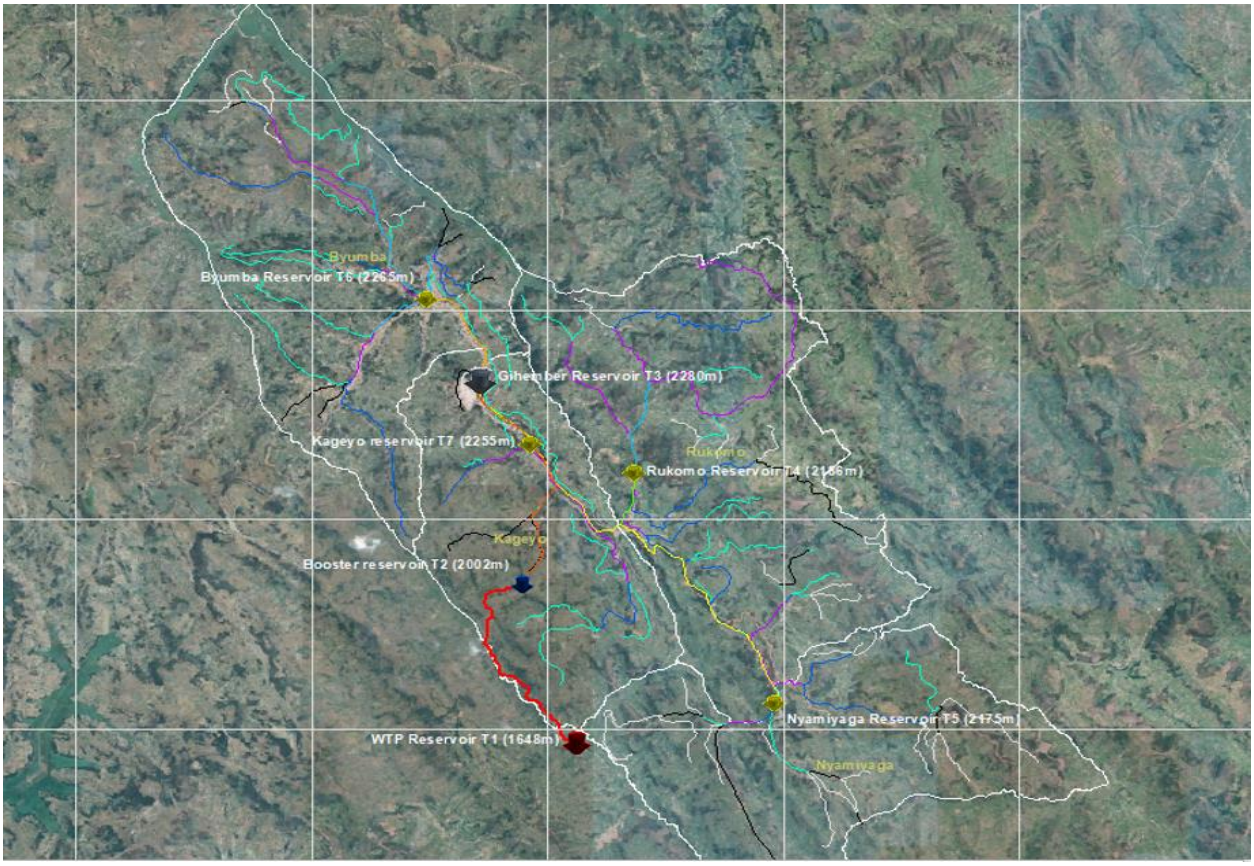
ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR THE PROPOSED CONSTRUCTION OF MWANGE WATER SUPPLY SYSTEMIN GICUMBI TOWN



Project Developer	**Prepared by**
Republic of Rwanda **Water and Sanitation Corporation (WASAC)**	**Namara Norine** **EIA Lead Expert: RAPEP/EA/020** **namara.nn@gmail.com** **+250 783 078806,**

CONTENTS

LIST OF ABBREVIATIONS

AIDS: ACQUIRED IMMUNE DEFICIENCY SYNDROME
CBD: CONVENTION ON BIOLOGICAL DIVERSITY
EA: ENVIRONMENTAL ASSESSMENT.
EIA: ENVIRONMENTAL IMPACT ASSESSMENT.
EMP: ENVIRONMENTAL MANAGEMENT PLAN.
EMMP: ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN.
ESIA: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT.
FGD: FOCUSED GROUP DISCUSSION.
GDP: GROSS DOMESTIC PRODUCT.
GHGs: GREEN HOUSE GASES.
GMOs: GENETICALLY MODIFIED ORGANISMS.
GoR: GOVERNMENT OF RWANDA.
HIV: HUMAN IMMUNO-DEFICIENCY VIRUS.
IFAD: INTERNATIONAL FUND FOR AGRICULTURAL DEVELOPMENT
MININFRA: MINISTRY OF INFRASTRUCTURE.
NEAP: NATIONAL ENVIRONMENT ACTION PLAN.
NEPAD: NEW PATNERSHIP FOR AFRICA'S DEVELOPMENT.
NES: NATIONAL EXPORT STRATEGY.
NGO: NON GOVERNMENTAL ORGANIZATION.
PA: PROTECTED AREA.
RDB: RWANDA DEVELOPMENT BOARD.
REMA: RWANDA ENVIRONMENTAL MANAGEMENT AUTHORITY.
RMS: ROAD MANAGEMENT STRATEGY.
SPAT: STRATEGIC PLAN FOR AGRICULTURAL TRANSFORMATION.
ToRs: TERMS OF REFERENCES.
UNFCCC: UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE.
WASAC: RWANDA WATER AND SANITATION CORPERATION
WATSAN: WATER AND SANITATION.
WCED:WORLD COMMISSION ONN ENVIRONMENT AND DEVELOPMENT.
WRM: WATER RESOURCE MANAGEMENT

GLOSSARY OF TERMS

Advance Impacts are effects that might occur on an environment as a result of implementing a project.

Affected Environment refers to an environmental component that might be impacted upon during construction and operation phases of project implementation.

Affected People refers to the people, who might be impacted by the construction and operation of the project.

Cumulative impacts refer to the total effects on the same aspect of the environment resulting from a number of activities or projects.

Developer is the person/ company proposing to develop or implement a new project or rehabilitate an existing project.

Direct impacts are effects on the environment brought about directly by the proposed projects. These are both positive and negative.

Due Date refers to the date by which the activity or measure must be in place or completed. Where due dates are not specifically given, this implies that the activity must be in place at the beginning of the phase and continues throughout the phase.

Environment refers to human beings and all other things that surround us. It is composed of atmosphere, biosphere, hydrosphere and lithosphere.

Environmental and Social Impact Assessment is a comprehensive analysis of the project and its impacts (positive and negative) on the environment and human beings, including a description of the mitigation measures that will be carried out in order to avoid or minimize these effects.

Environmental Monitoring is the process of following the progress of the construction of a project on a regular basis to ensure that it is in compliance with an Environmental Management Plan (EMP), or the Government of Rwanda (GoR) Environmental and Social Impact Assessment (ESIA) certification of approval terms and conditions and / or environmental prescriptions.

Indirect impacts are either positive or negative effects that a project indirectly has on the environment.

Lead Agency is an organization with primary responsibility for the protection of the environment. For instance, the lead agency for environment matters in Rwanda is the Rwanda Environment Management Authority (REMA).

Measures to be taken are commitments or requirements made to mitigate/reverse negative impacts.

Mitigation measures are actions identified in an EIA to negate or minimize the negative environmental or social impact that a project may have on the environment.

Ongoing refers to activities that are either continuous (take place at all times) or have no defined frequencies.

Project is a set of planned activities designed to achieve specific objectives within a given area and time frame.

Project Brief is the initial report submitted to REMA to initiate the process that will lead to the issuance of the EIS certificate of approval.

Responsibility refers to the responsible person, group of persons or organization who must ensure that the proposed measures are implemented.

Scoping is the initial stage in an environmental and social impact assessment that determines the likely environmental parameters that will be affected and the aspects of the project that will bring upon these effects.

Screening is an initial step when a project is being considered for environmental assessment. Screening is the determination of the level of assessment that will be conducted.

Significance refers to importance of an impact on the environment and/or the affected people.

Stakeholder is any person or group that has an interest in the project, and the environmental effects that the project may bring about.

LIST OF TABLES

LIST OF MAPS

LIST OF FIGURES

LIST OF PLATES

EXECUTIVE SUMMARY

1.Overview of the project

This document is an Environmental and Social Impact Assessment (ESIA) including Environmental and Social Management Plans (ESMPs) for Mwange water supply in Gicumbi district. This ESIA and associated ESMP has been prepared in compliance with the National Regulations and regulatory tools in force such as in the Organic Law determining the modalities of protection, conservation and promotion of the environment in Rwanda, published in the Official Gazette RWA Nº 9 of the 1st May 2005; The Chapter IV of the organic law on environmental protection, conservation and management, Article 65, clearly calls for the need to subject projects to mandatory Environmental and social impacts assessment (ESIA). The Article 65 further specifies that every project shall be subjected to environmental assessment prior to its commencement; The Law on Environment N°48/2018 of 13/08/2018; Ministerial order N.001/2019 of 15/04/2019 establishing the list of projects that must undergo environmental impact assessment, instructions, requirements and procedures to conduct EIA, the Ministerial order relating to the requirements and procedures for environmental impact assessment, 2018 as well as the general guidelines and procedures for environmental impact assessment, 2006.

The ESIA and ESMP were also prepared with reference to the AfDB Integrated Safeguards System (ISS) approved in 2013 especially operational safeguards 1: Environmental and Social assessment and Operational safeguards 2: Involuntary resettlement land acquisition, population displacement and compensation involuntary resettlement.

2.Objectives of the ESIA

The objective of ESIA is to identify, predict and determine adverse impacts of a proposed project on the environment and develop mitigation measures.

3.Nature of the Proposed Project and Scope

The proposed project is construction of a Water Treatment Plant and its associated forwarding infrastructures which have been prioritized to allow effective operation of network developed in context of rehabilitation, upgrading and extension of water networks in towns as parts of initial phase of Rwanda Sustainable Water Supply and Sanitation Program

4.Findings from Hydrological assessment

4.1. Description of Hydrological regime of Mwange river

4.1.1. Descriptive parameters of the catchment

Mwange River and Kagogo River are the two selected rivers for intakes to cover such deficiency in water supply in the Gicumbi Town. Mwange river drains into Nyabugogo River and Kagogo

drains into Lake Muhazi. Their catchment area includes Gicumbi district, a small part of Rulindo and Nyagatare districts in the North-Western part of Rwanda.

The alternative #5 which is the most downstream on Mwange river is selected alternative to be implemented in the Mwange wss project. Some parameters give characteristics of the catchment. The following parameters have been chosen and computed to be used in the following chapters especially in flood analysis. All the formulas are taken from "Hydrologie tropicale et appliquée en Afrique Subsaharienne" by Bernard Chzeville, France, 1990.

Table 1: Catchment Characteristic Parameters (Alternative #5)

No	Parameter	Value	Definition
1	Perimeter (P)	36.00 km	The perimeter of the catchment
2	Surface Area	64.27 km^2	The surface area of the catchment derived from 30 m resolution DEM data
3	Length	13.0 km	This is the length for the equivalent rectangle. Equivalent rectangle can be defined as A rectangle having the same surface area and the same perimeter. $L = (P+\sqrt{(P^2-16*S)})/4$ Where L = length of the equivalent rectangle P = perimeter S = surface area of the catchment
4	Width	4.94 km	This is the width for the equivalent rectangle Width = S/L
5	Height	634 m	This is the difference in elevation from the highest point to the lowest point between 5% and 95% of the surface
6	Slope factor (Ig)	48.8 m/km	The slope factor (indice de pente), this denotes the change in elevation over the length of the equivalent rectangle
7	Slope	4.8%	This is the general slope of the catchment. It is calculated on 60% of the total length of the catchment. Excluding 20% in the upstream and 20% in the downstream part.

No	Parameter	Value	Definition
8	Gravelius index, k (compactness index)	1.27	This can also be called shape coefficient, k equals to 1 for completely circular catchment and is greater than 1 as catchments are elongated $K = 0.28*P/\sqrt{S}$
9	Reduction coefficient, A	0.79, T=2 years 0.77, T=5 years 0.75, T=10 years 0.74, T=50 years 0.72, T=100 years	It is called "coefficient d'abattement" in French and can be computed as a = 1-0.001(9 log T – 0.042 Pan + 152) log S Where: A: is reduction coefficient T: return period for a particular storm Pan: annual precipitation for the catchment (from 250 to 3000 mm) S: surface area of the catchment (from 15 to 1500 km^2)
10	Runoff coefficient	Kr_2=0.15 Kr_5=0.17 Kr_{10}=0.19 Kr_{50}=0.21 Kr_{100}=0.23	An experimental formula has been proposed by Puech-Gonni du CIEH based on the types of soil in sub-Saharan Africa. $Kr_{10} = 2300\ Pan^{-0.67}$ Where Kr_{10} is the runoff coefficient for 10-year design storm 25 to 100-year Kr has been estimated accordingly taking into consideration that runoff coefficient increases as the rainfall increases.

4.1.2. Climate of the Study Area

The Gicumbi lies on 2221m above sea level. The climate in Gicumbi is warm and temperate. Byumba is a city with a significant rainfall. Even in the driest month there is a lot of rain. The average annual temperature lies between 15 °C to 16 °C.

July is the warmest month of the year. The temperature in July averages 16.0 °C. May is the coldest month, with temperatures averaging 15.3 °C. Throughout the year, temperatures vary by 0.7 °C.

4.1.3. Runoff Data

The Mwange-Rusumo water level record as were as the rating curve were collected from Rwanda Water Resources Board database. 3-dairly data set for a period of five years was collected and quality controlled before use.

Table 2: Hydrometric Station

HM Name	Coordinates Decimal Degrees- GCS_WGS_1984		Elevation	Data Period	No. Years	Resolution
	Latitude	Longitude	m a.s.l.			
MWANGE (RUSUMO) Station	-1.673014	30.091535	1678	1995-2000	5	3-daily

The location of the hydrometric stations, together with the relevant catchments is shown in the detailed report. The catchment area was recorded from the data base and computed as 48 km^2.

The following graph displays unprocessed flow data as recorded on Mwange (Rusumo Station). The average was computed at 0.518 m^3/s, a maximum was recorded at 4.867 m^3/s and an absolute minimum at 0.291 m^3/s.

4.2. Estimation of water availability and calculation of Environmental flow

4.2.1. Mean Runoff

The mean runoff has been computed from the recorded data at Mwange-Rusumo station and extrapolated at other proposed alternative intake sites location. The interim reporthad tried to use HEC-HMS to estimate rainfall runoff but results were not satisfactoryto due lack of calibration data at the proposed intake site. The specific runoff approach was found to be most suitable in these kinds of catchments given the fact that Mwange-Rusumo station has quite some good data for at least 5 years and the rating curve wasgenerated and approved by the Rwanda Water Resources Master Plan (2012).

4.2.2. Specific Runoff Approach (Based on Recorded Flows)

The Mwange-Rusumo hydrometric station has quite good data for 5 years. This is quiteenough to base on decisions how much water resources are available to be used inMwange Water Supply for Gicumbi Town. It is assumed that the catchment of allproposed alternatives behaves the same way as the Mwange-Rusumo catchment. Asimilar specific runoff (flow per unit catchment area) is assumed for all the proposed alternatives.

4.2.3. Monthly Flows

3-daily values were statistically analysed and monthly averages computed as displayed in the graph in **Figure 1** as shown below. The figure exhibits missing data from June1998 to December 1999. The year 2000 also has missing data from May to September.

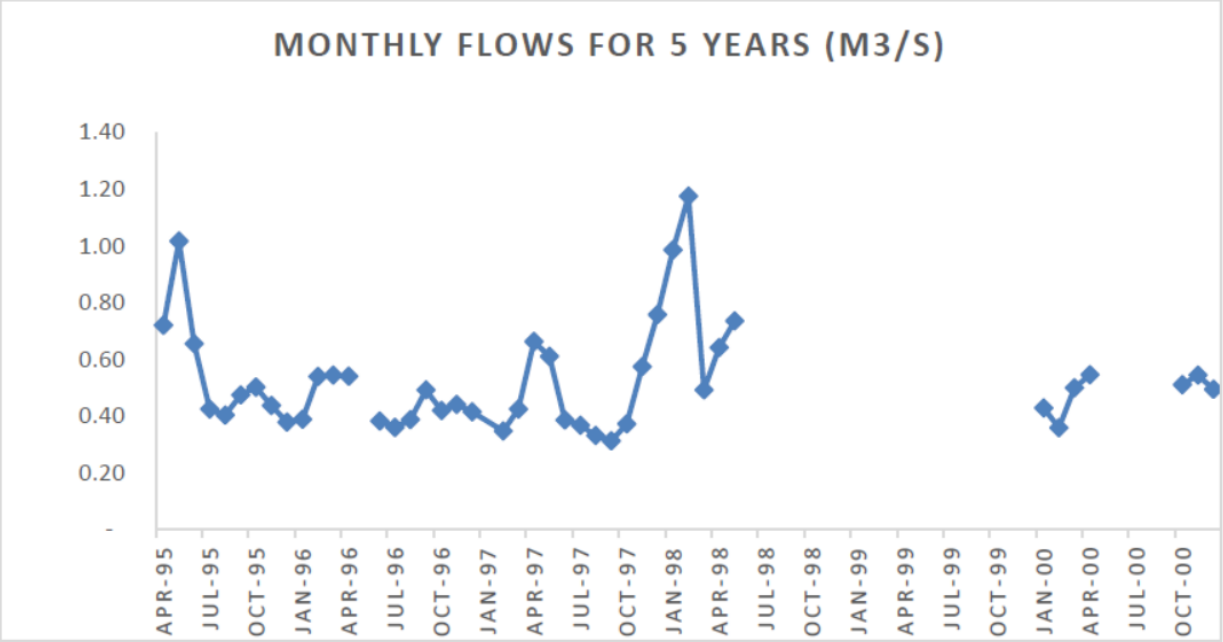


Figure 1: Monthly Flows at Mwange-Rusumo from 1995 to 2000

Further analysis has been done to compute the monthly average flow for the whole period of the available data and the following table was obtained.

Table 3: Monthly Flows at Mwange-Rusumo

Month	1995	1996	1997	1998	2000	Average
January		0.39	0.41	0.98	0.43	0.55
February		0.54	0.35	1.17	0.36	0.60
March		0.54	0.42	0.49	0.50	0.49
April	0.72	0.54	0.66	0.64	0.55	0.62
May	1.02		0.61	0.73		0.79
June	0.65	0.38	0.39			0.47
July	0.42	0.36	0.37			0.38
August	0.40	0.39	0.33			0.37

Month	1995	1996	1997	1998	2000	Average
September	0.47	0.49	0.31			0.43
October	0.50	0.42	0.37		0.51	0.45
November	0.44	0.44	0.57		0.54	0.50
December	0.38	0.41	0.76		0.49	0.51
AVERAGE	**0.56**	**0.43**	**0.49**	**0.69**	**0.52**	**0.50**

The next graph **Figure** displays the data depicted in the table above. The overall average at the station is computed as 0.5 m^3/s with a minimum at 0.37 m^3/s in the month of August. All water balance will be computed on monthly basis and will consider the minimum of 0.37 m^3/s as the available water resource on which all water supply designs should consider.

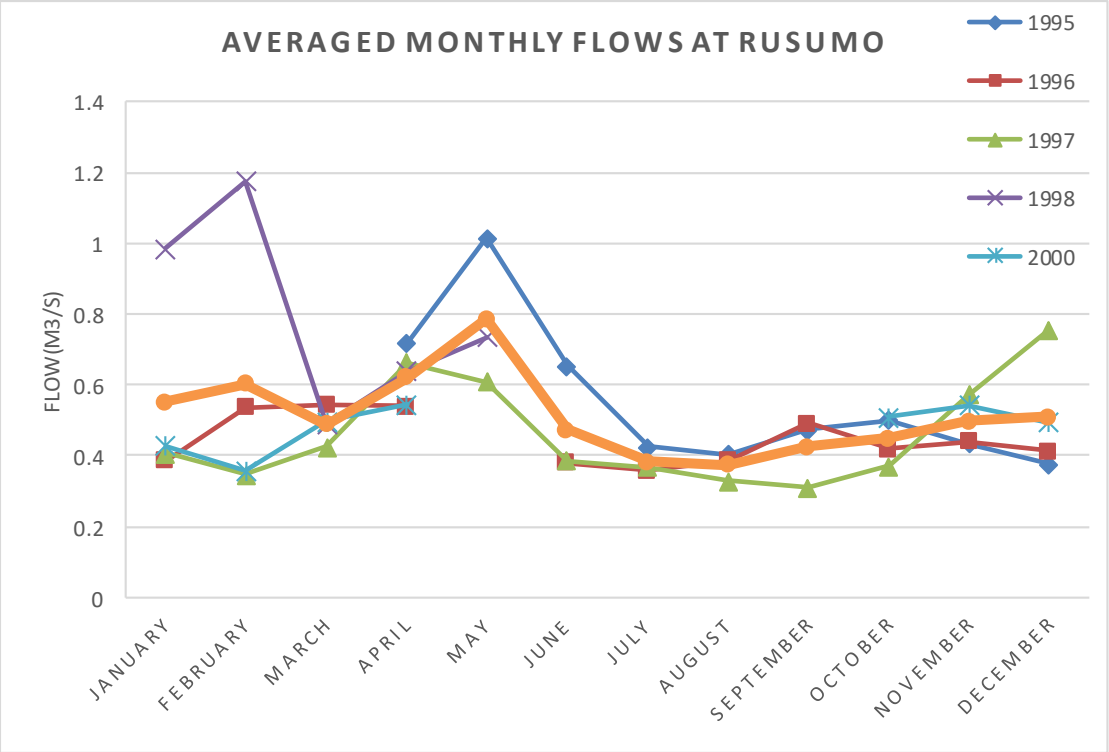


Figure 2: Graphic Representation of Monthly Flow at Mwange-Rusumo

Based on the average monthly runoff at the gauging station, all the expected flows at various alternatives have been computed using aerial extrapolation. The table below displays expected flows at each intake options.

Table4: Computed Monthly Flow at Various Alternatives

	Station Mwange-Rusumo	ALTERN #1 (Feasibility Study)	ALTERN #2 (Tail water)	ALTERN #3 (Dam)	ALTERN #4 (Kagogo)	ALTERN #5 Down
Cath. Area (km^2)	48	43	51.15	36.62	102	64.27
January	0.55	0.49	0.59	0.42	1.17	0.74
February	0.60	0.54	0.64	0.46	1.28	0.81
March	0.49	0.44	0.52	0.37	1.04	0.66
April	0.62	0.56	0.66	0.47	1.32	0.83
May	0.79	0.70	0.84	0.60	1.67	1.05
June	0.47	0.42	0.50	0.36	1.01	0.63
July	0.38	0.34	0.41	0.29	0.82	0.51
August	0.37	0.33	0.40	0.28	0.79	0.50
September	0.43	0.38	0.45	0.32	0.90	0.57
October	0.45	0.40	0.48	0.34	0.96	0.60
November	0.50	0.45	0.53	0.38	1.06	0.67
December	0.51	0.46	0.54	0.39	1.08	0.68

4.2.4. Water Balance at the different proposed intake locations

From hydrological, water resources and water balance point of view all the proposed 5 alternatives have been analysed to come up with a better option to be implemented. All computations made in this section are based on the available monthly flow as depicted in **Table5**. The **Table5** computed the water balance for various alternatives. Alternatives #4 and #5 are the ones yielding a positive water balance.

Table 5: Water Balance Table for the 5 Alternatives

	Station	Option 1 (Feasibility	Option 2 (Tail water)	Option 3 (Dam)	Option 4 (Kagogo)	Option 5

		Study)				
Catchment Area (km^2)	48	43	51.15	36.62	102	64.27
Available Flow (m3/s)	0.37	0.33	0.40	0.28	0.79	0.50
Sources	0.03	0.03	0.03	0.03	0.03	0.03
WS Project Requirement m^3/s	0.393	0.393	0.393	0.393	0.393	0.393
HPP Requirement	0.4	0.4		0.4		
Available Water (MCM/year)	12.72	11.49	13.49	9.93	25.96	16.71
WS Project (MCM/year)	12.39	12.39	12.39	12.39	12.39	12.39
HPP Requirement (MCM)	12.61	12.61		12.61		
Water Balance	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	**POSITIVE**	**POSITIVE**

Alternatives #4 and #5 exhibit positive water balance whereas alternatives #1, #2 and #3 resulted in a negative water balance due to the fact that they are located upstream of an existing HPP that has already has a 0.4 m^3/s water permit. Where possible, the negative water balance can be made positive with the help of a storage reservoir. Alternative #3 has been proposed with storage reservoir. The capacity of the reservoir can go up to the Mean Annual Runoff (MAR) equal to 12.37 MCM but still, challenges and conflicts may rise with the HPP.

4.2.5. Environmental Flow

The ecological flow is defined as the flow that remains in the river after the water supply requirement has been met. Given the fact that we will have no storage at the raw water intake, the minimum monthly flow is the critical one to be considered. The august flow (0.5 m^3/s) has been considered as a guaranteed flow which all designs are based. With a time-step of five years, the water balance has been computed with the exact amount of water demand and the available water in August (the driest month). All the remaining water in the stream has been considered as environmental flow available for the ecosystem.

The following table estimates the ecological flow up to the planning horizon (2050).

Table 0: Estimation of Environmental Flow

	2020	2025	2030	2035	2040	2045	2050
Demand	18,385.26	21,088.42	23,924.19	26,385.30	29,872.43	33,757.12	38,100.74

Available Flow (m^3/day)	43,200.00	43,200.00	43,200.00	43,200.00	43,200.00	43,200.00	43,200.00
Balance in m^3/day (Ecological flow)	24,814.74	22,111.58	19,275.81	16,814.70	13,327.57	9,442.88	5,099.26
Ecol. Flow %	57%	51%	45%	39%	31%	22%	12%

Up to 2045 we have ecological flow of more than 20% which is the minimum flow required to remain in rivers as per the regulations in Rwanda.

The implementation of Mwange water supply system project is divided into two phases which are 0.278 m^3/s for phase I and 0.115 m^3/s for phase II totallying 0.393 m^3/s. The implementation of the project is as follow:

Table7: Water demand calculation for various phases

Project Water Demand	Phase 1 (2020-2035) (m^3/day)	Phase 2 (2035-2050) (m^3/day)
Project Treated Water Demand	22,637.59	32,994.02
Water Treatment Plant Losses	2.5%	2.5%
Project Raw Water Demand	23,200.00	34,000.00

5.Analysis of Cumulative impacts of the project on Mwange river

The Phase I of Mwange water supply project will abstract 0.278 m^3/s which is equivalent to 47% of the total flow of Mwange river, being 0.59 m^3/s recently measured in July 2023 by WASAC and Rwanda Water Resources Board. This indicate that 53% of the available flow at the abstraction site will remain for both environmental flow (considered to be 20% minimum as per Rwandan regulations) and the remainder for other users (33%).In addition, the downstream of the abstraction site has more potential water resources in terms of water quantity as result of other 3 major tributaries to Mwange river.

The phase II of the same project, will be implemented from 2035 and will require 0.115 m^3/s in addition to the quantity of water taken in phase I totalling 0.393 m^3/s. The addition of the phase II of the project will lead to total abstraction of 66.6% of the total available flow in the river which guarantees the compliance with environmental flow. However, as the phase II will be implemented in 2035, there will be further assessment to update the current findings for water availability.

The ongoing hydropower plant was considered during analysis of the five alternatives proposed by the study. Given that the plant of water requirement 12.61MCM/year is located upstream, the three first alternatives proposed by the study were found not suitable as the calculation of water balance, in consideration of the mentioned hydropower water requirement, indicated a negative water balance as per the table and consequently they were rejected in favour of the alternative 5 which is located downstream the hydropower plant.

6. Proposed Intake and Water Treatment Plant Sites

The intake at river Mwange is located downstream of the HEP station that is under construction. The location has been selected to capture the water from river Bizi a tributary of river Mwange and improve on the available yield. The intake is situated at coordinates (510,858.3 m E, 4814,844.2 m S).

Using the Total Station and a GPS the team obtained multiple Coordinate Geometrical points which were used in the analysis using AutoCAD CIVIL D to generate a surface and contour map.

The elevation at both sites (Intake and WTP) vary between 1,645 m near the river and 1,668 m near the main road.

7.Current Water Demand

As per socio-economic survey and available documents (e.g., Rwanda National Water Master Plan, 2015; World Bank, Rwanda National Water Master Plan, 2015; World Bank, etc.), the current water demand in the project area including institutional and industrial and an estimated NRW of 30% is around 22,134 cubic meters per day.

8.Interventions for the Rehabilitation of the Existing Water Treatment Plant (Nyamabuye)

The existing water treatment plant at Nyamabuye currently has a capacity of 1,700 m^3/day, but its production can be increased to 2,400 m3/day by channeling in more water from Miliku springs.

The water treatment process in Nyamabuye currently involves addition of lime for PH correction and chlorination for elimination of pathogens. The recommendation regarding the refurbishment of this treatment plant is as follows:

- General rehabilitation of the existing structures
- Replacement of the existing pumps
- Replacement of the surge tank
- Replacement of the spray aerators
- Installation of pressure filters at Yaramba to ensure allowable turbidity
- The sprayer aerators are dilapidated and ought to be replaced with ones of the same design but in stainless steel.

During the field surveys, it was found that the turbidity of the water rises after heavy rains, which causes disruption in the water treatment process. This occurs because the water treatment process at Nyamabuye does not include the clarifiers. Therefore, it is recommended that the collection chamber at Yaramba be equipped with pressure filters to reduce the turbidity of the water as it is pumped into the water treatment plant.

9.Proposed Processes

The proposed water treatment plant will have the following main components:

1. Intake Structure equipped with diversion sharp crested weir, manual coarse screens and sand trapping system. In addition to raw water tank and intake pumping station.
2. WTP inlet works that includes pre-chlorination and cascade aeration tank
3. Flocculation and Coagulation Tanks
4. Rapid Sand Filters with backwashing system
5. Post Chlorination System
6. Drying Beds

10.Justification of the project

The development objective of the program is to improve the quality of life and socio-economic development of the people and country by ensuring equitable provision of adequate, reliable and sustainable water and sanitation services for targeted areas with a view to promote economic growth and transformation. Upon completion of the construction works, a number of people will be benefitting improved, liable and sustainable water supply services from the program.

11.Study Methodology.

A number of tools and methods were applied to get useful information and consequently arrive at the desired conclusion. A checklist was formulated and used to identify various possible impacts that may emanate from this project and their level of significance. This assisted in prioritizing the impacts and allowed focus on those viewed as being significant.

The terms of reference issued by RDB further assisted in guiding the study methodology to be applied in assessing the potential project impacts.

The general steps followed during the EIA/EMP study were as follows:

- Preliminary assessment of the site (made through Several Site visits).
- Environment screening, in which the project was identified as among those requiring a project report under the Law on Environment.
- Environmental scoping that provided the significant environmental issues related to the proposed project and the site activities.
- There were previous meetings and consultations.
- Detailed physical inspection of the site and the surrounding areas,
- Physical inspection of the site and surrounding areas.
- EIA/EMP Public participation via the use of questionnaires. and interviews
- Reporting.

12. Project description

12.1. Project Location and Baseline Information

The project is located in Gicumbi District and targets to provide drinking water to the City of Gicumbi and its immediate rural surrounding area that comprise 4 sectors: Byumba, Kageyo, Rukomo and Nyamiyaga.

The elevation of the study area within those 4 administrative sectors is ranging from 1,454 m to 2,418 m above the sea level. Thus, a particular attention will be paid for the pipeline layout throughout such hilly area and land prone to sliding process.

The whole District of Gicumbi is characterized by a succession of steep hills giving rise to a multitude of watershed converging, all of them, toward the Nile Basin through Nyabugogo stream and Lake Muhazi. Resulting from the topography, the valleys are narrow and lack real swamp, except in former Mulindi marchland (now-a-days occupied by an industrial plantation of tea) and current Rugezi area (direct water source of Ntaruka hydro-electric power). Such type of topography combined with soil coted Kaolisol gives way to catastrophic erosion process and even, to ravines-gullies and land sliding.

12.2. Project activities

The proposed system consists of a WTP at the river Mwange with a total capacity of 34,000 m3/day. The WTP comprises an intake at the river, and treatment processes, which are mainly coagulation, flocculation, sedimentation, and filtration. The treated water will be pumped from the clear water tank via a high lift station into a booster station. The booster station will pump water into a regional water reservoir located at the Gihembe refugee camp.

The clear water tank will be 2,000 cubic meters including the backwash volume.

The booster's balance tank has a total capacity of 5,000 cubic meters. 2,500 cubic meters to be implemented at each stage. It is to note that the balance tank is sized bigger than the clear tank to ensure water availability for the booster when a sudden failure occurs at the high lift station. This reserve storage will allow smooth shutting down of the booster without any effect on the pumps.

The storage tanks are designed to balance fluctuations in demand between minimum and peak, as well as, to accommodate a reserve storage for emergencies that is 5 hours for Gihembe and 7 to 8 hours for others.

The network system has around 245.0 km of new and existing pipes. The 245.0 km include pumping mains, main distribution pipes and distribution. The total model existing network is around 85.0 km with existing diameters vary between 25 and 110 mm. While the new introduced pipes are around 160.0 km with proposed diameters vary between 63 mm and 500 mm.

the system is hybrid. Water will be pumped from the WTP via a DN500 DIP to the booster station. From the booster station to Gihembe a DN500 DIP will be also laid. From Gihembe to the sector's reservoris water will be delivered via DN350 to Byumba, a DN300 to Kagyo, and a DN300 to Rukomo and Nyamiyaga. The DN300 to Rukomo and Nyamiyaga branches at coordinate (511,546.02, 4,819,872.91) into two DN250 pipes. Each feed one reservoir. All the transmission and pumping mains are new. They will be implemented in the first stage of the project.

13.Policy, legal and Institutional arrangements

13.1. At national Level

About legal framework, a number of laws that were taken in into considerations by indicating their provisions relevant to the implementation of the project for rehabilitation of MWANGE . These start with the constitution of the Republic of Rwanda of 2003 revised in 2015 stressing the right to live clean and healthy environment and the duty of everyone to protect, safeguard and promote it. In the same line, the Organic law of 2005 requiring projects mandatory to conduct Environmental Impact Assessment (EIA), the law on environment, 2018 and related ministerial orders for list and requirements for projects to conduct EIA complement the actions required in projects implementation to safeguard healthy environment. In addition, the law No.49/2019 on use and management of water resources is relevant as the project requires water abstraction permit that check that fact of no harm to environmental flow and conflict of use. The land law of 2013 was considered as land use and management as well as all transactions related to lands in this project the project will require to the complying with provisions of the law. The law relating to the expropriation to the public interest, 2015 will be guiding the effective compensation of affected persons while the law regulating labor in Rwanda will be reference to put in place

an effective occupational health and safety framework, with equal opportunity provisions, preventing discrimination and child labor as well as Rwanda building control regulations, 2012. Other laws and ministerial orders to guide the project execution are detailed in the report.

The policy framework to guide the project include, National Strategy for Transformation (NST1) of which the project aims to contribute the targets, National environmental and climate change policy 2019 as the project need to ensure protection of environment, National land policy 2004 as the project will require lands for implementation, National health policy 2016, as the project execution has be in good and safe working conditions, National sanitation policy 2016 as the project has to ensure the generated waste is appropriately managed without harming health and environment, national water supply policy 2016 by which the provisions have to be implemented in this project, as well as other policies detailed in this report.

The institutional framework has identified institutions whose roles will be relevant to the implementation of the project. In fact, MINIFRA is the leading ministry and monitoring institution for the implementation and progress of projects in the sector of water supply while WASAC is the implementing agency of the project. Rwanda National land use Authority will perform all the transactions required for the lands to be acquired under this project while Rwanda water resources board is responsible to ensure that the exploitation of water resources by this project is complying with laws and regulations provisions. Rwanda standards board is responsible to issue all the standards that the project will comply with, these include standards for works, material, occupational and safety, etc. The project will require to connect its premises and electromechanical system to the national grid and REG will be advising and performing such works.

13.2. The project category with respect to AfDB ISS

The African Development Bank (AfDB) Integrated Safeguards System (ISS) is designed to promote the sustainability of project outcomes by protecting the environment and people from the potentially adverse impacts of projects. The safeguards aim to avoid adverse impacts of projects on the environment and affected people, while maximizing potential development benefits to the extent possible as well as to minimize, mitigate, and/ or compensate for adverse impacts on the environment and affected people when avoidance is not possible; and help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks. The preparation of the environmental and social impact assessment for the proposed project has also followed the AfDB Environmental and Social Assessment Procedure (ESAP) which divides projects into four categories:

- Category 1: projects are those that are likely to have significant and irreversible environmental and social impacts, widespread in extent and require a full ESIA.

- Category 2: projects are likely to have detrimental and site-specific environmental and social impacts that can be minimized by the application of mitigation measures included in an ESMP.
- Category 3: shall not induce any adverse environmental and social impacts and do not need further action.
- Category 4: projects involve investment of Bank's funds through Financial Intermediaries (FIs) in subprojects that may result in adverse environmental or social impacts. Specific requirements for this type of project include an assessment of FI capacities to handle environmental and social considerations.

Therefore, according the ESAP categorization, the proposed project for the Rehabilitation of MWANGE Water Treatment Plant and Water Distribution Network in Gicumbi falls under a category 2 within the AfDB's ISS because the potential environmental and social impacts are not significant, localized in nature and can be managed via a robust ESMP which is an integral part of this ESIA.

13.3. Applicable international conventions

The implementation of MWANGE WTP shall ensure to comply with the provisions of the international conventions ratified by Rwanda, some are cited below while the full list and details are in the report.

- The BONN Convention opened for signature on June 23, 1979 on conservation of migratory species of wild animals as authorized to be ratified by Law No 35/2003 of 29 December 2003.
- The MONTREAL International Conventional on Substances that deplete the Ozone layer, signed in LONDON (1990), COPENHAGEN (1992), Montreal (1997), BEIJING (1999), especially in its article 2 of LONDON amendments and Article 3 of COPENHAGEN, MONTREAL and BEIJING amendments as approved by Presidential Order no 30/01 of 24 August 2003 related to the membership of Rwanda;
- The STOCKHOLM Convention on persistent organic pollutants, signed in STOCKHOLM on 22 May 2001, as approved by Presidential Order No 78/01 of 8 July 2002;
- The CARTAGENA protocol on biodiversity to the Convention on Biological biodiversity signed in NAIROBI from May 15, to 26, 2000 and in NEW YORK from June 5, 2000 to June 4, 2001 as authorized to be ratified by Law No 38/2003 of 29 December 2003;
- The KYOTO Protocol to the framework on climate change adopted at KYOTO on March 6, 1998 as authorized to be ratified by Law No 36/2003 of December 2003;

14.Project Alternatives

The purpose of this section is to examine feasible alternatives to the project and, highlight the benefits of and general rationale for the project that need to be considered against any potential environmental cost. The general principle involved in identifying option(s) to the proposed development is to ensure that the option chosen, which indeed may be the 'development' option, would result in optimal returns in social and environmental capital.

14.Recommended Alternative

Under the Proposed Development Alternative, the developer would be issued an EIA License. In issuing the certificate, REMA would approve the proposed development, provided all environmental measures are complied with during the construction period and operation of the office building. The economy would benefit from the purchase of services and materials all suppliers who would be involved in construction and other activities necessary to realize the project. This alternative also leads to creation of employment and optimal use of land resources. This alternative consists of the applicant's final proposal with the inclusion of the REMA regulations and procedures as stipulated in the Environmental Impact Assessment guidelines to minimize environmental impacts to the maximum extent practicable.

Based on the proposed technical design and proposed mitigation measures, based on the social and environmental social assessment of project site, the consultant can conclude that the most preferred alternative would be implementing the project with mitigation measures in place. The selected dam site, water treatment site, the water storage unit and the distribution network route should minimize the potential environmental and social impacts especially resettlement impacts.

15.Stakeholder consultations

Public consultation meetings were held in all the villages visited and located in the project's direct area of influence as well as at District level where key project stakeholders were invited.

At village level, with support from chiefs of villages, meetings were hold at cell offices bringing together people from concerned villages. Consultations started from 06/09/2022 and ended on 23/09/2022.

At district level, in collaboration with District one stop centers, the consultation meetings were organized on 19 and 20th October 2022. Districts invited all stakeholders in water and sanitation including Water, Sanitation and Hygiene board (District WASH Boards), private rural WSS operators, representative of WASAC at district & provincial level, development partners like World Vision.

In general, the project was appreciated by all interested stakeholders as it will contribute to the national target of covering the whole country with access to clean water and thanked

the Government of Rwanda for promoting modern households in their villages. However, the following concerns were raised and noted:

- The quality of water considering the existence of a hydropower plant located upstream of the proposed intake location.
- WASAC should request water permit to ensure the water allocation is effective and efficient.
- Owners of assets and crops to be affected by the project expressed their concern in regards to possible delay in payment of the compensation and requested that works should start after paying all affected people. There should be compensation for the land used for the pipeline, because when you want to construct on that land, it become a long process to relocate the pipe. They also suggested that the calculation of the compensation should be based on the maximum rate provided by the law
- District officials raised the concern about the location of the water treatment plant considering the topography of the area (steep slope)
- Project beneficiaries suggested that project should provide public water taps for people who don't have means to get water connected to their home.
- There was a concern in regards to some people who don't have land title at the moment but which is being processed in the land centers.

16.Predicted Impacts of the implementation of the proposed project

The project will generate environmental and social positive and negative impacts which have been listed in this report according to the project phases (preparatory, construction, operational and decommissioning phase).

The predicted positive impacts include the following: employment and knowledge transfer opportunities, business opportunities, increase to public revenues/taxes for both central and local authorities from construction materials, drinking water quality improved for beneficiaries. Potential negative impacts shall include the following:

16.1. Prediction and assessment of beneficial impacts

The following are beneficial impacts predicted from the implementation of the project for the construction of Mwange water supply system in Gicumbi district:

Table8: Expected benficial impacts of the project

Expected project beneficial Impact	Why is beneficial	Significance	Duration
Job opportunity for local people and gender balance enhancement in terms of employment benefits.	The project will give priority of local residents for employment	Important/High	Temporary and permanent.
Knowledge transfer to local people.	All required works will be undertaken by local employees guided by the contractors 'experts	Important/High	Temporary.
Possibility of business hiring equipment.	Water availability will give room for other businesses requiring the presence of water	Moderate/Middle	Temporary.
Selling foodstuff and other materials.	Migrant workers will need to purchase a number of goods from local selling points	Moderate/Middle	Temporary.
Increase income for the population working for the project.	By employment in the project, wages will bring money circulation		Temporary and permanent.
Possibility of savings for workers.	Workers will use one parts of their wages for savings	Important/High	Temporary and permanent.

Increase to public revenues/taxes for both central and local authorities from construction materials.	The project itself has a component of paying takes; all materials to be imported will also pay tax	Important/High	Temporary and permanent.
Drinking water quality that meets national, regional, and international quality indicators.	Increased access to clean water will alleviate waterborne diseases; promote sanitation and hygiene and health in general	Important/High	Permanent.

16.2. Predicted negative impacts from the Project implementation

Both environmental and social impact will be assessed in detailed but the anticipated negative impact of project implementation includes water pollution, loss of flora and fauna especially during site clearance, possibility of water table disturbance, loss of land, trees and crops (at WTP, water storage, water intake and along pipelines) generation of waste especially sludge from water treatment etc.

Pre-construction phase:

Bio-physical adverse impacts

- Loss of biodiversity and damage to ecosystem habitat while establishing the project camp sites. This activity requires the destruction of the natural habitat for both plant and animal species for the excavation purpose.
- Environmental pollution of water bodies due to human excreta and other wastes generated by the project workers during establishment of the campsite.
- Soil erosion (excavated soil) while establishing the project campsite. Inappropriate disposal of excavated soil may lead to erosion and pollution to downstream water bodies.
- Increased nuisance (noise, dusts and vibration) levels due to use of heavy machinery and earth moving equipment while establishing the project camp sites.

Socio-economic adverse impacts

- Loss of assets and crops by the local population while acquiring the land for the project,
- Potential risk of insecurity due to influx of job seekers.
- Conflicts among workers who temporally settle with the local community and residents; this is likey to happen if the local community is not given priority for jobs.

- Risk of spread of HIV/AIDS, STDs, and other communicable diseases due to influx people moving to the project area.

Construction phase:

Bio-physical adverse impacts

- Loss of biodiversity due to land and vegetation clearing for construction preliminary works.
- Preparation of trenches, laying of pipes and construction of reservoirs and pumping and treatment stations may cause Brutal spreading of materials in waterways and lowlands, and concrete laitance.
- Loss of land for quarry, borrow, and disposal spoil materials.
- Risk of increased greenhouse gas (GHG) emissions and amplified vulnerability to climate change.
- Generation of wastes from construction works and activities in the camp site.

Socio-economic adverse impacts

- Impacts related to nuisances (dust, noise, bad smell etc,),
- Impacts related to the community safety and workers health and safety.
- Risk of occupational injuries and/or accidents and deterioration of workers' health

Operation and maintenance phase:

Bio-physical adverse impacts

- Change of current environmental flow,
- Risks associated with water abstraction (withdrawal) such as water quantity and quality, hydrological pattern of Mwange river, potential conflicts from different users of Mwange river water.
- Foul smelling from toilets installed at the site and sludge from water treatment processes.
- Risk of increased greenhouse gas (GHG) emissions due to trucks and vehicle movement and amplified vulnerability to climate change.

Socio-economic adverse impacts

- Risks associated with water abstraction (withdrawal) such as water quantity and quality, hydrological pattern of Mwange river, potential conflicts from different users of Mwange river water
- Risk of occupational injuries and/or accidents and deterioration of workers' health in if no precautions taken for occupational health and safety requirements.

Decommissioning phases:

- Generation of wastes including hazardous waste from demolition
- Risk of increased greenhouse gas (GHG) emissions and amplified vulnerability to climate change.
- Biodiversity loss and habitat deterioration during decommissioning activities

- Loss of jobs and all business opportunities related to the project
- Degradation of water quality in Mwange river
- Soil erosion (excavated soil during decommissioning of the project)

Socio-economic adverse impacts

- Damage to crops while removing pipes and other equipment
- Loss of public revenues/taxes for both central and local authorities

17.Environmental and social management plan (ESMP)

The following are the summary of the predicted impacts together with their mitigation measures while the detailed and full ESMP is presented in chapter eight.

Proposed Mitigation measures on Accidents prevention

- Protective Equipment will include the following
- Proper maintenance of all machinery and equipment will be ensured to prevent premature failure or possible accidents;
- Particular attention will be given in the project design to put in place measures that would enhance safety during construction;
- The proponent will prepare clear work schedules and organization plans, having adequate worker insurance cover;
- The proponent will ensure strict enforcement of traffic rules and regulations and provision of traffic aid during peak hours

Proposed mitigation measures on Thereat to Occupational Health and Safety

In addition to the safety measures mentioned above, the following additional measures should be implemented:

- ✓ PPE should be provided to workers who are exposed to dust, noise and vibration for a prolonged period. There should be a supervisor to ensure the workers wear these PPES corrected whenever onsite.
- ✓ Water should be sprayed in working area especially near business places and schools at least two time a day.
- ✓ Watering regularly to suppress excessive dust during construction, use of gas masks and goggles for dusty sections is strongly recommended;
- ✓ The contractor together with local authorities is required to enforce acquiring medical insurance "mituelle de sante" for all workers as a means of affordability of treatment.
- ✓ The safety and sanitation plan will be prepared planned and regular safety education will be implemented, in consultation with a district work safety inspector.
- ✓ Covering of materials that emit dust during transportation and the heaped ones

Proposed Mitigation High expectations on Employment

- Local people within the project should be given the first priority during employing. The casual workers and foremen should be selected from around the project area.

Proposed Mitigation

- People should always support WASAC water supply by rain water harvesting. This will help in not dwelling on this new water supply all the time.

Proposed Mitigation for vandalism of Pipes

- The project proponent will closely monitor the workforce in the project area and site. In any event of security concerns arising, the proponent will engage security services to assist in ensuring that the same is maintained;

Proposed mitigation measures include Traffic and accidents

- ✓ Provision of training to enlighten drivers
- ✓ Preparation of traffic management plan and
- ✓ Provision of traffic marshals to guide traffic especially where the works will be undertaken near paved road with busy traffic and during busy traffic.

Mitigation measures Possible increases of HIV/AIDS

- ✓ Regular sensitization on ways of HIV/AIDS/Covid-19 prevention, importance of proper hygiene is important during execution of this project.
- ✓ Designated handwashing/ sanitization/temperature checking points should be put up within the sites among other precautionary measures to curb the spread of Covid-19 among the workers and their families
- ✓ The contractor is requested to arrange a health and hygiene training for workers and local communities in cooperation with health center near the construction site, in order to prevent infectious diseases.

Mitigation measures on Disruption of Public Utilities

- ✓ The contractor will avoid as much as possible these infrastructures but where they are affected they will be rehabilitated.

Proposed Mitigation Measures for Child Labor and GBV

- ✓ Protect workers' rights and provide contract to each employee
- ✓ Establish, maintain, and improve the employee–employer relationship;
- ✓ Promote compliance with national legal requirements and provide supplemental due diligence requirements where national laws are silent;
- ✓ Comply with international Labour Organization, and the UNICEF Convention on the Rights of the Child, where national laws do not provide equivalent protection;

- ✓ Protect the workforce from inequality, social exclusion, child labour, and forced labour;
- ✓ Employ employees with national identity cards

Mitigation Measure for Change in ecosystem

- ✓ The site clearance should be only done on an area demarcated for construction;
- ✓ Rehabilitation of construction site should include tree planting.

Proposed mitigation measures for Noise and vibrations

- ✓ Limitation of heavy works in daytime 6am to 7pm;
- ✓ Provision of PPE to workers;
- ✓ If necessary, local residents should be given notice of intended noisy activities so as to reduce degree of annoyances.
- ✓ Workers operating equipment that generates noise should be equipped with noise protection gear.

Mitigation air pollution

- ✓ Access roads and exposed ground should be regularly wetted in a manner that effectively keeps down the dust.
- ✓ Workers on the site should be issued with dust masks during dry and windy conditions.
- ✓ Most of the emissions are expected to come from vehicles, tractors and machines to be used. The contractor will be required to present technical control certificate for all vehicles, machines and trucks. Those certificates are issued by National police and are issued only when the vehicle emission is below the maximum permissible limit.

Mitigation measures Water pollution

- ✓ In addition to the respect of 10-meter river buffer zone and 50m on rivers and lakes where possible the same technical design used to avoid soil erosion apply here including;
- ✓ Before starting to use heavy equipment near the river side, the soils of the riversides need to be lined with gabions in order to prevent it from being eroded;
- ✓ After preparing for the Launch and Reception shafts, centrifugal reinforced concrete pipes are inserted into the ground as pipe sleeves by hydraulic jacks;
- ✓ After installing pipe sleeves, water pipes are inserted inside them, and aerated light-weight concrete is filled up between the pipe sleeves and water pipes in order to fix the water pipes in concrete.

18.Environmental and Social Monitoring Plan

This is done during Construction and preparation phase. The monitoring plan has all identified possible impacts, their mitigations and the person responsible for implementation. Costs are also attached to all monitoring plans analyzed. Participatory approach is encouraged in monitoring social issues.

The monitoring system will assist in observation, evaluation, assessment and reporting on the performance of different/various variables with regard to the environment. Monitoring aims at determining the effectiveness of actions to improve environmental quality. . It will consist of a number of activities, each with a specific purpose with key indicators and criteria for significance assessment. Monitoring includes:

- ✓ Visual observations;
- ✓ Selection of environmental parameters;
- ✓ Periodic ongoing monitoring will be required during the life of the Project and the level can be determined once the project is in operation

As the project proponent, WASAC shall play the overall coordination role for the project, it include coordination and monitoring of performance of implementation of the project, risk management, monitoring & evaluation, and disclosure of information, developing and managing performance agreements. Other entities which have responsibilities in the implementation of the project include the following:

- **Rwanda Development Board (RDB**): RDB shall review and approve the ESIA Reports and issue ESIA certificate.
- **Rwanda Environment Management Authority (REMA)**: to monitor implementation of environmental and social management plan (ESMP).
- **Supervising firm/ consultant**: ensure effective implementation of ESMP and provision of monthly report.
- **Contractor**: Development and implementation of contractor environmental and social management plan (C-ESMP).
- **Local community** shall support by participating and providing information in regards to any environmental, social issue, initiative and activity.

On both sides (contractor and supervising firm) shall ensure that qualifying staffs (3); Environmental Safeguard Specialist, Health and Safety Specialist and Social safeguard specialist are hired.

CHAPTER ONE: GENERAL INTRODUCTION AND STUDY BACKGROUND.

1.1 General Introduction.

The Government of Rwanda (GoR) intends to expand the scope of ongoing Sustainable Water and Sanitation Program. The project is funded by the African Development Bank (AfDB). The core objective of the water supply projects to Rwanda Sustainable Water Supply and Sanitation Program is to ensure full access to clean water services in targeted urban and peri-urban areas. In urban areas, the program will contribute to development of those cities by triggering growth of these areas and enhancing linkages to other towns and rural areas in line with National Strategy for Transformation (NST1). In rural areas, the program contributes to equitable provision of adequate, reliable and sustainable water services as per goal 6 of Sustainable Development Goals (SDGs).

This ESIA and associated ESMP has been prepared in compliance with the National Regulations and the Integrated Safeguards System (ISS) approved in 2013 especially operational safeguards 1: Environmental and Social assessment and Operational safeguards 2: Involuntary resettlement land acquisition, population displacement and compensation involuntary resettlement.

1.2 Author's presentation

The author of this report is a Lead EIA expert by the names of Namara Norine, she was subcontracted by Cavicon Consultants. Norine is a local multi-disciplinary environmental consultant who has been involved in elaboration and preparation of Environmental Impact assessment, socioeconomic assessment, environmental assessment and management services in various sectors ranging from mining, roads construction, renewable energy development, hydropower development, mining exploitation, small and large scale manufacturing industries, telecommunication towers, petrol stations construction, agriculture and irrigation projects,..etc.

1.3 Developer's Information:

The project developer is Water and Sanitation Corporation Ltd (WASAC) a government institution in charge of supplying water in Rwanda.

1.4 ESIA objectives.

The objective of ESIA is to identify, predict and determine adverse impacts of a proposed project on the environment and develop mitigation measures.

1.5 Scope of the EIA Study.

The scoping study was undertaken by the consultant's team with an intention of collecting enough and relevant information so as to ensure a focused EIA/EMP. The purpose of the scoping study for the project was:

- ✓ To consider the main environmental problems to be studied, alternatives and to ensure that the spatial and temporal scopes and extent of the environmental assessment is compatible with the size of the project;

- ✓ To determine appropriate EIA methods relevant to the project's potential environmental and socio-economic impacts;
- ✓ To provide information to communities in areas affected by the project on the environmental problems and alternatives so that they may take part in identification and assessment of the project's environmental and socio-economic impacts;
- ✓ Scoping was a necessary step in formulation of detailed ToRs for impact assessment by the developer.

The study also covered and reviewed the direct and indirect impacts of the project. In addition, it also examined the impacts in terms of short- term and long- term cumulative impacts and impact interaction. The impacts were classified as either positive or negative. An Environmental Management Plan (EMP) was then formulated to provide viable and environmentally friendly option to manage both the positive and negative impacts and to mitigate adverse impacts of the development.

It was carried out through desk research, several field visits and, consultations with the clients, experts and various stakeholders, the project architects and engineers. The consultant conducted extensive literature review in relation to the proposed project.

The Environmental approval of the project is sought on the grounds that no major predictable environmental harm is likely to ensue[1] from the implementation, preparation and operational phases of the project, and if any, stringent mitigation measures to counter them have been proposed and close monitoring is recommended to ensure that they have been implemented.

1.6 Objective of the study.

The main objective of this study is to carry out a comprehensive Environmental Study for the project.

It is important to note that reducing the burden of environmental impacts has necessary if development is to become sustainable. As resources become limited, environmental impacts become more complex. Thus the EMP studies have become of ever increasing importance as a tool for development and decision making in sustainable management of resources.

Environmental Impact assessment (EIA), as a national instrument, shall be undertaken for proposed activities that are likely to have significant adverse impact on the environment and are subject to a decision of a competent national authority". In practice, EIA is applied primarily to prevent or minimize the adverse effects of major development projects. It is also used as a

1 Ensue: come up/ Arise

planning tool to promote sustainable development by integrating environmental considerations into a wide range of proposed actions.

The aim and objective of EIA study can be divided into two categories.

- The immediate aim of EIA/EMP is to inform the process of decision making by identifying the potentially significant environmental effects and risks of development projects.
- The ultimate (long term) aim of EIA/EMP is to promote sustainable development by ensuring that development projects do not undermine critical resource and ecological functions or the well-being, lifestyle and livelihood of the communities and people who depend on them.

1.6.1 Immediate objectives of EIA

- Improve the environmental design of the project.
- Ensure that resources are used appropriately and efficiently.
- Identify appropriate measures for mitigating the potential negative impacts of the project.
- Facilitate informed decision making, including setting environmental terms and conditions for implementing the project.

1.6.2 Long term objectives of EIA Study.

- Avoid irreversible changes and serious damage to the environment.
- Safeguard valued resources, natural areas and ecosystem components.
- Protect human health and safety.
- Enhance the social aspects of the project.

1.7 Responsibilities for the Study.

The role of the EIA team was to provide the technical expertise on the following key areas:

- The legal framework guiding the project.
- Social Survey and enumeration of the social infrastructure within the project area.
- Environmental survey of the project area.
- Organisation of Stakeholder and Affected People meaningful consultation;
- Potential social and environmental impacts of the project,
- Possible Management options for mitigation of the negative impacts
- The Development of the Environmental Management and Monitoring Plan.

The client's role was to provide the following:

- Project site maps,
- Full details of nature of the project, design, materials usage and by-products,
- Site operational outline and any wastes to be generated,
- Anticipated measures for handling any wastes generated at the site,
- Anticipated management program for the proposed development,

- Make arrangements with the surrounding community to hold stakeholder meetings.

1.8 Study Methodology.

A number of tools and methods were applied to get useful information and consequently arrive at the desired conclusion. A checklist was formulated and used to identify various possible impacts that may emanate from this project and their level of significance. This assisted in prioritizing the impacts and allowed focus on those viewed as being significant. The terms of reference issued by RDB further assisted in guiding the study methodology to be applied in assessing the potential project impacts.

The general steps followed during the EIA/EMP study were as follows:

- Preliminary assessment of the site (made through Several Site visits).
- Environment screening, in which the project was identified as among those requiring a project report under the Law on Environment.
- Environmental scoping that provided the significant environmental issues related to the proposed project and the site activities.
- Previous meetings and public consultations
- Detailed physical inspection of the site and the surrounding areas,
- Physical inspection of the site and surrounding areas.
- EIA/EMP Public participation via the use of questionnaires. and interviews
- Reporting.

1.8.1 Preliminary assessment and Environmental Screening of the site.

The purpose of screening was to categorize whether or not a project requires a full EIA/EMP, partial EIA/EMP or no EIA/EMP at all. The step is applied to determine whether an environmental assessment project report was required and what level of assessment was necessary. The Consultant undertook environmental screening and scoping to avoid unnecessary data.

This was done in reference to requirements of the Organic LAW N°48/2018 OF 13/08/2018 Environmental protection (2018) and specifically the Article 67. And it's from this scoping exercise that RDB recommended that a full EIA/EMP assessment be undertaken for this project. The environmental relevance of a project depends on the type, location, sensitivity, and scale of the project, as well as the nature and magnitude of its potential impacts.

Key issues under consideration were:

- The existing environment of the project site,
- Objectives and characteristics of the project site,

- Major activities that will be conducted during site preparation for the water system, construction and during operational stage, materials to be used, products and by products including solid waste that will be generated.
- The current and future impacts of the project.
- The current social economic activities in the surrounding environment.

1.8.2 Environmental Scoping.

During the scoping stage, the main environmental and social issues were identified. The depth of analysis required for each impact was also identified.

The process of scoping mainly aimed at:

- Focusing the study on key and relevant issues for quick decision making,
- Facilitating an efficient assessment process that saves resources, time, cost and delays,
- Identifying potential stakeholders with an interest in the project.

1.8.3 Desk Study/Literature Review.

The desk study included documentary review on:

- Policy and legislative framework.
- The nature of the site activities,
- Project design,
- Operational requirements,
- The environmental setting of the area.
- Reference was made to various documentations that informed the experts on the identified issues.

1.8.4 Impact Assessment.

The information gathered during the desk and field studies was used to build up the baseline information of the project area and its environs. On the basis of acquired information, informed judgment and experiences from similar environmental projects, the consultant described the salient prevailing environmental characteristics of the project area and predicted the potential environmental impacts likely to emanate from the implementation of the project. Ultimately, the nature, magnitude and duration of both positive and negative environmental impacts were assessed.

1.8.5 Reporting.

A project report (EIA/EMP report) was prepared that details among other issues, the results of the social and environmental assessment and proposed mitigation measures for the adverse environmental impacts. Several report as indicted bellowed were prepared individually and then later combined to form the final EIA/EMP report. These reports included the following

- The social impact analysis report.
- The EIA Scoping report.

- The draft report
- Final EIA/EMP report.

CHAPTER TWO: PROPOSED PROJECT DESCRIPTION.

This chapter defines the project characteristics including its location, type, design layout and components. It also describes the various activities that will be undertaken during its development. The section narrows to project specific site in terms of its importance, location, administrative setup, settlement patterns, and the major environment attributes which will play a crucial role in the identification of impacts and influence the overall direction in the development of the project.

The Mwange Water Supply is designed to provide adequate potable water, clean and improved sanitation to Gicumbi Town. The project will involve construction of a new water treatment plant, rehabilitation and upgrading of the existing water supply systems. As per socio-economic survey and available documents (e.g., Rwanda National Water Master Plan, 2015; World Bank, Rwanda National Water Master Plan, 2015; World Bank, etc.), the current water demand in the project area including institutional and industrial and an estimated NRW of 30% is around 22,134 cubic meters per day. As a result, the WASAC and AfDB have financed this development of this water supply.

Table 9: Estimated Current Water Consumption per Sector and Category

	Sector				
Category	**Byumba**	**Kageyo**	**Rukomo**	**Nyamiyaga**	**Total**
Households	4,956.48	2,504.76	3,422.04	1,766.16	12,649.44
Institution	1,239.71	1,201.00	636.72	608.01	3,685.44
Industry	154.14	155.18	209.77	172.38	691.47
Total	6,350.33	3,860.94	4,268.53	2,546.55	17,026.35
NRW (30%)	1,905.10	1,158.28	1,280.56	763.97	5,107.91
Grand	8,255.43	5,019.22	5,549.09	3,310.52	22,134.26

2.1 Project need

The development objective of the program is to improve the quality of life and socio-economic development of the people and country by ensuring equitable provision of adequate, reliable and sustainable water and sanitation services for targeted areas with a view to promote economic growth and transformation. Upon completion of the construction works, a number of people will be benefitting improved, liable and sustainable water supply services from the program.

In Gicumbi District, the proposed Water Treatment Plant and associated forwarding infrastructures have been prioritized to allow effective operation of network developed in context of rehabilitation, upgrading and extension of water networks in towns as parts of initial phase of Rwanda Sustainable Water Supply and Sanitation Program.

2.2 Project Activities

2.2.1. Construction phase

Table10: project activities during construction phase

Activity	Detailed process /Activities
Site Clearing and Stripping	This involves clearing the project site in preparation of construction works. Stripping shall include top soil removal, levelling etc;
Excavation:	Ground and trench excavation will be done according to the site layout plans and the design of the unit.
Procurement and delivery of construction materials;	All these will be obtained from licensed dealers and especially those that have complied with the environmental management guidelines and policies and with Rwanda Standards Bureau specifications. It is worthwhile noting that most of the construction materials are locally available.
Foundation:	Foundation preparation for all the construction works;
Backfilling	Filling of trenches and other areas to ensure level surfaces after compaction. The fill material shall be compacted by mechanical means until the required degree of compaction;
Disposal of construction wastes;	Construction wastes to be recycled and reused as much as possible e.g. Donate recyclable/reused or residue materials to the local community, groups, institutions or residents , Disposal of the wastes will be done responsibly by dumping at designated dumping site this will be collected by a contracted waste management company.

2.2.2. Operation Phase.

Activities planned in this phase are mainly:

- ✓ Completion of construction activities will be followed by operation of the project (Water Treatment Plant)
- ✓ Both solid and liquid wastes will be produced during this phase of the project. Solid waste handlers will be contracted to collect and dump wastes in approved dumping sites.
- ✓ Storm water will be conveyed to the storm water drainage system that will have been developed.

Table 11: Project waste Source and Disposal methods

TYPE	Quantity	Source	DISPOSAL Method
Solid	Unknown	Excavated soil	Dump to the Approved disposal area
		Construction materials equipments and residuals	Disposal as per RURA guidelines
		Municipal solid waste like food leftovers,	To follow municipal solid waste management guidelines
Air Emission	Unknown		Into the atmosphere

2.2.3 Project Decommissioning.

Decommissioning of the proposed project will become necessary when the project completes its life cycle or when there is change of use. In a situation where the buildings complete their lifecycle, decommissioning process will typically involve demolition of the facility, clearing of the site and reclaiming or restoring the affected land into a natural condition.

During decommissioning, buildings, pavements, drainage systems, parking areas and perimeter fence will be demolished in order to restore land to its original state. Different kind of workers and equipment's will be deployed to carry out these tasks. This will produce a lot of solid waste, which will be reused for other construction works or if not reusable, disposed of appropriately by a licensed waste disposal company. Electrical installations, sewerage system, pipes among others will be dismantled during decommissioning of the project. The proponent is expected to recover most materials for sale or future use. Those that are obsolete or greatly damaged shall be disposed in authorized dumping site and incinerate some to reduce their volume in the environment.

Decommissioning will also entail restoring the project area to its original state. Activities during restoration include removal of debris, landscaping, planting of trees and removal of barriers among others. It will be upon the proponent and the contractor to ensure restoration is done in an orderly manner.

The implementation of the decommissioning activities will require the development of a plan of Works for the whole site will entail the following:

a) Equipment hygiene practices.

b) Removal of all infrastructure;
c) Removal of all non-hazardous materials and wastes;
d) Monitoring of surface and ground water during decommissioning period and for at least three years after rehabilitation.
e) Leave naturally regenerated native vegetation undisturbed where possible.
f) Spread substrate mix over prepared landform to a minimum depth of 300mm.
g) Use local native vegetation in the re-vegetation.
h) Monitor re-vegetation for at least three years.

➲ **Decommissioning Activities.**

Demolition works.

Upon decommissioning, the project components including WTP, pavements, drainage systems, and perimeter fence will be demolished. This will produce a lot of solid waste, which will be reused for other construction works or if not reusable, disposed of appropriately by a licensed waste disposal company.

Dismantling of equipment and fixtures

All equipment including electrical installations, finishing fixtures, pipe-work among others will be dismantled and removed from the site on decommissioning of the project. Priority will be given to reuse of these equipment in other projects. Those that are obsolete or greatly damaged shall be disposed in authorized dumping site and incinerate some to reduce their volume in the environment

Site restoration

Once all the wastes resulting from demolition and dismantling works is removed from the site, the site will be restored through and re-vegetation using indigenous plant species. Restoration of the affected land may involve the filling in of the open pits and grading the land to its natural contours, replenishment of the topsoil and finally planting appropriate tree species and under cover vegetation to hold the soil in place and to prevent flooding.

Positive Impacts during Decommissioning Phase

Site Rehabilitation

✓ Employment Opportunities

Negative Impacts during Decommissioning Phase

The demolitions of the whole of the WTP after the end of its life span will lead to the below mentioned environmental impacts whose risks need to fully be identified and methods to prevent or minimize risks be put in place. This could be done through undertaking a decommissioning study. Amongst the key impacts expected are:

✓ Noise Pollution and Vibration.

- ✓ Dust emissions/Air Pollution.
- ✓ Occupational health and Safety Issues.
- ✓ Water Pollution.
- ✓ Solid Wastes and other Materials.
- ✓ Traffic Impacts

2.3 Project components

The whole project consists of construction of intake,water treatment plant,water supply pipeline, pumping stations and reservoirs as indicated on the scheme below

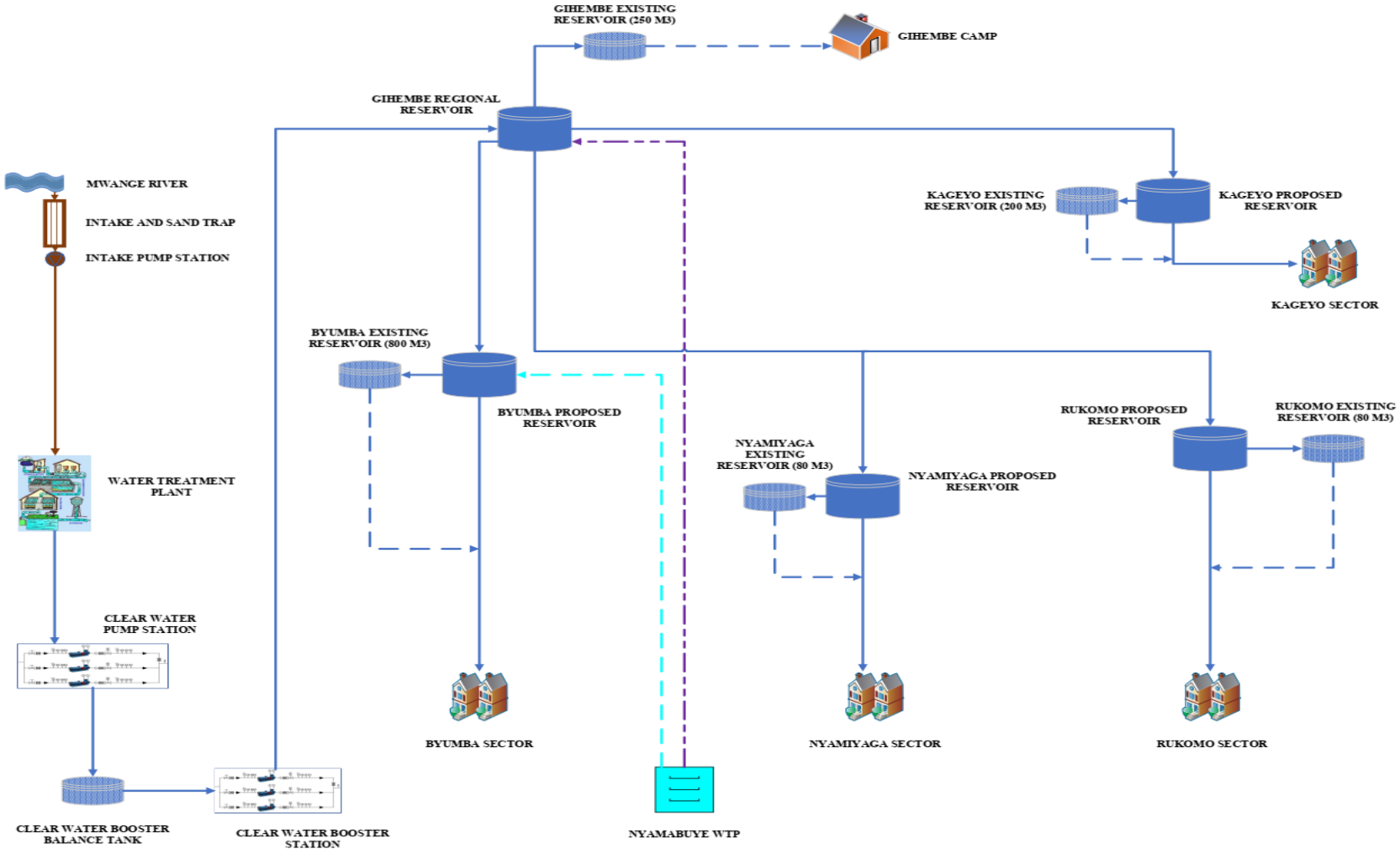


Figure3: proposed Mwange water supply scheme

2.3.1 Intake System

Intake and Sand Trapping System

The intake structure at the Mwange river consist of following main components:

- Diversion sharp crested weir that is to be constructed along the river. The main purpose of this weir is to maintain a specific level of water at the intake structure. Based on the topographic surveys, the weir will have a length of about 8.0 m and a height of about 2.0 m to maintain water at the required level. The weir will be supported by retaining walls at either side.
- Manual coarse screens with bar spacing of 20 mm. Due to the use of two channel intake works, two screens are to be installed. The main goal of these screens is to trap floating objects and any other large objects such as stones, trees, etc. The screen should be of stainless steels and mounted on concrete walls. The screens are to be manually cleaned.
- The sand trapping system is a two channel longitudinal sand traps that are equipped with weirs at an interval of 15 m. The proposed weirs are to aid the sand trapping by breaking the speed of water. The sand trapping system should be capable of eliminating all particulars larger than 200 micrometers. The sizing of the proposed trapping system has been done Stoke's law as shown below.

From the upstream tank, the water will be pumped to the treatment system. It is foreseen that all particles of above 200 micrometer and more will be eliminated at the intake. Based on the findings of the flood models, the walls of the intake chambers will be adequately raised and the outside embanked with suitable material to avert the possibility of storm water with high turbidity flowing in during the rainy season.

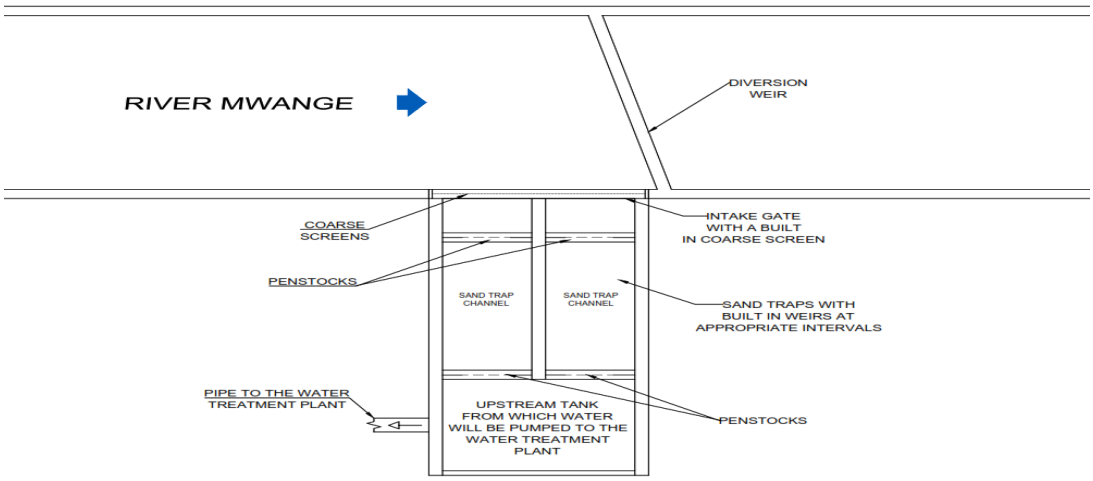


Figure 4: Proposed Intake Arrangement

The weir controls the intake level. The weir shall be construction up to 0.5 m below the top of the sand trap. The weir shall have 2 flush gates (penstock valve), which shall be opened to flush out the sand which have accumulated behind it. Flush gates shall also be opened in case of excess flows. They will be positioned at the top and at the middle of the weir, while the low shall be placed at the bottom of the weir. They will remain closed under normal operation.

Intake Pumping station with a capacity of 39,500 m3/day at the ultimate stage (2030 – 2050). During maintenance, the high penstock will be opened and when the levels reduce the low one can be opened also. They will be manually operated.

Sampling of river water shall be regularly taken to assess the effectiveness of the sand trap

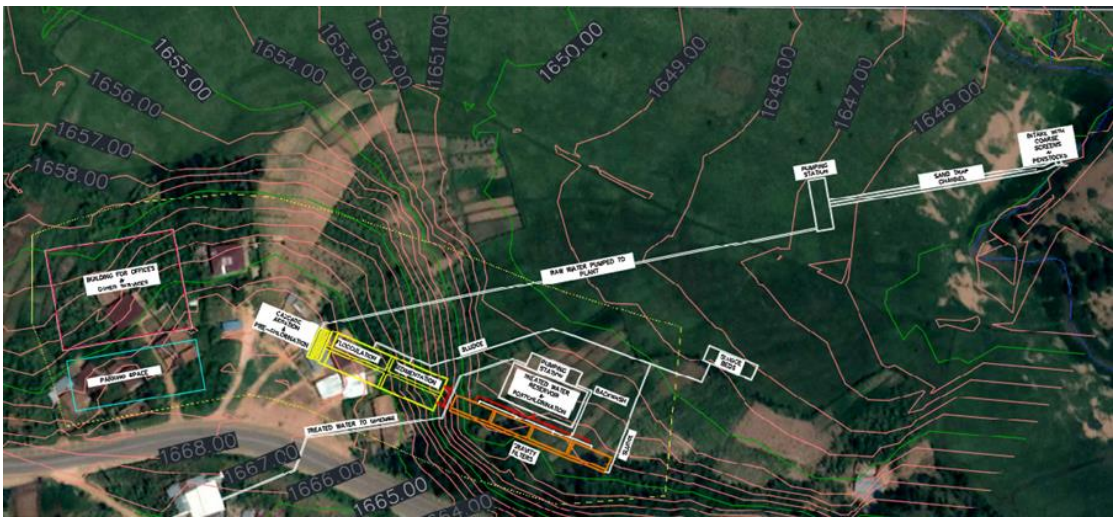


Figure 5: Proposed Intake and Water Treatment Plant Contour Map

2.3.1.1 Sand trap

The water from Mwange river requires sand trapping as previously detailed. The sand trap will have screens which shall be slotted into the provided grooves. They shall cover the entire width of the of the sand trap. Screens needs to be regularly cleaned.

The sand trap shall possess two penstocks to control extraction of water from the river.

The penstocks shall remain open under normal operation and only closed during maintenance. They are manually operated.

The trapped sand shall be removed by silt pumps running along the rails. They are set to rum at regular intervals (say 1 trip for every 30 minutes). It shall also be operated via the SCADA system. The sand shall then be pumped back to the river through a drain.

For any form of maintenance of the sand trap, the inlet penstocks will be closed while the raw water pumps are allowed to run until the water level has reduced to the minimum levels of the pumps as shall be indicated by the sensors.

2.3.1.2 Raw Water Pumps

The raw water submersible pumps shall be installed up to 0.3 m above the bottom of the upstream tank. They shall be controlled both by the SCADA system and at their respective control panels.

2.3.1.3 Raw Water Flow Meter

The raw water flow meter shall be digital and shall be read by the SCADA system. It shall be installed in an appropriate meter chamber.

2.3.1.4 Sampling and Testing of Raw Water

Raw water shall be sampled at the meter chamber to determine properties. a combined electronic kit reading the pH, Turbidity and Iron shall be installed and be read at the SCADA system. A control valve shall be installed in case manual sampling is required for calibration purposes.

2.3.2 Water treatment system

The proposed system consists of a WTP at the river Mwange with a total capacity of 34,000 m3/day. The WTP comprises an intake at the river, and treatment processes, which are mainly coagulation, flocculation, sedimentation, and filtration. The treated water will be pumped from the clear water tank via a high lift station into a booster station. The booster station will pump water into a regional water reservoir located at the Gihembe refugee camp.

The proposed water supply and reticulation system is a hybrid system comprising pumping from the raw water intake into the water treatment plant, followed by treated water pumping to the reticulation network reservoirs via a lifting station, and finally, gravity reticulation from the balancing reservoirs.

Based on raw water quality, the proposed water treatment process is full conventional with all treatment units to be constructed indicated on the figure below and thereafter described.

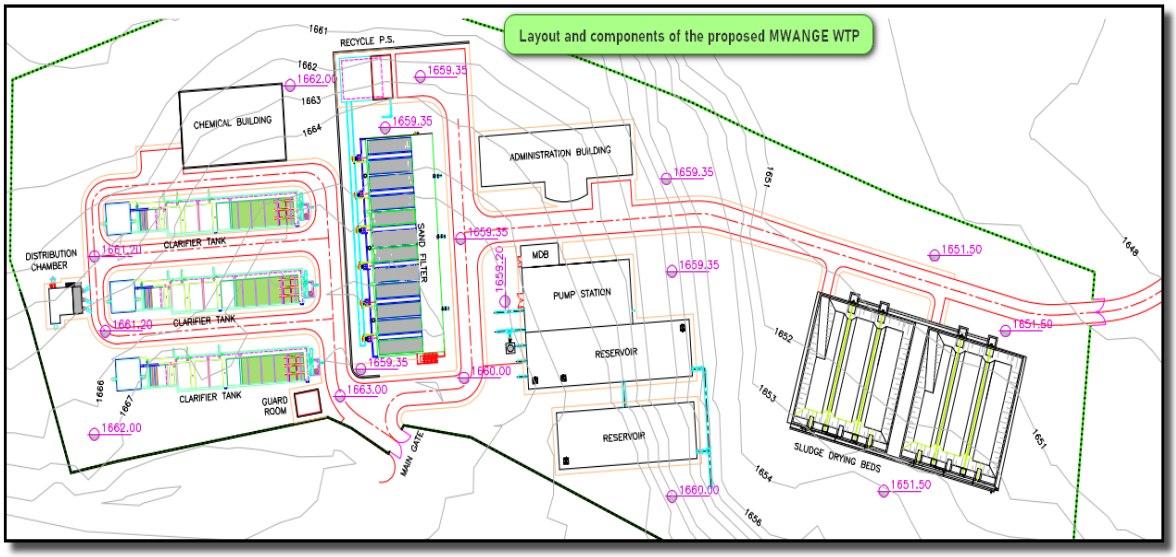


Figure6: Mwange water treatment process

2.3.3.1. Pre-Chlorination

Pre-chlorination is to remove organic matter and oxide ammonia, iron and manganese. 1 mg/l is considered as a rule of thumb for pre-chlorination, the required chlorine required per day is 39.5 kg/day. Assuming 65% purity of Calcium Hypochlorite, the total required Calcium hypochlorite will be 61 kg/day (39.5 / 0.65).

Table 12: summarises the design outcomes.

Design Parameters	Description
Required pre-chlorination concentration	1 mg/l
Required dosing rate for calcium hypochlorite	61 kg/day
Mixing interval	4 days
Selected mixing container	One 500-liter calibrated HDPE translucent tanks

The water will pass through the cascading aeration before proceeding to the coagulation tanks. The purpose of the aeration is to oxidize the excess iron, manganese, organic matter, reduce tastes and odor, and dissolved gases by introducing oxygen into the raw water. The oxygen added by aeration oxidizes dissolved iron and manganese to insoluble forms which can then be removed by sedimentation and filtration.

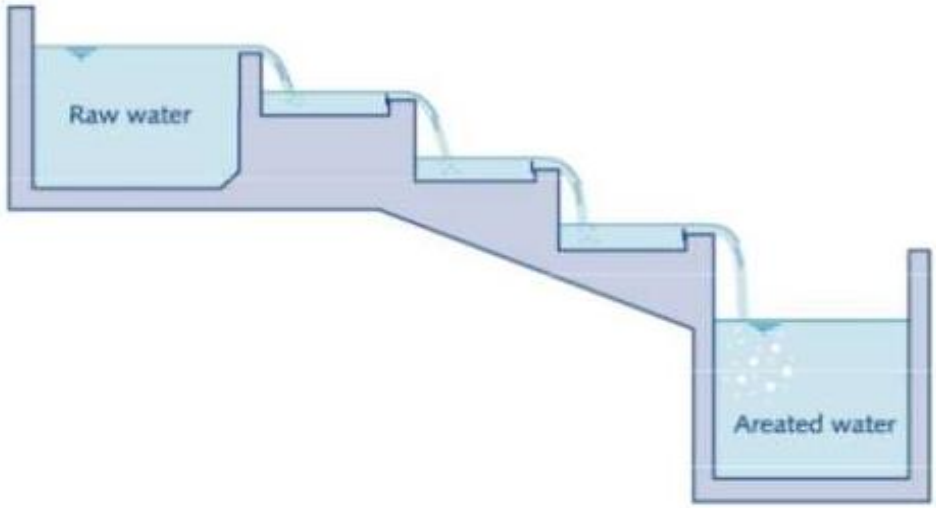


Figure 7: sample of cascade tank.

2.3.2.2 Flocculation and Coagulation Tanks

Flocculation is a physical process that involves accumulating the coagulated solids into flocs that can be removed via sedimentation. The formation of flocs is aided by adding chemical components such as polymers. Two parallel flocculation tanks are to be implemented, hence the flow for each will be 0.23 m^3 /s. Depth of the tank (H) is chosen as 2.50. For flocculation process, the retention time ranges between 15 and 30 mins *(Mc Ghee et al, 1991)*. The outlet of the flocculation tank will allow big flocs to enter gently into the sedimentation tank. The scum will be removed before entering the sedimentation tank. This is designed as a diffusion wall (i.e., with orifices) to prevent residual energy from entering into the sedimentation tank.

Table 13: Summary of the Sizing of the Flocculation Tank

Design Parameters	Description
Discharge required	1,646 m^3/h
Detention time	25 min
Number of Tanks	4 Tanks (2 in each treatment line)
Tank depth	2.5 m
freeboard	0.5 m
Width	7 m
Length	20 m (10 m each)
Mixers	Each to have a motorized mixer with adjustable revolutions ranging from 5 to 15 revolutions per minute.
Draining of the flocculation tanks	1 DI pipe 250 mm diameter for each tank unit. It should also be connected with a bell-mouth overflow.

Design Parameters	Description
Opening of the drainage pipes	One pneumatic and one manual butterfly valves to be installed on each outlet.

Due to relatively high turbidity, polypropylene lamella settlers with vertical flow are to be constructed. The flocculated water enters from the bottom part of the lamella and travels upwards counter current to settle sludge, which settles downward.

The lamella plates will be inclined at 60 degrees. Clarified water will be collected through perforated stainless pipes running at the upper part of the tank. The bottom of the tank is fixed for sludge collection. The lamella will be supplied as packed welded in the factory.

2.3.2.4 Rapid Sand Filters with backwashing system

After sedimentation, the water will be conveyed to a rapid sand filtration system to further reduce the turbidity. In concept, a balancing tank will be constructed adjacent to the filter to ensure delivering water to each filter and it will be equipped with penstocks. Each Penstock will deliver water into a suspended channel in the filter chamber to avoid disturbance of the filter media. The proposed filter will have three media layers: anthracite, sand and gravel layers as shown on the diagram below. Its specifications are presented in table below.

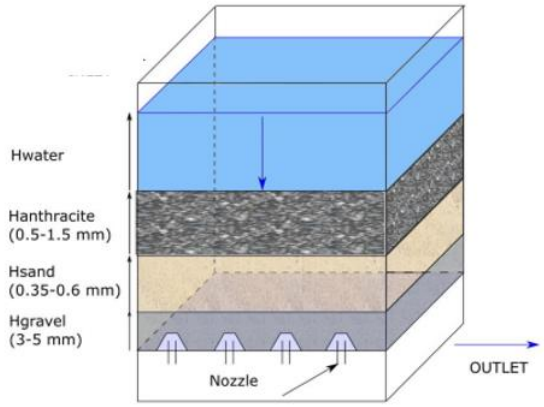


Figure 8: Typical Layers in Sand Filters

The filters will be rectangular with open surface (not pressurized). The filtration rates typically vary between 6 and 12 m/h (Amin etal,2002). A value of 7 m/h is selected to minimize the risk of breakthrough to avoid any risk of cryptosporidium oocysts and Giardia cysts in the raw water. Four filter chambers are to be utilized; each conveys on quarter (¼) of the total flow when no backwashing is in progress.

2.3.2.5 Post Chlorination System

Just like other chemical dosing systems, the operations will include mixing the chemicals in the provided container, setting the dosing rate to ensure the required residual chlorine is maintained as detected at the treated water pump house.

2.3.2.6. Drying Beds

The operations in this unit include allowing allow sludge into each chamber for 4 days before switching to another bed. The thickened sludge will then be scraped off the filter media, stocked up and then ferried to a safe dumping site.

2.3.3 water supply network to be constructed

A total of 245.0 km of pipes were modelled. These include existing and proposed new pipes. The 245.0 km include pumping mains, main distribution pipes and distribution. In the second stage of the project (2035 -2050), it is envisaged that the whole system will be totally new system except the 21.0 km tertiary pipes previously mentioned, as other the existing pipes will be completely either renewed or upgraded.

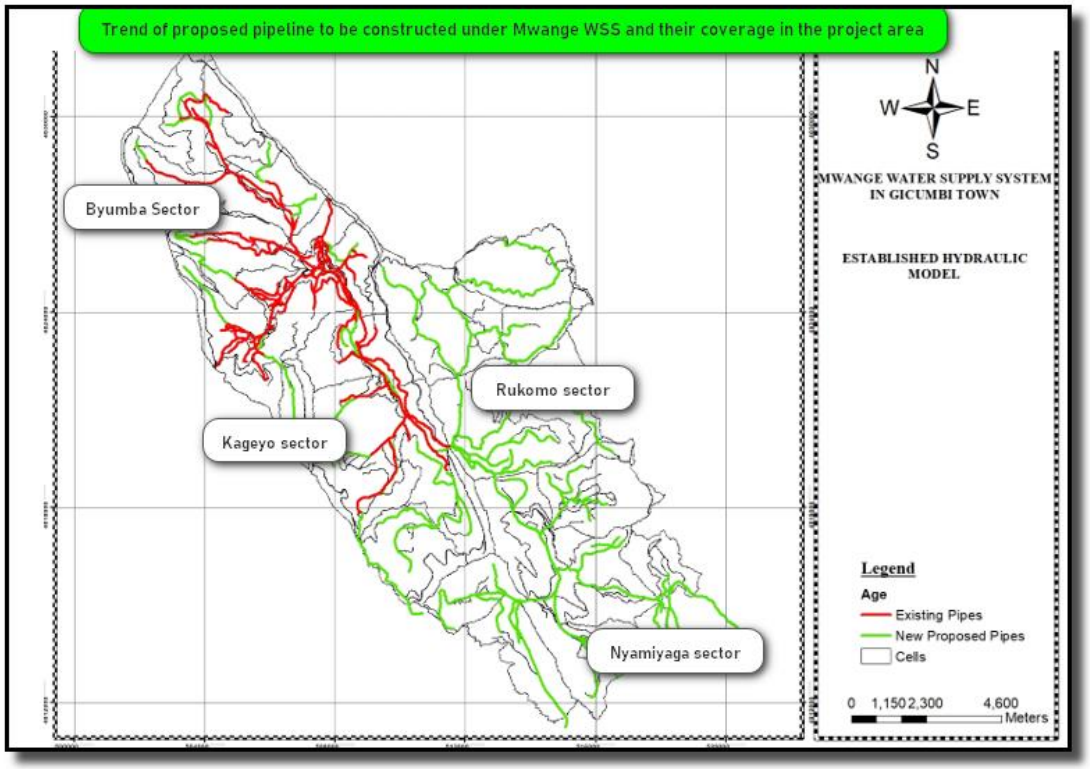


Figure9: proposed pipeline network to be constructed

2.3.3.1 Transmission/ Pumping Mains

As previously mentioned, the system is hybrid. Water will be pumped from the WTP via a DN500 DIP to the booster station. From the booster station to Gihembe a DN500 DIP will be also laid. From Gihembe to the sector's reservoris water will be delivered via DN350 to Byumba, a DN300 to Kagyo, and a DN300 to Rukomo and Nyamiyaga. The DN300 to Rukomo and Nyamiyaga branches at coordinate (511,546.02, 4,819,872.91) into two DN250 pipes. Each feed one reservoir. All the transmission and pumping mains are new. They will be implemented in the first stage of the project.

The transmission mains will be all implemented at the first stage. Table below presents the total length for each pipe**.**

2.3.3.2. Water Reservoirs

The water reservoirs within the system are designed as storage except the clear water tank and the booster balance tank. These two are to designed to balance inflow and outflow to reduce the switch on and off of the pumps to be less than 5 time in one hour. The clear water tank will be 3,700 cubic meters including the backwash volume. It will be implemented in two stages (2,000 cubic meters in the first stage and 1,700 cubic meters in the second stage). The booster's balance tank has a total capacity of 5,000 cubic meters. 2,500 cubic meters to be implemented at each stage. It is to note that the balance tank is sized bigger than the clear tank to ensure water availability for the booster when a sudden failure occurs at the high lift station. This reserve storage will allow smooth shutting down of the booster without any effect on the pumps. The storage tanks are designed to balance fluctuations in demand between minimum and peak, as well as, to accommodate a reserve storage for emergencies that is 5 hours for Gihembe and 7 to 8 hours for others. For the design of the storage reservoirs, the demand and supply were assumed the same at average demand.

Table14: Storage Capacities and Stagging of Implementation

Reservoir	Total Capacity	Stagging of Implementation	
		Stage 2020 - 2035	Stage 2035 - 2050
Byumba	4,500	3,000	1,500
Kageyo	3,000	1,500	1,500
Rukomo	3,000	1,500	1,500
Nyamiyaga	2,000	1,000	1,000
Gihembe	7,500	5,000	2,500
Total	**20,000**	**12,000**	**8,000**

Table15: Pumping and Transmission Mains

From	To	Diameter	Material	Length (m)
High Lift Station	Booster Station	DN500	DIP	5,531.00
Booster Station	Gihembe Reservoir	DN500	DIP	6,044.64
Gihembe Reservoir	Byumba Reservoir	DN350	DIP	2,558.49
Gihembe Reservoir	Rukomo and Nyamiyaga	DN300	DIP	5,286.36
Gihembe Reservoir	Kageyo Reservoir	DN300	DIP	2,113.82
Rukomo and Nyamiyaga	Rukomo Reservoir	DN250	DIP	1,385.46
Rukomo and Nyamiyaga	Nyamiyaga Reservoir	DN250	DIP	6,131.18
Total				**29,051.00**
DN500				11,575.64
DN350				2,558.49
DN300				7,400.18
DN250				7,516.64
Total				**29,050.95**

Note: Tentative Quantities. Actual quantities will be in the Tender Documents

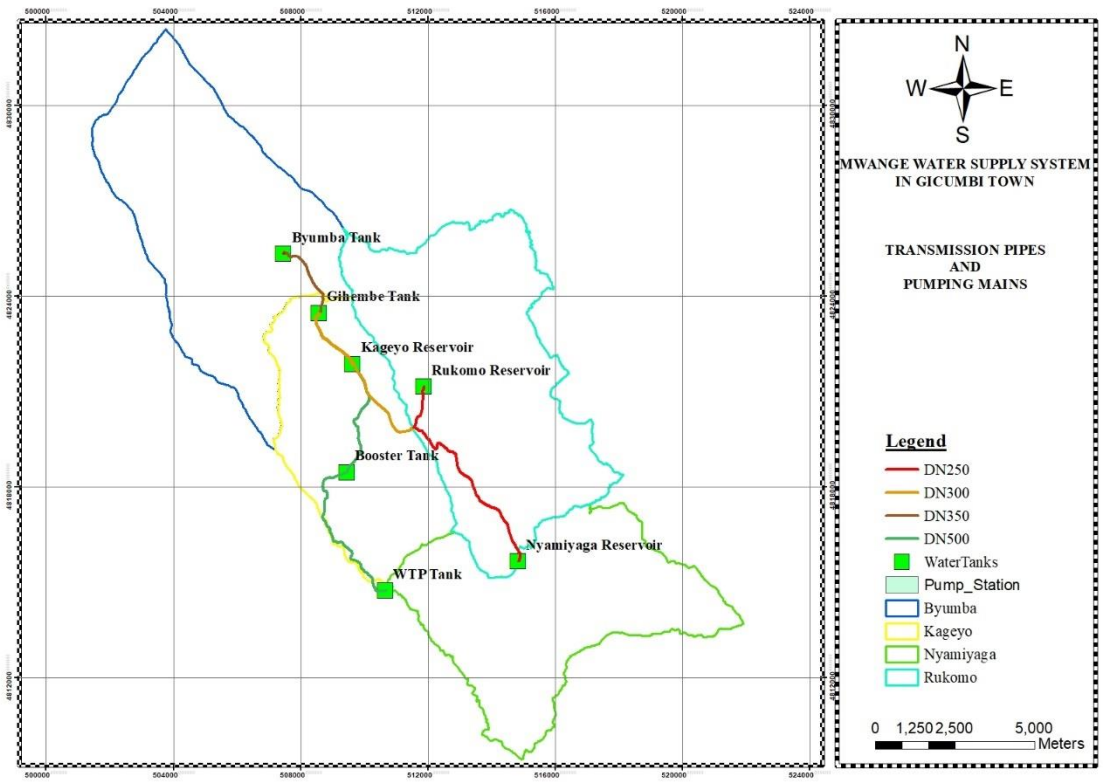


Figure10: General Layout of the Transmission and Pumping Mains

2.3.3.3. Distribution Mains

The distribution mains are the pipes transporting water from the reservoirs to the distribution network. They start from the outlet of the reservoir. All the distribution mains are new and will be implemented in the first stage of the projects. The following are the main distribution pipes per reservoirs. Gihembe Reservoir is a regional reservoir that will mainly supply the sector's reservoirs. However, it will supply the Gihembe refugee camp via a DN90 HDPE pipes.

Byumba Reservoir will feed Byumba sector via four distribution mains of DN250 (DIP), two DN200 (HDPE), and DN150 HDPE.
Kageyo Reservoir feeds Kageyo sector via three mains of DN63, DN90 and DN200. All are HDPE Pipes.
Rukomo Reservoir supplies its sector via two mains of DN150 HDPE pipes.
Three distribution mains supply Nyamiyaga area from its Reservoir. The pipes are DN200, DN150 and DN110. All are HDPE.

Table16: Mains Distribution Pipes

From	Diameter	Material	Length (m)
Gihembe Reservoir	DN90	HDPE	270.60
Byumba Reservoir	DN250	DIP	2,503.80
	DN200	HDPE	1,184.80
	DN200	HDPE	2,791.70
	DN150	HDPE	3,287.80
Kageyo Reservoir	DN200	HDPE	357.90
	DN200	HDPE	4,312.90
Rukomo Reservoir	DN200	HDPE	2,380.30
	DN200	HDPE	1,866.30
Nyamiyaga Reservoir	DN200	HDPE	402.10
	DN150	HDPE	1,381.10
	DN110	HDPE	2,085.00
Total			**22,824.30**
DN90			270.60

DN110	2,085.00
DN150	4,668.90
DN200	13,296.00
DN250	2,503.80
Total	**22,824.30**

Note: Tentative Quantities. Actual quantities will be in the Tender Documents

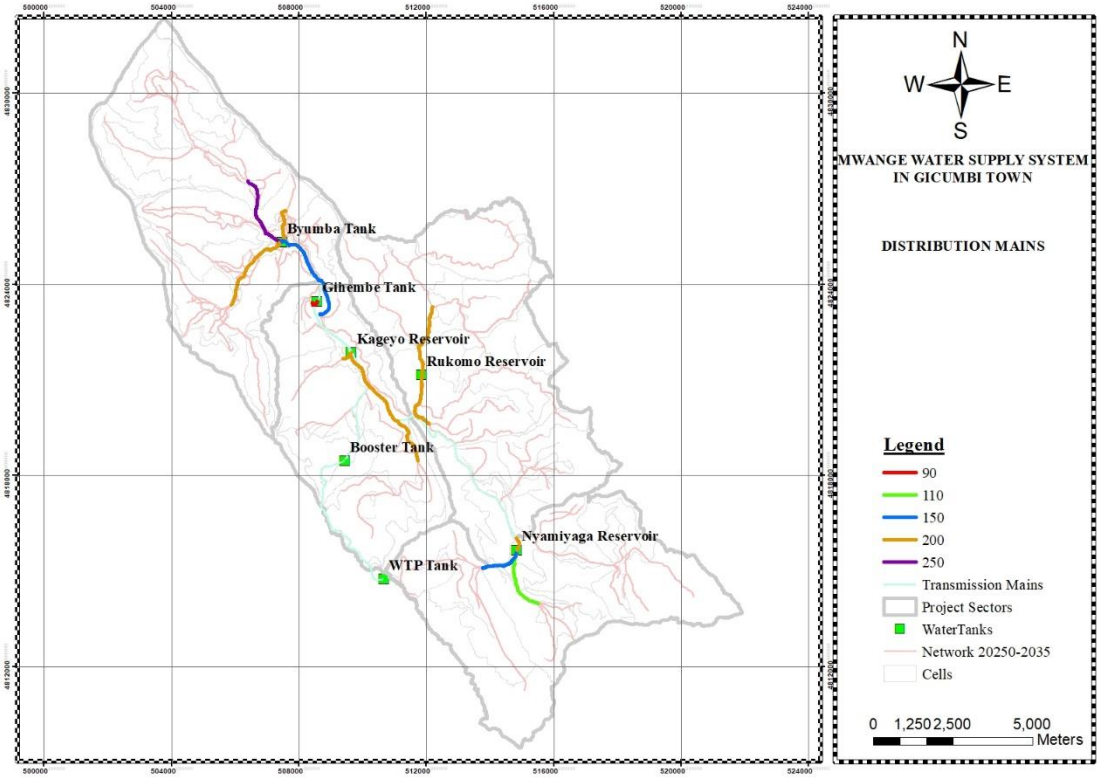


Figure11: General Layout of the Distribution Mains

2.3.3.4. Distribution Network

Excluding the transmission/ pumping and distribution mains, the remaining is the distribution network that will service the customers in each cell. The total distribution network in the year 2050 will be around 170.0 km including replacements of the existing system except the 21.0 km tertiary pipes previously mentioned. The lengths are shown in the table below. A general layout is shown in figure below. The total of 170.0 km becomes around 222.0 km including pumping mains and main distribution pipes, which is the total network in 2050 except the 21.0 km tertiary pipes.

Table 0: Distribution Network

Diameter	Material	Length (m)
DN63	HDPE	35,522
DN75	HDPE	18,005
DN90	HDPE	31,979
DN110	HDPE	54,029
DN150	HDPE	28,691
DN200	HDPE	1,948
Total		**170,174**

Note: Tentative Quantities. Actual quantities will be in the Tender Documents

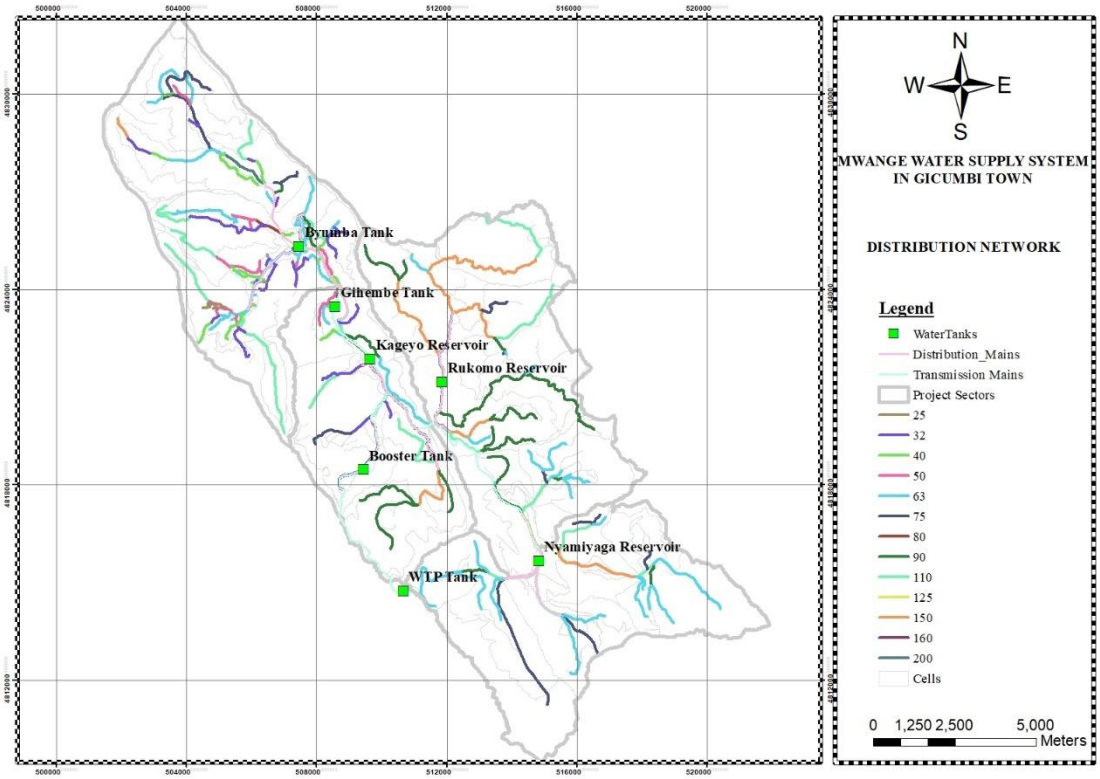


Figure 12: General Layout of the Distribution Network

2.4. Interventions for the Rehabilitation of the Existing Water Treatment Plant (Nyamabuye)

The existing water treatment plant at Nyamabuye currently has a capacity of 1,700 m^3/day, but its production can be increased to 2,400 m3/day by channeling in more water from Miliku springs. The water treatment process in Nyamabuye currently involves addition of lime for

PH correction and chlorination for elimination of pathogens. The recommendation regarding the refurbishment of this treatment plant is as follows:

- General rehabilitation of the existing structures
- Replacement of the existing pumps
- Replacement of the surge tank
- Replacement of the spray aerators
- Installation of pressure filters at Yaramba to ensure allowable turbidity
- The sprayer aerators are dilapidated and ought to be replaced with ones of the same design but in stainless steel.

During the field surveys, it was found that the turbidity of the water rises after heavy rains, which causes disruption in the water treatment process. This occurs because the water treatment process at Nyamabuye does not include the clarifiers. Therefore, it is recommended that the collection chamber at Yaramba be equipped with pressure filters to reduce the turbidity of the water as it is pumped into the water treatment plant.

Plate 1 showing the Water Tanks to be rehabilitated in this project

2.5. The materials and labour during the project implementation

2.5.1. list of equipment

No.	Equipment Type and Characteristics	Minimum Number required
1	Trucks to transport pipes and construction material	**1**
2	Dumper Trucks (load capacity ≥ 15 m³)	**1**
3	Excavator ≥ 130hp, bucket ≥ 1,5m³) for only lot 6	**1**
4	Self-loading concrete mixer (≥ 500 litres)	**1**
5	Pick up for transport staff (≥ 4WD)	**2**
6	Topographic survey equipment (New)	**3Total stations, 3 Dump level, 3 GPS**
7	Drawing software and equipment AutoCAD, ArcGIS or equivalent, plotter, computers	**1**
8	Drilling machine	**1**
9	Drilling Surveying camera	**1**
10	Concrete sampling and testing material set	**1**
11	Geotechnical sampling equipment set	**1**
12	Pressure testing equipment's (set)	**1**
13	Concrete vibrators (≥ 3 hp/6 cm)	**2**
14	Dewatering pumps (≥ 15 m³/h)	**2**
15	Generator (≥ 20 KVA)	**2**
16	Truck Water Tank (≥ 10 m³ or 10000 liters)	**1**
17	Fully hydraulic truck crane (≥ 100,000 kg/30,000kN.m)	**1**

- This list is not exhaustive; the Contractor may provide additional equipment it deems necessary to complete the works within the contractual period
- All equipment's age shall not exceed ten (10) years.

2.5.2. List and Source of materials for project implementation

All construction materials will be obtained from licensed dealers and especially those that have complied with the environmental management guidelines and policies and with Rwanda Standards Bureau specifications. It is worthwhile noting that most of the construction materials are locally available (eg: sand, stones and all aggreagates for masonry and concrete works will be the form the locally approved quarries). Moreover, other construction materials for this project such as cement, pipes, steel bars, ceramic tiles, etc) will be obtained from the local manufacturers after testing the compliance with quality requirements.

Other materials and equipment that are not manufactured locally such as chemicals for water treatment process, fittings for pipelines, electromechanical equipments (pumpS, SCADA, etc) shall be supplied from international manufacturers

2.5.3. Estimated number workers:

During construction phase, the total number of personnel to be employed will range from 3500-4000 and will be composed of formally educated and informally educated, women and men.

During operation phase the total number of 30 staff will be required to operate the plant and will work regularly while the casual workforce will range from 60-80.

2.6. Electricity and water supply

The main water and electricity to be used by the project infrastructures during construction and operation of the Proposed project and Water Treatment Plant will be supplied by EDCL/REG when connections are effective, to cover daily demand during the construction and operational phases of the project. The project will use electricity and water supply from EDCL/REG and this makes it the major source of electricity alternative and WASAC the main alternative source of water supply to the project construction and operational phases. However, there will be a standby generator in case of power shortage.

2.6. **During operation**

With reference process proposed by the design which is full conventional water treatment, the following chemicals will be required at the following treatment unit:

-pre-oxidation: chloline in the form of Calcium hypochlorite($Ca(OCl)_2$.

-Cascade aeration: Free air will be used to provide oxygen for Iron and Manganese removal

-coagulation: the polymer coagulants such as Zetafloc will be used for the coagulation and flocculation process. Alternatively, alum($Al_2(SO_4)_3.5H_2O$ will be used in case of Zetafloc is not available, in this case, Lime $Ca(OH)_2$ shall be used to correct the PH.

-Lastly for disinfection purpose, Calcium hypochlorite ($Ca(OCl)_2$ or Sodium chloride (Nacl) through electrolysis.

CHAPTER THREE: INSTITUTIONAL, LEGISLATIVE AND REGULATORY FRAMEWORK.

This chapter describes the various laws, policies and institutional framework that affects or guide the development of this project. There is a number of national legislations, policies and plans that provide a framework on the intentions and aspirations of Rwanda as well as governing guidelines for this project. Rwanda continues the process of putting appropriate legislations in place and a good number have already been completed. In this chapter, we define the legal requirements and context within which development and operation of this project is governed or influenced.

3.1 National legislative and regulatory framework

The Constitution of the Republic of Rwanda, adopted in June 2003 and revised in 2015, ensures the protection and sustainable management of environment and encourages rational use of natural resources. In consideration of the Constitution as amended to date, article 49 states that every citizen is entitled to a healthy and satisfying environment. Every person has the duty to protect, safeguard and promote the environment. The state shall protect the environment. The Organic Law determines the modalities for protecting, safeguarding and promoting the environment. To comply with this constitutional statement and to ensure that the country development is done in sustainable manner, the government has adopted different sectoral policies, laws and institutional set ups for their monitoring and enforcement.

3.2 Institutional arrangement for the environmental management in Rwanda

The institutional framework for environmental management is currently enshrined in the Law on environment 2018, that gives the modalities of protection, conservation and promotion of environment in Rwanda. But this is also intertwined with the ministries that have been given the responsibility to deal with Water management and development issues. It is important to note the following critical articles in the Environmental Law that are related to the environment

3.2.1 Ministry of Infrastructure (MININFRA)

The mission of Ministry of Infrastructure includes:

- To initiate programs, to develop, rehabilitate and maintain an efficient and integrated national transport infrastructure network, including roads, bridges, airports, railways, and water supply which will contribute towards economic development and regional integration.
- To initiate programs aimed at increasing access to affordable energy, water and sanitation, and transport infrastructure and related services for the population;

- To supervise the implementation of quality standards and norms, cost effectiveness, response to environmental sustainability, safety and cross-cutting issues in infrastructure development;
- To work towards implementation of programs to enhance human resource capacities under the transport, energy, habitat & urbanism, water and sanitation, and meteorology sub-Sectors respectively;
- To supervise activities meant to elaborate, monitor and assess the implementation of national policies and programs on matters relating to habitat and urbanism, transport, energy, water and sanitation.

3.2.2 Water and Sanitation Corporation Limited (WASAC)

WASAC Ltd is the entity setup to manage the water and sanitation services in Rwanda and was created by the law Nº 87/03 of 16/08/2014. The company was created in the on-going government reform intended to deliver water and sanitation utility sufficiently focused to deliver new infrastructure; efficient and effective service delivery; build a strong people capability; and meet key national milestones. It is expected to reverse the status quo that includes inadequate planning and investments; inefficient and wasteful operations; inadequate institutional management focus; improve viability and autonomy; and establish a sustainable and customer-centric utility to deliver an important mandate that touches people of all walks of life. The mission of the company is providing quality, reliable and affordable water and sewerage services through continuous innovations and detailed care to customers' needs.

As implementing agency, WASAC Ltd will play a critical role in project implementation but also in the implementation of ESMPs and RAPs as well as conditions of approval to be issued by Rwanda Development Board. WASAC Ltd is also responsible for monitoring of the implementation of mitigation measures and report back to Rwanda Environment Management Authority.

WASAC is the main client for this assignment and leads in the implementation of the same as per the institution guidelines. Under Project Implementation Unit WASAC has a team of project Manager, one environmental safeguards specialist, two social specialists, two M&E specialists, 15 engineers which will be implementing the ESIA and ESMP during project implementation.

3.2.3 Ministry of Environment (MoE)

The Ministry of Environment is responsible for the development of environmental policies and procedures (including impact assessments), protection of natural resources (water, land, flora, and fauna), environmental legislation, biodiversity, and other environmental aspects. The

Chapter IV of the organic law on environmental protection, conservation and management, Article 65, clearly calls for the need to subject projects to mandatory ESIA. The Article 65 further specifies that every project shall be subjected to environmental assessment prior to its commencement. It shall be the same for programs, plans and policies likely to affect the environment. Specific details of projects referred to in this Article shall be spelt out by the order of the Minister in charge of environment. MoE is one of the lead Agencies / Line Ministry as provided by the General Guidelines and Procedure for ESIA.

MoE is expected to perform the following functions in the ESIA process:

- Participate in screening at the request of Rwanda environment Management Authority (REMA);
- Publish the list of ESIA practitioners;
- At the request of REMA, review Project Briefs so as to advise on Terms of Reference;
- Ensure that their own projects adhere to ESIA requirements;
- Ensure that private-sector projects in fields over which they have jurisdiction comply with ESIA requirements;
- At the request of REMA, review ESIA report;
- Serve on REMA's Technical Committee;
- Serve on REMA's Executive Committee;
- Provide information or advice to developers and ESIA Experts during ESIA process;
- Participate as panellist at public hearings held during the conduct of ESIA;
- Advise developers on the requirement for ESIA (where relevant) before licensing their projects;
- Assist in inspecting and monitoring environmental compliance by ensuring that licensing terms and conditions are met, including those specified by REMA.

Water extraction use is managed under the Rwanda water board which is under the ministry. Further to this MoE guides sustainable environmental management of water resources in the country and their guidelines on the same will be consulted in the implementation of the project

3.2.4 Rwanda Environment Management Authority (REMA)

REMA was established in 2004 to act as the implementation agency of environment related policies and laws in Rwanda. Under supervision of the Ministry of Natural Resources, from the Law n°63/2013 of 27/08/2013 determining the mission, organization and functioning of REMA, it has the legal mandate for national environmental protection, conservation, promotion and overall management, including advisory to the government on all matters pertinent to the environment and climate change. Key responsibilities of REMA are as follows:

- Advise the Government on policies, strategies and legislation related to the management of the environment as well as the implementation of environment related international conventions, whenever deemed necessary;
- Conduct thorough inspection of environmental management in order to prepare a report on the status of environment in Rwanda that shall be published every two (2) years;
- Put in place measures designed to prevent climate change and cope with its impacts;
- Conduct studies, research, investigations and other relevant activities in the field of environment and publish the findings;
- Closely monitor and assess development programs to ensure compliance with the laws on environment during their preparation and implementation;
- Participate in the preparation of activities strategies designed to prevent risks and other phenomena which may cause environmental degradation and propose remedial measures;
- Provide, where it is necessary, advice and technical support to individuals or entities engaged in natural resources management and environmental conservation;
- Prepare, publish and disseminate education materials relating to guidelines and laws relating to environmental management and protection and reduce environmental degradation risks;
- Monitor and supervise impact assessment, environmental audit, strategic environmental assessment and any other environmental study. REMA may authorize in writing, any other person to analyze and approve these studies. The ESIA review has been delegated to Rwanda Development Board.

REMA as the Environmental Authority has the mandate to conduct environmental monitoring to make sure the recommendations of the Environment and Social Impact Assessment study and proposed mitigation measures.

3.2.5 Rwanda Water Resources Board (RWB)

Rwanda Water Resources Board (RWB) is established by the law N° 71/2019 of 29/01/2020 with the mission of ensuring the availability of enough and well managed water resources for sustainable development. RWB has the following objectives:

- To implement national policies, laws and strategies related to water resources;
- To establish water storage infrastructure;
- To establish water resources allocation plans;
- To establish water resources quality and quantity preservation strategies;
- To control and enforce water resources use efficiency;

- To examine the preparation of roads, bridges, dams and settlements designs in order to ensure flood mitigation and water storage standards;

The project will need to abstract water for this project, therefore the institution is relevant authorization that would be required for using water resources when necessary and Ensure that all the project activities adhere to the RWB requirement, they will also be required to ensure sustainable use and protection of water resources in the project area

3.2.6 Rwanda Land Management and Use Authority (RLMUA)

RLMUA is responsible for putting in place and operationalizing an efficient system of land administration, use and management that secures land ownership, promotes investment in land for socio-economic development and poverty reduction. Responsibilities of RLMUA are

- Put in place mechanisms which procure security of land tenure for the promotion of investments in land.
- Promote proper allocation of land, and proper use of land resources, according to their potential.
- Avoid the splitting up of plots, and to promote their regrouping in order to bring about optimum production.
- Establish of mechanisms which facilitate an optimum exploitation of land, targeting the social-economic development of the country.
- Orient land management towards a more profitable and sustainable production, by making good choices among methods of land development.
- Develop methods that protects land resources from various types of land degradation.
- Establish institutional frameworks which enable land to become more valuable in the economy or at the market.
- Promote research as well as the education of the public on all aspects concerning land tenure, management, and transactions.
- Establish order and discipline in the allocation of land, as well as in land transactions in order to control the pressure on land, inappropriate development, speculation and trafficking of land.

This institution has the mandate to monitor all the activities done on land, during project construction, there will be land management issues and this institution will manage such issues, Land registration and land use planning throughout the country, Compensation and resettlement will depend on legal ownership.

The RLMUA manages all land related issues in Rwanda, this institution will play the same role to this project.

3.2.7 Rwanda Development Board (RDB)

RDB was created by Organic Law N° 53/2008 of 02/09/2008. It has a mission of improving the well-being of all Rwandans by fast-tracking development, catalyzing sustainable economic growth, and creating prosperity for all. This a one stop institution bringing together several government bodies in Rwanda focused at promoting investment in Rwanda. Initially the responsibility for reviewing and approving ESIA reports was entrusted to REMA, this duty has now been transferred to the newly created Rwanda Development Board (RDB) where a department of ESIA has been created and tasked with review and approvals of all ESIA reports for proposed projects and programmes before they are approved for implementation. The Key responsibility of ESIA department under One Stop center in RDB is to:

- Receive and register ESIA Applications (Project Briefs) submitted by developers;
- Identify relevant Lead Agencies to review Project Briefs and provide necessary input during screening,
- Review Project Briefs and determine project classification at screening stage,
- Transmit Project Briefs to relevant Lead Agencies and concerned Local Governments to provide input on Terms of Reference (ToR),
- Publicize Project Briefs and collect public comments during development of ToR,
- Receive ESIA documents submitted by a developer and verify that they are complete,
- Transmit copy of ESIA Reports to relevant Lead Agencies, Local Governments and Communities to review and make comments,
- Review ESIA reports and make decision on approval, organize and conduct public hearings, appoint an officer from Authority to chair public hearings, receive public comments and compile public hearing reports,
- Appoint the Technical Committee and its representative to the Technical Committee,
- Forward ESIA Documents (ESIA Report, Environment Monitoring Plan and Public Hearing Report) to the Technical Committee,
- Chair the Executive Committee which makes final decision on approval of a project,
- Communicate decision on whether or not a proposed project is approved,
- Issue to developers ESIA Certificate of Authorization if their projects are approved

The Institution helps to make sure all environment related issues are addresses well before any activity is carried out. RDB will review the ESIA report and make decision and therefore Issue an environmental clearance certificate.

3.2.8 Rwanda Utility Regulatory Authority (RURA)

Rwanda Utilities Regulatory Authority (RURA) was initially created by the Law n° 39/2001 of 13 September 2001 with the mission to regulate certain public Utilities, namely: telecommunications network and/or Telecommunications services, electricity, water, removal of waste products from residential or business premises, extraction and distribution of gas and transport of goods and persons. This Law was further reviewed and replaced by Law Nº 09/2013 of 01/03/2013 establishing Rwanda Utilities Regulatory Authority (RURA) and determining its mission, powers, organization and functioning. This Law gives to RURA the mandate to regulate:

- Telecommunications, information technology, broadcasting and converging electronic technologies including the internet and any other audiovisual information and communication technology;
- Postal services;
- Renewable and non-renewable energy, industrial gases, pipelines and storage facilities;
- Water supply including tariffs;
- Sanitation;
- Transport of persons and goods; and
- Other public utilities, if deemed necessary

RURA is required to set the tariff for sanitation services, receive and respond to government complaints to facilitate dispute resolutions and advise the government on issues relating to sanitation.

3.2.9 Local Governments

Generally, decentralized entities are responsible for the implementation of laws, policies, strategies, objectives and programmes relating to protection, conservation and promotion of the environment in Rwanda. Article 61 of environmental law state that in the framework of conservation and protection of the environment, decentralized entities are particularly responsible for:

- ensuring activities related to better management of land, especially controlling soil erosion and tap rain water;
- Afforestation, protection and proper management of forests;
- efficient management of rivers, lakes, sources of water and underground water;
- efficient management and effective use of swamps;
- Protection and proper management of reserved areas, historical sites, endangered animal and plant species.

- Under the General Guidelines and Procedure for ESIA Local Governments in this case Gicumbi Gicumbi District and its respective sectors are tasked to perform the following functions:
  - ✓ At the request of RDB, review Project Briefs so as to advise on Terms of Reference,
  - ✓ Provide information or advice to developers and ESIA Experts when consulted during ESIA process,
  - ✓ At the request of RDB, review ESIA reports and provide comments to RDB,
  - ✓ Assist RDB in organizing public hearings,
  - ✓ Host public hearings,
  - ✓ Host individual consultations,
  - ✓ Gather written comments from public and transmit them to RDB.
  - ✓ Facilitate the land acquisition process through land bureau office;
  - ✓ Plan and complaints resolutions.

The district will act as the recipient of the project and as a result, they will be following up on all the projects and monitoring the progress. It is envisaged that District Land Bureaus (DLBs) will be involved in ARAP implementation as they are expected to be the executive bodies responsible for ensuring activities undertaken comply with National and District Level Land Use Master Plans.

3.3. Relevant policies for the proposed project

Environmental policies cut across all sectors and government departments and as such policy formulation should be consultative steered by interdisciplinary committees and also the policies that relates to environment are found in various government policy documents. The policies that relate and have an impact to this project include:

3.3.1 National Environment and Climate Change Policy, 2019

The main objective of the National Environment and Climate Change Policy is to make Rwanda a nation that has a clean and healthy environment, resilient to climate variability and change that supports a high quality of life for its society. The Environment and Climate Change Policy was approved by the Cabinet on 7 June 2019, and is a revised version of a previous policy which was introduced in 2003. The updated policy contains a number of new provisions to better align it with Rwanda's overarching medium-term National Strategy for Transformation, long-term Vision 2050 as well as multilateral commitments including the EAC Vision 2050, African Union Agenda 2063 and the Sustainable Development Goals. The Paris Agreement on Climate Change and the Kigali Amendment to the Montreal Protocol are also considered in the new policy.

The policy will ensure Rwanda has a clean and healthy environment that is resilient to climate variability and supports a high quality of life for all who call the country home. The implementation of the policy will be guided by the spirit of inclusiveness, economic and ecosystem value, adaptation and cooperation.

The main policy objectives are:

- Greening economic transformation
- Enhancing functional natural ecosystems and managing biosafety
- Strengthening meteorological and early warning services
- Promote climate change adaptation, mitigation and response
- Improve environmental well-being for Rwandans
- Strengthen environment and climate change governance
- Promoting green foreign and domestic direct investment and other capital inflows

Implementation of this policy affects the Water distribution network, land zoning, apportioning of different land uses, Utilization and conservation of natural resources, Pollutions which all have an impact on the proposed water collection treatment and distribution for the Mwangi Water Supply. The project will comply with this policy by ensuring the project implementation is keeping the standard of a healthy environment and climate change resilience.

3.3.2 National Biodiversity Strategy (NBS) 2015

The revised and updated Rwanda National Biodiversity Strategy (NBS) of 2015 has a long-term vision which is in line with the Convention on Biological Diversity (CBD) strategic plan to 2020 and states that: "by 2040, national biodiversity be restored and conserved, contributing to economic prosperity and human well-being through delivering benefits essential for Rwandan society in general." NBS as a 'living document', responsive, flexible and practical, including biodiversity conservation in economic decisions and turn it into a driver for national development. Relevant economic development sectors such as agriculture and animal resources, fisheries, forestry, mining and infrastructures will incorporate biodiversity conservation activities into their planning systems as well as in the annual budgets of upcoming years.

The project will adhere to this policy through ensuring that it does conserve biodiversity

3.3.3 Integrated Water Resources Management Policy (IWRMP) 2011

The National Policy for Water Resources Management (2011) is the latest development in

Government's consistent and continuous efforts to strengthen the water resources management sub-sector. It replaces the 2004 policy whose revision became indispensable due to its ill-alignment with the Water Law No. 62/2008, which embraced many modern and cutting-edge principles of sustainable water resources.

Additionally, the government has been introducing reforms in the water sector that have significantly changed the context for water resources management and rendered the 2004 policy out of date. With the promulgation of a law establishing the Rwanda Water and Forestry Authority (RWFA) with the mandate to lead the management of water resources across sectors, there is potential to achieve a coordinated approach to water resources management, in line with the integrated water resources management concept. In other to address the capacity limitations being faced by the sector, it will require concerted efforts in resource mobilization, human resource development and institutional capacity building.

3.3.4 National Land Policy, 2019

The National land policy was adopted in June 2019. This policy comes at a very important stage when Rwanda is embarking into a shift towards becoming an upper-middle income country by 2035 and a high-income country by 2050. In this respect, the country has already designed its National Strategy for Transformation (NST1) that will serve as the implementation plan and strategy for the remainder of Vision 2020 (2019-2020) and the first four years (2021-2024) of the Vision 2050. This revised land policy builds on the achievements of the 2004 land policy and ensures continuity of the unfinished agenda in different land thematic areas such as land use planning, land use management and land administration. The 2004 land policy focused mainly on land administration (e.g. Land law reform, securing land rights and tenure, administration of land fees and taxes, land registration and decentralization of land services), but left important gaps on new emerging issues related to efficient land management for sustainable development.

The land-based transport is planned to be done systematically and in accordance with the national land use master plan which also advocates for the development of a high density and mixed-use integrated land-use. A well-organized masterplan is also a tool of avoiding unprecedented levels of urban sprawl and any other form of misusing land resources.

The Land Policy is relevant to the Master Plan, given that the proposed infrastructure will need land and hence may change land tenure and may requires expropriation. Further, the project should be aligned with other land use master Plans.

The land policy plays a critical role in guiding the planning process this project since land will be utilized for the good of the project. And also there will be some relocation and expropriation of land

users at various points especially where the Water treatment works and storage units will be located.

3.3.5 Urbanization Policy, 2015

Approved in 2015, the National Urbanization Policy addresses all aspects of cross-sectoral action in urban development and governance. Rwanda guides urbanization in a way to efficiently use and manage its natural resources while promoting sustainable development, reinforce its system of urban areas and human settlements for local economic development based on local potentialities and inter-linkages, promote densification for cost effective public investment and infrastructure service delivery, and to reserve for agricultural production, open space and conservation of the environment, and plan for the needs of transportation, housing, culture, recreation, utilities, waste management, information and telecommunication, commercial and industrial development in response to macro-economic strategies and citizens views.

The overall intent of the policy is to create the conditions for well-managed growth generating vibrant urban environments and sustainable economic development. Rwanda's urban agenda encourages multi-institutional cooperation, for the development of safe public space, quality education, medical and transport facilities, and a friendly city ambiance offering public services and infrastructure. As part of this vision, the government seeks to prevent unplanned growth in support of the urban development system and an increasing quality of life.

3.3.6 Sanitation Policy, 2016

National Sanitation policy approved in 2016 outlines initiatives to overcome challenges and exploit existing opportunities in an integrated manner, and will effectively contribute towards achieving the goals of the National Development Agenda. The policy aims at ensuring expanded access to safe and sustainable sanitation services through a number of means including: establishing District sanitation centres providing a wide range of sanitation technologies; improving operation and maintenance of sanitation facilities; and assisting Gicumbi District and the City of Kigali to plan and design projects to mitigate urban storm water issues. Specific objectives of the sanitation policy are:

- Raise and sustain household sanitation coverage to 100% by 2020;
- Implement improved sanitation for schools, health facilities and other public institutions and locations;
- Develop safe, well-regulated and affordable off-site sanitation services for densely populated areas;

- Enhance storm water management in urban areas to mitigate impacts on properties, infrastructure, human health and the environment;
- Implement integrated solid waste management;
- Ensure safe management of e-waste, industrial waste, nuclear/radioactive waste and health-care waste;
- Develop the sanitation sub-sector's institutional and capacity-building framework.

Waste management services requires land to be provided for and this has to be taken into account while planning especially taking into account that there are plans to develop sanitation and water treatments sites for the secondary cities and other emerging centers.

3.3.7 National Water Supply Policy, 2016

National Water supply policy approved in 2016 outlines initiatives to overcome challenges and exploit existing opportunities in an integrated manner, and will effectively contribute towards achieving the goals of the National Development Agenda. The policy will ensure increased sustainability and access to safe and clean water through improving operations and maintenance of existing water supply infrastructure and providing new water facilities.
The policy has the following specific objectives:

- Raise rural water supply access to 100% by fast-tracking implementation of a strategic investment programme;
- Ensure sustainable functionality of rural water supply infrastructure by strengthening operation and maintenance management arrangements;
- Ensure safe, reliable and affordable urban water supply services for all while striving for financial sustainability;
- Ensure safe and reliable water supply services for schools, health facilities and other public places;
- Strengthen and consolidate the sector's institutional, legal and capacity building framework and;
- Provide Policy directions on cross-cutting issues.

3.3.8 Rwanda Employment Policy 2019

The National Employment Policy is a guiding document for the implementation of other policies in which some of the interventions have interfaces in promoting employment and income generating opportunities for Rwandans. Since the adoption of National Employment Policy in 2007, progress was registered in areas such as skills development, entrepreneurship promotion,

improvement of the business climate and access to finance for small and medium enterprises, among others.

The new policy will contribute to enhancing the coherence and impact of initiatives of a variety of institutional actors and stakeholders. In addition, it ensures that the priorities identified in 7-Year Government Programme and National Strategy for Transformation are effectively addressed.

This project plays a role in reduction of unemployment and developments of skills through the employments of over 150 persons during the construction and 75 during the operation.

3.3.9 National Occupational Safety and Health Strategy, 2019

This strategy aims at providing a framework for coordination of OSH activities among public, private, employee's organizations and civil society institutions. This policy will govern implementation of WASAC activities by establishing safety and health standards at workplace and ensure compliance with occupational safety and health standards. Contactor's policy is that all employee will be well equipped mean that contactor is committed to provide the accommodation houses, PPEs, first aids and insurance to the workers and staff.

The Strategy aims to lift the national workplace safety and health performance and directly supports other Government's development strategies and programs and its implementation and adherence by this project will support in its fulfilment

3.3.10 Vision 2050

Much advancement has been enrolled toward the present Vision 2020, subsequently clearing path for Vision 2050. Vision 2050 is about ensuring high standards of living for all Rwandans. The blueprint has elaborated in five main pillars; Quality of Life; Modern Infrastructure and livelihoods; Transformation for prosperity, Values for Vision 2050; and International cooperation and positioning. Among those five main pillars, one for Quality-of-life expected standards that for all Rwandans. Vision 2050 aspirations focuses on five broad priorities:

- High Quality and Standards of Life
- Developing Modern Infrastructure and Livelihoods
- Transformation for Prosperity
- Values for Vision 2050
- International cooperation and positioning

Regarding the Quality of Life, expected standards for all Rwandans: are: (i) Environmentally friendly and climate resilient surroundings, and (ii) Sustained national security.

Concerning Modern Infrastructure and livelihoods expectations are: (i) Modern and SMART cities (optimal space utilization, connected cities, broadband, internet of things); (ii) Green/Eco-friendly cities and neighborhoods; e.g. powered by renewable energy, recycling, etc.); (iii) SMART towns and rural settlements; (iv) Modern transport facilities and services (efficient public transport, reliable infrastructure); and (v) Efficient public and private services. ***This project focuses on improvement of people's living standards.***

3.3.11 National Strategy for Transformation (NST1/2017-2024)

The National Strategy for Transformation (NST1/2017-2024) which is 7 Government Programme, takes environment and climate change as one of the cross-cutting areas which will be embedded within Sector Strategic Plans and District Development Strategies.

In the area of environment and climate change, Rwanda has made significant progress in environment and climate change mainstreaming, as reported in State of Environment Reports (SEORs, 2009 and 2015). The environment is protected by relevant environmental laws and regulations that are captured under the Environmental Organic Law of 2005, as revised to date, and Climate Change has been addressed and informed by cross sectoral strategies, including the Green Growth and Climate Resilient Strategy (GGCRS) and the Nationally Determined Contributions (NDCs) for climate change mitigation and adaptation.

In this regard, focus will be on improving cross sectoral coordination to ensure smooth implementation of environmental policies and regulations. In this regard, critical sectors identified for strengthening include agriculture, urbanization, infrastructure and land use management. Additional emphasis will be put on strengthening monitoring and evaluation. High impact areas selected include implementation of: Environmental and social Impact Assessments, biodiversity and ecosystem management, pollution and waste management.

The implementation of this project will ensure that the goals and targets of National Strategy for Transformation are meet

3.4 Relevant Laws and guidelines

3.4.1 Constitution of the Republic of Rwanda 2015

In consideration of the Constitution of the Republic of Rwanda of June 4, 2003 and revised in 2015, article 49 states that every citizen is entitled to a healthy and satisfying environment.

Every person has the duty to protect, safeguard and promote the environment. The state shall protect the environment. The law determines the modalities for protecting, safeguarding and promoting the environment.

The Constitution is critical in ensuring the project is carried out without infringing on the rights of the people, by carrying out an EIA which is provided in this report. Further to this *the contractor shall ensure that there will be no pollution to any nearby rivers or groundwater systems. Further to this the constitution will guide Eligibility for compensation ass enshrined under the Rwandan constitution (article 29). As per the constitution WASAC and related government agencies have a legal mandate to develop the country and will ensure that the project affected persons and the sanity of the constitutional requirements are safeguarded*

3.4.2 Law n°48/2018 of 13/08/2018 on Environment

The Law on Environment Protection sets the modalities for protection, conservation and promotion of the environment in Rwanda. The law gives right to every natural or legal person in Rwanda to live in a healthy and balanced environment while obligating each and every citizen to contribute individually or collectively to safeguard country 's natural, historical and socio-cultural heritage. The framework of the law on the protection and management of natural resources centers on avoiding and reducing the disastrous consequences on environment. It measures result from an environmental evaluation of policies, programs and projects, aimed at preventing the consequences of such activities. It provides for a right to a healthy and productive life in harmony with nature and to equitably meet the needs of the present and future generation in infrastructure development.

The new environmental law approved No 48/2018 of 13/08/2018 determines modalities of protection, conservation and promotion of environment in Rwanda and regulates the Environmental Impact Assessment. Article 33 on Consideration and approval of environmental studies, states that the environmental impact assessment, environmental audit and strategic environmental assessment must be approved by the Authority or another State organ authorized in writing to do so by the Authority. If the approval is made by an authorized organ, such an organ does so on behalf of the Authority which is also responsible for its audit.
Currently the ESIA approval process is done on line via RDB one stop center and is done as follows**:**

- Project proponent /developer request ESIA terms of reference by submission of project brief;
- RDB review the project brief and conduct field visit before issuance of terms of reference;

- Once terms of reference are approved and sent to the project developer, this one is allowed to hire one of the certified experts based on the list approved by Ministry of Natural Resources;
- The hired consultant conducts the ESIA study and submit the ESIA report to the developer and this one sends the report to RDB if is satisfied with the report,

In order to fulfil this the requirements of this law this environmental assessment has been undertaken as per the given guidelines for undertaking ESIA in Rwanda have been adhered to. The project ESIA and implementation of the ESMP is in conformance with this law.

3.4.3 The National Land Law 2018

Land ownership in Rwanda is determined by the Organic law N°48/2018 OF 13/08/2018 determining the use and management of Land in Rwanda. It also institutes the principles that are respected on land legal rights accepted on any land in the country as well as all other appendages whether natural or artificial. This is the law that determines the use and management of land in Rwanda. It also institutes the principles that are to be respected on land legal rights accepted on any land in the country as well as all other appendages whether natural or artificial.

According to the Law, land in Rwanda is categorized into two: individual land and public land. The latter is subdivided into two categories: the state land in public domain and the state land in private domain both of which will be used in the implementation of this project. Under this law and relevant to this study are the definitions given to:

- *Land tenure* as the system by which land is held, describing the rights, responsibilities and restrictions that are attached to the land holder.
- *Expropriation:* an act of taking away individuals' land by the State due to public interest in circumstances and procedures provided by law and subject to fair and prior compensation.

- **Article 4** of the law allows any person or association with legal personality has the right over the land and to freely exploit it as provided for by this organic law in article 5 and 6.

- The ownership of Land is determined by article 4, which announces that, any person or association with legal personality has the right over the land and to freely exploit it as provided for by this organic law in article 5 and 6.
- **Article 5** states that any person or association with legal personality that owns land either through custom, or who acquired it from competent authorities or who purchased

it are allowed to own it on long term lease in conformity with provisions of this organic law.

Land use for the project will be guided and respect this law. The Mwange water supply project will utilize land (for various activities namely water storage and water distribution) and its use will be guided by the policy where, this is especially if they could be and take for the proposed projects.

3.4.4 Organic law n° 32/2015 of 11/06/2015 law relating to expropriation in the public interest

The Expropriation Law provides for public dissemination on the importance of the project to be established and the need for expropriation. This Law determines the procedures relating to expropriation of land in the interest of the public. The law stipulates that the government has the authority to carry out expropriation. However, the project, at any level, which intends to carry out acts of expropriation in public interest, shall provide funds for inventory of assets of the person to be expropriated. According to the organic law, no person shall hinder the implementation of the program of expropriation on pretext of self-centered justifications and no land owner shall oppose any underground or surface activity carried out on his or her land with an aim of public interest. In case it causes any loss to him or her, he or she shall receive just compensation for it.

- Article 3 stipulates that it is only the Government that shall order expropriation in the public interest, and must be done with prior and fair compensation. The law also bars anybody from interfering of stopping expropriation —on pretext of self-centered interests. Accordingly, Article 3 provides for any underground or surface activity carried out with in public interest on any land but with due and fair compensation to the land owner.
- Article 4 requires that any project, at any level, which intends to carry out acts of expropriation in the public interest, must budget and provide funding for valuation of the property of the person to be expropriated and for fair compensation.
- Article 12 of the Expropriation Law stipulates that the relevant Land Committee, after receiving the request for expropriation, shall examine the basis of that project proposal. In case it approves the basis of the project proposal, the relevant Land Committee shall request, in writing, the District authorities concerned to convene a consultative meeting of the population where the land is located, at least within a period of thirty (30) days after receipt of the application for expropriation, and indicating the date, time and the venue where the meeting is to be held. The relevant Land Committee shall take a decision

within a period of at least fifteen (15) days after the consultative meeting with the population.

The project will undertake a RAP study to cover this and the government will compensate the Project affected Person (PAP) with the assistance of the District and ensure that this law has been implemented and communities to be implanted during the project life Compensation for land uptake will be necessary for sites acquired to construct water storage units, the water treatment works and pipelines works. The compensation will be guided by this law.

3.4.5 Law Regulating Labour in Rwanda, 2018

This N° 66/2018 of 30/08/2018 regulating labour in Rwanda applies employment relations based on employment contract, apprentices, interns, self-employed person, informal sector, occupational health and safety and the right to from trade unions and employers' associations. In its article 6 state that it is prohibited to subject a child below the age of eighteen (18) years to any of the following forms of work:

- Forms of work which are physically harmful to the child;
- Work with dangerous machinery, equipment and tools, or which involves the manual handling or transport of heavy loads;
- Work in an environment which exposes the child to temperatures, noise levels or vibrations damaging to his/her health

Furthermore, Article 8: state that Sexual harassment in any form against supervisee is prohibited. All forms of discrimination will be avoided during recruitment of workers. Campaign about Sexual harassment, GBV, Child abuse and AIDS are the most topic of awareness during project implementation.

This project plays a big role in the promotion of employment and the employments will be guided by this Labour law. Further to this the contractor shall adhere to all Sections of the Act as they relate to this project, such as observing safety guidelines, provision of protective clothing, clean water, and insurance cover are observed so as to protect all from work related injuries or other health hazards. Further to this during the implementation the contractor and the project proponent will observe the OHS act to mitigate on the negative environmental health and safety to the public. Therefore, the requirements of this law have to be adhered too in the employment of staff during the development and construction of the Mwange Water supply infrastructure

3.4.6 LAW N°49/2018 of 13/08/2018: Determining the use and Management of Water Resources in Rwanda

This Law shall provide for the application and management of water resources in accordance with the following principles:

- 1°the principle of precaution aiming at preventing serious and irreversible risks for water resources, by the adoption of the efficient measures;
- 2° the principle of prevention of the pollution, with priority to the source;
- 3°the principles "user-payer and polluter-payer" according to which the user of water and the polluter support a significant part of expenses resulting from measures of prevention, of pollution reduction and restoration of the resource in quality and in quantity. The project will respect the delimitations of the 10- or 50-meter distance on watercourse and also respect the Wetlands use which may be on the way.

The extraction of the water, its use and distribution will respect the element of conservation and be guided by this law. Further to this the contractor shall ensure that there will be no pollution to any nearby rivers or groundwater systems during the implementation of this project.

3.4.7 Law N° 13/2014 of 20/05/2014 on mining and quarry operations

Mining and quarry exploitation laws provide the process of acquiring quarries for mining activities, the licensing process and the environmental consideration in exploiting a quarry. Nevertheless, the quarry component will be conducted by a contractor who will be required to fully respect strictly the process. Actually, an EIA Certificate will be required for each quarry to be exploited in the framework of this project.

The provisions of this Act will be applied by the proponent in the management of the project where the contractor will be required to adhere to the provisions of these regulation while sourcing for various raw materials.

3.4.8 LAW No37/2016 OF 08/09/2016: Determining Organization, Jurisdiction, Competence and Functioning of an Abunzi Committee

This Law determines the organization, jurisdiction, competence and functioning of Abunzi Committee, which are established at a cell level with jurisdiction over the Cell and Abunzi Committee of appeal at the Sector level with jurisdiction over the Sector is also established. Abunzi Committee competent to determine a dispute involving land property located in different territorial jurisdictions

The law guides on the organization, jurisdiction, competence and functioning of the Committees. Committees will be formed at the local level to solve any disputes that may arise from land disputes of various project.

3.5 Ministerial orders

They are various ministerial orders that will guide the implementation of this project as indicated below and summarized in table 3 below

Table 18: Ministerial orders relating to this project

Ministerial Orders	Outline/Objectives	Impact to the Project
Ministerial order No 001/ 2019 of 15/04/2019: Ministerial Order establishing the list of projects that must undergo environmental impact assessment, instructions, requirements and procedures to conduct environmental impact assessment.	This outlines the key Projects that need to undergo EIA before their implementation. This Order establishes: - 1° the list of projects that must undergo an environmental impact assessment before they obtain authorization for their implementation; - 2° instructions, requirements and procedures for conducting environmental impact assessment.	The projects that are being undertaken i.e., Waters projects all are required to have an approved EIA and this need to be undertaken in the way that as subscribed in the Law. This EIA conforms to this requirement
Ministerial order of 2008 relating to the requirements and procedure for environmental impact assessment	This gives the guidelines for undertaking EIA. Article 1 stipulates that Environmental Impact study is a systematic way of identifying environmental, social and economic impacts of a project before a decision of its acceptance is made.	The EIA has been undertaken as per the guidelines provided by this order.

Ministerial Orders	Outline/Objectives	Impact to the Project
Ministerial order n°004/minifom/2010 Of 14/09/2010 determining the Modalities of environment Conservation in mining and Quarry extraction	This Order determines the modalities of environment conservation applicable to mining and quarry extraction activities.	The contractors will ensure that they source their materials from quarries that meet this order requirements
N°003/16.01 of 15/07/2010 Ministerial Order preventing activities that pollute the atmosphere	This Order helps to show and ways of prevention activities that can pollute the atmosphere.	The Modalities of Preventing Air Pollution that have issued should be considered while undertaking the implementation of this project
MINISTERIAL ORDER N° 04/Cab.M/015 OF 18/05/2015 determining urban planning and building regulations	This Order determines urban planning and building regulations in Rwanda	The requirements of this order will be meet and be used in the planning of the various development that will emanate from this feasibility study
N° 007/2008 of 15/08/2008 Ministerial Order establishing the list of protected animal and plant species.	This covers the distance which have to be respected prior to implementation of the project.	Where they are any waterways this will be the key guide of what this will be and cover.
(Ministerial Order N° 001/2006 of 26/09/2006 determining the structure of Land	The Office prepares an annual budget that together with the budgets of the other units of the National Land Centre is consolidated into an overall	In case of any land takes for the proposed project will take this regulation to account.

Ministerial Orders	Outline/Objectives	Impact to the Project
Registers, the responsibilities and the functioning of the District Land Bureau).	budget for the land center to be defended by the Ministry having Lands in its attributions. Auditing of the office finances, as provided for in its budget, is carried out in conformity with the regulations governing management of State Finances.	
Ministerial order No. 002/16.01., determining the reference land price outside Kigali city.	This Order determines the modalities of land sharing and repayments for any land take	The PAPs if any will be compensated for their properties.
N° 005/19.20 of 17/03/2020 Ministerial Order determining modalities for the implementation of working hours a week in the private secto	This Order determines the modalities for the implementation of working hours in a week in the private sector	The contractor has to follow this guideline for working hours during the project implementation
Ministerial Order determining modalities of establishing and functioning of occupational health and safety committees: N°01 of 17/05/2012.	This Order determines modalities of establishing and functioning of occupational health and safety committees	This will ensure that Occupational health is observed at the work places as the developer will employ a specialist in charge of health and safety, and provide PPE at the site.

Ministerial Orders	Outline/Objectives	Impact to the Project
Ministerial Order determining conditions for occupational health and safety N°02 of 17/05/2012.	This Order determines the general and specific rules and regulations relating to health and safety at workplace in order to secure the safety, health and welfare of persons at work and protect them against risks to safety and health arising from work. It also determines the types of works prohibited for pregnant or breastfeeding women.	The impact of this Order to the project is that all activities around the project premises will follow all the guidelines concerning Occupational health and Safety rules.
Rwanda Building Code – 2019	The provisions of this Code shall apply to site planning, building site operations, materials selection, construction, alteration, movement, enlargement, replacement, repair, equipment, use and occupancy, maintenance, removal and demolition of any building or structure or any appurtenances connected or attached to such buildings or structures in Rwanda	The project will have various infrastructural developments and related facilities will have their developments and designs will be guided by these requirements.

Table 1 Ministerial Orders relevant to this project

3.6. African Development Bank Safeguard Standards

African Development Bank (AfDB) Integrated Safeguard Standards (ISS) to be followed by borrowers in projects financed by the Bank. The ISS are aimed at fostering development in a socially inclusive and environmentally sustainable manner. The safeguards standards are a tool for identifying risks, lowering development costs and improving project sustainability, thus

benefiting affected communities and helping to preserve the environment. The safeguards objectives are as follows:

- Avoid adverse impacts of projects on the environment and affected people, while maximizing potential development benefits to the extent possible,
- Minimize, mitigate, and/ or compensate for adverse impacts on the environment and affected people when avoidance is not possible, and
- Help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

To meet the above-mentioned objectives, the AfDB ensures that development projects it finances comply with the operation safeguard standards:

Operational Safeguard 1: Environmental and social assessment: This overarching safeguard governs the process of determining a project's environmental and social category and the resulting environmental and social assessment requirements. This project falls under category 2 projects that need to carry out ESIA and RAP.

Operational Safeguard 2: Involuntary resettlement land acquisition, population displacement and compensation – This safeguard consolidates the policy commitments and requirements set out in the Bank's policy on involuntary resettlement and incorporates a number of refinements designed to improve the operational effectiveness of those requirements. To comply with this operational safeguard, the project ensured people in the project area will not be physically displaced. This will be achieved by utilizing unoccupied public land spaces such as hills for water reservoirs. In instances where private owned land is required, only bare land will be utilized. The land being uesd for farming, only part of the land will be acquired. The land acquisition and compensation will be negotiated through PAPs engagement, and then compensated for. To that effect, the project developed a Resettlement Action Plan (RAP) to guide in compensation and mitigating losses that will occur due to project implementation

Operational Safeguard 3: Biodiversity and ecosystem services – This safeguard aims to conserve biological diversity and promote the sustainable use of natural resources. It also translates the commitments in the Bank's policy on integrated water resources management into operational requirements. To comply with this safeguard, the project conducted an ESIA for this project which has assessed impact on project on biodiversity and ecosystems. The ESMP outlined mitigation measures to be implemented to ensure that the project activities do not have severe impact on biodiversity and ecosystems.

Operational Safeguard 4: Pollution prevention and control, hazardous materials and resource efficiency – This safeguard covers the range of key impacts of pollution, waste, and hazardous materials for which there are agreed international conventions, as well as comprehensive

industry-specific and regional standards, including greenhouse gas accounting, that other multilateral development banks follow.

The project will ensure that the design promotes efficient resource utilization and pollution prevention techniques. To enhance compliance to the operational safeguard, the project will develop subsidiary pollution control and prevention plan to enhance the developed project ESMP to meet the safeguard standard.

Operational Safeguard 5: Labour conditions, health and safety – This safeguard establishes the AfDB's requirements for its borrowers or clients concerning workers' conditions, rights and protection from abuse or exploitation. It also ensures greater harmonization with most other multilateral development banks

Labour conditions, health and safety are very critical to implementation of the project in construction and operation phase.

To comply with the safeguard, the project shall ensure that all contractors to be engaged on the project register and are certified by the authority. The project will ensure gender balance when recruiting employees, no discrimination at work place and equal salary and wages for equal work. The project will also ensure no sexual exploitation and harassment at work place by developing Sexual Exploitation, Abuse and Harassment (SEA/SH) Management Plan. Similarly, the project will ensure health and safety of workers is adequately complied through training of workers, provision of Personal Protective Equipment (PPEs). To proactively prepare, the project has developed Health and Safety Management Plan to ensure compliance to this safeguard.

3.7 International Agreements

Rwanda is party to various international environmental and social development agreements that advocate for environmental conservation and better working conditions. The table below presents the relevant international environmental and social development agreements to which Rwanda is a party. Rwanda is also signatory to a range of International Labour Organization (ILO) fundamental (and other) conventions, which are summarized in the Table below

Table19: International Environmental Agreements Relevant to Rwanda

Theme	Convention and Objective	Summary
Biodiversity	International Plant Protection Convention - new revised text approved by Resolution 12/97 of the 29th Session of the FAO Conference in November 1997 – Declaration	To prevent the spread and introduction of pests of plants and plant products and to promote measures for their control.

Theme	Convention and Objective	Summary
	The international Convention on Biological diversity and its habitat signed in Rio de Janeiro in Brazil on 5 June 1992, as approved by Presidential Order No 017/01 of 18 March 1995;	To ensure the conservation of biological diversity; the sustainable use of its components and the fair and equitable sharing of the benefits
	Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), 1983, Bonn, West Germany	To protect migratory species of wild animals and their habitat.
	Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), 1975, Geneva, Switzerland.	To ensure that international trade in specimens of wild animals and plants does not threaten their survival.
Climate Change	Kyoto Protocol to the United Nations Framework Convention on Climate Change, 1992, New York, USA as authorized to be ratified by Law No 36/2003 of December 2003	To reduce or limit the emission of gases contributing to the "greenhouse effect" and causing climate change in the industrialized countries.
	United Nations Framework Convention on Climate Change (UNFCCC), 1992, Rio de Janeiro, Brazil	To achieve stabilization of greenhouse gas concentrations.
	The Paris climate change agreement-UNFCCC, 2015, Paris, France as authorized to be ratified by Law No 36/2003 of December 2003 16 February 2005	Its goal is to limit global warming to below 2, preferably to 1.5 degree Celsius, compared to pre-industrial levels.
Cultural Heritage	UNESCO Convention concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention), 1972, Geneva, Switzerland	To ensure that effective and active measures are taken to ensure protection, conservation and presentation of the “cultural and natural heritage" on its territories.

Theme	Convention and Objective	Summary
	UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage, 2003, Paris, France	To safeguard and ensure respect for the world's Intangible Cultural Heritage, including raising awareness of the importance of intangible heritage and encouraging international cooperation and assistance.
Waste Management	Basel Convention on the control of trans boundary movements of hazardous wastes and their disposal, 1989, Basel, Switzerland. approved by Presidential Order No 29/01 of 24 August 2003 approving the membership of Rwanda	To lay down obligations with regard to ensuring that the trans-boundary movement of wastes is reduced to the minimum consistent with the environmentally sound and efficient management of such wastes.
Occupational Health and Safety	ILO Occupational Safety and Health Convention, 1981 (No. 155), Geneva, Switzerland.	This convention sets out basic principles and rights at work in regard to workplace health and safety management.

Table 2 International Agreements for Rwanda

CHAPTER FOUR: PROJECT AREA DESCRIPTION AND BASELINE INFORMATION

4.1 Project Location

Environment is a diversity of things made up of natural and artificial environment. It includes chemical substances, biodiversity as well as socio-economic activities, cultural, aesthetic, and scientific factors likely to have direct or indirect, immediate or long-term effects on the development of an area, biodiversity and on human activities.

This chapter will cover general description of the project area that was identified earlier at the inception stage. Which will give better understanding on the environmental situation in the project premises, and set up the basis for the rest of study components.

4.2 Physical Environment

4.2.1 Project Location and Relief

Gicumbi District is one of 5 Gicumbi District composing the Northern Province of Rwanda. It is located in the East of the province and spreads over 867 km2. It is bordered by Burera district in the North, Nyagatare Rwamagana and Gatsibo in the East, Rwamagana and Gasabo in the South and in the West, it shares the border with Gasabo, Burera and Rulindo Gicumbi District.

The whole District of Gicumbi is characterized by a succession of steep hills giving rise to a multitude of watershed converging, all of them, toward the Nile Basin through Nyabugogo stream and Lake Muhazi. Resulting from the topography, the valleys are narrow and lack real swamp, except in former Mulindi marchland (now-a-days occupied by an industrial plantation of tea) and current Rugezi area (direct water source of Ntaruka hydro-electric power). Such type of topography combined with soil coted Kaolisol gives way to catastrophic erosion process and even, to ravines-gullies and land sliding.

Out of the whole Gicumbi District, the project Mwange Water Supply System targets to provide drinking water to the City of Gicumbi and its immediate rural surrounding area that comprise 4 sectors: Byumba, Kageyo, Rukomo and Nyamiyaga.

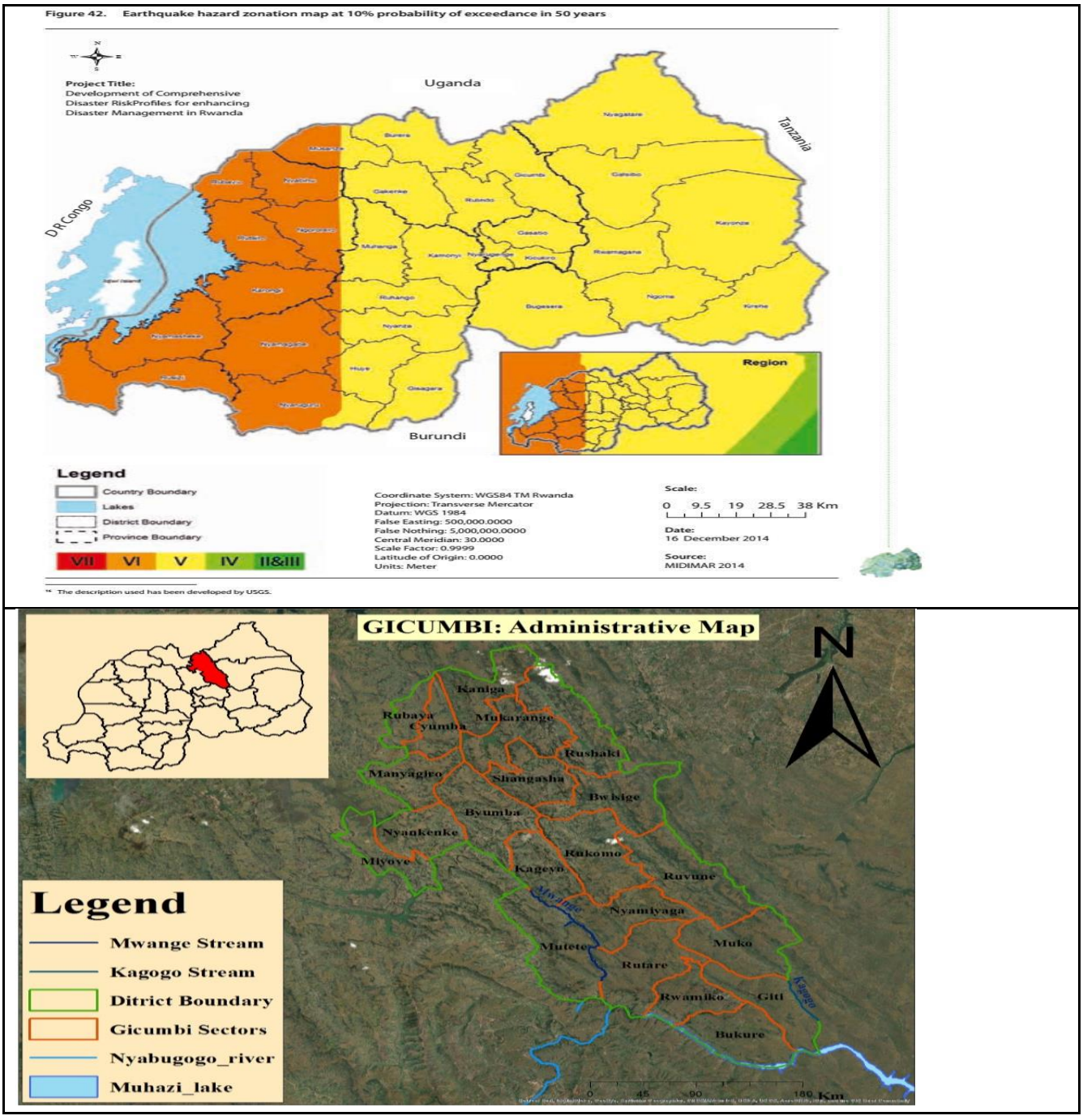


Figure13: Map of Gicumbi District location in Rwanda

The elevation of the study area within those 4 administrative sectors is ranging from 1,454 m to 2,418 m above the sea level. Thus, a particular attention will be paid for the pipeline layout throughout such hilly area and land prone to sliding process.

Figure14: Representative Relief of the Project Localization with Steep Hills Prone to Erosion and Potential Land Sliding

4.2.2 Climate

Gicumbi district has a tropical climate with a rainfall ranging between 1,200 mm and 1,500 mm. With rugged mountain culminating from 1,454 m in the valley at 2,418 m of altitude, the targeted area of Gicumbi district is characterized by a warm and temperate climate. The high altitude of the region permits nevertheless four alternate seasonal climates with 2 rainy periods and 2 dry periods. The first rainy season begins in mid-September to end in mid-December. That slight rainy season is followed by a short dry season extending up to mid-February to give way to a heavy and long rainy season from mid-February to mid-June. The climate year is closed by a long and harsh dry season starting from mid-June to end in mi-September. However, in the targeted area, the dry seasons (short and long) are softened by the altitude while the rainy seasons are exaggerated by the same features. Even though one may note a change in the regularity occurrence of the described seasons, it will be worth launching the project activities at the end of the heavy rainy season in June to benefit for easy works from the two dry seasons even though interrupted by a slight short rainy season in September-December.

4.2.3 Hydrology

From heavy rainfall in the targeted area, it results many torrential streams in the narrow valleys, sometimes cut by rapids and falls suitable for the production of hydro-electrical energy such as on Mwange fall at Rusumo. Thus, the hydrographic network in Gicumbi district is characterized

by the following main stream: Mwange, Kagogo, Mulindi, Muturirwa, Walufu, Muyanza, Gaseke and their tributaries.

However, the nearest streams for the targeted area (Sectors Byumba, Kageyo, Rukomo and Nyamiyaga) are Mwange and Kagogo. The stream Mwange drains into Nyabugogo river while the stream Kagogo drains towards Lake Muhazi. The catchment area of both streams includes the whole Gicumbi District, a small part of Rulindo and Nyagatare Gicumbi District. This means that a lot of alternatives with enough quantity of water are offered for the development of water supply system for Gicumbi City and the surrounding rural area from the existing local streams.

Figure 15: River Mwange, the nearest river of the targeted project area: At the bridge near Mwange village and Rusumo bridge

Groundwater is water that collects or flows beneath the Earth surface, filling the porous spaces in soil, sediments and rocks. It is formed due to rainfalls in the process of infiltration. As the targeted area is rich in quantity of rain, groundwater is abundant and emerges in the form of springs. Therefore, surface aquifers are known as springs. Indeed, that is the emergence of infiltrated rainfalls at the lowest zone of the hill. Some of springs in Gicumbi district have been harnessed and developed to provide drinking water to rural population, such as at Maya hill or at Nyamiyaga foothill.

In the targeted area, the main groundwater/springs are located in the watershed of Nyamabuye Water Treatment Plant where 19 out of 25 springs are already harnessed and connected since 1988 to the main water supply system in Gicumbi town. Other 6 main springs out of 8 located in the vicinity of Yaramba Pumping Station are collected, as well, to supplement Nyamabuye Water

Treatment Plant. In the whole, Gicumbi District is flourishingly provided with that can be harnessed by many other stakeholders for the benefit of rural population.

Figure 16: Spring Harnessing at Maya Hill Foot

Figure 17: Spring harnessing Near Nyamabuye to Supply Nyamabuye WTP

Considering Gicumbi hydrology, two surface water resources suit for water supply in Gicumbi City and the surrounding close rural area, that is: (a) Mwange that originates from Byumba sector and constitutes common border to sectors Kageyo/Mutete, Nyamiyaga/Mutete, Rutare/Mutete and finally flows into Nyabugogo; (b) Kagogo that originates from Nyamiyaga south border with Muko sector to cross through and flows along Giti sector border to pour into

Lake Muhazi. Lake Muhazi is the source of Nyabugogo stream that drains its tributary, Mwange, to Nyabarongo river up to Akagera and Nile Rivers.

4.2.4 Soil & Geology

From granitic rocks, gneiss and schists, the soils of the targeted area are essentially composed of kaolin and laterite. On the textural point of view, the predominant soil has sand content that occupies almost 50% of the project area, followed by clay and then by silt.

Thus, the erosion process, favoured by heavy rainfall, is developed on steep hills to give way to rich and deep clay soils in the swamps and shallow valleys often covered, in some places by sand and silt in form of alluviums and colluviums. However, the soil features vary from an ecological to another according to a lot of environmental factors. This aspect makes a diversity of soils depending on the location, i.e., summit of the hill or progressive lower level up to the valley. Indeed, without any land management process (terraces, trenches, agroforestry), water storms wash away the fertile top soil layers and even induce landslides.

The pipeline layout is to be executed with precaution in such types of soil features.

4.2.5 Water Quality

In Rwanda, drinking water quality is regulated by WASAC and specified in the Rwanda National standards/East African Community Standards for Potable Drinking Water (RS EAS 12: 2018, Third Edition).

According to the project hydrological assessment, there are two potential sources of raw water for Gicumbi Water Supply Project. That is, River Mwange and River Kagogo. For the purpose of water quality monitoring, sample taps are required at the closest point of the future intake. The constituents are normally divided into five groups as follows:

- Bacteriological (microbiological) parameters;
- Chemical parameters directly related to health;
- Chemical parameters indirectly related to health;
- Physical and chemical parameters related to aesthetic and technical effects; and
- Physical and chemical parameters affecting building and pipe materials.

Table 3: Water Quality Results for River Mwange and Kagogo

No	Parameter	Unit	River Mwange	River Kagogo	Standard Requirements
1	Total coliforms	MPN/100 ml	>2,419.6	>2,419.6	ND
2	E. coli	MPN/100 ml	1,800	1,200	ND

3	Shigella	MPN/100 ml	70	50	Absent
4	Salmonella	MPN/100 ml	180	150	Absent
5	Turbidity	NTU	160	63.6	>5
6	Colour	mg/1PtCo	593	352	15
7	Total suspended Solids	mg/l	91	50	ND
	Iron	mg/l	4.53	2.04	0.3
8	Manganese	mg/l	0.642	0.406	0.1
9	Organic matter	mg/l	3.5	3.5	3

Out of 25 analyzed parameters (Total coliforms, E. coli, Shigella, Salmonella, Ph, Turbidity, Colour, Total Suspended Solids, Sulphates, Aluminium, Total hardness, Tca, Calcium, Magnesium, Ammonia Nitrogen, Iron, Manganese, Phosphates, Fluorides, Electrical conductivity, Total dissolved solids/TDS, Chloride, Zinc, Nitrites, Organic Matter), 9 do not comply with Rwanda National Standards/East African Community Standards for Potable Drinking Water.

Therefore, it is obvious that the raw water from either River Mwange or River Kagogo will need a full conventional water treatment before use as drinking water in Gicumbi City and its surrounding rural area.

4.3 Biological Environment.

4.3.1. Vegetation/Flora

The natural ecosystems have disappeared due to the rapid growth of the population that have required much land for crops and habitations. The situation has been aggravated by the lack of planned rural settlement that has resulted in scattered housing destructing natural environment. Thus, out of former natural ecosystems, it remains a few species in project coverage area represented by *Ficus thoningii, Acacia sieberiana, Erythrina abyssinica, Dracaena afromontana* relegated along river embankment or preserved in in crop fields as agroforestry trees. By contrast, new cultivated tree species in the targeted area are abundant, especially *Eucalyptus div species.* There are also, nevertheless in few quantities *Acacia mearnsii, Tilia sp., Grevilea robusta, Leucaena leucocephala, Araucaria sp, Neflier du Japon.* As for cultivated crops, the project area is periodically covered by *Maize, Sorghum, Ipomea batatas, Manihot utilissima, Musa banana, Beans, Théiers*. This situation means that the execution of the project will impact on existing Flora. It will be wise to choose the pipeline network avoiding as much as possible big loss of indigenous species nor big expenses in compensation.

Figure 18: Erythrina Abyssinica on River Mwange Embankment

Figure19: Plantation of Eucalyptus and Théier Near Nyamabuye WTP

4.3.2. Animals/Fauna

- species of reptiles including Vervet monkey *(Chlorocebus pygerythrus)*, Olive baboon *(Papio Anubis)*, African grass rat *(Arvicanthis niloticus)*, The black rat (Rattus rattus) Boehm's bush squirrel (Paraxerus boehmi), etc.
- species of fish including *Amphilius jacksonii Boulenger, Astatoreochromis alluaudi Pellegrin, Clarias liocephalus Boulenger, Labeobarbus acuticeps*, dark stonebasher *(Pollimyrus nigricans),* etc.
- species of a birds including the Black Sparrowhawk *(Accipiter melanoleucus)*, the Sedge Warbler *(Acrocephalus schoenobaenus)*, The Black Crake *(Amaurornis flavirostra)*, African Openbill *(Anastomus lamelligerus)*, etc.
- species of odonates including *Brachythemis leucosticta Burmeister, Orthetrum julia Kirby, Palpopleura portia Drury, Platycypha caligata Selys, Pseudagrion kersteni Gerstaecker.*
- species of amphibians including *Afrixalus quadrivittatus, Amietia nutti, Hyperolius castaneus, Hyperolius cinnamomeoventris, Hyperolius kivuensis, Hyperolius laterali*, etc.

The fauna located in the project area shall be preserved in respect of national b iodiversity policy and legislations and in respect of AfDB's OS3 on Biodiversity and Ecosystem Services

4.4 Socio-Economic

4.4.1 Location and Demography

4.4.1.1 Current Population

According to Ubudehe data from statistical services of Gicumbi Town, the population in these two areas of Gicumbi town is organized in different categories as follow in Table 21 below:

Table21: Number of households in Gicumbi Town in March 2020

No	Sector	Cell	Female Headed HHs	Male Headed HHs	Total
1	BYUMBA	Gacurabwenge	520	1262	1782
		Gisuna	333	956	1289
		Kibali	150	441	591
		Kivugiza	233	517	750
		Murama	218	535	753
		Ngondore	189	493	682
		Nyakabungo	196	423	619
		Nyamabuye	305	750	1055

No	Sector	Cell	Female Headed HHs	Male Headed HHs	Total
		Nyarutarama	492	1271	1763
2	KAGEYO	Gihembe	324	785	1109
		Horezo	210	568	778
		Kabuga	206	540	746
		Muhondo	225	498	723
		Nyamiyaga	385	828	1213
3	RUKOMO	Cyeya	228	751	979
		Cyuru	304	699	1003
		Gisiza	226	662	888
		Kinyami	337	903	1240
		Mabare	285	849	1134
		Munyinya	254	748	1002
4	NYAMIYAGA	Gahumuliza	144	357	501
		Kabeza	229	579	808
		Kabuga	136	420	556
		Kiziba	178	515	693
		Mataba	187	453	640
	TOTAL		**6,494**	**16,803**	**23,297**

(Source: Statistical services of Gicumbi Town)

4.4.1.2 Population Growth Rate Estimation

According to data from Fourth Population and Housing census in Rwanda, National Institute of Statistics has used three different scenarios to estimate population projections at national level since 2012 to 2032 and illustrated that population growth will decrease as follow:

Table22: Population Growth Rate Calculations

No	Scenarios	2015	2020	2025	2030	2031
1	High hypothesis	2.47	2.45	2.40	2.26	2.23
2	Medium hypothesis	2.40	2.31	2.17	1.97	1.92
3	Low hypothesis	2.18	1.89	1.83	1.69	1.66

(**Source**: NISR)

4.4.1.3 Population Projections

For the purpose of water demand estimation in Gicumbi town, the population projections in each sector has been evaluated according to information on population growth rate from Fourth Population and Housing census of Rwanda in 2012 done by NISR.

4.4.2 Agriculture and Livestock Production

4.4.2.1 Agriculture

This sector has occupied 94.8% of population and has contributed nearly 85% of the total produce in the district as illustrated by last District Development Plan (DDP). For Gicumbi town and the surrounding, agriculture is the main source of income for farmers, although there are other activities such as livestock, and to some extent trade and crafts. The practice of farming in Gicumbi is not the responsibility of the town center, with the exception of a few plots around and in the valleys surrounding the town. This is due to the density of buildings that does not leave enough space for this activity.

Agricultural activities are much more experienced in the periphery Gicumbi District and transition areas less densely populated. The urban agriculture in the town of Gicumbi is based on:

The Cash Crops Production

The main cash crops are: wheat and maize. The objective here is to move from subsistence farming to cash crops that can generate an economic surplus for the purchase of equipment, fertilizers or pesticides that can be used to improve labor productivity and yields.

Food Crops

The food crops fields are subsistence to different families. They consist of vast banana plantations mixed with avocado, sweet potatoes, cassava, beans, potatoes, etc. These fields are located near the town. They are threatened by the expansion of the urban planning because their sites are in favour to urbanization: slopes, proximity, etc.

Vegetable Crops

Beside food crops, vegetable crops are experienced, such as tomatoes, peppers, onions, beans and especially vegetable leaves grown in the swamps. Swamps play an exceptional role in the development of agriculture of vegetables. Possibility for intensification exists on these lands with improved agriculture. Up to date this remains archaic techniques, which makes the work of farmers very hard, because everything is handmade with rudimentary tools. It is important to observe an increase in the use of improved seeds by farmers when they are available. Moreover, the work takes place either individually or informal or informal solidarity group.

Working time seems to oscillate between six and eight hours per day. Using an informal casual labor providing employment opportunities for part of the population already installed in town.

Livestock Situation

The urban livestock production in Gicumbi is characterized by the raising of poultry in the concessions and the raising of the ruminants (cow, goats, pork and sheep), inside and to the periphery of the town. The small ruminants are generally locked in the enclosures of the concessions. The raising subsector occupies an important place in the household economy as illustrated by table 7 below:

Table23: Livestock in Gicumbi Town

No	Name of the Sector	No. of cows	No. of pigs	No. of chickens	No. of goats	No. of sheep	No. of rabbit
1	Byumba	3,616	1,243	4,783	2,607	2,630	943
2	Kageyo	4,045	1,254	5,543	2,402	1,459	505
3	Nyamiyaga	4,464	1,752	1,821	2,603	1,638	1,530
4	Rukomo	5,889	813	3,210	3,858	1,055	826
TOTAL		**18,014**	**5,062**	**15,357**	**11,470**	**6,782**	**3,804**

Source: Agriculture Services in Gicumbi Town

4.4.3 Roads and Transport Infrastructure

4.4.3.1 Road Network

The purpose of finding out the road network is to use them for the designed routes for pipelines. Assessing the roads by their widths and the availability of the provisions for the utilities of which water is among will be done. Another critical assessment is whether provisions were made for service ducts where pipelines shall be made to cross from one side of the road to the other.

Another impact aspect is that just like all other towns, Gicumbi town also has a master plan. This will be the basis of route design of the pipelines. Our team shall acquire all the required information to enable us make a design with will be coherent with the physical plan needs. All paved and unpaved roads will be displayed as per the current situation as well as the project which shall be displayed by the master plan.

Another purpose for identification of the roads is the ease with which the different facilities of the water supply systems such as the intake, the treatment plant, the reservoirs and the offices will be accessed. Table **Table 8** below shows the number of roads per sector, their nature and the lengths as per the Integrated household living Conditions Survey (EICV3) conducted in 2012 and **Figure** shows the respective road network.

Table 24: Road per Sector as per EICV3

SECTOR	PAVED ROADS (km)	UNPAVED ROADS (km)	TOTAL (km)
Byumba	18	79	97
Kageyo	8	75.1	83.1
Rukomo	14.5	79	93.5
Nyamiyaga	4.5	87.5	92
TOTAL	**45**	**320.9**	**365.6**

(Source: EICV3**)**

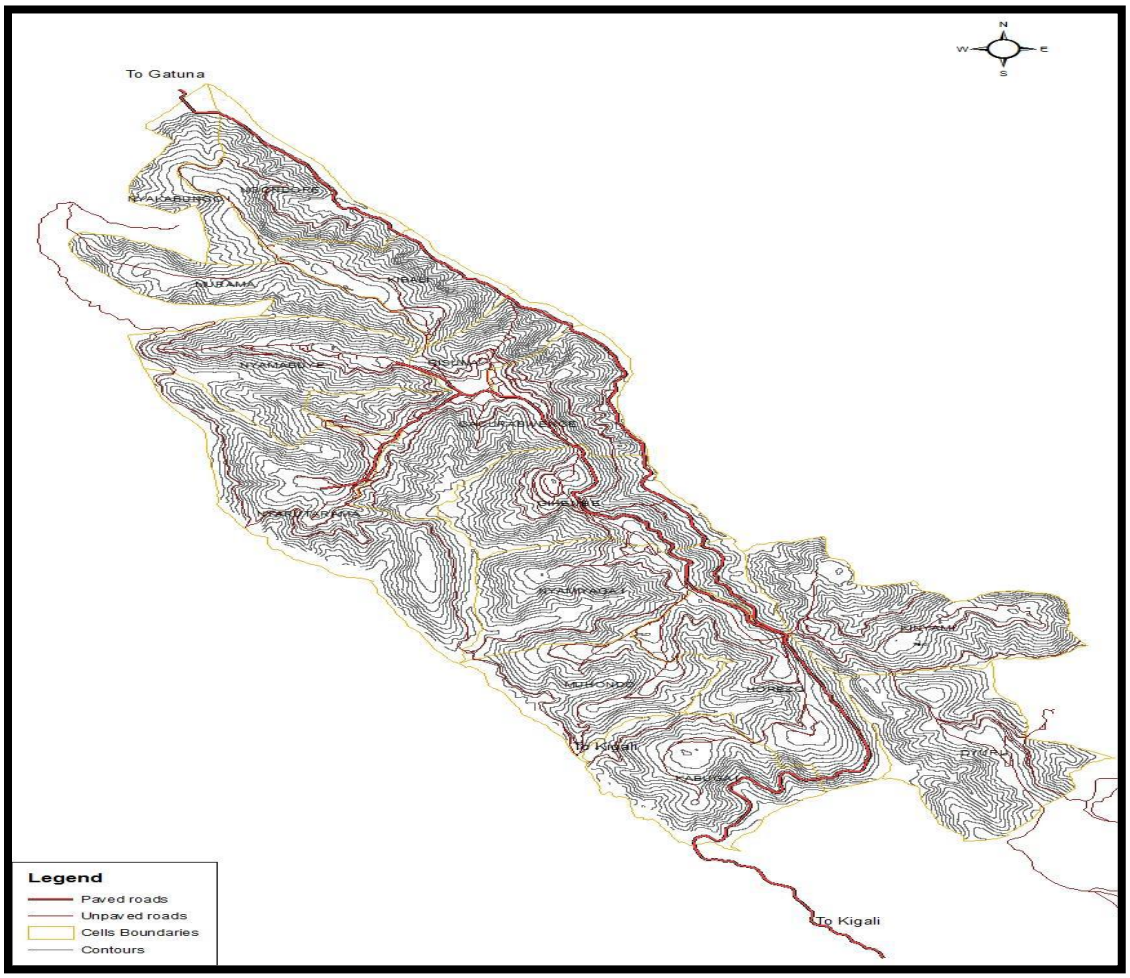


Figure 19: Road Network of Gicumbi Town

Figure20: A paved and un Unpaved Road in Gicumbi Town

Figure21: A Bridge on One of the Roads in Gicumbi Town

4.4.3.2 Transport Infrastructure

Transportation links Town-sectors and other Gicumbi District are made through a well-organized transportation means. There is indeed a transport system between Gicumbi Town and neighbouring Gicumbi District or with Kigali town (exchanges of food products with

processed goods). Some local business people will get food inside the District's market day and then sell them in town business center or to retailers. The transportation system in the villages is assured by secondary and tertiary unpaved roads. Transportation in these areas is assured by trucks to transport goods for trading in small shops and bars while motorbikes are used to transport people going to work, to market in town and returning home.

According to its last District Development Plan, Gicumbi Town, because of its mountainous nature, has limited road networks that would link the final products to the final consumers. There are limited tarmac roads, and limited roads that link sectors of the district. The roads network is of two types: the central road crossing the city, with 2 ways and 4 lanes, and the structuring roads or secondary roads. Therefore, they are characterized by their size, whose measurements are as follow:

- The main road: 22 m of total width and paved with asphalt
- The structuring or secondary roads: 16m of total width and paved with asphalt
- The lengths of these roads are the follows:
- The main road; from Rukomo trade center, crossing Gicumbi Town, to Gatuna Road with a length of 18.42 km,
- Structuring or secondary roads which link the different areas of the new land use plan of Gicumbi town, with a length of 59.41 km.

4.4.4 Water Supply Infrastructures

As per the feasibility study as well as the EICV 3, WASAC operates a water treatment plant in Byumba Sector from a spring catchment groundwater with a daily production between 850m3 and 900m3 depending on the season. The town and Rukomo business center only consume 87%. The urban population need is estimated at about 1500 m3 per day. The water supply network comprises water reservoirs consisting of 10 elevated masonry or concrete constructed tanks of capacities; 800m3 (Byumba sector), 200 m3 (Kageyo sector) and 10x 80m3(Kibali sector). The feasibility study proposes a pipe network up to the distribution reservoirs.

The survey of the existing water supply network as presented in this report was qualitative and a detailed quantitative survey of the complete existing water supply system will be conducted to establish the gaps and condition of the water supply system infrastructure.

4.4.4.1 Situation of Existing Water Treatment Plant

The water treatment plant is located in Byumba Sector. After treatment, water is collected by gravity into tanks equipped with pumps to raise water in a large reinforced concrete tank of 800m^3 capacity, cylindrical in shape from where water is distributed by gravity to the various subscribers of WASAC.

The water treatment plant is comprised of the following units;

- A dispatcher;
- A decanter;
- A pre-filtration basin;
- A filtration basin;
- A chlorination and pumping room;
- Three high-lift pumps (90 m^3/h each), with a possible extension to a fourth pump;
- A treated water rising main of 315 mm in diameter for pumping water to the distribution tank located at a distance of 3900m;
- A reservoir and distribution tanks.

Whilst, the map below indicates the water distribution network as per EICV3, the current network will be obtained from WASAC branch offices. It will also be compared with the proposed water distribution network as per EICV 3 as well as the current Masterplan.

The following photos show the existing Nyamabuye water treatment plant serving the whole of Gicumbi Town.

Figure22: Showing Nyamabuye Water Treatment Plant

4.4.4.2 Existing Water Supply System

The following Plate 11 shows the spread of the existing water supply system and its related features.

Figure23: Water Supply Network in Gicumbi Town by 2012

4.4.4.3 Storm Water Drainage and Sewerage Infrastructure

Storm Water Drainage

In general, there are two aspects of drainage system: Rain water drainage system and Waste water drainage system. According to Gicumbi Local Urban Development Plan, the field survey conducted in the district of Gicumbi with the authorities has shown that the district faces a lack of drainage system both rain and waste water and come out with the followings: - To the town level of the downtown, where we have a structured habitat and the existence of an urban road network, waters are drained toward the swamps by stone masonry ditches. In high standing habitat, rain and used water from kitchen are drained into a soak pit designed for this issue and waste water into septic tank. In the suburbs where housing is generally spontaneous, there are no drainage channels. Rainwater and waste water is discharged into swampy pond through streets resulting in degradation of roads. The sewage is discharged within the traditional latrines.

The district of Gicumbi experiences inadequate storm water Management, that later causes soil erosion to the farmers. In fact, due to its mountainous topography, storm water management remains a great challenge for the population. In that zone, with no proper water collection channels, the water storm causes landslides and washes away the top soil layers thus cause erosion which decreases land productivity.

Sewerage Infrastructure

The municipal garbage is from the households, the restaurants, the hospitals, the markets, the jails, the internal schools, etc. In Gicumbi town, there is not a collective system of sanitation, or purification, for the treatment of the waste water and other liquid or solid garbage. The only way of treatment of waste water used in the residential Gicumbi District of middle and high standard are the lost wells and the septic tanks.

According information from the District Development Plan, the district still faces a challenge of weak solid waste management. Insufficient public latrines in the town of Gicumbi and along the trading centres of the district remain a huge challenge as far as sanitation is concerned.

This challenge affects the expansion of Gicumbi town that is deemed to develop into a city. In fact, this district lacks a centralized sewerage system that would bring together a central district sewage control and management station. For that reason, the authorities of Gicumbi town have in their program, the organization of the management, collection and treatment of domestic garbage. It is a process that will include the collection, the separation, (while separating the biodegradable garbage to the non-biodegradable garbage), the transport and the transformation or treatment of the solid waste. Every household pays 1,000Frw per month to a licensed private company in charge of non-biodegradable garbage collection and disposal.

4.4.5 Electricity Infrastructure

In Gicumbi town, electricity infrastructure consists of the transmission lines supplying medium voltage, and feeder lines supplying low voltage to the equipment and population. REG Company covers to date 4 sectors, out of the 21 sectors of the Gicumbi Town; of which the sector of Byumba, Kageyo, Rukomo and Kaniga.

A current electricity grid map shall be acquired from REG from which tapping points for extensions to the project facilities are located. Grid electricity for reservoirs shall be for only cases where it is economically viable otherwise other forma of power supply such as solar energy may be opted for.

4.4.6 Education

According to information from Gicumbi Town Development Plan (2013 – 2018), the level of education quality is poor and must be improved to ensure sector contributes to national productivity and economic growth in the district and produce tangible results. There is still lack of more trained teachers, more classrooms, and more textbooks in various schools to meet the student's demands.

Without proper water and sanitation services, children are prone to the contagion of waterborne diseases. This Project suggests that access to water has a positive and significant effect on improvement of education.

Beside these involved persons in this sector, it is important to highlight also the situation of the University of Technology and Arts of Byumba in the sector of Byumba with 2,552 students and 105 teachers, among them 34 are female.

The following are photos of some of the schools in Gicumbi Town.

Figure24: Photo of a few Schools in Byumba Sector

4.4.7 Health Facilities

Hospital

The town of Byumba has one referral Hospital of Byumba which is for the district of Gicumbi with 21 administrative sectors. The Byumba hospital not only has an area of influence of the whole district of Gicumbi, but also of other Gicumbi District neighbouring of Gicumbi. This hospital counts 204 civil servants, 50 auxiliary workers and has 248 beds for patients.

Health Centers

This region counts 5 Health Centers which are managed as follow:

Table25: Health facilities in Gicumbi Town

SECTOR	Name of Health Institution	No of Staff	No of Beds
BYUMBA	BYUMBA Referral Hospital	254	248
	Byumba Health Centre	27	18
	RUHENDA Health Centre	24	17
KAGEYO	MUHONDO Health Centre	18	34
RUKOMO	MUNYINYA Health Centre	34	20
NYAMIYAGA	NYAMIYAGA Health Centre	8	5

According to information from Gicumbi Town Development Plan, high prevalence of poor

hygiene borne diseases illustrates that 7 out of 10 top causes of morbidity in health centers have a direct link to poor hygiene.
The study will update this information as it shall be obtained from the relevant authorities and assess how water is being used thus arriving at the required demand.

4.4.8 Commerce & Industry

In this sector, last Gicumbi Town Development Plan illustrates that as regards to financial sector development: 21 ''Imirenge'' SACCOs were registered in the District joining other financial institutions such as: Commercial Bank include I&M Bank, Bank of Kigali, BPR Atlas Mara and URWEGO OPPORTUNITY BANKING S.A while MFIs include ZIGAMA CSS, COOPEC ISHEMA, Vision Finance among others. These financial institutions increased saving and credits culture for the population. In Gicumbi town, there is one hotel URUMULI with 30 rooms and 3 rooms for meeting which would accommodate 1130 persons at the same time. There are also 3 small hotels: UMUTUZO with 25 rooms, VITA HOUSE with 11 rooms, UBWUZU with 5 rooms, and NICE GARDEN with 12 rooms.

It is important to highlight also the presence in Gicumbi town of a sport stadium with a capacity of 15.000 persons at the same time in one sight.

Few processing units of agricultural products are in place with an aim of increasing the value of certain products like wheat and maize that represent a considerable economic potential for the District. For that purpose, there are two factories in Gicumbi sector, one for wheat and another for maize, also one for maize in Kageyo sector.

The art and craft industry is usually practiced at the level of associations and individuals. The major artisanal activities are masonry, shoe making, carpentry, pottery, brick making, joinery, hair dressing, and weaving.

CHAPTER FIVE: IDENTIFICATION AND ANALYSIS OF THE ANTICIPATED IMPACTS

Preamble

The project components i.e. site preparation and operation will have several impacts both positive and negative. The mitigation of the environmental impacts can be reviewed. To this end therefore, with proper mitigation measures in place the project is environmentally sustainable. The potential environmental impacts and their significance can be summarised as follows.

A number of environmental issues were identified during the scoping process of the study. The purpose of this section is to predict and make an assessment of the impacts on the environment that may potentially arise as a result of the implementation of the project.

Impacts that could occur are grouped and discussed below under the various environmental components or receptors that are anticipated likely to be affected by implementation of the project. A certain amount of overlap between these components is unavoidable and therefore cross referencing is used where possible to avoid repetition.

An assessment of these impacts was made on the basis of information gathered during the scoping process, the detailed environmental baseline study of the project area which has included several field visits to the project site and its surroundings, as well as a desk study of relevant existing documents and information pertaining to the study and information describing the nature and design of the proposed project.

5.1 Anticipated Impacts.

An assessment of these impacts was made on the basis of information gathered during the scoping process, the detailed environmental baseline study of the project area which has included several field visits to the project site and its surrounding area, as well as a desk study of relevant existing documents, the public consultation process and information pertaining to the study and information describing the nature and design of the proposed project.

The impacts of the project during each life cycle stages; which can be categorized into: impacts on the biophysical environment; health and safety impacts and socio-economic impacts. All the potentially significant environmental impacts from the project are grouped below:

- ✓ ***Air Environment.***
  - Impact on ambient air quality.
- ✓ ***Noise Environment***
  - Impact on ambient noise.
- ✓ ***Water Environment.***
  - Impacts on surface and ground water quality.

- Impacts on river hydrology and morphology

- ✓ ***Land Environment***
  - Impacts on land use.
  - Impacts on soil fertility.
  - Land subsidence.
- ✓ ***Ecological Impacts***
  - Impacts on flora
  - Impacts on fauna.
- ✓ ***Socio-Economic Impacts***
  - Impacts on other infrastructure
  - Impacts on community cohesion-employment
  - Impacts on livelihood
  - Impacts on public health and safety
  - Impacts on cultural resources.
  - Impacts on aesthetics.
  - Gender issues
  - Community health and safety
  - Land ownership

Impacts can be positive or negative, direct or indirect. The magnitude of each impact is described in terms of:

- ✓ significant, minor or negligible,
- ✓ temporary or permanent,
- ✓ long-term or short-term,
- ✓ specific (localized) or widespread,
- ✓ Reversible or irreversible.

Some impact mitigation has already been addressed in the proactive design and other mitigation can only be guaranteed through active, responsible management, helped by following the guidelines in the project environmental management plan.

5.2. Analysis of the Significance of Impacts.

The methodology which has been adopted to evaluate the significance of the impacts is the semi-qualitative one and is presented in the matrix below. The following three tables were used in the evaluation of the impacts and thus defining and determining the mitigation measure to be put in place and also in reviewing the Environmental Management Plan requirements (monitoring, responsible parties and applicable statutory requirements). In order to provide a realistic

assessment of impacts, only the significance of impacts that still remain following effective implementation of mitigation measures is assessed.

The matrices used to undertake the analysis covered the following aspects: level of the impacts, the magnitude, and significance of the impact where each type of impact categories of insignificant, minor, moderate, severe and critical need to be defined precisely. Thus the impacts were reviewed based on a mix of the following critical factors which were considered when assessing the significance of impacts, these were:

1) Relationship of the impacts to temporal scales;
2) Relationship of the impacts to spatial scales;
3) The severity/benefits from the impacts and
4) The likelihood of the impacts occurring.
5) Are they subject to legislative control;
6) Are they related to protected areas or to historically and culturally important areas;
7) Are they of public concern and importance;
8) Are determined as such by technically competent specialists;
9) Will they trigger subsequent secondary impacts;
10) Will they elevate the risk to life threatening circumstances?
11) Will they affect sensitive environmental factors and parameter?

Table 25: Explanation and interpretation of significance rating for impacts

	Significance of impacts after mitigation	**Positive impacts**	**Negative impacts**
VL	Very low significance	Negligible effects	Negligible effects
L	Low significance	Some benefits	Acceptable effects
M	Moderate significance	Appreciable improvements to existing resources	Effects are serious enough to cause serious concerns, Changes to the project should be considered.
H	High significance	Very substantial improvements to existing resources	Unacceptable effects the project should not proceed unless design is changed so that the significance of this impact is reduced to acceptable levels.
VH	Very high significance	Extremely beneficial and enduring.	An automatic fatal flaw. The project should not proceed unless designed differently.

Table26: Impact Classification Table

KEY	Type of Impact	Key	Type of Impact
++	Major Positive impact	+	Minor Positive Impact
--	Major Negative Impact	-	Minor Negative Impact
0	Negligible /Zero Impact	NC	No Change
Sp	Specific/ Localized	W	Widespread
R	Reversible	Ir	Irreversible
Sh	Short Term	LT	Long Term
T	Temporally	P	Permanent

Table27: Matrix of Impact Significance.

Impact magnitude	Value of feature					
	Inter-national	National	Regional	High Local	Moderate Local	Low Local
High	Critical	Major	Major or moderate	Moderate or Major	Minor or moderate	Minor
Medium	Critical	Major	Major or moderate	Moderate	Minor or moderate	Minor
Low	Critical	Major or moderate	Moderate	Moderate or minor	Minor	Negligible or minor
Very Low	Critical or Major	Moderate	Moderate	Moderate or Minor	Negligible	Negligible

Table 28: Positive Impact Analysis

Environmental components	**Construction Phase**			***Operational Stage***			***Decommissioning stage***		
	L	**M**	**H**	**L**	**M**	**H**	**L**	**M**	**H**
Positive Impacts									
Employment									
Revenue to Government									

Improved Infrastructure									
Investment and capital flow									
Community benefit									

Environmental components	**Construction Phase**			**Operational Stage**			**Decommissioning stage**		
	L	**M**	**H**	**L**	**M**	**H**	**L**	**M**	**H**
Negative Impacts									
Contamination of Soil									
Noise and vibrations									
Solid Waste Generation									
Waste Water Generation									
Water Pollution.									
Risk of ground water pollution									

5.3 Existing environmental impacts.

The following are the existing environmental impacts:

- Poor Water facilities. From the survey that was conducted, it was found out that the residents of Gicumbi and especially Mutete and Kagyeyo sectors have no access to clean water. Most people use water from downstream of the rivers.

5.4 Environmental and social-Economic Impacts related to the project activities.

This section identifies both positive and negative impacts, their analysis and mitigation measures associated with the proposed development. An impact is any change to the existing condition of the environment caused by human activity or an external influence.

5.4.1 Positive Impacts of the proposed project.

The positive impacts are beneficial and will therefore not require any mitigation. However, the management and monitoring plan shall ensure their sustainability. The impacts and significance of these include are expounded below:

Local employment

The implementation of this project will provide employment opportunities for local population. The use of local laborers and skilled workers will improve the skill resource base in Rwanda through the implementation of training and development programmes. These are both positive outcomes of the project and for the local population. However, there will be an influx of people looking for work in general. If not carefully managed, this strain would be a negative impact. During the public consultation all the persons met solicited the access to the job. The project would therefore have a positive impact and reference made to preliminary design; the table below present the required labor.

Access to potable water and reliability of water supply system

The construction of Water Treatment Plants, water reservoir and pipeline will increase clean water production and the number of households with access to clean water. The improvement and expansion of water supply system will enable greater responsiveness to the demand, increasing also the reliability of the operating system. The reliability of the system will allow adequate planning for water supplies.

Knowledge transfer

Technical and planning skills will be gained by the Rwandese people that will be employed by the project and this is likely to contribute to the capacity building.

Economic Diversification and Improved local socio-economy

It expected that all works related to the project will provide a positive increase to the local and national economy in general this will contribute to the socio economic benefits within and around the project area. The economic expansion will enable alternative businesses and economic activities to develop. Also, increased earnings by staff will most likely be spent locally further supporting already established businesses in the area, as well as potential new businesses that may emerge.

Gender balance enhancement

It is expected that during the project implementation women will equally benefit as men in terms of employment benefits. In Rwandan culture, it is the responsibility of a woman to collect water and during water shortages, women and girls use most of their time for water. Therefore, the proposed project will be highly beneficial to women and girls. We therefore propose that

During employment of casual workers, gender equity may also be enhanced, especially for the labour-based activities on site

Healthcare for Employees

Employees and their immediate families will be provided with basic healthcare. This will benefit the overall health of the local population. HIV/AIDS and Covid-19 information will be dispersed to employees to prevent the spread of the diseases amongst the project employees and their families.

Possibility of savings for the employees

The increase of the project's employee's revenue will lead to the possibility of savings in local banks and micro-finances.

Increase of public revenue/taxes

The implementation of the project will increase revenue and taxes for both the central and local authorities. The project will fully participate in increased payments of taxes from suppliers of the clean water in the district and Kigali city.

5.5. Anticipated Negative Environmental Impacts during Construction

5.5.1 Environmental impacts on Socioeconomic Impacts

Accidents, Malfunctions and Unplanned events.

Accidents, malfunctioning and unplanned events will be prevented and mitigated by taking a systematic approach to safeguard workers health and safety and establishing a safety culture within the organization/company. The operational works unavoidably expose workers to occupational health and safety risks. Use of machineries and heavy works could lead to injury or loss of life, if management of their movement is poor.

Proposed Mitigation measures

- Workers at site will all be fitted with the appropriate safety gear depending on their duties.
- Protective Equipment will include the following
    - Fire extinguishers in good working conditions will be put at each corner, with exit plans and exit stairs provided and shown clearly on plans, posted at the entrance;
    - All electrical equipment shall be properly grounded;
    - Workers and caretakers of the building will be trained on firefighting, first aid and personal safety;
- Proper maintenance of all machinery and equipment will be ensured to prevent premature failure or possible accidents;

- Particular attention will be given in the project design to put in place measures that would enhance safety during construction;
- The proponent will prepare clear work schedules and organization plans, having adequate worker insurance cover;
- The proponent will ensure strict enforcement of traffic rules and regulations and provision of traffic aid during peak hours

Threat to Occupational Health and Safety

Improved occupational safety and health enhances productivity by reducing the number of interruptions in the manufacturing process, reducing absenteeism, decreasing the number of accidents and improving work efficiency. Employers and workers both have responsibilities and rights in relation to occupational safety and health (OHS). A preventative approach to OHS is the best strategy to eliminate most workplace accidents, injuries, and diseases.

The following actions of the employer can lead to injuries, accidents and diseases:

- Not informing or training workers on OHS issues.
- Failing to put adequate mechanisms in place to ensure co-operation between workers and managers on OHS.
- Not recording and/or reporting work-related accidents, injuries and diseases.
- Failing to provide adequate personal protective equipment (PPE) and/or training on its use.

Proposed mitigation measures

In addition to the safety measures mentioned above, the following additional measures should be implemented:

- ✓ PPE should be provided to workers who are exposed to dust, noise and vibration for a prolonged period. There should be a supervisor to ensure the workers wear these PPES corrected whenever onsite.
- ✓ Water should be sprayed in working area especially near business places and schools at least two time a day.
- ✓ Watering regularly to suppress excessive dust during construction, use of gas masks and goggles for dusty sections is strongly recommended;
- ✓ The contractor together with local authorities is required to enforce acquiring medical insurance "mituelle de sante" for all workers as a means of affordability of treatment.
- ✓ The safety and sanitation plan will be prepared planned and regular safety education will be implemented, in consultation with a district work safety inspector.

- ✓ Covering of materials that emit dust during transportation and the heaped ones.

Labor and Employment Impacts

There is within the local population, high expectations about jobs creation. During the public consultation, the issues raised were related to employment. Indeed, although the project will create employment opportunities, the jobs will be limited and it is therefore important that the procurement processes is clear and fair. It is expected that creation of not enough jobs will create frustration on part of the local people and conflicts can occur or be generated in relation to the project.

Proposed Mitigation

- Local people within the project should be given the first priority during employing. The casual workers and foremen should be selected from around the project area.

Expectations of short-term solution to all problems of water supply

The presence of a new water project can create very high expectations in the population as the immediate solution of all problems in the water supply sector. However, it is known that the solutions will be gradual and there are initiatives taken in the short term and others long-term due to limitations in the existing water sources and the costs involved with the alternatives identified.

Proposed Mitigation

- People should always support WASAC water supply by rain water harvesting. This will help in not dwelling on this new water supply all the time.

Resettlement implications

Permanent land acquisition is expected where Water Treatment Plant and water intakes will be constructed. Temporary land acquisition will be also required for laying pipelines. An abbreviated Resettlement Action Plan will be prepared and compensation provided before civil works. The RAP shall provide details on affected assets, proposed mitigation and compensation measures.

High expectations of getting great compensation in cases of resettlement

It is highly likely that people who will stand to lose land, infrastructure or business due to the project will have very high expectations of compensation to their loss.

Conflicts among workers and the local population in the project area

Though it is anticipated that the project will make an effort to employ the local population, projects involving major works include, often, the potential for the occurrence of social conflicts between workers who temporarily settle in the local and community residents. Such behaviors are generally related to socially unacceptable behaviors according to local social standards and can be seen, for example, cases of drunkenness and disregard/lack of respect for local customs. This impact should be considered even though an important part of the manpower to be recruited locally.

Proposed Mitigation

- The project proponent will closely monitor the workforce in the project area and site. In any event of security concerns arising, the proponent will engage security services to assist in ensuring that the same is maintained;

Traffic congestion and injuries or fatalities

The principal pipeline is mostly designed along the existing roads and at some point, it crosses both paved and unpaved roads. During construction period there will be increase in traffic due to moving machineries and vehicle traffic for material supply. This may cause both congestion and accidents.

- People struck or run over by moving vehicles (e.g. during reversing), causing minor to major injuries (fractures, wounds) or death;
- Falling from vehicles, causing injuries or death;
- Injuries or death because of vehicles overturning.

Proposed mitigation measures include

- ✓ Provision of training to enlighten drivers
- ✓ Preparation of traffic management plan and
- ✓ Provision of traffic marshals to guide traffic especially where the works will be undertaken near paved road with busy traffic and during busy traffic.

Possible increases of HIV/AIDS and communicable diseases

Risk of increased level of infection of HIV/AIDS, Covid-19 and other Sexually Transmitted Diseases (STD) due to the increase of people from outside of the project zone. Though there are no worker's camps planned for this projects Communicable diseases are anticipated among workers as there will be an influx of people in the area.

Mitigation measures

- ✓ Regular sensitization on ways of HIV/AIDS/Covid-19 prevention, importance of proper hygiene is important during execution of this project.
- ✓ Designated handwashing/ sanitization/temperature checking points should be put up within the sites among other precautionary measures to curb the spread of Covid-19 among the workers and their families
- ✓ The contractor is requested to arrange a health and hygiene training for workers and local communities in cooperation with health center near the construction site, in order to prevent infectious diseases.

Disruption of Public Utilities

At several points, small domestic water supply pipe lines and electricity and communication cables were observed. During construction, these infrastructures are likely to be affected by the construction activities for example some will be cut hence leading to water cut off to those areas that are served by WASAC pipes.

Mitigation measures

- ✓ The contractor will avoid as much as possible these infrastructures but where they are affected they will be rehabilitated.

Child Labour, forced Labour, discrimination and abusive dismissal

The implementation of the project should be done in compliance with national and international standards in terms of child labour forced labour and discrimination.

Proposed Mitigation Measures

- ✓ Protect workers' rights and provide contract to each employee
- ✓ Establish, maintain, and improve the employee–employer relationship;
- ✓ Promote compliance with national legal requirements and provide supplemental due diligence requirements where national laws are silent;
- ✓ Comply with international Labour Organization, and the UNICEF Convention on the Rights of the Child, where national laws do not provide equivalent protection;
- ✓ Protect the workforce from inequality, social exclusion, child labour, and forced labour;
- ✓ Employ employees with national identity cards.

5.4.2.2 Environmental impacts on Bio-physical environment

Project's adverse impacts during project phases (pre-construction, construction, operation and decommissioning phases) are described in this section. The significance and probability of occurrence of each impact can be reduced through the application of environmental preventive and mitigation measures. Potential environmental issues associated with this project, which may require management, are discussed below.

Change in ecosystem (natural habitat for flora and fauna).

The project will cause a change in the ecosystem of the area. Habitat alteration is one of the most significant potential threats to biodiversity associated with this project. Habitat alteration may occur during any stage of this project cycle with the greatest potential for temporary or permanent alteration of terrestrial and aquatic habitats occurring during project activities.
Some crops and trees established in the project area will have to be cleared where the pipeline and pump station will be installed. There is no plant or animal species of special conservation purpose surveyed that will be affected

Mitigation Measure

- ✓ The site clearance should be only done on an area demarcated for construction;
- ✓ Rehabilitation of construction site should include tree planting.

Disturbance of ecosystems habitats

The clearing of existing vegetation will result in the complete loss of associated ecological habitats and their fauna, within the project area. Noise, vibrations, and intrusive activities related to construction works will tend to scare away any animals remaining on the site after vegetation clearance. The project area the has been a natural habitat and so when it's cleared during site preparation, the flora and fauna of the place will be disturbed hence changing the ecosystem of the area.

Mitigation Measure

- ✓ Clearing and construction activity should be restricted to within the area of the development.

Soil erosion

Soil damage includes compaction and disturbance of the profile. Soil erosion involves transport of the soil down slope by running water or, more rarely but still a significant factor, away from the site by wind. Soil compaction and disturbance, usually accompanied by vegetation and litter

layer damage, are preconditions for accelerated soil erosion. Most soil damage occurs as the result of movement of machine, trucking, and to some extent through felling of trees during excavation works. Soil erosion depends not only on soil damage but also soil type, rainfall, and angle and length of slope.

Soil erosion is mostly anticipated on steep slope of river point and river. Without adequate water management on site, soil erosion will persist and result in loss of soil and sedimentation especially near water bodies. Contamination of soil may occur from the spillage of oils and lubricants during construction and operation activities. Degradation of the surrounding soil will affect flora and fauna and may restrict the future land use.

Mitigation measures proposed:

Pipe installation on steep slop

- ✓ Setting safety fence at bottom of the slope made by wooden/steel pile with mesh wire
- ✓ Setting mono-rail in order to carry the dug soil out of the site.
- ✓ Manual-excavating and carrying the dug soil.
- ✓ Constructing concrete foundation and laying of the pipes on the foundation (where necessary)
- ✓ Installing pipes and welding joint.
- ✓ Fixing pipes by covering with the concrete at some points.

Changes of landscape - Visual impact

Impacts on the physical environment will consist of landscape transformation causing visual impacts. Installing water pipe, river cross bridge and water pump station will alter slightly the landscape at some localities. These impacts will remain during operational phase. Temporary physical impacts will occur during the construction period at places selected to store construction material and pipes and at accommodation places for workers. However, those sites will be decommissioned after the construction phase; the visual impact is restricted to the construction period.

Mitigation measures

- ✓ To clear only the area demarcated for construction;
- ✓ Rehabilitation of construction sites.

Noise and vibration emissions

Noise and vibration during construction will be generated by the operation of heavy machines, heavy trucks, right of way preparation, soil stripping, trenching, pipe stringing, welding and laying and backfilling activities.

Limited construction activities may have to continue on a 24-hour basis increasing the exposure time of the workers and community people to noise. These impacts are of temporary nature.

Proposed mitigation measures include the:

- ✓ Limitation of heavy works in daytime 6am to 7pm;
- ✓ Provision of PPE to workers;
- ✓ If necessary, local residents should be given notice of intended noisy activities so as to reduce degree of annoyances.
- ✓ Workers operating equipment that generates noise should be equipped with noise protection gear.
- ✓ A regular monitoring of noise will be conducted as to check the compliance of noise pollution with permissible level.
- ✓ As most of the expected noise is from vehicles, truck and machines, the contractor will be requested to use equipment in good condition and certificate of technical control will be required

Air Quality / dust releases and nuisance

Exposed surface areas with loosened topsoil combined with the operation of plant and machinery will increase dust raised from the site, especially during initial levelling and preparation required under each phase of the project. The dust raised during construction can pose a nuisance to workers although the impact of this is considered relatively small and localized. Dust levels are likely to be higher at certain strategic locations on the site such as stockpile areas during the offloading of gravel and aggregate. Dust raised by construction activities can also pose a nuisance to adjacent settlements especially under dry and windy conditions. The impact of this affecting some parts of the settlements around the construction sites is potentially significant although intermittent.

It can be anticipated that a certain amount of air borne particulate matter (dust) will be generated by earth moving activities during construction phase of water treatment plant and water reservoirs. This situation will be worse during the dry season and during the afternoons when the winds are most prevalent. Air borne particulates may pose a hazard to residents in the vicinity or downwind of the construction site that suffer from upper respiratory tract problems.

Mitigation

- ✓ Access roads and exposed ground should be regularly wetted in a manner that effectively keeps down the dust.
- ✓ Workers on the site should be issued with dust masks during dry and windy conditions.
- ✓ Most of the emissions are expected to come from vehicles, tractors and machines to be used. The contractor will be required to present technical control certificate for all vehicles, machines and trucks. Those certificates are issued by National police and are issued only when the vehicle emission is below the maximum permissible limit.
- ✓ A regular monitoring on ambient air will be conducted to check the level of air pollution. In the case the level exceeds the minimum permissible air pollution level, the developer will be required to reduce his emissions

Water pollution

Laboratory test on water where water will be extracted shows that water is already heavily polluted with a lot of sediments. The construction of water intake, water Treatment Plan, the installation of pipeline especially at river crossing section, additional sediment is likely to go to the river.

Mitigation measures

- ✓ In addition to the respect of 10-meter river buffer zone and 50m on rivers and lakes where possible the same technical design used to avoid soil erosion apply here including;
- ✓ Before starting to use heavy equipment near the river side, the soils of the riversides need to be lined with gabions in order to prevent it from being eroded;
- ✓ Construction period: should be during the dry season;
- ✓ After preparing for the Launch and Reception shafts, centrifugal reinforced concrete pipes are inserted into the ground as pipe sleeves by hydraulic jacks;
- ✓ After installing pipe sleeves, water pipes are inserted inside them, and aerated light-weight concrete is filled up between the pipe sleeves and water pipes in order to fix the water pipes in concrete.

Alteration of hydrology and wetland

The installation off the pipeline below the wetland will alter the features of the wetland and therefore alter their hydrology (flow and water turbidity). Temporary loss of habitat and component species within the construction corridor. The construction phase will involve the use of heavy machines and vehicles and increase of circulation of people. For different purposes lay down yards will be needed, as for storage of parts and construction material, storage of pipes, parking of trucks and construction machines etc. and work camps have to be installed.

There is also the risk of alteration of hydrology for the population, that is, the people have been using this wetland, e.g. livestock feed and fetching water. The project area the has been a natural habitat and so when it's cleared during site preparation, the flora and fauna of the place will be disturbed hence changing the ecosystem of the area.

Mitigation measures

- ✓ Construction yard, equipment maintenance area should be placed far from water bodies and wetlands;
- ✓ For the installation of water pipe in the marshlands, appropriate construction methods are considered and consists of open cut method that will be taken by backhoe excavating, however, the contractor shall be careful to ensure the cutting angle does not collapse if the soil is loosely held.

Solid waste management

Solid waste generated during site preparation and construction work would include cut vegetation and typical construction waste. This waste would negatively impact the site and surrounding environment if not properly managed and disposed of at an approved dumpsite. Cleared vegetation burnt onsite would generate smoke, possibly impacting negatively on ambient air quality and human health.

Mitigation measures

It is anticipated that a big amount of construction waste will be generated. To manage this amount of waste it is proposed:

- ✓ A temporary storage place is established
- ✓ Transporting to the Dump site away from the construction site is.
- ✓ Waste recycling is also an option whereby construction companies can use recycled soil and concrete debris as road bed materials, but they have to inform the sources of materials to the City

Quarries and burrow pits

It is anticipated that the project will need construction material such as sand and stones. Therefore, it is appropriate to give consideration to the environmental implications in selection of quarry sources since poorly run operations create dust problems, contribute noise pollution, Occupational health and safety of their employees, or environmental degradation in general.

Mitigation measures

- ✓ To ensure adequate mitigation of potential adverse impacts, only licensed quarrying operations are to be used for material sources. Efforts should be made to use material commonly found along the roadway as a construction material.
- ✓ Burrow pit areas shall preferably be selected from high land and/or waste land. Although locations of the borrow areas are negotiated between contractor and landowners. The excavation and restoration of the burrow areas and their surroundings, in an environmentally sound manner to the satisfaction of the Supervising Engineer, is required before final acceptance and payment under the terms of the contract.
- ✓ All borrow pit areas will be properly drained. The side slopes shall be provided with surfing. Topsoil from the opening of burrow pits from agriculture land shall be saved and reused in re-vegetating the pits to the satisfaction of the Engineer/land owner. Additional borrow pits will not be dug without restoration of the former.
- ✓ Plans to restore borrow pits should be put in place after project completion.

5.6 Anticipated Negative Impacts during the operation phase

The key Environmental impacts resulting from operational phase include wastewater, sludge production, overwater abstractions etc. Environmental impacts related to the operation phase of proposed activities are provided below.

Impacts on Hydrology

During the operation phase, a significant amount of water will be impounded in the dam to supply to the treatment works. The selected river has enough water and the amount to be extracted shall not be huge. It has been proved beyond doubt in studies that impounding water in a dam results in increased water table in the surrounding areas upstream and downstream. Considering the available water discharge in the area, the project will have minor variation of water table taking into consideration, the abundant rainfall and other climatic patterns.

Mitigation Measure

- ✓ There will be no use of surface water during the operation of the plant and hence no impact is expected on the surface water.
- ✓ Environmental flows shall be released from the dam continuously to protect the downstream micro-organisms.
- ✓ Regular monitoring of water level and water table should be conducted as to maintain the minimum ecological flow especially in dry season (June, July and august. Bases on the monitoring result, the system operator will decide on the amount of water to be extracted.

Water pollution

During the operation phases some chemicals will be used and it is with no doubt that the plant will produce some sludge.

Mitigation Measure

- ✓ It is proposed to remove this sludge by dewatering m/c to be constructed at the Treatment plant area.
- ✓ All chemical sludge will be properly handled on site and brought to nearest landfill and this one will be monitored continuously. It is recommended that there not be any sludge disposal into rivers and lakes
- ✓ The back washed water to be mixed with clean water before releasing into the receiving water/rivers.

Sludge handling and disposal

During the operational phase two kinds of waste is expected including sludge and waste water. If not well handled, this waste may contribute to water pollution and environmental degradation. Therefore, a proper handling and disposal plan is required in order to avoid any pollution or environmental degradation.

Proposed sludge handling and disposal

- ❖ Backwash thickeners and belt press filtrate will be recycled to the inlet of the plant and Sludge will be thickened.
- ❖ **Dewatering** aims to reduce the water content further so that the solids content of the sludge is about 20 % (equivalent to 1 kg dry sludge with 4 L of water). The sludge can then be handled like a solid. Dewatering can be done mechanically using a filter press (employing pressure or vacuum), or a centrifuge.
- ❖ **Sludge reuse:** the sludge can be reused for different use including in agriculture or in bricks making. The expected sludge will have less biological component and there may be a presence of pathogens in the sludge in high numbers which make the use in agriculture unsatisfactory.
- ❖ **Final or ultimate disposal of sludge, which cannot be reused**, is by land filling or incineration. Since sludge for land filling usually contains heavy metals or toxic chemicals, lining of the landfill with clay or plastic liner may be required to prevent contamination of groundwater.
- ❖ Sludge disposal should be done in appropriate landfill approved by District authority and in accordance to the land use master plan.

Wastewater treatment

Dewatering the sludge will release wastewater and if not well handled it may have adverse impact on the environment and on human health as the water treatment plant is located near the wetlands. Environmental pollution by wastewater or consumption of wastewater contaminated water might lead to eruption water-borne diseases i.e. cholera, diarrhoea, dysentery and typhoid. Problems associated with the unmanaged increased wastewater could last during the whole project life.

Mitigation measures:

- The filtrate water which is generated from sludge dewatering will be recycled to the water treatment plan
- Wastewater from sanitary sewage which is generated from administration building, guard room and workshop will be treated in septic tanks.

Loss of income for small water supply operators

Although this in not a recognized income generation activity and these people are taking advantage of water shortage in the area, the developer should consider this category of people and give them priority in labour for sustainability of the projects. In case they are not taken care of they can vandalize the infrastructure and sabotage the project.

Mitigation measures

- During construction the contactor/ the developer will try to offer temporary jobs to them depending on the available opportunities.
- During the operational phase they will be encouraged to join Water user's association and will participate in selling water on public water point to be provided in centers.
- Reference made to the Government policy on cooperatives, they will be encouraged to join existing cooperatives and invest in other lucrative activities.

Vandalism of water supply infrastructure

With the coming of the project, a number of infrastructures will be made from metal, steel and concrete some people may be involved in vandalism of that equipment's.

Impact Significance

The impact could be of low significance in terms of magnitude. With community policing encouraged in Rwanda and existing security organ in the project area, such an impact might be of short-term scattered periods of vandalism.

Mitigation measures

Sensitization of local communities to ensure project ownership and use community policing as a means of ascertaining security, will collectively avoid vandalism.

- ❖ Regulations on penalties to perpetrators convicted of vandalism are necessary. Punitive actions towards perpetrators by the authorities will facilitate compliance by the locals thereby avoiding vandalism.
- ❖ Protecting exposed pipes on distribution lines.

Loss of biodiversity due to un-anticipated ground water over-abstraction:

During operational phase, over-abstraction of ground water has a negative impact on living organisms including flora and fauna. When the groundwater withdrawals exceed recharge, there is a falling of water table and living organism does not have enough water. Therefore, any project that need ground water should consider the minimum ecological flow to sustain the living organism.

Mitigation measure:

- ❖ Regular monitoring of water level and water table should be conducted as to maintain the minimum ecological flow especially in dry season (June, July and August. Bases on the monitoring result, the system operator will decide on the amount of water to be extracted.

Gender Based Violence/Sexual Exploitation and Harassment

During project implementation, there is always a risk of experimenting issues concerning GBV (gender based violation, Sexual harassment and abuse, HIV/AIDS and other STDs, these would be from employers to employees and sometimes within their homes.

Proposed Mitigation Measures

There should always be:

- Sensitize site workers on HIV/AIDS, Sexual harassment and abuse, GBV (gender based violation) to avoid negative effects from social& multicultural inclusion at the area.
- Voluntary testing to determine HIV status; counselling at existing medical facilities;
- Enforce and sensitize code of conducts

Impact on Child Labour, forced Labour, discrimination and abusive dismissal

During project operation selection of employees should be done in compliance with national and international standards in terms of child labour forced labour and discrimination.

Proposed Mitigation Measures

- ✓ Protect workers' rights and provide contract to each employee
- ✓ Establish, maintain, and improve the employee–employer relationship;
- ✓ Promote compliance with national legal requirements and provide supplemental due diligence requirements where national laws are silent;
- ✓ Comply with international Labour Organization, and the UNICEF Convention on the Rights of the Child, where national laws do not provide equivalent protection;
- ✓ Protect the workforce from inequality, social exclusion, child labour, and forced labour;
- ✓ Employ employees with national identity cards.

Occupational Health and Safety (workers maintaining the distribution line and at treatment works)

Improved occupational safety and health enhances productivity by reducing the number of interruptions in the manufacturing process, reducing absenteeism, decreasing the number of accidents and improving work efficiency. Employers and workers both have responsibilities and rights in relation to occupational safety and health (OHS). A preventative approach to OHS is the best strategy to eliminate most workplace accidents, injuries, and diseases.

Proposed Mitigation

- ✓ There should be a supervisor to ensure the workers wear these PPEs corrected whenever onsite.
- ✓ The contractor together with local authorities is required to enforce acquiring medical insurance "mituelle de sante" for all workers as a means of affordability of treatment.
- ✓ The safety and sanitation plan will be prepared planned and regular safety education will be implemented, in consultation with a district work safety inspector.
- ✓ Covering of materials that emit dust during transportation and the heaped ones.

Fire Hazards at treatment works

The possibility of fire outburst at this place always exists especially in the case of burning on site, poor electrical installations and use of hydrocarbons to power machinery and equipment in operation. Most especially the diesel-powered ones if not properly handled, might significantly start a fire. Such an occurrence will then inevitably have an environmental bearing on the atmosphere.

Proposed Mitigation measures

- The fire detection and alarm system be designed to accurately detect and identify the source of health/ smoke/ fire at early stages to minimize false alarms due to faulty equipment, electrical transients, system faults etc.

5.7, Anticipated Negative Impacts during the Decommissioning Phase

The following negative impacts are associated with decommissioning of the project

Generation of Solid Waste Material

This will arise from the decommissioning of the structures in place. The waste will mainly comprise of concrete rubble and steel. This impact will be low.

Dust and Exhaust Emissions

Dust will arise from demolition works. The use of heavy equipment will lead to exhaust emissions. This impact will be low and not significant.

Occupational Hazards

Workers undertaking decommissioning works will be exposed to hazards such as falls, excavation cave inns and other injuries. This impact will be moderate

Noise and Vibration from Structure Demolition

Heavy equipment that will be mobilized will lead to the emission of noise and vibrations. This impact will be low.

5.8 Cumulative impacts

These are impacts that result from a change caused by other past, present or reasonably foreseeable actions together with the project. The accumulation of impacts is characterized by two different types of relationships which are:

- Intra-relationship: combined effect of individual development – for example, noise, dust and visual on one particular receptor; and,
- Inter-relationship: several developments with insignificant impacts individually but which together represent a significant cumulative effect.

Cumulative impact on Soil erosion: During construction and excavation of trenches for pipes and reservoirs, would lead to soil erosion. As a result, the area would be affected by soil pollution from solid waste disposal.

Cumulative impact on Pollution of water severity increase: The operation of the facility especially the water treatment plant might lead to water pollution, this would be due to contamination from oil spillages Backwash water discharge Contamination from dumpsite facility Poor quality effluent discharge from water treatment plant can be a Contamination of water agriculture activities

Cumulative impact on Flora and fauna; Disturbance of flora and fauna during construction could lead to loss of flora and fauna. This is so because of the noise and movement of people around the natural habitat and hence a cause of loss of flora and fauna.

Cumulative impact on Increased access to potable water and reduction of diseases; availability Clean water would lead to reduction of disease in the community this is because, there has been a shortage of clean water where people would just drink any water and hence a number of cases at the health facilities. Therefore increased access to portable would lead to reduction of diseases**.**

CHAPTER SIX: PROJECT ALTERNATIVES.

6.1 Identified project alternatives and the selected alternative with consideration with the Existing Hydropower plant

The previous 2012 Feasibility Study, suggests two alternatives of potential water sources, that could provide the area with 500m^3/h of water. The first alternative was the abstraction of a deficit of 500m^3/ h from a water intake on the River Kagogo. While the second alternative was the abstraction of the deficit of 500 m^3/ h from a water intake on the River Mwange. The intake structure will be planned at about 1km upstream Mwange center just before the brickyard.

Although, the previous 2012 Feasibility study resulted in the consideration of the second alternative to be the adopted one, the Client of this project has asked the consultant for the possibility to identify more options that have been identified at this stage.

In addition to the previously two(2) proposed alternatives from the 2012 feasibility study, another three(3) additional alternatives were proposed by the current Mwange water supply system study along Mwange River, which was proposed to reconsider the hydro power plant on Mwange River.

The first additional identified alternative is water dam with intake located upstream to the previously proposed alternative (from FS-2012) along Mwange River, and in the upstream of the Hydro power plant.

The other identified intake location is located in the downstream of the Hydro power plant along Mwange River.The third additional alternative is proposed at the downstream Mwange river segment from after Bizi stream joins the river, which is also at the downstream of the Hydro power plant.

The hydrological behavior of the watersheds contributing to the proposed intake sites was studied, the guaranteed flow at the intake location to cover the water demand was computed and the peak flows depending on various return periods to be used in sizing the intake structure were specified. According to the hydrological evaluation for both streams regarding the expected flow, it was acknowledged that placing the raw water intake in the downstream of the Hydro power plant, has no impact on the power plant water needs. And the best location is after Bizi stream emerging location. Therefore, the evaluation of the major alternatives will be dependent on this location on Mwange and the only proposed location In Kagogo.

The two proposed water supply systems, namely;

The water supply system with the intake on River Mwange (downstream of the Hydro power station), and ii)

The water supply system with the intake on River Kagogo, were evaluated Accordingly.

The water quality tests showed both of the rivers suffer from high organic matter and high rates of iron and manganese substances in water, in addition to the reddish colour and turbid nature.

The proposed concept for the water supply system suggests to have a major pumping station after the raw water treatment plant, which forces the water into rising main that delivers the flow to a regional ground reservoir in Gihembe which distributes water to four other reservoirs each one placed in the relative sector. As per the below table:

Table129: Comparison of the two options

Water Supply System Element	Option No.1	Option No.2
Raw Water Intake	River Mwange	River Kagogo
Water Treatment Plant	Mwange Water Treatment Plant	Kagogo Water Treatment Plant
Treated Water Transmission Pipeline	Mwange WTP to the Gihembe Reservoir Site (Approx. 12,000m)	Kagogo WTP to the Gihembe Reservoir Site (Approx. 32,000m)
Lifting Station	One (1) Station	Two (2) Stations
Balancing Reservoirs	Same for Option 1 & Option 2	Same for Option 1 & Option 2
Water Distribution Network	Same for Option 1 & Option 2	Same for Option 1 & Option 2

6.2 .Description of hydrological regime of Mwange river

Mwange River and Kagogo River are the two selected rivers for intakes to cover such deficiency in water supply in the Gicumbi Town. Mwange river drains into Nyabugogo River and Kagogo drains into Lake Muhazi. Their catchment area includes Gicumbi district, a small part of Rulindo and Nyagatare districts in the North-Western part of Rwanda.

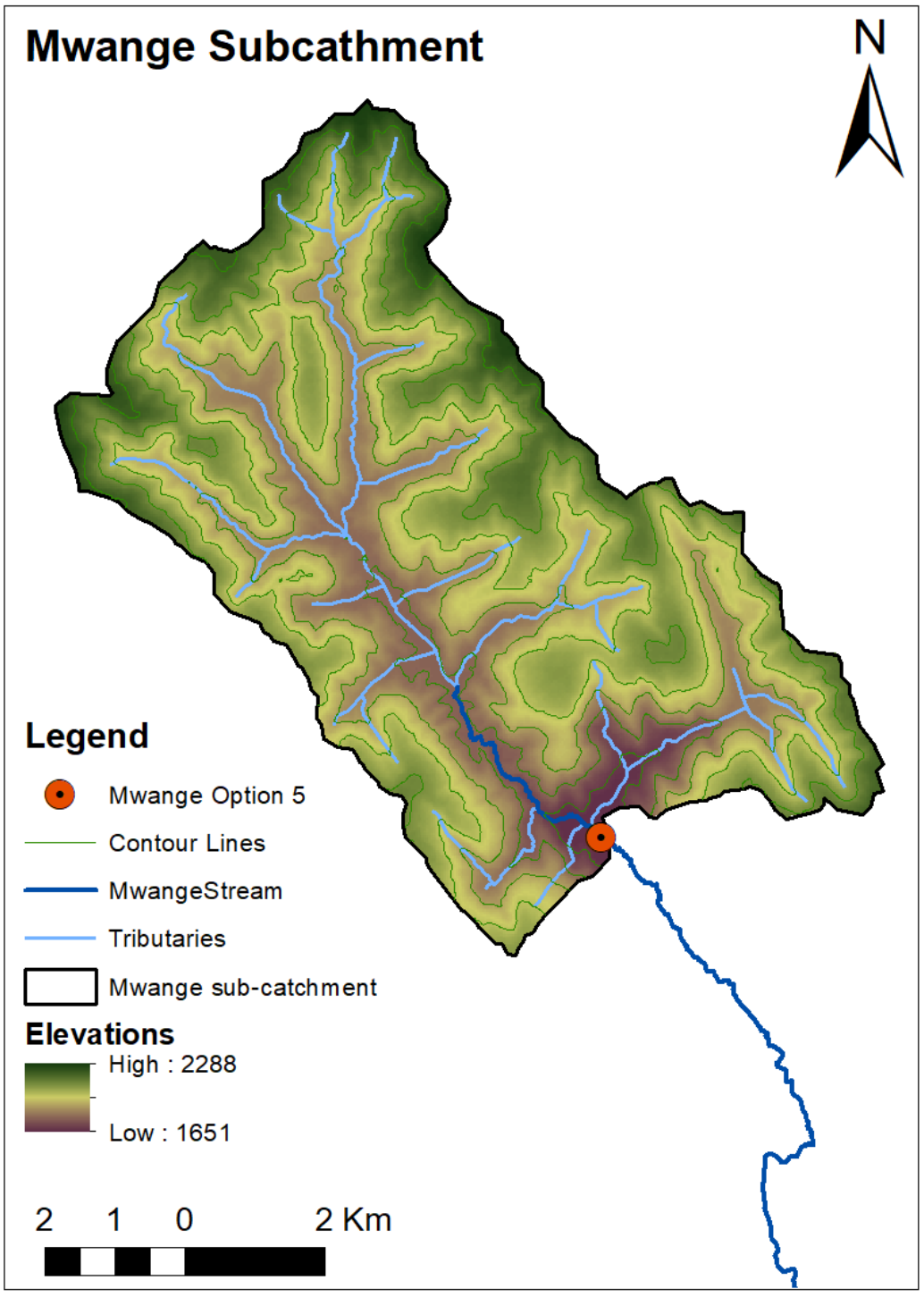


Figure 25: Catchment Delineation for Alternative 5 on Mwange River (the Most Downstream)

6.2.1. Summarised Characteristics of Mwange river catchment at the selected alternative

The alternative #5 which is the most downstream on Mwange river is selected alternative to be implemented in the Mwange wss project. Some parameters give characteristics of the catchment. The following parameters have been chosen and computed to be used in the following chapters especially in flood analysis. All the formulas are taken from "Hydrologie tropicale et appliquée en Afrique Subsaharienne" by Bernard Chzeville, France, 1990.

Table30: Catchment Characteristic Parameters (Alternative #5)

No	Parameter	Value	Definition
1	Perimeter (P)	36.00 km	The perimeter of the catchment
2	Surface Area	64.27 km^2	The surface area of the catchment derived from 30 m resolution DEM data
3	Length	13.0 km	This is the length for the equivalent rectangle. Equivalent rectangle can be defined as A rectangle having the same surface area and the same perimeter. $L = (P+\sqrt{(P^2-16*S)})/4$ Where L = length of the equivalent rectangle P = perimeter S = surface area of the catchment
4	Width	4.94 km	This is the width for the equivalent rectangle Width = S/L
5	Height	634 m	This is the difference in elevation from the highest point to the lowest point between 5% and 95% of the surface
6	Slope factor (Ig)	48.8 m/km	The slope factor (indice de pente), this denotes the change in elevation over the length of the equivalent rectangle
7	Slope	4.8%	This is the general slope of the catchment. It is calculated on 60% of the total length of the catchment. Excluding 20% in the upstream and 20% in the downstream part.
8	Gravelius index, k	1.27	This can also be called shape coefficient, k equals to 1 for completely circular catchment and is greater than 1 as catchments are elongated

No	Parameter	Value	Definition
	(compactness index)		$K = 0.28*P/\sqrt{S}$
9	Reduction coefficient, A	0.79, T=2 years 0.77, T=5 years 0.75, T=10 years 0.74, T=50 years 0.72, T=100 years	It is called "coefficient d'abattement" in French and can be computed as a = 1-0.001(9 log T – 0.042 Pan + 152) log S Where: A: is reduction coefficient T: return period for a particular storm Pan: annual precipitation for the catchment (from 250 to 3000 mm) S: surface area of the catchment (from 15 to 1500 km^2)
10	Runoff coefficient	Kr_2=0.15 Kr_5=0.17 Kr_{10}=0.19 Kr_{50}=0.21 Kr_{100}=0.23	An experimental formula has been proposed by Puech-Gonni du CIEH based on the types of soil in sub-Saharan Africa. $Kr_{10} = 2300\ Pan^{-0.67}$ Where Kr_{10} is the runoff coefficient for 10-year design storm 25 to 100-year Kr has been estimated accordingly taking into consideration that runoff coefficient increases as the rainfall increases.

6.2.2. Climate of the Study Area

The Gicumbi lies on 2221m above sea level. The climate in Gicumbi is warm and temperate. Byumba is a city with a significant rainfall. Even in the driest month there is a lot of rain. The average annual temperature lies between 15 °C to 16 °C.

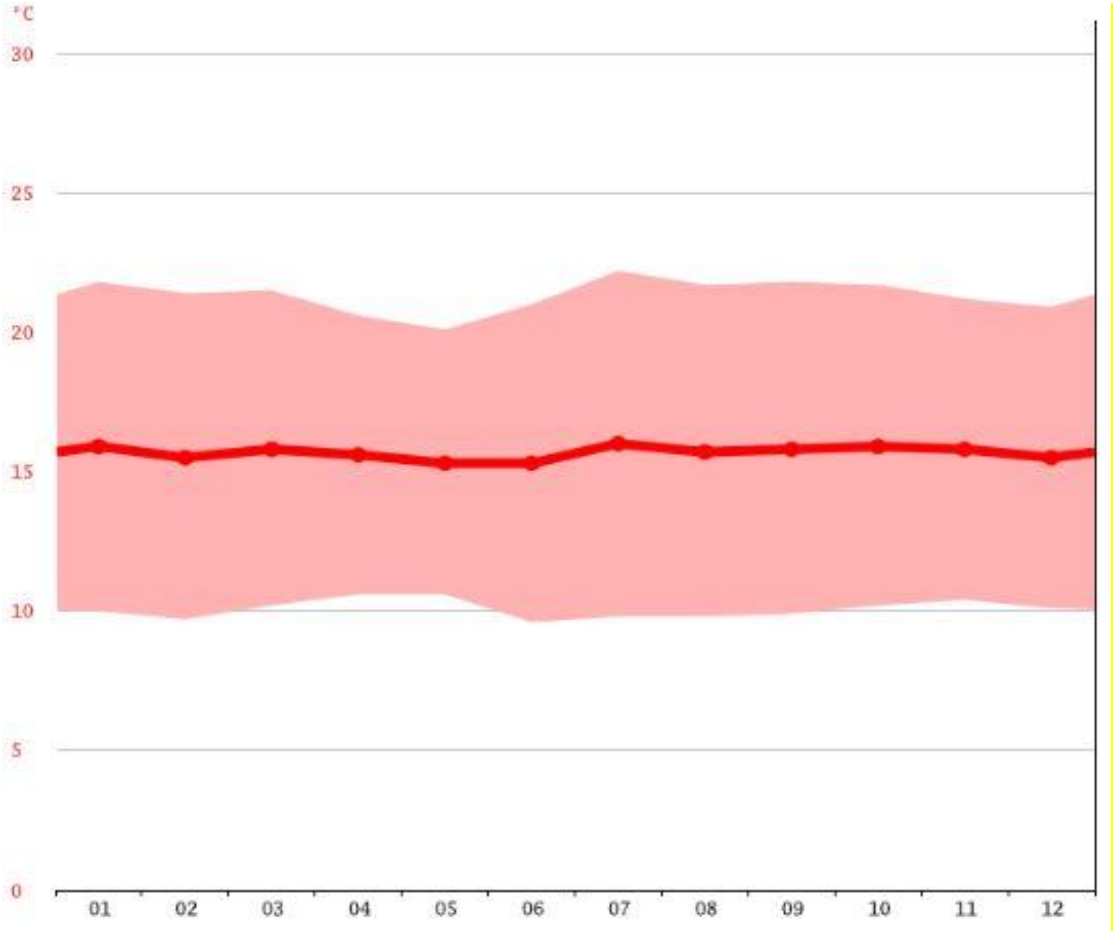


Figure26: Gicumbi Average Monthly Temperature (Source Meteo Rwanda)

July is the warmest month of the year. The temperature in July averages 16.0 °C. May is the coldest month, with temperatures averaging 15.3 °C. Throughout the year, temperatures vary by 0.7 °C

Table31: Monthly Average Temperature

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temp. (^{0}c)	15.9	15.5	15.8	15.6	15.3	15.3	16	15.7	15.8	15.9	15.8	15.5
Min. Temp. (^{0}c)	10	9.7	10.2	10.6	10.6	9.6	9.8	9.8	9.9	10.2	10.4	10.1
Max. Temp. (^{0}c)	21.8	21.4	21.5	20.6	20.1	21	22.2	21.7	21.8	21.7	21.2	20.9

6.2.3. Runoff Data

The Mwange-Rusumo water level record as were as the rating curve were collected from Rwanda Water Resources Board database. 3-dairly data set for a period of five years was collected and quality controlled before use.

Table32: Hydrometric Station

HM Name		Coordinates Decimal Degrees-GCS_WGS_1984		Elevation	Data Period	No. Years	Resolution
		Latitude	Longitude	m a.s.l.			
MWANGE (RUSUMO) Station		-1.673014	30.091535	1678	1995-2000	5	3-daily

The location of the hydrometric stations, together with the relevant catchments is shown in the **Figure27**. The catchment area was recorded from the data base and computed as 48 km^2.

The following graph displays unprocessed flow data as recorded on Mwange (Rusumo Station). The average was computed at 0.518 m^3/s, a maximum was recorded at 4.867 m^3/s and an absolute minimum at 0.291 m^3/s.

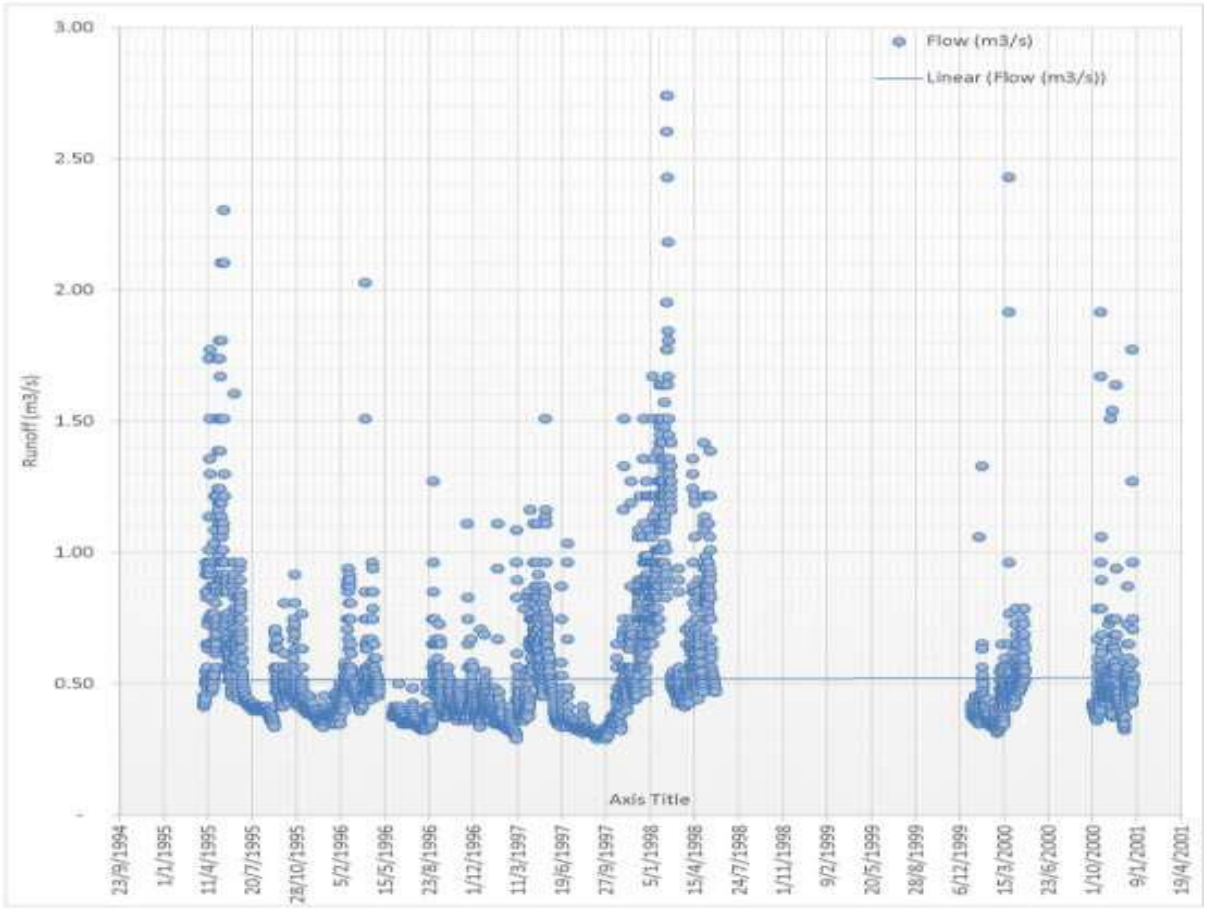


Figure 27: Flow Records at Mwange (Rusumo Station L2-SL70018)

The flow data were collected from Rwanda Water Resources Board (RWB). The flow were generated from the water levels collected for a period of 5 years. The **Figure 28** displays recorded water levels for the station whereas **Figure 29** displays the computed rating curve from Rwanda water resources master plan.

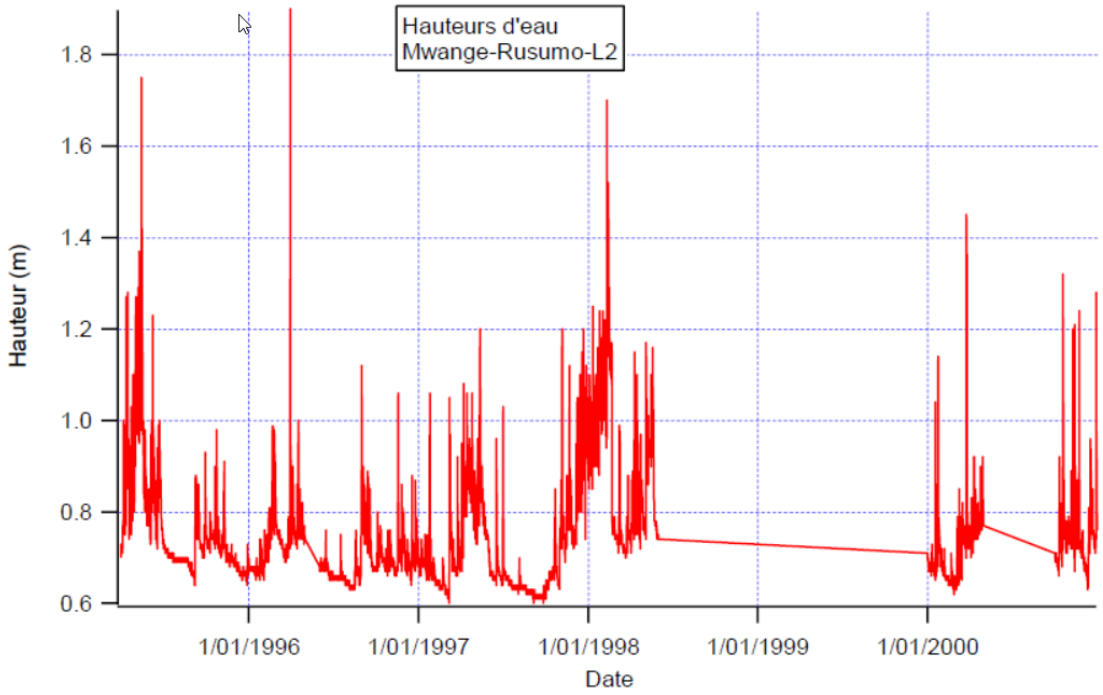


Figure 28: Snapshot of Mwange Water Levels (Source Water Resources Master Plan, SHER, 2014)

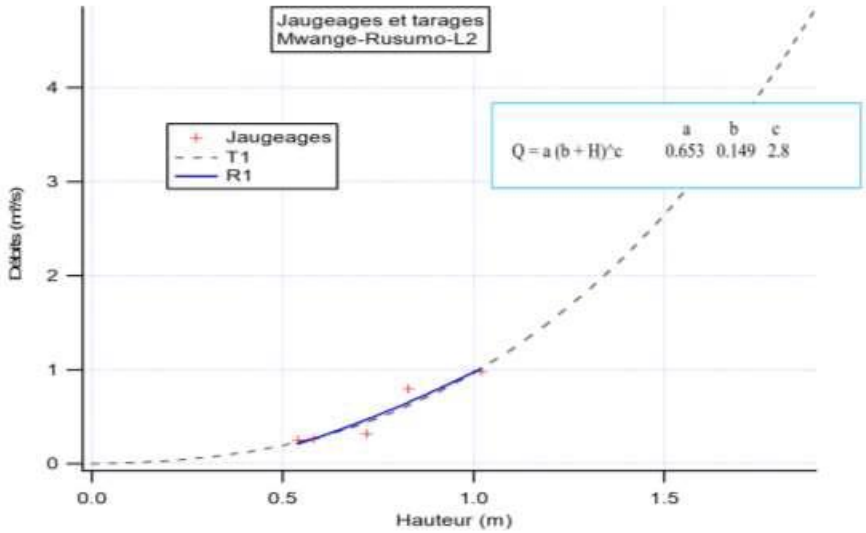


Figure 29: Rating Curve for Mwange-Rusumo (Source, WRMP 2014)

6.3 Estimation of water availability and calculation of Environmental flow

6.2.4. Mean Runoff

The mean runoff has been computed from the recorded data at Mwange-Rusumo station and extrapolated at other proposed alternative intake sites location. The interim reporthad tried to use HEC-HMS to estimate rainfall runoff but results were not satisfactoryto due lack of calibration data at the proposed intake site. The specific runoff approach was found to be most suitable in these kinds of catchments given the fact that Mwange-Rusumo station has quite some good data for at least 5 years and the rating curve wasgenerated and approved by the Rwanda Water Resources Master Plan (2012).

6.2.5. Specific Runoff Approach (Based on Recorded Flows)

The Mwange-Rusumo hydrometric station has quite good data for 5 years. This is quiteenough to base on decisions how much water resources are available to be used inMwange Water Supply for Gicumbi Town. It is assumed that the catchment of allproposed alternatives behaves the same way as the Mwange-Rusumo catchment. Asimilar specific runoff (flow per unit catchment area) is assumed for all the proposed alternatives.

6.3.2.1. Monthly Flows

3-daily values were statistically analysed and monthly averages computed as displayed in the graph in **Figure 30** as shown below. The figure exhibits missing data from June1998 to December 1999. The year 2000 also has missing data from May to September.

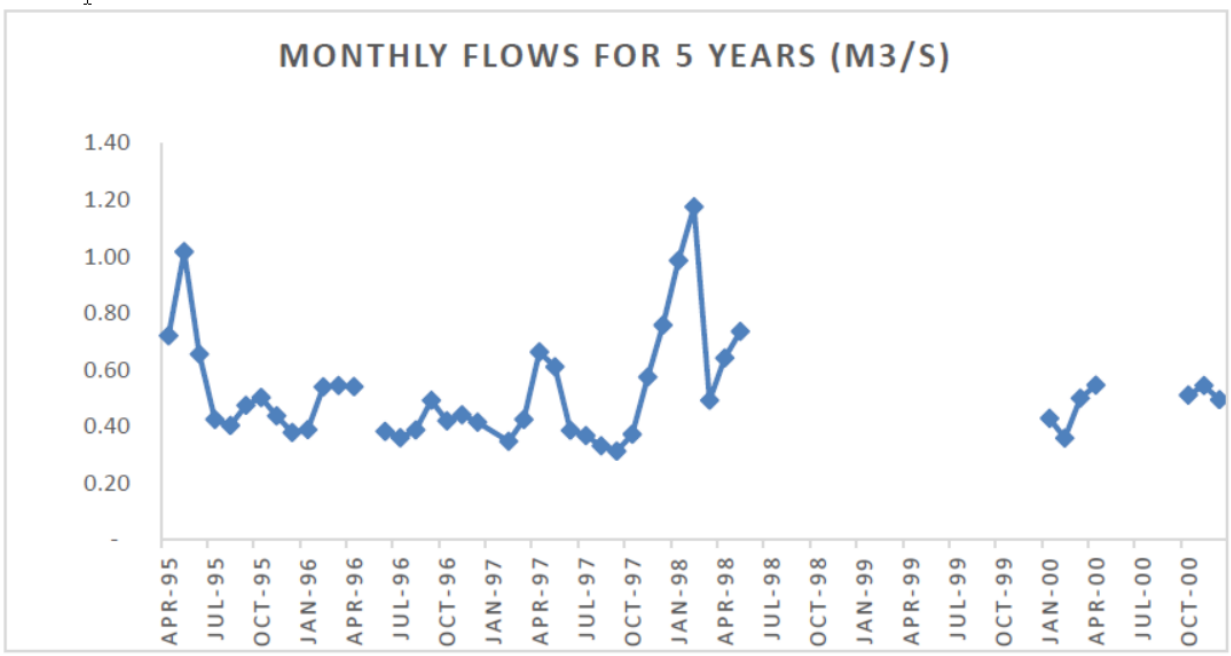


Figure 30: Monthly Flows at Mwange-Rusumo from 1995 to 2000

Further analysis has been done to compute the monthly average flow for the whole period of the available data and the following table was obtained.

Table 32: Monthly Flows at Mwange-Rusumo

Month	1995	1996	1997	1998	2000	Average
January		0.39	0.41	0.98	0.43	0.55
February		0.54	0.35	1.17	0.36	0.60
March		0.54	0.42	0.49	0.50	0.49
April	0.72	0.54	0.66	0.64	0.55	0.62
May	1.02		0.61	0.73		0.79
June	0.65	0.38	0.39			0.47
July	0.42	0.36	0.37			0.38
August	0.40	0.39	0.33			0.37
September	0.47	0.49	0.31			0.43
October	0.50	0.42	0.37		0.51	0.45
November	0.44	0.44	0.57		0.54	0.50
December	0.38	0.41	0.76		0.49	0.51
AVERAGE	**0.56**	**0.43**	**0.49**	**0.69**	**0.52**	**0.50**

The next graph **Figure 31**displays the data depicted in the table above. The overall average at the station is computed as 0.5 m^3/s with a minimum at 0.37 m^3/s in the month of August. All water balance will be computed on monthly basis and will consider the minimum of 0.37 m^3/s as the available water resource on which all water supply designs should consider.

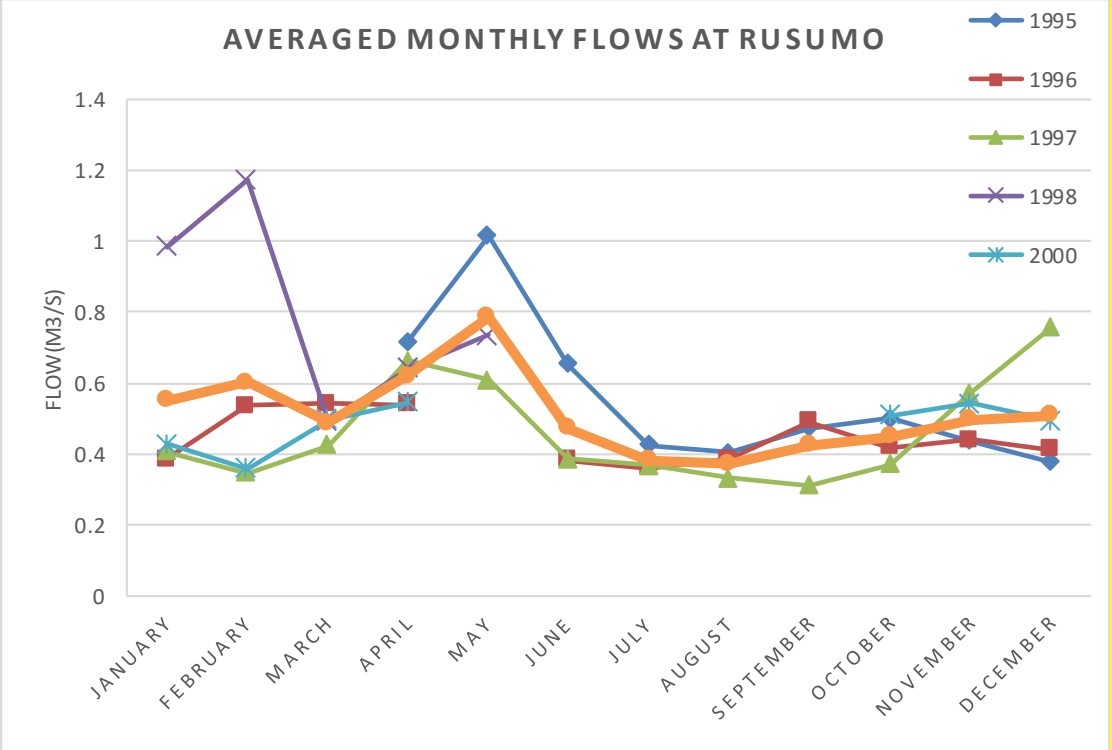


Figure31: Graphic Representation of Monthly Flow at Mwange-Rusumo

Based on the average monthly runoff at the gauging station, all the expected flows at various alternatives have been computed using aerial extrapolation. The table below displays expected flows at each intake options.

Table33: Computed Monthly Flow at Various Alternatives

	Station Mwange-Rusumo	ALTERN #1 (Feasibility Study)	ALTERN #2 (Tail water)	ALTERN #3 (Dam)	ALTERN #4 (Kagogo)	ALTERN #5 Down
Cath. Area (km^2)	48	43	51.15	36.62	102	64.27
January	0.55	0.49	0.59	0.42	1.17	0.74
February	0.60	0.54	0.64	0.46	1.28	0.81
March	0.49	0.44	0.52	0.37	1.04	0.66
April	0.62	0.56	0.66	0.47	1.32	0.83
May	0.79	0.70	0.84	0.60	1.67	1.05
June	0.47	0.42	0.50	0.36	1.01	0.63

July	0.38	0.34	0.41	0.29	0.82	0.51
August	0.37	0.33	0.40	0.28	0.79	0.50
September	0.43	0.38	0.45	0.32	0.90	0.57
October	0.45	0.40	0.48	0.34	0.96	0.60
November	0.50	0.45	0.53	0.38	1.06	0.67
December	0.51	0.46	0.54	0.39	1.08	0.68

6.2.3.2. Daily Flows

Three daily records were collected and analyzed. 4,009 daily flows were statistically analysed to understand the behaviour of daily flows in terms of guaranteed flows on which the project can be based on. A recession curve was produced as follows:

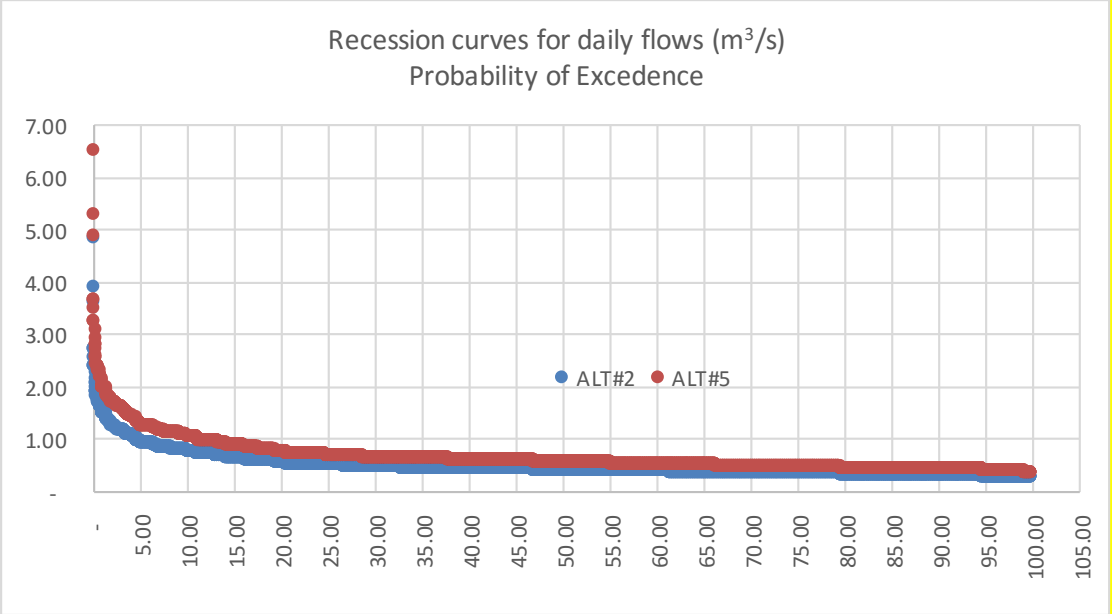


Figure32: Recession Curve for Mwange River

Table 34: Exceedance Probability at Alt. #2 and Alt. #5

No.	Exc. Prob.	ALT#2	ALT#5
1	5%	0.99	1.33
2	10%	0.81	1.09
3	20%	0.6	0.8
4	30%	0.5	0.67

5	40%	0.47	0.63
6	50%	0.44	0.59
7	60%	0.41	0.56
8	70%	0.39	0.52
9	80%	0.36	0.49
10	90%	0.35	0.47
11	95%	0.32	0.44
12	100%	0.30	0.40

The table above displays exceedance probability for various daily flow. An exceedance probability of 90% can be considered for this project. A minimum of 0.32 and 0.47 at Alt. #2 and Alt. #5 respectively can be considered with 90% degree of confidence.

6.2.6. Water Balance at the different proposed intake locations

From hydrological, water resources and water balance point of view all the proposed 5 alternatives have been analysed to come up with a better option to be implemented. All computations made in this section are based on the available monthly flow as depicted in **Table 35**. The **Table 35** computed the water balance for various alternatives. Alternatives #4 and #5 are the ones yielding a positive water balance.

Table 35: Water Balance Table for the 5 Alternatives

	Station	Option 1 (Feasibility Study)	Option 2 (Tail water)	Option 3 (Dam)	Option 4 (Kagogo)	Option 5
Catchment Area (km^2)	48	43	51.15	36.62	102	64.27
Available Flow (m3/s)	0.37	0.33	0.40	0.28	0.79	0.50
Sources	0.03	0.03	0.03	0.03	0.03	0.03
WS Project Requirement m^3/s	0.393	0.393	0.393	0.393	0.393	0.393
HPP Requirement	0.4	0.4		0.4		

Available Water (MCM/year)	12.72	11.49	13.49	9.93	25.96	16.71
WS Project (MCM/year)	12.39	12.39	12.39	12.39	12.39	12.39
HPP Requirement (MCM)	12.61	12.61		12.61		
Water Balance	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	**POSITIVE**	**POSITIVE**

Alternatives #4 and #5 exhibit positive water balance whereas alternatives #1, #2 and #3 resulted in a negative water balance due to the fact that they are located upstream of an existing HPP that has already has a 0.4 m^3/s water permit. Where possible, the negative water balance can be made positive with the help of a storage reservoir. Alternative #3 has been proposed with storage reservoir. The capacity of the reservoir can go up to the Mean Annual Runoff (MAR) equal to 12.37 MCM but still, challenges and conflicts may rise with the HPP.

6.2.7. Identification of Proposed Intake Sites

Under this study, five (5) alternative sites were identified and well discussed in the previous report. 4 sites are located on Mwange River and the 5th one is located on Kagogo River. From the intake, treated water will be pumped to the highest point located at Gihembe Refugee Camp. From Gihembe hill, distribution will be done by gravity. Four alternative intake locations have been investigated, which drains respectively an area of about 43, 51.15, 36.62, 102 and 64.27 km2. The drawing below shows the catchments area drained by the four intake site's alternatives and the location of the meteorological/ hydrometrical stations.

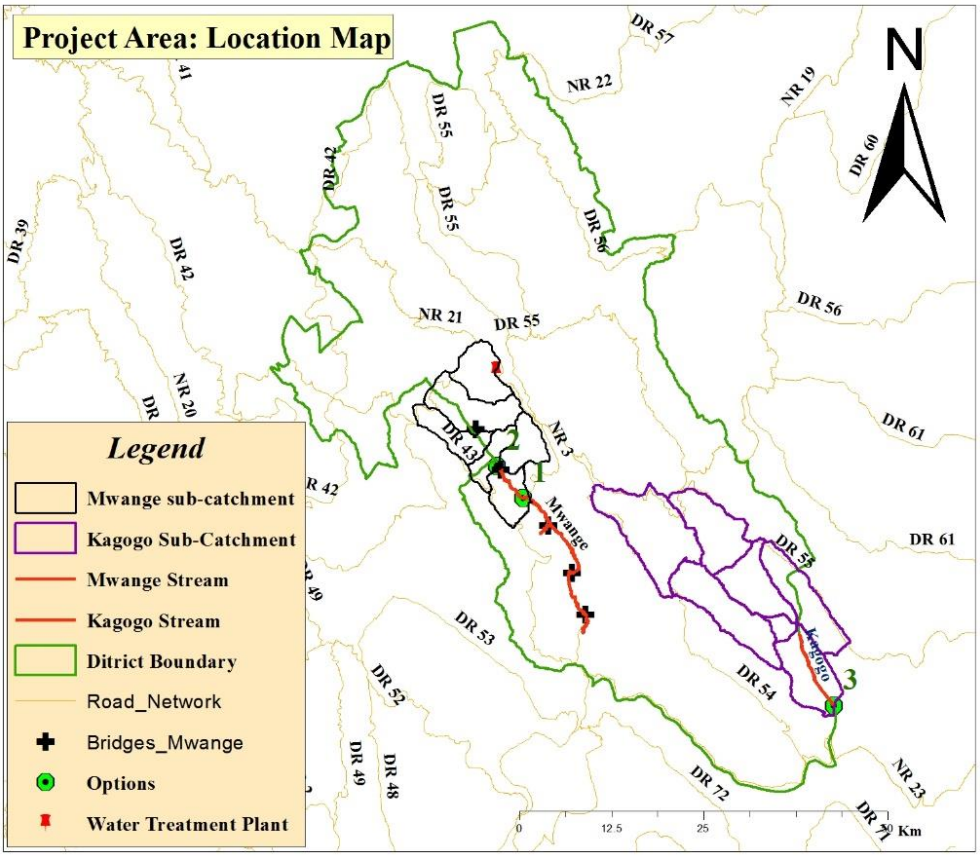


Figure 33: Location Map for the 5 Alternative Intake Sites

The proposed intake locations and the relevant watersheds features are summarized in the following table:

Table 36: Drained Area

SITE	LOCATION		BASIN ELEVATION		AREA
	GCS_WGS_1984 Decimal Degrees projection		MIN (masl)	MAX (masl)	(Km^2)
	Latitude	Longitude			
MWANGE SITE ALT. #1	-1.656012	30.078654	1793	2296	43
MWANGE SITE ALT. #2	-1.672818	30.092128	1677	2296	51.15
MWANGE SITE ALT. #3	-1.653919	30.076533	1802	2296	36.62
KAGOGO SITE ALT. #4	-1.795489	30.274192	1654	2296	102
MWANGE SITE ALT. #5	-1.672451	30.097017	1664	2296	64.27

6.2.8. Environmental Flow

The ecological flow is defined as the flow that remains in the river after the water supply requirement has been met. Given the fact that we will have no storage at the raw water intake, the minimum monthly flow is the critical one to be considered. The august flow (0.5 m^3/s) has been considered as a guaranteed flow which all designs are based. With a time-step of five years, the water balance has been computed with the exact amount of water demand and the available water in August (the driest month). All the remaining water in the stream has been considered as environmental flow available for the ecosystem. The following table estimates the ecological flow up to the planning horizon (2050).

Table37: Estimation of Environmental Flow

	2020	2025	2030	2035	2040	2045	2050
Demand	18,385.26	21,088.42	23,924.19	26,385.30	29,872.43	33,757.12	38,100.74
Available Flow (m^3/day)	43,200.00	43,200.00	43,200.00	43,200.00	43,200.00	43,200.00	43,200.00

Balance in m^3/day (Ecological flow)	24,814.74	22,111.58	19,275.81	16,814.70	13,327.57	9,442.88	5,099.26
Ecol. Flow %	57%	51%	45%	39%	31%	22%	12%

Up to 2045 we have ecological flow of more than 20% which is the minimum flow required to remain in rivers as per the regulations in Rwanda.

i. The present project is mainly dealing with phase I, and before phase II is implemented, another water resources assessment study will be conducted and required adjustments will be made
ii. This happens only in the month of August which can be acceptable given the fact that all the months have enough water and excess water balance
iii. From the intake, the stream meets another big stream at less than 4 km and at 12 km Mwange enter the Nyabugogo river which has enough water from Lake Muhazi
iv. From the intake down to Nyabugogo river, there is no other important user like irrigation scheme that might require a reasonable amount of water.

From the discussion above, the Alternative #5 is recommended to be used for Mwange Water Supply Project. The minimum available monthly flow is equal to 0.5 m^3/s in August and enough to supply Gicumbi town which is estimated around 0.393m^3/s in 2045. It is also important to compute the flow duration curve using daily values to understand which level of confidence is associated to the proposed minimum flow. Using daily flow records, the water demand will be met with 90% degree of confidence.

In terms of design flood, the results obtained using ORSTOM are recommendable during design of hydraulic structures.

The implementation of Mwange water supply system project is divided into two phases which are 0.278 m^3/s for phase I and 0.115 m^3/s for phase II totallying 0.393 m^3/s. The implementation of the project is as follow:

Table38: water demand for the various phases

Project Water Demand	**Phase 1 (2020-2035) (m^3/day)**	**Phase 2 (2035-2050) (m^3/day)**
Project Treated Water Demand	22,637.59	32,994.02
Water Treatment Plant Losses	2.5%	2.5%

Project Raw Water Demand	23,200.00	34,000.00

6.4. Analysis of Cumulative impacts of the project on Mwange river

The Phase I of Mwange water supply project will abstract 0.278 m^3/s which is equivalent to 47% of the total flow of Mwange river, being 0.59 m^3/s recently measured in July 2023 by WASAC and Rwanda Water Resources Board. This indicate that 53% of the available flow at the abstraction site will remain for both environmental flow (considered to be 20% minimum as per Rwandan regulations) and the remainder for other users (33%).In addition, the downstream of the abstraction site has more potential water resources in terms of water quantity as result of other 3 major tributaries to Mwange river.

The phase II of the same project, will be implemented from 2035 and will require 0.115 m^3/s in addition to the quantity of water taken in phase I totaling 0.393 m^3/s. The addition of the phase II of the project will lead to total abstraction of 66.6% of the total available flow in the river which guarantees the compliance with environmental flow. However, as the phase II will be implemented in 2035, there will be further assessment to update the current findings for water availability.

The ongoing hydropower plant was considered during analysis of the five alternatives proposed by the study. Given that the plant of water requirement 12.61MCM/year is located upstream,the three first alternatives proposed by the study were found not suitable as the calculation of water balance, in consideration of the mentioned hydropower water requirement, indicated a negative water balance as per the table and consequently they were rejected in favour of the alternative 5 which is located downstream the hydropower plant.

6.3 Analysis of construction Materials and Technology Alternatives.

Various alternative designs and technology has been evaluated by the proponent and various Professionals involved i.e. the water design and engineers, and surveyors and environmental consultants. After extensive discussions and relevant considerations, the various options were assessed and the most optimal design and technology were agreed as per the proposed plans, materials and technology.

The team will ensure that the project complies with all stipulated specifications and standards. The procedures used will ensure that the project conforms to the principle of best practice. The engineering team have utilized computer aided design technology such as ArchiCAD and AutoCAD to come up with the best design.

There is a wide range of construction and finishing materials which can be sourced locally and internationally. The proposed project will be constructed using modern, locally and

internationally accepted materials to achieve public health, safety, security and environmental aesthetic requirements. Equipment that saves energy will be given first priority which in line with the government policy of saving energy and also the global focus of reducing the GHG (Green House Gases). The same will apply to the equipment's that relate to water use where those that save water will be given first priority without compromising on cost or availability factors.

The concrete pillars and walls will be made using locally sourced stones, cement, sand (washed and clean), bricks, metal bars and fittings that meet the Rwanda Bureau of Standards requirements. Thus, in this case the **right construction materials technology and design** alternative is being used.

In terms of various resources, it is the intention of the developers to employ resource saving methods and technologies thus the developer will apply the best available **Resource conservation technology.**

6.4 Electricity and water supply

The main water and electricity to be used by the project infrastructures during construction and operation of the Proposed project and Water Treatment Plant will be supplied by EDCL/REG when connections are effective, to cover daily demand during the construction and operational phases of the project. The project will use electricity and water supply from EDCL/REG and this makes it the major source of electricity alternative and WASAC the main alternative source of water supply to the project construction and operational phases. However, there will be a standby generator in case of power shortage.

6.5 No- Project alternative

The No Project alternative option will entail leaving the population in the present situation and this option is not desirable considering the need of water supply in different part of the country. Though this option will not have direct environmental impacts there are many significant and specific benefits that would results in project implementation.

Benefits of the No-Project Option

The minor benefits of the No-Project Option are:

- Present flow regime of the proposed Water Supply source would be maintained.
- Short Term impacts caused by construction activities e.g. noise, dust generation, vibrations, etc., would not exist.
- Loss of the relatively small land to be used for construction of Water Treatment Plant, Water Storage Reservoir, etc., would not exist.
- Temporary inconvenience caused by construction activities in project area e.g. temporary road closure for pipeline crossings, would not exist.
- The limited possible water contamination associated to human activities within the area would not exist.

- The health risks associated with Water Treatment Plants i.e. handling of slightly harmful water treatment chemicals would not exist.

Negative Effects of the No-Project Option

- The growing population in project area will continue to suffer from water shortage caused by inadequate existing water supply system and a large percentage of the population living outside of the area of coverage of the existing water supply would continue having no access to safe water.
- The target for vision 2050 of having access to clean water will not be achieved.
- Occurrence of diseases caused by consumption of untreated drinking water would continue to be high.

Employment opportunities connected with the Project during and after implementation would not be available. Economic development of the area expected as a result of the Project would also be missed

CHAPTER SEVEN: PUBLIC CONSULTATION

Public consultation is useful for gathering environmental data, understanding likely impacts, determining community and individual preferences, selecting project alternatives and designing viable and sustainable mitigation and compensation plans.

Public consultation process for the proposed project took place at the scoping stage and the ESIA stage. The main objective for the consultation process was to involve the community at the very early stages so as to identify likely negative impacts and find ways to minimize negative impacts and enhance positive impacts of the project.

7.1 Objectives of Public Consultation

The overall goal of the consultation process is to disseminate project information and to incorporate the views of the project beneficiaries and Project Affected Persons (PAPs) in the design of the mitigation measures and a management plan.

The specific aims of the consultation process are to:

- Improve Project design and, thereby, minimize conflicts and delays in implementation;
- Facilitate the development of appropriate and acceptable entitlement options;
- Increase long term project sustainability and ownership;
- Reduce problems of institutional coordination;
- Make the resettlement process transparent; and
- Increase the effectiveness and sustainability of income restoration strategies, and improve coping mechanisms.
- All stakeholders and interested parties, are fully informed of the project and have the opportunity to raise their concerns;
- Any issues resulting from this process are addressed in the ESIA and incorporated into the design and implementation of the project.
- Consultation is done on sensitive issues and mitigation measures are established for management of any impacts that may arise during civil works and operation phase
- An important element in the process of impact assessment is consulting with stakeholders to gather the information needed to complete the assessment.
- Provide clear and accurate information about the project to the beneficiary community;
- Obtain the main concerns and perceptions of the population and their representatives regarding the project;
- Obtain opinions and suggestions directly from the affected communities on their preferred mitigation measures; and

- Identify local leaders with whom further dialogue can be continued in subsequent stages of the project.

7.2 Stakeholders Consultation and Public Participation

Public consultation is a key component of an ESIA process, its goal is to inform the local population, statutory bodies and local organizations and interested parties about the proposed project/activity. Further to this Public consultation is necessary for gathering environmental and social data, understanding likely impacts, determining community and individual preferences, selecting project alternatives and designing viable and sustainable mitigation and compensation plans.

The exercise identified all the stakeholders within and in the surrounding area including local community, local authorities, government ministries and agencies, government projects and private sector among other stakeholders. Though it's well noted that further stakeholder's consultation will take place during the development of the resettlement action plan.

During the preparation of this preliminary ESIAs and later on during the RAPs, extensive consultations were conducted. In general, Communities were given some detailed information about the project through presentations by consultant team. The presentations highlighted the project background, objectives, expected upcoming activities, potential socio-economic and environmental impacts. After the presentations the community was given opportunity to give their views, comments and queries. Questions were answered, clarifications offered and their recommendations received. Public consultation was undertaken to disseminate information to interested and affected parties (stakeholders), to solicit their views, fears and consult on sensitive issues.

Based on this the following issues were noted:

- The area has no clean water and the population draws its water from the streams and this is an issue during rainy season. And most of the population live far away from the water sources, it was indicated people moving for over one Kilometer to collect water from the stream.
- It was indicated that there are a few built up water sources which you find serving a whole village.
- The field survey indicated minimal Expropriation costs as the proposed site for the WTP has just a few houses, and therefore expropriation will mainly be on land than infrastructure.
- Lack of enough water in the area has led to out break of diseases especially in young children due to poor sanitation.

- Also school going kids miss school sometimes due to long distance taken to fetch water before they go to school.

7.3 Public Expectations from the Project

Issues raised during the stakeholder engagement process were compiled and summarised below and have been elaborated in more detail and considered in proceeding chapters for impact assessment and incorporation in the Environmental impact and management plan.

Table38: Summary of Issues Raised During Public Consultation

Issues at Hand	Stakeholders	Response to Issues at Hand
Lack of project awareness by locals	Local Population	Urgent and intensive sensitization of local population on project activities
Expropriation and compensation	Local Population	Compensation will be for those affected and will be guided by a Resettlement Action Plan (RAP), before project commencement.
Destruction of Crops without earlier warning	Local farmers	Clear planning schedule will be drawn, which will be referred to inform farmers not cultivate before construction commences.
Possibility of low wages to local workers for construction works.	Local residents of the area	The project coordination to ensure minimum wages by Rwanda labour law are followed by the contractor.

7.4 Summary of Views - Positive Impacts

The respondents mentioned the following positive impacts related to the proposed project.

- There will be reliable and safe water supply for the population of the three Gicumbi District
- Adequate water supply once the project is completed.
- Employment opportunities during the construction/ rehabilitation of water pipeline to the local youth.
- Installation of new pipes will reduce the cost of operation through checked water leakages.

- Health hazards associated with asbestos materials that made the old pipes will be eliminated once the project is done.

7.5 Analysis of Public Consultation.

The respondents had no major concerns raising the need not to implement the proposed project within their area. The respondents felt that the proposed project will be of great benefit not only for domestic purposes but also to the jobless youths and other professionals in the area.

The respondents however showed concerns on the need to conserve and manage the environment in a sustainable manner. Similarly, they felt that occupational health and safety were key issues which needed to be addressed when the proposed construction will take place.

7.6 Grievance Redress Mechanisms

This section identifies the procedures in which stakeholders can present their grievances for redress. Taking into account the complexity of resolving disputes and grievances, PAPs have to be informed about various grievance redress procedures and of their right to appeal if not satisfied. The Consultant proposes that the Supervising Engineer's office be in charge of collecting and forwarding the grievances to the relevant authority of redress.

The filing of grievances for accurate record keeping is important. If the complainant is not able to express his/her complaint in writing, he/she can be assisted by a local leader to file the complaint at the complaints desk in the project office. To ease follow-up, each complaint will be registered and assigned a unique reference number. The office will then evaluate the application and determine what implementing agency will resolve the issue.

A detailed grievance handling mechanism will be given in the proposed Resettlement Action Plan and will be guided by Rwanda legal mechanisms.

In case of any disputes and grievances, PAPs would be required to abide by the following a grievance channelling protocol;

- All complaints should be recorded and filed with Cell leadership for onward consideration by the Resettlement and Compensation Committee put in place for purposes of WASAC's project. The committees would be set by Social Development Specialist from WASAC and Director of Social Protection in the district.
- The Rwanda Expropriation Law clearly stipulates the complaints procedures for individuals dissatisfied with the value of their compensation. PAPs with complaints would be required to follow this procedure. The District Land Commission officer should

be present at the local meetings so as to closely follow the proceedings and to guide local leaders when addressing appeals

- In the event that the PAP rejects the value given by the Resettlement and Compensation Committee, they can ask for justification of the figure from the Committee. Should they still disagree with the value given, they can appeal to their local leadership starting at the Cell level, then the Sector and finally the District leadership.
- If the grievance is not resolved via the local leadership structure, and the District Land Committee upholds the original value, the complainant final resort shall be to file the case to the competent Court of Law. According to the Expropriation Law, filing a case in courts of law does not stop expropriation process to be affected. The suing for review of the compensation decision should be done within 15 days after the local appeals decision is made.

Pubic Consultations were carried out in all the 4 sectors that will benefit from this water supply project. Meetings were held at cell offices were a number of participants commented on this project as described in the sections above.

Table39: List Contacted persons

No	Name	Institution	Position	Phone No
1	Paterne Maniraguha	Gicumbi District	Infrastructure & Property Officer	0785645123
2	Felcien Niyoniringiy	Gicumbi District	Director OSC	0788493929
3	Joseph Vuguziga	Gicumbi District	Environmental Officer	0788262917
4	Emile Rugomeza	Gicumbi District	Natural Resources Specialiast	0788502200
5	Chantal Bamurange	Centre De Sante Gicumbi	Director	0788497132
6	Tharcisse Turatsinze	Director GS Byumba	School Director	0788808021

7	Solane Umuhire	GS Byumba	Director Of Studies	0788574478
8	Lucien Ndacyayisenga	Ecole Primary SOS Byumba	Teacher	0788620385
9	Justine Mutamba	Ecole Primary SOS Byumba	Teacher	0781882709

CHAPTER EIGHT: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN.

8.1 Preamble.

The Environmental and Social Management Plan (ESMP), is a vehicle for the effective implementation of the mitigation measures to ensure successful execution of the Project in an environmentally sound manner. The ESMP provides mechanism to address the adverse environmental as well as social impacts of the proposed project during its execution, to enhance project benefits and to introduce standards of good practice to be adopted for all project works.

An Environmental and Social Management Plan (ESMP) has been developed for the various proposed project works/activities. The EMP covers project construction/ Reclamation phase and the production/ rain-fed phase.

For each expected impact, the ESMP requires the following information:

- ✓ A comprehensive listing of mitigation measures.
- ✓ The institutions responsible for ensuring the full implementation of the actions.
- ✓ The socio-environmental issues and parameters to be monitored in order to ensure effective implementation.
- ✓ A time scale for implementation to ensure that the objectives of the mitigations are fully met with.

8.2 Objectives of the ESMP

- ✓ To ensure environmental conservation and sustenance to ensure a balanced approach between the development and the ecosystem.
- ✓ To provide a framework for the implementation of mitigation measures.
- ✓ Ensure and enhance safety during the construction and operation Phases
- ✓ Promoting environmental ethics within concerned parties and users.
- ✓ To take timely action in case of an unexpected situation.
- ✓ To support smooth implementation of project with minimum losses to environmental and social infrastructure.
- ✓ Manage and monitor social and socio-economic developments.
- ✓ To ensure compliance with national and international obligation.

8.3 Responsibilities for ESMP implementation.

Responsibility for the incorporation of mitigation measures for the project lies with the contractor, the Environmental Management Authority (REMA), the Local Authorities and the developers who must ensure specified mitigation measures are implemented.

Table40: Showing different institutions and their responsibilities.

Institution/Origination	Role	How to perform the task/frequency
REMA	General Monitoring and inspections.	➢ Site visits ➢ ESMP Review. ➢ Follow up and ensuring approval of the annual environment audits.
RDB	EIA report Review and Environmental Certification	➢ Once during the Initiation of the Project. ➢ Project After care.
RWB	Water Resources Management.	➢ Responsible for ensuring monitoring of quality and quantity of surface and ground water.
WASAC	Routine Monitoring	➢ Continuous Monitoring and undertaking of reviews of various targets. ➢ Provision of finances to implement the ESMP. ➢ Meet or exceed all environmental legal and other requirements. ➢ Encourage open, honest and responsive communication of environmental and social matters with employees, stakeholders and the community;
Local Authorities(District)	Routine Monitoring Issuance of construction and Operation Permits	➢ Assess compliance with the ESMP.

Table41: Environmental and Social Management Plan during preparatory phase

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
Preparatory phase						
• Local community • Contractor workers	Workforce recruitment	Risk of conflicts over discrimination, corruption and other conflicts during workforce recruitment	• Priority of employment is given to the local people • Compliance with national laws (workers with contracts, wages, no workers below the age of 16 years and no discriminations against women or other vulnerable). • Establish a Grievance Redress Mechanism	WASAC Gicumbi District Contractor	Before works start	n/a
		Potential risk of insecurity due to influx of job seekers.	• The contractor shall develop a Labour Influx Management Plan to manage influx of workers. • The above plan shall include awareness of the local	WASAC Gicumbi District Contractor	Before works start	n/a

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
			population to inform them about the potential influx and how they should behave. • Establish a Grievance Redress Mechanism			
• Local community • Contractor workers	Installation of the project camp site and mobilisation materials and equipment.	Risk accidents during site installation, mobilization of materials and equipment will increase movement of vehicles, heavy trucks with high risk to induce accidents.	• There shall be risk assessment for all proposed campsites subject to approval by the client. • Campsite shall not be located in the very inhabited place especially those typical area where we find with kids playing on road. • There shall be proper housekeeping measure to manage stock of materials.	Contractor	Before and during works	30,000,000

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
			• The campsite shall be equipped with fire extinguisher and first aid arrangements • Fence the campsite and post site safety notice at the entrance and prevent any entrance of visitors • Speed limitation to 20 km/h for engine and trucks within the campsite. • Report any accident and apply corrective measures			
Animals, plants, and biodiversity	Earth and vegetation clearing during campsite installation	Damage to ecosystem habitat and biodiversity loss	• Safeguard protected plants and other plants where possible • Earth and vegetation clearing shall be limited to the minimum required space.	Contractor	During construction phase	22,000,000

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
			• Restore the site and simulate the habitat, by re-planting indigenous tree species and plants.			
• Land owners Local Community	Land acquisition processes.	Risks of conflicts related to loss of land or land acquisition. In this phase the land will be required to establish a project site (camp site)	• Fair compensation at full replacement cost of properties and lands to be based on the approved Resettlement Action Plan, AfDB Operational Safeguard 2 and the Expropriation Law in Rwanda; • Ensure participation of owners and local administration in all compensation process; • Establish the Grievance Redress Mechanism	WASAC, Gicumbi District of Gicumbi	Before works start	481,758,865
Construction phase						

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
• Ecosystem Local community	Establishment of raw water intake facility	Impacts on water quality and subsequent ecosystems and habitat. The pollution shall be induced by works to establish water intake at the source increasing soil erosion and sedimentation.	Deviate water river when installing the water intake structure.	Contractor	During construction phase	200,000
		Modification of water flow by capturing water sources in Mwange water sources. This modification will threaten normal use of water by local community in agriculture, households use, animal feeding, and	Ensure that the quantity of available water is shared equitably. The total demand for the planned WSS in 2050 is 24,000 m^3/day while the flow conveyed through the river is Q = 12,960,000 m^3/day (150 m3/s), this indicated that 0,2% of water shall be captured from the river which does not represent a threat to the water	Contractor	During construction phase	n/a

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
		will threaten also biodiversity that depends on water flow from those sources.	balance and subsequent existing water uses.			
• Biodiversity • Ecosystem	Earth and vegetation clearing during sites preparation (sites for water intake, pumping stations, water treatment plant, pipes laying, tanks, tec…)	Loss of habitat and biodiversity due to site clearance, removal of top vegetable soil, and site leveling	• Restore the site and simulate the habitat, by re-planting indigenous tree species and plants • Safeguard protected plants and other plants where possible	Contractor	During construction phase	500,000

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
• Animals • Local Community • Workers	Trenches, foundation, borrow site excavation related works.	Risks of accidents of animals, people living near the project area, workers by falling in the excavated pits, trenches.	• Excavated trenches and pits shall be refilled immediately when the construction works is completed. • Excavated trenches and pits shall be protected by barricades or other safety barriers during the time those trenches or pits can't be immediately refilled.	Contractor	During construction phase	1,800,000
• Local community • Workers • Road users	Laying of pipes along the asphalt road (Gicumbi)	Risk of road accidents as some of works will be completed on the main road (Gicumbi) with high volume of traffic.	• There shall be a risk assessment for all works that will be completed near the asphalt road. • There shall be traffic management for all works that will be completed on the main road.	WASAC, Gicumbi District of Gicumbi Contractor Supervising firm	During construction phase	n/a

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
			• Involvement of the national police-traffic department.			
• Soil • Water courses • Vegetation	Soil excavation at all sites (water intake, pumping stations, water treatment plant, pipes laying, tanks, tec…)	Risks of soil erosion: excavated soil if not remove can be eroded in the neighboring areas.	• Remove soil immediately after excavation and store it in designated place. • Construct soil stability structure around stored soil.	Contractor Supervising firm	During construction phase	200,000
• Workers • Local community	Construction of proposed WSS facilities (intake, water treatment plant, pipes,	Risk of health injuries and accidents at work (falling, hit by flying or falling objects, hit by reversing vehicle, cuts, etc…)	• Established effective medical emergency response plan • Ensure availed first aid kits and train workers on use. • Safety signs availed at the site • Personal protective equipment availed (Types and quantities)	Contractor Supervising firm	During construction phase	6,000,000

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
	pumping stations, etc…)		• Documented risk Assessment and its communication • Health and safety training program and filled training participation list			
• Road users	Activities requiring road deviation like pipes laying along the road and or across the road.	Disruption of road users' movement on the road due to road closer, deviation during pipes laying activities.	• The contractor will seek permission to RTDA when there is planned work that will disrupt the road use. • There shall be signage to indicate the nature of disruption and guide road users on the alternative routes. • There should be consultations in the planning phase on how the traffic will be managed for all activities completed on road.	WASAC, Gicumbi District of Gicumbi Contractor Supervising firm	During construction phase	

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
• Soil • Water • Air	Generation of waste from construction activities (rest of paints, packaging)	Contamination of the soil, air and water by waste generated during construction works.	• Follow the 3 R (Reduce, Reuse, Recycle) hierarchy used in waste management. • Ensure proper mechanism to deal with spills (avail spill kits to contain oil and other chemical spill)	Contractor Supervising firm	During construction phase	500,000
• Workers • Local community	Labor influx- Recruitment and accommodating many people in one place from different provenance.	Risk of disease transmission between workers themselves, between workers and the local community (example of disease: HIV/AIDS, low hygiene related diseases)	• Measures to prevent poor hygiene and sanitation including availing hand washing and proper sanitary facilities. • Sensitize about prevention of HIV/AIDS and sexually transmitted diseases. • Provide condoms in some places like toilets	WASAC Ministry of Health Contractor Supervising firm	During construction phase	3,000,000

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
			• Recruit among local workforce so they can work and return at their home. • Workers required to register to the mutuelle de santé.			
• Workers	Human resources management related activities	Risk of delay or non-payment of casual labors	• District will closely supervise timely payment of labour by the contractor, • In case the contractor does not pay labor, the District shall hold his pending payment. • The District should also request the contractor to provide an assurance covering this kind of issues. • Strictly follow the labor law	WASAC, Gicumbi District of Gicumbi Contractor Supervising firm	During construction phase	n/a

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
• Local community • Workers	Construction activities (excavation, elevations, installation of pumps and other equipment, blasting, etc…)	Disturbance of the neighboring habitations due to noise, dust and vibration	• Use less heavy machinery that emits less gases and noise. • Early engagement and awareness raising to the community about construction activities • Provide personal protective equipment like dust mask and ear muffs. • Work hours limited to the day working period (7h00 am to 5h00 pm)	Contractor Supervising firm	During construction phase	600,000 Rwf
Operational phase						
• Biodiversity • Local communities	Water withdrawal from Mwange river.	Conflicts from different users of Mwange river water arising from water abstraction competition	• Every water user should respect his water abstraction level and seek water abstraction license from the	WASAC, Gicumbi District WTP Operator	During operational phase	n/a

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
			RWB before any activity is undertaken. • For this project, the total demand for the planned WSS in 2050 is 24,000 m^3/day while the flow conveyed through the river is Q = 12,960,000 m^3/day (150 m3/s), the quantity of water to be withdrawn shall not go beyond 0,2% of the total quantity of the river water.			
		Impacts on water quantity and quality, hydrological pattern of Mwange river, etc	• WASAC shall ensure that water abstracted from Mwange river shall not compromise water quality, quantity, and hydrological pattern required for the survival of ecosystems.	WASAC, Gicumbi District WTP Operator	During operational phase	n/a

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
		Conflicts related to the abstraction of transboundary water resources that might affect neighboring countries.	• WASAC shall seek a permit to abstract water as transboundary resources.	WASAC WTP Operator	During operational phase	n/a
• Soil • Water • Local community	Water treatment activities	Impacts related to management of sludge (bad smell, water & soil contamination)	• Establish sludge aerobic stabilization site which allows the reduction of odors, pathogens, the presence of viable seeds and shall prevent pollution to environment. • The stabilized sludge shall be composted and used as soil amendment.	WASAC WTP Operator	During operational phase	35,000,000
• Soil • Water	WSS maintenance operations	Risk of water leakage from broken pipes	• Avail a team of trained technicians ready for repair at any time the pipes break	WSS Operators	During operational phase	Maintenance and operational costs

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
• Local community		causing water and soil erosion.	• Use strong pipes during construction • Establish a water leakage reporting channel and communicate it to the people living near the WSS network • Conduct awareness among the population in that area and ask them to communicate any water leakage they may notice.			
• Local community	WSS maintenance operations	Conflict may arise over insufficient water distributed and people may fight for the small quantities available inducing them into crimes.	• Awareness on efficient use of natural resources available. • Ensure continual supply of water and establishment of as many as possible community water points.	WASAC, Gicumbi District WSS Operator	During operational phase	Maintenance and operational costs

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
• WSS system • Workers • Local community • Environment	WSS maintenance operations	Risk of fire outbreak during the operations of the WSS especially at the water treatment facility	• The water treatment plant shall be equipped with fire extinguisher and first aid arrangements • Workers shall be trained how to use fire extinguishing system. • A fire marshal team shall be established and trained to prevent and/or stop fire.	WASAC, WSS Operator	During operational phase	4,000,000
• Soil • Water • Air	WSS operations	Contamination of the soil, air and water by waste generated during operations of the WSS.	• Follow the 3 R (Reduce, Reuse, Recycle) hierarchy used in waste management. • Separate waste from the source and ensure hazardous waste are properly disposed off.	WSS Operator	During operational phase	n/a
• Climate	Use of non-renewable energy source.	Risk of increased greenhouse gas (GHG) emissions and amplified	• Use renewable source of energy where applicable.	WASAC, WSS Operator	During operational phase	n/a

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
		vulnerability to climate change.	• Encourage the use of machinery and equipment with low emissions of GHG.			
Decommissioning phase						
• Soil • Water Local community	Demolition and removal of debris from the WSS facilities	Soil and water pollution (surface and ground water) due to construction waste generation	• Follow the 3 R (Recover, Reuse, Recycle) hierarchy used in waste management. • All materials from demolition shall be recovered for reuse. • Non-reusable and non-recyclable materials shall be disposed in environmental approved manner.	WASAC, Contractor, Supervising firm.	Decommissioning phase	n/a
• Air Local community	Demolition activities.	Pollution to the ambient air affecting the air quality due to particulate matters that shall be released in the	• Regularly spread of water on the site during demolition works.	WASAC, Contractor, Supervising firm.	Decommissioning phase	8,000,000

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
		atmosphere from demolition activities.	• Manual demolishing to increase the quantity of materials recovered for reuse.			
• Local community • Wildlife animals	Demolition activities.	Increase of noise levels	• The works shall be scheduled between 7 a.m and 5 pm to avoid noise during night. • Preferably adopt labor intensive (manual) demolishing to avoid noise by machinery. • Ensure good maintenance of machinery.	Contractor, Supervising firm.	Decommissioning phase	n/a
• Workers • Local communities	Demolition activities.	Risk of health injuries and accidents at work (falling, hit by flying or falling objects, hit by reversing vehicle, cuts, etc…)	• Documented risk Assessment and its communication • Established effective medical emergency response plan • Ensure availed first aid kits and train workers on use. • Safety signs availed at the site	Contractor, Supervising firm	Decommissioning phase	6,500,000

Impact's receptor	Activity	Negative Impacts	Proposed mitigation measures	Responsible party	Timeline	Cost (Rwf)
			• Personal protective equipment availed (Types and quantities) • Health and safety training program and filled training participation list			
					Total ESMP budget	**600,058,865**

CHAPTER NINE: ENVIRONMENTAL AND SOCIAL MONITORING PLAN (ESMONP)

9.1. Introduction

The benefits of environmental and social monitoring plan fall in three general categories: (1) to audit mitigation measures, (2) to refine impact assessment methods, and (3) to improve project outcomes through adaptive environmental management. First, monitoring determines whether responsible agencies have implemented the proposed mitigation measures and whether these measures were effective; second, it compares the actual effects of a project to its predicted effects; and third, monitoring improves project outcomes through adaptive environmental management.

9.2. Institutional arrangement and roles

For this project WASAC will play the oversight role. The oversight will include coordination and monitoring of performance of implementation of the project, risk management, monitoring & evaluation, and disclosure of information, developing and putting in place performance agreements, etc. Agencies that will play a key role in implementing environmental and social safeguards recommendations are RDB in charge of issuance of ESIA certificate and REMA in charge of monitoring the implementation of the ESMP.

It is worth noting that the contractor (to be procured), the supervising firm (to be procured), WASAC, Gicumbi District will play a key role in the implementation of the project ESMP. The success in implementation of the project ESMP will highly depend on their joint efforts. The contractor and the supervising consultant shall have permanent staff (environmentalist and health and social safeguard officer), with the required skills and experience.

9.3. WASAC

WASAC strives to provide quality, reliable, and affordable water and sewerage services through continuous innovations and envisions to be the most sustainable Water and Sanitation Utility in Africa, exceeding stakeholder's expectations. WASAC has the responsibilities to manage the water and provide sanitation services in in Rwanda and under this project, it will be fully involved in implementing the Environmental and Social Monitoring Plan of this report as a national agency in charge of the operational phase.

9.4. Rwanda Development Board (RDB)

RDB shall review and approve the ESIA Reports and issue ESIA certificate.

9.5. Rwanda Environment Management Authority (REMA)

REMA shall:

a) Monitor and supervise the implementation of the environmental and social impact assessment and any other environmental study.
b) Monitor and assess development programs to ensure compliance with the laws on environment during their preparation and implementation.

The contractor shall:

a) Be responsible for developing a contractor's ESMP(CESMP) to achieve the environmental specifications contained herein and the relevant requirements contained in the certificate of approval issued by RDB.
b) Be responsible for the overall implementation of the CESMP in accordance with the provisions of the ESIA and its conditions of approval issued by RDB.
c) Ensure that all third parties who carry out all or part of the contractor 's obligations under the Contract comply with the requirements of the ESIA and CESMP and work closely with WASAC and Gicumbi District.
d) Develop a CESMP that comprises actions for the rehabilitation of borrow pits, dumping sites and quarries.
e) Contracting staff and provide them with PPEs.
f) Ensure the health and safety of both workers and communities.
g) Restore the borrow pits and quarry to the near previous condition.
h) Conduct awareness programmes for HIV/AIDS, STDs, and other transmissible diseases.

9.6. Supervising firm/ consultant

The consultant will be responsible for issuing instructions to the contractor and where environmental considerations call for action to be taken. The consultant Environmental Officer from the supervising firm shall submit monthly reports to WASAC and concerned Gicumbi District on the progress of implementation of ESIA provisions. In case of emergency of GBV, there should be a report within 24 hours. The supervising consultant will be responsible for

the monitoring, reviewing, and verifying of compliance with the ESIA and CESMP and conditions of the certificate of approval by the Contractor. His duties in this regard will include, inter alia, the following:

- Confirming that the certificate of approval and all permits required (ESIA certificate, permits for establishment of borrow pits, dumpsites, quarries, etc.) are following national regulations and AfDB's ISS.
- Monitoring and verifying that the CESMP, conditions of approval are always adhered to and acting if specifications are not followed.
- Monitoring and verifying that environmental and social risks and impacts are prevented or kept to minimum.
- Reviewing and approving method statements, to ensure that the environmental and social specifications contained in the CESMP, and the certificate of approval are adhered to.
- Monitoring the undertaking by the contractor of environmental awareness training for all new personnel on site during construction and for maintenance activities during operation.
- Ensuring that activities on site comply with all relevant environmental legislation.
- Ordering the removal of personnel and/or equipment not complying with the specifications of the CESMP and/or the certificate of approval.
- Undertaking a continual internal review of the CESMP and submitting any changes to WASAC and concerned Gicumbi District.
- Recommend additional environmental protection measures, where deemed necessary.
- Providing report back on any environmental issues during site meetings.
- Submit the status of the CESMP implementation on monthly, quarterly basis and at the end of the project.

9.7. Local Community

Local communities will be mostly affected by project impacts. The local community shall:

a) Provide information on violation or non-compliance to environmental requirements,

b) Participate in and provide information on the effectiveness of grievance resolution.

9.8. Organization of the WSS users and general maintenance

In respect of the provisions of the National Water Supply Policy (2016), it is advised to involve Gicumbi District in asset management. WASAC is advised to work with each district's water board in the management of WSS infrastructure and to position that district board as the contact point for water user committees, as the consumers' voice, as well as for reports and complaints received at lower decentralized levels (village to sector level).

Also, the beneficiaries of water supply services shall be actively involved in identification, planning, design and project implementation, and water users' committees should be actively involved in M&E of water service levels provided by service providers. In particular, they will choose the service level that responds to their needs. User associations/committees shall be involved in the oversight arrangements and shall have the role to represent consumer interests and user rights; their rights and obligations will be firmly established in the contractual and regulatory arrangements. The general maintenance of WSS infrastructure shall be under the responsibility of WASAC in coordination Gicumbi District.

11.4. Environmental and social monitoring plan for the preparation phase

Table42: Environmental and Social Monitoring Plan for preparation phase

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
Preparatory phase							
• Local community • Contractor workers	Risk of conflicts over discrimination, corruption and other conflicts during workforce recruitment	Priority of employment is given to the local people	Verification of the number of local households employed in the project.	Number of households with a member hired	Weekly	Contractor	n/a
		Compliance with national laws (workers with contracts, wages, no workers below the age of 16 years and no discriminations against women or other vulnerable).	Request IDs of job seekers before contracting or engaging them in the work.	Identity cards of workers	Daily	Contractor. Supervising firm.	Contractual budget

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
		Establish a Grievance Redress Mechanism	Verification of the GRCs operations and reports.	Number of established GRC	Weekly	Contractor. Supervising firm. WASAC	n/a
	Potential risk of insecurity due to influx of job seekers.	The contractor shall develop and implement a Labour Influx Management Plan which include awareness of the local population to manage influx of workers.	Verification of the availability and implementation of an approved Labor Influx Management plan	Labor Influx Management plan and implementation report	Before starting of the recruitment and on monthly basis	Contractor. Supervising firm. WASAC	Contractual budget
		Establish a Grievance Redress Mechanism	Verification of the GRCs operations and reports.	Number of established GRC	Weekly	Contractor. Supervising firm. WASAC	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
• Local community • Contractor workers	Risk accidents during site installation, mobilization of materials and equipment will increase movement of vehicles, heavy trucks with high risk to induce accidents.	There shall be risk assessment for all proposed campsites subject to approval by the client.	Verification of availability of the risk assessment report	Risk assesment report	Once before works and every time a new work is proposed	Contractor. Supervising firm. WASAC	n/a
		Campsite shall not be located in the very inhabited place especially those typical area where we find with kids playing on road.	Verification of the location of the campsite.	Location of the camp-site	Once before starting the works	Contractor. Supervising firm. WASAC	n/a
		There shall be proper housekeeping plan to manage stock of materials.	Verification of the availability and implementation of an approved	proper housekeeping plan and implement ation report	Before starting of works and on monthly basis	Contractor. Supervising firm. WASAC	Contractual budget

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
			proper housekeeping plan				
		Provide Personal Protective Equipment (PPEs) to all workers (e.g., helmets, dust masks, gloves, safety glasses, boots, and high visibility jackets).	Counting of workers with PPEs at the site.	Number of PPEs	Daily	Contractor. Supervising firm.	Contractual budget
		The campsite shall be equipped with fire extinguisher and first aid arrangements	Counting the number of first aid kit provided	Number of first-aid kits	Daily	Contractor	Contractual budget
		Fence the campsite and post site safety notice at the entrance and prevent any entrance of visitors	Verification of the campsite fence	Constructed fence	End of campsite construction	Contractor	Contractual budget

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
		Avail tout-risque chantier insurance covering the entire construction site.	Verification of the insurance document.	Copy of insurance	Daily	Contractor	Contractual budget
		Ensure that all workers have medical insurance.	Verification of medical insurance documents.	Copy of medical insurance	Daily	Contractor. Supervising firm.	Covered by workers
Animals, plants, and biodiversity	Damage to ecosystem habitat and biodiversity loss	Safeguard protected plants and other plants where possible	Counting the number of protected plants	Number of protected plant	Before starting of works and every 6 months	Contractor. Supervising firm.	Contractual budget
		Earth and vegetation clearing shall be limited to the minimum required space.	Measuring the surface of cleared area	Surface of cleared area	Monthly	Contractor. Supervising firm.	Contractual budget

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
		Restore the site and simulate the habitat, by re-planting indigenous tree species and plants.	Measuring the surface of the restored area	Surface of restored area	After construction works.	Contractor. Supervising firm.	Contractual budget
• Land owners • Local Community	Risks of conflicts related to loss of land or land acquisition. In this phase the land will be required to establish a project site (camp site)	Fair compensation at full replacement cost of properties and lands to be based on the approved Resettlement Action Plan, AfDB Operational Safeguard 2 and the Expropriation Law in Rwanda;	Verification of the approved RAP report and its implementation monitoring reports.	Report of RAP implementation	Monthly	Contractor. Supervising firm.	n/a
		Ensure participation of owners and local administration in all compensation process;	Verification of public consultation report	Public consultation report	Before starting of works.	Contractor. Supervising firm.	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	**Indicator**	**Frequency**		
		Establish the Grievance Redress Mechanism	Verification of the GRCs operations and reports.	Number of established GRC	Weekly	Contractor. Supervising firm. WASAC	n/a
Construction phase							
• Ecosystem Local community	Impacts on water quality and subsequent ecosystems and habitat. The pollution shall be induced by works to establish water intake at the source increasing soil erosion and sedimentation.	Deviate water river when installing the water intake structure.	Verification of the implementation of water deviation measure	Water quality monitoring report	Monthly	Contractor. Supervising firm. WASAC	400,000

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
	Modification of water flow by capturing water sources in Mwange water sources. This modification will threaten normal use of water by local community in agriculture, households use, animal feeding, and will threaten also biodiversity that depends on water flow from those sources.	Ensure that the quantity of available water is shared equitably. The total demand for the planned WSS in 2050 is 24,000 m^3/day while the flow conveyed through the river is Q = 12,960,000 m^3/day (150 m3/s), this indicated that 0,2% of water shall be captured from the river which does not represent a threat to the water balance and subsequent existing water uses.	Measurement of the quantity of water in the river and compare to the quantity withdrawn by the project.	Volume of water withdrawn. Volume of the total water flowing in the river.	Monthly	Contractor. Supervising firm. WASAC	150,000
• Biodiversity • Ecosystem	Loss of habitat and biodiversity due to site clearance,	Restore the site and simulate the habitat, by	Measure the restored surface	Restored surface	After completion of	Contractor. Supervising firm.	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	**Indicator**	**Frequency**		
	removal of top vegetable soil, and site leveling	re-planting indigenous tree species and plants			construction works.	WASAC	
		Safeguard protected plants and other plants where possible	Counting the number of protected plants	Number of protected plant	Before starting of works and every 6 months	Contractor. Supervising firm.	n/a
• Animals • Local Community • Workers	Risks of accidents of animals, people living near the project area, workers by falling in the excavated pits, trenches.	Excavated trenches and pits shall be refilled immediately when the construction works is completed	Verification of trenches refilling	The length of refilled trenches vs those not refilled	Daily basis	Contractor. Supervising firm.	n/a
		Excavated trenches and pits shall be protected by barricades or other safety barriers during the time those trenches or pits can't be immediately refilled.	Verification of the protected trenches	The length of the protected trenches	Daily basis	Contractor. Supervising firm.	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
• Local community • Workers • Road users	Risk of road accidents as some of works will be completed on the main road (Gicumbi) with high volume of traffic.	There shall be a risk assessment for all works that will be completed near the asphalt road.	Verification of availability of the risk assessment report	Risk assesment report	Once before works and every time a new work is proposed	Contractor. Supervising firm. WASAC	n/a
		There shall be traffic management for all works that will be completed on the main road.	Verification of availability of the traffic management plan and its implementation report.	Traffic management plan and its implementation report	Once before works and monthly basis	Contractor. Supervising firm. WASAC	n/a
• Soil • Water courses • Vegetation	Risks of soil erosion: excavated soil if not remove can be eroded in the	Remove soil immediately after excavation and store it in designated place.	Measuring the quantity of spoil removed and disposed in environmental	Quantity of spoil disposed in environmental	Daily	Contractor. Supervising firm.	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	**Indicator**	**Frequency**		
	neighboring areas.		approved manner	approved manner			
		Construct soil stability structure around stored soil.	Measuring the quantity of spoil stability structure established	Quantity of spoil stability structure	Daily	Contractor. Supervising firm.	n/a
• Workers Local community	Risk of health injuries and accidents at work (falling, hit by flying or falling objects, hit by reversing vehicle, cuts, etc…)	Established effective medical emergency response plan	Verification of availability of the medical emergency response plan and its implementation report.	Medical emergency response plan and its implementation report	Once before works and monthly basis	Contractor. Supervising firm. WASAC	n/a
		Ensure availed first aid kits.	Counting the number of first	Number of first-aid kits	Daily	Contractor	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
			aid kit provided				
		Safety signs availed at the site	Counting the number of safety signs provided	Number of safety signs	Daily	Contractor	n/a
		Personal protective equipment availed (Types and quantities)	Counting of workers with PPEs at the site.	Number of PPEs	Daily	Contractor. Supervising firm.	n/a
		Documented risk Assessment and its communication	Verification of availability of the risk assessment report	Risk assesment report	Once before works and every time a new work is proposed	Contractor. Supervising firm. WASAC	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	**Indicator**	**Frequency**		
		Health and safety training program and filled training participation list	Verification of the number of health and safety training sessions and participation lists	Number of health and safety training sessions	Monthly	Contractor. Supervising firm. WASAC	n/a
• Road users	Disruption of road users' movement on the road due to road closer, deviation during pipes laying activities.	The contractor will seek permission to RTDA when there is planned work that will disrupt the road use.	Verifying the permits for work with potential to disrupt the use of the road	Permits	Every time there is work to be completed on the asphalt road.	Contractor Supervising firm.	n/a
		There shall be signage to indicate the nature of disruption and guide	Verifying the presence of the road deviation signs	Road deviation signs and its use.	Every time there is work to be completed on the	Contractor Supervising firm.	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
		road users on the alternative routes.			asphalt road.		
		There should be consultations in the planning phase on how the traffic will be managed for all activities completed on road.	Verifying the consultations reports	Consultation report/meeting minutes.	Every time there is work to be completed on the asphalt road.	Contractor Supervising firm.	n/a
• Soil • Water Air	Contamination of the soil, air and water by waste generated during	Follow the 3 R (Reduce, Reuse, Recycle) hierarchy used in waste management.	Measuring the volume of waste reused, sent to recycling, disposed.	Volume of waste reused, sent to recycling, disposed	Weekly	Contractor Supervising firm.	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
	construction works.	Ensure proper mechanism to deal with spills (avail spill kits to contain oil and other chemical spill)	Counting spill kits and checking its use.	Number spill kits available. Spill kits use report	Weekly	Contractor Supervising firm.	n/a
• Workers Local community	Risk of disease transmission between workers themselves, between workers and the local community (example of disease: HIV/AIDS, low hygiene related diseases)	Measures to prevent poor hygiene and sanitation including availing hand washing and proper sanitary facilities.	Counting the number of hygiene and sanitation facilities provided	Number of hygiene and sanitation facilities provided	Monthly	Contractor Supervising firm.	n/a
		Sensitize about prevention of HIV/AIDS and sexually transmitted diseases.	Counting the number of sensitization session held and number of participants	Number of sensitization session held and number of participants	Quarterly	Contractor Supervising firm.	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
		Provide condoms in some places like toilets	Verify records of the quantities of condoms distributed	Number of condoms distribution sessions	Monthly	Contractor. Supervising firm.	n/a
		Recruit among local workforce so they can work and return at their home.	Counting the number of local workforces hired.	Number of local workforces hired.	Monthly	Contractor. Supervising firm.	n/a
		Workers required to register to the mutuelle de santé.	Counting the number of workers with health insurance	Number of workers with health insurance	Monthly	Contractor. Supervising firm.	n/a
Workers	Risk of delay or non-payment of casual labors	District will closely supervise timely payment of labor by the contractor,	Verifying payment report	Payment report	Monthly	Contractor. Supervising firm.	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
		In case the contractor does not pay labor, the District shall hold his pending payment.	Verifying report of held contractor payments	Report of held contractor payments	When there are cases of workers payment delays	WASAC, Contractor. Supervising firm. Gicumbi District	n/a
		WASAC should also request the contractor to provide an insurance covering this kind of issues.	Verifying the insurance for project completion	Insurance for project completion	Before starting of works	WASAC Contractor. Supervising firm. Gicumbi District	n/a
• Local community • Workers	Disturbance of the neighboring habitations due to noise, dust and vibration	Use of well-maintained and less heavy machinery that emits less gases and noise.	Checking the validity of technical control of machinery.	Valid technical control of machinery.	Every 6 months	Contractor. Supervising firm.	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
		Early engagement and awareness raising to the community about construction activities	Counting the number of awareness and engagement sessions/participation.	Number of awareness and engagement sessions/participation	Monthly	Contractor. Supervising firm.	n/a
		Provide personal protective equipment like dust mask and ear muffs.	Counting the number of PPEs provided	number of PPEs provided	Monthly	Contractor. Supervising firm.	n/a
		Work hours limited to the day working period (7h00 am to 5h00 pm)	Verifying the working hours report	working hours report	Monthly	Contractor. Supervising firm.	n/a
Operational phase							

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
• Biodiversity • Local communities	Conflicts from different users of Mwange river water arising from water abstraction competition	Every water user should respect his water abstraction level and seek water abstraction license from the RWB before any activity is undertaken. For this project, the total demand for the planned WSS in 2050 is 24,000 m^3/day while the flow conveyed through the river is Q = 12,960,000 m^3/day (150 m3/s), the quantity of water to be withdrawn shall not go beyond 0,2% of the total quantity of the river water.	Verification of water abstraction permit by competent authority	Water abstraction permit by competent authority	Before starting the abstraction operations	WASAC WSS Operator.	n/a
	Impacts on water quantity	WASAC shall ensure that water abstracted from	Measurement of water	Water quality and	Quarterly	WASAC	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
	and quality, hydrological pattern of Mwange river, etc	Mwange river shall not compromise water quality, quantity, and hydrological pattern required for the survival of ecosystems.	quality and quantity downstream of the intake site	quantity downstream of the intake site		WSS Operator.	
	Conflicts related to the abstraction of transboundary water resources that might affect neighboring countries.	WASAC shall seek a permit to abstract water as transboundary resources.	Verification of the permit, agreement to abstract transboundary water resources.	Permit and/or agreement to abstract transboundary water resources	Before starting the abstraction operations	WASAC Contractor. Supervising firm.	n/a
• Soil • Water • Local community	Impacts related to management of sludge (bad smell, water & soil contamination)	Establish sludge aerobic stabilization site which allows the reduction of odors, pathogens, the presence of viable seeds	Verification of the establishment of sludge aerobic stabilization site and the	Presence of sludge aerobic stabilization and the volume of	Monthly	WASAC WTP Operator.	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
		and shall prevent pollution to environment. The stabilized sludge shall be composted and used as soil amendment.	volume treated at the site	the treated sludge.			
• Soil • Water • Local community	Risk of water leakage from broken pipes causing water and soil erosion.	Avail a team of trained technicians ready for repair at any time the pipes break	Verification of the technical team mobilization	Number of technicians mobilised	Monthly	WASAC WSS Operator.	n/a
		Establish a water leakage reporting channel and communicate it to the people living near the WSS network	Verifying the water leakage report system	Documented water leakage reporting system	Before starting of operational phase.	WASAC WSS Operator.	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
		Conduct awareness among the population in that area and ask them to communicate any water leakage they may notice.	Verifying the number of awareness sessions and participation	Number of awareness sessions and participation	Quarterly	WASAC WSS Operator.	n/a
Local community	Conflict may arise over insufficient water distributed and people may fight for the small quantities available inducing them into crimes.	Awareness on efficient use of natural resources available.	Verifying the number of awareness sessions and participation	Number of awareness sessions and participation	Quarterly	WASAC WSS Operator.	n/a
		Ensure continual supply of water and establishment of as many as possible community water points.	Measuring the quantity of water supplied.	Quantity of water supplied	Daily	WASAC WSS Operator.	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
• WSS system • Workers • Local community • Environment	Risk of fire outbreak during the operations of the WSS especially at the water treatment facility	The water treatment plant shall be equipped with fire extinguisher and first aid arrangement	Checking the number of fire extinguisher and service expiration dates	Number of fire extinguisher and valid service expiration dates	Monthly	WASAC WSS Operator.	n/a
		Workers shall be trained how to use fire extinguishing system.	Verification of the number of training sessions/participation	Number of training sessions/participation	Monthly	WASAC WSS Operator.	n/a
		A fire marshal team shall be established and trained to prevent and/or stop fire.	Verification of the establishment of the fire marshal team	List of trained fire marshal team	Quarterly	WASAC WSS Operator.	n/a
• Soil • Water	Contamination of the soil, air and water by	Follow the 3 R (Reduce, Reuse, Recycle)	Measuring the volume of waste	Volume of waste recovered	Monthly	WASAC	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
Air	waste generated during operations of the WSS.	hierarchy used in waste management. Separate waste from the source and ensure hazardous waste are properly disposed off.	recovered for reuse, recycling and disposal	for reuse, recycling and disposal		WSS Operator.	
Climate	Risk of increased greenhouse gas (GHG) emissions and amplified vulnerability to climate change.	Use renewable source of energy where applicable. Encourage the use of machinery and equipment with low emissions of GHG.	Checking/counting the sources of renewable energy used in the WSS	Quantity of renewable energy used in the WSS	Monthly	WASAC WSS Operator.	n/a
Decommissioning phase							

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
• Soil • Water • Local community	Soil and water pollution (surface and ground water) due to construction waste generation	Follow the 3 R (Recover, Reuse, Recycle) hierarchy used in waste management.	Measuring the volume of waste recovered for reuse and recycling	Volume of waste recovered for reuse, and recycling	Monthly	WASAC Demolition contractor.	n/a
		Non-reusable and non-recyclable materials shall be disposed in environmental approved manner.	Measuring the volume of waste disposed through environmental approved manner.	Volume of waste waste disposed through environmental approved manner.	Monthly	WASAC Demolition contractor.	n/a
• Air • Local community	Pollution to the ambient air affecting the air quality due to particulate	Regularly spread of water on the site during demolition works.	Checking the volume of water spread on demolition sites	volume of water spread on demolition sites	Daily	Demolition contractor	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
	matters that shall be released in the atmosphere from demolition activities.	Manual demolishing to increase the quantity of materials recovered for reuse.	Verifying the volume of demolition completed manually.	Volume of demolition completed manually	Daily	Demolition contractor	n/a
• Local community • Wildlife animals	Increase of noise levels	The works shall be scheduled between 7 a.m and 5 pm to avoid noise during night.	Verification of the work schedules	Work schedule (7 am to 5 pm)	Daily	Demolition contractor	n/a
		Preferably adopt labor intensive (manual) demolishing to avoid noise by machinery.	Verifying the volume of demolition completed manually.	Volume of demolition completed manually	Daily	Demolition contractor	n/a
		Ensure good maintenance of machinery.	Verifying machinery technical	Validity of technical control certificates	Every 6 months	WASAC Demolition contractor	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
			control certificates				
• Workers • Local communities	Risk of health injuries and accidents at work (falling, hit by flying or falling objects, hit by reversing vehicle, cuts, etc…)	Documented risk Assessment and its communication	Verification of availability of the risk assessment report	Risk assesment report	Once before works and every time a new work is proposed	Demolition contractor WASAC	n/a
		Established effective medical emergency response plan	Verification of availability of the medical emergency response plan and its implementation report.	Medical emergency response plan and its implement ation report	Once before works and monthly basis	Demolition contractor WASAC	n/a

Impact's receptor	Negative Impacts	Proposed mitigation measures	Monitoring			Responsible	Cost (Rwf)
			Methodology	Indicator	Frequency		
		Ensure availed first aid kits and train workers on use.	Counting the number of first aid kit provided	Number of first-aid kits	Daily	Demolition contractor	n/a
		Safety signs availed at the site	Counting the number of safety signs provided	Number of safety signs	Daily	Demolition contractor	n/a
		Personal protective equipment availed (Types and quantities)	Counting of workers with PPEs at the site.	Number of PPEs	Daily	Demolition contractor	n/a
		Health and safety training program and filled training participation list	Verification of the number of health and safety training sessions and participation lists	Number of health and safety training sessions	Monthly	Demolition contractor	n/a

8.4 Monitoring Plan and reporting procedures

An environmental monitoring plan is normally designed and included in the EIA and ESIA reports. Monitoring is done to identify and mitigate changes in the environment brought about by the project activities related to the newly development land and the effectiveness of the proposed mitigation and enhancement measures. This is done during Construction and preparation phase. The monitoring plan has all identified possible impacts, their mitigations and the person responsible for implementation. Costs are also attached to all monitoring plans analysed. Participatory approach is encouraged in monitoring social issues.

The monitoring system will assist in observation, evaluation, assessment and reporting on the performance of different/various variables with regard to the environment. Monitoring aims at determining the effectiveness of actions to improve environmental quality.

8.4.1 Monitoring Schedule

The project proponent will work with EIA experts in identifying ways for the property to improve its environmental performance, setting objectives and targets and monitoring and evaluating implementation. The environmental monitoring program will operate through the research phase, construction, and production phases and will be based on the potential impacts identified. It will consist of a number of activities, each with a specific purpose with key indicators and criteria for significance assessment. Monitoring includes:

- ✓ Visual observations;
- ✓ Selection of environmental parameters;
- ✓ Periodic ongoing monitoring will be required during the life of the Project and the level can be determined once the project is in operation.

Monitoring frequency should be sufficient to provide representative data for the parameter being monitored. Monitoring should be conducted by trained individual following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data should be analysed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken.

The developer will follow the monitoring schedule that will assist in observation, evaluation assessment and reporting on the performance of different/various variables. The following table summarizes the suggested monitoring schedule of the facility.

Table43: Summary of the Monitoring Schedule.

Aspect	Performance Criteria	Frequency	Methods used
Neighbourhood issues and Monitoring of social impacts	Keeps a record of complaints or compliments coming from third parties and action taken ✓ Employment and procurement: impact. ✓ Quality of life impact. ✓ Community relationship	Review annually Parameters to be reviewed	Focus Group Discussion.
Aesthetic value	Ensure and maintain proper landscaping	Review annually	Observations
	Regularly monitor the breach system and act accordingly.	Bi-annually	Observations
Emergency preparedness	✓ Regular checking of the emergency preparedness Plan implementation	Twice a year	

Aspect	Performance Criteria	Frequency	Methods used
	✓ Ensure that there is maintenance of the Flood control channels and measures.		
Water Quality Monitoring	✓ Review of the water quality by checking the Physical, chemical and bacteriological water quality.	Parameters to be analysed will include: pH, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS)	Water sampling and laboratory analysis using recognized laboratories.
Monitoring of Accidents/Health Issues	✓ Annual Check-ups ✓ Workers absenteeism ✓ Recorded accidents and near misses	Twice a year	➲ Periodic health surveys ➲ Annual medical check-ups ➲ Accident reports

Record Keeping

Monitoring form should be devised for documentation, analysis and record of parameter. The form should focus attention on environmental issues and provide feedback for the future stages of the work. Mitigation and enhancement measures adopted in final design will be explicitly under the bill of quantities (BOQ) so that performance and completion is readily documented.

Daily project diaries would record environmental problems (spills, dust, noise, etc.) as well as safety incidents and will be retained as part of accepted modern contract management and summarized in Quarterly Environmental Reports.

8.4.2 Estimated budget for ESMPs implementation and monitoring

During implementation an Environmental Specialist should be appointed to oversee the implementation of the environmental mitigation measures incorporated in the design and contract specifications. Development and delivery of an environmental training program for selected staff and Project coordinators responsible for overseeing the construction contracts can commence immediately thereafter. This will be an on-going process since contracts will be awarded over a period stretching over many months. Most of the planned mitigation measure will be implemented along with project activities and is provided in Environmental Management Plan and environmental monitoring Plan.

8.4.3 Environmental Monitoring Plan for Mwange Water Supply

Table44: Summary of the Monitoring Schedule.

Parameters	Indicator	Monitoring frequency	Sampling Area	Measurement Units	Method	Target level/standard	Responsibility for monitoring	Costs estimate (Rwf)
Pre-construction stage								
Water Quality	Turbidity	Twice before the construction starts (Once during rainy season and once during dry season)	River BIZI	Nephelometric Turbidity Unit (NTU)	Turbid meter	10 Nephelometric Turbidity Unit(NTU)	Contractor/ EnvironmentConsultant	300,000
Air quality	Dust	Once before the constructionstarts	At Water Treatment Plant		Micro Dust Pro	0.01	Contractor/ Environmental and Social Safeguard Supervisor (EHS)	1,000,000

Parameters	**Indicator**	**Monitoring frequency**	**Sampling Area**	**Measurement Units**	**Method**	**Target level/standard**	**Responsibility for monitoring**	**Costs estimate (Rwf)**
Noise Baseline	Noise level/ mapping	Once before the constructionstarts	At Water Treatment Plant	dBA	calibrated precision integrating sound level meter, open Field Microphone and GPS, Garmin eTrex 12-Channel	110	Contractor, Environmental and Social Safeguard Supervisor (EHS)	400,000

Parameters	**Indicator**	**Monitoring frequency**	**Sampling Area**	**Measurement Units**	**Method**	**Target level/standard**	**Responsibility for monitoring**	**Costs estimate (Rwf)**
Biodiversity	Baseline information on biodiversity	Once before the construction work starts	All vegetation along the project area	type and number of living organisms	Observation		Contractor/Consultant	900,000
Compensation	Rate of compensation for land and properties	Once before the constructionstarts	All affected people	Once before construction begins	Resettlement Action Plan (RAP).		WASAC/District land Officers/ contractor	Covered in the project budget
Solid Waste	Presence of solid waste	Before construction	Entire projectarea	Tonnes	Visual observation	No solid wastes	Local Council	500,000
Machinery and equipments	Emissions, Soot, Noise, (Sox), (NoX), (CoX), (CO), (Pd),	As per manufacturesmanual	All plants, vehicles, equipments andmachinery	PM10/PM5, dBA, µg/m3	calibrated precision integrating sound level meter,		Contractor/ Environmental and Social Safeguard Supervisor	1,000,000

Parameters	Indicator	Monitoring frequency	Sampling Area	Measurement Units	Method	Target level/standard	Responsibility for monitoring	Costs estimate (Rwf)
	(03).				open Field Microphone and GPS,		(EHS),EMU	
Total cost of monitoring at pre-construction stage is Rwf.							**4,100,000**	

CHAPTER TEN: CONCLUSION AND RECOMMENDATIONS

10.1 Preamble

An evaluation of the impacts resulting from implementation of the proposed project indicates that the negative impacts vary. The ESMP developed provides for adequate redress to all these impacts. In view of this therefore, the project does not pose any serious and negative environmental impacts.

10.2 Conclusion

An Environmental and Social Impact Assessment (ESIA) ensures that both negative and positive impacts of any development activity or project are analyzed comprehensively, how it affects people, their property and environment; and a description of the mitigation measures that will be carried out in order to minimize these impacts are equally given.

It also identifies measures to mitigate the negative impact, while maximizing on the positive ones. EIA is basically a preventive, planning and an action-oriented process. The proposed development has no significant impact on the environment as measures for these impacts have been devised.

To this end therefore, with proper mitigation measures in place the project is environmentally sustainable. If all the recommendations outlined in the Environmental Management Plan are followed during project implementation and operation are followed, the project will have minimal negative environmental and social impacts, and will in turn be of great social-economic value.

From a socio-economic point of view, the project has significant economic and social benefits to the community in terms products that expected from the project activities. These products will be of a great importance to the community as water supply is an important part of the community.

Thus, the study recommends timely implementation of the project with strict adherence to the proposed Environmental Management and Social Management Plans. The project benefits have been identified to far outweigh the negative impacts for which a mitigation plan has been prepared. Further, the proponent has carefully considered and applied acceptable local and international standard/regulations at all stage of project planning and would thus qualify for donor funding.

9.3 Recommendations.

Recommendations for the prevention and mitigation of adverse impacts are as follows:

1. That owners encroaching on the project site be notified in good time to remove their structures before implementation of the Project. According to the Resettlement Action plan in compliance with the Integrated Safeguards System OS 2 (involuntary resettlement and the expropriation law in Rwanda) they will be compensated according to the entitlement matrix as specified by the plan. Compensation will be done according to the RAP in accordance with OS 2.
2. That a complete audit be undertaken and submitted to REMA after commissioning of the project and thereafter regularly on a yearly basis to ensure that all the proposed mitigation measures have been complied with.
3. That construction of all facilities in the proposed Project is carried out in accordance with approved plans, regulations, policies and laws.
4. That the Operation and Maintenance of the Water Supply should comply with the international Best Practices and the principles of environmental management including the principles of sustainability, prevention, precaution, and polluter pay principle and public participation.
5. Baseline and progressive water quality tests of the reservoir are necessary to determine mitigation measures for likely non-point source water pollution.
6. Capacity building framework for project beneficiaries is recommended in a number of sectors such as; marshland infrastructure maintenance and management, importance of collective harvesting, among others.
7. Water related diseases can be avoided by planting *Phytolaca decocandra* which will destroy the Bilharzia snails that serve as hosts of shistosomiasis along the shores of the lakes and river.

Based on the study, the Consultant is of the opinion that most of the potential environmental impacts identified can be mitigated. The proposed Environmental Management Plan and Environmental Monitoring Plan if implemented will safeguard the integrity of the environment.

CHAPTER ELEVEN: REFERENCES.

1. Climate Change Impacts on East Africa 2011
2. East African Community, 2004.East African protocol on environment and natural resources management.
3. Environmental profile of Rwanda (2006)
4. International Finance Corporation (2003). Environmental Guidelines for Occupational Health and Safety.
5. Law, N° 16/2006 of 03/04/2006, determining the organization, functioning and responsibilities of Rwanda Environment Management Authority.
6. National Strategy and Action Plan for the conservation of biodiversity in Rwanda.
7. Organic LAW N°48/2018 OF 13/08/2018, determining the modalities of protection, conservation and promotion of environment in Rwanda.
8. REMA, EIA Guidelines 2007.
9. Republic of Rwanda, MINITERRE, Sectorial Policy on Water and Sanitation, October 2004.
10. Rwanda Vision 2020, July 2000.
11. UNCED, 1992. The Rio United Nations Conference on Environment and Development (UNCED).
12. World Bank OP/BP 4.01. Environmental assessment.
13. East African Community, 2004. East African protocol on environment and natural resources management.
14. ESIA Guidelines, REMA 2007
15. Government of Rwanda, 2008. Ministerial order No. 007/2008. Establishing the list of Animal and plant species, 2008.
16. Government of Rwanda, 2004. National Land policy.
17. MINITERE (2003), the Rwandan Environmental Policy.

ANNEX 1

2.3 List of Contacted persons Kageyo Sector

Mwange Water Supply

List of Contacted person during ESIA process for Mwange Water Supply in Gicumbi District

No	Amazina	Umurenge	Akagari	Phone	Signature
1	GATUMYISI Elias	Kageyo	Horezo	0788326141	
2	BAJYINAMA J Baptiste	Kageyo	NYAMIYAGA	0785302651	
3	NYIGENA	Kageyo	GIHEMBE	0781367726	
4	NYAMVURA Claris	Kageyo	GIHEMBE	0784472021	
5	MUKAMWIZA	Kageyo	NYAMIYAGA	—	
6	Holoyo mbo jetibien	Kageyo	Nyiramgogo	0780949559	
7	HABARURAME	Kageyo	Nyiramgogo	0787123016	
8	[illegible] Sembagira	Kageyo	Nyamiyaga	0785594789	
9	Kazeguza	Kageye	Kagwa	0724893196	
10	NBACYAYIBA	KAGEYO	KAGWA	0720962738	

11. ATUMA Silas KAGEYO — 0783573938
Land Kageyo

List of Contacted persons MUTETE Sector

Mwange Water Supply

List of Contacted person during ESIA process for Mwange Water Supply in Gicumbi District

No	Amazina	Umurenge	Akagari	Phone	Signature
1.	MUNYANEZA Papias	MUTETE	NYARUBUYE	0788839149	
2	Mukakidende Solina	Mutete	Nyarubuye	0788484792	
3	Uwamahoro [illegible]	MUTETE	Nyarubuye	0788708531	
4	[illegible]	mutete	nyarubuye	0787185616	
5	Nemeyabahizi Jérôme	Kageyo	Kabuga	0780926656	
6	BANTEGEYE Eugenie	Mutete	Nyarubuye	0786794375	
7	mukoboyoyo [illegible]	mutete	nyarubuye	[illegible]	
8	Batamuriza Suzana	Mutete	Nyarubuye	0787755387	
9	[illegible]	Mutete	Nyarubuye	0786823299	
10	NGABOYIZONGA Anastase	Mutete	Nyarubuye	0788601885	

List of Contacted person during ESIA process for Mwange Water Supply in Gicumbi District

No	Amazina	Umurenge	Akagari	Phone	Signature
11	MAZIMPAKA Gr	MUTETE	NYARUBUYE	0788284223	
12	tuvuginayezu	Mutete	nyarubuye	073936427	
13	[illegible]	[illegible]	MUHONDO	0783809[illegible]5	
14	ALEXITOREXE MARDINE	KAGERO	KABUGA	0787758269	
15	Nyirinambajimana	Mutete	Nyarubuye	0787516530	
16	Manishimwe Germain	Mutete	Nyarubuye	079 1608120	
17	Niyonkuru Clarisse	MUTETE	nyarubuye	0782771877	
18.	MUKAMUGANGA M. LOUISE	MUTETE	Nyarubuye	—	
19.	NYIRABIMANA Françoise	MUTETE	NYARUBUYE	0788690145	
20	Manizagabe David	Mutete	Nyarubuye	0727126520	

Mwange Water Supply

List of Contacted person during ESIA process for Mwange Water Supply in Gicumbi District

No	Amazina	Umurenge	Akagari	Phone	Signature
21	MUKASHAFARI Annathia	MUTETE	Nyarubuye	0781830533	
22	NDAHIMANA Josiane	MUTETE	NYARUBUYE	0786958395	

List of Contacted persons RUKOMO Sector

List of Contacted person during ESIA process for Mwange Water Supply in Gicumbi District

No	Amazina	Umurenge	Akagari	Phone	Signature
1	UWITONZE J. M	Rukomo	Kinyami	0728520920	
2	HAKIZIMANA	Rukomo	Kinyami	0786248121	
3	UKOBIZABA Alexandre	Rukomo	KINYAMI	0783312362	
4	TWAHIRWA Bernard	Rukomo	Kinyami	0787277744	
5	NDAYISABYE Celestin	Rukomo	KINYAMI	0724750204	
6.	MINANI GAston	RUKOMO	KINYAMI	0728780307	
7.	Nyirandwatachantal	Rukomo	kinyami	0790257235	
8.	Ukurikiyezayinnocent	Rukomo	kinyami	0787813751	
9.	NZabonaye	Rukomo	kinyami	–	
10	NSENGI MANZAIONAT	RUKOMO	KINYAMI	0724715808	
11.	IRADUKUNDA ALPHONSE	RUKOMO	KINYAMI	0789840255	

List of Contacted person during ESIA process for Mwange Water Supply in Gicumbi District

No	Amazina	Umurenge	Akagari	Phone	Signature
1	AKINGENEYE Annonciata	RUKOMO	KINYAMI	0788488442	
2	UWAMARIYA Agnès	Rukomo	KINYAMI	0792420261	
3	Mukandagijje	''	''	0787754783	
4	Akimana Jaforoza	''	''	0727414810	
5	Mukamuyenzi	''	''	0782581802	
6	Ntabarushya theoneste	''	''	0784420554	
7	Gasetu [illegible]	''	''		
8	Bakunzikiza gervais	''		0782352886	
9	Mutandwase chatal	''	''	''	
10	Manirafasha	''	''	0724713242	

List of Contacted person during ESIA process for Mwange Water Supply in Gicumbi District

No	Amazina	Umurenge	Akagari	Phone	Signature
1.	NAMBAJIMANA J.MV	Rukomo	KIMYAMI	0787963465	
2	HAVUGURAMYE Diogene	Rukomo	KIMYAMI	"	
3.	KANIMBA Jean Bosco Celestine	"	"	"	
4.	MUYEKURE Jean pierre	"	"	"	
5.	MAAYABERURA Teonesto	"	"	"	
6	MIRUNGIYIMANA Hasima	"	"	0785777004	
7	MUKAREZIBA Jeanette	"	"	0784875645	
8	CYIMPAYE Joseri mme	"	"	0782154717	
9	UWAMURERA Consolee	"	"	0788465336	
10	BAVAKURE Damien	"	"	—	

List of Contacted person during ESIA process for Mwange Water Supply in Gicumbi District

No	Amazina	Umurenge	Akagari	Phone	Signature
	Emmanuel NGENDO	WASAC		0788649164	[signature]
	MUKAMANA Sandrine	SLM/ Rukomo		0781497943	[signature]
	NIZABALI Samuel	Consultant		0788709690	[signature]
	KOMUGISH BONITA	"		0780 264 250	[signature]
	Marango Alphonse			0788430214	[signature]
	MUREKASHYUNGWE Evergiste	E/S		0788831387	[signature]
	Ubarijoro Collestin	Rukomo	Kinyami	0727139497	[signature]
	TURIKUBWAYO SABIN	Rukomo	KINYAMI	0728396365	[signature]
	NSABIMANA Jean Claude	Rukomo	KINYAMI	0781770337	[signature]
	MUKAMPORE ARUA	RUKOMO	Kinyami	0724586766	[signature]

List of Contacted person during ESIA process for Mwange Water Supply in Gicumbi District

No	Amazina	Umurenge	Akagari	Phone	Signature
1.	VTABAZI LEONIDAS	RUKOMO	KINYAMI	0725614089	
2	HAKIZIMANA J BOSCO	Rukomo	Kinyami	0785348731	
3	KAZUMGU JMX	Rukomo	Kinyami	078899684	
4.	MUSEMINARI J. MARI VIANE	RUKOMO	KINYAMI	0726252732	
5.	MAJYAMBERESIRA NSE	RUKOMO	KINYAMI	0722237291	
6	~~MAJYAMBERE~~ Nirere Claudine	RUKomo	KINYAMI	0737737239	
7	MATYAMBERE Joel	RUKOMO	Kinyami	0783407806	
8	HABAGOHIRWA	RUKOMO	Kinyami	0724666122	
9	BIZIMANA BONAV	RuKomo	KINYAMI	——	
10	HAVUGUKAMYE	//	//	0784384235	

List of Contacted person during ESIA process for Mwange Water Supply in Gicumbi District

No	Amazina	Umurenge	Akagari	Phone	Signature
1	Uwiyingoma M. Claire	Rukomo	Kinyami	0780580665	[signature]
2	Nyiransabimana Alfonsena	Rukomo	Kinyami	0722798477	[signature]
3	IYAKAREMYE Célestin	RUKOMO	KIMYAMI	0787382348	[signature]
4	Twagiramungu	Rukomo	Kinyami	0783897[illegible]	[signature]
5,	HAKIZAYEZU Jean	RUKOMO	KIMYAMI	0787890582	[signature]
6,	RUTANGEGWA	RUKOMO	KIMYAMI		[signature]
7	MYIRAMPABUKA	RUKOMO	KIMYAMI	0791783908	[signature]
8	Gasha gazi	RUKOMO	Kinyomi		[signature]
	Bamporiki	Rukomo	Kinyomi	0789869877	[signature]
	ihujimoriyo.	RUKOMO	Kinyomi		[signature]

List of Contacted person during ESIA process for Mwange Water Supply in Gicumbi District

No	Amazina	Umurenge	Akagari	Phone	Signature
1	Nyiramatsiko Annoci	Rukomo	Kinyami	0724087030	[signature]
2.	Nirere Spesiyoza	Rukomo	Kinyami	0780180894	[signature]
3.	Izabiriza Aloza	Rukomo	Kinyami	—	[signature]
4.	Karuhije Agusitin	Rukomo	Kinyami	—	[signature]
5.	Ndahayo Jerome	Rukomo	Kinyami	0784196837	[signature]
6.	Byampiriye Alan	Rukomo	Kinyami	0727868007	[signature]
7.	Turadukunda Don	Rukomo	Kinyami	0787300771	[signature]
8.	Nzikobanyanga JMV	Rukomo	Kinyami	0788839147	[signature]
9.	USANABUGINGO SANATE	RUKOMO	KINYAMI	0784409999	[signature]
10	MUJAWAMARIYA Christine	RUKOMO	KINYAMI	0785617743	[signature]

ANNEX 2:

Photos taken during Public meetings in Kageyo Sector

Photos during Public meeting in Rukomo Sector

Photos during Public meeting in Mutete Sector