UNITED REPUBLIC OF TANZANIA

Jamhuri ya Muungano wa Tanzania

RUWASA
Rural Water Supply and Sanitation Agency

RURAL WATER SUPPLY AND
SANITATION AGENCY

Guidelines For Operations And Maintenance Of Rural Water Schemes And Sanitation Facilities

SEPTEMBER, 2022

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Guidelines For Operations And Maintenance

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ABBREVIATIONS

BWSO	Community based water supply organization
CIF	Cost, insurance and freight
DCOM	Design, Construction Supervision Operation and Maintenance
EFD	Electronic fiscal device
EIA	Environmental impact assessment
EWURA	Energy and water utilities regulatory authority
HDPE	High Density Polyethylene
HDP	High-Density Polyethylene
LPO	Local purchase order
NEMC	National environmental management council
PAYE	Pay as you earn
PCMM	Purchasing and Contract Management Manual
RUWASA	Rural water and sanitation authority
SSWP	Small Scale Water Provider
TANESCO	Tanzania electricity supply company
TBS	Tanzania bureau of standards
TRA	Tanzania revenue authority
VAT	Value added tax
WSP	Waste Stabilization Pond

CHAPTER ONE

INTRODUCTION

1.1. Background

The Water Supply and Sanitation Act No. 5 of 2019 underscores the space and mandate conferred upon RUWASA in initiation, construction, operation, management and regulation of the rural water projects, schemes and services. By design, RUWASA comes in as a well calculated strategic move to address a wailing quality and sustainability of rural water infrastructures and services. All supervisory and operational authority that were otherwise exercised by PO-RALG and Local Government Authorities are now concentrated on RUWASA. These changes in institutional set up and legal framework call for consequential changes in the mode of handling affairs at management and operational levels in desks and fields respectively.

It is, therefore, RUWASA's duty to put in an appealing mechanism to ensure a systematic Operations and Maintenance of rural water service schemes including Standardization of Water Equipment and Accessories and Availability of Spare parts and Specifications for Water Schemes. The current state of affairs in operation and maintenance of water schemes, Standardization of Water Equipment and Accessories and Availability of Spare parts and Specifications for Water Schemes is an inheritance from the previous sector management and repealed legal regime.

The tradition in operating Organizations and Water Schemes is situational; different CBWSOs in different localities in different parts of the Country are operating and managing schemes differently depending on supervising Authority, CBWSOs' leadership and service context. Dictated by the severity of water service gap, the operation and maintenance system can be strict or relaxed in response to the demand/supply elasticity.

At National, Regional and District levels, short of the Design, Construction Supervision, Operation and Maintenance (DCOM) 2020, there is no unified working mechanism that has been simplified and contextualized at operational level to allow and enable technical backstopping and hands-on coaching/ mentoring. The hard fact with operation and maintenance is that the more robust the system of operation and maintenance, the higher the possibility of the scheme and service sustainability.

It has been observed that lack of attention to the important aspect of Operation and Maintenance of water supply schemes in community rural water service delivery often leads to their deterioration and dysfunction of the systems necessitating premature replacement of many components. As such, even after building schemes by investing millions of money, they fail to provide proper services to the community for which they have been constructed and remain, most of the time, underutilized.

Some of the key issues contributing to the challenging Operation and Maintenance of the CBWSOs include insufficient finance, equipment, material, data on O&M and inappropriate system design. Other contributing factors are inadequate workmanship, multiplicity of agencies and overlapping responsibilities. Some issues are related to attitude, skills and competency. For example, inadequate operating staff, illegal tapping of water, inadequate training of personnel, lesser attraction of maintenance jobs in career planning. Lack of performance evaluation, regular monitoring and inadequate emphasis on preventive maintenance.

All these issues need to be addressed systematically. This tempts for a conclusion that preparation of this Guide is timely.

Under the Water Supply and Sanitation Act no.5 of 2019, the Minister of Water is vested with powers to prescribe codes of workmanship for project implementation cycle in the provision

of water supply and sanitation by water authorities and community organizations and private water supply and sanitation systems.

A code of workmanship may include design, construction, alterations, operation and maintenance or types of machinery, materials, fittings and appliances which may be used or the requirement for water works and sanitation works to only be executed by or under the direct supervision of a person holding a prescribed qualification or the procedure for obtaining approval for the works where necessary or any other thing connected to it.

The Guidelines on Operation and Maintenance is a long felt need of the Community Rural Water Service delivery. At present, there is no technical guide on this subject to benefit the field personnel and to help the supervisors to track and support operations systematically.

1.2. Objective of Operation and Maintenance Guideline

The main objective of the Guidelines is to put in place mechanisms that will provide directives and procedural steps to adhere and follow respectively in interventions related to Operations and Maintenance of Water Schemes, procedures for availability of spare parts and specifications. The Guidelines will apply in the management of Operation and Maintenance of Water schemes and services in the community rural part of the Tanzania mainland. The purpose of a water distribution system is to provide an adequate and reliable supply of safe water to its users. Operation and maintenance are those activities needed to continuously fulfil this purpose.

The definition of operation and maintenance is that operation involves activities necessary to deliver the service, while maintenance involve activities that keep the system in good operating condition

The aim of the guideline is to assist CBWSOs by providing information on proper operation and maintenance practices available in a practical and accessible way. The guideline focuses on water sources, water transmission system, storage, and water distribution systems including pipes, pumps, valves, storage reservoirs, meters and other fittings. It deals with important elements of the water supply chain such as the protection of water sources, raw water systems, water treatment plants and plumbing systems. In addition, the guideline focuses on technical issues of operation and maintenance, and includes factors such as environmental and financial management, payment and billing systems, funding, reporting mechanism, procurement and spare parts supply chain and accountability.

Proper operation and maintenance are indispensable to ensure that capital investments on new infrastructure result in sustainable service provision. Without a reliable water distribution system, the Government investment could decline to a point where service provision is compromised, leading to greater water losses, financial losses and health risks to consumers. If operation and maintenance are neglected for long enough, it may become necessary to replace the system, requiring RUWASA and Government in general a new injection capital that could otherwise be used for other needs or stimulating economic development. Operation and maintenance of water distribution systems are done in a very complex environment with numerous (and often conflicting) services to deliver, influencing factors, legislative requirements and stakeholder relationships. Factors making village service provision a challenging task are shown in Figure 1.

Figure 1: The possible challenge in operation and maintenance of CBWSOs

The water supply scheme in the village area can be affected greatly by the challenges mentioned in Figure 1. It is important therefore to monitor the system state, running the system and enforcing the operation and maintenance procedures for sustainability. The operation and maintenance require the factors mentioned in the figure to be addressed in order to increase level of services, productivity and low-cost operation. The operation and maintenance guidelines provided comprehensive and practical procedures on how operations and maintenance of drinking and waste water will be conducted. It involves chapters addressing legislative requirements, mapping of stakeholders, standard operating procedure covering cycle of water supply to sanitation, supply chain system, environmental auditing, financial management and assets management.

CHAPTER TWO

LEGAL FRAMEWORK FOR CBWSOS OPERATIONS AND MAINTENANCE

The chapter presents the major legal instruments that are directly related to the operations of CBWSOs and the implications in terms of what the organisations need to do.

2.1. Water Supply and Sanitation Act No. 5 of 2019

The Water Supply and Sanitation Act No. 5 of 2019 is the principal legal framework for RUWASA as well as CBWSOs. RUWASA is established in accordance with Clause42 (1) of the Act. And its responsibilities vs those of CBWSOs include:

(a) To plan, design, construct and supervise rural water supply and sanitation projects

(b) To register, regulate the activities of CBWSOs.

(c) To provide technical and financial support to the CBWSOs.

(d) To facilitate community participation from the planning of the projects to the operation stage after construction.

(e) To advise the Minister on all issues related to rural water and sanitation.

(f) To review and scrutinize all the plans especially from CBWSOs.

(g) To undertake regular project supervision and monitoring.

(h) To provide CBWSOs with strategic capacity building.

(i) To support CBWSOs in their resource mobilization efforts.

(j) To undertake thorough assessment of water technologies for swift implementation by CBWSOs.

(k) To provide regular advisory services to CBWSOs to ensure proper operation and maintenance of the water projects.

In this, CBWSOs are the basic units responsible for management of water supply and sanitation services in rural areas under overall coordination of RUWASA. They have been established under the Registration and Operations of the CBWSOs, GN 829 of 2019.

The Act seeks to ensure Tanzanians have access to reliable, affordable, and safe drinking water. It provides for the establishment of CBWSOs and has Financial Provisions for Community Based Water Supply Organisations and Monitoring and Regulation of Community Owned Water Supply Organisations.

Through the CBWSOs the Act provides for the transferring of ownership of water supply schemes in rural areas to the respective communities and enabling all the beneficiaries and stakeholders to participate effectively in the management of community water supply schemes. At the national level administrative responsibility is assigned to the Minister responsible for water. The Act also defines responsibilities at regional and local level and Minister responsible for local government to cooperate in development of water supply and sanitation.

The Act recognises CBWSOs as corporate bodies as may be prescribed in any law including- (a) a Water Consumer Association; (b) a Water Trust; (c) a Cooperative Society; (d) a Non-Government Organization; (e) a Company; or (f) any other body as approved by the Minister.

RUWASA shall have the overall regulatory oversight of CBWSOs and shall do so in the interest to achieve efficiency and economies of scale. RUWASA in cooperation with local government authorities will also be responsible for development and sustainable management of rural water supply and sanitation projects and the monitoring of CBWSOs. RUWASA shall

cooperate with in exercising its duties. The Act also established the national Water Fund to mobilize resources and provide investment support for water service provision, and the management of catchment areas serving water supply abstractions. The CBWSOs therefore expected to:

(1. To be quite well familiar with the **Water Supply and Sanitation Act No. 5 of 2019** and **Registration and Operations of the CBWSOs, GN 829 of 2019.**

(2. To understand clearly the dividing lines between RUWASA and CBWSOs responsibilities.

(3. To regularly engage with RUWASA to access all guidelines, directives and expectations of the regulator that must be observed and compiled by CBWSOs. The instruments will include the following:

(a) Ministry of Water Supply and Sanitation Management DCOM Manual

(b) CBWSOs clustering guidelines (2020)

(c) RUWASA guidelines for establishing and registering CBWSO (2020)

(d) RUWASA tariff setting and revenue collection management guidelines (2020)

(e) Private sector engagement guideline in operation and management of community-based water supply projects (2020).

(4. To develop and implement an engagement plan every year for working closely with each stakeholder. This is further illustrated later in this manual.

(5. To develop and implement practical annual business plans on the management of the water projects, schemes, and services in their areas of authority. In so doing to ensure that the plans are well aligned with RUWASA plans. They must also be submitted to RUWASA for approval.

(6. To report their performance to the Authority quarterly on the implementation of their business plans as further guided later in this manual.

(7. To understand and observe the Financial Provisions for Community Based Water Supply Organisations and Monitoring and Regulation of Community Owned Water Supply Organisations as provided in the Water Supply and Sanitation Act No. 5 of 2019

(8. To ensure that as CBWSOs are body corporates observe all relevant laws of the land. These include financial, tax, occupation safety, environment compliance, labour relations and many others. In cases of difficulties with such issues, CBWSOs management are expected to seek advice and guidance from RUWASA.

Table 1: Supporting Legislation

Income Tax Act of 2019	Assessment and collection of income tax Realization of Asset tax for tangible and intangible assets.
The Value Added Tax Act of 2014	Filing PAYE returns and VAT returns Document tax invoices
The Finance Act of 2020	Preparation of Annual budget and revised by the authority of concern. Planning and organizing developing programs and finance communities under regulatory authority.
Public Procurement Act of 2011 and Public Procurement (Amendment) Act of 2016	Guidance for preparation of annual procurement plan Procedure for procurement of goods, works, services, and disposal of CBWSOs public owned assets by tender and procedures for contract management

2.2. The Water Resource Management Act No.11 of 2009

The Act provides a principal legal and institutional framework for sustainable management of the water resources by outlining the principles for management, impact and risk assessments, prevention and control of pollution, waste management, environmental quality standards, public participation, compliance, and enforcement. Therefore, CBWSOs must mainly follow the provisions stipulated in the Act.

2.3. The Procurement Act, 2011 and Amendment Act of 2016 and Its Regulations

To a large extent all the assets that are managed by CBWSOs are publicly owned and therefore their procurement must follow all applicable public procurement laws of the land. In principle, all such procurements will be done by CBWSO as elaborated in later in these guidelines. Therefore, CBWSOs must mainly follow the guidelines.

2.4. The Environmental Management Act, 2004

The Act provides a principal legal and institutional framework for sustainable management of the environment by outlining the principles for management, impact and risk assessments, prevention and control of pollution, waste management, environmental quality standards, public participation, compliance, and enforcement. CBWSOs under the oversight and guidance of RUWASA are expected to fully comply with the Act as applicable to their operations. More specifically, they are expected to:

(1) To ensure that in their plans, the overarching goal is to deliver water to all communities under their authority in an efficient, effective, affordable, and sustainable manner.

(2) To take care and protect the water sources and ecosystem as well as the pumping, storage, and

distribution system. As such, they need to regularly undertake auditing of all these resources and the ecosystem and report to RUWASA as guided later in these guidelines.

(3) Have measures/plans to protect water sources in collaboration with all stakeholders in the ecosystem of the sources. The plans can include tree planting events – every year and incentives for communities to protect the sources.

(4) Train all staff responsible for protecting and maintaining water sources on how best to promote and ensure water sources protection.

Based on the foregoing presentation, Table 2 summarizes the main actions to be taken by CBWSOs.

Table 2: CBWSOs Operations According to the Laws and Regulation

Key activity	Operation	Frequency	Target
Law and registration compliance.	Familiarization with the Acts including Land Acts and registration and operations of CBWSOs, compliance of guidelines, directives and expectations of the regulator	Once-Quarterly	All staffs
Recognition of line of Authority	Familiarization with the dividing line of authorities between RUWASA and CBWSOs.	Once-Semi annually	Community Water Committee
Business plans	Developing engagement and business plans with all stakeholders.	Quarterly	Members of the Organization (Board)
Performance report	Reporting CBWSOs performance to the authority	Quarterly	Management

Financial requirement	Observing financial provisions for CBWSOs.	Daily	Management
Asset management	Compliance with asset management including registering all procured/purchased materials and equipment	Daily	Management
Conservation and protection of water sources and ecosystem	Protection of water sources and ecosystems with regular auditing of the water sources and ecosystem.	Periodically	Community Water Committee
Environment measures/plans	Execution of measures/plans in conserving water sources and ecosystems including afforestation.	Periodically	Community Water Committee
Training of personnel	Training of responsible personnel for maintenance and protection of water sources and operations.	Periodically	Community Water Management Team
Compliance with Financial laws and applicable tax laws.	Managing and monitoring progress on water bills, tax collection and budget preparation.	Daily	Community Water Committee

CHAPTER THREE

COMMUNITY WATER PROJECT STAKEHOLDERS MAPPING AND THE MAIN ACTIVITIES FOR CBWSOs

CBWSOs will be effective and efficient in fulfilling their duties and obligations if they work well with all key stakeholders. Stakeholders are institutions, groups and individuals that have interest in the work of the organisation and can either affect or be affected by the business. This Section of the manual maps all primary stakeholders of CBWSOs and for each indicates the expectation of each stakeholder and the major activities that the CBWSO needs to undertake with respect to the stakeholder to facilitate the work of providing access to reliable and cost-effective provision of safe and clean water to the communities. The analysis is presented in Table 3.1.

It is apparent from the analysis that CBWSOs engagement with each of the stakeholders is crucial given the importance of each analysed stakeholder. All this indicates a strong need for the Organisation to engage more in stakeholder management/ engagement to leverage on such relations for the benefit of the organization and the country at large.

Table 3: CBWSO Stakeholders Mapping and Analysis

S/N	Stakeholder Name	• Stakeholder Interests in CBWSO	• Key CBWSO Activities	frequency	Target
1	Ministry of Water	• To provide quality and sustainable water and sanitation services	• Familiarise with all laws, regulations, directives, and guideline issued by the Ministry and implement relevant ones with the guidance and support RUWASA • Take advantage of funding opportunities for projects initiated by the organisation by apply to the Water Fund or requesting support of the Ministry for applications sent to other sources of funding.	Periodically	All CBWSOs staff
2	RUWASA	• To provide quality and sustainable water and sanitation services • To manage the organisation in professional, efficient, and effective manner • To comply with all instruments and	• Ensure access to all current instruments and directives issued by the Authority and ensure regular compliance • Put in place adequate systems and structures to manage the organisation in professional, efficient, and effective manner • Ensure timely and effective maintenance and operations of	Regularly	Community Water Committee

		directives issued by the Authority	water projects under the Organisation's responsibility. • Respond promptly to customer complaints • Prepare and submit to RUWASA quarterly, semi-annual, and annual reports on performance of services. • Collect water charges from communities as per the regulations, guidelines and system stipulated by RUWASA • Work with RUWASA to ensure regularly updated water tariffs and other charges. • Maintain communication with RUWASA • Timely communication of major new investment needs to RUWASA		
3	Ministry of Finance	• Compliance with the Government Financial Laws and Circulars •	• Prepare annual activity and budget proposal for approval by RUWASA. • Adhere to Government financial regulations and circulars as updated from time to time.	Regularly	Community Water Committee

			• Seek guidance from RUWASA on how best to comply with all relevant Government financial regulations and circulars.		
4	TRA	• Compliance with all applicable tax laws	• Have competent persons/unit able to handle accounting, finance, and tax issues • Familiarize with all tax laws and regulations as updated from time to time. • Seek RUWASA support for tax issues. • Ensure timely payment of all applicable taxes and levies • File, timely, all required TRA reports (including PAYE and VAT returns monthly).	Regularly	Community Water Committee Community Water Manageme nt Team.
5	NEMC	• To promote environment management and conservation of water sources • To comply with rules and regulations of environmental management,	• Under regular environmental auditing in line with EMA (2004) regulations and guidance from RUWASA • Collaborate with RUWASA in the implementation of management plans for projects handled to the Organisation after completion of their	Annually	Community Water Committee

		conservation, and protection in line with the law	• construction.		
6	Ministry of Natural Resources and Tourism	• To corroborate in afforestation	• Observe national policy, rules, and regulations regarding Water Catchment areas • Implement forest conservation initiatives with the support of the Ministry and local government authorities	Regularly	Community Water Management Team. Community Water Committee
7	Ministry of Land	• To ensure Proper land use • To acquire title deeds • To pay Land Rent in time • To comply with Land rules and regulations	• Familiarise with and observe all land laws and regulations • Ensure proper maintenance and utilization of the land asset. • Compliance with the Land rules and regulation. • Regularly identify potential and actual land issues and take action to address them in good time. • Seek the support and guidance of RUWASA on land issues/matters	Annually	Community Water Committee
8	Politicians (MPs and Councilors	• To facilitate the provision of quality and sustainable water	• Regular provide them with information about the activities and accomplishments of the	Regularly	Community Water Committee

	)	and sanitation services to communities • To charge realistic water bills • Timely handling of customer complaints • Compliance to government laws and regulations	Organisation • Seek their support in protection of water sources and infrastructures • Seek their support in creating public awareness about the activities of the organisation • Seek their support in curbing water theft		
9	PO-RALG, Regional Secretariats and Local Government Authorities	• To facilitate provision of quality and sustainable water and sanitation services to communities •	• Regular provide them with information about the activities and accomplishments of the Organisation • Seek their support in protection of water sources and infrastructures • Seek their support in creating public awareness about the activities of the organisation • Seek their support in curbing water theft	Regularly	Community Water Committee Community Water Management Team.
10	Water Basin Authority	• To collaborate in environment conservation • To ensure water	• With the support of the basin authority, familiarise well with policies, rules and regulation regarding water sources	Regularly	Community Water Committee

		extraction is done in accordance to water permit issue • Timely payment of water user fee	protection and conservation • Develop and implement action plan for protecting each water source in line with the support of the basin authority • Ensure that the Organisation has valid water user permits for all its water sources • Regular meeting between CBWSO and Basin authorities • Regular provide the authority with information about the activities and accomplishments of the Organisation • Seek their support in protection of water sources and infrastructures • Seek their support in creating public awareness about the activities of the organisation • Seek their support in curbing water theft		Community Water Management Team.
11	TANESCO	• Timely payment of electricity bills • Feedback quality of service delivered by them	• Prompt repotting power outages and similar charges • Prompt payment of electricity bills • Regular maintenance and	Regularly	Community Water Management Team.

		• Water services	repairs of electrical systems		
12	Financial Institutions	• To provide credit and other services •	• Familiarize well with the available financial institutions in the areas (especially their services and conditions) and how the Organisation can cost effectively take advantage of them. • Regularly assess the needs of the Organisation in terms of services needed from the financial institutions and how to cost-effectively address them. • Ensure that the Organization is always credit worth • Work with the financial institutions on how best invest (idle) funds of the Organisation • Ensure the Organisation has internal expertise that can competently engage with financial institutions	Periodically	Community Water Committee
13	Customers	• To provide quality and sustainable water and sanitation services	• Timely maintenance operations of the water resources and infrastructure. • Establish positive	Regularly	Community Water Management Team.

		• Timely handling of complaints and feedback • Effective communication with customers • Timely information on service provision • Timely repair of water leakages • Timely meter reading • Timely bills dispatch • Accuracy of meter reading • Timely cleaning clogged meters • Metering of all customers	communication skills and dispute handling system • Timely and proper replacement of leaking pipelines. • Timely collection of water service charges. • Regular meeting between CBWSO and customers • Holding period awareness seminars • Carrying out period customer satisfaction surveys and acting on the feedback • Timely payment of monthly water bills • Protection of water infrastructures • Protection of water sources • Protection of water conservation •		
14	Employees	• Recognition of their efforts • Appreciation • Motivation • Remuneration • Transparency	• Develop and implement staff policies and regulations • Ensure all staff understand the policies and regulations • Recruit or ensure a person in the Organisation who is familiar with	Regularly	Community Water Committee

		• Recognition	human resources management including all relevant laws and regulations like the Employment and Labour Relations Act, 2004; occupation health and safety • Familiarise and implement all required staff related statutory obligations • Implement a suitable system of employee performance management/appraisal and rewards		
15	Suppliers/ service providers	• Timely payment for their service as per contract • Fair procurement process • Transparency	• Careful screening of service providers to ensure good changes of value for money services • Effective implementation of the procurement and contract management regulations (provided in this guidelines)	Regularly	Community Water Committee
16	Developm ent Partners with interest in supporting	• Investment to achieve intended objectives • Proper maintenance for longer life of infrastructures	• Regular mapping out development partners that can support water projects of the Organisation. • Work with/consult RUWASA on the preparation of bankable	Periodically	Members of the Organizatio n (Board)

	community water projects		project proposals. The Organisation must ensure that it engages with development partners with well-conceived proposals • Regular orient staff on effective management of projects including performance reporting writing		
17	Ministry of Heath	• To facilitate provision of quality and sustainable water and sanitation services to communities	• Regular provide them with information about the activities and accomplishments of the Organisation • Seek their support in creating public awareness about the sanitation activities	Regularly	Community Water Committee Community Water Management Team.
18	Ministry of Education	• To facilitate provision of quality and sustainable water and sanitation services to communities	• Regular provide them with information about the activities and accomplishments of the Organisation • Seek their support in creating public awareness about the sanitation activities	Regularly	Community Water Committee Community Water Management Team.

CHAPTER FOUR

STANDARD OPERATIONS PROCEDURES AND MAINTENANCE OF WATER SCHEMES

Standard operations procedures and maintenance of water schemes describe the process which will be followed by attendant for equipment, machine, and facilities used for water production, storage, distribution and disposal of waste water. The procedures are arranged holistically considering the cycle of the water system from the intake stream/spring or water well, production, transmission, storage, distribution and disposal of waste water. The operation in water scheme refers to the consideration of timely action of the system components, operation of water sources, treatment plant, machinery and equipment, conveying mains, service reservoirs, distribution system and waste water treatment plant are efficient and effectively attended by various technical personnel. Similarly, the maintenance procedures are described as the act of keeping the water sources, plants, machinery and equipment, and facilities working without frequent failure and ensure that facilities are available in an optimum working condition.

Maintenance requires skills, tools and spare parts (Carter, 2009). Maintenance may be Preventive, Corrective or Reactive:

- **Preventive maintenance** - includes work that is planned and carried out on a regular basis to maintain and keep the infrastructure in good condition, such as network inspection, flushing of the water wells and water lines, disinfection of water tanks, cleaning and greasing of mechanical parts and replacement of items with a limited lifespan.

- **Corrective maintenance** – include replacing or repairing something that was done incorrectly or that needs to be changed; an example is the reallocation of a pipe route or replacement of a faulty pump

- **Reactive maintenance** - a reaction to a crisis or public complaint; it normally occurs because of failure and the malfunctioning or breakdown of equipment. Responsive maintenance should allow for a quick and efficient response to WASH-related problems that occur suddenly.

The maintenance includes daily, weekly, monthly and yearly checking of equipment, machinery and accessories. The maintenance procedure depends on the standard schedule to maintain such related equipment including preventive maintenance, condition-based maintenance, and breakdown maintenance. The maintenance process involves the replacement of defective or worn-out components or parts. The maintenance activities can be grouped into two categories namely minor repair and major repair:

- **Minor Repair:** This includes activities which can be undertaken by a semi-skilled caretaker/CBWSO. For example, repairing of hand pump which does not require lifting of hand pump assembly including replacement of handle nut & bolts, repairing of chain, bearing etc. These activities are financed by CBWSOs through their revenue collection.

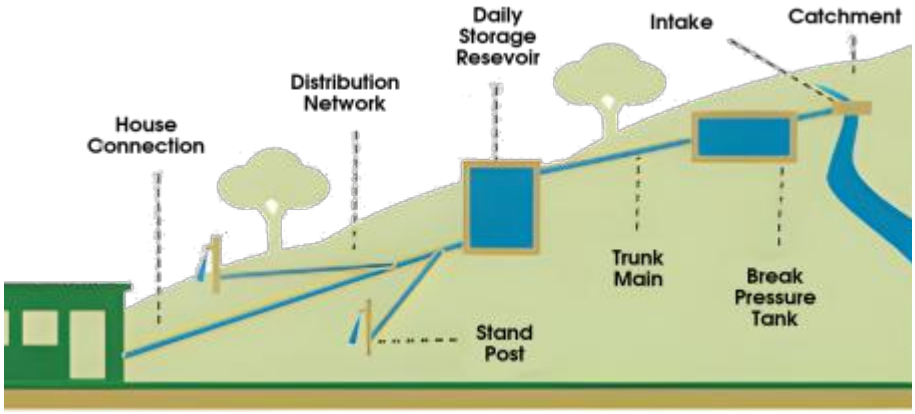
- **Major Repair:** This type of repairing can be carried out by specialist from RUWASA, the water supply and sanitation utility or private operator. For example, the repairing of a hand pump which involves pulling out and cleaning of the hand pump assembly. These activities are financed by Government and Development Partners.

4.1. Operation and Maintenance of Different Water Sources

The water flow are from surface water sources (e.g. lakes, rivers, man-made reservoirs) and groundwater sources (e.g. spring protection, dug well protection, and drilled well protection). The water sources usually supply water to the community by gravity. The gravity flow type water system is the action of gravity used

to move the water downhill from a source to the storage. An intake structure is built to collect the water, which is then piped down to the distribution through a pipeline of specific materials according to topography and design considerations.

The gravity intake may include a reservoir tank to be built above the distribution system, where the water is distributed to several tap-stands that are scattered throughout the users. Where multiple sources are used, a collection tank may be built, and due to the topography of the land, at certain points break-pressure tanks may be required to prevent excessive pressures from bursting the pipe. If the source water is carrying a lot of suspended particles, a sedimentation tank may be required to clean the flow of water. The schematic diagram from a suitable source should be located at an elevation higher than the distribution points.



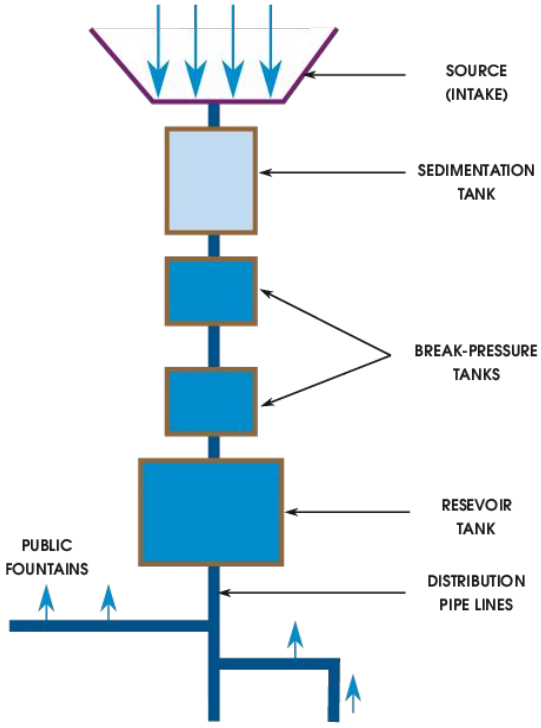


Figure 2: The main components of water gravity flow system

While surface water sources and springs are directly exposed to human activities, groundwater sources are often protected through overlying soil layers. However, accessing groundwater sources through dug or drilled wells allows contaminants to enter aquifers, polluting the well itself and the water in nearby lakes, rivers, or neighboring wells, which consequently threatens both public health and the environment.

A spring is a location at the land surface where groundwater discharges from the aquifer, creating a visible flow. This discharge is caused by difference in the elevation of the hydraulic head in the aquifer and the elevation of the land surface where the discharge takes place. Gravity springs emerge under unconfined conditions where the water table intersects land surface.

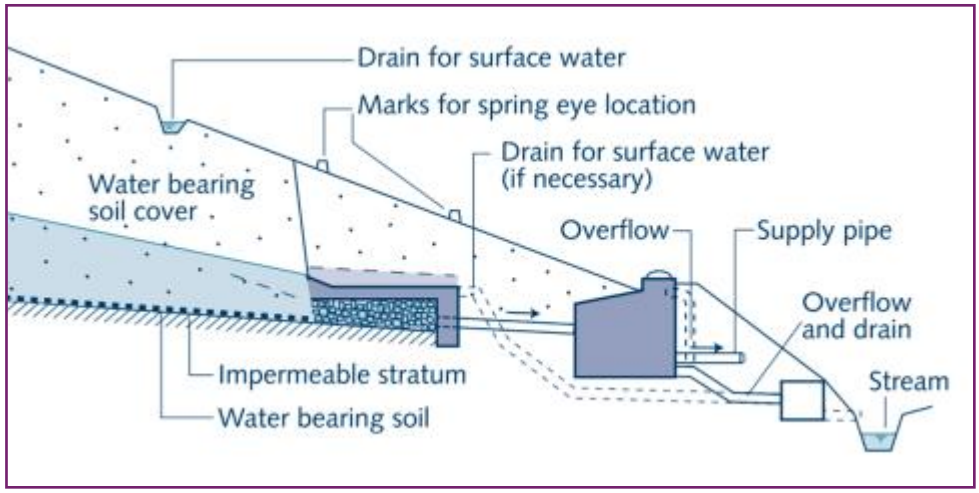


Figure 3: A spring water collection area

The Table below shows the checkpoints and checklists which are necessary to be verified during operation and maintenance activities of gravity and stream water sources.

Table 4: The Operation and Maintenance Procedures for Water Sources

CHECK POINT	CHECKLIST	FREQUENCY OF CHECK	REMARKS
SOURCE			
Pollution	To ensure that no defecation is taking place in and around the source	Once in two weeks	
	Source is protected from animals	,,	
	Burning of dead bodies of human beings or animals should not be allowed in and around the source	,,	
	Ensure the fence protecting area is not damaged	,,	

	Ensure no agriculture activities surrounding the water sources	,,	
Flood	Flood protected wall	,,	
	Spill over and drainage arrangement	,,	
Drying	Prevention of deforestation around the source	,,	
	Plantation of trees around the source	,,	
	Protection of animal surrounding the source		
INTAKE SPRING/ STREAM	Accessibility	For Spring: Once a month For Stream: Twice a month For rainy season Weekly inspections	
	Approach and Intake Stream surroundings should be cleared	,,	
	Strainer		
	Check and clean outlet pipe strainer cover	,,	
	Cover		
	Check cover of Intake Chamber for damage, cleanliness, repair and clean if required	,,	

	Valves, valve boxes and vent pipe		
	Check all pipes. fittings, valves for leakage and blockage	,,	
	Check whether valve boxes are covered, cleared and drained	,,	
	Check valve box walls for damage and leakage	,,	
	Check all the fillings of vent pipe	,,	
	Erosion and landslides		
	Check for erosion and landslides and repair with local materials as when required	,,	
	If damages are major report to the concerned authority	,,	
	Clean intake lank, drainage ditch and surrounding area	,,	
	Transmission Main Pipeline	At least once per month	REMARKS
	Ensure that pipeline is not exposed	,,	
	Check breakage, blockage and leakage of pipelines and illegal connections	,,	
	Check all the areas around the pipeline for erosion	,,	
	Stream crossing		
	Check anchoring structures for damage	,,	
	Cheek supporting pillars for damage	,,	

	Check binding of pipes	,,	
	Check erosion of banks	,,	
	Check that cable is taut	,,	
	Valves and valve boxes		
	Check all valves and valve boxes including walls for leakage and damage	,,	
	Check whether valve boxes are covered, cleaned and drained	,,	
	Proper Fittings	Twice a month	
	Check binding of pipes	,,	
	Check erosion of banks	,,	
	Check that cable is taut	,,	
	Valves and valve boxes		
	Check all valves and valve boxes including walls for leakage and damage	,,	
	Check whether valve boxes are covered, cleaned and drained	,,	
	Proper Fittings	Twice a month	
		for all valves, but weekly during rainy season	
	Check all valves have got proper fittings	,,	
	Cheek for leakages, blockages and proper functioning	,,	
	Check all valves for grease by valves for grease by opening and closing	,,	
	Fencing and Surroundings		

	Check for proper fencing		
	Plantation of trees around the source	,,	
	To ensure that no defecation is taking place in and around the source.	,,	
	Source is protected from animals	,,	
	Burning of dead bodies of human animals	,,	

4.2. Water Transmission System (Main Transmission Pipeline)

The objective of a transmission system is to deliver raw water and treated water from the source to the treatment plants and treatment plants to the storage reservoirs respectively for supply into distribution networks. Transmission of raw water can be either by canals or by pipes whereas transmission of treated water is by pipes only. Transmission through pipes can be either by gravity flow or by pumping.

The objective of O&M of transmission systems is to achieve optimum utilization of the installed capacity of the transmission system with minimum transmission losses and at minimum cost. To attain this objective, the agency has to evolve operation procedures to ensure that the system can operate satisfactorily, function efficiently and continuously, and last as long as possible at lowest cost.

4.3. Transmission by Gravity through Channels or Canals

4.3.1. Maintenance of Unlined Canal Transmitting Raw Water

- All grass should be scraped and weed removed from the silted bed
- Silt deposited should be removed
- Bed should be levelled and their gradient regularized.
- Berms should be kept straight by trimming
- Flow meters should be installed at the head and tail of canals at important points in between. The reading should be observed and recorded daily.
- Both edges of the bank, especially the inner one should be neatly aligned and should be free from holes, weeds.
- Ensure there is no Seepage through the banks

4.3.2. Maintenance of Lined Canals Transmitting Raw Water

Cavity or pockets or any activity detected behind the lining should be carefully packed with sand or other suitable material. Care should be taken to ensure that the lining does not get damaged or displaced. Damaged portions of lining should be removed and replaced with fresh lining of good quality by preparing a thoroughly compacted subgrade before laying fresh subgrade. The cracks in the lining should be filled with standard sealing compound. An effective sealing may be obtained by cutting the 'V' groove along the face of the cracks before filing with sealing compound. Packing with powdered clay upstream of the cracks may seal minor crack on the lining.

- Displaced portion of the joint filter should be removed and fresh filter material may be packed
- The chocked pressure release pipes should be cleaned by intermittent application of air and water by rodding.
- Subsoil water level should be observed regularly especially after the rainy season. If there is rise, adequacy of the pressure release system or other remedial measures like humps, regulators etc. provided for the safety of the lining should be reviewed.
- Seepage through embankments if any should be observed from time to time and remedial measures should be taken.
- Silt deposition if any notice should be flushed out during non-Monsoon period when the water is silt free.
- Aquatic weed growth if observed below the supply level should be removed. Land weed growing over the free board should also be controlled.
- Canal banks should be inspected for seepage condition at the outer slope and for some distance beyond the toe especially in high fill reaches.

4.4. Transmission through Pipes

In the case of gravity, a transmission line, where direct feeding into OHTs is envisaged then it should be ensured that design head is developed. Otherwise, water will be reaching only the OHT at lower elevation at the cost of OHT at higher elevation. This can be ensured by suitably regulating the sluice valves. All valves installed in the transmission main should be inspected daily to ensure that there is no leakage otherwise leakage should be attended to. If attending leakage requires stoppage of flow through pipes the same can be attended on a pre-fixed monthly shutdown day.

4.4.1.Problems in transmission mains

(i). Leakage

Water is often wasted through leaking pipes, joints, valves and fittings of the transmission system either due to bad quality of materials used, poor workmanship, and corrosion, age of the installations or through vandalism. This leads to reduced supply and loss of pressure. Review of flow meter data will indicate possible leakages. The leakages can be either visible or invisible. In the case of invisible leaks sections of pipeline can be isolated and search carried out for location of leaks.

Most common leaks are through the glands of sluice valves. Leaks also occur through expansion joints where the bolts have become loose and gland packing is not in position. Leaks through air valves occur due to improperly seated ball either due to the damage of the gasket or due to abrasion of the ball, through the gland of the isolating sluice valve or through the small orifice.

(ii). Air Entrapment

Air in free form in the rising main collects at the top of the pipeline and then goes up to higher points. Here, it either escapes through air valves or forms an air pocket which in turn, results in an increase or head loss. Other problems associated with air entrapment are: surging, corrosion, reduced pump efficiency and malfunctioning of valves or vibration. In rare cases bursting of pipes also is likely to occur due to air entrapment. There should always be an air valve chamber with cover slabs for the protection of the air valve and it should always be kept leakage free and dry. Frequent inspection should be conducted to check whether Air valves are functioning properly and to ensure that there is no leakage through the air valve.

(iii). Water Hammer

The pressure rise due to water hammer may have sufficient magnitude to rupture the transmission pipe or damage the valves fixed on the pipeline. Water hammer in water supply systems occurs due to rapid closure of valves and sudden shut off or unexpected failure of power supply to the pumps. The care should be taken to open and close sluice valves gradually.

(iv). Lack of Records/ Maps

Generally, maps showing the actual alignments of transmission mains and location of other pipes & the valves on the ground may not readily be available. The location of pipes and the valves on the ground becomes difficult in the absence of such updated maps and thus, need to be prepared and updated from time to time. Some minimum information about the location and size of pipes and valves and the direction of opening of valves etc. is required to operate and maintain the system efficiently.

4.5. Operation and Maintenance Activities for Transmission System

4.5.1. Operation schedule of transmission system

(i). **Mapping and inventory of pipes and fitting:** The transmission system map has valves, flow meters and pressure gauges for operation schedule.

- The valves indicated in the map should contain direction to open; number of turns to open, make of valve and date of fixing.
- The hydraulic gradient lines are to be marked to indicate the pressure in the transmission system by identifying high pressure or problem areas with low pressure.

(ii). System pressure: It is essential to maintain a continuous positive pressure in the pipeline.

- Measure pressure to avoid low pressure and investigate reasons if it happens.

(iii). System Surveillance: The maintenance staff should accomplish the following

- To detect and correct any deterioration of the transmission system.
- To detect if there is encroachment of transmission system failures
- To detect and correct if there is any unauthorized tapping of water
- To detect and correct if there is damage to the system by vandalism.

4.5.2. Maintenance schedule of transmission system

A maintenance schedule is required to improve the level of maintenance of the water Transmission system. The following activities are to be included in the schedule:

(i) Develop and conduct a surveillance programme for leaks in pipelines, pipe joints and valves.

(ii) Develop and conduct a water quality surveillance programme.

(iii) Develop and conduct a programme for locating and repairing leaks including rectifying cross connections if any, arrange for flushing, cleaning and disinfecting the mains,

(iv) Establish procedures for setting up maintenance schedules and obtain and process the information provided by the public and the maintenance teams about the pipeline leaks,

(v) Establish repair procedures for standard services and with provision for continuous training of the team members,

(vi) Procure appropriate machinery, equipment and tools for repair of leaks and replacement of pipes and valves,

(vii) Allocate suitable transport, tools and equipment to each maintenance team,

(viii) Establish time, labour and material requirement and output expected, time required and other standards for each maintenance task, and

(ix) Arrange for monitoring the productivity of each maintenance team

Table 5: Activities for Preventive Maintenance for Transmission System

CHECK POINT	CHECKLIST	FREQUENCY OF CHECK	REMARKS
Servicing of valves	Check valves, expansion joints flow meter and pressure gauges	Daily	
	Check leaks from spindle rods occur and bonnet separates from the body	,,	
	Maintenance of valve chambers	,,	
List of spare parts	Ensure list of spares include check nut, spindle rods, bolt and nuts are flanged joints, gaskets for flanged joints for all sizes of sluice valves, consumables like gland rope, grease, cotton waste, jointing materials like rubber gaskets, spun yarn, pig-lead and lead wool etc are available	,,	
List of tools	Ensure list of tools including key rods for operation of sluice valves, hooks for lifting manhole covers, pipe wrench, DE spanner set, ring spanner set, screw drivers, pliers, hammers, chisels, caulking tools, crow bars, spades, dewatering pumps are available.	,,	

4.5.3.Maintenance of pipelines

Operation procedures to maintain pipeline bursts/main breaks that can occur at any time. The technician/artisan should prepare the plan to attend to such problems and must be written down and made available. When a pipe breaks, a technician/artisan must determine which valve is to be closed to isolate the section where the break has occurred. Some important consumers may be on the transmission system and have an industrial process dependent on water supply which cannot be shut down as fast as the water supply lines are cut off and should be notified about the breakdown. These consumers have to be informed about the probable interruption in water supply and also the estimated time of resumption of water supply.

After the closure of the valve the dewatering/mud pumps are used to drain the pipe breakpoints. The sides of trenches have to be properly protected before the workers enter the pit. The damaged pipe is removed, and the accumulated silt is removed from inside the pipe and the damaged pipe is replaced and the line is disinfected before being brought into use. A report shall be prepared following every pipe break about the cause of such break, the resource required. The following are common problems causing failure of the main transmission pipeline and types of failure modes.

Table 6: The causes and failure modes of pipelines

Pipe material	Problems causing failure	Typical failure modes	Remarks
HDPE	• Excessive deflection • Joint misalignment • Welding jointing weakness due to misalignment, incorrect welding procedure or impurities • Excessive internal working or water hammer pressures Exposure to solvents • Difficult to find non-metallic pipe underground	• Joint imperfections • Mechanical degradation from improper installation methods	
Cast Iron	• Internal corrosion • Joint misalignment • Joint seal damaged, obstructed or misaligned • External corrosion • Manufacturing flaws • Shear failures due to inadequate bedding or external loads.	• Circumferential cracks • Split bell • Corrosion through holes • Longitudinal breaks • Spiral cracks • Blowout • Bell shear	

PVC	• Excessive deflection • Joint misalignment • Joint seal damaged, obstructed or misaligned • Exposure to sunlight. • Excessive internal working or water hammer pressures Exposure to solvents • Difficult to find non-metallic pipe underground	• Longitudinal breaks due to excessive mechanical stress	
Ductile Iron	• Internal corrosion • Joint misalignment • Joint seal damaged, obstructed or misaligned • External corrosion • Manufacturing flaws • Shear failures due to inadequate bedding or external loads.	• Corrosion through holes •	
Steel	• Internal corrosion • External corrosion • Excessive deflection • Joint seal damaged, obstructed or misaligned • Imperfections in welded joints	• Corrosion through holes • Large diameter pipes are susceptible to collapse	
Asbestos cement	• Internal corrosion • Cracks • Excessive deflection • Joint misalignment	• Circumferenti al breaks, • Pipe degradation	
	• Joint seal damaged, obstructed or misaligned • Handling damage (especially small diameters) Insufficient bedding support • Difficult to find non-metallic pipe underground • Shear failures due to inadequate bedding or external loads.	in aggressive water • Longitudinal splits	

4.5.4.Records and reports

(i) Updated transmission system maps with alignment plans. Longitudinal sectional plans

(ii) Record of daily readings of flow meter at upstream and downstream end of pipeline

(iii) Record of water level of reservoir at both upstream and downstream end of transmission system

(iv) Pressure reading of the transmission system

(v) Identification of persistent low-pressure location along the pipeline

(vi) Record of age of pipes

(vii) Identify pipelines to be replaced

(viii) Identify source of leaks

(ix) Record of Bulk meter/water meter reading before the delivery into overhead tank

(x) Record of residual chlorine

(xi) Record on when the pipeline leaks were repaired or pipe changed and the cost of materials and labour cost thereof.

4.6. Operations and Maintenance of Water Production Facilities

The primary prime mover for production of water is pump and pumping systems. The pumping is a very important component in water supply and sanitation projects. Pumping machinery is subject to wear, tear, erosion and corrosion due to the nature of their functioning and therefore is vulnerable to failure. Generally, more numbers of failures or interruptions in water supply and sanitation projects are attributed to pumping machinery than any other component. Therefore, correct operation and timely maintenance and upkeep of pumping stations and pumping

machinery are of vital importance to ensure sustainable supply and sanitation services. To avoid sudden failures of water system the following should be done:

(a) Timely inspection of pump and accessories following planned periodic maintenance.

(b) Maintaining an inventory of the fast-moving spare parts to avoid downtime

(c) Timely replacement of parts due to normal wear and tear will decrease inefficiency.

(d) Availability of standby pump with identical duty to be provided for reliable operations.

(e) In case of depletion of sources during dry season or rain failure, the technician/engineer should ensure that schemes are operated partially without throttling of pumps.

(f) While replacement of motors/ pumps is done, it must be insisted to provide star rated motors to have energy savings.

Technician/Engineer should ensure records on pump operations are maintained on:

(a) Timings when the pumps are started, operated and stopped during 24 hours,

(b) Voltage

(c) Current drawn by each pump-motor set and total current drawn at the installation,

(d) Frequency,

(e) Readings of vacuum and pressure gauges,

(f) Motor winding temperature,

(g) Bearing temperature for pump and motor,

(h) Water level in intake/sump,

(i) F low meter reading,

(j) Daily Power factor over 24 hours' duration, and

(k) Any problem or event such as burst in pipeline, tripping or fault, power failure.

Various types of pumps require different operations procedures. However, the Specific procedures for starting and stopping pump operations are:

(i). **Starting pump of low or medium specific speed under normal condition**

(a) Before starting, check the water level in the sump/ intake is above the low water level and inflow from the source or preceding pumping station is adequate.

(b) Check the power if available for the required single or three phases,

(c) All connections are properly thimble,

(d) Trip circuit for relays is in a healthy state,

(e) Check voltage for the required single or three phases,

(f) Check the permissible voltage variation to be within ± 10% of the rated voltage

(g) Check lubrication system specifically on turbine pumps and oil lubricated bearings,

(h) Check stuffing box to ensure that it is packed properly,

(i) Check and ensure that the pump is rotating freely

(j) Check over current setting if the pump is not operated for a week or longer periods

(ii). Stopping the Pump of low or medium specific speed under Normal Condition

(a) Close the delivery valve gradually to avoid rise to water hammer pressures

(b) Switch off the motor

(c) Open the air vent in case of Vertical Turbine (VT) and submersible pump

(d) Stop lubricating oil or clear water supply in case of oil lubricated or clear water lubricated VT pump as applicable.

(iii). Stopping after Power Failure/Tripping

(a) Check and ensure that all circuit breakers and starters are in the open condition i.e., off-position

(b) All switches and circuit breakers shall be operated to open i.e. off-position

(c) Open the air vent in case of a vertical turbine or submersible pump and close the lubricating oil or clear water supply in case of oil lubricated or clear water lubricated vertical turbine pump. Information about power failure should be given to all concerned, particularly to the upstream pumping stations to stop pumping so as to prevent overflow.

The general O&M schedule is provided by the manufacturers. However, the following points shall be observed while operating the pumps:

(a) Avoid dry running of the pumps

(b) Avoid operation near the shut off point in order to reduce overheating of the pump

(c) Ensure centrifugal pumps have to be primed before starting

(d) Operate pump within the recommended range of the head-discharge characteristics

(e) If a pump efficiency reduces, check if operation is away from the designated duty point.

(f) Voltage during operation of the pump-motor set should be within ± 10% of the rated voltage.

(g) Check electrical current to be below the rated as specified on nameplate of the motor

(h) In order to reduce the starting load on the motor, a pump of low or medium specific speed should be started against closed delivery valve

(i) The pumps of high specific speed draw more power at shut off. Such pumps should be started with the delivery valves open

(j) To avoid sudden change in flow velocity which can cause water hammer pressures, the delivery valve should be operated gradually.

(k) Check abnormal noise, vibrations, and hydraulic impacts to avoid negative effects in the system. Stop pump in case of abnormal vibration or noise is noticed

(l) For parallel operating pumps start and stop with a time lag between the two pumps to restrict change of flow velocity to a minimum and to restrict the dip in feeder voltage. The time lag should allow stabilizing the head on the pump, as indicated by a pressure gauge.

(m) For series operating pumps start and stop sequentially, but with minimum time lag. Next pump in sequence should be started immediately after the delivery valve of the previous pump is partly opened.

(n) The stuffing box should let a drip of leakage to ensure that no air is passing into the pump and that the packing is getting adequate water for cooling and lubrication.

(o) Make sure you refill the stuffing box adequately for the case of grease stuffing box

(p) The running of the duty pumps and the standby one

should be scheduled carefully so that no pump remains idle for a long period and all pumps are in ready-to-run condition.

(q) By-pass valves of all reflux valves, sluice valves and butterfly valves shall be kept in the closed position during normal operation of the pumps

(r) Avoid frequent starting and stopping of the pump as it causes overloading of the motor, starter and contactors.

(s) Do not operate the pump at a head higher than the maximum recommended to avoid overheating

(t) Do not operate pump at lower head than recommended minimum head to avoid unbalanced forces on the shaft which may cause failure of the pump shaft

(u) Do not operate pump on a higher suction lift than the permissible value to avoid, pitting on the suction side of the impeller and casing and mechanical damage

(v) Avoid throttled operation as the delivery valve is throttled to increase the head on the pump and to reduce power drawn from the motor. Such operation results in inefficient running as energy. Installation of variable voltage & variable frequency (VVVF) drive as a remedial measure is recommended

(w) The strainers and foot valves should be periodically cleaned, particularly during the rainy season to avoid cavitation and pitting.

4.7. Procedures for Maintenance of Pumps

The maintenance for the pump should be planned into a periodic maintenance schedule. The maintenance becomes a smoother, more efficient process and reduces the likelihood of unexpected pump failures and downtime. It also helps to reduce the cost of ownership as replacing wearing parts for example is a much cheaper process than replacing an entire pump. The following are schedule for frequency of maintenance and task to be done:

Table 7: Pump maintenance schedule

FREQUENCY	TASKS	REMARKS
DAILY	Check for overheating	
	Check for cavitation & bearing noise	
	Check for motor current & voltage	
	Check bearing oil for water and discoloration	
	Feel all bearings for temperature	
	Inspect bearings and oil rings through filling ports	
	Check oil leaks at the gaskets	
	Clean the pump, motor and other accessories	
	Check coupling bushes/rubber spider	
	Check changes in voltage	
	Check changes in current	
	Check changes in vacuum gauge and pressure gauge readings	
	Check sparks or leakage current in motor, starter, switch-gears, cable, etc.	
	Overheating of motor, starter, switch gear, cable, etc.	

DAILY RECORDS	Observations for irregularities to be recorded	**Remarks**
	Timings when the pumps are started, operated and stopped during 24 hours	
	Voltage in single or three phases	
	Current drawn by each pump-motor set and total current drawn at the installation	
	Frequency,	
	Readings of vacuum and pressure gauges,	
	Motor winding temperature,	
	Bearing temperature for the pump(s) and motors,	
	Water level in the intake/sump,	
	Flow meter reading,	
	Daily Power Factor (PF) over 24 hours duration,	
	Any problem or event in the pumping installation or pumping system (burst in pipeline, tripping or fault, power failure)	
WEEKLY	**TASKS**	**REMARKS**
	Check for suction & discharge pressures	
	Check for vibration & noise	
	Visual check for sealing and pipework leakage	
	Check for signs of corrosion or discoloration	
MONTHLY	**TASKS**	**REMARKS**
	Remove safety guards & check for shaft & auxiliary devices	
	Check for coupling alignment	
	Check alignment of the pump and the drive. The pump and motor shall be decoupled while correcting alignment, and both the pump and motor shafts shall be pushed to either side to eliminate effect of end play in bearings.	

	Clean oil lubricated bearings and replenish with fresh oil. An antifriction bearing should have its housing so packed with grease that the void space in the bearing housing should be between one third to half.	
	Check vibration level with instruments if available; otherwise by observation.	
	Tighten the foundation bolts and holding down bolts of the pump and motor mounting on the base plate or frame	
	Fill lubrication oil (if necessary)	
	Inspect the mechanical seal for wear and replacement if necessary	
	Check condition of bearing oil and replace or top up if necessary	
	Check free movement of the gland of the stuffing box; check gland packing and replace if necessary. Clean and apply oil to the gland bolts.	
ANNUALLY	**TASKS**	**REMARKS**
	If you have a backup pump, run the pump & check for maintainability	
	Calibrate pressure gauge, vacuum gauge, ammeter, voltmeter,	
	Check for axial movement of motor shaft	
	Check stuffing box, glands, lantern ring, and mechanical seal and rectify, if necessary	
	Remove & clean all auxiliary devices (valves, manometers, piping's, sight glasses, etc)	
	Clean and flush bearings with kerosene and examine for flaws that may have developed if any, e.g., corrosion, wear and scratches. Check end play. Immediately after cleaning, the bearings should be coated with oil or grease to prevent ingress of dirt or moisture	
	Remove coupling halves & check for wear at rubber part (renew if necessary)	

	Examine shaft sleeves for wear or scour and necessary rectifications. If shaft sleeves are not used, shaft at gland packings should be examined for wear	
	Clean bearing housing and examine for flaws, e.g. wear, grooving etc. Change oil or grease in the bearing housing,	
	Undertake performance test of the pump for discharge, head efficiency.	
	Clean and flush bearings with kerosene and examine for flaws e.g., corrosion, wear and scratches. Check end play. Immediately after cleaning, the bearings should be coated with oil or grease to prevent ingress of dirt or moisture,	
	Check clearances in the wearing ring	
	Check impeller hubs and vane tips for any pitting or erosion	
	Check interior of volute, casing and diffuser for pitting, erosion, and rough surface	
2 YEARS OR 10000 HOURS	**TASKS**	**REMARKS**
	Dismantle the pump from the piping & disassemble	
	Make inspection on parts, replace if necessary: Impellers, wear rings/wear plates, O-rings and Shaft	
	Apply coating on un-machined surfaces	
	Dismantle the pump from the piping & disassemble	

4.8. Procedures for Maintenance of Motor

The maintenance of motors as critical components for the supply of power to the pump should be planned into a periodic maintenance schedule. The plan should be at minimum maintenance recommendations, and such maintenance can typically be scheduled during planned production downtime. The tasks can include lubrication, visual inspection and parts cleaning. The detailed maintenance of motor periodically schedule is shown in Table below:

Table 8: Motor maintenance schedule

FREQUENCY	TASKS	REMARKS
DAILY	Clean the external surface of the motor,	
	Check for bearing noise	
	Check temperature of the motor and check whether overheated	
	Examine earth connections and motor leads	
	In case of oil ring lubricated bearings,	
	Examine bearings to check whether oil rings are working, vi. Note bearing temperature,	
	Add oil if necessary,	
	Check for any abnormal bearing noise,	
	Note pump vibration if any.	
	Clean the external surface of the motor,	
	Examine earth connections and motor leads,	
	In case of oil ring lubricated bearings,	
MONTHLY	TASKS	REMARKS
	Check belt tension. In case where this is excessive it should immediately be reduced	
	Blow dust from the motor	
	Examine oil in oil lubricated bearings for contamination by dust, grit. (To be judged from the colour of the oil)	
	Check functioning and connections of anti-condensation heater (space heater)	
	Check insulation resistance. Check the insulation resistance of the motor	
	Check tightness of the cable gland, lug and connecting bolts	
	Check and tighten foundation bolts and holding down bolts between motor and the frame	
	Check vibration level with instrument if available; otherwise by observation	
	Check belt tension. In case where this is excessive it should immediately be reduced	
	Blow dust from the motor	

BI-ANNUAL (6 MONTHS)	TASKS	REMARKS
	Clean oil lubricates bearings and replenishes fresh oil. If bearings are grease lubricated, the condition of the grease should be checked and replaced/replenished to correct quantity	
	Anti-friction bearings should have its housing so packed with grease that the void space in the bearing housing should be between one third to half. A fully packed housing will	
	overheat the bearing and will result in reduction of life of the bearing	
	Wipe brush holders and check contact faces of brushes of slip-ring motors. If contact face is not smooth or is irregular, file it for proper and full contact over slip rings,	
	Clean winding of the motor, bake and varnish if necessary	
	In case of slip ring motors, check slip-rings for grooving or unusual wear, and polish with smooth polish paper if necessary.	
ANNUALLY	**TASKS**	**REMARKS**
	Clean and flush bearings with kerosene and examine for flaws e.g., wear and scratches. Check end-play. Immediately after cleaning, the bearings should be coated with oil or grease to prevent ingress of dirt or moisture	
	Clean bearing housing and examine for flaws, e.g., wear, grooving etc. Change oil or grease in bearing housing,	
	Blow out dust from the windings of motors thoroughly with clean dry air. Make sure that the pressure is not so high as to damage the insulation	
	Clean and varnish dirty and oily windings. Re-varnish motors are subjected to severe operating and environmental conditions e.g., operation in dust-laden environments, polluted atmosphere, etc.	

	Check the condition of the stator, stamping, insulation, terminal box, fan, etc.	
	Check insulation resistance to earth and between phases of motor windings, control gear and wiring,	
	Check air gaps	
	Check resistance of earth connections.	

4.9. Operation and Maintenance for Selected Pumps

The operations and maintenance of the selected pumps shall elaborate the procedure to operate and conduct maintenance of submersible pumps, centrifugal pumps and jet valve pumps. The explanation of the pumps includes important elements of other types of pumps. Therefore, the understanding of the three selected pumps shall comprehend the characteristics without considering frequency of operations and maintenance to all types of pumps commonly used in water and sanitation.

4.9.1. Submersible pumps

A submersible pump is submerged in the fluid to be pumped. The main advantage of this type of pump is that it prevents pump cavitation, a problem associated with a high elevation difference between the pump and the fluid surface. The following Table shows the procedure for operations and maintenance.

Table 9: Procedures for operations and maintenance

PUMP OPERATIONS	TASKS	REMARKS
	Operate pumps manually with a switch located above ground level or automatically with a pressure switch, electrodes or float control device	
	Operate pumps while is below the water level	
	The pump should be installed higher than the well screen to prevent pump break suction which may lead to a burned pump motor.	
Pump Inspection	**TASKS**	**REMARKS**
	Inspect the pump immediately on start-up	
	Check alarm monitoring	
	Check pressure flow	
	Conduct visual Inspection: Inspect for clogging debris on suction inlet, Check pump exterior for dents, corrosion and abrasion, and clean off.	
	Check corrosion: Inspect valve threads if corroded	
Inspection for Submersible Borehole	**TASKS**	**REMARKS**
	Check voltage supply between all phases of the electrical control panel,	
	Check voltage balance between all phases on the load side of the pump / mixer control panel with pump / mixer running,	
	Check amperage draw on all phases of the motor (in amps),	
	Check condition and operation of the motor thermal protection control system (if equipped),	
	Remove pump / mixer from the lift station for physical inspection,	
	Check condition of upper and lower shaft seals (inspect condition of motor / stator housing, if applicable),	

	Check condition and operation of leakage and bearing sensors (if equipped),	
	Check for worn out or loose impeller or propeller,	
	Check impeller wear rings (rotating & stationary),	
	Check for any unusual noise in the upper and lower bearings,	
	Clean, reset and check operation of the level control system (if equipped),	
	Check for physical damage of power and control cables,	
	Check electrical condition of insulation on power cable(s) and on all phases of the motor,	
	Check for any loose or faulty electrical connections within the control panel,	
	Measure resistance between stator windings (in ohms),	
	Check for correct shaft rotation,	
	Check operation of valves and the associated equipment.	
Maintenance of Pump	**TASKS**	**REMARKS**
	Pump motor unit size and type;	
	Static and pumping water level of the well;	
	Size of drop pipe and/or drop cable;	
	Pump setting;	
	Discharge pressure required;	
	Capacity pumped;	
	Line voltage;	

4.9.2. Centrifugal pump

A centrifugal pump is a mechanical device designed to move a fluid by means of the transfer of rotational energy from one or more driven rotors, called impellers. The action of the impeller increases the fluid's velocity and pressure and also directs it towards the pump outlet. The following Table indicates the operations and maintenance of the centrifugal pumps.

Table 10: Operations and maintenance of the centrifugal pumps

PUMP OPERATIONS	TASKS	REMARKS
	When starting the motor, make sure that the discharge gate valve is closed	
	If the pump is not self-priming or has a defective suction line or foot valve, add priming water. Priming displaces the air in the suction line or drop pipe of the pump with water	
	Allow the pressure to build up, and then slowly open the discharge valve. Doing this slowly avoids water hammer, which could destroy the pipes and valves	
	Start the pump motor	
	After the pressure has built up, slowly open the discharge gate valve. In case the pump has been primed with water, waste the water pumped during the first 1 -2 minutes by opening the drain valve;	
	Make a routine check for faults in the operation of the system (abnormal noise, vibration, heat, and odour).	
Pump Inspection	**TASKS**	**REMARKS**
	Inspect the pump immediately on start-up	
	Check alarm monitoring	
	Check pressure flow	
	Conduct visual Inspection: Inspect for clogging debris on suction inlet, Check pump exterior for dents, corrosion and abrasion, and clean off.	

	Check corrosion: Inspect valve threads if corroded	
Inspection for Centrifugal Pumps	**TASKS**	**REMARKS**
	Check voltage supply between all phases of the electrical control panel	
	Check voltage balance between all phases on the load side of the pump / mixer control panel with pump / mixer running	
	Check amperage draw on all phases of the motor (in amps)	
	Check condition and operation of the motor thermal protection control system (if equipped)	
	Remove pump / mixer from the lift station for physical inspection	
	Check condition of upper and lower shaft seals (inspect condition of motor / stator housing, if applicable)	
	Check condition and operation of leakage and bearing sensors (if equipped)	
	Check for worn out or loose impeller or propeller	
	Check impeller wear rings (rotating & stationary)	
	Check for any unusual noise in the upper and lower bearings	
	Clean, reset and check operation of the level control system (if equipped)	
	Check for physical damage of power and control cables	
	Check electrical condition of insulation on power cable(s) and on all phases of the motor	
	Check for any loose or faulty electrical connections within the control panel	
	Measure resistance between stator windings (in ohms)	
	Check for correct shaft rotation	

	Check operation of valves and the associated equipment.	
Maintenance of Pump	**TASKS**	**REMARKS**
	Bearings, gears and other pump moving parts should be lubricated on a regular schedule, using the lubricants recommended by the supplier	
	If pump is operating at significantly lowered efficiencies, the pump should be pulled out, inspected and repaired or reconditioned	
	Maintain the water flowing through the stuffing box at a level just enough to prevent overheating. The gland nuts should be loosened or tightened one-quarter turn only to allow the packing to equalize against the pressure.	
	The pump vibrations could indicate a misalignment of the head shaft. Then • Remove the motor dust cover, motor head nut and key, and take out the motor drive flange. • Check if the head shaft is concentric with the motor hollow shaft bore. • If needed, adjust by using shims.	

4.9.3. Jet pumps

A jet pumps are one's which a fluid flows through a driving nozzle which converts the fluid pressure into a high-velocity jet stream; fluid is continuously entrained from the suction section of the jet pump by the jet stream emerging from the nozzle. The following Table indicate the procedure for operations and maintenance.

Table 11: Procedure for operations and maintenance of Jet pumps

JET PUMP OPERATIONS	TASKS	REMARKS
	Make sure that the power supply to the motor is off;	
	The single-phase jet Monoblock should be grounded	
	Make sure that the electrical connections (if any) are correctly and properly insulated	
	Link the cable correctly to the starter clamp so that the connection does not come loose	
	The low-voltage operation should be taken into account when selecting the wire size	
	Set the pressure control valve to the maximum delivery rate	
	Check lubrication. Make sure that the pump rotates fully by manually turning the shaft. (For more details, refer to the pump manual)	
	Stop the pump motor and repeat operating procedures. It may be necessary to repeat the procedure several times until the system is completely filled with water	
	Remove pressure gauge bushing and prime pump with clean water. Never start the motor until the pump has been filled with water	
	Replace pressure gauge bushing and close the discharge gate valve	
	Start the pump motor. Note build-up of pressure in the pressure gauge. Open the discharge valve slowly	
	If discharge pressure is lost and fails to build up again after a short time, the system still contains air.	

	build up again after a short time, the system still contains air.	
Maintenance of Pump	**TASKS**	**REMARKS**
	Pumps should be properly primed before starting	
	Use the given pipe size as indicated on the product label	
	Air vent to be fully opened before starting	
	Correct rotation of the pump	
	Pump should not be operated, if ratchet pins are missing	

4.9.4. Hand Pumps

The Bore hole drilled for the use of Hand Pump generally has various diameter sizes, which may be fitted with a variety of Hand Pump instruments. The pump body parts are extremely durable over the years. With all hand pumps the borehole is sealed to prevent the percolation of wastewater polluting the borehole. A user-friendly designed platform with drains connected to a soak pit/leach pit at least three meters from the borehole is critical. The hand pump should be mounted on top of the casing pipe of the borehole above ground level so that dirty water cannot enter into the borehole as shown in Figure 4.3.

Figure 4: Hand pump installation and operation

The daily, Monthly and Annual activities should include the following O&M activities:

Table 12: Monthly and Annual M&O activities

FREQUENCY	TASKS	REMARKS
DAILY	Carry out inspections daily, weekly, monthly	
	Keep records of all checks and work	
	Monitor pump output rate	
	Keep pump and base clean and clear of refuse	
WEEKLY	TASKS	REMARKS
	Check the fittings such as nuts, bolts and handle assembly and tighten them.	

	Check the axle bolt and tighten as needed.	
	Make sure the lock nut is tight.	
	Make sure the hand pump is firm on its base.	
	Check the flange bolts fastening the water chamber to the pedestal are tight.	
	Testing water quality using a Field Test Kit.	
MONTHLY	**TASKS**	**REMARKS**
	Tighten the handle axle nut and lock nut.	
	Check for loose or missing flange bolts and nuts and tighten as needed.	
	Open the cover and clean inside the pump.	
	Check the chain anchor bolt for proper position and tighten if needed.	
	Look for rusty patches, clean with a wire brush and apply anticorrosive paint.	
	Find out whether the hand pump base is loose and arrange for repair of the foundation as needed.	
	Measure the static water level.	
	Greasing of all components.	
ANNUALLY	**TASKS**	**REMARKS**
	Discharge is satisfactory.	
	Handle is shaky.	
	Guide bush is excessively worn out.	
	Chain is worn out.	
	Roller chain guide is excessively worn out.	
	Check all parts of the hand pump for wear and tear /damages, replace damaged parts and reassemble the hand pump.	
	Measure the well depth.	
	All the components of the hand pump to	

	be checked for wear and tear/damages and damaged parts replaced and hand pump re-assembled.	
	Washing and cleaning of the components of the hand pumps should be done with water and bleaching powder, if required instead of a mixture of water and kerosene.	
	The repairs to the hand pump platforms to be done as and when needed and need not be on daily basis.	
Disassembly, Inspection and Reassembly of Hand Pump	**TASKS**	**REMARKS**
	Loose pump head cover bolt.	
	Remove inspection cover from head assembly.	
	Insert chain coupling supporting tool.	
	Lift the handle to the top position and disconnect the chain from the handle by removing the "nylon" nut and bolt (i.e., nylon insert lock nut).	
	Take out the handle axle; while removing, use the handle axle punch to protect the axle thread and remove the handle from the head assembly.	
	Remove flange bolts from the head assembly.	
	Remove head assembly from the water tank.	
	Place the connecting rod vice on to the water chamber top flange and tighten the vice against the connecting rod and allow the head assembly to sit on the connecting rod vice.	
	Disconnect the chain assembly from connecting rod.	
	Support connecting rod with connecting rod lifter, loosen connecting rod vice and remove; gently lower connecting rod to sit on check valve; remove connecting rod lifter.	

	Loose water tank nuts and bolts and remove water tank bottom flange bolts.	
	Lift a water tank by using a tank pipe lifter and lifting spanners.	
	Fit a self-locking clamp and remove the water tank.	
	Join plunger assembly to check valve by turning the rod lifter in clockwise direction	
	To take out water from the pipe, remove the rod lifter; join the rod lifting adaptor to the connecting rod; place head assembly over water tank and fix handle to the lifter	
	Remove water from the riser pipe by pushing down the handle suddenly.	
	Lift handle upwards slowly and disconnect connecting rod lifting adapter and take-out head assembly.	
	Tighten the connecting rod lifter to the connecting rod and lift the connecting rod and fix the connecting rod vice.	
	Hold the connecting rod, slowly loosen the rod vice and lift the connecting rod; tighten the vice and repeat the process until it is possible to remove the connecting rod; repeat the process until the last connecting rod with plunger and check valve is pulled out.	
	Separate the check valve from the plunger.	
	Unscrew the plunger from the check valve.	
	Remove all the parts of the check valve and clean them.	
Inspection for reassembly covers	**TASKS**	**REMARKS**
	Check the water tank for leakage or damage.	
	Wash and clean all parts with a mixture of water and bleaching powder.	
	The stand assembly should be on a	

	perfect level - check with a spirit level	
	Check the coupler for broken threads.	
	Check flanges and spout pipe for cracks and leakage.	
	Check the handle axle, bearings and chain; apply grease to the bearings and chain	
Reassembly of Hand Pump	**TASKS**	**REMARKS**
	Ensure parts are clean and dry, and moving parts are lubricated with oil and grease	
	Check the 'O' ring and cup seal and replace as needed.	
	Remove cover of casing pipe for fixing stand assembly.	
	Place the stand assembly over the casing pipe and make sure that it is vertical and check the level of flange by spirit level.	
	Fix water tank assembly on the stand flange by tightening the nuts and bolts.	
	Join the check valve and plunger.	
	Connect the plunger to the connecting rod.	
	Insert the plunger assembly connected with the check valve in the riser pipe and connect the riser coupler to the water tank.	
	Insert the lower end of the connecting rod in the riser pipe, and place the connecting rod over the water tank and fix it to the vice.	
	Join the connecting rod pieces as per the requirement and insert in the riser pipe.	
	Remove the connecting rod vice from the water tank by holding the top end of the connecting rod.	

Fix the connecting rod lifter to the top end of the connecting rod and rotate in the direction of the arrow so as to separate the check valve from the plunger and ensure that it reaches the bottom plate.	
Make a mark by hack saw on the connecting rod at the level of the water tank.	
Lift the connecting rod assembly, fix the connecting rod vice and tighten the connecting rod.	
Cut the connecting rod as per the marking after removing the connecting rod lifter.	
Smoothen with the help of a file the cut surface of the connecting rod.	
Make necessary threads on the top most end of the connecting rod.	
Fix the middle flange on the top of the water tank and ensure that all four corners coincide.	
Tighten the check nut at the top of the connecting rod.	
Screw the chain onto the connecting rod.	
Place the chain coupling supporting tool on the middle flange and remove the rod vice.	
Place the middle flange and set flanges with a water tank.	
Place the head assembly over the middle flange and tighten it with a spanner.	
Place handle assembly and insert the handle axle by handle axle punch.	
Lift the handle for fixing chain and tighten chain anchor bolt and nylon nut fully (i.e., nylon insert lock nut); remove chain coupler supporting tool by lowering the handle	
Lift the handle up and apply grease on the chain.	

	Lower down the handle and fix inspection cover and tighten the cover bolt fully by the crank spanner.	

4.9.5. The Common Pump Problems, Possible Causes and Remedies

Table 13: The Common Pump Problems, Possible Causes and Remedies

SYMPTOM	PROBABLE FAULTS	REMEDY
Pump does not deliver liquid	Impeller rotating in the wrong direction.	Reverse direction of rotation by swapping two phases on the electrical supply.
	Pump not properly primed - air or vapour lock in suction line.	Stop pump and reprime.
	Inlet of suction pipe insufficiently submerged and sucking a vortex in the water.	Increase suction depth of suction pipe to at least 3 x diameter of suction pipe.
	Air leaks in suction lines or gland arrangement.	Make good any leaks or repack glands.
	Pump not up to rated speed.	Increase speed.
	Delivery/suction valve throttled or not fully opened or completely shut.	Check valve position.
Pump does not deliver rated quantity	Air or vapour lock in suction line.	Stop pump and reprime.
	Inlet of suction pipe insufficiently submerged sucking a vortex in the water	Increase suction depth of suction pipe to at least 3 times diameter of suction pipe.

	Pump not up to rated speed.	Increase speed by adjusting drive pulley ratios or use a variable speed drive.
	Air leaks in suction lines or gland arrangement.	Make good any leaks or repack glands.
	Foot valve or suction strainer choked.	Clean foot valve or strainer.
	Restriction in delivery pipework or pipe work incorrect.	Clear obstruction or rectify error in pipe work.
	Head underestimated and/or pump incorrectly selected.	Check head losses in delivery pipes, bends and valves, reduce losses as required or re-select pumps to required delivery rate.
	Unobserved leak in delivery.	Examine pipe work and repair leaks.
	Blockage in impeller or casing.	Remove half casing and clear obstruction.
	Excessive wear at neck rings or wearing plates.	Dismantle pump and restore clearances to original dimensions.
	Impeller damaged or vane angles not to specification.	Dismantle pump and renew impeller or re-machine vane angles.
	Pump gaskets leaking.	Renew defective gaskets.
	Suction/delivery or non-return valves faulty or not fully open.	Check valves for defects to replace if necessary.

Pump does not generate its rated delivery pressure	impeller rotating in the wrong direction.	Reverse direction of rotation by swapping two phases on the electrical supply.
	Pump not up to rated speed.	Increase speed by adjusting drive pulley ratios or use a variable speed drive.
	Impeller neck rings worn excessively	Dismantle pump and restore clearances to original dimensions.
	Impeller damaged or choked	Dismantle pump and renew impeller or clear blockage.
	Pump gaskets leaking	Renew defective gaskets.
Pump loses liquid after starting	Suction line not fully primed - air or vapour lock in suction line.	Stop pump and reprime.
	Inlet of suction pipe insufficiently submerged	Increase suction depth of suction pipe to at least 3 x diameter of suction pipe.
	Air leaks in suction line or gland arrangement.	Make good any leaks or renew gland packing.
	Liquid seal to gland arrangement lantern ring (if fitted) orifice choked.	Clean out liquid seal supply orifice.
	Lantern ring not properly located.	Unpack glands and relocate the lantern ring under supply orifice.

Pump overloads driving unit	Pump gaskets leaking.	Renew defective gaskets.
	Serious leak in delivery line, pump delivering more than its rated quantity.	Repair leak or choke the pump with the delivery valve to ensure that it runs on its curve.
	Speed too high.	Reduce speed.
	Bearings defective.	Replace bearing.
	Impeller neck rings worn excessively.	Dismantle pump and restore clearances to original dimensions.
	Gland packing too tight.	Stop pump, close delivery valve to relieve internal pressure on packing, slacken back the gland nuts and retighten to finger tightness.
	Impeller damaged.	Dismantle pump and renew impeller.
	Mechanical tightness at pump internal components.	Dismantle pump, check internal clearances and adjust as necessary.
	Pipe work exerting strain on the pump.	Disconnect pipe work and realign to pump.
	Misalignments between drive and pump.	Align pump and drive
	Pumping a product with a different density than what the pump was designed for (sludge vs water).	Check for what liquid the pump was designed for. Change the liquid
		product or change the pump.

Bearings wear	Pump and driving unit out of alignment.	Disconnect coupling and realign pump and driving unit.
	Rotating element shaft bent.	Replenish with correct grade of oil or drain down to correct level.
	Dirt in bearings.	Drain out bearing, flush through bearings; refill with correct grade of oil.
	Lack of lubrication.	Dismantle, clean out and flush through bearings; refill with correct grade of oil.
	Bearing badly installed.	Drain out bearing, flush through and refill with the correct grade of oil. Determine the cause of contamination and rectify.
	Pipe work exerting strain on the pump.	Ensure that bearings are correctly bedded to their journals with the correct amount of oil clearance. Renew bearings if necessary.
Excessive vibration	Air or vapour lock in suction.	Stop pump and reprime.
	Inlet of suction pipe insufficiently submerged.	Increase suction depth of suction pipe to at least 3 x diameter of suction pipe.
	Pump and driving unit incorrectly aligned.	Disconnect coupling and realign pump and driving unit.
	Worn or loose bearings.	Dismantle and renew bearings

	Worn or loose bearings.	Dismantle and renew bearings
	Impeller choked or damaged.	Dismantle pump and clear or renew impeller.
	Rotating element shaft bent.	Dismantle pump and straighten or renew shaft.
	Foundation not rigid or base plate holding down bolts loose.	Remove the pump, strengthen the foundation and reinstall the pump. Tighten holding down bolts and fit lock nuts.
	Foundation/Pump plinth not large enough.	Foundation/pump plinth to be increased to roughly 5 x the weight of the pump and motor combination.
	Cavitation due to implosion of air bubbles.	Ensure that there is sufficient NPSH (Net Positive Suction Height) available. Bring the pump closer to the suction surface.
	Foundation/Pump plinth not wide enough.	Drop a vertical line from the center of the motor, two lines radiating out thirty degrees from this center-line should pass through the baseplate, not the sides of the foundation. Increase the width of the foundation.
	Coupling damaged.	Renew coupling.
	Air or vapour lock in suction.	Stop pump and reprime.
	Inlet of suction pipe insufficiently submerged.	Increase suction depth of suction pipe to at least 3 x diameter of suction pipe.

	Pump and driving unit incorrectly aligned.	Disconnect coupling and realign pump and driving unit.
Bearing overheating	Pump and driving unit out of alignment.	Disconnect coupling and realign pump and driving unit.
	Oil level too low or too high.	Replenish with the correct grade of oil or drain down to the correctlevel.
	Wrong grade of oil.	Drain out bearing, flush through bearings; refill with correct grade of oil.
	Dirt in bearings.	Dismantle, clean out and flush through bearings; refill with the correct grade of oil.
	Moisture in oil.	Drain out bearing, flush through and refill with the correct grade of oil. Determine the cause of contamination and rectify.
	Bearings too tight.	Ensure that bearings are correctly bedded to their journals with the correct amount of oil clearance. Renew bearings if necessary.
	Too much grease in the bearing.	Clean out old grease and repack with the correct grade and amount of grease.
	Pipework exerting strain on the pump.	Disconnect pipe work and realign to pump.

Excessive Noise Level	Air or vapour lock in suction line.	Stop pump and reprime.
	Inlet of suction pipe insufficiently submerged.	Increase suction depth of suction pipe to at least 3 x diameter of suction pipe.
	Air leaks in suction lines or gland arrangement.	Make good any leaks or repack glands.
	Pump and driving unit out of alignment.	Disconnect coupling and pump and driving unit.
	Worn or loose bearings.	Dismantle and renew bearings.
	Rotating element shaft bent.	Dismantle pump, straighten or renew shaft.
	Foundation or base plate not rigid.	Remove the pump and driving unit and strengthen the foundation.
	Cavitation due to the pump not operating on its designed duty point.	Throttle the pump delivery valve to force the pump back onto its operating curve. Select another pump to fit with the required duty.
	Water hammer due to sudden pump stoppage. Sudden valve closure, etc.	Design pipeline and pump station components to minimize water hammer over pressures or release excess pressure to the atmosphere by mechanical means.
	Mechanical seal arrangement has come	Stop the pump and replace the seat.

	Re-machine pump shaft in case of serious damage.	
	Mechanical seal faces are running dry causing a high-pitched whistling noise.	Ensure that the pump is fully primed and avoid running the pump without water or fluid in the volute.

4.10. Operation and Maintenance for Water Storage System

The importance of storage of water from source before distribution cannot be undermined as water reserves provide short term availability to customers. The reservoir and water tower are two common and useful water storage systems. The reservoirs and water towers have different functions: reservoirs are constructed on ground level and provide the bulk of the required storage volume. Where possible, reservoirs are located on higher ground above the system to provide the required pressure. However, in some cases users are located at high elevations relative to the reservoir and thus cannot be supplied with adequate pressure. In these cases, water towers are commonly used to provide additional pressure for these users. Since it is expensive to provide elevated storage, water towers are sized for a few hours of peak demand only, and the pumps that supply them are sized to provide the peak user demand. Little emergency storage is provided in water towers, with the ground storage reservoirs holding the bulk of the required emergency storage. Reservoirs are mostly constructed from reinforced concrete, although smaller reservoirs are sometimes built out of bricks or steel panels.

Figure 5: Reservoir and water tower constructed by concrete and steel structure

4.10.1. Operations of water storage system

The operational plan of a reservoir is normally not done in isolation, but in combination with other storage and pump facilities in the system. However, individual reservoirs should be operated based on the following procedures.

Table 14: Procedures for operating individual reservoirs

RESERVOIR OPERATIONS	TASKS	REMARKS
	Operation is closely linked to energy costs since pumps are normally used to fill reservoirs. By pumping in the early morning hours, when electricity costs are at a minimum, and allowing the reservoir level to drop during the day, it is possible to minimize operational costs. A detailed analysis of the system and electricity tariffs is required to develop an optimal pumping schedule.	
	The reservoir levels should be kept as high as possible and maintenance crews should be on standby to repair leaks on the reservoir feeder pipes as quickly as possible. The risk of a reservoir running dry is much lower during the winter months when the seasonal demand is lower, and it may even be considered to operate the reservoir at lower levels during these periods	

	Should reservoir retention times be so high that chlorine levels are at risk of being depleted in the system, a booster chlorination station should be installed on the reservoir inlet pipe.	
	Staff entering the drained reservoir to remove accumulated sediments should clean reservoirs. During cleaning, consumers	
	can be served from another reservoir or by a different part of the reservoir if it is subdivided. Reservoir cleaning should be done twice a year when consumption, and thus the load on the reservoir, is at a minimum. In some cases, specially trained and certified divers may be used to clean the reservoir with special equipment without draining it	

4.10.2. Maintenance of reservoir

Table 15: The procedure for maintenance of reservoir

MAINTENANCE OF RESERVOIR	TASKS	REMARKS
	Empty the reservoir. The reservoir level should be allowed to drop as low as feasible by normal consumption. The valves on supply pipes are then closed and the scour valve opened to drain the remaining water	
	Check security fence, gate and lock and lighting.	
	Check water meters for proper operation and leakage.	
	Check pump station for proper operation of pumps and other equipment (e.g., control valves)	
	Check pipework and reservoir for signs of leakage or reservoir overflow.	
	Check that water level indicators function correctly.	
	Cut grass and edges, and clean paths, channels and maintain gardens.	
	Open and inspect valve and meter chambers and other on-site installations for proper operation. Clean strainers and chambers. Check chamber lids and locks, and oil hinges.	
	Check valves for corrosion or other damage, and that they are operating smoothly.	
	Check lids/doors and locks on pump stations, reservoirs and other facilities and oil hinges.	
	Check that signs are in place and	

	legible	
	Take all water meter readings and compare inlet and outlet meters to look for signs of water losses. Note that differences in meter readings may be due to variations in reservoir levels between the readings.	
	Movable parts on valves should be greased every three months. Finally, reservoirs and water towers should be drained, cleaned, inspected and maintained every three to five years.	
Pipes (Inlet, outlet, washout, overflow) and specials	Check all the pipe fittings for leak proof, any leakage nearby reservoir may affect the safety of reservoir	
	Overflow pipe should be connected with the distribution system after the sluice valve installed on delivery pipeline	
	Concrete platform as protection works shall be provided around the service reservoir, if not provided, so as to safeguard the reservoir foundation from any leakages/overflow of water	
Valves Maintenance	All valves should be inspected regularly in specified frequency of inspection	
	Lubrication is required to be done regularly	
	Spindles that develop leaks should be repacked	
	Rust and sediment in the valve is removed by shutting the disc hard in the seat, then opening a quarter way and closing tightly several times; the increased velocity usually flushes the obstructions away	

	Valve chambers of the SR require maintenance to ensure that the interiors of chambers are not silted up and also ensure that the covers are in good condition and are in position	
	Sluice valve chamber shall not be waterlogged.	

4.11. Distribution network

Water distribution systems consist of a large number of pipes and components connected in a network and functioning as a whole. Water distribution systems are mostly supplied from water reservoirs located at high points above the supply areas, such as hills or water towers. Thus, pressures and flows in the system are driven by gravity. If there are no demands or leaks in the system, the water will be static and the pressure head at any point in the network will simply be the difference in elevation between the reservoir's water surface and the point. This is called the static pressure. However, when a tap in the system is opened, the pressure in the system forces water out of the tap opening to supply it to the user. Similarly, when a system has leaks, water is forced out through the leak openings. When the pressures in the system become too low, the system is not able to supply the required flow rate and the system experiences a loss of hydraulic integrity.

Key system parameters should be continuously be monitored to ensure that problems in the system are identified as quickly as possible:

4.11.1. Water meters should be monitored continuously and the results analysed for changes in consumption patterns and levels of leakage. Techniques are becoming available that can identify new bursts occurrence by analysing its consumption patterns.

4.11.2. System input flow rates from water treatment plants and bulk water suppliers These flow rates are the largest in the system and thus accurate measurement is very important. Electromagnetic or ultrasonic flow meters are typically used and should be monitored continuously. The system input volume forms the basis for water loss estimation.

4.11.3. Consumption meters. Bulk consumers are the most important users of water in villages, a fraction of the total system demand. Their consumption monitoring should be given priority and should be done at least on a monthly basis, but more frequently if possible. Other consumer water meters should be read on a monthly basis. Metered consumption should be analyzed to identify patterns that may indicate defective meters, meter bypassing and on-site leakage.

4.11.4. System flow rates are important for monitoring the movement of water in the distribution system and maintaining adequate reservoir water levels while ensuring that pumps are operated in the most efficient cost periods.

4.11.5. Water quality should be monitored and corrective action taken immediately if problems are found.

4.11.6. Information should be gathered from pipe repair reports on the type and likely cause of failures, as well as the condition of the distribution system at the failure. This information should be analyzed annually to identify patterns and modify procedures if required.

4.11.7. The network that should be monitored includes galvanic protection, user complaints of pressure problems or strange tastes (that might indicate permeation occurring), pipe failures and pipe roughness.

4.11.8. Operators of the distribution system should be trained to correctly deal with situations that may potentially cause

damage. For instance, if a pressure relief valve opens to protect the system from over-pressure after the failure of a PRV, the natural reaction of an operator may be to close the pressure relief valve, thus stopping it from fulfilling its protective function.

4.11.9. Sudden changes in velocity should be avoided to prevent accumulated sediments from being suspended in the water.

4.11.10. Fire services should use soft couplings to connect to the distribution system to prevent negative pressures being created by fire pumps.

4.11.11. The fire risk classification of areas supplied should be investigated at least every three years, looking at all factors that affect fire risk and determining whether the fire risk classification remains the same or should be changed.

4.11.12. Water meters. A database of all water meters should be developed and regularly updated. This database should include the reasons for meter failures and results of meter accuracy tests, and inform meter servicing, maintenance and replacement decisions. Meters should be read on at least a monthly basis. Water meters are subjected to wear and have finite service lives. Regular maintenance is important to ensure that water meters are able to function satisfactorily for as long as possible.

4.11.13. **Mapping and inventory of pipes and fittings in the water supply system.**

Availability of updated distribution system maps with contours, location of valves, flow meters and pressure gauges or tapping points is the first requirement for preparation of the operation schedule. The agency should set up routine procedures for preparing and updating the maps and inventory of pipes, valves and consumer connections. The maps shall be exchanged with other public utilities to contain

information on utility services like electricity and communications.

4.11.14. Field survey and distribution network simulation

Existing maps are used or conventional surveys are employed for preparation and up-dating of maps. As an alternative to traditional survey and map preparation, 'total station method is gaining popularity. Total station instruments can be used for survey and mapping of villages where data is not readily available.

The use of modern databases GIS for analyses, specifically for monitoring of the network operation and maintenance. The use of GIS coupled with GPS in water distribution system management can also greatly enhance the amount and accuracy of data available. The GIS maps are becoming readily available and the GIS system can receive any additional information that becomes available after any replacement, connection or disconnection or expansion of the system has taken place. The maps enable multiple use: providing direct input for the computer model, accurate billing and the location of system components that are malfunctioning and have to be repaired.

4.11.15. Mapping distribution system

The distribution system is required to be mapped in order to capture important data for water points connection, valve and routing of water network. The mapping of water distribution system requires CBWSOs on a need basis to provide the following information:

- Water distribution pipeline for existing and new pipelines network
- Land use
- Name of village and ward

- Network number, boundaries, population, population density
- Valve details such as valve number and timings ward or village wise
- Water tank location along with all technical specification
- Water treatment plant along with name and specification

4.11.16. Evaluation of hydraulic conditions

The O&M personnel can do a continuous evaluation of the hydraulic conditions of the water supply system after obtaining the data on water volumes in the reservoirs, flow meter readings from and into the reservoirs connected to a transmission system and compared with the expected performance. This evaluation shall lead to identification of operational problems and/or system faults. Depending on the type of problems actions have to be initiated to ensure that the system functions as per the requirement.

Simulation of Distribution Network Operations has to be planned for specific circumstances such as failure at source, failure of pumps, leakages or bursts. Criteria have to be determined on the basis of analysis of the effects of particular operations on the hydraulic configuration of the water supply transmission system. These effects can be seen in simulated operating conditions. Mathematical simulation models can be developed from basic data on the network such as length, size, flow, characteristics of pumps, valves, reservoir levels etc. This approach can be very useful for analyzing the effects of variables on large and complex water supply transmission and distribution systems.

4.11.17. Routine Operations of the Water Supply Distribution System

The efficiency and effectiveness of a water supply system depends on the operating personnel's knowledge of the

variables that affect the continuity, reliability, and quantity of water supplied to the consumers. The operational staff should be able to introduce changes in the hydraulic status of the system as required depending on those variables promptly and effectively. Routine operations shall be specified which are activities for adjusting the valves and operation containing procedures for operating the distribution system. It should contain procedures to obtain, process, and analyse the variables related to water flows, pressures and levels as well as the consequences of manipulating control devices, such as operation of valves and/or pumps so that the hydraulic status of the system can match the demand for water. When operators change their shifts, information on valve closure and opening must be exchanged.

4.11.18. Operations in breakdowns and emergencies

Operations other than routine i.e., during breakdowns and emergencies have to be specified and should be carried out in specific circumstances when normal conditions change i.e., when flows, pressures and levels and operation of pumps change.

4.11.19. Measurement of flows, pressures and levels

It will be necessary to regularly monitor operational data concerning flows, pressures and SR levels to assess whether the system is functioning as per requirements. Analysis of data may reveal overdraws of water to some reservoirs and or bulk consumers. At such places, appropriate flow control devices may be introduced to limit the supplies to the required quantity. A list of priority points in the water supply system have to be identified such as installation of meters to measure flows, pressures and levels. A detailed map showing location or each measuring point has also to be prepared. The degree of sophistication of the devices used at each measuring point with regard to indication, integration,

recording, transmission and reception of data depends mainly on the skills of the O&M personnel available with the agency and affordability of the agency.

4.11.20. Sampling for quality of water

The agency operating the water supply system is charged with the primary responsibility of ensuring that the water supplied to the consumer is of an appropriate quality. To achieve this objective, it is necessary that the physical, chemical, bacteriological and microbiological tests are carried out at frequent intervals. Samples should be taken at different points on each occasion to enable one to make an overall assessment. In the event of epidemic or danger of pollution, more frequent sampling may be required, especially for bacteriological quality. For each distribution system, a monitoring programme has to be prepared showing the location of sampling points.

4.11.21. Adequate quantities of network components should be held in CBWSOs stores for repair and replacement of pipes and other components. Establishment of repair procedures for standard services and allocate suitable tools and equipment to each team.

4.11.22. The cost of maintaining pipes should be analysed and pipes replaced or refurbished when they come to the end of their economic service lives.

4.11.23. Establishment of procedures for setting up maintenance schedules and obtaining and processing the information provided by the public and the maintenance teams.

4.11.24. Formation of maintenance teams for each type of service with provision for continuous training. Establishment of time, labour and material requirement and output expected; time required and other standards for each maintenance task.

Table 16: Problems and Approach to Remedy the Situation

Problem	Approach to remedy the situation
Non-Availability of Required Quantity of Water	Check failure of source or failure of power supply may cause reduced supplies. The pumping hours if reduced the distribution reservoirs will not be filled up leading to reduced supply hours and hence reduced quantity of water.
Low Pressure at Supply Point	At peak demand the water supply is given only for a different duration, leading to large peak factors and hence affecting the pressures in the distribution system
Intermittent System	During the supply period, the water is stored in all sorts of vessels for use in non-supply hours, which might contaminate the water. During non-supply hours, polluted water may enter the supply mains through leaking joints and pollute the supplies. Intermittent systems and systems which require frequent valve operations are likely to affect equitable distribution of water mostly due to operator negligence.
Extension of service area	Ensure extension of service area is done with corresponding extension of distribution mains, otherwise the length of house connections will be too long leading to reduction in pressures.
Water Leakage	Check water leakage through leaking pipes, joints, valves and fittings of the distribution systems either due to bad quality of materials used, poor workmanship, and corrosion, age of the installations or through vandalism. This leads to reduced supply, loss of pressure and deterioration in water quality. Maintenance of appropriate positive pressure at all times to all consumers is the main concern

Water Leakage	Check water leakage through leaking pipes, joints, valves and fittings of the distribution systems either due to bad quality of materials used, poor workmanship, and corrosion, age of the installations or through vandalism. This leads to reduced supply, loss of pressure and deterioration in water quality. Maintenance of appropriate positive pressure at all times to all consumers is the main concern
Unauthorized Connections	Checking unauthorized users will contribute to the reduction in service level to authorized users/ consumers and deterioration of quality of water. Sometimes, even legally connected users draw water by sucking through motors causing reduction in pressures.
Lack of Records	Keep records of replacement of fittings/pipes/valves, scouring of the entire distribution system, system maps, designs of the network and reservoirs and historic records of the equipment installed in the distribution system are often not available, whereas some minimum information is required to operate and maintain the system efficiently.
Age of the System	Check aging of distribution infrastructure as age reduces carrying capacity of the pipelines due to encrustation. The consumer pipes get corroded or precipitates and leaks occur resulting in loss of water and reduced pressure and pollution of supplies

4.12. Water Treatment

The main objective of water treatment is to produce water that is fit for domestic use from a raw water source throughout the water supply system to the consumers. The raw water available from sources particularly surface water sources is normally not suitable for drinking purposes. Treatment processes to be applied by CBWSO include the following:

4.12.1. Scum and Floating matters removal

This is the unit operation that enables the manual or automated removal of the scum and floating matter ahead of the screening units. These are designed to skim the entire width of the approach area ahead of the screens. The procedures for removal of scum and floating matters are:

(a) Design the proper sieve size to be used for removal of floating matters by considering the size of matters floating on respective water around water source.

(b) Use the sieve to remove the floating matters before enters the screen.

(c) Cover the top part of water source to prevent any scum enters.

4.12.2. Screening /Straining

It is necessary to use screens to remove any large floating and suspended solids that are present in the inflow. These materials include leaves, twigs, paper, rags and other debris that could obstruct flow through the plant or damage equipment. There are coarse and fine screens. Coarse screens are steel bars spaced 5–15 cm apart, which are employed to exclude large materials (such as logs and fish) from entering the treatment plant, as these can damage the mechanical equipment.

For an appropriately well operation and maintenance of the screen, a structure to support the screen should be designed in such a way that can be removed and inserted easily purposely for removal of clogged matters and replacement.

(a) Choose the screens materials which are resistant to corrosion.

(b) Check the screens if they are at an angle of 60° to facilitate removal of the collected material.

(c) Check the screens daily and remove the clogging matters immediately.

(d) Inspect the screen regularly to determine whether is corroded or not.

(e) Inspect the screen if it is broken, and replace immediately.

4.12.3. Coagulation and Flocculation

Coagulation and flocculation are two separate processes, used in succession, to overcome the forces stabilizing the suspended particles. Coagulants are chemicals used to neutralize the charges on the particles, flocculation enables them to bind together, making them bigger, so that they can be more easily separated from the liquid through the Sedimentation tank

4.12.3.1. Chemical Coagulants Commonly Used in Treatment Process

Aluminium sulphate is a chemical compound with the formula Al2(SO4)3. Aluminium sulphate is mainly used as a flocculating agent in the purification of drinking water and wastewater treatment plants, and also in paper manufacturing. It is recommended to be used as the coagulant of choice in Tanzania

4.12.3.2. Procedures/Process to be involved in Coagulation and Flocculation

(a) Arrange the two solution tanks, one for mixing and the other for dosing, between them holding 48 hours of supply, should be provided. The solution strength should be in the range of 5-10%. The solution tanks could be equipped with hand agitators as shown

(b) Dose the coagulant at a spot of maximum turbulence, rapid mix of coagulant at a spot of maximum turbulence, followed by tapered flocculation in three compartmentalized units allows a maximum of mixing (reduced short circuiting), followed by a period of

agglomeration intended to build larger fast settling flocs.

(c) Mix the coagulant in water rapidly and instantaneously especially in waters with high alkalinity so as to achieve complete homogenization of a coagulant in the water to be treated. Mixing of the coagulant can be satisfactorily accomplished in a special coagulant tank with mixing devices or in the influent channel or a pipeline to the flocculation basin with high flow velocity which produces necessary turbulence.

4.12.4. Sedimentation

Sedimentation is a common way of treating water. It is a process that removes solids that float and settle in the water. The process relies on the use of sedimentation tanks that remove larger solids. Sedimentation tank is used as a component of a modern system of water supply treatment. It allows suspended particles to settle out of water as The Sedimentation basin can be divided into four zones viz. Inlet; Settling; Sludge and Outlet zone. The operation and maintenance procedures for sedimentation are as follow:

(a) Observe how far the flocs are visible beyond the basin inlet. When sedimentation is working well, the floc will only be visible for short distance. When the sedimentation is poor, the floc will be visible for a long distance beyond the inlet.

(b) Observe the quality of water passing through the outlet if not satisfactory (chemical dosage) must be adjusted to improve performance.

(c) Check for the accumulation of settled particles and hence perform the flushing regularly

(d) Clean the sedimentation tank based on routine inspections to remove the growing green algae.

4.12.5. Filtration

Filtration is the process whereby water flows through a filter designed to remove solid particles from within it. The filters are made of layers of sand and gravel. Filtration collects the suspended impurities in water, enhancing the effectiveness of disinfection

4.12.5.1. Slow Sand Filtration Plant

A Slow Sand Filter Plant consists of a box which is rectangular or circular in shape made either of concrete or masonry. Typically, the slow sand filter plant consists of two rectangular operating in parallel, one filter unit is kept in operation and other for maintenance. The supervising manager carries out daily bacteriological tests on the filtered water. Operation and Maintenance of Slow Sand Filter are as follow:

(a) Daily activities

(i) Checked the turbidity of the inlet water to ensure the water is of an acceptable turbidity to prevent rapid blocking of the filter

(ii) Check the rate of filtration on the flow indicator – adjust the rate of filtration as needed by turning the filtered water valve.

(iii) Check the water level in the filter – adjust the inlet vale as needed to maintain a constant water level.

(iv) Remove scum and floating material by further opening the inlet valve for short time;

(v) Check the water level in the clear well;

(vi) Sample and check water turbidity – if the inflow turbidity is too high close the intake; if the outflow turbidity is too high report to the supervisor.

(vii) Testing Water Quality: monitoring of water quality may be done whether it is slow sand filter or rapid sand filter. If the water supply scheme is having laboratory at the water

treatment plant site, water quality testing both the raw water and treated water may be carried out daily

(b) Weekly activities

Clean the water treatment plant site.

(c) Monthly activities

(i) Shut down the filter unit – remove scum and floating material;

(ii) Brush the filter walls; close the inlet, filtered water and distribution valves;

(iii) Drain water to 20 cm below the sand level;

(iv) Increase the filtration rate in the other filter to 0.2 m/h;

(v) Clean the drained down filter bed – wash boots and equipment before use; scrape upper 2-3 cm in narrow strips and remove scrapings from filter;

(vi) Check, and service, exposed inlet and drain valves; remove cleaning equipment and level sand surface; check and record depth of sand bed;

(vii) Adjust inlet box to the new sand level;

(viii) Re-start the filter – open the recharge valve; check sand surface and level as needed;

(ix) When water is 20 cm above the sand, open the inlet valve;

(x) Open the filtered water valve and stop when filtration rate reaches 0.02 m/h;

(xi) Open waste valve for outflow water to flow to waste;

(xii) Open filtered water valve to increase filtration rate every hour by 0.02 m/h until a rate of 0.1 m/h is reached;

(xiii) Adjust and check flow daily until safe to drink;

(xiv) Close waste valve and open distribution valve to pass filtered water into the supply;

(xv) Decrease filtration rate of other filter to 0.1 m/h;

(xvi) Wash the filter scrapings and store the clean sand

(d) Quarterly activities - cleaning of filter

(i) Close the water inlet and allow the filter to discharge clear water for at least 8-10 hours;

(ii) Close the treated water outlet valve;

(iii) Open the waste water outlet till the water in the filter bed reaches upto 0.1-0.2 mm from bottom;

(iv) Remove wastage on top of the filter;

(v) Remove the sand as little as possible, not more than 20-30 mm (the Schmutzdecke). Wastage can be removed manually or with mechanical equipment. Care should be taken avoid any contamination while removal of waste in the filter tank by observing hygiene and cleaning it as quickly as possible;

(vi) Level the sand in the filter;

(vii) Re-start the filter by opening inlet valves and outlet valves.

(viii) After sand cleaning is done for 20-30 times, the depth of sand layer will decrease and needs to replace.

(e) Annual activities

(i) Check if filter is water tight: close all valves and fill filter box from inlet valve until it overflows – close valve;

(ii) Leave for 24 hours and check if water level reduces; if filter box leaks, report for repair;

(iii) Open filtered water valve to fill outlet chamber and when full, close valve; leave for 24 hours and check if water level reduces; if chamber leaks, report for repair;

(iv) Open drain valve to empty filter; clean the clear well in the outlet chamber;

(f) Every two – three years, activities

(i) Re-sand the filter units – clean the filter as in a monthly filter clean;

(ii) open drain valve to empty water from the sand bed;

(iii) remove strip of old sand to one side;

(iv) place new clean sand on top of exposed gravel, and level;

(v) place old sand on top of the new sand to the correct depth of 0.8 m in total, and level the surface;

(vi) continue in strips until filter is re-sanded; adjust inlet box to new sand level;

(vii) Re-start the filter as per the monthly clean plan.

(g) Random checks, checks on the functioning of the plant by supervising staff including turbidity tests through a turbidity meter, and bacteriological tests of the filtered water.

(h) Record keeping, records have to be kept for the following activities:

(i) Daily Source water quality,

(ii) Daily Treated water quality,

(iii) Names of chemicals used,

(iv) Rates of feedings of chemicals,

(v) Daily consumption of chemical and quality of water treated,

(vi) Dates of cleaning of filter feds, sedimentation tank and clear water reservoir,

(vii) The date and hour of return to full service (end of re-ripening period),

(viii) Raw and filtered water levels (measured each day at the same hour) and daily loss of head,

(ix) The filtration rate, the hourly variations, if any,

(x) The quality of raw water in physical terms (turbidity, colour) and bacteriological terms (total bacterial count, E.Coli.) determined by samples taken each day at the same hour,

(xi) The same quality factors of the filtered water,

(xii) Any incidents occurring e.g. plankton development, rising Schmutzdecke, and unusual weather conditions,

(xiii) Precautions must be taken to minimize the chances of pollution of the filter bed surface by the labourers themselves.

(i) Re-Sanding

Re-sanding is necessary when the depth of the sand bed drops to its minimum designed level (usually about 0.5 – 0.8 m above the supporting gravel, depending on the grain size of the filter sand/medium). This depth is usually indicated by a marker (such as a concrete block or a step in the filter box wall) set in the structure during the original construction to serve as an indication that this level has been reached and that sanding has become due. After scraping, add new clean sand up to a level required and place back the old sand that was scraped off the top. The old sand will reduce the number of days needed for ripening the filter.

4.12.5.2. Rapid Sand Filtration Plant

This is a process in which water flows onto the top of the filter media and is driven through it by gravity. In passing through the small spaces between the filter's sand grains, impurities are removed. It is the filter media which actually removes the particles from the water. The filter media is routinely cleaned by means of a backwashing process. Rapid sand filtration is a highly effective method to remove turbidity if it is correctly applied.

Filter sand is defined in terms of effective size and uniformity coefficient. Effective size is the sieve size in mm that permits 10% by weight to pass. Uniformity in size is specified by the uniformity coefficient which is the ratio between the sieve sizes that will pass 60% by weight and the effective size

It is important to check shape size and quantity of filter sand as follows:

(i) Sand shall be of hard and resistant quartz or quartzite and free of clay, fine particles, soft grains and dirt of every description.,

(ii) Effective size shall be 0.4 to 0.7 mm,

(iii) Uniformity coefficient shall not be more than 1.7 nor less than 1.3,

(iv) Ignition loss should not exceed 0.7 per cent by weight,

(v) Soluble fraction in hydrochloric acid shall not exceed 5.0% by weight,

(vi) Silica content should be not less than 90%,

(vii) Specific gravity shall be in the range between 2.55 to 2.65,

(viii) Wearing loss shall not exceed 3%.

Operational and maintenance of Rapid sand filter

(i) Operate a filter just before clogging or breakthrough occurs or a specified time period has passed (generally 24 hours).

(ii) Stop the filtration process when a filter clogs/breakthrough this should be stopped and the filter be taken out of service for cleaning or backwashing

(iii) Activate the surface wash system before the backwash cycle starts to aid in removing and breaking up solids on the filter media and to prevent the development of mud balls. Also surface wash system should be stopped before completion of the back-wash cycle to permit proper settling of the filter media

(iv) Perform surface wash in order to produce optimum cleaning of the filter media during backwashing and to prevent mud balls, surface wash (supplemental scouring). Surface wash systems provide additional scrubbing action to remove attached floc and other suspended solids from the filter media.

(v) Perform regular backwashing and cleaning. The period between backwashes depends on the quality of the influent water and normally lies between 24 – 72 hours. The cleaning process requires an interruption of the purification process of 5 - 10 minutes per filter bed. Several parallel filter units are required to guarantee constant water supply.

(vi) Observed carefully the backwash process must be in particular the rate of flow must be controlled to avoid erosion of the filter medium.

(vii) Perform periodic repacking of the filter bed proper intervals to ensure efficient operation.

4.12.6. Disinfection

Drinking water is disinfected to kill bacteria, viruses and parasites, which may exist in the water and may cause illness and disease like Cholera, Amoebic Dysentery and Cryptosporidium. These organisms usually get into drinking water supplies when source of waters such as lakes or streams, community water transmission pipes or storage reservoirs are contaminated by animal waste or human sewage. In fact, shallow dug wells are often as contaminated as lakes or streams. The disinfection of potable water is almost universally accomplished by the use of gaseous chlorine or chlorine compounds. Chlorine is easy to apply.

4.12.6.1. Operation and Maintenance of Chlorination Facilities

(a). Dose: the chlorine effective in such a way that sufficient chlorine is there to react with organic matter, ammonia,

iron, manganese and other reducing substances in water at the same time leave sufficient chlorine to act as algaecide. dose required for this purpose may be over 2mg/L. can be

(b). Adjusted the post chlorination dose to obtain minimum 0.2 to 0.5 mg/l residual chlorine in potable water at consumer end.

(c). Make fresh solutions frequently to maintain the necessary residual. Chlorine, solutions lose strength while standing or when exposed to air or sunlight.

(d). Maintain a free chlorine residual of 0.3 mg/l after 30 minutes contact time.

(e). Measured residual chlorine every day.

(f). Increased the chlorine dosage to meet greater demand, do not decrease it unless the raw water quality improves.

(g). Maintain the chlorine residuals when there is a risk of cholera or an outbreak has already occurred, as follows:

- Distribution system: 0.5mg/l
- Tanker trucks at filling point: 2 mg/l

Maintenance of chlorination equipment and facilities for disinfection should be according to the installation manual (manufacture's product manual).

4.13. Working Tools for maintenance of water scheme service

To understand your responsibilities for keeping work equipment in good working order, how often you need to maintain it and where you can keep a record. You need to carry out maintenance to ensure the workplace structure, equipment, machinery, fixtures and fittings and facilities are in good working

order. Inadequate maintenance can lead to dangerous situations, accidents and health problems. It includes many tasks such as repairing, replacing, servicing, inspecting, and testing.

Table 17: List of Working Tools for Daily Operations and Maintenance

Description	Quantity	Unit
1. Tool box	1	Pc
2. Padlock	1	Pc
3. Healing place	1	Pc
4. Teflon cover	1	Pc
5. Blow lamp	1	Pc
6. Thermo chrome	2	Pc
7. Pipe compound	1	Can
8. Hem or jute	1	Bundle
9. Hacksaw frame	1	Pc
10. Hack blade	10	Pc
11. Flat file	1	Pc
12. Round file	1	Pc
13. Knife	2	Pc
14. Pliers	1	Pc
15. Adjustable wrench 10"	2	Pc
16. Pipe wrench 6",8'',12'',14''and 18''	@1Pc	
17. Pipe wrench 24'', 36'',48'' and 60''	@1Pc	
18. Tap 5-meter	1	Pc
19. Hammer 1 kg	1	Pc
20. Trowel	2	Pc
21. Shovel	2	Pc
22. Pick axe	2	Pc
23. Crowbar	2	Pc
24. Bucket	2	Pc
25. HDPE & G pipes of various diameters used in the system	50	Meters.
26. Pipe fillings to be decided by CBWSOs committee but should not exceed 10% of quantity installed		

CHAPTER FIVE

OPERATION AND MAINTENANCE REQUIREMENTS FOR SANITATION SYSTEMS

5.1. Sanitation Chain Systems

A Sanitation chain System is a series of technologies and services for the management of human excreter and wastewater from the point of generation to the point of use or ultimate disposal(i.e., units for collection, containment, transport, transformation, utilization or disposal)

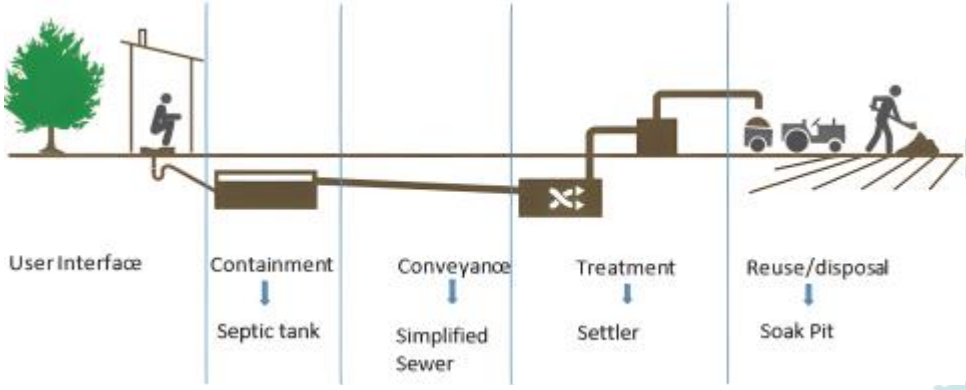


Figure 6: Sanitation Chain System

Different sanitation system has different operation and maintenance requirements for different sanitation units.

5.2. Single Pit System

This system is based on the use of a single pit technology to collect and store Excreta. The system can be used with or without Flush water, depending on the User Interface. Inputs to the system can include Urine, Faeces, Anal Cleansing Water,

Flush water and Dry Cleansing Materials.

This system is used where there is either enough space to continuously dig new pits or when there is an appropriate way to empty, treat and dispose of the faecal Sludge.

Figure 7: Single pit system

Maintenance

Slabs must be kept clean to make them pleasant to use. Faeces and urine need to be removed as soon as possible to prevent odours, the attraction of flies, and to prevent it becoming unsightly. Apart from regular cleaning and occasional repainting, slabs will need periodic inspection, repairs and maintenance to ensure that they remain structurally sound.

5.3. Waterless Pit System without Sludge Production

This system is designed to produce a solid, earthlike material by using alternating pits or a Composting Chamber. Inputs to the system can include Urine, Faeces, Organics, Anal Cleansing Water, and Dry Cleansing Materials. There is no use of Flush water. This system is especially appropriate for water-scarce areas and where there is an opportunity to use the humic product as soil conditioner.

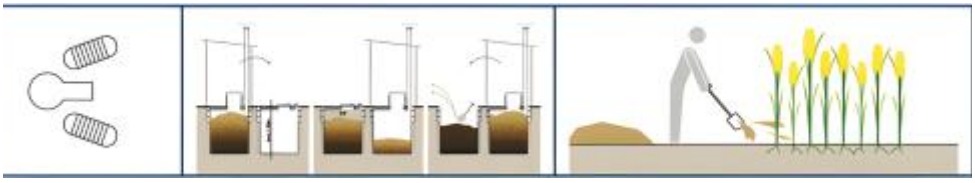


Figure 8: Waterless Pit System without Sludge Production

Maintenance

Slabs must be kept clean to make them pleasant to use. When the first pit is full, it is covered and temporarily taken out of service. While the other pit is filling with Excreta (and potentially Organics), the content of the first pit is allowed to rest and degrade. Only when both pits are full is the first pit emptied and put back into service. The material that is removed should be in a safe, useable form, although proper personal protection should be used during removal, transport and use.

5.4. Pour Flush Pit System without Sludge Production

This is a water-based system utilizing the Pour Flush Toilet (pedestal or squat pan) and Twin Pits to produce a partially digested, humus-like product, that can be used as a soil amendment. If water is not available, please refer to Systems 1, 2 and 4. Inputs to the system can include Faeces, Urine, Flushwater, Anal Cleansing Water, Dry Cleansing Materials and Greywater.

This system is suited to rural and peri-urban areas with appropriate soil that can continually and adequately absorb the leachate.

Figure 9: Pour Flush Pit System without Sludge Production

Maintenance

The Slabs must be maintained and kept clean to make them pleasant to use. The Twin Pits are lined with a porous material, allowing the liquid to infiltrate into the ground while solids accumulate and degrade at the bottom of the pit. While one pit is filling with Blackwater, the other pit remains out of service. When the first pit is full, it is covered and temporarily taken out of service. It should take a minimum of two years to fill a pit. When the second pit is full, the first pit is re-opened and emptied

This system is well-suited for anal cleansing with water. If possible, Dry Cleansing Materials should be collected and disposed of separately since they may clog the pipe fittings and prevent the liquid inside the pit from infiltrating into the soil.

5.5. Waterless System with Urine Diversion

This system is designed to separate Urine and Faeces to allow the Faeces to dehydrate and/or recover the Urine for beneficial use. Inputs to the system can include Faeces, Urine, Anal Cleansing Water and Dry Cleansing Materials. The system can be used any where, but is especially appropriate for rocky areas where digging is difficult, where there is a high groundwater table, or in water-scarce regions.

The system can be used anywhere, but is especially appropriate for rocky areas where digging is difficult, where there is a high groundwater table, or in water-scarce regions.

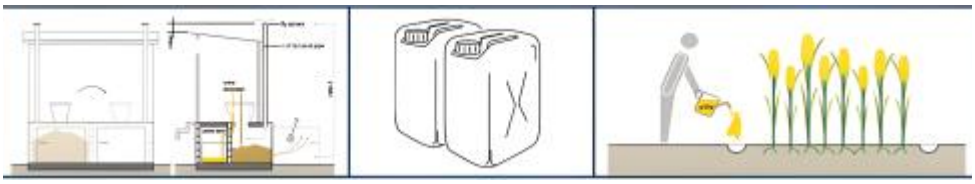


Figure 10: Waterless System with Urine Diversion

Operation

When storing the Faeces in vaults, they should be kept as dry as possible to encourage dehydration and pathogen reduction. Therefore, the chambers should be watertight and care should be taken to ensure that no water is introduced. Anal Cleansing Water should never be put into Dehydration Vaults, but it can be diverted and discharged into a Soak Pit. Also important is a constant supply of ash, lime, soil, or sawdust to cover the Faeces.

Maintenance

The Slabs must be maintained and kept clean to make them pleasant to use. Human-Powered Emptying and Transport is required for the removal and Conveyance of the Dried Faeces generated from the Dehydration Vaults. The alternating use of double Dehydration Vaults allows for an extended dehydration period so that the Dried Faeces pose little human health risk when they are removed. A minimum storage time of 6 months is recommended when ash or lime are used as cover material. The Dried Faeces can then be applied assoil conditioner.

5.6. Biogas System

This system is used as a Biogas Reactor to collect, store and treat the Excreta. Furthermore, the Biogas Reactor produces Biogas which can be used for cooking, lighting or electricity

generation. Inputs to the system includes Urine, Faeces, Flushwater, Anal Cleansing Water, Dry Cleansing Materials, Organics (e.g., market or kitchen waste) and, if available, animal waste.

This system is best suited to rural and peri-urban areas where there is appropriate space, a regular source of organic substrate for the Biogas Reactor and a use for the digestate and Biogas. The reactor itself can be built underground (e.g., under agricultural land)

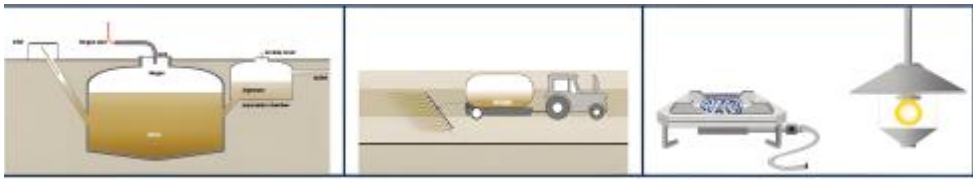


Figure 11:Biogas System

Operation and Maintenance

The units must be maintained and the used, if not used it will accumulate inthe tank and, with increasing pressure, will push out the digestate until the Biogas escapes to the atmosphere through the digestate outlet

5.7. Septic tank installed with Blackwater Treatment System with Infiltration

This is a water-based system that requires a flush toilet and a Collection Storage/Treatment technology that is appropriate for receiving large quantities of water. Inputs to the system can include Faeces, Urine, Flushwater, Anal Cleansing Water, Dry Cleansing Materials and Greywater.

The system is appropriate in areas where desludging services are available and affordable and where there is an appropriate way to dispose of the Sludge. For the infiltration technologies to work there must be a sufficient available space and the soil must have of a suitable capacity to absorb the Effluent. The system is used at HH level community or institutions

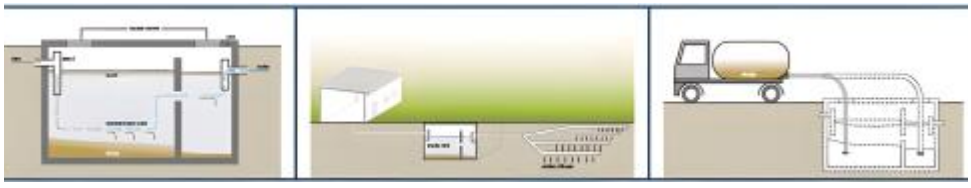


Figure 12:Septic tank installed with Blackwater Treatment System with Infiltration

5.8. Blackwater Treatment System with Effluent Transport

This system is characterized by the use of a household-level technology to remove and digest settleable solids from the Blackwater, and a Simplified or Solids-Free Sewer system to transport the Effluent to a (Semi-) Centralized Treatment facility. Inputs to the system can include Faeces, Urine, Flushwater, Anal Cleansing Water, Dry Cleansing Materials and Greywater

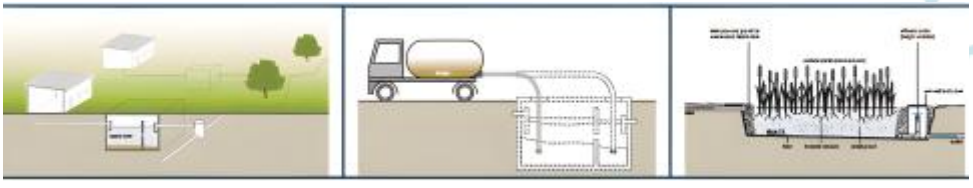


Figure 13: Blackwater Treatment System with Effluent Transport

5.9. Operation of sanitation services

- The septic tanks should be checked from time to time to ensure that they are watertight.
- Routine inspection is also necessary to remove floating debris such as coarse materials and grease, to ensure that there are no blockages at the inlet or outlet and to check whether desludging is needed
- Use a vacuum tanker equipped with a vacuum pump and tank, for emptying septic tanks and for hauling sludge to a disposal station. The emptying of septic tank should be done when is 2/3 full or septic tanks should be emptied every 2 to 5 years whatever earlier
- All vacuum tanker systems should use a pump to create a vacuum in the tank and suction hose. Ensure vacuum lifts the sludge into the tanker. If the bottom layers of sludge are compacted, they can be broken up with a long spade, or jetted with a water hose, before being pumped out.
- With mild detergents such as washing powders, etc. a minimum dilution factor of 50 parts water to 1-part detergent is recommended.
- Whilst good personal hygiene should always be maintained, disinfectants, acids, bleaches, chlorine and strong detergents must only be used where absolutely necessary.
- The discharge of rainwater to the septic tank is not recommended.
- Educate users to prevent the discharge of non-degradable matter into the tank, such as nappies, condoms, sanitary towels, etc. that will not decompose.
- Educate users to avoid all discharges of oils and cooking fats, which will congeal inside the tank and will not be digested by the bacteria.

5.10. Maintenance of Septic Tank

The sludge removal is important maintenance activities to be conducted frequently dependent on the use, size and type of the septic tank. The septic tank requires emptying approximately once every 2 years. A traditional septic tank contains no mechanical parts and should not require any other regular maintenance unless problems occur. It is a good idea when emptying brick / concrete tanks to leave the top layer of sludge within the vessel and to remove the solids from the base of the tank. This allows the bacteria to quickly re-establish when the tank fills again. The emptying services are offered by both the village councils or private providers

(1) Clean and pump your septic tank, do not only remove the waste but also remove the good bacteria that process the waste material.

(2) Avoid throwing or discharging unnecessary waste into the septic tank to avoid overflowing and blocking.

(3) Perform regular septic tank pumping to avoid overflowing and clogging of your septic tank. But you should also keep in mind the capacity of the septic tank and how many people are expected to use the septic tank on a regular basis.

5.11. The Compliance Monitoring

The compliance monitoring samples should be analysed in accredited laboratories. The second type is to check that treatment works are operating effectively to deliver sanitation services that meet the standards as specified by TBS (TZS 860) and to provide early warning that a treatment process is failing or there is a problem in the system. The operational monitoring samples need not be analysed in accredited laboratories. They may be analysed in small laboratories/benches at treatment

works provided the methods are properly calibrated and subject to analytical quality control. Regulated Water Utility (RWU) should have separate pre-determined compliance and operational monitoring programmes prescribed by RUWASA.

(a) Monitoring categories

There are two categories of compliance monitoring - check monitoring and audit monitoring - to determine compliance with the standards and indicator parameter values in the standards. Check monitoring should be carried out relatively frequently for a limited range of parameters. Audit monitoring has to be carried out less frequently for all the parameters, including those parameters subject to check monitoring. This means that for some parameters the monitoring frequency is the sum of the check and audit monitoring frequencies.

(b) Criteria for check monitoring parameters

The purpose of check monitoring is regularly to provide information on some selected wastewater quality parameters, in order to determine whether or not the sanitation system complies with the relevant parametric values laid down in TZS 800. The parameters for check monitoring are as specified by TBS.

(c) Criteria Audit monitoring parameters

The purpose of audit monitoring is to provide the information necessary to determine whether or not all the parametric values specified in TZS 860 are complied. All such parameters must be subject to audit monitoring unless specified otherwise, for a period of time to be determined by it, that a parameter is not likely to be present in a given supply in concentrations which could lead to the risk of a breach of the relevant parametric value.

5.12. Operational Monitoring

Each entity must have an operational monitoring programme for each of its sanitation systems. This programme is entirely separate from the compliance sampling programme. Operational monitoring is sampling and analysis carried out to check that sanitation infrastructure is operating effectively to comply with the standards and to provide early warning that the sanitation system is deteriorating, or failing or there is a problem in the system. In general, operational monitoring programme should consist of the following elements:

(a) Monitoring of the source water for parameters that provide a general indication of water quality, which if their concentration or value changed significantly would indicate that there could be deterioration in source water quality. It should also include any parameters that the treatment works is specifically designed to remove;

(b) Monitoring of the disinfection process for those parameters that provide evidence of the effectiveness of disinfection such as chlorine residual, pH value and microbiological parameters;

(c) Monitoring of the water leaving the treatment works for parameters that the works is designed to remove that are not adequately monitored by the compliance monitoring such as nitrate if nitrate removal is practiced

CHAPTER SIX

SPARE PARTS SUPPLY CHAIN SYSTEM AND PROCUREMENT MANUAL

6.1. Framework for Supply Chain

For the sustainability of rural water supply facilities, there must be appropriate spare parts that are readily available and reasonably priced. Since the supply and distribution of spares parts in rural areas in the country is not currently commercially viable. As the number of water systems increases, it is expected that the water supply systems spare parts business will experience some significant growth as a result of increased demand for parts. The situation is however different due to relatively low demand for parts as well as difficulty in forecasting required spare parts.

CBWSOs should procure spare parts and do maintenance of water works. In procuring spare parts CBWSOs should follow regulations in obtaining the quality and meet specification of the procured materials as stated in design or as directed by District Managers. District Managers will keep and update the most recent list of suppliers and vendors of fast-moving water schemes related items like spares, pumps, generators, pipes and common accessories. CBWSOs procuring whatever spare parts in the group will not exceed the provided threshold in accordance with the established procurement methods. The framework for supply chain Involve:

Figure 6: Framework for supply chain

On understanding the importance of accurate, reliable, and quality service; CBWSO should get technical support from competent staff at RUWASA district level or technical support centres. The technical support team will help complex operation and maintenance services on call basis. The support of technical support centre will keep inventory of necessary spare parts to support service. The primary objective of establishing technical support centre is to ensure CBWSOs is able to obtain spare parts and technical support on the same day as a fault arises in order to facilitate rapid and effective repair of their water system.

6.2. The Purchasing Structure and Authorization

CBWSOs are responsible for ensuring availability of quality spare parts certified by the Tanzania Bureau of Standards (TBS). The CBWSOs should establish a shortlist of suppliers for continuously replenish the spare parts. The proposed suppliers must comply

with sector standards. During procurement of works and goods, the CBWSO is required to follow and comply with the Procurement Act, 2011 and Amendment Act of 2016 and its Regulations. The procurement of spare parts and other items will use the following methods of procurement as provided in the respective Act.

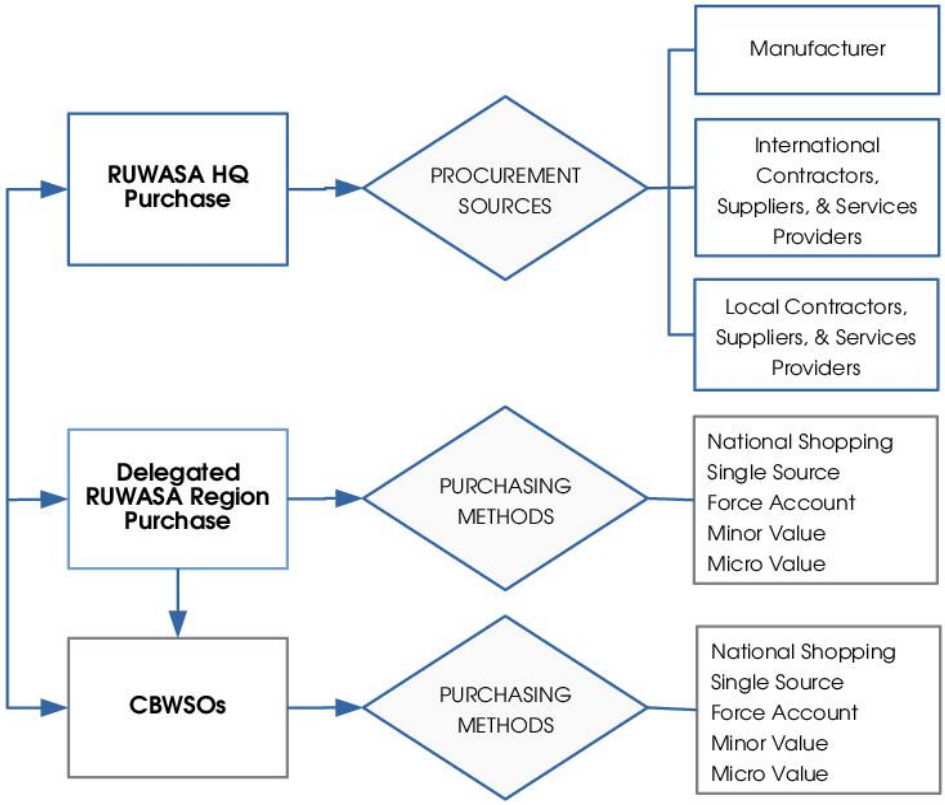


Figure 7: The Purchasing structure and procurement methods

6.3. Purchasing Methods and Threshold Limits

(i) Local Shopping Method

Local Shopping is a Purchasing method for procuring readily available off- the shelf goods or standard specification commodities that are of small value, it involves quotations obtained from at least three suppliers to ensure competitive prices. According to the Public Procurement Regulation 163 (3) of 2013 the CBWSOs shall obtain a list of suppliers from a shortlist prepared in accordance with guidelines. Regulation 163 provides a limit of local purchase of up to Tsh 120 million for Goods and Tsh 200 million for Works.

(ii) Single Source Method

(a) Single Source Method involves purchasing of goods, services from a single supplier or service provider, according to the Procurement Regulation 159 of 2013 the single source supplier or service provider should have exclusive rights in respect of the goods or services and no substitutes or alternatives. According to the seventh schedule under Regulation 159 there is no limit for the purchasing value, hence with CBWSOs there will be no limit for the purchasing or procuring goods or service under single source method. Similarly, Regulation 161 provide provision for CBWSO to obtain a priced quotation from a single contractor, negotiate and enter into a contract if-

(b) there is an urgent need for the works such that there would be insufficient time to engage any other method of procurement, provided that the circumstances giving rise to the urgency could not have been foreseen by the procuring entity and have not been caused by dilatory conduct on its part; or

(c) there is only one particular contractor to undertake the required works; or

(d) there are advantages to CBWSOs in using a particular contractor who has undertaken or is undertaking similar works or who may have already been mobilized with plant, equipment and staff in the vicinity or any other resources as may be appropriate;

(iii) Force Account Method

Force Account as described in the amended Public Procurement Regulation 167(2) of 2016 is a process where works are being carried out by public agencies or departments by utilizing its own personnel and equipment or in collaboration with any public entity, the amended regulation of 2016 there is no limit value but if necessary, it should be justified in proceeding with procuring works under force account method.

(iv) Micro Value Method

Micro Value method involves purchasing directly from established supermarkets, shops or drug stores and the limit of purchase should not exceed the set limit as provided in the seventh schedule of the Public Procurement Regulation 166 of 2013 where the limit value is up to Tsh 5 million for Goods. The purchase of maximum value under this method shall depend on the level of CBWSO as categorized by RUWASA. The set threshold limit values for CBWSOs will be based on the nature and capacity of performance in operations and maintenance of water resources for effective supply of water to the community.

The Micro Value authorizes purchase of the items using shops with Electronic Fiscal Device Receipt (EFD). The Officer should retire the same to the Procurement Committee to be compiled in the Monthly or quarterly reports for submission to the CBWSO Board

6.4. Annual procurement plan

(a) The procurement committee shall prepare the Annual Procurement Plan (APP) for all activities on the basis of CBWSO's approved Annual Work Plan and Budget covering a defined period of 12 (twelve) months; and thereafter updated at an interval of at least 3 (three) months.

(b) CBWSO's Procurement Plan can be reviewed by the CBWSO Committee thereafter forwarded to RUWASA District Management for ultimate approval before the commencement of implementation of the respective activities.

(c) For items that are funded by the Development Partners, the approved Procurement Plan shall be forwarded to the respective financier through RUWASA Tender Board for "no objection" prior to proceeding with the implementation of the Plan accordingly.

6.5. Fraud and corruption

(a) The CBWSO staff, suppliers and contractors shall handle the procurement proceedings in the most transparent and accountable manner during the procurement and execution of such contracts.

(b) Any official of the CBWSO or member of the approving authority who engages in corrupt or fraudulent practices shall face the penalties as highlighted under Section 104 of the Public Procurement Act No. 7 of 2011.

(c) No person whether such person has made an offer or not, shall give a gift or any form, or extend any advantage to or for the benefit of any officer of the CBWSO.

CHAPTER SEVEN

SYSTEM FOR PERFORMANCE REPORTING AND ACCOUNTABILITY

This section of the manual provides simple templates that will allow CBWSOs to report their performance and thus be accountable to RUWASA. The system is expected to assist the Regular in monitoring and evaluating the performance of CBWSOs. The system is expected to provide the basis for RUWASA to regularly engage and support the respective CBWSOs in fulfilling their obligations. The templates for reporting proposed herein will be computerized to ease their preparation and electronic submission to RUWASA. RUWASA will thus integrate them as part of its online system that connects it to the CBWSOs.

7.1. Aspects to Report

Every CBWSO periodically reports to RUWASA as required by the regulator. But, quarterly reporting of performance is one of those crucial types of reporting expected of each CBWSO. To facilitate the preparation of the quarterly performance reports – using the template given in Section 12.4 below, this subsection lists all major aspects/areas to report on.

The envisaged quarterly report shall cover the following aspects/areas (See Box 7.1) and for each one the CBWSO shall from the beginning of the respective financial year determine all major activities to be implemented to improve its services and include then in the annual activity plan of the Organisation (see Section 7.3 for template for the annual activity plan).

Box 7.1: Areas/Aspects for Quarterly Performance Reporting*	
1	Activities to improve and expand ***access to water services***
2	Activities to improve the ***quality and safety of water***
3	Activities to prevent and eliminate ***water leakages/losses***
4	Activities to ensure timely and professional ***maintenance of water infrastructures***
5	Activities to ***recruit all essential technical and administrative employees***
6	Activities to improve management and technical ***skills of employees***
7	Activities to improve customer services and ***expand customer base***
8	Activities to improve timely and expanded ***revenue collection***
9	Activities to ***control operational costs***
10	Activities to ***engage with all key stakeholders***
11	Activities to ***protect water sources***
12	Activities to ***digitize the operations including maintenance planning***
13	Activities to ensure timely ***procurement*** of spares and other key requirements
14	Others
15	*NOTE: The required new and habitation investments will be included in the Investment Plan – see Table 7.1

7.2. Investment Plans

The performance of a CBWSO depends alot on the Organization periodically investing in new infrastructures and facilities as well as rehabilitating existing ones. Since all major investments and rehabilitations to water infrastructures are the

responsibilities of RUWASA – each CBWSO shall prepare and submit their requirements to RUWASA and then continue to work with the regulator to get the investments and rehabilitations carried-out. Towards the end of each financial year, each CBWSO shall prepare/update an Investment Plan covering the forthcoming years as well as the subsequent two years and submit it to RUWASA. required new investments and rehabilitations. Thus, the investment plans will be for rolling periods of three years starting with the most immediate one. Table 18 provides for compiling and updating the investment plans. To ease the submission process, RUWASA will integrate the template as part of its online system that connects it to the CBWSOs.

Please note that the approved investment plans shall then be used to prepare the quarterly performance reports. As part of the reporting CBWSOs with the support of RUWASA shall report on the progress in implementing investments.

Table 18: Format of CBWSO: New and Rehabilitation Investment Plan: as an example, for 2021/22 – 2023/24

Purpose or target or activity to be achieved by investment	Asset	Asset Group	Summary of physicalworks to be carried out	Design period (months)	Implementation period (months)	CAPEX (TZS' Million)						Source of funding (Internal, RUWASA, donor)
						2021/2022		2022/2023		2023/2024		
						New Investment	Rehabilitation & Replacement	New Investment	Rehabilitation & Replacement	New Investment	Rehabilitation & Replacement	
TOTAL												

7.3. CBWSO Annual Activity Plan Approved by RUWASA

Towards the end of each outgoing financial year, each CBWSO shall prepare an Annual Activity Plan and submit it to RUWASA for approval. The approved Annual Activity Plan will then be the basis for quarterly performance reporting to RUWASA.

The CBWSO shall include in the Annual Activity Plan the activities determined for each of the areas/aspects listed in Box 7.1 and in the Annual Investment Plan (Table 7.1) above.

The CBWSO shall prepare the Annual Activity Plan using the format given in Table 7.2. Each activity in the table must be given a unique Activity Reference Number to facilitate the tracking of its progress.

RUWASA will train each CBWSO on how to prepare the Annual Activity Plan.

Table 19: Template for Detailed CBWSO Annul Activity Plan (Performance Contract with RUWASA): Financial Year:

Activity Ref. No(1)	Operation Area/ Function (e.g., Finance)(2)	Sub-area/Function (e.g. Revenue Accounting)(3)		(4) Measurable Output targets per Activity	Quarterly Milestone Targets				AllocatedActivity Budget (106)	Accountable
					QUARTER 1	QUARTER 2	QUARTER 3	QUARTER 4		

7.4. Detailed Progress Reporting for implementing the Annual Activity Plan

Each CBWSO shall prepare and submit to RUWASA a Quarterly Progress Report progress in implementing its Annual Activity Plan using the format given in Table 20. For each activity in the Annual Activity Plan, the CBWSO will indicate the actual achievement of progress and challenges faced if any as well as plans to be done to overcome the challenges in the subsequent quarter. The Quarterly Progress Report shall be submitted by the 7th of the first month of the subsequent quarter. In turn, RUWASA will review the progress and provide the CBWSO with guidance and instructions to improve performance in the next subsequent quarter of reporting. The directives from the regular shall be used by the CBWSO to update its Annual Activity Plan.

7.5. Monitoring and Evaluation of the Overall Performance/Results of a CBWSO

Monitoring and evaluation of the overall performance/results of a CBWSO will be done annually using the template given in Table 21. Overall performance will be assessed in water access and service; water quality; customer care; operational/business efficiency; and sanitation service. Each CBWSO with the technical support of RUWASA shall put in place arrangements to collect relevant data for collecting information related to the numerator and denominator (where applicable) of each performance indicator in Table 21

The CBWSO will complete the template and get it approved by the Water Committee for onward sharing with RUWASA as accompanied with the quarterly progress report for the fourth quarter of the reporting year. Where a performance indicator shows improvement during the year, then in addition to listing the main activities implemented, the CBWSO must also indicate

the main factors driving increased performance and the bottlenecks limiting performance. More importantly, the Organisation must indicate proposed measures to be implemented during the fourth coming reporting period to improve performance by addressing the identified challenges and levering the driving forces.

Table 20: Template for Quarterly Activity Progress Reporting

Activity Ref. No (1)	Operation Area/ Function (e.g., Finance) (2)	Sub-area/Function (e.g. Revenue Accounting) (3)	Activity to be done during year (3)	Progress achieved in the LAST quarterly (4)	Progress made in the CURRENT reporting quarter (5)	Challenges and actions to address them (6)	Outlook for the coming Quarter (7)	Status Colour (see note for legend) (8)

Assessment	Status Colour	Remarks
Poor		Off-track/poor performance
Average		Average performance
Good		On-track/good performance

Table 21: Template for CBWSO Water and Sanitation Service Performance

S/N	Performance Indicator	Performance at the BEGINNING of the reporting financial year: 20XX/YY	Description of ongoing MAJOR projects and/or operational activities to improve the current service levels in the reporting financial year	Performance at the END of the reporting financial year: 20XX/YY	Drivers nd Challenges	Proposed measures to improve services in the next financial year: 20XX+1/YY+1
			WATER ACCESS AND SERVICE			
1	Proportion of population living within the area with water network (%)					
2	Proportion of population served with water (%)					
3	Ratio of the total number of water connections to the total number of households (%)					
4	No. of public water Kiosks					
5	Average hours of Supply					
			WATER QUALITY			
6	Water quality compliance (%) – proportion of MoH quality standard complied with.					
7	E-coli (%) - Water					

	quality					
8	Turbidity (%)- Water quality					
CUSTOMER CARE AND SERVICE						
9	Proportion of response to written complaints to the total number of complaints (%) –					
10	Metering ratio (%) – proportion of metered customers					
OPERATIONAL / BUSINESS EFFICIENCY						
11	Non-Revenue water (%)					
12	Revenue collection Efficiency (%) – proportion of revenue collected					
13	% of all operating costs divided revenue collected					
14	Personnel expenditure as % of collection from water and sewerage bills					
15	Proportion of water mains rehabilitation (% per year)					

16	% of water service connections functioning (% per year)					
17	Revenue per staff per year (Million/ Staff)					
	Energy consumption (kWh/cu.m)					
SANITATION PERFORMANCE						
18	% of the households in the service area with modern pit or water latrine					

CHAPTER EIGHT

FINANCIAL MANAGEMENT: BILLING AND REVENUE COLLECTION, COST CONTROL

8.1. Budget Preparation

The CBWSO management shall prepare the budget, usually during the last quarter of the year, and should be approved by the CBWSO Board before being endorsed to the stakeholders and to the RUWASA

The budget hall contains basic components which are: 1. Statement of Objectives 2. Operation and Maintenance Budget 3. Capital Expenditure Budget; and 4. Financial Statements, including the Cash Flow and Income Statement.

(i) Statement of Objectives:

The first step in CBWO's budgetary preparation shall involve an analysis of the current year's actual expenditures as compared with the approved budget, and the presentation of objectives and goals for the coming calendar year. The deviations between the actual estimated disbursements and budgeted amounts for the current year must be explained, and related to the Utility's performance in terms of the current year's objectives.

(a) These analyses shall be presented to the CBWSO's Committee, which needs to appreciate and evaluate whether the objectives set for the following year are the right ones, are worth the budgetary outlays proposed, and are realistic in the sense that they can be supported by the revenues to be realized by the business. In other words, CBWSO management should state the reasons (objectives) for having a budget.

(b) Depending on management's presentation and the CBWSO's Committee's appreciation of the budgetary proposal, the Committee may request CBWSO's management to make the modifications it deems necessary, or approve the budgetary plan outright.

(c) It will take a minimum of 2 to 3 Committee meetings before the Board approves the budget.

(ii) Operation and Maintenance Budget

The O&M cost is the total estimated cost required to manage, operate and maintain the water supply system. The projection of the O&M Budget usually is fairly straightforward, unless major deteriorations of the facilities have created expectations of unpredictable cost levels, or serious local or global events are expected to cause large spikes in the prices of some essential supplies. Otherwise, it is projected from the results of past operations and adjusted to fit the current or projected prices and costs.

(a) Nature of O&M Costs

There are only two major groups of expenditures: Capital Outlay/Investment, the costs of which are determined at the initial stages of the business, or when it expands, upgrades, or replaces the physical facilities for water supply and distribution. The annual costs are then composed of the depreciation of the major facilities, the financial costs incurred in their acquisition and installation, and actual Capex disbursements during the year.

Operation and Maintenance, which involves practically all the activities of the business whose focus is basically to employ its physical facilities to distribute the water 24/7, reliably and efficiently, and to ensure that these physical facilities remain capable of continuing to distribute the water 24/7, reliably and efficiently.

From this it will be clear that the O&M cost is one of the two major components considered in determining the

initial water tariff of the system and the necessary adjustments in tariff that may be dictated by external factors and as the system expands in the succeeding years of operation.

(b) Revenues Needed to Support O&M Costs
CBWSOs shall collect water revenues continually and promptly in order to reliably operate and maintain the water distribution facilities. In too many instances, insufficiency of funds is at the root of poor CBWSOs maintenance.

(c) Need to Educate Users
Each CBWSO shall educate users on what the O&M budget comprises and why a collection is made for the CBWSO's O&M. The aim is to make them realize the importance of a well-supported O&M on the reliability of their water system.

(d) O&M Cost Items
Following is a list and description of items which each CBWSO should include as O&M cost items:

- Salary/wages refers to the gross personal services expenses;
- Power costs and related expenses refer to the total electricity and fuel, oil, and lubricants incurred in the operation;
- Maintenance expenses refer to the repairs and maintenance costs of facilities, exclusive of salaries and wages of CBWO's staff who undertook the repairs and maintenance
- Permits/Regulatory fees are expenses incurred in obtaining or updating business permits, licenses and payments for regulatory fees
- Board costs are expenses incurred during Board

meetings as well as board per Diems

- Operation capex are disbursements made which do not enhance the physical distribution system but are necessary in improving the office environment, work efficiency, or security, examples of which are fax equipment, light fixtures, housekeeping equipment, vault and filing cabinets, and computers
- Miscellaneous costs refer to other maintenance and operating expenses like representation expenses excluding depreciation, interest and other bank charges

(iii) CAPEX Budget

The annual capex budget summarizes the cost of the projects that the CBWSO will implement during the budget year. These are cost items that involve large amounts, like pipelines, reservoirs, connections, source development, major repairs or expansion of the network. The amount is determined based on the project plans and the estimates of their cost.

(iv) Cash Flow Statement

The Cash Flow Statement is a plan showing the sources and levels of cash revenues that will be realized, and the cash disbursements planned during the budget year. This document is essential in matching and timing the expenditures with the cash that will be available. It prevents fund shortfalls at the time critical items are scheduled to be purchased. When a cash shortfall is foreseen, the budget planners (management) can adjust spending priorities, delaying the purchase of non-critical items and, when needed, obtain additional funds from external sources. Serious prolonged cash deficiencies that are foreseen should trigger the consideration of tariff adjustments. The Cash Flow Statement should be based on the cash method of accounting rather than on the accrual method.

Table 22: Format of a Quarterly Cash Flow Statement

	1st Q	2nd Q	3rd Q	4th Q	Total
Collection (%)					
Receipts					
Sales collection					
Penalties					
Customer Deposits					
Loans					
Connection Fees					
Others					
Total Receipts					
Disbursements					
Operations					
Vouchers payable					
Staff advances					
Loan debt Service					
Customers Deposit Refunds					
Others					
Capex					
Total Disbursements					
Net Receipts (Disbursement)					
Cash Balance, Beginning					
Cash balance, End					

(v) Income Statement

Income statement is designed to determine profitability by using the accrual method of accounting, meaning that earned revenue is recognized as income for the time period in which it was earned, even if it will only be collected (encashed) at some

future time period. In the cash method, even if the income has been earned, as long as it is not received as cash, it is not reflected in the cash flow statement.

Table 23: Format of a Comparative Income Statement

	This Year	Last Year	Variance
Operating Revenue			
Less: Operating Expenses			
Operating Expenses			
Maintenance expenses			
Depreciation			
Total Operating Expenses			
Operating Income			
Less: Misc Income Deductions			
Net Income before Interest and Taxes			
Less: Interest Charges			
Taxes			
Net Income (Loss)			

(vi) Monitoring and Control

CBWSO Management must monitor the level of expenditures against the budget on a monthly basis in order to control overruns that could lead to unexpected fund shortfalls. Monitoring the budgeted expenditures enables management to take cost reduction measures, make decisions on budget realignments, and consider the need for a supplemental budget if it is forecast that the approved budget for essential expenditures will be exceeded.

8.2. Tariffs

Tariffs are the lifebloodof a small water utility business. Tariffs are basically the only sources of the revenues for supporting CBWSO's capital investments, operations and maintenance. They define the contributions that the CBWSO may demand from the users of the water distribution system, as their share in the cost of its construction and upkeep. The CBSO's Tariff setting requirements and methodologies shall be in line with the "CBWSOs Tariff Setting Guideline (2021)" which is a separate document prepared for that purpose.

8.3. Financial Systems and Controls

(i) Cash Security

There are several instances wherein the CBWSO can receive cash. These are from collections, donations or sales of assets. It is very important for the utility to have a procedure for each instance to ensure that the cash obtained is documented and secured.

The CBWSO Treasurer/Accountant shall prepare the Cash Collection Summary and compare collections with the Summary at the end of each day. Collections must then be kept in a steel vault. CBWSOs must deposit all collections the next day with a copy of the deposit slip. The deposited amount shall be recorded in the Daily Cash Position Report.

(ii) Disbursement Procedures

A CBWSO shall maintain disbursement procedures to keep track of the expenses and accountability purposes. There are different purposes for the disbursements and the utility must ensure that their disbursement procedures cover the

following purposes:

- Payrolls
- Operational expenses like chemicals, fuel, rentals
- Capital Expenditures
- Debt service
- New connections
- Maintenance expenditures
- Emergency procurement

(iii) Asset Register

Each CBWSO shall develop the Register, as it has three main uses: i) It documents the list of the assets owned by the utility; ii) It guides the utility in the computation of its depreciation expense; and iii) It gives the RUWASA or a lender an idea of the Utility's size and assets owned.

As for the donated assets, the CBWSO manager shall receive all donated assets. He must ensure that the donation includes the documents of the donation or title aside from the asset. Unless the accompanying documents indicate the value of the asset, a value must be assigned to it for inclusion in the Asset Register and for depreciation purposes.

The CBWSO's Treasurer shall prepare the corresponding journal voucher and lists the asset in the Asset Register. The asset, if transportable, is then consigned to a designated or accountable person or to the stockyard for safekeeping. A more detailed asset management procedure is covered in another part of this manual.

8.4. Billing Procedures

(i) Master List of Customers

In order to keep track of existing account numbers and control the number of customers in each Meter Reading Book, CBWSO shall prepare a Master List of service connections and grouped according to areas (or zones). Concessionaires in each meter reading book will be numbered consecutively from number 001 taking into consideration potential concessionaires within the area including vacant lots, which will be reserved with a corresponding account number.

(ii) Meter Reading

Each CBWSO shall group service activities in the best way, to achieve a system in which meters within an area can be read within a day. (The number of meters that can be read in a day should be determined.). A group of areas lumped together, which could be read in 5 to 10 days, could be grouped into a billing zone. The CBWSO shall read the water meters a monthly schedule. The area assignments of meter readers shall be rotated monthly, if possible, so that no meter reader will be making two consecutive readings of any meter. Aside from reading the meters, the meter reader should take note of and report service defects, complaints from customers, and any infraction of utility rule.

(iii) Billing

(a) Each CBWSO shall prepare water bills not later than the day before the next meter reading. Water bills prepared for the concessionaires belonging to a zone shall be checked for completeness against the total number of connections shown in the master list of service connections. Any discrepancy shall be investigated and rectified.

(b) Completed water bills are forwarded to the CBWSO manager, then to the bill deliverers (or meter readers) at the end of the day for distribution.

(c) Each CBWSO shall prepare a Daily Billing Report for all bills prepared for the day. This is to ensure a reporting mode, which will be very useful for analysing collection efficiency, sales breakdown and billing efficiency. This will serve as reference in the recording in the Customer Ledger Cards.

Table 24: Sample Daily Billing Report

Date							
Account No.	Customer	Bill No.	Consumption (m3)	Amount			
				Metered	Unmetered	penalty	Others

Table 25: Sample Customer Ledger Card

Name					Account No.			
Address								
Date installed								
Date disconnected								
Date re-opened								
Date	Bill #	Others	Particulars	Meter reading	Usage m^3	Billings	Collections & others	Balance

(d) A billing statement or Statement of Account should include the Due Date for the payment and a Notice to the customer that a penalty will apply for late payments.

Table 26: Sample Billing Statement

	Customer's copy
STATEMENT OF ACCOUNT	
No.xxxxx	
Account Name:	Account No:
Address:	Meter No:
Billing Period:	Present Reading:
Reading Date:	Previous Reading:
Due Date:	Consumption (m^3):
DETAILS OF CHARGES	
Current Charges:	
VAT (18):	
RUWASA:	
Other charges:	
Previous unpaid amount:	
TOTAL AMOUNT DUE:	
IMPORTANT REMINDERS: 1. XXX% Penalty Charge will be imposed on payment made after due date. 2. Please bring your billing statement to avoid any delay during payment. 3. No field collector assigned. Please pay your water bills at CBWSO Office. 4. Please report immediately the next time you have not received your bill 3 days after meter reading.	

(iv) Payments from Customers

(a) As a rule, customers should pay only at the CBWSO office where official receipts shall be issued. There should be no collectors from the CBWSO going to individual customers.

(b) Each CBWSO shall maintain Customer ledger cards (either manually or electronically) and regularly update. Customers cannot be expected to keep records of their payments for long and there is no reason for the Utility to have incomplete or un-updated records. As soon as payments are received, they must be recorded in the customer's ledger cards. Whenever a whole booklet of receipts is used up, a routine check comparing the sub entries to the ledger entries should be conducted.

(c) Each CBWSO should ensure that collection of water bills in the office is scheduled on specific dates during the month. The Due Date shall be indicated on the copies of the water bills for the customer's information and as reference for the imposition of the penalty charge.

(d) The bill shall indicate the Penalty Charge for bills not paid on time. This will be added to and collected together with the amount of the outstanding bill.

(e) An Official Receipt shall be issued when payment is made.

(f) All daily collections shall be tallied with the official receipts issued and kept in a steel safe during the night. A Daily Collection Summary shall then be prepared. The collections shall then deposit in the bank on the morning of the next banking day.

Table 27: Template for a Daily Collection Summary

Date					
Account No.	Customer	Amount Collected	Amount Credited		
			Current	Arrears	
				Current	Previous

(v) Disconnections

(a) The CBWSO shall set a reasonable but clear deadline for all customers to pay their dues. At the end of the deadline, the service shall be disconnected, unless the debt is paid immediately. To prevent abuse and avoid setting precedents, no exceptions shall be allowed. The CBWSO shall charge a reasonable amount for reconnection and should be firm but fair.

(b) CBWSO shall serve a customer with sufficient notice before actual disconnection.

(c) If payment after the due date has not yet been made, CBWSO shall issue a second notice (the first notice is the original Bill itself) clearly marked "Disconnection Notice". Such notice shall inform the customer of the deadline for payment, the penalties or interests to be paid, manner of payment, and the fee for reconnection.

(d) If payment is still not yet received after the Disconnection Notice deadline, CBWSO through its Treasurer shall issue a Disconnection Job Order to the one in charge of disconnections. This person shall go to the consumer residence and present the Disconnection Order. If payment is not immediately paid, the disconnection shall proceed.

Table 28: Sample Disconnection Notice

DISCONNECTION NOTICE	
Account Name:	**Account No:**
Address:	**Meter No:**
Dear Customer: Our records show that your water bill in the amount of _____ due on _____ is two (2) months overdue. We are giving you seven (7) days up to _____ to settle your account with us. Failure to settle payment will force us to disconnect our services without further notice. You will be charged a xxx percent (xx %) penalty upon settlement and a reconnection fee of xxx Tanzanian Shillings (TZSXXX.00). Please disregard this notice if payment has been made and we thank you for your payment. Sincerely,	
NOTE: PLEASE PAY YOUR WATER BILL ONLY AT THE SSWP OFFICE. WE DO NOT HAVE ANY FIELD COLLECTORS. ANY PAYMENT MADE TO OUR FIELD PERSONNEL IS AT YOUR OWN RISK. ONLY PAYMENTS WITH OFFICIAL RECEIPTS ISSUED BY OUR OFFICE SHALL BE HONORED	

(vi) Billing Adjustment

(a) If for some reason, a billing adjustment needs to be made on a customer's bill, the Bookkeeper makes the initial recommendation stating the reasons for the adjustments. The Manager reviews it, and upon approval, the CBWSO Bookkeeper/Treasurer shall prepare a Billing Adjustment Memo on which the Manager must indicate his approval.

(b) Upon receipt of the approved Billing Adjustment memo, the Bookkeeper/Treasurer shall note the corresponding adjustment in the Customer Ledger Card. The adjustment shall then be reflected either in a new or the next billing statement.

Table 29: Template Billing Adjustment Memo

BILLING ADJUSTMENT MEMO						
Memo No: Concessionaire: Date: Account No: Reason: Bill No:						
Consumption			Journal entries			
As Billed	Should be	Increase (Decrease)	Account		Amount	
			Title	No.	Debit	Credit
Prepared by: Approved by:						

(vii) Management Reports

(a) Commercial/Operational Information

As part of the Management Information System (MIS) of the CBWSO, the following commercial operational information should be summarized and reported on a monthly basis:

- Report on Billing and Collection.
- Production and Per Capita Consumption. The per capita consumption can be obtained from the total domestic consumption divided by the number of domestic persons served (no. of domestic connections x average family size). Production is from the production records;
- New Connections Applications. Number filed and number of active connections per category;
- Complaints. Number and nature of complaints and average resolution time.

(b) Billing and CollectionsT

The CBWSO billing and collection system should be able to summarize every month the following information:

- Total Billings & Collections by Type of Connections
- Total Number of Connections
- Collections on Current Billings and Arrears
- Cubic meters Billed
- Average Consumption per Domestic Connection
- Connections with Arrears of More than 1 Month

CHAPTER NINE

ENVIRONMENTAL MONITORING AND AUDITING OF WATER SUPPLY AND SANITATION

9.1. The Operations Condition on Environmental Issues

The CBWSOs being one of the interventions to implement water sector development programmes will follow the country's environmental and social management policies and procedures. These embrace Environmental Safeguards, Environmental and Social Management Plans, Environmental and Social Impact Monitoring and Compensation. CBWSOs are advised and expected to seek the technical backstopping of RUWASA in all aspects of environmental and social management given their technical, legal and social complexities.

The Tanzania Environmental Management Act (EMA), Cap 191 (2004) is the principal Act that establishes and sets out roles and responsibilities for institutions and bodies for the management of environmental and social issues of concern.

Section 44 (2a) of the EIA and Audit Regulations of 2005 (amended in 2018) requires all ongoing projects identified in the 1st Schedule of the Regulations, that have commenced prior to the EMA Cap 191 coming into force, to carry out Environmental Audit (EA). Initial Environmental Audit will help the Developer to set baseline information on the key environmental issues surrounding his project.

Environmental Monitoring and Auditing: The National Environmental Management Council (NEMC) shall conduct environmental monitoring in order to evaluate the performance of the mitigation measures following the prepared CBWSO's Environmental and Social Management Plan as well as Monitoring Plan at the tm of the project design.

Monitoring includes the verification of impacts, adherence to approved plans, environmental standards and general compliance of terms and conditions set out in the Environmental Impact Assessment certificate of the CBWSO.

The role of CBWSO in relation to environmental monitoring and audit according to this regulation include: i) CBWOS should undertake monitoring of the implementation of the project to ensure if mitigation measures are effective; ii) both the CBWOS and the Council shall collect data that may be used in future projects and for environmental management; iii) the Council and the CBWOS undertake environmental audits for the project; iv) mechanisms for stakeholders' participation during the monitoring and auditing process must be defined and followed through.

The auditing exercise may focus in the following areas: (i) implementation/enforcement audit, which takes place when the Council verifies if the mitigation measures and levels of pollution are within limits; (ii) performance/regulatory audit that entails identification of CBWOS's compliance to relevant legislation or safety standards; (iii) impact prediction audits checks the accuracy and efficacy of the impact prediction by comparing them with monitored impacts; (iv) the Council collects and compiles information arising from auditing for future use; and (v) CBWSO collects data from the auditing and compiles information for project management and also for submission to the Council.

During monitoring, the CBWSO shall measure specific environmental indicators determined by prevailing national standards, sectoral regulations and any other relevant legislation. The CBWSO will be responsible for regular and frequent monitoring and shall keep records of monitoring with respect to date and findings. Monitoring environmental parameters recommended by the EIA study should be an

ongoing responsibility of the CBWSO who should annually submit a monitoring report to the Council.

Monitoring shall follow a plan detailing a schedule for inspecting and reporting findings to NEMC and RUWASA. It shall also identify key indicators of the environmental quality and impacts to be monitored and threshold levels above which the impacts are significant, delineate responsibilities specifying who collects data, who acts, what specific actions and costs involved.

NEMC and RUWASA shall review the monitoring reports and advise on measures necessary to abate any ongoing impacts. CBWOS shall be considered non-compliant and could face penalties or closure if it does not submit monitoring reports or does not implement impact mitigation measures to the satisfaction of the Council. NEMC shall also undertake parallel monitoring as the CBWSO, but on an impromptu basis.

CBWOs and NEMC shall implement and monitor environmental aspects of the project in accordance with the impact mitigation plan described in the Environmental Impact Report. CBWSO shall prepare a monitoring report with the following information:

- Name or title of CBWSO
- Address of CBWSO
- Name of project
- Details of environmental parameters/ indicators monitored
- Results of monitoring exercise
- Specific parameters not in compliance
- New measures for improved environmental conservation (in cases where monitoring results show worse conditions than predictedin the Environmental Impact Assessment).

CHAPTER TEN

ASSETS REGISTER AND MANAGEMENT

10.1. Assets Management

The purpose of this section is to describe the system and actions to be followed in the management of assets of the CBWSO. These are assets whose life-time is greater than one year and with minimum threshold amount value of Tshs…….. These are sometimes known as fixed on non-current assets (e.g., water tanks).

Proper control procedures will be followed for all fixed asset acquisitions, transfers, and dispositions in order to provide internal control of the assets and to assist in reporting.

10.2. CBWSO's Responsibilities

(a) The Head of the CBWSO shall assign a competent unit/or staff member the responsibility for ensuring that expenditure on and handling of fixed assets is properly controlled and recorded. The unit should be the one responsible for the day-to-day management of the accounting/finance function of the Organisation.

(b) The competent unit/or staff member shall undertake the day to day recording of fixed assets and depreciation calculations.

(c) The Head of the CBWSO shall be responsible for authorising expenditure on capital projects and expenditure on acquisition of fixed assets.

10.3. Main Elements of the Fixed Assets Recording System

The CBWSO shall make sure that the following elements are in place and working:

(a) A manual fixed assets register is made for each asset on acquisition or on completion of a capital project;

(b) Each year, depreciation calculations are set out in the fixed asset register with support of the Accountant;

(c) Each quarter, the Accountant prepares a summary of the acquisitions and disposals during the quarter and forwards this to the Head of the CBWSO with the quarterly accounts;

(d) Details in respect of the disposal of fixed assets are recorded on the fixed asset register as and when they occur; and

(e) Any asset revaluations (directed, guided and approved by RUWASA) are recorded in the fixed asset register and the amount of depreciation charged is adjusted.

10.4. Forms Used

The CBWSO shall from outset ensure that the following forms are in place and being used as part of the fixed assets recording system:

- Non-Current Assets Register
- Non-Current Assets Disposal Advice
- Non-Current Assets Control Sheet

10.5. Summary of Procedures

The CBWSO shall follow the following procedures in accounting for fixed assets, specific actions are given in later sections:

(a) classification of fixed assets;

(b) the fixed assets register;

(c) depreciation calculations;

(d) disposal of fixed assets;

(e) revaluation of fixed assets; and

(f) inventory of fixed assets.

The figureshows the process of acquiring and disposing fixed assets.

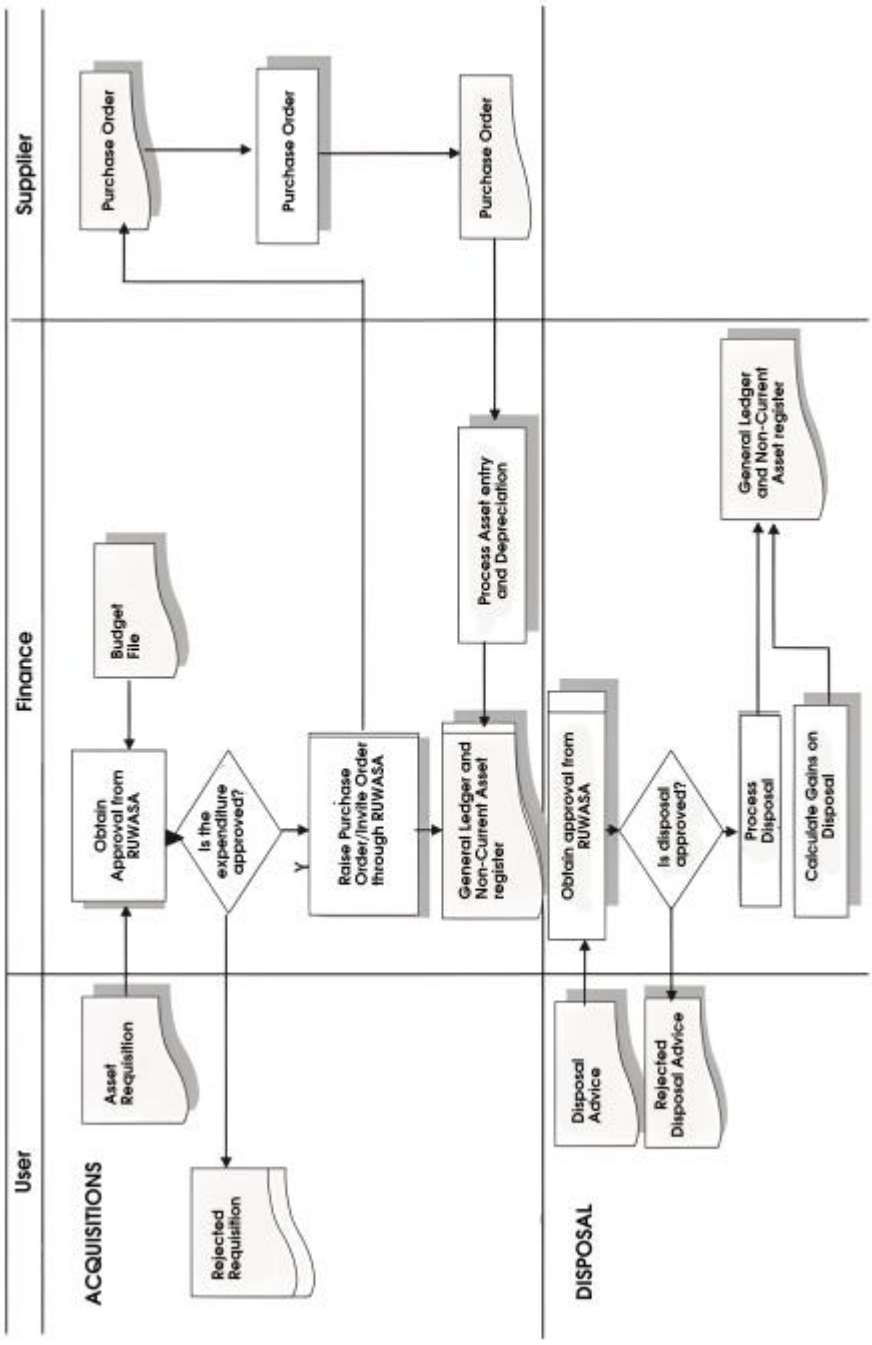


Figure 8: Process for recording Non-Current Assets

10.6. Classification of Fixed Assets and Useful Lives

(a) CBWSOs shall use the following classifications and useful life in assets in their Fixed Assets Recording System (Box 10.1). These are based on those used by EWURA for their WSSAs.

(b) Each fixed asset must be classified into one of the above categories.

(c) The depreciation rate shall be calculated as the inverse of the useful life time's 100 and shall be to be used for each category indicated in the individual noncurrent asset register

Table 30: Classification of Fixed Assets and Recommended Useful Lives

	Lower bound	Upper bound
Dams	75	100
Intake structures	35	45
Shallow Wells / Boreholes	15	20
Chlorination equipment	10	15
Storage tanks	30	60
Pumps	10	20
Buildings	30	50
Water treatment plants	40	50
Electrical systems	7	10
Transmission mains	35	40
Distribution pipes	35	40
Valves	10	15
Meters	10	15
Laboratory/Monitoring equipment's	5	7
Office furniture/equipment's	5	10
Intangible assets	3	5
Workshop equipment and tools	10	15
Computers	3	5
Vehicles, motorcycles and bicycles	3	5
Transportation equipment /heavy duty vehicles	8	10

10.7. Fixed Asset Register

The Accountant is responsible for ensuring that a fixed asset register is prepared for each asset. The details for each fixed asset are prepared by the Accountant and obtained from one of the following two sources: -

(a) cash vouchers, cheque vouchers and delivery notes received from suppliers. In the case of imported fixed assets, the cost comprises the CIF cost duties and taxes, clearing and forwarding charges and installation costs; and

(b) details obtained from the capital project records on costs for fixed assets that are constructed by RUWASA and transferred to the CBWSO for operations.

(c) All payments made for additions of fixed assets automatically are used to update the Fixed Asset register.

The following details, where appropriate, shall be noted on the fixed register from the information obtained above:

(a) Name and description of asset;

(b) Asset number and classification;

(c) Model / type / number;

(d) Serial / chassis number;

(e) Date of purchase;

(f) Location of the asset;

(g) Supplies name, address, invoice number;

(h) Cost of asset; and

(i) Depreciation rate in accordance with rates approved by RUWASA/ as shown in Box 10.1.

A Fixed Asset number should be clearly stamped or printed on the asset so that it is easily identified and can be traced in books. The Fixed Asset registers print outs shall be maintained in

a binder by category of assets to be put in a secure place.

The Fixed assets shall be summarised on a fixed assets control sheet. The main purpose of the fixed assets control sheet is to assist the Accountant to reconcile the general ledger Fixed Assets control accounts to the Fixed Assets register registers. The following details are entered on the Fixed Assets control sheet:

(a) Asset number;

(b) Date purchased;

(c) Description of the asset;

(d) Rate of depreciation;

(e) Cost / valuation of the asset;

(f) Depreciation;

(g) Net book value; and

(h) Disposal proceeds.

10.8. Depreciation Calculations

(a) CBWSOs shall depreciate their fixed assets using the straight-line method of depreciation.

(b) Fixed Assets which are fully depreciated but still used by the CBWSO should be kept in the noncurrent assets register and books of accounts at a nominal value of stipulated by RUWASA.

(c) At the beginning of the year depreciation amount shall be calculated for each asset. The amount of depreciation shall be used to update on the assets register. Depreciation is charged during the year of purchase or completion of a capital project. However, depreciation shall not be charged in the year of disposal.

10.9. Disposal of Fixed Assets

Fixed Assets may only be disposed-off after written authorisation has been obtained from the Head of the CBWSO who must have sought prior approval from RUWASA.

Receipts from sales of Fixed Assets will be credited to a general ledger account called disposal of Fixed Assets. The relevant assets cost and depreciation recorded in the fixed assets register are also transferred to this account.

Where the written down value of the asset on the fixed assets register is not equal to the proceeds arising on disposal, the difference is credited or debited to the operating account as a profit or loss on disposal of Fixed Assets.

10.10. Revaluation of Fixed Assets

When revaluations of Fixed Assets occur, the revised values shall be recorded on the fixed assets register and adjustments are made to the amount of depreciation to be charged to take account of the new valuation.

10.11. Inventory of Fixed Assets

At the end of each financial year an inventory of Fixed Assets shall be carried out to ascertain the existence and condition of individual assets. Fixed Assets that are no longer serviceable or not required should be identified and reported so that a decision can be made on how to dispose them.

Table 31: Fixed Assets Register Card

Asset Code				Asset Name							
Maker		Maker's Number			Date		Location	Ref			
Supplier		Drawing Number									
Invoice Number		Guarantee									
Invoice Date		New / Second Hand									
Full Description			Cost		Initial Allowances			Wear & Tear Charge			
					Item	Initial	Claimed	Year	Rate		
			Invoice Price								
			Additional Cost								
Expected Life in Years											
Depreciation Rate			Total								
Additions / Disposals (Enter Disposal in Red)											
Date	Invoice No	Supplier	Item	Amount	Nom. Code	Date	Replacement		Depreciated Replacement		

FORM 8.9

Table 32: Fixed Asset Disposal Advice

Section:	Date:
Asset Number:	
Asset Description:	
Date Disposed:	
Reason:	
_____	
_____	

Scrap	On Sale	Sold	
Disposal:			
Purchaser:			
Invoice No:			
Date:			

Sale Proceeds	TZS
Net Book Value	TZS
Gains/(Loss)	TZS
HEAD OF CBWSO	Accountant
Signature:	Signature:
Date:	Date:

Form 8.10: Fixed Assets Movement Request Form

I _____ of (organization/individual) _____ P.O. Box _____ request the following item(s) to be out of the office for use/repair from_____ to _____

No	Description	Code Number	Status of the Asset
1			
2			
3			
4			
5			

Table 33: Fixed Assets Movement Request Form

Signature _____ Date_____

B. Comments; Accountant

I do/don't recommend use /repair outside the office

Reasons: _____

Name of approving officer _____ Signature _____ Date_____

C:AUTHORISATION BY THE HEAD OF CBWSO:

I do authorise/not authorise use/repair from_____ to _____

Reasons: _____

Other comments_____

Signature _____ Date_____

D: Status of the Asset after use/repair (Returning Details)

1. Maintained the original status
2. Improved
3. Deteriorated

Comments:

_____

_____

Name of the Receiver_____ Signature _____ Date_____

Name of the returning _____ Signature _____ Date_____

CHAPTER ELEVEN

CONCLUSION AND RECOMMENDATION

This Operations Manual for CBWSOs has been prepared to provide relevant and comprehensive guidance for the efficient, effective, transparent, and accountable management of the organizations. Moreover, it provides directives and procedural steps to adhere and follow in undertaking different interventions related to operations and maintenance of water schemes, standardization of equipment and accessories and availability of spare parts and specifications.

It is therefore important that all staff and partners of the respective Organisation understand the manual well. Periodically, RUWASA will train CBWSOs on the manual. But since, by and large, the manual has been presented in a very simple and easy to understand manner, it should be quite possible for the Head of a CBWSO to train his/her people on the manual and ensure it is fully adhered to and implemented. Therefore, it is crucial for all staff of the Organisations to take implementation of the manual very seriously. RUWASA will use the manual as the basis for evaluating the performance and continuing the service of a CBWSO.

Guidelines For Operations And Maintenance Of Rural Water Schemes And Sanitation Facilities

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