2
The Guidelines: a framework for safe drinking-water

The quality of drinking-water may be controlled through a combination of protection of water sources, control of treatment processes and management of the distribution and handling of the water. Guidelines must be appropriate for national, regional and local circumstances, which requires adaptation to environmental, social, economic and cultural circumstances and priority setting.

2.1 Framework for safe drinking-water: requirements

The Guidelines outline a preventive management "framework for safe drinking-water" that comprises five key components:

— health-based targets based on an evaluation of health concerns (chapter 3);
— system assessment to determine whether the drinking-water supply (from source through treatment to the point of consumption) as a whole can deliver water that meets the health-based targets (section 4.1);
— operational monitoring of the control measures in the drinking-water supply that are of particular importance in securing drinking-water safety (section 4.2);
— management plans documenting the system assessment and monitoring plans and describing actions to be taken in normal operation and incident conditions, including upgrade and improvement, documentation and communication (sections 4.4–4.6); and
— a system of independent surveillance that verifies that the above are operating properly (chapter 5).

In support of the framework for safe drinking-water, the Guidelines provide a range of supporting information, including microbial aspects (chapters 7 and 11), chemical aspects (chapters 8 and 12), radiological aspects (chapter 9) and acceptability aspects (chapter 10). Figure 2.1 provides an overview of the interrelationship of the individual chapters of the Guidelines in ensuring drinking-water safety.

There is a wide range of microbial and chemical constituents of drinking-water that can cause adverse human health effects. The detection of these constituents in both raw water and water delivered to consumers is often slow, complex and costly,
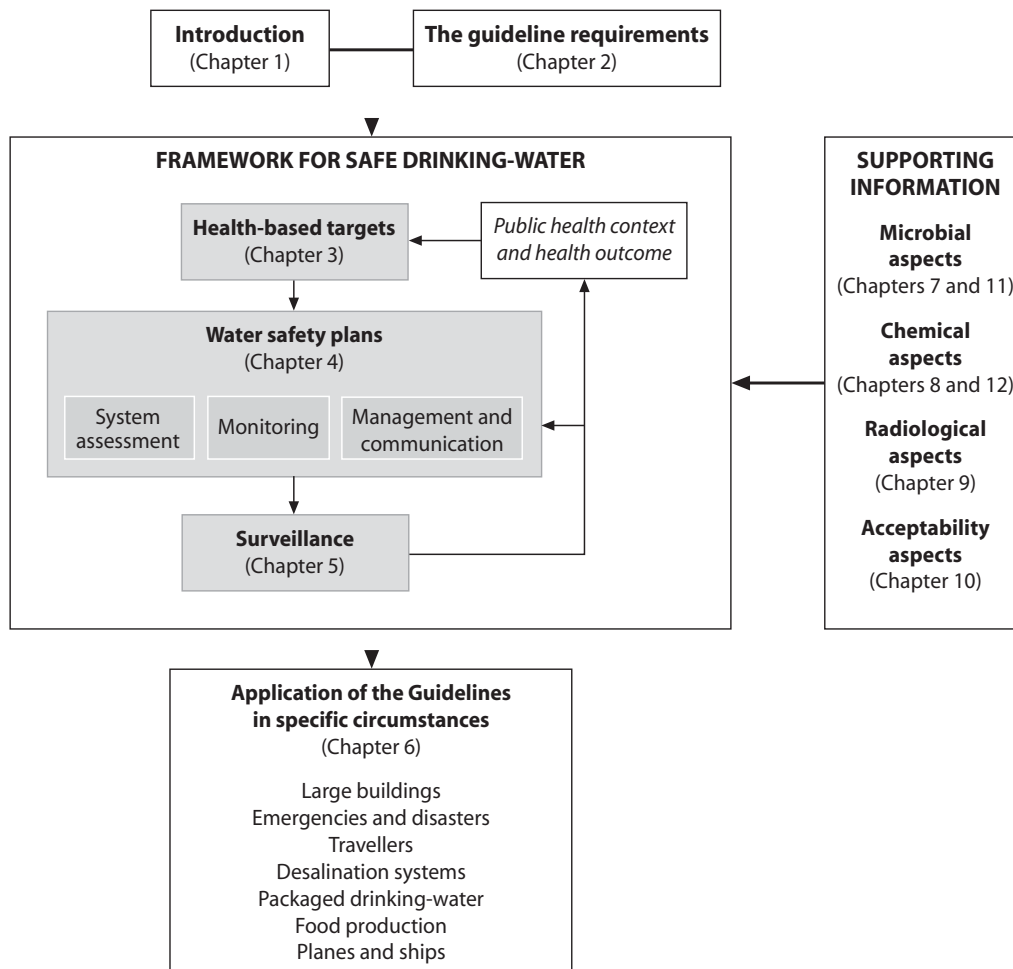
Figure 2.1 Interrelationship of the chapters of the *Guidelines for Drinking-water Quality* in ensuring drinking-water safety

which limits early warning capability and affordability. Reliance on water quality determination alone is insufficient to protect public health. As it is neither physically nor economically feasible to test for all drinking-water quality parameters, the use of monitoring effort and resources should be carefully planned and directed at significant or key characteristics.

Some characteristics not related to health, such as those with significant impacts on acceptability of water, may also be of importance. Where water has unacceptable aesthetic characteristics (e.g., appearance, taste and odour), further investigation may be required to determine whether there are problems with significance for health.

The control of the microbial and chemical quality of drinking-water requires the development of management plans, which, when implemented, provide the basis for system protection and process control to ensure that numbers of pathogens and concentrations of chemicals present a negligible risk to public health and that water is acceptable to consumers. The management plans developed by water suppliers are

best termed "water safety plans" (WSPs). A WSP comprises system assessment and design, operational monitoring and management plans, including documentation and communication. The elements of a WSP build on the multiple-barrier principle, the principles of hazard analysis and critical control points (HACCP) and other systematic management approaches. The plans should address all aspects of the drinking-water supply and focus on the control of abstraction, treatment and delivery of drinking-water.

Many drinking-water supplies provide adequate safe drinking-water in the absence of formalized WSPs. Major benefits of developing and implementing a WSP for these supplies include the systematic and detailed assessment and prioritization of hazards and the operational monitoring of barriers or control measures. In addition, a WSP provides for an organized and structured system to minimize the chance of failure through oversight or lapse of management and for contingency plans to respond to system failures or unforeseen hazardous events.

2.1.1 Health-based targets

Health-based targets are an essential component of the drinking-water safety framework. They should be established by a high-level authority responsible for health in consultation with others, including water suppliers and affected communities. They should take account of the overall public health situation and contribution of drinking-water quality to disease due to waterborne microbes and chemicals, as a part of overall water and health policy. They must also take account of the importance of ensuring access to water, especially among those who are not served.

Health-based targets provide the basis for the application of the Guidelines to all types of drinking-water supply. Constituents of drinking-water may cause adverse health effects from single exposures (e.g., microbial pathogens) or long-term exposures (e.g., many chemicals). Due to the range of constituents in water, their mode of action and the nature of fluctuations in their concentration, there are four principal types of health-based targets used as a basis for identifying safety requirements:

- *Health outcome targets:* In some circumstances, especially where waterborne disease contributes to a measurable burden, reducing exposure through drinking-water has the potential to appreciably reduce overall risks of disease. In such circumstances, it is possible to establish a health-based target in terms of a quantifiable reduction in the overall level of disease. This is most applicable where adverse effects follow shortly after exposure, where such effects are readily and reliably monitored and where changes in exposure can also be readily and reliably monitored. This type of health outcome target is primarily applicable to some microbial hazards in developing countries and chemical hazards with clearly defined health effects largely attributable to water (e.g., fluoride). In other circumstances, health outcome targets may be the basis for evaluation of results through quantitative risk assessment models. In these cases, health outcomes are estimated based on information con-

cerning exposure and dose–response relationships. The results may be employed directly as a basis for the specification of water quality targets or provide the basis for development of the other types of health-based targets. Health outcome targets based on information on the impact of tested interventions on the health of real populations are ideal but rarely available. More common are health outcome targets based on defined levels of tolerable risk, either absolute or fractions of total disease burden, preferably based on epidemiological evidence or, alternatively, risk assessment studies.

- *Water quality targets (WQTs):* WQTs are established for individual drinking-water constituents that represent a health risk from long-term exposure and where fluctuations in concentration are small or occur over long periods. They are typically expressed as guideline values (concentrations) of the substances or chemicals of concern.
- *Performance targets:* Performance targets are employed for constituents where short-term exposure represents a public health risk or where large fluctuations in numbers or concentration can occur over short periods with significant health implications. They are typically expressed in terms of required reductions of the substance of concern or effectiveness in preventing contamination.
- *Specified technology targets:* National regulatory agencies may establish targets for specific actions for smaller municipal, community and household drinking-water supplies. Such targets may identify specific permissible devices or processes for given situations and/or for generic drinking-water system types.

It is important that health-based targets are realistic under local operating conditions and are set to protect and improve public health. Health-based targets underpin development of WSPs, provide information with which to evaluate the adequacy of existing installations and assist in identifying the level and type of inspection and analytical verifications that are appropriate.

Most countries apply several types of targets for different types of supply and different contaminants. In order to ensure that they are relevant and supportive, representative scenarios should be developed, including description of assumptions, management options, control measures and indicator systems for verification, where appropriate. These should be supported by general guidance addressing the identification of national, regional or local priorities and progressive implementation, thereby helping to ensure that best use is made of available resources.

Health-based targets are considered in more detail in chapter 3.

2.1.2 System assessment and design

Assessment of the drinking-water system is equally applicable to large utilities with piped distribution systems, piped and non-piped community supplies, including hand pumps, and individual domestic supplies. Assessment can be of existing infrastructure or of plans for new supplies or for upgrading of existing supplies. As drinking-water

quality varies throughout the system, the assessment should aim to determine whether the final quality of water delivered to the consumer will routinely meet established health-based targets. Understanding source quality and changes through the system requires expert input. The assessment of systems should be reviewed periodically.

The system assessment needs to take into consideration the behaviour of selected constituents or groups of constituents that may influence water quality. Having identified and documented actual and potential hazards, including potentially hazardous events and scenarios that may affect water quality, the level of risk for each hazard can then be estimated and ranked, based on the likelihood and severity of the consequences.

Validation is an element of system assessment. It is undertaken to ensure that the information supporting the plan is correct and is concerned with the assessment of the scientific and technical inputs into the WSP. Evidence to support the WSP can come from a wide variety of sources, including scientific literature, trade associations, regulation and legislation departments, historical data, professional bodies and supplier knowledge.

If the system is theoretically capable of meeting the health-based targets, the WSP is the management tool that will assist in actually meeting the health-based targets, and it should be developed following the steps outlined in subsequent sections. If the system is unlikely to be capable of meeting the health-based targets, a programme of upgrading (which may include capital investment or training) should be initiated to ensure that the drinking-water supply would meet the targets. In the interim, every effort should be made to supply water of the highest achievable quality. Where a significant risk to public health exists, additional measures may be appropriate.

Assessment and design are considered in more detail in section 4.1 (see also the supporting document *Upgrading Water Treatment Plants*; section 1.3).

2.1.3 Operational monitoring

Control measures are actions implemented in the drinking-water system that prevent, reduce or eliminate contamination and are identified in system assessment. They include, for example, catchment management actions, the plinth surrounding a well, filters and disinfection infrastructure and piped distribution systems. If collectively operating properly, they would ensure that health-based targets are met.

Operational monitoring is the conduct of planned observations or measurements to assess whether the control measures in a drinking-water system are operating properly. It is possible to set limits for control measures, monitor those limits and take corrective action in response to a detected deviation before the water becomes unsafe. Examples of limits are that the plinth surrounding a hand pump is complete and not damaged, the turbidity of water following filtration is below a certain value or the chlorine residual after disinfection plants or at the far point of the distribution system is above an agreed value.

The frequency of operational monitoring varies with the nature of the control measure – for example, checking plinth integrity monthly to yearly, monitoring turbidity on-line or very frequently and monitoring disinfection residual at multiple points daily or continuously on-line. If monitoring shows that a limit does not meet specifications, then there is the potential for water to be, or to become, unsafe. The objective is timely monitoring of control measures, with a logically based sampling plan, to prevent the delivery of potentially unsafe water.

In most cases, operational monitoring will be based on simple and rapid observations or tests, such as turbidity or structural integrity, rather than complex microbial or chemical tests. The complex tests are generally applied as part of validation and verification activities (discussed in sections 4.1.7 and 4.3, respectively) rather than as part of operational monitoring.

In order not only to have confidence that the chain of supply is operating properly, but to confirm that water quality is being maintained and achieved, it is necessary to carry out verification, as outlined in section 2.2.

The use of indicator bacteria in monitoring of water quality is discussed in the supporting document *Assessing Microbial Safety of Drinking Water* (section 1.3), and operational monitoring is considered in more detail in section 4.2.

2.1.4 *Management plans, documentation and communication*

A management plan documents system assessment and operational monitoring and verification plans and describes actions in both normal operation and during "incidents" where a loss of control of the system may occur. The management plan should also outline procedures and other supporting programmes required to ensure optimal operation of the drinking-water system.

As the management of some aspects of the drinking-water system often falls outside the responsibility of a single agency, it is essential that the roles, accountabilities and responsibilities of the various agencies involved be defined in order to coordinate their planning and management. Appropriate mechanisms and documentation should therefore be established for ensuring stakeholder involvement and commitment. This may include establishing working groups, committees or task forces, with appropriate representatives, and developing partnership agreements, including for example signed memoranda of understanding (see also section 1.2).

Documentation of all aspects of drinking-water quality management is essential. Documents should describe activities that are undertaken and how procedures are performed. They should also include detailed information on:

— assessment of the drinking-water system (including flow diagrams and potential hazards and the outcome of validation);
— control measures and operational monitoring and verification plan;
— routine operation and management procedures;

27

— incident and emergency response plans; and
— supporting measures, including:
    — training programmes
    — research and development
    — procedures for evaluating results and reporting
    — performance evaluations, audits and reviews
    — communication protocols
    — community consultation.

Documentation and record systems should be kept as simple and focused as possible. The level of detail in the documentation of procedures should be sufficient to provide assurance of operational control when coupled with a suitably qualified and competent operator.

Mechanisms should be established to periodically review and, where necessary, revise documents to reflect changing circumstances. Documents should be assembled in a manner that will enable any necessary modifications to be made easily. A document control system should be developed to ensure that current versions are in use and obsolete documents are discarded.

Appropriate documentation and reporting of incidents or emergencies should also be established. The organization should learn as much as possible from an incident to improve preparedness and planning for future events. Review of an incident may indicate necessary amendments to existing protocols.

Effective communication to increase community awareness and knowledge of drinking-water quality issues and the various areas of responsibility helps consumers to understand and contribute to decisions about the service provided by a drinking-water supplier or land use constraints imposed in catchment areas. A thorough understanding of the diversity of views held by individuals or groups in the community is necessary to satisfy community expectations.

Management, documentation and communication are considered in more detail in sections 4.4, 4.5 and 4.6.

2.1.5 Surveillance of drinking-water quality
The surveillance agency is responsible for an independent (external) and periodic review of all aspects of safety, whereas the water supplier is responsible at all times for regular quality control, for operational monitoring and for ensuring good operating practice.

Surveillance contributes to the protection of public health by assessing compliance with WSPs and promoting improvement of the quality, quantity, accessibility, coverage, affordability and continuity of drinking-water supplies.

Surveillance requires a systematic programme of surveys that may include auditing of WSPs, analysis, sanitary inspection and institutional and community aspects. It should cover the whole of the drinking-water system, including sources and activ-

ities in the catchment, transmission infrastructure, whether piped or unpiped, treatment plants, storage reservoirs and distribution systems.

Since incremental improvement and prioritizing action in systems presenting greatest overall risk to public health are important, there are advantages to adopting a grading scheme for the relative safety of drinking-water supplies (see chapter 4). More sophisticated grading schemes may be of particular use in community supplies where the frequency of testing is low and exclusive reliance on analytical results is particularly inappropriate. Such schemes will typically take account of both analytical findings and sanitary inspection through approaches such as those presented in section 4.1.2.

The role of surveillance is discussed in section 1.2.1 and chapter 5.

2.2 Guidelines for verification

Drinking-water safety is secured by application of a WSP, which includes monitoring the efficiency of control measures using appropriately selected determinants. In addition to this operational monitoring, a final verification of quality is required.

Verification is the use of methods, procedures or tests in addition to those used in operational monitoring to determine if the performance of the drinking-water supply is in compliance with the stated objectives outlined by the health based targets and/or whether the WSP needs modification and revalidation.

2.2.1 Microbial water quality

For microbial water quality, verification is likely to include microbiological testing. In most cases, it will involve the analysis of faecal indicator microorganisms, but in some circumstances it may also include assessment of specific pathogen densities. Verification of the microbial quality of drinking-water may be undertaken by the supplier, surveillance agencies or a combination of the two (see sections 4.3.1 and 7.4).

Approaches to verification include testing of source water, water immediately after treatment, water in distribution systems or stored household water. Verification of the microbial quality of drinking-water includes testing for *Escherichia coli* as an indicator of faecal pollution. *E. coli* provides conclusive evidence of recent faecal pollution and should not be present in drinking-water. In practice, testing for thermotolerant coliform bacteria can be an acceptable alternative in many circumstances. While *E. coli* is a useful indicator, it has limitations. Enteric viruses and protozoa are more resistant to disinfection; consequently, the absence of *E. coli* will not necessarily indicate freedom from these organisms. Under certain circumstances, it may be desirable to include more resistant microorganisms, such as bacteriophages and/or bacterial spores. Such circumstances could include the use of source water known to be contaminated with enteric viruses and parasites or high levels of viral and parasitic diseases in the community.

Water quality can vary rapidly, and all systems are subject to occasional failure. For example, rainfall can greatly increase the levels of microbial contamination in source

29

waters, and waterborne outbreaks often occur following rainfall. Results of analytical testing must be interpreted taking this into account.

2.2.2 Chemical water quality

Assessment of the adequacy of the chemical quality of drinking-water relies on comparison of the results of water quality analysis with guideline values.

For additives (i.e., chemicals deriving primarily from materials and chemicals used in the production and distribution of drinking-water), emphasis is placed on the direct control of the quality of these products. In controlling drinking-water additives, testing procedures typically assess the contribution of the additive to drinking-water and take account of variations over time in deriving a value that can be compared with the guideline value (see section 8.5.4).

As indicated in chapter 1, most chemicals are of concern only with long-term exposure; however, some hazardous chemicals that occur in drinking-water are of concern because of effects arising from sequences of exposures over a short period. Where the concentration of the chemical of interest varies widely, even a series of analytical results may fail to fully identify and describe the public health risk (e.g., nitrate, which is associated with methaemoglobinaemia in bottle-fed infants). In controlling such hazards, attention must be given to both knowledge of causal factors such as fertilizer use in agriculture and trends in detected concentrations, since these will indicate whether a significant problem may arise in the future. Other hazards may arise intermittently, often associated with seasonal activity or seasonal conditions. One example is the occurrence of blooms of toxic cyanobacteria in surface water.

A *guideline value* represents the concentration of a constituent that does not exceed tolerable risk to the health of the consumer over a lifetime of consumption. Guidelines for some chemical contaminants (e.g., lead, nitrate) are set to be protective for susceptible subpopulations. These guidelines are also protective of the general population over a lifetime.

The exceedance of a guideline value does not necessarily result in a significant risk to health. Therefore, deviations above the guideline values in either the short or long term do not necessarily mean that the water is unsuitable for consumption. The amount by which, and the period for which, any guideline value can be exceeded without affecting public health depends upon the specific substance involved. However, exceedance should be a signal:

— as a minimum, to investigate the cause with a view to taking remedial action as necessary; and
— to consult with, and seek advice from, the authority responsible for public health.

When a guideline value is exceeded, it is recommended that the authority responsible for public health be consulted for advice on suitable action, taking into account the intake of the substance from sources other than drinking-water, the toxicity of the substance, the likelihood and nature of any adverse effects and the practicality of

remedial measures. In applying the guideline values, an important consideration is that unless there are appropriate alternative supplies available, maintenance of adequate quantities of water is a high priority. The use of the Guidelines in emergencies is considered in more detail in section 6.2.

It is important that recommended guideline values are both practical and feasible to implement as well as protective of public health. Guideline values are not normally set at concentrations lower than the detection limits achievable under routine laboratory operating conditions. Moreover, guideline values are established taking into account available techniques for controlling, removing or reducing the concentration of the contaminant to the desired level. In some instances, therefore, *provisional* guideline values have been set for contaminants for which there is some uncertainty in available information or calculated guideline values are not practically achievable.

2.3 National drinking-water policy

2.3.1 Laws, regulations and standards

The aim of national drinking-water laws and standards should be to ensure that the consumer enjoys safe potable water, not to shut down deficient water supplies.

Effective control of drinking-water quality is supported ideally by adequate legislation, standards and codes and their enforcement. The precise nature of the legislation in each country will depend on national, constitutional and other considerations. It will generally outline the responsibility and authority of a number of agencies and describe the relationship between them, as well as establish basic policy principles (e.g., water supplied for drinking-water should be safe). The national regulations, adjusted as necessary, should be applicable to all water supplies. This would normally embody different approaches to situations where formal responsibility for drinking-water quality is assigned to a defined entity and situations where community management prevails.

Legislation should make provision for the establishment and amendment of drinking-water quality standards and guidelines, as well as for the establishment of regulations for the development and protection of drinking-water sources and the treatment, maintenance and distribution of safe drinking-water.

Legislation should establish the legal functions and responsibilities of the water supplier and would generally specify that the water supplier is legally responsible at all times for the quality of the water sold and/or supplied to the consumer and for the proper supervision, inspection, maintenance and safe operation of the drinking-water system. It is the water supplier that actually provides water to the public – the "consumer" – and that should be legally responsible for its quality and safety. The supplier is responsible for continuous and effective quality assurance and quality control of water supplies, including inspection, supervision, preventive maintenance, routine testing of water quality and remedial actions as required. However, the supplier is normally responsible for the quality of the water only up to a defined point in the distribution system and may not have responsibility for deterioration of water quality

as a result of poor plumbing or unsatisfactory storage tanks in households and buildings.

Where consecutive agencies manage water – for example, a drinking-water wholesaler, a municipal water supplier and a local water distribution company – each agency should carry responsibility for the quality of the water arising from its actions.

Legal and organizational arrangements aimed at ensuring compliance with the legislation, standards or codes of practice for drinking-water quality will normally provide for an independent surveillance agency, as outlined in section 1.2.1 and chapter 5. The legislation should define the duties, obligations and powers of the water surveillance agency. The surveillance agency should preferably be represented at the national level and should operate at national, regional and local levels. The surveillance agency should be given the necessary powers to administer and enforce laws, regulations, standards and codes concerned with water quality. It should also be able to delegate those powers to other specified agencies, such as municipal councils, local health departments, regional authorities and qualified, government-authorized private audit or testing services. Its responsibilities should include the surveillance of water quality to ensure that water delivered to the consumer, through either piped or non-piped distribution systems, meets drinking-water supply service standards; approving sources of drinking-water; and surveying the provision of drinking-water to the population as a whole. There needs to be a high level of knowledge, training and understanding in such an agency in order that drinking-water supply does not suffer from inappropriate regulatory action. The surveillance agency should be empowered by law to compel water suppliers to recommend the boiling of water or other measures when microbial contamination that could threaten public health is detected.

Implementation of programmes to provide safe drinking-water should not be delayed because of a lack of appropriate legislation. Even where legally binding guidelines or standards for drinking-water have yet to be promulgated, it may be possible to encourage, and even enforce, the supply of safe drinking-water through educational efforts or commercial, contractual arrangements between consumer and supplier (e.g., based on civil law) or through interim measures, including health, food or welfare legislation, for example.

Drinking-water quality legislation may usefully provide for interim standards, permitted deviations and exemptions as part of a national or regional policy, rather than as a result of local initiatives. This can take the form of temporary exemptions for certain communities or areas for defined periods of time. Short- and medium-term targets should be set so that the most significant risks to human health are controlled first.

2.3.2 Setting national standards

In countries where universal access to safe drinking-water at an acceptable level of service has not been achieved, policy should refer to expressed targets for increases in

access. Such policy statements should be consistent with achievement of the Millennium Development Goals (http://www.developmentgoals.org/) of the United Nations (UN) Millennium Declaration and should take account of levels of acceptable access outlined in General Comment 15 on the Right to Water of the UN Committee on Economic, Social and Cultural Rights (http://www.unhchr.ch/html/menu2/6/cescr.htm) and associated documents.

In developing national drinking-water standards based on these Guidelines, it will be necessary to take account of a variety of environmental, social, cultural, economic, dietary and other conditions affecting potential exposure. This may lead to national standards that differ appreciably from these Guidelines. A programme based on modest but realistic goals – including fewer water quality parameters of priority health concern at attainable levels consistent with providing a reasonable degree of public health protection in terms of reduction of disease or reduced risk of disease within the population – may achieve more than an overambitious one, especially if targets are upgraded periodically.

The authority to establish and revise drinking-water standards, codes of practice and other technical regulations should be delegated to the appropriate government minister – preferably the minister of health – who is responsible for ensuring the safety of water supplies and the protection of public health. The authority to establish and enforce quality standards and regulations may be vested in a ministry other than the one usually responsible for public and/or environmental health. Consideration should then be given to requiring that regulations and standards are promulgated only after approval by the public health or environmental health authority so as to ensure their conformity with health protection principles.

Drinking-water supply policy should normally outline the requirements for protection of water sources and resources, the need for appropriate treatment, preventive maintenance within distribution systems and requirements to support maintaining water safety after collection from communal sources.

The basic water legislation should not specify sampling frequencies but should give the administration the power to establish a list of parameters to be measured and the frequency and location of such measurements.

Standards and codes should normally specify the quality of the water to be supplied to the consumer, the practices to be followed in selecting and developing water sources and in treatment processes and distribution or household storage systems, and procedures for approving water systems in terms of water quality.

Setting national standards should ideally involve consideration of the quality of the water, the quality of service, "target setting" and the quality of infrastructure and systems, as well as enforcement action. For example, national standards should define protection zones around water sources, minimum standard specifications for operating systems, hygiene practice standards in construction and minimum standards for health protection. Some countries include these details in a "sanitary code" or "code of good practice." It is preferable to include in regulations the requirement to consult

with drinking-water supply agencies and appropriate professional bodies, since doing so makes it more likely that drinking-water controls will be implemented effectively.

The costs associated with drinking-water quality surveillance and control should be taken into account in developing national legislation and standards.

To ensure that standards are acceptable to consumers, communities served, together with the major water users, should be involved in the standards-setting process. Public health agencies may be closer to the community than those responsible for its drinking-water supply. At a local level, they also interact with other sectors (e.g., education), and their combined action is essential to ensure active community involvement.

Other ministries, such as those responsible for public works, housing, natural resources or the environment, may administer normative and regulatory functions concerned with the design of drinking-water supply and waste disposal systems, equipment standards, plumbing codes and rules, water allocation, natural resource protection and conservation and waste collection, treatment and disposal.

2.4 Identifying priority drinking-water quality concerns

These Guidelines cover a large number of potential constituents in drinking-water in order to meet the varied needs of countries worldwide. Generally, only a few constituents will be of concern under any given circumstances. It is essential that the national regulatory agency and local water authorities determine and respond to the constituents of relevance. This will ensure that efforts and investments can be directed to those constituents that are of public health significance.

Guidelines are established for potentially hazardous water constituents and provide a basis for assessing drinking-water quality. Different parameters may require different priorities for management to improve and protect public health. In general, the order of priority is to:

— ensure an adequate supply of microbiologically safe water and maintain acceptability to discourage consumers from using potentially less microbiologically safe water;
— manage key chemical contaminants known to cause adverse health effects; and
— address other chemical contaminants.

Priority setting should be undertaken on the basis of a systematic assessment based on collaborative effort among all relevant agencies and may be applied at national and system-specific levels. It may require the formation of a broad-based interagency committee including authorities such as health, water resources, drinking-water supply, environment, agriculture and geological services/mining to establish a mechanism for sharing information and reaching consensus on drinking-water quality issues.

Sources of information that should be considered in determining priorities include catchment type (protected, unprotected), geology, topography, agricultural land use,

industrial activities, sanitary surveys, records of previous monitoring, inspections and local and community knowledge. The wider the range of data sources used, the more useful the results of the process will be. In many situations, authorities or consumers may have already identified a number of drinking-water quality problems, particularly where they cause obvious health effects or acceptability problems. These existing problems would normally be assigned a high priority.

2.4.1 Assessing microbial priorities

The most common and widespread health risk associated with drinking-water is microbial contamination, the consequences of which mean that its control must always be of paramount importance. Priority needs to be given to improving and developing the drinking-water supplies that represent the greatest public health risk.

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Microbial contamination of major urban systems has the potential to cause large outbreaks of waterborne disease. Ensuring quality in such systems is therefore a priority. Nevertheless, the majority (around 80%) of the global population without access to improved drinking-water supplies resides in rural areas. Similarly, small and community supplies in most countries contribute disproportionately to overall drinking-water quality concerns. Identifying local and national priorities should take factors such as these into account.

Health-based targets for microbial contaminants are discussed in section 3.2, and a comprehensive consideration of microbial aspects of drinking-water quality is contained in chapter 7.

2.4.2 Assessing chemical priorities

Not all of the chemicals with guideline values will be present in all water supplies or, indeed, all countries. If they do exist, they may not be found at levels of concern. Conversely, some chemicals without guideline values or not addressed in the Guidelines may nevertheless be of legitimate local concern under special circumstances.

Risk management strategies (as reflected in national standards and monitoring activities) and commitment of resources should give priority to those chemicals that pose a risk to human health or to those with significant impacts on acceptability of water.

Only a few chemicals have been shown to cause widespread health effects in humans as a consequence of exposure through drinking-water when they are present in excessive quantities. These include fluoride and arsenic. Human health effects have also been demonstrated in some areas associated with lead (from domestic plumbing), and there is concern because of the potential extent of exposure to selenium and uranium in some areas at concentrations of human health significance. Iron and

manganese are of widespread significance because of their effects on acceptability. These constituents should be taken into consideration as part of any priority-setting process. In some cases, assessment will indicate that no risk of significant exposure exists at the national, regional or system level.

Drinking-water may be only a minor contributor to the overall intake of a particular chemical, and in some circumstances controlling the levels in drinking-water, at potentially considerable expense, may have little impact on overall exposure. Drinking-water risk management strategies should therefore be considered in conjunction with other potential sources of human exposure.

The process of "short-listing" chemicals of concern may initially be a simple classification of high and low risk to identify broad issues. This may be refined using data from more detailed assessments and analysis and may take into consideration rare events, variability and uncertainty.

Guidance is provided in the supporting document *Chemical Safety of Drinking-water* (section 1.3) on how to undertake prioritization of chemicals in drinking-water. This deals with issues including:

— the probability of exposure (including the period of exposure) of the consumer to the chemical;
— the concentration of the chemical that is likely to give rise to health effects (see also section 8.5); and
— the evidence of health effects or exposure arising through drinking-water, as opposed to other sources, and relative ease of control of the different sources of exposure.

Additional information on the hazards and risks of many chemicals not included in these Guidelines is available from several sources, including WHO Environmental Health Criteria monographs (EHCs) and Concise International Chemical Assessment Documents (CICADs) (http://www.who.int/pcs/index.htm), reports by the Joint FAO/WHO Meeting on Pesticide Residues (JMPR) and Joint FAO/WHO Expert Committee on Food Additives (JECFA) and information from competent national authorities, such as the US Environmental Protection Agency (US EPA) (www.epa.gov/waterscience). These information sources have been peer reviewed and provide readily accessible information on toxicology, hazards and risks of many less common contaminants. They can help water suppliers and health officials to decide upon the significance (if any) of a detected chemical and on the response that might be appropriate.