



## TECHNICAL ASSISTANCE IN ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT

### Nile Akagera upper CATCHMENT integrated pollution management plan



30/10/2020

NILE AKAGERA UPPER CATCHMENT (NAKU)  
INTEGRATED POLLUTION MANAGEMENT PLAN



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**ABBREVIATIONS AND ACRONYMS**

BMPs	Best Management Practices
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
DDS	District Development Strategy
DO	Dissolved Oxygen
DPSIR	Drivers, Pressure, States, Impacts and Responses
EAC	East African Community
Eb	Ecosystem-based Adaptation
EDCs	Endocrine Disrupting Chemicals
EDPRS-2	Economic Development Poverty Reduction Strategy - 2
EIP	Early Implementation Project
EUCL	Energy Utility Cooperation Ltd
FONERWA	Rwanda Green Fund
GEF	Global Environment Fund
GIS	Geographical Information System
GoR	Government of Rwanda
JMP	Joint Monitoring Programme
IPMP	Integrated Pollution Management Plan
IWRM	Integrated Water Resources Management
LODA	Local Administrative Development Authority
LULC	Land Use Land Cover
LVB	Lake Victoria Basin
LVEMP	Lake Victoria Environmental Management Project
LWH	Land Husbandry, Water Harvesting and Hillside Irrigation
M&E	Monitoring and Evaluation
MIDIMAR	Ministry of Disaster Management and Refugee Affairs
MIGEPFOP	Ministry of Family and Gender Promotion
MINAFFET	Ministry of Foreign Affairs and Cooperation
MINAGRI	Ministry of Agriculture and Animal Resources
MINALOC	Ministry of Local Government
MINECOFIN	Ministry of Finance and economic Planning

**CATCHMENT INTEGRATED POLLUTION MANAGEMENT PLAN**

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MINEDUC	Ministry of Education
MINICOM	Ministry of Commerce
MININFRA	Ministry of Infrastructure
MINIRENA	Ministry of Natural Resources
MIS	Management Information System
MoE	Ministry of Environment
NGO	Non-Governmental Organization
NAKU	Nile Akagera Upper
NWRMP	Water Resources Master Plan
PhACs	Pharmaceutically Active Compounds
PAREF	Reforestation Support Project (Projet d'Appui à la Reforestation)
POPs	Persistent Organic Pollutants
RFA	Rwanda Forestry Authority
RDB	Rwanda Development Board
REMA	Rwanda Environment Management Authority
RHA	Rwanda Housing Authority
RLMUA	Rwanda Lands Management and Use Authority
RNRA	Rwanda Natural Resources Authority
RSSP	Rural Sector Support Project
RURA	Rwanda Utilities Regulatory Authority
RWB	Rwanda Water Resources Board
RWFA	Rwanda Water and Forestry Authority
SDG	Sustainable Development Goals
SEA	Strategic Environmental Assessment
UNEP	United Nations Environment Programme
WASAC	Water and Sanitation Corporation
WHO	World Health Organisation
W4GR	Water for Growth Rwanda

## **0. EXECUTIVE SUMMARY**

### **0.1. Introduction**

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

During the implementation, a need was identified to conduct a study on Wetland and Catchment Management Framework that will be used for upscaling of wetland ecosystem restoration activities under the project. The development of Integrated Pollution Management Plan for Nile Akagera Upper is under Water Quality Management task undertaken as part of the above study. It provides a comprehensive analysis of pollution issues in the Nile Akagera Upper catchment and proposes adequate interventions to sustainably tackle those issues identified.

### **0.2. Methodology**

Nile Akagera Upper (NAKU) Integrated Pollution Management Plan was developed using various methods. The literature review was undertaken to familiarise the project team members with the catchment area under consideration, and the historical pollution issues that have been documented. Also the project team reviewed relevant district development plans, catchment management plan, and district sanitation master plans where these were available at the time of the study. Consultation with institutions at national level such as Rwanda Land Use and Management Authority (RLMUA), Rwanda Water Board (RWB) and Rwanda Housing Authority (RHA) provided data and information (shapefiles) that were used to delineate the catchment boundaries and generated different maps related to catchment. Field visit and interviews with district officials, community users and others with knowledge of pollution sources and concerns within the catchment allowed the team to identify pollution hotspots in their areas, what the pollution concerns were and their impacts, the possible sources of pollution, and what is or could be done to manage them. At last, stakeholder workshops were organised to give officials and other delegates from the catchment the opportunity to confirm and prioritise the pollution issues in their area, to develop key elements of an integrated pollution management vision for their area, and to develop initial goals, objectives and interventions to manage pollution in their catchment.



### 0.3. Situation analysis

The Nile Akagera Upper (NAKU) catchment commences at the confluence of the Nile Nyabarongo Lower and the Akanyaru River and belongs to the Nile basin. The first half of the catchment is located within Rwanda but after Lake Rweru, the Akagera River forms the boundary between Rwanda and Burundi (RWRMP, 2014). It covers the following seven districts: Bugesera, Ngoma, Kirehe, Rwamagana, Kicukiro, Kayonza and Gasabo. A small area of the catchment is located in the district of Nyarugenge. The Akagera River has dense network of lakes such as Mugesera Lake and Rweru Lake which drains mostly from Burundi and Ruvubu River (a tributary) which takes its water exclusively from Burundi and Tanzania and enters the Akagera just upstream of Rusumo falls. The downstream limit of the catchment is at the Rusumo Falls where its waters fall into the lower Akagera River. Average annual rainfall is about 925 mm/annum which equates to 2,824 hm<sup>3</sup>/annum from the total land surface area of 3,053 km<sup>2</sup>. Groundwater annual recharge / safe yield is about 351 hm<sup>3</sup>/annum. With a total groundwater storage of 4,580 hm<sup>3</sup>/annum the mean residence time is about 13 years.

Data from the water quality monitoring network in NAKU catchment show high level of pollution in Upper Akagera river and its wetlands caused by the soil erosion, solid waste and wastewater dumped or discharged in the wetlands or river. A record of levels of TSS (2220mg/L), Turbidity (5516 NTU) and E.Coli above allowable limits were observed at Kanzenze station. Urban centres such as Kabuga, Nyamata and Ngoma as well as Mageragere and Nsinda prisons contribute to water pollution through discharges of partially or untreated sewage. However, this pollution is potentially attenuated by natural purification effects with the sequence of lakes and swamps located in its downstream. Similarly, levels above WHO allowable limits in groundwater were recorded in the catchment for Turbidity (226.0 NTU), TSS (83.5 mg/L), Mn (7.50 mg/L), iron (288.5 mg/L) and pH (5.28). This shows that, although it has been considered as more safe compared to surface water, the groundwater in NAKU is threatened by increasing pollution from agro-inputs (through leaching and erosion), and declining ability of ecosystems to naturally purify water which may adversely impacts on its quality.

In accordance with the 2012 population census, total population within the catchment was estimated to be 1.318 million dispersed throughout the catchment with highest densities in and around the urban areas of Kicukiro and Gasabo districts in the City of Kigali (between 4000-8000 habitants/km<sup>2</sup>) and Rwamagana, Kabarondo, and Kibungo in Eastern Province. The Rwanda Water Resources Master Plan projected the total population in the catchment to achieve 1, 476,099 in 2020, with 575,348 (40%) being urban and 900,751 (60%) .

The land use is dominated by seasonal and perennial crop (53.4%), then forested area (30.1%) while about 1.7 % is considered sparse, i.e. shows signs of tree felling or other forms of degradation. Economic activities and basic services infrastructure in Nile Akagera Upper catchment are on the one hand characteristic of those of the

urban areas, especially the City of Kigali and rural areas on the other hand. The City of Kigali is the country's essential economic hub that contributes 50% of the country's GDP (Surbana, 2012) with largest employment sectors being services, utilities, real estate development, businesses and trade. The rural part of the catchment is dominated by complicated agricultural systems based on diversification of productions and associations of crops. Seven major crops including banana, beans, maize, sweet potato, cassava, sorghum and Irish potato are found in the catchment. Poor fertilizers and pesticides use, weak level of equipment, land limited application of technologies and researches are translated into mediocre production very sensitive to climate hazards.

Livestock rearing is another important activity in the catchment and includes cattle, goat, sheep, pigs, rabbits and chicken. The main source of energy for cooking in the homesteads within the catchment is firewood. The demand for firewood has led to depletion of indigenous tree species, scarcity of wood resources, deforestation and high prices of charcoal. Mining and quarrying operations are a significant component of the economy with manufacturing activities including brickmaking and recycling of scrap metals (iron).

#### 0.4. Main pollution issues

Analysis of emerging pollution issues in Nile Akagera Upper Catchment led to the following prioritisation:

- Planning processes that are not aligned with catchment governance;
- Contamination of urban water bodies as consequence of discharge of inadequately treated liquid;
- Inadequate solid waste collection and illegal dumping;
- Aquatic invasive species in water bodies; and
- Low skills & awareness levels on pollution issues.

#### 0.5. Integrated Pollution Management Vision and objectives

The vision for the Nile Akagera Upper catchment is:

***“Nile Akagera Upper is a well-managed catchment supporting the community to meet its socio-economic needs in a sustainable manner without compromising natural ecosystem to provide its services”***

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

1. Enhanced governance of pollution management at catchment level
2. Efficient and effective pollution management in Nile Akagera Upper catchment
3. Effective information and knowledge management

#### 0.6. Interventions

Interventions proposed in this IPMP are in line with the above identified issues and have focused on aligning planning processes at both district and catchment levels, addressing issue of water bodies contamination by inadequately managed liquid wastes, maximising municipal waste collection and eradication of illegal dumping,

ensuring continuous removal of aquatic water weeds into water bodies as well as enhancing capacity and increase awareness levels on pollution issues·

- Interventions for addressing planning processes that are not-aligned with catchment governance, include institutionalisation of NAKU catchment office, supporting the integrated planning at catchment level, supporting regular meetings of different committees at catchment level and support district authorities to enforce regulations.
- Interventions for addressing issue of contamination of water bodies by discharge of inadequately treated liquid waste: the plan will contribute through carrying out a Feasibility Study on centralised wastewater in Bugesera industrial park, support proposed operation & maintenance interventions for Masaka Feacal Sludge treatment facility, support resettlement of population in high risk zones, support small industries &SMEs within the catchment to implement cleaner production measures, support rainwater harvesting on rooftops of settlement areas , invest in construction of water drainage to capture road drainage & settlements, enforce oil separation at all garages and vehicle workshops and multiply inspections for environmental compliance in mining sector·
- Interventions for addressing inadequate municipal solid waste collection and illegal dumping: the plan will introduce incentives to maximize waste collection, including separation at source and promote voluntary clean-up activities through community work initiatives and local NGOs·
- Interventions for addressing issue of invasive species and inadequate use of agrochemicals, include to enhance payment of ecosystem services in NAKU for catchment protection, support the valorisation of wetlands ecotourism initiatives, provision incentives package (e.g application for Payment for Ecosystem Services -PES) to the key stakeholders removing water hyacinth and other associated aquatic weeds in hotspots, implement buffer rehabilitation and remove illegal farming activities on river banks, and multiply inspections for environmental compliance in mining sector
- Interventions to build capacity and increase awareness on pollution issues, include to support cooperatives involved in the removal of water hyacinth and other aquatic weeds for procuring hand-tools, boats and protective wear; increase awareness and education on environment protection, integrated key urban hotspot monitoring points to national sampling program, develop training package on urban and rural pollution and BMPs, conduct trainings , awareness raising and capacity building among farmers on smart agriculture, organise trainings for technicians and operators for weed harvesters and loading equipment and disseminate policies, laws and regulatory instruments on environment protection, sustainable mining and smart agriculture.

## 0.7. Implementation, Monitoring & Evaluation

The above IPMP goals, objectives and associated interventions can only be achieved with clear institutional arrangements. Institutions roles and responsibilities were defined in this plan. The plan will be implemented through the District Development Strategies (DDS) at District level as well as Imihigo targets and action plans at local levels. Local Administrative Entities Development Agency (LODA) and Rwanda Water Board will coordinate the integration of interventions proposed in this plan into Districts annual action plans and Imihigo. Nile Akagera Upper catchment committee will also support the implementation of the plan.

The overall success of implementation of the Nile Akagera Upper Integrated Pollution Management Plan lies in strengthening the human and financial resources capacity of Districts and Rwanda Resources Board by sourcing for funds for the execution of the proposed interventions

## CHAPTER I. INTRODUCTION

### 1.1. Background and context

LDCF II Project entitled “Building resilience of communities living in degraded wetlands, forests and savannas of Rwanda through an ecosystem-based adaptation approach”

The Least Developed Countries Fund (LDCF) II Project titled “Building resilience of communities living in degraded forests, savannas and wetlands of Rwanda through an Ecosystem-based Adaptation (EbA) approach“ is funded by Global Environment Facility (GEF) through United Nations Environment Programme (UNEP) under climate change adaptation GEF focal area for total duration of four years..

The main objective of the project is to increase capacity of Rwandan authorities and local communities to adapt to climate change by implementing Ecosystem based Adaptation (EbA) interventions in degraded forests, savannas and wetlands ecosystems. The above objective will be achieved through

- i) increasing the technical capacity to plan and implement E-bA at national and local levels;
- ii) strengthening the national and local policies, strategies and plans to facilitate the national implementation of E-bA;
- iii) restoring degraded savanna, forests and wetlands to provide proof-of-concept for the role of ecological infrastructure in increasing climate resilience and providing alternative livelihoods for local communities

The project has three components:

1. The National and local institutional capacity development for the use of an EbA approach.
2. Policies, strategies and plans for adaptation to climate change, and
3. Ecosystem based Adaptation (EbA) interventions that reduce vulnerability and restore natural capital.

The LDCF II Project was designed to demonstrate the benefits of EbA by using intervention sites in the most vulnerable areas in Rwanda. To maximise the sustainability and upscaling of the interventions, the project will:

- (i) train national- and local-level authorities as well as local communities at intervention sites on the use of EbA;
- (ii) increase scientific knowledge on the benefits of EbA and identify best practices for EbA;
- (iii) provide guiding documents to mainstream EbA into policies, plans and strategies in Rwanda; and
- (iv) increase local community awareness on the role of ecological infrastructure in increasing climate resilience.

Technical Assistance in Environment and Natural Resources Management (this project)

With aim to collate current knowledge on status and health of the environment within catchments that include forest, savannah, and wetland ecosystems in Rwanda, to develop systematic mapping and monitoring tools to identify basin management needs and track progress towards addressing them as well as to develop an understanding of the drivers of their degradation and to prepare a range of plans based on the results of the analyses and in response to climate threats, LDCF II/REMA is conducting a study on wetland and catchment management framework that will be used for upscaling of wetland ecosystems restoration activities under LDCF II Project.

In accordance with the Term of References, the Technical Assistance in Environmental Management consists of a number of tasks:

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

Terms of Reference for Integrated Pollution Management Plan

This report is part of Water Quality Management task and presents the Integrated Pollution Management Plan for Nile Akagera Upper catchment

According to the ToRs, the development of the Integrated Pollution Management Plan will requires identification of key pollution indicators of interest (e.g. fecal coliforms, BOD, COD, DO, Nitrates, etc.), mapping of major sources of pollution (e.g. residential areas, schools, abattoirs, major industrial areas, etc.), existing pollution management facilities and their capacities, and loading estimates for key pollutants, understanding of the transport and fate of these pollutants, key sensitive areas (e.g. water intakes, areas of ecological concern, etc.), appropriate standards/guidelines, and a longer-term plan of investments to help meet these standards/guidelines. To the extent possible, the plan should also

survey economic costs and benefits to pollution and pollution management respectively.

In addition, the pollution management analysis and prioritization should consider the impacts and lessons from the current activities under the LDCF II and LVEMPII project and suggest improvements in the targeting or design of future activities, as appropriate

## 1.2. Scope and purpose

In Rwanda, high population density, expanding industrialization and urbanization, inappropriate waste and wastewater management and high rainfall intensity on steep slope high elevation are putting pressure on the natural environment leading pollution, particularly in urban areas. The potential pollutants that could arise from the above pollution drivers requires careful management to avoid negative impacts on human health and environmental factors such as groundwater, soils, surface water and ecology.

This Integrated Pollution Management Plan identifies key pollution indicators, maps major sources of pollution in the catchment, provides appropriate standards and guidelines applicable to pollution management and proposes long term actions to tackle pollution in Nile Akagera Upper catchment.

## 1.3. Layout of the report

The Integrated Pollution Management Plan for Nile Akagera Upper (NAKU) catchment consists of the following chapters:

Chapter 1: gives an introduction to the study through presenting the general background of the Integrated Pollution Management plan, scope of the plan as well as the layout of the report.

Chapter 2: is a description of the methodology followed in the preparation of the Integrated Pollution Management Plan.

Chapter 3: provides a brief overview of the catchment description, its key geographic features and socio-economic characteristic as well as hydrological features.

Chapter 4: provides an overview of the emerging pollution issues in the Nile Akagera Upper catchment, their characteristics and related mapping.

Chapter 5: describes an integrated pollution management plan to deal with the problems of pollution in the catchment, targets to achieve, indicators to be monitored as well as the resources required.

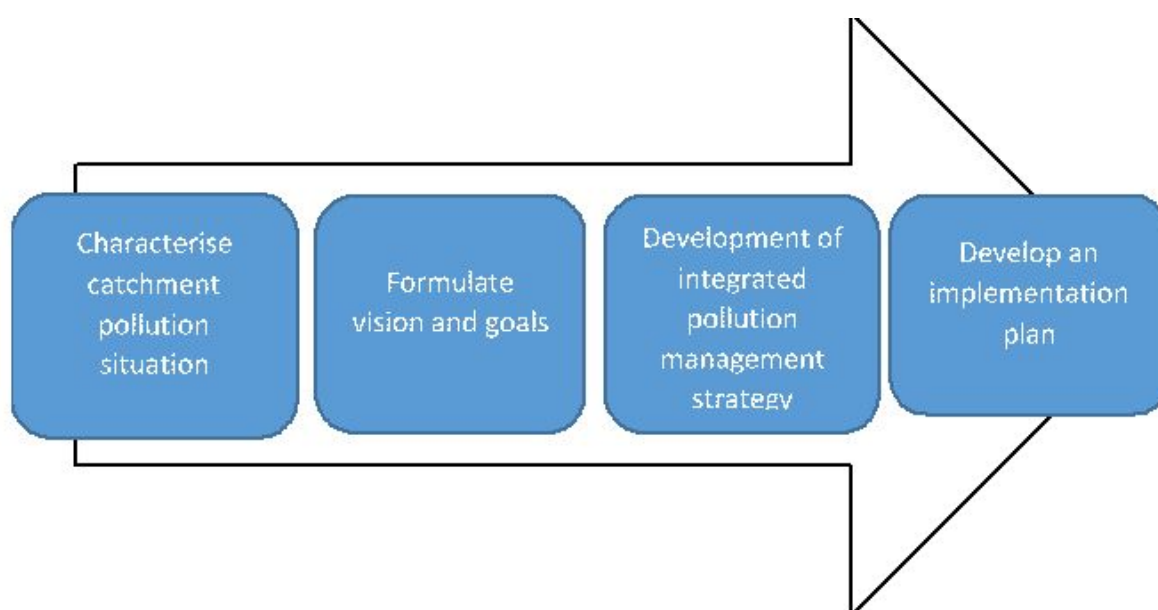
Chapter 6: describes monitoring that should be undertaken to assess the situation and the success of interventions.

## CHAPTER 2. METHODOLOGY

The process of developing strategies and plans to address the problems associated with pollution is known as integrated pollution management planning. The Integrated Pollution Management Plan (IPMP) is the main output of the planning process. The IPMP records a vision for the catchment area and formalises the key current and future trends of the various pollution categories such as water, land, air and noise pollution. The IPMP also provides additional details with regard to the specific implementation of options for improved catchment pollution management while still promoting green growth and development objectives.

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

The first step of the planning process, is to determine the current pollution state of the catchment area. The steps followed for the Nile Akagera Upper pollution management planning process are outlined in Figure 1.



**Figure 1: Steps in developing the Nile Akagera Upper Integrated Pollution Management Plan**

### **Step 1: Characterise the catchment pollution situation**

This step provides for gaining an understanding of current characterization of pollution issues and sources in the catchment area. It also identifies and prioritize the key pollution challenges and opportunities.

1. A review of relevant literature was undertaken to familiarise the project team members with the catchment area under consideration, and the historical pollution issues that have been documented. In this task the team also consulted the relevant district development plans, urban management plans, and district sanitation master plans provided these were available at the time.



2. The project team generated maps of the relevant catchment areas. The data and information (shapefiles) provided by the Rwanda Land Use and Management Authority (RLMUA), Rwanda Water Board (RWB) and Rwanda Housing Authority (RHA) were used to delineate the catchment boundaries and urban areas in the catchment. .
3. The team then met with district officials which included the District Environmental officers and others with knowledge of pollution sources and concerns. The objectives of the meetings were to identify pollution hotspots in their area, what the pollution concerns were and their impacts, the possible sources of pollution, and what is or could be done to manage it.

In order to guide the discussion, the officials were requested to consider beforehand the following aspects and whether it is relevant in their area:

- (i) Examples of sensitive urban areas which should be protected against pollution
  - Important water abstraction points (surface or groundwater) for domestic or urban agricultural use
  - Cultural areas at or near urban streams and rivers
  - Important urban parks or conservation areas
  - Stormwater drainage network
- (ii) Examples of types of pollutants
  - Sediments and erosion
  - Nutrients (nitrogen, phosphates) and excessive algae in streams and dams (fertilisers)
  - Hydrocarbon pollution from fuels, oils, and grease
  - Agrochemicals such as pesticides and herbicides
  - Microbiological pollution (pathogens) that cause diseases such as diarrhoea, cholera, etc.
  - Organic pollutants that consume oxygen in the water when it breaks down leading to fish kills
  - Trace metals from solid waste dumps, landfills, and industries
  - Solid waste and litter in urban streams
- (iii) Possible point sources of pollution
  - Wastewater Treatment Systems and their effluents
  - Industrial effluents
  - Hotels, hospitals, etc.
  - Formal and informal abattoirs
  - Landfills and solid waste dumps
  - Fish farm outflows
- (iv) Nonpoint or diffuse sources of pollution
  - Stormwater drainage system
  - Grey water disposal into stormwater system
  - Informal sewage disposal into urban canals, stormwater drains and urban streams
  - Urban agriculture and wetland agriculture, aquaculture
  - Garages, vehicle workshops, vehicle service centres
  - Fresh produce markets with no or poor solid waste management
  - Unpaved and poorly maintained urban roads, construction sites
  - Seepage from septic tanks
- (v) Existing pollution management options

- Regulations and bylaws that control certain activities and discharges into the stormwater drainage system
- Riparian buffer zones
- Stormwater detention dams, natural and artificial wetlands

Where possible, coordinates for issues were captured and integrated into the maps developed by the project team or directly in Google Earth as place marks with a title and description. These were then summarised in this report along with other issues stemming from the literature review

4. Some of the pollution hotspots that were identified during the discussions were visited to visually inspect the situation at the selected hotspots, to take photographs at the sites, and to undertake some water sample collection for measurement of temperature, pH, electrical conductivity, and turbidity.

### **Step 2: Formulating a vision and goals**

This involves describing the desired state of the catchment area over the long term with respect to pollution, together with goals (preliminary objectives) and targets to achieve this over time. This should be developed in a participatory approach with stakeholders from the catchment area.

A stakeholder workshop was held on the 3<sup>rd</sup> of October 2017 in Kigali where officials were given the opportunity to confirm and prioritise the pollution issues in their area, to develop the key elements of an integrated pollution management vision for their catchment area, and to develop initial goals, objectives and interventions to manage pollution in their catchment area.

### **Step 3: Developing an integrated pollution management strategy**

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

Incorporating the vision, goals and objectives determined through the stakeholder engagement process, as well as the information provided from the catchment pollution characterisation, an integrated pollution management strategy is proposed.

### **Step 4: Detailing an implementation plan**

The main activity at this point is defining the actions needed to give effect to the catchment pollution management strategy and that should ultimately achieve the vision and objectives, as well as who is responsible for the actions, the indicative phasing and cost estimates for the actions.

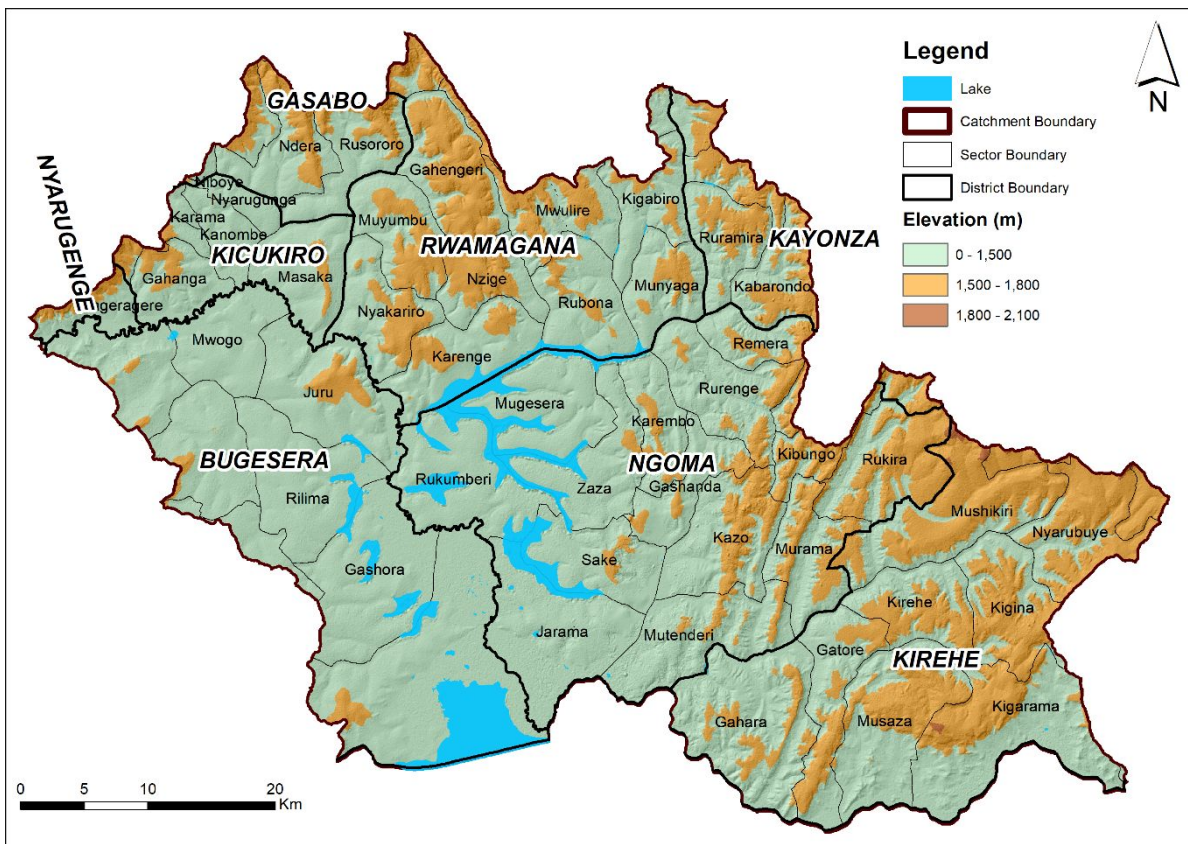
To give effect to the proposed strategy, and for the achievement of the goals, objectives and ultimately the vision of the Nile Akagera Upper area, an implementation plan is included in this IPMP.

**CHAPTER 3. BRIEF OVERVIEW OF THE NILE-AKAGERA UPPER CATCHMENT**

The purpose of this chapter is to provide a brief overview of the Nile Akagera Upper catchment, with a focus on those features that would affect both rural and urban pollution. Key pollution issues identified during the project are described in the chapters that follow on this descriptive chapter.

**3.1. Administrative boundaries**

The Nile Akagera Upper (NAKU) catchment commences at the confluence of the Nile Nyabarongo Lower and the Akanyaru River and belongs to the Nile basin. The first half of the catchment is located within Rwanda but after Lake Rweru, the Akagera River forms the boundary between Rwanda and Burundi (RWRMP, 2014). It is covered by the following seven districts: Bugesera, Ngoma, Kirehe, Rwamagana, Kicukiro, Kayonza and Gasabo. A small area of the catchment is located in the district of Nyarugenge. A small area of the catchment is located in the district of Nyarugenge.



**Figure 2: Nile Akagera Upper catchment administrative and geographic map**

**3.2. Population distribution and poverty rates**

The 2012 population census assessed the total population to be 1. 318 million dispersed throughout the catchment with highest densities in and around the urban centers of Kicukiro, Gasabo, Nyarugenge (all three for Kigali city), Rwamagana, Kabarondo, and Kibungo in Eastern Province. The Rwanda Water Resources Master Plan projected the total population in the catchment to achieve

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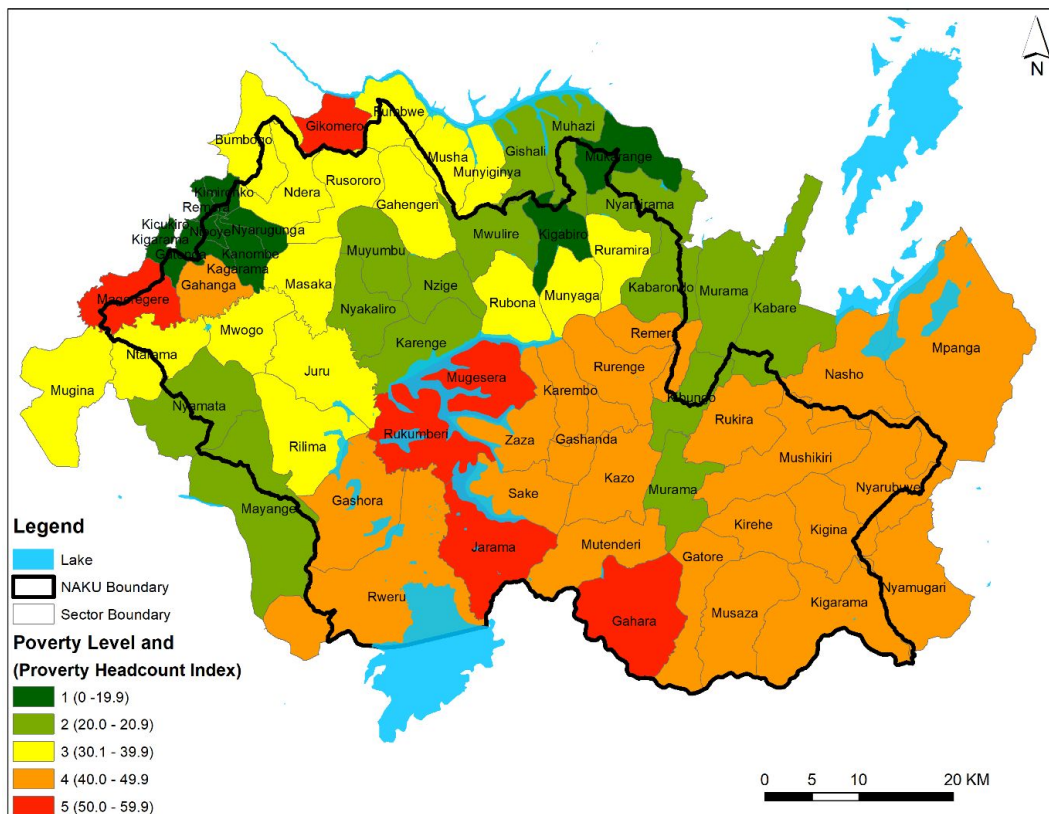
1, 476,099 with 575,348 (40%) being urban and 900,751 (60%) rural in 2020.

In Nile Akagera Upper catchment, the majority of sectors (42.6 %) have a population density ranging from 400-800 habitants/km<sup>2</sup> while a small number (7.1%), mainly in the City of Kigali attain a population density arising between 4000-8000 habitants/km<sup>2</sup> Table 1 presents the coverage of different sectors per population density in NAKU catchment while Figure 3 presents poverty levels.

**Table 1: Coverage of different sectors per population density in NAKU catchment**

S/N	Population density	Number of Sectors	% of Total Sectors in the Catchment
1	129 - 400	29	41.4
2	401 - 800	30	42.6
3	801 - 1200	2	2.6
4	1201 - 4000	4	5.7
5	4001 - 8194	5	7.1

Extreme poverty is observed in eastern parts, especially in Bugesera Districts (e.g.Mugesera) and Kirehe (e.g Gahara) compared to the rest of districts which range from moderate to low poverty as presented on the Figure 3 below.



**Figure 3: Levels of poverty in NAKU****3.3. Climate**

Large part of Nile Akagera Upper catchment (Bugesera, Ngoma and Kirehe districts) is characterized by a very hot climate resulting from the absence of mountains and due to relatively low altitude, there is rarity of rains and excessively prolonged periods of drought. Temperature varies between 20°C and 30°C with an average daily temperature 26°C.

The catchment presents two rainy seasons and two dry seasons. The long dry season and season of drought "impeshyi" spans from mid-June to the mid-October and is followed by the short rainy season that spans from October to December. The next season is a short dry season "Urugaryi" starting in mid-December and ends in mid-February. At last, the fourth season is a heavy rainy season "Itumba" that spans from mid-February to end of May.

**3.4. Land use**

Existing Land Use and/or Land Cover (LULC) map for NAKU was developed from the national land use / land cover (LULC) map developed by Water for Growth Rwanda using remote sensing technology combining radar and optical imagery from 2016- 2018. The area and relative proportion of each LULC class for the Nile Akagera Upper catchment is presented in Figure 4

Seasonal and perennial crop are predominant in NAKU catchment as they occupy 53.4% of the catchment area. The total forested area covers about 30.1% the catchment area and from this, about 1.7 % is considered sparse, i.e. shows signs of tree felling or other forms of degradation. Figure 4 below presents land use/land cover classification in Nile Akagera Upper catchment.

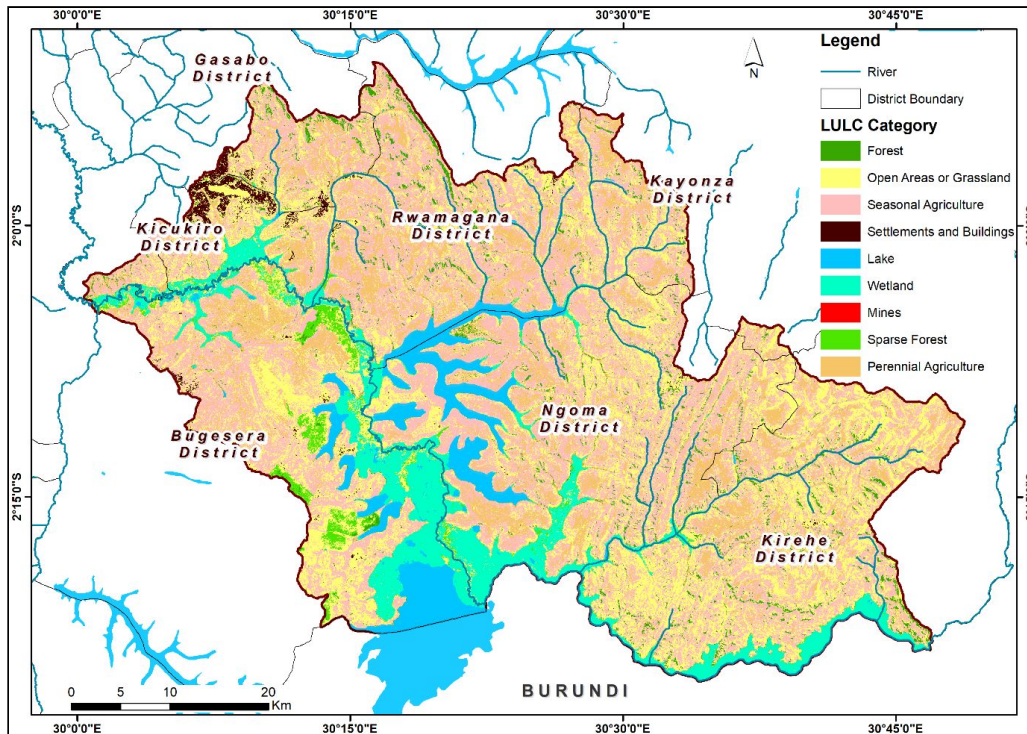


Figure 4: Existing Land Use and/or Land Cover (LULC) in NAKU

### 3.5. Economic activities and basic services infrastructure

Economic activities and basic services infrastructure in Nile Akagera Upper catchment are characteristic of those of the urban areas, especially the City of Kigali and rural areas. The City of Kigali is Rwanda’s financial and economic hub and contributes 50% of the country’s GDP (Surbana, 2012). The catchment’s largest employment sectors are agriculture, fishing, and forestry with other services, such as utilities, financial services and trade.

In rural areas, agricultural activity is the most predominant and is characterised by complicated agricultural systems based on diversification of productions and associations of products. Seven major products including banana, beans, maize, sweet potato, cassava, sorghum and Irish potato are found in the catchment. The poor fertilizers and pesticides use, weak level of equipment, land limited application of technologies and researches are translated into mediocre production very sensitive to climate hazards. The main economic activity in the catchment is the growing of coffee

Livestock rearing is another important activity in the catchment and includes cattle, goat, sheep, pigs, rabbits and chicken. The main source of energy for cooking in the homesteads within the catchment is firewood. The demand for firewood has led to depletion of indigenous tree species, scarcity of wood resources, deforestation and high prices of charcoal.

On the other hand, construction, mining, and quarrying operations are significant components of the economy together with manufacturing activities such as

brickmaking and recycling of scrap metals (iron). In Rwamagana and Ngoma in the Eastern Province, there are several quarries and mines with cassiterite and coltan deposits being mined. The Figure 5 below presents location and types of existing mining in Nile Akagera Upper catchment.

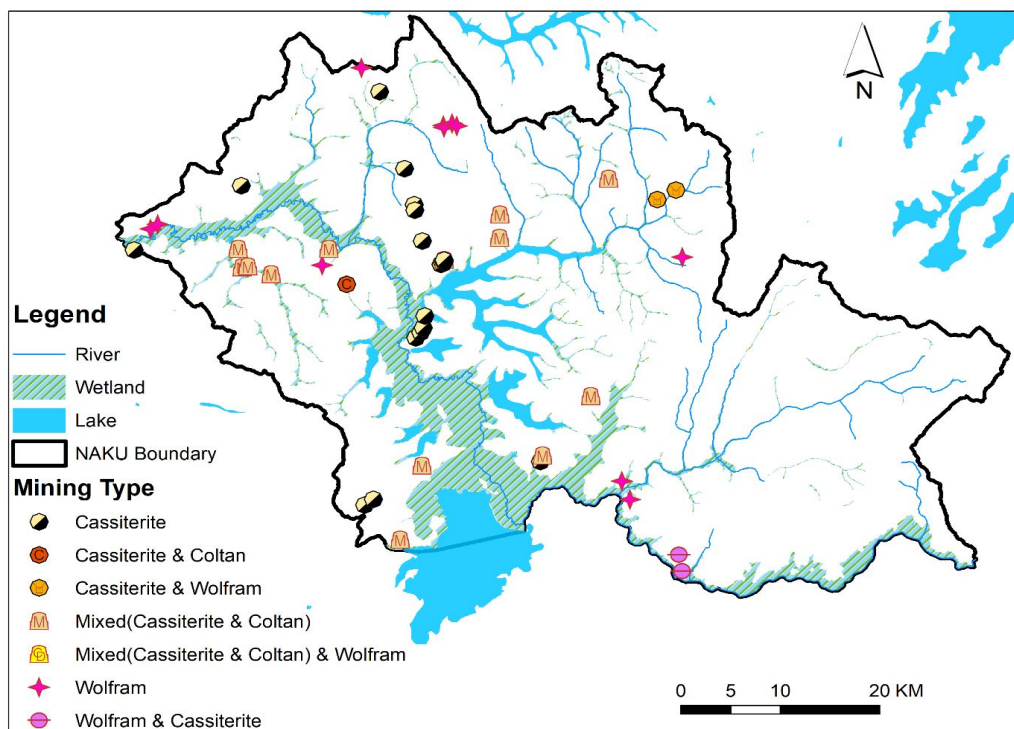


Figure 5: Existing mining types and locations in Nile Akagera catchment

### 3.6. Hydrology

The Upper Akagera river has dense network of lakes such as Mugesera and Rweru. It drains mostly from Burundi and Ruvubu River (a tributary) which takes its water exclusively from Burundi and Tanzania and enters the Akagera just upstream of Rusumo falls. The downstream limit of the catchment is at the Rusumo Falls where its waters fall into the Lower Akagera River.

Rwanda Water Resources Master Plan subdivided the Akagera catchment into two level 2 sub-catchments:

- Akagera Mugesera (NAKU\_1). The Akagera upstream of the Lake Rweru confluence where the catchment area is exclusively Rwandan (area of 1,888 km<sup>2</sup> in Rwanda), and
- Akagera Rweru (NAKU\_2). The Akagera downstream of Lake Rweru where the river follows the boundary between Rwanda and Burundi and the catchment area is shared between these neighbors (area of 1,165 km<sup>2</sup> in Rwanda).

The principal water resources in the catchment are as follows:

- the average annual rainfall is about 925 mm/annum which equates to 2,824 hm<sup>3</sup>/annum from the total land surface area of 3,053 km<sup>2</sup>.
- the combined average annual surface flow generated from the catchment area in Rwanda stands at 16 m<sup>3</sup>/s or some 504 hm<sup>3</sup>/annum.
- the groundwater annual recharge / safe yield is about 351 hm<sup>3</sup>/annum. With a total groundwater storage of 4,580 hm<sup>3</sup>/annum the mean residence time is about 13 years.

The surface runoff of the catchments own resources and the excess flow from the river is stored in the series of lakes and the wide permanently inundated floodplain. The main effect of this is a significant increase of evaporation losses to a total of 2,320 hm<sup>3</sup>/annum.

### 3.7. Water Quality

#### 3. 7.1. Surface water Quality

Water quality status in Nile Akagera Upper is not precisely known as there are few water quality sample locations monitored. Water Quality monitoring network in this catchment is based on two permanent locations: upstream at Kanzenze station and downstream Mfunze station. The most water quality issue reported is a high level of pollution in Nyabarongo wetland and Nyabarongo river caused by the soil erosion, solid waste dumping and wastewater discharge in the wetland / river. Water quality analysis conducted in the framework of this project recorded high TSS (2220mg/L), high Turbidity levels (5516 NTU) and E.Coli levels above allowable limits. Urban centres such as Kabuga, Bugesera and Ngoma districts as well as Mageragere and Nsinda prisons contribute to pollution through discharges of partially or untreated sewage. However, this pollution is potentially attenuated by natural purification effects with the sequence of lakes and swamps located in its downstream. Table2 below presents physico-chemical characteristics of water quality in Nile Akagera Upper catchment for a one sampling carried out for the purpose of this study.

**Table 2: Water quality characteristics in Nile Akagera Upper catchment**

<i>Sampling sites</i>	D.O	TSS	TURB	COD	BOD	DIN	DIP	Pb	Zn	E.Coli
AKAGERA AT KANZENZE	3.02	2220	5516	19.91	11.3	6.651	1.345	0.062	0.318	1.7x10 <sup>3</sup>
AKAGERA AT GASHORA	4.17	1550	3760	20.19	12.4	6.278	1.362	0.048	0.228	4.2x10 <sup>3</sup>
MUGESERA LAC	6.67	9	18	12.24	7.22	5.138	0.569	ND	1.077	5.2x10 <sup>2</sup>
SAKE LAKE	6.76	8	17	8.29	5.9	3.809	0.345	ND	1.979	2.2x10 <sup>2</sup>
RWERU LAKE	4.63	14	25	20.21	11.9	5.001	0.310	ND	1.891	3.2x10 <sup>2</sup>



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<b>AKAGERA BEFORE RUVUBU RSB Discharge Standards</b>	2.24	239	298	19.2 9	11.9	6.33 6	1.37 9	ND	0.44 5	3.3x1 0 <sup>2</sup>
	0 - 12	50	-	250	50	20	5	0.1	5	400

### 3.7.2. Groundwater Quality

Nile Nyabarongo Upper catchment has high potential of groundwater, with a total groundwater storage of 4,580 hm<sup>3</sup>/annum and mean residence time of about 13 years. Extensive borehole drilling and shallow well construction have mostly been done during the last two decades and there were several boreholes and wells in various parts of Nile Akagera Upper ( RWFA, 2019).

With regard to the groundwater quality, there are few data on groundwater quality in Nile Akagera Upper catchment. However, the assessment conducted in the framework of Groundwater Recharge and Storage Enhancement in Eastern Province in 2019, found high electric conductivity (EC) in groundwater sampled. In addition, iron and manganese were found to be common in the granitic areas of Bugesera and Rwamagana. In another study on Physical-chemical analysis of groundwater from Rugende II well, Rwamagana district (Gashugi, E, 2013) , it was found that levels for the following water quality parameters: Turbidity (226.0 NTU), TSS (83.5 mg/L), Mn (7.50 mg/L), iron (288.5 mg/L) and pH (5.28) were above WHO permissible limits. At last, the contamination of groundwater quality in Nile Akagera Upper was confirmed by the Microbiological Safety Assessment of Groundwater Wells in Bugesera (Wondatir N., et al., 2015).The assessment study found coliforms and other microorganisms such as Klebsiella, Escherichia coli, Shigella, Salmonella, M. morganii and Serratia spp.

From the above evidences, it can be concluded that the in Upper Akagera catchment is threatened by increasing pollution from agro-inputs (through leaching and erosion), and declining ability of ecosystems to naturally purify water which may negatively impacts on groundwater quality.

## CHAPTER 4. EMERGING POLLUTION ISSUES AND POLLUTION HOTSPOTS IN NILE AKAGERA UPPER

### 4.1. Introduction

Emerging pollution issues discussed in this chapter are pressures and threats to environment (with focus on water quality) that are assumed to be those things resulting from human actions (past, current and future), which have potential to impact water quality, along with natural phenomena and environmental factors. These include natural phenomena exacerbated by human interaction, inappropriate land management practices, and low enforcement of laws or misdirected policy settings.

### 4.2. Analysis of Policy and Legal Framework for Development and Implementation of the Integrated Pollution Management Plan for Nile Akagera Upper catchment.

An enabling policy, legal and institutional framework is key to the development and subsequent implementation of the Integrated Pollution Management Plan for Nile Akagera Upper catchment. These issues are explored in the sections below:

#### 4.2.1. Policy Framework

##### a) Vision 2050

Vision 2050 is about ensuring high standards of living for all Rwandans and is aimed to shift Rwandan's from the current livelihood to the society everyone wants and proud to belong. In order to realize this Vision, the country will embark on economic transformation, social transformation and governance and justice. The country will increase momentum towards reaching upper middle income by 2030 and high income by 2050. This will require average annual growth of above 10% per cent. Therefore, the Vision 2050 provides the policy context for the plan. Nile Akagera Upper Integrated Pollution Management Plan will contribute to this country ambition by progressively achieving pollution management to ensure high standard of living and environmental welfare

##### b) National Strategy for Transformation

The National Strategy for Transformation (NST1) which is also the Seven Year Government Programme (7 YRGM) is an implementation instrument for the remainder of Vision 2020 and for the first years of the journey under vision 2050. In order to achieve the high-level targets of Economic Transformation and prosperity, the contribution of Nile Akagera Upper Integrated Pollution Management Plan to the targets of NSTP is included in the following NST1 5.16 statement *“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** “*

##### c) National Environment and Climate Change Policy, 2018

The National Environment and Climate Change Policy provides strategic direction and responses to the emerging issues and critical challenges in environmental management and climate change adaptation and mitigation. The policy goal is for “Rwanda to have a clean and healthy environment resilient to climate variability and change that supports a high quality of life for its society.”

It sets up two key principles related to pollution management:

- Polluter Pays Principle according to which those responsible for environmental damage must be held liable for the repair caused to both the physical and human environments. They must also be held responsible for the costs of preventive measures to reduce or prevent further pollution and environmental damage.
- The Pollution Prevention Principle which anticipates problems and prevents negative impacts on the environment and people’s environmental rights

Nile Akagera Upper Integrated Pollution Management Plan will contribute to achieving the National Environment and Climate targets through the following key policy statements related to pollution management

- Prevent and promote integrated pollution control and waste management
- Promote the circular economy to advance sustainable consumption and production patterns:
- Promote green technologies and procurement: and
- Promote sustainable management of wetlands.

#### **d) National Water Resources Management Policy, 2011**

The overall goal pursued in this water policy is to manage and develop the water resources of Rwanda in an integrated and sustainable manner, so as to secure and provide water of adequate quantity and quality for all social and economic needs of the present and future generations, and ensure full participation of all stakeholders in decisions affecting water resources management. This plan will contribute to achieving the policy targets through the following strategic policy actions:

- Monitor and assess water resources to understand the water balance and to support water accounting, identify the spatial and temporal occurrence and distribution in the country;
- Formulate a water resources management strategy addressing, inter alia, watershed protection and provides mechanisms for the designation of special conservation and or protection zones; and
- Promote water conservation techniques and technologies, including rainwater harvesting, water recycling and other appropriate technologies.

#### **e) National Sanitation Policy**

The vision of National Sanitation Policy is to ensure sustainable, equitable and affordable access to safe sanitation and waste management services for all Rwandans, as a contribution to poverty reduction, public health,

economic development and environmental protection while the mission is to promote, plan, build and operate services in a sustainable, efficient and equitable manner. This plan will contribute to achieving the policy targets through the following policy objectives:

- Raise and sustain household sanitation coverage to 100 per cent by 2020, and promote hygiene behaviour change;
- Implement improved sanitation for schools, health facilities and other public institutions and locations;
- Develop safe, well-regulated and affordable off site sanitation services (sewerage and sludge collection, treatment and reuse/disposal) for densely populated areas;
- Enhance storm water management in urban areas to mitigate impacts on properties, infrastructure, human health and the environment<sup>5</sup>. Implement integrated solid waste management in ways that are protective to human health and the environment; and
- Ensure safe management of e-waste, industrial wastes, nuclear waste and health care waste.

**f) Mining Policy, 2010**

The Mining Policy covers wider aspects of regulation, institutional and investment framework for the mining industry, value addition and capacity building strategies as well as providing a clear plan of action to support the sub sector's growth.

This plan will contribute to the policy targets on improving the mining sector knowledge, skills and use of best use of best practices, especially the implementation of Model mining.

**g) Urbanisation and Human Settlements Policy, 2015**

This policy provides opportunities for alleviating pressure on rural land and biodiversity resources because increased urbanization raises challenges of utility supplies (water, energy, and housing) as well as waste disposal. This plan will contribute to this policy targets through addressing challenge related to waste minimization and promotion of green cities.

**h) Industrial policy and Investment code, 2011**

Environmental compliance advisory (especially relating to Environmental Impact Assessment), has been included among the services provided by the RDB, which is an opportunity to promote sustainable Environment and Natural Resources management. This plan will contribute to this policy targets through promoting resource efficient and cleaner production in industry sector.

**i) Health Policy 2014 and Health Sector Strategic Plan**

This objective of the Health Policy is centred on the reduction of burden of disease of the most important health problems in Rwanda - i.e., maternal and child health problems, infectious diseases and non-communicable diseases through access to primary health care. Both prevention and treatment and care services are included in these programmes, as well as interventions aimed at improving important health-determining factors, such as behaviour change communication, promotion

of adequate nutrition, environmental health and sanitation, and access to safe water.

Policy directions with relevance to pollution management include:

- Environmental health interventions will be strengthened from the national to the village levels. Hygiene inspections will be decentralized to empower districts and sectors and the Community-Based Environmental Health Promotion Programme will be scaled up to be implemented country-wide.

Inter-sectoral collaboration between non-health departments and the MoH is essential for interventions targeting health determinants: water distribution and sanitation systems to meet essential health needs, public hygiene activities (domestic and health-care waste management, health inspections

#### 4.2.2 Legal Framework

Table 2 below includes a summary of the relevant legislation related to pollution management.

**Table 3: Summary of relevant pollution management legislation**

Legislation	# and date	Relevance to pollution
<b>The National Constitution</b>	2003 (Amended in 2015)	The constitution of Rwanda guarantees the right to a clean environment for every citizen and other people living in Rwanda, and imposes on the state and population, the responsibility for keeping the environment clean and pollution-free. Article 23 states that everyone has the right to live in a clean and healthy environment while Article 53 of the amended Constitution states that everyone has the duty to protect, safeguard and promote the environment, that the State should ensure that the protection of the environment, and do so by means of a law that determines the modalities for the protecting, conserving and promoting the environment.
<b>Law determining the use and management of water resources in Rwanda</b>	Law N°49/2018 of 13/08/2018	This Law determines the use and management of water resources in Rwanda. It defines ‘water’ as a good belonging to the state public domain, recognizing the right to water for all. The Water Law provides a clear framework for the principles of integrated water resources management, including the

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		<p>prevention of pollution, and the principle of “user pays” and “polluter pays. It also provide that polluting water bodies by dumping, spilling or depositing chemicals of any nature above tolerable limit for human health or aquatic life, commits an offence (art.37) and set penalties for the defaulters</p>
<p><b>Law on environment</b></p>	<p>Law No 48/2018 of 13/08/2018</p>	<p>This Law determines modalities for protecting, conserving and promoting the environment.</p> <p>The law on environment gives effect to the National Environment and Climate Change Policy, which sets out how to transform into 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. It defines the responsibilities of citizen and state and set principles for exploiting natural resources such as land, water, forests and air as well as protecting biodiversity, among others. The law requires all project developers whose projects may have harmful effects on the environment to carry out environmental impact assessment (EIA) before launching them.</p> <p>Articles 17, 18, 19 and 20 provide guidance on conservation and protection of built environment, focusing on the management of liquid and solid wastes, management of hazardous and toxic wastes and the management of electronic wastes.</p> <p>Article 42, 43, and 45 provide for prohibited acts, including prohibited acts in wetlands and protected areas, prohibited emission of noise, prohibited acts in protection of biodiversity and prohibitions related to chemicals and wastes</p>

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		At last the law provides for administrative sanctions for all defaulters (from art.46 to art.60)
<b>Law relating to the prohibition of manufacturing, importation, use and sale of plastic carry bags and single-use plastic items</b>	Law N° 17/2019 of 10/08/2019	This Law prohibits the manufacturing, importation, use and sale of plastic carry bags and single-use plastic items. The law is expected to check the increasing habit of unnecessary consumption and disposal of single use plastic items which becomes a burden to the environment.
<b>Law governing the preservation of air quality and prevention of air pollution in Rwanda</b>	No. 18/2016 of 18/05/2016	This Law applies to all measures aimed at the preservation of air quality as well as all elements or activities likely to affect air quality or pollute the atmosphere. The law sets, amongst other, air quality standards, and describes compliance with minimum air quality standards, emission limits, specific tolerance limit of pollutants from industries, inspection of air pollutants from the transport sector, air pollutants from construction works, air pollutants from the storage of objects, air pollutants from waste incineration, and air pollutants from other sources. The law also makes provision for administrative sanctions.
<b>Ministerial Order establishing the list of projects that must undergo environmental impact assessment, instructions, requirements and procedures to conduct environmental impact assessment</b>	No 001/2019 of 15/04/2019	This Order establishes: 1° the list of projects that must undergo an environmental impact assessment before they obtain authorisation for their implementation; 2° instructions, requirements and procedures for conducting environmental impact assessment.
<b>Ministerial Order Determining the list of Water Pollutants</b>	No. 004/16.01 of 24/05/2013	This order defines a water pollutant and then provides a list of: Physico-chemical pollutants, organoleptic pollutants & Organic Pollutants ; radionuclides ; and Biological Pollutants.

<p><b>Ministerial Order Establishing Modalities of Inspecting Companies or Activities that Pollute the Environment</b></p>	<p>N° 006/2008 of 15/08/2008</p>	<p>This ministerial order describes the modalities of inspecting companies or activities that pollute the environment. It describes, amongst other, the responsibilities of inspectors, search and seizure of pollution products, analysis of suspected products, and decisions that REMA can take.</p>
<p><b>The Code of Criminal Procedure</b></p>	<p>No. 30/2013 of 24/5/2013</p>	<p>The Code of Criminal Procedure currently in force has been enacted in 2013. It governs the procedures by which authorities investigate, prosecute, and adjudicate crimes which includes environment offences.</p>

#### 4.2.3. Standards and guidelines related to pollution management

##### 4.2.3.1. Standards relevant to effluent discharges

Dischargers of domestic and industrial effluents must comply with Rwandan standards as specified by the Rwanda Standards Board.

*Rwanda Standard RS 110 of 2016* provides the limits for the discharge of treated domestic wastewater effluent into the environment as well as the test methods that should be employed for the individual constituents.

*Rwanda Standard RS 109 of 2009* specifies the limits for the discharge of treated industrial wastewater effluent into the environment as well as the test methods that should be employed for the individual constituents.

According to the EAC website, the EAC Secretariat is working to harmonise effluent discharge standards, strengthen the capacity of EAC Partner States in enforcement of pollution control laws and establish pollution monitoring system in the EAC, and urges Partner States to allocate more resources for the implementation of conventions to which they are party such as Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, and the Stockholm Convention on Persistent Organic Pollutants.

At EAC regional RECP meeting held in Nairobi in July 2016 for harmonizing GIS mapping report, all EAC countries represented by Directors of National cleaner production centres and RECP Experts agreed to apply regional EAC standards in order to harmonize limits used to assess industrial pollution levels (Niyonzima, 2017). The EAC standards “East African Industrial and Municipal Effluents Standards” was published in January 2016 (EAC Gazette, 2016. The Table3 below provides the Regional EAC standards used to assess industrial wastewater effluents.



**Table 4: Regional EAC standards used to assess industrial wastewater effluents (MINICOM, 2017)**

Minimum pollution load (Green)	Medium pollution load (Blue)	High pollution load (Red)
BOD < 30 mg/l	BOD between 31 - 250 mg/l	BOD > 500 mg/l
COD < 60 mg/l	COD between 61 - 500 mg/l	COD > 500 mg/l
TN < 10 mg/l	TN between 10 - 20 mg/l	TN > 20 mg/l
NO <sub>3</sub> < 5 mg/l	NO <sub>3</sub> between 5 - 10 mg/l	NO <sub>3</sub> > 10 mg/l
TP < 5 mg/l	TP between 5 - 10 mg/l	TP >10 mg/l

#### 4.2.3.2. Standards relevant to air emissions

Emitters of air pollution in Nile Akagera Upper catchment must comply with air emission standards set by Rwanda Standards Board. The Rwanda air quality law was promulgated in May 2016 and it is supported by the Rwanda Standards Board who has developed emission standards and air quality specifications that are applicable for Rwanda and aligned with East African Community standards. These include:

- *RS EAS 750 Air quality* - emissions to the air by cement factories - guidelines. This Rwanda Standard published in 2011 is identical to the first edition 2010 Regional Standard EAS 750/2010 Air quality - Emissions to the air by cement factories - Guidelines.
- *RS EAS 751 Air quality Air quality - specifications*. This Rwanda Standard published in 2011 is identical to the first edition 2010 of Regional Standard EAS 751/2010 Air quality - Specification.
- *RS EAS 752 Air Quality* - Tolerance limits of emission discharges to the air by factories. This Rwanda Standard published in 2011 is identical to the first edition 2010 of regional Standard EAS 752/2010 Air quality - Tolerance limits of emission discharged to the air by factories.
- *RS407-1 Emission limits* – Specification: Road Vehicles

The publication of these air quality guidelines and standards, aligned with EAC standards, demonstrates the good collaboration of the Rwanda Government with its East African Community partners.

#### 4.2.3.3. Water quality guidelines

In order to assess the fitness for use of the rivers and streams in Nile Akagera Upper catchment, it is recommended that a combination of guidelines be adopted based on full contact recreation and key aquatic ecosystem guidelines. Full contact recreation guidelines would be protective to children who play in streams

and rivers, and farmers who get in contact with streams when they work their agricultural fields. Aquatic ecosystem guidelines would be protective to fish and aquatic organisms in streams. The following guidelines are recommended for assessing the water quality status of rivers. Only a limited set of constituents was selected to keep the index simple.

**Table 5: Guidelines for assessing the status of rivers.**

Constituent	Units	Ideal	Good	Fair	Poor
<b>Physical requirements</b>					
Water clarity	Secchi disk (m)	>3	2	1	<1
Turbidity	NTU	<10	80	150	>150
Dissolved oxygen	mg/l	>8	6	4	<4
<b>Chemical requirements</b>					
Chloride	mg/l	<2	6	10	>10
pH	pH units	6.5 - 8.5	5.75 - 8.75	5 - 9	<5 or >9
Electrical conductivity	mS/m	<70	85	100	>100
<b>Microbial requirements</b>					
Faecal coliforms	cfu/100ml	<130	165	200	>200
E coli	cfu/100ml	<130	165	200	>200

From the above analysis, it can be concluded that there exists an enabling policy and legal and regulatory framework for developing and implementing the Integrated Pollution Management Plan for the Nile Akagera Upper catchment of Rwanda. Emerging issues are discussed in the paragraph below.

#### **4.2.4. Issues in current policy, legal and regulatory framework**

##### **4.2.4.1. Planning processes that are not aligned with catchment governance**

The Law determining the use and management of water resources in Rwanda (LAW N°49/2018 OF 13/08/2018) provides for establishment of permanent catchment committees. The exact composition and mandate of catchment committees will be laid down in the Ministerial Orders (which are currently under development). Meanwhile, the Integrated Pollution Management Plan for NAKU catchment has been using temporary arrangements where a Catchment Task Force composed of officials from the Districts, Water Users, Civil Society Organizations and private operators was set up to facilitated the development of this plan. In addition, current planning processes are district based where each district develop its own DDS, annual action plan and Imihigo without consultation with other districts within the catchment.

However, the implementation of this plan will require to have cross-sectoral cooperation at catchment scale, and to include both bottom-up and top-down participation, with emphasis on coordination across multiple scales. It is increasingly recognised that central government agencies cannot do everything and that some components of environment pollution are better handled by other

actors. Catchment-based planning approach will offer much greater stakeholder engagement through agreement of a common vision and shared understanding of pollution management issues.

#### **4.2.4.2. Lack of coordination, limited capacities and low awareness level on pollution issues**

There are many committees in various sectors, including environmental committees, water committees, agricultural water user committees, forestry management committees, Disaster Management Committees, health and hygiene committees etc. often with similar or overlapping roles and responsibilities for natural resources management. There is also limited capacities at decentralized level to promote pollution management measures.

In addition, the analysis of the existing policy and legal framework found some conflicting objectives in the programs for transformation of agriculture (e.g. objectives related to intensification in use of pesticides and fertilizers which conflict with objectives on improving water quality; as well, objectives for marshland reclamation which are potentially in conflict with objectives on wetlands protection) These soil intensive mechanisation measures are prioritised in agricultural mechanization strategies for Rwanda and in the national agriculture policy at the expense of the protection environment and natural resources management. Similarly, the national Environment and climate change policy seeks to aggressively promote protection of environment which may be at odds with agriculture transformation and economic development. These potential conflicts have to be carefully examined at local catchment level and interventions coordinated.

#### **4.2.5. Recommendation of strategic measures**

If the current situation where sector ministries, agencies and districts are implementing their own plans in isolation, there will be a limited implementation of proposed measures and no specific integrated pollution management measures implemented. There is a need to move for a catchment based planning where plans are developed in participative and vertically and horizontally integrated manner, resulting in a coherent program of measures for each sub-catchment.

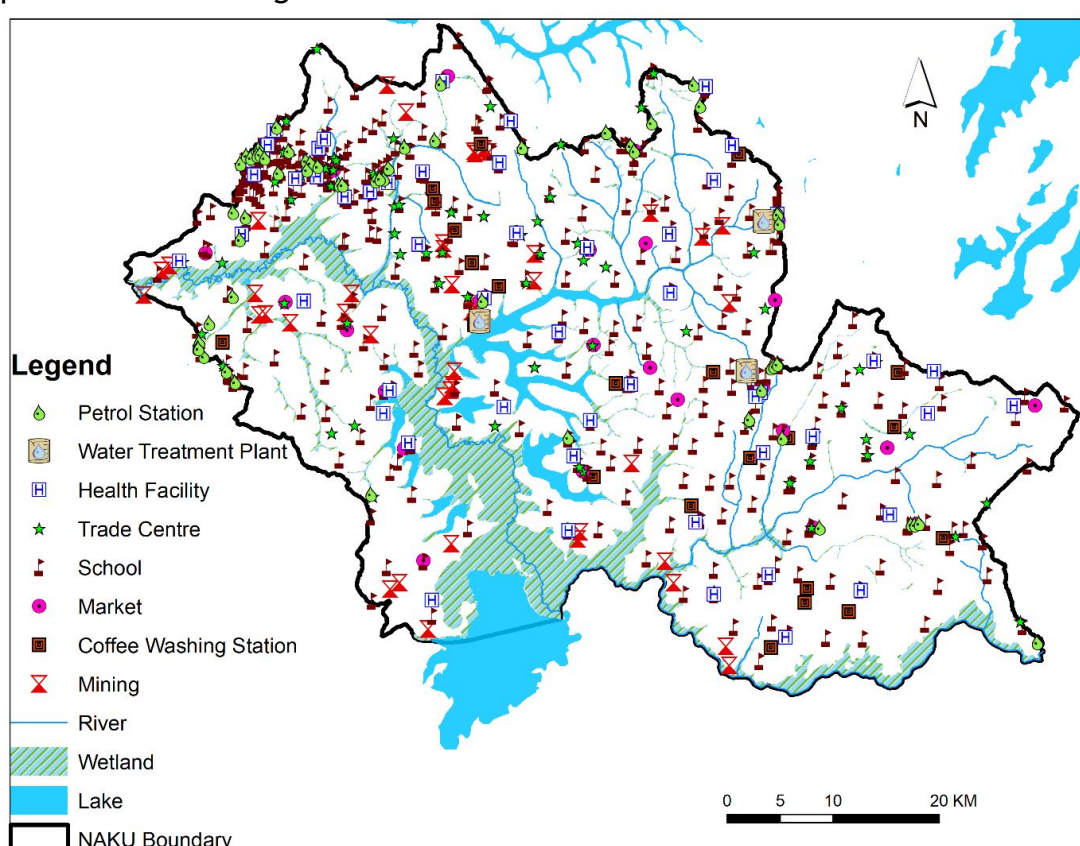
The catchment plans are developed in a participative and vertically and horizontally integrated manner, resulting in a coherent program of measures for each sub-catchment. Nile Akagera Upper Catchment Committee need to be established and tasked with the implementation and monitoring of the IPMP and must ensure that there is coordination and cooperation between all role-players and engagement with stakeholders for the effective implementation of the plan. The Implementation Plan identifies lead institutions for various activities of the IPMP. The Catchment Committee's task will be to ensure these institutions integrate their responsibilities into their development plans, and monitor that the activities are implemented. At a minimum, Catchment committees will need to be supported technically and organizationally, by some form of a permanent

secretariat (or Technical Committee) together with technical support from Rwanda Water Board.

### 4.3. Emerging pollution issues in NAKU catchment

#### 4.3.1. Identification and mapping of key activities and infrastructure, potential sources of pollution in Nile Akagera Upper

During discussions with the district officials and field visits, key pollution sources and concerns were identified. The list is by no means complete for all pollution sources. However, it includes the most important source categories namely industrial sources, landfills, workshops and garages, informal settlements and slums, mining, etc. Potential sources of pollution in Nile Akagera Upper are as presented in the Figure 9 below.



**Figure 6: Potential sources of pollution in NAKU**

Since the Nile Akagera Upper catchment covers both urban and rural areas, key sources of pollution and related emerging issues were discussed separately as urban or rural pollution issues in the paragraphs below.

#### 4.3.2. Urban pollution issues

Nile Akagera Upper catchment covers parts of Kicukiro and Gasabo in the City of Kigali, headquarters of other districts in the catchment, including Nyamata/Bugesera, Kigungo/Ngoma and Nyakarambi/Kirehe as well as other thirteen (13) emerging urban centers that pose a threat to environment. Identified pollution issues are those related to urban water pollution, littering of

solid municipal waste, urban air pollution and urban noise pollution of which details are discussed in the paragraphs below.

#### 4.3.1.1. Contamination of urban water bodies as consequence of discharge of inadequately treated wastewater

In NAKU Catchment, wastewater from most towns and villages are not treated such that there is extensive faecal pollution in the rivers resulting in outbreaks of water borne diseases. Many of the urban streams in Kicukiro district drains towards the Akagera River and exhibits symptoms of urban runoff pollution. As shown by Figure 6 below, waterbodies downstream the unplanned settlement in Kicukiro District are used for vegetables and crops watering though there are polluted by discharge of domestic wastewater. Similar situation of discharging inadequately treated wastewater into natural environment is also observed in other urban centres located in NAKU catchment such as Nyamata, Kabuga and Kibungo



**Figure 7: Domestic wastewater discharges from unplanned settlements in Kicukiro**

Nile Akagera Upper catchment also host industrial zones such as Kigali special economic zone, Gahanga industrial park and others are planned such as Bugesera industrial park, Rukumberi planned at about 0.7 km from Akagera River and Kibungo at about 0.5 km from Kibungo center. This means that industrial wastewater discharge is likely to increase worsening the current situation exacerbated by proliferation of water hyacinths in eastern lakes such Cyohoha, Mugesera, Mirayi, etc. Visual inspection of some pollution hotspots in the City of Kigali, part of Nile Akagera catchment showed that the river downstream the Kigali Special Economic Zone is vulnerable to discharges from inadequately maintained wastewater treatment plants of the above SEZ and may endanger people that use it in their daily domestic activities as shown on the Figure 7 below.



**Figure 8: Downstream Kigali Special Economic Zone****◆ Impacts on receiving environment****● Microbial pollution**

The Akagera Mugesera Catchment has inflow from Akanyaru and Nyabarongo rivers with a substantial pollution risk from the Nyabarongo. The E.coli monitoring assessment conducted in 2017 (Sekomo & Kagisha, 2017) indicated that E coli counts were 92 counts/100ml upstream of the Akanyaru confluence and increased to 153 counts/100ml downstream of the Akanyaru confluence. Before the confluence of Akanyaru and Nyabarongo, the Akanyaru contributed 750 counts/100ml. Further downstream at the Gashora bridge near Lake Bilira, the E coli counts had dropped to 35 counts/100ml indicating an improvement in microbial quality. This shows that microbial pollution originating from untreated or partially treated sewage effluents entering surface and groundwater as well as seepage and run-off from inadequate sanitation and waste disposal is high in upstream of NAKU catchment at the confluence of Nyabarongo and Akanyaru. However, microbial pollution reduces as the Akagera River flows farther away from urban areas. This is attributed to reduced urban pollution combined with auto-purification (since the river passes through a series of eastern wetlands) and dilution.

**● Hydrocarbon pollution**

Hydrocarbon pollution (i.e pollution with petroleum and petroleum-derived products such as petrol, naphthas and solvents, jet fuels, paraffin, diesel fuel, fuel oils and lubricating oils) originates from wash off from road surfaces and parking lots, especially during the early season rains, and dumping of used oil into storm water drains. In the Akagera Mugesera Catchment there are numerous filling stations and vehicle workshops that can contribute to hydrocarbon pollution, as well as the main thoroughfare road between Rusumo Falls and Kigali frequented by trucks. There does not appear to be a formal used oil collection programme in Rwanda, probably due to the relatively small market size hampering investment by waste oil recyclers. District officials have expressed concerns that used motor oil is informally disposed of into storm water drains, nearby wetlands, on the soil at the workshop, or into unlined solid waste dumps.

**● Organic pollution**

There are several coffee washing stations within the Akagera Mugesera Catchment. These coffee washing or depulping stations often operate without adhering to recognised standards and best practices for effluent discharge. As consequence, the wastewater released untreated into streams contains high levels of carbohydrates and organic matter (USAID, 2008). In addition, industries that process agricultural products (dairy products, fruit juices, etc), soft drink,

and brewing industries in Kicukiro district discharge effluents that are often high in COD. Although the impacts of high organic loads would be localised to the receiving streams, the high COD and low dissolved oxygen could carry through into the Akagera River. The same is also true for partially treated abattoir wastes discharged to streams eventually flowing into the Akagera River

#### 4.3.1.2. Inadequate solid waste collection, disposal and littering of Municipal Solid wastes

In urban areas of Kicukiro and Gasabo, municipal solid waste collection is provided by private operators grouped in 13 companies (AGRUNI, COPED, UBUMWE, INZIRA NZIZA, ROAD ENVIRONMENT PROTECTION (REP), CESCO, COCEN, COVAGAYING, ISUKU KINYINYA, UMURIMO MWIZA, INDATWA, and BAHEZA) and waste collected is landfilled at Nduba landfill. However, illegal dumping that lead to municipal waste littering has observed during our field visits as shown on Figure 8 taken in Kicukiro·



**Figure 9: Solid waste litter into water bodies in Kimironko near, Gasabo District**

The composition of municipal solid waste in urban areas of NAKU catchment matches Marais and Armitage classification system as shown in Table 3 below:

**Table 6: Municipal solid waste composition in NAKU**

Main categories	Sub-categories	Examples of items
Plastic	Packaging Polystyrene Containers Miscellaneous	Shopping bags, wrapping Polystyrene blocks and pellets, cooler boxes Containers, bottles, crates. Straws, straps, ropes, nets, music discs, syringes, eating utensils
Paper	Packaging. News / stationery. Cardboard Miscellaneous	Wrappers, serviettes Newspapers, advertising flyers, Food and drink containers, bus tickets.
Metal	Cans Miscellaneous	Foil, bottle tops, number plates.

Glass	Bottles	
Vegetation	Leaves & branches Food	Garden refuse Rotten fruit and vegetables.
Sediment	Sand	Building sand, building rubble
Miscellaneous	Animal Construction material  Cloth Fibre-glass Miscellaneous	Shutters, planks, timber props, broken bricks, lumps of concrete. Old clothing, rags, blankets. Fibre-glass Miscellaneous Shoes, sponges, balls, pens and pencils, balloons, oil filters, cigarette butts, tyres.

#### 4.3.1.3. Urban air pollution

Emissions from industries and motor vehicles specifically are identified as a major source of air pollution in NAKU catchment. Incidents of air pollution by two industrial hotspots (i.e Imana steelRwanda Bugesera District and SteelRwa in Rwamagana District ) have been reported at various times (New times,2016; New Times, 2019).Motor vehicles air pollution is growing as a result of population growth and associated urbanisation. Dust emissions from unpaved urban roads and maize and wheat milling operations also can be major sources of particulate organic matter in NAKU.

Monitoring of air pollution in Rwanda should be strengthened and management of sources that exceed EAC guidelines and standards should be instituted. Other measures has been extensively discussed in Nile Nyabarongo Lower catchment and can also apply in Nile Akagera Upper catchment.

#### 4.3.1.4. Urban noise pollution

Major transport routes have the potential to cause both increases and decreases in traffic noise by altering the traffic composition. The impact of a road at any location can be reported in terms of changes in absolute noise level. The effect on people from a road can also be reported in terms of nuisance. The assessment of nuisance is based on the average percentage of people who are interviewed and who expressed a considerable degree of bother at the level of noise experienced when at home. This measure of nuisance must be correlated with external noise levels based on a standard index used for traffic noise monitoring. It should be noted that this definition of nuisance is not the same as that used in some statutory documents

A road project also has the potential to cause nuisance and physical damage through vibration. Vibration is a low frequency disturbance producing physical movement in buildings and their occupants. These impacts can happen during the operation of an existing or new road, during the improvement or maintenance of an existing road, and during the construction of a new road. Vibration can be transmitted through the air or through the ground. Airborne vibration from traffic can be produced by the engines or exhausts of road vehicles with dominant frequencies in the 50-100 Hz range. Ground-borne vibration is more often in the



8-20 Hz range and is produced by the interaction between rolling wheels and the road surface.

Other sources of urban noise pollution can be entertainment centres playing loud music, construction activities where air compressors are used, diesel generators for generating electricity during power outages, etc. Noise pollution are especially noticeable at night when the traffic volumes decrease, and people want to sleep.

#### **4.3.1.4. Peri-urban diffuse sources of pollution**

Peri-urban land use area has been extensively investigated during this task, however it is recognised as an important landscape component being the transition zone between rural and urban areas where the majority of development takes place and such is a principal source of intensive diffuse pollutant. Among key development activities in peri-urban areas of NAKU include small industrial zones, known as Agakiro centres; quarries and unplanned settlement communities. Most of peri-urban centres in NAKU are not serviced with solid wastes and wastewater treatment systems, becoming a principal source of diffuse pollutants with the range of rural pollutants and some specific urban pollutant concentrations e.g. septic sewage. Therefore, concentration of pit latrines creates a potential water quality issues, especially with regard to seepage to groundwater and possibly to the base flow of waterways.

#### **4.3.2 Rural diffuse sources**

##### **4.3.2.1. General overview**

In Nile Akagera Upper catchment, agriculture (perennial) and open areas or grass jointly totalize 85% of land use. Rained agriculture is predominant, but also intensive puddly irrigation and non-irrigated crops (e.g. maize) is found in the catchment. The different management activities associated with these different land uses result in different types and/or quantities of water quality pollutants.

Typical diffuse source pollutants in rural areas include sediment, nutrients (nitrogen and phosphorus) and pesticides, which are eroded and/or collected from land surfaces, typically in rainfall runoff, and carried to receiving waters e.g. streams, lakes, reservoirs and wetlands. This overland flow, also known as sheet or hillslope erosion, combines with gully erosion and stream bank erosion to provide the majority of the total end of catchment pollutant loads

Movement of sediment and nutrients in rainfall runoff is a normal component of natural weathering and erosion processes. Additional inputs of bioavailable/soluble nutrients combined with land disturbance and inappropriate management practices often results in accelerated run off and erosion rates and the subsequent transport of sediment and nutrients to receiving waters, well above normal background levels. It is the delivery of sediment and nutrients to receiving waters at elevated levels (and for nutrients in forms that are bioavailable) that create threats to aquatic habitats and biodiversity and, in some cases, human health.

Sediment and nutrient pollutants, their sources and environmental threat rating are listed in Table 4

**Table 7: Main rural diffuse pollutants**

Pollutant	Source	Rating	notes
<b>nutrients</b>			
Nitrate (NO <sub>3</sub> )	Fertiliser	5	Low natural levels
Ammonia (NH <sub>4</sub> )	Fertiliser	2	Low natural levels
DON	Fertiliser	2	Moderate natural levels, slow turnover
PN	Fertiliser and erosion	4	Moderate natural levels, loss to sediments
Phosphate (PO <sub>4</sub> )	Fertiliser, salt licks	2	Low natural levels
DOP	Fertiliser	1	Moderate natural levels, slow turnover
PP	Fertiliser and erosion	3	Moderate natural levels, loss to sediments
Silicate (Si (OH) <sub>4</sub> )	Erosion	0	
Sewage	STP discharge septic	5	Contains all N, P forms at high levels
Coarse (>63 µm)	Erosion	0	No likely impact, forms delta fans
Medium (2-63 µm)	Erosion	2	Carried only short distance
Fine (< 2µm)	Erosion	4	Carried widely over shelf, especially after dry year

Source: Mitchell et al 2007 (p.7)

Note: Rating is potential threat posed by the pollutant where 5 is greatest threat and 0 is no threat. Unlike sediment and nutrients, pesticides are a water quality pollutant not measured against natural background levels, as there are no ‘natural’ background levels. Inappropriate management practices, increased stormwater run-off and accelerated erosion rates also affect the amount of pesticides reaching receiving waters. Pesticides that enter waterways become a water quality threat with a range of impacts depending on the pesticide type and concentration.

In addition to sediment and nutrients a range of pollutant groupings relevant to rural areas were identified by Mitchell et al (2007) and are listed in Table5. The ‘rural’ pollutants are also applicable to Nile Akagera Upper catchment given that rural land uses occupy the majority of the Nile Akagera Upper catchment area.

**Table 8: Other rural diffuse pollutants**

Pollutant group	Specific pollutant and comments
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Herbicides	Diuron, Atrazine, Ametryn, Hexazinone and 2, 4-D are principally used in the sugar industry. Simazine used in forestry. Tebuthiuron used in grazing industry. Glyphosate and Paraquat used broadly in sugar cane and horticulture.
Insecticides	Organochlorines e.g. Endosulfan, and a variety of others are used principally in horticulture and, to a lesser extent, sugar cane. Chlorpyrifos used in sugar cane for cane grubs.
Non insecticide organochlorines	PCB's from industry (reduced use but residues may persist) and Dioxins from agriculture and industry.  PAH's (polycyclic aromatic hydrocarbons) from cane firing, forest fires  and oil spills.
DO reducing materials (organic material)	Manure principally from cattle grazing. Sewage from urban areas. Plant litter occurs naturally and is increased as byproducts of intensive agriculture.
Heavy metals	Cadmium and potassium from fertiliser and mercury from fungicide. Other trace elements.
Oil or hydrocarbons	Primarily from liquid fossil fuels and oil spills.
Salinity	Both dryland and irrigation salinity resulting from land clearing (dryland) and irrigation activities.
Antifoulants	Used primarily in the fishing industry at mooring sites (TBT is now banned).
Acid	Principally associated with disturbance of acid sulphate soils.

#### 4.3.2.2. Nutrient enrichment and eutrophication

Nutrient enrichment and eutrophication refers to the accumulation of plant nutrients in rivers and dams in excess of natural requirements resulting in nutrient enrichment and eutrophication. The direct impacts include excessive growth of algae and macrophyte (rooted and free-floating water plants), the presence of toxic metabolites in cyanobacteria (blue-green algae), the presence of taste- and odour-causing compounds in treated domestic water, and difficulty in treating the water for potable and/or industrial use. Concerns have been expressed about nutrient pollution and eutrophication in rivers and in Lake Mugesera, and feeding into the Akagera Mugesera Catchment. The high turbidity in the Akagera River would mitigate against excessive growth of algae in the river. However, eutrophication is a concern in lakes. Recent water quality monitoring did not indicate wide fluctuations in dissolved inorganic phosphorus and nitrogen in the

Akagera River. DIP concentrations varied between 1.2 - 2.0 mg/l and DIN concentrations varied between 4.6 - 5.5 mg/l (Sekomo & Kagisha, 2017). In Mugesera Lake and Sake Lake the DIP was 0 and 0.4 mg/l respectively, and the DIN was 3.7 and 3.6 mg/l respectively. The DIN was regarded as elevated for lake ecosystems.

#### 4.3.2.3. Invasive aquatic plants

Invasive aquatic plants are not indigenous to the region, have no natural adversaries, and have a prolific growth rate. The main invasive aquatic plant in Rwanda is the water hyacinth (*Eichhornia crassipes*). Water hyacinth is a very fast-growing plant, with populations known to double in as little as 12 days. Infestations of this weed block waterways, limit boat traffic, clog water abstraction points, and interfere with fishing activities. Water hyacinth also prevents sunlight and oxygen from reaching the water column and submerged plants. Its shading and crowding of native aquatic plants dramatically reduces biological diversity in aquatic ecosystems. In the Akagera Mugesera Catchment WASAC has raised concerns about the presence of water hyacinth mats in Lake Mugesera and it is interfering with water abstractions for potable water treatment. The floating mats block the intake structures and the water beneath the mats are often coloured black due to the high organic content from decomposing dead plants. The water is also low in oxygen which can further interfere with the water treatment process. Water hyacinth originating from the Kagera River Basin is a major concern for Lake Victoria.

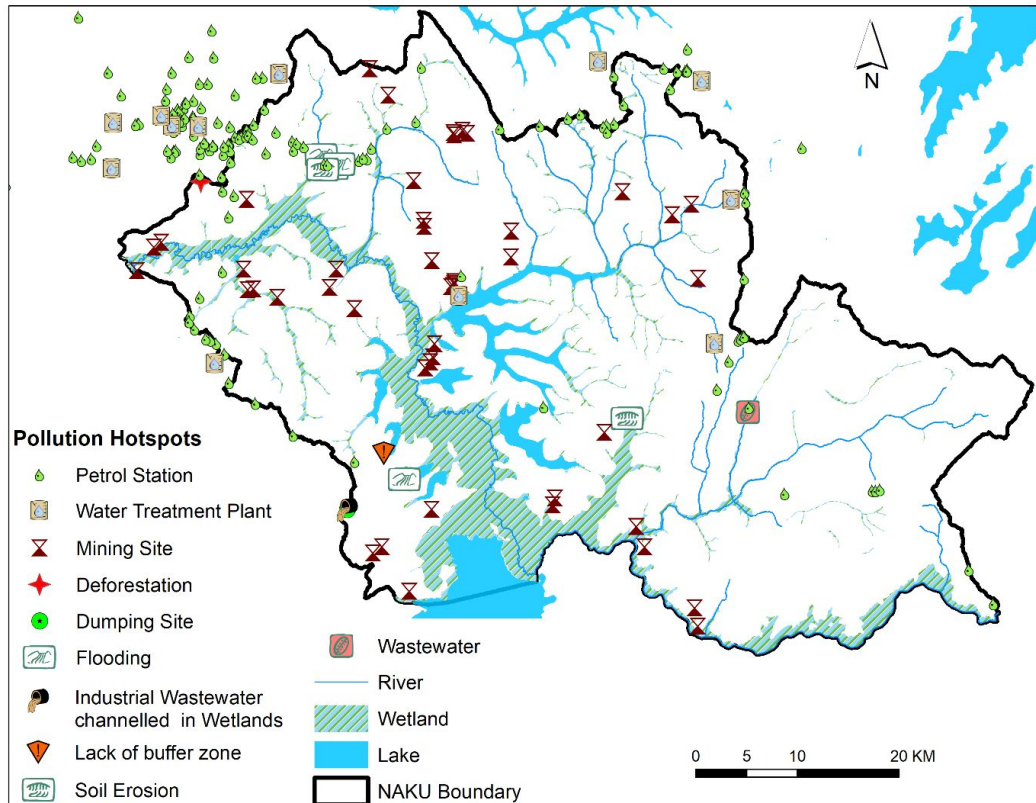
The dissolved oxygen concentration in the water is reduced in the presence of high organic loads. Monitoring of dissolved oxygen in the Akagera River indicated that upstream of the Akanyaru confluence, DO saturation was high (71.4%), but very low in the Akanyaru (5.1%) which impacted on the DO saturation in the Akagera downstream of the confluence (43.9%). Further downstream at the Gashora bridge the DO saturation was still low (53.2%) (Sekomo & Kagisha, 2017).

#### 4.3.2.4. Pollution by agrochemicals

Agrochemical refer to pesticides and herbicides residues in surface waters that are harmful to aquatic ecosystems and/or users of the water. It includes pesticides or their residues such as chlorpyrifos, endosulfan, atrazine, deltamethrin, DDT & penconazole. These compounds can have chronic or acute impacts on aquatic biota and/or it can cause respiratory diseases in humans and animals. Sources include spray-drift of pesticides/herbicides into surface water courses, the wash off of pesticides into surface and groundwater during rainfall events or irrigation of crops, or accidental spillages at storage facilities or during loading operations. In the Akagera Mugesera Catchment pesticide are probably used and pesticide and herbicide residues would probably be found in receiving waters in the catchment. Due to the high cost of pesticides and herbicides in Rwanda, its use is probably limited and it is used judiciously.

#### 4.4. Pollution hotspots

For a more comprehensive understanding of impacts of pollution sources on natural environment and to allow prioritisation of resources and actions, potential pollution sources were identified and mapped (Figure 9 above), then an overlay of identified sources of pollution with information on which environment resources may be affected (water bodies, wetlands, etc) was done and presented into the interactive maps as presented on Figure 10 below while the full lists of hotspots sites are attached as annex IV.



**Figure 10: Identified Pollution Hotspots in NAKU Catchment**

#### 4.5. Approaches to Integrated Pollution Management

Pollutants are produced through human activities and create long-term effects when released into ecosystems. Strategies for reducing these impacts can be directed at three different levels in the process: altering the human activity, regulating and reducing quantities of pollutant released at the point of emission, and cleaning up the pollutant and restoring ecosystems after pollution has occurred.

Figure 11 shows the value and limitations of each of the three different levels of intervention.

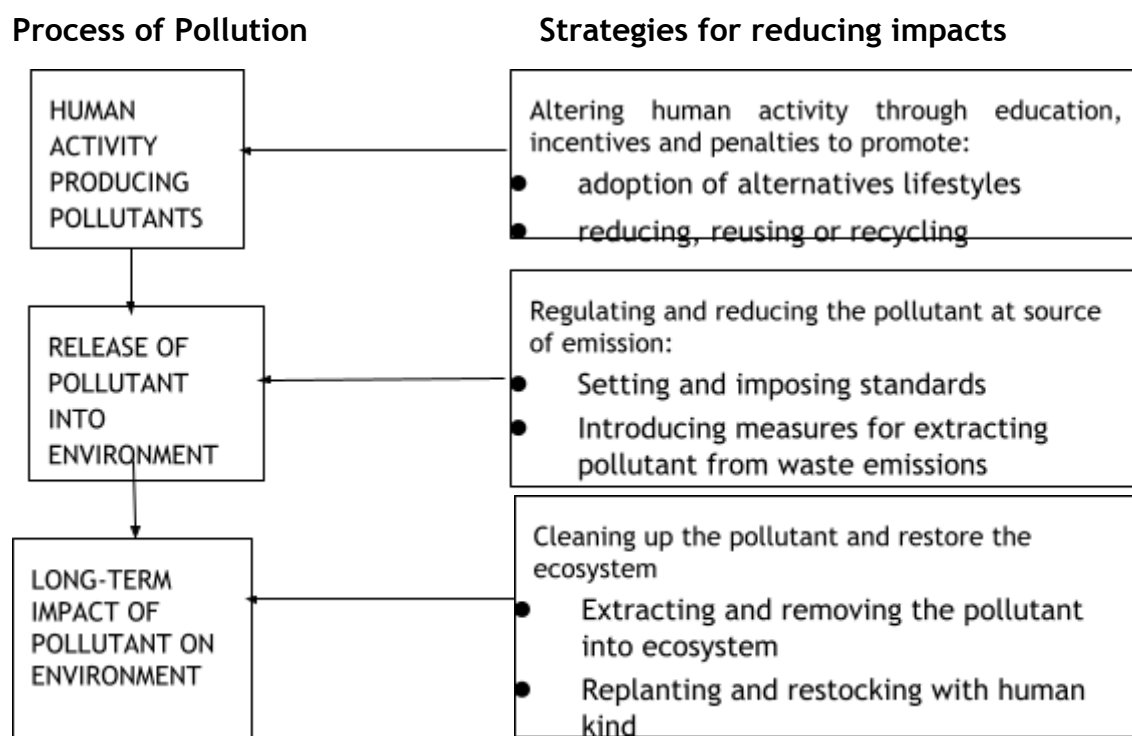


Figure 11: Approaches to integrated pollution management

#### 4.5.1. Altering human activity

Changing Human actions has the greatest benefit overall, but is often the hardest to achieve and takes long term planning. If no pollution was produced in the first place there is no need for any intervention. Though often intervention is needed originally to help change the behaviours that contribute to pollution. This strategy depends very much on behavioural change of people, industry / business and Governments and can come into conflict with short term economic tensions

#### 4.5.2. Regulating and reducing pollutant at source of emission

Reducing the amount of pollutant released into the environment has the next greatest impact. This help to control the source of the pollution rather than the effect of the pollution. This form of pollution management is built into government policies around the world where pollution regulation can have direct results. The Environment Organic Law (2005) was an early pollution legislation measure. While business and industry are often the main focus of pollution legislation, domestic pollution may also be controlled by legislation. Many countries, especially in Europe have legislation that forces households to separate domestic waste so less waste enters landfill and recyclable products like PET bottles can be separated out easily.

Imposition of appropriate standard is also important for source emission standards. Applicable standards and guidelines for pollution sources reduction in Rwanda that need enhanced enforcement during the implementation of this IPMP were analysed in paragraph 4.2 above.

### 4.5.3. Cleaning up the pollutant and restore the ecosystem

Cleaning up pollution problems is the least effective way of dealing with pollution. This is dealing with the problem after the problem has already caused damage. Much of the old industrialised world has inherited the problems created since the industrial revolution. Cleaning up an already damaged environment is often costly and can often take many years from inception to complete clean up. Though often where heavy industry has been in the past or with contaminants such as radiation the clean-up can only ever be limited

In case of urban stormwater discharges, the need for pollution reduction has led to an emphasis on a stormwater management approach that focuses on keeping pollutant out of receiving streams by upstream control; that is attenuation and treatment measures close to where the runoff is generated (Abbott Grobicki, 2001). Most urban stormwater management measures can be classified as structural or non-structural (Abbott Grobicki, 2001, Debo & Reese, 2003):

**Non-structural BMPs** are BMPs are almost exclusively focussed on pollution prevention and the objective is to minimise the pollutant load from urban areas. These include a variety of institutional and educational measures focussed on land development, public awareness to modify behaviour that contribute to urban pollution, detection of illicit wastewater discharges, and enforcement of ordinances designed to prevent the deposition of nutrient containing waste and products on urban landscapes. Non-structural BMPs are generally grouped into educational BMPs, planning and procedures BMPs, and site-based local control BMPs (Abbott Grobicki, 2001, Debo & Reese, 2003). Educational BMPs refer to measures that are devised to sensitise citizens about their role in water quality degradation, protection and enhancement. Planning & procedures refer to minimising urban stormwater pollution through effective planning procedures (e.g. master plans, comprehensive plans, and zoning ordinances) designed to promote improved water quality by restricting certain types of activities in sensitive areas. Site-based local controls refer to ordinances and by-laws that require the inclusion of buffer strips, preservation of riparian zones, minimising disturbance and impervious areas, and maximising open spaces.

**Structural BMPs** are generally measures that act as a backup for non-structural BMPs by providing attenuation or treatment facilities before transportation of polluted water to receiving streams and rivers. Structural BMPs can be grouped into storage practices, infiltration practices, and vegetative practices (Debo & Reese, 2003). Storage and detention BMPs refer to measures to collect urban runoff in wet ponds, dry basins or multi-chamber catch basins and slowly releasing to a receiving stream or river or stormwater canal. Infiltration practices refer to BMPs that facilitate infiltration of urban runoff through the soil to groundwater. Vegetative practices refer to landscaping BMPs that enhance pollutant removal, maintain and promote natural site hydrology, promote healthy habitats and increase aesthetic appeal.

Currently, only structural management facilities were selective planting of bamboo within the riparian buffer zones to stabilise river banks, and enforcement of exclusion zone (buffer zones) around the main rivers.

#### 4.6. Summary on Nile Akagera Upper catchment pollution drivers, pressures, states and impacts

The DPSIR (Driving forces, Pressures, States, Impacts and Responses) approach was adapted from IWRM/W4GR Upper Akagera Catchment Plan (2018-2024) developed by Rwanda Water and Forestry Authority in 2018. Table 9 below provides drivers, pressures, states and impacts of pollution in Nile Upper Akagera catchment

**Table 9: Drivers, Pressures, States and Impacts of pollution in Nile Akagera Upper Catchment**

Drivers	Pressures
<ul style="list-style-type: none"> <li>• Economic development</li> <li>• High population density</li> <li>• Low awareness levels</li> <li>• Insufficient enforcement of environment laws and regulations on mining</li> <li>• Little knowledge, understanding &amp; skills in agrochemicals/pesticides/herbicides application best practices</li> <li>• Low capacity and skills in solid waste and wastewater management</li> </ul>	<ul style="list-style-type: none"> <li>• Siltation from mining exploitations</li> <li>• Soil over exploitation, land degradation &amp; soil erosion</li> <li>• Limited management of solid and liquid wastes</li> <li>• Encroachment of river banks &amp; pollution of water bodies</li> <li>• Sub-standard farming &amp; mining practices aggravating soil erosion and pollution</li> <li>• Industrial and commercial pollution</li> </ul>
States	Impacts
<ul style="list-style-type: none"> <li>• High turbidity in rivers</li> <li>• Low water quality, including high E.Coli counts in surface water</li> <li>• High Nutrient loads and eutrophication</li> <li>• Pollution by agrochemicals</li> </ul>	<ul style="list-style-type: none"> <li>• Water in rivers often unsuitable for drinking water intakes</li> <li>• Water borne diseases</li> </ul>

#### 4.7. Opportunities

##### 4.7.1. Past and ongoing soil conservation interventions

Lessons learnt from reforestation and other soil conservation interventions implemented by different projects (PAREF, LVEMPII, PAGREF, FONERWA, LWH/RSSP, etc) in Nile Akagera Upper catchment will serve as an opportunity to upscale future plans to reduce soil erosion and increase productivity.



#### **4.7.2. Laws, regulations and standard**

During the decades, the Government of Rwanda put in place different laws, regulations and standard on environment and natural resources protection, management and conservation that would be regarded as opportunity to improve pollution management in Nile Akagera Upper. Limited enforcement capacity of the above legal instruments is still law in the catchment, for this opportunity to become effective, stakeholders need to join hands in enhancing enforcement of legislation, e.g. through water permitting and strengthening of field-level enforcement of environmental legislation.

#### **4.7.3. Decentralised governance framework**

Existing District authorities and catchment committees in Nile Akagera Upper Catchment are regarded opportunities since they have better knowledge of environmental and socio-economic problems of the catchment and are well placed to enhance environment protection measures if they are supported. In addition, they will facilitate local communities' participation and allow the building of local capacities for provision of services that are more consistent with the local requirements.

## CHAPTER 5. INTEGRATED POLLUTION MANAGEMENT PLAN

### 5.1. Introduction

The preceding chapters provided a characterisation of pollution situation in Nile Akagera Upper catchment and identified specific issues and challenges being experienced. This chapter sets out the Vision, goals and objectives to address these issues and to ensure the sustainable management of natural resources going forwards. The goals and objectives are generic for all catchment included in this project. However, the targets and activities are specific to the Nile Akagera Upper catchment.

### 5.2. Vision, goals and objectives

The vision statement has been formulated so as to ensure that it is broad to allow for wider interpretation and buy-in from various stakeholders. A generality has also been incorporated to give it a long lifespan and allow its constituent medium term plans to remain relevant to the long-term goal and objectives of the plan.

Scoping workshop that brought together representatives of all the districts in the catchment and national institutions discussed and agreed on common key pollution issues and opportunities. Major pollution management issues in Nile Akagera Upper catchment planning processes that are not aligned with catchment governance; contamination of urban water bodies as consequence of discharge of inadequately treated liquid; inadequate solid waste collection and illegal dumping; aquatic invasive species in water bodies; and low skills & awareness levels on pollution issues whereas the opportunities include past and ongoing sustainable land management & soil conservation interventions, existence of laws, regulations and standards on pollution management as well as decentralized governance framework that facilitate the participation of local communities during the implementation of the plan.

Following the scoping workshops held with stakeholders, consultancy team synthesized the workshop messages and outcomes and then formulated an agreed vision for the Nile Akagera Upper (NAKU) as follows:

***“Nile Akagera Upper is a well-managed catchment supporting the community to meet its socio-economic needs in a sustainable manner without compromising natural ecosystem to provide its services”***

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

#### **Goal 1: Alignment of catchment planning processes and strategies at District and catchment level**

In order to manage catchment pollution, there is a need to ensure that planning processes at districts and catchment levels are aligned and coordinated. Also District Development Strategies must be aligned with national plans, policies and

strategies to ensure that pollution and protection of the catchment as well as the environment is considered in all activities undertaken by the district. This goal will be achieved through the following objectives and targets:

*Objective 1.1. Alignment of catchment planning processes at Districts and catchment levels*

This objective will be achieved through the following key activities:

- i. Support District Authorities to enforce regulations on pollution control
- ii. Support joint inspections of environment polluting activities in NAKU

*Objective 1.2. Establish coordination mechanisms for pollution management at catchment level*

This objective will be achieved through the following activities:

- i. Establish and operationalize Nile Akagera Upper catchment committee;
- ii. Support integrated planning at catchment level; and
- iii. Support coordination meetings of various committees related to pollution management at NAKU catchment level (i.e. catchment committees, environment committees, water supply committees, water users organisations and health & hygiene committees)

**Goal 2: Efficient and effective pollution management in Nile Akagera Upper catchment**

There is a need for districts to be more adaptive in their management of pollution. This will require increasingly identification and implementation of efficient and effective management practices to minimise the impacts of rural and pollution. It would also require the strengthening of compliance and enforcement activities within catchment area. This goal will be achieved through the following objective and goals:

*Objective 2.1 Support effective pollution management in Urban and per-urban areas of NAKU*

This objective will be achieved through the following activities:

- i. Conduct a Feasibility & detailed design study on centralised wastewater for Bugesera industrial park;
- ii. Support the management and operationalization of sludge management and treatment facilities;
- iii. Support resettlement of population in high risk zones;
- iv. Support small industries & SMEs to implement cleaner production measures;
- v. Implement air pollution control guidelines;
- vi. Support rainwater harvesting on rooftops of settlement areas;

- vii. Construction of water drainage to capture road drainage & settlements
- viii. Enforce oil separation at all garages and vehicle workshops;
- ix. Provide incentives to maximize waste collection, including separation at source; and
- x. Promote voluntary clean-up activities through community work initiatives and local NGOs.

**Objective 2.2**      *Effective management of rural pollution*

This objective will be achieved through the following activities

- i. Invest in wetland valorisation & ecotourism initiatives;
- ii. Provision incentives package (e.g application for Payment for Ecosystem Services) to the key stakeholders removing water hyacinth and other associated aquatic weeds in hotspots
- iii. Implement buffer rehabilitation and remove illegal farming activities on river banks
- iv. Multiply inspections for environmental compliance in mining sector

**Goal 3: Effective information and knowledge management**

The old adage that you cannot manage what you do not measure holds true. This goal requires a renewed and strengthened drive to improve monitoring networks in urban areas and to strengthen and consolidate information management systems. Adaptive management is based upon the support of monitoring networks and systems. This goal also includes building capacity in catchment integrated pollution management through education, training, and knowledge transfer. Strategic goals are supported by specific objectives and targets.

**Objective 3.1** *Ensure continuous Monitoring of urban and rural pollution*

Planned interventions to achieve the above objective include:

- i. Support the integration of key pollution hotspots into the national monitoring program
- ii. Ensure continuous removal of invasive species through supporting cooperatives involved in invasive species removal for procuring adequate equipment

**Objective 3.2** *Building capacity in catchment pollution management*

This objective will be achieved through the following activities:

1. Develop training package on urban and rural pollution and BMPs;;
2. Conduct trainings, awareness raising and capacity building among farmers on smart agriculture;

3. Organise trainings for technicians and operators for weed harvesters and loading equipment;
4. Increase awareness and education on environment protection
5. Disseminate policies, laws and regulatory instruments on environment protection, sustainable mining and smart agriculture.

### **5.3. Implementation arrangements**

Effective implementation of this Integrated Pollution Management Plan will depend on how planned activities are owned by Districts within the catchment and how best planning processes are coordinated and harmonized. The Ministry of Environment is the primary coordinating government organ of pollution issues and will ensure a well coordination and synchronization of planning activities at national levels to avoid unnecessary duplication and conflicts that may arise. However, the Ministry of Local Government will coordinate the integration of actions in this plan into District Development Strategy, Annual Plans and Imihigo. The implementation mechanisms of the pollution management plan at national and catchment levels are outlined in the following sections.

#### **5.3. 1. Stakeholders' analysis**

The stakeholder analysis showed that the following key stakeholders will take part in implementation of the plan:

- Institutions at national level, in the form of line ministries and their authorities / agencies, including the significant projects and programmes carried out under their auspices;
- Parastatal utilities for water supply, sanitation or electricity;
- Decentralised entities such as district authorities, as the main catchment level plan owners, represented by their members of the Catchment Committee;
- NGOs and INGOs, active in the districts;
- Communities; and
- Private sector stakeholders.

The above stakeholders can be classified into three broad categories according to the role they are expected to play, the level of influence they are expected to exert within the framework for designing and implementation of the catchment plan, and their role in the stakeholder engagement strategy:

**5.3.1.1. Primary stakeholders:** Include local farmers, herders, fishermen etc., all of whom derive their livelihoods from land or water resources, or whose activities directly rely or impact on land and water resources. They are sometimes grouped into water user organisations within and downstream of the catchment and business entities directly affected by catchment management.

**5.3.1.2. Secondary stakeholders:** These are individuals, institutions or organisations that are intermediaries in catchment plan development and

implementation. Secondary stakeholders are "indirectly affected" by outcomes in the catchment and include District authorities, NGOs, WASAC, RURA, REG and key projects such as IUCN and LAFREC II. The catchment committee are the focal points for this group. Although only indirectly affected by the outcomes, secondary stakeholders are powerful and often highly involved in the catchment pollution planning process, and should remain so during the plan implementation;

**5.3.1.3. Tertiary stakeholders:** These are referred to external stakeholders and usually only play an advisory, approval or advocacy role. They include the institutions at national level, the development partners, and technical ministries which formulate policies, plans and programs relevant to the catchment plan (e.g. MoE, MINAGRI, MINALOC, MININFRA, etc). The apex bodies for water management, such as the Water Inter Ministerial Committee and National Water Consultative Committee, are also included in this category and play a critical role in approval of the catchment plan.

#### **5.3.2. Roles and Responsibilities of key stakeholders**

This Integrated Pollution Management Plan includes certain roles and responsibilities for various institutions which are has a stake in pollution management in Rwanda. These include: Ministry of Environment (MoE), Ministry of Agriculture and Animal Resources (MINAGRI), Ministry of Infrastructure (MININFRA), Ministry of Finance and Economic Planning (MINECOFIN), Ministry of Local Government (MINALOC), Rwanda Environment Management Authority (REMA), Rwanda Development Board (RDB), Rwanda Water Board (RWB), Rwanda Utilities Regulatory Agency (RURA), Ministry of Trade and Industry (MINICOM); Ministry of Health (MoH) among others. A wide variety of capabilities and expertise can be provided by the other institutions/organisations in support of implementing the plan's recommendations. Some of the diverse institutions/organisations that can be involved include the Districts in the catchment, Development Partners (e.g. World Bank), User Communities, Non-Governmental Organizations (NGOs), the private sector and Community Based Organisations. Table 10 provides details on institutions analysis and their roles in pollution management. Table 12 provides a summary on the lead, co-lead, support and analysis of roles and responsibilities for all identified institutions/organisations. A lead or co-lead designation means that the institutions/organisations noted would be responsible for leading the implementation of the activity but the actual work can be done by the lead group and/or others in a cooperative effort. The co-lead and other designations can also provide management support and/or technical assistance for actions led by the lead institution.

#### **5.4. Financing of the Plan**

Acquisition of adequate resources is a prerequisite for the successful implementation of this plan. Rwanda Environment Management Authority (REMA) and the Ministry of Environment who are the primary coordinating institution responsible for the implementation of the Pollution Management Plan should be

the vehicle for the mobilization of the necessary resources. These resources shall be mobilized from national sectoral budgets, bilateral and multilateral donors and the private sector. Support from organizations such as GCF, World Bank, GEF and SIDA and others with a long history of support in the conservation and sustainable development projects in Rwanda will be critical in providing the funding to implement the plan.

**Table 10: Institutions with important roles in Pollution Management**

No	Institution	Function
<b>Policy institutions</b>		
1	Ministry of Environment (MoE)	Ensure that environment and pollution control policies and strategies are passed by Cabinet and communicated to stakeholders. The Ministry of Environment will provide policy oversight to the plan implementation including enforcement of accountability and continued alignment to high level political interests
2	Ministry of Local Government (MINALOC)	Facilitate the management of efficient and effective decentralized government systems capable of law enforcement and delivery of required services to the local communities
3	Ministry of Agriculture and Animal Resources (MINAGRI)	In its mandate of increasing agricultural and animal production, modernising farming, ensuring food security and promoting surplus for the market, and given the close link between agriculture and the catchment management, especially for land husbandry, irrigation feeder roads improvement and fertilisers application in farms, this Ministry will be involved in promoting policies and strategies for soil conservation and agrochemicals/pesticides application best practices.
4	Ministry of Infrastructure (MININFRA)	MININFRA will facilitate implementation of the IPMP at catchment level and at national level through policy and standards formulation on integrated Municipal solid wastes and liquid wastewater management and participation in the programme steering committee, and at local level in the catchment;
5	Ministry of Trade and Industry (MINICOM)	Policy formulation and promotion of investments in cleaner production by the private sector for industries and manufacturing.
<b>Financing institutions</b>		
6	Ministry of Finance and Economic Planning	Mobilization and allocation of financial resources including co-ordination of donor inputs

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7	Rwanda Green Fund (FONERWA)	Funds Mobilization and investment in the best public and private projects that have the potential for transformative change and that align with Rwanda's commitment to building a strong green economy.
8	Development partners	LDCF, World Bank, German Embassy, Embassy of the Kingdom of Netherlands and other regional or international environment management partners on the ground and those not on the ground but with interest in pollution management in Nile Akagera Upper catchment will be critical to the success of the plan implementation. Their experience in pollution management and control links to potential financiers or financing capability will be very important for the implementation of the plan.
<b>Regulatory Institutions</b>		
9	Rwanda Environment Management Authority (REMA)	Key areas of intervention relate to prevention of soil erosion, deforestation, pollution and water contamination. REMA should support LODA in ensuring that the focus on LED does not negatively impact on the environment, including through destruction or depletion of natural resources, and should work towards promoting innovation and green enterprises
9	Rwanda Utilities Regulatory Agency (RURA)	Enforcement of compliance by public utilities with the laws governing their activities, mainly liquid and solid wastes collection, transportation & disposal
10	Rwanda Standard Board (RSB)	Provision of standards based solutions for a safe and stable environment.
<b>Implementation &amp; Services institution</b>		
11	Rwanda Water Board	The Rwanda Water Board leads management and promotion of water Resources. RWB establishes strategies related to the protection of catchments and coordinate the implementation of erosion control and water quality monitoring actions, including implementation of catchment management plans.
12	LODA	The Local Government Development Agency plays a unique and essential role in supporting and promoting local economic development across Rwanda. As a central agency but with staff at district level and providing funding to improve development at the local level, LODA has a key role in supporting LED. In close collaboration with MININFRA & MoE LODA will ensure that projects needed in the catchment are designed and executed in a sustainable manner( i.e without or low adverse environment impacts)



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13	WASAC	WASAC: is responsible for ensuring access to clean water and adequate sanitation infrastructure. WASAC is therefore a key player in catchment plan implementation especially with regard to achieving safely managed water and wastewater. In addition, WASAC will contribute through supporting the rehabilitation of buffer zones around water sources.
14	RDB	RDB is responsible for supporting private investment and business development in Rwanda, including through addressing the needs of companies and investors. In catchment pollution management plan implementation, RDB will lead attraction of investors in waste management infrastructure development and be consulted for approving Environmental Impact Assessments and mitigation plans for all pollution management projects at catchment level.
15	RAB	Given its responsibility to implement the national policy of agriculture and animal husbandry, RAB will ensure the promotion of agriculture and husbandry practices that minimise the impacts of diffuse agricultural pollution of water, land and air
16	NIRDA	Promote the use of environmentally friendly and resource efficient technologies and services in pollution management at catchment level
17	Districts	Implementation of the government policies and laws. Districts in Nile Akagera Upper catchment will be sole organs to lead the implementation of this plan.
18	PSF	Design, construction, operation and maintenance of pollution management infrastructure and equipment. Provision of other commercial services, e.g. mobilization of financial resources for waste management infrastructures.
19	Non-Governmental Organizations (NGOs)	NGOs operating in Nile Nile Akagera Upper catchment will supplement the public sector efforts in pollution management through conduct training and capacity building for communities

**5.5. Actions cost estimates**

The budget estimate for the implementation of this plan based on the strategic activities is presented in Table as Annex I. Funds for the implementation of the plan is expected to come from the government budget, grants and donor agencies. An explanation on how the cost estimates was made is attached as Annex II

## 5.6. Prioritization of Actions and Schedule

Effective implementation of the Nile Akagera Upper Integrated Pollution Management Plan is enhanced by the prioritization and scheduling of all recommended actions. In order to accomplish this, a priority rating system and implementation schedule parameters were considered for each action.

Factors included as part of the prioritization rating system include importance, coverage under existing programs, timing and sequencing, and ease/difficulty of implementation of the recommended actions. For each factor, professional judgment and experience were used to consider the following types of priority information:

- i. *Importance* - Recognizing that all recommended actions are essential for sound pollution management, which actions are most critical or critical versus others that are important?
- ii. *Coverage Under Existing Programs* - What are the significant pollution management needs that either have little or no, limited, or incomplete coverage under existing programs?
- iii. *Timing and Sequencing* - Are there any considerations, such as developmental time for programs and regulations that require actions to be phased in over time? Do any of the plan's recommendations rely upon another action(s) to be done first?
- iv. *Ease/Difficulty of Implementation* - Given the many parameters to be considered for implementation, which actions are relatively easy versus difficult? Some of the parameters to consider include technology available, staffing, in terms of manpower and subject matter expertise, competing program priorities and workload, legal or policy constraints, and public support.

Each recommended action was evaluated, using the factors listed above, to determine ratings of top priority, high priority, and priority. The importance factor was given added weight by requiring an action to be rated as a top or high priority in importance before it can have an overall rating of top or high priority, respectively.

**Table 11: Ratings System for Essential Pollution Management Actions in NAKU**

Rating Factor	High Priority (H)	Medium Priority (M)	Low Priority (L)
Importance	Most critical	Critical	Important
Coverage Under Existing Programs	Little or no coverage	Limited coverage	Incomplete coverage
Timing and Sequencing	No other action required	Other short-term action(s) required	Other long-term action(s) required
Ease/Difficulty of Implementation	Expect fairly easy implementation	Expect fairly easy implementation, but some difficulties possible	Expect some difficulty in implementation

The specific implementation schedule for each element of the management plan is dependent on the priority and resources given to the elements. For the purpose of this management plan, implementation scheduling was addressed by grouping actions under the following three time frames. Again, professional judgment and experience were used to assign schedule time frames.

- i. *Short-Term Actions* - Those actions of any priority level that should be initiated and/or effectively implemented within one or years.
- ii. *Medium-Term Actions* - Those actions of any priority level that should be initiated and/or implemented within two years and above but full implementation of these actions may not take more than 4 years.
- iii. *Long-Term Actions* - Those actions of any priority level that should take from three years and above to initiate and effectively implement.

An example of a medium-term action is ongoing program changes such as those that require new information or a complementary study is to be undertaken before implementation. Short-and long-term actions, will require positive program and budget decisions in the future. Rwanda Water Board and REMA will take a proactive approach to implementing the plan's recommendations in a timely manner. It is anticipated that the other lead stakeholders also will be proactive in plan implementation. Table 11 below presents the Integrated Pollution Management Plan actions prioritization, scheduling and roles and responsibilities of different stakeholders

**Table 12: Nile Akagera Upper IPMP actions prioritization, scheduling and key stakeholders**

Status	Challenge/Issue	Recommended action	Prioritisation	Sequencing	Responsible
<b>Goal 1: Alignment of catchment planning processes, policies and strategies to mitigate the impacts of pollution.</b>					
Planning processes non-aligned with catchment governance	Inadequate measures by District authorities to enforce pollution control guidelines and standards	Support District Authorities to enforce the Rwandan industrial effluent standards.	Medium	Short-term	<b>REMA (Lead)</b> , RURA (Co-lead), Districts, RNP, RIB (Others)
		Support District Authorities to enforce the EAC industrial and incinerator air emission standards	Low	Short-term	<b>REMA (Lead)</b> , MoH (Co-lead), Districts RNP, RIB (Others)
	Uncoordinated planning processes at catchment level	Support joint inspections of environment polluting activities in NAKU	High	Short-term	<b>REMA (Lead)</b> , Districts (Co-lead), RNP, RIB (others)
		Establish NAKU catchment committee	High	Short-term	<b>RWB (Lead)</b> , Districts (Co-lead), Catchment Committee (others)
		Operationalise NAKU catchment Technical Committee	Low	Short-term	<b>RWB (Lead)</b> , Districts (Co-lead), Catchment Committee (others)
		Support integrated planning at catchment level	High	Medium-term	<b>LODA (Lead)</b> , RWB (Co-lead), Districts, MINALOC, MINECOFIN (Others)
		Support regular coordination meetings of water committee, environment	Medium	Medium-term	<b>RWB (Lead)</b> , REMA (Co-lead), Districts (others)

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		committee and water users organisations			
<p><b>Goal 2: Efficient and effective pollution management in Nile Akagera Upper catchment</b></p> <p>Contamination of urban water bodies</p>	<p>Inadequate management liquid wastes</p>	<p>Feasibility study on centralised wastewater in Bugesera industrial park</p>	High	Mid-term	<p><b>MINICOM (Lead)</b>, WASAC (Co-lead), REMA, RWB, District (others)</p>
		<p>Support management and operationalisation of sludge management and treatment facilities</p>	High	Long-term	<p><b>WASAC (Lead)</b>, RURA (Co-lead), REMA, Districts (Others)</p>
		<p>Support resettlement of population in high risk zones</p>	High	Long-term	<p><b>MINALOC (Lead)</b>, LODA (Co-lead), MINEMA, Districts (others)</p>
		<p>Support small industries &amp; SMEs to implement cleaner production measures</p>	Medium	Long-term	<p><b>NIRDA (Lead)</b>, REMA (Co-lead) MINICOM, MoE, Districts (others)</p>
		<p>Implement air pollution control guidelines</p>	High	Continuing	<p><b>REMA (Lead)</b>, RNP (co-lead), RSB, MoE, PSF (others)</p>
		<p>Support rainwater harvesting on rooftops of settlement areas</p>	Medium	Continuing	<p><b>RWB (Lead)</b>, LODA (Co-lead), MINSLOC, districts (others)</p>
		<p>Construction of water drainage to capture road drainage &amp; settlements</p>	High	Continuing	<p><b>RTDA (Lead)</b>, RWB (Co-lead), MININFRA, MINALOC, Districts (others)</p>
		<p>Enforce oil separation at all garages and vehicle workshops</p>	High	Continuing	<p><b>RURA (Lead)</b>, REMA (Co-lead), PSF, Districts (others)</p>

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		Multiply inspections for environmental compliance in mining sector	High	Continuing	<b>RMB(Lead)</b> , Districts (Co-lead), REMA RNP, RIB, RMA (others)
Littering of municipal solid wastes	Inadequate solid waste collection and illegal dumping	Provide incentives to maximize waste collection, including separation at source	High	Short-term	<b>REMA (Lead)</b> , Districts &CoK (Co-lead), MoE, MININFRA, Partners (others)
		Promote voluntary clean-up activities through community work initiatives and local NGOs	High	Short-term	<b>Districts(Lead)</b> , NGOs (Co-lead)
Invasive species and agrochemicals	Sub-standard farming	Enhance payment of ecosystem services in NAKU for catchment protection	Medium	Continuing	<b>RWB (Lead)</b> , Districts (Co-lead), RDB, FONERWA, IUCN, development partners (others)
	Encroachment of wetlands, river banks & pollution of water bodies	Implement buffer rehabilitation and remove illegal farming activities on river banks	High	Long-Term	<b>RWB (Lead)</b> , REMA(Co-lead), Districts &COK, Partners (others)
		Support the valorisation of wetlands ecotourism initiatives	High	Continuing	<b>REMA (Lead)</b> , RDB(Co-lead), RWB, FONERWA, Districts (others)
		Increase awareness and education on environment protection	Medium	Continuing	Districts (Lead), NGOs (Co-lead), REMA, MoE (others)
	Infestation of water bodies by invasive species	Provision incentives package (e.g application for Payment for Ecosystem Services - PES) to the key stakeholders	High	Continuing	<b>REMA (Lead)</b> , Districts (Co-lead), FONERWA (others)

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		removing water hyacinth and other associated aquatic weeds in hotspots				
<b>Goal 3: Effective information and knowledge management</b>						
Low skills & awareness levels	Lack of financial capacity for water hyacinth & other invasive species removal	Support cooperatives for procuring hand-tools, boats and protective wear	High	Short-term	REMA (Lead), FONERWA (Co-lead), RWB, districts, NGOs (others)	
		Integrated key urban hotspot monitoring points to national sampling program	Medium	Short-term	RWB (Lead), REMA (Co-lead), WASAC, UR, RURA (Others)	
	Little knowledge, understanding & skills in agrochemicals/pesticides/herbicides application best practices	Develop training package on urban and rural pollution and BMPs.	Low	Short-term	REMA (Lead), UR (Co-lead), RAB, MINAGRI, RWB (Others)	
		Conduct trainings, awareness raising and capacity building among farmers on smart agriculture	Medium	Continuing	RAB (Lead), REMA (co-lead), MINAGRI, RWB, Districts, NGOs (others)	
	Low awareness in invasive water weeds removal	Organise trainings for technicians and operators for weed harvesters and loading equipment	Medium	Continuing	REMA (Lead), RWB (Co-lead), FONERWA, Districts, Development Partners (others)	
Little knowledge & understanding of environment laws and regulatory instruments	Disseminate policies, laws and regulatory instruments on environment protection, sustainable mining and smart agriculture	Medium	Short-term	MoE (Lead), MINAGRI (Co-lead), REMA, RAB, RWB, RWB, Districts (others)		

## **CHAPTER 6. MONITORING AND EVALUATION**

### **6.1. Framework for Pollution Management Plan Monitoring and Evaluation**

The monitoring and evaluation system will be based on the indicators defined in the log frame (Table as annex I). The monitoring system will function as a management tool to report progress, constraints, and deviation from annual activities against Annual Plan targets, as well as to review and adapt, where necessary, the program strategies. Furthermore, it will function as a mechanism to proceed with timely and punctual data collection.

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

#### **6.1.1. Sector level targets and indicators**

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

#### **6.1.2. Reports of Major Water Users**

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

#### **6.1.3. Decentralized entities M&E systems**

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

#### **6.1.4. Private sector, civil society and NGOs reporting systems**

The current legal framework requires these stakeholders to report regularly on their activities, and the districts in which they work must certify their good cooperation and conduct. This compels them to work within existing development priorities and share information about their work.

### **6.2. Indicators, data collection and reporting**

Data collected will be organized into quarterly and annual reports. Additionally, data collected will be used to expand the Water Information System of Rwanda Water Board as well as the RBME of the Ministry of Environment



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**ANNEX I: NILE AKAGERA UPPER CATCHMENT INTERVENTIONS LOG FRAME**

Goal 1: Alignment of planning processes and strategies at Districts and Catchment level									
Objective	Activities	Indicators	Baseline	Target	Timing			Responsible Authority	Indicative costs (US\$)
					2021/ 2022	2022/ 2024	2025- 2030		
Objective 1.1: Alignment of catchment planning, policies and strategies	Enforcement of Rwandan industrial effluent standards.	% of industries complying with Rwandan industrial effluent standards	TBD	80% of SMEs are complying	X	X	X	REMA (Lead), RURA (Co-lead), Districts, RNP, RIB (Others)	22,400
	Enforcement of EAC industrial and incinerator air emission standards.	% Compliance with standards	TBD	90% complying	X		X	REMA (Lead), MoH (Co-lead), Districts RNP, RIB (Others)	22,400
	Operationalise NAKU catchment Technical Committee	NAKU catchment Technical Committee operationalised	Water Resources Law (2018)	Operational catchment Technical Committee		X	X	RWB (Lead), Districts (Co-lead), Catchment Committee (others)	8,000
Objective 1.2. Establish coordination mechanisms for pollution management at catchment level	Establish NAKU Catchment Committee	NAKU catchment committee is established	Nyabugogo catchment Task Force	Catchment Committee in place		X		<b>RWB (Lead)</b> , Districts (Co-lead), Catchment Committee (others)	5,200
	Support integrated planning at	Number planning meetings	0	2 meetings/year (2 technical	X	X	X	<b>LODA (Lead)</b> , RWB (Co-lead), Districts,	12,800

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catchment level	% of water users organisations operational	Study reports	Industrial part feasibility study	Studies completed	committee meeting+1 general assembly)	X	X	X	MINALOC, MINECOFIN (Others)	12,800
Support regular coordination and environment committee meetings with water users organisations			TBD	100% of water users organisations are operational					<b>RWB (Lead), REMA (Co-lead), Districts (others)</b>	
<b>Goal 2: Efficient and effective pollution management in Nile Akagera Upper catchment</b>										
Objective2.1: Support effective pollution management in Urban and per-urban areas of NAKU	Feasibility & detailed design study on centralised wastewater in Bugesera industrial park	Study reports	Industrial part feasibility study	Studies completed				X	<b>MINICOM (Lead), WASAC (Co-lead), REMA, RWB, District (others)</b>	3,000,000
	Support the management of sludge management and treatment facilities	(i)% HH covered by FSTP services in Kicukiro, Gasabo and riparian areas  (ii) % Urban areas with operational sludge disposal services	TBD  TBD	40% of HH in the Kicukiro, Gasabo and riparian sectors  (ii) 25% of urban areas	X				<b>WASAC (Lead), RURA (Co-lead), REMA, Districts (Others)</b>	5,000,000

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Support resettlement of population in high risk zones	% of population in high risk zones relocated	TBD	80% of population in high risk zones relocated	X	X	X	<b>MINALOC (Lead), LODA (Co-lead), MINEMA, Districts (others)</b>	1,500,000
Support small industries & SMEs to implement cleaner production measures	% of small industries & SMEs implementing cleaner production measures	TBD	60% of small industries & SMEs	X	X	X	<b>NIRDA (Lead), REMA (Co-lead), MINICOM, MoE, Districts (others)</b>	10,500
Implement air pollution control guidelines	% of emitters of air pollutants in NAKU implementing air pollution control guidelines	TBD	100% of air pollutants emitters	X	X	X	<b>REMA (Lead), RNP (co-lead), RSB, MoE, PSF (others)</b>	11,200
Support rainwater harvesting on rooftops of settlement areas	% of settlements with RWH infrastructure		100% of public buildings & schools, 60% of trading centres & 90% individual houses newly developed	X	X	X	<b>RWB (Lead), LODA (Co-lead), MINSLOC, districts (others)</b>	25,200
Construction of water drainage to capture road drainage & settlements	% of district with urban drainage	TBD	Feasibility studies completed for all districts	X	X	X	<b>RTDA (Lead), RWB (Co-lead), MINIFRA, MINALOC, Districts (others)</b>	32,000

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	Enforce oil separation at all garages and vehicle workshops	% of garages enforcing oil separation	TBD	100%	X	X	X	RURA (Lead), REMA (Co-lead), PSF, Districts (others)	50,000
	Provide incentives to maximize waste collection, including separation at source	(i) Coverage of solid wastes collection services (%)  (ii) levels of waste segregation at source	90%  Low	100%  High	X	X	X	REMA (Lead), Districts & CoK (Co-lead), MoE, MININFRA, Partners (others)	372,000
	Promote voluntary clean-up activities through community work initiatives and local NGOs	Level of community participation	satisfactory	Excellent	X	X	X	Districts(Lead), NGOs (Co-lead)	5,200
Objective 2.2: Effective management of rural pollution	Invest in wetland valorisation & ecotourism initiatives	Nyandungu wetland Eco-park	1	Nyandungu wetland Eco-part is valorised	X	X	X	REMA (Lead), RDB(Co-lead), RWB, FONERWA, Districts (others)	2,000,000
	Provision incentives package (e.g	(i) Number livestock distributed	TBD	(i) 100 cows, 2000 goats and	X	X	X	RWB (Lead), REMA(Co-lead), Dis	60,000

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	application for Payment for Ecosystem Services) to the key stakeholders removing water hyacinth and other associated aquatic weeds in hotspots	(ii) Amount of money spent		(ii) US\$ 200,000 spent to support alternative jobs to subsistence agriculture			Partners (others)	
Implement buffer rehabilitation and remove illegal farming activities on river banks	Number of Ha	TBD	100 additional Ha	X	X	X	<b>RWB (Lead),</b> REMA(Co-lead), Districts RDB, FONERWA, IUCN, development partners (others)	26,400
Multiply inspections for environmental compliance in mining sector	% of mining operators complying with standards	TBD	80% of mining operators	X	XX			28,000
<b>Goal 3: Effective information and knowledge management</b>								
Objective	Support cooperatives involved in invasive species removal for procuring hand-tools,	Equipment provided	TBD	Key equipment availed	X	X	<b>REMA (Lead),</b> FONERWA (Co-lead), RWB, districts, NGOs (others)	60,000

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	boats and protective wear															
	Support the integration of key urban hotspot monitoring points to national sampling program	TBD		8 sites ( 4 in CoK, Bugesera, Ngoma, Kirehe & Rwamagana)	X		X					X				83,000
	Develop training package on urban and rural pollution and BMPs.	TBD		Training Manuel	X											10,000
	Conduct trainings , awareness raising and capacity building among farmers on smart agriculture	TBD		500			X									62,500
	Organise trainings for technicians and operators for weed harvesters and	TBD		100			X									20,400
<b>3.2: Building capacity in urban and rural pollution management</b>																

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loading equipment													
Increase awareness and education on environment protection	Number of miners trained				200			X		X		REMA (Lead), Districts (Co-lead), NGOs (others)	20,000
Disseminate policies, laws and regulatory instruments on environment protection, sustainable mining and smart agriculture	Number of material disseminated				1000			X		X		MoE (Lead), MINAGRI (Co-lead), REMA, RAB, RMB, RWB, Districts (others)	30,000
<b>Total</b>													<b>12,490,000</b>



**ANNEX II: NOTE ON IPMP BUDGET/COSTING ESTIMATION**

Item/	Unit	Quantity	Unit Price (US\$)	Total Indicative costs (US\$)	Source of data
Inspections to enforce EAC industrial and incinerator air emission standards.	Number	80	280	22,400	Ministerial Instructions (N° 001/15/10/TC DU 20/07/2015)
Define legal framework and institutionalise NNYL catchment office	Number	50	160	8,000	Estimated based on Hotel Contracts
Support integrated at catchment level (planning meetings)	Number	30	160	4,800	Estimated based on Hotel contracts
Support regular coordination and environment committee meetings with water users organisations	Number	80	160	12,800	Estimated based on Hotel contracts
Support the operation and management of sewerage systems and wastewater treatment plants	Number	1	33,000,000	33,000,000	WASAC Estimates
Support the management of sludge management and treatment facilities	Number	1	5,000,000	5,000,000	WASAC Estimates
Support resettlement of population in high risk zones	Number of HH	200	7,500	1,500,000	Adaptation Fund Project
Support small industries & SMEs to implement cleaner production measures	Persons trained	100	105	10,500	Based on W4GR estimates
Strengthen the national vehicle inspection center's capacity to implement new	Equipment purchased	N/A	N/A	300,000	Expert judgement

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standard on Road Vehicle Emission Limits					
Promote local vehicle assembly including introduction of incentives to promote electric vehicles	Incentives	N/A	N/A	15,600,000	Estimates/ MININFRA
Support increased access and use of LPG in urban and peri-urban household and improved cooking stoves and alternative fuels in rural areas for cooking	HHs	170,500	63	40,170,000	Estimates/MoE
		1,030,000	39	10,656,250	Estimates/MoE
Implement air pollution control guidelines	Number of inspections	40	280	11,200	Ministerial Instructions (N° 001/15/10/TC DU 20/07/2015)
Support rainwater harvesting on rooftops of settlement areas	Number (5m <sup>3</sup> )	60	420	25,200	RWH project/RWFA
Construction of water drainage to capture road drainage & settlements	m	1000	32	32,000	Expert judgement
Enforce oil separation at all garages and vehicle workshops	Number	20	2500	50,000	Expert judgement
Support construct of a designed landfill that makes provision for waste separation and recycling	Number	2	2,000,000	4,000,000	Estimates from WASAC
River bank protection along all rivers and wetlands in NNYL	Ha	120	220	26,400	REMA SAP
Support the implementation of sustainable mining	Persons trained	200	105	21,000	W4GR project

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practices/Model mining					
Enhance payment of ecosystem services in NNYL	Number of Cows	100	520	52,000	Reference price on local market
	Number of goats	2000	60	120,000	Reference price on local market
	Projects supported	10	20,000	200,000	Reference to LVEMPII project
Implementation of measures proposed for Gikondo and Nyabugogo systems catchment management plan	N/A	N/A	N/A	37,000,000	REMA/LVEMPII Project
Multiply inspections for environmental compliance in mining sector	Number	100	280	28,000	Ministerial Instructions (N° 001/15/10/TC DU 20/07/2015)
Inventory of small industries and SMEs with/without wastewater treatment facilities in NNYL	Reports	1	60,0000	60,000	Comparison with similar projects
Enforce continuous monitoring of vehicle emissions through regular standardised tests.	Project	1	40,000	40,000	Expert judgement
Integrated key urban hotspot monitoring points to national sampling program	Number	160	5200	83,200	UR contracts with RWFA
Develop training package on urban and rural pollution and BMPs.	Consultancy	1	40,000	40,000	Similar Consultancy
Conduct trainings , awareness raising and capacity building among farmers on smart agriculture	Number	200	105	20,400	W4GR Project
Conduct capacity building in sustainable mining	Number	200	105	20,500	W4GR Project

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approach/Model mining among mining operators					
Disseminate policies, laws and regulatory instruments on environment protection, sustainable mining and smart agriculture	Number	1000	30	30,000	Expert judgment

**ANNEX III: PHOTOS FROM VISUAL POLLUTION IN NAKU**

**1. Downstream Inyange Industry**



**Picture 1: Visible Algae growth**



**Picture 2: Lake on the right side is clear**



**Picture 3: Lake on the left side is heavily turbid and brown**



Picture 4: Downstream Inyange industry, the road that separate the two lakes and marshlands

## 2. Downstream Rwanda Color Factory



Picture 1: Downstream Rwanda colour



Picture 2: Downstream Rwanda colour where water was sampled







## ANNEX IV: LISTS OF POLLUTION HOTSPOTS IN NILE AKAGERA UPPER CATCHMENT

## IV.1. Coffee washing stations

S/N	Name	DISTRICT	SECTOR	CELL	OWNER_NAME	WATER_SOURCE	ENVIRO_P R	Village	X	Y
1	Nyamata CWS	BUGESERA	Nyamata	Kayumba	Kagwenderi Andre	ELCTROGAZ	Filtering System	Kayenzi	30.0878	-2.11981
2	RTC Kayonza	KAYONZA	Nyamirama	Rurambi	RTC	Natural Spring/Water Pump	Filtering System	Kabuye I	30.5253 5	-1.95915
3	Ungukamuhinzi	KIREHE	Gahara	Butezi	Ungukamuhinzi	Natural Spring	Filtering System	Cyamabuye	30.5525 8	-2.38008
4	Gatega CWS	KIREHE	Gatore	Curazo	Gisaka Trading Company	Natural Spring	Natural seepage	Gatega	30.5833 3	-2.32956
5	Cyiha Cws	KIREHE	Gatore	Ngando	Gisaka Trading Ltd	Natural spring	Filtering System	Ruseke	30.5812 1	-2.34171
6	MULTIPURPOSE	KIREHE	kigina	Ruhanga	Ungukamuhinzi&Barasikina JB	Natural Spring	Natural Seepage	Rubare	30.6985 2	-2.2867
7	COCAMU	KIREHE	Musaza	Musaza	Coop.COCAMU	Natural Spring	Natural seepage	Nyakariba	30.6184 4	-2.3493
8	Gisaka Coffee	KIREHE	Mushikiri	Rugarama	Cooperative Gisaka Coffee	Natural Spring	Natural Seepage	Ryogire	30.6601 3	-2.1455
9	Mugina coffee	KIREHE	Mushikiri	Rugarama	Nsengiyumva Flugence	Natural spring	Filtering System	Kamarashavu	30.6572 2	-2.19176
10	Abakangukiyekawa	NGOMA	Gashanda	Mutsindo	Abakangukiye kawa Cooperative	Natural Spring	Natural seepage	Gisenyi	30.5036 7	-2.14516

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11	ENAS	NGOMA	Murama	Kigabiro	Nkubiri Alfred	Natural Spring	Natural seepage + water	Kabaza	30.5670 <sub>3</sub>	-2.2014
12	IAKAB	NGOMA	Murama	Sakara	Coop.IAKB	Natural Spring	Natural seepage + water	Nyagatar e	30.5350 <sub>9</sub>	-2.21828
13	Sake Farm	NGOMA	Sake	Gafunzo	Sake Farm Ltd	Natural Spring	Natural seepage	Rwanyabi ranga	30.4021 <sub>9</sub>	-2.23453
14	COOCAFE	NGOMA	Zaza	Nyagatugunda	Sengoma	Natural Spring	Natural seepage	Kabonero	30.4210 <sub>3</sub>	-2.15486
15	Gahengeri Cws	RWAMAGAN A	Gahengeri	Gihumuza	Habumugisha Jean Paul	Natural Spring	Filtering System	Nyirujari	30.3068 <sub>7</sub>	-1.9505
16	Kopakabi	RWAMAGAN A	Kareng e	Kabasore	Kopakabi	Natural Spring	Natural seepage	Kabasore	30.322	-2.07197
17	Kareng e Cws/Rwacof	RWAMAGAN A	Kareng e	Kareng e	Rwacof	Natural Spring	Natural seepage + water	Byimana	30.3014	-2.1047
18	Bicumbi	RWAMAGAN A	Muyumbu	Murehe	Shema Charles	Existing water pipe network	Natural seepage	Bitega	30.2845 <sub>9</sub>	-2.02406
19	MCAC Cws	RWAMAGAN A	Muyumbu	Ntebe	MCAC	Natural spring	Natural seepage	Nyarubambo	30.2661 <sub>1</sub>	-1.98868
20	Bujyujyu CWS	RWAMAGAN A	Muyumbu	Bujyujyu	NTEZIRIZAZA Theogene	Natural spring	Filtering System	Yeruzale mu	30.2677 <sub>5</sub>	-1.99953
21	Impexcol/Bihembe Cws	RWAMAGAN A	Nyakariro	Kanyangese	Mwumvaneza Erneste	Natural Spring	Natural Seepage	Bihembe	30.2992 <sub>4</sub>	-2.05189
22	Mutenderi CWS	NGOMA	Mutenderi	Mutenderi	Ubumwe Betty	Natural Spring	Natural seepage	Cyanyung a	30.4851 <sub>4</sub>	-2.25906

IV.2. List of mining sites

S/N	Latitude	Longitude	Company_	District	Sector	Cell	Mine_Site	Mine_type
1	30.26611	-1.99917	Ets Munsad Minerals	Rwamagana	Muyumbu	Bujuju	Bujuju	Cassiterite
2	30.28222	-2.07028	HAJOS	Rwamagana	Kareng	Kareng	Ryamugabo	Cassiterite
3	30.28222	-2.07028	HAJOS	Rwamagana	Kareng	Kareng	Rukankama 1	Cassiterite
4	30.29889	-2.09333	HAJOS	Rwamagana	Kareng	Kareng	Kareng	Cassiterite
5	30.30083	-2.0925	HAJOS	Rwamagana	Kareng	Kareng	Rebero 1	Cassiterite
6	30.30194	-2.08917	HAJOS	Rwamagana	Kareng	Kareng	Rukankama 2	Mixed(Cassiterite & Coltan) & Wolfram
7	30.30194	-2.09083	HAJOS	Rwamagana	Kareng	Kareng	Rebero 2	Cassiterite
8	30.30194	-2.08917	HAJOS	Rwamagana	Kareng	Kareng	Rebero 3	Cassiterite
9	30.23	-2.33	Natural Resource Development (NRD)	Bugesera	Rweru	Kintabwe	Nemba-Nyirakane mba	Cassiterite
10	30.23778	-2.32444	Natural Resource Development (NRD)	Bugesera	Rweru	Kintabwe	Nemba-Kimporobwe	Cassiterite
11	30.27472	-2.03472	Modern Mining	Rwamagana	Nyakariro	Bihembe	Rusheshe	Cassiterite
12	30.27528	-2.04	Modern Mining	Rwamagana	Nyakariro	Bihembe	Nyakariro	Cassiterite
13	30.5175	-2.08611	Ets Karinda	Ngoma	Remera	Ndekwe	Gikomero	Wolfram
14	30.11833	-2.01583	SEAVMC	Kicukuro	Gahanga	Kagasa	Kagasa 2	Cassiterite
15	30.38889	-2.28722	SEAVMC	Ngoma	Jarama	Kibimba	Murutare	Cassiterite

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16	30.46278	-2.30639	SEAVMC	Ngoma	Mutenderi	Kibare	Buhuga-Kavumu	Wolfram
17	30.43472	-2.22278	HAVILA Mines	Ngoma	Sake	Nkanga	Gisera	Mixed(Cassiterite & Coltan)
18	30.28194	-2.29139	ROKA Rwanda	Bugesera	Rweru	Gasororo	Nkanga	Mixed(Cassiterite & Coltan)
19	30.22722	-1.9	Kigali Mining Company	Gasabo	Rusoro	Gasagara	Irwanda	Wolfram
20	30.24333	-1.92333	Kigali Mining Company	Gasabo	Rusoro	Gasagara	Rusororo 2	Cassiterite
21	30.03639	-2.05833	COODEMIBU	Nyarugenge	Magera gere	Nyarurenzi	Nyarunzenze	Wolfram
22	30.04278	-2.05389	COODEMIBU	Nyarugenge	Magera gere	Runzenze	Uwurugenge	Wolfram
23	30.49472	-2.02944	Multiserve Consults	Kayonza	Rurami ra	Bugambira	Rukira	Cassiterite & Wolfram
24	30.51167	-2.02	Multiserve Consults	Kayonza	Rurami ra	taba	Bugambira	Cassiterite & Wolfram
25	30.45056	-2.00917	UNM	Rwamagana	Munyaga	Zinga	Kabazeyi	Mixed(Cassiterite & Coltan)
26	30.27611	-2.16556	Ayabatwa	Ngoma	Rukum beri	Rwintash ya	Kagega	Cassiterite
27	30.28083	-2.16028	Ayabatwa	Ngoma	Rukum beri	Rwintash ya	Kibuga	Cassiterite
28	30.28306	-2.15556	Ayabatwa	Ngoma	Rukum beri	Rwintash ya	Bibungo (Shori)	Cassiterite
29	30.28444	-2.14417	Ayabatwa	Ngoma	Rukum beri	Rwintash ya	Karokora	Cassiterite
30	30.51444	-2.37889	Mining Company Gahara Kirehe	Kirehe	Gahara	Murehe	Isangano	Wolfram & Cassiterite
31	30.51722	-2.395	Mining Company Gahara Kirehe	Kirehe	Gahara	Murehe	Cyamakamba	Mixed(Cassiterite & Coltan)
32	30.11556	-2.07806	Mining Transporter Company (MTC)	Bugesera	Mwogo	Rurenge	Gitaraga	Mixed(Cassiterite & Coltan)

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33	30.11917	-2.09611	UNION MINES	Bugesera	Mwogo	Bitaba	Rurenge	Mixed(Cassiterite & Coltan)
34	30.12417	-2.09528	UNION MINES	Bugesera	Mwogo	Bitaba	Kaziramire	Mixed(Cassiterite & Coltan)
35	30.14528	-2.10306	UNION MINES	Bugesera	Mwogo	Bitaba	Gatwe	Mixed(Cassiterite & Coltan)
36	30.26222	-2.36417	Kigali goods kag	Bugesera	Rweru	Kintambwe	Nyiruruomboza	Mixed(Cassiterite & Coltan)
37	30.19167	-2.09417	Quincaillerie Piano	Bugesera	Juru	Musovu	Gikana	Wolfram
38	30.1975	-2.07806	Quincaillerie Piano	Bugesera	Juru	Musovu	Mbuye	Mixed(Cassiterite & Coltan)
39	30.39083	-2.28139	AMEKI Color	Ngoma	Jarama	Kibimba	Mbuye 2	Mixed(Cassiterite & Coltan)
40	30.30111	-1.95667	Luxiang Mining Company	Rwamagana	Gahengeri	Rweri	Mataba II	Wolfram
41	30.30167	-1.95861	Luxiang Mining Company	Rwamagana	Gahengeri	Rweri	Mataba I	Wolfram
42	30.30917	-1.95472	Luxiang Mining Company	Rwamagana	Gahengeri	Kibare	Munini	Wolfram
43	30.31333	-1.95722	Luxiang Mining Company	Rwamagana	Gahengeri	Gihumuz	Rebero	Wolfram
44	30.35194	-2.06722	HABATU Mining Company	Rwamagana	Kareng	Bicaca	Bicaca	Mixed(Cassiterite & Coltan)
45	30.35222	-2.04417	HABATU Mining Company	Rwamagana	Kareng	Nyamate	Nyamate 2	Mixed(Cassiterite & Coltan)
46	30.02139	-2.07917	Kivu Metal Supplier Company	Bugesera	Ntarara	Kibunga	Kangoma	Cassiterite
47	30.21361	-2.11278	Juru Mining Company	Bugesera	Juru	Rwinume	Gisororo	Cassiterite & Coltan
48	30.47028	-2.32472	Misercorde Trading Company	Kirehe	Gahara	Muhamba	Muhamba	Wolfram

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IV.3. Petrol stations

S/N	Latitude	Longitude	District	Sector	Cell	Name
1	-1.95279	30.34171	Rwamagana	Musha	Musha	Gatika
2	-2.14393	30.09134	Bugesera	Nyamata	Nyamata y' Umujyi	Nyamata I
3	-2.00834	30.55864	Kayonza	Kabarondo	Cyabajwa	Cyabajwa
4	-2.13093	30.07203	Bugesera	Nyamata	Kayumba	Rwanza
5	-1.9667	30.10305	Kicukiro	Niboye	Nyakabanda	Amarembo
6	-1.96425	30.15869	Kicukiro	Nyarugunga	Nonko	Kavumu
7	-1.96631	30.16246	Kicukiro	Nyarugunga	Kamashashi	Kabagendwa
8	-2.15951	30.54447	Ngoma	Kibungo	Karenge	Amahoro
9	-2.15326	30.09851	Bugesera	Nyamata	Nyamata y' Umujyi	Nyamata li
10	-1.97997	30.22468	Gasabo	Rusororo	Kabuga I	Kabeza
11	-2.13762	30.5588	Ngoma	Kibungo	Cyaseamakamba	Rubimba
12	-1.98476	30.18677	Gasabo	Rusororo	Nyagahinga	Runyonga
13	-2.27449	30.67144	Kirehe	Kirehe	Nyabikokora	Rugero
14	-1.96899	30.16886	Kicukiro	Nyarugunga	Kamashashi	Mulindi
15	-2.14076	30.55277	Ngoma	Kibungo	Cyaseamakamba	Bwiza
16	-1.8986	30.27244	Rwamagana	Fumbwe	Nyakagunga	Akabeza
17	-2.10297	30.07656	Bugesera	Ntarama	Kanzenze	Cyeru
18	-1.96042	30.11373	Gasabo	Remera	Rukiri I	Gisimenti
19	-1.96	30.10803	Gasabo	Remera	Rukiri I	Gisimenti
20	-1.95138	30.43359	Rwamagana	Kigabiro	Cyanya	Rurembo
21	-2.0099	30.55834	Kayonza	Kabarondo	Cyabajwa	Rutagara
22	-2.01244	30.10717	Kicukiro	Gahanga	Gahanga	Rinini
23	-2.13958	30.55502	Ngoma	Kibungo	Cyaseamakamba	Kabeza
24	-1.95606	30.43672	Rwamagana	Kigabiro	Cyanya	Busanza
25	-1.94012	30.41301	Rwamagana	Mwulire	Bushenyi	Kabahima
26	-1.89915	30.48691	Kayonza	Mukarange	Nyagatovu	Akamayange

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27	-1.9355	30.13388	Gasabo	Kimironko	Bibare	Imitari
28	-2.11902	30.06823	Bugesera	Nyamata	Kayumba	Kayenzi
29	-1.96171	30.11165	Kicukiro	Niboye	Nyakabanda	Amahoro
30	-2.24868	30.2135	Bugesera	Gashora	Kagomasi	Kuruganda
31	-2.01818	30.55939	Kayonza	Kabarondo	Cyinzovu	Munini
32	-1.95429	30.11852	Gasabo	Remera	Rukiri li	Amahoro
33	-1.98135	30.21751	Gasabo	Rusororo	Nyagahinga	Nyarucundura
34	-1.9561	30.14403	Kicukiro	Nyarugunga	Rwimbogo	Urwibutso
35	-1.97225	30.15938	Kicukiro	Nyarugunga	Nonko	Gitara
36	-2.07999	30.09663	Bugesera	Ntarama	Kanzenze	Kabeza
37	-2.27461	30.67452	Kirehe	Kirehe	Nyabikokora	Bwiza
38	-1.96032	30.11986	Gasabo	Remera	Rukiri li	Amahoro
39	-1.95964	30.11717	Kicukiro	Kanombe	Kabeza	Giporoso I
40	-2.37506	30.77851	Kirehe	Nyamugari	Kiyanzi	Rusumo
41	-1.95874	30.11972	Gasabo	Remera	Rukiri li	Ubumwe
42	-1.98495	30.18955	Gasabo	Rusororo	Nyagahinga	Runyonza
43	-2.13776	30.55813	Ngoma	Kibungo	Cyaseamakamba	Rubimba
44	-2.03156	30.10238	Kicukiro	Gahanga	Gahanga	Rwinanka
45	-1.91737	30.49269	Kayonza	Mukarange	Mburabuturo	Akabuga
46	-2.18452	30.53423	Ngoma	Kibungo	Kareng	Musamvu
47	0	0	Rwamagana	Muhazi	Karitutu	Karambo
48	0	0	Bugesera	Nyamata	Kayumba	Kayenzi
49	0	0	Gasabo	Rusororo	Ruhanga	Rugende
50	0	0	Gasabo			
51	0	0	kicukiro	Gahanga	Karembure	Kamuyinga
52	0	0	Kicukiro	Kanombe	Kabeza	
53	0	0	Bugesera	Nyamata	Kayumba	kayenzi
54	0	0	Rwamagana	Kareng	kareng	kareng

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55	0	0	Ngoma	Sake	Rukoma	Isangano
56	0	0	Kirehe	Gatore	Muganza	Bigaro
57	0	0	kirehe	Kigina	Ruhanga	Karambi I
58	0	0	Ngoma	Murama	Mvumba	Giteseke
59	0	0	Gasabo	RUSORORO	Rugende	Ruhanga
60	0	0	GASABO	RUSORORO	KABUGA II	ISANGANO
61	0	0	Gasabo	Rusororo		

**IV.4. Other pollution Sources**

S/N	Pollution	Latitude	Longitude	District	Sector
1	Deforestation	-2.000247	30.07763	Kicukiro	Gatenga
2	Dumping Site	-2.291582	30.20701	Bugesera	Gashora
3	Flooding	-1.98832	30.19447	Kicukiro	Masaka
4	Flooding	-2.264918	30.2579	Bugesera	Gashora
5	Flooding	-1.976834	30.18427	Gasabo	Ndera
6	Flooding	-1.9847	30.20007	Kicukiro	Masaka
7	Industrial wastewater channelled in wetlands and nearby waterbodies	-2.291737	30.20714	Bugesera	Mayange
8	Lack of buffer zone	-2.241738	30.23946	Bugesera	Gashora
9	Soil Erosion	-2.21053	30.45464	Ngoma	Gashanda
10	Soil Erosion	-1.989497	30.18545	Gsabo	Rusororo
11	Soil Erosion	-2.21053	30.45464	Ngoma	Gashanda
12	Wastewater	-2.204987	30.56133	Ngoma	Murama
13	Wastewater	-2.204987	30.56133	Ngoma	Murama