Government of the People's Republic of Bangladesh
Local Government Division
Ministry of Local Government, Rural Development & Cooperatives

Water Safety Framework (WSF) in Bangladesh

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Secretary
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Forward

WHO's Guidelines for Drinking-Water Quality (3rd Edition) recommends that countries should apply a "Water Safety Framework (WSF)" approach to ensure drinking water safety. The Government of Bangladesh has considered the recommendations of WHO as an important tool to achieve MDGs, which would reduce the Disability Adjusted Life Years (DALYs) and hence the poverty. This has also been reflected in the National Strategy for Accelerated Poverty Reduction-I I (Steps Toward Change), where it has been mentioned for water supply and sanitation that "preventing measures like WSPs are needed for rural and urban areas". On this target Local Government Division through its Policy Support Unit prepared "Water Safety Framework in Bangladesh".

Now it is utmost important to implement the Water Safety Framework by the service providers to supply safe drinking water to the consumers. In the National Guidelines for Water Safety Plans (WSPs), it has been mentioned that all new and rehabilitation water supply projects should have a component of WSP, which has also been reflected in the "National Vetting Guidelines for Water Supply and Sanitation Sub-sector Bangladesh." All concerned are, therefore, requested to follow the Guidelines and implement accordingly.

Nonetheless, it is also important to introduce WSPs in the existing water supply systems at the earliest possible time. I believe that DPHE will take the lead role to introduce WSPs in the rural and urban water supplies except WASAs. WASAs will take necessary initiative to introduce WSPs in their service areas to protect public health from the water born diseases.

I strongly believe that the "Water safety Framework (WSF) in Bangladesh" would be useful to the water service providers to provide safe drinking water to all.

Abu Alam Md. Shahid Khan
Secretary

Prefece

The Water and Sanitation Sector in Bangladesh has been implementing Water Safety Plans (WSPs) on pilot basis since 2005 to ensure safe drinking water for all. The Department of Public Health Engineering (DPHE) has already incorporated the WSPs in some of its water supply projects in both rural and municipal areas with technical assistance from the World Health Organization (WHO).

The WHO Guidelines for Drinking Water Quality (3rd Edition) recommends that countries should apply the 'Water Safety Framework (WSF)' approach to ensure the safety of drinking water. The Government of Bangladesh has accepted the recommendations of the WHO into its strong consideration as an important tool to reduce disease burden and to achieve the MDGs. On this target, the Local Government Division through its Policy Support Unit (PSU) has prepared 'Water Safety Framework in Bangladesh' as an important national dossier.

The most important thing, at this moment, is that all Pourashava authorities should adopt Water Safety Plans in their Water Supply Systems to ensure supply of safe water which is one of their major obligations. The Guidelines for Water Safety Plans (WSPs) recommends that there should be a component of the WSP in all new and rehabilitation water supply projects. So, we are requesting all concerned to follow the Guidelines and implement accordingly.

I strongly believe that the 'Water Safety Framework (WSF) in Bangladesh' would be useful to the water service providers to provide safe drinking water to all. I also believe that the Department of Public Health Engineering (DPHE) would take the lead role to implement it in all areas except those covered by the WASAs and WASAs would implement it in their respective service areas as soon as possible.

I would like to thank all relevant stakeholders, experts and consultants who were involved in preparing this national document. I would also like to thank my colleagues of Policy Support Unit (PSU) for introducing this important document to the sector stakeholders.

Zuena Aziz
Joint Secretary (Water Supply)
Local Government Division
Ministry of Local Government,
Rural Development and Cooperatives

Introduction

The 'Water Safety Framework (WSF) in Bangladesh' has been prepared based on WHO's 'Water Safety Framework (WSF)' approach and in consultations with the sector experts, stakeholders, professionals and water service providers to ensure the safety of drinking water. The WSF comprises three components: (i) Health Based Targets (HBTs), (ii) Water Safety Plan (WSP) and (iii) Surveillance.

Bangladesh has adopted the revised national water quality standards as the Health Based Targets (HBTs) for water supplies. The National Forum for the WSS has approved the revised HBTs consisting of 40 parameters and targets of which five (four HBTs and one non-HBT) are the parameters of first priority category and the remaining 35 are the parameters of second priority category. Of the second category, 26 are based on the HBTs and nine on aesthetic consideration and acceptability reasons.

The Water Safety Plan (WSP) is an improved risk management tool designed to ensure the delivery of safe drinking water through the risk management approach by accommodating all steps in water supply from source to the point of consumption. In Bangladesh the WSP was initiated as a pilot program in the rural water supply system in 2005. Gradually, technology-specific WSPs, monitoring tool, and sanitary inspection tools were developed. In 2008, the urban water supply systems started implementing the WSPs in the urban areas. At the institutional and policy levels, institutional mapping and policy gaps were identified and the Vetting Guidelines for the WSS and Sector Development Plan were made available to guide and streamline the sector to ensure the quality of water. Prompted by the favourable policy environment and institutional focus, the DPHE has, of late, scaled up the WSPs in the Pourashava Piped Water Supplies, Rural Piped Water Supplies and different point sources with technical assistance from the WHO. Besides, some NGOs are implementing the WSPs in their respective project areas.

This document provides a simple guideline for developing WSP for both piped and non-piped water supply systems with relevant examples. The WSP analyzes all potential risks, their control measures and perfect actions. Simple risk analysis tools known as sanitary inspection forms are prescribed to assess the degree of sanitary risks of the systems. It also analyzes system improvement and supporting program aspect, integration of the WSP with rural water supply system - implementation strategy, methodology and on-site preparation. The advocacy strategy is also provided for the management and technical staff of water supply systems.

The third element of the Framework is 'Independent Surveillance'. Surveillance is basically a follow-up-cum-supervision exercise to improve the management function of water suppliers/providers as well as the behavioral aspects of the consumers. The monitoring of critical drinking water quality parameters along with the operational monitoring of other control measures must be an inseparable part of water supply system management.

The protocol describes the system's sanitary compliance, safety measures against potential risks, critical water quality, accessibility to safe drinking water, consumers' satisfaction level, and action for improvement of quality services under the surveillance activities. The protocol also identifies responsible institutions for surveillance. The Directorate General of Health Services (DGHS) and Department of Public Health Engineering (DPHE) have been recommended to be responsible for rural water supply and the DPHE, Bangladesh Standards and Testing Institution (BSTI), the DGHS and the Department of Environment (DoE) for urban piped water supply.

Local Government Division holds overall responsibilities for coordination of implementation of the monitoring and surveillance protocols and implementation strategies. A Water Cell consisting of multidisciplinary professionals, being created to enhance its in-house capacity, will undertake audit, high level verification, monitoring and surveillance activities in coordination with the Ministry of Health and Family Welfare (MoHFW) and the Ministry of Environment and Forest (MoEF) for related surveillance parts and feed information to National MIS for WSS and overall implementation of the Water Safety Framework.

I express my sincere gratitude to the consultants of the assignment, experts, organizations, institutions and the government departments for their sincere support and cooperation towards accomplishing this national document.

I would like to convey my deep appreciation to the World Health Organization (WHO), Bangladesh for its consistent support to developing this national document including its printing.

Md. Shariful Alam
Project Director (Deputy Secretary)
Policy Support Unit (PSU)
Local Government Division
Ministry of Local Government,
Rural Development and Cooperatives

Abbreviations

AE	:	Assistant Engineering
ART	:	Arsenic Removal Technology
BOD	:	Biochemical Oxygen Demand
BSTI	:	Bangladesh Standards and Testing Institution
BUET	:	Bangladesh University of Engineering and Technology
CFU	:	Colony Forming Unit
DGHS	:	Directorate General of Health Service
DO	:	Dissolved Oxygen
DoE	:	Department of Environment
DPHE	:	Department of Public Health Engineering
DTW	:	Deep Tube-Well
EE	:	Executive Engineer
GFS	:	Gravity Flow System
HBT	:	Health Based Target
HTW	:	Hand Tube-Well
ITN	:	International Training Network
ICP	:	Inductively Coupled Plasma
IFG	:	Infiltration Gallery
JTU	:	Jackson Turbidity Unit
LG	:	Local Government
MoLGRD&C	:	Ministry of Local Government, Rural Development and Cooperatives
NSC	:	National Steering Committee
NTU	:	Nephelometric Turbidity Unit
O&M	:	Operation and Maintenance
PSU	:	Policy Support Unit
PSF	:	Pond Sand Filter
PWSS	:	Pourashava Water Supply Section
RWH	:	Rain Water Harvesting
RWS	:	Rural Water Supply System
SAE	:	Sub-Assistant Engineer
STW	:	Shallow Tube-Well
TC	:	Total Carbon/ Total Coliform
TLCC	:	Town Level Coordination Committee
TTC	:	Thermo -Tolerant Coliform
TTW	:	Tara Tube-Well
TWM	:	Tube-Well Mechanic
VSST	:	Very Shallow Shrouded Tube-Well
WASA	:	Water Supply and Sewerage Authority
WSP	:	Water Safety Plan
WHO	:	World Health Organization

Water Safety Framework (WSF) in Bangladesh

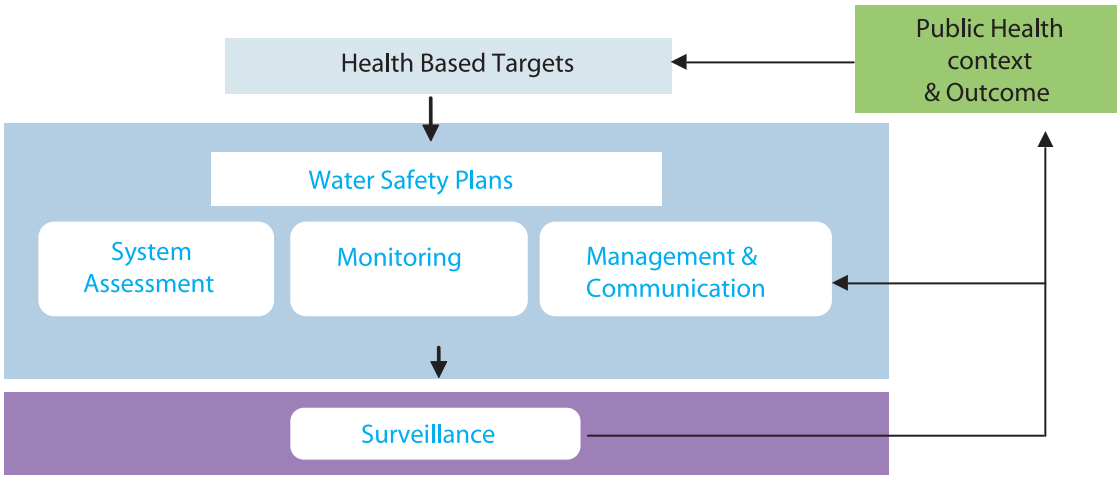
MAIN VOLUME

Outline

WHO's Guidelines for Drinking-water Quality (3rd Edition) recommends that the all member countries should apply a "Water Safety Framework" approach to ensuring drinking water safety. The Government of Bangladesh has considered the recommendation of WHO as an important tool to achieve MDGs, which would reduce the Disability Adjusted Life Years (DALYs) and hence the poverty. On this target Local Government Division through its Policy Support Unit has formulated "Water Safety Framework (WSF) in Bangladesh" in 2011 for its effective implementation throughout the country. Water Safety Framework approach brings together risk assessment and preventive management in a framework extending from water source to consumers. The framework is applicable to systems of all types from large complex piped systems to community-managed sources including point sources. The quality of drinking water may be controlled through a combination of protection of water sources, control of treatment processes and management of the distribution and handling of water. The Water safety Framework formulated in a way so that it would be appropriate for national and local circumstances. The Water Safety Framework comprises:

1. Health Based Targets;
2. Water Safety Plans; and
3. Surveillance

Following is the interrelation of these basic tools to have a sustainable Water Safety Framework;



The main volume of this document consists of three major sections, which are 'National Guidelines on Water Safety Plans (WSPs)', 'National Water Quality Monitoring Protocol' and 'Independent Surveillance'.

The first section is about the 'National Guidelines on Water Safety Plans (WSPs)'. This section provides a simple but detailed guidelines for developing WSP for both piped and non-piped water supply systems with relevant examples. The WSP analyzes all potential risks, their control measures and corrective actions. Simple risk analysis tools known as sanitary inspection forms are prescribed to assess the degree of sanitary risks of different components of a system. It also analyzes system improvement and supporting program aspect, integration of the WSP with rural water supply system - implementation strategy, methodology and on-site preparation. The advocacy strategy is also provided for the management and technical staff of water supply systems.

The second section deals with 'National Water Quality Monitoring Protocol'. The monitoring of critical drinking water quality parameters should be an integral part of water supply system management. The third section covers 'Independent Surveillance'. Surveillance is basically a follow-up-cum-supervision exercise to improve the management function of water supply service providers as well as the behavioral aspects of the consumers. The protocol describes the sanitary compliance, safety measures against potential risks, critical water quality, accessibility to safe drinking water, consumers' satisfaction level, and action for improvement of quality services. The protocol also identifies responsible institutions for surveillance including their roles.

WSF

Section- I

National Guidelines on Water Safety Plans (WSPs)

How to Use the Guidelines for Preparing WSP

This Guideline is prepared to enable water suppliers to develop WSPs without depending much on the external specialist. It will guide the users in developing Water Safety Plans (WSPs) following a simple step by step approach. At each stage, the principles are outlined as well as methods and tools required to achieve these principles. WSP Steps are written in simple way with relevant examples. Each section ends with a summary of key lessons to be learnt.

A sample Water Safety Plan (WSP) is appended with this guideline for the piped water supply for general understanding of the steps. However the suppliers are required to adapt this generic WSP in the light of real nature of the supply system and the existing context. It is important to mention here that WSPs must be precise and candid and should cover all the potential risks and their related control measures and corrective actions.

For non-piped water supply system a more straight forward approach is recommended. Tables are provided with the information of technology descriptions, which enable the users to understand, where probable intervention will be required. To assess sanitary risks of the system simple risk analysis tool for few technologies are provided. The tools are known as sanitary inspection forms. The score, determined from these form, will reflect the degree of sanitary risks of the system.

However, technology specify WSPs so far developed in Bangladesh will be available in the website of the Policy Support Unit (PSU)., www.psu-wss.org

1.0 Background

The Government of Bangladesh (GoB) realized the importance of the WHO concept and its recommendation for designing Water Safety Framework (WSF) and its countrywide application through effective risk assessment and risk management in the drinking water supply systems right from the source to ingestion. The importance of this framework has been emphasized by the WHO in its Guideline for Drinking Water Quality (3rd edition) to ensure safe drinking water to the consumers reducing the significant risks of contamination to an acceptable degree of tolerance. The GoB is now keen to formulate and implement Water Safety Framework considering the same to be an effective means to minimize the public health burden and thus help the general mass to lead economically productive life.

The WSF comprises the three major components, namely:

- Health Based targets (HBT)
- Water Safety Plans (WSP)
- Surveillance

This section is intended to deal with the development of guidelines to be used by the water suppliers/providers in preparing their respective Water Safety Plans (WSPs) including implementation plan in order to improve the quality of drinking water in line with Health Based targets (HBT). Summary of Health Based Target (HBT) is appended in Annex-9 of this document.

1.1 Rationale of Water Safety Plan (WSP)

The traditional approach to water quality and safety management has relied on the testing of drinking water. This takes place as it leaves the treatment works or at selected points, either within the distribution system or at consumer taps or at the Hand Tube Wells. This is known as 'end point testing'. The problem with this approach is that the results are too little and too late for preventive action. Too little because so few samples are taken compared to the amount of water produced. Therefore, conclusions drawn about the safety of water from the results of such sampling are compromised, particularly for microbial quality. Too late because by the time the results are available, the water has been already supplied and may have been consumed and therefore preventive action is no longer possible.

A Water Safety Plan (WSP) is an improved risk management tool designed to ensure the delivery of safe drinking water by consistently ensuring the safety of drinking water supply through risk management approach that encompasses all steps in water supply from catchment to consumer. It identifies:

- the hazards that the water supply is likely to be exposed to, and the level of risk associated with each. [A hazard is a biological, chemical, physical or radiological agent that has the potential to cause harm; A hazardous event is an incident or situation that can lead to the presence of a hazard (What can happen & how); and Risk is the likelihood of identified hazards causing harm in the exposed population in a specified time including the magnitude of that harm and/or the consequence;]
- how each hazard will be controlled;
- how the means of control will be monitored;
- how the operator can tell if control has been lost;
- what actions are required to restore control and
- how the effectiveness of the whole system can be verified.

By developing a WSP, the system managers and the operators will gain a thorough understanding of their respective systems and the risks that must be managed. This knowledge can be used to develop operational plans and identify key priorities for action. The development of a WSP will also help identifying what additional training and capacity building initiatives are required to support and improve the performance of the water suppliers/providers in meeting water safety targets.

2.0 Developing a Water Safety Plan (WSP)

The development of a WSP involves:

- preventing contamination of source waters;
- reducing or removing of contamination by treating water (if requires) in order that water safety targets are met; and
- preventing re-contamination during storage, distribution and handling of drinking water

In order to do this, the water supplier needs to:

- obtain commitment from the WS authority (mayor in case of PWSS) that the WSP will be implemented as a tool to ensure safe water supply.
- assemble a team of professionals that understands the system and has capacity to take decision to solve problems;
- identify resource to implement WSP and system upgradation (if needed);
- build capacity of staff and the organization to implement and verify WSP.

2.1 Preparatory Activities

2.1.1 Commitment from supply authorities

Before the process of developing the WSP, it is imperative that all members of the water supplier/providers agree on its benefits. Technical staff needs a commitment to the WSP approach from all management levels, from Field Managers to the Managing Director/Mayor/Chairman of the relevant institutions.For successful implementation of the WSP, it is important that senior management buy into the process. This process is crucial to obtain support for changes in working practices and to actively promote water safety as an essence of the organization.It is key to obtain a commitment from senior management so that clear and coherent arguments can be presented explaining why the adoption of a WSP is necessary and advantageous to the organization, and why a WSP is preferable. Therefore, it is important to outline:

- What is being done and how;
- Where the organization wants to be in future; and
- How the organization aims to get there.

Figure-1 outlines a way to engage senior management in the WSP process.

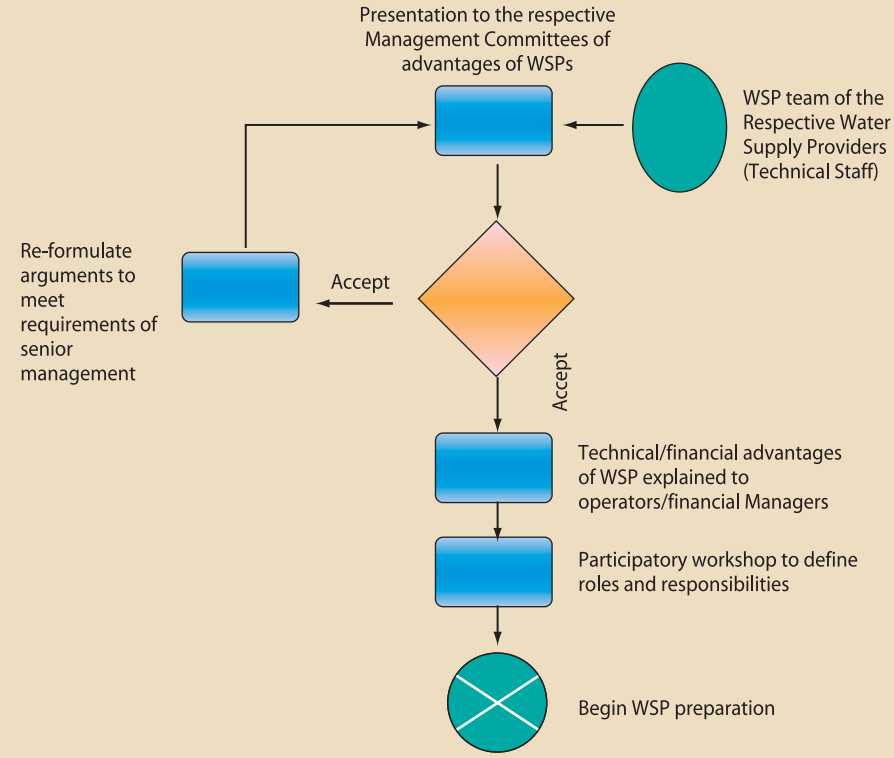


Figure-1 Engaging senior management in the WSP

The first stage in achieving management commitment to the WSP process is to prepare a short briefing note or proposal on the approach. A range of possible key entry points are as follows:

- WSPs are cutting-edge approaches that demonstrate to the management that the water supplier is applying best practice to secure water safety;
- Quality assurance can secure water safety;
- There are limitations to relying on end-product testing as a means of water safety control;
- There is potential for savings with the WSP approach;

An example of showing the format of the presentation to the Management is outlined in Box 1.

Box 1: Management buy in - Kampala, Uganda

A presentation was given by technical staff and covered the following topics:

1. Importance of WSP.
2. Current water quality monitoring practice.
3. Weakness in the end product testing in comparison to the water safety plan (WSP) approach.
4. How to establish/develop a WSP.
5. Advantage/disadvantages of the WSP approach (financial, technical) (e.g. Uganda saving 38% in their total budget for WQC; UFW will be reduced, etc.)
6. The benefits of piloting the WSP approach (being carried out in Bangladesh)

2.1.2 Commitment from operational staff

A WSP can only be successfully introduced if there is commitment from operational staff. So, the in-house promotion of WSPs is vital. The job descriptions of different professionals and staff of any water supply systems vary greatly. In some small system one or two individuals are responsible for all tasks, whereas, in larger systems a team of twenty or more people may be responsible for each of the jobs.

It is important to ensure that this operational commitment is developed in parallel with the development of WSPs itself. A meeting needs to be held with staff to present and discuss WSPs in relation to existing practice and to review the features of WSPs that make it a more effective way of ensuring water safety.

One important aspect of this process is to show the inter-linkage between the roles of different steps. This must be explained in language that is understandable at the local level. The use of decision chain such as those described in Figure-2 can help to explain the inter-linkages. The SEs (O&M) of the WASAs and the Heads of Engineering Sections of the Pourashavas/City Corporation or on their behalf the EEs, DPHE concerned should hold discussion meeting with the O&M staff. In the case of rural piped water supplies, the SAEs, DPHE, concerned can lead the discussion in the meetings.

For the WSP approach to function, clear job descriptions on roles and responsibilities for each staff members should be established. When initiating discussions with operational staff to obtain their commitment to WSPs, it is important to discuss fully and frankly the concerns they may have about changes in working practices. In many situations, actual working practices change very little under WSPs.

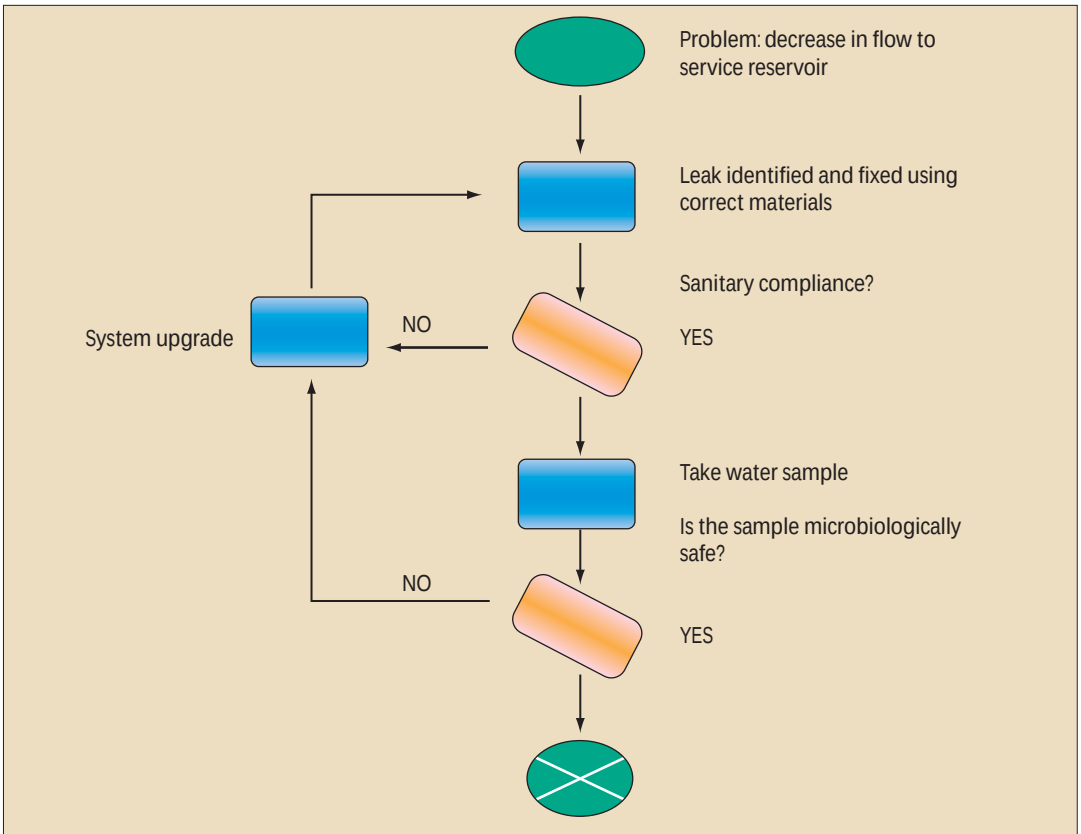


Figure-2 WSP Inter-linkages

The Figure-2 shows that if the analyst had relied solely on the results of the microbiological analysis before taking action (leak repair), there would have been a greater risk to public health; ongoing contamination would have occurred. The figure also stresses the importance of the inter-linkages between the roles of different operational staff.

3.0 Steps in Developing a WSP

Once the essential prerequisites are achieved, then the following steps are to be made in order to implement WSP in a system. Figure-3 outlines the key steps in developing a WSP, all of which are discussed in this section.

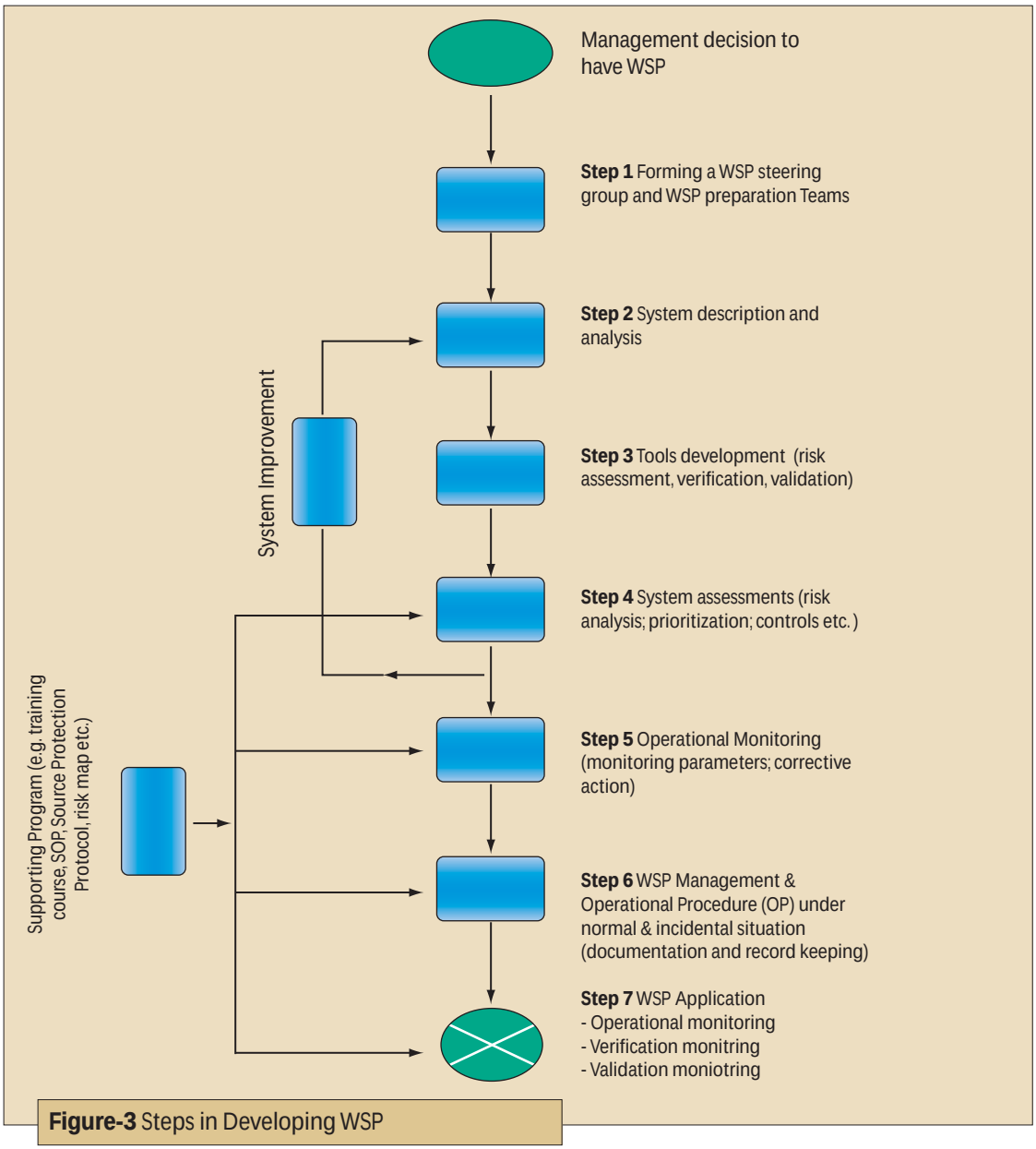


Figure-3 Steps in Developing WSP

3.1 Forming WSP Steering Group and WSP Preparation Teams (Step-1)

For each water supply system having the distribution network, a WSP steering group and a number of WSP teams (for preparation and implementation) will be required. The main role of the WSP steering group will be to coordinate and steer the WSP team activities. However some of the major activities related to WSP development will have to be undertaken by the steering group itself. In the task list that follows, the tasks of the steering group will be indicated.

In the light of the above each WASA is required to form a WSP steering group headed by the Chief Engineer with the Superintendent Engineer (SE), Maintenance Operation and Distribution Systems (MODS), the SE planning and design, Chief Revenue Officer, the Chief Chemist and/or the Chief Microbiologist as members. This steering group would be accountable to the WASA Board. It is recommended that steering group will include members from universities/ institutions including some independent members from professional organizations. For preparation and implementation of WSPs in the WASAs, each treatment plant as well as each MODS zone will have a WSP team.

For example, Dhaka WASA has 04 (four) treatment plants and 11 (eleven) MODS zones, so it may form 15 (fifteen) WSP teams each headed by the respective head of the treatment plant and the respective head of the O&M zone. Likewise other WASAs follow the same procedures to form WSP team (s).City Corporation and Pourashava having treatment plants and/or more than one MODS zone will have to form a steering group with the head of pourashava/city corporation engineering section as the head, and the EE or AE DPHE, the Chief of City corporation/Pourashava health section, representative from DGHS, academic members, TLCC representatives etc as members. The steering group will be accountable to the City Corporation/ Pourashava council.

Number of WSP preparation and implementation team(s) in each city corporation/Pourashava will be dependent on the number of treatment plant(s) and number of zone(s) existing in the city corporation/Pourashava. Each WSP team will be headed by the respective head of the treatment plant and the O&M zone concerned.

A national steering committee would be formed to oversee the overall implementation process of the WSPs throughout the country. The Joint Secretary (WS) of Local Government Division (LGD) would be the Chairperson of the National Steering Committee (NSC). Project Director, PSU would be the member secretary of the NSC and Policy Support Unit (PSU) will act as the secretariat. Other members of this committee will be from DPHE (Superintending Engineer, Water Quality and/or Addl Chief Engineer, WR, WASAs (ranked not bellow SE), BUET (Center Manager, ITN-BUET), BCSIR (as nominated) , BSTI (as nominated), DoE (as nominated), DGHS (as nominated), WHO (as nominated), representative of the Municipalities Association of Bangladesh (MAB).

Suggested principle to form WSP steering groups and WSP preparation & implementation teams is given below:

Treatment plant	No. of O&M zones	No. of WSP team Proposed	Local WSP Steering group (yes/no)
None	None	None	Yes
None	More than 1	Equal to the number of O&M zones	Yes
Yes	1	(1+1) 2 teams (assuming one treatment plant)	Yes
Yes	More than 1	equal to the total number of treatment plants plus O&M zones	Yes

WSP team, each of having 5-6 members, should be formed with professionals from relevant disciplines. Typically, such a team would include individuals involved in each stage of supply of drinking water, such as engineers, catchment and water managers, water quality specialists, environmental or public health or hygiene professionals (e.g. sanitary inspection), operational staff, one active local counselor and representative from consumers. The strength of teams (number of team members and capability) should commensurate with the task to be accomplished. However, respective water supplier will be responsible to constitute WSP team (s) considering their strength & weakness. The list of major tasks is given below indicating responsibility of the steering group and WSP teams.

Copy of "office order" regarding formation of WSP team along with the Terms of Reference (ToR) should be preserved as a record.

Major Task/Responsibility		
National Steering Committee (NSC)	Utility/Pourashava Counsel	WSP Team
• To make aware and to ensure the management commitments towards having WSP (s) and their implementation for each water supply. • To oversee the progress of implementing WSPs throughout the country • Taking and solve the issue(s) that will be brought to the notice of the NSC. • Steer and oversee the national surveillance activities	• Development of action plans for water conservation, protection and preservation (both quality and quantity) at sources/catchment • If water sources are highly contaminated and beyond the jurisdiction to intervene the same will be brought to the notice of the NSC. • Maintain systems for management, documentation and communication • Organize public education and communication to educate the consumers/beneficiaries about safe and hygienic methods of preservation, collection, transportation, storage, use etc. • Undertaking organizational and institutional review in line with the implementation of the WSP • Ensure the water quality monitoring protocol is operational • Ensure capacity of different categories of O&M staff	• Preparation of process description from source to consumption and analysis. • Preparation of detail process flow diagrams from catchment/source to the consumers. • Water quality analysis: Raw water at the catchment/source, at the point of entry into the transmission line, at the critical points of the distribution network, at the consumers storage level. • Correct preparation of detail layout plans of existing transmission lines and distribution network along with booster stations, production tube wells, overhead tanks, valves, washouts including all potential sources of pollution in the vicinity (sewers, drains, canals, garbage dump, waste pits, depressed grounds, ditches etc.). • Physical assessment (system assessment) of the infrastructures at its present condition; preparation of activity plan for improvement of safety; determining control measures and developing matrix for operational monitoring of control measure.

		• Development of routine operation procedures and preventive maintenance systems including disposal of sludge • Development of operational and maintenance procedures during emergency/incident period

The responsibilities of each WSP member need to be clearly defined during preparation of the WSP team so that it becomes clear who will do what and when.

Note: Respective water supply authority will supervise the activities of its WSP Team(s).

3.2 System Description and Analysis (Step 2)

It is important to describe correctly the water supply systems as detailed as possible and as per actual field condition. System descriptions have to cover the following major features but not necessarily limiting to them:

- Source of water and catchment -for instance capacity of the source in relation to demand, protection measures applied, developments in the catchment that may affect quality, known water quality problems;
- Treatment processes applied -providing information about configurations, numbers of individual units, age of plant, known design faults;
- Storage within the distribution systems (how many service reservoirs, their volume, areas that they serve, age, known design problems);
- Distribution system (pipe size, diameter, material, jointing, limit of responsibility of utility, extent, population served, known problems);
- Intended uses of water and vulnerability;
- Persistent water quality vulnerable areas;
- Persistent water supply problem (shortage, intermittence, leakage etc.) areas;
- Environment around the system;

An overview of water supply description of the Tungipara Pourashava is outlined in Box-2 as an example.

Box 2: Water Supply Description-Tongipara Pourashava

The Tungipara pourashava water supply system is fed from surface water extracted from the river Bhagia. It has conventional treatment unit processes viz. pre-settling tank, coagulator, baffle flocullator, sedimentation tank, rapid sand filter, chlorinator, pump unit etc. The capacity of the Water Treatment Plant (WTP) is 220 m3/hour. Treated water is then pumped to the Overhead Tank (OHT). The Tungipara pourashava (operators of the network) supplies 680 m3/day water from the WTP through the overhead water tank with 17 km distribution network (6 and 4 diameter pvc), 900 house connections and serving 7000 people of the pourashava. Last few years salinity has been observed in the Bhagia river in the dry season particularly 10 to 15 days of April which is now a concern of the pourashava authority.

3.2.1 Description of catchment/source, treatment processes, distribution

The description of the source of water and catchment should cover:

- Situation with regard to capacity of the source (Quantity including round the year availability, seasonal variation etc.);
- Water quality of the source including seasonal variation;
- Safety and protection of the catchment and source;
- Developments in the catchment that may affect quality of water;
- Likely source-water contaminant loads.

Treatment processes are best indicated by process flow diagrams. Diagram provides an overview description of the drinking-water system, including characterization of the source, identification of potential pollution sources in the catchment, measures for resource and source protection, treatment process, storage and distribution infrastructure.

Process flow diagram therefore needs to be prepared showing the flow of water through the treatment works, identifying each unit process and the location of principal inlets, flow control valves and dosing pumps as well as valves, backwashing tanks etc.

An example of process flow diagram of Tungipara Pourashava Piped Water Supply is shown in Figure-4.

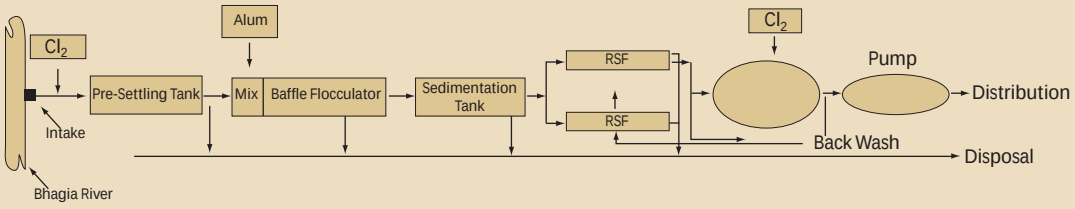


Figure-4 Flow diagram of Tungipara Pourashava Piped Water Supply

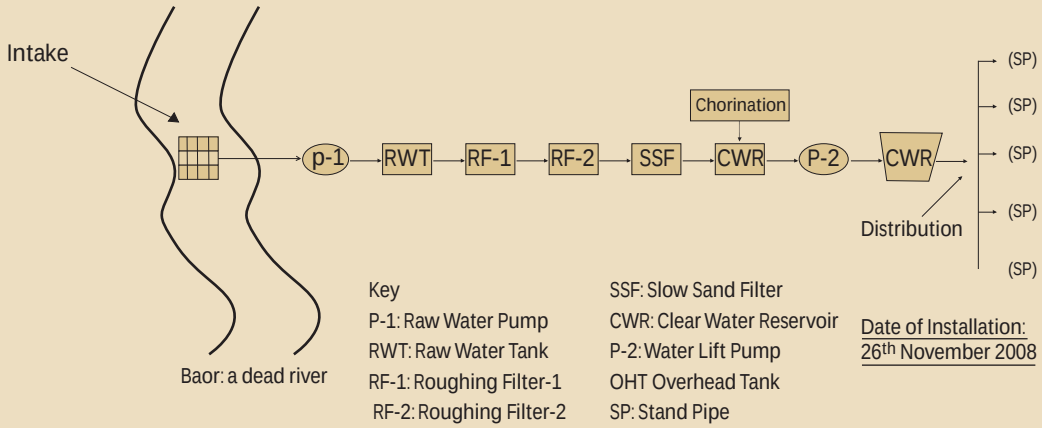
However, any water supplier/provider (WASAs, City Corporations, Pourashavas, Rural piped water authority) planning to prepare its WSP will have to develop its own process flow diagrams correctly on the basis of actual field condition.

Description of distribution system should include the following:

- A map of the distribution network showing the location of major infrastructure (intake, water treatment works, service reservoirs, production well, booster stations, transmission and trunk mains, secondary service mains and major valves) and zoning of supply.
- Detailed flow diagrams identifying how water flows through the system within each zone, cross connection between supply zone, population densities, leakage rates etc.
- Physical condition of the components of the distribution system (pipe age, pipe diameter, pipe length and jointing, pipe materials, age of the service reservoirs/supply tanks, age of the major valves).
- Location and description of the supply pipes, valves in relation to areas where hazards exist.
- Location and description of the 'problem spot' susceptible to contamination within the network.
- Pressure condition (constant or intermittent) of the distribution network and known problems.

In Box-3 an example of process flow diagram and system description of Chowgacha Rural Piped Water Supply is shown.

BOX-3 Process Flow Diagram and System Description of Chowgacha Rural Piped Water Supply at Village: Kushtia; Union: 4 No. Dhuliani; Upazilla: Chowgacha; District: Jessore



Raw water is continuously collected from the Baor (a dead river) into the RWT, from which it flows through RF-1 & RF-2 for removal of suspended particles and then through the SSF for removal of dissolved organic and inorganic substances including micro-organism. The treated water is then collected in the CWR where the water is chlorinated by periodical dosing of bleaching powder solution. From the CWR the water is lifted into OHT from where it is released twice daily to deliver to the consumers through standpipes located within the community. The flow of water from RWT to the CWR through RF-1, RF-2 and SSF takes place under gravity. The Baor is the perennial source of water for the water system. Baor water apparently looks clean and there is no visible potential source of contamination in the vicinity of the intake. The capacity of the system is 60 m3/day and it provides drinking and cooking water needs of 403 families. The distribution system comprises 64meter pipe of 150mm dia, 1677meter pipe of 100mm dia, 1270meter pipe of 75mm dia, 4893 meter PVC pipe of 50mm dia, 101 standpipe, 5 valves in boxes, and 15 washout outlets.

It should be noted here that the ground water in this area is contaminated by arsenic. Two trained operator cum plumber operate and maintain the system under the supervision of a management committee. Each family contributes a fixed service charge monthly to meet the cost of O&M. The operators test some water quality parameters daily. These are turbidity, color, odour and residual chlorine. Turbidity, color and odour are tested visually and physically while residual chlorine is tested by colorimetric method. The SAE DPHE tests bacteriological test monthly by Prota-test kit. The operator maintains all books & records.

3.2.2 Description of intended uses and vulnerability

To determine the susceptibility of the consumer to contaminated water the following information are necessary.

- Who the water is intended for and its intended use. What special considerations are in place for vulnerable groups such as infants, hospitalized patients, the elderly and the immune-compromised. Who the water is specifically not intended for;
- Number of people and institutions served by different service level (communal, yard, within house, industrial, commercial);
- Socio-economic status of different communities served;
- How water is to be used and what exposure routes are relevant;
- What consumer education is in place for water use and how this is communicated, including how consumers are notified of potential contamination.

The information is important as it will be used in the hazard analysis to determine the susceptibility of the consumer to contaminated water.

An example of uses of supplied water and vulnerability is given in Box-4.

BOX-4 Intended user description of Muktagacha Pourashava water supply system

Muktagacha PWSS provides water to approximately 30% of the Poura area and the population served is around 20% of its total population. The water is intended for general consumption by drinking, food preparation, washing and cleaning. There is no special consideration for vulnerable groups such as infants, hospitalized patients, the elderly or the immune-compromised. Street hydrants have been provided to serve the poor people, who always are vulnerable to high health risk. Consumer education on water use and notification on potential contamination is not in place in an effective way.

3.2.3 Description of Areas vulnerable to water supplies

- Areas where free chlorine residuals are not available (In systems where chlorination is applied)
- Areas where turbidity is often increased.
- Areas where microbial contamination has often been detected.
- Areas where leakage is commonly reported.
- Areas of regular intermittence.

The purpose of noting these information is to evaluate whether there are areas within the distribution system that might impact on water safety.

3.2.4 Description of the environment around the system

To understand the environment, more specifically the sanitary condition around the system and to assess the potential contamination hazards thereto it is necessary to collect and describe the following information:

- Detailed sanitation practice of the population;
- Location of sewers (domestic and storm);
- Location of drains, culverts, canals, ditches, ground depressions, ponds, water stagnant/ logged areas;

- Major roads;
- Population data;
- Population served;
- Location of Hat and Bazaars;
- Location of Hospitals and Diagnostic Clinics;
- Location of municipal waste disposal/dumping sites;
- Location of sewage & drainage outfall;
- Location of industries and their waste disposal methods & sites.

An example of description of environmental sanitation around a water supply system is given in Box-5.

Box-5 Example of description of environmental sanitation around Muktagacha PWSS

The environmental sanitation of the town is like that of other Pourashava of Bangladesh, and the town is served with onsite sanitation facilities consisting of mainly pit latrines and septic tanks with soak away pit. The management of the facilities, however, is not up to the level to keep the town environmentally clean. There is no sludge management of these onsite facilities. When the pits/tanks are filled up connections are given to the nearby surface drains and ditches with stagnant water. Thus the present sanitation practice is polluting the town environment as well as a big threat to the water supply system. The Pourashava authority claimed that sanitation coverage within the town is 90%. There are two garbage trucks and 20 dustbins. There is solid waste collection system, however, no specific sanitary land fill site. In most cases household garbage are just thrown around the house and the solid waste from dense area and market place are collected and dumped in the ditches within the town area as land development. Most of the supply mains are laid alongside these drains ditches/dump sites posing serious threat of cross contamination of the supply water. The supply area is thickly populated and not prone to flooding. Overall poor environmental sanitation is also a threat to the whole water supply system of the town.

Summary

At the end of "System Description and Analysis" the team will have a set of information that shows:

1. the supply's primary and secondary infrastructure;
2. how many people use the water supply in different parts of the system
3. major hydraulic zones within the distribution system;
4. areas where there is evidence of failures in water quality/safety management as a means of identifying particular areas of concern;
5. the environment within which the supply is found as a means of identifying potential hazardous areas;
6. known water quality failures within zones of the network.

3.3 Tools development and validation (Step 3)

In order to collect data from the field on the nature of system appropriate means are needed. These are data collection tool. Such data are to investigate what risks exist that may affect the system, and to develop an understanding of how hazards could enter the supply and how these could be controlled.

The first task in this process is to develop data collection tools and finalized these through field testing. The tools should be system specific and include sanitary inspections and testing of selected physico-chemical parameters. Following tools are recommended to assess and monitor the risks within the systems:

- Sanitary Inspection (SI) forms for primary mains, service reservoir, booster station, production tube-wells, valve boxes, roads/drains/ditches crossing, stand pipes, house connection, pump house, chlorination system, washout chambers, treatment units, overhead tanks, underground tanks of consumers, roof tanks etc. The forms should be developed in a way so that for each risk a question is asked that can be answered "Yes" or "No".
- Physical-chemical parameters such as: Free Residual Chlorine, Total Residual Chlorine, pH, Turbidity, color and odor.
- Being developed, the tools should be tested in the field to see their effectiveness and modified as required. The quality of the field test kits with regard to accuracy must be confirmed by cross checking with laboratory tests. Appropriate training of using the SI tools as well as testing of the water quality is very important.

Annex-1 provides one set of assessment tools/sanitary inspections forms.

Summary

At the end of this step, the WSP team should be aware of the importance and be competent in:
- Developing, piloting and finalizing Sanitary Inspection (SI) forms;
- Selecting appropriate physio-chemical parameters; and
- Operating appropriate field testing equipment.

3.4 System Assessment (Risk analysis, Prioritization) (Step- 4)

The objective of the system assessment is to verify the information gathered on the supply system during "System description and analysis". Using the information, inspection points within the network should then be identified for field inspection. As the WSP is an iterative process, the information gathered during the system analysis will be used to select the inspection points that are assessed in the field during the system assessment. The selection criteria for inspection point during system assessment are outlined in Table-1.

Table-1 Selection Criteria for Inspection points

Hazardous environment	Proximity Hazardous environment to physical hazard (sewer, low lying area)
	Proximity to area of high faecal loading (population density)
Evidence of Previous problems	Historical record of microbial contamination
	Historical record of intermittence in supply
	Historical record of leakage
	Evidence of frequent low residual chlorine levels
System characteristics of vulnerability	Proximity to primary/secondary infrastructure
	Pipe attribute (age/material/length)
	Pressure/supply zone
	Proximity to identified part of the system considered very vulnerable
Susceptibility	Number of people affected downstream

For the purpose of system assessment each unit/component of the system will have to be physically verified to assess its present condition in relation to hazard, vulnerability and potential risks to safety of water so that corrective actions can be undertaken. Furthermore, potential hazardous and vulnerable points identified and noted in the system description are also to be physically verified for determining safety measures needed. The assessment is to be carried out using the tools developed and necessary equipment as well as technical expertise and experience of the assessors. The systems to be verified broadly are listed in Table-2:

Table-2 System verification criteria

Inspection Point (Process Steps)	Detailed Inspection Points
Catchment	Boundary demarcation; Protection/safety; Prevention of water contamination, Intake.
Treatment process (Different treatment plants use in different combination)	**Surface water:** Pretreatment (de-silting, grit removal, roughing filtration, pre-chlorination); plain sedimentation; coagulation-flocculation-sedimentation/floatation; coagulation-clarification; Rapid Sand Filtration; Slow Sand Filtration; Chlorination; Treated Water Reservoir; Overhead Tanks; Distribution Network.
Treatment process (Different treatment plants use in different combination)	**Groundwater:** • No treatment at all (direct to distribution); • No treatment but with chlorination only (direct to distribution or through overhead tanks); • Aeration; Flocculation-sedimentation/ floatation; Rapid Sand Filtration (Iron Removal); Arsenic removal; Chlorination; Clear water reservoir; Overhead Tanks; Distribution Network.
Production tube wells	Tube-wells; Pump house, overhead tanks, Chlorination systems; all infrastructures in and around the well/pump house; Potential sources of pollution within the zone of influence of the tube-wells.
Distribution system	Trunk main; Secondary mains; tertiary main; valves/valve chambers, service connection, air vents, washouts, street hydrants and other infrastructure

What are hazards and barriers (control measures):

Hazard is a biological, chemical, physical or radiological agent that has the potential to cause harm. Identification of potential hazard of a water supply system may be identification of specific hazard (e.g. chemicals, bacteria, viruses, protozoa) and the sources of hazards (e.g. sewers, onsite sanitation, drains, industries, etc.). For ensuring water safety hazard event is the most effective way to identify and quantify risks than specific hazards. A hazardous event is a mechanism by which a contaminant of health concern is introduced into the water supply.

Control measures are barriers applied in the water supply system to prevent hazards to ingress into system. Control measure can be a physical barrier, a process or even a rule that can prevent hazardous event to take place. Control measures need to have defined limits for operational acceptability (termed as operational limit) that can be applied to operational monitoring parameters.

Implementation of control measures is based on the multiple-barrier principle. The strength of the approach is that a failure of one barrier may be compensated by effective operation of the remaining barriers, thus minimizing in likelihood of contaminants. All control measures are important and should be afforded ongoing attention. They should be subject to operational monitoring and control with means of monitoring and frequency of data collection based on the nature of the control measure. Control measures must be actions that can be taken that will prevent the hazard event from occurring and it should be clear from the description of the control measure what will be done to reduce the risks.

Validation is an investigative activity to identify the effectiveness of a control measure. It is typically an intensive activity when a system is initially constructed or rehabilitated. It provides information on reliability, achievable quality, improvement or maintenance to be used in system assessment in preference to assessed values. It also defines the operational criteria required to ensure that the control measures contribute to effective control of hazards.

How to prepare a hazard matrix:

To identify a hazard event in any distribution system, it is important to consider the source-pathway-receptor model of contamination. In this model the source is the source of the hazards, the receptor is the water supply (in this case the pipes that form the distribution system) and pathways are the means by which the hazards can leave the 'source' and reach the 'receptor'.

Source ⟶	**Pathway** ⟶	**Receptor**
(Hazard event/environment)	(Vulnerability of piped supply)	(Receiving water infrastructure)

Hazard Source = Sewer, drain, bird roosting on service reservoirHazard Movement Release = Leaking sewer, infiltration from drain, defecating bird Hazard Pathway = Effluent from sewer, grey water flush in drains, rain washing bird faeces Hazard Receptor = Pipe leaks (i.e. has holes) , pipe is submerged
= HAZARD EVENT

Risk is the likelihood of identified hazards causing harm to exposed populations in a specified time frame, including the magnitude (severity) of that harm and/or the consequences. Severity is usually gauged in relation to both the number of people affected and the likely impact on those affected people. Risk is proportionate with severity i.e. **Risk = Likelihood x Severity.**

Box 6 : Risk and Severity guidelines

Likelihood	**Definition**
Almost certain	Once a day
Likely	Once per week
Moderately likely	Once per month
Unlikely	Once per year
Rare	Once every 5 years
Impact	**Definition**
Catastrophic	Potentially lethal to large population
Major	Potentially lethal to small population
Moderate	Potentially harmful to large population
Minor	Potentially harmful to small population
Insignificant	No impact or not detectable

	Risk Factor Matrix	Rating	Severity or Consequence					
			Insignificant	Minor	Moderate	Major	Catastrophic	Risk = LxS
			1	2	3	4	5	
Likelihood or frequency	Almost Certain	5	5	10	15	20	25	
	Likely	4	4	8	12	16	20	
	Moderate	3	3	6	9	12	15	
	Unlikely	2	2	4	6	8	10	
	Rare	1	1	2	3	4	5	

Output of hazard assessment semi-quantitative risk prioritization in the catchment process step as an example is listed below:

Hazardous Event	Hazard Type	Likelihood	Severity	Risk	Control Measures	Basis
Sewage spill during large storm transporting pathogens to reach unacceptable concentrations at the surface water abstraction point	Microbial (pathogens)	2	5	10 **(Significant** because control measures are either not in existence or not effective)	Pollution control in source water catchment Filtration of water Disinfection of water Boil water advisory	Waterborne disease outbreaks have arisen from pathogens from sewage including Cryptosporidium and viruses during similar scenarios

Critical limits are levels of performance at which action must be taken to ensure that control is maintained, they should be set at a level where exceeding the limits will not result in a significant risk to health. Critical limits must be directly or indirectly measurable or observable, as otherwise control performance cannot be assessed.

Every control measure needs a system to monitor its performance in relation to the critical limits. Monitoring should concentrate on parameters directly related to process control and should use methods that provide results that can be easily interpreted at the time of measurement or observation.

Corrective measure will be undertaken to prevent contaminated water being supplied if monitoring demonstrates that the critical limit has been exceeded. Corrective action is an important part of an overall preventive management approach. If a control measure is identified where no corrective action can be identified, then it is essential that the water supplier undertakes further work to identify what options exist to rectify non-compliance. Corrective actions may require regular revision and there should be a regular review of working practices, best practice guidelines and available literature to ensure that the corrective actions are those most appropriate and effective.

In addition to operational monitoring of the performance of the individual components of drinking water supply system, it is necessary to undertake final verification for reassurance that the system as a whole is operating Safely. Verification may be undertaken by the supplier, by an independent authority, or by a combination of both. Verification typically includes testing for faecal indicator organisms and hazardous chemicals.

3.4.1 Guidelines for system assessment with regard to catchment, source, treatment processes, production tube-wells, distribution systems.

a. Catchment

Critical inspection items/criteria for assessment: Physical environment, raw water quality.

The following are the potential hazards in catchment:

- Production of flow and/or storage of water;
- Solid waste disposal in the catchment;
- Sewerage and septic system discharges in the catchment;
- Industrial waste discharges in the catchment;
- Chemical use in catchment areas (e.g. use of fertilizers and agricultural pesticides);
- Human access (e.g. recreational activity).
- Livestock access/washing in the catchment.

b. Source

Water sources are of mainly two kinds: surface water and ground water

Critical inspection items/criteria for assessment of surface water sources:

- Description of water body type (e.g., river, reservoir, dam)
- Physical characteristics (e.g., size, depth, thermal stratification, altitude)
- Flow and reliability of source water
- Retention times
- Water constituents (physical, chemical, microbial)
- Protection (e.g., enclosures, access)
- Recreational and other human activity
- Bulk water transport

The following are the potential hazards of surface water sources:

- rapid variations in raw water quality;
- sewage and septic system discharges;
- industrial discharges;
- chemical use in catchment areas (e.g. use of fertilizers and agricultural pesticides);
- major spills (including relationship to public roads and transport routes), both accidental and deliberate;
- human access (e.g. recreational activity);
- wildlife and livestock;
- land use (e.g. animal husbandry, agriculture, forestry, industrial area, waste disposal, mining) and changes in land use;
- inadequate buffer zones and vegetation, soil erosion and failure of sediment traps;
- storm water flows and discharges;
- active or closed waste disposal or mining sites/contaminated sites/hazardous wastes; and
- climatic and seasonal variations (e.g. heavy rainfalls, droughts) and natural disasters.

Critical inspection items/criteria for assessment of ground water sources:

- Confined or unconfined aquifer
- Aquifer hydrogeology

- Flow rate and direction
- Dilution characteristics
- Recharge area
- Wellhead protection
- Depth of casing
- Bulk water transport

The following are the potential hazards of ground water:

- Aquifer contamination from discharges or seepages associated with agricultural practices (e.g., pathogens, nitrates and pesticides), on-site sanitation and sewerage (pathogens and nitrates) and industrial wastes
- Depletion of ground water level due to consistent abstraction of ground water particularly in dry season due to irrigation
- Saline water intrusion due to climate change, seasonal variations and natural disaster

c. Treatment Process

Critical inspection items/criteria for assessment:

- Physical condition of various process units;
- Flow rate;
- Pollutant and impurities reduction efficiency and/or performance of each treatment unit/ process (De-silting/grit-removal; Pre-chlorination; pH correction; Coagulation/ flocculation/floatation/ sedimentation; coagulation/clarification; Rapid sand filtration; Slow sand filtration; Disinfection/storage; Post chlorination; IRP, ARP);
- Back-up (trained/ skilled human resources, buffer stock of pumps, equipment, appliance, fittings, chemicals, reagents, media etc.);
- Control systems;
- Quality of treatment chemicals and materials;
- Chemical dosing;
- Chemical mixing;
- Alarm system and monitoring equipment;
- Power;
- Potentials for accidents;
- Recurring natural disaster;
- Potential formation of disinfection by-products;
- Potential cross-connection to contaminated water/waste water, internal short circuiting;
- Sludge disposal with special attention to arsenic sludge;
- Water quality of the treated water in relation to health based targets.

The following are the potential hazards of treatment process:

- Hazards may be introduced during treatment, or hazardous circumstances may allow contaminants to pass through treatment in significant concentration. Constituents of drinking water can be introduced through the treatment process, including chemical additives used in the treatment process or products in contact with drinking water. Sporadic high turbidity in source water can overwhelm treatment process, allowing enteric pathogens into treated water and the distribution system. Similarly, sub-optimal filtration following filter backwashing can lead to the introduction of pathogens into the distribution system.

- Flow variations beyond design limits can have a negative impact on the treatment processes.
- Inappropriate or insufficient treatment by each unit /process including dis-infection can lead to the production of water of substandard quality.
- Inadequate back-up (infrastructure, human resources) can lead to the poor performance of the whole process.
- Process control failure and malfunction or poor reliability of equipment can lead to malfunctioning of the systems.
- Use of unapproved or contaminated water treatment chemicals and materials will contaminate the water instead of decontamination.
- Chemical dosing failure or inadequate mixing will lead water to pass through untreated.
- Failure of alarms and monitoring equipment might give rise to serious hazardous event without warning.
- Interruption in power supply will impair the quality of treatment.
- Lack of preparedness for potential accidents and recurring disasters may cause interruption to the process.
- Lack of alertness about harmful disinfection by-product (DBP) formation may lead to its formation unnoticed.
- Cross-connection to contaminated water/waste water, internal short circuiting will contaminate the treated water.
- Improper disposal of sludge, especially arsenic sludge can be very hazardous to the ground water and immediate surroundings.

d. Production Tube-wells

Critical Inspection items/criteria for assessment:

Physical environment	Whether well-head is properly sealed and above flood level; whether proper pump house provided; whether security fence provided; whether there are any source of pollution/contamination & hazards within the zone of influence of the well (garbage dump, municipal waste dumping sites, drains, ditches, latrines, urinals, washing place, cattle shed, compost pit, cattle grazing, depression causing water logging / water stagnancy; burrows; rat holes, canals, rivers, sewerage etc.); whether there are any source of pollution uphill the tube-well; whether agricultural activities with or without the use of fertilizers/ pesticides, ongoing if within the zone of influence; whether industries and its waste disposal sites are existing within the zone of influence.
Physical condition of the fittings-fixtures in and around the tube-well	Non-return valves working condition; whether any valve box or joint leaky/overflowing; whether meters, fitting-fixtures rusted or corroded; whether physical condition of pump house (roof, floor, plinth, walls, doors-windows, drainage, electric panel, switch gears) is in proper order in all respect or not.
Structural stability of the tube-wells	Whether securely fixed with floor block, discharge casting, and delivery pipe; whether column pipes, shafts, sockets etc. are in good physical condition; whether leakage exits between pump shaft & gland packing.
Pump maintenance and supply restoration procedure	Whether manual for such procedure exists and followed?

The following are the potential hazards of production tubewells:

- Unacceptable physical environment (to be determined by sanitary survey following assessment tools) might allow seepage, ingress and infiltration of pollution/contamination into the aquifer and the well;
- Unsatisfactory working condition of various fittings and control systems in general can affect the quality of the water, however, absence of non-return valve or its non-functioning will be invariably detrimental to the quality of tube-well water and aquifer due to return of water from the distribution system or rising main;
- Structural instability, e.g. loose joint between tube-well head and the pump house floor or loose joint between the motor and the floor could be hazardous;
- The chances of ingress of external pollution into the aquifer are greatest when the submersible/lift pumps are withdrawn and re-installed for repair, replacements and maintenance.

e. Distribution Systems

Critical inspection items/criteria for assessment

- Physical environment condition surrounding the infrastructures during dry season and monsoon. The infrastructure are transmission lines, secondary water mains, service reservoir, OHT, booster station, distribution networks, service line, pressure valves, sluice valves, washouts chambers/boxes, major joints/connections.
- Physical condition of the service reservoirs, overhead tanks, booster stations, standpipes, valves, control valves, pipes, fittings-fixtures, washouts.
- Leakage in the system (soil covering of pipeline).
- System pressure, especially in the persistently low pressure sections.
- Security system.
- Water quality especially P/A test for faecal contamination and chlorine residuals.
- Dead end sections of the system.
- Persistent water quality vulnerable areas, e.g. areas where free chlorine residuals are not available; areas where turbidity is often increased; areas where microbial contaminants have been detected; areas where leakage is commonly reported; areas of regular intermittence; areas where color, taste & odor problem is often reported.

The following are the potential hazards of distribution systems:

- When contaminated water from the sub-surface sources, especially from nearby sewers, drains, garbage pits, pit latrines, valve boxes, canals etc. surrounding the distribution system enters through existing loose joints, pin-holes, loose connection, cracks, holes in the pipeline because of low internal pressure or the effect of a 'pressure wave' within the system(infiltration/ingress);
- When contaminated water is drawn into the distribution system or storage reservoir through backflow resulting from a reduction in line pressure and a physical link between contaminated water and the storage or distribution system;
- Through open or insecured treated-water-reservoirs and overhead tanks which are potentially vulnerable to attracting animals, water fowl, birds as faecal contamination sources. The reservoir & the tanks may also be insecure against vandalism and tampering.
- Through pipe bursts when existing mains are repaired or replaced or when new water mains are installed, potentially leading to the introduction of contaminated soil or debris into the system;

- Through human error resulting in the unintentional cross connection of waste-water or storm-water pipes with the distribution system or through illegal or unauthorized connections.
- Through leaching of chemicals and heavy metals from materials such as pipes, solders/jointing compounds, tapes and chemicals used in cleaning and disinfection of the distribution systems;
- During natural disaster, especially flood, ingress/infiltration of highly contaminated water into the system.
- The contaminants that enter the pipes in an intermittent supply, especially during the dry season when the period of intermittence is too long, concentrated 'slug' of contaminated water are formed within the pipelines. As the supply is restored the charging of the system may cause these slugs to reach the consumers giving rise to serious health risk.

Examples of hazard event, cause, risk, control measure, critical limits, monitoring and corrective action are given in Box-7 & 8.

Box-7 Example of hazard event, cause, risk, control measure, critical limits, monitoring, corrective action

Hazard Event	Cause	Risk	Control Measures	Critical Limits		Monitoring			Corrective Actions
				Target	Action	What	When	Who	
Microbial contamination of service reservoir from birds	Birds faeces through open inspection hatches	Moderate /catastrophic	Inspection covers remain in place	Inspection covers locked in place	If inspection covers not in place or locked	Sanitary inspection or Chlorine residual	Daily	Operating staff	Replace inspection cover and check chlorine consume option

BOX-8 Example of critical operational limits for a variety of control points

Control Point	Critical limit	
	Target	Initiate Action if
Treatment works (Gravity flow rapid sand filters)	90% reductions in turbidity	Turbidity of <5 NTU not achieved
Service reservoir	Inspection covers locked in place	Inspection covers missing
Valve box	Packing not leaking	Evidence of leaking valve

Summary

At the end of this step the WSP team will have a good understanding of the following aspects and be assertive of how to carry out a system assessment.

- inspect point criteria;
- identifying inspection points;and
- undertake a field assessment;

3.5 Operation Monitoring (Monitoring Parameters; Corrective Action) (Step 5)

For operational monitoring, it is useful to have both target and action levels. Target levels are often related to national drinking water quality standards, such as zero E. coli, but not necessarily so. In the water resource section a target may relate to, for example, no landfills or housing projects within the watershed. The action levels are those, if breached, at which the pre-established corrective procedures come into force. The type and number of control measures will vary for each system and will be determined on the type and frequency of hazards and hazardous events associated with that system. Monitoring of control measures is essential to support risk management by demonstrating that the control measures effective and that if a deviation is detected, that actions can be taken in a timely manner to prevent health-based targets from being compromised.

3.5.1 Guidelines for operational monitoring with regard to catchment, treatment processes, production tube-wells, distribution systems

a. Catchment

Effective catchment management has many benefits. By decreasing contamination at the source, the amount of treatment required is reduced. This may reduce the treatment by-products and minimize operational cost.

Control Measures:

- Demarcating the catchment boundary and preventing all potential sources of pollution;
- Off-stream storage to reduce the impurities;
- Developing and implementing a catchment management plan;
- Enactment of regulatory laws to conserve, preserve and protect the catchment and effectively communicating to all concerned.
- Setting operational limits for raw water quality (commensurate with the capacity of the treatment plant) at the intake point.

Operational Monitoring:

- Physically checking the catchment daily, and enforcing prevention of any pollution entering the catchment.
- Reviewing weekly the implementation of the management plan
- Checking raw water quality (pH, Turbidity, DO, TDS, TOC, Algae)

Catchment operational monitoring tools is given in Annex-2

b. Treatment

After source water protection, the next barriers to contamination of the drinking- water system are those of water treatment processes, including disinfection and physical removal of contamination.

Control measures:

Control measures should be system and situation specific. Accordingly plausible control measures are mentioned below for different situations:

- In situation where coagulation-flocculation-sedimentation-floatation (clarification), filtration and dis-infection already exist, if required, pre-treatment can be introduced as a control measure to reduce and/or to stabilise the microbial, natural organic matter and particulate load. Pre-treatment includes processes such as roughing filtration, desilting, grit removal, micro-straining, pre-chlorination, off-stream storage and bank-side filtration. In periods of poor quality raw water, improvement can be expected by storing the raw water for a considerable period of time prior to commencing the treatment process.

- In situation where conventional treatment system does not exist, if required based on raw water quality , treatment processes in various combination with or without pre-treatment can be adopted as control measures. The treatment proces generally are plain sedimentation; roughing filtration, slow sand filtration; coagulation- flocculation- sedimentation/floatation; coagulation-clarification; rapid sand filtration; disinfection; IRP; ARP; storage; post chlorination.

Other general control measures are:

a. Ensuring proper specification of each infrastructure and process unit according to the drinking water quality requirement.

b. It is important that the processes are optimized and controlled to achieve consistent and reliable performance. In order to ensure process optimization and proper control, operation and maintenance manual showing optimal post-process-impurities and pollutants burden along with appropriate control measures and maintenance is to be developed and used for each process unit. Critical operational limit for each unit/process is to be set and shown in the operational manual including action required in case critical operation limit crosses.

c. Proper chemical dosing operation, especially chemical coagulation in proper pH regime, because it is the most important step in determining the removal efficiency of coagulation/flocculation/clarification process. It also directly affects the removal efficiency of granular media filtration units and has indirect impacts on the efficiency of the disinfection process. A failure or inefficiency in the coagulation process could result in an increased microbial load entering drinking water distribution. On the other hand excess and unutilized coagulation might increase its own concentration in the drinking water at the cost of human health.

d. Application of an adequate level of disinfection is an essential element for treatment system to achieve the necessary level of microbial risks reduction. Where disinfection is used, measures to minimize Disinfection By-Product (DBP) should be taken into consideration. Storage of water after disinfection and before supply to consumers can process by increasing disinfectant contact time.

e. Use of approved water treatment chemicals, media, reagents and materials.

f. Quality control of water treatment chemicals, media, reagents.

g. Availability of trained/skilled personnel; availability of buffer stock of chemicals/materials; spare parts; fittings-fixtures-equipments-appliances-parts etc. and uninterrupted power supply.

h. Optimization of chemical dosing, filter backwashing and flow rate.

i. Laboratory setup/test kits.

Operational Monitoring

- Measuring performance of each treatment unit/process daily or more frequently. Performance refers to the reduction/ removal of impurities /pollutants or attaining a degree of quality improvement within the predetermined operational, minimum and maximum limit/range.
- Measuring disinfectant concentration and contact time, pH, E-coli, significant chemical parameters, turbidity, and color, at the respective points in 3-4 hours interval for medium to large plants using surface water.
- Checking quality of chemicals, reagents, media etc. prior to use.
- Checking stock of essential items periodically.
- Frequent checking of flow rates.

Operational monitoring tools for treatment processes are given in Annex-3.

c. Production Tube-wells

In Bangladesh, piped water supplies, rural and urban, are predominantly based on ground water abstracted by deep production tube-wells of different diameters, varying from 1.5" to 8" Microbial qualities of the aquifers from which these wells extract water are generally of good standard. However, because of improper physical maintenance & handling and/or inadequate sanitary compliance, contaminant from surface or subsurface level might enter the aquifer and render the water unsafe. The chemical qualities of this water are also generally acceptable excluding occasional occurrence of high arsenic concentration in some situation. It is important that system assessment along with identifying other associated safety measures is carried out for the production tube-wells to ensure safety of water produced by these wells.

Control measures

- Provision of protection by fencing.
- Provision of chlorination at delivery site if no other treatment is intended.
- Best physical and environmental condition must always be maintained by removing and preventing all sources of pollution and contamination and potential hazards within the zone of influence. No unauthorized entrance by anybody and no entrance of livestock should be allowed within the protected area. All fittings-fixtures and infrastructures should also be kept in best working and physical condition by repairing, replacing, cleaning, re-fixing, refitting, painting.
- As much care as possible must be taken to prevent entry of external pollution/impurities during the maintenance work of the sub-pump/lift pump (good workmanship or hygienic). Immediately after the completion of maintenance work, the tube-well should be washed for a considerable period of time by opening the washout valve. It is always preferable to restore supply of water with chlorination.

Other points to note:

- Provision of operation, maintenance, sanitary compliance and communication manual/hand book.
- Provision of reporting system along with reporting tools/formats.
- Provision of operational monitoring and maintenance logbook.

Operational Monitoring

- Daily checking the functionality of the major valves, the flow meters, the flow control and chlorination systems.
- Daily checking of joints for leakage
- Daily checking for water logging, water pooling, water stagnancy in and around the pump house.
- Daily checking the security wall /fence.
- Daily checking for cleanliness in and around the pump house.
- Daily checking for ensuring prevention of any potential source of contamination and hazards.
- Daily checking of chlorine dosing.
- Weekly checking of operational and maintenance log book to see the activities performed in the preceding week.
- Conducting monthly sanitary survey.
- Periodical testing of water quality: P/A test, Arsenic, Mn, & others as per HBT
- Periodically checking the knowledge, technical skills and communication capability of the operators following the operation, maintenance, sanitary compliance and communication manual/handbook.
- Annual physical survey/inspection of all the infrastructures.

Operational monitoring tool for Production Tube-well (PTW) is given in Annex-4.

d. Distribution Systems

The protection of the distribution system is essential for providing safe drinking water. Because of the nature of the distribution system, which may include many kilometers of pipes along with storage tanks, standpipes, service connections and the potential for tampering and vandalism, possibilities of microbial contamination.

Control Measures

- Water entering the distribution system must be microbially safe and ideally should also be biologically stable. Maintaining a disinfectant residual throughout the distribution system can provide some protection against contamination and microbial growth problem. A more stable secondary disinfecting chemical (e.g. chloramines instead of free chlorine) can prove successful in controlling Nagleria-fowleri in water and sediments in long pipelines. Where a disinfectant residual is used within a distribution system, measure to minimize Produciry of Disinfection By-Product/(DBP) should be taken into consideration;
- Undertaking a programme of pipe replacement, flushing and relining;
- Maintaining a constant positive pressure in the system;
- Reducing the water retention time in the system by avoiding stagnation in storage tanks, loops and dead-end section will contribute to maintaining drinking water quality;
- Appropriate survey and maintenance procedures to prevent contamination and to prevent and remove accumulation of internal deposits;
- Compliance of appropriate repair procedures to ensure hygiene and disinfection;
- Implementing cross-connection and backflow prevention devices;
- Water distribution system should be fully enclosed, and storage reservoirs and tanks should be securely roofed, and entrance doors/manholes kept fully closed to prevent contamination;
- Where household storage is used to overcome intermittent supply, localized use of disinfectants to reduce microbial proliferation may be warranted;
- Increasing disinfectant dose during monsoon, especially during flood;
- Availability of backup systems (power supply, trained/skilled human resources, necessary equipment and materials);

Other points to note:

- Maintaining security to prevent sabotage, illegal tapping and tampering;
- For each control measure, implementation and operational procedure is to be produced along with critical operational limit, including action to be followed as corrective measures;

Operational Monitoring

The parameters selected for operational monitoring should reflect the effectiveness of each control measure, provide a timely indication of performance, be readily measured and provide opportunity for a appropriate response.

- Daily inspection/vigilance/surveillance for prevention and removal of any visible sources of contamination of the distribution system.
- Daily measurement of hydraulic pressure in the system, especially in vulnerable sections.
- Daily measurement of chlorine residuals at the critical points.

- Daily checking of presence and absence of faecal contamination.
- Daily measuring faecal coliform from the most vulnerable points following statistically significant methodology.
- Chemical parameters to be checked daily are: pH, Turbidity, DBP, Colour, Taste & Odour and others as required.
- Checking sanitary compliance of the physical infrastructure by monthly sanitary survey using the tools.

Operational Monitoring tool for distribution system is given in Annex-5.

Summary

At the end of this stage, a WSP matrix can be developed for each of the identified inspection points. This should begin with identification of the hazard event and end with the identification of corrective actions. This matrix can be used as the operational tool through which water quality can be managed in the system.

3.6 WSP Management & Operational Procedure (Documentation and Record Keeping) (Step 6)

Management

Effective management implies definition of action to be taken in response to variations that occur during:

- Normal operational period
- Predictable incidents
- Unforeseen events
- EmergenciesThe management plan should also include:
- Plan and action when required for closing supply, water avoidance and 'boil water' orders.
- Monitoring and verification plan as a routine activity
- Supporting programmes, which are important in ensuring water safety.

Documentation

Documentation of a WSP should include:

- Description and assessment of the drinking-water system including programmes to upgrade and improve water delivery.
- Plan for operational monitoring and verification of the drinking-water system.
- Water safety management procedures for normal operation, incidents and emergency situations including communication plan; and
- Description of supporting programmes.

Records are essential to review the adequacy of the WSP and to demonstrate the adherence of the drinking water to the WSP.

Five types of records are generally required:

- Supporting documentation for developing the WSP including validation;
- Records and results generated through operational monitoring and verification:
- Outcomes of incident investigations;

- Documentation of method and procedures used; and
- Records of employee training programme.

Periodic review of WSP records is recommended so that trends can be noted and appropriate actions decided upon and implemented.

Communication:

Communication strategies should include:

- Procedure for promptly advising of any significant incidents within the drinking-water supply, including notification of the public health authority, public announcement through miking, community radio, posters etc.
- Summary information to be made available to consumers- for example, through annual reports and on the Internet;
- Establishment of mechanisms to receive and actively address community complaints in a timely fashion.
- Public educational/awareness building communication programmes for:
  a. Enrolling the consumers' cooperation and support to prevent wastage, misuse and abuse of drinking water.
  b. Maintaining sanitary conditions of the in-campus/ in-house water supply infrastructure including in-house hygienic handling of water.

Operational Monitoring

- The operational monitoring plan should be prepared based on the operational monitoring needs identified and noted during system assessment. For each control measure there should be specified operational monitoring intervention describing what, how, when and who along with remedial actions required. It should also include the following information;
- Water quality parameters to be monitored and method of analysis;
- Sampling or assessment location and frequency;
- Sampling or assessment methods and equipment;
- Schedules for sampling or assessment;
- Methods for quality assurance and validation of results;
- Methods of checking and interpreting results;
- Responsibilities and necessary qualification of staff;
- Methods of documentations and management of records, including how monitoring results will be recorded and stored;

3.7 WSP Application (Step7)

Water Supply Provider(s) will prepare their respective WSPs for the piped water supply following the guideline given in the preceding sections 2 through 3.6. It is understood that without having the management commitment on implementing WSPs, the implementation of the WSPs will not possible in true sense. Though it is important to introduce WSP in each piped water supply for providing safe water to the consumers, which also reduces the cost of water quality problems and as the system assessment and updating is one of the important tasks of the WSP, the unaccounted for water (UFW) will also be reduced, preventing leakages. It is anticipated that it would not be possible to start implementing WSP in every piped water supply at the initial stage; it will require some results based study, which will lead other service providers to implement WSPs. Before full scale implementing of the WSP to each and every piped water supply following steps will need to be ensured.

1. WSP will be the part of any new and/or rehabilitation of piped water supply projects;
2. All WASAs will start piloting of the WSPs immediately and based on the results they will go for full scale WSPs within an achievable time;
3. WSP scaling up programme of WHO/Aus Aid, that is ongoing, will be carefully evaluated so that replication of the WSPs would become easier and acceptable to the providers;
4. Dissemination the benefits of the WSP to encourage implementing WSPs;
5. DPHE will play key role to build awareness among the Pourashavas/City Corporations and non-piped water supply areas to implement WSPs;
6. Support and guide the water supply authorities in the preparation and implementation of the WSPs;
7. Organize training to prepare and implement WSPs;
8. DPHE/PSU/ITN-BUET/WHO will make post implementation visits;
9. Update the National WSP guidelines based on the field experiences and lesson learnt.

For helping the piped water supplier in preparing a WSP, a typical WSP for piped water supply is appended as Annex-6.

3.8 System Improvement

Forming a WSP steering group and WSP preparation team a proper description of a supply system is required which should be well defined and self explanatory and may be supported by a basic flow diagram for the supply. This is followed by defining the intended use of the water and assessing the level of vulnerability of the varied end-user groups. Then to collect data from the field on the nature of the system, to investigate what risks exist that may affect the system and to develop an understanding of how hazards could enter the supply and how these could be controlled. Tools are developed and piloted data collections are done at the outset. The tools used in a field assessment should be system specific and include sanitary inspections and testing of selected physico-chemical parameters. Before undertaking the assessment, sanitary inspection tools are taken care of. Findings from sanitary inspection field testing in the development of these guidelines noted the importance of standardization in order to maintain comparability. To achieve standardization, forms are developed with personnel who have local knowledge of the design of individual facilities within the network (such as valve boxes, service reservoirs). These forms may be slightly different from the sanitary inspection forms used for monitoring, which may be modified for individual service reservoirs or valves. The gathered information during the system description and analysis on the supply network will be verified at the system assessment. With the gathered information, inspection points within the network are identified for field inspection. As the WSP is an iterative process, information gathered during the system analysis will be used to select the inspection points that are assessed in the field.

In the process of system description and analysis, tools development and system assessment if any sort of information gap on system description and analysis, tools preparation or system assessment are found then the system improvement is to be called for. After reviewing with proper improvement and modification by following the step 2, 3 & 4 the whole system should be improved by the system improvement process before entering the operational monitoring step.

3.9 Supporting Program

Supporting programmes can be defined as organization-wide programmes that are required to support the delivery of safe quality water by the organization and any contractors used. Supporting Programmes are those activities, which indirectly support water safety and are also essential for proper operation of the control measures. It covers a range of activities including training course, Standard Operating Procedure (SOP), source protection protocol, risk map etc. as well as legal aspects such as a programme for understanding the organization's compliance/obligations. Due to the increasing demands on organizations in terms of business aspects and the production of many water 'products' (drinking water, recycled water, etc.) it is essential that organizations understand their liabilities and have programmes in place to deal with these issues. Examples of types of Supporting Programmes are provided below in the Table-3.

Table-3 Types of Supporting Programmes that could be included in the WSP

Program	Purpose	Examples
Standard Operating Procedure (SOP)	To ensure that critical limit monitoring is reliable and of acceptable accuracy	Calibration schedules. Self-calibrating equipment.
Source protection protocols	To ensure that the source is well protected by fence, any permanent boundary etc. and the intake structure is in good working condition	Maintenance program
Training course and awareness	To ensure organization (and contractor) personnel understand water safety and the influence of their actions.	WSP training. Competency requirements. Induction training.
GIS risk mapping	Mapping areas of the water supply system with the physical, chemical etc. information to assess the utilities, to convert data displayed on paper maps into digital format, to provide the visualization of infrastructure assets and the tracking of their associated risk factors. Furthermore, applications of GIS technologies offer the capabilities to spatially analyze data, to examine infrastructure deterioration induced by spatially variable risk factors.	Mapping areas of catchment critical to water Quality (Figure-5)

The organization should use the examples (while not intended to be exhaustive) as a guide and assess the programmes it currently has in place and any gaps that need to be addressed including:

- Existing program updating; and
- New programmes development.

At the end it is important to ensure that version control on the programmes is clearly marked to ensure that staff follows the most current procedures.

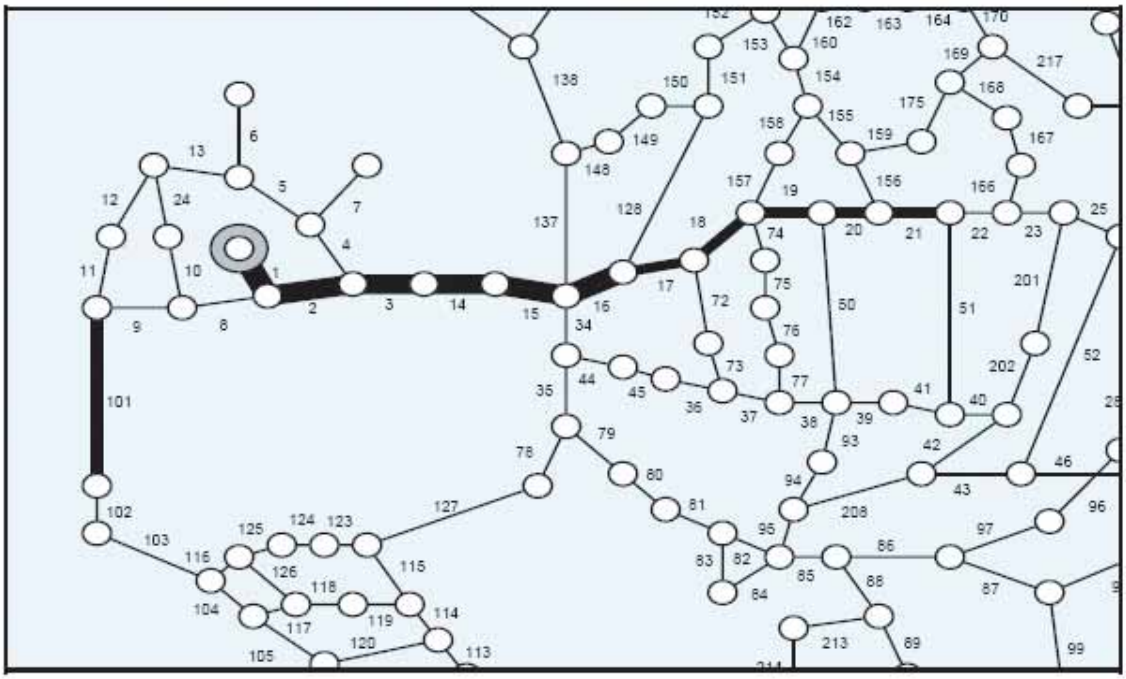


Figure-5 *Map displaying the hydraulic criticality of water mains: bold lines refer to a high criticality, (example from CARE-W)*

4.0 Guideline to prepare On-site Water Safety Plan (WSP) for Rural Water Supply Systems (RWSS) of Bangladesh

The technology that dominates the Rural Water Supply scenario of Bangladesh is Hand Tube Wells (HTW); namely Shallow Tube Wells (STW), Deep Tube Wells (DTW), Very Shallow Shrouded Tube Wells (VSST) and Tara Tube Wells (TTW).The other technologies that are in use in Bangladesh in limited scale are:

- Dug well/Ring well (DW/RW)
- Pond Sand Filter (PSF)
- Rain Water Harvesting (RWH)
- Infiltration Gallery
- Gravity Fed/Flow System (GFS)

There is no doubt that the mere size of the rural water supply systems poses a huge challenge for the sector to ensure the safety of the drinking water. But ensuring minimum safety of these systems can no longer be ignored as about 125 million people of Bangladesh are dependent on these systems for their drinking water. To make sure the safe rural water supply, some inspection point should be defined on the basis of the component of each technology. The inspection points will read out the likely hazard and potential risks to allow the required control measures. Operational monitoring with What, How, Who, When will solve the problem and accordingly proper management, communication and documentation will be followed. Technology specific guideline for assessment of rural water supply systems is shown in Annex-7.

5.0 Proposed WSP Implementation Strategies/ Methodologies for Rural Water Supply System

There are about on average 2000 Water Supply System in each union. Each of these systems needs to adopt safety measures in the light of the guideline for preparation of water safety plan(WSP) so that the water it produces and finally ingested by the people meet the health based targets set by the GoB. Ideally the users should be responsible to adopt and maintain safety measures of their respective systems, but in reality nearly most of them are not aware of such requirement, hence vulnerable to consume unsafe water, unaware. In view of this, the caretakers and the consumers/users need to be sensitized and mobilized so that they express their interest as well as demand for making their systems safe. Being the lowest tier of the Local Govt. Institutions (LGI) the union Parishad is in the best position to support the people in generating such demand and help meet the demand with support and cooperation from, the central government, the upazilla parishad and the line govt. departments. To carry out such function the union parishad will have to be mandated, authorized and provided with requisite funds, human resources and capacity building as described below. It is worth noting here that it might take 3-5 years for a union to plan and execute the safety interventions including attaining sustainability for all water supply systems within the union.

5.1 Strengthening the Union Parishad

In the light of the experience of LGI-JICA Chowgacha-Sharsha (Jessore) Integrated Sustainable Arsenic Mitigation Project the union parishads should be provided with:

1. Annual Budget under Local Govt. Support Project.
2. One trained Water Safety Plan-Implementation Organizer for each union. The union Parishad should be authorized to higher their organizers and also to pay monthly remuneration from the fund received under LG support project.
3. Authority to purchase test kits & reagents, and to carry out arsenic and P/A test on payment by the water testing service receiving beneficiaries.
4. Authority to purchase and provide two bags of cement per system, free of cost, to the owners/caretaker of water systems, if required to construct/reconstruct/repair the system following fulfillment by the users of the terms and the conditions set by the union parishad with respect to adopting safety measures.
5. Authority to use the services of its gram polices in conducting arsenic and P/A test.
6. Authority to print application cum agreement forms for distribution among the users of the water system (One form for each system). The application form will contain the terms and conditions of the Union Parishad and the undertaking by the applicant to qualify for soliciting support of the Union Parishad.
7. Authority to train up caretakers of the water systems and local private mechanics on maintenance of PSF, Dug wells, Rainwater harvesting etc. so that the users can employ their services as and when required.

5.2 Organizing the Users of the Water System

The WSP Implementation Organizer will visit a fixed number of systems each week to accomplish the following:

1. Help forming users committee (one committee for each system).
2. Sensitize/motivate the committees to agree to improve safety of their respective systems.
3. Undertake joint physical inspection (organizer and the committee) of the water system for need assessment following the check list and make a list of actions/works to be carried out for the improvement of the safety. System wise checklists are given in Annex-8.
4. Help filling the application-cum-undertaking form by the users committee. (Application form will contain the expressed desire for safety improvement; request for services of the organizer; undertaking to test water samples, to repair/replace parts as required, to maintain physical and sanitary conditions, to ensure hygienic use of water, to use the cement for the intended purpose only and to maintain meeting and financial records etc.).
5. Follow up visit to ensure actions by the users as mentioned in the application-cum-undertaking/agreement form and system/need assessment done earlier.
6. Test water samples at site if required.
7. The organizer will submit weekly accomplishment report to Union Parishad Chairman.

5.3 Implementation of Safety Measure of the Water System

1. The user committee will undertake the physical and other works/measures as determined during system need assessment and also as mentioned in the application-cum-agreement form.
2. All costs will be borne by the users committee except the cost of two bags of cement which will be provided by the union parishad free of cost.
3. The users committee will undertake operational monitoring and maintenance works as required as mentioned in the application-cum-agreement form.
4. The users committee will carry out water test as agreed in the application form. (Turbidity, Color, odour & tests to be carried out daily; arsenic and P/A test to be carried out half-yearly or more frequently as required)
5. The users committee will submit WSP implementation report to the Union Parishad.

5.4 Water Supply Safety Promotional Support by DPHE/Upazilla Parishad

DGHS field staff responsible for implementation of control of diarrhoeal diseases is in an ideal position to closely interact with the caretakers, owners and beneficiaries of the water supply systems to improve safety of their respective water supply systems. The safety measures will definitely, to a large degree improve the bacteriological quality of water which will directly impact on the incidence of diarhoeal diseases. The diarhoeal disease has been on the increase over the last few years, mainly due to the deterioration of bacteriological quality of water as is generally assumed. The safety measures the DGHS can promote among the caretakers, owners and users are:

1. Repair/rectify/reconstruct platforms of their respective HTWs including the sanitary seal/CC block.
2. Repair/rectify/reconstruct the CC drains and improve overall drainage around the water supply system by earth filling with proper compaction and outward slope so that no water pooling/logging/pooling/ stagnancy is created.
3. Removal of all sources of pollution from the catchments (an area within 10m radius of the water system). The potential sources of pollution are pit latrine, hanging latrine, solid/liquid waste pits/dumps, surface run off (storm, household) disposal pits, open defecation, cattle sheds, agricultural activities with use of fertilizers & pesticides etc.
4. Prevention of unsanitary activities like washing, cleaning, bathing etc. in the catchments and unsanitary priming of the HTW.
5. Promotion of sanitary and hygienic methods of the water collection, carriage, transportation, storages and handling.
6. Sanitary methods of restoration of services after natural disasters.

5.5 Training

1. Comprehensive training to be given to the WSP organizers in the light of their duties and responsibilities stated above.
2. Training of the gram polices to be given on testing of arsenic and faecal contaminants (P/A).
3. Training of DGHS staff engaged in promotion of safety of the water supply system.

5.6 Supervision

1. The SAE and the ward members will oversee the function of the organizers.
2. The SAE, the Ward members and the DPHE tubewell Mechanics will physically verify the quality of works done by the users.They will share their findings with the Union Parishad Chairman.

5.7 Review of Progress

1. In the monthly union parishad meeting progress of works (all items i.e. formation of water users committee, system assessment, application/agreement completed, cement distribution, actual physical works, water test etc) will be reviewed.
2. At the Upazilla Parishad monthly meeting, the progress of works will be reviewed based on reports received from the Union Parishads and oral reports of the SAE, DPHE. The Union Parishad will send the monthly reports to the Upazila parishad.

5.8 Piloting the Proposed Implementation Strategies

It is proposed that the above strategy be tested in a pilot scale in three upazillas under each administrative division to test feasibility. At the end of the pilot phase an in-depth evaluation should be carried out.

WSF

Section- 2

National Water Quality Monitoring Protocol

Development of Protocols and Implementation Strategies for Water Quality Monitoring of Water Supply Systems in Bangladesh

1.0 Introduction

Monitoring of critical drinking water quality parameters along with operational monitoring of other control measures would be an integral, inseparable and continuous activity of any water supply-system-management to ensure safe water for the consumers meeting significant health based and non-health based targets. Hence, the caretakers or the owners of various rural water supply systems, the operators or the management committees of the small community piped water supplies, and the superintendents or the managers of the medium to large water supply systems are responsible to carry out water-quality-monitoring of their respective systems on a regular basis. Types of parameters and frequency of testing depends on severity of the parameters, especially from health point of view and other unavoidable aesthetic considerations. Some parameters are to be tested daily or still more frequently, some are on weekly and yet some on monthly basis and so on. There are needs for seasonal adjustment and needs for special response to emergencies. However, as there are limitations in respect of technical capacity, logistics, finance and overall management of the water-supply-systems, the protocol for water quality monitoring is proposed on a perspective of safety requirement with the capacity of the systems authority. The identity of parameters and frequency of testing are system specific and determined in the light of potential hazards and magnitude of associated risks.

2.0 Health Based Parameters and Targets for Bangladesh

Bangladesh drinking water quality standards 1997 have been reviewed and critically analyzed to identify the priority parameters for Bangladesh considering consequences of health. The identification of the parameters and prioritization was finalized through an official workshop/meeting held on 5-6 August 2010 under the Chairmanship of the Secretary LGD, MoLGRD& C. The exercise revealed that there ware 5 parameters and targets which fell under first priority category and 35 parameters and targets fell under second priority category. Lists of both first priority as well as second priority category parameters have been given in Table-4.

3.0 Water Quality Analytical Capacity of Different Water Systems

It is now important to find out the appropriate analytical methods and equipment that are required for the analysis of first and second priority water quality parameters. This exercise will help each water-supply-system-management to assess their respective needs for capacity building in line with the responsibility of water quality monitoring. Laboratory methods and techniques along with equipment required as well as test kits that are applicable for testing various parameters have been included in Annex-9.

From Annex-10, it will be seen that many parameters which can only be analysed in the laboratory using sophisticated equipment (such as Atomic Absorption Spectrometer, Gas Chromatography, Ion Selective Electrode, Membrane Filtration unit, ICP-MS, Ion Chromatography, Flame Photometry, Multi-parameter analyzer etc.), cannot be tested by the caretakers, owners, operators and management of the rural systems. They can identify some common contaminants in water by applying their sensory clues and the parameters are turbidity, color, taste and odor.

Table: 4 Health Based Parameters and Targets

First priority parameters and targets			Second priority parameters and targets		
Health Based			Health Based		
Sl. No.	Parameters & Unit	Targets	Sl. No.	Parameters & Unit	Targets
1	Thermo-Tolerant Coliform (TTC) (N/100)	0	1	Cadmium (mg/l)	0.003
2	Arsenic (mg/l)	0.05	2	Cyanide (mg/l)	0.07
3	Chlorine (residual) (mg/l)	0.5	3	Fluoride (mg/l)	1
4	Nitrate (mg/l)	50 as Nitrate	4	Lead (mg/l)	0.03
Non-Health Based Target (acceptability)			5	Manganese (mg)	0.4
1	Turbidity (NTU)	5 (urban treated) 10 (rural)	6	Mercury (mg/l)	0.001
			7	Total alpha radiation(Bq/l)	0.5
			8	Total beta radiation(Bq/l)	1.0
			9	Benzene (mg/l)	0.01
			10	Carbon Tetra Chloride (mg/l)	0.004
			11	1,1-dichloro ethane (mg/l)	0.03
			12	1,2-dichloro ethane (mg/l)	0.03
			13	Tetra-chloro ethane (mg/l)	0.04
			14	Tri-chloro ethylene (mg/l)	0.07
			15	Chloroform (mg/l)	0.2
			16	Barium (mg/l)	0.7
			17	Boron (mg/l)	1.0
			18	Copper (mg/l)	2
			19	Nickel (mg/l)	0.05
			20	Selenium (mg/l)	0.01
			21	Sulfate (mg/l)	250
			22	Phenolic compound(mg/l)	0.002
			23	Penta-chloro –phenol (PCP) (mg/l)	0.009
			24	2,4,6-trichlorophenol (mg/l)	0.2
			25	Aldrin and dieldrin (µg/l)	0
			26	Chromium (Total) (mg/l)	0.05
			Non-Health Based Target (acceptability)		
			1	Color (TCU)	15
			2	Odour	Odorless
			3	pH	6.5-8.5
			4	Hardness as $CaCO_3$ (mg/l)	200-500
			5	Total Dissolved Solids (mg/l)	1000
			6	Aluminum (mg/l)	0.2
			7	Ammonia (mg/l)	1.5
			8	Chloride (mg/l)	<600
			9	Iron (mg/l) (urban) Iron (mg/l) (rural)	0.3-1 0.3-3.0

While the operators of small community piped water supply systems in the rural areas can be given responsibility after intensive practical training to test the parameters using relatively simple equipmen such as turbidity meter, colorimeter, field test kits etc., the caretakers and owners of millions of hand tube wells and other rural alternative systems cannot be given such responsibility.

The Union Parishads have demonstrated their capability to test arsenic using test kits (Chowgachha, Jessore). They have also the potential to carry out faecal contamination test using H2S method (P/A test).

DPHE-upazila SAEs have the potentials to test Thermo-tolerant Coliform (TTC) using Pota test kits and also arsenic using arsenic test kits (Chowgacha-Jessore). It should be pointed out here that the DPHE staff strength being limited, one SAE & 4 Tube-well Mechanics at each Upazila and one AE for every two Upazilas, they (DPHE, Upazilla Staff) may be given some limited tasks of surveillance instead of monitoring.While the municipal supplies and the city corporations have some laboratory based and/or test kits based capacity, the WASAs have full-fledged laboratory based water quality analytical capacity.

DPHE Zonal Labs (11 nos.) and DPHE Mohakhali Central Lab have the capacity and equipment for testing all the parameters under first priority category as well as second priority category list except radio-active parameters. DoE, BSTI and BCSIR also have the capacity to test all the parameters of both the lists except the radio-active parameters. Bangladesh Atomic Energy Commission (BAEC) has the capacity to analyze the radioactive water quality parameters as well as other parameters.

This situation analysis transpires that the caretakers/owners of RWS systems can take responsibility of water quality monitoring of their respective water supply systems for a limited number of parameters using sensory organs with Union Parishad supporting them in monitoring of two very critical parameters, namely, arsenic and faecal contamination. For other parameters they will have to be supported by DPHE or DoE, whichever is given the mandate.

It is believed that the small municipal water supplies and small community piped water supplies, if mandated and properly trained, will be able to monitor those parameters which can be tested using test kits or portable colorimeter including patented chemicals/pillows to test as many water quality parameters at the field level as possible. The rest of the selected or crucial parameters can be tested at DPHE or DoE laboratories.

The large municipal-water-supplies and the city corporation-water-supplies should be able to monitor water quality of their respective water supplies using existing analytical capacity or strengthening their present capacity or setting up full-fledged new laboratories.

As an interim approach, the alternative general options for all large & small municipal water supplies and community piped water systems will be to give the responsibility to them (water systems) to monitor water quality using test kits as much as possible, and leaving to DPHE or DoE the verification function of their (water systems) water supplies as well as the role of complementary monitoring for rest of the parameters.

The WASAs have well established analytical laboratories and they should be able to monitor most of the parameters of both the lists. The DPHE or the DoE may be given the verification roles of the WASA water supplies.

4.0 Water System-Specific Monitoring Protocols and Implementation Strategies

Considering the present potential capacity of the various water supply systems stated in Section-3 above (i.e. rural caretakers/owners have some capacity using visual and sensory methods; Union Parishads have some capacity using test kits; small community and all types of Pourashava & City Corporations have some capacity based on test kits; and the WASAs/ DPHE/the DoE have comprehensive analytical capacity) a series of water quality monitoring protocols along with implementation strategies have been developed and presented in Annex-11.

These protocols would be for the period interim apesiod until the analytical capacity of the Pourashavas and the City Corporations are enhanced by providing necessary equipment, trained technical manpower, logistics and finance.

Four (4) Water Quality Monitoring Protocols and Implementation Strategies proposed for Rural Water Supply Systems and Urban Piped Water Supply Systems including small community piped water supply systems in the rural areas are stated below:

4.1 Water Quality Monitoring Protocols and Implementation Strategies for Rural Water Supply Systems

4.1.1 Hand tube-wells (HTW)

a. Shallow tube-wells (STW)
b. Tara tube-wells (TTW)
c. Very shallow shrouded tube-wells (VSST)
d. Deep tube-wells (DTW)

4.1.2 Arsenic Removal Technologies (ART)

a. SIDKO
b. ALCAN
c. SONO
d. READ-F and others
e. Shawdesh
f. Nelima

4.1.3 Alternate Water Supply Systems

a. Pond Sand Filter (PSF)
b. Dug Well (DW)
c. Infiltration Gallery (IFG)
d. Gravity Flow System (GFS)

4.1.4 Rain Water Harvesting (RWH)

4.2 Protocol and Implementation Strategies piped water supply systems

Considerations have been given on the following issues to propose the protocols:

- Comparative advantages and strengths of potential supporting organizations, namely DPHE, BSTI and DoE have been taken into considerations in recommending monitoring and/or verification roles.
- To cover as many first priority as well as second priority category parameters as possible with own potential capacity of the water-systems themselves and the rest with the assistance of other institutions/organizations.
- In addition to self monitoring function of the rural-water supply-systems, they will have to take support from Union Parishads and also from DPHE for monitoring.
- All piped water supply systems in urban as well as rural areas will monitor a limited number of parameters themselves, and for the rest of the parameters the DPHE will take the monitoring function under comprehensive verification responsibility.
- WASAs will carry out their own comprehensive monitoring functions with the DPHE playing the role of verifications.
- Frequencies of monitoring by DPHE have been proposed considering the vast physical expanses to be covered with limited logistics capacity.
- In the selection of parameters considerations have been given to the sources of waters and treatment processes.

5.0 Utilization of Outcomes of the Monitoring of Water Quality

The main objective of monitoring is to look into the water quality continuously so that corrective measures can be taken whenever and wherever the water quality deteriorates compared to the HBT, the agencies mandated to intervene in corrective measures must be continuously provided with the results of monitoring. In view of this a communication strategic has been proposed accordingly. It has been attempted to specify who, when, why and to whom and for what the results/findings of monitoring should be communicated. The communication strategies are given in Annex-12.

Besides, inter-agency communication requirement and strategies proposed at Annex-13, there must be vibrant internal communication and reporting system within each water-supply-system through which the management will get to know, on daily basis, the status of quality of water being supplied to the consumers and, if required can intervene to rectify the situation as and when needed.

6.0 Data Collection, Storage, Processing and Reporting

Concerned authorities of water supply providers should develop their respective "Data Archive System" for storage and retrieval of all generated data in appropriate manner for present and future reference.

Useful and effective system(s) are to be developed by each water supply system for collecting, storage, and processing test result data including generating periodical and annual reports. DPHE, WASAs, City Corporations and the large Pourashava water supply systems should embark on digital system of data storage, processing and reporting. Small Pourashava and small community pipe system may use manual system for the interim.

The rural supply systems (HTWs and other alternative system) may maintain test results following simple method in operation and maintenance (O&M) registers.

In all cases the systems should be such that basic information i.e. date of sampling, date of analysis, result of analysis with parameters, particulars of the water supply system (address, specific component) etc. are recorded in quick retrievable method.

7.0 Piloting Protocols

Before embarking on nationwide implementation it will be worthwhile to test the feasibility of the protocols and the communication strategies in pilot scale.

8.0 Budget

For water quality monitoring to take place uninterrupted at each level as proposed in the protocols, the government will be required to make appropriate budget provisions under revenue head.

9.0 Control and Responsibility of Implementation of the Protocols

- LGD should hold overall control and responsibility of implementation of the protocols and communication strategies.
- Responsibility of monitoring to be carried out under part A and B for all rural water supply systems may be given to the Upazilla Parisahds with the national control retained by the LG division. That of part C of all rural systems may be retained by LGD entirely. (ref: Annex-2)
- Overall responsibility and control of monitoring of all parts (A,B&C; ref:Annex-2) for all Municipality, City Corporation and WASA systems should be retained by LGD. LGD will have to create its appropriate monitoring cell/team to assist it in its task of national level monitoring. (please refer to Section-5 of the surveillance protocol about the role of the proposed cell/team)

WSF
Section- 3

Independent Surveillance

Development of Protocols and Implementation Strategies for Surveillance of Water Supplies of Bangladesh

1.0 Introduction

Drinking water supply surveillance is the continuous and visilaant plublic health assessment and review of the safety and a acceptability of drinking water supplies. The primary responsibility of drinking water supply providers is to provide safe water to its consumers through day to day operational monitoring of water supply system against potential hazards. However, to ensure that the water suppliers/providers do perform their mandated roles properly, and also to ensure that the public health is protected by the quality water supply, independent surveillance system in drinking water supply interventions has been an universally recommended practice. The surveillance is expected to contribute to the protection of public health by promotion and improvement of the quality, quantity, acceptability, coverage, affordability and continuity of water supplies. The surveillance being basically a follow-up-cum supervision exercise is expected to improve the management function of the water suppliers/providers with respect to quality of drinking water, as well as behavioral aspects of the consumer with respect to personal health and hygiene practices. But the degree of success of surveillance largely depends on the quality of operational monitoring itself followed by corrective actions of-the water suppliers/providers. Therefore, routine surveillance role must include follow up with the water suppliers/providers for performing regular comprehensive operational monitoring covering both control measures and water quality. Drinking water suppliers are responsible at all times for the quality and safety of the water they provide.

2.0 Scope of Functions/Activities Under Surveillance

2.1 Major Functions for Drinking Water Surveillance

- Surveillance of systems sanitary compliance
- Surveillance of systems' safety measures against likelihood of vulnerability, hazards and potential risks.
- Surveillance of critical water quality as it leaves the systems and also within the system
- Surveillance of critical water quality at consumers' level
- Surveillance at consumers' level, of impact on public health
- Surveillance at consumers' level, of accessibility to safe drinking water/safe sources
- Assessment of satisfaction at consumers' level about the access to, and quality & quantity of drinking water
- Actions for improvement of quality of services following surveillance

2.2 Specific Scope of Surveillance for Water Supply Services Through RWS Systems and Urban/Rural Piped Water Supply Systems

2.2.1 Specific scope of surveillance under RWS services (HTW and other alternative systems)

- Surveillance of system specific sanitary compliance at the systems
- Surveillance of adoption of system specific safety and control measures against likelihood of hazards, vulnerability and potential risks
- Surveillance of critical water quality (arsenic, ammonia, nitrate, faecal contamination, turbidity, color, odor) at the delivery points of the system

- Surveillance of water storage practices at the family/consumers level
- Surveillance of critical water quality (arsenic, faecal contamination, turbidity,) of the water stored for drinking at family/consumers level
- Surveillance of prevalence of major drinking water borne diseases (diarrhoea of all types, arsenicosis, typhoid, polio-mylites, hepatitis) at family/consumers level
- Surveillance at consumers/family level of access to safe water and safe water sources, and assessment of satisfaction of consumers about the quality and quantity of drinking water
- Preparation of reports on surveillance findings and actions for remedy, if any required

2.2.2 Specific scope of surveillance under services through piped water supply systems

- Surveillance of component-specific sanitary compliance of various water supply systems
- Surveillance of adoption of component-specific safety and control measures against likelihood of hazards, vulnerability and potential risks in various systems
- Surveillance of critical raw water quality at catchment/intake (pH, TC, NH_3, NO_3, Pesticide [{Organo-Chlorine: DDT, Endrine, Aldrin, Heptachlor, Dieldrin} and {Organo-Phosphorus: Diazinon, Malathion Acephate Fenitrothion Quinalplus} of various surface water based systems (Ref: ECR-1997, surface water quality standard)
- Surveillance of critical water quality (Residual Chlorine, TTC, Arsenic, Nitrate, Ammonia, Turbidity, pH,) at the point of leaving the sources/treatment plants of various systems
- Surveillance of critical water quality (Residual Chlorine/Faecal contamination, Turbidity) in the distribution networks of various systems
- Surveillance of critical water quality (Residual Chlorine/Faecal contamination, Turbidity, Nitrate,) at the consumer's level. If any complain found, go for detail analysis.
- Surveillance of prevalence of major drinking water borne diseases (diarrhoea of all types, arsenicosis, typhoid, polio-mylites, hepatitis) at family/consumers level
- Surveillance at consumers/family level of access to safe water/safe sources and assessment of satisfaction of consumers about the quality and quantity of drinking water
- Preparation of reports on surveillance findings and communicating to all concerned; and actions for remedy

3.0 Potential Organizations to Undertake Surveillance for Different Water Supply Services

As a single organization will not be able to take care of all the aspects of surveillance so more than one organization have been suggested according to their comparative capacity and advantages.

3.1 Rural Water Supply System Services

3.1.1 Director General of Health Service

DGHS staffs are working all over the Upazilas and undertake visits to villages/paras and families in rural area as a requirement to carry out their routine functions. Each staff has geographical area of responsibility to implement various project as well as routine health services related activities. Most of the surveillance related activities stated under para 2.2 (system specific sanitary compliance and safety measures, family level water storage practices, assessment of access to safe water, assessment of prevalence of diseases at family level) can be given to DGHS staff, with the following supports/guideline.

I. Training of each staff to build his/her capacity to perform the assigned tasks properly
II. Monthly surveillance work scheduled for individual staff
III. Surveillance checklist and action instructions on

- Sanitary compliance
- Safety and control measures against hazards, vulnerability and potential risks
- Home level storage practices/methods
- Prevalence of drinking water borne diseases at family level
- Family's access to safe water sources and assessment of satisfaction of consumers

Note: The checklists should be easy to understand and comprehend by the users (DGHS staff)

3.1.2 Department of Public Health Engineering (Upazila)

In every upazila there is one Sub-Assistant Engineer (SAE) supported by 4 (four) Tube-well Mechanics (TWM). There is also one Assistant Engineer (AE) for every two Upazilas. Surveillance of water quality at systems delivery points as well as water stored at home/consumers level can be carried out by the TWMs under the guidance/support of the SAE/AE. However, the AEs, the SAEs and the TWMs need to be trained on testing water quality of different parameters such as, Arsenic, Iron, Chloride, Manganese, pH, Turbidity and Faecal contamination etc, by using portable taste kits. They can also be trained on some common/fundamental parameters such as Color, Odor, test, Turbidity, Iron, Chloride, Manganese, Hardness Taste. by applying their sensory clues. They will also need financial and logistic supports including the following:

a. Arsenic and other testing kits
b. Glass vials provided with reagents for testing presence/absence of faecal matters
c. Monthly testing schedule for individual staff
d. Data collecting forms

Note: Turbidity, Color and Odour will be tested using sensory organs

3.2 Water Supply Services Through Small Community Piped Water Supply Systems in Rural Areas

3.2.1 Department of Public Health Engineering

There are only a few such system in a Upazila and the SAE and the TWMs DPHE should be able to undertake surveillance of the following aspects of these systems.

- Component-specific sanitary compliance of the system (by SAE)
- Adoption of component-specific safety/control measures of the system (by SAE)
- Surveillance of critical water quality as it leaves the systems (Faecal contamination, Arsenic, Turbidity, Ammonia, Nitrate) (by TWMs and SAE)
- Surveillance of critical water quality of the distribution system (Residual Chlorine/Faecal contamination, Turbidity) (by TWMs and SAE)
- Surveillance of critical quality of water stored for drinking at family/consumers level (Residual Chlorine/Faecal contamination, Turbidity, Nitrate, Ammonia) (by TWMs and SAE)

3.2.2 Director General of Health Service

For the small community piped water supply system in rural areas also, the DGHS staff should be able to undertake the following surveillance activities.

- Family/consumers level drinking water storage methods/practices
- Family/consumers level assessment of access to safe water and satisfaction of consumers
- Prevalence of major drinking water borne disease at family/consumers level

3.2.3 Department of Environment

As raw water quality of surface sources are at potential risk of pollution from frequent discharges of industrial waste, agricultural waste, municipal waste and human waste, these waters, especially at catchment/intake points of water supply systems should be periodically checked for quality. This is because public health will be at high risk if the treatment processes fail to remove the pollutants. Therefore surveillance of raw water quality (pH, BOD,,COD, TOC, DO, TC, NH_3, NO_3, Pesticide [{Organo-Chlorine: DDT, Endrine, Aldrin, Heptachlor, Dieldrin} and {Organo-Phosphorus: Diazinon, Malathion; Acephate; Fenitrothion; Quinalplus} at the catchment of surface water sources should be carried out by DoE so that precautionary measures as appropriate can be taken on time. (Ref: ECR-1997, surface Water Quality Standard)

3.3 Water Supply Services through Pourashava and City Corporation Water Supply Systems

A single organization will not be able to carry out surveillance of these systems multidisciplinary approaches, rather some organizations will be required for comprehensive surveillance. Accordingly 4 (four) organizations are proposed for surveillance of these systems. The organizations and its roles are proposed below:

3.3.1 Department of Public Health Engineering

DPHE is in better position to be given the responsibility for surveillance of the performance of these water supplies with regard to WSP, operational monitoring of control measures and water quality monitoring. The specific roles should be are as follows:

- Whether or not Water Safety Plan (WSP) has been prepared following the national guideline for the system and being implemented as per plan?
- Whether or not likely vulnerable, hazardous, and potentially risky points/items in the systems from catchment to consumption have been identified and control measures being applied through operational monitoring?
- Whether or not water quality monitoring following the national protocol are being carried out?

3.3.2 Bangladesh Standards and Testing Institution

BSTI as the independent national organization for quality assurance holds the responsibility to check the quality of the products of these water supplies. The specific tasks proposed are given below:

- Checking critical water quality in the systems (TTC, Arsenic, NO_3, pH, Turbidity, Residual Chlorine)
- Checking critical water quality of the waters stored for drinking at the consumers/family level (TTC, Residual Chlorine, Arsenic, NO_3, NH_3, pH, Turbidity,)

3.3.3 Director General of Health Service

As the national organization responsible for health, DGHS should keep an eye on the status of public health related to drinking water, public access to safe water and people's hygienic practices in handling drinking water. The suggested specific items are as follows.

- Checking practices and methods of drinking water stored at consumers/family level
- Checking status of prevalence of drinking water related diseases at family level
- Checking access to safe drinking water at consumers/family level and assessing the satisfaction of the consumers about the services

3.3.4 Department of Environment

Many Pourashava and City Corporation water supplies are dependent on surface waters. These source water are generally unprotected and highly vulnerable to hazards and thus often risky for public health if not properly treated. On the other hand conventional treatment process won't be able to remove the hazards that might appear in the raw water. It is therefore imperative to keep these waters at catchment/intake point under surveillance and DoE has the capacity to do so. The parameters to be kept under surveillance are pH, BOD,COD, TOC, DO, TC, NH_3, NO_3, Pesticide [{Organo-Chlorine: DDT, Endrine, Aldrin, Heptachlor, Dieldrin} and {Organo-Phosphorus: Diazinon, Malathion; Acephate; Fenitrothion; Quinalplus}] and POPs. (Ref: ECR-1997; Surface Water Quality Standard)

3.4 WASAs' Water Supply Services

Same principles for surveillance as described for water supply services through pourashava and city corporation water supply systems are equally applicable for surveillance of WASAs' services. No single organization can carry out these functions because of multidisciplinary character of requirements. However, the Engineering Universities (BUET, CUET, KUET, RUET, DUET) in place of DPHE may be given the responsibility of surveillance of the performance of the WASAs' with respect to:

- Water Safety Plan preparation and its implementation;
- Identification and constantly effective controlling of likely vulnerable, hazardous and potentially risky points/items from catchments/sources to consumptions; and
- Effectively carrying out water quality monitoring following the national protocol.BSTI, DGHS and DoE may be given the same surveillance tasks as described for pourashava and city corporation water supplies.

4.0 Surveillance Protocols and Implementation Strategies

In the light of the above concepts, surveillance protocols and implementation strategies for drinking water supply services in Rural and Urban areas covering different systems have been proposed. Annex-1 describes the protocols along with implementation strategies for various services.

5.0 Control and Responsibility of Implementation of the Protocols & Strategies

- LGD should hold overall responsibility and control of implementation of the surveillance protocols proposed in Annex-1. However LGD will be required to enhance its in-house capacity by creating a cell/team consisting of multidisciplinary professionals. The cell, in addition to assisting the LGD in implementing the monitoring and surveillance protocols and implementation strategies for all rural as well as urban drinking water supplies will be responsible to undertake audit, higher level monitoring and surveillance activities through special surveys, verification and action researches as and when required. The cell/team will also be responsible to produce quarterly national reports on activities and findings of monitoring and surveillance of all rural as well as urban water supply systems of the country.
- Responsibility of surveillance related organizational tasks mentioned under 3.1.1, 3.1.2, 3.2.1 and 3.2.2 may be given to upazilla parishads with national level controls retained by the LGD with the consent of the MoHFP. The same stated under 3.2.3 may be retained by the LGD with the consent of MoE.
- Overall control and responsibility of surveillance related organizational tasks mentioned under 3.3.1, 3.3.2, 3.3.3 and 3.4 may be retained by the LGD with the consent and support from the relevant ministries and departments.

Water Safety Framework (WSF) in Bangladesh

ANNEXES

WSF Annex-I

Assessment Tools/ Sanitary Inspection Forms

Type of facility	PRIMARY MAINS

1. General information: Zone: Area:

2. Code number

3. Date of visit

4. Water samples taken? Sample No.

Specific diagnostic information for assessment:

(Please indicate at which sites the risk was identified)	**Risk Sample No.**
1. Is there any evidence of leakage?	Y/N
2. Is there any evidence of human faeces in vicinity of pipe?	Y/N
3. Are there animal faeces in the vicinity of the pipe?	Y/N
4. Does the primary main pass through stagnant water?	Y/N
5. Is there any evidence of solid waste in the vicinity of the pipe?	Y/N
6. Is there any evidence of excessive algal growth in proximity of the pipe?	Y/N
7. Is there any evidence of a primary line crossing culvert?	Y/N
8. Is there any air valve connected to standpipe?	Y/N

Risk score: 7 - 8= Very high, 5 - 6 = High, 3 - 4 = Medium, 0 - 2 = Low

Results and recommendations

The following important points of risk were noted: (list nos: 1-8)

Signature of health inspectors/assistant:

Comments _____

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Type of facility	PRIMARY MAINS

1. General information: Zone: Area:
2. Code number
3. Date of visit
4. Water samples taken? Sample No.

(Specific diagnostic information for assessment)
(Please indicate at which sites the risk was identified) **Risk sample No.**

1. Are vents not covered? (could animals or birds get into the reservoir) Y/N
2. Is the inspection cover or concrete around cover damaged or corroded? Y/N
3. Is the inspection cover not in place when inspected? Y/N
4. Is any observable part of the inside of the tank corroded or damaged? Y/N
   (including ladders, roof struts, walls)
5. Is there evidence of leakage/cracks in the reservoir? Y/N
   (check the outside of the tank to look for faults)
6. Can run-off form stagnant pools close to the reservoir? Y/N
7. Can stagnant or dirty water collect in valve boxes or washout chambers? Y/N
   (i.e. no or blocked washout chamber)
8. Is the reservoir unfenced or insecure? Y/N
9. Is there evidence of faecal material surrounding the valve box? Y/N
10. Has the tank not been cleaned within one month? Y/N
11. Is the valve in the power house leaking? Y/N

Risk score: 10 - 11 = Very high; 7 - 9 = High; 4 - 6 = Medium; 0 - 3 = Low

Results and Recommendations:

The following important points of risk were noted: (list nos. 1-11)

Signature of Inspector: _____

Type of facility	PRIMARY MAINS

1. General information: Zone: Area:

2. Code number

3. Date of visit

4. Water samples taken? Sample No.

(Specific diagnostic information for assessment)
(Please indicate at which sites the risk was identified) **Risk sample No.**

1.	Is the bleaching is added to the water in the booster?	Y/N
2.	Is any observable part of the inside of the booster corroded or damaged? (Including ladders, roof struts, walls)	Y/N
3.	Is there evidence of leakage/cracks in the booster? (Check the inside of the booster to look for faults)	Y/N
4.	Can run-off form stagnant pools close to the booster?	Y/N
5.	Can stagnant or dirty water collect in valve boxes?	Y/N
6.	Is the booster unfenced or insecure?	Y/N
7.	Is there evidence of faecal material surrounding the valve box?	Y/N
8.	Has the booster not been cleaned within one month?	Y/N
9.	Is the valve in the powerhouse leaking?	Y/N
10.	Is the connecting main leaking?	Y/N

Risk score: 9-10 = Very high; 6-8 = High; 3-5 = Medium; 0-3 = Low

Results and Recommendations:

The following important points of risk were noted: (list nos. 1-10)

Signature of Inspector:

Comments: _____

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Type of facility	PRIMARY MAINS

1. General information: Zone: Area:

2. Code number

3. Date of visit

4. Water samples taken? Sample No.

(Specific diagnostic information for assessment)
(Please indicate at which sites the risk was identified) **Risk sample No.**

1. Is the valve not operational? Y/N
2. Was the cover missing when visited? Y/N
3. Is the valve box cover cracked? Y/N
4. Is the valve corroded? Y/N
5. Does the valve leak? Y/N
6. Is there a lack of backflow preventers installed on supply main? Y/N
7. Is there debris or faecal matter in the valve box? Y/N
8. Is the valve box designed without washout? Y/N
9. Is there stagnant water in valve box? Y/N
10. Are there evident standpipes connected to the valve? Y/N

Risk score: 8-10 = Very high, 6-7 = High, 4-5 = Medium, 0-3 = Low

Results and Recommendations

The following important points of risk were noted: (list nos: 1-10)

Signature of inspectors/assistant:

Comments _____

_____

_____

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_____

Type of facility	PRIMARY MAINS

1. General information: Zone: Area:

2. Code number

3. Date of visit

4. Water samples taken? Sample No.

(Specific diagnostic information for assessment)
(Please indicate at which sites the risk was identified) **Risk sample No.**

1. Is there a valve box within 1m of road crossing? Y/N
2. Is the supply pipe exposed close to the road crossing? Y/N
3. Is there evidence of ingress into the pipe from stagnant water? Y/N
4. Is there evidence of cattle faeces in the area surrounding of the pipe? Y/N
5. Is there evidence of leakage around the pipe? Y/N
6. Does pipe cross open ditch/trench? Y/N
7. Is there evidence of faeces in trench/ditch? Y/N
8. Is there waste material around the pipe? Y/N
9. Is the pipe submerged in stagnant water? Y/N
10. Is the pipe damaged / cracked / leaking / pitted? Y/N

Risk score: 9-10 = Very high; 6-8 = High; 3-5 = Medium; 0-3 = Low

Results and Recommendations:

The following important points of risk were noted: (list nos. 1-10)

Signature of Health Inspector/Assistant:

Comments: _____

_____

_____

_____

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_____

Type of facility	PRIMARY MAINS

1. General information: Zone: Area:
2. Code number
3. Date of visit
4. Water samples taken? Sample No.

(Specific diagnostic information for assessment)
(Please indicate at which sites the risk was identified) **Risk sample No.**

1. Do any standpipes leak? Y/N
2. Does surface water collect around any standpipe? Y/N
3. Are animal faeces in the vicinity of the standpipe? Y/N
4. Are pipes exposed close to any tap stand? Y/N
5. Are human excreta on the ground within 10m of any standpipe? Y/N
6. Is the main pipe submerged in stagnant water? Y/N
7. Are there solid waste dumps 10m from tap stands? Y/N
8. Are there stagnant pools of water close to the pipe? Y/N
9. Does the main pipe pass through sewage/pit latrines/septic tank foul water bodies? Y/N
10. Does main pipe cross a drain/ditch? (if YES go to road crossing SI) Y/N

Risk score: 8-10 = Very high, 5-7 = High, 3-4 = Medium, 0-3 = Low

Results and recommendations

The following important points of risk were noted: (list nos: 1-10)

Signature of health inspectors/assistant:

Comments: _____

_____

_____

_____

_____

Type of facility	PRIMARY MAINS

1. General information: Zone: Area:

2. Code number

3. Date of visit

4. Water samples taken? Sample No.

(Specific diagnostic information for assessment)
(Please indicate at which sites the risk was identified) **Risk sample No.**

1.	Are there evident cracks in the pre filters?	Y/N
2.	Are there leaks in the mixing tank?	Y/N
3.	Is the mixing tank in an unsanitary condition?	Y/N
4.	Are there evident hydraulic surges in intake?	Y/N
5.	Is sedimentation tank in an unsanitary condition?	Y/N
6.	Is the air and water supply distribution in the sand bed uneven?	Y/N
7.	Are there mud balls or cracks in the filters?	Y/N
8.	Are there evident cross connections between backwashed and treated water?	Y/N
9.	Is there evidence of insufficient alum dosing?	Y/N
10.	Are insufficient Chlorine, Residual Chlorine levels not being achieved?	Y/N

Risk score: 8-10 = Very high; 6-7 = High; 3-5 = Medium; 0-2 = Low

Results and Recommendations:

The following important points of risk were noted:
(list nos. 1-10)

Signature of Health Inspector/Assistant:

Comments: _____

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WSF Annex-2

Operational monitoring tools of Catchment

Operational Monitoring Tool

1. Location address of the water supply System.....
2. Component for monitoring: Water Source/Catchments in the River..... or Lake.....
3. Date: .....

Sl. No.	Check/find out whether the Status/condition as stated below prevails/ exists or not	Who will monitor/ check	When	How	Response- Yes/ No	Significance of Yes-response	Action needed and who will be responsible to take action to control/ rectify/ improve
1.	Demarcation of catchments not yet made. (Boundary of the catchments around the intake keeping safe distance by land and water is to be delineated and marked to maintain safe distance from potential source of pollution)	• Treatment Plant Manager • Water System Manager	Continuously until demarcation completed	• Follow-up with higher authorities as required • Physical Supervision of delineation work		Very high significance; Without a defined catchment boundary enforcement of safety measures in the catchment will not be possible.	• Plant Manager/ Water Safety Manager with the support of appropriate authority(It is assumed that there is a law/regulation protecting the catchment)
2.	Industrial waste/effluent being discharged within the catchment boundary	catchment sanitary Inspectors	Daily	Physical Inspection		Very high significance; waste/effluent will cause direct and serious contamination to the source of water;	Waste and effluent discharge must be stopped forthwith. Action by plant/Water System Manager.
3.	Sewerage and septic tank effluent being discharged within the catchment boundary	Catchment Sanitary Inspectors	Weekly	Physical Inspection		High to very high significance. Discharge over land or underground will ultimately contaminate the source, On the other hand direct discharge into the catchment-water will immediately and seriously contaminate the source water.	Discharge/disposal must be stopped forthwith. Action by the plant/water system manager.

Sl. No.	Check/find out whether the Status/condition as stated below prevails/ exists or not	Who will monitor/ check	When	How	Response- Yes/ No	Significance of Yes-response	Action needed and who will be responsible to take action to control/ rectify/ improve
4.	Fertilizers and pesticides being used within the catchment boundary	Catchment sanitary Inspectors	weekly	Physical inspection		Significant; source water will get eventually contaminated by these objects.	Use of fertilizers and pesticides should be stopped and prevented within the catchment boundary; Actions by Plant Manager/ Water System Manager.
5.	Human recreational activities take place in the water bodies within the catchment boundary.	Catchment security Personnel	Daily	Physical Inspection		Some significance, because such activity may contribute to the contamination of source water.	Such activities should be prevented by the plant/water system manager with the help of the security personnel.
6.	Washing/cleaning of livestock, laundry or any other potential source of pollution take place within the catchment	Catchment security Personnel	Weekly	Physical Inspection		Significant; such activity will contaminate the source water.	Such activities should be prevented by the management with the help of security personnel.
7.	Open defecations and defecation from open and hanging latrines takes place within the catchment boundary.	Catchment sanitary Inspectors	Weekly	Physical Inspection		High significance; source water will get contaminated by human excreta.	Such practices must be stopped forthwith and prevented. Action by the management.
8.	Pit latrine seen in the catchment boundary within 30m from the bank of water source	Catchment sanitary Inspectors	Weekly	Physical Inspection		Significant; Pollutants from pit latrine likely to reach the source water.	Pit latrine should be removed and further installation prevented. Action by management.

Sl. No.	Check/find out whether the Status/condition as stated below prevails/ exists or not	Who will monitor/ check	When	How	Response- Yes/ No	Significance of Yes-response	Action needed and who will be responsible to take action to control/ rectify/ improve
9.	Municipal waste outfall, or any other garbage/waste dumps exist within the catchment boundary.	Catchment sanitary Inspectors	weekly	Physical inspection		Significant; Pollutants from the outfall and dumps will reach the source water by leaching underground and by surface run-off over ground.	Outfall and dumps must be removed and prevented further. Action by management.
10.	Raw water quality at intake point, (especially Turbidity, DO, Color, TDS, Ammonia, Organic Carbon, Pesticide, Algae) does not meet the Bangladesh Water quality Standards or WHO guideline values for source of drinking water for supply after conventional treatment.	Treatment plant Chemist or Water System Chemist.	Daily during dry season and weekly in rainy season.	Lab test following proper methods		High significance; because the existing treatment process may not be able to treat such contaminated water to a level that would achieve health based targets.	• All plausible measures to improve raw water quality must be taken including adopting off-stream storage, appropriate pretreatment as well as modifying the treatment processes if required. • Action by the management.

WSF Annex-3

Operational monitoring tools for treatment processes

Operational Monitoring Tool

1. Location address of the water supply System.....
2. Component for monitoring: Water Source/Catchments in the River..... or Lake.....
3. Date: .....

Sl. No.	Check/find out whether the Status/condition as stated below prevails/ exists or not	Who will monitor/ check	When	How	Response- Yes/ No	Significance of Yes-response	Action needed and who will be responsible to take action to control/ rectify/ improve
1. 1.1	**Coagulation** Jar test not being applied daily to determine the optimal dose to achieve adequate removal of turbidity and color.	• Laboratory in-charge • Plant/water system manager	Once daily and as many times as raw water turbidity changes	• Verifying the records of Jar test. • Occasionally verifying the dosing by himself conducting the tests		High significance; Incorrect dose will cause inadequate coagulation/ flocculation, hence inadequate removal of impurities.	Jar test must be carried out daily. Action by plant manager/ water system manager/laboratory in charge.
1.2	Jar test not being applied daily to determine the optimal pH at which the determined dose will achieve best removal	• Laboratory in-charge • Plant/water system manager	Once daily and as many times as raw water turbidity changes	• Verifying the records of Jar test. • Occasionally verifying the dosing by himself conducting the tests		High significance; Inappropriate pH will cause inadequate coagulation/ flocculation, hence inadequate removal of impurities.	Jar test must be carried out daily to determine optimal pH. Action by plant manager/ water system manager/ laboratory in charge.
1.3	Proper mixing of coagulant with inlet water not being achieved.	Operator	2-3 times daily	Appropriate method commensurate with the existing mixing process.		High significance; coagulation will be incomplete resulting in inadequate flocculation and removal	Fix electrical or mechanical or any other operational problem immediately as identified; Action by operator/plant manager.

Sl. No.	Check/find out whether the Status/condition as stated below prevails/ exists or not	Who will monitor/ check	When	How	Response- Yes/ No	Significance of Yes-response	Action needed and who will be responsible to take action to control/ rectify/ improve
1.4	Raw water in flow rate to the coagulation basin is not as per design.	Operator	2-3 times daily	Flow meter		High significance; Dosing will be either more or less leading to malfunctioning of the process	Fix any problem identified with regard to flow. Action by operator/plant manager.
1.5	Correct coagulant dose in proper pH regime is not maintained.	Operator	2-3 times daily	• By matching physical quantity with the flow rate. • pH electrode		High significance; Inadequate coagulation, flocculation and removal.	Fix problem caused to correct dosing as quickly as possible. Action by operator/plant manager.

(Note: Any of the conditions stated above will be an impediment to the removal efficiency of the sedimentation process resulting in mal-functioning of filtration process.)

Operational Monitoring Tool

1. Location address of the water supply System.....
2. Component for monitoring: Treatment Process (Sedimentation followed by coagulation/flocculation).
3. Date of monitoring: .....

Sl. No.	Check/find out whether the Status/condition as stated below prevails/ exists or not	Who will monitor/ check	When	How	Response- Yes/ No	Significance of Yes-response	Action needed and who will be responsible to take action to control/ rectify/ improve
2. 2.1	**Sedimentation after flocculation** pH of water entering the sedimentation basin is not at optimum level (as determined by jar tests)	Operator	2-3 times daily	pH electrode		High significance, because pH effects coagulation followed by flocculation and sedimentation	Control/maintain pH at the desired level by addition of acid or alkali, Action by operator/plant manager.
2.2	Rate of removal of turbidity by the sedimentation process is not up to the level as determined by the jar test. In other words the turbidity of outlet water from sedimentation basin is not same as that determined by jar test.	Operator	2-3 times daily	Turbidity-meter or appropriate laboratory method.		High significance ; high turbidity outside 2-5g/m^3ssload range directly affects the removal efficiency of granular media filtration units and has indirect impacts on the efficiency of disinfection process. A failure in coagulation process could result in an increased microbial load entering drinking water distribution.	Reasons for failure in removing turbidity to the desired level must be found out by investigation followed by quick remedial action. Action by operator/plant manager.
2.3	Influent flow rate to and effluent flow rate from sedimentation basin are not equal, and also not within designed regime.	Operator	2-3 times daily	Flow meter		Significant; Variation and/or difference in flow rates imply turbulence or stagnancy, and also either/ or long/short detention time than designed time.	Inflow rate and outflow rate should be same and as per designed value. Action by operator/plant manager.

Sl. No.	Check/find out whether the Status/condition as stated below prevails/ exists or not	Who will monitor/ check	When	How	Response- Yes/ No	Significance of Yes-response	Action needed and who will be responsible to take action to control/ rectify/ improve
2.4	Presence of organic Carbon in the sedimentation effluent has been observed	Laboratory In-charge	1-2 times per week and more frequently during dry season	Appropriate methods of analysis		Significant; Presence of organic carbon indicates overall impurity of water	After sedimentation process the concentration of organic carbon should be very low, preferably nil. Modification of existing treatment process or addition of appropriate process may be necessary. Action by management.
2.5	Reduction of bacterial load between 80 and 90% is not being achieved by sedimentation process	Lab. In-charge	Daily	Proper Bacteriological test		High Significance; Filtration and disinfection process that will follow may not be able to reduce bacterial load to desirable extent, hence risk of poor bacteriological quality water in the distribution system	Investigate to find the problems with coagulation/flocculation/sedimentation processes and fix as early as possible. If necessary bacterial load has to be reduced by additing pre-treatment process/es. Action by plant manager and higher management.

Operational Monitoring Tool

1. Location address of the water supply System.....
2. Component for monitoring: Treatment Process-Rapid Sand Filtration
3. Date of monitoring: .....

Sl. No.	Check/find out whether the Status/condition as stated below prevails/ exists or not	Who will monitor/ check	When	How	Response- Yes/ No	Significance of Yes-response	Action needed and who will be responsible to take action to control/ rectify/ improve
3. 3.1	**Rapid Sand Filtration** Turbidity of the filtered water is above 10 JTU	Operator	1-2 times daily and more frequently during dry season	Turbidity meter or proper laboratory method		High significance; high turbidity in water will interfere with disinfection process leading to poor bacteriological quality water in the distribution	Cause of high turbidity must be identified quickly and remedial action taken without delay. Action by Plant Manager.
3.2	Filter rate controller in influent or effluent line does not function properly	Operator	at 3-4 hour interval	Filtration Rate meter		Significant ; Different filtration rate than prescribed implies, higher or lower filtration indicating inadequate filtration or low production.	Filtration rates as stipulated in the design should be maintained Action by operator /plant manager.
3.3	Head loss is such that negative pressure is going to be build up within the filter bed.	Operator	at 3-4 hour Interval	Filtration Rate meter		High significance, Negative pressure will cause anaerobic condition in addition to stoppage of filtration.	Backwashing of the bed is to be done before negative pressure builds up, Action by operator.
3.4	Bacterial reduction by filtration process between 90 and 99% is not being achieved.	Chemist/Micro biologist	Once daily	Appropriate laboratory method.		High significance; Disinfection process that will follow may not be able to kill 100% bacteria before releasing to the distribution system.	Under optimum coagulation condition 99% bacterial removal should be achieved by filtration. If this is not achieved, thorough investigation needs to be carried out to find out and fix the problem. Action by operator /Plant Manager.

Operational Monitoring Tool

Annex-3

1. Location address of the water supply System.....
2. Component for monitoring: Treatment Process-Disinfection
3. Date of monitoring: .....

Sl. No.	Check/find out whether the Status/condition as stated below prevails/ exists or not	Who will monitor/ check	When	How	Response- Yes/ No	Significance of Yes-response	Action needed and who will be responsible to take action to control/ rectify/ improve
4. 4.1	**Disinfection** pH of treated water for which disinfection being carried out is outside the effective range.	Operator	At 4 hour Interval	pH Electrode		High significance; For the disinfection process to be effective, Chlorination must be done within the predetermined pH.	PH correction must be done as soon as it is found beyond the effective range. Action by operator/chemist.
4.2	Turbidity of treated water for which disinfection being carried out is above 5 NTU.	Operator	At 4 hour Interval	Turbidity meter		High significance; because median turbidity should be below 0.1 NTU for effective disinfection.	In case of high turbidity, the whole treatment process is to be improved. As an interim measure proper disinfectant dose is to be applied following determination of contact time, pH and temperature. It should however be carefully monitored to avoid production of disinfection by product (DBP). Action by Chemist/Treatment Plant Manager/Top management.

Sl. No.	Check/find out whether the Status/condition as stated below prevails/ exists or not	Who will monitor/ check	When	How	Response- Yes/ No	Significance of Yes-response	Action needed and who will be responsible to take action to control/ rectify/ improve
4.3	Disinfectant dosing is not as per the predetermined effective dose.	Operator	At 4 hour interval	Measuring the disinfectant concentration of the water at dosing point		High significance; Because higher dose might create taste and odour problem for the consumers. On the other hand lower dose will not render water safe.	Correct dosing of disinfectant should be maintained constantly by adjustment of the control systems. Action by operator/treatment plant manager.
4.4	Disinfectant flow rate is not in conformity with the stipulated rate	Operator	At 4 hour interval	Flow meter		High significance; Incorrect disinfectant flow rate will lead to incorrect dosing	Flow rate should be corrected as soon as found to differ from the stipulated rate. Action by operator.
4.5	DisinfectionCt (Disinfectant Concentration x Contact Time) is less than determined for effective disinfection.	Operator	At 4 hour interval	Measuring post dosing detention period or by measuring the disinfectant concentration if detention period is fixed.		Significant; Ct less than determined value may not be enough to complete disinfection process.	Predetermined Ct for disinfection process should be maintained. As it will be difficult to vary detention time, Ct can be achieved by adjusting the disinfectant concentration. Action by Operator/ Chemist.
4.6	Disinfection residual in water at the inlet point of the distribution system is lower than stipulated.	Operator	At 4 hour interval	Measuring the chlorine concentration of water at the inlet point of distribution.		High Significance; Low residual at this point will be inadequate to maintain stable water quality condition in the distribution system.	Stipulated residual should be maintained at the inlet point of distribution by controlling the related system. Action by Operator/Chemist.

Sl. No.	Check/find out whether the Status/condition as stated below prevails/ exists or not	Who will monitor/ check	When	How	Response- Yes/ No	Significance of Yes-response	Action needed and who will be responsible to take action to control/ rectify/ improve
4.7	Disinfection-by products (DBPs) are being generated in the drinking water.	Chemist/Lab in charge.	Once Weekly	By proper laboratory method of analysis of water samples taken at the point of releasing to the distribution.		Significant; DBPs have health significance.	Reasons for production of DBPS is to be found out and remedial action taken accordingly. DBP production can be minimized by changing process conditions or using a different disinfectant, or removing DBP prior to distribution. Action by chemist/Plant manager.

WSF Annex-4

Operational monitoring tools for Production Tube-well (PTW)

Operational Monitoring Tool

1. Location address of the water supply System
2. Component for monitoring: Production Tube-well
3. Date of monitoring: .....

Sl. No.	Check/find out whether the Status/condition as stated below prevails/ exists or not	Who will monitor/ check	When	How	Response- Yes/ No	Significance of Yes-response	Action needed and who will be responsible to take action to control/ rectify/ improve
1.	Zone of influence of the production well has not been determined and demarcated.	Water supply system manager	Weekly until the zone of influence has been determined and demarcated.	Follow up as an important activity of management		Significant; Protective safety measures for the source water cannot be ensured in an unknown zone of influence.	Zone of influence should be scientifically determined and demarcated. Action by water system manager/top management.
2.	There are visible signs of potential sources of pollution (garbage dumps, drains, ditches, latrines, urinals, washing/cleaning facilities, cattle shed, cattle grazing, compost pit, water logging, water stagnancy, burrows, rat holes, canals, rivers, Sewerage, agricultural activities, industries, industrial and municipal waste dumping /disposal site) within the zone of influence.	Pump operator/water supply inspector	Weekly during dry season and daily during monsoon.	Physical inspection		High significance; The water source of the well will get contaminated sooner or later.	Existing sources of pollution must be removed forthwith and further possibility stopped/prevented by regulation and public education. Action by water system manager/top management.

Sl. No.	Check/find out whether the Status/condition as stated below prevails/ exists or not	Who will monitor/ check	When	How	Response- Yes/ No	Significance of Yes-response	Action needed and who will be responsible to take action to control/ rectify/ improve
3	There are visible signs of potential sources of pollution (Ref. SL 2 above) uphill the production well.	Pump Operator/ Water supply inspector	Weekly during dry season and daily during monsoon.	Physical inspection		High significance; The water source of the well will sooner or later get contaminated.	Same as above.
4	Pump house is not properly protected by fencing/wall.	Watersystem manager	During routine visit to the well site.	Physical inspection		Significant; Absence of protective infrastructure will allow easy intrusion by outsiders, hence chance of tampering, vandalism.	Proper fencing /protective measure should be installed around pump house. Action by water system manager /top management.
5	Various valves, flow-meters, flow control and chlorination systems are not functioning properly.	Pump Operator	Daily	Physical checking.		Significant; non-functioning of non-return valve may cause entry of pollution into the well from the distribution system; Improper functioning of flow control and chlorination system will impair disinfection.	Non-functioning and improper functioning valves and control systems should be fixed /rectified/replaced as soon as detected. Action by operator / water system manager.
6	Unclean and unsanitary environment including water logging/water pooling /water stagnancy observed in and around the pump house.	Pump Operator	Daily	Physical checking.		Significant; Water source will sooner or later get contaminated.	Cleanliness and overall sanitary condition in and around the pump house must be maintained. Action by operator / supervisor.

Sl. No.	Check/find out whether the Status/condition as stated below prevails/ exists or not	Who will monitor/ check	When	How	Response- Yes/ No	Significance of Yes-response	Action needed and who will be responsible to take action to control/ rectify/ improve
7	Leakage observed in joints, valves, connections etc.	Pump Operator	Daily	Physical inspection		Significant; may contribute to pollution of the water sources.	Leakage should be stopped immediately. Action by operator/ plumber.
8	Water quality (P/A test, E.coli. Chlorine residual, Turbidity, Color, Taste & odours, Arsenic, Mn, Iron, Chloride) does not meet HBT or Bangladesh standards.	• Operator (P/A test, Chlorine residual, Turbidity, Color, Taste and odour)	• P/A test: weekly • Other test: daily	Test kit and visual method		Significant; P/A test, residual chlorine, E.coli, As, Mn have water safety implications. Other parameters have aesthetic significance.	Water quality problem should be fixed as soon as possible .Action by water system manager /top management.
		• Chemist (As, Mn, Iron, Chloride, E.coli.)	Quarterly	Test kit and lab method			

WSF Annex-5

Operational monitoring tools for distribution system

Operational Monitoring Tool

1. Location address of the Water Supply System.....
2. Component for monitoring: Distribution System
3. Date of monitoring: .....

Sl. No.	Check/find out whether the Status/condition as stated below prevails/ exists or not	Who will monitor/ check	When	How	Response- Yes/ No	Significance of Yes-response	Action needed and who will be responsible to take action to control/ rectify/ improve
1.	pH of water in the distribution system is outside the range prescribed as HBT or required as per Bangladesh Standard	• Personnel assigned for quality assurance of water in distribution system • Operator to check pH at points prior to entering to the distribution system.	Daily	pH electrode and Lab. method. Sampling to be done at critical/ vulnerable points/sites following proper statistical method. Sampling points should be fixed covering the entire distribution system.		High significance; To minimize the corrosion of water-mains and pipes in household water system the pH of water entering the distribution must be controlled. The optimum pH range for distribution system is 6.8-8.0. However lower pH water tends to be corrosive.	pH correction of water prior to entering the distribution system is essential. Reasons for variations observed in the distribution system should be identified and remedial measures taken accordingly. Action by operator/ chemist/ treatment plant manager.

Sl. No.	Check/find out whether the Status/condition as stated below prevails/ exists or not	Who will monitor/ check	When	How	Response- Yes/ No	Significance of Yes-response	Action needed and who will be responsible to take action to control/ rectify/ improve
2	Turbidity of water in the distribution system is above the HBT or Bangladesh Standard	Quality control personnel assigned for quality assurance of water in the distribution system.	Daily	Turbidity meter and proper lab method. Sampling to be done at critical/ vulnerable points/sites including persistent turbidity problem areas. Sampling should be designed following proper statistical method. Sampling points should be fixed covering the entire distribution system.		Very high Significance; Turbid water may imply leakage, breakage, damage, cracks in the system. Whatever may be the reason, it signifies highly contaminated water.	Cause of turbidity must be determined quickly and redressed accordingly. In the interim public notification may be served alerting them about the precaution they should take. Action by Public Relation Personnel/Water System Manager/Top Management.
3	Disinfectant residual at any point of distribution especially at critical points including persistent water quality problem areas at any time is below the minimum prescribed as HBT or as per Bangladesh Standards.	Quality Control Personnel assigned for quality assurance of water in the distribution system.	Daily	Field colorimetric kit and proper laboratory method.		High Significance; Drinking water with very low disinfectant residual is unsafe.	Water supply distribution system including disinfection methods should be rectified to improve the disinfectant residuals to the desired level. Action by water system manager/ treatment plant manager/top management.

Sl. No.	Check/find out whether the Status/condition as stated below prevails/ exists or not	Who will monitor/ check	When	How	Response- Yes/ No	Significance of Yes-response	Action needed and who will be responsible to take action to control/ rectify/ improve
4	DBPs have been found in the water samples taken from the distribution system	Quality Control Personnel assigned for quality assurance of water in the distribution system.	Daily	Appropriate laboratory method.		Significant; DBPs hold health significance.	Any DBP found persistently should be removed by changing process condition or using different disinfectant. Action by treatment plant manager/top management.
5	Presence of algae observed in water samples taken from the distribution system.	Quality Control Personnel assigned for quality assurance of water in the distribution system.	Daily	Appropriate laboratory method.		Significant; Algae contribute to cause coloration and turbidity in water in the distribution system.	Algae should be removed by pretreatment process. Action by treatment plant manager/top management.
6	Hydraulic pressure in the water distribution system is lower than the atmospheric pressure.	Quality Control Personnel assigned for quality assurance of water in the distribution system.	Daily	Measurement of pressure at critical points including persistent low pressure segments. (measurement to be carried out at the fixed points already decided during sampling design)		High Significance; At low pressure condition, especially at below atmospheric pressure situation, contaminants from external sources will enter the distribution system through pinholes cracks, loose joint etc.	Cause of low pressure must be identified and remedial action taken including rectifying the distribution network if required. Action by water system manager/top management.

Sl. No.	Check/find out whether the Status/condition as stated below prevails/ exists or not	Who will monitor/ check	When	How	Response- Yes/ No	Significance of Yes-response	Action needed and who will be responsible to take action to control/ rectify/ improve
7	P/A test for faecal contamination of the water in the distribution system found positive	Quality Control Personnel assigned for quality assurance of water in the distribution system.	Daily	Conducting P/A tests for water samples collected from critical points of the distribution system including persistent water quality problem areas. (Sampling to be done at the fixed points decided during sampling design).		Very high significance P/A positive test indicate faecal contamination of water.	Sources/causes of contamination must be determined quickly and remedial action taken forthwith. Depending on the gravity of the situation, public notification may be necessary. Action by water system manager/top management.
8	Microbiological test for water in the distribution system shows presence of E.Coli.	Quality Control Personnel assigned for quality assurance of water in the distribution system.	Weekly	Proper laboratory method of analysis, water samples to be taken from critical points including persistent water quality problem loops/areas. (Sampling to be done at the fixed points already decided during sampling design.)		Very high significance; Positive test indicates faecal contamination of water.	Sources/causes of contamination must be determined quickly and remedial action taken forthwith. Depending on the gravity of the situation, public notification may be necessary. Action by water system manager/top management

WSF
Annex-6

Water Safety Plan for Chapai Nawabgonj Pourashava

Foreword

The Bangladesh Water Supply Program Project (BWSPP) has created a National Core Water Safety Plan (WSP) Team to support the development and implementation of WSPs across Bangladesh. Following a request from BWSPP, this WSP was prepared for the Water Supply Section of Chapai Nawabgonj Pourashava (CNP) as a pilot WSP for the national program.

The process by which the WSP was developed to this point was as follows:

- BWSPP and ITN-BUET identified CNP as an ideal site for a WSP piloting in Bangladesh;
- Funding was provided by APSU to BWSPP to work with CNP to develop a pilot WSP;
- A meeting was held between APSU, ITN-BUET, BWSPP and the CNP Water Supply Section Superintendent and the CNP Chairman in July 2005 to discuss the WSP pilots and agree to undertake the work;
- A local WSP team was formed during July and August 2005 consisted of representatives of the CNP Water Supply Section and a medical practitioner from CNP and a local DPHE representative;
- ITN conducted a two-day training program during August 2005 for the local WSP team to help explain how to develop and implement WSPs;
- During October 2005 a motivational meeting was held with the CNP Chairman, Commissioners, Water Supply Section and other local elites to explain in the importance of the WSP for the Pourashava;
- During October and November 2005 a WSP was prepared with the local WSP team working with a support team from BWSPP, APSU and ITN-BUET; and
- This document is the current draft of the WSP as Developed by the end of November 2005.

This draft of the WSP was prepared with support from the following ITN-BUET/DHPE/APSU team:

- SG Mahmud, ITN-BUET
- AKM Ibrahim, BAMWSP, DPHE
- Daniel Deere, Water Futures, Australia, consulting to DFID/APSU
- Guy Howard, DFID/APSU

The stages of development that are to follow are:

- The local WSP team from CNP will implement the WSP and make any final changes required to the pilot WSP document;
- BWSPP/ITN/APSU will use the revised pilot WSP to help other Pourashavas, City Corporations and WASAs to implement WSPs nationally

1. Local WSP Team

The first stage of developing the WSP was to form a team of people from various sections of the Pourashava and representatives from DHPE. The team included people with authority to make any required changes as well as those with the technical ability to develop the WSP.

Name Affiliation	Title	Role in WSP team	Contact Information			
			Address	Phone	Fax	Email
1. Mr. Sadek	Executive Engineer	Chairman	Chapai			
2. Dr. Wahida Hasin	Medical doctor	Member	Chapai			
3. Mr. Nazrul	WW superintendent	Member	Chapai			
4. Mr. Razzak	SAE, DPHE	Member	Chapai			
5. M ?	Sanitary Inspector	Member	Chapai			

The WSP document is to be subjected to continuous improvement over time. As new knowledge or information becomes available about the water supply, and as the system improves, the WSP can be improved and modified to reflect these changes. Therefore, an important part of WSP development was to identify who would be the WSP Document Controller. The WSP Document Controller is responsible for keeping an up to date version of the WSP and for circulating this version to other WSP team members and interested parties. The Document Controller will be Mr Ibrahim of BWSPP until the BWSPP intervention is over after which the Document Controller will be the Superintending Engineer DHPE Rajshahi Circle.

Document Control Record Sheet

Approved by:	*Name:*	Mr Ihtishamul Huq Chairman WSP Core Team	*Date:*	
		Mr Khuda Bux PD, BWSPP	*Date:*	
		Mr Ataur Rahman Chairman Pourashava	*Date:*	
Document controller:	*Name:*	Mr AKM Ibrahim, DPHE	*For now*	
Document History:	*Version:*	Working Draft	*Version:*	*1*
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	By:	APSU	*Date:*	*October 2005*
	Version:	Working Draft	*Revision:*	*3*
	By: *Version:* *By:*	ITN-BUET/APSU/DHPE	*Date:* *Version:* By:	*November 2005*

2. Water Supply Process Description

Step	Description
Water source	Water is abstracted from 5 production tubewells (deep tubewell) by pumping. Total pumping time is 10-12 hours per day and is intermittent (6 am to 2 pm; 4 to 7 pm and in Ramadan 7 to 9 am; 2 to 5 am; 2 to 5 pm). Water is fed to the distribution system both directly from pumped wells and by drawing down from the overhead tank during periods when the pumps are off. At night the overhead tank is isolated and filled so for some of the time the reticulation system is not pressurised.
Water treatment	Water from most of the tubewells is not chlorinated or treated. Water from one of the tubewells and feeding the overhead tank is chlorinated before distribution but is not filtered or otherwise treated. There is no pH correction or other treatment applied.
Main supply storage after treatment	Water pressure is maintained during the daytime through a 1.5 lakh gallon capacity overhead tank.
Distribution of water	Water is distributed via with PVC, HDP or GI pipes. The size of the pipes ranges from 100 mm to 200 mm line.
Household collection and storage	Water is supplied to the consumers through house connections, yard connection and street taps. Floating and poor people collect water from public taps in a kulshi and jugs and transferred to another kulshi for storage in the kitchen area. Many households with house connection have underground reservoir and/or a rooftop reservoir fed by a pump. People store water to allow for non-supply hours.
Any special controls required?	The area has arsenic-affected aquifers and source water must be tested for arsenic and only arsenic-safe wells should be used. Intermittent supplies require special consideration in relation to ingress during periods of low or no pressure. Contamination of stored water particularly in the underground and rooftop reservoirs found in the Consumers must be controlled.
Water quality requirements?	Water quality is compared against the Bangladesh Standards for drinking water (GoB, 1997) and will be informed by the results of QHRA assessment.

3. Intended Uses and Users

Intended Use	Intended Consumer
❑ Water is obtained from production tubewells and then distributed via a piped network system and is intended for use in the home for drinking, cooking and personal hygiene. ❑ Water should meet safety and quality (aesthetic) standards i.e. the Bangladesh Drinking Water Standards (GoB, 1997): ❑ Safety (subset of parameters): • Thermotolerant coliforms (some E. coli) • Turbidity (must be low enough to allow chlorination) • PH (must be low enough to allow chlorine to be effective but not so low that it is corrosive and leads to leaks) • Free chlorine • Nitrate • Manganese • Arsenic ❑ Sanitary Inspection Score ❑ Aesthetic requirements (includes sanitation and clothes washing issues): • Iron • Taste not unpleasant • Colour	❑ The users of the water are people residing in Pourashava area and include the healthy, young, old, pregnant, disabled and immunocompromised. ❑ A number of users transport water in vessels that are not kept solely for drinking water use and store water in unsanitary conditions, which can lead to contamination. Controlling these risks requires hygiene education about the safe water chain by Sanitary Inspector working at the Pourashava. ❑ Chapai WW receive regular water quality testing by DPHE zonal lab, Rajshahi.

4. Process Flow Diagram

Process step	Diagram	Responsible party	CM	M
1. Natural aquifer recharge/storage	▼ ↓	Ministry of Water Resources	☒	☑
2. Abstraction by pump via deep tubewell	● ↓ ↓	Water Supply Section of Pourashava	☑	☑
3. Disinfection by chlorine	↓ ↓ ● ↓	Water Supply Section of Pourashava	☑	☑
4. Storage in 1.5 lakh G overhead reservoir	↓ ↓ ▼ ↵	Water Supply Section of Pourashava	☑	☑
5. Transport in piped reticulation network	→ ↓ ↓ ↓	Water Supply Section of Pourashava and Consumers for service lines	☑	☑
6. Storage in ground level household tanks	↓ ↓ ▼ ↓ ↓	Consumers	☒	☒
7. Pump to rooftop household tanks	↓ ↓ ↓ ● ↓	Consumers	☒	☒
8. Storage in rooftop household tanks	↓ ↓ ↓ ▼ ↓	Consumers	☒	☒
9. Consumers draw water from taps	● ↓ ← ↵ ↵	Consumers	☒	☒
10. Consumers store water in kulshis	↓ ↓ ▼ ↓	Consumers	☒	☒
11. Consumers use of water	● ↵	Consumers	☒	☒

Abbreviations and symbols

●	Operational step	**CM**	Control measures
→	Transport step	**M**	Monitoring
▼	Storage step	☒	Currently present
↓	Symbol connectors	☑	Currently absent

Verification of accuracy

On site verification by: Name: ITN/APSU/DPHE team Date: 17/10/05

Approved by: Name: Mr. Nazrul, Superintendent Date:

5. Hazard Analysis and Risk Assessment

Process Step	Hazardous Event	Hazard Type	Existing Control Measures	Risk	Additional Control Measures Desired	Improvement Action Plan Reference (Section 9)
1. Natural aquifer recharge/ storage	Polluted runoff from wet weather event carries faecal pathogens or agricultural chemicals into aquifer	Microbial (B,V,P) Nitrate Pesticides	Sealed apron around wellhead Well head raised above flood level Drainage provided around wellhead	U	Catch drains and other drainage controls to direct wet weather runoff away from critical source areas	1
	Sub-surface leaching carries faecal pathogens or agricultural chemicals into aquifer	Microbial (B,V,P) Nitrate Pesticides	Promote sanitation and discourage open defecation by Consumers	U	Landuse zoning and other planning controls to preclude faecal deposition and agricultural chemical application within critical source areas	1
2. Abstraction by pump via deep tubewell	Presence of harmful natural chemicals in water	Arsenic Nitrate Manganese Boron Barium	Contaminated tubewells are decommissioned or not used in the first place	S	Clear and reliable marking of contaminated tubewells	2
	Ingress of contaminated water into borehole from surface and shallow aquifer	Microbial (B,V,P) Agricultural chemicals	Sealed apron around wellhead Well head raised above flood level Drainage provided around wellhead Wellhead and joints sealed in top 5 m Ensure strainer is at appropriate depth	S		
	Back-siphonage from pipe into borehole	Microbial (B,V,P)	Non-return valve installed to prevent backflow	I		
3. Disinfection by chlorine	Chlorination failure due to system fault	Microbial (B,V)	Maintain adequate stocks of chlorine in dosing tank Only use chlorine stock that is within stated shelf life Dose chlorine to give = ? mg/L free residual dose	S	Reduce risks from chlorinator failure through scheduled preventative maintenance Chlorinate water from all production wells	3 4
4. Storage in 1.5 lakh G overhead reservoir	Contamination of water by birds and lizards	Microbial (B)	Storage tank is roofed and is bird and animal-proof	S		
	Contamination of water from biofilm and sediment	Aesthetic	Maintain chlorination Clean tank periodically	I		
	Storage tank allows mosquito breeding	Biological	Regular draw down then refill of tank to create turnover of water	I		

Process Step	Hazardous Event	Hazard Type	Existing Control Measures	Risk	Additional Control Measures Desired	Improvement Action Plan Reference (Section 9)
5. Transport in piped reticulation network	Ingress of contaminated water through leaking pipe or joint	Microbial (B,V,P)	Pipe laid in backfilled trench to reduce mechanical breakage risk Thrust blocks and stone/concrete walls used to reduce mechanical breakage risk Support provided at all crossings to reduce mechanical breakage risk Repair of any leaks reported or identified	S	Maximise extent and duration of pressurised supply Sound sealing of joints and fittings to reduce leakage risk and sluice valve chambers filled with sand/gravel and properly drained to reduce ingress risk	5 6
	Ingress of contaminated water through leaking service line	Microbial (B,V,P)	Repair of any leaks reported or identified	S	Consumers education about finding, preventing and repairing leaks in service lines Develop a legal obligation on consumers to repair any defective service lines to prevent water wastage and contamination risk	7 6
6. Storage in ground level household tanks and 8. Storage in rooftop household tanks	Contamination enters storage tank due to flooding and vermin	Microbial (B,V,P)	Keep storage tanks roofed Keep storage tanks out of flood prone areas	S	Consumers education about keeping storage tanks covered and above flood level and not using inundated tanks after floods until the tank has been drained and sanitised	7
	Insect breeding in storage tanks	Insect-borne disease		S	Consumers education about keeping storage tanks closed and properly sealed to prevent mosquito breeding, cockroaches etc.	7
7. Pump to rooftop household tanks	Pump draws pressure down in upstream system, sucking in contaminated water through leak	Microbial (B,V,P)		U	Consumers education about not pumping outside of the supply times	7
9. Consumers draw water from taps	Backflow of water into distribution system through hose connection to tap	Microbial (B,V,P) Chemical (commercial, industrial)		S	Consumers education about not leaving hoses in contaminated water which are then connected to the water supply taps unless there is a reliable air gap or backflow non-return valve present	7
10. Consumers store water in kulshis	Water contaminated by insects, dirty utensils or dirty hands or by carryover contamination from prior use	Microbial (B,V,P)		S	Consumers education about proper use and handling of water with kulshis and proper kulshi design	7
11. Consumers use of water	Water contaminated by dirty drinking utensil	Microbial (B,V,P)		S	Consumers education about use of clean cup for drinking	7

Abbreviations: B, bacteria; V, viruses; P, protozoa; S, significant; U, uncertain; I, insignificant.

6. Operational Monitoring Schedule

Process Step	Indicator	Monitoring		Critical Limit	Corrective Action		Supporting Programs
1. Natural aquifer recharge/ storage	Landuse and activity in critical source areas for recharge or inundation	What:	Land-use and activity	No latrines, animal pens, waste dumps or fertiliser use within 10 m of the tubewell	What:	Re-siting of latrines, animal pens, waste dumps	Consumers education (see Improvement Action 7 under Section 9)
		How:	Inspection of critical source areas		How:	Use of Pourashava bye-laws and Consumers dialogue	
		When:	Monthly for each tubewell		When:	Within one month, to be checked the following month	
		Where:	In critical source area of each well		Who:	Consumers/Ward Commissioners and Sanitary Inspector of Pourashava Water Supply Section	
		Who:	Pourashava Sanitary Inspector				
2. Abstraction by pump via deep tubewell	Integrity of production well	What:	Check fence, apron, capping and platform	No cracks or undercutting of apron or platform; no gaps in fence surrounds; capping in place and intact	What:	Repairs to fence, apron, capping or platform	Pump Driver training (see Improvement Action 8 under Section 9)
		How:	Sanitary inspection		How:	Concreting works, fencing works, cap replacement	
		When:	Monthly for each tubewell		When:	Within one month, to be checked the following month	
		Where:	At the tubewell		Who:	Pourashava Executive Engineer	
		Who:	Pump Driver				
	Flood protection of production well	What:	Drainage and height of wellhead	Unblocked, intact and adequate drains surround wellhead and wellhead raised above flood level	What:	Unblock, repair or augment drains or raise wellhead	Pump Driver training (see Improvement Action 8 under Section 9)
		How:	Sanitary inspection		How:	Plastering, cleaning, concreting as required	
		When:	Monthly for each tubewell		When:	Within one month, to be checked the following month	
		Where:	At tubewell		Who:	Pourashava Executive Engineer	
		Who:	Pump Driver				
	Integrity of well casing	What:	Well casing	Intact sanitary seal to at least 5 m depth	What:	Repair sanitary seal	Pump Driver training (see Improvement Action 8 under Section 9)
		How:	Sanitary inspection		How:	Concreting works	
		When:	Annually towards end of dry season		When:	Prior to floods coming, to be checked the following year	
		Where:	At tubewell		Who:	Pourashava Executive Engineer	
		Who:	Pump Driver				
	Chemical contamination of aquifer	What:	Arsenic, nitrate and manganese	GOB Drinking Water Standards 1997	What:	Check results and if confirmed decommission well	
		How:	Chemical testing		How:	Install alternative well and decommission affected well	
		When:	6-monthly, wet and dry season		When:	Within 6 months of confirmation	
		Where:	At every production tubewell		Who:	Pourashava Water Supply Section Superintendent	
		Who:	DPHE Zonal Lab Rajshahi/Pourashava WS Section				
	Protection against back-flow from pipe	What:	Non-return valve condition	Valve must be in good working condition	What:	Replace non-return valve	Pump Driver training (see Improvement Action 8 under Section 9)
		How:	Check non-return vale		How:	Purchase and install new valve	
		When:	Monthly for each valve		When:	Within one month, to be checked the following month	
		Where:	At pump		Who:	Pourashava Executive Engineer	
		Who:	Pump Driver				

Process Step	Indicator	Monitoring		Critical Limit	Corrective Action		Supporting Programs
3. Disinfection by chlorine	Effectiveness of chlorine	What:	Chlorine dose applied	Stocks of bleaching powder must be fresh Free chlorine must be = 3 mg/L applied dose and = 0.2 mg/L in line	What:	Repair system, replace bleaching powder, increase dose	Pump driver training (see Improvement Action 8 under Section 9)
		How:	Measurement		How:	Maintain, repair, replace, or increase, as required	
		When:	Daily for each chlorinator		When:	Within one day, to be checked following day	
		Where:	At chlorinator and in reticulation system		Who:	Pump Driver and Lineman	
		Who:	Pump Driver and Lineman				
4. Storage in 1.5 lakh G overhead reservoir	Integrity of overhead tank	What:	Tank integrity	Tank lid must be closed and intact. Tank vents to be sealed against entry of vermin.	What:	Repair or replace vents and lid	Pump driver training (see Improvement Action 8 under Section 9)
		How:	Sanitary Inspection		How:	Maintenance or repair as required	
		When:	Monthly for each tank		When:	Within one month, to be checked following month	
		Where:	On top of tank		Who:	Pump Driver and Water Superintendent	
		Who:	Pump Driver				
5. Transport in piped reticulation network	Sanitary condition of valves	What:	Sanitary condition of valves	Valve boxes clear of water and debris and, if required, drainage intact and/or valve box filled with coarse sand	What:	Improve drainage at valve box, clean debris, add sand	Lineman training (see Improvement Action 8 under Section 9)
		How:	Sanitary inspection		How:	Clean or insert additional drains or fill with coarse sand	
		When:	Monthly for each valve		When:	Clean within 1 day and repair/improve within 1 month	
		Where:	Throughout distribution system		Who:	Lineman	
		Who:	Lineman				
	Sanitary condition and integrity of pipes and joints	What:	Condition of pipes and joints	No leaks in pipes or joints, no missing coverings or fill around pipes or joints	What:	Repair pipes or joints, replace fill or coverings	Lineman training (see Improvement Action 8 under Section 9)
		How:	Sanitary inspection		How:	Use good quality fittings	
		When:	Annually for accessible portions of system		When:	Clean within 1 day and repair within 7 days	
		Where:	Throughout accessible distribution system		Who:	Lineman and Water Superintendent	
		Who:	Lineman				
	Structural integrity of crossing supports	What:	Support of pipes at crossings	Pipe supports must be in place.	What:	Provide support to pipes	Lineman training (see Improvement Action 8 under Section 9)
		How:	Sanitary inspection		How:	Use recommended support practices	
		When:	Annually for accessible portions of system		When:	Within 1 month	
		Where:	At all accessible crossings		Who:	Lineman and Water Superintendent	
		Who:	Lineman				
9. Consumers draw water from taps	Sanitary condition of tap stands	What:	Condition, drainage and cleanliness	Tapstand must have no cracks or damage and is clean and drains must be in good condition and clean.	What:	Repair tapstand and drains; clean tapstand and drains	Lineman training (see Improvement Action 8 under Section 9)
		How:	Sanitary inspection		How:	Re-plaster is necessary	
		When:	Monthly for all tap stands		When:	Clean within 1 day and repair within 7 days	
		Where:	At tap stands		Who:	Lineman and Water Superintendent	
		Who:	Lineman				

Process Step	Indicator	Monitoring		Critical Limit	Corrective Action		Supporting Programs
6. Storage in ground level household tanks, 7. Pump to rooftop household tanks and 8. Storage in rooftop household tanks	Hygienic water storage	What:	Condition of storage tanks	Tank must have no cracks, cover must be in place and properly located to avoid vermin and runoff entry, mosquito meshing should be in place	What:	Improve hygiene Consumers education program	Consumers education (see Improvement Action 7 under Section 9)
		How:	Sanitary inspection		How:	Enhance hygiene education	
		When:	Every three years on representative sample		When:	Every three years	
		Where:	With households and in Consumers		Who:	Pourashava	
		Who:	Pourashava				
9. Consumers draw water from taps, 10. Consumers store water in kulshis and 11. Consumers use of water	Hygienic water storage and use	What:	Hygiene practices	There should be a high level of awareness of good water collection, transport and storage hygiene practices	What:	Improve hygiene Consumers education program	Consumers education (see Improvement Action 7 under Section 9)
		How:	Consumers survey		How:	Enhance hygiene education	
		When:	Every three years on representative sample		When:	Every three years	
		Where:	With households and in Consumers		Who:	Pourashava	
		Who:	Pourashava				

7. Surveillance and Verification Schedule

There are a number of interpretations of the words 'verification' and 'surveillance' in different guidelines and documents. In this case the following definitions are used:

- Verification is intended to refer to the activity of the Pourashava high level officials in confirming that the WSP is being implemented properly; and
- Surveillance is intended to refer to the activity of the external agencies, in this case DHPE, in confirming that the Pourashava is implementing the WSP as well as the assessment of the quality of water being supplied

Activity	Description	Frequency	Responsible Party	Records
Internal verification auditing of sanitary inspection activities	Confirm by audit that sanitary inspection is being undertaken by the Linemen and Pump Drivers in accordance with their operational monitoring schedule by checking that records are being completed and that corrections and corrective actions are being undertaken in rectify any problems. Undertake randomised sanitary inspection (for samples of the whole system from recharge area through to the point of consumer use) for at least one day duration and check the results of this sanitary inspection against the records of the sanitary inspection carried out by the Linemen and Pump Drivers under their operational monitoring program.	Quarterly	Pourashava Water Supply Section Superintendent	Data stored at Pourashava
External surveillance auditing of sanitary inspection activities	Confirm by audit that sanitary inspection is being undertaken by the Pourashava in accordance with their operational monitoring schedule by checking that records are being completed and that corrections and corrective actions are being undertaken in rectify any problems. Undertake randomised sanitary inspection (for samples of the whole system from recharge area through to the point of consumer use) for at least one day duration and check the results of this sanitary inspection against the records of the sanitary inspection carried out by the Pourashava under their operational monitoring program.	Annually	DPHE Chapai and BWSPP	Data stored at DHPE Zonal Laboratory and copies sent to BWSPP (NAMIC national water supply information centre) and Pourashava
Microbial water quality assessment surveillance	Undertake routine monitoring at DPHE Zonal Laboratory for thermotolerant coliforms and confirmatory test for E. coli on 10% of positive samples.	Monthly	DPHE Zonal Lab Rajshahi	

Activity	Description	Frequency	Responsible Party	Records
Chemical water quality assessment testing verification	Undertake check sampling of operational chemical monitoring for arsenic, nitrate and manganese on 20% of samples using the standard method to verify validity of field kit results.	6-monthly	DPHE Zonal Lab Rajshahi	
DPHE internal auditing of water quality monitoring and surveillance activities	Confirm by audit that water quality monitoring and check sampling is being undertaken for each production well by DHPE Zonal Lab in accordance with the operational and surveillance and verification schedule by checking that records are being completed and that corrections and corrective actions are being undertaken in rectify any problems. Confirm by audit that sanitary inspection and surveillance auditing is being undertaken by DHPE Zonal Lab in accordance with the surveillance and verification schedule by checking that records are being completed and that corrections and corrective actions are being undertaken in rectify any problems.	Triennially	DPHE National WSP Core Team	

8. Supporting Programs

There are many activities that work together to support the operation of the WSP. Rather than have a separate program for each of these many supporting activities, similar activities are rolled together to give rise to 'programs' of closely related activities. These are the Supporting Programs. A number of Supporting Programs are to be developed as part of the Improvement Action Plan (see Section 9) during the implementation of the WSP. For this WSP the Supporting Programs to be developed include the following:

- Develop asset maintenance and calibration supporting program;
- Develop Consumers education supporting program; and
- Develop operator training supporting program.

In the longer term additional Supporting Programs that could be developed as part of the Pourashava's management systems including:

- Document control system; and
- Records management system.

When developing Supporting Programs, it is important to always involve the Pourashava WSP team and staff. In some cases all the development can be done by the Pourashava. In other cases support can be provided through external agencies and consultants. However, it is important that if external support is utilised, the Pourashava local WSP team should direct the work to ensure that it is of maximum value to the Pourashava.

A person will be responsible for developing and maintaining the Supporting Program. Supporting Programs could involve the development of checklists and simple procedures and should make use of existing information such as existing Consumers education or training material that is available within the sector.

9. Improvement Action Plan

Action	Description	Frequency	Responsible Party	Records
1 Review critical source areas in recharge zone	Review critical source areas as minimum safe distances for latrines, animal pens and waste dumps for each well source. This is currently set at 10 m but may need to be revised in some areas due to local conditions.	DPHE Hydrogeologist and Pourashava Superintendent		
2 Marking contaminated tubewells through an improvement program	Once contamination is identified a tubewell should be reliably marked so that it is very clear that the well should not be used for drinking water supply purposes	Pourashava Executive Engineer		
3 Develop asset maintenance and calibration supporting program	Monitoring equipment and important systems need to be maintained, cleaned and calibrated at programmed intervals to reduce the risk of asset failure. This schedule should cover assets such as those that follow: • Pumps • Wellheads • Chlorinators • Tanks • Pipes and valves • Tapstands • Monitoring equipment	Pourashava Executive Engineer		
4 Chlorinate water from all production wells	Over time, chlorinators should be introduced to all production wells	Pourashava Executive Engineer		
5 1. Maximise duration and extent of pressurised system through an improvement program	The more extensively and consistently positive hydraulic pressure can be maintained in the piped system, the lower the risk of backflow events of all kinds. Means for achieving this include those that follow. • Increasing pump hours • Increasing the period during which the overhead tank is pressurising the system • Creating distinct zones of similar pressure using non-return valves and shut valves	Pourashava Executive Engineer		
6 Improve sanitary protection and water conservation through improved distribution system asset management	Provide increased protection of distribution system by: • mproving jointing and sealing practices when making connections, replacements and extensions • Filling sluice valve boxes with sand/gravel and/or improve drainage from sluice valve boxes to improve • Develop legal obligation on consumers to repair any defective service lines	Pourashava Executive Engineer		

Action	Description	Frequency	Responsible Party	Records
7 Develop Consumers education supporting program	Consumers education should be undertaken to explain how to safely abstract, store and use water. This should cover concepts including: • Avoidance of pumping outside of supply times when the system is not pressurised • Keeping storage tanks covered • Locating storage tanks above flood level • Avoiding using water from tanks if inundated until tanks have been drained and sanitised • Avoiding contaminating water in kulshis with hands or other intrusions • Preventing backflow of contaminated stored water into system though air gaps and non-return vavles • Only using clean kulshis for storing and transporting water • Avoiding recontaminating water in kulshis with dirty hands or utensils • Keeping insects and vermin out of kulshis and water tanks • Controlling mosquito breeding in storage tanks • Using clean receptacles such as cups for drinking • Testing of microbial and chemical water quality	Pourashava Executive Engineer		
8 Develop operator training supporting program	Training is required for staff and should cover at least the following aspects of system sanitary inspection and corrective action: • Wellhead protection • Wellhead area drainage • Wellhead flood protection • Critical source area for wellhead and aquifer recharge area • Wellhead sanitary seal • Chlorine dosing system • Testing for free chlorine levels in dosed water • Bleaching powder storage and shelf life • Draw down rates of bleaching powder • Exclusion of vermin from tanks using meshing and lids • Valve box drainage and sand fill • Reticulation system supports • Integrity of pipes and joints and fill and covering • Tapstand condition and drainage	DPHE in short-term Pourashava Executive Engineer in long-term		

10. One-page quick-view WSP

Process step	Aquifer	Well	Chlorine dosing	Storage	Pipe distribution	Consumer
Risks	Landuses and activities pollute aquifer	Surface water entering well via ingress or backflow Arsenic, nitrate or manganese above GOB DW Standards in aquifer	Failure to disinfect water due to chlorinator problem	Ingress of faecal contamination via gaps in the water tank	Contamination enters distribution system via leaking reticulation system, valves and service lines	Contamination of consumer water due to storage tank ingress, poor hygiene or backflow
Controls and critical limits	Polluting landuse and activity must be excluded within 10 m of wellhead	Arsenic, nitrate and manganese must be within GOB DW Standards Wellhead, sealing, drainage and backflow prevention must be intact	System must be dosing at = 3 mg/L to reach = 0.2 mg/L at end of system and bleaching powder stocks must be within use by date	Roof, hatches and vermin-proofing must be intact	Leaks must be minimised through sound construction, maintenance and repair practices System must be pressurised as much as possible	Hygiene education and awareness must be carried out to promote safe water handling, leakage reporting, storage and backflow prevention
Monitoring	Sanitary Inspection monthly by CNP Sanitary Inspector	Sanitary inspection monthly by CNP Pump Driver Arsenic, nitrate and manganese testing 6-monthly by CNP with field kits	Bleaching powder stock date and chlorine dosing rate daily by CNP Pump Driver Chlorine concentration at end of system monthly by CNP Lineman	Sanitary inspection monthly by CNP Pump Driver	Sanitary inspection monthly by CNP Lineman	Community survey of hygiene awareness triennially by Pourashava
Corrective actions	CNP Ward Commissioners to re-site the problem land use or activity within on month	CNP Superintendent to decommission well within 6 months CNP Executive Engineer to repair fault within on month	CNP Pump Driver to replace stocks, increase dose or repair fault within one day	CNP Pump Driver and Superintendent to repair or replace holes, hatches or vermin-proofing within one month	CNP Lineman and Superintendent to repair fault within 7 days	Increase education efforts
Verification and surveillance	Internal audit and field assessments by CNP Superintendent to confirm that operational monitoring and corrective actions are being undertaken as stated in the WSP External audit and field assessments by DPHE Chapai and BWSPP to confirm that operational monitoring and corrective actions are being undertaken as stated in the WSP 20% of field kit chemical tests done by CNP being check-tested by DPHE Zonal Lab Rajshahi using their standard method Monthly sampling for thermotolerant coliforms by DHPE Zonal Lab Rajshahi					
Supporting Programs	Staff training Community education Maintenance and calibration Implementation of improvement actions					

11. Operational monitoring log sheet

Log sheets help to help support the tracking of operational monitoring. There is no fixed type of log sheet but a suggested layout is provided below for a Pump Driver. The suggested form is an example only.

Operational monitoring information needs to be recorded on a standard form to provide the following important benefits to the Pourashava:

- A de facto checklist to help remind people to the operational monitoring actions to undertake and the information to record;
- A means of tracking the operational monitoring results that are observed to help identify trends and problems and support the setting of water supply improvement priorities;
- An audit trail for verification and surveillance activities to make sure that operational monitoring is being are being undertaken in a timely manner and that corrective actions are being initiated in response to results that deviate outside the critical limits and target criteria.

Item	Details
Monitoring Point:	Process Step 2: Abstraction by pump via deep tubewell.
Performance Indicator:	Integrity of production well
Critical Limit:	No cracks or undercutting of apron or platform; no gaps in fence surrounds; capping in place and intact

Date	Signature	Location	Compliance	To whom corrective action notified	Date notified
1/11/05	Pump Driver Ahmed	No 5 tubewell	✔		
2/11/05	Pump Driver Ahmed	No 3 tubewell	✔		
5/11/05	Pump Driver Ahmed	No 1 tubewell	✕ Fence damaged, animals defecating around wellhead	Water Superintendent Ibrahim	7/11/05
7/11/05	Pump Driver Ahmed	No 2 tubewell	✔		

12. Corrective action log sheet

Log sheets help to help support the completion of corrective actions in response to operational monitoring, verification and surveillance results that exceed critical limits and target criteria. There is no fixed type of log sheet but a suggested layout is provided below. The suggested log sheet is an example only.

Corrective actions need to be recorded on a standard form to provide the following important benefits to the Pourashava:

- A de facto checklist to help remind people to the actions to undertake and the information to record when completing corrective actions;
- A means of tracking the types of corrective actions that are taken which can help identify common problems and support the setting of water supply improvement priorities;
- An audit trail for verification and surveillance activities to make sure that corrective actions are being taken in a timely manner in response to adverse operational monitoring results.

Date notified	Signature	Location	Problem identified	To whom corrective action notified		Date completed
				Corrective action taken	Long-term corrective action	
7/11/05	*Water Superintendent Ibrahim*	*No 1 tubewell*	*Fence damaged, animals defecating around wellhead*	*Fence repaired*	*Discussion held with owner of cattle to explain importance of issue*	*14/11/05*

WSF
Annex-7

Guideline to Assess Rural Water Supply System

1. Guideline to assess Hand-pump Tubewells (HTW) [Deep Tubewells (DTW), Shallow Tubewells (STW), Very Shallow Shrouded Tubewells (VSST), Tara Tubewell (TTW).]

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
Hand Pump	• Check valve/ Seat valve of Hand Pump no.-6 • Foot Valve of Tara Pump.	• Defective check/seat valve will allow entry of air in the tube causing loss of water in the column. Under such circumstances priming will be necessary with water from external sources. Each Priming event can contribute to the contamination of tubewells potentially increasing the risk of diarrhoea among the consumers. • Defective check/seat valve of HP no. 6 and foot valve of Tara pump will allow flood water to enter the tubewell and also aquifer causing water contamination, hence creating risk of diarrhoeal diseases.	• Priming with safe water only when needed. • Replacing the check/seat valve/foot valve immediately after identifying defective/leaky. • Defective check/seat valve of Hand Pump no. 6 and foot valve of Tara Pump must be replaced prior to the monsoon, so that flood water, if flood occurs, cannot enter the tube well and aquifer. • Replacing check/seat/foot valve every 6-9 months as a preventive measure. • Keeping a stock of check/seat valves, and preserving it in polythene bag after soaking in linseed oil. • Keeping basic tools required for replacing the cheek/seat valve handy.	• Check daily, preferably each morning the effectiveness of the check/seat valve. • Carryout special checking prior to the monsoon /flood. • Caretakers /owners responsibility. • Also the responsibility of the users to bring to the attention of the appropriate person(s) or management.	• Record the dates of replacement of the check / seat/foot valves in the O&M log book/sheet. • Sensitizing the users/ beneficiaries about proper priming method.
Hand Pump	Joint between base plate and barrel of both HP no. 6 and Tara pump	Loose joint between the base plate and barrel of HP no. 6 will also allow air entry and will give rise to similar cause and effect as stated above. • Loose joint between base plate and barrel of both types of pump will allow entrance of flood water into the tube well and aquifer.	• Fixing the loose joint immediately after identification by tightening the nuts & bolts or replacing the defective nuts and bolts if required • Loose joints between barrel and base (both HP no.6 & Tara) must be fixed prior to monsoon so that flood water, if flood occurs cannot enter the tubewell and aquifer.	• Check daily, preferably each morning the joint between base plate and barrel. • Carryout special checking prior to monsoon / flood. • Caretakers/ owners/ users responsibility.	• Record the dates of replacement of nuts and bolts in the O&M log book/sheet

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
			• Applying burnt mobil oil or grease in the nuts and bolts every 3-6 months to prevent rusting and to allow easy screwing and unscrewing. • Maintaining stock of nuts and bolts of proper size handy and preserving in polythene bag after applying grease in the threaded portion. • Keeping basic tools handy.		
Platform	Platform, Block, joint between block and top-pipe, drainage, surroundings	• Damaged/ broken /cracked/missing platform and block will cause seepage & ingress of contaminated water into the aquifer. • Gap between the block and the top pipe will allow ingress of contaminated water through to the aquifer. • Damaged/broken /cracked/missing drainage will cause water stagnancy and water logging and seepage/ infiltration of contaminated water into the aquifer. • Unclean Platform and drainage will prevent water drainage causing stagnation/water logging and consequent seepage of contaminated water into the aquifer. • Rat-holes, all types of burrows, depression, undulation, litters in the platform surroundings will cause seepage of the contaminated water into the aquifer.	• Platform, block and drains must always be kept in best physical condition by repairing, reconstruction, rehabilitation and maintenance. • No gap between the platform-block and top pipe should be allowed and must be sealed forthwith. • Surrounding soil should be in position with proper compaction and sloping, no hole, borrows, depression, undulation should be allowed, no gap between the ground and beneath the platform should be allowed. • Platform, drainage, and surroundings need frequent cleaning to prevent water stagnation and water logging. • Protection of Platform, drainage and its surroundings by fencing.	• Periodical inspection of platform, block, drains and surrounding condition, especially prior to the rainy season and daily during whole monsoon period and essentially immediately after rainy season and flood, if any. • Responsibility of the owner/ caretakers or community designated person.	• Record major maintenance, reconstruction and rehabilitation work in the maintenance log register/sheet. • Users or beneficiaries need to be periodically sensitized about importance of the control and its compliance.

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
		• Absence of compacted earth with proper sloping around the platform will cause water stagnancy/water logging and allow ingress/seepage of contamination into the aquifer • Water stagnation/water logging caused by any condition stated above will create offensive sight and unhygienic environment, and also allow mosquito breeding.			
HTW Catchment	All the sources of pollution/ contamination within 10m radius of the HTW	• Existence of latrines (pit latrine, open latrine, hanging latrine and open defecation) animal pens, cattle shed, waste dump, compost pit etc. within 10m of the HTW are hazardous for the safety of HTW. Microbial and organic pollution from these sources will find easy access to the subsurface and ground water by leaching, seepage, infiltration into ground and ingress from surface run off. • Use of chemical and/ or organic fertilizer and pesticide within the catchments can be very hazardous for the safety of water for the same reason as stated above	• Removal of all sources of pollution from the catchment. • Prevention of installation/ placement of all kinds of pollution sources • Stoppage of use of fertilizers and pesticides.	• Monthly physical inspection of the catchment. • Collective decision of the beneficiaries/ caretakers/ owners.	• Dates of inspection and measures taken should be recorded in the O&M logbook. • users or beneficiaries need to be periodically sensitized about importance of the control and its compliance

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
Users behavioral and hygienic practice	• Pumping pattern. • Polluting the spout by dirty hand. • Introducing liquid and solid substances through the head cover slit • Collecting water in unclean pitchers/kulshies • Putting dirty hands in collected water. • Washing and cleaning at the platform • Keeping collected and stored water uncovered • Use of unclean/ dirty mugs/glass/pots to drink water	• Improper & vigorous pumping can cause structural damage to the Hand pumps and the tube wells creating condition for ingress of contaminated water. • Introducing solid and liquid substance may pollute the tubewell water as well as cause operational problem. • Use of unclean pitchers, pots, touching spouts, touching water, keeping the collected water uncovered, washing and cleaning at platform, all are likely to contaminate the collected water.	• Frequent orientation of the users and beneficiaries at HTW site on proper handling of the hand pump, hygienic collection, carriage, storage and consumption of water. • Prevention of washing and cleaning at platform.	• Monitoring by observation at HTW sites, and physical inspection at home level. • Collective decision of the users and beneficiaries involving the enlightened people. • Bimonthly orientation meeting at HTW site. • Quarterly home visit.	• Dates of meetings held should be recorded. • Dates of home inspection should be recorded. • users or beneficiaries need to be periodically sensitized about importance of the control and its compliance
Post flood rehabilitation.	Tube well, platform, block, drainage, surroundings.	• Tubewell partially or fully submerged in flood water may cause health problem due to entrance of contaminated water in the barrel and tubewell. • Damaged, broken, cracked platform, block, drainage are likely to contaminate the aquifer. • Erosion of soil around the platform will cause water stagnancy and water logging, hence contamination of aquifer.	• Washing out the contaminated water by continuous pumping for 30 minutes or more immediately after flood. • Repairing, reconstructing the platform, block and drainage if affected by flood. • Refilling the platform surroundings with earth and compacting with proper slope.	• Physically inspecting immediately after flood water receded. • Rechecking physically the rehabilitation work done. • Responsibility of owners/ caretakers /beneficiaries.	• Dates of reconstruction/ rehabilitation to be recorded in the O & M log register.

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
Water quality	Arsenic, pH, Turbidity, Colour, Taste & Odour for all tubewells, and Nitrate & E.Coli especially for VSST.	Presence of Turbidity, Colour, pH, E.Coli, Nitrate above Bangladesh Water Quality Standards indicate unsafe water	• Maintaining best physical condition of the platform, block, Drains and surroundings. • Keeping the tubewell catchments in the best sanitary condition	• Daily checking of turbidity, colour, taste and odour by visual and physical method • Testing Arsenic, E.coli, pH and Nitrate 1-2 times every year • Owner/caretakers/ Beneficiaries responsibility	• Result of testing especially of E.coli, As, pH to be recorded with dates properly. • In case of substandard water, union parishad and DPHE will have to inform for advice/action.

2. Guideline to assess Dug Well/Ring Well (DW/RW)

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
Catchment	• Land Use	• Leaching from over application of fertilizers or organic waste dumps • Faecal contamination through surface leaching from human or animal waste • Nitrate, nitrite, Ammonia and microbial	• Fertilizer not used within at least 10m of the well • Waste dumping location should be at least 10m from the well • Provide fence around dug well • Prevent animal yard/pen within 10m of well • Establish safe distance for installing pit latrine (at least 10m from well as a default)	• Inspect (land use) catchment areas of dug well monthly by caretaker	• Record the dates of relocating of latrines, animal pens, waste dumps etc. • Sensitize the users/ beneficiaries about the need and compliance of control measures
Ground Water	• Presence of natural chemicals in the water	• Arsenic and Manganese	• Test for As, Mn and other important parameters	• Exclude As contaminated wells by testing and go for another source • Test to be done by NGO, LGI or DPHE before commissioning water supply	• Record test results
Dug Well	• Joint between rings • Apron, Slopes, headwall height, cover in place of the well etc. • Drainage around dug well • Mosquito mesh • chlorination	• Ingress of contaminated water through poorly sealed joint • Ingress of contaminated surface water • Introduction of faecal material • Inundation, breeding ground of Mosquitos • Poor construction • Turbidity, microbial and biological contamination will be added up	• Check the fence around the dug well system periphery • Inspect joints between rings and make sure joints are strong and impermeable • Inspect apron around the well (at 2.5-3 ft from headwall) slopes way from well and make sure that these are in good condition • Inspect all vents have mesh and in good condition • Ensure headwall height at least 3 ft and repair protection works if required • Ensure cover in place on the well and replace cover and seal if required • Prevent defecation (human or animal) within 10m	• Sanitary, protective maintenance, drainage around well and overall quality of dug well should be monitored monthly • Chlorination of dug well should be checked regularly • Caretaker will do the operational monitoring	• Record the dates of repair to protection works, drainage, damaged vents or meshes; replace cover and seal etc. in the O&M log book/sheet

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
Hand Pump	• Check valve/ Seat valve of Hand Pump no. 6	• Defective check/seat valve will allow entry of air in the tube causing loss of water in the column. Under such circumstances priming will be necessary	• Replacing the check/seat valve after identifying defective/leaky. • Replacing check/seat valve every 6-9 months as a preventive measure. • Keeping a stock of check/seat valves, and preserving it in polythene bag after soaking in linseed oil. • Keeping basic tools required for replacing the cheek/seat valve handy.	• Check daily, preferably each morning the effectiveness of the check/seat valve. • Caretakers /owners responsibility. • Also the responsibility of the users to bring to the attention of the appropriate person(s) or management.	• Record the dates of replacement of the check / seat valve in the O&M log book/sheet.
Hand Pump	• Joint between base plate and barrel of HP no. 6	• Loose joint between the base plate and barrel of HP no. 6 will also allow air entry and will give rise to similar cause and effect as stated above.	• Fixing the loose joint immediately after identification, by tightening the nuts & bolts or replacing the defective nuts and bolts if required • Applying burnt mobil oil or grease in the nuts and bolts every 3-6 months to prevent rusting and to allow easy screwing and unscrewing. • Maintaining stock of nuts and bolts of proper size handy and preserving in polythene bag after applying grease in the threaded portion. • Keeping basic tools handy.	• Check daily, preferably each morning the joint between base plate and barrel. • Caretakers/users responsibility.	• Record the dates of replacement of nuts and bolts in the O&M log book/sheet
Apron	• Physical/structural condition/ status	• Broken/damaged/ cracked apron can cause structural damage to the DW and can contribute to unsanitary water pooling situation	• Proper repair and maintenance	• Periodical physical inspection of the physical & structural conditions	• Record major repair/ maintenance work

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
Slow sand filter	• Inlet, outlet and washout systems • Filter cover • Filter structure • Filter bed depth • Filtration/flow rate through the bed • Water level over the filter bed	• Unclean or improperly maintained inlet, outlet and washout systems will interfere with hydraulic flow and filter washing • Uncovered or improperly covered filter bed will allow falling of leaves, debris and growth of algae • Damaged/broken brickwork, filter base and plaster will cause loss of water through leakage • Filter depth less than the minimum prescribed will not be able to treat the water properly • Low filtration/flow rate will impair the performance of the process adversely • Less than prescribed water depth over the filter bed might dry up the bed and also cause low hydraulic pressure in the filter bed. In a dry bed the bio-film will loose its affectivity, hence the performance of the filter will deteriorate	• Keeping the systems clean and physically intact • Keeping the filter cover and whole structure in best physical condition • Replenishing the filter bed with additional filter media of prescribed size to make up the lost depth as and when required • Scrapping, washing and replacing a few centimeter of the clogged top filter media as soon as the flow/filtration rate declines • Preventing water leakage and/or fixing hydraulic flow faults in case the prescribed water depth over the bed cannot be maintained	• Physical inspection of the inlet, outlet and washout systems weekly by the caretaker • Physically checking the filter cover and the whole structure monthly by the caretaker • Physically checking the filter bed depth fortnightly by the caretaker • Checking filtration/flow rate through the filter daily by the caretaker • Checking physically the depth of water over the filter bed daily by the caretaker	• Record cleaning, repair and maintenance works carried out with dates in the log book
Clear Water Reservoir	• Plaster • Top cover • washout • Air vent • Physical condition • Treated water collecting device from filter to reservoir	• Loss of inside & outside plaster or crack in the wall or base will cause loss of water • Improper top cover will allow insects intrusion • Unclean or ill maintained washouts & air vents will interface with smooth functioning • Non functioning of the water collecting device (pipe) from filter to reservoir can cause major operational and performance problem	• Keeping these items in best physical & working condition by maintenance	• Checking the physical and operational status fortnightly by the caretaker	• Record the inspection result and maintenance works carried out in the logbook

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
Condition of DW unit	• All the units • Drains • Peripheral condition	• Waste generation in and around the unit • Water pooling/ stagnation	• Keep the unit clean • Make sure the proper drainage of the waste water • Maintain proper slope around the DW	• Check the units every day by caretaker	• Record the inspection result in the log book
Taps	• Water collecting taps	• Defective Tap can cause loss of water through dripping	• Replace the damaged defective tap as and when observed	• Check the taps every day	• Record the inspection result & maintenance work done in the log book
Users behavioral and hygienic practice	• Pumping pattern/posture. • Polluting the tap/ spout by dirty hand. • Introducing solid substances through the head cover slit • Collecting water in unclean pitchers/kulshies • Putting dirty hands in collected water. • Washing and cleaning at the platform/apron • Keeping collected and stored water uncovered • Use of unclean/ dirty mugs/glass/pots to drink water	• Improper & vigorous pumping can cause structural damage to the Hand pump, the tube and the brick block. • Introducing solid substance may cause operational problem. • Use of unclean pitchers, pots, touching spout, touching taps, touching water, keeping the collected water uncovered, washing and cleaning at apron/platform, all are likely to contaminate the drinking water.	• Frequent orientation of the users and beneficiaries at DW site on proper handling of the taps, hand pump, hygienic collection, carriage, storage and consumption of water. • Prevention of washing and cleaning at platform. • users beneficiaries need to be periodically sensitized about importance of the control and its compliance • Collective decision of the users and beneficiaries involving the enlightened people. • Bimonthly orientation meeting at DW site.	• Monitoring by observation at DW sites, and physical inspection at home level. • Quarterly home visit. • Quarterly review of the orientation meeting, observations & home visit findings	• Dates of meetings held should be recorded. • Dates of home inspection should be recorded.
Water quality	• Arsenic, pH, Turbidity, Colour, Taste & Odour, and Nitrate & E.Coli of treated water • P/A test for faecal contaminant	• Presence of As, Turbidity, Colour, pH, E.Coli, Nitrate above Bangladesh Water Quality Standards indicate unsafe water • Presence of faecal contaminant indicate unsafe water	• Maintaining best physical condition of the DW, SSF, drains and surroundings etc. • Keeping the best sanitary condition around the DW, SSF etc.	• Daily checking of turbidity, colour, taste and odour by visual and physical method • Testing Arsenic, E.coli, pH and Nitrate 1-2 times every year • Conducting P/A test monthly or more frequently if possible • Owner/caretakers/ Beneficiaries responsibility	• Result of testing especially of E.coli, As, pH, Nitrate to be recorded with dates properly. • In case of substandard water, union parishad and DPHE will have to be informed for advice/action.

3. Guideline to assess Pond Sand Filter Water System

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
Pond	• Fencing • Latrine or pit at the bank of the pond • Solid waste dumping at the bank of pond • Bathing (cattle or human etc.) • Washing of cloths • Household wastewater runoff • Leaves from overhanging trees • Pesticide and nutrient application for fish culture	• Microbial and chemical contamination of water • Intrusion of organic matter into the water • Faecal Contamination of water	• Protection of the pond by fencing • No latrine, ditch or solid waste dumping should be allowed within 10m of the pond periphery • Restrict household waste runoff, bathing, cloth washing etc. in the pond • Keep the pond periphery free from overhanging tree • Fish culture should be allowed without any use of pesticide and nutrient • Overall, if possible reserve the pond solely for drinking water source	• Physically checking the fence, pond banks and surroundings weekly by the care taker & monthly by the management committee members to ensure implementation of the control measures	• Record the dates of inspections and findings including actions/ measures taken if any.
Intake screen, end cap & float	• Physical condition of intake screen, end cap & float • Intake position (distance from edge of water & vertical from water surface) • Slot opening	• Low intake rate if slots are clogged • Large particles and small fish entering in to the filter if end cap is missing • sucking water of undesirable quality if the proper position is lost • Improper functioning of the system if the intake screen, end cap & float are damaged, detached, displaced, dislocated	• Positioning the intake properly • Cleaning the slot periodically • Keeping the intake end always capped • Replacing the screen in case of damage • Keeping the float always working	• Physically checking the intake screen, end cap & float fortnightly by the caretaker or his agent	• Record the dates of inspection and findings including action taken
Intake pipe	• Joint at strainer and intake pipe • Joint at intake pipe and hand pump • Bend and other pipe joints • Physical conditions	• Leakage of water through loose joints and connections • Cracked, broken & damaged pipe will prevent PSF functioning	• Repair/replace the joints and fixing defective conditions • Replace the damaged pipe, bends	• Check the intake pipe regularly by the caretaker • Weekly inspection by a diver	• Record the dates of replacement of pipe, joints etc.

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
Hand Pump	• Check valve/ Seat valve of Hand Pump no. 6	• Defective check/seat valve will allow entry of air in the tube causing loss of water in the column. Under such circumstances priming will be necessary	• Replacing the check/seat valve after identifying defective/leaky. • Replacing check/seat valve every 6-9 months as a preventive measure. • Keeping a stock of check/seat valves, and preserving it in polythene bag after soaking in linseed oil. • Keeping basic tools required for replacing the cheek/seat valve handy.	• Check daily, preferably each morning the effectiveness of the check/seat valve. • Caretakers /owners responsibility. • Also the responsibility of the users to bring to the attention of the appropriate person(s) or management.	• Record the dates of replacement of the check / seat valve in the O&M log book/sheet.
Hand Pump	• Joint between base plate and barrel of HP no. 6	• Loose joint between the base plate and barrel of HP no. 6 will also allow air entry and will give rise to similar cause and effect as stated above.	• Fixing the loose joint by tightening the nuts & bolts or replacing the defective nuts and bolts if required • Applying burnt mobil oil or grease in the nuts and bolts every 3-6 months to prevent rusting and to allow easy screwing and unscrewing. • Maintaining stock of nuts and bolts of proper size handy and preserving in polythene bag after applying grease in the threaded portion. • Keeping basic tools handy.	• Check daily, preferably each morning the joint between base plate and barrel. • Caretakers/users responsibility.	• Record the dates of replacement of nuts and bolts in the O&M log book/sheet
Plat form	• Physical/ structural condition/ status	• Broken/damaged /cracked platform can cause structural damage to the PSF and can contribute to unsanitary water pooling situation	• Proper repair and maintenance	• Periodical physical inspection of the physical & structural status	• Record major maintenance work

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
Roughing filter	• Intake System • Outlet system • Washout systems • Filter bed thickness • Filter cover • Brick masonry work, plastering etc. • Filtration/flow rate through the bed	• Unclean or improperly maintained inlet & outlet systems will create impediments in the hydraulic flow • Unclean or improperly maintained washout will prevent proper washing/cleaning of the filter bed • Too much filter bed clogging will reduce filtration rate, hence decline in the performance • Filter depth less than the minimum required will not be able to reduce the suspended solid impurities to the desired level • Uncovered or improperly covered filter bed will be vulnerable to the falling leaves, branches, debris etc. ultimately leading to affect the quality of water due to rotting/ decompositions • Any damage to brick-wall, filter base and plaster will allow loss of water through leakage	• Keeping the inlet, outlet and washing systems clean and physically/ structurally intact • Washing the filter bed as soon as the flow rate/filtration rate decreases. • Putting additional filtration media of requisite size to make up the prescribed depth if required • Keeping the filter bed always properly covered and removing the leaves, debris etc. if observed • Keeping the filter structure in best physical condition by repair and maintenance	• Physical inspection of inlet, outlet & washout systems weekly by the caretaker • Checking filtration/flow rate daily by the caretaker • Checking the filter bed depth quarterly by the caretaker • Physically checking the filter bed cover as well as the whole structure monthly by the caretaker	• Record the cleaning repair & maintenance work, carried out with dates in the log book
Slow sand filter	• Inlet, outlet and washout systems • Filter cover • Filter structure • Filter bed depth • Filtration/flow rate through the bed • Water level over the filter bed	• Unclean or improperly maintained inlet, outlet and washout systems will interfere with hydraulic flow and filter washing • Uncovered or improperly covered filter bed will allow falling of leaves, debris and growth of algae • Damaged/broken brickwork, filter base and plaster will cause loss of water through leakage	• Keeping the systems clean and physically intact • Keeping the filter cover and whole structure in best physical condition • Replenishing the filter bed with additional filter media of prescribed size to make up the lost depth as and when required	• Physical inspection of the inlet, outlet and washout systems weekly by the caretaker • Physically checking the filter cover and the whole structure monthly by the caretaker • Physically checking the filter bed depth fortnightly by the caretaker • Checking filtration/flow rate through the filter daily by the caretaker	• Record cleaning, repair and maintenance works carried out with dates in the log book

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
		• Filter depth less than the minimum prescribed will not be able to treat the water properly • Low filtration/flow rate will impair the performance of the process adversely • Less than prescribed water-depth over the filter bed might dry up the bed and also cause low hydraulic pressure in the filter bed. In a dry bed the bio-film will loose its affectivity, hence the performance of the PSF will be adversely affected	• Scrapping, washing and replacing a few centimeter of the clogged top filter media as soon as the flow/filtration arte declines • Preventing water leakage and/or fixing hydraulic flow faults in case the prescribed water depth over the bed cannot be maintained	• Checking physically the depth of water over the filter bed daily by the caretaker	
Clear Water Reservoir	• Plaster • Top cover • washout • Air vent • Physical condition • Treated water collecting device from filter to reservoir	• Loss of inside & outside plaster or crack in the wall or base will cause loss of water • Improper top cover will allow insects intrusion • Unclean or ill maintained washouts & air vents will interface with smooth functioning • Non functioning of the water collecting device (pipe) from filter to reservoir can cause major operational problem	• Keeping these items in best physical & working condition by maintenance	• Checking the physical and operational states fortnightly by the caretaker	• Record the inspection result and maintenance works carried out in the logbook
Condition of PSF unit	• All the units • Drains • Peripheral condition	• Waste generation in and around the unit	• Keep the unit clean • Make sure the proper drainage of the waste water	• Check the units every day by caretaker	• Record the inspection result in the log book
Taps	• Water collecting taps	• Defective Tap can cause loss of water through dripping	• Replace the damaged defective tap as and when observed	• Check the taps every day	• Record the inspection result & maintenance work done in the log book
Users behavioral and hygienic practice	• Pumping pattern posture. • Polluting the spout by dirty hand. • Introducing solid substances through the head cover slit	• Improper & vigorous pumping can cause structural damage to the Hand pump, the tube and the brick block. • Introducing solid substance may cause operational problem.	• Frequent orientation of the users and beneficiaries at PSF site on proper handling of the taps, hand pump, hygienic collection, carriage, storage and consumption of water.	• Monitoring by observation at PSF sites, and physical inspection at home level. • Quarterly home visit. • Quarterly review of the orientation meeting, observations & home visit findings	• Dates of meetings held should be recorded. • Dates of home inspection should be recorded.

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
	• Collecting water in unclean pitchers/kulshies • Putting dirty hands in collected water. • Washing and cleaning at the platform • Keeping collected and stored water uncovered • Use of unclean/ dirty mugs/glass/pots to drink water	• Use of unclean pitchers, pots, touching taps, touching water, keeping the collected water uncovered, washing and cleaning at platform, all are likely to contaminate the collected water.	• Prevention of washing and cleaning at platform. • users beneficiaries need to be periodically sensitized about importance of the control and its compliance • Collective decision of the users and beneficiaries involving the enlightened people. • Bimonthly orientation meeting at PSF site.		
Water quality	• pH, Turbidity, Colour, Taste & Odour, Nitrate & E.Coli of treated water • P/A test for faecal contaminant • Residual Chlorine if Chlorination is applied	• Presence of turbidity, colour, taste & odor, pH, E.Coli, Nitrate above Bangladesh Water Quality Standards indicate unsafe water • Presence of faecal contaminant indicate unsafe water • Absence of residual chlorine indicates inadequate chlorination	• Maintaining best physical condition of the PSF, block, drains, filters and surroundings. • Keeping the pond in the best sanitary condition • Operation and maintenance following the O&M manual/guideline • Addition of roughing filtration if required • Applying chlorination if required or correcting the existing chlorination as needed	• Daily checking of turbidity, colour, taste and odour by visual and physical method • Testing, E.coli, pH and Nitrate 1-2 times every year • Conducting P/A test monthly or more frequently if possible • Testing residual chlorine daily by taste and odour method • Owner/caretakers/ Beneficiaries responsibility	• Result of testing especially of E.coli, pH to be recorded with dates properly. • In case of substandard water, union parishad and DPHE will have to be informed for advice/action.

4. Guideline to assess Rain Water Harvesting (RWH)

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
1. Roof	Roof Surface	Unclean roof will contaminate the collected rain water causing intestinal & in diarrhoeal diseases of the consumer/drinker.	• Clean up the roof surface thoroughly before on-set of monsoon. • Let first few minutes' rain go to waste and collect only clean water.	Inspect the roof 1-2 weeks before the on-set of monsoon and weekly throughout the monsoon. This function should be carried out physically by the owner of the roof or his agent.	• Dates of cleaning of roof to be recorded in operational and maintenance log book for reference.
2. Gutter	Joints between roofs & gutter; Joints between gutter & rain water down pipe, gutter slope, screen between gutter & rain water down pipe,	Loose joint between roof and gutter will cause rainwater to escape; Improper gutter slope will cause rainwater to overflow or flow backward; broken screen or missing screen between gutter and rainwater down pipe will cause impurities to get into the tank; loose joint between gutter and rainwater down pipe will allow rainwater to escape; unclean screen will block water-flow from gutter to the tank.	Secured joint between the roof and the gutter along the roof edge is to be maintained; Proper gutter slope towards the rainwater down pipe is to be ensured; screen between the gutter and the rainwater down pipe is to be kept intact; the joint between the gutter and the downward pipe is to be proper and smooth ; the screen should always be kept clean, especially in the rainy season	Physically check all joints, slope and screen sufficient time ahead of monsoon-commencement and repair, replace, fix as required; Physically check periodically during the monsoon; Physically check the screen twice every week and clean up as required. Responsibility of the owner.	Record the inspection date and maintenance work done.
3. Tank	Tank (inside & outside) and lid	Damaged, broken, worn-out tank and lid will cause loss of water and contamination of water from external sources and insects.	Tank and lid must always be kept in best physical condition by periodical maintenance and repair.	Thorough inspection of the inside and outside of the tank including lid well ahead of the on-set of monsoon by frequent visual checking. Responsibility of the owner or family member designated.	Record inspection date with findings and maintenance work done.
4. • Air vent. • Rain water down pipe • Waste water pipe • Overflow pipe • Washout pipe	• Air vent and its connection with the tank. • Rain water down pipe and its connection with gutter, tank and waste water pipe. • Overflow pipe and its connection with the tank. • Waste water pipe and its connection with rain water down pipe. • Washout pipe and its connection with the tank.	Cracked, damaged and broken pipes and loose joints/connection will cause either leakage/loss of water and contamination through entry of external objects and insects or both.	Defective pipes are to be replaced and loose connections/joints fixed as and when needed.	Periodic inspection of the pipes and joints/connections especially prior to the monsoon and frequently during monsoon. Responsibility of the owner/ family member designated.	Record inspection details and maintenance work carried out.

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
5. All valves	All valves	Non-functional Valve-1 will allow undesirable collection of unclean water or prevent flow of clean water into the tank. Non-functional valve-2 will cause collected water to drain out or will hinder washing of the tank when needed.	Repair and replace the valves as required.	Check the valves functionality physically, especially prior to the on-set of monsoon and frequently during monsoon. Responsibility of the owners or designated family member.	Dates of Inspection, repairing, replacement of valves to be recorded for reference.
6. All Caps	All Caps	Caps, if not placed in position may allow insects entry and will cause loss of water. Unworkable cap will hinder smooth operation.	Caps must always be kept in position unless required to remove for operational purpose. Replace non-functional/unworkable caps as soon as required.	Check the caps functionality physically, especially prior to monsoon & frequently during monsoon. Responsibility of the owner	Dates of replacement to be recorded.
7. Collecting tap	Collecting tap and its connection with the tank.	A leaking tap and or its loose connection/joint with the tank will cause loss of valuable water; loose joint/connection will allow insect entry.	Leaking or damaged tap must be replaced immediately; loose joints/ connection must be fixed without delay.	Periodic inspection of the tap and joint / connection, especially prior to monsoon and frequently during monsoon. Responsibility of the owner/family member designated.	Record inspection and maintenance work details.
8. Platform & Drainage	Platform, Drainage and surroundings	Broken or damaged platform/base of the tank may cause subsidence/tilting/ damage to the tank; erosion of the surrounding soil of the base may cause damage to the foundation and consequently to the tank, it will also cause water logging/ stagnation leading to weakening of the tank's foundation as well as mosquito breeding; broken, damaged and unclean drain will cause water logging, water stagnation and create unhygienic & offensive environment leading to contamination of water.	Platform, base and drains must always be kept in best physical condition by repairing & maintenance and cleaning, surroundings needs frequent cleaning, surrounding soil should be in position with proper compaction and sloping	Periodical inspection of the platform, base, drains, and surrounding condition especially prior to the rainy season and daily during whole monsoon period and after flood, if any. Responsibilities of the owner/ family member designated.	Major maintenance work to be recorded.

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
9. Water quality	Water quality (Turbidity, color, taste and odor, E-coli, Zinc, pH) at tap and stored at home.	Presence of turbidity, color, taste and odor problem and E-coli, Zinc & pH beyond Bangladesh standard indicate unsafe water.	Roof, gutter, screen, lid, pipes, tank inside need to be cleaned up frequently and properly; annual disinfection of tank to be carried out following the proper method. Collecting pots and pitchers must be thoroughly washed /cleaned before collection of water and kept properly covered.	Daily checking of turbidity, color, taste and odor by visual and physical method, (checking E-coli 1-2 times and pH & zinc once every year if possible). Responsibility of the owner/member designated.	Result of testing especially of E-coli and pH & zinc must be properly recorded.

5. Guideline to assess Infiltration Gallery (IFG)

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
Source/ catchment (pond/ stream/ canal)	• Fencing/protection around the catchment • Latrine or waste pit, solid waste dumping at the bank of source/catchment • Bathing (cattle or human etc.) in the source/catchment • Washing of cloths in the source/catchment • Household wastewater runoff into the source/catchment • Pesticide and nutrient application for fish culture in the source	• Microbial and chemical contamination of water • Intrusion of organic matter into the water • Faecal Contamination of water	• Demarcating the catchment of source and taking protection measures by fencing • No latrine, ditch or solid waste dumping should be allowed within the catchment • Restrict household waste runoff, bathing, cloth washing etc. in the catchment • Keep the pond periphery free from overhanging tree • Fish culture may be allowed without any use of pesticide and nutrient • Overall, if possible reserve the source solely for drinking water source	• Physically checking the catchment fence, source, banks and surroundings weekly by the care taker & monthly by the management committee members to ensure implementation of the control measures	• Record the dates of inspections and findings including actions/ measures taken if any.
IFG unit	• Physical condition of IFG unit • Settlement /deposition of solids over the IFG (top & side) • Rate of discharge from the pump	• Low yield/discharge from the system if the deposition of sediment on the top or periphery of the IFG unit is high • Disturbed positions of IFG components will hamper performance	• Keeping the IFG unit component in proper position • Cleaning the IFG unit of sediments when discharge falls • Keeping the minimum water level 900mm to 1000mm on the IFG unit if possible	• Physically checking the IFG unit by the caretaker or his agent monthly • Through annual physical inspection by the caretaker	• Record the dates of inspection and findings including action taken
Intake pipe and intake screen	• Joint at strainer and intake pipe • Joint at intake pipe and hand pump • Bend and other pipe joints • Slots of screen	• Leakage of water through loose joints and connections • Cracked, broken and damaged pipe & screen will prevent IFG functioning • Clogged slot of screen will cause to decrease the discharge from the IFG	• Repair/replace the joints and fixing defective conditions • Replace the damaged pipe, bends • Periodical clearing of slots are required • Annual preventive maintenance	• Checking the intake pipe regularly by the caretaker/diver • Thorough annual physical inspection by the committee members	• Record the dates of inspection, replacement of pipe, joints etc.

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
Hand Pump	• Check valve/ Seat valve of Hand Pump no. 6	• Defective check/seat valve will allow entry of air in the tube causing loss of water in the column. Under such circumstances priming will be necessary	• Replacing the check/seat valve after identifying defective/leaky. • Replacing check/seat valve every 6-9 months as a preventive measure. • Keeping a stock of check/seat valves, and preserving it in polythene bag after soaking in linseed oil. • Keeping basic tools required for replacing the cheek/seat valve handy.	• Check daily, preferably each morning the effectiveness of the check/seat valve. • Caretakers responsibility. • Also the responsibility of the users to bring to the attention of the appropriate person(s) or management.	• Record the dates of replacement of the check / seat valve in the O&M log book/sheet.
Hand pump	• Joint between base plate and barrel of HP no. 6	• Loose joint between the base plate and barrel of HP no. 6 will also allow air entry and will give rise to similar cause and effect as stated above.	• Fixing the loose joint by tightening the nuts & bolts or replacing the defective nuts and bolts if required • Applying burnt mobil oil or grease in the nuts and bolts every 3-6 months to prevent rusting and to allow easy screwing and unscrewing. • Maintaining stock of nuts and bolts of proper size handy and preserving in polythene bag after applying grease in the threaded portion. • Keeping basic tools handy.	• Check daily, preferably each morning the joint between base plate and barrel. • Caretakers/users responsibility.	• Record the dates of replacement of nuts and bolts in the O&M log book/sheet
Plat form	• Physical/ structural condition/ status • Drainage	• Broken/ damaged/cracked platform will cause and contribute to unsanitary unhygienic situation • Absence/ inadequate drainage around platform will cause water pooling	• Proper repair as required and routine maintenance of the platform • Keep the surrounding always clean • Ensure proper drainage around the platform	• Periodical physical inspection of the physical & structural status • Checking the platform surroundings every day by caretaker	• Record major maintenance work • Record the major works in the log book

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
Users behavioral and hygienic practice	• Pumping pattern posture. • Polluting the spout by dirty hand. • Introducing solid substances through the head cover slit • Collecting water in unclean pitchers/kulshies • Putting dirty hands in collected water. • Washing and cleaning at the platform • Keeping collected and stored water uncovered • Use of unclean/ dirty mugs/glass/pots to drink water	• Improper & vigorous pumping can cause structural damage to the Hand pump, the tube and the brick block. • Introducing solid substance may cause operational problem. • Use of unclean pitchers, pots, touching spouts, touching water, keeping the collected water uncovered, washing and cleaning at platform, all are likely to contaminate the collected water.	• Frequent orientation of the users and beneficiaries at IFG site on proper handling of the hand pump, hygienic collection, carriage, storage and consumption of water. • Prevention of washing and cleaning at platform. • Users/ beneficiaries need to be periodically sensitized about importance of the control and its compliance • Collective decision of the users and beneficiaries involving the enlightened people. • Bimonthly orientation meeting at IFG site	• Monitoring by observation at IFG sites, and physical inspection at home level. • Quarterly home visit. • Quarterly review of the orientation meeting, observations & home visit findings	• Dates of meetings held should be recorded. • Dates of home inspection should be recorded.
Water quality	• Turbidity, Colour, Taste & Odour, Nitrate & E.Coli of treated water • P/A test for faecal contaminant	• Presence of Turbidity, colour, taste & odor, E.Coli, Nitrate above Bangladesh Water Quality Standards indicate unsafe water • Presence of faecal contaminant indicate highly unsafe water	• Maintaining best physical condition of the IFG, block, drains, filters and surroundings. • Keeping the source of water in the best sanitary condition • Operation and maintenance following the O&M manual/guideline • Addition of roughing filtration if required • Applying chlorination if required or correcting the existing chlorination as needed	• Daily checking of turbidity, colour, taste and odour by visual and physical method • Testing, E.coli, Nitrate 1-2 times every year • Conducting P/A test monthly or more frequently if possible • Owner/caretakers/ Beneficiaries responsibility	• Result of testing especially of E.coli, P/A, Nitrate to be recorded with dates properly. • In case of substandard water, union parishad and DPHE will have to be informed for advice/action.

6. Guideline to assess Gravity Flow System (GFS)

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
Source/ Catchment	• Fencing around the catchment • Any defecation at the bank of the Stream or the spring point/catchment • Solid waste dumping at the bank of stream/ catchment • Bathing (cattle or human etc.) at catchment • Washing of cloths at catchment • Household wastewater runoff into catchment • Leaves from trees into catchment	• Microbial and chemical contamination of water • Intrusion of organic matter into the water • Faecal Contamination of water	• Demarcating the catchment of source and taking protection measures by fencing • No defecation or solid waste dumping should be allowed within catchment • Restrict household waste runoff, bathing, cloth washing etc. in the catchment • Overall, if possible reserve the catchment solely for drinking water source	• Physically checking the catchment fence, source, banks and surroundings weekly by the care taker & monthly by the management committee members to ensure implementation of the control measures	• Record the dates of inspections and findings including actions/ measures taken if any.
Water collecting perforated pipes (intake)	• Physical condition of perforated pipe • Pipes position (distance from edge of water & vertical from water surface) • Slot opening	• Low intake rate if slots are clogged • Large particles entering in to the filter if end cap is missing • Water of undesirable quality if the proper position is lost • Improper functioning of the system if the perforated pipes are damaged, detached, displaced, dislocated	• Positioning the perforated pies properly • Cleaning the slot periodically • Replacing the screen in case of damage • Annual preventive maintenance	• Physically checking the perforated pipes fortnightly by the caretaker or his agent	• Record the dates of inspection and findings including action taken
Main down water intake pipe	• Joint at strainer and intake pipe • Bend and other pipe joints • Physical conditions	• Leakage of water through loose joints and connections • Cracked, broken & damaged pipe will prevent GFS functioning	• Repair/replace the joints and fixing defective conditions • Replace the damaged pipe, bends	• Checking the intake pipe regularly by the caretaker	• Record the dates of replacement of pipe, joints etc.
Plat form	• Physical/ structural condition/status	• Broken/ damaged/cracked platform will cause and contribute to unsanitary, unhygienic situation	• Proper repair as required and routine maintenance of the platform	• Periodical physical inspection of the physical & structural status	• Record major maintenance work

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
Break Pressure Tank	• Washout pipe and its connection with the tank. • Overflow pipe and its connection with the tank. • Air vent and its connection with the tank. • Protection against sliding • Physical structure • Tank cover	• Cracked, damaged and broken pipes and loose joints/connection will cause either leakage/loss of water and contamination through entry of external objects and insects or both. • Bottom and side wall crack will allow loss of water • Land slide may dislodge the tank • Damaged, broken, worn-out tank cover will cause contamination of water from external sources and insects. • Non-functioning washout, overflow and air-vent system will impair the performance of the tank/system	• Defective pipes are to be replaced and loose connections/joints fixed as and when needed. • Any crack or settlement of the tank is to be taken care of. • Compacted soil with proper slope around the tank to be maintained with special attention during monsoon. • Tank cover must always be kept in best physical condition by periodical maintenance and repair	• Periodic inspection of the pipes and joints/connections especially prior to the monsoon and frequently during monsoon by the caretaker. • Thorough inspection of the inside and outside of the tank including lid well ahead of the on-set of monsoon by frequent visual checking by the caretaker • Monthly checking the washout, overflow, air vent systems • Fortnightly checking the stability and physical condition of the tank	• Record inspection details and maintenance work carried out.
Roughing filter	• Intake System • Outlet system • Washout systems • Filter bed thickness • Filter cover • Brick masonry work, plastering etc. • Filtration/flow rate through the bed	• Unclean or improperly maintained inlet & outlet systems will create impediments in the hydraulic flow • Unclean or improperly maintained washout will prevent proper washing/cleaning of the filter bed • Too much filter bed clogging will reduce filtration rate, hence decline in the performance • Filter depth less than the minimum required will not be able to reduce the suspended solid impurities to the desired level	• Keeping the inlet, outlet and washing systems clean and physically/ structurally intact • Washing the filter bed as soon as the flow rate/filtration rate decreases. • Putting additional filtration media of requisite size to make up the prescribed depth if required • Keeping the filter bed always properly covered and removing the leaves, debris etc. if observed • Keeping the filter structure in best physical condition by repair and maintenance	• Physical inspection of inlet, outlet & washout systems weekly by the caretaker • Checking filtration/flow rate daily by the caretaker • Checking the filter bed depth quarterly by the caretaker • Physically checking the filter bed cover as well as the whole structure monthly by the caretaker	• Record the cleaning repair & maintenance work, carried out with dates in the log book

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
		• Uncovered or improperly covered filter bed will be vulnerable to the falling leaves, branches, debris etc. ultimately leading to affect the quality of water due to rotting/ decompositions • Any damage to brick-wall, filter base and plaster will allow loss of water through leakage			
Slow sand filter	• Inlet, outlet and washout systems • Filter cover • Filter structure • Filter bed depth • Filtration/flow rate through the bed • Water level over the filter bed	• Unclean or improperly maintained inlet, outlet and washout systems will interfere with hydraulic flow and filter washing • Uncovered or improperly covered filter bed will allow falling of leaves, debris and growth of algae • Damaged/broken brickwork, filter base and plaster will cause loss of water through leakage • Filter depth less than the minimum prescribed will not be able to treat the water properly • Low filtration/flow rate will impair the performance of the process adversely • Less than prescribed water-depth over the filter bed might dry up the bed and also cause low hydraulic pressure in the filter bed. In a dry bed the bio-film will loose its affectivity, hence the performance of the GFS will be adversely affected	• Keeping the systems clean and physically intact • Keeping the filter cover and whole structure in best physical condition • Replenishing the filter bed with additional filter media of prescribed size to make up the lost depth as and when required • Scrapping, washing and replacing a few centimeter of the clogged top filter media as soon as the flow/filtration arte declines • Preventing water leakage and/or fixing hydraulic flow faults in case the prescribed water depth over the bed cannot be maintained	• Physical inspection of the inlet, outlet and washout systems weekly by the caretaker • Physically checking the filter cover and the whole structure monthly by the caretaker • Physically checking the filter bed depth fortnightly by the caretaker • Checking filtration/flow rate through the filter daily by the caretaker • Checking physically the depth of water over the filter bed daily by the caretaker	• Record cleaning, repair and maintenance works carried out with dates in the log book

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
Clear Water Reservoir	• Plaster • Top cover • Washout • Air vent • Physical condition • Treated water collecting device from filter to reservoir	• Loss of inside & outside plaster or crack in the wall or base will cause loss of water • Improper top cover will allow insects intrusion • Unclean or ill maintained washouts & air vents will interface with smooth functioning • Non functioning of the water collecting device (pipe) from filter to reservoir can cause major operational problem	• Keeping these items in best physical & working condition by maintenance	• Checking the physical and operational states fortnightly by the caretaker	• Record the inspection result and maintenance works carried out in the logbook
Condition of GFS unit	• All the units • Drains • Peripheral condition	• Waste generation in and around the unit	• Keep the surroundings clean • Ensure proper drainage around the platform	• Checking the platform surroundings every day by caretaker	• Record the major works in the log book
Taps	• Water collecting taps	• Defective Tap can cause loss of water through dripping	• Replace the damaged defective tap as and when observed	• Check the taps every day	• Record the inspection result & maintenance work done in the log book
Tap-stand	• Tap & pipe joint at the stand • Stand structure	• Loose connection of tap and pipe will cause loss of water and contamination as well • Cracking of stand will cause cracking of pipe joint which ultimately will create water loss and contamination	• Replace the damaged defective pipe and tap joints as and when observed • Keep the surrounding protected so that no damage of Standpipe is possible by animal or other unwanted persons	• Checking the tap stand every day by caretaker	• Record the inspection result & maintenance work done in the log book
Gate valves	• Gate valves of the GFS unit	• Leaky gate valve will allow loss of water from CWR • Improperly functioning gate valve will cause hindrance to supply the consumers	• Repair and replace the gate valves as required.	• Weekly check the valves functionality physically.	• Dates of Inspection, repairing, replacement of valves to be recorded for reference.

Component	Critical inspection point for assessment	Likelihood of hazards/ vulnerability and potential risks	Control measures in response to hazards / vulnerability and potential risks	operational monitoring of the control measures what, how, who, when	Management, communication and documentation
1	2	3	4	5	6
Users behavioral and hygienic practice	• Polluting the tap by dirty hand • Collecting water in unclean pitchers/kulshies • Putting dirty hands in collected water. • Washing and cleaning at the platform • Keeping collected and stored water uncovered • Use of unclean/ dirty mugs/glass/pots to drink water	• Use of unclean pitchers, pots, touching spouts, touching water, keeping the collected water uncovered, washing and cleaning at platform, all are likely to contaminate the collected water.	• Frequent orientation of the users and beneficiaries at GFS site on proper handling of the tap hygienic collection, carriage, storage and consumption of water. • Prevention of washing and cleaning at platform. • users beneficiaries need to be periodically sensitized about importance of the control and its compliance • Collective decision of the users and beneficiaries involving the enlightened people. • Bimonthly orientation meeting at GFS site.	• Monitoring by observation at GFS sites, and physical inspection at home level. • Quarterly home visit. • Quarterly review of the orientation meeting, observations & home visit findings	• Dates of meetings held should be recorded. • Dates of home inspection should be recorded.
Water quality	• Turbidity, Colour, Taste & Odour, Nitrate & E.Coli of treated water • P/A test for faecal contaminant	• Presence Turbidity, colour, taste & odor, E.Coli, Nitrate above Bangladesh Water Quality Standards indicate unsafe water • Presence of faecal contaminant indicate highly unsafe water	• Maintaining best physical condition of the GFS, block, drains, filters and surroundings. • Keeping the source of water in the best sanitary condition • Operation and maintenance following the O&M manual/guideline	• Daily checking of turbidity, colour, taste and odour by visual and physical method • Testing, E.coli, Nitrate 1-2 times every year • Conducting P/A test monthly or more frequently if possible • Owner/caretakers/ Beneficiaries responsibility	• Result of testing especially of E.coli P/A, Nitrate to be recorded with dates properly. • In case of substandard water, union parishad and DPHE will have to be informed for advice/action.

WSF
Annex-8

Rural Water Supply System Assessment Checklist

1. Hand Tube Wells (HTW-STW, DTW, SST, TTW)

Location address: .....

Date of Assessment: .....

Sl. No	Check/find out whether the Critical condition/ status as stated below prevails/exists or not	Finding		If yes, action required are: (Note: No action required if findings is no)
		Yes	No	
1	Check valve/seat valve of HP no. 6 defective			Replace the defective check/seat valve with a new check/seat valve
2	Foot valve of Tara Tube Well defective			Replace the defective foot valve with a new foot valve
3	Joint between the base plate and the barrel of the HP no. 6 loose.			Replace the old/rusted nuts and bolts and make the joint leak-proof /airtight.
4	Joint between the base plate and the barrel of the Tara pumps loose.			Replace the old/worn-out/rusted nuts and bolts and make the joint tight/leak proof.
5	Platform of HTW non-existing			New platform with block and drains are to be constructed following appropriate design.
6	Platform of HTW broken/damaged/cracked.			Repair/ reconstruct the platform with proper block and drainage.
7	Gap between top pipe and cc block exists.			The gap is to be sealed completely to prevent ingress of water.
8	Pucca drain from the platform to the appropriate point of disposal missing /broken/damage/cracked			New drain to be constructed if missing; reconstruction/repairing will be needed if broken/damaged/cracked
9	Platform surroundings is such that the ground is muddy/slushy; and/ or there is water ponding/stagnancy/logging			The surroundings is to be developed by earth filling with proper compaction and sloping outward.
10	There are rat-holes, burrows, depression, undulation in the immediate vicinity of tube well/platform.			All holes/burrows will be sealed up and depression, undulation leveled.
11	Source of pollution such as latrines, open defecation, animal pens, cattle-shed, waste dump, compost pit etc. are existing within 10m of tube well.			Source of pollution will be removed and further installation prevented.
12	Use of fertilizer s and pesticide within 10m of tube well are in practice.			Use of fertilizer s and pesticide within 10m of the tube-well will be stopped are prevented in future.
13	Washing and cleaning activities in and around the platform are in practice.			Washing and cleaning activities in and around the platform will be stopped and prevented in future.
14	Methods of water collection, transportation, storage and handling are not proper and hygienic.			Sanitary and hygienic methods of water collection, transportation, carriage, storage and handling will be promoted and followed up routinely.
15	Tube well partially or fully submerged during flood.			• Nipples (short pieces of pipes) with socket will be kept handy to raise the tubewell above flood level during flood. After flood, the tube well will be brought back to normal level. • Post flood cleaning, washing, rehabilitation of the tubewell, platform, surroundings as required will be done for proper restoration of services.

2. Water Supply System: Dug well with or without sand filter.

Location address: .....

Date of Assessment: .....

Sl. No	Check/find out whether the Critical condition/ status as stated below prevails/exists or not	Finding		If yes, action required are: (Note: No action required if findings is no)
		Yes	No	
1	**Catchment of dug-well** There are sources of pollution (use of fertilizer/pesticides, pit latrines, animal pens, cattle shed, waste dumps etc.) in the catchment (Area within10 m from radius of the well)			All sources of pollution will be removed.
2	**Dug-well and infrastructures** Joint between rings not properly sealed; apron around the well damaged/broken/cracked; headwall of the well damaged/broken/cracked; drainage around the well defective/non-functional; water pooling/logging around the well takes place; well cover broken/cracked/damaged; plaster inside and outside the well not in place; mosquito net damaged/missing, chlorination system of the well defective/non-functional			Any of the problems mentioned, if found during checking, will be rectified/addressed as required.
3	**HP No.6** Check valve/seat valve of hand pump no. 6 defective; Joint between base plate and barrel of HP No.6 loose.			Rectification/replacement will be done as required.
4	**Slow Sand Filter(SSF) & Clear water Reservoir(CWR)** Inlet system, outlet system and washout system of the Slow Sand Filter (SSF) and Clear Water Reservoir (CWR) defective /non functional, SSF & CWR covers defective/damaged; filtration rate through SSF is less than required; SSF bed depth is smaller than prescribed depth; water level over the filter bed is less than required; Air vent over the CWR defective/non functional; water collecting device between the SSF and CWR defective/not functioning properly; water collecting tap of the CWR leaking/defective; brick masonary work/plaster of the SSF, CWR and HP stand/steps damaged/cracked/broken.			Any of the problems as mentioned if observed during checking will be noted and will be rectified/taken care of as required.
5	**Users behavioral and hygienic practice** Methods of water collection, transportation, storage and handling are not sanitary/hygienic.			Sanitary and hygienic method of water collection, transportation/carriage, storage and handling will be promoted and followed up routinely.
6	Impact of flood Dug well gets partially/fully submerged during flood.			Dug well head will be raised to keep above flood level.

3. Water Supply System: Pond Sand Filter (PSF)

Location address: .....

Date of Assessment: .....

Sl. No	Check/find out whether the Critical condition/ status as stated below prevails/exists or not	Finding		If yes, action required are: (Note: No action required if findings is no)
		Yes	No	
1	Pond not protected by fencing			Fencing will be done around the pond to prevent unauthorized entry. It will be protected as a reserved pond.
2	Following sources of pollution exist on the bank or in the vicinity of the bank. • Hanging latrine, pit latrine, human and animal excreta. • Solid waste disposal dumps. • Liquid waste disposal pits • Leaves overhanging trees falling in the pond.			All these activities will be stopped.
3	Following activities are ongoing in an around the pond : • Open defecation • Washing and cleaning • Human and cattle bathing • Pesticide and nutrient being applied for fish culture. • Household wastewater run-off being discharged into the pond.			All these activities will be stopped.
4	• Intake pipe, screen, end cap, bends and float found damaged/ broken/ cracked. • Intake position found displaced. • Intake screen slot found clogged. • Joint found detached/loose.			Damaged/broken/cracked parts and components will be replaced, dislodged intake position will be properly relocated, clogged screen will be cleaned up, loose/detached joints will be fixed.
5	• Check valve/seat-valve of HP no. 6 defective. • Joint between base plate and barrel of HP no. 6 loose			Check valve/seat valve will be replaced, loose joint will be fixed.
6	Platform, block, drains damaged/cracked/broken			Damaged/cracked/broken components and part will be reconstructed.
7	Inlet, outlet and washout systems of Roughing Filter unclean/defective/ nonfunctional.			Cleaning, rectification, replacement as necessary will be done.
8	Roughing filter's cover damaged/ defective			Repairing/replacement as necessary will be done.
9	Roughing filter bed depth is smaller than required			Depth correction will be made adding additional filter media of prescribed material of proper size.
10	Brick masonry work, floor and plastering of roughing filter box need rectification/ rehabilitation /repairing.			Rectification/rehabilitation/repairing as necessary will be done.

Sl. No	Check/find out whether the Critical condition/ status as stated below prevails/exists or not	Finding		If yes, action required are: (Note: No action required if findings is no)
		Yes	No	
11	Filtration/flow rate of Roughing Filter is less than required.			Cleaning of bed will be done.
12	Inlet, outlet and washout systems of slow sand filter unclean/defective/ nonfunctional.			Cleaning, rectification, replacement as necessary will be done.
13	Slow Sand filter's cover defective/damaged			Repairing/replacement as necessary will be done.
14	Brick masonry work, floor and plastering of slow sand filter box need rectification/ rehabilitation/repairing.			Rectification/rehabilitation/repairing as necessary will be done.
15	Filtration/flow rate of slow sand filter is less than desired			Cleaning of filter bed will be done.
16	Slow Sand filter bed depth is smaller than original depth.			Depth correction will be made adding additional filter media of prescribed material of proper size.
17	Water level over slow sand filter bed is less than required			Leakage in the filter box if detected will be stopped and/or the water level control device will rectified if required.
18	Top cover of the Clear Water Reservoir(CWR) defective/ damaged			Repairing/replacement of the top cover as required will be done.
19	Water collecting tap of CWR defective /leaky			Defective/leaky tap will be replaced.
20	Air vent of CWR broken/missing			New vent will be fitted.
21	Washout system of CWR defective /nonfunctioning			Defective /nonfunctioning washout system will be replaced/rectified.
22	Water collecting devices between Slow Sand Filter and CWR defective/ nonfunctioning.			Defective /nonfunctioning devices will be rectified/reinstalled.
23	Brick masonry work, floor and plaster of CWR need repairing/rectification/ reconstruction			Rectification/repairing/reconstruction as necessary will be done.
24	Methods of water collection, transportation, storage and handling are not proper and hygienic.			Sanitary and hygienic methods of collection, carriage, storage and handling will be promoted and followed up routinely.

4. Water Supply System : Rain Water Harvesting

Location address: .....

Date of Assessment: .....

Sl. No	Check/find out whether the Critical condition/ status as stated below prevails/exists or not	Finding		If yes, action required are: (Note: No action required if findings is no)
		Yes	No	
1	Roof of the house is not clean			Roof will be cleaned thoroughly before the on-set of monsoon.
2	Gutter not properly attached to the roof and slope improper.			Gutter will be properly attached and slope corrected.
3	Physical condition of any of the following not in proper order. Gutter, tank, lid, rainwater down pipe, air vent, waste water pipe, overflow pipe, washout pipe.			• Repairing, reconstruction, replacement as necessary will be done. • Loose joint/connection observed will be rectified.
4	Valves/end caps/taps not properly functioning.			Defective/nonfunctioning valves/end caps/taps will be replaced.
5	Platform and drainage damaged/cracked/broken.			Repairing, reconstruction, replacement as necessary will be done.
6	Methods of water collection, carriage, storage and handling not proper and hygienic			Sanitary and hygienic method of water collection, transportation, carriage, storage and handling will be provided and followed up routinely.

5. Water Supply System: Infiltration Gallery (IFG)

Location address: .....
Date of Assessment: .....

Sl. No	Check/find out whether the Critical condition/ status as stated below prevails/exists or not	Finding		If yes, action required are: (Note: No action required if findings is no)
		Yes	No	
1	Catchment not demarcated and protected			Boundary of the catchment around the intake keeping safe distance by land and water is to be delineated and marked to maintain safe distance from the potential sources of pollution. All the people living in the vicinity will have to properly educated accordingly.
2	Within the catchment, especially in the upstream, there are sources of pollution such as pit latrine, hanging latrine, open defecation, waste pit, liquid/solid waste disposal outfall, human & cattle bathing practices, washing & cleaning activities, fish culture with application of pesticide and nutrient etc.			All sources of pollution will have to removed immediately and further installation/placement prevented.
3	Check valve/Seat valve HP no. 6 defective			Replace the defective check/seat valve with a new check/seat valve.
4	Joint between the base plate and the barrel of the HP no. 6 loose.			Replace the old/rusted nuts and bolts and make the joint leak proof /airtight.
5	Platform of HTW missing			New platform with block and drains are to be constructed following appropriate design.
6	Platform of HTW broken/damaged/cracked.			Repair/ reconstruct the platform with proper block and drainage.
7	Gap between top pipe and cc block exists.			The gap is to be sealed.
8	Pucca drain from the platform to the appropriate point of disposal missing /broken/damaged/cracked			New drain to be constructed if missing; reconstruction/repairing will be needed if broken/damaged/cracked.
9	Platform surroundings is such that the ground is muddy/slushy and/ or there is water pooling/stagnancy/logging			The surroundings is to be developed by earth filling with proper compaction and sloping outward.
10	There are rat-holes, burrows, depression, undulation in the immediate vicinity of tube well/platform.			All holes/burrows will have to be sealed up and depression, undulation leveled.
11	Washing and cleaning activities in and around the platform are in practice.			Washing and cleaning activities in and around the platform will have to be stopped and prevented in future.
12	Methods of water collection, transportation, storage and handling are not proper and hygienic.			Proper methods of water collection, transportation, carriage, storage and handling will be promoted and followed up routinely.

Sl. No	Check/find out whether the Critical condition/ status as stated below prevails/exists or not	Finding		If yes, action required are: (Note: No action required if findings is no)
		Yes	No	
13	Tube well partially or fully submerged during flood.			• Nipples (short pieces of pipes) with socket will be kept handy to raise the tube-well above flood level during flood. After flood, the tube well will be brought back to normal level. • Post flood cleaning, washing, rehabilitation of the tube-well, platform, surroundings as required will be done for proper restoration of services.
14	Discharge from the hand pump decreased			Clean up the sediments deposited over the IFG bed to restore infiltration. If necessary dismantle the IFG and rehabilitate completely during dry period.
15	Piping, joints, connections, bends, caps, intake screen etc. defective/leaky/loose			Repair/replace as necessary

6. Water Supply System: Gravity Flow System (GFS)

Location address: .....
Date of Assessment: .....

Sl. No	Check/find out whether the Critical condition/ status as stated below prevails/exists or not	Finding		If yes, action required are: (Note: No action required if findings is no)
		Yes	No	
1	Catchment not demarcated and protected			Boundary of the catchment around the intake keeping safe distance by land and water is to be delineated and marked to maintain safe distance from the potential sources of pollution. All the people living in the vicinity will have to properly educated accordingly.
2	Within the catchment, especially in the upstream, there are sources of pollution such as pit latrine, hanging latrine, open defecation, waste pit, liquid/solid waste disposal outfall, human & cattle bathing practices, washing & cleaning activities etc.			All sources of pollution will have to removed immediately and further installation/placement prevented.
3	Perforation of the intake pipe partly or fully clogged			Clear the holes/perforation of dirt/mud etc.
4	Joint between perforated intake pipe and the main down water pipe loose			Fix the joint properly
5	Other joints of main down water pipe loose			Fix/rectify the joints properly
6	Platform of the tap stand broken/damaged/cracked.			Repair/ reconstruct the platform as required.
7	Pucca drain from the platform to the appropriate point of disposal missing /broken/damaged/cracked			New drain to be constructed if missing; reconstruction/repairing will be needed if broken/damaged/cracked.
8	Platform surroundings is such that the ground is muddy/slushy and/ or there is water pooling/stagnancy/logging			The surrounding is to be developed by earth filling with proper compaction and sloping outward.
9	Washout, Overflow, Air vent etc. systems of different treatment units not functioning properly			Replace the defective pipes, vents and fix loose connections/joints. Including cleaning.
10	Soil around the treatment units eroded.			Fill up with earth with proper compaction & slope.
11	Cover of various units damaged/defective			Repairing/replacement as necessary will be done.
12	Roughing filter bed depth is smaller than required			Depth correction will be made adding additional filter media of prescribed material of proper size.

Sl. No	Check/find out whether the Critical condition/ status as stated below prevails/exists or not	Finding		If yes, action required are: (Note: No action required if findings is no)
		Yes	No	
13	Brick masonry work, floor and plastering of various units need rectification/rehabilitation /repairing.			Rectification/rehabilitation/repairing as necessary will be done.
14	Filtration/flow rate of Roughing Filter is less than required.			Cleaning of bed will be done.
15	Filtration/flow rate of slow sand filter is less than desired			Cleaning of filter bed will be done.
16	Slow Sand filter bed depth is smaller than original depth			Depth correction will be made adding additional filter media of prescribed material of proper size.
17	Water level over slow sand filter bed is less than required			Leakage in the filter box if detected will be stopped and/or the water level control device will be rectified if required.
18	Water collecting devices between Slow Sand Filter and CWR defective/ nonfunctioning.			Defective /nonfunctioning devices will be rectified/ reinstalled.
19	Methods of water collection, transportation, storage and handling are not proper and hygienic.			Proper methods of water collection, transportation, carriage, storage and handling will be promoted and followed up routinely.
20	Washing, cleaning activities are in practice on the platform			Such activities must be stopped
21	Tap stand unstable and taps leaky			Fix the stand securely and replace the taps.
22	Gate valves and other valves leaky/non-functioning			Replace/repair the non-functional leaky gate valves & other valves as required.

WSF Annex-9

Health Based Targets (HBT)

Health Based Targets: Health based targets provide a 'benchmark' for water suppliers. It underpine the development of WSPs and verification of their successful implementation and lead to improvements in public health outcomes.

There are four types of Health Based Targets, namely:

- Health outcome targets
- Water quality targets (WQT)
- Performance targets
- Specific technology targets

Condition and implications in application of these targets are briefly described below:

- **Health outcome targets:** In some circumstances, especially where waterborne disease contributes to a measurable burden, reducing exposure through drinking-water has the potential to appreciable reduce overall risks of disease. In such circumstances, it is possible to establish a health-based target in terms of a quantifiable reduction in the overall level of disease. In other circumstances, health outcome targets may be the basis for evaluating of results through Quantitative Health Risk Assessment Models (QHRA), which requires information concerning exposure and dose-response relationships. More common health outcome tagets based on defined levels of tolerable risk, either absolute or fraction of total disease burden, preferbly based on epidemiological evidences.

  Though it is the ideal health based targets, yet most of the countries including Bangladesh are not able to establish such targets because of many limitations such as non availability of authentic data on epidemiological evidences, and specific data to run QHRA models. It is also dificult to generate relevant data to run such model.

- **Water Quality Targets (WQTs)**: WQTs are established for individual drinking water constituents that represent a health risk from long-term exposure and where fluctuaions in concentration are small or occure over long periods. Adverse health consequences may arise from exposure to chemicals following long-term and, in some case, short-term exposure. Furthermore, concentrations of most chemicals in drinking-water do not normally fluctuate widely over short periods of time. Mangement through periodic analysis of drinking-water quality and comparison with WQTs is therfore commonly applied to chemicals in drinking-water where health effects arise from long-term exposure.

  For microbial hazards, WQTs in terms of pathogens serve primariliy as a step in the development of performance targets and have no direct application.

- **Performance targets:** Performance targets are employed for constituents where short-term exposure represents a public health risk or where large fluctuations in numbers or conecntartion can occur over short periods with significant health implications. It is frequently applied to control of microbial hazards.

- **Specific technology targets:** National regulatory agencies may establish targets for specific actions for smaller community supplies. Such targets may identify specific permission devices or processes for given situations and/or for generic drinking water system types.

It is now evident that Bangladesh, at this stage is not in a position to establish health outcome based targets to be used in the water safety framework. It will take sufficient lead time and intensive research work for Bangladesh to set health outcome targets and starts its application. However, it is believed that if the water supply service providers' capacity is enhanced to a level that they are able to supply drinking water meeting National Health Based Water Quality Target (NHBWQT), it will reduce the disease burden and bring about proportionate improvement in public health. Hence, to start with, it would be rational to develop and frame WSF with Health Based Water Quality Target (HBWQT) as the HBT, and subsequently develop and include other type of targets in the WSF.

Finalization of Health Based (Water Quality) Parameters and Targets:

To finalize the recommendations made by the consultant the Project Director organized two day long workshop from 5th to 6th August, 2010. The workshop was held in BRAC-CDM located in Rajendrapur, Gazipur. The workshop was chaired by Mr. Monzur Hossain, Secretary LG Division, MLGRD&C and participated by academics, scientists, sector professionals/specialists, water quality analysts and top officials of LG Division. The summary of outcome is produced in tabular format below. As will be seen from the table there are four (04) health based and one (01) non-health based (acceptability) parameters under first priority category. Under second priority category there are twenty six (26) health based and nine (09) non-health based (acceptability) parameters.

In addition, the workshop made the following recommendations and remarks about a number of parameters as mentioned below:

- Fecal Contamination (P/A) : this parameter has been dropped from the HBT list, however it has been recommended to conduct this test for rural water supply systems
- Arsenic: its target will be re-fixed based on scientific study to be undertaken
- Chlorine (residual): This parameter is applicable where disinfection is applicable
- Total Alpha Radiation: WHO will arrange testing of a few samples as test case
- Total Beta Radiation: WHO will arrange testing of a few samples as test case
- Radon: WHO will arrange testing of a few samples as test case before accepting as a HBT
- Aldrin and dialdrin: Importation of chlorine based pesticide is banned in Bangladesh
- Mycrocystin-LR: WHO will arrange testing of a few samples as test case before accepting as HBT

Summary of the Health Based Target (HBT)

First priority parameters and targets			Second priority parameters and targets		
Health Based			Health Based		
Sl. No.	Parameters & Unit	Targets	Sl. No.	Parameters & Unit	Targets
1	Thermo-Tolerant Coliform (TTC) (N/100)	0	1	Cadmium (mg/l)	0.003
2	Arsenic (mg/l)	0.05	2	Cyanide (mg/l)	0.07
3	Chlorine (residual) (mg/l)	0.5	3	Fluoride (mg/l)	1
4	Nitrate (mg/l)	50 as Nitrate	4	Lead (mg/l)	0.03
Non-Health Based Target (acceptability)			5	Manganese (mg)	0.4
1	Turbidity (NTU)	5 (urban treated) 10 (rural)	6	Mercury (mg/l)	0.001
			7	Total alpha radiation(Bq/l)	0.5
			8	Total beta radiation(Bq/l)	1.0
			9	Benzene (mg/l)	0.01
			10	Carbon Tetra Chloride (mg/l)	0.004
			11	1,1-dichloro ethane (mg/l)	0.03
			12	1,2-dichloro ethane (mg/l)	0.03
			13	Tetra-chloro ethane (mg/l)	0.04
			14	Tri-chloro ethylene (mg/l)	0.07
			15	Chloroform (mg/l)	0.2
			16	Barium (mg/l)	0.7
			17	Boron (mg/l)	1.0
			18	Copper (mg/l)	2
			19	Nickel (mg/l)	0.05
			20	Selenium (mg/l)	0.01
			21	Sulfate (mg/l)	250
			22	Phenolic compound(mg/l)	0.002
			23	Penta-chloro –phenol (PCP) (mg/l)	0.009
			24	2,4,6-trichlorophenol (mg/l)	0.2
			25	Aldrin and dieldrin (µg/l)	0
			26	Chromium (Total) (mg/l)	0.05
			Non-Health Based Target (acceptability)		
			1	Color (TCU)	15
			2	Odour	Odorless
			3	pH	6.5-8.5
			4	Hardness as $CaCO_3$ (mg/l)	200-500
			5	Total Dissolved Solids (mg/l)	1000
			6	Aluminum (mg/l)	0.2
			7	Ammonia (mg/l)	1.5
			8	Chloride (mg/l)	<600
			9	Iron (mg/l) (urban) Iron (mg/l) (rural)	0.3-1 0.3-3.0

WSF Annex-10

Water Quality testing methods and equipment need assessment

Ref: "Standard Methods for the Examination of Water and Wastewater"-APHA, AWWA & WEF, 20th Edition

Sl. No	Parameters to be tested	Laboratory method/s/ Techniques	Major equipment needed for lab methods	Test Kit method / Test kit
1st priority category parameters(Health Based)				
1	TTC/ E.Coli (CFU/100ml)	-Membrane filtration technique	a. Culture dishes b. Medium filtration unit c. Membrane filter d. Incubator e. Microscope & light sources etc.	Recognized Portable test kit
2	Arsenic (mg/l)	-AAS- HVG -Inductively coupled plasma(ICP), -Silver diethyl-dithio-carbamate	-Atomic Absorption Spectrometer (AAS) including electro thermal, - Inductive Coupled Plasma-Mass Spectroscopy(ICP-MS) -Arsine generator and absorber assembly	Arsenic field test kit
3	Chlorine, residual (mg/l)	Amperometric titration method DPD colorimetric method DPD ferrous titrimetric method Iodometric method	- Buret & Glassware - UV-Visible Spectrophotometer - Buret & Glassware - UV-Visible Spectrophotometer	Portable Colorimeter with patented chemicals /pillows or suitable test kit
4	Nitrate (mg/l)	-Ion chromatographic method - Ion selective electrode method	-Ion Chromatograph -Anion separator column -Guard column -Fiber suppressor or membrane suppressor	Portable Colorimeter with patented chemicals /pillows or suitable test kit
1st priority category parameters(Non-Health Based)				
5	Turbidity (JTU)	Nephelometric method	Turbidity meter	Turbidity meter

Sl. No	Parameters to be tested	Laboratory method/s/ Techniques	Major equipment needed for lab methods	Test Kit method / Test kit
2nd priority category parameters(Health Based)				
6	Cadmium (mg/l)	-Electrothermal Atomic Absorption Spectrometric method. - Flame Atomic Absorption Spectrometric method. -Inductively Coupled Plasma Method -Anodic Stripping Voltammetry method	-Atomic Absorption Spectrophotometer (AAS) with electrically heated atomizer or graphite furnace -Flame Atomic Absorption Spectrometry (AAS) - Inductively Coupled Plasma- Mass Spectrometer (ICP-MS) -Voltammetry with multi-mode electrode	Portable Colorimeter with patented chemicals /pillows
7	Chromium (total) (mg/l)	- Graphite Atomic Absorption Spectrometric method - Flame Atomic Absorption Spectrometric method - - Inductively Coupled Plasma Method	- Atomic Absorption Spectrophotometer (AAS) with graphite furnace - Flame Atomic Absorption Spectrometry (AAS) - Inductively Coupled Plasma- Mass Spectrometer (ICP-MS)	Portable Colorimeter with patented chemicals /pillow
8	Cyanide (mg/l)	-Colorimetric method - Titration method -Ion Selective Electrode method	-UV-Visible Spectrophotometer - Titration related apparatus - Ion meter with Cyanide selective electrode	Portable Colorimeter with patented chemicals /pillow
9	Fluoride (mg/l)	- Ion -Selective Electrode Method -SPADNS method -Ion -Chromatography method -Flow Injection Method -Complexone method	- Ion meter with Fluoride selective electrode - UV-Visible Spectrophotometer -Ion -Chromatograph Instrument -Flow Injection analysis instrument - UV-Visible Spectrophotometer	Portable Colorimeter with patented chemicals /pillow
10	Lead (mg/l)	- Graphite Atomic Absorption Spectrometric method - Flame Atomic Absorption Spectrometric method - Inductively Coupled Plasma Method -Anodic Stripping Voltammetry method - Dithizone Method	- Atomic Absorption Spectrophotometer (AAS) with graphite furnace - Flame Atomic Absorption Spectrometry (AAS) - Inductively Coupled Plasma- Mass Spectrometer (ICP-MS) -Voltammetry with multi-mode electrode - UV-Visible Spectrophotometer	Portable Colorimeter with patented chemicals /pillow
11	Manganese (mg/l)	-Flame Atomic Absorption Spectrometric method - Inductively Coupled Plasma Method - Persulfate method	- Flame Atomic Absorption Spectrophotometer (AAS) - Inductively Coupled Plasma- Mass Spectrometer (ICP-MS) - UV-Visible Spectrophotometer	Portable Colorimeter with patented chemicals /pillow

Sl. No	Parameters to be tested	Laboratory method/s/ Techniques	Major equipment needed for lab methods	Test Kit method / Test kit
12	Mercury (mg/l)	-Cold-Vapor atomic absorption method - Inductively Coupled Plasma Method	- Atomic Absorption Spectrophotometer (AAS) with Cold Vapor generator device - Inductively Coupled Plasma- Mass Spectrometer (ICP-MS)	Portable Colorimeter with patented chemicals /pillow
13	Total Alpha radiation (bq/l)	-Evaporation Method for Gross Alpha-Beta. -Co precipitation Method for gross Alpha Radioactivity in drinking water.	a. Counting pan b. Membrane filters. c. Thin end-window proportional counter. d. Alternate counter e. Gooch crucibles f. Counting Gas a. Hot plat/magnetic Stirrer and stirring bars b. Filter Membrane c. Drying lamp d. Planchets e. Alpha scintitillation	None
14	Total Beta radiation (bq/l)	-Evaporation Method for Gross Alpha-Beta.	a. Counting pan b. Membrane filters. c. Thin end-window proportional counter. d. Alternate counter e. Gooch crucibles f. Counting Gas	None
15	Benzene (mg/l)	-Gas Chromatography method -GC/MS-MS method	- GC Instrument - GC/MS-MS	None
16	Carbon Tetra Chloride (mg/l)	- Purge and Trap Capillary-Column -Gas Chromatographic Method -GC/MS-MS method	-Purge and Trap system including purging device, trap and related items -Gas Chromatograph including column, electrolytic conductivity or Microcoulometric detector, photoionization detector -GC/MS-MS instrument	None

Sl. No	Parameters to be tested	Laboratory method/s/ Techniques	Major equipment needed for lab methods	Test Kit method / Test kit
17	1,1- DiChloroethene (mg/l)	- Purge and Trap Capillary-Column -Gas Chromatographic Method -GC/MS-MS method	-Purge and Trap system including purging device, trap and related items -Gas Chromatograph including column, electrolytic conductivity or Microcoulometric detector, photoionization detector -GC/MS-MS instrument	None
18	1,2- DiChloroethene (mg/l)	- Purge and Trap Capillary-Column -Gas Chromatographic Method -GC/MS-MS method	-Purge and Trap system including purging device, trap and related items -Gas Chromatograph including column, electrolytic conductivity or Microcoulometric detector, photoionization detector -GC/MS-MS instrument	None
19	Tetra-Chloroethene (mg/l)	- Purge and Trap Capillary-Column -Gas Chromatographic Method -GC/MS-MS method	-Purge and Trap system including purging device, trap and related items -Gas Chromatograph including column, electrolytic conductivity or Microcoulometric detector, photoionization detector -GC/MS-MS instrument	None
20	Tri-Chloroethylene (mg/l)	- Purge and Trap Capillary-Column -Gas Chromatographic Method -GC/MS-MS method	-Purge and Trap system including purging device, trap and related items -Gas Chromatograph including column, electrolytic conductivity or Microcoulometric detector, photoionization detector -GC/MS-MS instrument	None
21	Chloroform (mg/l)	- Purge and Trap Capillary-Column -Gas Chromatographic Method -GC/MS-MS method	-Purge and Trap system including purging device, trap and related items -Gas Chromatograph including column, electrolytic conductivity or Microcoulometric detector, photoionization detector -GC/MS-MS instrument	None
22	Barium (mg/l)	- Flame(Nitrous Oxide) Atomic Absorption Spectrometric method -Graphite Atomic Absorption Spectrometric method -Inductively Coupled Plasma Method	-Flame Atomic Absorption Spectrophotometer (AAS) - Atomic Absorption Spectrophotometer (AAS) with graphite furnace - Inductively Coupled Plasma- Mass Spectrometer (ICP-MS)	None

Sl. No	Parameters to be tested	Laboratory method/s/ Techniques	Major equipment needed for lab methods	Test Kit method / Test kit
23	Boron (mg/l)	-Carmine Method, -Curcumin Method Inductively Coupled Plasma Method	- UV-Visible Spectrophotometer - UV-Visible Spectrophotometer - Inductively Coupled Plasma- Mass Spectrometer (ICP-MS)	Portable Colorimeter with patented chemicals /pillow
24	Copper (mg/l)	-Flame Atomic Absorption Spectrometric method -Graphite Atomic Absorption Spectrometric method -Inductively Coupled Plasma Method - Bathocuproine Method, - Neocuproine Method	-Flame Atomic Absorption Spectrophotometer (AAS) - Atomic Absorption Spectrophotometer (AAS) with graphite furnace - Inductively Coupled Plasma- Mass Spectrometer (ICP-MS) - UV-Visible Spectrophotometer - UV-Visible Spectrophotometer	Portable Colorimeter with patented chemicals /pillow
25	Nickel (mg/l)	-Flame Atomic Absorption Spectrometric method -Graphite Atomic Absorption Spectrometric method -Inductively Coupled Plasma Method	-Flame Atomic Absorption Spectrophotometer (AAS) - Atomic Absorption Spectrophotometer (AAS) with graphite furnace - Inductively Coupled Plasma- Mass Spectrometer (ICP-MS)	Portable Colorimeter with patented chemicals /pillow
26	Selenium (mg/l)	-Flame Atomic Absorption Spectrometric method - Hydride Generation -Atomic Absorption Spectrometric method -Inductively Coupled Plasma Method - Calorimetric Method	-Flame Atomic Absorption Spectrophotometer (AAS) - Atomic Absorption Spectrophotometer (AAS) with Hydride Generation system - Inductively Coupled Plasma- Mass Spectrometer (ICP-MS) - UV-Visible Spectrophotometer	Portable Colorimeter with patented chemicals /pillow
27	Sulfate (mg/l)	-Gravimetric Method with Ignition of Residue, -Gravimetric Method with Drying of Residue, - Turbidimetric(Barium Sulfate) Automated Methylthymol Blue Method	- Drying oven and other related apparatus - Vacuum oven and filtration apparatus - UV-Visible Spectrophotometer including magnetic stirrer - Automated analytical equipments	Portable Colorimeter with patented chemicals /pillow
28	Penta-Chloro-Phenol (PCP) (mg/l)	Liquid-Liquid Extraction Gas Chromatographic Method	-LC/MS including proper column	None

Sl. No	Parameters to be tested	Laboratory method/s/ Techniques	Major equipment needed for lab methods	Test Kit method / Test kit
29	2,4,6-Tri-ChloroPhenol(mg/l)	Liquid-Liquid Extraction Gas Chromatographic Method	-LC/MS including proper column	None
30	Aldrin & Dieldrine	-Liquid-liquid extraction GS method - Liquid-liquid extraction GS/MS method	1.a)Chromatographic column b)Gas Chromatograph 2.aSeparatory funnel, 2-L with TFE stopcock b)Drying column, c)Concentrator tube, d) evaporative flask, e)Snyder column f) Vials g) Continuous liquid liquid extractor h)Boiling Chips, i)Water bath, j) Balance k)Gas chromatograph	None
31	Phenolic Compound (derivatives) mg/l	Liquid-Liquid Extraction Gas Chromatographic Method	-LC/MS including proper column	None
2nd priority category parameters(Non-Health Based)				
32	Color (Hazen unit)	-Spectrophotometric method	- UV-Visible Spectrophotometer	Visual comparison methods
33	Odour	Threshold Odor Test	-Sample bottles -Constant-temperature bath -Odor flasks - Pipettes -Thermometer	Odour panel
34	pH	Electrometric Method (pH electrode)	pH Meter with electrode	Portable field kit
35	Hardness as CaCO3 (mg/l)	EDTA Titrimetric Method	- Burette and others glassware	Portable Colorimeter with patented chemicals /pillow
36	Total Dissolved Solid (TDS) (mg/l)	Total Dissolved Dried method (Dried oven method)	Filtration Unit including drying oven	TDS meter

Sl. No	Parameters to be tested	Laboratory method/s/ Techniques	Major equipment needed for lab methods	Test Kit method / Test kit
37	Aluminum (mg/l)	-Graphite Atomic Absorption Spectrometric method -Inductively Coupled Plasma Method - Eriochrome Cyanine R Method	Atomic Absorption Spectrophotometer (AAS) with graphite furnace - Inductively Coupled Plasma- Mass Spectrometer (ICP-MS) - UV-Visible Spectrophotometer	Portable Colorimeter with patented chemicals /pillow
38	Ammonia (mg/l)	-Ion Selective Electrode Method - Titrimetric method -Phenate method -Flow Injection method	- Ion meter with ammonia selective electrode - Burette and others glassware - UV-Visible Spectrophotometer - Flow Injection related instrument	Portable Colorimeter with patented chemicals /pillow
39	Chloride (mg/l)	-Argentometric Method -Mercuric Nitrate method -Automated Ferricyanide Method - Ion Chromatography method - Potentiometric Method	-- Burette and others glassware -- Burette and others glassware - Automated analytical equipments - Ion Chromatography instrument(IC) -Voltammetry with multi-mode electrode	Portable Colorimeter with patented chemicals /pillow
40	Iron (mg/l)	-Flame Atomic Absorption Spectrometric Method - Inductivity coupled plasma method. -.Phenonthroline method	-Flame Atomic Absorption Spectrophotometer (AAS) - Inductively Coupled Plasma- Mass Spectrometer (ICP-MS) - UV-Visible Spectrophotometer	Portable Colorimeter with patented chemicals /pillow

Note: It has been agreed in the HBT finalization workshop/meeting that faecal contamination determination by P/A test though not included as HBT, this test will be useful in the rural context of Bangladesh and should be carried out for rural water supply systems.

WSF
Annex-11

Water Quality Monitoring Protocols and Implementation Strategies for Water Supplies of Bangladesh

Water Supply Systems; Source of water and treatment processes	Parameter to be tested by Caretakers /Owners/Management Committees (Part -A)			Parameter to be tested through the Union Parishads by Caretakers/ Owners/ Management Committees (Part -B)			Parameter to be tested by DPHE Zonal Lab/ Central Lab (Part -C)		
	Parameters	**Method of testing**	**Frequency**	**Parameters**	**Method of testing**	**Frequency**	**Parameters**	**Method of testing**	**Frequency**
1.1 Hand Tubewells (HTWs) a) Shallow Tubewells (STW): Tapping shallow aquifer above all impervious layers; no treatment done . The water is collected by suction mode handpump. b) Tara Tubewells (TTW) : Same as above except that the water is pumped by a Tara hand pump which is a lift pump. c) Very Shallow Shrouded tubewells (VSST): Tapping sub-surface water (about 20-25 feet below ground surface); no treatment done. The water is collected by suction mode hand pump. d) Deep Tubewells (DTW): Tapping deep aquifer below impervious layer/s; no treatment done . The water is collected by suction mode handpump	**Common for all systems (a-d)**			**Common for all systems (a-d)**			**Common for all systems (a-d)**		
	Sanitary Compliance	Physical verification following checklist	Monthly	Arsenic	Arsenic field test kit.	Half Yearly	• TTC • Arsenic • Cadmium • Chromium • Cyanide • Fluoride • Lead • Manganese • Mercury • Nitrate • Turbidity • pH • 1,1 Dichloro ethene • 1,2 Dichloro ethene • TetraChloro ethene • TriChloro ethylene • Barium • Selenium • Hardness • Chloride • Iron • Boron • Copper • Nickel	Test Kits and/or appropriate laboratory method/s	These parameters broadly represent the quality of source water i.e. ground water. All of them are equally important for all water supply systems tapping ground water. Therefore, instead of testing water from each water system/HTW it would be rational, practicable as well as cost effective to test one sample from each union-ward each year (i.e. nine samples from each union), which would be reasonably representative for all HTWs of the union. However, HTW selection for all sampling should be such that all types of
	Color	Visual inspection	Weekly	Faecal contamination	P/A test kit (H2S method)	Quarterly and when waterborne diseases occur			
	Color	Nasal sensation	Weekly						
	Turbidity	Visual inspection	Weekly						

Water Supply Systems; Source of water and treatment processes	Parameter to be tested by Caretakers /Owners/Management Committees (Part -A)			Parameter to be tested through the Union Parishads by Caretakers/ Owners/ Management Committees (Part -B)			Parameter to be tested by DPHE Zonal Lab/ Central Lab (Part -C)		
	Parameters	**Method of testing**	**Frequency**	**Parameters**	**Method of testing**	**Frequency**	**Parameters**	**Method of testing**	**Frequency**
1.2 Arsenic Removal Technology (ART): • SIDKO • AL-CAN • SONO • READ-F • Showdesh • Nelima Source of raw water for all these water systems are arsenic contaminated tubewell water. Except for arsenic the water should be otherwise safe. Treatment process comprises removal of iron first followed by removal of arsenic.	**Common for all ARTs**			**Common for all ARTs**			**Common for all ARTs**		
	Sanitary Compliance	Physical verification following respective checklist	Monthly	**Treated Water**			**Untreated Water**		
	Treated Water			Arsenic	Arsenic field test kit.	Half Yearly	Arsenic	Proper laboratory method/s	Once a year
	Color	Visual inspection	Daily	Faecal contamination	P/A test kit (H_2S method)	Half Yearly and when diarrhea occur	Iron		
	Color	Nasal sensation	Daily				Phosphate		
	Turbidity	Visual inspection	Daily				pH		
	Untreated raw water			**Untreated raw water**			TTC		
	Color	Visual inspection	Daily	Arsenic	Arsenic field test kit.	Quarterly	**Treated Water**		
	Color	Nasal sensation	Daily	Faecal contamination	P/A test kit (H_2S method)	Half Yearly and when diarrhea occur	Arsenic,Cerium, Al, Fe	Proper laboratory method/s	Once a year
	Turbidity	Visual inspection	Daily				TTC		

Water Supply Systems; Source of water and treatment processes	Parameter to be tested by Caretakers /Owners/Management Committees (Part -A)			Parameter to be tested through the Union Parishads by Caretakers/ Owners/ Management Committees (Part -B)			Parameter to be tested by DPHE Zonal Lab/ Central Lab (Part -C)		
	Parameters	**Method of testing**	**Frequency**	**Parameters**	**Method of testing**	**Frequency**	**Parameters**	**Method of testing**	**Frequency**
1.3 Pond Sand Filter (PSF); Dug well (DW); Infiltration Gallery (IFG) Gravity Flow System(GFS) PSF: Raw water source is pond; water is treated by Roughing Filtration followed by Slow Sand Filtration. Water from the pond is drawn by a hand pump. DW:Water source is subsurface water at a depth of 25-30feet below ground surface; the water collected in the DW is drawn by a hand pump and then used directly by consumers; in some cases the water is treated by slow sand filter. IFG: Raw water source is sub-surface water in the bed /bottom of stream, creek, pond, canal. Below	**Common for all Systems (PSF,DW,IFG,GFS)**			**Common for all Systems (PSF,DW,IFG,GFS)**			**Common for all Systems (PSF,DW,IFG,GFS)**		
	Sanitary Compliance	Physical verification following respective checklist	Weekly	Faecal contamination	P/A test kit (H2S method)	Quarterly and when waterborne diseases occur	• TTC	Test Kits and/or appropriate laboratory method/s	Halt Yearly
	Color	Visual inspection	Weekly	**For DW only**			• pH		Yearly
	Color	Nasal sensation	Daily	Arsenic	Arsenic field test kit.	Half yearly	• Cadmium		Do
	Turbidity	Visual inspection	Daily				• Chromium		Do
							• Cyanide		Do
							• Manganese		Do
							• Mercury		Do
							• Nitrate		Do

Water Supply Systems; Source of water and treatment processes	Parameter to be tested by Caretakers /Owners/Management Committees (Part -A)			Parameter to be tested through the Union Parishads by Caretakers/ Owners/ Management Committees (Part -B)			Parameter to be tested by DPHE Zonal Lab/ Central Lab (Part -C)		
	Parameters	Method of testing	Frequency	Parameters	Method of testing	Frequency	Parameters	Method of testing	Frequency
the bottom of the water source artificial gallery/storage of infiltrated water is created within a bed of brick chips enveloped by sand layers. The impurities is removed by the sand as the water enters the brick-bed. The stored water is drawn by a hand pump installed in the bank of the water source. GFS: The raw water source is protected/unprotected springs, streams and creeks located up the hills which are collected by a down-water pipe through intake by gravity. The water is then treated by roughing filtration and slow sand filtration. The treated water is finally delivered to the consumers by gravity.	Common for all Systems (PSF,DW,IFG,GFS)			Common for all Systems (PSF,DW,IFG,GFS)			Common for all Systems (PSF,DW,IFG,GFS)		
							• Benzene	Test Kits and/or appropriate laboratory method/s	Do
							• Arsenic		Do
							• Barium		Do
							• Selenium		Do
							• Aldene and dieldrine		Do
							• Hardness		Do
							• TDS		Do
							• Ammonia		Do
							• Chloride		Do
							• Iron For PSF and GFS • Microcystin L-R	Proper lab methods	Do Once in a year when algal bloom occurs

Water Supply Systems; Source of water and treatment processes	Parameter to be tested by Caretakers /Owners/Management Committees (Part -A)			Parameter to be tested through the Union Parishads by Caretakers/ Owners/ Management Committees (Part -B)			Parameter to be tested by DPHE Zonal Lab/ Central Lab (Part -C)		
	Parameters	**Method of testing**	**Frequency**	**Parameters**	**Method of testing**	**Frequency**	**Parameters**	**Method of testing**	**Frequency**
1.4 Rain Water Harvesting (RWH): The source of water is rain water falling on the house-roofs from where it is collected by gutter into the rain water tank. From the tank the stored water iscollected by the consumers from taps. No other treatment except pre-monsoon dis-infection of the tank and frequent cleaning of roof is done.	**Common for all Systems (PSF,DW,IFG,GFS)**			**Common for all Systems (PSF,DW,IFG,GFS)**			**Common for all Systems (PSF,DW,IFG,GFS)**		
	Sanitary Compliance	Physical verification following respective checklist	Weekly	Faecal contamination	P/A test kit (H2S method)	Quarterly and when waterborne diseases occur	TTC	Test Kits and/or appropriate laboratory method/s	Yearly
	Color	Visual inspection	Daily				pH		Do
	Color	Nasal sensation	Daily				Color		Do
	Turbidity	Visual inspection	Daily				Turbidity		Do
							Nitrate		Do
							Lead		Do

Note: 1. For Arsenic Removal Technology, some additional parameter should be tested from treated water based on ingredient of media such as Cerium for READ-F; Aluminum for ALCAN technology.
2. WHO guideline values to be taken as target where HBT not given

WSF Annex-12

Communication strategies for action on water quality monitoring findings

Who	When	Why	To whom	For What
1. RWS System (HTWs, PSF, DW, IFG,GFS, RWH and the ARTs)				
1.1 Caretakers/ Owners/ management committee	Turbidity or color or odor problems observed	Could not solve the problem by repairing, maintenance and by improving sanitary compliance by themselves	Union Parishad through Ward Member concerned	• To solicit the services of the proposed Union WSP Implementation Organizer and the DPHE Tube-well Mechanic to help solve the problem • If required to solicit support from Upazila Parishad for the technical services of AE/SAE DPHE and also for THFPO, DGHS assistance to check any health impact on the consumers.
1.2 Union Parishad	• P/A test shows positive faecal contamination • Arsenic tests shows arsenic concentration more than 50ppb		Caretakers/owners/ management committe	• For improvement of sanitary condition as per requirement of sanitary compliance • For rectification of defects by repairing and maintenance • To avoid arsenic contaminated source or to adopt arsenic treatment technology if required
			• DPHE Tube-well Mechanic • Union WSP Implementation Organizer	To help the caretakers/owners/ management committees solve the problem
			• Upazilla Parishad	• Upazilla Parishad to take appropriate actions to arrange for alternate safe arsenic free sources for the community • To check if any health impact on the community through THFPO, DGHS
1.3 DPHE laboratory concerned	Whenever the laboratory finds, after testing, any parameter beyond the allowable limit or HBT		• Upazilla Parishad concerned • The EE DPHE concerned • The SE DPHE monitoring and surveillance (Entire test report from the laboratory to be sent to the SE) • Appropriate DGHS authority	• Upazilla Parishad to take as much appropriate action as possible at their disposal through THFPO, DGHS and the AE/SAE DPHE including THFPO, DGHS checking any health impact on the community • The EE DPHE to provide technical support to the upazilla parishad to solve the quality problem • The SE DPHE, Monitoring and Surveillance to take appropriate action at his end and also to share detail test report with the LG Division through proper channel • DGHS authority concerned to verify health impact on the community, if any.

Who	When	Why	To whom	For What
2. Small community piped water supply in Rural areas				
2.1 Caretakers/ Owners/ Management committee	Quality problem observed with any of these parameters • Turbidity • Color • Odor • Chlorine residual • pH	Themselves could not solve the problem by maintenance, repairing, and by improving sanitary and physical condition/ environment and also adhering to control measures	Union Parishad through the Ward Member concerned	• To solicit the services of the union WSP Implementation Organizer and/or the DPHE Tube-well Mechanic to help solve the problems • If required to solicit support from the upazilla parishad for the services of the AE/SAE DPHE and/or the EE DPHE concerned • To refer to the Upazilla Parishad to check through THFPO, DGHS health impact on the community, if any.
2.2 Union Parishad	• P/A test shows positive faecal contamination • Arsenic test shows arsenic concentration more than 50ppb		Caretakers/Owners/ Management committee	• For improvement of sanitary conditions and physical environment of the systems by adhering to control measures • For rectification of defects by repairing, replacement and maintenance as required • For adjusting chlorine dosing • To avoid arsenic contaminated sources or to adopt arsenic removal technology if required
			• Tube-well mechanic (DPHE) • Union WSP Implementation Organizer	To help the caretakers/owners/ management committees solve the problems
			• Upazilla parishad	• To solicit the services of the THFPO, DGHS staff to improve sanitary condition and also to check any health problem caused thereof • To solicit the technical services of the AE/SAE DPHE and/or the EE DPHE
2.3 DPHE laboratory concerned	Whenever any parameter is fond beyond HBT or allowable limit by the laboratory following verification/testing	Themselves could not solve the problem by maintenance, repairing, and by improving sanitary and physical condition/ environment and also adhering to control measures	• Upazilla parishad concerned • The EE DPHE concerned • The SE DPHE monitoring and surveillance (Entire test report from the laboratory to be sent to the SE) • Appropriate DGHS authority	• Upazilla parishad to take as much appropriate actions as possible at their disposal through THFPO, DGHS and the AE/SAE DPHE including THFPO, DGHS checking health problem caused, if any. • The EE DPHE to provide technical services to the upazilla • The SE DPHE, monitoring and surveillance to take appropriate action at this end and also to share detail test report with the LG Division through proper channel • DGHS authority to verify through THFPO any health problem, caused to the community

Who	When	Why	To whom	For What
3. Pourashava and city corporation piped water supplies				
3.1 Pourashava and city corporation	Quality problem observed with any of these parameters • Turbidity • Color • Odor • Chlorine residual • pH • TTC • Arsenic • Nitrate	Themselves could not solve the problems by maintenance, repairing and by improving physical condition and sanitary environment, and also adhering to control measures	• EE DPHE concerned • Appropriate DGHS authority	• To solicit technical assistance from the EE and if necessary to refer to DPHE higher authority for guidance and action • DGHS authority concerned to check health impact on the community if any.
3.2 DPHE laboratory concerned	Whenever any parameter is found beyond HBT or allowable limit by the laboratory following verification/testing		• The pourashava concerned or • The city corporation concerned • The EE DPHE concerned • The SE DPHE monitoring and surveillance circle (Entire test report from the laboratory to be sent to the SE) • Appropriate DGHS authority	• Pourashava or City Corporation to take appropriate action by repairing, maintenance and by improving physical and environmental condition, and also adhering to control measures • The EE DPHE to provide technical assistance to the pourashava/city corporation • The SE DPHE monitoring and surveillance to take appropriate action at his end and also to share detail test report with the LG Division through proper channel • DGHS authority concerned to check health impact on the community, if any.
4. WASAs' piped water supplies				
4.1 DPHE laboratory concerned	Immediately after completion of verification of WASA system		• Complete verification report to be sent to WASA authorities concerned	• For taking necessary measures following the verification reports
			• SE DPHE monitoring and surveillance circle ((Entire test report from the laboratory to be sent to the SE)	• For taking appropriate action at his end and also to share detail test report with the LG Division through proper channel
			• Appropriate DGHS authority	• DGHS to check health impact on the community, if any
4.2 WASA authority	Monthly		• Whole monitoring report of WASA to be sent to appropriate DGHS authority	• DGHS authority to check health impact if any, on the community

WSF Annex-13

Protocols and implementation strategies for surveillance of various water supply services

Proposed Surveillance Protocol and Implementation Strategies for Rural Water Supply Systems (Public & Private) [HTWs (STW, DTW, VSST, Tara), RWH, PSF, IFG, GFS, ART]

Sl. No.	Item for Surveillance	Organization and staff to undertake surveillance	Sample size/ Quantity and frequency	How	On the spot action	Preparation and utilization of output report
1.	System specific (a) Sanitary compliance and (b) adoption of safety and control measures against likelihood of hazards, vulnerability and potential risks	Upazila DGHS through its field level trained staff.	5% of the RWS Systems (Public/Private) per ward per month, selected randomly covering all systems	Physical inspection of the system following respective checklist for sanitary compliance and adoption of safety measures.	The inspector will advise caretaker /owner/ management committee for proper compliance as required.	Based on all the post surveillance checklist from the inspectors, the DGHS authority at Upazila level will prepare monthly union-wise consolidated report and place for action at monthly Upazila Parishad meeting.
2	Family/consumers' level drinking water storage methods/ practices.	Upazila DGHS through its field level trained Staff.	20 families per month per ward selected randomly.	Physical inspection of the storage system in real condition following checklist.	The inspector will advise the family/consumers' on proper and hygienic method of storage if required.	ditto
3	Family/consumers' level assessment of access to safe water	Upazila DGHS through its field level trained staff	20 families per month per ward selected randomly with special attention to un-served/ underserved areas/ pockets.	Interviewing the families to determine their sources of drinking water and assessing the safety of the source water & sources. Ascertain the causes of inaccessibility to safe water, if any. Checklist to be used for surveillance.	The surveillance inspector will advise the families/consumers to endeavor to collect and drink safe water.	ditto

Sl. No.	Item for Surveillance	Organization and staff to undertake surveillance	Sample size/ Quantity and frequency	How	On the spot action	Preparation and utilization of output report
4.	Prevalence of major drinking water borne diseases at family/ consumers' level (diarrhea, arsenicosis, typhoid, polio, hepatitis)	Upazila DGHS through its field level trained staff	20 families per month per ward selected randomly	Physically checking the health of each member of the family following the checklist	The inspector will advise for proper treatment of any family-member found to suffer from any of the diseases.	ditto
5.	Critical water quality at the delivery point of the system (Faecal contamination, Arsenic, Turbidity, Color, Odour)	Trained DPHE Tube-well Mechanics (TWM) under the super vision of the Sub-assistant Engineer (SAE)	2-3% of the water systems per ward per month	• Faecal contamination by P/ A test kit. • Arsenic by field test kit. • Turbidity & Color by visual method & Odour by nasal sensation • Findings of surveillance are to be recorded in checklist/ register.	If required, TWMs to advise the caretakers/ owners management committees for improvement of sanitary compliance and safety measures and also to stop using arsenic contaminated water for drinking and cooking.	Based on all the surveillance reports, the SAE DPHE will prepare union-wise consolidated report monthly and place for action at monthly Upazila Parishad meeting.

Sl. No.	Item for Surveillance	Organization and staff to undertake surveillance	Sample size/ Quantity and frequency	How	On the spot action	Preparation and utilization of output report
6.	Critical water quality (Faecal contamination, arsenic, turbidity, color, odour) of water stored for drinking and cooking at family/consumers' level.	Trained DPHE TWMs under guidance and supervision of the SAE DPHE	Each parameter of stored water of 3 families per ward, per month.	• Faecal contamination by P/A test kit. • Arsenic by field test kit. • Turbidity & Color by visual method & Odour by nasal sensation • Findings of surveillance are to be recorded in checklist/ register.	If required, TWMs to advise the families for proper and hygienic collection and storage of water and also to stop ingesting arsenic contaminated water through drinking and cooking.	Based on all the surveillance reports, the SAE DPHE will prepare union-wise consolidated report monthly and place for action at monthly Upazila Parishad meeting.

Proposed Surveillance protocol and implementation strategies for small community piped water supplies in the rural areas

Sl. No.	Item for Surveillance	Organization and staff to undertake surveillance	Sample size/ Quantity and frequency	How	On the spot action	Preparation and utilization of output report
1	Component specific sanitary compliances of the water supply system.	DPHE/SAE	All existing water systems in the Upazila, once every 6 (Six) months.	Physical verifications following monitoring/ assessment tools given in WSP guidelines.	Suggest the management committee/ operator to take corrective actions in case of non-compliance.	Based on all the surveillance carried out in a month the SAE will prepare a report and submit in the monthly Upazila meeting for actions.
2	Adoption of component specific safety/control measures against likelihood of hazard, vulnerability and potential risks.	DPHE/SAE	ditto	ditto	Suggest the management committee/ operator to take corrective measures wherever likelihood of hazards, vulnerability & potential risks observed.	ditto
3	Critical water quality (faecal contamination, arsenic, turbidity, colour and odour) as it leaves the system.	DPHE/TWM	One test for each parameter, quarterly, each system	• P/A test kit • Arsenic test kit • Visual/nasal method	Suggest rectification/ improvement as required by sanitary compliance and by repairing/ maintenance	• The TWMs will submit surveillance report to the SAE who will prepare a consolidated report for the monthly meeting of the Upazila Parishad. • If required the SAE will personally visit the system to help improve the quality of water. • The SAE will inform his DGHS counterpart to check any public health problems if any.
4	Critical water quality in the distribution system (faecal contamination, arsenic, turbidity, colour and odour)	DPHE/TWM	Each parameter at 3 points, quarterly, per system.	• P/A test kit • Arsenic test kit • Visual/ nasal method	Suggest rectification/ improvement as required by sanitary compliance and by repairing/ maintenance	• The TWMs will submit surveillance report to the SAE who will prepare a consolidated report for monthly meeting of the Upazila Parishad. • If required the SAE will personally visit the system to help improve the quality of water. • The SAE will inform his DGHS counterpart to check public health problems, if any.

Sl. No.	Item for Surveillance	Organization and staff to undertake surveillance	Sample size/ Quantity and frequency	How	On the spot action	Preparation and utilization of output report
5	Critical water quality at consumers'/ family level (faecal contamination, arsenic, turbidity, colour and odour)	DPHE/TWM	Each parameter of stored water of 3 families ,quarterly, per system	• P/A test kit • Arsenic test kit • Visual/ nasal method	Suggest rectification/ improvement as required by sanitary compliance and by repairing/ maintenance. If required the TWM to advise the families for proper and hygienic collection and storage of water and also to stop ingesting arsenic contaminated water through drinking and cooking	• The TWMs will submit surveillance report to the SAE who will prepare a consolidated report for the monthly meeting of the Upazila Parishad. • If required the SAE will personally visit the system to help improve the quality of water. • The SAE will inform his DGHS counterpart to check public health problems, if any.
6	Method of storage of drinking water at consumers/ family level.	DGHS/ designated staff	20 families per ward per month.	Physical inspection of the storage system in real condition following checklist.	Will advise the families on proper methods of collection and storage of drinking water	Based on all the surveillance checklists/reports from the inspectors, the DGHS authority at Upazila level will prepare monthly report, union-wise and place for action at monthly Upazila Parishad meetings.
7	Assessment at consumers/family level of access to safe water	DGHS/ designated staff	20 families per ward per month with special focus on un-served/ underserved areas.	Interviewing the families to determine their sources of drinking water and assessing the safety of the source water & source. Ascertain the cause of inaccessibility to safe water if any. Checklist to be used to record surveillance findings.	The surveillance inspector will advise the families / consumers' to endeavor to collect and drink safe water.	Ditto

Sl. No.	Item for Surveillance	Organization and staff to undertake surveillance	Sample size/ Quantity and frequency	How	On the spot action	Preparation and utilization of output report
8	Prevalence of major drinking water related diseases at family/consumers' level (diarrhea, arsenicosis, typhoid, polio, hepatitis)	DGHS/ designated staff	20 families, per ward, per month selected randomly	Physically checking the health of each member of the family following checklist	The inspector will advise for proper treatment of any patient if identified.	ditto
9	Surveillance of raw water quality at catchment and intake point, if the system uses surface water. The parameters are: pH , BOD, DO, TC, NO3, COD, TOC, NH3, Pesticides	DOE	Each system, half yearly	Using appropriate field kits and/or proper lab methods	Advising the system management in case any parameter is found to be beyond standards.	DOE will prepare and share the whole report with the system management, Upazila Parishad, top management of DPHE and the LG Division.

Pesticides: [Organo-Chlorine: DDT, Endrine, Aldrin, Heptachlor, Dieldrin;
Organo-Phosphorous: Diazinon, Malathion, Acephate, Fenitrothion, Quinalplus]

Proposed surveillance protocols and implementation strategies for piped water supply services of Pourashava and City Corporation and WASAs

Sl. No.	Item for Surveillance	Organization and staff to undertake surveillance	Sample size/ Quantity and frequency	How	On the spot action	Preparation and utilization of output report
1	1.1 Whether the Pourashava/City Corporation prepared the WSP following national guideline and implementing it accordingly	DPHE; the SE of the circle concerned and/or his designated engineer	Once every year	Personal visit and physically verifying the WSP and its implementation related documents including interviewing the implementing staff concerned	In case of no preparation of WSP, advise the Mayor to arrange to prepare the WSP; in case of any inadequacy found in the prepared WSP or its implementation advise specific action to improve/rectify	Prepare a detail report and share with the Mayor, the top DPHE management, the LG Division through proper channel and the EE DPHE concerned to follow up and provide technical assistance
	1.2 Whether the WASA prepared the WSP following the national guideline and implementing it accordingly	Division Environment, Engineering Universities	Once every year	Personal visit by the designated faculty members and verifying physically all WSP and its implementation related papers and interviewing the concerned implementing staff	Detail report to be prepared and shared with the chairman/the MD, and the LG Division	Prepare a detail report and share with the Mayor, the top DPHE management, the LG Division through proper channel and the EE DPHE concerned to follow up and provide technical assistance
2	2.1 Whether the Pourashava/City Corporation has identified the likely vulnerable, hazardous and potentially risky points/items from catchments/sources to the consumers, and whether implementing control measures through operational monitoring	DPHE; the SE of the circle concerned and/or his designated engineer	Once every year	• Personal visit to the Pourashava/ City Corporation • Review operational monitoring plan prepared by the	• Advise the Mayor, on the actions as required	Prepare detail report and share with the Mayor, the top DPHE management, the LG Division and the EE DPHE concerned to follow up and provide technical support

Sl. No.	Item for Surveillance	Organization and staff to undertake surveillance	Sample size/ Quantity and frequency	How	On the spot action	Preparation and utilization of output report
				pourashava/ city corporation for control measures • Verify all related/ relevant documents/ reports/data • Visit to critical spots • Interviewing the concerned implementation staff		
	2.2 The same for WASAs	Division Environment, Engineering Universities	Once every year	• Visits to the WASAs by the faculty members • Review operational monitoring plan for control measures prepared by WASAs • Verify related/relevant papers • Visit to critical spots • Interviewing the staff concerned	Advise the chairman/the MD as required	Prepare detail report and share with the Chairman/the MD and the LG Division

Sl. No.	Item for Surveillance	Organization and staff to undertake surveillance	Sample size/ Quantity and frequency	How	On the spot action	Preparation and utilization of output report
3	3.1 Whether the Pourashavas/City Corporation carryout water quality monitoring following the national protocol.	DPHE; the SE of the circle concerned and/or his designated engineer	Once every year	• Review of monitoring plan of Pourashavas and City Corporation • Checking the availability of the national monitoring protocol with the Pourashava/City Corporation • Verification of related and relevant documents • Review of data management • Review of reporting systems • Review of action taken following monitoring findings • Interviewing the staff concerned • Inspection of lab equipments and test kits • Review of sampling design, sample collection, testing methods etc.	Advising the Mayor for immediate action, mid-term as well as long term intervention as required	Prepare detail report and share with the Mayor, the DPHE top management, the LG Division through proper Channel and the SE DPHE Monitoring & Surveillance for technical support

Sl. No.	Item for Surveillance	Organization and staff to undertake surveillance	Sample size/ Quantity and frequency	How	On the spot action	Preparation and utilization of output report
3	3.2 The same for WASAs	Division Environment, Engineering Universities	Once every year	• Review of monitoring plan of WASAs • Checking the availability of the national monitoring protocol with the WASAs • Verification of related and relevant documents • Review of data management • Review of reporting systems • Review of action taken following monitoring findings • Interviewing the staff concerned • Inspection of lab equipments and test kits • Review of sampling design, sample collection, testing methods etc.	Advising the Chairman/ the MD for immediate action, mid-term as well as long term intervention as required	Prepare detail report and share with the Chairman/ the MD of WASAs and the LG Division

Sl. No.	Item for Surveillance	Organization and staff to undertake surveillance	Sample size/ Quantity and frequency	How	On the spot action	Preparation and utilization of output report
4	**For Pourashavas, City Corporations and WASAs**: In case of surface water sources, surveillance of raw water quality at catchments/intake points. The parameters are: pH, BOD, DO, TC, COD, TOC, NH3, NO3, Pesticides, POPs.	DOE	Each water supply system, half yearly	Using appropriate field test kits and or proper lab method	In case any parameter found to be outside the standard advise the water supply system management/authority (Mayor/Chairman/MD) for necessary action	DOE will prepare detail report and share the whole report with the systems management/ authority (Mayor/Chairman/MD) and also the LG Division
5	**For Pourashavas, City Corporations and WASAs:** 5.1 Critical water quality in the water supply systems, parameters are: TTC, pH, As, NO3, Residual Chlorine, Turbidity, Color, Odour	BSTI	Each parameter at several points of each systems; every 6 (six) months	Using appropriate field test kits and/or proper lab method	In case any parameter found to be outside the prescribed limit advise the system management/authority (Mayor/Chairman/MD) for necessary action	BSTI will prepare detail report and share the whole report with the systems management/ authority (Mayor/Chairman/MD) and also the LG Division
	5.2 Critical water quality of the water stored for drinking at the consumers'/family level (TTC, pH, As, NO3, Turbidity, Color, Odour)	BSTI	Each parameter of stored water from three randomly selected houses per ward per month of each water supply systems	Using appropriate field test kits/and or proper lab method	In case of non-compliance found with respect to any parameter, advise the system management/ authority (Mayor/Chairman/MD) to launch appropriate public education	BSTI will prepare detail report and share the whole report with the systems management/ authority (Mayor/Chairman /MD) and also the LG Division

Sl. No.	Item for Surveillance	Organization and staff to undertake surveillance	Sample size/ Quantity and frequency	How	On the spot action	Preparation and utilization of output report
6	**For Pourashovas, City Corporation and WASA**					
	6.1 Method of storage of drinking water stored at consumers/family level.	DGHS through its relevant staff.	20 families per ward per month; families to be randomly selected.	Physical inspection of the storage system in real condition following checklist and recording findings properly in the checklist.	The inspector will advise the families/consumers on proper and hygienic method of storage as required.	Based on all the surveillance checklist from the inspectors the DHGS authority concerned will prepare monthly system-wise report and share with the system management/ authority (Mayors /Chairman/MD) and the LG Division.
	6.2 Family/Consumers level assessment of access to safe water	DGHS though its relevant staff	20 families per ward per month; families to be randomly selected covering underserved/ un-served pockets/ area.	Interviewing the families to determine their source of drinking water and assessing the safety of the source water and sources. Ascertain the causes of inaccessibility, if any to safe water. Checklist to be used for recording findings.	The surveillance inspector will advise the families/consumers to endeavor to collect and drink and cook with safe water.	Ditto
	6.3 Prevalence of major drinking water borne diseases at family /consumers level (diarrhea, arsenicosis, typhoid, polio, hepatitis)	DGHS through its field level trained staff	20 families per ward per month; families to be selected randomly covering underserved/ un-served pockets/areas.	Physically checking the health of each member of the families following checklist and recording findings properly	The inspector will advise for proper treatment of any patient if identified.	Ditto

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