Guideline For Inclusive & Climate-Resilient Rural Water Supply Services

Ministry of Infrastructure and Transport
Departament of Infrastrucutre Development
Water and Sanitation Division
In partnership with SNV, Bhutan

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Executive Summary

The "Guideline for Inclusive and Climate Resilient Rural Water Supply Services" is jointly initiated and developed by SNV Bhutan and Water & Sanitation Division (WSD), Department of Infrastructure Development, Ministry of Infrastructure and Transport with a primary objective to combat emerging climate change impacts to water resources emphasizing on Gender Equality, Disability and Social Inclusion (GEDSI). The guideline aims to address Impact on the delivery of Rural Water Supply Services through incorporation of climate resilient designs and sustainable operation & management principles. The document also highlights on the environmental safeguard practices to be adopted for Rural Water Supply Services including institutional linkages and capacity building needs.

The guideline is intended to ensure that Rural Water Supply services is planned systematically, designed and managed professionally in assuring safe drinking water to the communities. It is developed mainly for planners, designers, implementers, Water Users' Association (WUA) and Local Government to enable them to plan, build resilient infrastructure and improve water use efficiency, water conservation and protection measures, amongst others.

The guideline emphasizes the need for environmental assessment to identify sector specific threats and issues associated with the proposed and planned Rural Water Supply Services to ensure that likely impacts are addressed well in time with appropriate adaptive and mitigation measures. It is designed to guide relevant individuals and agencies to integrate climate resilient measures and promote inclusive participation in Rural Water Supply Services. The guideline incorporates issues identified during the recent field visits and stakeholders' consultations and compiled as field report in September 2024. Some of the key considerations made during the field visit included data collection, primary surveys, chiwog-village level discussions and consultations on water resources availability, water supply and sanitation coverage, utilization, demographic, socio economic and health issues. The report highlights numerous challenges related to climate change impacts to water resources and the inadequate capacity of the communities to address the challenges. Some of the key issues encountered are: (i) inadequate field studies by the professionals due to staff shortages, (ii) time constraint, (iii) limited capacity of the communities to maintain and manage water supply system, (iv) inadequate fund for maintenance and (v)lack of appropriate forum to exchange experiences across communities to provide strategic insight into its role in addressing the climate crisis.

The details of the guiding aspects on Rural Water Supply Service are discussed and the corresponding actions towards an inclusive and climate resilient water system are enlisted in the document that emphasize systematic approach in planning, design, construction and maintenance of Rural Water Supply Schemes.

Acronyms & Abbreviations

BDWQS	Bhutan Drinking Water Quality Standard
DoID	Department of Infrastructure Development
DoPH	Department of Public Health
DoW	Department of Water
DPO	Disabled People's Organization
GEDSI	Gender Equality, Disability and Social Inclusion
IPCC	Intergovernmental Panel on Climate Change
MoENR	Ministry of Energy and Natural Resources
MoH	Ministry of Health
MoIT	Ministry of Infrastructure and Transport
NAPA	National Adaptation Programme of Action
NDC	Nationally Determined Contributions
NHS	National Health Survey
PWD	Person with Disabilities
RGoB	Royal Government of Bhutan
RWSS	Rural Water Supply Scheme
SDG	Sustainable Development Goal
SNV	Netherlands Development Organization
UNICEF	United Nations Children’s Fund
WHO	World Health Organization
WSD	Water and Sanitation Division
WUA	Water Users’ Association

A. Introduction

Bhutan has made significant progress in providing access to Rural Water Supply Services having achieved more than 99.8 coverage since its inception in 1974. According to the 5th National Health Survey (NHS), 2023 conducted by Ministry of Health, Bhutan, almost all households (99.7%) and the population (99.7%) have access to Improved sources of drinking water.
A rapid survey done in 2017 indicated that the inequalities related to income, gender, disability and geographic factors are often interrelated. Rural households are remote and scattered, and located on mountainous terrain with limited access and challenging supply chains. Climate change poses substantial new challenges for Rural Water Supply Services across 20 Dzongkhags, increasing threats of floods, droughts, increased temperatures, wildfires and glaciers melts thereby causing damage to infrastructure and auxiliary services, interrupting access to water and sanitation, and resulting in deterioration of water quality.

The existing resources is often not adequate to build resilience in water supply services and an additional investment is required to upgrade and improve water supply system and services. There are several water and sanitation features outlined in National Adaptation Plans (NAP) and Nationally Determined Contributions (NDC) which are required to be addressed in the wake of climate change. The Sustainable Development Goal (SDG) 6 ''Clean Water and Sanitation aims to ensure the availability and sustainable management of water and sanitation for all'', reflects the increased attention on water and sanitation issues globally. The 2030 Agenda lists rising inequalities, natural resource depletion, environmental degradation and climate change amongst other challenges. It recognizes that social development and economic prosperity depend on the sustainable management of water resources and ecosystems and it highlights the integrated nature of SDGs[1]. The effects of climate change are based on various climate scenarios evaluated through Intergovernmental Panel on Climate Change (IPCC). The frequency of sudden and extreme weather events, droughts and flooding risks are expected to increase, and the major sector being anticipated to be affected by the climate change is drinking and utility water.

Access to safe drinking water is a basic need and is one of the most important contributors to public health, and it can greatly reduce water related health problems thereby reducing burden on Health Sector. The water quality surveillance on physical, chemical and microbial parameters is being conducted by Ministry of Health (MoH) through a network of Hospitals and Primary Health Centers (PHCs) in keeping with the National Guideline for Drinking Water Quality Surveillance, 2019.

This Guideline is intended to improve and enhance potable drinking water supply amidst climate change from catchment to the consumers through climate resilient water supply system.

A.1. Policy and Regulation

The section 4.1 states that Bhutan Water Policy is a reflection of the Royal Government's commitment on the conservation, development and management of the country's water

[1] Sustainable Development Goal 6 Synthesis Report 2018 on Water and Sanitation, UN

resources. The Policy recognizes water as a precious natural resource and a heritage important to all aspects of social, economic and environmental wellbeing[2].
The Department of Water, Ministry of Energy and Natural Resources as the apex body is mandated to coordinate and regulate matters related to water resources in accordance to the policies, laws and regulation of the country.

According to RWSS Sector Policy 2002, decentralised implementation and management procedures are considered as a key element in improving the sense of ownership and self-management of schemes by the beneficiaries.

According to the Water Act of Bhutan, 2011- following the section 13 (f) and section 42 (a) & (b) Bhutan Drinking Water Quality Standard (BDWQS) have been developed outlining the requirements of drinking water. In addition, the chapter 11, section 50 states that any group of beneficiaries using a particular water source for their water supply needs may form a Water Users' Association (WUA) to maintain water source and to manage water supply services. While the water safety plan (WSP) is mandated to be implemented by every Gewog to ensure that the water quality standards are met as per BDWQS 2019, there is an urgent need to build the capacity and strengthen institutionalization of the WSP programme nationally.

A.2. Issues and Challenges

Climate change is emerging as a key challenge and is projected to have widespread adverse impacts to water and sanitation facilities. Degradation of forests and climate change are some of the causes underlined to accelerate drying up of water sources in Bhutan. Of the total 7399 water sources, 69 have already dried up and 1856 are in the process of drying up (Kuensel, April 6, 2023). The water scarcity has resulted primarily due to prolonged droughts or floods and Irregular precipitation pattern.
The other issues being confronted in the Rural Water Supply Services are as outlined below:

- The water supply to the rural communities Is provided free of charge thereby resulting in inefficient and misuse of water.
- In absence of formal establishment of WUA, there is no sense of ownership among the beneficiaries resulting in poor Operation & Management of the water scheme.
- Additionally, there is no committed funds provided to the water supply scheme on regular basis resulting in lack of maintenance leading to defunct water supply scheme.

B. Objectives

The primary objectives of inclusive and climate-resilient rural water supply services are to:

- Enable planners, designers, implementers, Water Users' Association (WUA) and Local Government to build climate resilient infrastructure to withstand potential hazards, such as floods, landslides and droughts
- Enhance sustainability through effective utilization of the water resources while ensuring

[2] https://www.moenr.gov.bt/wp-content/uploads/2017/07/Bhutan-Water-Vision.pdf

environmental and financial sustainability

- Ensure supply of safe and reliable drinking water to the communities including the vulnerable groups in the wake of climate change Impacts
- Promote water use efficiency and conservation practices creating community ownership through awareness and advocacy programmes
- Develop capacity building on climate resilient and inclusion aspects to implement water related programmes
- Develop coping mechanisms as a response to climate change impacts, especially during water scarcity and water related emergency situations

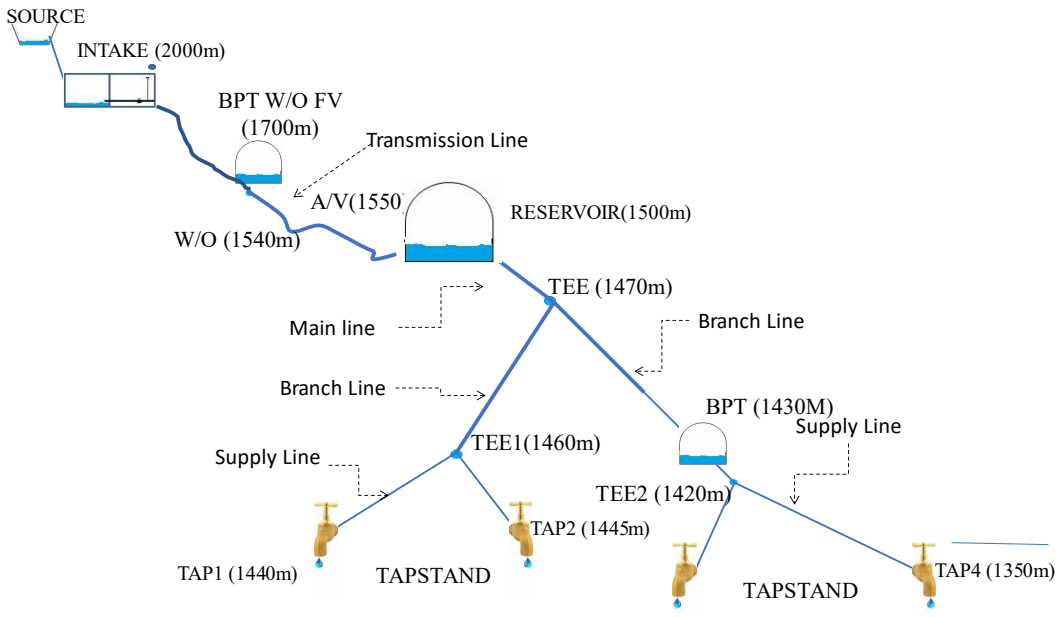
C. Scope

The Guideline is intended to facilitate planning, designing, Implementation of an inclusive and climate-resilient and sustainable management of RWS Services. It is developed in compliance with the provisions of the prevailing Water Act, Water Regulation and is intended to provide guidance to technical professionals, planners, designers, implementers and WUAs in achieving climate resilient Infrastructure and services.

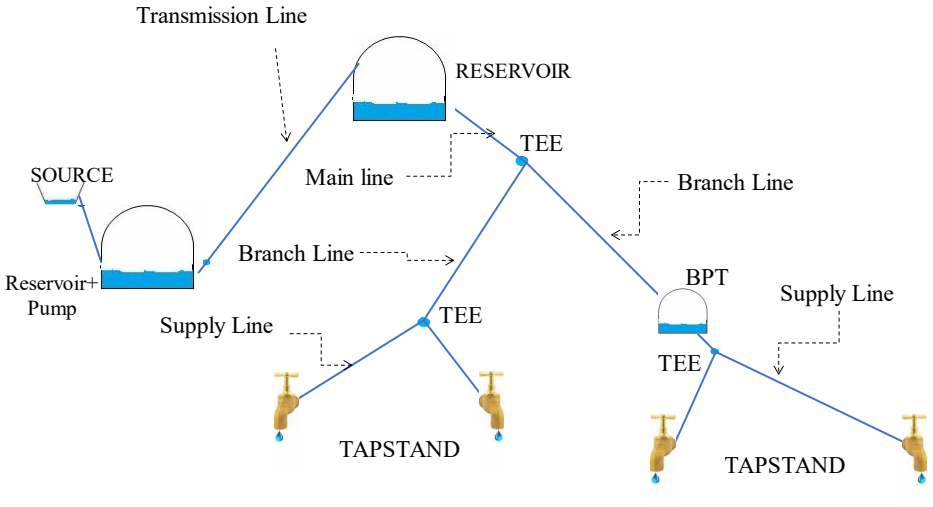
D. Basic RWS components

The information set-out in the diagram indicates the key components) of the rural water supply services: Catchment, Intake, Reservoir, Break pressure tank, transmission, distribution, pipelines, supply line and tap stands including other accessories (ARV,SCV,NRV,GV, PRV etc.)

D.1 Gravity Flow Rural Water Supply System



D.2 Dual water supply system consisting of pumping and gravity flow



E. Planning of inclusive and climate resilient RWS services

In order to facilitate the planning and implementation of an Inclusive and climate Resilient Rural Water Supply Services, the following guiding areas have been listed:

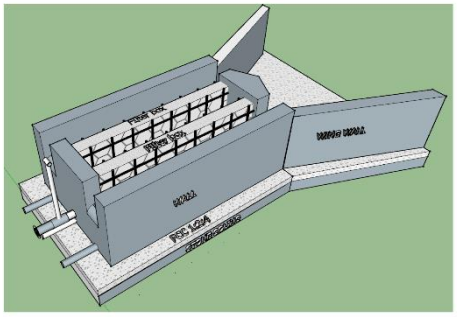
1. General information		**Key stakeholders**
1.1. General Information	1. Collect data to understand the demand and supply for design and implementation of inclusive and climate resilient water facilities and services. ▪ Prepare village mapping by the communities Indicating the locations of intake, reservoir, tap stands and houses/population o Name and number of Chiwogs, institutions (hospitals, schools, monastic body), commercial establishment, household and population including floating population, o potential water source data such as type, availability, perennity, quality and distance of water source o Identify preliminary climate induced risks	*Gewog, WUA, Dzongkhag*

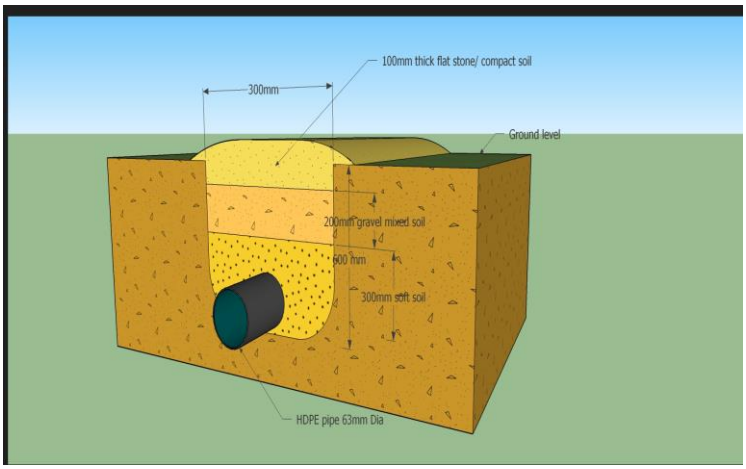
	2. Promote inclusive participation of the vulnerable groups to ensure that women, children, persons with disabilities, elderly and people with temporary mobility for their views, needs & preferences 3. Reflect on local beliefs and leadership to understand local context to make it more inclusive and resilient for long term sustenance: ▪ Traditional beliefs have proven ownership of the facilities, economics, environment protection and sustainability through water source and watershed management ▪ Identify successful traditional approaches and adopt them in planning as appropriate to make it simple and effective to understand by the beneficiaries ▪ Identify traditional approaches in water management through inclusive consultations and adopt the most successful local approach in planning of water services to make it climate resilient and convenient for the locals to operate and maintain the system	
1.2. Climate resilient measures	Design of climate resilient water facilities and services should include measures for adaptation and mitigation, involving all members in the community Including vulnerable groups. Delineation of clear roles and responsibilities of various stakeholders such as Dzongkhags, Gewogs communities and others If any Allocation of adequate fund to ensure use of quality materials and skilled manpower for infrastructure development including operation & management of the water supply schemes, incorporating climate resilient components ▪ Assessment of site viability of the various components (source to consumer point) ▪ Exercise due diligence in planning, designing and implementing climate resilient infrastructure avoiding vulnerable location. ▪ Revival and protection of water source by fencing, plantations, recharge, protection against potential damages from uncontrolled surface run-off, water conservation through nature-based solutions (Bio	*Gewog, WUA, Dzongkhag*

	engineering, construction of earth/masonry/log multi-layered mini check dams) ▪ Effective mechanism should be put in place to reduce water wastage and promote water efficient/saving devices ▪ Formation of Water User Association with clear roles, responsibilities and bylaws including appropriate financial mechanism to ensure sustainability of the water schemes.	
1.3. Consideration for Gender Equality Disability & Social Inclusion (GEDSI)	▪ Ensure that women, children, persons with disabilities, elderly, persons with temporary mobility restrictions such as pregnant women and the sick are included for their views and ideas on climate vulnerability and impacts to facilitate in planning, designing and implementation of climate resilient water supply Infrastructure and services. ▪ Create enabling environment for women, children, persons with disabilities, elderly, persons with temporary mobility restrictions for their participation throughout the project cycle (from planning stage to completion)	DOID (MoIT), DOW (MoENR), Dzongkhag, Gewog, WUA, DPOB
1.4. Feasibility study		Key stakeholders
1.4.1. Water source	Feasibility study should be conducted to ensure that the implementation of water supply is climate resilient ▪ Identify stable locations for siting of water source and other components that have less probability of landslides, floods and free from contamination. ▪ Assess upstream catchment condition for the presence of human settlement, animal shed, pasture land and human induced activities such as agricultures, road construction mining resulting contamination and drying of source ▪ Assess downstream of the catchment for Irrigation and water use by other communities to avoid potential water conflict between different users due to same source sharing resulting to water shortage ▪ Ascertain the adequacy of water source in terms of type reliability, availability, perennity, quality, distance, location for both gravity and pumping scheme. ▪ Ideally, nearest water source is preferred socially and economically if feasible	*Gewog, WUA, MoH (hospitals/PHC), DoID (MoIT), Dzongkhag, Dept of Forest and Park Services, DoW*

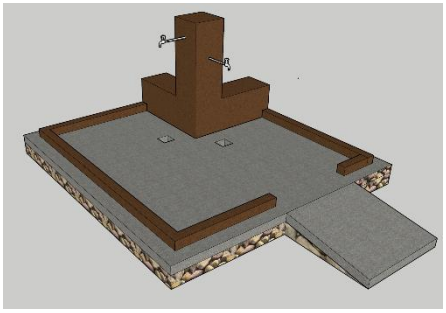
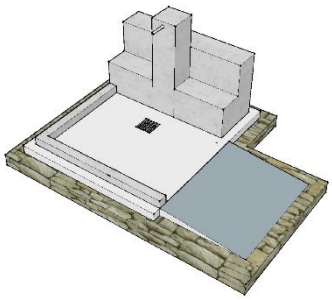
	▪ Spring sources should be preferred over stream source given the options since spring sources are considered to be reliable, sustainable and better quality If the source yield is adequate to cater to the population to be served ▪ Identify alternative sources to reduce reliance on single source ▪ Carry out physical and microbiological water quality test according to national guideline for drinking water quality surveillance 2019 in collaboration with the health sector ▪ Measure source yield (measurement month/lean season, e-flow consideration, source sufficiency using commonly adopted methods such as bucket and stop watch and velocity area method for the projected design demand ▪ Obtain necessary clearances (environment, social, forestry etc.) to ascertain that there Is no negative environmental Impact and conflict with the community, i,e, no environmental damages that may have adverse effects to environment and the settlements due to abstraction of water or establishment of water facilities ▪ Carry out assessment for water catchment area (disturbed or undisturbed) in collaboration with relevant agencies and LGs ▪ Use local hydrological data through the locals to know the history of water source and draw hypothesis on water sharing against consumers considering the present scenario of climatic impacts	
1.4.2. Pipeline (Transmission & distribution)	▪ Select tentative pipeline alignment avoiding potential landslide, flood prone areas, erosion, flash floods, subsidence and rocky area etc.), Use suitable apps to select the most economically feasible pipe alignment to avoid private and public properties. Avoid crossings points across roads, rivers, streams and gulleys as far as possible If unavoidable, identify suitable crossing points considering span and stability. ▪ Prepare pipeline profile and schematic diagram of the overall system	*Gewog, WUA, DoID (MoIT), Dzongkhag, Dept of Forest and Park Services*
1.4.3. Intake, Reservoir, BPT, tap stands etc.	▪ Select stable location to avoid landslides, flood and private land Select site using suitable apps (SW maps, GPS etc.)	*Gewog, WUA, DoID (MoIT),*

		Dzongkhag, DPOB
1.4.4. Preliminary cost estimate	▪ Prepare preliminary cost estimate incorporating climate resilient aspects for proposed water supply scheme. ▪ Climate resilient structures usually cost higher as compared to normal standards estimate but expected to be economical in long run by reducing O&M cost	*Gewog, DoID (MoIT), Dzongkhag*
1.4.5. Final consultation	▪ Carry out final consultation with the beneficiaries and stakeholders to convey the preliminary assessment findings ▪ Inform or mutually agree on the implementation modality to the beneficiaries about the status of the scheme and receive support for their active participation ▪ Execute agreement and commitment between community, local government and relevant stakeholders	*Gewog, WUA, Dzongkhag*
2. Detailed Survey and Design of Inclusive and Climate Resilient RWS Services		**Key stakeholder**
2.1 Detailed Survey	▪ Carry out detailed survey along the finalized alignment of the transmission main from source till the reservoir using appropriate equipment (Abney level, RTK, total station etc.) ▪ Carry out similar survey for distribution network from the reservoir to Individual tapstands showing the location of each houses/population ▪ Ensure to capture and record critical points (road crossings, gulleys, rivers, streams, rocky areas, low and high points) with respect to chainage and elevations ▪ Provide coordinates (elevation, northing and easting) preferably using RTK for higher accuracy. For survey conducted using conventional equipment (e.g. Abney Level), ensure to mark points/pipe alignments on the trees or use pegs at intervals not exceeding 30 meters ▪ Use survey field book and the pencil for recording survey readings Prepare schematic diagram and pipeline profile based on the survey data before leaving the station	*Community, Gewog, Dzongkhag, RoID*

2.2 Detailed design	▪ Scrutinize/analyze survey data to ensure that It Is reliable and consistent ▪ Finalize schematic diagram and pipeline profile and location of BPTs, air release valve, wash out/scour valve, TEEs (Y-junction) ▪ Compute supply and demand using RWS reservoir calculation software to determine the reservoir capacity, flow in each tapstand ▪ Carry out hydraulic design of the pipeline using RWS design software to determine pipe type, size, pressure class while ensuring velocity (0.4 to 3 m/s) and residual head (greater than 0 and less than the pressure class adopted) are within the permissible limits ▪ Prepare drawings (catchment, Intake, reservoir, BPTs, ARV, wash out /SCV, tapstand, schematic diagram and hydraulic profile) based on the design output referring prevailing RWSS standardization manual ▪ Finalize schematic diagram	*DoID (MoIT), Dzongkhag, Gewog*
2.2.1 Intake	▪ Identify intake structure based on type of source (weir, catchment Infiltration tank with valve box, catchment infiltration tank with intake, standard intake)   Fig: Catchment Infiltration ▪ Catchment infiltration tank offer better resilience to climate change impact. During stream flooding, debris and sand particles are automatically washed out through the channel and only clear water enters through the filter media into the inlet chamber. Excess water flows smoothly through the channel without damaging the structure. The structure being RCC can withstand climate induced risks as compared to conventional Intake. This structure ensures continuous flow avoiding water hammering in the pipeline and minimizing the	*Gewog, Dzongkhag*

	clogging of the outlet pipe. However, this structure can be used only for stream source and to be built on the stable foundation. ▪ Weir intake structure is built to divert the flow towards the catchment. It is built with sluice gate to facilitate flushing of debris and for flow regulation. The weir is constructed with convex shape facing against the flow direction to provide better resistance. This arrangement ensures continuous flow during lean period and reduce damage to the structure during monsoons. ▪ Identify source protection requirement which should be well protected using barbed-wire or chain-link fencing/using locally available materials for safety and to restrict unauthorized entry ▪ Closed conduit with strainer may be proposed where intake construction is not possible at source ▪ In case of spring source, locate the eye/outlet of a spring and construct wing wall as per prevailing standardization manual to divert water to the intake consist of collection chamber and valve chamber ▪ For standard RWSS intake, the floor slab of the collection chamber is recommended to be RCC to avoid cracks due to differential soil settlement	
2.2.2 Pipeline	 ▪ Ensure burying of pipes underground as far as possible at least 60cm depth to avoid freezing, fire hazards, tempering and Illegal tapping and potential damages from agricultural activities.	*Gewog, Dzongkhag*

	▪ where it is not possible to bury, providing insulation /encasement/concrete /masonry casing is recommended or encasing with GI pipe to avoid damages by falling boulders. ▪ Provide pipe suspension across river, stream, gulleys, rocky areas and landslide prone areas- with insulation (eg. jute coated with cement slurry, cover with aluminium sheet). ▪ Propose adequate supports, props, thrust -blocks, anchor blocks and other protective measures where pipes are exposed ▪ For pumping scheme, the material for rising main (source to reservoir) should be GI pipes (medium duty) to resist pipe vibration and preferably be buried and embedded in RCC thrust block if exposed. Thrust block is mandatory at the bends even if the pipes are buried. ▪ Each pumping stage should not exceed 120 meters vertical height. Standby pump should be installed at every pumping stage and one non return valve (NRV) shall be provided immediately after the pump and another at the mid span of the pump station. ▪ A three-phase power supply is required for pumping with provision for solar panel preferably as standby or diesel operated generator of required capacity ▪ Flange sets for GI and HDPEs should have minimum of six holed nuts and bolts provision to ensure water tight-joints. Refer RWS standardization manual for details	
2.2.3 Break-Pressure Tank (BPT)	▪ Based on the hydraulic design output, the type of BPT (with and without float valve) should be constructed as follows: ▪ BPT with float valve in the distribution system to avoid water overflowing and direct water flow to the reservoir ▪ BPT without float valve in the transmission pipeline ▪ Identify stable area for the construction of BPT with provision of suitable drainage for overflow and wash out. ▪ Use standard RWSS drawings for BPT construction ▪ Provide fencing with appropriate materials like barbed wire, chain link	*Gewog, Dzongkhag*

2.3.4 Reservoir	▪ Identify stable area for the construction of FCR with provision of suitable drainage for overflow and wash out. ▪ Identify reservoir site location nearer to the village for easy operation and maintenance ▪ Construct reservoir on stable and safe location to avoid potential landslides and floods ▪ Provide reservoir of required capacity based on the hydraulic pipeline design and reservoir design ▪ Use standard RWSS drawings of ferro-cement reservoir (FCR) of required capacity as per design ▪ Provide proper fencing using barbed-wire, chain-link or local materials to restrict unauthorized entry ▪ Provide proper drainage around the reservoir to avoid damage to the structure by soil erosion, surface runoffs and mudslides ▪ Construct retaining wall/breast wall as necessary to avoid potential damages from landslides	*Gewog, Dzongkhag*
2.3.5 Tap stand	  ▪ Identify tapstand location in an area which gets maximum sunlight to avoid freezing and algae formation ▪ Construct tapstand as per RWS Standardization manual. Consider tapstand height, platform and ramp accessible for people with disability, children and pregnant women for both households and public tapstands. ▪ Construct proper drainage to avoid water stagnation and soil erosion ▪ Under freezing conditions (cold places) the pipes should be concealed within the wall and tap pillars ▪ Provide user-friendly bib-cock, pillar taps or elbow operated tap for PWD	*Gewog, Dzongkhag*

	▪ Provide flow control regulating valves to ensure design flow behind the tapstand ▪ Provide supply line for inhouse connection only for concrete structure with internal plumbing in place	
3. Detailed estimate and documentation		***Key stakeholders***
3.1. Detailed Estimate	▪ Prepare detailed estimate and BoQ based on the designs and drawings for works to be executed through contract. However, if the work is to be executed departmentally or through cost sharing prepare cost estimates using RWS estimating software based on annual quotations of respective Dzongkhags.	*Gewog, Dzongkhag, MoIT*
3.2. Documentation	▪ Use Specification of Building and Road Works to prepare the technical specification for works to be executed through contract. ▪ Compile complete sets of documentation consisting of designs, drawings, and estimates prior to implementation ▪ Obtain technical and financial sanctions	
4. Alternative/Coping mechanism		***Key stakeholders***
4.1. Alternative options	▪ Explore alternative coping mechanisms such as rainwater harvesting, ground water recharge, pumping as a response to climate change impacts and during water related emergencies. Promote water use efficiency to minimize water wastage. ▪ Encourage water storage at household level with float valve to prevent wastage due to overflow and to direct water to the main reservoir.	*Gewog Dzongkhag, DoW, DoID*
5. Operations & Maintenance (O&M)		**Key stakeholders**
5.1. Operations & Maintenance (O&M)	1. Minor Repair and maintenance ▪ Conduct minor repair and maintenance of the water supply schemes on regular basis from source to the consumer points by beneficiary community ▪ Train water caretaker to manage the RWS scheme and provide basic tools	Gewog, Dzongkhag, WUA, Community

	▪ Carry out routine maintenance as per Caretakers' Manual ▪ Maintain as-built details and update in the WaSIS for all new connections in absence of a WUA: ▪ Ensure adequate essentials spares in stock ▪ Maintain log book to record nature and frequency of maintenance carried out ▪ Keep record of list of consumers and contributions made for O&M 2. Major repair and maintenance ▪ Prepare proposal for major rehabilitation including costing for appraisal to Gewog Tshogde for onward submission to Dzongkhag for support ▪ Adopt alternative strategies to ensure continuity of water supply (rainwater harvesting, storage, supply of water through tanker wherever possible, activating potential unused water source) ▪ Alternative measures (rainwater harvesting), and water source should be identified for connection to the existing system in case of insufficient water volume of existing water source	
6. Capacity building		**Key stakeholders**
6.1. Capacity building on Inclusive and CR Water Supply Services	▪ Build capacity of the planners, engineers and technicians on the inclusive climate resilient aspects ▪ Conduct periodic trainings for the Caretakers on O&M. Build capacity of the community contractors in climate resilient water supply works whenever necessary. Keep financial provision for caretaker training and tools in LGs ▪ Conduct awareness and advocacy to the communities on the importance of water and climate change impacts. Promote reuse of grey water for kitchen garden/agricultural purpose and for ground water recharge	DoID (MoIT), DoW (MoENR), Gewog, Dzongkhag, WUA, Community

7. Water Safety plan		**Key stakeholders**
7.1. Water Safety Plan and water quality surveillance	▪ Conduct climate resilient Water Safety Plan as per CR WSP guideline including periodic review Ensure compliance to the CR-WSP requirement and water quality surveillance as per the National guideline for Drinking Water Quality Surveillance 2019.	MoH, DoID (MoIT), DoW (MoENR), Dzongkhag, Gewog, WUA
8. Water User Association		**Key stakeholders**
8.1. Water User Association (WUA)	▪ Ensure every water supply scheme has WUA established as per the WUA guideline and by-laws developed and implemented. ▪ Bylaws for WUA should be developed upon consultations with the communities ▪ Conduct advocacy and awareness on WUA guideline to the beneficiaries ▪ Ensure that necessary gadgets and spare parts are stocked through community contributions. ▪ Maintain log book to record nature and frequency of maintenance carried out including expenses incurred ▪ Keep record of list of consumers and contributions made for O&M	DoW (MoENR), DoID (MoIT), Dzongkhag, Gewog
9. Coordination and Information exchange		**Key stakeholders**
9.1 Local knowledge on water resources	▪ Initiate local exchange programs on climate-resilience and water conservation measures. An experience sharing forums can provide opportunities to facilitate local knowledge and experiences for inclusive participation and sustainability. Share indigenous knowledge on coping mechanism during water scarcity ▪ Keep record of valuable knowledge and historical information/experiences shared by the locals	Gewogs, Dzongkhags
10. Monitoring & Evaluation		**Key stakeholder**
10.1 Monitoring of water	1. During Construction: ▪ Conduct periodic monitoring to ensure compliance with the designs, drawings and specifications	DoW (MoENR), DoID (MoIT),

supply schemes	▪ Water-conveyance facilities should be inspected by WUA and Water caretaker, and any adversities observed should be reported to the concerned authorities ▪ Record GPS coordinates of buried pipe lines, fittings etc. to relocate them in future when need arises ▪ Realign pipelines and relocate other infrastructures as may be necessitated due to occurrence of any disaster events post design. 2. Post construction ▪ Carry out monitoring to ensure functionality and performance of the scheme as Intended ▪ Review and adapt lessons learnt from the water scheme evaluation ▪ Prepare as-built drawings and details for reference during O&M and for proper succession planning in future ▪ Seek support from the experts, engineers or technicians for necessary planning for rehabilitation works ▪ Adopt online system (WaSIS) for information related to water scheme and use it for evidence-based planning and decision making	Dzongkhag, Gewog

F. ANNEXES

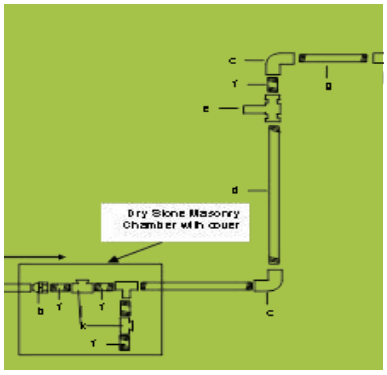
I. Images of a Rural Water Supply System that is climate resilient

The images depict several scenarios and illustrations of climate resilient RWS components

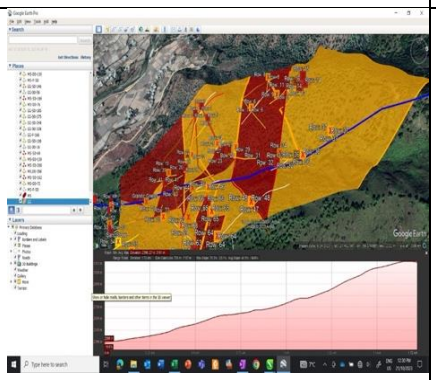
Pic-1: A climate resilient technique to collect rainwater in a ditch/pond to enhance infiltration recharging underground water that forms the spring.

Pic-2: Water is drawn from a spring prone to landslides with exposed pipeline. To make climate resilient, there is a need to burry HDPE pipes and draw water from the secured source or apply water conservation measures to secure the water source of this type.

Pic-3: Avoiding landslide areas by crossing hung water pipes overhead. This measure will reduce recurrent repairs and maintenance cost and other resources such as time and labors.



Pic-4: Schematic diagram to pre-plan valve-box chamber and tap connection for easy and inclusive design, operations & maintenence



Pic-5: Preliminary schematic contour drawings can help pipeline layout avoiding vulnerable sites

Pic-6: RCC filtration intake structure is a climate resilient technique to secure quality of drinking water

		
Pic-7: Reservoir tank that is climate resilient in terms of design and construction quality	Pic-8: Water is drawn from an ideal water source. The water source is well protected by barbed wire fencing and the water source is covered by well grown vegetations limiting risk of landslides.	Pic-9: The foothill has a water source that is well encircled by vegetation cover which will help any untowards water contamination.

II. Designs and drawings for climate resilient infrastructure

Adaptive, long lasting and sustainable elements are key components of climate resilient infrastructure designs and drawings in order to endure extreme weather, increasing flood levels, and other climate related Issues. For detail designs and drawings for climate resilient infrastructure, the RWSS standardization manual may be referred.

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