

Water Quality Testing Protocol

November, 2010



This protocol and instructions are mandatory for all partner organizations implementing water supply components with WaterAid funding

Table of Contents

1.0 Background

- 1.1 Country Context
- 1.2 Current Situation/Issues in Pakistan

2.0 Policy on Water Quality

- 2.1 WaterAid's principles & objectives
- 2.2 WAP Context
- 2.3 Objectives of the Policy

3.0 National Stakeholders

4.0 Responsibilities

5.0 High Risk Contaminants

- 5.1 Microbiological Contaminants
- 5.2 Chemical Contaminants

6.0 Proposed Water Quality Standards

7.0 Testing Arrangements and Frequency of Testing

- 7.1 Arrangements and Resources
- 7.2 Frequency of Testing

8.0 Testing Methods, Equipment, and Financial Resources

9.0 Documentation, Reporting and Disseminating Test Results

10.0 Follow-up Actions

1.0 Background

1.1. Country Context

Pakistan lies in southern Asia, bordering with India in the east, Afghanistan in the west and China in the north. The terrain consists of Indus plain in the east, mountains of Himalaya, Karakoram and Hindukush ranges in the north, hill regions (up to 4700 m) in the north-west and upland Baluchistan plateau in the west. The climate of the country is mostly arid to semi-arid with average rainfall varying from less than 125 mm in Baluchistan to in excess of 1000 mm in Islamabad, but becomes low again in northern mountains.

The Indus, the main river of Pakistan, has its source in the mountains of Karakoram range and flows southwards through the provinces of Punjab and Sindh to Arabian Sea. Sutlej, Ravi, Chenab and Jhelum are the major tributaries of Indus in Punjab. Relatively abundant water and fertile plain have encouraged major proportion of the population to settle in the main cities of Karachi, Islamabad, Lahore. However, flooding along the Indus valley is a frequent problem.

Agriculture forms major part of national economy. 27% of the land is arable and principal crops include cotton, wheat, rice, sugarcane, and maize. Most of the agriculture development is along the Indus plain. Irrigation is a major aspect of agriculture development, much being from canal-fed river water. Tube-well irrigation is also very common in the Indus plain. Fertilizers and pesticides have widely been used in Indus plain. Industries have been developed in many urban centres. Most important of this is the textile industry. Tanneries are also abundant in towns of Kasur, Lahore as well as Karachi.

The geology of Pakistan is dominated by young (quaternary) sediments which outcrop over large parts of the Indus plain and Baluchistan basins and are often 100 meters thick. The Indus sediments are mainly alluvial and deltaic deposits, consisting mainly of fine-medium sand, silt and clay.



Figure: Map of Pakistan

1.2. Current Situation/Issues in Pakistan

Water Availability

Although Pakistan has adequate ground and surface water resources but rapid population growth, urbanization and un-planned water consumption is affecting both quantity as well as quality of water. This depletion of water resources and deteriorating water quality has resulted in increased waterborne diseases. Per capita availability of water which was 5000 cubic meter in 1951 has decreased to 1000 cubic meters and will further decrease to 660 by year 2025.

Amongst the provinces, Punjab has the best rural water supply system where only 7% of the population has to depend on dug wells & river. In Sindh 24% of the rural population uses water from un-protected sources while the ratio of the rural population using dug wells and surface water in NWFP and Baluchistan is 46% & 72% respectively.

Water Quality

A national water quality study carried out in 2001 by Pakistan Council for Research in Water Resources (PCRWR), covering 21 cities indicated that 50% of the samples had bacteriological contamination.

Besides, samples from eight cities also had traces of arsenic above the WHO limits of 10 ppb. This study also indicated that un-treated discharge of industrial effluents were effecting the surface and ground water as the ground water samples from industrial areas of Karachi had presence of lead, chromium and cyanides.

Some other factors having direct affect on water quality include:

- non separation of municipal waste water and industrial effluents – both flow into open drains, which then flow to the nearby water bodies
- Absence of regular monitoring mechanisms to assess the water quality
- No approved surface or drinking water quality standards
- Use of 5.6 million tonnes of fertilizer & 70,000 tonnes of pesticides – This mixes with the irrigation water & leaches through the soil into the groundwater aquifers
- Industrial effluents from petrochemicals, paper & pulp, food processing, tanneries, refineries, textile and sugar industries

The recently approved National Drinking Water Policy also recognizes the need to “provide access to safe and sustainable drinking water supply to the entire population of Pakistan by 2025” and the safe water refers to the water complying with National Drinking Water Quality Standards.

2.0 Policy on Water Quality

2.1. WaterAid’s principles & objectives

WaterAid’s vision is of a world where everyone has access to safe water and effective sanitation, so that health benefits are maximized. WaterAid and its partners, work with communities through various projects that integrates water supply with sanitation and hygiene promotion.

WaterAid has recognized the need to develop a consistent approach to problem of water quality in the countries where it operates, and to develop a water quality policy in the context of each country that it works in.

WaterAid’s aims are that the quality of drinking-water delivered to consumers by the projects that it supports should be:

- Such that no significant health risk arises from its use
- Conform to at least the broadly accepted quality standards of the region or the country where the installation is located (or to better it, if this can be achieved at reasonable cost and effort)
- Acceptable in appearance, taste and odour

WaterAid recognises that in order to meet these objectives, there is a need to develop a consistent approach to problems of water quality in the countries where it operates.

2.2. WAP Context

WaterAid Pakistan is working with 15 partners. Out of current WAP partners only two (KCS, AWF) are involved in construction, rehabilitation, and improvement of water supply schemes. However, in the coming years lot of partners have shown their interest for including water supply into their project plans. In the new 5 year country strategy (2009-14), water supply and water quality monitoring has been defined as one of the priority objectives by WAP and its partners. However, looking into the volume of the current water supply plans, the capacity of the partners to deal with water quality management issues, and lack of institutional and policy framework at government level, we will start with very basic elements of water quality management and subsequently move towards much advanced methods and techniques.

However, keeping in view the importance of the rights of beneficiaries to safe water, WaterAid, its staff and partners are committed to evolve and follow a comprehensive policy for monitoring the quality of water.

2.3. Objectives of the Policy

The key objectives of WAP policy on water quality testing are:

- Define various standard methods & procedures used for monitoring drinking water contamination
- Provide information & guidelines on various standard parameters related to physical, chemical & micro-biological quality of drinking water
- Propose appropriate and affordable methods for treatment of contaminated Water
- Provide a mandatory guidelines both for WAP and partners to follow for ensuring provision of safe drinking Water

3.0 National Stakeholders

The table provides a list of some key actors including government, Research organizations, Non Governmental Organizations and that are involved in monitoring and assessment of water quality in Pakistan.

Stakeholder	Responsibility	Nature of Organization
Ministry of Environment	Development and regulation of National Water Quality Standards, guideline and limits on water quality contaminants	Government
Pakistan Council for Research on Water Resources (PCRWR)	National organizations with established laboratories in all main districts that provides support on testing micro-biological and	Government

Stakeholder	Responsibility	Nature of Organization
	chemical quality of water in accordance with national standards	
Pakistan Council for Scientific & Industrial Research (PCSIR)	Public sector institute that also has facilities for testing water quality	Government
National Institute of Biotechnology and Genetic Engineering (NIBGE), Faisalabad	The technical services division of this institute has the facility for water quality testing	Research Institute
Shah Abdul Latif University (SALU), Khairpur	A university that has a specialized wing for testing water quality	Academic Institution
UNICEF	Closely working with Ministry of Environment and local NGOs on water quality & sanitation	UN Organization
WHO	Working with government & NGOs on water quality	UN Organization
OXFAM	Working with local NGOs on disaster management and water quality management	INGO
WaterAid	Supports 15 national NGOs in implementation of water supply & sanitation projects	INGO

Note: The above list is not complete and may need further inclusions.

4.0 Responsibilities

The key WAP staff involved in drafting, implementation, roll-out and monitoring of this policy is as under:

Job title	Responsibility
Country Representative	Implementation and upholding of water quality policy
Programme Manager (Punjab)	Drafting, updating and rolling out of the policy to WAP & partners
Programme Managers (National, Punjab & Sindh)	Monitoring application of the policy at local level, training & orientation of partners, and networking with relevant stakeholders and institutes
Partners	Testing and passing results to WA on the agreed format

Once the policy is finalized and approved, WAP will review and update this policy annually keeping in view possible changes in the WHO guidelines, national standards, national legislation etc.

5.0 High Risk Contaminants

There are two major types of high risk contaminants that pose potential health risks. These include:

- Microbiological Contamination &

- Chemical Contamination

5.1. Microbiological Contaminants

Pakistan Council for Research in Water Resources (PCRWR) conducted a national water quality study in 2001. During first phase of this programme, covering 21 cities, 100% samples from 4 cities and 50% samples from 17 cities indicated bacteriological contamination. A second study conducted by PCRWR in 2004 found no significant improvement and almost 95% of the shallow ground supplies in Sindh had bacteriological contamination. The links between water quality and health risks are well established and proved. An estimated 250,000 child deaths occur each year in Pakistan due to waterborne diseases.

5.2. Chemical Contaminants

The chemical contamination mainly occurs due to sediments, industrial effluents, and agricultural runoff. According to GOP figures, 5.6 million tonnes of fertilizer and 70,000 tonnes of pesticides are being used in the country annually. These pesticides, mostly insecticides mix with the irrigation water, which leaches through the soil into the ground water aquifers. Out of 107 samples of ground water collected between 1988 and 2000, 31 samples were found to have contamination of pesticides beyond FAO/WHO safety limits.

Another major problem with ground water in Pakistan is the high salinity that occurs due to water-logging from irrigation, dissolution of salts from sediments, industrial pollution and from sea water intrusion. This problem affects large parts of Sindh, Punjab, Baluchistan and NWFP.

In addition to municipal & industrial effluents, contamination of ground water by arsenic is also becoming a serious problem. In Sindh (Dadu, Khairpur) & Punjab (Multan, Shiekhupura, Lahore, Kasur, Gujranwala & Bahawalpur), approximately 36% of the population is exposed to a level of contamination higher than 10ppb and 16% is exposed to contamination of 50 ppb.

Excessive fluoride concentrations are a problem in parts of Punjab, Sindh and Baluchistan. Incidences of dental fluorosis are very common in Tharparker, Thar Desert, Makran area, Patoki, Nowshera, the salt range, Kasur, and Bahawalpur. Concentrations up to 29 mg/l have been reported.

The table below provides a brief summary of key water contaminants:

Contaminant	Concentration range	Location	Risk to health
Microbiological contamination - waterborne pathogens	Based on very limited number of water quality tests (about 50) conducted by WAP partners, the thermo-tolerant faecal coli form were counted between 30-300 cfu/100ml have been observed in community based groundwater supplies.	Water quality testing by	Cause of diarrhoeal diseases, fever, death, parasitic infection. The greater the level of contamination, the greater the risk of infection.
Fluoride	Upto 29 mg/l has been observed	Fluvial aquifers in the Punjab, and Sindh region	Concentrations above 1.5mg/l and lower than 3.0mg/l have been found to cause dental imperfections. Greater

Contaminant	Concentration range	Location	Risk to health
			concentrations have been found to cause bone defects and deformity.
Arsenic	In Sindh & Punjab 36% of the population is exposed to Arsenic contamination higher than 10ppb & up to 50 ppb	Sindh & Punjab	Ingesting inorganic arsenic increases the risks of skin cancer and tumours of bladder, kidney, liver & lung.

6.0 Proposed Water Quality Standards

Keeping in view the WHO guidelines and the proposed national water quality standard that are still in the draft shape, WAP would like to set out following organizational water quality standards:

Sr. #.	Parameter	WHO Values	National Limits ¹	WAP Limits	Justification
A. PHYSICAL PARAMETERS					
1.	Colour	15 TCU	←15TCU	←15 TCU	Colour above 15 TCU will be detectable hence users may not accept this
2.	Taste & Odour	Acceptable	Acceptable	Acceptable	Users Acceptability
3.	Turbidity	← 5 NTU	←5 NTU	← 5 NTU	High level of turbidity will encourage growth of bacteria
4.	Total Dissolved Solids (mg/l)	←1000	←1000	←1000	Above this limit the water will become unacceptable and user may turn to an un-protected water source
B. CHEMICAL PARAMETERS					
1.	pH	6.5 – 8.5	6.5 – 8.5	6.5 – 8.5	Water is corrosive below 6.5 & soapy above 8.5
2.	Total Hardness as CaCO ₃ (mg/l)	-----	← 500	← 500	In absence of alternate source the value may be revised
3.	Nitrate (mg/l)	50	← 50	← 50	Above this limit, the illness called Blue-Baby Syndrome occurs
4.	Arsenic (mg/l)	0.01	0.05	0.05	0.05 is acceptable limit
5.	Fluoride (mg/l)	1.5	← 1.5	← 1.5	Same as proposed national standards
6.	Residual Free Chlorine (mg/l)	0.2 – 0.5	0.2 – 0.5	0.2 – 0.5	This value should be at user end while at source level it should be between

¹ National Water Quality Standards are not yet approved and are in draft

Sr. #.	Parameter	WHO Values	National Limits ¹	WAP Limits	Justification
					0.5 – 1.5
C. MICROBIAL PARAMETERS					
1.	Thermotolerant Faecal Coliforms (MPN/100 ml)	Zero	Zero	0 (Piped System) & 0 – 10 (Community schemes including shallow hand pumps & wells)	Although WHO & National standards for Thermotolerant Coliforms are 0/100 ml however, WHO guidelines relax it up to 10fc/100ml for community managed water supply schemes.

7.0 Testing Arrangements & Frequency

7.1 Arrangements & Resources

Currently none of the WAP partners or WAP itself has the technical capacity and required equipment for conducting water quality analysis for checking physical, chemical or microbiological parameters. However, those partners involved in water related projects have been using national research laboratories and academic institutions for getting their water samples tested. Some of the prominent institutes and organizations involved in water quality testing include:

- Pakistan Council for Research on Water Resources (PCRWR)
- Pakistan Council for Scientific & Industrial Research (PCSIR)
- National Institute of Biotechnology & Genetic Engineering (NIBGE), Faisalabad
- Shah Abdul Latif University (SALU), Khairpur
- Non Governmental Organizations and private institutes

All the above institutes have very good state of the art testing facilities, equipments and Human resources and charge between Rs. 2000 – 3000 for conducting complete microbiological and chemical analysis of water sample.

WAP and partners will continue using services of the above listed institutes till either some of our partners have developed their in-house capacity and skills in water quality testing or WAP enters into partnership with some potential organization/partner that could provide these services.

In the meanwhile, WAP will include periodic monitoring of all the newly developed, improved and rehabilitated water supply schemes especially for high risk contaminants.

7.2 Frequency of Testing

Sr. #.	Parameter to be Tested	Frequency of Testing	Remarks
1.	Microbiological	At the beginning and then twice a year during dry and rainy season	<ul style="list-style-type: none"> ▪ Randomly selected 15% of the total water points especially shallow wells, storage tanks, intakes and distribution chambers

Sr. #.	Parameter to be Tested	Frequency of Testing	Remarks
			<ul style="list-style-type: none"> All newly developed surface water schemes, tube wells and rain water harvesting systems
2.	Arsenic	Once a year or as situation demands	Arsenic has been detected in Sindh & Punjab so it is suggested to check each new well and test it for arsenic. In addition 15% of the other wells & hand pumps (randomly selected) should also be tested at least once a year
3.	Nitrate	Once a year	Surface water sources especially those located near agricultural forms
4.	Fluoride	Once during confirmation & more if concentrations are high	
5.	Free Residual Chlorine	Once a month for chlorinated schemes	Especially during conflicts & emergency when populations are displaced
6.	Turbidity	Each water source needs to be tested at the beginning and then twice a year through visual testing	WAP to support partners in developing sanitary inspection guidelines & systems
7.	pH	Each source to be tested once during confirmation	

8.0 Testing Methods, Equipment, and Financial Resources

As most of the water quality testing will be done through specialized institutes so WAP and partners will have to make sure that they are following the proper quality control mechanisms while sampling and testing the water samples.

WAP will work with relevant partners This section should outline the methods, equipment, training and financial resources required to test for each high risk contaminant. However, in cases of parameters where no formal testing is required, WAP will work with partners working on water projects to develop and implement sanitary inspection systems.

9.0 Documenting, Reporting and Dissemination of Test Results

- WAP partners must keep the record of all water quality testing for critical contaminants including microbiological contamination, arsenic, nitrates, and fluorides. A mutually agreed format for recording these results will be developed.
- All relevant partners will keep a systematic record file of these results containing periodic results from different geographic locations with full details like GPS coordinates nature of source etc. Partner will have to submit soft copy of these periodic results to WAP along with their quarterly reports.

- Partners will ensure that all water quality results, especially poor results are communicated to communities and other relevant stakeholders. The important point is to discuss below standard results with relevant line departments including district government, health and Public Health Engineering Department.

10.0 Follow-up Actions

This document will serve as a guideline for WAP programme staff, partners and other relevant stakeholders for planning, developing, supervising and maintaining water supply and sanitation facilities. Presently the document has been prepared mostly relying on secondary data and the currently on-going water projects and there have been hardly any consultations with partners and other stakeholders. This draft document will have to be shared with the partners and stakeholders who have expertise in water to seek and incorporate their views before these guidelines are finally implemented. WAP will also update these policy guidelines in light of the new development in the sector in terms of revised quality standards, introduction of new technology etc.

To follow-up on the water quality results obtained, especially for cases that fails to match the set quality standards, the results will be discussed with communities and partners involved. The main focus would be to carry-out further detailed investigation of the facilities to find source of contamination or finding alternate sources.



WaterAid transforms lives by improving access to safe water, hygiene and sanitation in the world's poorest communities. We work with partners and influence decision makers to maximise our impact.

For queries contact WaterAid in Pakistan

House No. 608, Service Road (East)
Sector G-10/4, Islamabad
Phone: +92 51 210 0708
Visit: www.wateraid.org

WaterAid is a registered charity in the UK (Numbers 288701)
(England and Wales) and SC039479 (Scotland)