

## Concentrations of PCDD/PCDFs in Soil Around a Point Source, 1992 - 1997

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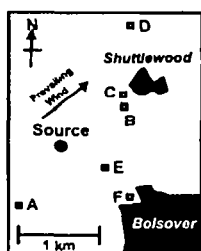
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### Introduction

In 1991 elevated concentrations of PCDD/PCDFs were discovered in cows milk near to a point source of emission in Bolsover, Derbyshire, UK. The source, a waste chemicals incinerator used in the destruction of chlorinated phenolic wastes, ceased operation in November 1991<sup>1</sup>.

As part of a larger project, soil samples have been taken from several locations within 2 km of the source since 1992. This paper comments on the congener profiles of the samples and reports the changes in concentration of PCDD/PCDFs between 1992 and 1997.



**Figure 1.**  
Plan of the sample area showing the location of the six soil samples (A - F) relative to the point source.

### Experimental

The 1992 soil samples were taken by AEA Technology on behalf of Her Majesty's Inspectorate of Pollution from which sub-samples were donated in 1994 for this project. Repeat samples were taken from, as far as has been practicable, the exact locations in 1994, 1995, and 1997.

The samples comprised of 5 x 50 mm diameter cores extracted with a bulb planter - one from each corner and the centre of a square of 1m length sides. The cores were cut to 50 mm depth and air dried before sieving to < 2 mm and storage at -20 ° C (the 1992 samples have been stored at this temperature only since 1994).

A plan of the sampling sites from which the soils were analysed and other key geographical features is shown at Figure 1.

## Analytical

Soil was extracted in soxhlet apparatus for 16 hours using toluene. The extract was cleaned using adsorption chromatographic techniques and thermally aided digestion using concentrated sulphuric acid. Quantification was performed by isotope dilution methods using high resolution gas chromatography with high resolution mass spectrometry (HRGC/HRMS). Samples were analysed on two capillary GC columns of different polarities (a 30m DB5 and 60m SP2331).

## Results and Discussion

The concentration of PCDD/PCDFs for each homologue group is shown in Table I and of selected 2,3,7,8-congeners in Table II. There was no sample available from 1992 for site E.

The  $\Sigma$ PCDD/PCDFs compared to the typical UK mean concentration<sup>2</sup> of 433 ng/kg are elevated at all sites in both years, however only two sites (D and E) are significantly higher than the typical U.K. urban concentration<sup>2</sup> (30 ng/kg) in terms of the I-TEQ value (see Figure II). All sites except site D have a similar and unusual congener profile compared to the typical U.K. soils characterised by the dominant TCDD, PeCDD, TCDF and PeCDF homologues compared to OCDD. At site D, however, although exhibiting high concentrations in terms of its I-TEQ value, the homologue profile was very different from the other sample sites (See Figure III).

Sample/Year	A92	B92	C92	D92	F92	A97	B97	C97	D97	E97	F97
Di-dioxins	28	33	51	29	25	22	32	35	22	209	26
Tri-dioxins	110	159	232	194	83	86	148	175	91	1,116	74
Tetra-dioxins	384	673	1,290	994	317	732	1,314	1,032	623	10,254	568
Penta-dioxins	255	624	676	748	204	228	628	626	328	5,254	293
Hexa-dioxins	83	106	114	638	54	91	131	142	247	828	65
Hepta-dioxins	63	54	80	1,176	34	61	66	144	1,174	133	56
OCDD	124	124	164	4,914	56	114	87	268	4,814	165	84
Mono-furans	24	82	112	42	65	7	32	1	2	81	15
Di-furans	144	199	267	139	157	112	182	173	82	616	155
Tri-furans	175	263	369	230	154	153	264	307	146	845	172
Tetra-furans	287	536	730	573	231	224	541	551	261	3,530	134
Penta-furans	66	174	145	167	55	66	196	152	91	471	76
Hexa-furans	43	89	68	499	32	44	104	74	198	170	45
Hepta-furans	39	61	39	1,122	21	33	68	55	467	82	23
OCDF	22	58	27	278	16	22	36	35	154	67	21
$\Sigma$ PCDD/PCDF *	1,848	3,237	4,366	11,743	1,505	1,996	3,830	3,771	8,700	23,822	1,806

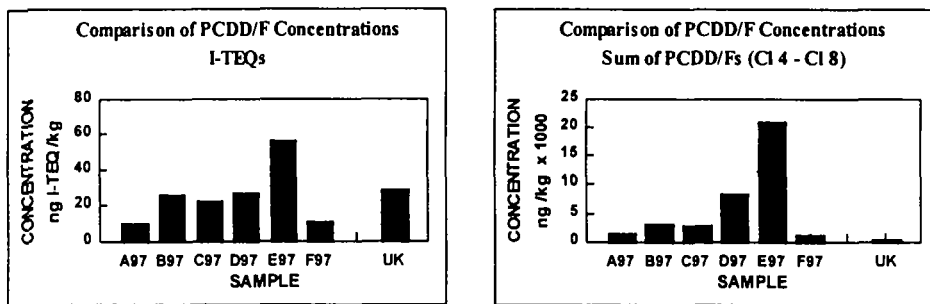
**Table I** Concentration of PCDD/PCDFs (ng/kg dry weight) in Bolsover soil samples 1992 and 1997

\* Note The  $\Sigma$  PCDD/F concentration shown is  $\Sigma$  C<sub>1</sub> to C<sub>8</sub> CDD/CDF congeners

Sample/Year	A92	B92	C92	D92	F92	A97	B97	C97	D97	E97	F97
2,3,7,8-TCCD	3.5	14.2	8.3	8.1	3.1	2.7	7.3	7.5	2.8	14.8	2.4
1,2,3,7,8-PeCDD	2.9	5.2	4.2	7.2	2.6	2.9	6.1	5.1	3.2	19.4	3.7
2,3,7,8-TCDF	5.4	12.5	10.6	5.1	4.8	5.5	15.9	11.3	4.8	16.5	7.2
1,2,3,7,8-PeCDF	6	15.3	12.5	8.1	5.2	6.4	18.9	13.6	5.8	24.3	7.3
2,3,4,7,8-PeCDF	4.3	11.8	8.7	5.9	3.7	4.8	14.4	9.4	4.2	9.9	5.3
Total I-TEQ	11.7	31.6	22	54.6	9.7	11	27.5	23.5	28.5	57.5	12

**Table II** Concentration (ng/kg dry weight) of selected congeners and total TEQ values in 1992 and 1997

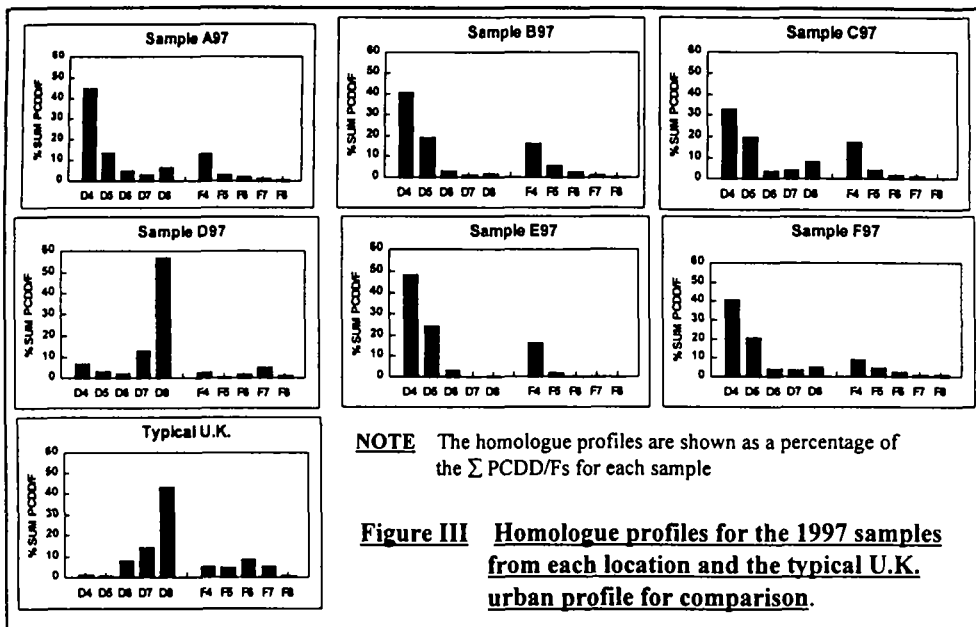
This may have been due to a very local source, such as the location of a bonfire. The homologue profiles of soils from the other five sample locations have a good resemblance of those found on vegetation and in the air around the time the contamination was arising.



**Figure II** Comparison of PCDD/F concentrations for the 1997 samples compared with the typical U.K. urban concentration.

The concentrations found in the 1997 samples are generally unchanged at the four sites having the similar homologue profiles (A,B,C and F) from those measured in 1992. For the  $\Sigma$ TCDD homologue, three of these four sites (A,B and D) showed an increase by almost a factor of two. This is consistent with the presence of a continuing diffuse source of  $\Sigma$ TCDD in the area as suggested by Jones et al<sup>2</sup> from air monitoring undertaken at several sites in the vicinity during 1993, although this is not found for other key homologue groups. At site D there is evidence of a reduction in concentration across all homologue groups and a fall in the  $\Sigma$  PCDD/PCDFs by 25%. This site is the furthest from the source and exhibited an atypical homologue profile for the area.

The difference in the homologue profiles for samples from each of the locations for 1997 and that of the typical U.K. profile is illustrated in Figure III



### Conclusions.

The soils analysed contained dioxins of a distinguishable and unusual homologue profile. One site exhibited elevated PCDD/Fs compared with typical UK urban concentrations in soil in 1992 but of a completely different profile to the other sites.

All sites showed elevated  $\Sigma$ PCDD/PCDF concentrations in both 1992 and 1997. The soil at two sites (D and E) was found to have elevated concentrations of approximately double the typical U.K. urban mean concentration, one of which was of a completely different profile to the other sites. The I-TEQ values are, with the exception of site E, in the typical range for the U.K.

Generally, there has been no change in the concentration of PCDD/Fs as homologues and individual congeners at the selected sites between 1992 and 1997, confirming the persistence of these compounds in soils.

### Acknowledgements.

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### References.

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2. Sandalls F.J, Berryman R.J, Bennett S.L, McCrorie S.K.C, Ambridge P.J. and Coleman P.J A Survey of Dioxins and Furans in Surface Soil in the Vicinity of the Coalite Works, Near Bolsover, Derbyshire. Published by The Environment Agency 1997
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