Chemical trespass: a toxic legacy

Executive summary
A WWF-UK Report
June 1999

For further information or a copy of the full report, *Chemical trespass: a toxic legacy*, by Gwynne Lyons, contact:

Elizabeth Salter
Head of Toxics Programme WWF-UK
Panda House, Weyside Park
Godalming, Surrey GU7 1XR
tel: +44 (0)1483 412 518
fax: +44 (0)1483 426 409
e-mail: esalter@wwfnet.org

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Executive summary

The post-war chemical revolution has left the planet contaminated

In humanity's rush to industrialise, thousands of substances have been released into the environment with few prior checks on their potential for causing long-term harm. Wildlife throughout the world has been contaminated and many species harmed, including whales, seals, otters, alligators, birds and fish. The human race itself is now contaminated with several hundred man-made chemicals which would not have been found in our Victorian ancestors.

Early life exposures are a major concern

The rapid post-war expansion in the chemical industry has certainly resulted in increased exposure of unborn babies to many contaminants, but the problems associated with early-life exposure to pollutants are only now becoming a focus of attention. Of major concern are subtle long-term effects, such as how exposure in the womb can affect children's mental development, increase their risk of cancer, reduce their defence against disease or their ability to conceive and bear children themselves later in life.

The offspring of mammals such as humans, seals and otters are particularly at risk from the pollutants which can build up in the food chain (bioaccumulate) because they are exposed to their mother's toxic chemical body burden both in the womb and during breast feeding.

To illustrate the possible extent of the contamination of the mammalian species, WWF has collated data on the pollutants found in humans. The sheer number of substances found, and the levels of certain substances, illustrate the need for tighter controls on hazardous substances. Reducing the exposure of the unborn and newborn infant to pollutants is now a major challenge for modern society. Human health is intimately connected with the food we eat, the water we drink and the air we breathe. We pay a price when we contaminate our environment. Therefore, if we succeed in reducing the environmental releases of hazardous substances, this will be of benefit both to wildlife and humans.

A drastic cutback in the amounts of persistent and dangerous chemicals released to the environment is necessary. Safer products made with less hazardous chemicals must be found, because exposure can arise not only from factory emissions but also from how products are used and disposed of at the end of their life.

At one time or another, more than 350 man-made contaminants have been found in the breast milk of mothers, including some 87 dioxin and dioxin-like compounds and some 190 volatile compounds. Moreover, even more contaminants are likely to be present because other toxic chemicals found in human body fat can potentially transfer to the newborn infant during breast feeding.

Breast feeding should still be encouraged

Despite the concerns raised in this report, there is convincing evidence of the benefits of breast milk to the overall health and development of the infant. Breast milk is the ideal nutrient which also delivers immunological advantages - and furthermore, breast feeding promotes mother and child bonding. Therefore breast feeding should certainly still be encouraged.

However, action should be taken to try to reduce our body burdens and the contamination of breast milk. Measures should be put in place to reduce human exposure and ensure that, over time, the contamination of breast milk is reduced.

The main conclusions of this briefing are that:

- action must be taken to reduce the exposure of the unborn and newborn child to man-made chemicals; and

- irrespective of their currently-known toxicity, substances that are persistent and able to bioaccumulate should be phased out, because if their effects do become evident, it will be impossible to remedy them in the short term.

The potential effects

Several studies in Europe and North America have linked reduced intelligence and/or behavioural effects with a child's exposure in the womb to PCBs (polychlorinated biphenyls) and co-contaminants. With regard to dioxins and dioxin-like PCBs, the World Health Organisation (WHO) noted in 1998 that "subtle effects may already occur in the general population in developed countries at current background levels".

In addition, some research into the offspring of Inuit women has suggested an association between increased PCB exposure in the womb and increased ear and other infections, which may indicate that these substances can weaken the immune system.

Pollutants may therefore be preventing our children from reaching their full potential, as well as causing other subtle effects. For example, animal experiments have shown increased territorial marking in male mice exposed in the womb to certain endocrine disrupting chemicals (EDCs) such as DDT, the "oestrogen mimicking" pesticide. In humans, it is speculated that these kinds of effects might translate to increased social aggression which could change the character of human communities.

Therefore there is mounting concern about chemicals that are EDCs or hormone disruptors. These are known to interfere with the normal functioning of the body's own hormones or chemical messengers. The potential effects of exposure in the womb to endocrine disrupting chemicals are shown in the box. However, harmful chemicals can cause effects by numerous mechanisms - and not all bioaccumulating substances are EDCs.

Summary of the possible effects of exposure to endocrine disrupting chemicals (Taken from Health Council of the Netherlands, 1997)

The possible effects of in-utero exposure to endocrine disruptors include:

- Abnormal development of the reproductive system such as undescended testes, and defects of the penis such as hypospadias and epispadias, which is when the urethra opens on the underside or dorsal side (respectively of the penis instead of at the end. Feminisation of the reproductive tract in males and masculinisation in females. Testicular cancer, and cancer of the cervix or vagina. Decrease in sperm concentration and quality, and decrease in spermatogenesis.
- Abnormal development of the central nervous system leading to neurological, cognitive and behavioural disorders (including effects on sexual behaviour), and smaller head size at birth.
- Other general developmental abnormalities such as shorter pregnancies, lower birth weight, disturbed hormonal regulation or thyroid gland effects, arrested growth and effects on sex ratios.

Lack of toxicity data and the "mixture effect"

For many contaminants found in humans there is a lack of data on chronic toxicity, which makes the potential long-term effects very difficult to assess.

In the general population, furthermore, exposure to numerous contaminants with additive, or even possibly synergistic (more than additive) effects, may be tipping some people over the threshold for endocrine disruptive effects. This provides a strong argument for action to be taken against biologically active substances, irrespective of whether current concentrations are below the predicted "effect" threshold level for that single substance. Further, some substances act at such low concentrations that they may have no threshold whatever.

Most people are likely to be contaminated with numerous pollutants and a few of the contaminants of concern have been listed in Table 2, along with some indication of the potential toxic effects of that substance.

UK situation

The levels of organochlorine pesticides and dioxin-like compounds in UK breast milk and body fat appear to be declining, but there is certainly no room for complacency. Breast-fed babies in the UK (and many other industrialised countries) are still receiving far in excess of the WHO Tolerable Daily Intake (TDI) of dioxins and dioxin-like PCB substances. Similarly, some infants in the UK are receiving more than the TDI of dieldrin, an organochlorine pesticide which was used for many years as a wood treatment agent. Furthermore, in the UK during the 1990s, the intakes of lindane and total DDT of some breast-fed babies were only just within the WHO TDIs for these substances. This situation is clearly undesirable, although it should be recognised that TDIs relate to *lifetime* exposure because they

are the predicted amount that can be ingested every day without there being an appreciable risk.

The full range of contaminants in UK breast milk is unknown because in the past surveys have focused on a very limited range of substances, many of which have been banned for several years. However, in 1998 additional government funding was allocated to investigate whether certain other contaminants of concern were also present, such as bisphenol A, polyaromatic hydrocarbons (PAHs), and various phthalates. Nevertheless, an even more extended survey of UK human contamination is needed.

The actual intake of toxic chemicals by babies in the UK should be a matter of concern. For example, in the latest study of dioxins in breast milk in 1993-4, the intake of dioxins (including dioxin-like PCB substances) by two-month old babies was around 170 picograms per kilogram body weight per day (pg/kg bw/day), which dropped to a figure of around 39 pg/kg bw/day at 10 months. This means that two-month old infants in the UK are receiving, as a "best case" estimate, around 40 times the WHO TDI of 1-4 pg/kg bw/day, while 10-month old infants receive around 10 times in excess.

Similarly, based on the assumption that the average eight-week old infant weighs approx. 5kg and consumes around 800g of milk per day, in the latest UK survey in 1996-97, out of a total of 168 samples of breast milk, 15 per cent were found to be contaminated with dieldrin. Furthermore, the most contaminated sample would have equated to a dose of 1.12Fg per kilogram body weight per day, which is over 10 times the WHO provisional tolerable daily intake (PTDI) of 0.1Fg/kg bw/day for total aldrin and dieldrin.

For lindane, in the 1989-91 UK survey, the intake of a breast fed baby receiving some of the most contaminated milk was 0.8Fg/kg bw/day, which is just within the temporary WHO TDI of 1Fg/kg bw/day set in 1997. In the 1996-97 survey, the levels appeared to have declined because the most contaminated sample would have resulted in an intake of around 0.32Fg per kilogram body weight of the infant, which is around a third of the tolerable daily intake.

At risk regions

Levels of contamination can vary considerably between populations in different areas. People with relatively high exposures to certain pollutants will include those living in large or industrial urban areas, and the offspring of women who regularly consume contaminated fish such as the polluted Great Lakes fish. However, people in the developing world are also at risk. Insecticides are widely used in tropical areas, and fat levels of DDT and its breakdown product DDE certainly tend to be highest where it is used on crops and in homes for control of malaria. Wildlife and people living in the far north are also at risk, because many persistent substances are redistributed in a process termed global redistillation. The Inuit are a population of particular concern because they eat a lot of food from the sea, including predator mammals which tend to be heavily contaminated. Inuit women's breast milk is on average several times more contaminated with numerous organochlorine pesticides than that of women from southern Canada.

International action to address the problem

The need for global agreements to reduce or eliminate discharges and losses of the most persistent and toxic substances which can cross international boundaries has been recognised by the United Nations. Thus, when finalised, the United Nations Environment Programme (UNEP) Convention on Persistent Organic Pollutants (POPs) will require global controls over 12 substances at the outset: aldrin, chlordane, DDT, dieldrin, dioxins and furans, endrin, heptachlor, HCB, mirex, PCBs and toxaphene. Criteria for identifying future substances for global controls are still being discussed but it appears that such substances will have to be transferred long distances, be both persistent and bioaccumulative, and have some toxicity concerns. Areas of concern could include endocrine disruption, as well as other harmful effects.

Similarly, international controls have been agreed by the United Nations Economic Commission for Europe Protocol on Persistent Organic Pollutants (UNECE POP Protocol) under the Convention on Long Range Transboundary Air Pollution (LRTAP). Forty-three countries are parties to the LRTAP Convention, and the POP Protocol relates to 16 substances, 12 of which are the ones earmarked for global controls by UNEP. The protocol also covers chlordecone (kepone), PAHs (polyaromatic hydrocarbons), hexabromobiphenyl, and hexachlorocyclohexane (including lindane which is predominantly -HCH). In addition, in a separate declaration, 18 countries including the UK agreed that they shared the objective of controlling the risks arising from the dispersive uses of short chain chlorinated paraffins and they urged countries to adopt controls over PCP (pentachlorophenol) that were similar in effect to those in place in the European Union.

The countries of the UN ECE have also negotiated a Heavy Metals Protocol which will address environmental concerns associated with the long-range transport of metals. At the outset this has addressed cadmium, lead and mercury.

Nearly all compounds covered in these UNEP and UN ECE agreements have been reported to be human contaminants. WWF considers that this underlines the need to eliminate them worldwide - or, where this is not possible, to reduce their formation and release to a minimum. Many of these substances are in fact already banned in western countries, but the numerous substances now found in breast milk highlight the need to consider phasing out or controlling many others.

WWF's role

In order to protect the world's biodiversity, WWF is actively involved with the UNEP POPs Convention negotiations. WWF is pushing for the phase-out of identified POPS, rather than just management options, and for the inclusion of certain criteria to identify further POPs, so that in future more dangerous chemicals can be eliminated worldwide. Similarly, within Europe and the UK, WWF is campaigning for better legislative controls for persistent and biologically active chemicals.

WWF has also played a key role in raising the alarm about the problems associated with EDCs, many of which first became evident in wildlife living in polluted areas. Furthermore, mindful of the need to establish better testing methods to identify EDCs, WWF has been an important force in the Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC) in the United States. In order to push

the need for international action, WWF has also taken part in the OECD (Organisation for Economic Cooperation and Development) Task Force on Endocrine Testing and Assessment.

A selection of substances found in breast milk or human body fat

Compound	Control	Toxicity	Found
Dioxins (TCDDs) [In milk, WHO TDI for dioxins and dioxin-like subs is frequently widely exceeded - eg. 1993/94 UK survey.]	UNEP UNECE	Dioxins can be formed during the combustion of chlorinated substances. They are emitted from incinerators and numerous other sources, including cars running on leaded petrol which use chlorinated additives. In animals the most sensitive endpoints are endometriosis, cognitive effects, effects on sperm counts, female urogenital malformations, and immunotoxic effects. One particular dioxin (TCDD) causes cancer in several species. (See TEFs in Notes to Table, below).	Milk + Fat [Found UK/EU/US + elsewhere]
PCBs (Polychlorinated biphenyls) [In milk, WHO TDI for dioxins and dioxin-like subs (incl. some PCBs) is frequently widely exceeded - eg. 1993/94 UK survey.]	UNEP UNECE	PCBs have been used as dielectric fluids in transformers and capacitors, but in the EU all existing PCBs must be taken out of use and destroyed by the end of 1999. Some PCBs have dioxin-like effects (see above). Several PCB mixtures cause cancer in animals, and PCBs have been implicated in effects on the liver, reproduction, infant birth weight, neuro-behavioural development, and the immune system. For risk assessment, they are grouped with certain dioxins and furans as they have similar toxicity. (See TEFs in Notes to Table, below).	Milk + Fat [Found UK/EU/US + elsewhere]
Furans (TCDFs) [In milk, WHO TDI for dioxins and dioxin-like subs (incl. some furans) is frequently widely exceeded - eg. 1993/94 UK survey.]	UNEP UNECE	Furans are a group of chemicals with similar effects as dioxins. They are found as contaminants of certain chlorinated compounds, and are formed as combustion by-products, often with dioxins. For risk assessment purposes, they are grouped with dioxins and some PCBs, as they have similar toxicity. (See TEFs in Notes to Table, below).	Milk + Fat [Found UK/EU/US + elsewhere]
DDT total DDT includes isomers of DDE and DDT	UNEP UNECE	DDT is now banned in the UK, but it is still used in several countries to prevent malaria. DDT and DDE can have a range of effects on reproduction, development, and the nervous system. DDT is also able to cause cancer in animals and numerous effects on wildlife have been noted. DDT and DDE, its metabolite, are EDCs. WWF has called for a global phase-out by 2007.	Milk + Fat [Found UK/EU/US + elsewhere]

Dieldrin Aldrin WHO provisional TDI is set for aldrin plus dieldrin. In the latest UK breast milk survey of 1996/97 some babies were found to exceed this TDI.	UNEP UNECE	Main uses nowadays are against termites and wood borers, and on textile pests, but aldrin and dieldrin have been used as agricultural insecticides. Aldrin is metabolised to dieldrin, and is also converted to dieldrin in the environment. In laboratory tests, dieldrin is oestrogenic, and both these substances can stimulate liver enzymes. Dieldrin has also been associated with breast cancer. In addition, there is limited evidence for effects on immune system.	Milk + Fat [Found UK/EU/US + elsewhere]
Chlordane	UNEP UNECE	Chlordane is actually a mixture, and is used as an organochlorine pesticide in termite control and against worms. Chlordane can induce enzyme production and disrupt endocrine control. Major effects are on the liver and nervous system, but it has been linked with immune function impairment (eg. a Swedish study suggested that exposure to chlordane compounds and PCBs may be associated with a higher risk of non-Hodgkins lymphoma).	Milk + fat [Found UK/US/+ elsewhere] [UK: found in fat but not milk]
Trans-nonachlor Oxychlordane		Impurities of chlordane (see above) include trans-nonachlor, while oxychlordane is a stable metabolite.	Milk + Fat [Found EU/US/+ elsewhere]
Heptachlor	UNEP UNECE	An insecticide, particularly used on termites and against insects on cotton. Also a minor component of chlordane. It oxidises to carcinogenic products such as the epoxide, which is also stored in body fats. Considered to be a possible human carcinogen. Limited evidence that it may affect immune responses. Banned in UK in 1981, but still found in a third of samples analysed in the latest UK fat survey in 1995-97, although was not found in latest UK milk survey.	Milk + Fat [Found in UK/EU/US/ + elsewhere]
Hexachloro- Benzene (HCB)	UNEP UNECE	Used as a fungicide, but no longer approved in the UK. However, it is commonly used in the manufacture of aromatic fluorocarbons, chlorinated solvents, and synthetic tyres. HCB is toxic to the immune system and carcinogenic in animals, and is also capable of enzyme induction and endocrine disruption.	Milk + Fat [Found UK/EU/US/+ elsewhere]

Mirex	UNEP UNECE	An organochlorine flame retardant and pesticide which has been used to control ants. It can affect the liver, the kidneys, the eyes and thyroid, and it is toxic to the developing foetus. Mirex is also carcinogenic in animals.	Milk + Fat [Found US/+ elsewhere] [UK: not used]
Toxaphene (Also known as camphechlor, it is a mixture of chemicals)	UNEP UNECE	An insecticide which prior to being banned was heavily used in USA. Still used in some parts of the world. High doses of toxaphene can affect the nervous system, the kidneys, and the liver, while longer term exposure can affect the adrenals, the immune system and the developing foetus. Toxaphene is an EDC which binds to the oestrogen receptor, and it can cause cancer in animals.	Milk + Fat [Found EU/US] [No records of use in UK agriculture]
Polyaromatic Hydrocarbons (PAHS)	UNECE	PAHs mainly arise from combustion- or oil-related man-made sources. Human exposure can also arise from barbecued and smoked foods, and cigarettes. Some studies suggest that PAHs can affect the immuno-competence of wildlife and humans. Also, some of these substances are carcinogenic and some are EDCs.	Milk + Fat [Found EU/US/+ elsewhere] [UK: milk monitoring planned]
Hexachloro Cyclohexane (HCH) Technical grade HCH is a mixture of different isomers including "-HCH, $-HCH, *-HCH and (-HCH. Lindane is 99% (-HCH.	UNECE	Beta-HCH is the most persistent and bio-accumulating isomer. Lindane is used as an agricultural insecticide, on wood, and against head lice. It has a weak oestrogenic effect, and can affect the liver, the nervous system, the kidneys, the reproductive system and possibly the immune system. There is evidence for the carcinogenicity of technical grade and "-HCH in animals, and limited evidence for $-HCH and lindane.	Milk + Fat [Found UK/EU/US/+ elsewhere] (Latest UK surveys in 95-97 show $-HCH + lindane in milk and fat)
Synthetic musks		Synthetic nitro musks and polycyclic musk compounds are used as fragrances as substitutes for natural musk, and are often added to cosmetics and detergents. Musk ambrette has neurotoxic and mutagenic effects, and musk xylene has been found to be carcinogenic. More studies are needed to determine their long-term toxicity.	Milk + Fat [Found EU/+ elsewhere] [UK: not monitored]

Poly Chlorinated Terphenyls (PCTs)	N. Sea States to eliminate all PCT uses and stocks by 1999.	Related to PCBs, these were used as plasticisers, hydraulic fluids and as flame retardants, but production volumes were lower than that for the PCBs. Suspected of causing damage similar to the PCBs. PCTs have been used in the UK in relatively low quantities compared with the PCBs.	Milk + Fat [Found EU/+ elsewhere] [UK: not monitored]
Poly Chlorinated Naphthalenes (PCNs)		PCNs were predecessors to the PCBs, and were used in the same types of applications, although small amounts were also used for wood preservation. They have also been found as contaminants in PCB products, and some are considered to have dioxin-like toxicity. In the UK, BT are reported to have stocks, but they are no longer made in Europe. Found in air over the Arctic.	Milk [Found EU/US] [UK: not monitored]
Poly Brominated Diphenyl Ethers PBDEs penta-BDE octa-BDE deca-BDPE		Used as flame retardants. In utero exposure to pentaBDE and tetraBDE has been linked to behavioural effects in animals, which got worse as the animals aged. The liver, thyroid, nervous and immune system appear to be targets, and penta and tetra are EDCs with effects on thyroid hormones. DecaBDE may have some potential to cause cancer in animals. Also, there is concern that higher brominated diphenyl ethers might break down to the more toxic and bioaccumulating tetra and pentaBDE. PBDEs in Swedish breast milk have increased dramatically from 0.07µg/kg in 1972 to 4µg/kg milk fat in 1997.	Milk + Fat [Found EU/US] [UK: not monitored]
Poly Chlorinated Diphenyl Ethers (PCDEs)		PCDEs are usually associated with dioxins and furans as by-products in the production of chlorinated compounds, such as pesticides and wood preservatives. May be found as contaminants in technical grade PCP.	Fat [Found US] [UK: not monitored]
Phthalates (eg. DEHP, DBP)		Used as plasticisers to impart flexibility to plastics and inks. Several phthalates are testicular toxicants and can adversely effect fertility in animals. Some considered to be endocrine disrupting chemicals (EDCs) - eg DEHP is reported to affect the oestrous cycle, and DBP has anti-androgenic effects.	Fat [Found EU/US] [UK: Milk studies underway]

1,4-Dichloro Benzene		Has been used in mothballs and toilet blocks. 1,4-dichlorobenzene causes cancer in experimental animals.	Milk +Fat [Found US/ + elsewhere] [UK: not monitored]
Tri - and Tetra-Chloro Benzene		1,2,4-tri and particularly 1,2,4,5-tetra chloro benzene might be of concern, although little data were found for EU countries. Chlorobenzenes are widely dispersed in the environment as a result of industrial usage and incinerator emissions.	Milk + Fat [Found US/ + elsewhere] [UK: not monitored]
Di-2-Ethyl Hexyl Adipate (DEHA)		A plasticiser which has been used to impart flexibility in PVC "cling type" films used for packaging food. In animal experiments, adverse effects on sperm have been noted. It is a suspected EDC from studies on the trout oestrogen receptor.	Fat [Found US] [UK: not monitored]
Benzophenone .		This has been identified as a constituent in some sun screens, and it is also used in soaps and shampoos. Suspected EDC from studies on the trout oestrogen receptor.	Milk [Found EU] [UK: not monitored]
Octyl Methoxy Cinnamic Acid (OMC) .		Also used as a sun screen and found in a wide range of cosmetics. Suspected EDC from E-screen test.	Milk [Found EU] [UK: not monitored]
Aromatic Amines		Aromatic amines are used in the manufacture of plastics (including polyurethane foams), dyes, pesticides, and pharmaceuticals. N-methylaniline, o-toluidine, aniline have been found in milk, and concern was noted because of possible links to breast cancer.	Milk [Found elsewhere] [UK: not monitored]
PCP (Pentachlorophenol)		Use of this wood treatment biocide is now restricted by EU legislation. Major organs or systems affected by long-term exposure in animals are the liver, kidneys, the nervous and immune systems.	Milk [Found EU] [UK: not monitored]

Lead	UN ECE Heavy Metals	In the late 1980s average background levels of lead in breast milk from industrialised countries were between 5 and 20ppb. The higher levels were found in areas with heavy traffic, and now in some areas levels will have now declined due to the removal of lead from petrol. The growing brain is particularly sensitive.	Milk [Found UK/EU/US/+ elsewhere]
Mercury	UN ECE Heavy Metals	Mothers living in coastal areas, eating tuna, swordfish, or marine mammals, such as whales and seals, have been found to have high mercury levels in their milk. Methyl mercury can cross the placenta and can cause neurological damage.	Milk [Found UK/EU/US/+ elsewhere]

Notes to Table

[Found in UK]	Found in milk and/or fat (as specified) in UK
[Found in EU]	Found in milk and/or fat in one or more EU countries, apart from UK
[Found in US]	Found in milk and/or fat in USA
[Found elsewhere]	Found in milk and/or fat in a country other than UK, EU, or USA
TEFS	The available toxicological and biological data for dioxins, furans and PCBs is used to generate a set of weighting factors, called Toxic Equivalency Factors (TEFs) each of which expresses the toxicity of the "dioxin like" compound in terms of the equivalent amount of TCDD. The TEQ is derived by multiplying the concentration of a compound by its TEF.

Abbreviations

ADI	Acceptable Daily Intake - the amount of a chemical which can be consumed every day of an individual's lifetime in the practical certainty, on the basis of all known facts, that no harm will result.
DBP	Di-n-butyl phthalate
DEHP	Di-(2-ethylhexyl) phthalate
DDT	The sum of p,p'DDT and o,p'DDT, the pesticide applied, and the metabolites,p,p'DDE and p,p'TDE. DDT is dichlorodiphenyl trichloroethane
EDC	Endocrine Disrupting Chemical
TDI	Tolerable Daily Intake - an estimate of the amount, expressed on a body weight basis, of a contaminant which can be ingested every day over a lifetime without appreciable health risk
TCDD	Tetrachlorodibenzo-p-dioxin
PAHs	Polyaromatic hydrocarbons
PBDEs	Polybrominated diphenyl ethers
PCBs	Polychlorinated biphenyls
PCNs	Polychlorinated naphthalenes
PCP	Pentachlorophenol
PCT	Polychlorinated terphenyls
ppb	parts per billion or Fg/kg1

General conclusions and recommendations

1. This report highlights that several hundred man-made chemicals have been found as contaminants in human body fat, and many of these can be passed on to babies at a particularly sensitive stage in their development, via the placenta and during lactation.

2. There is convincing evidence of the benefits of breast feeding to the overall health and development of the infant, and therefore this practice should still be encouraged, despite the concerns raised by this report.

3. Many of the contaminants found in breast milk are inherently toxic, especially the organochlorines and heavy metals, and these chemicals may exert effects on the developmental, neurobehavioural, reproductive, and the immune system. Also, several of the contaminants found in breast milk are suspected human carcinogens. Furthermore, there is a lack of data on the chronic effects of many of the over three hundred and fifty contaminants which have been found in human breast milk, and this makes the potential long term effects very difficult to assess.

4. Urgent action should be taken to reduce exposures, particularly to substances which can cross the placenta and/or which can be found in breast milk.

5. The levels of contaminants found in humans certainly give no room for complacency. For example, infants in the UK (and elsewhere) are still exposed to dioxin-like compounds and dieldrin-like compounds at levels in excess of those set as tolerable daily intakes (TDIs), despite the recorded decline in the levels of these substances.

6. Compounds which are persistent and bioaccumulative should be considered undesirable, irrespective of their toxicity, and should therefore be considered for phase-out. This is because the long term effects of these chemicals on species at the top of the food chain are difficult, if not impossible, to predict from limited short term toxicity tests on a few selected species. Also, if effects do become evident, then due to the persistent and bioaccumulative nature of these substances, it will be impossible to reverse these effects in the short term.

7. Toxicity tests should be developed and imposed in legislation, in order to identify chemicals with endocrine disrupting effects.

8. In particular, behavioural effects seem to occur at lower exposure levels than structural deformities, and therefore new toxicity tests need to be developed and implemented in order to identify chemicals which can exert neurodevelopmental effects, and to determine the lowest levels which can cause such effects.
9. New substances with endocrine disrupting effects should be banned from entry onto the market (except for pharmaceuticals).

10. Chemicals which are currently on the market, which are found to have endocrine disrupting effects, should be prioritised for review, and exposures should be eliminated or reduced to the lowest levels practicable on a precautionary basis, taking into account the potential for simultaneous exposure to numerous substances with interactive effects.

11. It is a matter of concern that when the risks posed by existing substances are evaluated, it is usually only the risk posed by exposure to a single substance in isolation that is considered, and this should be rectified. Therefore, when estimating Asafe@ exposure levels, the interactive effects of all the substances to which there is concurrent exposure should be considered.

12. Tests are therefore needed to determine the Amixture effects@ of the substances to which the foetus and neonate are commonly exposed. For example, in the USA, the Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC) has recommended that tests should be done to determine the toxicity of the mixtures of contaminants commonly found in breast milk (4-49).

Future research on foetal and neonatal exposures and effects

13. With regard to quantifying in-utero exposures, consideration should be given to monitoring the level of contaminants in blood lipids, as these can provide a good indication of the amounts of the lipophilic substance in circulation. Also, compared to taking fat samples, taking samples of blood is relatively easy.

14. Further studies are needed on the possible long term health hazards to infants from the transplacental exposure to pollutants, and from the intake of contaminated breast milk. The long term effects of exposure to chemical pollutants can only be clarified by continued surveillance. Particular consideration should be given to studies encompassing the analysis and data banking of placental cord blood, and the subsequent analysis of breast milk of these infants, coupled with epidemiological studies on the development of these children, so that any effects noted can be evaluated with respect to both in-utero and post-natal exposures.

15. Research is needed on the ability of certain toxic substances, including carcinogens (and their active metabolites) to cross the placenta. Also, more research is needed to fully understand the metabolic changes that occur during pregnancy and how these can affect the accumulation of toxic substances in the mother, or the production of toxic metabolites. In addition, the metabolic capacity of the placenta and the neonate need to be evaluated because a number of metabolic pathways responsible for bioactivation or detoxification are thought not to be present in the foetus, and are less developed in an infant.

16. Consideration should also be given to evaluating all the hormonally active substances found in breast milk, and those believed to cross the placenta. Identifying and quantifying the potency of the total oestrogenic component, and the total anti-androgenic component, would provide valuable data on in-utero and neonatal exposures to man-made endocrine disrupting compounds (EDCs).

National surveillance and international co-ordination

17. National governments should, if possible, initiate programmes to monitor human contamination in their countries, in order to provide an integrated assessment of exposures to toxic chemicals, particularly foetal and neonatal exposures. Such national programmes should be co-ordinated internationally, and a central data repository set up and maintained. The aim should be to monitor representative populations throughout the globe.

18. Within this report it has not been possible to review the potential hazards posed by the numerous substances which have been found, or which might be expected to be found in humans. However, it is recommended that this is done by national and/or international committees of experts, at least on a rough and ready basis. This would enable substances, which might be expected to pose the greatest risk, including those for which there was little information on the degree of contamination, to be prioritised for relevant further study, for example, as to their typical levels and routes of exposure. This is because such data would be invaluable in helping determine and prioritise effective control programmes.

19. In the UK, for example, in order to effectively target a national monitoring programme, it is recommended that an expert committee should be set up to oversee the programme and make recommendations as to its scope, on an on-going basis. Such an expert committee for human exposure surveillance, should be comprised of scientists working on the effects of toxic substances, representatives from the Environment Agency and environmental NGOs, and scientists from Government departments.

20. There should be an investigation of the extent of human breast milk contamination. Breast milk should be analysed for a wide range of contaminants, in order to effectively target policies for

reducing early-life exposures. As numerous factors influence the accumulation of pollutants, including diet, occupation, and place of residence, breast milk should be taken from a wide range of individuals, including those living near to certain industrial sites. It is recommended that women nursing their first child are sampled in order to compare levels over time in milk from mothers residing in different geographical areas.