ENVIRONMENTAL IMPACT ASSESSMENT PROJECT REPORT

FOR

MWEA – MAKIMA WATER SUPPLY SYSTEM IN TANA WATER SERVICES BOARD AREA

(AWSB / WASSIP – AF / COMP.1 / CS – 33 / 2012)

MAY 2014

EMPLOYER

CHIEF EXECUTIVE OFFICER
ATHI WATER SERVICES BOARD
HOSPITAL ROAD, AFRICA RE CENTRE, 3RD FLR
P.O. BOX 45283 – 00100
NAIROBI

CONSULTANTS

LUJO CONSULTING ENGINEERS LTD
BLESSED HOUSE, 2ND FLR, NGARA ROAD
P.O. BOX 62481 – 00200, NAIROBI

JV

DC CONSULTING ENGINEERS
P.O. BOX 53388 – 00200, NAIROB

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EXPERT CERTIFICATION

Ecoserv Consultants, a registered E I.A / Audit Lead expert has prepared this EIA study project report. The project report was prepared in accordance with Environmental Management and Coordination Act, 1999 and the Environmental (Impact Assessment and Audit) Regulations, 2003 for submission to National Environmental Management Authority (NEMA).

I certify that the report contains fair disclosure from the proponent, views of neighbours and recommendations to be undertaken by the proponent.

LEAD EXPERT

Name of Firm of Experts: Ecoserv Consultants

NEMA Certificate No. 1308

Address: P.O. Box 1303, 00100 NAIROBI

Signature é é é é é ...é é é é é

Date é é é é é é é é é é é

PROPONENT CERTIFICATION

I é é é é é é é é é é é é é é é é é é on behalf of Tana Water Services Board, the Sponsors of Mwea-Makima Water Supply Project submit this Environmental Impact Assessment project report for the development of the Project.

To my knowledge all information contained in this report is accurate and truthful representation of all findings as relating to the project.

Signature é é é é é é é é é é é é é .

Date é é é é é é é é é é é é é é

Designation é é é é é é é é é é é é é

ABBREVIATIONS

DWO	District Water Officer
EIA/EA	Environnemental Impact Assessment / Environmental Audit
EMCA	Environmental Management and Co-ordination Act
GI	Galvanized Iron
MASL	Meters Above Sea Level
NEMA	National Environmental Management Authority
NIB	National Irrigation Board
O&M	Operation & Maintenance
PRA	Participatory Rural Appraisal
PRSP	Poverty Reduction Strategy Paper
TWSB	Tana Water Services Board
uPVC	Un-plasticized Polyvinyl chloride
WARMA	Water Resources Management Authority

EXECUTIVE SUMMARY

Introduction

Tana Water Services Board (TWSB), is one of the eight regional Water Services Boards under the ministry of Water and Irrigation. The regional Boards were created to deliver reforms in the Water Sector and were mandated to provide water and sanitation services throughout the country. The World Bank has funded Tana Water Services Board through Athi Water Services Board to carry out implementation of this project. Tana Water Services Board has commissioned Lujo Consulting Engineers Limited in joint venture with Dams Consult for preparation of Detailed Design, Bidding Documentation, Supervision and Coordination of Construction of Mwea ï Makima Water Supply System in Tana Water Services Boardôs area of jurisdiction.

Lack of adequate water supply has been identified as the biggest problem and a hindrance to a better lifestyle for the people of Mwea and Makima Divisions of Mbeere South District and in its endeavor to achieve its vision in this area, TWSB conceptualized this water supply project. The Consultant has prepared the Final Design of phase one of the proposed project according to the Terms of Reference. This document presents the findings as summarized hereunder.

i. Description of the Project Area

The proposed project is expected to abstract water from Nyamindi River in Kirinyaga County. Phase one of the proposed project will supply water to Mwea and Makima Divisions of Mbeere South District in Embu County. The project area is located about 130 kilometres to the North-East of Nairobi City along the Nairobi-Makutano - Embu road.

The altitude of the area ranges between 1050-1300 metres above sea level and the main relief feature is the Mwea Plains which provides suitable land for rice irrigation fields. Most of the water resources within the project area are polluted by water draining from the rice paddies. The area is of low potential with annual rainfall not exceeding 500 mm.

Socio – Economic Infrastructure

Mbeere South District is a newly created district curved from the former Mbeere District with the district headquarters located at Kiritiri town along the Embu - Masinga Dam road. The district has no development plan or data bank. The project area is well endowed with primary/secondary schools as well as health facilities. Transport and communications infrastructure are satisfactory although some areas are not accessible during the rains. There are several market centres with small businesses such as shops and stalls, with rice, drought resistant cereals and livestock being the dominant commodities of trade.

ii. Existing Water Supply

The area faces acute shortage of water both for domestic use, livestock and irrigation. Sources of water in the area are streams, rivers and irrigation canals that are heavily polluted. Some boreholes have been sunk within the project area but these are not enough to meet the water demand. The area has unreliable and poorly distributed rainfall. From the foregoing, it is evident that communities in the targeted area walk for long distances to fetch water, whose quality is still wanting.
Karaba and Riakanau areas were initially targeted to be served by the major Ndia Water Scheme but the increased demand in the supply area outstripped the schemeôs water production and hence, this area has not been supplied with water for close to a decade.
This has led to vandalism of some of the infrastructure components on the ground as the system has remained consistently dry.

iii. Consumer Projections

The projection horizon has been taken as initial year 2015, future as year 2025 and ultimate as year 2035. Human population projection has been based on the 2009 population census. The growth rates are based on the Mbeere District Development Plan for 2008 ï 2012, which is given as 2.3% and the same was adopted for the proposed project area. According to the 2009 census, the total population in the

project area was 51,382. This population has been projected to be 58,893 in 2015, 73,930 in 2025 and 92,806 in 2035.

iv. Water Demand Projections

The projected water demand calculations are based on the guidelines of the Ministry of Water and Irrigation Practice Manual for Water supply Services in Kenya (October 2005).

The Initial water demand has been projected to be 934 m^3 / day while the Future water demand has been projected to be 1,390 m^3/ day. The Ultimate water demand (year 2035) is projected to be 2,110 m^3/ day as summarised in the following table.

Table 1 : Total Water Demand for Mwea and Makima Divisions (in m^3/day)

District	Division	Location	Sub Location	Initial 2015	Future 2025	Ultimate 2035
Mbeere South	Makima	Makima	Makima	56	79	123
			Mwea Grazing	123	175	270
			Mbondoni	101	144	222
	Mwea	Karaba	Karaba	114	162	251
			Wachoro	130	185	286
			Riakanau	88	125	193
			Gategi	64	91	141
Sub Total				**676**	**961**	**1,486**
Add Institutional Water Demand				102	197	272
Sub Total				**778**	**1,158**	**1,758**
Allow 20% (Wastages & Leakages)				155.6	231.6	351.6
Total				**934**	**1,390**	**2,110**

v. Components of the proposed system

(a) Intake: The intake structure will consist of a reinforced concrete cross weir with an intake chamber, a valve chamber and a scour pipe. From the intake chamber,

raw water will flow into a plain sedimentation basin located along the riparian a few metres downstream of the intake chamber.

(b) Raw Water Gravity Main: The raw water gravity main will be 12.2 km. long of DN 160 mm. uPVC pipes details of which are given in the annex 1.

(c) Treatment: Raw water will undergo a plain sedimentation process in the plain sedimentation basin located near the intake. After sedimentation, water will flow into a 225 m^3 masonry tank to be located at Kangu where it will be chlorinated.

(d) Clear Water Transmission Main: The transmission main will be 25 km. long and will comprise of DN 160 mm. uPVC pipes of various pressure classes ranging from PN 6 to PN 16. This pipeline will be connected to the existing Ndia-Karaba system (of Ndia Water Supply Project) at PI Market Centre along the Makutano-Wangôuru road. From PI, water will flow to the existing 100 m^3 tank at Karaba from where water will be distributed to Riakanau, Mbonzuki and Gategi.

vi. Cost Estimates

Phase One of Mwea ï Makima Water Supply System is estimated to cost **KShs. 111,963,664.60.**

1.0 INTRODUCTION

In fulfillment of EMCA, 1999, and EIA and EA regulations of 2003 Lujo consulting Engineers have contracted Ecoserv Consultants to carry out an Environmental Impact Assessment study on the proposed Mwea-Makima water supply project. Lujo Consulting Engineers Limited in joint venture with Dams Consult have been contracted by Tana Water Services Board for preparation of Detailed Design, Bidding Documentation, supervision and coordination of construction of Mwea ï Makima Water Supply System in Tana Water Services Board Area of jurisdiction.
It is a requirement that an Environmental and Social Impact Assessment is done and reviewed by NEMA before implementation of all projects. The review is meant to weigh sustainability of the projects in view of the potential impacts and formulated mitigation measures and NEMA may approve the project for implementation, call for more information or reject further progress. Depending on the severity and magnitude of the impacts NEMA may order for upgrading the project report to a full EIA Study. Mwea-Makima water supply project will be implemented in three phases and is expected to ultimately cover Mwea division in Kirinyaga East district and Mwea and Makima divisions in Mbeere South district. In the first phase the project will cover only a section of Mbeere south district that includes Karaba, Riakanau and Gategi locations. Based on the field observations and discussions with the public in the project area during the barazas, Mwea-Makima water supply project is not expected to cause severe environmental and negative social impacts since its implementation may not result in resettlement or health and safety concerns of high magnitude. From the scoping survey most of the identified potential negative impacts can be mitigated during implementation of the project.
In line with vision 2030 to reduce the population without access to safe domestic water by 50%, TWSB has identified the project area which suffers acute shortage as one of the targets for water development in the next two years. Lack of safe water for domestic use is the biggest problem in the area and a hindrance to a better lifestyle for the people. This has led to a great desire to provide water to this area and as a result, the birth of the Mwea - Makima Water Supply System.
The project is proposed to cover Mwea East and Mwea West Districts in Kirinyaga County and Karaba, Riakanau, Gategi and Makima Locations in Mbeere South District in Embu County.

The EIA Scoping and public consultations/awareness was done during initial visits and this provided baseline information for the project. This was supplemented by information from consulting engineers preliminary design report In view of the benefits resulting from provision of good quality water to the people of Mwea and Makima who are currently suffering from acute shortage of water for domestic consumption and the fact that the few potential negative impacts identified are effectively mitigatable, it is our opinion that the project should be approved.

2.0 Description of the Project

Mwea - Makima Water Supply System is expected to draw water from Nyamindi River. Through a gravity main, water will gravitate to a treatment facility about 8 km from the intake and then flow to serve the project area which includes areas in Mwea East, Mwea West Districts in Kirinyaga County, and Mbeere South Districts in Embu County.

The consultant has designed the project in such a way that avoids any chances of displacement of populations in the project area and the maximum that can happen is acquisition of land from the owners of the properties that will be affected. The location of the intake will be within the river riparian reserve. Access to the site especially during construction is the major concern. However the proposed plan is to use the riparian such that there will be minimum impact on the private land.

The proposed pipe line route is designed to ensure minimum interference with private properties by passing through road reserve. This means the project structures will only occupy private land where technically unavoidable. This will include the gravity main which must pass in peopleôs shambas before enough head is gained to allow gravity flow along the available road reserve. No land will be acquired in this case because the pipeline will be underground and the only impact on the peopleôs shambas will be during trenching and backfilling. Because of the said impacts on peopleôs shambas, negotiations with the affected persons have been among the project structures, the treatment works site will require the largest portion of private land and hence will have the maximum impact on the

affected individuals. The size of the land will be approximately three (3) acres. The size required inevitably dictates that displacement will occur. In this regard, the consultant proposes to site the treatment facility such that it will partly affect two or three families such that none will be forced to vacate the land and move elsewhere. This will therefore not necessitate relocating of any family but compensation will be the way forward. The gravity main is proposed to pass along the roads within the road reserve. There is therefore no land acquisition foreseen along the gravity main. It is however proposed that, towns of Kimbimbi, Wangûru, Thiba, Mutithi and PAI will be provided with water through water kiosks. The space for these kiosks will not require relocation of people as they will be on the road reserve, which is a government land. Onwards to Mwea and Makima, it is proposed that water tanks will be constructed, and will be sited on private lands. The magnitude of land requirement and hence the impacts will be low and no relocation is envisaged. The extent of land requirement in terms of compensation is shown on Annex.1 Annex 2 shows the location of project Intake, Treatment works and Pipeline route.

2.1Justification of the Project

Tana Water Services Board(TWSB) has developed a 10 year Strategic Plan (2005 - 2015) and a 5 year Business Plan (2006 - 2011) which focus on the improvement of the water service provision and a continuous rehabilitation and expansion of the water and sewerage infrastructure aimed at ensuring universal access to water and sewerage services by the year 2015. Towards this end and in order to guide the infrastructure investment, the Board has developed a Water and Sewerage Master Plan, which has guided the development of its Investment Plan. As part of this investment plan, TWSB proposes to implement Mwea ï Makima Water Supply System, to Mwea and Makima in its area of jurisdiction. This is in line with the recommendations of its Water Master Plan, which recommends the development of water supply sources from the forested areas where water is of very good quality and at high elevations to facilitate the gravitation of water to boost the capacities of the existing schemes and expansion to uncovered areas.

Therefore the project is a step in line with National policy and Boardôs strategic plan towards the development of the water supply system that traverse two of the 6 counties within the board area of jurisdiction.

The water sector in Kenya has been undergoing radical transformation driven by the new national policy, which separates water resources management and development from water services delivery. This conforms to the Poverty Reduction Strategy Paper (PRSP), the Economic Strategy for Wealth and Employment Creation and it is backed up by the Water Act of 2002. The Poverty Reduction Strategy Paper (PRSP) recognizes that water is a basic need and an important catalyst for both economic and social development of the country. It states that ñaccess to water for human consumption, agriculture, and livestock use is a major problem in rural areas.

The water supply situation in rural areas has deteriorated over the years to a point where demand cannot be sustained with current systems. Access to piped water has not increased since 1989 and those accessing other water sources have increased during the same period.òThe PRSP seeks to provide affordable safe water and sanitation to majority of the poor at reasonable distances.

This is expected to enhance efforts to meet the Millennium Development Goals and realize the objectives of the Vision 2030. The country needs to provide water to an estimated 60% of the population (about 16 million people) who have no access to improved water sources, reduce uncounted for water that currently stands at over 50% and manage water provision in sustainable, business-like approach.

Provision of safe and adequate water is an effective and efficient intervention for fighting poverty, disease and social disparities. This intervention alone has positive impacts on all other MDGs and the attainment of the Vision 2030. Mwea and Makima communities suffer from chronic shortage of clean safe water for domestic use and earlier investigations on alternatives are not considered sustainable. In Mwea, majority of the consumers fetch water for domestic use from polluted irrigation canals and is consumed without any form of treatment while Makima communities have travel more than 4 Km to get water from the nearest river which is highly polluted.

In the project area, provision of clean safe water will reduce costs of health care and child - mortality by reducing water - related infections which will ultimately contribute to attainment of MDGs: Universal Primary Education by freeing time for children, especially the girls, and by improving their nutritional status. The project will promote gender equity and empower women by releasing the time they now spend fetching water and seeking medication. Young people will have more time for formal and informal education and this will contribute to combating HIV / AIDS, and in line with the new constitution and the vision 2030.

It is against this background that the Tana Water Services Board has proposed the development of Mwea ï Makima Water Supply System to meet the water requirements for the entire area to enhance social-economic improvement leading to poverty reduction.

3.0 OBJECTIVE OF THE PROJECT

The objective of the project is to develop a potable water supply for the Mwea and Makima communities and ensure sustainability and compliance with NEMA EIA/EA regulations during the project cycle ie construction, operation and decommission phases of the project. The activities of the project will be analyzed and assessed to identify the potential benefits and losses and to formulate mitigation measures for the negative impacts or losses to the target community and the wider area.

4.0 SCOPE OF THE EIA STUDY

The study was conducted to identify the proposed project implementation activities in order to identify the associated potential positive and negative impacts in order to formulate the necessary mitigation measures at an early stage. The negative and positive impacts of the project activities were assessed in form of benefits and losses to the community and in the light of the mitigation measures before the decision are made on the way forward. The decision to approve the project implementation or not lies with NEMA.

The EIA study includes assessment of impacts of the project during construction, operation and decommissioning activities on the following;

- Physical environment
- Flora and Fauna
- Land use
- Social economic aspects
- Public and occupational health and safety.

The study assessed the impacts of the proposed development on the environment in accordance with EMCA (1999) and covering the following;

- Baseline information
- Activities of the project
- Design of the project
- Materials to be used
- Methodology
- Assessment of potential environmental impacts of the project and mitigation measures
- Economic and social impacts to the local community and mitigation measures
- Health and safety measures
- Environmental management and monitoring plan

Scoping process

The impacts of the proposed project were assessed through project site visits and the following;

- Evaluation of the location, extent of the Water Supply Scheme transmission lines, Intake, the treatment works and the current land use of the affected plots.
- Evaluation of the design and proposed construction activities, materials and methodology
- Stakeholders meetings and Public Barazas
- Discussion with the project neighbours the potential impacts related to project implementation activities and corresponding mitigation measures

4.0 METHODOLOGY

The study was carried out through

- Desk studies and literature review
- Field survey on the source intake, treatment works sites and distribution area
- Public participation/ sensitization by holding public barazas and consultative meetings with stakeholders
- Discussions with technical representatives from the proponent and relevant stake holders

5.0 BASELINE INFORMATION

5.1 Nature of the project

Mwea - Makima is a Water Supply Development Project and is expected to draw water from Nyamindi River and transmit this water through Mwea and finally to Makima using a gravity flow. The water will gravitate to a treatment facility about 8 km from the intake and then gravitate to serve the project area which includes areas in Mwea East, Mwea West Districts in Kirinyaga County, and Mbeere South District in Embu County.

5.2 Administrative Location

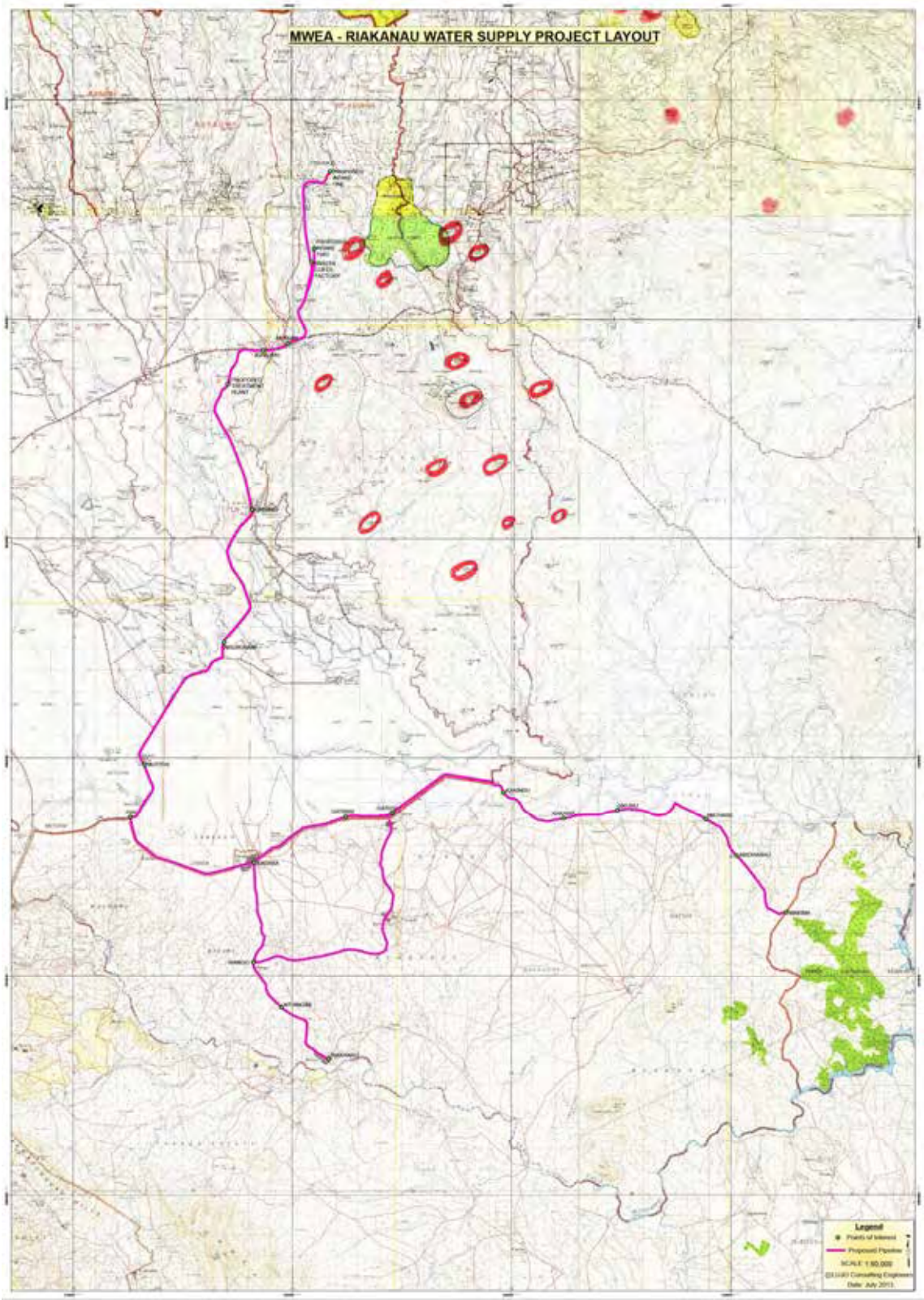
The proposed Mwea - Makima Water Supply System is located in Mwea East, Mwea West Districts in Kirinyaga County, and Mbeere South District in Embu County. The project area is located about 130 km to the North East of Nairobi City on the Nairobi - Embu Road.

The map below shows proposed intake site along Nyamindi River which has the following GPS Coordinates:-

$37M$ 032185m E 9946373m S Elevation = 1488m

As noted above, the project area transgresses across two counties of Kirinyaga and Embu in three districts. The two districts of Mwea East and West were curved out of the former Kirinyaga District and have not fully established all the departments in their respective headquarters. Much of their operations are done from the mother district headquarter at Kerugoya and data bank for the districts have not been developed. Development plans for the districts have not been done either. The two districts are former Mwea Division in Kirinyaga district. Three Locations of Karaba, Gategi and Makima in Mbeere South district are within Embu County and the district headquarters for this region is Kiritiri. This is also a newly created district curved from formerly Mbeere district. Figure 1 shows proposed project area. Layout plan is on Annex 2

Figure 1: Mwea - Makima Water Supply System Project Area



5.3 Topography

The altitude of the project area ranges between 1100 ï 1300 m above sea level which gently slopes from the highlands within the intake and the treatment works and is generally flat within the Mwea plains. The main relief feature is the Mwea Plains which provides suitable lands for rice irrigation fields. The upper areas within the intake and the treatment works are characterized with hanging and V shaped valleys.

5.4 Hydrology

There are five major rivers, all from the slopes of Mt. Kenya and drain into river Tana beyond the project area. These are Nyamindi, Rupingazi, Thiba, Rwamuthambi and Ragati. Figure 2 is a photograph of Nyamidi River upstream. River Tana originates from Aberdare Ridges. Most of the waters within the Mwea area are polluted by drains from the rice paddies with agro- chemicals and untreated human waste disposals as sanitation situation in the area is poor.

Figure 2 : Upstream of Nyamindi River

5.4.1 Flora and Fauna

The project area is under agricultural production and hence there are no animals and plants worth conservation.

The area is entirely in an agricultural zone where mixed farming (livestock rearing, subsistence crop production) is practiced. It is only in Mwea Division in Kirinyaga East where cash crop farming is practiced. The rest of the area in Mbeere is primarily under subsistence and livestock farming.

5.4.2 Geology

The geology of the area is characterized by volcanic soils in the upper part and red loam and clay soils in the lower parts of the supply area corresponding to Mt Kenya ecosystem.

5.5 Climate – Rainfall & Temperatures

5.5.1 Rainfall

The climate of the area is arid and semi-arid with erratic and unreliable rainfall, which is bi-modal. The annual rainfall ranges between 500 ï 700 mm with about fifty per cent reliability.

The long rains (April - May) are usually reliable while the short rains (November - December) are unreliable. The amount of rainfall received is influenced by the topography of the landscape with the southern area receiving less rainfall.

5.5.2 Temperatures

The project area experiences high temperatures throughout the year ranging from 20^0C to 30^0C, hottest and coldest months being January-February and June-July respectively.

6.0 SOCIO – ECONOMIC INFRASTRUCTURE

This section gives a brief general overview of the Socio - economic infrastructure development of the Project area. The project is proposed to cover Mwea East and Mwea West Districts in Kirinyaga County and Karaba, Riakanau, Gategi and Makima Locations in Mbeere South District in Embu County.

6.1 Education

The project area is well endowed with primary schools and secondary schools but with no post secondary institutions. The currently recorded primary school enrolment is about 24,758 while the secondary enrolment is 9,687. The community has taken advantage of the free primary education as envisaged by the high enrolment.

6.2 Health Facilities

The proposed supply area is well covered with health facilities most of which are dispensaries and private clinics. HIV/AIDS awareness is high in the area but behavioral change is still low and generally the rate of infection is on the rise. All the health facilities in the area offer VCT services and ARVs are available to all the infected persons in several government facilities. Malaria which used to be a major problem in the rice growing plains of Mwea East and West is gradually declining with the introduction of sterile mosquitoes that mate with the common breed to produce a breed that cannot transmit Malaria.

6.3 Transport and Communication

The communications infrastructure is satisfactory. The area is accessible through the Nairobi ï Embu ï Meru Highway as shown in Figure 4. Most of the other roads are graveled, but some are not accessible during the rains especially the lower zones of Gategi and Makima as in Figure 4. Telephone wise, almost all areas are covered by the major service providers. Internet services are available in most market centres.

Figure 3 : Makutano - Embu Road is the only tarmac within the Project Area

Figure 4 : Most of roads within the project area roads which are impassable during rainy seasons (Gategi - Makima Road)

6.4 Commerce and Industry

The project area has many market centres where locals and foreigners do small businesses ranging from general shops, butcheries and stalls. Wangôuru is the biggest town in the target area with rice as the dominant good of trade. In the lower areas of Mbeere South trade is mainly in cereals and livestock. The only industries in the area are several rice mills and Timber plant found in Wangôuru Town.

6.4.1 Economic Activities

The project area is richly agricultural with Mwea Irrigation Scheme being the predominant, growing and selling rice. There are other crops including horticultural crops like tomatoes, French beans and onions. Areas in Karaba, Riakanau,Gategi and Makima grow maize, beans, green grams, potatoes, millet and peas. Livestock rearing is practiced across the entire project area keeping mainly cattle, goats, donkeys and chicken. Cattle and goats are kept both for meat and dairy. Other livestock includes pigs and bee keeping. Fishing is done around Riakanau in Masinga Dam.

6.5 Agriculture

The upper zone is the border line between the highlands of Mt Kenya and the Mwea plains. It is a transition and it is where the treatment works is proposed as it is on a high altitude in relation to the supply area. Crops, mainly maize beans, bananas, potatoes, horticultural crops like French beans, tomatoes, carrots, onions, and livestock mostly for daily are produced. Mwea area is generally flat where irrigated paddy fields are dominant. Soils in this zone are predominantly black cotton soils. Horticultural crops including tomatoes onions, carrots and vegetables (kales and cabbages) are also produced. Livestock keeping including cattle, goats, chicken and pigs are also practiced. Donkeys are kept in big proportion for transportation of goods. The lower zones including Karaba, Riakanau, Gategi and Makima have generally rugged terrain with small interrupting valleys where the major rivers mature before draining into river Tana. The area has mixed type of soils ranging from sandy

roam, black cotton, and red loam. Mixed farming incorporating crops and livestock are kept. Farming is mostly rain fed in this zone but some irrigation is practiced.

7.0 EXISTING WATER SUPPLY

7.1 Water Supply Facilities in Mwea District

The area faces shortage of water both for domestic use, livestock and irrigation. Sources of water in the area are streams, rivers and irrigation canals that may be unsafe. Some boreholes have been sunk within the project area but are not enough to meet the water demand. The area has unreliable and poorly distributed rainfall and this result in communities walking for long distances to fetch water, whose quality is still wanting.

About 60% of the project area was initially served by the major Ndia Water Scheme but due to increased demand in the supply area outstripping the supply; most of the areas especially in Mbeere have not been supplied with water for close to a decade. This has led to vandalism of some of the infrastructure components on the ground as the system has remained dry consistently. Ngurubani market and its environs are currently being served by a pumping system which has over time proved insufficient and uneconomical.

Kimbimbi market has never had a formal water supply. People rely on donkeys to draw water from NIB Canals for their domestic use. The water is highly polluted from the rice paddies and also tedious to fetch.

Gategi Market relies on a privately owned pumping system from River Thiba. Most people around Karaba - Riakanau area have to walk for long distances to get water from streams around and the few existing hand-dug wells which are scattered in the region. There is also the use of bore holes in the region although there are only a few.

7.1.1 Rukanga Water Project

Rukanga Water Supply is a community project which was funded by IFAD under the Central Kenya Dry Areas Project. The source is Ragati River. The target population was 8,000 people. The project serves about 9,552 people in Mutithi and Rukanga Locations. It has about 96 km of pipelines.

7.1.2 Kamumwe Water Project

The project draws water draws water from Nyamindi River and has about 22,546 beneficiaries in Murinduko and Riagaceru Locations. The water system has about 120 km of pipelines. The water demand in the project area is about 500m^3/day while the production is 450 m^3/day.

7.1.3 Ndikiki Water Project

This is a self help water project covering Ndindiriku, Kiumbu and Kianugu areas. The source is Nyamindi River. The project was funded by IFAD and was targeted to serves about 4,000 people in Karukungu and Gathigiriri Sub / Locations. However, distribution and metering is yet to be done.

7.1.4 Karaba – Ciagiini Water Project

This project is under implementation. The source of water is the NIB canal (Thiba River). The project will have about 15 km of pipelines and will benefit about 2,500 people in Kiandegwa Sub / Location. The total demand is 125 m^3/day.

7.1.5 Thiba Water Supply

This water supply was abandoned but is now undergoing rehabilitation. It envisages to benefit about 1,700 people residing in Thiba village with a water demand of 100m^3/day. The project has about 5.3 km of both main and distribution pipelines.

7.1.6 Kimbimbi – Mwangaza Water Project

Kimbimbi / Mwangaza Project will draw water from Nyamindi River to benefit about 5,000 people in Nyangati Sub / Location. The intake and gravity main are complete. The remaining works comprise of provision of storage facilities, laying of distribution systems and metering. The project is therefore not yet operational.

7.1.7 Wang'uru Water Project

This is the only gazetted water supply in Mwea East District. It is operated by KIRIWASCO. Wangûuru water supply draws water from an NIB canal (Thiba River) to serve about 1,300 people. It has 31.6 km of pipelines.

7.1.8 Kiandegwa / Kirimumbi Water Project

This water project was part of the larger Ndia Water Project with 38.8 km of pipelines. The water supply serves about 4,500 people. The water demand in the project area is 230m^3/day while the supply is only 150 m^3/day.

7.1.9 Gathigiriri Borehole Project

The borehole has been drilled and equipped. However, distribution and metering are not yet done. There are several boreholes in Mwea area both functional and non functional.

7.1.10 Mithuthi-ini Borehole Project

The project is operational. However, distribution and metering are yet to be done.

7.1.11 Kenera Water Project

The project is operational. The remaining works comprises provision of storage facilities, distribution system and metering.

7.1.12 Karagara Water Project

The project is partially operational. The remaining works comprise re-location of the intake, main pipe, storage facilities, distribution system and metering.

7.1.13 Kugeria Water Project

The project is partially operational. However, provision of distribution system and metering are yet to be done.

7.1.14 Teitha-Teithia Water Project

The project is partially operational. However, provision of distribution system and metering are yet to be done.

7.1.15 Miuu Women Water Project

The project is operational. However, laying of distribution system and metering are yet to be done.

7.1.16 Mugambaciura Water Project

The project is operational. However, laying of distribution system and metering are yet to be done.

7.1.17 Rwang'ondu Gitooni Water Project

The project is targeted to serve 3,000 people with a water demand of 150 m^3/day. The project is incomplete and requires Kshs. 2.8 million for extension from the KIRIWASCO main line. The project will have 12 km of pipeline on completion.

7.1.18 Kanjema Water Project

The project was targeted to serve about 2,200 people with a water demand of 110 m^3/day. The main line is 3.5 km long and the total supply is only 80 m^3/day.

7.1.19 Huruma Clean Water Project

The project is targeted to serve a population of 3,000 people with a water demand of 150 m^3/day. The project is still under construction. About 3 km of pipelines have been laid.

Some water projects observed were non operational, example is a Borehole in Gathigiriri, see Fig 5 and 6, and shallow wells.

7.1.20 Kang'aru Water Project

The project is targeted to benefit 4,800 people with a water demand of 240 m^3/day. The project is operational and is supplying about 180 m^3/day.

7.2 Mbeere South District

There are approximately twenty (20 Nos) boreholes, six (6 Nos) earth dams and 8.6 km of pipelines in Makima area.

In Mwea area, there are approximately forty (40 Nos) boreholes, five (5 Nos) earth dams and 5 km of pipelines distributing water from the high yield boreholes as shown in Tables 2,3 and 4.

Table 1: Operational sources within Mwea and Makima Divisions

Name	Water body	Location	Owner	Popn (HH)
Wachoro Boys	Borehole	Karaba	Institution	120
Kikumini	Borehole	Karaba	Community	60
Gatuanyaga	Borehole	Makima	Community	50
Mulukunye	Borehole	Makima	Community	40
Mburutani	Borehole	Makima	Community	50
Ndundoni	Borehole	Makima	Community	50
Mbondoni	Borehole	Makima	Community	40
Nganga	Borehole	Karaba	Community	60
Nthingini	Borehole	Riakanau	Community	50

Table 2: Boreholes that need rehabilitation

Name	Location	Yield m^3/h	Popn (HH)
Mburutani	Makima	6	40

Table 3 : Boreholes that need to be equipped with motorized pumps

Name	Location	Tested Yield m^3/h	Depth, m	Priority Ranking
Irare	Makima	3.6	25	19
Mulukunye	Makima	7.2	63	12
Koma P.S	Riakanau	3.6	53	4
Gitaraka	Karaba	3.3	46.4	6
Kaseve	Riakanau	5.1	55	9
Kithunguthia	Riakanau	3.26	51.7	8
Wango P.S	Karaba	4.5	73	10
Nthingine	Karaba	4.5	51.5	20
Karuku	Karaba	8	80	1
Kathiani	Riakanau	7.2	100	2
Kakindu	Riakanau	3.27	40	7
Makutano	Karaba	4.5	54	17

According to the DWO, there are two proposed springs that require surveying and developing;

Kionywe in Mbondoni owned by community and Isilaka in Mbonzuki

Other sources of water include; shallow wells, water pans and seasonal rivers. The average distance from the households to the main water sources in the month of March is about 2.5 km. This distance increases to about 4.5 km in the dry months of the year.

Generally, the quality of the water in Makima and Mwea is based on home treatment. The 2008 ï 2012 District development Plan has identified water inaccessibility in the districts as a major problem caused by long distances to water points, poor water harvesting methods, poor operation and maintenance of existing water facilities and poor raw water quality from the surrounding sources (rivers and hand dug wells). The current District development Plan for Kirinyaga, which includes Mwea had envisaged increasing accessibility of clean/piped water by forty per cent by the year 2012 through construction / rehabilitation of boreholes, construction of dams and pans rehabilitation and augmentation of existing water supplies and promotion of roof catchments programmes.

Figure 5 : Borehole at Gathigiriri village which was constructed through CDF but has never been used after completion

Figure 6 : Abandoned shallow well with a hand pump at Gathigiriri

Intensive agricultural practice is carried out along Nyamindi River as shown in photograph in Fig 7. In Riakanau, within the project area, fishing is undertaken in Masinga Dam and River Tana as seen in Fig 8 below.

Figure 7 : Intensive agricultural being carried along Nyamindi River

Figure 8: The lower zone of the proposed project at Riakanau where fishing is practiced at Masinga Dam and along Tana River

7.3 Existing Sanitation Facilities

The existing sanitation facilities comprise on-site sanitation in the form of septic tanks and pit latrines, Fig 9. A few commercial entities in the major markets and institutions use septic tanks while households use pit latrines. However, quite a number of households do not have sanitation facilities and sharing between two or more households is common, and sometimes those households without latrines result to bushes that are fast diminishing. The existing arrangements are inadequate since the population density is above 120 persons per hectare (12,000 per km). This is the upper limit recommended for on-site sanitation. This is mostly within Mwea Rice Scheme where people live in villages. There are over 20 villages in Mwea and all of them are congested and sanitation facilities are inadequate. Paddy fields do not have sanitation facilities and those working in the fields results to defecation in the paddies and when draining of the fields is done, the drained water is returned in to rivers further polluting water, in addition to chemicals that are used in the fields.

Figure 9 : Typical Pit Latrine in Gathigiriri village

7.6 Public Participation

Public sensitization/consultations were done through public barazas held at the following sites in the project area;

i. At Mwalimu Thatia compound near proposed Mbiri bridge Intake (Ngiriambu Sub- location, Njukiini Location) on 22nd July 2013.
ii. Karucho Market centre (Ngiriambu sub-location, Njukiiini location) near the proposed Intake (Kenera Water supply Intake) on 24th July 2013.
iii. Kangu dispensary (Kutus Location, Kirinyaga East district, Kirinyaga East district) near the proposed treatment works site on 24th July 2013.
iv. Kianjiru market centre(Kianjiru sub-location,Baragwi location, Kirinyaga East district) near the alternative treatment works site on 25th July 2013.
v. Karaba market centre along the proposed pipeline route (Karaba location, Mwea Division, Mbeere South district) on 26th July 2013.
vi. Makima market centre, Assistant county commissioner's compound, Makima location, Makima division Mbeere south district on 26th July 2013

The barazas were held to provide a forum for the consultant to present to the public project area details, proposed project activities, and request them for their involvement in formulation of mitigation measures against negative impacts where necessary to avoid delays in project implementation. Among the issues covered during the meetings included;

A) Employment opportunities arising to be given to the local people as a priority
B) The possibility of the neighbors benefitting with water supply connections.
C) Possibility of using water for irrigation
D) Requirement for compensation for people's property affected by the project implementation
E) Health and safety during proposed project construction and operation phases
F) Conflict resolution during project operation phase
G) Impact of construction of the proposed project Intake works near the existing Water Supply Intakes
H) Availability of land for the proposed project
I) The community willingness to provide labour at prevailing market cost.

J) Willingness to pay for the cost of water provision within the target areas of Mwea and Makima communities.

As indicated in the minutes of the barazas held at the various market centres in the project area the communities in Kirinyaga East district did not object to the project so long their interests (employment, health and safety etc.) and the individuals affected directly by the project were compensated. Agreements for compensation of the affected persons have been done between them and Tana Water Services Board (TWSB) and are shown as Annex 1. The community in Mbeere south district was so appreciative of the project that they offered to provide Way Leave free of charge where required irrespective of the existing structures. Further, they agreed to pay for water supplied and provide labor during implementation at the prevailing market rates

In conclusion, from the comments made during open barazas, the communities especially in Mwea and Makima strongly support the proposed project. Minutes of the barazas are shown on Annex 3.The associated photographs are on Annex 6

7.7 LEGAL, REGULATORY AND INSTITUTIONAL FRAMEWORK

There is a growing concern in Kenya and at global level that many forms of development activities cause damage to the environment. Development activities have the potential to damage the natural resources upon which the economies are based. A major national challenge today is how to maintain sustainable development without damaging the environment.

Environmental impact assessment is a tool for environmental management, which has been identified as a key component for sustainable development. According to section 58 of the Environmental Management and Coordination Act (EMCA) No.8 of 1999, second schedule 9 (i), and Environmental (Impact Assessment and Audit) Regulation, 2003 requires new projects to undergo Environmental Impact Assessment while ongoing projects to undertake Environmental Audits. The report of the same must be submitted to National Environment Management Authority (NEMA) for reviewing, approval and issuance of the relevant certificates. This was necessary as many forms of developmental activities cause damage to the environment and hence the greatest

challenge today is to maintain sustainable development without degrading the environment.

7.7.1 WATER

The enactment of the water act 2002 and repeal of cap 372 was to address the shortcomings which had been noted in the water policy, 1999.

7.7.1.1 Water policy 1999

The policy recognizes that before 2002, there were many players in water resources management and development of water supplies in the country. This led to poor performance of the sector far below the expectations. It therefore called for delineation of roles. The role of the Ministry in the water sector was redefined and emphasis was put on regulatory and enabling environment functions as opposed to service provision. In this regard, organizational structures of all the actors in this sector were reviewed. This was accompanied by institutional reforms, which promoted integrated approach, changes in procedures, attitude and behavior changes and ensuring gender balance. The ministry supports private sector participation and community management of services backed by measures to strengthen local institutions in implementing and sustaining water and sanitation programmes.
The policy recognized that construction of Water Supply Scheme projects had both negative and positive impacts to the environment and human life. Therefore, in order to mitigate such negative impacts, a need to adopt a multi-objective approach and incorporating Environmental Impact Evaluation was necessary.

7.7.1.2 Water Act 2002

The Water Act 2002 provides the legal framework for the implementation of the new institutional arrangements based on the following principles: -

- Separation of operation from regulation/policy making.

- Separation of management of water supply and the water supply/sewerage provision.
- Decentralization, participation of stakeholders, autonomy, accountability, financial sustainability and ecological efficiency.

a. Clause 77 page 1006 requires the Water Service Provider to charge approved levy to sustain the Water Supply Scheme system.
b. The act requires both Water Supply Scheme Management and water delivery be run by one institution for sustainability.

7.7.2 LAND

Land Act 2012

It is an act of parliament that gives effects to Article 68 of constitution to revise, consolidate and rationalize land laws; to provide for sustainable administration and management of land based resources.

The land acquisition for the project will be guided by the constitution and laws of Kenya. The statues that handles matters of compensation for the land and valuation of assets include; Government Land Acts Cap 280, Land Titles Act Cap 282, Registration of Titles Act Cap 281, Land Accusation Act Cap 295, Registered Land Act Cap 300, Water Act 202, Land Control Act 302, Land (group representative (act cap 287), Agricultural Act 318, Acting Act Cap 687 and Valuer Act Cap 532.

In the past Kenya did not have a clear defined or codified National Land Policy. This, together with the existence of many land laws, some of which are incompatible, resulted in a complex land management and administration system,

- Institutions managing Land in Kenya have been many and varied but performing poorly
- Community land refers to land lawfully held, managed and used by a specific community.

The Trust Land Act and the Land Group Representative Act are the two laws which entrust the management of community land to representative of the community. County government is the trustees of Trust Land while Group representative are entrusted with members group land.

- Eminent domain, or compulsory acquisition, is the power of the state to extinguish or acquire any title or other interest in land for a public purpose, subject to prompt payment of the compensation and is provided for in the current constitution. The constitution permits a modified form of acquisition in the case of trust land which may be activated by the President or Local authorities. This is referred to as **' Setting Apart'**

7.7.2.1 Draft land policy 2006

- This draft policy is currently undergoing review, the public has already been requested to read and contribute.
- The policy is as a result of extensive consultation and deliberation between the Ministry of land, other Government Departments and other Non-state stakeholders for over two years.

Community Interest and Benefit Sharing

To protect community interests over land based Natural Resources and facilitate benefit sharing:-

- ✓ A legal frame work shall be established for recognizing community and private rights over natural resources and put in place procedures for use of and access to these resources by communities and private entities
- ✓ Devise and implement participatory mechanism for compensation for loss of lives and damage of property occasioned by wild animals;
- ✓ Establish mechanism for the sharing of benefits emanating from natural resources by the people of Kenya and by use of participatory methods, define benefit sharing criteria for natural resources within contiguous to the jurisdiction of local communities;
- ✓ Ensure that the management and utilization of land based natural resources by community entities take into account the need to share benefits with contiguous communities and that such communities are fully involved in the management and development of the resources;

- ✓ Encourage the development of wildlife sanctuaries and conservancies and involve local communities in the co-management of parks with communities living contiguous to the parks and protected areas. It shall also provide mechanism for resolving grievances of communities arising from human-wildlife conflict and
- ✓ Recognize and protect the rights of forest dependent or other natural resources dependent communities and facilitate their access, co-management and derivation of benefits from the resources.

7.7.2.2 Registered Land Act CAP 300

Under the Registered land Act any person may acquire ownership to any land once he has been registered as the absolute owner. On registration, such a person acquires freehold interests on the land. A subsequent buyer of the same land acquires the same Rights as enjoyed by the previous owner.

7.7.2.3 Land Control Act CAP 302

The Land Control Act was enacted to regulate the sale and sub-division of agricultural land. The constitution gives power to the officers of the Land Control Board to refuse or grant consent for transfers or sub-divisions of agricultural land into uneconomic units.

7.7.2.4 Land Acquisition Act, CAP 295

The Land Acquisition Act reinforces the provisions of the constitution on compulsory acquisition, and consequently gives powers to the Government to acquire any persons land for public utilities such as roads, hospitals, schools etc. the only requirement by both the constitution and this act is that once such is acquired, prompt and full compensation be paid to the owner.
However, the Act does not provide for the involvement of the land owners in determining the level and the mode of compensation.

7.7.2.5 Crop Production and Livestock Act, CAP 321

The purpose of the crop production and livestock Act is to regulate the quantity of land that can be utilized for food crops and livestock production; what type of crops to be Grown in which are etc.

7.7.3 ADMINISTRATION

7.7.3.1 The chiefs' Authority Act CAP 128

Section 10 parts (f), (g), (h), (i) and (o) of the chiefsôAct CAP 128 states that;
Any chief may from time to time issue orders to be obeyed by the persons residing or being within the local limits of his jurisdiction for any of the following purposes;

a. Preventing the pollution of the water in any stream, watercourse or water-hole, and preventing the obstruction of any stream or watercourse;
b. Regulating the cutting of timber and prohibiting the wasteful destruction of trees;
c. Preventing the spread of diseases, whether of human being or animals;
d. Prohibiting any act or thing that may cause damage to any public road or to any work constructed or maintained for the benefit of the community

7.7.4 Public Health Act (Cap. 242)

The Public Health Act regulates activities detrimental to the human health. Part IX, Section 115 of the Act states that no person or proponents sites shall cause nuisance or conditions liable to be injurious or dangerous to human health. Section 116 requires Local Authorities to take all lawful, necessary and reasonable practicable measures to maintain areas under their jurisdiction clean and sanitary to prevent occurrences of nuisance or conditions liable for injurious or dangerous to human health.
Under section 118(n) any factory or trade premises not kept in a clean state or free from offensive smell arising from any drain, privy, water closet or urinary or not ventilated as far as practicable, any gases or so overcrowded or so badly lighted or injurious or dangerous to health of those employed therein; section 118(q) defines any chimney sending forth smoke in such quantity or such a manner as to be

offensive or injurious or dangerous to health; would all be deemed to be a nuisance, liable to be dealt with as provided by the Act.

7.7.4.1 Occupational Health and Safety Act 2007

The Occupational Safety and Health Act, 2007 provide for the safety, health and welfare of workers and all persons lawfully present at workplaces, to provide for the establishment of the National Council for Occupational Safety and Health and for connected Purposes.

The Act covers provisions for health, safety and welfare of workers in factories and other places of work. It calls for cleanliness of all factories, free of dust, dirt, refuse, blocked drains, sanitary inconveniencies and nuisance fumes (section 51). Provision of protective clothing to the workers and training on health and safety, emergency preparedness including fire fighting (section 53) as given below

- Requires that any work place where dust is given out or fumes or other impurity of such a character and to such a character and to such extent as to be likely to be injurious or offensive to the persons employed, or any substantial quantity of dust of any kind, all practicable measures be taken to protect the persons employed against inhalation of the dust or other impurity and to prevent its accumulating in any workroom, and in particular, where the nature of the process makes it practicable , exhaust appliances be provided and maintained, as near as possible to the point of origin of the dust or fume or other impurity, so as to prevent it entering the air,
- Where workers are employed in any process involving exposure to wet or to any injurious or offensive substances, suitable protective clothing and appliances, including, where necessary, suitable gloves, footwear, goggles and head coverings shall be provided and maintained for the use of such workers.

7.7.5 The Standards Act CAP 496 and the Standard Amendment Act 2004

The Act empowers the Kenya Bureau of Standards to promote standardization through the Government or the representatives of any industry or with any local Authority or other public body or any other person, with a view to securing the adoption and practical application of standards.

7.7.6 Quality standard for sources of Domestic Water

Tana River water requires treatment before use.
Attachment 1.4 has the details on the standard on which the water has to attain to qualify for domestic use.

7.7.6 Environmental Management and Co-Ordination Act (EMCA), 1999

The Environmental management and Co-ordination Act (EMCA), 1999, provide a legal and regulatory framework to manage ecological and social economic matters of the environment. Part 111 section 7(1), the government of Kenya established National Environmental Management Authority NEMA), whose main task is to ensure that the laid provisions of the act are adhered to by all policies and projects.

7.7.6.1 Environmental Management and Co-Ordination (Waste Management) Regulations 2006

The responsibilities of a generator of waste are contained in Part II. A waste generator shall collect, segregate and dispose waste in accordance with these regulations. The waste shall not be discharged into public places and also shall be disposed in designated waste receptacle. Measures to minimize the generation of waste will be instigated and the waste generated will be transported by a person licensed by NEMA.

7.7.6.2 Environmental Management and Co-Ordination (Water Quality) Regulations 2006

The water quality regulations are aimed for application to drinking water, water used for industrial purposes, water used for agricultural purposes, water used for recreational purposes, water used for fisheries and wildlife, and water used for any other purposes. Part III deals with effluent discharge, covering discharge into the environment, public sewers and aquatic environment. This regulation requires that

persons operating a public water shall be issued with an effluent discharge license by NEMA and shall comply with prescribed effluent discharge standards

7.7.7 Physical Planning Act, 1999

The local Authorities are empowered under section 29 of the Act to reserve and maintain all land planned for open spaces, parks, urban forests and green belts. The same section, therefore allows for the prohibition or control of the use and development of land and buildings in the interest of proper and orderly development of an area. Section 30 states that any person who carries out development without development permission will be required to restore the land to it original condition. It also states that no other licensing authority shall grant license for commercial or industrial use or occupation of any building without a development permission granted by the respective local authority.

Finally, section 36 states that if connection with a development application, local authority is of the opinion that the proposed development activity will have injurious impact on the environment, the application shall be required to submit together with the application an environment impact assessment EIA report. EMCA, 1999 echoes the same by requiring that such an El A is approved by the NEMA and should be followed by annual environmental audits.

7.7.8 Land Planning Act (Cap. 303)

Section 9 of the subsidiary legislation (The Development and Use of Land Regulations. 1961) under this Act requires that before the local authorities submit any plans to the Minister for approval, steps should be taken as may be necessary to acquire the owners of any land affected by such plans. Particulars of comments and objections made by the landowners should be submitted. This is intended to reduce conflict with the interest such as settlement and other social and economic activities.

7.7.9 Penal Code Act (Cap.63)

Section 191 of the penal code states that if any person or institution that voluntarily corrupts or foils water for public springs or reservoirs, rendering it less

fit for its ordinary use is guilty of an offence. Section 192 of the same act says a person who makes or vitiates the atmosphere in any place to make it noxious to health of persons /institution is dwelling or business premise in the neighborhood or those passing along public way, commit an offence.

INTERNATIONAL LEGISLATIONS/CONVECTIONS

Besides the national legislations, there are international guidelines that govern the development of projects funded by World Bank and its institutions e.g. Operational directive OP 4.00.

Kenya is a signatory to several international treaties and convections and some that may have implications on projects like Mwea-Makima are shown below.

- The United Nations Framework Convention on Climate Change (UNFCCC), which has established an ultimate objective of stabilizing GHG emissions at a level that would prevent antrhropogenic interference with global climate. In order to achieve the conventionôs objectives, the Kyoto Protocol was drawn in 1997, where the development nations agree to limit their GHG emissions to levels emitted in 1990.

- The 1994 Convention for Biological Diversity, whose objective is conservation of biological diversity, the sustainable use of its components and fair and equitable sharing of the benefits arising out of the utilization of genetic resources. The convention is relevant as the lands on which water project is located are habitats with a diversity of flora, fauna and avifauna.

- The Ramsar Convention on Wetlands of International Importance especially the Waterfowl Habitat is concerned with the conservation and management of wetlands and their resources. Geothermal projects are located in the Rift Valley where various Ramsar Sites exist such as Lakes Naivaisha, Nakuru, Bogoria, Barigo, and Elementaita.

Emission of green house gases in this project is not significant and is limited to exhaust gases from delivery motor vehicles, excavation equipment and concrete mixtures. The project is located in agricultural area and hence no chances of encountering flora and fauna worth conservation.

The design of the intake works has taken care that acquatic organisms can swim across the intake weir during breeding season. Further the project is not expected to interfere with any Ramsar convention sites from the intake to consumer point.

8.0 PROJECT DESIGN DATA/ WATER DEMAND PROJECTION

8.1 Design Period

The project is designed for a 20 ï year period with the initial year as 2015 which is the year of Millennium Development Goals (MDGõs); the future as 2025 and the Ultimate 2035 which is five years after the Countyõs Vision 2030.

8.1.1 Projection of consumer growth rates

Growth rates were calculated using figures from KNBS: Population1999-2009 and district development plans 2008-2012. Assuming the figures from the census were sufficiently accurate, a geometric series progression formula is applied to determine the growth rate as shown below;

$$P_n = P_0\left(1+\frac{r}{100}\right)^n$$

Where;

P_n = projected population after n number of years

P_o = Initial population

n = Number of years

r = Population growth rate

Determined consumer growth rates based on census of 1999-2009 and district development plans, 2008-2012 are shown below;

District	**Rate(%)**
Mbeere	2.3

The following Tables 5 and 6 gives the human population projection in the proposed project area

Table 4 : Consumer Projections per Sub location for Mwea East and West

District	Division	Location	Sub - Location	2009 Census	Projected Population			
					Current 2013	Initial 2015	Future 2025	Ultimate 2035
Kirinyaga	Mwea	Mutithi	Rukanga	5,899	6,261	6,450	7,486	8,688
			Kabiriri	8,701	9,235	9,514	11,041	12,814
			Kiandegwa	5,619	5,964	6,144	7,130	8,275
			Kinyaga	6,645	7,053	7,266	8,432	9,786
		Thiba	Nguka	11,068	11,747	12,102	14,045	16,300
			Wamumu	17,881	18,978	19,552	22,691	26,334
		Nyangati	Nyangati	8,294	8,803	9,069	10,525	12,215
			Kirimara	2,471	2,623	2,702	3,136	3,639
			Mathangauta	5,066	5,377	5,539	6,429	7,461
		Tebere	Kiarukungu	31,645	33,587	34,602	40,157	46,604
			Gathigiriri	7,333	7,783	8,018	9,305	10,799
			Mahigaini	5,938	6,302	6,493	7,535	8,745
		Murinduko	Riagacheru	8,632	9,162	9,439	10,954	12,712
Total				**125,192**	**132,874**	**136,890**	**158,867**	**184,371**

Table 5 : Consumer Projections per Sub location for Mbeere South (Makima and Mwea Division)

District	Division	Location	Sub - Location	2009 Census	Projected Population			
					Current 2013	Initial 2015	Future 2025	Ultimate 2035
Mbeere South	Makima	Makima	Makima	4,245	4,649	4,866	6,108	7,667
			Mwea Grazing	9,343	10,233	10,709	13,443	16,875
			Mbondoni	7,677	8,408	8,799	11,046	13,866
	Mwea	Karaba	Karaba	8,679	9,505	9,948	12,488	15,676
			Wachoro	9,883	10,824	11,328	14,220	17,851
		Riakanau	Riakanau	6,673	7,308	7,648	9,601	12,053
			Gategi	4,882	5,347	5,596	7,024	8,818
Total				**51,382**	**56,275**	**58,893**	**73,930**	**92,806**

8.2 Livestock Population

The data from the District Livestock production Officers, Mwea East,Mwea West and Mbeere South districts shows the population of domestic animals as in the Table below.

Table 6 : Animal Population in the Proposed Project Area

Animal	Kirinyaga		Mbeere South	
	Mwea West	Mwea East	Mwea Division	Makima Division
Dairy Cattle	-	7,012	380	325
Zebu Cattle	12,000	10,081	19,000	29,061
Indigenous Poultry	52,000	68,350	76,500	79,100
Layers	2,500	4,150	350	326
Broilers	2,100	5,250	-	809
Ducks	1,200	402	-	217
Turkeys	350	283	-	-
Geese	56	140	-	-
Guinea Fowls	50	240	-	-
Quails	200	125	-	-
Ostrich	0	1	-	-
Meat Goats	9,900	6,605	45,000	53,290
Dairy Goats	1,400	3,245	270	650
Wool Sheep	1,500	3,550	25,000	15,290
Pigs	3,800	1,450	450	-
Langtroth	180	130	70	33
KTBH	360	480	230	93
Log Hive	680	680	900	4,800
Rabbits	3,700	6,150	600	796
Donkeys	1,150	2,950	650	2,016
Ken broils	-	-	-	713

According to Ministry of Water and Irrigation, Practice Manual for Water Supply Services in Kenya, (October, 2005), in livestock projections, grade cattle, local cattle, small stock and other livestock should be estimated separately. Normally, poultry need not be considered.

For the purposes of estimating the water demand for the livestock the following conversion factor apply;

I Grade Cow	equivalent to	1	Livestock Unit (LU)
3 Indigenous Cows	,	1	Livestock Unit (LU)
15 Sheep or Goats	,	1	Livestock Unit (LU)

5 Donkeys	,	1	Livestock Unit (LU)
2 Camels	,	1	Livestock Unit (LU)

From the above, livestock Units in the project area have been derived as shown in Table 7 and their demand will be included in the rates formulation for the total water demand.

Table 7 : Livestock Unit in the Proposed Area

Area	Current 2013	Initial 2015	Future 2025	Ultimate 2035
Mwea West	5,083	5,083	5,083	5,083
Mwea East	11,856	11,856	11,856	11,856
Mwea	11,528	11,528	11,528	11,528
Makima	15,031	15,031	15,031	15,031
Total	**43,498**	**43,498**	**43,498**	**43,498**

8.3 Institutions

There are several institutions in the project area namely;

- Primary Schools
- Secondary Schools &
- Health Centres

The population projection for primary, secondary and health facilities has been based on growth of population. A summary of population projections in these institutions is given in Tables 9 and 10.

Table 8 : Institution Population Projections for Mwea East and West

Institution	Current 2013	Initial 2015	Future 2025	Ultimate 2035
Primary Schools	48,119	49,573	57,532	66,768
Secondary Schools	7,229	7,447	8,643	10,031
Health Institutions	38	39	42	45
Sub District (No of beds)	6	24	27	32

Table 9 : Institution Population Projections for Mwea and Makima Division

Institution	Current 2013	Initial 2015	Future 2025	Ultimate 2035
Primary Schools	14,255	14,918	18,727	23,509
Secondary Schools	3,668	3,839	4,819	6,049
Health Institutions	22	23	29	36
Sub District (No of beds)	-	-	-	-

8.4 Commerce and Industry

The Consultant projected the commercial premises based on population growth in the project area. The Consultant anticipates the growth would be directly related to the growth of population. There are different businesses within the project area. In addition there are light industries; Rice Millers and Wood preservative within the area. The total number is summarized in Table 11 below.

Table 10 : Commercial Premises and Industry Projections

Description	Area	Current 2013	Initial 2015	Future 2025	Ultimate 2035
Commercial Premises & Industry	Mwea East & West Districts	2,793	2,877	3,339	3,875
	Mwea & Makima Division	485	508	637	800

8.5 Water Demand Forecast

The water demand analysis are based on the 2009 population census figures, which have been projected to the year 2013, 2015, 2025 and 2035 using the growth rate figures as given in chapter 5.

Table 11 : Human Projections for Mwea East and West in m^3/day

District	Division	Initial 2015	Future 2025	Ultimate 2035
Kirinyaga	Mwea East and West	2,622	3,648	5,639

Table 12 : Human Water Demand Projections for Mwea and Makima Divisions in m^3/day

District	Division	Initial 2015	Future 2025	Ultimate 2035
Mbeere South	Makima & Mwea	677	961	1485

8.5 Institutional Water Demand

Table 13 : Summary of Water Demand for Primary Schools in Mwea East and West in m^3/day

District	Division	Initial 2015	Future 2025	Ultimate 2035
Kirinyaga	Mwea West	100	115	134
	Mwea East	148	172	200

Table 14 : Summary of Water Demand for Primary Schools in Mwea and Makima Divisions in m^3/day

District	Division	Initial 2015	Future 2025	Ultimate 2035
Mbeere South	Mwea	25	31	39
	Makima zone	32	40	51
	Riakanau zone	322	381	451

Table 15 : Summary of Water Demand for Secondary Schools in Mwea West in m^3/day

Initial 2015	Future 2025	Ultimate 2035
91	105	122

Table 16 : Summary of Water Demand for Secondary Schools in Mwea East in m^3/day

Initial 2015	Future 2025	Ultimate 2035
125	144	167

Table 17 : Summary of Water Demand for Secondary Schools in Mwea and Makima Divisions in m^3/day

Initial 2015	Future 2025	Ultimate 2035
120	151	190

8.6 Health Facilities

Health facilities are categorized into three level of service; Hospitals, Health Centres and Dispensaries. Thus, the water demand for the projected health facilities is summarized below in Tables 19, 20 and 21.

Table 18: Water Demand for Health Centres in Mwea West in m^3/day

Institution	Initial 2015	Future 2025	Ultimate 2035
Sub District	7	8	8
Health Centre	5	5	5
Dispensary	45	45	45
Private Clinic	50	50	50
Total	**107**	**108**	**108**

Table 19 : Water Demand for Health Centres in Mwea East in m^3/day

Institution	Initial 2015	Future 2025	Ultimate 2035
Sub District	15	16	17
Health Centre	15	18	21
Dispensary	36	42	49
Private Clinic	41	48	56
Total	**108**	**123**	**142**

Table 20 : Water Demand for Health Centres in Mwea and Makima Divisions in m^3/day

Institution	Initial 2015	Future 2025	Ultimate 2035
Sub District			
Health Centre	5	7	8
Dispensary	37	46	58
Private Clinic	73	92	115
Total	**115**	**145**	**181**

8.7 Industrial Water Demand

In coming up with industrial water demand, the Consultant conducted a survey to establish existing business premises within proposed project area. The Consultant visited several centres and tallied all the shops as well as industries. The current premises were projected using growth rates. Using consumption rates for different business premises, the Consultant calculated water demand and summarized as in Tables 22, 23 and 24 below.

Table 21 : Water Demand for Commercial in Mwea East and West in m^3/day

Business Name	Initial 2015	Future 2025	Ultimate 2035
General Shop	50	58	67
Supermarket	0	0	0
High Class Hotel	0	0	0
Middle Class Hotel	2	2	2
Low Class Hotel	20	23	26
Dry Cleaner	2	2	3
Dobi	0	0	0
Guest House	7	8	9
Butchery	12	14	17
Slaughter House	1	1	1
Petrol Station	1	1	1
Garage	2	2	3
Banking Institution	1	1	2
Mosque	1	1	1
Church	8	10	11
Others (Cyber Café, Posho Mill, Book Shop, Agent, Hardware Store Saloons etc)	102	118	137
Bars / Pubs	45	52	60
Industry	41	48	56
Total	**295**	**343**	**398**

Table 22 : Water Demand for Commercial in Mwea and Makima Divisions in m^3/day

Business Name	Initial 2015	Future 2025	Ultimate 2035
General Shop	6	7	9
Supermarket	0	0	0
High Class Hotel	0	0	0
Middle Class Hotel	0	0	0
Low Class Hotel	7	8	11
Dry Cleaner	0	1	1
Dobi	0	0	0
Guest House	2	3	4
Butchery	1	2	2
Slaughter House	0	1	1
Petrol Station	1	1	1
Garage	1	1	2
Banking Institution	0	0	0
Mosque	0	0	0
Church	3	4	5
Others (Cyber Café, Posho Mill, Book Shop, Agent, Hardware Store Saloons etc)	5	7	9
Bars / Pubs	2	3	3
Total	**30**	**37**	**47**

Table 2 : Summary of Water Demand for Institutions in m^3/day

Institution	Initial 2015	Future 2025	Ultimate 2035
Primary Schools (Mwea East)	148	172	200
Primary Schools (Mwea West)	100	115	134
Primary Schools (Mwea & Makima)	75	94	118
Secondary Schools (Mwea East)	125	144	167
Secondary Schools (Mwea West)	91	105	122

Institution	Initial 2015	Future 2025	Ultimate 2035
Secondary Schools (Mwea & Makima)	120	151	190
Health Facilities (Mwea East)	108	123	142
Health Facilities (Mwea West)	107	108	108
Health Facilities (Mwea & Makima)	115	145	181
Total	**988**	**1,157**	**1,361**

8.8 Livestock Water Demand

The number of livestock keeps on fluctuating as the people tend to reduce them during the very dry spell and increase them during rainy season. They are sold during the dry season and re-stocked at onset of rainy season. The water demand for the livestock has been computed and tabulated in the following Table .

Table 24 : Water Demand for Livestock Unit in m^3/day

Area	Initial 2015	Future 2025	Ultimate 2035
Mwea West	254	254	254
Mwea East	593	593	593
Mwea	576	576	576
Makima	752	752	752
Total	**2,175**	**2,175**	**2,175**

8.9 Total Water Demand

The total water demand for the proposed project is **13,980** m^3/day. This is inclusive of 100 m^3/day for staff use at treatment plant. According to Practice Manual for Water Supply Services in Kenya, October, 2005, it is recommended a 5 and 20 per cent allowance be assumed for backwashing and water losses through leakage and wastage respectively. Thus in coming up with the total water demand, the consultant has included 5 and 20 per cent in the ultimate water demand. The water demand is summarized in Table below.

Table 25: Total Water Demand in m^3/day

Description	Initial 2015	Future 2025	Ultimate 2035
Domestic	3,299	4,610	7,124
Livestock	2,175	2,175	2,175
Institution (Pri Sch)	322	381	451
Institution (Sec Sch)	336	400	478
Commercial	325	380	444
Institution (Health)	330	376	431
Sub Total	**6,787**	**8,321**	**11,104**
Add 20% (wastage and leakage)	1,357	1,664	2,221
add 5% (Back washing)	339	416	555
Total	**8,484**	**10,401**	**13,880**

Allow 100 m^3/day for consumption by water treatment staff. Therefore, Ultimate Water Demand is **13,980** m^3/day

Due to financial constraints, only water demand for Mwea and Makima Divisions, **1,400** m^3/day has been used in design for the project.

9.0 ALTERNATIVE SOURCES OF WATER PREVIOUSLY INVESTIGATED IN THE PROJECT AREA IN THE PAST

In 2006, a consultant WASPOR, on behalf of Tana Water Services Board had carried a study of alternatives for a water supply project to benefit Mwea and Makima including Riakanau. After conducting a Participatory Rural Appraisal (PRA) study in the project area, water was identified as top on the communityôs need list and the following water supply options were considered:

- Gravity water system from River Thiba ï This was later discarded after actual survey revealed that water could not flow by gravity from the selected site and had to be extended by about 18 Km for the water to flow to the supply area.
- Gravity water system from Nyamindi River ï To lay gravity main 35 km long from Nyamindi to supply only Riakanau, Karaba and Gategi. At that time, it was considered unviable due to its high cost per capita ratio and hence discarded.
- Pumping water from Tana River ï Tana is only 4 km from Riakanau area but due to the quality of the water, it would necessitate inclusion of a full treatment works, this option was disregarded.
- Subsurface dams and shallow wells ï This was found that it could only be used as as supplement during the wet season.
- Water Pans ï This was found as viable but only for small scale irrigation initiatives and watering livestock.
- Sinking of a Borehole near Kilia Market ï This entailed sinking a borehole next to the existing 100 m^3 tank near Kilia Market and pump water into this tank then use an existing pipeline to another 100m^3 tank at Wango, then water flows by gravity to the supply area. WASPOR recommended this option and proceeded to develop a proposal for the project costing Kshs. 12.5 M including community contribution.

These alternatives were only viable for small community and coverage for the prevailing demand. Therefore no consideration for extensive future coverage and demand growth can be accommodated in these water supply schemes.

In 2011, DWO for Kirinyaga developed a Water Supply Project development proposal to serve Kimbimbi, Wangûru, Mutithi, Wamumu, Karaba, Riakanau, Gategi and Makima areas. He proposed to phase the project;

- Phase I ï Construct intake, lay a mainline to 225 m^3 storage tank, lay the major twin lines and connect to an existing Ndia Scheme infrastructure to Gategi
- Phase II ï Construct a full treatment works, lay the major distribution lines to areas not formerly covered by the Ndia Scheme like Makima area and re ï organize the distribution system to make use of the 225 m^3 tank at Kilia market. The project cost was estimated at Kshs. 363 M.

9.1 The Source of Water for the Project

9.1.1 Nyamindi River

Nyamindi River has its source in Mt Kenya at an altitude of over 4,000 masl. It has three source tributaries: Nyamindi West, Nyamindi and Nyamindi East which originate from the Moorland High Altitude Grasses of Mt Kenya at an altitude of 4,500 masl. Other tributaries join the river from Mt Kenya National Park at an altitude of 3,600 masl and from Mt Kenya Forest at an altitude of about 3,000 masl. The river then flows from the forest boundary at an altitude of 1,700 masl, through cultivated farmlands as it loses gradient. At the proposed intake site near Mbiri Bridge, about 10 km downstream of the Forest boundary, the altitude is about 1,492 masl, which decreases to about 1,200 masl at 4DB5 river gauging station near Kimbimbi. From here the river flows downstream to join Rupingazi and Thiba rivers and into Tana River at Kamburu hydropower reservoir.

Nyamindi River is characterized by steep and Rocky River banks, forming gorges in several locations. For this reason, its water is not over-utilized for irrigation due to lack of suitable sites for abstractions. NIB constructed a link canal in 1995 to transfer 9.29 cumecs of Nyamindi flood flow to Thiba basin for expanded irrigation. The intake works are located about 100m downstream of Nyamindi river gauging station, 4DB5.

9.1.2 Environmental considerations

The source of Nyamindi River in Mt. Kenya is free from the major causes of environmental pollution and therefore a suitable source for abstraction of water for domestic use. Further the quality of water is better compared to most of the other rivers in the area. The intake site is located in a agricultural production zone where most of the indigenous plants have been replaced with blue gum trees which have no conservation value. The trees were planted to protect the steep slopes from soil erosion, but owing to high consumption of water, the Ministry of Environment and Natural Resources is encouraging replacement of this type of trees with indigenous catchment vegetation to conserve water. There are no wild animals worth conservation in this area apart from the mountain Trout fish in river Nyamindi which should not be affected by intake works construction. The design of the intake has taken care of fish and other aquatic organismsô conservation to enhance biodiversity. According to JICAôs Draft Final Report on National Water Master Plan, July 2013, Nyamindi River at the proposed intake has fresh neutral, low mineralized water with turbidity estimated at less than 5 NTU. Chemically the water is suitable for domestic use but requires coagulation and filtration where turbidity exceeds 5 NTU and disinfection to meet WHO and National KEBS Standards for drinking water, Annex 4. However, owing to observed deterioration of quality of surface water in Kenya over the years, the project intends to carryout full treatment of the water supplied during the final phase to ensure health and safety to consumers.

9.1.3 Climate change projection

The increase global warming has given rise to droughts and flooding due to prolonged temperatures on the land and seas respectively. Consequently this is expected to result in global climatic changes. Therefore unexpected heavy rainfall and prolonged drought could occur at different times of the year from known seasons. The heavy rainfall could result to destruction of intake works and severe erosion of the adjacent lands. Owing to the steep slopes around the intake works and hence high velocity of the river water, this is not expected to occur. During prolonged droughts the water level in the river is expected to reduce with a chance to affect the flow to the lower zones hence the availability for their requirements. This

has been factored and WARMA in granting abstraction permit have considered high and low rainfall seasons flows. In a drastic drought occurrence occasioned by severe climatic change affecting the water volume for a long time, it would be expected that WARMA would advice on the relevant action to take (change the intake site or construction of a dam).

9.2 Availability of Water at Proposed Intake Site

There are two proposed alternative Intake sites along Nyamindi River as follows;

- Near the Intakes of Kenera and
- Kamumue water supply projects.

The two sites are barely 3 Km from each other are possible alternatives but access to each and impacts on private property makes Kamumue site a better choice. As discussed below availability of water has been assessed using the available hydrological data, Annex 4(Hydrological report) and confirmed adequate. WARMA have confirmed that there is adequate water for the project at Kamumue site and there is no potential to reduce availability for the downstream consumers. This is shown on the WARMA abstraction permit Annex 4.

The proposed intake site for the Mwea - Makima project will be located some 100m upstream of the Kamumue water project intake where a flow of **2.1626 cumecs** was measured on 25th March 2003. Kamumue intake is authorized to abstract **0.0379** cumecs for both domestic and irrigation purposes while demand for Mwea - Makima is estimated at **0.0984** cumecs in 2015**, 0.1215** cumecs in 2025 and **0.1622** cumecs in 2035. Using the ultimate demand, the balance of flow would be **2.1626-0.0379-0.1622 =1.9625** cumecs or 90.7%. This balance receives additional flows from downstream tributaries, a number of which have spot flow measurements as shown in Table 26 below.

Table 26: Nyamindi Tributaries Spot Flow Gaugings

Date	Tributary	Flow in cumecs
25-02-1979	Kiri	0.2271
17-07-1981	Mururi	0.3930
17-06-1991	Matakari	0.1190
02-05-1979	Mburi	0.0595
23-09-1977	Gikutha	0.0130

Total	0.8116

According to Water Resources Management Authority (WRMA) there is adequate water for the project at the proposed intake, Annex 5

9.3 Analysis of alternative Water Supply Systems

9.3.1 Water source

In accordance with the Terms of Reference, the ideal water source for the project area is surface water from Nyamindi River. The Consultant has analyzed two alternative water supply systems based on two possible abstraction points.

9.3.2 Alternative 1

In the first option, the intake site would be located about 500 metres upstream of Mbiri ï Kiamutugu Bridge and about 200 metres upstream of existing intake for Kamumwe Water Project. This site is at an elevation of 1484 masl and GPS coordinates;

37*M* 0321817m E 99466253m S

The proposed treatment works site is at Kangu (near Kangu Dispensary) with the following GPS coordinates:

37*M* 0317165m E 9937088m S Elevation 1328m

The raw water gravity main (DN 400 mm uPVC pipes of PN 6 and PN 10 Classes) would be approximately 12 km long. The total cost of Phase I of this option would be approximately **Kshs. 568,424,367.94.**

9.3.3 Alternative 2

For the second Alternative, the intake site would be located about 100 metres downstream of the intake for Kenera Water Project at Rianjue with the following coordinates;

37*M* 0320986*m* E 9943257m S Elevation 1413m

With the treatment works site at Kangu, the raw water gravity main (DN 400 mm uPVC pipes of PN 6, PN 10 and PN 12.5 pressure classes) would be approximately 9.5 km long. The total cost of Phase I of this alternative would be approximately **Kshs**. **564,221,548.02.**

9.4 Conclusion and Recommendation

Although Alternative 2 is Kshs. 4.2 million cheaper, the Consultant recommends Alternative 1 for the following reasons;

a. The access road for Alternative 2 will traverse through 2 parcels of land owned by different individuals. About 1.5 acres of land will have to be acquired from the owners who might not be willing to have a road pass through their private land parcels.
b. Construction of access road for Alternative 2 will be difficult and costly because of the steep terrain. The construction cost might therefore be much more than indicated in the estimates.
c. The raw water gravity main in Alternative 2 will most likely be along the left bank of the river. This means that the gravity main will have to cross the river at Nyamindi River Bridge in the Nairobi ï Embu highway. Most of the gravity main from the intake to the main road will be in peoplesô land parcels. This will not be ideal for operation and maintenance purposes.
d. Kiri River is a major tributary for Nyamindi River. It traverses through agricultural area. Its water is heavily polluted with agricultural chemicals. It drains into Nyamindi River upstream of the proposed intake site for Alternative 2. This will increase the cost of treatment of water for domestic consumption and ultimately increase the cost of operation and maintenance of the proposed water supply.

9.5 Phasing Of the Proposed Project

The project will be implemented in 3 phases but owing to constraints in funding, only the first phase will be considered in this project report. Therefore, this ESIA only covers the first phase of the project.

The financial resources that are currently available are not adequate to implement the entire project as proposed in Option 1 and as initially envisaged by the Client (i.e a project covering the Mwea Plains of the former Kirinyaga and Mbeere Districts with an estimated water demand of 14,000 m^3/day). The Consultant, therefore, proposes that the project be implemented in three (3) phases as described below. Further, as shown in the cost estimates of the first phase, the scope of the project has been drastically reduced owing to funding constraints

9.5.1 Phase 1 of the Proposed Project

This phase of the project will supply water to the most droughts stricken area of the project which will include Karaba, Riakanau and Gategi locations of Mwea Division in Mbeere South District. Therefore the bills of quantities given in this report refers to the cost of works in the first phase only.This phase will comprise of the following components;

- A weir and intake chamber along Nyamindi River
- 12.2 km of DN 160 mm uPVC PN 6 and 8 pipes raw water main
- A Plain Sedimentation basin at the Intake
- A Clear Water RCC tank and a chlorine dozing system at Kangu
- 24.8 km of DN 160 mm uPVC PN 6 and 8 pipes Transmission Line from Kangu, joining an existing line at PI.
- 8 Nos Water Kiosks to serve the community &
- A Double Grade 9 Staff House

9.5.2 Phase 2 of the Proposed Project

This phase will comprise of 24 km long (DN 160 mm uPVC pipes) extension from Gategi to supply water to Makima. In addition, 2 Nos 225 m^3 tanks to be constructed at Gategi and Makima respectively and 7 Nos Water Kiosks to serve the community.

9.5.3 Phase 3 of the Proposed Project

This phase of the project will cover Kimbimbi, Wangûru, Mutithi and Wamumu corridor including the surrounding villages in Mwea East and West Districts of Kirinyaga County. Phase 3 will comprise of the following components;

- 12.2 km of raw water main with a draw off at the Intake constructed in Phase 1
- Treatment Works at Kangu
- Clear Water Main from Kangu to connect with the existing system at Mutithi &
- A distribution network to serve the villages

10.0 PROJECT LAYOUT

According to available documents, the water quality at the proposed intake site (0.5 km upstream of Mbiri ï Kiamutugu Bridge and 0.2 km upstream of the existing intake for Kamumwe Water Project) would only require plain sedimentation and chlorination to meet the recommended drinking water standards. Accordingly, the proposed phase 1 of the project, the Consultants proposes construction of a plain sedimentation basin near the intake and chlorination at the Clear Water tank to be located at Kangu.

10.1 Proposed Phase 1 of the Project

10.1.1 Proposed Intake

The intake structure will consist of a reinforced concrete cross weir with an intake chamber, a valve chamber and a scour pipe. The crest of the weir will be about 15 m long and a height of about 1 m. From the intake chamber, raw water will flow into the plain sedimentation basin which will be constructed along the riparian with the following dimensions;

Flow rate, Q = 2,110 m^3/day

Effective length, L = 22.8 m

Width, m = 5.7 m

Depth, m = 3.75 m

Detention time, t = 3 hours

To maintain upstream and downstream fish and other aquatic organisms biodiversity the weir is designed such that the height difference of the crest of the flow between the upper and the lower section is one meter and is 12 meters wide.

10.1.2 Raw water Gravity Main

The Consultant proposes a raw water gravity main from Intake to treatment plant (about 12. 2 km long), DN 160 mm uPVC pipes

Details are as given in Annex 2.

11.0 PROPOSED TREATMENT WORKS

As indicated above, raw water will undergo a plain sedimentation process in the plain sedimentation basin located near the intake. After sedimentation, water will flow into a 225 m^3 tank located at Kangu where it will be chlorinated before distribution by gravity system to the coverage area.

11.1 Location of Treatment Works

The Consultant proposes that the Treatment Works be situated at Kangu. This is due to availability of land and the elevation of the site in relation to the coverage area.

11.2 Storage

Six (6 No.) reinforced concrete tanks with a total storage of 1,250 m^3 will be constructed for phase 1 and 2 of the project. Details are as shown in Table 3 below.

Table 3 : Distribution of Storage Tanks

Tank No	Location	Capacity in m^3
1	Kangu (Clear Water Tank) 2No, 225 m^3	500
2	Karaba (Existing)	100
3	Wango (Existing)	100
4	Kilia (Existing)	100
5	Gategi	225
6	Makima	225
Total		**1,250**

11.3 Distribution System

From the treatment plant at Kangu, the Consultant proposes a transmission line approximately 25 km comprising of DN 160 mm, uPVC / G.I pipes to be laid. This line will be connected to an existing line at PI which will supply Karaba, Gategi and

Riakanau in phase 1 of the project. The whole distribution system will be gravity and details are as shown in Annex 2.

11.3.1 Water Kiosks

The Consultant proposes Water Kiosks be provided along the transmission line in the market centres to provide water to the residents. For Phase 1, a total of 8 Nos. Water Kiosks will be constructed. The market centres are; Karaba, Gategi, Wango, Nthingini and Riakanau. In phase 2, Water Kiosks will be constructed at Kakindu, Kakawa, Gikuru, Mathare, Madharau and Makima.

11.3.2 Connections

For Phase 1, the Consultant proposes Water Kiosks be provided to serve the people. Individual connections will be undertaken in Phase 2 and 3 as well as provision of water to the villages within the project area.

12.0 PRELIMINARY COST ESTIMATES

12.1 Cost Estimate

Estimated summary cost of phase 1 is about **Kshs 111,963,664.60** million as shown in Table 4 below. This is extracted from the detailed cost estimate in project report

Table 4 : Cost Estimates

Bill No	Description	Amount Kshs
1	Preliminary	13,775,000.00
2	Day Works	13,338.00
3	Intake	4,429,505.00
4	Plain Sedimentation Basin	3,869,371.50
5	Raw Water Main Line	22,066,189.00
6	Clear Water 225 m^3 Masonry Tank & Chlorine Dosing System	2,543,625.00
7	Transmission Line (From Intake to PI)	48,792,054.00
8	Staff House, Fencing and Power Supply	2,510,000.00
9	Water Kiosk (8 No.)	2,652,026.64
Sub Total		**100,651,109.14**
10	Add 5% Contingencies	5,032,555.46
11	Project Land Acquisition/ way leave	6,000,000.00
12	Implementation of ESMP	280,000
12	Physical/Cultural chance find preservation	-
Grand Total		**111,963,664.60**

Therefore the NEMA environmental conservation fee payable at 0.1% of the project budget will be **Kshs. 111,963,664.60.**

13.0 RECOMMENDED TREATMENT PROCESS

Based on the estimated Ultimate Water production of **1,400** m^3/day, the treatment capacity to meet drinking water standards has been evaluated. A full conventional water treatment process with the following unit operations will be necessary;

- Coagulation
- Flocculation
- Sedimentation
- Filtration
- Chlorination

13.1 Coagulation/Flocculation Process

The process involves the removal of suspended solids in water. The solids are the cause of color and turbidity in raw water. Owing to their size and behavior in aqueous solution the particles are also classified as colloids. The process is partially chemical and physical and occurs in a coagulation chamber of a flocculation/coagulation basin designed using raw water flow rate into the plant and prevailing water quality characteristics especially turbidity and color. At this stage, coagulant and flocculant chemicals are used to bring the tiny particles together to form large settleable flocs easily removable through sedimentation.
The product of choice for coagulation/flocculation in Kenya is hydrated Aluminum sulphate but polyAluminium chloride and cationic synthetic polymers are also encountered in the market.

13.2 Sedimentation

As the flocculated water flows into the sedimentation basin, the flocs already more dense than water start settling leaving clear water. The smaller less heavier particles continue moving and colliding and some combine through either van da Waals forces enmeshment to form large settleable flocs. More particles are also removed through entrapment in the floc blanket.

13.3 Filtration

The clarified water from the sedimentation basin will flow to the filters to remove the remaining fine particles to achieve less than 5NTU and 5mg PtCo/l turbidity and color standards respectively for drinking water, Annex 5. Rapid sand filters as mostly used in conventional treatment will be used and will be designed in accordance with the plant desired output and raw water quality characteristics

13.4 Chlorination

Though the filtered water is clear and meets the Physical/chemical Standards for drinking water it is not yet safe for domestic use until it is disinfected to make it free of any disease causing bacteria. This completes the conventional process of potable water treatment. Chlorine either in form of liquid or powdered products is the most cost effective and hence commonly used product in Kenya.

14.0 CHOICE OF PIPELINE MATERIAL

The most commonly used materials for the water transmission lines, Galvanized Iron (G.I) and unplasticized (uPVC) pipes have been proven environmentally safe. Therefore consideration on which material to use is mainly based on design pressure and cost.

Galvanized Iron and uPVC pipes which are manufactured locally have previously been used within the project area. In pipeline material selection, the consultant has been guided by pipeline long ï term functional and service needs in addition to capital and maintenance costs. Although uPVC mains can be used in most cases, they are unsuitable in situations such as rocky areas and along road crossings since they do not have capacity to resist external loads especially for bigger diameters. On the other hand, uPVC is cheaper than steel and easy to install.

14.1 Availability of materials and technology level

All the materials for construction of the project are available in the country and therefore they will be readily delivered to the site at the time desired. Any materials required for repairs during operation including treatment chemicals will also be locally available and should not unnecessarily be the cause of water shortage. Further, the technology level of the project is within the capability of Mwea and Makima community and therefore operation and maintenance may not affect sustainability of the project. The technical expertise that may lack within the community will be easily reachable in Embu, Kiruguya or Nairobi in a short time

15.0 PROJECT ACTIVITIES

15.1 Construction Phase

The project activities will include:-

- Excavation of ground along the trunk and feeder pipelines and the site of the proposed treatment plant.
- Protection of the walls along the excavated trenches to prevent collapse and possible accidents.
- Laying connections of pipelines and refilling of the trenches.
- Compaction of the walls of the treatment plant
- Construction of workshop, laboratory and offices for maintenance, treatment performance monitoring and management of the works.
- Refilling of voids around the treatment works and landscaping to restore the site.

15.2 Operation Phase

These will include receiving raw water and subjecting it to unit operations of treatment and temporally storing it in clean storage tanks before distribution
Routine activities include at least the following

- Maintenance of pipelines and treatment works. Attending to blockages and breakages along the pipelines,
- Cleaning of screens and clearing of vegetation at treatment works.
- Treatment performance monitoring through laboratory analysis

15.3 Materials Inputs during Construction Phase

- Sand
- Ballast
- PVC pipes
- Stones and hardcore chips
- Cement
- Steel bars
- Timber

- Iron sheets
- Soil

The construction materials will be required to meet the KEBS standards and will be purchased from the local wholesalers and hardware shops

Equipments and Tools

- Concrete mixtures
- Vibrators
- Wielding equipments
- Plumbing equipments
- Lorries
- Bull dozers
- Pick up vehicles and cars
- Backhoe

15.4 Material Inputs during Operation Phase

Chemicals for water treatment will be part of the most important inputs during operation phase

Operation of water distribution system will require minimal input, apart from occasional repair materials and water itself. In cases of burst along the pipe line pieces of plastic pipes, adhesives, metal clips etc will be needed. The water will flow by gravity and therefore electrical power will not be an input requirement. Power for lighting of the premises as well as running office equipment will be supplied throughout operation phase. Spare parts for mechanical equipment, filter sand, water quality testing equipment and chemicals will also be required to run the water supply scheme.

Other inputs will include tools for unblocking pipelines, and occasional vehicles for administrative inspections and maintenance.

16.0 POTENTIAL ENVIRONMENTAL IMPACTS AND ASSOCIATED MITIGATION MEASURES

16.1 Construction Phase

16.1.1 Soil and Solid Waste

During trenching for the Pipelines and treatment works site excavation, soil will accumulate and may pose significant negative environmental effects. If left unattended over a long period, the soil may be swept into the nearby rivers resulting in excessive flooding and silting during the rainy seasons. Further, the soil may find its way into the communityôs farms thereby reducing soil fertility. Other solid wastes include; wasted mortar, ballast, cement and other packaging materials, sand, metals, plastics and parts of PVC pipes, and garbage. These wastes generated during construction may impact negatively on the environment if not properly handled and managed.

16.1.2 Air pollution

Generation of dust and particulates during construction activities may have significant potential adverse environmental impacts to the workers and neighborhood. Other pollution sources will include diesel fumes from construction equipment and material transport vehicles.

16.1.3 Water quality

The overall potential impact of the project will be improvement of domestic water quality for the community in the project area. This is a major positive impact but there will be also negative impacts associated with implementation activities. The disturbance of soil by excavation for foundation of installations and pipeline trenches will make it loose and can easily be eroded and transported into the nearby rivers and streams, thereby negatively affecting the water quality. It is already evident that continuous erosion of the catchment area upstream in the past has resulted in high turbidity and color of the rivers in the project area.

16.1.4 Flooding

While it is expected that this will be mitigated effectively during implementation, if not properly managed, silting could also cause significant rise in the water level of the rivers and streams in the project area with ultimate flooding downstream. Further, weir construction at the intake could also result in siltation and consequent flooding especially during the rainy season.

16.1.5 Noise

Construction activities during the trenching for foundation of buildings, reservoirs and pipelines near residencies and market centres will have a negative effect to the neighbors. Sources of noise include; Mechanical earth working excavators, manual compressed air excavators and hand tools

16.1.6 Destruction of Indigenous Vegetation

During trenching for the pipeline, construction of treatment plant and intake it will be inevitable to avoid destruction of any existing indigenous vegetation at the proposed sites. Therefore, it will be important to formulate ways of mitigating the impacts caused at the end of construction phase.

16.1.7 Physical/ Cultural Chance Find Procedures

Chance finds procedures are an integral part of the project ESMP and civil works contracts.

If the Contractor discovers archeological sites, historical sites, remains and objects, including graveyards and/or individual graves during excavation or construction, the Contractor shall:

- Stop the construction activities in the area of the chance find;
- Delineate the discovered site or area;
- Secure the site to prevent any damage or loss of removable objects. In cases of removable antiquities or sensitive remains, a night guard shall be arranged until the responsible local authorities or the Ministry in

charge of managing cultural heritage and related resources in the country (responsible ministry) take over;

- Notify the supervisory Project Environmental Officer and Project Engineer who in turn will notify the responsible local authorities and the responsible ministry immediately (within 24 hours or less);

  - Responsible local authorities and the responsible ministry would then be in charge of protecting and preserving the site before deciding on subsequent appropriate procedures. This would require a preliminary evaluation of the findings to be performed by the archaeologists assigned by the government. The significance and importance of the findings should be assessed according to the various criteria relevant to cultural heritage, namely the aesthetic, historic, scientific or research, social and economic values.

  - Decisions on how to handle the finding shall be taken by the responsible authorities and the responsible ministry. This could include changes in the layout (such as when finding irremovable remains of cultural or archeological importance) conservation, preservation, restoration and salvage.

  - Implementation for the authority decision concerning the management of the finding shall be communicated in writing by relevant local authorities.

Construction work may resume only after permission is given from the responsible local authorities or the responsible ministry concerning safeguard of the heritage.

16.1.8 Intake weir interference with aquatic organisms biodiversity

The weir design and construction at the intake should be such that it will not interfere with among other factors fish and other aquatic organisms migration during breeding season thus ensuring uniform aquatic environment.

16.2 Operation Phase

16.2.1 Noise

During operation phase, the source of noise will be limited to electrical pumping sets for filter backwash water at the treatment works. Though the pumps are expected to generate noise during operation, the type of equipment and regular servicing generally can reduce noise to tolerable levels.

16.2.2 Solid Waste

The solid waste generated during operation phase will mainly consist of garbage from the staff houses, few pieces of PVC and metallic materials replacements from repair and maintenance, spent filter media and clarifier sludge waste.

16.2.3 Air pollution

The only air pollution expected during operation is that related to chemical mixing activities at the treatment works. While this is inevitable, the operators should be provided with the necessary protective gear. There is not any significant air pollution expected outside the treatment works.

16.2.4 Disease hazards

Provision of increased water supply to Mwea and Makima residents may have some significant negative impacts arising from water borne sewage leakage from overflowing septic tank systems and pit latrines. If not properly managed, the waste water may overflow and pollute the environment with consequent outbreak of water borne and water washed diseases. Further, the raw sewage may end up percolating into the ground polluting adjacent ground water sources. Excessive discharge of grey water coupled with frequent leakages without proper drainage system may lead to accumulation of stagnant water thereby creating conducive habitat for breeding of mosquitoes.

16.2.5 Insecurity

Availability of clean water will attract investors and start of small scale businesses especially within the market centres. The result will be a rapid population increase in the project area with consequent benefits and associated problems. The migration may lead to insecurity problems that may be difficult to handle using the existing set-up.

16.2.6 Water management conflicts

Clean water, being scarce in the project area, the management of the new project could result in prolonged conflicts unless properly formulated and consumer driven. This could therefore become a major negative impact.

16.3 Mitigation measures against potential negative impacts

16.3.1 Construction Phase

- **Air pollution**

During construction air pollution should be avoided by provision of nose masks to the workers and preferably wetting the dusty surfaces neighboring residences. These are all the areas where the trenches for the pipeline will be excavated and at the site of treatment works. Though the ambient air conditions in the project area is dusty to an extent, effort must be made to reduce dust and particulate emission adjacent to residences. To minimize pollution from hydro ï carbon fumes from the excavator, exhaust should be oriented away from neighborsôresidences. This should apply throughout the project cycle from construction to decommissioning.

- **Noise**

Generation of noise during construction activities is inevitable due to use of mechanical excavation equipment, concrete mixers and material delivery trucks. To minimize noise around the construction site, potentially low noise equipment which is also regularly serviced should be used. The major works sites apart from the pipeline should be temporarily enclosed using iron sheets. Further the material delivery

vehicle engines should not be kept idling at the construction site. To ensure minimal disturbances of the neighboring community members at night and early morning hours, the work should be done between 8.0 am and 5.0 pm.

- **Destruction of indigenous trees and vegetation.**

  Though it may be inevitable to clear some indigenous trees and vegetation along the pipeline and site for the water works, the vegetation cover and trees destroyed should be replaced soon after completion or as the rainy seasons begins. The spillage water at the kiosks should be harnessed to grow indigenous tree nurseries for increasing vegetative cover and replacing those destroyed during project implementation activities.

- **Intake weir interference with fish and other aquatic organisms migration**

The constructed weir across the river should not inhibit free migration of fish and other organisms during breeding season. The weir should be designed in a way to allow free movement of aquatic organisms across, upstream and downstream. During spawning, some species of fish are known to migrate upstream to lay eggs in the conducive breeding environment. The weir height will be only 0.3 meters and 12.6 meters in length. The approach velocity to the intake chamber screens will be 0.1 to 0.2 m/s and therefore fish which is mainly mountain trout will be able to swim against the current.

- **Flooding**

To prevent chances of excavated soil erosion and transport to nearby streams, all these materials should be re-used during landscaping of the site.
The soil should be compacted and the appropriate vegetation planted to ensure no chances of erosion and silting of the water sources, which could ultimately cause flooding downstream.

- **Accumulation of solid waste**

All the solid waste generated during construction activities should be collected and sorted into non-recyclable and recyclable. The recyclable waste e.g., metal and

plastic pieces and papers could be sold to licensed waste handlers while the hardcore materials could be re-used on site for construction and filling the voids along the road.

- **Soil erosion**

The soil removed from pipeline trenches, reservoirs and water works foundation excavation should be re-used in filling back the voids and compacted properly to avoid any chances of transport down the valley during the rainy season. Where necessary the appropriate vegetative cover should be planted to reduce chances of future soil erosion.

- **Prevention and Management of Accidents**

To prevent accidents caused by slipping into the dug trenches or stumbling into heap of trenched out materials along the road, warning tapes should be put along the trench line to alert pedestrians on the dangers. Additionally before the start of construction in each area, the residents should be warned of possible accidents to prevent idling around the sites

Accidents could also occur to the workers while on duty. To avoid these accidents the following should be observed

- The workers should be provided with personal protection gear to avoid cuts on the feet, hands and head during the course of duty. This include helmets, gloves, safety boots overalls, face masks and ear plugs in dusty and noise activities, goggles for welders etc
- Training: the foreman should train the workers on procedures to prevent accidents while on site.
- The workers or their representatives should be trained on first aid and provided with first aid kits
- Emergencies: the workers should be provided with emergency telephone numbers to request for assistance at any time of accident. In areas of poor cell phone network there should be a stand by means of transmitting information

- The workers should be insured against accidental medical requirements and workmanship compensation.

16.3.2 Operation Phase

Noise

During operation, noise pollution from the treatment works should be minimized by enclosing the site and use of potentially low noise filter backwash pumps. The pumps should be regularly serviced to reduce noise generation. If necessary the pump house inner wall sides could be lined with sound proof material. To ensure noise does not affect the health of the workers, they should wear the necessary protective gear all the time they are on duty in noisy environment from construction to operation and decommissioning phases. Therefore the workers should be provided with ear protection devises for use while on duty.

Solid Waste Management

Solid waste generated during project operation phase will mainly include the clarifier de-sludging waste from water treatment plant, spent filter media, precipitates of powder chlorine products and either lime or soda ash. These waste should be temporary be disposed in drying beds with the works compound before transportation and final disposal in a designated site. Other types of solid waste include garbage, plastics and metal pieces from repairs and waste paper from office. This type of waste should be sorted for recyclables e.g. metals, plastics and paper for sale to recyclers before transportation for disposal at the designated site.

Disease Hazards

Proper maintenance of sewage and grey water handling systems will be required to avoid pollution of environment and consequent spread of diseases. Further proper management of drainage systems will be necessary to eliminate chances of having stagnant water which would otherwise be a breeding site for mosquitoes and

resultant outbreak of malaria and bilharzias. This water could be profitably used for irrigating food crops and tree nurseries where community can buy seedlings for various vegetation and trees.

- **Project management conflicts**

Owing to the high competition for water in the semi-arid area of Mwea and Makima, there could occur management conflicts. To prevent such conflicts the project management should follow the guidelines given in water sector reforms and hence in accordance to water act 2002 The Ministry Water and Irrigation should work with the relevant institutions to streamline the management to avoid negative impacts and losses that could arise from conflicts.

- **Insecurity and Strain on Infrastructure**

Rapid increase in population is expected to impact negatively due to resultant over loading of services eg hospitals, schools, housing, security services, solid waste facility, sewage handling facility etc. These impacts should be monitored in order to advise the relevant institutions on the need to expand service delivery to match rising demands i.e.

- The administration and police on the need to increase surveillance
- The hospital and dispensaries to expand services
- Ministry of Education and private development to invest on schools
- The public to invest more in construction of rental residential buildings
- The water sector to increase investment in water supply and sewage disposal.

Prevention and Management of Accidents

The commissioned water supply project will be run and managed in accordance with reforms in the water sector and Water Act, 2002. The water supply provider will be required to provide the relevant protective gear to the workers in all sections. The water treatment plant personnel should be provided with overcoats/overalls, safety boots, helmets, goggles/masks for protection from accidents while on duty. They should also be provided with medical insurance cover and workman compensation

or equivalent. The workers should be trained on first Aid treatment and first Aid kits installed at strategic sites in the water works.

17.0 SOCIO-ECONOMIC IMPACTS

Loss of property

The members of the community affected by the project will suffer impact of loss of land and or other properties on the same land. This is the most devastating impact of all in the project area especially in the fertile agricultural areas of Kirinyaga. Therefore, a careful approach should be formulated to reach an irrevocable agreement with satisfaction from all the stake holders.

During the public barazas it was agreed that the all the members of the community who will be affected by the project will enter into an agreement with TWSB for compensation of any loss before commencement of the project. Further, the compensation will be done according to the government valuation. Details are given in Annex 1

A socio-economic study report of the area, Annex8 has shown that the community will immensely benefit from the project as follows;

- The cost of water which is currently at an average of Ksh.12 in the project area will decrease to the accepted affordable Ksh.2 per 20 litre jerrican.
- The water supply will meet quality standards for domestic water unlike the currently contaminated water bought from various vendors in the project area.
- Diseases related to the quality of water consumed which are currently frequent in the area will decrease e.g. Typhoid, amoebiasis and generally parasitic and bacterial intestinal infections .Others include bilharzia ,malaria, general skin and respiratory infections are more related to stagnant irrigation water in Mwea.
- From observation of the running of the existing water schemes in the area the community has managerial skills that will be a benefit in enhancing sustainability of the project and they are willing to pay.
- The community will save time when the project brings water near their homes compared to the current walking 5-7Km to fetch water.
- Time and money saved by the community in the project area will be used in economic activities thereby improving the quality of life.

Therefore, socio-economic impacts arising from implementation of the project are numerous and include those associated with increased investment opportunities, health, cost saving and increase in population and are summarized below;

17.1 Positive Impacts

- Increased wealth creation owing to influx of investors coming to exploit the increased business potential due to availability of hygienically safe and clean water.
- Savings arising from reduced price and time spent fetching water
- increase in the government revenue generation
- creation of employment during construction and operation phases of the project
- boost in business of construction materials and consumables especially during construction phase
- increased value of land and property in the project area and environs

17.2 Negative Impacts

Though most of the expected socio-economic impacts are positive, there are also potential negative impacts.

Loss of property

The loss of property to the residents especially between the intake and the main road will mainly include food crop plants which will occupy the pipeline path. Further during construction of the pipeline more plants may be destroyed during delivery of materials to the intake site. Therefore farmers will be required to give way leave for the pipeline and road to the proposed intake works.

Mitigation measures

To mitigate against the losses the farmers will negotiate and make agreements on the value of losses which must be settled before the project starts implementation.

Population influx

The rapid increase in population may result in strain of infrastructure services e.g. electricity, road network and water supply systems which may get overloaded before the design period.

The high population may also lead to excessive generation of solid waste which does not presently have an elaborate collection and disposal system. The waste will therefore accumulate in the market centres and environs leading to the problems being encountered in other towns such as Nairobi e.g. Emission of malodorous gases and blockage of drainage system ultimately forcing their way into the nearby water sources. Increase in population may result in benefits owing to increased consumer base but may also lead to insecurity problems which overwhelm the current set up. Therefore mitigation measures should be formulated by the relevant institutions before the onset of these impacts;

- the planning department should be involved at all stages of new developments to accommodate changes
- administration to continuously monitor changes in insecurity levels and formulate new approaches to counter them

18.0 DECOMMISSIONING OF THE PROJECT

The project can be decommissioned when the design period ends or due to one of the following reasons;

- The source may become inadequate due to unexpected change in climate rendering the project inefficient
- Other cheaper means of getting water may be developed near the entire or part the community and other target areas and cause the proponent to close and change to the source

Under these circumstances, the proponent will demolish the all the structures including treatment works; remove the salvage materials and restore the sections affected to the original state.

The resultant waste should be sorted into re-recyclables and non-recyclables before disposal at the designated site in accordance to NEMA regulations on Solid Waste. The recyclables e.g. pump sets, GI pipes, plastic materials could be re-used in new projects or sold to recyclers.

The following table summarizes the impacts and associated mitigation measures during decommissioning phase;

ENVIRONMENTAL/SOCIAL IMPACTS	MITIGATION MEASURES
Accumulation of solid waste after demolition	Collection and sorting for waste disposal or recycling to ensure NEMA waste management regulation and procedures are followed as required
Aesthetic beauty and possible Soil erosion	Restoration of the affected site e.g. pump house, main storage tanks, rising main route etc through landscaping and planting vegetation cover
Possible loss of income for workers and neighboring community	Sensitize the workers and the community on imminent occurrence so that they can absorb the psychological shock without devastating consequences. The proponent could redeploy some of the staff in other relevant areas of operation

19.0 ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN (EMP)

Environmental Social Issues or Impacts	Proposed Mitigation Measures	Procedure for Implementation	Responsibility	Cost Kshs	Time Frame
Solid waste management	Proper solid waste management as per NEMA waste management regulations	Collection, sorting and recycling or disposal at designated site	Contractor Proponent during construction and operation phases respectively	Kshs. 30,000	Throughout construction and operation phases
Air pollution	Control of dust and hydrocarbon fumes during trenching and excavation	• Reduce dust generation by wetting using water. • Where diesel mechanical equipments are used, ensure the engines are in good working condition and properly maintained • Enclose the works and orient exhaust away from the nearby residences	Contractor	Kshs. 50,000	Throughout trenching and excavation activities Continuously during operation and at regular intervals
Noise	Control noise to be within the recommended limits to avoid disturbance of neighbors	✓ Enclose drilling and all excavation sites where mechanical equipment are used ✓ Ensure the work is done during the normal working hours (8.00am-5.00pm) ✓ Use low noise equipment	Contractor and proponent during construction and operation phases respectively	No costs	Throughout construction phase

		during construction • Ensure the equipment is regularly and properly maintained			
Health and safety	Prevention of accidents Protection against advanced health effects	✓ Use of physical barriers and labeled icons to prevent and warn the public on dangers of construction activities ✓ Provision of protective gears to the workers ✓ Training and Provision of first aid kits to the workers. ✓ Training workers on environmental health and safety procedures and emergency preparedness ✓ Insuring the workers on medical and workman compensation	Contractor and Proponent during construction and operation phases respectively	In accordance with prevailing costs	Throughout construction and operation
Management of conflicts	The water supply management to be done using guidelines for water user association from the Ministry of Environment, Water and	Formation of water users association to manage the water supply kiosks	Proponent	No cost	Once after commissioning

	Natural Resources				
Interference with fish and aquatic bio diversity	Provision of a means to allow migration of fish and other aquatic organism upstream/down stream across the weir	The weir is designed to allow free migration/ movement of aquatic organism across it	Proponent / constant	No cost	Once during construction phase
Loss of property Acquisition of Project land /way leave	Sensitization of the affected members of the public • Compensation for wayleave • Land purchase	Sensitization and consultations Negotiations, agreements and valuation Negotiations, agreements and valuation	Proponent and consultant Proponent Proponent	 2 million 4 million	Before the project implementation
Diseases Hazards	Sensitize the public on consequences of accumulation of stagnant water around the water kiosks	Sensitization, training on spillage waste management	Proponent	No cost	During operation phase
Project acceptance	Consultation and information during open barazas	consultations	Proponent and consultant	Kshs. 200,000 incurred during project	During feasibility and design studies

				preparation activities	
Insecurity	Sensitize the community and security institutions on the possible impacts of the project	Increased security surveillance	Proponent	In accordance with prevailing costs	During commissioning and operation phase
Physical cultural resources Chance find/discoveries e.g. archeological site, historical site, graveyard discovery	Chance find procedures Resident Engineer to stop works, secure the site and report to the relevant authority for evaluation and decision.	Meanwhile the Engineer will be required to liaise with authority to allow for project progress e.g. redesigning to avoid the site giving way for preservation, conservation, restoration and salvage as detailed under impacts during construction phase.	Contractor/ proponent /consultant/ relevant authority.	As per evaluation and advice from the relevant authority.	Throughout the project implementation period.
Total Cost				**6,280,000**	

20.0 CONCLUSION

Mwea-Makima Water Supply project will be funded by the World Bank/ Government of Kenya through Tana Water Services Board which intends to alleviate the acute lack of water in the semi-arid Mwea ,Kirinyaga East district and Mwea South and Makima Divisions of Mbere district; where the community normally walk for more than 10km to look for water which is neither adequate or safe for human consumption. Potential environmental impacts associated with implementation activities of the project i.e. construction and operation phases have been assessed and analyzed carefully and the necessary mitigation measures have been formulated.

Among the impacts include: soil erosion, generation of dust, noise disturbance, disease hazards, and possible accidents.

These including socio-economic benefits, health and safety issues of the workers and neighboring community have been considered and an Environmental Management and Monitoring Plan has been formulated to guide the proponent and NEMA in future audits.

Among Socio-economic benefits include eradication of waterborne diseases, improved livestock production and time saving for other economic activities. These together with expected improved business in the market centres in the project area are positive impacts that outweigh any negative impacts associated with the project. This is in consideration of the mitigation formulated against the negative impacts as indicated in this EIA project report.

It is therefore our request that NEMA approves the project for implementation to improve the quality lives of the people in the project area.

ANNEXES

Annex 1:	**Layout plan of the project showing, intake works and treatment works sites & pipelines**
Annex 2:	**Minutes on public participation open baraza**
Annex 3:	**Hydrological study report**
Annex 4:	**Water quality standards**
Annex 5:	**Public participation open baraza photo gallery**
Annex 6:	**Socio-economic study report of the area**

Annex 1: Layout plan of the project showing, intake works and treatment works sites & pipelines

MWEA - RIAKANAU WATER SUPPLY PROJECT LAYOUT

PROPOSED INTAKE ONE

PROPOSED INTAKE TWO

MIRICHI COFEE FACTORY

MURURI

KIANJIRU

PROPOSED TREATMENT PLANT

KIMBIMBI

NGURUBANI

MUTITHI

PIAI

GATWIRI

GATEGI

KAKINDU

KAKAWA

GIKURU

MATHARE

MADHARAU

MAKIMA

KARABA

WANGO

NTHINGINI

RIAKANAU

EMBU DC

MWEA NATIONAL RESERVE

Legend

Points of Interest

Proposed Pipeline

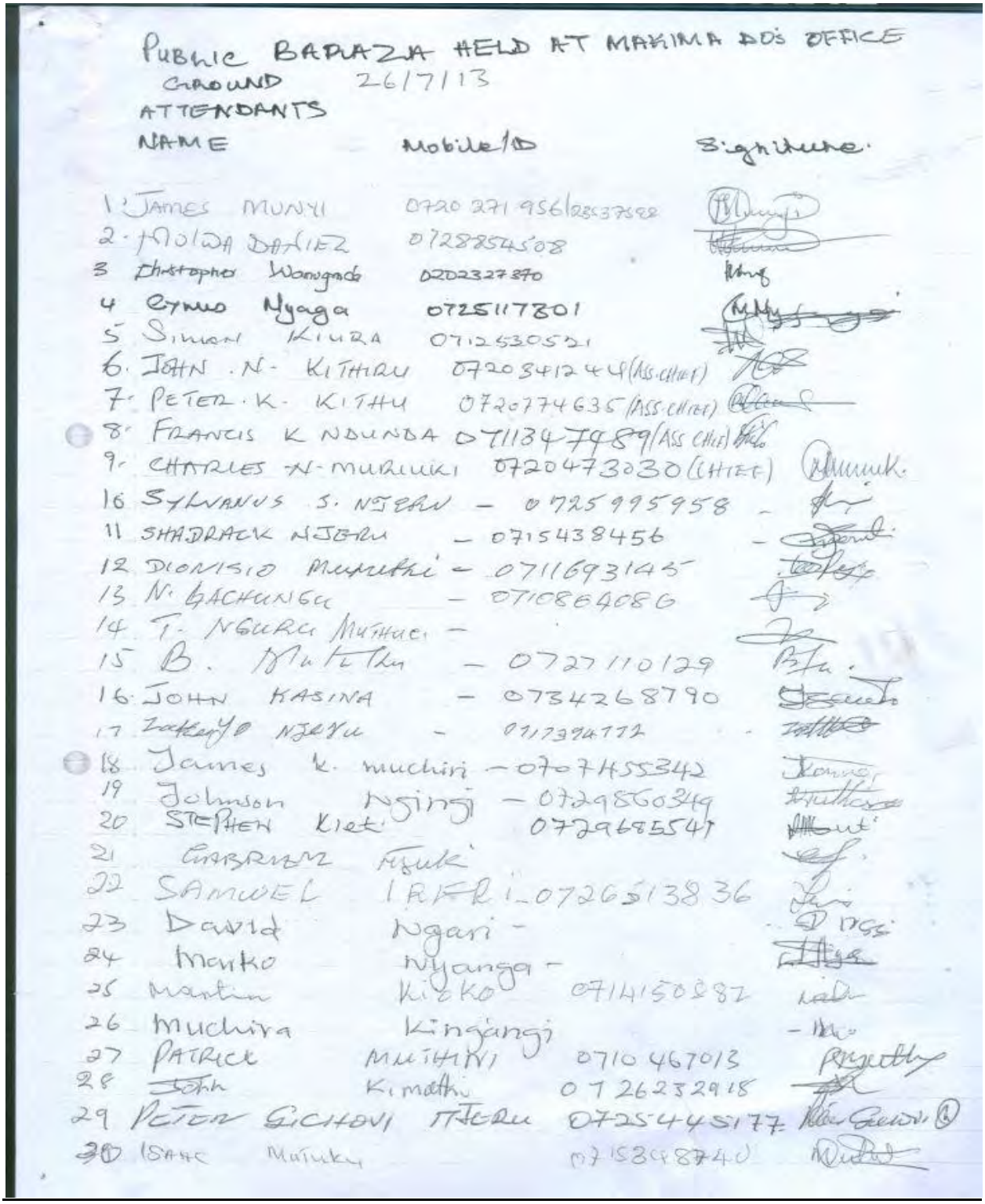
SCALE 1:50,000

Date: July 2013.

Annex 2: Minutes on public participation open baraza

MINUTES OF PUBLIC BARAZA HELD AT MAKIMA MARKET CENTRE, MAKIMA SUB-LOCATION, MAKIMA LOCATION ON 26TH JULY 2013.

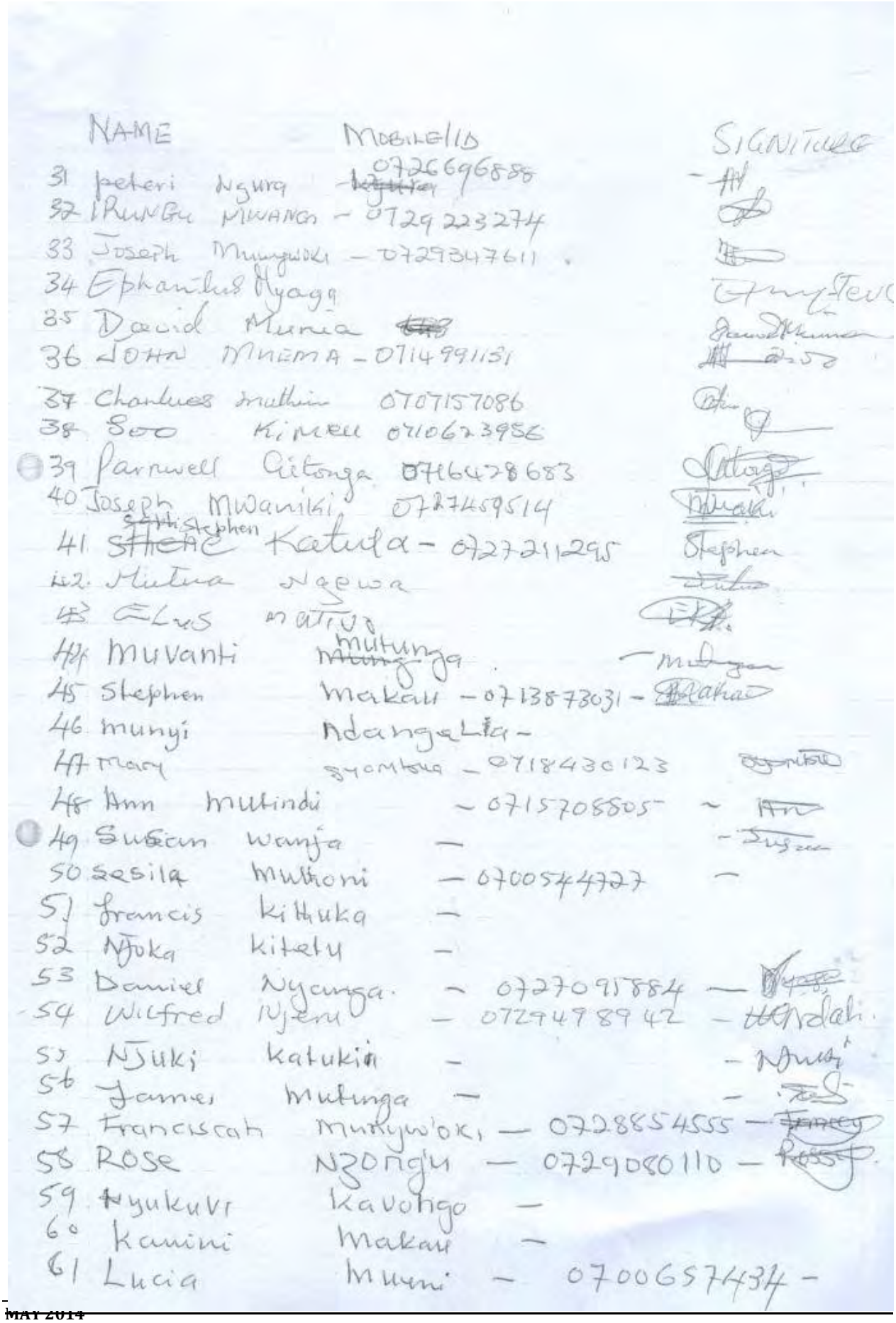
ATTENDANTS



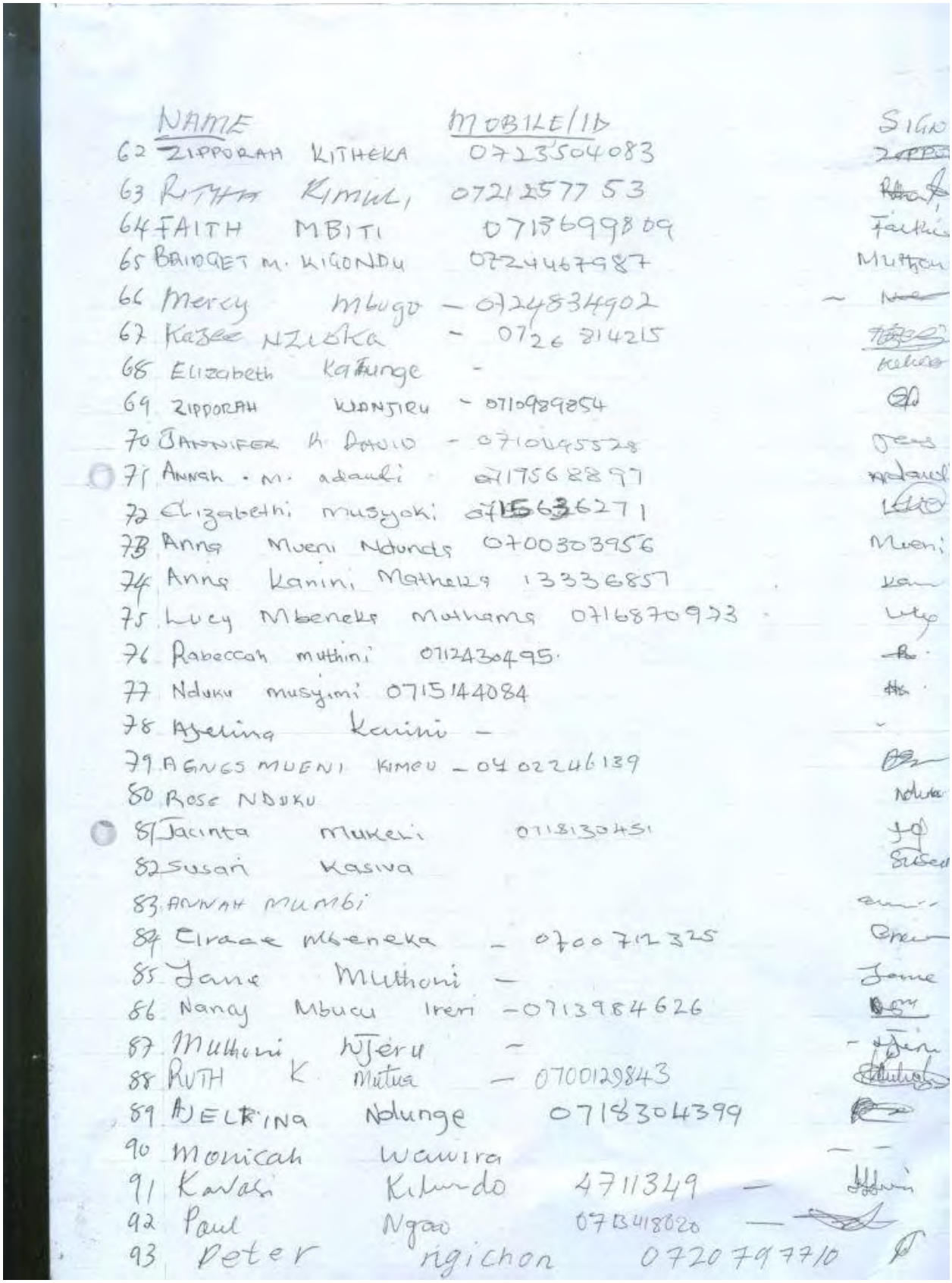
PUBLIC BARAZA HELD AT MAKIMA DO'S OFFICE GROUND 26/7/13

ATTENDANTS

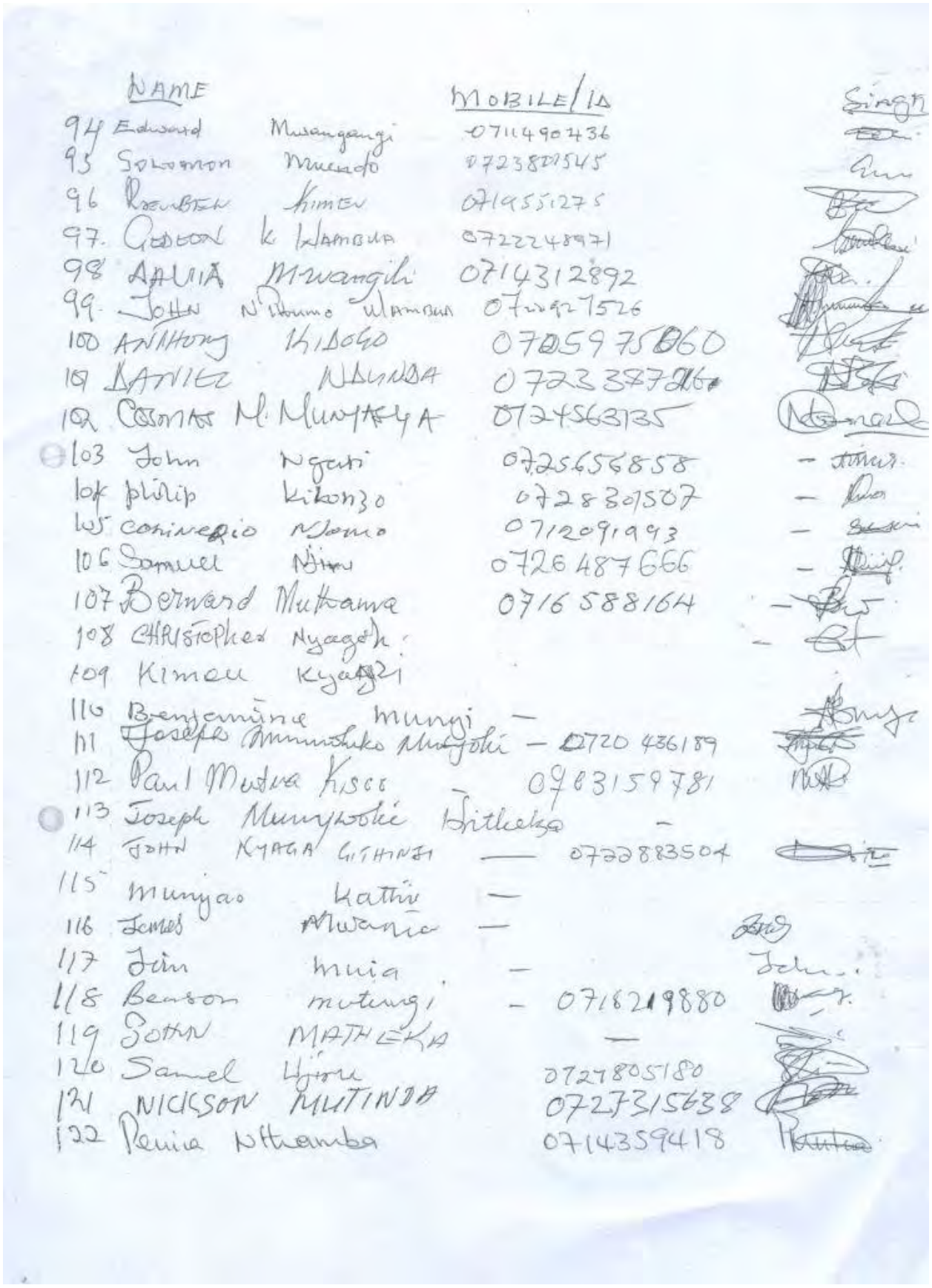
	NAME	Mobile/ID	Signature
1	JAMES MUNYI	0720 271 956/28637888	
2	MOLWA DAHIEZ	0728854508	
3	Christopher Wanyaaka	0202327870	
4	Cyrus Nyaga	0725117801	
5	Simon Kiura	0712530521	
6	JOHN .N. KITHIRU	0720341244 (ASS. CHIEF)	
7	PETER .K. KITHU	0720774635 (ASS. CHIEF)	
8	FRANCIS K NDUNDA	0711347989 (ASS CHIEF)	
9	CHARLES N. MURIUKI	0720473030 (CHIEF)	
10	SYLVANUS S. NJERU	– 0725995958	–
11	SHADRACK NJERU	– 0715438456	–
12	DIONISIO Muruthi	– 0711693145	
13	N. GACHUNGA	– 0710864086	
14	T. NGURU Muthee	–	
15	B. Mutethu	– 0727110129	
16	JOHN KASINA	– 0734268790	
17	Zakayo Njeru	– 0717394772	
18	James K. muchiri	– 0707455342	
19	Johnson Njingi	– 0729860349	
20	STEPHEN Kieti	0729685547	
21	GABRIEL Nguki		
22	SAMUEL IRERI	0726138836	
23	David Ngari	–	
24	Manko Nyanga	–	
25	Martin Kioko	0714150887	
26	Muchira Kingangi		–
27	PATRICK MUITHIKI	0710467013	
28	John Kimathi	0726232918	
29	PETER GICHOVI Mbeere	0725445177	
30	ISAAC Mutuku	0715847840	



	NAME	MOBILE/ID	SIGNATURE
31	peteri Ngura	0726696886	
32	IRUNGU MWANGI	- 0729 223274	
33	Joseph Mungwiki	- 0729347611	
34	Ephantus Nyaga		
35	David Munia		
36	JOHN MWEMA	- 0714991151	
37	Charles muthiu	0707157086	
38	Soo	KIMELI 0710623956	
39	Parnwell Gitonga	0716478683	
40	Joseph Mwaniki	0727459514	
41	Stephen Katula	- 0727211295	Stephen
42	Mutua	Ngewa	
43	CLES	MATIVO	
44	Muvanti	Mutunga	
45	Stephen	Makau - 0713873031 -	
46	munyi	NdangaLia -	
47	Mary	Nyombua - 0718430123	
48	Ann	Mutindi - 0715708805	~
49	Susan	Wanja -	
50	Cecila	Muthoni - 0700574727	-
51	francis	kithuka -	
52	Njoka	kitelu -	
53	Daniel	Nyaunga. - 0727095884	-
54	Wilfred	Njeru - 0729498942	-
55	Njuki	katukiu -	-
56	James	Mutunga -	-
57	Franciscah	Munywioki - 0728854555	-
58	ROSE	NZONGU - 0729080110	-
59	Nyukuvi	Kavonga -	
60	Kamini	Makau -	
61	Lucia	Muuni - 0700657434	-



	NAME		MOBILE/ID	SIGN
62	ZIPPORAH	KITHEKA	0723504083	
63	RUTH	KIMUL,	07212577 53	
64	FAITH	MBITI	0715699809	
65	BRIDGET M.	KIGONDU	0724467987	
66	Mercy	Mbugo	– 0724834902	
67	Kazee	NZISKA	– 07 26 814215	
68	Elizabeth	Kathunge	–	
69	ZIPPORAH	WANJIRU	– 0710989854	
70	JANNIFER	K. DAVID	– 0710455528	
71	ANNAH	M. adamki	0715688897	
72	Elizabethi	musyoki	0715636271	
73	Anna	Mueni Ndunda	0700303956	
74	Anna	Kanini Matheka	13336857	
75	Lucy	Mbeneka Muthama	0716870973	
76	Rabeccah	muthini	0712430495	
77	Nduku	musyimi	0715144084	
78	Ajelina	Kanini	–	
79	AGNES	MUENI KIMEU	– 0702246139	
80	ROSE	NDUKU		
81	Jacinta	Mukeri	0718130451	
82	Susan	Kasiva		
83	ANNAH	MUMBI		
84	Eliaae	Mbeneka	– 0700712325	
85	Jane	Muthoni	–	
86	Nancy	Mbuu Ireri	–0713984626	
87	Muthoni	Njeru	–	
88	RUTH	K Mutua	– 0700129843	
89	AJELKINA	Ndunge	0718304399	
90	Monicah	Wawira		
91	Kavaki	Kilundo	4711349 –	
92	Paul	Ngao	0713418820 –	
93	Peter	Ngichon	0720797710	



	NAME		MOBILE/ID	Singn
94	Edward	Mwangangi	0711490436	
95	Solomon	Mueedo	0723871545	
96	Reuben	Kimeu	0719551275	
97.	Gideon	k Wambua	0722248971	
98	Alvia	Mwangili	0714312892	
99.	John	Nzioumo Wambua	0719927526	
100	Anthony	Kidogo	0705975060	
101	Daniel	Ndunda	0723377206	
102	Cosmas	M. Munyaka	0724563135	
103	John	Ngati	0725656858	–
104	Philip	Kikonzo	0728807507	–
105	Conviegio	Ndomo	0712091993	–
106	Samuel	Njiru	0726487666	–
107	Bernard	Muthama	0716588164	–
108	Christopher	Nyaggah		–
109	Kimeu	Kyaggi		
110	Benjamine	Mungi	–	
111	Joseph	Mwanzuko Munyoki	– 0720 436189	
112	Paul Mutua	Kisoo	0703159781	
113	Joseph	Munyoki	Kitheka –	
114	John	Kyaga Githinji	— 0722883504	
115	Munyao	Kathiu	—	
116	James	Mwania	—	
117	Jim	Muia	—	
118	Benson	mutungi	– 0716219880	
119	John	Mathenya	—	
120	Samel	Njiru	0727805180	
121	Nickson	Mutinda	0727315638	
122	Peninah	Nthamba	0714359418	

The meeting started at 3.55p.m with a word of prayer led by one of the participants.

MINUTES 1: OPENING AND INTRODUCTION

The meeting was chaired by the chief of Makima Location. He welcomed the teams from Tana Water Services Board (TWSB), LUJO Consulting Engineers (LCE), Representative from Water Resources Management Authority (WARMA), Kirinyaga East DWO representative and Kirinyaga county Director of Environment NEMA. The teams introduced themselves as: - TWSB, Engineer T.Kibaki the Design Planning and Strategy Manager, Mr. B. Migwi, Communications and Resource Mobilization Manager, and C.Ndahi the Surveyor. Lujo Consulting Engineers representatives were Mr.J.G Muriuki, the Environmental Expert and Mr. C.Nyaga Social-Economic Consultant, Mr. W.Muchiri, Kirinyaga county Director Environment (NEMA), Mr. Simon Kiura represented DWO Kirianyaga East district.

MINUTES 2: PROJECT DISCIPLINE AND COVERAGE

Tana Water Services Board described the project from the source at Ngirigacha bridge, Mbiri, Njukiini Location, to Kangu and Kanjiru proposed treatment works sites, Mwea East, Mwea South up to Makima. It was explained that the proposed Water Supply was for domestic use only and will be treated to ensure safety for human consumption. Further, initially the water will be supplied through water kiosks in order to benefit as many people as possible.

MIN 3: ENVIRONMENTAL AND SOCIAL CONCERNS

Mr. Muriuki, thea Environmental expert explained that though the proposed project is expected to solve the serious and acute problem of lack of safe water for human consumption, there are concerns that need to be addressed in relation to environmental protection and conservation.

There are several positive and negative impacts that could arise from activities of the project. Among negative impacts that would need formulation of mitigation measures include:-

- Noise and dust pollution
- Destruction of delicate natural vegetation.
- Soil erosion
- Possible accidents
- Disturbance of project neighbors if the work is scheduled out of normal working time of the day(8.00am-5.00pm)

The social-Economist Mr. Cyrus Nyaga explained on some of positive social-Economic impacts of the project among which include:-

- Availability of employment
- Market for construction materials
- Saving of time which was required to fetch water for other income generating activities.
- Availability of good quality water will reduce incidences of water borne diseases, hence reduced hospital expenses.

Improve in value of properties. All the impacts either positive or negative will be analyzed in report and depending on severity of the impacts considered negative; a conclusion will be given before submission to NEMA for variation.

MIN 4: QUESTIONS / COMMENTS / CLARIFICATIONS

The participants were given chance to raise questions, comments or clarification.

Question 1

The participants wanted to know the extent of distribution around Makima.

Response

The water supply distribution around Makima will ensure that the residents within 2km radius are served.

Question 2

The participants wanted to know whether the contractor will employ the local people or come with their work force.

Response

The contactor will be required to give the local people priority especially for non-skilled labor.

Question 3

What will be the cost of water?

Response

The cost of water will be determined by the cost of delivering clean water to the people of Makima but will be within manageable value for the common man. The water will not be sold at a profit but only to recover costs.

Question 4

How long will the project take?

Response

The project is expected to take two years.

Comments

The community was grateful for the project and agreed to offer way leaves for pipeline and reservoir without compensation.

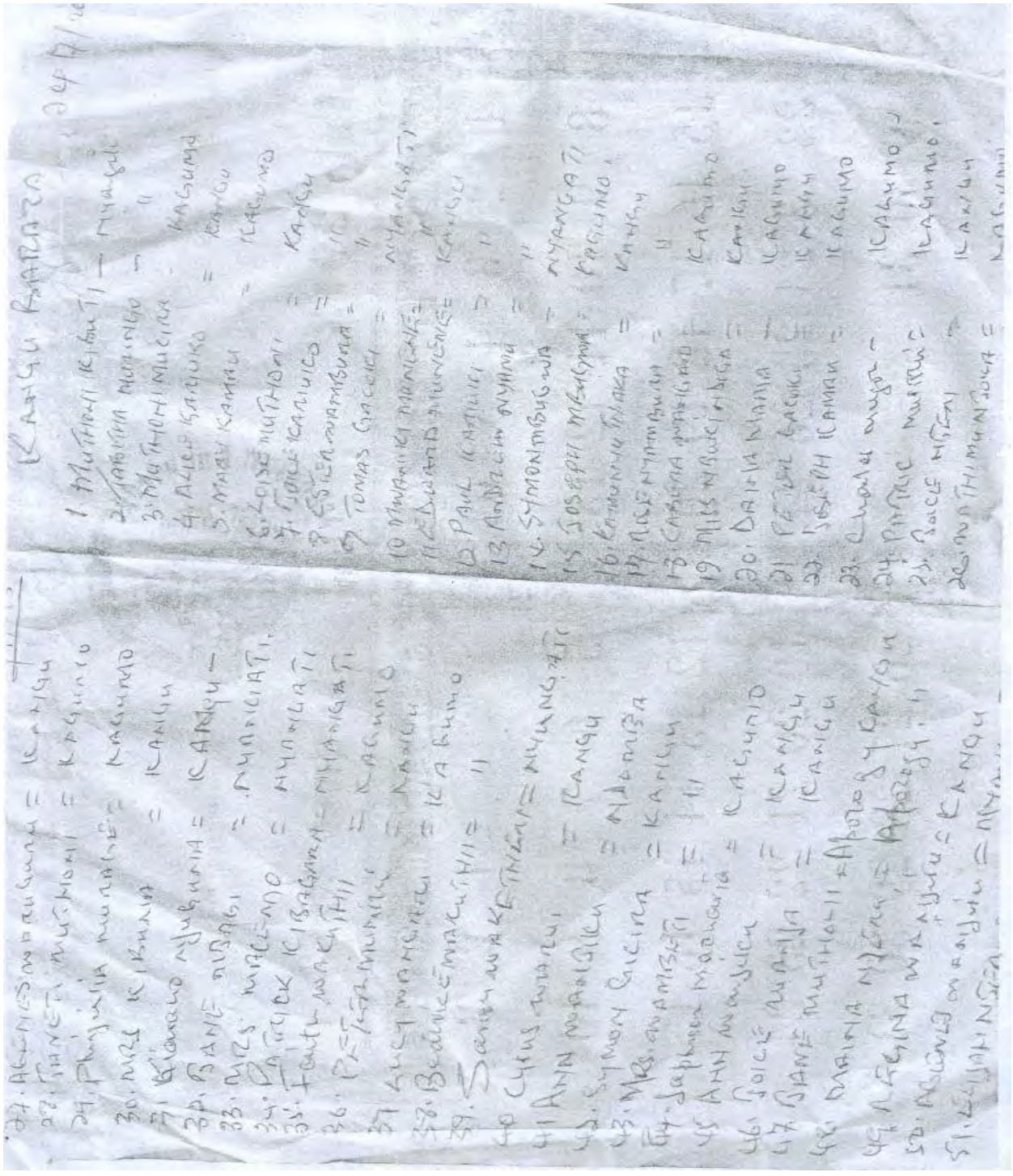
Way forward

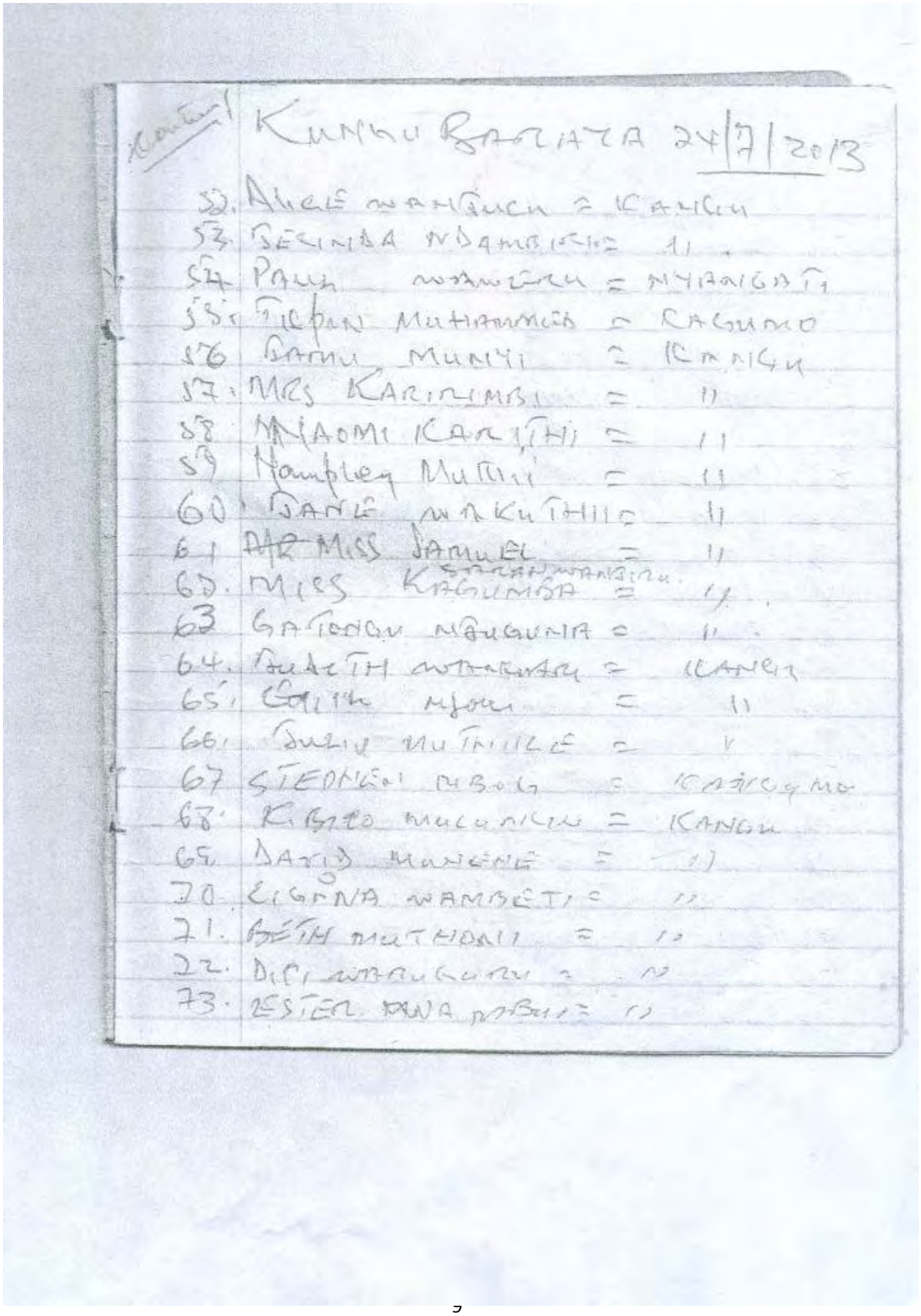
The community agreed to support them in all ways that will be requested.

The meeting ended at 4.40 PM.

MINUTES OF PUBLIC BARAZA HELD AT KANGU DISPENSARY, KANGU SUB-LOCATION KUTUS LOCATION

PRESENT

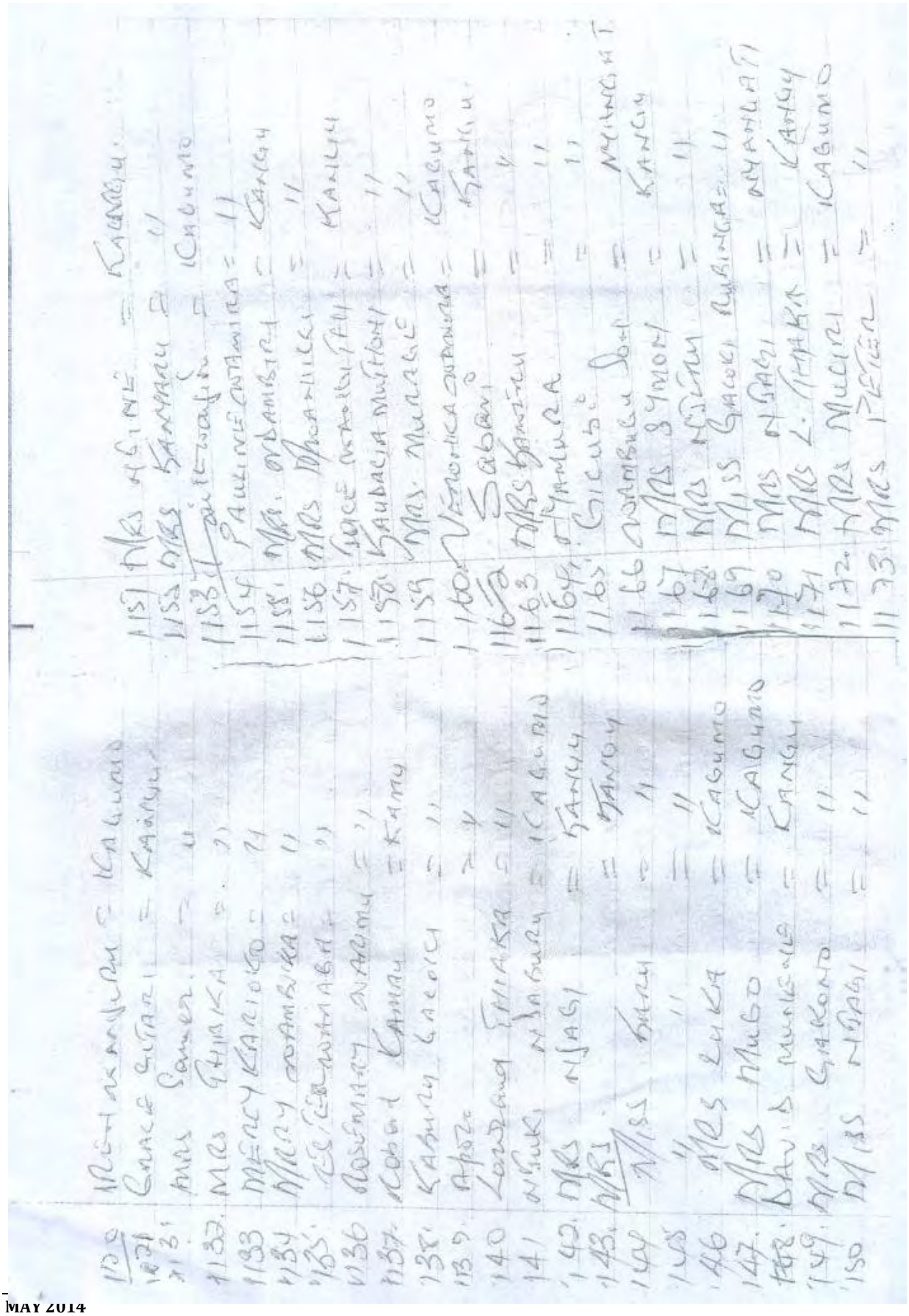




KUNGU BARIATA 24/7/2013

52. ALICE WANJIKU = KANGAI
53. SECINDA NDAMBUKI = 11
54. PAUL NDIRANGU = MYAHAGATI
55. TIRIAN MUTHAMBI = KAGUMO
56 BATHU MUNYI = KANGAI
57. MRS KARIUKI = 11
58 NAOMI KARITHI = 11
59 Hamphey Muthui = 11
60 DANIEL NJUKITHI = 11
61 ~~Mr~~ Miss JAMUEL = 11
62. MISS KAGUMBA = 11
63 GATOOKA NGUGUNIA = 11
64. RUTH WITHARUTA = KANGAI
65 CALIN MJOKI = 11
66 JULIE MUTHUI = 11
67 STEPHEN MBOYA = KAIRUGU
68. KIBIRO MUCHIRI = KANGAI
69. DAVID MWANGI = 11
70. EUNICE WAMBUI = 11
71. BETH MUTHONI = 11
72. DICI WAIGURU = 11
73. ESTER WANJIRU = 11

#174 Muema Kabera = NYANGATI
#175 Symon Ngine = Kangai
#176 Kaya wanja = "
over 200 people for the
Senara.
#177 Severin Mbogo = Kenya
#178 Teresia Muthoni = ICA Gamo
#179 Alice Muthoni = Kangai
#180 Daniel Muriithi = "
#181 Faith Nyanga = "
#182 Dawson Chomba = ICA Gamo
#183 Stanley Gacoki = "
#184 Symon Muthiga = ICA Kangai
#185 Margret Wanjiku = Nyangati
#186 Beth Njeri Chomba = Kangai
#187 Rose Wanjiku Samuel = Nyangati
#189 Millicent Wakuthii Gitau = Kangai
#190 Charity Muriithi = Nyangati
#191 Sheila Mwangi = "
#192 Naomi Ngeera = "
#193 Joseph Kariuki = ICA Gumo
#194 Mary Wanjiru = Kangai



The meeting chaired by the Kutus location Chief, Ms Nancy Gichuki started at 2.30p.m. a word of prayer led by one of the participants. Tana Water Services Board Design, Planning and Strategy manager Eng. T.Kibaki introduced his team and that from Lujo Consulting Engineers. The members from Tana Water Services Board were:- Engineer T.Kibaki, M.B.Migwi the communications and Resource mobilization Manager and the surveyor Mr. C.Ndehi.

MIN 1: PROJECT DISCRIPTION AND ENVIRONEMNTAL CONCERNS

The team from Tana Water Services Board gave the project discipline and coverage while Lujo Consulting Engineers explained Environmental Social-Economic concerns of the project. Mr. J.G Muriuki an Environmental expert from Lujo Consulting Engineers informed the meeting that it was a requirement that all projects in the category of water supplies undergo an Environmental Impact Assessment study before commencing implementation.

The process starts with sensitization of the community in and in and in the neighborhood of project. This is to allow them to air their views regarding impacts of the activities of the project so that they can be involved in formation of mitigation measures for the identified negative impacts.

Among the activities identified to have negative impacts were:-

Possible accidents at construction sites if not isolated and protected from public e.g construction of intake works, treatment works, reservoir tanks and pipeline trenches.

Noise and dust pollution

Possible disturbance of the community if normal working hours are not observed.

Destruction of property, fauna and flora where applicable.

Scenic beauty etc.

MIN 2: QUESTIONS AND COMMENTS

After presentation the baraza members were given time to ask questions, clarification and comment on the issues discussed.

Question 1

The community wanted to know what kind of compensation will be given to the affected persons.

Response

Tana water Services Board responded to the question as follows:- the compensation will be monetary pegged on the value of proper acquired for the project.

Question 2

The community wanted to know whether there will be compensation for pipeline way leaves where it passes through an individualôs property.

Response

The land acquired for pipeline way leave and any property destroyed will be compensated.

Question 3

The community wanted to know whether they could be supplied with the proposed supply to irrigate their land.

Response

The proposed project is for drinking water only i.e domestic use and not for irrigation and is meant for Mwea and Makima areas whose community desperately need clean water for domestic use. These communities have no sources of clean drinking water in adjacent areas.

Question 4

The community wanted to know whether the contractors for the project will have insurance for the workers in case of accident.

Response

The contractor will be required to have an insurance cover for their workers in case of an accident but he/she is not obliged to cover any idlers at the site.

Question 5

The community wanted to know whether water will be free.

Response

The water will be charged in accordance with the volume consumed as per meter reading.

Comment

The community was informed that, the project will be designed in such a way to avoid important cultural sites, graves and homes.

Question 6

How will the community benefit apart from the individuals who will be compensated for property losses.

Response

Since the treatment works be sited either at Kangu or Kianjiru Market, the community near the treatment works will be given water supply at a fee based on metered consumption.

Question 7

How long will the project take to implement.

Response

The project was expected to take two years.

Question 8

How far the water supply will be distributed.

Response

The distribution will only cover the community within 2km from the treatment works.

Question 9

The community wanted to know whether the excavation for the pipeline trenches and buildings foundation will be done using mechanical equipment or manually.

Response

The contractor will be advised to use manual labour as much as possible in order to provide jobs to the local youth unless they will not be available or will not be able to work as fast as contractor would like.

Question 10

What will be the effect of the proposed project on the existing project?

Response

The proposed project will not in any way interfere with the existing projects.

Way forward

The community agreed to support the project.

The meeting ended at 5.30 PM.

MINUTES OF PUBLIC BARAZA HELD AT KIANJIRU MARKET CENTRE, KIANJIRU SUB-LOCATION, BARAGWI LOCATION, GICHUGU DIVISION ON 25TH JULY 2013.

ATTENDANTS

NAME	TELEPHONE No.
1. James G.Muriuki(LCE)	0722781275
2. B.Migwi(TWSB)	0720692254
3. Simon M.Kiura	0712530521
4. Cyrus Nyaga	0725117301
5. Cyrus Kubuta	0722395048
6. Teresia Wanjiku	0703796533
7. Cecindah Wanjiku	
8. Simon Njuki	0712260843
9. Florence Muthoni	0718676223
10. Lucia Njoki	
11. Jane Wakuthii	0712400253
12. Susan N.Kongo	0721835508
13. Ann Muya	0711682239
14. Saravinah Wamarwa	0725704078
15. Faith Wangui	0703339357
16. Reginah Wambeti	
17. Judy Muthoni	
18. Richard Gacenge	
19. Jeremiah Nyaga	
20. Samuel Murage	0710405564
21. Peter Njeru	0728577418
22. Julius Nyaga	0710623141
23. Elijah Macharia	
24. Josphat Magondu	0728846838
25. Stephen Maina	0716428257
26. John Macharia	0714832155
27. Jose Mwangi	0714417463
28. Octivius M.Mugo	0718471932
29. Josphat Macharia	0725624231
30. Josphat Munene	0750398484
31. Sicky Muthoni	
32. Grace W.Ndwiga	0720370677
33. Pius Maganjo	0710623165
34. Kimuthu Calon	0711261844
35. Johnson G. Kiura	0703867610
36. Anliria wandoma	
37. Eunice Njoki	0722318142
38. Jane Wanjiku	0723618964

39.	John Njue	0722805512
40.	Peter G.Mwobe	0725542982
41.	Carol Wakitwi	0716921854
42.	Rebecca wawira	0710215736
43.	Isabera wawira	0712462711
44.	Jane kariuko	0715807600
45.	Anne Wanjiku	0706492919
46.	Kiura Mithamo	
47.	Joseph Murimi	0735859510
48.	John G.Kethi	0720043694
49.	Jane Njimiri	
50.	Sophia M.Ndamiri	0728779457
51.	Peter Kariuki	0704322382
52.	Josphat Kariuki	0712811303
53.	Juliana Mutitu	
54.	Milian Wanjiku	
55.	James Munene	0705886163
56.	Mary wambui	
57.	Daniel Nyaga	0705574759
58.	Leonard Kariu	0726401049
59.	Nancy Muthoni	0724139741
60.	Joseph Comba	0703786596
61.	Anthony Muchiri	0768555656
62.	John Kibuta	
63.	Beatrice wangithi	0710924216
64.	John Kinyua	0713748769
65.	Joseph M.Mboi	0700385374
66.	James Muthike	0704145694
67.	Munene Mohammed	0721258059
68.	Mary wakariru	0721437290
69.	Francis Gitari	0724792264
70.	John N. Magondu	0735002969
71.	James K.Njogu	0723129318
72.	Jamleck M.Njogu	0700310694
73.	Claire Wawira	0726490276
74.	Cecily Njoki	0725960541
75.	Janeffer Nyambura	0716838179
76.	Harrison wachira	0728221516
77.	Muriuki Muthike	0724488358
78.	Ephantus Nyaga	0722381085
79.	Mathew Muthuku	0724008846
80.	Consolata W.Mwangi	0726490726
81.	Pauline wanjiru	0700043684
82.	James Kongo	0722569915

83. Leonard Muthike	0728205000
84. Eliud K.Kaina	0726293688
85. Jeremia Nyaga	0713908466
86. Eustas Ndambiri	0722465062
87. Boniface Mwangi	0722661390
88. Samuel Mwithiga	
89. David Waweru	0712846778

The meeting started at 10.00a.m with a word of prayer led by one of the participants. The Chairman, Baragwi location. The chief introduced the area elders and the county representative.

The teams from Tana Water Services Board and Lujo Consulting Engineers introduced themselves indicating their role in implementation of the proposed project. Tana Water Services Board(TWSB) team included Engineer T.Kibaki, the Design, Planning and strategy Manager and the communications and Resource Mobilization Manager Mr. B.Migwi.

Members from Lujo Consulting Engineers (LCE) included Mr.J.G Muriuki Environmental lead expert and Social-Economist Mr.Cyrus Nyaga.

MIN 1: DISCRIPTION OF THE PROJECT AND COVERAGE

TWSB team described the project and its coverage from the proposed intake at Ngirigacha Bridge Mbiri area to Kangu sub-location, Kianjiru sub-location, Mwea and finally Makima market centre, Makima sub-location. There will be construction works at the proposed intake and the first section of the pipeline may pass through peopleôs property but that would depend on the results of the survey. There will be conventional treatment works which will be either located at Kangu dispensary or Kianjiru market centre. Most of the pipeline is envisaged to follow the main roads. Other installation will include water reservoirs which could be located on peopleôs property.

The community was requested to provide way leave where required but will be compensated as per government guidelines. The community was finally requested to allow the surveyors to enter their land.

MIN 2: ENVIRONMENTAL CONCERNS

The Baraza was sanitized on their constitutional rights to clean and healthy environment and potential impacts of project activities on their environment. The community was further informed that though there were obvious impacts whose mitigation measures will be formulated as required by NEMA there could be others that are unique to the community. The meeting provides a chance for the community to have their input on such issues as their contribution towards environmental assessment. All the positive and negative potential impact shall be identified and mitigation measures formulated where applicable.

Some of the negative impacts arising from project activities which need mitigation measures include:-

- Noise and dust pollution during excavation of pipeline treches and building foundation.
- Accumulation of construction waste.
- Possible accidents.

- Disturbance of the neighbours when work is scheduled outside normal working time (8.00 ï 5.00p.m)
- Mismanagement of chemical sludge waste
- Destruction of valuable vegetation
- Soil erosion
- Less of scenic beauty
- Disturbance of sites of cultural values.

Positive impacts

- Provision of employment
- Market for available construction inputs.

Mr. Cyrus Nyaga, Lujo Consulting Engineers Social Economist explained to the Baraza that all persons affected by the proposed project siting will be identified after the survey is carried out and a meeting will be convenience by TWSB to give further details on compensation process. The valuation will be guided by government regulations. It was clarified that to ensure maximum benefits are realized by the local community, priority will be given to them for nay arising employment opportunities. The entire non-skilled labor should be provided by the local community. The contractor will be encouraged to buy raw materials and hardware items from the local market so long they conform to the quality and are competitive in price. The contractor will be required to ensure all outsiders in his workforce follow security guidelines from the administration to avoid incidences of conflicts.

MIN 3: QUESTIONS, COMMENTS OR CLARIFICATIONS

After presentation the members were given a chance to raise questions, comments or seek clarification regarding the project implementation process.

1.The participants appreciated the proposed project and requested for supply of water since the existing water project, Rwambiti Water Supply Project does not provide reliable service due to lack of distribution system.

The proposed project is meant for the desperate community of Mwea and Makima areas and there may not be enough water to supply to other consumers, but it will be considered whether the neighbouring community could get connections from the water works. This will only be possible if the design locates the water works at this market. The participants were informed that development of bulk water supply project is underway to adequately cover the entire Kirinyaga members lamented that the market centre desperately needs infrastructural facilities and cited lack of designated market place and sanitation facilities. This problem forces public visiting the market centre either to sell or buy items to use individual neighbours toilets which was very inconveniencing.

It was noted that the entire county is in higher need for infrastructural planning including flood mitigation measures and water and sewerage facilities. During the Baraza a member of a tree planting Rural Welfare Association took opportunity to sensitize the public on their activities and benefits realizable. The member advised the participants to form working groups and request for information on possible funding of their tree planting project whose income depend on the number of trees planted.

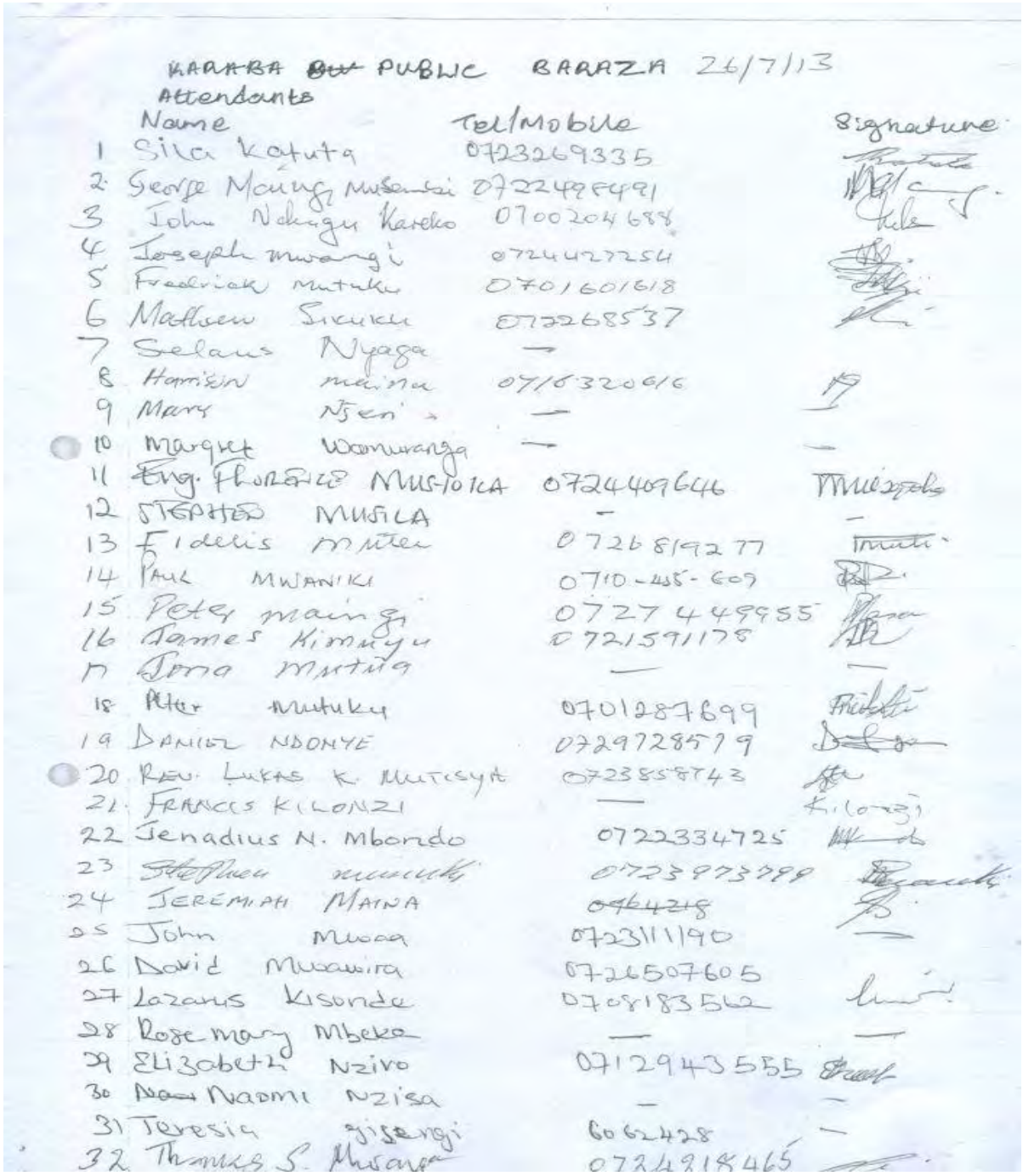
Way forward

The community agreed to support the project.

The meeting ended at 5.30p.m.

MINUTES OF PUBLIC BARAZA HELD AT THE ASSISTANT COUNTY COMMISSIONER (D.O) OFFICES, KARABA MARKET CENTRE, KARABA SUB-LOCATION, RIAKANAU LOCATION ON 26TH JULY 2013.

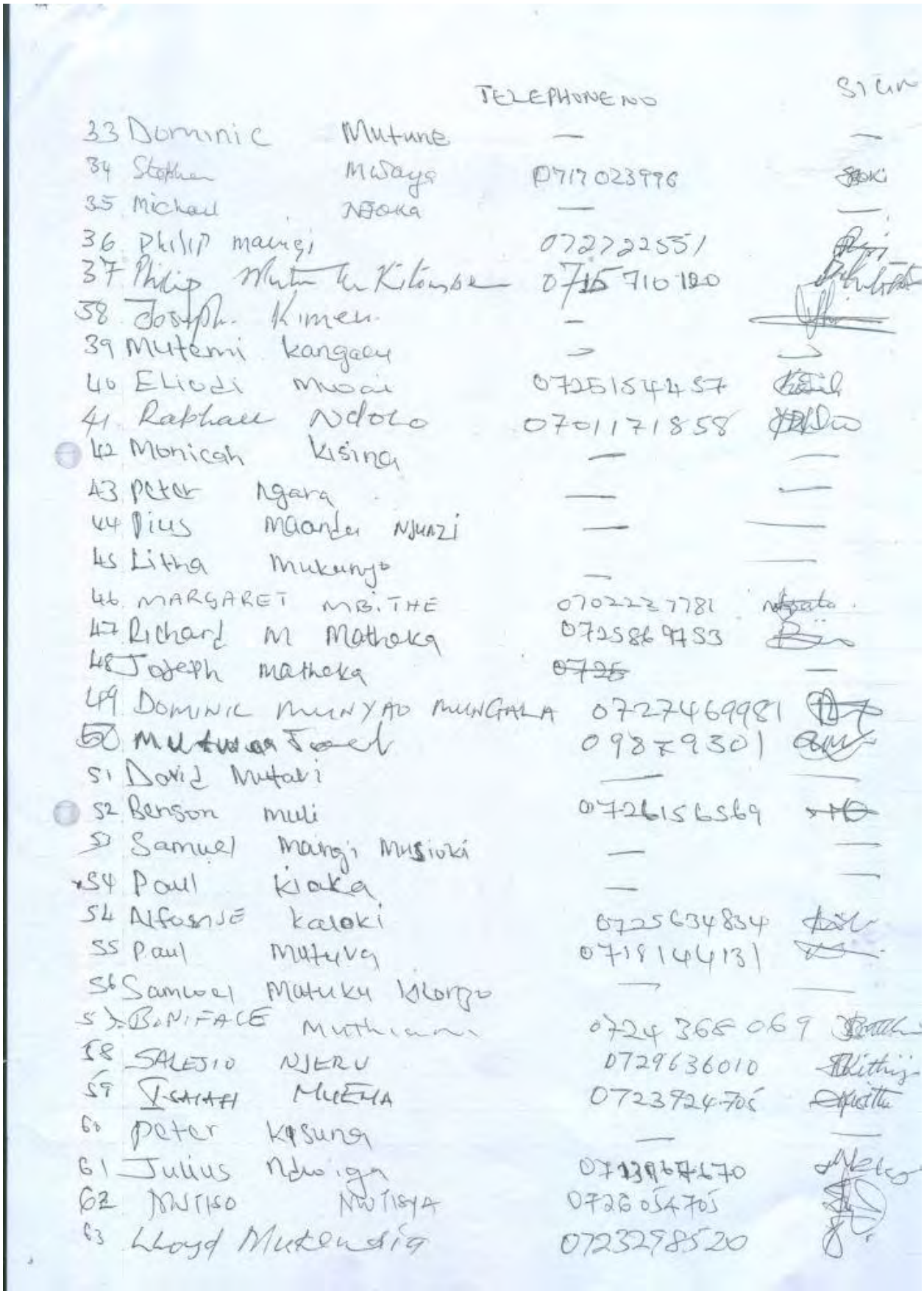
ATTENDANCE



KARABA ~~BU~~ PUBLIC BARAZA 26/7/13

Attendants

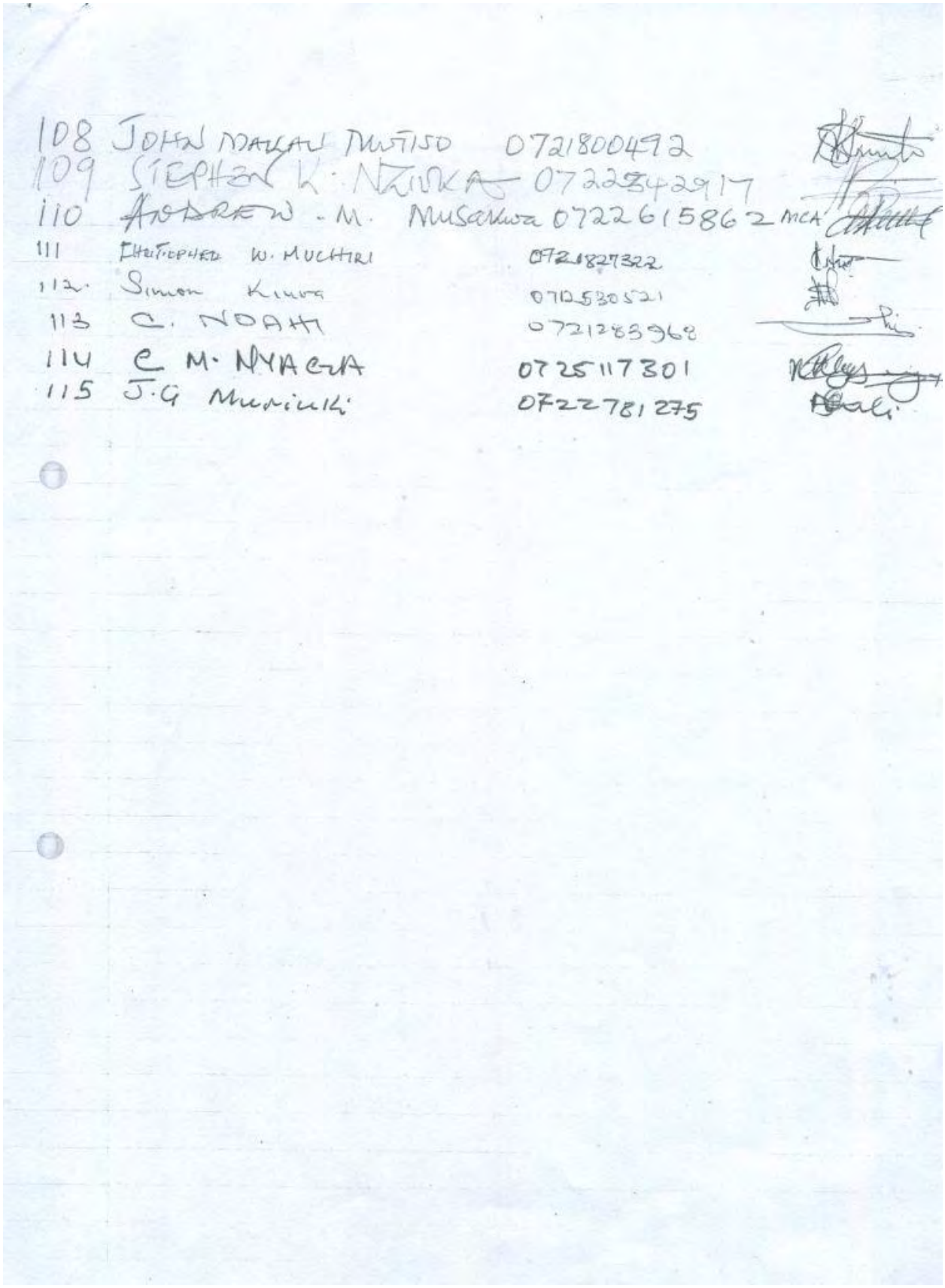
	Name	Tel/Mobile	Signature
1	Silas Katuta	0723269335	
2	George Maingi Musembi	0722499491	
3	John Ndungu Kareko	0700204688	
4	Joseph Mwangi	0724427254	
5	Fredrick Mutuku	0701601618	
6	Mathew Sikuku	0722685?7	
7	Selans Nyaga	—	
8	Harrison Maina	0716320616	
9	Mary Nzeni	—	
10	Margret Wamwanga	—	—
11	Eng. Florence Mutioka	0724409646	
12	STEPHEN MUSILA	—	—
13	Fidelis Mutei	0726819277	
14	PAUL MWANIKI	0710-485-609	
15	Peter maingi	0727449955	
16	James Kimuyu	0721591178	
17	Jona Mutua	—	—
18	Peter Mutuku	0701287699	
19	DANIEL NDONYE	0729728579	
20	REV. LUKAS K. MUTISYA	0723558743	
21	FRANCIS KILONZI	—	
22	Jenadius N. Mbondo	0722334725	
23	Stephen Mwaniki	0723973999	
24	JEREMIAH MAINA	0464218	
25	John Muoa	0723111190	—
26	David Muamira	0726507605	
27	Lazarus Kisonde	0708183562	
28	Rose Mary Mbeka	—	—
29	Elizabeth Nziva	0712943555	
30	Naomi Nzisa	—	—
31	Teresia Gitsangi	6062428	—
32	Thomas S. Musau	0724918465	



			TELEPHONE NO	SIGN
33	Dominic	Mutune	—	—
34	Stephen	Mwaya	0717023996	
35	Michael	Nzoka	—	—
36	Philip	Maingi	0727225551	
37	Philip	Mutua Ya Kilonzo	0715 710 120	
38	Joseph	Kimeu	—	
39	Mutemi	Kangaru	—	—
40	Elioda	Mwai	0725154457	
41	Raphael	Ndolo	0701171858	
42	Monicah	Kisinga	—	—
43	Peter	Ngara	—	—
44	Pius	Maanzo Nzuzi	—	—
45	Litha	Mukunya	—	—
46	MARGARET	MBITHE	0702237781	
47	Richard	M Matheka	0725869753	
48	Joseph	Matheka	0725	—
49	DOMINIC	MUNYAO MUNGALA	0727469981	
50	Mutua	Isaac	0987930	
51	David	Mutavi	—	—
52	Benson	Muli	0726156569	
53	Samuel	Maingi Musioki	—	—
54	Paul	Kioko	—	—
54	Alfonse	Kaloki	0725634834	
55	Paul	Mutuva	0718146131	
56	Samuel	Mutuku Kilonzo	—	—
57	BONIFACE	Muthiani	0724 366 069	
58	SALESIO	NJERU	0729636010	
59	ISAIAH	MUEMA	0723924705	
60	Peter	Kisuna	—	—
61	Julius	Ndungu	0713967670	
62	MUTISO	NDUSYA	0726054705	
63	Lloyd	Mukundia	0723285520	

			Mobile	Sign
64	David	Kanisi	0720213261/10	
65	Job	Kisiamo	0710814523	
66	Ngule	Kamau	—	
67	Paul	Nyumbi	—	
68	Stephen	Musyoki	—	
69	William	Nziwo	0720383416	
70	John	Nzioki	0719360621	
71	Regina	Mueni	0715 555 721	
72	Ruth	Ndunge	—	
73	Agolina	Nduku	—	
74	Mary	Ikami	0729089968	
75	Patricia	Mutindi	—	
76	Jane	Mulandi Kilonzo	—	
77	Purity	Kaemi Munyi	0717159122	
78	Ann	Mutuno	0720345515	
79	Petronilah	Mutisya	0727 628071	
80	Mary	Lumu	0722620344	
81	Helena	Mwelitya	0715710715	
82	Sarah	Muangi	0704460348	
83	Naomi	Mbithe	0700412841	
84	Veronica	Nzangi	0723968541	
85	Esther	Munyiva	—	
86	Benedetta	Ngami	0710147650	
87	Martha	Wayua	—	
88	Jane	Waanza	—	
89	Daniel	Nzioka	—	9679 5313
70	Daniel	Musili	072x153401	
71	Timothy	Muinde	0728021199	
72	Daniel	Kioko		
73	Samuel	Mulinge	0725720261	
74	Christine	Syombua	—	
75	Helenda	Mathuka	0712193280	

			Mobile	Sign
71	Raphael	Kitonyo	—	—
77	Justus	Muthoni	0713 949084	—
78	Agnes	Nzinga	—	—
79	Nahason	Kongo	—	—
80	John	Kilo	— 0722237753	
81	Hilary	Makali	— 0724253021	
82	Peter	Wambua	—	—
83	Alexander	Muithi	0717229570	
84	Robert	Ndonga	0724495721	
85	Joseph	Muoka	0721614334	
86	Peter	Mbatha	—	—
87	Jane Ester	Wangari	0705220461	
88	Susan	Wanjiku	0729971233	
89	Zuiser N	Samuel	0721230500	
90	Peter	Matheka	0712193280	
91	Ann	Kimau	0701302313	
92	Teresia	Mbitha	0704946083	
93	Paul	Muiruri	0711569022	
94	John	Mbithi	0727387490	
95	Boniface T.	Mwai	0727211936	
96	Gabriel	Kaia Mungai	0712475824	
97	Titus	Mungai Kanai	0718492344	
98	Jacinta	K. Maina	0727249278	J Maina
99	Diana	W. Kamuri	0726575209	
100	Mathias	Ndiso	0724752774	
101	Mwaka	Morris	0722670852	
102	William	N. Mulwa	0723799206	
103	Kimeu	Mwajuma	0722306909	
104	F.	M	0724472889	
105	Kanana	Kimwere	0722313773	
	Harrison	Mwakuwa	0722886338	
	Joel	Sylvich	0722-968761	



108	JOHN MAKAU MUTISO	0721800492	
109	STEPHEN K. NZISKA	0722542917	
110	ANDREW - M. MUSAKWA	0722615862 MCA	
111	CHRISTOPHER W. MUCHIRI	0721827322	
112	Simon Kimva	0705305521	
113	C. NOAH	0721283968	
114	C M. NYAGA	0725117301	
115	J.G Muriuki	0722781275	

MIN 1 OPENING AND INTRODUCTION

The Baraza started at 10:45a.m with a word of prayer led by one of the participants. The Baraza was chaired by the Assistant County Commission (formerly called D.O) of Mwea Division.) The following sub locations were represented;-

- Gategi sublocation
- Riakanau sublocation
- Machoro sublocation
- Karaba sublocation

The county Assistant Commissioner introduced the teams from Tana Water Services Board (TWSB). Lujo Consulting Engineers (LCE), NEMA Kirinyaga County Director and WARMA area officer.

MIN 2: PROJECT DICRIPTION AND COVERAGE

TWSB Communications and Resource Mobilization Manager Mr.B.Migwi described the project and its coverage from the source, treatment works to Mwea and Makima divisions. He explained that the water will be strictly for domestic use and not for any other use because the area lacked clean water.

Other officers from TWSB included the Design, Planning and strategy Manager Engineer T.Kibaki and Mr.Ndahi the surveyor.

MIN 3: ENVIRONMENTAL/SOCIAL CONCERN

The team from Lujo Consulting Engineer were Mr.Cyrus Nyaga social Economist and Mr.J.G Muriuki, Environmental lead expert. Mr. J.G. Muriuki explained that potential environmental concerns that would arise from the proposed project implementation. These include positive and negative impacts. Some of the negative impacts which will need formulation of mitigation measures include:-

- Water use conflicts
- Possible accidents
- Accumulation of soild waste.
- Soil erosion
- Noise and dust pollution
- Disturbance of the community members adjacent pipeline and reservoir sites when work is scheduled out of normal working time (8.00a.m ï 5.00p.m)
- Distraction of vegetation
- Disturbance of cultural sites and sacred places etc.

The social-Economist Mr. C.Nyaga explained social-Economic impacts of project activities among which include:-

- Availability of employment
- Market for construction and other materials.
- Saving of time for other economic activities when water is available.

- Reduced expenses in hospital expenses. Incidences of water borne diseases will reduce due to availability of clean and hygienic water.

MIN 4: WATER RESOURCES CONCERNS

The WARMA officer reiterated the need to consult his organization on the availability of adequate water for proposed projects because the intended sources may not be abstracted owing to reduced flow. The permit to abstract must be obtained from WARMA. WARMA mandate also include, protection of catchment, pollution control and reduction of conflicts through formation of Water Users Association.

MIN 5 QUESTIONS, COMMENTS, CLARIFICATION

Question 1

The community wanted to know whether the water will flow through pipeline or fullow so that they can use it for irrigation.

Response

The water will flow through a pipeline because it is treated clean water for domestic use not for irrigation. At this point the community expressed their need for irrigation water crop production to alleviate poverty. They were advised to follow the issued with National Irrigation Board and Ministry of Agriculture.

Comment

The community insisted that the project contract be instructed to use local labor as a matter of priority. Tana Water Services Board informed the baraza that the contact will be advised that all manual labor be provided by the local persons.

The community expressed their concern that a contractor earlier on employed local people but left the site before paying them. To solve this problem the community was advised to let the local administration handle their cases of employment with contractors inorder to enforce payment otherwise it would be difficult to understand what could have happened.

Question 2

What will be the service level of supply from the proposed project.

Response

The proposed project is intended to supply water through water kiosks and not individual connections.

Question 3

How long will the project implementation take.

Response

The project is expected to take two years.

Question 4

Is the community expected to contribute any money towards the project?

Response

The community will not be expected to contribute any money for the proposed project. The project will be wholly funded by the Government.

Question 5

How much will the laborers be paid?

Response

The contractor will be expected to pay the laborers at the rates approved by the Ministry of Labor or as per negotiated agreement with the workers but lower.

Way forward

The community agreed to support the project.

The meeting ended at 1:30p.m.

MINUTES OF PUBLIC BARAZA HELD AT KARUCHO MARKET, NGIRIAMBU SUB-LOCATION, NJUKIINI LOCATION, GICHUGU EAST DIVISION ON 24TH JULY 2013.

ATTENDANTS

NAME	TELEPHONE No.
1. Albert K.Ngari	0725686180
2. David Njeru	0729220939
3. Elius Kirundo	0728363718
4. Joseph Njine	0716127128
5. Dancan Kariuki	0725267078
6. Patrick Ndambiri	0714610033
7. Moses Ndambiri	0727960677
8. Henry Nyaga	0712079523
9. Anastacia Mugo	0716188449
10. Malicella Wanjiku	0729946923
11. Lucy Muthoni	0714900293
12. Agnes Wangingi	0712218925
13. Alice W.Njeru	0726232732
14. Tabitha Thatia	0728518782
15. Jackline Nyaga	0704660760
16. Tabitha Njeru	0716782166
17. Pauline Mwangi	0724581979
18. Elizabeth Njeri	0710883394
19. Pauline Wambura	0724001378
20. Ruth Kiura	0712563715
21. Elizabeth Wangui	0725264435
22. Rose Njoki Nderi	0721608814
23. Sammy Njogu	0721255012
24. Margaret Muchiri	0727004722
25. Mary Micere	
26. Keziah Mugwe	0721683757
27. Bancy Wawira	0727823403
28. Nancy Warira	0712306609
29. Cicilly Wairimu	0713800617
30. Mary Wanjiku Nyaga	0713800617
31. Elias M.Githinji	0728690853
32. Hilary M.Gachoki	0712876264
33. Helen Waweru	0710108845
34. Samuel M.Ngari	0710545697
35. James C.Ndege	0718137256
36. Peter G.Kimori	0713870291
37. Bernard M.Mwangi	20371518
38. Samuel B. Ndambiri	0720971857

39.	Gitari	
40.	David K.Mwaniki	0725810877
41.	Daniel Muchiri	
42.	Samuel K.Nyaga	0712903079
43.	Syprian Muchira	0708440891
44.	Peter Mwaniki	0702276430
45.	Joseph M.Mwangi	1401887
46.	David Muchira	0727937933
47.	Tomas M.Muthuku	0726801587
48.	Teresio N.Mucheru	
49.	Peter Irungu	0705328150
50.	Magdeline Muthike	0723710049
51.	Sospeter Mugo	0714936983
52.	Earnest Gakuru	0716195485
53.	Elias Mucira	0717554457
54.	Isaac Gachoki	0722638286
55.	John Njomo	0712657892
56.	Daniel Gitari	0711309273
57.	Virginiah Muringo	
58.	Teresia Muriithi	
59.	Andrew Mwaniki	
60.	Michael Muriuki	0726443251
61.	Mary Wangerwe	207805084
62.	Ephantus murithi	07241384159
63.	Simon M.Kiura	0712530521
64.	J.G.Muriuki	0722781275
65.	Cyrus Nyaga	0725117301
66.	Beato Migwi	0720692254
67.	C.Ndahi	0721283968
68.	T.W.Kibaki	0721279928
69.	Nancy Gathoni	0722351698

The meeting started at 11.10a.m with a word of prayer led by one of the participants.

MIN 1: OPENING AND INTRODUCTION

The baraza chaired by the Assistant chief Mr.Albert Kathiga of Ngiriambu sub-location, Njukiini Location, began the session by introduction of the representatives of Tana Water Services Board headed by Engineer Kibaki and Lujo Consulting Engineerõs. The project discipline and extent was given by Athi water Services Board Engineer T.Kibaki, the Planning, Design and Strategy Manager, the surveyor Mr. C.Ndahi and communication and Resource Mobilization officer Mr.B.Migwi.

MIN 2: ENVIRONMENTAL CONCERNS

Lujo Consulting Engineers, Environmental Expert Mr.J.G.Muriuki highlighted on:-

- Precautions against accidents at construction sites and along the pipeline.
- Proper management of waste generated.
- Measures to minimize generation of noise and dust during excavation of construction foundation and pipeline path.
- Work schedule to avoid working beyond normal working hours.
- Provision of jobs to the locals as a priority where applicable.

Protection of cultural sacred sites, sources and property the baraza was informed that the design will try and avoid destruction of property along the pipeline, intake works and storage reserves. The pipeline will be designed in such a way to follow the road reserves as much as possible. Further, those members of the community who will be affected by the project either at the intake treatment works, storage tanks or the pipeline will be compensated as per government guidelines.

Lujo Consultant on social economics issues elaborated that the project design will be done in such a way that no house hold will be relocated for resettlement. All properties including plants destroyed during construction will be compensated. Additionally he urged the community to apply for jobs they are qualified to do during implementation of the project.

MIN 3: QUESTIONS /COMMENTS

Question 1

The community wanted to know who will be affected by the project.

Response

The baraza was informed that it was only after the survey is done that the affected persons will be established. At this time they were requested to give the surveyor a chance to do his work while carrying out survey for the project.

Question 2

The community wanted to know whether negations for compensation on the affected property will be done individually or as a group.

Response

Athi water Services Board will negotiate with individual persons for compensation for the affected property.

Question 3

The community wanted to know whether those owners of land where the pipeline will pass will be supplied with water.

Response

The baraza was informed that the water supply project is meant for Mwea and Makima people who have no sources of clan water anywhere in the adjacent areas and will not be distributed to other people

because it is not even enough to supply the area, there are plans to develop a bulk supply from upstream sources for the entire Kirinyaga(Kirinyaga Bulk Water Supply Project)

Question 4

The community wanted to know why they are being involved if they are not benefiting from the water supply?

Response

It was explained that in accordance with Environmental management and Co-ordination Act,1999, it is a requirement that before any project begins, all stakeholders, community affected and neighbours must be sensitized to know they will be affected by the project, either positively or negatively. The current constitution of 2010 supports the same.

Comments

The community commented that now that they have benefited with water supply from Kamumoe and Kenera Water projects, they may not need water from the proposed project but only compensation where applicable.

At this point Tana Water Services Board informed the baraza that the most important issue for that day was to sensitize them on the proposed project and request them to allow the surveyor to enter their land to determine the pipeline path and the related construction at the intake. Further, they were informed for security reasons the surveyors will pass through the administration and also use services of an assistant from the local community soon after the survey is done the affected properties and owners will be known and a consultative meeting will be conducted with them to start negotiations.

Way forward

The community agreed to support the project only if the affected personôs properties are compensated in accordance with the Government guidelines.

The meeting ended at 12.45 PM.

MINUTES OF PUBLIC BARAZA HELD AT MWALIMU THATIA COMPOUND, NGIRIAMBU SUB-LOCATION NEAR THE PROPOSED PROJECT INTAKE WORKS ON 22ND JULY 2013.

ATTENDANTS

NAME	TELEPHONE NO.
1. Peter Irungu	0705328150
2. Michael Muriuki	0726443251
3. Peter Njoroge	0722145416
4. Mosews Ndambiri	0727960677
5. Ndambiri Kugeria	0714010033
6. Henry Nyaga	0712079523
7. Ephantus Gitari	0716640927
8. Pauline Wambura	0724001378
9. David Njeru	0729220939
10. Godfly Mwaniki	0712312934
11. Zachary Njeru	0726232732
12. Elizabeth Wangui	0725264435
13. Rose Nderi	0721608814
14. Margrate Muchiru	0727004722
15. John Njomo	0712657892
16. Leonard Thatia	
17. Joseph Njine	0716127128
18. Denis Nyaga	0716428347
19. Michael Muriuki	0726443251
20. Daniel Gitari	0711309273
21. Timothy W. Kibaki	0721279928
22. Beato Migwi	0720692254
23. J.G Mwangi	0722781275
24. Simon M. Kiura	0712530521
25. C. Ndahi	0721283968
26. Cyrus Nyaga	0725117301

The meeting started at 2.30p.m with a word of prayer led by one of the participants.

MIN 1: OPENING AND INTRODUCTION

The meeting was chaired by an area elder Mr.John Njomo who had been requested by the area assistant chief to represent him.

The team from Lujo Consulting Engineers and Tana Water Services Board introduced themselves indicating their roles in implementation of the proposed project. Tana Water Services Board(TWSB) team included Eng.T.Kibaki, Design, Planning and Strategy manager, Mr.B.Migwi, Communication and Resource Mobilization Manager and Mr.C.Ndahi the surveyor.

MIN 2: DISCRIPTION AND COVERAGE OF THE PROJECT

TWSB described the project and its coverage from the proposed intake works at Ngirigacha bridge to proposed treatment sites near Kangu dispensary and Kianjiru market centre in Kangu and Kianjiru sub-locations. The treated water will be conveyed to Mwea and Makimma divisons through Kimbimbi, Wamumu, Karaba, Gategi and finally Makima. TWSB explained to the baraza they need to have consultative meetings with the project neighbouring communities in accordance to the constitution.

MIN 3: ENVIRONMENTAL CONCERNS

The participants were explained on the importance of the Environmental Impact Assessment (EIA) process and precautional principle of Environmental law. The members were made to understand their role process of mitigation measures where negative impacts were envisaged regarding Environmental and social impacts during implementation of the project.

MIN 4: QUESTIONS, RESPONSES AND COMMENTS

Question 1

Participants wanted to what would happen to the intakes and way leaves of the existing water projects(Kamumoe and Kenera Projects) when the new intake for Mwea Makima is implemented.

Response

The participants were informed that the proposed project will not in any way interfere with the intakes of the existing projects and as soon the survey work is complete the affected persons will be known and they will be requested to provide way leave.

Question 2

The participants wanted to know who will negotiate with the owners of the properties affected by the project?

Response

The owners of the affected properties will negotiate with Tana Water Services Board using a government approved valuer.

Question 3

The community wanted to know where would meet with Mwea-makima communities who will be served by the project?

Question 4

The community wanted to know who will enter into agreement with the people who will be affected by the project.

Response

It is Tana Water Services Board who will enter into agreement with the people affected by the project.

Question 5

At what stage of the project will the affected persons enter into agreement with the Tana Water Services Board?

Response

The affected persons will enter into agreement with Tana Water Services Board the survey and design work by the consultant establishes the affected properties and their sizes(land sizes in hectares and hence values.)

Question 6

Will the affected persons be supplied with water as the pipeline passes through or installations eg.intake is located within their land properties?

Response

The water supply project is meant to supply water to Mwea and Makima communities who desperately need safe and sustainable supply water for domestic consumption and there were no such sources in those areas. The water source from Nyamindi will flow by gravity and the fact that it is of better quality than the sources closer to Mwea and Makima communities, it would be more economical in treatment and transmission.

Question 7

The members of the community wanted to know what will be done to prevent the contractor from leaving exposed excavated materials eg. Rocks exposed along the pipeline.

Response

The contractor will be instructed by the Resident Engineer to follow mitigation measures guidelines given in the EIA report. In case this is not followed by the contractor, the community have a right to question him or her failure to which NEMA can be requested to stop the project.

Comment

The community felt that another meeting is necessary to sensitize more people in the area since the notice was short.

Response

It was agreed that another meeting would be held in the near future. Another meeting was held later on 24th July at Karucho market.

Way forward

The community agreed to support the project so long as the owners of the properties that would be affected are compensated in accordance with government guidelines.

Annex 3: Hydrological study report

HYDROLOGICAL REPORT

FOR NYAMINDI RIVER's

MWEA-MAKIMA WATER SUPPLY PROJECT

Report Prepared by

D. N. Kimani – WD/WP/154

SEPTEMBER 2013

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LIST OF ABBREVIATIONS

cumecs	cubic metres per second
$_0$C	degrees Celsius
mm	millimetre
m	metres
masl	metres above sea level
km	kilometre
km2	square kilometre
M3/d	cubic metres per day
ASAL	Arid and Semi Arid Land
WRMA	Water Resources Management Authority
NIB	National Irrigation Board
CO2	Carbon dioxide
GCM	Global Climate Model
WMO	World Meteorological Organisation

HYDROLOGICAL REPORT FOR NYAMINDI RIVER's, MWEA-MAKIMA WATER PROJECT

1. Description of the Project Area

1.1 Introduction

In 2006, WASPOR on behalf of Tana Water Services Board carried out a study of Riakanau Water and Sanitation Project. After conducting a Participatory Rural Appraisal, water was identified as top on the communityôs need list. This scenario is replicated in the rest of the project area, most of which is low potential to ASAL. The area receives erratic and poorly distributed rainfall and results in the communities walking long distances to fetch water that is not portable and endangers human health.

This hydrological report is meant to evaluate the availability of water from Nyamindi river for domestic purposes to enhance the social economic well being of the community in the project area. The report is prepared in fulfillment of the requirements of Section 27 of the Water Resources Management Rules 2007 which enables the provisions of the Water Act 2002.

1.2 Name and details of Applicant

The Mwea-Makima Water Project is initiated by Tana Water Services Board to supply domestic water to communities in Mwea-East, Mwea-West and Mbeere districts. The project address is:

Tana Water Services Board,
P.O. Box 1292-10100,
NYERI.

1.3 Location and description of proposed activity

The proposed Mwea-Makima water supply project is located in Mwea-East and Mwea-West districts of Kirinyaga County and Mbeere South District of Embu County. Among the areas to be served are Kimbimbi, Wangôuru, Mutithi and Wamumu in Kirinyaga county and Karaba, Riakanau, Gategi and Makima in Mbeere district.

The applicant wishes to abstract an amount of 14,000 M3/d or 0.1620 cumecs from Nyamindi River for domestic purposes to benefit an ultimate population of about 277,000 people by 2035.

The total distance to be covered is about 80 km from the intake to the Piai market where the Mbeere line is to be connected to the existing system. The project covers an area of about 560 km2.

The proposed intake site is located about 7 km downstream of Mt Kenya Forest boundary at GPS Coordinates S 00^0 29ô06ò and E 037^0 23ô57ô at an elevation of about 1,488 masl. The site is some 500m upstream of the Mbiri market bridge and about 100m upstream of the

existing Kamumwe water project intake. It is also about 1km upstream of the Kiri tributary confluence (Figures 1.1, 1.2 and Annex 1).

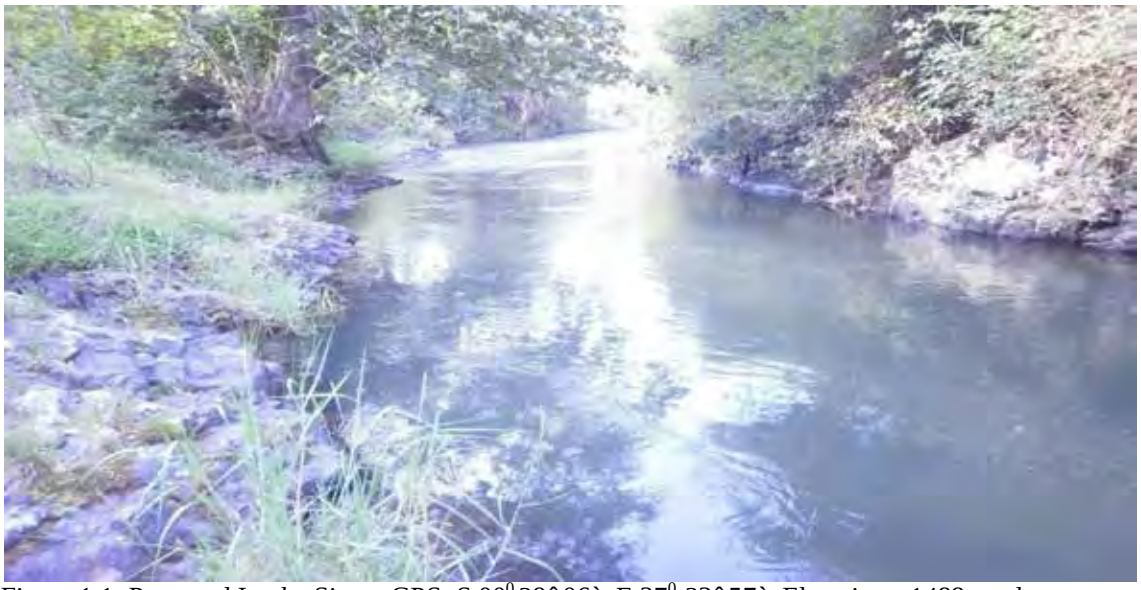


Figure 1.1: Proposed Intake Site at GPS: S 00^0 29ô06ò, E 37^0 23ô57ò, Elevation =1488 masl

Figure 1.2 Kamumwe water intake site - about 100m downstream of Proposed Intake

1.4 Climate of Project area

1.4.1 Proposed Intake

The proposed intake site is located in a high potential area and receives high rainfall amounts of over 1,400 mm per year while water loss through evaporation is about 1,300 mm per annum. Temperatures range from a high of 28 degrees to a low of 12 degrees centigrade. The proposed intake site enjoys surplus water as depicted by Figure 1.3 below.

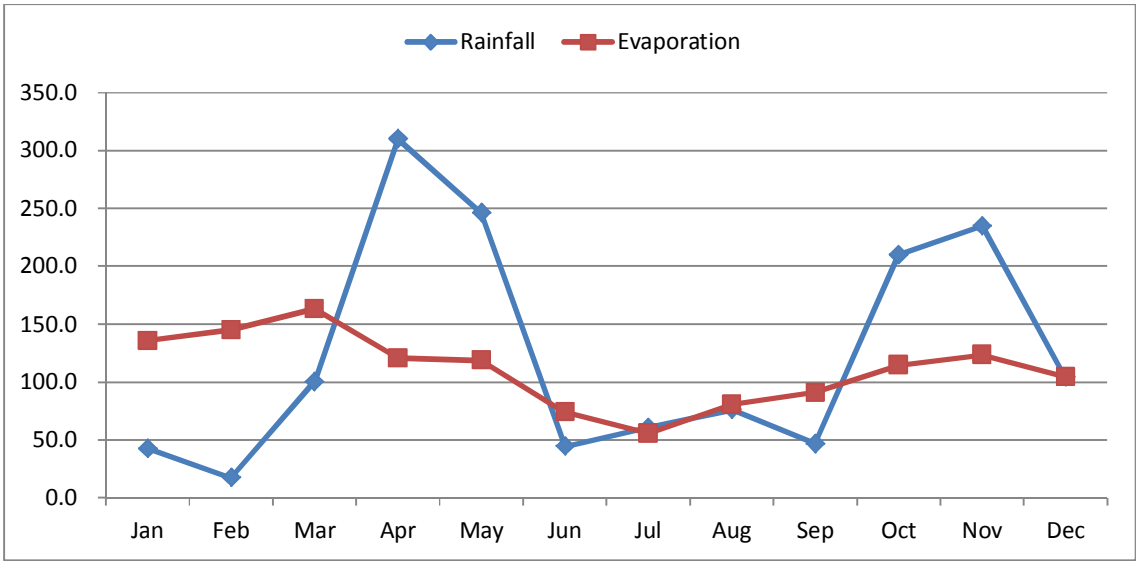


Figure 1.3 Rainfall and Evaporation Graphs at Kerugoya showing surplus Rains (mm)

1.4.2 Project Supply Area

The project supply area lies in a medium to low potential area where rainfall decreases with altitude from 1,000 mm at Wangûru, whose altitude is about 1150 masl to about 700 mm at Riakanau, an altitude of 1050 masl. Water loss through evaporation is estimated at 2,080 mm per annum in the Mwea plains. High temperatures prevail in this area with a maximum of 30.5 and a low of 14.5 degrees Celsius in March and June respectively.

The project supply area experiences water deficit as water loss through evaporation is more than double the amount of rainfall received. This is depicted by Figure 1.4 below. Clean and portable water for domestic use is difficult to find as rivers are polluted by upstream users especially paddy rice growers. The location of the proposed intake on a higher altitude upstream of the rice growers will avail clear and clean water whose treatment costs will be minimized.

Annex 3 shows the Layout of the whole Project area.

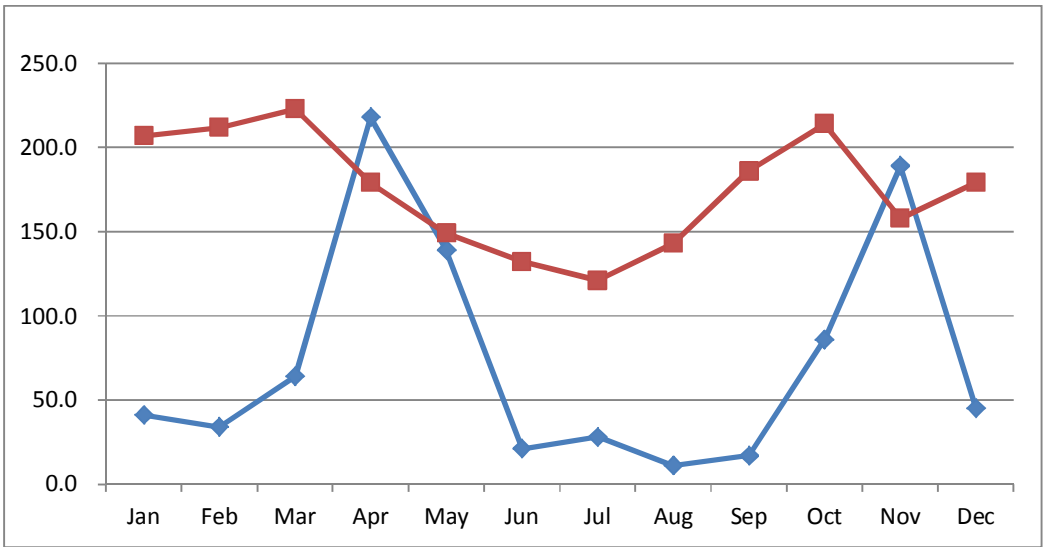


Figure 1.4 Rainfall and Evaporation Graphs at Mwea showing water deficit (mm)

1.5 Details of river – nearest RGS, sub catchment

Nyamindi river is in sub-catchment area 4DB bounded by Thiba sub-catchment area 4DA to the west and Rupingazi sub-catchment area 4DC to the east.

Nyamindi River has its source in Mt Kenya at an altitude of over 4,000 masl. It has three source tributaries: Nyamindi West, Nyamindi and Nyamindi East which originate from the Moorland High Altitude Grasses of Mt Kenya at an altitude of 4,500 masl. Several tributaries join the main river from Mt Kenya National Park at an altitude of 3,600 masl and from Mt Kenya Forest at an altitude of about 3,000 masl.

The river then flows from the forest boundary at an altitude of 1,700 masl, through cultivated farmlands as it loses gradient. At the proposed intake site near Mbiri market bridge, about 10 km downstream of the Forest boundary, the altitude is about 1,488 masl, which decreases to about 1,200 masl at 4DB5 river gauging station near Kimbimbi. From here the river flows downstream to join Rupingazi and Thiba rivers and into Tana river at Kamburu hydropower reservoir.

1.5.1 Flow Monitoring on Nyamindi River

For the whole length of Nyamindi river of about 65 km from its source in Mt Kenya Moorland to Rupingazi confluence, covering a catchment area of about 453 km2, the river and its tributaries have been monitored at six sites, but data is available at only one site. This could be due to difficulties of finding suitable sites for flow measurements as the river has steep and rocky banks.

The first river gauging station 4DB1 was established in 1949 and located about 1km downstream of the Embu-Nairobi road. It was closed in about 1957 and no records are available from this station. A second station 4DB2 is mentioned in some reports without giving its location and details. Stations 4DB3 and 4DB4 are said to have been located 2 km

downstream of the current station 4DB5. They operated between 1961 and 1973 and no records are available. Nyamindi river gauging station 4DB5 was established on 17th April 1979 but was washed away by the May 1991 floods. However, records are available from 16th October 1981 to 20th May 1991.

For the next 18 years (21/05/1991 to 15/03/2009), no records were collected on Nyamindi river until March 2009 when a new station was opened to monitor river levels and flows. Although the station bears the same number as the previous one, 4DB5, it is obvious that the sites were different as indicated by their altitudes, 1,204 masl and 1,225 masl respectively. Ideally the new station should have acquired a new number, like 4DB6??.

River gauging station 4DB5 was visited on 16th July 2013. It has two staff gauges running from 0-1.5m and 1.5-3.0m on the right bank. The first gauge was rusted below 0.6m and it was difficult to read the level which was 0.25m at 10.10 hours. Flow through the station was estimated at between 4 and 5 cumecs. The station is located about 100m upstream of NIB head works intake weir which abstracts Nyamindi flow through a link canal to Thiba basin. Figures 1.5 and 1.6 show the stationôs monitoring gauges while Figure 1.7 shows NIBôs intake weir. Annex 2 shows the location of the station.

Nyamindi river is characterized by steep and rocky river banks, forming gorges in several locations. For this reason, its water is not over-utilised for irrigation due to lack of suitable sites for abstractions. NIB constructed a link canal in 1995 to transfer 9.29 cumecs of Nyamindi flood flow to Thiba basin for expanded irrigation. The intake works are located about 100m downstream of Nyamindi river gauging station, 4DB5.

Figure 1.5 Nyamindi River Gauging Station 4DB5 looking downstream

Figure 1.6 The 0 ï 1.5m Gauge Plate showing the rusted 0 - 0.6m section

1.5.2 The Observer Records

Nyamindi river gauging station 4DB5 was visited on 16th July 2013 and water level read as 0.25m at 10.10 am. A check on observerôs readings showed that the station had been neglected since January 2013 when the observer, Mzee Tumbo fell sick in December 2012. His daughter, Millicent claimed that she had read the gauge today at 08.00 am and the level was 0.43m. She informed us that she had only started reading the gauge the previous day at 4.00 pm when the level was 0.34m. No other records were available from the station since January 2013.

Station 4DB5 has well protected river banks with trees and vegetation and these, together with a rocky bed downstream offers a suitable control for monitoring river levels and flows.

Figure 1.7 NIB Headworks Weir Transfering Nyamindi Flow to Thiba Basin

1.6 Details of Catchment (area, slopes and soils), Vegetation and Land use

Nyamindi catchment covers an area of about 453 km2 from its source in Mt Kenya (altitude 4,500 masl) to its confluence with Rupingazi river at an altitude of about 1060 masl. The catchment receives an average annual rainfall of about 1,345 mm, which varies from a high of 1,920 mm inside Mt Kenya Forest to about 900 mm at Rupingazi confluence. Net water loss through evaporation is estimated at between zero at the source in the Moorland High Altitude Grasses of Mt Kenya to about 2,100 mm at the confluence.

This means the catchment area enjoys surplus water from the rains. Figure 1.8 shows the well distributed rainfall in Mt Kenya Forest as monitored at Castle Guest House rainfall station whose altitude is 2,198 masl.

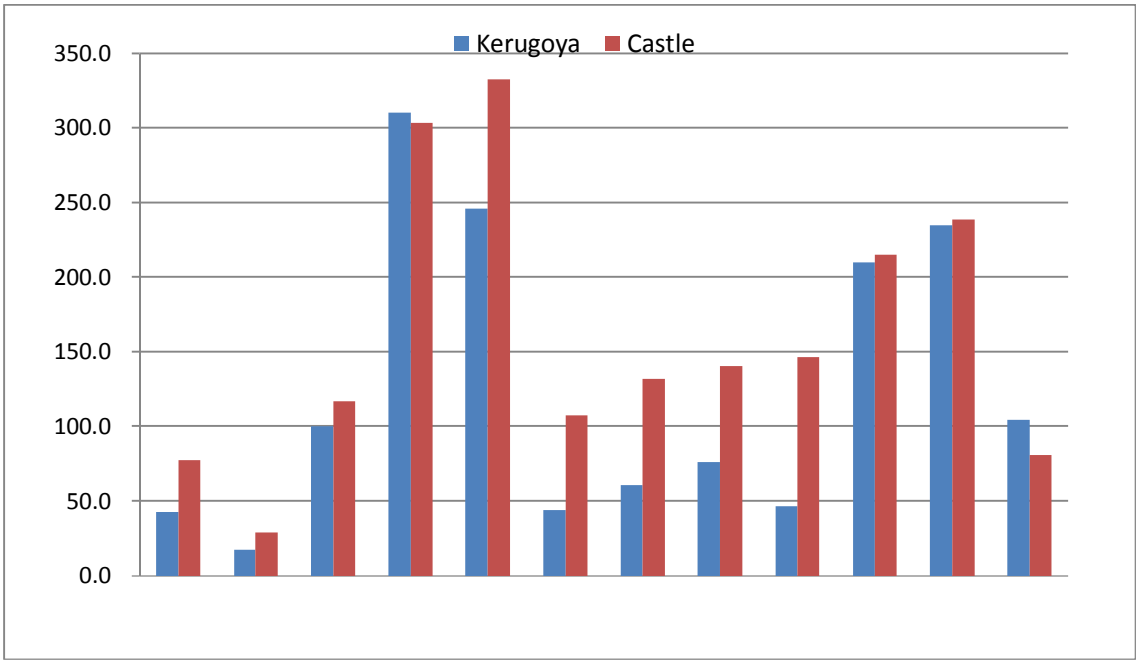


Figure 1.8. Rainfall Charts for Kerugoya and Castle Stations (mm)

About 35% of the catchment is located in the Mt Kenya Forest, the National Park and the High Altitude Moorland Grasses where the volcanic soils are well drained and protected by forest, vegetation cover and grasses, thus enhancing recharge into springs and ground water aquifers. The remaining 65% is farmland under either subsistence crops, or cash crops of coffee and tea in the upper reaches while the lower part of the catchment has a mixture of black cotton and red soils. It is in this part of the catchment where flood flows are generated.

Nyamindi river is said to have a reliable and stable flow due to its high and well distributed rainfall input into its catchment area.

2. Registered and non-registered abstraction

Forty six authorized water abstractions for domestic, irrigation and hydropower data was purchased from WRMA Regional office Embu. Most abstractions did not give coordinates of points of abstraction and the Hydrologist had to extract these from the files. A thorough scrutiny of the data showed that 5 abstractions were in the neighboring drainage areas of Thiba (4DA) and Rupingazi (4DC), 16 were downstream of 4DB5 and 2 had no coordinates at all. Only abstractions within the catchment area of the river gauging station 4DB5 were retained in the list for further analysis. The end result was that twenty three abstraction data was used in subsequent analysis giving a total water demand of 0.1401 cumecs for both domestic (0.0271) and irrigation (0.1130) use. Field visits showed that rampant water use for irrigation takes place in most areas without the mandatory 90 days storage facility being in place. This means water is abstracted from the rivers all the time without adherence to use of flood flows. This calls for surveillance and enforcement of the Water Resources Management Rules.

There are also illegal abstractors who are yet to be identified and registered. A survey of non-registered abstractors is being undertaken by WRMA.

2.1 NIB Water Abstraction from Nyamindi River

NIB abstracts Nyamindi river flow through an open link canal to Thiba basin whose length is about 13.1 km (Figure 2.1). The inter-basin water transfer is authorized to abstract up to 9.29 cumecs of flood flow for paddy rice irrigation. The mandatory 90 days storage is yet to be constructed on Nyamindi river, although a storage dam on Thiba river is planned whose resettlement is underway now. For the last five years (2008-2012) the maximum mean monthly flow abstracted through the inter-basin canal is 6.26 cumecs in June 2011 and a minimum of 1.0 cumec in March 2009. This is depicted in Figure 2.2 below.

From the canal, residents siphon and pump water to their farms resulting in a lot of wastage due to low efficiencies in their pumping, piping and unlined, open canal irrigation operations. Domestic water is also drawn from the same canal whose quality is poor due to pollution and water borne diseases.

Figure 2.1 NIBôs Nyamindi to Thiba Link Canal near the Intake Weir

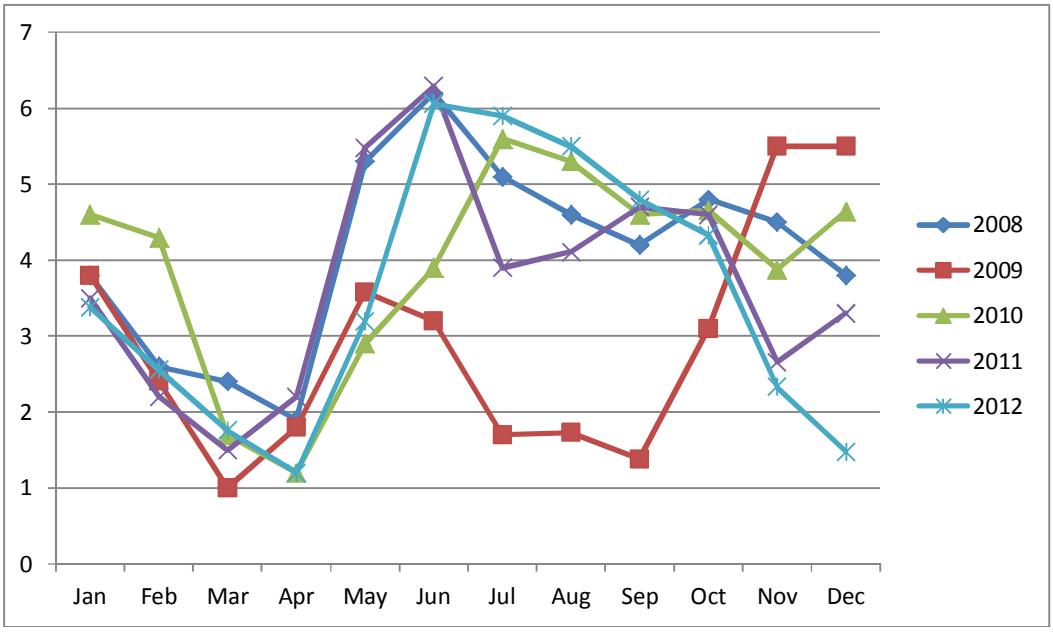


Figure 2.2 Nyamindi River Average Monthly Water Transfer (cumecs) to Thiba Basin

3. Permits related to this permit

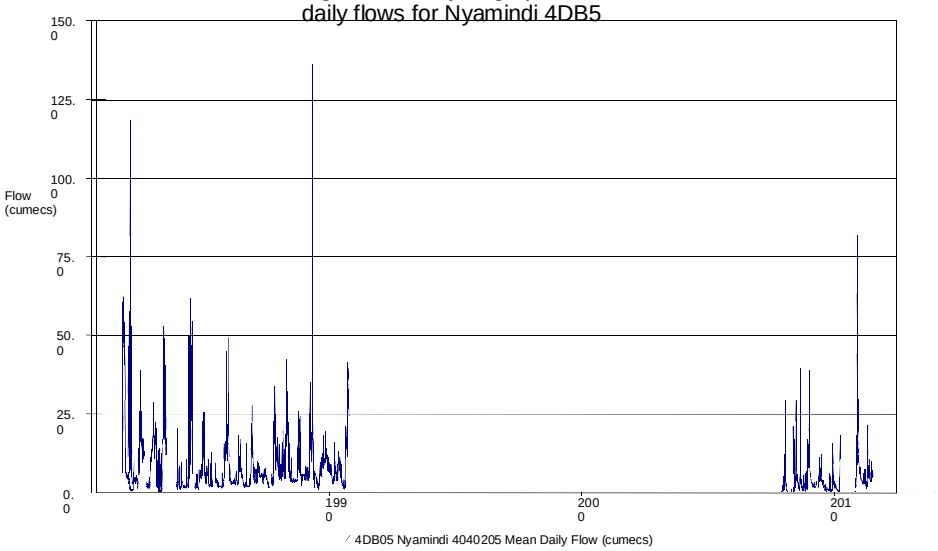
This permit is a stand-alone and is not related to any other permit.

4. Hydrological characteristics and analysis

4.1 Hydrological data availability

From WRMA Regional office in Embu, flow data for Nyamindi 4DB5 for the period 16th October 1981 to 20th May 1991 and 15th March 2009 to 31st December 2012 was purchased. The two sets of data were collected about 18 years apart of each other. Although the data is indicated as belonging to station 4DB5, the latter data, 2009-2012 should have been collected under a new station ID, for example 4DB6. Because of gaps of missing data, the 1981-1991 record decreases from 10 years to 8.8 years, while the 2009-2012 record decreases from 3.8 to 2.8 years. The mean daily flow hydrographs for the two sets of data are shown in Figure 4.1 below while their separate mean monthly flow hydrographs are presented in Figures 4.2 and 4.3 below.

Figure 4.1 Hydrograph of mean daily flows for Nyamindi 4DB5



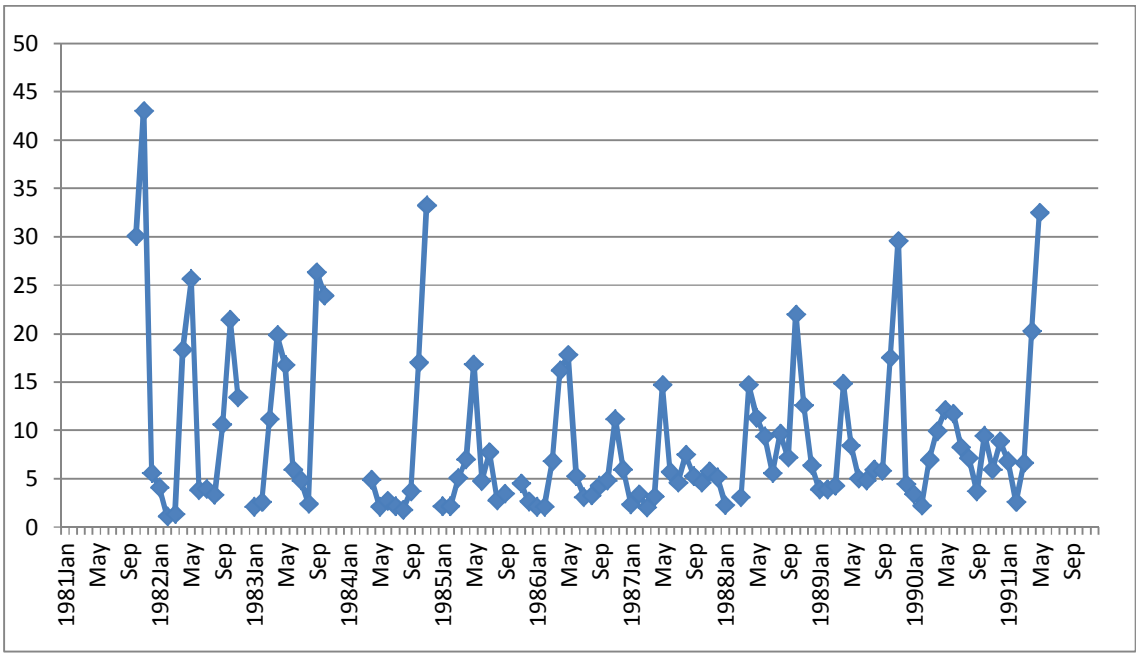


Figure 4.2 Hydrograph of mean monthly flows (cumecs) at 4DB5 for period 1981-1991

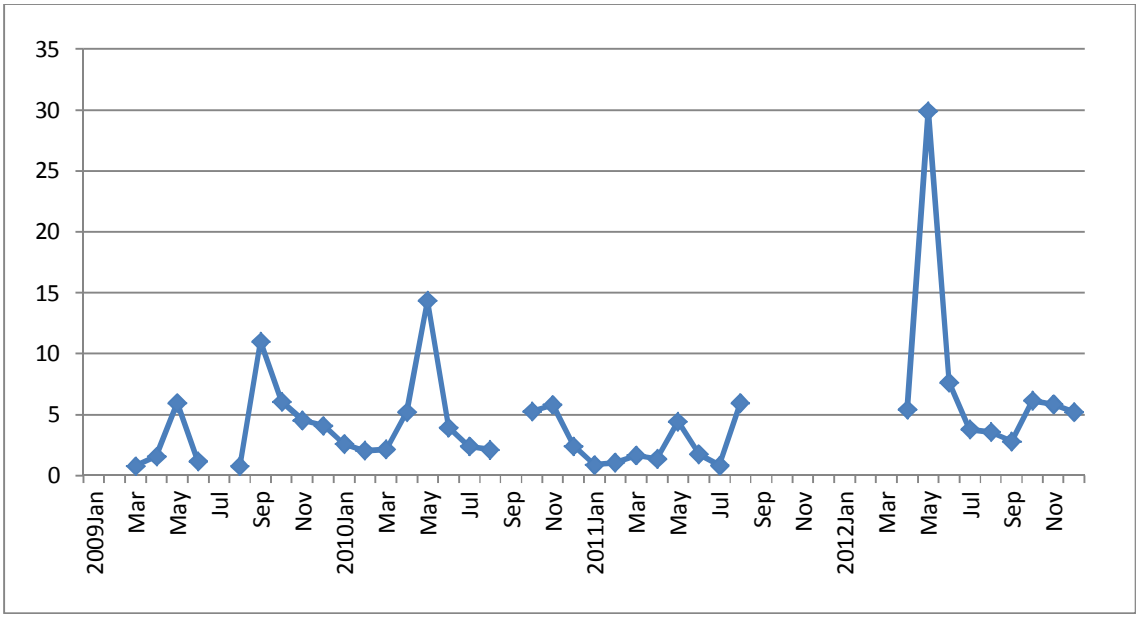


Figure 4.3 Hydrograph of mean monthly flows (cumecs) at 4DB5 for period 2009-2012

Scrutiny of the flow data for the two periods shows that while the earlier data, 1981-1991 was well balanced between dry and wet years, the recent data, 2009-2012 was biased towards drought. This is clearly shown in Figures 4.1, 4.2 and 4.3 above and also by a comparison of the mean monthly flows of the two periods in Figure 4.4 below. Thus the 1981-1991 data is more representative and amenable to hydrological analysis.

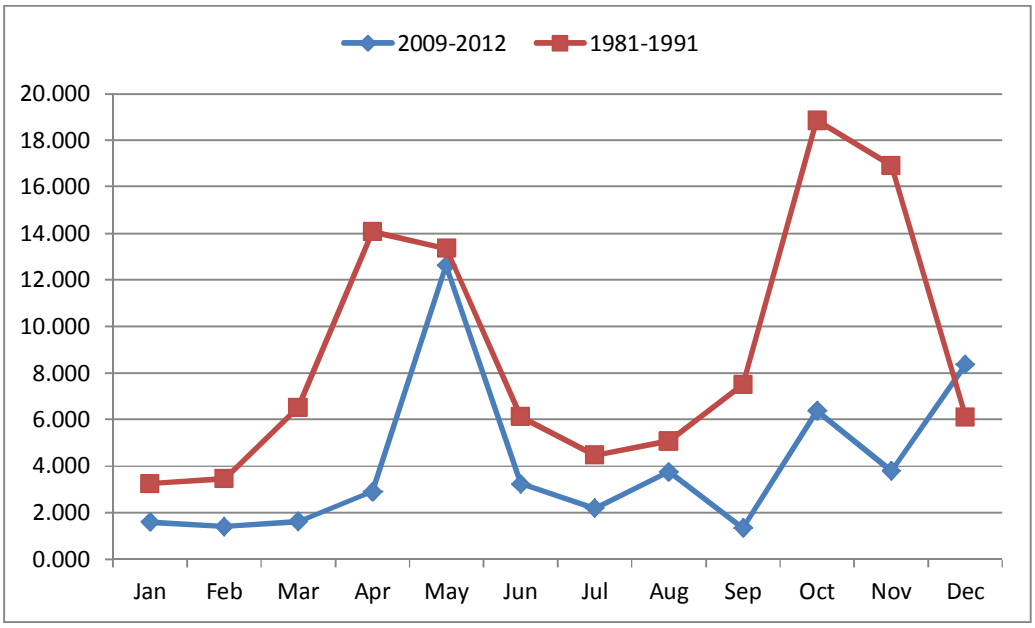


Figure 4.4 Comparison of mean monthly flow (cumecs) for 1981-1991 and 2009-2012

4.1.1 The 1981-1991 Data Record

This period has close to 9 years of data from which a maximum flow of 135.96 cumecs was recorded on 15th November 1989 with 0.3022 cumecs being the lowest flow recorded on 8th August 1983. Mean flow for this period is calculated as 8.7301 cumecs. The station was destroyed by floods in May 1991. Table 4.1 gives the salient parameters.

Table 4.1 Key Flow Parameters at 4DB5 in cumecs

	Original data	Original data	Edited and Naturalised data	All data edited
Parameter	1981 - 1991	2009 - 2012	2009 - 2012	1981 - 2012
Mean Flow	8.7301	4.264	4.8454	7.796
Maximum Flow	135.96	81.87	81.9849	135.96
Minimum Flow	0.3022	0.001063	0.3190	0.3022
Total years	10	3.8	3.8	31
Record years	8.8	3.1	2.8	11.6
No data years	1.2	0.7	1.0	19.4

4.1.2 The 2009-2012 Data Record

After 18 years of non-operation, flow data at 4DB5 (or is it 4DB6? Section 1.5.1) was re-started on 15th March 2009. The initial data up to 9th September 2009 had very low flows (0.001063 cumec, Table 4.1 above) which were not supported by NIB abstractions downstream (Section 2.1). Between March and September 2009, NIB abstracted a minimum mean monthly flow of 1.0 cumec in March and 1.38 cumecs in September. Table 4.2 compares mean monthly flows monitored at 4DB5 with mean monthly abstractions by NIB.

Flows at 4DB5 less than NIB abstractions indicate inaccurate records as NIB intake is about 100m downstream of river gauging station 4DB5.

Table 4.2 Comparison of monitored flows at 4DB5 with NIB abstractions in 2009

2009	March	April	May	June	July	August	September
4DB5	0.17	1.21	5.42	0.75	0.04	0.08	5.46
NIB	1.00	1.80	3.58	3.20	1.70	1.73	1.38

The extremely low flows between March and 10th September 2009 were edited to enhance credibility of the record and the remaining flows were ñnaturalisedò by adding abstractions upstream of 4DB5 gauging station amounting to 0.1401 cumecs. It should be noted that most abstractions during this critical drought period were not documented and the ñnaturalised flowò does not give a true picture of the flow magnitude of Nyamindi River. The flow data for the 2009-2012 were used cautiously in low flow and flood flow analysis but not in flow duration analysis as they gave poor results. These key parameters are summarized in Table 4.1 above.

4.2 Hydrological Analysis

4.2.1 Low Flow analysis

Annual minimum daily flows for Nyamindi River 4DB5 for the two sets of data (1981-1991 and 2009-2012) are tabulated in Table 4.3 below. The lowest flow recorded is 0.3022 cumecs on 9th August 1983 followed by years 2011, 2009, 2012 and 2010 with flows of between 0.3455 to 0.3975 cumecs, thus confirming drought in these recent years. The flows are ranked from the lowest to the highest in each year, and the frequency of occurrence computed as probability of non-exceedance (Figure 4.5) and return period in years. As the period of record is very short at 14 years, Q95 is estimated by plotting the data in a probability paper and extrapolating the curve (Q95 = 0.28 cumecs).

Q95 is the minimum annual daily flow that is equaled or exceeded 95% of the time (in this case, years) and only in 5 years out of 100 will the minimum annual daily flow fall below the Q95.

Table 4.3 Low Flow Frequency Analysis for Nyamindi 4DB05

Water Year	Start Date	Rank m	Flow cumecs	Return Period years	Probability of non exceedance	Probability of Exceedance
1983	9-Aug-1983	1	0.3022	15.0	0.07	0.93
2011	14-Apr-2011	2	0.3455	7.5	0.13	0.87
2009	29-Mar-2009	3	0.3493	5.0	0.20	0.80
2012	5-Apr-2012	4	0.3590	3.8	0.27	0.73
2010	19-Mar-2010	5	0.3975	3.0	0.33	0.67
1982	1-Mar-1982	6	0.5662	2.5	0.40	0.60
1984	30-May-1984	7	0.9837	2.1	0.47	0.53
1985	24-Feb-1985	7	0.9837	2.1	0.47	0.53
1990	15-Feb-1990	9	1.0716	1.7	0.60	0.40
1991	8-Mar-1991	10	1.1950	1.5	0.67	0.33
1986	13-Feb-1986	11	1.4487	1.4	0.73	0.27
1988	28-Jan-1988	12	1.5803	1.3	0.80	0.20
1989	15-Dec-1989	13	1.5974	1.2	0.87	0.13
1987	21-Jan-1987	14	1.7070	1.1	0.93	0.07

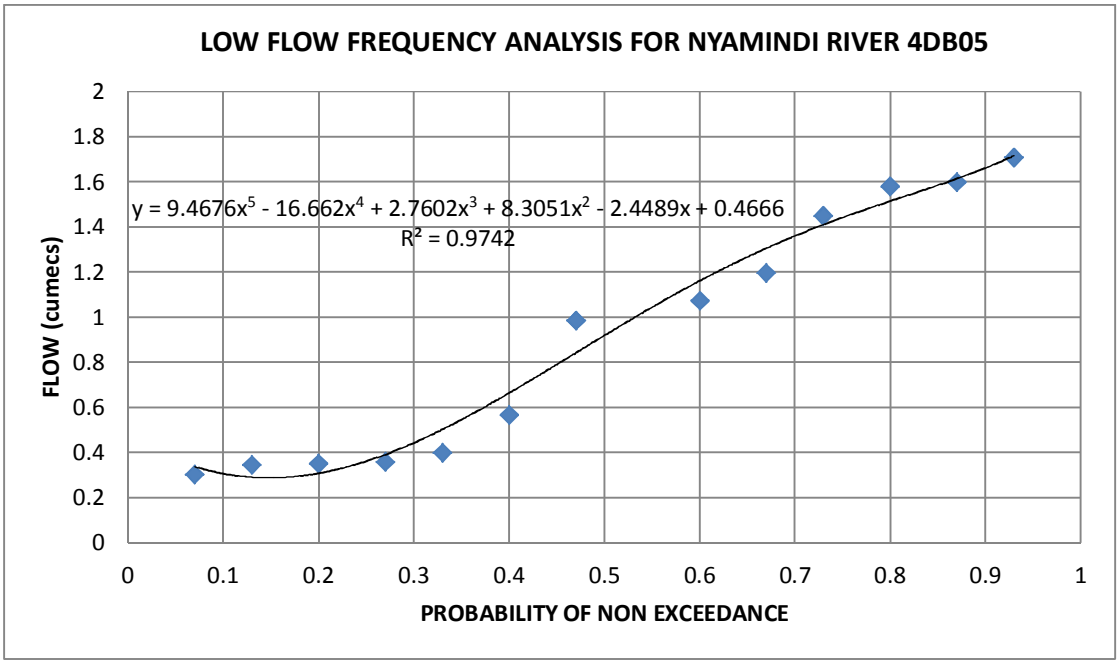


Figure 4.5 Low Flow Frequency Curve at 4DB5

4.2.2 Flood Flow Analysis

Annual peak daily flood flows were picked from the record of 15 years (1981-1991 and 2009-2012) and the frequency of occurrence computed as probability of exceedance and return period in years. This is shown in Table 4.4 below while Figure 4.6 is the frequency curve. The highest flood of 135.96 cumecs was recorded in November 1989 followed by May 1982 with 118.33 cumecs. Four of the remaining 13 years recorded floods of between 82 and 52 cumecs while the last 9 years recorded floods below 50 cumecs. This indicates the major challenges involved in flood monitoring, with the famous El-Nino floods of 1997-1998 missing.

Because of the short record of data (15 years), the Q95 exceedance flood was estimated by extrapolating the frequency curve (Q95 = 17.8 cumecs).

The Q95 is the annual daily flood flow equaled or exceeded 95% of the years and only in 5 years will the annual daily flood flows fall below Q95.

Table 4.4 Flood Flow Frequency Analysis for Nyamindi 4DB05

Water Year	Start Date	Rank m	Flow cumecs	Return Period years	Probability of Exceedance	Probability of non exceedance
1989	8-Nov-1989	1	135.96	16.0	0.06	0.94
1982	6-May-1982	2	118.33	8.0	0.13	0.87
2012	8-May-2012	3	82.01	5.3	0.19	0.81
1981	30-Oct-1981	4	62.31	4.0	0.25	0.75
1984	1-Nov-1984	5	61.63	3.2	0.31	0.69
1983	16-Sep-1983	6	52.98	2.7	0.37	0.63
1986	23-May-1986	7	49.34	2.3	0.44	0.56
1988	19-Oct-1988	8	42.45	2.0	0.50	0.50
1991	26-Apr-1991	9	41.58	1.8	0.56	0.44
2009	30-Dec-2009	10	39.72	1.6	0.63	0.37
2010	14-May-2010	11	38.94	1.5	0.69	0.31
1987	14-May-1987	12	27.83	1.3	0.75	0.25
1985	17-May-1985	13	25.69	1.2	0.81	0.19
1990	23-May-1990	14	19.69	1.1	0.87	0.13
2011	29-Aug-2011	15	18.2	1.1	0.94	0.06

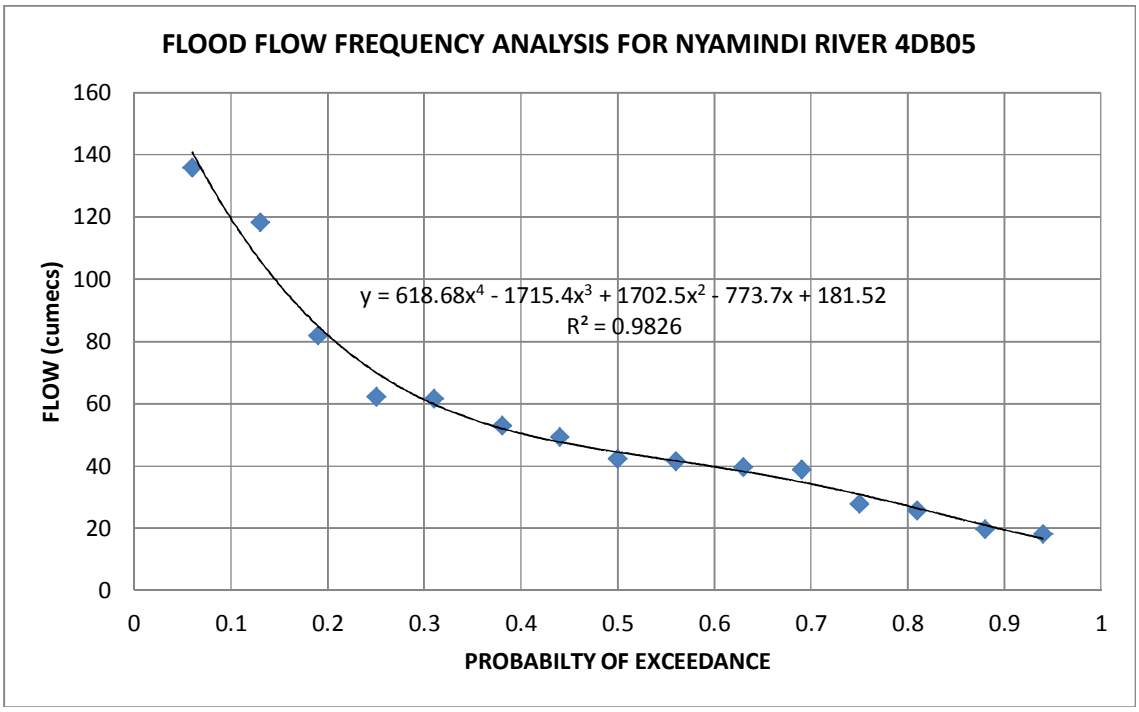


Figure 4.6 Flood Flow Frequency Curve at 4DB5

4.3 Availability of Water at Proposed Intake Site

4.3.1 Spot Flow Gaugings

The proposed intake site for the Mwea-Makima project is located some 100m upstream of the existing Kamumwe water project intake where a flow of 2.1626 cumecs was measured on 25th March 2003. Kamumwe intake is authorized to abstract 0.0401 cumecs for both domestic (193.3 M3/d=0.0023 cumecs) and irrigation (3,274 M3/d=0.0379 cumecs) purposes while demand for Mwea-Makima is estimated at 0.0984 cumecs in 2015, 0.1215 cumecs in 2025 and 0.1620 cumecs in 2035. Using the ultimate demand of 0.1620 cumecs, the balance of flow would be 2.1626-0.0401-0.1620 =1.9605 cumecs or 90.6%. According to WRMA rules, irrigation abstraction should be carried out from flood flow (Q50) and not from normal flow (Q80). If this rule is observed, the balance of flow would be 2.1626-0.0023-0.1620 = 1.9983 cumecs or 92.4%. This balance receives additional flows from downstream tributaries, a number of which have spot flow measurements as shown in Table 4.5 below.

Table 4.5 Nyamindi Tributaries Spot Flow Gaugings

Date	Tributary	Flow in cumecs
25-02-1979	Kiri	0.2271
17-07-1981	Mururi	0.3930
17-06-1991	Matakari	0.1190
02-05-1979	Mburi	0.0595
23-09-1977	Gikutha	0.0130
Total		0.8116

4.3.2 The Daily Flow Duration Analysis

The October 1981- May 1991 daily flow data was subjected to flow duration analysis whose results are as tabulated in Table 4.6 below. Figure 4.7 is a plot of the Flow Duration Curve.

Table 4.6 Parameters of Daily Mean Flow Duration Analysis at 4DB5

Level of Flow	Flow in cumecs	Parameter
Q95	1.6641	Environmental flow/Dry season flow
Q80	2.7817	Normal flow
Q50	5.4400	Flood flow
Qmean	8.7301	Mean flow
Qmin	0.3022	Minimum flow
Qmax	135.96	Maximum flow

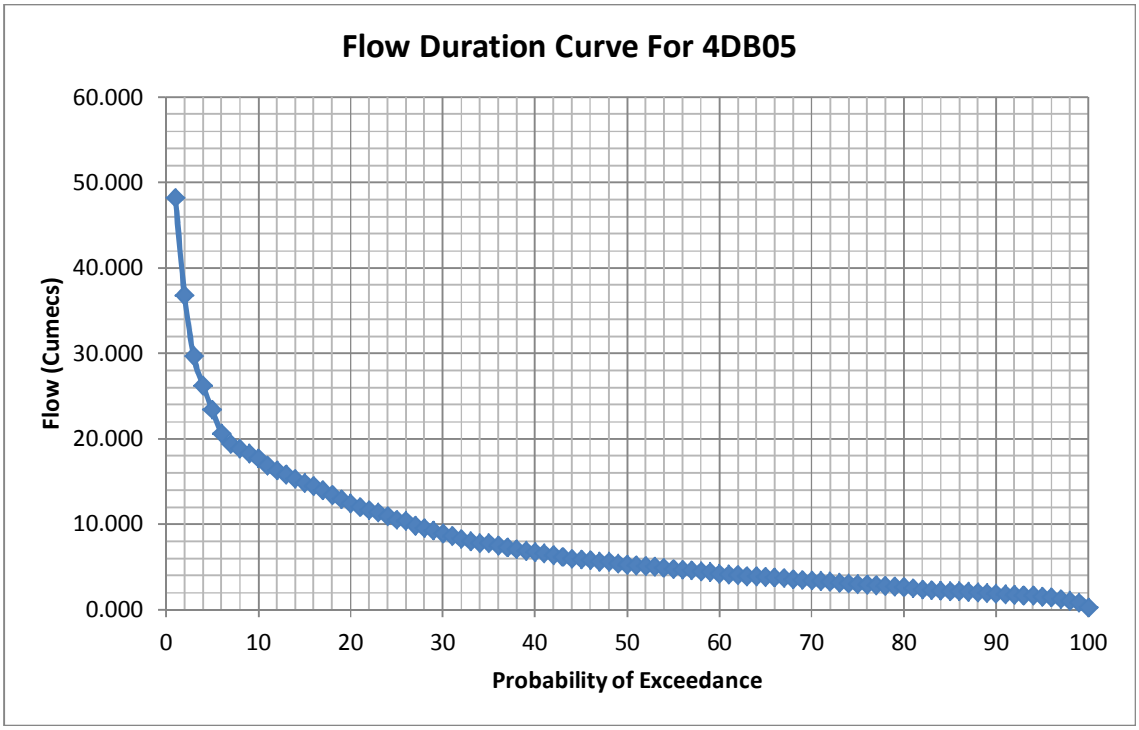


Figure 4.7 The Daily Mean Flow Duration Curve of Nyamindi River at 4DB5

The Q95 is the daily mean flow equaled or exceeded 95 days out of 100 days and only in 5 days will the daily mean flows fall below the Q95. Flows below Q95 have an average return period of 20 years, which denotes rare recurrence. Q95 is the flow that is left in the river to cater for basic human needs and ecological maintenance. It is equally referred to as the environmental flow or dry season flow or compensation flow.

The Q80 is the daily mean flow that is equaled or exceeded 80% of the time or 8 days out of 10 or 4 years in 5. Flows below Q80 have an average return period of 5 years, which denotes one year in 5. Q80 is regarded as the normal flow which caters for both environmental flow and allocation for domestic use. According to WRMA records held in Embu, about 0.0365

cumecs is abstracted for domestic use upstream of river gauging station 4DB5. From Q80, this leaves a balance of 2.7817-1.6641-0.0365 = 1.0811 cumecs, which receives additional flows from downstream tributaries. This flow is available to domestic users downstream of 4DB5 but is reduced by illegal irrigation abstractors by unknown amount.

Flows greater than Q80 and specifically Q50 is classified as flood flow and is used for irrigation purposes.

4.3.3 Use of Catchment Area Ratios

The catchment area of the proposed intake site was planimetred as 192 km2 while that of 4DB5 station is about 252 km2, giving a ratio of 0.7619. Extrapolating the Q80 flow (2.7817 cumecs) upstream to the proposed intake site results in a Q80 of 2.1194 cumecs. This compares very closely with the normal flow of 2.1655 cumecs measured on 25th March 2003. During a site visit of the proposed intake on 15th July 2013, the flow was estimated at between 2 and 3 cumecs.

Using the catchment area ratio of 0.7619, key parameters of flow duration analysis are extrapolated upstream from 4DB5 to the proposed intake site and summarized in Table 4.7 below.

Table 4.7 Parameters of Flow Duration Analysis at Proposed Intake Site

Level of Flow	Flow in cumecs	Parameter
Q95	1.2679	Environmental flow/Dry season flow
Q80	2.1194	Normal flow
Q50	4.1447	Flood flow
Qmean	6.3261	Mean flow
Qmin	0.2302	Minimum flow
Qmax	103.59	Maximum flow

The Qmax is too high for the catchment area which is 80% grassland and forest resulting in reduced surface runoff and enhanced recharge to springs and ground water aquifers. Qmin is expected to be higher as most water abstractions are downstream. Qmean is on the higher side due to reduced peak flood flows.

4.4 Surface Water Quality

During a site visit to the proposed intake on 15th July 2013, Nyamindi river appeared clean and clear of sediments. According to JICAôs Draft Final Report on National Water Master Plan, July 2013, Nyamindi river at the proposed intake has fresh neutral, low mineralized water with turbidity estimated at less than 5 N.T.U. Chemically the water is suitable for domestic use but requires coagulation and filtration where turbidity exceeds 5 NTU and disinfection to render the water portable. However, the project intends to give full treatment to the water supplied to ensure health and safety to consumers.

4.5 Analysis of Reserve

From the flow duration analysis in Section 4.5, the reserve flow or the dry season flow (Q95) is estimated at 1.6641 cumecs at 4DB5 river gauging station and 1.2679 cumecs at the proposed intake site. This flow is left in the river to cater for basic human needs and for ecological maintenance.

4.6 Assessment of availability of flow

4.6.1 At 4DB5 Gauging station

The flow duration analysis gives the normal flow (Q80) as 2.7817 cumecs. This flow caters for both reserve flow and domestic use. The difference between normal flow (Q80) and reserve flow (Q95) is 1.1176 cumecs, which is the allocatable water. Existing domestic water permits on normal flow are estimated at 0.0365 cumecs (3,153.6 M3/d), leaving a balance of 1.0811 cumecs (93,407.04 M3/day) available flow for allocation. This amount may not be available in total due to illegal abstractors who ignore registration by WRMA.

Flood flow at Q50=5.4400 cumecs, less reserve flow Q95=1.6641 cumecs leaves a balance of 3.7759 cumecs of allocatable flow. Existing irrigation water permits upstream of 4DB5 have a total allocation of 0.1130 cumecs leaving a balance of 3.6629 cumecs of available flow for allocation. As with normal flow, the flow balance is reduced by unregistered illegal abstractors. Table 4.7 gives a summary of the key parameters.

Table 4.8 Summary of key hydrological parameters at 4DB5 – flow in cumecs

Percentile	Category	Allocation	Allocated	Balance
Q95	Reserve flow	1.6641	0	1.6641
Q80	Normal flow	2.7817	0.0365	1.0811
Q50	Flood flow	5.4400	0.1130	3.6629

4.6.2 At The Proposed Intake Site

The daily flow duration parameters at 4DB5 are extrapolated upstream to the proposed intake site using the catchment area ratio of 0.7619 (Section 4.3.3) and Table 4.9 gives the salient parameters.

Table 4.9 Summary of key hydrological parameters at Proposed Intake-flow in cumecs

Percentile	Category	Allocation	Allocated	Balance
Q95	Reserve flow	1.2679	0	1.2679
Q80	Normal flow	2.1194	0.0023	0.8492
Q50	Flood flow	4.1447	0.0379	4.1068

5. Impact of proposed activity on flow regime, water quality and other abstractors

Flow Regime - The project will abstract about 0.1620 cumecs from the allocatable normal flow estimated at 0.8492 cumecs, or 7.6% of Q80 (2.1194 cumecs) (Table 4.9). The normal flow (Q80) is the flow that is equaled or exceeded 80% of the times or 8 days out of 10 and only in 2 days will the daily flows fall below Q80. The reserve flow (Q95=1.2679 cumecs) will be left in the river for ecological maintenance ï this being the daily mean flow that is equaled or exceeded 95 days out of 100. The project will not significantly impact on the flow regime and other abstractors as the flow balance of 0.6872 cumecs will receive additional inflows from downstream tributaries.

Water Quality ï The development will abstract water by constructing a concrete weir across the river and diverting part of the flow into a gravity pipeline to the treatment plant at Kangu. Water quality will not be affected since there will be no effluent discharge back to the river.

Other Abstractors ï Existing registered abstractors will not be impacted by this development as they have been catered for in the allocation of the resources (Tables 4.8 and 4.9).

6. Impact of Climate Change on Water Resources

Climate is the weather conditions prevailing in an area over a long period of time. Climate change refers to a process through which weather conditions change or deviate from the normal patterns as recorded over 20 years. This is brought about by human social-economic activities like industrial development, agricultural farming and deforestation which have tended to increase the Green House Gases emissions such as CO2 and Methane into the atmosphere resulting in damage to ozone layer which regulates temperatures reaching the earth from the sun. Regions may start experiencing erratic weather patterns in the form of rising air temperatures, abnormal amounts of rain, floods or extreme drought.

The Draft Final Report, July 2013, on the National Water Master Plan, Volume IV, Sectoral Report (B) ï Meteorology and Hydrology by JICA, has studied ñClimate change impact on Kenyaò. Based on the results of the climate change projection of 11 Global Climate Models (GCMs) being run by various Meteorological centres across the continents, the report has arrived at the following conclusions;

- The change of climatology in 2030 is not drastic
- Annual rainfall will increase in the whole country
- Rainfall during dry seasons will decrease in coaster areas
- Rainfall frequency will increase
- Annual mean temperature will increase by 1 degree Celsius in the 2030 climate
- Tana basin average annual rainfall is projected to increase from 837 mm/yr in 2010 to 899 mm/yr in 2030.
- Water loss through Evapotranspiration will increase in 2030.
- Most ASAL areas will be subjected to droughts
- Surface water runoff for the Tana basin was projected to increase from 5,858 mcm/yr in 2010 to 7,261 mcm/yr in 2030
- Flood flow is also expected to increase
- Tana basinôs renewable ground water recharge is projected to decrease from 7,719 mcm/yr in 2010 to 6,520 mcm/yr in 2030.

Each of the 11 GCMs has a future scenario which is different from the others but they are all representative of the potential range of future regional climate change. These GCMs utilize daily data, globally observed and exchanged between Meteorological Centres through WMO protocol.

Due to the uncertainties involved in long-term projections by the GCMs, regular reviews and updates are recommended to keep pace with climate change research findings.

7. Conclusion

- Nyamindi catchment has been shown to be a water surplus area with high rainfall amounts and low evaporation rates in the Mt Kenya Forest. This water needs to be well managed and efficiently used through better protection of the environment ï implementation of Catchment Management Plan, Soil and Water Management Plan and Environmental Management Plan.

- Enforcement of Water Resources Management Rules will ensure that more water is available for domestic use, as irrigation abstractors use normal flow which is meant for domestic allocation.

- Installation of controlling and measuring devices will enhance efficiency of water usage and avail more water to downstream users.

- With the projected change in climate in the future, leading to high frequencies of floods and droughts, large investments in water harvesting and storage infrastructure will be required to keep pace with increased population and economic growth.

8. Recommendations on proposed activity

From the results of the daily flow duration analysis, the normal flow (Q80) has a balance of 0.8492 cumecs of allocatable flow. The project is applying to progressively abstract about 0.0984 cumecs in 2015 (initial demand), 0.1215 cumecs in 2025 (future demand) and 0.1620 cumecs in 2035 (ultimate demand).

On the basis of the available data and information and the analysis carried out, it is recommended that the Client be authorized to construct intake works to abstract an ultimate (2035) water demand of 0.1620 cumecs (14,000 M3/d) from Nyamindi river at GPS Coordinates S00 29 10 E37 23 57 for domestic use. The progressive intake of water will be controlled by the Treatment Plant which will be constructed in phases.

The project is highly beneficial to the community which is water stressed and where women and girls spend a lot of time walking long distances to fetch water of questionable quality. The project will free the women to engage in social economic activities that will improve the well being of their families while the girl child will spend more time in her studies thus enhancing her social status.

The project will also result in improved health and reduced health costs as it is estimated that 80% of all communicable diseases are water related.

However, the Client must observe all the abstraction conditions as per water resources management rules.

Summary of Progressive Water Demands

Year	Estimated Population	Domestic Water Demand	
		Cumecs	M3/d
2015	196,000	0.0984	8,502
2025	233,000	0.1215	10,500
2035	277,000	0.1620	14,000

Annex 4: Water quality standards

DRINKING WATER QUALITY STANDARDS

Sl.No.	Characteristics	Drinking water
1)	Colour [a)]	15 true colour units max
2)	Turbidity	5 max. (NTU)
3)	pH	6.5 ï 8.5
4)	Taste	Not offensive
5)	Odour	Odourless
6)	Total dissolved solids	1000 max.
[a)]True colour units (TCU) mean 15 hazen units after filtration.		

Sl.No.	Substance or characteristic	Drinking water (mg/L max.)
1)	Suspended matter	Not detectable
2)	Total dissolved solids in mg/L, (TDS)	1000
3)	Total hardness as $CaCO_3$	300
4)	Aluminium as Al^{+++}	0.1
5)	Chloride as CL^{-}	250
6)	Iron as Fe^{++}	0.3
7)	Sodium as Na^{+}	200
8)	Sulphate	400
9)	Zinc as Zn^{++}	5
10)	Magnesium as Mg^{++}	100
11)	Residual chlorine [b)]	0.2
12)	Calcium as Ca^{++}	150

Sl.No.	Substance	Limit of concentration mg/L,max.
1)	Arsenic as, As	0.01
2)	Cadmium as, Cd	0.003
3)	Lead as, Pb	0.01
4)	Copper as, Cu	1
5)	Mercury (total as, Hg)	0.001
6)	Manganese as, Mn	0.5
7)	Selenium as, Se	0.01
8)	Ammonia (N)	0.5
9)	Chromium as, Cr	0.05
10)	Nickel as, Ni	0.02
11)	Cyanide as, CN	0.07
12)	Barium as, Ba	0.7
13)	Nitrate as, NO_3	50
14)	Boron as, (boric acid)	0.3
15)	Fluoride as, F	1.5[b)]
16)	Bromated as, BrO_3	0.01
17)	Nitrite	0.003
18)	Phosphates as, PO_4^{3-}	2.2

Annex 5: Public participation open baraza photo gallery

Photo 1: Baraza at Karucho Market - Kirinyaga East

Photo 2: Baraza at Karucho Market - Kirinyaga East

Photo 3: Baraza at Karucho Market - Kirinyaga East

Photo 4: Baraza at Karucho Market - Kirinyaga East

Photo 5: Baraza at Kangu - Mwea East

Photo 6: Baraza at Kangu - Mwea East

Photo 7: Baraza at Kangu - Mwea East

Photo 8: Baraza at Kangu - Mwea East

Photo 9: Baraza at Kangu - Mwea East

Photo 10: Baraza at Kianjiru - Kirinyaga East

Photo 11: Baraza at Kianjiru - Kirinyaga East

Photo 12: Baraza at Kianjiru - Kirinyaga East

Photo 13: Baraza at Kianjiru - Kirinyaga East

Photo 14: Baraza at Karaba - Mbeere South District

Photo 15: Baraza at Karaba - Mbeere South District

Photo 16: Baraza at Karaba - Mbeere South District

Photo 17: Baraza at Makima - Mbeere South District

Photo 18: Baraza at Makima - Mbeere South District

Photo 19: Baraza at Makima - Mbeere South District

Annex 6: Socio-economic study report of the area

SOCIO – ECONOMIC STUDY

This section focuses on the people's source of livelihood, the environment of the project area and infrastructure. In addition, it highlights communication, health and education issues. The Consultant carried out a social economic survey in the area to determine the following issues:-

- The health facilities in the area
- The HIV/AIDS situation and the most recurrent ailments in the area
- The people's sources of livelihood
- Levels of Gender inclusion
- The Society's ability to sustain ably manage development projects
- The existing water sources
- The average cost of water and the people's willingness to pay for water
- Sanitation levels in the supply area &
- The average distances to water sources.

1.1 Findings

The Consultant analyzed the findings and tabulated as in **Error! Reference source not found.** below.

Table 1 : Survey Findings for Mwea - Makima Water Supply System Project

Area surveyed	**Type of Health Facilities**	**Common diseases prevalent in the area**	**Level of HIV/AIDs awareness**	**Rate of HIV/AIDs infection**	**Water sources**	**Price in Kshs per 20 ltrs**	**Distance to source in km**	**Main source of income**	**Sanitation coverage in %**
MBEERE SOUTH DISTRICT									
Kilia Market	2 No Dispensaries and 1 No Private Clinic	Typhoid, Malaria, Intestinal worms, Diarrhoea	Awareness is high and VCT ARV services are available	Decreasing	Masinga Dam	20	3	Farming of maize, green grams and cow peas	80
Gategi Mkt	1 No. Dispensary and 3 No Private Clinics	Typhoid & Malaria,	Awareness is high and VCT ARV services are available	Infection is increasing	Thiba River	10	4	Livestock, maize, beans, green grams	90
Mbonzuki Mkt	1 No. Dispensary and 7 No Private Clinics	Malaria, Typhoid, Amoeba & Dysentery	Awareness is high and VCT ARV services are available	Infection is increasing	Masinga Dam	30	5	Maize, beans & Livestock keeping	90
Kaseve Mkt	1 No. Dispensary	Typhoid & Malaria,	Awareness is high and VCT ARV services are available	Infection is decreasing	Thiba River	15	4	Maize, beans & Livestock keeping	80

Pl 2	3 No. Dispensaries	Dysentery, Malaria, Typhoid, Diarrhoea	Awareness is high and VCT ARV services are available	Infection is decreasing	NIB Canal Water	20	3	Maize, tomatoes, French beans	90
Karaba	1 No. Dispensary & 1 No Private Clinic	Dysentery, Malaria, Typhoid, Diarrhoea	Awareness is high and VCT ARV services are available	Infection is increasing	Borehole	3	1	Green grams, maize, tomatoes	95
Riakanau Market	1 No. Dispensary	Malaria, Typhoid, Amoeba, Dysentery & Diarrhoea	Awareness is high and VCT ARV services are available	Infection is increasing	Masinga Dam	N/A	1	Livestock, maize, beans	80
Nthingini Market	1 No. Dispensary & 2 No Private Clinic	Hypertension, Diabetes, Typhoid, Malaria, Amoeba	Awareness is high and VCT ARV services are available	Infection is decreasing	Borehole	20	2	Maize, beans, green grams, livestock keeping	95
Wango Market	3 No. Dispensaries	Hypertension, Diabetes, Typhoid, Malaria, Amoeba	Awareness is high and VCT ARV services are available	Infection is increasing	3 No. Boreholes	20	2	Maize, beans, green grams, livestock keeping	90
Mbeere South DPHO	The district has 1 hospital, 9 dispensaries 1 health center and 10 clinics	Dysentery, Malaria, Typhoid, Diarrhoea	Awareness is high in the District	Rate of infection in the District is going down	Thiba and Tana Rivers	10	2	Maize, beans, green grams, livestock keeping	80
Gatwiiri Market	1 No. Dispensary	Dysentery, Malaria, Typhoid, Diarrhoea, Bilharzias	Awareness is high and VCT ARV services are available	Infection is increasing	NIB Canal Water	10	2	Beans, Green grams, livestock rearing	90

Makima makima market	1 No Dispensary, 2 No Private Clinics	Dysentery, Malaria, Skin diseases, Typhoid	Awareness is high and VCT ARV services are available	Infection is decreasing	Thiba River	30	5	Maize and Green grams	95
Mwocangondi village	None	Dysentery, Malaria, Typhoid, Diarrhoea, Bilharzias, Amoeba	Awareness is high and VCT ARV services are available	Infection is decreasing	Thiba and Nyamindi Rivers	20	5	Maize and Green grams	90
MWEA WEST DISTRICT									
Kianjogu village	No health facility	Dysentery, Malaria, typhoid, Diarrhoea, bilharzias, Amoeba	awareness is high and VCT ARV services are available	Rate of infection is increasing	Canal water	20	2	Rice, tomatoes and French beans	80
Kandongu market	1 No Health Centre	Dysentery, Malaria, typhoid, Diarrhoea, bilharzias, Amoeba	awareness is high and VCT ARV services are available	The rate of infection is decreasing	Canal water	1000 per season for irrigation water	1	Rice	80
Nguka sub-location	1 hospital and one dispensary	Dysentery, Malaria, typhoid, Diarrhoea, bilharzias, Amoeba	awareness is high and VCT ARV services are available	Infection rate is decreasing	Water canal	10	1	Rice	80
Kasarani Village	No health facility	Dysentery, Malaria, typhoid, Diarrhoea, bilharzias, Amoeba	awareness is high and VCT ARV services are available	Infection rate is going down	Water canal	10	1	Rice	70

Mwea East H/Q offices	The district has 1 hospital, 9 dispensaries 1 health center and 10 clinics	Dysentery, Malaria, typhoid, Diarrhoea, bilharzias, Amoeba	awareness is high and VCT ARV services are available	Infection is increasing	Thiba and Nyamindi rivers			Rice, tomatoes, French beans and maize	80
Mutithi Market	1 Health Center and 3 private clinics	dysentery, Malaria, typhoid, Diarrhoea, bilharzias, Amoeba	awareness is high and VCT ARV services are available	Infection is increasing	Canal water and a project of KIRIWASCO	20	1	Rice, tomatoes, French beans and maize	70
Wamumu sub location	2 dispensaries and one private clinic	Dysentery, Malaria, typhoid, diarrhoea, bilharzias, Amoeba	awareness is high and VCT ARV services are available	Infection is increasing	Canals from Thiba and Nyamindi			Mainly rice and tomatoes	80
MWEA EAST DISTRICT									
Kangu Market	1 No Dispensary	Dysentery, Malaria, typhoid, Diarrhoea, bilharzias, Amoeba	awareness is high and VCT ARV services are available	Rate of infection is decreasing	Mutungara water project	10	0.5	Rice, tomatoes, French beans and maize - small businesses	95
Mururi Market	5 No Private Clinics	Malaria, Typhoid, Skin diseases, Diarrhoea, Amoeba	awareness is high and VCT ARV services are available	Rate of infection is decreasing	Mutungara irrigation water project and River Nyamindi	20	1	tomatoes, French beans and maize, small businesses	98

Kianjiru Market	No health facility	Malaria, typhoid, skin infection, Diarrhoea ,Amoeba	awareness is high and VCT ARV services are available	Rate of infection is decreasing	Mutungar irrigation water project and River Nyamindi	20	1	tomatoes , French beans and maize, small businesses	98
Kiaurugari village	3 No Private Clinics	Malaria, typhoid, skin infection ,Diarrhoea ,Amoeba	awareness is high and VCT ARV services are available	Rate of infection is increasing	Canal water from river Nyamindi	20	1	tomatoes , French beans and maize, small businesses	95
Kimbimbi Town	1 hospital and 4 private clinics	Malaria typhoid skin infection Diarrhoea Amoeba	awareness is high and VCT ARV services are available	Rate of infection is decreasing	Two boreholes and canal water	2	0.5	Rice, tomatoes , French beans and maize - small businesses	95
Mwea East District Head Quarters	District has 2 hospitals, 7 dispensaries health centres, and 8 private clinics	Malaria typhoid skin infection Diarrhoea Amoeba	awareness is high and VCT ARV services are available	Rate of infection is decreasing	Thiba and Nyamindi rivers	10	1	Rice, tomatoes , French beans and maize - small businesses	70
Mahati Village	2 No Private Clinics	Malaria, Typhoid ,Skin infection, Diarrhoea, Amoeba	awareness is high and VCT ARV services are available	Rate of infection is increasing	Water from canal	10	0.5	Rice and tomatoes	80

Maisha Kamili and Dandora villages	1 No Private Clinic	Malaria typhoid skin infection Diarrhoea Amoeba	awareness is high and VCT ARV services are available	Rate of infection is increasing	Water from canal and a project of KIRIWASCO	5	1	Rice and tomatoes and casual labour	70
Kiamucege Village	2 No Private Clinics	Malaria typhoid skin infection Diarrhoea Amoeba	awareness is high and VCT ARV services are available	Rate of infection is increasing	Water from canal	10	2	Rice and casual labour	80
Gakungu Muthaiga village	1 No Private Clinic	Malaria typhoid skin infection Diarrhoea Amoeba	awareness is high and VCT ARV services are available	Rate of infection is decreasing	Water from canal	10	1	Rice and casual labour	90
Karira Village	1 Dispensary, and 1 No Health Centre	Malaria typhoid skin infection Diarrhoea Amoeba	awareness is high and VCT ARV services are available	Rate of infection is increasing	Water from canal and a project of KIRIWASCO	5	0.5	Rice and casual labour	80
Karukungu village	1 Dispensary, and 1 Health Centre	Malaria typhoid skin infection Diarrhoea Amoeba	awareness is high and VCT ARV services are available	Rate of infection is increasing	Water from canal	10	1	Rice and casual labour	90
California Village	1 Dispensary, and 1 Health Centre	Malaria typhoid skin infection Diarrhoea Amoeba	awareness is high and VCT ARV services are available	Rate of infection is increasing	Water from canal	20	1	Rice and casual labour	90
Gathigiriri Sub - location	1 Dispensary and 3 Private Clinics	Malaria typhoid skin infection Diarrhoea Amoeba	awareness is high and VCT ARV services are available	Rate of infection is increasing	Water from canal	10	2	Rice and casual labour	80
Kiamanyeki Village	1 Dispensary and 1 No Private Cinic	Malaria typhoid skin infection Diarrhoea Amoeba	awareness is high and VCT ARV services are available	Rate of infection is increasing	Water from Thiba River	5	2	Rice and casual labour	90

Murubara Village	1No Private Clinic	Urinary tract infection HBP typhoid skin infection Diarrhoea Amoeba Bilharzias	awareness is high and VCT ARV services are available	Rate of infection is increasing	Murubara spring and canal water	10	1	Rice and casual labour	80
Ciagene village	1 No. Dispensary	Malaria typhoid skin infection Diarrhoea Amoeba	awareness is high and VCT ARV services are available	Rate of infection is increasing	Thiba river	10	2	Rice , tomatoes and casual labour	95
Mahigaini Village	1 No Private Clinic	Malaria typhoid skin infection Diarrhoea Amoeba	awareness is high and VCT ARV services are available	Rate of infection is increasing	Nyamindi River	10	2	Rice , tomatoes and casual labour	90

1.2 Willingness and ability to pay for water supply

The community has managerial skills and has been successfully managing other existing water projects like Rukanga water project, Kamumwe water Project, Ndikiki and Karaba Ciagi - ni projects among others. In all the project areas the community is used to paying for water services. In Mwea East and west the rice farmers pay Ksh. 1,000 per acre per season for irrigation water from the National Irrigation Board. Water vending is a common business and when the canals are shut for water rationing most people buy water from vendors for between Ksh. 10 - 20 per 20 litres. The situation is even worse in Mbeere South where in places like Gategi and Mbonzoku people walk for about 5- 7 Km to fetch water and a 20 litre jerrican is sold at about Ksh. 30 in some locations. In all these areas the communities expressed their willingness to pay for water especially if it is clean and closer home. Thus the willingness to pay for water is demand driven since there is hardly any clean water found in the project area.

Assumptions-;

1. The current high degree of willingness to pay for water services is demand driven and will be maintained when the construction of water facilities are completed.
2. That there is no supplies of clean, portable water in the project area because all the current water sources are highly contaminated from human activities and agrochemicals.
3. That the community will use the money currently used to buy water from vendors to buy clean water from The Mwea Makima Water Supply Project.
4. That an effective O & M system will be implemented and this will lead to adequate revenue collection for sustainability of the water facility.
5. The average water cost in the project area is estimated at about 10/= per 20 litre jerrican

1.2.1 Water Revenues

The proposed project area covers areas in Mwea East and Mwea West Districts in Kirinyaga County and Mbeere South District of Embu County with a current total population of 56,275, 58,893 in the initial, 73930 in future and 92,806 people in the ultimate. The average household size the area is 6 persons and this translates to about

31,524 households. The average water consumption per day per household is 5 jerricans of 20 litres. The average cost of water from vendors in most of the project area is Ksh.10 - 20 per 20 litres jerrican. While the existing projects sell at a slightly lower price of Ksh.5 per 20 litres jerrican. When the water cost analysis in the rural areas is conducted, an average cost of kshs 12 per 20 litres jerrican is arrived at. However, survey on the willingness to pay for clean water indicated that people would be willing to pay kshs 2 per 20 litres jerrican. There are commercial entities in the numerous market centres in the proposed coverage areas that have been targeted for water services provision. Other institutions considered include secondary schools, primary schools and health institutions.

Water at kshs. 5/= per 20 litres jerrican

Households targeted	9,379
Water consumption per day per HH	5 jerricans
Cost of 20 litres jerrican, kshs	5/=

Cost of water in the project area per day (kshs)

9379*5*5 = Kshs. 234475

Cost of water in the project area per month (kshs)

9379*5*5*30 = kshs. 7034250

Water at kshs. 12 Per 20 litres jerrican

Households targeted	9,379
Water consumption per day per HH	5 jerricans
Cost of 20 litres jerrican, kshs	12

Cost of water in the project area per day (kshs)

9,379*5*12 = Kshs. 56,2740

Cost of water in the project area per month (kshs)

9379*5*12*30 = Kshs. 16,882,200

This is presuming that every house hold was buying water at the current average cost.

Water at kshs. 2 Per 20 litres jerrican

Households targeted	9,379
Water consumption per day per HH	5 jerricans

Cost of 20 litres jerrican, kshs 2

Cost of water in the project area per day (kshs)

9379*5*2 = Kshs. 93,790

Cost of water in the project area per month (kshs)

9379*5*2*30 = Kshs. 2,813,700

1.2.1 Business Plan

It has been assumed that the project will be implemented by 2015 and the following assumptions will been taken to develop a business plan for the project with an intention of entrenching sustainability in the project's O & M operations.

1. The projection horizon is 20 years with the initial as 2015, future as 2025 and ultimate as 2035.
2. The population to be served in the initial is 58,893 in about 9,379 HH whose size is 6 persons, with a population growth rate of 2.3%.
3. Maintenance cost will been taken as a percentage of the capital cost of the project, pegged at 1%.
4. Cost of water will be taken at 2/= per 20 litre jerrican in the initial to increase at 1% to 2.4/= in the ultimate. However, this rate is just slightly above the amount the people are willing to pay for water at the initial stage which will have doubled by the ultimate period.
5. The project will be run by KIRIWASCO and the only additional staff required will be; Water Operator, Meter Reader/ Line Patroller, Cleaner, security at the treatment and 8 Kiosks attendants in the initial stage of the project during phase I. However phase II, will require an addition of the following staff; Lab. Technician, Artisan (Electrical), Water Attendant and Chemical Attendants.
6. Cost of water for individual connections will be taken at 50/= per m^3 in the initial (going by what KIRIWASCO and other projects charge currently) to increase at 1% to 61.6 per m^3 in the ultimate.

1.3 Conclusions and Recommendations

1. The project area is surrounded by three great rivers which have plenty of water but which are all very contaminated within the area, namely Thiba, Nyamindi and Tana to the South.
2. There are very few projects in the project area that provide clean water. Treating and providing clean water to the people is the only solution to the current water situation.
3. In line with the GoK strategy articulated in the PRSP, the proposed project will support efforts to promote wider access to water and sanitation services, and improve the quality of service delivery, as a means of reducing poverty. This would be achieved through institutional reform, capacity building, and maximizing the efficient use of available resources.
4. The project is technically feasible, financially and economically viable, with important socio-economic benefits, as well as being environmentally sustainable, and will support the government's goal of providing the people of the project area with clean water for domestic use. This will drastically improve their health, save on time wasted on fetching water and reduce the average amount of money wasted by every household on medication.
5. The willingness to pay for portable water services in the area is far much higher than Kshs. 2/= per 20 litre jerrican because the amount of water supplied by vendors is sold at between kshs 10/= and 20/=, which is between 5 and 10 times higher.
6. The time, money and energy spent on water will be directed to other economic activities that will improve the people's income and standard of living
7. Provision of treated water to all the residents of the project area will save fuels, particularly firewood which is used for boiling water, as is the case where water of good quality is not available.
8. Alongside both the financial and economic evaluation, the social evaluation indicates the urgent need for water by the local residents. Acute need for water in most of the areas has been established after an assessment of the performance of the existing facilities. This project, which directly focuses on eliminating the water shortages, should be eligible for implementation.
9. Provision of water has been proved to be one important catalyst for stimulating socio-economic growth. Indeed it is a necessary infrastructure whose absence has been considered as holding back development, not only in the urban areas but also

in the rural areas. This project proposes to avail water of good quality to communities. This will result in the emergence of small - scale businesses that are water supported, which would otherwise have not been initiated due to lack of water. This project therefore has the potential for creating an enabling environment for income generating activities both in rural and urban areas.

The fragile environment of the area requires consideration during and after project implementation. Tree planting programme is highly recommended for environmental conservation. Most households in the project area especially the lower parts are not able to plant as many trees as they wish due to water shortage. This situation is expected to improve with the availability of water.