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DRINKING WATER QUALITY

The European Commission announced in September its intention to take the UK to the European Court for alleged breaches of the EEC directive on drinking water quality. One complaint is procedural, but others concern levels of contaminants that exceed permitted limits.

This briefing note describes the basis of current standards and highlights some[1] of the issues relating to the provision of safe drinking water.

HOW IS WATER QUALITY REGULATED?

The Directive lists 66 parameters, 44 of which are subject to upper limits in drinking water. With 24 "undesirable" and 13 "toxic" substances, as well as 4 microbiological parameters, two important figures are specified. The first is a "maximum admissible concentration" (MAC), which no sample should exceed. A lower "guide level" may also be specified, which should be "taken into account" by water suppliers in setting standards. Member states were required to apply the MAC standards to all water intended for human consumption by 1985.

The directive was implemented in 1982 in the UK by circulars or administrative action based on existing legislative powers. These called for all supplies to be in compliance by 1985. The Water Act 1989 and its Regulations have now incorporated the EEC directive in legislation for England and Wales, and similar regulations have just been made in Scotland. The standards are in general identical to those in the directive, although the regulations also specify standards for an extra 14 parameters not covered by the directive.

The Directive provides for derogations (relaxations) from a prescribed standard in emergencies and (for non-toxic parameters) when unavoidable because of the nature or structure of the ground or for meteorological reasons.

1. In view of the large number of factors affecting Drinking Water quality, this subject is complex and cannot be completely covered in a note of this length. We have thus focused on the *chemical* contaminants of highest profile at present.

WHY IS THE EEC PROSECUTING?

The UK, in common with other member states, has had difficulties in interpreting the Directive and implementing it in the timescale required. Over the last few years, the EEC has disagreed with the UK on a number of matters including:

- basing compliance with the MAC for some parameters on the **average** of sample concentrations, rather than as an **upper** limit
- providing derogations for nitrate in disputed circumstances
- delays in implementing legislation and meeting specific standards.

DoE has revised its guidance on MAC's and derogations, and has also announced a 5 year investment programme costing £1.4 b to bring supplies which regularly fail into compliance by 1995. The Commission however, acting on evidence from UK complainants, announced in September 1989 that it would take the UK to the European Court for not enacting legislation to implement the drinking water directive in Northern Ireland and Scotland, and for breaches of the standards for nitrate in England and lead in Scotland.

The UK is not alone in its difficulties with this directive: actions are reportedly underway against most member states - e.g. for failure to enact legislation, or for excessive amounts of nitrates, lead or pesticides. Recently there have been further complaints to the EEC from UK organisations concerning pesticides, aluminium and bacteria in public supplies.

SCIENTIFIC ASPECTS OF DRINKING WATER QUALITY

Origins of Contamination

Nationally two thirds of our drinking water is taken from surface waters (rivers, reservoirs, lakes) with the remaining third being supplied from groundwater (aquifers). The UK depends on surface waters to a much greater extent than most other EEC countries.

Potential pollutants enter the water cycle at various points, as shown in Figure 1. Contaminants can enter surface water from the atmosphere as well as from discharges and land run-off, and its quality can vary greatly with rainfall and river flows. Groundwater results from percolation over long periods of time, and its composition is thus more stable. However, it can take decades to recharge, so any contamination may take years to work itself out.

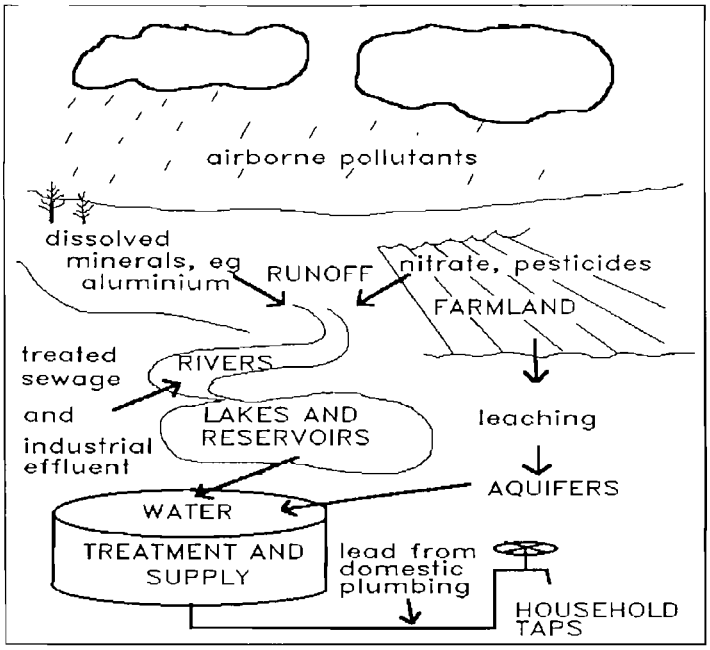

Figure 1:
Some Sources of Drinking Water Contamination

Water Quality Standards

The standards for controlling toxic substances in water can be based on either of two principles:

- harmful substances should be eliminated or kept to the lowest technically feasible level (the precautionary principle); or
- pollutants should be kept beneath a level (the acceptable daily intake) believed from medical and toxicological studies to avoid adverse health effects.

Most standards in the EEC directive were derived from World Health Organisation (WHO) health-based guidelines produced by medical expert committees. In the case of pesticides, however, the EEC applied the precautionary principle, setting limits effectively of zero.

The preferred approach is a matter for continued debate between Member States. Some support the wider application of the precautionary principle, on the basis that the long-term health effects of many pollutants remain uncertain. Others point out that health standards are set with wide margins for safety, and adequately safeguard health while avoiding the extra expense of advanced treatment technologies.

SPECIFIC DRINKING WATER ISSUES

Contamination by nitrate, lead, aluminium and pesticides[2] has put drinking water in the news recently. The EEC and UK standards for these substances, and the range of levels found in UK drinking waters, are shown in the Table.

Standards and Concentrations in UK Public Drinking Water Supplies

Substance	Guide level EEC	Limit (MAC) UK and EEC	Range found in UK water
Nitrate	25 mg/l	50 mg/l	0.1-100 mg/l
Lead	none	50 μg/l	0.05-300+ μg/l
Aluminium	0.05 mg/l	0.2 mg/l	0.01-3.5 mg/l
Any pesticide	none	0.1 μg/l	0-2.0 μg/l
Total pesticides	none	0.5 μg/l	0-4.4 μg/l

NB Units of concentration are also expressed as
mg/l as parts per million
μg/l as parts per 1000 million (billion)

Nitrate

In 1987, about 1.6 million people received water from 74 supplies that at some time exceeded the MAC of 50 mg/l - mostly in East Anglia or the Midlands. Nitrate levels in surface water appear to have stabilised in recent years, but the amounts in some groundwater sources are continuing to increase and some sources in low-rainfall areas of Central and Eastern England are likely to exceed 100 mg/l in the long term.

Nitrate comes from a variety of sources, including sewage, industrial discharges and air pollution. But a major contributor is agriculture, where nitrate is used as a chemical fertiliser and is also present in manure and silage. It is also released as a result of ploughing in grasslands.

Nitrate is relatively non-toxic, being a natural part of the normal diet. However, it can form other chemicals in the stomach, including nitrites and nitrosamines. Nitrites can cause "blue-baby" syndrome in infants, although only 14 UK cases in the last 35 years (and none since 1972) were possibly attributable to drinking water. Nitrosamines are carcinogens (chemicals that are known to cause cancer) in laboratory animals and, it is presumed, in man. There is no evidence in the UK that nitrate in water is associated with stomach cancer - indeed, stomach cancer in the UK has fallen over the years while the nitrate levels in water have risen. Nevertheless, because of the theoretical risk, the Department of Health (DH) prefers the 50 mg/l standard to be retained, while accepting that fluctuations into the 50-100 mg/l range can be allowed pending the implementation of measures to ensure compliance.

Meeting the nitrate standard will require additional water treatment in the short term, but many also favour measures to reduce nitrate levels in surface and groundwaters by reducing nitrate releases from agriculture. The relative effectiveness of water treatment and changes in agricultural practice has been reviewed by DoE for catchment areas of different geology. This showed that

2. While the EC action has focused attention on the control of these specific substances, the first objective of water suppliers remains to supply water that is free from microbiological hazards.

reductions in agricultural usage could allow the standard to be met in some areas. However, in other areas, even draconian measures would have little impact, making reliance on treatment essential.

Where treatment is required, the most economical method is by blending with water from a low-nitrate source, if available. Nitrate can alternatively be reduced by natural biological processes which operate during storage in lakes and reservoirs. The same process, accelerated by bacteria in a special treatment plant, is in use in Germany. A further (chemical) option is ion-exchange treatment which is used in France. The first UK plants are just entering use.

A number of steps have also been announced towards better control of agricultural sources. The Ministry of Agriculture, Fisheries and Food (MAFF) issues guidance on reducing nitrate losses, and since 1984, the use of nitrogen fertiliser has stabilised after a long increasing trend. The Water Act of 1989 enabled the designation of "nitrate sensitive areas" where drinking water sources are vulnerable to nitrate pollution, and in which agricultural practices may be statutorily controlled. MAFF has begun a voluntary pilot scheme to compensate farmers for reduced use of fertilisers in selected sensitive areas, though some have questioned the adequacy of voluntary measures alone.

At the European level, a directive has been proposed to control the release of nitrate, by requiring changes to farming practices in 'vulnerable' water catchment areas - those where surface water concentrations exceed 50 mg/l. This directive is important for the UK because of our dependence on surface waters and the great fluctuations that occur in nitrate concentrations at different times of the year, due to our short rivers with highly variable flow. The House of Lords Sub-committee on the European Communities concluded that these proposals would have far-reaching effects on agriculture without necessarily achieving the environmental aims of the Directive, and doubted whether the implications had been sufficiently evaluated by the Commission.

Lead

Lead is a toxic substance with a MAC of 50 µg/l (0.05 mg/l). This represents a limit below which there should be no acute effects on health. However, since lead is a cumulative poison, concern remains over sub-clinical effects, especially in children. Advice from a Medical Research Council Group in 1988 confirmed the need to keep reducing exposure to lead, and DoE regulations are more stringent than those in the directive[3].

The lead content of water leaving the treatment works and entering the distribution system is very low, and contamination is almost entirely due to lead being dissolved from lead plumbing in older properties. Households in parts of Scotland are known to be particularly at risk, but a survey in 1988 by Friends of the Earth(FoE) found that the lead standard was also exceeded in many areas of SW and NW England and East Anglia.

The standard applies to water coming out of the tap, while the suppliers' reponsibility ends at the point of connection to the premises (plumbing within the property being the responsibility of the householder). Where a risk of exceeding the standard exists, the water supplier is required to treat the water to reduce its ability to dissolve lead. Such action has been taken in Glasgow where, before 1977, over half of households had more than 0.1 mg/l of lead in their tapwater. Lime and orthophosphate were progressively added during water treatment, and by 1982 this proportion had fallen to 5%. Similar measures are underway in 103 action areas in Scotland, of which 85 are complete. The remainder will be concluded by 1992, and the UK will then have complied with the EEC lead standard.

Despite these preventative measures, many household supplies still exceed the MAC when the water has been standing and therefore fail the more restrictive UK regulations[3]. In such cases, the only remaining option is to replace lead plumbing. Some 8 million houses were estimated to contain lead pipes in 1982, and it was calculated in 1987 that the costs of replacement would exceed £1.5b. A proportion of these have been replaced by local authorities and by private householders (e.g. 58,000 grants to replace lead plumbing were made in Scotland from 1982-8), but some have called for a national programme to expand consumer awareness and for increased resources to locate and replace lead plumbing in both public and private housing.

Lead pipes are a legacy of the past, and Byelaws now prohibit the use of lead pipe and lead-containing solder in contact with potable supplies. However, lead may still be dissolved from solder available from DIY shops, since there is currently no trading standard limiting their lead content. Some have called for such a standard to be introduced, in order to avoid the creation of new sources of lead through DIY internal plumbing.

Aluminium

Aluminium in drinking water has been in the news both because of recent accidental spillages of aluminium sulphate into water supplies and because of concern that aluminium may be implicated in Alzheimer's disease.

The MAC (0.2 mg/l) is based on ensuring acceptable

3. The directive applies the standard of 50 µg/l to water from the tap *after flushing*, and allows levels of up to 100 µg/l where the water has been standing in pipes. This relaxation is not allowed in the UK Drinking Water Regulations, which require the 50 µg/l standard to be met under all conditions.

taste and appearance. Aluminium is present naturally in most water sources, since it is the most abundant metal in the earth's crust. It is not readily soluble in neutral water, but is easily dissolved by acidic water, so that upland rivers and lakes often contain over 0.2mg/l of aluminium. A further source is from the use of aluminium compounds in water treatment to remove the suspended solids from discoloured water, making it both more palatable and less likely to harbour microbes. Most of the aluminium precipitates from the water but some does remain in the supply.

The MAC for aluminium has been exceeded at some time between 1985 and 1987 in most local authority areas in Wales, the South-west and the North-west of England, with some supplies exceeding four times the MAC. The government has granted derogations for some supplies to remain above the MAC until 1995. However, the European Commission has now received complaints about aluminium levels at several locations in the U.K.

A current concern is over a possible link between aluminium and Alzheimer's disease, since the regions of the brain that are most affected by the disease are those with the highest uptake of aluminium. Tentative associations between the disease and aluminium levels in drinking water have also been suggested by studies in Norway and the UK. However, the DH's Committee on Contamination of Air, Soil and Water concluded that the association was too tentative to justify changes in the use of aluminium sulphate in water treatment.

Some have called for the drafting of a health based standard for aluminium. DH is funding research on the bioavailability of aluminium from different parts of the diet and other work to define the possible health risk. DoE has also confirmed that it will phase out derogations by 1995. The debate has also brought into question whether aluminium salts should continue to be used in water treatment. Some suppliers have reduced or eliminated its use, but others argue that for some supplies it remains necessary. They point out that poorly clarified water may increase the possible microbial hazards, which is not justified given the tenuous nature of the current evidence on Alzheimer's disease.

Pesticides

Following the precautionary principle, the EEC directive sets standards for pesticides which are effectively surrogates for zero. Although these values are now set in UK regulations, the DoE has also issued "advisory values" for 47 commonly used pesticides. These are derived generally from WHO recommendations for "acceptable daily intakes" - those levels at which no effects on health are expected. The DoE advisory values range from 0.03 µg/l for aldrin/dieldrin to 1000 µg/l for 2,4-D and glyphosate.

These advisory values determine the action to be taken by water suppliers if a supply fails the EEC standard and is thus legally "unwholesome". Where the advisory value is not exceeded, the supplier may investigate the pros and cons of alternative treatment methods or other measures (eg changes in agricultural usage) before deciding on the preferred action. Where the advisory value is approached or exceeded however, this is regarded as a "significant" failure requiring action to rectify the situation as soon as possible.

One issue relating to pesticides concerns the basis of the standards, and the applicability of the precautionary principle. Some (including the UK government) point out that toxicities of pesticides vary greatly, and argue that each pesticide should have its own health-based limit. Others prefer to maintain the precautionary principle in view of the uncertainties over the effects of long-term exposure to small amounts of pesticides, and the difficulty of predicting the effects of their breakdown products in treatment works and the environment.

Another issue concerns the monitoring of pesticides, in which over 400 different active ingredients may be in use. Reliable methods of analysis are technically demanding and expensive, and exist only for some 125 of these. Thus, only a small number of pesticides are currently reported in Britain (the FoE survey found that water suppliers had discovered 16 pesticides at more than the MAC levels between 1985 and 1987). Three herbicides (atrazine, simazine and mecoprop) accounted for two thirds of occurrences. The first two are widely used for clearing weeds alongside roads and railways, while mecoprop is used in cereal farming.

The DoE advises suppliers to monitor atrazine and simazine, as well as any other pesticides in use in the water supply area and likely to reach any water sources. Some however argue that a more comprehensive programme should be undertaken to establish levels of contamination by all pesticides whose use could result in drinking water contamination.

FURTHER READING

Additional details and background information are available from POST, 16, Great College Street, London SW1P 3RX, tel 222-3912/7085.