Climate Resilient Water Safety Plans Guideline

Urban Water Supply System

October 2017

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Panipokhari, Kathmandu, Nepal

About the Guideline

Nepal made significant progress on water supply and sanitation. Access to drinking water has gone from less than 25 percent to around 93 percent in recent years. Despite these gains, there is a significant issue to supply safe water. Government of Nepal (GoN) has been taking various steps to address these issues and Water Safety Plan (WSP) is considered one of the best options to provide safe water to the consumers.

Water Safety Plan (WSP) is a systematic approach for improving and maintaining drinking water quality from catchment to consumers. This approach is based on the risk assessment and risk management principles, stresses on identifying hazards in water supply systems, adopts control measures to prevent hazards, and monitors the effectiveness of control measures on regular basis. WSP has played a very important role in improving service levels and sustaining the water supply system in many parts of the world including in Nepal. However in recent years, the implementation of WSP has been affected by some external factors. Climate Change is one of the major factors which have been affecting the water supply systems causing depletion of sources, increasing water induced disasters, deteriorating water quality and many others. It demands consideration of these new emerging challenges in implementing WSP in water supply systems.

With this background, this guideline has been developed to implement full-fledged climate resilient water safety plan (CR-WSP) mainly for urban water supply schemes. A relatively new urban water system implementing WSP can use the Basic CR-WSPs guideline in the first phase (used by rural water system) and then shift to this Advance CR-WSP when the WUSC or utility operator has gained confidence of application of WSPs. Thus the application of Basic to Advance CR-WSP is the choice of WUSC/operator and the level of system and capacity built up of the WUSC. But for urban water system, it is mandatory to use the Advance CR-WSPs guideline once they are accustomed with WSPs process. They can use Basic WSPs guideline in the beginning but the time frame of upgrading to Advance WSPs should not be more than a year.

This guideline is mostly applicable for an advanced water supply system, which can be used for assurance of water quality of large system. The guideline is intended only as a guide given that development of WSP is always system specific. However the principles of all CR-WSP remain same with considerations of climate related aspects in ongoing plans.

This document is structured according to the WSPs developed by WHO and DWSS and draws from practical experiences on emerging issues such as climate change. It has been prepared considering available national and international guidelines on it, is based on the experiences obtained from the implementation of WSP since 2006 with WHO-Nepal's support and on the consultations provided by an international expert on this subject matter. It is expected that this guidelines is useful for water operators, which has been implementing WSP and for all agencies in water and sanitation sector like regulating bodies, executing/implementing agencies and water suppliers (water users' committee or water utilities). It will prove to be a very important tool for implementing WSP in water supply schemes.

This guideline is the result of untiring efforts of many individuals and is the product of the consultations with relevant experts in the sector. Department of Water Supply and Sewerage (DWSS) acknowledge the valuable inputs of Dr. Dinesh Raj Manandhar, WSP Expert and WHO Nepal's National Professional Officers Er. Raja Ram Pote Shrestha and Dr. Sudan Raj Panthi for preparation of this guideline. The development and production of this document were coordinated and managed by Sr. Divisional Engineer Kiran darnal, Mr. Ganga Datta Nepal and Mr. Krishna Bhakta Maharjan. It is to be acknowledged the financial as well as technical support provided by the WHO Nepal to prepare this document under DfID funded project "Building adaptation to climate change in health in LDCs through resilient WASH."

Acronyms

CCA	Climate Change Adaptation
CM	Control Measures
CR-WSPs	Climate Resilient Water Safety Plans
DoLIDAR	Department of Local Infrastructure Development and Agriculture Roads
DWSS	Department of Water Supply and Sewerage
FCHV	Female Community Health Volunteer
FRC	Free Residual Chlorine
KUKL	Kathmandu Upatyaka Khanepani Limited
LDC	Least Developing Country
NDWQS	National Drinking Water Quality Standard
NTU	Nephelometric Turbidity Unit
NWSC	Nepal Water Supply Corporation
O&M	Operation and Maintenance
ODF	Open Defecation Free
PoU	Point of Use
RVT	Reservoir Tank
RWSSFDB	Rural Water Supply and Sanitation Fund Development Board
SODIS	Solar Disinfection
SOP	Standard Operating Procedure
VHW	Village Health Worker
VMW	Village Maintenance Worker
WASH	Water Sanitation and Hygiene
WHO	World Health Organization
WSMB	Water Supply Management Board
WSPs	Water Safety Plans
WUSC	Water Users and Sanitation Committee

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Chapter I
The WSPs: Water Safety Framework

1.1 Background

Access to safe drinking water is a basic need and is one of the most important contributors to public health. Under goal 6 of ensuring access to water and sanitation for all, the Sustainable Development Goals (SDG) has a target to achieve universal and equitable access to safe and affordable drinking water for all by 2030. During the revision of the World Health Organization (WHO) Guidelines for Drinking Water Quality leading to the 4th edition, 2011, the importance of the Water Safety Plan (WSP) approach has repeatedly been highlighted. The Water Safety Plan (WSP) can be implemented by those responsible for supplying safe drinking water to the consumers.

WHO Water Supply Statistics

Around 1.1 billion people globally lack access to improved water supply.

People living in developing countries in extreme conditions of poverty, normally peri-urban dwellers or rural inhabitants are most affected.

About 2 million people die every year due to diarrheal diseases; most of them are children less than 5 years of age.

Ref: www.who.int/water_sanitation_health/hygiene/en/

This guideline provides practical guidance to water supply practitioners implementing WSP in organized water supply entities and complements the broader WHO Guidelines for Drinking Water Quality 2011 (GDWQ) and National Drinking Water Quality Standards and Guidelines of Nepal 2006. According to the NDWQS implementing schedule, all the water supply providers, both rural and urban, are supposed to meet the standards within two phases each of five years respectively and prepare a water quality improvement plan within a year. As it did not materialize, there is a need of continuous monitoring, capacity building and advocacy to ensure that the standards are actually enforced as per the implementing guidelines and water quality be ensured for consumers.

The Water Safety Plan (WSP) Framework offers the most cost-effective and protective means of consistently assuring a supply of safe drinking water. They can be applied across a wide range of situations from household solutions to community water supply schemes to large water supply utilities. In the Guidelines for Drinking-Water Quality, the World Health Organization (WHO) identified five key components that are required to deliver safe drinking water:

Table 1.1: The WHO's Water Safety Framework

Component	Requirements
1. Setting Health-based Targets	Targets are based on an evaluation of health concerns and need to be set at a tolerable level for the community (e.g. are risk-based and can be coordinated with national guidelines, standards or WHO guidelines).
2. System Assessment	An assessment is conducted to characterize the water supply system, assess risks and to determine whether the drinking water supply (from source through treatment to the point of consumption) as a whole can deliver water that meets the health-based targets).
3. Operational Monitoring	Monitoring of the control measures in the drinking water supply that are of particular importance in securing drinking water safety. Monitoring at multiple points within the system, rather than relying on end-product monitoring, provides the supplier with assurance that unsafe product does not end up with the consumer.
4. Management Plans	Management plans are set up and encompass: • Documentation of the system assessment • Monitoring plans including normal and incident operations, upgrades, improvements and communication
5. Surveillance	A system of independent surveillance verifies that the above components are operating properly and effectively.

The WHO's water safety framework comprises five key elements of which the WSPs encompasses elements 2 to 4, as illustrated in Table 1.1. Within the context of the WHO water safety framework, the GDWQ provide a range of advice on the microbial, chemical, radiological and acceptability aspects of drinking water. The establishment of health-based targets and surveillance are more typically the responsibility of the health sector (Havelaar et al., 2003; Howard, 2002; WHO, 1997; WHO, 2011). In Nepalese context, it is Health authority, which is responsible for surveillance of drinking water quality.

1.2 General Considerations and Principles

Water is essential to sustain life, and a satisfactory (adequate, safe and accessible) supply must be available to all. Improving access to safe drinking water can result in tangible benefits to health. Every effort should be made to achieve drinking water that is as safe as practicable.

Safe drinking water does not represent any significant risk to health over a lifetime of consumption, including different sensitivities that may occur between life stages. Those at greatest risk of waterborne disease are infants and young children, people who are debilitated and the elderly, especially when living under unsanitary conditions. Those who are generally at risk of waterborne illness may need to take additional steps to protect themselves against exposure to water borne pathogens, such as boiling their drinking-water. Safe drinking water is required for all usual domestic purposes, including drinking, food preparation and personal hygiene.

The National Drinking Water Quality Standards (NDWQS) and Implementation Guidelines are intended to support the development and implementation of risk management strategies that will ensure the safety of drinking-water supplies through the control of hazardous constituents of water. The NDWQS describe reasonable minimum requirements of safe practice to protect the health of consumers and derive numerical values for constituents of water or indicators of water quality. When defining mandatory limits, it is preferable to consider the context of local or national environmental, social, economic and cultural conditions. The NDWQS should also be part of an overall health protection strategy that includes sanitation and other strategies, such as managing food contamination. This strategy would also normally be incorporated into a legislative and regulatory framework that adapts the standards to address local requirements and circumstances. The main reason for not promoting the adoption of international standards for drinking-water quality is the advantage provided by the use of a risk benefit approach (qualitative or quantitative) in the establishment of national standards and regulations. Further, the Guidelines are best used to promote an integrated

preventive management framework for safety applied from catchment to consumer. Diseases related to contamination of drinking water constitute a major burden on human health. Interventions to improve the quality of drinking water provide significant benefits to health.

A holistic approach to the risk assessment and risk management of a drinking water supply increases confidence in the safety of the drinking water. This approach entails systematic assessment of risks throughout a drinking water supply from the catchment and its source water through to the consumer and identification of the ways in which these risks can be managed, including methods to ensure that control measures are working effectively. It incorporates strategies to deal with day-to-day management of water quality, including upsets and failures. In this respect, climate change in the form of increased and more severe periods of drought or more intense rainfall events leading to flooding can have an impact on both the quality and the quantity of water and will require planning and management to minimize adverse impacts on drinking-water supplies. Climate change also needs to be considered in the light of demographic change, such as the continuing growth of cities, which itself brings significant challenges for drinking water supply.

1.3 Water Safety Plans

Overall control of the microbial and chemical quality of drinking-water requires the development of management plans that, when implemented, provide the basis for system protection and process control to ensure that numbers of pathogens and concentrations of chemicals present a negligible risk to public health and that water is acceptable to consumers. The management plan developed by water suppliers is the Water Safety Plan (WSP).

Water Safety Plan (WSP) can be defined as:

- A way of ensuring the safety of drinking water, through the use of a comprehensive risk assessment and risk management approach that covers all steps in water supply from catchment to consumer.
- The most effective means of consistently ensuring the safety of a drinking water supply.
- A method of ensuring water safety through a variety of interventions at households, community, water operators 'level, often with an excellent cost-benefit ratio.

WSP is needed for providing a preventive risk management system in water system and mitigating public health related hazards in everyday operating conditions and in emergency situations. WSPs are designed on the principle of Hazards Analysis and Critical Control Points (HACCP) and based on Multi Barrier Approach. The plans should address all aspects of the drinking-water supply and focus on the control of abstraction, treatment and delivery of drinking water.

Many drinking water supplies provide adequate safe drinking-water in the absence of formalized WSPs. Major benefits of developing and implementing a WSPS for these supplies include the systematic and detailed assessment and prioritization of hazards, the operational monitoring of barriers or control measures and improved documentation. In addition, a WSPS provides for an organized and structured system to minimize the chance of failure through oversight or lapse of management and for contingency plans to respond to system failures or unforeseen events that may have an impact on water quality, such as climate change and associated droughts, intense rainfall or flood events.

1.4 Nepal Context and Rationale

Nepal has achieved coverage of 87% of people having access to basic water supply services and 92% having a usable toilet (DWSS, 2017)). The national target is to achieve universal coverage in basic water supply and sanitation by 2017 with gradual improvement in qualities and service levels. Sustainability has been a major challenge. The Interim Constitution of Nepal-2007 states "Clean Environment, Water and Sanitation" and "Basic Health Care" as basic rights for its citizens. There are still challenges related to holistic sector policies, robust institution setup, coordination and harmonization avoiding duplications of efforts among sector, delineation of responsibilities for rural and urban.

There is consensus that the existing and future water supply and sanitation infrastructure assets are at risk from climate change (***see the box news***).

CLIMATE CHANGE MAY LEAD TO SEVERE WATER SHORTAGE IN NEPAL

WASHINGTON: Climate change, increase in agricultural land use and population growth may lead to severe water shortage in Nepal in the coming decades, according to a new study. Using a sophisticated modeling tool called the Soil and Water Assessment Tool (SWAT), researchers at the Baylor University were able to account for land use, soil types, topography and meteorology to predict future climate change and project snow-melt and stream flow to assess the effects of land use on water availability in Nepal. They found that climatic changes, increase in agricultural land use and population growth in the Himalaya Mountain basins could have negative impacts on water availability, further stressing a region plagued by natural disasters and food insecurity. The findings indicate that the region - especially during low flow seasons - may be at severe risk for water shortages. "This study is very important in a country like Nepal since the research is primarily focused for estimating the effects of potential climate variability and land-use changes on water flow processes of specific Himalaya Mountain systems. Water availability has become problematic due to changing climate and land management practices in this region," said the study's lead author Ram P **Neupane, a postdoctoral research associate at South Dakota State University.**

In a country where roughly 70 per cent of the population is dependent on agriculture, this could signal major problems for the most vulnerable in the region - those in poverty. "The Nepalese population in this region will face many challenges over the coming decades as soil degrades and water resources continue to place enormous strains on food production and intensify recent trends of subsequent malnutrition, particularly in young children," said Sara E Alexander, associate professor of anthropology in Baylor's College of Arts & Sciences and director of the Institute of Archaeology. "In mountain regions, continuing climate change exaggerates impacts of temperature and precipitation," said Joseph D White, professor of biology in Baylor's College of Arts & Sciences. "This research highlights how geography plays a role in what potential impacts climate change is having on stream flow and erosion in this steep landscape," Mr White said. "From west to east in Nepal, roughly equivalent to the distance between Lubbock and Houston, differences in land use practices emerge as an important factor for future water conservation efforts," Mr White added. "How people in Nepal are using what little land is available for food and habitation is very sensitive to changing water supplied by snow water, glacier melt and monsoonal precipitation," he said.

The study was published in the Journal of Hydrology.
Story First Published: October 20, 2015 18:28 IST

Climate change is emerging as a key challenge and is projected to have widespread adverse impacts including on human health. Increase in temperatures, changes in precipitation patterns and extreme events due to climate variability are expected to increase a range of health risks. Similarly water and sanitation infrastructure is at risk from climate change. As a result, it is felt necessary to make WATSAN infrastructure and management systems more resilient to future climate change.

There is robust and consistent evidence that populations with poor access to WASH suffer higher rates of water related diseases. The supply of poor quality of water is considered one of the major reasons of spreading of these diseases. Considering this, WHO Country Office for Nepal has been supporting Department of Water Supply and Sewerage to implement Water Safety Plan since 2008. At present, there are about 42,000 water supply schemes of various types and sizes in Nepal. It is planned that over the next few years, all of these schemes will adopt WSP. However, all new schemes, and any existing scheme that is being repaired or rehabilitated, should implement WSPS from beginning of construction.

Chapter II
Foundations of CR-WSPS Implementation

2.1 Roles and Responsibilities

The process of development, implementation and maintenance of a CR-WSP is primarily the role of the water supply operator or provider but generally requires support and involvement from a number of supporting and regulatory organizations. Therefore, initial steps of the WSP include:

1. Identify the organization leading the CR-WSP process
2. Gain commitment from other key organizations or stakeholders

Responsibilities for the CR-WSPs need to be clear and documented. For example:

- Where a single water supply organization is primarily responsible for managing a water supply system, that organization will lead the CR-WSP for that system;
- Where multiple water supply organizations are collectively responsible for different components of a water supply system, a joint working group or committee might be identified as the entity with the overall responsibility for leading the CR-WSP for that system. Alternatively, each water supply organization might take the lead for the component of the water supply system for which they are responsible, which is generally may not applicable in Nepalese context;
- The authority responsible for regulating water quality will typically need to be formally engaged in the process to confirm the health-based targets and other target criteria, such as customer service standards. In addition, the water quality regulator will need to commit to auditing and surveillance roles. The auditing role may be undertaken directly by the regulator or there may be a requirement for independent, third party audits; and
- The authorities responsible for regulating and/or managing source water quality, customer plumbing, water treatment and consumer management and use might also need to be involved to undertake relevant aspects of the CR-WSP for those water supply system components.

In our context, generally the prime responsibility of water supply system lies with only one organization and regulatory/ standards implementation and monitoring lies with the same organization. But surveillance responsibility as per NDWQS lies with Ministry of Health and Department of Health Services at central and District Public Health Office at district level.

However multidisciplinary agencies involvement is necessary for inclusion of new emerging issues like climate change impacts, disaster and emergency situations. In these cases, coordination might be necessary with other line agencies like Department of Hydrology and Meteorology, Department of Forestry, Department of Watershed Management, Department of Water Induced Disaster, Department of Environment etc.

There are three main stakeholders or groups directly concerned with the establishment/construction and operation and maintenance of a water supply system:

1. Supporting/regulatory/facilitating agencies. Examples are: Department of Water Supply and Sewerage (DWSS); Department of Local Infrastructure Development and Agriculture Roads (DoLIDAR); and Rural Water Supply and Sanitation Fund Development Board (RWSSFDB).
2. Water supply providers/Operators. Examples are: Nepal Water Supply Corporation (NWSC), Water Supply Management Boards (WSMB), Kathmandu Upatyaka Khanepani Limited (KUKL), Water Users and Sanitation Committee (WUSC), and
3. Committee of Users or beneficiaries of the water supply systems (WUSC).

2.2 Resource Commitment

At a very beginning, two important steps are necessary to implement and maintain CR-WSP:

1. Commit to CR-WSP implementation and maintenance
2. Identify and allocate the resources required

Experience shows that successfully developing, implementing and maintaining WSP requires a firm high-level commitment to the WSP and the allocation of adequate resources. A CR-WSP represents a significant responsibility that is shared by all relevant employees within a water supply organization. For example:

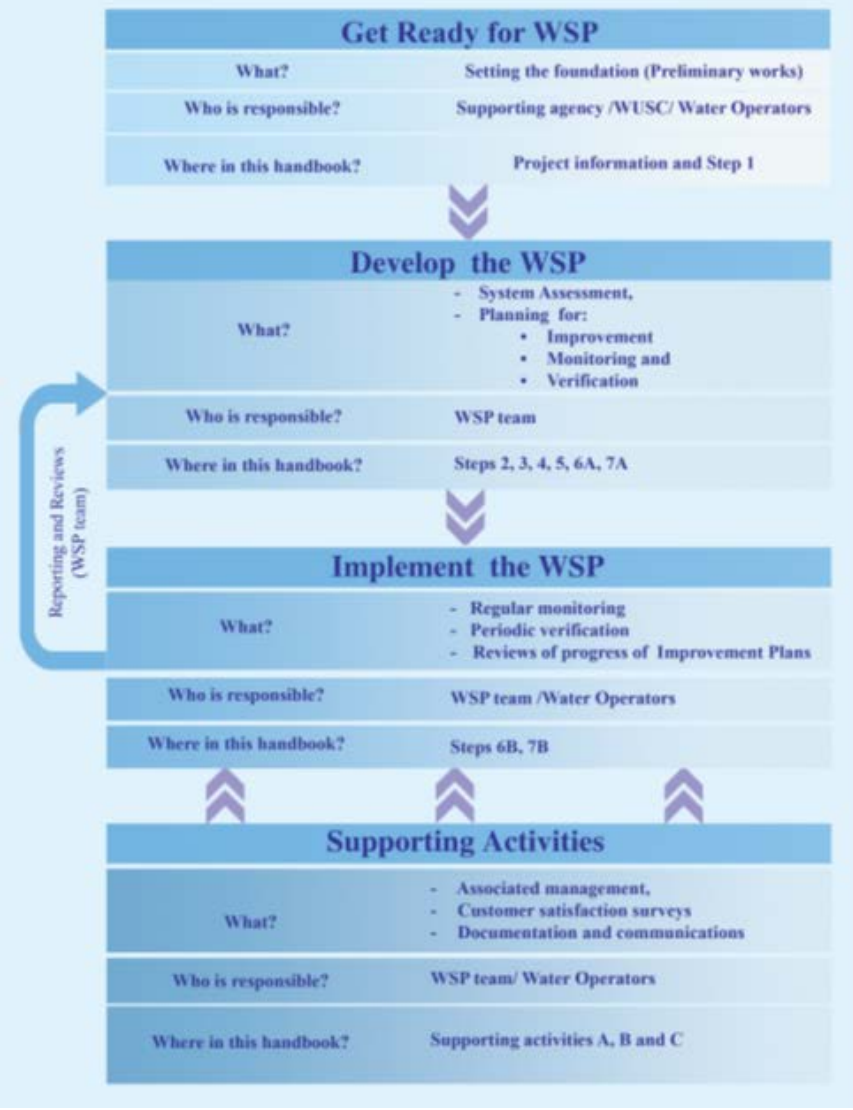
- Experience has shown that WSPs *development* and *implementation* takes many months and requires significant resources. However, *implementation* of CR-WSP within an organization requires genuine and strong commitment at all levels within that organization. At least one person within the water supply organization needs to be dedicated to coordinating the CR-WSP development and implementation process in a full time capacity. Many other employees will need to provide timely, significant and substantive inputs to the process to make it work;

- Experience has shown that WSP *maintenance* requires ongoing management attention to reinforce a culture of compliance with the requirements of the WSP. At least one person within the water supply organization needs to have the role of internal supervision to ensure that a CR- WSP is being implemented in practice. A person with sufficient authority needs to enforce compliance. While it may take several years until clear benefits emerge from CR-WSP implementation, water supply organizations, having implemented WSP have found that simply undergoing the WSP process has facilitated an improved understanding of their systems. Further, where regulators, such as Health departments have been involved in the WSPs process, communication links have been improved which ultimately flow on to improvements in system management. Water supply organizations have also found that a degree of organizational culture change may be required to ensure that the CR-WSP is adopted and implemented. In the medium to longer term however, the resource input is rewarded as the CR-WSP leads to efficiencies and better understanding of the water supply system including producing water of a quality that consistently meets the health-based targets.

Chapter III
Foundations of CR-WSPS Implementation

The WSP process can be broadly divided into three major components and few supporting activities as shown in Fig. 1. These three major components are:

A. Get Ready for WSP
B. Develop the WSP
C. Implement the WSP



The WSP process is implemented through 7 steps and 3 supporting activities. These are described in more detail as below.

3.1 Step 1: WSPs Team Formation

The WSPs team would typically comprise of at least 7 persons (7-9 members) including one of the members of water users and sanitation committee (WUSC) or key staff member of water supply provider/operators' organization as the coordinator. Other members should represent the staff involved in day to-day operation, consumers from different clusters within the service area and the stakeholders from education, health sectors. Persons with knowledge of local climate change should be included, who may be a science teacher from nearby school/college, staff of nearby meteorological station, etc. Any environmentalist or local person with good knowledge on historical change in the community, water quality can be included in the team. The women representation as far as practical should be one-third in the team.

This step involves assembling a team of individuals and stakeholders with the collective responsibility for understanding the water supply system and identifying hazards. In general the team will be a working party or taskforce that is collectively responsible for developing, implementing and maintaining the WSP. In addition, the team needs to have the authority to ensure the implementation and management of controls so that the WSP can be implemented smoothly.

In setting up the team, the following checklist points will need to be considered to ensure that an appropriate team mix is achieved:

- Technical expertise and operational system-specific experience required to develop the WSPs;
- Capacity and availability to undertake the WSPs development, implementation and maintenance;
- Organizational authority to report through to the relevant controlling authorities, such as the Executive of an organization, or leaders of a community;
- Understanding of the organizational and people management systems and processes that turn plans into actions and that communicate the results of monitoring and reporting;
- Understanding the health based targets to be met;
- General appreciation of the water quality needs of the end users;
- Understanding of the practical aspects of implementing WSPs in the appropriate operational context;
- Understanding of Climate issues, DRR/CCA and impact in water supply system and WQ
- Appreciation of the regulatory and policy environment of the organization, have knowledge of NDWQS of Nepal; and
- Familiarity with training and awareness programs.

Depending on the size of a water supply organization, and where organizations are responsible for multiple systems, it may be necessary to have multiple WSPs working groups, which report to a central team. The usefulness of this arrangement needs to be assessed at the commencement of the process but may include:

- A core team;
- Subordinate working groups that undertake particular aspects of the WSPs, such as a 'catchment', 'source water', 'treatment' and 'distribution system' working group and if necessary, where treatment aspects are complicated and varied for instance, it may be advantageous to have separate treatment teams; and
- External team members and reviewers (incorporating government agents and independent experts).

The typical roles and responsibility of a WSPs team is given in **Annex 1**.

*Use **Form 1** to record detailed information (name, affiliated organization, roles and responsibility, contact address etc.) on the composition of the WSP team.*

3.2 Step 2: Water Supply System Analysis

Documentation of the nature of the water quality and of the system used to produce water of that quality is important to ensure that hazards and risks are adequately assessed and managed. This step is for collecting sufficient information to describe the system and to understand the subsequent water quality risk assessment, and identify where the system is vulnerable to the hazardous events.

A detailed description of the water supply should include:

- The source of water including the runoff and/or recharges processes;
- If the water is stored or treated anywhere and how;
- What is added to the water;
- How the water is distributed;
- Potential climate induced disasters that may affect water quality;
- A water quality specification for each type of water produced e.g. for some systems, treated and raw water will be produced by the water supply organization and this information needs to be documented as different water quality targets will apply.

A detailed description of the water supply system is required to support the subsequent risk assessment process. Pertinent information on the system should be assembled and made readily available for use during that process. The description should include:

- Sufficient information to identify relevant types of hazards and controls;
- Regulatory water quality requirements;
- Chemicals or materials that are added to the water; and
- Climate resilient structures and arrangements

Form 2A, the community map includes main system and catchment features (source, pipeline and other structural components) of the water supply scheme and features of the service area like major roads, junction, river, forest. As far as possible, the area vulnerable to hazardous events, climate change affected structures should be indicated on this map.

Form 2B includes the process flow (flow chart of the water supply system) showing the discharge and direction of flow as well as the changes in the water quality parameters at various points especially at intake, inlet and outlet of the treatment plant, outlet of the reservoir, and at the taps or consumer's premises.

Form 2C should discuss the salient features of all components from the catchment to consumers. Physical features of the components as well as intended use of water, persistent water quality degradation and customers' water handling practice should be noted in this form at the relevant rows. While describing the physical features of the main structures/ equipment particularly for catchment area, it is suggested to describe their surroundings or the immediate vicinity. This may be helpful to indicate or identify the possibility of hazard or hazardous events. All the human or natural activities in the catchment areas should be discussed that can influence the water quality considering both normal and possible abnormal conditions/situations. The hazards and hazardous events due to climate change are also to be included specifically.

3.3 Step 3: Identification of Hazard and Hazardous Events & Risk Analysis of Hazard

Hazards are defined as:

- Physical, biological or chemical agents that can cause harm to public health.

Hazardous events are defined as:

- An event that introduces hazards to, or fails to remove them from, the water supply.

The objectives of this step are:

- To identify all potential biological, physical and chemical hazards that are associated with the drinking water supply;
- To document all potential hazards due to climate change, variations, disasters, emergency situations
- To identify the hazardous events that can result in hazards gaining entry to the water supply "What could happen here or what could go wrong here?"

Identification of hazard and hazardous events starts with inquisitive frame-of-mind by raising questions like:

1. What could go wrong here?
2. How could it go wrong?
3. Where and when could something wrong happen in the water system?

This step involves listing not only the past events affecting the quality of water, but ones that may occur in the future. Desktop studies, interaction with users about the historical events related to the water supply operations, analysis of flow diagram, site visits and inspections of the system components all help to identify the hazards and its causes.

When the hazardous events are well and clearly described, control measures become more specific.

In **Form 3-4**, in *Column 1*, describes hazardous event (properly as shown in the example) with considerations of climate change, disaster events, etc..

3.3.1 Risk Prioritization

Because a number of hazards or hazardous events may occur at any one step, it is important to decide whether any of these events present a significant risk and need to be elevated for action. A risk assessment process is therefore required to prioritize the events. The prioritization of climate change impacts on water system components, water quality and safety of water is utmost necessary.

The risk assessment process can involve a quantitative or semi-quantitative approach (estimation of Consequence/ Likelihood and Frequency/Severity) or a simple team decision to rule hazardous events in or out. A relatively small water supply system may only require a team decision approach to rule events in or out (this is applicable and included in CR-WSPs guideline for rural water supply).

A more complex system may benefit from a semi-quantitative risk prioritization approach. In either case, it is beneficial to record the basis of the decision as this acts as a reminder to the team and/or an auditor or reviewer, on why a particular decision was taken at the time.

The following checklist for risk prioritization can be used to help direct thinking:

- Decide on a consistent risk assessment methodology upfront;
- Be specific about what the risk is in terms of:
  - Risk of a specific event;
  - Leading to a specific hazard;
  - Reaching a specific and problematic concentration; and
  - At a specific point in time and space.
- Treat control measure failure as a separate hazard event in its own right and with its own likelihood and consequence.

The following sections detail the risk prioritization methods that can be used.

3.3.2 Risk Prioritization Method: Simple Team Decision

This method involves using the team's judgement to:

- Assess the hazardous event/s at each step in the process;
- Determine whether they are under control; and
- To document whether those events need *urgent attention*.

This is basically done for Basic CR-WSPs for rural system. The NZ MoH (2005) defines 'urgent attention' as those things that happen a lot and/or could cause significant illness. The descriptors listed in the Table 3.1 below can be used to capture this information.

3.3.3 Risk Definition

Risk is:

- The likelihood of identified hazards causing harm in exposed populations in a specified timeframe including the magnitude of that harm and/or the consequences; or

Table 3.1: Simple risk prioritization

Description	Meaning	Notes
Significant	Clearly a priority	The risk should be considered further by the team to define whether additional control measures are required and whether a particular process step should be elevated to a key control point in the system.
Uncertain	Unsure if event is or is not a significant risk	The risk may require further studies to understand if the event really is a significant risk or not. An example of an uncertain risk includes endocrine disruptors for which it is suggested that a watching brief be kept.
Insignificant	Clearly not a priority	Note that the risk will be described and documented as part of a transparent and diligent process and will be revisited in future years as part of the WSPs rolling review

Annex 2 gives some tips to identify hazards and hazardous event at different components of the water supply system. Another important task in this step is to analyze the risk. The risk score can be determined considering the frequency of occurrence (i.e. its likelihood) and the severity of the impact (i.e. its consequence) of the hazardous event.

There are many ways to analyze the risk, but it is suggested to use the semi-quantitative approach given in the 3x3 matrix in the **Annex 3**.

To use this approach: fill in risk score (likelihood and consequences) and level in *Column 2 and 3* of the **Form 3 - 4**. The climate change related hazards and hazardous events could be included in this score rather than giving separate dimensions.

At this stage risk score is determined without considering the affect of the existing control measures (CM). CMs are described in the next step (**Step 4**).

3.4 Step 4: Control Measures

Control measures (CM) are the actions/activity (or barrier) to prevent or eliminate a water safety hazard, or reduce the risk of a hazardous event to an acceptable level. Identifying control measures and ascertaining their capability to work

effectively in meeting water quality targets, or preventing contamination is the basic task in this step. **Annex 3-4** gives a few tips to identify control measures. It is recommended that for all kinds of treatment plants, you should justify it as control measures and record it in the WSP. The control measures for hazards due to climate change activities need to be specified.

Record all the existing control measures in *Column 4* of **Form 3-4.** Then determine the reduction in risk score and level in *Column 5 and 6*. If there is a need for further improvement of the existing control measure, or even a need to establish totally new control measure, indicate this in *Col 7* by saying only "Yes" (i.e. if there is a need to improve or create a new control measure). If the existing control measure satisfactory manages the risk, then say "No" in *Col. 7*. In this case Step 5 can be omitted.

The WSP team is responsible to assess if any improvements needed in an existing CM or if any new CM is required. Control measure improvements or new CMs established must reduce the risk further; otherwise there is no use of it.

While assessing the functional status of the control measures, if a new CM or an improvement in existing CM is needed, then it is necessary to develop and implement an Improvement Plan (**See Step 5**). The Improvement Plan must link with the "Yes" of *Col 7*. In other case, where existing control measures are in good condition, and working perfectly, then it is only necessary to monitor them (see **Step 6**).

3.5 Step 5: Improvement Plan

New control measures or improvement in the existing CMs should be prioritized on the basis of risk score obtained in Step 3 and Step 4. So there is linkage between **Form 3-4** and **Form 5**. Control measures that reduce the risk level from high to low should be given first priority for the implementation. However, in some cases, such priority may not be feasible due to lack of resources (for example lack of finance and manpower).

For preparing improvement plan use **Form 5**.

1. In ***Col 1***, briefly record the corresponding hazardous event for every row in Column 7 of Form 3-4 with “Yes”.

2. Then list the proposed improvement of works (change to existing CM) or new CM in ***Col 2*** of the form 5.

3. In ***Col 3*** and in ***Col 4***, record the assumed risk which would occur after the introduction of the new CM or after improving the existing CM.

4. **Cols *5-8*** are used to record further information about the improvement plan. Control measures should not be limited to only longer-term actions (*Col. 7*), but options should be given until for immediate action (*Col. 6*). The Improvement Plan should include the improvement works (new control measure, change to existing control measure), the person responsible to carry out the improvement, the estimated cost, and time frame to complete it.

3.6 Step 6: Monitoring

Another important step in WSP process is monitoring. In this section, the key WSPs step to be worked through is:

1. Define monitoring of control measures
2. Define corrective actions

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 measure is 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. ‘Monitoring’ may also comprise verification. The monitoring also should include general components that are working other than where CM, improvement activities and new CM are applied. This is because with due course of time, working components might go wrong at any time and may need corrections.

3.6.1 Operational Monitoring and Selection of Operational Control Parameters

Operational monitoring is the act of conducting a planned sequence of observations or measurements, to assess whether the control measures applied at a point in the system are achieving their objectives.

Effective monitoring relies on establishing:

- What will be monitored;
- How it will be monitored;
- Where it will be monitored;
- When it will be monitored;
- Who will do the monitoring

In most cases, routine operational monitoring will be based on simple surrogate observations or tests, such as turbidity or structural integrity, rather than complex microbial or chemical tests.

In defining operational monitoring, consider the following checklist:

- Have limits been defined for the control measure?
- Can the parameter be measured in a timely fashion (monitoring needs to be in line with the speed with which the barrier can fail – critical processes would ideally be on-line, less critical processes could be monitored monthly for instance)?
- Can corrective actions be implemented in response to the detected deviations?
- Has the list of hazardous events and hazards been checked against monitoring to ensure that all significant risks can be controlled?

Step 6A: Monitoring Plan

A Monitoring Plan should be made with a clear indication of what, who, when and how to monitor the control measures.

Form 6A is used for to plan what monitoring will be undertaken in Step 6B. This form applies to the operational monitoring carried out by the regular staff like plumber, technician or lab technicians.

All existing and new CMs should be recorded in the *Col. 1* of Form 6A, while other procedural information is given in *Col 2-5*. Under the *Column 6* "Operational Limit" a criteria, which separates acceptability from unacceptability, should be clearly mentioned. In *Column 7*, note what to do when the operational limit is exceeded.

Step 6B: Regular Monitoring

Regular monitoring is aimed at ensuring that the control measures are in place and functioning well. All control measures should be regularly monitored. Regular monitoring should be the day-to-day work of the operator of all working components including the CM applied. Monitoring works carried out by staff should be recorded in a logbook as shown in the sample **Form 6B**.

3.7 Step 7: Verification

Verification is the application of test or other evaluation methods to determine whether the system is delivering the water of the desired quality or not. It also refers to assessing the effectiveness of WSP being implemented in practice. Normally, testing of water quality by some kind of equipment is done in verification. Observations can be done to confirm if the operational monitoring is properly being done or not.

Step 7A: Development of Verification Plan

Form 7A relates to the verification plan. The WSP team prepares the plan to record when and what parameters have to be tested to check the quality of water. Col. 1 records the sampling point. *Col. 2* records how often (frequency) the verification will be done. *Col. 3* to *Col. 7* record the testing frequency of the water quality parameters. The parameters given here are just for example, there may be more or less parameters as appropriate for the system.

When preparing **Form 7A**, consider the issues discussed in **Step 7B.**

Step 7B: Periodic Verification

Inspection/observation of the system components especially the CM and water quality testing at various points may help verify that WSP has achieved its target. Periodic verification by the WSP team or the water operator itself can be termed as an "internal audit of WSP". The same task may be performed by the external agencies related to Ministry of Health – in which case it may be known as "water quality surveillance".

In urban water supply scheme, additional testing for those parameters prevalent in the region may take place. Verification with water quality testing can be as frequent as the laboratory facility allows. Water quality surveillance by the external agencies like health agencies can be done by auditing the WSP reports and cross checking the water quality test reports or conducting quality test and inspection of control measures by itself.

Form 7B to be used to record the results of the verification. A logbook should be prepared to record all the verification data.

Supporting Tools and Activities

1. **Management and support to WSPs**

   WSP activities mentioned in previous steps can be made more effective and fruitful with other supportive programs like training and support to capacity development of water users committee/utility to prepare Standard Operating Procedures (SOP) (particularly crucial for treatment plants), emergency management plans etc. Record this on **Form 8**.

2. **Users (Customer) satisfaction survey**

   Users' satisfaction surveys serve as a tool to find out the effectiveness of the WSP. They help water suppliers (WUSC/utility) to find out consumer's perceptions on the water quality, their confidence on the quality of supplied water, and the water consumption behavior. It also forms the basis of the approaches to be taken for awareness raising programs supporting the WSP implementation.

   Form 9A and 9B gives the outline of the information to be taken during such surveys. At least 20% HH in each cluster should be visited and information to be taken using the questionnaire given in **Form 9**. The details of incidence of water borne diseases may be taken from the Health post/center and recorded. These data are also helpful when verifying the WSP. The users' satisfaction survey taken before implementation of WSP will be helpful to compare the performance of the system.

3. **Documentation and Review of WSPs**

   Implementation of WSPs is not a onetime event. It is a continuous process, which should be reviewed time to time to ensure that WSP is up-to-date and appropriate to water operators. It is recommended that a planned review take place at least once every 6 months.

In addition to the regular planned review, it is also necessary when certain changes in the system take place like establishment of new intake or source development, installation of treatment units or any other incidence affecting the water quality. For this, all activities carried out need to be well recorded and presented and documented. The climate induced disasters and repairs activities need to be documented for future precautions and planning purpose. The threats

from other external factors such as pesticide use in agriculture, landslides, floods, natural calamities and impact on the WATSAN structures need to be documented.

Documentation of all aspects of drinking water quality management is essential. Documents should describe activities that are undertaken and how procedures are performed. They should also include detailed information on:

- Assessment of the drinking water system (including flow diagrams and potential hazards);
- Variation in water quality and discharge with meteorological data, flood events, disaster records, impact, source diversion, reduction
- Control measures and operational monitoring and verification plan;
- Routine operation and management procedures;
- Incident and emergency response plans; and
- Supporting measures, including:
    - Training programmes
    - Research and development if any
    - Procedures for evaluating results and reporting
    - Performance evaluations, audits and reviews
    - Communication protocols
    - Community consultation and awareness.

Documentation

Documentation pertaining to the WSP should include the elements set out in the following checklist:

- Description and assessment of the drinking water system including programmes to upgrade and improve existing water delivery of system elements;
- The plan for operational monitoring and verification of the drinking water system;
- Water safety management procedures for normal operation, incidents (specific and unforeseen) and emergency situations; and
- Description of supporting programmes.

In setting up documentation, it is preferable to interview staff to try and capture as much of their activity as possible rather than develop the documentation in isolation. This approach helps to foster ownership and eventual implementation of the procedures.

Records

Records are a necessary element of the WSP as they can be reviewed (through internal and external audit) to identify whether the WSP is adequate and also, to demonstrate adherence of the drinking water system to the WSP. The following checklist should be considered when developing records:

- Documents and records must be retained to provide an auditable system;
- Records need to include product identification, operational and critical limits and signatures;
- A system for capturing and recording completion of improvement actions is required;
- Corrective action records must correlate to monitoring records and include a description of the problem as well as record the method of contaminated water segregation and disposition; and
- Records should be reviewed at appropriate intervals to identify any trends that may indicate the need for preventative action and/or review of the WSPs.

Table 3.2: Examples of WSPs Records (adapted from Stevens et al, 2004)

Requirement	Component
Must contain	A complete WSP document
	WSP team information
	Process flow diagrams and including identifying control measures
	Description of the supply system, intended use and water quality requirements
	Operational monitoring procedures for control measures
	Hazard identification
	Contingency plans
Should contain	Supplier agreements for suppliers that are being relied upon to provide goods or services that influence water quality
	Detailed specifications for chemicals and materials used in the water supply system
	Job descriptions for those holding principal accountabilities for operating the water supply system
	Corrective action plans for deviations detected from operational monitoring
	Record-keeping requirements
	Verification and validation data for control measures and for the system as a whole
	Procedures for verification and revision of the WSP
May contain	Operational manuals such as for line hygiene, preventative maintenance, and equipment calibration
	Job descriptions and accountabilities for all staff
	Training programme and records for all staff
	Findings and corrective actions from previous audits (including verification procedures)
	Consumer complaint policy and procedure if any

Communication Strategies

Effective communication strategies are essential for mitigating risk. The following is a checklist for communication strategies:

- Procedures for promptly advising of any significant incidents with the drinking water supply, including notification of the public health authority;
- Summary information to be made available to consumers – for example, through annual reports and on the internet; and
- Establishment of mechanisms to receive and actively address community complaints in a timely fashion.

Chapter IV
Information and Formats

4.1 Introduction of the WS Project/Scheme:

A. **1. Project Information**
Name of the project:
1. District: Municipality/Village: Ward No:
2. Number of Households: **3.** Population: **4.** Daily water supply (l):
5. Year of operation: Is there a water treatment unit? Yes No If yes, year of operation?
6. Number of Taps: Private: Public/Community: Institutional: (School/Health Post, VDC Office):
7. Is there any area declared as ODF in project area? Yes No If yes, when was it declared? If not how many HH have toilets (in %)? Is there any target to ODF? If yes by which time is expected to meet? (Date)
8. Hours of water distribution in a day: Time and duration: Morning: Evening:

B. Description of the scheme
1.Intakes: Name type: stream/spring/tube well of Capacity (l/s) a) b) c)
2.Number of reservoir: Reservoir description Type: Elevated/ underground, capacity (l) a) b) c)
3.Distance between intake and reservoir: m or km
4. Which type of treatment units in place? a) Sedimentation tank b) Roughing filter c) Slow sand filter d) Pressure filter e) any other type
5. Is there chlorine dosing unit? Yes No ……. If yes which type? Daily consumption of bleaching powder or chlorine kg or l:
6. Is FRC test carried out? Yes No What is the frequency of test? and location of test?
7. How long is the pipeline? Transmission main: Distribution:

8. Number of BPTs: Number of valve chambers:
9. Any bypass mechanism installed in case of emergency at intake, reservoir, treatment plant?

C. Operation & maintenance
1.Is WUSC formed? Yes No. Is WUSC registered at district water resources committee? Yes No. Does WUC hold regular meeting ? How often meeting takes place?
2. How do users get information about water distribution time?
3. Briefly describe the alternate source, if any to fulfill the demand.
4. Has anybody in the service area participated in training on water quality?
5. For a pumping scheme, is there alternate source of energy at the time of load shedding (when no electricity)?
6. Are there technicians (engineer, sub-engineer) in the project? Or from where technical advice is taken? Any member related with climate change in the WSPS team?
7. Is there map of full system available for observation? Yes No. If "yes", where is it placed? Any vulnerable points indicated in the map? Yes No
8. How many staff are there? Technical staff : Other staff:
9. Is there regular maintenance of the scheme? If "yes", how and by whom is it maintained? Any specific responsibility given?
10. Is there a checklist of works related to operation and maintenance of the scheme? If "yes", is there record-keeping of such works done? a. Any record of damage of intake/catchment due to flood, landslide? b. Any record of decline in water discharge during dry period? c. Any record of pipeline bursting due to frost or landslide or over discharge? d. Any record of failure of treatment plant and bypass necessary at other structures?

D.	**Financial status of the project**
1.	How much is the water tariff? Monthly? Connection charge?
Connection charge Rs: Monthly tariff(min) Rs: additional charges: If there is different rate for people residing from the very beginning of water supply project, compared to for people migrating during or after the project construction, please mention.	
2.	What is the average monthly income of the project?
3.	What is the monthly expenditure? Staff: Electricity: Repair/maintenance: Major repair: other: Total:
4.	Net profit per month in Rs.
5.	Bank balance, Rs: as of the date:
6.	Is there extension of distribution pipeline? If yes, how much?

E.	**Water Quality of the project**
1.Water quality at source: Clear , Turbid iron bacteria other 1a. Is WUSC aware of NDWQS, 2005?	
2. How frequently intake is cleaned and well maintained? Daily, Weekly, Fortnightly, Monthly, Yearly	
3. Is there frequent problem of pipe leakage or bursting out? Daily, Weekly, Fortnightly Monthly, Yearly	
4. Is water quality tested? If "yes" when was it done? How was the test result? 4a. Are there any problems due to quality of raw/supplied water? If yes, what kind When it prevails?	
5. Does WUSC possess water quality test kits, if yes which kind?	
6. Are the kits in use?	
7. How do people drink water supplied from the system? a. directly from tap b. after boiling c. after using other kinds of HH level (PoU) treatment methods	
8. Was there any incidence of diarrhea in the service area in the last year? If "yes", How many incidence? How many deaths?	

9. How, in general, is the water quality of the distributed water? 9a. Does Water Quality comply with NDWQS 2005?
10. Is there any other program to improve the water quality?

F. **Additional Information, if any.**

Table 4.1: Users Satisfaction Survey (to be done prior to WSP)

Date:

Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8
SN	Questionnaire	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Average
1	Are Users aware of importance of water quality on public health?						
2	What users think about safety measures of water from source to taps?						
3	Is the intake or other structure safe from landslide or flood?						
4	Is the pipeline safe during landslide or frost?						
5	Do you get enough water during dry period?						
6	Are the Users 'complains area addressed by the supplier?						
7	Are Users' satisfied with the tariff (reasonable with the service)?						
8	Do Users' think that system is maintained or improved during emergency and other abnormal incidents?						
9	Has anyone in the family suffered from water-borne diseases in the last 15 days? Disease (Percentage of household saying "yes")						
	i. Cholera						
	ii. Typhoid						
	iii. Diarrhea						
	iv. Dysentery						
	v. Worms/Helminthes						
	vi. Jaundice						
	vii. Others if any						

Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8
SN	Questionnaire	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Average
10	How do you treat water fetched from tap before drinking? (Percentage of Household)						
	i. Do Nothing						
	ii. Boling						
	iii. Use Chlorine						
	iv. Filter						
	v. Use SODIS (Solar disinfection)						
	vi. Other Methods						

Note: Well representation (Not less than 25%) of HHs should be covered during survey in each cluster. The individual answer sheet from HHs may be attached in the WSPs document. Answer in the above table to be given in percentage of HH saying "Yes"

B. Information regarding water borne disease (from Health Post or District Health Office):

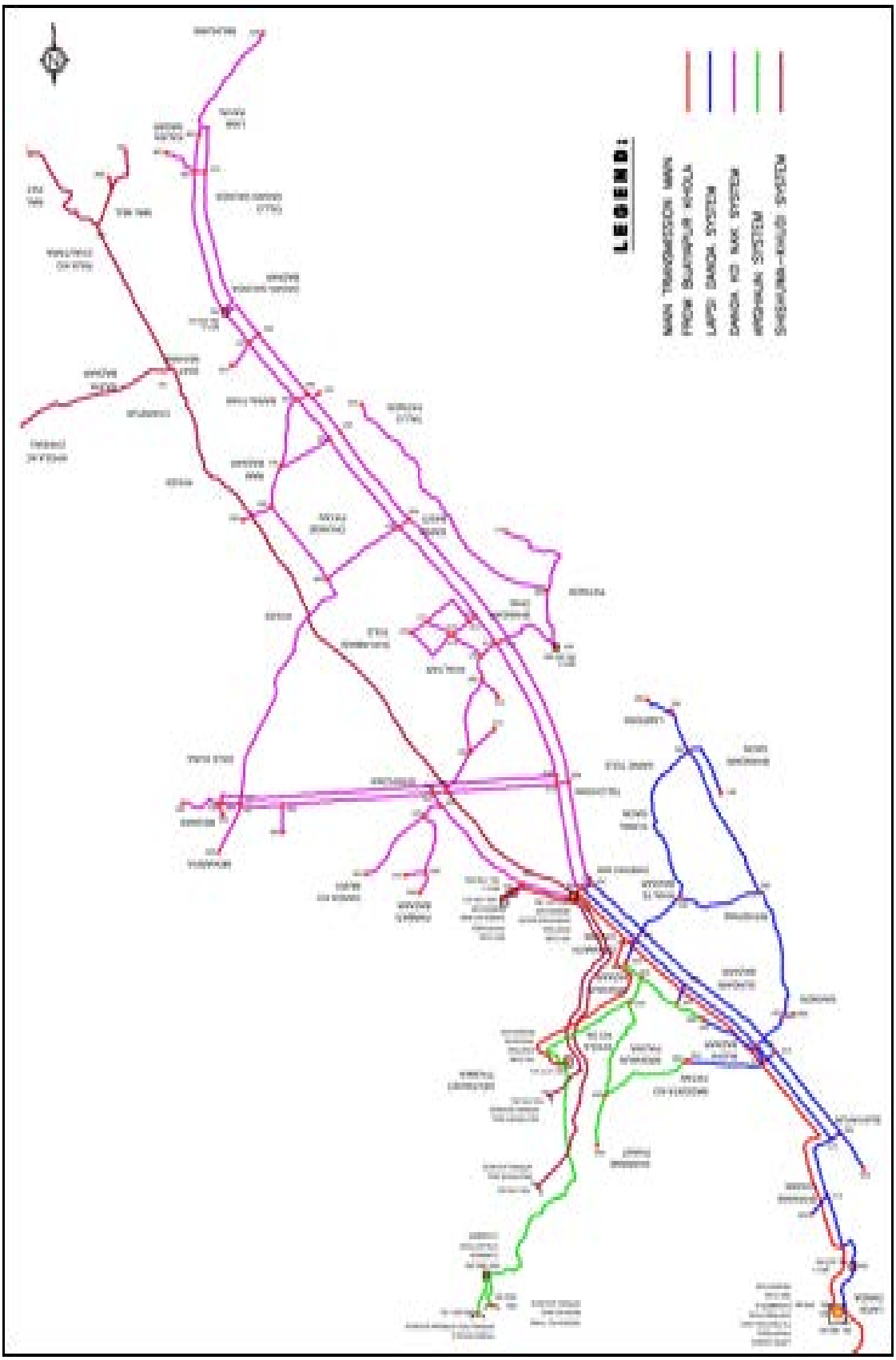
.....
.....

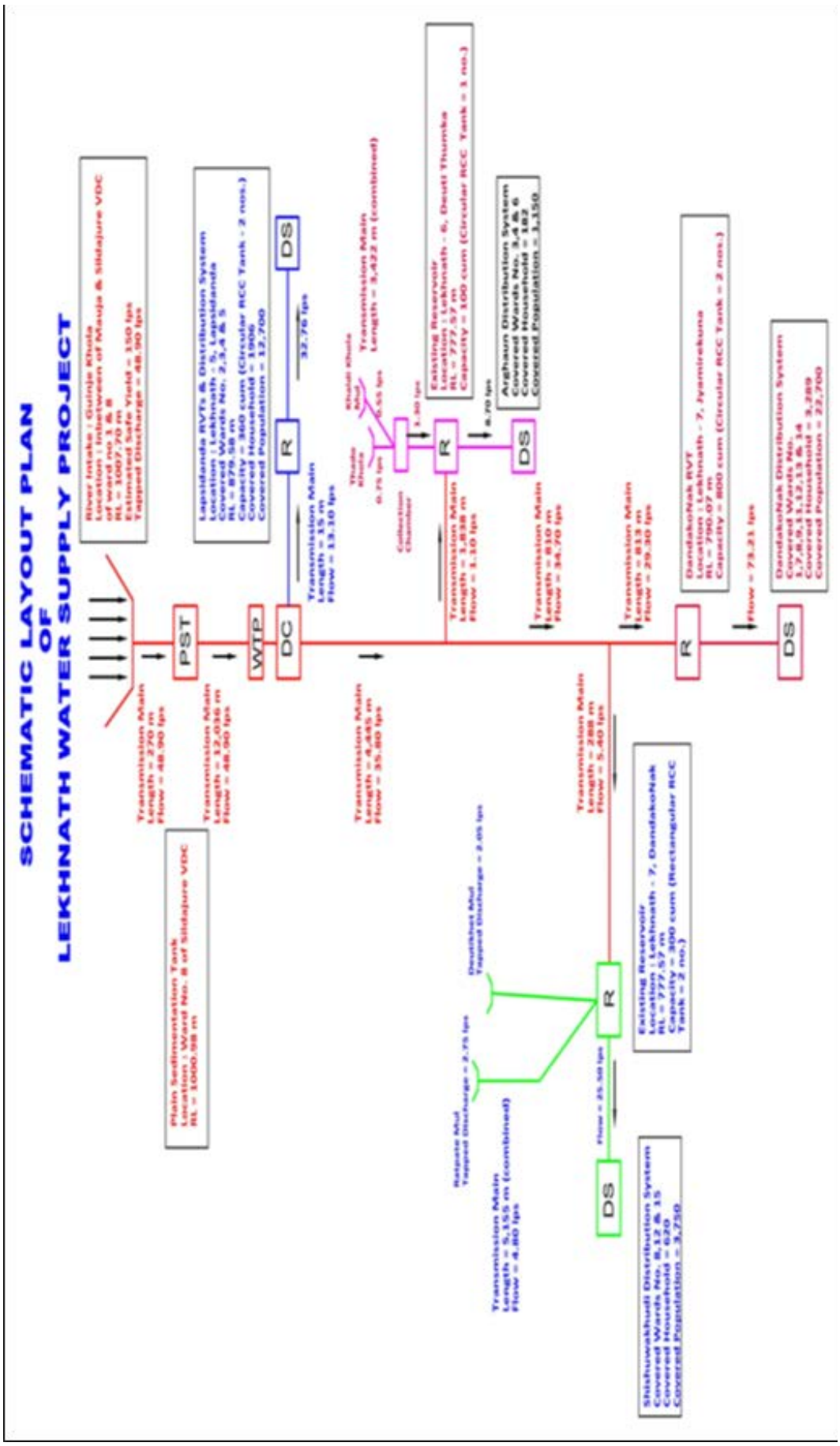
Form 1: Water Safety Plan Team

Col.1	Col.2	Col.3	Col.4	Col.5	Col.6
S.No	**Name**	**Position**	**Affiliated organization and designation**	**Role/Responsibility**	**Contact Address/Tel.**
1	*Ms……*	*Coordinator*	*WUSC, Member*		
2	*Mr……*	*Member*	*------School, Science, EPH Teacher*		
3	*Mr……*	*Member*	*……..Meteorological Station*		
4	*Ms……*	*Member*	*……Forest User Committee*		
5	*Ms……*	*Member*	*CCA or DRR committee member of DDC*		
6	*Ms……*	*Member*	*Retired GoN employee of Department of Hydrology and Meteorology*		
7	*Mr……*	*Member*	*Retired GoN employee of Department of Forest and Soil Conservation*		
8	*Ms……*	*Member*	*Retired GoN employee of Department of Water Supply and Sewerage*		
9	*Mr……*	*Member*	*Retired GoN employee of Department of Environment*		
10	*Mr……*	*Member*			
11	*Ms……*	*Member*			

Note: The affiliated organizations provided here are just for examples; all of the personnel may not be available or applicable and depend upon specific water supply system. The inclusion of members from various disciplines and experts related with climate change is necessary so that climate resilient WSP could be implemented properly. The stakeholders of water system may be well represented in the WSP team in coordination with the WUSC or operator of water system.

Form 2A: Water Supply Scheme Analysis: Community map (Example)





Form 2B: Water Supply Scheme Analysis: Flow Chart (Example)

Form 2C: Water Supply Scheme Analysis: Main components

Col.1	Col. 2
SN	Name and detail of components
1.	Catchment/Source (Discuss activity influence the water quality normal and abnormal cases, during rainy season, flood, landslide, pesticide use in agriculture field up-stream of catchment and any possible contamination from settlement existing)
2.	Intake (type, safe yield, Protection work against flood, landslide, if any, O & M practices). Any diversion during emergency incidents
3.	Transmission and Distribution Pipeline (length, pipe type and sizes, crossing and possible hazardous events, bursting of pipe due to landslide, flood, frost)
4.	Treatment Plant/Reservoir (location, type, capacity and more information related to possible hazardous events, water quality during rainy season, storage during dry period, algal blooming, eutrophication in ponds)
5.	Consumers Point (Tap stand) (private, public, maintenance and other information)
5.1	Water Use (Domestic, Irrigation, cottage industry……..)
5.2	Water Use Practices (Storage vessel, Storage tank, Fetching behaviours, internal plumbing….)

Form 3-4: Hazard Identification, Risk Analysis and Control Measures

Col. 1	**Col. 2**			**Col. 3**	**Col. 4**	**Col. 5**			**Col. 6**	**Col. 7**
Source and type of Contamination (Hazardous Event)[1]	Risk assessment (before consideration of the impact of the existing control measures (CMs) (Refer annex 1)				Existing control measures only Risk Level	Risk with Control Measure (Reassessment of Risk)				Is there a need for new CM or Improvement, if Yes then go to Form 5, if No then go to Form 6(a)
	Score 1-9			Level (low, medium or high)		Risk score			Risk Level	
	Likelihood	Consequences	Score			Likelihood	Consequences	Score		
Source/catchments area/ Intake/Deep Boring:										
1. *Water gets contaminated due to cattle g.razing in the vicinity of intake – (microbial contamination)*	*3*	*3*	*9*	*High*	*Fencing around the intake*	*1*	*3*	*3*	*Medium*	*Yes*
2. *Water gets contaminated due to turbidity from landslides/floods*	*2*	*3*	*6*	*High*	*Protection of intake*	*1*	*3*	*3*	*Medium*	*Yes*
3. *Sediment collection, Collapse of intake structure*	*3*	*3*	*9*	*High*	*Diversion channel*	*1*	*3*	*3*	*Medium*	*Yes*
Pipelines										
1. Cracks and rupture due to increased temperatures, Leakage and poor delivery	*3*	*3*	*9*	*High*	*Protect and provide concrete/steel casing with abutments to the transmission pipelines laid along the historic landslide zones*	*1*	*3*	*3*	*Medium*	*Yes*

[1]Include only those hazardous event which happened before the control measure in place or might happen in future

Reservoir/ Treatment plant										
1. Because of turbidity, pressure filter doesn't work properly (overloaded) which makes water biological & physical hazardous.	*3*	*3*	*9*	*High*	*We don't use pressure filter during this time we bypass the water from filter and not supply too users.*	*1*	*1*	*1*	*Low*	*Yes*
2. Chance of over and under chlorination.	*2*	*2*	*4*	*Medium*	*Develop pre chlorination system.*	*1*	*1*	*1*	*Low*	*Yes*
3. Intermittent supply leads to biological hazardous from the point of leakages.	*2*	*2*	*4*	*Medium*	*Manage 24 hrs water supply.*	*1*	*1*	*1*	*Low*	*Yes*
4. Difficult to maintain FRC level at the last point of distribution pipeline	*3*	*1*	*3*	*Medium*	*Aware users about water quality and safe use of water.*	*1*	*1*	*1*	*Low*	*Yes*
Tap and users place										
1. Meters are blocked, leakages and chance of biological hazardous.	*2*	*1*	*2*	*Low*	*Old meter replaced by New meter. Installation of household's water meter raised 6-9" above the ground level. It helps to protect water contamination at the meter inlet & outlet points*	*1*	*1*	*1*	*Low*	*No*
2. Poor sanitation practice, dirty collection tanks and storage vessel makes water biological and physical hazardous.	*2*	*2*	*4*	*Medium*						
					Conduct awareness program to users	*1*	*1*	*1*	*Low*	*Yes*

Form 5: Improvement Plan:

Col.1	**Col. 2**	**Col. 3**			**Col. 4**	**Col. 5**	**Col.6**	**Col. 7**	**Col. 8**
Link to Form 3 Hazardous events	List of improvement works and possible new CM	Assumed Risk After Introducing new control measure				who	Possible time of completion		Tentative cost/ comment
		Risk Score			Level		Immediately	Longer term	
Source /Catchment /Intake									
1. Water gets contaminated due to cattle grazing in the vicinity of intake – (microbial contamination)	*Construction of fencing (barbed wire) around intake at 2 m away.* *Intake structures to be relocated*	*1*	*1*	*1*	*Low*	*WUSC*	June 30,2013		*Rs. 100,000*
2. *Water gets contaminated due to turbidity from landslides/floods*		*1*	*1*	*1*	*Low*	*WUSC*	October 30, 2013		*Rs. 200,000*
3. *Sediment collection, Collapse of intake structure*	*Construct new intake structure with screening system*	*1*	*1*	*1*	*low*	*WUSC/Contractors*	August 30,2015		*Rs. 300,000*
Pipelines									
1. Cracks and rupture due to increased temperatures, Leakage and poor delivery	*Rebuild transmission pipelines with better alignment and temperature resistant materials*	*1*	*1*	*1*	*low*	*WUSC/Contractors*	September 30,2015		*Rs. 700,000*

Reservoir/ Treatment plant									
1.Because of turbidity, pressure filter doesn't work properly (overloaded) which makes water biological & physical hazardous. *2.Chance of over and under chlorination.* *3.Intermittent supply lead to biological hazardous from the point of leakages.* *4.Difficult to maintain FRC level at the last point of distribution pipeline.*	*Change Filter media and control high turbid water at intake site by construction of filter plants.* *Conduct training on Chlorination system to Plumbers and Chaukidars.* *Construct Deep Well at different places for supplying 24 hrs water supply.* *Installation Chlorine Dosing Unit at different points of distribution pipeline.*	*1* *1* *1* *1*	*1* *1* *1* *1*	*1* *1* *1* *1*	*Low* *Low* *Low* *Low*	*DWSS + WUSC* *WUSC* *WUSC* *WUSC*	*2072/05*	*2 years* *4 years* *5 years*	*2,22,00,000* *10,000* *2,00,000,00* *10,000,00*
Tap and Users' place									
1. *Poor sanitation practice, dirty collection tanks and storage vessel makes water biological and physical hazardous.*	*Conduct awareness program to users about sanitation activities.*	*1*	*1*	*1*	*Low*	*WUSC*		*4 years*	*50,000.00*

Form 6A: Monitoring Plan: Operational (to be carried out by Staff: lab technician, plumber, technicians etc)

Col. 1	**Col.2**	**Col. 3**	**Col. 4**	**Col. 5**	**Col. 6**	**Col. 7**
Control Measures (Existing+new completed)	**What?**	**How?**	**Who?**	**When?**	**Operational Limit**	**What to do if it is exceeded**
Source /Catchment/intake						
Barbed wire fencing	*Condition of the fencing and door.*	*Inspection*	*Watchman –Mr…..*	*Every weekend*	*Barbed wire fencing are intact and no cattle grazing inside the fence is seen*	*Repair if needed*
Construct new intake structure with screening system	*Functioning of new structure*	*Inspection*	*WUSC/VMW/ Technicians*	*Once in every month*	*No leakage observed from the intake*	*Repair if needed*
Pipelines						
Rebuild transmission pipelines with better alignment and temperature resistant materials	*Check if there is leakage*	*Inspection*	*WUSC/VMW/ Technicians*	*Once in every month*	*No leakage observed from the pipeline*	*Repair if needed*
Reservoir/ Treatment plant						
Tap and users place						

Form 6B: Record Keeping of Monitoring Works (sample)

Name: *1. Mr. …….. 2. Ms……3. Mr……4. Ms……* Date:

Col. 1	Col. 2		
Control Measures	Finding (condition)		
	OK	Improved	Need improvement
1 *2* *3*			

Form 7A: Verification Plan

List the name of the members involved in this work: *1. Mr. …….. 2. Ms……..3. Mr……4. Ms……*

Col. 1	**Col. 2**	**Col. 3**	**Col. 4**	**Col. 5**	**Col. 6**	**Col. 7**
Sampling Point and Condition	How often (frequency) observation needed*	Water Quality Testing Frequency				
		Turbidity	pH	E-Coli	FRC	……..
Source /Catchment/Intake	*monthly*	*monthly*	*monthly*	*monthly*		
Pipelines						
Reservoir/ Treatment plant	*Daily*	*Daily*	*Once a week*	*Once a month*	*Daily*	
Tap and users place	*Once in six month*	*Once a month*	*Once a year*	*Once a month*	*Once a week*	

* These observations would effectively provide simple auditing of WSPs.

Form 7B: Record Keeping of Periodic Verification

Date:

Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8
Sampling Point and Condition	Finding from field visit /observation	Water Quality Test Results, if any					Assessment of the Record Keeping (Internal Audit)
		Turbidity	pH	E-Coli	FRC	……..	
Source /Catchment/Intake	*Barbed wire fencing are intact*	*Below 5 NTU*	*6*	*1 cfu/100 ml*			
	Source is safe from human and animal hazards. Need tree plantation around the catchment area of source.	*1500 during rainy season* *And <10 during winter season*	*8.2 (average value)*	*>100 during rainy season and <10 during winter season*	*No added chlorine in raw water*	*Source is safe from human and animal hazards. Need tree plantation around the catchment area of source.*	*1500 during rainy season* *And <10 during winter season*
Pipelines							
Reservoir/ Treatment plant	*All the RVTs and others structures are safe and no chances of any outer contamination.*			*No E-coli in RVTs water.*	*0.3 to 0.5 mg/l chlorine is found in RVTs water*	*All the RVTs and others structures are safe and no chances of any outer contamination.*	

Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8
Sampling Point and Condition	Finding from field visit /observation	Water Quality Test Results, if any					Assessment of the Record Keeping (Internal Audit)
		Turbidity	pH	E-Coli	FRC	……..	
Tap and users place							

If external auditing (Water Quality Surveillance) has been carried out, when and how was it done?.....

Form 8: Brief listing of Management and support to WSPs (sample)

Col.1	Col. 2	Col. 3	Col. 4	Col. 5
S.N.	**Documented SOP (Standard Operating Procedure)**	**Emergency management plan**	**Activities under water shed management/ Adaptation for Climate change**	**Awareness program on WASH (planned and or conducted)**
1	*SOPs for treatment plant units (grit chamber, roughing filter, and slow sand filter*	*Not available*	*Forest user committee has been asked to help for source protection work for which WUSC has paid*	*Sanitation campaign has been carried out every month.*
2	*All the activities under WSPS are recorded. Cleaning of RVTs 4 times a year. Cleaning PST 2 times a month. Backwash the pressure filter 6 times in rainy season and 2 times in winter season.*	*Water extract from deep boring for sustainability of the project as well as 24 hrs supplying of the water which helps to maintain the water quality also.*	*Tree plantation activities are undergoing at upper part of water sources. Deep boring system is adopted instead of gravity system in terms of alternative sources.*	*Conducted WASH awareness program to women groups, child clubs, youth clubs etc. We are planning to conduct more orientation program to users to make aware about WSPS program & WASH activities.*
3	*Daily testing of turbidity, pH, Colors, Taste & FRC. All the tested records are recorded systematically. Raw water's E-coli & Total coliforms are tested once a week.*	*If water is high turbid in source we stop the water supply from the source and notice to users by NeWSPsapers and FM radios.*		
4	*Installation of household's water meter raised 6-9" above the ground level. It helps to protect water contamination at the meter inlet & outlet points.*			

Form 9A: Users Satisfaction Survey (to be done after reassessment of risk)

Date:

Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8
SN	Questionnaire	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Average
1	Are Users aware of importance of water quality on public health?						
2	What users think about safety measures of water from source to taps?						
3	Is the intake or other structure safe from landslide or flood?						
4	Is the pipeline safe during landslide or frost?						
5	Do you get enough water during dry period?						
6	Are the Users 'complains area addressed by the supplier?						
7	Are Users' satisfied with the tariff (reasonable with the service)?						
8	Do Users' think that system is maintained or improved during emergency and other abnormal incidents?						
9	Has anyone in the family been suffered from water-borne diseases in the last 15 days? Disease (Percentage of household saying "yes")						
	i. Cholera						
	ii. Typhoid						
	iii. Diarrhea						
	iv. Dysentery						
	v. Worms/Helminthes						
	vi. Jaundice						
	vii. Other (any)						

Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8
SN	Questionnaire	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Average
10	How do you treat water fetched from tap before drinking? (Percentage of House-hold)						
	i. Do Nothing						
	ii.Boling						
	iii.Use Chlorine						
	iv.Filter						
	v.Use SODIS (Solar disinfection)						
	vi. Other methods						

Note: Well representation (Not less than 25%) of HHs should be covered during survey in each cluster. The individual answer sheet from HHs may be attached in the WSPS document. Answer in the above table to be given in percentage of HH saying "Yes"

9B. Information regarding water borne disease (Health Post or District Health Office):

……
……
……

Annex 1: Roles & Responsibilities Regarding Water Safety Plans

1.1 Roles & Responsibilities of Water Users Committee

Major responsibilities to operate and maintain the community based water supply projects lie on the shoulders of the water users committee. Experiences of the past indicate that the project managed by well-trained and active users committee is more effective and sustainable compared to the ones managed by government, non-government and other type of agencies. Water users committee is formed with 9 to 11 members including minimum of 3 women. Maintaining potable quality of water also falls under the responsibilities of the water users committee. Regarding WSPs, following roles and responsibilities should be taken by the WUSC:

- Maintain water quality in compliance to NDWQS, 2005 in water supply schemes/project.
- Implement WSPs by forming WSPs team
- Facilitate WSPs team work and evaluate latter performance evaluation
- Make necessary provisions of budget and carry out necessary corrective action as demanded and suggested by the WSPs team
- Guarantee all water users that the water supply by the scheme is potable
- Make aware all users that safe drinking water is very much important
- Document all activities related to WSPs and make it easily available
- Verify regularly all works carried out by WSPs team

1.2 Roles & Responsibilities of WSPs Team

The main task of WSPs team is to carry out in sequence all activities envisaged in the WSPS. In addition, the team should help WUSC to the activities that are supportive to WSPS; communicate and coordinate with other stakeholders in order to mobilize the resources for WSPs implementation. Here are the major roles and responsibilities of the WSPs team:

- Analyze the system and make clear understanding of the water supply scheme. Prepare community map, flow –diagram, and keep it visible to the public.
- Visit all parts of the scheme (from source to tap/consumers), identify hazard and hazardous events, assess risks and determine and validate control measures, prepare monitoring plan
- During the operational monitoring, the technicians carry out the corrective works. If such works are beyond their capacity, they report to the WSPs team that further develop the improvement plan and prioritize according to risk level and carry out them in coordination with WUSC
- Validate the control measures taken under WSPs by testing regularly water quality and verify them
- Keep record of all activities including monitoring of the control measures and get them verified
- Assess users satisfaction, identify the impact of WSPs on health of people, carry out public awareness program
- Prepare a document including accounts of all activities done under WSPs and make it updated each year and distribute to concerned agencies
- Define task of each members of the WSPs team. All members of the team should at least twice in a year, visit /observe the system (from source to tap).

After completion of one cycle of all steps of WSPs, the WSPs team should, at least once in a year, review the WSPs document and as needed, update the latter by amendment or improvement. In normal condition, the cycle may start again from the step 6 (monitoring plan). Include also the plan of actions to cope with the emergency situation that may occur in the scheme/system due to degradation of water quality.

Annex 2. Tips for Hazard Identification

1. **Typical hazards affecting a catchment**

Source of hazard	**Associated hazards (and issues to consider)**
Meteorology and weather patterns	Flooding, rapid changes in source water quality
Seasonal variations	Changes in source water quality
Geology, natural chemicals	Arsenic, fluoride, lead, uranium, Swallow holes (Surface water Ingress)
Agriculture/Farming	Microbial contamination, pesticides, nitrate Slurry and dung spreading Disposal of dead animals
Housing- septic tanks or untreated domestic wastes	Microbial contamination
Wildlife	Microbial contamination
Recreational use	Microbial contamination
Unconfined aquifer	Water quality subject to contamination from affected aquifer
Well/ borehole head works not watertight	Surface water intrusion
Borehole casing corroded or incomplete	Surface water intrusion
Flooding	Highly turbid water
Landslide	Intake and other structures damaged. Highly turbid water

2. **Typical hazards associated with treatment**

Source of hazard	**Associated hazards (and issues to consider)**
Capacity of treatment works	Overloading treatment
Treatment failure	Untreated water or partially treated water
Blocked filters	Inadequate particle removal
Inadequate filter media depth	Inadequate particle removal
Security/ vandalism	Contamination/ loss if supply
Instrumentation failure	Loss of Control
Inadequate chlorination	Inadequate disinfection
pH outside effect range	Inadequate disinfection
Power failure	No treatment or partial treatment
Flow rates too high for process unit	Inadequate particle removal

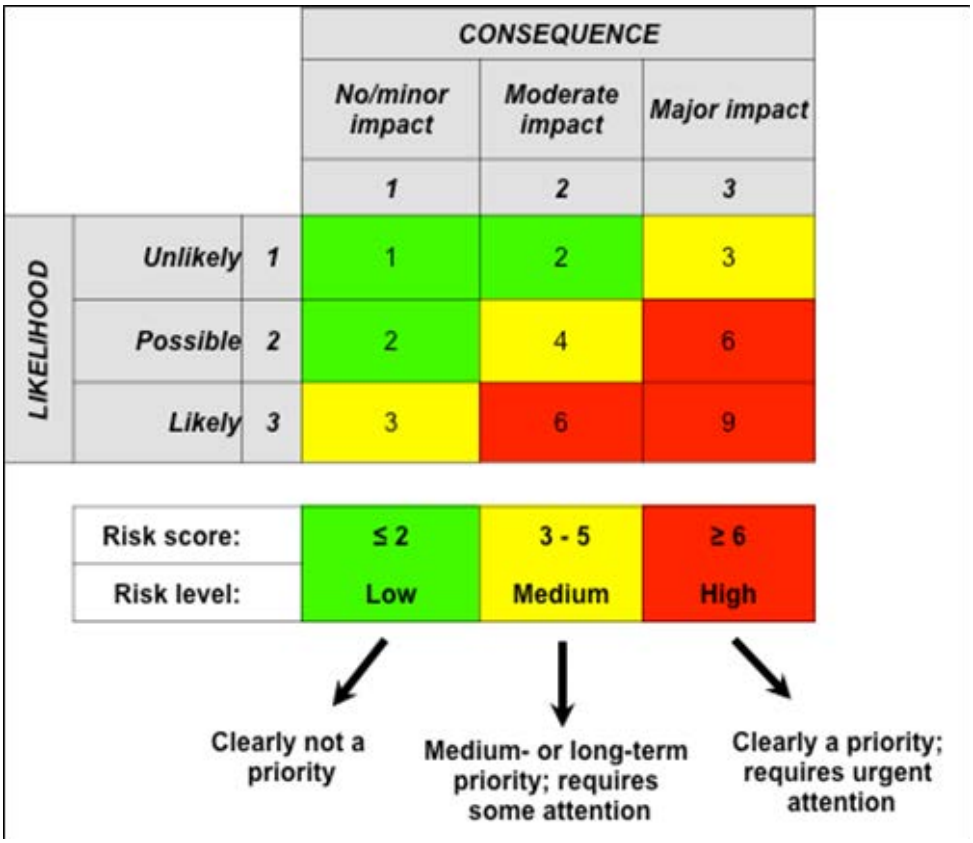
3. **Typical hazards within a distribution network**

Source of hazard	**Associated hazards (and issues to consider)**
Mains burst	Ingress of contamination
Pressure fluctuation	Ingress of contamination
Intermittent supply	Ingress of contamination
Unauthorized connections	Contamination by backflow
Open service reservoir	Contamination by wildlife
Leaking service reservoir	Contamination
Unprotected service reservoir	Contamination
Contaminated land and corrosion of pipe	Contamination of water supply through wrong pipe type
Cross connection of sewer	Contamination of water supply

4. Typical hazards affecting consumer premises

Source of hazards	**Associated hazards (and issues to consider)**
Unauthorized connections	Contamination by backflow
Poor water handling practices	Recontamination of water after collection
Cross connection	Contamination of water supply

Annex 3: Semi-quantitative matrix for risk analysis



Descriptions of categories provided as below

Descriptor		Description
Likelihood	Likely	Will probably occur in most circumstances; has been observed regularly (e.g. daily to weekly)
	Possible	Might occur at some time; has been occurred occasionally (e.g. monthly to quarterly or seasonally)
	Unlikely	Could occur at some time but has not been observed; may occur only in exceptional circumstances
Severity / Consequences	Major Impact	Major Water Quality impact; illness in community associated with water supply; large number of complaints; significant level of customer concerns; significant breach of regulatory requirement
	Moderate Impact	Minor Water Quality impact (e.g. not health related, aesthetic impact for a large percentage of customers; clear rise in complaints; community annoyances; minor breach of regulatory requirement
	No/Minor impact	Minor or negligible Water Quality impact (e.g. not health related, aesthetic impact for a small percentage of customers; some manageable disruptions to operation; rise in complaints not significant

Note: For consideration of risk analyses of hazards due to climate change, the matrix descriptions and number assigned remain similar. There will be additional analyses of risks to be included in the provided formats, which will be system specific.

Annex 4: Tips for identifying Control Measures

1. **Typical control measures associated with hazards at a catchment**
   - Restricted access to catchments
   - Water utility ownership and control of catchment land
   - Fencing
   - Codes of practice on agricultural chemical use and slurry spreading
   - Moving farm operations away from sensitive locations
   - Planning controls
   - Communication and education of catchment stakeholders
   - Industrial effluent standards and volume controls
   - Raw water storage
   - Ability to close intakes to isolate inlet
   - Covering and protecting springs
   - Ability to use good alternative water sources when hazards affect on source
   - Continuous monitoring of intake and river
   - Site inspections
   - Regular internal inspections of well and boreholes

2. **Typical control measures associated with hazards at treatment**
   - Validated treatment processes
   - Determine and document acceptable flow rates for range of raw water quality
   - Alarmed operating limits (in automatic system)
   - Stand by generator
   - Continuous or daily manual monitoring of key parameters (with alarms in an automatic system)
   - Trained staff (operator competency) and standard operating procedures for unit operations
   - Purchasing policy and procedure to ensure chemical quality
   - Fencing, locked premises, intruder alarms, guards
   - Communications back-up
   - Filter media
   - Periodic checks on free available chlorine
   - Stick controls to ensure that sufficient chlorine is always available on site
   - Out of date chemicals are not used
   - Close of intake in high raw water turbidity situations ((when turbidity is beyond treatment plant capacity) or reduced throughput when high turbidity
   - Regular checks on depth of filter media
   - Scheduled maintenance carried out on pumps and other equipment
   - Bypass from treatment plant during flooding and landslide

3. **Typical control measures associated with hazards at a distribution network**
    - Regular reservoir inspections (external and internal)
    - Cover open service reservoirs
    - Up-to-date network map to understand system
    - Known valve status
    - Mains repair procedures
    - Trained staff (operator competency)
    - Hygiene procedures
    - Hydrant security
    - Non-return valves
    - Pressure monitoring and recording
    - Protected pipes
    - Fencing, locked hatches, intruder alarms for service reservoirs and towers
    - Avoiding the cross connection of sewer

4. **Typical control measures associated with hazards at consumer premises**
    - Property inspections
    - Consumer education (non structured)
    - Non- return valves
    - Advice to boil/ not use the water (non structured)
    - Avoiding the cross connection of sewer

Annex 5: National Drinking Water Quality Standards (2005)

Category	Parameter	Unit	Maximum Concentration Limit	remarks
Physical	Turbidity pH color Test & Odor Total Dissolved Solids Electrical Conductivity	NTU TCU mg/L µs/cm	*5 (10)* *6.5-8.5** *5(15)* Non objectionable 1000 1500	
Chemical	Iron Manganese Arsenic Cadmium Chro-mium Cyanide Fluoride Lead Ammonia Chloride Sulphate Nitrate Copper Total Hardnes) Calcium Zinc Mercury Aluminium Residual Chlorine	mg/L mg/L mg/L mg/L mg/L mg/L mg/L mg/L mg/L mg/L mg/L mg/L mg/L mg/L mg/L mg/L mg/L mg/L	*0.3 (3)* *0.2* *0.05* *0.003* *0.05* *007* *0.5-1.5** *0.01* *1.5* *250* *250* *50* *1* *500* *200* *3* *0.001* *0.2* *0.01-0.2**	 in systems using chlorination
Microbiological	E. Coli Total Coliform	MPN/100ml MPN/100ml	95% samples	