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A REVIEW OF HAZARDOUS SUBSTANCES

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A REVIEW OF HAZARDOUS SUBSTANCES IN THAMES REGION

1. Introduction

This report reviews the background to the monitoring of priority hazardous substances in Thames region and looks at the results of monitoring carried out from 1990 to 1992. A number of issues are highlighted with respect to the monitoring strategy and the interpretation of the data. Recommendations are made to establish plans of action for those substances which are detected in over 30% of samples, and to stop monitoring those substances which are rarely detected. Sites have also been identified where specific substances are detected most frequently or at the greatest concentrations and where some form of action may need to be considered.

2. Background

To date there have been three international conferences on the protection of the North Sea. The first was held in Bremen, Germany in 1984, the second in London in November, 1987 and the third at The Hague in March, 1990. A fourth conference is scheduled to be held in Denmark in 1995. Nine North Sea states (including Switzerland) participated in the conference at The Hague, and also the Commissioner of the European Communities. The North Sea, for the purposes of these conferences, has been defined as shown in Fig.1.

The North Sea Action Plan arose out of measures that were agreed at the second conference in London[(1)] on inputs via rivers and estuaries of substances that are persistent, toxic and liable to bioaccumulate. Specifically, it was envisaged that the application of these measures should achieve reductions of the order of 50% in total inputs of such pollutants between 1985 and 1995. It was also agreed that plans of action should be prepared to achieve this goal.

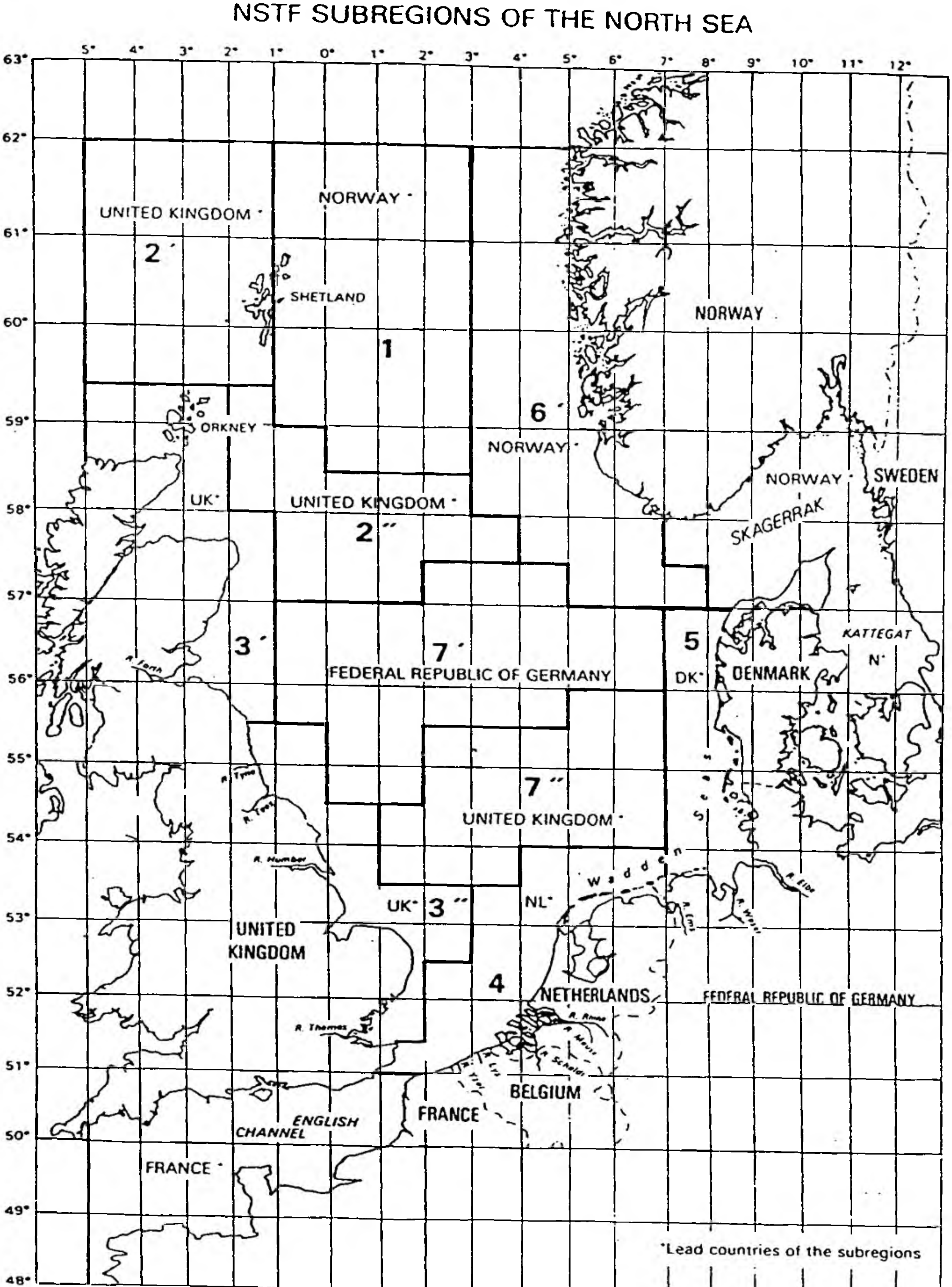
In response to these agreements the UK formulated a North Sea National Action Plan which was published in March, 1990[(2)]. It was decided by the UK government that all agreed measures and actions taken for the North Sea would be applied equally to all UK coastal waters including the Irish Sea.

3. Identification of Priority Substances

At the time of the second North Sea conference there was no agreed list of substances which were toxic, persistent, and bioaccumulative requiring priority action. The UK therefore took the lead in identifying those substances that it considered would pose a serious threat to the aquatic environment. Following consultation[(3)], a first list of 23 priority substances - the 'red list' - was announced in April, 1989[(4)] (Table 1).

The red list was based on a screening of the EC list of 129 substances which are candidates for List I status under the EC Dangerous Substances Directive[(5)]. The red

Fig. 1


NSTF SUBREGIONS OF THE NORTH SEA
63°
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60°
59°
58°
57°
56°
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53°
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UK *
UNITED KINGDOM *
2 ″
NORWAY *
SWEDEN
SKAGERRAK
3 ′
7 ′
FEDERAL REPUBLIC OF GERMANY
5
DK *
DENMARK
KATTEGAT
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UNITED KINGDOM *
R. Tyne
R. Tees
R. Humber
R. Forth
Wadden
Seas
R. Elbe
R. Weser
R. Ems
UK * 3 ″
NL *
UNITED KINGDOM
4
NETHERLANDS
FEDERAL REPUBLIC OF GERMANY
R. Thames
R. Rhine
R. Meuse
R. Scheldt
R. Lys
R. Yser
BELGIUM
FRANCE
ENGLISH CHANNEL
FRANCE *
*Lead countries of the subregions

list includes all List I substances except chloroform and carbon tetrachloride which were not considered to be particularly toxic or persistent.

The third North Sea Conference at The Hague in 1990[6] strengthened and added to the commitments on reducing inputs of dangerous substances:

(a) The commitment to reduce inputs via rivers and estuaries by 50% by 1995 on a 1985 baseline should apply to a list of 39 substances as set out in Annex 1A of the Declaration (Table 2). This includes the 23 substances on the original UK red list with the exception of PCBs.

(b) For a group of 17 substances there should be a reduction of 50% in atmospheric emissions by 1995 or by 1999 at the latest using best available technology (BAT).

(c) For dioxins, mercury, cadmium, and lead to achieve a reduction of 70% or more of total inputs via all pathways.

At the Hague conference it was also agreed that a review of a further 170 reference list substances as set out in Annex 1D of the Declaration should be carried out, to compile a draft list of additional priority substances for the Fourth North Sea Conference.

4. Monitoring

A key element of the National Action Plan was the implementation of a monitoring programme to assess progress in effecting reductions in the loads discharged to the North Sea. Monitoring for the original red list commenced mid-way through 1990, though monitoring for many of these substances had already been carried out in Thames region at "KEY" environmental monitoring sites from 1989 or earlier. Monitoring for the priority hazardous substances (Annex 1A) commenced at the beginning of 1991.

Monitoring is carried out at 10 sites in Thames region on a monthly basis to specifically measure loads discharged to the North Sea (Table 3). These sites were originally identified as contributing at least 90% of all inputs of red list substances to the Thames estuary. So that loads can be calculated it is also necessary to obtain instantaneous flow measurements at the time of sampling. In practice however, mean daily flows are provided by Thames Water Utilities from flow recorders at the inlets to the sewage treatment works. Flow figures for the freshwater rivers are provided by the hydrological services section. The data is sent to Anglian region who are coordinating the national sampling programme for England and Wales and collating the data.

"Less than" values are dealt with in two ways:

(a) The true concentration is taken to be zero.

(b) The true concentration is taken to be the limit of detection.

The first method provides a low estimate of the annual mean load, and the second method provides a high estimate of the annual mean load.

So that discharges can be targeted for reduction programmes, the data from all the regions has been collated for each substance, and each discharge ranked according to its contribution to the overall load.

There are a several problems created by this monitoring strategy and these are outlined below.

4.1 Estimation of Load

4.1.1 Method of Estimation

The annual load of a given substance transported by a particular river can be most precisely estimated when the flow is measured continuously and the concentrations of the specified substance are obtained from a continuous series of composite samples taken by a flow-propotional sampler.

However, because of the practicalities and costs involved, sampling has been based on 12 spot samples taken periodically through the year. The concentration in each sample is determined and combined with flow data measured at the time of sampling to produce an instantaneous load. The loads are then summed and averaged to give an estimation of the mean annual load.

A previous study carried out by WRc on pesticides in the R.Thames at Teddington Weir[7], concluded that estimates of annual load based on weekly spot samples differed from those achieved by continuous flow-proportional sampling by as much as $\pm$ 50%. Confidence intervals for estimates based on discrete sampling were often very wide. The study concluded that methods of estimation based on discrete sampling suffer from large uncertainties associated with their inability to account fully for the temporal variations in concentration and flow, particularly because peaks can be inadequately represented or completely missed.

4.1.2 Temporal Variation

The same study by WRc showed a very strong temporal variation in pesticide loads. A large proportion of the total load over the year was discharged in a comparatively short period of high flows following a flood event. This has also been tentatively confirmed within the region for lindane loads at Teddington Weir, based on data from 1974. High loads occur at times of high flows. Contributory factors are surface water run-off and the association of some pesticides with suspended material. The implications are that estimates of annual loads will be influenced by drought years and years with above average rainfall. It would be particularly significant if the target date of 1995 by which reductions in load must be achieved was a wet year.

4.1.3 Flow Measurement

An additional problem in estimating loads, is obtaining reliable flow information. In the case of the R.Thames at Teddington Weir, an ultrasonic gauging station estimates flows to ± 5%. No such gauges exist at the other monitoring sites, and flows are estimated by applying a factor to a gauging station sited further upstream. Flows at the sewage treatment works are measured at the inlet and provided by Thames Water Utilities Ltd..

To give an indication of the accuracy and nature of flow measurement at each sample point, the data is annotated by a confidence rating on a scale of 1 to 5;

(a) Flow accurately measured at the sampling point at the time the sample was taken.

(b) No flow recorder available at the sampling point but one available nearby: eg at the inlet for a sewage works; or at an upstream gauging point for a river (provided there is no major tributary/input in between gauging point and sampling point).

(c) No flow recorder but reliable estimate of flow available from metered water consumption figures (with some loss allowance if necessary).

(d) A reasonable estimated flow can be derived: eg for a sewage works, from population served (where the population does not fluctuate); for a river, by combining a gauging station figure with calculated flows for smaller catchments.

(e) Estimated flow subject to significant error: eg for a sewage works, holiday resort with widely fluctuating figure for population served; for a river, a catchment with no gauged flows; for a factory, one where the effluent is a small proportion of water consumption.

4.2 Limits of Detection

Many of the substances in Annex 1A can only be found at very low concentrations, if at all. The handling of limits of detection is therefore very important when estimating load figures.

If the limit of detection is higher than the expected concentration of the substance, a succession of "less than" values will result in a zero low load estimate and a large high load estimate. For a given flow and concentration regime, a more stringent limit of detection will result in the substance being detected in more samples and hence the low load estimate will increase and the high load estimate will decrease. The load estimates will converge as the limit of detection becomes even more stringent, until they are both exactly the same when the substance is detected in all samples.

The practical consequence is that apparent changes in estimated load figures can be masked by changes in the limits of detection. For example, higher low load estimates may be due to more stringent limits of detection being achieved in the analytical laboratory.

It is therefore desirable, for the purposes of comparability, that the limit of detection is set at an appropriate level and at one that is consistent from year to year, and from region to region. In practice this is extremely unlikely.

Many Annex 1A substances will be found at concentrations at or below the limit of detection. An exceptional single positive result can take on a significance of its own, particularly if the sample is taken from a site with a high volume of discharge. The low load estimate will be high and can make a disproportionate contribution to the national total load when compared with other regions

4.3 Comparability Across Regions

Comparability with other regions can be complex, if not impossible. Analysis for Annex 1A substances is carried out at a number of laboratories often employing different methods and achieving different limits of detection. A relaxed limit of detection may mean that a substance is not detected in a particular region.

In addition a substance may not be reported either because the laboratory cannot carry out the necessary analysis, or through local knowledge it is considered that the substance is not present in a specific discharge or in the region. For those regions where the sustance continues to be reported, the contribution to the national load becomes even more significant.

5. Site Selection

For the screening survey carried out in 1989, ten sites were selected which it was thought would contribute 90% of the inputs of red list substances into the North Sea from Thames region referred to hereafter as the "red list" sites (Table 3). The ten sites include eight major sewage treatment works which discharge directly or indirectly to the Thames estuary, and two riverine inputs - the R.Thames and the R.Lee. There are no direct industrial discharges which are included in the monitoring programme. The selection of these sites has raised issues both for monitoring and for implementing control procedures;

(a) Riverine inputs or discharges from sewage treatment works can only be subjected to load reduction programmes if a specific point source can be identified discharging to the river further upstream, or to the sewerage system.

Only then can some sort of control procedure be considered;

(b) The flows associated with the sewage treatment works discharging to the tidal Thames are relatively large, as are the flows from the R.Thames and the R.Lee. This results in high loads being reported for substances even when they are detected at very low concentrations.

(c) The potentially diffuse nature of inputs of Annex 1A substances to the watercourse or sewerage system, has meant that analysis has to be carried out for all substances unless it can be established that a particular substance is unlikely to be present. With industrial discharges it is usually possible to isolate the substances of interest.

6. Baseline Data

Baseline data for 1985 inputs into UK waters is only available for mercury, cadmium and lindane, and for the List II metals, copper, zinc, lead, chromium and nickel. These are shown in Table 4. The baseline figures provided by the former Thames Water Authority in a draft regional action plan(8) are shown in Table 5.

For the remaining substances no 1985 baseline figures can be given since very little data from 1985 exists about discharges to water. Baseline figures will have to be derived from monitoring carried out in 1990/91, although this still has to be decided, and where possible extrapolated back to 1985 where there is evidence of reductions made through, for example, tighter controls or discharges ceasing.

The estimated loads discharged to the North Sea from Thames region for each individual substance since 1990 are shown in Table 6 together with the percentage contribution to the load discharged from England and Wales to UK coastal waters.

7. Significance of Substances in Thames Region

The accuracy in estimating loads discharged into the North Sea is uncertain due to problems of obtaining reliable flow measurements, analytical errors and limits of detection, and a representative sampling regime. The significance of the load contribution from Thames region becomes even more uncertain when data is compared with other regions using different laboratories and reporting limits.

A qualitative assessment has therefore been made about the real significance of a particular substance within the region by analysing all the data obtained from the red list sites over the past three years, and comparing it with data obtained from the "key" environmental monitoring sites throughout the rest of the region. Using this approach a detailed account for each individual substance is given in the Appendix. The significance of priority hazardous substances in Thames region can be divided into four categories.

Category 1. Substances not Detected

The following priority hazardous substances are not detected in Thames region, or positive results are very exceptional (generally less than 5 positive results in any one year):

Fenitrothion
Fenthion
Parathion
Parathion-methyl
Malathion
Dichlorvos
Trifluralin
Azinphos-ethyl
Endosulfan A
Endosulfan B

Category 2. Substances where Positive Results are Exceptional

The following priority hazardous substances are generally not detected in Thames region, but there may be exceptional positive results (sample results may be suspect, or the substance may be detected more frequently if a more stringent limit of detection was used; substance detected frequently at a specific site):

Aldrin
Endrin Azinpho-methyl
pp DDT
1,2-Dichloroethane
Carbon Tetrachloride
Hexachlorobenzene
Arsenic
PCBs
Trichlorobenzene
Hexachlorobutadiene

Exceptional positive results for these substances has sometimes resulted in high percentage contributions to the national low loads because of the large discharge volumes associated with the red list sites in Thames region, and because they are infrequently detected in other regions. In the case of PCBs, TCB, and HCBD large contributions to the load can also be attributed to erroneous or suspect results.

It should also be noted that carbon tetrachloride is frequently detected in the Brent/GUC at Lock 100, if not elsewhere in the region, and arsenic frequently detected in the Pumney Farm Ditch. Neither of these are red list sites.

Category 3. Substances Detected Occasionally

The following substances are detected in a small proportion (less than 10%) of samples taken in Thames region:

Trichloroethane
Dieldrin
Mercury
Cadmium
Chromium
beta HCH

Category 4. Substances Detected Frequently

The following substances are detected in a significant proportion (generally greater than 30%) of samples taken in Thames region:

Atrazine
Simazine
Pentachlorophenol
Chloroform
Trichloroethylene
Tetrachloroethylene
gamma HCH
Copper
Zinc
Lead
Nickel

Tables 7 & 8 show sites where the data tentatively indicates that a particular substance is detected at the greatest concentrations, or more frequently when compared with other sites in the region. Table 7 is listed by site, and Table 8 is listed by substance. These sites include environmental monitoring sites as well as 'red list' sites.

8. Summary of Data

A detailed statement for each substance is given in the Appendix. However a brief summary is given for those substances in categories 3 & 4, i.e. substances detected frequently or occasionally in Thames region.

8.1 Atrazine

Atrazine is detected throughout the region. In 1992, 87% of samples gave positive results. The annual mean concentration at "red list" sites was generally no higher than at environmental monitoring sites in the region. The contribution to the national low load of 6.1% in 1991, was insignificant compared to the 65% contributed by the rivers Mersey, Ribble, and Weaver in North West region.

8.2 Simazine

Simazine is detected throughout the region. In 1992, 80% of samples gave positive results. The contribution to the national low load of 24% in 1990, and 15.3% in 1991 is significant. The annual mean concentration of simazine was generally no higher at the "red list" sites compared to the environmental monitoring sites with the possible exception of Crossness STW. The mean concentration is also consistently elevated at R.Ravensbourne at Deptford Bridge.

8.3 Pentachlorophenol

PCP was detected in 67% of samples taken in 1990, but in only 4% of samples taken in 1992. This decline is attributed to more variable and relaxed reporting limits. The low load contribution from Thames region was 14.2% in 1990, and 11.6% in 1991, but will be negligible in 1992. The load contribution will increase if more stringent limits of detection are applied. PCP is frequently detected in the effluent from Riverside STW where the mean concentration is generally more elevated than at other sites.

8.4 Chloroform

Chloroform was detected in 49% of samples taken throughout the region in 1991. However, the contribution to the national low load of 2.6% was insignificant compared to specific industrial discharges in other regions. Chloroform is generally more evident in the discharges from the sewage treatment works. Elevated concentrations are, however, also found in the R.Lee at Carpenters Road, and the R.Beam at Havering Sluice. The R.Lee at Carpenters Road failed the environmental quality standard of 12 μg/l as an annual mean during 1991.

8.5 Trichloroethylene

Trichloroethylene is detected at most "red list" and environmental monitoring sites in Thames region. In 1991 35% of samples gave positive results. The overall contribution to the national low load of 14.8% in 1991 was significant and can be mainly attributed to the R.Thames at Teddington Weir. Only two other inputs contributed a greater load; Hull STW (35.4%) and ICI Runcorn (19.5%). Trichloroethylene is also detected frequently or at elevated concentrations at the following sites:

Cut above Thames
Lee at Carpenters Road
Kew STW
Brent/GUC at Lock 100, Brentford
Beam at Havering Sluice
Duke of Northumberland's River at Kidds Mill

8.6 Tetrachloroethylene

Tetrachloroethylene is detected at most sites in Thames region. In 1991, 49% of samples gave positive results. The overall contribution to the national low load of 5% in 1991 was insignificant when compared to specific industrial discharges in other regions. Tetrachloroethylene is detected frequently or at elevated concentrations at the following sites:

Kew STW
Beckton STW
Beam at Havering Sluice
Lee at Carpenters Road
Brent/GUC at Lock 100, Brentford
Crane at Northcote Road

8.7 Lindane (gamma HCH)

Lindane is detected at all sites and in about 90% of samples taken in Thames region. The contribution to the national low load of 30% in 1990, and 16.6% in 1991 is significant. The concentration of lindane is more elevated in the discharges from the sewage treatment works. River sites which fail the environmental quality standard for lindane, or where average concentrations are elevated are:

Hogsmill above Thames
Wandle at the Causeway
Thames at Barnes (tideway)
Thames at London Bridge (tideway)

8.8 Trichloroethane

Trichloroethane is detected occasionally at all "red list" sites in Thames region, and at many environmental monitoring sites. However, the contribution to the national low load of 3.9% in 1991 was insignificant when compared to the contribution from ICI Wilton of 72%. Elevated mean concentrations are found at the R.Colne above Thames, Brent/GUC at Lock 100 Brentford, and Whitewater 10m above Greywell.

8.9 Dieldrin

Dieldrin is detected on rare occasion at most "red list" sites but at low concentrations. Potentially significant contributions to the national low load (49% in 1990) are due to the relatively large discharge volumes associated with some sites in the region, and dieldrin being detected at few other site throughout the country. The intermittent presence of dieldrin at low concentrations make control procedures difficult to implement. Historical data suggests that dieldrin would be more frequently detected if a limit of detection more stringent than 5 ng/l was used.

8.10 Mercury

Mercury is infrequently detected in Thames region, and the overall contribution to the national low load of 1.4% in 1991 is insignificant. Mercury is most frequently detected in the Thames tideway samples, but this is due to lower limits of detection being used for saline samples.

8.11 Cadmium

Cadmium was detected in 43% of samples taken in 1990, but only 6% in 1992. This is due to the limit of detection being relaxed for freshwater rivers from 0.1 μg/l to 0.5 μg/l. Of the "red list" sites, cadmium is most frequently detected at Mogden STW and R.Lee at Carpenters Road. The presence of cadmium in the R.Lee may be due to the effect of the discharge from Deephams STW where cadmium is also frequently detected. The overall contribution to the national low load of 0.5% in 1991 is insignificant.

8.12 Copper

Copper is detected in about 60% of the samples taken at red list and environmental sites throughout the region. The contribution to the national low load from Thames region in 1991 was not particularly significant at 3.6%. Howver, very few individual sites throughout the rest of the country contributed significant loads with the exception of ICI Wilton (18.3%). This reflects the diffuse nature of copper in the aquatic environment.

8.13 Zinc

Zinc is detected in about 90% of samples taken at red list and environmental monitoring sites throughout the region. The overall contribution of 3.6% to the national low load in 1991 was not particularly significant. However, only two sites in the rest of the country contributed greater than 10%.

8.14 Lead

Lead is detected in around 40% of samples taken at red list sites and environmental monitoring sites throughout the region. Lead is detected at all red list sites, but the overall contribution to the national low load in 1991 of 2.4% was not significant. The mean concentration of lead at the red list sites is no more significant than at other sites in the region.

8.15 Chromium

Chromium is detected in less than 10% of samples taken at red list sites, but the overall contribution to the national low load in 1991 of 0.2% was insignificant. Chromium is detected most frequently at the Brent/GUC at Lock 100, Brentford where the annual mean concentration is higher than at other sites.

8.16 Nickel

Nickel was detected in about 40% of samples taken at the red list and environmental monitoring sites in Thames region in 1990. The detection rate fell in 1991 and 1992 due to the limit of detection being relaxed. Nickel is frequently detected at Riverside STW and Mogden STW and at elevated concentrations. The overall contribution to the national low load in 1991 of 5.1% was significant in that few sites throughout the rest of the country contribute a large load.

9. Recommendations

(a) Monitoring and reporting of the substances inluded in category 1 of this report (substances not detected in Thames region) should cease with the exception of Parathion which is monitored for the purposes of the EC Surface Water Abstraction Directive. They are:

Fenitrothion	Fenthion
Parathion-methyl	Malathion
Dichlorvos	Trifluralin
Azinphos-ethyl	Endosulfan A
Endosulfan B	

This will need approval from the NRA North Sea Group and the DoE.

(b) Monitoring and reporting of the remaining priority hazardous substances should continue.

(c) A plan of action should be established for the substances in categories 3 and 4 (substances detected occasionally or frequently in Thames region) with the aim of effecting reductions in loads where possible. They are:

Atrazine	Simazine
Pentachlorophenol	Chloroform
Trichloroethylene	Tetrachloroethylene
gamma HCH	Copper
Zinc	Lead
Nickel	Mercury
Cadmium	Chromium
Trichloroethane	Dieldrin

(d) Sites where substances are detected most frequently or at elevated concentrations as shown in Tables 7 and 8 should be investigated further.

A H Place, Senior Scientist **December 1993**

References

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(5) COMMISSION OF EUROPEAN COMMUNITIES. Communication from the Commission to the Council on Dangerous Substances which might be included in List I of Council Directive 76/464/EEC. Official Journal C176, 14 July 1982.

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(7) VAN DIJK P A H, SAGE A, HARRISON R M. Variability of Pesticides in River Water and its effect on Estimation of Load. WRc Report NR 2656, January 1991.

(8) THAMES WATER AUTHORITY. Red List Draft Action Plan, February 1989

Table 1

UK RED LIST

Mercury and its compounds
Cadmium and its compounds
gamma HCH
pp DDT
Pentachlorophenol
Hexachlorobenzene
Hexachlorobutadiene
Aldrin
Dieldrin
Endrin
Polychlorinated Biphenyls
Endosulfan
Dichlorvos
1,2-Dichloroethane
Trichlorobenzene
Atrazine
Simazine
Tributyltin compounds
Triphenyltin compounds
Trifluralin
Fenitrothion
Azinphos-methyl
Malathion

Table 2

PRIORITY HAZARDOUS SUBSTANCES

(ANNEX 1A)

Mercury and its compounds
Cadmium and its compounds
gamma HCH
pp DDT
Pentachlorophenol
Hexachlorobenzene
Hexachlorobutadiene
Aldrin
Dieldrin
Endrin
Isodrin
Dichlorvos
1,2-Dichloroethane
Trichlorobenzene
Atrazine
Simazine
Tributyltin compounds
Triphenyltin compounds
Trifluralin
Fenitrothion
Azinphos-methyl
Malathion
Endosulfan
Copper
Zinc
Lead
Arsenic
Chromium
Nickel
Carbon Tetrachloride
Chloroform
Azinphos-ethyl
Fenthion
Parathion
Parathion-methyl
Trichloroethylene
Tetrachloroethylene
Trichloroethane
Dioxins

Table 3

RED LIST MONITORING

THAMES REGION

PTNE.0065	MOGDEN STW	12/annum
PTSE.0084	KEW STW	12/annum
PTNE.0007	BECKTON STW	12/annum
PTSE.0028	CROSSNESS STW	12/annum
PRGE.0080	RIVERSIDE STW	12/annum
PTSE.0088	LONG REACH STW	12/annum
PWAE.0010	BEDDINGTON STW	12/annum
PBVE.0043	WORCESTER PARK STW (Biological Filter)	12/annum
PBVE.0044	WORCESTER PARK STW (Activated Sludge)	12/annum
PTHR.0107	THAMES AT TEDDINGTON WEIR	12/annum
PLER.0057	LEE AT CARPENTERS ROAD	12/annum

Table 4

BASELINE INPUTS TO UK COASTAL WATERS

1985 (Tonnes/year)

Substance	North Sea	Other Coastal Waters	Total
Mercury	9.7	17.3	27.0
Cadmium	39.5	40.4	79.9
Lindane	0.56	1.0	1.56
Copper	575	700	1275
Zinc	2050	1580	3630
Lead	1350	310	1660
Chromium	540	520	1060
Nickel	370	310	680

Table 5

BASELINE INPUTS TO NORTH SEA

THAMES REGION
1985 (Tonnes/year)

Substance	Riverine	STWs	Other	Total
Mercury	0.96	0.34	0.1	1.4
Cadmium	3.42	3.45	0.6	7.47
Lindane	0.038	0.01	0.005	0.053
Copper	26.0	12.1	4.6	42.7
Zinc	73.5	139.3	20.2	233.0
Lead	34.8	12.8	3.9	51.5
Chromium	20.8	9.4	1.0	31.2
Nickel	21.0	19.0	3.8	43.8

Table 6: Loads Discharged To The North Sea in Kg

Thames Region NRA

Figures in brackets refer to the percentage contribution to the load discharged from England and Wales

	1990		1991		1992	
Substance	High Load	Low Load	High Load	Low Load	High Load	Low Load
Atrazine	1917.0 *(46.0)*	245.0 *(10.4)*	464.0 *(5.0)*	450.0 *(6.1)*	353.0	331.0
Simazine	2249.0 *(55.3)*	580.0 *(24.0)*	483.0 *(8.0)*	464.0 *(15.3)*	477.0	470.0
Pentachlorophenol	525.0 *(19.0)*	374.0 *(14.2)*	431.0 *(3.7)*	202.0 *(11.6)*	527.0	113.0
Chloroform	Not Reported		3956.0 *(2.8)*	3420.0 *(2.6)*	3693.0	2220.0
Trichloroethene	Not Reported		1416.0 *(12.8)*	1140.0 *(14.8)*	2034.0	273.0
Tetrachloroethene	Not Reported		1065.0 *(5.2)*	972.0 *(5.2)*	2503.0	1204.0
gamma HCH	131.0 *(27.0)*	131.0 *(30.0)*	91.0 *(12.2)*	90.0 *(16.6)*	88.7	88.7
Trichloroethane	Not Reported		519.0 *(4.0)*	345.0 *(3.4)*	1799.0	282.0
Dieldrin	11.0 *(9.5)*	7.6 *(49.3)*	13.1 *(5.0)*	0.5 *(5.5)*	12.2	0.5
Aldrin	7.4 *(7.0)*	0.7 *(13.6)*	15.5 *(6.4)*	0.4 *(15.9)*	12.1	0.0
Endrin	8.7 *(7.8)*	0.3 *(34.6)*	16.2 *(3.5)*	0.0 *(0.0)*	13.6	0.0
Trichlorobenzene	662.0 *(10.7)*	81.0 *(22.9)*	412.0 *(9.3)*	412.0?? *(27.0)*	638	0.0
pp DDT	10.4 *(7.9)*	2.2 *(73.1)*	16.1 *(5.0)*	0.0 *(0.0)*	12.4	0.0

Table 6: Loads Discharged To The North Sea in Kg

Thames Region NRA

Figures in brackets refer to the percentage contribution to the load discharged from England and Wales

Substance	1990 High Load	1990 Low Load	1991 High Load	1991 Low Load	1992 High Load	1992 Low Load
Hexachlorobutadiene	28.5 *(20.8)*	1.9 *(7.4)*	60.0 *(8.6)*	15.0 *(13.8)*	114.0	0.0
1,2 - Dichloroethane	1526.0 *(4.2)*	134.0 *(1.5)*	1716.0 *(0.06)*	9.9 *(0.08)*	2888.0	0.0
Carbon Tetrachloride	Not Reported		227.0 *(0.49)*	34.0 *(0.08)*	1692.0	0.0
Hexachlorobenzene	9.0 *(9.9)*	3.1 *(10.4)*	13.5 *(1.4)*	0.0 *(0.0)*	11.7	0.0
Azinphos-methyl	88.0 *(33.3)*	79.0 *(84.1)*	197.0 *(25.5)*	0.0 *(0.0)*	45.3	0.0
PCB 28	23.5 *(53.6)*	19.0 *(84.8)*	12.6 *(4.6)*	0.0 *(0.0)*	11.3	0.0
PCB 52	37.5 *(29.9)*	33.8 *(66.2)*	12.6 *(5.3)*	0.0 *(0.0)*	11.2	0.0
PCB 101	26.2 *(21.5)*	22.8 *(48.3)*	12.6 *(4.9)*	0.0 *(0.0)*	11.6	0.0 *
PCB 118	5.4 *(6.8)*	0.0 *(0.0)*	12.6 *(5.1)*	0.0 *(0.0)*	11.6	0.0
PCB 138	6.3 *(7.8)*	1.5 *(72.3)*	12.6 *(5.0)*	0.0 *(0.0)*	11.6	0.0
PCB 153	5.9 *(6.0)*	1.2 *(5.8)*	12.8 *(5.2)*	0.0 *(0.0)*	11.5	0.0
PCB 180	6.9 *(8.8)*	2.1 *(90.5)*	12.6 *(5.5)*	0.0 *(0.0)*	11.6	0.0 *

* Trace

Table 6: Loads Discharged To The North Sea in Kg

Thames Region NRA

Figures in brackets refer to the percentage contribution to the load discharged from England and Wales

	1990		1991		1992	
Substance	High Load	Low Load	High Load	Low Load	High Load	Low Load
Mercury	203.0 *(2.9)*	9.4 *(0.2)*	210.0 *(3.2)*	46.8 *(1.4)*	252.0	32.0
Cadmium	695.0 *(3.7)*	233.0 *(1.0)*	782.0 *(2.3)*	127.0 *(0.5)*	1008.0	34.0
Copper	Not Reported		19700.0 *(4.4)*	14500.0 *(3.6)*	20190.0	17270.0
Zinc	Not Reported		101600.0 *(3.6)*	100200.0 *(3.6)*	104960.0	104860.0
Lead	Not Reported		15800.0 *(3.1)*	10680.0 *(2.4)*	16660.0	12350.0
Arsenic	Not Reported		9890.0 *(3.6)*	360.0 *(0.2)*	11250.0	0.0
Chromium	Not Reported		16554.0 *(2.8)*	1051.0 *(0.2)*	22870.0	1635.0
Nickel	Not Reported		31110.0 *(11.3)*	10430.0 *(5.1)*	38070.0	8827.0

Table 7

PRIORITY HAZARDOUS SUBSTANCES

Sites Substances Detected Frequently or at Greatest Concentrations

SITE	SUBSTANCE
Crossness STW	Simazine
Riverside STW	PCP, Zn, Ni
Kew STW	Trichloroethylene, Tetrachloroethylene
Beckton STW	Tetrachloroethylene
Beddington STW	Lindane
Long Reach STW	Lindane, Zn
Deephams STW	Lindane, Cd
Mogden STW	Cd, Ni
'Red List' STWs	Chloroform, Lindane, Zn
Ravensbourne at Deptford Bridge	Simazine
Lee at Carpenters Road	Chloroform, Trichloroethylene, Tetrachloroethylene, Cd
Beam at Havering Sluice	Chloroform, Trichloroethylene, Tetrachloroethylene
Thames at Teddington Weir	Trichloroethylene
Cut above Thames	Trichloroethylene
Brent/GUC at Lock 100, Brentford	Trichloroethylene, Tetrachloroethylene, Trichloroethane, Carbon Tetrachloride, Cr
Hogsmill above Thames	Lindane
Colne above Thames	Trichloroethane
Pumney Farm Ditch	Arsenic
Whitewater 10m above Greywell	Trichloroethane
Wandle at the Causeway	Lindane

Table 8

PRIORITY HAZARDOUS SUBSTANCES

Sites Substances Detected Frequently or at Greatest Concentrations

SUBSTANCE	SITE
Simazine	Crossness STW Ravensbourne at Deptford Bridge
Pentachlorophenol	Riverside STW
Chloroform	Lee at Carpenters Road Beam at Havering Sluice 'Red List' STWs
Trichloroethylene	Thames at Teddington Weir Lee at Carpenters Road Kew STW Cut above Thames Brent/GUC at Lock 100, Brentford Beam at Havering Sluice
Tetrachloroethylene	Kew STW Beckton STW Lee at Carpenters Road Brent/GUC at Lock 100, Brentford Beam at Havering Sluice
gamma HCH	Beddington STW Long Reach STW Deephams STW Hogsmill above Thames Wandle at the Causeway Red List' STWs
Trichloroethane	Brent/GUC at Lock 100, Brentford Colne above Thames Whitewater 10m above Greywell
Carbon Tetrachloride	Brent/GUC at Lock 100, Brentford
Cadmium	Mogden STW Lee at Carpenters Road Deephams STW
Zinc	Riverside STW Long Reach STWs 'Red List' STWs
Arsenic	Pumney Farm Ditch
Chromium	Brent/GUC at Lock 100, Brentford
Nickel	Riverside STW Mogden STW