TRAINING MANUAL ON CLIMATE RESILIENT WATER SAFETY PLAN (CR-WSP)

FACILITATOR'S HANDBOOK

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Government of Nepal
Ministry of Water Supply & Sanitation
Department of Water Supply & Sanitation
Panipokhari, Kathmandu, Nepal

Preface

Water Safety Plan (WSP) is a comprehensive risk assessment and management approach for improving and maintaining drinking water quality from catchment to consumers. There are more than 42,000 water supply schemes. At the beginning, most of them started supplying safe water; however these schemes have been polluted over the years dues to natural and human activities and operational deficiencies. Considering this, WSP has been piloted in Nepal since 2006 with the support of the World Health Organization (WHO). WSP has played a very important role in addressing these issues during pilot stage.

As WSP proved itself as an effective tool to improve water quality, Department of Water Supply and Sewerage (DWSS) has included it in its regular programme. Similarly it has been piloting climate resilient water safety plans in some district in order to address climate change issues in water quality. In mean time, some other organisations have also started implementing WSP in water supply schemes.

WSP follows various steps that allow the assessment and management of risks involved in maintaining quality of water. The awareness and orientation is considered one of the first steps to develop WSP in any water supply schemes. All organizations commence developing WSP by organizing these kinds of capacity building activities. However, these training programmes are conducted differently as there is no standardized module as such. It is now necessary not only to standardize the existing training materials but also to consider new issues such as climate change. With this background, this training manual is developed. It has three major parts i.e. facilitator's handbook, participant's workbook and presentations structured in eight modules, which can be customized to the extent applicable.

This training manual 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 training materials and is based on the experiences obtained from the implementation of WSP since 2006 with WHO-Nepal's support and on the consultations provided by various experts on this subject matter. It is expected that this manual is useful for all, who has been working on implementation of 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).

This manual is the result of untiring efforts of many individuals. Department of Water Supply and Sewerage (DWSS) acknowledge the inputs of Dr. Dinesh Raj Manandhar, Dr. Bandana Pradhan and Dr. Rijan Bhakta Kayastha. The department also recognizes the valuable contribution of WHO Nepal especially of Er. Raja Ram Pote Shrestha and Dr. Sudan Raj Panthi to finalise this document. 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."

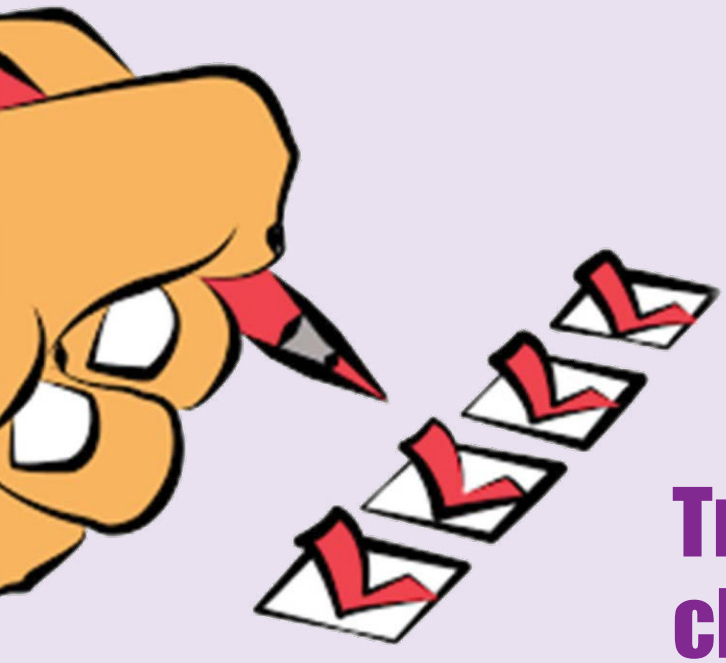
Contents

Glossary

Control measure	:	Any action or activity that prevents, eliminates or reduces water safety hazards to an acceptable level
Control point	:	A step at which control can be applied to prevent or eliminate a water safety hazard or reduce it to an acceptable level.
Corrective action	:	Remedial actions or steps taken after the results of monitoring indicate a failure of control measures to maintain the water quality
Critical limit	:	A threshold that separates the limit of acceptability and unacceptability
Flow diagram	:	A systematic representation of the sequence of steps or operations for the production or manufacture of a particular water item.
HACCP	:	(Hazard analysis and critical control points) a systematic preventive approach during the water tapping, treatment and conveyance processes from preventing water quality against physical, chemical and biological risks during its consumption
Hazard analysis	:	The process of recognizing hazards that may arise from contamination in a system or its environment, documenting their unwanted consequences and analyzing their potential causes.
Hazard	:	Any agent (physical, chemical, biological or radiological) that can cause harm to public health
Hazardous event	:	Any process that introduces hazards to, or fails to remove them from, the water supply
Operational monitoring	:	The act of conducting a planned sequence of observations or measurements of control parameters to assess whether a control measure is operating within design specifications
Risk assessment	:	A process to identify potential hazards in the water supply system as well as water quality, and analyze what could happen if a hazard occurs
Risk score	:	The score assigned to a hazard based on the risk analysis process
Supporting programmes	:	Actions such as training and management practices that are catalyst to ensuring drinking water quality, water safety and better management of water supply schemes
Unaccounted-for-water	:	(Also called non-revenue water) the difference between the quantity of water supplied to a city's network and the metered quantity of water used by the customers.
Validation	:	Investigate activity to identify the effectiveness of control measures
Verification	:	Application of system procedures, tests and other evaluations to determine compliance with WSP, and its effectiveness
Water Safety Plan	:	Water supply 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.
Surveillance	:	Verification by an independent person or a body to check whether or not the components devised under water safety plans are operating properly and effectively.

Acronyms

BPT	Break Pressure Tank
CCA	Climate Change Adaptation
CM	Control Measure
DDG	Deputy Director General
DDRC	District Disaster Relief Committee
DRR	Disaster Risk Reduction
DWSS	Department of Water Supply and Sewerage
GoN	Government of Nepal
HH(s)	Household(s)
NDWQS	National Drinking Water Quality Standard
ODF	Open Defecation Free
SDE	Senior Divisional Engineer
SOP	Standard Operating Procedure
ToT	Training of Trainers
UFW	Unaccounted for Water
WASH	Water Supply Sanitation and Hygiene
WHO	World Health Organization
WSP	Water Safety Plan
WUSC	Water Users and Sanitation Committee
MWSS	Ministry of Water Supply and Sanitation



Training event checklist

- ☑ Make sure you read the participant's workbook and familiarize yourself with its contents.
- ☑ Make sure you adjust and modify the content of the presentations depending upon the target audience (participants) and the service level of water supply scheme.
- ☑ Check if you have all the materials required for the training at your disposal.
- ☑ Ensure that you have printed out and collated all the participant's materials.
- ☑ Ensure that the training hall is ready, that the tables and chairs can be arranged as required.
- ☑ Check if the light and sound arrangement is suitable and comfortable for the participants to see and hear.
- ☑ Check if the hall has arrangements for projector and a screen and necessary training aids. Also make sure there is a backup option if in case there is a power failure.
- ☑ Make sure you practice and re-practice each session.
- ☑ Ensure that all the resource persons meet at least one day before the actual training to discuss the preparation, proceedings and methods of the program.

PART ONE

OVERVIEW OF THE HANDBOOK AND THE TRAINING PROGRAMME

INTRODUCTION

1. Introduction

Water safety plan is a plan to ensure the safety and quality of drinking water through the implementation of a comprehensive risk assessment and management approach that encompasses all steps in water supply from catchment to consumer. The significance of WSP in water supply projects can be understood from this definition of WSP itself: it is essentially comprehensive, and thus keeps into account the broader picture of ensuring water quality by mitigating risks from the source itself through to the transmission and distribution processes and ultimately to the consumers. The training manual attempt to promote system sustainability of the water supply projects under consideration by fulfilling the following objectives:

- Help make all the stakeholders understand the significance of Water Safety Plan.
- Make the participants aware about the key terms and steps to implement water safety plan so that they can assure water quality and minimize risks in the water supply systems.
- The participants of ToT can further train other stakeholders such as WUSC and their sub ordinates at their concerned offices.

1.1 Introduction of the handbook

This handbook is a part of the water safety plan training manual toolkit developed to train the trainers (ToT) and is applicable to other target audiences as well. It is accompanied by the participant's workbook, PowerPoint presentations for the training and reference documents. This handbook is to be used by the facilitators who have prior knowledge of the concepts and steps of WSP, and who intend to conduct training on WSP based on the guidelines previously set by DWSS in the WASH sector. The handbook is divided into four parts:

- Part one: Overview of the training approach, training structure and mode of training assessment
- Part two: Ice-breaking session
- Part three: Module learning material, which includes module objectives, delivery information, key points and exercises
- Part four: Annex and reference materials

The target audience is basically the technical and non-technical staff of water supply service providers, consultants, contractors/developers and line agencies personnel, and the members of the water supply and sanitation users committee. These people are the ones responsible to implement the WSP for the concerned water and sanitation system. However, other members from outside the water supply sector such as health sector staffs or school/college teachers and education, agricultural, soil conservation, forestry sector people could also participate.

Water supply schemes in Nepal are differentiated as urban and rural type on the basis of the nature of the systems, the number of communities or people being served or the sophistication in treatment facilities and service level of the system. As such, it is essential to discriminate the plans for these two. This handbook intends to cover the needs to

conducting the training in either of these systems. Therefore, the handbook has been made flexible enough to allow the facilitators to maneuver and modify their presentations that suit the target audiences. The facilitators can refer table 1 to decide the type of scheme and the modifications required into their presentation.

Table 1: Guide to determine if urban or rural WSP should be used

Basis of difference	Urban schemes	Rural Schemes
Size and capacity	Medium to large scale, preferably year round water supply with a range of service levels (public tap stands to fully plumbed).	Very small to medium size with mostly intermittent water supply.
Operators	Full time trained and paid employees.	Part time, untrained and partly paid employees with mostly voluntary contribution.
Access to expert assistance	Expert advice is accessible when required.	Limited or no access to expert assistance owing to remote locations.
Management and technical support	Relatively good access to management and technical support from governmental agencies	Limited capacity of water user committees and limited support and access to government agencies
Financial resources	Secure, consistent and reasonable financial resource	Limited and inconsistent

Note: If in case the discrimination of a particular system is not clear, it is advised that the WSP is considered for the individual system component.

1.2 Objective of the handbook

The major objective of this facilitator's handbook is to assist the trainer/facilitator in conducting training that inform and educate various stakeholders, technical and non-technical staff of water supply service providers, consultants, contractors/developers, WUSCs, line agencies as well as consumers about the significance of WSP. Therefore, the specific objectives of the handbook can be outlined as following:

- To provide a clear guidelines and instructions to a trainer/facilitator conducting training.
- To provide a comprehensive reference document for the trainers that they can use to gain information about all facets of WSP and facilitate hands-on, face to face training to the target groups.
- To provide specific instructions to the trainer/facilitator about the content and use of PowerPoint slides, and use of videos, games and energizers.

1.3 Training approach

The training programme encompasses the following set of activities that the facilitator must conduct and the participants should participate in to best understand the concepts of WSP and be able to utilize it in their respective projects. A reference case study has been included in Annex H of this handbook to allow all the participants to practice their exercises for a common water supply project, so that different views of the participants can be determined for a common set of problems.

- Instructive presentations – imparting information/theory
- Small group exercises – assimilating theory
- Case-study examples and/or a site visit – contextualizing key concepts
- Small group and large group feedback – deepening understanding of theory
- Energizer and review activities – informal review of theory and practical aspects
- Workbook – a comprehensive workbook to accompany module learning sessions for participants
- Support documents- WSP manual, presentation slides, videos and references

1.4 Training structure

The format and the system requirements to conduct the programme effectively have been listed below. The training structure varies according to participant numbers, available facilities and the facilitator's preferences. However, the following could be an ideal set up for the programme:

- Ideally, training should be limited to 20-25 participants and presented by two to three facilitators as far as possible.
- A facilitator: participant ratio of 1:20 is suitable (preferable)
- Room layout and facilities: Assuming a cohort of 20-25 participants, a spacious room is required so as to accommodate the recommended seating arrangements, as given in Figure 1. Ideally, the room should be on one level to enable participants and facilitators to move around freely. The room should have natural ventilation and light, but with blinds to enable the lighting conditions to be controlled and air-conditioning to maintain a suitable temperature.

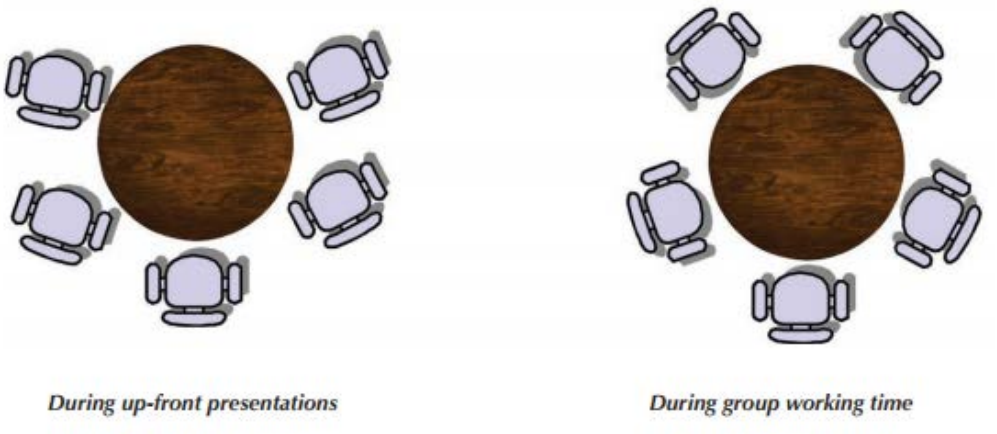


Figure 1: Recommended seating arrangement for the programme

Source: (WHO, 2015)

- Timetables: Specific sessions with breaks in between that run for five days (assuming training time from 9 AM to 5 PM, give or take a few minutes for refreshment or energizers). However, it is necessary to emphasize here that five days for the training programme has been allotted considering the need to explain the components of WSP and the implementation procedure in detail. In addition, one also needs to understand that that the toolkit is to be used for training of trainers so an in-depth and comprehensive course is essential. The training for smaller audience or a particular WUSC may be reduced to 2-3 days depending upon need but covering essentials of WSP programme. For this, the facilitator may wish to ignore the case studies illustrated in this document, and simply carry out the proceedings of WSP for the particular water supply system under consideration.

1.5 Training assessment

The assessment includes both the participants' understanding as well as the trainer's (facilitator's) delivery and content.

The former can be conducted continuously throughout the training by the facilitators, through paying close attention to the individual participants' engagement in the training and in the group work in particular. Pre- and post- test will be conducted to measure the learning by the participants, the format of which is given in Annex E.

- The assessment of the training (thus implying to the incorporation of WSP in the participants' water supply projects) can be done three months after the end of the training in which the organizers will follow up with the participants' progress in incorporating WSP in their projects.

1.6 Note to the facilitators

The facilitators will be at a great advantage if s/he possesses the tact and trades required to conduct the sessions effectively (this includes courtesy, polite yet commanding oration, encouraging participation, responsiveness to queries and so on). The facilitators are expected to have a good command and control over the programme, content and timing in that they can be firm and authoritative while being polite and courteous at the same time.

As mentioned above, a reference case has been included in Annex H of this handbook to allow all the participants to practice their exercises for a common water supply project, so that different views of the participants can be determined for a common set of problems.

The participants' workbook, presentation slides, videos and energizers and reference materials are to be used as appropriate and depending upon the level of training.

1.7 Materials required

The following materials should be made available before starting the training programme. The list comprises only a selected few items and therefore, the facilitator and the organizers should make provisions of other accessories as required.

- LCD projector and screen
- Speakers and microphones
- White board, board markers and a wiper/eraser
- A3/chart papers
- Pointer (or Pointing stick)
- Meta card, Glue stick
- Thumb pins
- Highlighter pens
- Notebooks and other stationery supplies
- Scissors and paper cutters
- USB drives for the distribution of training materials
- Water quality test kits for demonstration and field work
- Videos and reference materials
- Other accessories

1.8 Overview of the handbook

Each session has been divided into the following sub-headings so that the facilitator can best express him/herself while delivering his/her presentation:

- **Session goals**

  This points out the objectives of the session, and highlights what the participants are to learn from it.

- **Time allotted**

  This represents the time allotted for that particular session, including the time for the exercises, which is flexible. The facilitators can adjust as per situation.

- **Resources**

  This makes a reference to supporting documents and PowerPoint slides relevant to the particular session that the facilitators should use to accomplish the session goals.

- **With reference to the Participant's workbook**

  This links the Participant's workbook with this handbook. This section makes reference to the corresponding session in the Participant's workbook such as the chapter and section name.

- **Important points to be emphasized**

  This section points out the key information that the facilitators should emphasize. In a way, this represents the gist of the session, and relaying these points properly is the key to making the participants clearly understand the session goal.

- **Keys to conducting the exercise**

  This session gives hints and instructions as to how the facilitators are to guide the participants to complete a particular exercise related to the session. This may include a step-by-step guidance or an example relevant to the exercise.

1.9 Videos

Some videos and/or clips related with WSPs to be shown at the programme at appropriate sessions and leisure times. The related videos are included.

1.10 Documentation and training completion report

In order to record all the discussions and questions raised, a report should be prepared right after the training is over. The report should comprise the following:

- Executive summary
- Summary of the speech/remarks made by guests and/or important representatives
- Daily log of the proceedings
- Question raised/topics discussed
- Photographs and clips
- Outcomes/results
- Way forward, follow ups and future plans

1.11 Proposed schedule

The following (table 2) is the proposed schedule for conducting a WSP training programme. It is strongly recommended that the schedule be followed. However a slight modification may be allowed depending upon the field situation without hampering the main objective and content. The numbers in the parentheses represent the time allotted for the particular exercise for that particular session. As mentioned earlier, this schedule may be tailored made in case of WUSC training as required.

Table 2: Proposed tentative schedule for the training

Day 1				
SN	**Activity**	**Time**	**Interval (minutes)**	**Reference**
1.1	Opening ceremony and Participants' Introduction	9.00-10.00	60	Ice-breaking session
1.2	Water quality, impacts on public health and WSP	10.00-10.45	45	Module 0
	Break	10.45-11.00	15	
1.3	Climate change and WSP	11.00-11.45	45	Module 0
1.4	WSP team formation: leadership, roles and responsibilities	11.45-12.30	45	Module 1
	Lunch	*12.30-13.30*	*60*	
1.5	Water supply system analysis	13.30-15.00	45+(45)	Module 2
	Tea Break	*15.00-15.30*	*30*	

1.6	Identification of hazards and risks to water supply systems	15.30-17.00	45+(45)	Module 3
1.7	Summary	17.00-17.15	15	
Day 2				
2.1	Recap of day 1	9.00-9.15	15	
2.2	Preventive and control measures	9.15-10.00	30+(15)	Module 4
	Break	*10.00-10.15*	*15*	
2.3	Improvement/upgrade plan	10.30-11.15	30+(15)	Module 5
2.4	Define monitoring of the control measures	11.15-12.45	45+(45)	Module 6
	Lunch	*12.45-13.45*	*60*	
2.5	Verify the effectiveness of the WSP	13.45-15.15	45+(45)	Module 7
	Tea Break	*15.15-15.45*	*30*	
2.6	Briefing of field visit and WQ Kit demonstration	15.45-16.45	60	
2.7	Summary	16.45-17.00	15	
Day 3				
3.1	Field visit	8.00-13.30	330	
	Lunch	*13.30-14.30*	*60*	
3.2	Feedbacks and preparation for group presentation of field findings	14.30-16.30	120	
	Tea Break	*16.30-17.00*	*30*	
3.3	Summary	17.00-17.15	15	
Day 4				
4.1	Recap of Day 3	9.00-9.15	15	
4.2	Group presentation on field findings -I	9.15-10.15	(20*3=60)	
	Break	*10.15-10.30*	*15*	
4.3	Group presentation on field findings -II	10.30-11.15	(20*2=40)	
4.4	Evaluation and discussions of observed scenario at the site	11.15-12.00	45	
	Lunch	*12.00-13.00*	*60*	
4.5	Reporting exercise (including group/individual exercise) -I	13.00-14.30	45+45	
	Tea break	*14.30-15.00*	*30*	
4.6	Reporting exercise (including group/individual exercise)-II	15.00-16.30	45+45	
4.7	Summary	16:30-17.00	30	
Day 5				
5.1	Recap of day 4	9.00-9.15	15	
5.2	Presentation on Chlorination and Dosing	9.15-10.15	45+(15)	
	Break	*10.15-10.30*	*15*	
5.3	Develop supporting programmes (including financial and administration of implementation of Water Safety Plan)-I	10.30-12.00	45+45	Module 8
	Lunch	*12.00-13.00*	*60*	
5.4	Develop supporting programmes (including financial and administration of implementation of Water Safety Plan)-II	13.00-13.45	45	Module 8
5.5	Evaluation and feedback	13.45-14.30	45	
5.6	Closing	14.30-15.00	30	

PART TWO

ICE BREAKING SESSION

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2. Ice-breaker

This is the first session of the training in which all the participants, including the facilitators and the support staffs, should introduce themselves. This session also covers the time required for the facilitators to give a brief outline of the training programme, its objective and format.

2.1 Session goals

- To introduce yourself to the participants and share your experience in WSP sector, as well as conducting such programmes.
- To give an overview of the training schedule, and the need to adhere to the schedule and time allotted for each session and activity.
- To clarify what the objective of this training is, and what is expected from the participants.

2.2 Time allotted for this session:

60 minutes in total/ 30 seconds for the introduction of each participant

2.3 Session approach

Before conducting this session, check to see:

- What previous experience the participants have on overall WSP,
- If they have any specific expectations or goals behind attending this training programme

As a facilitator, you are also supposed to ensure that there is no redundancy in the opening remarks and this session. In particular, you should arrange beforehand that you do a self-introduction and that you arrange for the participants to introduce themselves. Participants could introduce themselves in ways they think suitable, or the facilitator could give a framework or a guideline as suggested in Table 3.

Table 3: Suggested framework for participant's introduction

Name	
Water supply project	
Project location	
Position	
Expectations (optional)	

During the introduction and collection of expectations, a simple game can be played (depending upon the level of participants) by making the participants introduce each other by making a pair e.g.: coming from same region, similar dress color, wearing glass etc. or by making them choose pair numbers and identifying on their own.

In order to keep track of the time, you could also consider keeping a timekeeper. S/he will ring a bell before 5 minutes, and then multiple bells before 1 minute of full time, until the speaker stops. To make it more interesting, regularly change the timekeeper.

PART THREE

LEARNING MATERIALS AND RESOURCES TO CONDUCT THE TRAINING

MODULE 0: INTRODUCTION TO WSP

3. Learning materials

This section deals with tips and strategies to disseminate information regarding general water quality and importance, WSP (approach and its components), effects of climate change and impacts on public health through effective use of the materials and exercises.

The assessment of climate change impacts is very essential for an efficient, effective and sustainable planning of water supply projects. Besides, water is getting increasingly scarce. Hence, the planners and managers concerned need to be aware of the impacts of climate change on water resources management.

The NDWQS (2005) consists of altogether 27 parameters representing physical, chemical and microbiological aspects. It is very important for all water supply projects to adhere to these standards. In this direction, the focus of this session is on the microbiological and chemical parameters that affect water quality, and the need to implement the water safety plan.

3.1 Introduction to WSP (Module 0)

3.1.1 Session goals

The session aims to accomplish the following tasks:

a. **Water quality**

- To define water quality and explain the components that affect water quality
- To link water quality with water supply and treatment goals
- To highlight few water quality cases (exemplifying cases with low water quality) to establish its significance in water supply projects

b. **Public health and WSP**

- To introduce the concepts of public health and highlight its importance on the water resources.
- To explain the need for the water supply projects to put public health impacts under consideration by identifying possible impacts of climate change on particular water supply components.
- To discuss various mitigation and preventive measures to make the scheme climate resilient.

c. **Climate change and WSP**

- To introduce the concepts of climate change and highlight its importance on the water resources.
- To explain the need of consideration of impacts of climate change on water supply projects by identifying possible impacts of climate change on water supply components.
- To discuss various mitigation and preventive measures to make the water project climate resilient.

d. **Considering equity into WSP**

- To contribute to equitable realization of the benefits of a WSP and access to safe water
- To minimize any (inadvertent) discrimination through a WSP process
- To strengthen WSP effectiveness through an inclusive WSP approach

e. **WSP**

- To give a brief overview about the system indicators of water supply system in relation to climate change and public health
- To introduce various physical, chemical and biological parameters that define water quality
- To relate issues of poor water quality with public health
- To emphasize on equity issues related with WSP
- To introduce the concepts of WSP, and then explain its status in Nepalese context
- To give an overview of the approaches, objectives, components and significance of WSP

3.1.2 Time allotted for this session:

45 minutes + 45 minutes (for climate change section)

3.1.3 Resources

- PowerPoint slide entitled Module 0- Introduction to WSP
- Other references

3.1.4 Reference to the Participant's workbook

- Exercise 1 of section 3.1.1

3.1.5 Important points of this session

a. **Water quality**

- Water quality describes the condition of the water, including chemical, physical, and biological characteristics, usually with respect to its suitability for a particular purpose such as drinking or swimming
- Water quality is measured by several factors, such as the concentration of DO, bacteria levels, the salinity, or the turbidity. The concentration of algae and quantities of pesticides, herbicides, heavy metals, and other contaminants are also concern.
- Water quality is relative to the purpose of the water – is it for drinking or to wash a car with or for some other purpose?
- Water Supply goals
  - Meet domestic demand
  - Ensure quantity, quality and round the clock service
- Drinking water treatment goals
  - To provide safe water
  - To provide aesthetically pleasing water
  - To ensure that the technology applied does not create further problems

b. **Public health**

- Public health: "The science and art of preventing disease, prolonging life, and promoting health through the organized efforts and informed choices of society, organizations, public and private communities, and individuals."

- WSP: WSPs provide a risk based, preventative approach to managing drinking-water safety from catchment-to-consumer.
- The rationale behind WSP:
  - ✓ An estimated 80% of all diseases and over one-third of deaths in developing countries are caused by the consumption of contaminated water and on average as much as one-tenth of each person's productive time is sacrificed to water-related diseases (WHO 2014).
  - ✓ Ensure citizens right to live in healthy environment through effective control of environmental pollution for health protection and promotion (Health policy 2014).
  - ✓ Right to healthcare: Each citizen shall have the right to access to clean water and hygiene. (GON-Constitution of Nepal, 2072).
  - ✓ Water quality deterioration and prevalence of water borne diseases are in increasing trend and showing distinct seasonal peaks.
  - ✓ Since the water borne diseases including diarrhea have been identified as important climate sensitive diseases, factors attributed to the climate need to be assessed for the prevention of these diseases.
  - ✓ Implementing WSP to ensure drinking water quality (GoN 2005)
- Route of contamination:

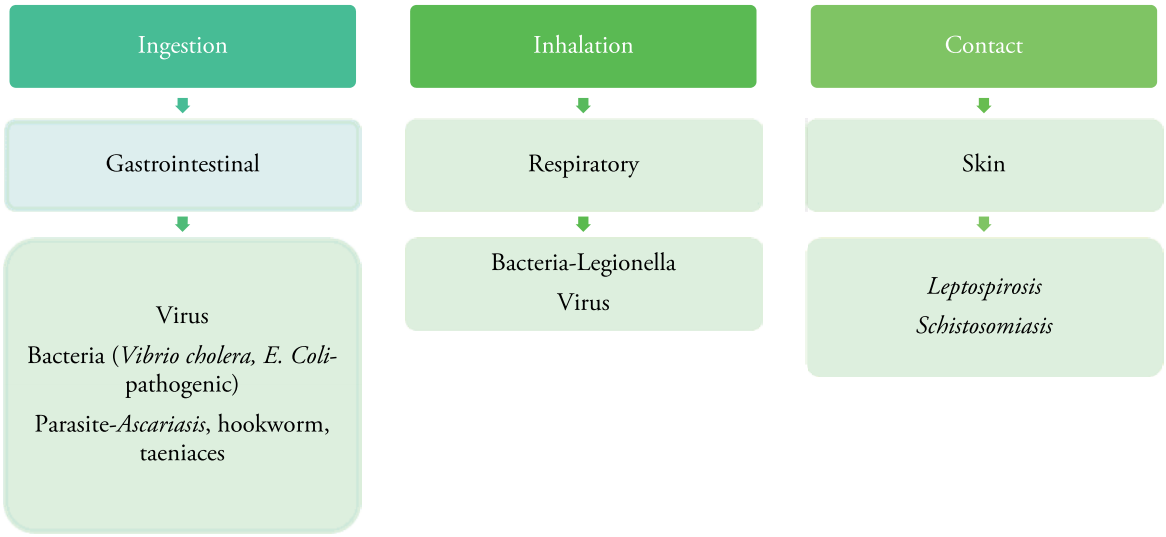
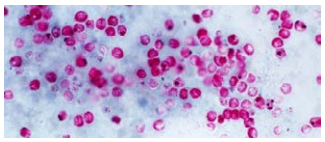
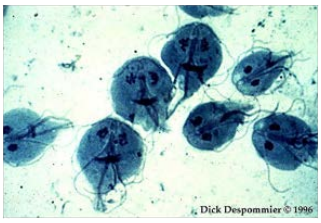
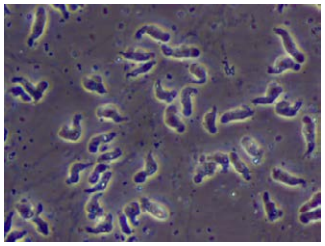


Figure 2: Route of contamination

- H_2S tests and other simple and affordable tests have great value and even greater potential use for drinking water supply management and health education in the water and sanitation sectors. However, these tests must be evaluated and judged on the basis of their reliability and predictability as well as their accessibility, practicality and affordability.
- Some important water quality parameters, potential health impact and potential source:

Table 4: Potential health impacts due to impure water

Parameter	Potential health impact	Potential source (in water)	Image/photo source
Escherichia coli 	Diarrhoea 	Faecal contamination (indicator for faecal contamination)	*E. coli:* http://theodysseyonline.com/southern-connecticut-state/what-you-know-and-dont-know-about-coli/454114 Ill boy: http://hetv.org/resources/diarrhoea/diarrhoea-flipbook.htm
Shigella spp. 	Dysentery	Faecal contamination	*Shigella spp.:* http://www.barnstablecountyhealth.org/disease-agents/shigella-spp
Vibrio cholera 	Cholera	Faecal contamination	*Vibrio cholera:* https://sites.google.com/site/thevibrioresearchgrouputs/
Cryptosporidium parvum 	Diarrhoea	Faecal contamination	*Cryptosporidium parvum:* http://abcnews.go.com/Health/cdc-warns-pool-parasite-summer/story?id=32060444
Giardia intestinalis 	Diarrhoea and intestinal malabsorption	Faecal contamination (wide range of animal species)	*Giardia intestinalis:* http://web.stanford.edu/group/parasites/ParaSites2009/NevinsANDLiu_Giardiasis/NevinsANDLiu_Giardiasis.htm
Naegleria fowleri 	Amoebic meningitis	Occurs naturally, grows well at high temperatures	*Naegleria fowleri:* http://www.cdc.gov/parasites/naegleria/naegleria-fowleri-images.html#photos

Legionella pneumophila 	Pneumonia	Occurs naturally and in certain human-made installations such as water cooling devices	*Legionella pneumophila;* http://www.bioquell.asia/technology/microbiology/legionella-pneumophila/
Fluoride	Too much: adverse changes in bone structure	Addition during treatment and naturally in the environment	
Arsenic	Skin changes and cancers of the skin, lung and bladder (after long term exposure) 	Sulphide mineral deposits	Arsenicosis Patient: http://ngof.org/wdb_new/media-gallery/detail/63/230
Lead	Adverse neurological effects	Old pipes and plumbing 	Lead pipe, corroded steel pipe and lead pipe with protective orthophosphate: http://iowadailydemocrat.com/news/2016/02/water-deregulation/
Cyanobacterial toxins	Liver damage, neurotoxicity and possibly tumour promotion	Bacterial blooms in raw water	

- Other water quality parameters and their effects on public health are as below:

Table 5: Water quality parameters and their effects on public health

Hazard	Impact on health
Manganese	– Adverse neurological effects
Arsenic	– Arsenicosis diseases, later cancer
Cadmium	– Kidney damage and bone demineralization
Chromium	– Damage to the nasal mucosa and lower respiratory tract.
Cyanide	– Weakness and confusion, Headache, Nausea, stomach, Gasping for air and difficulty breathing, Seizures, Cardiac arrest
Fluoride	– Low concentration leads to dental caries while high concentration with Thyroid malfunction, Arthritis, Dementia, Bone fractures
Lead	– Toxic and neurological disorder
Ammonia	– Exposure to high concentrations resulting in respiratory distress
Nitrate	– Blue baby disease, anemia
Copper	– GI ulcerations and bleeding, CNS manifestations, including dizziness, headache, convulsions, lethargy, stupor, and coma
Zinc	– loss of appetite, decreased sense of taste and smell
Mercury	– Harm the brain, heart, kidneys, lungs, and immune system
Aluminum	– Alzheimer's disease or senile dementia

- Responsible people for the Microbiology quality of water

The maintenance of microbiologically safe drinking water requires the commitment of individuals from different disciplines and organizations, including, amongst others:

- ✓ All personnel within water companies responsible for engineering and operational activities associated with drinking water treatment and supply, and for laboratory analyses and quality assessment and District level stakeholders/line agencies and community level involvement and commitments
- ✓ those responsible for public health such as DPHO, Epidemiology and Disease Control Division
- ✓ hospital and Public Health Laboratory Service microbiologists
- ✓ Epidemiologists from the Communicable Disease Surveillance Centre
- ✓ Responsible personnel for the Investigation of Environmental Health
- ✓ Policy makers in the Department of Health, responsible persons from community level to the district to the center

c. **Climate change**

Climate change impacts on WASH

- Small sources of the mountain & hilly areas are drying up gradually due to the climate change and/or over use.
- In the Himalayas snowfall is decreasing and in high mountain areas instead of snowfall, rainfall is occurring due to increase in air temperature. This has reduced amount of snow and ice in the high mountains and himalayas.
- Intensity and amount of floodwater increased and possibility of destroying structures constructed at the riverside.
- In case of river as water source, changes in the period and cycle of low flow and high flow will affect the adjustment of water intake, and changes in water temperature will influence the water source's own purification capacity.

- Enclosed water bodies such as lakes and ponds that serve as water sources, have their water quality vulnerable to changes in solar radiation and temperature, while the water levels are dependent on precipitation amount.
- In case of groundwater as water source, climate change may influence on groundwater recharges in the long term and may affect groundwater level and quality.
- Due to increase in temperature the domestic water demand will increase.
- There is large uncertainty with respect to climate change predictions and impacts on future water availability and quality. Global warming is projected to cause an intensification of present climatic and hydrological variability and may cause extreme events – such as intense storms, floods and drought
- In terms of water availability, projected effects include: increase in higher intensity rainfall events; increasing seasonality of river flows; modification of groundwater recharge patterns; and risk of significant reduction in the volume of reliable surface water**.** In terms of water quality, climate change is likely to exacerbate existing problems. More intense rainfall events will result in increased turbidity of surface water as well as higher (seasonal) contaminant loading of shallow groundwater, possibly leading to an increase in water-borne disease. Increased flooding may also overwhelm currently used sanitary protection measures leading to damage of infrastructure and water contamination.
- Malfunctioning of the water intake and change in water quality will affect water supply capacity and indirectly worsen health & hygiene conditions around human settlements.
- Increase in water temperature may cause an epidemic of water-borne diseases.

Adaptation and mitigation measures

- Urban areas located in humid climate regions, where surface water resources are sufficiently available but exposed to water shortages, are readily adaptive to extreme and long-term climate change impacts.
- 3 R principles: recharge, retain & reuse should be mandatory.
- Rainwater collection & use for domestic as well as industrial purposes should be encouraged.
- Arid and semi-arid areas, where water sources are heavily dependent on groundwater, are exposed to uncertainties in the future water supply, thereby exhibiting likely low adaptive capacities.
- In case of high operational capacities of water service providers that also exhibit low rates of unaccounted-for-water (UFW) as well as high users' awareness on water conservation initiatives, the adaptive capacity seems to be higher.
- It is necessary to strengthen and expand the hydrological glaciological and meteorological observation networks for short, medium and long -term data collection and analysis for proper utilization of available water resources in the context of climate change.
- Redefinition of the water structure design criteria and identification of vulnerable areas and climate friendly technologies
- Development of adaptive measures and proper implementation, researches on water resources for the application of the 3R principles

d. **Incorporating equity into WSP**

- Considering the heterogeneity of groups of people, including women, men, boys, girls, young, old, poor and in particular those who may be disadvantaged, marginalized or vulnerable, during the design, team formation and implementation phases of WSP
- Closely associated with Module 1: WSP team formation (and therefore discussed in depth in the other module)

e. **Water Safety Plan**

- The establishment of health based targets for microbial, physical and chemical quality of water
- Water Safety Plan (WSP) is implemented through Hazard Analysis of Critical Control Points (HACCP). The process diagram of WSP is shown in Figure 3.

Module 1-WSP team formation

Module 2-Describe the system

Module 3-Hazard identification and initial risk assessment

Module 4-Control measures and risk assessment

Module 5-Improvement plan

Module 6-Control measure monitoring

Module 7-Verification

Module 8-Management procedures and supporting programme

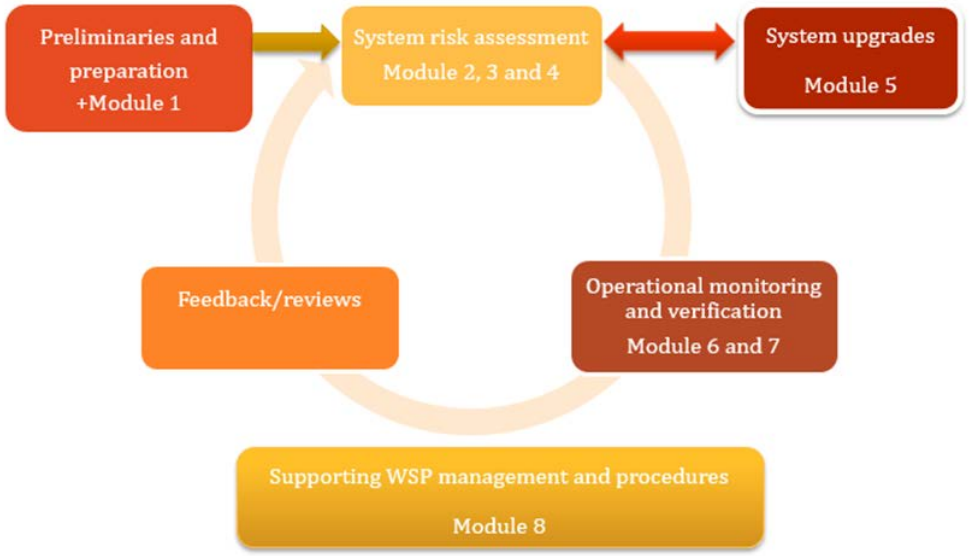


Figure 3: WSP process diagram

- General introduction to the framework of the WSP, as depicted in Table 6 and shown schematically in Figure 3 and Figure 4:

Table 6: WSP framework

Component	Requirements
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)
System requirement	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).
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.
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
Surveillance	A system of independent surveillance verifies that the above components are operating properly and effectively.

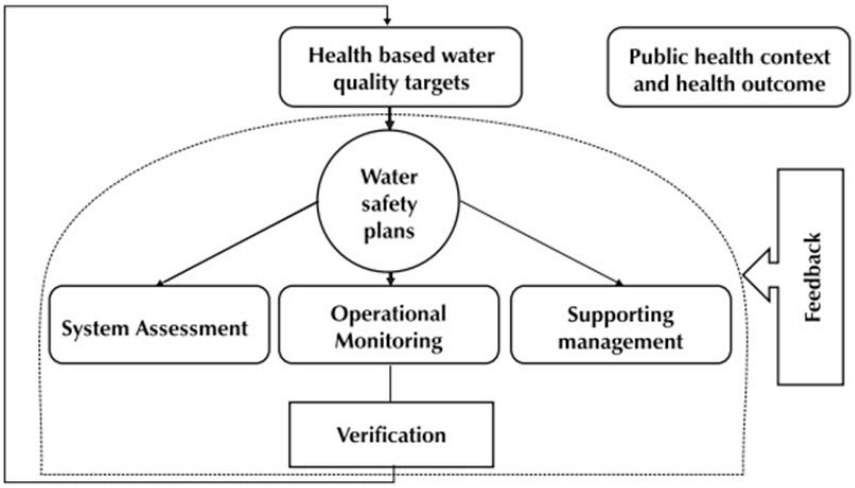


Figure 4: WSP framework schematic

- Objectives of WSP:
  - ✓ Prevent contamination of source waters
  - ✓ treat the water to reduce or remove contamination that could be present to the extent necessary to meet the WQ targets
  - ✓ Prevent contamination during storage, distribution and handling
- Brief overview of the (7+3) WSP steps
- Benefits of implementing WSP: awareness, cost savings, basis to draw capital investments, assurance of health and so on (as shown in Figure 5)

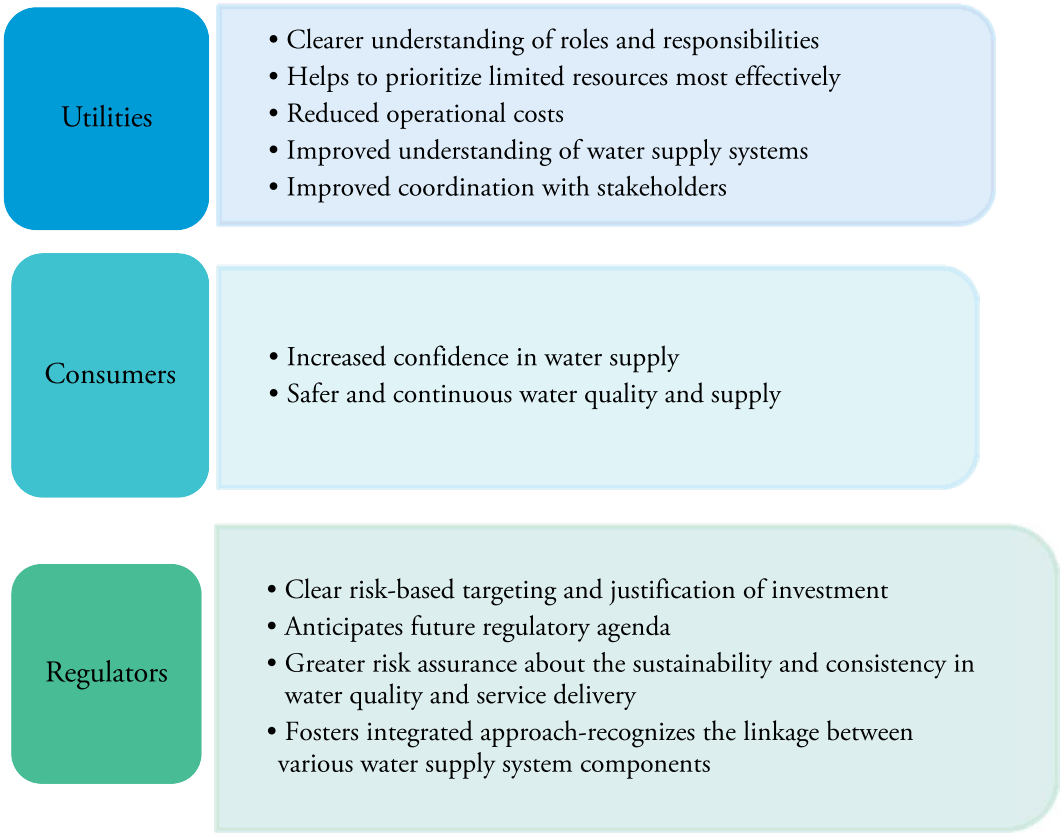


Figure 5: Benefits of WSP

3.1.6 Exercise(s) of this session

a. Public health

This is a group exercise. The participants should be asked to do the following tasks.

1. Calculation of average amount of water required for

(a) Consumption

Average water consumption per person per day = 2 litres

Average water required for consumption per house per day = 5 *2 litres

Total water required for consumption per house per year = 5 *2*365 litres=3,650 litres =3.65m^3

(b) Domestic activities

Average minimum water required for domestic activities/person /day = 45litres

Average water required for domestic activities per house /day = 45 *5 litres

Total water required for domestic activities/house /year = 45 *5*365 litres=82,125 litres= 82.1m^3

If we could ensure about 3.65m^3 water for consumption and 82.1 m^3 for domestic activities about 80% of our diseases related to quality of water will be prevented.

Knowledge Check in Public Health

2. Fill in the blank with the correct answer

A. Pandemic B. Intervention

C. Epidemic D. Prevention

A_____ is a disease occurrence among a population that is in excess of what is expected for a given time and place.

Answer: A

Knowledge Check in Public Health

3. Match each stakeholder to its role in public health

A. Academia	1. Vehicle for public discourse
B. Employment and business	2. Health in all policy
C. Government	3. Education and training
D. Media	4. Wellness initiative and benefits

Answer: D-1, C=2, A-3, B-4

Knowledge Check in Public Health

4. Match each component of the public health approach with the questions they answer.

A. Risk factor identification	1. What is the problem?
B. Surveillance	2. What is the cause?
C. Implementation	3. What works?
D. Intervention Evaluation	4. How do you do it?

Answer: B-1, A-2, D-3, C-4

b. **Climate change**

In this exercise, the facilitators should show a few pictures of either the impacts of climate change on water resources or the impact of WSP in conserving them. The participants should be asked to distinguish the pictures in the two categories. Please refer the exercise section of **PowerPoint presentation entitled Supplementary presentation 1: Climate Change and WSP** for more details.

MODULE 1: WSP TEAM FORMATION

3.2 WSP team formation (Module 1)

3.2.1 Session goals

The objective of this session is to help the participants understand the following points about formulating a WSP team:

- Engage senior management (Why is it required? How is it formed?)
- Identify required expertise (What skills or experience are required to implement the plan, the number of people required, need for external experts?)
- Appoint a chairperson (Why is it required? How is it appointed? What skills are required?)
- Define roles and responsibilities (Clearly defined and documented, performance analysis and evaluation)
- Define time frame (Time input required of the team)
- Challenges of assembling a competent WSP team

3.2.2 Time allotted for the session

30 minutes (for presentation) +15 minutes (for exercise)

3.2.3 Resources

- PowerPoint entitled as Module 1- WSP team formation
- Others

3.2.4 Reference to the Participant's workbook

- Exercise 2 of section 3.2.1

3.2.5 Important points of this session

In this session, you must make sure to stress the following key points:

- It is very essential to form a WSP team comprising honest and capable people, and of different backgrounds and expertises, to lead the way towards achieving the WSP goals.
- In addition to WSP team positions, the roles and responsibilities need to be established and understood. It should be made very clear that the leaders in particular need to know that they are the drivers for the process. Defining team roles and responsibilities and encouraging regular (e.g. monthly or quarterly) meetings and minute keeping will serve to clarify and formalize expectations of the WSP team and will encourage ongoing activity.
- The team members should have the skills and resources to link WSP with other community initiatives such as WASH, solid waste management and environmental management.

- A WSP should not be restricted to paperwork or a 'plan' only. Its implementation and regular review is vital to ensuring good quality water to serve the consumers. As such, it should become a day-to-day operational tool, which must include operational managers.
- Operators of the system who physically work in or on the system (e.g. water treatment plant operator and linesman) should understand the system from a day-to-day operation perspective and their input is important to a team.
- It is essential that members of the District Disaster Relief Committee (DDRC) are also included in the team as their inputs and direction may be vital during times of crises such as natural calamities.

3.2.6 Exercise(s) of this session

- In this exercise, the participants should be asked to enlist a team of "ideal" WSP members for the reference water supply project.
- It should be strongly emphasized that the names should not be imaginary or dummy, and that only responsible, genuine and eligible persons should be named.
- The participants should be asked to write down job titles and names, if they know them, the expertise they will bring to the team, contact information and back-up contact details.
- It should be clarified that the WSP team members should bring the following knowledge and expertise to the fore:
  - ✓ 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 programmes.

(Some references/suggestions have been made in column 4 of Table 7)

- The participants should be asked to identify the missing expertise and make suggestions of whom they could ask to help source this expertise.

Table 7: Water Safety Plans 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/ Telephone no.
1			WUSC, Member		
2			School Science, EPH Teacher		
3			Meteorological Station		
4			Forest User Committee		
5			CCA or DRR committee member of DDC		
6			Retired GoN employee of Department of Hydrology and Meteorology		
7			Retired GoN employee of Department of Forest and Soil Conservation		

Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6
S. No.	Name	Position	Affiliated organization and designation	Role/responsibility	Contact address/ Telephone no.
8			Retired GoN employee of Department of Water Supply and Sewerage		
9			Retired GoN employee of Department of Environment		
10					
11					
12					
13					

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 WSPs team in coordination with the WUSC or operator of water system.

MODULE 2: WATER SUPPLY SYSTEM ANALYSIS

3.3 Water supply system analysis (Module 2)

3.3.1 Session goals

The objectives of this session is to help the participants get familiarized with:

- Risks to be assessed and managed (field investigations, local knowledge) in the water supply system
- Water quality standards (National Drinking Water Quality Standards)
- Likely changes to source water quality following changes in weather
- Interconnectivity of source waters (e.g. 2 wells, 1 stream)
- Information relating to water storage
- The operational & managerial staff involved, etc.
- Documentation of the components of the water supply system

3.3.2 Time allotted for the session

45 + (45) minutes

3.3.3 Resources

- PowerPoint entitled as Module 2- Water supply system analysis
- Others

3.3.4 Reference to the Participant's workbook

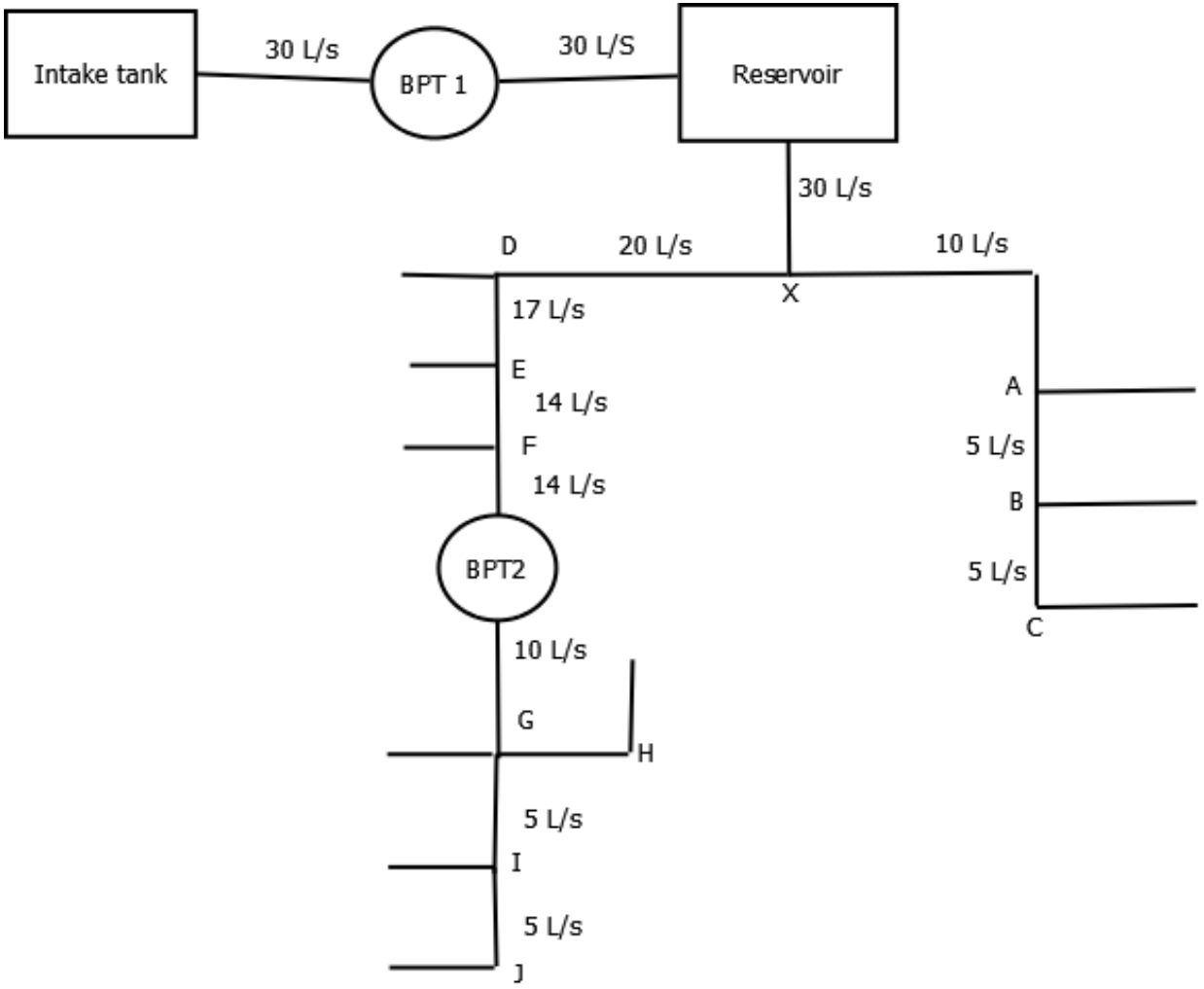
- Exercise 4 and 5 of section 3.3.1

3.3.5 Important points of this session

- The operators of any water supply scheme must understand that the reason for analyzing or describing a water supply project is to provide sufficient information in order to understand the subsequent water quality risk assessment and to identify where the system is vulnerable to hazardous events.
- It is important to make sure that the catchments to consumer descriptions are accurate and field-verified. Descriptions need to be as specific as possible-generic descriptions should be used as a starting point only.
- The system needs to be described relative to the water quality standards required (which in turn are based on the local health-based targets).
- It is necessary to include the key staff involved while describing the water supply systems.
- Assessment should include the suppliers' and communities' understanding of water quality and risks and make the links to other WASH activities (e.g. open defecation free zones in catchments, agricultural and forestry management activities, and industrial discharge management in catchments).

3.3.6 Exercise(s) of this session

- In Box 1, the participants should be asked to draw a schematic diagram of the reference water supply projects. This will help them accomplish the exercises that are to be done in the future sessions.
- In Table 8, the participants 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.
- It is essential for the facilitators to stress that while describing the physical features of the main structures/ equipment particularly for catchment area, the surroundings or the immediate vicinity should also be discussed. 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.
- Flow diagrams are not always well understood. Errors often result and system assessments therefore lack information. You should spend some time to ensure that both the system and diagrammatic approach are well represented.
- The upstream descriptions should be described as they are. In other words, for schemes having multiple sources (say surface water and groundwater), the description and analysis should be done separately as the risks in each of these may not be common.
- You should make sure that treatment descriptions are not far too simple since these are key barriers. Those responsible for water treatment may be inadequately trained and/or skilled. You may need to provide some specific guidance in this area – e.g. the concentration-time (CT) relationships of chlorination – either in the training or separately.



Box 1: *Space to map schematically the participant's water supply system mechanism*

Table 8: Analysis of main components of water supply scheme

Col. 1	Col. 2
S. No.	**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 upstream 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)

Col. 1	Col. 2
S. No.	**Name and detail of components**
5.	Consumers Point (Tap stand) (private, public, maintenance and other information)
5.1	Water Use (Domestic, Irrigation, cottage industry, etc)
5.2	Water Use Practices (Storage vessel, Storage tank, Fetching behaviours, internal plumbing)

MODULE 3: IDENTIFICATION OF HAZARDS AND RISKS

3.4 Identification of hazards and risks (Module 3)

3.4.1 Session goals

The objective of the session is to accomplish the following tasks by the participants:

- Define hazards and hazardous events
- Identify all hazardous events that could contaminate, compromise or interrupt supply
- Identify all potential hazards in supply chain
- Help participants record and present their hazardous events.
- Evaluate the risks associated with each hazard/hazardous event

3.4.2 Time allotted for the session

45+ (45) minutes

3.4.3 Resources

- PowerPoint entitled as Module 3-Possible contamination of water resources and risk to water supply systems
- Others

3.4.4 Reference to the Participant's workbook

- Exercise 6 of section 3.4.1

3.4.5 Important points of this session

The following are the key points to be stressed while delivering the presentations of this session:

- Hazards and hazardous events are related, but different;
- Hazardous event descriptions need to be specific;
- Whenever you as a presenter give an example of a hazardous event, ensure it illustrates the principles clearly.
- Ensure there is a balance of focus on system components. For example, in some cases, upstream components receive too much attention (relative to their risk) compared to treatment plants.
- Ensure there is a good understanding of the types and nature of hazardous events. For example, 'intermittent supplies' may be listed as a hazardous event but specific hazardous events relating to intermittency are not listed. Encourage the underlying causes of problems to be understood and included as separate hazardous events.
- Assessing hazardous events means thinking more about causes and a little less about consequences as this will enhance the development of appropriate control measures to reduce / eliminate hazardous events.
- Identification of hazard and hazardous events starts with inquisitive frame-of-mind by raising questions like:

- ✓ What could go wrong here?
- ✓ Why and how could it go wrong?
- ✓ Where and when could something wrong happen in the water system?

3.4.6 Exercise(s) of this session [1]

- 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 more complex system, such as those in the urban regions, may benefit from a semi-quantitative risk prioritization approach. A 3×3 semi quantitative matrix has been shown in Table 9 and its description has been shown in Table 10.

Table 9: 3 x 3 semi-quantitative matrix

No/minor impact **Moderate impact** *1* *2*			**Consequence**		
			Major impact *3*		
Likelihood	**Unlikely**	*1*	1	2	3
	Possible	*2*	2	4	6
	Likely	*3*	3	6	9

Risk score:	⩽2	3-5	⩾6
Risk level:	Low	Medium	High

Table 10: Description of outputs of the semi-quantitative matrix

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

- 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.
- In Table 11, possible hazards are identified, and its likelihood, severity and consequences are determined quantitatively and qualitatively from columns 1 through 3.
- In column 4 of the same table, existing control measure in place (in the participants' water supply systems) is listed.

1 Form 3-4 of (National) Climate Resilient Water Safety Plans Guideline for Urban water supply system

Table 11: Hazard identification and risk analysis

Col. 1	Col. 2			Col. 3	Col. 4
Source and type of contamination	Risk assessment (before consideration of the impact of the existing control measures)				Existing control measures only
	Score 1-9			Level (low, medium or high)	
	Likelihood	Conse-quences	Score		
Source/catchments area/Intake/Deep boring:					
1. Water gets contaminated due to cattle grazing in the vicinity of intake – (microbial contamination)	*3*	*3*	*9*	*High*	*Fencing around the intake*
2. Water gets contaminated due to turbidity from landslides/floods	*2*	*3*	*6*	*High*	*Protection of intake*
3. Sediment collection, Collapse of intake structure	*3*	*3*	*9*	*High*	*Diversion channel*
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*
Reservoir/Treatment plant					
1. Because of turbidity, pressure filter doesn't work properly (overloaded) which makes water biologically & physically hazardous.	*3*	*3*	*9*	*High*	*We don't use pressure filter during this time we bypass the water from filter and not supply to users.*
2. Chance of over and under chlorination.	*2*	*2*	*4*	*Medium*	*Develop pre- chlorination system*
3. Intermittent supply leads to biologically hazardous from the point of leakages.	*2*	*2*	*4*	*Medium*	*Manage 24 hours water supply*

Tap and users place					
1. Meters are blocked, leakages and chance of biologically 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.*
2. Poor sanitation practice, dirty collection tanks and storage vessel makes water biologically and physically hazardous.	*2*	*2*	*4*	*Medium*	*Conduct awareness programme to users*

MODULE 4: DETERMINATION OF PREVENTIVE AND CONTROL MEASURES

3.5 Determination of preventive and control measures (Module 4)

3.5.1 Session goals

The objective of this session is to make the participants able to learn and perform the following tasks:

- Document existing and potential control measures
- Assess their effectiveness (validation)-monitoring, historical records, sanitary surveys etc.
- Recalculate risks accounting for existing control measures
- Prioritize risks via the use of different risk methods and matrices

3.5.2 Time allotted for the session

30+ (15) minutes

3.5.3 Resources

- PowerPoint entitled as Module 4- Determine and validate control measures
- Others

3.5.4 Reference to the Participant's workbook

- Exercise 8 of section 3.5.1

3.5.5 Important points of this session

The following are the key points to be stressed while delivering the presentations of this session:

- Definitions:
  - ✓ Control measure- any action or activity that prevents, eliminates or reduces water safety hazards to an acceptable level
  - ✓ Validation-activities to investigate the effectiveness of control measures
- The control measures should always be associated with an existing or potential hazardous event. The term 'validation' always refers to that of the control measures.
- The prioritization of risks is an important aspect that the participants should learn in order to develop an action/ upgrade plan to mitigate those risks.

3.5.6 Exercise(s) of this session [1]

- This is a continuation of the exercise from the previous module.
- Existing control measure in place (in the participants' water supply systems) as written in column 4 of Table 11

1 Form 3-4 of (National) Climate Resilient Water Safety Plans Guideline for Urban water supply system

is written in column 1 of Table 122. The risk is reassessed after considering the impacts of these control measures through columns 2 and 3. For the assessment, Table 9 and Table 100 should be referred.

- A verdict is to be given in column 4 in which it must be stated whether or not a new control measure or a rehabilitation/improvement of the existing one is required.

Table 12: Control measures to counter the identified hazard in WS components (urban)

Col. 1	Col. 2			Col. 3	Col.4
Existing control measures	Risk with control measure (Reassessment of risk)				Is there a need for a new control measure or improvement?
	Risk score 1-9			Risk level (low, medium or high)	
	Likelihood	Conse-quences	Score		
Source/catchments area/Intake/Deep boring:					
1. Fencing around the intake	*1*	*3*	*3*	*Medium*	*Yes*
2. Protection of intake	*1*	*3*	*3*	*Medium*	*Yes*
3. Diversion channel	*1*	*3*	*3*	*Medium*	*Yes*
Pipelines					
1. Protect and provide concrete/ steel casing with abutments to the transmission pipelines laid along the historic landslide zones.	*1*	*3*	*3*	*Medium*	*Yes*
Reservoir/Treatment plant					
1. 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. Develop pre chlorination system	*1*	*1*	*1*	*Low*	*Yes*
3. Manage 24 hours water supply	*1*	*1*	*1*	*Low*	*Yes*
Tap and users place					
1. 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. Conduct awareness programme to users	*1*	*1*	*1*	*Low*	*No*

MODULE 5: IMPROVEMENT/UPGRADE PLAN

3.6 Improvement/upgrade plan (Module 5)

3.6.1 Session goals

- Prioritize action for each uncontrolled or ineffectively controlled risk
- Implement short-, medium-, and long-term activities
- Maximize effectiveness of resources

3.6.2 Time allotted for the session

30 + (15) minutes

3.6.3 Resources

- PowerPoint slide entitled as Module 5 - Develop, implement and maintain an improvement/upgrade plan

3.6.4 Reference to the Participant's workbook

- Exercise 9 of section 3.6.1

3.6.5 Important points of this session

- An improvement/upgrade plan aims to mitigate the risks as identified in the previous sessions by improving or modifying the existing controls that are not effective enough.
- An improvement/upgrade plan can include short-, medium- and long-term programmes and should be implemented based on the significance of the risk and available resources.
- Capital investment and resources are required to formulate an implementation/upgrade plan. Since they may be very limited, the risks that were identified as critical in the previous exercises (risk prioritization exercise) are to be addressed first.

3.6.6 Exercise(s) of this session [1]

In this exercise, new and improvement on existing control measures are listed, as well as the time and cost required for them to take effect. Table 13 provides a form to determine the improvement plan of the existing control measures

1 Form 5 of (National) Climate Resilient Water Safety Plans Guideline for Urban water supply system

Table 13: Improving and formulating new control measures (CMs)

Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6
Source and type of contamination	New and improvement on existing CMs	Who?	Possible time of completion	Cost (NRs.)	Remarks
Source/catchments area/Intake/Deep boring:					
1. Water gets contaminated due to cattle grazing in the vicinity of intake – (microbial contamination)	*1. Construction of fencing (barbed wire) around intake at 2 m away.*	*WUSC*	*2 months*	*~100,000/-*	
2. Water gets contaminated due to turbidity from landslides/floods	*2. Intake structures to be relocated*	*WUSC*	*5 months*	*~200,000/-*	
3. Sediment collection, Collapse of intake structure	*3. Construct new intake structure with screening system*	*WUSC/Contractors*	*2 years*	*~300,000/-*	
Pipelines					
1. Cracks and rupture due to increased temperatures, leakage and poor delivery	*1. Rebuild transmission pipelines with better alignment and temperature resistant materials*	*WUSC/Contractors*	*2 years*	*~700,000/-*	
Reservoir/Treatment plant					
1. Because of turbidity, pressure filter doesn't work properly (overloaded) which makes water biological & physical hazardous.	*1. Change Filter media and control high turbid water at intake site by construction of filter plants.*	*DWSS+WUSC*	*3 years*	*~700,000/-*	
2. Chance of over and under chlorination.	*2. Conduct training on chlorination system to plumbers and watchman.*	*WUSC*	*2 years*	*~10,000/-*	

Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6
Source and type of contamination	New and improvement on existing CMs	Who?	Possible time of completion	Cost (NRs.)	Remarks
3. Intermittent supply leads to biological hazardous from the point of leakages.	*3. Construct deep well at different places for supplying 24 hours water supply.*	*WUSC*	*4 years*	*~200,000/-*	
Tap and users' place					
1. Poor sanitation practice, dirty collection tanks and storage vessel makes water biological and physical hazardous.	*1. Conduct awareness programme to users about sanitation activities.*	*WUSC*	*4 years*	*~50,000/-*	

MODULE 6: MONITORING OF THE CONTROL MEASURES

3.7 Monitoring of the control measures (Module 6)

3.7.1 Session goals

- Define and validate the monitoring of control measures
- Assess if the control measures are working
- Know what corrective actions are needed when things go wrong

3.7.2 Time allotted for the session

45 + (45) minutes

3.7.3 Resources

- PowerPoint slide entitled as Module 6 - Define monitoring of the control measures

3.7.4 Reference to the Participant's workbook

- Exercise 11 of section 3.7.1

3.7.5 Important points of this session

- Definitions
  - ✓ Operational monitoring – the act of conducting a planned sequence of observations or measurements of control parameters to assess whether a control measure is operating within design specifications
  - ✓ Critical limit – a criterion that separates acceptability from unacceptability
  - ✓ Corrective actions – any action to be taken when critical limits are exceeded
- Operational monitoring aims to answer this question: Is the control measure effectively working now?
- Operational monitoring should include corrective actions, which are the actions that should be taken when the results of monitoring show that the critical limit is exceeded.
- Illustrate the logic of operational monitoring and corrective action.
- How to choose which control measures must have an operational monitoring and corrective action plan so that all essential control measures have operational monitoring plans. Use the decision question "If this control measure was not functioning correctly, would the risk of its hazardous event(s) be unacceptable?" to decide which control measures shown in the hazard/risk table need to be shown in the "operational monitoring plan".
- Procedures need to be in place on how to monitor these control measures, including information related to critical limits and corrective actions.
- Monitoring programmes need to include: what, how, when, where, who.
- Persons responsible for monitoring, analyzing and receiving results need to be identified.

3.7.6 Exercise(s) of this session [1]

- A monitoring plan should be made with a clear indication of what, who, when and how to monitor the control measures.
- Table 12 and 13 are used to plan what monitoring will be undertaken in Table 14. 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 Table 14 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.
- 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 Table 15.

1 Form 6A and 6B of (National) Climate Resilient Water Safety Plans Guideline for Urban water supply system

Table 14: 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	What?	How?	Who?	When?	Operational limit	What to do if not in order?
Source/catchments area/Intake/Deep boring:						
1. Construction of fencing (barbed wire) around intake at 2 m away.	*Condition of the door and the fence*	*Site visit, inspection (mostly eye judgement)*	*Watchman, Guard*	*Weekend*	*Barbed wire fencing are intact and no cattle grazing inside the fence is seen*	*Repair*
2. Intake structures to be relocated	*Functioning of new structure*	*Site visit, inspection (mostly eye judgement)*	*WUSC/ VMW/Technicians*	*Once a month*	*No leakage observed from the intake*	*Repair*
Pipelines						
1. Rebuild transmission pipelines with better alignment and temperature resistant materials	*Check for leakages at multiple points*	*Site visit, inspection (mostly eye judgement)*	*WUSC/ VMW/Technicians*	*Once a month*	*No leakage observed from the pipeline*	*Repair*
Reservoir/Treatment plants						
Taps and users' place						

Table 15: Record keeping of monitoring plans

Date:
Time:
Recorded by:

Col. 1	Col. 2	Col. 3
Control measures	Status	Remarks
1. Construction of fencing (barbed wire) around intake at 2 m away.	*Not okay*	*Repair the fence. Make sure it strongly prevents human and animal interference into the catchment.*
2. Intake structures to be relocated	*Okay*	

MODULE 7: VERIFY THE EFFECTIVENESS OF WSP

3.8 Verify the effectiveness of WSP (Module 7)

3.8.1 Session goals

The session aims to clarify the following points about verifying the effectiveness of the WSP:

- application of methods, procedures, tests and other evaluations to determine compliance with the WSP
- confirms that the water quality targets are being met and maintained and that the system as a whole is operating safely and the WSP is functioning effectively

3.8.2 Time allotted for the session

45+ (45) minutes

3.8.3 Resources

- PowerPoint slide entitled as Module 7 - Verify the effectiveness of the WSP

3.8.4 Reference to the Participant's workbook

- Exercise 13,14 of section 3.8.1

3.8.5 Important points of this session

- Definitions:
  - ✓ Verification - application of system procedures, tests and other evaluations to determine compliance with WSP, and its effectiveness
  - ✓ Validation – investigate activity to identify the effectiveness of control measures
  - ✓ Operational monitoring - the act of conducting a planned sequence of observations or measurements of control parameters to assess whether a control measure is operating within design specifications
- Three activities of verifications: compliance monitoring (if the water quality meet the set targets?), internal and/or external auditing (to assess the practical implementations of WSPs and compliance by the members from and outside the water supply schemes), and consumer satisfaction (whether or not the consumers are happy with the quality and amount of water being supplied)
- Key challenges to verifying a WSP: lack of capable auditors, lack of qualified laboratories, lack of resources, no consumer feedback and inaccurate documentation

3.8.6 Exercise(s) of this session [1]

- 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 WSPS being implemented in practice.
- 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.
- Table 16 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.
- Inspection/observation of the system components especially the CM and water quality testing at various points may help verify that WSPs has achieved its target. Periodic verification by the WSPS team or the water operator itself can be termed as an "internal audit of WSPs".

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 WSPs reports and cross checking the water quality test reports or conducting quality test and inspection of control measures by itself.

- Table 17 to be used to record the results of the verification. A logbook should be prepared to record all the verification data.

1 Form 7A and 7B of (National) Climate Resilient Water Safety Plans Guideline for Urban water supply system

Table 16: Verification plan

Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7
Sampling point and condition	**Frequency of observation**	**Water quality testing frequency**				
		Turbidity	pH	E. coli	FRC	…..
Source/catchment/Intake	*Monthly*	*Monthly*	*Monthly*	*Monthly*		
Pipelines						
Reservoir tank/treatment plant	*Daily*	*Daily*	*Once a week*	*Once a month*	*Daily*	
Tap and users' place	*Once in a six month*	*Once a month*	*Once a year*	*Once a month*	*Once a week*	

Table 17: Record keeping of periodic verification

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 tank/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.*	
Tap and users' place							

MODULE 8: DEVELOPING SUPPORTING PROGRAMMES

3.9 Develop supporting programmes (Module 8)

3.9.1 Session goals

This session (module 8) incorporates the last three steps (+3) of WSP as depicted in the National Water Safety Plan Manual, designed by DWSS. For convenience, all three steps have been included in this particular module. The facilitators/trainers are free to teach the three steps separately should they feel doing so would be much more effective. The three steps are:

- Management and support to WSP (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.)
- Users (customer) satisfaction survey (to find out consumer's perceptions on the water quality, their confidence on the quality of supplied water, and the water consumption behavior)
- Documentation and review of WSP (continuous process which should be reviewed time to time to ensure that WSP is up-to-date and appropriate to water operators)

In addition to these steps, financial and administrative aspects of WSP implementation can be covered in this session.

3.9.2 Time allotted for the session

135 minutes (45*3)

3.9.3 Resources

- PowerPoint slide entitled as Module 8-Develop supporting programmes

3.9.4 Reference to the Participant's workbook

- Exercise 16 of section 3.9.1

3.9.5 Important points of this session

- Definitions
  - ✓ Supporting programmes – actions such as training and management practices that are catalyst to ensuring drinking water quality, water safety and better management of water supply schemes
- Supporting programmes help increase the core competency of the staffs in water supply projects, their skill and knowledge and commitment to WSP approach
- The supporting programmes range from research to development trainings and seminars
- WSP is a step-by-step procedure and constant improvement is a must. In this, supporting programmes play a vital role.

3.9.6 Exercise(s) of this session

WSPs activities mentioned in previous steps can be made more effective and fruitful with other supportive programmes 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 table 18.

Table 18: Brief listing of Management and support to WSPs

Col. 1	Col. 2	Col. 3	Col. 4	Col. 5
S. No.	**Documented Standard Operating Procedure (SOP)**	**Emergency management plan**	**Activities under water shed management/ Adaptation for Climate change**	**Awareness programme on WASH (planned and or conducted)**
1	*SOPs for treatment plant units (grit chamber, roughing filter, and slow sand filter)*	*N/A*	*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 programme to women groups, child clubs, youth clubs etc. We are planning to conduct more orientation programme to users to make aware about WSPS programme & WASH activities.*

FIELD TRIP AND FIELDWORK

3.10 Field trip and fieldwork activities

In order to ensure that the participants get a sound knowledge of WSP and understand its importance in their water supply projects, a field visit is crucial as a part of the training programme. The facilitators should strongly urge the participants to make a keen observation of the water supply project being visited and try to analyze it from WSP point of view. This requires careful consideration of the potential risks, analysis of existing control measures as well as its effectiveness in maintaining the water quality. As such, it is recommended for the facilitators to refer the following checklist to make sure that all the prerequisites are in order before and during the field visit.

☐ The transportation arrangement for the field visit is arranged beforehand, and that the management committee of the Water supply projects being visited is informed several days in advance.

☐ The physical devices such as water quality test kit, cameras and audio recorders for recording the session are available.

☐ A team leader or a project manager of the water supply system under study is approached to guide the whole tour.

☐ The field visit should cover the whole system, i.e. from catchment to distribution and house connection. (Although this may be difficult if the source is very far away or in a difficult terrain; in this case, a thorough visit to the treatment facility and distribution system should suffice).

☐ The field visit is done only after the participants are trained to do a system description and a desk-top-based list of hazardous events as well as raw-risks, control measures and re-assessed risks.

☐ The participants are briefed about the objective of the session, and are instructed about the procedure of the day as well as ways to complete the assigned exercises.

☐ The participants are split into smaller groups for the field visit (The groups covering i) source and catchment, ii) transmission system, iii) reservoirs and treatment units, iv) distribution system and v) house connections and public stand posts) so that each smaller group has more time to explore issues.

☐ On return to the main venue, a sharing exercise and preparation of presentation is conducted to ensure that all hear the lessons from each other.

3.10.1 Exercise during the fieldwork

- The participants will observe the particular allotted water supply component in group, as per the prior instructions of the facilitators.

- The facilitators are required to instruct the participants answer the following key questions based on their observations and analysis in the water supply project:
  - ✓ What are the potential risks?
  - ✓ What are the existing control measures?
  - ✓ Are they working efficiently? How should they be improved or upgraded?
- They should write the information of the project on a format as shown below in Box 2.
- At the catchment/intake and water treatment plant:
  - ✓ Each group is to develop at least three hazardous events based on their discussions with the operators and their observations.
  - ✓ For these, identify existing control measures used (assuming they exist) based on discussions with the operators.
  - ✓ Identify the risks of the hazardous events allowing for the existing control measures.
  - At the distribution system and customer's residences:
  - ✓ Each group is to develop at least two hazardous events for both the distribution system and customers' residences based on their discussions with the operators/linesman and/or their observations. One of these must be related to repairs of pipes.
  - ✓ For these, identify existing control measures used (assuming they exist).
  - ✓ Identify the risks of the hazardous events allowing for the existing control measures.
-

Box 2: Space for recording information during the field visit

Group: *Source + catchment/Pipelines/Reservoir tank and treatment plant/ distribution*

1. *Schematic diagram*

Participants should be asked to draw a flowchart and/or take pictures of the component they have been assigned

2. *Hazards with photos*

Participants should be asked to identify and enlist the hazard identified in the system component and take photos (Best one may be later awarded during the training for motivation)

3. *Existing control measures with photos*

Participants should be asked to identify and enlist the existing control measures to mitigate hazard identified in the system component

4. *Suggested improvements*

Participants should be asked to suggest improvements to the existing control measures

3.10.2 Exercise after the fieldwork

- After the fieldwork, the participants should be able to complete a task to describe the system in a form as shown in Table 19.
- The task at hand is to describe the conditions of the catchment/intake, water treatment plant, distribution system and customer's residences.
- At the catchment/intake and water treatment plant:
  - ✓ Each group is to develop at least three hazardous events based on their discussions with the operators and their observations.
  - ✓ For these, identify existing control measures used (assuming they exist) based on discussions with the operators.
  - ✓ Identify the risks of the hazardous events allowing for the existing control measures.
- At the distribution system and customer's residences:
  - ✓ Each group is to develop at least two hazardous events for both the distribution system and customers' residences based on their discussions with the operators/linesman and/or their observations. One of these must be related to repairs of pipes.
  - ✓ For these, identify existing control measures used (assuming they exist).
  - ✓ Identify the risks of the hazardous events allowing for the existing control measures.

Table 19: Risk assessment for the water supply system under study during the field visit

Table/group number: ……..

S. No.	Hazardous event	Existing control measure	Risk assessment		
			Likelihood	*Severity or consequence*	*Overall risk score*

PART FOUR

ANNEX AND REFERENCE MATERIALS

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Annex A: Roles & responsibilities regarding Water Safety Plans

A1. 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 projects managed by well trained and active users committee are 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 WSP, following roles and responsibilities should be taken by the WUSC:

- Maintain water quality in compliance to NDWQS, 2005 in their water supply schemes/project.
- Implement WSP by forming WSP team
- Facilitate WSP team to work and carry out latter performance evaluation
- Make necessary provisions of budget and carry out necessary corrective action as demanded and suggested by the WSP 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 WSP and make it easily available
- Verify regularly all works carried out by WSP team
- Coordinate with line agencies and provide support to have external audit of water safety plan (water quality surveillance)

A2. Roles and responsibilities of WSP team

The main task of WSP team is to carry out in sequence all activities envisaged in the WSP. In addition, the team should help WUSC to the activities that are supportive to WSP; communicate and coordinate with other stakeholders in order to mobilize the resources for WSP implementation. Here are the major roles and responsibilities of the WSP 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 WSP team that further develop the improvement plan and prioritize according to risk level and carry out them in coordination with WUSC
- Make sure the CM taken under WSP are valid (working effectively) and the WSP process is verified by conducting water quality test.
- Assess users satisfaction, identify the impact of WSP on health of people, carry out public awareness programme
- Prepare a document including accounts of all activities done under WSP and update each year and distribute to concerned agencies
- Define task of each members of the WSP 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 10 steps of WSP(7 steps + 3 Supporting Activities), the WSP team should, at least once a year, review the WSP 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.
- Make sure the system/components have standard operating procedure (SOP) and the system is operated accordingly.

Annex B: Tips for hazard identification

B1. Typical hazards affecting a catchment

Source of hazard	Associated hazards (and issues to consider)
Meteorology and weather patterns	Flooding, rapid changes in 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
Well/ borehole head works not watertight	Surface water intrusion
Borehole casing corroded or incomplete	Surface water intrusion
Flooding	Highly turbid water

B2. 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
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

B3. Typical hazards associated with 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

B4. Typical hazards affecting consumer premises

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

Annex C: Tips for identifying control measures

C1. Typical control measures at a catchment

Restricted access to catchments
Water utility ownership and control of catchment land
Stock fencing
Moving stock away from river access at calving/lambing times
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 source is affected
Continuous monitoring of intake and river
Site inspections
Regular internal inspections of well and boreholes

C2. Typical control measures 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

C3. Typical control measures 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

C4. Typical control measures at consumer premises

Property inspections
Consumer education
Plumbo-solvency control
Non- return valves
Advice to boil/ not use the water

Annex D: National Drinking Water Quality Standards (2005)

Parameter	Unit	Maximum concentration limits	Remarks
PHYSICAL			
Turbidity	NTU	5 (10)	
pH		6.5-8.5*	
Colour	TCU	5 (15)	
Taste and odour		Should not be objectionable	
Total dissolved solids	mg/L	1000	
Electrical conductivity	Micro-Siemens/cm	1500	
CHEMICAL			
Iron	mg/L	0.3 (3)	
Manganese	mg/L	0.2	
Arsenic	mg/L	0.05	
Cadmium	mg/L	0.003	
Chromium	mg/L	0.05	
Cyanide	mg/L	0.07	
Fluoride		0.5-1.5*	
Lead	mg/L	0.01	
Ammonia	mg/L	1.5	
Chloride	mg/L	250	
Sulphate	mg/L	250	
Nitrate	mg/L	50	
Copper	mg/L	1	
Total hardness	mg/L, as $CaCO_3$	500	
Calcium	mg/L	200	
Zinc	mg/L	3	
Mercury	mg/L	0.001	
Aluminum	mg/L	0.2	
Residual chlorine	mg/L	0.1-0.2*	For systems using the chlorination
BACTERIOLOGICAL			
E. coli		0	
Total coliforms		0 (in 95% samples)	

* These values represent the minimum and maximum limits
( ) Values within parenthesis are acceptable only when no other alternative is available

Annex E: Pre- and post test questionnaire

Climate resilient water safety plan training programme

Name: **Date:**

Please circle the correct option:

1. **What do you understand by WSP?**
   a. Domestic water treatment process
   b. Water consumption after treating it with SODIS, chlorine or boiling process
   c. Identifying risks and possible hazards in water supply projects and finding necessary solutions
   d. None of the above

2. **What kind of water supply projects is appropriate for WSP?**
   a. Ones without treatment systems
   b. Only large scale projects
   c. All types of water supply projects, whether large scale or small
   d. None of the above

3. **WSP needs to be implemented even if the source of water being supplied is a clean spring. Why?**
   a. Because the water maybe contaminated when it rains
   b. Because the water may be contaminated by the time it is consumed
   c. Contaminants may pollute water when it is being distributed
   d. All of the above

4. **Who implements WSP?**
   a. District (sub) division office
   b. Engineers
   c. Local governmental agencies
   d. WSP team

5. **What do you understand by faecal coliform?**
   a. Microorganisms present in faeces
   b. Microorganisms that cause diarrhea
   c. Essential nutrient of water
   d. Both (a) and (b)

6. **How should WSP be approached in Nepal?**
   a. A program to improve the quality of water as per the requirements of national drinking water quality standards

7. **Where is FRC test done?**
   a. In cases where coliform has been detected in water
   b. Water containing arsenic
   c. Water containing chlorine

8. What is the required value for FRC test?

a. 0.1-0.2 mg/L
b. <0.5 mg/L
c. 0.1-0.5 mg/L

9. When was the NDWQS implemented in Nepal?

a. There are no drinking water quality standards in Nepal
b. In progression since 2062 BS
c. Since 2052 BS

10. Where in the water supply system is the test for contamination conducted?

a. Source and intake
b. Pipe line and chamber
c. Water reservoir/tank and treatment centre
d. At point of use/public taps
e. All of the above

11. What do you understand by contaminated water?

a. Water that adversely affects health due to presence of physical, chemical and biological impurities.
b. Water containing minerals
c. Water containing various gases

12. How can we check the effectiveness of WSP?

a. Testing the water quality
b. Consumer satisfaction
c. Both a and b

13. What can be done about WSP if the water supply sytem under consideration requires a massive repair and maintenance work?

a. Prioritize the repair and maintenance work first
b. Initiate WSP, and prepare a long term plan for WSP implementation simultaneously.
c. Put aside a huge budget for WSP

14. What should be done if a responsible person of WSP team has to go elsewhere?

a. The knowledge and all the information should be passed down to a new or fellow member
b. Explain all the proceedings to the whole team, and arrange a timely meeting to ensure everything is in order
c. Both a and b

Annex F: Participant's feedback form

Training on climate resilient water safety plans
Participant's feedback form

1. Are you satisfied with the course and plan to recommend to others?

   ☐ **Yes** ☐ **No**

2. Is the course worth the time and money?

   ☐ **Yes** ☐ **No**

3. Is there harmony among the sessions with respect to WSP?

   ☐ **Yes** ☐ **No**

4. Does the course consider the importance of WSP in water supply projects?

   ☐ **Yes** ☐ **No**

5. Did the facilitators allow discussion of viewpoints other than his/her own and encouraged questions?

   ☐ **Yes** ☐ **No**

6. Suggest other topics that should have been changed or covered in the training.

   ☐ **Yes** ☐ **No**

7. Suggest improvement for training course and management, if any.

   ☐ **Yes** ☐ **No**

8. Please provide topics of training, you deem necessary in future or you and your subordinate staff would like to attend.

   ☐ **Yes** ☐ **No**

9. Any other remarks:

Comments:

Annex G: User satisfaction form (to be done before and after the WSP implementation)

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 table below to be given in percentage of HH saying "Yes"

Date:

S.N.	Questionnaire	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Average
1.	Are you (the users) aware of importance of water quality on public health?						
2.	What do you think about water safety measures 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 your complaints area addressed by the supplier?						
7.	Are you satisfied with the tariff (reasonable with the service)?						
8.	Do you 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						
10.	How do you treat water fetched from tap before drinking? (Percentage of household)						
	i. Do Nothing						
	ii. Boiling						
	iii. Use Chlorine						
	iv. Filter						
	v. Use SODIS (Solar disinfection)						
	vi. Other Methods						

Annex H1: A case study of a water supply project (Gravity supply)

This is a case study of a water supply and sanitation project of a small town serving for about 3000 households. The source of water is stream intake. In stream intake system, a grit chamber filters out grit, sand, and small pebbles. The water is then sent to a sedimentation tank. The water effluent from the roughing filter goes to the four-chambered slow sand filter. Water is then disinfected in the chlorination unit. Disinfected water is stored in a reservoir tank before distributing to the service area.

There is an overhead tank connected to the system from which water is distributed to the 3000 households.

Few Conditions:

- ✓ The stream source and catchment is in Hill area and there is farmland upstream of the catchment
- ✓ The structures of intake and treatment plant are easily accessible
- ✓ There are risks of damages to the pipes due to landslides and extreme temperature fluctuations.
- ✓ There is no adequate cleaning mechanism of structures
- ✓ There is no proper use of chlorine in treatment
- ✓ There is one primary and another higher secondary school benefiting from the system
- ✓ The service area is more or less flat area and have shallow tube wells in most of the HHs

The health post office shows yearly record of water borne diseases, morbidity and mortality due to diarrhea

Annex H2: A case study of a water supply project (Terai)

In a village in Terai, shallow tube wells are used to extract groundwater to meet most of the water supply needs. There are household (private) tube wells and community (public) tube wells.

However, reports have shown that the groundwater is contaminated with bacteria such as fecal coliform. In most cases, the microbial contamination is caused by unsanitary practices of constructing or using the wells. These practices are responsible for such a result have been identified to be:

- ✓ Sludge drilling using cow dung slurry while constructing the tube well.
- ✓ Use of contaminated water to prime (extracting water when the water level is low due to which suction cannot be created) the tube well.
- ✓ Inadequate sealing of the wells
- ✓ Lack of protective measures such as platforms to protect wells.
- ✓ Improper drainage that result in accumulation of wastewater in the pit near the well.
- ✓ Flooding during monsoon.