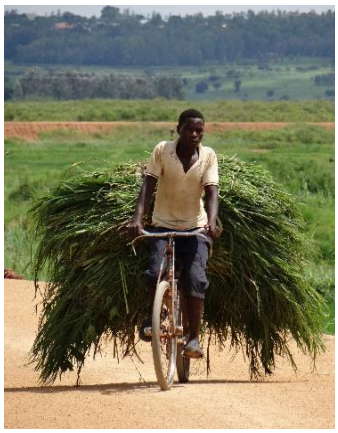
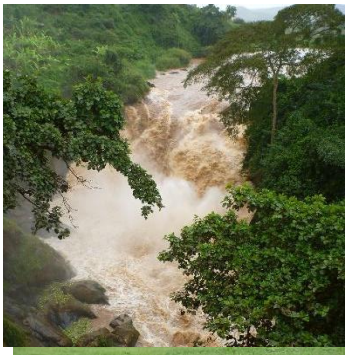
TECHNICAL ASSISTANCE IN ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT

Water Quality Management Plan for Rwanda





30/06/2020 **Water Quality Management Plan for Rwanda (Final)**

EXECUTIVE SUMMARY

The Government of Rwanda (GoR) through Rwanda Environment Management Authority (REMA) is implementing a pilot project of Least Developed Countries Fund (LCDF) II titled "Building resilience of communities living in degraded forests, savannahs and wetlands of Rwanda through an Ecosystem-based Adaptation (Eba) approach" funded by Global Environment Facility (GEF) through United National Environment Programme (UNEP) under climate change adaptation GEF focal rea. The main objective of the project is to increase capacity of Rwandan authorities and local communities to adapt to climate change by implementing Ecosystem based Adaptation (EbA) interventions in degraded forests, savannahs and wetlands ecosystems.

During the implementation, a need was identified to conduct a study on Wetland and Catchment Management Framework that will be used for upscaling of wetland ecosystem restoration activities under the project. The development of the Water Quality Management Plan for Rwanda was undertaken as part of the above study under Water Quality Management task and provides strategic actions and responses to the emerging water quality management issues and concerns in Rwanda. Key emerging issues and concerns include erosion and sedimentation, nutrient enrichment, eutrophication and invasive aquatic weeds, littering of and leachates from inadequately managed solid wastes, uncontrolled or untreated wastewater discharge, untreated industrial effluent discharge, and agrochemical and pesticides residues, among others.

The Water Quality Management Plan is developed within the national, regional and global policy and commitments context (e.g. National Environment and Climate Change Policy, National Policy for Water Resources Management, National Sanitation Policy, National Strategy for Transformation, Sustainable Development Goals (SDGs), etc). The Plan was developed through a consultative process involving all stakeholders. Thorough literature review, interviews and consultations with actors at national and local levels, private sector and civil society informed the development of the plan's vision, goals and objectives.

The Plan's vision is "Sustainable management and protection of water quality in Rwanda is in balance with the country's socio-economic development needs". The three goals of the plan are (1) Enhancing Water Quality Management governance (2) Efficient and effective management of water quality and (3) Effective information and knowledge management. To implement these goals, six (6) objectives and 21 targets were identified.

The above plan goals, objectives and associated interventions can only be achieved with clear institutional arrangements. This include the defined roles and responsibilities of all institutions in coordination, monitoring and evaluation. The plan will be implemented through Sector Strategic Plans (SSPs) central, District Development Strategies (DDS) at District level as well as Imihigo targets and action plans at both central and local levels. The existing coordination mechanisms (e.g. Environment and natural resources (ENR) sector working groups, IWRM Thematic Working Group, Catchment Committee) and the new created one (National Water Quality Network Committee) will also support the implementation of the plan.

The overall success of implementation of the Water Quality Management Plan lies in strengthening the human and financial resources capacity of Rwanda Resources Board by recruitment of strong team of water quality professionals, sourcing for funds for the execution of the proposed interventions such as operationalizing the national water quality monitoring program, and supporting the existing laboratories that will in turn generate data for planning and management purposes.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

BOD	Biological Oxygen Demand
CIP	Crop Intensification Program
COD	Chemical Oxygen Demand
CAVM	College of Agriculture, Animal Sciences and Veterinary Medicines
DBMS	Database Management System
DO	Dissolved Oxygen
EAC	East African Community
EDCL/REG	Energy Development Corporation / Rwanda Energy Group
EDCs	Endocrine Disrupting Chemicals
EDPRS-2	Economic Development Poverty Reduction Strategy - 2
EIP	Early Implementation Project
ENR SSP	Environment and Natural Resources Sector Strategy Plan
EUCL	Energy Utility Cooperation Ltd
FONERWA	National Fund for Environment (Rwanda Green Fund)
GIS	Geographical Information System
GoR	Government of Rwanda
IDA	International Development Association
IDP	Integrated Development Plan
INES	Institute of Applied Sciences
IWRM	Integrated Water Resources Management
LKMP	Lake Kivu Management Plan
LVB	Lake Victoria Basin
LVEMP	Lake Victoria Environmental Management Project
M&E	Monitoring and Evaluation
MIDIMAR	Ministry of Disaster Management and Refugee Affairs
MIGEPROF	Ministry of Family and Gender Promotion
MINAFFET	Ministry of Foreign Affairs and Cooperation
MINAGRI	Ministry of Agriculture and Animal Resources
MINALOC	Ministry of Local Government
MoE	Ministry of Environment

MINECOFIN	Ministry of Finance and economic Planning
MINEDUC	Ministry of Education
MINICOM	Ministry of Commerce
MININFRA	Ministry of Infrastructure
MINIRENA	Ministry of Natural Resources
MIS	Management Information System
MISWWTS	Management Information System for Wastewater Treatment Systems
MoE	Ministry of Environment
NGO	Non-Governmental Organization
NPS	Nonpoint source
NST	National Strategy for Transformation
NWRMP	National Water Resources Master Plan
PCDD	Polychlorinated dibenzo-p-dioxins
PCDF	Polychlorinated dibenzofurans
PhACs	Pharmaceutically Active Compounds
POPs	Persistent Organic Pollutants
PS	Point source
RDB	Rwanda Development Board
REMA	Rwanda Environment Management Authority
RLMUA	Rwanda Land Management and Use Authority
RMB	Rwanda Mines, Petroleum & Gas Board
RNRA	Rwanda Natural Resources Authority
RWB	Rwanda Water Resources Board
RSB	Rwanda Standards Board
RURA	Rwanda Utilities Regulatory Authority
RWFA	Rwanda Water and Forestry Authority
RWQOs	Receiving Water Quality Objectives
SCPOPs	Stockholm Convention Persistent Organic Pollutants
SDG	Sustainable Development Goals
SEA	Strategic Environmental Assessment
UES	Uniform Effluent Standards

UNEP	United Nations Environmental Program
UR	University of Rwanda
USEPA	United States Environmental Protection Agency
WASAC	Water and Sanitation Corporation
WMC	Water Management Committee
WQMP	Water Quality Management Plan
WRM	Water Resources Management
WUA	Water User Association
WWTW	Wastewater Treatment Works

CHAPTER 1 INTRODUCTION

1.1 Background of the action plan

A study on wetland and catchment management framework was commissioned by the Government of Rwanda represented by Rwanda Environment Management Authority (REMA) under the pilot project of Least Developed Countries Funds II (LCDF II) titled "Building resilience of communities living in degraded forests, savannahs and wetlands of Rwanda through an Ecosystem-based Adaptation (EbA) approach". The project is funded by Global Environment Facility (GEF) through United Nations Environment Programme (UNEP) under climate change adaptation GEF focal area for total duration of four years. The main objective of the project is to increase capacity of Rwandan authorities and local communities to adapt to climate change by implementing Ecosystem based Adaptation (EbA) interventions in degraded forests, savannahs and wetlands ecosystems. The project is being implemented for restoration of Nyiramuhondi watershed in Ngororero District; Murago wetland and Lake Cyohoha North in Bugesera District; Kibare lakeshores in Kayonza District and Nyandungu wetland in Gasabo and Kicukiro Districts; and Lake Ruhondo in Musanze District

In accordance with the Term of References, the study will be used for upscaling of wetland ecosystems restoration activities under LDCF II Project and the main aim is to collate current knowledge on status and health of wetland and catchment ecosystems in Rwanda with particular focus on Nile-Akagera upper, Nile-Nyabarongo lower and Nile-Nyabarongo upper catchments including Nyiramuhondi watershed

The Technical Assistance in Environmental Management project consists of a number of tasks:

- Strategic Plan for Ecosystem Based Adaptation and Wetland Management which includes a status quo description, national wetland management plan, guidelines for wetland management, and technical support with implementation of the plan.
- Water Quality Management which includes identification of pollution hotspots in Rwanda, develop water quality management guidelines, develop water quality management plan for Rwanda, a water quality modelling tool, and integrated urban pollution management plans for five urban areas.
- Develop integrated catchment management for some catchments in Rwanda (Nile-Akagera upper, Nile-Nyabarongo lower and Nile-Nyabarongo upper including Nyiramuhondi watershed), and
- Capacity building and training

This report is part of Water Quality Management task and presents the Water Quality Management Plan for Rwanda. The plan describes the current and emerging water quality issues in Rwanda, set future visions for water quality and pollution management objectives and approaches to achieve the visions as well as the costing of these approaches.

1.2 Scope and purpose

Water of adequate quantity and quality is important for the improvement of living conditions of population, poverty reduction and socio-economic development of the country. The quality of water in Rwanda is important to achieve universal access to safe drinking water, for irrigated agriculture expansion, electricity, food production and maintenance of ecological habitat and biodiversity, among others. However, there are

many pressures impacting water quality across Rwanda including population growth, industries, mining activities, recreation activities, agricultural activities, domestic waste water discharges, among others.

This Water Quality Management Plan provides guidance on key implementable actions for a planning span of a five year planning period. It defines roles and responsibilities of stakeholders and provide framework for protection, enhancing and restoring water quality to provide a range of outcomes, including spiritual, cultural, economic value, economic values, improvement of ecological processes, healthy aquatic ecosystems as well as recreational amenities, among others. It also included activities related to the coordination to ensure that strategic actions to be implemented by key stakeholders are fully integrated and coordinated.

1.3 Layout of this report

This report consists of the following chapters:

Chapter 1	…gives an introduction to the study through presenting the general background of the WQM plan, scope of the plan as well as the layout of the report.
Chapter 2	... describes the methodology that was followed in the preparation of the National Water Quality Management Plan and how it is aligned with the principles of adaptive management. It also provides a brief overview of water quality management in Rwanda, the laws, policies and strategies related to water quality management, the institutions involved in aspects of water quality management, and the higher education urban area, its key geographic features, and the challenges that affect pollution
Chapter 3	… provides an overview of the current and emerging water quality issues in Rwanda, an overview of water pollution sources, and provides an initial list of key water quality issues, causes and potential interventions. It also maps out a framework for water quality management in Rwanda, principles to guide water quality management interventions, a description of regulatory instruments, guidance on making decisions about individual dischargers, and lastly, guidance on how to select a suite of water quality management interventions.
Chapter 4	… describes a water quality management plan for Rwanda, the vision, goals and objectives for water quality management, as well as the activities to support the goals and objectives that were identified. For each activity, indicators that can be monitored is provided, indicative phasing and duration, authorities responsible for its implementation, and indicative costs.
Chapter 5	… provides an overview of monitoring and evaluation of the implementation of the plan.

CHAPTER 2 METHODOLOGY

The process of developing a Water Quality Management Plan for Rwanda is illustrated in Figure 2-1. The Water Quality Management Plan records a vision for the water quality and formalises the key current and future trends of the various water pollution categories such as physical, chemical and biological water quality. The Water Quality Management Plan also provides additional details with regard to the specific implementation of options for protecting and improving water quality while still promoting growth and socio-economic development objectives.

The Water Quality Management Plan states how issues and concerns will be addressed through management strategies within a specified time period, and outlines an associated procedural and technical framework for implementation.

2.1 Steps in developing a water quality management plan

The development of Water Quality Management Plan for Rwanda was guided by the Technical Committee comprising representatives from key stakeholders in water sector in Rwanda. The key components of the Water Quality Management Plan (fig 2.1), involving the characterisation of water quality in Rwanda and consultation included:

- Characterisation of water quality situation in Rwanda by gathering background information, including identifying issues and threats;
- Formulating visions and goals for water quality management;
- Development of a water quality Management strategy; and
- Development of water quality implementation plan l .

Figure 1: Steps in developing the Water Quality Management Plan

Step 1: Characterise the water quality status in Rwanda

This step provides for understanding the current water quality situation in Rwanda and the causes for those concerns. The report, "Water Quality Management: Identification of pollution hotspots", produced as part of this project provides a comprehensive review of pollution related institutional framework, legislation,

policies and plans an overview of the water quality standards and guidelines pertinent to Rwanda; an overview of water pollution sources, both point and nonpoint sources; a review of water quality concerns, its impacts and causes; and water pollution hotspots in Rwanda. This is summarised in Chapter 4 of this report.

Step 2: Formulating a vision and goals for Water Quality Management

This step involves describing the desired state in Rwanda, over the long term, with respect to water quality, together with goals (preliminary objectives) and targets to achieve this over time. This was developed in a participatory approach with stakeholders from various government agencies.

Workshops were organised and officials from key institutions in relation with water management were given the opportunity to confirm and prioritise the water quality concerns and sources, to develop the key elements of a water quality management vision for Rwanda, and to develop initial goals, objectives and interventions to manage and improve water quality.

Step 3: Developing a Water Quality Management Strategy

This includes specifying a coherent suite of strategic objectives and outcomes related to water quality management, designed to achieve the vision.

Incorporating the vision, goals and objectives determined through the stakeholder engagement process, as well as the information provided from the water quality status assessment, a Water Quality Management Strategy is proposed.

Step 4: Detailing an implementation plan

The main activity at this point is defining the actions needed to give effect to the Water Quality Management strategy and that should ultimately achieve the vision and objectives, as well as who is responsible for the actions, the indicative duration, and cost indications for the actions.

2.2 Adaptive water quality management

The management of water quality in Rwanda takes place within an environment that is constantly changing. This is because of, inter alia, economic growth and stimulation of mining and industrial developments, changes in effluent discharge patterns from industries and wastewater treatment works, instream transformation of pollutants, seasonal rainfall patterns and changes in flow, implementation of erosion control measures, and rehabilitation of agricultural lands which in turn affects diffuse source contributions, etc. Water quality management therefor needs to be flexible enough to adapt to changes in water pollution loads, and the receiving environment. This is referred to as the adaptive management cycle (Figure 2-2).

An adaptive management approach involves reviewing alternative options for meeting a specific objective, considering the possible outcomes of these management options based on the current state of knowledge, and then implementing the most desirable options. The next step involves monitoring and assessing the impacts of the implemented options to inform if any adjustments are required in the strategy or interventions. This creates a structured feedback loop of learning by doing, and adapting to changes in the environment and drivers of water pollution.

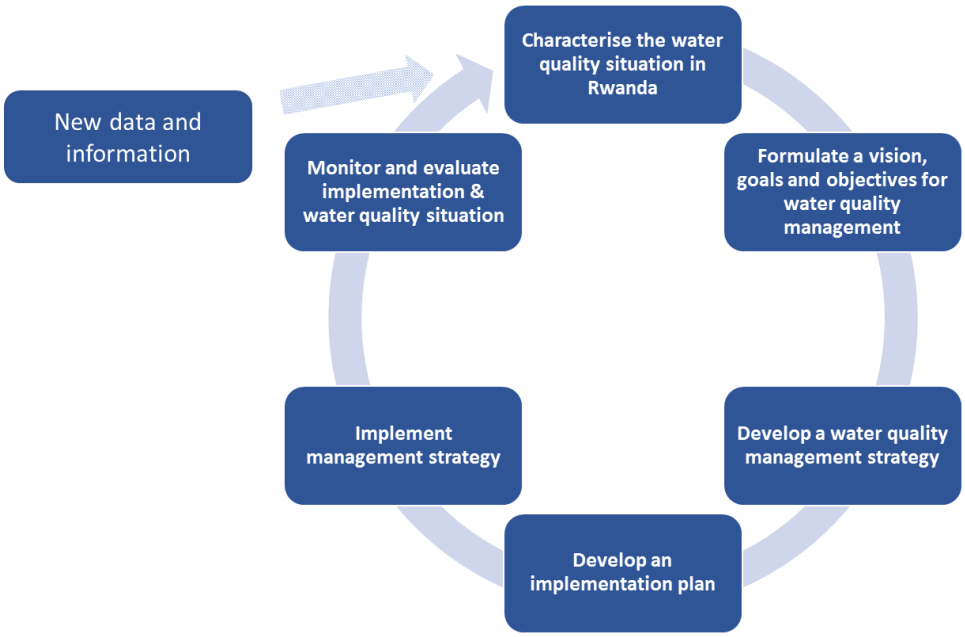


Figure 2: Water quality management planning as part of the cycle of adaptive management

CHAPTER 3 WATER QUALITY MANAGEMENT SITUATION IN RWANDA

In this section we present information on legal and institutional framework guiding the management of water quality in Rwanda. We start with the fundamental law, key policies and strategic documents related directly to environment (including water quality) and finally to institutions involved in its management, as there is no specific law related to the management of the quality of water in the country.

3.1. Policy, Legal and Institutional Framework

3.1.1. Legal and Regulatory instruments

This sub-section provides a brief summary on legal and regulatory instruments related to water quality management in Rwanda. For more detailed information refer to the report entitled "Water Quality Management: Identification of pollution hotspots".

▪ 3.1.1.1. The constitution and the Law on Environment

The constitution of Republic of Rwanda as amended in 2015 highlights the right of each citizen to live in a clean and healthy environment. The same constitution gives to the population of Rwanda the duty of safeguarding; protecting and promoting of environment while the state will ensure overall protection of environment (See Articles 22, 53 and 169 of the constitution).

3.1.1.2. The Law on environment

Law on environment (No 48/2018 of 13/08/2018) provides guidance on the protection of water resources (art. 11, 12, 37, and 40) to preserve quality and quantity of waterbodies (rivers, lakes and groundwater). Article 42, provide for prohibited acts in wetlands and protected areas while articles 47. 48 and 49 set administrative sanctions for polluting and damaging wetlands, changing the nature of wetlands and violating required distances from wetlands or waterbodies. A list of inorganic physical-chemical, organoleptic, radionuclide and biological pollutants was annexed to the Ministerial Order N° 004/16.01 of 24/05/2013 determining the list of water pollutants. 2013, a ministerial Order.

▪ 3.1.1.3. Rwanda Water Resources Law

The law determining the use and management of water resources in Rwanda was gazetted in 2018 (Law N°49/2018 of 13/08/2018 and determines the use and management of water resources in Rwanda. It provides a clear framework for the principles of integrated water resources management, including the prevention of pollution, and the principle of "user pays" and "polluter pays. It also provide that polluting water bodies by dumping, spilling or depositing chemicals of any nature above tolerable limit for human health or aquatic life, commits an offence (art.37) and set penalties for the defaulters.

▪ 3.1.2. National policies and strategies relevant to water quality management

This sub-section provides a brief summary on national policies and strategies relevant to water quality management in Rwanda. For more detailed information refer to the report entitled "Water Quality Management: Identification of pollution.

3.1.2.1. National Policies relevant to water quality management

This water quality Management plan is in line with key sectoral policies that are related to environment and water resources management as summarised in the Table 1 below:

Table 1: Summary of relevant to water quality management policies

Policies	Date	Relevance to pollution
National Environment and Climate Change Policy	2018	Its overall objectives are to improve the human welfare, to use properly natural resources and to protect and manage rationally ecosystems for sustainable and equitable development.
National Policy for Water Resources Management	December 2011	The overall goal pursued in this water policy is to manage and develop the water resources of Rwanda in an integrated and sustainable manner, so as to secure and provide water of adequate quantity and quality for all social and economic needs of the present and future generations, and ensure full participation of all stakeholders in decisions affecting water resources management
Water Supply Policy	2016	The National Water Supply Policy aims to ensure sustainable, equitable, reliable and affordable access to improving public health and socio-economic development.
National Sanitation Policy	2016	The National Sanitation Policy aims to ensure sustainable, equitable and affordable access to safe sanitation and waste management services for all Rwandans as a contribution to poverty reduction, public health, economic development and environmental protection.
National Industrial Policy		The National Industrial Policy stresses that waste produced by industrial processes is harmful to the environment and needs proper management and disposal strategy.

3.1.2.2. Strategies relevant to water quality management

This water quality Management plan is in line with key sectoral strategies and plans that are related to environment and water resources management as summarised in the Table 3.2 below

Table 2: Summary of relevant water quality management strategies and plans

Strategy	Date	Relevance to pollution
National Strategy for Transformation (NST1)	2017-2024	The National Strategy for Transformation (NST1) set as a priority the promotion of Sustainable Management of the Environment and Natural Resources to Transition Rwanda towards a Green Economy (Priority area 7) where to further improve integrated water resource management,

		water catchment areas will be effectively managed and protected to mitigate disasters in partnership with communities On the other hand, improved water sources are critical towards achieving universal access to water for a Modern Rwandan Household (NST1,Priority Area 5)
Water Resources Management Sub-Sector Strategic Plan (2011 – 2015)	December 2011	The strategic plan describes water resources planning (developing and implementing the WRM and Master Plan); water quality monitoring; controlling water weeds, water quality monitoring and rehabilitating critically degraded watersheds.
Rwanda National Water Resources Master Plan	May 2014	The Rwanda NWRS Master Plan is the development of a Master Plan for sustainable water resources development, utilization and management in the country. The Masterplan shall be a blueprint for a process of sustainable water, land and related resources development and management with the aim to maximize economic and social welfare in an equitable manner while safeguarding the environment.
Integrated development plan (IDP)	2012	Through the IDP, the GoR encourages adoption of holistic and cross-sectoral approaches in planning and development – integrating settlement, agriculture, infrastructure development, environmental protection and good governance.

3.1.3. Institutions involved in water quality management

In Rwanda, there are limited information on the collection and management of water quality data. Inconsistencies were noted in water quality sampling in terms of sampling sites, frequency of sampling and even in terms of the water quality variables to monitor. Some water quality data were collected by the University of Rwanda in collaboration with the former Ministry of Natural Resources and or with the former Rwanda Natural Resources Authority (RNRA).

Many public institutions such as the Ministry of Environment, Ministry of Land and Forestry, Ministry of Agriculture and Animal Resources, the Ministry of Health, Ministry of Infrastructure, Rwanda Water Resources Board (RWB), Rwanda Standards Board (RSB), Rwanda Environment Management Authority (REMA), Rwanda Green Fund (FONERWA) and Water and Sanitation Corporate (WASAC), Rwanda Utility Regulatory Authority (RURA) are directly or indirectly involved in the management of water quality in Rwanda. Thus, this multi-sectorial nature of managing of water quality in Rwanda makes it difficulty. In addition, continuous changes of the public institutions, for example, recent restructuring in MINIRENA and establishment of RWB, RLMUA and RMB from RNRA can delay meeting the targets for water quality management as a result of budget allocations to the various institutions.

However, as some of the institutions that are presented below are still new, this institutional arrangement will be adjusted as more information becomes available about their mandates, and roles and responsibilities.

Table 3: Institutions involved in water quality management in Rwanda

Institutions		Roles and responsibilities
Ministries	Ministry of Environment	Ensure that the Water Resources Management policy and strategy are passed by Cabinet and communicated to stakeholders. The Ministry of Environment also leads and actively participates in resource mobilisation; provides policy oversight to Strategy implementation including enforcement of accountability and continued alignment to high level political interests.
	Ministry of Infrastructure (MININFRA)	Develop institutional and legal frameworks, national policies, strategies and master plans relating to water supply and sanitation.
	Ministry of Agriculture and Animal Resources (MINAGRI)	MINAGRI is the ministry responsible for the development of agriculture and animal resources in Rwanda. The objective of agricultural development is to monitor and evaluate the implementation of programs related to crop production, and to formulate policies and strategies to support agriculture. With respect to animal resources the ministry develops and monitors policies, strategies, and guidelines to improve animal resources in the country. These policies, strategies, and guidelines deal, amongst other, with the One Cow per poor family program, promoting milk production and the dairy industry, improving animal production and meat consumption, promoting small stock such as sheep, goats, pigs and rabbits, beekeeping, and promoting aquaculture. The ministry with its implementing agencies play a pivotal role in managing pollution from agriculture.
Regulatory Institutions	Rwanda Environment Management Authority (REMA)	REMA is non-sectorial institution mandated to facilitate coordination and oversight of the implementation of national environmental policy and the subsequent legislation. It develops regulations and ensure protection and conservation of the Environment and natural resources across the country. REMA has, amongst other, a department for Environmental Regulation and Pollution Control. This department is responsible for ensuring that environmental degradation is prevented and remedial measures are proposed where degradation occurs. It also develops regulations, guidelines and procedures aimed at promoting better environmental sustainability of developmental activities
	Rwanda Utilities Regulatory Agency (RURA)	Integrate the IWRM targets for infrastructure and utilities within its regulatory framework and priorities. RURA also monitor enforcement of IWRM regulations and laws into water-related utilities' planning, financing and implementation to ensure compliance. Also regulates construction, licensing, and monitoring and enforcement of decentralised wastewater treatment systems, as well as the governing of liquid waste collection and transportation to disposal works.
	Rwanda Standards Board (RSB)	Provision of standards based solutions for Consumer Protection and Trade promotion for socio-economic growth in a safe and stable environment.

		Set standards for, amongst other, drinking water, domestic wastewater discharges, industrial wastewater discharges, limits for irrigation water supply, and for livestock watering.
	Rwanda Water Resources Board (RMB)	Rwanda Water Resources Board is a newly established Authority in charge of water resources management in Rwanda. This authority has among its missions, the establishment of strategies related to water resources quality and quantity preservation, catchments protection and coordination of the implementation of erosion control plans
Management/Services Institutions	Rwanda Agricultural Board (RAB)	The Rwanda Agriculture Board is an autonomous body that has the general mission of championing the agriculture sector development into a knowledge based; technology driven and market oriented industry, using modern methods in crop, animal, fisheries, forestry and soil and water management in food, fibre and fuel wood production and processing. Through its Department of Land Husbandry, Irrigation & Mechanization, best irrigation management practices can be promoted to protect receiving rivers and lakes, and through its Department of Animal Resources good livestock management practices can be promoted to minimize the impact on water resources.
	Water and Sanitation Corporation (WASAC)	The Water and Sanitation Corporation (WASAC) is the entity setup to manage the water and sanitation services in Rwanda. It does this by providing quality, reliable and affordable water and sewerage services through continuous innovations and detailed care to the needs of Rwanda's population. With respect to pollution, WASAC often have to treat water contaminated with high sediments, organic matter, and algae, to drinking water standards. It is also responsible for compliance to domestic wastewater standards at WWTWs.
	Local Government Authorities	Plan, mobilise resources, supervise and monitor the implementation of WRM projects and activities in line with the overall GoR policies, laws and strategies related to WRM.
	Water User Associations (WUAs)	Irrigation Water Users Association (IWUA) is an association formed by all water users of a defined irrigation scheme. It is endowed with a legal personality in view of the management, enhancement and sustainability of the water resource and irrigation scheme. The Ministry of Agriculture and Animal Resources, is responsible for regulation, monitoring and evaluating the performance of all Irrigation WUAs.

	Water Management Committees (WMCs)	Water management committees that will operate and maintain the water facilities at a district level, and help with monitoring, especially in rural areas not served by WASAC. Sometimes also referred to as District hydrographic committees.
	Non-Governmental Organizations (NGOs)	Supplement the public-sector efforts in water resource management and development. Empower communities and Water user groups with skills, knowledge and information in IWRM. Enhance advocacy and accountability in water service delivery and watershed protection.
High Learning and Research Institutions	Universities of Rwanda (UR), CAVM, INES-Rwanda, other universities)	The University of Rwanda through its college of science and technology and the College of Agriculture, Animal Sciences and Veterinary Medicines is involved in various research studies related to water quality monitoring of rivers and lakes in Rwanda. Some of these studies involve national or internationally shared waterbodies (such as Lake Kivu). Equally the Institute of Applied Science (INES-Ruhengeri) is involved in research oriented studies looking to water quality monitoring in the Lake Kivu catchment. This database comprises the collection of meteorological and hydrological data which can affect the quality of water in the catchment.
	The Lake Kivu Monitoring Programme	The Lake Kivu Monitoring Programme under Rwanda Environment Management Authority has implemented a regular monitoring programme on the hydrodynamic stability of the Lake Kivu since 2008. This monitoring programme is oriented to the ongoing activities of extraction of methane gas from the Lake Kivu, and it also comprises near-plant monitoring, on-plant monitoring, and overall monitoring of the whole Lake Kivu (LKM). The LKMP is able to achieve its objectives due the financial support provided by the Embassy of the Kingdom of the Netherlands in Rwanda

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3.1.4. Conclusion

Our institutional analysis indicates that the Rwanda Water Board is the leading public institution responsible for implementation of the Water Quality Management Plan. However, there are other public institutions which also play significant roles, such as REMA, RURA, RSB and WASAC. At national level, the Ministry of Environment, MINAGRI and MININFRA are also involved. The multifaceted nature of water resources management in Rwanda was identified and it is a key concern in cases where those institutions work in isolation. This should be considered at all aspects of water quality management (legal and institutional levels).

● 3.2. CURRENT & EMERGING WATER QUALITY ISSUES IN RWANDA

This section summarises the findings from the report entitled "Water Quality Management: Identification of pollution hotspots" prepared for the Wetland and Catchment Management Framework Study. Details on current and emerging water quality issues can be found in that study.

○ 3.2.1. Overview of key water quality issues

Water quality issues are assumed to be those things resulting from human actions (past, current and future), which have potential to impact water quality, along with natural phenomena and environmental factors. In most cases these issues are pressures and threats which may be natural phenomena exacerbated by human interaction, inappropriate land management practices, and misdirected policy settings and incentives. They can generally be defined in terms pollutants type and sources associated with land use and management practices.

.In this section these are introduced and the situation in Rwanda briefly described in one or two sentences. Detailed information is available in the Report on Water Quality Management: Identification of pollution hotspots.

▪ 3.2.1.1. Rapid population growth

Rwanda is among the most densely populated countries in the world. Data from National Institute of Statistics in Rwanda (NISR) shows that Rwandan population is projected to increase from 10.5 million in 2012 to 15.4 million (low scenario) by 2032. Figure 3.1 below present the growth trend of the population of Rwanda from 2002 to 2018

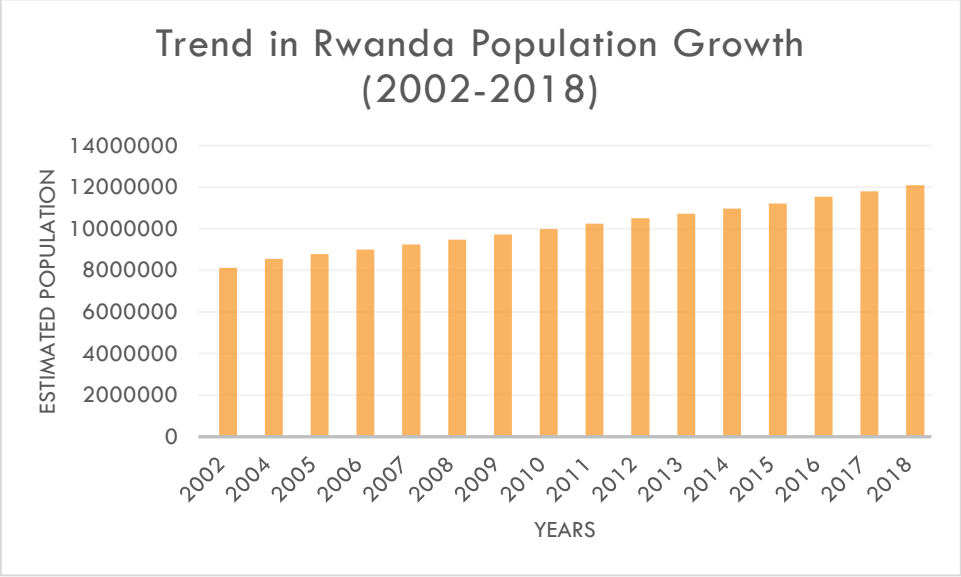

Figure 3: Population of Rwanda from 2002 to 2018

Rapid population growth is the primary driver of development activity and associated demand for infrastructure and services. Rwanda's rapid population growth is putting an incredible pressure on environment and natural resources throughout the country. Many uncontrolled rapidly growing towns are without matching infrastructure with no or poor sewerage systems and industrial pollution. On the other hand, reclamation of land for settlement and agriculture coupled with encroachment of water bodies and steep slopes areas as well as poor level of agricultural technology (little commercial fertilizer use, inefficient irrigation practices, poor soil conservation techniques, rampant soil erosion on the farms) in rural areas are leading incredible water quality deterioration and river siltation.

3.2.1.2. Water quality Pollutants

Details on water quality pollutants and sources were provided in the report entitled "Water Quality Management: Identification of pollution hotspots" prepared for the Wetland and Catchment Management Framework Study. This section provides only a summary of the findings

3.2.1.2.1. Suspended sediment and erosion

High sediments loads are readily present in Rwanda's highly turbid and muddy streams and rivers, particularly during the rainy season. Total Suspended Solids were especially elevated in water samples taken from the Sebeya and Nyabarongo Rivers, which registered from 500 to 660 mg/L and 320 to 350 mg/L, respectively. Sediment concentrations vary considerably with run-off patterns. High sediment loads is attributed to changes in land use through intensive agricultural activities and practices, construction activities, silviculture practices, destruction of riparian vegetation and the physical disturbance of land by industrial and urban developments. Presence of high levels of suspended sediments in Rwandan water bodies are associated with considerable economic losses due to siltation of rivers, lakes and reservoir that generate almost half of Rwanda electricity.

- **3.2.1.2.2. Microbiological pollution and pathogens**

Levels of faecal coliforms and E.Coli were found to be above acceptable limits in most of water bodies in Rwanda.Human settlements, inadequate sanitation and waste removal practices, stormwater wash-off and sewage spills are the major sources of deteriorating microbiological water quality in Rwanda.

The high E coli counts in Rwandan rivers mean that the water poses a real health risk to users that take water directly from the river for drinking water and for other domestic uses. It also poses a health risk children swimming and playing in rivers and streams, and there is a risk of contracting diseases if vegetables are eaten raw if it was irrigated with river water high in pathogens.

- **3.2.1.2.3 Organic material and dissolved oxygen**

A review of the average dissolved oxygen concentrations recorded by RWFA from 2011-2017 indicate that many of the rivers in Rwanda had DO concentrations below the lower limit of 6 mg/l (or 68% saturation). Of the 39 sampling points, DO concentrations less than 6 mg/l were recorded at 25 points.

Low dissolved oxygen concentrations are detrimental to aquatic organisms and it affects the solubility of metals. Metals adhered onto bottom sediment particles in streams, lakes and reservoirs can dissociate under low or anoxic conditions, dissolving back into the water where it can affect aquatic biota.

- **3.2.1.2.4 Nutrients**

A review of the average total phosphorus and total nitrogen concentrations from 2011-2017 indicate that most of the rivers in Rwanda had levels of the above nutrient within acceptable limits for most of surface water bodies. Nevertheless, present levels were still high enough to induce eutrophication in lakes and reservoirs

Eutrophication and nuisance algal growth were observed in some of the lakes that serve as a source of domestic water for surrounding communities and towns. In addition, nutrient enriched water contributed to the growth of invasive aquatic water plants such as water hyacinth.in many water bodies in Rwanda.

- **3.2.1.2.5. Hydrocarbon pollution**

Surface water concerns about hydrocarbon pollution are about wash off from road surfaces and parking lots, especially during the early season rains, and dumping of used oil into stormwater drains.

Hydrocarbon pollution is not routinely monitored in Rwanda. However, interview with stakeholders revealed t an irresponsible dumping of used motor oil by garages and workshops, often onto the soil, into stormwater drains, or nearby streams and wetlands. This appears to be problem wherever workshops are located.

- **3.2.1.2.6.. Heavy metals**

In Rwanda some rivers and lakes are affected by elevated metal concentrations, often associated with industrial activities in their catchments. Limited measures of lead, cadmium, and zinc exceeded international guideline values

The main sources of trace metals in water bodies are geological weathering, the atmosphere, industrial effluents, leaching from solid waste dumps, agricultural runoff, and drainage from mining activities (from both direct discharge and leaching from the spoils of operational and abandoned mines). Many trace metals are employed in, and result from, industrial activities.

3.2.1.2.8. Solid waste and litter

As in many other countries, the presence and magnitude of solid waste in water courses are not monitored actively in Rwanda. Although Rwanda has a reputation for being the cleanest country in the region, many district environmental officers have raised concerns about solid waste and litter in urban water bodies. This was strongly linked to the lack of solid waste removal services in many areas, especially in informal settlements and slums located in urban areas.

- **3.2.1.2.8. Agrochemicals**

In Rwanda, sources of agrochemicals include spray drift of pesticides/herbicides into surface water courses, the wash off of pesticides into surface and groundwater during rainfall events or irrigation of crops, or accidental spillages at storage facilities or during loading operations. In many cases pesticides adhere onto soil or organic particles and are washed off along with these particles.

Concerns have been expressed about the potential impacts of irresponsible use of agrochemicals on aquatic ecosystems, but little data exists about the concentrations and impacts of agrochemicals in Rwanda.

▪ 3.2.1.2.9. Emerging pollutants

There are a number of emerging pollutants that could be a cause for concern but too little is known about their status in Rwanda. These often occur in low concentrations, are difficult and expensive to detect, and requires sophisticated analytical equipment for sample analysis. They include endocrine disrupting chemicals (EDCs), persistent organic pollutants (POPs), and nanoparticles. As is the case in many developing countries, research is required to develop a better understanding of the severity and extent of emerging pollutants in Rwanda before strategies can be developed for its management. In the meantime a precautionary approach should be followed in the management of these pollutants

Endocrine disrupting chemicals

Chemicals that interfere with the endocrine systems of humans and wildlife are termed endocrine disrupting chemicals (EDCs). Chemicals that elicit a pharmaceutical response in humans are termed pharmaceutically active compounds (PhACs). EDCs and PhACs are not mutually exclusive classifications, as some, but not all, PhACs are also EDCs.

An EDC has been defined as "an exogenous substance or mixture that alters the function(s) of the endocrine systems and consequently causes adverse health effects in an intact organism, or its progeny or (sub) populations". A wide range of chemicals has been found or suspected to be capable of disrupting the endocrine systems.

Pharmaceuticals and personal care products include a large number of chemical contaminants that can originate from human usage and excretion, veterinary applications of a variety of products, such as prescription/non-prescription medications, and fungicides and disinfectants used for industrial, domestic, agricultural and livestock practices. PhACs, PCPs and their metabolites are continually introduced into the aquatic environment and are prevalent at detectable concentrations that can affect water quality and potentially impact drinking water supplies, and consequently ecosystems and human health respectively. EDCs are generally associated with large cities where there is a large concentration of inhabitants.

● Persistent organic pollutants (POPs)

Persistent Organic Pollutants (POPs) are highly stable, toxic, hydrophobic and lipophilic compounds, with the ability to accumulate in biological tissues. Many POPs can be lethal in high concentrations, but their greatest detrimental effects lie in their chronic toxicity, leading to dermal effects, liver and kidney disease, defects of the immune-, reproductive-, nervous-, and endocrine systems and even cancer. Because of their lipophilic nature, these pollutants tend to accumulate in matrices rich in organic matter, such as soil, sediment and biota, and can bio-accumulate in food chains. Global concerns about POPs lead to the United Nations Environment Programme (UNEP) initiating the Stockholm Convention on Persistent Organic Pollutants (SCPOPs) in May 1995 of which Rwanda is a signatory. The initial list of POPs targeted in the SCPOPs included certain chlorinated pesticides (Aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex and toxaphene), two groups of industrial chemicals – hexachlorobenzene (HCB) and polychlorinated biphenyls (PCB), and unintentional combustion by-products known as polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF).

● Nanoparticles

Nanomaterials or nanoparticles are defined as objects with one, two, or three external dimensions in the size range of 1-100 nanometres (nm). Nanoparticles are commonly used in personal care products, food storage containers, cleaning supplies, bandages, clothing, and washing machines. Nanoparticles are likely to enter surface waters during the production, usage, and disposal of nanoparticle containing products. Estimates of nanoparticle concentrations in some natural surface waters are in the ng/L - µg/L range (parts per trillion to parts per billion), but the concentrations may increase with greater production and use of nanoparticle-containing.

o 3.2.2. Pollutants sources

● 3.2.2.1. Point Sources

The main point sources emitters in Rwanda have been identified and described in detail in the Water Quality Management: Identification of pollution hotspots report. They include Industries, wastewater treatment works, mining and quarry operations, coffee washing stations and solid waste dumps and landfills.

3.2.2.1.1. Industrial point sources

A countrywide survey of some 88 factories and industries producing different items, was undertaken in 2017. It was found that, more than 30 % of the industries did not treat their wastewater due to insufficient capacity to treat their wastes, or treatment not being required. It was concluded that, depending on the complexity of processes occurring at some specific industrial sites, special attention needed to be taken into account during the monitoring of on-site wastewater treatment facilities as well as for any wastewater monitoring plan.

Based on the 2016 and 2017 surveys undertaken for the Resource Efficient and Cleaner Production Project of the Ministry of Trade and Industry, high organic loads characterised by high BOD and COD concentrations that exceed effluent standards, appears to be a common pollution concern amongst many industries.

● 3.2.2.1.2. Wastewater treatment works (WTWs)

Wastewater treatment works (WWTWs) that discharge treated effluent into surface water streams are important point sources of pollution if they do not meet effluent standards. However, if there is a high density of WWTWs, all meeting effluent standards, their cumulative impacts might also be significant.

A comprehensive survey of wastewater treatment systems in Rwanda for REMA in 2016 found that there were about 161 wastewater treatment systems in Rwanda with most of the systems concentrated in Kigali City (some 119 of the 161 WWTWs). However, these tended to be small, often on-site, treatment systems designed to treat the wastewater of a hospital, hotel, resort, training institution, office complex, etc. The study also sampled the final effluent from some of the WWTWs and found that, of the 13 treatment works sampled, 5 exhibited no environmental or public health problems, 4 posed no environmental problems but required chlorination of the final effluent, 3 posed a serious health risk and urgent interventions were recommended, and 1 had an odour problem.

● 3.2.2.1.3. Mining and quarrying operations

Mines can be significant source of pollution and pollutants such as heavy metals, suspended solids, salinity, sulphates, and acidification are associated with mining activities. The impacts of mining on water quality is a major concern in Rwanda, especially on suspended sediments, but also arsenic in soils and stream sediments. There are some 102 mines registered with the Mining Authority (2015 count). The impacts of the many small mining operations are more difficult to control than the impacts from large mines that can afford to implement pollution control measures.

● 3.2.2.1.4. Coffee washing stations

Coffee plays a major role in the economy of Rwanda, contributing significantly to foreign exchange earnings and to the monetisation of the rural economy. However, concerns have been expressed about the impacts of coffee washing stations on receiving water streams. Coffee washing stations contribute significantly to the organic loads in receiving rivers and streams during the coffee harvesting season which runs from 15 March to 30 June each year.

● 3.2.2.5. Solid waste dumps and landfills

Solid waste dumps and landfills can also be regarded as point sources of pollution. Pollutants associated with landfills include organic wastes from decomposing organic wastes, heavy metals from corroding metallic objects and old batteries, waterborne pathogens from discarded diapers and sewage sludge, acidic waters, hydro-carbons and oils from used motor and cooking oils, etc.

In Rwanda, unlined and unprotected landfills and solid waste disposal facilities pose a water and air pollution risk to nearby communities and ecosystems. It was highly recommended that properly designed landfills be installed for major urban centres to ensure that waste is properly collected, transported and safely disposed of, recycled or reused. These designs should specifically focus on preventing or mitigating liquid and gaseous emissions from landfills.

▪ 3.2.2.2. Nonpoint sources of pollution

● 3.2.2.2.1.. Agricultural nonpoint sources

Agriculture is the predominant land use in most of rural Rwanda and is a major source of sediments in Rwanda. The Rwandan economy is primarily based on rudimentary agriculture where over 80% of the population is dependent on subsistence agriculture. With a hilly and mountainous relief, coupled with a fragile soil and a high average rainfall intensity of 1156 mm per annum that concentrates in the wet season, the lands of Rwanda are highly susceptible to soil erosion.

Agriculture is also a major source of nutrient enrichment of rivers and lakes. The Crop Intensification Program (CIP), that begun 2007, has promoted increased agricultural productivity of high-potential food crops by creating incentives for producers to adopt new production technologies, especially fertilizer, seed and irrigation. The program has emphasized improving the availability, access and use of fertilizers. There has been a resultant increase in fertilizer access and use, and productivity of major staples. However, fertilizers applied to a field are not all taken up by the crop. Leachate losses, especially nitrogenous fertilizers which are highly soluble, are strongly influenced by when and how fertilizers are applied. Timing of application in relation to rainfall, season and crop growth is crucial.

● 3.2.2.2.2 Urban nonpoint sources

High levels of non-point sources of contamination, particularly organic material (BOD/COD), hydrocarbons, pathogens, and sediments are associated with formal urban areas and industrial activities with the urban boundaries.

In most urban areas in Rwanda, the storm-water drainage systems which was designed to mitigate the impacts of flooding during heavy rainfall events, were found to be inadequate and not keeping pace with the rapidly growing urban population. Localised impacts have been erosion of unstable land and water courses, increased flooding, and threats to private and public infrastructure. When flooding was combined with poor liquid and solid waste collection in urban settlements, it was found that urban runoff carried high loads of pollutants such as hydrocarbons, heavy metals, bacteria, sediment, pesticides and fertilizers into streams or groundwater, threatening environmental and human health.

● 3.2.2.2.3 Gravel roads and erosion

Roads, and gravel roads can be a significant source of erosion and fine sediments. When roads are constructed, they create an interference with the natural drainage systems and collect water, channel it through culverts, increasing its volume and velocity, resulting in accelerated erosion downstream of a bridge or culvert. One of the area's most prone to erosion and gully formation is along the side of roads, especially gravel roads. Roads also act as a source of oil pollution due to vehicle maintenance often conducted next to a road. Most rural roads in Rwanda are unpaved gravel roads with the exception of the national roads that are paved. The data from the Rwanda Transport Development Agency shows that in 2016 Rwanda had 1,305 km of National Paved Roads, 1,444 km of National Unpaved roads, 3,818 km of District Unpaved roads Class 1, and 88 km District paved roads Class 1.

Many roads in urban areas are also unpaved roads and the dust generated by vehicle traffic accumulate and are washed off as sediment during the first rain events. For example, in the City of Kigali there are 153 km of paved classified roads and 864 km on unpaved classified road.

○ 3. 2. 3. Summary on water quality issues causes and potential interventions

Stakeholder consultations were held with purpose to provide the project team with an initial indication of what they regard as the most pressing water quality issues in Rwanda, its main causes, and identify a few of interventions to address the concerns.

This list is by no means comprehensive and reflects the collective wisdom of the delegates on the day. It does, however, provide an initial insight to the priority water quality concerns.

Table 4: Initial identification of priority water quality concerns, causes and possible interventions

Water quality issue	Causes	Possible interventions
Erosion and sedimentation	● Excessive catchment erosion ● Uncontrolled mining activities ● Unsustainable agricultural practices	● Sustainable land management ● Enforcement of mining law and policies, and country discharge standards

	• Poor stormwater drainage • Poor solid waste management • Inadequate rainwater harvesting systems	• Implementation of Smart agriculture • Promote rainwater harvesting • Construct and maintain proper road drainage systems • Increase capacity of landfills and promote recycling initiatives
Eutrophication and invasive aquatic weeds	• Uncontrolled use of inorganic fertilisers • Discharge of untreated effluents • Open grazing of livestock • Atmospheric deposition	• Construction of check dams to settle nutrients associated with sediment particles • Targeted fertiliser applications – test soils to determine fertiliser requirements. • Promote use of organic fertilisers. • Review, and update standards for effluent discharges to rivers/lakes. • Calculate pollutant loads by measuring effluent flows and concentrations.
Inadequate solid waste management	Dump sites that are: • not properly designed or lined to prevent infiltration • No on-site sorting of waste • Insufficient collection • No or inadequate recycling • Inadequate capacity for the volume of solid waste • Lack of awareness about solid waste management	• Consider solid waste as an economic good/resource • Involve private sector in solid waste management • Increased awareness of the need for managing solid waste • Enforcement of solid waste regulations
Discharge of untreated wastewater	• Lack of wastewater treatment plants for some industries, hospitals, domestic wastewater, markets, and schools. • Lack of centralised WWTWs for large urban centres	• Establishment of centralised WWTWs for large urban centres • Enforcement of standards and regulations pertaining to WWTWs. • Promote the generation and use of biogas.

		● Regular monitoring and inspections of existing WWTWs. ● Procurement of funding for monitoring and inspection service ● Promotion of recycling and reuse of wastewater ● Budget for the cost of maintaining WWTWs ● Control of organic pollution

3.3. FREMEWORK FOR MANAGING WATER QUALITY IN RWANDA

This section provides an introduction to guiding principles for water quality management, regulatory instruments commonly used in water quality management, guidance on decision making when considering whether to authorise the discharge of polluted water into the receiving environment, and a protocol for selecting a suit of management interventions to address a specific water quality concern.

○ 3.3.1. Guiding principles

The United Nations Environment Programme (UNEP) and the World Health Organisation (WHO) published a set of guidelines for water pollution control that provides a suitable basis for the sound management of water quality and pollution (Helmer and Hespanhol, 1997). These principles provide good guidance for the development of water quality management strategies and plans in Rwanda.

- **Prevent pollution rather than treating symptoms of pollution.** Experience has shown that remedial actions to clean up polluted water bodies are generally much more expensive than applying measures to prevent pollution from occurring. The most logical approach is therefore to prevent the production of wastes that require treatment. Approaches to water pollution control that focus on wastewater minimisation, in-plant refinement of raw materials and production processes, recycling of waste products, etc., should be given priority over traditional end-of-pipe treatments.
- **Use the precautionary principle**. It is generally accepted that water bodies have a capacity to assimilate waste unless scientific research has proved unambiguously a causal link between the substance and a well-defined environmental impact. As a result, there are many examples of the discharge of hazardous substances into rivers and lakes, even when such substances are suspected of having detrimental effects on the environment. However, in most cases it takes a very long time to establish causal links. The precautionary principle encourages water pollution regulators to prevent the discharge of hazardous waste into rivers and lakes until it can be proved not to have a significant on receiving water bodies and aquatic ecosystems.
- **Apply the polluter-pays-principle.** The polluter-pays-principle, where the costs of pollution prevention, control and reduction measures are borne by the polluter, is not a new concept but has not yet been fully implemented, despite the fact that it is widely recognised that the perception of water as a free commodity can no longer be maintained. The principle is an economic instrument that is aimed at affecting behaviour, i.e. by encouraging and inducing behaviour that puts less strain on the environment.
- **Apply realistic standards and regulations.** The formulation of realistic standards and regulations is an important element in a water quality management strategy is realistic standards and regulations. The standards must be achievable and the regulations enforceable. Unrealistic standards and non-enforceable regulations may do more harm than having no standards and regulations. Standards and regulations should be tailored to match the level of economic and administrative capacity and capability. Standards should be gradually tightened as progress is made towards meeting them. Thus, the setting of standards and regulations should be an iterative and on-going process to keep up with improvements in wastewater treatment technologies.

- **Balance economic and regulatory instruments**. Most governments rely heavily on regulatory management instruments for controlling water pollution. Economic instruments, typically in the form of wastewater discharge fees and fines, have been introduced but are mainly used in industrialised countries. UNEP and WHO was of the opinion that most countries should to apply a mixture of regulatory and economic instruments for controlling water pollution. In developing countries, where financial resources and institutional capacity are limited, the most important criteria for balancing economic and regulatory instruments should be cost-effectiveness (those that achieve the objectives at the least cost) and administrative feasibility.
- **Apply water pollution control at the lowest appropriate level.** The appropriate level has been defined as the level at which significant impacts are experienced. If, for example, a specific water quality issue only has an impact within a local community (sector) then the sector level is the proper management level. If impacts affect several sectors, then a district level, or catchment level management might be appropriate. Where significant impacts occur in several countries (e.g. Rwanda, Uganda & Tanzania), then basin scale management would be appropriate
- **Establish mechanisms for cross-sectoral integration**. In order to ensure the co-ordination of water quality management efforts within water-related sectors, such as health and agriculture, formal mechanisms and means of co-operation and information exchange need to be established. The Water Interministerial Committee (IMC) described in the National Water Resources Master Plan could be a practical platform for a single and comprehensive interministerial water management strategy development and to ensure coordination of water quality management efforts between water-related ministries.
- **Encourage participatory approach with involvement of all relevant stakeholders.** The participatory approach involves raising awareness of the importance of water pollution control among policy-makers and the general public. Decisions should be taken with full public consultation and with the involvement of groups affected by the planning and implementation of water pollution control activities. In Rwanda, the involvement of Catchment Water Management Offices and catchment committees in water quality management decision making would go a long way to realising this principle.
- **Give open access to information on water pollution.** This principle is directly related to the principle of involving citizens in the decision-making process, because a precondition for participation is free access to information held by government authorities. Open access to information helps to stimulate understanding, discussions and suggestions for solutions of water quality problems. In many countries, notably the countries in economic transition and the developing countries, there is no tradition of open access to environmental information. Unfortunately, this attitude may seriously jeopardise the outcome of any international co-operation that is required.
- **Promote international co-operation on water pollution control**. Trans-boundary water quality management, typically encountered in large river basins, requires international co-operation and co-ordination of efforts in order to be effective. The Nile Basin Initiative (NBI) and the LVEMP project offers a mechanism for cooperation on water quality management and trans-boundary pollution concerns in the international rivers flowing towards Lake Victoria.

3.3.2. Regulatory instruments

Regulatory instruments influence environmental outcomes by regulating processes or products, limiting the discharge of specified pollutants, and by restricting certain polluting activities to specific times or specific areas. Regulation can be defined as "*the means by which any activity, person, organisation or institution is guided to behave in a regular fashion, or according to rule.*" Under this definition, the regulatory framework for water quality consists of a great number of players and processes, some falling within the formal regulatory process, i.e. regulation as practiced by the state, and some falling within a more informal regulatory process, for example through the media, community pressure groups, consumer behaviour, and so on.

There are broadly four categories of regulatory instruments for managing water quality – Command and Control, Economic/Market Mechanisms, Voluntary Agreements, and Information.

3.3.2.1. Command and Control

Under the command and control approach to regulation, government prescribes specific guidelines or standards that regulated parties must comply with. There are various forms that such guidelines or standards can take, such as prohibitions on certain activities, licensing of regulated activities, setting of product or technical production standards, or setting of performance standards.

Two approaches are generally used under the category of command and control namely the uniform effluent standard approach, and the receiving water quality objectives approach.

- **Uniform effluent standards approach** – Uniform effluent standards (UES) usually sets limits to pollutant concentrations in an effluent, using the "best available technology" to treat wastewater. Examples are the Rwanda standards for the discharge of treated domestic wastewater (RS 110), and the discharge of industrial wastewater effluent (RS109). The advantage of the UES approach are that it is simple, comprehensible and straightforward to apply, and if standards are frequently revised to reflect the ability of the best pollution treatment technology, it should have the effect of reducing pollution from point sources. The drawbacks of the UES approach are that it is focused on effluent and largely ignores the impacts of effluent discharges on water quality in receiving river or lake, in cases where there are multiple point sources of a particular pollutant, or where there are high background levels arising from diffuse sources, the UES approach may fail to protect the quality of water resources, and the UES approach is not necessarily cost-effective, because it requires all effluent to comply with the same standards irrespective of variations in the assimilative capacity of the receiving river or lake or in the cost involved.
- **Receiving water quality objectives approach** – The RWQOs approach involves specifying the water quality requirements in receiving rivers or lakes, and then controlling pollution loads to ensure that the quality requirements are met. It is based on acceptance of the principle that receiving waters have a capacity to assimilate pollution without detriment to accepted uses for the waters concerned. Because it is focused on managing the quality of receiving waters in such a way that there is a minimum interference with legitimate uses of those waters, has to consider both point and diffuse sources of pollution. The advantages of the RWQOs approach are that it is cost-effective because, by considering the assimilative capacity of receiving waters for particular pollutants, it minimizes the level of control required for

adequate protection of water-uses. It also provides an incentive for industry to locate where receiving waters are less sensitive to pollution. The drawbacks are that from a regulatory point of view, the RWQO approach is technologically much more demanding because it requires a thorough investigation and understanding of the fate of pollutants in the water environment and their impacts on water-uses. It is not as straightforward to apply as a UES because the RWQO approach leads to site-specific effluent standards, and problems may arise because RWQO could vary with different seasonal flows.

- **Pollution prevention approach** - Some pollutants are regarded as hazardous or dangerous because they present a major threat to rivers and lakes due to their toxicity, persistence, and/or capacity to bioaccumulate. For these pollutants an approach based on preventing or minimising inputs to the water environment would be appropriate. Some of the organoleptic pollutants listed in the Ministerial Order N°004/16.01 of 24/05/2013 - Determining the list of Water Pollutants, should be controlled using the pollution prevention approach.

These three approaches can be applied simultaneously (refer to Section 5.3) depending on the local situation.

▪ 3.3.2.2. Economic Mechanisms

While there are variations in the definition of economic instruments in the literature, UNEP (undated) offers the following definition: "*a policy, tool or action which has the purpose of affecting the behaviour of economic agents by changing their financial incentives in order to improve the cost-effectiveness of environmental and natural resource management.*"

Since the inception of environmental policy in most industrial countries, governments have tended to use these instruments as their main strategy for controlling pollution. Many countries, however, are becoming aware that regulatory instruments are inefficient for achieving most pollution control objectives, and that the level of expenditure required to comply with increasingly stringent environmental laws and regulation is becoming a major cost of production. Economic instruments have been described as promising tools for advancing sustainable development and therefore, water quality management.

▪ 3.3.2.3. Voluntary Agreements

Voluntary regulation is an important addition to the suite of instruments that government agencies can use to achieve regulatory objectives. While voluntary regulation is used in both developed and developing countries, there is disagreement on how effective it has been in developing countries. Examples of voluntary agreements include cooperative governance; multi-sector partnerships; self-regulation; environmental agreements negotiated between regulators and industry; public programs that individual firms are invited to join; public disclosure initiatives that collect and disseminate information on participants' environmental performance; and unilateral commitments made by firms.

▪ 3.3.2.4. Information

While adequate information is a prerequisite for all forms of regulation, and the exercise of all regulatory instruments, it can also be used as a regulatory tool in its own right. Requiring water users to disclose information about their effluent, can provide a useful way for authorities to collect information. Equally, if the information is made public, such disclosure can also give the public access to the information and

provide for monitoring and control both by the authorities and by public pressure. The collection of information also signals to water users that the authorities are taking their regulatory role seriously.

3.3.3. Guide to making decisions about individual dischargers

Water quality management is about finding the right balance between environmental protection, and socio-economic development. More protection of a receiving water body implies more stringent limits being set on dischargers and possibly impeding socio-economic development, while less protection implies less stringent limits set on dischargers and possibly promoting socio-economic development at the cost of the environment.

The exact nature of regulatory controls that will be applied to a particular wastewater discharger, will depend on the objectives that are set for the receiving water body. Overall, the regulator should apply an approach that ensures conservative decision making in order to minimise the risk of unacceptable ecological impacts that may influence the long-term sustainability of the receiving waters. The regulator should balance the protection of ecological services with that of supporting socio-economic development. A hierarchy of sequential steps of water pollution management decision-making can be applied (Figure 5-1).

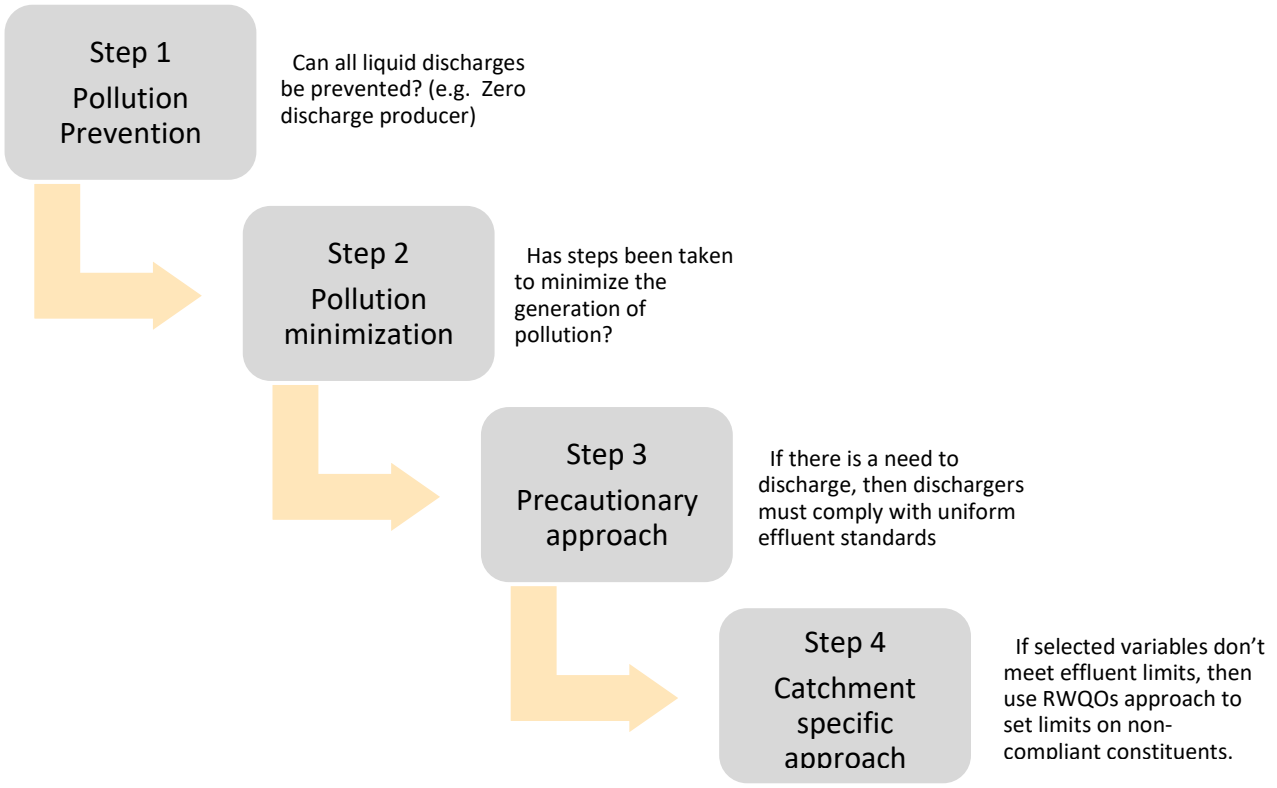

Figure 4: Sequence of decision making

Step 1: Pollution Prevention

The first step in decision-making on water quality will be to prevent pollution where possible, while recognising the need for equitable socio-economic development to take place. This is based on the premise

that it is better to prevent harm than to manage it after the fact. Thus, irrespective of the amount of dilution available in the receiving water body, dischargers should be encouraged to prevent pollution where possible.

Prevention is especially important for controlling the handling, discharge and disposal of hazardous substances, or substances that could present a major threat to water quality. This is particularly important in the field of emerging contaminants, where understanding cumulative impacts is particularly complex, for pollutants of high toxicity, hazard or bio-accumulation, or in the context of uncertainty arising, for example, from climate change.

Step 2: Pollution Minimisation

Where prevention of pollution is not altogether possible, and is in the interests of promoting ecologically sustainable and justifiable economic and social development, the discharge of wastewater (point source or diffuse source) should be minimised. Tools for the minimisation of pollution include detoxification, neutralisation, application of best practices, recycling and re-use of water that would otherwise be discharged, and the capture for re-use of products in the water that would otherwise be discharged into a receiving water body.

Since many land uses have a significant impact on water pollution, the regulation of land use, including the prohibition of polluting activities, should, where appropriate, be used as an instrument to minimise pollution.

Step 3: Precautionary Approach

Where there is no alternative to discharging wastewater or disposing of waste, discharges with a pollution potential should be regulated under the Rwanda Standards Bureau of Standards (e.g. domestic or industrial effluent standards), authorisations with specific discharge conditions, or through prohibition of particular discharges or activities.

Step 4: Differentiated / Catchment Specific Approach

As a basis, catchments differ in their hydrological and ecological functioning. Additionally, there are differences in the ways and extent to which they are used, and this requires a differentiated and adaptive management response. This should be guided by the extent of water quality degradation that is experienced within the catchment.

In order to protect water resources, the regulating authority should be guided by the level of protection it wants to achieve in a specific river or lake. In practical terms, for a river, for instance, this implies that collectively all the dischargers in a specific river reach must ensure that the water quality targets at a downstream site can be achieved and maintained. This approach aims to put focus on this systemic management of water quality and accounting for cumulative effects of many pollution discharges.

The desirable level of protection varies between catchments and water resources, and decisions should be informed by the specific catchment management strategy. In catchments with no water quality stress, minimum standards for wastewater discharge can be applied. These may be relaxed in special circumstances, but the level of protection should be maintained.

In water quality stressed catchments or river reaches where application of the minimum standards are not sufficient to maintain the desired level of protection, standards stricter than the minimum effluent standards should be applied. These standards should be site-specific and should be based on the results of a waste load

allocation investigation. In addition, due consideration will be given to the need to rehabilitate specific resources.

Rehabilitation

In specific catchments or rivers there may be the need to rehabilitate heavily polluted water resources in order to improve water quality. Rwanda Water Resources Board should drive a programme to rehabilitate and remediate these impacts in critical catchments or rivers.

Remediation or rehabilitation may include direct intervention on degraded land to minimise contamination risk to a water resource. In determining the approach to rehabilitation, the critical role of green infrastructure, such as wetlands, should be recognised, and such infrastructure should be both protected and rehabilitated and sufficient investment should be made for this.

Rehabilitation will either require action and funding by the GoR, or actions to be taken by those responsible for the pollution, depending on the nature of the polluting activity and the rehabilitation actions required. The rehabilitation of sources of pollution should also be addressed, such as rehabilitation of mining sites, landfills and other contaminated sites. The protection and restoration of wetlands and similar green infrastructure is an important part of integrated water quality management.

o 3.3.4. Selecting a suite of water quality management options

The Source/pathway/receptor/use framework provided a useful framework to integrate the process and response components of water quality management, and for grouping water quality management options (Figure 5-2). This framework is described in more detail in the document "Guidelines for Water Quality Management", document 113517/NRM/POLLUT/04 of this project.

Some water quality problems are best managed at source, while others may be easier manage along the delivery pathways. Once a pollutant has entered a waterway, it can be managed in the receptor water body (in the river or a lake), or finally, if all else fails, a water user can treat the water to its own specifications. The framework consists of:

1. Production or sources of pollutants,
2. Delivery or pathways that pollutants follow to a surface water resource,
3. Transport and storage of pollutants within the receiving water resource (**receptor**), including transport in rivers and storage/transformations within lakes and reservoirs.
4. Use of the resource for various consumptive or non-consumptive uses.

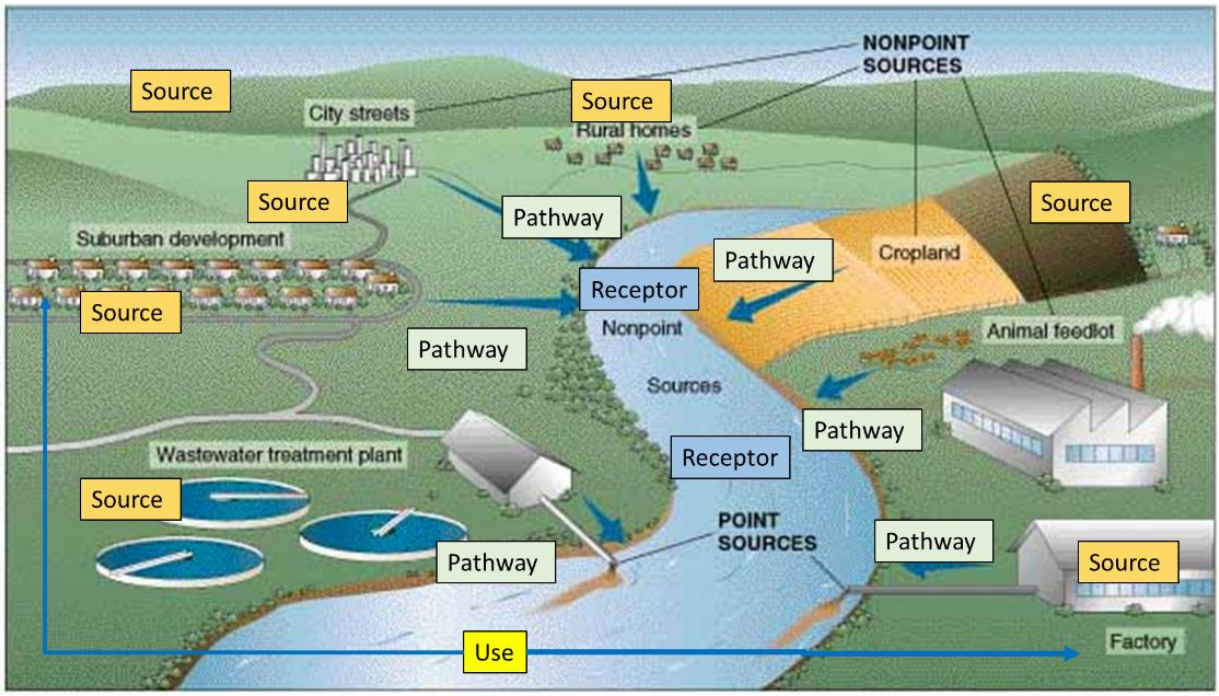

Figure 5: Illustration of source/pathway/use framework for water quality management

Debo & Reese (2003) referred to the concept of a Treatment Train within the context of urban runoff management. This is a useful approach because it recognises that it is only through a combination of various pollution management options employed within a particular catchment that water pollution can be reduced to the maximum extent possible. The Treatment Train Concept is thought to have five major components: Education and prevention programmes, Runoff and load generation, Conveyance and pre-treatment, End treatment and/or attenuation, and In-stream and habitat programmes.

The process of selecting a suite of water quality management options is illustrated in Figure 5-3.

The first step entails the assessment of water pollution and linking them to their root causes determines where attention should be focused in the treatment train (sources & pathways / transport & storage / use). The next basic step is to develop a first-cut laundry list of management options that address all the components of the water quality management framework. The different laundry lists are then combined and prioritised and a shortened list of options is then organised, analysed and prioritised to become the strategy and programme of actions that will be implemented in the short to medium term.

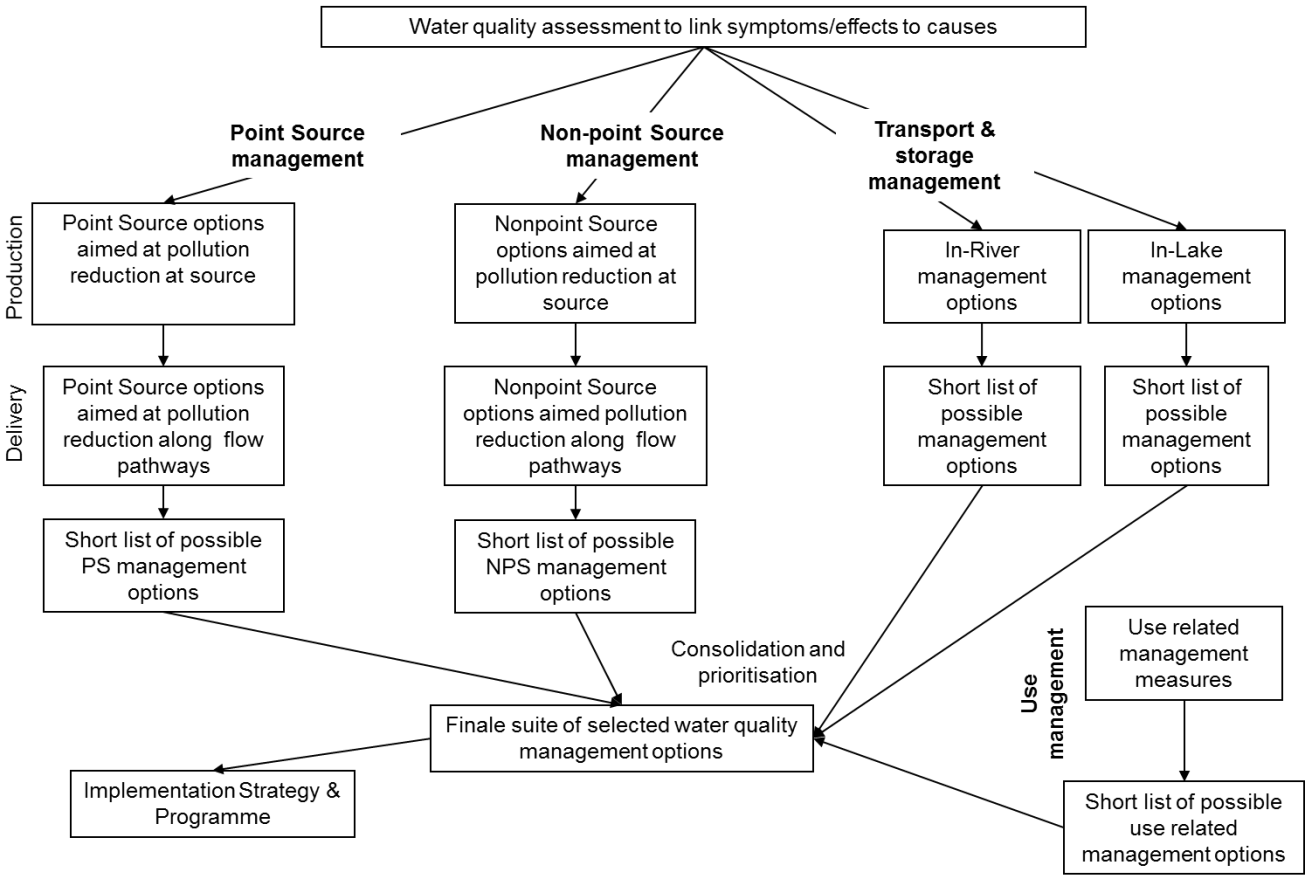

Figure 6: The process of identifying and selecting a suite of water quality management options

Production sources and pathways

The hierarchy of water quality management decision-making encourages managers to start at pollution prevention (source management) and waste minimization (pathway management). This is done by identifying a short list of possible options to manage point and/or nonpoint sources at source, and/or along the flow pathways. A water quality assessment study provides guidance on how much of the pollutant loads originated from point or non-point sources, and how much of an effort should be expended to control these sources and the pathways. In general, it was found that sources and pathways are considered as a group. For example, to reduce point source impacts, advanced wastewater treatment (source reduction) is designed in combination with artificial wetlands (pathway reduction) to meet a final effluent discharge limit. The overall objective of these activities is to identify a short list of possible options to manage pollutant sources and pathways.

Transport and storage

A water quality assessment study also provides guidance on whether management in the receiving water body (transport and storage management) should be considered. These include in-river management options where the assimilative capacity of the river to reduce pollutant concentrations (transport management) or in-lake management options are designed to reduce impacts, suppress internal loading, or reduce water

retention time where possible (flushing). The objective of these activities is to identify a short list of possible in-river and in-lake options to manage the impacts of pollution.

Use modification

A water quality assessment study will also provide guidance on whether the use of the water resource should be modified to accommodate, in the short term, the negative impacts of pollution. These include options such as restricting certain activities in the receiving river or lake, or designing modular water treatment systems that can cope with high sediment loads during certain times of the year. The objective of this activity is to identify a short list of possible use modification options to cope with the negative impacts of poor water quality.

Suite of management options

The last step is to consolidate and prioritise the various management options identified in the previous steps. The previous steps considered mostly the technological merits of various management options. In this step aspects such as social and economic considerations, urgency for taking action, available resources, and institutional capacity are also considered to derive a suite of options that can be implemented at various stages of the treatment train. This list forms the foundation for an implementation strategy and programme.

Time horizon

The time horizon for control should also be considered. In the short term, it may be more practical to implement in-river or in-lake controls because it often yields immediate results and mitigation of pollution symptoms. At the same time, catchment control measures such as structural and non-structural nonpoint source control measures can be implemented. These often take a long time to develop and implement but have longer-term positive impacts.

CHAPTER 4 WATER QUALITY MANAGEMENT PLAN

The preceding chapters provided a brief overview of water quality management in Rwanda, the water quality status, and sources of pollution. It identified specific issues and challenges being experienced. This chapter sets out the vison, goals, and objectives to address these issues and to ensure the sustainable management of water quality going forward.

4.1 Vision, goals and objectives

The overall objective of the Rwanda National Water Resources Master Plan is "*to ensure a sustainable water resources development, utilization and management in the country*" (MINIRENA, 2015). It also stated that the National Policy for Water Resources Management emphasised that "*water is a cross-cutting natural resource, whose use cuts across all sectors, including domestic consumption, agriculture, commerce and industry, as well as ecological uses for environmental conservation, such as forests, fisheries and wildlife. The management of water resources therefore is best undertaken within a framework that provides for decision making in an integrated manner*."

The National Strategy for Transformation (NST1) assigned priority on promotion of Sustainable Management of the Environment and Natural Resources to Transition Rwanda towards a Green Economy (Priority area 7) where to further improve integrated water resource management, water catchment areas will be effectively managed and protected to mitigate disasters in partnership with communities.

Managing water quality in Rwanda is therefore about finding a balance between ***protecting*** the quality of water resources and its beneficial uses and *using* water resources to promote socio-economic development and prosperity in Rwanda.

Therefore, the vision for water quality in Rwanda is:

Sustainable management and protection of water quality in Rwanda is in balance with the country's socio-economic development needs

As stated earlier in this document, the National Strategy for Transformation recognises the importance of sustainable management and protection of the environment as a driving force to achieve its targets. Water quality is one of the drivers of the aquatic environment. Furthermore, the wise utilisation of the natural resources was emphasised in EDPRS 2 (2013-2018) in which the GoR planned to reach 100% of access to safe clean water and adequate sanitation countrywide. It is understood that by putting in place safe water supply, and appropriate hygiene and sanitation infrastructure in rural and urban areas, the country will improve the quality of its rivers and lakes. EDPRS 2 was also aligned with the targets of Vision 2020. Vision 2020 envisages to provide to all Rwandans with clean water, and to protect water resources from pollution.

Achievement of the vision will be through the following strategic goals:

Goal 1: Enhancing Water Quality Management governance.

Goal 2: Efficient and effective management of water quality

Goal 3: Effective information and knowledge management

The above three strategic goals are supported by specific objectives and targets.

Goal 1: Enhancement of Water Quality Management governance

Implementing effective water quality management requires a coherent approach across ministries and public institutions directly and indirectly involved in protecting water quality. This coherent approach will increase the efficient use of limited resources. Furthermore, ensuring that policies and strategies of these institutions address both water quality and water quantity is crucial to entrench good water quality management as a government-wide challenge and to secure its long-term sustainability. There is therefore a need to be more inclusive in managing water quality, and to improve the alignment between the many policies and legislation, as well as strategic approaches to water quality management.

Furthermore, many public institutions are directly or indirectly involved in the management of water quality in Rwanda (refer Chapter 3). These include the Ministry of Environment, Ministry of Land and Forestry, Ministry of Agriculture and Animal Resources, the Ministry of Health, Ministry of Infrastructure, Rwanda Water Resources Board (RWB), Rwanda Standards Board (RSB), Rwanda Environment Management Authority (REMA), Rwanda Green Fund (FONERWA), Water and Sanitation Corporation (WASAC), and the Rwanda Utility Regulatory Authority (RURA). This multi-sectorial nature of managing of water quality in Rwanda makes it difficulty. It is therefore essential that functional roles and responsibilities be clarified to ensure good governance of water quality.

Objective 1.1 Harmonise policies and strategies to promote improved water quality management

With so many institutions involved in different aspects of water quality management, it is inevitable that there may be misalignment between policies and strategies as these organisations have different developmental, or environmental protection mandates. It is recommended that policies and strategies that relate to the water quality management be harmonised where required. This can be achieved by ensuring that all policies and strategies developed by the government institutions under Ministry of Environment coherently address water quality management, and that policies and strategies developed by other ministries and their institutions/agencies are aligned with those of the Ministry of Environment to coherently address water quality management.

Objective 1.2 Coordination and cooperation mechanism on water quality issues established at national level

With so many institutions involved in different aspects of water quality management, it is inevitable that there may be uncertainty about the role each institution in water quality management. This objective can be met by clarifying the mandates, and roles and responsibilities of the different role players involved in water quality management. This can be achieved by reviewing the mandates, and roles and responsibilities of the different role players involved in water quality management, especially with recent changes in institutional structures. It is also important that there be effective arrangements between role players with regard to water quality management to ensure that cooperative governance of water quality is made a reality. This can be achieved by establishing mechanisms for cooperation between government institutions on water quality management and pollution control issues. Lastly, Rwanda shares rivers and lakes with their neighbours and it is therefore important that transboundary water quality be managed in order to meet the objectives of shared rivers protocols. This can be achieved by establishing mechanisms for the exchange of information on transboundary water quality, and for resolving transboundary water pollution issues.

Specific targets for this goal are:

- Target 1.2.1 Clarify mandates, and roles and responsibilities of the different role players involved in water quality management
- Target 1.2.2 Establish effective coordination arrangements between role players with regard to water quality management
- Target 1.2.3 Transboundary water quality management

Goal 2: Efficient and effective management of water quality

The water quality challenges in Rwanda will require efficient and effective management practices within catchments. This will mean critical review of these processes and practices at various levels within the water quality management system. It includes identification and implementation of a suite of management interventions to deal with the point and nonpoint sources of water pollution, and the symptoms evident in rivers and lakes.

Objective 2.1 - Efficient and effective management of point sources of water pollution

Monitoring of compliance with Rwandan domestic and industrial effluent standards appears to be in its infancy. This function should be strengthened, and consideration should be given to requiring effluent dischargers to submit regular analysis results of their effluent quality. REMA can then audit these results on a regular basis. All effluent monitoring data should be stored in a central database (e.g. the Aquarius database at Rwanda Water Resources Board). Protocols should be developed for enforcing standards, and for dealing with non-compliant dischargers. To meet this goal, producers of wastewater should be encouraged to treat wastewater at source as described in Chapter 5 of this report. This can be achieved by identifying industrial polluters with no wastewater treatment and not meeting effluent standards and directing them to implement onsite wastewater treatment. This includes hospitals and health centres, hotels, garages and petrol stations, slaughter houses, and industries. It can also be achieved by requiring onsite wastewater treatment at all new industries being established, and wastewater treatment works to be constructed at new industrial zones to treat the wastewater emanating from tenants at the zone. Consideration should also be given to the design and construction of centralised WWTWs and sludge treatment facilities for large urban centres, and to progressively connect households and large wastewater producers to the sewerage network. Lastly, Rwanda has a very initiative to promote resource efficiency and cleaner production in industries. This initiative under the RRECPC should be supported, and industries should be encouraged to participate in this initiative.

Specific targets for this goal are:

- Target 2.1.1 Compliance with effluent standards
- Target 2.1.2 Promote wastewater treatment at source
- Target 2.1.3 Support for resource efficiency and cleaner production initiatives

Objective 2.2 - Efficient and effective management of nonpoint sources of water pollution

Nonpoint sources of pollution probably have the greatest regional impacts on water quality in Rwanda. Erosion and sedimentation from agricultural lands is probably the biggest concern and strategies for its management has been dealt with comprehensively in the various catchment management plans that have been developed as part of this project, and undertaken by other consultants. It has also been the focus

of soil conservation initiative undertaken in the country over many years. Reducing erosion and sedimentation also has a large positive impact on water pollution as many pollutants attach onto sediment particles, and intercepting the particles before they enter water courses, also prevents these pollutants from entering streams, rivers, and lakes. To meet this objective, a number of targets have been identified dealing with urban stormwater, riparian buffer strips, hydrocarbon pollution, runoff from informal settlements, other agricultural impacts, and runoff from unpaved roads.

The management of stormwater in urban areas is important because it is the conduit for transporting pollutants into urban streams, and eventually nearby rivers and lakes. This requires promoting the use of structural stormwater control and treatment facilities (e.g. instream detention ponds) in urban areas, as well as reducing stormwater runoff by improved rainfall infiltration systems, efficient drainage network, and improved rainwater harvesting by households, complexes, and commercial buildings. Riparian buffer strips are an important approach to intercepting polluted runoff. The installation and maintenance of riparian buffer zones and vegetated buffer strips should be promoted and enforced. Hydrocarbon pollution from the dumping of used oil can contaminate large volumes of water rendering it unfit for use. The installation of oil separators at all garages and vehicle workshops should be enforced and illegal dumping of used oil should be policed, and culprits be prosecuted. It would be beneficial if there is a national used oil recycling facility which collects used motor and cooking oil in all urban areas and recycles it for reuse. Informal settlements have a large impact on water quality due to indiscriminate disposal of liquid and solid wastes. It is recommended that a national strategy be developed specifically to reduce pollution at slums and informal settlements. The recommendations of the National Sanitation Policy with respect to informal settlements should be implemented, and the use of improved sanitation facilities for all households should be implemented as defined in the National Sanitation Policy. Agricultural also have impacts on nutrient enrichment and pollution from the use of agrochemical to control pests. To deal with these impacts, authorities should promote climate smart urban agriculture, encourage farmers to use a combination of organic and inorganic fertilisers on their fields, and promote integrated pest management and the use of biodegradable pesticides where possible. Roads, particularly unpaved roads have a large impact on erosion and sediment production. It is recommended that gravel road drainage infrastructure be maintained to reduce erosion, and to implement dust suppression measures on unpaved urban roads to manage wash-off of fine sediments into the stormwater drainage system during rainfall events.

Specific targets for this goal are:

- Target 2.2.1 Stormwater management in urban areas
- Target 2.2.2 Protected buffer strips
- Target 3.2.3 Reduced hydrocarbon pollution
- Target 3.2.4 Pollution from informal settlements controlled
- Target 3.2.5 Reduced agricultural impacts
- Target 3.2.6 Road infrastructure impacts to water quality reduced

Goal 3: Effective information and knowledge management

Water resources management is only possible if there is sufficient data and information available. This is certainly the case with water quality management. This goal therefore refers to improving the water quality monitoring networks and strengthening and consolidating information management systems. The management approach for water quality is based upon the support of these networks and systems. It also refers to officials who have the necessary training and capacity to collect and interpret the data and information to support decision making.

Objective 3.1 monitoring of water quality - It is not possible to manage what you don't measure. Good water quality monitoring is essential to support effective enforcement and compliance. Added to this, the timely sharing of the right data and information, in the required format, enables the development of relevant and applicable water quality management interventions. Continuous improvement of monitoring networks and monitoring services enables effective enforcement and compliance of laws and regulation, and supports an adaptive management approach to water quality management. Garrick et al. (2017) stated that measurement underpins the valuation of water and that robust measurement, modelling and accounting are the foundation for water valuation.

Targets and activities to support this goal are the establishment of a dedicated monitoring unit, and implementation of routine surface water quality monitoring of rivers and lakes, effluent discharges, and urban rivers and lakes. It also refers to initiation of limited duration water quality surveys to investigate specific problems in collaboration with academic institutions and selected specialists. Lastly, it is essential that all the data gathered by means of routine programs and surveys, be stored and managed to maintain the integrity of the data, and to generate information and routines reports that meet the requirements of water resource managers.
Specific targets for this goal are:

- Target 3.1.1 Operational water quality monitoring programme
- Target 3.1.2. Enhanced nationally water quality testing capacity
- Target 3.1.3. A well-defined framework for data storage, management, information generation and reporting
- Target 3.1.4. Regular reporting on status of water quality, including river, lakes and effluent discharges

Objective 3.2 Building capacity in water quality management

Capacity building is fundamentally about improving effectiveness, often at organisational level. To this end, there is a need to strengthen the skills base at RWB, REMA, RURA and its partners to ensure that internal structures, capacity and systems are improved and aligned towards the effective and efficient management of water quality. Equally important is that national government departments and district governments take responsibility for their roles in managing water quality. Even though developing countries are, traditionally, less likely to have the institutional, technical or financial capacity to undertake many water resource management activities, several developing and developed countries have illustrated how innovation, through research and development, can help conquer traditional barriers. The building and maintaining of water quality management capacity, including civil society, through education, training, research and communication, is essential in supporting the inclusive approach towards ensuring effective management of water quality.

In order to support this objective, it is recommended that an overall capacity building programme be based on an assessment of capacity gaps and training needs. Training and development that can be considered include an introduction to water quality management, training in the design of monitoring systems, training in conducting pollution incident investigations, emergency responses to mitigate impacts, and prosecution of polluters. Training can also be considered in enforcing compliance to effluent standards and the legal requirements, as well as in the principles of monitoring data management, information generation, and routine reporting. Water quality management should be underpinned by applied research and innovation in dealing with specific types of pollutants. Applied research into recent innovations and development related to water quality management should be promoted, as well as applied research into specific water quality problems facing Rwanda. Water quality management should also be supported by well informed and actively engaged citizens. This can be achieved by publishing easy to understand annual reports on the status of water quality in Rwanda, and by create awareness campaigns of the dangers of water quality pollution and how prevent it.

Specific targets for this goal are:

- Target 3.2.1. Key staff in water quality related institutions have been trained to undertake their duties.
- Target 3.2.2.Underpin water quality management by applied research and innovation
- Target 3.2.3.Well informed and actively engaged citizens

The sector expects to achieve these goals and objectives via several targeted streams of activity, which are designed to specifically support and achieve the results described above. Necessary inputs include human and budgetary resources, as well as material resources. The extent of these inputs are detailed in the log frame that follows (Table 3-4).

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Table 5: Water Quality Management Plan interventions log frame

Goal 1: Enhanced Water Quality Management Governance								
Objectives	**Activities**	**Timing**					**Implementing Institution**	**Estimated cost (FRW)**
		2020/ 2021	**2021/ 2022**	**2022/ 2023**	**2023/ 2024**	**2024/ 2025**		
Objective2.1: Policies and strategies to promote improved water quality management are harmonized	Develop guidelines which describe the impacts of deteriorating water quality and mitigation measures for specific user sectors	X	X				**RWB*,** MoE, MINAGRI, MININFRA, RURA, REMA	125,000,000
	Develop simple water quality index for Rwanda to be used while reporting on status of water quality	X	X	X	X		**MoE, RWB,** UR, other universities	10,000,000
	Develop protocols for national and transboundary water quality monitoring	X	X				**RWB,** MoE	7,200,000
	Periodic review and follow up that policies, strategies and regulations being developed conform and coherently address water quality management	X	X	X	X	X	**MoE**, RWB, REMA	480,000
Objective 1.2: Coordination and cooperation mechanism on water quality issues established at National Level	Establish the National Water Quality Monitoring network Committee		X				**RWB, WASAC, UR, other partners**	1,200,000
	Participate in regional and international mechanisms for the exchange of data and information on transboundary water quality	X	X	X	X	X	**RWB**, MoE, REMA, MININFRA, WASAC	5,000,000
	Initiate the biennial regional conference on water quality monitoring		X		X		**RWB**, UR and other universities	24,000,000
	Facilitate the incorporation of water quality management guidelines and measures in the key sector strategic plans	x	X	X	X	X	**MoE**, RWB, REMA	67,750,000

Goal2: Promoted efficient and effective water quality management								
Objective2.1: Promote efficient and effective management of point sources of water quality	Increase environmental monitoring and inspections to ensure compliance of WWTPs with effluent standards	X	X	X	X	X	**REMA**, RWB, CoK, Districts	24,390,000
	Build capacity of industries to implement resource efficiency and cleaner production practices	X	X	X	X	X	**NIRDA,** MINICOM, RWB	7,200,000
	Develop urban water quality improvement plan for the City of Kigali and secondary cities		X	X	X	X	**RWB,** REMA, MoE, CoK, Secondary Cities	360,000,000
	Enforce guidelines on sound management of waste disposal sites (landfill) and regulations on solid waste collection and transportation to ensure compliance	X	X	X	X	X	**REMA,** CoK, Districts, RNP, RIB	1,626,000
	Incorporate effluent treatment and discharge licensing into water abstraction permit			X			**RWB**, RURA	720,000
	Conduct a study to assess effectiveness of current measures for erosion and sediments control in improving water quality		X				**REMA**, RWB, RAB, MoE, MINAGRI	150,000,000
Objective2. 2: Promote efficient and effective management of non-point sources of water quality	Promote best practices for management of non-point sources pollution in different sectors (storm water, agriculture, roads, etc)	X	X	X	X	X	**RWB,** REMA, MoE, MININFRA, RAB, RTDA	7,200,000
	Implement the aquatic weed/water hyacinth management strategy	X	X	X	X	X	**REMA, RWB, CoK, Districts**	400,000,000
	Develop comprehensive programme to educate farmers and pastoralists on best practices for usage and management of pesticides and agrochemicals		X	X			RWB, MINAGRI, RAB	15,000,000
	Sensitize and educate communities on policies, laws and regulations that concern public health	X	X	X	X	X	REMA, RWB, RAB, Districts	24,000,000

	Enhance the enforcement of environmental guidelines, rules and regulations on prohibitions in wetlands and protected areas.	X	X	X	X	X	**REMA,** RWB, RURA, RAB	2,700,000
	Develop a project proposal on used oil recycling to minimise the impacts of hydrocarbon pollution on water bodies in the country		X				**REMA**, MoE, RDB, MINICOM	1,872,000
	Develop a prioritisation process tool to rank areas for rehabilitation on the basis of water quality improvement potential;			X			**RWB**, REMA	7,000,000
Goal3: Effective information and knowledge management								
Objective3.1: Enhance water quality monitoring	Update the National Water Quality Monitoring Programme	X					**RWB**	960,000
	Identify laboratories to assist in the implementation of water quality monitoring programme by carrying out testing and entering data into the national water quality database	X	X				**RWB,** RSB, NAEB, WASAC,UR, other universities	720,000
	Upgrade the national water quality database to accommodate data from key stakeholders		X	X			**RWB**	25,000,000
	Conduct comprehensive water quality assessment for key hotspots and develop water quality improvement plans	X	X	X			**REMA, RWB**	288,000,000
	Prepare regular annual report on status of water quality in Rwanda and share water quality information and data	X	X	X	X	X	**RWB**	3,600,000
	Develop a Water Quality Exchange data model to support submission of water quality records from various stakeholders to the Rwanda Water Boards database		X				**RWB**	7,200,000
	Develop protocols and management systems for coordinating water quality monitoring initiatives,		X	X			**RWB,** REMA, Universities	3,600,000

	data analyzing and sharing to ensure quality assurance							
Objective 3.2: Build capacity in water quality management	Support modernization of equipment in key national laboratories to meet regional and international good practices and standards		X	X	X	X	**RWB,** REMA, MoE	600,000,000
	Conduct capacity gaps analysis in water quality management	X					RWB	25,000,000
	Conduct trainings to fill the gaps identified by the capacity gap analysis study		X	X	X	X	**RWB,** REMA, Universities	7,200,000
	Support applied research into recent innovations and development related to water quality management		**X**	**X**	**X**	**X**	**RWB,** REMA,UR, other Universities	320,000,000
	Disseminate water quality management plan, guidelines and other material on water quality management best practices	**X**	**X**	**X**	**X**	**X**		118,000,000
Total								**2,641,618,000**

* Institution with text in bold will lead implementation with support of the remaining institutions

4.2 . Water Quality Management Plan implementation arrangement

1.1.1 . Institutions roles and Responsibilities

This water quality management plan will be implemented through a complex institutional structure comprising government ministries and agencies at central and local government level, as well as inter-sectoral coordination structures that bring together stakeholders from public, private and civil society. The institutional roles and responsibilities are outlined here-below

1.1.2 . Coordinating institutions

Rwanda Water Resources Board will formulate the annual action plan, the Investment plan as well as resource mobilization strategy with guidance from MINECOFIN. RWB will also coordination and integration of all line institutions responsible for the implementation of their respective actions under this plan and organise donor consultation forums to speed up the implementation.

Ministry of Environment will provide overall policy direction and political oversight, coordinate the preparation of the sector budget and defend it in cabinet, and lead resource mobilization and accountability. The Ministry of Environment will also proactively engage other water-related ministries and agencies to include water quality management activities in their sector strategic plans and budgets.

Ministry of Finance and Economic Planning (MINECOFIN) will assist to link the plan outcomes with the National Strategy for Transformation (NST1) and higher level plans. It will facilitate resource mobilisation meetings with development partners and approve new innovative financing mechanisms for this plan.

Line Ministries and Agencies:

Line Ministries and Agencies are key to the successful implementation of the plan since most of the planned activities will be undertaken by them.

(i) The Ministry of Infrastructure has a particularly unique role since all the 5 sectors under its supervision are directly related to water quality management, including Water Supply and Sanitation (WASAC), Energy Development (EDCL), Housing and Urbanization (RHA) and Transport (RTDA).

(ii) Regulating Institutions: REMA will work in environmental regulation, RBS will develop water quality guidelines and standards while RURA will regulate water utilities

Universities and research institutions will be involved in various research studies and publication on water quality management. Also they will contribute through developing special professional

courses for identified knowledge and skills gaps in water quality management

Decentralized entities

Districts through the District Environmental Officers will be the focal points for Water Quality Management in each district. They will coordinate water quality management activities with other technical units (agriculture, infrastructure, and social affairs).

Private Sector

Industries and businesses are at the centre of water resource extraction and their activities generate waste. Their innovativeness, entrepreneurship skills and self-drive will be leveraged to control water pollution by adopting cleaner production technologies Also they will be encouraged to support payment for Ecosystem Services.

1.2 .Conditions to implement the WQM Plan

There are some issues that should be taken care as a condition for successful implementation of this WQM plan.

1.2.1 . Political commitment

The existing culture, tradition and way of ensuring water quality management is quite different from the proposed water quality management concept and a continuous and conscious actions focusing on building political commitment starting from the beginning of implementation of this plan is crucial. The political commitment will be maintained through a continuous awareness program among the highest political decision makers, managers, practitioners and key stakeholders.

1.2.2 . Coordination of institutions

This WQM plan will be implemented mainly within the framework of the Ministry of Environment and Rwanda Water Resources Board which are real implementing bodies for the most of the proposed activities. Despite their leading effort, all activities in the plan can only be implemented with support of all other line government institutions identified as implementing bodies during the definition of institution roles. Thus, for smooth implementation of the actions and its successful securing the commitment of all high level decision makers of implementing partners avoiding ambiguities of duties and responsibilities of institutions and raising awareness of decision makers on the importance of WQM for sustainable development of the nation are critical conditions.

1.2.3 . Other prevailing conditions

Beside political commitment and coordination of institutions, other prevailing conditions such as inadequate capacity, securing, difficulties to secure commitments from stakeholders, inability to secure adequate financing as well as insufficient budgetary absorption capacity will dictate the success in the implementation of this plan

CHAPTER 2 : MONITORING AND EVALUATION

2.1 . Framework for WQM Plan Monitoring and Evaluation

The monitoring and evaluation system will be based on the indicators and means of verification defined on the Results Framework. The monitoring system will function as a management tool to report progress, constraints, and deviation from annual activities against Annual Plan targets, as well as to review and adapt, where necessary, the program strategies. Furthermore, it will function as a mechanism to proceed with timely and punctual data collection.

The overall responsibility for monitoring and evaluation will rest with the Authority in charge of Water Resources Management, Rwanda Water Board but sources data during monitoring and reporting under this Water Quality Management Plan entail the following mechanisms:

5.1.1. ***Sector level targets and indicators***: Information for the indicators set by the plan will come primarily from the districts with Rwanda Water Resources Board to ensure quality assurance. Information will also be drawn from national institute of statistics in Rwanda (NISR) for surveys, censuses and abstracts as well as from databases of key line sectors, such as health, agriculture, disaster management, land, environment, etc.

5.1.2. .**Reports of Major Water Users**

RSB, WASAC, EDCL, RAB and processing industries may have good water quality data for various water uses included in their annual reports.

5.1.3. **Decentralized entities *M&E systems***

District annual performance contracts (*imihigo)* provide another important source of information and will be reviewed on a quarterly basis. Districts have targets relating to soil erosion control, protection and rehabilitation of buffer zones, effluent discharge and environment inspection, in their *imihigo* and District Development Strategies (DDS).

5.1.4. ***Private sector, civil society and NGOs reporting systems***: The current legal framework requires these stakeholders to report regularly on their activities, and the districts in which they work must certify their good cooperation and conduct. This compels them to work within existing development priorities and share information about their work.

2.2 Indicators, data collection and reporting

Data collected will be organized into quarterly and annual reports. Additionally, data collected will be used to expand the Water Information System of Rwanda Water Board as well as the RBME of the Ministry of Environment. The M&E framework below provides impacts, outcomes, outputs, indicators and data sources for this plan

Table 6: M&E indicators and targets

Impact: Water quality and ecological indicators improved to sustain improved livelihood and economic development					
Outcomes/Outputs	**Indicators**	**Baseline**	**Target**	**Responsible Agency**	**Source of data**
Outcome1: Water Quality Management Governance is enhance	(i) % of institutions mainstreaming approved water quality management plan in their strategic and annual work plans		(i) 80% of institutions	MoE &RWB	RBME
Output1.1: Policies and strategies to promote improved water quality management are harmonized	Number of specific water user sectors with guidelines developed	Reviewed standards on drinking water (RS435), Water quality-irrigation tolerance limits (RS 188), Water quality-swimming pool tolerance limits (RS189), Rainwater harvesting systems (RS187) and Water quality-livestock feeding tolerance limits)	Five additional guidelines developed (Domestic water use, Recreational water use, Industrial water use, Agricultural water use and Aquatic ecosystem)	RSB &RWM	Board's Annual Performance contract Report
	Number of tools/ instruments developed and implemented	2 tools (Aquarius&RBME)	One additional tool	RWB	Board's Annual Performance contract Report
Output1.2: Coordination and cooperation mechanism on water quality issues established at National Level	Number of platforms established	One platform (Water Resources Thematic Working Group)	Two additional platforms (biennial WQ conference & National WQMN Committee)	RWB	Board's Annual Performance contract Report
	Number of institutions/sectors facilitated	None	5 institutions (RAB, RTDA, CoK, MINICOM & NIRDA)	REMA &RWB	Institutions' annual performance contract report

Outcome2: Promoted efficient and effective water quality management	(i) Number and % of effluent dischargers with sustainable effluent management best practices (ii) % of increase in environmental fine & collection		(i) (ii) Revenues from collection of environmental fines and fees increased by 20%	RWB FONERWA	(i) Inspection reports Financial statement reports
Output 2.1:Efficient and effective management of point sources of water quality is promoted	% of effluent dischargers , disaggregated into industries, WWTPs, etc meeting Rwandan effluent standards	TBD	80% of effluent dischargers are complying with Rwanda effluent standard	REMA, CoK & WASAC	Institutions 'annual performance contract report
	% of trained industries implementing cleaner production technologies	TBD	100% of industries involved in cleaner production trained	REMA, NIRDA	Institutions 'annual performance contract report
	% facilities with water abstraction permits that reports on status of water quality of their effluent discharges	TBD	30% of the facilities with water abstraction permits	RURA &RWB	Institutions 'annual performance contract report
Output2.2: Efficient and effective management of non-point sources of water quality is promoted	Set of erosion and sediments control measures that are effective for replications	Catchment Restoration Opportunity Mapping (CROM)	Report on measures	RWB	Annual performance contract report
	% of specific sector implementing best practices for management of non-point sources pollution	None	60% of specific sectors	MoE, REMA &RWB	RBME report

	% of trained cooperatives of farmers' and pastoralists applying best practices for usage and management of pesticides and agrochemicals	TBD	30% of cooperatives and pastoralists with water abstraction permits trained	RMB&RAB	Annual performance contract report
	Number of people sensitized	TBD	5000 additional people sensitized	RWB, REMA	Sensitization campaign reports
	% of reduction in pollutant loads for identified key hotspots	TBD	30 % of sampled sites showing reduction of 10% in pollutant loads released into water bodies	RWB, REMA, WASAC and UR	Annual water quality status reports
	% of increase in number of defaulters punished for violating environmental regulations	TBD	10% per annual	REMA , RIB &RNP	Inspection reports
	Number of innovative frameworks to enforce environmental regulations and collection of fines and fees	MoU with RNP	1 additional (private companied hired to collect environmental fines and fees)	REMA, FONERWA	FONERWA Financial statement reports
	Number of Project proposals developed	N/A	One project proposal developed	REMA &MoE	Annual performance contracts
Outcome3: Effective information and knowledge management	(i) % of water bodies with good ambient water quality	**(i)** 15% of water bodies	(i) 45% of water bodies	RWB	RMBE

Output 3.1: Water quality monitoring is enhanced	Operational national water quality monitoring programme	Programme initiated by W4GR in 2015 but not fully operational	Updated national water quality monitoring programme	RWB	Water quality status reports
	No of laboratories assisting in water quality testing	Currently UR/CST and WASAC laboratories are involved	3 additional laboratories involved (RSB, NAEB &CAVM)	RWB	Water quality status reports
	No of qualitative water quality status report produced	5 reports	One additional WQ status report per year (10 reports at the end of the plan)	RWB	Water Quality status reports
	% of identified hotspots with comprehensive water quality assessment studies	0	2 catchment hotspots	RWB &REMA	Annual performance contract reports
	Number of institutions reporting water quality data into the national water quality database using the developed tool	Only data generated by former RWFA are in the database	WASAC, UR/CST and IPRC/KICUKIRO reporting	RWB	Water resources portal data display
	% of increase in number of people accessing /downloading water quality data from the central water quality database	TBD	200% increase	RWB	Water resources portal
Output3.2: Build capacity in water quality management	Number of laboratories with international accreditation	Only RSB laboratory is accredited internationally	Two additional (UR/CST &WASAC laboratories)	RWB, REMA, WASAC& RSB	Certification reports
	Number of publications on water quality issues/initiatives	TBD	At least 10 publications annually	UR and other	Biennial water quality

	and presented in the biennial water quality conference			universities	conference reports
	Number of professionals in water quality discipline trained	TBD	At least 20 water quality professionals are trained annually	RWB, UR/CST and other universities	RBME
	Number of news reports in the local press and media covering water quality management initiatives	0	25 (5 per year)	RWB &REMA	News reports

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