

Guidelines for drinking-water quality

SECOND EDITION

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



World Health Organization
Geneva



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Preface

The first edition of *Guidelines for drinking-water quality* was published by WHO in 1984–1985 and was intended to supersede earlier European and international standards. Volume 1 contained guideline values for various constituents of drinking-water and Volume 2 the criteria monographs prepared for each substance or contaminant on which the guideline values were based; Volume 3 was concerned with the monitoring of drinking-water quality in small communities, particularly those in rural areas.

During the International Drinking-Water Supply and Sanitation Decade (1981–1990) considerable experience was gained in the surveillance and improvement of small-community supplies, notably through a series of demonstration projects supported by WHO. This new edition of Volume 3 of *Guidelines for drinking-water quality* reflects the experience of these and many other projects concerned with improving the quality of water services undertaken during the Decade.

A number of important principles were established in the first edition of Volume 3 of the *Guidelines* and these continue to form an important part of the second edition. They include the distinct and complementary roles of the water supplier and the surveillance agency; the unique nature of the problems associated with monitoring small-community supplies (especially in developing countries); the central role of the microbiological monitoring of supplies of this type; and the importance of ensuring that surveillance leads to engineering improvements and other remedial measures. Experience gained during the Decade has highlighted the importance of other fundamental concepts which have been incorporated into this new edition, including the need to consider not only drinking-water quality, but also all aspects of water-supply services that influence health, and to address the problems of small periurban areas not covered by such services.

While conditions vary from country to country as a result of differences in economic, geographical, cultural and social conditions, the strategies and procedures described here should nevertheless be widely applicable. Thus it is hoped that this Volume, like the first edition, will prove useful to all those concerned with drinking-water supply to small communities: environmental health inspectors, sanitary technicians, laboratory personnel, water engineers, planners and all those in the health and water-supply sector with managerial responsibility for

PREFACE

improving water-supply services to communities. For the purposes of this publication, the term “communities” applies not only to villages and small private water supplies in rural areas but also to other centres of population within, or in close proximity to, urban centres.

Acknowledgements

The preparation of this volume was begun at a Review Meeting on Surveillance of Community Supplies, held in Harare, Zimbabwe, on 24–28 June 1991, when a detailed outline was agreed. The first draft of Volume 3 was reviewed at the Final Task Group Meeting on the Revision of the *WHO guidelines for drinking-water quality*, held in Geneva on 21–25 September 1992, and a revised draft was subsequently finalized at a Meeting on Technical Revision of Volume 3, held in Tirana, Albania, on 15–20 June 1993. The final version is the outcome of the work of a number of contributors and reviewers whose names are given in Annex 1; their assistance is greatly appreciated. The coordinator for Volume 3 of the *Guidelines* was J. Bartram, Manager, Water and Wastes, WHO European Centre for Environment and Health, Rome, Italy, formerly of the Robens Institute of Health and Safety, University of Surrey, Guildford, England.

The first edition of Volume 3 of the *Guidelines* provided the basis for a number of pilot projects and country programmes in Central and South America, Africa, various parts of Asia and in the Pacific region, funded jointly by the United Nations Environment Programme (UNEP) and the United Kingdom Overseas Development Administration (ODA). Regional and national training courses were conducted, which were also supported by the Danish International Development Agency (DANIDA) and which allowed for the review and evaluation of the approaches proposed in the *Guidelines*. The experience gained in the projects in Indonesia, Peru, and Zambia was evaluated and published (Lloyd B. Helmer R. *Surveillance of drinking water quality in rural areas*. Harlow, Longman Scientific and Technical, 1991), and provided the basis for much of the revised methodology in the second edition, including an intensified sanitary-inspection process and a new hazard-analysis scheme.

The revision of Volume 3 of the *Guidelines* was made possible through a grant provided by ODA to the Robens Institute of Health and Safety, University of Surrey, Guildford, England. Financial support for the review meetings was provided by DANIDA.

Acronyms and abbreviations used in the text

CFU	colony-forming units
DPD	diethyl- <i>p</i> -phenylenediamine
ESA	external support agencies
HTH	high-test hypochlorite
ISO	International Organization for Standardization
JTU	Jackson turbidity unit
MF	membrane filtration
MPN	most probable number
MSD	minimum safe distance
MT	multiple tube
NA	not applicable
NGO	nongovernmental organization
NTU	nephelometric turbidity unit
PA	presence-absence test
TCU	true colour unit
UNCED	United Nations Conference on Environment and Development
WHO	World Health Organization

Contents

Preface	ix
Acknowledgements	xi
Acronyms and abbreviations used in the text	xii
1. Introduction	1
1.1 Scope and purpose	1
1.2 Community water supplies	1
1.3 Health implications	3
1.3.1 Water quality	4
1.3.2 Water-washed diseases	11
1.4 Objectives of surveillance and quality control	11
1.5 Organizational structure	12
1.5.1 The surveillance agency	13
1.5.2 Quality control and the role of the water supplier	13
1.6 Community participation	14
1.7 Role of surveillance in improvement of water supplies	15
2. Plar	17
2.1	17
	17
	18
2.2 Planning	20
2.2.1 General considerations	20
2.2.2 Strategies	22
2.3 Implementation	23
2.3.1 Inventories	23
2.3.2 Designing forms	26
2.3.3 Training	28

2.3.4	Preliminary surveys	30
2.3.5	Undertaking fieldwork	31
2.3.6	Establishing routine surveillance	31
2.3.7	Evaluation	31
2.4	Information management	31
2.4.1	Flow and use of information	31
2.4.2	Information exchange with suppliers	32
2.4.3	Information exchange within the surveillance agency	34
2.4.4	Information exchange with consumers	35
2.4.5	Communication with local and national government	36
2.4.6	Communication linkage between surveillance and remedial action	36
2.4.7	Use of computers	37
2.5	Support structure	38
2.5.1	Laboratory network	38
2.5.2	Transport	39
2.5.3	Financial support	39
2.5.4	Staffing	41
3.	Surveys	42
3.1	Nature and scope of community surveys	42
3.2	Sanitary inspections	44
3.3	Sanitary inspection reports	44
3.3.1	Functions of sanitary inspection report forms	45
3.3.2	Design of sanitary inspection report forms	46
3.4	Carrying out sanitary inspections	47
3.5	Timing and frequency of sanitary inspections	48
3.5.1	New sources	48
3.5.2	Routine surveys of existing supplies	48
4.	Water sampling and analysis	51
4.1	Sampling	52
4.1.1	Location of sampling points	52
4.1.2	Sampling frequency	53
4.1.3	Sampling methods for microbiological analysis	53
4.1.4	Storage of samples for microbiological analysis	53

4.1.5	Sampling methods for physicochemical analysis	56
4.2	Bacteriological analysis	56
4.2.1	Indicator organisms	58
4.2.2	Principal analytical techniques	60
4.2.3	Choice of methods	63
4.2.4	Minimizing the cost of analysis	63
4.2.5	Laboratory-based versus on-site testing	65
4.2.6	Single-application (disposable) test kits	66
4.3	Physicochemical analysis	67
4.3.1	Chlorine residual	67
4.3.2	pH	67
4.3.3	Turbidity	68
4.4	Aesthetic parameters	68
4.4.1	Colour	68
4.4.2	Taste and odour	69
4.5	Other analyses of relevance to health	69
4.6	Analytical quality assurance and quality control	70
4.7	Safety	72
5.	Data analysis and interpretation	73
5.1	Introduction	73
5.2	Results of community surveys	73
5.2.1	Evaluation of water-supply systems	73
5.2.2	Hygiene practices	76
5.3	Assessment of the sanitary situation	76
5.4	Microbiological water quality	77
5.5	Risk assessment	78
5.6	Presentation of information	80
5.6.1	Target audiences	80
5.6.2	Simple data presentation	81
5.7	Use of surveillance findings	82
5.7.1	Use of data at local level	82
5.7.2	Regional use of data	82
5.7.3	Use of data for national planning	83
6.	Technical interventions	84
6.1	Prevention and remedial measures	84
6.2	Protecting water sources	85

6.2.1	Catchment protection	85
6.2.2	Groundwater protection	89
6.3	Wells	92
6.3.1	Dug wells	92
6.3.2	Hand-pumped and mechanically pumped wells	94
6.4	Springs	96
6.5	Rainwater catchment	99
6.6	Water treatment	100
6.6.1	Abstraction	100
6.6.2	Preliminary treatment by storage	102
6.6.3	Plain sedimentation	102
6.6.4	Prefiltration	104
6.6.5	Slow sand filtration	105
6.6.6	Coagulation, flocculation, and sedimentation	107
6.6.7	Rapid sand filtration	110
6.6.8	Aeration	111
6.6.9	Fluoride removal	113
6.6.10	Control of nitrites and nitrates	113
6.6.11	Disinfection	114
6.6.12	Water-treatment plants	115
6.7	Household water treatment and storage	116
6.7.1	Household water treatment	119
6.7.2	Household water storage	125
6.7.3	Storage tanks	127
7.	Hygiene education	129
7.1	Scope of hygiene education	129
7.1.1	Community-based surveillance	129
7.1.2	Hygiene behaviours	129
7.2	Planning hygiene education	131
7.2.1	Community participation and empowerment	131
7.2.2	Selection of behaviours to be changed	132
7.2.3	Factors influencing hygiene behaviour and selection of content of education	133
7.2.4	Selection of target groups	133
7.2.5	Information needs for hygiene education	134
7.3	Educational methods	134
7.4	Human resources for hygiene education	136
7.5	Role of the surveillance agency in hygiene education	138
7.6	Funding hygiene education activities	139

8. Legislative, regulatory, policy, and basic management aspects	141
8.1 Application of water-supply legislation	141
8.1.1 Short- and medium-term targets	141
8.1.2 Compliance: the role of the water-supply agency and the surveillance agency	142
8.1.3 Surveillance requirements	143
8.1.4 Sampling frequencies and parameters	144
8.1.5 Prescribed analytical methods	144
8.2 Technical regulations: construction, operation, and plumbing codes of practice	144
Selected further reading	145
Annex 1. List of contributors and reviewers	147
Annex 2. Examples of sanitary inspection forms	150
Annex 3. Examples of possible responsibilities of surveillance staff	178
Annex 4. Sampling methods for bacteriological testing	182
Annex 5. Multiple-tube method for thermotolerant (faecal) coliforms	189
Annex 6. Membrane filtration method for thermotolerant (faecal) coliforms	212
Annex 7. Field test method for thermotolerant (faecal) coliforms	219
Annex 8. Presence-absence test for total coliform bacteria	224
Annex 9. Residual free chlorine test	226
Annex 10. Turbidity and pH	231
Annex 11. Examples of regional and national monitoring report forms for water supplies and for coverage with basic sanitary facilities	234

1.

Introduction

1.1 Scope and purpose

This volume of *Guidelines for drinking-water quality* describes the methods employed in the surveillance of drinking-water quality in the light of the special problems of small-community supplies, particularly those of developing countries, and outlines the strategies necessary to ensure that surveillance is effective. It is also concerned with the linkage between surveillance and remedial action and with the form that remedial action should take.

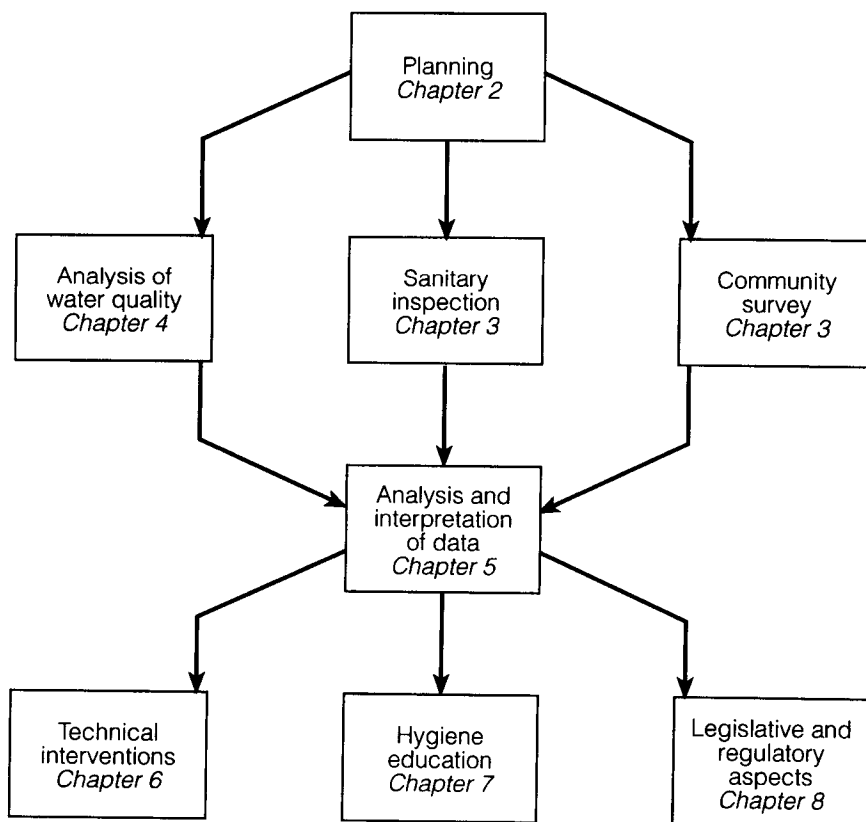
The structure of this volume reflects the key stages in the development of surveillance, as summarized in Fig. 1.1. Thus Chapter 2 covers planning, and subsequent chapters deal with the procedures used in the collection of information—sanitary inspection and community surveys (Chapter 3), and the analysis of water quality (Chapter 4). Chapter 5 considers the analysis and interpretation of the information gathered and its use in improving water-supply services. The final three chapters cover strategies for improvement—technical interventions (Chapter 6), hygiene education (Chapter 7) and legislation and regulation (Chapter 8).

1.2 Community water supplies

The precise definition of a “community water supply” will vary. While a definition based on population size or the type of supply may be appropriate under many conditions, it is often administration and management that set community supplies apart, and this is especially true in developing countries. The increased involvement of ordinary, often untrained and sometimes unpaid, community members in the administration and operation of water-supply systems is characteristic of small communities; this provides a ready distinction between community water supplies and the supply systems of major towns and cities. However, water supplies in periurban areas—the communities surrounding major towns and cities—are often organizationally similar to those of rural communities; these may also be classified as “community water supplies” and are therefore included in this volume.

While the safe quality of water supplied to communities is an important consideration in the protection of human health and well-being, it is not the only factor that affects consumers. *Access to water* is of paramount concern and other

Fig. 1.1 Key stages in the development of water-supply surveillance and strategies for improvement



WHO 96536

factors, such as the population served, the reliability of the supply and the cost to the consumer, must therefore be taken into account. At the United Nations conference at Mar del Plata in 1977, which launched the International Drinking-Water Supply and Sanitation Decade, this philosophy was adopted unambiguously: *“all peoples, whatever their stage of development and social and economic condition, have the right to have access to drinking-water in quantities and of a quality equal to their basic needs.”*

Access to water may be restricted in several ways, e.g. by prohibitive charges, daily or seasonal fluctuations in availability or lack of supplies to remote areas, and many countries face problems of this sort. In some parts of the world where water is scarce and has to be transported over long distances by road or on foot, the cost of drinking-water may absorb a significant proportion of the average daily income. Elsewhere, seasonal, geographical and hydrological factors may

conspire to deny individual households or entire communities a continuous, reliable supply of drinking-water. During dry seasons, spring sources may dwindle, reservoirs may become exhausted and excessive demands by one group of people may limit supplies to their neighbours. Such problems are not confined to poorer countries; they are also experienced with increasing frequency in industrialized countries where management of demand has failed or population growth has outpaced the development of water resources.

If the performance of a community water-supply system is to be properly evaluated, a number of factors must be considered. Some countries that have developed national strategies for the surveillance and quality control of water-supply systems have adopted *quantitative service indicators* for application at community, regional and national levels. These usually include:

- quality: the proportion of samples or supplies that comply with guideline values for drinking-water quality and minimum criteria for treatment and source protection
- coverage: the percentage of the population that has a recognizable (usually public) water-supply system
- quantity: the average volume of water used by consumers for domestic purposes (expressed as litres per capita per day)
- continuity: the percentage of the time during which water is available (daily, weekly or seasonally)
- cost: the tariff paid by domestic consumers

Together, these five service indicators provide the basis for setting targets for community water supplies. They serve as a quantitative guide to the comparative efficiency of water-supply agencies and provide consumers with an objective measure of the quality of the overall service and thus the degree of public health protection afforded.

1.3 Health implications

The provision of an adequate supply of safe water was one of the eight components of primary health care identified by the International Conference on Primary Health Care in Alma-Ata in 1978. The guidelines presented here are in full accord with the spirit of the Alma-Ata declaration on primary health care, which expanded the concept of health care to include broader notions of affordability, accessibility, self-reliance, intersectoral collaboration, community participation, sustainability and social justice.¹

In most countries the principal risks to human health associated with the consumption of polluted water are microbiological in nature (although the importance of chemical contamination should not be underestimated). As indicated in Chapter 18 of "Agenda 21" of UNCED, "An estimated 80% of all diseases and over one-third of deaths in developing countries are caused by the

¹ *Alma-Ata 1978: primary health care*. Geneva, World Health Organization, 1978.

consumption of contaminated water and on average as much as one-tenth of each person's productive time is sacrificed to water-related diseases."

The risk of acquiring a waterborne infection increases with the level of contamination by pathogenic microorganisms. However, the relationship is not necessarily a simple one and depends very much on factors such as infectious dose and host susceptibility. Drinking-water is only one vehicle for disease transmission. Some agents may be transmitted primarily from person to person and, for bacteria capable of multiplication in food, foodborne transmission may be more important than transmission by drinking-water. Other agents, however, such as *Salmonella typhi*, *Vibrio cholerae*, *Giardia lamblia* and hepatitis A virus, are frequently transmitted via contaminated drinking-water and, where this is the case, improvements in drinking-water quality may result in substantial reductions in disease prevalence.

Because of this multiplicity of transmission routes, improvements in the quality and availability of water, excreta disposal, and hygiene in general are all important factors in reducing diarrhoeal morbidity and mortality.

Epidemiological investigations indicate that all aspects of the quality of water supply services influence health, as do hygiene behaviours and sanitation. Experience has shown that analysis of disease incidence (epidemiological surveillance) is not a useful tool for guiding even large-scale remedial programmes for community water supplies. It is expensive and yields data that are difficult to interpret.

In the same way that indicators of the quality of water-supply services have been found useful in guiding remedial action, indicators of hygiene practices should also be used. Such indicators should be based on simple, standardized observations, and used to guide hygiene education programmes and the selection of key messages regarding hygiene behaviours.

1.3.1 Water quality

Guideline values for drinking-water quality are given in Volume 1 of the *Guidelines for drinking-water quality*, which also explains how the values should be interpreted. The health criteria used in establishing these values are summarized in Volume 2. A drinking-water quality guideline value represents the concentration of a constituent that does not result in any significant health risk to the consumer over a lifetime of consumption. Drinking-water should be suitable for human consumption and for all usual domestic purposes. When a guideline value is exceeded, the cause should be investigated and corrective action taken. The amount by which, and for how long, any guideline value can be exceeded without endangering human health depends on the specific substance involved.

In drawing up national standards for drinking-water quality, it will be necessary to take into account various local, geographical, socioeconomic and cultural factors. As a result, national standards may differ appreciably from the guideline values.

There may be a need for *interim standards* to provide a medium-term goal as a step towards the achievement of guideline values in the longer term. There is no objection to such a stepwise approach provided that the relevant authorities in each country, especially the ministry of health or its equivalent, are consulted and approve it. There are dangers in leaving such matters entirely to the agencies responsible for water supply because of the conflict of interests that may arise.

While supplies that fail to meet ideal criteria should be neither condoned nor ignored, interim standards permit resources to be directed first towards those communities with the greatest problems. They provide incentives to upgrade rather than blame for failure; this is particularly important in countries subject to severe economic constraints. The use of categories of bacteriological contamination of small-community supplies is useful in this context and is discussed in greater detail in Chapter 5.

In some countries, health authorities have adopted interim standards for intractable natural contaminants such as fluoride, pending the development of appropriate treatments for their removal from community supplies.

No attempt is made here to establish guideline values for service indicators other than drinking-water quality, such as those for the coverage, continuity, and cost of community water supplies. It is for national authorities to establish medium- and long-term targets for such factors. This should be done on a multisectoral basis, since the setting of these targets will have a number of social and economic implications. Nevertheless, because of the importance to public health of adequate access to safe water, the adoption of standards in this area is strongly recommended.

Microbiological aspects

Ideally, drinking-water should not contain any microorganisms known to be pathogenic—capable of causing disease—or any bacteria indicative of faecal pollution. To ensure that a drinking-water supply satisfies these guidelines, samples should be examined regularly. The detection of *Escherichia coli* provides definite evidence of faecal pollution; in practice, the detection of thermotolerant (faecal) coliform bacteria is an acceptable alternative.

Guideline values for bacteriologically safe supplies of drinking-water are provided in Volume 1 of the *Guidelines*. Although developed for large water-supply systems, the values for treated and untreated water supplies are also applicable to community supplies and are therefore reproduced in Table 1.1. Background information on the significance and choice of indicator organisms, as well as the selection of analytical methods, is given in Chapter 4.

A complementary strategy for securing the microbiological safety of drinking-water supplies has also been advocated by WHO and a number of other agencies, based on the minimum treatment for certain types of water. This helps to ensure the elimination of faecal pathogens by specifying the conditions to be observed and treatments to be applied at the water-treatment plant. For example,