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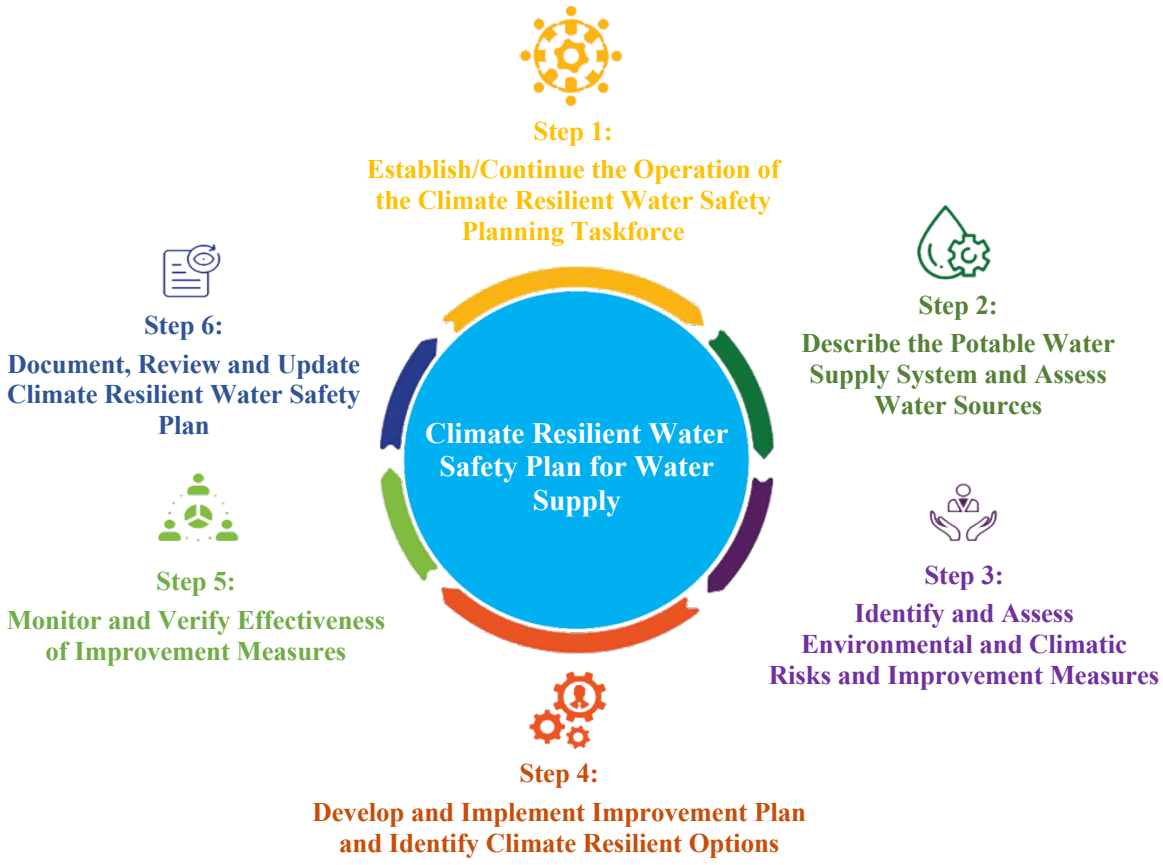
Ministry of Industry, Science, Technology and Innovation

Guideline on Climate Resilient Water Safety Plan for Water Supply



Prepared by: Department of Technical Affairs and Project Management, General Department of Potable Water Supply

Supported and Co-Developed by: UNICEF and Cambodian Rural Water Supply Association

2023

The Kingdom of Cambodia
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Ministry of Industry, Science, Technology and Innovation
No. 090 MISTI / 2023

Prakas

On

The Implementation of Guideline on Climate Resilient Water Safety Plans for Water Supply

The Minister of Industry, Science, Technology and Innovation

- Having seen the Constitution of the Kingdom of Cambodia
- Having seen Royal Decree No. NS/RKT/0918/925 dated September 6, 2018 on the Appointment of the Royal Government of Cambodia
- Having seen Royal Decree No. NS/RKT/0320/421 dated March 30, 2020 on the Appointment and Adjustment of the Composition of the Royal Government of Cambodia
- Having seen Royal Kram No. NS/RKM/0618/012 dated June 28, 2018 promulgating the Law on the Organization and Functioning of the Council of Ministers
- Having seen Royal Kram No. NS/RKM/0320/009 dated March 26, 2020 promulgating the Law on the Establishment of the Ministry of Industry, Science, Technology and Innovation
- Having seen Royal Kram No. NS/RKM/0323/002 dated March 11, 2023 promulgating the Law on Potable Water Management
- Having seen Sub-decree No. 48 ANKr.BK dated April 6, 2020, on the Organization and Functioning of the Ministry of Industry, Science, Technology and Innovation
- Referring to the request of the Ministry

Hereby Decides:

Article 1.-

The Guideline on Climate Resilient Water Safety Plans for Water Supply is introduced for implementation to ensure the quality, safety, and sustainability of potable water supply by enhancing the climate resilience of potable water supply systems as attached to this Prakas.

Article 2.-

This Prakas shall apply to all water supply services under the Ministry of Industry, Science, Technology and Innovation mandate, particularly water supply systems located in areas vulnerable to climate change impacts.

Article 3.-

The Guideline on Climate Resilient Water Safety Plans for Water Supply is developed based on the 2015 Water Safety Plan.

The Guideline provides a risk assessment and management approach for dealing with climate change risks to water supply systems from water sources to connection facilities through the implementation of 6 steps including: (1) Establish/Continue the Operation of Water Safety Planning Taskforce (2) Describe the Drinking Water Supply System and Assess Water Sources (3) Identify and Assess Environmental and Climatic Risks and Improvement Measures (4) Develop and Implement Improvement Plan and Identify Climate Resilient Options (5) Monitor and Verify Effectiveness of Improvement Measures (6) Document, Review and Update Climate Resilient Water Safety Plan.

Article 4.-

Article 4 of Prakas No. 210 MIH/2015 dated December 14, 2015, on National Standards for Potable Water, which instructed the implementation of Water Safety Plans in the water supply sector, and any provisions that contradict this Prakas shall be considered null and void.

Article 5.-

Chief of Cabinet, Director Generals, Inspector General, Directors of Centers, and Heads of Units under the Ministry at national and sub-national levels, and water supply operators involved shall be responsible for implementing this Prakas from the date of signature.

Phnom Penh, May 2, 2023

Senior Minister
Minister of Industry, Science, Technology and Innovation

H.E. Kitti Setha Bandith **Dr. CHAM Prasidh**

CC:

- Office of the Council of Ministers
- Ministry of Interior
- Ministry of Economy and Finance
- Capital/Provincial Administrations
- Provincial Departments of Industry, Science, Technology and Innovation
- Cambodia Water Supply Association
- As mentioned in Article 5
- Archive

Preface

“Water” serves as the foundation for growth in all sectors and sustains human livelihoods. Hence, the Royal Government of Cambodia consistently prioritizes water sector development among its four priority areas - human, roads, electricity, and water. Moreover, the Royal Government's water supply policy states, *"Extend urban water supply coverage to 90% by 2023 and 100% by 2025 to cater to the essential needs of the people as well as various productions and services through the development and extension of both public and private water supply systems, focusing on four conditions* - ***water quality, safety, sustainability, and affordability."***

Due to natural factors, climate change, increased water usage, and pollution, water sources, water supply systems, and the provision of water supply services have been and continue to be impacted. Therefore, to respond to the above objectives and ensure the quality, safety, and sustainability of water supply, the Ministry of Industry, Science, Technology and Innovation is introducing the **"Guideline on Climate Resilient Water Safety Plan for Water Supply"** to assess and manage various risks that affect drinking water supply systems from source to tap, to enhance the climate resilience of water supply system.

These guidelines were developed based on the 2015 Water Safety Plan framework and involve the implementation of six steps including: (1) Establish/Continue the Operation of the Water Safety Planning Taskforce (2) Describe the Drinking Water Supply System and Assess Water Sources (3) Identify and Assess Environmental and Climatic Risks and Improvement Measures (4) Develop and Implement Improvement Plan and Identify Climate Resilient Options (5) Monitor and Verify Effectiveness of Improvement Measures (6) Document, Review and Update Climate Resilient Water Safety Plan.

I firmly believe that these beneficial guidelines will achieve widespread dissemination and application, with complete cooperation from all relevant stakeholders, both public and private sectors, to minimize potential impacts on water supply systems and water sources, especially in the context of climate change, for the common benefit of all Cambodian people.

Finally, on behalf of the Ministry of Industry, Science, Technology, and Innovation, I would like to express my gratitude to the UNICEF team, Cambodia Water Supply Association (CWA), and all stakeholders for their technical and financial support in preparing these guidelines. I would like to express my high appreciation to the technical officials, management of the General Department of Potable Water Supply, and all management of the Ministry of Industry, Science, Technology and Innovation who have made significant efforts in preparing this Guideline on Climate Resilient Water Safety Plans for Water Supply.

Phnom Penh, May 02, 2022

Senior Minister
Minister of Industry, Science, Technology and Innovation

H.E. Kitti Setha Bandith **Dr. CHAM Prasidh**

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Annex

Annex 1: Climate Resilient Water Safety Plan Template

Abbreviations

CCA	Climate Change Adaptation
CR-WSP	Climate Resilient Water Safety Plan
DISTI	Department of Industry, Science, Technology and Innovation
DRR	Disaster Risk Reduction
SOPs	Standard Operating Procedures

1. Background

Water Safety Plan (WSP) is a risk assessment and management approach implemented across all water supply facilities to protect the safety and quality of drinking water for human health. WSPs provide a comprehensive strategy to assess and manage risks throughout the entire production chain from water source to consumer tap.

The Ministry of Industry, Science, Technology and Innovation (MISTI) established and mandated Water Safety Plans in 2015 for water supply systems with support from the World Health Organization (WHO). The 2015 WSP process involved nine steps providing a comprehensive risk assessment and management framework for entire water supply systems. The 2015 WSP Guideline has been revised and expanded in scope under this document to strengthen risk management approaches in responding to water quantity, water quality, and system functionality issues related to climate in addition to general hazards that only included biological and chemical hazards before. Therefore, the Climate Resilient WSP Guideline is an update from the 2015 WSP Guideline by incorporating the UNICEF-GWP Climate Resilient WASH framework into the water supply context in Cambodia.

The Climate Resilient Water Safety Plan process has consolidated the 2015 WSP steps to six by adding three activities as follows:

- Activity 1 (Step 2): Water Source Assessment - When describing the treatment system, consider water source assessment, including catchment area, intake location, rainfall harvesting potential, surface water use options, etc.
- Activity 2 (Step 3): Climate Hazard Assessment - When identifying and assessing risks and improvement measures, consider climate-related hazards using risk assessment tools.
- Activity 3 (Step 4): Identify Climate Resilient Options - Consider options to address climate-related issues when developing and implementing improvement plans.

The primary goal of the Climate Resilient Water Safety Plan remains the same as the previous Water Safety Plan, which is to ensure the resilience of the water supply system in the face of increasing uncertainties and threats posed by climate change impacts in the future and to ensure water quality, safety, and sustainability for water supply for consumers at all times under the climate change condition.

2. Introduction

Water Safety Plan (WSP) is the cycle of activities to assess and manage public health risks that may be present in the water supply system. Climate resilient water supply systems have the adaptive capacity to be robust and cope with environment- and climate-related risks, meaning they continue to operate and deliver services despite facing unfavorable conditions and external threats from climate change impacts. With this recent update, the Guideline is now called the **Guideline on Climate Resilient Water Safety Plan (CR-WSP)**[1]. The Guideline has been updated from regular WSPs by integrating climate resilience considerations into the WSP approach through the application of the UNICEF-GWP Climate Resilient WASH framework in the context of local water supply in Cambodia, including by incorporating three additional activities into the CR-WSP process (Figure 1).

To ensure sustainable water supply systems, we need to ensure systems can reliably treat and distribute sufficient quantities of good quality water to users in both dry and rainy seasons. Health risks from inadequate water quantity and quality supplied may arise from chemical or microbial pollution, poor management at each point of the water supply system, and/or poor management of the water sources being used, as well as various impacts from climate-related risks. Climate Resilient Water Safety Plan can enable water supply systems to function well to address the above challenges by following the six steps outlined below:

- Step 1: Establish/Continue the Water Safety Planning Taskforce Operation - To define roles and responsibilities for developing, implementing, and monitoring the CR-WSP.
- Step 2: Describe Drinking Water Supply System and Assess Water Sources - To understand the entire supply system from source to tap, including assessing the water sources for quantity and quality.
- Step 3: Identify Risks and Assess Improvement Measures - To identify risks posed by environmental and climatic hazards across the entire supply chain, including available control measures.
- Step 4: Develop and Implement Improvement Plans and Identify Climate Resilient Options - Develop improvement plans based on Step 3 and prioritize based on financial, human, and time resources.
- Step 5: Monitor and Verify Effectiveness of Improvement Measures - To update on implementation status and evaluate effectiveness in addressing identified risks.
- Step 6: Document, Review, and Update CR-WSP - To progressively improve all aspects of implementation and documentation of status and process and incorporate lessons learned to date for further enhancements towards greater resilience.

[1] MISTI WSPs version 2015

Figure 1: Climate Resilient Water Safety Planning Process for Water Supply Providers

2.1. Who is this document for?

This Guideline is developed to guide water supply operators on how to implement and establish Climate Resilient Water Safety Plans for their water supply systems to address environmental and climate hazards impacting water supply systems and to ensure sufficient and good quality water supply for consumers at all times, including during climate events like floods, droughts, etc. The Guideline is also for provincial/municipal officers of the Ministry of Industry, Science, Technology and Innovation (MISTI) to understand the process of implementing Climate Resilient Water Safety Plan on water supply systems and provide technical assistance when needed to water supply operators in implementing and developing Climate Resilient Water Safety Plan.

2.2. Structure of the Climate Resilient Water Safety Plan Report Template

The structure of the Climate Resilient Water Safety Plan report template is shown in Table 1 below. The details of each section and sub-section in Table 1 will be further explained in the sections below. The Climate Resilient Water Safety Plan report template is in Annex 1. Operators can use this template in developing Climate Resilient Water Safety Plans for their systems.

Table 1: Outline of Climate Resilient Water Safety Plan Report

Section	Sub-Section
1. Introduction	1.1. General information on water supply business 1.2. License and supply status 1.3. History of the Water Safety Plan implementation
2. Step 1: Establish/Continue Water Safety Planning Taskforce	2.1. List of Climate Resilient WSP Taskforce members 2.2. Competency levels
3. Step 2: A. Description of Drinking Water Supply System	1. Schematic of water supply system 2. Reservoirs, water sources and volumes abstracted 3. Treatment process 4. Treated water storage 5. Distribution system
B. Water Source Assessment	1. Water quality assessment 2. Water quantity assessment
4. Step 3: Identify Environmental and Climate Risks and Assess Improvement Measures	1. Identify and assess hazards, impacts, and vulnerabilities at each point of the entire water supply system 2. Assess risks 3. Define and prioritize control measures to address identified risks
5. Step 4: Develop and Implement Improvement Plans and Identify Climate Resilient Options	Table of improvement plans to address priority risks identified, along with assessment of financial, human resource, and time capacity
6. Step 5: Monitor and Verify Effectiveness of Improvement Measures	Monitoring table for tracking progress and verifying effectiveness of the implementation of environmental and climate risk improvement plans
7. Step 6: Document, Review and Update Climate Resilient Water Safety Plan	Table for documenting, reviewing, and improving all aspects of the implementation of the Climate Resilient Water Safety Plan

Developing a Climate Resilient Water Safety Plan report is crucial for each water supply system because it helps enhance system resilience to various climate events like floods, droughts, pollution, etc. and improves service quality and sustainability to consumers. Identifying environmental and climate risks and climate resilient options to address risks within the CR-WSP process also strengthens operators' planning capabilities for continued service to their consumers and business continuity during severe climate events.

3. The six steps of the Climate Resilient Water Safety Plan for water treatment systems are:

3.1 Step 1: Establish or Continue Climate Resilient Water Safety Planning Taskforce

The Climate Resilient Water Safety Planning Taskforce should comprise **implementers** with roles in undertaking the six CR-WSP steps and a **coordinator** providing technical support and motivating stakeholders' participation in CR-WSP implementation.

CR-WSP Taskforce members with distinct responsibilities include:

Implementers:

- **Taskforce Leader**: Owner or manager/representative in charge of the entire water supply system with authority to decide, organizing skills, drive, and motivation to push the CR-WSP forward.
- **Administrator**: Station staff with IT skills, including document processing and using MS Word and Excel.
- **Technical Expert**: Station technical staff who understand the whole system, including infrastructure and technical nature of water treatment operations, and appreciate the public health significance of water quality. It is advisable that this person has attended some WSP and CR-WSP-related training.
- **Technical Advisor (optional)**: Could be public health officials, researchers from institutions (local or international), economists skilled in cost-benefit analysis of improvement plans, or irrigation specialists who can provide scientific data and information on climate change and projections of water resources for water source assessment. Other experts are knowledgeable on environmental aspects.

Coordinator (optional):

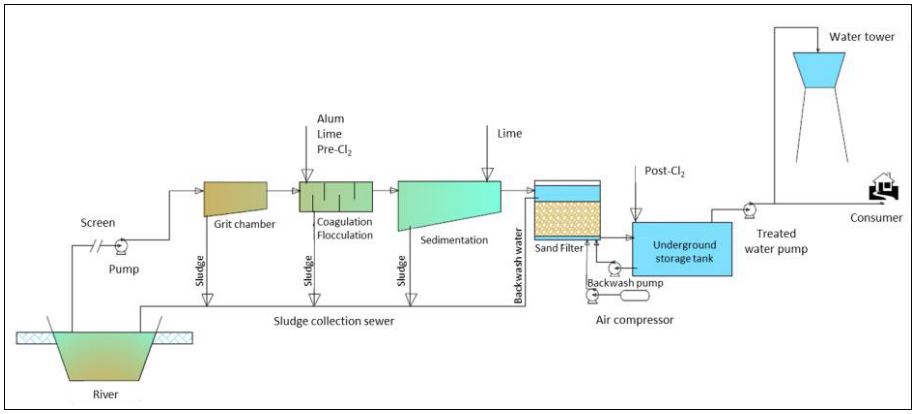
- **DISTI Officials**: DISTI officials play an essential role in providing technical assistance to implementers in developing and implementing the CR-WSPs.
- **Local Authorities**: These could be village or commune chiefs who can facilitate and assist, especially with community participation and engagement during CR-WSP implementation.

After identifying suitable individuals for the CR-WSP Taskforce, you can start gathering information on each CR-WSP Taskforce member and clearly define roles and responsibilities for each while also identifying critical competencies within your taskforce to look for additional human resources to fill those gaps. You can complete Section 2 - Step 1: Establish/Continue Climate Resilient WSP Taskforce in Annex 1 - CR-WSP Report Template to finish Step 1.

3.2 Step 2:

1. Description of the Drinking Water Supply System

This step aims to understand and describe the entire water supply system from source to tap. When describing the water supply system, you should include the following information in Section 3 of Annex 1 - CR-WSP Report Template.

	Key information to include when describing the drinking water supply system:
Schematic of Water Supply System	Schematic diagram representing your system from the sources to the water supply network. See the example below, where important treatment and chemical dosing facilities are depicted in the diagram. 
Water Source and Intake	☐ Type of raw water source (e.g. groundwater, river, pond, lake) ☐ Season when most water is used ☐ Details on raw water pumps and status ☐ Raw water pipes (length, diameter, status) ☐ Groundwater abstraction volumes possible ☐ Depth of boreholes or size of reservoir/pond
Water Treatment System	☐ Type of treatment system ☐ Treatment capacity ☐ Chemical dosages used for treatment ☐ Chemical dosing system (automatic or free flow) ☐ Water quality monitoring and testing at various stages of treatment process and waste sludge handling in clarifier and filter backwash ☐ Available Standard Operating Procedures (SOPs) ☐ Cleaning and maintenance schedule
Water Storage	☐ Number of reservoirs and volumes ☐ Water volume determination or management approach ☐ Location of reservoirs ☐ Condition of reservoirs ☐ Available Standard Operating Procedures (SOPs) ☐ Frequency of inspection, maintenance or cleaning, or existing procedures

Water Distribution	☐ Aeration reservoir capacity ☐ Number of distribution pumps ☐ Details on distribution pumps and status ☐ Distribution network ☐ Distribution network map ☐ Lengths of distribution network ☐ Pipe types (HDPE, PVC, steel) and diameters ☐ Monitoring (water quality and pressure check) ☐ Pipe flushing schedule ☐ Drain valves ☐ Available Standard Operating Procedures (SOPs) ☐ Consumer storage and usage

2. Water Source Assessment:

This step aims to assess the quantity and quality of water sources used for the treatment system. Data is essential for assessing water sources. However, in Cambodia, data is still limited, and water supply operators may face challenges in accessing and utilizing such data to determine their water sources. Participation from local communities such as villages/communes and officials at the provincial level in this water source evaluation is essential because they have local knowledge/information that could benefit the assessment.

Water Quality for your treatment system can be obtained through water quality testing during feasibility studies, and water volumes required for your system can be calculated by completing Section 4 - Water Source Assessment in Annex 1. Guidance on how to estimate water volumes for your system is provided in Table 2 below. Note this calculation only applies to groundwater and surface water (boreholes, lakes, ponds, and dam water...). Raw water sources like rivers, Tonle Sap Lake, river tributaries/streams, creeks, canals, etc., are not applicable for the calculation.

Table 2: Guidance on Estimating Water Volumes for Treatment System

	Description	**Cubic Meters/Year**
1	Raw water sources	Raw water only from boreholes: A: Total (No. of boreholes x Volume of Water)
		Raw water from ponds or reservoirs: A = For reservoir/pond, total per month - Ratio of water in the reservoir/pond * Size of reservoir/pond
2	Total water required to meet demand	= Water consumption + (Water consumption * 15%)
3	Does the water supply adequately meet the demand?	= 1-2

3.3 Step 3: Identify Environmental and Climatic Risks and Improvement Measures

Risk assessment aims to identify which environmental and climate hazards are most significant for your water supply system and which should be prioritized for action planning.

Risk assessment can be defined as "the methodology to identify and define the characteristics and magnitude of risks by analyzing hazards, the likelihood that those hazards occur, and evaluating existing conditions of vulnerability that together could potentially harm exposed people, assets, services, livelihoods and the environment on which they depend.[2]" The overall risk score for your system is the multiplication of the scores for **hazard, impact, and vulnerability**. It can be represented as:

Risk = Hazard x Impact x Vulnerability

The sections below will explain in detail how to characterize and score the hazard, impact, and vulnerability to derive the overall risk score and rating. Improvement measures will be defined for each risk, and financial and human resources will be assessed and utilized to determine the timeframe of implementation. The risk assessment methodology is summarized in Figure 2 below:

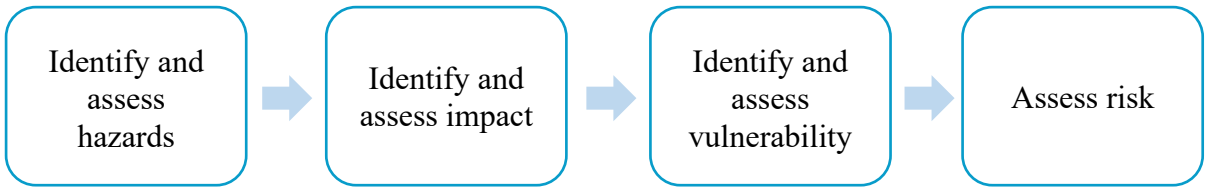


Figure 2: Risk Assessment Methodology

3.3.1. Characterize and assess hazards

Hazards refer to phenomena which can cause dangers, including: pollution from various substances, human activities, or conditions that can cause loss of life, injury, public health impacts, and damage to property, business, or the environment. There are two critical steps to assess hazards, as shown in Figure 3:

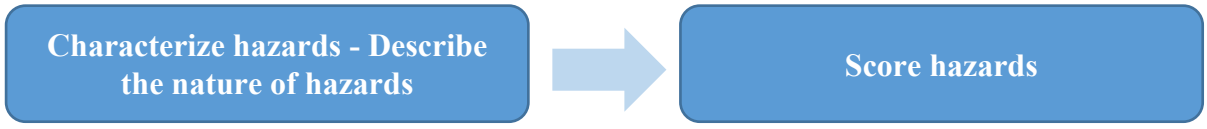


Figure 3: Hazard assessment steps

Characterize Hazards

It would be best if you characterize the hazard types relevant to your treatment system. Hazards can arise from external factors to the water sources and/or treatment system and internal factors of malfunctioning system components and/or operator practices. Examples of different types

[2] UNICEF-GWP Guidance Note on Risk Assessment for WASH

of hazards that treatment systems may encounter are listed in Table 3 below. The critical hazards impacting most treatment systems in Cambodia are flooding, drought, wastewater pollution, industrial wastewater, solid waste dumping, animal waste, and agricultural chemical runoff.

Table 3: Examples of Different Types of Hazards Treatment Systems May Face

Climatic Hazards	Biological Hazards	Chemical Hazards	Operator Error Hazards
• Drought • Flooding • Heavy rainfall • Erosion • Riverbank collapse • Storm surge • Landslide • Others	• Pathogens from animal and human feces • Zoonotic diseases • Natural toxins • Solid waste dumping • Sewage and industrial wastewater pollution • Algal blooms • Others	• Arsenic • Iron • Manganese • Fluoride • Nitrite • Nitrate • Phosphorus • Heavy metals • Agricultural chemicals • Pesticides/fertilizers • Others	• Excessive chlorine residues • Improper coagulant dosing • Chemical dosing pump failure • Lack of chemicals • Excessive loss from frequent backwashing • Others

You should gather and record information on each identified hazard for your system, as noted below because this information will be used to score the hazards in the next step:

- Frequency of hazard - e.g., how often does the hazard occur?
- Magnitude/severity of hazard - e.g., flash flooding and river flooding
- Duration of hazard - how long does the hazard last?
- Geographical extent impacted by hazard - e.g., how many villages in your commune are affected by this hazard?
- When does the hazard occur? - e.g., flooding occurs in the rainy season

Scoring Hazards

The hazard score is determined by two parameters - **frequency and duration**. Frequency is categorized into six types - daily, weekly, monthly, yearly, every five years, and more than five years, while duration is categorized into three types - less than one week, one week to 1 month, and more than one month. Based on your assessment of the frequency and duration of a hazard, you can assign a hazard score of 3 (high), 2 (medium), or 1 (low). Please refer to Table 4 for guidance on scoring hazards based on frequency and duration.

Table 4: Risk scoring guidance based on frequency and duration

Duration / Frequency	Less than 1 week	1 week - 1 month	More than 1 month
Daily (e.g. once a day)	3 (High)	3 (High)	3 (High)
Weekly (e.g. once a week)	2 (Medium)	3 (High)	3 (High)
Monthly (e.g. once a month)	2 (Medium)	3 (High)	3 (High)
Annually (e.g. once a year)	2 (Medium)	2 (Medium)	3 (High)
Every 5 years (e.g. once every 5 years)	1 (Low)	2 (Medium)	2 (Medium)
More than 5 years (e.g. once every 10 years)	1 (Low)	1 (Low)	2 (Medium)

It should be noted that hazard scoring can be considered as one or two attributes, depending on the type of hazard and data available. For example, flooding may be scored based on both frequency and duration, while pesticide pollution of water sources would be scored based just on frequency. Additionally, hazard scoring for individual hazards may differ from Table 4, depending on the type of hazard and how severe it is for your water supply system.

After you have characterized and gathered relevant information about the nature of hazards to your system, you can complete Section 4.1 in your climate-resilient Water Safety Plan template. The example below in Table 5 can serve as a reference for characterizing and scoring hazards you may encounter.

Table 5: Examples of hazard characterization and scoring

Hazard	Hazard Characterization				Hazard Scoring
	Duration	Duration	Location impacted in the treatment system	Time of the year	Score
Flooding	Annually	1 week	Treatment plant (all boreholes inundated)	Sep - Oct	2 (Medium)
Drought	Every 3 years	1 month	Water source (high turbidity)	Apr - May	2 (Medium)
Animal waste pollution	Daily	-	Water source (pollution from livestock)	Jan-Dec	3 (High)
Pesticides/fertilizer	Weekly	-	Water source (pesticide runoff from farms upstream)	Jan-Dec	3 (High)
Pump breakdown	Monthly	2-4 days	Pumping station (old pumps breaking down frequently)	Jan-Dec	2 (Medium)
Improper chemical dosing (PAC/alum)	2-3 times/week	-	Reservoirs, clarifiers (poor coagulation)	Jan-Dec	2 (Medium)

Algal blooms	Annually	-	Treatment system (algae growing in reservoir)	Jan-Dec	2 (Medium)
Running out of Ca(OCl)2	2-3 times/year	-	Ca(OCl)2 supply runs out during production	-	2 (Medium)
Bird/bat fecal contamination	Daily	-	Storage reservoir (treated water contaminated by bird/bat feces)	-	3 (High)
Pipe bursts	Monthly	-	Distribution network (pipes frequently bursting due to road works)	-	2 (Medium)

3.3.2 Characterize and assess impacts

Severe hazards can impact people, property, systems, or other components. There are two key steps to assess impacts as shown in Figure 4.

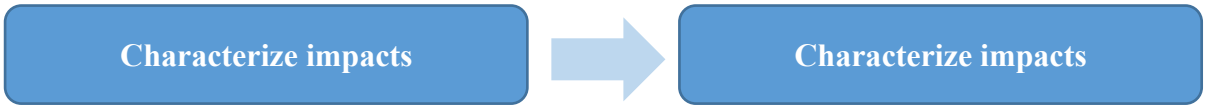


Figure 4: Impact assessment steps

Categorizing Impacts

In this step, you consider the relationship between the hazards you identified and their impacts. In the context of water supply systems in Cambodia, there are two primary components that will be impacted – the environmental components (water sources) and the physical components (infrastructure). The physical components include all the infrastructure in your water supply system (raw water pumping stations, treatment system, storage reservoirs, piped network). The environmental components (raw water sources) are processed into potable water for your system. An example template for scoring impacts is shown in Table 7.

Scoring impacts

Once impacts are identified and components are selected, impact scores can be assigned based on the severity of the impact caused by the hazard. A single hazard may have multiple impacts; similar impacts may arise from different hazards. However, each occurrence should be scored separately. Guidance on how to score impacts is shown in Table 6 for your reference, and an example of characterizing hazards to impacts and scoring along the treatment process chain is shown in Table 7. Please note that the percentage values given in Table 6 will serve as the baseline for your scoring. However, some impacts may be more severe than the calculation percentages show. In this regard, final scores can be adjusted based on your expert judgment of the scorer.

Table 6: Guidance for scoring impacts

Impact	Component	High = 3	Medium = 2	Low = 1
Water sources	-	Score based on assessment of impact from hazard on infrastructure of water source (boreholes, ponds, lakes etc), volume and quality.		
Infrastructure - Boreholes, ponds, lakes	Physical	% of water sources impacted (unusable) out of total used for treatment system		
		>20%	10-20%	<10%
- Rivers, streams, other surface water	Physical	If these types of water bodies are impacted, can assume 100% impacted. In this case score is High = 3.		
Water volume Boreholes, ponds, lakes, rivers, streams, other water sources	Environmental	% reduction of annual abstractable volume compared to previous years' volumes		
		<90%	90-95%	>95%
Water quality Boreholes, ponds, lakes, rivers, streams, other water sources	Environmental	Water quality can be impacted by physical, biological, and chemical pollution*.		
		Chemical	Biological	Physical
Pumping station	Physical	Score based on impacts to different components of pumping station		
		Unusable	Partially usable	Fully operational
Treatment system	Physical	Score based on impacts to different components of treatment system		
		> 20% Impacted	10-20% Impacted	<10% Impacted
Storage reservoir	Physical	Percentage of storage reservoirs impacted compared to total number of all reservoirs		
		> 20% Impacted	10-20% Impacted	<10% Impacted
Distribution network	Physical	Percentage of distribution network length impacted compared to total network length in service area		
		> 5% Impacted	0.5-5% Impacted	<0.5% Impacted

Table 7: Impact Characterization and Scoring Models

Hazard	Characterize Impacts			Score Impacts
	Impact in system	Component	Description of impact	
Flooding	Water source	Physical	All boreholes used for treatment system inundated and unusable	3 (High)
	Water source	Environmental	Water quality at source polluted by physical and biological means	2 (Medium)
	Physical	Physical	No major impact to treatment system. Plant operating normally.	1 (Low)

	Storage reservoirs	Physical	No major impact to reservoirs as they are all fully enclosed and elevated.	1 (Low)
	Distribution network	Physical	100 meters of distribution network damaged during flooding (total network length in impacted village is 20,000 meters). % network length impacted = 0.5% (100 m / 20,000 m)	2 (Medium)
Drought	Water source	Environmental	No water sources (boreholes) impacted during drought. No reduction in borehole water volumes used for this system.	1 (Low)
	Treatment system	Physical	No impact to treatment system, can operate normally.	1 (Low)
Bird fecal contamination	Water source	Environmental	Water source polluted biologically by birds from nearby farms.	2 (Medium)
Pesticides/fertilizer	Water source	Environmental	Water source chemically polluted by pesticide/fertilizer runoff from agriculture.	3 (High)
Intake pump breakdown	Pumping station	Physical	Pumping station not operating well. Pumps commonly breaking down but station still operating with backup pumps.	2 (Medium)
Improper chemical dosing (PAC/alum)	Treatment system	Physical	Poor coagulation in clarifiers, which then impacts filters and clear well. May impact around 50% of entire system not working properly.	3 (High)
Algal blooms	Water source	Environmental	Raw water polluted biologically with algae and cyanobacteria.	2 (Medium)
Running out of Ca(OCl)2	Treatment system	Physical	Disinfection system not functioning, which will severely impact water quality before supply to users.	2 (Medium)
Bird/bat fecal contamination	Storage reservoirs	Physical	All storage reservoirs contaminated by bird/bat feces from roosting on covers.	3 (High)
Pipe bursts	Distribution network	Physical	Around 10% of distribution network impacted monthly at road construction sites.	3 (High)

3.3.3 Characterize and score vulnerability

Vulnerability refers to the characteristics and conditions of systems or assets that make them susceptible to impacts from hazards[3]. There are two key steps to assess vulnerability, as shown in Figure 5:

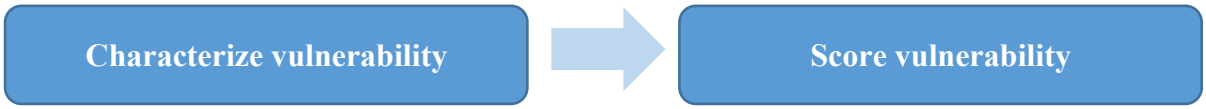


Figure 5: Vulnerability assessment steps

Characterizing vulnerability

In this step, you characterize vulnerability according to the components identified/selected from the previous step of characterizing impacts. In the context of water supply systems, vulnerability is considered for two main components – the environmental components (water sources) and the engineered components (critical infrastructure). The environmental components of your water supply system include the vulnerability of your water sources, such as critical points or vulnerability to flooding, drought, chemical, microbial, or contamination hazards. The physical components include the vulnerability of your water supply system infrastructure that is exposed and susceptible to damage from the hazards. An example template for characterizing vulnerability is shown in Table 9.

Scoring vulnerability

At this stage, the vulnerability components are scored for each occurrence. In the context of treatment systems, the vulnerability components will be scored based on probing questions to understand the damage susceptibility from the hazards identified in the first stage. Guidance on scoring vulnerability and examples of characterizing and scoring vulnerability in a treatment system are provided in Tables 8 and 9. There may be additional questions beyond those in the tables that are specific to your treatment system and anything else you want to use for this assessment.

Table 8: Scoring vulnerability

Component	Location	Question	Vulnerability Score		
			High = 3	Medium = 2	Low = 1
Physical	Raw water pumping station	Can pumping station withstand hazards when they occur?	No – it fails during hazards.	Partially – some parts fail during hazards.	Yes – operates normally during hazards.
Environmental	Water source	Are there guidelines/regulations for wastewater/agricultural runoff management?	No – no regulations exist.	Yes – regulations exist but enforcement is very limited. Current practices directly discharge into water sources.	Yes – regulations exist and enforcement is ongoing.

[3] GWP-UNICEF Guidance Note - Risk assessments for WASH

Environmental	Water source	Are water sources adequately protected from flooding or pollution?	No water sources are protected.	Some water sources are protected.	All water sources are adequately protected.
Physical	Treatment system	Is the water treatment plant designed considering flooding and drought events?	No – treatment plant was designed long ago without considering flooding or drought conditions.	Partially – treatment plant constructed on raised ground but not high enough in case of high flood levels.	Yes – treatment plant constructed well above flood levels.
Physical	Treatment system	Can the water treatment plant withstand hazards when they occur	No – fails during hazards.	Can withstand some parts during hazards.	Yes – as robust as normal during hazards.
Physical	Storage reservoirs	Are storage reservoirs waterproof and constructed above flood levels?	No – reservoirs constructed below ground with small openings.	Yes – reservoirs protected with waterproofing but small openings not sealed from ground	Yes/Correct – reservoirs constructed at non-flooding sites and have waterproof sealing protections.
Physical	Distribution network	Are pipe markers for location used during pipe laying? Are there any guidelines from local authorities for pipe laying?	No – pipe markers for location not used and no proper guidelines/standards from authorities for pipe installation.	Yes – pipe markers used but not at all locations. No clear guidelines/standards from authorities for pipe installation.	Yes – pipe markers used and installed properly based on guidelines from authorities.

Table 9: Vulnerability for characterizing and scoring models

Hazard	Impact in water supply system	Relevant vulnerability question	Description of vulnerability	Vulnerability score
Flooding	Water source	Are water sources adequately protected from flooding?	Boreholes located in low lying areas and prone to inundation even during minor floods.	3 (High)
	Water source	Are there any infrastructure/materials for protecting water quality impacts?	Raw water from lake has no way of protecting its quality during floods but treatment system can treat any water quality impacts.	2 (Medium)

	Raw water pumping station	Is pumping station designed considering flooding events?	Pumping station typically inundated during floods but can still function partially because it is a floating station.	2 (Medium)
	Treatment system	Is the treatment plant designed considering flooding events?	Treatment plant constructed on raised ground but not high enough in case of high flood levels.	2 (Medium)
	Treated water storage	Are water reservoirs waterproof and constructed above flood levels?	Treated water reservoirs constructed on high ground with waterproofing protections.	1 (Low)
	Distribution network	Is there any vulnerability to damage of network during floods?	Network uses appropriate thrust blocks and high quality pipes. It is protected during floods.	1 (Low)
Drought	Water source	How much above normal is peak water demand compared to average demand?	Water source capacity is sufficient for current demand. It will be insufficient during drought.	2 (Medium)
	Treatment system	Can treatment system function during drought?	Treatment system can function but with difficulty due to lack of lab equipment to confirm adjustment of PAC dosing levels.	2 (Medium)
Bird/bat fecal /Pesticides/fertilizer contamination	Water source	Are there any guidelines/regulations for wastewater/agricultural runoff management?	Regulations exist locally but enforcement is very limited. Water sources typically polluted by pesticides/fertilizer/animal waste running off from upstream areas.	2 (Medium)
Raw water pump breakdown	Pumping station	Are there backup pumps at the pumping station?	Backup pumps are available at pumping station. They can be used until pump replacement or repair is done.	1 (Low)
Improper chemical dosing (PAC/alum)	Treatment system	Is there a jar test equipment in the water treatment plant? Any SOP or routine monitoring of plant operation?	No jar test equipment in plant but operators visually check plant operation every morning	2 (Medium)
Algal blooms	Water source	Are there any procedures for raw water protection?	No proper procedures or regulations but this happens during severe hot season due to very low water levels.	2 (Medium)

Running out of Ca(OCl)2	Treatment system	Is there a SOP on supply and storage of chemicals? Are staff roles and responsibilities clearly defined for this task?	No such SOP but one staff assigned to monitor chemical stocks.	2 (Medium)
Bird/bat fecal contamination	Storage reservoirs	Is there routine monitoring? Are storage reservoir covers present?	Staff inspect routinely. So far, all storage reservoirs do not have covers.	3 (High)
Pipe bursts	Distribution network	Can road contractors take some more precautions?	Yes but with some difficulty.	2 (Medium)

3.3.4. Risk Assessment

In this step, you will multiply the individual scores for hazard, impact, and vulnerability to obtain an overall risk score. These scores are then used to categorize risks for subsequent risk prioritization. Risks with the highest scores are given priority and immediate action, while risks with the lowest scores are given less priority and can be addressed later. The risk scores guide you to attempt to address all high risks first, even with limited financial and human resources, because delaying action on these high risks may lead to even more significant risks later. The priority of actions to respond to the risks can be categorized into four levels, as shown in Table 10.

Table 10: Risk score ranges for prioritizing actions

Risk Score	Risk Priority
<4: Low	Not a priority
4 - 8: Medium	Long-term priority
9 - 17: High	Short-term priority
17: Very high	Immediate priority

An example of calculating aggregate risk scores is provided in Table 11. The column "Risk Score" shows total scores, while the "Classification" column is used to determine which risk should be addressed first.

Table 11: Examples of Risk Scoring:

Hazard		Impact		Vulnerability		Risk Score	Categorization
Description	**Scores**	**Description**	**Scores**	**Description**	**Scores**	**Description**	**Scores**
Annual flooding (lasts 1 week)	2	Water source - All water sources (boreholes) inundated	3	Boreholes located in low lying areas and prone to inundation even during minor floods	3	18	2
Annual flooding (lasts 1 week)	2	Treatment system - No major impact to water treatment system. Plant operating normally.	1	Treatment plant constructed on raised ground but not high enough. It can be inundated if flood levels are high.	2	4	5
Annual flooding (lasts 1 week)	2	Distribution network - 0.5% of total network length in service area damaged	2	Network uses appropriate thrust blocks and high quality pipes. It is protected during floods.	1	4	5
Drought (occurs every 3 years and lasts 1 month)	2	Treatment system - No impact to water treatment system. Plant operates normally.	1	Treatment system can function but with difficulty due to lack of lab equipment to confirm adjustment of PAC dosing levels	2	4	5
Bird fecal contamination (daily)	3	Water source - Polluted biologically by birds from nearby farms.	2	Policies exist locally but enforcement is very limited. Water sources typically polluted by pesticides/fertilizer/animal waste running off from upstream areas.	2	12	3
Raw water intake pump breakdown (monthly)	2	Water treatment - Pumping station not operating well.	2	Backup pumps available at pumping station. They can be	1	4	5

		Pumps commonly breaking down but station still operating with backup pumps.		used until pump replacement or repair is done.			
Improper chemical dosing (2-3 times/year)	2	Water treatment - Poor coagulation in clarifiers, which then impacts filters and clear well. May impact around 50% of entire system not working properly.	3	No jar test equipment in plant but operators visually check plant operation every morning.	2	12	3
The emergence of algal/cyanobacterial blooms (occur every 3 years and last 1 month)	2	Water sources - Freshwater becomes polluted with algae and cyanobacteria along with algal/cyanobacterial blooms.	2	There are no proper procedures or regulations in place, but this happens during severe hot seasons due to very low water levels.	2	8	4
Running out of Ca(OCl) (happens 2-3 times/year)	2	Water treatment system - Disinfection system is not working, and it will severely impact the water quality before supply to consumers.	2	There is no such SOP, however one staff has been assigned to monitor the chemical inventory.	3	12	3
Contamination by birds/bats (daily)	3	Water storage tanks - All the water storage tanks are contaminated by bird/bat feces from their nests on reservoir covers.	3	Staffs inspect regularly. So far, none of the water storage tanks are covered.	3	27	1
Distribution pipe bursting (monthly)	2	Distribution network - Approximately 10% of the distribution network is	3	Road constructors may take some additional precautions, but it is difficult to completely avoid.	2	12	3

		affected monthly at road construction sites.					

3.3.5. Categorizing and evaluating corrective measures and capabilities

After completing the risk assessment and rating, you will need to identify relevant corrective measures to address the risks. All identified risks must be **addressed**, some quickly addressed using short-term measures and others over a longer timeframe, depending on financial and human resources. Financial and human resources will be allocated to corrective measures for prioritized risks. Examples of corrective measures are shown in Table 12.

Table 12: Examples of risk mitigation measures

Hazard		Impact		Vulnerability		Risk Score	Catego-rization	Mitigation measure	Capabilities
Description	Scores	Description	Scores	Description	Scores				
Contamination by birds/bats (daily)	3	Water storage tanks - All the water storage tanks are contaminated by bird/bat feces from their nests on reservoir covers.	3	Staff inspects regularly. So far, none of the water storage tanks are covered.	3	27	1	○ Set up barbed wire fencing around reservoirs to prevent animals from entering and creating waste.	Financial: High Human resources: High
Annual flooding (lasts 1 week)	2	Water source - All water sources (boreholes) inundated	3	Boreholes located in low lying areas and prone to inundation even during minor floods	3	18	2	○ Raising the upper part of the borehole higher than the flood level	Financial: High Human resources: Low
Bird fecal contamination (daily)	3	Water source - Polluted biologically by	2	Policies exist locally but enforcement is very limited. Water sources typically polluted by	2	12	3	○ Coordinate with local authorities to prevent	Financial: High

		birds from nearby farms.		pesticides/fertilizer/animal waste running off from upstream areas.				livestock from entering water sources. ○ Construct protective barriers to prevent wild animals from entering water sources.	Human resources: Moderate
Running out of Ca(OCl) (happens 2-3 times/year)	2	Water treatment system - Disinfection system is not working and it will severely impact the water quality before supply to consumers.	2	There is no such SOP, however one staff has been assigned to monitor the chemical inventory.	3	12	3	○ Designate roles, responsibilities, and monitoring schedules to check inventories	Financial: High Human resources: High
Improper chemical dosing (2-3 times/year)	2	Water treatment - Poor coagulation in clarifiers, which then impacts filters and clear well. May impact around 50% of entire system not working properly.	3	No jar test equipment in plant but operators visually check plant operation every morning.	2	12	3	○ Purchase Jar-Test equipment and test whenever raw water changes	Financial: Moderate Human resources: High
Distribution pipe bursting (monthly)	2	Distribution network - Approximately 10% of the distribution network is affected	3	Road constructors may take some additional precautions, but it is difficult to completely avoid.	2	12	3	○ Meet with contractors and request they pay extra attention with some precautionary	Financial: High Human resources: High

		monthly at road construction sites.						measures to prevent pipe damage	
The emergence of algal/cyanobacterial blooms (occur every 3 years and last 1 month)	2	Water sources - Freshwater becomes polluted with algae and cyanobacteria along with algal/cyanobacterial blooms.	2	There are no proper procedures or regulations in place, but this happens during severe hot seasons due to very low water levels.	2	8	4	○ Modify dosing system to kill algae in early stages	Financial: High Human resources: High
Drought (occurs every 3 years and lasts 1 month)	2	Treatment system - No impact to water treatment system. Plant operates normally.	1	Treatment system can function but with difficulty due to lack of lab equipment to confirm adjustment of PAC dosing levels	2	4	5	○ Purchase Jar-Test equipment to determine PAC dosing levels, ○ Monitor coagulation and sedmination tanks frequently to ensure effectiveness	Financial: Moderate Human resources: High
Annual flooding (lasts 1 week)	2	Distribution network - 0.5% of total network length in service area damaged	2	Network uses appropriate thrust blocks and high quality pipes. It is protected during floods.	1	4	5	○ Repair 0.5% of damaged distribution network and adjust pressure	Financial: Low Human resources: High
Annual flooding (lasts 1 week)	2	Treatment system - No major impact to water treatment	1	Treatment plant constructed on raised ground but not high enough. It can be	2	4	5	○ Consider strengthening treatment plant infrastructure	Financial: Low

		system. Plant operating normally.		inundated if flood levels are high.					Human resources: Low
Raw water intake pump breakdown (monthly)	2	Water treatment - Pumping station not operating well. Pumps commonly breaking down but station still operating with backup pumps.	2	Backup pumps available at pumping station. They can be used until pump replacement or repair is done.	1	4	5	○ Purchase new pumps	Financial: Moderate Human resources: High

4. Step 4: Develop and implement improvement plans and climate resilience options

After you have identified and assessed all risks to the water supply system, as well as relevant improvement measures and the capacity to address these risks, you will need to develop an additional improvement plan for implementing these improvements. The improvement plan will describe the timeline for implementing the improvement measures, those responsible for implementation, and the costs of each improvement measure in implementing these measures. Table 13 shows an example of how to develop an additional improvement plan with climate resilience options included.

Table 13: Example for developing an additional improvement plan

Hazard	Impact	Vulnerability	Risk Score	Mitigation measure	Capabilities	Estimated Budget Needed	Lead	By When
Contamination by birds/bats (daily)	Water storage tanks - All the water storage tanks are contaminated by bird/bat feces from their nests on reservoir covers.	Staffs inspect regularly. So far, none of the water storage tanks are covered.	1	○ Set up barbed wire fencing around reservoirs to prevent animals from entering and creating waste.	Financial: High Human resources: High	$1000	Owner of treatment system	August 2022
Annual flooding (lasts 1 week)	Water source - All water sources (boreholes) inundated	Boreholes located in low lying areas and prone to inundation even during minor floods	2	○ Raising the upper part of the borehole higher than the flood level	Financial: High Human resources: Low	$500	Treatment system manager	September 2022
Bird fecal contamination (daily)	Water source - Polluted biologically by birds from nearby farms.	Policies exist locally but enforcement is very limited. Water sources typically polluted by pesticides/fertilizer/ani	3	○ Coordinate with local authorities to prevent livestock from	Financial: High Human resources: Moderate	$700	Treatment system manager	September 2022

		mal waste running off from upstream areas.		entering water sources. ○Construct protective barriers to prevent wild animals from entering water sources.				
Running out of Ca(OCl) (happens 2-3 times/year)	Water treatment system - Disinfection system is not working, and it will severely impact the water quality before supply to consumers.	There is no such SOP, however one staff has been assigned to monitor the chemical inventory.	3	○Designate roles, responsibilities, and monitoring schedules to check inventories	Financial: High Human resources: High	$0	Treatment system manager	November 2022
Improper chemical dosing (2-3 times/year)	Water treatment - Poor coagulation in clarifiers, which then impacts filters and clear well. May impact around 50% of entire system not working properly.	No jar test equipment in plant but operators visually check plant operation every morning.	3	○Purchase Jar-Test equipment and test whenever raw water changes	Financial: Moderate Human resources: High	$ 1,500	Owner of treatment system	December 2022
Distribution pipe bursting (monthly)	Distribution network - Approximately 10% of the distribution network is affected monthly at road construction sites.	Road constructors may take some additional precautions, but it is difficult to completely avoid.	3	○Meet with contractors and request they pay extra attention with some precautionary measures to prevent pipe damage	Financial: High Human resources: High	$0	Treatment system manager	December 2022

The emergence of algal/cyanobacterial blooms (occur every 3 years and last 1 month)	Water sources - Freshwater becomes polluted with algae and cyanobacteria along with algal/cyanobacterial blooms.	There are no proper procedures or regulations in place, but this happens during severe hot seasons due to very low water levels.	4	○Modify dosing system to kill algae in early stages	Financial: High Human resources: High	$200	Owner of treatment system	March 2023
Drought (occurs every 3 years and lasts 1 month)	Treatment system - No impact to water treatment system. Plant operates normally.	Treatment system can function but with difficulty due to lack of lab equipment to confirm adjustment of PAC dosing levels	5	○Purchase Jar-Test equipment to determine PAC dosing levels, ○Monitor coagulation and sedmination tanks frequently to ensure effectiveness	Financial: Moderate Human resources: High	$1,500	Owner of treatment system	January 2023
Annual flooding (lasts 1 week)	Distribution network - 0.5% of total network length in service area damaged	Network uses appropriate thrust blocks and high quality pipes. It is protected during floods.	5	○Repair 0.5% of damaged distribution network and adjust pressure	Financial: Low Human resources: High	$2,500	Owner of treatment system	January 2023
Annual flooding (lasts 1 week)	Treatment system - No major impact to water treatment system. Plant operating normally.	Treatment plant constructed on raised ground but not high enough. It can be inundated if flood levels are high.	5	○Consider strengthening treatment plant infrastructure	Financial: Low Human resources: Low	$2,500	Owner of treatment system	July 2023
Raw water intake pump	Water treatment - Pumping station not operating well. Pumps	Backup pumps available at pumping station. They can be used until	5	○Purchase new motors	Financial: Moderate	$5,000	Owner of treatment system	June 2024

breakdown (monthly)	commonly breaking down but station still operating with backup pumps.	pump replacement or repair is done.			Human resources: High			

5. Step 5: Monitor and evaluate the effectiveness of improvement measures

After you have developed and implemented additional improvement plans for the treatment system, you will need to monitor the implementation progress and update Section 7 of your climate-resilient water safety plan. You will also need to verify the effectiveness of the improvement measures in successfully addressing the identified risks after implementing those specific improvement measures. Suppose any improvement measures have low effectiveness in responding to the identified risks. In that case, you will need to review and adjust those improvement measures again to address the risks effectively. Table 14 below shows an example of how to monitor and verify the effectiveness of improvement measures.

Table 14: Example for monitoring and verifying the effectiveness of improvement measures.

Hazard	Impact	Vulnerability	Risk Score	Mitigation measure	Description of Progress	Percentage Achieved	Effectiveness of Control Measures in Addressing Risks
Contamination by birds/bats (daily)	Water storage tanks - All the water storage tanks are contaminated by bird/bat feces from their nests on reservoir covers.	Staffs inspect regularly. So far, none of the water storage tanks are covered.	1	○ Set up barbed wire fencing around reservoirs to prevent animals from entering and creating nests.	Barb wire fences have been set up around the reservoir to protect animals from entering.	100%	100% effective in preventing birds/bats from entry and creating nests
Annual flooding (lasts 1 week)	Water source - All water sources (boreholes) inundated	Boreholes located in low lying areas and prone to inundation even during minor floods	2	○ Raising the upper part of the borehole higher than the flood level	All boreholes have been raised above flood level.	100%	The extent is immeasurable as the floods have not yet reached.

Bird fecal contamination (daily)	Water source - Polluted biologically by birds from nearby farms.	Policies exist locally but enforcement is very limited. Water sources typically polluted by pesticides/fertilizer/animal waste running off from upstream areas.	3	○ Coordinate with local authorities to prevent livestock from entering water sources. ○ Construct protective barriers to prevent wild animals from entering water sources.	Continuing to work with local authorities on educating the public about not to dispose animal waste into water sources. Protective barriers have been constructed around water sources.	70%	They are 80% effective at preventing animals from entering the water sources, but people still do not cooperate on not dumping animal waste. More work needs to be done with local authorities.
Running out of Ca(OCl) (happens 2-3 times/year)	Water treatment system - Disinfection system is not working, and it will severely impact the water quality before supply to consumers.	There is no such SOP, however one staff has been assigned to monitor the chemical inventory.	3	○ Designate roles, responsibilities, and monitoring schedules to check inventories	A cleaning schedule has been created and staff assigned to regularly check the inventory.	100%	100% effective Through consistent monitoring, Ca(OCl)2 is consistently available during water production..
Improper chemical dosing (2-3 times/year)	Water treatment - Poor coagulation in clarifiers, which then impacts filters and clear well. May impact around 50% of entire system not working properly.	No jar test equipment in plant but operators visually check plant operation every morning.	3	○ Purchase Jar-Test equipment and test whenever raw water changes	In progress. Purchase orders have been sent to suppliers for equipment, but the Jar-Test equipment has	80%	Effectiveness is currently immeasurable.

					not yet been supplied.		
Distribution pipe bursting (monthly)	Distribution network - Approximately 10% of the distribution network is affected monthly at road construction sites.	Road constructors may take some additional precautions, but it is difficult to completely avoid.	3	○ Meet with contractors and request they pay extra attention with some precautionary measures to prevent pipe damage	Met road contractors two times to discuss this issue	100%	70% Effective, after discussing with contractors, they will pay more attention on distribution network
The emergence of algal/cyanobacterial blooms (occur every 3 years and last 1 month)	Water sources - Freshwater becomes polluted with algae and cyanobacteria along with algal/cyanobacterial blooms.	There are no proper procedures or regulations in place, but this happens during severe hot seasons due to very low water levels.	4	○ Modify dosing system to kill algae in early stages	Not yet implemented	0	-
Drought (occurs every 3 years and lasts 1 month)	Treatment system - No impact to water treatment system. Plant operates normally.	Treatment system can function but with difficulty due to lack of lab equipment to confirm adjustment of PAC dosing levels	5	○ Purchase Jar-Test equipment to determine PAC dosing levels, ○ Monitor coagulation and sedmination tanks frequently to ensure effectiveness	Not yet implemented	0	-

Annual flooding (lasts 1 week)	Distribution network - 0.5% of total network length in service area damaged	Network uses appropriate thrust blocks and high quality pipes. It is protected during floods.	5	○ Repair 0.5% of damaged distribution network and adjust pressure	Not yet implemented	0	-
Annual flooding	Treatment system - No major impact to water treatment system. Plant operating normally.	Treatment plant constructed on raised ground but not high enough. It can be inundated if flood levels are high.	5	○ Consider strengthening treatment plant infrastructure	Not yet implemented	0	-
Raw water intake pump breakdown (monthly)	Water treatment - Pumping station not operating well. Pumps commonly breaking down but station still operating with backup pumps.	Backup pumps available at pumping station. They can be used until pump replacement or repair is done.	5	○ Purchase new motors	Not yet implemented	0	-

6. Step 6: Compiling, reviewing, and updating the climate resilient water safety plan document:

The climate resilient water safety plan report is a living document that can be continuously updated. You will likely keep modifying different sections of this document as you implement the climate resilient water safety plan. Given the changing climate, environment, deep uncertainty about the future, and other evolving situations, it is critical that you revise, update, and enhance the climate resilient water safety plan report at least annually. You and your climate resilient water safety planning taskforce will likely find that you need to add new risks, re-evaluate your risks, propose new improvement measures, and modify your available implementation plans. Table 15 provides an example of how to fill out this section.

Table 15: Examples of how to compile, review, and revise documents implementing climate-resilient water safety plans.

Hazard	Impact	Vulnerability	Risk Score	Mitigation measure	Effectiveness of monitoring measures in addressing risks	Modifications/ changes to monitoring measures for updating climate resilient water safety plans	Lessons learned
Contamination by birds/bats (daily)	Water storage tanks - All the water storage tanks are contaminated by bird/bat feces from their nests on reservoir covers.	Staffs inspect regularly. So far, none of the water storage tanks are covered.	1	○ Set up barbed wire fencing around reservoirs to prevent animals from entering and creating waste.	100%	No improvement needed	Regular maintenance and cleaning of water storage ensures treated water remains hygienic and safe for supply to users
Annual flooding (lasts 1 week)	Water source - All water sources (boreholes) inundated	Boreholes located in low lying areas and prone to inundation even during minor floods	2	○ Raising the upper part of the borehole higher than the flood level	Not yet addressed	-	-
Bird fecal contamination (daily)	Water source - Polluted biologically by birds from nearby farms.	Policies exist locally but enforcement is very limited. Water sources typically polluted by pesticides/fertilizer/animal waste running off from upstream areas.	3	○ Coordinate with local authorities to prevent livestock from entering water sources. ○ Construct protective barriers to	80%	There is a need for more collaboration with local authorities to find safe disposal sites for residents dumping animal waste, and to educate them	Increasing awareness is not easy, and people do not listen to local authorities. Law enforcement is required. Finding land for waste disposal is a challenge due to

				prevent wild animals from entering water sources.		about the health impacts of improper animal waste disposal.	concerns over who will pay for the land.
Running out of Ca(OCl) (happens 2-3 times/year)	Water treatment system - Disinfection system is not working and it will severely impact the water quality before supply to consumers.	There is no such SOP, however one staff has been assigned to monitor the chemical inventory.	3	○ Designate roles, responsibilities, and monitoring schedules to check inventories	100%	No improvement required	It is necessary to develop standard operating procedures (SOPs) for water treatment operation systems to ensure improved chemical management.
Improper chemical dosing (2-3 times/year)	Water treatment - Poor coagulation in clarifiers, which then impacts filters and clear well. May impact around 50% of entire system not working properly.	No jar test equipment in plant but operators visually check plant operation every morning.	3	○ Purchase Jar-Test equipment and test whenever raw water changes	Not yet addressed	-	-
Distribution pipe bursting (monthly)	Distribution network - Approximately 10% of the distribution network is affected monthly at road construction sites.	Road constructors may take some additional precautions, but it is difficult to completely avoid.	3	○ Meet with contractors and request they pay extra attention with some precautionary measures to prevent pipe damage	70%	There needs to be ongoing collaboration with road construction contractors that are causing damage to the pipelines	Even though contractors are being more careful when constructing roads, damage still happens because the contractors do not know where the

							pipes are located. Close cooperation with the contractors is needed.
The emergence of algal/cyanobacterial blooms (occur every 3 years and last 1 month)	Water sources - Freshwater becomes polluted with algae and cyanobacteria along with algal/cyanobacterial blooms.	There are no proper procedures or regulations in place, but this happens during severe hot seasons due to very low water levels.	4	○ Modify dosing system to kill algae in early stages	Not yet addressed	-	-
Drought (occurs every 3 years and lasts 1 month)	Treatment system - No impact to water treatment system. Plant operates normally.	Treatment system can function but with difficulty due to lack of lab equipment to confirm adjustment of PAC dosing levels	5	○ Purchase Jar-Test equipment to determine PAC dosing levels, ○ Monitor coagulation and sedmination tanksfrequently to ensure effectiveness	Not yet addressed	-	-
Annual flooding (lasts 1 week)	Distribution network - 0.5% of total network length in service area damaged	Network uses appropriate thrust blocks and high quality pipes. It is protected during floods.	5	○ Repair 0.5% of damaged distribution network and adjust pressure	Not yet addressed	-	-
Annual flooding	Treatment system - No major impact to water treatment	Treatment plant constructed on raised ground but not high	5	○ Consider strengthening	Not yet addressed	-	-

	system. Plant operating normally.	enough. It can be inundated if flood levels are high.		treatment plant infrastructure			
Raw water intake pump breakdown (monthly)	Water treatment - Pumping station not operating well. Pumps commonly breaking down but station still operating with backup pumps.	Backup pumps available at pumping station. They can be used until pump replacement or repair is done.	5	○ Purchase new motors	Not yet addressed	-	-

Appendix 1

The Kingdom of Cambodia
Nation Religion King

Reporting Template

Climate Resilient Water Safety Plan

[Name] Water Supply System

[Name] Village, [Name] Commune, [Name] District, [Name] Province

[Day] [Month] [Year]

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1. Introduction

1.1. General Information about the Water Supply System

[Brief overview of the water supply system – history of water supply system]

[Please fill in the table below on staff information in your system and add extra rows if needed]

Staff List						
No.	Name	Gender	Age	Position	Experience	Education
1						
2						
3						
4						
5						

[Please fill in the results of your water source quality tests. If you have more than one water source, please add another table for each water source.]

Water Source Quality Testing			
Parameter	Unit	Maximum Standard Value	Result
Turbidity	NTU	5	
pH	-	6,5-8,5	
Total Dissolved Solids	mg/L	1000	
Iron	mg/L	0,3	
Total Hardness	mg/L	250	
Arsenic	µ/L	50	
Fluoride	mg/L	250,0	
Manganese	mg/L	0,3	
Nitrate	mg/L	3	

1.2. License and Supply Status

[Please briefly describe the license status, villages/communes supplied, and number of households and population in the supply area.....add extra rows if needed.]

License Status	

Number of Communes Supplied				
Number of Villages Supplied				
No.	Village Name	No. of Household Members	Population	Notes
1				
2				
3				
4				
5				

1.3. History of Implementing Water Safety Plans

[Please fill in the table below on history of implementing water safety plans in your system.]

1	Have you previously developed and implemented PWS?	☐ Yes/No (If Yes, answer questions 2-5) ☐ No
2	When?	
3	Was it successful?	
4	What lessons were learned?	
5	Are you currently still implementing WSP?	☐ Yes ☐ No (If No, answer question 6)
6	Why not?	☐

2. Step 1: Establishing/Reactivating Water Safety Plan Taskforce

2.1. Water Safety Plan Taskforce Member List

[Please fill in the table below with information about your Water Safety Plan taskforce]

Water Safety Plan Taskforce Member List								
No.	Name	Type (Implementer or Facilitator)	Position	Position in WSP Taskforce	Roles and Responsibilities in WSP Taskforce	Education Level and Skills	Work Experience	Contact Information
1								
2								
3								
4								

5								

2.1. Capacity Gaps

[Describe any capacity gaps in your WSP taskforce, if any]

3. Step 2: Describing the Water Supply System and Assessing Water Sources

3.1. Water Supply System Schematic

[Please draw a schematic of your water supply system following the water supply system schematic in the Guideline on Climate Resilient Water Safety Plans.]

3.2. Water Sources and Pump Status

[Description of water storage tanks, water sources, and intake parts of your system, including the following information. Please add any relevant information you want to include in this section.]

- ☐ Type of raw water source (e.g., groundwater, river, pond/lake)
- ☐ Season when water use is highest in the system
- ☐ Detailed information on raw water pumps and pipe status (length, diameter, condition)
- ☐ Groundwater yield
- ☐ Borehole depth or reservoir or pond size

3.3. Treatment System

[Description of the treatment system, including the following information. Please provide any additional relevant information you want to include in this section.]

- ☐ Type of treatment
- ☐ Treatment capacity
- ☐ Chemical dosing volumes for water treatment
- ☐ Chemical dosing system (gravity or pumped)
- ☐ Water quality monitoring and testing at various stages of the treatment process and waste sludge handling in clarifier and filter backwash
- ☐ Available standard operating procedures (SOPs)
- ☐ Available maintenance schedules and monitoring.

3.4. Water Storage

[Description of water storage, including the following information. Please provide any additional relevant information you want to include in this section.]

- [ ] Number and volumes of reservoirs
- [ ] Water volume monitoring approach
- [ ] Location of reservoirs
- [ ] Condition of reservoirs
- [ ] Available standard operating procedures (SOPs)
- [ ] Frequency of monitoring, maintenance, cleaning or procedures available

3.5. Water Distribution

- [ ] Aeration reservoir capacity
- [ ] Number of distribution pumps
- [ ] Detailed information on distribution pumps and status

3.6. Water Distribution System

[Description of the distribution system, including the following information. Please provide any additional relevant information you want to include in this section.]

- [ ] Distribution network map
- [ ] Length of distribution system
- [ ] Pipe types (HDPE, PVC or iron) and diameters
- [ ] Monitoring (water quality and pressure check)
- [ ] Pipe cleaning schedule
- [ ] Valves
- [ ] Available standard operating procedures (SOPs)
- [ ] Customer use and storage

4. Water Source Assessment

4.1. Water Source Quality Assessment

[Please fill in the information on water source quality from section 1.1 above]

4.2. Water Source Quantity Assessment

[Please fill in the table below to assess the raw water quantities available from your water sources and to assess whether those water sources are adequate to meet the water demand in your supply area.]

	Description	cubic meters/year
1	Raw water source	For groundwater only: a = total (no. boreholes * borehole yield)

		For pond/reservoir: a = for pond/reservoir, total monthly inflows – water ratio in pond/reservoir * pond/reservoir surface area
2	Raw water required to meet demand	= Water use + (Water use*15%)
3	Is water supply adequate to meet demand?	= 1 - 2

5. Steps 3a and 3b: Environmental and Climate Risk Characterization and Assessment and Improvement Measures

5.1. Characterization and Assessment of Hazard, Impacts and Vulnerability across the entire Water Safety Plan

[Please fill the 3 tables below on hazards, impacts and vulnerabilities for your system. Add extra rows as needed.]

Vulnerability	Identify Hazards				Hazard Scoring
	Frequency	Duration	Location in Water Supply System	Time of Year	Score

Hazard	Identify Impacts			Impact Scoring
	Impacts within Water Supply System	Component	Description of Impacts	Score

Hazard	Impacts within Water Supply System	Vulnerability Questions	Description of Vulnerability	Vulnerability Score

5.2. Risk Assessment

[Please fill in risk assessment table below. Add extra rows as needed.]

Hazard		Impact		Vulnerability		Risk Score	Categorization
Description	Scores	Description	Scores	Description	Scores		

5.3. Improvement Measures and Capacity Assessment

[Please fill in table below. Add extra rows as needed.]

Hazard		Impact		Vulnerability		Risk Score	Categorization	Management Measures	Capacity
Description	Scores	Description	Scores	Description	Scores				

6. Steps 4a and 4b: Develop and Implement Additional Improvement Measures and Define Climate Resilient Options

[Please fill in the table below. Add extra rows as needed.]

Hazard	Impact	Vulnerability	Risk Rating	Management Measures	Capacity	Estimated Budget Needed	Lead	By When

7. Step 5: Monitor and Validate Effectiveness of Improvement Measures

[Please fill in the table below. Add extra rows as needed.]

Hazard	Impact	Vulnerability	Risk Rating	Management Measures	Description of Progress	% Completed	Effectiveness of Management Measures in Addressing Risk

8. Step 6: Document, Review, and Improve Climate Resilient Water Safety Plan

[Please fill in the table below. Add extra rows as needed.]

Hazard	Impact	Vulnerability	Risk Rating	Management Measures	Effectiveness of Management Measures in Addressing Risk	Modifications to Monitoring Measures for Updated Water Safety Plan	Effectiveness of Management Measures in Addressing Risk