successfully applied, and preliminary results indicate that the level of total-Fluor exceed the sum of targeted analysis. Such results are very useful for determining the proportion of known fluorinated substances with respect to the total.

Several of the substances that were detected in this study (albeit at very low concentrations) have previously been identified by non-target screening in Arctic Air (Röhler et al. 2020). This included 26DCBN, pBDN, TeCPY, CTCMPY, DCFd, Cbzl, BPon, NCN, pNA, mBDN and oBDN. The substances in this group have no known common function or use. Several are potential bactericides, fungicides or herbicides (26DCBN, CTCMPY, DCFd). Cbzl occurs in tobacco smoke, while the remaining may be used in the manufacture of polymers. It is therefore difficult to speculate on the emission scenario or pathways for these substances.

The Volatile Organic Compounds (VOCs) TFE, CTFE, HFP, and Freon-C-138 were found in all air samples except from Ny-Ålesund. In addition, siloxane H-L3 was found in both indoor and outdoor air but not in air from remote locations.

Cuminal, Jasminal and DEcHDC were found in several of the biota samples including Arctic samples. Jasminal, MPDcH, TXiB, MEP and MEHP were found at concentrations exceeding PNEC values for marine water and /or fresh water in samples related to WWTP effluents and tunnel-wash water.

The measured concentrations of iMAC-P, TXIB, HDBP and HDEHP in tunnel-wash exceeded (or were close to) the PNEC for sediment. DEcHDC and Cuminal exceeded PNECs for samples from both the Arctic and the Oslo fjord. oNA, OCSt and pNA were the only substances from the VOC Group III that exceeded or were close to the PNEC values for the Oslofjord. Concentrations in the marine mussels exceeded PNEC levels in both the Oslofjord and the Arctic for Cbzl and pNA.

It should be highlighted that PNECs are potentially unreliable and should not be used as the sole criteria for discussing substances. This study involves many substances that are relatively “unknown” and where data is sparse so reliable PNECs are not yet agreed. In this case detection frequency (as presented in this study) is a useful measure of concern. By this measure PFOS was found with the highest (summed) detection frequency across all sample types. This was followed (in descending order) by oNA, Cbzl, HDBP, MAQ, pBDN, 26DCBN. DPP and mBDN. The latter resulted in just half the rate of detection of PFOS.

If results are simply compared by reporting the compound with the highest measured concentration in each sample type, the list includes TXIB in air, MAQ in dust, TFA in river water, oNA in STP effluent, MMP in tunnel wash water, HDEHP in STP sludge and 6:2 diPAP in arctic biota

6 References

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7 Appendix 1: List of substances with CAS number and analytical method

Table A1 List of analytical methods, compounds, CAS numbers and short names

Method	MD	CAS	IUPAC name	Short
REE			Lanthanum-139	La139
			Cerium-140	Ce140
			Praseodymium-141	Pr141
			Neodymium-146	Nd146
			Samarium-147	Sm147
			Europium-153	Eu153
			Gadolinium-157	Gd157
			Terbium-159	Tb159
			Dysprosium-163	Dy163
			Holmium-165	Ho165
			Erbium-166	Er166
			Thulium-169	Tm169
			Ytterbium-172	Yb172
			Lutetium-175	Lu175
PBT Group I	6	112-84-5	Erucamide	Erucamide
	17	6422-86-2	Di(2-ethylhexyl) terephthalate	DEHTP
	18	643-79-8	o-Phthalaldehyde	OPA
	25	15520-11-3	bis(4-tert-butylcyclohexyl) peroxydicarbonate	BCHPC
	28	108-99-6	3-Picoline	3-Picoline
	29	2855-13-2	Isophorone diamine	IPDA
	36	18559-94-9	Albuterol	Albuterol
	42	6386-38-5	Metilox	Metilox
	45	488-10-8	Jasmone	Jasmone
	46	104-68-7	Phenoxydiglycol	Phenoxydiglycol
	64	122-03-2	4-Isopropylbenzaldehyde	Cuminal
	68	122-40-7	amyl cinnamal	Jasminal
	79	676532-44-8	2-(3,5-dimethylhex-3-en-2-yloxy)-2-methylpropyl cyclopropanecarboxylate	Sylkolide
	80	41317-15-1	4-methoxy-N-phenyl-o-toluidine	MPT
	83	14367-46-5	N-ethyl-p-methoxy-a-methylphenethylamine	PMEA
	85	1477-55-0	Mxda	Mxda
	86	853-23-6	Dehydroepiandrosterone acetate	DHEASA
	87	31981-44-9	17-(acetyloxy)-19-Norpregn-4-ene-3,20-dione	NPD
	88	59151-19-8	ethyl 2-methyl-4-oxo-6-pentylcyclohex-2-ene-1-carboxylate	cycE88
	91	477218-42-1	Serenolide	Serenolide
	93	96507-80-1	Decyl isoundecyl phthalate	DiUnDP
	94	849-99-0	Dicyclohexyl adipate	DcHA
	95	72903-27-6	Diethyl 1,4-cyclohexanedicarboxylate	DEcHDC
	96	97398-80-6	1,1'-Bicyclohexyl, 4-methoxy-4'-propyl-, (trans,trans)-	MPDcH
	113	7069-42-3	Retinyl propionate	Retinyl
	114	28043-10-9	Methyl 2,6,6-trimethylcyclohex-2-ene-1-carboxylate	cycE114
	117	2605-79-0	decyl(dimethyl)amine oxide	DDAO

PBT Group II	51	6558-27-6	PhenylAcetylene-HexaChloroCycloPentaDiene	PAHHCCPD
	53	172600-80-5	BisTriChloroMethylTriazinoBromoAnisol	BTCMTBA
	55	77169-18-7	3,4-dichloro-N-(1,2-dichloroethylene)aniline	DCDCEA
	57	14047-09-7	3,3',4,4'-TetraChloroAzoBenzene	TCAz
	61	5181-10-02	4,4'-DiChloroDiPhenylSulfide	DCDPS
	62	1431149-68-6	BromoTetraFluoroTerphenyl	BTFTP
	63	17078-76-1	4-Ethyl-4-IodoBiPhenyl44	EIBP
	65	157229-45-3	2-Methyl-3-Nitro-5-ChloroBenzoTriFluoride	MNCBTF
	69	21232-47-3	3,3',4,4'-TetraChloroAzOxyBenzene	TCAzO
	104	28736-42-7	1,4-DiFluoroAnthraQuinone	DFAQ
	105	76092-29-0	4-BromoBenzoTriBromide	BBTB
	107	187804-77-9	4-Bromo-2,3',4',5'-TetraFluoroBiPhenyl	BTFBP
	108	107392-35-8	2-(3,4-DiFluoroPhenyl)-5-PropylPyrimidine	DFPPP
	116	3194-57-8	1,2,5,6-TetraBromoCycloOctane	TBCO
PBT Group III	1	6846-50-0	2,2,4-Trimethyl-1,3-pentanediol diisobutyrate	TXIB
	15	123-31-9	1,4-dihydroxybenzene	Quinol
	20	26172-55-4	5-chloro-2-methyl-4-isothiazolin-3-one	MCI
		88-18-6	Phenol, isobytylated	TBP
	21	585-34-2	Phenol, isobytylated	TBP
		98-54-4	Phenol, isobytylated	TBP
	27	2634-33-5	1,2- benzoisothiazolin-3-one	BIT
	35	514-10-3	Abietic acid	ABA
	37	1740-19-8	Dehydroabietic acid	DABA
	40	88-53-9	5-amino-2-chlorotoluene-4-sulfonic acid	Red-C-Amine
	47	95-25-0	chlorzoxazone	chlorzoxazone
	48	83164-33-4	Diflufenican	Diflufenican
	112	748080-34-4	2-Chloro-α-hydroxybenzenemethanesulfonic acid	Cl-HBMS
		96-65-1	6,6'-Di-tert-butyl-4,4'-methylenedi-o-cresol	DBM-cresol
	129	88-04-0	chloroxylenol	PCMX
	136	55-56-1	Chlorhexidine	CHX
		4430-21-1	Chlorophenol Blue	Chlorophenol Blue
VOC Group III	2	2498-66-0	1,2-Benzanthraquinone	BAQ
	12	1194-65-6	2,6-DiChloroBenzoNitrile	26DCBN
	19	91-23-6	2-NitroAnisole	oNA
	22	623-26-7	1,4-DiCyanoBenzene	pBDN
	23	147-82-0	2,4,6-TriBromoAniline	TBAnl
	25	84-54-8	2-Methyl-9,10-AnthraQuinone	MAQ
	28	1570-64-5	4-Chloro-2-MethylPhenol	CMP
	31	2402-79-1	2,3,5,6-TetraChloroPyridine	TeCPy
	33	13608-87-2	2,3,4-TriChloroAcetoPhenone	TCAP
	34	1929-82-4	2-Chloro-6-TriChloroMethylPyridine	CTCMPy
	38	2176-62-7	PentaChloroPyridine	PCPy
	39	695-77-2	1,2,3,4-TetraChloroCycloPentaDiene	TCCPD
	50	4714-35-6	TetraChloroStyrene	TCSt
	52	88218-49-9	PentaChloroStyrene	PCSt
	52	2675-77-6	1,4-DiChloro-2,5-DiMethoxyBenzene - Chloroneb	DCDMB
	54	428442-17-5	HeptaChloroMethylBiPyrrole	HCMBP

	56	13321-73-8	2-Bromo-3,5-DiMethoxyToluene	BDMT
	76	1085-98-9	DicloFluanid	DCFd
	78	86-74-8	Carbazol	Cbzl
	84	3074-00-8	6H-Benzo[c,d]Pyren-6-one	BPon
	85	29082-74-4	OctaChloroStyrene	OCSt
	97	613-46-7	2-Naphthalenecarbonitrile	NCN
	99	706-78-5	OctaChloroCycloPentene	OCCP
	100	6574-98-7	2,4-DiChloroBenzoNitrile	24DCBN
	106	66321-24-2	MHC-1	MHC-1
		100900-16-1	Chrysen Quinone	ChrQ
		109699-80-1	Benzo[c]Phenanthrene-1,4-Dione	BPQ-14
		734-41-8	Benzo[c]Phenanthrene-5,6-Dione	BPQ-56
		208-37-7	BenzoBisBenzoFuran	BBBF
		6575-00-4	3,5-DiChloroBenzoNitrile	35DCBN
		21663-61-6	2,5-DiChloroBenzoNitrile	25DCBN
		6574-99-8	3,4-DiChloroBenzoNitrile	34DCBN
		6574-97-6	2,3-DiChloroBenzoNitrile	23DCBN
		555-03-3	3-NitroAnisole	mNA
		100-17-4	4-NitroAnisole	pNA
		626-17-5	1,3-DiCyanoBenzene	mBDN
		91-15-6	1,2-DiCyanoBenzene	oBDN
		3430-15-7	2,3,5-TriBromo-6-MethylPyridine	TBMPy
		525-82-6	Flavone	iMAC-F
		83-12-5	PheninDione	iMAC-P
		575-61-1	BenzalPhthalide	iMAC-B
		55934-01-5	2,4,5-TriChloroPyridine	245TCPy
		16063-69-7	2,4,6-TriChloroPyridine	246TCPy
		33216-52-3	3,4,5-TriChloropyridine	345TCPy
		1090-13-7	5,12-NaphthaceneDione	NCQ
Siloxanes	16	1873-88-7	HeptaMethylTriSiloxane	H-L3
	103	690-56-2	TriFluoropropylDiMethylDiSiloxane	TFPDMDS
AntiOx.	44	31570-04-4	IrgafosP	btBPP
	75	95906-11-9	IrgafosPO	btBPPO
Short PFAS	7	76-04-0	chlorodifluoroacetic acid (Cl TFA)	Cl-TFA
	10	76-03-9	Trichloroacetic acid (TClA)	TClA
	24	76-05-1	trifluoroacetic acid (TFA)	TFA
	43	37181-39-8 & 1493-13-6	Perfluoromethanesulfonate (TFMeS)	TFMeS
	58	661-82-5	3-Cl-Perfluoropropanoic acid (Cl-PFPrA)	Cl-PFPrA
	59	756-09-2	3-H-Perfluoropropanoic acid (H-PFPrA	H-PFPrA
	70	354-19-8	Dichlorofluoroacetic acid (2Cl-TFA)	2Cl-TFA
	73	108410-37-3 & 354-88-1	Perfluoroethanesulfonate (PFEtS)	PFEtS
	74	110676-15-8 & 423-41-6	Perfluoropropanesulfonate (PFPrS)	TFPrS
	123	1493-13-6	trifluoromethane sulfonic acid (TFMS)	TFMS
	128	422-64-0	perfluoropropanoic acid (PFPrA)	PFPrA
	131	354-88-1	perfluoroethane sulfonic acid (PFEtS)	PFEtS
	132	423-41-6	perfluoropropane sulfonic acid (PFPrS)	PFPrS
New PFAS	66	376-72-7	5-H-Perfluoropentanoic acid	H-PFPeA
	67	76-21-1	9-H-Perfluorononanoic acid	H-PFNA
	109	13252-14-7	Gen-X related trimeric acid	HFPO-TA

	111	45187-15-3	Perfluorobutanesulfonate (PFBS)	PFBS
	118	330562-41-9	Perfluoro-3,6,9-trioxatridecanoic acid	PFPE-6
	119	65578-62-3	2,3,3,4,4,5,5-heptafluorotetrahydro-2-Furancarboxylic acid	HFHFCA
	120	377-73-1	Propanoic acid, 2,2,3,3-tetrafluoro-3-(trifluoromethoxy)	PF4OPeA
	125	13252-13-6	Gen-X Propanoic acid	HFPO-DA
	126	65150-95-0	Gen-X related pentameric acid	HFPO-PA
	127	65294-16-8	Gen-X related tetrameric acid	HFPO-TeA
	130	919005-14-4	ADONA Propanoic acid	ADONA-A
	133	2706-91-4	perfluoropentane-1-sufonic acid (PFPeS)	PFPeS
	135	375-22-4	Perfluorobutanoic acid (PFBA)	PFBA
PFAS		2706-90-3	perfluoro-n-pentanoic acid	PFPeA
		307-24-4	perfluoro-n-hexanoic acid	PFHxA
		375-85-9	perfluoro-n-heptanoic acid	PFHA
		335-67-1	perfluoro-n-octanoic acid	PFOA
		375-95-1	perfluoro-n-nonanoic acid	PFNA
		335-76-2	perfluoro-n-decanoic acid	PFDA
		2058-94-8	perfluoro-n-undecanoic acid	PFUA
		307-55-1	perfluoro-n-dodecanoic acid	PFDoA
		72629-94-8	perfluoro-n-tridecanoic acid	PFTDA
		376-06-7	perfluoro-n-tetradecanoic acid	PFTeDA
		141074-63-7	perfluoro-n-pentadecanoic acid	PFPDA
		67905-19-5	perfluoro-n-hexadecanoic acid	PFHxDA
		57475-95-3	perfluoro-n-heptadecanoic acid	PFHDA
		16517-11-6	perfluoro-n-octadecanoic acid	PFODA
		59933-66-3	perfluoro-1-butanesulfonate	PFBS
		22767-49-3	perfluoro-1-pentanesulfonate	PFPS
		355-46-4	perfluoro-1-hexanesulfonate	PFHxS
		22767-50-6	perfluoro-1-heptanesulfonate	PFHS
		754-91-6	perfluoro-1-octanesulfonate	PFOS
		98789-57-2	perfluoro-1-nonanesulfonate	PFNS
		335-77-3	perfluoro-1-decanesulfonate	PFDS
		441296-91-9	perfluoro-1-undecansulfonate	PFUS
		79730-39-5	perfluoro-1-dodecansulfonate	PFDoS
		N/A	perfluoro-1-tridecansulfonate	PFTDS
		N/A	ipPFNS	ipPFNS
		N/A	8-ClPFOS	8-ClPFOS
		754-91-6	PFOSA	PFOSA
		31506-32-8	N-MeFOSA	N-MeFOSA
		4151-50-2	N-EtFOSA	N-EtFOSA
		24448-09-7	N-MeFOSE	N-MeFOSE
		1691-99-2	N-EtFOSE	N-EtFOSE
		2806-24-8	FOSAA	FOSAA
		2355-31-9	N-MeFOSAA	N-MeFOSAA
		2991-50-6	N-EtFOSAA	N-EtFOSAA
		30334-69-1	perfluoro-1-butansulfonamide	PFBS-amide
		41997-13-1	perfluoro-1-hexansulfonamide	PFHxS-amide
		757124-72-4	4:2 FTS	4:2 FTS
		27619-97-2	6:2FTS	6:2FTS

	39108-34-4	8:2 FTS	8:2 FTS
	120226-60-0	10:2 FTS	10:2 FTS
	N/A	12:2 FTS	12:2 FTS
	N/A	14:2 FTS	14:2 FTS
	N/A	8:2 F53B	8:2 F53B
	73606-19-6	6:2 F53B	6:2 F53B
	N/A	4:2 F53B	4:2 F53B
	57677-95-9	6:2 diPAP	6:2 diPAP
	678-41-1	8:2 diPAP	8:2 diPAP
	943913-15-3	6:2/8:2 diPAP	6:2/8:2 diPAP
	30381-98-7	SAmPAP di	SAmPAP di
	67584-42-3	PFECHS	PFECHS
	62037-80-3	Gen X	Gen X
	958445-44-8	ADONA	ADONA
Tot-F		Total Extractable Organic Fluor	Tot-F
TOPA		TOPA	TOPA
Phos-Phtal	4376-18-5	Monomethyl phthalate	MMP
	2306-33-4	Monoethyl phthalate	MEP
	30833-53-5/131-70-4	Mono butyl phthalate	MiBP/MnBP
	40321-98-0	Mono(2-ethyl-5-oxohexyl) phthalate	MEOHP
	2528-16-7	Monobenzyl phthalate	MBzP
	40321-99-1	Mono(2-ethyl-5-hydroxyhexyl) phthalate	MEHHP
	4376-20-9	Mono(2-ethylhexyl) phthalate	MEHP
	3040-56-0	Bis(2-chloroethyl) phosphate	BCEP
	789440-10-4	Bis(2-chloropropyl) phosphate	BCPP
	838-85-7	Diphenyl phosphate	DPP
	107-66-4	Di n-butyl phosphate	HDBP
	72236-72-7	Bis (1,3-dichloro-2-propyl) phosphate	BDCPP
	14260-97-0	Bis(2-butoxyhexyl) phosphate	BBOEP
	298-07-7	Di(2-ethylhexyl) phosphate	HDEHP

8 Appendix 2: Complete list of Detection Frequencies for all substances

Detection frequency of all compounds in each sample type.

It should be noted that, as always, the results are dependent on detection limits for each compound and the amount of sample available. A non-detect or zero in this table is not a guarantee that the compound is not present, but instead that the compound was not detectable with the analytical methods applied.

The limit of detection (LoD) and limit of quantification (LoQ) are calculated for each individual sample type. Accepted standard methods of calculation are used. That is based on replicate analysis of blank samples with and without the addition (spiking) of a known amount of the target compound. The average of blanks plus 3 times the signal-to-noise ratio (s/n) standard deviation of the blanks forms the basis of LoD estimation.

Table A2. Detection frequency of all compounds in all samples. Detection frequency is given by the number of detects divided by the total number of measured samples given in percent. Substances marked * were identified via suspect screening by exact mass, isotopic pattern and predicted retention time. “na” represents Not Analysed.

		Air							Dust			Water	Effluent			Sludge/Sediment			Biota			Arctic Biota			
		Bekkelaget STP	Residential Building	Nonresidential Build.	Urban	Recycling Centre	Birkenes	Ny-Ålesund	Residential Building	Nonresidential Build.	Recycling Centre	Alna River - Water	VEAS STP	Bekkelaget STP	Smestad Tunnel	VEAS STP	Bekkelaget STP	Smestad Tunnel	Herring gull - Egg	Blue mussel	Whiting - Liver	Arctic cod - Liver	Arctic bird - Egg	Arctic mussel	Polar bear - Plasma
REE	La139	na	na	na	na	100	na	na	100	100	100	100	100	100	100	100	100	na	na	100	na	na	na	100	na
	Ce140	na	na	na	na	100	na	na	100	100	100	100	100	100	100	100	100	na	na	100	na	na	na	100	na
	Pr141	na	na	na	na	100	na	na	100	100	100	100	100	100	100	100	100	na	na	100	na	na	na	100	na
	Nd146	na	na	na	na	100	na	na	100	100	100	100	100	100	100	100	100	na	na	100	na	na	na	100	na
	Sm147	na	na	na	na	100	na	na	100	100	100	100	100	100	100	100	100	na	na	100	na	na	na	100	na
	Eu153	na	na	na	na	100	na	na	100	100	100	100	100	100	100	100	100	na	na	100	na	na	na	100	na
	Gd157	na	na	na	na	100	na	na	100	100	100	100	100	100	100	100	100	na	na	100	na	na	na	100	na
	Tb159	na	na	na	na	100	na	na	100	100	100	100	100	100	100	100	100	na	na	100	na	na	na	100	na
	Dy163	na	na	na	na	100	na	na	100	100	100	100	100	100	100	100	100	na	na	100	na	na	na	100	na
	Ho165	na	na	na	na	100	na	na	100	100	100	100	100	100	100	100	100	na	na	100	na	na	na	100	na
	Er166	na	na	na	na	100	na	na	100	100	100	100	100	100	100	100	100	na	na	100	na	na	na	100	na
	Tm169	na	na	na	na	100	na	na	100	100	100	100	100	100	100	100	100	na	na	100	na	na	na	100	na
	Yb172	na	na	na	na	100	na	na	100	100	100	100	100	100	100	100	100	na	na	100	na	na	na	100	na
	Lu175	na	na	na	na	100	na	na	100	100	100	100	100	100	100	100	100	na	na	100	na	na	na	100	na
PBT Group I	Erucamide	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DEHTP*	0	na	na	na	na	na	na	na	na	na	100	67	83	100	na	na	na	30	80	0	0	0	0	0
	OPA	0	na	na	na	na	na	na	na	na	na	0	0	0	0	na	na	na	na	na	na	na	na	na	na
	BCHPC	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3-Picoline	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	IPDA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Albuterol	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Metilox	0	29	0	0	88	na	na	na	na	na	100	100	100	0	0	0	0	0	0	0	0	0	0	0
	Jasmone	0	57	na	0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na

		Air							Dust			Water	Effluent			Sludge/Sediment			Biota			Arctic Biota			
		Bekkelaget STP	Residential Building	Nonresidential Build.	Urban	Recycling Centre	Birkenes	Ny-Ålesund	Residential Building	Nonresidential Build.	Recycling Centre	Alna River - Water	VEAS STP	Bekkelaget STP	Smestad Tunnel	VEAS STP	Bekkelaget STP	Smestad Tunnel	Herring gull - Egg	Blue mussel	Whiting - Liver	Arctic cod - Liver	Arctic bird - Egg	Arctic mussel	Polar bear - Plasma
PBT Group I	Phenoxydiglycol	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Cuminal	0	100	na	100	na	na	na	na	na	na	0	0	0	0	100	33	0	0	100	90	100	0	100	0
	Jasminal	0	100	100	0	33	na	na	na	na	na	83	50	67	83	0	0	0	50	0	100	0	50	0	0
	Sylkolide*	0	0	na	0	na	na	na	na	na	na	0	0	0	0	na	na	na	100	100	100	100	100	100	100
	MPT	0	0	0	0	0	na	na	na	na	na	0	0	0	0	67	100	0	0	0	0	0	0	0	0
	PMEA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mxda	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DHEASA	0	0	na	0	na	na	na	na	na	na	17	0	0	0	na	na	na	0	0	0	0	0	0	0
	NPD*	0	0	na	0	na	na	na	na	na	na	0	0	0	0	na	na	na	0	0	0	0	0	0	0
	EMOPCC*	0	0	0	0	0	na	na	na	na	na	0	0	0	0	na	na	na	0	0	60	100	0	0	0
	Serenolide*	0	43	na	0	na	na	na	na	na	na	0	0	0	0	na	na	na	100	100	100	100	100	100	0
	DiUnDP*	0	na	na	na	na	na	na	na	na	na	0	0	0	100	100	100	100	0	100	0	0	50	33	50
	DcHA*	0	100	na	100	na	na	na	na	na	na	100	0	0	0	na	na	na	0	0	0	0	0	0	0
	DEcHDC	0	na	na	na	na	na	na	na	na	na	0	0	0	83	0	0	0	0	100	90	100	0	100	0
	MPDcH	0	0	na	0	na	na	na	na	na	na	83	50	67	0	0	0	0	0	0	0	0	0	17	0
	Retinyl*	0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	MTCC*	0	0	na	0	na	na	na	na	na	na	0	0	0	33	33	25	50	0	0	0	0	0	0	0
	DDAO	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PBT Group II	PAHHCCPD*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BTCMTBA*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DCDCEA*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TCAz	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DCDPS	0	43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		Air							Dust			Water	Effluent			Sludge/Sediment			Biota			Arctic Biota			
		Bekkelaget STP	Residential Building	Nonresidential Build.	Urban	Recycling Centre	Birkenes	Ny-Ålesund	Residential Building	Nonresidential Build.	Recycling Centre	Alna River - Water	VEAS STP	Bekkelaget STP	Smestad Tunnel	VEAS STP	Bekkelaget STP	Smestad Tunnel	Herring gull - Egg	Blue mussel	Whiting - Liver	Arctic cod - Liver	Arctic bird - Egg	Arctic mussel	Polar bear - Plasma
PBT Group II	BTFTP*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EIBP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MNCBTF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TCAzO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DFAQ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BBTB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BTFBP*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DFPPP*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TBCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PBT Group III	TXIB	0	100	100	100	100	na	na	na	na	na	50	50	33	67	33	0	17	0	0	0	0	0	0	0
	Quinol	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MCI	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TBP	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TBP	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TBP	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BIT	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ABA	33	29	100	100	100	na	na	na	na	na	0	0	0	0	100	100	0	0	0	0	0	0	0	0
	DABA	0	57	0	67	100	na	na	na	na	na	0	0	0	0	100	100	0	0	0	0	0	0	0	0
	ACSA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	chlorzoxazone	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Diflufenican	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Cl-HBMS	0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	DBM-cresol	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		Air							Dust			Water	Effluent			Sludge/Sediment			Biota			Arctic Biota			
		Bekkelaget STP	Residential Building	Nonresidential Build.	Urban	Recycling Centre	Birkenes	Ny-Ålesund	Residential Building	Nonresidential Build.	Recycling Centre	Alna River - Water	VEAS STP	Bekkelaget STP	Smestad Tunnel	VEAS STP	Bekkelaget STP	Smestad Tunnel	Herring gull - Egg	Blue mussel	Whiting - Liver	Arctic cod - Liver	Arctic bird - Egg	Arctic mussel	Polar bear - Plasma
	PCMX	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	100	0	0	0	0	0	0	0	0
	CHX*	0	0	0	0	0	na	na	na	na	na	0	0	0	0	100	100	0	0	0	0	0	0	0	0
	Cl-phenol Blue	0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
New PFAS	H-PFPeA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	H-PFNA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	HFPO-TA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PFBS	0	0	0	0	13	na	na	na	na	na	100	100	100	100	0	0	0	na	na	na	na	na	na	na
	PFPE-6	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	HFHFCA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PF4OPeA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	HFPO-DA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	HFPO-PA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	HFPO-TeA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ADONA-A	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PFPeS	0	0	0	0	0	na	na	na	na	na	0	0	33	0	0	0	0	0	0	0	0	0	0	0
	PFBA	0	29	0	0	75	na	na	na	na	na	83	83	100	0	0	0	0	na	na	na	na	na	na	na
ShortPFAS	Cl-TFA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	na	na	na	na	na	na	na
	TClA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	na	na	na	na	na	na	na
	TFA	0	86	14	100	25	na	na	na	na	na	100	100	100	0	0	0	0	na	na	na	na	na	na	na
	TFMeS	0	0	0	0	0	na	na	na	na	na	0	0	67	0	0	0	0	na	na	na	na	na	na	na
	Cl-PFPrA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	na	na	na	na	na	na	na
	H-PFPrA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	na	na	na	na	na	na	na
	2Cl-TFA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	na	na	na	na	na	na	na

		Air							Dust			Water	Effluent			Sludge/Sediment			Biota			Arctic Biota			
		Bekkelaget STP	Residential Building	Nonresidential Build.	Urban	Recycling Centre	Birkenes	Ny-Ålesund	Residential Building	Nonresidential Build.	Recycling Centre	Alna River - Water	VEAS STP	Bekkelaget STP	Smestad Tunnel	VEAS STP	Bekkelaget STP	Smestad Tunnel	Herring gull - Egg	Blue mussel	Whiting - Liver	Arctic cod - Liver	Arctic bird - Egg	Arctic mussel	Polar bear - Plasma
ShortPFAS	PFEtS	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	na	na	na	na	na	na	na
	TFPrS	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	na	na	na	na	na	na	na
	TFMS	0	0	0	0	0	na	na	na	na	na	0	0	67	0	0	0	0	na	na	na	na	na	na	na
	PFPrA	0	14	0	0	38	na	na	na	na	na	100	100	100	0	0	0	0	na	na	na	na	na	na	na
	PFEtS	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	na	na	na	na	na	na	na
	PFPrS	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	na	na	na	na	na	na	na
Other PFAS	PFPeA	0	0	0	0	0	na	na	na	na	na	100	100	100	100	0	0	0	0	0	0	0	0	0	0
	PFHxA	0	0	0	0	0	na	na	na	na	na	100	100	100	100	0	0	0	0	0	0	0	0	0	0
	PFHA	0	0	0	0	0	na	na	na	na	na	100	100	100	100	0	0	0	0	0	0	0	0	0	50
	PFOA	0	0	0	0	63	na	na	na	na	na	100	100	100	100	0	0	0	20	0	0	0	0	0	100
	PFNA	0	0	0	0	0	na	na	na	na	na	33	50	83	67	0	0	0	40	0	0	0	50	0	100
	PFDA	0	0	0	0	0	na	na	na	na	na	0	0	0	83	50	100	0	90	0	30	0	50	0	100
	PFUA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	90	0	60	0	100	0	100
	PFDoA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	90	0	40	0	17	0	100
	PFTDA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	100	0	10	0	100	0	100
	PFTA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	90	0	0	0	0	0	0
	PFPDA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PFHxDA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PFHDA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PFODA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PFBS	0	0	0	0	13	na	na	na	na	na	100	100	100	100	0	0	0	na	na	na	na	na	na	na
	PFPS	0	0	0	0	0	na	na	na	na	na	0	0	33	0	0	0	0	0	0	0	0	0	0	0
	PFHxS	0	0	0	0	38	na	na	na	na	na	100	67	100	0	0	0	0	70	0	0	0	67	0	100

		Air							Dust			Water	Effluent			Sludge/Sediment			Biota			Arctic Biota			
		Bekkelaget STP	Residential Building	Nonresidential Build.	Urban	Recycling Centre	Birkenes	Ny-Ålesund	Residential Building	Nonresidential Build.	Recycling Centre	Alna River - Water	VEAS STP	Bekkelaget STP	Smestad Tunnel	VEAS STP	Bekkelaget STP	Smestad Tunnel	Herring gull - Egg	Blue mussel	Whiting - Liver	Arctic cod - Liver	Arctic bird - Egg	Arctic mussel	Polar bear - Plasma
Other PFAS	PFHS	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	80	0	0	0	0	0	100
	PFOS	0	43	86	0	63	na	na	na	na	na	100	100	100	100	100	100	0	100	20	100	100	100	0	100
	PFNS	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PFDS	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	70	0	20	0	0	0	0
	PFUS	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PFDoS	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PFTDS	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ipPFNS	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8-ClPFOS	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PFOSA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	100	100	0	0	0	0
	N-MeFOSA	0	14	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	N-EtFOSA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	N-MeFOSE	0	57	0	0	25	na	na	na	na	na	0	0	0	0	100	0	0	0	0	0	0	0	0	0
	N-EtFOSE	0	57	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	FOSAA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	N-MeFOSAA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	100	0	0	0	0	0	0	0	0
	N-EtFOSAA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	100	100	0	0	0	0	0	0	0	0
	PFBS-amide	0	0	0	0	0	na	na	na	na	na	0	100	100	0	0	0	0	0	0	70	0	0	0	0
	PFHxS-amide	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4:2 FTS	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	10	0	0	0	0
	6:2FTS	0	0	0	0	0	na	na	na	na	na	67	33	100	0	0	0	0	0	0	0	100	0	0	0
	8:2 FTS	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	10	0	0	0	0	0	0
	10:2 FTS	0	0	0	0	0	na	na	na	na	na	0	0	0	0	100	75	0	10	0	0	0	0	0	0

		Air							Dust			Water	Effluent			Sludge/Sediment			Biota			Arctic Biota			
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Other PFAS	12:2 FTS	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	10	0	0	0	0	0	0
	14:2 FTS	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8:2 F53B	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6:2 F53B	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4:2 F53B	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6:2 diPAP	0	0	0	0	0	na	na	na	na	na	0	0	0	0	100	100	0	0	0	0	0	0	100	0
	8:2 diPAP	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6:2/8:2 diPAP	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SAmPAP di	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PFECHS	0	0	0	0	0	na	na	na	na	na	0	0	100	0	0	0	0	0	0	0	0	0	0	0
	Gen X	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ADONA	0	0	0	0	0	na	na	na	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tot-F	na	na	na	na	na	na	na	na	na	na	100	100	100	na	100	100	na	na	na	na	na	na	na	na
Medusa	TFE	50	86	14	17	11	83	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	CTFE	100	100	100	100	100	100	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	HFP	17	86	0	0	22	83	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	Freon-C-318	100	100	100	100	100	100	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Sil	H-L3	0	100	100	17	67	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	TFPDMDS*	0	0	0	0	0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
VOC Grp III	BAQ	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	26DCBN	0	29	17	50	0	100	100	0	0	0	100	100	100	100	100	67	0	0	0	0	0	0	0	0
	oNA	0	100	83	100	83	100	100	29	86	33	100	100	83	67	0	0	0	0	0	70	0	0	0	0
	pBDN	0	100	100	100	100	100	100	57	100	89	0	0	0	83	0	0	0	0	0	0	0	0	0	0

		Air	Dust	Water	Effluent	Sludge/Sediment	Biota	Arctic Biota

		Bekkelaget STP	Residential Building	Nonresidential Build.	Urban	Recycling Centre	Birkenes	Ny-Ålesund	Residential Building	Nonresidential Build.	Recycling Centre	Alna River - Water	VEAS STP	Bekkelaget STP	Smestad Tunnel	VEAS STP	Bekkelaget STP	Smestad Tunnel	Herring gull - Egg	Blue mussel	Whiting - Liver	Arctic cod - Liver	Arctic bird - Egg	Arctic mussel	Polar bear - Plasma
VOC Grp III	TBAnl	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MAQ	0	0	0	100	0	0	0	57	86	100	100	100	100	100	100	100	17	0	0	0	0	0	0	0
	CMP	0	0	83	0	17	0	0	100	100	100	0	0	0	67	0	0	0	0	0	0	0	0	0	0
	TeCPy	0	29	17	17	0	50	60	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0
	TCAP	0	43	0	17	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CTCMPy	0	0	17	33	33	67	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PCPy	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TCCPD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TCSt*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	90	50	50	17	0
	PCSt*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	10	90	100	83	17	0
	DCDMB	0	0	0	100	0	83	0	0	0	0	17	100	100	0	0	0	0	0	0	0	0	0	0	0
	HCMBP*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	10	30	17	67	0	0
	BDMT	0	0	0	67	0	83	0	0	0	0	0	17	100	0	0	0	0	0	0	0	0	0	0	0
	DCFd	0	100	33	100	67	100	100	71	0	22	0	0	0	0	0	0	17	0	0	0	0	0	0	0
	Cbzl	0	100	33	100	83	17	0	57	86	100	50	100	100	0	0	0	17	89	10	20	0	83	17	0
	BPon	0	14	17	100	100	0	0	na	na	na	0	0	0	0	na	na	na	0	0	0	0	0	0	0
	OCSt	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	30	0	67	17	0
	NCN	0	100	100	100	100	100	100	0	14	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	OCCP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	24DCBN	0	29	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0
	MHC-1*	0	na	0	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0
	ChrQ	0	0	0	83	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BPQ-14	0	0	0	67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		Air							Dust			Water	Effluent			Sludge/Sediment			Biota			Arctic Biota			
		Bekkelaget STP	Residential Building	Nonresidential Build.	Urban	Recycling Centre	Birkenes	Ny-Ålesund	Residential Building	Nonresidential Build.	Recycling Centre	Alna River - Water	VEAS STP	Bekkelaget STP	Smestad Tunnel	VEAS STP	Bekkelaget STP	Smestad Tunnel	Herring gull - Egg	Blue mussel	Whiting - Liver	Arctic cod - Liver	Arctic bird - Egg	Arctic mussel	Polar bear - Plasma
VOC Grp III	BPQ-56	0	0	0	33	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BBBF	0	0	0	17	33	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	35DCBN	0	43	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25DCBN	0	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	34DCBN	0	0	17	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	23DCBN	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	mNA	0	86	67	0	0	17	0	86	100	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	pNA	0	43	17	83	0	100	100	0	0	0	0	0	0	0	0	0	0	0	90	10	67	0	67	17
	mBDN	0	100	100	100	83	100	100	29	0	33	0	0	0	83	0	0	0	0	0	0	0	0	0	0
	oBDN	0	100	67	100	33	0	0	0	57	56	0	0	0	100	0	0	0	0	0	0	0	0	0	0
	TBMPy	0	0	na	0	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	iMAC-F	0	0	na	0	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	iMAC-P	0	na	na	na	na	0	0	29	57	89	0	0	0	0	0	0	17	0	0	0	0	0	0	0
	iMAC-B	0	0	0	0	100	50	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	245TCPy	0	0	0	17	0	33	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	246TCPy	0	0	0	0	0	33	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	345TCPy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	NCQ	0	0	0	83	0	na	na	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AO	btBPP	0	na	na	na	na	na	na	na	na	na	na	na	na	na	0	0	0	na	na	na	na	na	na	na
	btBPPO	0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na

		Air							Dust			Water	Effluent			Sludge/Sediment			Biota			Arctic Biota			
		Bekkelaget STP	Residential Building	Nonresidential Build.	Urban	Recycling Centre	Birkenes	Ny-Ålesund	Residential Building	Nonresidential Build.	Recycling Centre	Alna River - Water	VEAS STP	Bekkelaget STP	Smestad Tunnel	VEAS STP	Bekkelaget STP	Smestad Tunnel	Herring gull - Egg	Blue mussel	Whiting - Liver	Arctic cod - Liver	Arctic bird - Egg	Arctic mussel	Polar bear - Plasma
OPFR/Phthal-metabolites	MMP	na	100	86	50	na	100	0	86	100	67	0	0	0	67	0	na	17	na	na	na	na	na	na	na
	MEP	na	67	14	0	na	0	0	100	83	89	0	50	0	0	0	na	0	na	na	na	na	na	na	na
	MiBP/MnBP	na	0	0	0	na	0	0	100	100	100	0	0	0	0	0	na	33	na	na	na	na	na	na	na
	MEOHP	na	0	0	0	na	0	0	57	29	60	0	0	0	0	0	na	0	na	na	na	na	na	na	na
	MBzP	na	0	0	0	na	0	0	29	43	70	0	0	0	0	0	na	0	na	na	na	na	na	na	na
	MEHHP	na	0	0	0	na	0	0	57	71	60	0	0	0	0	0	na	0	na	na	na	na	na	na	na
	MEHP	na	0	0	0	na	0	0	100	100	100	33	33	17	17	100	na	83	na	na	na	na	na	na	na
	BCEP	na	0	0	0	na	0	0	na	na	na	0	0	0	0	na	na	na	na	na	na	na	na	na	na
	BCPP	na	67	29	0	na	0	0	0	43	20	0	0	0	0	na	na	0	na	na	na	na	na	na	na
	DPP	na	17	14	0	na	0	0	57	86	80	67	67	100	100	100	na	100	na	na	na	na	na	na	na
	HDBP	na	100	71	0	na	0	0	71	86	90	100	100	100	100	100	na	100	na	na	na	na	na	na	na
	BDCPP	na	0	0	0	na	0	0	0	14	30	0	83	83	0	na	na	0	na	na	na	na	na	na	na
	BBOEP	na	0	43	0	na	0	0	57	71	50	67	100	100	83	100	na	0	na	na	na	na	na	na	na
	HDEHP	na	0	0	0	na	0	0	100	100	100	0	0	0	0	100	na	100	na	na	na	na	na	na	na

NIVA: Norges ledende kompetansesenter på vannmiljø

Norsk institutt for vannforskning (NIVA) er Norges viktigste miljøforskningsinstitutt for vannfaglige spørsmål, og vi arbeider innenfor et bredt spekter av miljø, klima- og ressursspørsmål. Vår forskerkompetanse kjennetegnes av en solid faglig bredde, og spisskompetanse innen mange viktige områder. Vi kombinerer forskning, overvåkning, utredning, problemløsning og rådgivning, og arbeider på tvers av fagområder.

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