

CATCHMENT INTEGRATED POLLUTION MANAGEMENT PLAN



TECHNICAL ASSISTANCE IN ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT

NILE NYABARONGO LOWER CATCHMENT INTEGRATED POLLUTION MANAGEMENT PLAN



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NILE NYABARONGO LOWER (NNYL) CATCHMENT 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				
EbA	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				
MIGEPROF	Ministry of Family and Gender Promotion				
MINAFFET	Ministry of Foreign Affairs and Cooperation				
MINAGRI	Ministry of Agriculture and Animal Resources				
MINALOC	Ministry of Local Government				
MINECOFIN	Ministry of Finance and economic Planning				

MINEDUC	Ministry of Education
MINICOM	Ministry of Commerce
MININFRA	Ministry of Infrastructure
MINIRFNA	Ministry of Natural Resources
MIS	Management Information System
MoF	Ministry of Environment
NGO	Non-Governmental Organization
NNYI	Nile Nyabarongo Lower
NWRMP	Water Resources Master Plan
PhACs	Pharmaceutically Active Compounds
DADEE	Performation Support Project (Project d'Appui à la
PAREF	Reforestation)
POPs	Persistent Organic Pollutants
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 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 rea. The main objective of the project is to increase capacity of Rwandan authorities and local communities to adapt to climate change by implementing Ecosystem based Adaptation (EbA) interventions in degraded forests, savannahs and wetlands ecosystems.

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

0.2. Methodology

The development of Integrated Pollution Management Plan for Nile Nyabarongo Lower was developed using various methods. Prior the development, a 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. Thereafter, the team consulted the relevant district development plans, catchment management plan, and district sanitation master plans provided these were available at the time. 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 visits 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 area, what the pollution concerns were and their impacts, the possible sources of pollution, and what is or could be done to manage it. 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 the 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

Nile Nyabarongo Lower catchment has a total surface area of about 3,304 km² completely included in Rwanda and covers the following ten districts: Gakenke, Muhanga, Rulindo, Kamonyi, Gicumbi, Gasabo, Nyarugenge, Gatsibo, Rwamagana and Kayonza. Nile Nyabarongo Lower catchment comprises numerous small catchments with three significant tributaries which include the Base river (in the North West), the Mambu (in the West), and the Nyabugogo River (in the East). Nyabugogo sub-catchment covers almost half of the entire catchment area and is particularly large. The rainfall pattern shows high annual rainfall arising at 1,200 mm/year which equates to some 3,935 hm³/annum with separate two rain seasons (long rains which spans from March, April and May, and short rains which spans September, October, November and December) and two dry seasons (Jan-February and June-September). Average water quality data from monitoring network in the catchment indicate strong impact of the urban center and associated industrial areas at downstream of Nyabugogo where levels of nutrients, chemical and biochemical oxygen demands are high as consequence of inflows from untreated municipal and industrial effluents. Mining sites located in the sectors of Ruli and Coko are also suspected to pollute.

Basing on data from 2012 population census, the total population in the Nile Nyabarongo Lower (NNYL) catchment was assessed at 2.182 million dispersed throughout the catchment with highest density in the City of Kigali and around the urban centers of Gicumbi, Kamonyi (Ruyenzi) and Rwamagana. Poverty rates within the catchment area are very high, with approximately 32% living below the poverty line with the cause often linked to high population growth and declining soil fertility in a largely agrarian-based economy.

Dominant socio-economic activities are based on construction, mining and quarries and manufacturing activities (brick making, textiles, paint, tanneries, iron and sugar), especially in the City of Kigali which is the country's financial and economic hub, contributing about 50% of the country's GDP (Surbana, 2012). Commercial and subsistence agriculture, fishing, financial services and trade are the largest sources of employment sectors. In Gatsibo and Kayonza in the Eastern Province, Kamonyi/Southern Province and Rulindo, Gakenke and Gicumbi in Northern Province there are several quarries and mines with tungsten, cassiterite and coltan deposits being mined. Other economic drivers that have strong links with environment pollution to consider include: Lake Muhazi (tourism, fishing, water supply, irrigation) and planned special economic zones in Rwamagana.

0. 4. Main pollution issues and opportunities

The Analysis of emerging pollution issues in Nile Nyabarongo Lower catchment prioritised the following:

• planning processes that are not aligned with catchment governance;

- contamination of water bodies and wetlands by discharge of polluted runoff and inadequately treated wastewater from industrial, household, institutional and commercial establishment,
- littering of municipal solid wastes that impacts on aesthetic appearance, disturbance of stream flow, groundwater and soil contamination as consequence of inadequate service coverage and operational inefficiencies of services; limited utilization of recycling activities;
- inadequate landfill disposal and inadequate management of hazardous and healthcare waste;
- high river sediment loads resulting from poor agricultural practices (hillside agriculture and encroachment of river banks and inadequate mining practices (artisanal mining) and deforestation
- poor ambient air quality due to vehicle emissions and the use of three stone cookstoves ;

Whereas the opportunities include past and ongoing sustainable land management & soil conservation interventions, existence of laws, regulations and standards on pollution management, decentralized governance framework that facilitate the participation of local communities during the implementation of the plan as well as the catchment being located in a zone with high potential income generating activities (business hub, Ecotoursm & hotels, Economic zones, etc).

0.5. Integrated Pollution Management Vision and objectives

The vision for the Nile Nyabarongo Lower catchment is:

"A well-managed catchment that is home to prosperous communities living in harmony with their environment and drawing social and economic benefits from sustainable ecosystem"

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

1. Enhanced governance of pollution management at catchment level

2. Sustainable and environmentally sound management of all wastes in Nile Nyabarongo Lower catchment

3. Effective information and knowledge management

0.6. Proposed interventions

The main interventions for integrated pollution management considered in Nile Nyabarongo Lower are:

- <u>Interventions for aligning and coordination planning processes at District and</u> <u>catchment levels</u>, including supporting district authorities to enforce pollution control guidelines and standards, coordinate planning meetings at catchment level, carry out regular catchment committee & environment committee meetings as well as coordination of water users organisations.
- Interventions for addressing Pollution of water bodies and wetland following <u>discharges of inadequately treated wastewater</u>, including to support the operation and management of sewerage systems and wastewater treatment plants, support the management of sludge management and treatment

facilities, support resettlement of population in high risk zones and supporting industries &SMEs to implement cleaner production measures.

- Interventions for addressing urban stormwater discharge, including to <u>support rainwater harvesting on rooftops of settlement areas, construction of</u> water drainage to capture road drainage & settlements and enforce oil separation at all garages and vehicle workshops.
- Interventions for addressing issues of municipal solid waste litter: the plan will support the construction of a designed landfill that makes provision for waste separation and recycling, promote waste-to-resource initiatives including composting, biogas to energy, plastic recycling for construction materials etc as well as promotion of voluntary clean-up activities through community work initiatives and local NGOs.
- <u>Interventions to improve air quality</u>: include to strengthen the national vehicle inspection canter's capacity to implement new standard on Road Vehicle Emission Limits, implement air pollution control guidelines, promote local vehicle assembly including introduction of incentives to promote electric vehicles ,support increased access and use of LPG in urban and peri-urban household for cooking and support increased access and use of improved cooking stoves and alternatives fuels in rural areas.
- Interventions for addressing issue of high sediment loads: In addition to catchment rehabilitation measures that were defined in Nile Nyabarongo Lower catchment management plan, this plan will contribute through supporting the implementation of sustainable mining practices, enhancing payment of ecosystem services for catchment protection, multiplication of inspections for environmental compliance in mining as well as implementation of measures proposed for Gikondo and Nyabugogo systems catchment management plan.
- Interventions for capacity building and increasing awareness include: to develop training package on urban and rural pollution and BMPs, conduct trainings, awareness raising and capacity building among farmers on smart agriculture, conduct capacity building in sustainable mining approach/Model mining among mining operators as well as disseminate policies, laws and regulatory instruments on environment protection, sustainable mining and smart agriculture.

0.6. Implementation, Monitoring & Evaluation

The above Integrated Pollution Management Plan 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 Nyabarongo Lower catchment committee will also support the implementation of the plan.

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

CHAPTER ONE: INTRODUCTION

1.1. Background and context

entitled "Building resilience of communities living degraded in wetlands, forests and savannas of Rwanda through an ecosystem-based adaptation approach"

LDCF II Project The Least Developed Countries Fund (LDCF) II Project titled "Building resilience of communities living in degraded forests, savannahs 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, savannahs 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.

3. Ecosystem based Adaptation (EbA) interventions that reduce vulnerability and restore natural capital.

The LDCF II Project was designed to demonstrate The LDCFdemonstrates 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 in environment within catchments that include forest, savannah, and wetland ecosystems in Rwanda, to develop systematic mapping and es monitoring tools to identify basin management needs and track nis 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

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 integrated pollution management plans for four catchment areas (Nile Nyabarongo Upper, Nile Mukungwa, Nile Nyabarongo Lowe and Nile Akagera Upper catchments).
- Develop integrated catchment management for some catchments in Rwanda (Nile-Akagera Lower, Nile-Nyabarongo lower and Nile-Nyabarongo Lower including Nyiramuhondi watershed), and
- Capacity building and training

This report is part of Water Quality Management task and presents the Integrated Pollution Management Plan for Nile-Nyabarongo Lower Catchment

Terms of Reference for Integrated Pollution Management Plan

According to the ToRs the development of the Integrated Pullution 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, high rainfall intensity on steep slope high elevation are putting pressure on 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 provides identified key pollution indicators, mapped major sources of pollution in the catchment, provided appropriate standards and guidelines applicable to pollution management and proposed long term actions to tackle pollution in Nile Nyabarongo Lower (NNYL) catchment.

1.3. Layout of the report

The Integrated Pollution Management Plan for Nile Nyabarongo Lower (NNYL) 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 the challenges that affect pollution.
- Chapter4: provides an overview of the emerging pollution issues in the Nile Nyabarongo Lower 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 catchment integrated pollution management planning process are outlined in Figure 1



Figure 1: Steps in developing the Catchment 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 3rd 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 catchment pollution in their 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, a catchment 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 Nyabarongo Lower area, an implementation plan is included in this IPMP.

CHAPTER 3. BRIEF OVERVIEW OF THE NILE-NYABARONGO LOWER CATCHMENT

The purpose of this chapter is to provide a brief overview of the Nile Nyabarongo Lower 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 this descriptive chapter.

3.1. Administrative boundaries

The Nile Nyabarongo Lower ((NNYL) or Lower Nyabarongo catchment starts at the confluence of the Upper Nyabarongo River with Mukungwa Rver. Nile Nyabarongo Lower belongs to the Nile basin, entirely located in Rwanda and is a downstream catchment in the sense that there is flow entering the catchment from upstream. The downstream limit of the catchment is defined at the confluence with the Akanyaru River for a length of some 70 km over which a significant catchment area is drained. The catchment area is essentially covered by the following ten districts: Gakenke, Muhanga, Rulindo, Kamonyi, Gicumbi, Gasabo, Nyarugenge, Gatsibo, Rwamagana and Kayonza. Some small areas of the catchment are located in the districts of Kicukiro and Burera. The overlay of the catchment and the districts is presented in Figure 2.



Figure 2: Nile Nyabarongo Lower (NNYL) catchment and district boundaries

3.2. Population distribution and poverty rates

Basing on data from 2012 population census, the total population in the NNYL catchment was assessed at 2.182 million dispersed throughout the catchment with highest density in the City of Kigali and around the urban centers of Gicumbi, Kamonyi (Ruyenzi) and Rwamagana (RWRMP, 2014) High population densities exert considerable pressure on land and water resources, often manifesting itself in high rates of land and wetland degradation and pollution of water sources. Figure 3 below provides the population density in Nile Nyabarongo Lower catchment



Figure 3: Population density distribution in Nile Nyabarongo Lower catchment

Poverty rates within the catchment area are very high, with approximately 32% living below the poverty line with the cause often linked to high population growth and declining soil fertility in a largely agrarian-based economy. Poverty levels tend to be high in rural areas with both very high population densities and in agrarian areas where the principal economic activity is agriculture, i.e. crop production and livestock rearing. (MoE/W4GR, 2018). Figure 4 provides the levels of poverty in Nile Nyabugogo Lower catchment





3.3. Climate

Temperature observation data within Nile Nyabarongo Lower catchment shows a maximum daily temperature of almost 22°C and minimum of 13°C in the highlands of Gicumbi in Byumba sector. Kigali city is at a lower elevation than the rest of the catchment and thus experiences higher temperatures, with a maximum daily temperature of 27°C and minimum daily temperature of almost 16°C.

3.4. Land use

Nile Nyabarongo Lower land use land cover map was delivered 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, and ground truthing in the field. The area and relative proportion of each LULC class for the Nyabarongo lower catchment is presented in Table1

Total forested area (dense and sparse) covers 16. 9 % of the catchment area, which is below the national average and below the national target of 30%. From this, about 6.2% is considered sparse forest, showing signs of tree felling or other forms of degradation

The influence of pressure resulting from a high population is very clear, with 62.8% of LULC classes representing some form of agriculture as the prominent land use. This comprises of seasonal agriculture (54.8 %) and perennial agriculture. This reflects the enormous impact of agriculture on land cover and, combined with the high soil erosion risks on steep slopes, contributes strongly to sediment ingress from such land into rivers.

The class 'grassland (for cattle) and open areas' is also prominent at 16% catchment coverage. The LULC classes of 'settlements and buildings', as well as 'water' and 'wetlands' were recorded and form important cover/use types in the catchment with the city of Kigali and Lake Muhazi both clearly distinguishable, albeit it in much smaller shares. Table 1 provides the existing land use/land cover classification in Nile Nyabarongo Lower catchment while Figure 5 displays also the land use/ land cover classification in the same catchment.

S/N	LULC Category	Area (Ha)	Area (%)
1	Seasonal Agriculture	181,399.8	54.8
2	Perennial Agriculture	26,612.5	8.0
3	Dense Forest	35,574.0	10.7
4	Sparse Forest	20,637.3	6.2
5	Open Areas or Grassland	55,841.9	16.9
6	Settlements and		
	Buildings	5,134.6	1.5
7	Waterbody	4,628.0	1.4
8	Wetland	1,486.1	0.4

Table 1:	Table:	Land use <i>i</i>	' land co	ver classi	ification	in N	yabarongo	Lower
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Figure 5: Existing Land Use and/or Land Cover (LULC) in NNYL

3.5. Economic activities and basic services infrastructure

The uniqueness of Nile Nyabarongo Lower catchment is based on the fact that it hosts the City of Kigali, the capital of the Republic of Rwanda. The City of Kigali is the country's financial and economic hub, contributing about 50% of the country's GDP (Surbana, 2012). Commercial and subsistence agriculture, fishing, financial services and trade are the largest sources of employment sectors.

In this catchment, the economy is based on the following activities: construction, mining and quarries and manufacturing activities (brick making, textiles, paint, tanneries, iron and sugar). In Gatsibo and Kayonza in the Eastern Province, there are several quarries and mines with tungsten, cassiterite and coltan deposits being mined. In Rulindo, Gakenke and Gicumbi in the Northern Province, and Kamonyi in the southern Province, the same minerals are mined as well. Other economic drivers that have strong links with water resource management to consider include: Lake Muhazi (tourism, fishing, water supply, irrigation); food security, through crop intensification, and, in the urban areas of Kigali, the city master plan and special economic zones. The Table 2 below provides highlights on key socio-economic activities in Nyabarongo lower catchment.

Table 2: Key features of Socio-Economic activities and Infras	structure in NNYL
Catchment	

S/N	Socio-economic Infrastructure	Number
1	Health Centers	98
2	Trade Centers	209
3	Schools	726
4	Markets	54
5	Coffee Washing Stations	36
6	Industry	9
7	Tea Factory	1
8	Hydropower Station	6

3.6. Hydrology

The Water Resources Master Plan (2014) subdivided Nyabarongo Lower into two subcatchments:

• Nyabugogo sub-catchment (including Muhazi lake), with Nyabugogo river as the major tributary with both flooding and pollution problems originating in the Kigali area just upstream of the confluence with the Nyabarongo. Lake Muhazi drains an important inflow area with a potential for flow regulation to control flooding in the Kigali area (area of 1,540 km²) and the possibility to operate it as a storage reservoir for carrying over surface water from the wet season to the dry season • Nyabarongo valley that drains the main valley of the Nyabarongo with numerous level 3 catchments contributing to the flow; at this lower level the Nyabarongo is meandering through a relatively wide river valley hence features substantial groundwater resources (area of 1,764 km² in Rwanda).

The Water Resources Master Plan reported that principal water resources in the catchment are as follows:

- • the average annual rainfall is slightly below 1,200 mm/annum which equates to some 3,935 hm³/annum from the total land surface area of 3,304 km².
- • the combined average annual surface flow generated within the catchment stands at 28m³/s or some 899 hm³/annum; and
- • the groundwater annual recharge / safe yield is about 545 hm³/annum. With a totalstorage estimated at 8,673 hm³, the mean residence time of groundwater in the catchment is some 16 years.

3.7. Water Quality

3.7.1. Surface water quality

Water quality of water bodies in lower Nyabarongo catchment is largely influenced by the link between population growth, urbanization and industrial development that are likely to generate pollution. Nyabugogo river, an affluent of Nyabarongo river that pass through the city of Kigali, is polluted by various human activities, including littering, pouring chemicals down drains and industrial discharges, all of which are washed into stormwater drains.

Water quality monitoring network in lower Nyabogogo catchment is based on five permanent locations: Lake Muhazi at Rukara near Jambo beach and downstream at Rwesero beach, Nyabugogo river at Rusine river, Nyabugogo river downstream at Nemba station and Nyabarongo at Ruliba gauging station

Average water quality data from the above monitoring network indicate strong impact of the urban center and of associated industrial areas at downstream of Nyabugogo where levels of nutrients, chemical and biochemical oxygen demands are high as consequence of inflows from untreated municipal and industrial effluents. Mining sites located in the sectors of Ruli and Coko are also suspected to pollute. At last, the lower Nyabarongo catchment is characterized by pollution sediments coming from soil erosion. The impact of pollutants on receiving water bodies will be discussed in the next chapter. The Table3 below presents key water quality characteristics in Nyabarongo Lower catchment

Table 3: Water quality status in Nyabarongo lower catchment

Sampling sites	TUR B	COD	BO D	DIN	DIP	Pb	Zn	E.Coli
NYABARONGO AFTER NYABARONGO LOWER	6490	13.7 7	8.8	5.99 8	1.13 8	ND	0.20 6	2.5x10
NYABARONGO BEFORE NYABUGOGO	4456	20.2	14. 1	5.95 1	0.93 1	0.00 7	0.43 4	2,3x10
MUHAZI UPSTREAM	8	7	5.8	1.31 1	0.19 0	ND	0.39 1	6.1x10 2
MUHAZI DOWNSTREAM	9	10.3 3	8.4	1.16 7	0.36 2	ND	0.40 0	4,5x10 2
RUSINE BEFORE NYABUGOGO	5560	6.77	4.5	2.66 2	0.77 6	ND	0.46 7	9,5x10 2
NYABUGOGO AFTER RECEIVING MULINDI	1032	10.7 9	8.2 7	1.64 5	0.31 0	0.00 7	0.23 3	5,5x10 2
NYABUGOGO FROM INDUSTRIAL PARK	388	42.6	19. 9	7.25 7	1.51 7	0.14 0	0.28 6	5,0x10 2
NYABUGOGO BEFORE NYABARONGO	800	20.9 4	11. 1	3.69 8	0.83 1	0.10 3	0.35 4	3,1x10 2
NYABARONGO AT RULIBA	4780	23.5 5	12. 6	5.86 9	1.48 3	0.09 0	0.45 5	9,1x10
NYABARONGO AT NTARAMA	7460	23.8	12. 2	5.58 3	1.17 2	0.08 7	0.23 5	6.2x10
Standards (RSB)	-	250	50	20	5	0.1	5	400

3.7.2. Groundwater quality

Groundwater can become contaminated by pollution at the surface (or at depth), and there are many different anthropogenic sources of contamination. The vulnerability of aquifers to pollution depends on several factors, including the depth to the water table, the permeability of the material between the surface and the aquifer, the permeability of the aquifer, the slope of the surface, and the amount of precipitation. Confined aquifers tend to be much less vulnerable than unconfined ones, and deeper aquifers are less vulnerable than shallow ones. Steeper slopes mean that surface water tends to run off rather than infiltrate (and this can reduce the possibility of contamination). Contamination risk is also less in dry areas than in areas with heavy rainfall.

There is no data on the status of groundwater quality in Nile Nyabarongo Lower catchment. However, given that about 85% households in the City of Kigali use pit latrines, there is high potential for the pollution of groundwater under or near pit latrines, particularly in areas with high water table, which is the case of most of informal settlements of Kigali (.Tsinda. A, 2013)

CHAPTER 4. EMERGING POLLUTION ISSUES IN NILE NYABARONGO LOWER

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 Nyabarongo Lower catchment.

An enabling policy, legal and institutional framework is key to the development and subsequent implementation of the Integrated Pollution Management Plan for Nile Nyabarongo Lower 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 Nyabarongo Lower 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 Nyabarongo Lower 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 Nyabarongo Lower 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 environment5. 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 healthdetermining 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.

Legislation	# and date	Relevance to pollution
The National Constitution	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.
	Law N°49/2018	This Law determines the use and management of water resources in

Table 4: Summary of relevant pollution management legislation

Law determining the use and management of water resources in Rwanda	of 13/08/2018	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 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			
Law on environment	Law No 48/2018 of 13/08/2018	This Law determines modalities for protecting, conserving and promoting the environment. 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. 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. 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 At last the law provides for administrative				
		sanctions for all defaulters (from art.46 to art.60)				
Law relating to the prohibition of manufacturing, importation, use and sale of plastic carry bags and single-use plastic items	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.				
Law governing the preservation of air quality and prevention of air pollution in Rwanda	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 the storage of objects, air pollutants from waste incineration, and air pollutants from other sources. The law also makes provision for administrative sanctions.				
Ministerial Order establishing the list of projects that must undergo environmental impact assessment, instructions, requirements and procedures to conduct environmental impact assessment	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.				

Ministerial Order Determining the list of Water Pollutants	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.
Ministerial Order Establishing Modalities of Inspecting Companies or Activities that Pollute the Environment	N° 006/2008 of 15/08/2008	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.
The Code of Criminal Procedure	No. 30/2013 of 24/5/2013	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.

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 5: 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 ₃ < 5 mg/l	NO ₃ between 5 - 10 mg/l	NO ₃ > 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 Nyabarongo Lower 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 Nyabarongo Lower 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.

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

Table 6: Guidelines for assessing the status of rivers.

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 Nyabarongo Lower 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 $N^{\circ}49/2018$ 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 NMUK 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 on 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 Nyabarongo Lower 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 Nile Nyabarongo Lower catchment

4.3.1. Key sources of pollution, pollution hotspots and associated impacts on receiving environment in Nile Nyabarongo Lower catchment

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, coffee washing stations, petrol stations, markets, informal settlements and slums, mining, etc. Key point sources of pollution and pollution hotspots are as presented on Figures 12&13 below.



Figure 6: Existing sources of pollution in NNYL Catchment

Since the Nile Nyabarongo lower catchment covers both urban and rural areas, emerging issues were discussed separately as urban or rural pollution issues.

4.3.2. Urban Pollution Issues

Key urban areas in the Nile Nyabarongo lower include the City of Kigali, headquarters of Districts in the catchment, especially Kamonyi, Rwamagana and Kayonza, and other trade centres around the City of Kigali, such Ruyenzi, Kabuga, Nyagasambu, among others. Different types of pollution featuring in the above city centres include water pollution, air pollution, noise pollution and land contamination which the current status is detailed here below.

4.3.2.1. Flooding and urban stormwater

Urbanization typically increases runoff rates due to increased impervious areas, and replacement or filling up of natural watercourses and overland flows. In Nile Nyabarongo Lower catchment, there is frequent uncontrolled discharge of stormwater that may have a significant impact on water quality and public health since it can include a variety of pollutants such as sediments, litter, bacteria, organic nutrients, hydrocarbon, metal, oil and grease and pesticides. Full list of pollutants found in stormwater are attached as annex 2.



Figure 7: Direct discharges of Mpazi channel into Nyabugogo river

Even though issues related to flash floods and inadequate urban storm water management is observed in all urban areas of Nile Nyabarongo Lower catchment, it is most pronounced in the City of Kigali. Historically, flooding in Kigali has been experienced since 1960s and have increased with the city growth through years; its impacts got a huge intensity from 2000s till now. According to Bizimana (2010) flooding in Kigali mainly happens during the long rainy season from April to June and September to December where intense rainfall is recorded. The Nyabugogo wetland has been affected by flooding for several times. This is mainly due to its topography which is a lower land area where drainage systems of Kigali city are converging. The heavy precipitation associated with climate variability combined with urban development in Nyabugogo flood plain increase the flood risk and flood damages in the wetland. Table 4 below reports key pollution issues identified during a visual inspections carried out in Nyabugogo wetland.

No	Qualification	Pollution issues
1	Stomwater floods	 Contaminants in run-off from roads, motorways and bridge which were including Sediment that these may contain pollutants such as heavy metals or pesticides Hydrocarbons, oils and grease leak onto road surfaces and pavements, spills at petrol stations and fuel depots. Iridescence is a sure sign within run-off of spilled petroleum products Fertilizers, pesticides and herbicides: in rural and peri-urban areas seasonally elevated concentrations of these chemicals may be washed into waterways
2	Sewer discharges	Due to lack of centralised wastewater treatment plant, the wastewater from domestic and commercial areas is normally discharged into waterways and may potentially contain a variety of contaminants from domestic and commercial sources
3.	Hazardous landfill sites	 Flooding events impact on Nduba landfill where runoff may contain: odours of public health significance from chemicals such as hydrogen sulphide and mercaptan Organic matters with high BOD, COD and E.Coli

 Table 7: Key pollution issues in Nyabugogo wetland

Photos presented on Figure present respectively: Photo1 shows the floodplain in Nyabugogo after a heavy storm event; Photo2&3 show destroyed road at Nyabugogo after heavy rainfall while Photo4 shows heavy pollutant loads deposited by Mpazi river in its riverbed during the floods season (Source: Mnyaneza et al., 2017)



Figure 8: key pollution issues caused by inappropriate management of urban stormwater in the city of Kigali

4.3.2.2. Inappropriate liquid waste treatment and disposal

Inappropriate liquid waste treatment and disposal is commonly present in all urban areas of Nile Nyabarongo Lower catchment and very pronounced in the City of Kigali. Therefore, here focus will be on the status of liquid waste management in the City and key emerging issues.

• Inappropriate domestic and commercial wastewater management

On one hand, in most of planned settlements, some hotels and institutional buildings; domestic water is collected in flow equalization tanks then channeled into semi centralized wastewater treatment plants where sequencing Batch Reactor and modular based extended aeration wastewater treatment technologies are applied (CoK, 2019). Fecal sludge mainly from septic tanks and some pit latrines is collected by vacuum tracks and transported to central disposal site located at Nduba. At the disposal site, emptied fecal sludge is dumped in open retention pits without any subsequent treatment; this poses a serious threat to public health and environment.

On the other hand, most of commercial buildings and hotels which generate commercial wastewater have got their own decentralized wastewater treatment plants (REMA 2015). The treatment technology of blackwater and greywater from hotels in those plants do not differ from those found in residential estates. However, some commercial buildings and restaurants still rely on on-site sanitation systems

used to contain fecal sludge and greywater. The common technology used for containment are septic tanks which once filled up are subject to mechanical emptying by a vacuum tanker truck. Emptied fecal sludge is disposed of also at Nduba site.

However, informal practices have been observed where pit latrines are manually emptied, and faecal sludge put into other dug holes or are simply latrines closed when filled up (Akumuntu et al. 2017). Concerning greywater and stormwater; they are often discharged into soak pits or open drains where they end up being discharged into swamps, rivers and streams. These practices are regarded as major sources of pathogens, organic pollution, and nutrients in downstream water bodies

• Inappropriate Faecal Sludge Management

Issues in faecal sludge management are found in the whole value chain from containment, emptying, transportation, treatment and disposal or reuse of faecal sludge from pit latrines, septic tanks or other onsite sanitation systems.

The 2016 National Sanitation Policy provides two options for safe management of faecal sludge: sewered and non-sewered. In the 'sewerage system', fecal matter is flushed down a toilet and conveyed via piped systems to treatment plants where the waste is treated and then disposed, or where possible reused. In the 'non-sewered system' or 'FSM system' it is expected that fecal waste follows two pathways:

- Whenever pit latrines are used and filled; the pit should be emptied and waste transported, treated, disposed, or possibly reused.
- Whenever, septic tanks are used and filled (normally flush toilets into septic tanks), the septic tanks should also be emptied and waste transported, treated, disposed, also with a possibility of reuse

However, the proportion of faecal sludge safely collected from households with pit latrines is therefore small and is reported to be between only 2% -7%. So, over 90% of fecal sludge generated in Kigali either remains in pits in household compounds or is illegally dumped following manual de-sludging. Currently, about 100 to 200 m³ of faecal sludge collected daily from the Kigali City is dumped in Nduba, with minimal treatment. The proposed FSTP at Masaka was slated for operation by 2018 but has been delayed. It was planned to ultimately have a capacity of 1,000 m³. The plan was to begin with a limited capacity and increase the volume progressively (500 m³/day in 2018 to 750 m³/day in 2020 then to full capacity of 1000 m³/day in 2023. However, due to delayed funding, WASAC is currently working to put in place a shortterm plan to deal urgently with fecal sludge dumped at Nduba. The plan is to close Nduba site and install a mobile FSTP at Masaka with limited capacity. This temporary system will enable the current volume to be treated but is not a solution for the volume that is currently going untreated in Kigali, let alone future expectations.

Currently the review of detailed design is under way and a multi-stakeholder talks continue to place between government and donors around the development of the Masaka plant, although nothing concrete yet in place on the financing. The City of Kigali recognizes the value of the FSTP to serve the city and continues to seek a solution.

Figure Feacal ponds Nduba

In with Sludge



9: sludge in

> regard Feacal

disposal and reuse, currently, there are no known reuse initiatives from faecal sludge in Kigali City. However, in the procurement plans for the new FSTP at Masaka, there is a clause included that the plant should "ensure co-composting that meets national and international standards for agricultural use".

In previous years, a private company, Pivot, operated a plant at the Nduba landfill that converted fecal sludge into fuel, a valued output for many industries in the city. During its last few months of operation, additional technology had been introduced to the plant allowing for the wastewater extracted during the process to be treated. However, the treatment plant closed in January 2018. A few cases have been mentioned where individual households are turning household faecal matter to biogas. In some communities outside the city, dubbed as "Green Villages", REMA has been leading initiatives of turning faecal sludge to biogas, an initiative that the city can learn from.

• Inappropriate industrial wastewater management

In the past, industries, petroleum depots and garages have been established in unplanned locations which renders pollution control untenable. Lack of planning has resulted in locating industries in the proximity of residential areas which constitute an additional threat to human health and environment. Even though almost all garages and the first batch of industries have been relocated in the wetlands of the City of Kigali, some of industries (UTEXRWA, Kabuye Sugar Works, etc) are still in Nyabugogo wetland and are still discharging effluents and by-products in the water bodies. Most of industries in the City of Kigali treat the generated liquid waste through in house wastewater treatment plants.

• Low compliance of liquid wastewater quality

The existing data on quality of treated effluent from different wastewater treatment systems in the City of Kigali showed low compliance compared to existing effluent treatment standards. As an example, in a study commissioned by the City of Kigali on Municipal Liquid Waste Management in Kigali, water quality test results revealed that quality of the liquid waste generated in the City of Kigali is classified as "very poor" consequent to high levels of total suspended solids, total phosphorus, organic contaminants (BOD and COD), high concentrations of heavy metals, especially Pb, bacteriological pollutants (fecal coliforms and E. coli) and oil and grease, which do not comply with RSB standards on effluent discharge limits. The presence of high pollutants above permissible limits in liquid waste was attributed to human-induced activities, such lack of (1) sanitation facilities, (2) municipal sewerage system and (3) operation and maintenance of existing centralised and semi-decentralised wastewater treatment works. Figure 9 and 10 present levels of BOD and Nutrients as found in wastewater in the City of Kigali



Figure 10: Levels of BOD in effluent discharge from wastewater treatment plants in Kicukiro and Gasabo Nyarugenge District (Source: CoK)

Results from the CoK study (2019) revealed that 17.3% compliance and 82.7 % noncompliance with Rwandan standard for domestic and industrial effluent discharge limit of 50 mg/l for BOD levels. Recorded BOD concentrations were varying between 7.0 and 4,028.0 mg/l. Similarly, results found that 70 % non-compliant samples for total phosphorus compared to permissible limits set by the Rwandan standard for domestic wastewater discharge. Levels of TP in analysed samples varied between 0.72 and 47.60 mg/l as shown on Figure 10 below



Figure 11: Levels of Nutrients (in terms of TP) in effluent discharges from wastewater facilities in Kicukiro and Nyarugenge Districts

Impacts of wastewater discharges on receiving natural environment

While we generally measure the concentrations and loads of physico-chemical pollutants entering receiving waters, it is the subsequent ecosystem health impacts of these pollutants that are the real concern. Different pollutants affect the aquatic environment in different ways. While at low concentrations many pollutants (e.g. organic materials, N and P) may be beneficial, at high levels they can adversely affect the ecology of the system. Excess nitrate can be particularly harmful to babies.

Many of the toxic pollutants in effluents are synthetic, and therefore do not easily biodegrade naturally. The effects of physical pollution on the ecology of a river system can be complex, affecting the feeding and breeding habits of the different species. Biological pollutants can spread disease through water, and also disrupt the ecology. Pollution management and control of water quality is therefore of crucial importance in the interests of public health and the maintenance of the environment. Table 5 gives a summary of the effects of the different pollutants on receiving aquatic environment.

Table 8: Summary of different pollutants on receiving aquatic environment

Pollutant	General effect	Effect on biota	Effect on water	Sources: result of
Organic (biodegradable wastes)	Increased oxygen demand; food provided for organisms lower down in food chain	Tolerated in moderate quantities if release not too quick, serious if dissolved oxygen (DO) drops too quickly	Increased need of treatment	Domestic sewage, food processing, animal wastes
Plant nutrients	Excessive plant growth	Demand on DO	Increased need of treatment	Animal wastes, fertilisers, detergents, industrial wastes
Toxic chemicals (e.g. heavy metals, pesticides, phenols, PCBs)	Toxic to humans, animals and plants	Could be lethal	Increased need of treatment or control	Detergents, pesticides, tanneries, pharmaceuticals, wool scouring, refineries
Acids/alkalis	Lowering/raising of pH; acids can dissolve heavy metals	Only narrow range of pH tolerable for most plants and animals; heavy metals toxic	Corrosion	Battery, steel, chemical and textile manufacturing; coal mining
Suspended solids	Reduction in light penetration (increased turbidity), blanketing, introduction of colour	Photosynthesis reduced; blanketing of benthic plants and animals; obstruction of gills of fish	Obstruction of filters; increased need of treatment	Pulp mills, quarrying, any building or development work involving ground disturbance
Immiscible liquids	Formation of a layer at the water surface that could prevent O ₂ /CO ₂ interchange	Reduced DO; insect breeding affected	Interference with treatment processes	Oil-related activity
Heat	Decrease in DO; increase in metabolic rate of aquatic organisms	Possible reduced breeding or growth of aquatic organisms	None	Power plants, steel mills
Taste-, odour- and colour- forming compounds	Taste, malodour, colour	Tainting of fish	Increased need of treatment	Chemical manufacture or processing
Microorganisms	Pathogenic to humans	None	Increased need of treatment	Contamination from human wastes

Source: Suresh Nesaratnam, 2016

In the case of Nile Nyabarongo Lower catchment, impacts of liquid waste discharge in Nyabogogo wetland has been extensively documented. Key identified impacts include:

- <u>Impairment of water bodies</u>: water bodies from rural areas are heavily contaminated with nutrients, suspended sediments (due to a lot of erosion upstream) and organic materials whilst from urban areas the predominant pollutants are heavy metals, high BOD and COD as well as some nutrients (Nkuranga et. Al, 2007; Muhirwa et al., 2010; Nhapi et.al, 2014)
- <u>Soil pollution</u>: there is highest accumulation of heavy metals in sediment with up to 4.2 mg/kg for Cd, 68 mg/kg for Cu, 58.3 mg/kg for Pb, and 188.0 mg/kg for Zn (Sekomo et al., 2010)
- <u>Crop contamination</u>: there is high accumulation in the roots of C.papyrus with up to 4.2 mg/kg for Cd, 45.8 mg/kg for Cr, 29.7 mg/kg for Cu, and 56.1 mg/kg for Pb

• <u>Contamination of fish and other aquatic species</u>: there is high accumulation of heavy metal (Cd, Cr, and Pb) in fishes such Clarias sp., Oreochromis sp., and Oligochaetes. (Sekomo et al., 2014)

Here below are industrial firms located in Nyabugogo wetland and around Nyabugogo River that do not possess equipment to treat their waste or partially treat effluent and discharge it in the waters of the Nyabugogo River:

- Slaughterhouses (e.g Nyabugogo Slaughterhouse): large quantities of organic waste generated. Potential to transmit parasitic diseases;
- Sugar producing factory (e.g. Kabuye Sugar Works): the waste generated is discharged directly into the river, causing eutrophication and clogging of river channels;
- Soap making (e.g: Sulfo Rwanda): causes unpleasant odors, and is a health hazard around residential areas;
- Manufacture of alcoholic and soft drinks :(Skol ltd): residual water filled with toxic waste with high levels of BOD. Causes unpleasant odors, risk of transmission of diseases, depletion of oxygen in receiving water bodies and contamination of soil and water with organic pollutants and chemicals;
- Tannery: Waste contains arsenic, DDT, and a range of dichlorobenzenes;
- Manufacturing of galvanized and heavy metal sheets heavy metals and chrome salts discharged into the river;
- Battery manufacturing Residual waste water containing a variety of chemicals and heavy metals;
- Manufacture of paints: Residual waste water containing a variety of oils and chemical residues that are discharged to the environment, contaminating soils, and water;
- Manufacture of textiles and fabrics (e.g: UTEXRWA): Residual waste water containing dyes and chemicals residues such as hydrogen peroxide and sodium silicate. Certain dyes are known to be carcinogenic;
- Waste dump site (e.g Nduba dumpsite): storage of all forms of municipal waste. Risk of contamination of groundwater.

Recommended strategic actions to reduce pollution from the discharges of stormwater and liquid waste in Nile Nyabarongo Lower catchment

a) Flash floods

- Limit construction in flood-prone areas to avoid soil compaction;
- Rebuilt/built drainage channels, sewers, outfalls, on- and off-road ditches, and detention ponds to hold or move water away from local areas;
- Maintaining, cleaning and upgrading city drainage systems.

b) Inappropriate liquid wastewater management

- Ensure that industries have wastewater treatment facilities for which they can send their effluents to be properly treated;
- Ensure that regular inspections are established to guarantee that industries are complying with national regulations regarding sewage treatment and disposal. Ensure as well that penalties are imposed when industries are not in

compliance with those regulations. This can also be applied to commercial buildings, prisons, hospitals, hotels, schools, population, slaughter houses, garages, etc.

- Make sure that national regulations regarding sewage treatment and disposal are properly enforced. For instance, the "Directives on Minimum Requirements for Liquid Wastes Disposal and Treatment" (RURA, 2009), provide guidance in the disposal of liquid wastes, sets up fundamental principles for liquid waste management and treatment, among other considerations;
- Promote the use of recycled wastewater for agriculture, recreation or irrigation purposes. This can help mitigate water scarcity problems and reduce water pollution;
- Pit latrine should not penetrate groundwater and should be at least two meters above the water table. The site should be well drained and above flood level;
- Construction of pit latrines in high slopes should therefore be avoided since contaminated matter has a high chance of being transported downhill and reach watercourses;
- During pit latrine emptying, removed sludge should not be dumped in the water or onto land as to avoid soil and water contamination. Other alternatives such as using the sludge for compost, direct it to biogas units or to drying beds should be considered instead;
- Introduce licensing mechanisms in place for waste water discharge;
- Enforce waste water discharge permit system, polluter pays, enforcement to compliance; and
- Support the upscaling of industrial zones with separate waste treatment plants

4.3.2.3. Pollution by municipal solid waste

Solid waste refers to litter (other terms used include trash / rubbish / garbage / refuse / floating matter) that entered urban stormwater drains and is deposited in urban streams and rivers. This includes solid waste that has deposited directly into the river of tributaries. One definition of litter is "all improperly discarded waste material, including, but not limited to, convenience food, beverage, and other product packages or containers constructed of steel, aluminium, glass, paper, plastic, and other natural and synthetic materials, thrown or deposited on the lands and waters". Marais and Armitage (2003) developed a hierarchical classification system for recording litter items (Table 6).

Main categories	Sub-categories	Examples of items
Plastic	Packaging Polystyrene Containers Miscellaneous	Shopping bags, wrapping Polystyrene blocks and pellets, cooler boxes Containers, bottles, crates.

Table 9:	Solid	waste	classification	system
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		Straws, straps, ropes, nets, music
		cassettes, syringes,
		eating utensils
Paper	Packaging.	Wrappers, serviettes
	News / stationery.	Newspapers, advertising flyers, ATM
	Cardboard	dockets
	Miscellaneous	Food and drink containers, bus tickets.
Metal	Cans	Foil, bottle tops, number plates.
	Miscellaneous	
Glass	Bottles	
Vegetation	Leaves & branches	Garden refuse
	Food	Rotten fruit and vegetables.
Sediment	Sand	Building sand, building rubble
Miscellaneous	Animal	Dead dogs and cats, sundry skeletons.
	Construction	Shutters, planks, timber props, broken
	material	bricks, lumps of concrete.
		Old clothing, rags, blankets.
	Cloth	Fibre-glass
	Fibre-glass	Miscellaneous Shoes, sponges, balls, pens
	Miscellaneous	and pencils, balloons, oil filters, cigarette
		butts, tyres.

Rapid population growth and improvement of life standards in urban areas of Nile Nyabarongo Lower catchment, especially the City of Kigali, resulted in high demand for public services including solid waste services. For this, the public sector is not able to provide the service alone which has opened door to the privatisation of waste collection in Kigali and other cities as well. This has increased the service coverage where 90% of the population in Kigali, has access to solid waste collection service in 2015 from 44% in 2012 (Nishimwe P., 2016). However, low performance in waste source separation associated with a basic practice of "collect and dump" is resulting in huge amount of waste ending into open dumpsites (more than 96% of collected waste) and corresponding greenhouse gas emissions from 24.04 Gg CO2eq to 186.99 Gg CO2eq, (2006-2015) respectively, with an increase rate of 3.12% per year (REMA, 2016).

A rapid assessment (2019) that was intended to provide a snapshot of the critical challenges in the waste management sector in Kigali, observed the following critical issues in the management of solid waste in the City of Kigali:

- Toxic leachate: Leachate is being generated and is percolating into the groundwater table and overflowing into the sub-catchments that are tributaries to the Nyabugogo River, releasing toxins and carcinogenic chemicals that are harmful to humans and ecology.
- Slope failure for Nduba landfill: Compacting of solid waste on the Nduba plateau, increasing the risk of geotechnical slope failure;
- Pond failure: Holding wall failure of the temporary leachate and septage disposal ponds, leading to the overflow of leachate containing toxins and pathogens;
- Unsanitary septage disposal: Disposal of septage in temporary holding ponds, which is most likely polluting underground water/springs through deep percolation;

- Methane fueled fires: Generation of methane gas trapped and released by decomposing organic matter, which could cause fires on site that might burn for months, releasing toxins and greenhouse gases (GHGs).
- Health and safety of workers: Occupational health and safety risks to workers, waste pickers, nearby residents, and the local ecosystems due to non-sanitary disposal; and
- Lack of data: No credible empirical data to inform effective waste management solutions, e.g. the need to understand the waste composition and quality

In general, the following issues were identified in Municipal Solid Waste Management in Nile Nyabarongo Lower catchment:

- inadequate service coverage and operational inefficiencies of services;
- limited utilization of recycling activities;
- inadequate landfill disposal and
- inadequate management of hazardous and healthcare waste

BOX.4.1: ISSUE OF NDUBA LANDFILL

Background

Before 2012, all wastes generated in the City of Kigali were transported to the Nyanza landfill for disposal, where they were compacted and covered with soil using bulldozers. As of May 2012, Nyanza landfill had already become a health hazard and was promptly closed following the ultimatum by Prime Minister. Following this prompt closure, the alternative solution has been to relocate it to Nduba site / Gasabo (around 2014/2015) for a transition period of two years. This improvised relocation did not wait to pass through important steps such as conducting feasibility and detailed design studies, carrying out the environmental impact assessment (EIA) study, expropriation of nearby population, among others. In addition, the dump site started operating without formal activities of waste treatment nor landfill gas management.

Consequences

Currently, Nduba landfill has also become an environmental and health hazard to the city. The critical issues observed during the field visit include:

Increased percolation risk of the leachate from the dumping site which may reach groundwater table and overflowing into the sub-catchments that are tributaries to the Nyubogogo River

Lack of segregation of biodegradable and non-biodegradable waste

Disposal of septage in temporary holding ponds, which is most likely polluting underground water/springs through deep percolation;

Lack of methane gas management: Generation of methane gas trapped and released by decomposing organic matter, which could cause fires on site that might burn for months, releasing toxins and greenhouse gases (GHGs)

Inappropriate working conditions at landfill site;

Among others.

Proposed management strategies

Extend affordable collection services

Ensure the controlled disposal

Promote the reducing waste improves resource security, improves well-being and saves everyone money

Maximize repair, reuse and manufacture

Keep materials separate/segregate waste at source to minimize contamination and facilitate reuse and recycling

Separate hazardous waste, and in particular hazardous healthcare waste, from other waste at source and manage them separately in environmentally sound facilities

Impact of Municipal Solid waste on receiving environment

Solid waste has a number of impacts on water quality in urban streams and rivers:

- Aesthetic impacts The presence of large amounts solid waste detracts from the aesthetic appeal of the river and affects the economic value of waterfront properties.
- Impacts on dissolved oxygen The decomposition of biodegradable solid waste (garden or agricultural refuse, food wastes, dead animals, faecal matter, etc.) can have a significant localised impact on oxygen depletion in a river. This affects the dissolved oxygen content of the water and in turn, aquatic organisms that are sensitive to low dissolved oxygen concentrations. Dissolved oxygen also affects the solubility of trace metals and nutrients and low concentrations promote the release of metals and nutrients from the sediments.
- Bacteriological impacts Solid waste can threaten the health of contact (e.g. kids playing in streams, urban farmers diverting water onto their crops) and limited contact users. Of particular concern are bacteria and viruses associated with disposable nappies, medical wastes, animal carcasses, and human and domestic pet wastes. Ingestion of river water when in contact with the water can expose users to water borne diseases such as diarrhoea, gastroenteritis, cholera, salmonellosis, dysentery, and eye, ear, nose and skin infections.
- Safety of users Lacerations caused by broken glass or sharp metal fragments can expose the bloodstream of recreational users to microbes that can cause waterborne diseases such as hepatitis, and typhoid fever.
- Impeding flow and bank destabilisation The accumulation of floating solid waste, dumping of building rubble, or dumping of large objects such as car bodies, broken furniture, tyres, can redirect stream flow and destabilise the river channel.
- Entanglement of domestic animals and aquatic organisms Entanglement can occur if animals or aquatic organisms are ensnared by debris in the river. It can occur accidentally and lead to wounds and infections, or loss of limbs in livestock. It can also cause strangulation or suffocation, or impair the ability of to swim resulting in downing or difficulty in movement which may affect the ability to find food or escape from predators.
- Ingestion by livestock Ingestion of floating or deposited rubbish can lead to starvation of malnutrition if the intestinal tract is blocked or digestion of food is impaired. Ingestion of sharp objects can also to damage of the mouth, digestive tract or stomach lining causing infection and pain in the animal. Rubbish that settle at the bottom of the river such as glass, cigarettes, rubber, and construction debris, are a problem for bottom feeders and dwellers.
- *Hydrocarbon pollution* Hydrocarbon pollution from dumped oil cans or automotive parts can kill microscopic organisms in the river.

- *Trace metals* Trace metals from rusting batteries or electronic equipment can be toxic to aquatic organisms.
- Nutrient enrichment the decomposition of organic solid waste and release of nutrients during this process would contribute to the nutrient load in the river. However, when compared to other nutrient loads from sources such as grey water disposal, treated *wastewater*, and agricultural runoff or seepage, decomposing organic solid waste would probably represent a minor source.
 - Recommended strategic actions for Municipal Solid Waste Management in Nile Nyabarongo Lower.
 - Improve solid waste collection coverage in order to prevent waste dumping in rivers, wetlands, ditches and other public spaces.
 - Promote awareness and best practice campaigns to build a culture of sorting for recycling, reducing and reusing in Kigali.
 - Promote voluntary clean-up activities with the communities and local NGOs in areas where there is evidence of littering and illegal waste dumping, especially in locations where the garbage is close to a water source. These actions will decrease the pollution caused by littering, prevent diseases, improve the quality of life of the surrounding communities and raise awareness for the issue. Ideally, waste collected in these activities would be sorted and sent to recycling facilities whenever possible.
 - Promote cleaner production to ensure that industries and commercial institutions have waste management practices that minimize waste production and that their waste is disposed in a responsible way, especially for the case of hazardous wastes.
 - Promote waste sorting at household level and ensure that collection trucks are able to effectively carry sorted waste to proper facilities. Assess the availability of markets for recyclables and the technologies available for recycling waste. Assess the feasibility of recycling materials such as paper or plastic in order to reduce usable waste in the landfill and decrease the demand for importing these types of materials.
 - Since most of the waste produced in Kigali is biodegradable (REMA, 2013), the use of composting facilities to turn biodegradable waste into compost should be encouraged. For landfill disposal, the following should be taken into account:
 - Landfill disposal should only be considered when other alternatives (such as recycling or composting) are not possible or feasible.
 - Ensure that landfill sites are in compliance with national regulations and that there are no issues regarding groundwater contamination, rainfall exposure, surface runoff, or human health risks.

4.3.2.4 Urban air pollution

Urban air pollution is in the form of diverse and widespread sources of emissions and natural phenomena. The primary man-made sources of urban air pollution arise from transportation, industry, combustion fuels, industrial processes, and use of pesticides in urban agriculture. More specifically, the pollutants include suspended particulate matter, sulphur dioxide (SO₂), nitrogen dioxide (NO₂), hydrocarbons and ozone due to population growth, urbanisation, industrialisation, and increased use of motor vehicles (Rugigana et al, 2016). Emissions from motor vehicles specifically are identified as a major source of air pollution growing as a result of population growth and associated urbanisation.

The study conducted by Rwanda Environment Management Authority (REMA) in 2018 on Inventory of Sources of Pollution in Rwanda revealed that vehicle emissions are the biggest contributor to poor ambient air quality for locations adjacent to busy roads. According to the same study, the older vehicles (that make large portion of road flee 60%) emit higher levels of NOx and PM10 than newer vehicles and contribute more than 50% of total emissions. In addition, vehicles made before the year 1999 contributed 58% of NOx and 66% of PM10 emissions.

The analysis of data from the air quality monitoring reference station in Kigali from May to August 2019 showed that levels of particulate matters that have a diameter less than 2.5 micrometres, often known as PM2.5 and Ozone (O3) fell in the unhealthy range for sensitive groups such as children and elderly people with chronic diseases. Unhealthy levels for PM2.5 are those above 65.5 microgram per square meter (PM2.5 >65.5 μ g/m2) while those for Ozone range above 85 part per billion (O3>85 ppb). This is expected in the dry season since these pollutants increase with atmospheric dust and temperature. However, a decrease in concentrations of the above pollutants was observed during rainy season (September to December, 2019).

Figure11 below presents the levels of Particulate Matter (PM2.5) as recorded at air quality monitoring reference station in the City of Kigali during May, June & July 2019.



Figure 12: Levels of Particulate Matter (PM2.5) as recorded at air quality monitoring reference station in the City of Kigali for three months (May, June & July, 2019)

The Covid-19 Air Quality Report (April, 2020) reported an unprecedented decrease in air pollution across the country, especially in the City of Kigali. As consequence of the lockdown that was implemented in Rwanda since March 21, 2020 in response to the Coronavirus pandemic.

In Kigali, a decrease of 24% in PM2.5 while all other pollutants (PM10, CO and NO2) also recorded significant decrease during car free days in 2019 and 2020, NO2 being the gas to record highest decrease in 2019 in Kigali City (-18%) and this indicates that Rwanda government's ongoing efforts to limit vehicle emissions in the City of Kigali are fruitful..

Considering the rapid rate of urbanisation, economy and industrialisation, it is evident that the transport of both goods and people will definitely keep increasing. The increasing number of motor vehicles in Rwanda, particularly in the City of Kigali City will therefore exacerbate the problem of air pollution if emissions from this sector are not controlled. Dust emissions from unpaved urban roads and maize and wheat milling operations can be major sources of particulate organic matter. Monitoring of air pollution in Rwanda should be strengthened and management of sources that exceed EAC guidelines and standards should be instituted. Other strategic approaches to halt air pollution in Rwanda include:

- Implementation of the planned actions leading to migrating to electric mobility need to be expedited;
- Multiply effort for inspections of vehicle emissions at the motor vehicle inspection centre operated by Rwanda National combined with hand held vehicle emissions inspection using mobile equipment for on spot checks implemented by Traffic Police;
- Uphold the efforts of road construction and increasing plant cover on road sides to reduce dust; and
- Promotion of clean energy such as LPG to reduce negative health impacts from use of domestic wood and charcoal cookstoves.

4.3.2.5. Urban noise pollution

Traffic noise is a general term used to define the noise from traffic using the road network. A traffic stream is made up of a variety of vehicle types which have their own individual noise sources. Close to a road, individual vehicles can be distinguished in the traffic stream, but further from the road the influence of individual vehicles is less noticeable as the noise from traffic becomes a continuous drone.

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 been 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.

4.3.2.6. 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 Nile Nyabarongo Lower include small industrial zones, known as Agakiriro centres; quarries and unplanned settlement communities. Most of per-urban centres in Nile Nyabarongo Lower 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.

4.3.3. Rural diffuse sources

4.3.3.1. Agriculture diffuse sources

In Nile Nyabarongo Lower catchment, agriculture (perennial)' and open areas or grass jointly totalize 62% of land use. Rained agriculture is predominant, but also intensive puddy 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 agricultural diffuse source pollutants 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 streambank 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 7.

Pollutant	Source	Ratin	notes
		g	
nutrients			
Nitrate (NO3)	Fertiliser	5	Low natural levels
Ammonia (NH4)	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 (PO4)	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)4)	Erosion	0	
Sewage	STP discharge, septics	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

Table 10: Main rural diffuse polluants

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 Table8 The 'rural' pollutants are also applicable to Nile Nyabarongo Lower catchment given that rural land uses occupy the majority of the Nile Nyabarongo Lower catchment area.

Pollutant group	Specific pollutant and comments
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.

 Table 11: Other rural diffuse pollutants

4.3.3.2. Deforestation, soil erosion and river sedimentation

The high population density in the catchment, combined with a high use of fuel wood for cooking and poor agricultural practices, leads to deforestation and overexploitation of agricultural land. Due to a lack of adequate management, soils become depleted of nutrient and, especially in the western part of the catchment which has steep slopes, rates of soil loss are very high. Once the eroded soils enter waterways, they contribute to high sediment loads thereby, amongst other adverse impacts, they increase flood risk as they deposit in the riverbed and floodplains reducing flow capacity.

Farmers will need to be encouraged to adopt and utilise agro-forestry and other tree species e.g. fruit trees, on their farms. Combined with other tailor-made and already popular soil and water conservation technologies, based on lessons from ongoing and past projects, this can curb the rates of deforestation, soil erosion, stream sedimentation and flood risk.

4.3.3.3. Mining activities

Mining sector is well developed in Nyabugogo lower catchment particularly in Kamonyi district and many other mining sites such as Gatumba and Rutongo in Nyabugogo sub-catchment. During the preparation of mine ores, a lot of water is used leaving major pollutants in water bodies. The impact is determined by brown color characteristic of the rivers in Nyabarongo lower. Also, the catchment has several quarries sites. The contribution of mining activities to sediment loading in rivers is considered at least to be equal to the contribution made by agricultural soil erosion, and in some individual sub-catchments mines are the predominant source of sediments;

- Recommended strategic actions to rural diffuse pollution in NNYL
- Chemical use on agricultural lands should be reduced where possible. Chemical sprays should be used with care, ensuring that there is a low likelihood of rain after application;
- Promote the use of non-chemical methods of pest control, including:
 - biological controls: use of the natural enemies of crop pests, which include parasites, predators and insect pathogens
 - cultural control and crop or livestock management: tissue culture, disease-free seed, trap crops, cross-protection, cultivation techniques, refuge management, mulching, field sanitation, crop rotations, grazing rotations and intercropping (REMA:2015);
 - strategic control: variety selection, planting location, timing of planting and timing of harvest; and
 - genetically based controls: insect- and disease-resistant root stock and varieties, developed through classical and modern molecular breeding
- Limit the use of chemical fertilizers to a minimum in order to prevent excessive weed and algae growth on wetlands, to prevent surface and groundwater contamination and biodiversity impacts. Instead, promote the use of compost on agriculture land. This will improve soil structure, soil fertility and water retention, thus reducing the demand for fertilizers.
- Adopt measures such as minimum tillage systems, maintaining ground cover in high rainfall periods, installing and maintaining effective wetland buffers or filter strips, use sediment traps, etc.
- Manage irrigation sustainably by using more resource efficient techniques such as drip irrigation, treadle pumps, rain-fed irrigation and cultivating more drought resistant and less demanding crop varieties.
- Implement payment for ecosystems services as an incentive for farmers to implement landscape rehabilitation and conservation measures, and the adoption of sustainable mining practices for mining companies.

• Support model mining in mining industry

4.4 Mapping of 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 13 below displays key hotspots in Nile Nyabarongo Lower (NNYL) catchment. Lists of key hotspots are attached as annex VI



Figure 13: Key Pollution Hotspots in NNYL Catchments 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 14 shows the value and limitations of each of the three different levels of intervention. **Process of Pollution Strategies for reducing impacts**



Cleaning up the pollutant and restore the ecosystem Extracting and removing the pollutant into ecosystem Replanting and restocking with human kind

Figure 14: 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 laws, standards and guidelines for pollution sources reduction in Rwanda were analysed in point 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 nonstructural (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 catchment areas. These include a variety of institutional and educational measures focussed on land development, public awareness to modify behaviour that contribute to catchment 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 Nyabarongo Lower catchment pollution drivers, pressures, states and impacts

The DPSIR (Driving forces, Pressures, States, Impacts and Responses) approach was adapted from IWRM/W4GR Lower Nyabarongo Catchment Plan (2018-2024) developed by Rwanda Water and Forestry Authority in 2018. Table 13 below provides drivers, pressures, states and impacts of pollution in Nile Lower Nyabarongo catchment

Table 12: Drivers, Pressures, States and Impacts of pollution in Nile Nyabarongo Lower Catchment

Drivers Pro	ressures
-------------	----------

 Rapid population growth, high density and urbanization Development in Economic zones and industrial parks Low skills & awareness levels Insufficient enforcement of environment laws and regulations on mining Little knowledge, understanding & kskills in agrochemicals/pesticides/herbicide s application best practices Low capacity and skills in solid waste and wastewater management 	 Siltation from mining exploitations Soil over exploitation, land degradation & soil erosion Limited management of solid and liquid wastes Encroachment of river banks & pollution of water bodies Sub-standard farming & mining practices aggravating soil erosion and pollution Small farm lands & encroachment on forest areas
States	Impacts
 Planning processes at District levels are not aligned with catchment governance Water bodies and wetlands in NNYL are highly polluted (tubidity, heavy metals & nutrient above allowable limits); Inadequately managed municipal solid wastes; High river sediment loads and siltation; Poor ambient air quality ; Low skills & awareness levels 	 Water in rivers often unsuitable for drinking water intakes High cost for drinking water treatment & maintenance of distribution networks Water borne diseases Heavy metals contamination through food chain

4.7. Opportunities

4.7.1. Past and ongoing soil conservation interventions

Lessons learnt Reforestation and other soil conservation inventions implemented by different projects (PAREF, LVEMPII, PAGREF, FONERWA, LWH/RSSP, etc) in Nile Nyabarongo Lower 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 opportunities to improve pollution management in Nile Nyabarongo Lower. Limited enforcement capacity of the above legal instrument is still law in the catchment, for this opportunity to

become effective, stakeholders need to join hands in improving 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 Nyabarongo Lower Catchment are regarded opportunities since they have better knowledge of environmental and socio-econmic 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.

4.7.4. High potential income generating activities

(Eco) Tourism, mining, fish culture and economic zones are listed among the opportunities for economic activity in the catchment, even though they are also mentioned among the main issues in the catchment. A sustainable approach to mining is required in order for there to be economic benefit from this sector without associated environmental damage. Experience needs to be developed in sustainable mining, e.g. through the concept of model mines. Best practices can be developed in pilot projects e.g. in one sub-catchment and replicated in other sub-catchments within and beyond catchment boundaries.

5. INTEGRATED POLLUTION MANAGEMENT PLAN

5.1. Introduction

The preceding chapters provided a characterisation of pollution situation in Nile Nyabarongo Lower 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 Nyabarongo Lower 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.

A scoping workshop that brought together representatives of all the districts in the catchment and national institutions was convened, discussed and agreed on common key pollution issues and opportunities. Major pollution management issues in Nile Nyabarongo Lower catchment are planning processes that are not aligned with catchment governance; contamination of water bodies and wetlands by discharge of polluted runoff and inadequately treated wastewater from industrial, household, institutional and commercial establishment, littering of municipal solid wastes that impacts on aesthetic appearance, disturbance of stream flow, groundwater and soil contamination as consequence of inadequate service coverage and operational inefficiencies of services; limited utilization of recycling activities; inadequate landfill disposal and inadequate management of hazardous and healthcare waste, poor ambient air quality due to vehicle emissions and the use of three stone cookstoves and high river sediment loads resulting from poor agricultural practices (hillside agriculture and encroachment of river banks and inadequate mining practices (artisanal mining) and deforestation whereas the opportunities include past and ongoing sustainable land management & soil conservation interventions, existence of laws, regulations and standards on pollution management, decentralized governance framework that facilitate the participation of local communities during the implementation of the plan as well as the catchment being located in a zone with high potential income generating activities (business hub, Ecotoursm & hotels, Economic zones, etc).

Following the feedbacks from the above scoping workshops with stakeholders, consultancy team synthesized the workshop messages and outcomes and then formulated an agreed on the vision for the Nile Nyabarongo Lower as follows:

"Nile Nyabarongo Lower is well-managed catchment that is home to prosperous communities living in harmony with their environment and drawing social and economic benefits from sustainable ecosystem".

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

Goal 1: Enhanced governance of pollution management at catchment level.

In order to effectively manage pollution in Nile Nyabarongo Lower catchment, there is a need to enhance governance at catchment level and ensure that planning is coordinated and aligned at catchment and district levels of plans. This goal will be achieved through the following objectives and activities:

Objective 1.1. Support Districts to enforce pollution control guidelines and standards

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 Nile Nyabarongo Lower catchment.

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

This objective will be achieved through the following key activities:

- i. Establish NNYL catchment committee
- ii. Operationalise NNYL catchment Technical Committee
- iii. Support integrated planning at catchment level
- iv. Support regular coordination meetings of water committee, environment committee and water users organisations
- v. Establish the National Solid Waste Task Force

Goal 2: Sustainable and environmental sound management of all wastes in Nile Nyabarongo Lower catchment

There is a need for districts in Nile Nyabarongo Lower catchment 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 urban 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 NNYL.

This objective will be achieved through the following key activities:

- i. Develop sewerage systems and wastewater treatment plants;
- ii. Develop 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. Support rainwater harvesting on rooftops of settlement areas;
- vi. Construction of water drainage to capture road drainage & settlements;
- vii. Support the construction of an engineered sanitary landfill that makes provision for waste separation and recycling;
- viii. Enforce oil separation at all garages and vehicle workshops;

- ix. Promote waste-to-resource initiatives including composting, biogas to energy, plastic recycling for construction materials etc; and
- x. Promote voluntary clean-up activities through community work initiatives and local NGOs

Objective 2.2. Effective management of diffuse rural pollution.

This objective will be achieved through the following key activities:

- i. Support the implementation of sustainable mining practices/Model mining;
- ii. Enhance payment of ecosystem services in NNYL for catchment protection;
- iii. Multiply inspections for environmental compliance in mining sector;
- iv. Implement measures proposed for Gikondo and Nyabugogo systems catchment management plan;
- v. River bank protection along all rivers and wetlands in NNYL;
- vi. Increase awareness and education on environment protection;
- vii. Strengthen the national vehicle inspection canter's capacity to implement new standard on Road Vehicle Emission Limits;
- viii. Implement air pollution control guidelines;
- ix. Promote local vehicle assembly including introduction of incentives to promote electric vehicles;
- x. Support increased access and use of LPG in urban and peri-urban household for cooking in NNYL; and
- xi. Support increased access and use of improved cooking stoves and alternatives fuels in rural areas of NNYL.

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 catchment area 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 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

This objective will be achieved through the following key activities:

- i. Conduct inventory of small industries and SMEs with/without wastewater treatment facilities in NNYL;
- ii. Integrate key urban hotspot monitoring points to national sampling program;
- iii. Introduce permanent effluent discharges monitoring for compliance programme in key urban areas of NNYL.

Objective 3.2. Building capacity in urban and rural pollution management.

This objective will be achieved through the following key activities

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

- iii. Conduct capacity building in sustainable mining approach/Model mining and law enforcement among mining operators;
- iv. Organise training in conducting urban pollution incident investigations, mitigation, and prosecution of polluters; and
- v. 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.

5.4.1.2. 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 13 below provides details on institutions analysis and their roles in pollution management. Table 15 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.

No	Institution	Function
Poli	cy institutions	
1	Ministry of	Ensure that environment and pollution control policies
	Environment (MoE)	and strategies are passed by Cabinet and communicated
		to stakeholders. The Ministry of Environment will

Table	13:	Institutions	with i	important	roles in	Pollution	Management

		provide policy oversight to the plan implementation including enforcement of accountability and continued
		alignment to high level political interests
2	Ministry of Local	Facilitate the management of efficient and effective
	Government	decentralized government systems capable of law
	(MINALOC)	enforcement and delivery of required services to the
2	Ministry of	local communities
S	Ministry Of	noduction modernicing farming ensuring food
	Agriculture and Animal Resources	security and promoting surplus for the market and
	(MINAGRI)	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
	Minister of	practices.
4	Ministry of	MININFRA will facilitate implementation of the IPMP at
	(MININFRA)	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	Policy formulation and promotion of investments in
	and Industry	cleaner production by the private sector for industries
Fine	(MINICOM)	and manufacturing.
Fina	incing institutions	
6	Ministry of Financo	Mobilization and allocation of financial recourses
6	Ministry of Finance	Mobilization and allocation of financial resources
6	Ministry of Finance and Economic Planning	Mobilization and allocation of financial resources including co-ordination of donor inputs
6	Ministry of Finance and Economic Planning Rwanda Green	Mobilization and allocation of financial resources including co-ordination of donor inputs Funds Mobilization and investment in the best public
6	Ministry of Finance and Economic Planning Rwanda Green Fund (FONERWA)	Mobilization and allocation of financial resources including co-ordination of donor inputs Funds Mobilization and investment in the best public and private projects that have the potential for
6 7	Ministry of Finance and Economic Planning Rwanda Green Fund (FONERWA)	Mobilization and allocation of financial resources including co-ordination of donor inputs Funds Mobilization and investment in the best public and private projects that have the potential for transformative change and that align with Rwanda's
6 7	Ministry of Finance and Economic Planning Rwanda Green Fund (FONERWA)	Mobilization and allocation of financial resources including co-ordination of donor inputs 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.
6 7 8	Ministry of Finance and Economic Planning Rwanda Green Fund (FONERWA) Development	Mobilization and allocation of financial resources including co-ordination of donor inputs 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. LDCF, World Bank, German Embassy, Embassy of the
6 7 8	Ministry of Finance and Economic Planning Rwanda Green Fund (FONERWA) Development partners	Mobilization and allocation of financial resources including co-ordination of donor inputs 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. LDCF, World Bank, German Embassy, Embassy of the Kingdom of Netherlands and other regional or
6 7 8	Ministry of Finance and Economic Planning Rwanda Green Fund (FONERWA) Development partners	 Mobilization and allocation of financial resources including co-ordination of donor inputs 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. LDCF, World Bank, German Embassy, Embassy of the Kingdom of Netherlands and other regional or international environment management partners on the
6 7 8	Ministry of Finance and Economic Planning Rwanda Green Fund (FONERWA) Development partners	Mobilization and allocation of financial resources including co-ordination of donor inputs 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. 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
6 7 8	Ministry of Finance and Economic Planning Rwanda Green Fund (FONERWA) Development partners	Mobilization and allocation of financial resources including co-ordination of donor inputs 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. 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 Nyabarongo Lower
6 7 8	Ministry of Finance and Economic Planning Rwanda Green Fund (FONERWA) Development partners	Mobilization and allocation of financial resources including co-ordination of donor inputs 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. 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 Nyabarongo Lower catchment will be critical to the success of the plan
6 7 8	Ministry of Finance and Economic Planning Rwanda Green Fund (FONERWA) Development partners	Mobilization and allocation of financial resources including co-ordination of donor inputs 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. 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 Nyabarongo Lower catchment will be critical to the success of the plan implementation. Their experience in pollution
6 7 8	Ministry of Finance and Economic Planning Rwanda Green Fund (FONERWA) Development partners	Mobilization and allocation of financial resources including co-ordination of donor inputs 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. 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 Nyabarongo Lower catchment will be critical to the success of the plan implementation. Their experience in pollution management and control links to potential financiers or
6 7 8	Ministry of Finance and Economic Planning Rwanda Green Fund (FONERWA) Development partners	Mobilization and allocation of financial resources including co-ordination of donor inputs 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. 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 Nyabarongo Lower 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
6 7 8	Ministry of Finance and Economic Planning Rwanda Green Fund (FONERWA) Development partners	Mobilization and allocation of financial resources including co-ordination of donor inputs 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. 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 Nyabarongo Lower 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
6 7 8	Ministry of Finance and Economic Planning Rwanda Green Fund (FONERWA) Development partners	Mobilization and allocation of financial resources including co-ordination of donor inputs 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. 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 Nyabarongo Lower 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.
6 7 8 8 <u>Reg</u> u 9	Ministry of Finance and Economic Planning Rwanda Green Fund (FONERWA) Development partners	Mobilization and allocation of financial resources including co-ordination of donor inputs 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. 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 Nyabarongo Lower 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.

9	Management Authority (REMA) Rwanda Utilities Regulatory Agency	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 Enforcement of compliance by public utilities with the laws governing their activities, mainly liquid and solid		
10	(RURA)	wastes collection, transportation & disposal		
10	Board (RSB)	stable environment.		
Imp	lementation & Servi	ces institution		
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)		
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 Implementation of the government policies and laws. Districts in Nile Nyabarongo Lower catchment will be sole organs to lead the implementation of this plan.		
17	Districts			
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 Nyabarongo Lower catchment will supplement the public sector efforts in pollution management through conduct training and capacity building for communities		

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.

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 Nyabarongo Lower 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.

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

Table 14: Ratings System for Essential Pollution Management Actions in NNYL

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 15 below presents the Integrated Pollution Management Plan actions prioritization, scheduling and roles and responsibilities of different stakeholders

	Status	Challenge/Issue	Recommended action	Prioritisation	Sequencing	Responsible
C	Goal 1: Enhanced gov	ernance of pollution	management at catchment le	evel		
1	Planning processes at District levels are not aligned with catchment	Inadequate measures by District authorities to enforce	Support District Authorities to enforce the Rwandan industrial effluent standards.	Medium	Short-term	REMA (Lead), RURA (Co-lead), Districts, RNP, RIB (Others)
	governance	pollution control guidelines and standards	Support District Authorities to enforce the EAC industrial and incinerator air emission standards	Low	Short-term	REMA (Lead), MoH (Co-lead), Districts RNP, RIB (Others)
			Support joint inspections of environment polluting activities in NNYL	High	Short-term	REMA (Lead), Districts (Co-lead), RNP, RIB (others)
			Review of the standards and norms for stormwater planning	High	Medium- term	RSB (Lead), RWB (Co- lead), MoE, REMA, RHA, RTDA (Others)
		Uncoordinated planning processes at catchment level	Establish NNYL catchment committee	High	Short-term	RWB (Lead), Districts (Co-lead), Catchment Committee (others)
			Operationalise NNYL catchment Technical Committee	Low	Short-term	RWB (Lead) , Districts (Co-lead), Catchment Committee (others)
			Support integrated planning at catchment level	High	Medium- term	LODA (Lead), RWB (Co-lead), Districts, MINALOC, MINECOFIN (Others)

Table 15: Nile Nyabarongo Lower IPMP actions prioritization, scheduling and key stakeholders

			Support regular coordination meetings of water committee, environment committee and water users organisations	Medium	Medium- term	RWB (Lead), REMA (Co-lead), Districts (others)
			Establish the National Solid Waste Task Force	High	Short-term	MININFRA (Lead), MoE (Co-lead), WASAC, REMA, Others
(Goal 2: Sustainable a	nd environmental so	und management of all waste	s in Nile Nyaba	rongo Lower d	atchment
	2 Water bodies and wetlands in NNYL are highly polluted due to discharge of polluted runoff	Inadequate management liquid wastes	Develop sewerage systems and wastewater treatment plants	High	Long-term	WASAC (Lead), CoK &Districts (Co-lead), MINICOM, MoE, MININFRA, REMA, RWB, (others)
	and inadequately treated wastewater		Develop sludge management and treatment facilities	High	Long-term	WASAC (Lead), RURA (Co-lead), REMA, CoK, Districts (Others)
			Support resettlement of population in high risk zones	High	Long-term	MINALOC (Lead),LODA (Co- lead), MINEMA, Districts (others)
			Support small industries &SMEs to implement cleaner production measures	Medium	Long-term	NIRDA (Lead), REMA (Co-lead) MINICOM, MoE, Districts (others
			Support rainwater harvesting on rooftops of settlement areas	Medium	Continuing	RWB (Lead), LODA (Co-lead), MINSLOC, districts (others)
			Construction of water drainage to capture road drainage & settlements	High	Continuing	RTDA (Lead), RWB (Co-lead), MININFRA,

						MINALOC, Districts
						(others)
			Support construct of a	Medium	Long-term	RURA (Lead), REMA
			designed landfill that makes			(Co-lead), PSF,
			provision for waste			Districts (others)
			separation and recycling			
			Enforce oil separation at all	High	Continuing	RMB(Lead), Districts
			garages and vehicle			(Co-lead), REMA
			workshops			RNP, RIB, RMA (others)
			Multiply inspections for	High	Continuing	REMA (Lead), RIB (co-
			environmental compliance			lead), RNP, RSB, MoE,
			in mining sector			PSF (others)
3	Inadequately	Inadequate	Support construct of a	High	Medium-	WASAC (Lead), CoK
	managed	separation and	designed landfill that makes		Term	(Co-lead), MINICOM,
	municipal solid	valorization of	provision for waste			MoE, REMA, RWB,
	wastes	organic and other	separation and recycling			District (others)
		landfilled wastes	Promote waste-to-resource	High	Short-term	NIRDA(Lead),
		at the Nduba	initiatives including			WASAC(Co-lead),MoE,
		landfill in Kigali	composting, biogas to			MINICOM, RURA,
			energy, plastic recycling for			REMA, Districts
			construction materials etc.			(Others)
		Inadequate solid	Promote voluntary clean-up	High	Short-term	CoK & Districts
		waste collection	activities through			(Lead), NGOs
		and illegal	community work initiatives			
		dumping	and local NGOs			
4	High river	Sub-standard	Support the implementation	High	Long-term	RMB (Lead), Districts
	sediment loads	farming & mining	of sustainable mining			(Co-lead), MoE,
	and siltation	practices	practices/Model mining			REMA, RMA (others)
		aggravating soil	Enhance payment of	Medium	Continuing	RWB (Lead),
		erosion and	ecosystem services in NNYL			FONERWA (Co-lead),
		pollution	for catchment protection			REMA, , Districts
						(others)

			Multiply inspections for environmental compliance in mining sector	High	Short-term	REMA (Lead), RIB (Co-lead), RMB, RNP, Districts
		Encroachment of wetlands, river banks & pollution of water bodies	Implement measures proposed for Gikondo and Nyabugogo systems catchment management plan	High	Long-Term	REMA (Lead), COK (Co-lead), Partners (others)
			River bank protection along all rivers and wetlands in NNYL	High	Continuing	RWB (Lead), REMA (Co-lead), Districts (others)
			Increase awareness and education on environment protection	Medium	Continuing	REMA (Lead), Districts (Co-lead), NGOs, CSOs (others)
		Low enforcement of laws and regulatory instruments on environment	Strengthen the national vehicle inspection canter's capacity to implement new standard on Road Vehicle Emission Limits	High	Continuing	RNP (Lead), MoE (Co- lead), REMA, Development Partners (others)
		pollution	Implement air pollution control guidelines	Low	Short-Term	REMA (Lead), districts (Co-lead), MoE, RIB (others)
5	quality	Older vehicles that make a large fraction of Rwandan Fleet.	Promote local vehicle assembly including introduction of incentives to promote electric vehicles	High	Long-Term	MININFRA (Lead), PSF (Co-lead), RDB, MINICOM, Development Partners (others)
		High dependency on wood biomass/Charcoal	Support increased access and use of LPG in urban and peri-urban household for cooking in NNYL	High	Medium- Term	REG (Lead), PSF (co- lead), MoE, MININFRA, CoK, RFA, Partners (others)

			Support increased access and use of improved cooking stoves and alternatives fuels in rural areas of NNYL	High	Short-Term	REG (Lead), MoE (Co-lead), REMA,PSF, Districts
C	Goal 3: Effective info	rmation and knowled	dge management			
6	Low skills & awareness levels	Lack of data on pollution	Inventory of small industries and SMEs with/without wastewater treatment facilities in NNYL	High	Short-term	NIRDA (Lead), REMA (Co-lead), MoE, districts
			Integrate 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/	Develop training package on urban and rural pollution and BMPs.	Low	Short-term	REMA (Lead),UR (Co- lead), RAB,MINAGRI,RWB (Others)
		pesticides/herbici des application best practices	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 sustainable mining practices	Conduct capacity building in sustainable mining approach/Model mining and law enforcement among mining operators	Medium	Continuing	REMA (Lead), RMB (Co-lead), FONERWA, Districts, Development Partners (others)
		Little knowledge & understanding of environment laws	Disseminate policies, laws and regulatory instruments on environment protection,	Medium	Short-term	MoE (Lead), MINAGRI (Co-lead), REMA, RAB, RMB, RWB, Districts (others)

	and regulatory	sustainable mining and		
	instruments	smart agriculture		

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 on 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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Goal 1: Enhan	ced governance of	pollution managemer	nt at catchme	ent level					
Objective	Activities	Indicators	Baseline	Target		Timing		Responsible	Indicative
					2021/ 2022	2022/ 2024	2025- 2030	Authority	costs (US\$)
Objective1.1: Support Districts to enforce pollution control guidelines	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
and standards	Enforcement of EAC industrial and incinerator air emission standards.	% Compliance with standards	TBD	90% complying	X	X	X	REMA (Lead),MoH (Co-lead), Districts RNP, RIB (Others)	22,400
	Support joint inspections of environment polluting activities in Nile Nyabarongo Lower catchment office	Number of joint inspections conducted	TBD	2 inspections per year		Х	X	REMA (Lead), Districts (Co-lead), RNP, RIB (others)	8,000
	Review of the standards and norms for stormwater planning	Standards and norms for stormwater planning	N/A	Standards and norms available		X		RURA, REMA, others	5200

ANNEX I: NILE NYABARONGO LOWER CATCHMENT INTERVENTIONS LOG FRAME

Objective 1.2. Establish coordination mechanisms for pollution management at catchment level	Establish NNYL Catchment Committee	NNYL catchment committee is established	Nyabugogo catchment Task Force	Catchment Committee in place		X		RWB (Lead), Districts (Co-lead), Catchment Committee (others)	5,200
	Operationalise NNYL catchment Technical Committee	NNYL catchment Technical Committee operationalised	Water Resources Law (2018)	Operational catchment Technical Committee		Х	X	RWB (Lead), Districts (Co- lead), Catchment Committee (others)	8,000
	Support integrated planning at catchment level	Number planning meetings	0	2 meetings/ year (2 TC meeting+1 GA meeting)	Х	X	X	RWB, District, catchment office	12,800
	Support regular coordination and environment committee meetings with water users organisations	% of water users organisations operational	TBD	100% of water users organisations are operational	X	X	X	REMA; RWB District Others	12,800
	Establish the National Solid Waste Task Force	National SW Task Force established	Sanitation TWG	National SW Task Force	Х			MININFRA	5,200
Goal 2 Sustain	able and environm	entally sound manage	ement of all v	wastes in Nile N	lyabaro	ngo Low	ver catc	hment	

Objective2.1: Support effective pollution management in Urban and per-urban areas of NNYL	Support the operation and management of sewerage systems and wastewater treatment plants	 (i)%HH connected to centralised sewerage system (ii) % rural villages with WWT facilities 	0 TBD	(i) 30% of HH (ii) 100% of IDP villages and 80% of trading centres with WWTPs	X	X	X	WASAC (lead), Districts, PPP, others	33,000,000
	Support the management of sludge management and treatment facilities	 (i)% HH covered by FSTP services (ii) % Urban areas with operational sludge disposal services 	TBD TBD	40% of HH in the City of Kigali and riparian sectors (ii) 25% of urban areas	X	X		WASAC (lead), Districts, others	5,000,000
	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	Х	Х	MINALOC (lead), RHA, LODA, MINIFRA, others	1,500,000
	Support industries &SMEs to implement cleaner production measures	 (i)% of small industries& SMEs implementing cleaner production measures (ii)% industries and Hotels adopting cleaner technologies 	TBD	60% of small industries & SMEs (ii) 80% of industries and 100% of hotels	X	X	x	NIRDA (Lead) , REMA, Districts, others	250,000
	Strengthen the national	% of vehicles regularly inspected for emissions in	0	100% of vehicles and				RNP (lead) MoE,	300,000

vehicle inspection canter's capacity to	accordance with new standards		motorcycles inspected				REMA, others	
implement new standard on Road Vehicle Emission Limits								
Promote local vehicle assembly including introduction of incentives to promote electric vehicles	% of vehicles locally assembly on the fleet	0	10 % of vehicles	X	X	X	MININFRA (lead) , MoE, REMA, FONERWA, Partners	15,600,000
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	% of HHs depending on biomass for cooking	79.9%	42 % HHs	X	X	X	REG (lead) MoE, , CoK, Districts RWFA, Partners	50,826,250

Implement air pollution control guidelines	% of emitters of air pollutants in NNYL implementing air pollution control guidelines	TBD	100% of air pollutants emitters	X	X	X	REMA (lead), RSB, RNP	11,200
Support rainwater harvesting on rooftops of settlement areas	% of settlements with RWH infrastructure	TBD	100% of public buildings &schools, 60% of trading centres & 90% individual houses newly developed	X	X	X	RWB (lead), RHA, Districts	25,200
Construction of water drainage to capture road drainage & settlements	% of district with urban drainage	N/A	Feasibility studies completed for all districts	X	X	X	RTDA (lead) , RWB, Districts, others	32,000
Enforce oil separation at all garages and vehicle workshops	% of garages enforcing oil separation	TBD	100%	X	X	X	RURA (lead), REMA, Districts	25,000
Support construct of a designed landfill that makes provision for waste	 i) % HH with access to solid waste collection (ii)% rural settlements with 	(i)90% (ii) TBD	(i)100% of HH (ii) 100%	X	X	X	WASAC (lead) , Districts, PPP, others	4,000,000

	separation and	solid waste							
	Promote waste-to- resource initiatives including composting, biogas to energy, plastic recycling for construction materials etc.	Portion of municipal waste that is valorised (%)		40 %	X	X		MININFRA (lead) ,MoE, NIRDA, CoK, Partners, others	2,200,000
	Promote voluntary clean-up activities through community work initiatives and local NGOs	Levels of community participation	Medium	High	X	X	X	Districts (lead), NGOs	10,000
Objective 2.2: Effective management of rural pollution	River bank protection along all rivers and wetlands restored in NNYL	Number of Ha newly protected	N/A	Additional 200 Ha of river banks and wetlands protected	X	X	X	REMA (lead), RWB, partners, Districts	26,400
	Support the implementation of sustainable mining practices/Model mining	% of mining companies supported	TBD	10% of companies supported	X	X	X	RMB (Lead), RMA,REMA, others	21,000

	Enhance payment of ecosystem services in NNYL	(i)Number livestock distributed (ii) Amount of money spent	(i) 0 (ii) 0	(i)100 cows, 2000 goats and (ii) US\$ 200,000 spent to support alternative jobs to subsistence agriculture	X	X	X	REMA (lead) RWB, MoE, FONERWA, others	372,000
	Implementation of measures proposed for Gikondo and Nyabugogo systems catchment management plan	% of measures implemented	TBD	60% of measures	X	X	X	REMA (lead), CoK	37,000,000
	Multiply inspections for environmental compliance in mining sector	% of mining operators complying with standards	TBD	80% of mining operators	X	X	X	REMA (lead), RMB, RNP, RIB, Districts	28,000
Goal 3: Effect	ive information an	d knowledge managen	nent						
Objective	Inventory of small industries and SMEs with/without wastewater treatment facilities in NNYL	% of industries complying with Rwandan industrial effluent standards	N/A	Inventory report	X			NIRDA (lead), MINICOM, REMA, CoK, Districts	60,000

	Enforce continuous monitoring of vehicle emissions through regular standardised tests.	% of road vehicles undergoing emission monitoring	TBD	80% of vehicles	X	X	X	RNP (lead), REMA, RSB	40,000
	Integrated key urban hotspot monitoring points to national sampling program	Number of urban hotsports integrated into national water quality monitoring programme	0	16 sites (2 per District)	×	X	X	RWB (lead) REMA, UR, WASAC, others	83,200
3.2: Building capacity in urban and rural pollution	Develop training package on urban and rural pollution and BMPs.	Training document	N/A	Training Modules	X			REMA (lead), UR other stakeholders	40,000
management	Conduct trainings , awareness raising and capacity building among farmers on smart agriculture	Number of farmers trained	0	500		X	X	RAB (lead), MINAGRI, REMA	20,400
	Conduct capacity building in sustainable mining approach/Model	Number of miners trained	0	200		X	X	REMA, RMB (lead), Districts	20,500

	mining among mining operators								
	Disseminate policies, laws and regulatory instruments on environment protection, sustainable mining and smart agriculture	Number of material disseminated	0	1000	X	X	X	MoE (lead), REMA, RWB, RMB	30,000
Total									150,623,150

ANNEX II: POLLUTANTS COMMONLY FOUND IN URBAN STORMWATER AND THEIR SOURCES

No	Type of pollutant	Common source
1	Solids (Settleable solids, Total suspended solids (TSS), Turbidity (NTU)):	Unpaved urban roads, Urban agriculture and grazing, Pavement wear, Construction sites, Quarries
2	Oxygen-demanding material (Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Organic matter (OM), Total organic carbon (TOC)):	Agriculture and grazing, Human sewage, Grey water disposal, Aquaculture in urban areas, Agro- processing industries within urban areas
2	Phosphorus (P) - (Total phosphorus (TP), Soluble reactive phosphorus (SRP), Biologically available phosphorus (BAP)):	Agriculture and grazing, Parks, lawn and landscape fertilizer
4	Nitrogen (N) (Total nitrogen (TN), Total kjeldahl nitrogen (TKN), Nitrate + nitrite-nitrogen (NO ₃ +NO ₂ -N), Ammonia-nitrogen (NH ₃ -N)):	Agriculture and grazing, Parks, lawn and landscape fertilizer
5	Metals (Copper (Cu), lead (Pb), zinc (Zn), cadmium (Cd), arsenic (As), nickel (Ni), chromium (Cr), mercury (Hg), selenium (Se), silver (Ag)- Galvanized metals, Paints and wood preservatives, Roofing and gutters, Tires (for Zn);	Gasoline, Paint, Batteries (for Pb); Building materials, Paints and wood preservatives, Algicides, Brake pads (for Cu); Electro-plating activities, Paints and preservatives (for Cd and Cr)
6	Herbicides and pesticides	Urban agriculture and grazing, Residential and commercial use, Roadside vegetation maintenance
7	Pathogens (Faecal coliform bacteria (FC), Enterococcus bacteria (EC), Total coliform bacteria (TC), Viruses):	Human sewage, Livestock manure, Domestic animal faecal material
8	Petroleum hydrocarbons (Oil and grease (OG), Total petroleum hydrocarbons (TPH)-	Internal combustion engines, Automobiles, Industrial machinery, Workshops and garages
9	Synthetic organics (Polynuclear aromatic hydrocarbons (PAH), Pesticides and herbicides, Polychlorobiphenols (PCB):	Industrial processes, Power generation

ANNEX III: NOTE ON IPMP BUDGET/COSTING ESTIMATION

Item/	Unit	Quantity	Unit Price	Total	Source of data
			(032)	costs (US\$)	
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 canter's capacity to implement new standard on Road Vehicle Emission Limits	Equipment purchased	N/A	N/A	300,000	Expert judgement
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	HHs	170,500	63	40,170,000	Estimates/MoE

in urban and peri-urban		1,030,000	39	10,656,250	Estimates/MoE
household and					
stoves and alternative					
fuels in rural areas for					
cooking					
Implement air pollution	Number of	40	280	11,200	Ministerial
control guidelines	inspections				Instructions
					DU 20/07/2015)
Support rainwater	Number	60	420	25,200	RWH
harvesting on rooftops	(5m ³)				project/RWFA
of settlement areas					
Construction of water	m	1000	32	32,000	Expert
drainage to capture					Judgement
settlements					
Enforce oil separation	Number	20	2500	50,000	Expert
at all garages and					judgement
vehicle workshops	M	2	2 000 000	4 000 000	Entrance Course
Support construct of a	Number	Z	2,000,000	4,000,000	Estimates from
makes provision for					WAJAC
waste separation and					
recycling					
River bank protection	Ha	120	220	26,400	REMA SAP
along all rivers and					
Support the	Porsons	200	105	21,000	W//CP project
implementation of	trained	200	105	21,000	W4ON project
sustainable mining	cramed				
practices/Model mining					
Enhance payment of	Number of	100	520	52,000	Reference price
ecosystem services in	Lows	2000	60	120,000	on local market
	goats	2000	00	120,000	on local market
	Projects	10	20,000	200,000	Reference to
	supported				LVEMPII project
Implementation of	N/A	N/A	N/A	37,000,000	REMA/LVEMPII
measures proposed for					Project
Gikondo and					
Nyabugogo systems					
catchment					
management plan					
Multiply inspections for	Number	100	280	28,000	Ministerial
environmental					Instructions
compliance in mining					(N ⁻ 001/15/10/1C
Inventory of small	Reports	1	60,0000	60,000	Comparison with
industries and SMEs	Reports		00,0000	00,000	similar projects
with/without					
wastewater treatment					
tacilities in NNYL	Droject	1	40,000	40.000	Export
monitoring of vehicle	Project	1	40,000	40,000	iudgement
emissions through					Judgement

regular standardised tests.					
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 approach/Model mining among mining operators	Number	200	105	20,500	W4GR Project
Disseminate policies, laws and regulatory instruments on environment protection, sustainable mining and smart agriculture	Number	1000	30	30,000	Expert judgment

ANNEX IV: STATUS OF POLLUTION IN NILE NYABUGOGO LOWER IN PHOTOS Photo 1: Mpazi downtream



Photo1&2:

Mpazi downstream_The water is black with a lot of foam, plastic, some tyres and litter. This water looks very unsafe for any activity. This water flows downstream to Nyabugogo River.



Photo 2: Kabuye Sugar Works discharges



Photo 3: Kabuye Sugar Works_ It was observed that the sugar factory discharge the effluents directly into the River.

Photo4: Downstream UTEXRWA



Photo 4&5: Downstream_UTEXRWA Textile Industry: The water is green and a little bit black but mostly green. Some plastic bottles, plastic bags and fabrics like old shoes are observed in the stream. It was also observed that the people in the surrounding area do their laundry at the stream and some cattle were observed grazing nearby the stream. People told us that normally the stream looks black and has a fishy smell when the factory discharge the effluent but because it was raining, the stream looks a little bit clear than usual.



ANNEX V: TYPES OF MINING IN NYABARONGO LOWER

ANNEX VI. LISTS OF KEY HOTSPOTS SITES IN NILE NYABARONGO LOWER (NNYL) CATCHMENT

VI.1. List of Coffee Washing stations in Nile Nyabarongo Lower (NNYL)

S										
/	Maraa a	DICTRICT	SECTO	CELL		WATER COUL			X	X
N	Name	DISTRICT	K	CELL	OWNER_NAM	WATER_SOU	ENVIRO_PR	village	X	Y
	C	CATCIDO	Gasan		Cooperative		Natural	D. L.	20.20045	4 705 45
0	Gasange Cws	GATSIBO	ge	Kimana	Gasange	Natural Spring	seepage	Byani	30.28815	-1./8545
		6 . TO D O	Kagey		Cocahu		Natural		20.00/5/	
1	Cocahu	GATSIBO	0	Gituza	Coopeartive	Natural Spring	seepage	Gisiza	30.28654	-1./0144
			Muhur				Natural			
2	Coffee Village	GATSIBO	a	Taba	BAGAZA Tom	Water Pump	Seepage	Karenge	30.26364	-1.71266
			Muhur	Gakorok			Natural			
3	RTC Muhura	GATSIBO	a	ombe	RTC Muhura	Natural Spring	Seepage	Bibare	30.30756	-1.75309
							Natural			
			Reme	Rwareng			seepage +			
4	Enas Muhura	GATSIBO	ra	е	Enas	Natural Spring	wate	Kagasha	30.33032	-1.73715
						Natural				
	Mununu/Aburwaga	RWAMAG	Fumb		Cooperative	Spring,Water	Natural			
5	sabo	ANA	we	Mununu	ABURWAGASABO	pump	Seepage	Nyirabiteri	30.31063	-1.87843
	Abanyamurava	RWAMAG		Budahan	Cooperative		Natural			
6	CWS	ANA	Musha	da	Amanyamurava	Natural spring	seepage	Nyantoki	30.3164	-1.89146
		RWAMAG		Nyakaba			Filtering			
7	Nzige Cws	ANA	Musha	nda	Nkubiri Alfred	Natural Spring	System	Bitsibo	30.33081	-1.91317
						Natural				
			Giko			Spring/Well/Wat	Natural			
8	RTC/Gikomero	GASABO	mero	KIBARA	RTC/Gikomero	er pump	seepage	Gasharu	30.23596	-1.85852
	DUKUNDE KAWA						Natural			
9	Mbilima	GAKENKE	Coko	Mbilima	DUKUNDE KAWA	Natural spring	seepage	Akanduga	29.82201	-1.79572
					Cooperative					
1	Twongere kawa				Twongere kawa		Filtering			
0	Coko	GAKENKE	Coko	Nyanza	Coko	Natural Spring	System	Gitaba	29.83514	-1.77728
							Natural			
1			Matab		NZIRASANAHO		seepage +			
_1	Bukonya coffee	GAKENKE	a	Nyundo	Anastase	Natural spring	wate	Mataba	29.74816	-1.72202
1			Minaz				Natural			
2	Abakunda kawa	GAKENKE	i	Munyana	Abakunda kawa	Natural Spring	seepage	Kivuba	29.78125	-1.7532

1	Terimbere Kawa		Muho		TERIMBERE KAWA		Natural			
3	Yacu Muhondo	GAKENKE	ndo	Musenyi	YACU	Natural spring	seepage	Buhinya	29.88577	-1.79637
1	TUZAMURE KAWA		Muyo				Natural			
4	Muyongwe	GAKENKE	ngwe	Va	TUZAMURE KAWA	Natural spring	seepage	Bukwera	29.88872	-1.76979
1	ABAKUNDA KAWA						Direct in			
5	Muzo	GAKENKE	Muzo	Kabatezi	ABAKUNDA KAWA	Natural spring	water	Busoro	29.67555	-1.71112
1							Natural			
6	Nkara	GAKENKE	Ruli	Busoro	Dukunde kawa	Well	seepage	Gitaba	29.85595	-1.78557
1	Cooperative						Natural			
7	Dukunde kawa	GAKENKE	Ruli	Ruli	Dukunde kawa	Natural Spring	seepage	Gatagara	29.84648	-1.81359
1							Natural			
8	1000 Hills cws	GAKENKE	Ruli	Rwesero	Jonathan Golden	Natural Spring	seepage	Mugwato	29.86732	-1.84495
1			Rusha				Natural			
9	Abakunda kawa	GAKENKE	shi	Kageyo	Abakunda kawa	Natural Spring	seepage	Nganzo	29.85725	-1.72964
2			Bukur		Mukamushinja		Natural			
0	Novacoffee	GICUMBI	е	Kivumu	Agnes	Natural spring	seepage	Ruyange	30.24816	-1.81524
2							Natural			
1	Enas	GICUMBI	Giti	Murehe	Nkubiri Alphred	Natural spring	seepage	Cyamabono	30.25179	-1.75335
2					Cooperative		Natural		20.00074	
2	Mayogi coffee	GICUMBI	Muko	Ngange	Mayogi coffee	Natural spring	seepage	Rudogo	30.220/1	-1./1551
2			_	D /		Existing Woter	F 11.			
2			Bureg	Butanga		pipe	Filtering	N	20.05442	4 70700
3	Caferwa/Buliza	RULINDO	a	mpunau	Gatari Gilbert	network(wasac)	System	Nyamiyaga	30.05113	-1./3/22
2			Duraha		Nzungize		Matumal			
	C		Busho		Rwakagara		Natural	Datasa	20,025,45	4 70005
4	Coopac	RULINDO	K1	Kayenzi	Emmanuel	Natural Spring	seepage	Rebero	29.92545	-1./0995
	Duch alti aaffaa		Busno	Multana	Karunura Biranari	Natural Caring	Natural	Dungunga	20.0454	4 74 420
<u>ン</u>	Busnoki cottee	RULINDO	KI	MUKOLO	Ltd	Natural Spring	Seepage	Buvumo	29.9151	-1./1439
2 4	Tumba coffoo l td			Musezer	Mugiraneza	Natural caring	Naturat	Taba	20 05240	1 40554
0	Tumba corree Ltu	RULINDU	d	0	venuste	Natural Spring	seepage	TaDa	29.95249	-1.09554
						Natural Spring/Existing				
2			Tumb			water pipe	Direct in	Nyirambug		
7	Cocatu		Juino	Taba	Cocatu	network(Wasac)	river	annug	20 05256	-1 73115
2	Cocacu		a Kara	Nyamire		network(wasat)	Natural	α	27.73230	-1./3113
2	Karama Coffee	KAMONYI	ma	mbe	Karama Coffee	Natural Spring	Seenage	Kavumu	29 84805	-1 94370
2	Narama_conce		Kavu	mbe		Natural	Natural	Ryamanyw	27.07003	1.77377
9	Rwacof Kayumbu	καμονγι	mbu	Giko	Rwacof Export Ltd	Spring/Well/Evict		a	29 80152	-1 95223
	uyumbu		mbu	GINO	indeor Export Etu		Jeepuge	u u	27.001JL	1.75225

						ing water pipe network/Water				
						pump				
3			Musa	Musambi			Filtering			
0	Koabaka	KAMONYI	mbira	ra	Koabaka	Natural Spring	System	Mbari	29.82785	-2.05405
						Natural				
3			Ngam	Kazirabo		Spring,Well,Wate	Natural			
1	Rwacof	KAMONYI	ba	nde	Rwacof	r Pump	seepage	Munoga	29.90881	-1.88525
						Natural				
3	Nyamiyaga CWS		Nyami			Spring/Water	Natural			
2	(Horizon)	KAMONYI	yaga	Ngoma	Rwacof Export Ltd	Pump	seepage	Rwanteke	29.9485	-2.08704
3	Abateraninkuga ba	MUHANG			Abateraninkunga		Filtering			
3	Sholi	А	Cyeza	Sholi	ba Sholi	Natural Spring	system	Nyarubuye	29.76837	-2.00538
3			Nyami				Filtering			
4	Dallas	Gicumbi	yaga	Kabuga	Kamarade Immy	Private	system	Kaduha	30.16307	-1.6763
3		RWAMAG		Kagaram	Habumugisha Jean	Community	Natural			
5	Musha Coffee	ANA	Musha	а	Paul	spigot	Seepage	Muhogoto	30.35513	-1.94613

VI.2. List of Hydropower stations

S/N	Site_name	F3	Atlas_Code	District	Sector	Х	Y	Est_Max_Ca
(Gihinga	Gihinga	NGA-13	Gakenke	Gakenke- Karambo	479692	9817226	500
					Muko-Nyamiyaga-			
	Kabumba	Kabumba	NGI-18	Gicumbi	Rutare	520355	9813633	100
2	Kavumu	Kavumu	NGI-01	Gicumbi	Kageyo	509958	9815453	380
				Muhanga-				
	Mugambazi	Mugambazi	NGA-11	Gakenke	Nyabinoni-Mataba-Muzo	467691	9806885	500
4	Mukoki	Mukoki	NGA-22	Burera	-	470150	9810730	100

S/N	Latitude	Longitude	Company_Co	District	Sector_	Cell	Mine_Site	Mine_type
0	30.02	-1.778333	Rutongo Mines	Rulindo	Cyinzuzi	Mvuzo	Gisanze 1	Cassiterite
1	30.045	-1.824167	Rutongo Mines	Rulindo	Masoro	Nyamyumba	Masoro 1	Cassiterite
2	30.04833	-1.765278	Rutongo Mines	Rulindo	Cyinzuzi	Budakiranya	Karambo 1	Cassiterite
3	30.04972	-1.793611	Rutongo Mines	Rulindo	Murambi	Gasambya	Gasambya	Cassiterite
4	30.05389	-1.812222	Rutongo Mines	Rulindo	Masoro	Nyamyumba	Nyamyumba	Cassiterite
5	30.08194	-1.793611	Rutongo Mines	Rulindo	Ntarabana	Mahaza	Mahaza	Cassiterite
6	29.97139	-1.861667	EuroTrade International	Rulindo	Shyorongi	Kabaraza	Nyakabingo 1	Wolfram
7	29.72778	-2.0225	Ets Munsad Minerals	Muhanga	Muhanga	Nyamirama	Gasura	Mixed(Cassiterite & Coltan)
8	29.73583	-2.016111	Ets Munsad Minerals	Muhanga	Muhanga	Remera	Kanyinya	Mixed(Cassiterite & Coltan)
9	29.80917	-1.769722	EPROCOMI	Gakenke	Coko	Nyanza	Tumba	Coltan
10	29.82389	-1.79	EPROCOMI	Gakenke	Coko	Mbirima	Coko-Mbirima	Mixed(Cassiterite & Coltan)
11	29.84694	-1.838056	EPROCOMI	Gakenke	Ruli	Ruli	Ruli-Musave	Mixed(Cassiterite & Coltan)
12	29.85167	-1.842222	EPROCOMI	Gakenke	Ruli	Rwesero	Mpanga	Mixed(Cassiterite & Coltan)
13	29.85778	-1.845833	EPROCOMI	Gakenke	Ruli	Ruli	Rwesero	Mixed(Cassiterite & Coltan)
14	29.74944	-1.9675	HAJOS	Muhanga	Cyeza	Shori	Shori 2	Mixed(Cassiterite & Coltan)
15	29.76722	-1.974167	HAJOS	Muhanga	Cyeza	Shori	Shori 1	Mixed(Cassiterite & Coltan)
16	29.76778	-1.968611	HAJOS	Muhanga	Cyeza	Shori	Kamapfundo	Mixed(Cassiterite & Coltan)
17	29.91861	-1.964444	Rwanda Allied Partners (RAP)	Rutsiro	Rusebeya	Rulonde	Kirumbi 1	Mixed(Cassiterite & Coltan)
18	29.89028	-1.923056	Sengati John	Kamonyi	Nduba	Gishyeshye	Murambi 1	Coltan + Cassiterite
19	29.89194	-1.921944	Sengati John	Kamonyi	Rukoma	Gishyeshye	Kaganga	Mixed(Cassiterite & Coltan)
20	29.89361	-1.926667	Sengati John	Kamonyi	Rukoma	Gishyeshye	Kabuma	Mixed(Cassiterite & Coltan) & Wolfram
21	30.10417	-1.819444	Sengati John	Gasabo	Nduba	Gasura	Binyama	Cassiterite
22	30.11361	-1.825	Sengati John	Gasabo	Nduba	Gasura	Kigarama 1	Cassiterite
23	30.11361	-1.825	Sengati John	Gasabo	Nduba	Gasura	Nyakabingo 2	Cassiterite

VI.3.List of mining sites in Nile Nyabarongo Lower catchment

24	29.80139	-1.843611	COMIKAGI	Gakenke	Ruli	Gikingo	Kababara	Mixed(Cassiterite & C	Coltan)
25	29.82528	-1.977778	COMIKAGI	Gakenke	Ruli	Gasiza	Simba 1	Mixed(Cassiterite & C	Coltan)
26	29.83	-1.828333	COMIKAGI	Gakenke	Ruli	Gikingo	Kaborombe	Mixed(Cassiterite & C	Coltan)
27	29.83361	-1.743611	COMIKAGI	Gakenke	Ruli	Gikingo	Bukamba	Coltan	
28	29.83833	-1.836111	COMIKAGI	Gakenke	Ruli	Gikingo	Kabumbogo	Mixed(Cassiterite & C	Coltan)
29	30.31833	-1.8175	Modern Mining	Gatsibo	Gasange	Kigabiro	Kome-Maya	Mixed(Cassiterite & C	Coltan)
30	29.82444	-1.731944	Internos	Gakenke	Minazi	Gasiho	Kabarima	Mixed(Cassiterite & C	Coltan)
31	29.99	-2.076667	Rwanda Trinity Minerals (RTM)	Kamonyi	Mugina	Nteko	Rusagara 1	Mixed(Cassiterite & C	Coltan)
32	29.885	-1.906944	Ets Karinda	Kamonyi	Rukoma	Gishyeshye	Rubare A	Mixed(Cassiterite & C	Coltan)
33	29.88611	-1.910556	Ets Karinda	Kamonyi	Rukoma	Gishyeshye	Rubare B	Cassiterite	
34	29.76639	-1.864444	SEAVMC	Muhanga	Kiyumba	Rukeri	Rwansibo	Mixed (Coltan +Cassi	terite)
35	29.7925	-1.904167	SEAVMC	Muhanga	Kiyumba	Remera	Gitwa	Mixed (Coltan +Cassi	terite)
36	29.81028	-1.855	SEAVMC	Muhanga	Kiyumba	Budende	Ruramba	Mixed (Coltan +Cassi	terite)
37	29.85694	-1.864167	Munyabarenzi Mathius	Gakenke	Ruli	Kinyevu	Kinyevu	Mixed (Coltan +Cassi	terite)
38	29.85972	-1.8525	Munyabarenzi Mathius	Gakenke	Ruli	Gihande	Kabakene	Mixed(Cassiterite & C	Coltan)
39	29.8925	-1.912778	DEMICO	Kamonyi	Rukoma	Gishyeshye	Akanyamwishyura	Mixed(Cassiterite & C	Coltan)
40	29.89472	-1.901944	DEMICO	Kamonyi	Ngamba	Kazirabonde	Kagihima 1	Coltan	
41	29.89611	-1.904722	DEMICO	Kamonyi	Rukoma	Gishyeshye	Gatebe	Mixed(Cassiterite & C	Coltan)
42	29.90194	-1.909444	DEMICO	Kamonyi	Rukoma	Gishyeshye	Munyinya	Mixed(Cassiterite & C	Coltan)
43	29.88667	-1.916667	COMIRWA	Kamonyi	Rukoma	Gishyeshye	Murambi 2	Mixed(Cassiterite & C	Coltan)
44	29.89806	-1.944722	COMIRWA	Kamonyi	Rukoma	Gishyeshye	Cyatenga	Mixed(Cassiterite & C	Coltan)
45	29.69278	-1.7475	Ets Sindambiwe	Muhanga	Rongi	Gasharu	Rongi	Wolfram	
46	29.72278	-1.7675	Ets Sindambiwe	Muhanga	Nyabinoni	Gashorera	Gashorera	Cassiterite & Wolfrar	n
47	29.77222	-1.76	Ets Sindambiwe	Gakenke	Minazi	Murambi	Murambi 3	Cassiterite	
48	29.77583	-1.743333	Ets Sindambiwe	Gakenke	Minazi	Murambi	Gitwa 2	Coltan	
49	29.77639	-1.774167	Ets Sindambiwe	Gakenke	Minazi	Murambi	Nyirangoroye	Coltan	

			Ndaberetse Thadee					
50	29.91028	-1.925833	(NT)	Kamonyi	Rukoma	Taba	Bukokora	Coltan
51	30.01556	-1.971111	ROKA Rwanda	Nyarugenge	Kigali	Ruliba	Bashyamba	Cassiterite
52	30.355	-1.741111	ROKA Rwanda	Gatsibo	Remera	Bushobora	Bugarura	Mixed(Cassiterite & Coltan)
53	29.7225	-1.995833	SECOCOGE	Muhanga	Muhanga	Remera	Nyaruvuma	Mixed(Cassiterite & Coltan)
54	29.785	-1.952778	COMAR	Muhanga	Kabacuzi	Butare	Rushoka	Mixed(Cassiterite & Coltan)
55	29.78528	-1.944722	COMAR	Muhanga	Kabacuzi	Butare	Gitima	Mixed(Cassiterite & Coltan)
56	29.7925	-1.927778	COMAR	Muhanga	Kabacuzi	Butare	Nyamabondo	Mixed(Cassiterite & Coltan)
57	29.9025	-1.902222	SEMICO	Kamonyi	Ngamba	Kagihima	Rwobe	Mixed(Cassiterite & Coltan)
58	29.9075	-1.903889	SEMICO	Kamonyi	Rukoma	Bugoba	Bugoba	Mixed(Cassiterite & Coltan)
59	29.91333	-1.965556	Rutsiro Miners Cooperative (RMC)	Rutsiro	Rusebeva	Ruronde	Kigali	Mixed(Cassiterite & Coltan)
			Rutsiro Miners					
60	29.91861	-1.964444	Cooperative (RMC)	Rutsiro	Rusebeya	Ruronde	Kirumbi 2	Coltan
61	29.92056	-1.952778	Rutsiro Miners Cooperative (RMC)	Rutsiro	Rusebeya	Ruronde	Matyazo	Wolfram
62	30.52611	-1.938611	Trading Service Logistics (TSL)	Kayonza	Nyamirama	Shyogo	Rwashyunga	Mixed(Cassiterite & Coltan) & Wolfram
63	29.74417	-2.0125	AFRICOME International	Muhanga	Muhanga	Remera	Ruzuru	Mixed(Cassiterite & Coltan)
			AFRICOME	je				
64	29.78639	-1.920556	International	Muhanga	Kabacuzi	Butare	Nyabitare 1	Mixed(Cassiterite & Coltan)
65	29.78944	-1.945	AFRICOME International	Muhanga	Kabacuzi	Butare	Rukaragata 3	Mixed(Cassiterite & Coltan)
66	29.90444	-1.9025	COMIKA	Kamonyi	Runda	Kagina	Rwisha	Mixed(Cassiterite & Coltan)
67	29.90778	-1.901667	COMIKA	Kamonyi	Ngamba	Kazirabonde	Gisoro 1	Mixed(Cassiterite & Coltan)
68	29.94139	-1.915	COMIKA	Kamonyi	Rukoma	Murehe	Binyeri	Mixed(Cassiterite & Coltan)
69	29.96833	-1.921667	COMIKA	Kamonyi	Runda	Kagina	Gasharara	Cassiterite
70	29.8	-1.626667	DUSUZUMIMIRIMO	Gakenke	Nemba	Gisozi	Kajwi	Cassiterite
71	29.86528	-1.616389	DUSUZUMIMIRIMO	Gakenke	Gasenyi	Rutabo	Buturuba	Gold
72	30.45139	-1.799444	VIMICO	Kayonza	Rukara	Kawangire	Gitega	Cassiterite & Wolfram
73	30.47333	-1.808889	VIMICO	Kayonza	Rukara	Rukara	Butimba	Cassiterite

74	30.47944	-1.798333	VIMICO	Kayonza	Rukara	Rukara	Muntambara	Cassiterite
75	29.81222	-1.770833	SOMICAR	Gakenke	Coko	Rwahi	Rwahi	Mixed(Cassiterite & Coltan)
76	29.82306	-1.768611	SOMICAR	Gakenke	Coko	Nyanza	Nyanza	Cassiterite
77	29.82361	-1.785278	SOMICAR	Gakenke	Coko	Rwahi	Muganza	Mixed(Cassiterite & Coltan)
78	29.79333	-1.848333	MCCS	Muhanga	Kiyumba	Rukeri	Musagara	Mixed(Cassiterite & Coltan)
79	29.80667	-1.874444	MCCS	Muhanga	Kiyumba	Budende	Byanone	Mixed(Cassiterite & Coltan)
80	29.80722	-1.854167	MCCS	Muhanga	Kiyumba	Budende	Musenyi	Mixed(Cassiterite & Coltan)
81	29.82389	-1.7575	MCCS	Gakenke	Coko	Kiruku	Rushari	Mixed(Cassiterite & Coltan)
82	29.83722	-1.749444	MCCS	Gakenke	Coko	Kiruku	Kumubanga	Mixed(Cassiterite & Coltan)
83	29.8225	-1.829167	Ruli Mining Trade	Gakenke	Ruli	Jango	Gikombe	Mixed(Cassiterite & Coltan)
84	29.82417	-1.830556	Ruli Mining Trade	Gakenke	Ruli	Jango	Kadehero	Mixed(Cassiterite & Coltan)
0.5	20 40722		Crystal Mining and			<i>c</i>		
85	30.10722	-1.844444	I rading	Gasabo	Nduba	Gasura	Gikombe	Mixed(Cassiterite & Coltan)
86	30.11306	-1.842222	Trading	Gasabo	Nduba	Gasura	Gasura	Mixed(Cassiterite & Coltan)
			BARWA Mining					
87	30.45667	-1.798889	Company	Kayonza	Rukara	Rwimishinya	Rwibikona	Cassiterite & Coltan
88	30 47806	-1 705	BARWA Mining	Kayonza	Pukara	Kawangiro	Kawangiro	Cassitorito
00	30.47800	-1.775	Special Mining	RayUliza	πακαια	Rawaligite	Rawaligite	Cassilence
89	29.72694	-1.937222	Company (SPMC)	Muhanga	Rugendabari	Nsanga	Rubona	Wolfram
			Service Polyvalent					
			de Construction et					
	20 44/77	4 02 44 4 7	Topographie			C	D	
90	30.11667	-1.834167	(SPCT)	Gasado	Nduba	Gasura	Rugarama Z	Lassiterite
91	29 78 <i>444</i>	-1 949444		Muhanga	Kabacuzi	Butare	Kagote	Wolfram
	27.70111	1.717111	Standard Mining	mananga	Rabacazi	Duture	nagote	
92	29.82194	-1.696111	Company	Gakenke	Gashenyi	Shyombwe	Shyombwe	Cassiterite
			Standard Mining		-	-	-	
93	29.84222	-1.705556	Company	Gakenke	Rushashi	Mbogo	Gitongo	Mixed(Cassiterite & Coltan)
			Standard Mining					
94	29.84417	-1.695278	Company	Gakenke	Rushashi	Mbogo	Mbogo	Wolfram

			Standard Mining					
95	29.84417	-1.7	Company	Gakenke	Rushashi	Mbogo	Busoro	Mixed(Cassiterite & Coltan)
			Centrale Multi					
96	29.8375	-1.828611	Services (CMS)	Gakenke	Ruli	Ruli	Rucyamo	Mixed(Cassiterite & Coltan)
97	29.91333	-1.965556	KAMU Mining	Kamonyi	Rukoma	Buguri	Nyabubari	Mixed(Cassiterite & Coltan)
			New Line Mining					
98	29.81917	-1.741944	Company (NLMC)	Gakenke	Coko	Kiruku	Kiruku	Wolfram
	20.025	4 7 47770	New Line Mining					
99	29.835	-1./4///8	Company (NLMC)	Бакепке	Соко	Кігики	Gasino	Mixed(Cassiterite & Coltan)
100	20 71861	1 06/777	JASPER Minerals	Muhanga	Kabacuzi	Buramba	Musasa	Mixed(Cassiterite & Coltan)
100	27.71001	-1.904722	IASPER Minerals	mullaliga	Kabacuzi	Duraniba	musasa	Mixed(cassitence & cottail)
101	29,7275	-1.966111	Supplies	Muhanga	Kabacuzi	Buramba	Giturwa	Mixed(Cassiterite & Coltan)
			JASPER Minerals					
102	29.72806	-1.96	Supplies	Muhanga	Kabacuzi	Kabuye	Ndiza	Coltan & Wolfram
			Mining Quality					
103	29.97611	-2.057778	Supply	Kamonyi	Rugarika	Nyarubuye	Remera	Cassiterite, Coltan, Wolfram
			Furniture Business		-			
104	29.75944	-1.990278	and Technology	Muhanga	Cyeza	Shori	Gatovu	Cassiterite
405	20 7447	4 000000	Furniture Business		C	Chard	Kiha ang ka	Caltar
105	29.76417	-1.980833	and Technology	Munanga	Cyeza	Shori	KIDUMDa	Coltan
106	30 03333	-2 007222		Nyarugenge	Nyamirambo	Gashari	Kadunda	Cassiterite
100	30.03333	-2.007222	Lamine Mining	Nyarugenge	Nyammambo	Gashari	Nagunga	Cassicence
107	30.04667	-1.999167	Company	Nvarugenge	Nvamirambo	Gashari	Kiberinka	Coltan
108	29.81778	-1.815278	SEMIRWA	Gakenke	Coko	Mbirima	Ryarubasha	Mixed(Cassiterite & Coltan)
109	29 81944	-1 805556	SEWIRWA	Gakenke	Coko	Mbirima	Shyunga	Coltan
110	20 27044	1 605930		Gatsibo	Kagovo	Kiptu	Byabusbagara II	Cassitorito
110	30.27 744	-1.093033	Trust Storage and	Gatsibo	Кадеуо	Kiitu	Ryabushogoro n	Cassilence
111	30.10417	-1.798333	Supply	Rulindo	Ntarabana	Kajevuba	Gatare	Cassiterite, Wolfram & Coltan
112	29.80333	-1.895556	COOPEMIKA	Kamonyi	Kayenzi	Nyamirama	Marenga	Mixed(Cassiterite & Coltan)
113	29.83222	-1.876944	COOPEMIKA	Kamonyi	Kayenzi	Cubi	Cubi	Mixed(Cassiterite & Coltan)
114	29.85167	-1.875556	COOPEMIKA	Kamonyi	Kayenzi	Kirwa	Rwibiraro	Mixed(Cassiterite & Coltan)
115	29.87833	-1.903056	СООРЕМІКА	Kamonyi	Kayenzi	Bugarama	Buhurura	Mixed(Cassiterite & Coltan)
116	29.75083	-1.915278	CEMAM	Muhanga	Kabacuzi	Kavumu	Gasiza	Mixed(Cassiterite & Coltan)

	20.00022	(=000=0	Musoni & Sons Mining Company (M					
11/	30.00833	-1./802/8	ቲ Sons)	Rulindo	Kinzuzi	Rudogo	Gasekabuye	Cassiterite
			Cooperate Miniere					
			de Nyabikenke					
118	29.73639	-1.92	(COMINYA)	Muhanga	Kabacuzi	Kibyimba	Rutarabana	Mixed(Cassiterite & Coltan)
			Strategic Rwanda					
			Minerals Company					
119	29.94111	-1.915833	(SRMC)	Kamonyi	Rukoma	Murehe	Gataba	Cassiterite, Wolfram & Coltan

VI.4. List of Water Treatment Plants

S/N	District	Sector
1	Kayonza	Gahini
2	Kayonza	Mukarange
3	Rwamagana	Gishari
4	Gasabo	Bumbogo
5	Nyarugenge	Muhima
6	Nyarugenge	Kimisagara
7	Nyarugenge	Kimisagara
8	Nyarugenge	Kanyinya
9	Nyarugenge	Kigali

S/N	Latitude	Longitude	District	Sector	Cell	Name
1	-1.942567	30.070545	Nyarugenge	Muhima	Rugenge	Ubumanzi
2	-1.968078	29.985525	Kamonyi	Runda	Ruyenzi	Nyagacaca
3	-1.903099	29.995738	Nyarugenge	Kanyinya	Taba	Ngendo
4	-1.889108	30.066995	Gasabo	Jabana	Kabuye	Kabeza
5	-1.982426	30.103953	Kicukiro	Gatenga	Nyanza	Bwiza
6	-1.85401	29.969501	Rulindo	SHYORONGI	Bugaragara	Gatimba
7	-1.96866	30.088867	Kicukiro	Kicukiro	Ngoma	Ahitegeye
8	-1.901705	30.506103	Kayonza	Mukarange	Bwiza	Abisunganye
9	-1.942639	30.041757	Nyarugenge	Kimisagara	Kimisagara	Gakaraza
10	-1.972674	30.053955	Nyarugenge	Rwezamenyo	Rwezamenyo li	Umucyo
11	-1.902	30.498903	Kayonza	Mukarange	Nyagatovu	Akanyinya
12	-1.579749	30.068031	Gicumbi	Byumba	Gacurabwenge	Gacurabwenge
13	-1.967734	30.082715	Kicukiro	Gikondo	Kinunga	Kigugu I
14	-1.948981	30.021923	Nyarugenge	Kigali	Nyabugogo	Giticyinyoni
15	-1.934555	30.077871	Gasabo	Kacyiru	Kibaza	Virunga
16	-1.954493	30.073545	Nyarugenge	Nyarugenge	Kiyovu	Ganza
17	-1.969147	30.101041	Kicukiro	Kicukiro	Gasharu	Amajyambere
18	-1.94934	30.124634	Gasabo	Kimironko	Nyagatovu	Ijabiro
19	-1.940653	30.043478	Nyarugenge	Kimisagara	Kimisagara	Nyabugogo
20	-1.94432	30.072535	Nyarugenge	Muhima	Rugenge	Ubumanzi
21	-1.952673	30.07379	Nyarugenge	Muhima	Ubumwe	Isangano
22	-1.936023	30.044531	Gasabo	Gatsata	Nyamabuye	Musango

VI.5. List of Petrol Stations in Nile Nyabugogo Lower Catchment
22			Caraba	laharaa	Martin d	Lh
23	-1.865562	30.087255	Gasabo	Jabana	Ngiryi	Uwanyange
24	-1.93571	30.057409	Nyarugenge	Muhima	Amahoro	Kabirizi
25	-1.579825	30.067711	Gicumbi	Byumba	Gacurabwenge	Gashirwe
26	-1.948737	30.022921	Nyarugenge	Kigali	Nyabugogo	Giticyinyoni
27	-1.967113	30.102349	Gasabo	Remera	Rukiri I	Ubumwe
28	-1.981382	29.971961	Kamonyi	Runda	Muganza	Nyagacyamu
29	-1.966535	30.081617	Kicukiro	Gikondo	Kinunga	Kigugu I
30	-1.930644	30.063665	Gasabo	Kacyiru	Kamutwa	Urwibutso
31	-1.900268	30.507882	Kayonza	Mukarange	Kayonza	Kayonza Centre
32	-1.934795	30.062622	Gasabo	Kacyiru	Kamutwa	Inkingi
33	-1.93974	30.044556	Nyarugenge	Kimisagara	Kimisagara	Nyabugogo
34	-1.943899	30.402159	Rwamagana	Mwulire	Bushenyi	Kabahima
35	-1.975434	30.076863	Kicukiro	Gikondo	Kanserege	Kanserege lii
36	-1.942554	30.042531	Nyarugenge	Kimisagara	Kimisagara	Gakaraza
37	-1.761722	30.123674	Gicumbi	Mutete	Gaseke	Gihira
38	-1.971922	30.085323	Kicukiro	Gatenga	Karambo	Ihuriro
39	-1.949434	30.020009	Nyarugenge	Kigali	Nyabugogo	Nyabugogo
40	-1.903102	30.052182	Gasabo	Jabana	Kabuye	Karuruma
41	-1.995743	30.096029	Kicukiro	Gatenga	Nyanza	Juru
42	-1.934788	30.062225	Gasabo	Kacyiru	Kamutwa	Inkingi
43	-1.800711	30.418048	Gatsibo	Kiramuruzi	Gakenke	Akurusizi
44	-2.072543	29.784019	Muhanga	Shyogwe	Ruli	Murambi
45	-1.950396	30.377201	Rwamagana	Mwulire	Bushenyi	Byange
46	-2.075025	29.754404	Muhanga	Nyamabuye	Gitarama	Gatika
47	-1.941004	30.045858	Nyarugenge	Muhima	Nyabugogo	Ubucuruzi
48	-1.941259	30.043741	Nyarugenge	Kimisagara	Kimisagara	Nyabugogo
49	-1.97249	30.055795	Nyarugenge	Nyamirambo	Mumena	Irembo
50	-1.62994	30.102946	Gicumbi	Kageyo	Horezo	Nyirangoga
51	-1.79586	29.928351	Rulindo	RUSIGA	Kirenge	Rebero

52	-1.949883	30.436398	Rwamagana	Muhazi	Nyarusange	Plage
53	-1.905959	30.442663	Rwamagana	Muhazi	Nsinda	Kibare
54	-2.003361	29.905074	Kamonyi	Gacurabwenge	Nkingo	Kamonyi
55	-1.88214	30.507896	Kayonza	Mukarange	Bwiza	Amizero
56	-1.953441	30.075507	Nyarugenge	Muhima	Ubumwe	Isangano
57	-1.970231	30.07716	Kicukiro	Kigarama	Karugira	Umurimo
58	-1.912881	30.076219	Gasabo	Kinyinya	Kagugu	Rukingu
59	-1.938134	30.058133	Nyarugenge	Muhima	Amahoro	Inyarurembo
60	-1.97378	30.054428	Nyarugenge	Rwezamenyo	Rwezamenyo li	Amahoro
61	-1.965747	30.080904	Kicukiro	Gikondo	Kinunga	Kigugu I
62	-1.912845	30.084047	Gasabo	Kinyinya	Kagugu	Kabuhunde I
63	-1.972523	30.103438	Kicukiro	Kicukiro	Kicukiro	Gasave
64	-1.6575	29.879399	Rulindo	BASE	Gitare	Nyamugali
65	-1.947444	30.092579	Gasabo	Kacyiru	Kamatamu	Kabare
66	-1.90224	30.506854	Kayonza	Mukarange	Nyagatovu	Irebero
67	-1.930305	30.064829	Gasabo	Kacyiru	Kibaza	Iriba
68	-1.943357	30.071231	Nyarugenge	Muhima	Rugenge	Ubumanzi
69	-1.928049	30.071334	Gasabo	Kacyiru	Kibaza	Umutako
70	-1.927557	30.046547	Gasabo	Gatsata	Nyamugari	Akamwunguzi
71	-1.901556	30.507633	Kayonza	Mukarange	Kayonza	Kayonza Centre
72	-2.077552	29.771786	Muhanga	Nyamabuye	Gitarama	Nyarutovu
73	-1.940684	30.046564	Nyarugenge	Muhima	Nyabugogo	Ubucuruzi
74	-1.941911	30.043968	Nyarugenge	Kimisagara	Kimisagara	Nyabugogo
75	-1.978175	30.051244	Nyarugenge	Nyamirambo	Mumena	Mumena
76	-1.958651	30.071259	Nyarugenge	Nyarugenge	Kiyovu	Cercle Sportif
77	-1.948774	30.443267	Rwamagana	Muhazi	Nyarusange	Plage
78	-1.944764	30.059599	Nyarugenge	Nyarugenge	Kiyovu	Inyarurembo
79	-1.950137	30.061141	Nyarugenge	Nyarugenge	Kiyovu	Ishema
80	-1.976039	30.09755	Kicukiro	Kicukiro	Ngoma	Iriba

81	-1.978115	29.964498	Kamonyi	Rugarika	Sheli	Ntebe
82	-1.923069	30.007291	Nyarugenge	Kanyinya	Nyamweru	Ruhengeri
83	-1.946525	30.061083	Nyarugenge	Nyarugenge	Kiyovu	Ishema
84	-1.647888	29.792936	Gakenke	Gakenke	Rusagara	Umujyi Wa Gakenke
85	-1.972482	30.048051	Nyarugenge	Rwezamenyo	Kabuguru li	Gasabo
86	-1.937894	30.043968	Gasabo	Gatsata	Nyamabuye	Kibaya
87	-1.955473	30.053515	Nyarugenge	Kimisagara	Kamuhoza	Buhoro
88	-1.979637	29.980696	Kamonyi	Runda	Muganza	Nyagacyamu
89	-1.922903	30.107759	Gasabo	Kimironko	Kibagabaga	Urumuri
90	0	0	Gasabo	Bumbogo	Ngara	Birembo
91	0	0	Gasabo	Kinyinya	Murama	Taba
92	0	0	Gasabo	Nduba	Gasanze	Nyakabungo
93	0	0	Nyarugenge	Muhima	Ubumwe	Isangano
94	0	0	Rulindo	Bushoki	Nyirangarama	Nyirangarama
95	0	0	Gicumbi	Byumba	Gacurabwenge	Ruyaga
96	0	0	Muhanga	Shyogwe	Ruli	Murambi
97	0	0	Kicukiro	Kicukiro	Kagina	Muremure
98	0	0	Kicukiro	kicukiro	Kagina	
99	0	0	Nyarugenge	Muhima		
100	0	0	Gasabo	Remera		
101	0	0	Nyarugenge	Kimisagara		
102	0	0	Nyarugenge	Nyarugenge		
103	0	0	Nyarugenge			
104	0	0	Nyarugenge	Kimisagara		
105	0	0	Nyarugenge	Gatsata	Karuruma	
106	0	0	kicukiro	Gikondo	kagunga	
107	0	0	Gatsibo	Muhura	Taba	Kanyinya
108	0	0	Gatsibo	Kiziguro	Gakenke	

S/N	Latitude	Longitude	District	Sector	Pollution
1	-1.958651	30.071259	Nyarugenge	Kiyovu	Sport activities in wetland
2	-1.63182	29.937497	Rulindo	Cyungo	Clay Extraction
4	-1.876813	30.513442	Kayonza	Mukarange	Dumping in Wetland
5	-1.981762	29.987403	Kamonyi	Runda	Dumping Site
6	-1.981578	29.987423	Kamonyi	Runda	Dumping Site
7	-1.981673	29.987452	Kamonyi		Dumping Site
8	-1.887128	30.086343	Nyarugenge	Kanyinya	Flooding
9	-1.889017	30.08745	Gasabo	Kinyinya	Flooding
10	-1.835068	30.081668	Kicukiro	Gahanga	Flooding
11	-2.020245	30.027372	Nyarugenge		Flooding
12	-1.944782	30.004067	Nyarugenge		Flooding
13	-1.891553	30.088205	Gasabo		Flooding
14	-1.982599	30.058714	Kicukiro		Flooding
15	-1.750957	29.956353	Rulindo	Mbogo	Flooding
16	-1.758007	29.959025	Rulindo	Mbogo	Flooding
17	-1.965452	29.994747	Kamonyi	Runda	Flooding
18	-1.965395	29.994732	Kamonyi	Runda	Flooding
19	-2.026283	29.758477	Muhanga	Muhanga	Flooding
20	-2.02483	29.758477	Muhanga	Muhanga	Flooding

VI.6. Other pollution hotspots sites (flooding, dumpsites, etc)