REPORT SNO 6144-2011

Dioxins associated with suspended particulate matter in Grenlandsfjords (Norway)

Norwegian Institute for Water Research
– an institute in the Environmental Research Alliance of Norway

REPORT

Main Office	Regional Office, Sørlandet	Regional Office, Østlandet	Regional Office, Vestlandet	Regional Office Central
Gaustadalléen 21 NO-0349 Oslo, Norway Phone (47) 22 18 51 00 Telefax (47) 22 18 52 00 Internet: www.niva.no	Jon Lilletuns vei 3 NO-4879 Grimstad, Norway Phone (47) 22 18 51 00 Telefax (47) 37 04 45 13	Sandvikaveien 59 NO-2312 Ottestad, Norway Phone (47) 22 18 51 00 Telefax (47) 62 57 66 53	Thormøhlens gate 53 D NO-5006 Bergen Norway Phone (47) 22 18 51 00 Telefax (47) 55 31 22 14	Pirsenteret, Havnegata 9 P.O.Box 1266 NO-7462 Trondheim Phone (47) 22 18 51 00 Telefax (47) 73 54 63 87

Title Dioxins associated with suspended particulate matter- in the Grenlandsfjords (Norway)	Report No.. 6144-2011	Date March 2011
	Project No. O-10426	Pages Price 47
Author(s) Ian J Allan, Morten T Schaanning and Bjørnar Andre Beylich	Topic group Contaminants in the marine environment	Distribution Free
	Geographical area Grenland	Printed NIVA

Client(s) Fylkesmannen i Telemark, Miljøvernavdelingen	Client ref. Marianne Olsen

Abstract

Polychlorinated dibenzo-*p*-dioxins and furans (PCDD/Fs), hexachlorobenzene (HCB) and octachlorostyrene (OCS) concentrations were measured in suspended particulate matter (SPM) samples collected at three sites across the Grenlandsfjord area. The three sites included Frierfjorden, Eidangerfjorden and Kalven, representing three distinct areas of the fjord system. Samples were collected using a submersed high volume water sampler close to the water surface (~ 5 m below the surface) and closer to the seabed (~ 7 m above the seabed). For the surface water, SPM associated PCDD/Fs were similar in all samples, but HCB and OCS was higher in the Frierfjord than in the outer fjords. The deep water in the outer fjords were 4-9 times more contaminated than the surface water and PCA analyses showed that the PCDD/F pattern was similar to the pattern in sediment samples collected in the same area. The data are relevant for contaminant uptake in organisms exposed in the fjord water and may be used to improve models predicting contaminant fate and transport in the Grenlandfjords.

4 keywords, Norwegian	4 keywords, English
1. Sedimentfeller	1. Suspended particulate matter
2. Konsentrasjoner av organiske miljøgifter	2. Trace organic contaminant concentrations
3. Grenlandsfjord	3. Grenland fjord
4. Dioksiner	4. Dioxins

Ian J Allan	*Torgeir Bakke*	*Bjørn Faafeng*
Project Manager	Research Manager	Senior Adviser

ISBN 978-82-577-5879-0

Dioxins associated with suspended particulate matter- in the Grenlandsfjords (Norway)

Preface

This project was funded by the Fylkesmannen i Telemark in 2010 and their contact Marianne Olsen. Fieldwork was conducted on board R/V Trygve Braarud in 2.-12. November 2010. We are thankful to the crew of Trygve Braarud and Sigurd Øxnevad, NIVA, for their assistance during fieldwork. The report also includes analytical results for six sediment samples collected during the survey.

Oslo, 25th March 2011

Ian J. Allan

Contents

Summary

The Grenlandsfjords, a system of five connected fjords in the south of Norway have been severly contaminated with a range of nonpolar organic contaminants including dioxins and furans (PCDD/Fs), hexachlorobenzene (HCB) and octachlorostyrene (OCS). An understanding of the movement and (re)distribution (spatially and with depth) of these contaminants within fjord waters is a prerequisite to the implementation of possible remedial actions in the area. To this end, a sampling campaign was initiated in November 2010 and aiming to provide estimate of suspended particle-associated contaminant concentrations at two distinct depths for three sampling locations in Eidangerfjord, Kalven and Frierfjord. High volume water sampling (~ 300 L) and collection of suspended particulate matter with a 0.7 µm GF/F filter was undertaken *in situ*. Filters were analysed for PCDD/Fs, HCB and OCS. Water samples were collected at the respective sites to provide supporting physico-chemical information.

SPM-associated PCDD/F concentrations in water were highest in deep waters of Eidangerfjord. For Eidangerfjord and Kalven, PCDD/F concentrations were generally higher by a factor of 4-9 in deep waters than in surface layers. PCDD/F concentrations were similar in the brackish surface layer of Frierfjord to those from the outer fjord. However SPM-associated HCB and OCS concentrations in water were higher than those in the shallow waters from the outer fjord. The difference suggested that current sources in Frierfjorden are more important for transport of HCB and OCS than PCDD/F to the outer fjords.

A principal component analyses (PCA) for the relative distribution of the 17 PCDD/Fs components showed close similarity between bottom sediment samples and suspended matter in the deep water in the outer fjords which would be expected from resuspension and internal sediment cycling in the outerfjord, rather than sedimentation of particles from external sources. The PCA-analyses may, however, have been biased by low concentrations of dioxins in shallow SPM.

This data provide us with an improved overview and increased resolution on concentration of PCDD/Fs, HCB and OCS associated with suspended particulate matter in the water column of Eidangerfjord, Kalven and Frierfjord. These data may in the future be used to refine model predictions for the fate, distribution, transport of contaminants in the Grenlandsfjord and ultimately affect exposure of biota.

Sammendrag

Sedimentprøver fra grunne lokaliteter og suspendert materiale (SPM) fra grunne og dype vannmasser ble innsamlet i Frierfjorden, Eidangerfjorden, Ormefjorden og Kalven i November 2010 og analysert for dioksiner og furaner (PCDD/F), heksaklorbensen (HCB) og oktaklorstyren. Undersøkelsen var ledd i arbeidet mot beslutningen om eventuelle tiltak mot forurensingen i sedimenter og biota i Grenlandsfjordene. En bedre forståelse av transport og omsetning av miljøgifter assossiert med suspenderte partikler er et viktig element i en slik beslutning. SPM ble innsamlet ved *in situ* filtrering av store (ca 300 L) volumer sjøvann gjennom 0,7 µm GF/F filter.

De høyeste konsentrasjonene av partikkelbundet PCDD/F ble funnet i dypvannet i Eidangerfjorden og Kalven som inneholdt 4-9 ganger mer enn vann innsamlet i overflatelaget. Brakkvannslaget ytterst i Frierfjorden (like innenfor terskelen ved Brevik) inneholdt mer HCB og OCS, men ikke vesentlig mer PCDD/F, enn prøvene innsamlet på tilsvarende dyp i Kalven og Eidangerfjorden. Dette indikerte at i forhold til transport av forurensing til det ytre fjordområdet er kilder i Frierfjorden viktigere for HCB og OCS enn for PCDD/F.

En mønsteranalyse (PCA) for den relative fordelingen av de 17 PCDD/F komponentene analysert i sediment og SPM prøvene, viste stor likhet mellom det suspenderte materialet i dypvannet og sedimentene fra det ytre fjordområdet. Dette var som forventet dersom det suspenderte materialet primært var resultat av resuspensjon og intern omfordeling av sedimenter i det ytre fjordområdet, men analysen kan ha vært misvisende pga lave konsentrasjoner av dioksiner i overflateprøvene.

Dataene har gitt oss en bedre oversikt og forståelse av variasjonene av PCDD/F, HCB og OCS i suspendert materiale i vannmassene i Eidangerfjorden, Kalven og Frierfjorden. Dataene er relevante i forhold til opptak av miljøgifter i organismer eksponert i vannmassene i fjorden og vil kunne bli benyttet til å forbedre modeller for transport og omsetning av miljøgifter i Grenlandsfjordene.

1. Introduction

The Grenland fjord system (Norway) has been substantially contaminated with PCDD/Fs, hexachlorobenzene (HCB) and octachlorostyrene (OCS) as a result of discharges from a magnesium production plant at Herøya in the Frierfjord from 1951 to 2002. While PCDD/F discharges have been significantly reduced over the last 25 years, concentrations in the different fjords remain high as a result of the high hydrophobicity and low biodegradation potential of PCDD/Fs. These high concentrations together with recommendations against the consumption of local fish/shellfish imply that some form of remediation may be necessary [1, 2]. This, however, can only be undertaken with a clear understanding of factors controlling PCDD/F fate in this fjord system and those affecting PCDD/F availability to organisms in water and sediments [3-7]. The movement and re-distribution of these hydrophobic contaminants in the fjord system is linked to the movement and settling of suspended particles. Until now, limited data on the concentrations of PCDD/Fs, HCB and OCS associated with suspended particulate matter (SPM) and on their distribution across the water column are available [5, 8]. The distribution and levels of contaminants at different depths in the water column in the fjords has also received limited attention. With freshwater input to Frierfjord, outflowing surface waters will have a lower salinity and suspended particles that differ (in amount and in source) from those in deeper layers of water in the fjord.

This project therefore aims to provide concentrations of contaminants associated with suspended particulate matter in three areas of the Grenlandsfjord, namely Frierfjord, Eidangerfjord and Kalven. Objectives included (i) the measurement of PCDD/Fs, HCB and OCS associated with SPM sampled using high volume water sampling [9, 10], (ii) the measurement of these concentrations at two distinct depths in water to assess differences that may exist for waters at different depths. For Eidangerfjord and Kalven, sampling at depth was undertaken relatively close to the seabed, while for Frierfjord "deep" samples were collected further up in the water column. These parameters are relatively important for the estimation of particle-associated flow of contaminants in the fjord system.

2. Material and methods

2.1 Study site description and high volume water sampling

A total of five connected fjords (see Figure 1) constitute the Grenland fjord system in the south of Norway (59º 05' N, 9º 38' E). The innermost fjord, Frierfjord, has been the subject of significant PCDD/F contamination due to discharge from a magnesium production plant at Herøya. While emissions spanned a total of 50 years, a significant reduction in discharges occurred over the last 25 years of activity of the plant. Despite this, PCDD/F concentrations remain high in the fjord system. The map presented in Figure 1, shows the sites selected for sampling of suspended particulate material and those for the bed sediment sampling campaign (shallow areas also included in this work). As shown on the map (Figure 1), Site GFD01, FA S3 and GY08 were situated in Frierfjord, Eidangerfjord and Kalven, respectively.

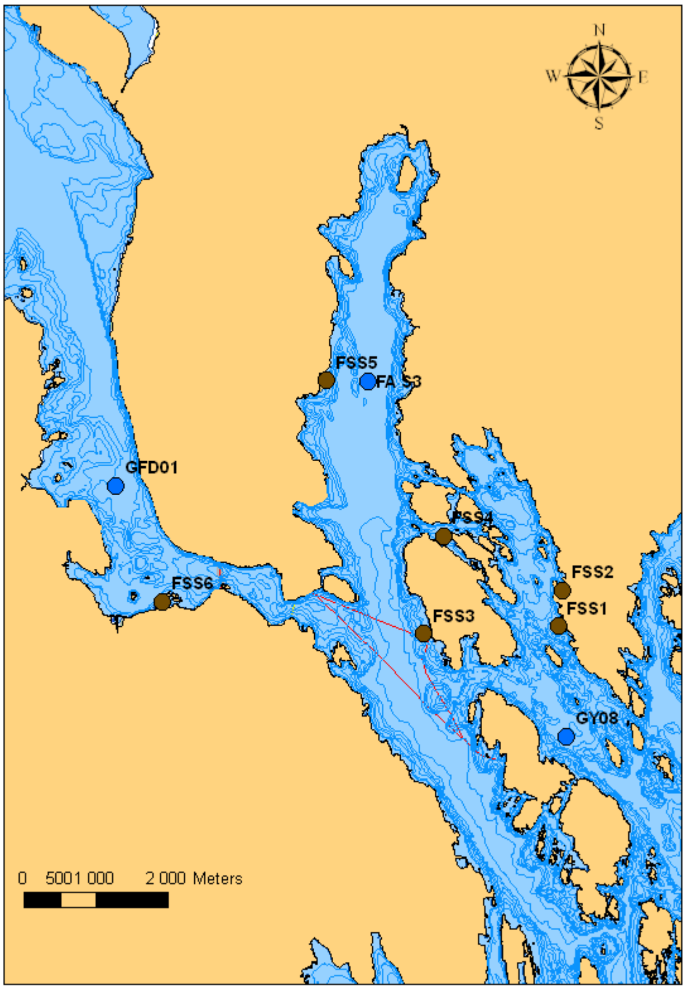


Figure 1. Map of the Grenlandsfjord area with high volume water sampling stations (blue dots) and bed sediment samples collected in shallow areas (brown dots)

A picture of the custom-made high volume water sampler used in this study is presented on Figure 2. Water is filtered through a filter placed onto the filter holder on top of the instrument. The water then passes through a chamber where it is possible to place a sorbent for extraction of dissolved contaminants. The water is then drawn through the battery-driven pump and the flowmeter for accurate measurement of the volume of water sampled.

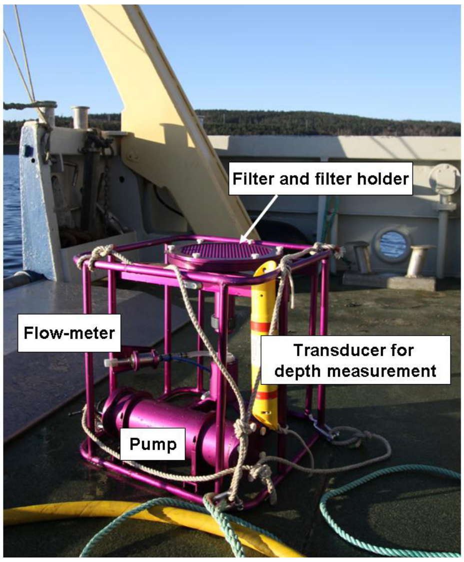


Figure 2. The high volume water sampler with a filter holder accepting 30 cm-diameter filter, a pump and flowmeter. A transducer was fastened to the rig for accurate measurement of depth.

The table below (Table 1) summarises some of the sampling data. This includes the dates samples were taken on, the coordinates of each of the three sites, the total depth of water at each of the sites and finally the total volumes of water sampled for each sampling event. Most samples were close to 300 L of water extracted, except for the GFD01 sample for which only 250 L of water were sampled.

Table 1. Sampling site identification (with coordinates and water depth), date of sampling and volume of water sampled with the high volume water sampler.

Site ID	Date	Coordinates Lattitude	Longitude	Depth (m)	Volume sampled (L)
FA S3 Shallow-5m	04.11.2010	59.07848	9.70780	96	297
FA S3 Deep-89m	04.11.2010				297
GY08 Shallow-5m	05.11.2010	59.03595	9.76282	57	298
GY08 Deep-50m	05.11.2010				279
GFD01 Shallow-4m	10.11.2010	59.06295	9.64853	43	247
GFD01 Deep-7m	10.11.2010				298

High volume water sampling was undertaken with a custom-made automatic sampler and filters with a nominal pore size of 0.7 µm were used to collect suspended particles during pumping of approximately 300 L of water over a time period of approximately 2 hours. Filters were prebaked at 550 °C and packed in clean aluminium foil to ensure that blanks presented minimal levels of PCDD/Fs. Sampling was undertaken at three sites in the Grenlandsfjord and at two depths for each of these sites (See Table 1). The first site (FA S3) is situated in Eidangerfjord and sampling depths were 7 m above the seabed for FA S3 Deep sample and 5 m below the surface for the “shallow” sample. The second site (GY08) in Kalven was sampled on the following day and the sampler was set 7 m above the seabed and 5 m below the surface for “deep” and “shallow”, respectively. The final site in Frierfjord (GFD 01) was sampled the following week and the “shallow” sample was collect from 4 m below the surface, while the “deep” sample was 7 m below the surface in order to sample incoming water to the fjord. Prior to setting up the high volume water sampler, CTD profiles were obtained to establish depths of sampling for each of the stations.

Profiles of temperature and salinity (conductivity) were obtained for each of the three sites and are presented in Figure 3. In Eidangefjord (FA S3), a thermocline is shown to present at approximately 60 m depth, while the salinity increases from 29 for surface waters to 34.5 at depth. In Frierfjord (GFD01) a clear drop in both temperature (6 °C) and salinity (7) can be seen for the layer of water 2-3 m below the surface, as a result of the freshwater input from the Skienselva. Below 3 m, a steep increase in salinity can be observed. The salinity plateaus at approximately 30-33. A step can be seen in the temperature profile 5 and 13 m below the surface and indicate a water mass moving into Frierfjord over the sill at Brevik. Finally profiles of temperature and salinity with depth for Kalven (GY08) appear very similar to those obtained in Eidangerfjord with a rise in salinity from 29 at the surface to 34 approximately 30 m below the surface. At 30 m depth, the temperature drops sharpely by about 4 °C.

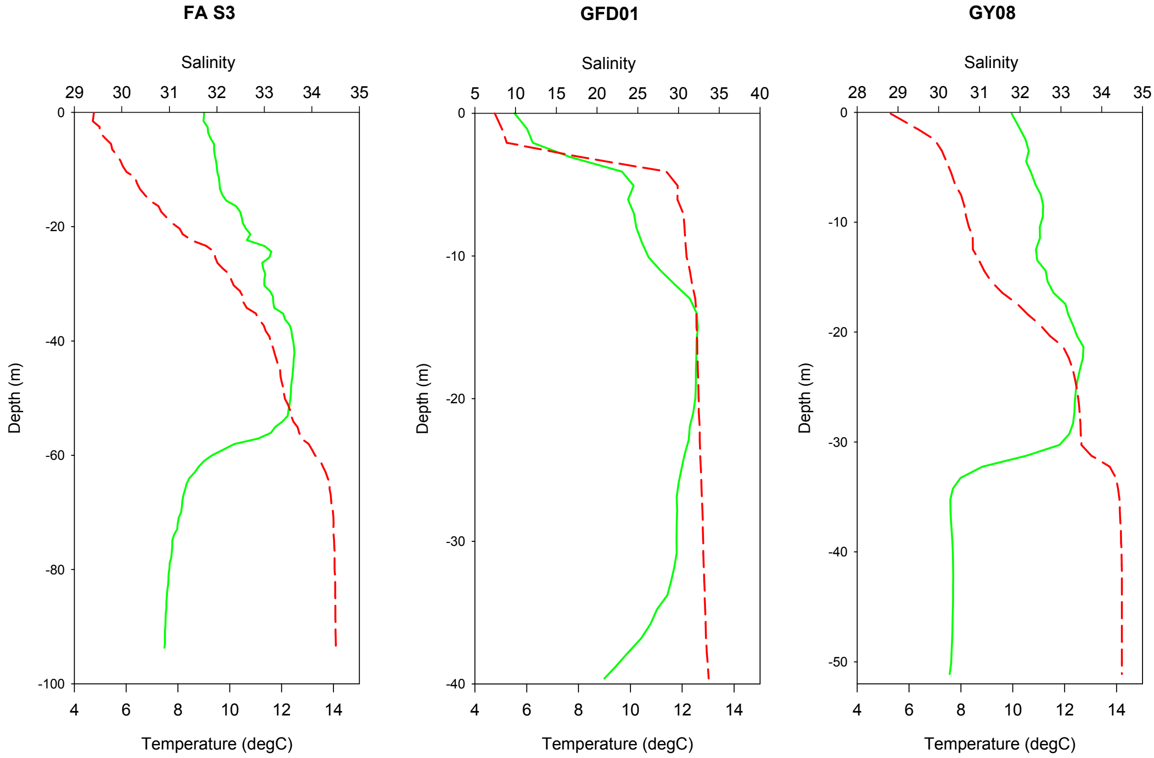


Figure 3. Temperature (°C) (green line) and salinity (red dashed line) profiles for the three high volume water sampling stations in Eidangerfjord (FA S3), Frierfjord (GFD01) and Kalven (GY08), respectively.

2.2 Analysis of water samples for additional parameters

Water samples were collected at the same sites as those obtained for high volume water sampling and this sampling was conducted either close to the start of the high volume water sampling period or close to the end. A total of six water samples were collected at the same depths as that used for high volume water sampling and aimed to supplement information obtained by high volume water sampling. Samples were collected for further determination of total suspended particulate matter content of the water, total and dissolved organic content, salinity and for chlorophyll *a* analysis. A range of suitable plastic and glass bottle provided by the laboratory at NIVA was used. Sample analysis was conducted at NIVA's laboratory following standard procedures.

2.3 Analysis for PCDD/Fs, HCB and OCS

Glass fibre filters (0.7 µm) were baked in a muffle furnace to remove potential organic contaminants and packed in clean (baked) aluminium foil. Filters were kept in aluminium foil until use. Clean gloves and solvent rinsed twisers were used to place the filter onto the instrument. Once sampling completed, filters were retrieved, carefully folded and placed in clean aluminium foil. Sotrage was in the freezer at -20 °C until extraction and analysis. Extraction and analysis was undertaken at Umeå University (Sweden) following accredited protocols (Appendix B). A picture of the filters following sampling is presented in Figure 4.

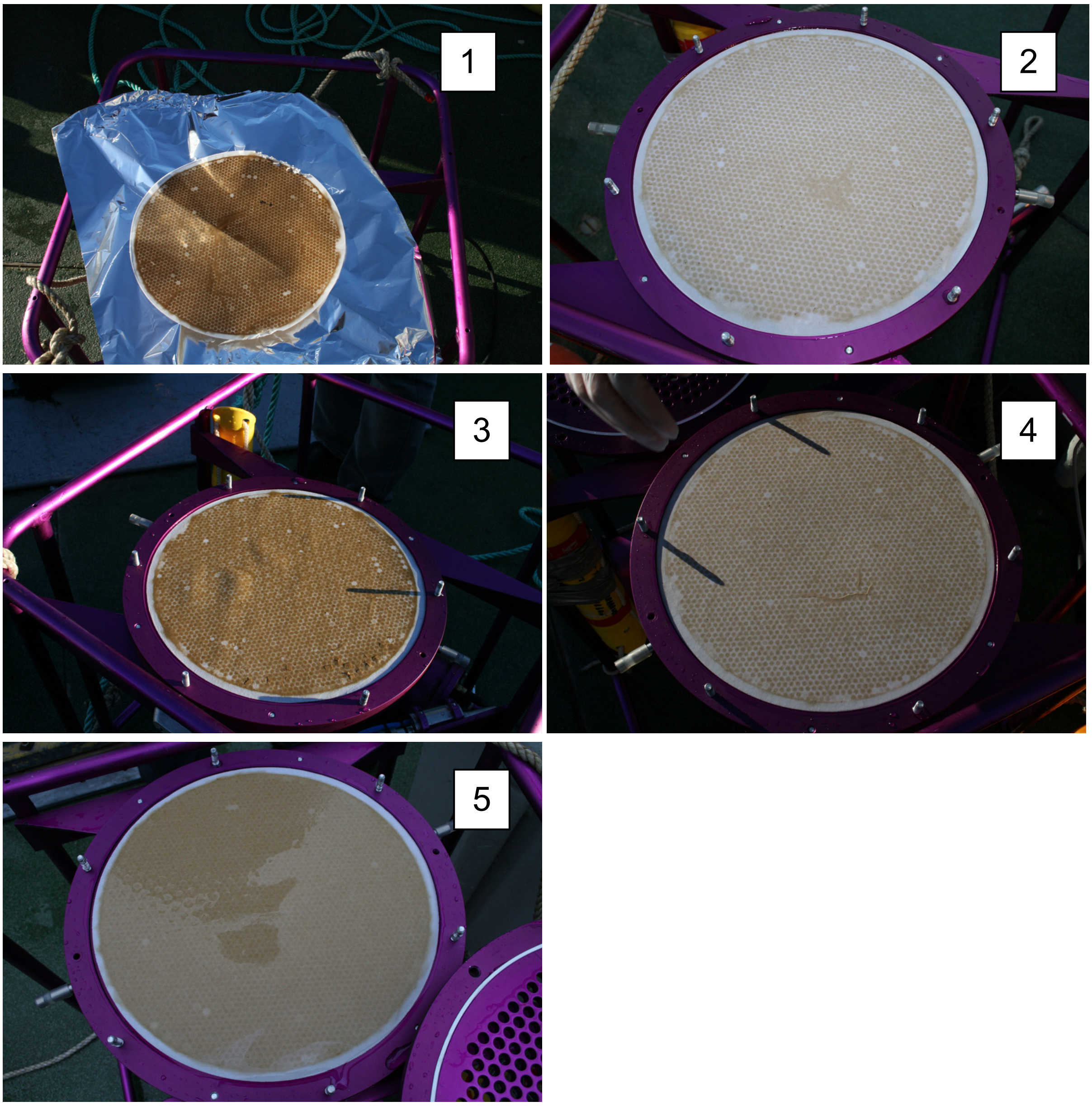


Figure 4. Large diameter (30 cm) filters with a pore size of 0.7 µm following high volume filtration at FA S3 Deep and Shallow (1 and 2), GY08 Deep and Shallow (3 and 4) and GFD1 Deep (5). Note that one picture is missing from the last site.

3. Results and discussion

3.1 Supporting measurement of main parameters

Water samples collected either at the start or the end of the high volume water sampling were analysed for a number of parameters and these are reported in the table below (Table 2). Levels of suspended particulate matter were in a relatively narrow range and varied between 1.5 and 2.7 mg L^{-1} depending on the sites and the depth. A SPM level for the sample of surface water from Eidangerfjord higher than that collected deeper in the water column is suprising considering the colour of the filters following high volume water filtration (See Figure 4). Levels of organic matter, organic carbon and SPM varied in a relatively narrow range. Levels of chlorophyll *a* in the samples were in agreement with sampling depth, with consistently higher concentrations for samples taken from the surface. Levels measured in samples from the Frierfjord were higher than those from Eidangerfjord or Kalven. The salinity measured in samples from Eidangerfjord and Kalven were consistent with profiles measured with the CTD probe (Figure 3). Both samples from Frierfjord had surprisingly high salinity, particularly when compared with CTD profiles.

Table 2. Measurement of suspended particulate matter (SPM), organic matter content (OM), total and dissolved organic carbon content, chlorophyll *a* and salinity.

Site ID	Depth (m)	SPM[1] (mg L^{-1})	OM[2] (mg L^{-1})	NPOC/DC[3] (mg C L^{-1})	NPOC/DC,m[4] (mg C L^{-1})	Chlorophyll *a* (µg L^{-1})	Salinity
Eidangerfjord	5	2.7	0.8	1.7	2.8	0.39	28.6
Eidangerfjord	90	1.8	1.7	1.0	1.2	<0.31	34.4
Kalven	5	1.9	1.0	1.5	1.7	0.45	29.3
Kalven	40	2.8	1.3	1.1	1.0	<0.31	33.4
Frierfjord	4	2.1	1.0	1.8	2.1	0.97	27.4
Frierfjord	8	1.5	0.5	1.8	1.8	0.69	27.6

[1] Suspended particulate matter concentration
[2] Organic matter content
[3] Dissolved organic carbon
[4] Total organic carbon

3.2 PCDD/F concentrations in the suspended particulate phase

Results from the extraction and analysis of filters for PCDD/Fs, HCB and OCS following high volume water sampling in Eidangerfjord, Kalven and Frierfjord are presented in Tables 3, 4 and 5, respectively. Concentrations are given in amount of compounds associated with suspended particulate matter per volume of water. In addition, PCDD/F toxicity equivalents (TEQs) calculated using the WHO_{1998} guidelines are also provided. Concentrations range from below limits of detections to 29 pg L^{-1} for OCDF for the sample from Eidangerfjord (FA S3 Deep; see Table 3). SPM-associated PCDD/F concentrations measured close to the seabed in Eidangerfjord are generally higher than those measured during the fieldwork campaign in June 2008 by a factor of 3 [10] before any trawling took place in the fjord. However, concentrations measured here also remain a factor of 5-10 below those obtained during measurements made in a benthic trawler-generated plume of re-suspended sediments [10]. It may be that benthic trawling had been conducted relatively recently and we were able to detect traces from such activity. Concentrations of PCDD/Fs measured in Kalven are generally in agreement with those from Eidangerfjord. The levels measured just above the seabed at the two locations are very similar while samples taken from closer to the surface also show good agreement (Tables 3 and 4). Concentrations measured in both samples from the Frierfjord are very similar to values reported previously for high volume filtration undertaken at very similar depths near Brevik sill [8].

Concentrations measured previously were in the range 0.07-5.4 pg L^{-1} and 0.004-0.9 pg L^{-1} for furans and dioxins, respectively. Estimates of the total transport of SPM-associated contaminants with the Skien River (Skienselva) into the outer fjord were calculated from the sample collected in surface waters from Frierfjord and are given in Table 5. Total fluxes of PCDD, PCDFs and HCB to the outer fjord and OCS were 3.9, 64, 257, 29 g $year^{-1}$, respectively. This flux expressed in TEQ was in the range 1.8-2.1 g TEQ $year^{-1}$ (Table 5).

Table 3. Concentration of PCDD/Fs, HCB and OCS associated with suspended particulate matter at Site FA S3 (Eidangerfjord) sampled in shallow and deep water. PCDD/F toxicity equivalent are also provided.

Contaminant ID	SPM-associated concentration (pg L^{-1} dry weight)	
	FA S3 Deep*	FA S3 Shallow*
2,3,7,8-TCDD	<0.03	<0.002
1,2,3,7,8-PeCDD	<0.06	<0.004
1,2,3,4,7,8-HxCDD	0.064	<0.02
1,2,3,6,7,8-HxCDD	0.093	<0.02
1,2,3,7,8,9-HxCDD	0.085	<0.03
1,2,3,4,6,7,8-HpCDD	0.85	0.11
OCDD	2.5	0.30
2,3,7,8-TCDF	0.35	0.094
1,2,3,7,8/1,2,3,4,8-PeCDF	0.72	0.14
2,3,4,7,8-PeCDF	0.42	0.07
1,2,3,4,7,8/9-HxCDF	1.7	0.33
1,2,3,6,7,8-HxCDF	0.94	0.19
1,2,3,7,8,9-HxCDF	0.44	**
2,3,4,6,7,8-HxCDF	0.67	0.09
1,2,3,4,6,7,8-HpCDF	4.6	0.76
1,2,3,4,7,8,9-HpCDF	2.0	0.37
OCDF	29	3.64
HCB	1.2	0.30
OCS	0.26	0.21
TEQ_{max} (pg TEQ L^{-1})***	0.84	0.13
TEQ_{min} (pg TEQ L^{-1})***	0.75	0.12

*See methods and text for further description of depths sampled
**Limit of detection/contaminant concentration per filter similar or below value for the blank filter
***Min/max values based on whether data below limits of detection is given a value = 0 or the limit of detection and toxicity equivalent factors TEF from WHO_{1998}

Table 4. Concentration of PCDD/Fs, HCB and OCS associated with suspended particulate matter at Site GY 08 (Kalven) sampled in shallow and deep water. PCDD/F toxicity equivalent are also provided.

Contaminant ID	SPM-associated concentration (pg L^{-1} dry weight)	
	GY 08 Deep*	GY 08 Shallow*
2,3,7,8-TCDD	**	**
1,2,3,7,8-PeCDD	0.016	**
1,2,3,4,7,8-HxCDD	0.036	**
1,2,3,6,7,8-HxCDD	0.056	<0.002
1,2,3,7,8,9-HxCDD	0.062	<0.02
1,2,3,4,6,7,8-HpCDD	0.47	0.075
OCDD	1.0	0.20
2,3,7,8-TCDF	0.19	0.026
1,2,3,7,8/1,2,3,4,8-PeCDF	0.37	0.059
2,3,4,7,8-PeCDF	0.28	0.031
1,2,3,4,7,8/9-HxCDF	1.2	0.18
1,2,3,6,7,8-HxCDF	0.61	0.094

1,2,3,7,8,9-HxCDF	0.20	**
2,3,4,6,7,8-HxCDF	0.32	0.037
1,2,3,4,6,7,8-HpCDF	3.5	0.49
1,2,3,4,7,8,9-HpCDF	1.2	0.17
OCDF	14	2.2
HCB	14	3.0
OCS	0.93	0.26
TEQ$_{max}$ (pg TEQ L^{-1})***	0.51	0.07
TEQ$_{min}$ (pg TEQ L^{-1})***	0.49	0.06

*See methods and text for further description of depths sampled

**Limit of detection/contaminant concentration per filter similar or below value for the blank filter

***Min/max values based on whether data below limits of detection is given a value = 0 or the limit of detection and toxicity equivalent factors TEF from WHO$_{1998}$

Table 5. Concentration of PCDD/Fs, HCB and OCS associated with suspended particulate matter at Site GFD 01 (Frierfjord) sampled in shallow and deep water and resulting estimated SPM-associated contaminant flux for the Skienselva. For comparison, some high volume sampling data from Ref. [8] is also given. PCDD/F toxicity equivalent are also provided.

Contaminant ID	SPM-associated concentration (pg L^{-1} dry weight)		SPM-associated concentration (pg L^{-1} dry weight) from Ref [8]***	Flux of SPM-associated contaminants (g $year^{-1}$)****
	GFD 01 Deep*	GFD 01 Shallow*		
2,3,7,8-TCDD	<0.07	**	0.005	<0.1
1,2,3,7,8-PeCDD	<0.06	**	0.021	<0.2
1,2,3,4,7,8-HxCDD	<0.06	**	0.027	<0.2
1,2,3,6,7,8-HxCDD	<0.07	0.006	0.031	0.05
1,2,3,7,8,9-HxCDD	<0.08	<0.02	0.035	<0.1
1,2,3,4,6,7,8-HpCDD	0.21	0.14	0.26	1.2
OCDD	0.40	0.29	0.90	2.5
2,3,7,8-TCDF	<0.09	0.10	0.18	0.9
1,2,3,7,8/1,2,3,4,8-PeCDF	0.20	0.18	0.30	1.5
2,3,4,7,8-PeCDF	0.11	0.12	0.08	1.0
1,2,3,4,7,8/9-HxCDF	0.60	0.44	0.60	3.8
1,2,3,6,7,8-HxCDF	0.34	0.25	0.30	2.2
1,2,3,7,8,9-HxCDF	0.030	<0.2	0.083	2.7
2,3,4,6,7,8-HxCDF	0.15	0.097	0.30	0.8
1,2,3,4,6,7,8-HpCDF	1.4	1.1	1.4	9.6
1,2,3,4,7,8,9-HpCDF	0.67	0.41	0.50	3.5
OCDF	7.3	4.4	5.4	37.6
HCB	15	30	-	257
OCS	1.2	3.3	-	29
TEQ$_{max}$ (pg TEQ L^{-1})*****	0.36	0.24		2.1
TEQ$_{min}$ (pg TEQ L^{-1})*****	0.21	0.17		1.8

*See methods and text for further description of depths sampled

**Limit of detection/contaminant concentration per filter similar or below value for the blank filter

***From Ref [8]; sampling at 3 m depth

****Based on an average flow of 270 $m^3 s^{-1}$ for the skienselva river

***** Min/max values based on whether data below limits of detection is given a value = 0 or the limit of detection and toxicity equivalent factors TEF from WHO$_{1998}$

As shown on Figure 5, SPM-associated contaminant concentrations tend to be highest in samples collected closer to the seabed. PCDD/F concentrations were found to be highest for the sample collected closer to the seabed in Eidangerfjord. Slightly lower concentrations were measured at depth in Kalven. PCDD/F concentrations for both sampling depths in the overlying water of Frierfjord were very similar and lower than those found at depth in Kalven. Lowest PCDD/F concentrations were measured for surface waters of Kalven. For HCB and OCS however, SPM-associated concentrations were found highest for the most surfacial waters of Frierfjord. These were higher than those measured close to the seabed in Eidangerfjord and Kalven.

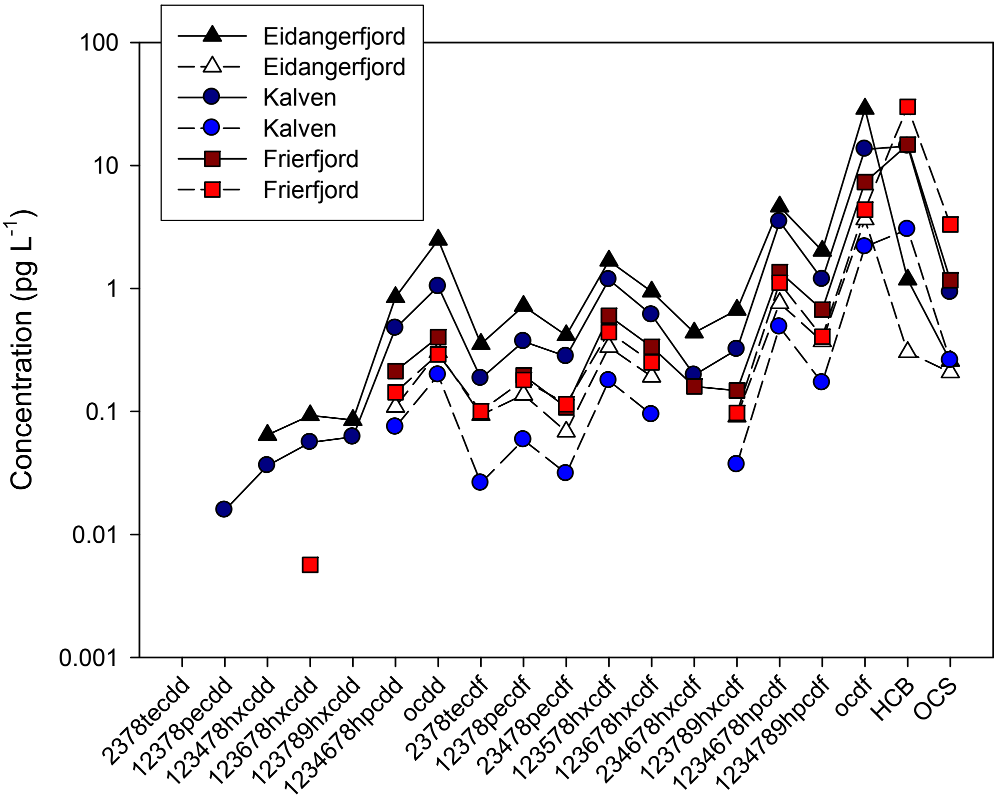


Figure 5. Concentrations of SPM-associated PCDD/F, HCB and OCS measured in deep (black symbols) and shallow/surface waters (white symbols) in Eidangerfjord, Kalven (Ormefjord) and Frierfjord. Lines linking congeners for each sample have no scientific meaning; they are plotted for visual impression only.

Ratios of contaminant concentrations measured in deep waters over those obtained in shallow areas for Eidangerfjord, Kalven and Frierfjord are presented on Figure 6. These ratios indicate that for Eidangerfjord and Kalven, SPM-associated contaminant concentrations in deep waters were between a factor of 4 and 9 higher than those measured in shallow/surface waters (Figure 6). Ratios obtained for samples collected from Frierfjord are generally close to or slightly above 1 for PCDD/Fs. However these ratios are below 1 for HCB and OCS (0.49 and 0.35 for HCB and OCS, respectively). If as assumed, high volume water sampling at depth was undertaken in the water layer moving upstream in the fjord, this would suggest for that particular site that there is a flux of SPM-associated HCB and OCS from Frierfjord to Eidangerfjord and concentrations in incoming waters are slightly lower. The more marginal difference for PCDD/F suggest comparatively lower outflow of dioxins. It is possible that the less hydrophobic compounds (HCB and OCS) are more mobile and able to be remobilised from point sources and shallow sediments.

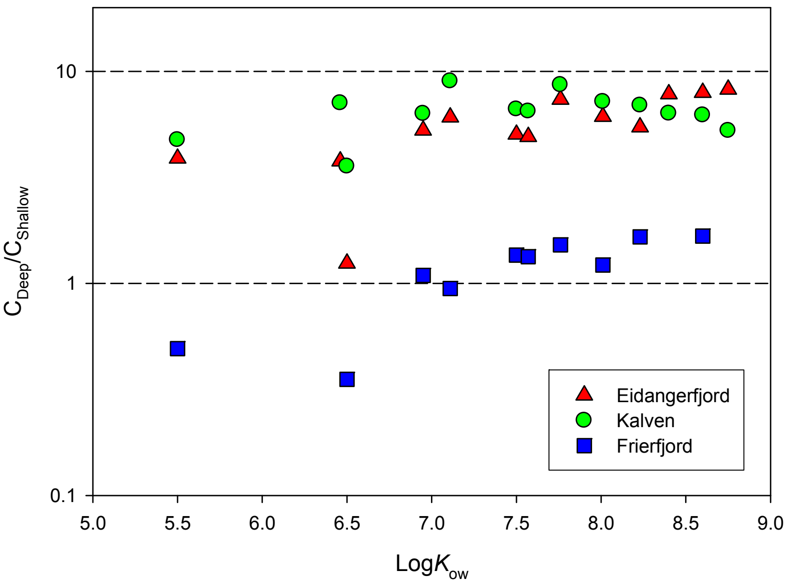


Figure 6. Ratios of SPM-associated PCDD/F, HCB and OCS measured in deep waters over those measured in shallow/surface waters in Eidangerfjord, Kalven and Frierfjord.

Concentrations of SPM-associated PCDD/Fs, HCB and OCS were also converted into concentrations based on masses of suspended particulate matter (pg g^{-1} dry weight SPM) measured in bottle samples collected alongside high volume water sampling (Table 2). These data are provided in Tables A1, A2 and A3 in Appendix A.

3.3 PCDD/Fs, HCB, OCS and metal concentrations in bed sediments from six shallow areas

The concentration of PCDD/Fs, HCB and OCS in bed sediment from six sampling stations in shallow areas is presented in the Table below (Table 6). This table also include the total organic carbon content of each of the sediment samples and the fraction of particles < 63 µm.

Table 6. Concentrations of PCDD/Fs, HCB, OCS in bed sediments at sampling stations FSS1-6. Total organic carbon content (TOC) and % particle < 63 µm are also given. PCDD/F toxicity equivalent are also given.

	Bed sediment concentration (pg g^{-1} dry weight)					
	FSS1	FSS2	FSS3	FSS4	FSS5	FSS6
TOC (mg C g^{-1})	9.3	29.8	1.8	5.7	7.2	41.8
% particles < 63 µm	25	83	2	34	57	95
2,3,7,8-TCDD	1.7	6.7	0.44	2.0	1.2	49
1,2,3,7,8-PeCDD	8.6	33	2.2	10	6.0	220
1,2,3,4,7,8-HxCDD	13	45	3.2	13	7.8	310
1,2,3,6,7,8-HxCDD	17	67	4.7	20	11	470
1,2,3,7,8,9-HxCDD	15	59	3.7	17	11	400
1,2,3,4,6,7,8-HpCDD	120	430	31	130	81	2600
OCDD	320	870	80	310	220	5100
2,3,7,8-TCDF	48	190	13	60	34	1600
1,2,3,7,8/1,2,3,4,8-PeCDF	81	380	23	120	65	2300
2,3,4,7,8-PeCDF	36	240	17	77	44	2000
1,2,3,4,7,8/9-HxCDF	270	1000	72	320	180	7400

1,2,3,6,7,8-HxCDF	140	570	31	170	100	4400
1,2,3,7,8,9-HxCDF	69	270	18	84	43	2200
2,3,4,6,7,8-HxCDF	82	290	22	89	54	2100
1,2,3,4,6,7,8-HpCDF	860	2900	220	890	540	11000
1,2,3,4,7,8,9-HpCDF	280	970	70	320	180	8000
OCDF	3300	11000	880	3600	2300	59000
HCB	3700	9800	880	3500	2000	97000
OCS	210	490	41	200	100	11000
TEQ (pg TEQ g^{-1})*	111	472	32	148	85	3494

*Toxicity equivalent factors TEF from WHO_{1998}

The concentrations of cadmium (Cd), copper (Cu), mercury (Hg), lead (Pb) and zinc (Zn) are presented in Table 7.

Table 7. Concentrations of Cd, Cu, Hg, Pb and Zn in bed sediments from stations FSS1 to FSS6.

	Bed sediment concentration (µg g^{-1} dry weight)					
	FSS1	FSS2	FSS3	FSS4	FSS5	FSS6
Cd	<0.2	0.3	<0.2	<0.2	<0.2	<0.2
Cu	8.39	25.1	14.8	5.8	6.29	38.1
Hg	0.16	0.8	0.039	0.17	0.14	1.95
Pb	21	49.5	7.1	14	12	118
Zn	51.9	104	19	32	31	187

3.4 Principal component analyses

A principle component analysis (PCA) for PCDD/Fs in shallow sediments (Table 6) and suspended matter (table 3-5) was performed using the multivariate platform in JMP® 9.0.0 statistical software from SAS Institute Inc. The relative (%) congener distribution of the 17 components shown in Table 3-6 was used for the analyses. 50% of the detection limit was assigned for component concentrations lower than detection limit.

The results (Figure 7) showed that the sediment samples from the outer fjords (FSS1-5) and the two deep samples of suspended matter in Kalven (GY08) and Eidangerfjorden (FAS3) grouped close to origo (small scores for both PCA1 and PCA2). The sediment sample from Frierfjorden (FSS6 = red, filled circle in fig. 7a) scored close to zero for PCA2, but was separated from the other sediment samples by a positive score for PCA1. The four samples for suspended matter in shallow (<10m depth) water were all characterised by scores that differed from zero for PCA2.

The loadings plot in Figure 7b show that the PCA1 tend to score positively for hepta- and negative for octa -components (both dioxins and furans). PCA2 tend to score positively for tetra-, penta- and hexa-dioxins and negatively for the corresponding furans.

The PCA analyses should not be over-interpreted, but it appears interesting that the PCDD/F pattern in suspended particles in the deep waters of Kalven and Eidangerfjorden was more similar to the pattern in shallow sediments in the outer fjords than they were to the particles in the brackish layer in Frierfjorden near the Brevik sill. This would be expected if the suspended particles in the deep water result primarily from internal cycling of sediments in the outer fjord rather than from recent input from the Frierfjord. Unfortunately, tetra-, penta- and hexa-dioxins were frequently below detection limits in the SPM-samples from shallow waters and this may have affected the differentiation of the stations along PCA2.

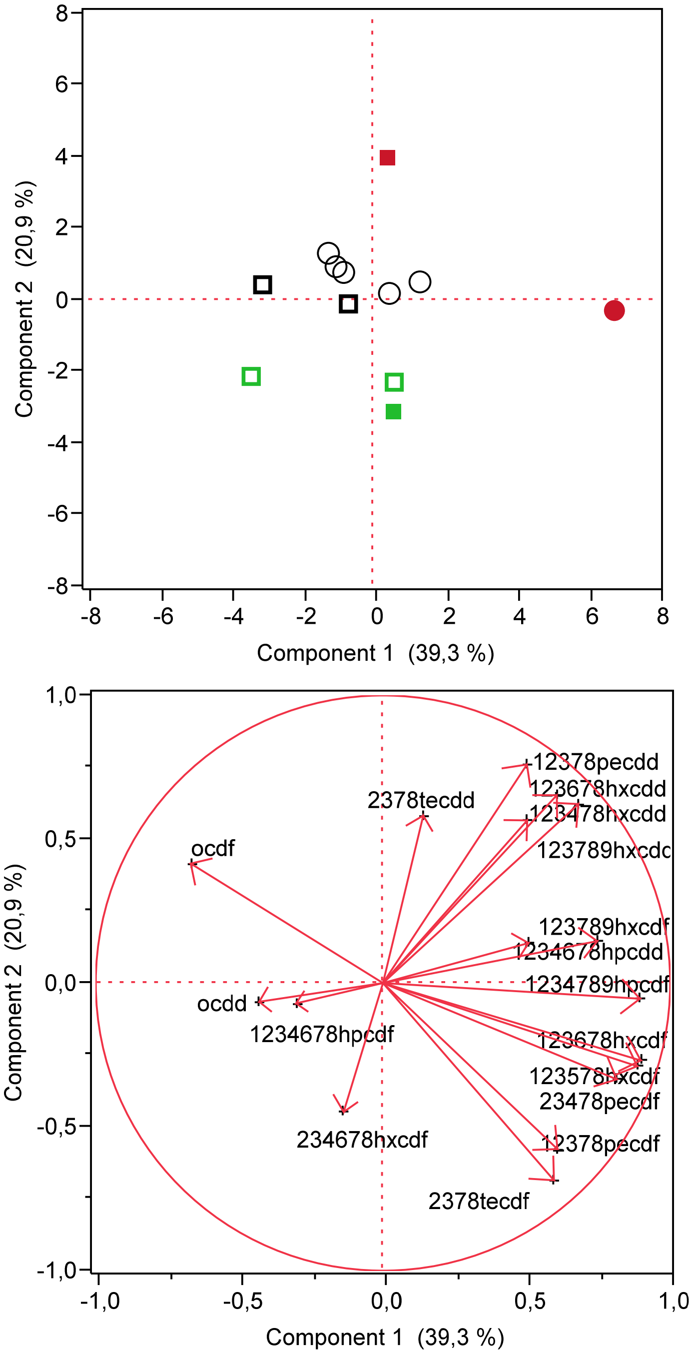


Fig.7. PCA plot for the relative distribution of PCDD/F components in six samples of sediment (circles) and suspended matter (squares) collected in november 2010. a) Score plot shows the score of PCA1 and PCA2 for the distribution pattern at each station. Open symbols represent samples from outer fjords (Eidangerfjorden, Kalven and Ormefjorden). Filled symbols represent samples from Frierfjorden near Brevik. The two black squares near the sediment samples and plot origo represent suspended matter collected near the bottom of Eidangerfjord and Kalven, respectively. (See text for further details). b) Loadings plot indicates the magnitude and direction of contribution from each of the seventeen components.

4. Conclusions

The Grenlandsfjords, a system of five connected fjords in the south of Norway have been severly contaminated with a range of nonpolar organic contaminants including dioxins and furans (PCDD/Fs), hexachlorobenzene (HCB) and octachlorostyrene (OCS). An understanding of the movement and (re)distribution (spatially and with depth) of these contaminants within fjord waters is a prerequisite to the implementation of possible remedial actions in the area. To this end, a sampling campaign was initiated in November 2010 and aiming to provide estimate of suspended particle-associated contaminant concentrations at two distinct depths for three sampling locations in Eidangerfjord, Kalven and Frierfjord. For Eidangerfjord and Kalven, sampling at depth was undertaken relatively close to the seabed, while for Frierfjord "deep" samples were collected further up in the water column. High volume water sampling (~ 300L) and collection of suspended particulate matter with a 0.7 µm GF/F filter was undertaken *in situ*. Filters were analysed for PCDD/Fs, HCB and OCS. Water samples were collected at the respective sites to provide supporting physico-chemical information. Conclusions of this work are:

- SPM-associated PCDD/F concentrations in water were found to be highest in deep waters of Eidangerfjord.
- For Eidangerfjord and Kalven, PCDD/F concentrations were generally higher by a factor of 4-9 in deep waters than in surface layers of water.
- PCDD/F concentrations were similar in surface (water from the skienselva with a relatively low salinity, although this was not shown by the bottle sample) and deeper surface waters of Frierfjord.
- SPM-associated HCB and OCS concentrations in water were higher the surface layer than in the deeper overlying water in Frierfjord.
- The data indicated that the Frierfjord presently is a stronger source for less hydrophobic HCB and OCS than for PCDD/Fs. If active industrial process sources have been reduced to a negligible level, diffuse and point sources based on contamination present in soils and shallow sediments are the most likely to be the current source upstream Breivik.
- The relatively high concentrations in the deep water in Kalven and Eidangerfjorden indicates that suspended particles still represent a significant risk for contamination of organisms living at or in the deep bottoms of the outer fjords.
- The similarity of the PDD/F patterns in the SPM in deep water and shallow sediment samples was consistent with resuspension and internal sediment cycling in Eidangerfjorden and Kalven rather than new input from external sources.

This data provide us with an improved overview and increased resolution on concentration of PCDD/Fs, HCB and OCS associated with suspended particulate matter in the water column of Eidangerfjord, Kalven and Frierfjord. These data may in the future be used to refine model predictions for the fate, distribution, transport of contaminants in the Grenlandsfjord and ultimately affect exposure of biota.

5. References

[1] Saloranta TM, Andersen T, and Naes K. Flows of dioxins and furans in coastal food webs: Inverse modeling, sensitivity analysis, and applications of linear system theory. Environmental Toxicology and Chemistry 2006;25:253-64.

[2] Saloranta TM, Armitage JM, Haario H, Naes K, Cousins IT, and Barton DN. Modeling the effects and uncertainties of contaminated sediment remediation scenarios in a Norwegian Fjord by Markov chain Monte Carlo simulation. Environmental Science & Technology 2008;42:200-6.

[3] Persson NJ, Bucheli TD, Gustafsson O, Broman D, Naes K, Ishaq R, et al. Testing common sediment-porewater distribution models for their ability to predict dissolved concentrations of POPs in The Grenlandsfjords, Norway. Chemosphere 2005;59:1475-85.

[4] Persson NJ, Cousins IT, Molvaer J, Broman D, and Naes K. Modelling the long-term fate of polychlorinated dibenzo-p-dioxins and furans (PCDD/Fs) in the Grenland Fjords, Norway. Science of the Total Environment 2006;369:188-202.

[5] Persson NJ, Gustafsson O, Bucheli TD, Ishaq R, Naes K, and Broman D. Soot-carbon influenced distribution of PCDD/Fs in the marine environment of the Grenlandsfjords, Norway. Environmental Science & Technology 2002;36:4968-74.

[6] Persson NJ, Gustafsson O, Bucheli TD, Ishaq R, Naes K, and Broman D. Distribution of PCNs, PCBs, and other POPS together with soot and other organic matter in the marine environment of the Grenlandsfjords, Norway. Chemosphere 2005;60:274-83.

[7] Ruus A, Berge JA, Hylland K, Bjerkeng B, Bakke T, and Naes K. Polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) in the Grenland Fjords (Norway) - Disposition, levels, and effects. Journal of Toxicology and Environmental Health-Part a-Current Issues 2006;69:185-200.

[8] Cornelissen G, Broman D, and Naes K. Freely dissolved PCDD/F concentrations in the Frierfjord, Norway: Comparing equilibrium passive sampling with "active" sampling. Journal of Soils and Sediments 2009;in press.

[9] Allan IJ, Fjeld E, Garmo ØA, Langford K, Kringstad A, Bratsberg E, et al. RiverPOP: Measuring concentrations of persistent organic pollutants and trace metals in Norwegian rivers. Oslo: Norsk Institutt for Vannforskning; 2009, p. 112.

[10] Allan IJ, Tjensvoll I, Bradshaw C, Nilsson HC, and Næs K. Towing passive samplers reveals PCDD/F release during benthic trawler-induced sediment re-suspension. in prep 2011.

Appendix A.

Table A1. Concentration of PCDD/Fs, HCB and OCS associated with suspended particulate matter at Site FA S3 (Eidangerfjord) sampled in shallow and deep water

Contaminant ID	SPM-associated concentration (pg g^{-1} dry weight)	
	FA S3 Deep*	FA S3 Shallow*
2,3,7,8-TCDD	<24	<6
1,2,3,7,8-PeCDD	<43	<9
1,2,3,4,7,8-HxCDD	47	<12
1,2,3,6,7,8-HxCDD	62	<11
1,2,3,7,8,9-HxCDD	52	<12
1,2,3,4,6,7,8-HpCDD	472	40
OCDD	1384	112
2,3,7,8-TCDF	206	41
1,2,3,7,8/1,2,3,4,8-PeCDF	412	59
2,3,4,7,8-PeCDF	243	34
1,2,3,4,7,8/9-HxCDF	954	137
1,2,3,6,7,8-HxCDF	542	84
1,2,3,7,8,9-HxCDF	318	45
2,3,4,6,7,8-HxCDF	393	47
1,2,3,4,6,7,8-HpCDF	2572	281
1,2,3,4,7,8,9-HpCDF	1122	137
OCDF	16049	1347
HCB	655	112
OCS	143	77

*See methods and text for further description of depths sampled

Table A2. Concentration of PCDD/Fs, HCB and OCS associated with suspended particulate matter at Site GY 08 (Kalven) sampled in shallow and deep water

Contaminant ID	SPM-associated concentration (pg g^{-1} dry weight)	
	GY 08 Deep*	GY 08 Shallow*
2,3,7,8-TCDD	<6	<9
1,2,3,7,8-PeCDD	14	<14
1,2,3,4,7,8-HxCDD	20	<11
1,2,3,6,7,8-HxCDD	27	<10
1,2,3,7,8,9-HxCDD	26	<11
1,2,3,4,6,7,8-HpCDD	169	39
OCDD	371	104
2,3,7,8-TCDF	73	23
1,2,3,7,8/1,2,3,4,8-PeCDF	141	42
2,3,4,7,8-PeCDF	109	28
1,2,3,4,7,8/9-HxCDF	435	113
1,2,3,6,7,8-HxCDF	230	67
1,2,3,7,8,9-HxCDF	122	<39
2,3,4,6,7,8-HxCDF	128	39
1,2,3,4,6,7,8-HpCDF	1248	256
1,2,3,4,7,8,9-HpCDF	422	90
OCDF	4839	1148
HCB	5120	1590
OCS	331	137

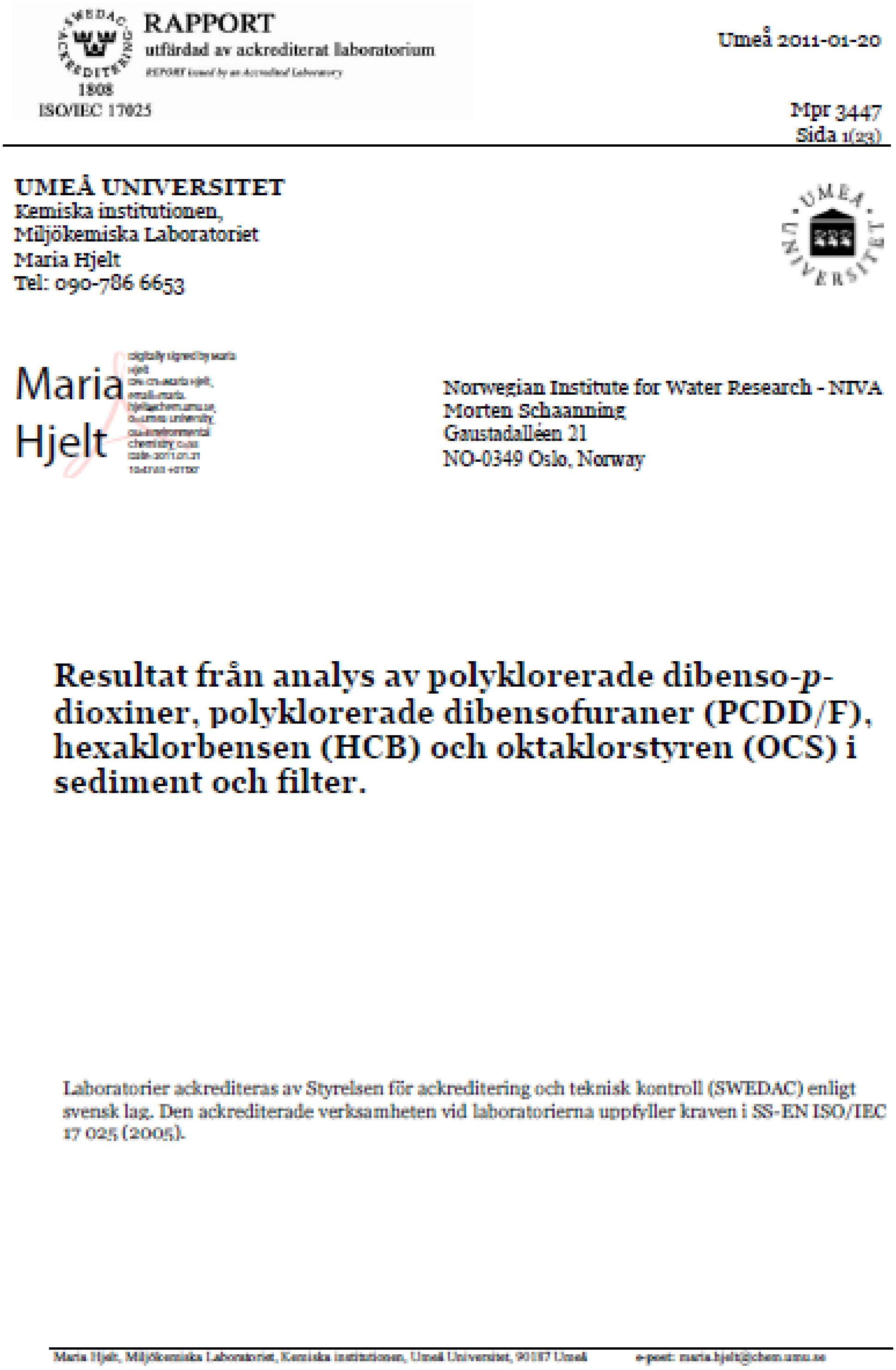
*See methods and text for further description of depths sampled

Table A3. Concentration of PCDD/Fs, HCB and OCS associated with suspended particulate matter at Site GFD 01 (Frierfjord) sampled in shallow and deep water

Contaminant ID	SPM-associated concentration (pg g^{-1} dry weight)	
	GFD 01 Deep*	GFD 01 Shallow*
2,3,7,8-TCDD	<54	<7
1,2,3,7,8-PeCDD	<51	<8
1,2,3,4,7,8-HxCDD	<51	<10
1,2,3,6,7,8-HxCDD	<54	13
1,2,3,7,8,9-HxCDD	<56	<11
1,2,3,4,6,7,8-HpCDD	142	68
OCDD	268	139
2,3,7,8-TCDF	<72	58
1,2,3,7,8/1,2,3,4,8-PeCDF	145	98
2,3,4,7,8-PeCDF	87	67
1,2,3,4,7,8/9-HxCDF	425	231
1,2,3,6,7,8-HxCDF	246	139
1,2,3,7,8,9-HxCDF	110	<148
2,3,4,6,7,8-HxCDF	123	67
1,2,3,4,6,7,8-HpCDF	906	530
1,2,3,4,7,8,9-HpCDF	447	193
OCDF	4877	2082
HCB	9843	14266
OCS	780	1578

*See methods and text for further description of depths sampled

Appendix B.



RAPPORT
utfärdad av ackrediterat laboratorium
REPORT issued by an Accredited Laboratory
1808
ISO/IEC 17025

Umeå 2011-01-20

Mpr 3447
Sida 1(23)

UMEÅ UNIVERSITET
Kemiska institutionen,
Miljökemiska Laboratoriet
Maria Hjelt
Tel: 090-786 6653

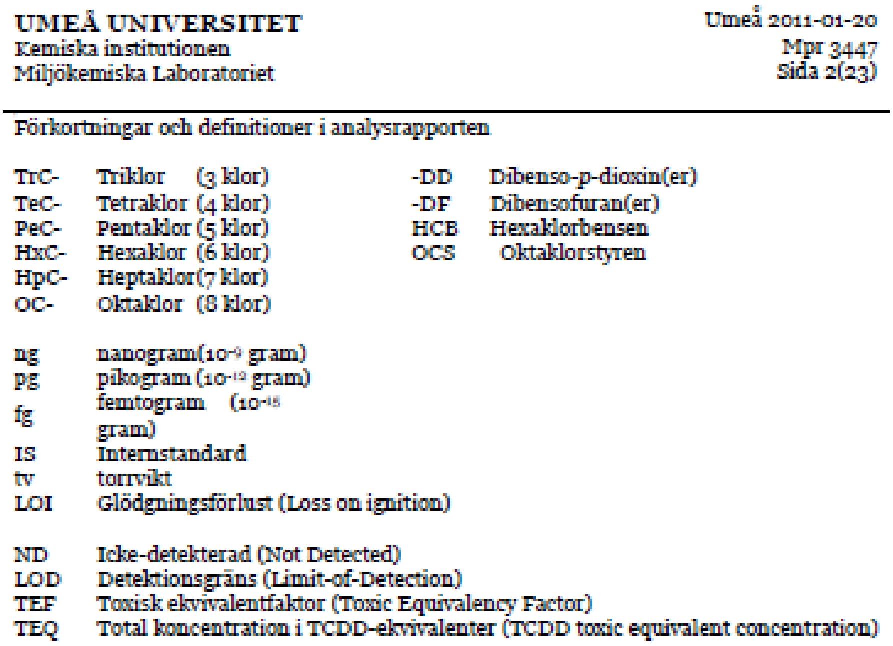
Maria
Hjelt

Norwegian Institute for Water Research - NIVA
Morten Schaanning
Gaustadalléen 21
NO-0349 Oslo, Norway

Resultat från analys av polyklorerade dibenso-*p*-dioxiner, polyklorerade dibensofuraner (PCDD/F), hexaklorbensen (HCB) och oktaklorstyren (OCS) i sediment och filter.

Laboratorier ackrediteras av Styrelsen för ackreditering och teknisk kontroll (SWEDAC) enligt svensk lag. Den ackrediterade verksamheten vid laboratorierna uppfyller kraven i SS-EN ISO/IEC 17 025 (2005).

Maria Hjelt, Miljökemiska Laboratoriet, Kemiska institutionen, Umeå Universitet, 90187 Umeå e-post: maria.hjelt@chem.umu.se



UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

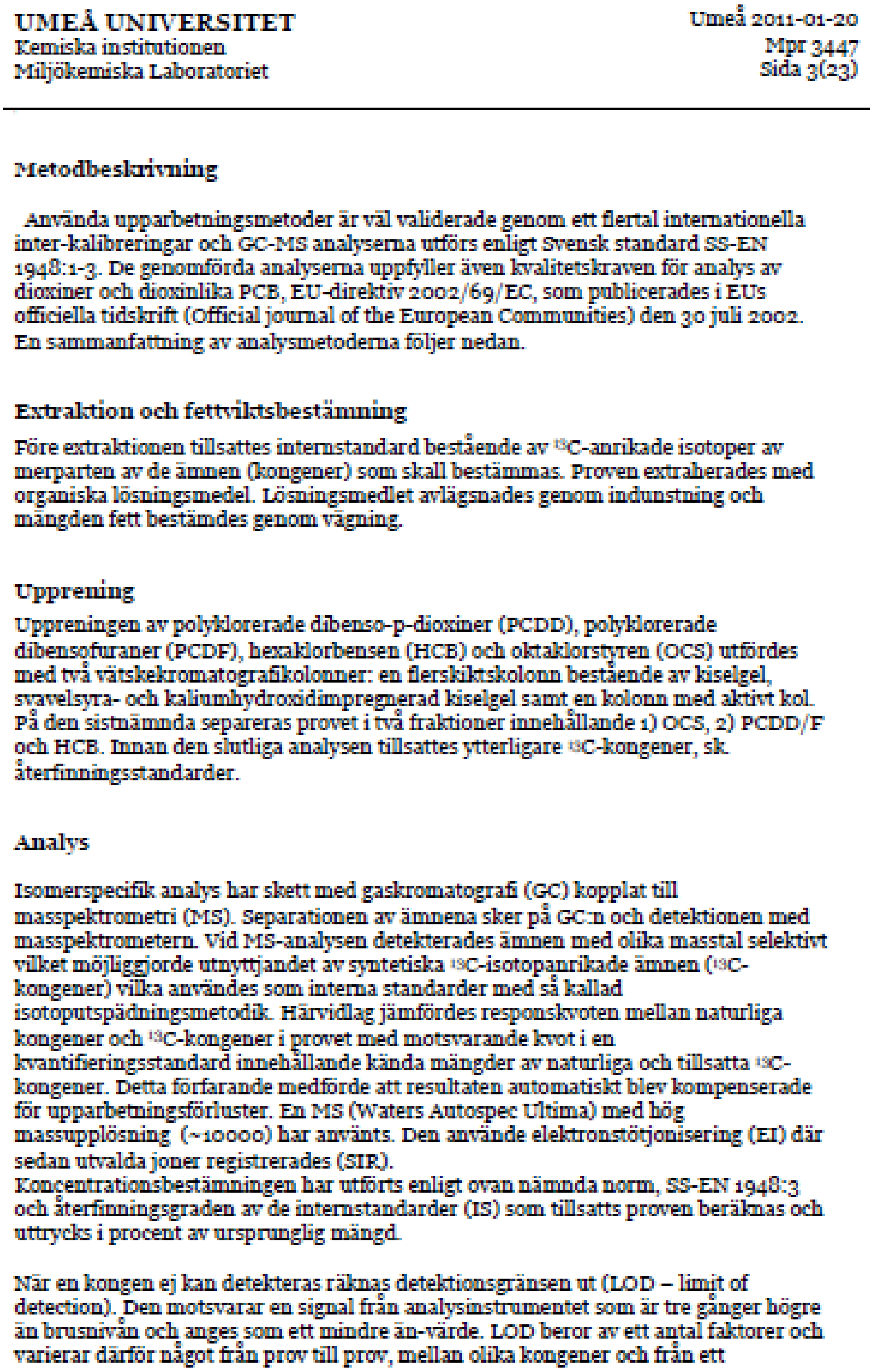
Umeå 2011-01-20
Mpr 3447
Sida 2(23)

Förkortningar och definitioner i analysrapporten

TrC-	Triklor (3 klor)	-DD	Dibenso-p-dioxin(er)
TeC-	Tetraklor (4 klor)	-DF	Dibensofuran(er)
PeC-	Pentaklor (5 klor)	HCB	Hexaklorbensen
HxC-	Hexaklor (6 klor)	OCS	Oktaklorstyren
HpC-	Heptaklor(7 klor)		
OC-	Oktaklor (8 klor)		

ng	nanogram(10^{-9} gram)
pg	pikogram (10^{-12} gram)
fg	femtogram (10^{-15} gram)
IS	Internstandard
tv	torrvikt
LOI	Glödgningsförlust (Loss on ignition)

ND	Icke-detekterad (Not Detected)
LOD	Detektionsgräns (Limit-of-Detection)
TEF	Toxisk ekvivalentfaktor (Toxic Equivalency Factor)
TEQ	Total koncentration i TCDD-ekvivalenter (TCDD toxic equivalent concentration)



Metodbeskrivning

Använda upparbetningsmetoder är väl validerade genom ett flertal internationella inter-kalibreringar och GC-MS analyserna utförs enligt Svensk standard SS-EN 1948:1-3. De genomförda analyserna uppfyller även kvalitetskraven för analys av dioxiner och dioxinlika PCB, EU-direktiv 2002/69/EC, som publicerades i EUs officiella tidskrift (Official journal of the European Communities) den 30 juli 2002. En sammanfattning av analysmetoderna följer nedan.

Extraktion och fettviktsbestämning

Före extraktionen tillsattes internstandard bestående av ^{13}C-anrikade isotoper av merparten av de ämnen (kongener) som skall bestämmas. Proven extraherades med organiska lösningsmedel. Lösningsmedlet avlägsnades genom indunstning och mängden fett bestämdes genom vägning.

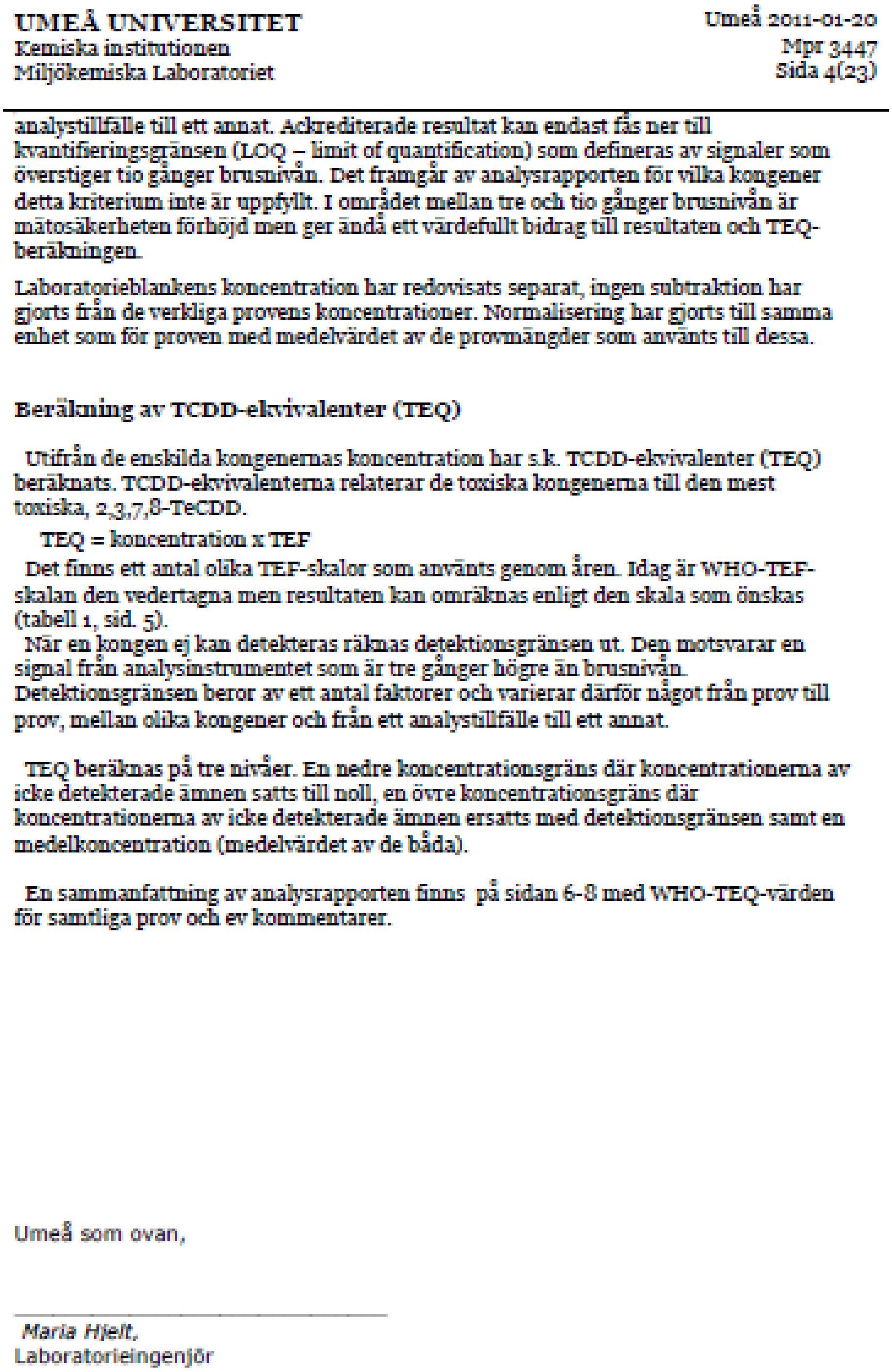
Upprening

Uppreningen av polyklorerade dibenso-p-dioxiner (PCDD), polyklorerade dibensofuraner (PCDF), hexaklorbensen (HCB) och oktaklorstyren (OCS) utfördes med två vätskekromatografikolonner: en flerskiktskolonn bestående av kiselgel, svavelsyra- och kaliumhydroxidimpregnerad kiselgel samt en kolonn med aktivt kol. På den sistnämnda separeras provet i två fraktioner innehållande 1) OCS, 2) PCDD/F och HCB. Innan den slutliga analysen tillsattes ytterligare ^{13}C-kongener, sk. återfinningsstandarder.

Analys

Isomerspecifik analys har skett med gaskromatografi (GC) kopplat till masspektrometri (MS). Separationen av ämnena sker på GC:n och detektionen med masspektrometern. Vid MS-analysen detekterades ämnen med olika masstal selektivt vilket möjliggjorde utnyttjandet av syntetiska ^{13}C-isotopanrikade ämnen (^{13}C-kongener) vilka användes som interna standarder med så kallad isotoputspädningsmetodik. Härvidlag jämfördes responskvoten mellan naturliga kongener och ^{13}C-kongener i provet med motsvarande kvot i en kvantifieringsstandard innehållande kända mängder av naturliga och tillsatta ^{13}C-kongener. Detta förfarande medförde att resultaten automatiskt blev kompenserade för upparbetningsförluster. En MS (Waters Autospec Ultima) med hög massupplösning (~10000) har använts. Den använde elektronstötjonisering (EI) där sedan utvalda joner registrerades (SIR).
Koncentrationsbestämningen har utförts enligt ovan nämnda norm, SS-EN 1948:3 och återfinningsgraden av de internstandarder (IS) som tillsatts proven beräknas och uttrycks i procent av ursprunglig mängd.

När en kongen ej kan detekteras räknas detektionsgränsen ut (LOD – limit of detection). Den motsvarar en signal från analysinstrumentet som är tre gånger högre än brusnivån och anges som ett mindre än-värde. LOD beror av ett antal faktorer och varierar därför något från prov till prov, mellan olika kongener och från ett



analystillfälle till ett annat. Ackrediterade resultat kan endast fås ner till kvantifieringsgränsen (LOQ – limit of quantification) som defineras av signaler som överstiger tio gånger brusnivån. Det framgår av analysrapporten för vilka kongener detta kriterium inte är uppfyllt. I området mellan tre och tio gånger brusnivån är mätosäkerheten förhöjd men ger ändå ett värdefullt bidrag till resultaten och TEQ-beräkningen.

Laboratorieblankens koncentration har redovisats separat, ingen subtraktion har gjorts från de verkliga provens koncentrationer. Normalisering har gjorts till samma enhet som för proven med medelvärdet av de provmängder som använts till dessa.

Beräkning av TCDD-ekvivalenter (TEQ)

Utifrån de enskilda kongenernas koncentration har s.k. TCDD-ekvivalenter (TEQ) beräknats. TCDD-ekvivalenterna relaterar de toxiska kongenerna till den mest toxiska, 2,3,7,8-TeCDD.

TEQ = koncentration x TEF

Det finns ett antal olika TEF-skalor som använts genom åren. Idag är WHO-TEF-skalan den vedertagna men resultaten kan omräknas enligt den skala som önskas (tabell 1, sid. 5).

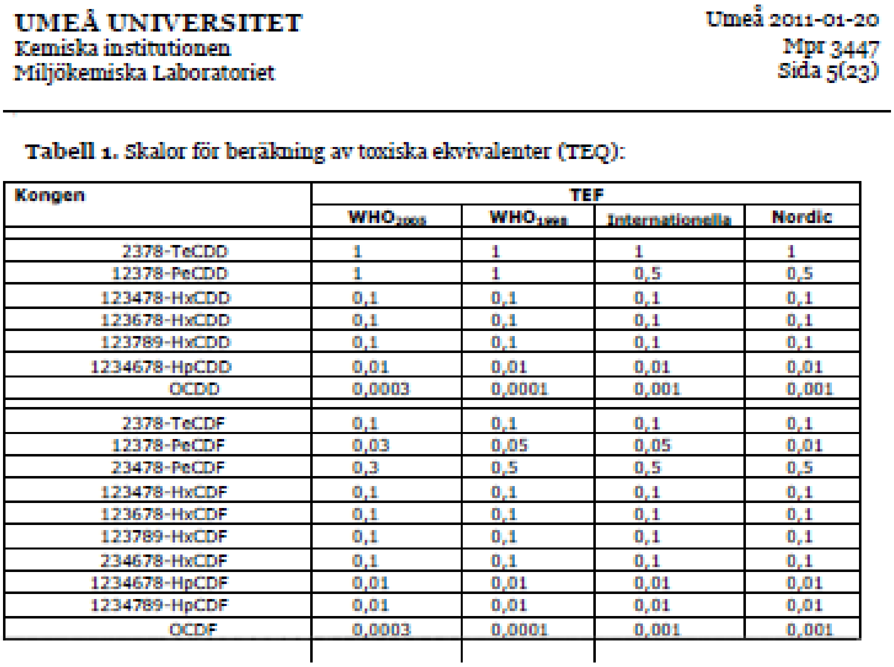
När en kongen ej kan detekteras räknas detektionsgränsen ut. Den motsvarar en signal från analysinstrumentet som är tre gånger högre än brusnivån. Detektionsgränsen beror av ett antal faktorer och varierar därför något från prov till prov, mellan olika kongener och från ett analystillfälle till ett annat.

TEQ beräknas på tre nivåer. En nedre koncentrationsgräns där koncentrationerna av icke detekterade ämnen satts till noll, en övre koncentrationsgräns där koncentrationerna av icke detekterade ämnen ersatts med detektionsgränsen samt en medelkoncentration (medelvärdet av de båda).

En sammanfattning av analysrapporten finns på sidan 6-8 med WHO-TEQ-värden för samtliga prov och ev kommentarer.

Umeå som ovan,

Maria Hjelt,
Laboratorieingenjör

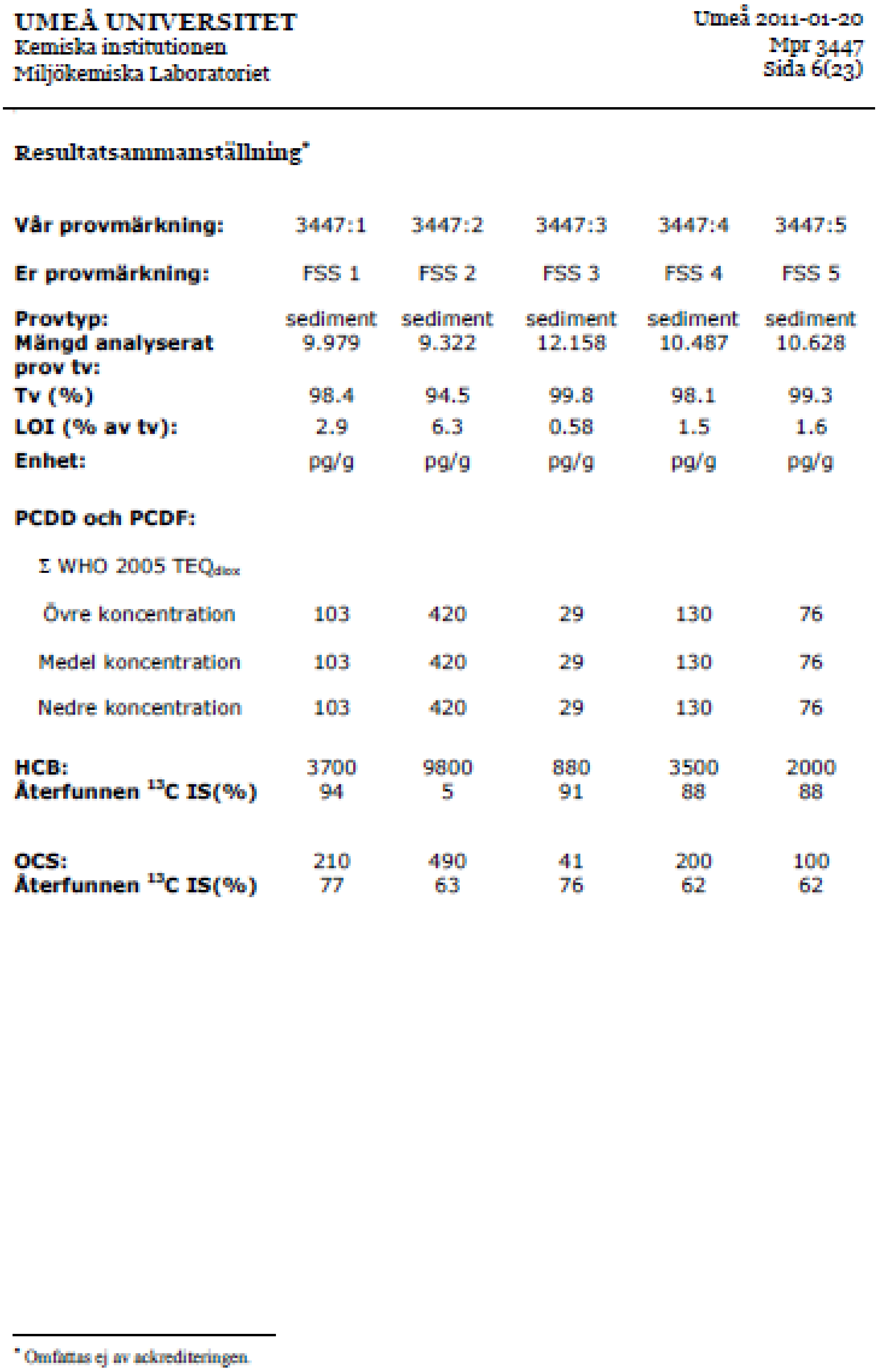


UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

Umeå 2011-01-20
Mpr 3447
Sida 5(23)

Tabell 1. Skalor för beräkning av toxiska ekvivalenter (TEQ):

Kongen	**TEF**			
	WHO_{2005}	**WHO_{1998}**	**Internationella**	**Nordic**
2378-TeCDD	1	1	1	1
12378-PeCDD	1	1	0,5	0,5
123478-HxCDD	0,1	0,1	0,1	0,1
123678-HxCDD	0,1	0,1	0,1	0,1
123789-HxCDD	0,1	0,1	0,1	0,1
1234678-HpCDD	0,01	0,01	0,01	0,01
OCDD	0,0003	0,0001	0,001	0,001
2378-TeCDF	0,1	0,1	0,1	0,1
12378-PeCDF	0,03	0,05	0,05	0,01
23478-PeCDF	0,3	0,5	0,5	0,5
123478-HxCDF	0,1	0,1	0,1	0,1
123678-HxCDF	0,1	0,1	0,1	0,1
123789-HxCDF	0,1	0,1	0,1	0,1
234678-HxCDF	0,1	0,1	0,1	0,1
1234678-HpCDF	0,01	0,01	0,01	0,01
1234789-HpCDF	0,01	0,01	0,01	0,01
OCDF	0,0003	0,0001	0,001	0,001



UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

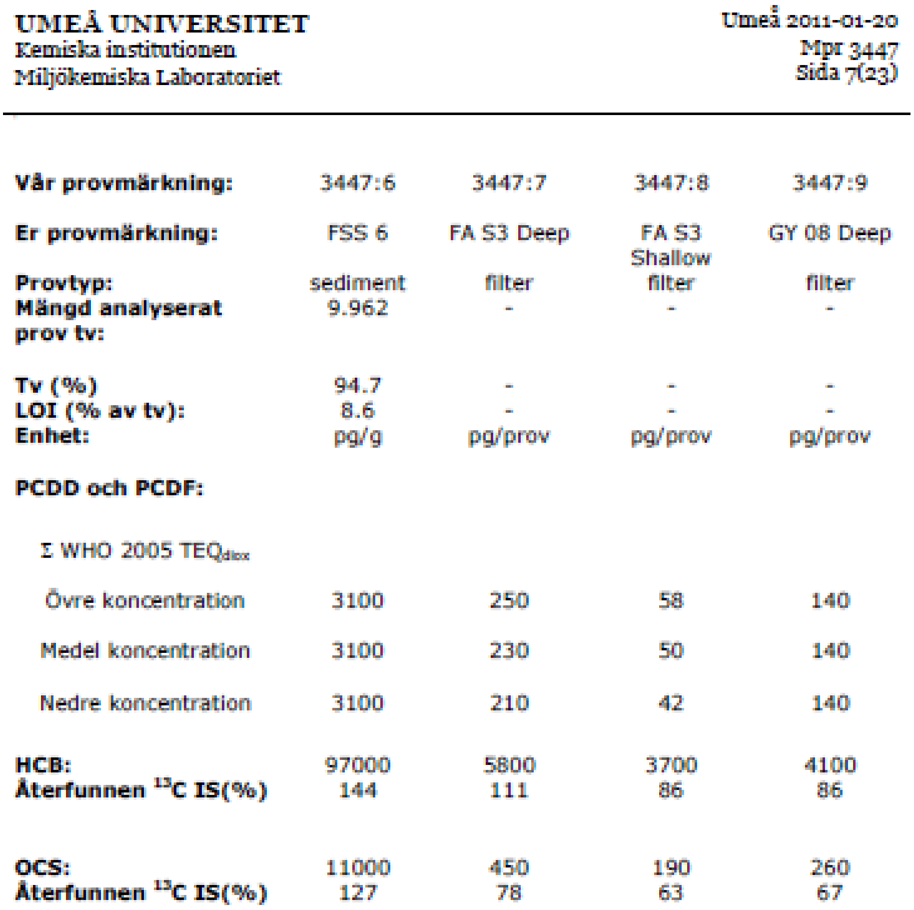
Umeå 2011-01-20
Mpr 3447
Sida 6(23)

Resultatsammanställning*

Vår provmärkning:	3447:1	3447:2	3447:3	3447:4	3447:5
Er provmärkning:	FSS 1	FSS 2	FSS 3	FSS 4	FSS 5
Provtyp:	sediment	sediment	sediment	sediment	sediment
Mängd analyserat prov tv:	9.979	9.322	12.158	10.487	10.628
Tv (%)	98.4	94.5	99.8	98.1	99.3
LOI (% av tv):	2.9	6.3	0.58	1.5	1.6
Enhet:	pg/g	pg/g	pg/g	pg/g	pg/g
PCDD och PCDF:					
Σ WHO 2005 TEQ_{diox}					
Övre koncentration	103	420	29	130	76
Medel koncentration	103	420	29	130	76
Nedre koncentration	103	420	29	130	76
HCB:	3700	9800	880	3500	2000
Återfunnen ^{13}C IS(%)	94	5	91	88	88
OCS:	210	490	41	200	100
Återfunnen ^{13}C IS(%)	77	63	76	62	62

---

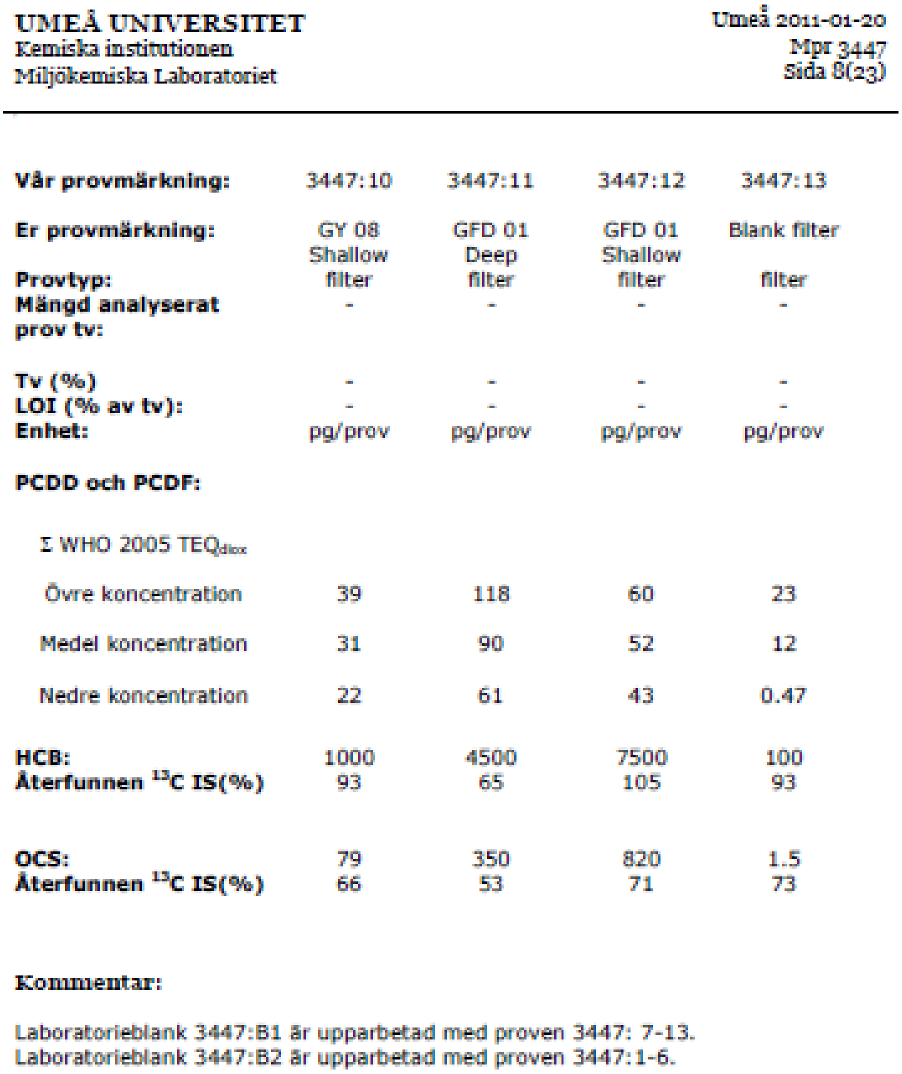
[*] Omfattas ej av ackrediteringen.



UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

Umeå 2011-01-20
Mpr 3447
Sida 7(23)

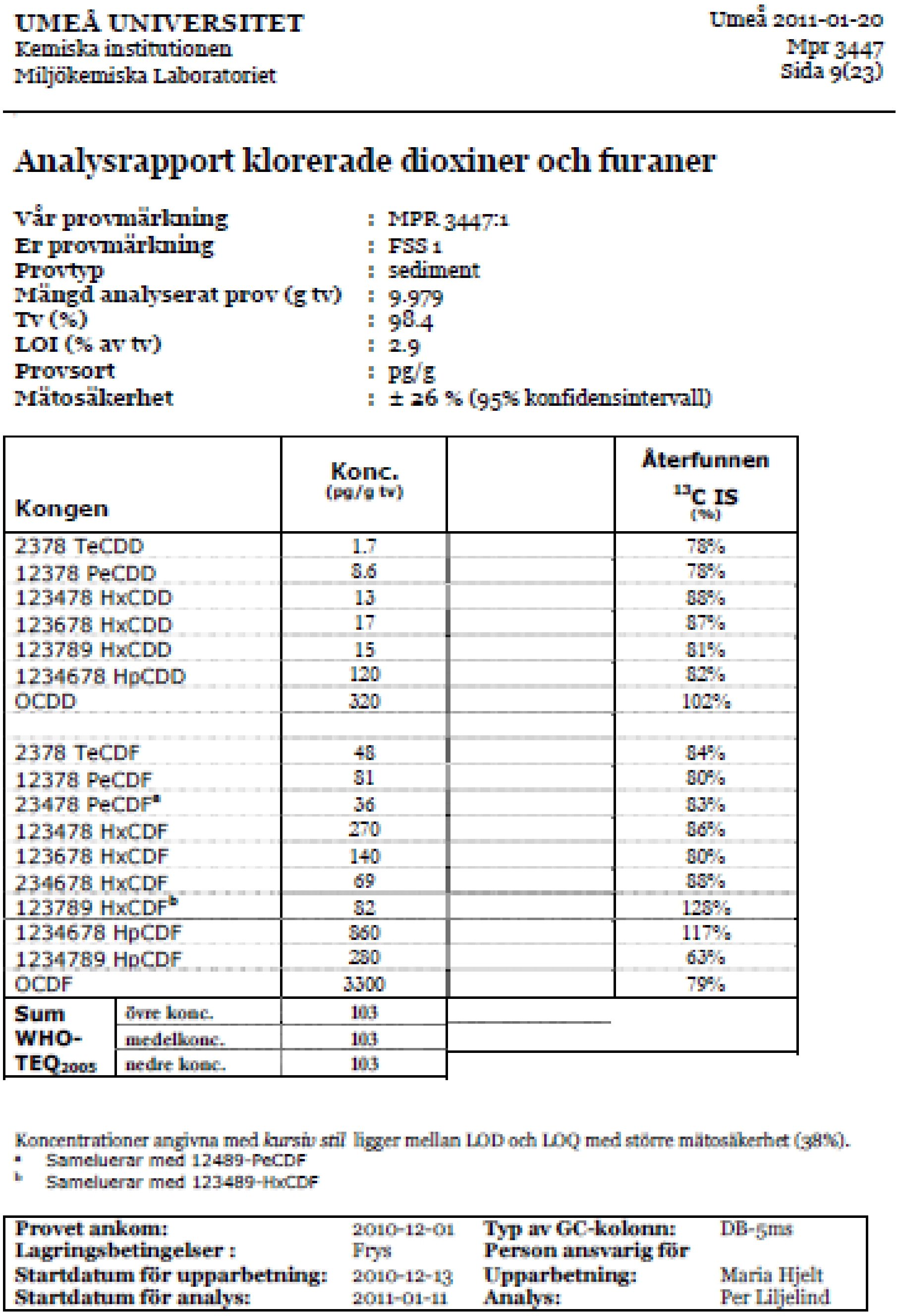
Vår provmärkning:	3447:6	3447:7	3447:8	3447:9
Er provmärkning:	FSS 6	FA S3 Deep	FA S3 Shallow	GY 08 Deep
Provtyp:	sediment	filter	filter	filter
Mängd analyserat prov tv:	9.962	-	-	-
Tv (%)	94.7	-	-	-
LOI (% av tv):	8.6	-	-	-
Enhet:	pg/g	pg/prov	pg/prov	pg/prov
PCDD och PCDF:				
Σ WHO 2005 TEQ_{diox}				
Övre koncentration	3100	250	58	140
Medel koncentration	3100	230	50	140
Nedre koncentration	3100	210	42	140
HCB:	97000	5800	3700	4100
Återfunnen ^{13}C IS(%)	144	111	86	86
OCS:	11000	450	190	260
Återfunnen ^{13}C IS(%)	127	78	63	67



Vår provmärkning:	3447:10	3447:11	3447:12	3447:13
Er provmärkning:	GY 08 Shallow	GFD 01 Deep	GFD 01 Shallow	Blank filter
Provtyp:	filter	filter	filter	filter
Mängd analyserat prov tv:	-	-	-	-
Tv (%)	-	-	-	-
LOI (% av tv):	-	-	-	-
Enhet:	pg/prov	pg/prov	pg/prov	pg/prov
PCDD och PCDF:				
Σ WHO 2005 TEQ_{diox}				
Övre koncentration	39	118	60	23
Medel koncentration	31	90	52	12
Nedre koncentration	22	61	43	0.47
HCB:	1000	4500	7500	100
Återfunnen ^{13}C IS(%)	93	65	105	93
OCS:	79	350	820	1.5
Återfunnen ^{13}C IS(%)	66	53	71	73

Kommentar:

Laboratorieblank 3447:B1 är upparbetad med proven 3447: 7-13.
Laboratorieblank 3447:B2 är upparbetad med proven 3447:1-6.



UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

Umeå 2011-01-20
Mpr 3447
Sida 9(23)

Analysrapport klorerade dioxiner och furaner

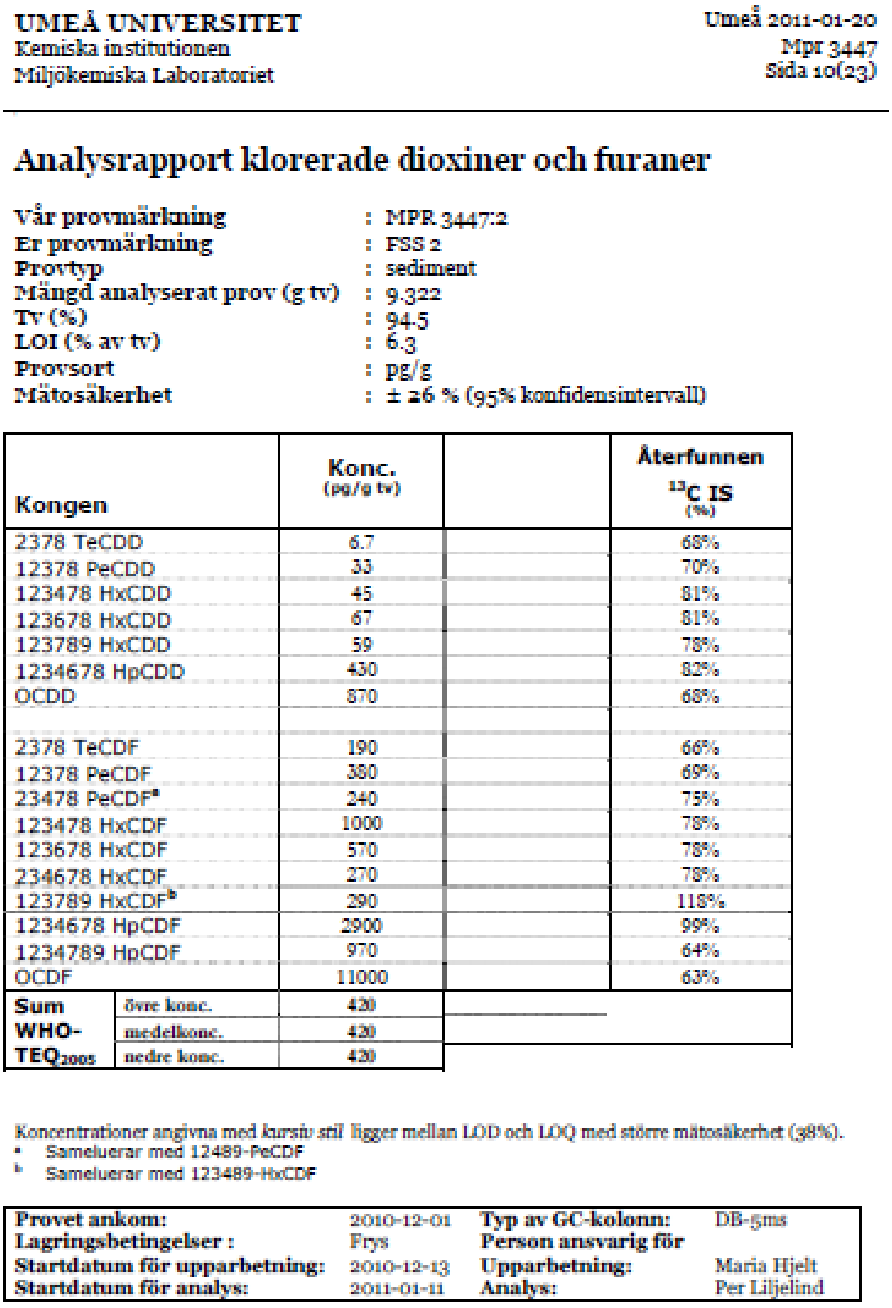
Vår provmärkning : MPR 3447:1
Er provmärkning : FSS 1
Provtyp : sediment
Mängd analyserat prov (g tv) : 9.979
Tv (%) : 98.4
LOI (% av tv) : 2.9
Provsort : pg/g
Mätosäkerhet : ± 26 % (95% konfidensintervall)

Kongen	**Konc.** (pg/g tv)		**Återfunnen** ^{13}C IS (%)
2378 TeCDD	1.7		78%
12378 PeCDD	8.6		78%
123478 HxCDD	13		88%
123678 HxCDD	17		87%
123789 HxCDD	15		81%
1234678 HpCDD	120		82%
OCDD	320		102%
2378 TeCDF	48		84%
12378 PeCDF	81		80%
23478 PeCDF[a]	36		83%
123478 HxCDF	270		86%
123678 HxCDF	140		80%
234678 HxCDF	69		88%
123789 HxCDF[b]	82		128%
1234678 HpCDF	860		117%
1234789 HpCDF	280		63%
OCDF	3300		79%
Sum WHO-TEQ$_{2005}$ övre konc.	103		
medelkonc.	103		
nedre konc.	103		

Koncentrationer angivna med *kursiv stil* ligger mellan LOD och LOQ med större mätosäkerhet (38%).

[a] Sameluerar med 12489-PeCDF
[b] Sameluerar med 123489-HxCDF

Provet ankom:	2010-12-01	**Typ av GC-kolonn:**	DB-5ms
Lagringsbetingelser :	Frys	**Person ansvarig för**	
Startdatum för upparbetning:	2010-12-13	**Upparbetning:**	Maria Hjelt
Startdatum för analys:	2011-01-11	**Analys:**	Per Liljelind



UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

Umeå 2011-01-20
Mpr 3447
Sida 10(23)

Analysrapport klorerade dioxiner och furaner

Vår provmärkning : MPR 3447:2
Er provmärkning : FSS 2
Provtyp : sediment
Mängd analyserat prov (g tv) : 9.322
Tv (%) : 94.5
LOI (% av tv) : 6.3
Provsort : pg/g
Mätosäkerhet : ± 26 % (95% konfidensintervall)

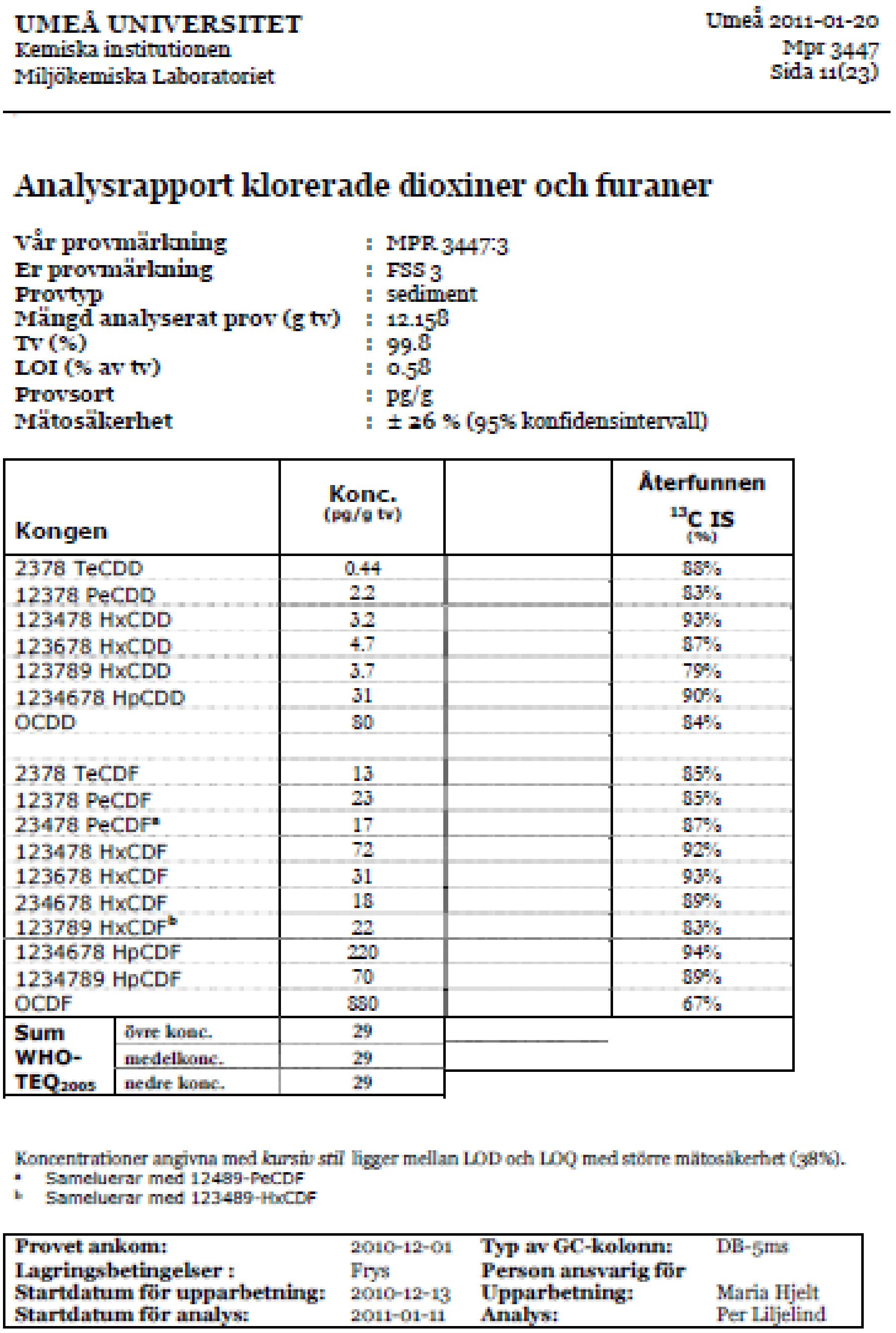
Kongen		**Konc.** (pg/g tv)		**Återfunnen** ^{13}C IS (%)
2378 TeCDD		6.7		68%
12378 PeCDD		33		70%
123478 HxCDD		45		81%
123678 HxCDD		67		81%
123789 HxCDD		59		78%
1234678 HpCDD		430		82%
OCDD		870		68%
2378 TeCDF		190		66%
12378 PeCDF		380		69%
23478 PeCDF[a]		240		75%
123478 HxCDF		1000		78%
123678 HxCDF		570		78%
234678 HxCDF		270		78%
123789 HxCDF[b]		290		118%
1234678 HpCDF		2900		99%
1234789 HpCDF		970		64%
OCDF		11000		63%
Sum WHO-TEQ$_{2005}$	övre konc.	420		
	medelkonc.	420		
	nedre konc.	420		

Koncentrationer angivna med *kursiv stil* ligger mellan LOD och LOQ med större mätosäkerhet (38%).

[a] Sameluerar med 12489-PeCDF

[b] Sameluerar med 123489-HxCDF

Provet ankom:	2010-12-01	**Typ av GC-kolonn:**	DB-5ms
Lagringsbetingelser :	Frys	**Person ansvarig för**	
Startdatum för upparbetning:	2010-12-13	**Upparbetning:**	Maria Hjelt
Startdatum för analys:	2011-01-11	**Analys:**	Per Liljelind



UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

Umeå 2011-01-20
Mpr 3447
Sida 11(23)

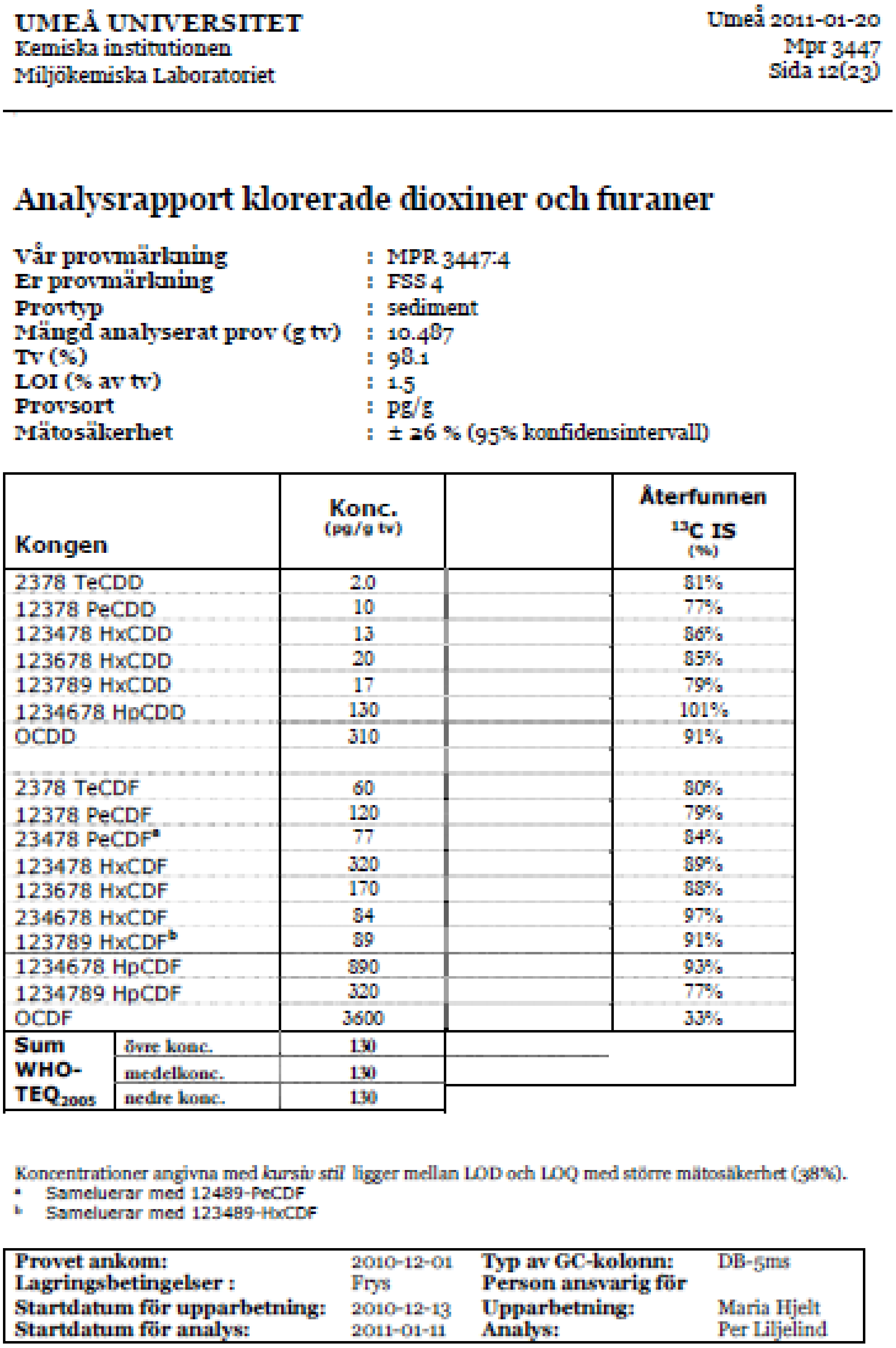
Analysrapport klorerade dioxiner och furaner

Vår provmärkning : MPR 3447:3
Er provmärkning : FSS 3
Provtyp : sediment
Mängd analyserat prov (g tv) : 12.158
Tv (%) : 99.8
LOI (% av tv) : 0.58
Provsort : pg/g
Mätosäkerhet : ± 26 % (95% konfidensintervall)

Kongen	**Konc.** (pg/g tv)		**Återfunnen** ^{13}C IS (%)
2378 TeCDD	0.44		88%
12378 PeCDD	2.2		83%
123478 HxCDD	3.2		93%
123678 HxCDD	4.7		87%
123789 HxCDD	3.7		79%
1234678 HpCDD	31		90%
OCDD	80		84%
2378 TeCDF	13		85%
12378 PeCDF	23		85%
23478 PeCDF^{a}	17		87%
123478 HxCDF	72		92%
123678 HxCDF	31		93%
234678 HxCDF	18		89%
123789 HxCDF^{b}	22		83%
1234678 HpCDF	220		94%
1234789 HpCDF	70		89%
OCDF	880		67%
Sum WHO-TEQ$_{2005}$ övre konc.	29		
medelkonc.	29		
nedre konc.	29		

Koncentrationer angivna med *kursiv stil* ligger mellan LOD och LOQ med större mätosäkerhet (38%).
[a] Sameluerar med 12489-PeCDF
[b] Sameluerar med 123489-HxCDF

Provet ankom:	2010-12-01	**Typ av GC-kolonn:**	DB-5ms
Lagringsbetingelser :	Frys	**Person ansvarig för**	
Startdatum för upparbetning:	2010-12-13	**Upparbetning:**	Maria Hjelt
Startdatum för analys:	2011-01-11	**Analys:**	Per Liljelind



UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

Umeå 2011-01-20
Mpr 3447
Sida 12(23)

Analysrapport klorerade dioxiner och furaner

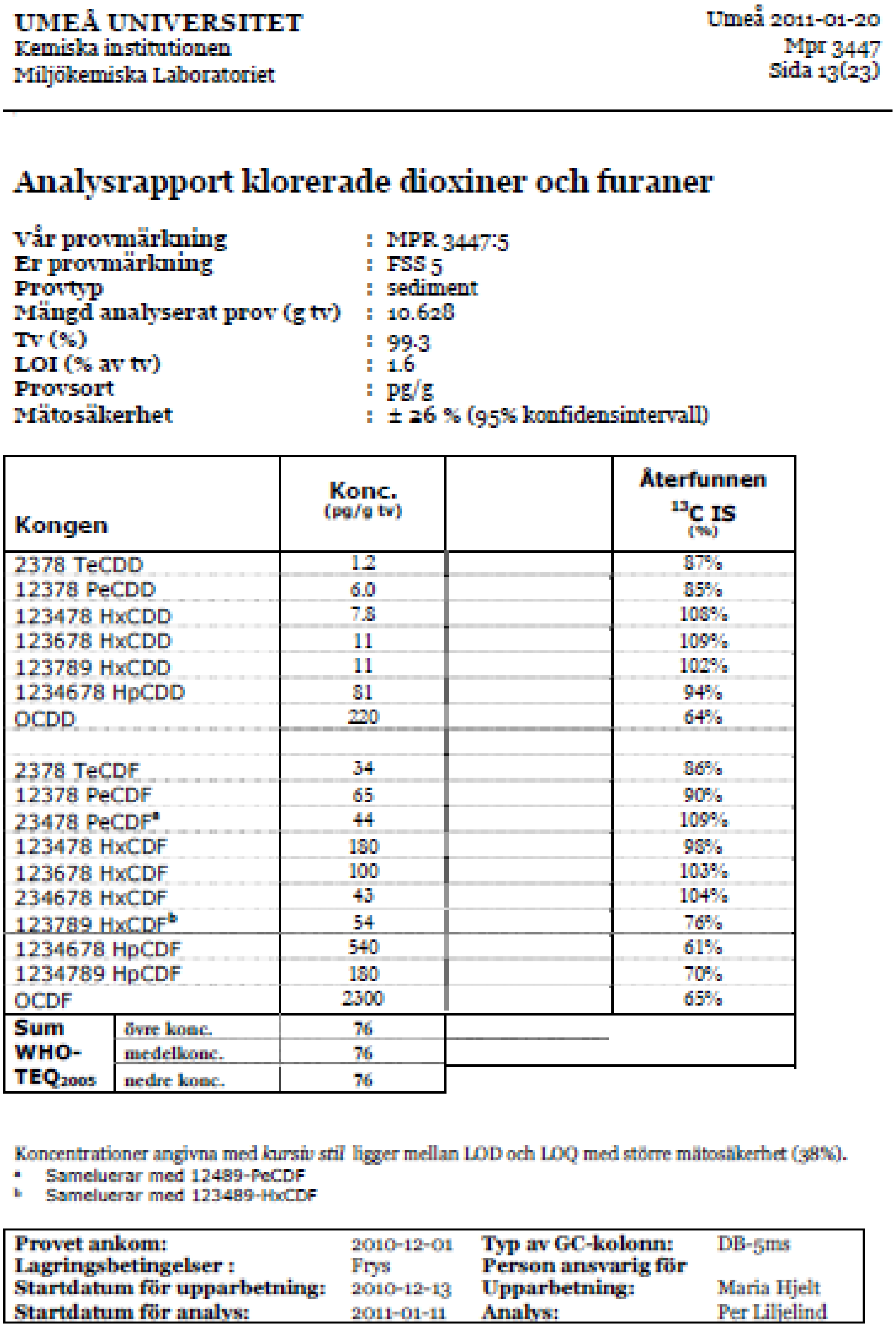
Vår provmärkning : MPR 3447:4
Er provmärkning : FSS 4
Provtyp : sediment
Mängd analyserat prov (g tv) : 10.487
Tv (%) : 98.1
LOI (% av tv) : 1.5
Provsort : pg/g
Mätosäkerhet : ± 26 % (95% konfidensintervall)

Kongen		**Konc.** (pg/g tv)		**Återfunnen** ^{13}C IS (%)
2378 TeCDD		2.0		81%
12378 PeCDD		10		77%
123478 HxCDD		13		86%
123678 HxCDD		20		85%
123789 HxCDD		17		79%
1234678 HpCDD		130		101%
OCDD		310		91%
2378 TeCDF		60		80%
12378 PeCDF		120		79%
23478 PeCDF[a]		77		84%
123478 HxCDF		320		89%
123678 HxCDF		170		88%
234678 HxCDF		84		97%
123789 HxCDF[b]		89		91%
1234678 HpCDF		890		93%
1234789 HpCDF		320		77%
OCDF		3600		33%
Sum WHO-TEQ$_{2005}$	övre konc.	130		
	medelkonc.	130		
	nedre konc.	130		

Koncentrationer angivna med *kursiv stil* ligger mellan LOD och LOQ med större mätosäkerhet (38%).

[a] Sameluerar med 12489-PeCDF
[b] Sameluerar med 123489-HxCDF

Provet ankom:	2010-12-01	**Typ av GC-kolonn:**	DB-5ms
Lagringsbetingelser :	Frys	**Person ansvarig för**	
Startdatum för upparbetning:	2010-12-13	**Upparbetning:**	Maria Hjelt
Startdatum för analys:	2011-01-11	**Analys:**	Per Liljelind



UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

Umeå 2011-01-20
Mpr 3447
Sida 13(23)

Analysrapport klorerade dioxiner och furaner

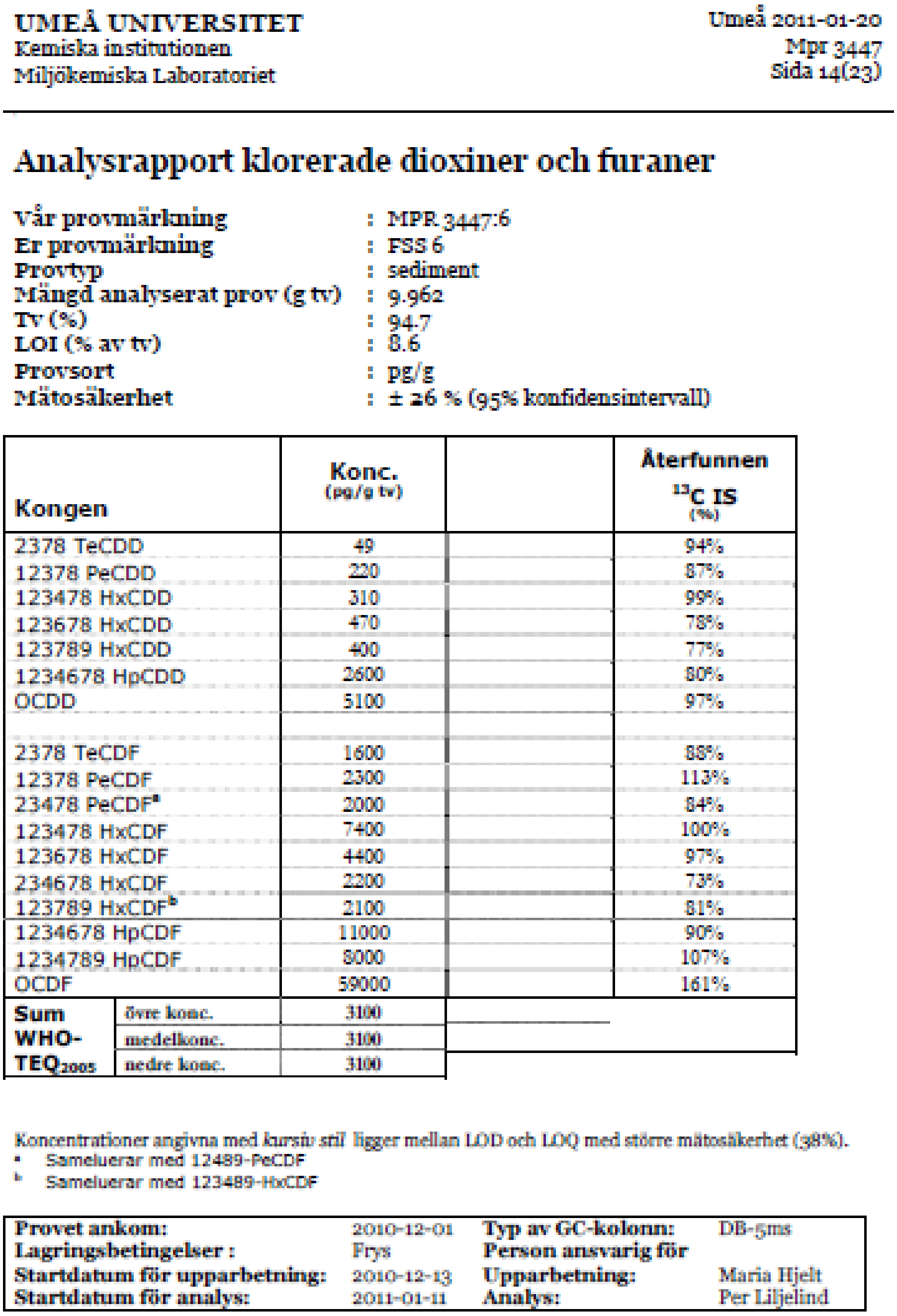
Vår provmärkning : MPR 3447:5
Er provmärkning : FSS 5
Provtyp : sediment
Mängd analyserat prov (g tv) : 10.628
Tv (%) : 99.3
LOI (% av tv) : 1.6
Provsort : pg/g
Mätosäkerhet : ± 26 % (95% konfidensintervall)

Kongen	**Konc.** (pg/g tv)		**Återfunnen** ^{13}C IS (%)
2378 TeCDD	1.2		87%
12378 PeCDD	6.0		85%
123478 HxCDD	7.8		108%
123678 HxCDD	11		109%
123789 HxCDD	11		102%
1234678 HpCDD	81		94%
OCDD	220		64%
2378 TeCDF	34		86%
12378 PeCDF	65		90%
23478 PeCDF[a]	44		109%
123478 HxCDF	180		98%
123678 HxCDF	100		103%
234678 HxCDF	43		104%
123789 HxCDF[b]	54		76%
1234678 HpCDF	540		61%
1234789 HpCDF	180		70%
OCDF	2300		65%
Sum WHO-TEQ$_{2005}$ övre konc.	76		
medelkonc.	76		
nedre konc.	76		

Koncentrationer angivna med *kursiv stil* ligger mellan LOD och LOQ med större mätosäkerhet (38%).

[a] Sameluerar med 12489-PeCDF
[b] Sameluerar med 123489-HxCDF

Provet ankom:	2010-12-01	**Typ av GC-kolonn:**	DB-5ms
Lagringsbetingelser :	Frys	**Person ansvarig för**	
Startdatum för upparbetning:	2010-12-13	**Upparbetning:**	Maria Hjelt
Startdatum för analys:	2011-01-11	**Analys:**	Per Liljelind



UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

Umeå 2011-01-20
Mpr 3447
Sida 14(23)

Analysrapport klorerade dioxiner och furaner

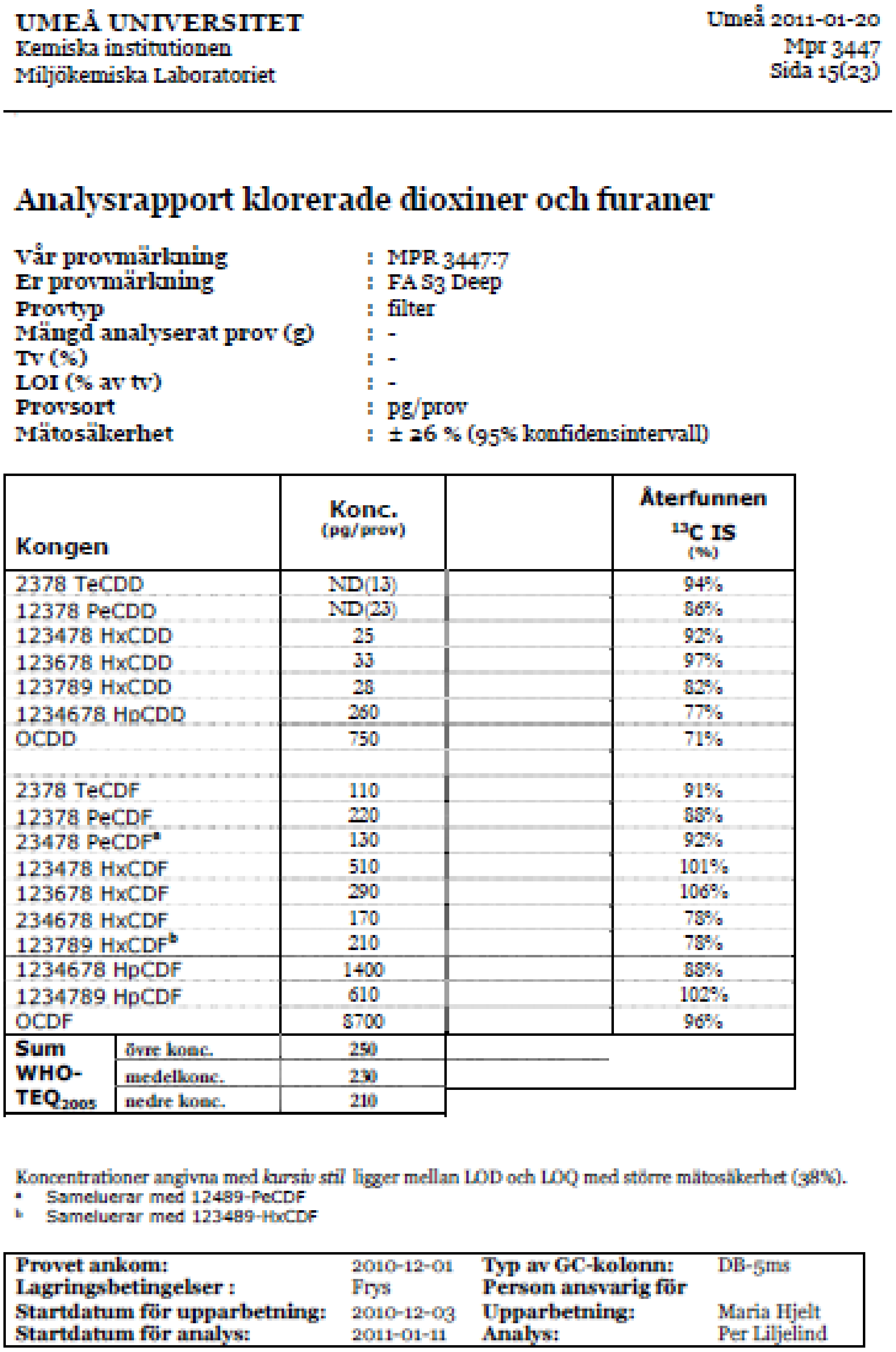
Vår provmärkning	: MPR 3447:6
Er provmärkning	: FSS 6
Provtyp	: sediment
Mängd analyserat prov (g tv)	: 9.962
Tv (%)	: 94.7
LOI (% av tv)	: 8.6
Provsort	: pg/g
Mätosäkerhet	: ± 26 % (95% konfidensintervall)

Kongen	**Konc.** (pg/g tv)		**Återfunnen ^{13}C IS** (%)
2378 TeCDD	49		94%
12378 PeCDD	220		87%
123478 HxCDD	310		99%
123678 HxCDD	470		78%
123789 HxCDD	400		77%
1234678 HpCDD	2600		80%
OCDD	5100		97%
2378 TeCDF	1600		88%
12378 PeCDF	2300		113%
23478 PeCDF[a]	2000		84%
123478 HxCDF	7400		100%
123678 HxCDF	4400		97%
234678 HxCDF	2200		73%
123789 HxCDF[b]	2100		81%
1234678 HpCDF	11000		90%
1234789 HpCDF	8000		107%
OCDF	59000		161%

Sum WHO-TEQ$_{2005}$	övre konc.	3100
	medelkonc.	3100
	nedre konc.	3100

Koncentrationer angivna med *kursiv stil* ligger mellan LOD och LOQ med större mätosäkerhet (38%).
[a] Sameluerar med 12489-PeCDF
[b] Sameluerar med 123489-HxCDF

Provet ankom:	2010-12-01	**Typ av GC-kolonn:**	DB-5ms
Lagringsbetingelser :	Frys	**Person ansvarig för**	
Startdatum för upparbetning:	2010-12-13	**Upparbetning:**	Maria Hjelt
Startdatum för analys:	2011-01-11	**Analys:**	Per Liljelind



UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

Umeå 2011-01-20
Mpr 3447
Sida 15(23)

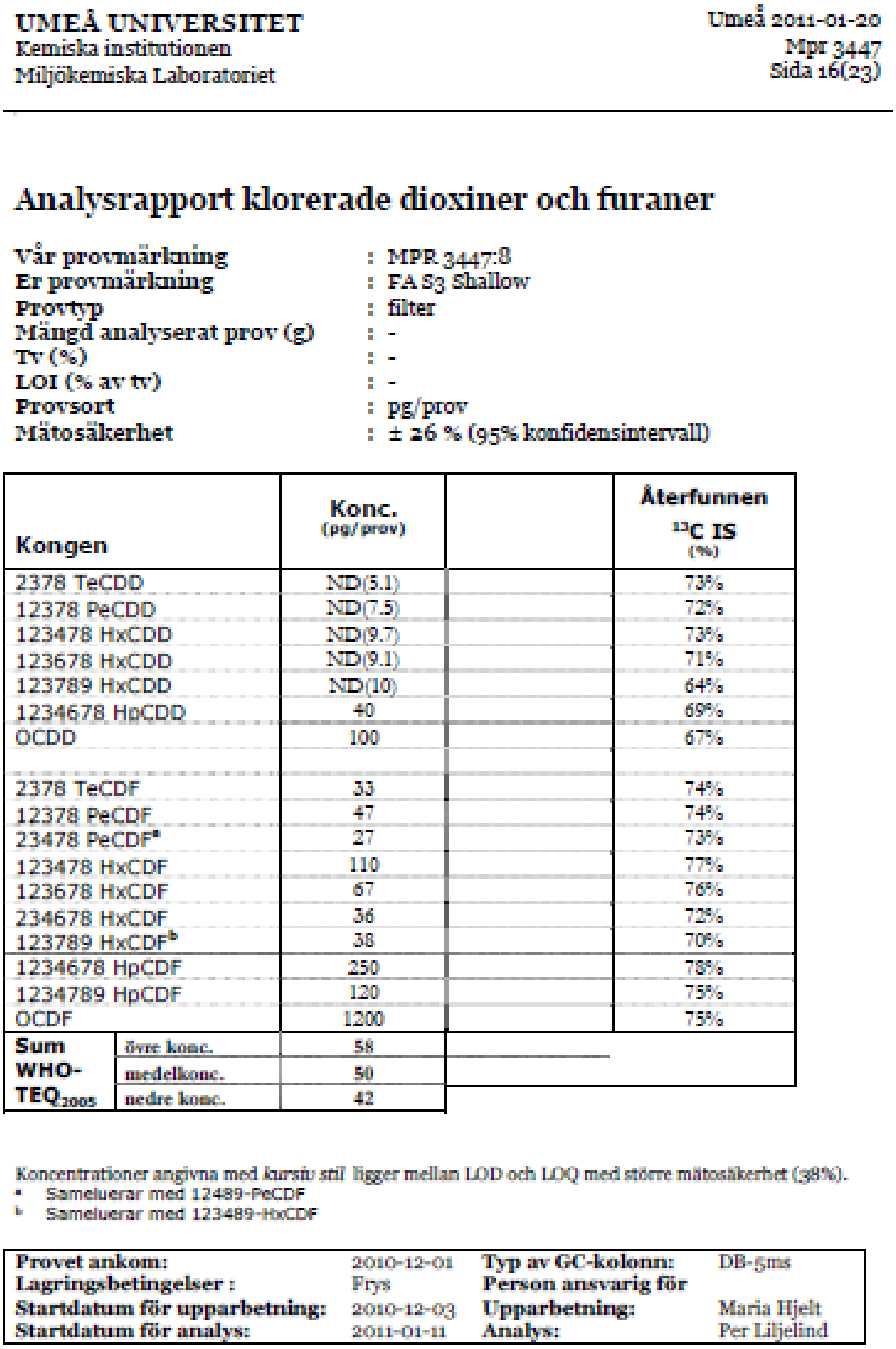
Analysrapport klorerade dioxiner och furaner

Vår provmärkning : MPR 3447:7
Er provmärkning : FA S3 Deep
Provtyp : filter
Mängd analyserat prov (g) : -
Tv (%) : -
LOI (% av tv) : -
Provsort : pg/prov
Mätosäkerhet : ± 26 % (95% konfidensintervall)

Kongen	**Konc.** (pg/prov)		**Återfunnen** ^{13}C IS (%)
2378 TeCDD	ND(13)		94%
12378 PeCDD	ND(23)		86%
123478 HxCDD	25		92%
123678 HxCDD	33		97%
123789 HxCDD	28		82%
1234678 HpCDD	260		77%
OCDD	750		71%
2378 TeCDF	110		91%
12378 PeCDF	220		88%
23478 PeCDF[a]	130		92%
123478 HxCDF	510		101%
123678 HxCDF	290		106%
234678 HxCDF	170		78%
123789 HxCDF[b]	210		78%
1234678 HpCDF	1400		88%
1234789 HpCDF	610		102%
OCDF	8700		96%
Sum WHO-TEQ$_{2005}$ övre konc.	250		
medelkonc.	230		
nedre konc.	210		

Koncentrationer angivna med *kursiv stil* ligger mellan LOD och LOQ med större mätosäkerhet (38%).
[a] Sameluerar med 12489-PeCDF
[b] Sameluerar med 123489-HxCDF

Provet ankom:	2010-12-01	**Typ av GC-kolonn:**	DB-5ms
Lagringsbetingelser :	Frys	**Person ansvarig för**	
Startdatum för upparbetning:	2010-12-03	**Upparbetning:**	Maria Hjelt
Startdatum för analys:	2011-01-11	**Analys:**	Per Liljelind



UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

Umeå 2011-01-20
Mpr 3447
Sida 16(23)

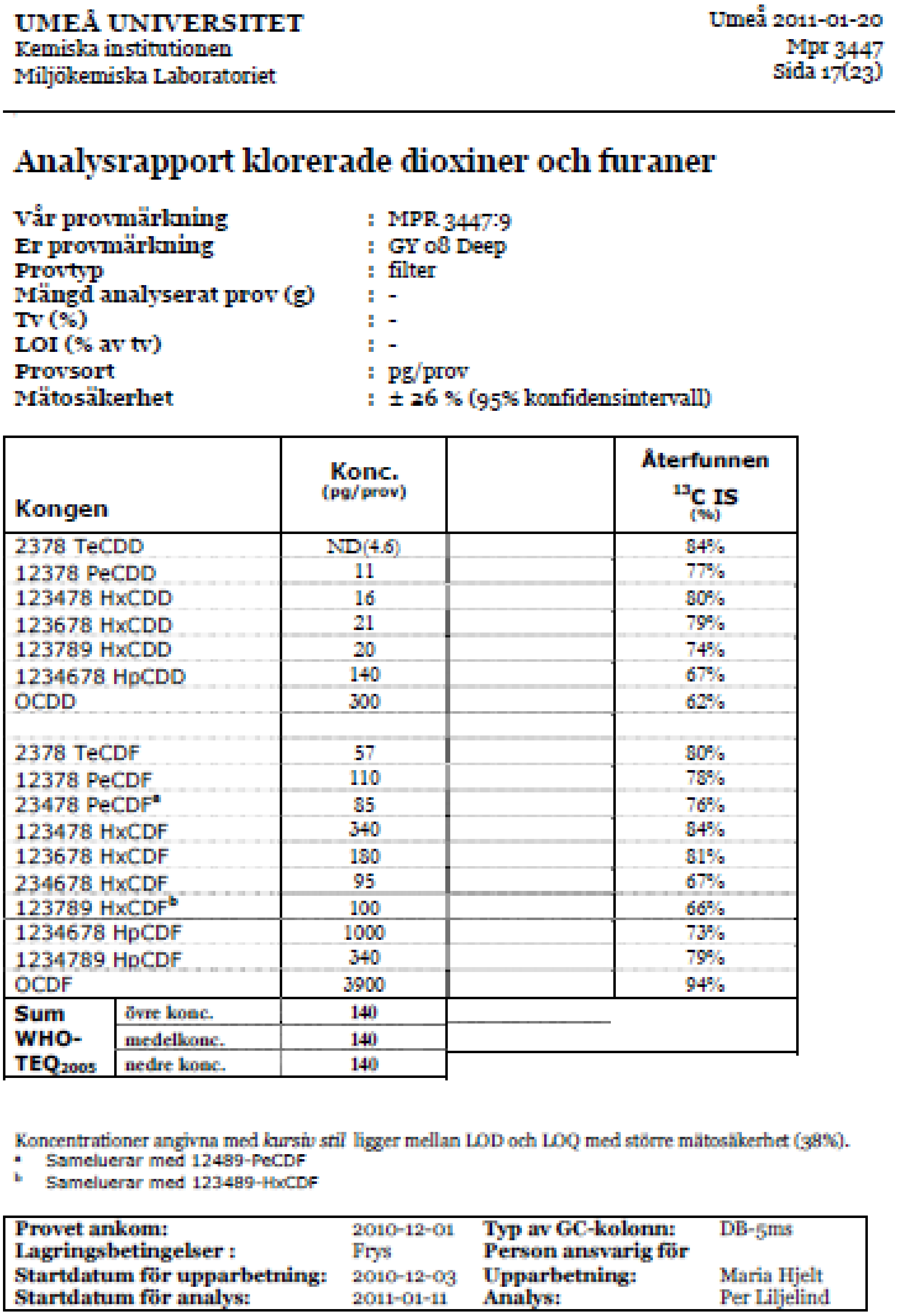
Analysrapport klorerade dioxiner och furaner

Vår provmärkning : MPR 3447:8
Er provmärkning : FA S3 Shallow
Provtyp : filter
Mängd analyserat prov (g) : -
Tv (%) : -
LOI (% av tv) : -
Provsort : pg/prov
Mätosäkerhet : ± 26 % (95% konfidensintervall)

Kongen	Konc. (pg/prov)		Återfunnen ^{13}C IS (%)
2378 TeCDD	ND(5.1)		73%
12378 PeCDD	ND(7.5)		72%
123478 HxCDD	ND(9.7)		73%
123678 HxCDD	ND(9.1)		71%
123789 HxCDD	ND(10)		64%
1234678 HpCDD	40		69%
OCDD	100		67%
2378 TeCDF	33		74%
12378 PeCDF	47		74%
23478 PeCDF[a]	27		73%
123478 HxCDF	110		77%
123678 HxCDF	67		76%
234678 HxCDF	36		72%
123789 HxCDF[b]	38		70%
1234678 HpCDF	250		78%
1234789 HpCDF	120		75%
OCDF	1200		75%
Sum WHO-TEQ$_{2005}$ övre konc.	58		
medelkonc.	50		
nedre konc.	42		

Koncentrationer angivna med *kursiv stil* ligger mellan LOD och LOQ med större mätosäkerhet (38%).
[a] Sameluerar med 12489-PeCDF
[b] Sameluerar med 123489-HxCDF

Provet ankom:	2010-12-01	**Typ av GC-kolonn:**	DB-5ms
Lagringsbetingelser :	Frys	**Person ansvarig för**	
Startdatum för upparbetning:	2010-12-03	**Upparbetning:**	Maria Hjelt
Startdatum för analys:	2011-01-11	**Analys:**	Per Liljelind



UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

Umeå 2011-01-20
Mpr 3447
Sida 17(23)

Analysrapport klorerade dioxiner och furaner

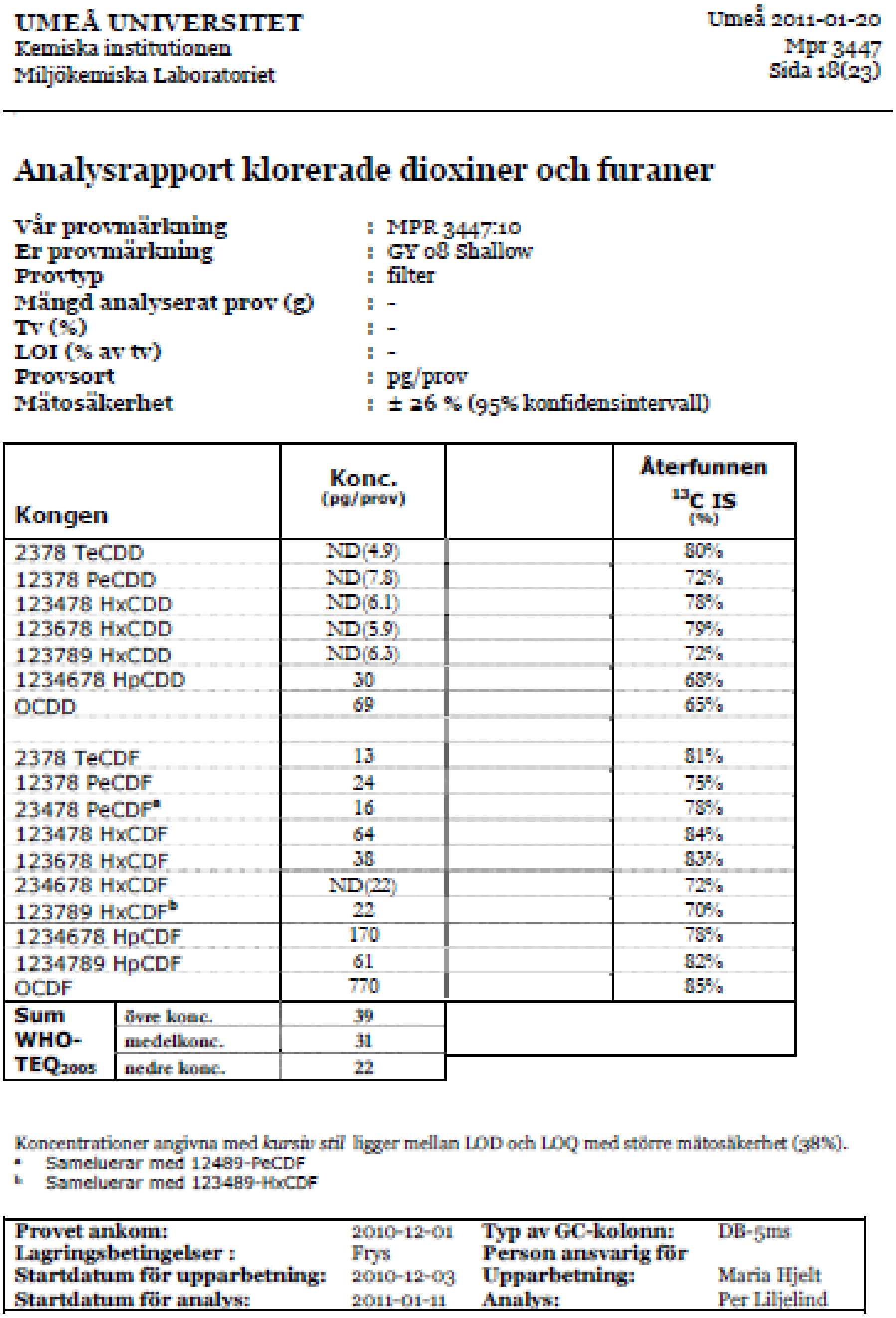
Vår provmärkning : MPR 3447:9
Er provmärkning : GY 08 Deep
Provtyp : filter
Mängd analyserat prov (g) : -
Tv (%) : -
LOI (% av tv) : -
Provsort : pg/prov
Mätosäkerhet : ± 26 % (95% konfidensintervall)

Kongen	Konc. (pg/prov)		Återfunnen ^{13}C IS (%)
2378 TeCDD	ND(4.6)		84%
12378 PeCDD	11		77%
123478 HxCDD	16		80%
123678 HxCDD	21		79%
123789 HxCDD	20		74%
1234678 HpCDD	140		67%
OCDD	300		62%
2378 TeCDF	57		80%
12378 PeCDF	110		78%
23478 PeCDF[a]	85		76%
123478 HxCDF	340		84%
123678 HxCDF	180		81%
234678 HxCDF	95		67%
123789 HxCDF[b]	100		66%
1234678 HpCDF	1000		73%
1234789 HpCDF	340		79%
OCDF	3900		94%

Sum WHO-TEQ$_{2005}$	övre konc.	140
	medelkonc.	140
	nedre konc.	140

Koncentrationer angivna med *kursiv stil* ligger mellan LOD och LOQ med större mätosäkerhet (38%).
[a] Sameluerar med 12489-PeCDF
[b] Sameluerar med 123489-HxCDF

Provet ankom:	2010-12-01	**Typ av GC-kolonn:**	DB-5ms
Lagringsbetingelser :	Frys	**Person ansvarig för**	
Startdatum för upparbetning:	2010-12-03	**Upparbetning:**	Maria Hjelt
Startdatum för analys:	2011-01-11	**Analys:**	Per Liljelind



UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

Umeå 2011-01-20
Mpr 3447
Sida 18(23)

Analysrapport klorerade dioxiner och furaner

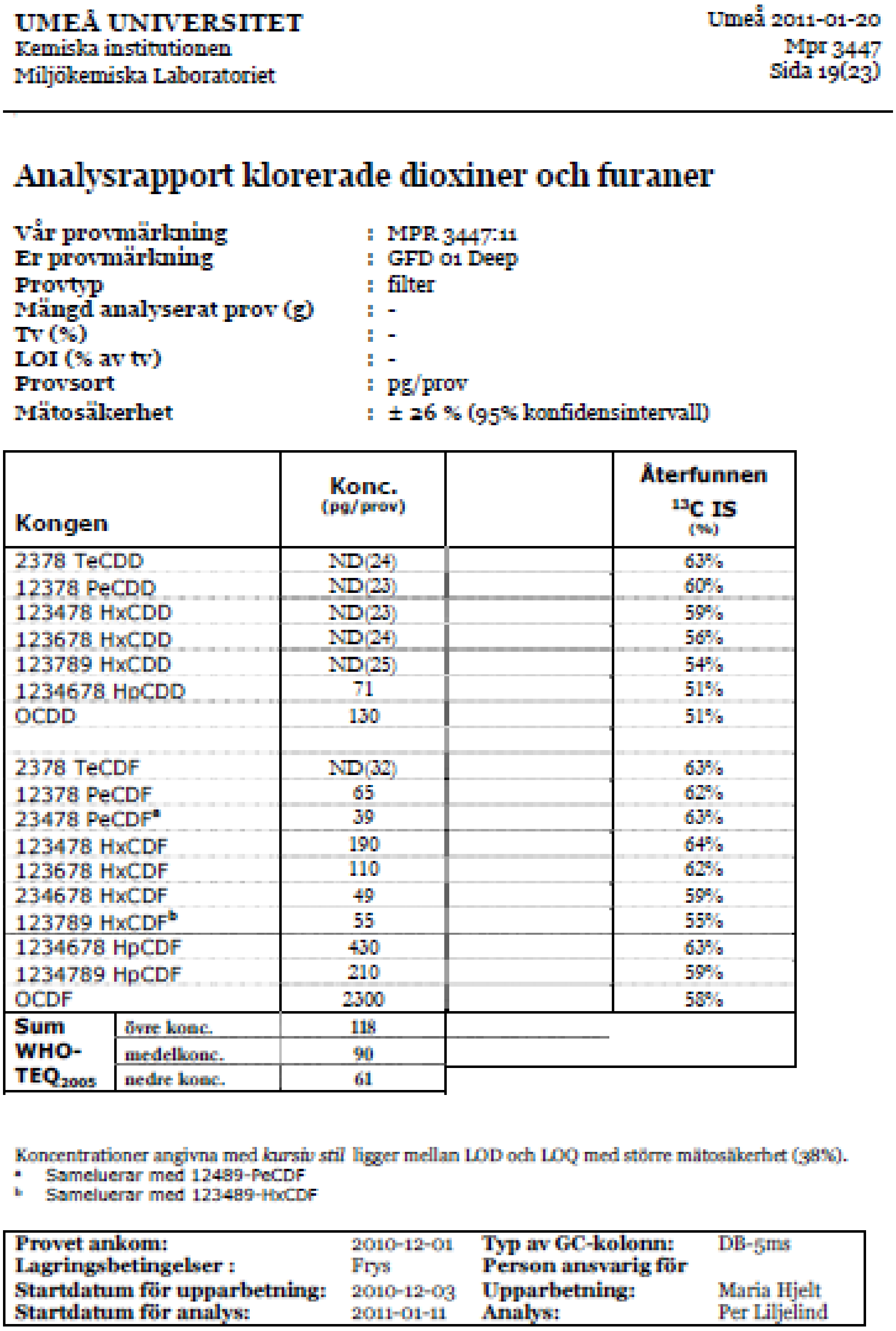
Vår provmärkning : MPR 3447:10
Er provmärkning : GY 08 Shallow
Provtyp : filter
Mängd analyserat prov (g) : -
Tv (%) : -
LOI (% av tv) : -
Provsort : pg/prov
Mätosäkerhet : ± 26 % (95% konfidensintervall)

Kongen	Konc. (pg/prov)		Återfunnen ^{13}C IS (%)
2378 TeCDD	ND(4.9)		80%
12378 PeCDD	ND(7.8)		72%
123478 HxCDD	ND(6.1)		78%
123678 HxCDD	ND(5.9)		79%
123789 HxCDD	ND(6.3)		72%
1234678 HpCDD	30		68%
OCDD	69		65%
2378 TeCDF	13		81%
12378 PeCDF	24		75%
23478 PeCDF[a]	16		78%
123478 HxCDF	64		84%
123678 HxCDF	38		83%
234678 HxCDF	ND(22)		72%
123789 HxCDF[b]	22		70%
1234678 HpCDF	170		78%
1234789 HpCDF	61		82%
OCDF	770		85%
Sum WHO-TEQ$_{2005}$ övre konc.	39		
medelkonc.	31		
nedre konc.	22		

Koncentrationer angivna med *kursiv stil* ligger mellan LOD och LOQ med större mätosäkerhet (38%).

[a] Sameluerar med 12489-PeCDF
[b] Sameluerar med 123489-HxCDF

Provet ankom:	2010-12-01	**Typ av GC-kolonn:**	DB-5ms
Lagringsbetingelser :	Frys	**Person ansvarig för**	
Startdatum för upparbetning:	2010-12-03	**Upparbetning:**	Maria Hjelt
Startdatum för analys:	2011-01-11	**Analys:**	Per Liljelind



UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

Umeå 2011-01-20
Mpr 3447
Sida 19(23)

Analysrapport klorerade dioxiner och furaner

Vår provmärkning : MPR 3447:11
Er provmärkning : GFD 01 Deep
Provtyp : filter
Mängd analyserat prov (g) : -
Tv (%) : -
LOI (% av tv) : -
Provsort : pg/prov
Mätosäkerhet : ± 26 % (95% konfidensintervall)

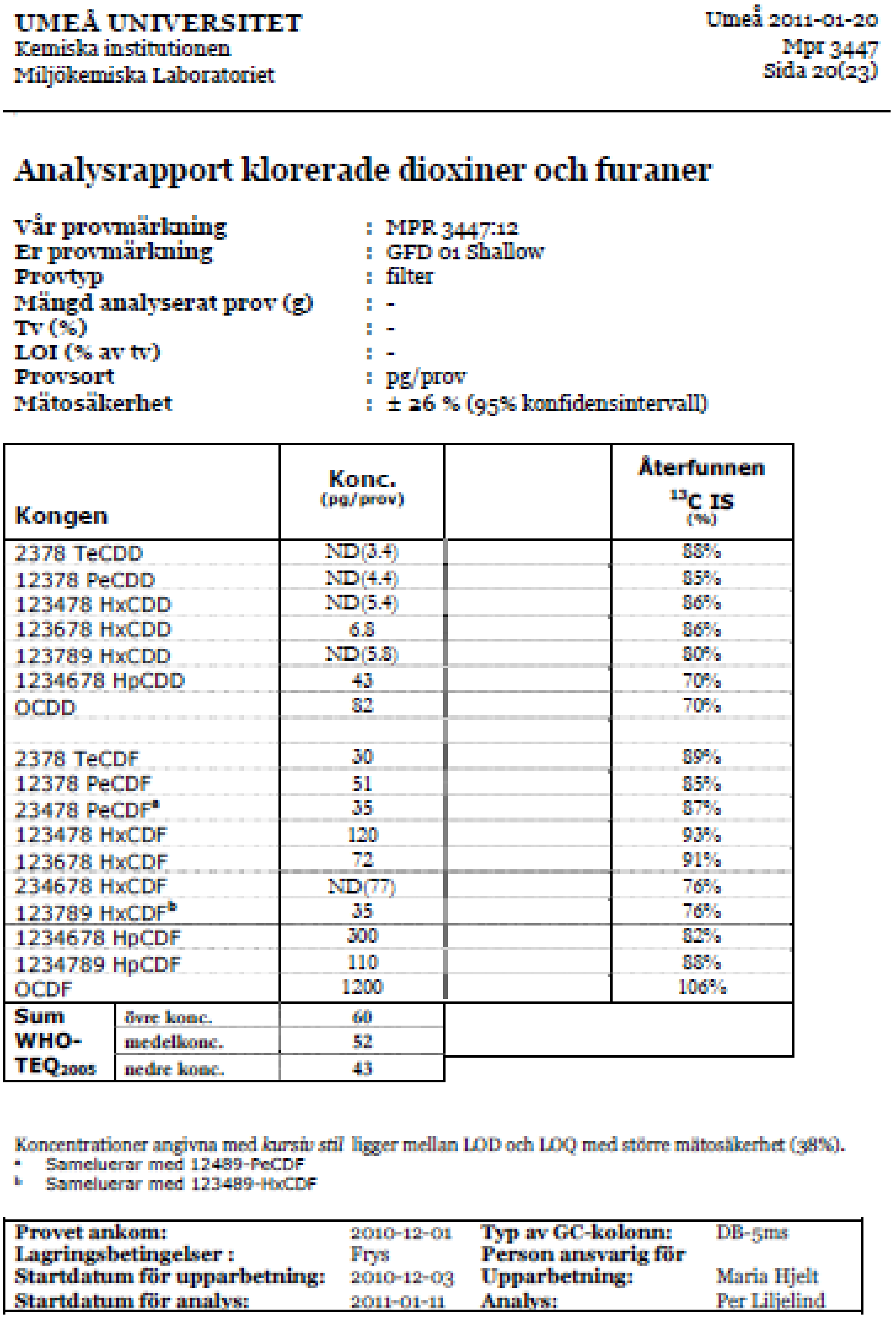
Kongen		**Konc.** (pg/prov)		**Återfunnen** ^{13}C IS (%)
2378 TeCDD		ND(24)		63%
12378 PeCDD		ND(23)		60%
123478 HxCDD		ND(23)		59%
123678 HxCDD		ND(24)		56%
123789 HxCDD		ND(25)		54%
1234678 HpCDD		71		51%
OCDD		130		51%
2378 TeCDF		ND(32)		63%
12378 PeCDF		65		62%
23478 PeCDF[a]		39		63%
123478 HxCDF		190		64%
123678 HxCDF		110		62%
234678 HxCDF		49		59%
123789 HxCDF[b]		55		55%
1234678 HpCDF		430		63%
1234789 HpCDF		210		59%
OCDF		2300		58%
Sum WHO-TEQ$_{2005}$	övre konc.	118		
	medelkonc.	90		
	nedre konc.	61		

Koncentrationer angivna med *kursiv stil* ligger mellan LOD och LOQ med större mätosäkerhet (38%).

[a] Sameluerar med 12489-PeCDF

[b] Sameluerar med 123489-HxCDF

Provet ankom:	2010-12-01	**Typ av GC-kolonn:**	DB-5ms
Lagringsbetingelser :	Frys	**Person ansvarig för**	
Startdatum för upparbetning:	2010-12-03	**Upparbetning:**	Maria Hjelt
Startdatum för analys:	2011-01-11	**Analys:**	Per Liljelind



UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

Umeå 2011-01-20
Mpr 3447
Sida 20(23)

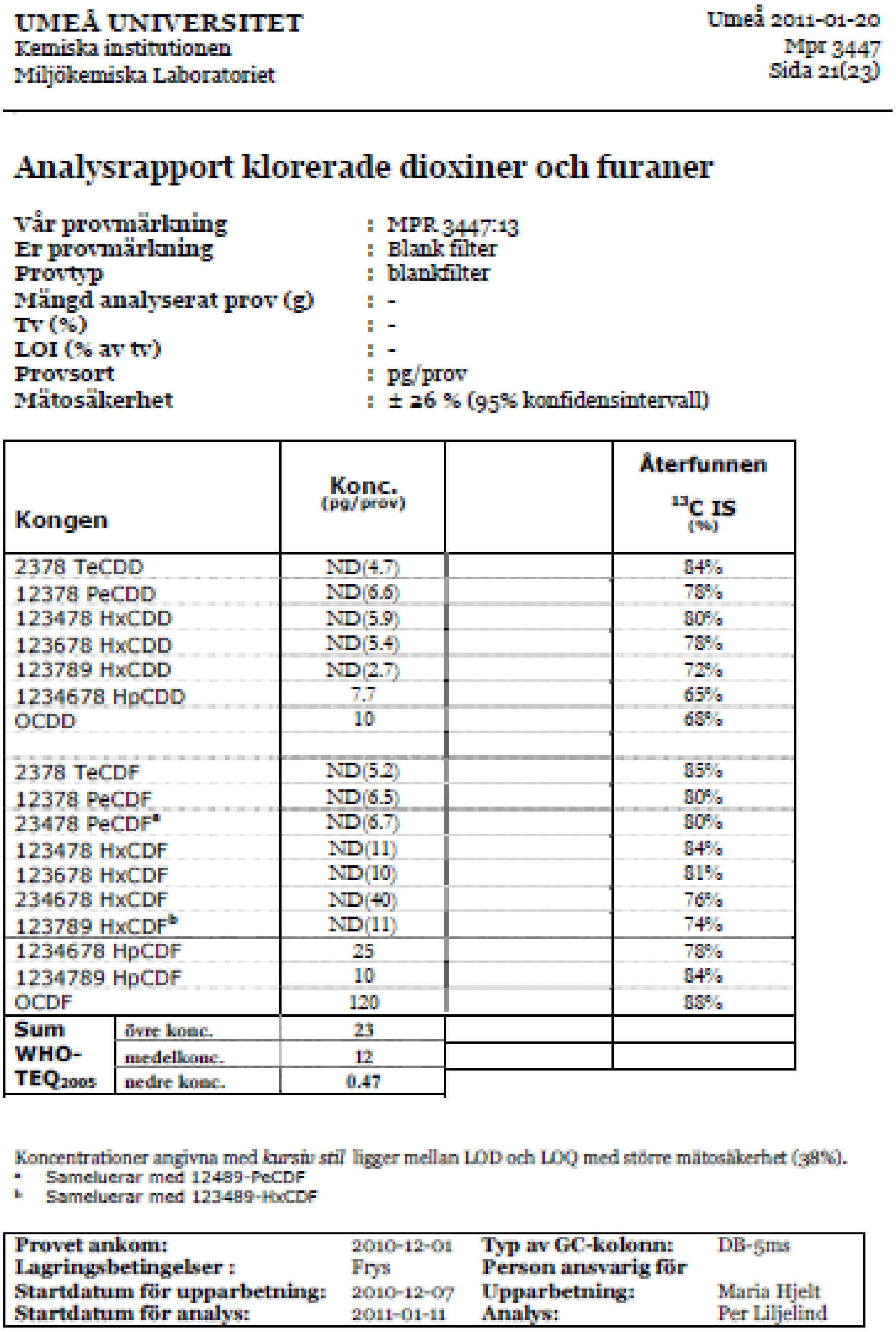
Analysrapport klorerade dioxiner och furaner

Vår provmärkning : MPR 3447:12
Er provmärkning : GFD 01 Shallow
Provtyp : filter
Mängd analyserat prov (g) : -
Tv (%) : -
LOI (% av tv) : -
Provsort : pg/prov
Mätosäkerhet : ± 26 % (95% konfidensintervall)

Kongen	Konc. (pg/prov)		Återfunnen ^{13}C IS (%)
2378 TeCDD	ND(3.4)		88%
12378 PeCDD	ND(4.4)		85%
123478 HxCDD	ND(5.4)		86%
123678 HxCDD	6.8		86%
123789 HxCDD	ND(5.8)		80%
1234678 HpCDD	43		70%
OCDD	82		70%
2378 TeCDF	30		89%
12378 PeCDF	51		85%
23478 PeCDF[a]	35		87%
123478 HxCDF	120		93%
123678 HxCDF	72		91%
234678 HxCDF	ND(77)		76%
123789 HxCDF[b]	35		76%
1234678 HpCDF	300		82%
1234789 HpCDF	110		88%
OCDF	1200		106%
Sum WHO-TEQ$_{2005}$ övre konc.	60		
medelkonc.	52		
nedre konc.	43		

Koncentrationer angivna med *kursiv stil* ligger mellan LOD och LOQ med större mätosäkerhet (38%).
[a] Sameluerar med 12489-PeCDF
[b] Sameluerar med 123489-HxCDF

Provet ankom:	2010-12-01	**Typ av GC-kolonn:**	DB-5ms
Lagringsbetingelser :	Frys	**Person ansvarig för**	
Startdatum för upparbetning:	2010-12-03	**Upparbetning:**	Maria Hjelt
Startdatum för analys:	2011-01-11	**Analys:**	Per Liljelind



UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

Umeå 2011-01-20
Mpr 3447
Sida 21(23)

Analysrapport klorerade dioxiner och furaner

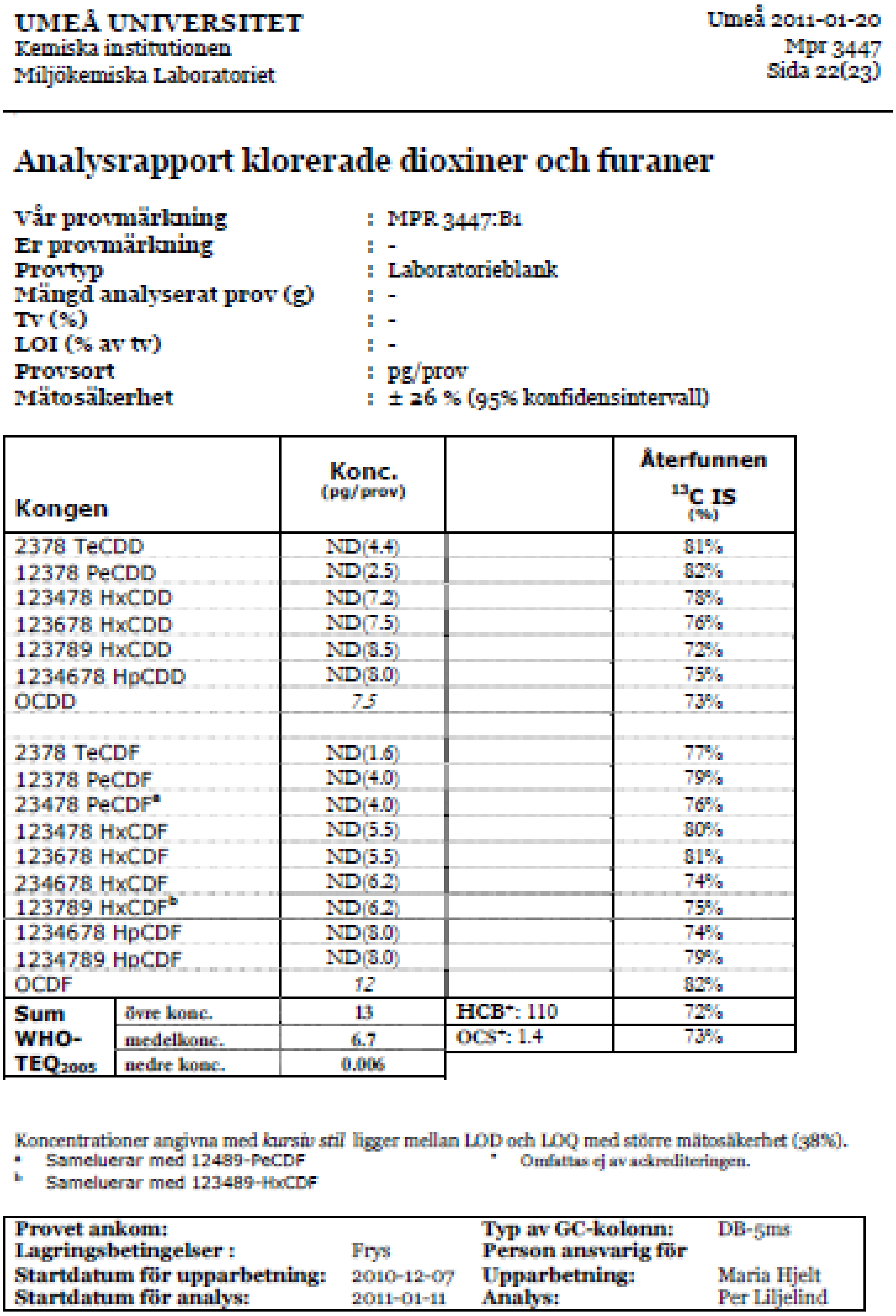
Vår provmärkning : MPR 3447:13
Er provmärkning : Blank filter
Provtyp : blankfilter
Mängd analyserat prov (g) : -
Tv (%) : -
LOI (% av tv) : -
Provsort : pg/prov
Mätosäkerhet : ± 26 % (95% konfidensintervall)

Kongen		**Konc.** (pg/prov)		**Återfunnen** ^{13}C IS (%)
2378 TeCDD		ND(4.7)		84%
12378 PeCDD		ND(6.6)		78%
123478 HxCDD		ND(5.9)		80%
123678 HxCDD		ND(5.4)		78%
123789 HxCDD		ND(2.7)		72%
1234678 HpCDD		7.7		65%
OCDD		10		68%
2378 TeCDF		ND(5.2)		85%
12378 PeCDF		ND(6.5)		80%
23478 PeCDF[a]		ND(6.7)		80%
123478 HxCDF		ND(11)		84%
123678 HxCDF		ND(10)		81%
234678 HxCDF		ND(40)		76%
123789 HxCDF[b]		ND(11)		74%
1234678 HpCDF		25		78%
1234789 HpCDF		10		84%
OCDF		120		88%
Sum WHO-TEQ$_{2005}$	övre konc.	23		
	medelkonc.	12		
	nedre konc.	0.47		

Koncentrationer angivna med *kursiv stil* ligger mellan LOD och LOQ med större mätosäkerhet (38%).

[a] Sameluerar med 12489-PeCDF
[b] Sameluerar med 123489-HxCDF

Provet ankom:	2010-12-01	**Typ av GC-kolonn:**	DB-5ms
Lagringsbetingelser :	Frys	**Person ansvarig för**	
Startdatum för upparbetning:	2010-12-07	**Upparbetning:**	Maria Hjelt
Startdatum för analys:	2011-01-11	**Analys:**	Per Liljelind



UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

Umeå 2011-01-20
Mpr 3447
Sida 22(23)

Analysrapport klorerade dioxiner och furaner

Vår provmärkning : MPR 3447:B1
Er provmärkning : -
Provtyp : Laboratorieblank
Mängd analyserat prov (g) : -
Tv (%) : -
LOI (% av tv) : -
Provsort : pg/prov
Mätosäkerhet : ± 26 % (95% konfidensintervall)

Kongen		**Konc.** (pg/prov)		**Återfunnen** ^{13}C IS (%)
2378 TeCDD		ND(4.4)		81%
12378 PeCDD		ND(2.5)		82%
123478 HxCDD		ND(7.2)		78%
123678 HxCDD		ND(7.5)		76%
123789 HxCDD		ND(8.5)		72%
1234678 HpCDD		ND(8.0)		75%
OCDD		*7.5*		73%
2378 TeCDF		ND(1.6)		77%
12378 PeCDF		ND(4.0)		79%
23478 PeCDF[a]		ND(4.0)		76%
123478 HxCDF		ND(5.5)		80%
123678 HxCDF		ND(5.5)		81%
234678 HxCDF		ND(6.2)		74%
123789 HxCDF[b]		ND(6.2)		75%
1234678 HpCDF		ND(8.0)		74%
1234789 HpCDF		ND(8.0)		79%
OCDF		*12*		82%
Sum WHO-TEQ$_{2005}$	övre konc.	13	**HCB***: 110	72%
	medelkonc.	6.7	OCS*: 1.4	73%
	nedre konc.	0.006		

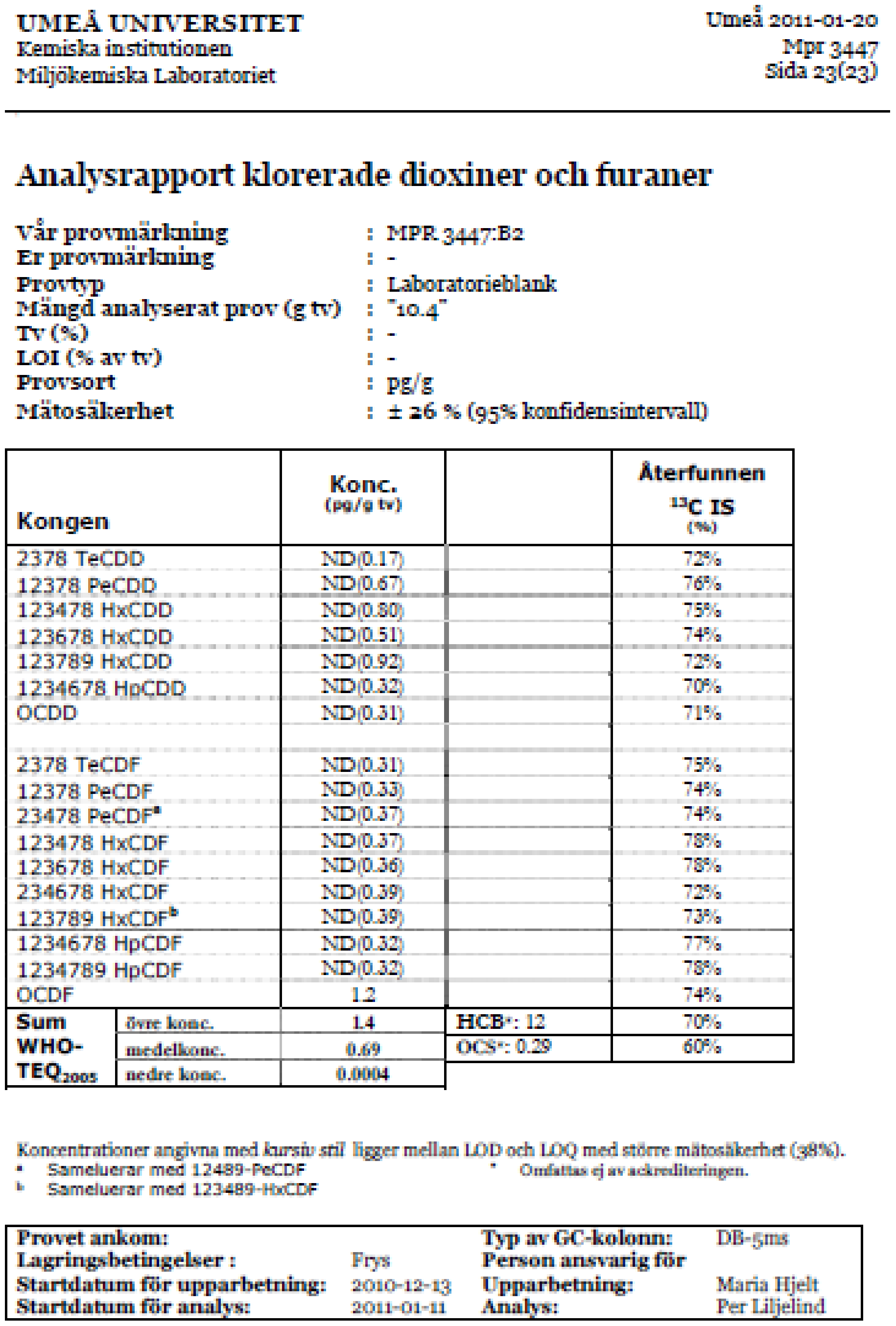
Koncentrationer angivna med *kursiv stil* ligger mellan LOD och LOQ med större mätosäkerhet (38%).

[a] Sameluerar med 12489-PeCDF

[b] Sameluerar med 123489-HxCDF

* Omfattas ej av ackrediteringen.

Provet ankom:		**Typ av GC-kolonn:**	DB-5ms
Lagringsbetingelser :	Frys	**Person ansvarig för**	
Startdatum för upparbetning:	2010-12-07	**Upparbetning:**	Maria Hjelt
Startdatum för analys:	2011-01-11	**Analys:**	Per Liljelind



UMEÅ UNIVERSITET
Kemiska institutionen
Miljökemiska Laboratoriet

Umeå 2011-01-20
Mpr 3447
Sida 23(23)

Analysrapport klorerade dioxiner och furaner

Vår provmärkning : MPR 3447:B2
Er provmärkning : -
Provtyp : Laboratorieblank
Mängd analyserat prov (g tv) : "10.4"
Tv (%) : -
LOI (% av tv) : -
Provsort : pg/g
Mätosäkerhet : ± 26 % (95% konfidensintervall)

Kongen		**Konc.** (pg/g tv)		**Återfunnen** ^{13}C IS (%)
2378 TeCDD		ND(0.17)		72%
12378 PeCDD		ND(0.67)		76%
123478 HxCDD		ND(0.80)		75%
123678 HxCDD		ND(0.51)		74%
123789 HxCDD		ND(0.92)		72%
1234678 HpCDD		ND(0.32)		70%
OCDD		ND(0.31)		71%
2378 TeCDF		ND(0.31)		75%
12378 PeCDF		ND(0.33)		74%
23478 PeCDF[a]		ND(0.37)		74%
123478 HxCDF		ND(0.37)		78%
123678 HxCDF		ND(0.36)		78%
234678 HxCDF		ND(0.39)		72%
123789 HxCDF[b]		ND(0.39)		73%
1234678 HpCDF		ND(0.32)		77%
1234789 HpCDF		ND(0.32)		78%
OCDF		1.2		74%
Sum WHO-TEQ$_{2005}$	övre konc.	1.4	**HCB**[*]: 12	70%
	medelkonc.	0.69	OCS[*]: 0.29	60%
	nedre konc.	0.0004		

Koncentrationer angivna med *kursiv stil* ligger mellan LOD och LOQ med större mätosäkerhet (38%).

[a] Sameluerar med 12489-PeCDF

[b] Sameluerar med 123489-HxCDF

[*] Omfattas ej av ackrediteringen.

Provet ankom:		**Typ av GC-kolonn:**	DB-5ms
Lagringsbetingelser :	Frys	**Person ansvarig för**	
Startdatum för upparbetning:	2010-12-13	**Upparbetning:**	Maria Hjelt
Startdatum för analys:	2011-01-11	**Analys:**	Per Liljelind

Appendix C.

Rekvisisjonsnr : **2010-02838** Mottatt dato : **20101125** Godkjent av : **KLR** Godkjent dato: **20101208**
Prosjektnr : **O 10426**
Kunde/Stikkord : **SPM-Grenland**
Kontaktp./Saksbeh. : **ALI,MTS**

Analysevariabel					KORN<63µm	TOC/F	Cd/ICP-Sm	Cu/ICP-Sm	Hg-Sm	Pb/ICP-Sm	Zn/ICP-Sm
Enhet ==>					% t.v.	µg C/mg TS	µg/g t.v.	µg/g t.v.	µg/g t.v.	µg/g t.v.	µg/g t.v.
Metode ==>				TESTNO	Intern*	G 6	E 9-5	E 9-5	E 4-3	E 9-5	E 9-5
PrNr	PrDato	Merking	Prøvetype								
1	20101108	FSS 1	sedis	2010-02838	25	9.3	<0.2	8.39	0.16	21	51.9
2	20101108	FSS 2	sedis	2010-02838	83	29.8	0.3	25.1	0.80	49.5	104
3	20101108	FSS 3	sedis	2010-02838	2	1.8	<0.2	14.8	0.039	7.1	19
4	20101108	FSS 4	sedis	2010-02838	34	5.7	<0.2	5.8	0.17	14	32.0
5	20101108	FSS 5	sedis	2010-02838	57	7.2	<0.2	6.29	0.14	12	31
6	20101108	FSS 6	sedis	2010-02838	95	41.8	<0.2	38.1	1.95	118	187

* Analysemetoden er ikke akkreditert.

Informasjon om analyseusikkerhet finnes på K:\Kvalitet\Godkjente_dokumenter\Akkreditering\Diversedokumenter\Y3Usikker.doc, eller kan fås ved henvendels til laboratoriet.

NIVA: Norway's leading centre of competence in aquatic environments

NIVA provides government, business and the public with a basis for preferred water management through its contracted research, reports and development work. A characteristic of NIVA is its broad scope of professional disciplines and extensive contact network in Norway and abroad. Our solid professionalism, interdisciplinary working methods and holistic approach are key elements that make us an excellent advisor for government and society.

NIVA
Norwegian Institute for Water Research

Gaustadalléen 21 • NO-0349 Oslo, Norway
Telephone: +47 22 18 51 00 • Fax: 22 18 52 00
www.niva.no • post@niva.no