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SCIENTIFIC COMMITTEE ON TOXICITY, ECOTOXICITY AND THE ENVIRONMENT (CSTEE)

OPINION OF THE CSTEE ON "STUDIES CONCERNING THE QUALITY OF DRINKING WATER IN SELECTED EUROPEAN CITIES."

Opinion expressed at the 38th CSTEE plenary meeting Brussels, 12 June 2003

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A study on drinking water quality in selected cities in eight member states has been performed on commission by the DG SANCO. The CSTEE has been asked to give comments in relation to the materials provided and in accordance with the Terms of reference cited below. The results of the study are presented in two reports: 1) "Pilot programme to monitor the quality of drinking water in Belgium, Northern Italy and Southern Spain" by the Austrian Energy Agency (called the report A in this opinion) and 2) "Final Report. Pilot programme for the quality control of drinking water in 11 cities in France, Germany, Greece, the Netherlands and Ireland" by the Fresenius Institute in Germany (called the report B). The opinion is based on the provided material, which is extensive. The original reports in German have also been made available to the CSTEE, as the translated versions were not complete.

Terms of Reference

1. The Committee is requested to assess the overall scientific quality of the study. In considering this, the Committee is asked to comment on:
   - The study methodology, the sampling design and their implications on the potential of this study to be representative of the European tap and bottled water;
   - The microbiological, physical, and chemical parameters examined;
   - The validity of the conclusions of the laboratories which carried out the research;
   - The comments of the water companies involved.

2. Furthermore, the Committee is requested to identify and assess the health risks (if any) to consumers in general and to specific population subgroups (children, elderly, diabetics, dialysis patients, etc) that may be associated with the consumption of the sampled tap or bottled drinking water in general or in specific cases.

3. Finally, the Committee is asked to identify additional studies (research, sampling, monitoring, etc) which will be needed to fully assess the safety and quality aspects of tap and bottled drinking waters in Europe. In particular the Committee is asked to comment on a study design (countries, regions, sampling methodologies, frequency of sampling and duration of study etc), and the parameters to be examined.

Answers to the questions

Summary

The main aim was to determine the quality of drinking water when it reaches the consumers. Samples were taken at the household taps without flushing or disinfection of the tap. This may lead to enhanced levels of metals released from the pipes and to bacterial contamination from the domestic environment as well as an increase due to bacterial growth in standing water. The study design cannot generally separate different potential pollution sources, such as factors due to the raw water, the water treatment, the water distribution within the cities and within the buildings and due to a local impact at the sampled taps. In a future study, sampling of the first portions of water, and thereafter a new sampling after removing of devices such as filters etc as well as after flushing and flaming of the tap would give further information of the local impact.

The main risks from a microbiological point of view are the faecal contamination of the drinking water. The indicator bacteria *E coli*, enterococci and sulphite reducing clostridia aim at reflecting the risk of the presence of faecal contamination and potential presence of enteric pathogens. Total coliforms may both relate to faecal contamination and other sources. Microbial water quality may vary rapidly both in raw water and due to treatment performance. This may result in short-term peaks in pathogen occurrence that may result in outbreaks of waterborne disease. Water-borne disease outbreaks are infrequently registered within the European community. Testing in the distribution system and at the consumers is an important quality-control to ensure that water quality targets are met, but also function as a calibrator of the appropriateness of management plans. However, it can never be used as the sole basis from a public health view point. Systematic reporting of failure events as a driving force to direct sampling may add valuable information

A relatively high frequency of non-compliance was found both for the group of indicator bacteria including the coliforms and of heterotrophic plate counts (high frequency of values exceeding the target value). The finding of high heterotrophic plate counts may in part be a consequence of the way the sampling was performed (without flushing or disinfection). Elevated heterotrophic colony counts were also found at a high frequency of bottled waters (especially non-carbonated water). Generally, these types of bacteria carry no health risks. In the Report B, tests for facultatively pathogenic bacteria were also performed, and showed elevated counts with a higher proportion in the tap water than in the bottled water. The finding of different organisms that may affect immunocompromised persons merit further studies and is an area where current information is limited. Such further studies may also include other organisms, not accounted for in this study, such as other slow growing bacteria of potential health importance (i. e. mycobacteria, legionella and fungi).

Concerning the chemical parameters examined, lead released from piping material is a matter of concern, and is regarded as the main problem from the health point of view. Some other notable findings were the presence of pesticide residues and nitrate from agriculture in several samples, and chemicals indicating industrial contamination such as the high concentrations of tri- and tetrachloroethene in Milan. Some chemicals found in drinking water are of geological origin. Of these, arsenic and fluoride are of health relevance. Arsenic is carcinogenic and may pose a certain cancer risk even at concentrations below the parametric value. Fluoride that has a protective effect for dental caries is detrimental to the skeleton at higher concentrations. However, the parametric value was only exceeded in one city. The parametric value for disinfection byproducts was exceeded in some cities that use surface water, but in this case the possible cancer risks with these compounds needs to be weighed against microbial risks.

Other quality aspects of drinking water, such as odour, taste, colour and turbidity are very important from the consumers' point of view, and influence the choice of bottled water for consumption.

Although the presented study is very comprehensive, the samples and results obtained cannot give a full picture of the variability of drinking water quality throughout Europe, but rather functions as a base-line study. Future studies would have to include other areas, such as Nordic countries and accession countries, where the raw water quality and the purification techniques may be different. Also smaller waterworks should be included.

1a. The study methodology.

Within the study in Belgium, Northern Italy and Southern Spain (the Report A), three towns were selected in each country with at least one served by ground water and one should have a large and another medium population density. Sampling was repeated 4 times over a year. Bottled water were purchased and analysed centrally in the laboratory in Vienna. Consumer questionnaires were filled in during sampling, and consumption surveys were performed for the bottled water.

A surprising value on drinking water supply (23% groundwater, 77% surface water) is reported for Italy, were the major amount of drinking water supply (particularly in the north) derives from groundwater. These data need to be checked.

Within the study in France, Germany, Greece, the Netherlands and Ireland (the Report B), the same general approach has been taken as in the above described study. In this study the results are presented in a more uniform way with much clearer information about the water sources and the treatment and distribution. The consumer survey is also more clearly presented.

The study methodology gives a general background on the quality of the tap water as it is used by the consumers in larger and medium sized cities and of the bottled water. The information, however, cannot generally be extrapolated to the sources of potential pollution, possibly with the exception of some of the organic pollutants such as presence of pesticides and solvents. For other parameters no attempts were made in the study design to separate potential pollution sources, such as due to the raw water, the water treatment, the water distribution within the cities and within the buildings and due to a local impact at the sampled taps. The study selection criteria of surface versus groundwater sources can therefore not be further assessed.

The water treatment as such may have profound implications on the quality of the tap water, but in the Report A the information in this respect is very sparse, while it is better systematically presented in the Report B.

Since information is limited about factors affecting the quality during distribution and flow modeling not included, which may identify areas of stagnation, areas of mixture between different raw water sources, as well as areas with limited effect of residual disinfectants, the impact from the distribution system can neither be assessed.

The variability within each city is, however, partly represented by the repeated sampling, by the selection of multiple sampling points within each city, and the number of cities included. The information may therefore serve as a baseline for further in depth studies in the future.

***1b. The sampling design*.**

The main aim was to determine the quality of drinking water when it reached the consumers and get reliable and comparable data of the drinking water quality in the pilot areas of the selected cities. The sampling procedure is contrary to what is normally practiced, where filters etc. are removed from the tap, the tap is flamed in order to reduce the impact of external contamination of bacteria, and the water is flushed until a constant temperature is reached. As has also been pointed out by some of the waterworks representatives, the present sampling technique may lead to enhanced levels of metals released from the pipes and to bacterial contamination from the domestic environment as well as an increase due to bacterial growth in standing water. The CSTEE believes that the normal practice should be continued in the surveillance of drinking water quality by the waterworks or competent authorities, but appreciates the additional information provided by the present study that presumably gives a worst case exposure estimate. However, it would have been easier to interpret the results if parallel samples had been taken also at the point where the water is leaving the waterworks and with flushing and disinfection at the consumers' taps, respectively.

Sampling points were selected according to the raw water supplied, the community structure and the consumers' acceptance to participate. Around 20 sampling points were selected in each town of the Report A (Milan 40; Seville 25) and four sampling rounds performed in each town/location. In the Report B 25 sampling points were selected in each of the 11 cities.

It is stated that the sampling points accounted for the water treatment, the water distribution and the pipe network. However, information of (a) raw water quality and its variability (b) the water treatment, its efficiency and variability in performance (c) the flow characteristics and distribution residence time and (d) the potential influence from pipe material cannot be assessed based on the investigation. These limitations of the study have also been pointed out by the authors.

The study gives snapshots of the water quality, and does not account for the full variability of this, neither within the cities, nor as a general background of the drinking water quality in Europe. Extreme conditions, such as run-off and drought, may not be covered by the applied design. This was also pointed out in reference to the selection of sampling points "A statistically representative overview of general water quality cannot be obtained with the number of random samples stipulated in the invitation to tender".

The selection of bottled water were mainly based on a mixture of market distribution, market shares and questionnaires and should constitute brands of a market share of >40%. Although the responsibility of the producers only covers the quality of the water when leaving the production facility, the investigated samples can be regarded as typical examples from the consumers' point of view. Any deterioration during storage is most likely to affect the microbiological quality.

We fully acknowledge the difficulties encountered in the consumers' acceptance of sampling.

1c. The implication of representativity of the European tap and bottled waters.

Although the presented study is very comprehensive, the samples and results obtained cannot give a full picture of the variability. This study should therefore not be taken as representative of European tap water, but rather function as a baseline study. The northern European countries, as well as Great Britain are not represented; the study does not take into account the smaller waterworks (which are dominating in some areas, and that may encounter greater difficulties in quality, for example due to water scarcity in southern Europe or due to less attendance). The study could thus be said to aim for representativity of medium-large urban centers in central and southern Europe.

In relation to the bottled water, the representativity, seen from the consumer point of view, is fully acceptable. Although limited, it gives a view of the market share, relates the results to what is stated by the producers (label versus analytical results), points at the changes that may occur from production to consumption and is not hampered by the variability at the consumers' taps, which are part of the difficulties in analyzing the results from the tap waters.

1d. The microbiological parameters examined.

Within the study in Belgium, Northern Italy and Southern Spain (the Report A), the selected microbiological parameters included: Aerobic heterotrophic bacteria 22^{o}C/48h (excl 1st series), *E coli* and total coliforms, sulphite reducing clostridia and enterococci (the information about the analytical procedure is not directly included in the report. Reference is however made to the equivalence to DIN 38411. The same parameters were analyzed in the Report B (with normally clear indication of the procedure; however the quantification of *E coli* is not clearly stated, and the culture media for colony count not stated. An incubation time of 3 days has been applied for the 22 ^{o}C incubation). For bottled water these parameters were supplemented with Aerobic heterotrophic bacteria 37C/48h and *Pseudomonas aeruginosa*.

Additional analysis with the aim to identify major groups of bacteria that could be of concern as opportunistic pathogens was included in the Report B (37 C/24 hours on Columbia blood agar).

All sampling volumes were in accordance with the relevant stated volumes in the Directives, and as far as possible processed within 8 hours in a stationary local laboratory in the Report A or transported to a central German laboratory and analyzed within 24 hours in the Report B. Information about the quality assurance for the microbiological tests are not included. Since the analyses were performed by the same laboratory and staff using the same methodology within each study, variability due to laboratories can mainly be ruled out.

The selection of culture media, the incubation time as well as how the plates are read (ocular or under magnification) will all affect the quantitative values obtained. Since the heterotrophic plate counts were read after 2 days in the Report A and after 3 days in the Report B, these values are not fully comparable. It is however anticipated that local factors at the taps would be the major factor influencing the variability.

All of the parameters are routinely applied as indicators of microbiological water quality, in water laboratories all over Europe. The CSTEE has no reason to question the microbiological quantifications of these studies.

1e. The physical and chemical parameters examined

Some parameters (temperature, pH, conductivity) were measured at the sampling site, while all other measurements were done in the laboratories. The sample bottles and conservation techniques seem to be appropriate for the respective determinations, but no detailed information is given regarding recycling and nature of bottles. Almost all methods used for the physical and chemical parameters were standards within the ISO, CEN, DIN or ÖNORM systems, which mean that they are well established. The pesticide determinations in the Austrian laboratory were performed with a method called A-14 GCMS 5970, which is not known to the CSTEE, but its performance is reasonably well described in the report (information on recoveries is missing). There are no descriptions of the performance given for any of the used methods. A problem is that none of the laboratories has been able to analyze for acrylamide or epichlorohydrin. These substances may emanate from the flocculants and materials in the water distribution system, respectively. Material released from plastic bottles were not analysed for.

The German laboratory analyzed for all the other chemical parameters included in Directive 98/83/EC, while the Austrians did not determine antimony, chromium, cyanide, mercury, selenium, vinyl chloride, chloride, sulphate, and sodium. There was also a big difference between the numbers of pesticides analyzed in the studies, the study B included 106 different substances, while the study A had only 21. The study B included a number of additional parameters, such as several chlorinated solvents, toluene and xylene.

1f. The validity of the conclusions of the laboratories which carried out the research.

The Report A

The Report A contains a chapter called "Evaluation of the results". Here the results are discussed, and comparisons are made with the parametric values in Directive 98/83/EC. It also contains a short section with conclusions (Chapter 5). Pesticides, organic chlorine compounds, heavy metals and microbiological agents were identified as the most critical parameters.

Chemical parameters

The conclusion that "the isolated cases in which the limits (for pesticides) were exceeded are clearly not a sign of permanent contamination" is difficult to understand. As pointed out below in 2a, the presence of pesticides and nitrate indicate agricultural pollution. In one town, Milan, traces of industrial contaminants were also found in the groundwater. According to the CSTEE, indications of agricultural and industrial pollution of drinking water sources is an environmental problem that is especially serious when it comes to ground water, because ground water regenerates at such a slow rate that any deterioration of the water quality will take a very long time to be restored.

With regard to possible problems with lead, the CSTEE agrees with the conclusion that it would not be advisable for children and pregnant women to consume water that has been standing in pipes that contain lead. According to the present investigation, lead seems to be the most important metal from the public health point of view (see also section 2a of this opinion). However, the conclusion that "It is therefore important to make clear to consumers that water that has been standing in the pipes can be harmful and should not even be used for cooking"(page 195) and the recommendation on page 196 that "The water to emerge from the tap at first, particularly if it has been stagnating in the pipes for a long time – such as in the morning or after a holiday period –, should not be used for drinking, cooking or washing food" are too general. In most cases consumption of standing water will carry no health risks.

Microbiological parameters

Regarding the microbiological parameters, it is concluded " in no town faecal organisms were found over large areas which means that it can be assumed that untreated water is not bacteriologically contaminated". The CSTEE considers this a misleading conclusion, since some of the studied cities used several water sources with unknown microbiological quality and the mixture characteristics in the distribution network is not known.

The CSTEE can, however, agree with the main recommendations made in the report.

From the chapter 4 "Evaluations of the results" it is evident that the total aerobic heterotrophic plate counts were in many instances exceeding the set value of alert, 100/ml. As stated in the report, the reasons may reflect growth either during distribution or peripheral in the houses or at the consumers' taps, where also an external contamination may occur. In addition to the factors mentioned, like temperature, stagnation time and materials in contact with the water, the content and type of organic material also are of crucial importance. The high cold-water temperatures, nutrients, as well as the mode of sampling may substantially have influenced the results.

The growth of heterotrophic bacteria, as shown in the investigations of bottled water (especially non-carbonated water), may in some instances reach even higher values than in tap water. The guidelines for bottled water apply from a production point of view (within 12 hours) and not directly from a consumers' point of view.

Consumer survey

The consumer survey, although limited, gives essential information related to the variability of use of tap water in the areas. In Italy and in Almeria in Spain, less than half of the respondents used the tap water for drinking, while in Huelva and Sevilla in Spain more or less all drank tap water. Fifty percent of the respondents in Belgium used tap water for drinking. The avoidance of tap water for drinking should also be seen in the light of high heterotrophic bacterial counts in bottled waters. As this type of bacteria occurs both in tap water and bottled water, there is no rationale to prefer bottled water in this respect.

<u>The Report B</u>

Chemical parameters

The conclusions of the report (Chapter 5.5) concentrate on arsenic, lead, trihalomethanes, PAHs, vinyl chloride, acrylamide and epichlorhydrin.

According to the CSTEE, the risk assessment of arsenic should be based on the risk for cancer as the critical effect (see section 2a of this opinion).

The section on lead contains the following statement: “In general terms, given the very alarming potential and actual effects of lead, joint action should be taken in collaboration with the health authorities, water companies, householders and other interested parties, to stop human exposure to lead in these polluted areas via this route as soon as possible.” The CSTEE agrees with this proposed joint action.

Regarding disinfection byproducts in drinking water, the report mainly discusses chloroform toxicity and assumes “a certain potential risk“ due to the presence of trihalomethanes in drinking water. Other chemicals not directly addressed in the report may also be relevant (see section 2a of this opinion). The statement on page 189 that the presence of trihalomethanes in drinking water is always undesirable needs some modification. The trihalomethanes are formed as disinfection by-products, and the possible cancer risk with these compounds needs to be weighed against microbial risks.

The recommendation to exchange the materials that may be sources of vinyl chloride and epichlorohydrin seems premature. Improved analytical techniques should be developed and validated to try to determine the magnitude of the possible problems due to these substances first and to permit a risk assessment. The pros and cons of different piping materials is a matter of high relevance for human health, but it cannot be solved by a study of this kind. Instead, the health risk assessment of different materials has to be based on the ingredients of the material, combined with analytical results from standardised leaching tests in the laboratory.

The risk assessment of acrylamide should be based on the risk for cancer rather than neurotoxic effects. The CSTEE questions the conclusion that “ …an increased risk of neurotoxic effects cannot be ruled out for the unborn, infants, small children and people with nerve damage”.

Potential health risks with contaminants in drinking water are addressed below in more detail (2a and b).

Microbiological parameters

The CSTEE agrees with the main comments of the external reviewers in their assessment and evaluation of the report.

The information and conclusions made in the Report B is highly relevant. The results are summarized from the 4 performed sampling rounds of microbial analysis. This showed variations between the sampled cities and also variations between the sampling rounds, where also external factors, like temperature, may have played a role. A relatively high frequency of non-compliance was found both for the group of indicator bacteria including the coliforms (actual figures not given in the report) and of heterotrophic plate counts (high frequency of values exceeding the target value).

Based on the investigations of the bottled waters elevated heterotrophic colony counts were found at a high frequency of non-carbonated waters. That coliforms were found in two of the samples requires special attention.

Further investigations of rapidly growing bacteria performed on Columbia blood agar (37°C/24 h) showed elevated counts with a higher proportion in the tap water than in the bottled water. The findings of different organisms that may affect immunocompromised persons merit further studies and is an area where current information is limited. Such further studies may also include other organisms, not accounted for in this study, such as other slow growing bacteria of potential health importance (i.e. mycobacteria, legionella and fungi). The most frequently detected types are summarized in Table 6 (p 51) and the main conclusions drawn by the investigators as well as the external reviewer II (5.5.3) seem to be valid.

Consumers' survey

Most complaints were in relation to chlorine or metallic taste (however, Athens with high chlorine content had few complaints in this respect). Few people reacted on color or turbidity of the water. The higher the social level the fewer complaints were made! Consumption habits varied between the different countries and cities, where virtually all the Greek respondents drank tap water but only about 25 % to half of the German respondents did. The consumers' survey is thought to be of high validity.

1g. The comments of the water companies involved.

In most European cities, drinking water quality is regularly monitored by the water works and often a huge amount of data is available.

In the Report A a comparison between the results of the study and the available monitoring data was performed only on a few sporadic data. For example, in Milano daily controls on all major wells (many tens) are regularly performed by the water works. In the report, only samples from three wells (one has the same name of a well in Udine, is it a mistake?) in two dates are reported. No explanations are given on how the wells and the dates were selected. Moreover, no comments on the comparison are reported. Therefore, the following questions may not be answered:

- Is the comparison significant?
- Are data comparable?
- Can the differences be explained by the different sampling procedure?

In the Report B, this comparison is better described and, usually, gives satisfying results.

According to the material sent to the CSTEE (CSTEE/2002/14Add2), written comments were given by the water works representatives in Antwerp, Milan, Florence, Karlsruhe, Mannheim, Stuttgart, Mulhouse and Athens. Most of them are concerned about the way the sampling was performed, as the waterwork's responsibility for the quality of the water does not include deterioration within buildings. As samples were taken without flushing of the water, removal of filters etc, or disinfection by flaming the tap, enhanced levels of metals, TOC and bacterial count can occur as well as a high temperature. The waterworks of Florence, Karlsruhe and Mannheim took parallel samples after flushing and disinfection, which confirmed this suspicion. Thus, the samples were not considered to be representative for the water distributed by the waterworks. The CSTEE understands the concern from the water companies in this respect. However, from the consumer point of view the sampling methodology is relevant (although giving a worst case). The dilemma of which factors are influencing the actual quality at the consumers' tap cannot be solved by the present study design (see also below, point 4).

Besides these general comments, there were also some specific ones. The waterworks of Milan explains that the levels of tri- and tetrachloroethene comply with the old limit value of 30 µg/l, but is exceeded according to the new Directive (10 µg/l). They also question this parametric value in comparison with the much higher limit for trihalomethanes (100 µg/l). However, both are toxicologically based although tri- and tetrachloroethene indicate unwanted industrial pollution while the trihalomethanes are a result of necessary disinfection.

The waterworks of Florence claims that the finding of the pesticide pendimethalin in three December samples is incorrect, because it was not found in the remaining 17 samples of the same series, and not at the waterworks plant. Other pesticides are found in the raw water (the Arno River) from March to September, as confirmed by the data on terbutaline and metolachlor. The CSTEE cannot judge whether the analytical result is wrong or if, by some reason, there was an actual presence of pendimethalin in the three samples.

The waterworks of Stuttgart criticises both the sampling and testing methods for microorganisms because the investigation showed high bacterial counts whereas their own measurements have shown low bacterial counts. As pointed out before, in the comments from CSTEE as well as by the investigators and reviewers, large variations can occur due to the sampling procedures as well as contamination at the tap.

The waterworks of Stuttgart commented on two unexplainable samples with a high concentration of PAHs, and one with a high fluoride concentration. The CSTEE cannot have any additional view on this except that PAH may have been released from some material in the distribution system, for example bitumen-coated pipings.

The waterworks of Karlsruhe also comments on a few samples showing PAH that has not been detected at the water works. They also comment on enhanced values found for ammonium, nitrite, boron, cadmium, benzene, dichloromethane and tetrachloroethane. The explanation that these findings could be attributed to the sampling environment seems highly unlikely to the CSTEE (with the exception of cadmium).

The waterworks of Athens comments that high levels of calcium, chloride and nitrate indicate possible cross-connections with private irrigation deep wells. The CSTEE agrees that this need immediate investigation, but at the same time questions how there can be such cross-connections.

Concerning the bottled waters, most producers explain that their responsibility is to check the bacterial counts of the bottled water within 12 hours. Thus, the purchased samples are not representative for what is produced. They also state that growth of saprophytic bacteria is normal and carries no health risks. The CSTEE agrees that this generally does not constitute a health risk.

2a. *Identify and assess the health risks (if any) to consumers in general.*

The health risks for consumers are mainly confined to the microbiological quality, the presence of toxic chemicals and in some cases also the presence of indicator substances that reveal the influence of industrial or agricultural pollution. Other quality aspects of drinking water, such as odour, taste, colour and turbidity are very important from the consumer's point of view, but they are not commented further although in some instances such parameters may indicate unwanted pollution. In the following, some chemical parameters are commented upon that are important from the toxicological point of view. Emphasis is on those compounds where the parametric values stated in Dir. 98/83/EC were exceeded.

Chemical parameters

Nitrate and pesticides from agriculture

The nitrogen compounds ammonium, nitrite and nitrate may indicate contamination from wastewater or agricultural run-off. Due to the high leachability, *nitrate* is normally occurring in groundwater, often at concentrations higher than in surface waters of the same area. Levels are often higher in shallow wells than in deep wells. Therefore, it is not surprising that nitrate was detected in all towns, but only in a single sample was the parametric value (limit value) of 50 mg/l exceeded in the Report A. This limit value is toxicologically based, and set with regard to the risk for methaemoglobin formation in small children, especially infants fed with breast milk formulas prepared using the drinking water. The highest average concentrations were found in Milan and Liège (average values around 25 and 30 mg/l, respectively). Such high average values were not measured in the other towns in the Report A or in any of the towns in the Report B, where the highest averages were 14-16 mg/l in Stuttgart, Mannheim, Mulhouse and Maastricht. Assuming the maximum admissible nitrate concentration of 50 mg/l, two cases of exceedence are reported in Table 8 of the Report B. It is not clear how these exceedances may disappear in Table 10, assuming a different parametric value ([nitrate mg/l]/50 + [nitrite mg/l]/3 <1).

Several *plant protection products and pesticides*, such as triazines (atrazine, simazine, terbutylazine) and their metabolites (desethylatrazine, desisopropylatrazine), were detected at various sites in the Report A, particularily in Udine, Milan, Liège and Antwerp, but only pendimethalin exceeded in 2-3 cases the parametric value of 0.1 µg/l in Udine, Milan and Florence, respectively (it was not measured in the other cities). (Pendimethalin was not listed at page 5 among the pesticides analysed in Milan, probably by mistake). The result is surprising for at least two reasons:

- In comparison with herbicides used in major amounts in Northern Italy (such as alachlor or terbutylazine), the application rate as well as the crop area treated with pendimethalin is much lower, so the total amount used is about ten times less;
- Pendimethalin is less soluble and more lipophilic in comparison with other herbicides (Koc is about two orders of magnitude higher in comparison to alachlor or terbutylazine), so it is much less leachable than these chemicals.

Low levels of pesticides in drinking water may not constitute a health risk, but the frequent findings of pesticides in this limited study indicate that contamination of both groundwater (Udine, Milan, Liège) and surface water (Florence, Antwerp) occurs in Europe. This is not surprising in intensive agricultural areas and for leachable pesticides used on major crops (cereals, maize).

The analysis of plant protection products and pesticides was much more comprehensive in the Report B, covering approximately 100 compounds in 1100 drinking water samples. Most results were below the detection limit. Detectable levels of either atrazine, deethylatrazine, dicegulac, simazine, mecoprop, 2,4-D or chlorfenvinphos were found in Mulhouse, Strasbourg, Nancy, Stuttgart, Mannheim, Athens and Dublin in a total of 217 samples. Dicegulac is a reaction product in the manufacture of vitamin C that was found in Strasbourg. In 30 cases did the concentration exceed 0.1 µg/l. Other exceedances only occurred for simazine in two cases in Mannheim and Dublin, and for mecoprop in two cases in Dublin (according to Fig. 99).

It should be taken into account that the parametric value for pesticides in drinking water (0.1 µg/l for each individual compound) is frequently much lower compared to the WHO drinking water guidelines (WHO 1996). For example, the toxicologically based WHO guideline for pendimethalin is 20 µg/l, and 2 µg/l for atrazine and simazine. Still, the presence of pesticides, especially in groundwater, indicates a situation of contamination which calls for careful monitoring and/or action concerning the practice of pesticide usage or establishment of protection areas around the water sources.

Industrial contaminants

Some of the chemical parameters may indicate industrial contamination, such as tri-and tetrachloroethene, benzene, 1,2-dichloroethane, cadmium, chromium and nickel. Metals may also be released from piping materials, and are commented on in the next section.

The solvents *tri- and tetrachloroethene* were detected in some samples in several of the towns in the Report A. In the Report B tetrachloroethene was more frequently detected than Tri (positive samples found in 5 and 1 town out of 11 towns, respectively). Tri- and tetrachloroethene were detected in almost all samples in Milan, and the parametric value of 10 µg/l for the sum of the two compounds was exceeded in several samples (mean of the four sampling rounds: Tetra 5.0 µg/l, Tri 2.8 µg/l, maximum values 29.6 and 8.5 µg/l, respectively). Milan takes its water from many deep wells (150 – 200 m). According to the WHO Guidelines for drinking water quality (WHO, 1996), the toxicologically based guideline values for tri- and tetrachloroethene are 70 (provisional) and 40 µg/l, respectively (application of an uncertainty factor to levels giving effects on the liver in mice). Thus, although these contaminants do not implicate any serious health risk they indicate that the groundwater of Milan is contaminated. *Benzene* and 1*,2-dichloroethane*, that may emanate from industrial pollution or petroleum products (1,2-dichloroethane is also used as scavenger in leaded gasoline) were also detected in some samples in Milan. Benzene also occurred in several of the other towns in the Report A, and in one (Karlsruhe) in the Report B, although never exceeding the parametric value of 10 µg/l. This value is the same as recommended in the WHO drinking water guidelines, that is based on an excess lifetime risk of $1x10^{-5}$ for leukaemia.

The Report B also included several other solvents, not included in the EU Drinking water Directive. However, all samples were below the detection limits except for 1,1,1-trichloroethane in Mannheim, toluene in Karlsruhe, ethylbenzene in Strasbourg, and 1,2-dichloroethene in Mannheim and Strasbourg.

Chemicals that may be released from the distribution system

Iron, copper, cadmium, lead, nickel and chromium may be released from pipes, plumbing and fittings and give enhanced levels especially in stagnant water. Of those, *lead* is most important from the health point of view. Lead was detected in all the towns and test series in the Report A, and the parametric value of 10 µg/l, equal to the WHO drinking water guideline value (WHO, 1996), was exceeded a total of 80 times. The critical effect of lead is effects on the development of the brain in the foetus and the child. The problem with lead from pipes and plumbing was evident also in the Report B. The parametric value was exceeded eight times in Nancy, twice in Maastricht, eight times in Dublin and once in Athens. Due to the high sensitivity of young children to lead- induced neurophysiological effects, the CSTEE agrees that high lead concentrations in drinking water due to the release of lead from pipes and plumbing is a matter of concern. In the absence of lead pipes in the water system, the uptake of lead with drinking water represents only a minor contribution to the total lead exposure in children and adults.

Nickel was also detected in all the towns, and the parametric value of 20 µg/l was exceeded in 38 cases in the Report A, but not in the Report B. 20 µg/l is also the WHO recommended guideline value, set to provide sufficient protection for nickel-sensitive individuals.

Chromium was only measured in the Report B. Detectable levels were found in 5 of the towns. The parametric value of 50 µg/l, which is the same as the WHO provisional guideline value (WHO, 1996) was only exceeded once in Stuttgart.

Cadmium is a toxic metal of relevance for public health that may cause kidney damage after long-term exposure. It was detected in most towns in the Report A, but only in Karlsruhe in the Report B. The parametric value of 5 µg/l was not exceeded. The WHO guideline value is lower, 3 µg/l.

Copper was found in samples from all the towns, but the parametric value of 2 mg/l was not exceeded. Copper is an essential metal, but may be toxic in high doses. The provisional WHO guideline value (WHO, 1996) is the same as the EU parametric value. The main problem with copper released from copper pipes is the taste of the water.

Iron will of course be released from iron pipes. The parametric value of 0.2 mg/l was exceeded in several cases, but this will mainly cause problems with the taste and colour of the water, and is of no health concern.

Polycyclic aromatic hydrocarbons (PAH). Benzo[a]pyrene as a representative for PAHs was detected in a small number of samples in low concentrations. The parametric value of 0.01 µg/l was exceeded at four points in Huelva, Antwerp and Kalmthout in the Report A and the parametric values for benso(a)pyrene and total PAH were exceeded twice in Stuttgart and Dublin in the Report B.

PAHs may be released into the drinking water from tar coated water pipes which were used as main supply pipes and are gradually replaced to reduce potential human exposure to PAHs from drinking water. In drinking water, PAHs are usually bound to particles due to their very low water solubility. Under normal conditions, PAH uptake with drinking water (in concentrations below the legal limits) only represents a minor contribution (< 1 %) of estimated daily intake of PAHs from other sources such as inhalation and diet. Therefore, the presence of PAHs in a few of the water samples is considered to represent only a minor health risk. However, since benzo(a)pyrene and other PAHs are genotoxic carcinogens, exposure should be minimised. According to the WHO Drinking water guidelines (1996), the cancer risk with benzo(a)pyrene may be estimated to $1x10^{-5}$ at 0.7 µg/l, which is a higher concentration than the parametric value in the EU Directive, 0.01 µg/l.

Acrylamide is present as a residual monomer in polyacrylamide flocculants, which may be used in the treatment of drinking water. Due to the lack of sensitive analytical methods, the actual concentrations of acrylamide were not measured, but according to the Report B the calculated concentrations never exceeded the parametric value of 10 µg/l. According to a risk assessment report of the EU, drinking water concentrations of acrylamide resulting from the use of polyacrylamide for drinking water treatment are estimated to be low (0.125 µg/l) resulting in an estimated intake of 0.25 µg acrylamide per person with drinking water; a small contribution to the estimated total average human exposure (1 µg/kg/day) by the consumption of fried food containing acrylamide. Acrylamide is mutagenic, carcinogenic and neurotoxic, and exposure should be minimised.

Disinfection by-products

Trihalomethanes (trichloromethane or chloroform, tribromomethane or bromoform, bromodichloromethane and dibromochloromethane) are formed as by-products of chlorination of drinking water at the waterworks. In the Report A, the sum of trihalomethanes exceeded 150 µg/l in Huelva and Seville and also in some cases in Liège. There is no information in the Extended summary of chlorination practices at the different water works, and the concentrations of trihalomethanes are not recorded. Both Huelva and Seville use surface water from reservoirs that probably need high chlorine dosages for a good disinfection result. In the Report B, the parametric value for total trihalomethanes was exceeded in Nancy, where surface water is used and chlorinated after treatment (according to page 152, but not mentioned in the description of the waterworks at page 32). In Athens and Dublin, that also use surface water, lower levels of trihalomethanes were measured. All the other towns use ground water and do not chlorinate their water in most cases. Consequently, the levels of trihalomethanes are low in these towns.

Trihalomethanes are relevant water contaminants formed during chlorination of drinking water. Based on the available data on the tumorigenicity of chloroform (kidney tumours in male rats), chronic cytotoxicity has been identified as a mechanism of action suggesting a thresholded response. Thresholded dose-response-curves for chloroform have been introduced into regulations of chloroform exposures (German MAK-limits for occupational exposure). Therefore, cancer risks due to chloroform in the determined concentrations in drinking water most likely are very low. In the WHO drinking water Guidelines (1996), a linear model was used to estimate human cancer risk, although it was recognised that chloroform may induce tumours through a non-genotoxic mechanism. According to their estimate, a lifetime cancer risk of $1x10^{-5}$ would correspond to a guideline value of 200 µg/l suggesting only a low risk at the concentrations found in the study. Bromodichloromethane is a genotoxic rodent carcinogen causing kidney and intestinal tumours. The WHO guideline value is 60 µg/l, corresponding to a cancer risk of $1x10^{-5}$. The WHO guideline values for bromoform and dibromochloromethane are 100 µg/l for each, based on effects on the liver in rats.

Other disinfection byproducts, not directly addressed in the report, may also be relevant. Several of them are discussed in the WHO Drinking water guidelines and toxicolologically based recommendations are given for some of them. In the Report B, bromate was analysed (can be formed from bromide by ozonation). The parametric value of 10 µg/l was exceeded in

29 samples from Nancy that use ozone. Bromate is a genotoxic carcinogen, and the WHO Drinking water guideline is based on renal tumours in male rats. An excess cancer risk for humans was estimated as $1x10^{-5}$ at 3 µg/l using a linear extrapolation, but the WHO provisional guideline is 25 µg/l, because of limitations in available analytical and treatment methods.

In case the parametric values for disinfection by-products are exceeded, the possible cancer risk with these compounds needs to be weighed against microbial risks.

Contaminants of geological origin

The levels for inorganic *arsenic* in the water samples were in the range of 0 – 5 µg/l and therefore below the 10 µg/l limit for drinking water in all samples. Inorganic arsenic in drinking water is mostly of geogenic origin. Inorganic arsenic is a human carcinogen and arsenic exposure is associated with skin lesions, and skin and lung cancer in occupationally exposed persons. The available data also show an association of human exposure to inorganic arsenic in drinking water and the development of skin lesions and tumors in the skin and in several internal organs. Application of the multistage model for a cancer risk assessment of arsenic in drinking water results in a cancer risk of $1x10^{-5}$ at 0.17 µg/l, according to the WHO drinking water guidelines (1996). The WHO provisional drinking water guideline is 10 µg/l, thus corresponding to an excess risk for skin cancer of $6x10^{-4}$, which is a higher risk than what is used for other carcinogens ($1x10^{-5}$) in the WHO guidelines. Thus, even at concentrations below 10 µg/l, this risk level of ($1x10^{-5}$) may still be exceeded. However, non-linear or thresholded dose-response-curves may be applicable for arsenic as a result of consideration concerning the mechanisms of action. No specific risk groups may be identified based on the available data.

Enhanced levels of *fluoride* may occur in certain geological areas, especially in deep wells. The parametric value of 1.5 mg/l was exceeded only in Stuttgart in the present investigation. Fluoride is added to drinking water in Ireland (and in Switzerland) with target concentrations of 1 mg/l to prevent dental caries. According to Swiss sources, drinking water fluoridation is highly effective to improve dental health of the general population. The concentrations of fluoride normally present in fluoridated drinking water do not present a health risk according to a large number of animal studies and human epidemiology. The WHO Drinking water guideline is the same as in the EU Directive, 1.5 mg/l. Dental fluorosis occurs at concentrations above 1.5-2 mg/l according to the WHO in temperate areas, but fluoride may give rise to mild dental fluorosis even at lower concentrations, 0.9-1.2 mg/l. Skeletal fluorosis occurs at higher concentrations of fluoride in drinking water (starting at 3 – 6 mg/l).

In Dublin the water is fluoridated, but the parametric value of 1.5 mg/l was not exceeded. The highest concentration recorded was 0.9 mg/l according to the report.

Aluminium may be present in well waters as a consequence of leaching from soil and rock. Enhanced levels may be found in acidified areas. Aluminium salts are also used as coagulants in water treatment, and the parametric value for drinking water is set to 0.2 mg/l. According to table 34 of the Report A, the parametric value was exceeded occasionally in some towns, and in the Report B it was exceeded repeatedly in Athens, where aluminium sulphate is used as flocculant.

Aluminium is of low toxicity in laboratory animals. The human intake of aluminium from drinking water is low compared to the intake from food. Generally, less than 1 % of dietary inorganic aluminium is absorbed from the gastro-intestinal tract. Aluminium has been reported to cause severe brain damage (dialysis dementia) in dialysis patients using the tap water for dialysis. However, in this case aluminium is absorbed directly into the blood; an exposure pathway that is not comparable to drinking water. Some epidemiological studies have investigated an association between Alzheimers disease and aluminium in drinking water, but this hypothesis has not been substantiated. The WHO Drinking water guidelines (1996) do not propose any health-based guideline value.

Bottled water

The number of parameters analysed in bottled water was less than in drinking water, especially in the Report B. For example, mercury, cadmium, pesticides and tri- and tetrachloroethene were included in the Report A, but not in the Report B.

Some bottled water samples had levels of fluoride that exceeded the parametric value for tap water. Such waters are not suitable for children if it is used as a main source of drinking water. It is notable that pesticide residues were found in some samples in the Report A.

Some of the bottled waters had high salt contents, exceeding the parametric value for sodium in tap water, 200 mg/l (only measured in the Report B). One brand contained more than 1000 mg/l. The intake of sodium from such drinking water is of relatively minor importance compared to the normal daily intake from food, 2-8 g/day. However, it may be important for those who need to restrict their sodium intake to less than 2 g/day. A possible association between sodium in drinking water and the occurrence of hypertension has been discussed, but according to the WHO drinking water guidelines (1996), no firm conclusions can be drawn and no health-based guideline value is proposed.

Microbiology

The main risks from a microbiological point of view are the faecal contamination of the drinking water. This includes a broad number of pathogenic bacteria, viruses and parasitic protozoa. The indicator bacteria (*E coli*, enterococci and sulphite reducing clostridia) aim at reflecting the risk of the presence of faecal contamination and potential presence of enteric pathogens. The total coliforms may both relate to faecal contamination and other sources as well as potential growth. The heterotrophs do not reflect a faecal contamination.

Microbial water quality may vary rapidly both in raw water and due to treatment performance. This may result in short-term peaks in pathogen occurrence that increase disease risks considerably and may result in outbreaks of waterborne disease. As far as possible, water sources should be protected from contamination by human and animal waste, which can contain a variety of bacterial, viral, and protozoan pathogens and helminthic parasites.
Water-borne disease outbreaks are infrequently registered within the European community as a result of sudden contamination of sources or due to treatment deficiencies. Reliance cannot be placed on water quality measurements alone, even if sampling are done frequently, to determine the microbial safety. Testing in the distribution system and at the consumers is an important quality-control to ensure that water quality targets are met, but also function as a calibrator of the appropriateness of management plans. However, it can never be used as the sole basis from a public health viewpoint.

Compliance with the directive needs a management approach with emphasis on preventing or reducing the entry of pathogens to drinking-water and the efficiency of the treatment processes for removal of pathogens. Verification of microbial quality of drinking water includes testing for *Escherichia coli* or other indicators of faecal pollution. These provide evidence of faecal pollution and should not be detected which is as relevant for drinking water systems as for sources used for the bottling of water. Both *E. coli* and other indicators have some limitations. Enteric viruses and protozoa are more resistant to disinfection and the absence of *E. coli* may therefore not in all circumstances reflect the absence of risk from these for example from *Cryptosporidium* and some viruses. Chemical disinfection of a water supply that is faecally contaminated will reduce the overall risk of disease but may not necessarily render the supply safe. Disinfection efficacy may also be unsatisfactory against pathogens within flocs or particles, which protect them from disinfectant action.

As has been stated in the new WHO Guideline currently under review (2003), the targets for health outcome are an essential part. In some circumstances it is possible to establish a health-based target in terms of a quantifiable reduction in the overall level of disease. The exposure assessment is a fundamental base for the risk validations. Because of this the present and future consumer surveys are essential.

A weak point in the current evaluations is the dose-response relationship for different pathogens that can be transmitted through water. These relationships are mainly based on healthy individuals, and have most often been handled as ID_{50} values. However, vulnerable groups may get infections from lower doses of organisms, and an ID_{20} value may be more appropriate. However, the dose-response can also be handled as a mathematical function, rather than as a fixed value. The effects on immunocompromised and other vulnerable groups are of current interest. Voluntary exposure of these groups would not be ethical, and therefore further investigations into the occurrence of potential opportunistic pathogens for these groups are highly merited. Legionella has been fairly well investigated as nosocomial cases, but its occurrence and relevance as community-aquired cases are less well documented. The occurrence and relevance of the *Mycobacterium avium* complex is currently under investigation.

The relevance of the organisms under investigation in the Report B probably have less relevance as potential pathogens for the healthy part of the population, but may play an essential role for specific vulnerable subgroups. However this needs to be treated in the light of other potential transmission routes.

2b. *Identify and assess the health risks (if any) to specific population subgroups (children, elderly, diabetes, dialysis, patients etc.*

Microbiological risks

The infective dose for pathogenic microorganisms differs between individuals as well as between different pathogens and pathogenic strains. In a population it is generally assumed that around 20 % may have some types of deficiencies in their immune defense (the very young, the elderly, pregnant women and the immunocompromised, see Gerber *et al.* Int J Food Microbiology 30, 113-123, 1996). However, the current information of infective doses is principally based on healthy adult individuals. It can generally be assumed that the infective

doses can be substantially lower for vulnerable groups. Information is at large missing for these groups, but partly available on the severity of disease.
The relevance of water transmission in relation to other transmission routes in Europe is largely lacking for these groups. This question may be of relevance in the future follow-up of water-borne outbreaks.

In relation to opportunistic pathogenic bacteria (and fungi) a number of case-studies, nosocomial outbreaks and other reports that relate to direct or indirect water exposure is available. Comments on this are also included in the Report B in relation to the findings from the typing of the organisms recovered from the Columbia agar. However, also here the general information of the relevance of these organisms is lacking. Further work within this area, and linked with epidemiological investigations would be useful.

Chemical risks

Infants and small children who drink water will receive a proportionally higher dose per kg bodyweight compared to adults. In this respect bottle-fed babies are especially exposed. Children have also been shown to be especially sensitive to some pollutants, such as lead, nitrate and fluoride. However, in the case of lead and nitrate the limit values have been set with special reference to children in order to be protective also for children. For other pollutants, the limit value may be less protective for children than for adults. In the case of pesticide residues, however, the parametric value is often lower than toxicologically based guidelines, which means that children should be protected anyhow.

The specific case with dialysis dementia caused by aluminium in tap water highlights the need to pay attention to the fact that tap water may be unsuitable for home-dialysis unless purification of the water is performed.

3a. Identify additional studies (research, sampling, monitoring) needed to assess the safety and quality aspects of tap and bottled water in Europe.

1. **Compilation and public availability of monitoring data**.

Sampling at the waterworks and in the distribution network is routinely done as part of the regular compliance scheme in most of the countries in the Union. Some of these data are compiled on a local level, while other, mainly for the larger waterworks, may be summarised yearly on a national level. To work towards a higher transparency (i.e. as Internet accessibility) work should be initiated for public availability (of the most recent data) and general accessibility for compilations (similar to what is occurring on the bathing water quality). This may further give inputs for the relevance and frequencies of certain monitoring parameters as inputs for the revision of guidelines and directives, and as a public alert. This is a huge task but may give more relevant data and supplement future directed studies.

2. **Sampling with and without flushing.**

A compilation of existing data from studies in this field ought to be made. Otherwise, a separate study could be made. Since a separation of the origin of pollution and the impact due to contamination of the taps, no flushing or the influence of aerators or other attached devices is difficult to assess, further sampling should be promoted to look into these matters. Parallel sampling of the first portions of water, and thereafter after removing of devices such as filters etc as well as after flushing and flaming would give further information of the local impact. Such investigations can be done either as a contracted part of the normal water sampling from the water works or community side, or be included in other investigations in the future, and therefore do not need to be promoted as a separate project.

3. Consumer surveys.

The consumer surveys are felt as an essential part of these investigations although this was performed on a limited scale. The information both in relation to tap water and bottled water use is limited, but has large implications for the future demands for water, for technical options to be promoted on a local scale, as well as for background information. In addition this information is valid for future exposure assessments, as well as for comparative assessments related to other exposure routes. Additionally, further follow-up investigations would merit in relation to the consumers acceptance and use (or non-use) of tap water for drinking water purposes in the already investigated areas (i.e. the 25% of use in the German cities, stated 100 % use in Greece, the variations seen between different areas in Spain and so on).

If the information could be further broken down into different social groups (as already done in the Report B), but also include the water use for different vulnerable groups, (the children, the elderly, immunocompromised individuals) or special risk groups, it would have even higher value.

4. Variability in quality of tap water based on raw water and treatment and distribution.

The normal sampling both performed in this study as well as in the regulatory monitoring performed by the waterworks, or community, officials seldom pinpoint the fluctuations of microbial parameters (and thereby the risks) for the consumers that occurs in the raw water (assuming a constant treatment efficiency), or sudden events in the waterworks giving a lower treatment efficiency (and thereby a higher risk). Each of these situations represents a certain volume of delivered water to the consumers. If such events are taken as the governing factors directing sampling, a better frame would be developed to understand the effects of these events on the consumer level.

Even just a general compilation of failure frequencies and its variations throughout Europe would probably be a driving force, partly to score their severity and partly to give further information in a risk assessment. Much such information is probably already available at the local level, but has not been systematised and used for general assessments.

Similar information, i.e. interruption of service, repair frequencies, low pressure zones and so on may give similar background information for the distribution.

Follow up of the impact of low water quality from some sources in a system with several sources falls into the same category.

Systematic reporting of failure events as a driving force to direct sampling may therefore add valuable information for the future in relation to health risks for consumers.

5. Opportunistic pathogenic bacteria growing or occurring in water-works, distribution biofilms, or in buildings.

The studies have identified several types of bacteria that may be present or grow in the tap water or its installation. These are normally of no or little concern for healthy individuals, but can have a major impact of immunocompromised persons. Waterborne nosocomial (hospital) infections and their implications are relatively well documented, but its effects due to changing hospitalisation patterns (larger proportion of people treated in their homes), a larger proportion of elderly people in the population merit further investigation of the relevance of these organisms. Within this group water-borne transmission is not limited to drinking water, but transmission may also occur through contact and aerosolisation. It may also be through equipment contamination from the water. Aspiration of waterborne pathogens may be of importance in immunocomprimised persons and aerosolisation is a well known mode of transmission for example for *Legionella*. For this organism nosocomial outbreaks are relatively well documented, while community acquired cases need further investigations.

Further compilation of information on the frequencies and severities of immunocompromised individuals in society is necessary as a baseline within the member states in the society (including nursing homes).

Further information is also needed in this context, in the actual use of water within these groups and for what purposes. The relevance of such an occurrence in water, or water related activities in comparison with other sources is also necessary in assessing the relevance of the potential water transmission. The sampling could be case–oriented, which would validate the relative importance of risks and transmission routes.

Several bacterial species of potential relevance have been isolated in the Report B and have been well commented. Others not taken into account in the Report B are *Legionella* (of at least seasonal relevance at elevated water temperature, 20-25 ^{o}C), *mycobacteria* and other slow-growing bacteria (pseudo-infections registered in relation to hospital water sources,). Potentially also some of the fungal agents should be accounted for. Several different strains of *Aspergillus* and *Fusarium* have been isolated from water and with potential connection to human cases.

3b. Comment on the "future" study design (country, regions, sampling methodology, frequency and duration) and the parameters to be examined.

Future studies would have to include other areas, such as Nordic countries and accession countries, where the raw water quality and the purification techniques may be different. Also smaller waterworks should be included.

The chemical parameters included in this study are given by the Drinking Water Directive and will be mandatory to include in future monitoring programmes. It is obvious that several of them are below detection limit in many samples, and considerable resources will be spent to report non-detects. At the same time there are a number of other potential pollutants that may be present in the drinking water. If a certain parameter has been much lower than the limit value for a certain time it may be possible to reduce the frequency of the measurement of that component to release resources for the inclusion of new parameters. The results from a corresponding program in the US are stored in the National Contaminant Occurrence Database (NCOD; www.epa.gov/ogwdw/data/ncod.html), and some of the substances found in that base, but not analysed in European projects are methyl tert-butylether (MTBE), perchlorate, dibromochloropropane, ethylene dibromide, chlorobenzene, 1,4-dichlorobenzene, and naphthalene. Also, other chlorination products may be of interest, especially in water with high concentrations of humic substances. Interest is also focused on pharmaceuticals and endocrine disruptors in drinking water.