WATER QUALITY ANALYSIS

Presentation By
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Introduction

- The most important factor to take into account is that, in most communities, the principal risk to human health derives from faecal contamination.
- In some countries there may also be hazards associated with specific chemical contaminants such as fluoride or arsenic, but the levels of these substances are unlikely to change significantly with time.
- Thus, if a full range of chemical analyses is undertaken on new water sources and repeated thereafter at fairly long intervals, chemical contaminants are unlikely to present an unrecognized hazard.
- In contrast, the potential for faecal contamination in untreated or inadequately treated community supplies is always present.
- he minimum level of analysis should therefore include testing for indicators of faecal pollution (thermotolerant (faecal) coliforms), turbidity, and chlorine residual and pH (if the water is disinfected with chlorine).

Location of sampling points

• Sampling points should be selected such that the samples taken are representative of the different sources from which water is obtained by the public or enters the system.

• These points should include those that yield samples representative of the conditions at the most unfavourable sources or places in the supply system, particularly points of possible contamination such as unprotected sources, loops, reservoirs, low-pressure zones, ends of the system, etc.

• Sampling points should be uniformly distributed throughout a piped distribution system, taking population distribution into account; the number of sampling points should be proportional to the number of links or branches.

• The points chosen should generally yield samples that are representative of the system as a whole and of its main components.

• Sampling points should be located in such a way that water can be sampled from reserve tanks and reservoirs, etc.

• In systems with more than one water source, the locations of the sampling points should take account of the number of inhabitants served by each source.

• There should be at least one sampling point directly after the clean-water outlet from each treatment plant.

Minimum frequency of sampling and analysis of unpiped water supplies

Source and mode of supply	Minimum frequency of sampling and analysis		Remarks
	Bacteriological	Physical/chemical	
Open wells for community supply	Sanitary protection measures; bacteriological testing only if situation demands	Once initially for community wells	Pollution usually expected to occur
Covered dug wells and shallow tubewells with hand-pumps	Sanitary protection measures; bacteriological testing only if situation demands	Once initially, thereafter as situation demands	Situations requiring testing: change in environmental conditions, outbreak of waterborne disease, or increase in incidence of waterborne diseases
Deep tubewells with hand-pumps	Once initially, thereafter as situation demands	Once initially, thereafter as situation demands	Situations requiring testing: change in environmental conditions, outbreak of waterborne disease, or increase in incidence of waterborne diseases
Protected springs	Once initially, thereafter as situation demands	Periodically for residual chlorine if water is chlorinated	Situations requiring testing: change in environmental conditions, outbreak of waterborne disease, or increase in incidence of waterborne diseases
Community rainwater collection systems	Sanitary protection measures; bacteriological testing only if situation demands	Not needed	—

Model sample collection form

WATER-QUALITY
CONTROL
PROGRAMME

[Name of body responsible. . . . .]

SAMPLING AND BACTERIOLOGICAL ANALYSIS

Sampling data:

Locality _____
Sample site _____
Place _____
Source _____
Sender _____
Date collected _____
Time collected _____
Date of analysis _____
Time of analysis _____
Residual chlorine _____ mg/litre

Results:

TOTAL COLIFORMS . . . . . _____ /100 ml
FAECAL COLIFORMS . . . . . _____ /100 ml
(OTHER) . . . . . _____

Laboratory Sample No. _____

WATER BACTERIOLOGICALLY
GOOD – BAD

ACTION TAKEN

_____
_____
_____

_____
(signed)

SAMPLE DATA

Locality _____
Sample site _____
Place _____
Source _____
Residual chlorine _____
Date of sampling _____
Time of sampling _____
Sender _____

Section detached and stuck to the sample bottle

Analytical results entered by laboratory; copies of this section sent by laboratory to local surveillance agency or water-supply agency and person responsible for sampling

WHO 96543

Minimum sample numbers for piped drinking-water in the distribution system

Population served	No. of monthly samples
<5000	1
5000–100 000	1 per 5000 population
>100 000	1 per 10 000 population, plus 10 additional samples

Bacteriological analysis

- The principal risk associated with water in small-community supplies is that of infectious disease related to faecal contamination.
- The microbiological examination of drinking-water emphasizes assessment of the hygienic quality of the supply. This requires the isolation and enumeration of organisms that indicate the presence of faecal contamination.
- In certain circumstances, the same indicator organisms may also be used to assess the efficiency of drinking-water treatment plants, which is an important element of quality control.
- Other microbiological indicators, not necessarily associated with faecal pollution, may also be used for this purpose.
- The isolation of specific pathogens in water should be undertaken only by reference laboratories for purposes of investigating and controlling outbreaks of disease. Routine isolation in other circumstances is not practical.

Typical sample volumes for membrane-filtration analysis

Sample type	Sample volume (ml)
Treated drinking-water	100
Partially treated drinking-water	10–100
Protected source water or groundwater	10–100
Surface water and water from open wells	0.1–100[a]

[a] Volumes less than 10 ml should be added to the filtration apparatus after addition of at least 10 ml of sterile diluent to ensure adequate dispersal across the surface of the membrane filter.

Typical sample volumes and numbers of tubes for the multiple-tube method

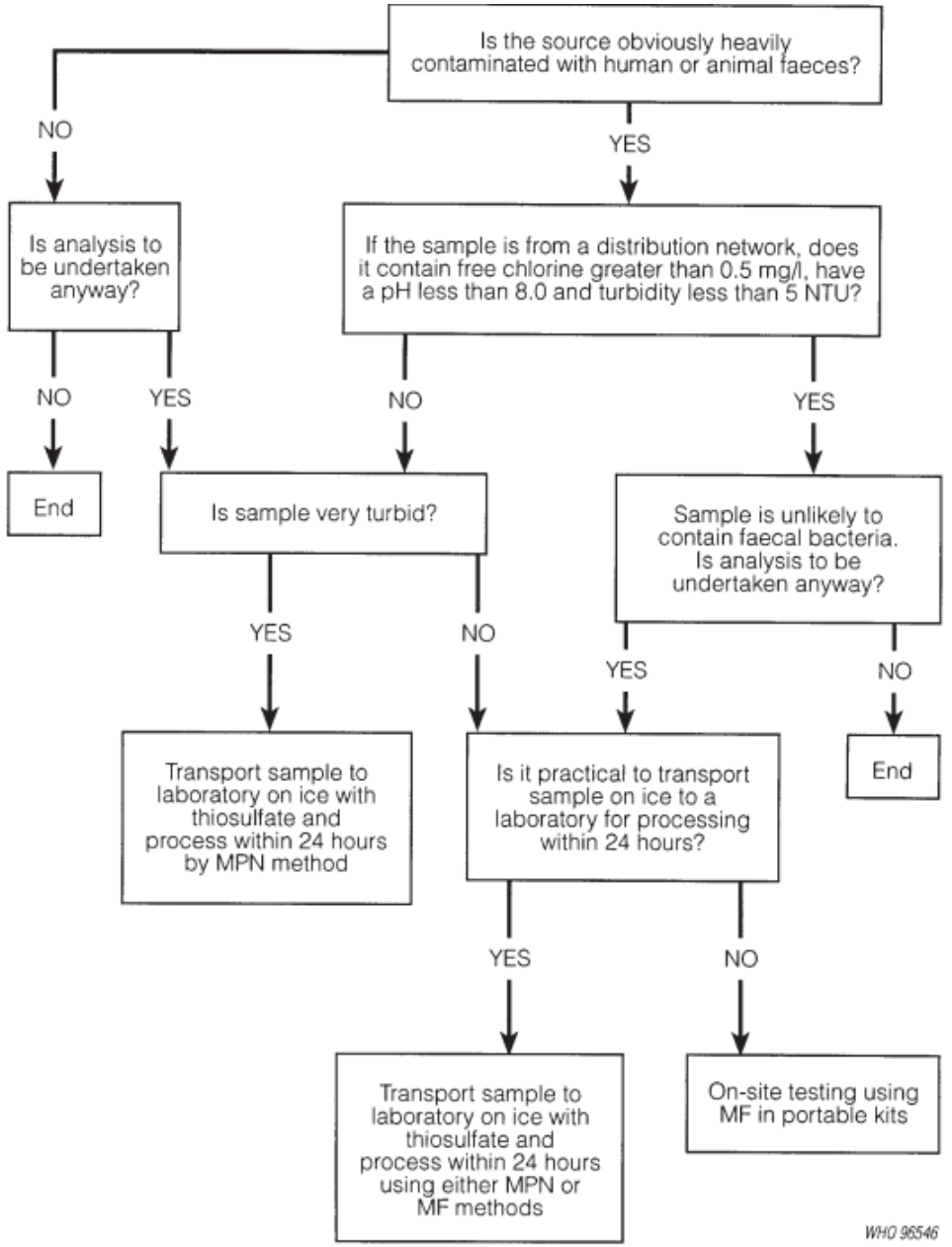
Sample type	Number of tubes for sample volume:				
	50 ml	10 ml	1 ml	0.1 ml	0.01 ml[a]
Treated drinking-water	1	5	—	—	—
Partially treated drinking-water	—	5	5	5	—
Protected source water or groundwater	—	5	5	5	—
Surface water or water from open wells	—	—	5	5	5

[a] Volumes of 0.1 and 0.01 ml are tested by the addition of 1 ml of a 1/10 and 1/100 dilution sample, respectively, to 10 ml of single-strength culture medium.

Comparison of methods for analysis of coliform bacteria

Most probable number method	Membrane-filtration method
Slower: requires 48 hours for a negative or presumptive positive result	Quicker: quantitative results in about 18 hours
More labour-intensive	Less labour-intensive
Requires more culture medium	Requires less culture medium
Requires more glassware	Requires less glassware
More sensitive	Less sensitive
Result obtained indirectly by statistical approximation (low precision)	Result obtained directly by colony count (high precison)
Not readily adaptable for use in the field	Readily adaptable for use in the field
Applicable to all types of water	Not applicable to turbid waters
Consumables readily available in most countries	Consumables costly in many countries
May give better recovery of stressed or damaged organisms under some circumstances	

Decision-making network for selection of method of analysis



Laboratory-based versus on-site testing

Water-quality testing in communities may be subject to the following problems, especially when the communities or the sampling sites are remote or inaccessible:

— deterioration of samples during transport to centralized laboratory facilities;

— high cost of transporting samples;

— inadequate techniques for sample storage and preservation during prolonged transport, thus limiting the sampling range;

— increased personnel costs because of the need for repeat sampling journeys;

— the need for reporting, which may necessitate further return journeys

• Independence from (unreliable) power supplies. Several types of portable equipment either incorporate a rechargeable battery or may be connected to an external battery. Where energy supplies are unreliable (because of either voltage fluctuation or intermittent supply), battery operation may be advantageous.

• Cost. Comparison of the costs of the equipment required, even after allowing for that needed for back-up, may show that it is more economical to provide portable testing equipment to peripheral or decentralized laboratories than conventional laboratory equipment.

• Ease of use. Because portable equipment is often designed for use by personnel who are not fully qualified in laboratory techniques, its use is usually straightforward. However, this does not obviate the need for proper training of personnel, particularly since some portable equipment may not be accompanied by clear, well-illustrated manuals in the language of the users

DOs

- Collect the bacteriological sample first from a sampling point
- Only collect in sterile bottles
- Keep the bottle closed until the sample is ready to be collected
- Hold the bottle around the base
- Carry some spare sterile bottles
- Wipe clean the outside of the bottle before use
- Re-sample if there is a possibility of contamination
- Transport the sample in a cooled covered container (0 to 4OC – i.e. melting ice) within 24 hours
- Label the sample with a waterproof marker pen with location, time, date and sampler's name
- Test for chlorine residual on site

DO NOTs

- Do not contaminate the sampling point
- Do not allow the top or neck of the bottle to touch anything
- Do not collect samples in dirty bottles
- Do not completely fill the bottle
- Do not put yourself at risk from bilharzia – wear waterpoof gauntlets or waders