KINGDOM OF CAMBODIA

NATION RELIGION KING

MINISTRY OF INDUSTRY MINES AND ENERGY

DRINKING WATER QUALITY STANDARDS

JANUARY, 2004

Drinking Water Quality Standards

Preface

The Task Force on Drinking Water Quality Standards prepared these standards with guidance from the World Health Organization and the Advisory Panel of specialists. The standards were based on the latest WHO drinking water quality guidelines (2003) and those of other countries with particular adaptation to the water quality problems in Cambodia. Several local and international agencies provided guidance and data on the important parameters and frequency to be monitored. The DWS was reviewed through an inter-ministerial and inter-agency consultation among the sectors from water authorities, rural development, health, environment, water resources, private, academe, and NGO last June 12-13, 2003. A seminar-workshop to initiate the process of developing drinking water standards was also held on June 24-25, 2002.

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1. Introduction

The Royal Government of Cambodia has established a comprehensive policy on National Water Supply and Sanitation, covering both urban and rural water supplies. Based on this policy and to ensure access to safe drinking water to all people, it required the Drinking Water Quality Standard (DWS) for Cambodia. These standards are developed by an inter-ministerial process initiated by Ministry of Industry, Mines and Energy and concerned ministries with support from the World Health Organization.

Drinking water should be clean and clear with pleasant taste and odor. The public will assess drinking water quality using these aesthetic indicators but actually the safety of water is determined by microbiological, physical, and chemical quality. It should be safe so that it does not contain suspended matter, harmful chemical substances, and disease causing microorganisms. Microbiological quality is most important and is a priority for monitoring.

Using a risk-based approach and taking into consideration local environmental, social, economic and cultural conditions, the Drinking Water Quality Standards (DWS) were developed to make sure that the people are protected from water-related and water-borne diseases in Cambodia. In general, the greatest microbial risks are associated with ingestion of water that is contaminated with human and animal excreta.

The aim of these standards are to ensure that drinking water will be safe in the future, that there are no health risks to the public, to serve as a basis for the design and planning of water supply treatment, and to provide a benchmark for assessing long-term trends in the performance of the water supply system. They should be used along with sanitary surveys and barriers to prevent contamination of water supplies.

United Nations Committee on Economic, Cultural and Social Rights, 2002

"Water is fundamental for life and health. The human right to water is indispensable for leading a healthy life in human dignity. Water, like health, is an essential element for achieving other human rights, especially the rights to adequate food and nutrition, housing and education.

2. Definition of terms

Terms	Definition
Coliforms, fecal	Subgroup of coliform bacteria associated with fecal contamination from warm-blooded animals. Can fennent lactose at 44.5 T during analysis. Also known as thermotolerant coliforms.
Coliforms, total	Both fecal and non-fecal bacteria from humans, animals, and decayed organic matter that are able to ferment lactose at either 35 or 37'C within 24-48 hours.
Disinfecting	Treatment of water to inactivate disease-causing microorganisms using chlorine, chlorine dioxide, chloramines, ultraviolet radiation, ozone, or other disinfectant. Boiling is popular at household level.
Disinfection by-products (DBPs)	Carcinogenic DBPs are formed by the reaction of excess disinfectant chlorine with organic substances found in water, especially surface water
Drinking water	Water that is suitable for human consumption such as drinking and cooking.
Escherichia coli (E. coli)	Indicator of pathogenic bacteria found in human intestines Grab sample. A one-time sample collected using a dipper or bottle and represents the concentration of water at that particular time and place.
Groundwater	Any water found beneath the surface of the ground in rock crevices and in the pores of geologic materials.
Helminth	Worm found in the intestines especially in children
Inorganic parameters	Non-carbon based chemicals such as arsenic, cadmium, iron
mg/L (ppm)	Milligram per liter - concentration at which one thousandth of a gram(1/1000) is found in a volume of one liter; it is approximately equal to the unit parts per million (ppm) in very dilute solutions.
pg/L (ppb)	Microgram per liter – mg/L divided by 1000, approximately equal to the unit parts per billion (ppb) in very dilute solutions
Monitoring	Routine collection of water samples for analysis to determine water quality, usually, usually done by water supplier.
Nephelometric Turbidity Unit (NTU)	A measure of the turbidity (cloudiness) of water as measured by a nephelometer
Organic parameters	Carbon-based chemicals such as pesticides

Pathogens	Disease-causing microorganisms such as bacteria, protozoa, algae, helminths and viruses found in water
Pesticides	Agricultural chemicals used to eradicate or control pests such as insects, weeds, snails, rodents, and mites.
pH	A measure of acidity (low pH) or alkalinity (high pH) of water with a neutral value of 7.
Physical parameters	Characteristics of water that can be detected by the senses including taste, odor, color and turbidity.
Raw water	Untreated, un-disinfected surface water or groundwater
Residual Chlorine	Excess chlorine in treated water, usually between 0.2 to 0.5 mg/L, which indicates sufficiency of chlorination and an assurance of protection from pathogens.
Sanitary inspection	Onsite inspection of a community or facility to identify the hazards associates with water supply. Usually includes water sampling and analysis.
Sanitary survey	An evaluation of the physical environment to identify existing and potential sources of health hazards and environmental contamination that may affect water supply and community health.
Surface water	Freshwater on the Earth's surface, such as stream, river, lake, pond or reservoir.
Surveillance	Process of checking if monitoring of drinking water supplies conforms to the standards. Usually conducted by government authority and may include sanitary inspection, water monitoring, data processing, and report.
Thermotolerant coliforms	Also known as fecal coliforms, which can grow at 44-45 T. Indicator of fecal contaminations as well as efficiency of water treatment and bacterial removal.
Trihalomethanes (THM)	The main DBPs produced in highest concentrations. Formed by reaction of excessive chlorine in water with naturally occurring organic substances.
True Color Unit (TCU)	Measure of color of filtered water sample that could come from iron or dissolved organic substances, also quoted in Hazen unit.
Turbidity	Characteristics of cloudiness of water. The amount of solid particles that are suspended in water that can cause scattering of light. Low turbidity is essential for effective disinfection.
Virus	Smallest of all infectious agents especially those that multiply in the human intestine and excreted in the feces.
Water quality	A description of the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose, such as for drinking.

Water quality standard	A level for a water constituent which does not result in significant health risk and which ensures acceptability of the water to consumers.
Well (water)	A tube well or dug hole put down for the purpose of withdrawing water from the ground. Sometimes fitted with a pump (could be manual or motorized).

3. General clauses

3.1 Mandate

The relevant government regulatory agencies shall make sure that all drinking waters delivered to the population will comply with these standards. The drinking water quality standards shall be referred hereto as DWS.

The DWS will be reviewed every 5 years in order to accommodate changes in knowledge of the risk posed by various chemical and microbial constituents of water as well as the capacity to respond to water quality risks.

3.2 Scope of the DWS

The DWS are applicable as the minimum requirement to all sources of drinking water in both urban and rural areas, public or private water supply regardless of its source including groundwater, surface water, rainwater, intended for human consumption. There are separate standards for bottled/packaged water of non-mineral, natural mineral waters and other beverages from the Industrial Standard of Cambodia (ISC) based on Codex Alimentarius.

3.3 The point of use (POU)

The DWS shall be applied in water treatment plants, in the distribution network, at the tap, and in community sources. Samples shall be taken from all these points at specified frequency.

4. Table of parameters and concentrations (TPC)

In the selection of the parameters and their concentrations, the following were considered in Cambodia: resources, water quality, epidemiological data, industrial activity, pesticides usage and imports, cultural habits, and climate. The drinking water quality standards are in Tables I to 5. In Table I are indicators of microbial contamination of water to indicate presence of from bacteria, protozoa, viruses and helminths**.** Table 2 provides inorganic constituents such as heavy metals of health significance**.** Table 3 lists the organic constituents of health significance to drinking water while Table 4 contains the physical and chemical quality that may rise to consumer complaints if exceeded. Table 5 provides the priority parameters to be monitored in small water supplies. The maximum values of the standards shall not be exceeded to assure protection of the public drinking water.

It should be noted that some of the DWS differ from WHO guideline values. These differences were carefully noted and debated during the development of these Standards. In particular, the Arsenic standard of 50 ppb is higher than the WHO guideline value of 10 ug/l. The higher level of 50 ug/l was selected in recognition of several key facts: 1) it will be very difficult and costly to monitor and enforce a standard of 10 ug/l in Cambodia at the present time; 2) the potential health risk of ingesting water with arsenic levels between 10 and 50 ug/l is low relative to the risk posed by water with bacteriological contamination, and more attention should be placed on monitoring and enforcing the latter standard in Cambodia; and 3)) other countries in the region are using 50 ppb as their standard. It was concluded that while 10 [ug/l may be a desirable long-term goal for arsenic in drinking water, it was an impracticable level to use in Cambodia at the present time.

All water supply systems should be tested for water quality parameters set out in Tables I through 4 prior to commissioning to ensure compliance with DWS. Small water supply systems (those serving less than 100 people or delivering less than 10 m3 /day) should be tested for priority parameters set out in Table 5,

Table 1 **Bacteriological quality for drinking water**

Parameter	**Maximum Value**
Thermotolerant (Fecal) Coliforms or E. coli	*0* per 100 mL
Total coliforms	0 per 100 ml,

Table 2 Inorganic constituents of health significance in drinking water

Parameter	**Maximum Value* mg/11-, (ppm)**
Arsenic	0.05
Barium	0.7
Cadmium	0.003
Chromium	0.05
Cyanide	0.07
Fluoride	1.5
Lead	0.01
Mercury	0.001
Nickel	0.02
Nitrate as N03-	50
Nitrite as N02-	3
Selenium	0.01

* For very low concentrations, laboratory results are reported in [tg/L or ppb. Note the conversion: I mg/L (pprn) = 1000 ug/L (ppb)

Table 3 Organic constituents of health significance to drinking water

Parameter*	**Maximum Value" <u>ug/L (ppb)</u>**
Polychlorinated biphenyls (PCBs)	0.5
Benzene	10
<u>Disinfection-by-product</u>	
Trihalomethanes	250
<u>Pesticides</u>	
2,4 D	30
Aldrin and Dieldrin	0.3
Carbofuran	10
Chlordane	0.2
DDT	20
Dichlorvos	I
Dirnethoate	6

Endosulfan	30
Endrin	0.6
Glyphosate	10
Heptachlor	0.3
Hexaclorobenzene	I
Methyl parathion	0.3
Mevinphos	5
Monocrotophos	I
Paraquat	30
Parathion	10
Permethrin	20

*Routine monitoring for organic constituents (Table 3) is not required unless there is a potential for contamination of water supplies.

"For very low concentration, laboratory results are reported in ug/L or ppb. Note the conversion: I mg/L (ppm) = 1000 ug/L (ppb)

Table 4 Physical and chemical quality: aesthetic quality

Parameter	Maximum Value, mg/1L
Taste	Acceptable
Odor	Acceptable
Color	5 TCU
Turbidity	5 NTU
Residual chlorine	0.2-0.5
pH	6.5 - 8.5 (no unit)
Aluminum	0.2
Ammonia	1.5
Chloride	250
Copper	I
Hardness*	300
Hydrogen Sulfide	0.05
Iron	0.3
Manganese	0.1
Sodium	200
Sulfate	250
Total dissolved solids**	800
Zinc	3

* Hardness is expressed as mg/L CaC03

"Conductivity (uS/cm) can also be measured and it is roughly equivalent to twice the TDS value.

Table 5: Priority parameters in small water supplies

Parameter*	Maximum Value
pH	6.5-8.5
Turbidity	5 NTU
Arsenic	0.05 mg/L
Iron	0.3 mg/L
Total Dissolved Solids (TDS)	800 mg/L
Thermotolerant Coliforms or **E. coli**	0 per 100 mL

*Additional parameters such as conductivity can be monitored but these are the minimum requirements.

5. Timing and frequency of sampling

The most important technique for ensuring that drinking water does not contain contaminants at concentrations to affect health is monitoring. However, monitoring is costly and the resources required such as personnel, portable equipment, transport, and laboratory should be considered with care.

Inspectorates within the relevant government agencies shall be established to implement the DWS and to carry out the sanitary surveys. The frequencies of sampling for water analysis and visits to water systems for sanitary inspections will depend on:

a) Type of source water (groundwater or surface water)
b) Quality of the source water
c) Number of water sources
d) Treatment the water receives
e) Risks of contamination in various parts of the system
f) Particular type of system
g) Previous history of water quality
h) Size of the population supplied with water.

Grab samples for chemical and physical parameters shall be taken from the source water (lake, pond, river, reservoir, well or spring) and from the distribution system[1]. The distribution system samples shall be taken at the point leaving the system and at the tap. Additional sampling locations may be identified if deemed necessary.

Results of monitoring shall be made known to both the operator of the water supply system and the consumers. When the water analysis showed values exceeding the standards, efforts should be made to find the source of the problem for control and to carry out re-sampling to verify the results.

Due to higher risks to human health compared with aesthetic parameters, the microbiological parameters should have a higher frequency of sampling. Table 6 below shows the various sampling frequency to be followed in these standards while Table 7 presents the minimum frequency and number of samples for microbiological analysis. Residual chlorine, turbidity, pH, and color should be analyzed immediately onsite.

[1] Detailed sampling procedures can be found in Volume of the WHO drinking water quality guidelines

Table 6 Frequency of sampling and analysis of parameters in a water distribution system

Parameter	Frequency
Color, pH, residual chlorine, turbidity, total dissolved solids*	Daily
Arsenic, iron, manganese, nitrates, chloride, sulfate, hardness, aluminum	Quarterly
Inorganic constituents (Table 2)	Once a year
Organic constituents and pesticides (Table 3)	Every 3 years

* Can be measured with conductivity (VS/cm)

Table 7 Minimum sampling frequencies for microbiological analysis

Population Served	**Frequency of sampling**	**Number of Samples**
Less than 5000	Monthly	I sample
5000 - 100 000	Every two weeks	I sample per 5 000 people
More than 100 000	Weekly	I sample per 10 000 people plus additional 10 samples

6. Methods of sampling

6.1 Methods of sampling for bacteriological quality

The sample should be representative of the water under examination. Contamination during collection and before examination should be avoided.

The tap should be cleaned and free from attachments and fully opened with water allowed to run to waste for a sufficient time to permit the flushing/clearing of the service lines. Flaming of the tap is not necessary. Taps with a history of previous contamination may be disinfected with hypochlorite solution (NaOCI 100 mg/L). No samples shall be taken from leaking taps.

Sterilized glass bottles, provided with either ground glass stoppers or plastic screw-caps, should be used for collection of samples. A paper or a thin aluminum foil cover should protect both the stopper and neck of the bottle. For waters that have been chlorinated, bottles containing 0.1 mL of a 3% solution of sodium thiosulfate for every 100 mL of water sample should be used.

The bottle should be kept unopened until it is ready for filling. It should be filled without rinsing and ample space (at least 2.5 cm) must be left for mixing samples. The stopper or cap should be replaced with a protective cover for additional protection.]

6.2 Methods of sampling for physical and chemical analysis

The actual collection of the water sample is a matter of considerable importance. Refer to Table 8 for additional guidance. The following procedures should be observed for sampling:

a) Collect samples from wells only after the well has been pumped sufficiently to ensure that the sample represents the quality of the groundwater that feeds the well. Sometimes it will be necessary to pump at a specified rate to achieve a characteristic drawdown as part of the sample record. New wells will require sufficient utilization and abstraction before sampling. Collect samples from open shallow wells by taking a composite sample(s).

b) When samples are collected from a river or stream, it is best to take a composite sample from three depths (top, middle and bottom). In this way the sample becomes representative. If only a grab or catch sample can be collected, it is best to take in the middle of the stream and at mid-depth.

c) When sampling lakes and reservoirs, which are naturally subjected to considerable variations from normal causes, the choice of location, depth, and frequency of sampling will depend on the local conditions and the purpose of the investigations.

d) Before samples are collected from distribution systems, flush the lines sufficiently to ensure that the sample is representative of the supply, taking into account the diameter and length of the pipe to be flushed and the velocity of flow.

6.3 Sample Size

A one (1) liter sample should suffice for most physical and chemical analyses but it could vary depending on the requirement of the laboratory. However, no attempt should be made to use the sample for microbiological and microscopic examinations because the methods of collection and handling are quite different.

6.4 Sample containers

In all cases, the container should be chosen so that it will not contaminate the sample.

a) Chemically resistant glass (Pyrex), polyethylene, or hard rubber is suitable material for containers. For samples containing organics, avoid plastic containers except those made of fluorinated polymers such as polyfluoroethylene (PTFE).
Glass containers generally are preferred for volatile organics. Sample containers must be carefully cleaned to remove all extraneous surface dirt, thoroughly rinsed with distilled water and drained before use. For glass bottles, rinsing with chromic acid cleaning solution is necessary. An alternative method is with the use of alkaline permanganate solution followed by an oxalic acid solution. For polyethylene bottles, detergents or concentrated hydrochloric acid can be used.

b) Stoppers, caps and plugs should be chosen to resist the attack of material contained in the vessel or container. Cork stoppers wrapped with a relatively inert metal foil are suitable for many samples, or polytetraflouroethylene (PTFE).

c) The sample containers should be such that when filled with the desired amount of sample, space roughly equivalent to I percent of the volumetric capacity of the containers is available for expansion of the liquid.

d) The stoppers closing the sample containers must be fixed in place by wire, tape, or cord to prevent leakage during transit.

e) Sample containers must be properly labeled. A gummed label, or a cardboard or tag securely affixed to the container should be provided with the following information: date and time of sampling, source of sample, point of sampling (designed in sufficient detail to enable anyone to collect a second sample from the identical spot from which the first sample was taken), sampled by (name of collector).

6.5 Sample handling and storage

In general, the shorter the time lapse between collection of a sample and its analysis, the more reliable will be the analytical results.

a) For certain constituents and physical values, immediate analysis in the field is required in order to obtain dependable results, because the composition of the sample may change before it arrives at the laboratory.

b) Changes caused by the growth of organisms may be greatly retarded by keeping the sample in the dark and at a low temperature until it can be analyzed.

c) It is necessary to keep the samples cool or refrigerated. Storage at low temperature (40C) in a cooler is the best way to preserve most samples.

d) Add chemical preservatives to samples only as specified in the analytical methods. Suitable preservative that will not affect the results of the analyses to be made must be selected (See Table 8).

7. Approved analytical methods for analysis

7.1 Field testing using portable kits

Reputable field equipment are acceptable to use in water quality testing but should be supported by the use of sanitary surveys and risk assessment. There are field kits using membrane filtration for bacteriological analysis and are capable of monitoring thennotolerant coliforms (fecal). Presence/absence tests for microbiological quality can also be used especially in small water supplies. Priority parameters such as residual chlorine (where chlorination was used), turbidity, pH, color, conductivity, and total dissolved solids should be analyzed onsite using field test kits. Portable kits for arsenic analysis are also popular. Residual chlorine and pH should be analyzed at the same time since pH should be less than 8 for disinfection to be effective.

In sampling the source of water located in a remote place where transport of samples back to a laboratory is not possible within the time allocation for sample preservation, it is better to carry out onsite analysis. Within reasonable level of confidence, portable kits for both microbiological and physico-chemical analysis can be used.

7.2 Laboratory analysis

The analyses and tests must be carried out in accordance with Industrial Standard of Cambodia Volume 11 on drinking water testing. In addition, laboratory analysis of parameters should conform with the standard methods found in any of the following references: *Water Quality Series* from the International Organization for Standardization *(ISO), Standard Methods for the examination of water and wastewater* from the American

Public Health Association; *Report 71* from the British Public Health Service and the *Methods for chemical analysis of water and wastes* from the US Environmental Protection Agency. Recommendations for sampling, preservation and analysis of selected parameters are listed in Table 8. When collecting chlorinated samples for laboratory analyses, add sodium thiosulfate to the sample and transport the sample at controlled conditions preferably in a cooler at - 4'C.

For community-managed schemes, sanitary surveys should be accompanied by analysis of pH, turbidity, conductivity, and total dissolved solids (TDS) using simple field equipment. Changes in these parameters, plus the sanitary survey data, can act as substitute indicators for other changes in water quality. A low pH could indicate chemical contamination, high turbidity could indicate microbial pollution or ineffective disinfection, and high TDS could indicate soluble metals and ions present in the water. This information could alert community members for further investigation and remedial action.

Table 8: Recommendation for sampling, preservation and method of analysis of samples for selected parameters

Parameter	Container plastic/ glass	Mode of preservation	Holding time rec/req	Minimum sample (ml)	Method of analysis
Coliforms	G	Refrigerate	6 h	100	Membrane filtration/MPN
Color (true)	P, G	Reftigerate	48 h/48 h	500	Visual comparator/platinumcobalt method
Turbidity	P, G	Analyze same day; store in dark up to 24 h, refrigerate	24 h/48 h		Nephelornetric
Aluminum					AAS/ICP
pH	P,G	Analyze immediately	2 h/stat	-	Electrode
Hardness	P, G	Add HN03 to pH<2	6 months /6 months	100	EDTA titration
Chlorine, residual	P, G	Analyze immediately	0.5 h/stat	500	DPD
Cyanide	P, G	Add NaOH to pH> 12; Refrigerate in dark	24 h/14 d; 24h if sulfide present	500	Ion Specific Electrode
Ammonia	P, G	Analyze asap or add H2SO4 to pH<2; Refrigerate	7 d/28 d	500	Indophenol Phenate
Nitrate	P, G	Analyze asap or refrigerate sample	48 h/48 h (28 d for Chlorinate None/48 h	100	Colorimetric IC
Nitrite	P, G	Analyze asap or refrigerate	None/48 h	100	Colorimetric IC
Nitrate+Nitrite	P, G	Add H2SO4 to pH>2, Refrigerate	Non/48 h	200	Colorimetric IC
Organics	P, G	Add H2SO4 to pH>2, Refrigerate	28 d	500	GC
Chloride	P, G	Refrigerate	I week	-	1C
Fluoride	P	Non required	28 d/28 d	300	IC

Metals	P(A), G(A)	For dissolved metals filter immediately, add add HN03 to pH<2	6 months/6 months	- 100	AAS 1CP
Solid, total dissolved					Gravimetric
Sulfate	P, G	Refrigerate	28 d/28 d	-	1C
Arsenic	P,G			-	AAS
Selenium				100	1CP
Mercury					

Source: APHA *Standard Methods for the Examination of Water and Wastewater, 1999*

P - Plastic (polyethylene or equivalent)
G - Glass
P(A) - Rinsed with I + I HN03
G(A) - Rinsed with I + I HN03
Rec/Req- Recommended/required
Stat - No storage allowed; analyze immediately
asap - As soon as possible
AAS - Atomic Absorption Spectrophotometer
IC - Ion Chromatograph
GC - Gas Chromatograph
ICP - Inductively Coupled Plasma Mass Spectroscopy
DPD - N,N-diethyl-p-phenylenediamine

NOTE: If samples cannot be returned to the laboratory in less than 6 hours and holding time exceeds this limit, the final reported data should indicate the actual holding time.

8. Sanitary surveys

A sanitary survey is an on-site review of the water source, facilities, equipment, operation and maintenance, of a public water system to evaluate whether it is producing and distributing safe drinking water. During an inspection, records, operation and maintenance practices are reviewed. Guidance can be obtained on the proper conduct of sanitary surveys from Volume 3 of WHO Drinking Water Quality Guidelines (2003).

The frequency for carrying out sanitary surveys varies between 6 months to 2 years depending on the size of the facility and the source of water, as shown in Table 9 below. Surface water should be inspected more frequently than groundwater since it is more vulnerable to contamination and exhibits more variation in water quality.

Table 9: Frequency of Sanitary Inspection

Frequency of inspection by source of water

Location	Groundwater	Surface Water
Cities	Every year	Every 6 months
Towns	Every 2 years	Every year
Rural areas	Every 3 years	Every 2 years

9. General requirements

In implementing the DWS, there are requirements that need to be followed by the stakeholders involved in water. These are the following:

a) The water service is obliged to disinfect water regardless of whether the source is surface or ground water.
b) The water supplier should at all times protect water sources and watersheds.
c) The water treatment facilities should be operated and maintained by certified or trained operators.
d) The water service should make sure to disinfect mains and distribution networks every time repairs have been completed.
e) The water service should monitor the quality of the chemicals used in water treatment with a fixed frequency.
f) The water service shall submit reports of monitoring to the DWS central database

10. Good water practice recommendations

Applying good practice means to manage the quality of water from the source to consumer. Specific treatment of water include disinfection and associated conditions (e.g., concentration of disinfectant, contact time, pH and turbidity), reduction of risk of contamination, use of materials and chemicals, removal of organic substances prior to disinfection to reduce the formation of disinfection by-products, the need to always have positive pressure in the distribution network and so on. If all these best practices are followed, then the quality of water is safeguarded.

An urban water system is by definition a four-stage barrier to prevent any contamination of water: the storage reservoir; chemical treatment (coagulation, flocculation, and sedimentation); filtration; and the final disinfection. If these stages are properly managed, then the quality of the water should be secured in the long term. Sampling and analysis should be the last steps after making sure the barriers are in place.

11. Information, record keeping and reporting

The objectives of a drinking water quality surveillance or control program are to detect anomalies in the production of drinking water with the intention of solving the problem. To do this would require an organized system of record keeping that could be used for such decision-making. Existing databases currently found in Cambodia can be the foundation for a drinking water quality database.

A database of water quality monitoring data over time and in different locations should be established, initially in a spreadsheet format until sophisticated enough to be in a geographic information system (GIS) format that could be overlaid with thematic maps. As an important part of every surveillance and control, record keeping and its availability to the public should be assured to better appreciate monitoring efforts.

12. Surveillance and control programs

The principal objective of surveillance is to identify public health risks so that action may be taken promptly to prevent public health problems. Surveillance requires a systematic program of surveys that combine analysis, sanitary inspection, and institutional and community aspects. Surveillance contributes to the protection of public health by promoting improvement of the quality, quantity, coverage, cost, and continuity of water supplies. The most common and widespread health risk associated with drinking-water is microbial contamination so this is given the highest priority for monitoring, and surveillance. When the standard is exceeded, this should be a signal to investigate the cause with a view to taking remedial action, and to consult with, and seek advice from the responsible authority.

Inspectorates at relevant agencies at the national and local level should implement these standards and will have the following responsibilities:

a) Implement the drinking water quality surveillance program according to the national guidelines
b) Implement and maintain a drinking water quality surveillance program.
c) Analyze the information presented by the water service.
d) Have the proper laboratories facilities to develop their surveillance activities
e) Assess systematically the human health risk by monitoring the water source, the physical characteristics of the water systems (sanitary inspections), and the drinking water quality history and trends.
f) Audit the drinking water quality control programs.
g) Inform the public about drinking water quality and associated risks.
h) Maintain records on drinking water quality characteristics.
i) Maintain open resources for the public to express their complaints and concerns
j) Inform the water service of anomalies detected in the water system and demand the needed corrective actions.
k) Approve the sampling programs as presented by the water service.

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