



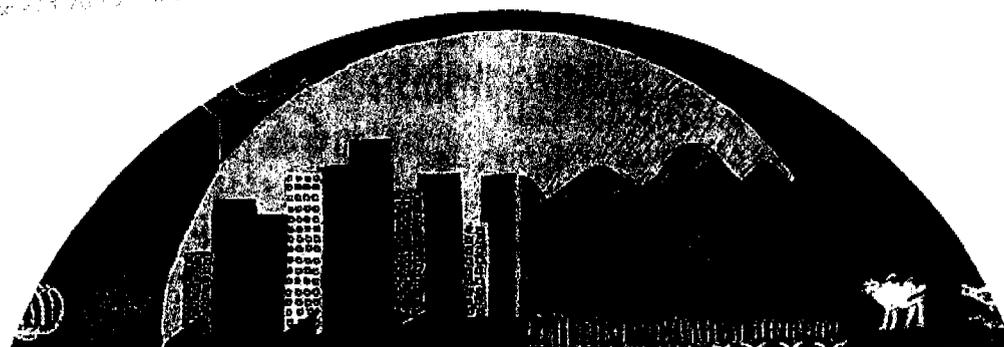
World Health Organization  
Sustainable Development and  
Healthy Environments

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# Expert Consultation on Preparation of Supporting Documents for the Updating of Microbial Aspects of WHO Guidelines for Drinking Water Quality

Loughborough, UK  
18-23 November 2001

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Protection of the Human Environment  
Water, Sanitation and Health  
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**EXPERT CONSULTATION ON PREPARATION OF  
SUPPORTING DOCUMENTS FOR THE UPDATING OF  
MICROBIAL ASPECTS OF WHO GUIDELINES FOR  
DRINKING WATER QUALITY**

**LOUGHBOROUGH, UK**

**18<sup>th</sup> – 23<sup>rd</sup> November 2001**

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## Background

The first WHO publication dealing specifically with drinking water quality was published in 1958 as the *International standards for drinking water*. It was subsequently revised in 1963 and in 1971 under the same title. In 1984-85, the first edition of the WHO *Guidelines for Drinking water quality* was published in three volumes:

Volume 1: *Recommendations*

Volume 2: *Health criteria and other supporting information*

Volume 3: *Surveillance and control of community water supplies*

The three volumes of the second edition of the Guidelines were published in 1993, 1996 and 1997 respectively. Addenda to Volumes 1 and 2 were published in 1998 and 1999, addressing selected chemicals only. An addendum on microbial aspects reviewing selected micro-organisms is in press.

The primary aim of the *Guidelines for Drinking Water Quality* (GDWQ) is the protection of public health. The GDWQ provide an assessment of the health risk presented by microorganisms, chemicals and radionuclides present in drinking water. The guideline values recommended for individual constituents of water are not mandatory limits. They are intended to be used in the development of risk management strategies, including national or regional standards developed in the context of local or national environmental, social, economic and cultural conditions. Such strategies, if properly implemented, will ensure the safety of drinking water supplies through the elimination, or reduction to a minimum concentration, of constituents of water that are known to be hazardous to health.

Volume 3 of the GDWQ: *Surveillance and Control of Community Supplies* is distinct in orientation as it is a document oriented toward "good practice." The present edition is principally focussed upon the situation in developing countries. Other "good practices" guidance linked to the GDWQ include, for example, *Toxic Cyanobacteria in water*.

It was recommended in 1995 that the GDWQ be subject to a rolling revision process. Through this process, microbes and chemicals are subject to periodic review, and documentation related to aspects of "protection and control" of drinking water quality is prepared progressively. This process was initiated at a meeting of the co-ordinating Committee for the rolling revision of the GDWQ, at which three working groups were established. These were formed to address microbial aspects, chemical aspects and aspects of protection and control of drinking water quality.

The programme of work of the Microbial Aspects Working Group (WG) was adopted directly by the 1995 Co-ordinating Committee meeting. For the period 1996-98, it comprised preparation of selected Microbial Review Documents (MRD's). In its first phase of work review documents on a number of specific microbes were prepared. A strategy for major revision of the microbial aspects of the WHO water-related guidelines, including the GDWQ, was also developed.

Since the 1995 Co-ordinating Committee meeting, a series of chemical review documents has been prepared, adopted and published through addenda to the GDWQ as output of the work of the Chemical Aspects WG.

The WG on aspects of Protection and Control of Drinking Water Quality met in 1996 (Bad Elster, Germany) and in 1998 (Medmenham, UK). The terms of reference of the WG have

been established, and four institutions assist in the coordination of the principal thematic areas of work: resource and source protection (Federal Environmental Agency, Berlin); materials and chemical used in the protection and distribution of drinking-water (NSF-International); water treatment (WRc, UK); and monitoring and assessment (Robens Centre, UK). All of these institutions are WHO Collaborating Centres concerned with water. A plan of work has been pursued, based initially upon the recommendations of the Co-ordinating Committee, which has included development of a series of documents principally concerning aspects of "good practice" in achieving the safe conditions described in the GDWQ and organisation of meetings.

The Co-ordinating Committee met in Berlin in 2000 and recommended a plan of work for the development of the 3<sup>rd</sup> edition of the GDWQ and their subsequent rolling revision; a plan of work for the development of supportive materials on implementation of the GDWQ and a Procedures Manual for the preparation of the third edition of GDWQ and subsequent revisions.

At a WHO expert consultation in Stockholm in 1999, a harmonised framework for assessment and management of risk relating to microbial hazards associated with water was developed which linked health targets, risk management, public health status, assessment of risk guidelines derivation. Details of the framework have since been published (Fewtrell and Bartram, 2001) At the co-ordinating committee meeting in Berlin 2000, this framework was further developed and adapted for drinking-water into a proposed scheme for microbial aspects for the 3<sup>rd</sup> edition of GDWQ. Essential building blocks to support the development of the 3<sup>rd</sup> edition of GDWQ were identified in the Medmenham (1998) meeting as critical review documents of major issue areas including resource protection, treatment, distribution, household management, indicators and hazard characterisation and risk assessment.

The development of these and other documents was reviewed during a joint meeting of the microbial aspects Working Group with the Working Group on aspects of protection and control, in Adelaide, Australia in May 2001. For each document a process of development including review was defined in line with the requirements of procedures for guidelines development.

In order to accelerate the process of review of selected documents important to the development of microbial aspects of GDWQ, a small expert consultation was organised in the Water, Engineering and Development Centre (WEDC), Loughborough, UK between the 18<sup>th</sup> and the 23<sup>rd</sup> of November 2001. During this consultation, the progress of six documents was reviewed. Five of these related to microbial aspects of water quality.

## 1. Introduction

Dr Jamie Bartram, WHO HQ opened the meeting with a welcome to the participants on behalf of WHO. On behalf of the host institution, Guy Howard welcomed the participants to WEDC, outlined the history of the institution and described WEDC's involvement with WHO in developing the GDWQ. Guy Howard was nominated as chair and Sam Godfrey (WEDC, UK) was selected as rapporteur.

## 2. H<sub>2</sub>S Method for Detection of Faecal Contamination of Drinking Water

A draft working document on the use of H<sub>2</sub>S test was presented and discussed in detail. The aim of the document was to compile and critically review data on the applicability of the H<sub>2</sub>S test in the absence of standard laboratory facilities. The review addressed evidence of the fundamental microbiology of the test as well as its advantages and disadvantages, with reference to documented experiences from the field.

The meeting recommended that the document be revised and that the following major points be considered:

- It should be clear early on that there is no single "H<sub>2</sub>S text".
- Discussion on cost compared with "nearest alternatives" should be included.
- Selection criteria for test validity should be presented and used as a basis for evaluation. For example, although a potentially applicable tool, concern was raised over probable false positives of non-faecal H<sub>2</sub>S producing bacteria. Particular concern was raised over false positives which require explicit discussion, e.g. the potential of environmentally common and ubiquitous microorganisms such as *Delusfovibrio* and *Aeromonas* producing false positive results. Discussion of these criteria should be tabulated and underpinned by further research and data.
- Community monitoring – it was recognised that the test promotes community involvement in monitoring and may be employed as an educational tool. Concern was expressed about false positives and over sensitivity leading to condemnation of safe sources and inability to demonstrate improvements achieved, thereby undermining this role.
- Presence / Absence testing and H<sub>2</sub>S – need for difference and explicit discussion on P / A testing. Cross-referencing to indicator text with OECD and vice-versa.

Specific discussions and recommendations are outlined in annex 4. It was concluded that the report requires updating to take account of discussion at the meeting and, if available, from other groups involved in the use of the test. Once added, the document should be peer reviewed. The possibility of targetting its launch in the IWA meeting in Melbourne, Australia, April 7<sup>th</sup> – 12<sup>th</sup> 2002 as a WHO document was noted.

The documents had been prepared and was presented by Mark Sobsey. Recommended as reviewers were: Will Robertson (Health Canada, Canada), Julie West (British Geological Survey, UK), Steve Pedley (Robens Centre, UK), Professor KG Nath (Graduate University for Advanced Studies, Japan), Bilqis Hoque (EPRC, Bangladesh), Islam (ICDDR, Bangladesh), Jillian Lewis (Auckland University, New Zealand), Ian Bailey (UMGENI Water, South Africa), Willie Grabow (University of Pretoria, South Africa), Nick Ashbolt (University of New South Wales, Australia), Joan Joffre (University of Barcelona, Spain), Steven Rogers (USEPA, USA) and all WHO regional offices.

### **3. Household water treatment and storage**

A draft of this document had been presented at the Berlin 2000 meeting at which recommendations for its further development were made including the need for further supporting epidemiological data. During the Adelaide 2001 meeting a revised version of the document was tabled and it was concluded that the document was appropriate for association with the GDWQ. Specific proposed improvements were noted and therefore peer review was proposed.

The revised document was presented and discussed. Limited recommendations for improvement were made (Annex 5). Once addressed it should be submitted for peer review. Given the importance of the subject meeting participants noted further potential activities:

- Target audience – an additional shorter document required in due course.
- Linkage – greater cross-referencing to existing texts (e.g. CDC – household treatment text) on implementation is required.
- Implementation projects – recommended that practical demonstration of document in the field are required (proposed in WHO – SEARO/WPRO).

Mark Sobsey (University of North Carolina, USA) had prepared and presented the document. Proposed potential reviewers included: Andrew Trevett (Cranfield University, UK), Eric Minz (CDC, USA), Han Heijnen (WHO staff, Bangladesh), Felipe Solsona (WHO staff, PAHO), Caroline Chan (WHO/PAHO, Ecuador), Steve Gundry (University of Edinburgh, Scotland), Ricardo Rojas (CEPIS-WHO/PAHO, Peru), David Cunliffe (Department of Human Services, Adelaide, Australia), Joe Cotruvo (NSF International, USA), Michael Taylor (Ministry of Health, New Zealand) and all WHO regional offices.

Once reviewed, it is recommended that the document be finalised in light of comments received. The possibility of ‘launching’ it during the IWA meeting in Melbourne 2002, as well as during the International Institute of Life Sciences (ILSI) and IFH meetings in India (April 2002) and the WEDC conference in November 2002 was noted.

### **4. Water safety plans and HACCP**

During the Adelaide 2001 meeting, participants reiterated the importance of linking risk assessment and risk management, with both components being clearly evidence-based. To achieve this, it was proposed that the risk management component be based upon the assessment and management of the water supply system and its ability to meet the defined water quality targets. Hazard Analysis Critical Control Point (HACCP) and similar approaches were recognised as an important tool to support effective management in achieving this goal.

Meeting participants noted that although HACCP is an effective tool, it is not always presented in a scientific manner. It is important to clearly define its applicability for the water industry. In order to do this the following was proposed:

- Terminology: It was recommended that the terms outlined below be used:
  - *Risk assessment* – defining potential health outcomes (of water supply).
  - *System assessment* – ability of water supply system to remove pathogens (quality changes from source to exposure) and achieve defined water quality targets.
  - *Process Control* – Hazard analysis critical control points (HACCP) and similar methods.
  - *Water Safety Plan (WSP)* – process documentation including of all of the above and both steady state and incident based management plans (see annex 6 for details)

- Applicability – water safety plans (WSP) are applicable for both small and large systems of diverse types
- Blank forms – Inclusion of generic formats
- Case studies: Two types of case studies were proposed (brief case studies in generic text and detailed case studies in annexes). The case studies should reflect a range of simple and complex analyses (e.g. similar to USEPA microbial toolbox with simple numbers and complex maths of frequency distributions calibrated by data).
- Hygiene codes – the merging/inclusion of the hygiene codes document written by Guy Howard and Roy Kirby with the *HACCP and water quality* text.

Detailed discussions and outcomes are outlined in annex 6. It was recommended that potential case studies be finalised by mid December and that the document be completed by January 2002, for peer review in February 2002. It was proposed that the document be presented in the IWA meeting in April 2002.

### **5. Indicators Text**

During a meeting in Medmenham in 1998, it was noted that a specific text on microbiological indicators in drinking water was required as a supporting document to the GDWQ. It was subsequently agreed that this document be prepared in collaboration with OECD. Drafts of this document were reviewed during dedicated meetings in Basingstoke, UK and Kuesnacht, Switzerland and subsequently at the GDWQ meeting in Adelaide in May 2001.

It was noted in the Adelaide meeting that although the text contained valuable information, it had limited direction and was not adequate in the current form to support GDWQ derivation and application. General and specific recommendations for improvement were made.

The revised document was reviewed and it was concluded that the document was in an advanced form but still required the following critical changes:

- Structure – Alterations to the structure were recommended in order to make the document more fluid and user-friendly
- Terminology – All references to Critical Control Points (CCP's) and HACCP reference should be harmonized in accordance with current terminology outlined above.
- Incidents – Inclusion of section on incidents and preventative risk management

Specific recommendations included:

- The foreword provided an adequate introduction to the book and an Executive Summary was not necessary
- Chapter 1 - include a text box indicator definitions water safety plans
- Chapter 2 - include ammonia and conductivity as possible indicators
- Chapter 5 – exclude references to CCP, but ensure that each treatment stage highlighted key indicators. Expand the section on solar water disinfection (to include developing country aspects)
- Chapter 6 – inclusion of a section on non-piped distribution
- Chapter 7 – inclusion of contamination incident investigation
- Move chapter 8 to chapter 3 to highlight broader overview of risk assessment
- Methodology chapter – include a list of abbreviations

Lorna Fewtrell (CREH, UK) presented the text. It was recommended that she co-ordinate with co-authors on finalising the documents by the end of 2001.

## **6. Microbial quality of piped water supply networks**

The need for a text concerned with changes in quality of piped distribution and storage was first noted during the GDWQ meeting in Medmenham in 1998. The first draft document was presented at the Adelaide meeting in May 2001. During that meeting it was noted that greater focus was required to re-balance the document in health terms. It was also noted that the text paid particular emphasis to regrowth issues and required more detail on potential forms of contamination for ingress of pathogens. Finally, it was proposed that risk management principles be considered.

The meeting reviewed the document in light of changes since April 2001. It was concluded that although the document was comprehensive, a number of alterations were still required. These included:

- Terminology – revision of Water Safety Plan (WSP) and Indicator terminology in light of earlier records of this meeting
- Foreword – redefinition of foreword to include proposed target audience
- Case studies - inclusion of “boxed” case studies in each chapter of the text (see annex 7 for further detail).
- Back siphonage – greater detail was required on potential microbial contamination of water supplies through back siphonage. It was proposed that John Langford (WSAA, Australia) be contacted for detailed examples.
- Chapter 6 – Proposed that chapter 6 be prepared by Melita Stevens (Melbourne Water Corporation, Australia) with input from Guy Howard. Cross-referencing to Water Safety Plan and HACCP document is required.
- Source protection – Inclusion in chapter 3 and 4 of construction and sanitary checklists.
- Health Impacts – Increased emphasis required in detailing potential health risks associated with Chapter 4 – Planned Maintenance of distribution systems
- Higher Organisms – additional chapter or section on potential health effects of higher organisms in distribution systems (note, existence of a WHO Facts Sheet on this theme).

It was recommended that the above be addressed by the end of February 2002 and that following completion the document be peer reviewed in March 2002.

Preparation and editing of the document had been undertaken by Richard Ainsworth. Support has been provided by UKWIR and IWA.

Suggested reviewers included: Guy Howard (WEDC, UK), Mike Smith (WEDC, UK), Mark LeChevallier (AWWSC, USA), Dick van der Kooij (KIWA, Netherlands), Ed Geldreich (retired, USA); Anne Camper (Montana State University, USA); Jean-Claude Bloch (University CNRS, France), Don Reasoner (USEPA, UK), Dr Wanchai Gooprasest (MOH, Thailand), Jennifer Clancy (Consultant, USA), Alan Godfree (North West Water, UK), John Langford (WSAA, Australia, Country) and all WHO regional offices. Joe Cotruvo should be included in the list of reviewers to ensure harmonisation with and cross-referencing to and from the outputs of the forthcoming conference and expert meeting on HPC bacteria.

## **7. Protocol on Monitoring Chemicals in Drinking Water**

The development of guidance on monitoring of chemicals in drinking water was discussed at an expert consultation meeting on Monitoring Chemicals in Drinking Water in Bangkok, Thailand in 2001. During this meeting it was decided to trial the draft document in a selected number of countries in the WHO Western Pacific Region to assess the documents practicability.

At the meeting experience in application of the protocol was reviewed and recommendations from working group members obtained on the current version of the protocol. Opportunity was also taken to discuss next-steps in the development of the protocol.

The meeting participants made the following recommendations:

- Writing style - concern was expressed that the protocol's writing style was not sufficiently scientific. It was recommended to re-write sections of the protocol in a style consistent with the WHO *Guidelines for Drinking-water Quality* (GDWQ).
- Health priorities - chemicals of local concern for which no guideline value exists must be emphasised as important and explanation given for why WHO has not developed guideline values for those chemicals. The protocol should also explain that guideline values do not exist for certain chemicals as insufficient information is available on the frequency of their occurrence.
- Structure – chapters 1 to 7 prioritise chemicals. This should be complemented by additional chapters on standard setting and on the design of rational monitoring programmes. To achieve this, the following was proposed:
  1. incorporating in the protocol a publication on standard setting
  2. developing a new chapter on design of rational monitoring programmes.

It was recommended that these suggestions be discussed at the forthcoming expert consultation on monitoring chemicals in drinking-water in Bangkok in December 2001. Following these meetings the protocol will be further developed incorporating ideas from both meetings.

The following specific action points were noted:

1. Terrence Thompson (WHO, SEARO) will be responsible for editing/finalising the style of the document during the first quarter of 2002.
2. Jamie Bartram (WHO, Geneva) would discuss the proposed chapter 8 with Felipe Solsona (WHO, PAHO) and Water Aid (UK). John Fawell (Metcalf and Eddy, UK) and Terrence Thompson (WHO, SEARO) will prepare a draft communication to Water Aid for this purpose.

Once the above changes have been made to the document, it is proposed that WHO should issue and widely disseminate the protocol as an unrestricted draft document for comment prior to finalisation. Full detailed recommendations can be found in annex 8.

## **8. Adoption of meeting report**

The draft report of the meeting was discussed and adopted by meeting participants.

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**List of Working Papers**

1. Evaluation of the H<sub>2</sub>S Method for Detection of Faecal Contamination of Drinking Water
2. Household water treatment and storage as appropriate technology for the developing world
3. Water safety plans and HACCP
4. Indicators text
5. The Microbiology of water supply networks: a review of knowledge and practices
6. Protocol on Monitoring Chemicals in Drinking Water

**Agenda**

1. Opening
2. Introduction, purpose
3. Evaluation of the H<sub>2</sub>S Method for Detection of Faecal Contamination of Drinking Water
4. Household water treatment and storage as appropriate technology for the developing world
5. Water safety plans and HACCP
6. Indicators text
7. The Microbiology of water supply networks: a review of knowledge and practices
8. Protocol on Monitoring Chemicals in Drinking Water
9. Adoption of report
10. Closure

## (1) H<sub>2</sub>S Test - detailed comments

The underlying premise was that the test was useful for detecting faecal contamination, based on the assumption that many faecal bacteria produce H<sub>2</sub>S. However it was noted that non faecal bacteria are also H<sub>2</sub>S producers under suitable conditions. It was noted for example that SRB in iron pipes are non faecal bacteria but produce H<sub>2</sub>S. It was recommended the author include information on the cleaning of drill rigs from areas where SRB are an issue.

Cross-referencing to and from; and compatibility with the WHO/OECD “indicators” document was considered important.

### Discussion and Analysis

Introduction - Concluded that the beginning of the text requires strengthening. The existing introduction and purpose should be largely re-worked as a foreword, expanded and an acknowledgement included. The first section, which needs a new title, should include the following:

- Introduction to faecal indicator detection
- Community participation in monitoring
- Testing as an educational tool
- Holistic approach (testing and sanitary inspection) and role of H<sub>2</sub>S test in it
- Identification of ‘gaps’ that might be filled by H<sub>2</sub>S test and propose criteria for adequacy of new test to add to “arsenal”.
- Applicability of test
- Identify the need for the test - evaluation required to identify areas of appropriate use for the test.

Conclusions - Need to identify the limitations and the benefits (e.g. is it cheap enough that it can replace current tests)

Page 2 - 2<sup>nd</sup> paragraph - needs as acknowledgement that there are limitations to all tests used for faecal contamination.

Page 2 - 2<sup>nd</sup> paragraph - last sentence - need to identify gaps (e.g. community involvement) and also to include points that describe an integrated approach with sanitary inspection. It must be stated that indicators have a place but cannot be an exclusive tool.

Page 2 - Benefit of the test as a means of convincing people that contamination exists. Need to include points on sensitisation and hygiene education. Proposed to include a paragraph on this.

Page 4 - Table 1 - Author to include the freshwater geothermal data

### Additional comments from group discussion

- Issues of false positives and lack of quantitation should be stressed in the text
- Need criteria for what constitutes a meaningful tool. On what criteria would a test be judged. One may be verification.
- Need to separate the discussion of P / A testing from discussion of the H<sub>2</sub>S test. Confirmation with the author of the indicator text is required to assure correct use of language.
- Need a table that shows which bacteria are able to produce H<sub>2</sub>S e.g. Aeromonas - does it give positive results under reasonable conditions of test. Include those, which are pathogens, those of faecal origin, and those from environmental sources.

- Confirm what medium should / can be used
- A concern expressed regarding many studies was that implicated organisms were not re-tested to ensure that they gave a positive reaction.

### **Conclusions**

- Some non faecal bacteria give chemical reaction that may give significant positive results from non-biological or environmental components.
- Tabulate contribution of principal studies to specific understanding and defined criteria as yet unresolved. Include case studies.
- Cost effectiveness - include the cost of external factors associated with testing the samples, including cost of visit and staff time costs.
- A new end section is required identifying major methodological flaws in studies and what is needed to overcome them.

Criteria might include:

- Should not give positive reaction under normal conditions of test by common or ubiquitous organisms of little or no sanitary significance.
- Organisms responsible for the reaction under real conditions of testing should be exclusively or predominantly of faecal origin.
- When comparing with other tests, if there are excess positives due to organisms of faecal origin these should be classified as true positives.

## Household water treatment and storage

### General

- Title: recognising its emphasis on under-served communities in the developing world, the title should be reviewed
- Documents contains detail on solar treatment and potential reduction in levels of microbial contamination
- Type of audience needs to be considered
- Suggested to include the combination of solar and chlorine treatment
- Data on cost effectiveness of different treatment methods must be included
- Following recommendations from the meeting in Adelaide 2001, effectiveness of treatment should be supported by epidemiological evidence and data
- More detailed case studies should be included
- Chemical treatment – household level treatment for chemical toxins should be included

### Discussion and Analysis:

Foreword - Need to include foreword which specifies target audience

Introduction - Emphasis that household water treatment is universally applicable in under-served communities in both developed and developing countries

Page 1 - 1<sup>st</sup> paragraph - change access to *safe* water to access to *improved sources*. The definitions from the Global assessment should be included to avoid confusion. Could also consider the reference to the Millennium declaration, which indicates halving the proportion of people without access to or can not afford safe drinking water.

Page 3 - 1<sup>st</sup> paragraph - Remove and place in the forward at the beginning of the document

Page 4 - Emphasis the importance the combined role of safe water and adequate hygiene and sanitation of non-piped systems in both developed and developing countries.

Page 6 - Table 1 & 2 - Reduction in log should be included under table. Costs should be revised. Chlorination is moderate and as fabrication of sodium hypochlorite at field level if difficult. Include membrane filtration which could be used in emergencies (cross reference to emergencies text).

Page 7 - Table 3 - Include calabash as additional water storage container. Indicate that Oxfam bucket is primarily for emergency use. (*Mark Sobsey to co-ordinate with Sam Godfrey*) Footnote that recycled materials are often used.

Page 10 - *Boiling or heating with fuel* - Quote WHO position on effectiveness of boiling when brought to a *rolling* boil.

Page 11 - *Solar treatment* - Recognise the role of the American University of Beirut in developing the technology.

Page 12 -Table 4 - *Water aeration* - Consider effect of oxygen on bacteria during aeration - further research required.

Page 15 - Table 6 - Need for more epidemiological data to support figures. Note of inclusion of health and hygiene promotion in section is important.

Page 17 - Table 7 - Suggested that sand filters should be underplayed due to maintenance restrictions.

Page 17 - Include section on guinea worm

Page 28 - Table 10 - Porous ceramic filters – can produce ceramic filters in developing countries (cost). Problems of operation and maintenance rephrase – affordability and available.

Page 30 - Table 11 - Costs are country/location specific. Recommended that Laurence Haller undertake this research. Include chemical disinfectants – Use at a household level / advantages and disadvantages. Practical and usability in developing world. Parts of the world where it is difficult to get free chlorine.

Page 41 - Table 15 - Include an additional column for service level (e.g. communal /yard - on plot / off plot). Indicate if disease reduction was related to only water quality or also health interventions.

**Additional comments from group discussion**

The document must consider two additional areas:

1. Comparison of technologies
2. Inclusion of water safety or HACCP

## Water safety plans and HACCP

### General

Need to make water safety a universal concept, so all operators and utilities are able to follow similar methodology. In order to do this, the plans have to be applicable to all types of systems. However, as many small water supplies are not monitored, a phased approach to introducing HACCP/WSP to these systems would be required.

In order to make the concept universal, water safety plans should ideally be adapted to both chemical and microbial risk assessment.

It was recommended that as incremental change in quality occurs through source protection/degradation treatment and distribution, the concept of control points be inter linked with system assessment. An approach is therefore required that demonstrates where and how incremental improvement can be managed. The concept of control points is an engineered process where as control measures are more generic. Therefore recommended to change *Critical for Control*.

System assessment required to assess where risk and hazards lie. Feedback from each part of system is required and should be disseminated through a circular process. To assist readers, the text should include more detail on the potential forms of contamination and their movement, through flow diagrams.

It is recommended that source protection and hazard analysis should become more obvious in the text. Examples are needed of source waters e.g. variation in *Cryptosporidium* by protection and in reductions through natural attenuation in groundwater systems.

Data should be used to quantify the case for substantial source protection. Possible sources of information include USEPA website. A variety of case studies are required from complex to simple analyses. Recommended to include case studies including two from Australia, one from Thailand (safe drinking water) and one from a small water supply.

## The Microbiology of water supply networks

### General

- Specific attention should be paid to terminology in light of discussions at the expert consultation. Throughout the document references to “Hazard Analysis Critical Control Points” (HACCP) and “Indicators” should be reviewed.
- A foreword is required to include description of intended target audience.
- Health effects - throughout the document, linkage to health effects must be emphasised and increased
- Case studies -Case studies should be included to illustrate text. They should be .approximately 450 words in length
- Additional chapter on higher organisms and effects on water quality required

### Discussion and analysis:

#### Chapter 1:

- Two case studies should included - Possible suggestions include: - Outbreaks on ships (Roisin Rooney, WHO, HQ); Bird proofing (ref. Geldrich text); Islamabad back siphonage (Margaret Ince, WEDC, UK).
- page 6 - Infectious viruses – need to supported by a reference (from Pierre Payment)
- page 6 - typographical (oo) cysts – giardia and crypto
- page 6 - Legionella – survive and accumulate – source of endemic disease (low level break through and endemic disease. Need data and reference.
- Intrusion of contaminated water – general idea that chlorine masks *E coli*. Reference – Mark Lechavillier for the chlorine residual
- Page 9 - paragraph –last paragraph– pathogens and biofilms (viruses do absorb to pipes) - Dan Deere to follow up.
- Page10 - Cross reference to rainwater catchment document
- Page 11 - Delete paragraph at the top of page 11 and cross reference to treatment text.
- Page 11 - Consistency in terminology – ‘total coliforms’ *not* ‘coliforms’
- Page 12 - second paragraph – delete
- Page 13 - change title of 1.4.2 from microbiological to microbial and from sampling to monitoring. Add more specific advice on sanitary inspection – Guy Howard WEDC, UK
- Page13 – ISO standards exist for good practice
- Add additional paragraph on higher organisms and their health effects e.g. Amoebae – higher organisms and aesthetic problems (possible sources Margaret Ince past MSc projects, WEDC, UK and Colin Evans from DWI); also WHO Facts Sheet.
- Delete table 1

#### Chapter 2:

- Ideally include some photos (possible source: Andrew Wheatley)
- Page 3 – need to include oxygen on the figure and change micro invertebrates to invertebrates
- Page 4 – rephrase temperature section, replace heterotrophic with autotrophic
- Page 5 – assure that no pathogens are leaving the treatment works / rewrite quality assurance section. Stress the importance of possible contamination in lengthy transfer main etc.
- Page 6 – Remove the first paragraph and cross reference the treatment text

- Page 8 – 2.3.3 – rework the nitrogenous matter paragraph
- Page 13 – Product names should not normally be included.
- Page 14 – Last paragraph remove the word huge and elaborate on meaning of TOC and BOM (remove TOC)
- Page 14/15 – Remove bullet points
- Page 15 – Change BOM for organic carbon.
- Page 16 - Include section on plumbing codes

Possible case studies:

- Pathogen entrapment in biofilm and/or release of sediment e.g. Sydney.
- Corrosion in the US – see chapter 1 ref. Craun / Craun

Chapter 3 –

- Include outbreaks from higher organisms when entering distribution
- Page 7 – Remove section 3.2.5 and use in chapter 6 – (Melita Stevens, Melbourne, Australia )
- Page 9 – Include damaged vermin proofing
- Page 10 – Reference for baffle section
- Page 20 - Include section on zoning of systems (Dr Jamie Bartram, Guy Howard to advise)
- Include case studies e.g. low mains pressure – Menzing 1981; high pressure system – injecting pathogens (giardia – Kramer et al 1986)
- Include a checklist for health risks associated with design and construction

Chapter 4 –

Rework this chapter to include possible health risks associated with planned maintenance.

Recommended that the following health concerns are considered:

1. aesthetic quality - increased turbidity / free residual chlorine
2. monitoring parameter
3. dirty systems due to maintenance results in it being difficult to monitor chlorine residuals
4. supports replacement
5. better target less risk

It was proposed that Guy Howard includes a section on user vulnerability.

Consider different techniques of maintenance:

- non aggressive techniques e.g. relining
- aggressive techniques

Include case studies (e.g. cleaning of water storage tanks – West Bank and Gaza, Margaret Ince to contact Mike Smith, WEDC, UK)

Include checklist of inspection about service reservoirs / sanitary surveys

Chapter 5 -

- Page 4 - consider vaccination for personnel
- Include case studies of outbreaks e.g. Swerderler 1995 (*E coli* O157 outbreak)

Chapter 6 –

Inclusion of new chapter entitled *Water Safety plans for piped water systems*. Melita Stevens and Dan Deere to coordinate with John Langford and Guy Howard. The chapter should summarise conclusions from each chapter and focus on using water safety plans to reduce public health risk.

**Suggested format includes:**

- 1. Overall WSP philosophy / distribution system**
- 2. Control Points and Control Measures - should be performance indicators**
- 3. Monitoring – commissioning and routine monitoring (including Sanitary Inspection Analysis) resulting in remedial action**
- 4. Management Plans – Steady state / Incident**
- 5. Surveillance – 3<sup>rd</sup> party audit /independent surveillance**

## Protocol on Monitoring Chemicals in Drinking Water

### General

Concern was expressed that the present style of the protocol was not sufficiently scientific. There is a need to re-write sections of the protocol that is consistent with the style of the WHO *Guidelines for Drinking-water Quality* (GDWQ).

Need to identify those chemicals of local concern for which no guideline value exists. Users may question, if the protocol identifies specific chemicals as potential priorities, why WHO has not developed guideline values for those chemicals.

### Discussion and analysis:

- Section 2.5.2 - The discussion on adsorption is too complicated and needs to be simplified. The discussion is also oriented only towards groundwater and needs to include surface water. *Dr. Fawell agreed to suggest new text prior to the Bangkok meeting. Mr. Thompson will request the author, Steven Appleyard, to review this.*
- Section 3.1 - The last sentence of this section is incomplete. *Mr. Thompson will request Darryl Jackson to review this.*
- Section 3.5 - Dr. Fawell expressed some concern about the accuracy of statements regarding algal toxins as well as the location of this section in the text. *Dr. Fawell will propose new language, prior to the Bangkok meeting. The new language will be reviewed in the Bangkok meeting and subsequently inserted, with any revisions as needed, after Section 3.8 to become the new Section 3.9. The existing Section 3.9 will become 3.10.*
- Table 3.2 - It was noted that the column on "Population Exposed" was not needed and may only generate controversy. *It was agreed to delete this column.*
- Section 3.5 - The fluorosis case study is not defensible and should be deleted. *It was agreed that Hiroki Hashizume would solicit an alternative fluorosis case study from Dr. Aitio. The case study on selenosis was also considered to be inappropriate. Terrence Thompson will request the author of this section, Steven Appleyard, to consider other case studies currently in Vol. 2 of the WHO GDWQ.*
- Section 3.8 - The advice given in this section on acidity and potential acidity is not appropriate for developing countries that may use wet chemistry techniques and that therefore need to prioritise chemicals for which laboratory testing may be needed. It is not appropriate to recommend that they analyse a "full suite" of metals. *It was agreed to discuss this section in the Bangkok meeting. Meanwhile, Dr. Fawell will seek additional advice from laboratory analysts.*
- Box 4.1 - Dr. Fawell suggested adding an additional risk factor: history of blue baby syndrome in the study area. *It was agreed to add this additional risk factor to the box. Dr. Fawell suggested that algal blooms are not an appropriate risk factor for nitrate contamination as phosphate is usually the limiting nutrient, not nitrate. It was agreed to delete algal blooms as a risk factor.*
- Section 4.4 - Dr. Fawell questioned whether the term "feedlots" was widely used
- Section 4.7 - Dr. Fawell questioned the statement about fluoride in the fourth paragraph and suggested deleting the reference to mosquitoes in the sixth paragraph.
- Box 4.6 - Dr. Fawell suggested that the working group consider whether to delete or retain this box, as it seems not to be helpful.

- Section 4.10 - Only one reference is given and it seems not to pertain to agriculture. Agriculture references seem to be missing. *Terrence Thompson will request Darryl Jackson to check this.*
- Pesticides Tables - WHO/HQ will offer an APW to Colin Brown (Cranfield University, UK), to prepare Part 2 of these tables, as discussed in the writers' workshop (Loughborough, 18-19 July 2001). *John Fawell will draft the terms of reference for the contract and will send them to Hiroki Hashizume who, in turn, will prepare and issue the APW.*
- Section 5.3 - It was agreed that the wastewater characterisation data, and leachate characterisation data, should be reviewed. Concern was expressed that the current data may not be representative of developing countries. *Terrence Thompson will request the author to look at this.* Dr. Fawell suggested that a new section should be added on plastic pipes. *Dr. Fawell will draft this section prior to the Bangkok meeting.*
- Chapter 6 - It was agreed that a new section is needed on degreasing fluids. *Terrence Thompson will request that the author, Dr. Shoichi Kunikane, develop this section.* It was agreed that the case study on gold panners was not relevant to the protocol. *Terrence Thompson will request that Darryl Jackson edit or delete this case study.*
- Box 6.2 - It was agreed that Box 6.2 is not helpful. *Terrence Thompson will edit or delete this box.*

**Additional comments from group discussion:**

After the Bangkok meeting, an effort will be made to issue an updated version of the protocol incorporating the suggestions made in the Loughborough and Bangkok meetings.

*Chemicals of local concern* - Dr. Bartram felt that certain chemicals that may be of local concern (e.g., I, Ni, etc.) should not be omitted from the protocol even though no guideline values have been established for them. Instead, the protocol should note that WHO has no information to suggest that these chemicals occur with sufficient frequency in drinking water that may warrant establishing guideline values but they be of local importance.

*Chapter 8* - Very little has been written in this chapter. Chapters 1 to 7 deal with the issue of prioritising chemicals. This should be complemented by significant information on standard setting and on the design of rational monitoring programmes. Dr. Bartram suggested:

1. incorporating in the protocol a publication being prepared by Felipe Solsona on standard setting
2. developing a new chapter on design of rational monitoring programmes.

*It was agreed that Jamie Bartram would discuss this idea with Felipe Solsona.*

**Conclusions:**

The immediate next steps are to conduct the Experts consultation Thailand, December 2001. Recommendations from this meeting will be incorporated into the text. Once edited, the text should be disseminated as an unrestricted document. *It was agreed that Hiroki Hashizume would begin the administrative procedures needed to secure internal approvals for this purpose. Terrence Thompson will draft the needed Foreword (background, objectives, work-in-progress, contact information). WHO/HQ will disseminate the unrestricted version of the protocol once available. This version will also be included in a CD ROM for the Global Meeting on GDWQ, which is also to be prepared by Hiroki Hashizume by mid-April 2002.*