

Results from the Swedish National Screening Programme 2008

Subreport 4: Screening of unintentionally produced organic contaminants

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Summary

The overall objective of this screening study was to determine the concentrations of selected unintentionally produced substances in a variety of media in the Swedish environment. Additional aims were to assess the possible emission sources and to highlight important transport pathways in the environment. Substance groups included in the screening program were oxygenated and nitrated forms of polycyclic aromatic hydrocarbons (PAHs) as well as nitrogen, sulphur and oxygen containing heterocyclic compounds. Polybrominated dibenzodioxins (PBDD) and furans (PBDF), polychlorinated dibenzothiophenes (PCDT) and dibenzotianthrenes (PCDTA) were also included in the study. PAHs and polychlorinated biphenyls (PCBs) were included as reference substances.

Emissions to air were identified as the main release pathway and the sampling program was therefore focused on air and deposition measurements in both urban and background areas. Sediment, soil, storm water sludge and sewage sludge was sampled in an urban area. Soil and sediment were also collected in background areas. Biota and human milk samples were included in the screening in order to investigate the potential for bioaccumulation of some of the substances.

The results of the screening showed that oxidized and nitrated forms of PAHs as well as heterocyclic analogues of PAHs were frequently found in background and urban areas and in most of the environmental matrices included in the study. The concentrations and the relative distribution among the different substances and groups of substances differed between sampling matrices but also between different sampling sites, e.g. between background and urban sites. Elevated concentrations occurred in urban areas compared to background areas. Compared to other environmental matrices, few of the PAH-related substances were found in biotic samples.

As for PAHs, atmospheric transport and deposition was shown to be an important pathway for oxy- and nitro-PAHs as well as for heterocycles. The importance of atmospheric long-range transport for some of these substances to remote areas was confirmed. Air emissions from traffic but also wood burning were identified as important sources. Also atmospheric formation of especially nitro-PAHs was indicated.

Most of the heterocyclic substances were found in soil and sediment with increased concentrations in the urban area. Heterocycles occurred more frequently in storm water sludge compared to STP sludge, a possible indication of influence from traffic. The concentrations of oxy-PAHs were in similar orders of magnitude in background sediments as in urban sediment and soil, however the relative distribution among the substances varied. Like oxygenated PAHs, nitro-PAHs were found in background and urban sediment and soil in similar concentrations. The nitrated forms occurred in higher concentrations in storm water sludge compared to municipal sludge indicating influence from traffic.

PCDTs were found in most abiotic samples but only in one biotic sample while PCDTA generally was below the limit-of-detection. Traffic and long-range air transport were identified as likely sources. Considering the relative concentrations and biological potencies of PCDTAs and PCDD/Fs the former are likely to be of minor concern.

The concentrations of PBDDs were generally below the limit-of-detection but were found in deposition, urban sediment, background sediment, and fish from Kvädöfjärden. The PBDF concentrations in air varied widely in time and space, which suggest that long-range air transport

from specific source regions may occur. OBDF occurred in similar concentrations as PCBs in air, deposition, sediment and soil.

Elevated concentration levels were found in sewage sludge that cannot be explained by atmospheric deposition. The PBDF concentrations were about 1000-fold higher than the PCDD/F concentrations.

TBDF, HpBDF and OBDF occurred in human milk and contributes significantly (about 20 %) to the total TEQ, and the peak PBDF-TEQs are only 2-fold lower than the peak PCDD/F-TEQs reported by the National Food Administration for 2006.

Sammanfattning

Syftet med föreliggande screening var att bestämma koncentrationer av ett antal ofrivilligt producerade organiska ämnen i ett den svenska miljön. Ytterligare mål var att påvisa möjliga källor och viktiga transportvägar. Föreningsgrupper som ingick i screeningen var oxygeneterade och nitrerade former av polyaromatiska kolväten (PAH) och kväve-, svavel- och syrenehållande heterocykliska föreningar. Polybromerade dibenzodioxiner (PBDD) och furaner (PBDF), polyklorerade dibenzotiofener (PCDT) och dibenzotiantrener (PCDTA) inkluderades också i studien. PAHer och polyklorerade bifenyler (PCB) ingick som referenssubstanter.

Utsläpp till luft identifierades som en huvudsaklig emissionsväg. Provtagningsprogrammet inriktades därför på mätningar i luft och atmosfärisk deposition i både urbana miljöer och bakgrundsområden. Sediment, jord, dagvattenslam och reningsverksslam provtogs i ett urbant område. Jord och sediment provtogs i bakgrundsområden. Biota och modersmjölksprover inkluderades också för att kunna ge en uppfattning om vissa av substansernas potential för bioackumulering.

Resultaten av screeningen visade att nitro- och oxy-PAHer och även heterocykliska föreningar frekvent kunde påvisas i prov från bakgrundsområden och urban miljö och i de flesta provmatriserna. Koncentrationerna av, och den relativa fördelningen mellan, de olika substanserna och substansgrupperna varierade mellan provmatriser och provlokaler. Förhöjda koncentrationer förekom i urban miljö jämfört med bakgrundsområden. Jämfört med andra matriser förekom få PAH-relaterade substanser i biota.

Liksom för PAHer var atmosfärisk transport och deposition en viktig transportväg för oxy- och nitro-PAHer, och även för heterocykler. Betydelsen av långväga atmosfärisk transport för vissa av dessa substanser till avlägsna områden konfirmerades. Luftutsläpp från trafik, men också vedeldning, identifierades som viktiga källor. Tecken sågs på atmosfärisk bildning av speciellt nitro-PAHer.

De flesta heterocykliska substanserna hittades i jord och sediment med ökande halter i urban miljö. Heterocyklerna hittades mer frekvent i dagvattenslam än i reningsverksslam vilket kan vara tecken på påverkan från trafik. Koncentrationen av oxy-PAHer var i samma storleksordning i bakgrunds-sediment som i urbana sediment och jord, men fördelningen mellan enskilda substanser varierade. Även nitro-PAHer förekom i samma storleksordning i bakgrundssediment som i urbana sediment och jord. Nitro-PAHer hittades mer frekvent i dagvattenslam än i reningsverksslam vilket kan vara tecken på påverkan från trafik.

PCDTs förekom i de flesta abiotiska prov, men enbart i ett biotaprov, medan PCDTA i allmänhet var under detektionsgränsen. Trafik och långväga lufttransport identifierades som troliga källor. Med hänsyn tagen till relativa koncentrationer och olika biologisk potens hos PCDTA jämfört med PCDD/F är de förstnämnda troligen mindre betydelsefulla.

Koncentrationerna av PBDD var vanligen under detektionsgränsen, men hittades i atmosfärisk deposition, urbant sediment, bakgrundssediment och i fisk från Kvädöfjärden. Koncentrationen av PBDF i luft varierade mycket i tid och rum vilket tyder på att långväga lufttransport från speciella källregioner kan förekomma. PBDF förekom i liknande koncentrationer som PCBer i luft, deposition, sediment och jord.

Förhöjda halter hittades i reningsverksslam vilket inte kan förklaras med atmosfärisk deposition. Koncentrationen av PBDF var ca 1000 gånger högre än av PCDD/F.

TBDF, HpBDF och OBDF förekom i modersmjölk och bidrog signifikant (ca 20%) till det sammanlagda toxicitetsvärdet TEQ.

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1. Introduction

As an assignment from the Swedish Environmental Protection Agency, a screening study has been performed during 2008/2009. This screening includes biocides, unintentionally produced substances and fuel additives. These substances/substance groups are emitted to and distributed in the environment via a variety of sources, *e.g.* different point sources and/or diffuse sources. Table 1-1 shows the major reason for their concern as well as the number of the report where individual results are presented.

Table 1-1 Overview of substances / substance groups included in the screening 2008 and the reason of concern.

Substance / Substance group		Banned/ restricted	HPV ^a	Indications of toxicity	B/P ^b	Sub- report #
Biocides	3-Iodo-2-propynyl butyl carbamate (IPBC) 2,2-Dibromo-2- cyanoacetamide (DBNPA)			x		1
	Glutaraldehyde		x	x		2
	Difenacoum	x		x	x	3
Unintentionally produced substances	PAHs and related substances Brominated and chlorinated aromatic substances			x	x	4
Fuel additives	Methyl <i>tert</i> -butyl ether (MTBE) Ethyl <i>tert</i> -butyl ether (ETBE)		x	x	x	5

a) High Production Volume

b) Bioaccumulation/Persistence

The overall objective of a screening study is to determine the concentrations of selected substances in a variety of media in the Swedish environment. Additional aims are to assess the possible emissions sources and to highlight important transport pathways in the environment. An issue for a screening study could also be to estimate the importance of to accumulation of a substance in the ecosystem and to generate data for risk assessment.

This report considers the screening of unintentionally produced substances. Substance groups included in the screening program are oxygenated and nitrated forms of polycyclic aromatic hydrocarbons (PAHs) as well as nitrogen, sulphur and oxygen containing heterocyclic compounds. Polybrominated dibenzodioxins (PBDD) and furans (PBDF), as well as polychlorinated dibenzothiophenes (PCDT) and dibenzothianthrenes (PCDTA) were also included in the study. A general lack of data on environmental concentrations of these substances has previously been identified (S-EPA 2007). PAHs and polychlorinated biphenyls (PCBs) were included in as reference substances.

The substances under focus are persistent to various degrees, which make the chronic toxicity relevant to consider when conducting risk assessment. For many of the substances there are clear evidence for bioaccumulative properties whereas for others there is still lack of data. Many of the

compounds included biomagnify, as opposed to the PAHs, which are efficiently metabolized in animals representing higher trophic levels. (S-EPA 2007)

This screening study has been carried out by IVL Swedish Environmental Research Institute (IVL), together with the Norwegian Institute for Air Research (NILU) and the University of Umeå (UmU). The chemical analyses of PAHs, PCBs and heterocycles were undertaken at IVL, the Nitro-PAHs and oxy-PAHs at NILU and PBDD, PBDF, PCDT and PCDTA at UmU.

2. Background: Sources, pathways, properties and toxicity

2.1. PAHs and related substances

Polycyclic aromatic hydrocarbons (PAHs) and their oxidized and nitrated forms, as well as their heterocyclic analogues, are mainly formed unintentionally during incomplete combustion of organic matter such as coal, oil, wood and petroleum products. Emission to air is the most important pathway of these substances to the environment and it may take place from both stationary and mobile sources.

Individual PAH substances, as well as their oxygenated, nitrated and heterocyclic forms, differ in chemical and physical properties. This affects their transport processes and behaviour in the environment. They are semivolatile and as such they can be transported in either the gaseous or particulate phase of the atmosphere. The distribution between the phases affects their transport distance in the atmosphere.

Some PAHs are reactive and may be transformed by photochemical and chemical reactions with other air pollutants such as nitrogen dioxide (NO₂) and ozone (O₃). The reactions in the atmosphere may take place both in the gas- and particle phases and lead to formation of *e.g.* nitro- and oxy-PAHs. The transformation products may differ from their precursors in chemical and physical properties as well as in toxicity. Previous studies have shown that PAHs may be transformed to nitro-PAHs and other oxidized forms during air sampling (Brorström *et al.* 1983; Albinet *et al.*, 2007).

In spite of their reactivity, it is well documented that PAHs, similar to persistent organic pollutants (POPs), are subject to atmospheric long-distance transport. Atmospheric deposition is an important pathway to aquatic and terrestrial ecosystems, both close to and far from source areas (Brorström-Lundén 1995).

PAHs, and their related substances, include a large number of individual substances. The relative distribution among different substances and substance groups may give an indication of the source. Some PAHs are more reactive than others and the PAH profile may also give an indication of the transport distance.

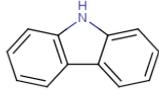
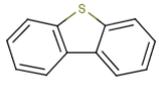
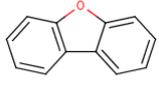
PAHs and related substances can have ecotoxicological effects as well as effects on human health. The members of this vast group of substances have different toxicological characteristics, some well known and others less studied. In some cases the toxic effects can be related to a transformation

product, formed via *e.g.* the exposed organism's metabolism, bacterial transformation or exposure to UV light (S-EPA 2007). The classic example of a PAH with toxic properties is benzo(a)pyrene (BaP), which is known to be metabolised to form a tumorigenic dipolepoide (Parkinson 2001).

2.1.1. Heterocyclic substances

Heterocyclic aromatic compounds (see Table 2-1 for specification) are formed in the same processes as PAHs, during incomplete combustion in the presence of nitrogen, sulphur or oxygen, which are incorporated in the ring structure and form azarenes (N-heterocycles), thiophenes (S-heterocycles) and furans (O-heterocycles). Heterocycles are lipophilic substances with low vapour pressure and some degree of polarity, making them slightly more water soluble than the corresponding PAHs. They are transported to the ecosystem and distributed in the environment in a similar way as PAHs, but with a slightly higher proportion in the aqueous phase. A certain proportion of the heterocyclic substances will partition to solids and thus the major exposure pathway is via the food for aquatic organisms and via food and soil contact for terrestrial organisms (S-EPA 2007).

Table 2-1 The heterocyclic substances included in the screening, including three examples of molecular structures

Heteroatom	Name	CAS No	Molecular structure
Nitrogen	Indole	120-72-9	
Nitrogen	Carbazole	86-74-8	
Nitrogen	5H-Benzo(a)carbazole	243-28-7	
Nitrogen	7H-Dibenzo(c,g)carbazole	194-59-2	
Nitrogen	Quinoline	91-22-5	
Nitrogen	Iso-quinoline	119-65-3	
Nitrogen	Acridine	260-94-6	
Nitrogen	Benz(a)acridine	225-11-6	
Nitrogen	Dibenz(a,h)acridine	226-36-8	
Sulphur	1-Benzothiophene	11095-43-5	
Sulphur	Dibenzothiophene	132-65-0	
Sulphur	Benzo(b)naphto(2.1-d)thiophene	239-35-0	
Oxygen	2,3-Benzofuran	271-89-6	
Oxygen	Dibenzofuran	132-64-9	
Oxygen	Benzo(b)naphtofuran		

Bleeker *et al.* (2002) conducted a comparative study to assess the acute toxicity (LC₅₀, 96 hrs) of analogue series of PAHs and azarenes to the midge *Chironomus riparius*. The authors concluded that unexposed to UV-light the PAHs were more toxic than the respective azarene compound and that for both types of compounds the toxicity increased with increased number of aromatic rings (increasing log K_{ow}). In the presence of UV light some of the azarenes did however show increased toxicity to the midge. LC₅₀ values were in the range 0.072-4.9 mg/l (0.40-37.9 µM) in the presence of UV light, and 0.48-1.5 mg/l (2.1-8.2 µM) in the absence of UV light. Eisentraeger *et al.* (2008) studied the acute toxicity of a number of heterocycles to the alga *Desmodesmus subspicatus* (EC₅₀, growth inhibition 72 hrs) and the invertebrate *Daphnia magna* (EC₅₀, immobilization 24 hrs). The algal toxicity values were in the range 2.1-60.9 mg/l and toxicity to the invertebrate varied between 0.2-17.7 mg/l for the different compounds.

Recalculating these effect concentrations to sediment concentrations with the equilibrium partition method (EqP¹), gives a span between 100-400 mg/kg DW. The derived sediment effect concentrations should be used with caution as recalculations based on the EqP method is associated with uncertainties. It should also be noted that in environments with a pH where a substance is ionized the method, and thus the calculated sediment concentrations, are not applicable. Paumen *et al.* (2008) studied the toxicity of; *inter alia*, acridine to benthic organisms. EC_{50/10} (28 d) for the reproduction of *Lumbriculus variegatus*, in spiked sediments, was 224/35.3 mg/kg DW (1248/197 µmol/kg DW).

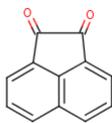
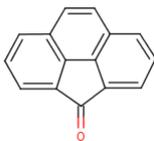
In addition to the ecotoxicity described above, azarenes have been shown to be mutagenic and also to be able to activate the Ah-receptor, *i.e.* the same receptor that is activated by the dioxins. Thiophenes can be genotoxic to human liver cells and seem to have the liver and kidney as target organs for toxicity. Also the furans have in animal tests shown toxicity to the liver and kidney as well as increased tumour frequency.

2.1.2. Oxy-PAH

The oxy-PAHs (see Table 2-2 for specification) are formed directly in combustion processes or by reactions in the atmosphere which may take place in both the gas- and particle-phases. The substances may also be formed through different processes in soil and water. Oxy-PAHs differ from the corresponding PAHs by their higher polarity and thus higher water solubility and lower volatility. The lower volatility leads to a greater tendency to be distributed to atmospheric particles which affects the atmospheric deposition process.

¹ EqP; $C_{\text{sed}} = C_{\text{water}} \times K_{\text{oc}} \times f_{\text{oc}}$, where K_{oc} is the partition coefficient to organic carbon and f_{oc} is the fraction organic carbon in the sediment; see *e.g.* Di Toro *et al.* 1991. The K_{oc} was obtained from Banwart *et al.* (1982) or calculated from the K_{ow} ($\log K_{\text{oc}} = \log K_{\text{ow}} - 0.317$; Banwart *et al.* 1982) and the f_{oc} was set to the standard value 5 % (TGD-EQS 2010). K_{ow} values were obtained from S-EPA 2007, annex 6.1. EqP calculations were performed for substances with $K_{\text{oc}} \geq 3$ as indicated relevant in the TGD for EQS derivation (2010)

Table 2-2 The oxygenated PAHs included in the screening including examples of molecular structures.

Name	CAS No	Molecular structure
1,2-Acenaphthylenedione	82-86-0	
4H-Cyclopenta(def)phenantrenone	5737-13-3	
9-Fluorenone	486-25-9	
1-Hydroxy-9-fluorenone	6344-60-1	
2-Hydroxy-9-fluorenone	6949-73-1	
Anthracene-9,10-dione, Anthraquinone	84-65-1	
2-Methylanthracendione	84-54-8	
7H-Benzo(de)anthracene-7-one	82-05-3	
Bens(a)anthracen-7,12-dione	2498-66-0	
6H-Benzo(cd)pyrene-6-one	3074-00-8	

Road traffic is the dominant source of oxy-PAHs in urban areas and the emissions are comparable to PAH emissions. The concentrations of oxy-PAHs in urban atmospheres are in the same level as for PAHs, and thus 10-100 times higher than concentrations of the nitro-PAHs (S-EPA 2007).

Exposure to oxy-PAHs may occur via particulate matter and sediments in the aquatic environment and via air for terrestrial organisms (S-EPA 2007). Oxy-PAHs have shown acute toxicity to bacteria, crustaceans and plants, have shown to be inducing oxidative stress, to be endocrine disruptors, to cause cytotoxic effects in mammals and to be mutagenic (S-EPA 2007). Selected toxicity values, for the compounds included in the present study, are listed in Table 2-3.

Table 2-3 EC₅₀ values for selected oxy-PAHs from the review by Lundstedt *et al.* (2007)

Compound	Organism	EC ₅₀ (µg/l)
Anthracene-9,10-dione	Invertebrate; <i>Daphnia magna</i>	231 ^a
	Plant; <i>Lemna gibba</i>	500 ^b
	Algae	750 ^c
Benz[a]anthracene-7,12-dione	Invertebrate; <i>Daphnia magna</i>	3.82 ^a

a) Lampi *et al.* 2006 quoted in Lundstedt *et al.* 2007

b) Mallakin *et al.* 1999 quoted in Lundstedt *et al.* 2007

c) Brack *et al.* 2003 quoted in Lundstedt *et al.* 2007

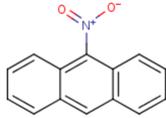
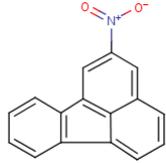
The oxy-PAHs were by the Swedish EPA (2007) assessed to be less important than the nitro-PAHs from a human health perspective. The mutagenicity is relatively low, as is the potential to induce effects via the Ah-receptor and oestrogen receptor. To assess the potential risk to human health it is however necessary to also estimate the human exposure to these compounds.

2.1.3. Nitro-PAH

The dominant source for nitro-PAHs (see Table 2-4 for specification) in the atmosphere is formation by atmospheric reactions. They may, however, also be formed during combustion and traffic exhausts, mainly from diesel, have been identified as important contributing sources. The concentrations of nitro-PAHs in urban air have shown to be elevated compared to other sites, in particular during the winter, and corresponds to about 1% of the PAH levels (S-EPA 2007).

Nitro-PAHs have similar properties as PAHs, but with less volatility due to higher molecular weight and polarity. This affects their distribution between the gas- and particle phases and nitro-PAHs are to a greater share bound to atmospheric particles compared to the corresponding PAHs, which subsequently affects their transport in the atmosphere and deposition processes (Brorström-Lundén 1995).

Table 2-4 The nitro-PAHs included in the screening, including examples of molecular structures

Name	CAS No	Molecular structure
9-Nitroanthracene	602-60-8	
2-Nitrofluoranthene	13177-29-2	
3-Nitrofluoranthene	892-21-7	
1-Nitropyrene	5522-43-0	
4-Nitropyrene	57835-92-4	
3-Nitrobenzanthrone	17117-34-9	
7-Nitrobenz[a]anthracene	20268-51-3	
1,3-Dinitropyrene	75321-20-9	
1,6-Dinitropyrene	42397-64-8	

Nitro-PAHs may undergo atmospheric long-range transport and like the PAHs, they can be transported to aquatic and terrestrial ecosystems through atmospheric deposition. However, nitro-PAHs are more rapidly degraded than PAHs, particularly by photochemical oxidation, which is most significant during the summer.

Nitro-PAHs, as well as their transformation products, are mutagenic and carcinogenic. Exposure to nitro-PAH in the aquatic environment is expected to occur mainly via feed and sediments and terrestrial animals are exposed mainly via air. Nitro-PAHs have in some cases shown to be acute toxic to aquatic organisms (Table 2-5). (S-EPA 2007)

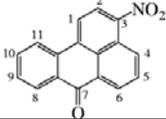
Table 2-5: Acute toxicity of the compound 1-nitronaphtalene to fish and ciliate (Schultz and Moulton 1985 and Curtis and Ward 1981 quoted in S-EPA 2007)

Compound	Organism	Acute toxicity (mg/l)
1-Nitronaphtalene	Fish; <i>Pimephales promelas</i>	1-10
	Ciliate; <i>Tetrahymena pyriformis</i>	10-100

2.1.4. 3-Nitrobenzanthrone

3-Nitrobenzanthrone (3-NBA; Table 2-6) is a nitroketone, with a structure similar to that of nitro-PAHs, but with a carbonyl group added to the ring structure. The substance is formed during incomplete combustion of fossil fuels and by nitrication of benzanthrone in the atmosphere.

Table 2-6 CAS number and structure for 3-Nitrobenzanthrone

Name	CAS No	Structure
3-Nitrobenzanthrone, 3-NBA 3-Nitro-7H-benz[de]anthracen-7-one	17117-34-9	

Like the nitro-PAHs, 3-NBA can also be formed in diesel engines and its metabolite has been found in urine from salt miners exposed to diesel exhaust. 3-NBA has been found on airborne particles outside Copenhagen, Denmark, in concentrations of up to 68 pg/m³. It has also been detected in urban air and at point sources in Germany, USA, China and Japan. (Arlt 2005).

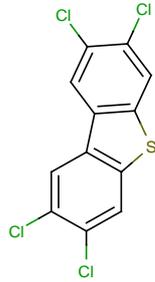
The substance is a suspected human carcinogen due to the fact that it is a potent mutagen and has been found to cause cancer in animals. The primary exposure pathway for humans is believed to be via the respiratory tract. (Arlt 2005).

2.2. Polychlorinated and polybrominated substances

2.2.1. Polychlorinated dibenzothiophenes (PCDT) and dibenzothianthrenes (PCDTA)

Polychlorinated dibenzothiophenes (PCDTs) and dibenzothianthrenes (PCDTAs) are sulphur analogues to dioxins and furans, with similar characteristics and effects. The structure of one congener is shown in Table 2-7. They are formed in the same processes as dioxins, but in smaller amounts (corresponding to a few percent).

Table 2-7 CAS number and structure of 2,3,7,8-Tetrachloro-dibenzothiophene

Name	CAS No	Structure
2,3,7,8-Tetrachloro-dibenzothiophene	133513-17-4	

Despite the low concentrations in comparison with dioxins, these substances are interesting as the formation is dependent on the sulphur content of fuels. Sulphur addition has been proposed to reduce dioxin levels, but may lead to higher levels PCDT/PCDTA instead.

The properties of PCDT and PCDTA are poorly known, but assumed from the structure to be similar to the dioxins and furans. The distribution in the environment is therefore assumed to be similar to that for dioxins/furans, *i.e.* mainly to soil and sediment, but with the atmosphere as an important transport route. The persistence of the thiophenes is comparable with that for dioxins and the concentration ratio between dioxins and thiophenes do not change dramatically with increasing distance from the source.

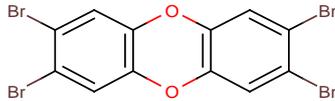
Based on the similarity in structure with the dioxins, exposure of these kinds of compounds is believed to occur via the food, and in the aquatic environment also via sediments and particles and via the soil in the terrestrial environment. (S-EPA 2007)

PCDT and PCDTA also have dioxin like biological activity (Paasivirta 2000 and Kopponen *et al.* 1994 quoted in S-EPA 2007), although the toxicity seems to be lower compared to the dioxins. TEF-values (Toxic Equivalency Factors), *i.e.* the toxicity in relation to the dioxin TCDD, have been calculated to 0.001 and 0.01 for 2,3,7,8-TeCDT and TeCTA, respectively (Safe 1990, Kopponen *et al.* 1994 and Sawyer *et al.* 1984 quoted in S-EPA 2007). Animal studies indicate that these compounds are metabolised relatively fast (S-EPA 2007).

2.2.2. Polybrominated dibenzodioxins (PBDD) and -furans (PBDF)

Polybrominated dibenzodioxins (PBDDs) and dibenzofurans (PBDFs) and bromochlorodioxins are like chlorinated dioxins primarily formed by combustion processes or in other high temperature processes. The structure of one congener is shown in Table 2-8.

Table 2-8 CAS number and structure of 2,3,7,8-Tetrabromodibenzo-4-dioxin

Name	CAS No	Structure
2,3,7,8-Tetrabromodibenzo-4-dioxin	50585-41-6	

An increased formation of both brominated and chlorinated dioxins may take place if the fuel contains high levels of chlorine and/or bromine. Main sources of formation of PBDDs and PBDFs are combustion plants with electronic waste and other waste containing flame retardants, and at industries dealing with brominated flame retardants as well as products containing those. In the environment these substances can be formed by photochemical transformation of polybrominated diphenylethers (PBDEs).

Brominated dioxins and furans have similar properties and distribution pattern as their chlorinated counterparts. The higher molecular weight of bromine compared to chlorine makes PBDDs and PBDFs more lipophilic and non-volatile compared to the corresponding chlorinated substances. The stability in soil, sediment and biota is similar to that of chlorinated dioxins, but the brominated substances may undergo photochemical reactions more easily in water and air which may lead to the formation of stable chlorinated dioxins. The atmosphere is an important transport medium because the emissions take place here and atmospheric deposition is a major pathway to aquatic and terrestrial ecosystems. Soil and sediment are the major sinks where these substances can be very persistent.

Recently, high levels of PBDDs were detected in samples of macroalgae and cyanobacteria from the Baltic Sea and the Swedish west coast (Haglund 2007). They have also been found in high concentrations in coastal fish from the same areas (the levels of the most prevalent tribromDD is similar to PCB153) while the concentrations were much lower in freshwater fish samples.

There are strong indications that PBDD are naturally formed. The PBDD profiles differ significantly between combustion-related samples and marine primary producer samples. In the former, there are many different congeners; mainly highly brominated DD., while the latter contains a small number of different congeners; mainly mono-tetrabromoDD.

These compounds have similar toxicological properties as the chlorinated dioxins and furans. Congeners substituted with both chlorine and bromine has shown a relative potency even higher than for TCDD. (S-EPA 2007)

3. Sampling programme

A sampling strategy was developed to determine concentrations of the selected substances/groups of substances in different matrices in the Swedish environment (Table 3-1, Figure 3-1, Appendix 1). The sampling program was aimed to identify major emission sources, important transport pathways in the environment and possible accumulation in the ecosystem as well as in humans. Sampling locations are shown in **Figure 3-2** and **Figure 3-3**.

As most of the substances included in this screening are formed during combustion processes, emissions to air were identified as the main release pathway. The sampling program was therefore focused on measurements of air concentrations. Air (gas- and particle phases) and atmospheric deposition were sampled in background and in urban areas close to point sources.

Several of the substances included are persistent and expected to be transported long distances in air. Air measurements were carried out at two background sites: Råö, which is an EMEP (Co-operative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe) station at the Swedish west coast and Pallas, a monitoring station in northern Finland within AMAP (Arctic Monitoring Assessment Programme). The air measurements at Råö and Pallas were co-ordinated with measurements carried out within the Swedish Monitoring Programme for Air Pollutants. Atmospheric concentrations were also measured in urban areas in Göteborg at the Swedish west coast (to which Råö is a suitable background station) and Lycksele in the north of Sweden. The samples in Göteborg were collected in urban background (roof level), close to high-traffic streets and in a traffic tunnel. Lycksele was identified as an urban area where traffic and small scale wood burning are important sources.

Atmospheric deposition has been identified as an important pathway for unintentionally produced substances to aquatic as well as terrestrial areas. Deposition measurements were carried out in a background area, Råö, and in the urban area of Göteborg. The deposition measurements at Råö were co-ordinated with measurements carried out within the Swedish Monitoring Programme for Air Pollutants and the air and deposition measurements at Råö were carried out in parallel.

The primary recipients of atmospheric deposition as well as traffic emissions are soil, storm water and surface water, with further transport to sediments. To investigate levels in such recipients, soil samples were collected close to trafficked streets in Göteborg, storm water sludge samples were taken in Göteborg and sediment was sampled in gradient from Göteborg city in Göta Älv. As references, background samples were collected at Lake Gårdsjön on the Swedish west coast (soil, sediment) and at remote sites in the Baltic Sea (sediment).

A possible pathway for unintentionally produced substances could also be via sewage treatment plants, therefore sewage sludge samples were collected in Ryaverken in Göteborg and Henriksdal in Stockholm.

To investigate the potential for bioaccumulation of some of the substances, biota and human milk samples were collected. Biota samples were taken at background locations (fish) and in an urban area (fish and molluscs), Göteborg. Human milk samples were provided by the University Hospital in Lund.

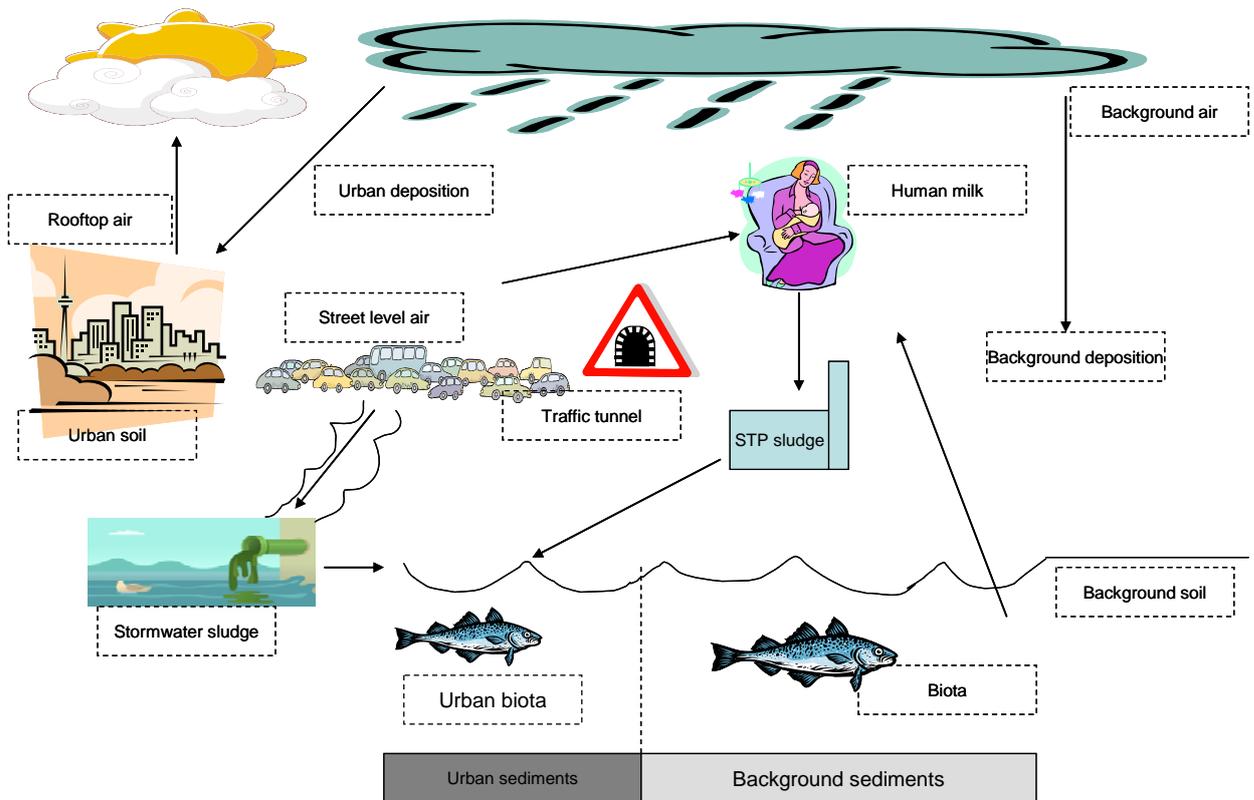


Figure 3-1 Schematic figure indicating potential flows (arrows) of unintentionally produced substances included in the current screening as well as the types of samples that were included in the sampling programme (labelled boxes).

Table 3-1 Sampling programme; number of samples at the different sampling stations

	Air	Atm. Deposition	Sedi-ment	Biota	Soil	Stormwater sludge	STP sludge	Breast milk	Total
Background sites									
Råö	3	2							5
Pallas	3								3
Gårdsjön				1	1				2
Kvädöfjärden				1					1
Gotska Sandön			1						1
Karlsödjupet			1						1
Diffuse sources									
<i>Urban, city/traffic:</i>									
Göteborg, Lundby tunnel	2								2
Göteborg, Gårda	2								2
Göteborg, Järntorget	2	3							5
Göta älv, Eriksberg			1	1					2
Göta älv, Rivö			1	1					2
Göta älv, Klinten			1						1
Göteborg				2	3	3	1		9
Stockholm							1		1
<i>Urban, wood combustion:</i>									
Lycksele	3								3
Human exposure								10	10
Total	15	5	5	6	4	3	2	10	50

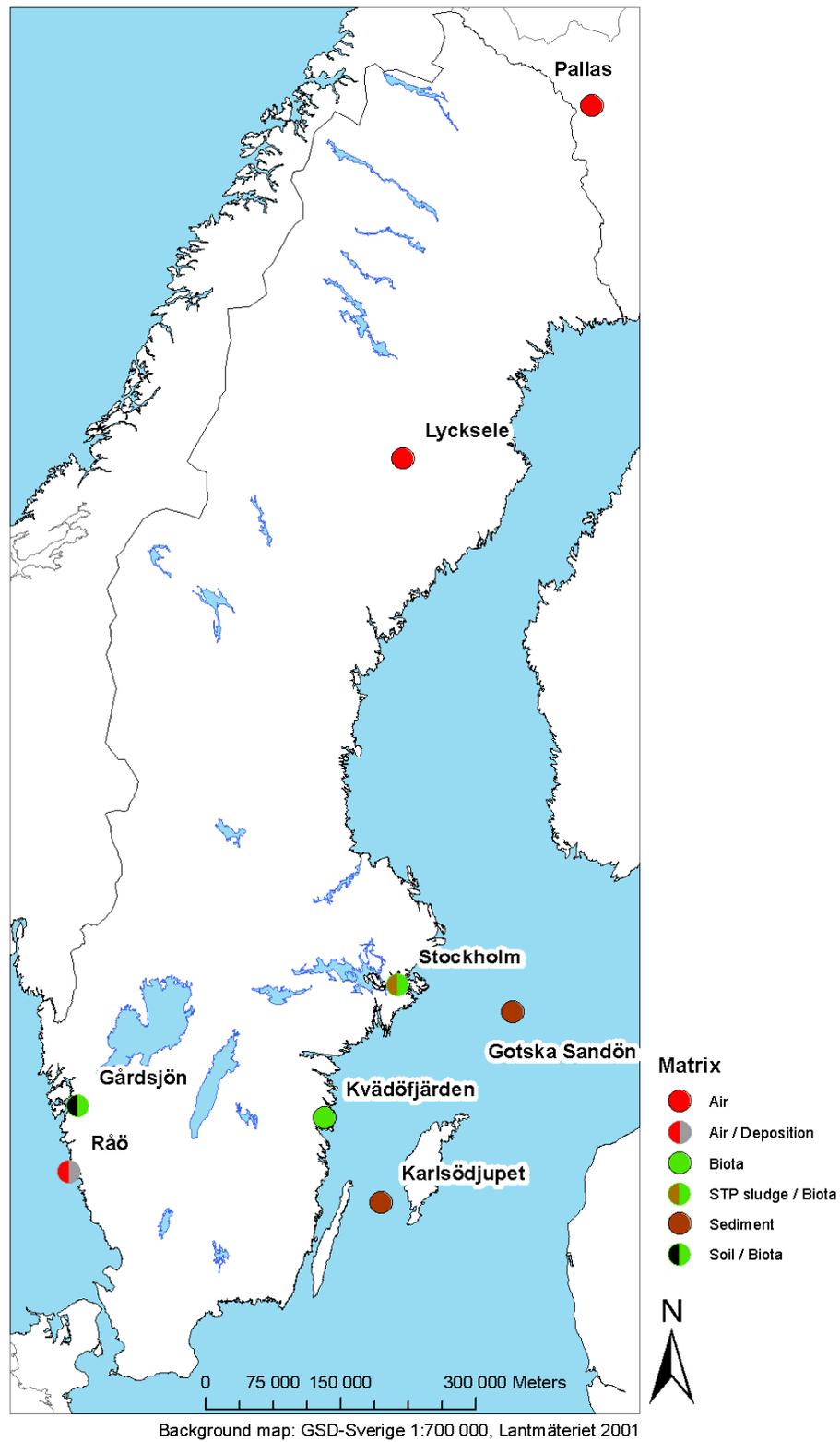


Figure 3-2 Geographic location of sampling sites for the national screening study of unintentionally produced substances.

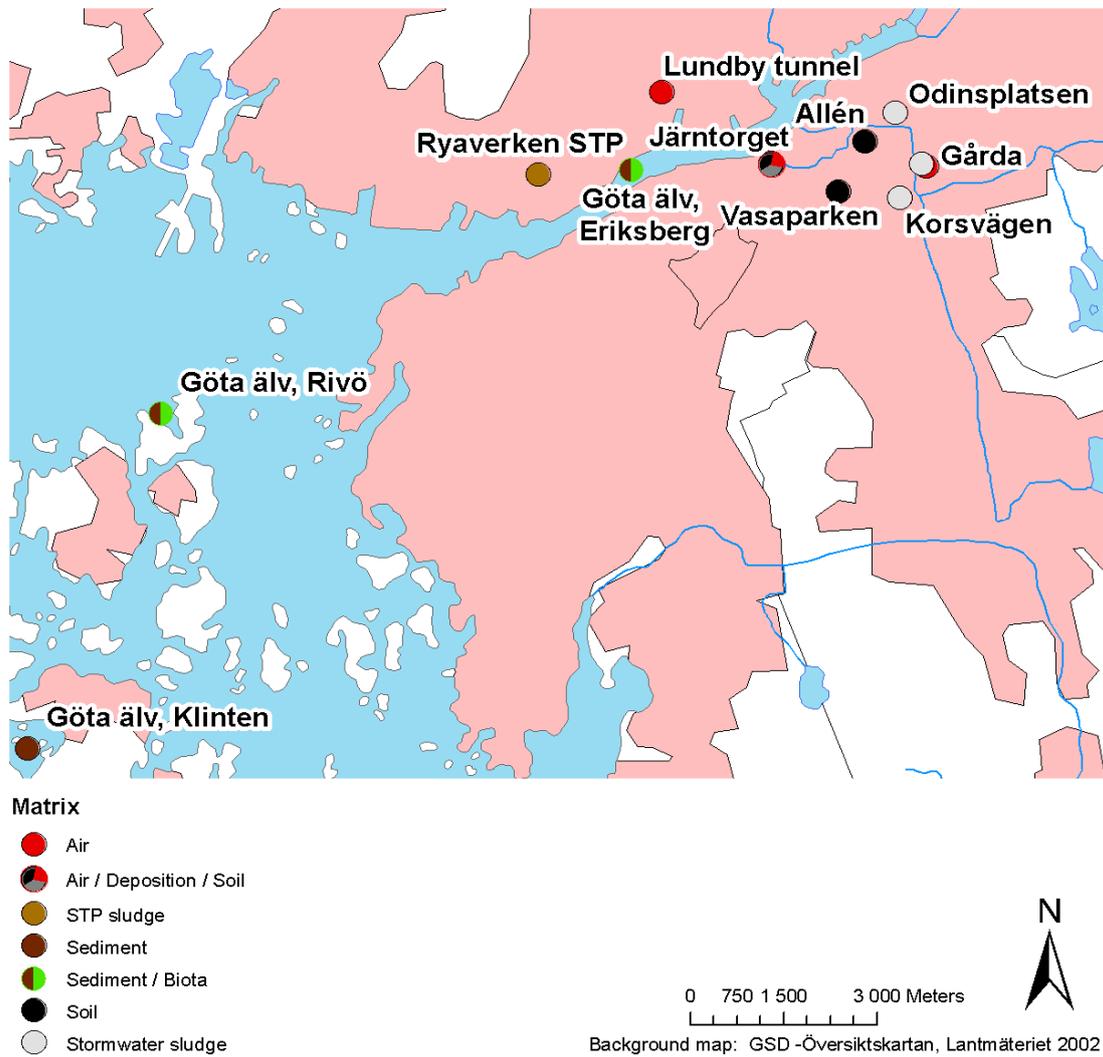


Figure 3-3 Location of sampling sites in Göteborg.

4. Methods

4.1. Sampling

Air: The atmospheric samples were collected using a high volume air sampler (HVS). A glass fibre filter was used for trapping the particles followed by an adsorbent of polyurethane foam (PUF) for collecting compounds in the gas phase. The air sampling was carried out weekly and sample extracts was then combined to represent longer time periods.

Deposition: Both wet and dry deposition was collected using an open sampler (bulk sampler). This sampler consists of a 1 m² Teflon coated surface with 10 cm high edges. The bottom declines slightly to a central opening where a cassette with an adsorbent of PUF is attached. The deposition sample includes both compounds in the precipitation and compounds deposited to the collection surface of the sampler (PUF, filters and ethanol). Both the precipitation and the deposited particles are included in the analysis. The deposition sampling was carried out weekly and sample extracts was then combined to represent longer time periods.

Soil: The upper 2-3 cm of surface soil was collected in glass jars and stored in a freezer until the analysis.

Sediments: The surface sediments (0-2 cm) from Göta älv, Göteborg, were provided by Marine Monitoring at Kristineberg AB. A ponar type grab sampler was used. Two sediments from remote areas in the Baltic Sea, collected in the Swedish national monitoring programme of marine sediments by the Geological Survey of Sweden (SGU), were also used.

Fish from Gårdsjön and the two sites in Stockholm were collected by means of fishing nets. The net fishing in Stockholm was approved by the fishery authorities in Stockholm and the ethical board for animal testing in northern Stockholm (D. no. 527/07). Perch muscle from Kvädöfjärden was provided from the specimen bank at the Swedish Museum of Natural History. The fish muscle samples consisted of a homogenate of 10 individuals. All fish samples were stored at -18 °C in pre-cleaned glass jars.

Molluscs from Göta älv, Göteborg were provided by Marine Monitoring at Kristineberg AB. The molluscs were caught in a special trap with dead fish used as bait.

Storm water sludge was sampled at three traffic related sites in Göteborg. The samples were provided by the Swedish Road Administration (Vägverket) and "Gatukontoret" in Göteborg. The storm water sludge was collected in glass jars and stored in a freezer.

STP sludge: The staff at the different STPs (sewage treatment plants) collected de-watered sludge samples from the anaerobic chambers. The sludge was transferred into glass jars and stored in a freezer (-18 °C) until analysed. All glass equipment used was muffled (400 °C) before use.

Human breast milk samples were provided by The University Hospital of Lund (Department of Occupational and Environmental Medicine). The sampling strategy and methodology have been described elsewhere (Högberg 2008). The samples were primarily collected for analysis of phthalates. They were acidified with phosphoric acid (1 M; 125 µl/ml) immediately after collection and stored

frozen. The obtained samples were marked with numbers and carried no personal information or medical history.

4.2. Analysis

4.2.1. Sample preparation

General

Air and deposition samples were extracted in accordance with the methods used in the monitoring program for air pollutants. Therefore all air and deposition samples were Soxhlet extracted at IVL. The samples (PUF-plugs and filters) were Soxhlet extracted with acetone for 24 hours (+/- 2 hours). Extracts from the adsorbent and filter were combined and divided for determination of the different substance groups, according to Figure 4-1. The filters were further Soxhlet extracted in toluene. A part of the toluene extract was combined with the acetone extract and used for determination of chlorinated and brominated substances.

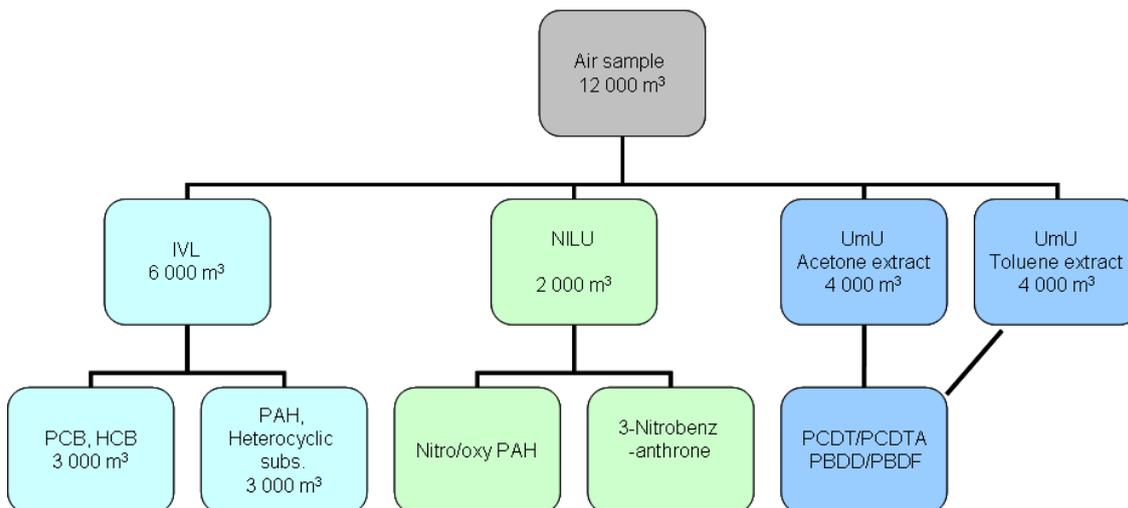


Figure 4-1. A schematic picture showing how the air extracts were split prior to analysis.

The sediment, sludge, biota and soil samples were divided prior to analysis to according to Figure 4-2. For determination of PAHs, oxy-PAHs, nitro-PAHs, hetrocycles and PCBs The samples were Soxhlet extracted in acetone at IVLs laboratory. After the Soxhlet extraction, internal standards were added and the organic compounds were extracted to an organic phase by liquid/liquid extraction.

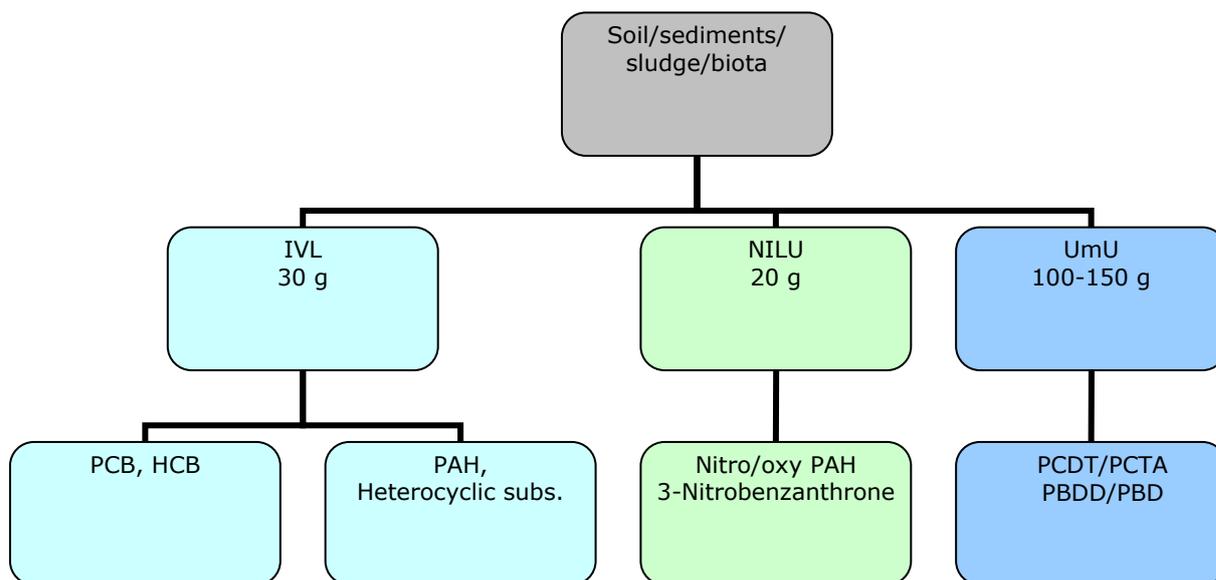


Figure 4-2. A schematic picture showing how the soil, sediment, biota and sludge samples were divided prior to analysis.

PAHs

Prior to the determination of PAHs the extracts were fractionated on a silica gel column, where a fraction containing PAHs was collected. Two more polar fractions were collected for determination of the N-heterocycles. The PAHs were analyzed using a high performance liquid chromatograph (HPLC) with a fluorescence detector.

IVL is accredited for analysis of PAH. The laboratory is audited every year by the Swedish control agency Swedac. Part of the quality control consist of duplicate or triplicate analysis of appropriate certified reference materials as well as duplicates made of samples for verification of results. IVL take part in interlaboratory tests and intercalibrations on a regular basis. Instrument performance and analysis are verified by calibration standards. Certified reference standards and duplicate analysis of samples are analyzed and monitored in so called X and R-charts.

Heterocycles

The analysis was made using a 7890A gas chromatograph connected to a 7000A triple quadrupole mass spectrometer (Agilent). The analytical column, HP-5MS 30m x 250 µm, film thickness 0,25µm (Agilent), was connected via a purged tee to a restrictor connected to the mass spectrometer. This arrangement made it possible to backflush the column when all analytes had been eluted. The injection was made pulsed splitless at 250°C. The column temperature was held at 50°C for 1 min, increased to 120°C at 26°C /min and to 280°C at 5°C /min.

The mass spectrometer was used in the MRM mode using EI ionization. The PAH-extracts were analyzed for S and O heterocycles according to Table 4-1. The F2 and F3 extracts were analysed for N heterocycles according to **Table 4-2**.

Table 4-1. Pairs of precursor and product ions (MRM) and collision energies (CE) used for S and O heterocycles.

Name	Hetero-atom	Quantifer		Qualifier	
		MRM	CE (V)	MRM	CE (V)
1-Benzothiophene	S	134->89	30	134->90	20
Dibenzothiophene	S	184->152	23	184->139	30
Benzo[b]naphtho[2,1-d]thiophene	S	234->202	28	234->189	40
2,3-Benzofuran	O	118->89	25	118->90	10
Dibenzofuran	O	168->139	27	168->113	40
Benzo(b)naphtho(2,1-d)furan	O	218->189	28	218->163	40
Benzo(b)naphtho(1,2-d)furan	O	218->189	28	218->163	40
Benzo(b)naphtho(2,3-d)furan	O	218->189	28	218->163	40

Table 4-2. Pairs of precursor and product ions (MRM) and collision energies (CE) used for N heterocycles.

Name	Hetero-atom	Quantifer		Qualifier	
		MRM	CE	MRM	CE
Indole	N	117->89	30	117->90	15
Carbazole	N	167->166	20	167->139	30
5H-Benzo(a)carbazole	N	217->216	30	217->189	30
7H-Dibenzo(c,g)carbazole	N	267->266	20	267->265	35
Quinoline	N	129->102	20	129->78	20
Iso-quinoline	N	129->102	20	129->78	20
Acridine	N	179->178	20	179->151	30
Benz(a)acridine	N	229->228	30	229->201	30
Dibenz(a,h)acridine	N	279->278	30	279->277	40

Nitro-PAH and oxy-PAH

Air and deposition sample extracts were spiked with internal standard mixture and evaporated to 0.5 ml under a stream of nitrogen. All extracts were adjusted to 1.0 ml with cyclohexane. The extracts were purified using a ISOLUTE SPE cartridges containing 500 mg Silica. Before application of the extracts, the SPE cartridges were rinsed with 10 ml hexane. The PAH derivative compounds were collected with 10 ml of a (65/35, v/v) pentane/dichloromethane mixture. The extract volume was reduced to 200 µl and recovery standard (Fluoranthene d10) was added to each sample.

Soil/Sediment and biota extracts were spiked with an internal standard mixture (1-Nitropyrene d9 and 3-Nitrofluoranthene d9) and the extracts were concentrated to 0.5 ml under a stream of nitrogen. The extracts were diluted in 4 ml cyclohexane/ethylacetate (1:1) and the sample matrix removed by the means of gel permeation chromatography (GPC). The cleaned extracts were concentrated to 0.5 ml before further clean-up as described below.

Oxy-PAH and Nitro-PAH were analysed by HR-GC/MS in NICI mode. The column used for analysis was DB-5MS, 30 m x 0.25 mm ID, 0.25 µm film thickness (J&W scientific). The samples were split-splitless injected at 300° C temperature. The oven temperature program was initial

temperature at 60° C hold for 2 min, rate 45° C/min to 150° C for 5 min; rate 5° C/min to 300° C for 15 min. Total run time was 54 min.

The mass spectrometer was run in Selective ion monitoring (SIM) mode and methane was used as reagent gas for NICI. Quantifications were performed using the internal standard technique.

Monitored ions and associated deuterium labelled Nitro-PAHs internal standard are shown in Table 4-3.

Table 4-3 Monitored ions and associated deuterium labelled Nitro-PAHs internal standard

Name	m/z
Fluoranthene d10	212,1410
1-Nitropyrene d9	256,1198
9-Nitroanthracene	223,0633
2+3-Nitrofluoranthene	247,0633
1-Nitropyrene	247,0633
4-Nitropyrene	247,0633
3-Nitrobenzanthrone	273,0790
7-Nitrobenz(a)anthracene	275,0583
1,3-Dinitropyrene	292,0583
1,6-Dinitropyrene	292,0583
3-Nitrofluoranthene d9	256,1198
9-Fluorenone	181,0607
Acenaphthenequinone	182,0370
4H-Benzanthraquinone	204,0575
2-Methyl-9,10-anthraquinone	222,0680
7H-benz[de]anthracen-7-one	230,0732
6H-Benzanthraquinone	254,0731
1,2-Benzanthraquinone	258,0681

1- Hydroxy-9-fluorenone and 2-hydroxy-9-fluorenone

The Soxhlet extracts from air samples were acetylated without further clean-up. The Soxhlet extracts from sludge, sediment and biological samples which contained large amounts of matrix molecules was subjected to a developed back-extraction procedure where the extract, dissolved in hexane, was vortexed with a mixture of carbonate buffer and methanol. The buffer phase, containing the analytes, was transferred to a new test tube, diluted with water, acidified and extracted with hexane:MTBE. This extract was then subjected to acetylation.

The extract was dissolved in toluene in a test tube. 2-Hydroxy-dibensofurane was added as a positive acetylation control. Acetic acid anhydride, and a base (pyridine containing 4-DMAP) was added and the reaction was accomplished on a heating block for 1 hour at 75°C. The excess reagent was removed by shaking the extract with carbonate buffer. The derivatized extract was dried over sodium sulphate and finally cleaned up on a deactivated silica gel column. The acetylated analytes were eluted by a hexan:MTBE-mixture. Internal standard was added to the extracts prior to analysis by GC-MSMS in MRM mode using instrumentation described under heterocycles.

PCB

Prior to analysis of PCB, the samples were treated with concentrated sulphuric acid. The samples were fractionated on aluminium columns. Laboratory blanks as well as field blanks followed the

same procedures in the analytical work. The PCBs were analysed on a gas chromatograph (GC) equipped with an electron capture detector (ECD) and a capillary column with non-polar bonded phase. IVL is accredited for analysis of PCB, see above for PAHs.

PCDTs, PCDTAs, PBDDs and PBDFs

PCDTs/PBDFs and PCDTAs/PBDDs are structural analogues to polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs), respectively and behave similarly during extraction and clean up. Therefore the standard PCDD/F protocols that are used for SS/EN 17025 accredited analysis were used for the four classes of dioxin-like compounds. They were then analyzed using gas chromatography – high resolution mass spectrometry (GC-HRMS) with electron ionization and selected ion recording (SIR). In order to separate PCDD from PCDT a higher than normal resolution was used ($\geq 20\ 000$).

For a positive identification the sample components had to elute within the GC time windows of the corresponding standard substances and have an isotope ratio of two monitored SIR ions (for each compound class and degree of halogenation) that differed no more than 10 % from the theoretical value. In addition, the blank should contain none or negligible quantities of target analytes. The quantification was performed by the isotope dilution technique, using ^{13}C -labelled internal standards.

5. Results

The results from the measurements of the “unintentionally produced substances” are presented in Appendix 1 where the concentrations of the individual substances are given. Overviews of the detection frequencies, e.g. the fraction of samples where a substance was found in a concentration above the detection limit for the different sample matrices, are given in Table 5-1 and Table 5-2.

In general, PAH related substances were regularly found in all the matrices, with the exception of biota, where mainly the PAHs and the oxy-PAHs occurred. A number of the nitro-PAHs were detected only in sewage sludge (7-Nitro-Benz(a)anthracene, 1,3-Di-Nitro-pyrene, 1,6-Dinitro-pyrene) and a couple of the heterocycles were detected only in air and/or deposition. PAHs and PCBs were detected in all samples.

PCDTs were generally detected in all matrices apart from biota and human milk, whereas the PCDTAs were hardly ever detected. The PBDFs were more frequently detected than the PCDTs and PBDDs, and were found in all matrices sampled. The PCDTAs were only found in air and soil.

In the following, the results from each substance group will be presented in more detail.

Table 5-1 Detection frequency (%) of the individual PAH related substance for the different sample matrices (dep= deposition; sed=sediment)

Matrix	Air	Dep	Sed	Soil	Biota	Storm water sludge	STP sludge
Number of samples	15	5	5	4	6	3	2
	%	%	%	%	%	%	%
Heterocycles							
Indole	60	40	20	100	33	100	100
Carbazole	100	100	80	100	0	100	100
5H-Benzo(a)-carbazole	93	100	100	75	0	100	100
7H-Dibenzo(c,g)-carbazole	7	40	40	50	0	100	100
Quinoline	87	60	0	0	0	0	0
Iso-quinoline	0	20	0	0	0	0	0
Acridine	80	100	80	100	17	100	100
Benz(a)-acridine	87	100	60	100	0	100	100
Dibenz(a,h)-acridine	73	100	100	100	0	100	0
1-Benzothiophene	100	100	40	50	0	100	100
Dibenzothiophene	100	100	60	75	0	100	100
Benzo(b)naphto(2.1-d)thiophene	87	100	60	75	0	100	100
2,3-Benzofuran	100	100	0	0	0	67	0
Dibenzofuran	100	100	60	75	0	100	100
Benzo(b)naphtofuran	100	100	100	100	0	100	100
Oxy-PAH							
9-Fluorenone	100	100	100	100	100	100	100
1,2-Acenaphthendione	100	100	100	100	67	100	100
4H-Cyclopenta[def]phenanthron	100	100	100	100	100	100	100
9,10-anthraquinone	100	100	100	100	100	100	100
2-Mehtyl-9,10-anthraquinone	100	100	100	100	100	100	100
7H-Benz(de)Anthracene	100	100	100	100	100	100	100
6H-benzo[cd]pyren-6-one	100	100	100	100	100	100	100
Benz(a)anthracen-7,12-dione	100	100	100	100	100	100	100
1-Hydroxy-9-fluorenone	6	20	80	75	0	100	100
2-Hydroxy-9-fluorenone	100	60	80	100	0	67	100
Nitro-PAH							
9-Nitro anthracene	100	100	80	75	50	100	100
2+3-Nitro Fluoranthracene	100	100	100	100	33	100	100
1-Nitropyrene	100	100	100	100	17	100	100
4-Nitropyrene	100	100	80	100	33	100	100
7-Nitrobenz(a)anthracene	0	0	0	0	0	33	0
1,3-Dinitropyrene	0	0	0	0	0	33	0
1,6-Dinitropyrene	0	0	0	0	0	33	0
3-Nitrobenzanthrone	80	80	0	0	0	67	0

Table 5-2 Detection frequency (%) of the individual polybrominated and polychlorinated substances for the different sample matrices

Matrix	Air	Dep	Sed	Soil	Biota	STP sludge	Stormwater sludge	Human exposure
Number of samples	15	5	5	4	6	2	3	10
	%	%	%	%	%	%	%	%
Polybrominated dibenzofurans (PBDF)								
2,3,7,8-TeBDF	53	60	20	25	50	100	100	60
Sum TeBDF	100	100	100	100	50	100	100	0
Sum PeBDF	100	100	80	100	17	100	100	0
Sum HxBDF	80	100	60	100	17	100	100	0
Sum HpBDF	100	100	100	100	100	100	100	90
OBDF	100	100	100	100	100	100	100	100
Sum PBDF	100	100	100	100	83	100	100	100
Polybrominated dibenzodioxins (PBDD)								
2,3,7,8-TeBDD	0	0	60	0	33	0	0	10
Sum TeBDD	20	0	100	75	17	50	67	0
Sum PeBDD	27	0	100	0	0	0	0	0
Sum HxBDD	0	0	0	0	0	100	33	0
Sum HpBDD	0	0	0	0	0	0	0	0
OBDD	0	0	60	0	0	0	0	0
Sum PBDD	0	0	80	0	0	0	0	0
Polychlorinated dibenzothiophenes (PCDT)								
2,3,7,8-TeCDT	20	100	40	75	0	100	0	0
Sum TeCDT	67	80	100	75	17	100	100	0
Sum PeCDT	47	100	100	75	0	100	33	0
Sum HxCDT	20	100	100	75	0	100	33	0
Sum HpCDT	13	80	60	50	0	50	33	0
OCDT	7	60	0	50	0	50	0	0
Sum PCDT	53	100	80	75	0	100	33	0
Polychlorinated dibenzothianthrenes (PCDTA)								
Sum TeCDTA	13	0	0	50	0	0	0	0
Sum PeCDTA	0	0	0	25	0	0	0	0
Sum HxCDTA	0	0	0	0	0	0	0	0
Sum HpCDTA	0	0	0	0	0	0	0	0
OCDTA	0	0	0	0	0	0	0	0
Sum PCDTA	0	0	0	0	0	0	0	0

5.1. PAHs and related substances

5.1.1. Air

PAHs

PAHs occurred in all air samples (Figure 5-1). Concentration levels of Σ_{12} PAH varied between 0.3 and 9.7 ng/m³ at urban and background stations whereas the traffic tunnel samples showed concentrations as high as 16 and 22 ng/m³.

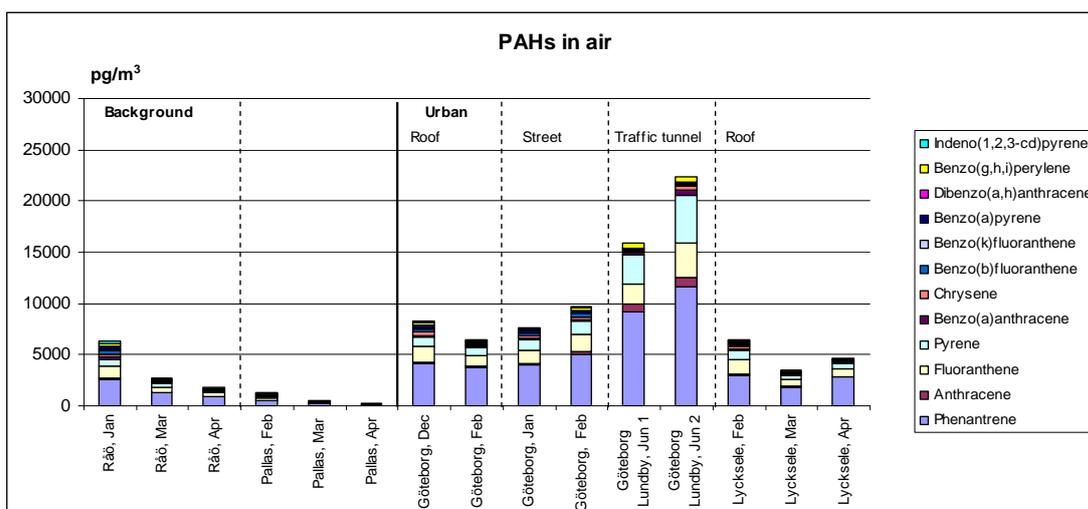


Figure 5-1 Concentration of PAHs in air samples

The PAH concentrations in background air were about ten times higher at the Swedish west coast (Råö) compared to the north of Finland (Pallas), which is in agreement with the results from the monitoring data from 1995-2008 (environmental data, www.ivl.se). Decreasing levels in the samples from the spring were observed, which is in agreement with the seasonal variations observed in the national monitoring programme (Figure 5-2).

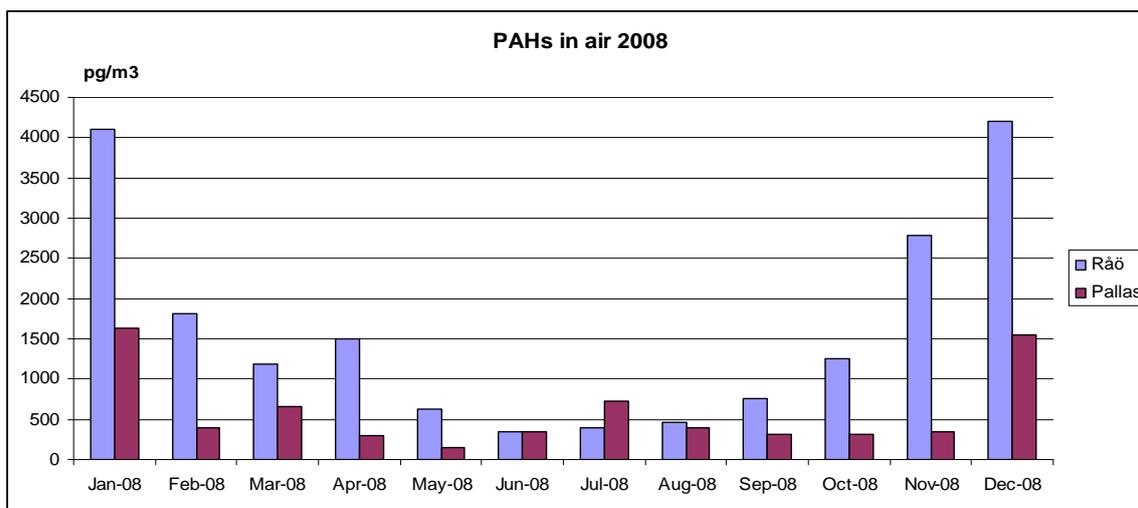


Figure 5-2 Σ_{12} PAH concentrations in air at Pallas and Råö 2008 (environmental data, www.ivl.se)

The PAH concentrations in Göteborg were higher compared to Råö, the background station at the Swedish west coast. The concentrations at street level, close to the traffic, were somewhat higher than at roof level, representing urban background. The highest PAH concentrations, up to 22 ng/m³, were measured in the traffic tunnel. Table 5-3 presents the $C_{\text{average,urban}}/C_{\text{average,background}}$ ratio for individual PAHs in Göteborg, distinguishing between street level, rooftop and tunnel samples.

As evident from the table, a clear influence from traffic is observed for anthracene in particular, even if all PAHs appear to be elevated in the tunnel samples. However, the samples in the traffic tunnel were taken close to the source and anthracene is a reactive PAH component and may in the atmosphere be transformed to an oxygenated PAH.

Table 5-3 Ratios between average concentrations in three categories of urban air in Göteborg and background air (Bkgr) at Råö, for selected PAHs. Only ratios above 2 are presented.

Compound	Gbg roof / Bkgr	Gbg street / Bkgr	Gbg tunnel / Bkgr
Phenanthrene	2.4	2.8	6.4
Anthracene	5.6	11	37
Fluoranthene		2.2	4.1
Pyrene	2.1	2.7	8.9
Benzo(a)anthracene			5.6
Benzo(g,h,i)perylene			3.6
Σ_{12} PAH	2.1	2.4	5.3

The average Σ_{12} PAH concentration in urban background air from Lycksele was slightly lower than in Göteborg (a factor of 1.5). Thus no increased levels due to influence from small scale wood burning was found. However, the relative difference between urban and background air was more pronounced in the north of Sweden, with the $C_{\text{average,urban}}/C_{\text{average,background}}$ (Lycksele/Pallas) ratio for Σ_{12} PAH varying from 5 in February to 15 in April (with an average ratio of 9). The samples in Lycksele and Göteborg were not taken in the same period of the year.

Benzo(a)pyrene (B(a)P) is a relevant PAH to consider for human health concerns (Figure 5-3). This substance, which occurs almost exclusively in the particle phase of the atmosphere, is included in the EU directive on air quality (2004/107/EC). The directive specifies a target value of 1.0 ng/m³ on an annual average basis, which should not be exceeded after 31 December 2012. B(a)P also has a national target of 0.3 ng/m³, which should not be exceeded starting from 2015 (www.miljomal.nu). The monthly average concentration of B(a)P in this study was between 0.07 and 0.2 ng/m³ at the different sites, *i.e.* never exceeding the suggested target values.

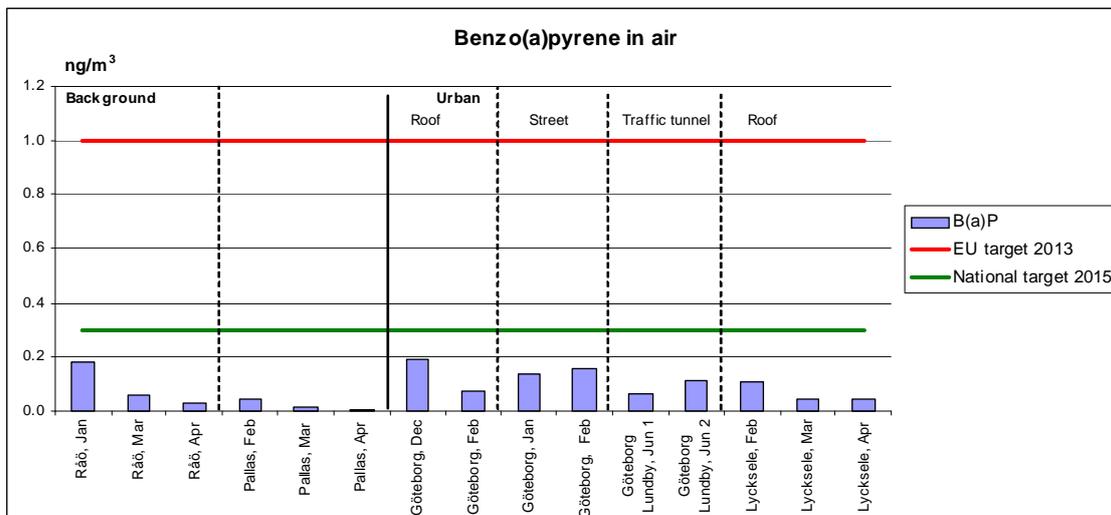


Figure 5-3 Concentration of benzo(a)pyrene in air

Heterocyclic substances

The heterocyclic substances were present in all air samples, with the O-heterocycles in the highest concentrations followed by S-heterocycles and N-heterocycles, Figure 5-4 a-c. They occurred at the background sites, like PAHs, in higher concentrations at the Swedish west coast compared to northern Finland. Their presence in background air shows that atmospheric long-range transport of these substances takes place. The results from the background stations also indicated a seasonal variation similar to PAHs with decreasing concentrations during the spring, when the ambient temperature increase. The air concentrations in the urban areas were higher compared to the background sites and generally higher at street level than in the urban background air (roof level) but with different behaviour for different individual compounds. This is illustrated in Table 5-4 and discussed for each of the heterocyclic types below.

All three included **O-heterocycles** were found in all air samples. Dibenzofuran was the dominating species with concentrations in the range 200- 2200 pg/m³ followed by benzo(b)naphtofuran. 2,3-Benzofuran made up less than 2 % of the summed concentration of this group. The highest concentration of O-heterocycles was found in the air sample from Lycksele in February while the lowest concentrations occurred in a sample from the traffic tunnel. This sample showed concentrations in the same levels as in background air. No clear impact of traffic could be observed for this group (Table 5-4).

The **S-heterocyclic** compounds were detected in most of the air samples. Dibenzothiophene occurred in the highest concentrations, 11-1400 pg/m³, which is in the same range as individual PAHs. Similar to the case of PAHs, the highest concentrations were detected in the traffic tunnel. The relative increase with traffic load was most pronounced for benzo(b)naphto(2,1-d)thiophene and for dibenzothiophene (Table 5-4).

The **N-heterocyclic** compounds were like other heterocyclics generally present in the air samples, where eight of the nine included compounds were detected. The N-heterocyclic compounds occurred in lower concentration compared to PAHs as well as to the O- and S-heterocycles. Carbazole occurred in the highest concentrations of the included substances. The highest concentration 2-220 pg/m³ was found in one of the samples from the traffic tunnel. As evident from Table 5-4, the indole concentrations were most influenced by traffic, with $C_{average}$,

urban/ $C_{\text{average,background}}$ ratio increasing from 8.5 for rooftop urban air to 110 for the traffic tunnel. Also acridine and carbazole concentrations were higher in the traffic tunnel, but not to the same extent (Table 5-4).

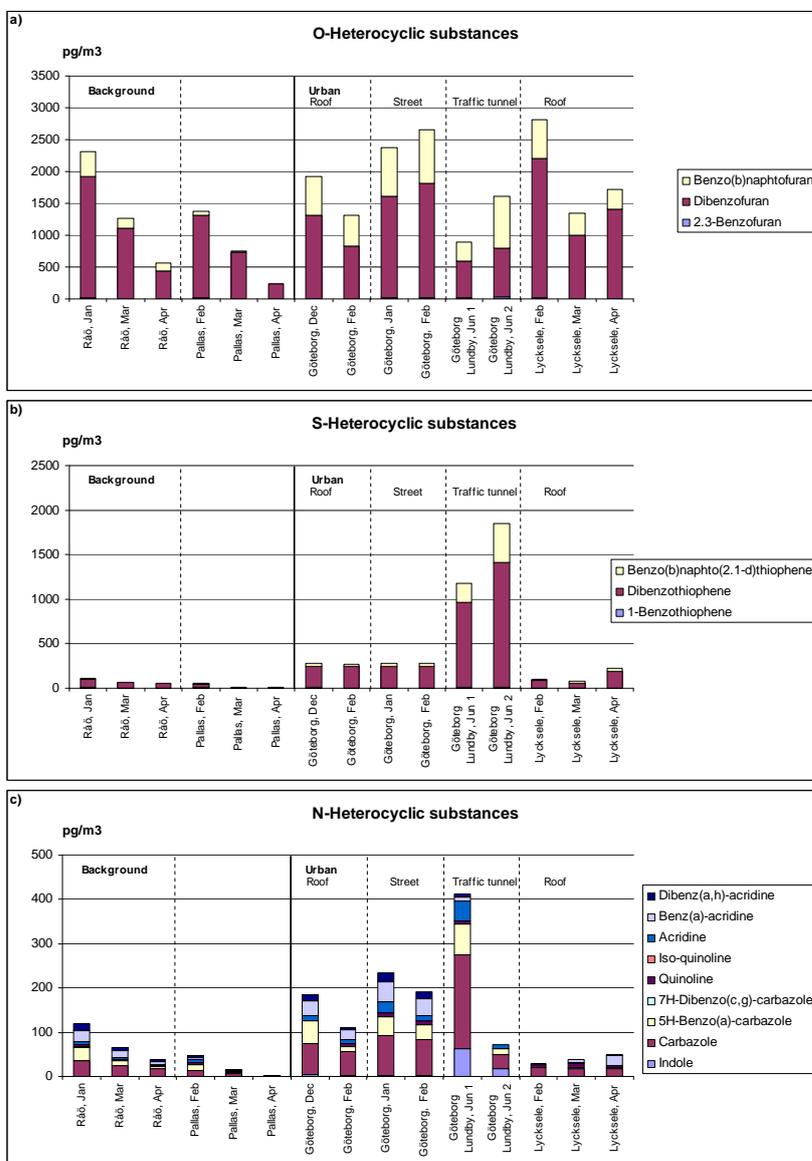


Figure 5-4 a-c. Concentrations of heterocyclic substances in air. Note the different scales on the y-axis in the three diagrams.

Table 5-4 Ratios between average concentrations in three categories of urban air in Göteborg (Gbg) and background (bkgr) air (Råö) for heterocyclic compounds. Only ratios above 2 are presented.

Hetero-atom	Compound	Gbg roof / Bkgr	Gbg street / Bkgr	Gbg tunnel / Bkgr
O	2,3-Benzofuran			3.0
O	Benzo(b)naphtofuran	2.5	3.6	2.5
S	1-Benzothiophene			2.5
S	Dibenzothiophene	3.4	3.3	16
S	Benzo(b)naphto(2.1-d)thiophene	3.3	5.6	45
N	Indole	8.5	7.0	110
N	Carbazole	2.3	3.2	4.6
N	5H-Benzo(a)-carbazole	2.1	2.6	2.8
N	Quinoline		2.5	
N	Acridine	2.4	4.0	6.0
N	Benz(a)-acridine		2.6	
N	Dibenz(a,h)-acridine		2.2	

Oxy-PAH

With the exception of 1-hydroxy-9-fluorenone, all oxy-PAHs were present in all air samples. The concentration and distribution among the compounds are shown in Figure 5-5. The measured atmospheric concentrations of the oxy-PAHs were mostly higher in the urban areas compared to background sites, with the exception of the January sample at Råö, which showed higher concentrations than street level samples in Göteborg. Highest concentrations were measured in the traffic tunnel. In most samples, anthraquinones occurred in highest concentrations. Slight differences in distribution among the substances occurred among different sampling sites, especially the samples from Lycksele showed different patterns (Table 5-5).

The oxy-PAHs showed a different seasonal variation at the background stations when compared to the PAHs. After an initial decrease in atmospheric concentrations as a result of spring arrival and reduced burning activities, the levels increased in April which may be a result of increased photochemical activity and oxidation of PAHs.

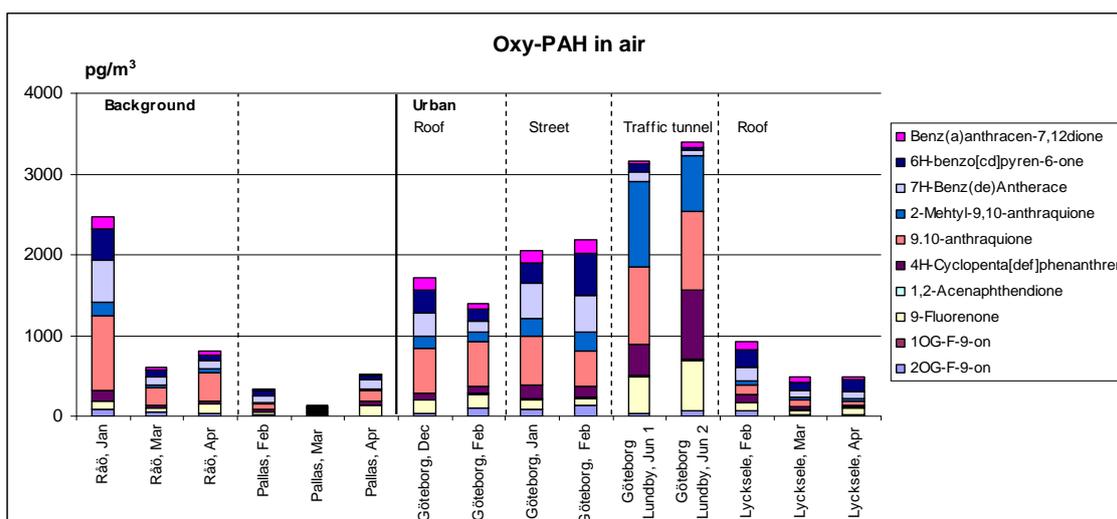


Figure 5-5 Concentration of oxygenated PAHs in air

Table 5-5 Ratios between average concentrations in three categories of urban air in Göteborg (Gbg) and background (Bkgr) air (Råö) for oxy-PAHs. Only ratios above 2 are presented.

Compound	Gbg roof / Bkgr	Gbg street / Bkgr	Gbg tunnel / Bkgr
1,2-Acenaphthendione	12	12	16
4H-Cyclopenta[def]phenanthren-4-one		2.2	9.4
9-Fluorenone			5.7
2-Hydroxy-9-fluorenone		2.2	
2-Mehtyl-9,10-anthraquinone		2.5	9.5
Benz(a)anthracen-7,12dione		2.1	
6H-Benzo[cd]pyren-6-one		2.2	

Nitro-PAH

Nitro-PAHs were present in all air samples, in the concentration range <1 - 130 pg/m³, *i.e.* mostly a factor of 10 -100 lower than the PAH concentrations. 9-nitroanthracene, 2- and 3-nitrofluoranthene, 1-nitropyrene and 4-nitropyrene were detected in all air samples while 7-nitrobenz[a]anthracene, 1,3-dinitropyrene, 1,6-dinitropyrene were not found at all. The concentration and distribution among the detected nitro-PAHs are shown in Figure 5-6.

The measured atmospheric concentrations were mostly higher in the urban areas compared to background sites. The highest concentrations occurred in the traffic tunnel. The distribution among the individual compounds differed between the samples. 9-Nitroanthracene occurred in all samples in the highest concentration, while the share of 1-Nitropyrene and 4-Nitropyrene differed among the samples with the greatest share in the samples from Pallas. Thus there was a difference between the samples from the south of Sweden compared to both Lycksele and Pallas.

Similar to the oxy-PAHs a difference in the seasonal variation was found for the nitro-PAHs compared to PAHs as the air concentrations seemed to increase during April, the month with highest photochemical activity. The highest concentration was found in Pallas in April, which is in contrast to Råö where the highest concentration occurred during a winter period, in January. These results indicate that transformation of PAHs during the atmospheric transport may take place and is important for the occurrence of nitro-PAHs in remote areas.

There were also differences in the relative distribution of among the nitro-PAHs in the samples collected in the traffic tunnel compared to urban air. The share of 1-nitropyrene which is a marker for diesel exhaust was higher in the traffic tunnel compared to the other samples collected Göteborg, see Table 5-6.

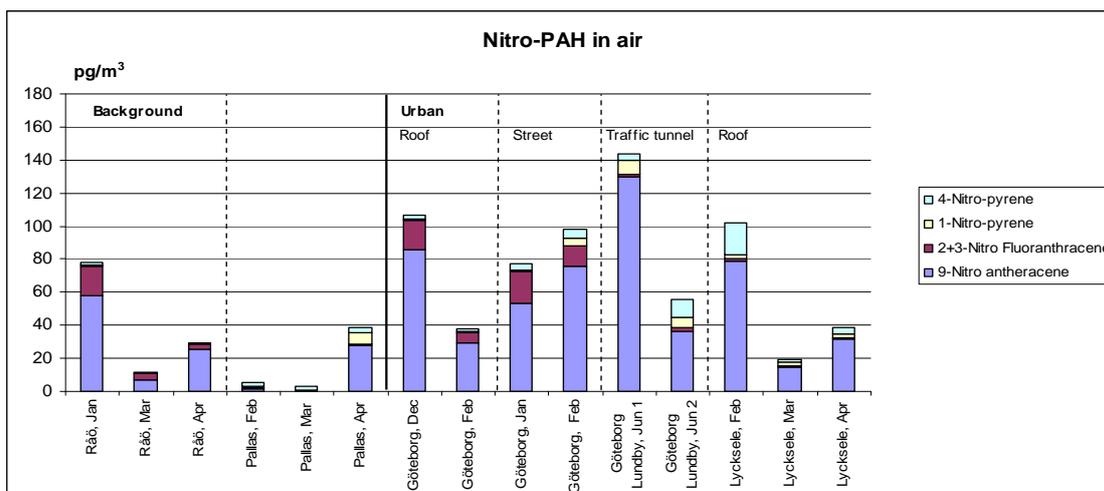


Figure 5-6 Concentration of nitro-PAHs in air

Table 5-6 Ratios between average concentrations in three categories of urban air in Göteborg (Gbg) and background (Bkgr) air (Råö) for nitro-PAHs. Only ratios above 2 are presented.

	Gbg roof / Bkgr	Gbg street / Bkgr	Gbg tunnel / Bkgr
9-Nitroanthracene		2.1	2.7
1-Nitropyrene		5.3	16
4-Nitropyrene	2.2	6.2	10
3-Nitrobenzanthrone		2.5	

3-Nitrobenzanthrone

The nitro-ketone 3-nitrobenzanthrone was, like the nitro-PAHs, frequently found in air. The highest concentrations were observed in urban air in Göteborg. The concentrations in Lycksele were in the same level as in Råö. 3-Nitrobenzanthrone occurred in air in Pallas during one of the three sampling periods, in April, which is in agreement with the higher concentrations of nitro-PAH during this period.

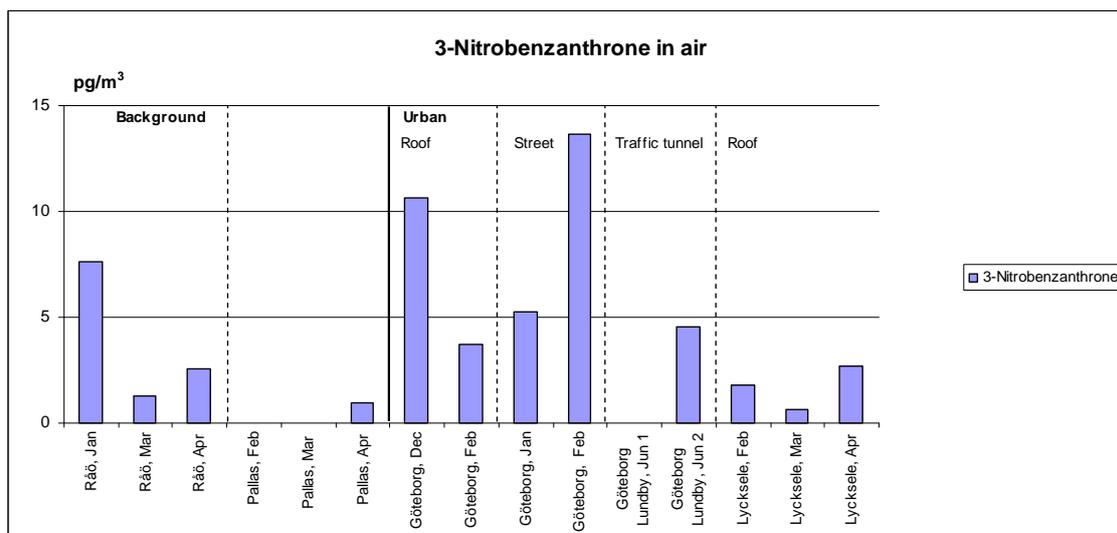


Figure 5-7 Concentration of 3-Nitrobenzanthrone in air

5.1.2. Deposition

The deposition fluxes of Σ_{12} PAHs and the related substances are given together with the corresponding air concentrations in Table 5-7. In addition, deposition fluxes of Σ_7 PCB are given for comparison.

The results of the measurements show that atmospheric transport and deposition is an important pathway to the environment for the oxy- nitro- and heterocyclic forms of PAHs in both urban and background areas.

The deposition fluxes of oxy-PAHs were higher than observed fluxes of PAHs, which may depend on the greater share of particle bound oxy-PAHs compared to PAHs. Previous measurements have shown that deposition of semivolatile POPs like PAHs mainly takes place as particle deposition in connection with precipitation (Brorström-Lundén 1995). The deposition fluxes of nitro-PAHs were lower than for the PAHs but higher or in the same order of magnitude as of the PCBs.

The highest deposition flux was measured at Råö during January. Otherwise no significant differences was found between the urban and background area. No relationship was found between the amount of precipitation and the deposition fluxes. However, only four monthly deposition measurements were undertaken in this screening why no further evaluation of the data is possible.

Table 5-7 Comparison between concentration in air and the atmospheric deposition for PAHs and related substances. The precipitation rate corresponding to the sampling periods is also given (Råö precipitation data: air database, ivl.se; Göteborg data: Luftnet, miljöförvaltningen 2008, 2009)

	Precipitation, mm	Unit	Sum PAH	Sum heterocyclic subs.	Sum Oxy-PAH	Sum Nitro-PAH	3-Nitro-benz-anthrone	Sum PCB
Råö, Jan, Air		pg/m ³	6300	2500	2500	78	7.6	7.1
Råö, Jan, Dep	30	ng/m ² month	10400	1300	34000	1600	76	28
Råö, Mar, Air		pg/m ³	2700	1400	600	11	1.3	7.4
Råö, Mar, Dep	38	ng/m ² month	3600	520	8600	230	10	36
Göteborg, Dec, Air		pg/m ³	8300	2400	1700	110	11	28
Göteborg, Dec, Dep	9	ng/m ² month	4200	610	800	150	<1	210
Göteborg, Feb, Air		pg/m ³	6500	1700	1400	38	3.7	28
Göteborg, Feb, Dep	37	ng/m ² month	7900	1700	13000	130	4.0	64

The importance of atmospheric deposition as a source of contaminants to water bodies is of interest, in particular within the work of the EU Water Frame Directive (2000/60/EC), where sources and their various impacts on water quality are central. In order to investigate the loads of unintentionally produced substances to national water bodies, annual deposition fluxes at Råö were estimated based on the fluxes measured in the current study. Adopting these annual deposition fluxes and assuming that the fluxes measured at Råö are relevant for the entire western water district (Västerhavet; surface area 73 988 km²), this would yield total annual depositions according to Table 5-8. For comparison, previous estimates for PAH and PCB (Hansson *et al.* 2006) are also included.

Table 5-8 Estimated annual deposition (kg) of PAHs and related substances in the western water district, based on data from this screening study.

Water District	Sum PAH (sum12)	Sum heterocyclic	Sum oxy-PAH	Sum nitro-PAH	3-nitro-benz-anthrene	PCB (sum 7)
Western (Västerhavet)	6200	810	19000	810	38	28
2005 estimate (Hansson <i>et al.</i> , 2006)	2400					27

As evident from Table 5-8, the annual amounts of PAHs and related substances deposited to the western water district are estimated to be in the size of kilograms to tonnes per year, indicating that the atmosphere can be regarded as an important source of these contaminants to the aquatic environment. The estimates presented are likely to be overestimates as PAH fluxes are usually higher in the winter time, when most samples were taken, compared to the summertime. This becomes clear when comparing the loads to previous estimates done for the year 2005 (Hansson *et al.* 2006). The deposition loads of PAH appear to have increased by a factor of 2.5 whereas the PCB loads, which are less seasonally dependent have remained constant. This is most probably a reflection of the fact that the 2005 estimates were based on measurements from an entire year whereas the current estimates are based on samples taken only during the early part of the year. However, the relative loads should be fairly reliable, indicating that the loads of oxy-PAH are about 3 times higher compared to PAHs, whereas the deposition loads of nitro-PAHs are somewhat lower and similar to the heterocycles.

5.1.3. Soil, sediments and sludge

PAHs

PAHs were present in all samples of soil, sediment and sludge. The concentrations of Σ_{12} PAH were generally higher in urban areas compared to background, with one sample showing unexpectedly high concentrations, representing Klinten, a fairly remote location outside Göteborg. The concentrations in storm water sludge were a factor of 2-3 higher compared to STP sludge, indicating the importance of traffic emissions followed by urban runoff.

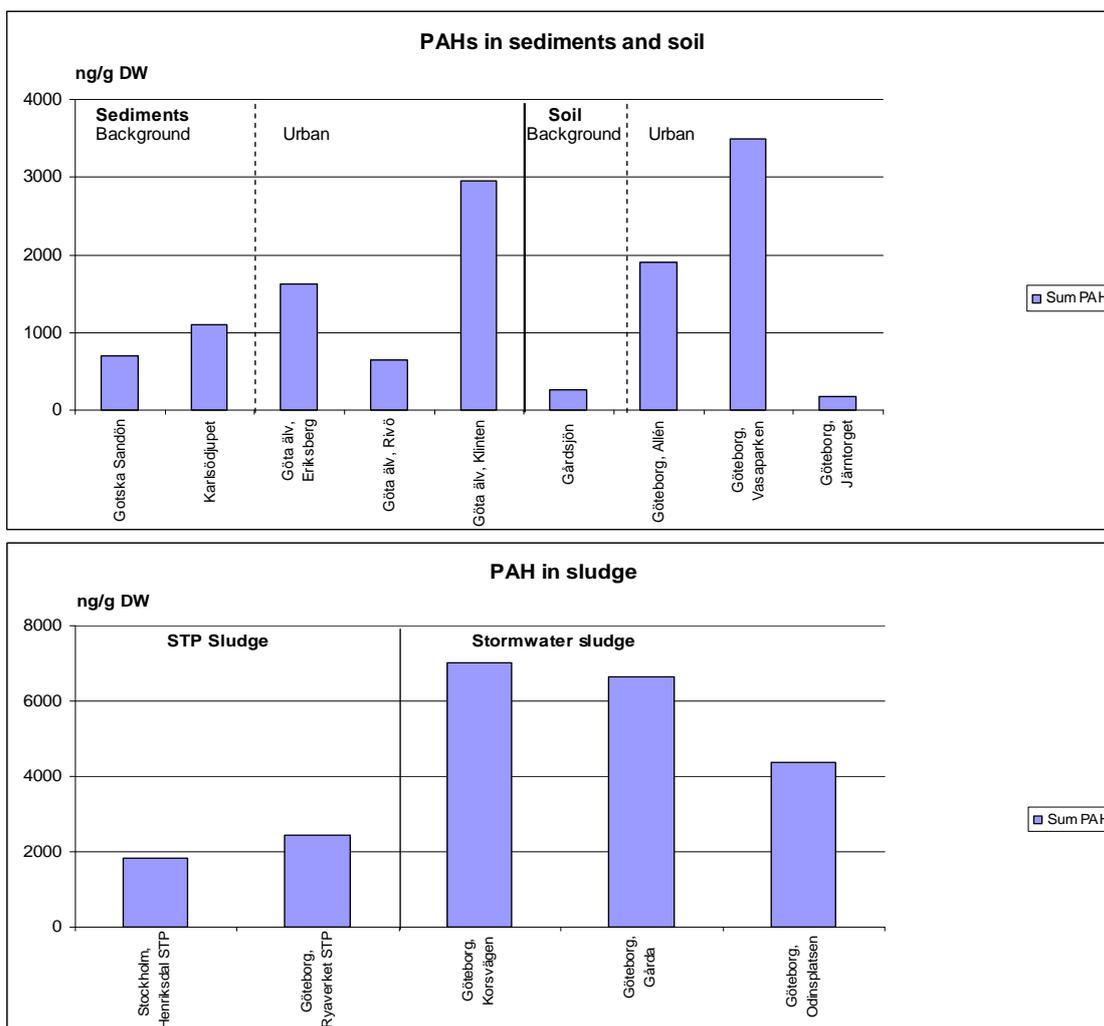


Figure 5-8. Concentrations of Σ PAH in soils, sediments and sludge. Note the different scales on the y-axis in the three diagrams.

Heterocyclic substances

All the heterocyclic substances were found in soil and sediment with the exception of quinoline, iso-quinoline and 2,3-benzofuran. Also in sludge from storm water and STPs most substances were detected, with even higher detection frequencies (Table 5-1). Heterocycles occurred more frequently in storm water sludge and compared to STP sludge, a possible indication of influence from traffic.

Summed together to substance groups N-heterocycles quantitatively dominated (45 – 77%) soil and sludge samples followed by O- and S-heterocycles. The dominating group in sediments were O-heterocycles (44 - 56%) followed by N- and S-heterocycles.

The dominating O-heterocycle was always benzo(b)naphtofuran. The dominating S-heterocycle was always benzo(b)-naphto(2.1-d)thiophene (Figure 5-9, Figure 5-10).

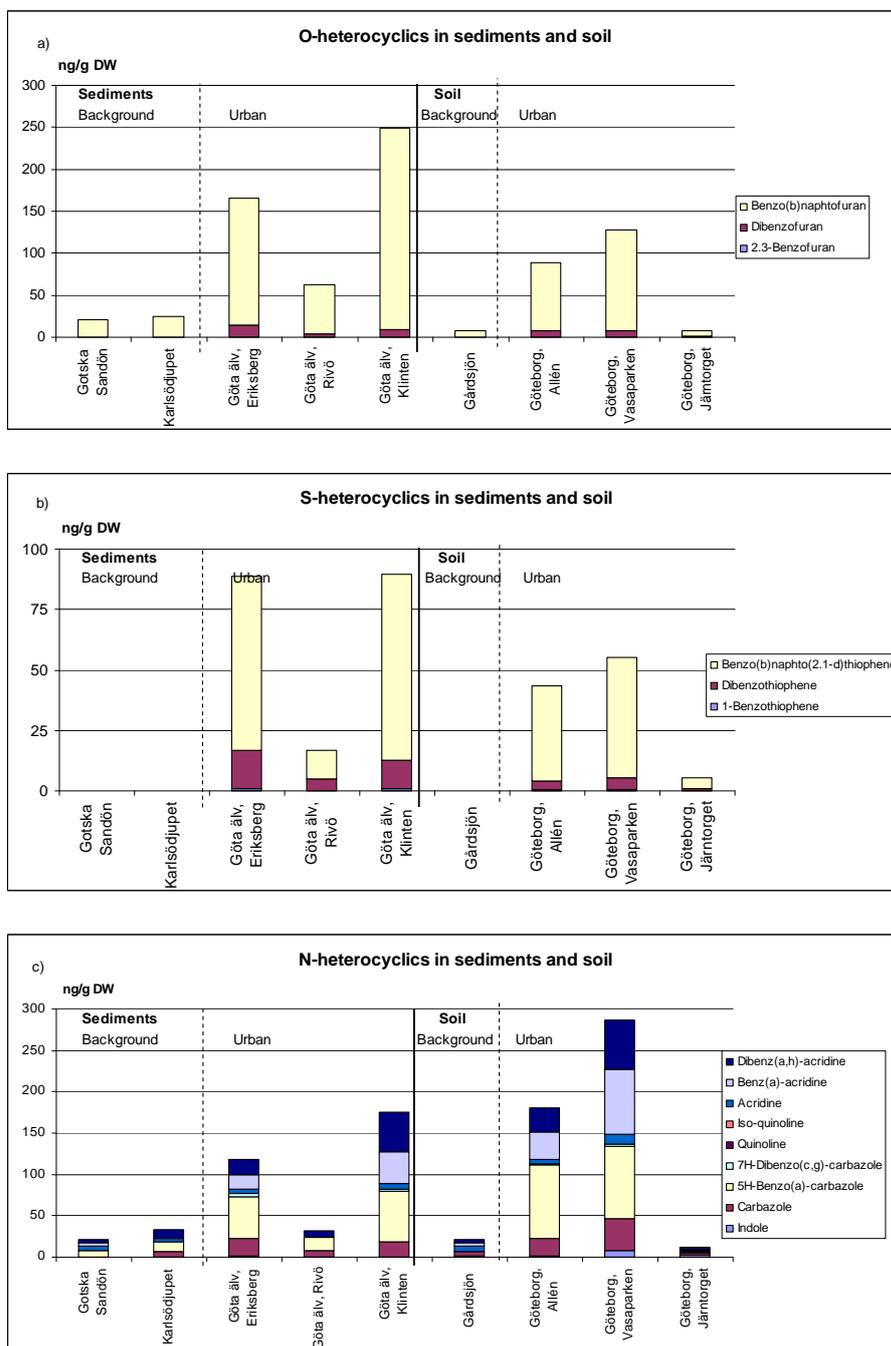


Figure 5-9 Concentrations of heterocyclic substances in sediment and soil. Note the different scales on the y-axis in the diagrams.

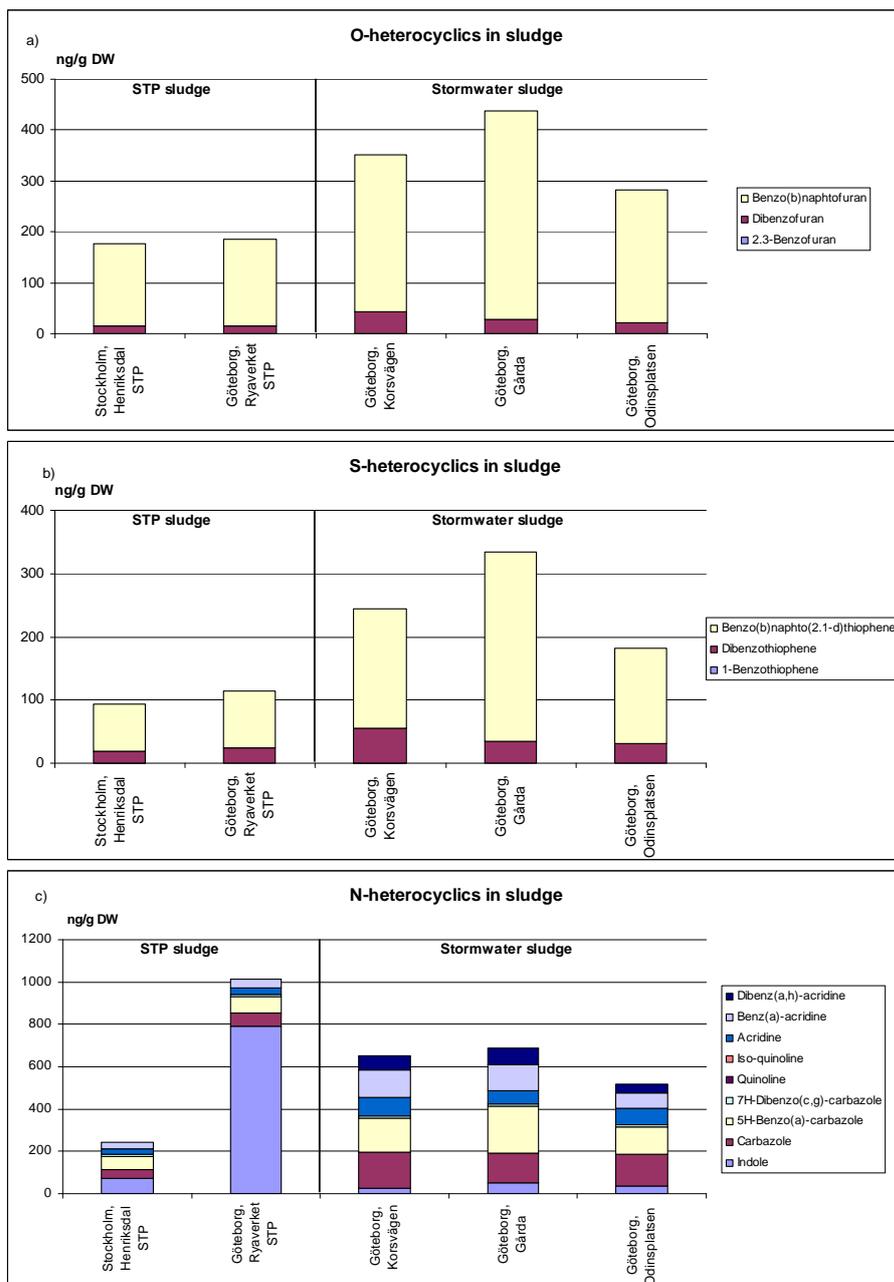


Figure 5-10 Concentrations of heterocyclic substances in sludge. Note the different scales on the y-axis in the diagrams.

For all heterocycles, the concentrations in sludge were higher than in sediments; ratios of average concentrations varying from a factor of 2 to 130 (Table 5-9). With a few exceptions also the concentrations in soil were higher than in sediments. This is different compared to PAHs, which showed soil concentrations of similar order of magnitude as the sediment levels, and only slightly elevated levels in sludge.

Table 5-9 Average concentration in soil and sludge relative to sediment for individual heterocycles. The concentration in sediment is set to 1. Concentrations below the detection limit have been assigned a value of 0. For comparison, the relative occurrence for Sum PAH is included.

Name	Sediment	Soil	Sludge
Indole	1	9	130
Carbazole	1	1.6	11
5H-Benzo(a)carbazole	1	2	4.9
7H-Dibenzo(c,g)carbazole	1	1.9	7.8
Acridine	1	1.4	15
Benz(a)acridine	1	2.5	7.4
Dibenz(a,h)acridine	1	1.3	3.4
1-Benzothiophene	1	1.5	2.1
Dibenzothiophene	1	0.5	5.2
Benzo(b)naphto(2.1-d)thiophene	1	0.97	5.6
Dibenzofuran	1	0.91	4.6
Benzo(b)naphtofuran	1	0.55	2.9
Sum PAH	1	1	3.5

To determine the urban influence on concentrations of heterocycles in solid matrices, the ratios between urban and background concentrations were calculated where possible (Table 5-10). The highest ratio (>8) between urban and background soil were observed for 5H-benzo(a)-carbazole, benzo(b)naphtofuran, dibenz(a,h)-acridine and benz(a)-acridine. The highest ratio (>6) between urban and background sediments were observed for benzo(a)-acridine and benzo(b)naphtofuran.

Table 5-10 Average concentration of heterocyclic substances in urban and background soils and sediments as well as their ratios.

Substance	Soil (ng/g DW)			Sediment (ng/g DW)		
	Back-ground	Urban	Ratio	Back-ground	Urban	Ratio
Indole	1.5	3.8	2.5			
Carbazole	5.8	21	3.6	3.6	16	4.4
5H-Benzo(a)-carbazole	<2.3	59	>26	9.9	43	4.3
7H-Dibenzo(c,g)-carbazole	<2.9	2.4	>0.8			
Acridine	5.8	6.2	1.1	4.5	4.2	0.94
Benz(a)-acridine	4.5	38	8.5	1.9	19	9.8
Dibenz(a,h)-acridine	3.3	29	8.9	7.6	25	3.3
Dibenzothiophene	<3	3.1	>1	<6	11	>1.8
Benzo(b)naphto(2.1-d)thiophene	<5.9	31	>5.3	<12	54	>4.5
Dibenzofuran	<3	5.3	>1.8	<6	9.7	>1.6
Benzo(b)naphtofuran	7.3	70	9.6	23	150	6.5

As was stated above benzo(b)naphtofuran dominated among the **O-heterocycles**. This is different from the situation in air, where dibenzofuran occurred in highest levels. This is expected, as the lighter, more volatile substances tend to partition to air, whereas the heavier more hydrophobic compounds end up in soils and sediments. There seemed to be an impact of urban activities on the concentrations of O-heterocycles, in particular for benzo(b)naphtofuran, which showed 9.6 and 6.5 times higher concentrations in urban soil and sediment respectively, when compared to background areas.

The most abundant **S-heterocycle** was benzo(b)naphto(2,1-d)thiophene, with clearly elevated concentrations in the urban samples. In fact all background samples showed levels below the detection limit for this substance. This agrees with the findings for air, where the traffic influence was apparent for this substance.

In total, **N-heterocycles** accounted for 29 to 77 % of the total concentrations of heterocycles in solid matrices. This is, relatively seen, higher levels compared to their occurrence in air. The individual substances in the group showed relatively similar concentrations with a slight dominance by benzo(a)acridine, carbazole and 5H-benzo(a)carbazole. The influence of urban activities/traffic was most pronounced for 5H-benzo(a)-carbazole, benz(a)-acridine, dibenz(a,h)-acridine, and not at all as clear for indole, acridine and carbazole, which were highlighted for air.

A comparison between the measured concentrations in soil and sediment (Table 5-10) with the indicative effect concentrations as calculated in chapter 2.1.1 shows that, based on these data, no negative effects for sediment dwelling organisms can be foreseen (possible accumulative effects to considered). The indicative effect concentrations are however based on acute ecotoxicological effects and no assessment can be made on potential long term effects. It should also be noted that the recalculation of effect values entail rather large uncertainties. For acridine a long term EC₁₀ is available (35.3 mg/kg DW; Paumen *et al.* 2008) but measured concentrations were below also this value.

Oxy-PAHs

The total concentrations of oxygenated PAHs were in similar orders of magnitude in background sediments as in urban sediment and soil. The relative concentrations among the substances varied, with a clear dominance for 2-methyl-9,10-anthraquinone in background sediments, whereas the distribution of oxy-PAHs in other locations were more even (Figure 5-11).

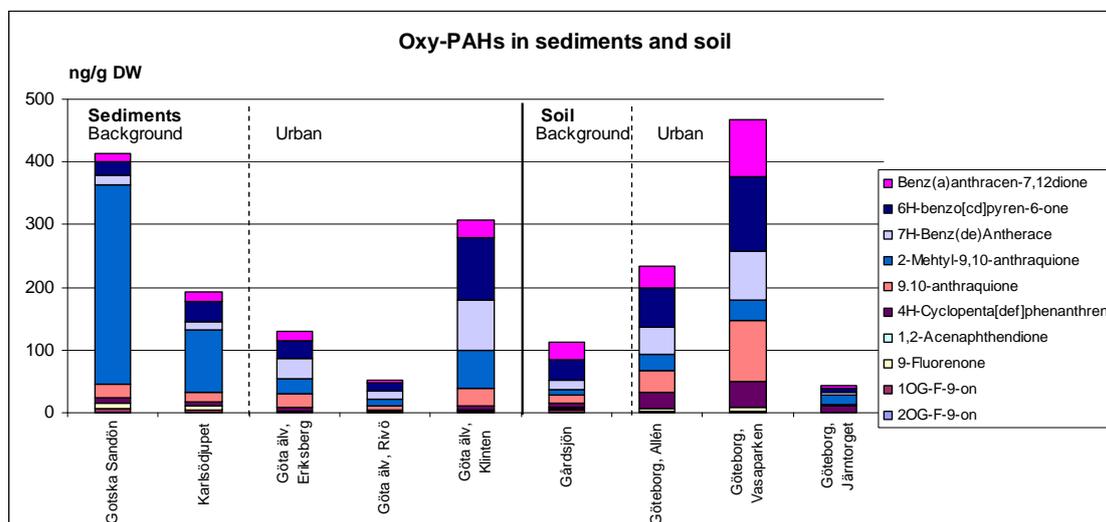


Figure 5-11 Concentrations of oxy-PAH in sediments and soil

The concentrations of oxy-PAHs (sum of the included substances) were higher in STP sludge compared to storm water sludge (Figure 5-12), which is different from the observation for heterocycles. In sewage sludge, 2-methyl-9,10-anthraquinone and 9,10-anthraquinone were the

dominant oxy-PAHs, whereas the concentrations of the different compounds were more evenly distributed in storm water sludge.

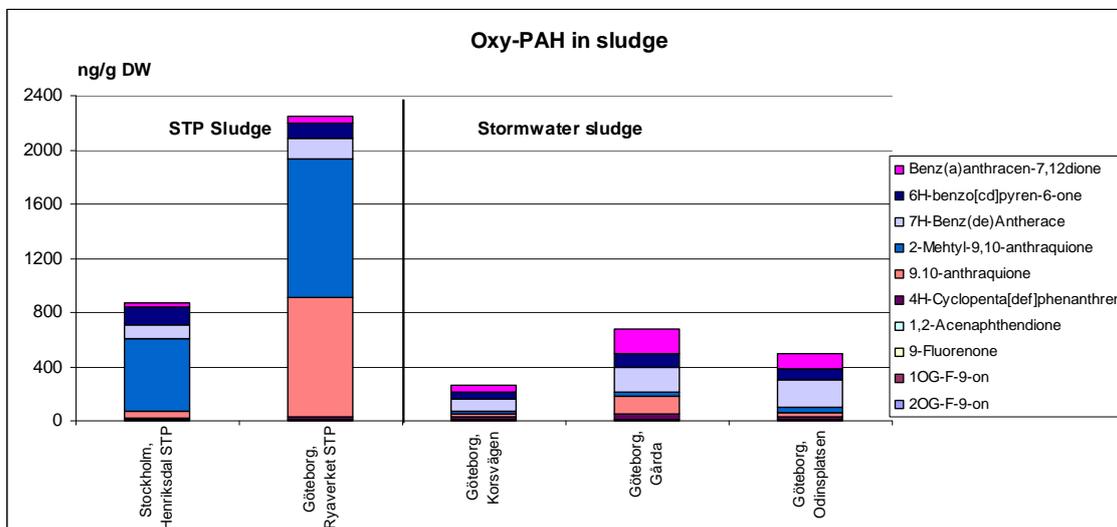


Figure 5-12 Concentrations of oxy-PAH in sludge

Nitro-PAHs

Nitro PAHs occurred in sediments both from background and urban areas in similar levels. However there were differences in the distribution among the different nitro-PAHs; 9-nitroanthracene was the dominating substance in the background sediments while 2,3-nitro-fluoranthene and nitro-pyrenes generally occurred in relatively higher levels in the urban sediments (Figure 5-13).

Also the soil contained nitro-PAH and the concentrations were in the same order of magnitude as in the sediments. Unexpectedly the highest concentration occurred in the soil sample collected at the background location (Figure 5-13).

The occurrence of nitro-PAHs in both urban and background soil and sediment indicate that atmospheric deposition is an important pathway for the substances in both urban and background areas. However, the relative distribution among the nitro-PAHs differed from the situation in air, where 9-nitroanthracene generally was the dominating substance.

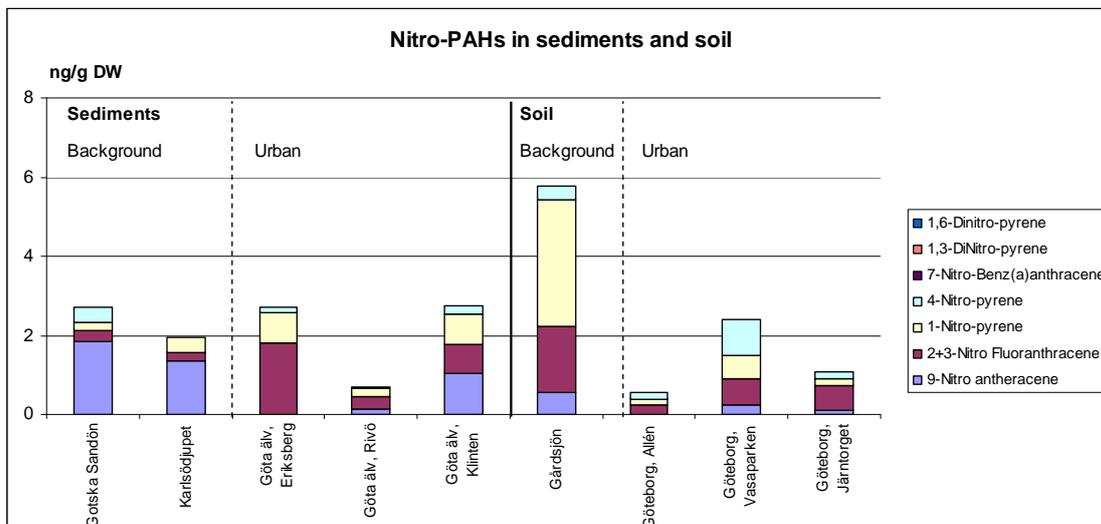


Figure 5-13 Concentrations of nitro-PAHs in sediments and soil

As opposed to oxy-PAHs but similar to the heterocycles, the nitrated forms occurred in higher concentrations in storm water sludge compared to municipal sludge. Most samples were dominated by 2+3-nitrofluoranthene, apart from one storm water sludge sample from Gårda, where also 1,3- and 1,6-dinitropyrene contributed to a large extent. The increased concentrations in storm water sludge indicates, as do the findings in air, that emissions from traffic are important for the occurrence of these substances.

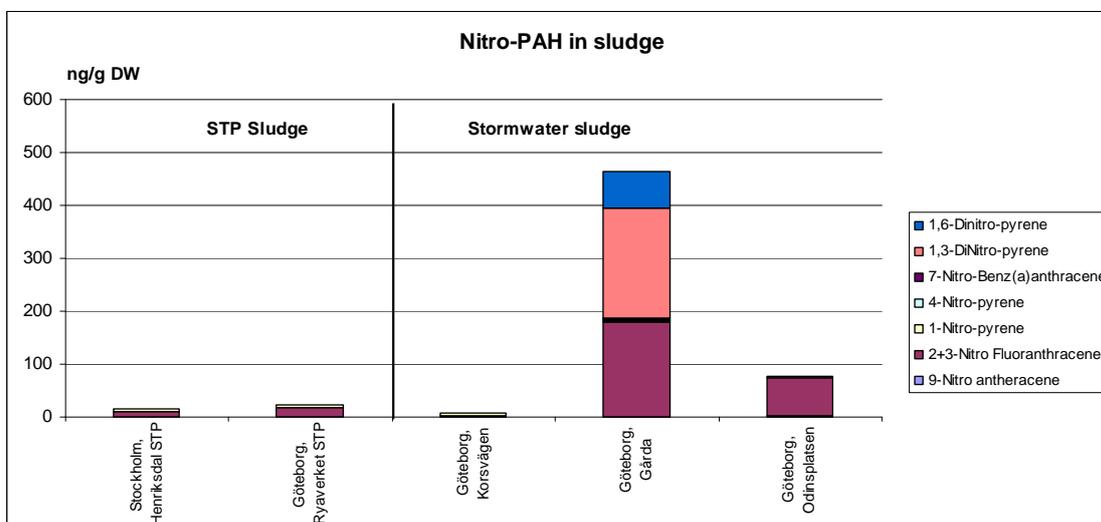


Figure 5-14 Concentrations of nitro-PAHs in sludge

3-Nitrobenzanthrone

3-Nitrobenzanthrone was, among the solid matrices, only detected in storm water sludge (Figure 5-15), while the concentrations in sediment, soil and STP sludge were below the detection limit (0.02- 0.4 ng/g DW). The concentrations of 3-nitrobenzanthrone in storm ware sludge were in the same levels or lower as for individual nitro-PAHs. The increased concentration in storm water sludge indicates, like for the nitro-PAHs, that emissions from traffic is important for the occurrence

and distribution of these substances in an urban area. (3-Nitrobenzanthrone was also frequently found in air and the highest concentrations were observed in Göteborg, see 5.1.1.)

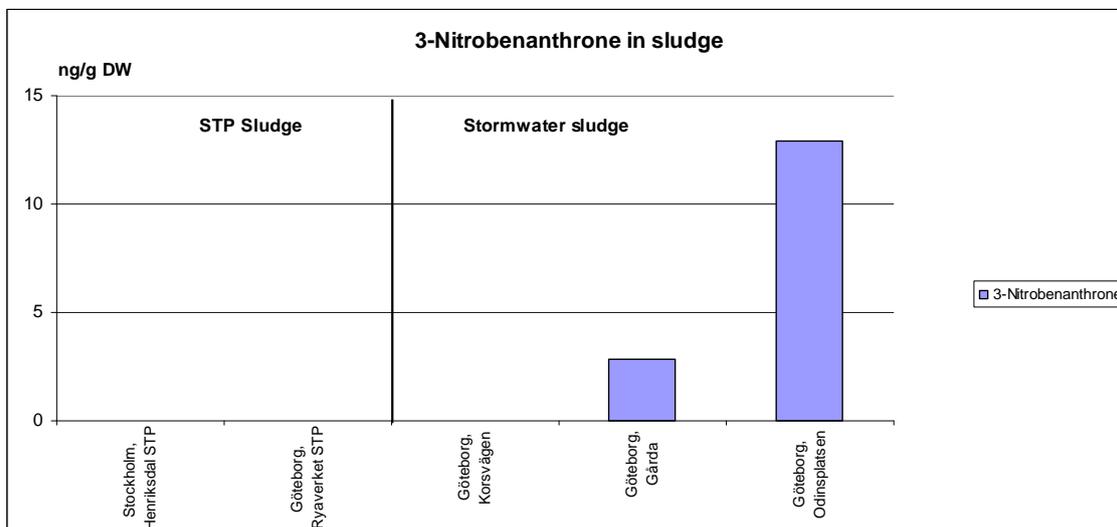


Figure 5-15 Concentrations of 3-nitrobenzanthrone in sludge

5.1.4. Biota

Compared to other environmental matrices, few of the PAH-related substances were found in biotic samples. Of the heterocycles, only indole was detected in aquatic biota, and only in two samples. Oxy-PAHs (mainly 9,10-anthraquinone) and nitro-PAHs (predominantly 9-nitroanthracene) occurred in some urban biota samples and in some samples of background fish.

Overall, molluscs collected at Eriksberg in Göta Älv showed highest concentrations of heterocycles, nitro-PAHs as well as PAHs. For oxy-PAHs, perch from Riddarfjärden in Stockholm showed the highest concentrations.

5.2. Polychlorinated and polybrominated substances

5.2.1. Air

PCBs

PCBs, measured for comparison with the polychlorinated and polybrominated target substances, occurred in all air samples. The concentrations of the sum of the seven identified PCBs varied between 2.3 and 62 pg/m³. The atmospheric concentrations of PCBs found at the background sites and in the urban areas are shown in **Figure 5-16**.

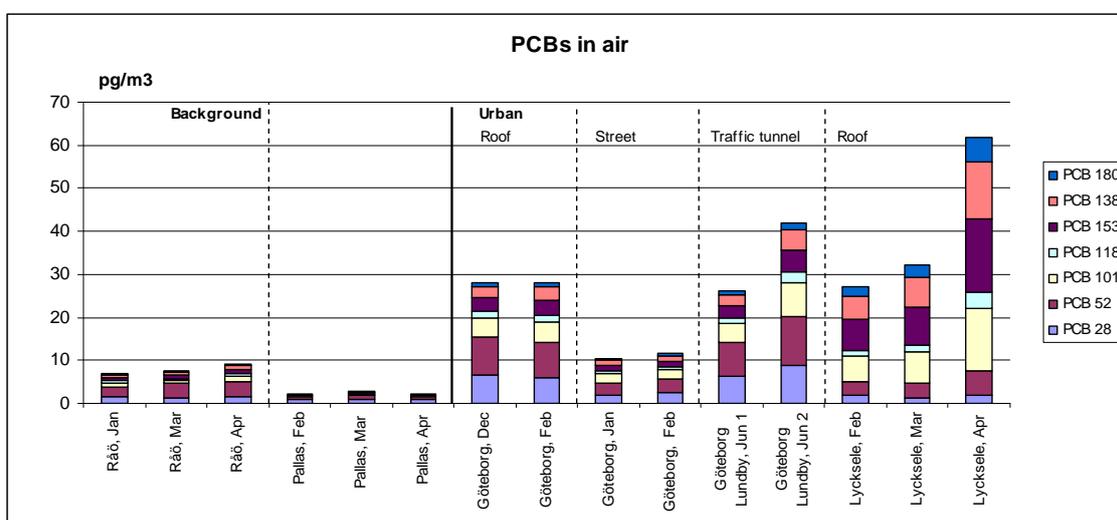


Figure 5-16 Concentrations of sum seven PCBs in air

The PCB concentrations in background air were somewhat higher at the Swedish west coast compared to the north of Finland, which is in agreement with the results from the Swedish monitoring program for air pollutants (www.ivl.se). The air concentrations of PCBs found in the three samples from Råö and Pallas respectively were in the same ranges as generally found in the monitoring program. For comparison, the PCB concentrations at Råö and Pallas from 2008 are shown in Figure 5-17 where also a typical seasonal variation is illustrated.

The PCB levels in urban air were higher compared to background indicating an urban influence. The highest concentration was measured in an air sample collected in the northern urban site Lycksele. The deposition fluxes of PCBs are given together with the corresponding air concentrations in **Table 5-7**.

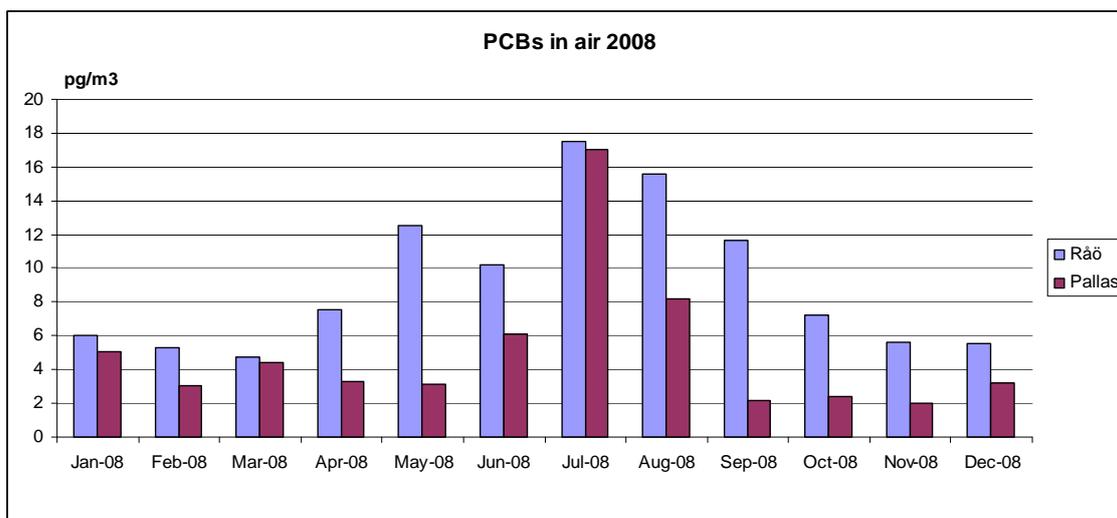


Figure 5-17 PCB (sum 7) concentrations in air at Pallas and Råö, 2008.

PCDTs and PCDTAs

The levels of PCDTs tend to increase from background locations to urban locations and the highest levels were found in a traffic tunnel (Figure 5-18). The congener patterns of the tunnel, street and roof top samples are similar with dominance of TeCDTs and decreasing homologue contribution with increasing degree of chlorination. This suggests that traffic is a considerable source of PCDTs. However, municipal solid waste (MSW) and industrial waste incineration yield similar congener profiles (S-EPA 2007) and it cannot be excluded that MSW incineration and long-range air transport contributes to the PCDT concentrations detected.

The total concentrations of PCDTs in background and urban air (<20-40 fg/m³) are of the same magnitude as the total dioxin equivalent (TEQ) concentrations for polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) in Aspvreten air sampled the winter 2006-2007 (ca. 10 fg/m³) (Sellström *et al.* 2009). Considering that 2,3,7,8-TeCDT contributed with about 10 % to the total PCDT and that 2,3,7,8-TeCDT is less potent than 2,3,7,8-TeCDD (Kopponen *et al.* 1994) the TEQ-contribution to the overall TEQ of air is most likely negligible.

The total TCDT concentrations in deposition samples ranged from 1 to 9 pg/m² day with about 5-fold higher levels in urban samples as compared to background samples. The congener profiles were very similar to the air samples.

PCDTAs were not detected in air with the exception of Sum TeCDTA in two urban samples at 0.009 and 0.013 pg/m³.

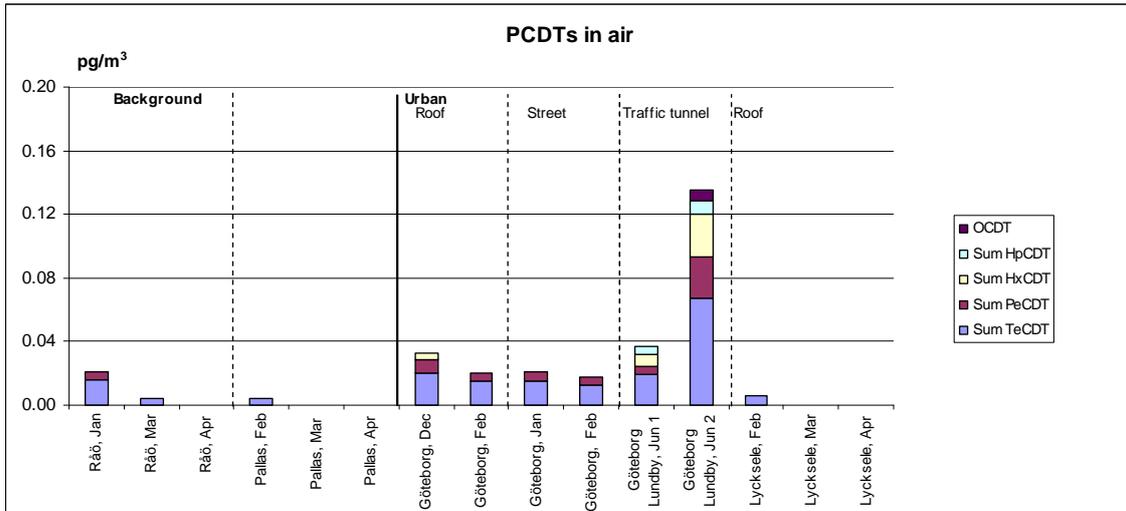


Figure 5-18 Concentration of PCDTs in air. Compound groups that are not indicated in the bars are all <math><0.004\text{ pg/m}^3</math>.

PBDFs and PBDDs

The PBDF concentrations in air were rather high (in the pg/m^3 range) and the PBDF background air concentrations exhibited a considerable temporal (see Råö samples in Figure 5-19) and spatial (Råö vs. Pallas and Lycksele) variation.

Among the urban air samples both the traffic tunnel and roof top samples contained higher concentrations of PBDFs than the street level samples and, thus, there is no clear coupling to traffic as a source of contamination. Further, the PBDF concentrations in urban and background air samples increased with the degree of bromination. These results points to diffuse PBDF emissions in the urban environment and/or long-range air transport as the dominant source(s).

None of the PBDDs were detected in background air. Sum TeBDD and Sum PeBDD were detected in street and traffic tunnel air at low concentrations; $0.012 - 0.083\text{ pg/m}^3$.

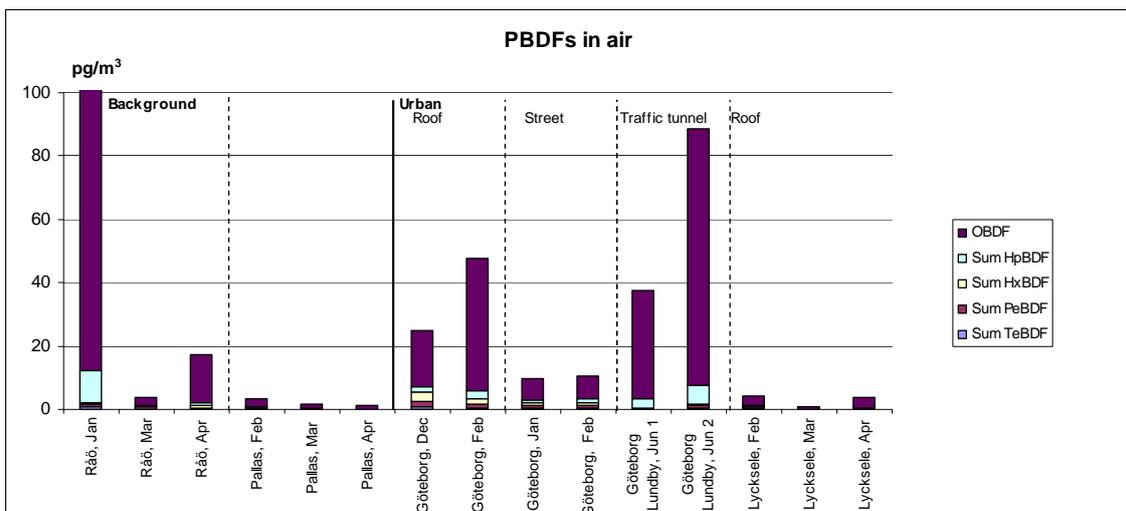


Figure 5-19 Concentration of PBDFs in air. For Råö, Jan OBDF = 530 pg/m^3 which is off scale.

5.2.2. Deposition

The deposition fluxes of Σ_{12} PAHs, sum PCB, sum PBDFs and sum PCDTs are given together with the corresponding air concentrations in Table 5-11. The results of the measurements show that atmospheric transport and deposition is a pathway to the environment for the PBDFs and PCDTs both urban and background areas. The deposition fluxes of PBDFs were at three out of four sampling occasions higher than the observed fluxes of PCBs. PCDTs which occurrence in lower concentrations in the atmosphere also showed the lowest deposition fluxes.

Table 5-11 Comparison between concentration in air and the atmospheric deposition for PAHs, PCBs PBDFs and PCDTs The precipitation rate corresponding to the sampling periods is also given (Råö precipitation data: air database, ivl.se; Göteborg data: Luftnet, miljöförvaltningen 2008, 2009)

	Precipitation rate, mm	Unit	Sum PAH	Sum PCB	Sum PBDF	Sum PCDT
Råö, Jan, Air		pg/m ³	6300	7.1	540	0.021
Råö, Jan, Deposition	30	ng/m ² month	10400	28	180	0.041
Råö, Mar, Air		pg/m ³	2700	7.4	3.0	0.004-0.020
Råö, Mar, Deposition	38	ng/m ² month	3600	36	53	0.050
Göteborg, Dec, Air		pg/m ³	8300	28	25	0.035
Göteborg, Dec, Deposition	9	ng/m ² month	4200	210	98	0.040
Göteborg, Feb, Air		pg/m ³	6500	28	48	0.024
Göteborg, Feb, Deposition	37	ng/m ² month	7900	64	1400	0.10

5.2.3. Soil, sediments and sludge

PCBs

The PCB concentrations in storm water sludge and STP sludge varied between 29 and 70 ng/g DW (Figure 5-20). The highest concentration was measured in storm water sludge from central Göteborg (Korsvägen).

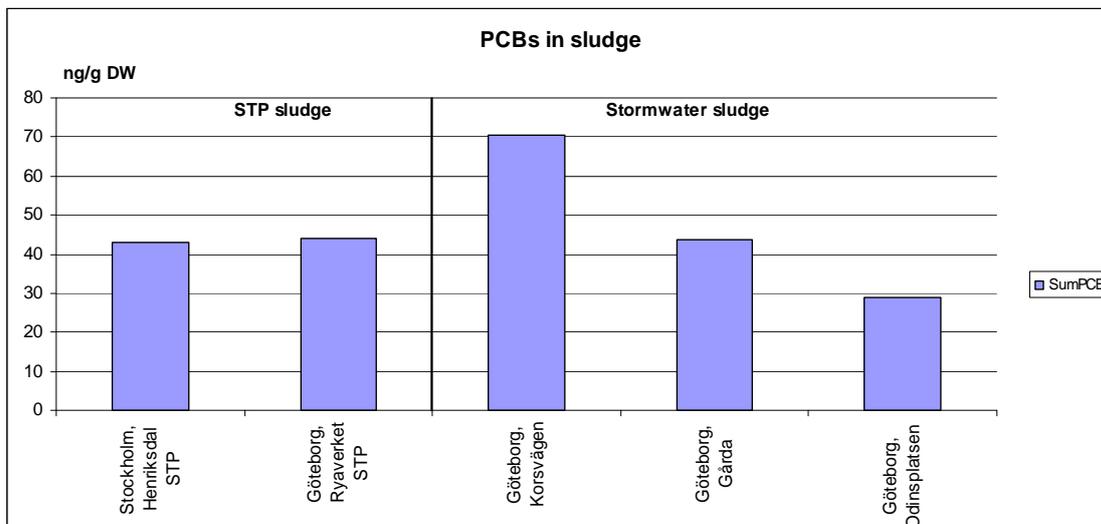


Figure 5-20 PCBs in STP and storm water sludge

The highest PCB concentration was found in the sediment collected in Göta älv close to Eriksberg, a former industrial area, where the sum of the seven PCBs was 55 ng/g DW. The other two samples from Göta älv contained somewhat higher concentrations, 6.9 and 9.1 ng/g DW, than the background sediments (3.6 and 3.9 ng/g DW). The PCB concentrations in soil varied between 4.7 and 17 ng/g DW with the highest levels at two urban sites in Göteborg. The results are presented in **Figure 5-21**.

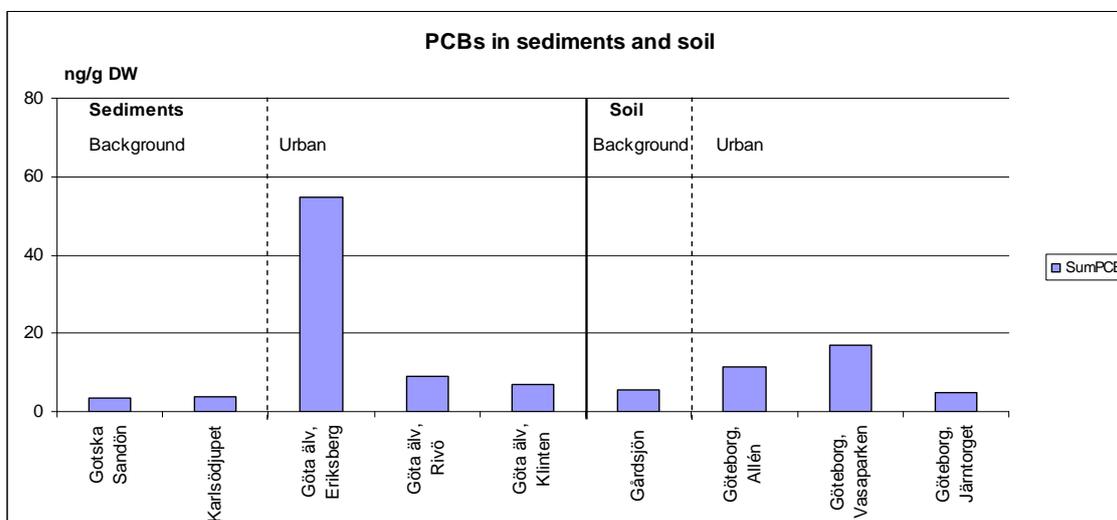


Figure 5-21 PCBs in sediments and soil from background and urban sites

PCDTs and PCDTAs

All of the solid samples contained similar concentrations of PCDTs (about 5-75 pg/g DW) which indicates wide dispersion and diffusive sources of pollution. The congener profiles also generally agree well with those of urban air (previous section) and incineration samples (S-EPA 2007).

PCDTAs were only detected in the samples that contained the highest PCDT concentrations (soil from Göteborg) and in low levels (about 10 pg/g DW).

PBDFs and PBDDs

The results are summarized in Figure 5-22 and Figure 5-23.

The highest PBDF concentrations were found in the STP sludge samples (>700 000 pg/g DW), while storm water sludge contained much less (average 40 000 pg/g DW) indicating low influence of traffic and air deposition. Also one soil sample (Järntorget, Göteborg) contained elevated levels of PBDFs (480 000 pg/g DW). However, the congener profile of all these urban samples are dominated by highly brominated hepta- and octa BDFs (Figure 5-22, as were the air and deposition samples (Figure 5-19).

From a mass balance perspective there must thus be an additional source of pollution connected to the sewage treatment plants, with the same profile as air and deposition, or PBDFs must be formed in the sewage treatment plant (STP) water or sludge treatment processes. One potential source of highly brominated DFs is decabromodiphenylether containing plastics. The level of PBDD/Fs have, for example, been measured in the TV housing of a used Swedish TV set and high concentrations of PBDF (0.59 mg/g plastic) have been found (Lundstedt 2009). Evaporation and wear-and-tear could result in release to house dust and subsequent transfer to the sewage system during cleaning.

The PBDF concentrations in sewage sludge (750 000 pg/g DW) are 1000-fold higher than the corresponding PCDD concentrations (1 160 pg/g DW). The congener profiles of the two classes of analogues are also very different with octabromodibenzofuran (98 %) as the most abundant PBDD/F and octachlorodibenzo-*p*-dioxin (70%) as the most abundant PCDD/F, which indicates different formation processes.

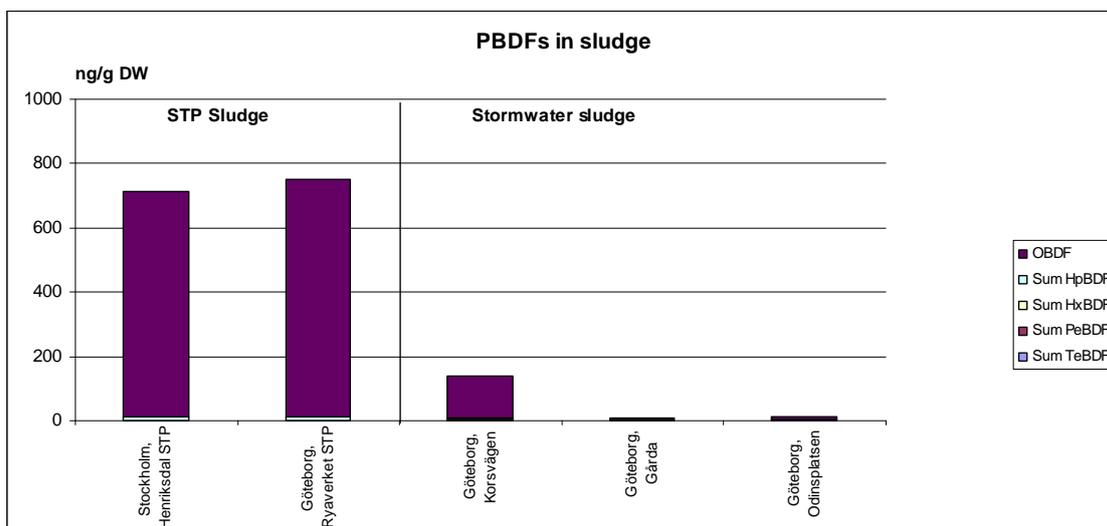


Figure 5-22 Concentration of PBDFs in sludge samples.

PBDFs are also found with a similar homologue profile, in sediment from Gotska Sandön – a marine background location (Figure 5-23), which indicates wide dispersion in the environment.

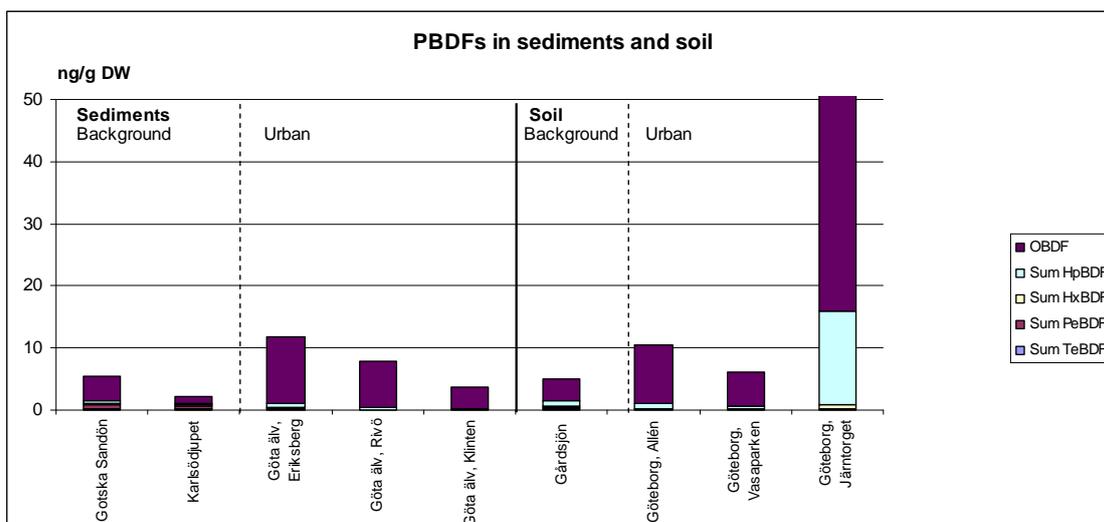


Figure 5-23 Concentration of PBDFs in sediments and soil. In the soil sample Göteborg Järntorget OBDF= 480 ng/g DW which is off scale.

5.2.4. Biota and human milk

PCDTs and PCDTAs

Among the chlorinated substances, only PCDTAs were found and only in one biota sample (mollusc).

PBDFs and PBDDs

Polybrominated dibenzofurans (PBDFs) were found in nearly all biotic samples analyzed. The brominated dioxins were only detected in one biotic sample at low levels.

Among the marine samples, molluscs collected at Eriksberg in Göta Älv contained the highest levels of PCDTs (1.9 pg/g wet weight; WW), PBDFs (190 pg/g WW) and PCBs (220 ng/g DW). This may indicate an urban influence. Fish from Kvädöfjärden, a Baltic Sea background location, contained HpBDFs (0.69 pg/g WW), OBDF (32 pg/g WW) and TeBDDs (0.65 pg/g WW). The homologue profile of the PBDFs is consistent with the urban samples, which suggests an anthropogenic origin. A natural origin has been suggested for the TeBDDs (Haglund *et al.* 2007) and the two structurally related compounds classes may, thus, stem from different sources.

Relatively high levels of the higher brominated PBDFs were measured in human milk (4-300 pg/g WW). This is similar to the PBDE concentrations detected in Uppsala mothers milk sampled 2000-2001 (ca. 100 pg/g WW) (Lind *et al.* 2003). As the main source of PBDEs has been suggested to be ingestion of dust that contain wear particles from consumer articles (Webster *et al.* 2009), and PBDFs have been found in flame retarded materials, the pollutants may partially stem from the same source. However, exposure via food may also occur, supported by the fact that PBDFs were also detected in most of the fish samples analysed. The total dioxin equivalency (TEQ) concentrations of PBDFs (assuming equal toxic equivalent factors; TEFs) were in the range of 0.017-0.17 pg/g WW (median 0.025 pg/g WW), which is slightly lower than the PCDD/F-TEQ concentrations, which according to Lignell *et al.* 2009 are in the range 0.072-0.27 pg/g WW (median 0.14 pg/g WW) (assuming 3 % lipid content).

6. Summary of the results

The overall results of the occurrence of the unintentionally produced substances included in this screening are illustrated in Figure 6-1. As evident from the figure, PAHs and their related substances typically occurred in all sample matrices with the exception of biota, where only PAHs and in urban biota also oxy-PAHs occurred. Also PCBs and PBDFs were widely distributed in the environment. PCDTs were commonly occurring, apart from in biota, human milk and background air, whereas PCDTA was typically found only in urban soil. Brominated dibenzodioxins appear to be present in sediments, but otherwise only the tetrabrominated congeners were common, especially in sludge and urban air.

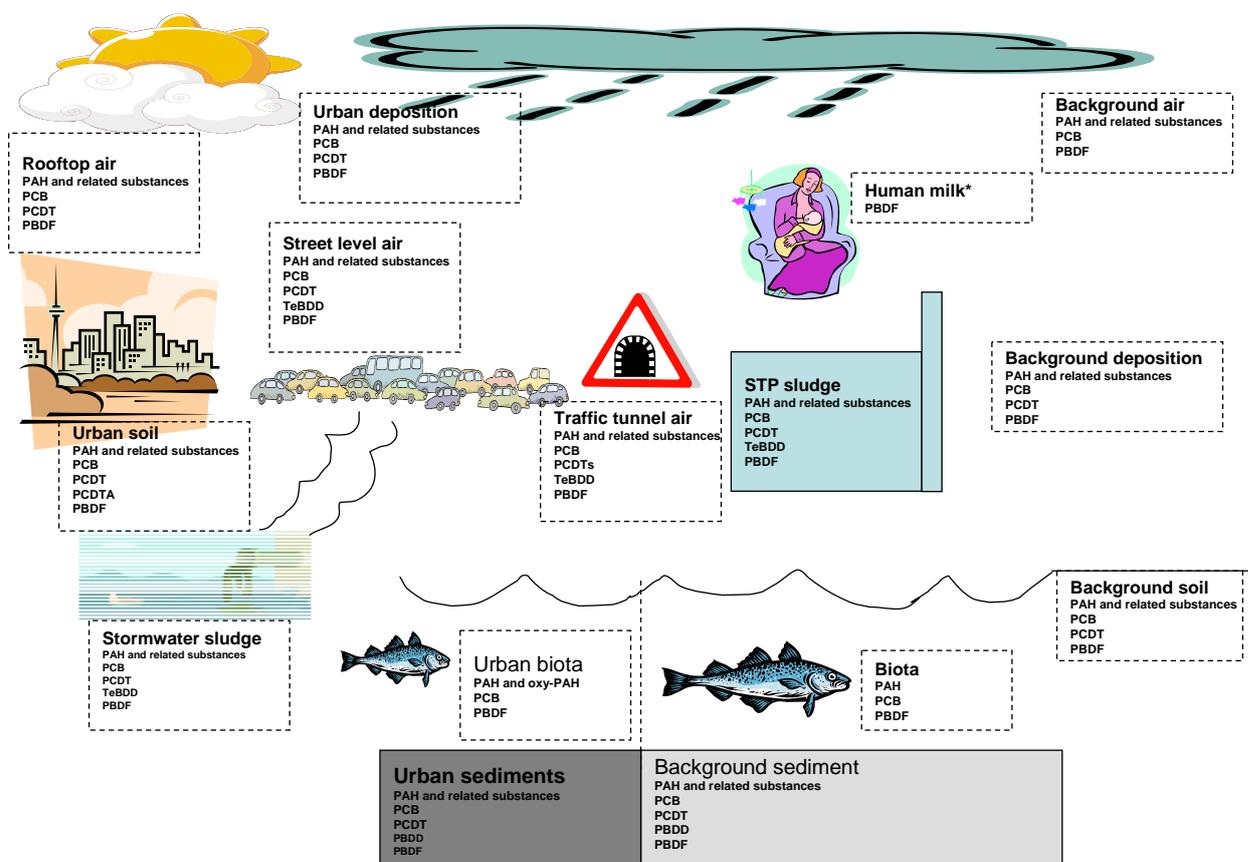


Figure 6-1 Typical occurrence of unintentionally produced substances in the different types of samples and locations measured. "PAH and related substances" refer to PAHs, heterocycles, oxy-PAH and nitro-PAH including 3-nitrobensanthrone. TeBDD refers to tetrabrominated dibenzodioxins.
*Only PBDFs, PBDDs and PCDT/PCDTA were analyzed in human milk.

Principal components analysis

To give an overview of the air data a principal components analysis was attempted. Sums of concentrations for the different chemical groups (PAH, O-heterocycles etc.) were used as variables. The observations were the individual samples. The score plot for the first two principal components shows the background samples grouped together (with one exception, Råö, January). The urban samples from Lycksele are closest to the background sample group with the Göteborg

urban samples further away. The samples from the traffic tunnel deviate from the rest. The most important reason is high values of S-heterocycles, PCDT and PBDD. When results for individual compounds instead of grouped results were used as variables the score plot stayed very much the same. The third principal component separates the samples from Lycksele. This is explained by high PCB, and to some extent high PBDD values.

Then the variables were limited to the individual compounds in the groups PAH, oxy-PAH and nitro-PAH. The score plot still showed a pattern close to the one described above. The samples from the traffic tunnel are even more separated from the rest mainly because of the PAH and oxy-PAH compounds.

7. Conclusions

Substances related to PAHs

- Oxidized and nitrated forms of PAHs as well as heterocyclic analogues of PAHs were frequently found in background and urban areas and in most of the environmental matrices included in the study.

Elevated concentrations occurred in urban areas compared to background. Oxy-PAHs occurred in the highest concentration followed by the heterocycles and nitro-PAHs. The concentration of oxy-PAHs were in the same level as PAHs and in some samples, *e.g.* sediments, in even higher concentrations than PAHs.

The relative distribution among the different substances and groups of substances differed between sampling matrices but also between different sampling sites, *e.g.* between background and urban sites. Compared to other environmental matrices, few of the PAH-related substances were found in biotic samples.

- Oxy- and nitro PAHs as well as heterocycles were generally found in air.

As for PAHs, atmospheric transport and deposition was shown to be an important pathway for these substances both close to and far from source areas. The importance of atmospheric long-range transport of these substances to remote areas was confirmed

Air emission from traffic but also wood burning were identified as important sources. Also atmospheric formation of especially nitro-PAHs was indicated.

- Most of the heterocyclic substances were found in soil and sediment with increased concentrations in urban areas. Heterocycles occurred more frequently in storm water sludge compared to STP sludge, a possible indication of influence from traffic.
- The concentrations of oxy-PAHs were in similar orders of magnitude in background sediments as in urban sediment and soil. The relative distribution among the substances varied, with a clear dominance by 2-methyl-9,10-anthraquinone in background sediments, whereas the distribution of oxy-PAHs in other locations were more even.

- Like oxygenated PAHs, nitro-PAHs were found in background and urban sediment and soil in similar concentrations. The nitrated forms occurred in higher concentrations in storm water sludge compared to STP sludge indicating influence from traffic.

Polychlorinated and polybrominated substances

PCDTs and PCDTAs

- PCDTs were found in most abiotic but only in one biotic sample. PCDTA were generally below the limit-of-detection.
- Traffic and long-range air transport are likely sources.
- Considering the relative concentrations and biological potencies of PCDTAs and PCDD/Fs the former are likely to be of minor concern.

PBDFs and PBDDs

- PBDDs were generally below the limit-of-detection but were found in deposition, urban sediment, background sediment, and fish from Kvädöfjärden.
- The PBDF concentrations in air varied widely in time and space, which suggest that long-range air transport from specific source regions may occur.
- OBDF occurred in similar concentrations as PCBs in air, deposition, sediment and soil.
- Elevated levels were found in sewage sludge that cannot be explained by air deposition. The PBDF concentrations were about 1000-fold higher than the PCDD/F concentrations.
- TBDF, HpBDF and OBDF occurs in human milk and contributes significantly (about 20 %) to the total TEQ. The peak PBDF-TEQs are only 2-fold lower than the peak PCDD/F-TEQs reported by the National Food Administration for 2006.
- Further studies are needed to find the sources of PBDFs.
- A retrospective study of PBDF concentrations in human milk is also recommended.

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Appendix 1 Environmental samples

Sample ID	Umeå ID	Type	Station	Matrix	Date, Start	Date, Stop	RT90, X	RT90, Y
AG2009-2758:1	3368:1	Background	Råö	Air	2008-12-29	2009-02-01	6369857	1266139
AG2009-2758:14	3368:2	Background	Råö	Air	2009-03-02	2009-03-30	6369857	1266139
AG2009-2758:28	3368:3	Background	Råö	Air	2009-03-30	2009-04-27	6369857	1266139
AG2009-2758:29	3368:4	Background	Pallas	Air	2009-02-03	2009-03-04	(67° 58'N)	(24° 07'E)
AG2009-2758:30	3368:5	Background	Pallas	Air	2009-03-04	2009-03-31	(67° 58'N)	(24° 07'E)
AG2009-2758:31	3368:6	Background	Pallas	Air	2009-03-31	2009-04-27	(67° 58'N)	(24° 07'E)
AG2009-2758:3	3368:7	Urban, roof	Göteborg, Folkets Hus	Air	2008-12-02	2008-12-19	6403883	1270388
AG2009-2758:32	3368:8	Urban, roof	Göteborg, Folkets Hus	Air	2009-02-24	2009-03-16	6403883	1270388
AG2009-2758:15	3368:9	Urban, street	Göteborg, Gårda	Air	2009-01-12	2009-02-02	6403833	1272877
AG2009-2758:33	3368:10	Urban, street	Göteborg, Gårda	Air	2009-02-02	2009-02-24	6403833	1272877
AG2009-2758:34	3368:11	Urban, road traffic tunnel	Göteborg, Lundbytunneln	Air	2009-06-17	2009-06-22	6405064	1268616
AG2009-2758:35	3368:12	Urban, road traffic tunnel	Göteborg, Lundbytunneln	Air	2009-06-22	2009-06-26	6405064	1268616
AG2009-2758:36	3368:13	Urban, roof	Lycksele	Air	2009-02-20	2009-03-16	7168663.7	1637490.9
AG2009-2758:37	3368:14	Urban, roof	Lycksele	Air	2009-03-16	2009-04-06	7168663.7	1637490.9
AG2009-2758:38	3368:15	Urban, roof	Lycksele	Air	2009-04-06	2009-05-04	7168663.7	1637490.9
AG2009-2758:2	3368:16	Background	Råö	Deposition	2008-12-29	2008-02-02	6369857	1266139
AG2009-2758:39	3368:17	Background	Råö	Deposition	2009-03-02	2009-03-30	6369857	1266139
AG2009-2758:4	3368:18	Urban, roof	Göteborg, Folkets Hus	Deposition	2008-12-02	2008-12-16	6403883	1270388
AG2009-2758:5	3368:19	Urban, roof	Göteborg, Folkets Hus	Deposition	2008-12-16	2009-01-12	6403883	1270388
AG2009-2758:40	3368:20	Urban, roof	Göteborg, Folkets Hus	Deposition	2009-02-24	2009-03-16	6403883	1270388
AG2009-2758:26	3332:7	Background	SGU SE-5, Gotska Sandön	Sediment			6548221	1758796
AG2009-2758:27	3332:8	Background	SGU SE-10, Karlsödjupet	Sediment			6335668	1612810
AG2009-2758:6	3332:9	Urban, diffuse	Göta älv, Eriksberg	Sediment	2008-12-10	2008-12-10	6403799	1268142
AG2009-2758:7	3332:10	Urban, diffuse	Göta älv, Klinten	Sediment	2008-11-21	2008-11-21	6394257	1258422
AG2009-2758:8	3332:11	Urban, diffuse	Göta älv, Rivö	Sediment	2008-12-10	2008-12-10	6399788	1260573
AG2009-2758:22	3332:1	Urban, diffuse	Stockholm, Henriksdal	STP sludge				
AG2009-2758:12	3332:2	Urban, diffuse	Göteborg, Ryaverket	STP sludge	2009-01-29		6403708	1266633
AG2009-2758:16	3332:12	Urban, diffuse	Göteborg, Korsvägen	Storm water sludge	2009-02-23	2009-02-23	6403326	1272445
AG2009-2758:17	3332:13	Urban, diffuse	Göteborg, Gårda (Fabriksgatan)	Storm water sludge	2009-02-23	2009-02-23	6403880	1272799
AG2009-2758:18	3332:14	Urban, diffuse	Göteborg, Odinsplatsen	Storm water sludge	2009-02-23	2009-02-23	6404721	1272374
AG2009-2758:19	3332:3	Background	Gårdsjön	Soil	2008-11-20	2008-11-20	6443900	1276500
AG2009-2758:13	3332:4	Urban, diffuse	Göteborg, Allén	Soil	2009-01-30	2009-01-30	6404254	1271884
AG2009-2758:11	3332:5	Urban, diffuse	Göteborg, Vasaparken	Soil	2009-01-27	2009-01-27	6403426	1271458
AG2009-2758:21	3332:6	Urban, diffuse	Göteborg, Järntorget	Soil	2009-03-17	2009-03-17	6403883	1270388
AG2009-2758:25	3337:1	Background	Kväddöfjärden	Fish, perch, (abborre)			(58° 02'N)	(16° 46'E)
AG2009-2758:20a		Background	Gårdsjön	Fish, charr, (fjällröding)	2008-11-20		6443900	1276500
AG2009-2758:20b	3337:2	Background	Gårdsjön	Fish, trout, (öring)	2008-11-20		6443900	1276500
AG2009-2758:23	3337:3	Urban, diffuse	Årstaviken	Fish, perch, (abborre)	2008-11-08		6578147	1628330
AG2009-2758:24	3337:4	Urban, diffuse	Riddarfjärden	Fish, perch, (abborre)	2008-11-08		6580118	1627286
AG2009-2758:9	3337:5	Urban, diffuse	Göta älv, Eriksberg	Mollusc, netted dog-whelk, (nätsnäcka)	2008-12-10	2008-12-10	6403799	1268142
AG2009-2758:10	3337:6	Urban, diffuse	Göta älv, Rivö	Mollusc, netted dog-whelk, (nätsnäcka/eremitkräfta)	2008-12-10	2008-12-10	6399788	1260573

1. Individual results, HCB, PCBs

Prov ID	Station	Matrix	Unit	HCB	PCB 28	PCB 52	PCB 101	PCB 118	PCB 153	PCB 138	PCB 180	SumPCB
AG2009-2758:1	Råö, Jan	Air	pg/m ³	30	1.4	2.4	1.0	0.36	0.83	0.68	0.35	7.1
AG2009-2758:14	Råö, Mar	Air	pg/m ³	20	1.3	3.3	0.89	0.30	0.71	0.61	0.29	7.4
AG2009-2758:28	Råö, Apr	Air	pg/m ³	11	1.5	3.6	1.2	0.51	1.0	0.86	0.35	9.0
AG2009-2758:29	Pallas, Feb	Air	pg/m ³	19	0.94	0.75	0.28	0.10	0.14	0.11	0.033	2.3
AG2009-2758:30	Pallas, Mar	Air	pg/m ³	24	1.0	1.0	0.32	0.15	0.14	0.11	0.028	2.7
AG2009-2758:31	Pallas, Apr	Air	pg/m ³	23	0.85	0.79	0.30	0.13	0.14	0.11	0.031	2.4
AG2009-2758:3	Göteborg, Folkets Hus, Dec	Air	pg/m ³	14	6.5	8.8	4.6	1.6	3.0	2.6	1.0	28
AG2009-2758:32	Göteborg, Folkets Hus, Feb	Air	pg/m ³	9.8	5.9	8.1	4.9	1.5	3.6	2.9	1.1	28
AG2009-2758:15	Göteborg, Gårda, Jan	Air	pg/m ³	12	2.0	2.7	2.1	0.63	1.4	1.2	0.42	10
AG2009-2758:33	Göteborg, Gårda, Feb	Air	pg/m ³	13	2.6	3.1	2.1	0.63	1.4	1.2	0.51	12
AG2009-2758:34	Göteborg, Lundbytunneln, I	Air	pg/m ³	14	6.2	7.8	4.5	1.3	2.9	2.4	0.89	26
AG2009-2758:35	Göteborg, Lundbytunneln, II	Air	pg/m ³	27	8.8	12	7.6	2.5	5.3	4.5	1.7	42
AG2009-2758:36	Lycksele, Feb	Air	pg/m ³	21	1.9	3.1	6.1	1.4	7.1	5.4	2.2	27
AG2009-2758:37	Lycksele, Mar	Air	pg/m ³	20	1.3	3.3	7.2	1.7	8.9	6.8	2.8	32
AG2009-2758:38	Lycksele, Apr	Air	pg/m ³	16	1.9	5.6	15	3.6	17	13	5.9	62
AG2009-2758:2	Råö, Jan	Deposition	ng/m ² day	0.10	<0.01	0.24	0.09	0.06	0.15	0.17	0.12	0.83
AG2009-2758:39	Råö, Mar	Deposition	ng/m ² day	0.10	<0.01	0.30	0.12	0.12	0.25	0.29	0.21	1.3
AG2009-2758:4	Göteborg, Folkets Hus, Dec	Deposition	ng/m ² day	0.18	0.51	1.2	1.7	0.80	3.60	3.9	3.4	15
AG2009-2758:5	Göteborg, Folkets Hus, Jan	Deposition	ng/m ² day	0.087	0.024	0.55	4.3	2.1	13	15	12	47
AG2009-2758:40	Göteborg, Folkets Hus, Feb	Deposition	ng/m ² day	0.40	0.21	0.56	0.62	0.39	1.1	1.2	0.90	4.9
AG2009-2758:26	SGU SE-5, Gotska Sandön	Sediment	ng/g DW	0.20	0.43	0.53	0.64	0.45	0.54	0.66	0.33	3.6
AG2009-2758:27	SGU SE-10, Karlsödjupet	Sediment	ng/g DW	0.18	0.36	0.25	0.58	0.49	0.89	0.94	0.45	3.9
AG2009-2758:6	Göta älv, Eriksberg	Sediment	ng/g DW	1.3	0.58	3.9	10	8.1	12	13	6.5	55
AG2009-2758:7	Göta älv, Klinten	Sediment	ng/g DW	0.11	0.21	0.66	0.69	1.6	2.2	2.7	0.99	9.1
AG2009-2758:8	Göta älv, Rivö	Sediment	ng/g DW	0.11	0.15	0.26	0.90	0.82	1.8	2.0	0.95	6.9
AG2009-2758:22	Stockholm, Henriksdal	STP sludge	ng/g DW	4.9	4.8	5.4	4.5	4.1	10	9.6	4.6	43
AG2009-2758:12	Göteborg, Ryaverket	STP sludge	ng/g DW	16	3.7	5.0	7.2	3.8	10	9.7	4.3	44
AG2009-2758:16	Göteborg, Korsvägen	Storm wtr sludge	ng/g DW	13	1.6	2.3	11	13	15	18	9.3	70
AG2009-2758:17	Göteborg, Gårda	Storm wtr sludge	ng/g DW	8.1	1.4	2.0	6.2	9.1	4.6	13	7.0	44
AG2009-2758:18	Göteborg, Odinsplatsen	Storm wtr sludge	ng/g DW	13	1.1	1.9	4.7	3.0	6.8	7.5	4.1	29
AG2009-2758:19	Gårdsjön	Soil	ng/g DW	1.0	<0.01	<0.01	0.62	0.61	1.5	1.6	1.0	5.4
AG2009-2758:13	Göteborg, Allén	Soil	ng/g DW	0.77	0.047	0.13	1.1	0.60	3.3	3.7	2.4	11
AG2009-2758:11	Göteborg, Vasaparken	Soil	ng/g DW	3.8	0.043	0.33	2.1	1.3	4.9	5.2	3.1	17
AG2009-2758:21	Göteborg, Järmtorget	Soil	ng/g DW	1.4	0.20	0.69	0.72	0.36	1.1	0.99	0.70	4.7
AG2009-2758:25	Kvädöfjärden	Fish	ng/g DW	0.19	1.4	0.17	0.34	0.54	1.4	1.0	0.51	5.5
AG2009-2758:20	Gårdsjön	Fish	ng/g DW	0.21	0.062	0.12	0.58	0.74	3.1	2.8	1.6	8.9
AG2009-2758:23	Årstaviken	Fish	ng/g DW	1.1	2.4	7.4	21	20	19	22	4.7	96
AG2009-2758:24	Riddarfjärden	Fish	ng/g DW	1.6	3.3	8.6	20	16	30	29	10	120
AG2009-2758:9	Göta älv, Eriksberg	Mollusc	ng/g DW	0.75	1.9	14	42	31	63	52	12	220
AG2009-2758:10	Göta älv, Rivö	Mollusc	ng/g DW	0.16	0.17	0.59	2.4	2.5	8.0	6.1	1.4	21

2. Individual results, PAHs

Prov ID	Station	Matrix	Unit	Naphth- alene	Ace- naphth- ene	Fluo- rene	Phenan- trene	Anthra- cene	Fluor- anth- ene	Pyrene	Benso(a)- anthra- cene	Chry- sene	Benso(b)- fluor- anthene	Benso(k)- fluor- anthene	Benso(a)- pyrene	Dibenso- (a,h)- anthracene	Benso- (g,h,i)- perylene	Indeno- (1,2,3-cd)- pyrene	Sum PAH
AG2009-2758:1	Råö, Jan	Air	ng/m3				2.6	0.045	1.2	0.73	0.15	0.37	0.33	0.15	0.18	0.047	0.30	0.24	6.3
AG2009-2758:14	Råö, Mar	Air	ng/m3				1.3	0.014	0.49	0.30	0.041	0.12	0.11	0.044	0.057	0.012	0.077	0.078	2.7
AG2009-2758:28	Råö, Apr	Air	ng/m3				0.95	0.010	0.31	0.20	0.022	0.079	0.065	0.028	0.032	0.006	0.048	0.050	1.8
AG2009-2758:29	Pallas, Feb	Air	ng/m3				0.54	0.007	0.25	0.15	0.028	0.084	0.067	0.028	0.047	0.007	0.042	0.044	1.3
AG2009-2758:30	Pallas, Mar	Air	ng/m3				0.25	0.002	0.10	0.057	0.007	0.057	0.024	0.009	0.014	0.002	0.013	0.017	0.55
AG2009-2758:31	Pallas, Apr	Air	ng/m3				0.14	0.001	0.045	0.024	0.006	0.045	0.007	0.003	0.007	0.001	0.003	0.005	0.29
AG2009-2758:3	Göteborg, Folkets Hus, Dec	Air	ng/m3				4.1	0.17	1.5	0.97	0.14	0.32	0.30	0.13	0.19	0.042	0.27	0.19	8.3
AG2009-2758:32	Göteborg, Folkets Hus, Feb	Air	ng/m3				3.8	0.085	1.1	0.76	0.065	0.19	0.16	0.065	0.076	0.016	0.12	0.12	6.5
AG2009-2758:15	Göteborg, Gårda, Jan	Air	ng/m3				4.0	0.19	1.3	0.95	0.12	0.27	0.24	0.10	0.14	0.026	0.18	0.16	7.7
AG2009-2758:33	Göteborg, Gårda, Feb	Air	ng/m3				5.0	0.31	1.6	1.3	0.16	0.32	0.28	0.12	0.16	0.028	0.24	0.20	9.7
AG2009-2758:34	Göteborg, Lundbytunneln, I	Air	ng/m3				9.2	0.77	1.9	2.8	0.28	0.22	0.094	0.029	0.066	0.014	0.47	0.059	16
AG2009-2758:35	Göteborg, Lundbytunneln, II	Air	ng/m3				12	0.94	3.4	4.5	0.52	0.39	0.18	0.052	0.11	0.061	0.56	0.055	22
AG2009-2758:36	Lycksele, Feb	Air	ng/m3				3.0	0.21	1.3	0.99	0.087	0.24	0.17	0.081	0.11	0.022	0.17	0.12	6.5
AG2009-2758:37	Lycksele, Mar	Air	ng/m3				1.9	0.070	0.60	0.50	0.045	0.13	0.087	0.040	0.044	0.013	0.086	0.060	3.5
AG2009-2758:38	Lycksele, Apr	Air	ng/m3				2.8	0.084	0.73	0.51	0.027	0.14	0.10	0.040	0.047	0.013	0.10	0.062	4.6
AG2009-2758:2	Råö, Jan	Deposition	µg/m2 day				0.041	0.002	0.058	0.037	0.012	0.037	0.037	0.014	0.016	0.004	0.026	0.021	0.31
AG2009-2758:39	Råö, Mar	Deposition	µg/m2 day				0.028	0.001	0.034	0.018	0.003	0.012	0.009	0.003	0.005	0.001	0.007	0.006	0.13
AG2009-2758:4	Göteborg, Folkets Hus, Dec	Deposition	µg/m2 day				0.041	0.002	0.063	0.045	0.014	0.030	0.026	0.011	0.016	0.004	0.033	0.018	0.30
AG2009-2758:5	Göteborg, Folkets Hus, Jan	Deposition	µg/m2 day				0.026	0.001	0.036	0.030	0.006	0.020	0.013	0.005	0.006	0.002	0.017	0.007	0.17
AG2009-2758:40	Göteborg, Folkets Hus, Feb	Deposition	µg/m2 day				0.10	0.004	0.13	0.094	0.022	0.057	0.049	0.019	0.026	0.009	0.063	0.027	0.60
AG2009-2758:26	SGU SE-5, Gotska Sandön	Sediment	µg/g DW	0.003	0.002	0.003	0.020	0.003	0.061	0.046	0.023	0.042	0.094	0.042	0.062	0.021	0.14	0.13	0.70
AG2009-2758:27	SGU SE-10, Karlsödjupet	Sediment	µg/g DW	0.005	0.002	0.005	0.029	0.006	0.11	0.079	0.038	0.041	0.15	0.072	0.088	0.031	0.22	0.22	1.1
AG2009-2758:6	Göta älv, Eriksberg	Sediment	µg/g DW	0.014	0.014	0.020	0.086	0.035	0.23	0.19	0.15	0.13	0.18	0.086	0.17	0.028	0.19	0.097	1.6
AG2009-2758:7	Göta älv, Klinten	Sediment	µg/g DW	0.014	0.007	0.014	0.11	0.028	0.36	0.36	0.20	0.16	0.37	0.18	0.32	0.056	0.43	0.33	2.9
AG2009-2758:8	Göta älv, Rivö	Sediment	µg/g DW	0.007	0.005	0.006	0.035	0.011	0.089	0.072	0.047	0.041	0.077	0.037	0.070	0.012	0.084	0.054	0.65
AG2009-2758:22	Stockholm, Henriksdal	STP sludge	µg/g DW	0.007	0.012	0.041	0.20	0.029	0.29	0.35	0.12	0.15	0.13	0.064	0.11	0.035	0.21	0.10	1.8
AG2009-2758:12	Göteborg, Ryaverket	STP sludge	µg/g DW	0.052	0.032	0.063	0.28	0.050	0.39	0.41	0.18	0.20	0.16	0.079	0.14	0.040	0.23	0.13	2.4
AG2009-2758:16	Göteborg, Korsvägen	Storm wtr sludge	µg/g DW	0.078	0.041	0.13	0.77	0.090	1.3	1.3	0.38	0.61	0.45	0.20	0.31	0.12	0.80	0.46	7.0
AG2009-2758:17	Göteborg, Gårda	Storm wtr sludge	µg/g DW	0.060	0.029	0.064	0.54	0.071	1.0	1.2	0.37	0.55	0.43	0.19	0.34	0.14	1.1	0.55	6.6
AG2009-2758:18	Göteborg, Odinsplatsen	Storm wtr sludge	µg/g DW	0.028	0.032	0.065	0.45	0.044	0.81	0.79	0.21	0.43	0.32	0.14	0.19	0.078	0.50	0.29	4.4
AG2009-2758:19	Gårdsjön	Soil	µg/g DW	0.004	0.003	0.002	0.017	0.001	0.036	0.023	0.012	0.030	0.045	0.014	0.016	0.005	0.035	0.026	0.27
AG2009-2758:13	Göteborg, Allén	Soil	µg/g DW	0.011	0.004	0.005	0.087	0.014	0.28	0.24	0.14	0.16	0.20	0.095	0.20	0.032	0.25	0.18	1.9
AG2009-2758:11	Göteborg, Vasaparken	Soil	µg/g DW	0.017	0.005	0.008	0.15	0.020	0.50	0.43	0.24	0.31	0.45	0.19	0.35	0.055	0.42	0.34	3.5
AG2009-2758:21	Göteborg, Järntorget	Soil	µg/g DW	0.002	0.001	0.002	0.012	0.002	0.018	0.019	0.012	0.014	0.020	0.007	0.012	0.004	0.032	0.011	0.17
AG2009-2758:25	Kvädöfjärden	Fish	ng/g DW	8.6	3.2	6.9	1.9	0.18	0.66	0.76	0.10	0.034	0.026	0.014	0.026	<0.011	0.31	<0.059	23
AG2009-2758:20	Gårdsjön	Fish	ng/g DW	3.2	0.16	0.35	0.80	0.020	0.37	0.17	0.045	0.028	0.030	0.018	0.011	<0.010	0.22	<0.054	5.4
AG2009-2758:23	Årstaviken	Fish	ng/g DW	2.8	0.26	0.61	1.0	0.041	0.43	0.33	0.091	0.040	0.027	0.014	0.018	<0.012	0.37	<0.062	6.1
AG2009-2758:24	Riddarfjärden	Fish	ng/g DW	4.6	0.36	0.72	3.1	0.13	0.89	0.62	0.16	0.066	0.033	0.021	0.032	<0.018	0.64	<0.096	11
AG2009-2758:9	Göta älv, Eriksberg	Mollusc	ng/g DW	5.4	1.8	2.6	18	2.5	52	16	5.9	7.0	1.9	3.4	2.2	0.77	3.9	1.3	130
AG2009-2758:10	Göta älv, Rivö	Mollusc	ng/g DW	4.9	0.90	1.2	4.2	0.33	3.7	1.1	0.45	0.56	0.34	0.40	0.29	0.080	0.76	0.31	19

3. Individual results, Heterocycles

Prov ID	Station	Matrix	Unit	Indole	Carbazole	5H- Benzo(a)- carbazole	7H- Dibenzo- (c,g)- carbazole	Quino- line	Iso- quino- line	Acridine	Benz(a)- acridine	Dibenz (a,h)- acridine	1- Benzo- thio- phene	Dibenzo- thio- phene	Benzo(b)- naphto(2.1-d) thiophene	2.3- Benzo- furan	Dibenz o-furan	Benzo- (b)naphto- furan
AG2009-2758:1	Råö, Jan	Air	ng/m ³	0.0003	0.037	0.029	0.0005	0.004	<0.001	0.0078	0.024	0.016	0.007	0.096	0.013	0.015	1.9	0.39
AG2009-2758:14	Råö, Mar	Air	ng/m ³	0.0004	0.025	0.010	<0.0004	0.004	<0.002	0.0039	0.016	0.0058	0.002	0.063	0.0052	0.0033	1.1	0.16
AG2009-2758:28	Råö, Apr	Air	ng/m ³	0.0004	0.018	0.005	<0.0003	0.002	<0.001	0.0014	0.0071	0.0033	0.001	0.056	0.0033	0.0016	0.44	0.12
AG2009-2758:29	Pallas, Feb	Air	ng/m ³	<0.0003	0.014	0.013	<0.0003	0.005	<0.001	0.0067	0.0044	0.0044	0.016	0.031	0.0041	0.016	1.3	0.060
AG2009-2758:30	Pallas, Mar	Air	ng/m ³	<0.0003	0.006	0.004	<0.0003	0.002	<0.001	0.0013	0.00047	0.0011	0.001	0.011	<0.003	0.0030	0.73	0.012
AG2009-2758:31	Pallas, Apr	Air	ng/m ³	<0.0003	0.002	0.001	<0.0003	0.001	<0.001	<0.0003	<0.0003	<0.0003	0.000	0.0055	<0.003	0.0034	0.23	0.004
AG2009-2758:3	Göteborg, Folkets Hus, Dec	Air	ng/m ³	0.005	0.070	0.052	<0.001	<0.001	<0.005	0.012	0.034	0.013	0.007	0.24	0.029	0.0071	1.3	0.62
AG2009-2758:32	Göteborg, Folkets Hus, Feb	Air	ng/m ³	0.001	0.054	0.012	<0.001	0.007	<0.005	0.0093	0.022	0.0057	0.002	0.25	0.018	0.0034	0.83	0.48
AG2009-2758:15	Göteborg, Gårda, Jan	Air	ng/m ³	0.003	0.089	0.043	<0.001	0.009	<0.005	0.024	0.045	0.021	0.005	0.24	0.039	0.0089	1.6	0.76
AG2009-2758:33	Göteborg, Gårda, Feb	Air	ng/m ³	0.003	0.080	0.035	<0.001	0.007	<0.004	0.012	0.038	0.016	0.005	0.24	0.041	0.010	1.8	0.84
AG2009-2758:34	Göteborg, Lundbytunneln, I	Air	ng/m ³	0.064	0.211	0.069	<0.004	0.008	<0.02	0.044	0.0086	0.0077	0.007	0.96	0.21	0.015	0.58	0.30
AG2009-2758:35	Göteborg, Lundbytunneln, II	Air	ng/m ³	0.017	0.032	0.014	<0.005	<0.005	<0.03	0.0086	<0.005	<0.005	0.009	1.4	0.44	0.025	0.77	0.82
AG2009-2758:36	Lycksele, Feb	Air	ng/m ³	<0.002	0.021	<0.002	<0.002	0.006	<0.01	<0.002	0.002	<0.002	0.003	0.087	0.006	0.0080	2.2	0.61
AG2009-2758:37	Lycksele, Mar	Air	ng/m ³	<0.002	0.019	0.002	<0.002	0.009	<0.01	0.0023	0.006	<0.002	0.002	0.052	0.022	0.0056	1.0	0.34
AG2009-2758:38	Lycksele, Apr	Air	ng/m ³	<0.002	0.018	0.002	<0.002	0.005	<0.01	<0.002	0.022	0.0035	0.002	0.19	0.037	0.0046	1.4	0.32
AG2009-2758:2	Råö, Jan	Deposition	ng/m2 day	<0.2	4.5	2.20	<0.2	<0.2	<1	0.60	2.5	1.5	0.20	0.78	0.92	0.73	7.0	17
AG2009-2758:39	Råö, Mar	Deposition	ng/m2 day	<0.2	3.3	0.92	<0.2	<0.2	<1	0.39	0.95	0.41	0.19	0.74	0.95	0.42	5.2	5.2
AG2009-2758:4	Göteborg, Folkets Hus, Dec	Deposition	ng/m2 day	0.50	5.4	3.20	0.52	0.26	<1	0.89	2.4	1.4	0.20	1.2	2.1	0.91	7.4	17
AG2009-2758:5	Göteborg, Folkets Hus, Jan	Deposition	ng/m2 day	<0.2	4.4	2.20	<0.2	0.23	<1	0.36	1.2	0.74	0.12	1.4	2.7	0.44	5.1	15
AG2009-2758:40	Göteborg, Folkets Hus, Feb	Deposition	ng/m2 day	0.33	16	6.90	0.52	0.92	1.6	2.3	5.1	2.8	0.45	4.9	18	0.78	19	53
AG2009-2758:26	SGU SE-5, Gotska Sandön	Sediment	ng/g DW	<7.3	<7.3	7.7	<7.3	<7.4	<37	5.7	3.8	4.2	<2.9	<7.3	<15	<7.3	<7.3	21
AG2009-2758:27	SGU SE-10, Karlsödjupet	Sediment	ng/g DW	<4.6	7	12	<4.6	<4.6	<23	3.2	<8	11	<1.8	<4.6	<9.2	<4.6	<4.6	25
AG2009-2758:6	Göta älv, Eriksberg	Sediment	ng/g DW	1.8	21	50	3.7	<0.8	<3.9	6.3	17	19	0.78	16	72	<0.78	15	150
AG2009-2758:7	Göta älv, Klinten	Sediment	ng/g DW	<1.4	19	61	2.5	<1.4	<7.2	6.3	39	47	0.69	12	77	<1.4	9.6	240
AG2009-2758:8	Göta älv, Rivö	Sediment	ng/g DW	<1	7.5	17	<1	<1	<4.9	<1	<4	8.0	<0.39	4.8	12	<0.98	4.5	58
AG2009-2758:22	Stockholm, Henriksdal	STP sludge	ng/g DW	72	40	66	8.3	<2	<9.8	25	31	<2	0.25	18	75	<0.52	16	160
AG2009-2758:12	Göteborg, Ryaverket	STP sludge	ng/g DW	790	61	82	6.3	<1.8	<9.1	33	41	<2	0.81	24	89	<0.46	16	170
AG2009-2758:16	Göteborg, Korsvägen	Storm wtr sludge	ng/g DW	26	170	160	11	<0.8	<3.8	90	130	66	0.85	54	190	0.35	42	310
AG2009-2758:17	Göteborg, Gårda	Storm wtr sludge	ng/g DW	53	140	220	9.3	<1.8	<9.1	66	120	78	0.74	34	300	<0.48	27	410
AG2009-2758:18	Göteborg, Odinsplatsen	Storm wtr sludge	ng/g DW	35	150	130	10	<0.6	<3.2	81	71	39	0.58	31	150	0.29	22	260
AG2009-2758:19	Gårdsjön	Soil	ng/g DW	1.5	5.8	<2.3	<2.9	<2.9	<15	5.8	4.5	3.3	<1.2	<3	<5.9	<3	<3	7.3
AG2009-2758:13	Göteborg, Allén	Soil	ng/g DW	1.0	22	88	1.9	<0.8	<4	5.0	34	28	0.37	3.9	39	<0.75	7.3	82
AG2009-2758:11	Göteborg, Vasaparken	Soil	ng/g DW	7.5	39	87	2.9	<0.8	<4	12	79	59	0.52	4.7	50	<0.81	7.7	120
AG2009-2758:21	Göteborg, Järntorget	Soil	ng/g DW	2.9	1.8	2.0	<0.7	<0.7	<3.2	1.7	1.5	1.4	<0.26	0.74	4.5	<0.65	0.94	7.4
AG2009-2758:25	Kväddöfjärden	Fish	ng/g W W	<0.2	<0.2	<0.2	<0.2	<0.2	<1	<0.2	<0.2	<0.2	<0.12	<0.12	<0.12	<0.12	<0.12	<0.5
AG2009-2758:20	Gårdsjön	Fish	ng/g W W	<0.2	<0.2	<0.2	<0.2	<0.2	<1	<0.2	<0.2	<0.2	<0.15	<0.15	<0.15	<0.15	<0.15	<0.5
AG2009-2758:23	Årstaviken	Fish	ng/g W W	<0.2	<0.2	<0.2	<0.2	<0.2	<1	<0.2	<0.2	<0.2	<0.15	<0.15	<0.15	<0.15	<0.15	<0.5
AG2009-2758:24	Riddarfjärden	Fish	ng/g W W	<0.2	<0.2	<0.2	<0.2	<0.2	<1	<0.2	<0.2	<0.2	<0.17	<0.17	<0.17	<0.17	<0.17	<0.5
AG2009-2758:9	Göta älv, Eriksberg	Mollusc	ng/g W W	3.7	<0.2	<0.2	<0.2	<0.2	<1	0.21	<0.2	<0.2	<0.14	<0.14	<0.14	<0.14	<0.14	<0.5
AG2009-2758:10	Göta älv, Rivö	Mollusc	ng/g W W	1.2	<0.2	<0.2	<0.2	<0.2	<1	<0.2	<0.2	<0.2	<0.18	<0.18	<0.18	<0.18	<0.18	<0.5

4. Individual results, Nitro-PAHs

Prov ID	Station	Matrix	Unit	9-Nitro-anthracene	2+3-Nitro-fluor-anthene	1-Nitro-pyrene	4-Nitro-pyrene	7-Nitrobenz-(a)anthracene	1,3-Dinitro-pyrene	1,6-Dinitro-pyrene	3-Nitro-benz-anthrone
AG2009-2758:1	Råö, Jan	Air	ng/m ³	0.058	0.018	0.0010	0.0014	<0.0001	<0.0002	<0.0002	0.0076
AG2009-2758:14	Råö, Mar	Air	ng/m ³	0.0072	0.0036	0.0002	0.0003	<0.0001	<0.0004	<0.0004	0.0013
AG2009-2758:28	Råö, Apr	Air	ng/m ³	0.025	0.0031	0.0002	0.0004	<0.0001	<0.0006	<0.0005	0.0025
AG2009-2758:29	Pallas, Feb	Air	ng/m ³	0.0016	0.0010	0.0006	0.0023	<0.0001	<0.0003	<0.0003	<0.00003
AG2009-2758:30	Pallas, Mar	Air	ng/m ³	0.00043	0.00028	0.0001	0.0021	<0.0001	<0.0004	<0.0004	<0.00005
AG2009-2758:31	Pallas, Apr	Air	ng/m ³	0.028	0.00019	0.0076	0.0028	<0.0005	<0.003	<0.004	0.0010
AG2009-2758:3	Göteborg, Folkets Hus, Dec	Air	ng/m ³	0.086	0.018	0.0011	0.0017	<0.0001	<0.0005	<0.0005	0.011
AG2009-2758:32	Göteborg, Folkets Hus, Feb	Air	ng/m ³	0.029	0.0065	0.0003	0.0015	<0.0001	<0.0004	<0.0004	0.0037
AG2009-2758:15	Göteborg, Gårda, Jan	Air	ng/m ³	0.053	0.019	0.0009	0.0035	<0.0002	<0.0007	<0.001	0.0053
AG2009-2758:33	Göteborg, Gårda, Feb	Air	ng/m ³	0.076	0.013	0.0042	0.0055	<0.0002	<0.0006	<0.0008	0.014
AG2009-2758:34	Göteborg, Lundbytunneln, I	Air	ng/m ³	0.130	0.0011	0.0088	0.0040	<0.0006	<0.003	<0.004	<0.0008
AG2009-2758:35	Göteborg, Lundbytunneln, II	Air	ng/m ³	0.036	0.0023	0.0062	0.0107	<0.0005	<0.003	<0.002	0.0046
AG2009-2758:36	Lycksele, Feb	Air	ng/m ³	0.079	0.0019	0.0018	0.0194	<0.0002	<0.0009	<0.0006	0.0018
AG2009-2758:37	Lycksele, Mar	Air	ng/m ³	0.015	0.0005	0.0022	0.0015	<0.0001	<0.0007	<0.0004	0.0006
AG2009-2758:38	Lycksele, Apr	Air	ng/m ³	0.032	0.0009	0.0023	0.0035	<0.0002	<0.001	<0.001	0.0027
AG2009-2758:2	Råö, Jan	Deposition	ng/m ² day	33	9.6	0.28	3.2	<0.2	<1	<0.8	2.2
AG2009-2758:39	Råö, Mar	Deposition	ng/m ² day	5.2	2.5	0.037	0.24	<0.1	<1	<0.8	0.36
AG2009-2758:4	Göteborg, Folkets Hus, Dec	Deposition	ng/m ² day	9.8	0.16	0.19	0.37	<0.1	<0.9	<0.6	<0.1
AG2009-2758:5	Göteborg, Folkets Hus, Jan	Deposition	ng/m ² day	17	2.1	0.10	0.72	<0.3	<2	<2	4.1
AG2009-2758:40	Göteborg, Folkets Hus, Feb	Deposition	ng/m ² day	2.0	5.8	0.98	0.98	<0.4	<4	<3	0.31
AG2009-2758:26	SGU SE-5, Gotska Sandön	Sediment	ng/g DW	1.8	0.26	0.23	0.36	<0.1	<0.4	<0.4	<0.1
AG2009-2758:27	SGU SE-10, Karlsödjupet	Sediment	ng/g DW	1.3	0.20	0.41	<0.03	<0.09	<0.3	<0.3	<0.1
AG2009-2758:6	Göta älv, Eriksberg	Sediment	ng/g DW	<0.07	1.8	0.75	0.17	<0.07	<0.3	<0.3	<0.05
AG2009-2758:7	Göta älv, Klinten	Sediment	ng/g DW	1.0	0.75	0.75	0.21	<0.5	<0.1	<0.2	<0.4
AG2009-2758:8	Göta älv, Rivö	Sediment	ng/g DW	0.13	0.33	0.18	0.050	<0.3	<0.1	<0.1	<0.04
AG2009-2758:22	Stockholm, Henriksdal	STP sludge	ng/g DW	1.1	9.9	4.0	0.48	<0.05	<0.1	<0.2	<0.09
AG2009-2758:12	Göteborg, Ryaverket	STP sludge	ng/g DW	0.034	17	5.1	0.16	<0.1	<0.3	<0.3	<0.2
AG2009-2758:16	Göteborg, Korsvägen	Storm wtr sludge	ng/g DW	0.60	0.70	6.6	0.23	<0.5	<4	<3	<0.5
AG2009-2758:17	Göteborg, Gårda	Storm wtr sludge	ng/g DW	0.31	180	1.5	3.3	0.95	210	69	2.9
AG2009-2758:18	Göteborg, Odinsplatsen	Storm wtr sludge	ng/g DW	2.3	73	0.54	1.2	<0.6	<4	<3	13
AG2009-2758:19	Gårdsjön	Soil	ng/g DW	0.55	1.7	3.2	0.38	<0.04	<0.1	<0.1	<0.2
AG2009-2758:13	Göteborg, Allén	Soil	ng/g DW	<0.05	0.23	0.15	0.16	<0.02	<0.06	<0.6	<0.1
AG2009-2758:11	Göteborg, Vasaparken	Soil	ng/g DW	0.25	0.64	0.60	0.92	<0.02	<0.07	<0.07	<0.05
AG2009-2758:21	Göteborg, Järntorget	Soil	ng/g DW	0.12	0.63	0.17	0.18	<0.02	<0.05	<0.05	<0.02
AG2009-2758:25	Kväddöfjärden	Fish	ng/g W W	2.5	<0.04	<0.05	<0.08	<0.6	<3	<3	<0.3
AG2009-2758:20	Gårdsjön	Fish	ng/g W W	<0.5	0.19	<0.08	1.2	<0.4	<2	<2	<0.2
AG2009-2758:23	Årstaviken	Fish	ng/g W W	<0.6	<0.03	<0.04	<0.06	<0.5	<2	<2	<0.2
AG2009-2758:24	Riddarfjärden	Fish	ng/g W W	0.43	<0.03	<0.03	<0.06	<0.1	<0.3	<0.3	<0.1
AG2009-2758:9	Göta älv, Eriksberg	Mollusc	ng/g W W	2.4	0.14	0.24	0.71	<0.1	<0.7	<0.6	<0.07
AG2009-2758:10	Göta älv, Rivö	Mollusc	ng/g W W	<0.7	<0.04	<0.06	<0.09	<0.6	<3	<2	<0.3

5. Individual results, Oxy-PAHs

Prov ID	Station	Matrix	Unit	2-Hydroxy-9-fluorenone	1-Hydroxy-9-fluorenone	9-Fluorenone	1,2-Acenaphthendione	4H-Cyclopenta[def]phenanthren-4-one	9,10-Anthraquinone	2-Mehtyl-9,10-anthraquinone	7H-Benz(de)-anthracene-7-one	6H-Benzo[cd]pyren-6-one	Benz(a)-anthracen-7,12dione
AG2009-2758:1	Råd, Jan	Air	ng/m ³	0.076	<0.004	0.110	0.0015	0.12	0.93	0.17	0.53	0.37	0.160
AG2009-2758:14	Råd, Mar	Air	ng/m ³	0.056	<0.004	0.052	0.00041	0.034	0.21	0.043	0.094	0.075	0.040
AG2009-2758:28	Råd, Apr	Air	ng/m ³	0.026	<0.004	0.120	0.00084	0.045	0.34	0.062	0.094	0.073	0.041
AG2009-2758:29	Pallas, Feb	Air	ng/m ³	0.021	<0.004	0.034	0.00031	0.024	0.07	0.012	0.085	0.073	0.023
AG2009-2758:30	Pallas, Mar	Air	ng/m ³	0.009	<0.004	0.029	0.00043	0.011	0.03	0.0045	0.023	0.022	0.0080
AG2009-2758:31	Pallas, Apr	Air	ng/m ³	0.006	<0.004	0.130	0.0068	0.040	0.13	0.026	0.11	0.048	0.022
AG2009-2758:3	Göteborg, Folkets Hus, Dec	Air	ng/m ³	0.029	<0.004	0.170	0.0073	0.087	0.54	0.16	0.29	0.28	0.15
AG2009-2758:32	Göteborg, Folkets Hus, Feb	Air	ng/m ³	0.095	<0.004	0.180	0.014	0.082	0.56	0.11	0.14	0.15	0.070
AG2009-2758:15	Göteborg, Gårda, Jan	Air	ng/m ³	0.086	<0.004	0.120	0.012	0.16	0.62	0.21	0.44	0.25	0.16
AG2009-2758:33	Göteborg, Gårda, Feb	Air	ng/m ³	0.140	<0.004	0.081	0.010	0.13	0.44	0.24	0.46	0.51	0.17
AG2009-2758:34	Göteborg, Lundbytunneln, I	Air	ng/m ³	0.038	<0.004	0.450	0.023	0.38	0.95	1.1	0.11	0.11	0.029
AG2009-2758:35	Göteborg, Lundbytunneln, II	Air	ng/m ³	0.074	<0.004	0.620	0.0058	0.87	0.97	0.68	0.067	0.037	0.074
AG2009-2758:36	Lycksele, Feb	Air	ng/m ³	0.063	0.008	0.096	0.0061	0.10	0.11	0.054	0.16	0.23	0.091
AG2009-2758:37	Lycksele, Mar	Air	ng/m ³	0.015	<0.004	0.057	0.0080	0.035	0.087	0.030	0.091	0.091	0.074
AG2009-2758:38	Lycksele, Apr	Air	ng/m ³	0.016	<0.004	0.087	0.0067	0.027	0.056	0.023	0.082	0.15	0.036
AG2009-2758:2	Råd, Jan	Deposition	ng/m ² day	4.0	2.3	20	1.2	57	220	103	300	130	150
AG2009-2758:39	Råd, Mar	Deposition	ng/m ² day	4.4	<2	15	0.68	31	79	26	80	19	52
AG2009-2758:4	Göteborg, Folkets Hus, Dec	Deposition	ng/m ² day	<3	<2	1.4	0.74	3.3	18	4.1	11	9.8	8.8
AG2009-2758:5	Göteborg, Folkets Hus, Jan	Deposition	ng/m ² day	<2	<2	26	39	56	69	29	140	21	58
AG2009-2758:40	Göteborg, Folkets Hus, Feb	Deposition	ng/m ² day	8.7	<4	46	0.28	76	160	65	380	110	160
AG2009-2758:26	SGU SE-5, Gotska Sandön	Sediment	ng/g DW	0.14	6.6	8.8	0.076	7.4	22	320	13	23	14
AG2009-2758:27	SGU SE-10, Karlsödjupet	Sediment	ng/g DW	0.20	4.6	5.7	0.28	7.4	15	99	14	32	16
AG2009-2758:6	Göta älv, Eriksberg	Sediment	ng/g DW	0.022	<0.02	2.8	0.066	6.8	20	25	32	29	13
AG2009-2758:7	Göta älv, Klinten	Sediment	ng/g DW	0.047	1.6	2.8	0.22	7.1	28	59	80	99	30
AG2009-2758:8	Göta älv, Rivö	Sediment	ng/g DW	<0.02	1.0	1.1	0.12	2.5	5.5	12	13	12	3.6
AG2009-2758:22	Stockholm, Henriksdal	STP sludge	ng/g DW	2.0	4.2	5.6	1.2	9.8	44	540	103	130	30
AG2009-2758:12	Göteborg, Ryaverket	STP sludge	ng/g DW	2.4	3.3	5.3	2.1	12	890	1020	150	110	55
AG2009-2758:16	Göteborg, Korsvägen	Storm wtr sludge	ng/g DW	<0.02	2.4	5.7	0.55	20	25	16	95	51	47
AG2009-2758:17	Göteborg, Gårda	Storm wtr sludge	ng/g DW	1.7	3.5	8.3	0.27	32	140	28	180	98	190
AG2009-2758:18	Göteborg, Odinsplatsen	Storm wtr sludge	ng/g DW	3.0	2.1	4.5	0.13	18	34	38	200	86	110
AG2009-2758:19	Gårdsjön	Soil	ng/g DW	0.46	3.5	3.6	0.25	7.4	13	10	15	31	28
AG2009-2758:13	Göteborg, Allén	Soil	ng/g DW	0.33	1.3	4.7	0.31	25	34	27	43	63	35
AG2009-2758:11	Göteborg, Vasaparken	Soil	ng/g DW	0.36	1.4	6.1	0.37	42	98	32	78	120	90
AG2009-2758:21	Göteborg, Järntorget	Soil	ng/g DW	0.043	<0.02	0.93	0.033	8.8	3.6	14	5.1	7.1	2.6
AG2009-2758:25	Kvädöfjärden	Fish	ng/g W W	<0.4	<0.4	8.7	<0.2	10	170	8.5	1.0	0.46	0.74
AG2009-2758:20	Gårdsjön	Fish	ng/g W W	<0.4	<0.4	9.4	0.39	5.4	18	4.1	2.0	1.5	1.1
AG2009-2758:23	Årstaviken	Fish	ng/g W W	<0.4	<0.4	7.6	0.18	4.7	8.4	4.0	3.7	0.89	0.57
AG2009-2758:24	Riddarfjärden	Fish	ng/g W W	<0.4	<0.4	30	0.87	7.9	860	38	4.1	4.4	1.2
AG2009-2758:9	Göta älv, Eriksberg	Mollusc	ng/g W W	<0.4	<0.4	32	<0.3	14	29	6.7	7.6	2.8	3.3
AG2009-2758:10	Göta älv, Rivö	Mollusc	ng/g W W	<0.4	<0.4	3.9	0.73	2.5	9.2	4.1	2.9	1.4	1.5

6. Individual results, PBDFs

Prov ID	Station	Matrix	Unit	2,3,7,8- TeBDF*	Sum TeBDF	Sum PeBDF	Sum HxBDF	Sum HpBDF	OBDF	Sum PBDF
AG2009-2758:1	Råö, Jan	Air	fg/m ³	6.0	660	910	602	10200	530000	540000
AG2009-2758:14	Råö, Mar	Air	fg/m ³	<3	170	590	290	390	2400	3000
AG2009-2758:28	Råö, Apr	Air	fg/m ³	<3	180	380	680	960	15000	17000
AG2009-2758:29	Pallas, Feb	Air	fg/m ³	<3	120	170	220	370	2700	3600
AG2009-2758:30	Pallas, Mar	Air	fg/m ³	<3	39	76	150	220	1400	1900
AG2009-2758:31	Pallas, Apr	Air	fg/m ³	<3	20	32	<40	120	1100	1300
AG2009-2758:3	Göteborg, Folkets Hus, Dec	Air	fg/m ³	22	790	1700	2800	1700	18000	25000
AG2009-2758:32	Göteborg, Folkets Hus, Feb	Air	fg/m ³	10	450	1040	2040	2300	42000	48000
AG2009-2758:15	Göteborg, Gårda, Jan	Air	fg/m ³	14	460	830	820	740	6700	9600
AG2009-2758:33	Göteborg, Gårda, Feb	Air	fg/m ³	15	440	910	970	900	7200	10400
AG2009-2758:34	Göteborg, Lundbytunneln, I	Air	fg/m ³	5.0	140	240	50	3100	34000	37000
AG2009-2758:35	Göteborg, Lundbytunneln, II	Air	fg/m ³	9.5	430	710	380	6200	81000	88000
AG2009-2758:36	Lycksele, Feb	Air	fg/m ³	12	330	260	180	350	3300	4400
AG2009-2758:37	Lycksele, Mar	Air	fg/m ³	<3	17	12	<40	68	930	1030
AG2009-2758:38	Lycksele, Apr	Air	fg/m ³	<3	36	42	<40	340	3200	3600
AG2009-2758:2	Råö, Jan	Deposition	pg/m ² day	2.8	91	120	160	1200	3800	5400
AG2009-2758:39	Råö, Mar	Deposition	pg/m ² day	<2	26	51	62	350	1400	1900
AG2009-2758:4	Göteborg, Folkets Hus, Dec	Deposition	pg/m ² day	<2	88	130	390	4600	1800	7000
AG2009-2758:5	Göteborg, Folkets Hus, Jan	Deposition	pg/m ² day	2.3	130	190	550	4600	39000	45000
AG2009-2758:40	Göteborg, Folkets Hus, Feb	Deposition	pg/m ² day	4.2	260	330	550	4500	98000	104000
AG2009-2758:26	SGU SE-5, Gotska Sandön	Sediment	pg/g DW	4.1	220	600	200	490	4000	5500
AG2009-2758:27	SGU SE-10, Karlsödjupet	Sediment	pg/g DW	<2	170	400	280	230	1200	2300
AG2009-2758:6	Göta älv, Eriksberg	Sediment	pg/g DW	<2	110	140	210	570	10700	12000
AG2009-2758:7	Göta älv, Klinten	Sediment	pg/g DW	<2	48	<5	<20	170	3400	3700
AG2009-2758:8	Göta älv, Rivö	Sediment	pg/g DW	<2	35	10	<20	330	7500	7900
AG2009-2758:22	Stockholm, Henriksdal	STP sludge	pg/g DW	4.3	50	110	130	11000	700000	708000
AG2009-2758:12	Göteborg, Ryaverket	STP sludge	pg/g DW	5.6	130	390	400	10300	740000	750000
AG2009-2758:16	Göteborg, Korsvägen	Storm wtr sludge	pg/g DW	31	890	1300	1600	5200	130000	140000
AG2009-2758:17	Göteborg, Gårda	Storm wtr sludge	pg/g DW	191	3400	880	1100	1600	3300	10400
AG2009-2758:18	Göteborg, Odinsplatsen	Storm wtr sludge	pg/g DW	88	1030	700	850	1300	6700	10600
AG2009-2758:19	Gårdsjön	Soil	pg/g DW	3.0	180	340	140	840	3500	5060
AG2009-2758:13	Göteborg, Allén	Soil	pg/g DW	<2	200	32	79	770	9500	10500
AG2009-2758:11	Göteborg, Vasaparken	Soil	pg/g DW	<2	210	37	65	330	5400	6000
AG2009-2758:21	Göteborg, Järntorget	Soil	pg/g DW	<2	69	160	620	15000	480000	500000
AG2009-2758:25	Kväddöfjärden	Fish	pg/g WW	<0.1	<0.5	<0.5	<1	0.69	32	33
AG2009-2758:20b	Gårdsjön	Fish	pg/g WW	0.19	0.81	<0.5	<1	1.2	34	37
AG2009-2758:23	Årstaviken	Fish	pg/g WW	<0.1	<0.5	<0.5	<1	0.54	22	23
AG2009-2758:24	Riddarfjärden	Fish	pg/g WW	0.16	<0.5	<0.5	<1	1.7	98	100
AG2009-2758:9	Göta älv, Eriksberg	Mollusc	pg/g WW	0.13	15	3.5	3.2	5.4	160	190
AG2009-2758:10	Göta älv, Rivö	Mollusc	pg/g WW	<0.1	6.6	<0.5	<1	1.6	52	60

* Maximum value (there is a potential risk for coelution with other TeBDFs from the GC)

7. Individual results, PBDDs

Prov ID	Station	Matrix	Unit	2,3,7,8- TeBDD*	Sum TeBDD	Sum PeBDD	Sum HxBDD	Sum HpBDD	OBDD	Sum PBDD
AG2009-2758:1	Råö, Jan	Air	fg/m ³	<3	<10	<10	<40	<40	<20	<120
AG2009-2758:14	Råö, Mar	Air	fg/m ³	<3	<10	<10	<40	<40	<20	<120
AG2009-2758:28	Råö, Apr	Air	fg/m ³	<3	<10	<10	<40	<40	<20	<120
AG2009-2758:39	Pallas, Feb	Air	fg/m ³	<3	<10	<10	<40	<40	<20	<120
AG2009-2758:30	Pallas, Mar	Air	fg/m ³	<3	<10	<10	<40	<40	<20	<120
AG2009-2758:31	Pallas, Apr	Air	fg/m ³	<3	<10	<10	<40	<40	<20	<120
AG2009-2758:3	Göteborg, Folkets Hus, Dec	Air	fg/m ³	<3	<10	<10	<40	<40	<20	<120
AG2009-2758:32	Göteborg, Folkets Hus, Feb	Air	fg/m ³	<3	<10	10	<40	<40	<20	<120
AG2009-2758:15	Göteborg, Gårda, Jan	Air	fg/m ³	<3	<10	<10	<40	<40	<20	<120
AG2009-2758:33	Göteborg, Gårda, Feb	Air	fg/m ³	<3	40	<10	<40	<40	<20	40-120
AG2009-2758:34	Göteborg, Lundbytunneln, I	Air	fg/m ³	<3	12	12	<40	<40	<40	24-140
AG2009-2758:35	Göteborg, Lundbytunneln, II	Air	fg/m ³	<3	83	<10	<40	<40	<80	83-180
AG2009-2758:36	Lycksele, Feb	Air	fg/m ³	<3	<10	<10	<40	<40	<20	<120
AG2009-2758:37	Lycksele, Mar	Air	fg/m ³	<3	<10	22	<40	<40	<30	22-130
AG2009-2758:38	Lycksele, Apr	Air	fg/m ³	<3	<10	31	<40	<40	<30	31-130
AG2009-2758:2	Råö, Jan	Deposition	pg/m ² day	<2	<10	<10	<40	<40	<20	<120
AG2009-2758:39	Råö, Mar	Deposition	pg/m ² day	<2	<10	<10	<40	<40	<20	<120
AG2009-2758:4	Göteborg, Folkets Hus, Dec	Deposition	pg/m ² day	<2	<10	<10	<40	<40	<20	<120
AG2009-2758:5	Göteborg, Folkets Hus, Jan	Deposition	pg/m ² day	<2	<10	<10	<40	<40	<20	<120
AG2009-2758:40	Göteborg, Folkets Hus, Feb	Deposition	pg/m ² day	<2	<10	<10	<40	<40	<20	<120
AG2009-2758:26	SGU SE-5, Gotska Sandön	Sediment	pg/g DW	15	91	150	<20	<20	<10	240
AG2009-2758:27	SGU SE-10, Karlsödjupet	Sediment	pg/g DW	67	200	58	<20	<20	<10	250
AG2009-2758:6	Göta älv, Eriksberg	Sediment	pg/g DW	3.5	16	0.40	<20	<20	12	31-60
AG2009-2758:7	Göta älv, Klinten	Sediment	pg/g DW	<2	28	7.0	<20	<20	64	99
AG2009-2758:8	Göta älv, Rivö	Sediment	pg/g DW	<2	15	8.0	<20	<20	84	120
AG2009-2758:22	Stockholm, Henriksdal	STP sludge	pg/g DW	<2	22	<5	23	<20	<10	<60
AG2009-2758:12	Göteborg, Ryaverket	STP sludge	pg/g DW	<2	<5	<5	24	<20	<10	<60
AG2009-2758:16	Göteborg, Korsvägen	Storm wtr sludge	pg/g DW	<2	11	<5	<20	<20	<10	<60
AG2009-2758:17	Göteborg, Gårda	Storm wtr sludge	pg/g DW	<2	56	<5	<20	<20	<10	<60
AG2009-2758:18	Göteborg, Odinsplatsen	Storm wtr sludge	pg/g DW	<2	<5	<5	28	<20	<10	<60
AG2009-2758:19	Gårdsjön	Soil	pg/g DW	<2	9.3	<5	<20	<20	<10	<60
AG2009-2758:13	Göteborg, Allén	Soil	pg/g DW	<2	13	<5	<20	<20	<10	<60
AG2009-2758:11	Göteborg, Vasaparken	Soil	pg/g DW	<2	13	<5	<20	<20	<10	<60
AG2009-2758:21	Göteborg, Järntorget	Soil	pg/g DW	<2	<5	<5	<20	<20	<10	<60
AG2009-2758:25	Kvädöfjärden	Fish	pg/g WW	<0.1	0.65	<1	<1	<1	<0.5	<4
AG2009-2758:20b	Gårdsjön	Fish	pg/g WW	<0.1	<0.5	<1	<1	<1	<0.5	<4
AG2009-2758:23	Årstaviken	Fish	pg/g WW	0.11	<0.5	<1	<1	<1	<0.5	<4
AG2009-2758:24	Riddarfjärden	Fish	pg/g WW	<0.1	<0.5	<1	<1	<1	<0.5	<4
AG2009-2758:9	Göta älv, Eriksberg	Mollusc	pg/g WW	<0.1	<0.5	<1	<1	<1	<0.5	<4
AG2009-2758:10	Göta älv, Rivö	Mollusc	pg/g WW	0.27	<0.5	<1	<1	<1	<0.5	<4

* Maximum value (there is a potential risk for coelution with other TeBDDs from the GC)

8. Individual results, PCDTs

Prov ID	Station	Matrix	Unit	2,3,7,8- TeCDT*	Sum TeCDT	Sum PeCDT	Sum HxCdT	Sum HpCDT	OCdT	Sum PCDT
AG2009-2758:1	Råö, Jan	Air	fg/m ³	<1	16	5.2	<4	<4	<4	21
AG2009-2758:14	Råö, Mar	Air	fg/m ³	<1	4.2	<4	<4	<4	<4	4-20
AG2009-2758:28	Råö, Apr	Air	fg/m ³	<1	<4	<4	<4	<4	<4	<20
AG2009-2758:29	Pallas, Feb	Air	fg/m ³	<1	4.0	<4	<4	<4	<4	<20
AG2009-2758:30	Pallas, Mar	Air	fg/m ³	<1	<4	<4	<4	<4	<4	<20
AG2009-2758:31	Pallas, Apr	Air	fg/m ³	<1	<4	<4	<4	<4	<4	<20
AG2009-2758:3	Göteborg, Folkets Hus, Dec	Air	fg/m ³	<1	20	8.6	4.1	<4	<4	35
AG2009-2758:32	Göteborg, Folkets Hus, Feb	Air	fg/m ³	1.2	15	5.0	<4	<4	<4	24
AG2009-2758:15	Göteborg, Gårda, Jan	Air	fg/m ³	<1	15	5.8	<4	<4	<4	25
AG2009-2758:33	Göteborg, Gårda, Feb	Air	fg/m ³	<1	12	5.4	<4	<4	<4	23
AG2009-2758:34	Göteborg, Lundbytunneln, I	Air	fg/m ³	3.8	19	4.8	8.0	4.9	<4	40
AG2009-2758:35	Göteborg, Lundbytunneln, II	Air	fg/m ³	1.0	67	26	27	7.8	7.0	135
AG2009-2758:36	Lycksele, Feb	Air	fg/m ³	<1	5.8	<4	<4	<4	<4	6.8-20
AG2009-2758:37	Lycksele, Mar	Air	fg/m ³	<1	<4	<4	<4	<4	<4	<20
AG2009-2758:38	Lycksele, Apr	Air	fg/m ³	<1	<4	<4	<4	<4	<4	<20
AG2009-2758:2	Råö, Jan	Deposition	pg/m ² day	0.062	0.23	0.49	0.48	<0.2	<0.2	1.2
AG2009-2758:39	Råö, Mar	Deposition	pg/m ² day	0.050	0.42	0.22	0.71	0.48	<0.2	1.8
AG2009-2758:4	Göteborg, Folkets Hus, Dec	Deposition	pg/m ² day	0.11	<0.2	0.74	1.1	0.84	0.21	2.9
AG2009-2758:5	Göteborg, Folkets Hus, Jan	Deposition	pg/m ² day	0.073	3.8	0.74	1.7	2.4	0.20	8.8
AG2009-2758:40	Göteborg, Folkets Hus, Feb	Deposition	pg/m ² day	0.19	2.3	1.3	1.9	1.8	0.49	7.8
AG2009-2758:26	SGU SE-5, Gotska Sandön	Sediment	pg/g DW	0.72	8.5	5.8	5.0	<2	<2	21
AG2009-2758:27	SGU SE-10, Karlsödjupet	Sediment	pg/g DW	<0.5	37	19	12	3.8	<2	73
AG2009-2758:6	Göta älv, Eriksberg	Sediment	pg/g DW	<0.5	25	7.0	6.6	2.1	<2	41
AG2009-2758:7	Göta älv, Klinten	Sediment	pg/g DW	1.1	32	12	12	5.9	<2	62
AG2009-2758:8	Göta älv, Rivö	Sediment	pg/g DW	<0.5	2.8	2.8	3.1	<2	<2	8.7-10
AG2009-2758:22	Stockholm, Henriksdal	STP sludge	pg/g DW	0.96	16	5.5	12	3.1	2.3	39
AG2009-2758:12	Göteborg, Ryaverket	STP sludge	pg/g DW	0.56	7.1	7.9	6.4	<2	<2	23
AG2009-2758:16	Göteborg, Korsvägen	Storm wtr sludge	pg/g DW	<0.5	18	3.7	4.0	2.0	<2	29
AG2009-2758:17	Göteborg, Gårda	Storm wtr sludge	pg/g DW	<0.5	5.9	<2	<2	<2	<2	5.9-10
AG2009-2758:18	Göteborg, Odinsplatsen	Storm wtr sludge	pg/g DW	<0.5	3.8	<2	<2	<2	<2	3.8-10
AG2009-2758:19	Gårdsjön	Soil	pg/g DW	0.57	8.5	5.0	4.2	<2	<2	19
AG2009-2758:13	Göteborg, Allén	Soil	pg/g DW	0.67	20	12	18	24	2.9	77
AG2009-2758:11	Göteborg, Vasaparken	Soil	pg/g DW	1.1	17	13	19	23	2.6	74
AG2009-2758:21	Göteborg, Järntorget	Soil	pg/g DW	<0.5	<2	<2	<2	<2	<2	<10
AG2009-2758:25	Kvädöfjärden	Fish	pg/g WW	<0.1	<0.5	<1	<1	<1	<1	<5
AG2009-2758:20b	Gårdsjön	Fish	pg/g WW	<0.1	<0.5	<1	<1	<1	<1	<5
AG2009-2758:23	Årstaviken	Fish	pg/g WW	<0.1	<0.5	<1	<1	<1	<1	<5
AG2009-2758:24	Riddarfjärden	Fish	pg/g WW	<0.1	<0.5	<1	<1	<1	<1	<5
AG2009-2758:9	Göta älv, Eriksberg	Mollusc	pg/g WW	<0.1	1.9	<1	<1	<1	<1	1.9-5
AG2009-2758:10	Göta älv, Rivö	Mollusc	pg/g WW	<0.1	<0.5	<1	<1	<1	<1	<5

* Maximum value (there is a potential risk for coelution with other TCDTs from the GC)

9. Individual results, PCDTAs

Prov ID	Station	Matrix	Unit	Sum TeCDTA	Sum PeCDTA	Sum HxCDDA	Sum HpCDTA	OCDTA	Sum PCDTA
AG2009-2758:1	Råö, Jan	Air	fg/m ³	<6	<6	<6	<6	<6	<30
AG2009-2758:14	Råö, Mar	Air	fg/m ³	<6	<6	<6	<6	<6	<30
AG2009-2758:28	Råö, Apr	Air	fg/m ³	<6	<6	<6	<6	<6	<30
AG2009-2758:29	Pallas, Feb	Air	fg/m ³	<6	<6	<6	<6	<6	<30
AG2009-2758:30	Pallas, Mar	Air	fg/m ³	<6	<6	<6	<6	<6	<30
AG2009-2758:31	Pallas, Apr	Air	fg/m ³	<6	<6	<6	<6	<6	<30
AG2009-2758:3	Göteborg, Folkets Hus, Dec	Air	fg/m ³	9.4	<6	<6	<6	<6	9.4-30
AG2009-2758:32	Göteborg, Folkets Hus, Feb	Air	fg/m ³	<6	<6	<6	<6	<6	<30
AG2009-2758:15	Göteborg, Gårda, Jan	Air	fg/m ³	<6	<6	<6	<6	<6	<30
AG2009-2758:33	Göteborg, Gårda, Feb	Air	fg/m ³	13	<6	<6	<6	<6	13-30
AG2009-2758:34	Göteborg, Lundbytunneln, I	Air	fg/m ³	<6	<6	<6	<6	<6	<30
AG2009-2758:35	Göteborg, Lundbytunneln, II	Air	fg/m ³	<6	<6	<6	<6	<6	<30
AG2009-2758:36	Lycksele, Feb	Air	fg/m ³	<6	<6	<6	<6	<6	<30
AG2009-2758:37	Lycksele, Mar	Air	fg/m ³	<6	<6	<6	<6	<6	<30
AG2009-2758:38	Lycksele, Apr	Air	fg/m ³	<6	<6	<6	<6	<6	<30
AG2009-2758:2	Råö, Jan	Deposition	pg/m ² day	<0.4	<0.4	<0.4	<0.4	<0.4	<2
AG2009-2758:39	Råö, Mar	Deposition	pg/m ² day	<0.4	<0.4	<0.4	<0.4	<0.4	<2
AG2009-2758:4	Göteborg, Folkets Hus, Dec	Deposition	pg/m ² day	<0.4	<0.4	<0.4	<0.4	<0.4	<2
AG2009-2758:5	Göteborg, Folkets Hus, Jan	Deposition	pg/m ² day	<0.4	<0.4	<0.4	<0.4	<0.4	<2
AG2009-2758:40	Göteborg, Folkets Hus, Feb	Deposition	pg/m ² day	<0.4	<0.4	<0.4	<0.4	<0.4	<2
AG2009-2758:26	SGU SE-5, Gotska Sandön	Sediment	pg/g DW	<4	<4	<4	<4	<4	<20
AG2009-2758:27	SGU SE-10, Karlsödjupet	Sediment	pg/g DW	<4	<4	<4	<4	<4	<20
AG2009-2758:6	Göta älv, Eriksberg	Sediment	pg/g DW	<4	<4	<4	<4	<4	<20
AG2009-2758:7	Göta älv, Klinten	Sediment	pg/g DW	<4	<4	<4	<4	<4	<20
AG2009-2758:8	Göta älv, Rivö	Sediment	pg/g DW	<4	<4	<4	<4	<4	<20
AG2009-2758:22	Stockholm, Henriksdal	STP sludge	pg/g DW	<4	<4	<4	<4	<4	<20
AG2009-2758:12	Göteborg, Ryaverket	STP sludge	pg/g DW	<4	<4	<4	<4	<4	<20
AG2009-2758:16	Göteborg, Korsvägen	Storm wtr sludge	pg/g DW	<4	<4	<4	<4	<4	<20
AG2009-2758:17	Göteborg, Gårda	Storm wtr sludge	pg/g DW	<4	<4	<4	<4	<4	<20
AG2009-2758:18	Göteborg, Odinsplatsen	Storm wtr sludge	pg/g DW	<4	<4	<4	<4	<4	<20
AG2009-2758:19	Gårdsjön	Soil	pg/g DW	<4	<4	<4	<4	<4	<20
AG2009-2758:13	Göteborg, Allén	Soil	pg/g DW	6.5	8.2	<4	<4	<4	14-20
AG2009-2758:11	Göteborg, Vasaparken	Soil	pg/g DW	5.6	<4	<4	<4	<4	5.6-20
AG2009-2758:21	Göteborg, Järntorget	Soil	pg/g DW	<4	<4	<4	<4	<4	<20
AG2009-2758:25	Kvädöfjärden	Fish	pg/g WW	<0.5	<1	<1	<1	<1	<5
AG2009-2758:20b	Gårdsjön	Fish	pg/g WW	<0.5	<1	<1	<1	<1	<5
AG2009-2758:23	Årstaviken	Fish	pg/g WW	<0.5	<1	<1	<1	<1	<5
AG2009-2758:24	Riddarfjärden	Fish	pg/g WW	<0.5	<1	<1	<1	<1	<5
AG2009-2758:9	Göta älv, Eriksberg	Mollusc	pg/g WW	<0.5	<1	<1	<1	<1	<5
AG2009-2758:10	Göta älv, Rivö	Mollusc	pg/g WW	<0.5	<1	<1	<1	<1	<5

Appendix 2 Human breast milk

10. Individual results PBDF, PBDD

Umeå ID	Sample	Unit	Brominated dibenzofurans, PBDF							Brominated dibenzodioxines, PBDD						
			2,3,7,8-TeBDF*	Sum TeBDF	Sum PeBDF	Sum HxBDF	Sum HpBDF	OBDF	Sum PBDF	2,3,7,8-TeBDD*	Sum TeBDD	Sum PeBDD	Sum HxBDD	Sum HpBDD	OBDD	Sum PBDD
3373:1	Sample 1	pg/g ww	0.18	<0.5	<0.5	<1	6.8	290	300	0.11	<0.5	<1	<1	<1	<0.5	<4
3373:2	Sample 2	pg/g ww	0.16	<0.5	<0.5	<1	1.0	30	31	<0.1	<0.5	<1	<1	<1	<0.5	<4
3373:3	Sample 3	pg/g ww	0.11	<0.5	<0.5	<1	1.0	3.5	5.0	<0.1	<0.5	<1	<1	<1	<0.5	<4
3373:4	Sample 4	pg/g ww	0.11	<0.5	<0.5	<1	<0.5	3.3	4.3	<0.1	<0.5	<1	<1	<1	<0.5	<4
3373:5	Sample 5	pg/g ww	0.13	<0.5	<0.5	<1	0.84	6.8	8.1	<0.1	<0.5	<1	<1	<1	<0.5	<4
3373:6	Sample 6	pg/g ww	<0.1	<0.5	<0.5	<1	0.66	6.7	7.7	<0.1	<0.5	<1	<1	<1	<0.5	<4
3373:7	Sample 7	pg/g ww	0.14	<0.5	<0.5	<1	0.88	15	16	<0.1	<0.5	<1	<1	<1	<0.5	<4
3373:8	Sample 8	pg/g ww	<0.1	<0.5	<0.5	<1	2.5	67	70	<0.1	<0.5	<1	<1	<1	<0.5	<4
3373:9	Sample 9	pg/g ww	<0.1	<0.5	<0.5	<1	1.1	19	20	<0.1	<0.5	<1	<1	<1	<0.5	<4
3373:10	Sample 10	pg/g ww	<0.1	<0.5	<0.5	<1	0.54	9.1	9.9	<0.1	<0.5	<1	<1	<1	<0.5	<4

* Maximum value (there is a potential risk for coelution with other TBDD/Fs from the GC)

11. Individual results PCDT, PCDTA

Umeå ID	Sample	Unit	Dibenzothiophenes, PCDT							Dibenzothiantrenes, PCDTA						
			2,3,7,8-TeCDT*	Sum TeCDT	Sum PeCDT	Sum HxCdT	Sum HpCDT	OCdT	Sum PCDT	Sum TeCDTA	Sum PeCDTA	Sum HxCdTA	Sum HpCDTA	OCdTA	Sum PCDTA	
3373:1	Sample 1	pg/g ww	<0.1	<0.5	<1	<1	<1	<1	<1	<5	<0.5	<1	<1	<1	<1	<5
3373:2	Sample 2	pg/g ww	<0.1	<0.5	<1	<1	<1	<1	<1	<5	<0.5	<1	<1	<1	<1	<5
3373:3	Sample 3	pg/g ww	<0.1	<0.5	<1	<1	<1	<1	<1	<5	<0.5	<1	<1	<1	<1	<5
3373:4	Sample 4	pg/g ww	<0.1	<0.5	<1	<1	<1	<1	<1	<5	<0.5	<1	<1	<1	<1	<5
3373:5	Sample 5	pg/g ww	<0.1	<0.5	<1	<1	<1	<1	<1	<5	<0.5	<1	<1	<1	<1	<5
3373:6	Sample 6	pg/g ww	<0.1	<0.5	<1	<1	<1	<1	<1	<5	<0.5	<1	<1	<1	<1	<5
3373:7	Sample 7	pg/g ww	<0.1	<0.5	<1	<1	<1	<1	<1	<5	<0.5	<1	<1	<1	<1	<5
3373:8	Sample 8	pg/g ww	<0.1	<0.5	<1	<1	<1	<1	<1	<5	<0.5	<1	<1	<1	<1	<5
3373:9	Sample 9	pg/g ww	<0.1	<0.5	<1	<1	<1	<1	<1	<5	<0.5	<1	<1	<1	<1	<5
3373:10	Sample 10	pg/g ww	<0.1	<0.5	<1	<1	<1	<1	<1	<5	<0.5	<1	<1	<1	<1	<5

* Maximum value (there is a potential risk for coelution with other TeCDTs from the GC)