

2-3 Obligation of Recipient Country

The Government of Kenya will undertake the following measures on condition that the Grant Aid by the Government of Japan is extended to the Project;

- ✓ To provide data and information necessary for the Project
- ✓ To secure the land necessary for the execution of the Project, such as the land for construction works, stock yards, work shops, field offices, and others
- ✓ To provide borrow pits, quarry sites and waste disposal areas
- ✓ To bear commissions to the bank in Japan for its banking service in connection with the Project
- ✓ To ensure prompt tax exemption, customs clearance, and effective inland transportations of materials and equipments
- ✓ To exempt Japanese nationals engaged in the Project from any customs duties for the supply of products and services necessary for the project.
- ✓ To accord Japanese nationals necessary legal rights for their entry and stay in Kenya.
- ✓ To provide all necessary permission, licenses and certificates in connection with environmental issues and earthwork for the Project (EIA approval, construction permission, traffic control permission, detour permission, construction permission in river, earthwork permission etc.)
- ✓ To relocate all obstruction structures such as electric poles & wires, telephone poles & cables, water pipes, sewer pipes, optical fibre cables, billboards & signboards, etc. in the project road
- ✓ To arrange proper use and effective maintenance of the road after the completion of the project
- ✓ To coordinate and solve any issues related to the Project that may be raised from residents and/or third parties
- ✓ To bear all the expenses, other than covered by the Japanese Grant Aid, agreed and necessary for the Project
- ✓ To secure safety of the construction site

2-4 Project Management and Maintenance Plan

2-4-1 Organization for Road Management and Maintenance

Road management and maintenance after the Project is under the responsibility of Kenya Urban Road Authority (KURA). The KURA was officially established in July 2009, and they do not have actual implementation of the road management and maintenance works yet, therefore, their capabilities are still unknown.

However, most of their technical staffs are transferred from road related departments of the Ministry of Roads, Ministry of Local Government, and City Council of Nairobi. Execution of road projects and management and maintenance works have been carried out by those technical staffs before transformation without any particular problems, they will have reasonable capability for the road management and maintenance requirements, once the organization start working properly.

2-4-2 Road Maintenance Plan

Necessary road maintenance works are as follows;

Periodical Maintenance

- ✓ Routine inspection and cleaning of side ditches, culverts, supplemental facilities, etc

Ad-hoc Maintenance

- ✓ Repair for damaged parts, such as ceiling & patching pavement, repainting pavement marking, and any other damaged parts

2-4-3 Present Road Maintenance Conditions and Recommendations

Recent road management & maintenance conditions observed are as follows;

- ✓ Road surfaces have been relatively repaired regularly
- ✓ Road side ditches and inlets have not been well maintained periodically. For instance, cleaning works of road surfaces and drainages are observed at various places in the City, on the other hand, long time clogged drainage pipes and inlets as well as submerged points are also observed at several segments in the City

To achieve effective results of the Project and sustain good conditions of the road facilities, it is important to manage and maintain road facilities adequately by keeping in good condition

of the pavements and other supplemental facilities and extending their life spans, so the following recommendations are proposed;

- ✓ To check facilities regularly for controlling their conditions
- ✓ To clean facilities up, especially drainage
- ✓ To secure necessary budget for maintenance

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimate

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

✓ Total Cost	:	156.0 Million Kenya Shillings (Approx. 190.3 Million Yen)
✓ Social Cost for Relocation of houses	:	12.7 M. KSH (Approx. 15.5 M. Yen)
✓ Land Acquisition Cost	:	111.8 M. KSH (Approx. 136.4 M. Yen)
✓ Social Cost for Relocation of Person	:	5.0 M. KSH (Approx. 6.1 M. Yen)
✓ Supervision Cost for Relocation	:	1.9 M. KSH (Approx. 2.3 M. Yen)
✓ Utility Relocation Cost	:	16.0 M. KSH (Approx. 19.5 M. Yen)
✓ Environmental Assessment Cost	:	7.8 M. KSH (Approx. 9.5 M. Yen)
✓ Bank Commission	:	0.8 M. KSH (Approx. 1.0 M. Yen)

(2) Conditions in Cost Estimate

✓ Time of Cost Estimate	:	April 2009
✓ Exchange Rate	:	1 United States Dollar = 96.08 Yen 1 Kenya Shilling = 1.22 Yen
✓ Construction Period	:	As shown in the Implementation Schedule
✓ Other Conditions	:	Cost estimate is implemented in accordance with the guideline of Japan's Grant Aid

2-5-2 Operation and Maintenance Cost

Kenya Urban Road Authority is in charge of maintenance for the road rehabilitated by the Project.

Annual maintenance cost necessary for the road is estimated at 2,342 Thousand Million Kenya Shillings (Approximately US\$ 30,400). Details are shown in Table 2-5-1.

Table 2-5-1 Maintenance Work and Annual Cost for Missing Link No.3/6/7

✓ Routine Inspection

(unit: Kenya Shilling)

Facility	Inspection Item	Frequency	No. of Staff	Equipment	Quantity	Unit Price	Cost
Pavement	Crack, deformation, pothole, etc.	12 times a year 1 day each time	2 persons	Scoop, hammer, sickle, barricade, pick-up truck	24 man-day	2,500	60,000
Shoulder/slope					/ year	/day	
Road marking	Rainwater erosion & collapse, etc.				12 veh-day/ year =96 hours/year (8 hours/day)	2,500	240,000
Drainage							
						Total	300,000

✓ Daily Maintenance Work

(unit: Kenya Shilling)

Facility	Inspection Item	Frequency	No. of Staff	Equipment	Quantity	Unit Price	Cost
Cleaning	Cleaning soil, obstacles	4 times a year	5 persons	Scoop, hammer, sickle, barricade,	80 man-day	5,000	400,000
Drainage					/ year	/day	
Pavement	Cutting grass,	4 days each time		Pick-up truck (2 units)	12 veh-day/ year (8 hours/day)	6,000	384,000
Shoulder							
Road marking	Cleaning						
						Total	784,000

1,084,000

✓ Repair

(unit: Kenya Shilling)

Facility	Repair Item	Frequency	Unit Price (per Year, per km)	Road length
Pavement	Patching pothole	1 times / 5 years	69,200	8.36 km
Shoulder/slope	Repairing damaged part	1 times / 5 years	9,500	
Drainage	Repairing damaged part	1 times / 2 years	57,400	
Road attached facilities	Repairing damaged part	1 times / 5 years	4,800	
Structure	Repairing damaged part	1 times / 10 years	9,600	
Total			150,500	1,258,000

2,335,600

CHAPTER 3 PROJECT EVALUATION AND RECOMMENDATIONS

3-1 Project Effect

The direct and indirect effects brought by the Project are as follows:

Present Problem

- Existing road is disconnected at river and the traffic congestion is very hard on the detour route.
- Pedestrians and bicycle users are inconvenient due to the lack of roadside facilities for NMT.

Measure by the Project

- Construction of concerned road

Direct Effect and Impact of Betterment

- Travel time at off peak hour will be shorten from 14 minutes to 8 minutes on 4.61 km stretch of ML3 & ML6 and from 13 minutes to 6 minutes on 3.75 km stretch of ML7.
- Safety and convenience of pedestrians and bicycle users will be secured by the construction of sidewalk and bicycle lane.

Indirect Effect and Impact of Betterment

- Traffic congestion of surrounding roads will be mitigate by the construction of missing link.
- The accessibility of logistics will be improved and it will support the promotion of regional economy.

3-2 Recommendation

To fully secure and sustain the Project effects, Kenyan side shall execute the following issues.

- To carry out the proper maintenance, in particular cleaning of drainage facilities to prevent the earlier deterioration of the road
- To secure the budget of road maintenance in accordance with long term maintenance program
- To develop ability of staffs of maintenance

[Appendices]

1. Member List of the Study Team.....	A1-1
5. Study Schedule	A2-1
6. List of Parties Concerned in Kenya	A3-1
4. Minutes of Discussion (M/D)	A4-1
5. Technical Note	A5-1
6. Design Data	A6-1

1. Member List of the Study Team

(1) Field Survey

Mr. Takahashi Yoshiyuki	Team Leader	Chief Representative, JICA Kenya Office
Ms. Wakamiya Ai	Program Officer	Officer Economic Infrastructure Department, JICA H.Q.
Mr. Isomoto Kenji	Chief Consultant/ Traffic Plan	Katahira & Engineers International
Mr. Murakami Keiichi	Deputy Chief Consultant/Road Design	Katahira & Engineers International
Mr. Izawa Mamoru	Bridge Design	Katahira & Engineers International
Mr. Aoki Yasushi	Natural Condition Survey	Katahira & Engineers International
Mr. Hatakeyama Yuji	Environmental & Social Consideration	Katahira & Engineers International
Mr. Sato Tadashi	Construction Plan/ Cost Estimation	Katahira & Engineers International
Mr. Yamajyuku Tsuyoshi	Construction Plan/ Cost Estimation	Katahira & Engineers International

(2) Explanation of Draft Report

Mr. Sanui Kazumasa	Team Leader	Assistant Director Economic Infrastructure department, JICA H.Q.
Mr. Isomoto Kenji	Chief Consultant/ Traffic Plan	Katahira & Engineers International
Mr. Murakami Keiichi	Deputy Chief Consultant/Road Design	Katahira & Engineers International

2. Study Schedule

(1) Field Survey

No.	Name		Mr. Takahashi Team Leader, Chief Representative (JICA Kenya Office)	Mr. Ito Deputy Team Leader, Deputy Director General (JICA HQ)	Ms. Wakamiya Officer in charge of the Project (JICA HQ)	Mr. Isomoto Project Manager / Transport Plan (Katahira & Engineers International)	Mr. Murakami Assistant Project Manager/Road Design (Katahira & Engineers International)	Mr. Sato Civil Work Plan and Procurement (Katahira & Engineers International)	Mr. Aoki Natural Condition Survey (Katahira & Engineers International)	Mr. Izawa Bridge & Structure Design (Katahira & Engineers International)	Mr. Hatakeyama Environment Study (Project Environment)	Mr. Yamajuku Civil Work Plan and Procurement II (Katahira & Engineers International)
	Date	Day										
1	23-Mar-09	Mon				Arrive at Nairobi / Visit at JICA Kenya Office			Arrive at Nairobi / Visit at JICA Kenya Office			
2	24-Mar-09	Tue				Courtesy call at Ministry of Local Government, CCN			Courtesy call at Ministry of Local Government, CCN			
3	25-Mar-09	Wed				Consultation on Local Consultants Contract			Consultation on Local Consultants Contract			
4	26-Mar-09	Thu				Site survey			Site survey			
5	27-Mar-09	Fri				Consultation on Local Consultants Contract			Consultation on Local Consultants Contract			
6	28-Mar-09	Sat			Haneda-kansai				Site survey			
7	29-Mar-09	Sun			Dubai-Nairobi				Site survey			
8	30-Mar-09	Mon										
9	31-Mar-09	Tue										
10	01-Apr-09	Wed										
11	02-Apr-09	Thu										
12	03-Apr-09	Fri										
13	04-Apr-09	Sat										
14	05-Apr-09	Sun										
15	06-Apr-09	Mon										
16	07-Apr-09	Tue										
17	08-Apr-09	Wed										
18	09-Apr-09	Thu										
19	10-Apr-09	Fri										

No.	Name		Mr. Takahashi Team Leader, Chief Representative (JICA Kenya Office)	Mr. Ito Deputy Team Leader, Deputy Director General (JICA HQ)	Ms. Wakamiya Officer in charge of the Project (JICA HQ)	Mr. Isomoto Project Manager / Transport Plan (Katahira & Engineers International)	Mr. Murakami Assistant Project Manager/Road Design (Katahira & Engineers International)	Mr. Sato Civil Work Plan and Procurement (Katahira & Engineers International)	Mr. Aoki Natural Condition Survey (Katahira & Engineers International)	Mr. Izawa Bridge & Structure Design (Katahira & Engineers International)	Mr. Hatakeyama Environment Study (Project Environment)	Mr. Yamajuku Civil Work Plan and Procurement II (Katahira & Engineers International)
	Date	Day										
20	11-Apr-09	Sat									Data analysis	Data analysis
21	12-Apr-09	Sun									Data analysis	Data analysis
22	13-Apr-09	Mon					Consultation of Road Plan	Planning of Execution of Civil Works	Supervision of Local Consultants	Consultation of Bridge & Structure Design	Environment and Social Impact Study	Planning of Execution of Civil Works
23	14-Apr-09	Tue					Consultation of Road Plan	Planning of Execution of Civil Works	Supervision of Local Consultants	Consultation of Bridge & Structure Design	Environment and Social Impact Study	Planning of Execution of Civil Works
24	15-Apr-09	Wed					Consultation of Road Plan	Planning of Execution of Civil Works	Supervision of Local Consultants	Consultation of Bridge & Structure Design	Environment and Social Impact Study	Planning of Execution of Civil Works
25	16-Apr-09	Thu					Consultation of Road Plan	Planning of Execution of Civil Works	Supervision of Local Consultants	Consultation of Bridge & Structure Design	Environment and Social Impact Study	Planning of Execution of Civil Works
26	17-Apr-09	Fri					AM Meeting with MoLG, MoL, CCN PM Report to JICA Office	Planning of Execution of Civil Works	AM Meeting with MoLG, MoL, CCN PM Supervision of Local Consultants	Consultation of Bridge & Structure Design	AM Meeting with MoL, CCN PM Environmental and Social Impact Study	Planning of Execution of Civil Works
27	18-Apr-09	Sat									Data analysis	Data analysis
28	19-Apr-09	Sun									Data analysis	Nairobi-Dubai
29	20-Apr-09	Mon									Data analysis	Kansai-Haneda
30	21-Apr-09	Tue									Environment and Social Impact Study	
31	22-Apr-09	Wed									Environment and Social Impact Study	
32	23-Apr-09	Thu									Environment and Social Impact Study	
33	24-Apr-09	Fri									Environment and Social Impact Study	
34	25-Apr-09	Sat									Environment and Social Impact Study	
35	26-Apr-09	Sun									Environment and Social Impact Study	
36	27-Apr-09	Mon									Environment and Social Impact Study	
37	28-Apr-09	Tue									Environment and Social Impact Study	
38	29-Apr-09	Wed									Environment and Social Impact Study	
39	30-Apr-09	Thu									Environment and Social Impact Study	

(2) Explanation of Draft Report

	Mr. Kazumasa SANUI Team Leader (JICA.HQ)	Mr. Kenji ISOMOTO	Mr. Keiichi MURAKAMI
10/21/2009		Tokyo (EK 6257 and EK 317, 19:55) →	
10/22/2009		→ Dubai (05:30) Dubai (EK 719, 10:40) → Nairobi (14:50)	
10/23/2009		AM Chief Representative of JICA Kenya Office PM at JICA 16F : Draft Explanation & Minutes Discussion to MoR, MoLG, KURA, Nairobi City	
10/24/2009		Internal Meeting for Discussion	
10/25/2009		Internal Meeting for Discussion	
10/26/2009		AM at JICA 16F : Minutes Discussion with MoLG, KURA, Nairobi City Signing on M/D at MoLG (P.M.)	
10/27/2009	Nairobi (EK 720, 16:40) → Dubai (22:40)	Signing M/D at MoR (A.M.) 11:30 Embassy of Japan Nairobi (JO 835, 14:15) → Juva (16:15)	Nairobi (EK 720, 16:40) → Dubai (22:40)
10/28/2009	Dubai (EK 316 and EK 6252, 03:10) → Tokyo (20:25)		Dubai (EK 316 and EK 6252, 03:10) → Tokyo (20:25)

3. List of Parties Concerned in Kenya

Ministry of Local Government

Mr. Sammy Kirui, CBS Permanent Secretary
Mr. Tom N. Omai
Mr. Silas O. Nyambok
Mr. E. Kibe
Mr. Joshva Maitho Ndiango
Mr. Marclus Mwai

Ministry of Roads

Eng. Michael M.S. Kamau, CBS Permanent Secretary
Eng. J. M. Mwatu Principal Superintending Engineer

Ministry of Land

Mr. Ephantus Murage Director of Surveys
Mr. Bowers Owino Deputy Director of Surveys
Mr. C. Mwangi
Mr. S. Kiruma

National Environment Management Authority

Mr. Wilkister Magangi

Ministry of Labor and Human Resource Development

Mr. Samuel M. Kariuki
Mr. Nicholas W. Mugambi

City Council of Nairobi

Mr. G.C.K. Katsolleh Ag. Town Clerk
Mr. Philip M.A. Kisia Town Clerk
Mr. Kainga K. Mario
Mr. Erastus K. Chepkwony
Mr. Mumo Richard
Mr. Eston Kimathi
Mr. Anderson M. Njenga
Mr. Benjamin K. Njenga
Mr. Marrian Mutete Kioko
Mr. Isaac Wagangi
Eng. Cristine A. Ogut

Kenya Urban Roads Authority

Eng. Joseph N. Nkadayo

Mr. James W. Theuri

Eng. Silas M. Kinoti

Director General & CEO

General Manager

General Manager

4. Minutes of Discussion (M/D)

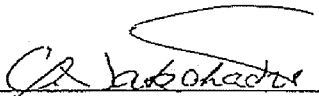
Minutes of Discussions
on
the Preparatory Survey
on
the Project for the Construction
of
Nairobi Missing Links 3, 6 & 7

Referring to the results of Preliminary Study conducted in August 2008, the Government of Japan decided to conduct a Preparatory Survey for Basic Design on the Project for the Construction of Nairobi Missing Links 3,6 & 7 (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

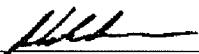
JICA sent to Kenya the Preparatory Survey team for Basic Design headed by Mr. Yoshiyuki TAKAHASHI, Chief Representative, JICA Kenya Office, and is scheduled to stay in the country from March 23rd to April 29th, 2009.

The Team held discussions with the concerned officials the Government of Kenya. In the course of the discussions, both sides have confirmed the main items described in the attached sheets. The Team will proceed to further works and prepare the Preparatory Survey Report.


Nairobi, April 7, 2009



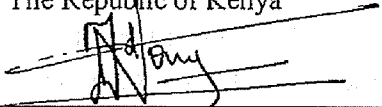
Mr. Yoshiyuki Takahashi
Leader
Preparatory Survey Team
Japan International Cooperation Agency
Japan



Eng. Michael M.S. Kamau, CBS
Permanent Secretary
Ministry of Roads
The Republic of Kenya

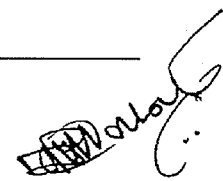


Mr. Sammy Kirui, CBS
Permanent Secretary
Office of the Deputy Prime Minister and
Ministry of Local Government
The Republic of Kenya



Eng. Joseph N. Nkadayo
Director General & CEO
Kenya Urban Road Authority
The Republic of Kenya

Mr. G.C.K. Katsolleh
Ag. Town Clerk
City Council of Nairobi
The Republic of Kenya





ATTACHMENT

1. Objective of the Project

The objective of the Project is to construct the Missing Link of No.3, 6 and 7 in Nairobi City in order to formulate a radial and circumferential road network and to encourage non-motorized transport.

2. Project Site

The site of the Project is shown in Annex-1.

3. Responsible and Implementing Organizations

3-1. The responsible Ministries are Ministry of Road (MOR) and Office of the Deputy Prime Minister and Ministry of Local Government (ODPM&MOLG).

The organization charts of the responsible Ministries are shown in Annex-2 and Annex-3.

3-2. The implementing organizations are Kenya Urban Road Authority (KURA) and City Council of Nairobi (CCN). The organization charts of the implementing organizations are shown in Annex-4 and Annex-5.

4. Items Requested by the Government of Kenya

After discussions with the Team, the items described below were requested by the Kenyan side.

Construction of Missing Link 3, 6 and 7(ML 3, 6 and 7) which contain unpaved sections and paved sections

ML3: Mander Road/ Riverside Drive to Lantana Road/ Westlands (1.76km)

ML6: Ole Dume Road/ Mazaras Road to Mander Road (2.85km)

ML7: James Gichuru Road/ Mugumo Road to Argwings Kodhek Road/ Ngong Road (3.75km)

(1) Unpaved Section

ML3: Riverside Drive – Lantana Road (0.66km)

ML6: Mazaras Road - Mander Road (2.40km)

ML7: Mugumo Road - Argwings Kodhek Road (2.20km)

h - Construction of 3 bridges: Nairobi River(ML3), Kirichwa Ndogo River(ML7), Kirichwa Kubwa River(ML7)

- Road Pavement Construction (2-lane carriageway)
- Construction of Non-Motorized Transport(NMT) facilities
- Construction of storm water drainage system
- Street light facilities
- Traffic signals and/or roundabouts to be installed as per the recommendations of the final report

(2) Paved Section

ML3: Mander Road - Riverside Drive(0.95km)

Lantana Road -Westlands (0.15km)

ML6: Ole Dume Road - Mazeras Road (0.45km)

ML7: James Gichuru Road - Mugumo Road (0.75km)

Argwings Kodhek Road - Ngong Road(0.80km)

- Construction of storm water drainage system
- Construction of NMT facilities
- Widening intersections needed
- Traffic signals and/or roundabouts to be installed as per the recommendations of the final report
- Construction of culverts
- Overlay of the section heavily damaged
- Street light facilities
- Widening to 4-lane carriageways if necessary

JICA will assess the appropriateness of the request and will recommend to the Government of Japan. JICA will report the result to the Kenyan side when explaining the draft report.

5. Japan's Grant Aid Scheme

5-1. The Kenyan side understands the Japan's Grant Aid scheme (for General Project) explained by the Team, as described in Annex-6.

5-2. The Kenyan side will take the necessary measures, as described in Annex-7, for smooth implementation of the Project, as a condition for the Japanese Grant Aid to be implemented.

6. Schedule of the study

6-1. The consultants will proceed to further study in Kenya until April 29th, 2009.

6-2. JICA will prepare the draft report in English and dispatch a mission to Kenya in order to explain its contents around the beginning of October, 2009.

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6-3. After the contents of the report is 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 by January, 2010.

7. Other Relevant Issues

7-1. Both sides confirmed that the Kenyan side will install beacons along the boundary lines on both sides of Project Road and the truncations of the intersections in appropriate manner based on the related regulations by the end of June, 2009.

7-2. Both sides confirmed that the Kenyan side should conduct the necessary procedure concerning the environmental assessment (including stakeholder meetings for effective public participation about the outline of the Project, the EIA survey, RAP etc.) based on the relevant law of Kenya by the end of September, 2009.

7-3. Both sides confirmed that the Kenyan side shall secure the land necessary for the Project with its own expenses by the commencement of the construction.

7-4. The Kenyan side confirmed that the following undertakings should be taken by the Kenyan side at the Kenyan expenses.

- Relocation of existing utilities (power, telecommunication lines, water lines, plants, trees etc) and removal of obstructing facilities by the commencement of the construction in accordance with necessary procedure,
- Necessary arrangement and coordination with concerned Ministries, Agencies and other relevant organizations,
- Budget allocation to the Public Relation of stakeholder meetings, public hearings etc for the Project through electronic and/or print media,
- Securing and clearance of the temporary yard,
- Securing of site for disposal of waste

7-5. The Kenyan side shall provide security for all concerned Japanese nationals working for the Project, if deemed necessary.

7-6. The Kenyan side shall secure enough budget and personnel necessary for the operation and maintenance of the facilities implemented by the Project, including the periodical maintenance work after the completion of the Project.

7-7. The Kenyan side shall provide all necessary information requested in the Questionnaire, which the Team handed to the Kenyan side, by April 29, 2009.

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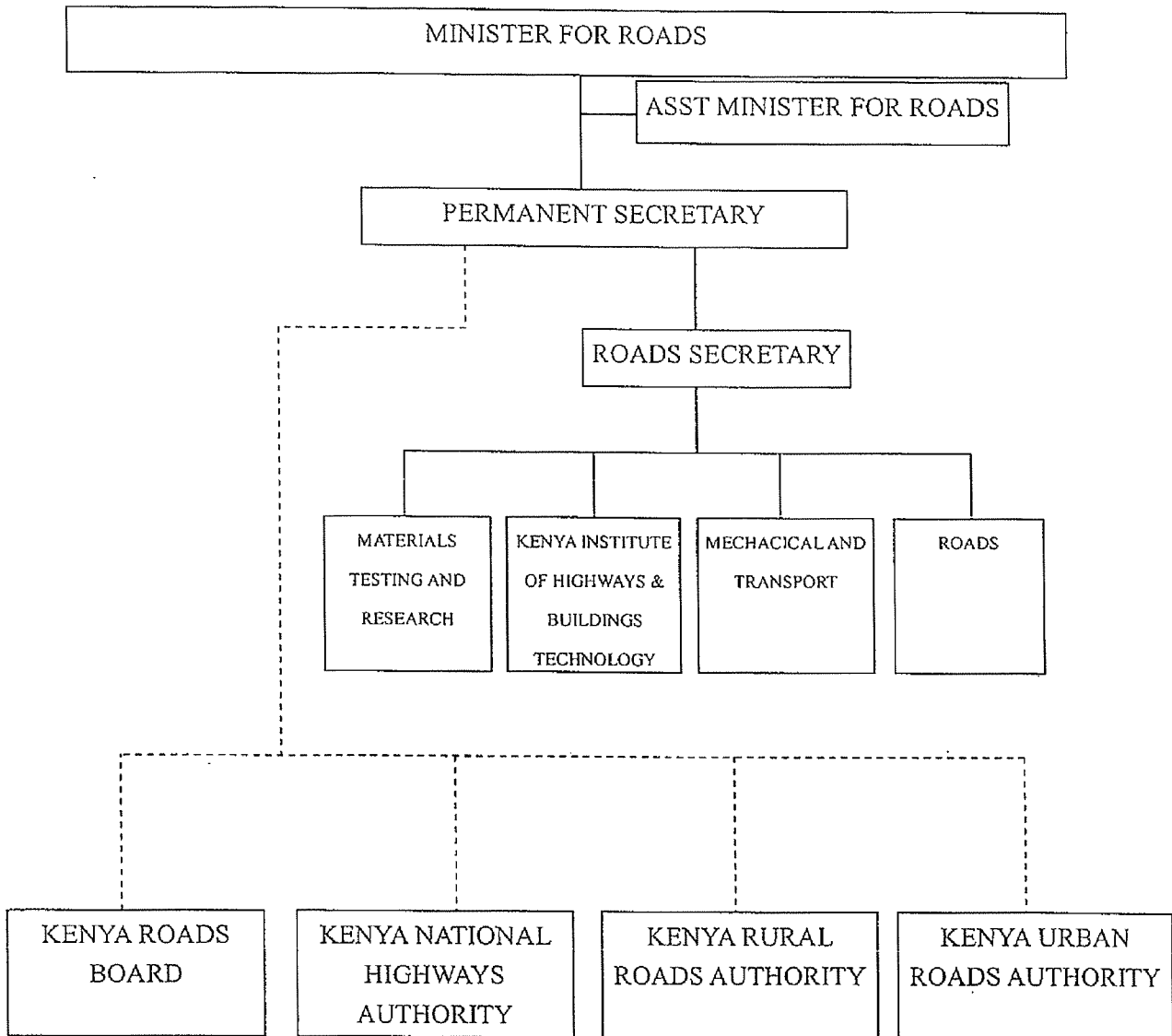
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Project Site Map

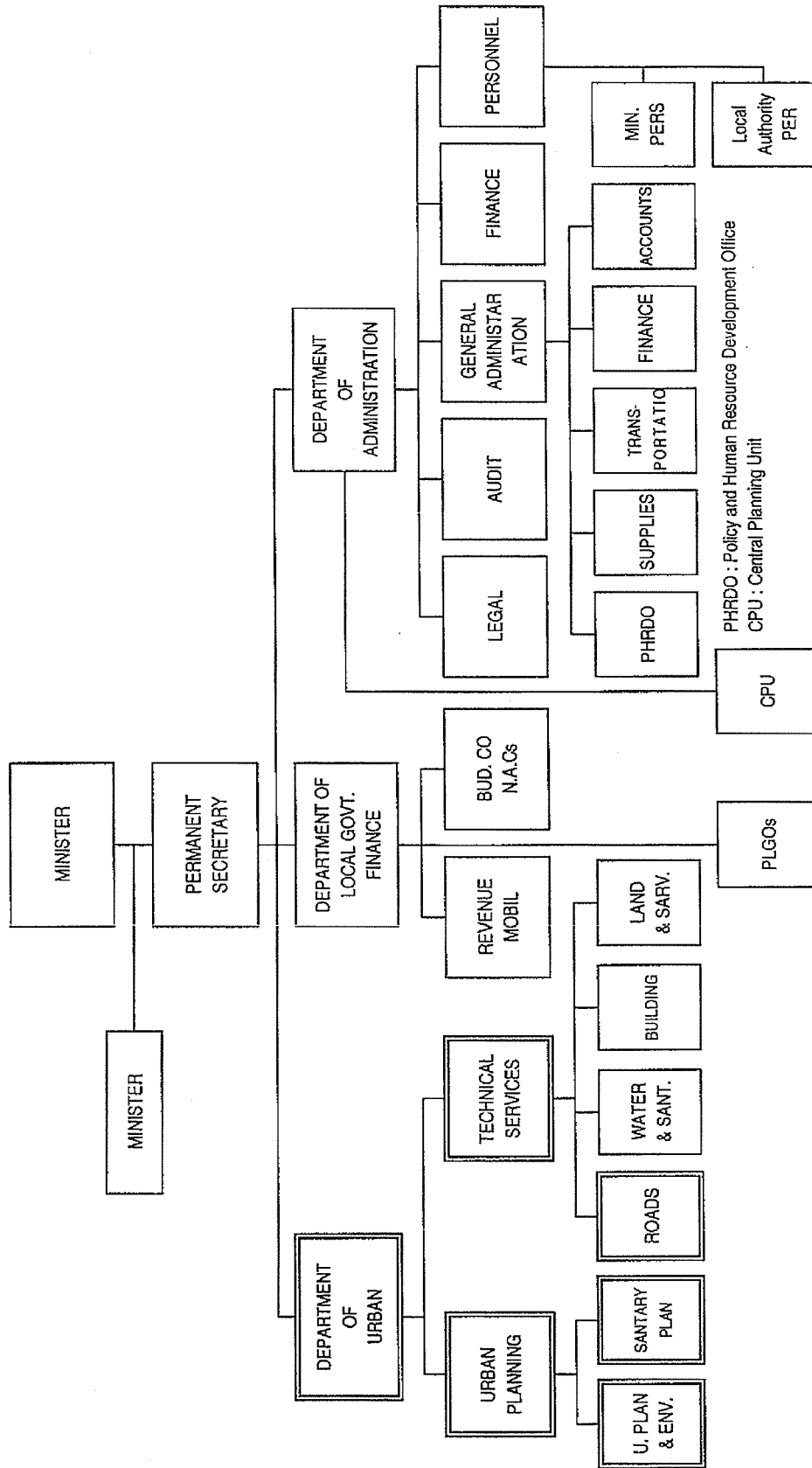
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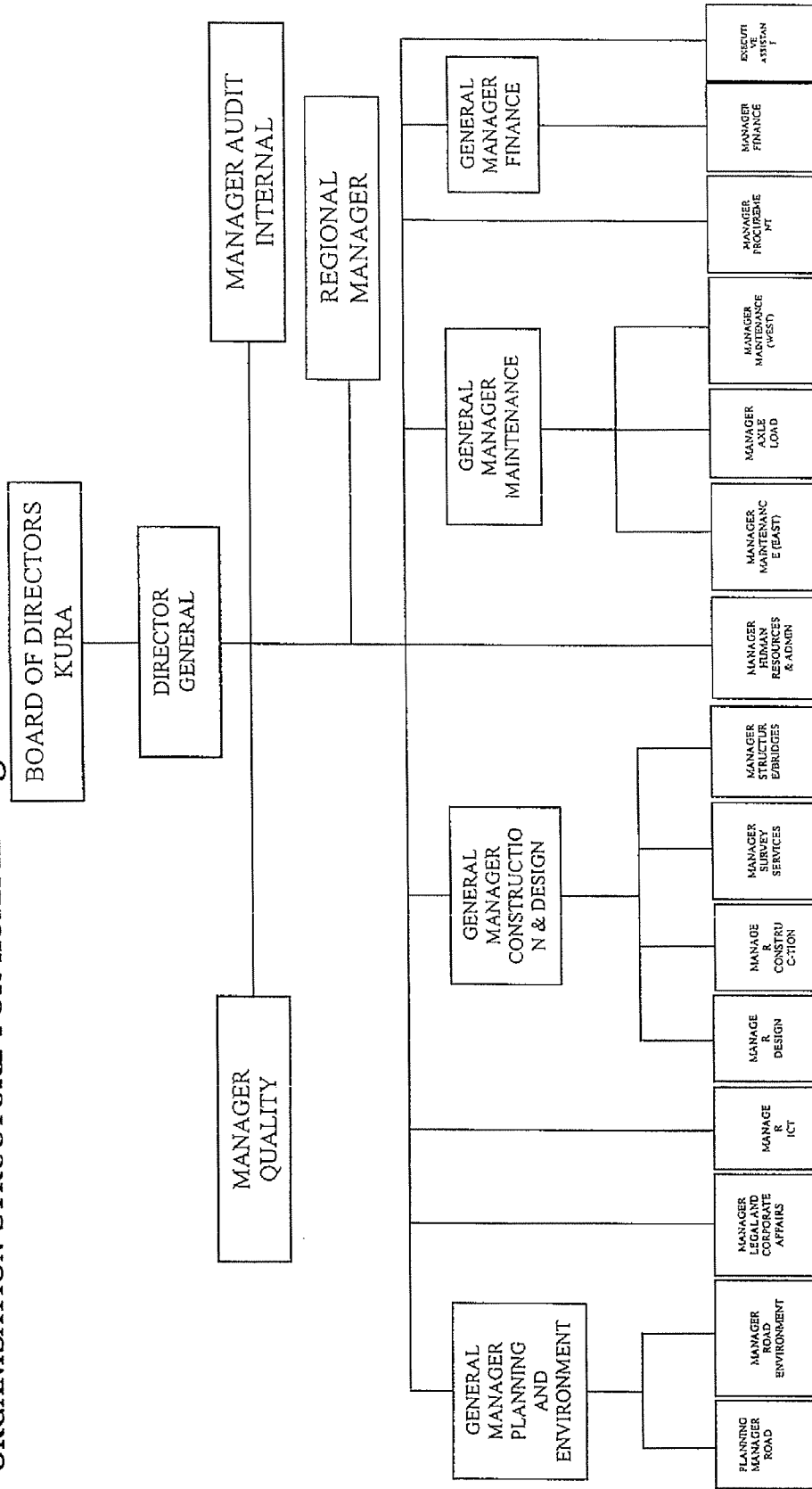
The organization chart of the responsible Ministry (The Ministry of Road [MOR])

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The organization chart of the responsible Ministry (Office of the Deputy Prime Minister and Ministry of Local Government [ODPM & MOLG])

ORGANISATION STRUCTURE FOR KURA HEADQUARTERS

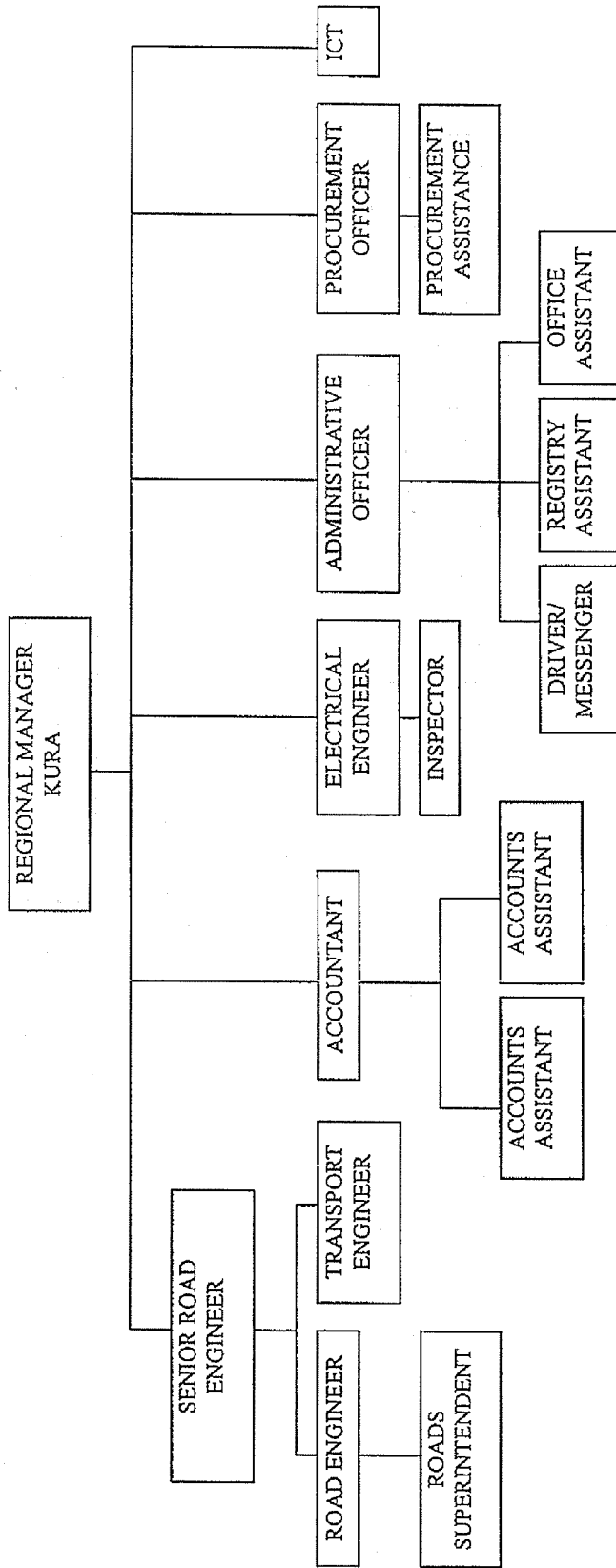


The organization chart of the implementing organization (Kenya Urban Road Authority [KURA] Headquarters)

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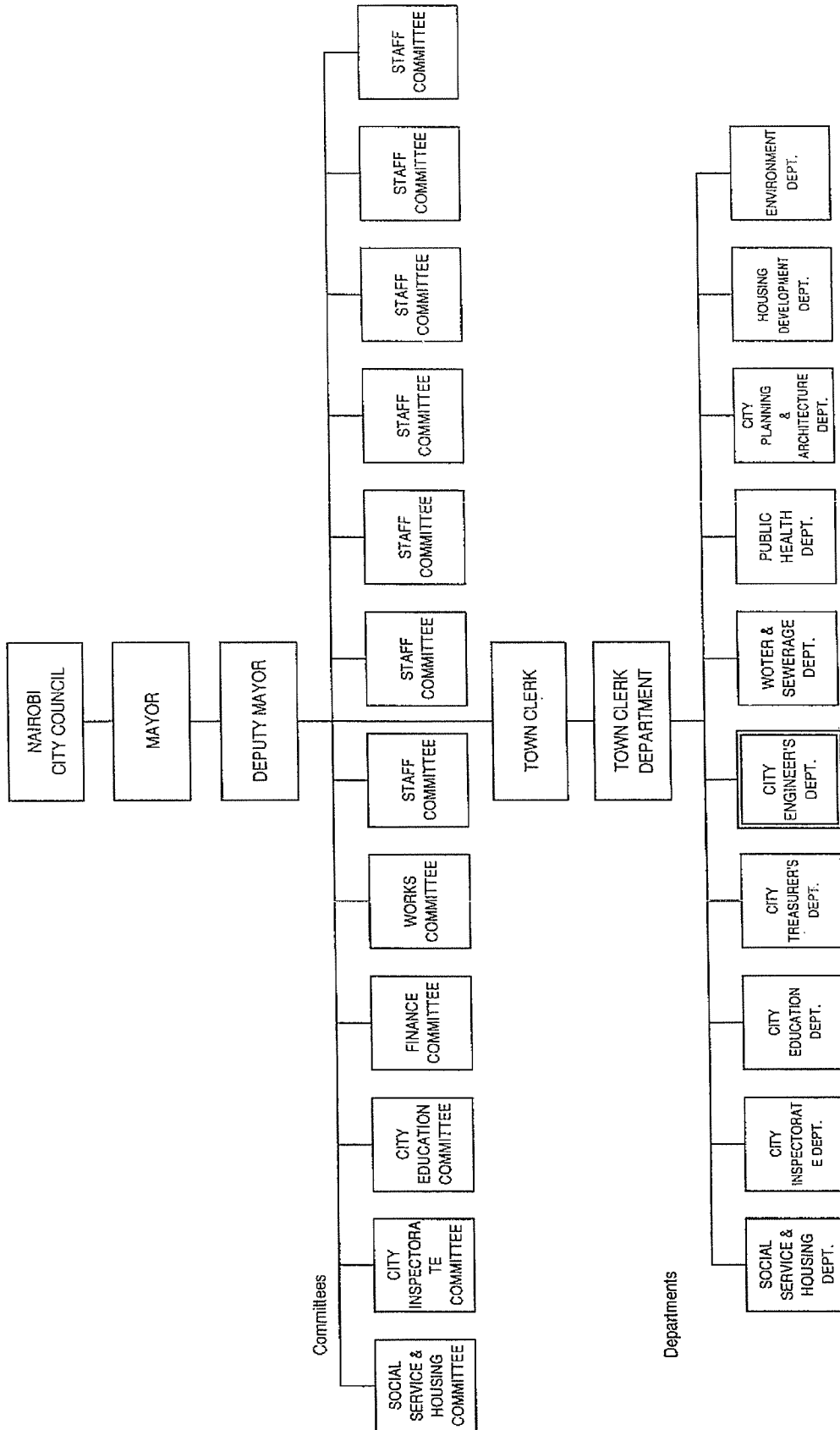
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REGIONAL ORGANIZATION CHART



NOTE: Regional Roads Manager reports directly to Director General

The organization chart of the implementing organization (Kenya Urban Road Authority [KURA] Regional Organization)



The organization chart of the implementing organization (City Council of Nairobi [CCN])

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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 part of this realignment, JICA was reborn on October 1, 2008. After the rebirth of JICA, following the decision of the GOJ, Grant Aid for General Project is extended by JICA.

Grant Aid is non-reimbursable fund to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles 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

Japanese Grant Aid is conducted as follows-

- Preparatory Survey (hereinafter referred to as “the Survey”)
 - The Survey conducted by JICA
- Appraisal & Approval
 - Appraisal by The GOJ and JICA, and Approval by the Japanese Cabinet
- Determination of 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 Survey is to provide a basic document necessary for the appraisal of the Project by JICA and the GOJ. The contents of the Survey are as follows:

Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of agencies concerned of the recipient country necessary for the implementation of the Project.

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- 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 on by both parties concerning the basic concept of the Project.
- Preparation of a basic 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 Basic Design of the Project is confirmed considering the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever measures are necessary to ensure 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 in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through the Minutes of Discussions.

(2) Selection of Consultants

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

(3) Result of the Survey

The Report on the Survey is reviewed by JICA, and after the appropriateness of the Project is confirmed, JICA recommends the GOJ to appraise the implementation of the Project.

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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 E/N will be signed between the GOJ and the Government of the recipient country to make a plea 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

The consultant firm(s) used for the Survey will be recommended by JICA to the recipient country to also work on the Project's implementation after the E/N and the G/A, in order to maintain technical consistency.

(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". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality.)

(4) Necessity of "Verification"

The Government of 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 secure 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-7.

(6) "Proper Use"

The Government of recipient country is required to maintain and use the facilities constructed and the equipment purchased under the Grant Aid properly and effectively

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and to assign staff necessary for this operation and maintenance as well as 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 in 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 to the Bank.

(10) Social and Environmental Considerations

A recipient country must ensure the social and environmental considerations for the Project and must follow the environmental regulation of the recipient country and JICA socio-environmental guideline.

(End)



Major Undertakings to be taken by Each Government

NO	Items	To be covered by the Grant	To be covered by 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 a bank of Japan for the banking services based upon the B/A		
	1) Advising commission of A/P		•
	2) Payment commission		•
5	To ensure prompt unloading and customs clearance at the port of disembarkation in recipient country		
	1) Marine(Air) 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 services 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 contract		•
8	To maintain and use properly and effectively the facilities constructed 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, N/A: Not Applicable)

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Minutes of Discussions
on the Basic Design Study
on The Project for the Construction of Nairobi Western Ring Roads
in the Republic of Kenya
(Explanation on Draft Report)

In March 2009, Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched a Basic Design Study Team on the Project for the Construction of Nairobi Western Ring Roads (hereinafter referred to as "the Project") to the Republic of Kenya (hereinafter referred to as "Kenya"), and through discussion, field survey as well as after technical examination of the results in Japan, JICA prepared a draft report of the study.


In order to explain and consult with the officials of the Government of Kenya on the components of the draft report, JICA sent to Kenya the Basic Design Explanation Team (hereinafter referred to as "the Team") which is headed by Kazumasa Sanui, Assistant Director of Economic Infrastructure Department, JICA from October 22 to October 27, 2009.

As the result of the discussion, both parties confirmed the main items described on the attached sheets hereto;

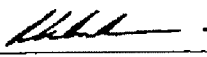
Nairobi, October 26, 2009



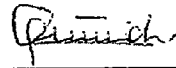
Mr. Kazumasa Sanui
Leader
Basic Design Explanation Team
Japan International Cooperation Agency
Japan



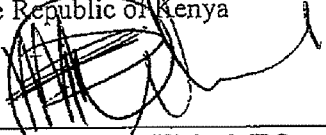
Mr. Sammy Kirui, CBS
Permanent Secretary
Office of the Deputy Prime Minister and
Ministry of Local Government
The Republic of Kenya



Eng. Michael M.S. Kamau, CBS, HSC
Permanent Secretary
Ministry of Roads
The Republic of Kenya



Eng. Silas M. Kinoti
Manager – Roads
Kenya Urban Roads Authority (KURA)
for Eng. Joseph N. Nkadayo
Director General & CEO
Kenya Urban Roads Authority (KURA)
The Republic of Kenya



Mr. Philip M.A. Kisia, MBS
Town Clerk
City Council of Nairobi
The Republic of Kenya

ATTACHMENT

1. Contents of the Draft Report

The Kenyan side agreed and fully accepted the contents of the draft final report explained by the Team.

2. Japans' Grant Aid scheme

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-1.

3. Schedule of the Study

JICA will complete the final report in accordance with the confirmed items and send it to the Government of Kenya by January, 2010.

4. Cost Estimation

The Project Cost Estimation, as attached in Annex-2, is confidential and should never be duplicated or disclosed to any outside parties before the signing of all the contracts for the Project.

5. Other Relevant Issues

5-1. The Team confirmed with the Kenyan side that the Project title to be changed from the previous title ("The Project for the Construction of Nairobi Missing Links 3, 6 and 7") to read as follows; "The Project for the Construction of Nairobi Western Ring Roads".

5-2. The Kenyan side proposed, on April 28, 2009, that 24 meter wide road reserve includes dual carriage way two lanes both ways. The Team examined and came to a conclusion that dual two-lane carriage way is technically difficult due to site topography and the expected traffic volume. The Kenyan side accepted the Team's counterproposal of single carriage way two lanes.

5-3. The Kenyan side confirmed that it has obtained Environmental Impact Assessment License and Resettlement Action Plan (RAP) agreed with the Project Affected Persons (PAPs).
The Kenyan side shall complete the land acquisition and relocations before commencement of the Construction Work.

5-4. The Kenyan side shall bear the banking commissions as a condition for the Japan's Grant Aid to be implemented, and secure the sufficient budget to cover the following cost.

- 1) The commissions for the banking services based upon Banking Arrangement (B/A)
- 2) The advising commission of the Authorization to Pay (A/P).

5-5. The Kenyan side ensured that tax exemption for the Project shall be fulfilled in a timely manner, as a condition for the Japan's Grant Aid to be implemented.

5-6. The Kenyan side shall secure enough budget and personnel necessary for operation and maintenance of the roads, bridges and relevant facilities constructed by the Project.

5-7. The Team requested the Kenyan side to clarify the responsible organization(s) for each undertaking issue as shown in Annex-4 for the purpose of smooth implementation of the Project. The Kenyan side should agree and inform JICA Kenya Office within 2 weeks from the signing date, namely November 10, 2009.

Annex-1: Major Undertakings to be taken by Each Government

Annex-2: Project Cost to be borne by Japan's Grant Aid

Annex-3: Environmental Impact Assessment Licence

Annex-4: Responsible Organization for Undertakings of Kenyan side

Major Undertakings to be taken by Each Government

No.	Items	To be covered by Grant Aid	To be covered by Recipient side
1	To secure land		•
2	To clear, level and reclaim the site when needed		•
3	Relocation, improvement and/or repair of existing utilities(power lines, telecommunication lines, water lines, etc.), if necessary		•
4	To bear the following commissions to a bank of Japan for the banking services based upon the B/A		
	1) Advising commission of A/P		•
	2) Payment commission		•
5	To ensure prompt unloading and customs clearance at the port of disembarkation in recipient country		
	1) Marine(Air) transportation of the products from Japan to the recipient country	•	
	2) Tax exemption and custom 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 services 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 contract		•
8	To maintain and use properly and effectively the facilities constructed 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 the transportation and installation of the equipment		•

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Princip

SK

Environmental Impact Assessment Licence



Application Reference No. ETA/466
Registration No. 0003981
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 LOCAL GOVERNMENT (Name
of individual/firm) P.O. BOX 30004-00100, NAIROBI (Address)
submitted to the National Environment Management Authority in accordance with the Environmental Impact
Assessment & Audit Regulations regarding PROPOSED ROAD PROJECT FOR THE MISSING
LINKS ROADS NO. 3, 5, & 7
(title of project) whose objective is to carry on CONSTRUCTION OF THE MISSING LINKS ROADS
WITHIN KILELESHA AND LAVINGTON TO EASE TRAFFIC CONGESTION WITHIN CITY
..... (briefly describe purpose) located
at KILIMANI, LAVINGTON AND KILELESHA AREA, NAIROBI
..... (locality and district)
has been reviewed and a licence is hereby issued for implementation of the project, subject to attached
conditions.

Dated this 15TH day of SEPT of 2009

Signature [Handwritten 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 hereof.
- 2. The Director-General shall be notified of any transfer/variation/surrender of this licence.

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3. The proponent shall take care of the temporary occupiers who will be displaced by the project.
4. The proponent shall adhere to Environmental Management and Coordination (Noise and Excessive Vibrations Pollution Control) Regulations of 2009 during construction.
5. The proponent shall ensure that valuable trees species that will cut down are replaced.
6. The proponent shall ensure that a functional traffic management plan is in place.
7. The proponent shall ensure that blasting is not done at night.
8. The proponent shall also put clear signage to warn motorists and pedestrians.
9. 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.
10. The proponent shall ensure strict adherence to the Environmental Management Plan developed throughout the project cycle.
11. The proponent shall collaborate with the EIA Expert(s) and contractor(s) to ensure that proposed mitigation measures are adhered to during the construction phase and where necessary appropriate mending –up activities undertaken and a report of the same submitted to NEMA. Emphasis must be given to control of dust, noise, vibrations and occupational hazards and provision of sanitary accommodation to construction workforce.
12. 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 Ministry of Lands, City Council of Nairobi, Nairobi City Water and Sewerage Company, Ministry of Roads, Kenya Roads Board and other relevant Authorities.
13. 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.
14. The proponent shall ensure that during the construction phase, the operations adhere to Occupational Safety and Health Act, No. 15 of 2007.
15. The proponent shall ensure that environmental protection facilities or measures to prevent pollution and ecological deterioration such as proper disposal of excavated soils, re-vegetation, landscaping, storm water drains, traffic management plans are designed, constructed and employed simultaneously with the proposed Project.
16. The proponent shall ensure that records on conditions of licences/approval and project monitoring and evaluation shall be kept on the project site for inspection by NEMA's Environmental Inspectors.
17. The proponent shall submit an Environmental Audit Report in the first year of occupation/operation/commissioning to confirm the efficacy and adequacy of the Environmental Management Plan.
18. The proponent shall comply with NEMA's improvement orders throughout the project cycle.

Responsible Organization for Undertakings of Kenyan side

Before Exchange of Note (January 2010)

Item	MoR KURA	MoLG CCN
To provide data & information for the Project		
To execute RAP		

Before Construction (September 2010)

Item	MoR KURA	MoLG CCN
To execute land acquisition		
To relocate PAPs		
To remove & relocate existing trees		
To relocate public utilities & other obstacles		
To maintain the route of inland transportation		
To make Banking Arrangement (B/A) & Authorization to Pay (A/P)		
To bear advising commission of A/P & payment commission to the bank		
To accord Japanese nationals necessary legal rights for their entry & stay in Kenya		
To exempt Japanese nationals engaged in the Project from customs duties, internal taxes and other fiscal levies		

During Construction (~ January 2012)

	MoR KURA	MoLG CCN
To ensure TAX exemption and custom clearance of the product at the port of disembarkation		
To maintain the route of inland transportation		
To provide all necessary permissions, licenses & certificates for the project		
To provide necessary coordination with related agencies and personal		
To arrange traffic control during construction of existing road		
To coordinate and solve any issues related to the Project that may be raised from residents & third parties		
To secure the office, construction & stock yard		
To secure borrow pit, quarry & waste disposal site		
To relocate public utilities & other obstacles		

After Construction

Item	MoR KURA	MoLG CCN
To demolish existing bridges		
To install underground duct pipe		
To install traffic signal, if necessary		
To maintain the road & facilities		

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5. Technical Note

The Preparatory Survey on
the Project for the Construction of
Nairobi Missing Links 3, 6 & 7

TECHNICAL NOTE

Kenyan Counterpart Team and JICA Preparatory Survey Team discussed and confirmed following matters. It is, however, understood that the decision for the draft report will be made through the discussions with concerned Japanese agencies during the analysis in Japan.

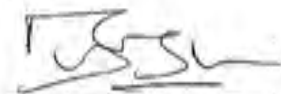
Design Conditions;

- a. Road Classification : Urban Collector Road
- b. Design Speed : Basically 50 kph, Absolute Value 30 kph
- c. Lane Width : Basically 3.3 m, and 3.0 m for Exclusive Right Turn Lane
- d. Median Width : Basically 1.5 m, and 0.6 m for Widening Section near Intersection
- e. Shoulder Width : 0.6 m for Outer Lane
- f. Sidewalk Width : Basically 2.5 m, however reduced to secure other facilities, if necessary
- g. Cycle Lane Width : Basically 2.0 m, however reduced to secure other facilities, if necessary
- h. Maximum Grade : Basically 8.0 %
- i. Pavement : Basically Design Load for up to 15years based on Revised Future Traffic Demand (especially Heavy Vehicle Demand)
- j. Live Load (Bridge) : Equivalent Load with HA Load in BS5400
- k. Intersection : Basically, Roundabout or Conventional Intersection (either signalized or non-signalized), based on the evaluation criteria, such as space available, traffic conditions, classifications of crossing roads, etc.
- l. Drainage : Basically 0.75m wide
- m. Facility Space : Basically 0.8m wide

Basic Design Drawings will be prepared in Japan based on the above design conditions. The drawings will be presented to Kenyan side during the explanation of Draft Final Report, which is scheduled in October 2009.

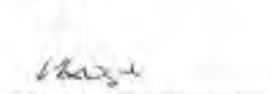
27 April 2009

Noted by:



Eng. James W. Theuri
General Manager
Planning & Environment
Kenya Urban Road Authority

Noted by:



Eng. Christine A. Ogut
City Engineer
City Council of Nairobi

Noted by:



Mr. Kenji Isomoto
Chief Consultant
JICA Preparatory Survey Team

6. Design Data

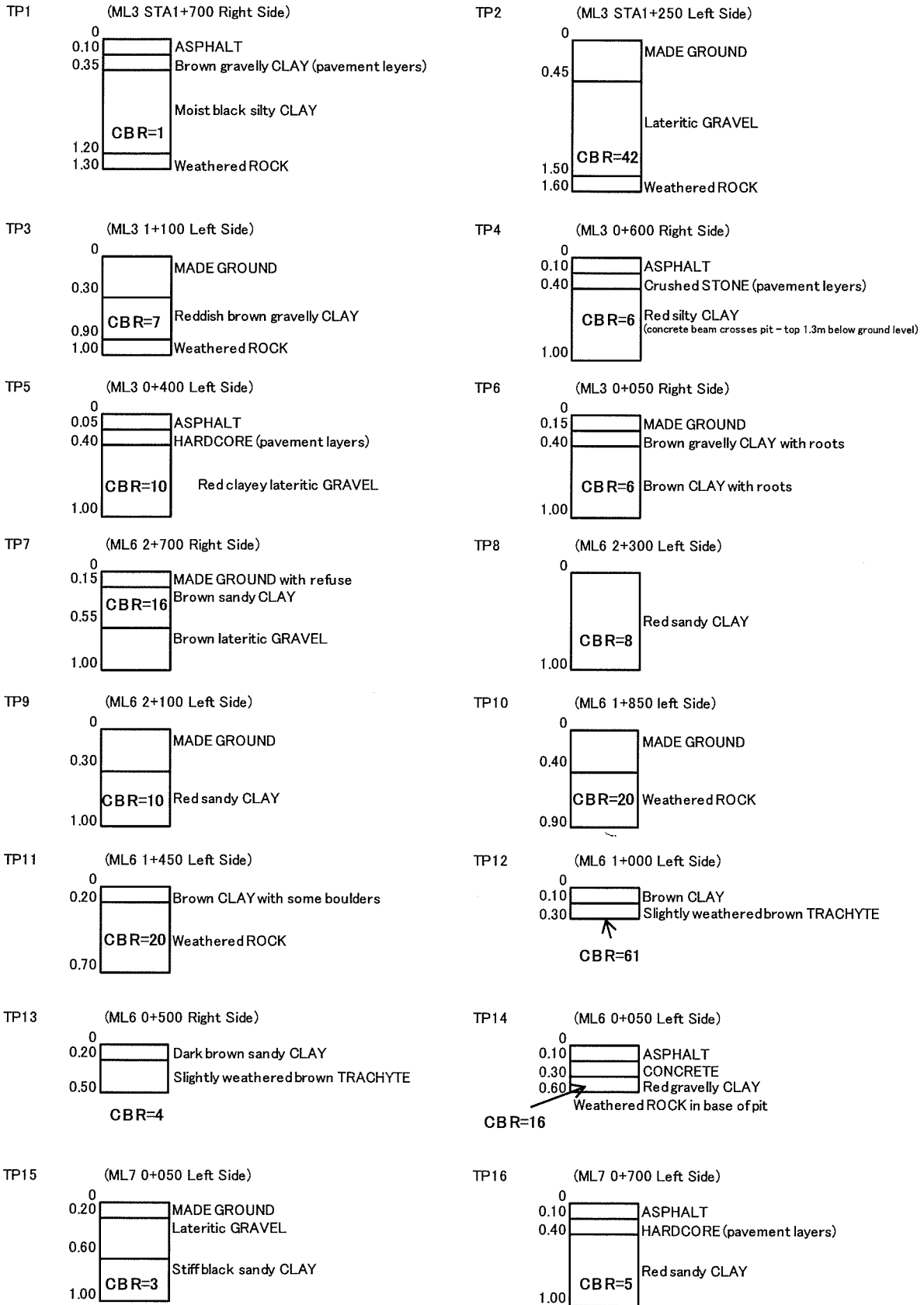
6.1 Traffic Survey Result

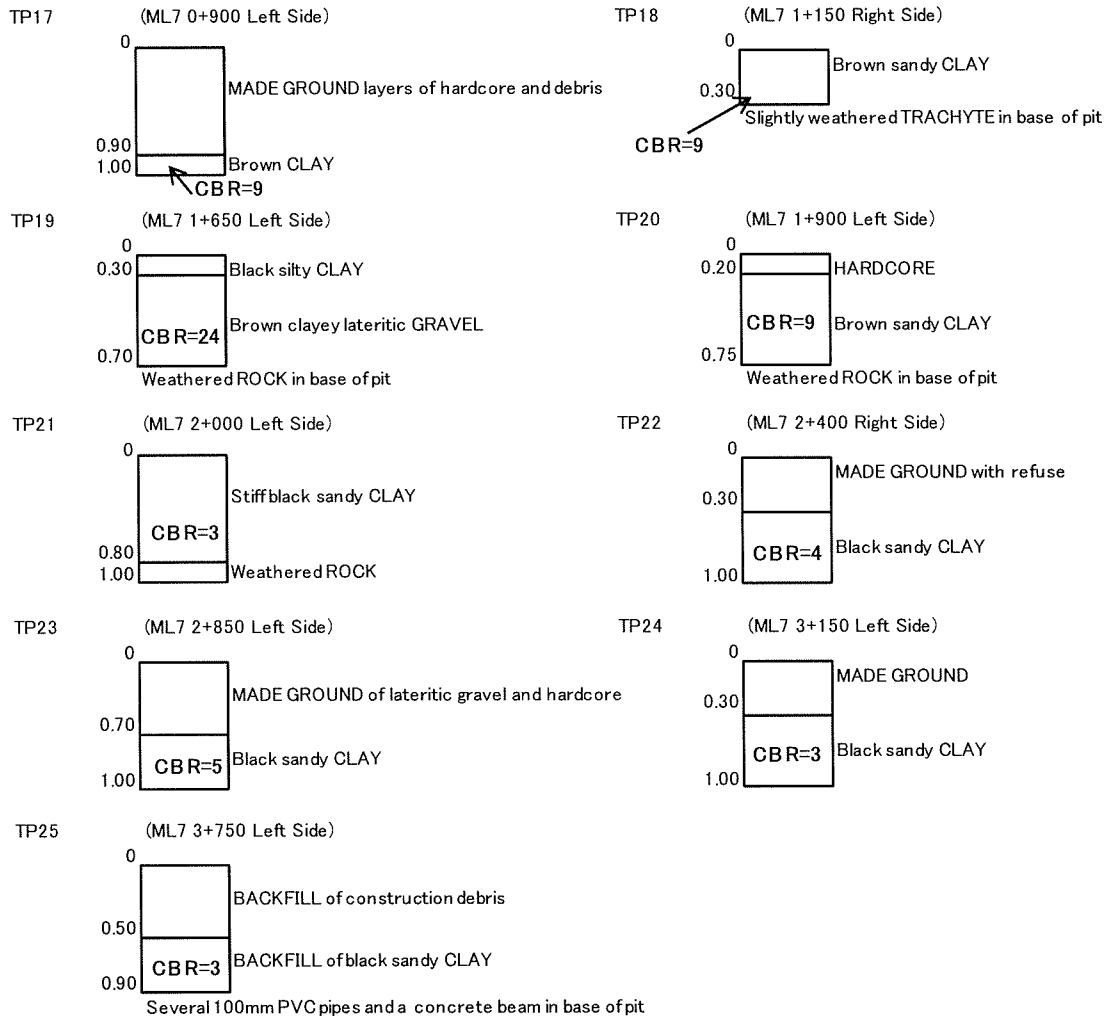
Jct. No.	Jct. Name	Time		MT											NMT				
		WEEKDAY/ SUNDAY	MT	Motor Cycles	Cars	P/ups Jeeps	Matatu / Minibus	Large Bus	Light Truck	Medium Truck	Heavy Truck	Artic Truck	MT Total	PCU					
														0.5	1.0	1.0	1.5	2.0	2.0
1	Westlands	Weekday	24hr	3,181	103,870	65,353	30,933	5,667	3,882	2,778	1,756	4,196	221,616	256,904	30,030	359	21	30,410	
		Sunday	12hr	621	49,220	31,822	15,448	2,721	1,515	813	660	1,597	104,417	120,306	28,556	176	22	28,754	
2	Rhapta	Weekday	16hr	689	17,415	8,504	367	30	246	92	12	0	27,355	27,457	24,405	617	58	25,080	
		Sunday	24hr	712	18,436	10,354	1,988	41	348	208	47	4	32,138	33,278	11,469	577	11	12,057	
3	Riverside	Weekday	12hr	136	6,065	3,603	815	13	69	48	11	6	10,766	11,230	3,544	206	6	3,756	
		Sunday	16hr	435	20,021	8,876	2,003	70	260	65	36	1	31,767	32,872	9,356	241	0	9,597	
4	Aboretum	Weekday	24hr	521	15,424	10,867	4,914	128	184	77	44	2	32,161	34,725	12,135	180	1	12,316	
		Sunday	12hr	111	3,437	4,423	1,292	36	50	18	8	1	9,376	10,060	3,120	66	6	3,192	
5	Mandera	Weekday	16hr	233	4,103	3,188	103	21	67	32	4	0	7,751	7,779	9,697	232	7	9,936	
		Sunday	12hr	828	14,723	10,326	5,394	1,522	133	153	74	10	33,163	37,319	8,807	1,188	13	10,008	
6	ML6/ML7	Weekday	24hr	176	7,407	5,173	2,372	820	106	34	9	4	16,101	18,128	4,877	539	4	5,420	
		Sunday	12hr	691	14,806	16,117	3,963	192	539	280	80	18	36,686	39,220	3,438	772	0	4,210	
7	Gitanga	Weekday	16hr	187	5,234	5,710	983	52	161	66	41	4	12,438	13,104	2,526	574	5	3,105	
		Sunday	12hr	205	6,325	4,676	1,182	40	109	47	7	2	12,593	13,238	5,789	211	1	6,001	
8	James Gichuru	Weekday	16hr	211	5,054	3,560	195	11	99	42	7	0	9,179	9,284	8,366	331	2	8,699	
		Sunday	12hr	415	7,134	4,695	720	84	266	61	72	0	13,447	13,986	13,352	242	25	13,619	
9	Nyeri	Weekday	24hr	540	18,971	11,008	4,878	1,294	298	87	43	7	37,126	40,904	24,957	663	12	25,632	
		Sunday	12hr	144	8,431	5,138	3,319	785	86	35	7	0	17,945	20,406	10,737	367	13	11,117	
10	Argwings Kodhek	Weekday	16hr	778	6,906	3,844	2,665	899	233	40	17	10	15,392	17,437	10,748	293	11	11,052	
		Sunday	12hr	665	16,590	10,614	6,917	1,699	721	286	134	48	37,674	43,443	33,209	588	39	33,836	
11	Chania	Weekday	24hr	417	13,941	10,116	5,765	1,794	246	164	55	28	32,526	37,420	25,239	471	12	25,722	
		Sunday	12hr	1,013	25,444	19,156	15,005	3,024	2,489	1,530	1,029	1,057	69,747	86,199	9,964	548	2	10,514	
12	Ngong	Weekday	16hr	12,909	388,957	257,123	111,221	20,943	12,107	6,956	4,153	6,995	821,364	-	294,321	-	271	304,033	
		Sunday	12hr	6,455	388,957	257,123	166,832	41,886	18,161	13,912	10,383	20,985	-	924,692	-	-	-	-	
Total		PCU																	

6.2 Calculation of Pavement Thickness

(1) CBR Test Result

TRIAL PIT LOGS & CBR RESULT





(2) Design CBR

No. Lane	Soil Condition	CBR Result	Destruction Rejection	→Replacement	Design CBR
1 ML3-4	Moist black silty clay	1			6
2 ML3-3	Lateritic gravel	42			
3 ML3-3	Reddish brown gravelly clay	7			
4 ML3-2	Red silty clay	6		9 points $\gamma=0.437$	10.4
5 ML3-1	Red clayey lateritic gravel	10		Ring Road 42-20/42-6=0.61 > γ Rejection	5.1
6 ML3-1	Brown clay with roots	6		8 points $\gamma=0.468$	5
7 ML6-4	Brown lateric gravel	16		20-16/20-6=0.29 < γ Adoption	
8 ML6-3	Red sandy clay	8			
9 ML6-3	Red sandy clay	10			
10 ML6-3	Weathered rock	20			
11 ML6-2	Weathered rock	20			
12 ML6-2	Slightly weathered brown Trachyte	61	Destruction	3 points $\gamma=0.941$	13.3
13 ML6-2	Slightly weathered brown Trachyte	4		Radial Road 16-4/20-4=0.75 < γ Adoption	8.3
14 ML6-1	Red gravelly clay	16			5
15 ML7-1	Stiff black sandy clay	3 -> 6	Improvement		
16 ML7-1	Red sandy clay	5		5 points $\gamma=0.642$	6.3
17 ML7-2	Brown clay	9		Radial Road 24-9/24-3=0.71 > γ Rejection	3.7
18 ML7-2	Slightly weathered Trachyte	5			3
19 ML7-2	Brown clay lateric gravel	24	Rejection		
20 ML7-2	Brown sandy clay	9		3 points $\gamma=0.941$	6.0
21 ML7-2	Stiff black sandy clay	3	Destruction	Ring Road 9-5/9-4=0.80 < γ Adoption	2.6
22 ML7-3	Black sandy clay	4			3
23 ML7-3	Black sandy clay	5			
24 ML7-4	Black sandy clay	3 -> 6	Improvement		
25 ML7-4	Backfill of black sandy clay	3 -> 6	Improvement		

Design CBR ML3&6 5%
 ML7 Radial Road 4%
 ML7 Ring Road 3%

(3) Traffic Load

Daily Traffic Demand in PCU by Ln Regression

(unit: pcu's per day)

No.	Section	From	To	2005	2010	2015	2020	2025
No.3	1	Westlands R/A	Ring Rd Kileleshwa	7,300	19,800	27,100	32,300	36,300
	2	Ring Rd Kileleshwa	Nairobi River	7,600	20,500	28,100	33,500	37,700
	3	Nairobi River	Rivieside Dr	8,100	21,800	29,800	35,500	39,900
	4	Rivieside Dr	Arboretum Dr	8,000	21,500	29,400	35,000	39,300
No.6	5	Arboretum Dr	Mandara Rd					
	6	Mandara Rd	Ring Rd Kilimani					
	7	Ring Rd Kilimani	Denis Pritt Rd	5,000	15,800	21,600	25,700	28,900
	8	Denis Pritt Rd	Ole Odume Rd	6,200	16,800	23,000	27,400	30,800
No.7	9	James Gichuru Rd	Ring Rd Kileleshwa	6,000	16,300	22,300	26,500	29,800
	10	Ring Rd Kileleshwa	Denis Pritt Rd					
	11	Denis Pritt Rd	Lenana Rd	6,700	18,200	24,900	29,600	33,300
	12	Lenana Rd	Argwings Kodhek Rc	8,200	22,200	30,400	36,200	40,700
	13	Argwings Kodhek Rc	Chania Ave					
	14	Chania Ave	Ngong Rd	7,200	19,600	26,800	31,900	35,800

Exclusion because of the possibility of 4-lane widening

Section	Average	20467	28,000	33,350	37,500
ML3&5 Ring Road	Average	20,467	28,000	33,350	37,500
ML6 Radial Road	Average	16,800	23,000	27,400	30,800
ML7 Radial Road	Average	16,300	22,300	26,500	29,800
ML7 Ring Road	Average	21,280	29,140	34,680	38,880
	Bus	M-Truck	L-Truck	A-Truck (Trailer/Tank Lorry)	
Distribution	0.9%	0.9%	0.5%	0.2%	
Ave. PCU	2.50	2.50	3.00	3.00	

W18 per lane

	2013-2020	2013-2022	2013-2027
1	7.12E+05	9.21E+05	1.49E+06
2	6.86E+05	7.60E+05	1.23E+06
3	6.66E+05	7.32E+05	1.18E+06
4	7.39E+05	9.57E+05	1.55E+06

Design Load for Pavement Design

ML3&5 Ring Road

	PCU	Bus	M-truck	L-truck	A-truck	Conversion	Bus 1.0	M-truck 1.0	L-truck 4.0	A-truck 4.0
2013-2020	2010	20,467	78	73	32	16	2.77E+04	2.66E+04	4.67E+04	2.34E+04
ESAL for 8 years 1.42E+06	2011	21,797	81	77	34	17	2.96E+04	2.81E+04	4.96E+04	2.48E+04
	2012	23,214	86	82	36	18	3.14E+04	2.99E+04	5.26E+04	2.63E+04
	2013	24,723	92	88	38	19	3.36E+04	3.21E+04	5.58E+04	2.77E+04
2013-2022 ESAL for 10 years 1.84E+06	2014	26,330	98	94	41	21	3.58E+04	3.43E+04	5.99E+04	3.07E+04
	2015	28,000	104	99	43	22	3.80E+04	3.61E+04	6.28E+04	3.21E+04
	2016	29,008	108	103	45	23	3.94E+04	3.76E+04	6.57E+04	3.36E+04
2013-2027 ESAL for 15 years 2.38E+06	2017	30,052	112	107	47	24	4.06E+04	3.91E+04	6.86E+04	3.50E+04
	2018	31,134	116	111	48	24	4.23E+04	4.05E+04	7.01E+04	3.56E+04
	2019	32,255	120	115	50	25	4.38E+04	4.20E+04	7.30E+04	3.65E+04
	2020	33,350	124	118	52	26	4.53E+04	4.31E+04	7.59E+04	3.80E+04
	2021	34,150	127	121	53	27	4.64E+04	4.42E+04	7.74E+04	3.94E+04
	2022	34,970	130	124	54	27	4.75E+04	4.53E+04	7.88E+04	3.94E+04
	2023	35,809	133	127	56	28	4.85E+04	4.64E+04	8.18E+04	4.09E+04
	2024	36,668	136	130	57	29	4.96E+04	4.75E+04	8.32E+04	4.23E+04
	2025	37,500	139	133	58	29	5.07E+04	4.85E+04	8.47E+04	4.23E+04
	2026	38,400	142	136	60	30	5.18E+04	4.96E+04	8.76E+04	4.38E+04
2027	39,322	146	140	61	31	5.33E+04	5.11E+04	8.81E+04	4.53E+04	

ML6 Radial Road

	PCU	Bus	M-truck	L-truck	A-truck	Conversion	Bus 1.0	M-truck 1.0	L-truck 4.0	A-truck 4.0
2013-2020	2010	16,800	62	60	26	13	2.26E+04	2.19E+04	3.80E+04	1.90E+04
ESAL for 8 years 1.17E+06	2011	17,892	68	64	28	14	2.41E+04	2.34E+04	4.09E+04	2.04E+04
	2012	19,055	71	68	30	15	2.59E+04	2.48E+04	4.38E+04	2.19E+04
	2013	20,294	75	72	32	16	2.74E+04	2.63E+04	4.67E+04	2.34E+04
2013-2022 ESAL for 10 years 1.52E+06	2014	21,613	80	77	34	17	2.92E+04	2.81E+04	4.96E+04	2.48E+04
	2015	23,000	85	82	36	18	3.10E+04	2.99E+04	5.26E+04	2.63E+04
	2016	23,828	88	85	37	19	3.21E+04	3.10E+04	5.40E+04	2.77E+04
2013-2027 ESAL for 15 years 2.45E+06	2017	24,888	92	88	38	19	3.36E+04	3.21E+04	5.58E+04	2.77E+04
	2018	25,975	95	91	40	20	3.47E+04	3.32E+04	5.84E+04	2.92E+04
	2019	26,496	98	94	41	21	3.58E+04	3.43E+04	5.99E+04	3.07E+04
	2020	27,400	102	97	43	22	3.72E+04	3.54E+04	6.28E+04	3.21E+04
	2021	28,058	104	100	44	22	3.80E+04	3.65E+04	6.42E+04	3.21E+04
	2022	28,731	107	102	45	23	3.91E+04	3.72E+04	6.57E+04	3.36E+04
	2023	29,421	109	105	46	23	3.98E+04	3.83E+04	6.72E+04	3.36E+04
	2024	30,127	112	107	47	24	4.09E+04	3.91E+04	6.86E+04	3.50E+04
	2025	30,800	114	109	48	24	4.18E+04	3.98E+04	7.01E+04	3.56E+04
	2026	31,539	117	112	49	25	4.27E+04	4.09E+04	7.15E+04	3.65E+04
2027	32,298	120	115	50	25	4.38E+04	4.20E+04	7.30E+04	3.65E+04	

ML7 Radial Road

	PCU	Bus	M-truck	L-truck	A-truck	Conversion	Bus 1.0	M-truck 1.0	L-truck 4.0	A-truck 4.0
2013-2020	2010	16,300	60	58	25	13	2.19E+04	2.12E+04	3.65E+04	1.90E+04
ESAL for 8 years 1.13E+06	2011	17,300	64	62	27	14	2.34E+04	2.28E+04	3.94E+04	2.04E+04
	2012	18,488	69	66	29	15	2.52E+04	2.41E+04	4.23E+04	2.19E+04
	2013	19,690	73	70	31	15	2.68E+04	2.58E+04	4.53E+04	2.19E+04
2013-2022 ESAL for 10 years 1.46E+06	2014	20,970	78	74	33	16	2.85E+04	2.70E+04	4.82E+04	2.34E+04
	2015	22,300	83	79	35	17	3.02E+04	2.88E+04	5.11E+04	2.48E+04
	2016	23,081	86	82	36	18	3.14E+04	2.99E+04	5.26E+04	2.63E+04
2013-2027 ESAL for 15 years 2.37E+06	2017	23,889	89	85	37	19	3.25E+04	3.10E+04	5.40E+04	2.77E+04
	2018	24,725	92	88	38	19	3.36E+04	3.21E+04	5.58E+04	2.77E+04
	2019	25,590	95	91	40	20	3.47E+04	3.32E+04	5.84E+04	2.92E+04
	2020	26,500	98	94	41	21	3.58E+04	3.43E+04	5.99E+04	3.07E+04
	2021	27,136	101	96	42	21	3.69E+04	3.50E+04	6.13E+04	3.07E+04
	2022	27,787	103	99	43	22	3.76E+04	3.61E+04	6.28E+04	3.21E+04
	2023	28,454	106	101	44	22	3.87E+04	3.69E+04	6.42E+04	3.21E+04
	2024	29,137	108	104	45	23	3.94E+04	3.80E+04	6.57E+04	3.36E+04

		2025	29,800	111	106	46	23	4.05E+04	3.87E+04	6.72E+04	3.36E+04
		2026	30,515	113	108	47	24	4.12E+04	3.94E+04	6.86E+04	3.50E+04
		2027	31,247	116	111	49	25	4.23E+04	4.05E+04	7.15E+04	3.65E+04
ML7 Ring Road											
		PCU	Bus	M-truck	L-truck	A-truck	Conversion	Bus	M-truck	L-truck	A-truck
		1.0	1.0	4.0	4.0						
2013~2020		2010	21,280	79	76	33	17	2.88E+04	2.77E+04	4.82E+04	2.48E+04
ESAL for 8 years		2011	22,663	84	81	35	18	3.07E+04	2.96E+04	5.11E+04	2.63E+04
	1.48E+06	2012	24,136	90	86	37	19	3.29E+04	3.14E+04	5.40E+04	2.77E+04
2013~2022		2013	25,705	95	91	40	20	3.47E+04	3.32E+04	5.84E+04	2.92E+04
ESAL for 10 years		2014	27,376	102	97	43	21	3.72E+04	3.54E+04	6.28E+04	3.07E+04
	1.91E+06	2015	29,140	108	104	45	23	3.94E+04	3.80E+04	6.57E+04	3.36E+04
2013~2027		2016	30,160	112	107	47	24	4.09E+04	3.91E+04	6.86E+04	3.50E+04
ESAL for 15 years		2017	31,216	116	111	48	24	4.23E+04	4.05E+04	7.01E+04	3.50E+04
	3.10E+06	2018	32,309	120	115	50	25	4.38E+04	4.20E+04	7.30E+04	3.65E+04
		2019	33,440	124	119	52	26	4.53E+04	4.34E+04	7.59E+04	3.80E+04
		2020	34,660	129	123	54	27	4.71E+04	4.49E+04	7.88E+04	3.94E+04
		2021	35,492	132	126	55	28	4.82E+04	4.60E+04	8.03E+04	4.09E+04
		2022	36,344	135	129	56	29	4.93E+04	4.71E+04	8.18E+04	4.23E+04
		2023	37,216	138	132	58	29	5.04E+04	4.82E+04	8.47E+04	4.23E+04
		2024	38,109	141	135	59	30	5.15E+04	4.93E+04	8.61E+04	4.38E+04
		2025	38,980	145	138	61	31	5.29E+04	5.04E+04	8.91E+04	4.53E+04
		2026	39,916	148	142	62	31	5.40E+04	5.18E+04	9.05E+04	4.53E+04
		2027	40,874	152	145	63	32	5.55E+04	5.29E+04	9.20E+04	4.67E+04

(4) Calculation of Pavement Thickness

① ML6 Radial Road Section (General Section)

- CBR = 5 % SN = 3.0
- 1) ACP Thickness
Considering a minimum thickness D1 = 7.5 cm of asphalt concrete.
SN1 of asphalt = 0.390 x 7.5 / 2.54 = 1.152
- 2) Base Course Thickness
Considering a minimum thickness D2 = 15 cm.
SN2 of the Base = 0.135 x 15 / 2.54 = 0.797
- 3) Subbase Thickness
Considering a minimum thickness D2 = 20 cm.
SN3 of Subbase = 0.108 x 20 / 2.54 = 0.850
- SN1 + SN2 + SN3 = 2.799 OK

Asphalt Concrete Course	7.5	cm
Bituminous treated Base Course	15.0	cm
Crushed Gravel Base Course	20.0	cm

③ ML3 & ML6 Ring Road Section (General Section)

- CBR = 5 % SN = 3.1
- 1) ACP Thickness
Considering a minimum thickness D1 = 7.5 cm of asphalt concrete.
SN1 of asphalt = 0.390 x 7.5 / 2.54 = 1.152
- 2) Base Course Thickness
Considering a minimum thickness D2 = 20 cm.
SN2 of the Base = 0.135 x 20 / 2.54 = 1.063
- 3) Subbase Thickness
Considering a minimum thickness D2 = 20 cm.
SN3 of Subbase = 0.108 x 20 / 2.54 = 0.850
- SN1 + SN2 + SN3 = 3 OK

Asphalt Concrete Course	7.5	cm
Bituminous treated Base Course	20.0	cm
Crushed Gravel Base Course	20.0	cm

② ML6 Radial Road Section (Special Section: On the Rock)

⚠ Standard Composition on the Rock

Asphalt Concrete Course	10.0	cm
Lean Concrete	10.0	cm

④ ML3 Ring Road Section (Special Section)

- CBR = 6 % SN = 2.8
(Replaced Material for Subgrade)
- 1) ACP Thickness
Considering a minimum thickness D1 = 7.5 cm of asphalt concrete.
SN1 of asphalt = 0.390 x 7.5 / 2.54 = 1.152
- 2) Base Course Thickness
Considering a minimum thickness D2 = 15 cm.
SN2 of the Base = 0.135 x 15 / 2.54 = 0.797
- 3) Subbase Thickness
Considering a minimum thickness D2 = 20 cm.
SN3 of Subbase = 0.108 x 20 / 2.54 = 0.850
- SN1 + SN2 + SN3 = 2.799 OK

Asphalt Concrete Course	7.5	cm
Bituminous treated Base Course	15.0	cm
Crushed Gravel Base Course	20.0	cm

⑤ ML7 Radial Section (General Section)

- CBR = 4 % SN = 3.2
- 1) ACP Thickness
Considering a minimum thickness D1 = 7.5 cm of asphalt concrete.
SN1 of asphalt = $0.390 \times 7.5 / 2.54 = 1.152$
- 2) Base Course Thickness
Considering a minimum thickness D2 = 15 cm
SN2 of the Base = $0.135 \times 15 / 2.54 = 0.797$
- 3) Subbase Thickness
Considering a minimum thickness D2 = 30 cm
SN3 of Subbase = $0.108 \times 30 / 2.54 = 1.276$
- SN1 + SN2 + SN3 = 3.124 OK

Asphalt Concrete Course	7.5	cm
Bituminous treated Base Course	15.0	cm
Crushed Gravel Base Course	30.0	cm

⑦ ML7 Ring Road Section

- CBR = 3 % SN = 3.7
- 1) ACP Thickness
Considering a minimum thickness D1 = 7.5 cm of asphalt concrete.
SN1 of asphalt = $0.390 \times 7.5 / 2.54 = 1.152$
- 2) Base Course Thickness
Considering a minimum thickness D2 = 20 cm
SN2 of the Base = $0.135 \times 20 / 2.54 = 1.063$
- 3) Subbase Thickness
Considering a minimum thickness D2 = 35 cm
SN3 of Subbase = $0.108 \times 35 / 2.54 = 1.488$
- SN1 + SN2 + SN3 = 3.7 OK

Asphalt Concrete Course	7.5	cm
Bituminous treated Base Course	20.0	cm
Crushed Gravel Base Course	35.0	cm

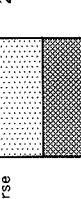





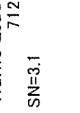
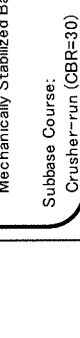

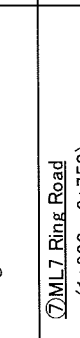
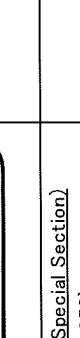

⑥ ML7 Radial Section (Special Section)

- CBR = 6 % SN = 3.2
- 1) ACP Thickness
Considering a minimum thickness D1 = 7.5 cm of asphalt concrete.
SN1 of asphalt = $0.390 \times 7.5 / 2.54 = 1.152$
- 2) Base Course Thickness
Considering a minimum thickness D2 = 15 cm
SN2 of the Base = $0.135 \times 15 / 2.54 = 0.797$
- 3) Subbase Thickness
Considering a minimum thickness D2 = 30 cm
SN3 of Subbase = $0.108 \times 30 / 2.54 = 1.276$
- SN1 + SN2 + SN3 = 3.124 OK

Asphalt Concrete Course	7.5	cm
Bituminous treated Base Course	15.0	cm
Crushed Gravel Base Course	30.0	cm

(5) Calculation Result List

Table- Calculation Result List of Pavement Thickness

①ML6 Radial Road (General Section)	②ML6 Radial Road (Special Section) (On the Rock: 0+500~1+500)	③ML3 & ML6 Ring Road (General Section)	④ML3 Ring Road (Special Section) (1+610~1+760)
 <p>Surface Course + Binder Course 7.5cm 15cm 25cm</p> <p>Subgrade: CBR=5</p> <p>Design CBR=5 Traffic Load 586,000 SN=3.0</p>	 <p>Surface Course + Binder Course 10cm 10cm</p> <p>Subgrade: Rock</p> <p>Standard Composition on the Rock</p> <p><Material> Surface Course + Binder Course : Asphalt Concrete (Binder:4.5cm + Surface:3.0cm) Base Course: Mechanically Stabilized Base (CBR=80) Subbase Course: Crusher-run (CBR=30)</p>	 <p>Surface Course + Binder Course 7.5cm 20cm 20cm</p> <p>Subgrade: CBR=5</p> <p>Design CBR=5 Traffic Load 712,000 SN=3.1</p>	 <p>Surface Course + Binder Course 7.5cm 15cm 20cm 77.5cm</p> <p>Replacement of Subgrade material (CBR>6)</p> <p>Design CBR=6 Traffic Load 712,000 SN=2.8</p> <p>(Rock below GL-1.2)</p>
 <p>Surface Course + Binder Course 7.5cm 15cm 30cm</p> <p>Subgrade: CBR=4</p> <p>Design CBR=4 Traffic Load 566,000 SN=3.2</p>	 <p>Surface Course + Binder Course 7.5cm 15cm 30cm 40cm</p> <p>Replacement of Subgrade material (CBR>15)</p> <p>Design CBR=4 Traffic Load 566,000 SN=3.2</p> <p>Combination CBR=6</p>	 <p>Surface Course + Binder Course 7.5cm 20cm 35cm</p> <p>Subgrade: CBR=3</p> <p>Design CBR=4 Traffic Load 739,000 SN=3.7</p>	 <p>Surface Course + Binder Course 7.5cm 20cm 35cm 77.5cm</p> <p>Replacement of Subgrade material (CBR>6)</p> <p>Design CBR=6 Traffic Load 712,000 SN=2.8</p> <p>(Rock below GL-1.2)</p>
 <p>⑤ML7 Radial Road (General Section) (0+250~1+800)</p>	 <p>⑥ML7 Radial Road (Special Section) (0+000~0+250)</p>	 <p>⑦ML7 Ring Road (General Section) (1+800~3+750)</p>	 <p>⑧ML7 Ring Road (Special Section) (1+610~1+760)</p>

6.3 Calculation of Drainage

(1) Rain fall - Data

Source: Kenya Meteorological Department, Ministry of Transport and Communication

Station 9136164(=164): Dagoretti Corner

Data period: 1970~2004

No Date: -98

Missing data: -99

Data Unit: x10⁻¹ mm

Sta. Year	Mon.	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th	18th	19th	20th	21st	22nd	23rd	24th	25th	26th	27th	28th	29th	30th	31st		
164 1970	1	0	0	30	63	266	14	56	12	1	0	177	13	0	0	0	0	1	0	0	14	29	149	1	0	0	0	0	23	68	9	92		
164 1970	2	0	0	0	0	0	0	0	0	3	0	105	0	0	14	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	-98	-98	-98	
164 1970	3	0	0	0	0	17	6	1	41	30	0	0	0	0	30	3	0	0	0	0	7	0	0	114	128	63	138	297	236	19	354	148		
164 1970	4	55	558	467	24	2	21	496	8	57	2	7	82	66	23	8	0	0	0	1	31	755	290	396	0	0	38	71	0	15	0	-98		
164 1970	5	8	0	77	23	210	1	0	80	213	53	0	15	13	0	0	0	40	7	58	398	0	0	0	0	46	232	561	6	158	0	224		
164 1970	6	166	0	35	0	0	0	0	0	0	0	0	3	0	10	2	0	7	19	0	0	0	0	0	0	0	0	0	0	0	0	0	-98	
164 1970	7	2	0	129	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	6	0	14	
164 1970	8	0	0	0	0	0	0	3	0	0	0	0	0	0	0	2	0	0	0	0	0	0	8	16	6	0	5	2	4	0	0	4		
164 1970	9	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39	0	0	0	4	0	-98		
164 1970	10	0	0	0	0	15	4	0	0	1	30	151	32	0	0	8	2	0	0	0	0	0	0	18	23	0	0	0	0	0	0	28		
164 1970	11	4	9	30	0	7	26	70	3	0	17	116	12	132	0	704	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-98		
164 1970	12	0	46	14	0	0	0	0	0	0	0	0	0	131	247	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	44		
164 1971	1	0	15	0	0	0	0	0	0	0	0	0	0	0	0	17	433	0	0	0	0	0	0	0	23	26	1	0	0	0	0	0		
164 1971	2	0	31	15	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	-98	-98	-98		
164 1971	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	53	39	0	2	0	2	75			
164 1971	4	0	0	0	0	0	21	0	150	36	39	104	15	6	134	444	131	41	39	437	188	18	0	0	85	240	2	0	24	167	-98			
164 1971	5	0	210	614	36	0	3	0	44	39	25	0	0	94	0	108	976	300	71	29	390	179	0	0	0	0	0	5	0	67	17			
164 1971	6	0	1	0	0	0	0	0	0	0	0	0	0	180	9	0	0	7	29	5	0	0	0	0	0	0	0	0	0	0	0	-98		
164 1971	7	0	8	0	0	0	28	4	0	0	0	0	0	0	2	0	1	35	0	11	0	0	0	1	1	0	0	0	0	0	0	0		
164 1971	8	0	-99	0	0	0	0	0	-99	0	3	-99	20	0	-99	0	0	0	0	0	13	16	35	4	3	0	-99	-99	0	2	0	-99		
164 1971	9	0	0	4	8	6	0	0	0	0	0	29	0	0	65	0	0	0	0	0	0	0	0	0	0	372	0	0	0	29	0	-98		
164 1971	10	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	57	17	0	0			
164 1971	11	0	0	0	27	0	0	0	0	7	0	113	0	0	25	104	0	0	0	8	0	0	14	38	14	74	32	50	67	6	88	-98		
164 1971	12	0	84	0	0	0	0	0	0	0	0	0	0	0	0	341	123	83	194	4	220	34	98	355	0	0	0	0	0	53	31			
164 1972	1	0	4	0	0	62	88	0	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
164 1972	2	0	163	0	0	0	33	232	51	3	0	0	0	0	0	9	0	0	0	0	0	0	8	47	214	0	0	0	0	0	-98	-98		
164 1972	3	0	0	2	0	0	0	0	0	24	99	0	0	0	43	0	0	0	0	0	204	0	0	0	0	0	0	0	0	0	0	0	0	
164 1972	4	0	0	0	0	0	0	0	0	27	0	19	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	126	10	-98		
164 1972	5	0	122	195	4	0	30	537	83	0	15	31	345	40	134	0	152	208	191	65	26	15	0	8	0	22	23	6	2	32	0	0		
164 1972	6	0	0	30	855	149	0	2	0	0	0	0	0	0	0	15	0	0	0	187	0	0	0	124	16	0	0	0	0	0	0	-98		
164 1972	7	0	0	0	0	0	29	0	0	0	71	25	0	2	4	0	0	0	0	0	0	0	34	0	0	0	0	0	0	0	0	0	0	
164 1972	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	6	10	18	0	0	0	0	0	0	0	0	1	0		
164 1972	9	0	0	0	0	0	5	278	0	0	0	0	0	112	0	0	0	0	6	0	8	0	0	4	41	71	0	0	32	0	-98			
164 1972	10	0	0	0	0	0	0	0	0	0	0	0	0	51	0	100	6	0	0	0	24	0	128	1	326	32	222	0	0	563	462			
164 1972	11	0	0	0	74	44	52	109	0	104	98	0	0	37	188	314	0	0	57	42	12	5	24	0	0	0	75	18	0	0	0	-98		
164 1972	12	0	0	4	7	0	0	0	0	24	0	56	13	20	0	0	0	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0		
164 1973	1	0	0	307	29	258	137	3	15	0	0	0	0	0	438	183	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
164 1973	2	0	0	0	0	0	39	0	0	0	0	530	0	0	0	51	251	5	0	0	86	11	0	0	0	0	0	0	0	0	-98	-98	-98	
164 1973	3	0	0	0	0	0	44	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	95	0	0	0	7	0	0	0	0	0	
164 1973	4	0	0	8	0	0	0	0	38	6	0	13	3	0	0	0	1391	106	89	0	781	285	113	60	213	0	0	30	6	125	-98			
164 1973	5	2	65	0	0	11	69	5	0	0	3	0	0	4	0	140	0	0	0	0	36	0	0	0	0	0	0	198	2	0	78			
164 1973	6	90	22	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	30	0	-98			
164 1973	7	0	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	9	0	0	0	0	
164 1973	8	0	4	17	0	3	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	6	0	0	0	0	0	0	0	0	0	8	0	0
164 1973	9	0	0	0	0	0	0	0	0	63	0	0	0	0	0	16	0	0	0	426	9	46	17	14	304	58	65	0	0	0	0	-98		
164 1973	10	0	0	0	0	0	0	0	51	0	0	0	0	0	107	0	0	6	0	0	0	0	0	0	5	0	0	53	0	0	0	0	0	

164 1973	11	0	7	43	0	32	5	36	90	120	10	0	76	0	0	0	5	0	13	0	4	0	0	0	0	26	0	16	63	140	-98		
164 1973	12	0	94	0	0	0	0	0	0	132	4	0	0	0	0	0	0	206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
164 1974	1	0	0	0	0	0	0	0	0	10	0	0	0	0	64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
164 1974	2	0	0	0	0	85	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-98	-98	-98	
164 1974	3	375	140	95	3	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55	0	0	86	0	220	418	
164 1974	4	60	123	68	44	38	130	14	205	189	9	29	183	111	271	95	0	0	75	81	47	0	88	96	43	42	23	8	30	5	444	-98	
164 1974	5	348	7	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	114	0	7	0	0	0	0	0	0	7	13
164 1974	6	48	10	0	0	26	0	0	14	0	0	54	296	0	0	5	173	16	0	0	0	0	0	194	16	0	47	45	3	19	-98		
164 1974	7	111	58	66	3	13	78	28	75	0	3	0	5	40	35	0	0	17	0	0	0	159	0	0	0	0	0	0	0	0	0	0	
164 1974	8	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	23	23	0	0	0	0	0	33	11	
164 1974	9	0	0	100	0	0	0	46	0	30	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-98	
164 1974	10	11	0	0	116	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	102	15	33	0	0	0	3	0	0	0	
164 1974	11	0	67	106	43	60	108	82	53	58	119	10	0	0	0	0	19	77	76	99	0	0	0	0	0	0	6	0	0	0	0	-98	
164 1974	12	0	0	0	203	54	32	0	0	0	0	0	0	4	6	44	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
164 1975	1	25	0	0	0	0	0	0	0	94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
164 1975	2	0	0	0	0	0	0	0	0	0	0	0	14	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-98	-98	-98
164 1975	3	0	0	0	17	0	3	0	137	10	0	0	0	0	0	0	11	3	0	0	0	0	0	0	0	0	0	0	0	72	15	170	
164 1975	4	43	0	0	13	0	0	0	0	111	213	16	0	215	29	154	314	5	34	8	5	159	206	27	180	0	0	0	0	0	0	-98	
164 1975	5	6	4	0	0	0	0	0	0	0	0	137	82	0	582	167	233	34	3	0	23	0	0	0	26	0	0	75	408	23	35	43	
164 1975	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78	0	0	4	0	0	0	0	0	4	8	10	0	0	0	-98		
164 1975	7	0	0	4	7	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	106	26	37	47	0	0	0	16	0	
164 1975	8	0	0	0	0	3	4	0	0	0	0	4	3	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
164 1975	9	0	237	8	0	0	16	58	0	0	173	33	31	0	0	9	509	72	0	0	0	0	0	0	0	0	61	4	74	10	81	-98	
164 1975	10	0	0	0	0	0	5	0	0	16	27	0	0	0	0	0	0	0	0	15	11	137	164	0	0	0	40	10	97	89	0	0	
164 1975	11	0	0	0	0	0	0	0	0	0	0	0	92	27	73	16	54	213	115	14	0	29	132	171	4	13	0	0	0	50	0	-98	
164 1975	12	9	140	0	0	481	120	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	
164 1976	1	154	0	0	0	0	0	0	0	0	0	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
164 1976	2	0	0	202	6	50	0	0	0	0	0	0	0	0	0	71	0	0	0	0	0	0	0	0	38	11	29	16	0	0	-98	-98	
164 1976	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	19	261	2	13	0	0	0	0	0	
164 1976	4	0	0	0	0	0	0	0	3	170	55	76	0	318	147	4	7	0	7	0	0	0	53	51	0	26	25	45	0	0	-98		
164 1976	5	0	0	0	0	7	0	57	0	0	0	3	0	0	52	32	78	1	0	5	51	7	566	0	0	0	0	0	0	0	0	0	
164 1976	6	0	0	0	0	0	0	0	0	0	0	0	0	7	12	0	0	4	0	256	148	0	0	0	0	0	0	0	18	18	-98		
164 1976	7	0	0	0	0	0	0	118	0	0	41	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	
164 1976	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	179	0	0	0	0	0	0	0	0	0	
164 1976	9	35	467	0	49	0	0	16	0	0	0	0	0	0	0	0	0	0	0	10	0	0	28	6	0	0	0	0	0	0	0	-98	
164 1976	10	0	0	8	95	8	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	19	0	0	0	0	0	0	0	0	0	0	
164 1976	11	0	32	171	2	0	0	0	0	42	3	0	0	0	0	0	0	106	510	52	121	112	2	0	13	335	21	0	179	75	-98		
164 1976	12	190	13	0	0	0	0	5	0	0	0	24	137	67	0	13	50	0	0	0	1	11	11	23	32	0	0	0	60	337	0	0	
164 1977	1	1	89	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	155	8	0	0	0	0	0	29	0	15	0	0	0	0	
164 1977	2	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	15	66	181	189	277	0	12	0	0	0	0	-98	-98	-98
164 1977	3	0	0	0	0	14	9	0	7	0	0	0	0	0	15	0	5	21	10	154	41	0	0	0	0	0	0	0	6	48	45	0	
164 1977	4	0	0	0	63	869	0	414	305	28	74	36	60	498	372	78	0	21	5	4	41	93	9	21	159	96	326	56	520	158	679	-98	
164 1977	5	233	320	0	0	82	0	0	662	493	60	128	262	19	163	537	130	0	19	21	0	0	0	0	0	0	0	0	0	0	0	0	
164 1977	6	0	0	0	0	3	229	67	0	0	0	0	0	0	23	0	81	21	0	0	0	0	0	0	0	0	0	0	0	0	0	-98	
164 1977	7	0	0	0	1	60	5	38	28	0	0	365	0	0	0	7	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	10	
164 1977	8	0	0	0	13	244	0	0	6	50	0	0	0	0	44	147	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
164 1977	9	0	0	0	0	0	0	1	0	0	23	0	0	0	0	82	3	4	69	53	0	0	0	0	0	0	0	0	0	0	0	-98	
164 1977	10	0	0	0	0	0	0	0	16	0	0	0	10	0	0	0	0	7	31	75	23	40	81	0	0	0	0	0	2	16	152	0	
164 1977	11	3	77	143	11	191	203	140	3	171	1	3	9	14	0	30	423	24	38	6	491	18	0	175	386	3	13	5	85	15	0	-98	
164 1977	12	32	0	0	0	0	23	0	0	42	0	0	0	33	0	0	7	32	7	27	219	47	262	18	386	0	0	0	0	0	0	0	
164 1978	1	0	0	0	0	0	0	0	0	0	0	9	0	0	405	20	274	18	559	0	54	96	0	0	0	0	0	0	0	0	0	0	
164 1978	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	107	5	23	50	55	32	0	16	54	0	0	0	0	-98	-98	-98		
164 1978	3	13	2	0	0	0	0	102	0	68	0	0	0	980	29	123	6	7	0	67	16	29	90	393	616	147	19	21	84	177	0	0	
164 1978	4	0	18	0	0	104	19	15	0	400	266	0	22	116	86	22	0	0	0	25	0	43	37	86	105	102	4	217	18	8	864	-98	
164 1978	5	74	1	61	23	8	15	7	8	0	24	11	8	0	0	9	116	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	
164 1978	6	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	13	25	4	0	0	0	0	0	2	10	26			

Table with 40 columns and 100 rows. Each row represents a year from 1983 to 1988, grouped by year (1983, 1984, 1985, 1986, 1987, 1988). Each row contains 40 numerical values, some of which are negative, representing data points for that year.

Table with columns representing year, month, and various numerical values. Rows range from 1988 to 1993. Some values are negative, indicating a decrease or deficit.

164 1993 3 0 0 0 0 0 0 93 0 0 0 95 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 12 91 0
164 1993 4 0 0 0 0 0 49 0 0 0 0 0 5 0 148 36 4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 -98
164 1993 5 0 0 216 153 20 0 185 0 0 47 67 0 121 75 3 14 9 0 0 0 0 0 40 0 2 0 0 0 0 0 0 0 0
164 1993 6 0 0 0 152 38 0 14 4 29 210 15 2 0 0 2 0 0 0 0 0 0 0 0 0 14 0 0 0 0 0 0 0 0
164 1993 7 0
164 1993 8 0 0 0 0 6 0 0 0 0 0 0 0 111 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
164 1993 9 0 -98
164 1993 10 0 0 0 0 0 5 2 0 0 0 0 0 0 25 40 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 130 229 23
164 1993 11 23 349 0 0 0 34 79 30 0 0 0 0 0 0 0 6 0 0 36 40 92 7 0 0 0 41 0 59 211 5 -98
164 1993 12 31 0 31 34 453 493 0 0 0 0 0 11 0 0 0 15 0 0 0 0 0 0 0 7 0 7 0 0 0 0
164 1994 2 0 0 0 0 0 0 0 0 0 0 0 75 263 20 9 505 10 0 0 0 0 0 46 0 0 0 0 0 0 -98 -98 -98
164 1994 3 0 0 0 18 7 0 0 0 0 0 0 0 140 0 0 0 0 3 0 0 0 30 71 25 3 0 294 0 0 0
164 1994 4 0 0 0 0 126 0 135 182 0 31 20 346 0 311 0 0 0 0 0 229 0 392 358 155 81 22 0 0 82 -98
164 1994 5 35 32 67 0 0 0 26 3 0 0 68 0 14 10 291 18 50 0 125 115 0 0 27 9 16 0 0 236 0 0 0
164 1994 6 0 0 0 0 0 0 0 101 0 0 0 0 0 0 7 0 9 0 0 0 0 0 0 0 0 0 0 11 0 70 -98
164 1994 7 0 28 17 0 0 0 0 0 0 0 128 0 0 16 0 0 0 0 0 4 0 0 0 0 0 0 0 0 0 0 0
164 1994 8 0 29 0 2 0 0 4 0 0 18 1 0 0 225 257 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
164 1994 9 0 0 0 0 14 0 0 0 0 0 0 16 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 0 0 0 -98
164 1994 10 0 0 0 0 0 3 0 0 0 0 195 418 0 0 0 22 7 9 0 3 115 106 0 0 0 0 0 0 0
164 1994 11 0 4 0 334 267 129 43 200 0 391 148 69 202 134 26 78 3 0 0 2 154 5 0 0 0 21 12 41 65 127 -98
164 1994 12 0 0 0 67 266 15 122 51 2 3 0 0 5 0 0 0 0 0 0 0 0 0 0 138 0 8 0 0 0 0 0
164 1995 1 0 139 0 0 0 0 0 0 0 3 0 0 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
164 1995 2 0 0 0 0 0 0 60 77 321 22 48 0 276 364 0 0 0 0 0 0 0 0 0 0 0 0 0 0 -98 -98 -98
164 1995 3 0 374 615 77 32 0 0 31 0 0 0 0 140 0 0 0 0 0 0 0 256 76 57 0 20 0 0 4 0
164 1995 4 0 0 28 2 106 4 0 1 0 62 59 0 0 0 0 0 0 297 14 30 0 0 0 0 15 182 31 126 140 -98
164 1995 5 418 147 39 0 0 734 5 223 8 0 7 14 0 3 164 64 60 6 11 0 0 0 0 0 0 33 0 16 79 72 0
164 1995 6 0 0 81 0 79 0 8 0 0 0 0 0 0 3 20 0 0 0 0 0 0 0 0 0 14 35 6 67 -98
164 1995 7 17 0 0 0 0 55 0 0 0 0 0 0 0 0 0 0 0 2 30 0 7 0 1 6 0 0 0 0 0
164 1995 9 0 0 3 4 103 0 0 0 11 47 7 11 0 0 0 0 0 0 0 0 7 0 0 99 0 0 0 0 -98
164 1995 11 0 76 1 0 0 0 0 0 0 0 117 81 127 144 0 6 0 0 6 0 130 0 0 87 10 31 136 0 0 -98
164 1995 12 11 26 7 0 0 0 0 0 0 0 145 23 0 0 49 50 13 0 0 0 3 0 0 3 0 2 0 0 0
164 1996 1 0 0 0 0 0 0 0 0 0 64 0 0 0 0 7 0 0 0 33 78 0 0 0 0 0 0 0 0 0
164 1996 2 0 0 0 3 37 0 0 0 0 9 0 0 0 0 53 325 0 0 16 0 0 0 0 0 0 12 0 0 -98 -98
164 1996 3 0 0 0 196 0 0 0 0 145 0 0 0 47 0 0 0 0 26 65 0 104 0 0 0 463 0 131 5 0 32
164 1996 4 214 9 0 0 0 157 22 588 0 0 3 6 0 26 0 0 0 0 0 0 0 0 0 0 0 0 0 103 -98
164 1996 5 3 0 0 0 11 1 0 0 0 2 3 3 116 3 0 4 305 4 199 10 67 26 0 53 82 2 0 0 0
164 1996 6 0 34 44 50 0 0 0 92 45 19 14 90 123 49 0 0 0 0 0 1 0 10 0 12 0 0 0 0 -98
164 1996 7 0 0 0 0 0 5 23 3 0 0 5 61 8 0 42 46 2 0 0 0 0 0 0 0 0 0 0 0 0
164 1996 9 197 0 19 0 0 0 0 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0 0 0 0 0 0 0 -98
164 1996 10 15 0 0 0 0
164 1996 11 5 10 78 210 0 0 13 2 0 23 258 170 45 189 5 0 0 0 302 96 65 0 0 135 34 1 36 0 0 -98
164 1996 12 0
164 1997 1 0 0 0 0 0 13 0
164 1997 2 0 -98 -98 -98
164 1997 3 0
164 1997 5 413 0 85 190 68 152 0 0 11 18 27 0 0 86 153 0 0 0 0 3 26 76 6 0 0 0 0 14
164 1997 6 0 0 0 0 0 0 0 14 0 0 0 0 2 0 0 0 8 4 0 8 0 0 0 0 0 8 5 0 -98
164 1997 7 0 3 0 0 0 0 10 1 6 0 0 0 0 0 0 0 0 0 18 12 0 0 0 0 0 0 0
164 1997 8 0 0 0 0 0 61 31 0 7 0 0 0 0 27 3 0 0 0 0 24 0 0 0 0 0 0 0 0
164 1997 9 0 0 0 1 0 4 0 -98
164 1997 10 0 0 0 22 0 47 1 18 0 5 37 142 67 1 0 0 0 58 63 43 596 2 5 0 0 0 0 176 89 185
164 1997 11 59 69 22 316 219 150 269 3 13 0 17 9 0 178 274 25 14 475 0 3 93 0 46 222 216 101 201 356 429 59 -98
164 1997 12 0 82 139 280 36 278 60 71 0 73 0 36 62 0 4 15 10 155 0 0 0 7 0 116 107 78 204 146 0 2 0
164 1998 1 49 22 20 425 0 76 145 27 78 87 639 46 81 490 817 435 10 0 20 3 0 0 0 0 0 0 74 47 16 0 4
164 1998 2 0 0 0 0 0 2 10 5 523 207 225 47 84 151 56 66 7 0 21 38 0 0 0 0 0 0 0 -98 -98 -98
164 1998 3 0 0 0 0 0 0 45 9 6 0 0 0 0 0 6 0 0 0 97 163 126 8 78 148 14 0 11 2 0 26
164 1998 4 0 0 56 0 48 47 0 0 82 10 320 137 52 9 0 0 0 2 0 132 0 10 10 0 26 0 1 69 27 80 -98

164 1998	5	290	200	83	98	102	216	157	173	76	398	152	116	0	33	9	452	4	0	0	0	465	18	47	0	15	110	881	32	0	0	0						
164 1998	6	0	0	0	0	64	0	206	456	2	0	0	0	0	0	0	0	0	1	8	0	0	0	0	0	127	0	0	0	0	0	0	-98					
164 1998	7	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	386	11	0	0	0	0	0	0	0	0	0	11	0				
164 1998	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	0	0	0	2	0	0	0	135	88	0	0	0	0	0	0					
164 1998	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	247	0	0	0	-98					
164 1998	10	0	6	65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
164 1998	11	38	0	0	29	0	0	0	136	30	54	0	0	0	0	0	0	0	32	88	4	3	3	29	0	51	0	32	16	0	3	14	-98					
164 1998	12	0	4	0	0	2	0	0	28	0	0	0	0	0	0	0	0	0	630	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0				
164 1999	1	0	0	0	0	0	0	0	111	5	0	0	0	0	0	0	58	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0				
164 1999	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-98	-98	-98			
164 1999	3	0	0	0	0	0	0	0	152	70	15	455	125	21	26	0	26	50	0	0	0	0	0	0	0	75	526	22	79	6	13	189						
164 1999	4	284	0	51	28	0	28	6	157	45	368	0	0	0	0	109	0	0	252	0	37	0	32	0	0	0	0	0	30	1	313	-98						
164 1999	5	13	0	0	0	0	6	0	0	26	0	0	0	30	0	0	7	169	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0				
164 1999	6	9	0	14	0	0	0	7	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	-98					
164 1999	7	0	0	4	0	0	0	0	0	0	0	0	0	0	0	23	8	4	0	0	0	0	0	0	0	0	0	1	0	9	0	0	0					
164 1999	8	0	0	0	0	0	0	0	0	0	0	0	8	0	0	9	15	0	21	6	0	0	0	0	400	7	0	0	0	0	130	16						
164 1999	9	6	0	0	2	0	0	2	0	0	0	137	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-98				
164 1999	10	0	0	0	0	0	0	0	0	0	3	0	30	0	0	7	0	0	0	0	0	0	0	0	0	30	41	52	61	0	0	0	0	0				
164 1999	11	0	0	0	0	0	351	14	48	5	28	153	234	82	40	38	20	230	33	101	30	108	0	2	24	158	40	41	49	464	574	-98						
164 1999	12	532	204	0	158	4	213	85	31	0	11	0	0	0	0	0	0	50	126	155	34	20	64	10	1	0	91	48	0	0	0	0	0	0				
164 2000	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	18	0	0	0	0	0	0	0	0	0	0	0	0			
164 2000	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-98	-98			
164 2000	3	23	0	0	0	0	0	0	0	0	0	0	0	235	0	46	0	0	16	0	0	0	0	0	56	0	19	0	0	0	0	0	0	0				
164 2000	4	49	0	0	283	201	44	12	23	10	0	2	0	0	0	0	0	0	0	0	0	0	272	156	25	0	0	0	0	0	0	0	0	-98				
164 2000	5	2	32	0	0	0	26	0	426	214	0	2	0	0	0	18	0	0	0	0	0	0	0	0	0	390	90	0	3	0	0	0	0	0				
164 2000	6	0	0	0	0	0	0	0	0	116	20	0	0	0	30	0	170	103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-98				
164 2000	7	0	0	0	5	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	10	5	6	0	0	0	0	11	5	0	0	0	0			
164 2000	8	0	0	0	0	71	0	0	2	0	0	0	0	12	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
164 2000	9	0	0	0	0	0	0	0	0	0	0	0	85	0	0	0	0	0	155	2	0	0	0	0	0	0	0	144	0	0	0	0	0	-98				
164 2000	10	0	0	0	0	0	0	9	0	0	0	0	0	0	80	147	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
164 2000	11	89	0	24	54	0	176	0	0	33	3	0	15	13	47	9	268	62	12	305	383	15	52	2	57	101	0	27	0	0	0	0	0	-98				
164 2000	12	67	0	0	0	0	57	0	52	113	127	0	0	0	161	333	2	0	48	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
164 2001	1	0	0	274	524	20	413	149	585	23	200	19	204	1284	3	0	0	0	0	0	8	0	375	5	175	8	16	0	15	0	0	0	0	0	0			
164 2001	2	0	0	0	0	212	0	0	29	0	14	0	23	0	0	0	0	0	0	0	0	0	10	0	29	0	0	0	0	0	0	0	-98	-98	-98			
164 2001	3	0	0	0	0	263	630	0	0	0	0	122	112	0	0	0	23	0	8	0	0	0	0	42	256	777	240	240	0	161	52							
164 2001	4	12	0	0	70	158	35	194	150	78	0	0	0	52	0	0	0	48	0	293	72	0	57	1	0	0	115	18	97	-98								
164 2001	5	0	541	94	27	2	57	0	0	0	40	0	22	0	67	0	0	0	0	0	0	0	15	0	0	0	218	6	0	0	0	0	0	0	0			
164 2001	6	0	0	0	0	67	991	0	0	0	0	0	0	0	0	0	0	0	5	4	0	0	0	0	0	0	2	0	0	0	0	0	0	-98				
164 2001	7	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	3	32	120	83	0	0	0	8	3	0	0	0	0	0	0	0	0			
164 2001	8	0	5	0	0	0	0	23	0	0	0	148	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
164 2001	9	0	0	0	0	0	276	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-98			
164 2001	10	5	3	4	22	0	187	21	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58	0	0	40	9								
164 2001	11	247	10	48	330	99	19	0	20	0	0	196	243	102	45	0	0	0	0	0	43	24	0	11	110	5	35	0	0	0	0	0	0	0	-98			
164 2001	12	0	0	0	0	0	0	8	0	27	14	6	46	0	0	2	25	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
164 2002	1	0	0	0	0	83	0	0	0	0	0	0	35	168	144	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
164 2002	2	0	0	0	0	0	0	0	0	0	0	0	0	38	0	6	0	0	0	0	0	0	2	0	122	24	357	5	-98	-98	-98							
164 2002	3	0	84	409	13	0	85	0	146	117	0	13	0	0	7	0	0	8	3	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	8		
164 2002	4	0	13	0	0	0	0	0	0	0	34	0	0	89	170	19	1	5	151	7	285	42	11	27	0	120	183	866	29	-98								
164 2002	5	192	164	4	305	5	23	168	13	46	66	18	156	8	0	0	161	0	0	79	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
164 2002	6	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-98		
164 2002	7	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	210		
164 2002	8	0	0	6	0	0	0	0	8	2	0	3	15	0	0	0	5	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
164 2002	9	0	0	0	0	0	46	0	0	0	36	0	0	0	180	0	0																					

164 2003	2	0	0	0	0	47	0	0	0	0	89	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-98	-98	-98
164 2003	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	97	28	0	0	70	66	3	0	0	0	0			
164 2003	4	0	0	0	0	0	0	0	0	0	0	0	0	0	317	0	14	0	0	0	138	583	486	337	0	0	0	48	56	39	311	-98						
164 2003	5	40	106	166	26	164	83	112	537	28	4	6	219	39	403	4	27	0	0	0	5	69	49	25	9	18	0	86	76	4	50	120						
164 2003	6	0	200	0	0	0	46	12	0	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-98		
164 2003	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	4	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
164 2003	8	0	0	0	8	0	0	0	0	14	0	7	0	0	2	0	0	31	0	0	12	6	2	0	0	0	18	23	0	0	0	0	0	0	0	0	0	
164 2003	9	0	0	0	0	0	0	0	0	0	0	313	0	0	119	0	0	8	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-98		
164 2003	10	2	4	5	3	13	0	0	0	0	0	0	4	0	0	0	0	100	8	0	0	0	0	0	0	22	41	29	0	47	27	256	148					
164 2003	11	40	88	40	10	78	0	0	0	0	0	0	0	339	60	0	0	0	0	0	0	286	59	114	0	542	0	4	12	2	0	0	0	-98				
164 2003	12	93	2	3	28	0	0	0	29	3	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	
164 2004	1	0	10	8	2	12	0	0	0	0	0	0	0	245	679	30	0	0	0	0	0	247	106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
164 2004	2	0	56	25	3	0	0	0	39	109	0	14	0	0	0	10	32	0	0	0	0	0	27	2	0	0	0	0	0	0	0	0	0	0	-98	-98		
164 2004	3	0	0	0	0	0	0	0	0	30	68	310	38	0	0	0	0	0	0	0	0	0	0	0	0	13	0	138	0	0	78	210						
164 2004	4	0	0	0	0	380	94	150	122	588	624	24	41	29	15	0	0	0	0	0	0	16	74	87	78	9	0	427	360	-98								
164 2004	5	146	628	674	30	415	0	13	0	0	31	16	0	0	9	0	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0		
164 2004	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	8	80	2	0	-98				
164 2004	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
164 2004	8	0	0	0	0	0	0	0	0	0	0	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0		
164 2004	9	0	4	0	0	0	0	0	0	0	0	0	0	6	10	22	0	0	0	0	0	5	0	0	0	13	2	172	0	0	0	-98						
164 2004	10	4	14	0	0	0	0	0	0	0	0	0	0	16	3	93	0	32	28	7	8	0	277	90	19	115	3	13	35	0	0	0	0	0	5	-98		
164 2004	11	0	0	122	0	39	49	2	249	36	0	0	119	10	56	0	180	8	3	0	0	0	177	53	563	8	0	0	0	0	0	0	5	-98				
164 2004	12	4	0	30	0	5	37	166	62	69	5	0	0	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	210	0	0	0	0	0	

Rainfall Data

Source: Kenya Meteorological Department, Ministry of Transport and Communication

Station 9136164(=164): Dagoretti Corner

Data period: 2005~2008

No Date: -98

Missing data: -99

Data Unit: x10-1 mm

Sta.	Year	Mon.	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th	18th	19th	20th	21st	22nd	23rd	24th	25th	26th	27th	28th	29th	30th	31st		
164	2005	1	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	976	0	0	0	26	0.1	26		
164	2005	2	0	0	0	0	0	2	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	350	-98	-98	-98	
164	2005	3	13	0	0	0	0	0	0	2	0.1	0	0	2	47	0.1	0	0	0	32	27	8	14	47	0.1	194	0	0	0	0	0	0	0	0	
164	2005	4	0	0	3	94	19	16	94	516	39	10	34	0	0	0	0	6	3	0	0	0	3	0	0	0	0	0	6	310	113	360	-98		
164	2005	5	0	98	8	18	0.5	36	127	596	121	20	0	0	0	0	14	24	0	0	0	370	99	0	7	155	4	274	93	345	21	2	0		
164	2005	6	0	0	0	0	0	0	0.1	20	0	0	0	0	0	0	0	2	0.1	3	0	84	37	19	0.1	0	0	0	0	0	0	0	0	-98	
164	2005	7	0	0.1	0	0.1	0	0	0	19	0	0	0	0	0	0	0	0	20	3	0.1	0	5	0.1	0	0	0	0	21	5	10	59	24		
164	2005	8	3	0	1	0.1	0	0.1	0.1	0	0	5	11	8	2	7	4	26	0.1	0	0	0	0.1	0	0	0	0.1	0	0	0	0	0	49	0.1	
164	2005	9	3	0	0	0	168	0	0	0	11	0	10	5	7	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-98	
164	2005	10	0	0	0	0	0	0	0	0	0.1	66	0	0	0	187	19	0	0	9	0.1	0	77	12	2	74	0	11	0	0	0	0	0	0	
164	2005	11	17	27	0	167	392	4	0	0	0	130	153	10	28	39	0	0	0	0.1	0	0.1	28	115	6	14	14	0	0.1	0	0	0	0.1	-98	
164	2005	12	0	0	0.1	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
164	2006	1	0.1	34	0	0	0	0	0	0	0	0	0	4	0	0	23	0	0	0	0	6	0	14	0	0	0	0	0	0	0	0	0	0	0
164	2006	2	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
164	2006	3	91	286	266	0	47	536	0.1	57	0	0	0	0.1	5	0	0	0	0	0	0	0.1	0.1	0.1	12	0	0	28	0.1	0	0	66	168	0	
164	2006	4	0	64	398	66	536	701	318	186	31	24	18	5	0	0	11	200	6	90	22	63	38	0	71	10	53	84	0.1	46	41	0	0	-98	
164	2006	5	45	140	209	166	84	4	0.1	519	50	49	0	0	17	144	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0
164	2006	6	0	0	0	5	0	0	0	76	0	0.1	14	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	7	0.1	0	0	0	0.1	-98	
164	2006	7	0.1	0	0	0	0	0	0	0.1	0	0	0	0	30	0	0	0.1	0.1	0.1	0	0	0	10	10	0	0	0	0.1	7	11	0.1	4	0	
164	2006	8	0	0	96	198	0.1	0.1	6	28	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	82	41	0	0	0	0	0	
164	2006	9	0	0	0	8	30	0	0	0	0.1	0.1	0	0.1	0.1	0	6	0.1	11	0.1	200	188	0.1	0	0	0	0	0	0	0	0	17	35	-98	
164	2006	10	0	0	0	0	0	0.1	0.1	0	0	0	8	38	0	0	80	210	0	0	0.1	0.1	9	0	43	0	0	0	0	0.1	0	0	0	154	
164	2006	11	84	0.1	1	0	71	143	82	0	0	231	407	93	46	42	186	6	126	56	13	10	0.1	525	105	0	2	16	674	39	133	19	-98		
164	2006	12	5	90	0	4	19	0	64	0	0	0	0	0	0	0	0	0	0.1	0	0.1	0	154	136	1	8	112	242	614	24	278	53	0		
164	2007	1	0	0	64	68	0	0	0	0	0	0	0	0	113	0	5	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	6	17	
164	2007	2	164	0	0	18	0	0	0	0	0	67	211	0	375	0	0	0	0	0	0	0	0	0	0	6	68	91	70	3	-98	-98	-98		
164	2007	3	0	0	5	0	0	0	0	0	24	17	76	0	0	0	0	0	0	0	90	11	0	0.1	11	0	37	32	0	0.1	9	0	0	0	
164	2007	4	0.1	0	0	0	0	6	0	0	0	142	29	0.1	37	77	0	12	772	48	0	67	14	2	239	371	111	12	50	0	0.1	7	-98		
164	2007	5	0	0	0	0.1	8	0.1	0	0.1	7	0	53	16	2	0	0.1	157	585	14	0	0	0	0	0	0	0	26	0	0.1	6	0	226		
164	2007	6	2	16	0.1	5	0.1	0.1	0	6	150	4	0	0.1	24	262	0	0	0	0	0	0	0	0.1	0	0.1	0.1	4	0.1	0.1	0.1	0	-98		
164	2007	7	0	0	0	0	0	9	0	0	0	0	1	0	0	0	0	0	9	0	0.1	0	0	0	0.1	0	0	0	0	100	222	180	31	0	
164	2007	8	0	0	56	1	0	0	6	0.1	3	2	20	0	8	0	0	0	74	11	7	151	0.1	0	0	0.1	0	0	0	0	0	26	0	0	
164	2007	9	0	21	0	0.1	0.1	0	0	0	143	2	10	249	23	50	6	4	0	0	0	0	0	0	0	0	0	0	0	0.1	7	0	-98		
164	2007	10	0	0.1	0	0	0	39	28	0.1	0	2	36	0	0.1	0	0	0	0	0	0	0	0	0	0	0.1	0.1	42	0	0	0	0	0	72	
164	2007	11	62	0	0	0	0.1	0.1	0	0.1	48	16	59	52	4	132	38	11	0	8	10	45	28	73	0	0	0	0	40	38	25	-98	-98		
164	2007	12	32	25	0	0.1	0	0.1	0.1	0	28	10	89	23	0	0	0	0	0	0	163	0.1	0	0	0	0	0.1	0	22	0	0	0	0	0	
164	2008	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	170	98	38	46	12	36	0	0	0	0	0	0	0	0	0	0	0	0	0
164	2008	2	0	0	0	0	5	142	41	24	16	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-98	-98
164	2008	3	0.1	0	0	0	8	0.1	24	0.1	0	0	0	0	14	20	0	0	0	0	22	191	236	0	150	28	14	197	123	298	0	0	0	0	
164	2008	4	0	0	0	0	5	0	0.1	0	41	36	56	37	17	0.1	0	0	0	26	50	13	239	130	62	220	65	16	0	0	0	0.1	-98	-98	
164	2008	5	0.1	0	0	0	0	0.1	0.1	0.1	5	0.1	0	0	0	0	0	6	6	17	0	0	0.1	8	40	0	0	0	244	0	0	0	0	0	0
164	2008	6	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	11	0	2	0	0	0.1	0	9	13	0	0	0	0	0	0	0	0	-98	-98
164	2008	7	0.1	0	0	82	0	0	0	0	0	0	378	0.1	3	19	0	0	0	0	0	0.1	0.1	16	7	0.1	0	0	0.1	0	2	8	36	0	
164	2008	8	12	0.1	0.1	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0.1	0	0.1	35	0.1	33	3	0.1	0.1	0	0	3	0	0	0	0	
164	2008	9	194	0.1	0.1	0	0	0	0.1	232	342	0.1	126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	-98	-98	
164	2008	10	0.1	70	2	270	8	0.1	0	0	0.1	49	6	0	0	0	153	16	14	236	131	82	59	17	16	8	1	0	0	0	0	0	0	0	
164	2008	11	31	0	0	0	580	559	120	103	52	60	20	0	0	140	0	0.1	0	0	0	0	0	0	0	0	2	33	0.1	0	0	14	-98	-98	
164	2008	12	0.1	0	0	0	0.1	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0

(2) Rainfall Calculation by Gumbel Method

Rainfall Data and Gumbel Method (Extreme Value distribution)

(1) Rank i	(2) Year	Rainfall x (mm)	(3) Exceedance Probability F(x)	(4) x ²	(5) Peak Variate y
1	1973	139.1	0.97500	19,348.81	3.6762
2	2001	128.4	0.95000	16,486.56	2.9702
3	1980	125.6	0.92500	15,775.36	2.5515
4	1981	111.7	0.90000	12,476.89	2.2504
5	1986	104.5	0.87500	10,920.25	2.0134
6	1978	98.0	0.85000	9,604.00	1.8170
7	1971	97.6	0.82500	9,525.76	1.6483
8	2005	97.6	0.80000	9,525.76	1.4999
9	1998	88.1	0.77500	7,761.61	1.3669
10	1977	86.9	0.75000	7,551.61	1.2459
11	1972	85.5	0.72500	7,310.25	1.1345
12	1989	80.2	0.70000	6,432.04	1.0309
13	1970	77.5	0.67500	6,006.25	0.9338
14	2007	77.2	0.65000	5,959.84	0.8422
15	1995	73.4	0.62500	5,387.56	0.7550
16	2006	70.1	0.60000	4,914.01	0.6717
17	1979	69.0	0.57500	4,761.00	0.5917
18	1982	67.5	0.55000	4,556.25	0.5144
19	1983	67.5	0.52500	4,556.25	0.4395
20	1990	66.5	0.50000	4,422.25	0.3665
21	1988	63.6	0.47500	4,044.96	0.2951
22	1987	60.5	0.45000	3,660.25	0.2250
23	1991	59.9	0.42500	3,588.01	0.1559
24	1997	59.6	0.40000	3,552.16	0.0874
25	1996	58.8	0.37500	3,457.44	0.0194
26	2004	58.8	0.35000	3,457.44	-0.0486
27	2003	58.3	0.32500	3,398.89	-0.1168
28	1975	58.2	0.30000	3,387.24	-0.1856
29	2008	58.0	0.27500	3,364.00	-0.2554
30	1976	56.6	0.25000	3,203.56	-0.3266
31	1993	55.6	0.22500	3,091.36	-0.3999
32	1992	54.5	0.20000	2,970.25	-0.4759
33	1994	50.5	0.17500	2,550.25	-0.5556
34	1985	48.0	0.15000	2,304.00	-0.6403
35	1999	46.4	0.12500	2,152.96	-0.7321
36	1974	44.4	0.10000	1,971.36	-0.8340
37	1984	44.1	0.07500	1,944.81	-0.9518
38	2000	42.6	0.05000	1,814.76	-1.0972
39	2002	40.9	0.02500	1,672.81	-1.3053
Total		2,831.2		228,868.8	
Ave. $\Sigma x/N=$		72.59	$\Sigma x^2/N=$	5868.431	

*) (3): $F(x)=1-j/(N+1)$
(5): $-\ln(-\ln F(x))$

$$S_x = \sqrt{\overline{x^2} - (\overline{x})^2} = 24.4770$$

$$\overline{y} = 0.543 \quad S_y = 1.1388 \quad (N=39, \text{ See Table A})$$

$$1/a = S_x/S_y = 21.4937$$

$$\overline{x}_0 = \overline{x} - (1/a) * \overline{y} = 60.919$$

$$x = 60.919 + 21.4937 * y$$

*Relation between Probability Year T and Peak Variate y is shown in Table B, therefore Probability Rainfall x is calculated by above formula.

Probability Year T	F(%)	y	(1/a)*y	x
2	50	0.3665	7.877	68.80
3	67	0.9027	19.402	80.32
4	75	1.2459	26.779	87.70
5	80	1.4994	32.228	93.15
10	90	2.2504	48.369	109.29
20	95	2.9702	63.840	124.76
30	97	3.3843	72.741	133.66
40	98	3.6763	79.017	139.94
50	98	3.9019	83.866	144.79
100	99	4.6002	98.875	159.79

$$\Rightarrow = (24 * 6)^{(2/3)} * X / 24 \quad 91.9 \text{ (mm/hr)}$$

(For Side Ditch)

$$\Rightarrow = (24 * 6)^{(2/3)} * X / 24 \quad 106.6 \text{ (mm/hr)}$$

(For Cross Drainage)

Table A - Sample no. and \bar{y} , S_y

Sample No.	\bar{y}	S_y
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

Probability Rainfall T	$1/T = 1-F$	Peak Variate 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

(3) Calculation of Discharge

Table – Calculation of Discharge (Side Ditch)

No.	Catchments Area A ha	Return Period	Reinfall R mm/hr	Discharge Coefficient C	Discharge Q cu.m/sec
	1.0	3	91.9	0.80	0.204
	1.5	3	91.9	0.80	0.306
	2.0	3	91.9	0.80	0.408
	2.5	3	91.9	0.80	0.511
	3.0	3	91.9	0.80	0.613
	3.5	3	91.9	0.80	0.715
	4.0	3	91.9	0.80	0.817
	4.5	3	91.9	0.80	0.919
	5.0	3	91.9	0.80	1.021
Residential Area C=0.6	0.5	3	91.9	0.60	0.077
	1.0	3	91.9	0.60	0.153
	1.5	3	91.9	0.60	0.230
	2.0	5	91.9	0.60	0.306
	2.5	3	91.9	0.60	0.383
	3.0	3	91.9	0.60	0.460
	3.5	3	91.9	0.60	0.536
	4.0	3	91.9	0.60	0.613
	4.5	5	91.9	0.60	0.689
	5.0	3	91.9	0.60	0.766
Residential Area with wide garden C=0.4	0.5	3	91.9	0.40	0.051
	1.0	3	91.9	0.40	0.102
	1.5	3	91.9	0.40	0.153
	2.0	5	91.9	0.40	0.204
	2.5	3	91.9	0.40	0.255
	3.0	3	91.9	0.40	0.306
	3.5	3	91.9	0.40	0.357
	4.0	3	91.9	0.40	0.408
	4.5	5	91.9	0.40	0.460
	5.0	3	91.9	0.40	0.511

Table – Calculation of Discharge (Cross Drainage)

No.	Catchments Area A ha	Return Period	Reinfall mm/hr	Discharge Coefficient C	Discharge Q cu.m/sec
	1.0	5	106.6	0.80	0.237
	1.5	5	106.6	0.80	0.355
	2.0	5	106.6	0.80	0.474
	2.5	5	106.6	0.80	0.592
	3.0	5	106.6	0.80	0.711
	3.5	5	106.6	0.80	0.829
	4.0	5	106.6	0.80	0.948
	4.5	5	106.6	0.80	1.066
	5.0	5	106.6	0.80	1.184
Residential Area C=0.6	0.5	5	106.6	0.60	0.089
	1.0	5	106.6	0.60	0.178
	1.5	5	106.6	0.60	0.267
	2.0	5	106.6	0.60	0.355
	2.5	5	106.6	0.60	0.444
	3.0	5	106.6	0.60	0.533
	3.5	5	106.6	0.60	0.622
	4.0	5	106.6	0.60	0.711
	4.5	5	106.6	0.60	0.800
	5.0	5	106.6	0.60	0.888
Residential Area with wide garden C=0.4	0.5	5	106.6	0.40	0.059
	1.0	5	106.6	0.40	0.118
	1.5	5	106.6	0.40	0.178
	2.0	5	106.6	0.40	0.237
	2.5	5	106.6	0.40	0.296
	3.0	5	106.6	0.40	0.355
	3.5	5	106.6	0.40	0.415
	4.0	5	106.6	0.40	0.474
	4.5	5	106.6	0.40	0.533
	5.0	5	106.6	0.40	0.592

※) $Q=A*R*C/360$

(4) Calculation of Velocity and Depth

Table - Calculation of Velocity and Depth (Pipes)

No.	Pipe Dia. φ (m)	Roughness n	Catchments Area (ha)	Return Period	Rainfall (mm/hr)	Discharge Coefficient	Discharge Q(m ³ /sec)	Gradient (%/100)	Velocity V(m/sec)	W. Depth (m)	Sec. Area (m ²)	R (m)	Spec.	Remarks
ML6-1A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.015	2.264	0.215	0.090	0.118	DP-600	Side Ditch, (0+000 ⁰ +320)
ML6-2A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.050	3.488	0.157	0.059	0.091	DP-600	Side Ditch, (0+320 ⁰ +560)
ML6-3A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.025	2.722	0.188	0.075	0.106	DP-600	Side Ditch, (0+560 ⁰ +700)
ML6-4A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.025	2.722	0.188	0.075	0.106	DP-600	Side Ditch, (0+700 ⁰ +820)
ML6-5A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.025	2.722	0.188	0.075	0.106	DP-600	Side Ditch, (0+820 ⁰ +920)
ML6-6A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.005	1.512	0.291	0.135	0.147	DP-600	Side Ditch, (0+920 ¹ +140)
ML6-7A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.040	3.221	0.166	0.063	0.096	DP-600	Side Ditch, (1+140 ¹ +350)
ML6-8A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.060	3.722	0.150	0.055	0.088	DP-600	Side Ditch, (1+350 ¹ +500)
ML6-9A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.015	2.264	0.215	0.090	0.118	DP-600	Side Ditch, (1+500 ¹ +700)
ML6-10A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.010	1.953	0.239	0.105	0.128	DP-600	Side Ditch, (1+700 ¹ +960)
ML6-11A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.010	1.953	0.239	0.105	0.128	DP-600	Side Ditch, (1+960 ² +200)
ML6-12A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.020	2.512	0.199	0.081	0.111	DP-600	Side Ditch, (2+200 ² +520)
ML6-13A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.010	1.953	0.239	0.105	0.128	DP-600	Side Ditch, (2+520 ² +620)
ML6-14A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.030	2.906	0.179	0.070	0.102	DP-600	Side Ditch, (2+620 ² +860)
ML6-1B	0.594	0.013	1.5	5	106.6	0.8	0.355	0.005	1.709	0.417	0.208	0.176	DP-600	Cross Drainage, (0+320)
ML6-2B	0.594	0.013	1.0	5	106.6	0.8	0.237	0.005	1.569	0.318	0.151	0.155	DP-600	Cross Drainage, (0+700)
ML6-3B	0.594	0.013	1.0	5	106.6	0.8	0.237	0.005	1.569	0.318	0.151	0.155	DP-600	Cross Drainage, (0+820)
ML6-4B	0.594	0.013	1.5	5	106.6	0.8	0.355	0.005	1.709	0.417	0.208	0.176	DP-600	Cross Drainage, (1+140)
ML6-5B	0.594	0.013	1.5	5	106.6	0.8	0.355	0.005	1.709	0.417	0.208	0.176	DP-600	Cross Drainage, (1+500)
ML6-6B	0.594	0.013	1.5	5	106.6	0.8	0.355	0.005	1.709	0.417	0.208	0.176	DP-600	Cross Drainage, (1+960)
ML6-7B	0.594	0.013	1.5	5	106.6	0.8	0.355	0.005	1.709	0.417	0.208	0.176	DP-600	Cross Drainage, (2+200)
ML6-8B	0.594	0.013	1.0	5	106.6	0.8	0.237	0.005	1.569	0.318	0.151	0.155	DP-600	Cross Drainage, (2+520)
ML6-9B	0.594	0.013	1.5	5	106.6	0.8	0.355	0.005	1.709	0.417	0.208	0.176	DP-600	Cross Drainage, (2+860)
ML3-1A	0.594	0.013	1.5	3	91.9	0.8	0.306	0.038	3.528	0.209	0.087	0.115	DP-600	Side Ditch, (0+000 ⁰ +540)
ML3-2A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.030	2.906	0.179	0.070	0.102	DP-600	Side Ditch, (0+540 ⁰ +700)
ML3-3A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.010	1.953	0.239	0.105	0.128	DP-600	Side Ditch, (0+700 ⁰ +940)
ML3-4A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.010	1.953	0.239	0.105	0.128	DP-600	Side Ditch, (0+940 ¹ +200)
ML3-5A	0.594	0.013	1.5	3	91.9	0.8	0.306	0.025	3.045	0.233	0.101	0.125	DP-600	Side Ditch, (1+200 ¹ +620)
ML3-6A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.015	2.264	0.215	0.090	0.118	DP-600	Side Ditch, (1+620 ¹ +790)
ML3-1B	0.594	0.013	1.5	5	106.6	0.8	0.355	0.005	1.709	0.417	0.208	0.176	DP-600	Cross Drainage, (0+540)
ML3-1B	0.594	0.013	1.0	5	106.6	0.8	0.237	0.005	1.569	0.318	0.151	0.155	DP-600	Cross Drainage, (1+620)
ML7-1A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.005	1.512	0.291	0.135	0.147	DP-600	Side Ditch, (0+000 ⁰ +160)
ML7-2A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.014	2.179	0.221	0.094	0.120	DP-600	Side Ditch, (0+160 ⁰ +460)
ML7-3A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.020	2.512	0.199	0.081	0.111	DP-600	Side Ditch, (0+460 ⁰ +740)
ML7-4A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.060	3.722	0.150	0.055	0.088	DP-600	Side Ditch, (0+740 ¹ +080)
ML7-5A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.070	3.931	0.144	0.052	0.085	DP-600	Side Ditch, (1+080 ¹ +280)
ML7-6A	0.594	0.013	2.0	3	91.9	0.8	0.408	0.025	3.286	0.273	0.124	0.140	DP-600	Side Ditch, (1+280 ¹ +800)
ML7-7A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.080	4.122	0.139	0.050	0.082	DP-600	Side Ditch, (1+800 ¹ +940)
ML7-8A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.080	4.122	0.139	0.050	0.082	DP-600	Side Ditch, (1+940 ² +160)
ML7-9A	0.594	0.013	1.5	3	91.9	0.8	0.306	0.010	2.170	0.301	0.141	0.150	DP-600	Side Ditch, (2+160 ² +600)
ML7-10A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.005	1.512	0.291	0.135	0.147	DP-600	Side Ditch, (2+600 ² +980)
ML7-11A	0.594	0.013	1.5	3	91.9	0.8	0.306	0.005	1.662	0.375	0.184	0.169	DP-600	Side Ditch, (2+980 ³ +300)
ML7-12A	0.594	0.013	1.0	3	91.9	0.8	0.204	0.005	1.512	0.291	0.135	0.147	DP-600	Side Ditch, (2+980 ³ +300)
ML7-1B	0.594	0.013	1.0	5	106.6	0.8	0.237	0.005	1.569	0.318	0.151	0.155	DP-600	Cross Drainage, (0+160)
ML7-2B	0.594	0.013	1.0	5	106.6	0.8	0.237	0.005	1.569	0.318	0.151	0.155	DP-600	Cross Drainage, (0+460)
ML7-3B	0.594	0.013	1.0	5	106.6	0.8	0.237	0.005	1.569	0.318	0.151	0.155	DP-600	Cross Drainage, (0+740)
ML7-4B	0.594	0.013	1.5	5	106.6	0.8	0.355	0.005	1.709	0.417	0.208	0.176	DP-600	Cross Drainage, (1+800)
ML7-5B	0.594	0.013	1.5	5	106.6	0.8	0.355	0.005	1.709	0.417	0.208	0.176	DP-600	Cross Drainage, (2+160)
ML7-6B	0.594	0.013	1.5	5	106.6	0.8	0.355	0.005	1.709	0.417	0.208	0.176	DP-600	Cross Drainage, (3+300)

※) Open drainage Area is bigger than pipes, therefore calculation of open drainage should be abbreviated because of more safty than pipes.