WRA
WATER RESOURCES AUTHORITY

Accounting for every drop!

Water Resources Status Performance Report

A report to the Public from Water Resources Authority For the Period 2021 -2022

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List of abbreviations

AG	Attorney General
AWL	Automatic Water level
AWS	Automatic Weather Station
CMS	Catchment Management Strategies
CoK	Constitution of Kenya
CSOs	Civil society organisations
DPs	Development Partners
EDCP	Effluent Discharge Control Plan
ENNBA	Ewaso Ngiro North Basin Area
FFEWS	Flood Forecasting and Early Warning System
FM	Flood Management
FMU	Flood Management Unit
FY	Financial Year
GCA	Groundwater Conservation Area
GW	Ground Water
KENAWRUA	Kenya National Association of WRUAs
KMD	Kenya Meteorological Department
LVNBA	Lake Victoria North Basin Area
LVSBA	Lake Victoria South Basin Area
M3/day	Cubic metres per day
M^3/s	Cubic metres per second
MCM	Million Cubic Metres
MWS&I	Ministry of Water, Sanitation and Irrigation
PDB	Permit Database
RVBA	Rift Valley Basin Area
SCMPs	Sub-Catchment Management Plans
SDGs	Sustainable Development Goals
SW	Surface Water
WAPs	Water Allocation Plans
WRA	Water Resources Authority
WRM	Water Resources Management
WRR 2021	Water Resources Regulations 2021
WRUAs	Water Resources Users Associations

Foreword

The Water Resources Regulations 2021 was published in February 2022 to operationalize the provisions of the Water Act 2016. The Water Resources Authority in implementing its mandate of regulating the management and use of water resources in Kenya has made great strides towards automating key services. This automation aims to ensure efficient and prompt service delivery to citizens.

During the 2021-2022 Financial Year, the Authority began the process of transitioning from the manual permit database to E-Permitting system. This will ensure timely permit issuance to applicants and increase efficiency in the apportionment and allocation of water resources, based on water availability for national development.

This report communicates to the public, water resources issues across the six basin areas in Kenya. It focuses on national water resources availability, the status of water quality in surface and groundwater as well as the Advanced Water Meter Management System. The report also highlights the Annual WRA Performance Contract which rated the Authority; amongst the Top 10 best performed state corporations in the country. This outstanding score was achieved through pragrams covering, Financial Leadership, Core Mandate, Service Delivery, Presidential Directive, AGPO, Promotion of Local Content and Cross Cutting Issues.

The Authority recognises the water sector policy and commits to promoting the realization of the human right to water towards universal access. It regulates the management and use of water resources through equitable allocation and apportionment. This ensures access to water for economic uses including irrigation and industrial production.

Mohamed M. Shurie, OGW
Chief Executive Officer
Water Resources Authority

Executive Summary

This report outlines the projects, programs and activities undertaken in the Financial Year commencing July 1, 2021 and ending on June 30, 2022.

During this period, there was an increase in water abstraction, to a total volume of 88,856,426.95 m^3/day, which includes water for hydropower, illustrating a 10% rise of 510,511.95 m^3/day. Additionally 1,173 authorizations were converted to permits and 576 expired permits were renewed. To enhance efficiency in water resources data collection, 45 weather and 5 groundwater stations were automated and configured to transmit data to the WRA server and 119 telemetric stations were maintained.

One notable achievement was the establishment and operationalization of the National Data Centre at the Headquarters, along with six regional data centres in Tana, Athi, Ewaso Ngiro North, Rift Valley, Lake Victoria South and Lake Victoria North Basin Areas to ensure a seamless roll-out of the smart metering.

In the protection of vulnerable ecosystems, the Authority carried out riparian marking and pegging with Water Resources Users Associations (WRUAs), where 325kms of the riparian reserve was marked and pegged with branded concrete beacons. Management guidelines were also developed for Marura swamp, Kajulu hills, Kabeere springs, and Manguo swamp, which were submitted to the AG's Office for alignment and forwarded to parliament for gazettement.

The Authority also undertook conservation efforts in Kikuyu and Lamu Groundwater Conservation Areas (GCAs). This included drilling one monitoring borehole in Ondiri and two in Lamu; planting 13,000 trees in Kikuyu springs and Lamu sand dunes; carrying out identification of coastal sand dune and conducting a hydrogeological assessment of Belebele well fields in Lamu.

Additionally WRA distributed 20No. 10m3 rainwater harvesting tanks to institutions near Lamu and Kikuyu GCAs.

The WRUAs also actively participated in soil and water conservation activities,including gabion construction, terracing and livelihood activitiessuch as bee keeping, dairy and poultry all aimed at motivat-ingcatchment conservation and promoting livelihoods opportunities. They were also involved in spring protection that led to improved water quality for use by the public.

In regards to water quality and pollution control, the Authority undertook quarterly monitoring upstream of Thwake and Karimenu dams; Developed guidelines for solid waste management for upstream of Thwake dam and disseminated results to stakeholders; Calibrated and standardized laboratory equipment; Assessed and characterized solid waste and their sources in the upper and middle Athi Basin Area.

Introduction

1.1 Content of the report

The report demonstrates the Authority performance in the financial year 2021/2022 in its various Basin Areas implementing its mandate of regulating the management and use of water resources.

1.2 River Basin Water Resources Management

Section 24 of the Water Act, 2016 requires the Authority, following consultations with the Cabinet Secretary, to designate a defined area from which rain water flows into a watercourse to be a basin area for purposes of the Act. In this regard, the Authority designated the 6 Basin Areas of Kenya and were gazetted vide Legal Notice 235 of 16th November,2021.

Kenya is naturally divided into 5 Drainage Areas or Basins, deriving their names from the dominate water body, namely:

- Lake Victoria Basin (divided into Lake Victoria North and Lake Victoria South for administrative purposes);
- Rift Valley Internal Drainage;
- Athi Basin;
- Tana Basin;
- Ewaso Ngiro North Basin

1.2.1 Kenya Basin Offices

WRA has 3 operational (functional) levels with 33 offices comprising of:

- 1 National Headquarters located in Nairobi (NHIFBuilding);
- 6 Basin Area Offices;
- 26 Sub Basin Area offices.

1.2.2 WRA Sub Basin Area within the Basin Area

Basin Area Office	Sub Basin Area Office
Lake Victoria North	Kitale, Eldoret, Siaya
Lake Victoria South	Kericho, Kisii, Kisumu
Rift Valley	Narok, Naivasha, Kabarnet, Kapenguria, Lodwar
Athi	Nairobi, Kiambu, Kibwezi, Loitoktok, Mombasa
Tana	Muranga, Kerugoya, Meru, Kitui, Garissa
Ewaso Ngiro North	Nanyuki, Rumuruti, Isiolo, Marsabit, Wajir

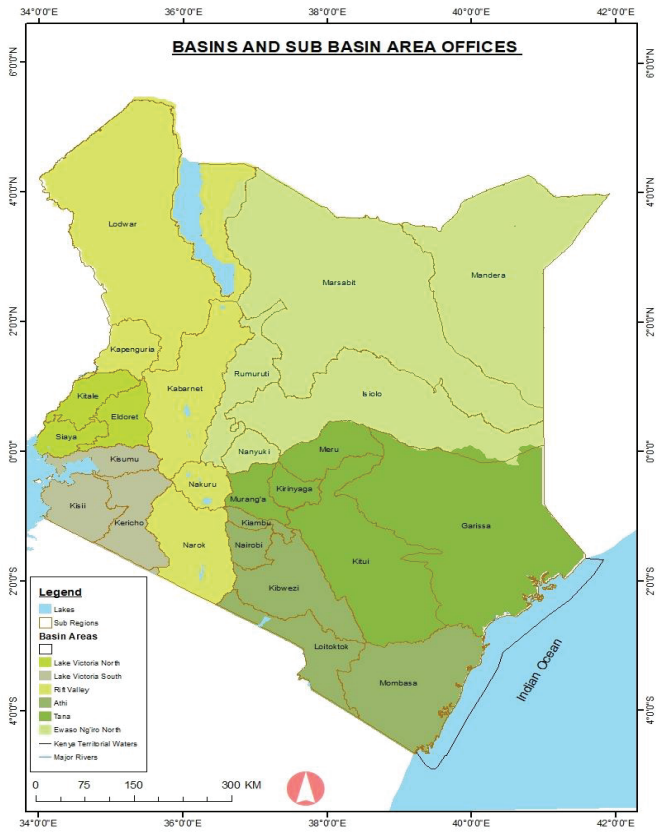

Fig.1. Kenya Basin Areas and Counties

I1.3 Highlights of major achievement

- WRA Performance Contract had a score of 2.0515 translating to "Excellent" in the Annual Performance Contract Evaluation conducted by the Public Service Performance Management Unit

- Kenya National Association of WRUAs (KENAWRUA) a lobby group for water resources activities, with membership of individual WRUAs across Kenya with good governance, was registered at the Attorney General with no objection letter from the Authority.

- Publication and operationalization of Water Resources Regula tions, 2021 which will streamline the water resources sector and assist the Authority in discharging its mandate.

- WRA through the Ministry of Water, Sanitation and Irrigation gazett ed, WRA Basin Areas as aligned to the Counties within the Basin Areas.

- All staff in the organization have been aligned to the new designa tions/positions as required by the establishment.

- Transitioning from manual permit database to E-permitting an online system for permit processing.

- In conservation and protection of water resources by WRUAs the following activities were undertaken 36 Springs protected, increased storage of 740M^3 through rain water harvesting tanks, 9No water pans constructed, 6 sand dams constructed with 2 Cattle troughs, establishment of two tree nurseries, construction of 20 gabions, Construction of 2 fish ponds, drilling of 2 No Boreholes, establishment of apiary with 40 beehives for bee keeping, construction of 1 common water intake. 6 Sub Catchment Management Plans were developed and 5 SCMPs were reviewed.

2. Regulating the management and use of water resources

2.1 Per Capita Water Availability

All the available water worldwide is contained in what is referred to as the hydrological cycle, which defines water per capita (amount of water available for each person per year). The water per capita is area specific and depends on the water availability in that area. The globally acceptable per capita water availability is 1,000m3 ,however in Kenya the average per capita is estimated at 620m3 which continues to decrease. With the growing population, Kenya faces enormouschallenges in the management of its limited water resources across most sectors of the economy, making water resources management a high priority.

It is therefore crucial to increase this figure through the conservation and protection of water resources, riparian and catchment areas.

2.2 Water Demand Verses Availability

According to the National Water Master Plan 2030, the total water demand will increase significantly against the available water by the year 2030. In the year 2010, the total demand was 3,218MCM/year against available 22,564 MCM/year (surface and groundwater yields).

The demand will rise to 21,468 MCM/year in the year 2030 against available 26,634 MCM/year as shown in the table below

Table.1. Available Water against the demand per Basin Area

Basin Area	Area (Sq Km)	2010		2030		2050	
		Demand	Available	Demand	Available	Demand	Available
Lake Victoria North	18,374	228	4,742	1,337	5,077	1,573	5,595
Lake Victoria South	31,734	385	4,976	2,953	5,937	3,251	7,195
Rift Valley	130,452	357	2,559	1,494	3,147	1,689	3,903
Athi	58,639	1,145	1,503	4,586	1,634	5,202	2,043
Tana	126,026	891	6,533	8,241	7,828	8,476	7,891
Ewaso Ng'iro North	210,226	212	2,251	2,857	3.011	2,950	1,810
Total	575,451	3,218	22,564	21,468	26,634	23,141	28,437

***Source**: National Water Master Plan (NWMP 2030)*

Athi, Tana and Ewaso Ngiro North Basin Areas will suffer water resource deficit as the demand will be higher than availability by the year 2030. However, the deficit might be realized earlier due to the impacts of climate change and if no proactive water resources and catchment management activities are undertaken.

2.3 Smart Metering

In order to operationalize the Water Act, the Water Resources Regulations 2021 (WRR 2021) were enacted and came into effect in February 2022. Regulation 77 requires that all abstractors install a smart meter within 2 years from the date the WRR 2021 came into effect. The requirement to install smart meters was informed by the fact that abstractors are scattered across the country and the previous requirement (under the repealed Water Resources Management Rules 2007) that they submit their meter readings was largely ignored, thus making it difficult to monitor abstraction and enforce compliance with permit conditions.

As part of the preparations for the migration to the smart metering system, WRA was required to develop a system that would receive, store, analyze and archive the meter reading data for decision making and support. Towards this end, the Government of Kenya, through the Cabinet Secretary to the National Treasury signed a Financing Agreement on 24th September 2020 with Stichting KIFFWA Foundation, Kenya Airports Parking Services and Earthview Management Limited for the development, financing and deployment of services, hardware and software to set up the Advanced Metering Infrastructure.

Fig.2. Installation of smart Meters

2.3.1 Advanced Metering Infrastructure

To actualize this and ensure the meter reading data is received, WRA is developing the Advanced Metering Infrastructure (AMI) for Online Capture of Water Meter Data system. The system will comprise of 4 modules:

- E-Permit module for receiving, processing and issuance of water use permits. This has replaced the stand-alone Permit Database (PDB) which has been in use for the last 12 years. The E-Permit is a web-based application which uses a central data base located at WRA headquarters and to which all the 33 offices of WRA (Headquarters, 6 Basin Area Offices and 26 Sub Basin Area Offices) involved in permit processing connect to. This has eliminated the need to transfer files between the differ ent levels thus improving efficiency;

- Meter reading module for receiving, processing and storage of water meter data from smart meters installed at abstraction points. During the transition period, the module will also receive and process meter reading data from the existing non-smart meters through the use of a Mobile Meter Reading App developed for that purpose;

- Billing module which acquires data from both the E-Permit and Meter Reading modules to generate invoices for abstrac tion and wastewater discharges and forward the same to the abstractor/discharger for settlement through an SMS or e-mail. The module is also capable of generating bills/invoices based on estimates using the permitted volumes in the E-Permit;

- Revenue management module which integrates the M-Pesa and KCB payment platforms into the AMI and allows all pay ments for assessment, permit issuance and water use charges to be validated and the abstractor/discharger account updatedautomatically.

Fig.3. The AMI Control room located at the Headquarters

2.4 Catchment conservation and protection - gazette ment and riparian

The Water Act mandates the Authority to protect catchment areas (Section 22) and groundwater conservation (Section 23) by preparing a Management Guidelines/Plan for the Protected (surface water) or Groundwater Conservation Area (groundwater). The Management Guidelines are prepared in conjunction with stakeholders in the area, describing the area and water resources issues, proposed measures required for the protection and conservation of water resources and proscribed activities within the protected or groundwater conservation area. The Guidelines are published as part of the Order in the Kenya Gazette, imposing such requirements or prohibiting some activities as may be considered necessary for the conservation of water resources.

WRA has gazetted various areas for protection and conservation; the following are among them:

- **Ngarelen Springs located in** Rombo and Njukiini Sub Locations of Rombo Location Kajiado County and a source of River Rombo (Ngarelen Springs Catchment Conservation Area, 2021- LN No. 207 of 2021

- **Kikuyu Springs Aquifer groundwater conservation area** located within Kiambu and Nairobi City Counties and a major recharge zone for Nairobi Aquifer Suite (Kikuyu Springs Aquifer Groundwater Conservation Area Management Order, 2021 LN No. 208 of 2021)
- **Lake Kenyatta Sub Catchment located within Lamu County** which is a source of water for Mpeketoni Division of Lamu West Sub County, Lamu County (Lake Kenyatta Sub Catchment Conservation Area Order, 2021- LN No. 209 of 2021).
- **Amu Sand-dunes located within Amu Island and** which is the main source of water for the island (Amu Sand-dunes Groundwater Conservation Area, Order 2021- LN No. 210 of 2021)

The following activities are expressly prohibited within protected areas: Tilling or cultivating, clearing of indigenous trees or vegetation, building of permanent structures, disposing any form of waste (in pit latrines, soak pits, septic tanks, solid waste dumpsites), excavating soil or developing quarries, planting of exotic species that may have adverse effect to the water resource and any other activity that in the opinion of the Authority may degrade the water resource; In addition, the process for the gazettement of 8 more areas is at an advanced stage, having been forwarded to the Attorney General's Chambers for perusal and transmission to Parliament for discussion and approval. These areas include:

- Kajulu Hills in Kisumu County;
- Ewaso Narok (Marura) Swamp in Laikipia County;
- Kabeere Springs in Laikipia County;
- Manguo Swamp in Kiambu County;
- Lari Swamp in Kiambu County;
- Karai Swamp n Kiambu County;
- Lake Ol Bolossat in Nyandarua County; and
- Mwangea Hills in Kilifi County.

In the financial year 2023 – 2024, WRA will initiate the protection through the Kenya gazette of the following areas:

- Fafi swamp in Garissa County;
- Kamatargui Wetland Conservancy in Nandi County;
- Kibirong Wetland in Nandi County;
- Chereni wetlands in Nairobi City and Machakos Counties;
- Eneyampuipui Swamp in Nakuru and Narok Counties;
- Siany wetland in Nyamira and Kisii Counties; and
- Mereroni -Mbaruk swamp in Nakuru County.

Riparian restoration was undertaken through riparian conservation; at least 113 Km of riparian reserve was marked and pegged. This will go a long way in ensuring that illegal activities are not carried out within the riparian reserves and provide the opportunity for ecological functions.

2.4.1 Planned Activities on the Protected Areas

Plans are under implementation to ensure that the gazetted areas are protected and conserved properly to avoid degradation and/or encroachment. The following are some of the planned activities:-

- Stakeholder engagements and initiatives on catchment management;
- Revegetation of the catchment area in partnership with stakeholders;
- Native Plant Propagation;
- Exotic species control;
- Water storage enhancement to ease pressure on use the resource;
- Promotion of rain water harvesting and related storage infrastructure;
- Controlling abstraction limits and observing of safe yields; and
- Controlling encroachment and cancellation of illegal titles.

The activities carried out in these recharge areas are done in collaboration with the Water Resources Users Associations, communities, National/County Governments among others.

2.5 Drying of Rivers

The Authority undertakes a number of activities to ensure that the available water resources are shared equitably and fairly, considering the needs of the environment (reserve flow) as well as the down-stream users. Due to the effects of climate change that results in rain-fall of high intensity for short duration, higher runoffs are realized (flash floods) at the expense of groundwater recharge (which is ideally realized with rainfall of lower intensity falling over a longer time). The impacts of climate change include longer and more severe dry sea-sons that occur with more frequency. These tends to impact negative-ly on the vegetation cover that leads to reduced infiltration of rainwa-ter and increased run-off. The reduced infiltration leads to depressed river discharges from the catchment areas leading to low water levels.

During drought flows go down while at the same time water demand from rivers increases exponentially as it is at times that the river is the only readily available water source. The situation has been made worse in some instances by the driving of livestock into water catch-ment areas in search of pasture, which has resulted in the trampling of the catchment and destruction of the vegetation cover resulting in reduced infiltration and hence reduced discharges. This has led to rivers drying up before they reach their full length.

2.6 Kenya Water Security and Climate Resilient Project

During the year under review, the Water Resources Authority through Kenya Water Security and Climate Resilience Project (KWSCP) finalized the upgrade of Flood Forecasting and Early Warning System (FFEWS) for Nzoia river basin. It comprises of the National Flood Forecasting Center at The Kenya Meteorological Department, Flood Impact Assessment Centre and Regional Flood Management Center at the Authority.

WRA supported five (5) WRUAs financially and technically in implementing catchment restoration activities focusing on soil erosion in targeted erosional hotspots. This effort aims to reduce sediment to the lower parts of the river basin that host Nzoia River Dykes and Bunyala Irrigation intake. The WRUA activities consisted of rehabilitating 1,135.5 ha of degraded land in their respective sub-catchments through terraces, riparian protection and rehabilitation, tree planting, and gabions.

Fig.4. Riparain Marking and Pegging of River Kisama funded by the KWSCP-WRA

2.7 Resource Mobilization and Partnership

The Authority developed 13No proposals, with 3No reaching the final stage for financing, 4No. undergoing negotiations, and 6No forwarded to the Ministry of Water, Sanitation and Irrigation to be included in sourcing for funds. The existing partnership with the Authority are, Dutch Water Authorities through Blue Deal Project in Upper Tana, Ministry of Agriculture, Livestock, Fisheries and Cooperatives (State Department of Livestock) in a project named "TWENDE" Towards Ending Drought Emergencies: Ecosystem Based Adaptation in Kenya's Arid and Semi-Arid Rangelands. The implementation of this project is in eleven (11) Counties. These counties include: Garissa, Tana River, Isiolo, Marsabit, Samburu, Kajiado, Kitui, Makueni, Tharaka-Nithi, Meru and Taita –Taveta.

WWF/IWRM-WASH Nexus Programme "Catchment to Tap Project" is aimed at developing an integrated program on water resource management in support of enhancing sustained water and sanitation supply in Kenya.
The program is to be implemented over a period of 5 years. This is collaboration between WRA and WWF.

Fig.5. Empowering Communities in the Tana Basin Area through the Blue Deal Project

2.8 WRA Certification ISO 9001:2015

WRA has been implementing the ISO 9001:2015 Quality Management System since 2010 and was first ISO Certified under 9001:2008 on 21st February, 2013 and successfully transited to ISO 9001:2015 that took effect in September 2015.
The organization went for ISO 9001:2015 and got certified in February 2020. To ensure certified entities continue implementing the QMS, the certifying body keeps watch by conducting early surveillance audits for the three years of the certificate.

During the year 2021-2022 WRA underwent 1st surveillance Audit that was carried out in July 2021 having been certified on 14th February 2020 and due to expire in February 2023. Due to organizational changes during the year that included some changes in its mandate and operational processes including the logo, the organizational QMS documentation was revised accordingly. The Authority retained the ISO certification and continues to implement the QMS in readiness for 2023 before applying for recertification on expiry of the three-year certification.

2.9 Human Resource and Staff Competence

The approved Human Resource Policy instruments continued to be implemented, in adhering to the pension policy there was timely payment of Pension to retiring staff. Staff of the various cadres were promoted, there was increase in staff trainings, the biometric clocking system was operationalized increasing timely reporting and efficiency in service delivery. There was smooth transition of staff retiring due to the implementation of succession planning.

2.10 Laboratory Operations

The Authority is mandated to provide water quality and pollution analytical services at its various laboratories across the country. The Central Water Testing Laboratory in Nairobi is the national referral laboratory. Other Laboratories are located in Kisumu, Kakamega, Nakuru, Naivasha, Murang'a, Embu and Nyeri which serves Ewaso Ng'iro Basin Area. These laboratories serve the internal and external customers by providing the necessary data for informed decisions in regard to various uses of water. Kenya Bureau of Standards has undertaken calibration and standardisation of the laboratory equipment. The certification process is ongoing.

Fig.6. Lab Technician analysing radon 22 at the CWTL

2.11 WRA Capital Projects

The Authority contributes to the Kenya Vision 2030 by implementing capital projects which are strategically located in specific drainage basins that are vital in achievement of the vision 2030. During the reporting period the Authority implemented the following capital projects:

2.11.1 Lamu Groundwater Conservation

The Authority implemented various activities within the Lamu Groundwater Conservation Area to conserve and secure the amu sanddunes aquifer which is threatened by sea water intrusion. The conservation efforts are geared towards ensuring sustainable supply of fresh water in Lamu Island.

The project outcome is to ensure that groundwater resources are secured and recharge area completely protected from encroachment.

The Lamu Groundwater Conservation Area management plan was implemented by development of a Water allocation Plan for Amu Island, Planting of 10,000 trees, installation of 10No. plastic tanks 10m3 rainwater harvesting systems to 10No. public institutions within Amu WRUA, construction of 2No. Djabias and construction of 2No. groundwater monitoring wells. The water sector institutions participated in a tree planting exercise within the sand dunes.

The Authority embarked on identification of other coastal sand dunes aquifers within Lamu County with a view to augment the Shella – Kipungani Lamu sand dunes aquifer which is currently under a threat of over abstraction. An additional three sand dunes with good groundwater potential were identified. These are Tewe, Kiwayu and Murnadine – Bargoni – Mashini. A hydrogeological assessment of the Belebele well field was also undertaken to assess the impacts of abstraction on the water levels and water quality within this crucial water resource.

Fig.7. Tree planting activity at the Lamu sand dunes

2.11.2 Kikuyu Groundwater Conservation

Kikuyu Groundwater Conservation Area (GCA) is a key groundwater recharge area for the Nairobi aquifer suite. In an effort to protect and conserve the Kikuyu GCA, the Authority implemented various activities which included; development of management guidelines for gazettement of Manguo swamp, drilling of one monitoring borehole to monitor groundwater levels and water quality, planting of 5,000 trees, provision of 10No, 5m3 plastic tanks to public institutions, marking and pegging of the riparian area of Manguo swamp.

2.11.3 Implementation of Sub Catchment Management Plans

Implementation of Sub-Catchment Management Plans (SCMPs) is an important step towards protection and conservation of catchment areas. This ensures communities have access to clean water in adequate quantities in accordance to the constitutional requirement. In addition, SCMP implementation provides a platform for communities to participate in decision making and provide local solutions to chronic water related problems by integrating science and local knowledge.

The Authority provides technical support to the WRUAs to ensure activities are implemented professionally and in a timely manner to achieve their intended purpose.

During the year under review, in collaboration with other stakeholders, the Authority supported WRUAs to undertake implementation of the following activities;

- Construction of 5No springs by Safu and Bukhungu WRUAs in Nzoia watershed, Kakamega County, Lake Victoria North Basin.
- Construction of 20No gabions by Safu (8No.) and Isiukhu (12No.) WRUAs in Nzoia watershed, Kakamega County, Lake Victoria North Basin.
- Construction of Morumbus and Kapsimatia Water pans by Kamasian and Bendera WRUAs respectively, West Pokot County, Rift Valley Basin Area.
- Developed 4 No. SCMPs namely, Lagha Bulale in Garissa County, Githombokoni Mandune, Ndarugu and Mukuyu SCMPs in Kiambu County in Tana and Athi basins respectively

Fig.8. Spring protection done by Mumias WRUA in Nzoia watershed, Kakamega County, Lake Victoria North Basin

2.11.4 Water Abstraction and Pollution Surveys

Abstraction and pollution surveys are important for the Authority and water users as the information obtained is used to develop a Water Allocation Plan. The Water Allocation Plan informs equity in water allocation for different water uses that enables decision making and reduces water use conflict through enhanced water resources regulation and management. These surveys also inform enforcement for compliance to permit conditions, sensitise communities on legal water use, legalise water use. There were four Water Abstraction and Pollution Surveys done for these sub catchments of Moiben, Ngong, Mbagathi, and Mweteta.

2.11.5 Drilling of Exploratory Boreholes

In order to enhance and strengthen assessment and monitoring of Groundwater resources, the Authority drilled 8No. exploratory boreholes for data collection, mapping and classification of aquifers. To facilitate groundwater data acquisition 6No. electrical dippers, and 4No. sets PQWT geophysical equipment were procured. The Nairobi aquifer suite water allocation plan was adopted by stakeholders to guide groundwater resources allocation.

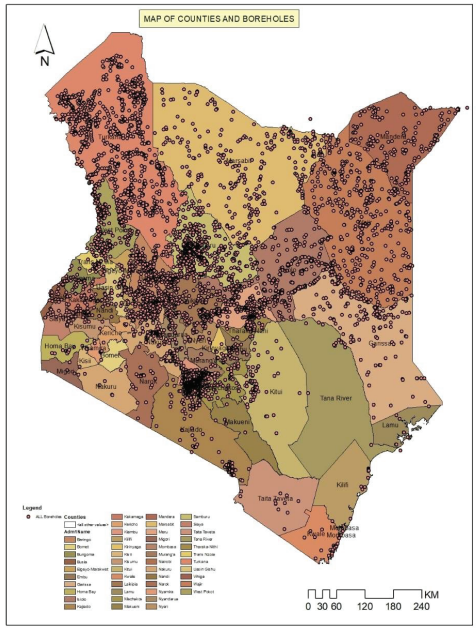

Fig.9. Borehole distribution in the country

2.11.6 Athi River Restoration Programme

Athi River basin is most threatened by pollution in the country, pollution hotspots have been mapped and enforcement carried out to mitigate pollution. A total of 26No. points were assessed, sampled, analysed insitu and at the laboratory. There are available datasets generated from the mapping and georeferencing. In monitoring upstream of Thwake, 469No. pollution points were mapped, including solid waste dumping, sewer bursts and soil dumping, car/motorbike washing, markets, urban centers and informal settlements which were georeferenced along the rivers. 142No. monitoring points were sampled and analysed. 14No. Effluent dischargers checked for compliance through inspection, sampling and sample analysis mapping and geo-referencing. 33 datasets generated and available. 28No. Stakeholders involved in marking and pegging exercise. Water Quality Monitoring generated 142No. Data sets. -Pollution point(s) monitoring and enforcement generated 330No. Data sets.

2.11.7 Telemetric Station

The Water Resources Authority embarked on its program to automate and upgrade its monitoring stations to transmit real time data to ensure quality data and timely transmission. This is coupled with installation of a Water Resources Information Management System (WRIMS) that enables data management, data processing and information packaging. The information is used in apportioning and allocating water resources as well as for regulation and enforcement purposes. The key outputs and products include:

- Country/County/Basin water resources assessment and databases indicating water resource availability in terms of quantity and quality;
- Models for Water resources forecasting and to guide investments;
- Models for Flood early warning;
- Hydrological reports and bulletins (year books, quarterly and monthly water situation reports) to inform all water users on the water situation in country;
- Criteria for water allocation and apportionment;
- Scenarios for water resources planning, balancing, transfers and development; and
- Data and Information for Management of Floods and Droughts.

Prior to the FY 2021/2022, WRA had installed 73 surface water and 14 ground water telemetric stations distributed across the basins. The target is to upgrade a total of 300 stations to telemetry by the year 2030.

During the period under review, WRA configured 45 Automatic Weather Stations to transmit data to WRA as a backup server. The stations were upgraded to telemetry in the year 2020/2021 under the Kenya Water Security and Climate Resilience Project (KWSCRP) and transmitted data to the Kenya Meteorological Department.

Table.2. List of Stations Upgraded to Telemetry

Basin	Station ID	Station Name
LVS	AWS	Sigor DCC Office
	AWS	Bomet Huduma Centre
	AWS	Sotik VeterinaryOffice
	AWS	Tebesonik Secondary School
	AWS	Soin Agricultural Training Centre
	AWS	Kaptele Primary School
	AWS	St. Monica Marani Girls High School
	AWS	St. Anjela Sengera Girls High School
	AWS	St. Peters Suneka Boys Secondary School
	AWS	Gianchere Friends School
	AWS	Kongoi Weather Station
	AWS	MoAWF Kilgoris
RV	AWS	Heni Secondary School
	AWS	Lake Nakuru National Park
	AWS	Elburgon Forest Station
	AWS	MoALF Ololulunga
	AWS	Suswa Ramat Holding Ground

Basin	Station ID	Station Name
Athi	AWS	Lenkisim Mixed Secondary School
	AWS	Ruiru G. K. Prison
	AWS	Gatatha Farmers Company
	AWS	Limuru Sub County HQS
	AWS	Mua Hills Girls High School
	AWS	Deputy County Commissioner Office Matungulu
	AWS	Kathiani Girls High School
	AWS	Mukaa Sub County HQS
	AWS	Mukaa Boys Secondary School
	AWS	Kitoto Secondary School
Tana	AWS	Kangeta Primary School
	AWS	Caritas Kamaindi
	AWS	Caritas Kanjoro
	AWS	Sagana State Lodge
	AWS	Gathaithi Primary School
	AWS	Wanjerere Meteorological Site
	AWS	FTC Kenyatta Farm
	AWS	Kimakia Forest Station
	AWS	Christ the King Igembe School
	AWS	Kyome Boys Secondary School
	AWS	Kanyangi Girls Secondary School
	AWS	St Paul Ikanga Boys High School
	AWS	St. Lukes Kavia Secondary School
	AWS	Thiba WRA SRO
ENN	AWS	County Commissioner Isiolo (NEMA office)
	AWS	Kiandongoro Forest Station
	AWS	Kambaa Technical Secondary School
	AWS	Ndaragwa Forest Station

2.12 Upgrading Flood Forecasting and Early Warning System

In the financial year 2021/2022, the project undertook implementation of upgrading of the Flood Forecasting and Early Warning System (FFEWS) for Nzoia river basin and upgrading of old Nzoia FFEWS Automatic Stations.

WRA undertook flood inundation mapping which was informed by forecast data from the FFEWS system installed at Kenya Meteorological Department. Other deliverables from the implementation were: Upgrading of 13 AWS and 12 AWL in Nzoia basin. In other sub basin areas there was installation of: Atomic absorption spectrophotometer equipment at the Central Water Testing laboratory, 16 Automatic Water level (AWL) stations, 45 Automatic Weather Stations detailed list of stations and their locations annexed. Annex 1. Below is a screenshot of the installed FFEWS system in KMD.

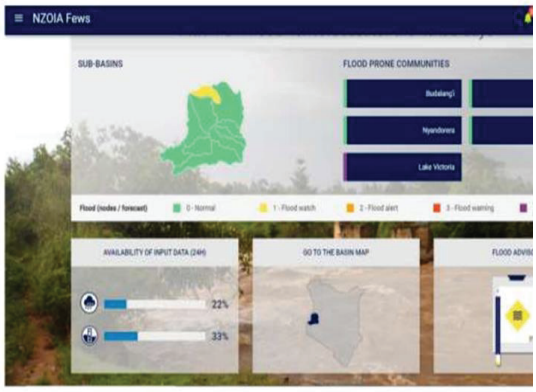

Fig.11 ***Screenshot of the installed FFEWS systems in KMD***

Fig.12. Installed Atomic Absorption Spectrophotometer Equipmen

Fig.13. Ruiru GK Prison AWS and Ewaso Narok AWL

2.13 Water Quality Status

Water quality determines availability of water for use and nature determines the quality. Groundwater quality is determined by age, geology, human activity, interaction between ground, surface water and biological process. The surface water bodies are vulnerable to point and nonpoint sources of pollution. Surface water undergoes self-epuration. The Authority endeavours to continuously ensure water resources are in good quality through engaging stakeholders and undertaking monitoring and enforcement.

2.13.1 Waste Management practices

The water resources as surface water bodies – lakes, streams, rivers, pans ,dams; and ground water bodies – springs, shallow wells and deep wells traversing the urban and peri-urban areas are threatened with pollution from improper solid and liquid waste management. The cases of solid and liquid waste are prominent in the informal settlements and places where riparian reserves are critically encroached.

The solid waste management chain fails to undertake / implement;

- Coordinated segregation of solid wastes at the source;
- Transfer of the solid wastes to the approved and designated waste recovery sites and dumpsites; and
- Science – based Investments to establish and operationalize wastes circularity and sanitary landfills, a shift from linear to circular economy.

Majority of the dumpsites are located on the riparian reserves and causes pollution to the water resources with surface water bodies being more vulnerable. In the case of liquid wastes, failure to collect wastewater through functional sewer lines, satisfactorily manage wastewater conveyance system, unsatisfactory operationalization of wastewater treatment plants, effective treatment of wastewater to acceptable standards before discharging to the environment. As such, the conservation and protection of the freshwater resources will only result from sustained and effective solid and liquid wastes management alongside preserving ecological riparian reserves through integratedstructural and non-structural approaches that include satisfactory spring protection and management.

Kochieng spring before protection

Well managed Kochieng Spring after protection

Fig.14. ***Unsatisfactorily managed protected spring***

2.13.2 Water Pollution

Water pollution is caused by intentional and unintentional human activities. During dry season the surface water bodies have low flows (base flows) and dependence on groundwater increases. Point sources of pollution are defined as sources with a specific origin and have traceable point of entry into the water course, while non-point/-diffuse sources of pollution are non-specific in nature.

WRA in collaboration with stakeholders who include WRUAs intensifies nationally the water quality surveillance and monitoring through in-situ and laboratory bench analyses and enforce compliance to the regulations for sustained conservation and protection of freshwater resources from pollution. In wet seasons the quality of water in the water resources is improved due to dilution effects. However, pollution from non-point sources remains to be of concern and complex to manage satisfactorily.

2.14 Water Resources Information data handling

The Authority has a water resources information system which is a comprehensive and flexible data management and data integration system, focused on making temporal and spatial data sets available for a variety of purposes. The system uses a Postgres geodatabase as the background database for data storage and processing. The main features of MIKE INFO include:

- Storing of GIS datasets;
- Storing of time-series data;
- Reporting capabilities; and
- Publication and data saring

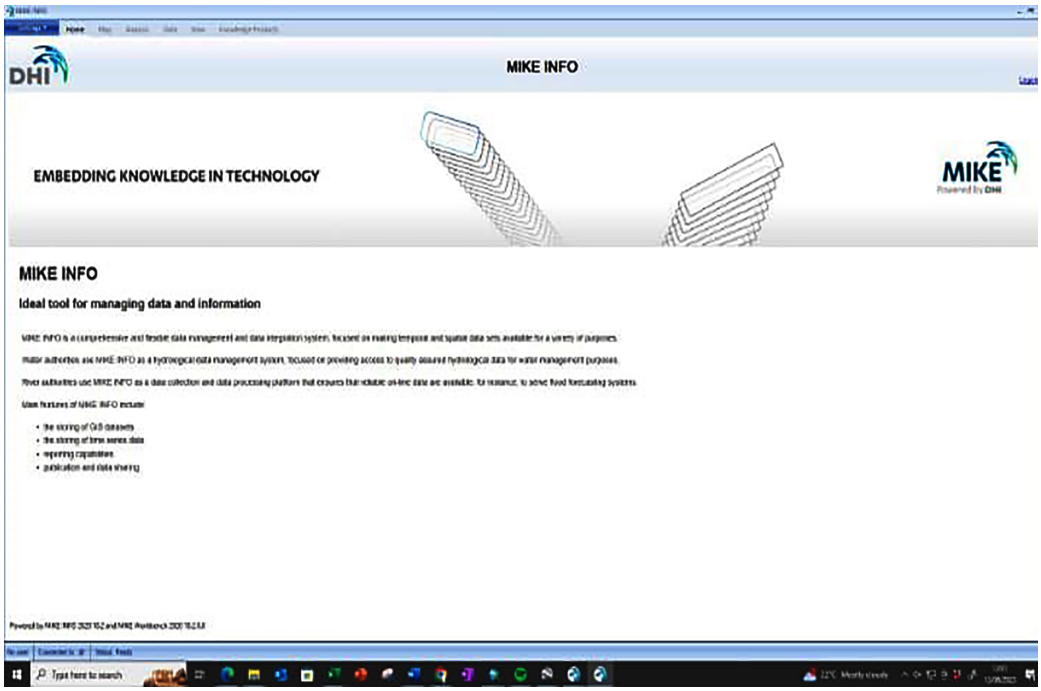

Fig.15. Mike Info Database Login Page

2.14.1 Types of data collected

The Authority collects water resources data from different regular gauging stations within the country. The regular gauging stations are classified as either National, Management or Special stations. Gauge readers are engaged by the Authority in data collection. The types of water resources data and information collected by the authority include: -

- Rainfall
- Climate
- Water level and Flow/discharge
- Reserve flow
- Flood water
- Ground and Surface water quality
- Groundwater
- Drainage basins
- Pollution sources
- Abstraction
- Water Resources Maps

The frequency of data collection is determined by the hydrological and hydrogeological practices and standards within the profession. The frequency of data collection is as indicated in the table below: -

Table.3. Data collection schedule

S/No	Frequency	Type of Data
1.	Hourly	Rainfall, water levels and climate (Few stations)
2.	Daily	Rainfall, water levels, climate
3.	Monthly	Ground and surface water
4.	Quarterly	Ground, Water quality

2.14.2 Data sharing and dissemination

This data is available in all the offices of the Authority across the country. However, every basin area, sub-basin area only has access to data from stations within their jurisdiction. The national database at the WRA headquarter has data from all the stations in the country. The data is available upon a formal written request to the Authority by the user.

WRA also disseminates this information to the public through different fora and media. Some of the methods include: -

- Basin fora
- WRUA sensitization and formation
- World Water Day
- WRA Website: www.wra@go.ke
- Social media - @WRA_Kenya and Facebook

The Authority also produces regular publications and reports for internal and public consumption. Some of the reports and publications are produced on a quarterly, semi-annually and annual basis. They include:-

- Performance Report
- Hydrological year book
- Quarterly Water situation reports
- Water Resources monthly Bulletins
- Annual Performance Contract reports

2.14.3 The Data acquisition procedure.

Water resources data collected by the Authority can be access and issued in line with the laid down procedures of the Authority with guidance from the WRA customer service charter and the Water Resources Regulations 2021.

The client has to follow the laid down procedure as: -

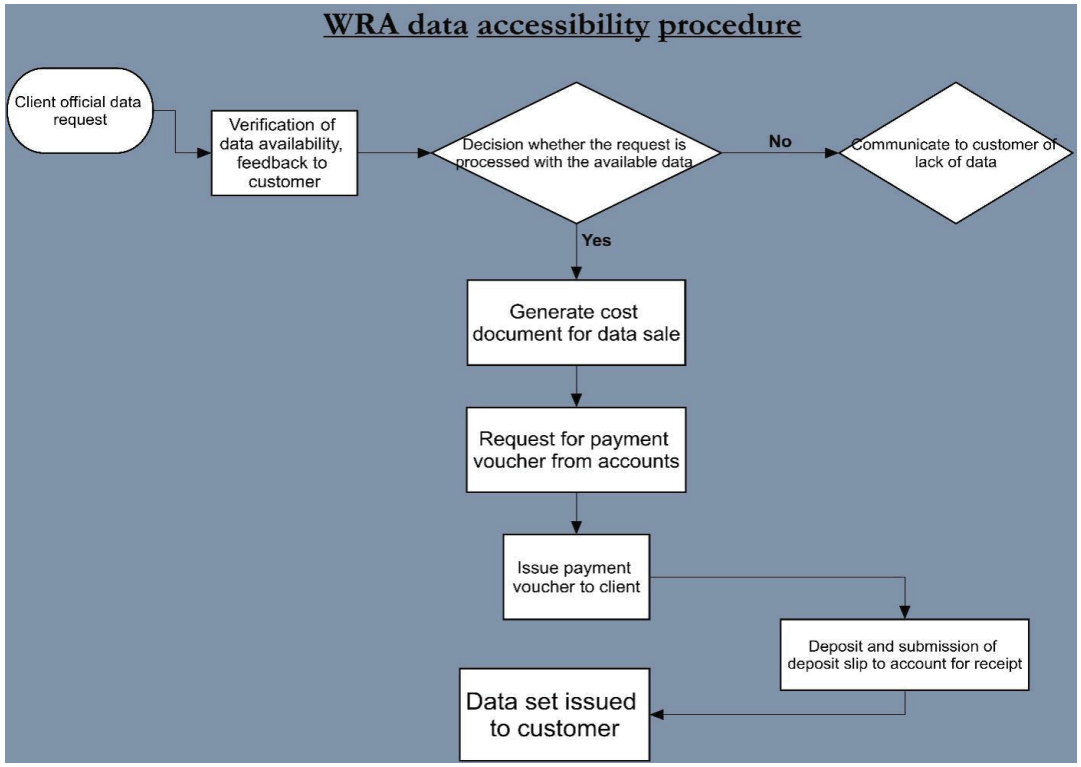

Fig.16. WRA Data Accessibility ProcedureFlowchart

2.14.4 Achievements

- Upgrading of Water Resourcing Monitoring information system using (Mike IPO)
- Establishment of real time (Telemetric) RGS data portal for viewing publishing and archiving and dissemination of data
- Development of WR spatial Geo database
- Use of Open Data Kits used to relay data through mobile phones to WRA cloud servers
- WRUA boundaries delineated and updated for the whole country
- Database profile and data inventory generated
- Development of RGS mobile App
- Creation of cloud repository of relevant WRM reports and interactive Atlas
- Development of 6No WRA Basins models for Regulation and Water Allocation
- Digitization of SW and GW hardcopy data in the MWI

2.14.5 Water resources data and its contribution to the Kenya Vision 2030

Kenya Vision 2030 refers to a long-term development blueprint for the country. The country aspires to achieve these goals by the year 2030. The blueprint is aimed at creating a globally competitive and prosperous country with a high-quality of life by the year 2030. The blue print aims to transform the country to a newly-industrialising, middle income country providing a high quality of life to all its citizens in a clean and secure environment. Water is at the core of achieving these goals. The Water Resources Authority has a role to play in achieving these goals as it is the lead agency in water resource monitoring and apportionment. The Authority works with different stakeholders to achieve these goals. The Water Resources Resource Centre is charged with the responsibility of storing and disseminating water resources data and information to different stakeholders and consumers of this data.

The Water Resources Resource Centre division plays a role in disaster risk reduction and ending drought emergency by: -

1. Providing critical weather data for the development of the Integrated Drought Early Warning system which can be used to trigger response by different actors in the country.
2. Contribution to the integrated knowledge management system for drought where data, information and learning on drought and ending drought emergencies will be collected, collated and disseminated.
3. Storing and sharing data on groundwater mapping in the Northern frontier counties for ground water situation analysis

3 WRA PERFORMANCE

3.1 Water Allocation

3.1.1 Management of water use through the permitting system

The Authority allocates water through a permitting system, the permit classes are categorized as A, B C, D. A is for basic human needs and not motorised; this should be reported to WRA Sub Basin Area office for approval. This is important when calculating water balance. Class B is approved at the Basin Area and doesn't have much impact on the environment, Class C and D is advertised and thereafter C is approved at the Basin Area and D is approved at the Headquarter. Each category is within thresholds which varies per water body and basin.

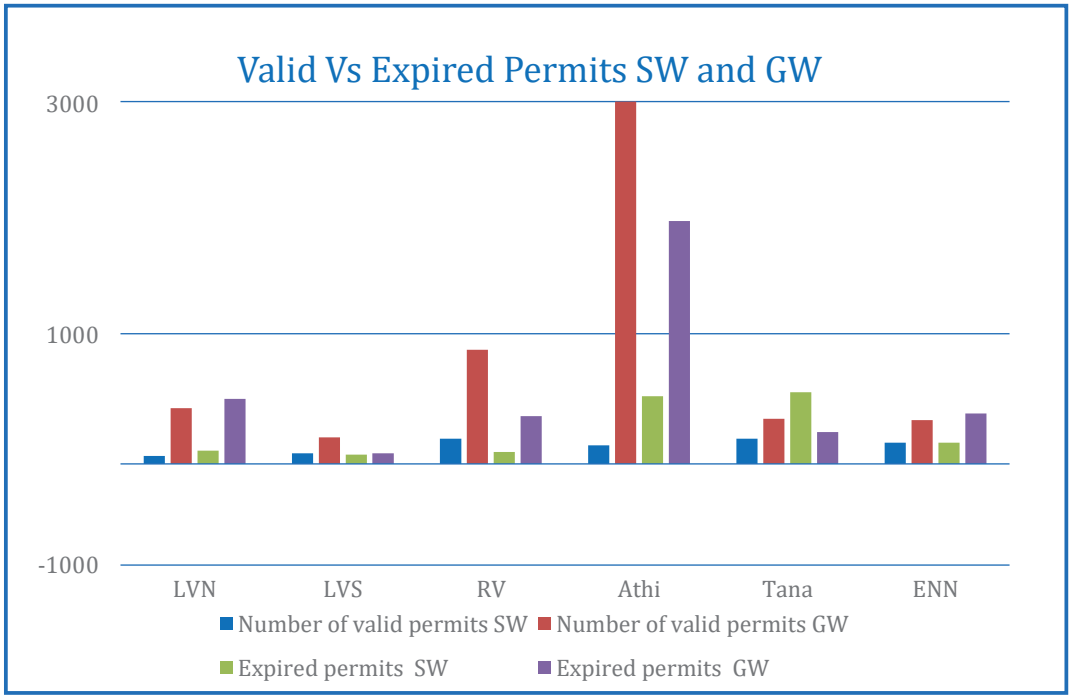

Fig.18. Valid and Expired Permits

Athi had the highest number of valid and expired permits for groundwater permits. Tana had the highest number of valid and expired permits for surface water. LVN had the lowest number of valid permits for surface water and LVS had the lowest valid permits for groundwater. LVS the lowest number of expired permits for surface water and groundwater.

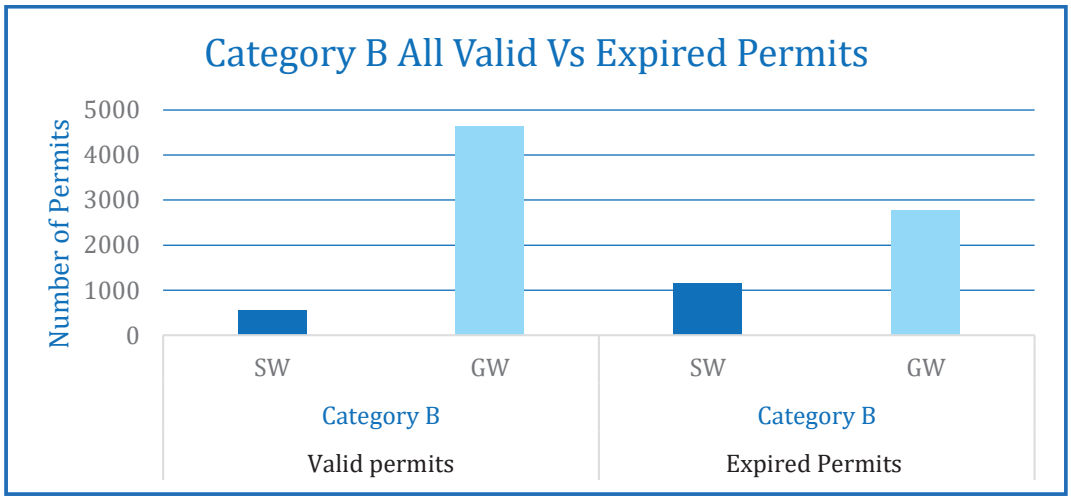

Fig.19. Valid and Expired Category B Permits

During the period category B groundwater had higher valid permits than surface water abstractions. Category B surface water abstractions with expired permits were higher than those with valid permits. This demonstrates the results of the Authority enforcing its regulations to ensure abstractors, abstract water under permits.

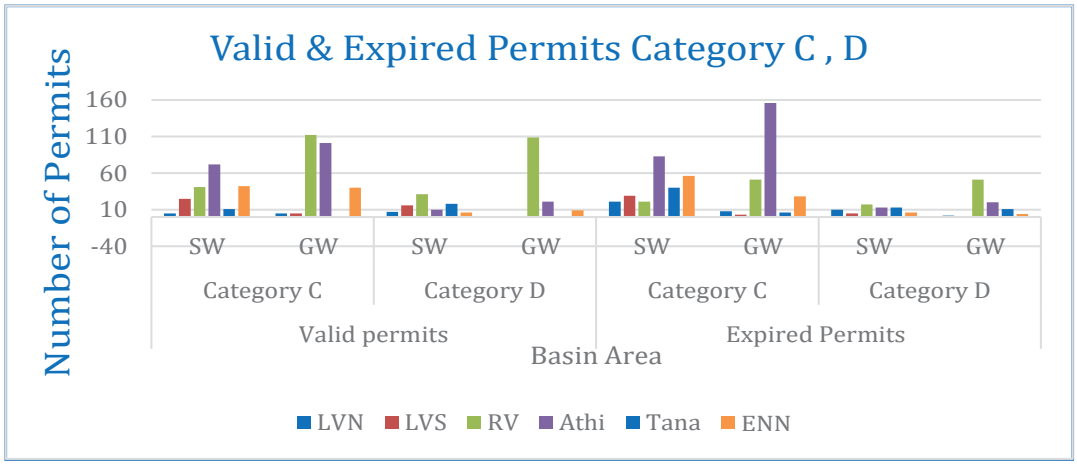

Fig.20. Valid and Expired Category C and D Permits

Rift Valley Basin Area had the highest number of category C valid permits for GW, while Athi Basin had the highest number of category C valid permits for surface water. RV had the highest valid permits for Category D both for Surface water and groundwater. Athi had the highest number of Category C surface water and groundwater expired permits and thus more efforts shall be put on enforcement to ensure the expired permits are renewed.
Cumulative abstraction with measuring devices and permitted up to June 202

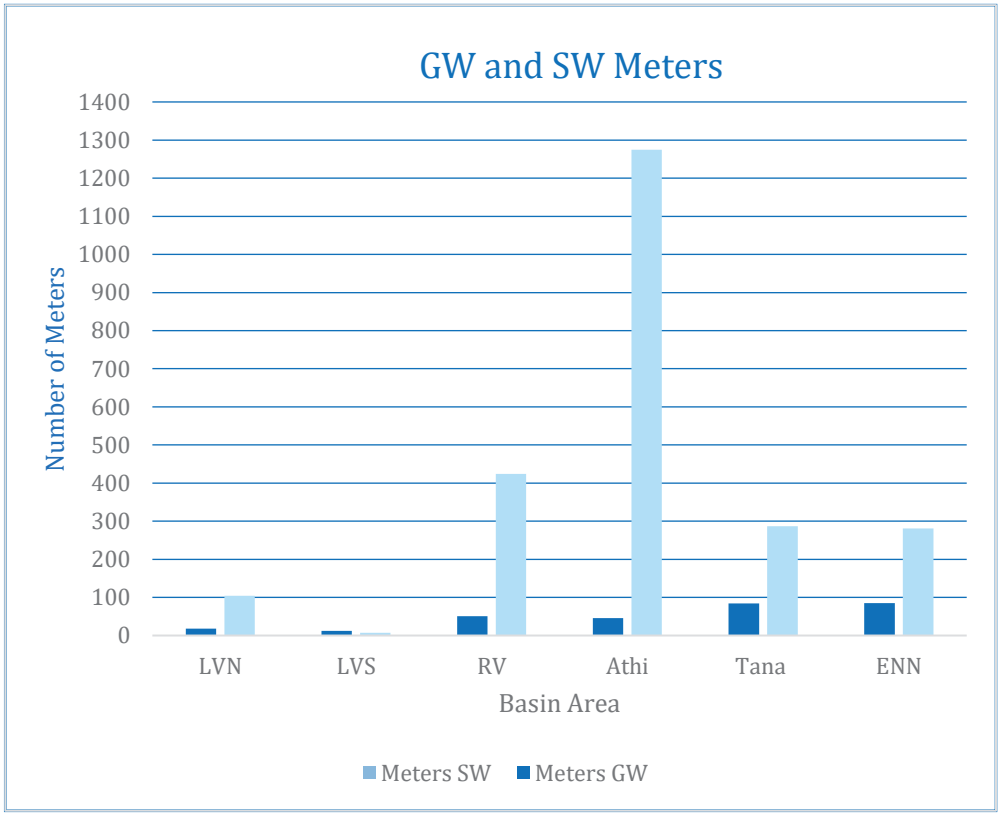

Fig.21.cumulative Abstractions With Measuring Devices

Athi had the highest number of meters for groundwater abstractions while ENN had the highest number of surface water meters installed.

3.2 Water Allocation Criteria

3.2.1 Water use by category

Table.4. Water use by category

Volume of water by category of water use up to June 2021 (x 1000 m^3/day)														
	Public		*Domestic*		*Livestock*		*Irrigation*		*Industrial*		*Power*		*Other*	
	SW	*GW*	*SW*	*GW*	*SW*	*GW*	*SW*	*GW*	*SW*	*GW*	*SW*	*GW*	*SW*	*GW*
LVN	88.15	0.92	10.04	16.29	2.03	0.23	11.1	0.29	123.3	0.23	411.5	0	12.4	0.18
LVS	104.75	0.23	6.64	6.04	0.012	0.08	17.14	0.12	24.12	0.31	2646.5	0.01	1.9	0.09
RV	8.61	64.5	5.75	22.8	3.6	1.9	55.04	202.24	0.47	3.24	1657.9	0.32	6.18	8
Athi	84.2	60	12	102.33	0.16	2.44	288.14	31.16	38.33	31.4	0.07	1.48	1.06	1.75
Tana	407.8	10.7	488.2	10.7	3.7	1.8	934.9	1.9	12.1	0.14	80628	0	60.1	1.1
ENN	30.6	2.23	45.3	8.7	6.5	0.99	101.9	22 4.4	0.71	0.18	0.07	4.4	0.165	

Table.5. Status of surface water storage

	PANS	Class of Dam as at June 2022		
		CLASS "A"	CLASS "B"	CLASS "C"
No. of applications	0	68	10	5
Valid authorizations	11	25	6	0
Expired Authorizations	5	149	129	18
Valid permits	1	20	28	5
Expired permits	3	13	349	6
Valid+ expired permits	4	33	377	11
Total storage capacity (m3) (valid + expired permits)	**29,262**	**1,610,035.33**	**8,848,99.83**	**3,516,140.63**

3.3 Engagement of WRUAs in Catchment Conservation and Restoration

The optimum number of Water Resources Users Associations (WRUAs) to be formed in the country by WRA is 1237. As at June 2022 there were 756 WRUAs established cumulatively.

Establishment of WRUAs is critical since they provide a platform for communities and stakeholders to collaboratively manage water resources and manage water related conflicts. The data above therefore displays the number of potential WRUAs per basin areas and the achievement towards realising this potential. During the year under review the status of WRUA formation was as follows; LVN Basin had achieved 89%, LVS Basin had achieved 78%, Rift Valley Basin had achieved 49%, Athi Basin had achieved 78%, Tana Basin had achieved 57% and Ewaso Nyiro North Basin had achieved 39%. This therefore means that Lake Victoria North had the highest number of WRUAs formed (89%) compared to Ewaso Nyiro North which had the lowest WRUA formation (39%). This might have been attributed to the vastness of the basin areas, insecurity challenges and inadequate financing.

This notwithstanding, 26 new WRUAs were formed during the period under review as compared to the previous year. This may be attributed to the realisation of the importance of WRUAs in managing conflicts and water resources.

Table.6. Progress in formation of WRUAs and SCMP implementation up to June 2022

Basin	WRUAs Formation Status			Status of SCMP Development			SCMP Implementation	
	Potential	Achieved	Proportion (%)	Potential	Achieved	Proportion (%)	Total	Proportion %
LVN	106	94	89	106	68	64	5	7
LVS	137	107	78	137	51	37	3	6
RV	175	86	49	175	50	29	3	6
Athi	240	188	78	240	87	36	6	7
Tana	309	175	57	309	91	29	29	32
ENN	270	106	39	270	70	26	4	6

NB: The SCMP Implementation varies from year to year.

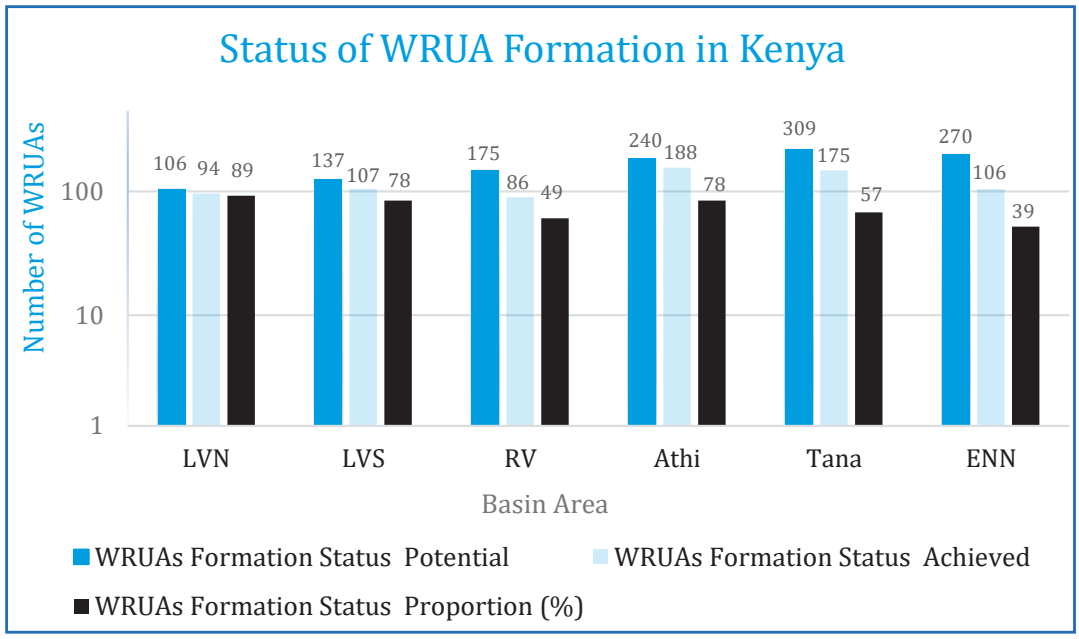

Fig.22. Number of WRUAs formed as at June 2022

WRA provides technical support to WRUAs in preparation of Sub-Catchment Management Plans (SCMPs). During preparation of SCMPs, science and local knowledge is used to analyse and map out water resources issues in the sub-catchments, to arrive at interventions which can be implemented to solve the identified issues. The SCMPs are used as a shopping basket for WRUAs to seek for funds to implement the unique water resources issues for each sub-catchment.

The data above shows the numbers and percentage of SCMPs developed to date cumulatively in comparison to potential number achievable. During the period under review, LVN Basin had achieved 64% in development of SCMPs, LVS basin had achieved 37%, Rift Valley basin had achieved, 29%, Athi basin had achieved 36%, Tana Basin had achieved 29% and Ewaso Nyiro North Basin had achieved 26% in development of SCMPs out of the total potential number to be achieved for the basin area. This meant that LVN Basin had the highestpercentage of SCMPs developed (64%) compared to Rift Valley andTana Basin areas which were at 29% each. Some of the factors whichmay have influenced the difference may include availability of funding and vastness of the basin areas.

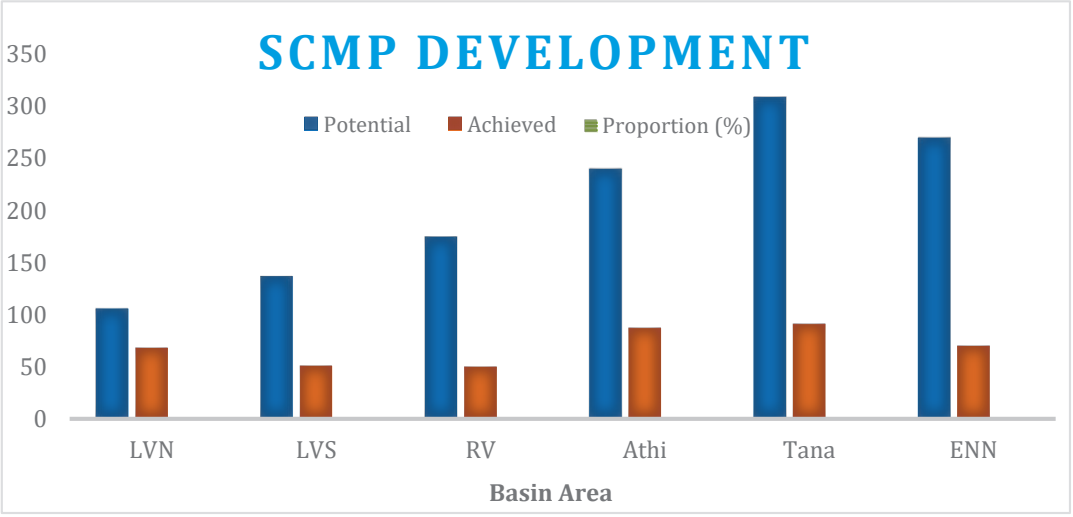

Fig.23. Number of SCMPs Developed as at June 2022

WRUA Members preparing a community resource map during SCMP Development Exercise

Implementation of SCMPs is important in ensuring the WRUAs address some of the water resources challenges facing their subcatchments.

This helps to improve catchment conditions, increasing water availability, protection of vulnerable water ecosystems, improvement in water quality and improved adaptation to the effects of climate change among other benefits.

The data above shows that during the period under review, LVN Basin implemented 5 SCMPs, LVS implemented 3 SCMPs, RV Basin implemented 3 SCMPs, Athi Basin implemented 6 SCMPs, Tana Basin implemented 29 SCMPs and ENN Basin implemented 4 SCMPs. This was orchestrated by a number of WRUA funding projects supported by various partners coming to a close. A number of new projects are in the pipeline to support the WRUAs to implement SCMPs.

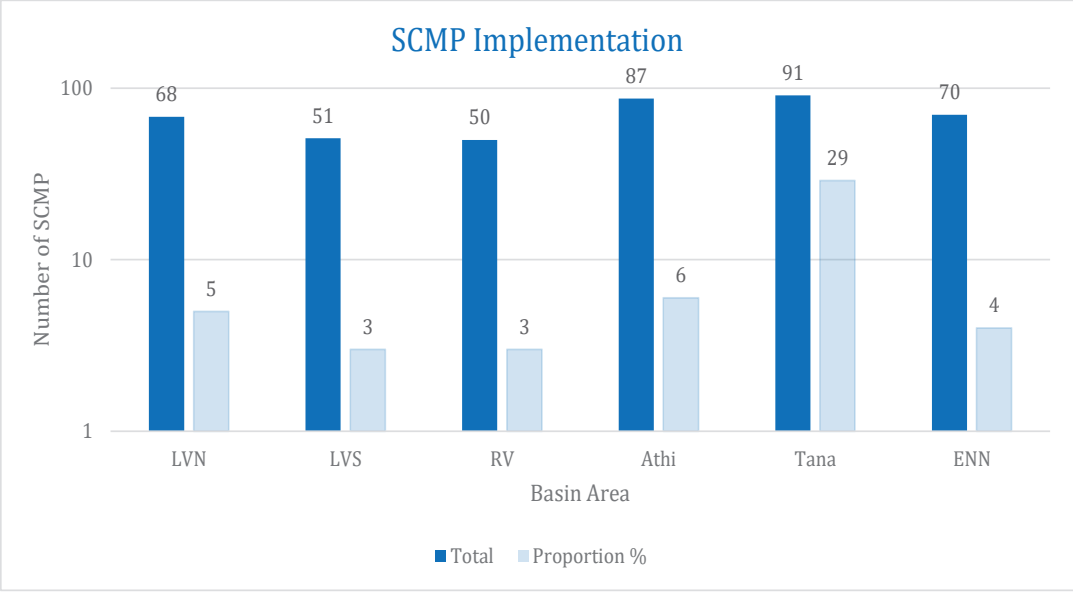

Fig.24. Status of WRUA Implementation as at June 2022

3.4 Water Resources Assessment and Monitoring

3.4.1 Water resource availability

Assessment of water resource potential was done in the year 2018 under the Kenya Water Security and Climate Resilience Project. Daily long-term flows data over the basins were used to model the potential surface water resources. On the other hand, groundwater assessment was derived from hydro-geological, topography, rainfall and estimates of recharge. Each of these characteristics was categorized and weighted to quantify groundwater availability.

Water resources availability determines the patterns of human settlements and socio-economic development. The available water resources (both surface and ground water) in all the basins in Kenya have been assessed in the National Water Master Plan 2030.

There are projected water resources for the years 2010, 2030 and 2050 and water demand respectively. The increase in available water resources in the six basins is attributed to the projected increased rainfall due to impacts of climate change.

Table.7. Available Water Resources by basins (Units in MCM/yr.)

Basin Area	Area (Sq Km)	2010		2030		2050	
		Demand	Available	Demand	Available	Demand	Available
Lake Victoria North	18,374	228	4,742	1,337	5,077	1,573	5,595
Lake Victoria South	31,734	385	4,976	2,953	5,937	3,251	7,195
Rift Valley	130,452	357	2,559	1,494	3,147	1,689	3,903
Athi	58,639	1,145	1,503	4,586	1,634	5,202	2,043
Tana	126,026	891	6,533	8,241	7,828	8,476	7,891
Ewaso Ng'iro North	210,226	212	2,251	2,857	3.011	2,950	1,810
Total	575,451	3,218	22,564	21,468	26,634	23,141	28,437

***Source**: National Water Master Plan (NWMP 2030)*

Table.8. Distribution of Monitoring Stations

Basin	Number of Surface Water Stations	Stations with water level records	Stations with updated rating curves (earmarked for FY 2022/2023)	Number of monitoring boreholes	Number of operational boreholes	% Operational	Boreholes with Water Rest data
LVN	28	22	2	20	18	90	18
LVS	47	28	2	37	7	23	33
RV	42	17	2	55	32	41.82	32
Tana	45	30	2	45	23	51.1	18
Athi	47	40	2	25	20	80	20
ENN	40	35	2	16	12	75	12

3.4.2 Maintenance of Reserve Flows

Maintenance of reserve flow is crucial in water resource managment and its determination because the variations in hydrologic regime support both ecological and basic human needs. The hydrologic regime is defined by the cycle of low and high flows. Reserve flows help to maintain ecological needs of rivers and therefore it should always be maintained.

Reserve flows were determined at 41 points in various rivers in all the six basin areas. These are shown in the Table.9. below which also presents the values of reserve flows determined, monitoring points, and the number of days of violation of the reserve.

Table.9. Stations with reserve flow determined and maintained by June 2022

Region	River	Point of Determination	Reserve flow (m^3/s)	Monitoring Point
LVN	Kipkaren	Kipkaren market	1.715	1CE01
	Malakisi	At Kimama	4.512	1AB01
	Nzoia	WebuyeTown	11.598	1DA02
	Nzoia	100m. upstream of ferry at Rwambwa on Siaya Ukwala road	21.981	1EF01
	Nzoia	Moi's Bridge	2.5	1BB01
	Rongai	4Km from Naitiri Trading centre, downstream the bridge along Naitiri/ Tongaren road	0.722	1BG07
	Yala	Yala Town	6.7	1FG01
	Yala	Bondo Water Supply	5.04	1FG02
	Yala	North of Maseno on Maseno-Petro's road	7.83	1FE02
LVS	Amala	Kapkimolwa	0.686	1LB02
	Awach	Wath Ong'er Bridge	0.005187	1HA14
	Mara	Mararianda	1.904	1LA04
	Nyando	Ogilo Bridge	0.2711	1GD03
	Nyangores	Bomet Town	0.252	1LA03
	Sondu	Nyakwere Market	3.0607	1JG04

Region	River	Point of determination	Reserve flow (m^3/s)	Monitoring Point
RVCA	Perkerra	Marigat bridge	0.294	2EE7B
ACA	Athi	Munyu	0.000332	3DA2
	Thiririka	Ndarasha	0.0942	3BD05
	Kamiti	Brookside	0.00001	3BB12
	Ruiru	Nairobi Thika Highway	0.038	3BC08
TCA	Tana	Garissa Town	4.736	4G01
	Gura	Tambaya Bridge	0.0583	4AD01
	Maragua	Muranga/Maragua bridge	0.1057	4BE01
	Mathioya	Muranga - Sagana bridge	0.00127	4BD01
	N. Mathioya	Kiria-ini/Nyakianga bridge	1.941	4BD07
	New Chania	Nyeri Town	0.016	4AC04
	Ragati	Sagana-Karatina, KR Bridge	0.0078	4BB01
	Rukanga	South of Rukanga Pri. School.	0.328	4BE10
	Sagana	Kiganjo-Marua Bridge	0.027	4AC03
	Sagana Marua	Kiganjo Sagana bridge	0.0073	4AA05
	Thika	Near Thika, Blue Posts Hotel	0.0122	4CB04
ENN	Ewaso	Narok Sosian Ranch	0.057	5AC10
	Kongoni	Gakeu	0.0007	5BE03
	Ontulili	Mathagiro	0.12	5BE02
	Pesi	Ndaragwa Centre	0.0007	5AB04
	Pesi	Pesi Centre at Salama	0.0002	5AB02
	Teleswani	Githithina	0.0005	5BE05
	Timau	Timau Market	0.08	5BE06
	Sirimon	Kirimara	0.17	5BE04
	Isiolo	Town	0.015	5DA07

3.4.3 Effective water allocation system

Table.10. Ageing Analysis of permit processing up to June 2022

Permit category	Service charter timeline *	no of permits process within timeline	no of permit processed outside timelines	% efficiency
Cat A	60	412	544	43%
Cat B	90	19,350	9,414	67.3%
Cat C	150	313	290	52%
Cat D	180	58	154	38%

3.4.4 Rating Curve Update

Although flow is the variable usually required for hydrological analysis, its continuous measurement at a river section is usually impractical or prohibitively expensive. However, stage (water level) can be observed continuously or at regular short time intervals with comparative ease and economy. The relationship between stage and flow is termed as stage-discharge curve or rating curve (equation).

The reliability of flow data generated by this tool is highly dependent on its continuous validation to ensure the stage – discharge relationship at a specific river section is representative of the actual situation. To do this, the WRA undertakes occasional discharge measurement and record the corresponding water levels. Discharge data are plotted versus the concurrent stage to define the rating curve for the stream section.

The Authority has therefore proposed to update rating equations for 12No. Regular Gauging Stations during the FY 2022-2023 Performance Contract. This will entail the following activities:

i. Check the rating curves to establish whether if the stage – discharge relationship has changed;
ii. Compile long term discharge measurement records for all Regular Gauging Stations;
iii. Analyse different cross-sectional survey drawings for specific sections and highlight the change in the sections;
iv. Select the stations whose rating curves require updating;
v. Update the rating curves; and
vi. Approve and publish the new rating equations for the 12 stations.

3.4.5 Water quality monitoring network

3.4.5.1 Surveillance and Monitoring A pproach

Guided by the previously conducted Water Abstraction and Pollution Surveys, point and non – point / diffuse sources of pollution have been identified and are prioritized for surveillance and monitoring during the dry spell. This is in addition to routine water quality and pollution monitoring from the established monitoring network through manual, automatic and telemetric practices.

The point sources include; downstream of Wastewater Treatment Plants operated by the Water Service Providers, dumpsites especially on the riparian reserves, the industrial zones in the urban and perurban areas and artisanal mining areas.

The diffuse point sources of pollution largely encompass the informal settlements, unsewered zones and degraded catchments.

In - situ water quality measurement and sampling

In - situ water quality measurement and sampling- Final effluent

3.4.6 Water quality trend on case study rivers

WRA has been monitoring the water quality in the main R. Athi and its tributaries – R. Ngong, R. Nairobi, R. Mathare, R. Rui Ruaka and R. Mbagathi. In this report, the results of monitoring during the second quarter of the FY 2022/2023 has been presented. To provide a general overview of the water quality trend in the rivers, selected waterquality indicators have been used. The indicators include biochemicaloxygen demand (BOD), chemical oxygen demand (COD), totalsuspended solids (TSS) and total dissolved solids (TDS). However, some other parameters are mentioned in brief. Generally, BOD and COD are indicative of the level of organic load in the river system whereas TDS is a measure of both organic and inorganic substances that are dissolved in the water. TDS is directly corelated to electrical conductivity (EC) by a factor of about 0.5 to 0.7. Overall, the pH (6.7-8.3), conductivity (130-1215 µS/cm), color (85-3750 Pt), turbidity (14-2300 NTU), total phosphorus (0.1-3.2 mg/L) and total nitrogen (0.2-5.9 mg/L) vary significantly within the basin.

The three tributaries that traverse the informal settlements (R. Ngong, R. Nairobi and R. Mathare) recorded higher level for all the measured parameters. Instructively, BOD and COD in some sections of the rivers are at the same level as that of raw domestic wastewater, an indication of direct discharge of raw effluent from households or burst sewers into the rivers. The water quality trends for individual rivers are discussed below.

a) River Ngong

The BOD, COD, TSS and TDS in R. Ngong varied significantly along the river profile (Fig. 16.). Whereas the values are lowest near the Ngong forest where there is limited settlement and thus low pollution input, it peaks at the Nairobi dam after the river has traversed Kibera informal settlement where there is a lot of wastewater discharges from the settlement. However, the dam seems to have some positive impact on the water quality as the concentrations of all the parameters reduce at Mbagathi Way bridge after the dam. Nevertheless, the quality further deterio rates as the river flows through other informal settlements and the industrial area before it finally joins R. Nairobi after Kangundoroad.

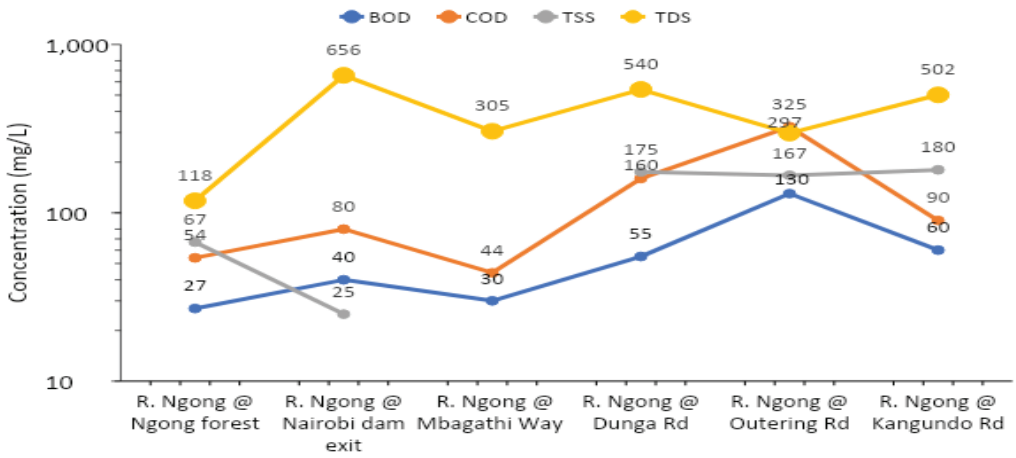

Fig.25. Water quality trend in R. Ngong

b) River Mathare

Similar to R. Ngong, BOD, COD and TDS in R. Mathare increases along the river profile. The highest impact is observ able at Outering after the river has drained the populous Mathare informal settlement with marginal reduction within Ngomongo area where it joins R. Nairobi, an indication of the impact of the slums on the river.

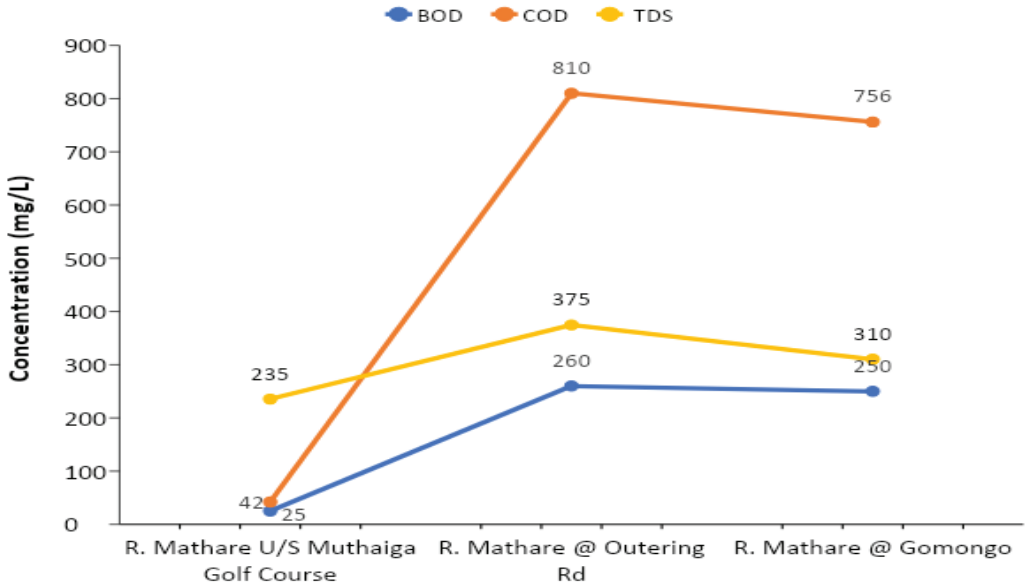

Fig.26.Water quality in R. Mathare

c) River Nairobi

A similar trend of water quality is observed in R. Nairobi. Whereas areas with less settlements show lower levels of the water quality pollution indicators, the densely populated areas, especially slum influenced areas are more impacted. Additionally, the Dandora and Kariobangi wastewater treatment plants (WWTPs) appears to incrementally affect the water quality of the river.

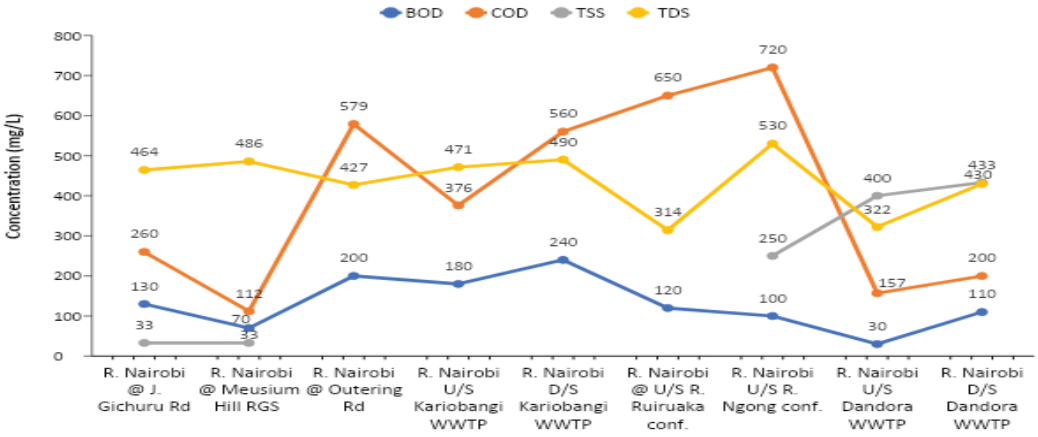

Fig.27. Water quality in R. Nairobi

d) River Ruaraka

Unlike the rivers discussed above, R. Ruaraka is relatively small and does not traverse informal settlements upstream. Consequently, the water quality pollution indicators levels are lower. However, from Lucky Summer area, the water quality deteriorates drastically.

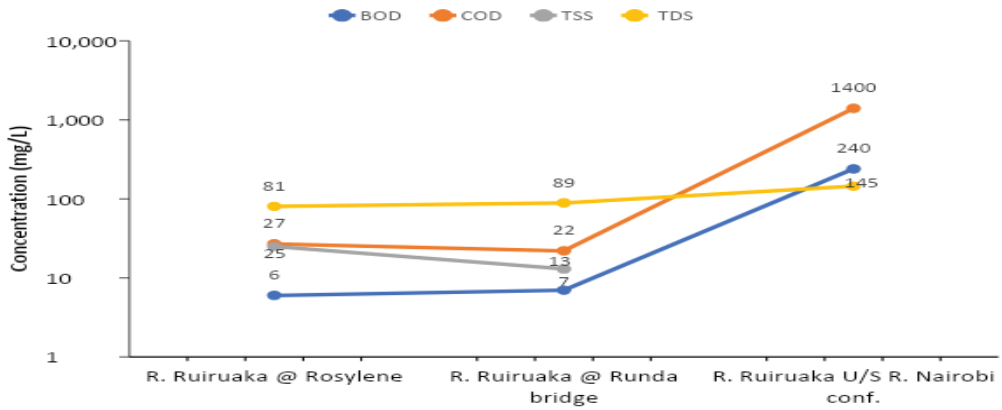

Fig.28.Water quality trend in R. Ruiruaka

e) River Mbagathi/Athi

In this report, R. Athi has been considered to comprise R. Mbagathi upstream, into which the other tributaries flow. Overall, the water quality pollution indicators in this system have lower concentration when compared to the upstream tributaries.

At Ongata Rongai, the river is impacted by wastewater discharged into it through storm drains. However, the impact reduces significantly as the river flows through the Nairobi National Park where pollution input is relatively limited. However, once the upstream tributaries from Kiambu and Nairobi join, the quality deteriorates further due to the additional pollution load introduced by the heavily polluted tributaries. Nonetheless, as the river flows downstream, a lot of self- cleansing and reduced pollution input in the middle Athi leads to improvement of the water quality.

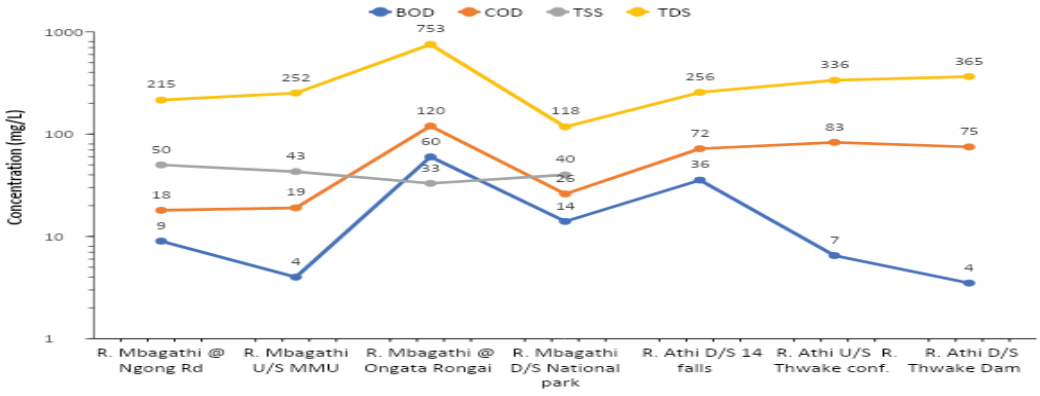

Fig.29. Athi rivers water quality trend

Basin	Municipal wastes/ Untreated sewage	Industrial Waste Discharges	Soil erosion / Sediment	Mining wastes e.g Gold, Titanium, building stones and sand	Oil drilling wastes	Agro-chemicals
LVN	✓	✓	✓	✓		✓
LVS	✓	✓	✓	✓		✓
RV	✓	✓	✓	✓	✓	✓
Athi	✓	✓	✓	✓		✓
Tana	✓	✓	✓			✓
ENNBA	✓	✓				✓

Table.11. Major water pollution threat

3.5 Enforcement

This is done in an integrated and sustainable manner in collaboration with stakeholders and in accordance with the Water Act and the operating Water Resources Regulations and as per the established Waste Disposal Control Plan tool and the conditions in the EffluentDischarge Permit. It is a mandatory requirement that all Water Abstractors who end up discharging wastewater into the environment in one form or the other should acquire the Effluent Discharge Permit from WRA.

3.6 Economic and Financial Management

3.6.1 Improving water use efficiency and economic value for water

Table.12. Status of water use charges up to June 2022

Basin	Amount of revenue (Million KES) by June 2022				Efficiency (%) by June 2022	
	Potential Kshs. (M)	PC Target Kshs. (M)	Billed Kshs. (M)	Actual collection Kshs. (M)	Water use (Percentage)	Revenue collection (Percentage)
HQ	355.2	206.67	314.298	367.732	88.48	117.00
LVN	53	30.84	47.784	37.422	90.16	78.31
LVS	51	29.67	49.172	34.072	96.42	69.29
RV	144	83.79	86.99	90.416	60.41	103.94
Athi	205	119.28	134.251	157.49	65.49	117.31
Tana	158	91.93	101.893	82.785	64.49	81.25
ENN	65	37.82	42.824	42.872	65.88	100.11
Total	**1,031.2**	**600**	**777.212**	**812.789**	**75.37**	**104.58**

‡Water use efficiency = Bills against potential: Revenue collection efficiency =Actual collection against target

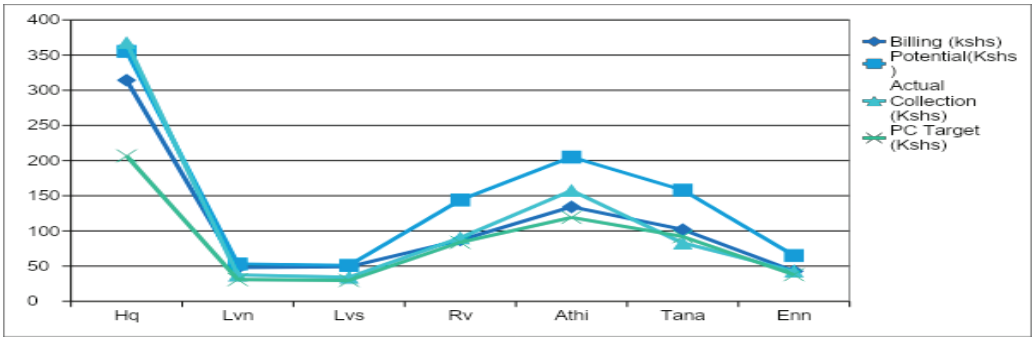

Fig.30. Water Use Efficiency

3.7 Information Management

3.7.1 Managing water resources monitoring data and information

Table.13. Water resources monitoring stations and data frequency up to June 2022

Basin	Operational stations			Duration of data collection		Frequency of update
	SW	GW	WQ	SW	GW	SW
LVN		18		12 months	10 Years	Monthly
LVS		37		12months	193 months	Monthly
RV		47		12months	12 Years	Monthly
		60		12months	12 Years for Manual stations and 3 Years for 12 Telemetric and 2 years for other 2 telemetric stations.	Monthly
Tana		23		12months	12 Years	Monthly
ENN		12		12months	Stations Monitored since 2007 but with gaps	Monthly

ZZ SW: surface water; GW: groundwater; WQ: water quality

3.9 Gender in WRA

3.9.1 Gender Representation in WRA

Table.14. Gender representation among representative WRA staff by June 2022

Office	Male	Female	Total
Headquarters & Central Water Testing Laboratories	66	68	134
Athi Basin Area	70	46	116
Lake Victoria North Basin Area	37	27	64
Lake Victoria South Basin Area	44	34	78
Rift Valley Basin Area	57	37	94
Tana Basin Area	58	38	96
Ewaso Ng'iro North Basin Area	45	29	74
GRAND TOTAL	**377**	**279**	**656**
MALE	**57%**		
FEMALE	**43%**		

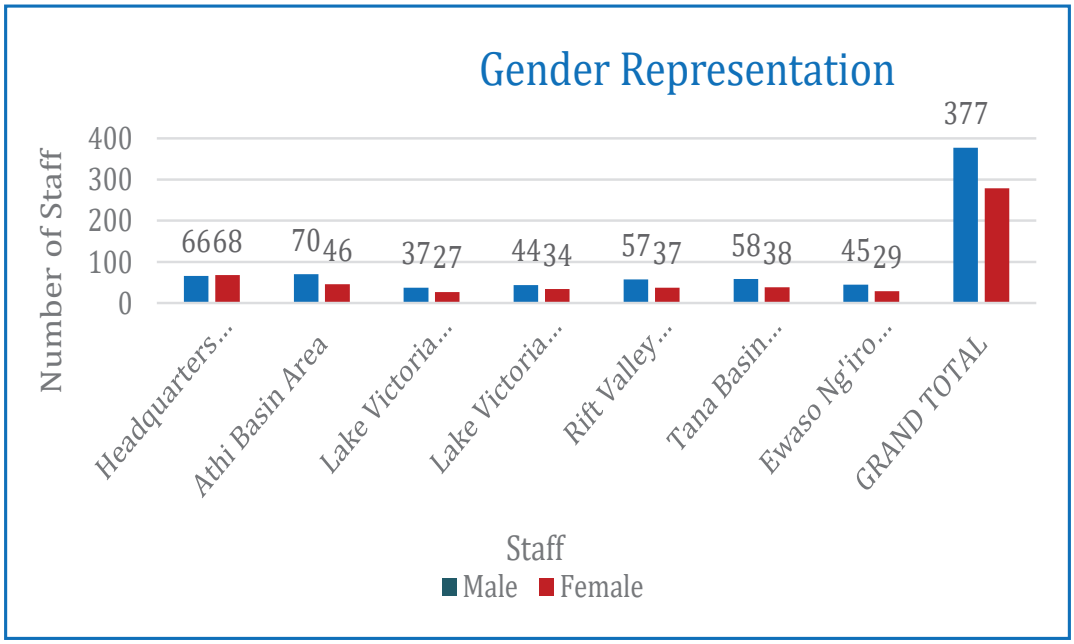

Fig.31.Gender Representation

3.10 Complaint's resolution

Table.15. Complaint Resolution

Parameter	Number
Complaints received from CAJ	0
Complaints handled directly	110
Complaints Resolved	79

Fig.32. Public Complaints

4. WRA Doctorate Publications

1. Jonnah Rao PhD Risk Factors and Water Sanitation Infrastructure Investments in Kenya (Doctoral dissertation, United States International University-Africa). Rao, J. O. (2021).
2. Meshack O. Amimo PhD., Viterbi Algorithm-Based Hidden Markov Modelling and the Fuzzy Gaussian Membership Function Regression Mapping of the Lithologic Logs Along the Madogo-Mor ro-Maramtu Settlements (2022) & and the Kohonen Self-Organizing Map (SOM) Assessment of Aquifer Water Struck Levels In the Merti Aquifer, Northern Kenya (2021) Aramtu Settlements & and the Kohonen Self Organizing Map (SOM) Assessment of aquifer water Struck Levels in the Merti Aquifer, Northern Kenya.

5.0 Conclusion

The Authority made great strides during the year in undertaking its mandate in regulating the management and use of water resources. There were more partners and stakeholders collaborating in water resources activities. A major milestone in engaging WRUAs was establishment of Kenya National Association of Water Resource Users Association which is a group that shall lobby for water resources management activities. This shall strengthen the governance of water resources in Kenya.

Table.16. WRA Basin and Sub Basin Offices Contacts

S/No	WRA Basin Office	WRA Sub BasinOffice
1	Lake Victoria South Basin Area Regional Office P.O. Box 666, **Kisumu**	Northern Shoreline_ Nyando P.O. Box 666, **Kisumu**
		Southern Shoreline_ Gucha Migori P.O. Box 4114, **Kisii**
		Mara Sondu P. O. Box 563 , **Kericho**
2	Lake Victoria North Basin Area Elgon_Cherangányi P.O. Box 774 **Kakamega**	Elgon_Cherangányi P. O. Box 2764-30200, **Kitale**
		Kipkaren_Upper Yala P.O. Box 3040-30100, **Eldoret**
		Lower Nzoia Yala P.O. Box 374-40600, **Siaya**
3	Rift Valley Basin Area P.O. Box 1600, **Nakuru**	Lower-Turkwel P.O. Box 73 **Lodwar**
		Upper Turkwel P.O. Box 49, **Kapenguria**
		Lakes Naivasha-Nakuru P. O. Box 66, **Naivasha**
		South Rift Valley P.O. Box 1029, **Narok**
		Lakes Baringo- Bogoria P. O. Box 544-30400, **Kabarnet**
4	TANA Basin Area P.O Box 1930-60100 **Embu**	Upper Tana P.O. Box 460-10200,**Murang'a**
		Tiva/Tyaa P.O.Box 781-90200, **Kitui**
		Thiba P.O. Box 1291-10300, **Kerugoya**
		Kathita/Mutonga P.O. Box 3256-60200, **Meru**
		Lower Tana P.O. Box 31-70100, **Garissa**

S/No	WRA Basin Office	WRA Sub BasinOffice
5	ATHI Basin Area P.O Box 1159-90100 **Machakos**	Nairobi P.O. Box 18150-00500, **Nairobi**
		Middle Athi P. O. Box 176-90137, **Kibwezi**
		NolTuresh Lumi P.O. Box 53-00209, **Loitoktok**
		Upper Athi P.O. Box 1864-00900, **Kiambu**
		Coastal Athi P.O. Box 80100-85672, **Mombasa**
6	Ewaso Ngiro North Basin Area P.O Box 1331-10400 **Nanyuki**	Engare Narok Melghis P.O. Box 631-20300, **Nyahururu**
		Ewaso Daua Laggas P.O. Box 308-70300, **Mandera**
		Upper Ewaso Ngiro P.O. Box 1331-10400, **Nanyuki**
		Middle Ewaso Ngiro P.O. Box 58-60300
		North Ewaso Laggas P.O. Box 207-60500, **Marsabit**

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Water Resources Authority.

Accounting for every drop!

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