THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF WATER

THE WATER ALLOCATION PLANNING GUIDELINES

DODOMA

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FOREWORD

With large lakes and adequate river flows, Tanzania is perceived to be among the countries with enough water resources for its social-economic development. However, on the ground the country faces temporal and spatial variations in water availability. On the other hand, most of the country's water resources are shared with neighbouring countries as seven out of nine Basins are Trans boundary. Increasing population, climate change/ variability and increased industrialization sound an alarm on the need to sustainably manage and utilize the available water resources.

The Ministry of Water has developed Water Allocation Planning Guidelines, to guide the process of water resources allocation in an equitable manner for domestic, environment and other social-economic needs. Water allocation prioritization modalities set out in these guidelines are meant to be used when water resources in a given source are insufficient to meet all demands, hence denying equitable allocation of the same.

These guidelines outline the principles and procedures to ensure sustainable allocation of water resources to different users in Mainland Tanzania. The procedures set in the guidelines are meant to contribute to enhancement of implementation of the National Water Policy of 2002 and the Water Resources Management Act No.11 of 2009 through proper water allocation.

The guidelines recognize compliance and enforcement, use of underlying principles in water resources management, proper water planning, proportional allocations and re-allocations being among important factors to ensure equitable and appropriate water resources allocation. In addition, the conditions of the provided permits, quantification of water resources for different sectoral water demand and consideration of losses during allocation are key in water allocation process.

It is therefore my sincere hope that these guidelines shall provide needed guidance in preparation and implementation of Water Allocation Plans for enhanced water resources management and utilization to Basin Water Boards, relevant stakeholders and water users. It is high time that water resources allocation be done based on water resources assessment findings on quantity and quality, quantified demands and allocation prioritization.

Eng. Anthony Sanga
PERMANENT SECRETARY

EXECUTIVE SUMMARY

The Water Allocation Planning guidelines outline the principles and procedures to ensure equity in allocating water resources to different users in Mainland Tanzania. The procedures set in the guidelines are meant to enhance the implementation of the Water Resources Management Act No 11 of 2009, as the principle law in managing water resources in Tanzania.

The preparation of these guidelines involved consultation of legislations and manuals used by the Water Sector. Consultations were also made to experts from water related sectors and stakeholders.

Effective water allocation includes assessment of the situation including water availability, supply options, projected water demands, socio-economic assessments of impacts of different options, assessments of water use efficiency and demand-management options, and environmental flow assessments to identify key environmental assets and processes and their water needs. Water allocation mechanisms consider overarching policy objectives such as equity, environmental protection, balancing supply and demand and promoting efficient water use. Sharing water amongst competing users needs a proper guide to decide how water resources should be shared between different users included proportionate division, existing uses and future use projections.

The Guidelines provide various criteria to be applied to allocate water depending on the existing situation. From the experienced challenge of water shortage during dry season in many Basins, the Guidelines suggest flexibility, security of tenure, real opportunity cost, review of existing permits, and prioritization in order to effectively allocate the available water resources to different water users.

It is therefore my sincere hope that through application of these guidelines water allocation mechanism will be improved and the available water resources will be shared equitably to meet human needs and socio economic support for enhanced livelihood.

Dr. George Lugomela
Director of Water Resources

Definition of Terms

Bathymetric survey: Measurement of depth as well as the underwater features of a water body.

Environmental Flow Requirement: is the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems that depend on that particular ecosystems.

Evaporation: is the process of a substance in a liquid state changing to a gaseous state due to an increase in temperature and/or pressure. It is a fundamental part of the water cycle and is constantly occurring throughout nature.

Evapotranspiration: is the sum of evaporation and plant transpiration from the Earth's land and ocean surface to the atmosphere and is an important part of the water cycle.

Flow Duration Curve: The flow-duration curve is a cumulative frequency curve that show the percent of time specified discharges were equalled or exceeded during a given period. It combines in one curve the flow characteristics of a stream throughout the range of discharge, without regard to the sequence of occurrence

Groundwater: is the water found underground in the cracks and spaces in soil, sand and rock. It is stored in and moves slowly through geologic formations of soil, sand and rocks called aquifers.

Initial year: is the year when the supply is expected to be taken into operation that shall be assumed to be 0-5 years from the date of commencement of the preliminary design.

Mean Annual Flow (MAF): is the average flow for the individual year or multi-year period of interest obtained by dividing the sum of all the individual daily flows by the number of daily flows recorded for that particular year

Safe Yield Capacity: is the amount of water that can be withdrawn from an aquifer over a long period of time without producing an undesired effect

Spot measurement: Measurement conducted in dry and wet season in cases where the River is ungauged. All the measured flow should be converted in m3/day.

Transboundary Water Basin: is a river basin that crosses at least one political border, either a border within a nation or an international boundary.

Water Abstraction: is the process of taking or extracting water from a natural source (rivers, lakes, groundwater aquifers, etc.) for various uses including drinking, irrigation, and industrial applications

Water allocation plan: is a plan that outlines how much water can be taken from either groundwater or surface water resources, while safeguarding the sustainability of the resource and protecting the water-dependent environment.

Water demand: is the measure of the total amount of water that the source must produce to meet water requirements for various water uses both for consumptive and non-consumptive

Water use permit: Permits that authorizes withdrawal/diversion of a specified amount of water from surface and groundwater sources for reasonable and beneficial uses.

Water Reservoir: A single/multi-purpose structure designed to fulfil functions, such as irrigation, power generation, navigation, flood control, water supply, recreation, or low-flow regulation. The trend has been toward construction of multiple-purpose reservoirs designed to serve at least two principal functions

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ABBREVIATIONS

BWB	Basin Water Board
CWC	Catchment Water Committee
DEV	Daily Flood Volume
DCOM	Design, Construction Supervision, Operation and Maintenance Manual
L/d	Liters per day
L/bed	Liters per bed per day
L/visitor/d /d	Liters per visitor per day
L/worker	Liters per worker
MoW	Ministry of Water
NAWAPO	National Water Policy
NWSDS	National Water Sector Development Strategy
SCWCs	Sub Catchment Water Committees
WB	World Bank
WAP	Water Allocation Plan
WRBWB	Wami Ruvu Basin Water Board
WRMA	Water Resource Management Act
WUA	Water Users Association

1. INTRODUCTION

1.1 Background information

Water resources provide important benefits to humankind, both commodity benefits and environmental values (WB, 1997). The increase in competing demands for the water resources in Basins poses a huge challenge to the process of water allocation. Main increase has been raising from water demand for industrialization and domestic while the available limited resource being threatened by inefficient water, pollution and climate change and variability.

To address such challenges, the above challenges, the Government set out a system of issuance of water use permits through the WRMA No. 11 of 2009 to management of water resources in the country. The key elements to carry out water allocation involve assessment of available water resources, quantification of demands at Basin level and allocation of the available resources according to the priority set. For a successful planning and implementation of water allocation plan, consultation and engagement of stakeholders throughout the process is very important.

Currently, Water allocation is done based on Water Resources Management (Water Abstraction, Use and Discharge; Environmental Water Requirements; and Rain Water Harvesting) Regulations. The allocation is done through provision of water use permits, which are given to a particular user on a demand driven basis. The allocation process involves the assessment of the available water resources in terms of quantity and quality, set aside water requirements for domestic, environment and socio-economic activities. The existing permit holders are consulted before allocating water to a new user in order to make sure that new user do not affect the already permitted uses.

Generally, the allocation of water from a particular water body take into consideration the following demands:

i. The amount of water resource required to meet domestic demands;
ii. The amount of water resources required to meet environmental reserve;
iii. The amount of water resources required to meet other socio-economic demands such as livestock, agriculture, industry, mining, energy, fisheries, wildlife and tourism and navigation; and
iv. The amount of water for which commitments have been made in trans-boundary water and inter basin water transfers.

The distinction between water allocation and compliance/enforcement should be considered during allocation. Failure to comply with the provided water use permits may lead to extreme situations such as depleting the water sources both ground water and surface water sources.

1.2 Objective of the guidelines

These guidelines have been prepared to facilitate implementation of the Water Resources Management Act, No. 11 of 2009 as far as water allocation is concerned. The Act provides for preference for water allocation under Section 6 subsection (2) such where domestic use has the first priority, followed by environment and lastly socioeconomic uses. Basin water allocation planning is typically undertaken to achieve a numerous policy objectives. These guidelines will enhance to achieve:

(i) **Equity:** Allocating water in a way that is fair and equitable amongst different user groups. This include equity between upstream and downstream areas.

(ii) **Environmental protection:** Allocating water in a way that recognizes the needs of freshwater-dependent ecosystems and protects key freshwater services such as sediment transport, groundwater recharge, waste assimilation and estuarine functioning.

(iii) **Development priorities:** Allocating water in a way that supports and promotes socio economic development. This include supporting strategic priorities and protecting existing dependencies.

(iv) **Balancing supply and demand:** Water allocation plans need to balance water supplies with demands, particularly to manage the natural variability of water availability, and to avoid frequent or unexpected water shortfalls.

1.3 Governing Laws, Policies and Regulations

1.3.1 National Water Policy 2002

The National Water Policy narrates several remedial actions that have to be taken in order to protect water pollution and harmful depletion. The policy sets an object wihich is to develop a comprehensive framework for sustainable development and management of Nation's water resources.

1.3.2 Water Resources Management Act, 2009

WRMA No. 11 of 2009 among other things, provides guidance on, control of water abstraction and use and also addresses the issue of granting water use permits. In addition, Section 70 and 74 of the Act provides duration for the water use permit and conditions attached to a water user permit respectively.

Furthermore, the Act under Section 13 (2) (g) mandates the Minister "to formulate regulations, technical standards and guidelines" to enhance smooth implementation of the Act.

1.3.3 Water Resources Management (Water Abstractions, Use and Discharge) Regulations

Part II, Section 3(1), (2) of the Regulations provides details on the procedures for application of water use permit as well a discharge permit. Water use permitting system has been introduced in order to monitor water abstractions and release to the environment.

1.4 Justification for Developing Water Allocation Guidelines

Water scarcity increases steadily thereby water triggering the need for water allocation plans in resolving water use related conflicts over access to water. Water is a key input to food production, economic growth and power generation. With water shortage and with the rapid decline in the health of aquatic ecosystems significance of water allocation mechanisms become vivid.

Traditional water allocation conducted over the years, has contributed to over allocation perpetuating lack of enough water to allocate for other sectors and future developments. The increase in water demand with limited water resources has raised a need to have in place guidelines for water allocation.

Section 13 (2) (g) of the WRMA, 2009 mandates the Minister "to formulate regulations, technical standards and guidelines" to enhance smooth implementation of the Act. Therefore, preparation of these guidelines is a legal requirement aimed at ensuring sustainable water management, allocation and utilization such that water national security is guaranteed.

1.5 Methodology of developing the guidelines

The preparation of Water Allocation Guidelines was participatory whereby different stakeholders were involved in the process. The drafting of this document involved a team of technical experts drawn from sector Ministries, Institutions, private sector and Non-Governmental Organizations. The process of developing the document involved literature review and stakeholders' consultation followed by preparing the draft document which was shared with stakeholders for provision of comments. The views of stakeholders were incorporated to the draft document and later the document was presented to stakeholders for final review before presentation to the Ministry's Management Team for finalization and approval of the guidelines.

2. BASIS FOR WATER ALLOCATION

2.1 Role of water allocation

Water allocation is the process of sharing a limited natural resource between different competing users. It is a process made necessary when the natural distribution and availability of water fails to meet the needs of all water users in terms of quantity, quality, timing of availability, or reliability. In simple terms, it is the mechanism for determining who can take water, how much they can take, from which locations, when, and for what purpose.

Historically, access to water has been regulated to meet a wide range of social objectives, including agricultural production, economic development, public health and more recently environmental protection. As water scarcity has increased, water allocation plans taken on increasing significance in resolving conflicts over access to water.

The right to use water is conferred by the government to the users by means of a water permit which is issued by the Basin Water Boards. Sections 43 (2) and (3) of the Water Resources Management Act, 2009 provides that:

i. A water use permit shall be issued taking into account of water required for maintaining Environmental Flow Requirement, and
ii. No permit or licence issued under any other law shall apply to a watercourse without a written authorisation of the Basin Water Board.

2.2 Underlying Principles

The following principles apply directly to these guidelines:

i. The precautionary principle, which implies that decisions shall, or indeed must be made even where information is incomplete in relation to:
    a) Taking preventive action in the face of uncertainty;
    b) Shifting the burden of proof to the proponents of an activity;
    c) Exploring a wide range of alternatives to potential harmful actions; and
    d) Providing for public participation in decision making.
ii. Polluter pays principle: any person who pollutes the water in any river, stream or water course or any surface water body should be subjected to fines or imprisonment;
iii. Principle of ecosystem and integrity: water for environment to protect the eco-systems that underpin our water resources, now and in the future shall attain second priority and shall be reserved;
iv. The principle of public participation in development of policies, plans and processes for the management of water resources;

v. The principle of international cooperation in management of environmental resources shared by two or more states;

vi. Principle of International cooperation: The trans-boundary water resources management requires understanding and agreement among the riparian states; and

vii. The principle of common but differentiated responsibilities;

2.3 Transboundary Water Basins Allocation Principles

In consideration of the fact that there are transboundary and non-transboundary Water Basins in the country, water allocation processes shall observe the following key principles listed here under;

In transboundary water sources, the following principles shall be observed:

(i) Reasonable and equitable utilization

This principle entitles each basin state to reasonable and equitable share of water resources for beneficial uses within its own territory. In determining an equitable and reasonable share, relevant factors such as the geography of the basin, hydrology of the basin, the population dependent on the waters, economic and social needs to the existing utilization of waters, potential needs in the future, and climatic and ecological factors of a natural character and availability of other resources should all be taken into account.

(ii) Not to cause significant harm

This principle is also part of the theory of limited territorial sovereignty. According to this principle, no state in an international drainage basin are allowed to use the water courses in their territory in such a way that would cause significant harm to other basin states or to their environment, including harm to human health of safety.

(iii) Cooperation and information exchange

It is the responsibility of each riparian state of an international water course to cooperate and exchange data and information regarding the watercourse as well as current and future planned uses along the water course.

(iv) Notification, Consultation and negotiation

Every riparian state in an international watercourse is entitled to prior notice, consultation and negotiation in cases where the proposed use by another riparian of a shared watercourse may cause serious harm to its rights or interest. There principles are generally accepted by international legal documents. It is

through this principle where each BWB proposes to undertake or to permit the undertaking of a project that may substantially affect the interests of any co-basin state, it shall give such State or State notice of the project, that shall include information, data, and specifications adequate for assessment of the effects of the project.

(v) Peaceful settlement of disputes

This principle advocates that all states in an international watercourse should seek a settlement of the disputes by peaceful means. In case states concerned cannot reach agreement of the disputes by peaceful means in case states concerned cannot reach agreement by negotiation.

2.4 Key Considerations during Water Allocation process

Flexibility: Is the allocation of supplies so that the resource can be shifted from one use to another, place to place as demand changes, making it possible to equate marginal values over many uses with least cost.

Security of tenure for established users, so that they will take necessary measures to use the resource efficiently, security does not conflict with flexibility as long as there is a reserve of the resource available to meet unexpected demands.

Real opportunity cost of providing the resource is paid by users so that the other demand or externality effects are internalized. This allows the allocation to account for environmental uses with a non-market value (such as providing a habitat for wildlife). This also directs the employment of the resource to activities with the highest alternative values.

Review of existing permits adjustments to the existing permits shall be done to accommodate the changes in the volume of water availability during shortage periods.

Prioritization of permits will be done as per WRMA 2009 where domestic needs will be given high priority followed by environmental requirements and lastly will be socio economic requirements depending on the availability of water.

Predictability of the outcome of the allocation process, so that the best allocation can be materialized and uncertainty (especially for transaction costs) is minimized.

Equity of the allocation process should be perceived by the prospective users providing equal opportunity gains from utilizing the resource to every potential user

Allocation of uncontrolled flooding: Since basins have enough water to meet all the demands, in addition to all necessary criteria, unmet demands of the dry periods shall be permitted during abundant water periods i.e. allocation of flood water.

2.5 Stages in Preparation of the Plan

In the preparation of the plan, there shall be five stages; namely (i) planning initiation (ii) situation assessment (iii) scenario development and analysis (iv) decision and approval and (v) final plan and implementation of the plan.

2.5.1 Planning initiation

This is the first stage where all interested parties get informed of the plan development. Important issues to be shared shall consider at least the following: area of the catchment to be considered in the plan, the process and timeline for preparing the plan; and the data that will be used or collected to inform the planning process.

2.5.2 Situation assessment stage

This stage shall involve assessment of total water availability; supply options (including from existing or new infrastructure); projected water demands; socio-economic assessments of impacts of different options; assessments of water use efficiency and demand-management options; and environmental flow assessments to identify key environmental assets and processes and their water needs.

2.5.3 Scenario development and analysis

Scenarios development and analysis shall be necessary at this stage in order to provide understanding of the options that are available, and their implications. Scenario development should consider possible futures in the context of uncertainty related to economic development or a changing climate

2.5.4 Decision and approval

This stage shall involve making decision on how water is to be allocated and the allocation plan to be adopted. The requirements for approval shall involve validation of the draft plan through stakeholders' consultation and approval of the final draft by the relevant Basin Water Board.

2.5.5 Final plan and implementation of the plan

The final plan shall comprise of allocation objectives and strategies that have been agreed on. There shall be development of detailed implementation plan. The final plan approved shall include the following detailed plans:

- Water Allocation Plans (at catchment level)
- Physical works, such as construction of infrastructure (if proposed in the plan) or implementation of water use efficiency measures
- Monitoring and Evaluation plan to ensure water is allocated between entitlement holders in accordance with the plan

- Environmental management plan including approaches to managing environmental flows

3. CONSULTATION AND COORDINATION OF STAKEHOLDERS

Preparation of a Water Allocation Plan will require consultation and coordination with a range of stakeholders and decision-makers at various stages from the planning process to implementation of the Plan. This includes both those parties that must endorse a plan for it to take effect i.e. the government institutions, relevant agencies who must agree to a plan before it can be given legal or practical effect and those parties whose agreement and support would be beneficial, because of either their political influence or their role in implementation.

Consultation and coordination shall target to achieve the following objectives,

(i) Identification of economic, social and environmental information in the development of the plan.
(ii) Alignment with other existing development and environmental plans.
(iii) Support for decisions and reduction of conflict

Analysis of stakeholder shall be conducted in order to identify parties with an interest in, or able to inform, the water allocation process. It may include government and non-government entities, research bodies, water users, industries and the broader community. The nature of the consultation, and who should be consulted, will also vary for different stages of water allocation plan. Finally, it is necessary to determine the most appropriate mechanism for engaging stakeholders. Recommended approaches include:

(i) Public (or restricted) meetings and workshops to allow an opportunity to present and discuss issues related to the plan.
(ii) Consultative committees to allow representatives of affected groups to provide input to the process.
(iii) Surveys to gauge public attitudes to the plan and different alternatives and collect information on community priorities and expectations that are valuable in setting plan objectives and reconciling competing interests.
(iv) Requests for submissions to obtain direct feedback from a broad range of stakeholders, by providing an official process for affected parties to provide comment at key stages in the planning process

3.1 Stages for stakeholders Consultation

Stakeholders shall be engaged and consulted at three key steps of Water Allocation Planning process as per Figure 3.1;

(i) Initiation of the planning process;

This stage will involve sharing of all necessary information with stakeholders that the planning process has commenced. The information to be shared should involve the scope of the planning activity and the future plan, methodology, timeline for preparing

the plan; and the data that will be used or collected to inform the planning process. Stakeholders will be responsible to support the process through provision of economic, social and environmental condition data that are available to them.

(ii) Allocation options;

This stage follows after situation assessment including scenario development and analyses. At this stage decision-makers and stakeholders will be provided with the opportunity to understand the options that are available, and the implications of those options. In some cases, this might result in the need to revisit earlier situation assessments, or undertake further studies on the social, economic and ecological impacts of different scenarios, as new issues or risks are identified. Being an iterative process it is necessary in identification of ways to maximize the benefit and minimize the adverse impacts of different allocation and management options.

(iii) Detailed Final Draft plan

The Final detailed plan shall include the following;

- further allocation plans (at the catchment level/ regional (interbasin transfer)
- physical works, such as construction of infrastructure or implementation of water use efficiency measures
- annual allocation and management activities, to ensure water is allocated between entitlement holders in accordance with the plan
- development and implementation of new reservoir operation rules
- monitoring plan including approaches to managing environmental flows

Once the final draft plan has been developed the final stakeholders' consultation will be conducted in order to validate the proposed plan.

The approval of the plan shall be done by the respective Basin Water Board. The approved plan shall be subjected to minor review annually and overall review of the plan be conducted after five years.

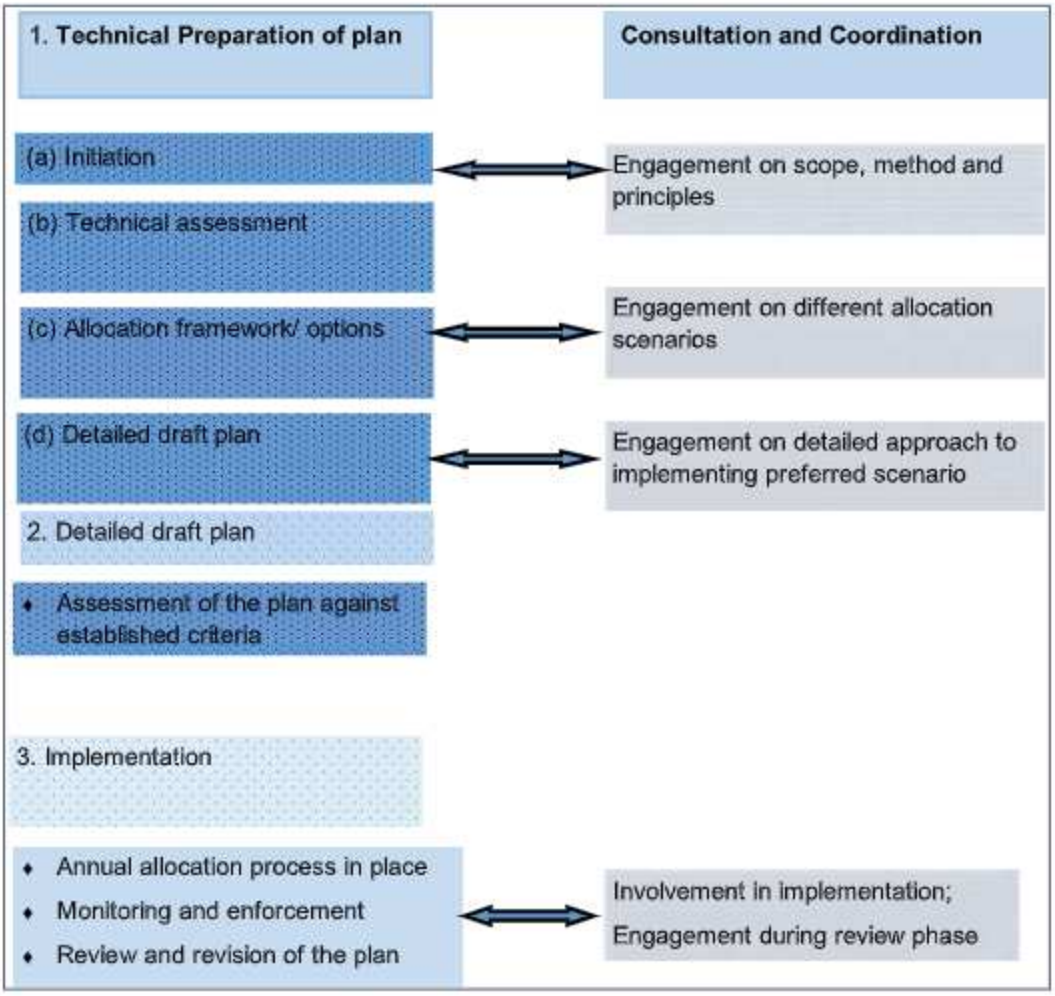

Figure 3.1: Consultation process at different stages of planning process

4. ASSESSMENT OF WATER AVAILABILITY FOR ALLOCATION

The first step in the allocation of water resources shall be to determine the available water resources. The available water shall be determined by conducting quality and quantity assessment of water resources which shall depend on the nature as follows:

4.1 River

River water sources may be seasonal or perennial. In both circumstances, rivers need to be gauged to allow quantification of the amount of water available at a particular period of time. Key steps to be observed during quantification of water availability in the river include;

(i) To quantify water in the gauged river by determining Mean Annual Flow (MAF) and/ or Mean Flow Duration Curve (MFDC) for a minimum period of five years considering both wet and dry periods.

(ii) Spot measurement, conducted in dry and wet season in cases where the River is ungauged. All the measured flow should be converted in m^3/day;

Table 3.1 provides a methodology to quantify the availability of water in a River flow regime.

Table 4.1: Procedures to Quantify Water Availability in Rivers

Step	Action	Remarks
1	Develop Flow Duration Curve based on naturalized daily stream flow data.	Utilization of reliable historic records (when abstraction was significantly less than at present) shall be used. The hydrological records should be representative of the hydrological unit under consideration.
2	Extract the Q_{95}, Q_{80} and Q_{50} values (m^3/day) from the naturalized flow duration curve.	The values shall easily be obtained from a properly established FDC for a particular River with consideration of dry months of the year as a critical aspect.
	• The Reserve is not less than the	A check for the values has to be done and guides the decision

Step	Action	Remarks
	equivalent to the naturalized Q_{95} (m^3/day) • Normal flow available for allocation is determined by: NY = Q_{80} – the Reserve flow (m^3/day)	This method provides a reasonable estimate on which allocation decisions shall be based on.
3	Normal Water available for allocation to any new application = (Q_{80} –Reserve flow) — (Sum of existing allocations) (m^3/day)	The existing allocations shall include bulk transfers. Existing allocations upstream and downstream should be considered within the boundaries of the hydrological unit
4a	Flood Volume (FV) available for allocation = Area above Q_{80} on the Flow Duration Curve (m^3/year)	This approach makes the assumption that the probability of occurrence over an entire record period is reasonably similar to what might be expected in any one "average" year. This provides an estimate of the Average Flood Volume (m^3/ year).
4b	Establish a time series of Annual Flood Volumes (AFV) based on a summation of Daily Flood Volume (DFVi = Qi - (280) where DEV is daily flood volume on day and Qi is the actual daily flow on day. Undertake a frequency analysis to determine the AFV value with 80% reliability (i.e. fails once in every 5 years) (m^3per year).	This is likely to result in a value that is more conservative than the methodology shown above (6a).
5	Flood Water available for allocation to any new application FV — (Sum of existing allocations from flood volume) (m^3/year).	All existing allocation should be translated into a volume per year.

4.2 Spring

Quantification of water at the spring water source should follow consider quantification of the amount of water available at the spring source. A spring with variable flow, Flow

Duration Curve method should be used to determine the available water at each particular time for regulation of water abstractions.

4.3 Lake/ Reservoir

In order to quantify the available water in the Lake/reservoir, the following steps should be followed;

(i) Establish the volume of the Lake/reservoir by applying appropriate method such as bathymetric survey or other mathematical methods;

(ii) Quantify the amount of water available in the lake/ reservoir;

4.4 Ground Water

In order to quantify water available in a borehole the following steps must be followed:

(i) Establish the value for safe yield capacity of a borehole; refer Groundwater Exploration and Well Drilling Guidelines (2018) for details on establishment of safe yield capacity.

5. ASSESSMENT OF WATER DEMAND

5.1 Introduction

The quantification of water demand shall be done based on main categories of water uses with reference to relevant national and international regulations, guidelines and manuals. The categories of water uses as categorized in MoW Design Manual, 2020 include domestic, environment, institutions, Irrigation, livestock and commercial. It should be noted that the water consumption figures shall include an addition of 20% allowance for water losses through leakage and wastage.

Water demand projections shall normally be made for the "initial", the "future" and the "ultimate" year. Therefore, water allocation shall be based on ultimate demand.

5.2 Quantification of Demand

5.2.1 Domestic Demand

Details for quantification of demand and methodology for determining the amount of water for this category are provided in DCOM Manual (2020) Vol.1. The methodology includes various steps as provided below;

(i) Determine the present population and future projection as per design period. The present population shall be estimated based on the latest census and projected into future for the appropriate planning horizons. Other credible methods of estimating population like statistics from the local administration shall be used

(ii) Undertake population analysis to determine water demand service level to be anticipated for any given area as per DCOM (2020) Vol 1. Table 3 below provides more details for demand analysis.

Table 5.1: Water Requirements for Rural and Urban Areas

Consumer Category	Rural Area (L/ca/d)			Urban Area (L/ca/d)			Remarks
	FR	M-UT	M-PBT	FR	M-UT	M-PBT	
Low income using kiosks or public taps	25	25	25	25	25	25	Squatter area, to be taken as minimum
Low income multiple households with yard tap	50	450	40	50	45	40	Low income group housing No inside installation and pit latrine

Low income single households with yard tap	70	60	50	70	50	50	Low income group housing NO inside installation and pit latrine
Medium income house holds				130	110	90	Medium income group housing with sewer or septic tank
High income households				250	200	150	High income group housing with sewer or septic tank
FR= flat rate: M-UT= metered with uniform tariff: M-PBT= metered with progressive block tariff							

Source: Ministry of Water Design Manual of 2009

5.2.2 Institutional Demand

Institutions category shall include Schools, Hospitals, Administration Offices, Police, Missions, Prisons, Churches and Mosques. The following steps shall be followed during quantification of institutional demand;

(i) Identify type of the institution as per Table 4.2

(ii) Determine the present population and future projection as per design period for a particular institution whereby the water requirements for staff working in the institutions should be estimated separately in the same way as for other domestic water consumption.

Note: If large demand units are included in the scheme, such as Irrigation schemes, hydropower project, Universities, major hospitals, boarding schools etc., a special study of their water requirements is recommended to depict their actual demand instead of using the average figures given in the table.

Table 5.2: Institutional Demand for Rural and Urban

Consumer	Unit	Rural (L/d)	Urban (L/d)	Remarks
School -Day school	L/std/d	10	10 25	With pit latrine With WC
-Boarding	L/std/d	70	70	With WC
Health care Dispensary	L/visitor/d	10	10	Out patients only
Health	L/bed/d	50	50	No modern facilities

Consumer	Unit	Rural (L/d)	Urban (L/d)	Remarks
Health	L/bed/d	100	100	With WC and sewer
Hospitals, District	L/bed/d	-	200	With WC and sewer
Hospitals, Regional	L/bed/d	-	400	With surgery unit
Administrative Offices	L/worker	10	- 70	With pit latrines With WC

Source: Ministry of Water Design Manual of 2009

5.2.3 Commercial Water Demand

This category shall include but not limited to hotels, restaurants, bars, shops, small workshops, service stations. The following steps shall be followed;

(i) Identify type of the consumer as per Table 4.3

(ii) Quantify present water requirement for staff for a particular institution whereby the water requirements shall be estimated separately in the same way as for other domestic water consumption

(iii) Total demand shall be the summation of (i) and (ii) above

Note: If there is only a reservation in the town plan for the future business area without any specification, the estimate must be based on per hectare demand. As a guide, a water demand of 10 to 15m^3/ha/d for a non-specified commercial area in a new town plan shall be adopted.

Table 5.3: Commercial Water Demand

Consumer	Unit	Rural	Urban	Remarks
Hotels	L/bed/d	70	70 200 400	Low class Medium class High class
Bars	L/bed/d	70	70 100 300	Low class Medium class High class
Shops	L/bed/d	25	70 130	Low/Medium class High class

Source: Ministry of Water Design Manual of 2009

5.2.4 Industrial Water Demand

The water consumption in industries vary considerably depending on the type and size of the industry. Table 6 below provides data of the water consumption for different types of industries. The following steps shall be followed to establish industrial water demand;

(i) Identify type of industry as per Table 4.4.

(ii) Quantify present water requirement for staff for a particular industry whereby the water requirements shall be estimated separately in the same way as for domestic water consumption

(iii) Total demand shall be the summation of (i) and (ii) above

Note: In industries where no water is needed for production, the only water consumption is that for staff and cleaning of the premises.

Table 5.4: Industrial Water Demand

Industry	Product or Raw Material Unit	Water Consumption in m^3 per Unit of Raw Material
Food industry		
Dairy	Milk received (1000 Liters)	2 – 5
Abattoir	Animal slaughtered	4 – 10
Brewery	Beer (1000 Liters)	10 – 20
Sugar	Shalle (tons)	10 – 20
Wood processing		
Pulp mill	Bleached pulp (tons)	100- 800
Paper mill	High quality paper (tons)	300- 450
Chipboard factory	Chipboard (tons)	50 – 150
Others		
Tannery	Raw skins (tons)	50 – 120
Cotton mill	Cotton thread tufi	50 – 150

Source: Ministry of Water Design Manual of 2009

Note: Where there is only a reservation for an industrial area in the town plan but without any specifications; estimates of the future water requirements shall be based on table 4.5 below:

Table 5.5: Industry and Type of Water Demand

Industry Type	Water Demand m^3/ha/d
Medium scale (water intensive)	50
Medium scale (medium water intensive)	20
Small scale (dry)	5

Source: Ministry of Water Design Manual of 2009

5.2.5 Livestock Water Demand

Water demand for livestock shall be graded for domestic animals in terms of stock unit before being used. One stock unit shall be considered to be equal to one cattle, or two donkeys, or five goats or five sheep (shoats), or thirty poultry (hens, duck, and goose). Special cases shall be high grade dairy cows where one cow shall be equal to 2 (or 3), stock units.

Present livestock numbers shall be found from social surveys and data from relevant authorities and then converted into stock units.

Note: It shall be assumed that one stock unit shall consume 25 liters per animal per day. The annual growth rate for livestock shall further be taken as 2.6% and 2.0% for sheep and goats, respectively. Other estimation for livestock shall be referred in Table 12. The future population of livestock shall be taken as 25% growth in 10 years and 50% growth in 20 years. Table 4.6 below shall further illustrate water demand for livestock.

Table 5.6: Water Demand for Livestock

Consumer	Unit	Consumption Rate in L/d	Remarks
Livestock	1/animal/d	50 – 90	High grade dairy cattle
		25	Local breed cattle
		5	Sheep and Goats
		12.5	Donkeys

5.2.6 Water Demand for Wildlife

Water requirements for wildlife differ between and within species. It also differs due to the season, sex, and reproductive conditions. The actual water needs for a specie or population shall therefore be determined using the detailed information on the above parameter. In cases where this information is absent, the average daily water for a specie shall be used (WRBWB, June 2019).

The estimated values of drinking water for some species is highlighted in table 4.7 below

Table 5.7: Estimated Values of Drinking Water for some Species

Common English Name	Average Body Weight (M) kg	Daily Drinking Water Needs per Individual needs	Common English Name	Average Body Weight (M) kg	Daily Drinking Water Needs per Individual needs
Elephant	1950	200	**Sable Antelope**	210	24
Buffalo	550	80	**Duiker**	24	3
Zebra	213	24	**Hippopotamus**	1750	190
Impala	50	6	**Baboon**	23	3
Giraffe	815	46	**Bart Eared Fox**	4	1
Eland	450	50	**Lasser Kudu**	89	10
Hart beast	151	17	**Reedbuck**	40	5
Warthog	60	7	**Wildebeest**	200	20
Roan Antelope	252	18	**Bushbuck**	42	5
Greater Kudu	168	19	**Waterbuck**	180	9

5.2.7 Water Demand for Irrigation

Irrigation Water demand is influenced by climate type, irrigation method and type of crops grown.

Table 4.8 below gives indicative values of the crop water needs for the total growing period of various important field crops. The values indicated in the table provide a rough estimate and should only be used if the crop water needs shall not be calculated more accurately due to lack of data. The table gives for each crop a minimum and a maximum value for the crop water need. As the crop water needs depend heavily on the

duration of the total growing period, the maximum value should be used in the case of a long total growing period (Table 4.9) and the minimum value should be used when the total growing period is short. An average value is to be used with a medium total growing period (Brouwer, Goffeau et al. 2006.).

Table 5.8: Indicative values of the crop Water needs and Sensitivity to drought

Crop	Crop water need (mm/total growing period)	Sensitivity to drought
Alfalfa	800-1600	low-medium
Banana	1,200-2,200	high
Barley/Oats/Wheat	450-650	low-medium
Bean	300-500	medium-high
Cabbage	350-500	medium-high
Citrus	900-1200	low-medium
Cotton	700-1300	low
Maize	500-800	medium-high
Melon	400-600	medium-high
Onion	350-550	medium-high
Peanut	500-700	low-medium
Pea	350-500	medium-high
Pepper	600-900	medium-high
Potato	500-700	high
Rice (paddy)	450-700	high
Sorghum/Millet	450-650	low
Soybean	450-700	low-medium
Sugarbeet	550-750	low-medium
Sugarshalle	1500-2500	high
Sunflower	600-1000	low-medium
Tomato	400-800	medium-high

Source : *http://www.fao.org/docrep/S2022E/s2022e09.htm#*

Table 5.9: Indicative Values of the Total growing period

Crop	Total growing period (days)	Crop	Total growing period (days)
Alfalfa	100-365	Millet	105-140
Banana	300-365	Onion green	70-95
Barley/Oats/Wheat	120-150	Onion dry	150-210

Crop	Total growing period (days)	Crop	Total growing period (days)
Bean green	75-90	Peanut/Groundnut	130-140
Bean dry	95-110	Pea	90-100
Cabbage	120-140	Pepper	120-210
Carrot	100-150	Potato	105-145
Citrus	240-365	Radish	35-45
Cotton	180-195	Rice	90-150
Cucumber	105-130	Sorghum	120-130
Eggplant	130-140	Soybean	135-150
Flax	150-220	Spinach	60-100
Grain/small	150-165	Squash	95-120
Lentil	150-170	Sugar beet	160-230
Lettuce	75-140	Sugarshalle	270-365
Maize sweet	80-110	Sunflower	125-130
Maize grain	125-180	Tobacco	130-160
Melon	120-160	Tomato	135-180

Source: http://www.fao.org/docrep/S2022E/s2022e07.htm#

5.2.8 The Approximate Method to determine Irrigation need

The approximate method of determining the irrigation water need of an entire irrigation area assumes a constant **net irrigation need**, for the entire season. The most simplified standard value of this **net irrigation need** is 1 litter per second per hectare. This is equivalent to a daily water requirement of 8.6 mm (Table 4.10 below). When the daily water requirement is 4.3mm, the irrigation need would be 0.5 l/s. Like most rules of thumb, this rule should be applied with caution.

The proxy values of **net irrigation need** in hot and dry climates shall be three times as great as in humid climates. Typical values are presented in Table 16 below.

Table 5.10: Approximate average net Irrigation values for different climates and Rice

Climate	Water requirement
Humid tropical climate	0.5 l/s/ha
Monsoon climate wet season	0.5 l/s/ha
Monsoon climate dry season	1.0 l/s/ha
Semi-arid climate wet season	1.0 l/s/ha
Semi-arid climate dry season	1.5 l/s/ha

Climate	Water requirement
Arid climate	1.5 l/s/ha
Rice	1.5 l/s/ha

Source: http://www.fao.org/docrep/u5835e/u5835e04.htm

The approximate values of the irrigation need for an entire area, $\mathbf{SIN_{net}}$ shall be calculated by multiplying the $\mathbf{IN_{net}}$ with the area, **Area** (in hectares). Therefore, the equation representing the approximate Net Scheme Irrigation Need is given by this mathematical relationship; $\mathbf{SIN_{net}}$ (l/s) = **Area** (ha) x $\mathbf{IN_{net}}$ (l/s/ha). The table 4.11 below presents the conversion from mm/day into l/s/ha.

Table 5.11: Conversion table of mm/d into l/s/ha

mm/day	l/s/ha	l/s/ha	mm/day
2	0.23	0.2	1.7
3	0.35	0.3	2.6
4	0.46	0.4	3.5
5	0.58	0.5	4.3
6	0.69	0.6	5.2
7	0.81	0.7	6.0
8	0.93	0.8	6.9
9	1.04	0.9	7.8
10	1.16	1.0	8.6
12	1.39	1.2	10.4
14	1.62	1.4	12.1
16	1.85	1.6	13.8
18	2.08	1.8	15.6
20	2.31	2.0	17.3

Source: http://www.fao.org/docrep/u5835e/u5835e08.htM

6. WATER ALLOCATION MECHANISMS

6.1 Management Stage for Water Allocation

The management stage in water allocation shall involve the provision of water to specific users. Water allocation is the final process after assessing the demand (permits plus reserve) and quantifying the available water.

The water available for allocation is the computation of water balance done as one of the factors for deciding whether a permit is worthy providing, renouncing or changing.

The following equation shall be applied:

Water Available for Allocation = Quantified Water — (Reserve + Transfers + Summation of available Water Allocations).

A positive water balance implies that the available water resource is sufficient to meet all water demands.

6.1.1 Water Allocation where there are sufficient resources

In this case, although the permit details will be checked to establish that the appropriate quantities of water have been applied for and allocated, there shall be no need for prioritisation as all demands can be met. This shall be in consideration with future uncertainties.

6.1.2 Water Allocation where there is insufficient resource

A negative water balance implies the opposite, and at such situation, the Basin has to apply various options such as plan for alternative water sources to be able to satisfy the unmet demands or implement the following recommended options;

This implies that the Basin Water Boards shall apply one or more of the following approaches to meet demand during periods of insufficient water resources:

(i) **Prioritisation;**

- Existing lawful uses;
- Efficient and public benefit;
- Commitments or priorities set in the Basin's Integrated Water Resources Management and Development Plan;
- Potential impacts on other water users and the water resources;
- The class and resource quality objectives as per water body classification;
- Existing and future investments by the applicant ;
- Strategic importance of the application;
- Quality of the water which should be required for the Reserve; and
- Probable duration of the water use activity.

(ii) **Reallocation and proportional Allocation;**

- BWB shall review permitted water use to reallocate and do proportional allocation of water use so as to promote sustainability, equity, public beneficial interests, efficiency and to protect and maintain the water quality and quantity to sustain the aquatic ecosystem

(iii) **Water Demand Management;**

- The BWBs shall implement relevant interventions in order to manage water demand such as promoting water use efficiency and compliance of water use permits

7. MONITORING, REPORTING AND COMPLIANCE

7.1 MONITORING

Monitoring and reporting the results is a critical part of the implementation of a Water Allocation Plan and water resources management. Monitoring shall be conducted to serve the following roles among others:

(i) To assist water management and the implementation of the plan. Information on current flows, reservoir levels and groundwater levels are fundamental to making decisions on water allocation plans.

(ii) To ensure compliance, monitoring is an important tool to ensure that water is being allocated and used in accordance with the principles and rules prescribed by the plan. This will apply equally to ensuring that water abstractors and users are complying with the plan, and that government agencies and entities, such as dam owners and operators, are adhering to it. Compliance monitoring shall serve to generate public confidence in the plan by demonstrating that this is happening.

(iii) To provide relevant information to stakeholders with specific interest from a particular water source in enhancing informed decision making.

(iv) To inform future allocation and management decisions. Monitoring will provide the opportunity to gather information about the basin that is necessary to support future management decisions including information to fill knowledge gaps.

Monitoring objectives will guide the monitoring programme of the allocation plan. Typically, a monitoring programme will gather information on some or all of the following depending on the existing situation at the source;

(i) water resources such as a river flow data at different sites in the basin, water in storages (lakes and dams), inflows to storages, groundwater levels and pressures, and water quality

(ii) water abstraction and use, such as the volumes of water abstracted from watercourses or aquifers, and releases made from reservoirs

(iii) dependent ecosystems, including information on the extent and condition of species, habitats and ecosystems that are dependent on freshwater resources in the basin and

(iv) Environmental flows.

The monitoring programme shall at least consider the listed aspects in Table 7.1 in order to fit the purpose of monitoring.

Table 7.1 Monitoring plan

SN	Water Use Category	Monitoring Frequency	Data to be Monitored
1.	Domestic	Quarterly	Amount of abstraction, flow, water level, installed bulk meter, pump capacity, water quality parameters*
2.	Environmental flow	Monthly	Amount of abstraction, flow, water level, installed bulk meter, pump capacity, water quality parameters*
3.	Institutional	Monthly	Amount of abstraction, flow, water level, installed bulk meter, pump capacity, water quality parameters*
	WSSAs	Monthly	Amount of abstraction, flow, water level, installed bulk meter, pump capacity, water quality parameters*
	Schools	Monthly	Amount of abstraction, flow, water level, installed bulk meter, pump capacity, water quality parameters*
	Hospitals	Monthly	Amount of abstraction, flow, water level, installed bulk meter, pump capacity, water quality parameters*
	Hotels	Monthly	Amount of abstraction, flow, water level,

			installed bulk meter, pump capacity, water quality parameters*
	Administrative offices	Quarterly	Amount of abstraction, flow, water level, installed bulk meter, pump capacity, water quality parameters*
	HPP	Daily	Amount of abstraction, flow, water level, installed bulk meter, pump capacity, water quality parameters*
3.	Commercial	Weekly	Amount of abstraction, flow, water level, installed bulk meter, pump capacity, water quality parameters*
4.	Industrial	Monthly	Amount of abstraction, flow, water level, installed bulk meter, pump capacity, water quality parameters*
6.	Irrigation	Weekly	Amount of abstraction, flow, water level, installed bulk meter, pump capacity, water quality parameters*

7.2 REPORTING

Reporting information on water resources allocation and management achieves several functions. It will enhance a degree of transparency and promote accountability in the allocation process. Reporting will be important ways of sharing information required by stakeholders to inform their decisions, including allowing water users to know current and predicted water availability in a particular water source. Monitoring report shall include but not limited to; Monitoring objective, date of monitoring, name and type of the

water source monitored, Participants, flows, quality of water, amount abstracted against permitted, non-licensed users at a particular source, amount abstracted, environmental flow requirement at source, water level, recharge amount. The monitoring reports shall be shared through Catchment fora, Basin fora and other relevant avenues.

7.3 COMPLIANCE AND ENFORCEMENT

The success of an allocation plan in achieving its broader social, economic and environmental objectives will depend on the level of compliance. The compliance will cover the compliance by water abstractors, different levels of government and government agencies, and water infrastructure operators.

The Basin Water Board shall be responsible for any necessary actions to defaulters identified during the monitoring exercise.

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