4. Minutes of Discussions
The Preparatory Survey (18/3/2014)

MINUTES OF DISCUSSIONS
ON THE PREPARATORY SURVEY (OUTLINE DESIGN STUDY) ON DUALLING OF NAIROBI-DAGORETI CORNER ROAD C60/C61 (PHASE-2) IN THE REPUBLIC OF KENYA

In response to a request from the Government of the Republic of Kenya (hereinafter referred to as "Government of Kenya"), the Government of Japan decided to conduct a Preparatory Survey for Outline Design (hereinafter referred to as "the Survey") on the Dualling of Nairobi-Dagoreti Corner Road C60/C61 Project (PHASE-2) (hereinafter referred to as "the Project"), and entrusted the Survey to Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent a Preparatory Survey Team for Outline Design (hereinafter referred to as "the Team") to Kenya. The Team is headed by Mr. Yoshihiro Kakishita, Senior Advisor, Economic Infrastructure Department, JICA and is scheduled to stay in the country from 2nd March to 11th April 2014.

The Team held a series of discussions with the officials of the Government of Kenya and conducted a field survey at the Project area. In the course of the discussions, both sides have confirmed the main items described in the attached sheets. The Team will proceed with further Survey works and prepare the Preparatory Survey Report.

Nairobi, 18th March 2014

Leader
Yoshihiro Kakishita
Preparatory Survey Team
Japan International Cooperation Agency

Eng. John K. Mosonik, EBS
Principal Secretary, Infrastructure
Ministry of Transport and Infrastructure
Republic of Kenya

Eng. Joseph N. Nkadayo, MBS
Director General
Kenya Urban Roads Authority
Republic of Kenya

ATTACHMENT

1. Objective of the Project

The objective of the Project is to improve urban mobility and traffic safety in Nairobi by dualling the Nairobi-Dagoreti Corner Road (Ngong Road) and providing traffic safety facilities, thereby contributing to economic and social development of Kenya.

2. Project Site

The Project site is in Nairobi as shown in Annex-1.

3. Responsible and Implementing Organizations

The responsible agency of the Project is the Ministry of Transport and Infrastructure (hereinafter referred to as "MoTI"). The implementing agency of the Project is the Kenya Urban Roads Authority, (hereinafter referred to as "KURA"). The organization chart is shown in Annex 2.

4. Items requested by the Government of Kenya

4-1. The requested items in the application form as of August 2012 were as follows.

(1) Construction of BRT/MRT system along Ngong Road Corridor (Road NoC60)

(2) Rehabilitation and dual section of existing Naivasha road (C61) from Dagoretti Corner to Waiyaki Way (4.0km)

(3) Construction of interchanges at the junction between Ngong Road and Mbagathi Way and at junction between Ngong Road and Naivasha Road.

(4) Construction of traffic safety facilities at major intersections

(5) Construction of storm water drainage system to outfalls along Ngong Road, Naivasha Road and adjoining roads along Ngong Road

4-2. As a result of discussions, it was confirmed that as a main component of the Project the Survey will focus on the rehabilitation and expansion of Ngong road for the section between the end of Phase 1 to the Dagoretti Corner with road ancillary facilities.

The outline design covers the following:

(1) Improvement of the existing road from single carriageway with 2 lanes to dual carriageway with 4-lanes and with Non-Motorized Transport lanes (Total Length: 3.8km)

(2) Improvement of the Dagoretti Corner intersection, through the study of alternatives including the grade separation.

(3) Development of road ancillary facilities such as traffic signals with considerations given to applicability of Intelligent Transportation System (ITS) technology

JICA will assess the appropriateness of the project component(s) recommended by the Survey and will report the findings to the Government of Japan. Implementation of the Project will be decided by the Government of Japan.

4-3. The Kenyan side agreed that the median width of the Ngong road to be widened under the Project should be 3.0m so as to allow enough space for the structures to be constructed under the LRT project, as which was concurred for the Phase-1 project by the Ministry of Transport and the Ministry of Roads on 15th February 2013.

5. Japan's Grant Aid Scheme

5-1. The Kenyan side understands the Japan's Grant Aid Scheme and the necessary measures to be taken by the Government of Kenya as explained by the Team and described in Annex 3 and 4.

5-2. The Kenyan side will take the necessary measures, as described in Annex-5, for smooth implementation of the Project.

6. Schedule of the Survey

6-1. The Team will proceed with further studies in Kenya until the mid April 2014.

6-2. JICA will prepare a draft final report in English and dispatch a mission to Kenya in order to explain its contents around October 2014.

6-3. When the contents of the report are accepted in principle by the Government of Kenya, JICA will complete the final report in English and send it to the Government of Kenya around November 2014.

7. Environmental and Social Considerations

7-1. The Team explained that all JICA financed project shall comply with JICA Guidelines for Environmental and Social Considerations (April 2010) (the "JICA Guidelines"). The Project is tentatively categorized as Category B because the project is not considered as a large-scale road and bridge sector project, is not located in a sensitive area, and has none of the sensitive characteristics under the Guidelines, it is not likely to have significant adverse impact on the environment.

7-2. The Team explained that JICA conducts an environmental review in accordance with the project category and refers to the environmental checklist for the road sector as attached in the Guidelines.

7-3. Both sides agreed that an environmental and social considerations survey will be confirmed of the validity in accordance with the JICA Guidelines as well as Kenyan Guidelines for environmental and social consideration. Also draft Abbreviated Resettlement Action Plan (hereinafter referred to as "ARAP") will be prepared in accordance with the JICA Guidelines and the Kenyan laws.

7-4. The Kenyan side shall bear the expenses of EIA procedures except the draft EIA report and the draft ARAP prepared by the consultant members of the Team.

7-5. The Kenyan side shall secure the necessary land for the Project in accordance with the Kenyan law. The expenses of the procedures and compensation to the Project Affected Persons (PAPs) shall be borne by the Kenyan side. The Kenyan side shall hold meetings and/or negotiate with land owners and confirm the consensus on the expropriation and/or temporally use of land necessary for the Project by the end of Survey (October 2014). The Kenyan side shall report the results to JICA Kenya office.

7-6.The consultant members of the Team shall provide the Kenyan side with necessary information of Outline Design to smoothly carry out the abovementioned procedures.

8. Other Relevant Issues

8-1. The following undertakings should be taken by the Kenyan side at their expenses before the commencement of the Project. The Kenyan side agreed to secure a necessary resource to conduct these undertakings in a timely manner including request the budget for next fiscal year and to share with the Team by next mission a tentative schedule with work breakdown for each of the following items.

(1) Acquisition of necessary land for the Project
(2) Relocation of existing utilities (power, telecommunication lines, water lines, etc.)
(3) Removal of existing road structures and bridges if applicable
(4) Securing and clearance of temporary yard and land for detour, and
(5) Securing of the site for borrow pit and disposal area

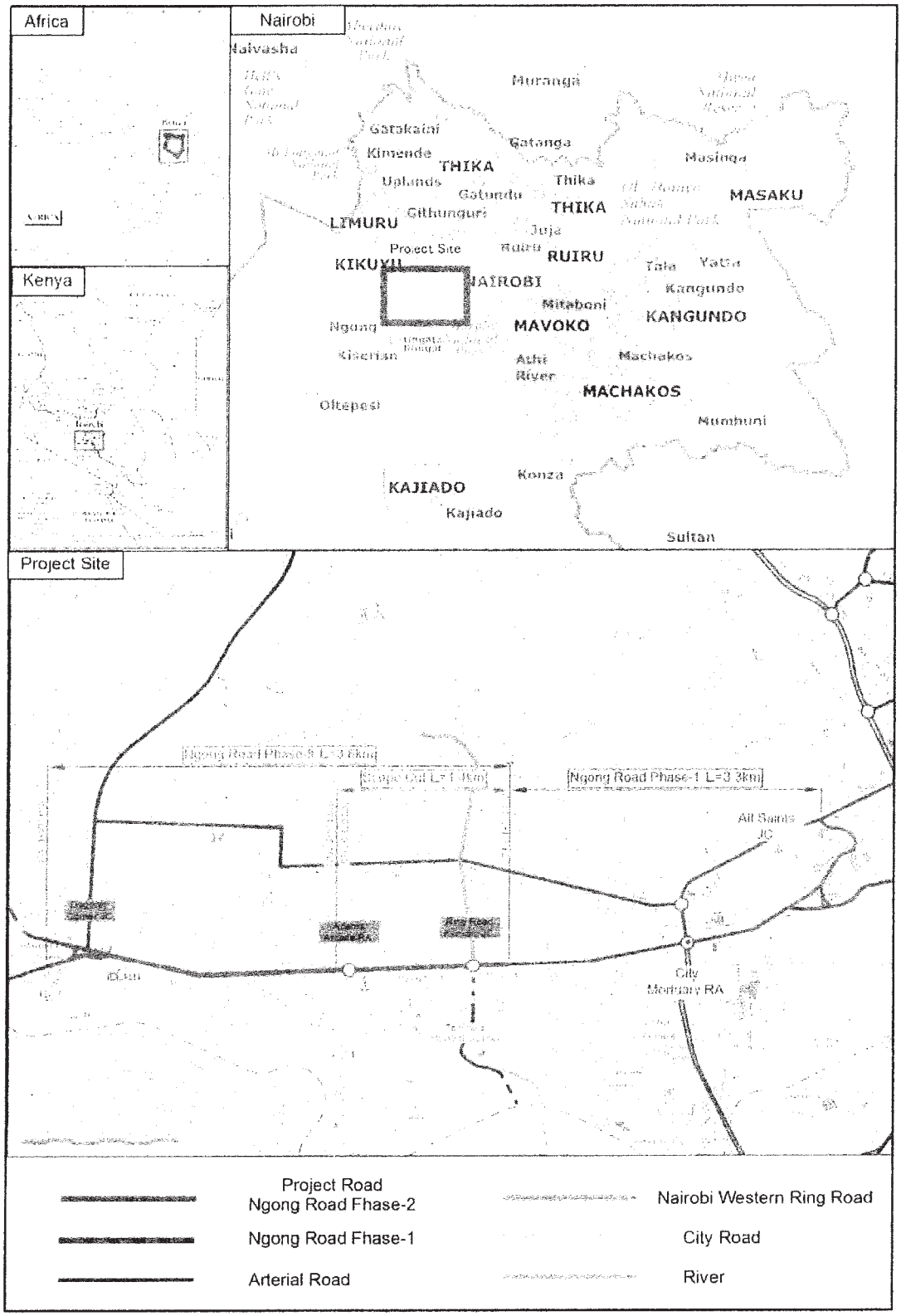
8-2. The Kenyan side shall secure enough budget and personnel necessary for maintenance of the road sections rehabilitated/widened by the Project.

8-3. The Kenyan side ensured that there is no overlap of similar support by other development partners for the Project.

8-4. The Kenyan side shall provide necessary counterpart personnel to the Team during the period of Survey in Kenya.

8-5. The Team conveyed concern on the prolonged delay of utility relocation and land acquisition in the Phase-1 project. The Kenyan side undertook to complete these undertakings by the end of May 2014, with the understanding that the Phase-1 project is unlikely to be completed within the available period of the Grant Aid whose closure date is 28th February 2016, as stipulated in the Exchange of Notes of the Phase-1 project signed between the Government of Japan and the Government of the Republic of Kenya on 2nd June 2012. The Kenyan side understands that any further delay may affect the acceptance of Phase-2 project.

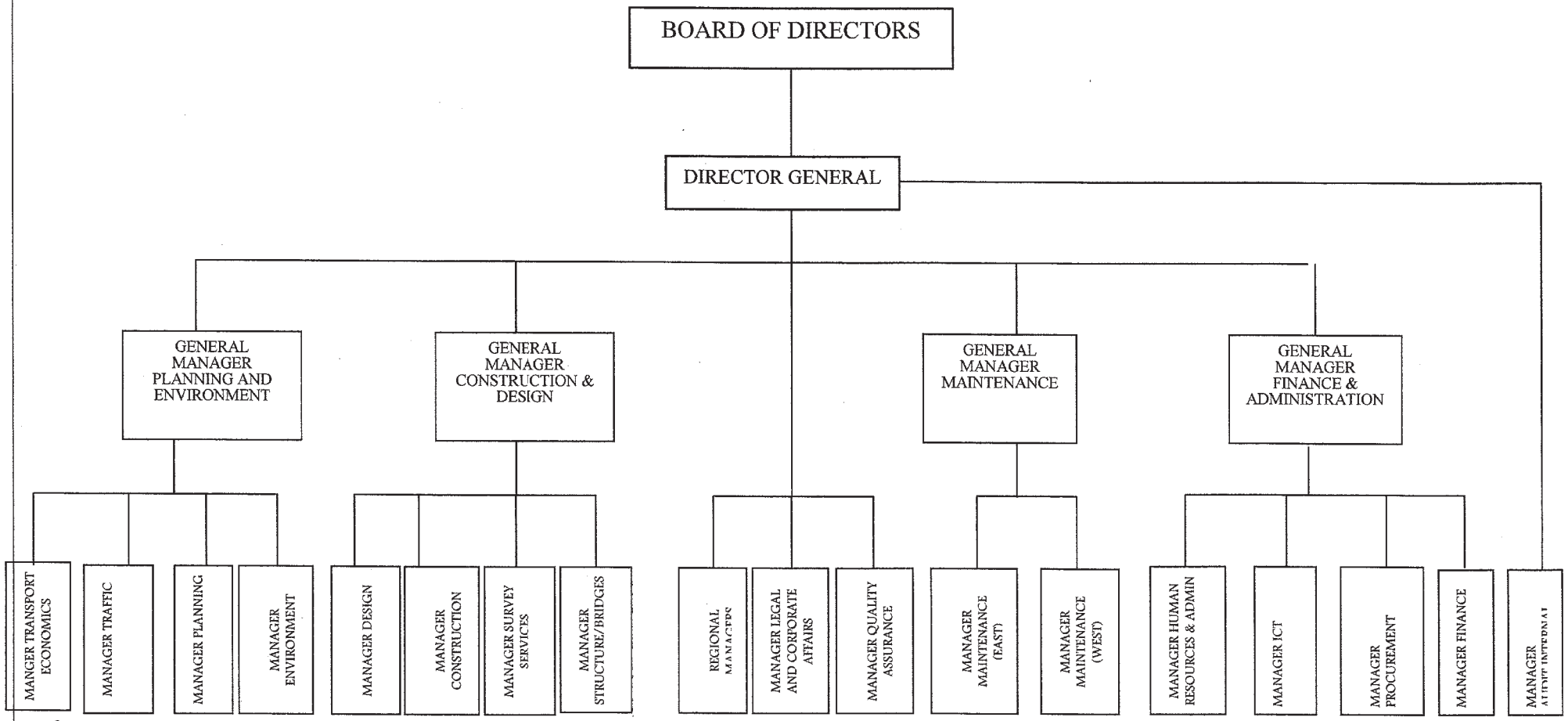
Annex-1	Project Site
Annex-2	Organization Chart
Annex-3	Japan's Grant Aid
Annex-4	Flow Chart of Japan's Grant Aid Procedures
Annex-5	Major Undertakings to be taken by Each Government



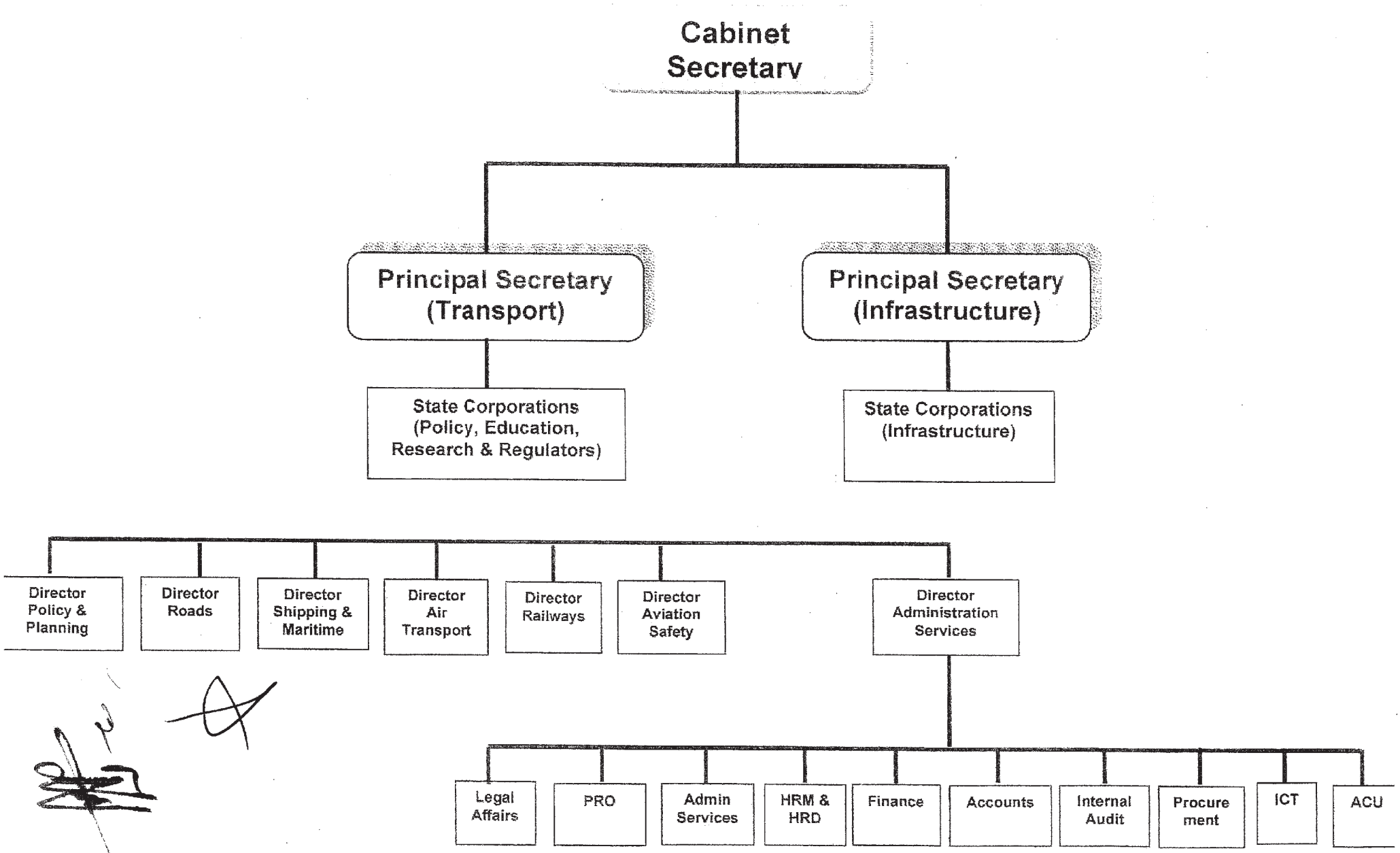
Location Map

Annex-2

ORGANISATION STRUCTURE FOR KENYA URBAN ROADS AUTHORITY



MINISTRY OF TRANSPORT & INFRASTRUCTURE



JAPAN'S GRANT AID

The Government of Japan (hereinafter referred to as "the GOJ") is implementing the organizational reforms to improve the quality of ODA operations, and as a part of this realignment, a new JICA law was entered into effect on October 1, 2008. Based on this law and the decision of the GOJ, JICA has become the executing agency of the Grant Aid for General Projects, for Fisheries and for Cultural Cooperation, etc.

The Grant Aid is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures

The Japanese Grant Aid is supplied through following procedures :

- Preparatory Survey
  - The Survey conducted by JICA
- Appraisal &Approval
  - Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet
- Authority for Determining Implementation
  - The Notes exchanged between the GOJ and a recipient country
- Grant Agreement (hereinafter referred to as "the G/A")
  - Agreement concluded between JICA and a recipient country
- Implementation
  - Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the preparatory Survey is to provide a basic document necessary for the appraisal of the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the recipient country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of an outline design of the Project.
- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Outline Design of the Project is confirmed based on the guidelines of the Japan's Grant Aid scheme.
JICA requests the Government of the recipient country to take whatever measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA employs (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the Report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the appropriateness of the Project.

3. Japan's Grant Aid Scheme

(1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes(hereinafter referred to as "the E/N") will be singed between the GOJ and the Government of the recipient country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the recipient country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country

Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When JICA and the Government of the recipient country or its designated authority deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals".

(4) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Annex-5.

(6) "Proper Use"

The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant Aid, to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant Aid.

(7) "Export and Re-export"

The products purchased under the Grant Aid should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). JICA will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

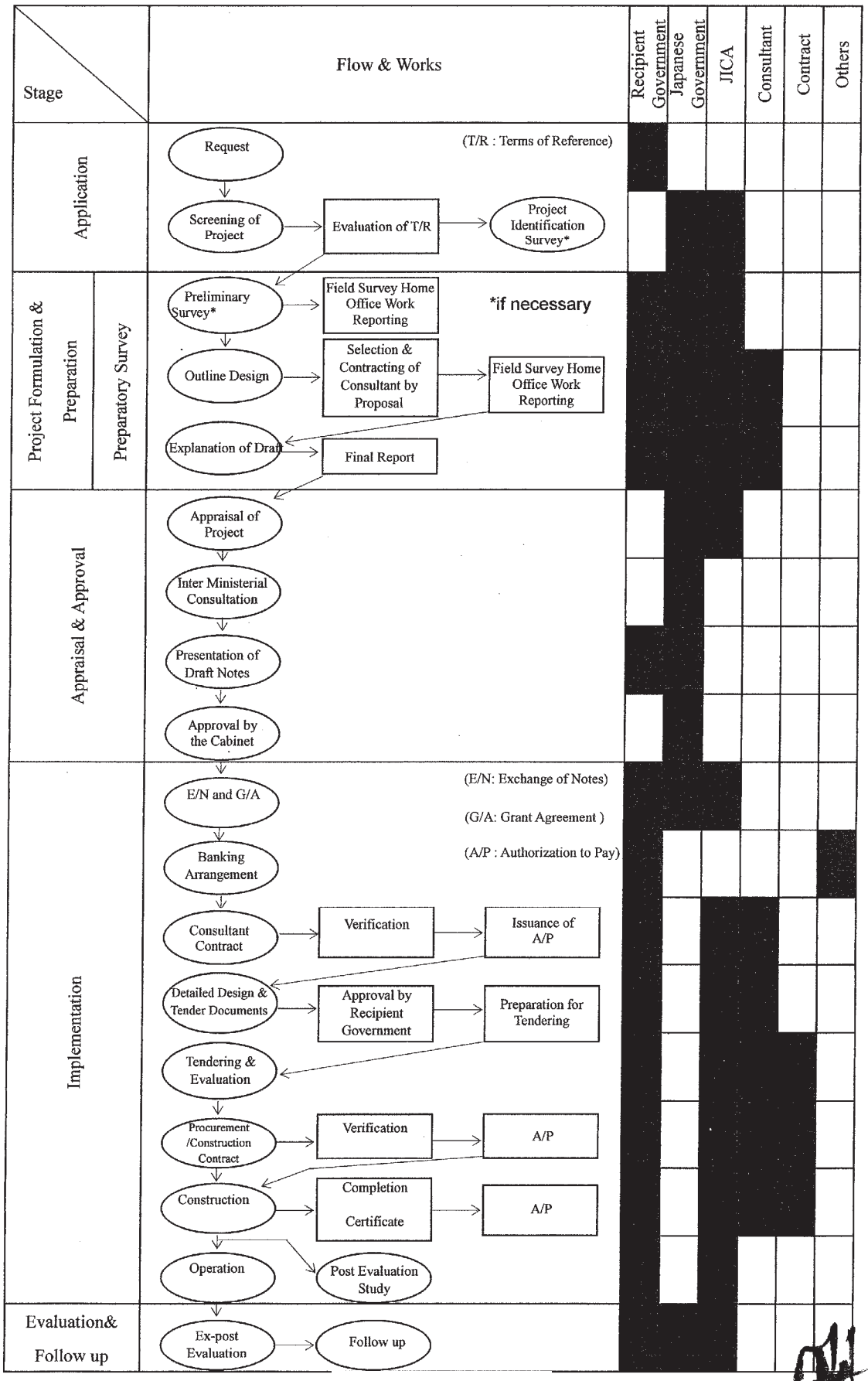
The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions paid to the Bank.

(10) Social and Environmental Considerations

A recipient country must carefully consider social and environmental impacts by the Project and must comply with the environmental regulations of the recipient country and JICA guidelines for environmental and social considerations.

Annex-4

FLOW CHART OF JAPAN's GRANT AID PROCEDURES



Annex-5

Major Tasks to be Undertaken by Each Government

No.	Items	To be covered by Grant Aid	To be covered by the Recipient Side
1	To secure land		●
2	To clear, level and reclaim the site when needed		●
3	To construct gates and fences in and around the site		●
4	To bear the following commissions to the Japanese bank for banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
5	To ensure unloading and customs clearance at port of disembarkation in recipient country		
	1) Marine/Air/Land transportation of the products from Japan to the recipient country	●	
	2) Tax exemption and customs clearance of the products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	(●)	(●)
6	To accord Japanese nationals, whose service may be required in connection with the supply of the products and the services under the Verified Contract, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
7	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the Verified Contracts		●
8	To maintain and use properly and effectively the facilities contracted and equipment provided under the Grant Aid		●
9	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for construction of the facilities as well as for the transportation and installation of the equipment		●

(B/A : Banking Arrangement, A/P : Authorization to Pay)

4. Minutes of Discussions
Explanation of Preparatory Survey Final Draft Report (10/3/2017)

MINUTES OF DISCUSSIONS
ON
THE PREPARATORY SURVEY FOR THE PROJECT
FOR
DUALLING OF NAIROBI-DAGORETTI CORNER ROAD
C60/C61 PROJECT (PHASE-2)
IN THE REPUBLIC OF KENYA

(EXPLANATION OF PREPARATORY SURVEY FINAL DRAFT REPORT)

With reference to the minutes of discussions signed between the Ministry of Transport, Infrastructure Housing and Urban Development, Kenya Urban Roads Authority (hereinafter referred to as "KURA and Japan International Cooperation Agency (hereinafter referred to as "JICA") on 18 March 2014 and in response to the request from the Government of the Republic of Kenya (hereinafter referred to as "GOK") in August 2012, JICA dispatched a preparatory Survey Team (hereinafter referred to as "the Team") for the explanation of Draft Preparatory Survey Report (hereinafter referred to as "the Draft Report") for Dualling of Nairobi-Dagoretti Corner Road C60/C61 Project Phase 2 (hereinafter referred to as "the Project"), headed by Mr. Jitsuya Ishiguro, Acting Director, Team 1, Transportation and ICT Group, Infrastructure and Peacebuilding Department, JICA from 6-10 March 2017.

As a result of the discussions, both sides agreed on the main items described in the attached sheets.

Nairobi, 10th March 2017

Jitsuya Ishiguro	Eng. Silas Murira Kinoti
Leader	Director General
Preparatory Survey Team	Kenya Urban Roads Authority
Japan International Cooperation Agency	Republic of Kenya

ATTACHMENT

1. Responsible authority for the Project
   Both sides confirmed that KURA will be the executing agency for the Project (hereinafter referred to as "the Executing Agency"). The Executing Agency shall coordinate with all the relevant authorities to ensure smooth implementation of the Project and ensure that the undertakings for the Project shall be taken care by relevant authorities properly and on time.
   The line ministry of the Executing Agency is the Ministry of Transport, Infrastructure, Housing and Urban Development responsible for supervising the Executing Agency on behalf of the Government of Kenya.

2. Contents of the Draft Report
   After the explanation of the contents of the Draft Report by the Team, the Kenyan side agreed to its contents.

3. Cost estimate
   Both sides confirmed that the cost estimate described in Annex 1 is provisional and will be examined further by the Government of Japan for its approval. The contingency would cover the additional cost against natural disaster, unexpected natural conditions, etc.

4. Confidentiality of the cost estimate and technical specifications
   Both sides confirmed that the cost estimate and technical specifications in the Draft Report should never be duplicated or disclosed to any third parties until all the contracts under the Project are concluded.

5. Timeline for the project implementation
   The Team explained to the Kenyan side that the expected timeline for the project implementation is as attached in Annex 2.

6. Expected outcomes and indicators
   Both sides agreed that key indicators for expected outcomes are as follows. The Kenyan side will be responsible for monitoring agreed key indicators targeted in year and shall monitor the progress based on those indicators.

   [Quantitative Effect]

Indicators	Base year 2016	Target year 2022 (3 years after project completion)
Annual Average Daily Traffic Volume (unit/lane/day)	14,100	18,600
Travel time (minutes) Kilimani jct.– Dagoreti Corner jct. Peak Time	40	6.4

   [Qualitative Effect]

- Improved safety for pedestrians and cyclists realized through non-motorised

transport lanes

- Improved traffic situation through ITS traffic signals

7. Undertakings of the Project
   Both sides confirmed the undertakings of the Project as described in Annex 3. With regard to exemption of customs duties, internal taxes and other fiscal levies as stipulated in 1. (1) of Annex 3, both sides confirmed that such customs duties, internal taxes and other fiscal levies include VAT, commercial tax, income tax and corporate tax, which shall be clarified in the bid documents by the Executing Agency during the implementation stage of the Project.
   The Kenyan side assured to take the necessary measures and coordination including allocation of the necessary budget which are requirement for implementation of the Project without delay. It is further agreed that the costs are indicative, i.e. at Outline Design level. More accurate costs will be calculated at the Detailed Design stage.
   Both sides also confirmed that the Annex 3 will be used as an attachment to G/A.

8. Monitoring during the implementation
   The Project will be monitored by the Executing Agency and reported to JICA by using the form of Project Monitoring Report (PMR) attached as Annex 4. The timing of submission of the PMR is described in Annex 3.

9. Project completion
   Both sides confirmed that the project completes when all the facilities constructed and equipment procured by the grant are in operation. The completion of the Project will be reported to JICA promptly, but in any event not later than six months after completion of the Project.

10. Ex-Post Evaluation
    JICA will conduct ex-post evaluation after three (3) years from the project completion, in principle, with respect to five evaluation criteria (Relevance, Effectiveness, Efficiency, Impact, Sustainability). The result of the evaluation will be publicized. The Kenyan side is required to provide necessary support for the data collection.

11. Items and measures to be considered for the smooth implementation of the Project
    Both sides confirmed the items and measures to be considered for the smooth implementation of the Project as follows:
    - Resettlement of Project Affected Persons before tender notice as per (1) of Annex 3
    - Tax exemption described in (2) 5 of Annex 3 is approved by The National Treasury before tender notices
    - Construction safety secured with reference to the "Guidance for the Management of Safety for Construction Works in Japanese ODA Projects"

12. Schedule of the Study

JICA will finalize the Preparatory Survey Report based on the confirmed items. The report will be sent to the Kenyan side around May 2017.

13. Environmental and Social Considerations

13-1 General Issues

13-1-1 Environmental Guidelines and Environmental Category

The Team explained that 'JICA Guidelines for Environmental and Social Considerations (April 2010)' (hereinafter referred to as "the Guidelines") is applicable for the Project. The Project is categorized as B because the project is not considered as a large-scale road and bridge project, is not located in a sensitive area, and has none of the sensitive characteristics under the Guidelines, it is not likely to have significant adverse impact on the environment.

13-1-2 Environmental Checklist

The environmental and social considerations including major impacts and mitigation measures for the Project are summarized in the Environmental Checklist attached as Annex 5. Both sides confirmed that in case of major modification of the content of the Environmental Checklist, the Kenyan side shall submit the modified version to JICA in a timely manner.

13-2 Environmental Issues

13-2-1 Environmental Impact Assessment (EIA)

Both sides confirmed that the EIA report was approved by the National Environmental Management Authority (NEMA) in March 2013 and the Supplementary EIA is to be approved in April 2017.

13-2-2 Environmental Management Plan

Both sides confirmed the Environmental Management Plan (EMP) of the Project is as Annex 6. Both side agreed that environmental mitigation measures shall be conducted based on the EMP, which may be updated during the detailed design stage.

13-3 Social Issues

13-3-1 Land Acquisition and Resettlement

Both sides confirmed that the Project will not involve any land acquisition because widening of the road will be done within existing RoW of KURA.

Both sides also confirmed that relocation and compensation for 351 business owners and 120 workers as Project Affected Persons (PAPs) are necessary due to loss of assets and/or incomes, as follows. In addition, 1,809 trees will be cut for the Project and utilities over RoW will be relocated..

Such relocation and compensation shall be implemented based on the Resettlement Action Plan (RAP) prepared and authorized by KURA in [Month/Year]. KURA will secure budget for the cost of RAP implementation..

		owners and entities	employees
1	Tree Nursery Operators	22	42
2	Kiosks	4	-
3	Petty traders	169	78
4	Mobile benders	156	-
	total	351	120

		structures/places	
5	Billboards	19	-
6	Parking Area (Private company)	12	-
7	Water and Sewage service venders (Water Truck)	74	135

13-3-2 Indigenous People

Both sides confirmed that there is no indigenous people to be affected by the Project.

13-4 Environmental and Social Monitoring

13-4-1 Environmental Monitoring

Both sides confirmed environmental monitoring will be conducted by KURA in accordance with Environmental Monitoring Plan as per Annex 7.

Both sides agreed that the Kenyan side will submit results of environmental monitoring to JICA with Project Monitoring Report (PMR) by using the monitoring form attached as Annex 7. The timing of submission of the monitoring form is described in Annex 5.

13-4-2 Social Monitoring

The Kenyan side and the Team confirmed that monitoring of relocation and compensation proposed in the RAP will be conducted by KURA. The Kenyan side agreed that progress of relocation and compensation will be monitored until livelihood restoration is confirmed after completion of relocation and compensation.

The Kenyan side and the Team agreed that KURA will submit results of social monitoring to JICA with PMR by using the monitoring form attached as Annex 8.

In case there is a remaining issue that needs to be addressed (e.g. insufficient restoration of livelihood of displaced Project Affected Persons (PAPs)), JICA may request to extend the period of monitoring and reporting until JICA confirms the issues have been properly addressed and solved in accordance with the agreement between [Name of EA] and JICA.

13-4-3 Information Disclosure of Monitoring Results

Both sides confirmed that the Kenyan side will take stipulated procedures for information disclosure in accordance with relevant laws and regulations of Kenya. In addition, the Team requested and the Kenyan side agreed to disclose results of environmental and social monitoring to local stakeholders through their website or in their field offices.

The Kenyan side agreed that JICA will disclose results of environmental and social monitoring submitted by the Kenyan side as the monitoring forms attached as Annex 7 on its website, to the extent that they are made public in Kenya. When the third parities request further information, JICA disclose it, subject to approval by the Kenya side.

14. Other Relevant Issues

14-1. Disclosure of Information

Both sides confirmed that the Preparatory Survey Report from which project cost is excluded will be disclosed to the public after completion of the Preparatory Survey. The comprehensive report including the project cost will be disclosed to the public after all the contracts under the Project are concluded.

Annex 1 Project Cost Estimation
Annex 2 Project Implementation Schedule
Annex 3 Major Undertakings to be taken by the Government of Kenya
Annex 4 Project Monitoring Report (template)
Annex 5 Environmental Checklist
Annex 6 Environmental Management Plan (EMP)
Annex 7 Environmental Monitoring Plan (EMoP)
Annex 8 Environmental and Social Monitoring Form

Annex 1 Project Cost Estimation

CONFIDENTIAL

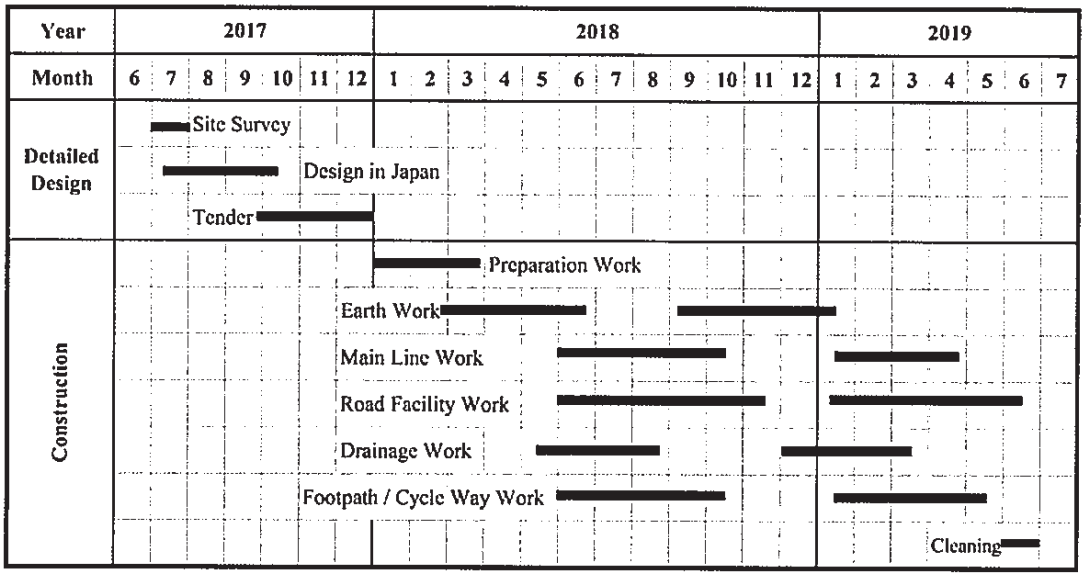
(1) Cost Borne by the Government of the Republic of Kenya

- Relocation of Utility and Environmental Monitoring, etc.: JPY202 million

(2) Conditions of Cost Estimation

- Estimated timing: October 2016
- Exchange rates: USD 1.00 = JPY 103.39
- Others: The project is implemented in accordance with the system of Japan's Grant Aid. The above cost estimation does not assure the ceiling cost on the Exchange of Note (E/N) and shall be reviewed by the Government of Japan (GOJ) before signing of the E/N between the two Governments.

Annex 2 Project Implementation Schedule



Annex 3 Major Undertakings to be taken by the Government of Kenya

Specific obligations of the Government of Kenya which will not be funded with the Grant

(1) Before the tender

NO	Items	Deadline	in charge	estimated cost	ref.
1	To open bank account (B/A)	within 1 month of the signing of the G/A	KURA	Nil	
2	To issue A/P to a bank in Japan (the Agent Bank) for the payment to the consultant	within 1 month of the signing of the contract	KURA		
3	To approve Supplementary ESIA Report (Conditions of approval should be fulfilled, if any) and secure the necessary budget for implementation.	ESIA was approved in March 2013. Supplementary ESIA Report is to be approved in July 2017.	NEMA		
4	To approve Resettlement Action Plan (RAP) and secure the necessary budget and implement relocation and compensation activities, in accordance with RAP	before notice of the bidding document	KURA		
5	To implement social monitoring, and to submit the monitoring results to JICA, by using the monitoring form, on a quarterly basis as a part of Project Monitoring Report	till livelihood restoration is confirmed after completion of relocation and compensation activities.	KURA		
6	To secure and clear the following lands: 1) Right of Way: 60m width 2) Temporary construction yard and stock yard near the Project area 3) Borrow pit and disposal site near the Project area	before notice of the bidding document	KURA		
7	To obtain the planning, zoning, building permit	before notice of the bidding document	KURA		
8	To clear obstacles, level and reclaim the following sites 1) Remove public utilities (water pipes, electricity line, telephone line, etc.) 2) Remove obstacles (advertise board, existing street lighting and others)	before notice of the bidding document	KURA		
9	To submit Project Monitoring Report (with the result of Detail Design)	before preparation of bidding documents	KURA		

(B/A: Banking Arrangement, A/P: Authorization to pay, N/A: Not Applicable)

(2) During the Project Implementation

No.	Items	Deadline	In charge	Estimated Cost	Ref.
1	To issue A/P to a bank in Japan (the Agent Bank) for the payment to the Consultant/Contractor	within 1 month of the signing of the contract(s)	KURA		
2	To bear the following commissions to a bank in Japan for the banking services based upon the B/A				
	1) Advising commission of A/P	within 1 month after the signing of the contract(s)	KURA		
	2) Payment commission for A/P	every payment	KURA		
3	to ensure prompt unloading and customs clearance at ports of disembarkation in recipient country and to assist the Consultant/Contractor with internal transportation therein	during the Project	KURA		
4	To accord Japanese nationals and/or physical persons of third countries whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the country of the Recipient and stay therein for the performance of their work	during the Project	KURA		
5	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the country of the Recipient with respect to the purchase of the products and/or the services be exempted as follows. - Custom duty - Corporation tax - Income tax The following shall be borne by its designated authority without using the Grant; -Value Added Tax (VAT)	during the Project	KURA		
6	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project	during the Project	KURA		
7	1)To submit Project Monitoring Report	every month	KURA		
	2) To submit Project Monitoring Report (final)	within one month after signing of Certificate of Completion for the works under the contract(s)	KURA		
8	To submit a report concerning completion of the Project	within six months after completion of the Project	KURA		

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9	To provide facilities for distribution of electricity, water supply facilities necessary for the implementation of the Project		KURA		
	1) Electricity a) The distributing line to the temporary site yard b) Permanent power supply for traffic signal and Street lighting	before start of the construction	KURA		
	2) Water Supply The city water distribution to the temporary site yard	before start of the construction	KURA		
10	To take necessary measure for traffic control coordinating with the Police for safety construction	during the construction	KURA		
11	To implement EMP and EMoP	during the construction	KURA		
12	To submit results of environmental monitoring to JICA, by using the monitoring form, on a quarterly basis as a part of Project Monitoring Report	during the construction	KURA		
13	To implement RAP (livelihood restoration program, if needed)	for a period based on livelihood restoration program	KURA		
14	To implement social monitoring, and to submit the monitoring results to JICA, by using the monitoring form, on a quarterly basis as a part of Project Monitoring Report - Period of the monitoring may be extended if affected persons' livelihoods are not sufficiently restored. Extension of the monitoring will be decided based on agreement between KURA and JICA.	- until the end of livelihood restoration program (In case that livelihood restoration program is provided) *- for two years after* livelihood restoration is confirmed after completion of relocation and compensation activities. *(In case that livelihood restoration program is not provided)*	KURA		

(3) After the Project

NO	Items	Deadline	In charge	Estimated Cost	Ref.
1	To implement EMP and EMoP	for a period based on EMP and EMoP	KURA		
2	To submit results of environmental monitoring to JICA, by using the monitoring form, semiannually - The period of environmental monitoring may be extended if any significant negative impacts on the environment are found. The extension of environmental monitoring will be decided based on the agreement between KURA and JICA.	for three years after the Project	KURA		
3	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid 1) Allocation of maintenance cost 2) Operation and maintenance structure 3) Routine check/Periodic inspection	After completion of the construction	KURA		

Annex 4 Project Monitoring Report (template)

Project Monitoring Report
on
Project Name
Grant Agreement No. XXXXXXX
20XX, Month

Organizational Information

Signer of the G/A (Recipient)	Person in Charge (Designation) Contacts Address: Phone/FAX: Email:
Executing Agency	Person in Charge (Designation) Contacts Address: Phone/FAX: Email:
Line Ministry	Person in Charge (Designation) Contacts Address: Phone/FAX: Email:

General Information:

Project Title	
E/N	Signed date: Duration:
G/A	Signed date: Duration:
Source of Finance	Government of Japan: Not exceeding JPY _____ mil. Government of (_____): _____

1: Project Description

1-1 Project Objective

1-2 Project Rationale

- Higher-level objectives to which the project contributes (national/regional/sectoral policies and strategies)
- Situation of the target groups to which the project addresses

1-3 Indicators for measurement of "Effectiveness"

Quantitative indicators to measure the attainment of project objectives		
Indicators	Original (Yr)	Target (Yr)
Qualitative indicators to measure the attainment of project objectives		

2: Details of the Project

2-1 Location

Components	Original *(proposed in the outline design)*	Actual
1.		

2-2 Scope of the work

Components	Original* *(proposed in the outline design)*	Actual*
1.		

Reasons for modification of scope (if any).

(PMR)

2-3 Implementation Schedule

Items	Original		Actual
	(proposed in the outline design)	*(at the time of signing the Grant Agreement)*	

Reasons for any changes of the schedule, and their effects on the project (if any)

2-4 Obligations by the Recipient

2-4-1 Progress of Specific Obligations

See Attachment 2.

2-4-2 Activities

See Attachment 3.

2-4-3 Report on Record of Discussion (RD)

See Attachment 11.

2-5 Project Cost

2-5-1 Cost borne by the Grant(Confidential until the Bidding)

Components			Cost (Million Yen)	
	Original *(proposed in the outline design)*	Actual *(in case of any modification)*	Original[1),2)] *(proposed in the outline design)*	Actual
	1.			
Total				

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar = Yen

2-5-2 Cost borne by the Recipient

Components			Cost (currency unit)	
	Original *(proposed in the outline design)*	Actual *(in case of any modification)*	Original[1),2)] *(proposed in the outline design)*	Actual
	1.			

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar =

Reasons for the remarkable gaps between the original and actual cost, and the countermeasures (if any)

(PMR)

2-6 Executing Agency

- Organization's role, financial position, capacity, cost recovery etc,
- Organization Chart including the unit in charge of the implementation and number of employees.

Original *(at the time of outline design)*
name: role: financial situation: institutional and organizational arrangement (organogram): human resources (number and ability of staff):
Actual *(PMR)*

2-7 Environmental and Social Impacts

- The results of environmental monitoring based on Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- The results of social monitoring based on in Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- Disclosed information related to results of environmental and social monitoring to local stakeholders (whenever applicable).

3: Operation and Maintenance (O&M)

3-1 Physical Arrangement

- Plan for O&M (number and skills of the staff in the responsible division or section, availability of manuals and guidelines, availability of spareparts, etc.)

Original *(at the time of outline design)*
Actual *(PMR)*

3-2 Budgetary Arrangement

- Required O&M cost and actual budget allocation for O&M

Original *(at the time of outline design)*
Actual *(PMR)*

4: Potential Risks and Mitigation Measures

- Potential risks which may affect the project implementation, attainment of objectives, sustainability
- Mitigation measures corresponding to the potential risks

Assessment of Potential Risks *(at the time of outline design)*

Potential Risks	Assessment
1. (Description of Risk)	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action required during the implementation stage:
	Contingency Plan (if applicable):
2. (Description of Risk)	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action required during the implementation stage:
	Contingency Plan (if applicable):
3. (Description of Risk)	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action required during the implementation stage:
	Contingency Plan (if applicable):
Actual Situation and Countermeasures	
(PMR)	

5: Evaluation and Monitoring Plan (after the work completion)

5-1 Overall evaluation

Please describe your overall evaluation on the project.

5-2 Lessons Learnt and Recommendations

Please raise any lessons learned from the project experience, which might be valuable for the future assistance or similar type of projects, as well as any recommendations, which might be beneficial for better realization of the project effect, impact and assurance of sustainability.

5-3 Monitoring Plan of the Indicators for Post-Evaluation

Please describe monitoring methods, section(s)/department(s) in charge of monitoring, frequency, the term to monitor the indicators stipulated in 1-3.

Attachment

1. Project Location Map
2. Specific obligations of the Recipient which will not be funded with the Grant
3. Monthly Report submitted by the Consultant

Appendix - Photocopy of Contractor's Progress Report (if any)
- Consultant Member List
- Contractor's Main Staff List

4. Check list for the Contract (including Record of Amendment of the Contract/Agreement and Schedule of Payment)
5. Environmental Monitoring Form / Social Monitoring Form
6. Monitoring sheet on price of specified materials (Quarterly)
7. Report on Proportion of Procurement (Recipient Country, Japan and Third Countries) (PMR (final)only)
8. Pictures (by JPEG style by CD-R) (PMR (final)only)
9. Equipment List (PMR (final)only)
10. Drawing (PMR (final)only)
11. Report on RD (After project)

Monitoring sheet on price of specified materials

1. Initial Conditions (Confirmed)

	Items of Specified Materials	Initial Volume A	Initial Unit Price (¥) B	Initial total Price C=A×B	1% of Contract Price D	Condition of payment	
						Price (Decreased) E=C−D	Price (Increased) F=C+D
1	Item 1	●●t	●	●	●	●	●
2	Item 2	●●t	●	●	●		
3	Item 3						
4	Item 4						
5	Item 5						

2. Monitoring of the Unit Price of Specified Materials

(1) Method of Monitoring : ●●

(2) Result of the Monitoring Survey on Unit Price for each specified materials

	Items of Specified Materials	1st ●month, 201X	2nd ●month, 201X	3rd ●month, 201X	4th	5th	6th
1	Item 1						
2	Item 2						
3	Item 3						
4	Item 4						
5	Item 5						

(3) Summary of Discussion with Contractor (if necessary)

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Report on Proportion of Procurement (Recipient Country, Japan and Third Countries)
(Actual Expenditure by Construction and Equipment each)

		Domestic Procurement (Recipient Country) A	Foreign Procurement (Japan) B	Foreign Procurement (Third Countries) C	Total D
Construction Cost		(A/D%)	(B/D%)	(C/D%)	
	Direct Construction Cost	(A/D%)	(B/D%)	(C/D%)	
	others	(A/D%)	(B/D%)	(C/D%)	
Equipment Cost		(A/D%)	(B/D%)	(C/D%)	
Design and Supervision Cost		(A/D%)	(B/D%)	(C/D%)	
Total		(A/D%)	(B/D%)	(C/D%)	

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Annex 5 Environmental Checklist

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) Y (b) Y (c) Y (d) N	(a)(b)(c) The EIA report for whole Ngong road (C61/C60) including target site of this project has been prepared in Aug, 2009. EIA license has been issued in Mar. 2011 and it's validity period has been extended for additional 24 months in Aug. 2014. License conditions complied with RAP.KURA is submitted the supplementary EIA Report and RAP Report by March 2017, so NEMA is approved the supplementary EIA Report by April 2017. (d) Permission of tree cutting should be obtained from Nairobi City County and Kenya Forestry Service. Permission of transportation of trees should be obtained from District Agricultural Committee. KURA is to obtain permits by April 2017.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) Y (b) Y	(a) The stakeholder meeting and public forum have been conducted from April to June, 2014 and from October to November, 2016. General consent of the local people has been obtained. (b) Comments about the design of bus stop, intersection and public space have been reflected to the extent possible.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) Alternative plans have been compared and examined from the point of environment, society and project cost.

2 Pollution Control	(1) Air Quality	(a) Is there a possibility that air pollutants emitted from the project related sources, such as vehicles traffic will affect ambient air quality? Does ambient air quality comply with the country's air quality standards? Are any mitigating measures taken? (b) Where industrial areas already exist near the route, is there a possibility that the project will make air pollution worse?	(a) Y (b) N	(a) The travel speed of vehicles is expected to be normalized due to easing congestion, but air pollutants is estimated to escalate by increase of future traffic volume. Current air quality is deemed to be within quality standards according to the result of baseline survey. Amount of emission (CO_2, NO_x, SPM) estimated from future traffic volume in 2026 is expected to be inhibited by 40% compared with zero option. Adverse effect to air quality by gas emission is expected to be mitigated by easing congestion while increasing of traffic volume. (b) Current air quality satisfies the air quality standards. However, construction plans and methods minimizing the impact of ambient air quality are taken into account and it is confirmed that using of emission-controlled construction machinery and stop unnecessary idling.
	(2) Water Quality	(a) Is there a possibility that soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling will cause water quality degradation in downstream water areas? (b) Is there a possibility that surface runoff from roads will contaminate water sources, such as groundwater? (c) Do effluents from various facilities, such as parking areas/service areas comply with the country's effluent standards and ambient water quality standards? Is there a possibility that the effluents will cause areas not to comply with the country's ambient water quality standards?	(a) N (b) N (c) N	(a) Distabilised soil (Cut and Fill areas) will be protected by grouted riprap and turfing, so there is no possibility of soil runoff and water quality degradation in downstream water area. (b) There is a possibility that oil and dust on the project road could permeate the groundwater, but the influence of surface runoff water is little. Periodical cleaning on the road is proposed in mitigation. (c) The baseline Survey revealed pollution of waters in the side ditches along the project road. Since the leakage of sewage water, organic effluent and oil leaks from vehicle wash are estimated as the pollutant source. Water quality of side ditch is expected to be improved by the relocation of utility and parking areas currently used by water and sewage service vendors.
	(3) Wastes	(a) Are wastes generated from the project facilities, such as parking areas/service areas, properly treated and disposed of in accordance with the country's regulations?	(a) Y	(a) Litter-bin for waste is partly set up around project road by NCC and waste are regularly collected and transported to final disposal site by NCC licensed collector.

2 Pollution Control (continued)	(4) Noise and Vibration	(a) Do noise and vibrations from the vehicle and train traffic comply with the country's standards?	(a) N	(a) Current noise level doesn't satisfy the standard according to the result of baseline survey. Though easing congestion and normalization of travel speed of vehicle are expected by dualling of project road and improvement of intersection, increase of traffic volume is estimated. Therefore leveling of road surface and construction of green belt are planned to alleviate noise. In addition, line ministries and organizations are encouraged to strengthen restrictions on ill-serviced vehicles.
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) There are no protected areas in and around the site.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Are adequate protection measures taken to prevent impacts, such as disruption of migration routes, habitat fragmentation, and traffic accident of wildlife and livestock? (e) Is there a possibility that installation of roads will cause impacts, such as destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystems due to introduction of exotic (non-native invasive) species and pests? Are adequate measures for preventing such impacts considered? (f) In cases the project site is located at undeveloped areas, is there a possibility that the new development will result in extensive loss of natural environments?	(a) N (b) Y (c) N (d) N (e) N (f) N	(a) There are no primeval forests, tropical rain forests and ecological valuable habitats in and around the site. (b) There is one endangered species of tree, which is classified into Vulnerable (VU) in IUCN Red List and restricted international trade by CITES. But This tree can be easily transplant since the height is about 1.5m. (c) The project will not affect the ecosystem significantly. (d)(e)(f) Since only extension of existing roads is planned, improving roads will not cause disruption of migration routes, habitat fragmentation, destruction of forest, poaching and significant ecological impacts on the ecosystem.
	(3) Hydrology	(a) Is there a possibility that alteration of topographic features and installation of structures, such as tunnels will adversely affect surface water and groundwater flows?	(a) N	(a) Significant impact on surface and ground water will not occur.

3 Natural Environment (continued	(4) Topography and Geology	(a) Is there any soft ground on the route that may cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides, where needed? (b) Is there a possibility that civil works, such as cutting and filling will cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides? (c) Is there a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites? Are adequate measures taken to prevent soil runoff?	(a) N (b) N (c) N	(a) (b) The project site is flat and it is thought to be safe from slope failures or landslides. (c) There is no possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites.
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement?(b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement?(c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement?(d) Are the compensations going to be paid prior to the resettlement?(e) Are the compensation policies prepared in document?(f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples?(g) Are agreements with the affected people obtained prior to resettlement?(h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan?(i) Are any plans developed to monitor the impacts of resettlement?(j) Is the grievance redress mechanism established?	(a) Y (b) Y (c) Y (d) Y (e) Y (f) Y (g) Y (h) Y (i)Y (j) Y	(a) There are no residents in project site, but relocation and compensation of 169 Petty traders and 156 mobile benders,22 tree nursery owners and 4 kiosk owners and their employees are required. To minimize involuntary resettlement, 3 alternative plans are considered. (b) At the stage of RAP preparation, 7 stakeholder meetings were conducted and appropriate explanation on compensation and resettlement assistance was given to PAPs. (c) Replacement cost study was carried out and appropriate compensation amount was calculated based on the study to recover livelihood after resettlement of PAPs. (d) RAP states that the compensations is going to be paid prior to the resettlement/site handover to contractor and the same was explained to PAPs. (e) Compensation policies are shown in RAP and RAP will be disclosed to public after NEMA approval. (f) Vulnerable groups are given particular attention and provision is provided in the RAP. (g) There are no residents in project site. Agreements with people requiring economic resettlement can be obtained. (h) Organizational framework centering on KURA/PIT will be established. KURA has implemented projects of WB and AfDB and have capacity to implement RAP. Also necessary budget will be allocated. (i) Monitoring surveys are expected to be implemented properly by both internal and external organizations. (j) Grievance redress mechanism is established by reference to past project.

4 Social Environment	(2) Living and Livelihood	a) Where roads are newly installed, is there a possibility that the project will affect the existing means of transportation and the associated workers? Is there a possibility that the project will cause significant impacts, such as extensive alteration of existing land uses, changes in sources of livelihood, or unemployment? Are adequate measures considered for preventing these impacts? (b) Is there any possibility that the project will adversely affect the living conditions of the inhabitants other than the target population? Are adequate measures considered to reduce the impacts, if necessary? (c) Is there any possibility that diseases, including infectious diseases, such as HIV will be brought due to immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (d) Is there any possibility that the project will adversely affect road traffic in the surrounding areas (e.g., increase of traffic congestion and traffic accidents)? (e) Is there any possibility that roads will impede the movement of inhabitants? (f) Is there any possibility that structures associated with roads (such as bridges) will cause a sun shading and radio interference?	(a) N (b) N (c) N (d) N (e) N (f) N	(a)(b)(c)(d)(e) Since only extension of existing roads is planned, improving roads will not seriously affect the life of residents and road traffic.The Project is implemented along the EMP and EMoP, so the health hazard and the infection damage are evaded or minimized. (f) Sun shading and radio interference will not be caused by this project.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) There are no historical and cultural heritage along the project site.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) Serious adverse effect will not be expected.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources to be respected?	(a) - (b) -	(a)(b) The project area is not inhabited by ethnic minorities and indigenous peoples.

4 Social Environment	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures being taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a) Y (b) Y (c) Y (d) Y	(a) Contract with contractor shall include the prescription of observance to labor law in Kenya. (b) Construction workers will be provided with protective equipment. (c) Contract with contractor shall include prescription on safety and HIV/AIDS education to construction workers. (d) Route of construction vehicle shall be discussed with NCG, Nairobi police and local residents. Information regarding description of work, construction plan and executing agency will be provided through newspapers and radio.
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)?(b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts?(c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	(a) Y (b) Y (c) Y	(a) To reduce impacts during construction, following measures are considered; using appropriate construction machinery, regular maintenance work of construction machinery, prevention of unnecessary idling, regular sprinkling of water to prevent dust, recycle-use of construction waste, using low-noise construction machineries, consideration to working time, etc. (b) Trees which do not affect road structures in ROW remain. 1.0 m width green belt is installed along the entire road length and planting recommended. (c) RAP was prepared based on the WB and JICA guidelines, and environmental law of Kenya, and proper resettlement shall be carried out. Working opportunity for construction work shall be provided to PAPs and the poor on a priority basis.

5 Others	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) Y (d) Y	(a) An Environmental Monitoring Plan (EMoP) has been prepared as part of the EIA process. (b) Towards pollution control, KURA will conduct monitoring once every 4 months during construction, and biannually after commissioning. For natural environment, KURA will conduct monitoring biannually during construction and annually during operation. For social environment, the Project Implementation Team in KURA will conduct internal monitoring based on the project implementation manual. Besides, external monitoring will be conducted by third-party institutions procured by KURA. (c) Many projects have been implemented by WB and AfDB in Kenya and it's confirmed that serious problems have not been reported. Adequate monitoring framework for this project has been established based on lessons from past projects. (d) KURA will routinely share monitoring information with NEMA through the annual self audit cycles.
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Forestry Projects checklist should also be checked (e.g., projects including large areas of deforestation).(b) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of power transmission lines and/or electric distribution facilities).	(a) N (b) N	(a) This project will not entail largescale deforestation.(b) This project will not entail construction/ installation of power transmission lines and/or electric distribution facilities.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed, if necessary (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) Y	Regarding possible global warming (increase of CO_2 emission), CO_2 emission is estimated to increase by increase of traffic volume. However, increase of CO_2 emission is expected to be mitigated compared with zero-option due to easing of congestion and normalization of traffic speed.

1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made. In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

Annex 6 Environmental Management Plan

#	Impact Item	Expected Mitigation Measures	Implementation Organization	Responsible Organization	Cost (USD)
Planning Stage / Construction Stage					
1	Air Quality	· Appropriate construction machinery is used and maintained regularly. In addition, unnecessary idling is avoided. · Water spraying is done regularly to avoid raising sand dust during dry seasons. · In case backfilling materials and construction materials are stocked temporally in the stock yards or the construction site, these materials are covered by sheets to avoid scattering. · Right-turn lanes are introduced at major intersections and then traffic congestion around the intersections is alleviated, eventually the volume of air pollutants from vehicles decrease. · The alleviation of traffic congestion and decrease of on-street parking are promoted by developing parking space and area for sorting out merchandize. · Regular monitoring surveys are carried out around the Project road. In addition, in case the values get worse extremely compared to baseline survey's values, KURA finds out the reason and implements measures necessary. · Line ministries and organizations are recommended to strengthen restrictions on ill-serviced vehicles.	Contractor ／KURA	KURA	6,000
2	Water Quality	· Appropriate construction machinery is used and maintained regularly. · Waste water arising from construction works is discharged via the temporary pond into the side ditch and the remained waste is the temporary pond is handled as industrial waste. · Construction machinery is not washed in the rivers. · Regular monitoring surveys are carried out around the Project road. In addition, in case the values get worse extremely compared to baseline survey's values, KURA finds out the reason and implements measures necessary. · Line ministries and organizations are recommended to strengthen restrictions on ill-serviced vehicles.	Contractor	KURA	2,800
3	Waste	· Wastes are recycled and reused as much as possible. · Wastes unable to be recycled and reused are disposed by facilities authorized by NEMA.	Contractor	KURA	-
4	Soil Contamination	· In order to avoid oil leaking from construction machinery, regular maintenance works are done.	Contractor	KURA	-

#	Impact Item	Expected Mitigation Measures	Implementation Organization	Responsible Organization	Cost (USD)
5	Noise and Vibration	· Appropriate construction machinery is used and maintained regularly. · Low-noise construction machinery is utilized. · Construction works are done during only daytime around school and clinic/hospital. · In case of night work, the permission of Nairobi police is obtained and the notice of the work is notified to local residents in advance. · Regular monitoring surveys are carried out around the Project road. In addition, in case the values get worse extremely compared to baseline survey's values, KURA finds out the reason and implements measures necessary. · Line ministries and organizations are recommended to strengthen restrictions on ill-serviced vehicles. · Surface joints on road are reduced as many as possible in order to keep flatness of the Project roads. · Dumpy earthen roads are paved. · 1.0 m width of green belt is installed along the entire road length and trees are planted in it.	Contractor ／KURA	KURA	2,100
6	Odor	· Appropriate construction machinery is used and maintained regularly. In addition, unnecessary idling is avoided. · Right-turn lanes are introduced at major intersections and then traffic congestion around the intersections is alleviated, eventually the volume of air pollutants decrease. · Line ministries and organizations are recommended to strengthen restrictions on ill-serviced vehicles	Contractor	KURA	-
7	Ecosystem	· Trees in ROW classified into (VU) and not affecting newly constructed road structures are not cut to the extent possible. · 1.0 m width of green belt is installed along the entire road length and trees are planted in it.	Contractor ／KURA	KURA	5,100
8	Resettlement	· RAP in accordance with JICA Guidelines and WB OP4.12 is prepared. · Resettlement is carried out according to the RAP. · Monitoring works for resettlement is carried out according to the RAP.	KURA	KURA／NEMA	-

#	Impact Item	Expected Mitigation Measures	Implementation Organization	Responsible Organization	Cost (USD)
9	The Poor	· The poor and PAPs are given priority to be employed by the construction works for the Project. · PAPs especially commercial businesses (hawkers/tree nurseries) are allowed to be resettle the area in or outside of ROW where newly constructed road structures are not disturbed.	Contractor ／KURA	KURA	-
10	Local Economy such as Employment and Livelihood etc.	· Local residents are employed as many as possible by the construction works without special skills. · PAPs especially commercial businesses (hawkers/tree nurseries) are allowed to be resettle the area in or outside of ROW where newly constructed road structures are not disturbed.	KURA ／Contractor	KURA	-
11	Land Use and Utilization of Local Resources	· RAP is implemented properly.	KURA	KURA／ NEMA	-
12	Water Usage	· Waste water arising from construction works is not discharged into the side ditch directly.	Contractor ／KURA	KURA	-
13	Existing Social Infrastructures and Services	· Traffic controllers are mobilized properly. · Temporal bus stops are installed.	Contractor ／KURA	KURA	-
14	Landscape	· Trees in ROW not affecting newly constructed road structures are not cut to the extent possible. · 1.0 m width of green belt is installed along the entire road length and trees are planted in it.	Contractor ／KURA	KURA	
15	Infectious Disease such as HIV/AIDS	· Education for HIV/AIDS is provided for workers. In addition, the contract of the Project implementation with the contractor stipulates the article of the education above.	Contractor ／KURA	Ministry of Health	-
16	Working Condition including Occupational Safety	· The contract of the Project implementation with the contractor stipulates that labor laws in Kenya must be complied.	Contractor ／KURA	Ministry of Labor, Social Security and Services	-
17	Accident	· Safety educations are provided construction workers with. The contract with the contractor stipulates the implementation of the safety educations. · Construction workers put on safety equipment such as helmet and safety shoes. · 29 pedestrian crossings are installed around facilities such as shopping malls, school and church. · Sidewalks separated from carriage ways are installed. · Medians serving as safety zone are installed.	Contractor ／KURA	KURA	-

#	Impact Item	Expected Mitigation Measures	Implementation Organization	Responsible Organization	Cost (USD)
		· Right-turn lanes are installed at the major intersections including the existing road in order to avoid rear-end accidents. · Sign boards and road markings with a high regard for safety are placed. · The safety for bus users in getting in and out are secured by introducing new bus stops. · In terms of the operation route of construction vehicles, KURA and the contractor discuss it with Nairobi Police and NCC as well as local residents in advance. · Information such as construction plans are disclosed to the public through newspapers and radios.			
18	Global Warming	· Appropriate construction machinery is used and maintained regularly. In addition, unnecessary idling is avoided.	Contractor ／KURA	KURA	-
		Sub-total			16,000
Operation Stage					
1	Air Quality	· Regular monitoring surveys are carried out around the Project road. In addition, in case the values get worse extremely compared to baseline survey's values, KURA finds out the reason and implements measures necessary.	KURA	KURA	8,000
2	Water Quality	· Regular monitoring surveys are carried out around the Project road. In addition, in case the values get worse extremely compared to baseline survey's values, KURA finds out the reason and implements measures necessary.	KURA／NEMA	KURA	3,800
3	Wastes	· Drainage facilities are regularly maintained. · Status of illegal dumping around the Project road is monitored every month in collaboration with NCC and NEMA to maintain good hygiene.	KURA	KURA (NEMA／NCC)	-
4	Noise and Vibration	· Regular monitoring surveys are carried out around the Project road. In addition, in case the values get worse extremely compared to baseline survey's values, KURA finds out the reason and implements measures necessary. · Line ministries and organizations are recommended to strengthen restrictions on ill-serviced vehicles. · Line ministries and organizations are recommended to strengthen restrictions on overloaded vehicles. · In case pot holes and damages on the Project road are found, they are repaired immediately. · Trees planted in the green belt are maintained well.	KURA	KURA	2,800

#	Impact Item	Expected Mitigation Measures	Implementation Organization	Responsible Organization	Cost (USD)
5	Odor	· Line ministries and organizations are recommended to strengthen restrictions on ill-serviced vehicles.	KURA	Nairobi Police	-
6	Resettlement	· Monitoring works for resettlement is carried out according to the RAP.	KURA	KURA／NEMA	-
7	Landscape	· Trees planted in the green belt are maintained well.	KURA	KURA／NEMA	
8	Accident	· Traffic flow is controlled just after the opening of the Project road in cooperation with Nairobi Police.	Nairobi Police	Nairobi Police	-
Sub-total					14,600
Grand Total					30,600

Source: JICA Survey Team

Annex 7 Environmental Monitoring Plan

Kind of Survey	Parameter	Survey Point (same as each baseline survey*[1])	Upper: Construction Stage / Lower: Operation Stage	Responsible Organization
【Construction Stage】【Operation Stage】				
Ambient Air Quality	$PM_{2.5}$, PM_{10}, CO, NOx, SOx, Wind Direction/Velocity	Dagoreti Corner	Every Three Months / Every Six months	Contractor /KURA
Noise & Vibration	Noise & Vibration Level (L_{Aeq}・L_{Amax}・L_{Amin})	Dagoreti Corner	Every Three Months / Every Six Months	Contractor /KURA
Water Quality	pH, SS, EC, COD, DO, Oil, Conductivity, Turbidity, Odor, Color	Dagoreti Corner	Every Three Months / Every Six months	Contractor /KURA
Biological	Flora and Fauna	Whole project site	Every Six Months / Every year	Contractor /KURA
Wastes	Watch	Reserved waste area	Every Six Months / Every year	Contractor /KURA
HIV/AIDS	Worker Education	Whole project site	Every Month / —	Contractor
Working Environment	Meeting	Whole project site	Every Month / —	Contractor
Accident	Accident Number	Whole project site	Every time / —	Contractor

Annex 8 Environmental Monitoring Format

Air Quality, Water Quality, Noise& Vibration

Item	Parameter	Location	Baseline Result	Monitoring Result	Standard	Remarks
Air Quality	PM10 (average 24h)	Dagoretti Corner			50μg/m³(WHO)	
	Nox (average 24h)	Dagoretti Corner			80μg/m³(National), 20μg/m³(WHO)	
	SOx (average 24h)	Dagoretti Corner			80μg/m³(National)	
	CO (average 8h)	Dagoretti Corner			2.0mg/m³(National), 1.0mg/m³(WHO)	
	CO2 (average 8h)	Dagoretti Corner			2.0mg/m³(National)	
	Lead(Pb) (average 24h)	Dagoretti Corner			1.0μg/m³(National)	
	Wind Direction/Velocity	Dagoretti Corner			-	
Noise	Noise Level (Day Time: 06:01-22:00)	Dagoretti Corner			75dB(National,other area except other area except and Residential)	
	Noise Level (Night Time: 22:01-06:00)	Dagoretti Corner			65dB(National,other area except other area except and Residential)	
Vibration	Vibration Level (Day Time: 06:01-22:00)	Dagoretti Corner			70dB(National, Industrial, commercial)	
	Vibration Level (Night Time: 22:01-06:00)	Dagoretti Corner			70dB(National, Industrial, commercial)	
Water Quality	pH	Dagoretti Corner			6.5-8.5(National, 6.0-9.0(EHS)	
	BOD	Dagoretti Corner			30mg/l(National, EHS)	
	COD	Dagoretti Corner			50mg/l(National), 125mg/l(EHS)	
	BTEX (Benzene)	Dagoretti Corner			0.1mg/l(National)	
	TPH (Oil&Grease)	Dagoretti Corner			Nil mg/l(National), 10mg/l(EHS)	
	Total Nitrogen	Dagoretti Corner			2mg/l(National), 10mg/l(EHS)	
	Total Coliform Bacteria	Dagoretti Corner			30counts/100ml(National), 400MPN/100ml(EHS)	
Biological	Flora and Fauna	Project area			-	

WHO:World Health Organization, EHS: General EHS Guidelines of IFC

<Monitoring Frequency>1 time before construction, Every four(4)months during construction, Every six(6)months after construction

Progress of Compensation/Removing/Relocation for Affected Objects

Item		Total Number of Objects	Payment of Compensation		Vacation of Land		(Expected) Date of Completion
Prunus africana		1		0%		0%	YYYY/MM
Trees		1809		0%		0%	YYYY/MM
Hawkers with temporally structure		4		0%		0%	YYYY/MM
Tree nursery operators		64		0%		0%	YYYY/MM
Total		1878	0	0%	0	0%	YYYY/MM

Progress of Assistance

Item	Total Number of Households	Payment of Assistance		(Expected) Date of Completion
Compensation for Loss of Income (Hawkers including employees):30,000Ksh	4		0%	YYYY/MM
Compensation for Loss of Income (Tree nurseries including employees):30,000Ksh	64		0%	YYYY/MM
Compensation for advertising tower;500,000Ksh	19		0%	YYYY/MM
Street tree; 5,276Ksh	1809		0%	YYYY/MM

Procedures

Procedure	Date
Institutuional Arrangement	
Establishment of RAP Implementation Committee	YYYY/MM/DD
Establishment of Grievance Redress Committee	YYYY/MM/DD
Detailed Asset Survey and Compensation Estimation	
Start of Survey	YYYY/MM/DD
Completion of Survey	YYYY/MM/DD
RAP Budget	
Submission	YYYY/MM/DD
Approval	YYYY/MM/DD

Submission of Moritoring Report

Monitoring		
2017(4th qtr)		YYYY/MM/DD
2018(1st qtr)		YYYY/MM/DD
2018(2nd qtr)		YYYY/MM/DD
2018(3rd qtr)		YYYY/MM/DD
2018(4th qtr)		YYYY/MM/DD
2019(1st qtr)		YYYY/MM/DD
2019(2nd qtr)		YYYY/MM/DD
2019(3rd qtr)		YYYY/MM/DD
2019(4th qtr)		YYYY/MM/DD
2020(1st qtr)		YYYY/MM/DD
2020(2nd qtr)		YYYY/MM/DD

Grievance Redress

	Outline of Grievance and Remarks(If any)	Grievance received	Grievance resolved
1		YYYY/MM/DD	YYYY/MM/DD
2		YYYY/MM/DD	YYYY/MM/DD
3		YYYY/MM/DD	YYYY/MM/DD
		YYYY/MM/DD	YYYY/MM/DD
		YYYY/MM/DD	YYYY/MM/DD

Public Consultation

	Agenda	Place	Number of Participants	Date
1				YYYY/MM/DD
2				YYYY/MM/DD
3				YYYY/MM/DD
				YYYY/MM/DD
				YYYY/MM/DD

A7-2

		Submission of Moritoring Report
1	2018(First Half)	YYYY/MM/DD
2	2018(Latter Half)	YYYY/MM/DD
3	2019(First Half)	YYYY/MM/DD
4	2019(Latter Half)	YYYY/MM/DD

Complaint

	Complaint received	Complaint resolved	Type of Complaint
1	YYYY/MM/DD	YYYY/MM/DD	
2	YYYY/MM/DD	YYYY/MM/DD	
3	YYYY/MM/DD	YYYY/MM/DD	
	YYYY/MM/DD	YYYY/MM/DD	
	YYYY/MM/DD	YYYY/MM/DD	
	YYYY/MM/DD	YYYY/MM/DD	
	YYYY/MM/DD	YYYY/MM/DD	
	YYYY/MM/DD	YYYY/MM/DD	

HIV/AIDS and other Sexually Transmitted Diseases <Campaing>

	Date	Place	Namber of Safety Measures Distributed		Number of Participants		
			Contraceptive	Condome	Male	Female	Total
1	YYYY/MM/DD						
2	YYYY/MM/DD						
3	YYYY/MM/DD						
	YYYY/MM/DD						
	YYYY/MM/DD						
	YYYY/MM/DD						
	YYYY/MM/DD						
	YYYY/MM/DD						

Sanitary Situation <Garbage along the road> <Monitoring Frequency>Monthly

	Date	Situation Observed	Measure Taken
1	YYYY/MM/DD		
2	YYYY/MM/DD		
3	YYYY/MM/DD		
	YYYY/MM/DD		
	YYYY/MM/DD		
	YYYY/MM/DD		
	YYYY/MM/DD		
	YYYY/MM/DD		

Drainwage Situation <Monitoring Frequency>Every two (2)weeks

	Date	Situation Observed	Measure Taken
1	YYYY/MM/DD		
2	YYYY/MM/DD		
3	YYYY/MM/DD		
	YYYY/MM/DD		
	YYYY/MM/DD		
	YYYY/MM/DD		
	YYYY/MM/DD		
	YYYY/MM/DD		

5. Technical Note
Site Survey (19/10/2016)

Technical Note

The Preparatory Survey on
The Project for Dualling of Nairobi-Dagoretti Corner Road C60/C61 (Phase II)

Kenya Urban Roads Authority (KURA) and JICA Survey Team (the Consultants) have made a series of discussions and tentatively confirmed the followings matters. It is, however, understood that the confirmations/proposals below might be revised in further analysis/discussions in Japan.
This Technical Note supersedes the one signed on April 16, 2014 between KURA and the Consultant.

1. Design Standard
   Kenyan Design Standard issued by Ministry of Transport and Roads (former Ministry of Transport and Communications 1987) will be basically adopted. Specifications of AASHTO (for pavement design), BS (for bridge and loads) Japan Road Association (for road design detail) will be adopted as supplementary.

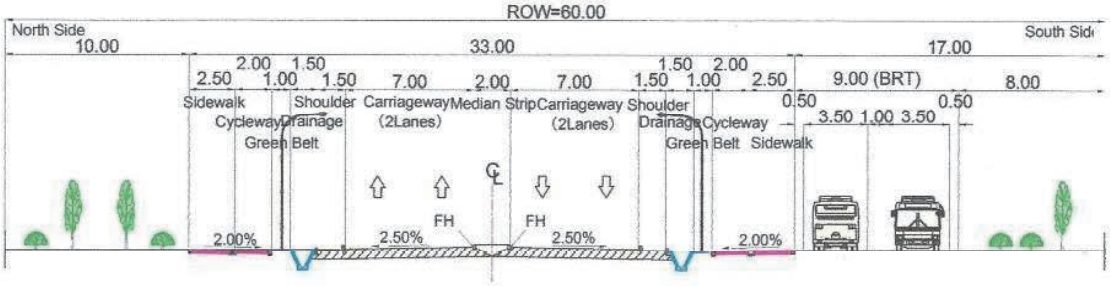
2. Road Class
   The Project road class is Urban Arterial.

3. Particular Design Criteria
   (1) Pavement Design Period
   The carriageway width and pavement structure are designed to accommodate the traffic volume in the period of 2019 – 2028 (for 10 years period from opening in 2019).

   (2) Geometric Standard
   The proposed geometric standards are shown as below.

Item	Geometric Standard
Design Speed (km/h)	60
Maximum Grade (%)	6.0
Minimum Horizontal Curve Radius (m)	160
Stopping Sight Distance (m)	85
Minimum Vertical Curve Radius (convexity) (m)	800
Minimum Vertical Curve Radius (Sag) (m)	1,800
Typical cross-elevation (%)	2.5

4. Cross Sectional Component of the Project Road
   The proposed typical cross section is shown as below.



5. Road Improvement Plan

Scheme of road improvement plan including intersection improvement plans from the junction of the Prestige plaza NAKUMATT to the end point of the Project road is shown in Appendix-1.

(1) Major Junction

The intersection improvement as follows will be further studied based on the comprehensive traffic analysis in Japan.

Dagoretti Corner Junction

The junction plan is a normal junction controlled by traffic signal. The improvement plans will be also taken into consideration in light of future traffic volume and financial validity.

Ole Dume Road Junction

The junction plan is a normal junction controlled by traffic signal. The improvement plans will be also taken into consideration in light of future traffic volume and financial validity.

Adams Arcade Junction

The junction plan is a normal junction controlled by traffic signal. The improvement plans will be also taken into consideration in light of future traffic volume and financial validity.

(2) Traffic Signal

Traffic signals are proposed to be newly installed at the Dagoretti Corner junction and the Ole Dume Road Junction and Adams Arcade Junction.

(3) Street Light

The Street lights will be newly installed basically every 50m in staggered alignment.

(4) Bus Stop

The bus stop is shown in Appendix-1.

(5) Crosswalk

The cross walk is shown in Appendix-1.

(6) Foot bridge

The foot bridge is shown in Appendix-1.

(7) Installation of the pipe culvert

The pipe culvert (Diameter 0.6m) will be installed basically every 500m for the utility cable.

6. Other Items confirmed

(1) Beginning and End Point of the Project Road

Beginning point (Sta.0-040) of the Project road is 380m south-east from the edge of Dagoretti Corner Junction and tentative end point (Sta.3+408) is 120m west from Kilimani Junction, which is the beginning point of Phase I. Total length of the Project road is about 3.45km. Naivasha road is out of scope of the Project road.

(2) Utility Relocation

With consideration of future development plans, all utilities in the ROW will be relocated to the edge of the ROW before the commencement of the Project road construction. KURA will be responsible for the relocation of the utilities. The removal of the existing street lights will be also responsibility of KURA.

(3) Bus Rapid Transit (BRT) plan

The consultant to adopt BRT plan (9m+8m width) at south side of the Ngong Road.

(4) Environmental Impact Assessment (EIA) License

EIA License for Project road (Phase II) as well as Phase I will be renewed by April 2017 at KURA's own responsibility.

(5) Resettlement Action Plan (RAP)

Once the RAP of the Project road is approved by National Environmental Management Authority (NEMA), KURA will secure the budget necessary for the RAP implementation and immediately carry out resettlement procedures in accordance with the RAP.

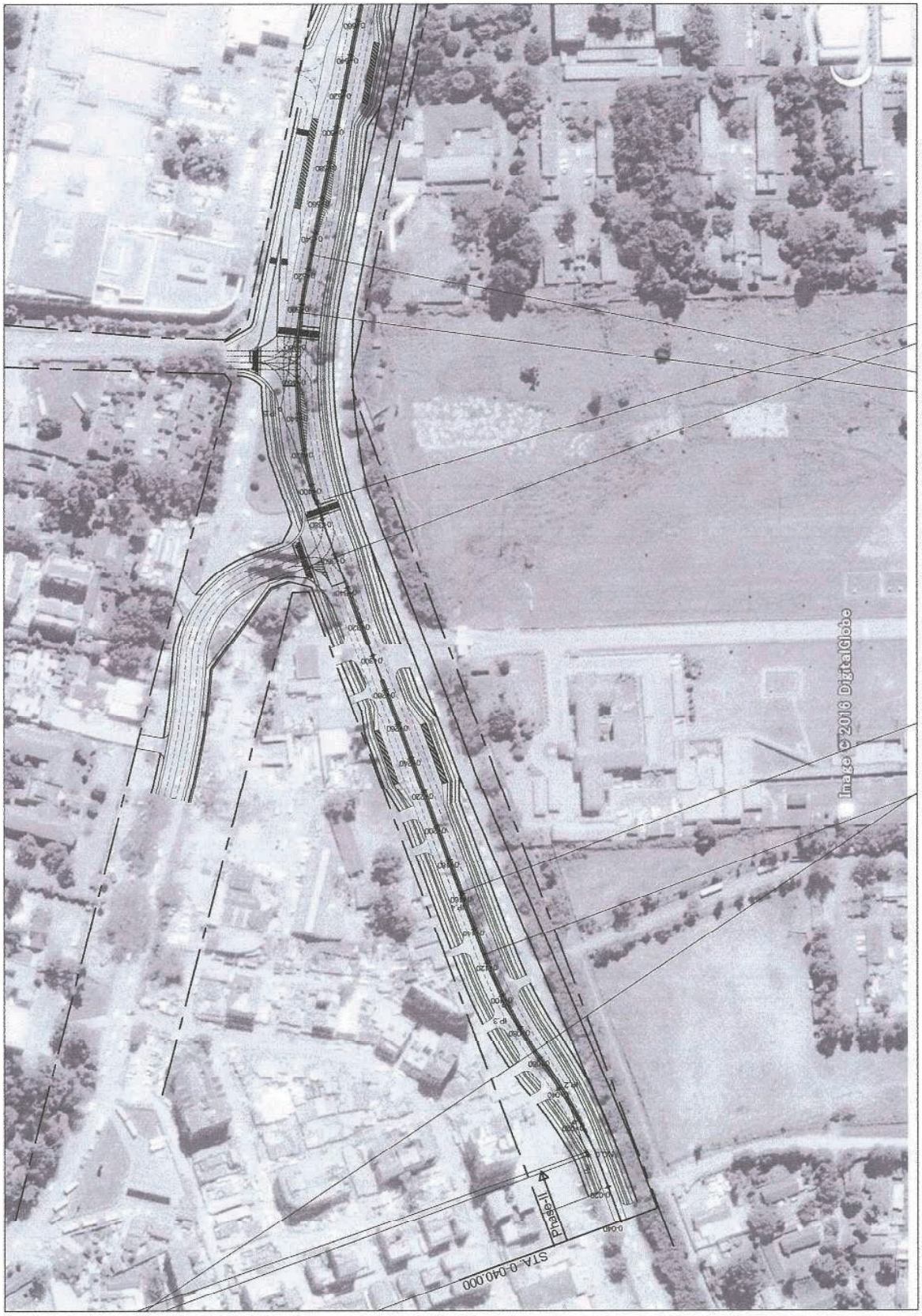
October 19, 2016

Noted by :

Eng. Silas M. Kinoti
Director General
Kenya Urban Roads Authority

Noted by :

Tsuyoshi Yamajuku
Chief Consultant
JICA Survey Team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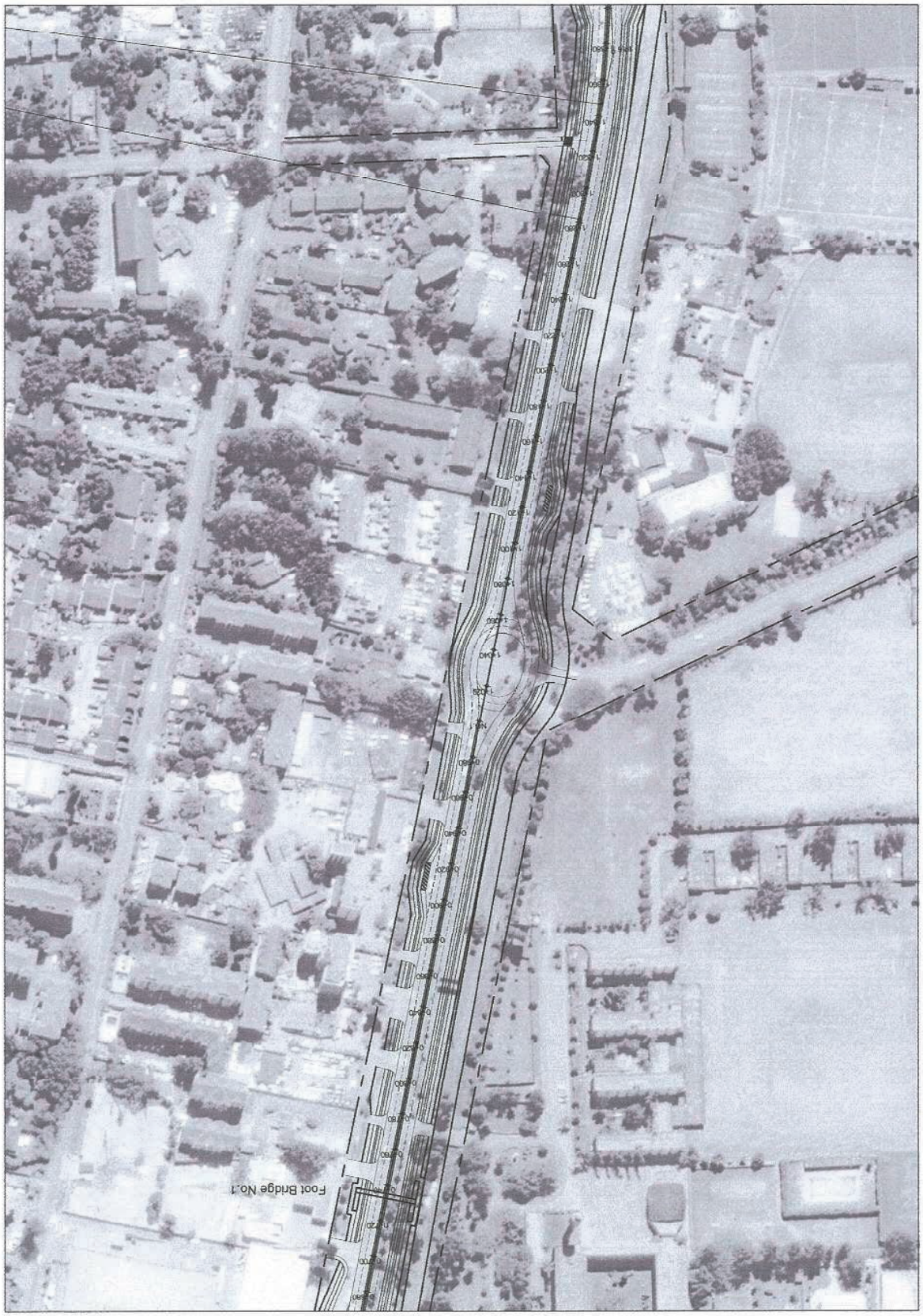
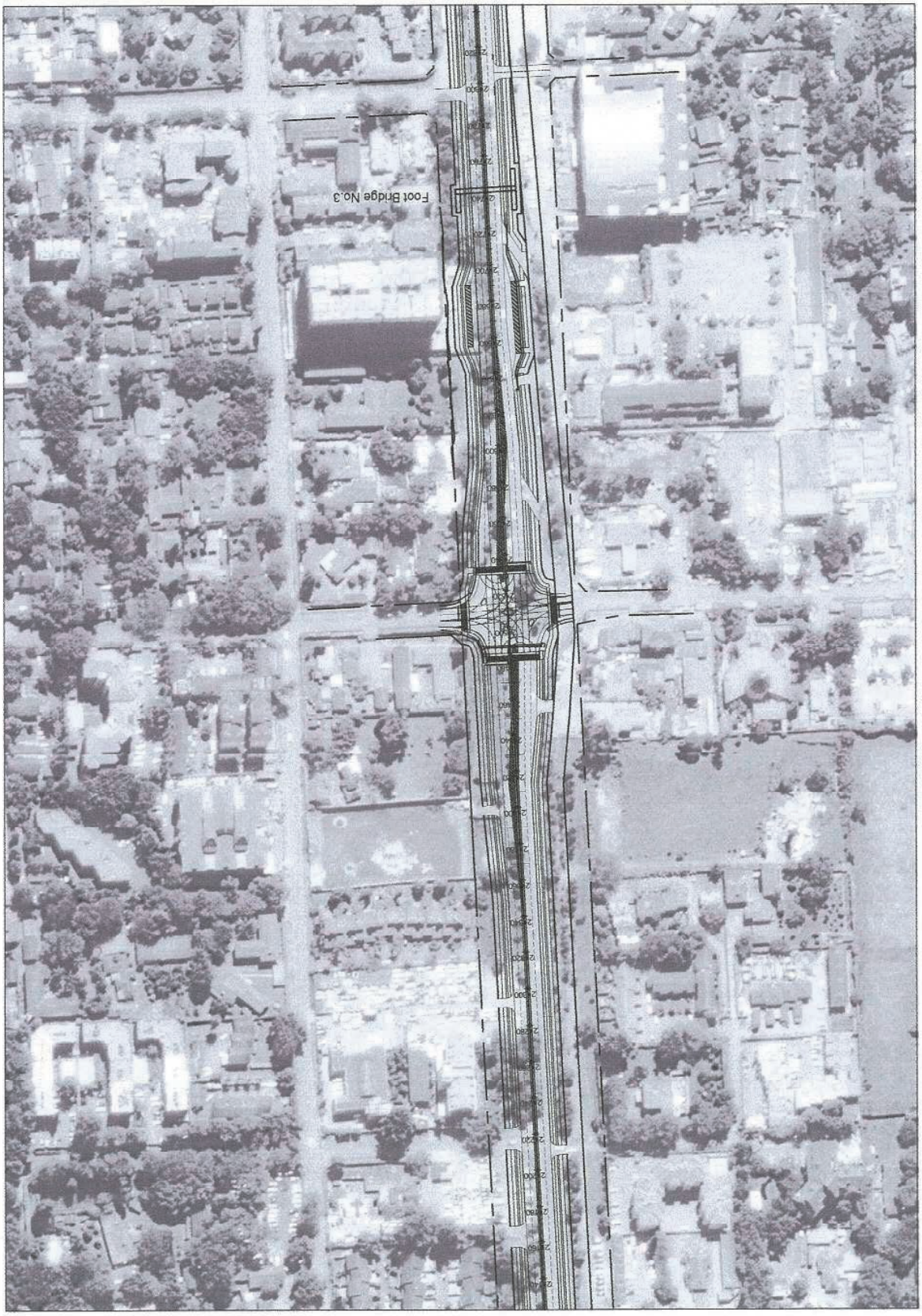

Foot Bridge No.1

Foot Bridge No.2


Foot Bridge No.3

Phase-I
Phase-I
STA. 3+420.000
Foot Bridge No.4

6. Environment and Socail Consideration

(1) Environmental Permit

Application Reference No. PR/7107

Registration No: 0008151

For official use

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY (NEMA)

THE ENVIRONMENTAL MANAGEMENT AND CO-ORDINATION ACT

ENVIRONMENTAL IMPACT ASSESSMENT LICENCE

This is to certify that the Project Report/Environmental Impact Assessment Study Report received from ..THE..PERMANENT..SECRETARY,MINISTRY..OF..ROADS..... (Name of individual/firm) .....P.O. BOX 30260-00100, NAIROBI..... (Address) submitted to the National Environment Management Authority in accordance with the Environmental Impact Assessment & Audit Regulations regarding ...PROPOSED UPGRADING OF ALL SAINTS CATHEDRAL ..JUNCTION-CITY-MORTUARY-DAGORETTI..CORNER-NGONG..TOWN...(C61/C60)...ROADS-KAREN BOMAS ROADS (title of project) whose objective is to carry on .....EXPANSION..OF..THE..ROAD..INTO..DUAL..... ..CARRIAGE..THROUGHOUT..... .... (briefly describe purpose) located at ...CITY..MORTUARY...-DAGORETTI..CORNER-NGONG..TOWN(C61/C60)...ROADS-KAREN-..... ..BOMAS..ROADS..... (locality and district) has been reviewed and a licence is hereby issued for implementation of the project, subject to attached conditions.

Dated this.....3RD.....day....MAR..... of 20..11..

Signature.....

(SEAL)

Director General

The National Environment Management Authority

CONDITIONS OF LICENCE

1. This licence is valid for a period of ....24 MONTHS..... (time within which the project should commence) from the date

1.0 General Conditions

1.1 The license shall be valid for 24 months from the date of issue.

1.2 Without prejudice to the other conditions of this license, the proponent shall implement and maintain an environmental management system, organizational structure and allocate resources that are sufficient to achieve compliance with the requirements and conditions of this license.

1.3 The Authority shall take appropriate action against the proponent in the event of breach of any of the conditions stated herein or any contravention to the Environmental Management and Coordination Act, 1999 and regulations thereunder.

1.4 This license shall not be taken as statutory defence against charges of environmental degradation or pollution in respect of any manner of degradation/pollution not specified herein.

1.5 The proponent shall ensure that records on conditions of licenses/approval and project monitoring and evaluation shall be kept on the project site for inspection by NEMA's Environmental Inspectors.

1.6 The proponent shall submit an Environmental Audit report in the first year of occupation/operations/commissioning to confirm the efficacy and adequacy of the Environmental Management Plan.

1.7 The proponent shall comply with NEMA's improvement orders throughout the project cycle.

1.8 The proponent shall ensure strict adherence to the Environmental Management Plan developed throughout the project cycle.

2.0 Construction Conditions

2.1 The proponent shall ensure storm drainage systems are installed and maintained.

2.2 The proponent shall ensure where construction materials are sourced are rehabilitated.

2.3 The proponent shall ensure that all excavated material and debris is collected, re-used and where need be, disposed off as per the Environmental Management and Coordination (Waste Management) Regulations of 2006.

2.4 The proponent shall ensure strict adherence to the provisions of Environmental Management and Coordination (Noise and Excessive Vibrations Pollution Control) Regulations of 2009.

2.5 The proponent shall ensure strict adherence to the Occupational Safety and Health Act (OSHA), 2007.

2.6 The proponent shall ensure that construction workers are provided with adequate personal protection equipment (PPE), sanitary facilities as well as adequate training.

2.7 The proponent shall ensure that construction activities are undertaken during the day (and not at night) between 08.00 hrs and 17.00 hrs; and that transportation of construction material to site are undertaken during weekdays (and not weekends) off peak hours.

2.8 The proponent shall ensure strict adherence to the Environmental Management Plan developed throughout the project cycle.

2.9 The proponent shall ensure that the development adheres to zoning specifications issued for development of such a project within the jurisdiction of the City Council of Nairobi, with emphasis on approved land use for the area.

2.10 The proponent shall ensure the road reserves are planted with vegetation to prevent soil erosion.

3.0 Operational Conditions

3.1 The proponent shall ensure vegetation destroyed will be restored once the road works are completed.

3.2 The proponent shall ensure that all waste water is disposed as per the standards set out in the Environmental Management and Coordination (Water Quality) Regulations of 2006.

3.3 The proponent shall ensure that rain water harvesting facilities are provided to supplement surface and ground water.

3.4 The proponent shall ensure that the road is watered frequently and dust is not a source of nuisance to road users as well as the neighbourhood.

3.5 The proponent shall ensure that appropriate functional efficient air pollution control mechanisms are installed in the facility to control all air emissions.

3.6 The proponent shall ensure that all equipment used are well maintained in accordance with the Environmental Management and Coordination (Noise and Excessive Vibration Pollution Control) Regulations of 2009.

3.7 The proponent shall ensure that all solid waste is handled in accordance with the Environmental Management and Coordination (Waste Management) Regulations of 2006.

3.8 The proponent shall ensure that all workers are well protected and trained as per the Occupational Safety and Health Act (OSHA) of 2007.

3.9 The proponent shall comply with the relevant principal laws, by-laws and guidelines issued for development of such a project within the jurisdiction of the City Council of Nairobi, Ministry Roads and other relevant Authorities.

3.10 The proponent shall ensure that environmental protection facilities or measures to prevent pollution and ecological deterioration such as storm drains, sprinkling of the roads with water, creation of diversions for road users are employed simultaneously with the proposed project.

4.0 Notification Conditions

4.1 The proponent shall seek written approval from the Authority for any operational changes under this license.

4.2 The proponent shall ensure that the Authority is notified of any malfunction of any system within 12 hours on the NEMA hotline No. **020 6006041** and mitigation measures put in place.

4.3 The proponent shall keep a record of all pollution incidences and notify the Authority with 24 hours.

4.4 The proponent shall notify the Authority in writing of its intent to decommission the facility **three (3) months** in advance.

5.0 Decommissioning Conditions

5.1 The proponent shall ensure that a decommissioning plan is submitted to the Authority for approval at least three (3) months prior to decommissioning.

5.2 The proponent shall ensure that all pollutants and polluted material is contained and adequate mitigation measures provided during the phase.

6. Environment and Socail Consideration
(1) Environmental Permit for Extension

Application Reference No: PR/7107
Certificate No: 0001577
For official use

THE ENVIRONMENTAL MANAGEMENT AND COORDINATION ACT

CERTIFICATE OF VARIATION OF ENVIRONMENTAL IMPACT ASSESSMENT LICENCE

This is to certify that the Environmental Impact Assessment Licence No: **0008151**
Issued on **3rd March 2011** (date) to **The Permanent Secretary, Ministry of Roads** (name of individual/firm)
of **P. O. Box 30260-00100, Nairobi** (address) regarding
Proposed Upgrading of all Saints Cathedral to Bomas Roads (title of project)
whose objective is to **Expansion of the road into dual carriage throughout**
(briefly describe purpose)
located at **Dagoretti Corner-Ngong Town (C61/C60) Roads-Karen Bomas Roads** (locality and district) has been varied to **Extension of EIA license validity period by an additional 24 months**
(nature of variation) With effect from **1st August, 2014** (date of variation) in accordance with the provisions of the Act.

Dated this **1st** day of **Aug** 20**14**

Signature

(SEAL)

Director General
The National Environment Management Authority

GPK (L)

(2) The result of Fauna Survey

The result of fauna survey

Taxa	Common name	Species	Trend	Status
Bird	Common Bulbul	*Pycnonotus barbatus*	increasing	Least Concern
Bird	Hadada Ibis	*Bostrychia hagedash*	increasing	Least Concern
Bird	Baglafecht Weaver	*Ploceus baglafecht*	stable	Least Concern
Bird	Emerald-spottedWood-dove	*Turtur chalcospilos*	stable	Least Concern
Bird	Scarlet-chested Sunbird	*Nectarinia senegalensis*	stable	Least Concern
Bird	African Palm-swift	*Cypsiurus parvus*	increasing	Least Concern
Bird	Firefinch	*Lagonosticta rubricata*	increasing	Least Concern
Bird	Pied Crow	*Corvus albus*	stable	Least Concern
Snake	Black Mamba	*Dendroaspis polylepis*	stable	Least Concern
Lizard	Mabuya striata	*Trachylepis punctatissima*	stable	Least Concern
Butterfly	Dark Blue Pansy	*Junonia oenone*	unknown	Least Concern

(3) The result of Flora Survey

The result of flora survey

Trees species found along Ngong Road, road reserve between the Uchumi Ngong Hyper Supermarket and the Nairobi City Council Ngong Road Senior Staff Houses entrance						
Block 1: Between Uchumi Ngong Hyper supermarket and Ring Road Kilimani						
Botanical name	Common/Local Name	Family	Habit	Origin	Count	Block
Trichilia emetica	Cape mahogany, Mururi	Meliaceae	Tree	Indigenous	1	1R
Cupressus lusitanica	Mexican cypress	Cupressaceae	Tree	Exotic	2	1R
Acacia xanthophloea	Fever tree, Naivasha thorn	Mimosaceae	Tree	Indigenous	1	1R
Melaleuca armillaris	Honey myrtle	Myrtaceae	Tree	Exotic	1	1R
Grevillea robusta	Silk oak, Mukima	Proteaceae	Tree	Exotic	11	1R
Bauhinia tomentosa	Camel's foot	Caesalpiniaceae	Shrub	Exotic	1	1R
Ficus benjamina	Java fig, Weeping fig	Moraceae	Tree	Exotic	15	1R
Psidium guajava	Guava	Myrtaceae	Tree	Exotic	1	1R
Syzygium cumini	Mzambarao	Myrtaceae	Tree	Exotic	2	1R
Schinus molle	Pepper tree	Anacardiaceae	Tree	Exotic	1	1R
Erythrina lysistemon	Lucky bean tree	Papilionaceae	Tree	Exotic	1	1R
Croton megalocarpus	Mukinduri	Euphorbiaceae	Tree	Indigenous	4	1R
Eucalyptus sp.	Blue gum	Myrtaceae	Tree	Exotic	3	1R
Tipuana tipu	Pride of Bolivia, Tipu tree	Papilionaceae	Tree	Exotic	1	1R
Spathodea campanulata	Nandi flame	Bignoniaceae	Tree	Indigenous	1	1R
Jacaranda mimosifolia	Jacaranda	Bignoniaceae	Tree	Exotic	1	1R
Elaeodendron buchananii	Mutanga	Celastraceae	Tree	Indigenous	6	1R
Prunus serotina	Wild black cherry	Rosaceae	Tree	Exotic	1	1R
Brachychiton acerifolium	Australian flame tree	Sterculiaceae	Tree	Exotic	1	1R
Warburgia ugandensis	E.A. Greenheart, Muthiga	Canellaceae	Tree	Indigenous	2	1R
Sub-Total – Right side					57	
Eucalyptus sp.	Blue gum	Myrtaceae	Tree	Exotic	2	1L
Casuarina cunninghamiana	River oak	Casuarinaceae	Tree	Exotic	2	1L
Grevillea robusta	Silk oak, Mukima	Proteaceae	Tree	Exotic	20	1L
Fraxinus pennsylvanica	Mexican ash, Green ash	Oleaceae	Tree	Exotic	2	1L
Duranta erecta	Golden dew drop	Verbenaceae	Shrub	Exotic	7	1L
Bridelia micrantha	Mukoigo	Euphorbiaceae	Tree	Indigenous	3	1L
Podocarpus falcatus	Podo, Muthengera	Podocarpaceae	Tree	Indigenous	6	1L
Melaleuca armillaris	Honey myrtle	Myrtaceae	Tree	Exotic	1	1L
Ficus benjamina	Java fig, Weeping fig	Moraceae	Tree	Exotic	7	1L
Warburgia ugandensis	E.A. Greenheart, Muthiga	Canellaceae	Tree	Indigenous	4	1L
Olea europaea ssp. cuspidata	Brown olive, Mutamaiyu	Oleaceae	Tree	Indigenous	6	1L
Jacaranda mimosifolia	Jacaranda	Bignoniaceae	Tree	Exotic	1	1L
Terminalia mentaly	Madagascar terminalia	Combretaceae	Tree	Exotic	1	1L
Euphorbia mauritanica	Yellow milkbush	Euphorbiaceae	Shrub	Exotic	2	1L
Hibiscus rosa-sinensis	China rose	Malvaveae	Shrub	Exotic	5	1L
Senna spctabilis	Yellow shower	Caesalpiniaceae	Tree	Exotic	1	1L
Ficus sycomorus	Sycamore fig	Moraceae	Tree	Indigenous	2	1L
Vitex keniensis	Meru oak, Muhuru	Verbenaceae	Tree	Indigenous	1	1L
Aloe kedongensis	Aloe	Aloaceae	Shrub	Indigenous	4	1L
Markhamia lutea	Markhamia	Bignoniaceae	Tree	Indigenous	2	1L
Synadenium compactum	Watha	Euphorbiaceae	Shrub	Indigenous	2	1L
Filicium decipiens	Thika palm	Sapindaceae	Tree	Indigenous	1	1L
Croton megalocarpus	Mukinduri	Euphorbiaceae	Tree	Indigenous	4	1L
Euphorbia mauritanica	Yellow milkbush	Euphorbiaceae	Shrub	Exotic	2	1L
Sub-Total – Left side					88	
Block 2: Between Ring Road Kilimani and Elegeyo Marakwet Road (AdamsArcade Roundabout)						
Spathodea campanulata	Nandi Flame	Bignoniaceae	Tree	Indigenous	11	2R
Melaleuca armillaris	Honey myrtle	Myrtaceae	Tree	Exotic	4	2R
Grevillea robusta	Silk oak, Mukima	Proteaceae	Tree	Exotic	58	2R
Jacaranda mimosifolia	Jacaranda	Bignoniaceae	Tree	Exotic	29	2R
Eucalyptus saligna	Blue gum	Myrtaceae	Tree	Exotic	3	2R
Duranta erecta	Golden dew drop	Verbenaceae	Shrub	Exotic	Hedge	2R
Hibiscus rosa-sinensis	China rose	Malvaceae	Shrub	Exotic	4	2R
Casuarina cunninghamiana	River oak	Casuarinaceae	Tree	Exotic	9	2R
Tipuana tipu	Pride of Bolivia, Tipu tree	Papilionaceae	Tree	Exotic	3	2R
Markhamia lutea	Muu, Lusiola	Bignoniaceae	Tree	Indigenous	5	2R
Eucalyptus sp.	Blue gum	Myrtaceae	Tree	Exotic	10	2R
Schinus molle	Pepper tree	Anacardiaceae	Tree	Exotic	3	2R
Senna spectabilis	Yellow shower	Caesalpiniaceae	Tree	Exotic	14	2R
Tipuana tipu	Pride of Bolivia, Tipu tree	Papilionaceae	Tree	Exotic	3	2R
Markhamia lutea	Muu, Lusiola	Bignoniaceae	Tree	Indigenous	5	2R
Eucalyptus sp.	Blue gum	Myrtaceae	Tree	Exotic	10	2R
Schinus molle	Pepper tree	Anacardiaceae	Tree	Exotic	3	2R
Senna spectabilis	Yellow shower	Caesalpiniaceae	Tree	Exotic	14	2R
Eucalyptus sp.	Blue gum	Myrtaceae	Tree	Exotic	10	2R

Botanical name	Common/Local Name	Family	Habit	Origin	Count	Block
Schinus molle	Pepper tree	Anacardiaceae	Tree	Exotic	3	2R
Senna spectabilis	Yellow shower	Caesalpiniaceae	Tree	Exotic	14	2R
Hamelia patens	Firebush	Rubiaceae	Shrub	Exotic	4	2R
Ficus thonningii	Stragler fig, Mugumo	Moraceae	Tree	Indigenous	1	2R
Eucalyptus sp.	Blue gum	Myrtaceae	Tree	Exotic	3	2R
Cupressus lusitanica	Mexican cypress	Cupressaceae	Tree	Exotic	1	2R
Acacia gerrardii	Gerrard's acacia	Mimosaceae	Tree	Indigenous	1	2R
Acrocarpus fraxinifolius	Indian ash, Shingle tree	Caesalpiniaceae	Tree	Exotic	3	2R
Ficus benjamina	Java fig, Weeping fig	Moraceae	Tree	Exotic	3	2R
Tecomaria capensis	Cape honeysuckle	Bignoniaceae	Shrub	Exotic	Hedge	2R
Erythrina lysistemon	Lucky bean tree	Papilionaceae	Tree	Exotic	1	2R
Warburgia ugandensis	E.A. Greenheart, Muthiga	Canellaceae	Tree	Indigenous	1	2R
Hibiscus rosa-sinensis	China rose	Malvaveae	Shrub	Exotic	4	2R
Sub-Total - Right side					237	
Ceiba speciosa	Bombax, Chorisia	Bombacaceae	Tree	Exotic	6	2L
Cordia africana	Cordia, Muringa	Boraginaceae	Tree	Indigenous	1	2L
Croton megalocarpus	Mukinduri	Euphorbiaceae	Tree	Indigenous	4	2L
Senna spectabilis	Yellow shower	Caesalpiniaceae	Tree	Exotic	1	2L
Markhamia lutea	Muu, Lusiola	Bignoniaceae	Tree	Indigenous	6	2L
Fraxinus pennsylvanica	Mexican ash, Green ash	Oleaceae	Tree	Exotic	33	2L
Tecoma stans	Tecoma	Bignoniaceae	Shrub	Exotic	1	2L
Croton megalocarpus	Mukinduri	Euphorbiaceae	Tree	Indigenous	2	2L
Nerium oleander	Oleander	Apocynaceae	Shrub	Exotic	1	2L
Craibia brownii	Mukubu, Craibia	Papilionaceae	Tree	Indigenous	1	2L
Bambusa vulgaris	Golden Bamboo	Gramineae	Tree	Exotic	3	2L
Tipuana tipu	Pride of Bolivia, Tipu tree	Papilionaceae	Tree	Exotic	1	2L
Eriobotrya japonica	Loquat	Rosaceae	Tree	Exotic	4	2L
Jacaranda mimosifolia	Jacaranda	Bignoniaceae	Tree	Exotic	9	2L
Grevillea robusta	Silk oak, Mukima	Proteaceae	Tree	Exotic	37	2L
Mangifera indica	Mango	Anacardiaceae	Tree	Exotic	1	2L
Hibiscus rosa-sinensis	China rose	Malvaceae	Shrub	Exotic	1	2L
Cupressus lusitanica	Mexican cypress	Cupressaceae	Tree	Exotic	2	2L
Hamelia patens	Firebush	Rubiaceae	Shrub	Exotic	1	2L
Ficus benjamina	Java fig, Weeping fig	Moraceae	Tree	Exotic	12	2L
Podocarpus falcatus	Podo, Muthengera	Podocarpaceae	Tree	Indigenous	3	2L
Eucalyptus sp.	Blue gum	Myrtaceae	Tree	Exotic	1	2L
Euphorbia cotinifolia	Red euphorbia	Euphorbiaceae	Shrub	Exotic	1	2L
Psidium guajava	Guava	Myrtaceae	Tree	Exotic	2	2L
Morus alba	Mulberry	Moraceae	Shrub	Exotic	1	2L
Acacia kirkii	Kirk's acacia	Mimosaceae	Tree	Indigenous	1	2L
Albizia gummifera	Mukurue	Mimosaceae	Tree	Indigenous	1	2L
Duranta erecta	Golden dew drop	Verbenaceae	Shrub	Exotic	Hedge	2L
Melaleuca armillaris	Honey myrtle	Myrtaceae	Shrub	Exotic	1	2L
Bridelia micrantha	Mukoigo	Euphorbiaceae	Tree	Indigenous	2	2L
Callistemon citrinus	Scarlet bottlebrush	Myrtaceae	Tree	Exotic	1	2L
Sub-Total - Left side					141	
Block 3: Between Elegeyo Marakwet Road and Ndemi Road						
Spathodea campanulata	Nandi flame	Bignoniaceae	Tree	Indigenous	6	3R
Warburgia ugandensis	E.A. Greenheart, Muthiga	Canellaceae	Tree	Indigenous	7	3R
Jacaranda mimosifolia	Jacaranda	Bignoniaceae	Tree	Exotic	21	3R
Olea europaea ssp. cuspidata	Brown olive, Mutamaiyu	Oleaceae	Tree	Indigenous	5	3R
Phoenix reclinata	Wild date palm	Palmae	Palm	Indigenous	5	3R
Agave americana	American aloe	Agavaceae	Shrub	Exotic	2	3R
Bridelia micrantha	Mukoigo	Euphorbiaceae	Tree	Indigenous	1	3R
Ficus benjamina	Java fig, Weeping fig	Moraceae	Tree	Exotic	4	3R
Callistemon citrinus	Scarlet bottlebrush	Myrtaceae	Tree	Exotic	8	3R
Schinus molle	Pepper tree	Anacardiaceae	Tree	Exotic	2	3R
Ficus thonningii	Stragler fig, Mugumo	Moraceae	Tree	Indigenous	3	3R
Solanum mauritianum	Asian bug tree	Solanaceae	Shrub	Exotic	2	3R
Plumeria rubra	Frangipani	Apocynaceae	Shrub	Exotic	4	3R
Croton megalocarpus	Mukinduri	Euphorbiaceae	Tree	Indigenous	1	3R
Duranta erecta	Golden dew drop	Verbenaceae	Shrub	Exotic	Hedge	3R
Ocimum suave	Ocimmum	Labiatae	Shrub	Indigenous	2	3R
Grevillea robusta	Silk oak, Mukima	Proteaceae	Tree	Exotic	1	3R
Erythrococca bongensis	Muhara-ngware	Euphorbiaceae	Shrub	Indigenous	1	3R
Ficus benjamina	Java fig, Weeping fig	Moraceae	Tree	Exotic	1	3R
Melaleuca armillaris	Honey myrtle	Myrtaceae	Shrub	Exotic	4	3R
Acacia gerrardii	Gerrard's acacia	Mimosaceae	Tree	Indigenous	1	3R
Ficus sycomorus	Sycamore fig	Moraceae	Tree	Indigenous	1	3R
Ehretia cymosa	Murembu	Boraginaceae	Tree	Indigenous	1	3R
Schefflera actinophylla	Octopus tree	Araliaceae	Tree	Exotic	1	3R

Botanical name	Common/Local Name	Family	Habit	Origin	Count	Block
Manihot glaziovii	Tree casava	Euphorbiaceae	Shrub	Exotic	1	3R
Euphorbia mauritanica	Yellow milkbush	Euphorbiaceae	Shrub	Exotic	1	3R
Acacia mearnsii	Black wattle	Mimosaceae	Tree	Exotic	1	3R
Sub-Total - Right side					87	
Markhamia lutea	Muu, Lusiola	Bignoniaceae	Tree	Indigenous	19	3L
Spathodea campanulata	Nandi Flame	Bignoniaceae	Tree	Indigenous	2	3L
Ficus benjamina	Java fig, Weeping fig	Moraceae	Tree	Exotic	3	3L
Warburgia ugandensis	E.A. Greenheart, Muthiga	Canellaceae	Tree	Indigenous	4	3L
Podocarpus falcatus	Podo, Muthengera	Podocarpaceae	Tree	Indigenous	11	3L
Olea europaea ssp. cuspidata	Brown olive, Mutamaiyu	Oleaceae	Tree	Indigenous	10	3L
Grevillea robusta	Silk oak, Mukima	Proteaceae	Tree	Exotic	34	3L
Acacia polyacantha	Falcon's claw acacia	Mimosaceae	Tree	Indigenous	1	3L
Erythrococca bongensis	Muhara-ngware	Euphorbiaceae	Shrub	Indigenous	1	3L
Sesbania sesban	Sesbania, River bean	Papilionaceae	Shrub	Indigenous	1	3L
Acacia xanthophloea	Fever tree, Naivasha thorn	Mimosaceae	Tree	Indigenous	1	3L
Fraxinus pennsylvanica	Mexican ash, Green ash	Oleaceae	Tree	Exotic	10	3L
Cordia africana	Cordia, Muringa	Boraginaceae	Tree	Indigenous	1	3L
Erythrina lysistemon	Lucky bean tree	Papilionaceae	Tree	Exotic	1	3L
Croton megalocarpus	Mukinduri	Euphorbiaceae	Tree	Indigenous	1	3L
Bridelia micrantha	Mukoigo	Euphorbiaceae	Tree	Indigenous	4	3L
Acalypha wilkesiana	Copperleaf	Euphorbiaceae	Shrub	Exotic	3	3L
Solanum mauritianum	Asian bug tree	Solanaceae	Shrub	Exotic	1	3L
Melaleuca armillaris	Honey myrtle	Myrtaceae	Shrub	Exotic	1	3L
Ensete ventricosa	Wild banana	Musaceae	Shrub	Indigenous	1	3L
Casuarina cunninghamiana	Casuarina	Casuarinaceae	Tree	Exotic	1	3L
Dracaena fragrans	Cornstalk dracaena	Dracaenaceae	Shrub	Indigenous	1	3L
Schefflera actinophylla	Octopus tree	Araliaceae	Tree	Exotic	1	3L
Euphorbia pulcherrima	Poinsettia	Euphorbiaceae	Shrub	Exotic	4	3L
Sub-Total -Left side					117	
Block 4: Between Ndemi Road and Ole Odume Road						
Albizia gummifera	Mukurue	Mimosaceae	Shrub	Indigenous	1	4R
Eucalyptus sp.	Blue gum	Myrtaceae	Tree	Exotic	4	4R
Cupressus lusitanica	Mexican cypress	Cupressaceae	Tree	Exotic	5	4R
Markhamia lutea	Muu, Lusiola	Bignoniaceae	Tree	Indigenous	4	4R
Olea europaea ssp. cuspidata	Brown olive, Mutamaiyu	Oleaceae	Tree	Indigenous	4	4R
Warburgia ugandensis	E.A. Greenheart, Muthiga	Canellaceae	Tree	Indigenous	4	4R
Schinus molle	Pepper tree	Anacardiaceae	Tree	Exotic	1	4R
Syagrus romanzoffiana	Queen palm	Palmae	Palm	Exotic	2	4R
Grevillea robusta	Silk oak, Mukima	Proteaceae	Tree	Indigenous	9	4R
Jacaranda mimosifolia	Jacaranda	Bignoniaceae	Tree	Exotic	2	4R
Brachychiton acerifolium	Australian flame tree	Sterculiaceae	Tree	Exotic	1	4R
Spathodea campanulata	Nandi flame	Bignoniaceae	Tree	Indigenous	6	4R
Plumeria rubra	Frangipani	Apocynaceae	Shrub	Exotic	6	4R
Grewia similis	Grewia, Mutheregendi	Tiliaceae	Shrub	Indigenous	1	4R
Filicium decipiens	Thika palm	Sapindaceae	Tree	Indigenous	2	4R
Maytenus heterophylla	Muthuthi	Celastraceae	Shrub	Indigenous	1	4R
Melaleuca armillaris	Honey myrtle	Myrtaceae	Shrub	Exotic	3	4R
Erythrococca bongensis	Muhara-ngware	Euphorbiaceae	Shrub	Indigenous	1	4R
Ficus thonningii	Stragler fig, Mugumo	Moraceae	Tree	Indigenous	3	4R
Archontophoenix alexadrae	Alexandra palm, King palm	Palmae	Palm	Exotic	4	4R
Agave americana	American aloe	Agavaceae	Shrub	Exotic	2	4R
Casuarina cunninghamiana	Casuarina	Casuarinaceae	Tree	Exotic	5	4R
Erythrina lysistemon	Lucky bean tree	Papilionaceae	Tree	Exotic	1	4R
Podocarpus falcatus	Podo, Muthengera	Podocarpaceae	Tree	Indigenous	2	4R
Sub-Total - Right side					74	
Grevillea robusta	Silk oak, Mukima	Proteaceae	Tree	Exotic	15	4L
Fraxinus pennsylvanica	Mexican ash, Green ash	Oleaceae	Tree	Exotic	17	4L
Jacaranda mimosifolia	Jacaranda	Bignoniaceae	Tree	Exotic	8	4L
Terminalia mentaly	Madagascar terminalia	Combretaceae	Tree	Exotic	1	4L
Melaleuca armillaris	Honey myrtle	Myrtaceae	Shrub	Exotic	16	4L
Schinus terebinthifolius	Brazillian pepper tree	Anacardiaceae	Tree	Exotic	3	4L
Erythrina lysistemon	Lucky bean tree	Papilionaceae	Tree	Exotic	1	4L
Ficus benjamina	Java fig, Weeping fig	Moraceae	Tree	Exotic	24	4L
Schinus molle	Pepper tree	Anacardiaceae	Tree	Exotic	3	4L
Nerium oleander	Oleander	Apocynaceae	Shrub	Exotic	6	4L
Trichilia emetica	Cape mahogany, Mururi	Meliaceae	Tree	Indigenous	2	4L
Yucca gloriosa	Adam's needle	Agavaceae	Shrub	Exotic	2	4L
Phoenix reclinata	Wild date palm	Palmae	Palm	Indigenous	1	4L
Spathodea campanulata	Nandi flame	Bignoniaceae	Tree	Indigenous	1	4L
Tipuana tipu	Pride of Bolivia, Tipu tree	Papilionaceae	Tree	Exotic	1	4L
Filicium decipiens	Thika palm	Sapindaceae	Tree	Indigenous	2	4L

Botanical name	Common/Local Name	Family	Habit	Origin	Count	Block
Hibiscus rosa-sinensis	China rose	Malvaceae	Shrub	Exotic	2	4L
Syzygium cumini	Msambarao, Java plum	Myrtaceae	Tree	Exotic	1	4L
Thevetia peruviana	Thevetia, Yellow oleander	Apocynaceae	Shrub	Exotic	2	4L
Croton megalocarpus	Mukinduri	Euphorbiaceae	Tree	Indigenous	8	4L
Acacia kirkii	Kirk's acacia	Mimosaceae	Tree	Indigenous	2	4L
Markhamia lutea	Muu, Lusiola	Bignoniaceae	Tree	Indigenous	12	4L
Craibia brownii	Mukubu, Craibia	Papilionaceae	Tree	Indigenous	1	4L
Callistemon citrinus	Scarlet bottlebrush	Myrtaceae	Tree	Exotic	20	4L
Bauhinia tomentosa	Camel's foot	Caesalpiniaceae	Shrub	Indigenous	1	4L
Sub-Total - Left side					152	
Block 5 - Between Ole Odume Road and Makindi Road						
Ceiba speciosa	Bombax, Chorisia	Bombacaceae	Tree	Exotic	3	5R
Aleurites moluccana	Candlenut tree	Euphorbiaceae	Tree	Exotic	2	5R
Podocarpus falcatus	Podo, Muthengera	Podocarpaceae	Tree	Indigenous	2	5R
Melaleuca armillaris	Honey myrtle	Myrtaceae	Shrub	Exotic	19	5R
Grevillea robusta	Silk oak, Mukima	Proteaceae	Tree	Exotic	14	5R
Acrocarpus fraxinifolius	Indian ash, Shingle tree	Caesalpiniaceae	Tree	Exotic	3	5R
Jacaranda mimosifolia	Jacaranda	Bignoniaceae	Tree	Exotic	17	5R
Erythrina abyssinica	Red-hot poker tree	Papilionaceae	Tree	Indigenous	1	5R
Ehretia cymosa	Murembu	Boraginaceae	Tree	Indigenous	1	5R
Acacia gerrardii	Gerrard's acacia	Mimosaceae	Tree	Indigenous	1	5R
Ficus benjamina	Java fig, Weeping fig	Moraceae	Tree	Exotic	13	5R
Ficus elastica	Indian rubber plant	Moraceae	Tree	Exotic	2	5R
Markhamia lutea	Muu, Lusiola	Bignoniaceae	Tree	Exotic	10	5R
Syncarpia glomulifera	Turpentine wood	Myrtaceae	Tree	Exotic	1	5R
Syzygium cumini	Msambarao, Java plum	Myrtaceae	Tree	Exotic	1	5R
Ficus thonningii	Stragler fig, Mugumo	Moraceae	Tree	Indigenous	1	5R
Olea europaea ssp. cuspidata	Brown olive, Mutamaiyu	Oleaceae	Tree	Indigenous	12	5R
Opuntia vulgaris	Cactus	Cactaceae	Shrub	Exotic	3	5R
Senna spectabilis	Yellow shower	Caesalpiniaceae	Tree	Exotic	2	5R
Eucalyptus sp.	Blue gum	Myrtaceae	Tree	Exotic	2	5R
Solanum mauritianum	Asian bug tree	Solanaceae	Shrub	Exotic	5	5R
Manihot glaziovii	Tree casava	Euphorbiaceae	Shrub	Exotic	9	5R
Tipuana tipu	Pride of Bolivia, Tipu tree	Papilionaceae	Tree	Exotic	2	5R
Spathodea campanulata	Nandi Flame	Bignoniaceae	Tree	Indigenous	5	5R
Schinus molle	Pepper tree	Anacardiaceae	Tree	Exotic	6	5R
Senna septemtrionalis	Mucingiri	Caesalpiniaceae	Shrub	Indigenous	1	5R
Eriobotrya japonica	Loquat	Rosaceae	Tree	Exotic	2	5R
Croton megalocarpus	Mukinduri	Euphorbiaceae	Tree	Indigenous	5	5R
Croton macrostachyus	Mutundu	Euphorbiaceae	Tree	Indigenous	1	5R
Acacia mearnsii	Black wattle	Mimosaceae	Tree	Exotic	6	5R
Schrebera alata	Schrebera, wooden-pear	Oleaceae	Tree	Indigenous	1	5R
Lantana camara	Curse of India	Verbenaceae	Shrub	Exotic	1	5R
Acacia kirkii	Kirk's acacia	Mimosaceae	Tree	Indigenous	1	5R
Melia azedarach	Persian lilac, Chinaberry	Meliaceae	Tree	Exotic	1	5R
Ficus benjamina	Java fig, Weeping fig	Moraceae	Tree	Exotic	6	5R
Cordia africana	Cordia, Muringa	Boraginaceae	Tree	Indigenous	6	5R
Acacia xanthophloea	Fever tree, Naivasha thorn	Mimosaceae	Tree	Indigenous	3	5R
Erythrina lysistemon	Lucky bean tree	Papilionaceae	Tree	Exotic	1	5R
Casuarina cunninghamiana	Casuarina	Casuarinaceae	Tree	Exotic	2	5R
Erythrococca bongensis	Muhara-ngware	Euphorbiaceae	Shrub	Indigenous	2	5R
Caesalpinia spinosa	Caesalpinia	Caesalpiniaceae	Shrub	Exotic	1	5R
Senna didymobotrya	Candle bush, Mwinu	Caesalpiniaceae	Shrub	Indigenous	1	5R
Sub-Total - Right side					178	
Podocarpus falcatus	Podo, Muthengera	Podocarpaceae	Tree	Indigenous	11	5L
Grevillea robusta	Silk oak, Mukima	Proteaceae	Tree	Exotic	58	5L
Sesbania sesban	Sesbania, River bean	Papilionaceae	Shrub	Indigenous	3	5L
Jacaranda mimosifolia	Jacaranda	Bignoniaceae	Tree	Exotic	3	5L
Prunus africana	Red stinkwood	Rosaceae	Tree	Indigenous	1	5L
Olea capensis ssp. welwitschi	Elgon olive	Oleaceae	Tree	Indigenous	4	5L
Markhamia lutea	Muu, Lusiola	Bignoniaceae	Tree	Indigenous	7	5L
Fraxinus pennsylvanica	Mexican ash, Green ash	Oleaceae	Tree	Exotic	8	5L
Warburgia ugandensis	E.A. Greenheart, Muthiga	Canellaceae	Tree	Indigenous	6	5L
Filicium decipiens	Thika palm	Sapindaceae	Tree	Indigenous	3	5L
Schinus molle	Pepper tree	Anacardiaceae	Tree	Exotic	10	5L
Vitex keniensis	Meru oak, Muhuru	Verbenaceae	Tree	Indigenous	1	5L
Spathodea campanulata	Nandi flame	Bignoniaceae	Tree	Indigenous	4	5L
Ficus benjamina	Java fig, Weeping fig	Moraceae	Tree	Exotic	13	5L
Acacia polyacantha	Falcon's claw acacia	Mimosaceae	Tree	Indigenous	1	5L
Erythrina lysistemon	Lucky bean tree	Papilionaceae	Tree	Exotic	1	5L
Brachychiton polpulneum	Bottle tree	Sterculiaceae	Tree	Exotic	1	5L

Botanical name	Common/Local Name	Family	Habit	Origin	Count	Block
Sub-Total - Left side					135	
Block 6 Between Makindi Road and Dagoretti Corner Roundabout						
Grevillea robusta	Silk oak, Mukima	Proteaceae	Tree	Exotic	13	6R
Senna spectabilis	Yellow shower	Caesalpiniaceae	Tree	Exotic	3	6R
Jacaranda mimosifolia	Jacaranda	Bignoniaceae	Tree	Exotic	6	6R
Podocarpus falcatus	Podo, Muthengera	Podocarpaceae	Tree	Indigenous	5	6R
Schinus molle	Pepper tree	Anacardiaceae	Tree	Exotic	1	6R
Casuarina cunninghamiana	Casuarina	Casuarinaceae	Tree	Exotic	20	6R
Melaleuca armillaris	Honey myrtle	Myrtaceae	Shrub	Exotic	6	6R
Croton megalocarpus	Mukinduri	Euphorbiaceae	Tree	Indigenous	13	6R
Ficus benjamina	Java fig, Weeping fig	Moraceae	Tree	Exotic	1	6R
Filicium decipiens	Thika palm	Sapindaceae	Tree	Indigenous	17	6R
Spathodea campanulata	Nandi flame	Bignoniaceae	Tree	Indigenous	4	6R
Duranta erecta	Golden dew drop	Verbenaceae	Shrub	Exotic	Hedge	6R
Eucalyptus sp.	Blue gum	Myrtaceae	Tree	Exotic	2	6R
Acacia xanthophloea	Fever tree, Naivasha thorn	Mimosaceae	Tree	Indigenous	6	6R
Phoenix reclinata	Wild date palm	Palmae	Palm	Indigenous	3	6R
Euphorbia cotinifolia	Red euphorbia	Euphorbiaceae	Shrub	Exotic	10	6R
Hibiscus rosa-sinensis	China rose	Malvaceae	Shrub	Exotic	20	6R
Albizia schimperiana	Long-podded albizia	Mimosaceae	Tree	Indigenous	2	6R
Yucca gloriosa	Adam's needle	Agavaceae	Shrub	Exotic	1	6R
Fraxinus pennsylvanica	Mexican ash, Green ash	Oleaceae	Tree	Exotic	6	6R
Eriobotrya japonica	Loquat	Rosaceae	Tree	Exotic	2	6R
Acacia melanoxylon	Australian blackwood	Mimosaceae	Tree	Exotic	1	6R
Brachychiton acerifolium	Australian flame tree	Sterculiaceae	Tree	Exotic	1	6R
Roystonea regia	Royal palm	Palmae	Palm	Exotic	2	6R
Archontophoenix alexadrae	Alexandra palm, King palm	Palmae	Palm	Exotic	5	6R
Aleurites moluccana	Candlenut tree	Euphorbiaceae	Tree	Exotic	7	6R
Bougainvillea glabra	Bouganvillea	Nyctaginaceae	Shrub	Exotic	Hedge	6R
Lantana sp.	Lantana	Verbenaceae	Shrub	Exotic	2	6R
Nerium oleander	Oleander	Apocynaceae	Shrub	Exotic	5	6R
Persea americana	Avocado	Lauraceae	Tree	Exotic	1	6R
Mangifera indica	Mango	Anacardiaceae	Tree	Exotic	1	6R
Duranta erecta	Golden dew drop	Verbenaceae	Shrub	Exotic	Hedge	6R
Araucaria columnaris	Cook's araucaria	Araucariaceae	Tree	Exotic	2	6R
Terminalia mentaly	Madagascar terminalia	Combretaceae	Tree	Exotic	1	6R
Thevetia peruviana	Thevetia, Yellow oleander	Apocynaceae	Shrub	Exotic	3	6R
Ravenala madagascariensis	Traveller's palm	Strelitziaceae	Shrub	Exotic	2	6R
Syagrus romanzoffiana	Queen palm	Palmae	Palm	Exotic	4	6R
Yucca gloriosa	Adam's needle	Agavaceae	Shrub	Exotic	1	6R
Acacia kirkii	Kirk's acacia	Mimosaceae	Tree	Indigenous	2	6R
Strelitzia augusta	Great white strelitzia	Strelitziaceae	Shrub	Exotic	2	6R
Hamelia patens	Firebush	Rosaceae	Shrub	Exotic	2	6R
Aloe sp.	Aloe	Aloeaceae	Shrub	Indigenous	2	6R
Sansevieria conspicua	Sansevieria	Agavaceae	Shrub	Indigenous	6	6R
Sub-Total - Right side					193	
Grevillea robusta	Silk oak, Mukima	Proteaceae	Tree	Exotic	67	6L
Acacia mearnsii	Black wattle	Mimosaceae	Tree	Exotic	5	6L
Caesalpinia spinosa	Caesalpinia	Caesalpiniaceae	Shrub	Exotic	2	6L
Schrebera alata	Schrebera, wooden-pear	Oleaceae	Tree	Indigenous	1	6L
Spathodea campanulata	Nandi Flame	Bignoniaceae	Tree	Indigenous	28	6L
Dracaena fragrans	Cornstalk dracaena	Dracaenaceae	Shrub	Indigenous	1	6L
Markhamia lutea	Muu, Lusiola	Bignoniaceae	Tree	Indigenous	9	6L
Senna spectabilis	Yellow shower	Caesalpiniaceae	Tree	Exotic	4	6L
Tecomaria capensis	Tecomaria	Bignoniaceae	Shrub	Exotic	2	6L
Schefflera actinophylla	Octopus tree, umbrella tree	Araliaceae	Tree	Exotic	1	6L
Acrocarpus fraxinifolius	Indian ash, Shingle tree	Caesalpiniaceae	Tree	Exotic	2	6L
Eucalyptus sp.	Blue gum	Myrtaceae	Tree	Exotic	44	6L
Agave americana	American aloe	Agavaceae	Shrub	Exotic	4	6L
Casuarina cunninghamiana	Casuarina	Casuarinaceae	Tree	Exotic	5	6L
Melaleuca armillaris	Honey myrtle	Myrtaceae	Shrub	Exotic	4	6L
Ligustrum lucidum	Glossy privet	Oleaceae	Shrub	Exotic	4	6L
Olea europaea ssp. cuspidata	Brown olive, Mutamaiyu	Oleaceae	Tree	Indigenous	28	6L
Podocarpus falcatus	Podo, Muthengera	Podocarpaceae	Tree	Indigenous	6	6L
Fraxinus pennsylvanica	Mexican ash, Green ash	Oleaceae	Tree	Exotic	27	6L
Croton megalocarpus	Mukinduri	Euphorbiaceae	Tree	Indigenous	1	6L
Filicium decipiens	Thika palm	Sapindaceae	Tree	Indigenous	14	6L
Warburgia ugandensis	E.A. Greenheart, Muthiga	Canellaceae	Tree	Indigenous	1	6L
Psidium guajava	Guava	Myrtaceae	Tree	Exotic	1	6L
Jacaranda mimosifolia	Jacaranda	Bignoniaceae	Tree	Exotic	2	6L
Acacia kirkii	Kirk's acacia	Mimosaceae	Tree	Indigenous	1	6L

Botanical name	Common/Local Name	Family	Habit	Origin	Count	Block
Sesbania sesban	Sesbania, River bean	Papilionaceae	Shrub	Indigenous	8	6L
Aleurites moluccana	Candlenut tree	Euphorbiaceae	Tree	Exotic	1	6L
Ligustrum lucidum	Glossy privet	Oleaceae	Tree	Exotic	1	6L
Ficus elastica	Indian rubber plant	Moraceae	Tree	Exotic	1	6L
Ipomoea arborescens	Morning glory tree	Convolvulaceae	Shrub	Exotic	1	6L
Dombeya torrida	Dombeya, Mukeu	Sterculiaceae	Tree	Indigenous	1	6L
Erythrina lysistemon	Lucky bean tree	Papilionaceae	Tree	Exotic	1	6L
Bridelia micrantha	Mukoigo	Euphorbiaceae	Tree	Indigenous	2	6L
Sesbania sesban	Sesbania, River bean	Papilionaceae	Shrub	Indigenous	4	6L
Tecoma stans	Tecoma, Yellow elder	Bignoniaceae	Shrub	Exotic	2	6L
Ehretia cymosa	Murembu	Boraginaceae	Tree	Indigenous	1	6L
Acacia xanthophloea	Fever tree, Naivasha thorn	Mimosaceae	Tree	Indigenous	1	6L
Ricinus communis	Castor oil plant	Euphorbiaceae	Shrub	Indigenous	1	6L
Ficus benjamina	Java fig, Weeping fig	Moraceae	Tree	Exotic	8	6L
Trichilia emetica	Cape mahogany, Mururi	Meliaceae	Tree	Indigenous	2	6L
Tipuana tipu	Pride of Bolivia, Tipu tree	Papilionaceae	Tree	Exotic	1	6L
Sub-Total - Left side					300	
Block 7: Between Dagoretti Corner Roundabout and Nairobi City Council Ngong Rd Staff Houses entrance						
Spathodea campanulata	Nandi flame	Bignoniaceae	Tree	Indigenous	8	7R
Olea capensis ssp. welwitschi	Elgon olive	Oleaceae	Tree	Indigenous	2	7R
Markhamia lutea	Muu, Lusiola	Bignoniaceae	Tree	Indigenous	9	7R
Terminalia mentaly	Madagascar terminalia	Combretaceae	Tree	Exotic	4	7R
Acacia kirkii	Kirk's acacia	Mimosaceae	Tree	Indigenous	2	7R
Olea europaea ssp. cuspidata	Brown olive, Mutamaiyu	Oleaceae	Tree	Indigenous	2	7R
Grevillea robusta	Silk oak, Mukima	Proteaceae	Tree	Exotic	16	7R
Casuarina cunninghamiana	Casuarina	Casuarinaceae	Tree	Exotic	2	7R
Melaleuca armillaris	Honey myrtle	Myrtaceae	Shrub	Exotic	3	7R
Ficus sycomorus	Sycamore fig	Moraceae	Tree	Indigenous	1	7R
Croton megalocarpus	Mukinduri	Euphorbiaceae	Tree	Indigenous	1	7R
Cordia africana	Cordia, Muringa	Boraginaceae	Tree	Indigenous	1	7R
Podocarpus falcatus	Podo, Muthengera	Podocarpaceae	Tree	Indigenous	1	7R
Sub-Total - Right side					52	
Acacia kirkii	Kirk's acacia	Mimosaceae	Tree	Indigenous	2	7L
Tipuana tipu	Pride of Bolivia, Tipu tree	Papilionaceae	Tree	Exotic	45	7L
Grevillea robusta	Silk oak, Mukima	Proteaceae	Tree	Exotic	4	7L
Schinus molle	Pepper tree	Anacardiaceae	Tree	Exotic	1	7L
Jacaranda mimosifolia	Jacaranda	Bignoniaceae	Tree	Exotic	6	7L
Sub-Total - Left side					58	
GRAND TOTAL					**1869**	

7.Design Data
7.1 Geological Survey Result
（1）DCP test Resut (October,2016)

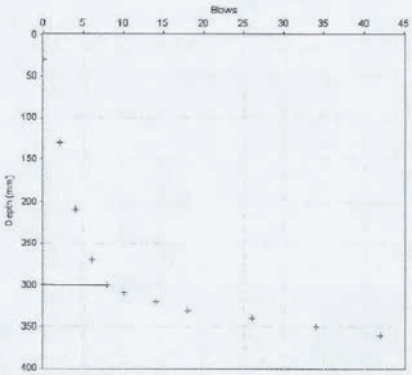
UK DCP V3.1

DCP Layer Strength Analysis Report

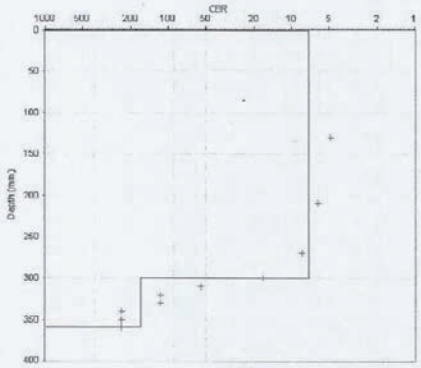
Project Name: GEOTECHNICAL SURVEY FOR NGONG ROAD TP 1 (DEPTH 1.0M)

Chainage (km):	0.000	Surface Type:	Unpaved
Direction:	TP 1	Thickness (mm):	0
Location/Offset:	Lay-by / other	Base Type:	
Cone Angle:	60 degrees	Thickness (mm):	
Zero Error (mm):	0	Surface Moisture:	Dry
Test Date:	15/10/2016	Moisture adjustment factor:	Not adjusted

Layer Boundaries: Chainage 0.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	33.75	7	300	300	Base	0.02	0.24	0.24	0.24
2	1.76	166	60	360	Base	0.14	0.34	0.34	0.34

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Pavement Strength

Layer	Layer Contribution SN	SNC	SNP
Surface	--	--	--
Base	0.58	0.58	0.58
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	0.58	0.58	0.58

CBR Relationship:
TRL equation: $\log_{10}(CBR) = 2.48 - 1.057 \times \log_{10}(Strength)$

Report produced by .....

Report Date: 15-Oct-2016

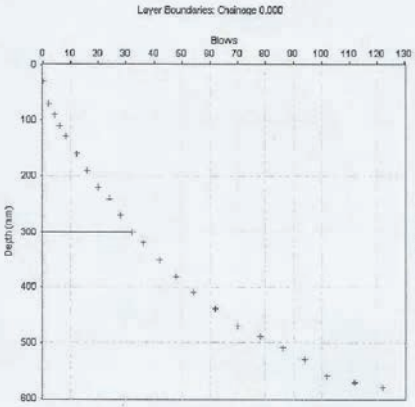
Page 1 of 1

UK DCP V3.1

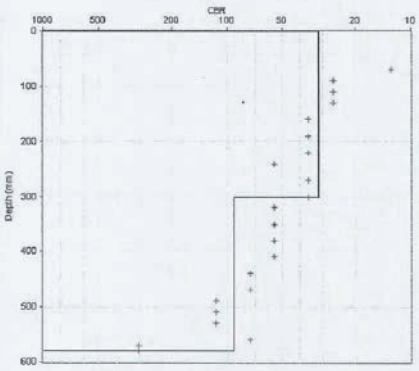
DCP Layer Strength Analysis Report

Project Name: GEOTECHNICAL SURVEY FOR NGONG ROAD TP 2 (DEPTH 1.0M)

Chainage (km):	0.000	Surface Type:	Unpaved
Direction:	TP 2	Thickness (mm):	0
Location/Offset:	Verge	Base Type:	
Cone Angle:	60 degrees	Thickness (mm):	
Zero Error (mm):	0	Surface Moisture:	Dry
Test Date:	15/10/2016	*Moisture adjustment factor:	Not adjusted



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	8.44	32	300	300	Base	0.07	0.87	0.87	0.87
2	3.11	91	280	580	Base	0.14	1.49	1.49	1.49

Pavement Strength

	Layer Contribution		
Layer	SN	SNC	SNP
Surface	--	--	--
Base	2.37	2.37	2.37
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	2.37	2.37	2.37

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CBR Relationship:

TRL equation: $\log_{10}(CBR) = 2.48 - 1.057 \times \log_{10}(Strength)$

Report produced by .....

Report Date: 15-Oct-2016

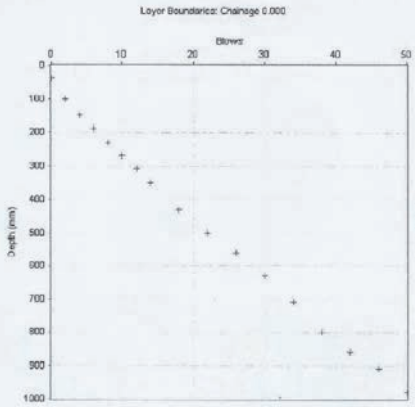
Page 1 of 1

UK DCP V3.1

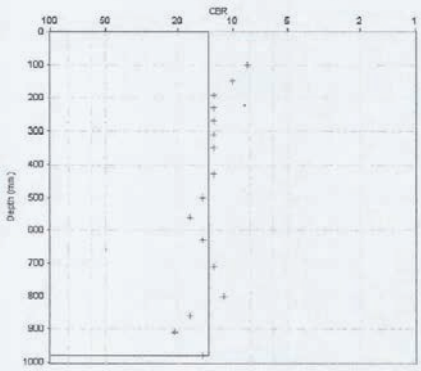
DCP Layer Strength Analysis Report

Project Name: GEOTECHNICAL SURVEY FOR NGONG ROAD TP 3 (DEPTH 1.0M)

Chainage (km):	0.000	Surface Type:	Unpaved
Direction:	TP 3	Thickness (mm):	0
Location/Offset:	Verge	Base Type:	
Cone Angle:	60 degrees	Thickness (mm):	
Zero Error (mm):	0	Surface Moisture:	Dry
Test Date:	15/10/2016	Moisture adjustment factor:	Not adjusted



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	18.80	14	980	980	Base	0.04	1.39	1.39	1.39

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	1.39	1.39	1.39
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	1.39	1.39	1.39

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CBR Relationship:
TRL equation: $\log_{10}(CBR) = 2.48 - 1.057 \times \log_{10}(Strength)$

Report produced by .....

Report Date: 15-Oct-2016

Table 1: A summary of the DCP test results

Chainage	Subgrade Strength	Soil description
Km 0+360 LHS	0.58	Fine soil with murram
Km 0+620 RHS	2.37	Hard lateritic gravel
Km 1+400 RHS	1.39	Lateritic murram

(1) DCP test Resut (April,2014)

K DCP Test Data Sheet										
Project name	Adams Arcade - Dagoretti Corner - Naivasha Rd (C60/C61))									
Test number	1		2		3		4		5	
Chainage (km)	0.020		0.240		0.480		0.485 (Tea Board Acces		0.720	
Location	C		C		C		C		C	
Lane number	Carriage way		Carriage way		Carriage way		Carriage way		Carriage way	
Offset (m)	-0.2		0.4		1.2		0		2	
Direction	LHS		RHS		RHS		RHS		RHS	
Zero error (mm)	60		60		60		60		60	
Test date (dd/mm/yyyy)	15/03/2014		15/03/2014		15/03/2014		15/03/2014		15/03/2014	
Remarks										
Layers removed	0		0		0		0		0	
Surface type	U		U		U		U		U	
Surface moisture	W		W		W		W		W	
Surface thickness (mm)										
Surface condition										
rface strength coefficient										
Base type										
Base thickness (mm)										
Base condition										
Base strength coefficient										
	Blows	Depth (mm	Blows	Depth (mm)	Blows	Depth (mm	Blows	Depth (mm)	Blows	Depth (mm
	0	215	0	100	0	80	0	70	0	90
	1	280	3	155	2	110	1	130	1	100
	1	335	3	203	2	120	1	148	1	120
	1	390	3	253	3	140	1	153	5	130
	1	445	3	320	3	160	2	192	5	138
	1	494	3	380	3	180	2	236	5	138
	1	538	3	433	3	210	2	268	5	140
	1	582	2	480	3	230	2	300	5	144
	1	620	2	530	3	250	2	340	10	145
	1	658	2	560	3	265	2	378	10	146
	1	693	2	575	3	285	2	390		
	1	730	5	595	3	313	2	400		
	1	760	5	620	3	330	2	405		
	1	792	5	630	3	340	2	410		
	1	825	10	632	3	352	5	418		
	1	864			3	360	5	427		
					3	380	5	433		
					3	400	5	442		
					3	440	5	448		
					3	470	5	457		
					3	500	5	460		
					3	515	5	473		
					3	522	5	487		
					3	530	5	490		
					3	540	5	500		
					3	550	5	501		
					3	560	5	510		
					3	575	5	520		
					3	585	5	530		
					3	600	5	535		
					3	610	5	543		
					3	620				
					3	625				
					3	630				
					3	640				
					3	650				
					3	655				
					3	660				
					3	665				
					3	670				
					3	680				
					3	690				
					3	700				
					3	720				
					3	740				
					3	755				
					3	770				
					3	795				
					3	800				
					3	805				
					3	820				
					3	830				
					3	855				
					3	900				
					3	930				
					3	960				
					3	1050				

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6		**7**		**8**		**9**		**10**	
1.500		1.760		2.020		2.240		2.500	
C		C		C		C		C	
Carriage way		Carriage way		Carriage way		Carriage way		Carriage way	
0.2		-1		-0.5		0.9		0.6	
RHS		LHS		LHS		RHS		RHS	
60		60		60		60		60	
15/03/2014		15/03/2014		15/03/2014		15/03/2014		15/03/2014	
0		0		0		0		0	
U		U		U		U		U	
W		W		W		W		W	
Blows	Depth (mm)			Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)
0	90	0	140	0	118	0	90	0	100
1	122	1	181	1	160	1	120	1	178
1	142	1	212	1	198	1	160	1	245
1	165	1	225	1	230	1	190	1	308
1	185	2	252	1	275	1	220	1	375
1	215	2	275	1	328	1	255	1	440
1	226	2	290	1	368	1	300	1	500
2	270	2	300	1	380	1	350	1	545
2	315	2	314	3	390	1	405	1	590
2	350	2	335	3	400	1	470	1	620
2	385	2	363	3	410	1	530	1	680
2	425	2	382	3	420	1	580	1	724
2	463	2	410	3	424	1	630	1	759
2	495	2	475			1	680	1	775
2	520	2	515			1	730	1	785
2	545	2	544			1	770	1	795
2	568	2	558			1	800	1	805
2	595	2	595			1	820	2	825
2	640	2	616			1	840	2	844
2	660	2	630			1	855	2	860
2	680	2	656			1	870	2	875
2	700	2	665			1	880	2	885
2	722	2	677			1	900	2	890
2	742	2	688			1	920	2	905
2	762	2	704			1	930	2	915
2	786	2	725			1	950	2	925
2	815	2	740			1	960	2	940
2	832	2	760			1	980	2	955
2	860	2	780			1	1000	2	965
2	880	2	792			1	1020	2	975
2	900	2	805					2	996
2	924	2	825					2	1020
2	943	2	830						
2	970								
2	995								
2	1015								
2	1040								
2	1060								
2	1064								

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DCP Result

Summary of Test Results from DCP Analysis

Chainage	Offset (m)	Subgrade Strength	Remarks
Km 0+020 LHS	0.2	5	Black cotton
Km 0+240 RHS	0.4	13	Hard lateritic gravel
Km 0+480 RHS	1.2	18	-
Tea Board Access	0.9	12	Red Soil
Km 0+720 RHS	2.0	17	Hard rock underneath
Km 1+500 RHS	0.2	14	-
Km 1+760 RHS	1.0	18	High water table
Km 2+020 LHS	0.5	6	-
Km 2+240 RHS	0.9	5	Black cotton
Km 2+500 RHS	0.6	4	Black cotton

(2) CBR test Resut for Subgrade (October,2016)

SAMPLE NO	SAMPLE DEPTH	Natural moisture content	ATTERBERG PARAMETERS: plastic limit	liquid limit	plasticity index	linear shrinkage	passing 425mic	plasticity modulus	GRADING: passing 10mm	passing 5mm	passing 2mm	passing 75mc	COMPACTION: optimum moisture content	maximum dry density	CBR: 4 day soak	swell	REMARKS
	(M)	%	%	%	%	%	%		%	%	%	%	%	kg/M³	%	%	
TP1 S1		14.4											22.8	1728	28	0.61	Fine Lateritic Murrum
TP1 S2		7.8											19.8	1752	32	0.52	Fine Lateritic Murrum
TP2 S1		18.0											30.0	1414	18	0.80	Fine Soil with Murrum

MASS LABS LTD.
P. O. Box 10782 - 00100, NAIROBI
24 OCT 2016
Tel: 020 - 3871985 / 0790 943231
E-mail: info@masslabs.co.ke

SUMMARY OF SOIL TEST RESULTS

MASS LABS LTD

Specialist in site investigation,
Quality contol and Material testing
P.O. Box 10782-00100, Tel/Fax: 3871985 NAIROBI

CLIENT: ACROSS AFRICA CONSULTANTS LTD

PROJECT: GEOTECHNICAL SURVEY FOR NGONG ROAD

DATE: 24/10/2016

SHEET No. 2016/447/02

Table 2: A summary of the CBR Results

Chainage	Sample No.	Natural moisture content (%)	Optimum moisture content (%)	Maximum dry density Kg/m³	CBR 4 days soak %	Swell %	Soil Description
Km 0+440 LHS	TP1 S1	14.4	22.8	1728	28	0.61	Fine lateritic murram
Km 0+440 LHS	TP1 S2	7.8	19.8	1752	32	0.52	Fine lateritic murram
Km 1+300	TP2 S1	18.0	30.0	1414	18	0.80	Fine soil with murram

(2) CBR test Resut for Subgrade (April,2014)

MINISTRY OF TRANSPORT AND INFRASTRUCTURE

MATERIALS TESTING & RESEARCH DEPARTMENT

P.O.Box 11873 - 00400 NAIROBI. Tel 554950/3/4, Fax 554877, e-mail chief.engineer@materials.go.ke

Test Certificate for Soil samples

(Testing as per BS 1377:1990)

CLIENT : Across Africa Consulting Engineers Limited

MOTI/I/QMS/MD 038

ADDRESS:

Date:31st March,2014

Sample No	Reference	GRADING % passing Sieve								Atterberg Limits					ompaction T		ompaction T 18		CBR (%)	
		50 mm	7.5 mm	20 mm	10 mm	5 mm	2mm	425 µm	75 µm	LL (%)	PL (%)	PI (%)	LS (%)	PM	MDD (Kg/m³	OMC (%)	MDD Kg/m³	OMC (%)	4 days soak	Swell
834/S/14	KM 0+020 LHS			100	100	99	96	93	88	58	28	30	15	2790	1280	26.8			1	2.4
835/S/14	KM 0+720 RHS			100	83	74	70	65	60	52	27	25	13	1625	1405	28.8			5	0.2
836/S/14	KM 1+080 RHS			100	85	76	73	68	63	50	26	24	12	1632	1410	27.0			6	0.2
837/S/14	KM 1+500 RHS			100	100	98	93	88	84	60	29	31	16	2728	1340	29.2			1	2.2
838/S/S14	KM 1+760 RHS			100	81	53	30	22	18	34	19	15	13	330	1525	16.2			15	0.1
839/S/14	KM 2+020 RHS			100	85	75	67	57	48	49	22	27	13	1539	1370	24.5			3	0.3
840/S/14	KM 2+500 RHS			100	100	99	98	95	89	55	25	30	15	2850	1340	27.4			1	2.3
841/S/14	Relocated to Tea board			100	99	98	92	82	73	56	24	32	16	2624	1415	26.1			2	0.6

OIC SOILS LAB

SPSE(PDC)

CHIEF ENGINEER (MATERIALS)

(3) **Benkelman Beam test Resut (April,2014)**

Chainage	Side	D Max (1/100mm)	Moving Ave. (1/100mm)
II-STA.0+100	R	35	20
	L	31	20
II-STA.0+340	R	36	26
	L	27	18
II-STA.0+500	R	32	20
	L	29	19
II-STA.0+560	R	49	33
	L	23	18
II-STA.0+800	R	36	22
	L	21	13
II-STA.1+040	R	34	23
	L	39	28
II-STA.1+320	R	25	17
	L	24	17
II-STA.1+600	R	39	27
	L	33	23
II-STA.1+880	R	32	16
	L	30	14
II-STA.2+060	R	39	23
	L	35	24
II-STA.2+240	R	36	23
	L	40	23
II-STA.2+480	R	43	28
	L	49	33
I-STA.0+100	R	36	25
	L	36	24
I-STA.0+300	R	24	22
	L	24	14
I-STA.0+500	R	36	26
	L	26	25
I-STA.0+700	R	24	16
	L	25	18
I-STA.0+900	R	30	25
	L	24	20
I-STA.1+100	R	20	25
	L	18	25

(4) Underground Facility Survey Resut (October,2016)

Site 1　Sta. 0+730
Find a telecom line at depth 900mm.

Site2　Sta. 1+050
Find a75mm diameter water pipe at depth 2000mm.

Site 3　Sta. 1+550
No utilities.

Site4　Sta. 2+750
Find a water pipe at depth 400mm and two telephone lines at 600mm

Site5　Sta. 3+350
Find a water pipe at depth 700mm

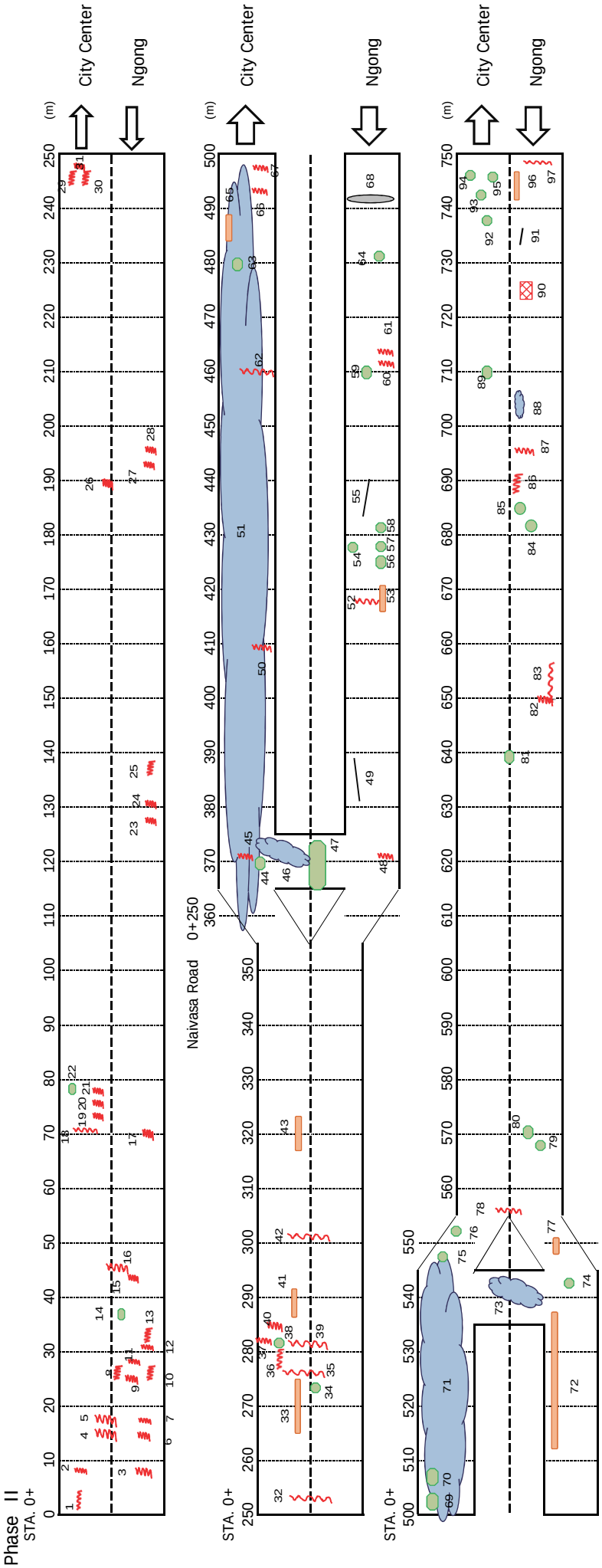
(4) Underground Facility Survey Resut (April,2014)

Site 1
Utilities found • No utilities found • Hard rock was encountered at a height of 1.36m below the surface.
Site 2
Utilities found • One water pile of 150mm was found at a height of 1.40m below the surface.

Site 3
Utilities found • Two water pipes were found at a height of 0.72m below the surface. • Hard rock was encountered at a height of 1.06m below the surface.
Site 4
Utilities found • Water piles of 150mm were found at a height of 0.6m below the surface and those of 20mm each were found at a height of 0.6m.

Site 5
Utilities found • No utilities found • Hard rock was encountered at a height of 0.76m below the surface.

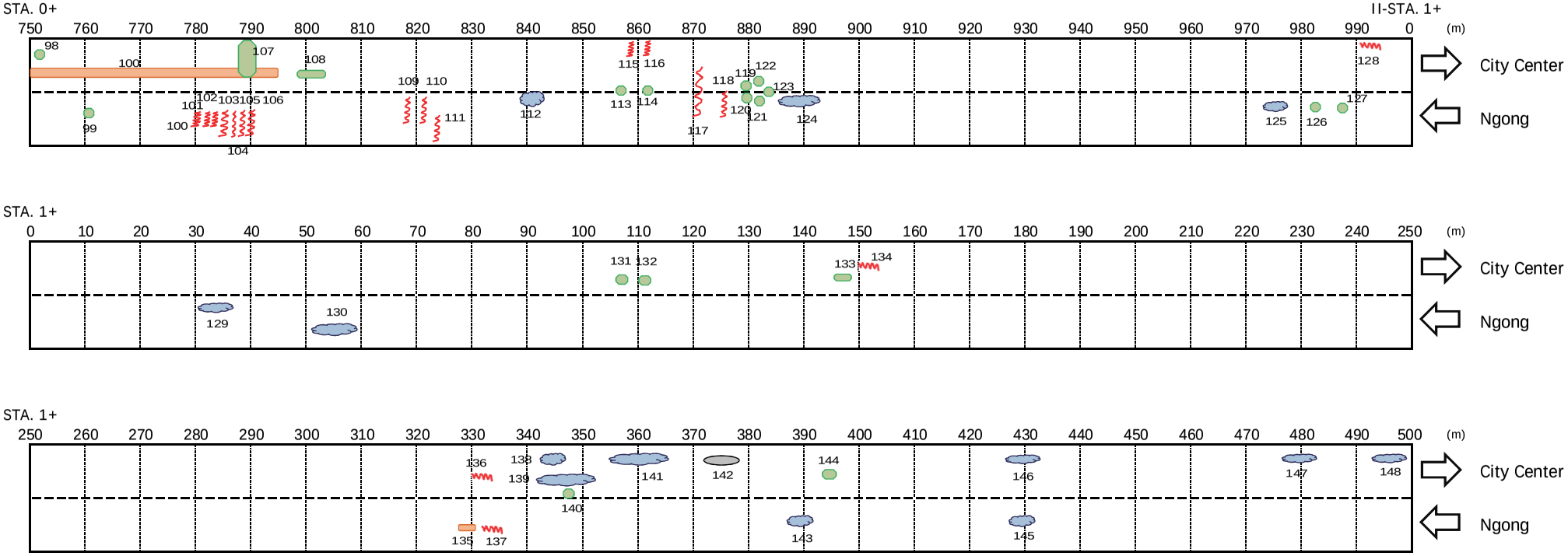
7.2 Existing Road Pavement Survey Result (October,2016)



No.	Damage	Detail	No.	Damage	Detail	No.	Damage	Detail	No.	Damage	Detail
1	Crack	L=3.0m	21	Crack	L=1.0m	41	Rutting	L=10.0m	61	Crack	L=1.0m
2	Crack	L=1.0m	22	Pot Hole	D=0.1m	42	Crack	L=3.0m	62	Crack	L=2.0m
3	Crack	L=1.0m	23	Crack	L=1.0m	43	Rutting	L=7.0m	63	Pot Hole	D=0.3m
4	Crack	L=2.0m	24	Crack	L=1.0m	44	Pot Hole	D=0.1m	64	Pot Hole	D=0.1m
5	Crack	L=2.0m	25	Crack	L=1.0m	45	Crack	L=1.0m	65	Rutting	L=2.0m
6	Crack	L=1.0m	26	Crack	L=1.0m	46	Scarring	5.0m x 0.3m	66	Crack	L=1.0m
7	Crack	L=2.0m	27	Crack	L=1.0m	47	Pot Hole	D=0.1m	67	Crack	L=1.0m
8	Crack	L=2.0m	28	Crack	L=1.0m	48	Crack	L=1.0m	68	Hollow	1.5m x 7.0m
9	Crack	L=1.0m	29	Crack	L=1.0m	49	Scratch	L=5.0m	69	Pot Hole	3.0m x 0.5m
10	Crack	L=2.0m	30	Crack	L=1.0m	50	Crack	L=1.0m	70	Pot Hole	3.0m x 0.5m
11	Crack	L=1.0m	31	Crack	L=1.0m	51	Scarring	130.0m x 3.0m	71	Scarring	50.0m x 3.0m
12	Crack	L=1.0m	32	Crack	L=3.0m	52	Crack	L=2.0m	72	Rutting	L=25.0m
13	Crack	L=1.0m	33	Rutting	L=10.0m	53	Rutting	L=1.5m x 0.2m	73	Scarring	5.0m x 0.3m
14	Pot Hole	D=0.1m	34	Pot Hole	D=0.3m	54	Pot Hole	D=0.2m	74	Pot Hole	D=0.5m
15	Crack	L=1.0m	35	Crack	L=2.0m	55	Scratch	L=5.0m	75	Pot Hole	D=0.1m
16	Crack	L=2.0m	36	Crack	L=1.0m	56	Pot Hole	D=0.1m	76	Pot Hole	D=0.1m
17	Crack	L=1.0m	37	Crack	L=1.0m	57	Pot Hole	D=0.2m	77	Rutting	L=2.0m
18	Crack	L=2.0m	38	Pot Hole	D=0.1m	58	Pot Hole	D=0.3m	78	Crack	L=1.0m
19	Crack	L=1.0m	39	Crack	L=2.0m	59	Pot Hole	D=0.1m	79	Pot Hole	D=0.3m
20	Crack	L=1.0m	40	Crack	L=1.0m	60	Crack	L=1.0m	80	Pot Hole	D=0.2m

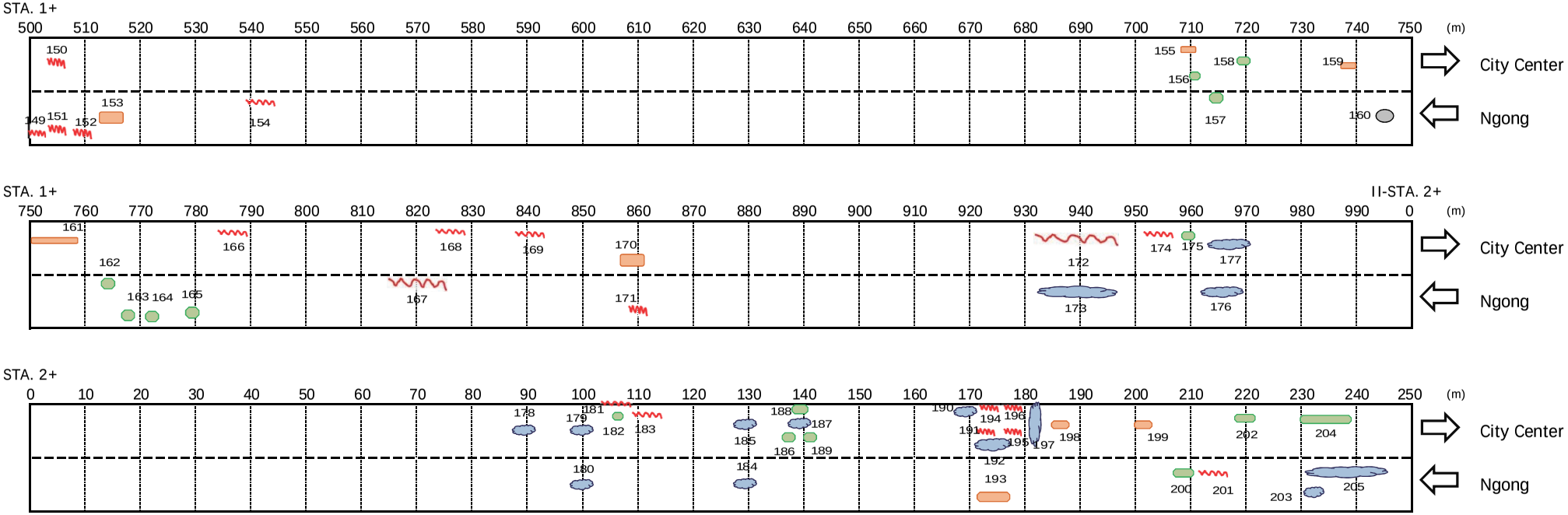
No.	Damage	Detail
81	Pot Hole	D=0.1m
82	Crack	L=1.0m
83	Crack	L=3.0m
84	Pot Hole	D=0.3m
85	Pot Hole	D=0.3m
86	Crack	L=1.0m
87	Crack	L=1.0m
88	Scarring	5.0m x 0.3m
89	Pot Hole	D=0.1m
90	Crack	1.0m x 2.0m
91	Scratch	L=1.0m
92	Pot Hole	D=0.1m
93	Pot Hole	D=0.5m
94	Pot Hole	D=0.2m
95	Pot Hole	D=0.3m
96	Rutting	L=10.0m
97	Crack	L=2.0m

Phase II



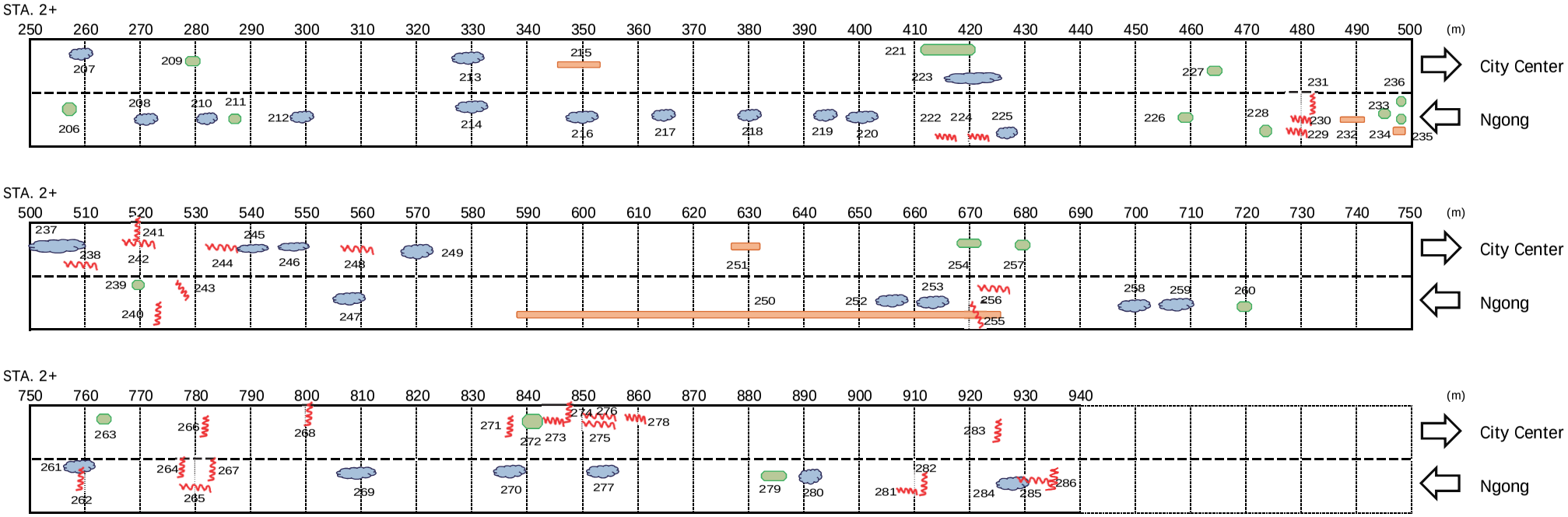
No.	Damage	Detail	No.	Damage	Detail	No.	Damage	Detail	No.	Damage	Detail	No.	Damage	Detail
98	Pot Hole	D=0.2m	108	Pot Hole	D=0.1m	118	Crack	L=1.0m	128	Crack	L=1.0m	138	Scarring	5.0m x 0.5m
99	Pot Hole	D=0.5m	109	Crack	L=3.0m	119	Pot Hole	D=0.1m	129	Scarring	2.0m x 1.5m	139	Scarring	10.0m x 0.5m
100	Rutting	L=50.0m	110	Crack	L=3.0m	120	Pot Hole	D=0.1m	130	Scarring	5.0m x 1.0m	140	Pot Hole	D=0.1m
101	Crack	L=1.0m	111	Crack	L=2.0m	121	Pot Hole	D=0.1m	131	Pot Hole	D=0.2m	141	Scarring	10.0m x 1.5m
102	Crack	L=1.0m	112	Scarring	D=0.3m	122	Pot Hole	D=0.1m	132	Pot Hole	D=0.3m	142	Hollow	3.0m x 1.0m
103	Crack	L=1.0m	113	Pot Hole	D=0.5m	123	Pot Hole	D=0.1m	133	Pot Hole	D=0.1m	143	Scarring	5.0m x 0.5m
104	Crack	L=1.0m	114	Pot Hole	D=0.3m	124	Scarring	5.0m x 1.0m	134	Crack	L=1.0m	144	Pot Hole	D=0.3m
105	Crack	L=2.0m	115	Crack	L=1.0m	125	Scarring	2.0m x 0.5m	135	Rutting	L=1.0m	145	Scarring	5.0m x 0.5m
106	Crack	L=2.0m	116	Crack	L=1.0m	126	Pot Hole	D=0.1m	136	Crack	L=1.0m	146	Scarring	3.0m x 1.0m
107	Pot Hole	3.0m x 3.0m	117	Crack	L=4.0m	127	Pot Hole	D=0.1m	137	Crack	L=1.0m	147/148	Scarring	5.0m x 1.0m

Phase II



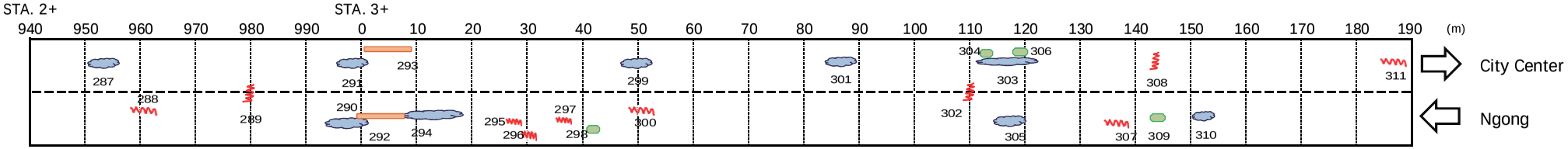
No.	Damage	Detail	No.	Damage	Detail	No.	Damage	Detail	No.	Damage	Detail	No.	Damage	Detail
149	Crack	L=1.0m	161	Rutting	L=10.0m	173	Scarring	15.0m x 0.5m	185	Scarring	4.0m x 0.3m	197	Scarring	1.0m x 3.0m
150	Crack	L=1.0m	162	Pot Hole	D=0.5m	174	Crack	L=3.0m	186	Pot Hole	D=0.1m	198	Rutting	L=5.0m
151	Crack	L=1.0m	163	Pot Hole	D=0.1m	175	Pot Hole	D=0.1m	187	Scarring	5.0m x 0.3m	199	Rutting	L=5.0m
152	Crack	L=1.0m	164	Pot Hole	D=0.1m	176	Scarring	5.0m x 0.3m	188	Pot Hole	D=0.3m	200	Pot Hole	2.0m x 0.5m
153	Rutting	3.0m x 1.0m	165	Pot Hole	D=0.1m	177	Scarring	5.0m x 0.3m	189	Pot Hole	D=0.1m	201	Crack	L=3.0m
154	Crack	L=1.0m	166	Crack	L=5.0m	178	Scarring	3.0m x 0.3m	190	Scarring	2.0m x 0.3m	202	Pot Hole	5.0m x 0.5m
155	Rutting	L=1.0m	167	Crack	L=10.0m	179	Scarring	3.0m x 0.3m	191	Crack	L=2.0m	203	Scarring	1.0m x 0.3m
156	Pot Hole	D=0.5m	168	Crack	L=5.0m	180	Scarring	1.0m x 0.3m	192	Scarring	5.0m x 0.3m	204	Pot Hole	10.0m x 0.3m
157	Pot Hole	D=0.1m	169	Crack	L=1.0m	181	Crack	L=1.0m	193	Rutting	L=10.0m	205	Scarring	5.0m x 0.3m
158	Pot Hole	D=0.5m	170	Rutting	5.0m x 1.0m	182	Pot Hole	D=0.2m	194	Crack	L=1.0m			
159	Rutting	L=10.0m	171	Crack	L=1.0m	183	Crack	L=3.0m	195	Crack	L=1.0m			
160	Hollow	D=0.5m	172	Crack	L=20.0m	184	Scarring	1.0m x 0.3m	196	Crack	L=2.0m			

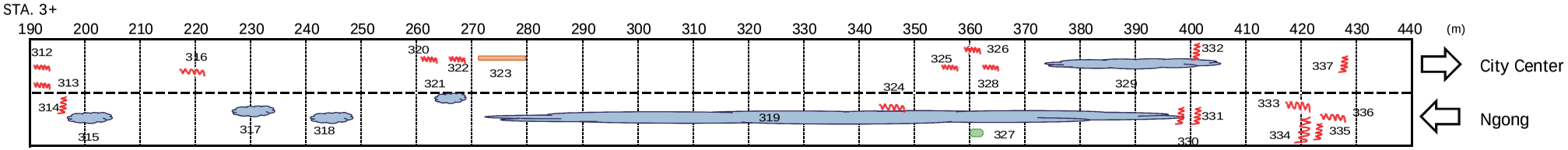
Phase II



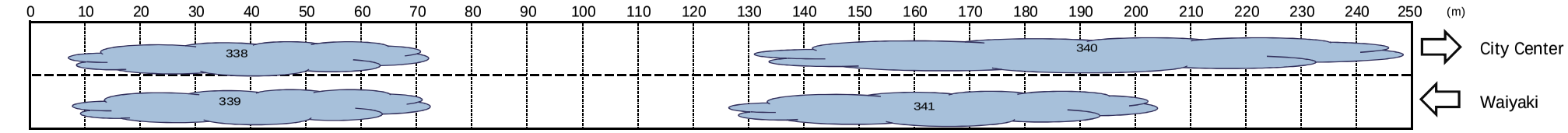
No.	Damage	Detail	No.	Damage	Detail	No.	Damage	Detail	No.	Damage	Detail	No.	Damage	Detail
206	Pot Hole	0.1m x 0.2m	223	Scarring	15.0m x 0.5m	240	Crack	L=1.0m	257	Pot Hole	1.0m x 0.3m	274	Crack	L=1.0m
207	Scarring	1.0m x 0.5m	224	Crack	L=1.0m	241	Crack	L=2.0m	258	Scarring	2.0m x 0.3m	275	Crack	L=1.0m
208	Scarring	L=1.0m	225	Scarring	2.0m x 0.3m	242	Crack	L=3.0m	259	Scarring	2.0m x 0.3m	276	Crack	L=1.0m
209	Pot Hole	D=0.1m	226	Pot Hole	D=0.1m	243	Crack	L=1.0m	260	Pot Hole	D=0.3m	277	Scarring	5.0m x 1.0m
210	Scarring	3.0m x 0.5m	227	Pot Hole	D=0.3m	244	Crack	L=2.0m	261	Scarring	2.0m x 0.3m	278	Crack	L=1.0m
211	Pot Hole	D=0.3m	228	Pot Hole	D=0.1m	245	Scarring	4.0m x 1.0m	262	Crack	L=1.0m	279	Pot Hole	1.0m x 0.2m
212	Scarring	3.0m x 0.5m	229	Crack	L=1.0m	246	Scarring	1.0m x 1.0m	263	Pot Hole	D=0.5m	280	Scarring	D=0.5m
213	Scarring	1.0m x 0.3m	230	Crack	L=1.0m	247	Scarring	3.0m x 2.0m	264	Crack	L=1.0m	281	Crack	L=1.0m
214	Scarring	1.0m x 0.3m	231	Crack	L=1.0m	248	Crack	L=3.0m	265	Crack	L=2.0m	282	Crack	L=1.0m
215	Rutting	7.0m x 1.0m	232	Rutting	L=3.0m	249	Scarring	1.0m x 0.3m	266	Crack	L=1.0m	283	Crack	L=2.0m
216	Scarring	3.0m x 0.3m	233	Pot Hole	D=0.1m	250	Rutting	L=85.0m	267	Crack	L=1.0m	284	Scarring	5.0m x 0.3m
217	Scarring	1.0m x 0.3m	234	Rutting	L=1.0m	251	Rutting	5.0m x 0.1m	268	Crack	L=1.0m	285	Crack	L=3.0m
218	Scarring	2.0m x 0.3m	235	Pot Hole	D=0.1m	252	Scarring	3.0m x 2.0m	269	Scarring	5.0m x 0.3m	286	Crack	L=1.0m
219	Scarring	1.0m x 0.3m	236	Pot Hole	D=0.1m	253	Scarring	5.0m x 2.0m	270	Scarring	7.0m x 1.0m			
220	Scarring	2.0m x 0.3m	237	Scarring	10.0m x 1.0m	254	Pot Hole	3.0m x 0.2m	271	Crack	L=1.0m			
221	Pot Hole	15.0m x 0.5m	238	Crack	L=5.0m	255	Crack	L=1.0m	272	Pot Hole	D=0.3m			
222	Crack	L=1.0m	239	Pot Hole	D=1.0m	256	Crack	L=3.0m	273	Crack	L=1.0m			

Phase II





Naivasa Road



No.	Damage	Detail	No.	Damage	Detail	No.	Damage	Detail	No.	Damage	Detail	No.	Damage	Detail
287	Scarring	1.0m x 0.3m	298	Pot Hole	D=0.1m	309	Pot Hole	D=0.1m	320	Crack	L=3.0m	331	Crack	L=1.0m
288	Crack	L=1.0m	299	Scarring	5.0m x 1.0m	310	Scarring	3.0m x 2.0m	321	Scarring	1.0m x 0.3m	332	Crack	L=2.0m
289	Crack	L=1.0m	300	Crack	L=3.0m	311	Crack	L=1.0m	322	Crack	L=1.0m	333	Crack	L=2.0m
290	Scarring	5.0m x 1.0m	301	Scarring	1.0m x 0.3m	312	Crack	L=1.0m	323	Rutting	10.0m x 1.0m	334	Crack	L=2.0m
291	Scarring	5.0m x 1.0m	302	Crack	L=1.0m	313	Crack	L=1.0m	324	Crack	L=3.0m	335	Crack	L=1.0m
292	Rutting	10.0m x 0.2m	303	Scarring	12.0m x 1.0m	314	Crack	L=1.0m	325	Crack	L=1.0m	336	Crack	L=2.0m
293	Rutting	10.0m x 0.2m	304	Pot Hole	1.0m x 0.5m	315	Scarring	4.0m x 0.3m	326	Crack	L=3.0m	337	Crack	L=1.0m
294	Scarring	12.0m x 0.3m	305	Scarring	3.0m x 1.0m	316	Crack	L=1.0m	327	Pot Hole	2.0m x 0.5m	338	Scarring	60.0m x 3.0m
295	Crack	L=1.0m	306	Pot Hole	2.0m x 0.5m	317	Scarring	5.0m x 1.5m	328	Crack	L=3.0m	339	Scarring	60.0m x 3.0m
296	Crack	L=1.0m	307	Crack	L=5.0m	318	Scarring	10.0m x 0.5m	329	Scarring	30.0m x 0.5m	340	Scarring	120.0m x 3.0m
297	Crack	L=1.0m	308	Crack	L=1.0m	319	Scarring	L=130.0m	330	Crack	L=1.0m	341	Scarring	70.0m x 3.0m

7.3 Traffic Survey
(1) Traffic Volume Survey Resut (October,2016)

Traffic Volume Survery

	Sedan / Wagon	Pick-up / 4WD	Mini Bus / Van	Light Truck	Standard Bus	2-Axle (SingleRearAxle) Truck	3-Axle (DoubleRearAxle) Truck	Articulated Truck (Semi&Full Trailer)	Motorcycle/ Bike Trailer	Bicycle / Tricycle	Animal Cart / Farm Trctor	Pedestrian	TOTAL
A1 Naivasha Road (12 Hours)													
PCU	1.00	1.00	1.00	1.50	3.00	3.00	4.50	6.00	0.50				
Survey Data	1,926	589	2,016	243	81	185	20	9	821	276	11	2,504	
Survey Data	2,758	732	2,127	56	806	232	33	5	870	257	11	3,178	
Survey Data	1,820	587	2,114	208	91	162	34	10	909	254	11	2,692	
Survey Data	2,744	817	1,748	72	657	223	30	12	1,118	314	7	3,055	
2-Lane	4,624	1,363	4,003	290	818	401	59	18	1,859				
Conversion 1day	7,052	2,079	6,105	442	1,247	612	90	27	2,835				20,489
Conversion Number	7,052	2,079	6,105	663	3,741	1,836	405	162	1,418				23,461
Traffic Volume for 1-Lane (PCU / day)													11,731
A2 Meteorological Bus Stop (12 Hours)													
Survey Data	4,232	1,793	820	184	33	152	59	21	1,268	319	44	1,023	
Survey Data	4,611	2,473	868	100	35	325	71	26	1,084	200	49	1,228	
Survey Data	4,406	2,627	931	205	50	232	62	17	1,129	198	59	1,458	
Survey Data	4,574	1,823	812	164	40	304	64	15	751	154	57	1,007	
2-Lane	8,912	4,358	1,716	327	79	507	128	40	2,116				
Conversion 1day	13,591	6,646	2,617	499	120	773	195	61	3,227				27,729
Conversion Number	13,591	6,646	2,617	749	360	2,319	878	366	1,614				29,140
Traffic Volume for 1-Lane (PCU / day)													14,570
A3 Impara Club (24 Hours)													
Survey Data	6,939	2,189	1,995	359	299	262	105	7	1,722	333	6	1,309	
Survey Data	7,305	2,322	2,163	146	185	313	110	13	1,767	402	6	2,076	
2-Lane	14,244	4,511	4,158	505	484	575	215	20	3,489				
Conversion 1day	14,244	4,511	4,158	505	484	575	215	20	3,489				28,201
Conversion Number	14,244	4,511	4,158	758	1,452	1,725	968	120	1,745				29,681
Traffic Volume for 1-Lane (PCU / day)													14,841
A4 Green House (12 Hours)													
Survey Data	3,890	1,879	1,308	109	265	135	28	6	1,500	241	4	2,294	
Survey Data	3,739	1,057	1,426	137	193	117	40	2	1,172	197	7	1,512	
Survey Data	3,638	1,447	1,425	77	288	124	48	1	1,659	300	2	2,442	
Survey Data	3,749	1,296	1,535	164	108	138	58	9	1,330	205	10	1,799	
2-Lane	7,508	2,840	2,847	244	427	257	87	9	2,831				
Conversion 1day	11,450	4,331	4,342	372	651	392	133	14	4,317				26,002
Conversion Number	11,450	4,331	4,342	558	1,953	1,176	599	84	2,159				26,652
Traffic Volume for 1-Lane (PCU / day)													13,326
A5 Baptist Church (24 Hours)													
Survey Data	6,112	2,205	1,864	116	269	211	48	4	2,218	292	5	4,992	
Survey Data	8,007	3,130	2,283	93	254	305	68	9	2,385	336	22	4,291	
2-Lane	14,119	5,335	4,147	209	523	516	116	13	4,603				
Conversion 1day	14,119	5,335	4,147	209	523	516	116	13	4,603				29,581
Conversion Number	14,119	5,335	4,147	314	1,569	1,548	522	78	2,302				29,934
Traffic Volume for 1-Lane (PCU / day)													14,967

(2) Direction Intersction Survey Resut (October,2016)

Direction Intersection Survey

TRAFFIC SURVEYTIMETABLE

TYPE OF SURVEY	LOCATION	DATE OF SURVEY	TIME
Junction Traffic Count	Dagoretti Corner Junction (All the roads leading to and getting out of the Junction)	13thOctober 2016 & 14th October 2016	6:30 – 9:30AM & 4:00 – 7:00PM
Number Plate Survey	Dagoretti Corner Junction (All the roads leading to and getting out of the Junction)	13thOctober 2016 & 14th October 2016	6:30 – 9:30AM & 4:00 – 7:00PM
Junction Traffic Count	Adams Arcade Junction (All the roads leading to and getting out of the Junction)	17th October 2016 & 18th October 2016	6:30 – 9:30AM & 4:00 – 7:00PM
Number Plate Survey	Adams Arcade Junction (All the roads leading to and getting out of the Junction)	17th October 2016 & 18th October 2016	6:30 – 9:30AM & 4:00 – 7:00PM
Junction Traffic Count	Ole Dume Junction (All the roads leading to and getting out of the Junction)	17th October 2016 & 18th October 2016	6:30 – 9:30AM & 4:00 – 7:00PM
Number Plate Survey	Ole DumeJunction (All the roads leading to and getting out of the Junction)	17th October 2016 & 18th October 2016	6:30 – 9:30AM & 4:00 – 7:00PM

Number Plate Survey Method

-Plot number plate and time (each direction)

-Match the license plates

-Calculate Origin-Destination table

Number Plate Survey result

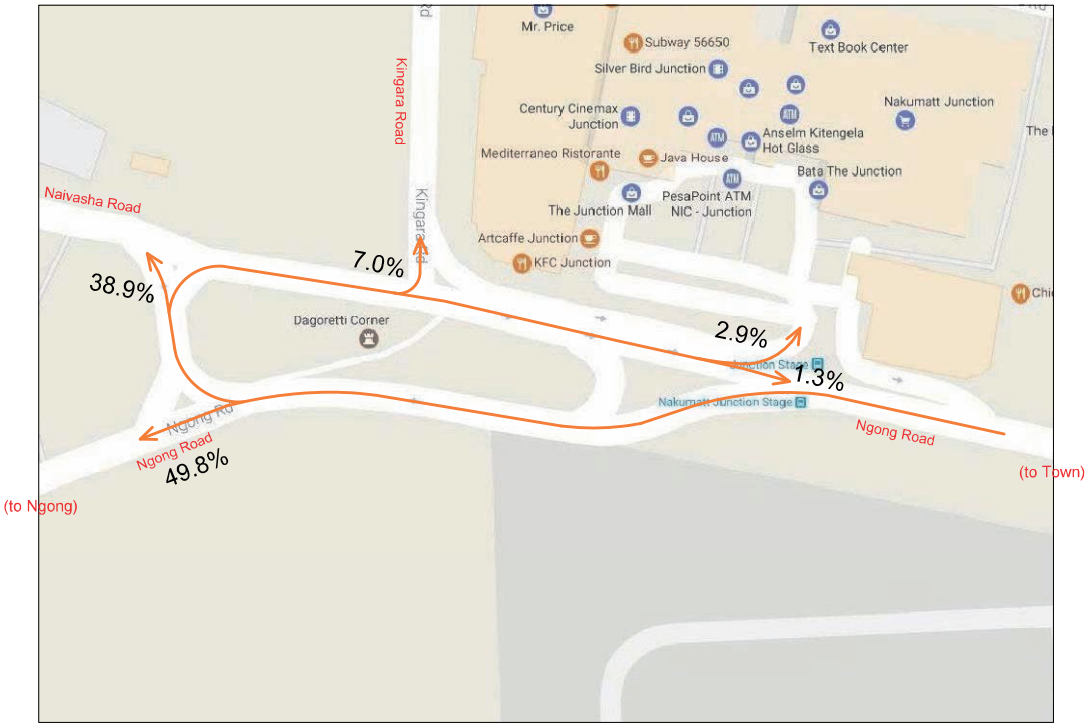
-Average traffic volume.

-Average Origin-Destination flow (AADT)

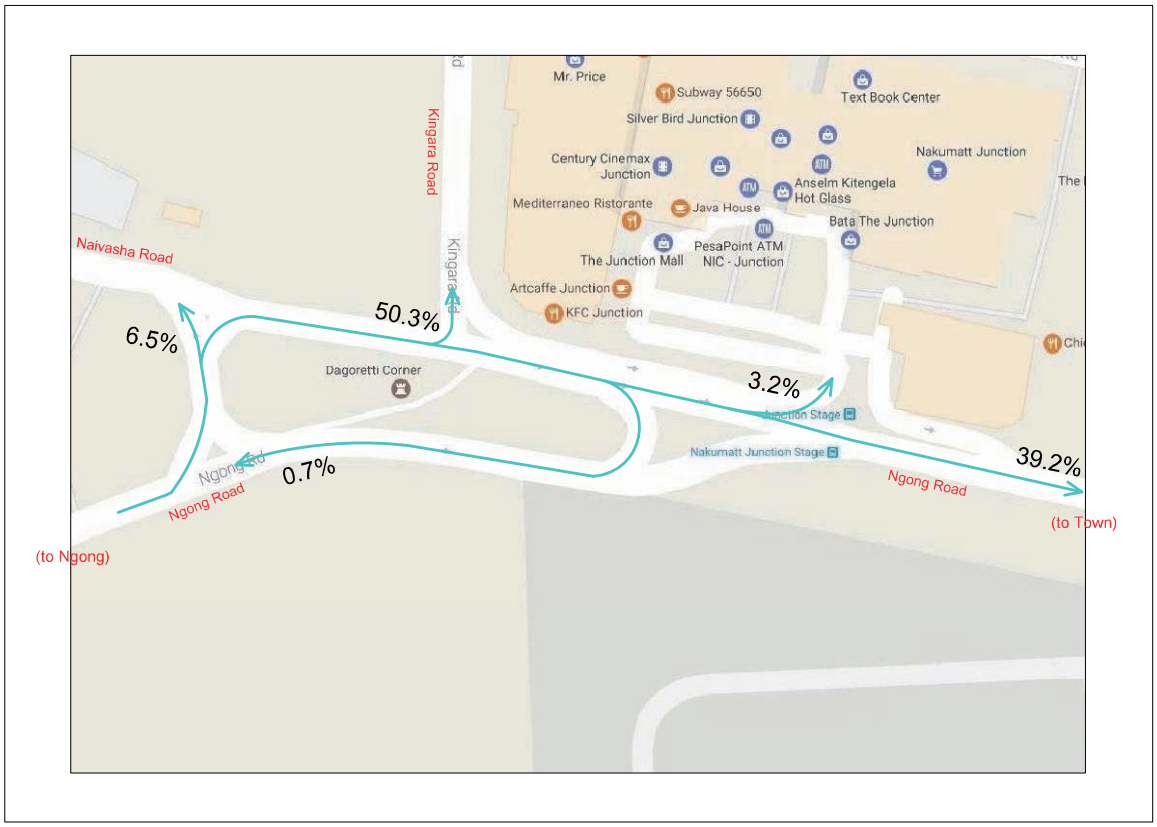
The Origin-Destination flow is shown below:

Dagoretti Junction

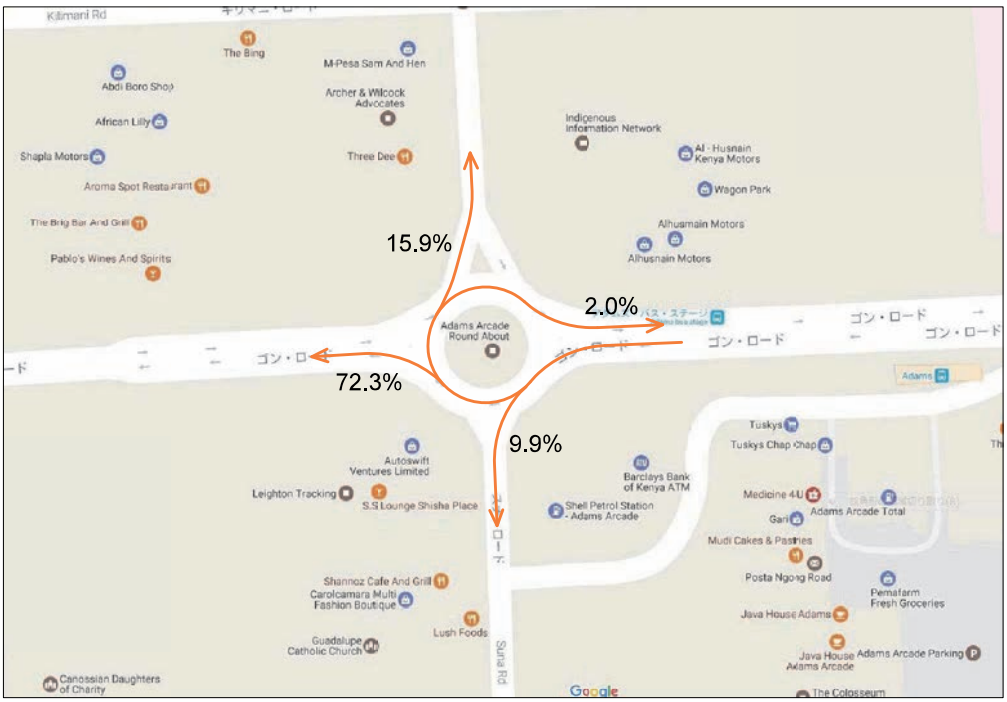
Dagoretti Junction



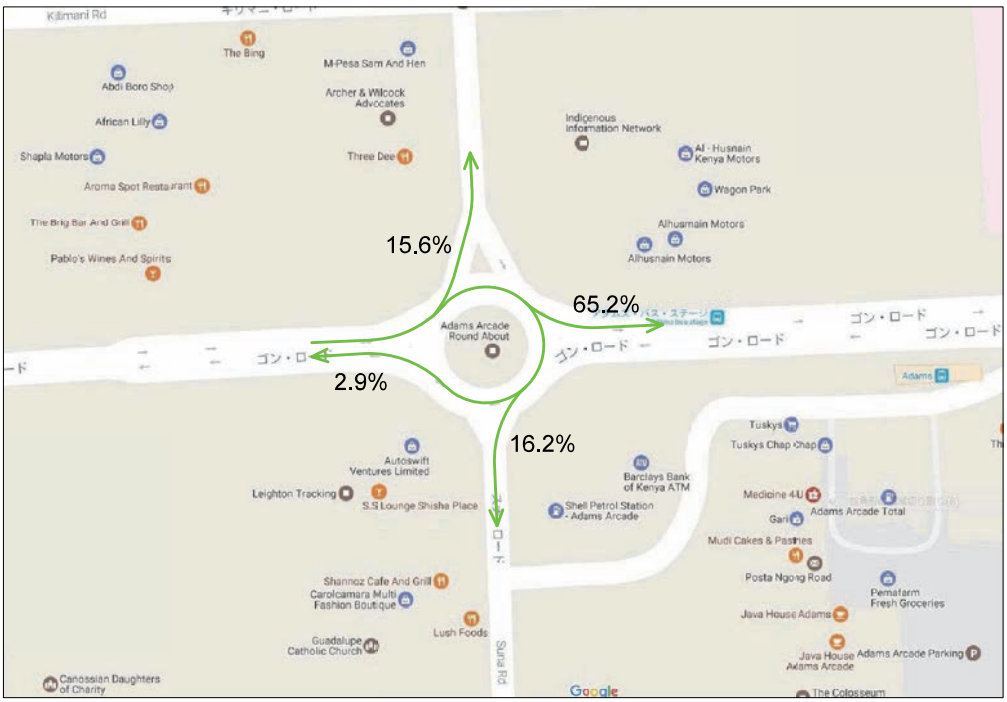
Dagoretti Junction

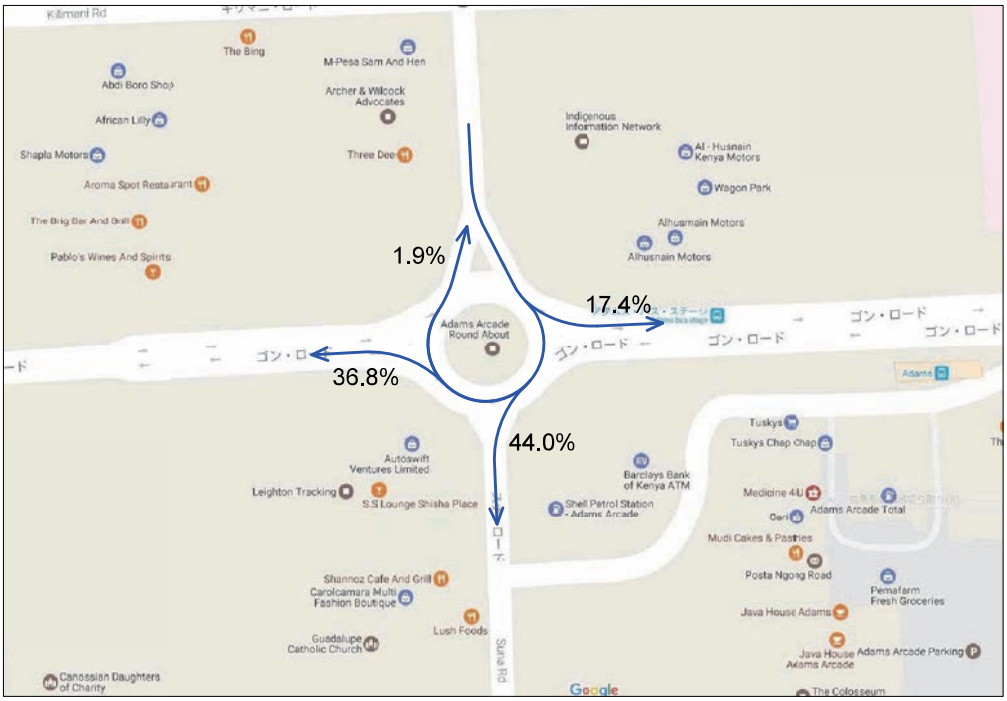


Adams Arcade Junction

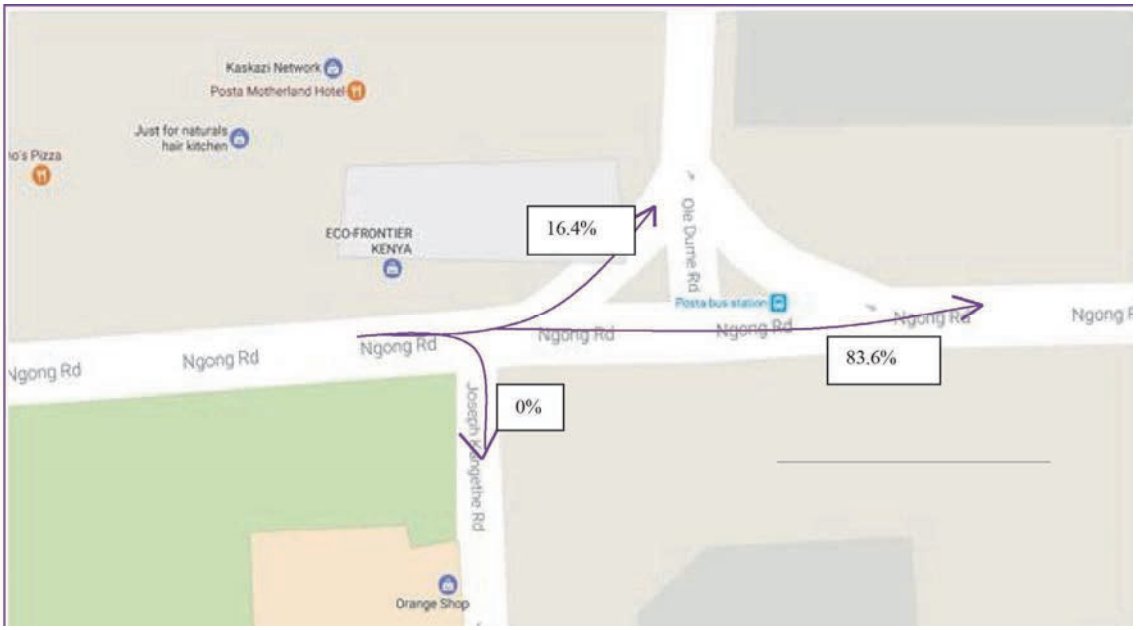


Adams Arcade Junction





Ole Dume Junction



Ole Dume Junction

7.4 Pavement Structure Design

Daily Traffic Volume Data (2016)

Design Section	Traffic Count Station	Station	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck
-	Total (Naivasha)	II-STA.0+000	1,247	442	613	90	29
N1	Dagoretti Bus Stop	II-STA.0+200	122	499	773	197	61
N2	Impara Club	II-STA.1+250	484	505	575	215	20
N3	Green House	I-STA.2+600	653	247	393	133	20
N4	Baptist Church	I-STA.2+350	1,412	209	516	116	13

Design Term 2017-2026

At Dagoretti Bus Stop

Year	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Growth Rate
2016	49	200	309	79	24	
2017	51	210	325	83	26	1.05
2018	53	218	338	86	27	1.04
2019	55	227	351	89	28	1.04
2020	57	233	362	92	29	1.03
2021	59	240	373	95	29	1.03
2022	61	248	384	98	30	1.03
2023	62	255	395	101	31	1.03
2024	64	263	407	104	32	1.03
2025	66	271	419	107	33	1.03
2026	68	279	432	110	34	1.03
2027	70	287	445	113	35	1.03
2028	72	296	458	117	36	1.03
Total	**231,900**	**948,508**	**1,469,332**	**374,461**	**115,950**	

At Impara Club

Year	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Growth Rate
2016	194	202	230	86	8	
2017	203	212	242	90	8	1.05
2018	211	221	251	94	9	1.04
2019	220	229	261	98	9	1.04
2020	226	236	269	101	9	1.03
2021	233	243	277	104	10	1.03
2022	240	251	285	107	10	1.03
2023	247	258	294	110	10	1.03
2024	255	266	303	113	11	1.03
2025	263	274	312	117	11	1.03
2026	270	282	321	120	11	1.03
2027	279	291	331	124	12	1.03
2028	287	299	341	127	12	1.03
Total	**919,996**	**959,913**	**1,092,970**	**408,676**	**38,016**	

At Green House

Year	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Growth Rate
2016	261	99	157	53	8	
2017	274	104	165	56	8	1.05
2018	285	108	172	58	9	1.04
2019	297	112	179	60	9	1.04
2020	306	116	184	62	9	1.03
2021	315	119	189	64	10	1.03
2022	324	123	195	66	10	1.03
2023	334	126	201	68	10	1.03
2024	344	130	207	70	11	1.03
2025	354	134	213	72	11	1.03
2026	365	138	220	74	11	1.03
2027	376	142	226	77	12	1.03
2028	387	146	233	79	12	1.03
Total	**1,241,234**	**469,502**	**747,021**	**252,809**	**38,016**	

At Baptist Church

Year	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Growth Rate
2016	706	105	258	58	7	
2017	741	110	271	61	7	1.05
2018	771	114	282	63	7	1.04
2019	802	119	293	66	7	1.04
2020	826	122	302	68	8	1.03
2021	851	126	311	70	8	1.03
2022	876	130	320	72	8	1.03
2023	902	134	330	74	8	1.03
2024	929	138	340	76	9	1.03
2025	957	142	350	79	9	1.03
2026	986	146	360	81	9	1.03
2027	1,016	150	371	83	9	1.03
2028	1,046	155	382	86	10	1.03
Total	**3,354,943**	**496,589**	**1,226,027**	**275,619**	**30,888**	

ESAL at Dagoretti Bus Stop

	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Total
Traffic 2017 - 2026	231,900	948,508	1,469,332	374,461	115,950	
ESAL per Vehicle	0.200	0.012	0.381	1.269	2.349	
ESAL	**46,380**	**11,382**	**559,815**	**475,191**	**272,366**	**1,365,135**

ESAL at Impara Club

	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Total
Traffic 2017 - 2026	919,996	959,913	1,092,970	408,676	38,016	
ESAL per Vehicle	0.200	0.012	0.381	1.269	2.349	
ESAL	**183,999**	**11,519**	**416,422**	**518,610**	**89,300**	**1,219,850**

ESAL at Green House

	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Total
Traffic 2017 - 2026	1,241,234	469,502	747,021	252,809	38,016	
ESAL per Vehicle	0.200	0.012	0.381	1.269	2.349	
ESAL	**248,247**	**5,634**	**284,615**	**320,814**	**89,300**	**948,611**

ESAL at Baptist Church

	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Total
Traffic 2017 - 2026	3,354,943	496,589	1,226,027	275,619	30,888	
ESAL per Vehicle	0.200	0.012	0.381	1.269	2.349	
ESAL	**670,989**	**5,959**	**467,116**	**349,760**	**72,557**	**1,566,381**

Required pavement structure index

Pavement design section		N1	N2	N3	N4
Predicted number of 18-kip equivalent single axle load applications	W18	1,365,135	1,219,850	948,611	1,566,381
Functional Classification (Principal Arte	R (%)	85	85	85	85
Standard normal deviate	ZR	-1.037	-1.037	-1.037	-1.037
Combined standard error of the traffic prediction and performance prediction	S0	0.45	0.45	0.45	0.45
Initial Serviceability	P0	4.2	4.2	4.2	4.2
Temminal Serviceability	P1	2.0	2.0	2.0	2.0
Difference between the initial (P0-P1)	ΔPSI	2.2	2.2	2.2	2.2
CBR (%)	CBR	6	6	6	6
Resilient modulus (psi)	MR	9,000	9,000	9,000	9,000
Structural number for the pavement	SN	3.145	3.092	2.976	3.211

$$Log_{10}(W_{18})=Z_R\times S_0+9.36\times Log_{10}(SN+1)-0.20+\{Log10[\Delta PSI/(4.2-1.5)]/[0.40+1094/(SN+1)^{5.19}]\}+2.32\times Log_{10}(M_R)-8.07$$

The left side of an equation log10(W18)=	6.135	6.086	5.977	6.195
The right side of equation=	6.135	6.086	5.977	6.195

Structural number for the proposed pavement

Pavement composition(New	Layer drainage	coefficient (a)				
Pavement design section			N1	N2	N3	N4
Asphalt Concrete Surface Cour	-	0.440	10.0	10.0	10.0	10.0
Base Course	0.9	0.140	15.0	15.0	15.0	15.0
Subbase Course	0.8	0.110	25.0	25.0	25.0	25.0
Structural number for the proposed pavement (SN)			3.34	3.34	3.34	3.34
Decision			OK	OK	OK	OK

Daily Traffic Volume Data (2016)

Design Section	Traffic Count Station	Station	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck
-	Total (Naivasha)	II-STA.0+000	1,364	484	671	98	32
N1	Dagoretti Bus Stop	II-STA.0+200	271	1,110	1,720	438	136
N2	Impara Club	II-STA.1+250	997	1,041	1,185	443	41
N3	Green House	I-STA.2+600	1,466	554	882	299	34
N4	Baptist Church	I-STA.2+350	2,428	359	887	199	22

At Dagoretti Bus Stop

Year	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Growth Rate
2016	109	444	688	175	54	
2017	114	466	722	184	57	1.05
2018	119	485	751	191	59	1.04
2019	123	504	781	199	62	1.04
2020	127	520	805	205	64	1.03
2021	131	535	829	211	65	1.03
2022	135	551	854	218	67	1.03
2023	139	568	879	224	69	1.03
2024	143	585	906	231	71	1.03
2025	147	602	933	238	74	1.03
2026	152	620	961	245	76	1.03
2027	156	639	990	252	78	1.03
2028	161	658	1,019	260	80	1.03
Total	**516,005**	**2,110,545**	**3,269,442**	**833,221**	**258,003**	

At Impara Club

Year	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Growth Rate
2016	399	416	474	177	16	
2017	419	437	498	186	17	1.05
2018	436	455	518	194	18	1.04
2019	453	473	538	201	19	1.04
2020	467	487	554	207	19	1.03
2021	481	501	571	213	20	1.03
2022	495	517	588	220	20	1.03
2023	510	532	606	227	21	1.03
2024	525	548	624	233	22	1.03
2025	541	564	643	240	22	1.03
2026	557	581	662	248	23	1.03
2027	574	599	682	255	24	1.03
2028	591	617	702	263	24	1.03
Total	**1,895,631**	**1,977,879**	**2,252,041**	**842,067**	**78,332**	

At Green House

Year	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Growth Rate
2016	586	222	353	119	13	
2017	616	233	371	125	14	1.05
2018	640	242	385	130	15	1.04
2019	666	252	401	136	15	1.04
2020	686	259	413	140	16	1.03
2021	706	267	425	144	16	1.03
2022	728	275	438	148	17	1.03
2023	749	283	451	153	17	1.03
2024	772	292	465	157	18	1.03
2025	795	301	479	162	18	1.03
2026	819	310	493	167	19	1.03
2027	844	319	508	172	19	1.03
2028	869	329	523	177	20	1.03
Total	**2,786,316**	**1,053,936**	**1,676,910**	**567,504**	**64,004**	

At Baptist Church

Year	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Growth Rate
2016	1,214	180	444	100	11	
2017	1,275	189	466	105	12	1.05
2018	1,326	196	484	109	12	1.04
2019	1,379	204	504	113	13	1.04
2020	1,420	210	519	117	13	1.03
2021	1,463	217	535	120	13	1.03
2022	1,507	223	551	124	14	1.03
2023	1,552	230	567	127	14	1.03
2024	1,598	237	584	131	15	1.03
2025	1,646	244	602	135	15	1.03
2026	1,696	251	620	139	16	1.03
2027	1,747	259	638	143	16	1.03
2028	1,799	266	657	148	17	1.03
Total	**5,769,288**	**853,953**	**2,108,323**	**473,964**	**53,117**	

ESAL at Dagoretti Bus Stop

	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Total
Traffic 2017 - 2026	516,005	2,110,545	3,269,442	833,221	258,003	
ESAL per Vehicle	0.200	0.012	0.381	1.269	2.349	
ESAL	**103,201**	**25,327**	**1,245,657**	**1,057,358**	**606,048**	**3,037,590**

ESAL at Impara Club

	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Total
Traffic 2017 - 2026	1,895,631	1,977,879	2,252,041	842,067	78,332	
ESAL per Vehicle	0.200	0.012	0.381	1.269	2.349	
ESAL	**379,126**	**23,735**	**858,028**	**1,068,584**	**184,002**	**2,513,473**

ESAL at Green House

	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Total
Traffic 2017 - 2026	2,786,316	1,053,936	1,676,910	567,504	64,004	
ESAL per Vehicle	0.200	0.012	0.381	1.269	2.349	
ESAL	**557,263**	**12,647**	**638,903**	**720,162**	**150,346**	**2,079,321**

ESAL at Baptist Church

	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Total
Traffic 2017 - 2026	5,769,288	853,953	2,108,323	473,964	53,117	
ESAL per Vehicle	0.200	0.012	0.381	1.269	2.349	
ESAL	**1,153,858**	**10,247**	**803,271**	**601,461**	**124,771**	**2,693,608**

Required pavement structure index

Pavement design section		N1	N2	N3	N4
Predicted number of 18-kip equivalent single axle load applications	W18	3,037,590	2,513,473	2,079,321	2,693,608
Functional Classification (Principal Arte	R (%)	85	85	85	85
Standard normal deviate	ZR	-1.037	-1.037	-1.037	-1.037
Combined standard error of the traffic prediction and performance prediction	S0	0.45	0.45	0.45	0.45
Initial Serviceability	P0	4.2	4.2	4.2	4.2
Temminal Serviceability	P1	2.0	2.0	2.0	2.0
Difference between the initial (P0-P1)	ΔPSI	2.2	2.2	2.2	2.2
CBR (%)	CBR	6	6	6	6
Resilient modulus (psi)	MR	9,000	9,000	9,000	9,000
Structural number for the pavement	SN	3.544	3.446	3.350	3.481

$$Log_{10}(W_{18})=Z_R\times S_0+9.36\times Log_{10}(SN+1)-0.20+\{Log10[\Delta PSI/(4.2-1.5)]/[0.40+1094/(SN+1)^{5.19}]\}+2.32\times Log_{10}(M_R)-8.07$$

The left side of an equation log10(W18)=	6.483	6.400	6.318	6.430
The right side of equation=	6.483	6.400	6.318	6.430

Structural number for the proposed pavement

Pavement composition(New	Layer drainage	coefficient (a)				
Pavement design section			N1	N2	N3	N4
Asphalt Concrete Surface Cour	-	0.440	10.0	10.0	10.0	10.0
Base Course	0.9	0.140	20.0	20.0	20.0	20.0
Subbase Course	0.8	0.110	25.0	25.0	25.0	25.0
Structural number for the proposed pavement (SN)			3.59	3.59	3.59	3.59
Decision			OK	OK	OK	OK

Existing Road pavement

Required pavement structure index

Pavement design section		N1
Predicted number of 18-kip equivalent single axle load applications	W18	3,037,590
Functional Classification (Principal Arte	R (%)	85
Standard normal deviate	ZR	-1.037
Combined standard error of the traffic prediction and performance prediction	S0	0.45
Initial Serviceability	P0	4.2
Temminal Serviceability	P1	2.0
Difference between the initial (P0-P1)	ΔPSI	2.2
CBR (%)	CBR	30
Resilient modulus (psi)	MR	45,000
Structural number for the pavement	SN	1.985

$$Log_{10}(W_{18})=Z_R\times S_0+9.36\times Log_{10}(SN+1)-0.20+\{Log10[\Delta PSI/(4.2-1.5)]/[0.40+1094/(SN+1)^{5.19}]\}+2.32\times Log_{10}(M_R)-8.07$$

The left side of an equation log10(W18)=	6.483
The right side of equation=	6.483

Structural number for the proposed pavement

Pavement composition(New	Layer drainage	coefficient (a)	
Pavement design section			Ngong Road
Asphalt Concrete Surface Cour	-	0.440	10.0
Base Course	1.0	0.140	20.0
Subbase Course	0.8	0.110	5.0
Structural number for the proposed pavement (SN)			3.01
Decision			OK

Naivasha road - Kingara road **Current Plan-1** AADT

Hour: 7:00 - 8:00 (morning Peak Hour)

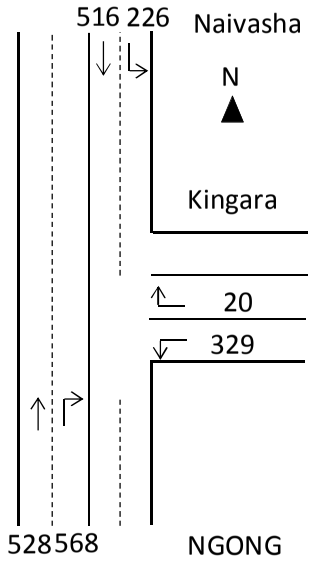
1. Inflow Traffic Volume

Approach	North		South		East			
Street								
Direction	Through	Left	Through	Right	Left	Right		
Number of lanes	1	1	1	1	1	1		
Basic saturation flow rate	2,000	1,800	2,000	1,800	1,800	1,800		
Safety Factor	0.81	0.81	0.81	0.81	0.81	0.81		
Saturation flow rate	1,620	1,458	1,620	1,458	1,458	1,458		
Traffic volume (PCU/h)	516	226	528	568	329	20		
Traffic volume per lane	516	226	528	568	329	20		**Saturation**
Normalized traffic volume	0.32	0.16	0.33	0.39	0.23	0.01		**Degree**
Demanf factor of phase 1			0.33	0.39			0.39	
Demanf factor of phase 2	0.32	0.16	***				0.32	
Demanf factor of phase 3					0.23	0.01	0.23	**0.93**
							0.00	**< 0.9**
Green time rate of phase 1			0.37	0.37				**OK**
Green time rate of phase 2	0.30	0.30	0.30					
Green time rate of phase 3					0.21	0.21		
Leg Capacity by Direction	486	437	1,080	535	304	304		
VCR (Vehicle/Capacity Ratio)	1.06	0.52	0.49	1.06	1.08	0.07		
Evaluation	OK	OK	OK	OK	OK	OK		

2. Signal Phase

Signal phase	1 ϕ	2 ϕ	3 ϕ	
Saturation degree	0.39	0.32	0.23	
Demand for green	47	39	28	
Green time	44	36	25	
Yellow + red time	5	5	5	
Cycle	120			
			Saturation Degree of Intersection =	**0.93**

3. Lane Composition & Traffic Demand (PCU/h)



Kingara road - Ngong road

Current Plan-1

AADT

Hour: 7:00 - 8:00 (morning Peak Hour)

1. Inflow Traffic Volume

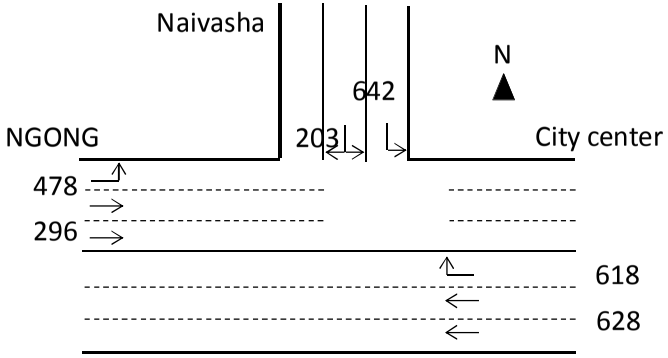
Approach	West		East		North			
Street								
Direction	Through	Left	Through	Right	Left	Left/Right		
Number of lanes	2	1	2	1	1	1		
Basic saturation flow rate	2,000	1,800	2,000	1,800	1,800	1,800		
Safety Factor	0.81	0.81	0.81	0.81	0.81	0.81		
Saturation flow rate	1,620	1,458	1,620	1,458	1,458	1,458		
Traffic volume (PCU/h)	296	478	628	618	642	203		
Traffic volume per lane	148	478	314	618	642	203		**Saturation**
Normalized traffic volume	0.09	0.33	0.19	0.42	0.44	0.14		**Degree**
Demanf factor of phase 1			0.19	0.42			0.42	
Demanf factor of phase 2	0.09	0.09					0.09	
Demanf factor of phase 3		***			0.44	0.14	0.44	**0.96**
							0.00	**< 0.9**
Green time rate of phase 1			0.39	0.39	0.39			**OK**
Green time rate of phase 2	0.08	0.08	0.08					
Green time rate of phase 3		0.40			0.40	0.40		
Leg Capacity by Direction	270	705	1,539	571	1,154	583		
VCR (Vehicle/Capacity Ratio)	1.10	0.68	0.41	1.08	0.56	0.35		
Evaluation	OK	OK	OK	OK	OK	OK		

2. Signal Phase

	1 ϕ	2 ϕ	3 ϕ	
Signal phase				
Saturation degree	0.42	0.09	0.44	
Demand for green	51	11	53	
Green time	47	10	48	
Yellow + red time	5	5	5	
Cycle	120			
Saturation Degree of Intersection =				**0.96**

3. Lane Composition & Traffic Demand

(PCU/h)



Naivasha road - Ngong road **Current Plan-2** AADT

Hour: 7:00 - 8:00 (morning Peak Hour)

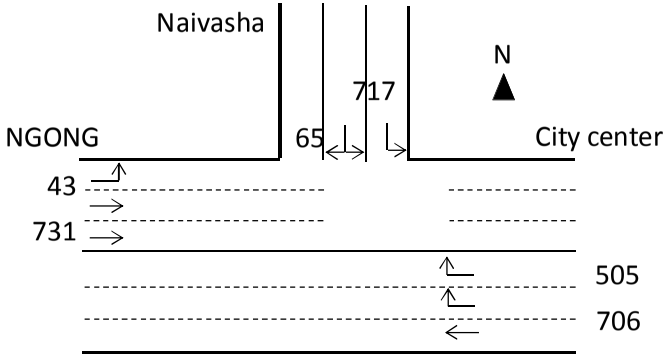
1. Inflow Traffic Volume

Approach	West		East		North			
Street								
Direction	Through	Left	Through	Right	Left	Left/Right		
Number of lanes	2	1	1	2	1	1		
Basic saturation flow rate	2,000	1,800	2,000	1,800	1,800	1,800		
Safety Factor	0.81	0.81	0.81	0.81	0.81	0.81		
Saturation flow rate	1,620	1,458	1,620	1,458	1,458	1,458		
Traffic volume (PCU/h)	731	43	706	505	391	391		
Traffic volume per lane	366	43	706	253	391	391		**Saturation**
Normalized traffic volume	0.23	0.03	0.44	0.17	0.27	0.27		**Degree**
Demanf factor of phase 1		***	0.21	0.17	****		0.21	
Demanf factor of phase 2	0.23	***	0.23				0.23	
Demanf factor of phase 3		***			0.27	0.27	0.27	**0.70**
							0.00	**< 0.9**
Green time rate of phase 1		0.26	0.26	0.26	0.26			**OK**
Green time rate of phase 2	0.28	0.28	0.28					
Green time rate of phase 3		0.33			0.33	0.33		
Leg Capacity by Direction	918	1,276	878	753	863	486		
VCR (Vehicle/Capacity Ratio)	0.80	0.03	0.80	0.67	0.45	0.80		
Evaluation	OK	OK	OK	OK	OK	OK		

2. Signal Phase

	1 ϕ	2 ϕ	3 ϕ	
Signal phase				
Saturation degree	0.21	0.23	0.27	
Demand for green	26	28	33	
Green time	31	34	40	
Yellow + red time	5	5	5	
Cycle	120			
			Saturation Degree of Intersection =	**0.70**

3. Lane Composition & Traffic Demand (PCU/h)



Kingara road - Ngong road **Current Plan-2** AADT

Hour: 7:00 - 8:00 (morning Peak Hour)

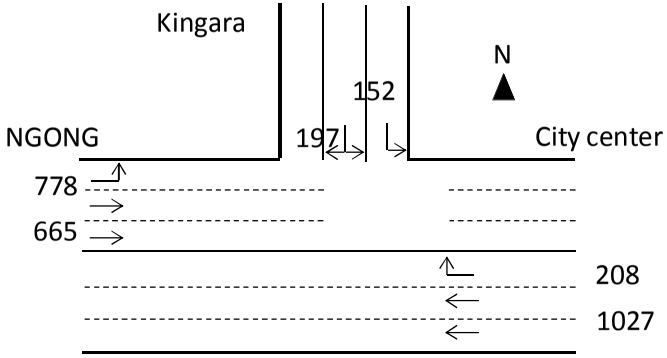
1. Inflow Traffic Volume

Approach	West		East		North			
Street								
Direction	Through	Left	Through	Right	Left	Left/Right		
Number of lanes	2	1	2	1	1	1		
Basic saturation flow rate	2,000	1,800	2,000	1,800	1,800	1,800		
Safety Factor	0.81	0.81	0.81	0.81	0.81	0.81		
Saturation flow rate	1,620	1,458	1,620	1,458	1,458	1,458		
Traffic volume (PCU/h)	665	778	1,027	208	152	197		
Traffic volume per lane	333	778	514	208	152	197		**Saturation**
Normalized traffic volume	0.21	0.53	0.32	0.14	0.10	0.14		**Degree**
Demanf factor of phase 1			0.32	0.14			0.32	
Demanf factor of phase 2	0.21	0.40					0.40	
Demanf factor of phase 3		0.14			0.10	0.14	0.14	**0.85**
							0.00	**< 0.9**
Green time rate of phase 1			0.33	0.33	0.33			**OK**
Green time rate of phase 2	0.41	0.41	0.41					
Green time rate of phase 3		0.14			0.14	0.14		
Leg Capacity by Direction	1,323	802	2,376	474	680	207		
VCR (Vehicle/Capacity Ratio)	0.50	0.97	0.43	0.44	0.22	0.95		
Evaluation	OK	OK	OK	OK	OK	OK		

2. Signal Phase

	1 ϕ	2 ϕ	3 ϕ	
Signal phase				
Saturation degree	0.32	0.40	0.14	
Demand for green	39	48	17	
Green time	39	49	17	
Yellow + red time	5	5	5	
Cycle	120			
Saturation Degree of Intersection =				**0.85**

3. Lane Composition & Traffic Demand (PCU/h)



Naivasha road - Ngong road **Current Plan-3** AADT

Hour: 7:00 - 8:00 (morning Peak Hour)

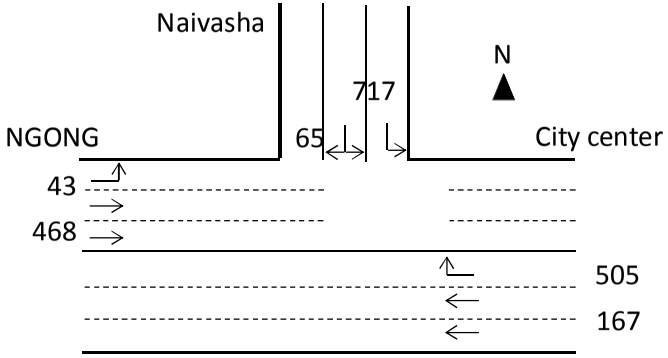
1. Inflow Traffic Volume

Approach	West		East		North			
Street								
Direction	Through	Left	Through	Right	Left	Left/Right		
Number of lanes	2	1	2	1	1	1		
Basic saturation flow rate	2,000	1,800	2,000	1,800	1,800	1,800		
Safety Factor	0.81	0.81	0.81	0.81	0.81	0.81		
Saturation flow rate	1,620	1,458	1,620	1,458	1,458	1,458		
Traffic volume (PCU/h)	468	43	167	505	391	391		
Traffic volume per lane	234	43	84	505	391	391		**Saturation**
Normalized traffic volume	0.14	0.03	0.05	0.35	0.27	0.27		**Degree**
Demanf factor of phase 1		***	0.05	0.35	****		0.35	
Demanf factor of phase 2	0.14	***	****				0.14	
Demanf factor of phase 3		***			0.27	0.27	0.27	**0.76**
							0.00	**< 0.9**
Green time rate of phase 1		0.40	0.40	0.40	0.40			**OK**
Green time rate of phase 2	0.17	0.17	0.17					
Green time rate of phase 3		0.31			0.31	0.31		
Leg Capacity by Direction	540	1,276	1,836	583	1,033	450		
VCR (Vehicle/Capacity Ratio)	0.87	0.03	0.09	0.87	0.38	0.87		
Evaluation	OK	OK	OK	OK	OK	OK		

2. Signal Phase

	1 ϕ	2 ϕ	3 ϕ	
Signal phase				
Saturation degree	0.35	0.14	0.27	
Demand for green	42	18	33	
Green time	48	20	37	
Yellow + red time	5	5	5	
Cycle	120			
Saturation Degree of Intersection =				**0.76**

3. Lane Composition & Traffic Demand (PCU/h)



Kingara road - Ngong road **Current Plan-3** AADT

Hour: 7:00 - 8:00 (morning Peak Hour)

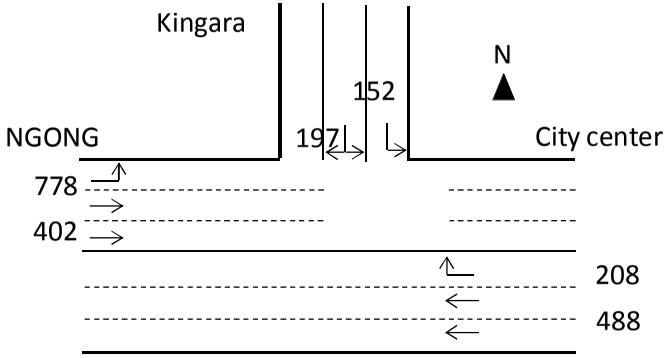
1. Inflow Traffic Volume

Approach	West		East		North			
Street								
Direction	Through	Left	Through	Right	Left	Left/Right		
Number of lanes	2	1	2	1	1	1		
Basic saturation flow rate	2,000	1,800	2,000	1,800	1,800	1,800		
Safety Factor	0.81	0.81	0.81	0.81	0.81	0.81		
Saturation flow rate	1,620	1,458	1,620	1,458	1,458	1,458		
Traffic volume (PCU/h)	402	778	488	208	152	197		
Traffic volume per lane	201	778	244	208	152	197		**Saturation**
Normalized traffic volume	0.12	0.53	0.15	0.14	0.10	0.14		**Degree**
Demanf factor of phase 1			0.15	0.14			0.15	
Demanf factor of phase 2	0.12	0.40					0.40	
Demanf factor of phase 3		0.14			0.10	0.14	0.14	**0.68**
							0.00	**< 0.9**
Green time rate of phase 1			0.19	0.19	0.19			**OK**
Green time rate of phase 2	0.51	0.51	0.51					
Green time rate of phase 3		0.18			0.18	0.18		
Leg Capacity by Direction	1,647	996	2,268	279	535	255		
VCR (Vehicle/Capacity Ratio)	0.24	0.78	0.22	0.74	0.28	0.77		
Evaluation	OK	OK	OK	OK	OK	OK		

2. Signal Phase

	1 ϕ	2 ϕ	3 ϕ	
Signal phase				
Saturation degree	0.15	0.40	0.14	
Demand for green	19	48	17	
Green time	23	61	21	
Yellow + red time	5	5	5	
Cycle	120			
Saturation Degree of Intersection =				**0.68**

3. Lane Composition & Traffic Demand (PCU/h)



Naivasha road - Kingara road **future Plan-1** AADT

Hour: 7:00 - 8:00 (morning Peak Hour)

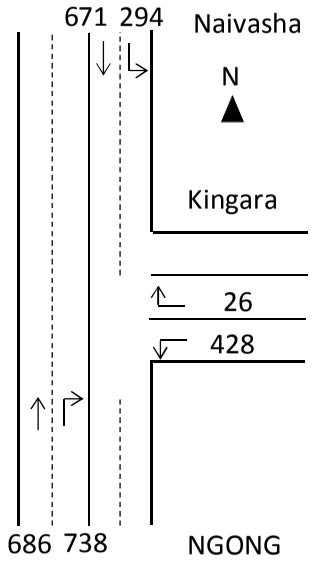
1. Inflow Traffic Volume

Approach	North		South		East			
Street								
Direction	Through	Left	Through	Right	Left	Right		
Number of lanes	1	1	1	1	1	1		
Basic saturation flow rate	2,000	1,800	2,000	1,800	1,800	1,800		
Safety Factor	0.81	0.81	0.81	0.81	0.81	0.81		
Saturation flow rate	1,620	1,458	1,620	1,458	1,458	1,458		
Traffic volume (PCU/h)	671	294	686	738	428	26		
Traffic volume per lane	671	294	686	738	428	26		**Saturation**
Normalized traffic volume	0.41	0.20	0.42	0.51	0.29	0.02		**Degree**
Demanf factor of phase 1			0.42	0.51			0.51	
Demanf factor of phase 2	0.41	0.20	***				0.41	
Demanf factor of phase 3					0.29	0.02	0.29	1.21
							0.00	< 0.9
								OK
Green time rate of phase 1			0.37	0.37				
Green time rate of phase 2	0.30	0.30	0.30					
Green time rate of phase 3					0.21	0.21		
Leg Capacity by Direction	486	437	1,080	535	304	304		
VCR (Vehicle/Capacity Ratio)	1.38	0.67	0.64	1.38	1.41	0.09		
Evaluation	OK	OK	OK	OK	OK	OK		

2. Signal Phase

	1 ϕ	2 ϕ	3 ϕ	
Signal phase				
Saturation degree	0.51	0.41	0.29	
Demand for green	61	50	36	
Green time	44	36	25	
Yellow + red time	5	5	5	
Cycle	120			
Saturation Degree of Intersection =				**1.21**

3. Lane Composition & Traffic Demand (PCU/h)



Kingara road - Ngong road **future Plan-1** AADT

Hour: 7:00 - 8:00 (morning Peak Hour)

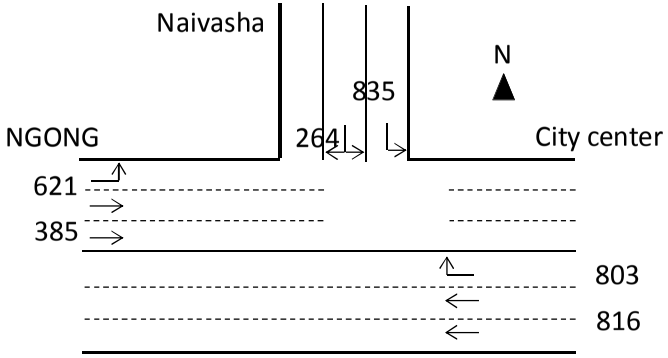
1. Inflow Traffic Volume

Approach	West		East		North			
Street								
Direction	Through	Left	Through	Right	Left	Left/Right		
Number of lanes	2	1	2	1	1	1		
Basic saturation flow rate	2,000	1,800	2,000	1,800	1,800	1,800		
Safety Factor	0.81	0.81	0.81	0.81	0.81	0.81		
Saturation flow rate	1,620	1,458	1,620	1,458	1,458	1,458		
Traffic volume (PCU/h)	385	621	816	803	835	264		
Traffic volume per lane	193	621	408	803	835	264		**Saturation**
Normalized traffic volume	0.12	0.43	0.25	0.55	0.57	0.18		**Degree**
Demanf factor of phase 1			0.25	0.55			0.55	
Demanf factor of phase 2	0.12	0.12					0.12	
Demanf factor of phase 3		***			0.57	0.18	0.57	1.24
							0.00	< 0.9
Green time rate of phase 1			0.39	0.39	0.39			OK
Green time rate of phase 2	0.08	0.08	0.08					
Green time rate of phase 3		0.40			0.40	0.40		
Leg Capacity by Direction	270	705	1,539	571	1,154	583		
VCR (Vehicle/Capacity Ratio)	1.43	0.88	0.53	1.41	0.72	0.45		
Evaluation	OK	OK	OK	OK	OK	OK		

2. Signal Phase

	1 ϕ	2 ϕ	3 ϕ	
Signal phase				
Saturation degree	0.55	0.12	0.57	
Demand for green	67	15	69	
Green time	47	10	48	
Yellow + red time	5	5	5	
Cycle	120			
Saturation Degree of Intersection =				**1.24**

3. Lane Composition & Traffic Demand (PCU/h)



Naivasha road - Ngong road **future Plan-2** AADT

Hour: 7:00 - 8:00 (morning Peak Hour)

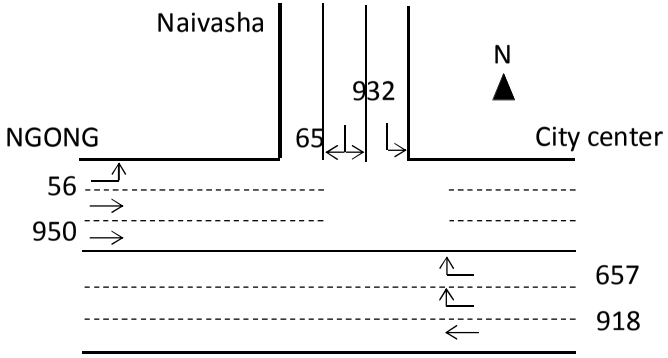
1. Inflow Traffic Volume

Approach	West		East		North			
Street								
Direction	Through	Left	Through	Right	Left	Left/Right		
Number of lanes	2	1	1	2	1	1		
Basic saturation flow rate	2,000	1,800	2,000	1,800	1,800	1,800		
Safety Factor	0.81	0.81	0.81	0.81	0.81	0.81		
Saturation flow rate	1,620	1,458	1,620	1,458	1,458	1,458		
Traffic volume (PCU/h)	950	56	918	657	608	408		
Traffic volume per lane	475	56	918	329	608	408		**Saturation**
Normalized traffic volume	0.29	0.04	0.57	0.23	0.42	0.28		**Degree**
Demanf factor of phase 1		***	0.27	0.23	0.14		0.27	
Demanf factor of phase 2	0.29	***	0.29				0.29	
Demanf factor of phase 3		***			0.28	0.28	0.28	**0.85**
							0.00	**< 0.9**
Green time rate of phase 1		0.29	0.29	0.29	0.29			**OK**
Green time rate of phase 2	0.31	0.31	0.31					
Green time rate of phase 3		0.29			0.29	0.29		
Leg Capacity by Direction	995	1,291	960	833	844	427		
VCR (Vehicle/Capacity Ratio)	0.95	0.04	0.96	0.79	0.72	0.96		
Evaluation	OK	OK	OK	OK	OK	OK		

2. Signal Phase

	1 ϕ	2 ϕ	3 ϕ	
Signal phase				
Saturation degree	0.27	0.29	0.28	
Demand for green	39	42	40	
Green time	40	43	41	
Yellow + red time	5	5	5	
Cycle	140			
			Saturation Degree of Intersection =	**0.85**

3. Lane Composition & Traffic Demand (PCU/h)



Kingara road - Ngong road **future Plan-2** AADT

Hour: 7:00 - 8:00 (morning Peak Hour)

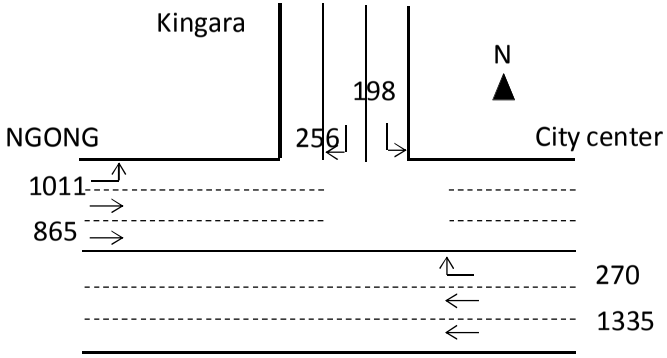
1. Inflow Traffic Volume

Approach	West		East		North			
Street								
Direction	Through	Left	Through	Right	Left	Left/Right		
Number of lanes	2	1	2	1	1	1		
Basic saturation flow rate	2,000	1,800	2,000	1,800	1,800	1,800		
Safety Factor	0.81	0.81	0.81	0.81	0.81	0.81		
Saturation flow rate	1,620	1,458	1,620	1,458	1,458	1,458		
Traffic volume (PCU/h)	865	1,011	1,335	270	198	256		
Traffic volume per lane	433	1,011	668	270	198	256		**Saturation**
Normalized traffic volume	0.27	0.69	0.41	0.19	0.14	0.18		**Degree**
Demanf factor of phase 1			***	0.19			0.19	
Demanf factor of phase 2	0.27	0.52	***				0.52	
Demanf factor of phase 3		0.18			0.14	0.18	0.18	**0.88**
							0.00	**< 0.9**
Green time rate of phase 1			0.19	0.19	0.19			**OK**
Green time rate of phase 2	0.53	0.53	0.53					
Green time rate of phase 3		0.18			0.18	0.18		
Leg Capacity by Direction	1,713	1,031	2,314	271	531	260		
VCR (Vehicle/Capacity Ratio)	0.51	0.98	0.58	1.00	0.37	0.98		
Evaluation	OK	OK	OK	OK	OK	OK		

2. Signal Phase

	1 ϕ	2 ϕ	3 ϕ	
Signal phase				
Saturation degree	0.19	0.52	0.18	
Demand for green	26	73	25	
Green time	26	74	25	
Yellow + red time	5	5	5	
Cycle	140			
Saturation Degree of Intersection =				**0.88**

3. Lane Composition & Traffic Demand (PCU/h)



Naivasha road - Ngong road **future Plan-3** AADT

Hour: 7:00 - 8:00 (morning Peak Hour)

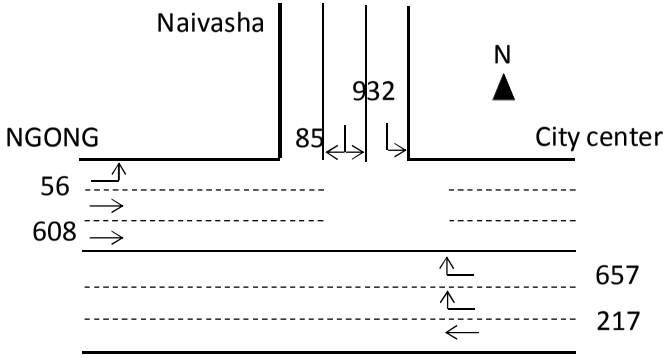
1. Inflow Traffic Volume

Approach	West		East		North			
Street								
Direction	Through	Left	Through	Right	Left	Left/Right		
Number of lanes	2	1	1	2	1	1		
Basic saturation flow rate	2,000	1,800	2,000	1,800	1,800	1,800		
Safety Factor	0.81	0.81	0.81	0.81	0.81	0.81		
Saturation flow rate	1,620	1,458	1,620	1,458	1,458	1,458		
Traffic volume (PCU/h)	608	56	217	657	508	508		
Traffic volume per lane	304	56	217	329	508	508		**Saturation**
Normalized traffic volume	0.19	0.04	0.13	0.23	0.35	0.35		**Degree**
Demanf factor of phase 1		***	***	0.23	***		0.23	
Demanf factor of phase 2	0.19	***	***				0.19	
Demanf factor of phase 3		***			0.35	0.35	0.35	**0.76**
							0.00	**< 0.9**
Green time rate of phase 1		0.26	0.26	0.26	0.26			**OK**
Green time rate of phase 2	0.22	0.22	0.22					
Green time rate of phase 3		0.41			0.41	0.41		
Leg Capacity by Direction	717	1,302	787	771	979	594		
VCR (Vehicle/Capacity Ratio)	0.85	0.04	0.28	0.85	0.52	0.86		
Evaluation	OK	OK	OK	OK	OK	OK		

2. Signal Phase

	1 ϕ	2 ϕ	3 ϕ	
Signal phase				
Saturation degree	0.23	0.19	0.35	
Demand for green	32	27	49	
Green time	37	31	57	
Yellow + red time	5	5	5	
Cycle	140			
			Saturation Degree of Intersection =	**0.76**

3. Lane Composition & Traffic Demand (PCU/h)



Kingara road - Ngong road **future Plan-3** AADT

Hour: 7:00 - 8:00 (morning Peak Hour)

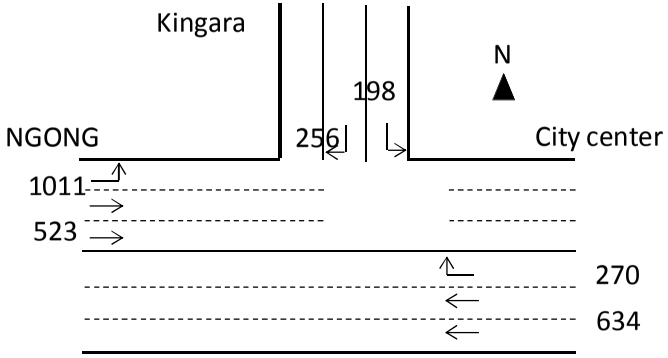
1. Inflow Traffic Volume

Approach	West		East		North			
Street								
Direction	Through	Left	Through	Right	Left	Left/Right		
Number of lanes	2	1	2	1	1	1		
Basic saturation flow rate	2,000	1,800	2,000	1,800	1,800	1,800		
Safety Factor	0.81	0.81	0.81	0.81	0.81	0.81		
Saturation flow rate	1,620	1,458	1,620	1,458	1,458	1,458		
Traffic volume (PCU/h)	523	1,011	634	270	198	256		
Traffic volume per lane	262	1,011	317	270	198	256		**Saturation**
Normalized traffic volume	0.16	0.69	0.20	0.19	0.14	0.18		**Degree**
Demanf factor of phase 1			****	0.19			0.19	
Demanf factor of phase 2	0.16	0.52	****				0.52	
Demanf factor of phase 3		0.18			0.14	0.18	0.18	**0.88**
							0.00	**< 0.9**
Green time rate of phase 1			0.19	0.19	0.19			**OK**
Green time rate of phase 2	0.53	0.53	0.53					
Green time rate of phase 3		0.18			0.18	0.18		
Leg Capacity by Direction	1,713	1,031	2,314	271	531	260		
VCR (Vehicle/Capacity Ratio)	0.31	0.98	0.27	1.00	0.37	0.98		
Evaluation	OK	OK	OK	OK	OK	OK		

2. Signal Phase

	1 ϕ	2 ϕ	3 ϕ	
Signal phase				
Saturation degree	0.19	0.52	0.18	
Demand for green	26	73	25	
Green time	26	74	25	
Yellow + red time	5	5	5	
Cycle	140			
			Saturation Degree of Intersection =	**0.88**

3. Lane Composition & Traffic Demand (PCU/h)



7.6 Drainage Calculation

Rainfall Data by Gumbel Method

Rainfall Data and Gumbel Method（Exteam Value distribution）

(1) Rank i	(2) Year	(2) Rainfall x (mm)	(3) Exceedance Probability F(x)	(4) x^2	(5) Peak Variate y
1	1973	139.1	0.97561	19,348.81	3.7013
2	2001	128.4	0.95122	16,486.56	2.9955
3	1980	125.6	0.92683	15,775.36	2.5772
4	2015	116.0	0.90244	13,456.00	2.2764
5	1981	111.7	0.87805	12,476.89	2.0398
6	1986	104.5	0.85366	10,920.25	1.8438
7	1978	98.0	0.82927	9,604.00	1.6755
8	1971	97.6	0.80488	9,525.76	1.5276
9	2005	97.6	0.78049	9,525.76	1.3950
10	2014	96.8	0.75610	9,370.24	1.2745
11	1998	88.1	0.73171	7,761.61	1.1636
12	1977	86.9	0.70732	7,551.61	1.0605
13	1972	85.5	0.68293	7,310.25	0.9640
14	1989	80.2	0.65854	6,432.04	0.8729
15	1970	77.5	0.63415	6,006.25	0.7864
16	2007	77.2	0.60976	5,959.84	0.7038
17	1995	73.4	0.58537	5,387.56	0.6245
18	2006	70.1	0.56098	4,914.01	0.5481
19	1979	69.0	0.53659	4,761.00	0.4740
20	1982	67.5	0.51220	4,556.25	0.4019
21	1983	67.5	0.48780	4,556.25	0.3315
22	1990	66.5	0.46341	4,422.25	0.2625
23	1988	63.6	0.43902	4,044.96	0.1945
24	1987	60.5	0.41463	3,660.25	0.1274
25	1991	59.9	0.39024	3,588.01	0.0608
26	1997	59.6	0.36585	3,552.16	-0.0055
27	2013	59.2	0.34146	3,504.64	-0.0719
28	1996	58.8	0.31707	3,457.44	-0.1386
29	2004	58.8	0.29268	3,457.44	-0.2059
30	2003	58.3	0.26829	3,398.89	-0.2744
31	1975	58.2	0.24390	3,387.24	-0.3443
32	2008	58.0	0.21951	3,364.00	-0.4163
33	1976	56.6	0.19512	3,203.56	-0.4911
34	1993	55.6	0.17073	3,091.36	-0.5697
35	1992	54.5	0.14634	2,970.25	-0.6533
36	1994	50.5	0.12195	2,550.25	-0.7439
37	1985	48.0	0.09756	2,304.00	-0.8447
38	1999	46.4	0.07317	2,152.96	-0.9613
39	1974	44.4	0.04878	1,971.36	-1.1054
40	1984	44.1	0.02439	1,944.81	-1.3120
	Total	3,019.7		251,712.1	
	平均Σx/N=	75.49	$\Sigma x^2/N=$	6292.803	
		$\bar{x}$		$\overline{x^2}$	

*) (3): F(x)=1-j/(N+1)
(5): -ln{-lnF(x)}

$Sx = \overline{(x^2}-(\bar{x})^2)$^0.5 = 24.3734

$\bar{y}$ = 0.543 Sy = 1.1388 (N=39, See Table A)

1/a=Sx/Sy= 21.4027

$\bar{x}_0 = \bar{x}-(1/a)*\bar{y}$ = 63.868

x=63.868+21.4027*y

Establish Year T	F(%)	$\bar{y}$	(1/a)*y	Establish Rainfall (mm/day) x				
2	50	0.3665	7.844	71.71				
3	67	0.9027	19.320	**83.19**	⇒	=(24*6)^(2/3)*X/24	95.2 (mm/hr)	For
4	75	1.2459	26.666	90.53				Draiage
5	80	1.4994	32.091	**95.96**	⇒	=(24*6)^(2/3)*X/24	109.8 (mm/hr)	For
10	90	2.2504	48.165	112.03				Crossing
20	95	2.9702	63.570	127.44				
30	97	3.3843	72.433	136.30				
40	98	3.6763	78.683	142.55				
50	98	3.9019	83.511	147.38				
100	99	4.6002	98.457	162.33				

Table A - Sumple no. and y',Sy

Sumple No. N	$\bar{y}$	Sy
15	0.5128	1.0206
16	0.5157	1.0316
17	0.5181	1.0411
18	0.5202	1.0493
19	0.5220	1.0565
20	0.5236	1.0628
21	0.5252	1.0696
22	0.5268	1.0754
23	0.5283	1.0811
24	0.5296	1.0864
25	0.5309	1.0915
26	0.5320	1.0961
27	0.5332	1.1004
28	0.5343	1.1047
29	0.5353	1.1086
30	0.5362	1.1124
31	0.5371	1.1159
32	0.5380	1.1193
33	0.5388	1.1226
34	0.5396	1.1255
35	0.5403	1.1285
36	0.5410	1.1313
37	0.5418	1.1339
38	0.5424	1.1363
39	**0.5430**	**1.1388**
40	0.5436	1.1413
41	0.5442	1.1436
42	0.5448	1.1458
43	0.5453	1.1480
44	0.5458	1.1499
45	0.5463	1.1519
46	0.5468	1.1538
47	0.5473	1.1557
48	0.5477	1.1574
49	0.5481	1.1590
50	0.5485	1.1607
51	0.5489	1.1623
52	0.5493	1.1638
53	0.5497	1.1653
54	0.5501	1.1667
55	0.5504	1.1681
56	0.5508	1.1696
57	0.5511	1.1708
58	0.5515	1.1721
59	0.5518	1.1734
60	0.5521	1.1747
61	0.5524	1.1759
62	0.5527	1.1770
63	0.5530	1.1782
64	0.5533	1.1793
65	0.5536	1.1804
66	0.5538	1.1814
67	0.5541	1.1824
68	0.5543	1.1834
69	0.5546	1.1844
70	0.5548	1.1854
71	0.5550	1.1864
72	0.5552	1.1873
73	0.5555	1.1882
74	0.5557	1.1890
75	0.5559	1.1898
76	0.5561	1.1906
77	0.5563	1.1915
78	0.5565	1.1923
79	0.5567	1.1931
80	0.5569	1.1938

Table B - T and y

Establish Year T	1/T＝ 1－F	Changing Volume y
500	0.00200	6.21361
400	0.00250	5.99021
300	0.00333	5.70213
250	0.00400	5.51946
200	0.00500	5.29581
150	0.00667	5.00729
100	0.01000	4.60015
80	0.01250	4.37574
60	0.01667	4.08595
50	0.02000	3.90194
40	0.02500	3.67625
30	0.03333	3.38429
25	0.04000	3.19853
20	0.05000	2.97020
15	0.06667	2.67375
10	0.10000	2.25037
8	0.12500	2.01342
7	0.14286	1.86983
6	0.16667	1.70198
5	0.20000	1.49940
4	0.25000	1.24590
3	0.33333	0.90272
2	0.50000	0.36651

Water Catchment Area	㎡	ha	Final Drainage	Side	Length	BP	EP	W	Return Period	Reinfall	Discharge Coefficient	Discharge Q	Drainage Section	Roughness Coefficient	Slope	Sectional -area	Depth	Water Flow Speed	Water Flow Rate	Section Margin Ratio	Judgment
										mm/hr	C	cu.m/sec	Drainage Type	n	i(‰)	A (m^2)	R (m)	V (m/s)	Qa(m^3/s)	Qa/Q	
1	3795	0.380	1	L	230	-40	190	16.5	2	95.2	0.95	0.095	φ450	0.015	0.900	0.136	0.137	1.680	0.229	2.40	OK
1	1485	0.149	1	L	90	190	280	16.5	2	95.2	0.95	0.037	φ450	0.015	1.400	0.136	0.137	2.095	0.286	2.15	OK
1	1650	0.165	1	L	100	280	380	16.5	2	95.2	0.95	0.041	φ600	0.015	2.000	0.242	0.183	3.034	0.736	1.04	OK
1	1650	0.165	1	L	100	380	480	16.5	2	95.2	0.95	0.041	φ600	0.015	2.100	0.242	0.183	3.109	0.754	1.01	OK
1	3795	0.380	1	R	230	-40	190	16.5	2	95.2	0.95	0.095	φ450	0.015	0.900	0.136	0.137	1.680	0.229	2.40	OK
1	1485	0.149	1	R	90	190	280	16.5	2	95.2	0.95	0.037	φ450	0.015	1.400	0.136	0.137	2.095	0.286	2.15	OK
1	1650	0.165	1	R	100	280	380	16.5	2	95.2	0.95	0.041	φ450	0.015	1.000	0.136	0.137	1.771	0.242	1.39	OK
1	1650	0.165	1	R	100	380	480	16.5	2	95.2	0.95	0.041	φ450	0.015	1.900	0.136	0.137	2.441	0.333	1.54	OK
1	3465	0.347	1	AR	165			21	2	95.2	0.95	0.087	φ450	0.015	1.900	0.136	0.137	2.441	0.333	3.82	OK
Final Drainage 1												0.303	φ600×2	0.015	2.000	0.485	0.137	2.504	2.429	1.53	OK
3	330	0.033	2	L	20	480	500	16.5	2	95.2	0.95	0.008	φ450	0.015	1.900	0.136	0.184	2.971	0.405	48.88	OK
3	2970	0.297	2	L	180	500	680	16.5	2	95.2	0.95	0.075	φ450	0.015	1.366	0.136	0.184	2.519	0.344	4.14	OK
3	5610	0.561	2	L	340	680	1020	16.5	2	95.2	0.95	0.141	φ600×2	0.015	0.650	0.485	0.267	2.227	1.080	1.28	OK
3	3300	0.330	2	L	200	1020	1220	16.5	2	95.2	0.95	0.083	φ600×2	0.015	1.200	0.485	0.267	3.026	1.467	1.59	OK
3	1815	0.182	2	L	110	1220	1330	16.5	2	95.2	0.95	0.046	φ600×2	0.015	2.600	0.485	0.267	4.454	2.160	1.34	OK
Final Drainage 2												0.352	φ600×2	0.015	2.500	0.485	0.183	3.392	1.645	1.02	OK
3	495	0.050	2	L	30	1330	1360	16.5	2	95.2	0.95	0.012	φ600×2	0.015	2.600	0.485	0.267	4.454	2.160	1.33	OK
3	3300	0.330	2	L	200	1360	1560	16.5	2	95.2	0.95	0.083	φ600×2	0.015	1.650	0.485	0.267	3.548	1.721	1.01	OK
3	2310	0.231	2	L	140	1560	1700	16.5	2	95.2	0.95	0.058	φ600×2	0.015	2.000	0.485	0.267	3.906	1.894	1.07	OK
5	3795	0.380	2	L	230	1700	1930	16.5	2	95.2	0.95	0.095	φ600×2	0.015	4.500	0.485	0.267	5.859	2.841	1.03	OK
Final Drainage 3												0.249	φ600×2	0.015	5.200	0.485	0.137	4.038	1.958	1.71	OK
5	5445	0.545	2	L	330	1930	2260	16.5	2	95.2	0.95	0.137	φ450	0.015	1.366	0.136	0.183	2.507	0.342	2.50	OK
6	1716	0.172	4	L	104	2260	2364	16.5	2	95.2	0.95	0.043	φ450	0.015	0.955	0.136	0.183	2.096	0.286	1.59	OK
6	924	0.092	4	L	56	2364	2420	16.5	2	95.2	0.95	0.023	φ600	0.015	0.943	0.242	0.183	2.083	0.505	2.49	OK
6	1485	0.149	4	L	90	2420	2510	16.5	2	95.2	0.95	0.037	φ600×2	0.015	0.297	0.485	0.365	1.856	0.900	1.13	OK
8	2805	0.281	4	L	170	2510	2680	16.5	2	95.2	0.95	0.070	φ600×2	0.015	0.350	0.485	0.365	2.014	0.977	1.13	OK
8	2310	0.231	4	L	140	2680	2820	16.5	2	95.2	0.95	0.058	φ600×2	0.015	2.579	0.485	0.243	4.173	2.024	1.68	OK
8	2310	0.231	4	L	140	2820	2960	16.5	2	95.2	0.95	0.058	φ600×2	0.015	0.700	0.485	0.365	2.849	1.382	1.10	OK
8	1980	0.198	4	L	120	2960	3080	16.5	2	95.2	0.95	0.050	φ600×2	0.015	1.050	0.485	0.365	3.489	1.692	1.29	OK
Final Drainage 5												0.477	φ600×2	0.015	3.000	0.485	0.091	2.341	2.270	1.44	OK
8	1320	0.132	4	L	80	3080	3160	16.5	2	95.2	0.95	0.033	φ600	0.015	0.250	0.242	0.183	1.073	0.260	7.84	OK
8	2640	0.264	4	L	160	3160	3320	16.5	2	95.2	0.95	0.066	φ600	0.015	0.063	0.242	0.183	0.538	0.131	1.31	OK
10	469	0.047	5	L	28.4	3320	3348.4	16.5	2	95.2	0.95	0.012	φ600×2	0.015	0.187	0.485	0.365	1.472	0.714	1.34	OK
3	330	0.033	2	R	20	480	500	16.5	2	95.2	0.95	0.008	φ600	0.015	1.900	0.242	0.183	2.957	0.717	86.48	OK
3	2970	0.297	2	R	180	500	680	16.5	2	95.2	0.95	0.075	φ600	0.015	1.366	0.242	0.183	2.507	0.608	7.33	OK
3	5610	0.561	2	R	340	680	1020	16.5	2	95.2	0.95	0.141	φ600	0.015	0.650	0.242	0.183	1.729	0.419	1.87	OK
3	330	0.033	2	R	20	1020	1040	16.5	2	95.2	0.95	0.008	φ600	0.015	1.200	0.242	0.183	2.350	0.570	2.45	OK
3	2970	0.297	2	R	180	1040	1220	16.5	2	95.2	0.95	0.075	φ600	0.015	1.200	0.242	0.183	2.350	0.570	1.86	OK
3	2310	0.231	2	R	140	1220	1360	16.5	2	95.2	0.95	0.058	φ600	0.015	2.600	0.242	0.183	3.459	0.839	2.30	OK
3	3300	0.330	2	R	200	1360	1560	16.5	2	95.2	0.95	0.083	φ600	0.015	1.600	0.242	0.183	2.713	0.658	1.47	OK
3	2310	0.231	2	R	140	1560	1700	16.5	2	95.2	0.95	0.058	φ600	0.015	2.457	0.242	0.183	3.362	0.815	1.61	OK
5	3630	0.363	2	R	220	1700	1920	16.5	2	95.2	0.95	0.091	φ600	0.015	1.366	0.242	0.183	2.507	0.608	1.02	OK
5	5610	0.561	2	R	340	1920	2260	16.5	2	95.2	0.95	0.141	φ600×2	0.015	1.366	0.485	0.243	3.037	1.473	2.00	OK
6	1716	0.172	4	R	104	2260	2364	16.5	2	95.2	0.95	0.043	φ600×2	0.015	0.955	0.485	0.243	2.539	1.232	1.58	OK
6	924	0.092	4	R	56	2364	2420	16.5	2	95.2	0.95	0.023	φ600×2	0.015	0.943	0.485	0.243	2.523	1.224	1.52	OK
6	1485	0.149	4	R	90	2420	2510	16.5	2	95.2	0.95	0.037	φ600×2	0.015	0.297	0.485	0.365	1.856	0.900	1.07	OK
Final Drainage 4												0.841	φ600×2	0.015	1.900	0.485	0.137	2.441	1.184	1.41	OK
8	2805	0.281	4	R	170	2510	2680	16.5	2	95.2	0.95	0.070	φ600	0.015	0.297	0.242	0.183	1.169	0.283	4.02	OK
8	2310	0.231	4	R	140	2680	2820	16.5	2	95.2	0.95	0.058	φ600	0.015	2.579	0.242	0.183	3.445	0.835	6.50	OK
8	2310	0.231	4	R	140	2820	2960	16.5	2	95.2	0.95	0.058	φ600	0.015	0.464	0.242	0.183	1.461	0.354	1.90	OK
8	2310	0.231	4	R	140	2960	3100	16.5	2	95.2	0.95	0.058	φ600	0.015	0.250	0.242	0.183	1.073	0.260	1.06	OK
8	990	0.099	4	R	60	3100	3160	16.5	2	95.2	0.95	0.025	φ600×2	0.015	0.250	0.485	0.243	1.299	0.630	2.34	OK
8	2640	0.264	4	R	160	3160	3320	16.5	2	95.2	0.95	0.066	φ600×2	0.015	0.063	0.485	0.365	0.855	0.414	1.23	OK
10	469	0.047	5	R	28.4	3320	3348.4	16.5	2	95.2	0.95	0.012	φ600×2	0.015	0.187	0.485	0.243	1.124	0.545	1.57	OK
Final Drainage 6												0.459	φ0.60	0.015	1.900	0.242	0.183	2.957	0.717	1.56	OK