THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF WATER AND IRRIGATION

NATIONAL GUIDELINES ON

DRINKING WATER QUALITY MONITORING AND REPORTING

VOLUME I: MAIN DOCUMENT

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ACRONYMS

BWBs	Basin Water Boards
COWSOs	Community Owned Water Supply Organizations
EWURA	Energy and Water Utilities Regulatory Authority
LGAs	Local Government Authorities
MoALF	Ministry of Agriculture Livestock and Fisheries
MoHCDGEC	Ministry of Health, Community Development, Gender, Elderly and Children
MoPF	Ministry of Planning and Finance
MoWI	Ministry of Water and Irrigation
NAWAPO	National Water Policy
PO-RALG	President Office Regional Administration and Local Government
UWSAs-	Urban Water Supply and Sanitation Authorities
VPO	Vice President Office Environment
WQMPCS	Water Quality Management and Pollution Control Strategy
WSPs	Water Safety Plans
HWTS	Household water treatment and safe storage
POU	Point of Use

FOREWORD

Access to safe drinking water is crucial for improved health and human welfare in general, and it is regarded as a basic human right. Given its significance, provision of adequate and safe drinking water is one of the essential components of the National Water Policy of 2002 (NAWAPO, 2002). The same has been reflected in several national development plan documents, including the Tanzania Vision 2025 and the Five Year Development Plans.

Unsafe drinking water is the main route for the transmission of water borne diseases, such as Trachoma, Bacillary Dysentery, Typhoid, Cancer, and Schistosomiasis. It is, therefore, critical that the Government puts in place mechanisms to safeguard its people from health hazards caused by water borne, water based and water washed diseases.

These guidelines have been developed in recognition of the fact that human activities on the environment constantly tend to reduce and interfere with water quality. Therefore, there is a need to constantly monitor and report data on water quality in order to ensure that water quality standards are sustainably met.

The ultimate goal of these guidelines is to make certain that drinking water supplied at various levels meets the acceptable national water quality standards. The guidelines have been developed in collaboration with all relevant key stakeholders, drawing from national and international benchmarks on water quality, as well as relevant legislations and regulations governing the water sector. I call upon all institutions and individuals involved in the provision of drinking water to follow these guidelines judicially and determine that these guidelines come into effect on and from 1st January, 2018.

Prof. Kitila Mkumbo
PERMANENT SECRETARY
Ministry of Water and Irrigation

AKNOWLEDGMENT

The preparation of these guidelines began with different review meetings on the current situation of monitoring drinking water quality in the country whereby a detailed outline of the guidelines was agreed upon. The first draft was reviewed at different stakeholders meetings and thereafter submitted to the multidisciplinary technical experts to finalize the draft. Thus, the final version of the guidelines is the outcome of contributions from a number of individuals; whose inputs are greatly appreciated. We acknowledge the cooperation received from the UNICEF on intervention related to WASH activities, particularly for the financial support which enabled us to finalize these Guidelines.

DEFINITION OF TERMS

i. **Catchment:** refers to an extent or an area of land where surface water from rain, melting snow, or ice converges to a single point at a lower elevation, usually the exit of the basin, where the waters join another water body, such as a river, lake, reservoir, estuary, wetland, sea, or ocean.

ii. **Chlorine residue (free chlorine):** chlorine present in water that is not combined with other chemicals and available to disinfect any additional contaminants introduced to the water.

iii. **Compliance monitoring:** is to determine whether water supplies comply with the standards and indicator parameter values in the regulations.

iv. **Contamination:** degradation of water quality compared to original or natural conditions due to human or natural activity.

v. **Drinking water:** potable water intended for human consumption.

vi. **Drinking water quality monitoring:** is a wide range assessment of the quality of water in the water supply system which includes regular sampling and testing to ascertain whether water quality is meeting national standards and regulatory requirements or agreed levels of service.

vii. **Household water treatment and safe storage (HWTS):** is a way of treating water and safety storing it in the home or treating water at the point of use (**POU**).

viii. **Operational monitoring:** is to check whether or not the treatment works and distribution networks are operating effectively to deliver water that meets the standards and provide early warning that source water quality is deteriorating, a treatment process is failing or there is a problem in the distribution network.

ix. **Point of use (POU):** is the technology designed to treat only the water intended for direct consumption (drinking and cooking), typically at a single tap or limited number of taps.

x. **Potable water:** water that is safe and suitable for human consumption.

xi. **Toxic contaminants:** are substances that may cause harm to an individual if it enters the body.

xii. **Water quality:** is the characteristic of water which defines its use in terms of physical, chemical, biological, bacteriological or radiological characteristics by which the acceptability of water is evaluated for a particular purpose.

xiii. **Water quality surveillance:** is the continuous and vigilant public health assessment and review of the safety and acceptability of drinking water supplies. The surveillance contributes to the protection of public health by promoting improvement of the quality and quantity of water and is complementary to the quality control function of the drinking water supplier.

xiv. **Water safety:** refers to water that meet the health related criteria for substances specified in drinking water quality standards.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Water quality is a primary concern in all water projects in Tanzania, and the improved health and human well-being are the major expected benefits. The quality factor must be the uppermost from the planning to the implementation stages of water projects, as well as from source selection to the choice of technology for maintenance to the completed systems.

However, evidences suggest that the issues of water quality are not uniform across the country. Therefore, it is recommended that the projects draw water from the best available sources, as it is easier to maintain high quality water than to provide treatment to poor quality water sources. In addition, water quality should not be allowed to deteriorate between the source and the ultimate user. The maintenance of water quality requires a combination of hardware (source improvement, technical design, construction, etc.) and software skills (education, rules for system usage, monitoring and testing, etc.) for the purpose of ensuring that the suppliers provide water that is safe for public health.

On the one hand, the National Water Policy (NAWAPO, 2002) states clearly that water quality should be monitored to meet agreed objectives and standards while, the Water Supply and Sanitation Act No. 12 of 2009 requires the water supply authorities to supply water that complies with water quality standards. Additionally, the Water Quality Management and Pollution Control Strategy (WQMPCS,2010) emphasizes the community involvement in the water quality management and the provision of water quality monitoring to determine the safety and cleanliness of water for human use as well as extension of provision of drinking water quality monitoring services more widely across the country.

Despite comprehensive efforts of the government to increase water supply coverage in both urban and rural settings, water supply utilities do not provide consistent and adequate management of monitoring drinking water as a result the quality of drinking water quality is sometimes not compliant with national standards. This situation can be attributed to factors such as lack of clear guidance mechanism for monitoring the quality of drinking water being supplied, as well as lack of awareness that drinking water quality issues can be identified through a well-designed monitoring program. In recognition of these challenges, the National Guidelines on Drinking Water Quality

Monitoring and Reporting have been developed to enable effective management of drinking water quality in the country for the protection of public health.

Drinking Water Quality Monitoring is a wide range assessment of the quality of water in the water supply system which involves regular sampling and testing to ascertain whether water quality follows the national standards and regulatory requirements or agreed levels of service. The present guidelines provide monitoring approach of drinking water quality which includes identifying sources of contamination and implementation of corrective actions with subsequent verification complimented by surveillance. This approach is considered the best practices in the provision of safe water to the community. The guidelines are designed to provide an authoritative reference on what defines safe, good quality water, how it can be achieved and how it can be assured. The guidelines provide a basis for determining the quality of water to be supplied to consumers in all parts of the country. However, these determinations need to consider the diverse array of regional (local) factors, and take into account the economic, political and cultural issues, including customer expectations and willingness and ability to pay.

1.2 Objectives of the Guidelines

The Guidelines are designed to provide guidance to water supply entities on the monitoring of the quality of drinking water in both rural and urban areas including private water suppliers, vendors as well as in the community not yet served with potable water. The Guidelines aim specifically to:

i. Provide guidance to entities on the monitoring of water quality at the source;

ii. Provide guidance to entities on the monitoring of water quality at treatment units; storage points and distribution systems;

iii. Provide guidance to entities on the monitoring of water quality at the points of use (households) as well as situations where communities are not yet served with potable water;

iv. Provide description of roles and responsibilities of various stakeholders on the management of drinking water quality; and

v. Provide a quick reference for water supply entities and all stakeholders on issues related to monitoring of drinking water quality in the country.

1.3 Rationale of the Guidelines

NAWAPO (2002) states clearly that safe drinking water and good sanitation practices are the basic considerations for human health and the use of contaminated sources poses waterborne diseases such as diarrhea and cholera. Despite, the achievement attained for the water supply coverage in the country but the quality of water supplied to consumers is not adequately monitored to assess its compliance with national drinking water quality standards due to lack of proper guiding tool. Additionally, the Circular No. 1 of 1999 issued by the government as guidelines for water quality monitoring on new developed water scheme and existing water supply scheme has been found to be redundant because of various reforms undertaken by the government.

Given such situations, communities have been supplied with water which is not known its quality, hence linked to various waterborne diseases that continue to prevail in the country. The recent experiences of cholera outbreak which has persisted since August, 2015 have also informed the country on the serious consequence that can occur if water supplies are not properly managed and indicate the importance of having a preventive risk management approach rather than a primarily reactive approach of monitoring only treated drinking water quality. Hence, the developed guidelines provide mechanisms for identifying problems within the water supply system and the necessity for any immediate corrective actions or incident and emergency response. The guidelines therefore create uniformity approaches for monitoring drinking water quality and restore the state of the art for the availability of clean and safe water at all levels.

1.4 Scope

The development of these guidelines is based on the current best practice monitoring approaches and attitudes that have shown to be effective in water quality monitoring. For this reason, the guidelines will need to be updated continuously as monitoring approaches and/or technologies change. The guidelines are intended for use by implementing agencies with direct or indirect responsibilities associated with the monitoring of drinking water quality. These implementing agencies are urban water supply and sanitation authorities (UWSAs), Small Towns, Community Owned Water Supply Organizations (COWSOs), Private Drinking Water Supplies, Vended Drinking Water Supplies, District Water Engineers (DWEs), Regional Administrative Secretariat (RAS), Energy and Water Utilities Regulatory Authority (EWURA), Water Quality Laboratories, Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) and Ministry of Water and Irrigation. Other stakeholders will also benefit from the guidelines, as they provide quick references on issues related to drinking water quality monitoring.

1.5 Applying the Guidelines

Application of the Guidelines will vary depending on the arrangements for water supply within each jurisdiction considering water supply is either managed by the Water Supply and Sanitation Authorities, Community Owned Water Supply Organizations, Private or Vendors. This is likely to affect the manner and degree to which the Guidelines are implemented. However, all water suppliers and relevant government agencies are still encouraged to use the Guidelines as a model for best practice to ensure the safety of drinking water.

The application of the Guidelines will also depend on the needs of the organization, the separation of responsibilities, and the institutional arrangements. Each organization should develop an internal plan for implementing the Guidelines in a manner that suits its particular circumstances. The Guidelines can be applied as a stand-alone drinking water quality management approach or can be integrated within an existing management system.

The time and resources required to develop a drinking water quality monitoring programme will depend on the extent in which the features of the present Guidelines have been practiced and the degree of advancement of the existing drinking water quality managements. It is obvious that the current management applied by most drinking water suppliers and associated agencies have incorporated many of the elements specified in the Guidelines. However, existing practices may not be sufficiently comprehensive to address fully the range of drinking water quality issues that can arise, and may not be systematically structured or sufficiently visible to ensure that drinking water being supplied meet the required quality criteria. When such situation arises, review, documentation and formalize of the practices should be done, as well as addressing areas where improvements are required.

CHAPTER TWO

2.0 LOCALIZED WATER QUALITY ISSUES IN THE COUNTRY

Evidences suggest that different parts of the country experience different challenges in relation to water quality issues. Therefore, challenges of water quality in each locality should also be addressed differently. Localized water quality problems are mainly caused by a number of factors including existing parent rocks (natural occurrence), human economical activities, climate change, pollution and over-exploitation of water resources. The pace of industrialization and individual practices also play an important role in determining the quality of water of a certain locality. The problem is sometimes aggravated by uneven distribution of rainfall and an extended drought. During drought, low flows and extended heat raised water temperatures and increased salinity levels in rivers and streams. Localized water quality issues in the country need to be identified, assessed, addressed and considered when performing drinking water quality monitoring activities.

2.1 Factors Affecting Water Quality

As water passes through the water cycle (precipitation, evaporation and evapotranspiration) its mineral content changes as a result of processes that occur in air, water and earth. The variability in concentrations of chemicals (dissolved ions) in runoff, stream flow and groundwater that enter sources is caused by several factors. These factors tend to be local but they are not similar in all areas. Therefore, this aspect should be considered when planning to undertake drinking water monitoring activities. These factors include:

i. Nature of the parent rocks (i.e. existence of parent rock material at the area);
ii. Climate effects (especially arid and semi-arid);
iii. Geographic effects;
iv. Stream flow;
v. Human effects and major economical practices performed around the area;
vi. Possibility of seawater intrusion;
vii. Over extraction of groundwater sources and less recharge of aquifers.

2.1.1 Nature of the Parent rocks

The chemical characteristics of water depend on the degree to which the water has come in contact with geologic formations (rock units/parent rock) and on the types of minerals present in those formations. Chemical and physical weathering of soil and rock, through dissolution and redox reactions, provides major dissolved ions to waters.

2.1.2 Climate effects

Climate influences surface water quality through the balance of precipitation and evapotranspiration. Arid regions tend to have higher concentrations of salts in surface waters than do humid regions due to higher rates of evaporation. Climate also has a considerable influence on the type and extent of vegetation cover and it therefore indirectly affects the physical, chemical, and biological characteristics of soils and the degree to which soils are eroded and transported by surface waters.

2.1.3 Geographical effects

The chemistry of water entering an aquifer also depends on the size of the watershed, the slope of the landscape, soil texture, and topographic variations. The presence of upstream water sources also influences the quality of water entering downstream water sources.

2.1.4 Stream flow effects

The water quality of surface runoff, streams and ground water varies seasonally. During high precipitation seasons, surface water recharges aquifers and therefore has fewer dissolved minerals. During dry seasons, ground water contributes largely to streams and aquifers, generally increasing the concentration of dissolved minerals in the water.

2.1.5 Human Effects

The modification of surface water through human activities often drastically alters the chemical composition of stream flow and ground water. Drainage from agricultural fields often have increased concentrations of sediments, nutrients (nitrogen and phosphorous) and some herbicides and pesticides. Water drained from urban and suburban areas may have high concentrations of trace organics, certain toxics (heavy metals, petroleum products) and nutrients from lawn and garden fertilizers.

It is evident from the above explanations that many areas face multiple and diverse water quality challenges. Therefore, in order to ensure adequate and safe drinking water, one needs to take into consideration a variety of water quality challenges across the country. The following are the proposed steps that should be considered when planning and undertaking drinking water quality monitoring in various places:

i. Measure all important water quality parameters during monitoring of drinking water supply system as addressed in chapter three.
ii. Put emphasis on local-specific factors (e.g. parent rock, climate effect etc.) that lead to water quality issues at that particular area.
iii. Microbiological parameters should always be monitored.

2.2 Local Specific Water Quality Problems in Tanzania

In order to design the best drinking water quality monitoring plan, every drinking water supplier should identify the possible predominant localized water quality problem which could make drinking water unsuitable. Together with other important water quality parameters to be tested as addressed in chapter three, predominant issues should be included in the monitoring program. Table 2.1 summarizes the possible local specific water quality issues in the country.

Table 2.1: Localized water quality problems in the country

Parameter	Affected regions/districts/ areas
Low pH	i. Dar es Salaam -Ilala, Kinondoni, Temeke. ii. Coast -Kisarawe. iii. Kigoma -Buhigwe, Kasulu, Kigoma MC, Kakonko, Kibondo. iv. Katavi -Mpanda, Nsimo, Tanganyika, Mlele. v. Rukwa -Sumbawanga DC. vi. Songea -Mbinga, Namtumbo, Nyasa, Songea MC, Songea DC, Tunduru. vii. Kagera -Bukoba DC, Bukoba MC, Karagwe, Kyerwa, Misenyi, Muleba, Ngara. viii. Geita -Chato, Bukombe, Geita DC, Geita TC, Mbogwe, Nyang'hwale. ix. Mtwara- Newala. x. Shinyanga-Bukombe, Mbogwe. xi. Mbeya- Mbozi.
Hardness	i. Dodoma -Mpwapwa, Kongwa, Chamwino, Chemba,

Parameter	Affected regions/districts/ areas
	Dodoma City. ii. Dar es Salaam -Temeke, Kinondoni, Ilala. iii. Singida -Singida MC, Manyoni, Iramba, Mkalamo, Ikungi. iv. Morogoro -Gairo, Morogoro DC, Morogoro MC, Mvomero. v. Coast -Kibaha, Bagamoyo. vi. Iringa -Iringa DC. vii. Mbeya -Mbarali, Chunya. viii. Songwe-Songwe DC. ix. Mara -Rorya, Musoma DC, Butiama, Serengeti, Bunda. x. Lindi -Lindi MC, Ruangwa, Nachingwea. xi. Mtwara -Mtwara MC. xii. Tanga -Korogwe, Mkinga, Handeni, Pangani. xiii. Kagera -Kyerwa. xiv. Kigoma-Kigoma MC. xv. Kilimanjaro-Same, Mwanga. xvi. Manyara-Simanjaro. xvii. Katavi-Mlele.
Fluoride	i. Arusha -Arumeru, Monduli, Ngorongoro, Arusha City, Longido. ii. Manyara -Babati TC, Babati DC, Hanang, Simanjiro. iii. Kilimanjaro -Siha, Hai, Moshi DC, Mwanga Same iv. Katavi -Mlele. v. Mwanza -Magu, Busega, Sengerema, Misungwi, Mwanza City, Kwimba. vi. Singida -Singida DC, Iramba, Mkalama. vii. Shinyanga -Shinyanga DC, MC, Kishapu . viii. Mbeya -Busokelo. ix. Dodoma –Chemba x. Simiyu-Maswa, Bariadi, Simiyu DC, Itilima xi. Mbeya-Busokelo, Rungwe xii. Tabora-Nzega xiii. Tanga-Korogwe,
Chloride	i. Lindi -Lindi MC, Kilwa, Ruangwa, and Nachingwea Liwale. ii. Mtwara -Mtwara MC, DC, Tandahimba, Newala, Masasi and Nanyumbu. iii. Dar es Salaam -Temeke, Kinondoni, Ilala. iv. Morogoro -Morogoro MC & DC, Gairo, ,Kilombero,

Parameter	Affected regions/districts/ areas
	Ulanga. v. Coast -Kisarawe, Bagamoyo. vi. Tabora -Uyui. vii. Kigoma -Kigoma DC. viii. Geita -Nyang'hwale. ix. Tanga -Korogwe, Mkinga, Tanga City, Handeni, Pangani. x. Dodoma -Dodoma MC, Mpwapwa, Kongwa, Chamwino. xi. Coastal areas. xii. Kagera -Kyerwa. xiii. Singida - Singida MC, Manyoni, Iramba, Mkalamo, Ikungi. xiv. Songea-Tunduru. xv. Manyara-Simanjiro, Babati. xvi. Kilimanjaro-Same, Mwanga, Hai.
Nitrate	i. Mwanza -Magu, Sengerema, ii. Geita - Nyang'hwale. iii. Singida -Ikungi, Iramba, Manyoni, Singida DC, Singida MC. iv. Tanga –Tanga City, Mkinga. v. Iringa-Iringa DC. vi. Dodoma -Bahi, Chamwino, Chemba, Kondoa, Dodoma City. vii. Dar es Salaam -Temeke, Kinondoni. viii. Lindi-Kilwa Masoko ix. Mbeya-Busokelo. x. Arusha- Longido, Arusha City.
Sulphate	i. Mtwara – Mtwara MC ii. Lindi-Ruangwa. iii. Dodoma – Kongwa, Mpwapwa iv. Morogoro-Morogoro DC, Gairo v. Singida- Singida MC. vi. Mbeya-Chunya. vii. Kilimanjaro-Same, Mwanga. viii. Manyara- Babati.
Iron	i. Mtwara -Mtwara MC, Tandahimba. ii. Shinyanga- Shinyanga MC, Kahama, Ushetu, Msalala iii. Mara -Serengeti. iv. Kigoma -Buhigwe.

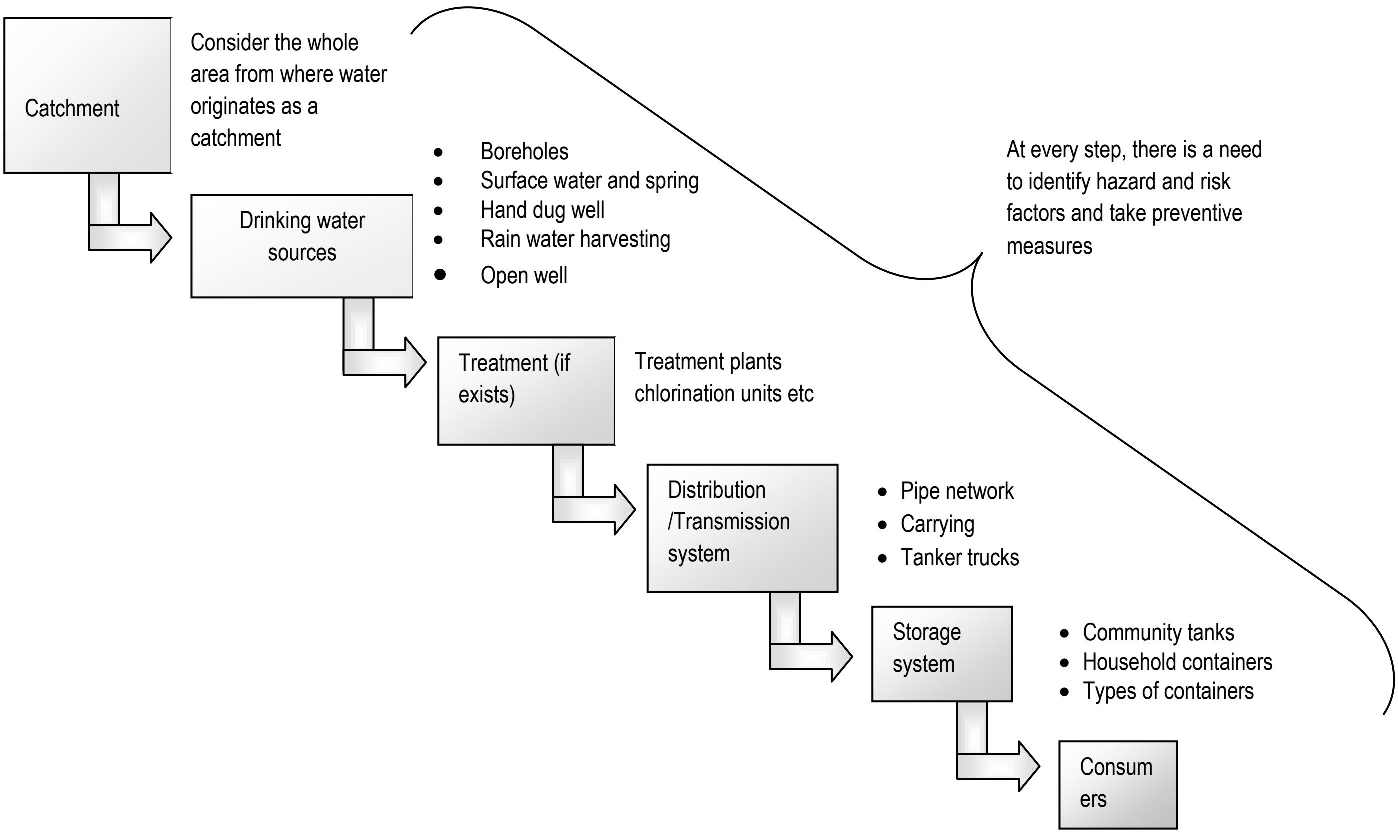
Parameter	Affected regions/districts/ areas
	v. Lindi -Liwale, Kilwa. vi. Coast -Kisarawe. vii. Dar es Salaam -Kinondoni, Ilala, Temeke. viii. Tanga -Handeni, Muheza, Mkinga. ix. Singida -Manyoni. x. Kagera -Ngara, Biharamulo, Karagwe, Bukoba DC, Muleba, Kyerwa. xi. Tabora-Tabora MC, Uyui, Urambo, Kaliua. xii. Songea-Madaba, Namtumbo. xiii. Morogoro-Morogoro DC. xiv. Mbeya-Chunya, Kyela xv. Katavi-Mpanda.
Manganese	i. Dar es Salaam -Kinondoni. ii. Lindi - Ruangwa, Nachingwea, Kilwa, Masasi, Liwale. iii. Mtwara -Nanyumbu, Makondeko, Nanyamba, Mtwara MC. iv. Simiyu -Maswa, Bariadi. v. Songea-Songea DC. vi. Manyara -Kiteto. vii. Kigoma -Kigoma MC, Kasulu, Buhigwe, Kibondo, Kakonko. viii. Tabora-Tabora MC, Uyui, Urambo, Kaliua. ix. Simiyu-Bariadi x. Iringa-Iringa DC xi. Mbeya-Chunya, Kyela
Cadmium	Near mining sites
Selenium	Near mining sites
Arsenic	Near mining sites
Mercury	Near mining sites
Lead	Near dyes, textiles, paints, firearms industries
Copper	Near mining sites
Uranium	Near mining sites -Manyoni, Namtumbo.
Chromium	Near leather industry sites
Nickel	Kagera -Biharamulo, Kyerwa
Cyanide	Near mining sites
Hydrocarbons	Near petrol stations/fields/garages
Pesticides	Areas with agricultural activities

CHAPTER THREE

3.0 DRINKING WATER QUALITY SUPPLY SYSTEM MONITORING OVERVIEW

The key principal for monitoring water quality at the entire drinking water supply system (that is from the source/intake to household/end user) is to provide assurance that the quality of drinking water meets national standards as well as detecting any problems that may occur and trigger necessary corrective actions. Hence, the implementation of the guidelines considers the use of preventive strategy for monitoring drinking water from catchment to consumer. This entails, therefore, that at every stage of drinking water system there is a need to identify hazard and risk factors and take preventive measures accordingly. The figure below shows water supply system from catchment to consumers that must be considered when undertaking drinking water quality monitoring programme.

Figure 1: Water Supply from Catchment to Consumers



The following sections provide guidance on monitoring drinking water quality from source/intake to household as well as to communities not yet served with potable water. However, the monitoring parameters identified may be added or changed due to site specific circumstances.

3.1 Monitoring of drinking water quality at sources/intake

The importance of understanding the catchment, reservoirs(s) and source water characteristics cannot be underestimated. Source water monitoring is the foundation of the strategic and evidence-based monitoring as it provides important information on water supply system. Understanding of the water supply system enables a water supplier to be aware of the catchment, the hazards that may arise and the contamination challenges present in the given area. As a result of understanding the contamination challenges that are facing water supply system, the supplier will be in a position to provide treatment system, hence providing a much greater level of assurance of drinking water safety than solely monitoring treated drinking water.

In addition, effective monitoring of source water is vital because it is preventive rather than reactive in the sense that it is an initial process which can inform both long-term and short-term risk assessment, and may provide an opportunity for real-time process control and the predication of potential contaminants. Therefore, given its significance, source water monitoring should be incorporated as part of regular monitoring. Monitoring may necessarily be more intensive to start but as understanding of the water system increases over time, monitoring programs will evolve and change depending on the requirements and uncertainties. Source water quality data should continually develop greater understanding of the system and feed into the monitoring design rather than allowing monitoring programs to become static and routine.

Effective source management has additional benefits in that it decreases contamination of source water, hence the amount of treatment and quantity of chemicals needed is reduced. This may lead to health benefits through reducing the production of treatment by products, and economic benefits through minimizing operational costs.

In monitoring drinking water sources, water suppliers in both urban and rural areas should assess the following:

i. The location of water sources to check for runoff or flood ways leading towards the source of water that may be possible sources of drinking water contamination;
ii. The topographic features of the land: whether plain or sloppy, to assess risks caused by erosion;
iii. The nature of human or development activities around the source including agriculture, cattle grazing, mining, waste disposal, and common defecation sites;
iv. The water source quality by collection and testing of samples to identify the levels of microbial, chemical or physical contaminants;
v. The presence of proper fencing, flood diversion ditches, and heavy traffic road crossing over water bearing spring catchment.

Parameters to be monitored at the source are divided in two groups. The first group is for parameters which should be checked during the development of the source/intake, and the second group is for parameters which should be monitored on routine basis at the source/intake. The parameters to be monitored in both groups are as indicated in Table 3.1a and 3.1b, respectively.

Table 3.1a: Parameters to be monitored during the development of the source/intake

S/N	Parameter	S/N	Parameter	S/N	Parameter
i	Temperature	xiv	Sulphate	xxvii	Arsenic
ii	Sodium	xv	Potassium	xxviii	Chloride
iii	Hydrocarbons	xvi	Pesticides	xxix	Barium
iv	pH	xvii	Orthophosphate	xxx	Boron
v	Alkalinity	xviii	Bacteriological- Total coliform, fecal and/or E.coli	xxxi	Aluminium
vi	Total Dissolved Solids	xix	Nitrate	xxxii	Cadmium
vii	Hardness	xx	Nitrite	xxxiii	Chromium
viii	Turbidity	xxi	Odour and taste	xxxiv	Lead
ix	Colour	xxii	Iron	xxxv	Selenium
x	Suspended Solids	xxiii	Manganese	xxxvi	Uranium
xi	Calcium	xxiv	Fluoride	xxxvii	Cyanide
xii	Magnesium	xxv	Copper	xxxviii	Mercury
xiii	Conductivity	xxvi	Zinc	xxxix	Dissolved oxygen

Table 3.1b: Parameters to be monitored on routine basis at the water source/intake

S/N	Parameter	S/N	Parameter	S/N	Parameter
i	Temperature	v	pH	ix	Hardness
ii	Turbidity	vi	Colour	x	Total Dissolved Solids
iii	Bacteriological- fecal and /or *E.coli*,	vii	Nitrate		
iv	Suspended Solids	viii	Alkalinity		

Note: Any known characteristics (parameters) that can be reasonably expected to exceed the standards value, even if occasionally should be monitored.

3.2 Monitoring of drinking water quality at the water treatment processes

Monitoring at the water treatment processes is crucial as it helps in assessing water treatment needs and information to implement process adjustments that is increasing or reducing the cost of treatment.

Operational monitoring of treatment processes and performance are instrumental for providing information about potential contamination of water sources and identifying ineffective treatment processes such as inadequate disinfection, shortening of filter runs and degraded filtered water quality. The advantage of monitoring treatment performance is that effective substitutes can be developed which can be monitored continuously in real-time and potentially identify incidents as they occur. If water treatment is well understood under a variety of conditions and performance is monitored continuously, then greater confidence in water safety can be assured.

In monitoring of drinking water quality at the treatment processes, the following should be assured:

i. Samples must be collected in appropriate manners as per sampling protocols (sampling procedure, collection and preservation) and analyzed using an acceptable method to ensure representable results;

ii. Water supply variation considering type of water source, for example, surface water will be subject to seasonal and hydrological changes, while ground water is often less variables on short term basis;

iii. Treatment capabilities and performance of treatment facilities;

iv. Vulnerability of water source to potential contamination;

v. Past trends in water quality information as well as information of raw water source data should be considered;

vi. Parameters to be monitored at the treatment plants are indicated in Table 3.2.

Table 3.2: Parameters to be monitored at the Water Treatment processes

S/N	Parameter	S/N	Parameter	S/N	Parameter
i	Temperature	v	pH	ix	Dissolved Solids
ii	Turbidity	vi	Colour	x	Chlorine residual
iii	Bacteriological-fecal and/*or* *E. coli* [xx]	vii	Aluminum (if Aluminum based coagulant is used)	xi	UV dose rate
iv	Filter head loss	viii	Flock characteristics	xii	Visual observation of flock or flock blankets

Note: Any known characteristics (parameters) that can be reasonably expected to exceed the standards value even if occasionally, should be monitored at the water treatment processes.

[XX]E .coli should be taken as the prerequisite requirement but where there is inadequate capacity to analyse it, faecal coliform should be considered.

3.3 Monitoring of drinking water quality at the storage facilities

The treated water can be contaminated through storage system, and thus the quality can be deteriorated due to the bacteria that remain after treatment or those that enter the system through broken pipes and subsequently grow in the storage system. Waterborne outbreaks have occurred in the community where birds and other animals used to contaminate the water through open storage reservoirs. Uncovered reservoirs also can allow the growth of microorganisms such as fungi and toxin forming cyanobacteria which reduce the quality of water. The rate of water quality deterioration can be controlled by adding preservatives (residual disinfectant).

Monitoring mechanism at the storage facilities should include:

i. Ensure the clear water storage tanks covered;
ii. Bacteriological testing should be conducted to confirm the disinfection treatment;
iii. Routine checks of the system;
iv. Routine cleaning of the storage facilities;
v. Parameters to be monitored at the storage facilities are as shown in Table 3.3.

Table 3.3: Parameters to be monitored at the Storage Facilities

S/N	Parameter	S/N	Parameter	S/N	Parameter
i	Temperature	iv	pH	vii	Free chlorine
ii	Turbidity	v	Colour	viii	Suspended Solids
iii	Bacteriological- fecal and /*E. coli* [xx]	vi	Odour and Taste		

Note: Any known characteristics (parameters) that can be reasonably expected to exceed the standards value, even if occasionally should be monitored

[XX]*E.coli should be taken as the prerequisite requirement but where there is inadequate capacity to analysis, faecal coliform should be considered.*

3.4 Monitoring of drinking water quality in the distribution system

Assuring that treated drinking water quality is maintained from the distribution system to the point of delivery to consumers is a key aspect of drinking water quality management that is often overlooked. Contamination in the distribution system is a significant problem and a major cause of waterborne diseases outbreaks. These outbreaks are attributable to microbial and chemical contamination mostly from cross-connections and back siphonage, but also from leaking main breaks, repairs and leaching of metals.

Therefore, monitoring of distribution system should consider the potential for stagnation and ingress of contamination through faults in the distribution system. Stagnation and growth of biofilms can occur in poorly designed and operated distribution systems, while ingress of contamination can occur through tanks, reservoirs and pipes, cross contaminations to the pipe networks, and poor control of repairs or installation of new mains. In these guidelines ***four*** categories are considered under distribution system, and parameters to be monitored are as indicted in Tables 3a and 3b, with respect to the type of distribution facilities. The categories are elaborated in the following subsections:

3.4.1 Piped water supply system

Piped distribution systems for drinking water are as important to the quality and safety of drinking water as the treatment itself. The water entering the distribution system must be bacteriologically safe and ideally stable. The distribution system itself provides a secure barrier for post treatment as the water is transported to the users.

3.4.2 Non-piped water supply system

Water contamination occurring in a non-piped water supply (shallow or deep wells) is a result of poor handling during collection and transportation. Parameters to be monitored at the distribution facilities (piped & non-piped) are as indicated in table 3.4a.

Table 3.4a: Parameters to be monitored at the distribution facilities (piped and non-piped distribution system)

S/N	Parameter	S/N	Parameter	S/N	Parameter
i	Turbidity	ii	Bacteriological- fecal and / or *E. coli* [xx]	iii	Free chlorine

Note: Any known characteristics (parameters) that can be reasonably expected to exceed the standards value, even if occasionally should be monitored

[XX]*E.coli should be taken as the prerequisite requirement but where there is inadequate capacity to analysis, faecal coliform should be considered.*

3.4.3 Private drinking water supply system

The quality of private water supplies varies considerably. Some have adequate treatment and are well managed, but others undoubtedly present a risk to health due to the quality of the water. If you own or use a private supply, it is important that you are aware of the quality of the supply and the risks associated with it. Thus private drinking water suppliers must undertake the following measures to protect the users:

i. ensuring the source is protected from contamination by grazing animals or material washing down from upstream;
ii. installing and maintaining appropriate treatment that is capable of treating water consistently to a satisfactory quality;
iii. ensuring the water is adequately disinfected prior to use;
iv. making sure that the water is stored and distributed safely to avoid contamination after treatment.

3.4.4 Vended drinking water supply system

The principal risk to human health from vended water supplies is the presence of pathogenic microorganisms. Therefore, to ensure safe water, the focus in vended water should be on regular inspection of the system to check for any direct or potential sources of contamination, and/or the use of a clean and unpolluted water source for filling.

When vendors water supplies are not taken from utility piped supplies, routine testing and sanitary inspection is desirable. For very small vendors, it may not be possible to undertake routine monitoring but occasional assessments are worthwhile.

Monitoring mechanism for vendors should include:

i. Awareness creation on drinking water handling and hygiene;
ii. Sanitary surveys of source water, abstraction devices and hoses for protection from external sources of contamination;
iii. Integrity, cleanliness and maintenance of equipment and devices such as hydrants, standpipes, backflow preventers, storages, hoses, containers and bulk water tankers;
iv. Design and characteristics of containers used to transport and deliver water should be dedicated to transport drinking water and made of suitable materials.

Parameters to be monitored at the Private and Vendor operators are as indicated in Table 3.4b.

Table 3.4b: Parameters to be monitored for Private and Vendor operators

S/N	Parameter	S/N	Parameter	S/N	Parameter
i	Bacteriological- fecal and / or *E. coli* [xx]	ii	Free Chlorine & pH	iii	Registration status

Note: Any known characteristics (parameters) that can be reasonably expected to exceed the standards value, even if occasionally should be monitored.

[xx]E. coli should be taken as the prerequisite requirement but where there is inadequate capacity to analysis, faecal coliform should be considered.

Note 01

i. These guidelines can be applied as a standalone drinking water quality management system for private and vended drinking water supplies, or can be integrated within an existing managerial system and where private and vendor are registered or have a contract with a utility, implementation and operation of their activities should be regularly checked by the regulatory organization (utility itself);

ii. It is very critical that the monitoring of private and vendor supplies lead to some form of action, either through working with them to improve practices and regulating their practices or by banning all drinking water activities being undertaken by private and vendors if they do not comply with the required standards;

iii. Drinking water supplied by private and vendors must be of a quality consistent with regulated standards, and every water supply utility must monitor the performance of private and vendor water supplies within its area of jurisdiction to ensure standards and norms are met.

3.5 Monitoring of Drinking Water Quality at the Point of Use

Monitoring consumer satisfaction is another important surveillance mechanism. Consumers are located throughout distribution systems and their feedback on the quality of drinking water supplied in their areas is considerably important in monitoring process. Consumers can provide timely information on potential problems, particularly within the distribution system that may otherwise go unidentified.

It is a well-known fact that a drinking water supplier is only responsible for delivery of clean and safe water to the consumer, and that has no control over consumer's actions after the delivery. However, it is recommended that the supplier through relevant organization consider the safety of the quality of the supplied water by providing appropriate information to consumers to maintain water quality and safety which may be affected during handling and storage processes at the households.

Thus, household water treatment and safe storage (HWTS) is an important intervention to improve drinking water quality and thereby interrupt one major pathway of disease transmission. In order to develop effective mechanisms to encourage and sustain the correct use of the household water treatment and safe storage (HWTS), there is a need to monitor and evaluate uptake. During monitoring, indicators should be used to track the progress, and these indicators should be grouped according to *reported and observed use* as indicated in Table 3.5*.*

Table 3.5: Reported and observed indicators for monitoring drinking water safety at the point of use

Indicator	**Question**	**Answer/observation**
self-report treating drinking water	What do you usually do to the water to make it safer for drinking?	• *Nothing* • *Water is already safe* • *Boil* • *Bleach/chlorine* • *Strain through cloth* • *Filter* • *Solar disinfection* • *Stand and settle* • *Other (specify)*
Observation of drinking water treatment method	Ask to see drinking water treatment Method	• *Observe boiled water, fuel source* • *Observe chlorine bottle/tablets, test free chlorine residual (FCR)* • *Observe cloth, and if it appears intact* • *Observe filter, and if it appears intact* • *(i.e. not broken)* • *Observe if bottles are in house/on roof* • *Observe settling containers or* • *sediment* • *Other (if other option listed)*
self-report safely storing water	How do you store your drinking water?	• *Do not store water* • *In container with no lid or cover* • *In container with lid but no spigot/tap* • *In container with lid and spigot* • *In narrow-mouthed container* • *Other (specify)* • *Do not know*

In addition, randomly selected samples of water from households should be taken after every three months for microbial analysis to ensure effectiveness of the HWTS methods.

3.6 Drinking Water Quality Management in Communities not yet served with Potable drinking Water

Whilst the government is making progress in reducing water backlogs in the country, the un-served populations rely on rivers, streams, dams, springs, wetlands, boreholes and other raw water sources for drinking and other domestic purposes. In most cases, the quality of these water sources is unsatisfactory and to a large extent has not been determined.

Preventative drinking water quality management for the un-served communities focuses on protection of the catchment and raw water source used by un-served communities, and measures that can be implemented to reduce incidents associated with unsafe water consumption in un-served communities.

Whatever the source (ground, surface or rain water tanks), householders should assure themselves that the water they use is safe for their health. Generally, surface water or shallow groundwater should not be used as a source of drinking water without household water treatment. An individual household should consider having the water tested for any key health characteristics specific for the given areas as identified in the guidelines. For example, northern regions water should be tested for fluoride before being used for the intended purposes.

For monitoring drinking water in un-served communities, authorities both in urban and rural areas should observe the following:

i. Identify un-served communities and their existing water sources;

ii. Provide alternative water sources where possible (mobile water supplies/tanks should be provided while interventions are undertaken to improve the situation);

iii. Undertake water quality monitoring of water sources being used;

iv. Liaison with Basin Water Boards in protection of water sources, particularly in situations where communities are not yet served with potable water;

v. Liaison with affected communities to propose possible interventions to improve water quality;

vi. Use reported and observed indicators (Table 3.5) to track the quality of water being used in communities not yet served with potable drinking water.

CHAPTER FOUR

4.0 VERIFICATION OF DRINKING WATER QUALITY

Verification of drinking water quality provides an important link to the operation of water supply system and additional assurance that the preventive measures and treatment barriers in the water supply system have worked, and are working to supply safe drinking water. Verification process involves ***sampling*** and ***analysis*** of water for the purpose of assessing long-term system performance and identifying any trends or problems within the water supply system that may have gone unrecognized. The process is also carried out in order to assure consumers and regulators regarding the quality of water being supplied.

In relation to the present guidelines, verification shall be undertaken through ***operational monitoring*** by the water suppliers themselves. Operational monitoring is to ensure if the treatment works and distribution networks are operating effectively to deliver water that meets the standards, and provide early warning in case any source of water quality is deteriorating, report cases of treatment process failure or a problem in the distribution network.

The operational monitoring samples ***need not be*** analyzed in specialized laboratories. However, they may be analyzed in small laboratories or benches at the treatment works provided that the methods are properly calibrated and subject to analytical quality control. The operational monitoring ***should always be undertaken by water utilities themselves of any kind*** *(*either through in-house expertise or through a third-party arrangement*).* In this case, each control measure resulting from hazard identification (appendix 1) shall be monitored in a timely manner with the objectives of achieving effective systems management and ensuring that health-based targets are achieved.

Operational monitoring consists of the following elements:

i. Monitoring of the source water for parameter that provide a general indication of water quality, which if their concentration or value changed significantly would indicate that there could be deterioration in source water quality. It should also include any parameters that the treatment works are specifically designed to remove (refer chapter three);

ii. Monitoring of water treatment processes (coagulation, settlement and filtration processes) for those parameters that provide evidence of the effectiveness of treatment such as tests for optimum coagulation conditions, coagulant residual, pH value and turbidity, as well as monitoring disinfection process for those parameters that provide evidence of the effectiveness of disinfection such as chlorine residual, pH value and microbiological parameters, and monitoring if the water leaving the treatment works for parameters that the works are designed to remove (refer chapter three);

iii. Monitoring within the distribution network for parameters that provide evidence that there is no deterioration or contamination within the distribution (refer chapter 3).

4.1 Water sampling and analysis

Ideally, a laboratory infrastructure should be available to enable all samples to be returned to a laboratory within a few hours after being taken. However, this depends on the availability of a good road system and reliable motorized transport for all sampling officers. Although it is possible for water supply utilities to establish well-equipped laboratories for water analysis, this should necessarily be done on a relatively small number of simple tests (critical-parameter water testing).

It should be noted that in most communities, the principal risk to human health derives from faecal contamination. In some cases 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/intake, developed 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 drinking water supplies is always present. The minimum level of analysis should, therefore, include testing for parameters described in chapter three for monitoring drinking water quality in the water supply system.

A rational sampling and analytical strategy should be devised which carefully incorporate selected critical parameter tests, locations using simple methods, and portable water testing equipment where appropriate. Whenever possible, in rural areas the community should be involved in the sampling process. For the areas where water happens to be disinfected, health workers and sometimes community members can be trained to carry out simple chlorine residual testing. The same people can also be involved in collecting samples for physicochemical analysis and arrange for their delivery to the identified laboratory. Involving community members has significant implications in terms of training and supervision, but also it a way of ensuring more complete surveillance coverage and sustainability of the services.

4.1.1 Sampling

The present guidelines take into consideration experiences obtained from drinking water quality monitoring programmes in rural, urban and peri-urban communities, and therefore, sampling components should consider the location of sampling points, frequency, sampling methodology and sample storage as detailed in the following subsections.

4.1.1.1 Location of sampling points

Samples must be taken from locations that are representative of the water sources, treatment plant, storage facilities, distribution network, points at which water is delivered to the consumer, and points of use. In selecting sampling points, each locality should be considered individually. However, the following general criteria are usually applicable to all localities:

i. Sampling point should be selected in such a way that the samples taken are representative of the different sources from which water is obtained be the public or enters the system;

ii. The sampling points should include those that yield samples representative of the conditions at the most unfavorable sources or places in the supply system, particularly points of possible contamination such as unprotected sources, loops, reservoirs, low-pressure zones, ends of the systems, etc.;

iii. Sampling points should be evenly distributed throughout the pipes distribution system, taking population distribution into account and the number of sampling points should be proportional to the number of links or branches;

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

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

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

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

4.1.1.2 Monitoring frequency

The frequency of monitoring of each water quality parameter should consider the hazard and risk profile of the parameter as identified through analysis of the water supply system. In general, parameters that pose a high level of risk require more monitoring, while those posing a low risk require less monitoring. Typically, the most frequent monitoring is required for microbial safety, followed by known or identified high priority parameter and those with less frequent monitoring for any parameters that are not likely to present a risk.

Verification through operational monitoring for preventive measures and barriers throughout the water supply system must be carried out with sufficient frequency to promptly reveal any challenges or failures so that corrective actions can be taken. Continuous operational monitoring should be used whenever possible, particularly during essential processes identified as critical control points, such as disinfection and filtration.

Disease outbreaks associated with drinking water supplies are often linked to unusual events. Such events should, therefore, be recognized as potential triggers for more challenges and potential suboptimal performance. These should then alert water managers to the potentiality of the problems and the need for increased monitoring frequency of performance throughout the system. Unusual events that include any sudden or extreme change in weather, flow or water quality, as well as treatment variations, and maintenance and repairs require an increased monitoring frequency until there is confidence that the quality of water conforms to the required standards.

Frequency of observations may be increased at times of increased risk; for example, inspections of reservoirs for algal blooms may be more frequent during dry season, or folk blanket observations during the coagulation process may be increased when there are higher flow rates through the treatment plant.

Verification through operational monitoring requirements and frequency of monitoring will vary for each water supply, depending on the key characteristic identified through analysis of the water supply system and risk assessment. Besides, the minimum sampling frequency outlined in Table 7, and the parameters required for minimum monitoring as indicated in Table 8 of the Tanzania Standards (TZS 789:2016) to be considered but things to observe in monitoring frequency within a catchment to consumer during ***operational monitoring program*** are as indicated in Table 4.1 (risk-based operational monitoring).

Table 4.1 Risk-based operational monitoring program (characteristics and frequencies)

Location	**Characteristics/parameters**	**Monitoring frequency**	**Rationale for monitoring frequencies**
Catchment			
General catchment	Rain fall	Daily	Understand impact of rainfall on water quality to help predict challenge under range of rainfall intensity.
	Inspection	Monthly to Daily Frequency depends on the level of access and use permitted in catchment.	Detect human and animal activities that could cause contamination; confirm that fences and signs are effective.
Source Water			
Storage dam or raw water reservoir	Temperature and Dissolved oxygen profile	Monthly to weekly	Information for management of water quality in storage with existing or new management systems.
	General water quality profile	Weekly to event-based	Allow best quality water to be selected for supply.
	Inspection	Weekly	Detect human and animal activities that could cause contamination.
	Coliform bacteria	Risk-based	Information for changes to water treatment processes in order to maintain optimal *coliform bacteria* removal.
	Turbidity	Continuous	Information for

	Color	Weekly to event based	changes to water treatment processes in order to maintain optimal turbidity and color removal.
River intake	Rainfall	Daily	Understand the impact of rainfall on water quality to help predict challenge under range of rainfall intensity.
	Turbidity	Continuous	Inform changes to water treatment processes in order to maintain optimal turbidity and color removal.
	Color	Weekly to event-based	
	Turbidity	(Rain-related monitoring)	Understand rainfall effects.
	E.coli	Risk-based	Identify high challenge periods and forewarn downstream processes; identify local point source of contamination. Intervene in catchment before reservoir is affected.
	Pesticides and color	Risk-based	Feedback to industry and source of contamination.
	Other chemicals (e.g. Iron and Manganese)	Weekly (risk-based)	Inform changes to water treatment processes in order to maintain optimal iron and manganese removal; forewarn of water quality that may cause customer complaints.
Treatment Processes			

Coagulation (inlet to flocculation tank)	pH	Daily to Continuous	Optimize pH for effective coagulation of selected coagulants when raw water quality changes. Provide alarm if pH is outside set limits.
Flocculation (last compartment)	Flock characteristics	Daily to Event-based	Optimize flock characteristics for effective clarification or filtration when changes occur to raw water quality or operating conditions.
Clarifier (clarified water outlet)	Turbidity	Daily to continuous	Confirm coagulant dose, pH correction, flocculation and clarifier operations are optimized when changes occur to raw water quality or operating conditions.
	Color	Daily to Event-based	Provide alarm if turbidity is above set limits.
	Visual observation of flock or flock blankets	Daily to Event-based	Assess if adjustment needed to process to improve stability of clarification process.
Filtration (Individual or combined filtered water)	Turbidity	Continuous	Provide alarm if filtrate turbidity is above set maximum and trigger for initiating filter cleaning to avoid turbidity breakthrough.
	Filter Head loss	Continuous	

Filtration (Combined filtered water post pH correction)	pH	Continuous	Confirm target pH range is maintained. Provide alarm if pH is outside target limits for effective disinfection and corrosion control.
	Aluminum (If aluminum-based coagulant used)	Weekly	Assess inadvertent carry-over of aluminum from sub-optimal flocculation pH.
Chlorine Disinfection	Free chlorine Residual	Continuous	Provide alarm if chlorine residual is outside set limits for maintaining integrity of water quality during reticulation and for reticulation hygiene.
UV Disinfection	UV dose rate	Continuous	Confirm UV system is operating satisfactorily. Provide alarm if below minimum set dose.
Distribution System			
Disinfection (at various locations in the reticulation system selected by careful during monitoring design)	Chlorine residual	Continuous to Daily	Confirm total chlorine target or free chlorine residual target range are achieved.
Service Reservoirs and tank	Integrity from contamination	Quarterly to semi-annual or risk-based	Confirm roof/hatches are effective against ingress of contaminants.

Consumers	Customer complaints	Ongoing	Clusters of complaints of turbidity, objectionable taste and odor, illness allow investigation to identify cause (s) of water quality problems.

4.1.1.3 Sampling methods for microbiological analysis

When water samples are collected for analysis, care should be taken to ensure that there is no external contamination of the samples. Unless valid samples are collected, the results of the subsequent analyses may be misleading. Any types of bottles may be used for sampling, but glass bottles are the best. The bottles to be used should have securely fitting stoppers or caps with nontoxic liners, and both bottles and stoppers should be sterilized. Each cap should have a metal sleeve clear of the screw thread to ensure that the risk of contaminating the water sample is minimized. Cotton wool plugs and paper caps should be avoided as they tend to fall off during and after sampling, thus increasing the risk of contamination.

The bottles should hold at least 200ml of water. It should be understood that whenever chlorine is used for disinfection, the chlorine residual may be present in the sample and therefore continue to act on any bacteria in the sample taken for microbiological analysis. In this case, the results of the analysis may, therefore, not be indicative of the true bacteriological content of the water. To overcome this challenge, *sodium thiosulfate* should be added to the sample, which immediately inactivates any residual chlorine without affecting the microorganisms that may be present in the sample. The *sodium thiosulfate* should be added to sample bottles before they are sterilized. For 200-ml samples, four or five drops of aqueous *sodium thiosulfate* solution (100 g/liter) should be added to each clean sample bottle. The stopper should be loosely inserted into the bottle, and a brown paper or aluminium foil cover should be tied to the neck of the bottle to prevent dust.

The bottle should then be sterilized in hot-air oven for 1 hour at 160^0C or 170^0C for 40 minutes or in an autoclave at 121^0C for 20 minutes. If those facilities are unavailable, a portable sterilizer or pressure cooker can be used, but sterilization will then take 30-45 minutes. To prevent the stopper from getting stuck during sterilization, a strip of brown paper (75 X 10 mm) should be inserted between the stopper and the neck of the bottle. For reasons of cost, bottles should be reused after the samples have been analyzed in the laboratory and should be re-sterilized and, if possible, returned to the sender. Sampling methodology depends on the sampling locations or points (from water course/source/intake, distributions, fixed pump outlets, dug well etc.). The following subsections provide details of those sampling points:

4.1.1.3.1 Sampling from a tap or pump outlet

Sampling from a tap or pump outlet should take into account the following procedures:

i. Clean the tap
Remove from the tap any attachments that may cause splashing. Using a clean cloth, wipe the outlet to remove any dirt.

ii. Open the tap
Turn on the tap at maximum flow and let the water run for 1- 2 minutes

Note 02: Some investigators do not continue to stages iii and iv, instead they take the sample at stage ii; in this case, the tap should not be adjusted or turned off, but left to run at maximum flow. The results obtained in this way will provide information on the quality of the water as consumed. If the procedure is continued to stage iii and iv, however, the results represent the quality of the water excluding contamination by the tap.

iii. Sterilize the tap
Sterilize the tap for a minute with the flame from a gas burner, cigarette lighter, or an ignited alcohol-soaked cotton wool swab.

iv. Open the tap before sampling
Carefully turn on the tap and allow the water to flow for 1 – 2 minutes at a medium flow rate. Do not adjust the flow after it has been set.

v. Open the sterilized bottle
Take out a bottle and carefully unscrew the cap or pull out the stopper

vi. Fill the bottle
While holding the cap and protective cover face downwards (to prevent entry of dust, which may contaminate the sample), immediately hold the bottle under the water jet, and fill.

vii. Stopper or cap the bottle

Place the stopper in the bottle or screw on the cap and fix the brown paper protective cover in place with the string. A small air space should be left to make shaking before analysis easier.

4.1.1.3.2 Sampling from a watercourse or reservoir

Open the sterilized bottle as described in section 4.1.1.3.1

Fill the bottle

Holding the bottle by the lower part, submerge it to a depth of about 20cm, with the mouth facing slightly upwards. If there is a current, the bottle mouth should face towards the current. The bottle should then be capped or stoppered as described previously.

4.1.1.3.3 Sampling from dug wells and similar sources

i. Prepare the bottle

With piece of string attach a clean weight to the sampling bottle

ii. Attach the bottle to the string

Take a 20-m length of clean spring rolled around a stick and tie it to the bottle string. Open the bottle as described in section 4.1.1.3.1

iii. Lower the bottle

Lower the bottle, weighed down by the weight, into the well, unwinding the string slowly. Do not allow the bottle to touch the sides of the well.

iv. Fill the bottle

Immerse the bottle completely in the water and lower it well below the surface without hitting the bottom or disturbing any sediment.

v. Raise the bottle

Once the bottle is judged to be filled, rewind the string on the stick to bring up the bottle. If the bottle is completely full, discard some water to provide an air space. Stopper or cap the bottle as described previously.

4.1.1.4 Storage of samples for microbiological analysis

Although recommendations vary, the time between sample collection and analysis should, in general, not exceed 6 hours. However, 24 hours is considered the absolute maximum. It is recommended that the samples immediately be placed in a lightproof insulated box containing melting ice or ice-packs with water to ensure rapid cooling. If ice is not available, the transportation time must not exceed 2 hours.

Note 03: It is imperative that samples are kept in the dark and that cooling is rapid. If these conditions are not met, the samples should be discarded. When water that contains or may contain even traces of chlorine is sampled, the chlorine must be inactivated. If it is not, microbes may be killed during transit and an erroneous result will be obtained. The bottles in which the samples are placed should therefore contain sodium thiosulfate to neutralize any chlorine present, as described in 4.1.1.3. The box used to carry samples (cool box) should be cleaned and disinfected after each use to avoid contaminating the surfaces of the bottle and the sampler's hands.

4.1.1.5 Sampling methods for physicochemical analysis

Results of physicochemical analysis are of no value if the samples tested are not properly collected and stored. This has important consequences for sampling regimes, procedures, and methods of sample preservation and storage. In general, the time between sampling and analysis should be kept to a minimum. Storage in glass or polyethylene bottles at a low temperature (e.g. 4^0 C) in the dark is recommended. Sample bottles must be clean but need not be sterile. Special preservatives may be required for some analyses.

Note 04: Residual chlorine, pH and turbidity should be tested immediately after sampling as they will change during storage and transportation.

4.1.2 Analysis

4.1.2.1 Bacteriological Analysis

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 drinking water quality control. Other microbiological indicators which are not necessarily associated with faecal pollution, may also be used for this purpose, as Table 5 – TZS 789:2016 indicates.

The use of standardized methods and laboratory procedures is very important during analysis of bacteria in water samples. International standard methods should be evaluated under local conditions before they are formally adopted.

The principal methods used in the isolation of indicator organisms from water are the membrane-filtration (MF) method, the multiple-tube (MT) or most probable number (MPN) method and plate count (PC).

4.1.2.1.1 Selection of Analytical Methods

The selection between the multiple-tube, the membrane-filtration methods and/or plate count will depend on local factors such as the availability of equipments and the cost of the required consumables. The schematic decision-making network should aid the selection of procedure and method to be used.

Note 05: The detailed laboratory procedures for enumerating bacteria in water by using the above methods can be found in the laboratory standard operating procedures (SOPs) as well as the standard methods available in the Ministry's Water Quality Laboratories

4.1.2.2 Physicochemical analysis

Although the great majority of quality problems with community drinking water are related to faecal contamination, a significant number of serious problems may occur as a result of chemical contamination from a variety of natural and man-made sources. In order to establish whether or not such problems exist, chemical analyses must be undertaken. However, it would be extremely costly to undertake the determination of a wide range of parameters on a regular basis, particularly in the case of supplies that served small numbers of people. Fortunately, such parameters tend to be less variable in source waters than faecal contamination, so that alternative strategies can be employed. Moreover, experience shows that in many, but not all, such incidents, the water becomes undrinkable owing to unacceptable taste, odour and appearance.

In order to establish whether or not this type of problem exists, a selected numbers of chemical parameters have to be measured. However, it may be both costly and physically impractical to cover a large number of parameters, particularly in the case of rural water supplies and small towns water schemes, but issues that should be considered in developing chemical analysis verification are as follows:

i. The availability of appropriate analytical facilities;
ii. Cost of analysis;
iii. The possible deterioration of samples;
iv. The stability of the contaminant;

v. The likely occurrence of the contaminants in various supplies;
vi. The most suitable point for monitoring and the frequency of sampling.

Note 06: For a given chemical, the location and frequency of sampling will be determined by its principal sources and variability in its concentration. Substances that do not change significantly in concentration over time require less frequent sampling than those that might vary significantly.
Note 07: In many cases, analysis of source of water quality once per year, or even less, may be adequate particularly in stable groundwater, where the concentrations of naturally occurring substances of concern show little differences across time. Concentrations of naturally occurring substances are likely to be variable in surface waters, therefore may require a greater number of samples and frequencies, depending on the contaminant and its importance. Sampling locations will depend on the water quality characteristics being examined.

With regard to these guidelines, a range of chemical parameters that can be monitored are as indicated in respective stage of drinking water supply system described in chapter 3. However, monitoring parameters may be added or changed accordingly to suit specific circumstances of a site.

4.1.2.3 Delays in Sample Transportation

If there are delays in sample transportation and analysis, a report for remedial action (if any) is also likely to be delayed. For these reasons, on-site water testing using portable equipment is appropriate particularly in remote areas. Portable equipment can be used to overcome a number of logistic and financial constraints. However, the equipment varies widely in terms of technical specifications including the range of analyses that can be performed, the range of methods employed, its robustness, the degree of independence from laboratory facilities, its portability, and requirements for consumables.

Portable testing equipment may also be favored by agencies that undertake surveillance in more than one area on a non-routine basis, and therefore prefer portability to the establishment of a conventional laboratory. Portable equipment may also be used in conventional laboratories in place of normal laboratory equipment, especially when the number of analyses to be performed per day is relatively low. Other factors that may necessitate the use of portable equipment in conventional laboratories are as follows:

i. ***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 voltage fluctuation or intermittent supply), battery operation may be advantageous;

ii. ***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;

iii. ***Ease of use***: portable equipment is often designed for use by any personnel who can interpret the measured value; its use is usually straightforward. However, this does not obviate the need for employing qualified personnel to handle water quality matter in the utility.

4.1.2.4 Analytical quality assurance and quality control

In the context of analytical work, the terms quality assurance and quality control are often treated as synonymous. Analytical quality control is the generation of data for the purpose of assessing and monitoring how good an analytical method is and how well it is operating. This is normally described in terms of within day-to-day precision.

On the contrary, analytical quality assurance comprises all the steps taken by a laboratory to assure valid results are produced. Quality assurance thus encompasses analytical quality control but also includes many other aspects such as proving that the individuals who carry out an analysis are competent and ensuring that the laboratory has established and documented analytical methods, equipment calibration procedures, management lines of responsibility, systems for data retrieval, sample handling procedures and so on. A checklist for effective analytical quality assurance is given in Table 4.2.

Table 4.2 Checklist for effective analytical quality assurance

Do laboratory personnel have	- Clearly defined responsibilities? - Qualifications? - Experience? - Training?
Is Space:	- Adequate for the types and number of analyses being undertaken?
Is equipment:	- Adequate? - Regularly serviced and maintained? - Calibrated and used only by authorized personnel
Are materials:	- Bought from a reliable supplier, who carries out quality control?

Are there proper facilities:	- For the receipt and storage of samples, and systems for coding and identifying them?
Are data:	- Archived? - Retrievable?
Are methods:	- Validated? - Documented? - Monitored (i.e. the results subjected to analytical quality control)?
Is safety assured by:	- Adequate working and waste-disposal procedures? - Training of staff? - Proper maintenance of equipment? - Proper supervision of staff? - Personal protective gears?

4.1.2.5 Field and Laboratory Safety Management

The safety of staff undertaking analytical procedures, both in the field and in the laboratory is of the greatest importance. All staff should be trained in safety procedures relevant to their work. Staff members or newly employed staff should be authorized to undertake procedures involving risk of any type only after being trained. Unauthorized staff should not be allowed to undertake analysis in the field or in the laboratory.

4.1.2.5.1 Safety in Fieldwork

Field staff should be trained to recognize and deal with any possible hazards they are likely to encounter. If fieldwork involves working in surface water like river or lake, staffs should be aware of appropriate safety equipment to be used. In addition to that, a basic first-aid kit should be carried at all times during the drinking water quality monitoring exercise especially in rural and remote areas. Precautions should be given out to all field analyses.

4.1.2.5.2 Laboratory Safety

All laboratories should formulate and implement a safety policy that should cover cleaning, disinfection, and the containment of hazardous substances. Staffs should adhere to Material safety Data sheet (MSDS) during analysis which involves the use of any chemical/reagent. Safety equipment such as fire extinguishers, personal protective gears and first-aid kits should be suitably located, and readily available. These safety facilities should be routinely checked and all staff should be trained on their uses. The laboratory should carryout regular training on issues pertain to safety such as:

i. Supervision and provision of information to all staff members to reduce risk which may result from inappropriate practices by following both regulatory and operational procedures;

ii. Proper use of safety equipment such as Personal Protective Equipment (PPE), and apparel to the staffs and provision of suitable facilities to perform the task in a safe manner;

iii. Conducting regular and periodic safety audits to assess the environmental health and safety performance of the respective laboratory;

iv. Enforcing safety rules, procedure, practices and demonstrate safety behavior and promote a culture of safety in every aspect of laboratory operations;

v. Be proactive in every aspect of laboratory safety and making safety a priority;

vi. Ensuring that all Staffs comply with all safety requirements, acting in a responsible and constructive manner and highlighting any areas of risk and taking care of themselves and others.

CHAPTER FIVE

5.0 SURVEILLANCE OF DRINKING WATER QUALITY

5.1 Drinking water quality surveillance approaches

Surveillance of drinking water quality is planned to ensure that routine set of activities used to determine control measures continue to work effectively. Surveillance of drinking water quality is the continuous and vigilant public health assessment and review of the safety and acceptability of drinking water supplies. Surveillance contributes to the protection of public health by promoting improvement of the quality, quantity, accessibility, coverage, affordability and continuity of water supplies (known as service indicator), and is complementary to the quality control function of the drinking water supplier.

With regard to these guidelines, surveillance of drinking water shall be undertaken through ***compliance monitoring*** whereby determination is done to check whether water supplies comply with the standards and indicator parameter values as stipulated in the regulations. In this case compliance monitoring samples should be analyzed in well-established laboratories with all the capacities (authorized laboratories) and ***always should be taken by surveillance agencies***. However, this does not limit the water supply entities to undertake compliance monitoring ***in any kind either*** through in house expertise or through third party arrangement***.***

Note 08: Drinking water supply surveillance does not remove or replace the responsibility of the water supplier of ensuring that a drinking water supplied is of acceptable quality and meets predetermined health based targets.

This chapter addresses the work to be done by surveillance agencies and/or drinking water suppliers and the following surveillance approaches will be undertaken to ensure effective and efficiency of drinking water quality:

5.1.1 Audit Approach

In the audit approach, assessment activities including verification would be undertaken largely by the supplier, with third-party auditing to verify compliance. It is increasingly common that analytical services are procured from external laboratories. An audit approach requires the existence of a stable source of expertise and capacity within the monitoring agency in order to:

i. Examine the records to ensure that system management is being carried out in a proactive approaches;

ii. Ensure that operational monitoring parameters are kept within operational limits and that compliance is being maintained;

iii. Ensure that verification programmes are operated by the water supplier (either through in-house expertise or through a third-party arrangement);

iv. Assess supporting programmes and strategies for improving and updating the Water Safety Plans (WSPs) if exist;

v. Undertake in some circumstances, sanitary inspection, which may cover the whole of the drinking water system including sources, transmission infrastructure, treatment plants, storage reservoirs and distribution systems.

The implementation of an audit-based approach places responsibility on the drinking water supplier to provide the surveillance agency with information regarding system performance against agreed indicators.

In addition, a programme of announced and unannounced visits by auditors to drinking water suppliers should be implemented to review documentation and records of operational practice in order to ensure that data submitted are reliable. Such an approach does not necessarily imply that water suppliers are likely to falsify records, but it does provide an important means of reassuring consumers that ***there is true independent verification*** of the activities of the water supplier. The surveillance agency will normally retain the authority to undertake some analysis of drinking water quality to verify performance or enter into a third-party arrangement for such an analysis. This approach is appropriate to be undertaken by all surveillance agencies that are directly and/or indirectly involved in regulating water supply authorities ***e.g. EWURA*** which regulates Urban and Small Towns Water Supply and Sanitation Authorities and other agencies deemed appropriate for the purposes.

5.1.2 Direct Assessment Approach

It may be appropriate for the drinking water supply surveillance agency to carry out independent testing of water supplies. Such an approach often implies that the agency has access to analytical facilities with staff trained to carry out sampling and analysis. Direct assessment also implies that surveillance agencies have the capacity to assess findings and to report to and advise suppliers and communities. A surveillance programme based on direct assessment would normally include:

i. Sampling which should be carried out by qualified personnel;

ii. Tests that should be conducted using suitable methods by water quality laboratories or using approved field testing equipment and qualified personnel;

iii. Sanitary inspections which should be carried out by qualified personnel;

iv. Procedures on reporting findings and follow up to ensure that they have been acted on.

For community-managed drinking water supplies and where the development of in-house verification or third-party arrangements is limited, direct assessment may be used as the principal system of drinking water quality monitoring. This may apply to drinking water supplies in small towns or local government. Direct assessment may lead to the identification of requirements to amend or update the WSP if present, and where direct assessment is carried out by the surveillance agency, it complements other verification testing of the water supplier. An example of the surveillance agency appropriate for this approach is ***Water Quality Laboratories under the Ministry of Water***.

5.1.3 Adapting approaches to specific circumstances

Adaptive approaches surveillance will be undertaken in specific circumstances where control of water quality and implementation of drinking water quality monitoring programmes often face significant constraints. Those situations will include community drinking water supplies, household water treatment, and safe storage systems.

5.1.3.1 Community drinking water supplies

Community-managed drinking water supplies are the predominant form of drinking water supply for large parts of the population in rural areas. Community-managed supplies may include simple piped water systems or a range of point sources such as boreholes with hand pumps, dug wells and protected springs. The control of water quality and implementation of monitoring programmes for such supplies often face significant constraints including the following:

i. Limited capacity and skills within the community to undertake process control and verification. This increases the need both for surveillance to assess the state of drinking water supplies and for surveillance staff to provide training and support to community members;

ii. Large number of widely dispersed supplies which significantly increases overall costs in undertaking surveillance activities.

Thus, surveillance of community drinking water supplies requires a systematic programme that encompasses all aspects of the drinking water supply to the population as a whole, including sanitary inspection, catchment inspections, institutional and community aspects. In the evaluation of the overall strategies, the principal aim should be to derive overall lessons for improving water safety for all community supplies, rather than relying on monitoring the performance of individual supplies.

Frequent visits to every individual COWSO may be impractical because of the very large numbers of such supplies and the limitations of resources for such visits. However, surveillance of large numbers of community supplies can be achieved through a rolling programme of visits. The aim should be to visit each supply periodically (quarterly at a minimum). During each visit, sanitary inspection and water quality analysis should be done to provide insight on the contamination of community drinking water. The surveillance agency appropriate for this circumstance is ***MOWI's Water Quality Laboratories and other agencies as deemed suitable for the purposes.***

5.1.3.2 Household water treatment and storage systems

Where water is handled during storage in households, it may be vulnerable to contamination, and sampling of household stored water is of interest in independent surveillance. It is often undertaken on a "survey" basis to develop insights on the extent and nature of prevailing problems. The ***surveillance agency appropriate for this circumstance is the Ministry responsible for Health and other agencies deemed appropriate*** for the purposes.

The indicators to be used in the verification of household water treatment and safe storage include those mentioned in table 3.5, in chapter three.

5.2 Surveillance Agencies

Surveillance agency must have access to expertise on drinking water and water quality, and must be responsible for independent (external) surveillance through periodic audit of all aspects of drinking water safety. Surveillance of drinking water quality is also used to ensure that any transgressions that may occur are appropriately investigated and resolved. In this regard, it will be more appropriate to use surveillance as a mechanism for collaboration between surveillance agencies and drinking water suppliers to improve drinking water supply than to resort to enforcement, particularly when the community-managed drinking water suppliers are the source of the problem.

For smooth implementation of these guidelines, a dual-role approach, which differentiate the roles and responsibilities of service providers (water supply utilities) from those of an authority responsible for independent oversight ("drinking water supply surveillance"), is of paramount. Organizational arrangements for the maintenance and improvement of drinking water supply services should, therefore, take into account the vital and complementary roles of the agency responsible for surveillance and of the water supplier. On the one hand, an authority involved in supplying water for consumption by any means should be required to ensure and verify that the systems they administer are capable of delivering safe water and that they routinely achieve this. On the other hand, a surveillance agency is responsible for independent (external) surveillance through periodic audit of all aspects of safety and/or verification testing.

The Guidelines are intended to apply from catchment to consumer; as such, address the necessity of inter-agency involvement. Drinking water suppliers are responsible for the quality of drinking water delivered to consumers, hence should be the role model in the implementation of the Guidelines. However, implementation will generally require coordination and consultation with other agencies. The range of agencies involved in individual water supply systems will need to be determined and relevant agencies need to be encouraged to recognize their roles and responsibilities as stipulated in the Guidelines. The agencies should also support drinking water suppliers through partnership agreements. The breadth and depth of partnership arrangements between agencies and the mechanisms by which they operate will vary in terms of jurisdictions, depending on the division of responsibilities and legislative authorities.

The Guidelines should be applied at the state level using a whole-of-government approach as indicated in table 7.1, with each agency responsible for implementing the Guidelines within its areas of control and consulting with relevant partnership agencies. This approach requires a high level of commitment by all agencies, clear definition of accountabilities and responsibilities within the Guidelines, and increased communication and coordination of planning and management of activities.

5.3 Compliance Sampling Sites

For these guidelines, surveillance agencies shall undertake compliance sampling in the form of:

i. Fixed and agreed with the Water Supply Utilities;

ii. Fixed, but not agreed with the Water Supply Utilities or

iii. Random or variable.

Each type of sampling site has certain advantages and disadvantages as elaborated in the following:

Fixed sites agreed with the supplier are essential when legal action is to be used as a means of ensuring improvement; otherwise, the supply authority may object to a sample result on the grounds that water quality may have deteriorated in the household beyond the area of responsibility of the supplier. Nevertheless, fixed sampling points are rare or unknown in some water supply utilities.

Fixed sites that are not necessarily recognized by the supply authority are used frequently in investigations, including surveillance. They are especially useful when results have to be compared over time, but they limit the possibility of identifying local problems such as cross-connections and contamination from leaking distribution networks.

Sampling regimes using variable or random sites have the advantage of being more likely to detect local problems but are less useful for analyzing changes over time. Sampling strategies for compliance to be used are as shown in Table 5.1

Table 5.1: Sampling Strategies

Strategies	Description
Distribution System	Sampling system components including raw water treatment, water and piped network water
Geographic	Sampling an area of jurisdiction that may contain multiple source type

Population based	Sampling the source serving areas with highest population densities
Risk-based	Sampling area where disease rates are known to be high
Reactive	Sampling after disease outbreak or after resolving distribution problem
New points	After new water source is established
Ad-hoc	Sampling points determined by sample collector

CHAPTER SIX

6.0 RESPONSE TO MONITORING DATA, DOCUMENTATION AND REPORTING

6.1 Response to Monitoring Data

Assuring drinking water safety is essential exercise in risk management and thus often requires making important decision on drinking water quality data without complete or compelling evidence. Concurrently, monitoring data should be interpreted in the context where all relevant information is available. Monitoring results alone are not enough, therefore, careful consideration should be given to all risk factors that can be identified such as turbidity spikes, loss of chlorine residual, maintenance and repairs, known contamination of the water supply, heavy rainfall and runoff events, etc. This information is critical in search for convincing evidence and interpreting the significance of positive results.

In order to ensure protection of public health, drinking water suppliers must undertake the following:

i. A rapid response to adverse monitoring and immediate decisions that must often be required;

ii. A coordinated response to any adverse monitoring results is important and a response protocol to confirm initial monitoring results should be prepared in advance to deal with such events;

iii. Readily available evidence such as filtration or disinfection plant performance results that can be collected and used quickly to assist interpretation of monitoring data;

iv. In other cases it may be appropriate to wait on confirmation of results and collect further evidence without putting public health at risk;

v. Sufficient supporting evidence of potential contamination to warrant immediate actions prior to confirmation from further testing;

vi. Drinking water supplier must decide when it is appropriate to act immediately or to delay possible response actions pending confirmation and additional information;

vii. Considerable proximity of the situation, the potential magnitude of the event and corresponding to health risks, as well as other site specific circumstances such as availability of sufficient storage, potential of closing intakes, and using alternative sources of water (plans for emergency water supplies);

viii. A formal and defensible process must be in place whereby evidence is collected to enhance the judgment of decision makers;

ix. The proper interpretation of monitoring data and appropriate strategy for responding to monitoring results are important consideration for the effective public health protection.

Note 09: Designing more strategic drinking water quality monitoring system can provide the understanding and supporting evidence to judge more effectively the meaning of any given positive test result. Better sampling or analytical techniques alone are not enough to improve the interpretation and response to monitoring results. Clearly, the greater the understanding and knowledge of water system, its catchment, the treatment capabilities and performance, the better interpretation and decision making can be. Thus, the practice and quantitative qualities of monitoring data must be recognized so that monitoring strategies and programs can be planned effectively to support this.

Note 10: The strategy for responding to any adverse monitoring result must be a well-developed protocol to ensure that follow-up is conducted for all monitoring results and that subsequent actions are taken and decisions are made according to the evidences obtained. The challenge, however, is to take sensible and responsible actions and make decisions based on evidence collected from a considered approach. Therefore, action should always be taken before discounting any positive results.

Note 11: A common response to positive screening results of rare hazards is re-sampling the treated water. Negative results on repeated sampling do not necessarily imply the previous positive results were false. However water quality does not remain constant, so resampling will only be effective in cases of on-going contamination and may not be effective for intermittent contamination because the hazard may truly be absent in the re-sample. Intermittent contamination may still affect the health of some consumers. Therefore, finding ways to re-analyze a sample is an important aspect of research, and attention must be given to samples to make sure that they are not contaminated.

6.2 Documentation and Reporting

Appropriate documentation provides the foundation for the establishment and maintenance of an effective drinking water quality management system. Documentation also provides a basis for effective communication within the organization as well as within the community and various stakeholders. A system of regular reporting, both internal and external, is important to ensure that the relevant people receive information needed to make informed decisions about the management or regulation of drinking water quality and indicators. Reporting publicly on drinking water quality performance ensures a high level of transparency and public accountability.

6.2.1 Reporting on Results of Drinking Water Monitoring Programme

Under these guidelines, Drinking Water Suppliers are required to provide the responsible regulator with a summary of water quality monitoring results, according to their current drinking water monitoring programme. The summary of monitoring results should be reflective of the following areas within the service:

6.2.1.1 Water Source

Results reported here should be representative of the raw water from the source. The actual location of sampling points will depend on the individual conditions of the scheme. For example, samples may be taken at the off take from the water source or from the raw water entering the water treatment plant. For a scheme with more than one water source, each source, while in use, should be monitored individually and results from each individual source should be reported.

6.2.1.2 Water treatment plant

Results reported here should be representative of the final treated water and be taken from a point following satisfactory completion of all treatment and contact with disinfectant.

6.2.1.3 Distribution

Results reported here include any location at which water is sampled in the bulk transfer pipeline system which transmits water to the reticulation system. This may include pump stations and service reservoirs. Sampling from the distribution may not be applicable to all providers. It is not expected for the provider to report on each individual sampling point, unless that sampling point is the only point within the transmission system.

6.2.1.4 Reticulation

Results reported here include any location at which water is sampled in the reticulation system. Providers should provide maximum, minimum and average results for all chemical samples taken in the reticulation system. E coli or other microbiological re-samples taken as a result of an initial detection in the reticulation system need to be reported.

6.2.1.5 Incident reporting

Providers must report any incident that will or is likely to adversely affect water quality. The importance of reporting incidents to the regulator is to ensure that actions are taken by the provider for the purpose of managing risk factors on public health. Providers are also required to report on actions taken to manage the incidents. The following examples illustrate possible incidents that are reportable and/or non-reportable to the responsible regulator.

Example 1: A water utility uses river water flowing from catchments with extensive agricultural activity and routinely tests for pesticides in the source and treated water is being undertaken whereby DDT is detected in the source water above the water quality criteria of 1µg/L (Tanzania standard), if this is the only sampling point for the service, the provider must report the result to the responsible regulator. If the utility undertakes further sampling in the treated water for DDT, and the level is above 1µg/L, the utility must report the result to the responsible regulator, but if the level is below 1µg/L, the provider does not have to report the result to the regulator.

Example 2: Hardness (as $CaCO_3$) does not pose a health risk, but high levels may lead to customer dissatisfaction due to scaling and inability to lather. The standard recommends an aesthetic value of 300mg/L for drinking water. If the concentration is above 300mg/L, problems with scaling may increase as hardness increases. Water supply entities aim to provide much lower concentrations of hardness in the treated drinking water. However, these efforts may fail and thus, may not be able to reduce hardness below the aesthetic guideline value due to high levels in source water and/or the cost of treatment. The provider is not required to report this to the responsible regulator.

6.2.1.6 Event

An event as used in these guidelines refers to any sudden or extreme change in water quality, flow or environmental conditions, for example, excessive rainfall or flood, or equipment failure. An event should raise concerns that drinking water might be, or could become contaminated. Disease outbreaks from drinking water may result when the treatment process fails to cope with major fluctuations in source water quality or flow. Therefore, it is essential that Drinking Water Suppliers are aware of the implications of such events and only events that have the potential to affect the drinking water quality are required to be reported.

In some cases, a Drinking Water Supplier may sit back believing that the impacts of the drinking water quality that arising from an event can be managed using normal mitigation actions or treatment processes, but after a while find that the situation has not been resolved. In this case, the entity must report this to the responsible regulator regardless of time span of the event itself. An event that may impact the quality of drinking water is illustrated below.

Example: Turbidity is a useful indicator for monitoring the effectiveness of treatment processes. Turbidity levels provide an indication of the effectiveness of filtration processes. However, deviation from operational (or other) limits set for turbidity does not necessarily constitute a risk to public health, although it may indicate potential impacts on the effectiveness of chlorine disinfection processes. Often, in times of heavy rainfall or flooding, turbidity levels in source water increase substantially. When this occurs and the treatment processes are unable to effectively reduce the turbidity levels to ensure effective disinfection, the provider must report it as an event.

6.2.1.7 Customer Satisfaction

As part of commitment of the Drinking Water Suppliers to continuously improve their services, it is important for them to measure customer satisfaction and identify area of weakness for improvement. Thus customer satisfaction survey findings should be reported in order to build confidence for the services being offered.

6.2.2 Type of Reports

There are various types of reports that must be prepared in any process of monitoring the quality of drinking water. These reports are clarified in the following subsections:

6.2.2.1 Monthly report (Operational monitoring report)

This is usually a summary report of the compliance of the drinking water quality during the month. It is useful in assessing the system's performance, treatment process efficiency and infrastructure problems. Monthly reports are also useful for benchmarking purposes. Benchmarking plays an important role in assessing the performance of water services from one authority or institution against the other, thus promoting learning and exchange of information between the institutions. This report is normally for internal consumption within the entity.

6.2.2.2 Quarterly report (Consultative audit report)

This report is proposed to be used by Consultative Audit teams to assess compliance of each Water Supply Utility with the Compulsory National Standards for Drinking Water (Potable Water). These audits can be used to determine required regulatory intervention, assess progress in achieving drinking water quality compliance, and recommend capacity building where necessary.

6.2.2.3 Semi-Annual (Mid-year audit report)

This report is used to check whether the water quality monitoring plans are implemented effectively. It is also used to check possibility of necessary review of monitoring plans. The objective of semi-annual report is to provide a visual presentation of drinking water quality monitoring data submitted to an institution and to discuss key important issues that occurred.

6.2.2.4 Annual Report (Stakeholder information report)

Annual reports should be produced and made available to consumers, regulatory authorities and stakeholders. The report must summarize drinking water quality performance over the preceding year against numerical guideline values and regulatory requirements. The report should include targets for water services quality, performance against targets, interventions undertaken to improve drinking water services during the annual period such as instituting monitoring programmes, upgrading infrastructure and working with Basin Water Boards to improve raw water quality. Reports should also provide a summary of system failures and the action taken to resolve them. Annual reports should also provide a mechanism for feedback and encourage consumers and stakeholders to provide comment on the quality of the water supplied in their areas.

CHAPTER SEVEN

7.0 ROLES AND RESPONSIBILITIES OF DIFFERENT STAKEHOLDERS IN MONITORING DRINKING WATER QUALITY

This chapter provides brief descriptions of specific responsibilities of key stakeholders for effective management of drinking water quality. Drinking water quality management in the country is a shared responsibility of different stakeholders, and everyone has a role to play to ensure that drinking water supply services is sustainable with the objective of protecting public health.

7.1 Sector collaboration

One of the most critical aspects relating to achieving effective drinking water quality monitoring in the country is ensuring effective and meaningful sector collaboration. The principle objective is to create an enabling and supporting environment, which fosters collaboration, mutual support and learning. Given that different stakeholders have different strengths and weaknesses within their areas of expertise, national-based knowledge on drinking water quality initiatives is required for smooth implementation. For the smooth implementation of these guidelines, roles and responsibilities of different stakeholders have been identified and presented in Table 7.1. National commitment to drinking water quality management and a formal coordination of responsible stakeholders should be encouraged and even where commitments and partnership agreements among the stakeholders are difficult to establish, the Guidelines should still be implemented and gradually, as partnerships among stakeholders are established, the Guidelines can be further improved and more integrated approach can be developed.

7.2 Resource Mobilization

Drinking water quality monitoring is very expensive. It involves the provision of transport, the use of chemicals which are costly and the use of equipments which often need repair. Fund made available by the government for such work have always been inadequate, thus resulting into the deterioration of the service.

For smooth and sustainable implementation of the guidelines, urban regional centers, small towns, national water projects and private suppliers will need to continue covering all the costs pertaining to implementation of the guideline. For rural water supply schemes, the LGAs shall fund all activities associated to water quality monitoring issues including water testing costs, travel and transportation and training costs, while the Operation and Maintenance (O&M) cost of disinfectants and minor remedial expenses should be covered through contributions from the community. Each LGA should facilitate implementation of monitoring drinking water quality to ensure the communities consume clean and safe water.

Table 7.1: Institutions role and responsibilities

S/N	INSTITUTION	ROLES/DUTIES/ RESPONSIBILITY	SPECIFIC ACTIVITIES FOR WATER QUALITY MONITORING	FREQUENCY/ TIMELINE	REPORT TO WHOM	PERFORMANCE INDICATORS
1	MoFP	Monitors and regulates the finances of all public bodies; Supporting Water Sector and other departments in fulfilling their duties and regulatory roles insofar as these roles relate to fiscal and financial matters.	Release Drinking Water Quality Monitoring related fund to MoWI, MOHCDGEC, PO- RALG, MoA, MLF	Quarterly	MoWI, MOHCDGEC, PO- RALG, MoA, MLF	Annual performance reports
2	MoWI	Developing and setting supportive policies, strategies, legislations and regulations relating to drinking water quality management;	Make Review of National Drinking Water Quality Monitoring Guidelines when necessary	After every 3 years	MoWIMgt	Revised Guidelines in place
		Providing technical support to the Urban Water Supply and Sanitation Authorities (UWSAs) and Local Government Authorities (LGAs) for smooth implementation of drinking water quality monitoring	Provide training and appropriate guidance to Water Quality Monitoring to UWSAs and LGAs on issues pertaining to water quality monitoring activities	Annually	MoWI, PO-RALG, UWSAs	Annual performance reports

S/N	INSTITUTION	ROLES/DUTIES/ RESPONSIBILITY	SPECIFIC ACTIVITIES FOR WATER QUALITY MONITORING	FREQUENCY/ TIMELINE	REPORT TO WHOM	PERFORMANCE INDICATORS
		activities.				
		Champion and direct sector awareness, collaboration and the alignment of activities concerning drinking water quality monitoring activities/programmes.	Conduct regular seminars/ workshops/ Sensitization /Awareness Meetings, Media adverts, and distribute brochures on drinking water monitoring technology and innovations	Annually	MoWI / PO-RALG	Annual performance reports
		Develop appropriate, practical and sustainable technical support documents and tools to assist implementation of drinking water quality monitoring	Prepare and disseminate simple documents/guidelines/leaflets/booklets on drinking water quality monitoring	Semi-Annually	MoWI	documents/guidelines/leaflets/booklets Produced and Disseminated

S/N	INSTITUTION	ROLES/DUTIES/ RESPONSIBILITY	SPECIFIC ACTIVITIES FOR WATER QUALITY MONITORING	FREQUENCY/ TIMELINE	REPORT TO WHOM	PERFORMANCE INDICATORS
		Undertake evaluations to understand holistic Drinking Water Quality Monitoring activities (include SWOT evaluations, infrastructure investment, operation and maintenance) in the country.	Carry out analysis of collected water quality data and take appropriate measures	Annually	MoWI	Annual performance reports
3	MoHCDGEC	Health promotion for water safety, water source protection and safe storage at household level	Conduct Community Sensitization /Awareness Meetings, Media adverts, brochure distributions, etc	Annually	MoWI, MoHCDGEC	Annual performance reports
		Monitoring of household drinking water safety	Collect, analyze and keep records of household drinking water treatment and storage facilities and take appropriate action	Annually	MoHCDGEC, PO-RALG	Annual performance reports
		Liaison with Ministry of Water and Irrigation on issues related to water safety, sanitation and hygiene	Develop/review in collaboration with Ministry of Water and Irrigation, national health-related Key Performance Indicators, targets, measures and systems related to	2018/2019	MoWI, MoHCDGEC	Annual Reports (Performance Indicators, targets in place)

S/N	INSTITUTION	ROLES/DUTIES/ RESPONSIBILITY	SPECIFIC ACTIVITIES FOR WATER QUALITY MONITORING	FREQUENCY/ TIMELINE	REPORT TO WHOM	PERFORMANCE INDICATORS
			drinking water quality monitoring;			
			Establish and implement a system for regular sanitary inspection of drinking water systems in order to safeguard public health.	2018/2019	MoWI, MoHCDGEC	Annual Reports
			Conduct adequate training of Environmental Health Practitioners in Drinking Water Quality Management;	2018/2019	MoWI, MoHCDGEC	Annual Reports
			Collect information on incidences of outbreaks of waterborne diseases and use the information to facilitate the interventions;	Annually	MoWI, MoHCDGEC	Annual Reports
4	Ministry of Agriculture	To ensure agrochemicals and pesticides used in agriculture are not sources of water pollution;	Conduct regular inspection of agrochemicals and pesticides used near water sources to ensure that they are not sources of pollution	Annually	MoWI, MoA	Annual Reports

S/N	INSTITUTION	ROLES/DUTIES/ RESPONSIBILITY	SPECIFIC ACTIVITIES FOR WATER QUALITY MONITORING	FREQUENCY/ TIMELINE	REPORT TO WHOM	PERFORMANCE INDICATORS
			Identify proper sites for agricultural activities with adherence to EMA of 2004 and WRMA of 2009.	Annually	MoA,	Annual Reports
5	Ministry of Livestock and fisheries	To ensure that livestock keeping and fishery activities are not affecting water sources	Conduct regular inspection of livestock grazing areas and fishing sites to ensure that they are not sources of pollution	Annually	MoWI, MoLF	Annual Reports
			Identify proper sites for livestock grazing and fishing activities with adherence to relevant existing laws and regulations	Annually	MoWI, MoLF	Annual Reports
6	VPO- Environment (NEMC)	To ensure environmental protection and pollution control;	Enforcement of Environmental Management Act (2004); and coordinate environmental programs, plans and Strategies.	At all time	MoWI, VPO-Environment	Annual Reports
7	PO-RALG	Liaison with Ministry of Water and Irrigation and MOHCDGEC on issues	Undertake periodic regulatory audits of water quality data and Water	Annually	MoWI, PO - RALG	Annual Reports

S/N	INSTITUTION	ROLES/DUTIES/ RESPONSIBILITY	SPECIFIC ACTIVITIES FOR WATER QUALITY MONITORING	FREQUENCY/ TIMELINE	REPORT TO WHOM	PERFORMANCE INDICATORS
		related to water safety, sanitation and hygiene	Supply Systems of LGAs;			
			Build Capacity to LGAs staff on Drinking Water Quality Monitoring activities	Annually	MoWI, PO-RALG	Annual Reports
			Coordinate LGAs Plans for Drinking Water Quality Management status, needs and outcomes;	Annually	MoWI, PO-RALG	Annual Reports
8	BWBs	Water resource planning and management at the catchment level, including licensing of water use and discharges, monitoring abstractions and discharge	Prepare and update regularly a list of holders of Water Use and Discharge Permits and make appropriate analysis	Annually	MoWI, BWBs	Annual Reports
		Initiate, control and coordinate activities connected with the development and utilization of water sources.	Implement Water Sources Conservation Programs in the basin/catchments	Annually	MoWI, BWBs	Annual Reports

S/N	INSTITUTION	ROLES/DUTIES/ RESPONSIBILITY	SPECIFIC ACTIVITIES FOR WATER QUALITY MONITORING	FREQUENCY/ TIMELINE	REPORT TO WHOM	PERFORMANCE INDICATORS
		Protection of water sources, particularly in situations where communities are not yet served with potable water.	Enforce WRMA of 2009 and its Regulations where Drinking Water Quality is at stake	As needs arise	MoWI, BWBs	Annual Reports
9	Water Quality Laboratory	Provision of technical guidance in term of analytical methods and good laboratory practices for routine sample analysis and assist in drinking water quality data management;	Analyze and interpret water quality data as well as Translate Standard Operating Procedures into simplified language	Annually	MoWI, WQL	Annual Reports
		Assist in the facilitation, coordination, communication and roll out of national guidelines for monitoring drinking water quality	Collaborate with MoWI, LGAs, Private Partners in training of water supply utilities and LGAs staff on drinking water quality monitoring activities	As need arise	MoWI	Annual Performance Reports
		Act as a third party auditor (surveillance agency) to verify drinking water compliance in both UWSAs and COWSOs	Carry out surveillance on drinking water quality issues and immediately notify the water utilities of any test result that exceed drinking water quality	Semi – Annual(LGAs) Quarterly(UWSAs) As need arise	MoWI	Annual Performance Reports

S/N	INSTITUTION	ROLES/DUTIES/ RESPONSIBILITY	SPECIFIC ACTIVITIES FOR WATER QUALITY MONITORING	FREQUENCY/ TIMELINE	REPORT TO WHOM	PERFORMANCE INDICATORS
			standards;	(e.g in case of outbreaks)		
		Liaison with Regional Administration Secretariat and District Water Engineers on drinking water quality issues and water development schemes;	Provide technical advice/support for proper design/operation of water treatment facilities	As need arise	MoWI	Annual Performance Reports
10	LGAs	Ensure availability of clean and safe water to the community	• Implement Water Supply Projects with Consideration to Water Safety Plans; • Incorporate drinking water quality monitoring activities in Water Supply Development Plans; • Provide technical support/advice in collaboration with	Annually	MoWI, PO-RALG	Annual Reports

S/N	INSTITUTION	ROLES/DUTIES/ RESPONSIBILITY	SPECIFIC ACTIVITIES FOR WATER QUALITY MONITORING	FREQUENCY/ TIMELINE	REPORT TO WHOM	PERFORMANCE INDICATORS
			relevant stakeholders on issues pertaining to drinking water quality; • Facilitate and undertake drinking water quality compliance monitoring at appropriate frequency			
11	EWURA	Regulate and monitor water quality related issues in UWSAs	Undertake periodic regulatory audits of drinking water management systems of the Water Services Authorities	Quarterly	MoWI	Annual Reports
			Communicate the results of monitoring to MoWI and respective water authorities	Quaterly	MoWI	Annual Reports

S/N	INSTITUTION	ROLES/DUTIES/ RESPONSIBILITY	SPECIFIC ACTIVITIES FOR WATER QUALITY MONITORING	FREQUENCY/ TIMELINE	REPORT TO WHOM	PERFORMANCE INDICATORS
12	Urban Water Supply Authorities, National Water Projects and Small towns Utilities	Ensure provision of adequate and safe water	• Implement water safety plan • Undertake operational drinking water quality monitoring	On daily basis	MoWI	Annual Reports
13	COWSOs	Ensure water supply infrastructure and treatment facilities are properly functioning and customers get safe water	• Implement water safety plan • Undertake operational drinking water quality monitoring	On daily basis	MoWI, LGAs, PO-RALG	Annual Reports
14	Vended Water Suppliers	Ensure communities are supplied with safe drinking water	• Registered by responsible authority • Observe and adhere to drinking water quality standards	Annually On daily basis	MoWI, PO-RALG	Annual Reports

REFERENCES

NAWAPO 2002: National Water Policy

Tanzania Standard 2016: Potable Water Specification- TZS 789:2016 – EAS 12:2014. ICS: 67.060.20. Third Edition

Water Quality Management and Pollution Control Strategy 2010

Water Supply and Sanitation Act 2009

APPENDICES

Appendix 1: Checklist for Hazard Identification

Resource and source protection		YES	NO	REMARKS
1.	Is the source protected by a strong fence to prevent animals entering?			
2.	Are animals or humans prevented from drinking water/defecating of leaving garbage around the source?			
3.	There should be no latrines or seepage from latrines just above the source- is this the case?			
4.	Are people prevented from bathing, washing, laundry, animals or vehicles at the source?			
5.	Is there a sign board at the site "Drinking Water Source- Keep it Clean"			
Treatment				
1.	Is the treatment system designed properly?			
2.	Is the pipe from the source in good condition?			
3.	Does the sedimentation tank have a cove?			
4.	Does the last chamber contain only clear water?			
Piped distribution systems				
1.	Are pipes in good condition and free from leakage?			
2.	Are joints and valves in good condition and free from leakage?			
3.	Does the storage tank have a lid/cover?			
4.	Is the pipe from the sedimentation tank in good condition?			
None piped, community and household systems				
1.	Is the storage tank cleaned at least once every three month?			
2.	Is the storage container in the house cleaned daily before storing water?			
3.	Is there a clean ladle to remove water from the storage container?			
4.	Do households practice hand washing with soap?			
Vendors				
1.	Are the 20 litrers containers cleaned every day?			
2.	Is the source of your water protected from contamination?			
3.	Are you registered by responsible authority?			
4.	Is the water being supplied safe?			