ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT PROJECT REPORT

PROPOSED SEWERAGE TREATMENT PROJECT ON 32 UNCONSOLIDATED PLOTS BY EMBU WATER AND SANITATION COMPANY LIMITED

SITE GPS COORDINATES:
S00^{0}33'01.7''
E037^{0}27'42.1''

ALTITUDE:
1,353 M ASL

BEARING:
249^0

THIS ENVIRONMENTAL IMPACT ASSESSMENT PROJECT REPORT IS SUBMITTED IN COMPLIANCE WITH PRINCIPLES OF SUSTAINABLE DEVELOPMENT, ENVIRONMENT MANAGEMENT AND COORDINATION ACT (1999) AMENDED AND ENVIRONMENTAL MPACT ASSESSMENT AND AUDIT REGULATIONS (2003)

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ACRONYMS AND ABBREVIATIONS

EA	**Environment Audit**
EIA	**Environment Impact Assessment**
EMCA	**Environment Management and Coordination Act**
EMP	**Environmental Management Plan**
EWASCO	**Embu Water and Sanitation Company**
MSDS	**Material Safety Data Sheet**
NEMA	**National Environment Management Authority**
PCC	**Public Complaints Committee**
TWSB	**Tana Water Services Board**
WRMA	**Water Resources Management Authority**

EXECUTIVE SUMMARY

The proposed waste water treatment system project will be implemented by Embu Water and Sanitation Company Ltd (EWASCO) as the proponent and an Agent of Tana Water Services Board (TWSB) which manages the water and sewerage system for Embu town and its environs. The proposed site of sewage treatment plant to supplement the existing facility is to be built at the confluence of Rupingazi River and Kamiugu Stream as recommended in the report by consultants for the design. Inflow to the treatment works is estimated at 2,000m^3/day. The relatively short distance from the sewered areas to the treatment plant will allow most of the funds to be used for construction of the sewer reticulation system. The sewer lines will be constructed to improve the sanitary conditions in the central business district, some parts of residential and commercial areas under phase 1 i.e. Blue Valley, part of Majimbo Village and its immediate neighbourhood, Dallas, Stadium Estate, Kanjuru and Muruatetu Estate, part Spring Valley Estates, Kangaru Schools and Kenya School of Government, Embu and its surroundings. The proposed project will be located on 32 unconsolidated plots of land (see copies of title deeds in the annexes) measuring a total of 1.87 ha with absolute form of land ownership owned by Tana Water Services Board (TWSB) on behalf of EWASCO.

The sewage disposal problem still persists in Embu town and is becoming more and more pronounced as the town continues to expand and grow. A viable solution to the waste water disposal problem is still being sought in order to specifically address the most critical areas in need of sewage services in Embu town apart from the proposed project. The existing sewerage system and treatment plant in Embu town was constructed in 1972 All the sewers are designed for ultimate flow based on population projections. To avoid duplication of sewer lines in the future, sewers in areas traversed by flow from the areas not in phase 1, have been designed to also cater for ultimate flow from these areas.

The project will consist of the following:

i. Construction of waste stabilization ponds composed of two anaerobic ponds, two facultative pond and two maturation ponds
ii. A wetland
iii. Two drying beds
iv. Laying of sewer line network to the proposed site
v. Lockable gate
vi. Fencing the site
vii. Staff houses

The sewage flow into the proposed treatment plant working in tandem with the existing treatment works is estimated at 3,000m^3/day. The Treatment Plant in the design Report was designed for 5,000m^3/day, though the flow was estimated at 5,151m^3/day. However, the proposed treatment plant is designed for a flow of 2,000m^3 per day so as to fit in the five acre piece of land owned by EWASCO.

The Environmental Impact Assessment (EIA) experts have prepared this Project Report to fulfil the legal requirements outlined in Section 58 to 69 of the Environmental Management and Coordination Act (EMCA) 1999 amended and Part I and II of the Environmental Impact Assessment and Audit Regulations. This Project Report is based on proponent documents review, field data gathered, and discussions with the Proponent, contractor and neighbours as well as other relevant stakeholders.

From the Environmental Assessment carried out, the following mitigation measures are recommended to make the project environmentally sustainable and reduce negative impacts:

Table 1: Potential adverse environmental impacts and recommended mitigation measures

Potential adverse impact	Mitigation measure
Excavation and earthworks resulting into stock piles, soil erosion:	• Excavation should be carried out such that drainage is controlled and water is not allowed to accumulate at the project site. Any water that collects has to be drained and disposed of sensibly, so as not to cause erosion • Establish controls for surface runoff during excavation e.g. digging trenches around excavated areas and earthworks to control erosive potential of surface runoff • Control excavation activities to limit excavation to land which is required for construction • Securing of the site using iron sheets or other appropriate materials to protect passersby and control noise. • Use the excavated soil as back fill • Excavated and piled soils should be covered when there is rainfall to

Potential adverse impact	Mitigation measure
	prevent it causing sedimentation in R. Rupingazi
Noise and dust during construction	• Construction work shall be done during day time hours only i.e. from 8:00 AM to 5:00 PM • Control working hours to limit noise, dust and traffic nuisance. Noisy construction activities should be scheduled to hours with minimal interruption for residents. • Sprinkle water on areas where dust is likely to be generated • When excessive noise is anticipated, acquire a licence from the County Government and follow NEMA regulations and orders.
Wastewater discharge to sewers	• The contractor shall erect a functioning sewer waste disposal system to cater for anticipated increase in waste generation • Portable toilet facilities should be provided for workers and visitors to the site
Occupational health and safety	• Develop a site safety action plan detailing safety equipment, emergency procedures, restrictions on site, safety inspections and controls; • Reporting and recording of health, safety and environmental incidences as per Legal Notice No 40, The Factories (Building Operations and Works of Engineering Construction) Rules 1984. • Erect warning signs on site warning residents and visitors of inherent danger posed in the construction site and restricting access at all times
Project maintenance / impacts on the local river and the neighbourhood	• Timely maintenance of sewer conveyance, distribution system; • Maintenance of access routes and the drainage system; • Manage solid wastes and dispose it appropriately; • Monitor water quality, upstream and downstream and at the point of discharge
Drainage management	• Proper project site drainage management to Control erosion • Avoid ponding water; • Proper waste and material handling, and storage to avoid flushing of wastes in to the neighbouring river • Follow designs made for the system
Loss of Water Quality and interference with riparian reserve	• Runoff channels to be constructed to drain storm waters • Water quality tests at the river to be conducted quarterly • Maintain the riparian reserve as per WRMA requirements • Replant the riparian zone with suitable trees • Leave the riparian area without any development • Maintain the required buffer zone to the Rupingazi river
Waste handling and disposal	• Develop a solid waste management plan prior to project commencing, identifying optimal waste re-use options and disposal in licensed sites • Comply with NEMA guidelines on solid and liquid waste disposal. • Acquire requisite licenses from NEMA offices
Foul Odours	• Monitor and ensure that influent sulphate levels are below 240 mg/l. • Ensure that the pond series have adequate water flow to reduce the potential of odour formation.
Decommissioning phase	• Inform NEMA of intentions • Perform a close down Environmental Audit • Restore the area as per NEMA recommendations

Construction at the site will be immediate after a go ahead is issued and the estimated cost of the project is Ksh. 400,000,000. Through a careful assessment, it has been noted that there are no adverse environmental impacts likely to arise that cannot be mitigated as per available information. An annual Environmental Audit should be undertaken upon completion of the Project to gauge the level of implementation of Environmental Management Plan (EMP). Its therefore recommended that NEMA approval can be issued on the basis of this report.

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Background information

The sewage disposal problem still persists in Embu town and the problem is becoming more and more prevalent as the town continues to expand and grow. A viable solution to the waste water disposal problem is still being sought in order to specifically address the most critical areas in need of sewage services in Embu town.

The existing sewerage system and treatment plant in Embu town was constructed in 1972 following a "Study Master-plan" by Desmond Fitzgerald and Associates in 1970. It was augmented by Embu Water and Sanitation Company (EWASCO) in 2009 to improve the deteriorating sanitation condition in town as no funds were available to build a new one as recommended in Master Plan by consultants. The existing sewer system serves a small portion of the population of Embu town's western part of the town, mainly due to the limitations of location and the capacity of the treatment plant. The existing treatment plant was designed for an ultimate capacity of 800 m^3 of waste water per day. The waste water treatment plant has already exceeded the ultimate design capacity.

EWASCO, an Agent of Tana Water Services Board (TWSB) which manages the water and sewerage system for Embu town and its environs, carried out a design review based on the above reports and updated the design to cover the period 2015 and selected a portion of the town that was most needy so as to comply with the Kenyan Laws and Regulations, Millennium Development Goals and also with Kenya's Vision 2030 and came up with engineering cost estimate with a view of getting financing from the World Bank.

The areas that are to be sewered have been identified as high priority as per the EWASCO assessment and specifically are Dallas, Stadium, Blue Valley, Parts of Majimbo, Kanjuru, Muruatetu and parts of Central Business District all within Embu Town. Not only are these areas built up but some of them have a large and growing population whose earnings are in the low income bracket and they need the sewerage services immediately since most developments are coming up there and are not sewered. These areas are within areas bounded by Kapingazi River to the east and Rupingazi River to the south and west of Embu town.

The present population for both the selected needy areas and in the whole of Embu town study area as projected from the growth rate of Embu town as derived from the 1999 and the 2009 census. The projected population of Embu town and the selected needy areas for the ultimate design period is estimated at 95,509 and 52,783 persons respectively. However the critically affected areas have an estimated population of about 12,500 persons.

The proposed sewerage system consists of 32 km gravity sewers and waste stabilization ponds treatment works of capacity 2,000m^3 per day that is based on the size of the land available. It has been found necessary to retain the existing treatment plant that can effectively treat 1,500m^3 sewage per day as part of the future sewerage system until the time when the proposed phase 2 of the works recommended in Master Plan that can treat 15,000m^3 of sewage per day are put in place as abandoning them now would create a bigger problem in waste disposal management. The available area for proposed sewage treatment works of about five acres can only accommodate a flow of 2,000m^3/day which is far much less than the sewage generated in the already sewered area of Embu and the area being considered for sewering.

The selected area covers the substantially developed areas of the Embu town that are generating more than 5,000m^3 of waste water. The other areas of the town and those outside the existing town boundaries shall be considered for sewering as per the future EWASCO strategic plans and the availability of funds.

The proposed site of sewage treatment plant to supplement the existing facility is to be built at the confluence of Rupingazi River and Kamiugu Stream as recommended in the design report by Runji and partners. Inflow to the treatment works is estimated at 2,000m^3/day. The relatively short distance from the sewered areas to the treatment plant will allow most of the pledged funds to be used for construction of the sewer reticulation system. The sewer lines will be constructed to improve the sanitary conditions in the central business district, some parts of residential and commercial areas. In the area proposed for sewering, there are **8,068** potential connections out of which **3,500** are connectable after the completion of the construction of the proposed trunk and lateral sewers.

Towards fulfilling the requirements of this project, the proponent seeks to fulfil the requirements of Environmental Management and Coordination Act (1999) as well as Environmental Impact Assessment and Audit (2003) guidelines. This Project Report has been prepared to provide sufficient and relevant information on the proposed project to enable the National Environment Management Authority (NEMA) establish whether the activities of the project are likely to have significant adverse environmental impacts. If the negative impacts are adequately addressed as proposed in the Environmental Management Plan (EMP), then, this Report can form a basis for the issuance of an Environmental Impact Assessment (EIA) Licence.

This Report documents the findings of an assessment and study of the proposed project site, project design and neighbour's concerns. Mitigation measures have been proposed for identified impacts and an Environmental Management Plan for the implementation of the proposed measures has been presented.

1.2 Objectives

The objectives of the Environmental Impact Assessment (EIA) are:

- To fulfil the legal requirements as outlined in Section 58 to 69 of the Environmental Management and Coordination Act (EMCA) amended and Part I and II of the EIA/Audit Regulations
- To obtain background biophysical information of the site and legal and regulatory issues associated with the project
- To assess and predict the potential impacts during site preparation, construction and operational phases of the project
- To make suggestions of possible alterations to the proposed design, based on the assessment findings
- To propose mitigation measures for the potential significant adverse environmental impacts and safety risks
- To allow for public participation
- To lower project cost in the long term
- To prepare an Environmental Management and Mitigation Plan (EMMP).

1.3 Terms of reference

The Terms of Reference for this assessment are based on the NEMA *Environmental Impact Assessment and Audit Regulations*, 2003. According to the Regulations, the Project Report should, where possible, contain descriptions of the following:

- The location of the project including the physical area that may be affected by the project's activities
- A summary description of the project
- A concise description of the national environmental legislative and regulatory framework, baseline information and any other relevant information related to the project
- Objectives of the project
- The technology, procedures and processes to be used in the implementation of the project
- Materials to be used in the construction and implementation of the project
- The activities that shall be undertaken during the project construction, operation and de-commissioning phases
- Products, by-products and waste generated by the project
- Description of the potentially affected environment
- The environmental effect of the project, including the social and cultural effects and the direct, indirect, cumulative, irreversible, short-term and long-term effects anticipated
- Alternative technologies and process available and reasons for preferring the chosen technology and processes
- Analysis of alternatives including project site, design and technologies and reasons for preferring the proposed site, design and technologies
- An environmental management plan proposing the measures for eliminating, minimising or mitigating adverse impacts on the environment, including cost, time frame and responsibility to implement the measures
- Provision of an Action Plan for the prevention and management of foreseeable accidents and hazardous activities in the cause of carrying out activities or major industrial and other development projects
- Measures to prevent health hazards and to ensure security in the working environment for the employees and for the management of emergencies
- The project budget
- The design of the project
- Any other information that NEMA may require.

1.4 Methodology

The procedure used in undertaking the environmental assessment included the following:

- A desk-study to obtain background biophysical information of the site and legal and associated regulatory issues
- Literature review
- Interviews with the proponent and relevant stakeholders
- Site visits assessment for collecting the baseline conditions and public consultation by taking photographs
- Assessment and prediction of potential impacts during the site preparation, construction and operational phases of the project
- Preparation of a Project Report, including the Environmental Management Plan and mitigation measures.

1.5 Registration

As required by NEMA, the Lead Expert is currently registered by NEMA as an Expert for "Environmental Impact Assessment and Audit" and also with EIK and is therefore authorised to undertake the EIA project study and submit a report.

2 PROJECT DESCRIPTION AND DESIGN

2.1 Introduction

Sewage may comprise both domestic and industrial effluent and may be diluted by ground water and storm water. The connection of storm water drains to the sewers should generally be prohibited. In order to estimate the quantities of sewage, water consumption has to be multiplied by a reduction factor; some of the water is either lost in leaks in the distribution system or is not, after use, conveyed to the sewerage system. The table below shows sewage quantities from Households, Institutions and Commercial Areas for the project

Table2.1: Sewage Quantities from Households

Types of establish ment	**Water consumption**	**Factor approx.**	**Anticipated quantity of sewerage produced**
High class housing	300 1/p/d	75%	225 1/p/d
Average class housing	150 1/p/d	80%	120 1/p/d
Average low cost housing	120 l/p/d	85%	100 1/p/d
Low cost housing	75 1/p/d	85%	65 1/p/d

Table 2.2: Sewage quantities from Commercial and Institutional areas

Types of establishment	**Water consumption**	**Factor**	**Anticipated quantity of sewage produced**
Hospitals	200 l/b/d	80%	160 l/b/d
Embu Prison	75 1/p/d	85%	65 l/p/d
Residents at school and institutions	150 l/p/d	80%	120 l/p/d
Boarding schools	50 l/p/d	80%	40 l/p/d
Day schools	25 l/p/d	85%	21 l/p/d

Administration Offices	25 l/p/d	85%	21 l/p/d
Hotel	200 l/p/d	80%	160 l/p/d
Average Factor		81%	

When the total reduction factors from different sources are combined together the average reduction factor is found to be 0.81. This figure is used to calculate the average sewage produced in the areas of Embu town that are to be sewered.
The types of industries to be put up in Embu town in future are not known; therefore, it is estimated, as indicated the effluent will be 25m^3day/ha from areas scheduled for heavy industrial development. For light industry, the effluent is assumed to be 12m^3/day/ha. It is worth to note that the areas that were earmarked for heavy industries in Embu were converted for other uses. Industrial area that has now been left is only for the light industries and has been considered in this report.

2.2 Sewage quantities from Embu town area

Based on the water consumption presented in the tables above for both Embu and the part of the selected areas of Dallas/Stadium and Kamiu and using the sewage factor of 0.81 the daily quantity of sewage produced is estimated as shown in the table below:

Table 2.3: Sewage Projected In Embu town and the selected areas

Area	**Sewage Generated m^3/d**			
	2016	2018	2028	2038
Embu town	10,494	10,817	12,583	14,696
Dallas/Stadium, Kamiu	5,540	5,710	6,625	7,698

To obtain the peak flow in the pipes, the total daily quantity is distributed over 24 hours and multiplied by the peak factor. It has been assumed that the peak flows, from domestic users and the industries, will coincide. In accordance with the ministry of water and irrigation Practice Manual, the following peak factors are used for the design of the sewerage system:

Table 2.4: Peak Factors

Diameter Of uPVC Sewer	**Peak F Factor**
315 mm or less	2 ½
Between 315 and 600 mm	2
Over 600mm	1 ½

2.3 Quantity of sewage conveyed to the treatment plant.

The sewage quantities, which form the basis for the sewer pipe design, are the ultimate total amount of sewage produced in initial Embu town area which has been developed. The inclusion of the ultimate sewage in the whole Embu town for final design report is because it is expected that the whole of Embu town shall be sewered. The sewers that are to be

designed are expected to carry the whole quantity of sewage generated in Embu town ultimately. The sewering processes shall be carried out as the company grows.

A treatment plant for selected areas for phase 1 is proposed at a site on the confluence of river Rupingazi and Kamiugu within the municipality. In phase 2, a treatment plant to handle the ultimate sewage flow from the whole study area was proposed by Runji and Partners to be constructed at a site near the airstrip on the Embu - Kiritiri road. However development has taken place in that area. Another site of more than 50 acres has been identified south west of Don Bosco about 500m away past Werus Academy next to Rupingazi River where a sewage treatment plant can be built.

The time of the implementation of phase 2 works is not known. The quantity of sewage projected to be produced in the selected area of Dallas/Stadium and Kamiu is far much more than the amount of waste water that can be accommodated at the 5 acre plot that belongs to EWASCO. The available plot can take a treatment works that can accommodate only 2,000m^3 of waste water as opposed to the estimated **7,698m^3** of waste water generated. To avoid overloading of the treatment plant in the event of late implementation of the phase 2 due to this uncertainty, it has become necessary to retain the existing sewage treatment plant that currently treats 1,500m^3 of waste water per day. In addition, the ultimate sewage produced in Embu town by the year 2038 is estimated at **14,696m^3**. This shows that an area that can accommodate the amount of sewage generated should be sourced for as soon as possible.

The calculation of the sewage flow for Dallas/Stadium and Kamiu is calculated from the total water consumed in the area and average figure of 0.81 taken as the factor for sewage as per WHO Report No. 9 for sewage values from various sources. The designed sewage treatment plant for Dallas/Stadium and Kamiu area will take only 2,000m^3 out of the ultimate 7,698m^3 is dictated by the availability of the land and is the site being assessed in this report.

2.4 Composition of sewage discharged into public sewer

2.4.1 Sewage from households (residential)

Each person is assumed to contribute 55 grams of BOD, 20^{o}C and 80 grams of Suspended Solids (SS) every day, as stated in Ministry of Water and Irrigation Practice Manual.

2.4.2 Sewage from schools, administration offices et al

In the above values for the BOD and SS contributed by each person, an allowance is included on the domestic sewage flowing from institution areas.

2.4.3 Sewage from industries

For any existing industry and future unknown industries, it is assumed that the composition of industrial effluent will be approximately the same as for sewage from residential areas. For the calculations, a figure of 450 mg BOD5/1 has been adopted.

2.4.4 BOD at the treatment plant for selected area

The water consumed for the selected area is 9,503m^3/d. This gives an overall consumption average rate of 160l/p/day and the number of consumers is therefore estimated at 59,394 persons. But the design of the pond is restricted to an influent of 2,000m^3/d that will only cater for about 12,423 persons. The total BOD load that is generated from both the industrial and domestic effluent is 782kg BOD/Day. As stated earlier the total quantity of sewage for selected areas is 2,000 m^3 day. The average oxygen demand per litre will therefore, be:

782kg BOD5/day/2,000 m^3/day = 391mg BOD 5 /l

Results of sewage laboratory analysis (ref 7) show the BOD5 of the existing treatment works influent to range from 380 to 630 mg/1. The calculated value of 391mg/l is thus reasonable representative of the actual BOD5 values.

2.5 Groundwater infiltration and storm water in the sewer

2.5.1 Groundwater infiltration

The soils investigations carried out along the proposed sewer lines during the preparation of sewage master plan indicate that the groundwater table at most places are below the sewer system. However, the groundwater level is likely to be relatively high in the flat areas along the streams and in the bottom of the valleys. Some sewer sections have been proposed to be laid in these areas. If the new sewers and manholes are properly constructed, the groundwater infiltration should not be a concern. Furthermore the PVC pipes with flexible rubber ring joints to be used will certainly eliminate the risk of leakages at the joints.

2.5.2 Unauthorized and unavoidable storm water

All sewers are designed to run at only half capacity. This means that there should be adequate space for dealing with some of the unauthorized and unavoidable storm water, which might enter the system.

In WHO report No. 9 it is recommended that sewerage system in Kenya shall be partially separate systems. The authorized storm water, conveyed to the sewers, originates from areas likely to be polluted by organics dirt, or from roof connections at the end of the sewer lines. Areas which are to be drained to the sewers must be bounded by kerbs, in order to exclude the drainage from surrounding areas. The areas must also be paved.

It is also strongly recommended that the storm water passes through a grit chamber, before it is conveyed to the sewers. At present there are no such likely places in Embu, except the area around the market and the bus stations that could be drained to the sewers.

As it is unlikely that there will be many paved areas in the future which will be particularly polluted by organic dirt, the above mentioned spare capacity in the trunk sewer as recommended in the report by consultants should be sufficient. The expansion of the Embu town boundary has resulted in the increase of the population that can drain to the sewer network and therefore to the sewage treatment works. However, the ultimate volume of sewage generated in the developed area of the municipality and the sizing of the trunk sewers should take into consideration of this volume of wastewater but not size using the capacity of the proposed treatment works that can only take 2,000m^3.

2.6 Sewerage design criteria and costs

2.6.1 Choice of pipe materials

There are three different types of pipe materials that are available for sewer pipes in the market today: concrete, PVC and Glassfibre Reinforced Plastic (GRP). The three types of pipes are described and evaluated below.

a) Concrete pipes available in Kenya

Concrete pipes are made locally and are in accordance with BS 5911 part 1. 1985. (Specification for concrete cylindrical pipes and fittings). Pipes are now available in different strength classes. Pipes with diameter of 375 mm or more can be manufactured reinforced, on request. The nominal dimensions for concrete pipes relevant for this study are: 225, 300, 380, 450, 525 and 600 mm. Three types of concrete pipes are available.

i) OGEE jointed pipes (rigid joints)

The pipes are available in dimensions up to 1200 mm and length of 1.0 m. The joint is rigid and the pipes have to be laid in a concrete bedding to prevent leaks at the joints due to the settling of the ground.

ii) Spigot and socket jointed pipes (rigid joints)

The pipes are available in dimensions up to 1,200 mm and in the lengths of 1.0 to 1.8 m. The pipes need jointing with Hessian hemp and cement mortar and as above, the pipes have to be laid in concrete bedding. Rubber jointing of the pipes have been introduced by some manufacturers but concrete bedding is still required.

iii) Spigot and socket profiled jointed pipes (flexible joint)

The profiled pipes of 1.0 to 1.5 m length are available in dimension from 150mm to 600 mm. Due to the flexible joint (rubber ring joint), the pipes only require a sand/gravel bedding, normally.

b) uPVC pipes available in Kenya

uPVC pipes for sewers are manufactured locally, according to ISO class34 and 41 or KS 06 217 class 34 and 41. The pipes have flexible rubber ring joints, and are available in the nominal dimensions (External Diameter) 110, 160, 225, 250, 315, 355, 400 and 600mm.

c) GRP pipes

The Glass – fibre Reinforced Polyster (GRP) pipes are new in the market. They are produced in sizes ranging from150mm to 3500mm. GRP pipes are highly resistant to corrosive substances and are therefore, ideal for municipal waste water. However, these pipes are not produced locally and can only be imported which reduces their chance of being used in the project under consideration since the importation cost will make their price uncompetitive.

2.6.2 Comparison of characteristics of concrete and pVC sewers

The pipes to be considered for the project are concrete pipes with rigid spigot and socket joints, concrete pipes with flexible rubber ring joints and PVC pipes with flexible rubber ring joints. The PVC pipes have the advantage of being resistant to all

matter normally found in sewage. They also have good resistance to mechanical impact and they are easy to transport, join, handle and lay. They, however, must be protected against direct solar radiation during storage. Concrete pipes are not resistant to sulphuric acid which is common in sewers in the tropic. Their resistance to mechanical impact is also low. Though concrete pipes with flexible rubber ring joints are easy to join, concrete pipes are generally difficult to handle and lay due to their considerable weight. Local contractors, however, have experience handling concrete pipes which is of some advantage.

2.6.3 Comparison of costs for laying of concrete and pvc pipes

The estimated costs for laying of concrete and uPVC pipes include:

i. Material price, inclusive of value added tax duty and contractors profit
ii. The costs have been estimated from information supplied by the manufacturers
iii. Transport to Embu.
iv. Manual excavation of trench in soil, backfilling, compacting and disposal of surplus material
v. Laying, jointing and bedding.
vi. Handling

For uPVC pipes, wall protection sleeves in connections to manholes are included. The assumption is that the pipes in various strength classes are used. The minimum dimension used for trunk and branch sewer is 230 mm for concrete pipes, and 200 mm for PVC pipes. The 100 mm and 150mm pipes in concrete, or the 110 mm and 160 pipes in PVC, are used for property drains only.

2.6.4 Recommended pipes

When comparing the characteristic of the three types of pipes, the uPVC pipes are more advantageous than concrete pipes. The unit price per meter for both types of pipes is almost the same. The mass production of uPVC sewer pipes and handling of the same have made them much cheaper than concrete which is not easy to handle and transport.

2.7 Hydraulic design

The flow of waste water from the existing waste water treatment plant to the proposed waste water treatment plant at the confluence of Kamiugu stream and Rupingazi River shall be through a trunk sewer. The trunk sewer shall be expected to convey all the sewage from these works once they are abandoned after a sewage treatment works of a capacity of 15,000m^3 is constructed. This trunk sewer is expected to carry a flow of 3,000m^3 of waste water per day.

The quantity of waste water from Embu Level Five hospital through Muruatetu, Kajuru western part of Blue Valley, and the market is also supposed to carry 3,000m^3 of waste water. The third trunk sewer also of a capacity of 3,000m^3 carries waste water from Majimbo, and areas of east Blue valley. The two trunk sewers join at Ndumari/Matakari to create a combined main trunk sewer carrying waste water volume of 6,000 m^3. This trunk sewer then empties its content at the proposed sewage treatment plant at Kamiugu/Rupingazi confluence.

2.7.1 Pipe flow

For design purposes, the roughness is assumed to be 0.00025 m for PVC pipes. The sewers are designed so that half capacity corresponds to the peak flow. This allows for unauthorized and unavoidable storm water and for groundwater infiltration. As ventilation impedes the creation of hydrogen sulphide, it is an added advantage that the sewers are normally not running full.

2.7.2 Self- cleansing velocity

It is essential to obtain a certain minimum velocity in sewers to prevent the settling out of solids in the sewer pipes. In the ministry of water and irrigation Practice Manual it is stated that a velocity of 0.5 metres per second, occurring at least once per day, is sufficient to keep sewers clean.

However, in small sewers it is practically impossible to obtain such high velocities. Experience shows that small sewers are kept clean with a 1% minimum slope. This requirement is based on the fact that, unlike in large sewers, the flow is neither constant nor regular since this flow emanates from the property drains that are not constantly in use throughout the day.

In this project all sewers are designed so that either the velocity is at least 0.5 metres per second, once every day, or the slope is at least 1 per cent with exception of some smaller sewer stretches, especially on the existing sewer network.

Nevertheless, in the first years after the completion of the project, the flow in the sewers will be below that for which they are designed and it will, therefore, occasionally be necessary to flush the sewers to wash out all deposits.
The maximum slope is fixed at 30 per cent for sewers because a steeper slope will often cause wear and tear to the bottom of pipe, as the velocity will be too high. However, for short distances, the maximum slope may be exceeded to avoid drop manholes. Where slope is excessive a special pipe and manhole design is adopted.

2.7.3 Hydrogen sulphide in sewers

Hydrogen sulphide in sewers is a problem in warm climates, as the sewage quickly turns septic due to biological activity, thus reducing the dissolved oxygen content. The bulk of the hydrogen sulphide is generated in deposited silt and in the biological slime layer, formed on the submerged surfaces of the sewers.
The minimum velocity required to prevent build-up of sulphide has been computed as 0.86 m/s, in the Sewerage Master Plan. Normally such a high velocity will only be reached in the main sewers on some smaller section, so it is of primary importance for the sewers to be kept clean of silt. Formation of thick sludge layers below water level should also be prevented, because, as mentioned above, it is here that the bulk of the hydrogen sulphide is generated. The sewers will be kept clean, if the conditions mentioned under above in this section are complied with. Since PVC sewers are to be used in the implementation of the project, the corrosion from hydrogen sulphide is avoided completely.

2.7.4 Laying of pipes

In the design of sewers, care should be taken to ensure that pipes are protected against any external load or mechanical impact. Of importance, also, is that infiltration of groundwater, due to leaks or poor joints, is kept to a minimum. It is very important that the pipes are joined and bedded properly.

2.8 Property drains

Construction of property drains will be the responsibility of the land owners. The drains should be constructed in PVC material as the trunk and branch sewers. Where possible, the property drains should connect into manhole. The pipe diameter of property drains should be 100 mm, for connections to houses with one family, and 150 mm for larger houses, groups of houses and institutions. The slope should preferably be a minimum of 2.0 % but if this is not possible, the connections can be laid with a minimum slope of 1%.

2.9 Manholes

In order to facilitate the inspection and cleaning of the sewers, manholes will be provided at all changes of vertical or horizontal direction and at all junctions between trunk sewers and lateral sewers. The maximum distance between manholes should be approximately 60 m for the smaller sewer sizes and 90m for the 600mm diameter sewer.

2.10 Sewage treatment system

The treatment plant is to be located at the confluence of Rupingazi River and Kamiugu stream. The existing and the proposed sewage treatment plants are capable of treating 3,000m^3 of waste water which is equivalent to the sewage generated by the developed area of Embu town and far much less than the ultimate sewage that is being used for design purposes. To avoid overloading of the treatment plant in the event of late implementation of phase 2, the treatment plant is designed to handle flows for only the pro poor areas while awaiting the procurement of land for a treatment plant that can handle 15,000m^3 of waste water.
Waste stabilization ponds are proposed. For operation and maintenance reasons, two parallel streams, allowing for bypassing of any of the ponds if necessary, are proposed. Each stream comprises one anaerobic, one facultative and two maturation ponds. The site for the treatment plant has a slope of about 15%. A cut and fill pond construction is therefore the most economic method of construction. The upper area of the proposed site has murram and rock boulders at a depth of 2m; the middle area has murram and loam soil at same depth while the lower end has loamy soil up to a depth of 2m.

2.10.1 Sewage treatment plant alternatives

The selected areas are designed to provide the greatest relieve to the currently poor sanitary condition of the town, at the least cost. Waste stabilization ponds for treatment are the best option for operations and maintenance as well as sustainability. The waste stabilization ponds are designed to meet the set standards by the Ministry of Water and Irrigation and NEMA.

Table: Ponds Size alternatives

Description of Ponds	Depth (m)	Length (m)	One Pond Breadth(m)	Volume m^3	Retention Days	No of Ponds
Anaerobic Ponds	3	100	55	16,500	5	2
Facultative Ponds	1.5	183	94	25,803	9.5	2
Maturation Ponds	1.5	121	63	11,435	4	4

Table: Proposed Ponds Sizes of 2,000m3 Based On Available Land

Description Of Ponds	One Pond					No of Ponds
	Depth (m)	Length (m)	Breadth(m)	Volumem^3	Retention Days	
Anaerobic Ponds	5	27	27	3,465	3.5	2
Facultative Ponds	2.5	80	48	9,600	9.5	2
Maturation Ponds	1.5	55	40	3,300	3.5	2
Wetland	1.5	50	15	1,125	0.5	1

Notes: Due to the need for the maintenance of the treatment works, it is prudent to put up two sets of ponds so that when one fills up the flow is diverted to the other set to avoid raw sewage being discharged to the receiving system.

2.10.2 Sewerage design alternatives

The sewage undergoing treatment normally goes through five stages before it can be released to the receiving waters. The stages may involve different methods of treatment but the end result for each stage is the same. Some methods are more efficient than others and they are also used depending on location and also the availability of land. The fifth stage is rarely used except where there is need to reuse the water for domestic needs. These stages are:

i) Preliminary treatment: At this stage the works involved entails screening, shredding, grit removal, pre-aeration, pre-.chlorination and catch basins. The main purpose in this process is to remove large floating suspended solids and grit.

ii) Primary treatment: the process involves employs preliminary sediment clarifiers, dissolved aeration/flotation, chemical assisted sedimentation and settlers. The end result is the removal of suspended solids and some heavy metals.

iii) Secondary treatment: The methods employed in this process includes trickling filters, activated sludge units, lagoons coupled with wetlands, external aeration, oxidation ditches, sequential batch reactors. Sewage undergoes these processes to remove suspended solids, biodegradable organics, volatile organics and some nutrients namely Nitrogen and phosphorous.

iv) Tertiary treatment: The process uses flocculation, clarification, filtration (sand), Ultraviolet (UV) lagoons, adsorption through activated carbon, reverse osmosis. In the process, nutrients N&P, dissolved solids, Heavy metals, pathogens are removed.

v) Advanced treatment: When an effluent undergoes this kind of treatment it can be recycled for domestic use. The process uses granulated advanced carbon, ozonation, hydrogen peroxide filtration, denitrification and precipitation which lead to the removal of organics, salts, ionic contaminants, pathogens.

When financial and technical aspects are considered, the following is recommended:

a. Development of a network of sewers covering the fully developed areas not covered by the existing sewerage system as the client recommends in the mostly pro poor areas.
b. Retention of the existing treatment plant to serve the existing sewer network and proposed sewer network for Kaunda Estate, un-serviced areas to the west of Embu Level Five Hospital and of Izaac Walton Inn including Embu University College.
c. Construction of a new treatment plant comprising of waste stabilization ponds at the Rupingazi-Kamiugu Rivers confluence
d. To construct a trunk sewer main to link the existing sewer system to the ultimate Treatment Plant to be built further downstream once land and finances become available.

2.10.3 Project phasing

The experts recommend implementation of the project in phases due to environmental, financial and technical aspects. Generally, the areas to the East side of Majimbo - Kangaru Road cannot gravitate to the proposed Treatment Plant. Therefore they are omitted. Otherwise this phase caters for developed areas from which sewerage can gravitate to the proposed treatment plant.

The areas to be provided with sewers generally are Dallas, Stadium, Blue Valley, Parts of Majimbo, Kanjuru, Muruatetu and parts of Central Business District. The Sewage from these areas will mostly gravitate to the proposed Treatment Plant at Kamiugu-Rupingazi Rivers Confluence.

The existing enhanced Treatment Plant will continue to cater for the greater part of CBD, East College including the areas to its south, the Embu Level Five Hospital neighborhoods, Spring Valley, Upper Blue Valley, Kaunda Estate and Majengo Estate among other areas.

2.10.4 Proposed sewer network

An extensive sewerage system is proposed for construction in the substantially developed areas. Areas to be provided with sewers under phase 1 are Blue Valley, part of Majimbo Village and its immediate neighbourhood, Dallas, Stadium Estate, Kanjuru and Muruatetu Estate, part Spring Valley Estates, Kangaru Schools and Kenya School of Government, Embu and its surroundings.

All the sewers are designed for flows for ultimate flow based on population projections. To avoid duplication of sewer lines in the future, sewers in areas traversed by flow from the areas not in phase 1, have been designed to also cater for ultimate flow from these areas.

2.10.5 Prioritized sewers

The initial sewer construction is comprised of:

a) The trunk sewer line C from the existing treatment works to the proposed site sewage treatment plant passes through Dallas and Stadium

b) The trunk sewer line A from the proposed sewage treatment works to Muruatetu estate c) The trunk sewer line D from the proposed sewage treatment works to Dallas estate d) The trunk sewer line D a branch of Sewer line A emanating from Embu - Kiritiri road to Majimbo estate

e) The trunk sewer line E, a branch of Sewer line A emanating from Embu - Kiritiri road to end of Blue Valley estate

2.10.6 Effluent Quality

All of the effluent parameters are expected to pass NEMA and WHO guidelines. Periodic testing should be carried out to determine the quality of waste water being discharged to the environment.

2.11 Project facilities

The project will consist of the following:

- Construction of waste stabilization ponds composed of two anaerobic ponds, two facultative pond and two maturation ponds
- Two drying beds
- A wetland
- Laying of sewer line network to the proposed site

- Lockable gate
- Fencing the site
- Staff houses

2.12 Project cost

The estimated project cost of the project is Ksh. 400,000,000 million

3 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

An Environmental Impact Assessment (EIA) is "a structured approach for obtaining and evaluating environmental information prior to its use in decision-making in the development process. This information consists, basically, of predictions of how the environment is expected to change if certain alternative actions are implemented and advice on how best to manage environmental changes if one alternative is selected and implemented".

3.1 The importance of EIA

EIA is conducted for the following purposes:

i. Identify impacts of a project on the environment.
ii. Predict likely changes on the environment because of the development.
iii. Evaluate the impacts of the various alternatives on the project.
iv. Propose mitigation measures for the significant negative impacts of the project on the environment.
v. Generate baseline data for monitoring and evaluating impacts, including mitigation measures during the project cycle.
vi. Highlight environment issues with a view to guiding policy makers, planners, stakeholders, and government agencies to make environmentally and economically sustainable decisions.

3.2 The Constitution of Kenya 2010

Article 42 of the Bill of Rights of the Kenyan Constitution provides that 'every Kenyan has the right to a clean and healthy environment, which includes the right to have the environment protected for the benefit of present and future generations through legislative and other measures'. Under Chapter 5 (Land and Environment), Part 1 is devoted to land. It requires that land be used and managed in 'a manner that is equitable, efficient, productive and sustainable, and in accordance with the following principles:

(i) Equitable access to land;
(ii) Security of land rights;
(iii) Sustainable and productive management of land resources;
(iv) Transparent and cost effective administration of land; and
(v) Sound conservation and protection of ecologically sensitive areas.

Part 2 of Chapter 5 of the Constitution is dedicated to Environment and Natural Resources. Article 69 in Part 2 provides that the state shall;

(i) Ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits;
(ii) Work to achieve and maintain tree cover of at least ten per cent of the land area of Kenya;
(iii) Encourage public participation in the management of, protection and conservation of the environment;
(iv) Protect genetic resources and biological diversity;
(v) Establish systems of environmental impact assessment, environmental audit and monitoring of the environment;
(vi) Eliminate processes and activities that are likely to endanger the environment; and
(vii) Utilize the environment and natural resources for the benefit of the people of Kenya.

Further, Article 70 states that if a person alleges that a right to a clean and healthy environment recognized and protected under Article 42 has been, is being or is likely to be, denied, violated, infringed or threatened, the person may apply to a court for redress. The sub-project should ensure compliance with the constitution in so far as equitable sharing of the resources, between the stakeholders. Further, the project should ensure the sustainability of livelihoods and biological resources within the project areas are protected. Any development proposals should also be cognizant of the increased powers under the Constitution given to communities and individuals to enforce their rights through legal redress.

3.3 Vision 2030

Vision 2030 is the new country's development blueprint covering the period 2008 to 2030. It aims at making Kenya a newly industrializing middle income country providing high quality life for all its citizens by the year 2030. The vision has been developed through an all inclusive stakeholder consultative process, involving Kenyans from all parts of the country. The vision is based on three pillars namely; the economic pillar, the social pillar and the political pillar. The vision 2030 comes after the successful implementation of the Economic Recovery Strategy (ERS) for Wealth and Employment Creation 2003-2007.

The Kenya Vision 2030 economic pillar aims at providing prosperity of all Kenyans through an economic development programme aimed at achieving an average GDP growth rate of 10% per annum over the next 25 years from the year 2008. The social pillar seeks to build a just and cohesive society with social equity in a clean and secure environment'. On the other hand, the political pillar aims at realizing a democratic political system founded on issue based politics that respects the rule of law, and protects the rights and freedoms of every individual in the Kenyan society.

3.4 Policy framework

3.4.1 Water Rules 2006

To operationalize the Water Act 2002, the Water Resources Management Authority has developed water rules and regulations. It has already come up with the draft water rules, which are due for Gazettement. The rules cover the following areas: the reserve, protected areas, swamps, wetlands and riparian areas. They have also incorporated the means through which we can protect these fragile water resources and related environment.

Other areas that these rules cover include:

- Threshold levels for water allocation
- Harmonization of water permitting fees and water use charges for different permits
- Provide the Water Resources Management Authority (WRMA) with powers to place control orders, to stop destruction and anti-social behavior which are detrimental to our water resources.
- Formulation of Catchments Management Strategies (CMS) including the zoning of catchments
- Re-enforce and separate functions between different water sector institutions
- Promote decentralization of decision making
- Promote participation and offer channels through which civil rights issues can be addressed.

3.4.2 Land Policy 2006

The policy is as result of extensive consultation and deliberation between the Ministry of lands, other Government Departments and other Non-State stakeholders for over two years. Kenya has not had a clearly defined or codified National Land Policy since independence. This, together with the existence of many land laws, some of which are incompatible, has resulted in a complex land management and administration system.

3.4.3 The National Environmental Action Plan (NEAP) -1994

According to this plan, it's recognized that the development projects on the environment i.e. industrial, economic and social development programs that do not take care of environmental considerations in their operations are not sustainable. Under the NEAP process, EIA was introduced and among the key targets recognized were the industrialists, business community and local authorities.

3.4.4 The National Water Resources Management Policy -1999

It enhances the systematic development of water resources for all the sectors in promotion of the country's socio-economic development. It also recognizes the by-products of these developments as wastewater and therefore calls for development of appropriate sanitation systems to protect the people's health and water resources from institutional pollution.

It is therefore imperative that these activities be accompanied by appropriate waste management plans. The policy also recommends that all such developments should undergo comprehensive EIA that will provide measures to protect environment and people's health in the neighborhood of the project including the downwind communities.

As its predecessor, the EMCA (1999) calls for annual Environmental Audits (EA) to ensure continuous implementation of Environmental Management Plans (EMP) proposed in the EIA and any other recommendations and issues arising.

The policy requires that those who pollute water bodies must pay the full cost of remediation of the contaminated water; in tandem with the "Polluter Pays Principle."

3.4.5 Sessional paper No. 6 (1999)

Policy guidelines on environment and development – the key policy objectives of this paper includes:

- Ensuring that all development projects at the inception stage and programs, as well as policies consider environmental considerations.
- Ensuring that an EIA report is prepared for any undertaking or development project before implementation.
- Coming up with effluent treatment standards that will conform with acceptable health guidelines.

It's important to note that issues of waste water management and human settlements are given prominence and therefore, the policy recommends re-use and recycling of residues i.e. waste water, use of low waste generation technologies and increasing public awareness on benefits of a clean environment. It also recognizes the role of stakeholders in all these initiatives within their localities.
The paper encourages better planning in rural and urban areas in provision of needs i.e. water, drainage system, waste disposal facilities et al.

3.5 Legal framework

The relevant national legal framework for the proposed project includes the following:
Environmental Management and Coordination Act of 1999

i. Water Act of 2002
ii. The Physical Planning Act Cap 286
iii. The Public Health Act, Cap 242.
iv. The land Act, Cap 303
v. The Environmental (Impact Assessment and Audit) Regulation. Kenya Gazette supplement No.56 of 13.06.2003
vi. The Environmental Management and Coordination (Water Quality) Regulation. Kenya Gazette supplement No.68 of 2006.
vii. The Environmental Management and Coordination (Waste Management) Regulation. Kenya Gazette supplement No.69 of 2006.
viii. The Water (Services Regulatory) Rules, Kenya Gazette supplement No. 183 of 23.11.2012
ix. Guidelines on drinking water quality and effluent monitoring of WASREB

3.5.1 Environmental Management and Co-ordination Act (EMCA) amended of 1999

According to section 58 of the Environmental Management and Co-ordination Act (EMCA) of 1999 Legal Notice No. 8, a project proponent whose project falls under the second schedule 9 (i) of the act is required to submit Impact Assessment and audit report to the National Environment Management Authority (NEMA). Part V of the Environmental Impact Assessment (EIA) and Environmental Audit (EA) regulations provide for the Environmental audit and Monitoring. The Act provides that an Environmental Impact Assessment shall be undertaken on all upcoming development activities, which are likely to have adverse Environmental Impacts. These development activities include ongoing projects that commenced prior to the coming into force of the fore said regulations.
This Act of Parliament came in to force on 14th January, 2000. It's aimed at providing for the establishment of appropriate legal and institutional frame work for the management of the environment, and covers over seventy other statutes, it's important to note that this Act eliminates duplication of rules and consolidates all other environmental laws hence enhancing its practicability. The Act entitles every person in Kenya to a clean and a healthy environment and safeguards it. The Act stipulates that any operator of any undertaking should carry out an EIA and EA afterwards every year, and submit the report to NEMA, which in turn issues an EIA license if the report is accepted.
The said Act prohibits discharging or application of poisonous, toxic, noxious or obstructing matter or other pollutants into aquatic environments. Any person who goes against this rule must pay for restoration of the damaged environment, or pay third party's compensation.
Section 74 requires that all effluent generated from point sources are discharged only into the existing sewerage system upon issuance of prescribed permit from local authorities.
Section 147 provides the framework for carrying out EIA and EA by NEMA through licensed experts and firms of experts.

The institutional framework of the Act

The Act provides for various administrative structures, which includes the National Environment Council (NEC), charged with the responsibility of developing the National Environmental Policy (NEP) in Kenya and sets the annual environment goals and objectives.
NEMA was established to deal with general supervision and coordination with all matters pertaining to the environment in Kenya. It's a principal government organ for implementation of environmental policies in Kenya. The Public Complaints Committee (PCC) was formed to investigate environmental complaints and submit its findings to NEC. The Standards and Enforcement Review Committee (SERC) advises NEMA on criteria and procedures for measurement of water quality in Kenya and minimum water quality.

3.5.2 The Environmental Management and Co-Ordination (Wetlands, River Banks, Lake Shores and Sea Shore Management) Regulations, 2009

17. The following principles shall be observed in the management and conservation of river banks, lake shores and the seashore;
(a) Resources on the river banks, lake shores and the sea shore shall be utilized in a sustainable manner;
(b) Environmental impact assessment as required under the Act shall be mandatory for all major activities on river banks, lake shores and the seashore; and
(c) Special measures, including prevention of soil erosion, siltation and water pollution are essential for the protection of river banks, lake shores and the seashore.

Identification and inventory of degraded river banks, lake shores and sea shores and conservation measures
18. (1) within five years from the date of commencement of these Regulations, the Authority shall, in consultation with the relevant lead agencies –
(a) Identify river bank, lake shores and the part of the seashore which are at risk from environmental degradation;
(b) Prepare and maintain an inventory of the river banks, lakeshore and the part of the sea shore which are at risk from environmental degradation, and cause such measures as are necessary to be taken to prevent and reduce degradation of such areas;
(c) Promote soil conservation measures along river banks, lake shores, and the seashore, including the following.

i. bunding;
ii. terracing;
iii. mulching;
iv. tree planting or agro forestry;
v. grassing;
vi. Soil engineering, compaction and placement of fills;
vii. zoning and planning;
viii. building of gabions;
ix. control of grazing, and
x. Recommending the promulgation of appropriate by-laws by the relevant local authorities.

3.5.3 The Environmental Management and Coordination (Waste Management) Regulations, 2006

Relevant parts of this regulation include

- Prohibition of any waste disposal on a public highway, street, road, recreation area or in any public place except in designated waste receptacle;
- All waste generator to collect, segregate and dispose such waste in a manner provided for under these regulations;
- All waste generators to minimize waste generated by adopting cleaner production methods;
- All waste transporters to be licensed according to the act;
- All vehicles used to transport waste to be labelled in such a manner as may be directed by the Authority;
- Collection and transportation of the waste to be done in such a manner no to cause scattering of the waste;
- The vehicle and equipment for waste transportation to be in such a manner not to cause scattering of or flowing out of waste; and
- The vehicles for transportation and other means of conveyance of waste to follow the scheduled routes approved by the authority from the point of collection to the disposal site.

PART IV: HAZARDOUS WASTES	
Hazardous Waste Specifications	22. For the purposes of this part, waste considered as hazardous, shall be any waste specified in the Fourth Schedule or any waste having the characteristics defined in the Fifth Schedule, and any wastes which do not fit the said categories of classification will be treated as non-hazardous waste.
Requirement for Environmental Impact Assessment	23. No person shall engage in any activity likely to generate any hazardous waste without a valid Environmental Impact Assessment licence issued by Authority under the provisions of the Act.
Handling, storing, and transporting of hazardous waste	24. (1) Every T The generator of hazardous waste shall ensure that every container or package for storing such waste is secure and labelled in easily legible characters, written in English and Kiswahili. (2) The label shall contain the following information: (a) the identity of the hazardous waste. (b) the name, physical address and telephone contact of the generator of waste. (c) the waste composition and total weight of waste. (d) the normal storage stability and methods of storage. (e) the name and percentage of weight of active (f) warning or caution statements which may include any of the following as appropriate: (i) the words **"WARNING"** or **"CAUTION"**; (ii) the word **"POISON"** (marked indelibly in red on a contrasting background; and (iii) the words **"DANGER! KEEP AWAY FROM UNAUTHORIZED PERSONS"**; and (iv) a pictogram of a skull and crossbones. (g) a statement of first aid measures, including the antidote when inhaled, ingested or dermal contact and a direction that a physician must be contacted immediately. (3) The provisions of Part II of these Regulations relating to the license for transportation of waste and mode of transporting waste shall apply *mutatis mutandis* to this Part.
Treatment of Hazardous Waste	26. (1) Every person who generates toxic or hazardous waste shall treat or cause to be treated such hazardous waste using the classes of incinerators prescribed in the Third Schedule to these Regulations or any other appropriate technology approved by the Authority. (2) Any leachate or other by-products of such treated waste shall be disposed of or treated in accordance with the conditions laid down in the license or in accordance with guidelines issued by the Authority in consultation with the relevant lead agency. (3) In issuing a license for the disposal of waste, the Authority shall clearly indicate the disposal operation permitted and identified for the particular waste
operators of disposal sites. Cap 265	tor of a disposal site or plant shall apply the relevant provisions on waste treatment under the Local Government Act and Regulations thereunder to ensure that such waste does not present any imminent and substantial danger to public health, the environment and natural resources.
Validity of license and renewals	to operate a waste disposal site or plant shall be valid for a period of one year from the date of issue and may be renewed for a further similar period on such terms and conditions as the Authority may deem necessary or impose for purposes of insuring public health and sound environmental management.
Requirement for Environmental Audit	nsed owner or operator of a waste disposal site or plant shall carry out an annual environmental audit pursuant to the provisions of the Act.

3.5.4 County Governments Act (2012)

Section 109 of the Act helps counties to ensure effective coordination of spatial developments. Sub section 2 part C states in part; spatial County Plan shall:

i. Indicate desired patterns of land use within the county
ii. Address spatial construction or reconstruction of the county
iii. Provide strategic guidance in respect of the location and nature of development within the county
iv. Set out basic guidelines for a land use management system taking into account any guidelines, regulations or laws as provided under Article 67 (2) (h) of the Constitution of Kenya
v. Set out capital investment framework for the Counties development programs
vi. Contain a strategic assessment of the environment impact of the spatial development framework

3.5.5 Land planning Act (repealed), Cap. 303)

A local authority may, after consultation with, and with the agreement of, the Minister, prepare and submit to the Minister for his approval a town plan or area plan, as the case may be, for that part of the area under its jurisdiction to which these Regulations apply.

Subject to the provisions of any rules made under these Regulations for regulating the form and content of area plans and town plans, any such plans shall include such maps and descriptive matter as may be necessary to illustrate the planning proposals as may be appropriate to different parts of the area and any such plans shall in particular define existing development, proposed roads, the different use and density zones proposed and areas (if any) in which no sub-division is permitted for the time being.

The Minister, for the purpose of securing the proper sub-division of land in an area other than of unalienated Government land, may require a local authority which has submitted a town plan or area plan, as the case may be, for approval, to submit to him for approval subdivision and use plans for its area or any part thereof.

An interim planning authority may prepare and submit to the Minister for his approval plans and particulars of any amendment to a town or area plan, as the case may be, which has previously been approved.

Subject to these Regulations, no person shall carry out development in an interim planning area except with the consent of the authority under these Regulations empowered to grant consent.

Any person who carries out development without consent shall be guilty of an offence against these Regulations and shall be liable to a fine not exceeding five thousand shillings or to imprisonment for a term not exceeding six months or to both such fine and imprisonment.

3.5.6 Physical Planning Act, Cap. 286

The protection of the environment, the conservation of the natural resources and pollution are tied up with the question of the permitted use of land. The land planning law in Kenya is found in the Physical Planning Act, Cap. 286. The main purpose of the physical planning legislation is to control the use of land, which is of great importance since it affects the environment. When an owner seeks to develop a plot of land which is within the jurisdiction of the Local Authority, approval from the Local Authority Director of Physical Planning is mandatory. The Act defines 'Development' to mean any material change in the use or density of any building or land.

Section 36 specifically provides that in connection with a development activity which will have an injurious impact on the environment; the applicant shall be required to submit together with the application an Environmental Impact Assessment study (EASR) report. Section 29 of the Act allows for 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 of the said Act states that any person who carries out development without permission will be required to restore the land to its original condition and that no other licensing authority shall grant license for commercial and industrial use or occupation of any building without development permission granted by the local authority. Section 36 states that where the project will be injurious to the environment, the developer shall be required to submit an EIA report and thereafter, an EA every year.

3.5.7 Water Act of 2002

Water Rights and Works

A permit shall be required for any of the following purposes:-

i. Any use of water from a water resource, except as provided by section 26;
ii. The drainage of any swamp or other land;
iii. The discharge of a pollutant into any water resource;
iv. Any purpose, to be carried out in relation to a water resource, which is prescribed by rules made under this Act to be a purpose for which a permit is required.
v. Nothing in this section applies to the purpose of a state scheme under this part.

Except as provided by the subsection (2), a permit is not required:-
For the abstraction or use of water, without the employment of works, from or in any water resource for domestic purposes by any person having lawful access thereto;
For any development of ground water, where none of the works necessary for the development are situated-Within one hundred meters of any body of surface water (other than enclosed spring water, as defined in the subsection (3); or Within a ground water conservation area ;
For storage of water in, or the abstraction of water from a dam constructed in any channel or depression which the Authority has declared, by notice published in the gazette, not to constitute a watercourse for the purpose of this Act.
Subsection (1) does not apply in relation to any activity mentioned in that subsection which is carried on in prescribed circumstances, where rules made under this Act provide that a permit shall be required for the carrying on of that activity in those circumstances.
For the purpose of subsection (1) (b) (i), "enclosed spring water" means water in a spring which:-
Is situated wholly within the boundaries of the land owned by any one landholder; and
Does not naturally discharge water into a watercourse abutting on, or extending beyond, the boundaries of that land.
Rules made under this Act may take provision for or with respect to the use of water from a water resource in any manner for which a permit is not required.

3.5.8 The Public Health Act

Section 115 of the Act states that, no person or institution shall cause nuisance or condition liable to be injurious or dangerous to human health. Section 116 of the Act requires that Local Authorities take all lawful, necessary, reasonable and practicable measures to maintain in their jurisdiction, clean and sanitary environment to prevent occurrence of nuisance or condition liable to be injurious or dangerous to health; these includes waste pipes, sewers, drains, refuse pits situated or constructed as in the opinion of a medical officer of health not to be offensive or injurious to health.
According to Sec. 118, any noxious matter or wastewater flowing or discharged from any premises into a public street or into the gutter, side channel, watercourse, irrigation canal or bed is also a nuisance. Others include accumulation of materials or refuse which may harbor rats or vermin i.e. collections of water, rubbish or refuse and any disposable fluid which permits and facilitates breeding of pests. Section 130 provides for making and imposing regulations by the local authorities and allows the duty of enforcing the rules in prohibiting use of water supply or erection of structures draining filth or noxious matter into a water supply.

3.5.9 The Physical Planning Act, 1996, (Cap 286)

The Physical Planning Act, 1996 commenced operation in 1998 after its revision. The Act provides for the preparation and implementation of physical development plans and other related purposes. Its provisions apply to all parts of the country except those areas as the Minister may specify. Thus the Act directs, regulates and harmonizes development and use of land over the country. In addition, the Act provides a vital link with the Environment Management and Co-ordination Act. For example, Section 36 of the Act states that" In connection with a development application a local authority is of the opinion that proposals for industrial location, dumping sites, sewerage treatment, quarries or any other development activity will have injurious impact on the environment, the applicant will be required to submit together with the application an environmental impact assessment report". This reinforces EIA requirements under EMCA (1999).
Section 29 of the Act allows for 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 of the said Act states that any person who carries out development without permission will be required to restore the land to its original condition and that no other licensing authority shall grant license for commercial and industrial use or occupation of any building without development permission granted by the local authority.
Section 36 states that where the project will be injurious to the environment, the developer shall be required to submit an Environmental Impact Assessment Report and thereafter, an Environmental Audit every year.

3.5.10 The Way leaves Act Cap 292

According to the Way leaves Act cap 292 Section 2, Private land does not include any land sold or leased under any Act dealing with Government lands. Section 3 of the Act states that the Government May carry any sewer, drain or pipeline into, through, over or under any lands whatsoever, but May not in so doing interfere with any existing building.
Section 8 further states that any person who, without the consent of the Permanent Secretary to the Ministry responsible for works (which consent shall not be unreasonably withheld), causes any building to be newly erected over any sewer, drain or pipeline the property of the Government shall be guilty of an offence and liable to a fine of one hundred and fifty shillings,

and a further fine of sixty shillings for every day during which the offence is continued after written notice in that behalf from the Permanent Secretary; and the Permanent Secretary May cause any building erected in contravention of this section to be altered, demolished or otherwise dealt with as he may think fit, and May recover any expense incurred by the Government in so doing from the offender. The proposed site is not inhabited hence there will be no need for compensation.

3.5.11 The Malaria Prevention Act Cap 246

Section 5 – Drainage System

No operations shall obstruct flow of water into or out of any drainage. The management shall be required to maintain the drainage system within the area of the project for removal of water from any land around the project to prevent larvae breeding.

3.5.12 The Penal Code Cap 63

Section 191 – Fouling water

The management shall ensure that no foul water of any public spring or reservoir is rendered unfit for the purpose for which it was ordinarily used for by the community.

Section 192 – Dwellings and Neighborhood

The operation phases of the project shall ensure that health of persons in general dwellings or carrying on business in the neighborhood or passing along a public facility are protected.

Section 193 - Offensive Trade

The proponent shall control loud noises or offensive and unwholesome smells so as not to interfere with the common rights of the people within the surrounding. This offence is punishable for common nuisance.

3.5.13 The Land Acquisition Act (CAP. 295)

This Act provides for the compulsory or otherwise acquisition of land from private ownership for the benefit of the general public. Section 3 states that when the Minister is satisfied on the need for acquisition, notice will be issued through the Kenya Gazette and copies delivered to all the persons affected. Full compensation for any damage resulting from the entry onto land to things such as survey upon necessary authorization will be undertaken in accordance with section 5 of the Act. Likewise here land is acquired compulsorily; full compensation shall be paid promptly to all persons affected in accordance to sections 8 and 10 along the following parameters;

i. Area of land acquired,
ii. Property value in the opinion of the Commissioner of land (after valuation)
iii. Amount of the compensation payable,
iv. Market value of the property
v. Damages sustained from the severance of the land parcel from the land
vi. Damages to other property in the process of acquiring the said land parcel.
vii. Consequences of changing residence or place of business by the land owners.
viii. Damages from diminution of profits of the land acquired

Part II of the Act allows for the temporary acquisition of land for utilization in promotion of the public good for periods not exceeding 5 years. At the expiry of the period, the Commissioner of Land shall vacate the land and undertake to restore the land to the conditions it was before. Any damages or reduction of value shall be compensated to the land owners.

3.5.14 Occupational Health and Safety Act (2007)

This legislation provides for protection of workers during construction and operation phases. It is tailored at implementation of the Environment, Health and Safety (EHS) plan in compliance with the relevant sections of this Act.

It shall be the duty of every employer to:

1. Ensure, so far as is reasonably practicable, the safety, health and welfare at work of all his employees.

2. Without prejudice to the generality of an employer's duty under subsection (1), the matters to which that duty extends include in particular;

(a) The provision and maintenance of plant and systems of work that are, so far as is reasonably practicable, safe and without risks to health;

(b) Arrangements for ensuring, so far as is reasonably practicable, safety and absence of risks to health in connection with the use, handling, storage and transport of equipment, machinery, articles and substances;

(c) The provision of adequate and suitable protective clothing or devices of an approved standard to employees who in the course of employment are likely to be exposed to the risk of head, eye, ear, hand or foot injury, injury from air contaminant or any other bodily injury and the provision of adequate instructions in the use of such protective clothing or devices;
(d) The provisions of such information, instruction, training and supervision as is necessary to ensure, so far as is reasonably practicable, the safety and health at work of his employees;
(e) So far as is reasonably practicable as regards any place of work under the employer's control, the maintenance of it in a condition that is safe and without risks to health and the provision and maintenance of means of access to and egress from it that are safe and without such risks;
(f) The provision and maintenance of a working environment for his employees that is, so far as is reasonably practicable, safe, without risks to health, and adequate as regards amenities and arrangements for their welfare at work; a
(g) Compliance with sections 7, 12, 37, 46, 75 and 76, Parts III and IX and such other duties as may be imposed on him by regulations made under this Act.
3. An employer shall—
Ensure that all hazardous chemicals present in the industrial establishment are labeled in a way easily understandable to the employees, or are identified in the prescribed manner;
Obtain or prepare, as may be prescribed, an unexpired chemical safety data sheet for all hazardous chemicals present in the workplace;

3.6 Licenses and Permits

In order to manage the environmental quality standards, the EMCA requires that project proponents apply to the NEMA for various types of permits depending on the nature of the project once it becomes operational. These permits include:

- Effluent Discharge License (for wastewater discharges into sewer systems)
- Air Emission License (for air pollution)
- Waste License (for transport, storage and disposal of all types of wastes)
- Other statutory licenses and permits

3.7 Policy Guidelines on Environment and Development

Among the key objectives of the Policy Paper on Environment and Development (Sessional Paper No. 6 of 1999) are to ensure that from the onset, all development policies, programmes and projects take environmental considerations into account and to ensure that an immediate environmental impact assessment (EIA) report is prepared for any industrial venture or other development before implementation among others.
The policy recommends the need for enhanced re-use/recycle of residues including wastewater, use of low non-waste technologies, increased public awareness and appreciation of clean environment. It also encourages participation of stakeholders in the management of wastes within their localities.

3.8 Building Code 2000

Section 194 requires that where sewer exists, the occupants of the nearby premises shall apply to the local Authority for a permit to connect to the sewer line and all the wastewater should be discharged into sewers. The code also prohibits construction of structures or buildings on sewer lines.

4 BASELINE INFORMATION

4.1 Location and General Description

Embu Municipality is located in Embu West Sub County in Embu County on longitude 37^0 27' East and latitude 0^0 32' south, at an altitude of approximately 1,400 m above sea level. Embu town is situated about 130 km north of Nairobi, on the tarmac Road B6 from Nairobi to Meru. It covers an area of approximately 80 km^2. The most developed area is within the area of 24 km^2 of which 5.5 km^2 constitutes Embu Town centre. The proposed site of sewage treatment plant to supplement the existing facility is to be built at the confluence of Rupingazi River and Kamiugu Stream as recommended in the report by consultants for the design at the outskirts of Embu Town.

Embu town Settlement Patterns are influenced by its topography. The settlements reflect both concentrated settlements and scattered settlement following the topographical ridges within the areas of the expanded town covering a total of 80 km^2 as stated earlier. Pockets of concentrated settlements are however noticeable in satellite towns. The real urban settlements are found within the old 24 km^2 while the scattered settlements (unplanned) take up the bulk of the extended town. This element is explained by extension of the Embu town boundaries into the rural settlement that are in the periphery of the old Embu town. Outside the initial 24 km^2 the urban growth is ribbon and tends to follow the two major trunk roads B6 (Embu – Meru Road) and B7 (Embu – Kiritiri Road). The Local Service Centres within the extended Embu town boundary area include:- Mutunduri, Kangaru, Karurina, Kimangaru, Njuikiri markets in Embu County and PI, Gathoge Njukiini, and Mugamba Ciura markets in Kirinyaga County. Emerging from the above observation, the population densities within the town boundary have also followed a similar pattern. However, available data on densities as per the census only refers to the old Embu town boundaries of 24 km^2 thus leaving the bulk of the area within the 80 km^2 area unaccounted for.

The areas that constitute the expanded Embu town currently are as stated below. However, the area that requires immediate sewage facilities are the old developed areas of 5.5 km^2 within the former 24km^2 extended town boundaries before the current Embu town boundary was further expanded to the current size of 80km^2 later.

Table4.1: Population for all areas of expanded Embu Town

Name Of Area	**Area In Km^2**	**Population 2009 Census**
Gatituri	10.7	5,875
Kiangima	6.3	4,345
Itabua	30.1	8,228
Dallas/Stadium	3.5	18,767
Kamiu	6.6	15,020
Njukiri	6.7	4,615
Nthambo	6.7	4,290
Gatunduri	9.0	6,309
Total	**79.6**	**67,449**

Embu Town is the seat of the County Government of Embu County and the Headquarters for Embu West Sub County and the Central Government Regional Headquarters. The northern part of the town comprises schools and government institutions while the central and southern parts of the town comprises the County, Sub County and Central Government administration offices as well as commercial establishments.

The developed part of Embu town is in dire need of sewerage facilities. The western part of the town and a portion of the

Central Business District are sewered. But the greater part of the town does not have sewerage system. The selected areas of town proposed for sewering in this report that exhibit pro poor tendencies are Dallas, Stadium, Blue Valley, Parts of Majimbo, Kanjuru, Muruatetu and parts of Central Business District that are bounded by Rupingazi River to the south and west and Kapingazi River to the east. The Refined sewerage final design report covers the whole of the developed town but zeros only on some selected areas of phase 1 area as set out by Runji and Partners report of 1994. The coverage of the whole developed portion of Embu town has been considered because the sewers expected to be constructed are expected to eventually carry the ultimate sewage generated within the town to the future site of the sewage treatment plant.

4.2 Topography

Embu Municipality is traversed by a number of small streams and rivers which are tributaries to the two major rivers, Rupingazi and Kabingazi. These streams and rivers have cut deep valleys and have created steep hillsides which have caused great difficulties in urban development. The development of the town was initially concentrated mainly on the ridges between the streams and rivers but is now taking place in the gently sloping areas east of the town Centre towards Don Bosco area along the Embu - Kiritiri road. There is a general slope from north to south of 170 m in 4 km, or 4.3% within the valleys and gently slopes on the land east of Kapingazi River.

4.3 Climate

The details of the Embu town climate presented in the sewage master plan are as reproduced below.

4.3.1 Temperature

Temperature has been recorded in Embu during the period 1942 – 1951 at Embu Agricultural training school. The records are given on Table below. The records indicate that the coldest month is August when the mean minimum temperature is 13.0^{o}C. The table shows the biggest deviation from the yearly mean minimum temperature is only 1.1^{o}C.

4.3.2 Rainfall

Observations of rainfall have been carried out at the then Embu Development Centre which is now known as Embu Kenya School of Government. The mean precipitation for Embu town indicates two rainy seasons: Long rains in March – April – May and short rains in October – November - December

4.4 Evaporation

Evaporation is not measured at Embu, but can be estimated from “studies of potential Evaporation in Kenya” by T. Woodhead, Nairobi, 1968. Sheet No. 7 of this publication shows that the annual mean evaporation is estimated at about 1900 mm per annum. To illustrate the variation during the year, statistics from a meteorological station, some 20 km south of Embu, at Mwea Rice Irrigation scheme Experimental Station are presented in the table below.

From the table below it appears that the monthly mean evaporation does not vary significantly from the average monthly mean of 8.3% for the whole year.

Table 4.2: The Variation of Evaporation. Embu – Mwea Experimental Station No. 90 37/112

Period	Mean Monthly Evaporation (1963 – 1970) (mm)	Monthly mean in Percentage of Annual mean
January	192	9.7
February	198	10.0
March	191	9.7
April	164	8.3
May	139	7.1
June	120	6.1

July	112	5.7
August	135	6.8
September	178	9.0
October	211	10.7
November	153	7.8
December	178	9.0
Year Total	**1971**	**100**

4.5 Geology and soil conditions

The geology of the area is described in the "Geology of the Fort Hall Area" Report no. 73, Geological Survey of Kenya. The Geology of the area is characterized by the nearby now extinct volcano, Mount Kenya. The geological strata resting upon the Precambrian rocks are of volcanic origin in the area around Embu and they are called the Mount Kenya phonolite. Four kilometres west of the proposed treatment works, the basement rock outcrops is the Murinduko Hill. Along the Rupingazi River, the Mt. Kenya phonolite was heavily eroded in Tertiary times, and a deep valley formed in the phonolite, was in Pleistocene times filled up with Thiba basalt flowing down from Mt. Kenya.

Soil investigations were carried out during the preparation of the sewerage master plan and also during current reporting period. Investigations revealed that, the upper part of the plot up to a depth of two metres, the soil consists of murram and rock boulders. The middle portion of the pond site at the same depth has murram on the lower quarter and the upper part deep loam soil. The lower part of the plot has deep loam soil only. The soil profiles result means that it is possible to carry out cut and fill pond construction without borrowing construction soil from other areas.

4.6 Institutions and industries

Embu is the administration centre of Embu County. It houses the County Headquarters for both the Central and County governments as well as the headquarters of Embu West Sub County. The town therefore hosts a large array of Government Offices. In addition, there is a Level Five Hospital, a Prison, hotels and various educational facilities. The Town is however lacking in heavy industries and only boasts of a few light industries, mainly for processing agricultural and forest products.

4.6.1 Schools

There are many public primary and secondary schools within the town area, private boarding and day schools, secondary schools both private and public, as well as technical schools.

4.6.2 The level five hospital and medical centers

The Embu Level Five Hospital has an average attendance of more than 700 outpatients daily. The number of inpatients range between 700 and 800 though the number of hospital beds is 714. The Level Five hospital employs 750 persons. There are some 32 staff houses within the hospital with about 175 residents.

A medical training centre is attached to the hospital. The current number of students in the centre is 350. The hospital is located at the area of Embu town that is connected to the existing sewerage system. Private clinics have sprung up in Embu town and most are located in the Phase 1 areas that were recommended for sewering in the design report. Some clinics attend to outpatients only while others have got both outpatient and inpatient.

4.6.3 Embu prison

The Embu GK Prison is located at Majimbo, about 500m from the Embu - Siakago road. The prison is planned for 2,500 prisoners and approximately 2,500 staff and their dependents. Currently, the prison holds 700 prisoners and about 600 resident staff and dependents.

4.6.4 Institutions and colleges

KARLO Center is located in the Northern side of the town. The centre situated south of Kangaru water storage site for EWASCO has 150 employees. Across the Embu – Meru road east of the College is the Kenya School Government formerly the Government Training Institute. The school has a student population of 520 day scholars and 700 boarding students. It has 45 residential houses for the staff in the compound.

Embu University has taken up the land that formerly was being used by the EAST College. It currently has a student population of 2,000 that is going to increase to 5,000 students by the end of this year once the recent intake joins the college. When fully constituted, the university shall have a student population of 10,000students.

4.6.5 Embu Slaughterhouse

A slaughterhouse is located at Majimbo area past the Embu GK prison. 12 persons are employed at the slaughterhouse but none is resident. Twenty cattle and fifteen goats are slaughtered every day. The slaughterhouse has its own effluent treatment plant consisting of screens and a grease trap and two waste stabilization ponds in series. Effluent from the ponds is led to soak away pits in form of trenches. Currently, the performance of the treatment plant is satisfactory.

4.6.6 Hotels

The growth of Embu town has led to the opening of several hotels to cater for the increased demand for accommodation and catering services. There are 54 hotels of varying standards with a total bed capacity of 1,690 rooms.

4.6.7 Food premises

There are many places in Embu town that serve food related items. The food premises number approximately 22 in the town dealing with different classes of food products.

4.6.8 Non food premises

There are also premises in town that provide other services other than food products such as electrical gadgets, furniture etc. they number approximately 25 and are of different classes.

4.7 Embu town water supply

Initially Embu town had one water source namely the Kapingazi water source. Due to the inadequacy of the Kapingazi source due to the high water demand for Embu town, Ngandori/Nginda water supply project was used to supplement the Embu water supply. The water supply was still insufficient to cater for the needs of Embu town and a second source was identified by EWASCO and constructed on river Rupingazi.

The raw water from Kapingazi intake was being treated at Kangaru water treatment works and it had a production capacity of 2,700m^3 per day. This source has since been abandoned after the Rupingazi source was constructed and later expanded. The former Kangaru water treatment works site is now being used by EWASCO as a treated water storage site.

The raw water from Rupingazi Water intake is gravitated to a treatment works at Mukangu which is situated about 6km north of Kangaru site where the old water treatment plant used to be. This new water treatment plant constructed by EWASCO has a production capacity of 12,000m^3 per day. However, the water supply for Embu town was recently augmented with funds obtained from JICA that increased the water supply production capacity to 27,000m^3 per day an increase of 15,000m^3 per day. The Embu water treatment works is managed by 17 persons. The whole town is now fully supplied with piped water except for those that have not applied to be connected and those who buy water from kiosks that were constructed by Plan International that tap water from springs below the Kanjuru estate. The water supply has also been connected to people living in rural areas within and on outskirts of the town that have applied for connection and also to the people on the periphery of the town.

EWASCO has also extended the water coverage to satellite towns of Kiritiri and Gachoka in Mbeere South sub-county and their periphery too.

4.8 Existing sewerage and water systems

The existing sewer reticulation system covers most of the Central Business District, some parts of the western part of the town centre, the area around the Embu Level Five Hospital and Majengo site and services schemes. It has recently been extended to cover Kaunda Estate, the neighbourhoods of Embu Level Five Hospital, Spring Valley Estate and Upper Blue Valley Estate.

The sewerage system in Embu town centre was constructed in 1973 while that in Majengo site and service scheme was constructed in 1978. Several extensions to the sewer lines have since been made by EWASCO. The total length of the

existing main and branch sewer lines with diameter 150 mm and above is more than 27.0 km. The sewers are generally in good condition and are well maintained.

4.8.1 Existing sewage treatment plant

The sewerage system is connected to a public treatment plant consisting of a screen, grit chamber and four waste stabilization ponds with an outlet to Rupingazi River. The treatment plant was designed to treat 800m^3 of waste water per day. The spiral pond and the original sewer network were constructed in 1973. Two new stabilization ponds were added by EWASCO in 2008 and they became operational in 2009 bring the capacity of the treatment plant to about 1,500m^3 per day.

The initial treatment works is circular in shape but is partitioned to form a spiral channel with an inlet on the outer side and an outlet at the centre to increase the sewage detention time.

The pond has a mid – depth diameter of 110 m and a water depth of 1.37 m and thus, a volume of approximately 13,000 m^3. It is furnished with a baffle wall on one side of the inlet to prevent short circuiting of flow. On average, desludging has been carried out at 4 years intervals.

The flow from the circular pond now enters a 5,000m^3 maturation pond that empties to a 3,000m^3 pond. These ponds were added in year 2008 - 2009 to improve the quality of effluent.

The 3,000m^3 empties to the last pond that was originally constructed as a temporary pond to take up the influent during desludging of the spiral pond. This last pond has a capacity 2,000m^3. All the sewage ponds at the existing treatment works taken together have a combined capacity of 23,000m^3. With a full sewage treatment to achieve the acceptable BOD effluent load of 20mg/l, the current treatment works can only comfortably treat about 1,500m^3 of waste water per day.

Flow measurements carried out in the year 2009 by the EWASCO show the average inflow into the first pond to be about 700 m^3 / day compared to a flow of 610m^3/day in 1993. The current flow to the pond that was taken in May 2016 was found to be 1,500m^3 of waste water per day. This shows that the flow of sewage from the connected part of Embu town to the sewerage treatment works has more than doubled the treatment capacity of the then existing sewerage treatment plant before the addition of the extra maturation ponds notwithstanding the fact that the bigger part of the developed Embu town is not sewered.

The composition of the treatment plant influent and effluent were determined occasionally by the then Municipal Council that was running the Embu sewage treatment works and lately by EWASCO, that runs both water supply and waste water disposal systems.

The results for the final effluent released from the sewage treatment works taken in 2009 shows the BOD to have been 35mg/l. The figure was expected to become better when the two ponds attained their full treatment potential once the seeded aerobic bacteria multiply to their full potential but as long as the influent keeps on increasing, the BOD would hardly be reduced further. This value of the final effluent BOD5 level of 35 mg/1 exceeds the acceptable BOD standard of 20 mg/1 as per set WHO.

The faecal coliform (FC) bacteria, in the final plant effluent had earlier in the study of the Master Plan found to be about 2.6 $x10^6$ FC/100 ml. The required standard of 5 x 10^3 FC/100 ml was, therefore, far from fulfilled. The above results show the performance of the treatment plant with its existing load is not only unsatisfactory but cannot effectively treat the waste water as it is already overloaded.

4.8.2 Effluent recipients

There are two major rivers in Embu County that traverse Embu town. These rivers are the Rupingazi and the Kapingazi. The rivers are both perennial but are heavily tapped for both domestic and irrigation waters. The existing sewage treatment works and the proposed one are both situated adjacent to river Rupingazi. Rupingazi is therefore, the recipients of the current sewage effluent and the expected effluent from the proposed sewage ponds.

Records of the flow of the river Rupingazi shows that the Rupingazi waters can accept an effluent of more than 1,800m^3 per day and provide a dilution exceeding the recommended ratio of 1:8 as per the Master Plan Report

4.8.3 Other methods of waste water disposal in project area

The sanitary conditions in the unsewered areas in Embu town are deplorable and requires immediate relieve. This has been compounded by the availability of adequate potable water supply in Embu town. When the sewage system was built the water demand in Embu town was a meagre 2,500m^3 per day. However, as the town continued to grow, the water demand substantially increased but the water supply production at Kangaru water treatment works remained only 2,500m^3 per day. Meanwhile, the waste water that was being generated in sewered area of Embu town and taken to the existing treatment works at that time was receiving proper treatment and the effluent was within the WHO acceptable standards.

EWASCO sought a loan in form of materials from the suppliers and upgraded the Embu water supply system and

constructed a new intake at river Rupingazi and a water treatment plant at Mukangu that has a capacity of 12,000m^3 per day thereby easing the water shortage in town. The water supply has since been augmented to the current capacity of 27,000m^3 per day.
This increased water supply system without corresponding increase in the capacity for water treatment plant has resulted in sullage finding its way in the open drains in Embu town posing a grave health hazard.
Kangaru secondary school and Embu University College have old and well maintained sewers consisting of concrete pipes of 150mm diameter that are connected to the institutional treatment works. The sewage treatment works for Kangaru School consists of a grit chamber, a septic tank and a trickling filter with hydraulically propelled rotating arms. The operation of the plant is, however, very poor. The effluent is released without proper treatment. The treatment works for the university consists of lagoons that are also overflowing due to the increased population that currently uses the facility that was being used by EAST College and KARI.
Other areas which are not covered by the existing sewerage system are served by either septic tanks or pit latrines. Depending on the number of users and the nature of the soak area the sewage flow sometimes exceeds the capacity of the soak area. This is especially the case in unsewered central commercial and residential areas. EWASCO provides septic tank exhausting services at a nominal fee of Kshs. 2,000.00 per 5m^3 load. Access to most of the septic tanks, however, is often very difficult, resulting in infrequent and/or unhygienic manual emptying of these septic tanks to open grounds mostly during the night. The revenue that was generated by the exhauster service in year 2008 was Kshs 2,880, 000.00. In rural areas and in areas with low class housing, the use of pit latrines is very common. Unimproved pit latrines are odorous, attract flies and are, a potential health risk. The sanitary conditions in areas where the latrines are used are therefore generally bad.

4.9 Population projections and development plans

The population growth rate and projections up to 2038 are shown in table below. This draft refined sewerage reviewed final design report has based its population projection on the 1999 census and the 2009 census which gives Embu town a growth rate of 1.55 % per annum which is adopted instead of the 1.45% which is the growth rate of Embu County. The growth rate of Embu town is higher than the growth rate of Embu County. This higher growth rate of the town is attributed to the movement of people from rural to urban areas in search of employment opportunities.

Table 4.3: Population Growth Rate for Embu County and Embu Town

Name	**Actual Population/year**		**Growth Rate** %
Area	1999	2009	
Embu County	447,159	516,212	1.45
Embu Town	52,446	61,140	1.55

4.10 Town development plan and population projections

The former Ministry of Lands and Settlement, the then Department of Physical planning compiled a provisional long term town Development plan, in September 1978, which was the basis for the Sewerage Master Plan prepared by Cowiconsult. However with time the area use has been changed quite significantly to the extent that it is not now possible to use land use as a basis for the determination of the waste water produced in each Zone for Embu town. The current development that is taking place in Embu town shows that the residential areas are scattered all over Embu town in an unplanned manner in the area. The commercial, business and administrative areas are located in any area in Embu town and not only at the town centre.
The institutional areas are, like the residential areas, scattered throughout the town, but the larger institutions (Kenya School of Government, Kangaru School, Embu Girls, Kangaru Primary School, Embu Agricultural Research Station and Embu University College) are situated to the north of the town along the main Embu-Meru road and between the Embu Level Five hospital and Kangaru village. The industrial development is planned to take place in the southern part of the Municipality. The industrial areas are mostly planned for light industries. The small area that was reserved for heavy industry has been taken up and developed as commercial and residential area.
The steep hillsides along the small streams which traverse the Embu town were considered as unsuitable for any development of the town and were therefore defined as open space area for agriculture and recreational activities. But demand for housing and commercial facilities have led to the grabbing and subsequent development of those spaces.

The north-western part of the town is mainly reserved for agriculture.

4.10.1 Population projection in the study area

The population projections that were arrived at in the Runji and Partners design report during the review of Master Plan are at a considerable variance when compared to 2009 Census. The estimated population in the Runji report for the Municipality was 84,000 in 2005 compared to actual census population of 61,000 for year 2009. Therefore, it is prudent to use the population growth rates for Embu town derived from the last two previous censuses as the more realistic approach especially when it comes to design of the sewers and the Treatment Plant. Even if the Treatment facility is to prove in-adequate in the near future it is going to ease the overloading being experienced by the existing treatment works and it can also be expanded later when more funds are availed.

During the review of the Runji Embu sewerage design report by EWASCO, a small area of phase 1 in the design report was identified for sewering as it was found to be the neediest in terms of sewage disposal problems. The population growth rate for each area was considered as shown in the below:

Table4.4: The population growth rate for the selected areas to be sewered

Area	**Actual Population**		**Growth** Rate (%) Pa
	1999	2009	
Central Division	52,446	61,140	1.55%
Municipality Location	36,920	42,692	1.46%
Dallas/Stadium	16,993	18,767	1.00%
Kamiu	11,357	15,020	2.83%

4.10.2 Total population within the prioritized area

The areas that are desperately in need to be sewered and have been prioritized as per the EWASCO report and are in the terms of reference for this consultancy are specifically Dallas, Stadium, Blue Valley, Parts of Majimbo, Kanjuru, Muruatetu and parts of Central Business District. These are built up areas in Embu town and are currently struggling with waste water disposal problem and they need the sewerage services immediately. Dallas, Stadium and Majimbo are low income estates and the people in these areas use pit latrine for waste disposal considering the fact that these areas are almost encompassed by the development that is taking place in Embu town and also need better sanitation facilities.

The following table shows the total population within the developed Embu Central Division covering 5.5km^2, on which the design of the sewerage system and sewage treatment plant is based. Part of the population of Embu town shall continue using the existing sewage treatment works as the proposed new works is designed to cater for only an addition population of 12,500 persons due to the unavailability of land as the available 5 acres can only accommodate a sewage treatment ponds of capacity of 2,000m^3 per day.

The sewer design is now based on the ultimate water demand as opposed to the land carrying capacity of the previous design as carried out by Runji and Partners due to the change in land use in Embu town.

Table 4.5: Projected Total populations within Embu town

Year	1999	2009	2016	2018	2028	2038
Population	52,446	61,140	68,091	70,218	81,893	95,909

4.11 Electrical Power

Electricity is readily available for any key developments within the town. The present situation is that electricity has been extended to many areas outside the old Municipality boundaries. Power for industrial development is readily available

4.12 Communication and transport

Internet services are fully available in the town with many cyber cafes as well as connections through portable broad band modems supplied by Airtel, Safaricom and Orange cellular phone companies. There are also courier services provided by G4S, Wells Fargo and others as well as the Post Office services

The two main roads serving Embu Municipality are B7-Embu-Kiritiri-Garissa Road and B6 Embu Meru Road. Both roads are tarmac with heavy vehicular flow. The approximate length of major roads in the Municipality is about 54.4Kms. Out of this only about 18Kms (33%) are tarmacked. The roads within the study area need constant maintenance. A number of roads are not motorable especially during the rainy seasons. There are no provisions for the non-mortised modes of transport in the town.

4.13 Petroleum dispensing outlets

There are about 13 fuel stations within the town comprising of 7 petrol stations, 4 filling stations and 2 kerosene pumps. These facilities are located along the B7 and B6 roads. Those along the B7 (Kiritiri) road are characterized by congestion and vehicle/human conflict. Some petrol stations are used as parking spaces at night when the town is less busy. More are coming up.

4.14 Public Transport System

Matatu services have improved for the last five years. It is estimated that there are about 200 Matatu vehicles operating the following routes:Embu – Nairobi, Embu – Kiambere, Embu – Kathageri, Embu – Kitui, Embu – Mwingi, Embu-Meru. Formal employment from the Matatu industry is estimated to be 450 people and an equal number-earning livelihood through part time tout business, vehicles, vehicle washing and vehicle servicing.

4.15 Recreational Facilities

There are two major public recreational facilities in Embu, namely Embu Municipal Stadium and Njukiri ASK showground having areas of 5.0 Ha and 33.0Ha respectively. These two facilities have remained underdeveloped hence limiting sporting facilities. National and provincial sporting activities normally take place in Kangaru School and Kigari Teachers' college playgrounds. This often interferes with learning programmes. The ownership of the stadium has also remained unresolved.

4.16 Wetlands/Riparian Reserves

Embu has several pockets of wetlands scattered in the entire Municipality. These take the form of swamps and collection basins. The riparian reserves are along the major rivers (Rupingazi and Kapingazi) as well as small streams. The reserve varies from 6 – 30 meters depending on the river valley gradient.

5 ANALYSIS OF ALTERNATIVES

In considering the development options, three alternatives can be considered. These are:

i. The No Action Alternative
ii. The Proposed Development
iii. The Proposed Development with modifications
iv. Proposed Development in another location
v. The recommended alternative

5.1 The no action alternative

The selection of the "No Action" alternative would mean the discontinuation of project designs and result in the site being retained in its existing form. There are physical, biological and socio-economic implications of this alternative. Physically, the site is unlikely to undergo any major changes from its condition at present, with the exception of the potential for plot to lie idle. Biologically, there is vegetation present on the site which is likely to be affected, other than the potential for growth of weeds introduced by avifauna, wind or other means. If the vacant condition is maintained, this could result in future out breaks of diseases due to poor sanitation for the urban residents hence perpetuating poverty due to increase on money spent on hospital bills and drugs. The "No Action" Alternative is likely to have the greatest implications on the socio-economic and health environment of the area and surrounding residential town community. Due to the proposed quality of the development it is anticipated that it would provide a major opportunity for eradicating diseases spread due to poor sanitation, and benefits associated with the employment among others. If this alternative were adopted, the proponent would need to find an alternative site for the development or to implement it outside Embu Town

5.2 The proposed development

This alternative would see the construction of the sewer facility as proposed by the proponent, and as outlined in this EIA document. This option has good support (based on results of stakeholder consultation) by the persons who would be most affected by its implementation, i.e., residents within the environs and land owners as well as developers. Therefore, residential community support is anticipated for the development. The proposed development is in tandem with town plans hence is appropriate at the present proposed site.

Generally, it is believed that this alternative will provide positive benefits to the residential community and in improvement of sanitation and ultimately reduction of disease prevalence in the town due to poor sewer waste disposal. This also includes benefits such as employment opportunities, reduced cost of construction for land lords, increase in living standards et al. If approved, construction at the facility is scheduled to last approximately 12 months, and is likely to provide employment for an average of 10 individuals during pre-construction, 50 labourers during construction. Site work will be completed on a single shift basis to minimize disturbance to residents in the area. Additionally, the multiplier effects to the construction and support businesses like food during this period are likely to affect a much larger number of persons. The proposed development is being designed and built to meet or exceed local and international standards and regulations. The proposed construction technology and design is suitable for the project.

5.3 The proposed development with modifications

If there are issues concerning the project that may be enhanced, changed or modified to increase the acceptability of the project, then these issues should be considered. At this time based on consultation with residents of the area, it appears that there are several issues that once resolve satisfactorily whether through modification or compromise would further increase support for the development. These include but are not limited to:

- The proponent should follow requisite laws when constructing
- Foul odours should be controlled

All these issues are easily resolvable through either modification or compromise and we do not foresee these issues resulting in disapproval of the development by interested persons and regulatory agencies. The proponent has resolved to work with the neighbours and residents to design, construct and operate a quality facility that will be the pride of all involved or benefiting in its operation. This alternative retains the same positive benefits as with maintaining the proposed development option.

5.4 The proposed development in another location

Other locations were considered in conjunction with the proposed location for implementation of this project.

Alternative 1

The construction works will be implemented in two phases i.e. 1 and 2. Phase one was implemented with construction of a concentric sewer system and two ponds of capacity to hold 5,000 M^3 of effluents per day. This caters for areas which are substantially developed and where waste water can flow easily by gravity. These areas are bounded by Kamiugu stream to the east, Rupingazi River to the south and Kathita River to the North West and Kangaru Schools to the north. The existing sewer plant is located near Embu town approximately 1 kilometre from town center near Dallas Estate. The treated waste is discharged into Rupingazi River from Kamiugu stream. However, due to the elevation of this site, only the western parts of the town are covered. Phase two involves construction of a treatment plant at a site off Embu – Kiritiri road and laying of an 8 kilometre trunk sewer line to the site.

Alternative 2
The works in this phase can be implemented in alternative phase 1 above, but another phase i.e. 1B could be incorporated to service Majimbo area and other areas bordering Kamiugu stream to the west and Kapingazi River to the East. In Phase 1B, the second sewerage system can be constructed in Majimbo and Kamiu areas and a second treatment plant is constructed at the confluence of Kapingazi and Rupingazi Rivers. This second treatment plant site requires about 2 kilometres of an access road on a difficult terrain. This is envisaged to have a capacity of holding 15,000 m^3 of waste water per day.
As noted earlier, the Rupingazi and Kapingazi Rivers confluence site has been considered as the ideal site for the whole of phase 1 by environmental and financial considerations. The site is however inadequate and hence the choice of Kamiugu confluence site. Implementation of this phase will involve abandonment of both Kamiugu and Kapingazi confluence treatment plants.

Alternative 3
This phase can be implemented as is recommended in the sewage master plan. The main features of this alternative is the initial construction of a treatment plant at the site near the airstrip off Embu – Kiritiri road and an 8 kilometer long trunk sewer line to the plant. This could be implemented in three parts:
Stage 1 of phase 1 involves construction of a part treatment plant near the airstrip off Embu – Kiritiri road, a trunk sewer for the ultimate flow to the treatment plant and some selected primary and secondary sewers in the central commercial and residential areas
Stage 2 aims to improve the sanitary conditions for the institutions in the Embu northern areas of the municipality, the western part of the town center and areas east of kamiugu stream
Stage 3 aims to improve the sanitary conditions in kangaru and majimbo areas and others to the east and south of matakari stream phase 2 of the works caters for the whole of the municipality including areas north of Kangaru Village and East of Kapingazi River.
All the above 3 alternatives are not feasible because there are no funds available now or in the near future and would require over Ksh. 500 million to implement.

5.5 Recommended alternative
No other location was able to offer the comprehensive package as indicated above. As a result, no location that was more suitable or amenable than the present site was identified i.e. the Kamiugu and Rupingazi Rivers confluence site. The recommended alternative is the “Proposed Alternative” because it recognizes the viability and need for the proposed development, is designed to address environmental health issues and concerns, meets or exceeds all local regulatory requirements and supports communication and close relations during all stages of the development between the proponent and the surrounding residents. The area land owners have full support for the project also.

6 PUBLIC PARTICIPATION

Section 17-1 of The Environmental-Impact Assessment and Audit Regulations, 2003 requires that an EIA should "seek the views of any person who may be affected by the project". Immediate neighbour's comments were sought and the following comments were presented:

The public participation was carried out using structured questionnaires. (See copy of filled questionnaires in the annexes). Some of the residents refused to participate in filling the questionnaire for personal reasons. The following is therefore the analysis of the questionnaire:

Questionnaire analysis for the construction of Embu town sewer system by EWASCO at blue valley and Dallas areas

Question 1:
A 100% of all the respondents supported the proposed expansion of Embu sewer system by EWASCO for sewage treatment.

Question 1a:
100% or all the respondents said that there will be positive aspects during implementation of the proposed project. The respondents highlighted the following as the positive aspects of the proposed project;

- The project will encourage investors to develop high-rise buildings in the proposed areas as the management of sanitation waste will be catered for.
- The new sewer system will help accommodate more people in the town as well as commercial and residential buildings that are not currently connected to the already existing sewer system.
- Some respondents were of the view that they will be able to save a lot of money that they use to pay for services rendered by exhauster companies that are always very expensive.
- The respondents noted that there would be better land use practices where land used for construction of soak pits will be used for other gainful developments.
- The respondents acknowledged that the construction of a new sewer system will ease the congestion currently experienced at the existing sewer plant which is very inadequate.
- The respondents said that the proposed project will create job opportunities for the town residents.
- The respondents noted that the proposed sewer system will enhance and improve the hygiene of Blue valley and Dallas estates, as well as that of Embu town in general.
- The respondents noted that the sewer system will be able to curb the use of pit latrines in some low income areas hence promoting hygienic practices.
- The respondents said that treated waste water can be reused for agricultural purposes.
- The respondents highlighted that a new sewer system will lead to the closure of the old sewer plant which has been limiting the expansion of Embu town towards that direction. This in turn will lead to the growth and expansion of Embu town.
- The new sewer plant will ease the treatment process that is currently burdening the existing sewer system.
- Cleanliness in plots currently using pit latrines will be greatly enhanced.
- The proposed project will reduce land pollution that is usually as a result of leakages in the existing sewer system as well as sewer line bursts experienced in some parts of Embu town.
- There will be proper disposal and drainage of waste waters and this will improve the cleanliness of Dallas estate especially during the rainy seasons.
- The respondents noted that the facility will be able to cater for the increasing number of Embu Town residents since the town's population is rising steadily.

Question 2:
The respondents highlighted the following as some of the negative impacts of the proposed project implementation;

- Foul odors will affect neighbors adjacent to the proposed facility as well as the areas' residents.
- The site will become a breeding ground for mosquitoes hence increasing the cases of illnesses in the area.
- Improper treatment of waste water in the sewer plant may cause diseases.

- Accumulation of waste substances in the facility may affect the adjacent lands making them unsuitable for agricultural practices.
- Leakages of untreated water from the sewer plant may find its way into rivers hence leading to water pollution.
- Air pollution may occur.

Question 3:
All of the respondents did not find any sensitive sites of cultural, scientific or of their interests that would be interfered with permanently or temporarily by the implementation of the proposed project.

Question 4:
The respondents gave the following as issues they would like to be addressed concerning the proposed project;

- The proponent (EWASCO) should ensure proper maintenance of the facility to avoid any leakages and run-offs.
- The proponent should ensure proper maintenance of sewer line pipes to avoid bursts that have been experienced previously in some parts of Embu town.
- The sewer plant should be operated well to reduce bad odor associated with sewer facilities.
- The facility should be properly fenced to reduce chances of occurrence of any accidents around the place, for example, cases of drowning of children.
- The current existing sewer plant should not be neglected and should be maintained regularly.
- Respondents from Embu College would like control measures taken to curb bursts that are experienced regularly in the institution.
- The proponent should consider constructing decentralized waste water treatment facilities to cater for people who will not be accommodated by the proposed facility.

7 ENVIRONMENTAL IMPACT IDENTIFICATION AND MITIGATION

An environmental impact is defined as any change to an existing condition of the environment.
To systematically identify the impacts associated with the proposed development, an impact matrix was made which arrayed the main project activities against the relevant environmental factors and mitigation measures.

7.1 Site Preparation phase

Impact: Lack of ground cover

Site clearance and construction practices generally lead to the removal of existing vegetation. These practices remove ground protective plant cover and expose the soil to erosive surface runoff during heavy rainfall events as well as wind erosion. The inappropriate disposal of the cleared vegetation could lead to associated negative impacts on local air quality due to dust generation. Approximately 3 acres of land will be cleared of all vegetation. As previously discussed, the sections of the site proposed for construction are primarily lands populated with bushes and a few trees. As a result, there are no significantly important floral species or vegetation communities that would be negatively impacted by site clearance and construction activities.
Similarly, negative impacts on avifauna, associated with the loss of onsite vegetation/habitat, are expected to be minor. The project site is not used for nesting or breeding by birds. There could also be a possibility of local river sedimentation

Mitigation:

Vegetation site clearance should be phased and the project site cleared as the need arises; as opposed to the practice of clearing the entire site in a single major clearance exercise. This will help to minimise the amount of bare/exposed soil present at the site, and thereby help reduce the risk of soil erosion during heavy rains and flash flooding. Areas of exposed soil should be replanted with grass as soon as possible after construction; to help mitigate against flash flood erosion.

- The riparian area should be conserved and the area enhanced with suitable riparian vegetation
- Maintain the riparian reserve of twice the width of the river undeveloped

Impact: Noise Pollution

Site clearance and construction of the proposed project necessitates the use of equipment to carry out the job as well as human labor. Transport vehicles have the potential to have a direct negative impact on the environment by noise generation.

Mitigation:

- Use equipment that has low noise emissions as stated in the operations manual.
- Use equipment that is properly fitted with noise reduction devices such as mufflers.
- Operate noise-generating equipment during regular working hours (e.g. 8 am – 5 pm) so as to reduce the potential of creating a noise nuisance during the night or early morning.
- Construction workers operating equipment that generates noise should be equipped with noise protection. A guide is a worker operating equipment generating noise of ≥ 80 dBA (decibels) continuously for 8 hours or more should use ear muffs. Workers experiencing prolonged noise levels 70 - 80 dBA should wear earplugs.

Impact: Water Quality

Removal of the vegetation can result in high suspended sediment concentrations from the runoff from the site, during construction phase. Fortunately, the majority of the earth works are stable areas to gently sloping areas and hence the storm water will be naturally drained in the area.

Mitigation:

Surface runoff will be controlled by temporarily dyking the outlet of the significant storm water features to provide some detention behind the dykes.

Impact: Air Quality

Site preparation and construction has the potential to have a twofold direct negative impact on air quality. The first impact is air pollution generated from the construction equipment and transportation. The second is from fugitive dust from site and access roads, cleared areas and raw materials stored on site. Fugitive dust has the potential to affect the health of construction workers, the resident population and the vegetation and nearby rivers.

Mitigation:

- Site access road should be watered every 6 hours or within reasonable time to prevent a dust nuisance and on hotter days, this frequency should be increased.
- The access roads (unpaved sections) through to the site should also be watered and the sections of the road monitored so that any material falling on it as a result of the construction activities be removed.
- Minimize cleared areas to those that are needed to be used.
- Cover or wet construction materials such as soil for backfill to prevent a dust nuisance.
- Construction workers working in dusty areas should be provided and provided with respirators.

Impact: Employment

During this phase, an average of approximately 10 persons will be employed. This has the potential to be a significant positive impact.

Mitigation

Not required.

Impact: Solid Waste Generation

During this construction phase of the proposed project, solid waste generation may occur mainly from two points:

- From the construction campsite
- From construction activities such as site clearance and excavation.

Mitigation:

- Waste bins should be strategically placed within the construction site.
- The waste bins at the construction site should be adequately designed and covered to prevent access by vermin and minimise odour.
- The bins at the construction site should be adequately covered to prevent a dust nuisance.
- The bins at both the construction campsite and construction site should be emptied regularly to prevent overfilling.
- Disposal of the contents of the bins should be done at an approved disposal site. The Embu County dump site is recommended. Appropriate permission should be sought (from the NEMA) as appropriate.

Impact: Wastewater Generation and Disposal

With every construction site comes the need to provide construction workers with showers and sanitary conveniences. The disposal of the wastewater generated at the construction campsite has the potential to have a minor negative impact on groundwater. No significant environmental impacts were identified from this activity since the scope of the project is medium.

Mitigation:

Provide portable sanitary conveniences for the construction workers for disposal of sewage waste. A proposed ratio of approximately 25 workers per toilet should be used.

Impact: Storage of Raw Material and Equipment

Raw materials, for example sand, gravel, used in the construction of the proposed development will be stored onsite. There will be a potential for them to become air or waterborne. Stored fuels and the repair of construction equipment have the potential to leak hydraulic fuels, oils et al.

Mitigation:

- Raw materials that generate dust should be covered or wetted frequently to prevent them from becoming air or waterborne.
- Raw material should be placed on hard stands surrounded by barriers for containment.
- Equipment should be stored on impermeable hard stands surrounded by walls to contain any accidental surface runoff.
- No storage of fuels and oils should be done onsite

Impact: interference with traffic flow and obstruction
Trucks will transport raw materials and equipment. This has the potential to directly impact traffic flow along the main road and along the earth road to the site. Additional traffic will occur as a result of:

- Construction of the pipeline works
- Mobilizing and demobilizing of the equipment; and
- Construction of the sewer system.

The mobilizing of all of the equipment should be phased so as not to magnify impacts.

Mitigation:

- Adequate and appropriate road signs should be erected to warn road users of the construction activities i.e. reduced speed near the entrance roads. This should be done in conjunction with the NTSA
- Raw materials such as sand, murram should be adequately covered within the trucks to prevent any escaping into the air and along the roadway.
- The movement of equipment (trucks) during the construction of the facility should be limited to the working hours, 8:00 am - 5:00 pm per day.
- All equipment should be transported early morning (8 am – 12 pm) with proper care being taken to reduce inconveniences to locals.
- The use of flagmen should be employed to regulate when trucks have access to the main roads.
- Vehicles entering the site should do so safely without causing obstruction
- Adequate notices should be placed the tarmac access road.

Impact: increase in accidents and injuries
Construction of the proposed development will involve approximately 50 construction workers. The possibility of accidental injury is high. There may be minor or major accidents.

Mitigation:

- A lead person should be identified and appointed to be responsible for emergencies occurring on the site. This person should be clearly identified to the construction workers.
- Make prior arrangements with health care facilities such as a Health Centre in proximity, a private doctor or the Provincial Hospital to accommodate any eventualities.
- Material Safety Data Sheets (MSDS) should be displayed onsite.

7.2 Operational Phase
Impact: Flooding
The construction of the facility could minimize the areas of natural detention of water and result in more peaked storm water runoff flows. The potential for this impact from the project on the storm water flow regime of the catchment involved was assessed.
The natural drainage on the site should be modified in the design in order to minimize flooding and protect the treatment ponds. The flood plain investigation results indicated that the flood plains downstream would be reduced as a result of the reduction of the effective catchment area. The flood plain upstream of the area is noted to be affected by implementation. It can therefore be concluded that the implementation of the project with the drainage provisions considered will have a positive impact on the flood plain characteristics of the catchments involved, by reduction of the likely flood plain area.

Mitigation:
Site drainage system should be made to recommended standards and maintained

Impact: Employment creation
During this phase, an average of approximately 10 staff may be needed for the proper operation of the project. This represents an increase in the level of employment within the project area. This has the potential to be a positive impact.

Mitigation
Not required.

Impact: Solid Waste Generation and Disposal
The operation of the development has the potential of significantly increasing the solid waste at the site. There will be a need to remove the screenings and grit from the site on need basis. This material can be handled with the same care as municipal solid waste and should be carried to the CGE dumpsite for proper disposal. The volume of solid waste is anticipated to be medium; hence it must be well disposed. The removal of sludge from the system will require that sludge be removed frequently on schedule. The material will be removed to the Embu County dump site or put to any other appropriate and recommended use.

Mitigation:
- Sludge drying beds should be incorporated in the design
- Provision of solid waste storage bins.
- Provision of adequately designed bins to prevent access by vermin.
- Monitor exhauster trucks so that they do not become overfilled and spill waste enroute to the site.
- Ensure that the solid waste generated is disposed of in an approved dumpsite or landfill.

Impact: Transportation/Traffic
The project is expected to increase the traffic along the access roads marginally, as there will be approximately 2 septage trucks driving to the site each day.

Mitigation:
- Limit sepatage delivery to the site between the hours of 8 am and 5 pm. This will limit the noise nuisance to residents and possibly reduce the population exposed to potential accidents, as most persons would have already left their homes to go to work and schools.
- Add adequate and appropriate signs including speed limits along the access roads.

Impact: Septage Disposal
The proposed development will be a receptacle for septage disposal. This activity has the potential to have two negative impacts. The first being unscrupulous cesspool emptiers who carry septage from the source to the site. The other impact is on the operations of the system, in that it has the potential to impact the final effluent quality.

Mitigation:
- Institute and maintain a ticketing system for cesspool emptier, where upon successful disposal, the site operator would issue a receipt to the cesspool emptier.
- County Government and particularly NEMA, should put in place a system to monitor cesspool service providers and in addition, have a public educational campaign to educate and inform the public about the system.
- Ensure that septage is only accepted at the site when there is enough capacity for treatment.

Impact: Emergency Response
The operation of the proposed project will involve workers who may become ill or have accidents. In addition, disasters such as, floods and drowning are real possibilities.

Mitigation:
- Make prior arrangements with health care facilities such as a Health Centre in proximity.
- Design and implement an Emergency Response Plan (ERP).
- Coordinate with first aid organisations/agencies i.e. St. John’s Ambulance, Red Cross to prepare for any eventuality.
- Display telephone numbers of emergency response departments for all people accessing the site to clearly see

Impact: Water Pollution
The discharge of treated effluent from the treatment plant will be continuous and will meet the NEMA guidelines for both irrigation and direct discharge.

Mitigation:
Follow the NEMA and WHO waste water quality guidelines strictly

Impact: foul odours
Wastewater treatment facilities carry a risk of odour nuisance if proper buffers between the treatment units and existing populations are not provided. A buffer area should be provided on all boundaries. Additionally, the perimeter of the proposed site will be vegetated with trees and plants of varying heights thereby forming a windbreaker.

Mitigation:
- Monitor and ensure that influent sulphate levels are below 240 mg/l.
- Ensure that the system has adequate flow to reduce the potential of odour formation.
- Maintain the system regularly as per schedule

7.3 Environmental monitoring programme/waste management plan
7.3.1 Monitoring during site clearance and preparation of the proposed development
- Daily inspections to ensure that construction activities are not being conducted outside of regular working hours (e.g. 8 am – 5 pm). The project engineer / construction site supervisor should monitor the construction work hours. NEMA should conduct spot checks to ensure that the hours are being followed. It is not anticipated that this exercise will incur additional costs.
- Daily monitoring to ensure that the cleared areas and access roads are not creating a dust nuisance. The project engineer / construction site supervisor should monitor or nominate a named person to carry out this activity. NEMA should conduct spot checks to ensure that this requirement is followed. It is not anticipated that this exercise will incur additional costs.
- Undertake daily inspections of trucks carrying solid waste generated from site clearance activities to ensure that they are not overloaded as this will damage the public roads and onsite soil compaction as well as spillages.

7.3.2 Monitoring during the construction phase of the proposed development
Daily inspection of site clearance activities to ensure that the proposed plans are followed and to ensure that site drainage is being constructed as planned. NEMA, EWASCO and the county administration can provide checks and balances. Person(s) appointed by the developer may perform this exercise.
No additional cost is anticipated for this exercise.
- Undertake monthly water quality monitoring to ensure that the construction works are not negatively impacting on the river water quality. The parameters that should be monitored are as indicated i.e. dissolved oxygen, nitrates, phosphates, turbidity and total Coliforms et al according to NEMA Water quality standards.
- NEMA approved labs with the capability to conduct monitoring of the listed parameters should be used to perform this exercise i.e. the EWASCO laboratory or any other NEMA approved lab. It is recommended that a report should be given to NEMA at the end of each monitoring exercise.
- This is estimated to cost approximately **Ksh 20,000** per monitoring exercise.
- Daily inspections to ensure that construction activities are not being conducted outside of regular working hours (e.g. 8 am – 5 pm). In addition, a one off noise survey should be undertaken to determine workers exposure and construction equipment noise emission.
- The project engineer / construction site supervisor should monitor the construction work hours. NEMA should conduct spot checks to ensure that the hours are being followed. Any suitable qualified company or individual may conduct the noise survey. The monitoring of the construction work hours is not expected to incur any costs.
- Daily monitoring to ensure that fugitive dust from cleared areas, access roads and raw materials are not being entrained in the wind and creating a dust nuisance. The project engineer / construction site supervisor should monitor the construction work hours. NEMA should conduct spot checks to ensure that this requirement is being followed. In addition, the local community within the area can be used to provide additional surveillance.

It is not anticipated that this exercise will incur additional costs.
- Undertake daily inspections of trucks carrying raw material to ensure that they are not over laden as this will damage the public access roads and onsite leading to soil compaction. Also to ensure that they are covered and not spilling materials along the roadway.

Person(s) appointed by the developer may perform this exercise.
No additional cost is anticipated for this exercise.

- Conduct daily inspections to ensure that trucks carrying raw materials and heavy equipment are parked at the designated area on the proposed site so as to prevent traffic congestion and accidents.

Person(s) appointed by the developer may perform this exercise.
No additional cost is anticipated for this exercise.

- Conduct daily inspections to ensure that flagmen are in place and that adequate signs are posted along the access road as necessary. This is to ensure that traffic along the access roads have adequate warnings and direction.

Person(s) employed by developer may perform this exercise.
No additional cost is anticipated for this exercise.

- Undertake daily assessment of the quantity of solid waste generated and keep records of its ultimate disposal. Additionally, solid waste generation and disposal of the campsite should also be monitored.

Person(s) appointed by the developer may perform this exercise.
No additional cost is anticipated for this exercise.

- Weekly assessment to determine that there are adequate numbers of portable toilets and that they are in proper working order. This will ensure that sewage disposal will be adequately catered for.

Person(s) appointed by the developer may perform this exercise.
No additional cost is anticipated for this exercise.

- Where possible, construction crews should be sourced from within the project area. This will ensure that the local community will benefit from the investment.

Person(s) appointed by the developer may perform this exercise.
No additional cost is anticipated for this exercise.

7.3.3 Monitoring during the operational phase of the proposed development

The proponent should undertake quarterly water quality monitoring exercises yearly to ensure that the development is not negatively impacting on the local river water quality. The parameters that should be monitored are PH, BOD, COD, Suspended solids Ammonia, Total Dissolved solids, E. Coli and Total coliform as per NEMA waste water quality guidelines.

It is recommended that both influent and effluent water quality be monitored on a weekly basis by EWASCO. This recommendation is based on NEMA guidelines for the monitoring of wastewater treatment plants with discharges especially those above 1,000 m^3/day. It is further proposed that the flow rate be estimated from Parshall Flume measurements. This information should be compiled and stored in a database by the facility manager and compared with NEMA guidelines for compliance. Corrective action should be undertaken in the event of non-compliance. The recommended list of parameters and the point of sampling is summarized on the table below.

Table: List of Parameters to be monitored at the facility

Parameter	Guide value
PH	6.5 – 8.5
BOD	30 mg/l max
COD	50 mg/l max
Suspended solids	30 mg/l max
Ammonia	100 mg/l max
Total Dissolved solids	1200 mg/l max
E. Coli	Nil/100ml
Total coliform	1000/100 ml

The proponent should undertake daily assessment of the quantity of solid waste generated and keep records of its ultimate disposal. This is to ensure that the drying areas do not become overfilled.

- Person(s) appointed by the developer may perform this exercise.
- No additional cost is anticipated for this exercise.

8 ENVIRONMENTAL MANAGEMENT PLAN

8.1 Introduction

The Environmental Management Plan (EMP) involves risk management strategies that should be undertaken by the proponent and all the stakeholders to ensure environmental sustainability of the project. They are approaches to monitor, control, reclaim and restore the environment to an appropriate state. EMP for projects thus provide logical frameworks within which the identified issues of environmental concern can be mitigated or monitored.

Environmental monitoring involves measurement of relevant parameters, at a level of details accurate enough, to distinguish the anticipated changes. Monitoring aims at determining the effectiveness of actions to improve environmental quality. The environmental management and monitoring plans have been developed and outlined to highlight key findings of the Environmental Impact Assessment (EIA); recommending necessary mitigation actions, defining roles, indicators that can be monitored and the estimated cost.

The EMPs outlined in this report addresses the identified issues of concern (potential negative impacts) and mitigation measures as well as roles, costs and indicators that can be monitored and can help to determine the effectiveness of actions to enhance the quality of environment as regards the proposed project.

The contractor together with the proponent will incorporate mitigation measures highlighted in this chapter into the contract documents. The project supervisor will ensure the mitigation measures highlighted in this Chapter of the report are implemented. Once the project comes into operation, the health and safety issues as well as environmental considerations will be handed over to the relevant staff committee of the project as well as the technical staff. They should be trained to develop capacity to implement the project which can include issues on environmental considerations and issues affecting the project, implementation of Environmental Management Plan, project management, health and safety risks and their prevention.

Table 8.1: Environmental Management Plan

Environmental / Social issue/ aspect/ activity	Anticipated negative impact	Management and mitigation	Responsibility	Performance indicator	Estimated cost (KES)
Site preparation phase					
Establishment of site office:	Construction wastes generation.	• Landscape the area once construction is complete to incorporate as many trees as possible; • Develop a waste management plan and implement it.	Project Manager / Supervising Consultant.	Waste disposal records.	5,000 once
Earthworks, demolitions and excavations:	• Collection and stagnation of surface runoff; • Increase in susceptibility to soil erosion; • Production of spoil from excavated ground; • Reduction in aesthetic value of the area; • Risk of contamination to surface water; • Control dust and noise onsite • Provide workers with personal protective equipment	• Excavation should be carried out such that drainage is controlled, and water is not allowed to accumulate; • Establish controls for surface runoff during excavation; • Control excavation activities to limit excavation to land which is required for construction; • Cordoning the site off using iron sheets or other appropriate materials to protect passersby and control noise. • Control any likelihood of occurrence of risks	Project Manager / Supervising Consultant.	Performance of erosion control measures. Noise and dust generation General due diligence practised	15,000 once
Transportation of debris:	Fuel consumption and exhaust fumes; Increase in traffic flow in the area.	• Maintenance of equipment for efficiency, minimising noise production, emissions, spills and consumption; • Erect informative signs prior to commencing construction activities to warn residents; • Avoid transporting during periods of peak traffic activity.	Project Manager / Supervising Consultant and Contractor.	• Fuel consumption; • Frequency of equipment replacement and repair.	15,000 per month
Levelling and laying of foundation:	Noise and dust.	• Water sprinkling and use of screens to control dust;	Project Manager / Supervising	• Daily spot checks; • Regular servicing	• 2,000 when dusty

Environmental / Social issue/ aspect/ activity	Anticipated negative impact	Management and mitigation	Responsibility	Performance indicator	Estimated cost (KES)
		• Maintenance of equipment for efficiency, minimising noise production, emissions and spills; • Cordoning the site off.	Consultant and Contractor.	of equipment.	conditions set in • 10,000 for site isolation
Occupational health and safety:	Health hazard; Physical injury from slipping falling and handling equipment.	• Carefully plan for construction sanitary facilities • Provide personal protective equipment (PPE) appropriate to working area for staff and visitors to the site; • Regular site reporting on health, safety and environment (HSE) issues by an appointed HSE representative; • Develop a monitoring programme to assess noise performance in accordance with the revised Noise Prevention and Control Rules (April 2005); and NEMA Noise Control Regulations, 2009 • Assessment of HSE mitigation measures and recording of any matters arising as per Legal Notice No 40, The Factories (Building Operations and Works of Engineering Construction) Rules	Project Manager / Supervising Consultant.	• Regularly check on performance of provided sanitary facilities; • Have regular spot checks on use and adequacy of PPE provided • Conduct regular internal assessments on environmental site performance and record findings.	3,000 per month
Production of waste:	Soil degradation and surface water pollution.	• Develop a solid waste management plan prior to project commencing, identifying optimal waste re-use options and licensed disposal areas; • Waste should not be burned on site or dumped in undesignated	Project Manager / Supervising Consultant.	Report on all waste production and handling procedures.	10,000 once

Environmental / Social issue/ aspect/ activity	Anticipated negative impact	Management and mitigation	Responsibility	Performance indicator	Estimated cost (KES)
		waste disposal areas; • Minimise waste production by utilising best available techniques for site preparation; • Re-use construction waste to the maximum extent possible; • Excavation activities and dumping of spoil should be properly managed such that land which is not required for the project is left undisturbed.			
Construction phase					
Environmental / Social issue/ aspect/ activity	**Anticipated negative impact**	**Management and mitigation**	**Responsibility**	**Performance indicator**	**Cost estimate (KES)**
Vegetation Clearance	Loss of vegetation cover Soil erosion	• Areas with exposed soil should be replanted with grass as soon as possible after construction; to help mitigate against flash flood caused soil erosion. • Waste generated during the site clearance/construction phases of the project must be disposed of at an approved disposal site (Embu County dump site). • Suitable trees should be planted at the periphery of project site and near the River bank • No unnecessary removal of any vegetation shall be done	Contractor EWASCO	• Spot checks • Number of trees planted	35,000 for planting trees and other suitable vegetation
Loss of Water Quality and interference with	Pollution of nearby stream and sedimentation	• Runoff channels to be constructed to drain storm waters	Contractor WRMA EWASCO	• Spot checks • Water quality	20,000 quarterly

Environmental / Social issue/ aspect/ activity	Anticipated negative impact	Management and mitigation	Responsibility	Performance indicator	Estimated cost (KES)
riparian reserve		• Water quality tests at the river to be conducted quarterly • Maintain the riparian reserve of 10 meters • Replant the riparian zone with suitable trees		tests • Number of trees planted	
Air Quality	Excessive generation of dust and other particulate matter	• Site access roads should be dampened every 4-6 hours or within reasonable time to prevent a dust nuisance and on hotter days, this frequency should be increased. • The access roads (unpaved sections) through to the site should also be wetted and the sections of the road monitored so that any material falling on it as a result of the construction activities be removed. • Minimize cleared areas to those that are needed to be used. • Cover or wet construction materials such as soil for backfill to prevent a dust nuisance. • Where unavoidable, construction workers working in dusty areas should be provided and fitted with respirators	Contractor	• Workers with respirators, nose masks, ear plugs • Wetted roads	3,000 on demand
Storage of Raw Material and Equipment	Stored materials becoming air, water or soil borne	• Raw materials that generate dust should be covered or wetted frequently to prevent them from becoming air or waterborne.	Contractor EWASCO	• Impoundment walls constructed • Labeling of materials	30,000 once

Environmental / Social issue/ aspect/ activity	Anticipated negative impact	Management and mitigation	Responsibility	Performance indicator	Estimated cost (KES)
		• Raw material should be placed on hard stands surrounded by walls. • Equipment should be stored on impermeable hard stands surrounded by walls to contain any accidental surface runoff. • No storage of oils or fuels onsite			
Wastewater Generation and Disposal	• Pollution of ground water • Pollution of local stream	Provide portable sanitary conveniences for the construction workers for control of sewage waste. A ratio of approximately 25 workers per toilet should be used as a guide.	Contractor EWASCO Public Health	Sanitary facilities provided	35,000
Transportation of Raw Material and Equipment	Interference with traffic flow including pedestrians	• Adequate and appropriate road signs should be erected to warn road users of the construction activities. For example, reduced speed near the entrance roads. This should be done in conjunction with the Ministry of Transport • Raw materials such as sand, murram and cement should be adequately covered within the trucks to prevent any escaping into the air and along the route to the site. • The movement of equipment (trucks) during the construction of the system should be limited to the working hours, 8:00 am - 5:00 pm per day. • Equipment should be transported early morning (6	Contractor	Road signage erected	20,000

Environmental / Social issue/ aspect/ activity	Anticipated negative impact	Management and mitigation	Responsibility	Performance indicator	Estimated cost (KES)
		am – 7 am) with proper care being taken. • The use of flagmen should be employed to regulate when trucks have access to the main roads.			
Traffic Obstruction	Obstruction caused by laying of sewer lines to persons and vehicles	• The laying of sewer pipes across any access road should be done when traffic volumes are lowest, for example, early morning or on weekends (specifically on Saturdays and Sunday). • Adequate notices should be placed along the route. • Adequate signs and flagmen should be put in place.	Contractor	• Signage posted • Flagmen posted appropriately along the route	No extra cost
Emergency Response plans	Occurrence 0f accidental injuries	• A lead person should be identified and appointed to be responsible for emergencies occurring on the site. This person should be clearly identified to the construction workers. • Make prior arrangements with health care facilities such as a Health Centre in proximity, a private doctor or the Provincial Hospital to accommodate any eventualities. • Material Safety Data Sheets (MSDS) should be store onsite.	Contractor	• Availability of MSDS on site • Lead person to oversee health and safety issues appointed	30,000
Drainage management	Soil, surface and ground water pollution, work area health and safety	• Proper construction site drainage management i.e.: Control erosion • Avoid ponding water;	Construction supervisor. Contractor.	Daily auditing and spot checks	No additional cost

Environmental / Social issue/ aspect/ activity	Anticipated negative impact	Management and mitigation	Responsibility	Performance indicator	Estimated cost (KES)
		• Proper waste and material handling, and storage to avoid flushing of wastes in to the neighbouring stream • Follow designs made for the system			
Waste management	Pollution, infestation by vermins, work area health and safety	• Waste bins should be strategically placed within the construction site. • The waste bins at the construction site should be adequately designed and covered to prevent access by vermin and minimize odour. • The bins at the construction site should be adequately covered to prevent a dust nuisance. • The bins at the construction site should be emptied regularly to prevent overfilling. • Disposal of the contents of the bins should be done at an approved disposal site. The Embu Town dump site is recommended. Appropriate permission should be sought (from the NEMA) as appropriate. • Controlled use of materials on site; • Waste minimization at the source • Safe waste storage and handling on site	Construction supervisor. Contractor.	Daily auditing and spot checks	20,000

Environmental / Social issue/ aspect/ activity	Anticipated negative impact	Management and mitigation	Responsibility	Performance indicator	Estimated cost (KES)
		• Monitoring and reporting • Erect warning signs against poor waste disposal • Sensitization of workers on waste disposal methods • Encourage and practice reuse and recycling			
Soil erosion	Soil loss and sedimentation of the local stream	• Minimize vegetation disturbance; • Reinstate site immediately after construction • Put bunds to prevent soil and any material from getting to the local stream	Construction supervisor. Contractor.	• Daily spot checks • Workers wearing protective gear • Monitoring of the stream nearby	25,000
Noise / vibration	Nuisance in the project area	• Use equipment that has low noise emissions as stated by the manufacturers. • Use equipment that is properly fitted with noise reduction devices such as mufflers. • Operate noise-generating equipment during regular working hours (e.g. 8 am – 6 pm) so as to reduce the potential of creating a noise nuisance during the night. • Construction workers operating equipment that generates noise should be equipped with noise protection. A guide is a worker operating equipment generating noise of ≥ 80 dBA (decibels) continuously for 8 hours or more should use ear muffs. Workers experiencing	Construction supervisor. Contractor. EWASCO	Daily spot checks	20,000

Environmental / Social issue/ aspect/ activity	Anticipated negative impact	Management and mitigation	Responsibility	Performance indicator	Estimated cost (KES)
		prolonged noise levels 70 - 80 dBA should wear earplugs. • The working hours shall be regulated i.e. from 8 AM to 6PM • Workers shall wear earplugs during construction phase • Implement noise minimization measures; • Site screening; • Manage vibration, where it occurs • Monitoring, reporting and community liaison			
Earthworks excavation	Wastes arising, safety, noise, vibration, surface contamination,	• Noise, dust, vibration minimization measures should be put into place • Minimize excavation and materials for disposal • Exclude water from excavation; • Properly support excavated areas as appropriate • Manage any contaminated materials found • Minimize risk of contaminating surface water • Safe material storage and disposal at appropriate sites.	Construction supervisor. Contractor.	Daily auditing	10,000
Materials for construction	Destruction caused by mines and quarries, wastage.	• Document and report on all material sources • Control wastage of block, brick and stone work et al; • Utilize damaged materials elsewhere.	Construction supervisor. Contractor.	Monthly reporting	No additional cost

Environmental / Social issue/ aspect/ activity	Anticipated negative impact	Management and mitigation	Responsibility	Performance indicator	Estimated cost (KES)
Concrete works	Dust, noise, materials, oil contamination.	• Controlled batching; • Control dust and noise • Use re-usable shuttering;	Construction supervisor. Contractor.	Daily, spot checks	No extra cost
Fire safety and general accidents	Working conditions, fire related incidents and accidents, pollution.	• Compliance with OHS laws and health and safety committee rules; • Provision of PPE (personal protective equipment) • Secure / screen hazardous areas; • Provision of fire suppression equipment; • "No smoking" signage Prominently displayed; • Provision of First Aid box facilities; • Training in fire response/ First Aid; • No burning of waste or material on site • Fencing the site with strong wire mesh material	Construction supervisor. Contractor. community	• Regular fire audit • Strict site supervision • A register of incidents and accidents should be kept	30,000

Operation phase					
Environmental / Social issue/ aspect/ activity	**Anticipated negative impact**	**Management and mitigation measures**	**Responsibility**	**Performance indicator**	**Cost estimate (KES)**
Solid Waste Generation and Disposal	Increase in solid waste on site	• Provide sludge drying beds in the project • Provision of adequately designed bins to prevent access by vermin. • Monitor skips so that they do not become overfilled. • Ensure that the solid waste collected is disposed of in an approved dumpsite	• Waste bins onsite • Disposal of grit/sludge in licensed dump sites	EWASCO WRMA NEMA	30,000
Transportation/ Traffic	Increase in traffic along the access road	• Limit septage delivery to the site between the hours of 8 am and 5 pm. This will limit the noise nuisance to residents and possibly reduce the population exposed to potential accidents, as most persons would have already left their homes to go to work or and schools. • Add adequate and appropriate signs including speed limits along the road in proximity to the access roads.	• Regulated transport hours and times • Noise levels generated enroute by vehicles minimization • Signs posted enroute	EWASCO	No extra cost
Septage Disposal	Poor depositing of septage by cess pool emptier	• Institute and maintain a ticketing system for cesspool emptiers, where upon successful disposal, the WWTP operator would issue a receipt to the cesspool emptier. • County Government and particularly NEMA, should put in place a system to monitor cesspool service providers and	Tickets issued by the EWASCO	EWASCO Cess pool operators NEMA	No extra cost

		in addition, have a public educational campaign to educate and inform the public about the system. • Ensure that septage is only accepted at the site by authorization			
Emergency Response	Accidents occurrence and sicknesses	• Install safety valves on gas conveyance system • Reduce distances for conveying gas to neighbours • Make prior arrangements with health care facilities such as a Health Centre in proximity. • Design and implement an emergency response plan. • Coordinate with first aid organisations/agencies i.e. St. John's Ambulance, Red Cross to prepare for any eventuality. • Display telephone numbers of emergency response departments for all people accessing the site to clearly see	• Sickness and Accident records • Safety valves on gas conveyance system installed	EWASCO	10,000
Wastewater Disposal/Water Pollution	Pollution of local stream	Follow the NEMA waste water quality guidelines strictly	Periodic Water quality tests	EWASCO WRMA	40,000
Foul Odours	Generation of foul smell at the site	• Monitor and ensure that influent sulphate levels are below 240 mg/l. • Ensure that the pond series have adequate water flow to reduce the potential of odour formation.	• Periodic tests • Presence of foul smells	EWASCO NEMA	6, 000 per test
Future environmental protection	Any impact arising	• Environmental monitoring procedures • Involve all stakeholders and let them play their roles in	Documented procedures	EWASCO	80,000

		monitoring activities			
Project maintenance / impacts on the local stream and the neighbourhood	• Leakage • Visual impacts; • Health and safety; • Water quality	• Timely maintenance of sewer conveyance, distribution system; • Maintenance of access routes; • Manage solid wastes and dispose appropriately; • Monitor water quality, both in the river and in the conveyance system	• Monthly reporting • Once a year water quality tests in an approved lab	EWASCO	6,000 per test
Decommissioning phase					
Environmental / Social issue/ aspect/ activity	**Anticipated negative impact**	**Management and mitigation measures**	**Responsibility**	**Performance indicator**	**Cost estimate (KES)**
Structures, wastes and demolition machinery	Generation of scrap material and other waste debris on site	• All buildings, machinery, equipment, structures, tools that cannot be reused or recycled shall be removed from site • Where reuse is not possible, materials should be taken into approved dumping sites	Project contractor, proponent and site manager	Amount of generated waste and stockpiles	200,000
Rehabilitation of project site	Clearing of vegetation, soil erosion	• Fencing and warnings posted at the site restricting access • Do re-vegetation of the site to restore the site to its original status • During demolition, appropriate surface run-off controls will be undertaken to minimize erosion rates • Constant monitoring and inspection of the demolition works to prevent accidents	Contractor EWASCO	Number of trees planted Biomass volume present	380,000

Socio-economic and health impact	Increased disease incidents levels, lowering of quality of life	• Provide alternatives to connected plots/premises • Offer advice on alternative income generating ventures to workers • Redeploy workers. • Consider redeveloping the project • Prepare proposals to donors for a new sewer project	Project proponent	once	150,000

8.2 Decommissioning phase

Decommissioning is an important phase in the project cycle and comes as the last to wind up the operations/activities of a project. The main purpose of decommissioning is to restore/rehabilitate the project site to acceptable standards. Rehabilitation is to occur after the close down of the project and when its no longer economically viable to continue operating it. It will entail reestablishment of topographical elements once the ponds are no longer in use. The site could be developed into a forested spot or redevelopment of the project.

The lifespan of the system is dependent on the ability of the EWASCO to maintain them. In this particular case, the proponent will design a desludging schedule which if followed will enhance the lifespan of the project which is estimated at over 30 years. This gives the company the option of continuing to use the system and therefore they take the responsibility of decommissioning when the time comes normally after viability of the project comes into question or when other circumstances may prevail warranting decommissioning. It is therefore recommended that a closing Environmental Audit be conducted when the time for decommissioning comes so that all aspects will be looked at against the prevailing conditions and requirements. However, the purpose of decommissioning is mainly to rehabilitate the project site to an acceptable standard and all efforts should be geared towards making the site as close as possible to its original state before the project was implemented. The decommissioning will in brief involve replanting the area with suitable trees and vegetation, demolition of the structures, removal of debris and landscaping. The other social implications will involve the laying off workers who may have been employed. They will lose their income, as well as issues of health and safety et al. In the reality of this case, decommissioning on part of the proponent will be to landscape the area and put it to any other appropriate use. As such, the effects of the decommissioning will be minimal affecting mainly the area community which will lack effective sewer services. It will also affect water quality in local stream.

9 CONCLUSION AND RECCOMENDATIONS

This Project Report has been prepared to provide sufficient and relevant information on the proposed waste water treatment system to enable NEMA to establish whether the activities of the project are likely to have significant adverse environmental impacts.

Mitigation measures have been proposed for identified impacts in this Report and an Environmental Management Plan (EMP) for the implementation of the proposed measures has been presented. The EMP presented in this Report is a tool to be used by the Project Implementation Team and Proponent during the construction, hand-over and operation periods.

To ensure implementation, mitigation measures should be reflected in the Conditions of Contract. It is the responsibility of the Project Manager to ensure these measures are incorporated into this document.

Overall, it is recommended that this Project can be approved pursuant to implementation of the proposed mitigation measures and as per NEMA discretion.

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