CHAPTER 11

ENGINEERING DESIGN

11. ENGINEERING DESIGN

11.1 General

On the basis of the data and information obtained through the field surveys, the basic engineering design was carried out using the existing topographical map at a scale of 1/2,500 for the road design. A supplemental topographical map at a scale of 1/500 was prepared by the Study Team for junction design.

The basic engineering design was carried out for the following items of engineering works:

- Road Design
- Junction Design
- Road Drainage Design
- Pavement Design
- Road Facilities Design
- Public Utilities Design

11.2 Road Design

11.2.1 Basic Concept of Road Design

Prior to the execution of the engineering design, the following concepts were introduced:

(1) The Project will constitute a basic framework for the urban road network in Kampala, so the geometric design including the alignment should meet the requirement of the expected function as an arterial road.

(2) The Project should be designed paying due attention to the characteristics of the traffic components and locality of Kampala where rate of traffic accidents is extremely high due mainly to mixture of vehicles, pedestrians and bicycles.

(3) Widening of the existing road should be executed inside the present right-of-way strip in principle to avert the removal and relocation of houses.

(4) Road related facilities including the road drainage and sidewalks should be provided, since most of these facilities have been neglected in the past, which has resulted in the present chaos in urban traffic in Kampala.

(5) Public utilities including water mains, sewerage, telephone cables, electric wires/poles, etc., that are located inside the right-of-way strip should be thoroughly investigated. Relocation and/or protection of these utilities should be executed at minimum level and in an efficient manner taking into consideration the maintenance work afterward.

(6) Since bus services including matatu are the main means of public transport in Kampala, road design should be carried out taking their operation into consideration.

(7) Intersection design should be carried out taking the prospect of road development in Kampala into account with the recognition that intersections are parts of the roads. Characteristics of traffic and future traffic volume of each arm of the intersections have also to be carefully examined.

11.2.2 Geometric Design Standards

Geometric design standards to be applied for each road project are shown in Table 11.1.

Table 11.1 Geometric Design Standards

	Natete Road	Gaba Road	Port Bell Road	Gayaza Road	Hoima Road
Category	A	A	A	A	A
Design speed(km/hr)	60 - 40	60 - 40	60 - 40	60 - 40	60 - 40
Lane width(m)	3.5	3.5	3.5	3.5	3.5
Carriageway width(m)	2 x 3.5=7.0	2 x 3.5=7.0	2 x 3.5=7.0	2 x 3.5=7.0	2 x 3.5=7.0
Shoulder width(m)	0.5-2.0 m	0.5-2.0 m	0.5-2.0 m	0.5-2.0 m	0.5-2.0 m
Buffer zone width(m)	1.0-3.0 m	1.0-3.0 m	1.0-3.0 m	1.0-3.0 m	1.0-3.0 m
Sidewalk width(m)	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m
Cycle lane width(m)	2.0 m	2.0 m	2.0 m	2.0 m	2.0 m
Cross fall(%)	2.0 %	2.0%	2.0%	2.0 %	2.0 %

11.2.3 Traffic Capacity of the Project Roads

Traffic capacity of the proposed roads are analyzed by referring to the Highway Capacity Manual (USA) and the Road Capacity Manual (Japan Road Association).

Traffic capacity of the proposed roads are calculated applying the following traffic elements:

1) The capacity of two-lane roads under ideal conditions: 2,800 pcu

2) Width of lane
3) Lateral clearance
4) Heavy vehicle proportion
5) Motorcycle proportion
6) Directional factor
7) Volume/Capacity Ratio

Table 11.2 and Table 11.3 show traffic characteristics and the design capacity of the proposed road in 2005.

Table 11.2 Traffic Characteristic on the Project Roads (2005)

Road Name	Natete	Gaba	Port Bell	Gayaza	Hoima
Basic Capacity (pcu/hr)	2,800	2,800	2,800	2,800	2,800
Volume/Capacity Ratio	1.0	1.0	1.0	1.0	1.0
Width of Lane (m)	3.5	3.5	3.5	3.5	3.5
Lateral Clearance (m)	≥ 0.75	≥0.75	≥0.75	≥0.75	≥0.75
Heavy Vehicle Ratio (%):T	7.3	5.1	4.6	5.1	6.3
Passenger Car Equiv.	2.0	2.0	2.0	2.0	2.0
Motorcycle Ratio (%):PM	3.3	0.5	3.0	0.5	4.1
Passenger Car Equiv.	0.5	0.5	0.5	0.5	0.5
ADT in 2005	23,835	26,066	13,313	26,066	18,404

Table 11.3 Analysis of Proposed Road Capacity (2005)

Road Name	Natete	Gaba	Port Bell	Gayaza	Hoima
Width of Lane	1.0	1.0	1.0	1.0	1.0
Lateral Clearance	1.0	1.0	1.0	1.0	1.0
Heavy Vehicle	0.93	0.95	0.96	0.95	0.94
Motorcycle	0.98	1.00	0.99	0.97	0.98
Directional Factor	1	1	1	1	1
Design Capacity	2,567	2,657	2,637	2,592	2,581
ADT in 2005	23,835	26,066	13,313	25,567	18,404
Design Hour Factor	0.1	0.1	0.1	0.1	0.1
Design Hour Volume (DHV)	2,384	2,557	1,840	2,607	1,331

It can be concluded from the above analysis that the design traffic capacity of each project road is sufficient to the design hour volume in 2005.

11.2.4 Typical Cross Section

(1) Basic Concept

Typical cross sections to be adopted for the project roads were designed based on the following concepts:

- Sufficient carriageway width to accommodate increasing traffic,
- Segregation of vehicles from pedestrians and non- motorized vehicles,
- Protection of roadside environment and enhancement of roadside amenity,
- Consideration of available right-of-ways depending on the location of the individual roads, and
- Provision of drainage system to prevent rapid deterioration of road surface.

Components for road cross section including carriageway shoulder, sidewalk and median width have been designed for each project road.

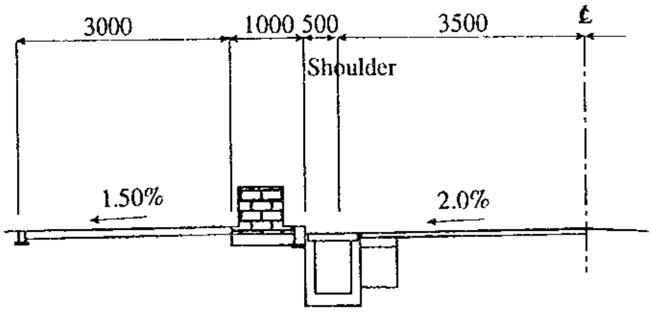
(2) Lane width of 3.5 m is adopted referring to the Japan's Road Standard and British Standard for all the project roads. Widening of lanes from existing 3.0 m to 3.5 m does not involve additional land acquisition for all the project roads.

(3) Shoulder

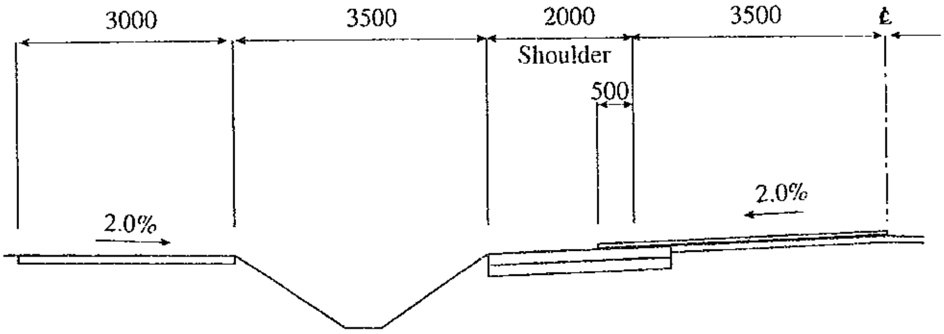
Two types of shoulder have been designed taking into account the right-of-way width constraint. Along the road sections located in urban areas where rights-of-way are relatively narrow compared with those in suburban areas, shoulder width of 0.5 m has been adopted, whilst in suburban areas shoulder width of 2.0 m has been adopted. An narrower shoulder would contribute to the reduction of illegal roadside parkings in the urban areas.

Shoulder designs by type are illustrated as below:

- Shoulder width 0.5 m



- Shoulder width 2.0 m



(4) Side walks

A sidewalk of 3.0 m width has been adopted for the passage of pedestrians and bicycles.

(5) Buffer zone

Two types of buffer zone with planted trees have been proposed taking land use along the roadside into consideration:

- 3.0 m Wide buffer Zone

  This type of buffer zone has been adopted for the roads located mainly in suburban areas. The wide buffer zone with the planted trees will effectively function to improve the roadside environment in suburban areas.

- 1.0 m wide buffer zone

  This type of buffer zone has been adopted along the road sections located in urban areas.

11.2.5 Alignment Design

(1) Natete Road

The proposed road section, starts from Bakuli runs towards south-east and goes through the suburban area of Namirembe, Rubaga and Wakaliga, and ends at the junction with Masaka road. The total length of the road section is 3.8 km. This road includes two road sections passing in low areas where the road is prone to inundate during the rainy season. The road is an alternative route for traffic from Kampala destined for Masaka road.

The vertical alignment has been determined considering the elevation and drainage condition of the road. The alignment design is shown in Drawings.

(2) Gaba Road

The route starts at the Nsambya-Kibuli Junction and follows a southerly direction, through the towns and built up areas of Kabalagala, Kansanga and ends at Gaba on the shores of Lake Victoria. It traverses one of the most densely inhabited areas in Kampala. The total length of the road section is 9.1 km.

The Kampala - Gaba road is broken up into the following two sections depending upon the geographic features of the area:

Section A:	Kampala - Kabalagala section This section passes the hilly area of Nsambya and Kayunga and contains some slopes and curves.
Section B:	Kabalagala - Kansanga section This section contains a low swamp area near Nabutiti which needs to be raised.

(3) Port Bell Road

The route branches off the Kampala-Jinja road at Lugogo and follows a south-eastern direction through the towns and built up areas of Bugolobi and Kitintale and ends at Port Bell, Uganda's main port and railway wagon terminal on Lake Victoria. Various industrial and urban facilities are located along the route. These include factories of Tumpeco, Uganda Distilleries Limited, Uganda Breweries, a hospital and Uganda's main prison. The total length of the road section is 4.8 km. The road passes through a low and flat, built up area near Lake Victoria.

The alignment of the road has been designed taking these characteristics of the area into account as shown in Drawings.

(4) Gayaza Road

The road is part of the main road connecting Kampala city to Gayaza and areas beyond it. The road branches off the Kampala- Gulu road at a junction near Bwaise and traverses a densely inhabited area of Kalerwe up to Mperewe 6 km from Kampala. The route passes across flat terrain and most sections of the road are straight. Small shops and stores are located along the roadside near the towns of Mulago and Kanyanya. The total length of road section is 4.6 km.

The alignment design of the road of shown in Drawings.

(5) Hoima Road

The road starts at Bakuli, and follows a north westerly direction through Nakulabye and Kasubi town and ends at Nansana 10 km north of Kampala city. This road is a section of the main road from Kampala to Busunju and Hoima. The area is either flat hilly area with gentle curvature or low swamp area after the town of Namongoona. The total length of the road section is 8.5 km.

The alignment design of the road is shown in Drawings.

11.3 Intersection Design

11.3.1 Introduction

Intersection designs have been carried out for six (6) of the project junctions. The objectives of the designs are to improve the safety of pedestrians and cyclists by the provision of walkways and crossing facilities, to ensure a smoother flow of traffic and to provide capacity for the forecast traffic flows in year 2005, provided only that this is not at the expense of safety, and does not involve grade separation or excessive demolition.

11.3.2 Observed Turning Counts

Classified turning counts were carried out at each of the six existing junctions. Five (5) of them are roundabouts, the exception being the Port Bell Road/Jinja Road major/ minor T-junction. The turning movement survey involved counting inflows, outflows and left turners on each junction arm, and the derivation of the other turning movement by computation. The counts were carried out at two peak periods (7:30 -

9:30, 16:30 - 18:30) of week days and number of vehicles by six (6) vehicle types were counted. The survey results are shown in Fig. 11.1 and Table 11.4 where the turning movement at each junction is shown by peak hour period.

11.3.3 Forecast Turning Volumes for Year 2005

The peak period turning flows of each junction were forecast for design purposes applying growth factors of 1.93 for private vehicles, 1.77 for trucks and 1.31 for public vehicles (matatus and buses). These are the growth factors derived from the production of matrices for 1997 and 2005. The forecast turning volumes (hourly rates) are shown in Table 11.5 and are approximately 70% more than present turning volumes in terms of total traffic flow for 6 junctions.

11.3.4 Analysis of Junction Designs

The new junction designs were carried out applying UK Transport Research Laboratory computer programs OSCADY3 for signalized junctions and ARCADY3 for roundabouts. The control types of the new designs are Natete (signals), Makerere (roundabout), Kibuye (roundabout) and the Port Bell Road/Jinja Road (signals), Wandegeya (signals) and Jinja Road Junction (roundabout). For comparison purposes, ARCADY3 analysis of the existing roundabouts was undertaken at Natete, Kibuye, Makerere and Wandegeya.

In the flow data input to OSCADY3 and ARCADY3, classified inflows were provided for each arm for each 15 minute time, but turning proportions were input as an overall average for the two hour period. In OSCADY3, passenger car unit factors (pcu) appropriate to Kampala were applied by means of the application of saturation flow adjustment factors for each junction arm. These adjustment factors were calculated to compensate for the differences between the UK pcu factors used by OSCADY3 and the Ugandan pcu factors.

Table 11.4 Observed Turning Movement in 1997 (excluding bicycles)

Natete Roundabout	AM Peak Period 7:30 - 9:30				
From / To	A	B	C	D	Total Outflow
A: Makasa Road (East)	0	62	288	199	549
B: Old Masaka Road	118	0	13	0	131
C: Masaka Road (West)	480	0	0	451	911
D: Natete Road	70	70	349	0	534
Total Inflow	648	132	695	650	2,125
	PM Peak Period 16:30 - 18:30				
From / To	A	B	C	D	Total Outflow
A: Makasa Road (East)	0	88	512	120	720
B: Old Masaka Road	100	0	17	0	117
C: Masaka Road (West)	404	0	0	351	755
D: Natete Road	76	91	453	0	620
Total Inflow	580	179	981	471	2,212

Makerere Roundabout	AM Peak Period 7:30 - 9:30				
From / To	A	B	C	D	Total Outflow
A: Kitante Road	0	41	97	342	480
B: Bombo Road (South)	141	0	546	198	885
C: Bombo Road (West)	499	852	0	9	1,360
D: Gayaza Road	403	654	155	0	1,212
Total Inflow	1,044	1,547	797	549	3,937
	PM Peak Period 16:30 - 18:30				
From / To	A	B	C	D	Total Outflow
A: Kitante Road	0	77	444	521	1,042
B: Bombo Road (South)	326	0	526	226	1,078
C: Bombo Road (West)	280	637	0	33	950
D: Gayaza Road	238	393	101	0	732
Total Inflow	844	1,107	1,071	779	3,802

Kibuye Roundabout	AM Peak Period 7:30 - 9:30					
From / To	A	B	C	D	E	Total Outflow
A: Makindye Road	0	26	472	291	430	1,218
B: Entebbe Road	74	0	140	609	900	1,722
C: Masaka Road	5	353	0	460	61	879
D: Katwe Road	5	362	69	0	14	450
E: Queensway	538	1,056	202	124	0	1,918
Total Inflow	620	1,976	882	1,484	1,405	6,187
	PM Peak Period 16:30 - 18:30					
From / To	A	B	C	D	E	Total Outflow
A: Makindye Road	0	50	207	76	255	589
B: Entebbe Road	246	0	170	263	884	1,563
C: Masaka Road	73	515	0	433	261	1,282
D: Katwe Road	103	731	301	0	51	1,186
E: Queensway	346	982	404	149	0	1,881
Total Inflow	768	2,278	1,083	921	1,451	6,501

Port Bell Road/Jinja Road Junction	AM Peak Period 7:30 - 9:30			
From To	A	B	C	Total Outflow
A: Jinja Road (East)	0	146	2,012	2,158
B: Port Bell Road	189	0	510	699
C: Jinja Road (West)	1,620	273	0	1,893
Total Inflow	1,809	419	2,522	4,750
	PM Peak Period 16:30 - 18:30			
From To	A	B	C	Total Outflow
A: Jinja Road (East)	0	195	1,951	2,146
B: Port Bell Road	178	0	341	519
C: Jinja Road (West)	2,107	307	0	2,414
Total Inflow	2,285	502	2,292	5,079

Wandegeya Roundabout	AM Peak Period 7:30 - 9:30				
From To	A	B	C	D	Total Outflow
A: Mulago Hill Road	0	968	730	477	2,175
B: Bombo Road (South)	1,228	0	291	231	1,750
C: Makerere Hill Road	738	791	0	152	1,681
D: Bombo Road (West)	113	1,320	323	0	1,756
Total Inflow	2,079	3,079	1,344	860	7,362
	PM Peak Period 16:30 - 18:30				
From To	A	B	C	D	Total Outflow
A: Mulago Hill Road	0	748	814	459	2,021
B: Bombo Road (South)	1,314	0	670	343	2,327
C: Makerere Hill Road	707	643	0	210	1,560
D: Bombo Road (West)	206	831	344	0	1,381
Total Inflow	2,227	2,221	1,829	1,011	7,285

Jinja Road Roundabout	AM Peak Period 7:30 - 9:30				
From To	A	B	C	D	Total Outflow
A: Jinja Road (East)	0	539	1,993	1,541	4,073
B: Access Road	1,188	0	275	404	1,867
C: Jinja Road (West)	1,264	622	0	46	1,932
D: Kitante Road	1,051	464	415	0	1,930
Total Inflow	3,503	1,625	2,683	1,991	9,802
	PM Peak Period 16:30 - 18:30				
From To	A	B	C	D	Total Outflow
A: Jinja Road (East)	0	834	1,706	1,280	3,600
B: Access Road	1,276	0	324	150	1,750
C: Jinja Road (West)	1,189	981	0	81	2,251
D: Kitante Road	1,251	987	191	0	2,429
Total Inflow	3,716	2,602	2,220	1,492	10,030

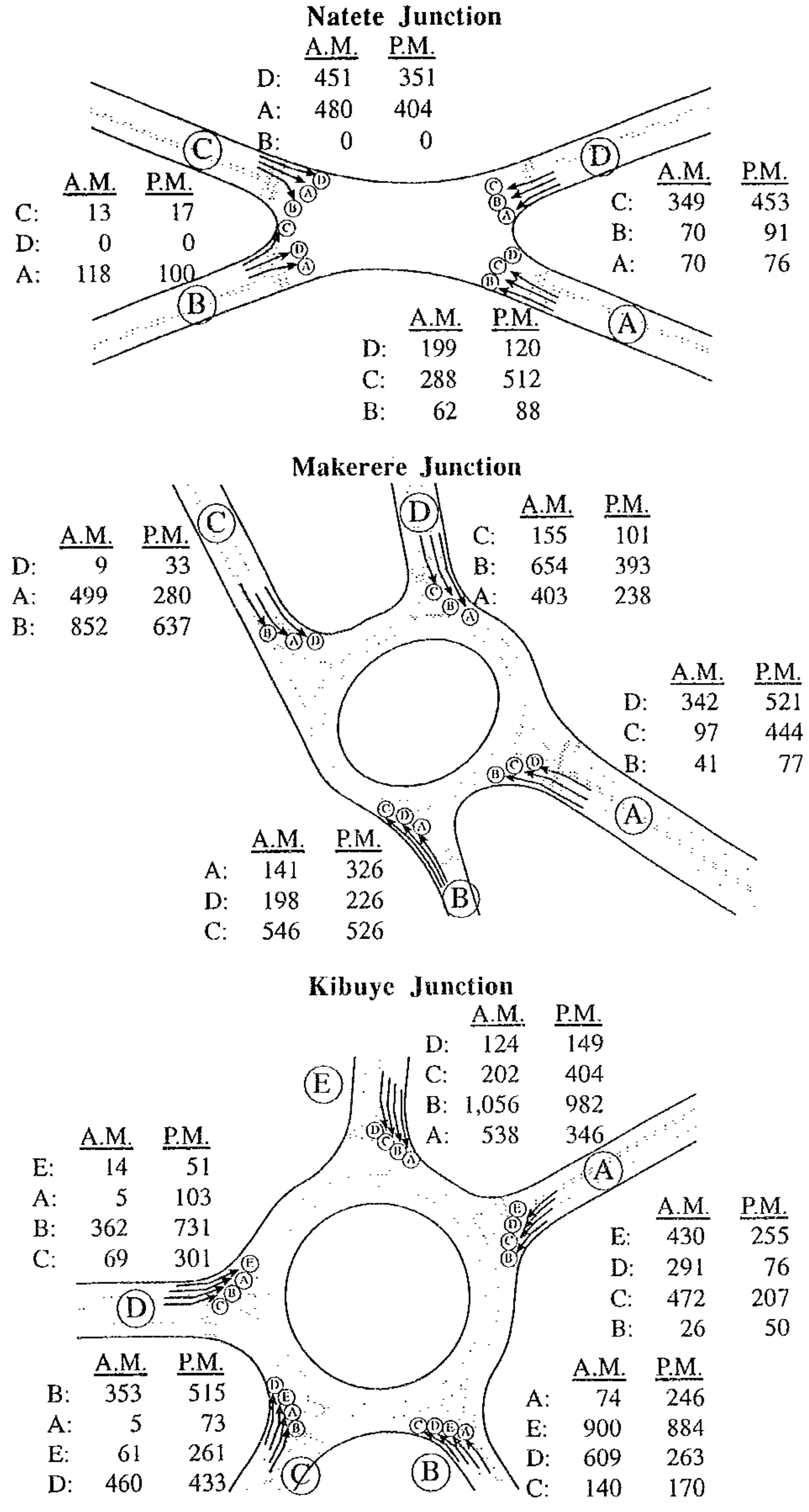


Figure 11.1 Observed Turning Movement in 1997 - 1

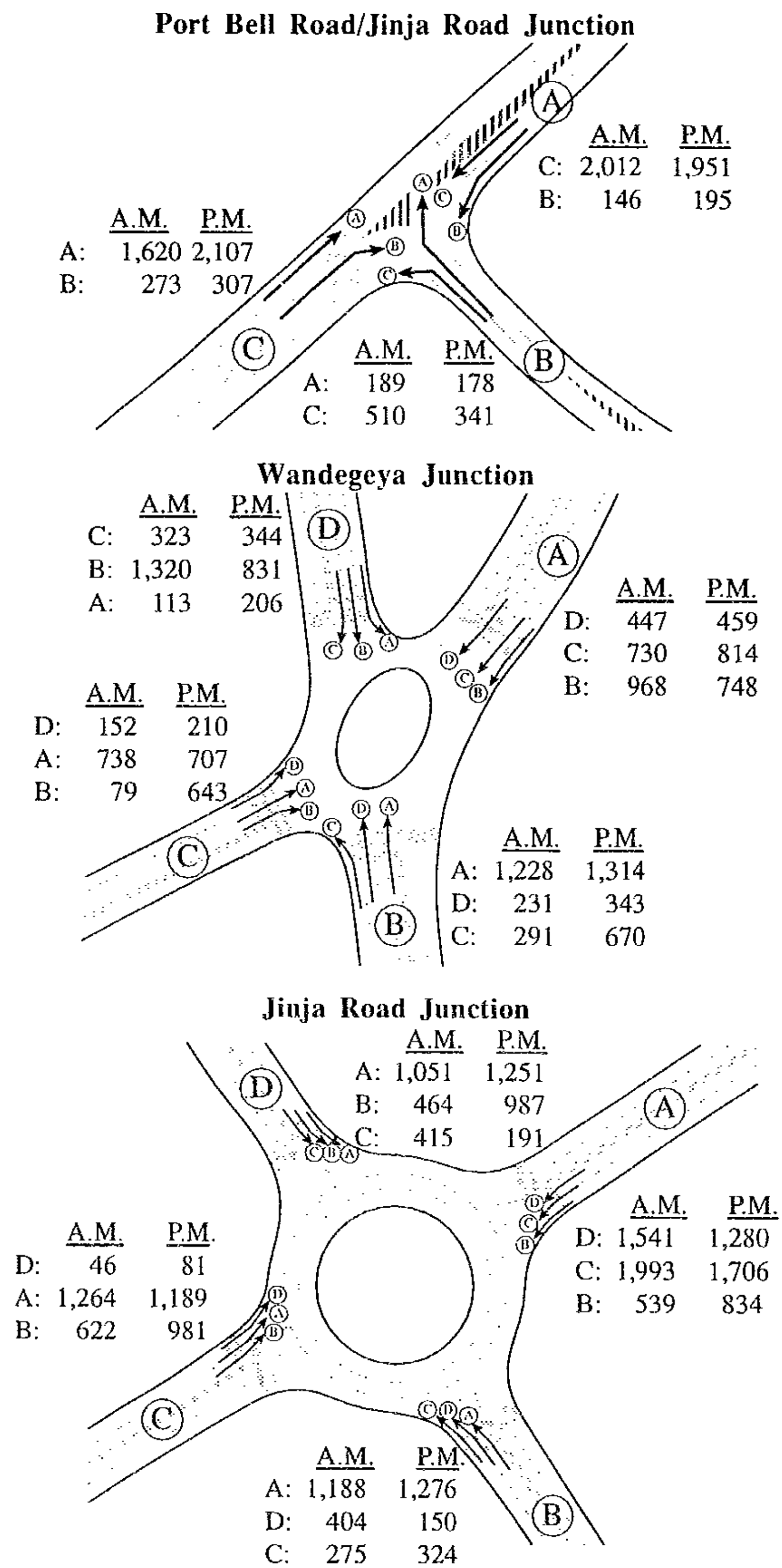


Figure 11.1 Observed Turning Movement in 1997 (AM) - 2

Table 11.5 Forecast Turning Movement in 2005 (excluding bicycles)

Natete Roundabout	AM Peak Period 7:30 - 9:30				
From To	A	B	C	D	Total Outflow
A: Makasa Road (East)	0	99	457	317	872
B: Old Masaka Road	200	0	22	0	222
C: Masaka Road (West)	780	0	0	765	1,545
D: Natete Road	111	111	624	0	846
Total Inflow	1,092	209	1,104	1,082	3,486
	PM Peak Period 16:30 - 18:30				
From To	A	B	C	D	Total Outflow
A: Makasa Road (East)	0	144	838	197	1,178
B: Old Masaka Road	172	0	29	0	202
C: Masaka Road (West)	685	0	0	595	1,281
D: Natete Road	127	152	756	0	1,035
Total Inflow	985	296	1,623	792	3,696

Makerere Roundabout	AM Peak Period 7:30 - 9:30				
From To	A	B	C	D	Total Outflow
A: Kitante Road	0	74	174	619	868
B: Bombo Road (South)	208	0	803	290	1,302
C: Bombo Road (West)	847	1,445	0	16	2,308
D: Gayaza Road	678	1,098	261	0	2,037
Outflow	1,733	2,616	1,238	926	6,514
	PM Peak Period 16:30 - 18:30				
From To	A	B	C	D	Total Outflow
A: Kitante Road	0	143	821	963	1,927
B: Bombo Road (South)	527	0	849	364	1,741
C: Bombo Road (West)	475	1,078	0	56	1,609
D: Gayaza Road	403	665	171	0	1,239
Total Inflow	1,405	1,886	1,841	1,383	6,515

Kibuye Roundabout	AM Peak Period 7:30 - 9:30					
From To	A	B	C	D	E	Total Outflow
A: Makindye Road	0	43	799	493	728	2,063
B: Entebbe Road	123	0	231	1,009	1,488	2,852
C: Masaka Road	9	596	0	777	104	1,486
D: Katwe Road	8	567	109	0	22	705
E: Queensway	845	1,670	318	197	0	3,030
Total Inflow	985	2,876	1,456	2,477	2,343	10,136
	PM Peak Period 16:30 - 18:30					
From To	A	B	C	D	E	Total Outflow
A: Makindye Road	0	87	360	133	443	1,024
B: Entebbe Road	417	0	290	447	1,504	2,658
C: Masaka Road	125	882	0	743	449	2,200
D: Katwe Road	169	1,197	494	0	84	1,943
E: Queensway	604	1,713	705	259	0	3,281
Total Inflow	1,315	3,879	1,849	1,582	2,480	11,106

Port Bell Road/Jinja Road Junction	AM Peak Period 7:30 - 9:30			
From / To	A	B	C	Total Outflow
A: Jinja Road (East)	0	250	3,424	3,674
B: Port Bell Road	353	0	953	1,306
C: Jinja Road (West)	2,730	459	0	3,189
Total Inflow	3,082	709	4,378	8,169
	PM Peak Period 16:30 - 18:30			
From / To	A	B	C	Total Outflow
A: Jinja Road (East)	0	338	3,376	3,714
B: Port Bell Road	333	0	637	970
C: Jinja Road (West)	3,637	529	0	4,166
Total Inflow	3,969	867	4,013	8,850

Wandegeya Roundabout	AM Peak Period 7:30 - 9:30				
From / To	A	B	C	D	Total Outflow
A: Mulago Hill Road	0	1,730	1,306	851	3,888
B: Bombo Road (South)	1,908	0	451	359	2,717
C: Makerere Hill Road	1,367	1,467	0	280	3,114
D: Bombo Road (West)	178	2,092	512	0	2,782
Total Inflow	3,453	5,289	2,269	1,490	12,502
	PM Peak Period 16:30 - 18:30				
From / To	A	B	C	D	Total Outflow
A: Mulago Hill Road	0	1,350	1,471	829	3,650
B: Bombo Road (South)	2,211	0	1,127	575	3,913
C: Makerere Hill Road	1,302	1,185	0	388	2,875
D: Bombo Road (West)	346	1,397	578	0	2,320
Total Inflow	3,859	3,932	3,176	1,792	12,759

Jinja Road Roundabout	AM Peak Period 7:30 - 9:30				
From / To	A	B	C	D	Total Outflow
A: Jinja Road (East)	0	0	3,474	2,680	6,153
B: Access Road	2,233	0	516	762	3,511
C: Jinja Road (West)	2,055	1,012	0	75	3,142
D: Kitante Road	0	863	770	0	1,632
Total Inflow	4,288	1,874	4,759	3,517	14,438
	PM Peak Period 16:30 - 18:30				
From / To	A	B	C	D	Total Outflow
A: Jinja Road (East)	0	0	3,024	2,233	5,257
B: Access Road	2,343	0	595	276	3214
C: Jinja Road (West)	1,999	1,651	0	136	3786
D: Kitante Road	0	1,855	355	0	2,210
Total Inflow	4,342	3,505	3,974	2,646	14,467

(1) Natete Junction

The new design is a signalized intersection with two lanes on each approach, one for left turning and straight ahead traffic. Through the use of OSCADY3, it was confirmed that a simple two-stage cycle for motorized vehicles, with a cycle time of 60 seconds, would work well in both peak periods. Inter-green periods of the 4 and 16 seconds were assumed; the latter would include a pedestrian stage of at least 8 seconds. In the AM peak period, the flow through the junction is forecast to be 1,744 veh/hr, with an average queuing delay of 1.25 min/veh. Aggregate queuing delay over the 2-hour period is 4,346 veh-min and aggregate geometric delay is 248 veh-min. In the PM peak period, the corresponding results are 1,899 veh/hr, 1.06 min/veh, 4,008 veh-min and 265 veh-min.

The existing design is a roundabout which was modeled using ARCADY3. In the AM peak period, the flow through the junction is forecast to be 2,631 veh/hr (which includes many bicycles), with an average queuing delay of 1.88 min/veh. Aggregate queuing delay is 9,871 veh-min and aggregate geometric delay is 691 veh-min. In the PM peak period, the corresponding results are 2,462 veh/hr, 1.06 min/veh, 5,200 veh-min and 668 veh-min. In fact, the existing roundabout would perform much worse than this because the junction is the focal point of Natete market, and many of the traffic movements into and out car parks take place at the junction or very close to it. Even now, with observed traffic flow through the junction being much less than the forecast level, there are times when congestion occurs.

(2) Makerere Junction

The new design incorporates a revised central island shape, with the addition of a separate pedestrian crossing close to each entry. The aim is to build in extra safety facilities rather than to increase capacity. In the AM peak period, flow through the junction will be 3,260 veh/hr. The ARCADY3 analysis indicates that average queuing delay will be 4.30 min/veh, aggregate queuing delay will be 28,015 veh-min and aggregate geometric delay will be 1,208 veh-min. Most of the queuing is forecast to be on the Gayaza Road arm, with an average queuing delay of 13 min/veh. In the PM peak period, the corresponding results are 3,258 veh/hr, 2.11 veh/min, 13,756 veh-min and 1,248 veh-min.

The junction has spare capacity at the moment, but this is forecast to change by 2005. In the AM peak period flow through the junction is forecast to be 4,097 veh/hr, with an average queuing delay of 20.93 veh/min. Aggregate queuing delay will be 171,550 veh -min, and aggregate geometric delay will be 1,508 veh-min. In the PM peak period, corresponding results are 3,971 veh/hr, 7.65 veh/hr, 60,735 veh-min and 1,513 veh-min.

(3) Kibuye Junction

The new design is an improved roundabout offering wider entries, particularly in the Entebbe Road, Masaka Road and Queensway approaches, and smoother circulation. The Katwe Road entry needs no widening, whilst the available land for widening the Makindye Road entry is limited by the close proximity of a narrow railway bridge on the approach. In the AM peak period, traffic flow through the roundabout is forecast to be 5,086 veh/hr, with an average queuing delay of 7.43 min/veh. Aggregate forecast queuing delay is 75,314 veh-min and aggregate forecast geometric delay is 2,034 veh-min. In the PM peak period, the corresponding figures are 5,552 veh/hr, 12 min/veh, 133,217 veh-min and 2,302 veh-min.

The existing roundabout already experiences congestion, and the delays forecast are very high. In the AM peak period, aggregate forecast queuing delay is 521,983 veh-min and aggregate forecast geometric delay is 2,362 veh-min. The respective PM peak period figures are 658,637 veh-min and 2,658 veh-min.

(4) Port Bell/Jinja Road Junction

The new design is a signalized T-junction. The best arrangement has been found to be a 3 stage cycle for motorized traffic of 90 seconds duration, including early cut-off for the benefit of vehicles turning right from Jinja Road (west) to Port Bell Road. Interstage green times are 11,3 and 3 seconds, the first of which might allow a short pedestrian stage. In the AM peak period, flow through the junction is forecast to be 4,088 veh/hr, 1.92 min/veh, 17,036 veh-min.

The existing intersection is a major/minor T-junction. Already, it is difficult to emerge from the minor arm (Port Bell Road) onto the main road (Jinja Road). It is also difficult to turn off Jinja Road (west). There is conflict between the two rights turns, leading to a hazardous situation.

(5) Wandegeya Junction

The new design is a high capacity signals junction. This type of junction barely copes with the demand forecast for year 2005. The design adopted has 3 stages in the signals cycle, for east-west traffic, for north-south traffic and for right turns from the northern and southern arms. There is a heavy right turn volume from south to east, for such both a double turning lane and a stage in the cycle have been provided. Also, the heavy movement southbound towards the city center in the AM peak must be catered for. This is done by providing 2 left turn lanes from he eastern arm, 2 ahead lanes from the northern arm, and 2 right turn lanes from the western arm. A 90 second signals cycle with three inter-green periods of 4 seconds each has been assumed. This does not allow for an exclusive pedestrian stage.

In the AM peak period average queuing delay is 24.49 min/hr. Heavy delays are forecast for the through movement from north to south, for the right turn from west to south, for the right turn from south to east. Aggregate queuing is 306,244 min-min and aggregate geometric delay is 1,115 veh-min. The corresponding figures for the PM peak period are 23.23 min/veh, 296,344 veh-min and 1,196 veh-min.

Assuming the existing roundabout is under the forecast future traffic volume, the aggregate queuing delay is 800,925 veh-min and aggregate geometric delay at 2,196 veh-min in the AM period. In the PM peak period the respective figures are 495,120 veh-min and 2,116 veh-min.

(6) Jinja Road Junction

The existing intersection is a 4-arm roundabout, which already has a throughput in the peaks of approximately 5,000 veh/hr. Police supervision is often provided in the peaks in order to maintain adequately smooth flow. With traffic growth, this is forecast to increase to more than 9,600 veh/hr. As a consequence, very large delays are predicted. In the AM peak period, aggregate queuing delays are forecast to be 1,268,656 veh-min and aggregate geometric delays to be 3,849 veh-min. Average queuing delay would be in excess of 65 minutes. In the PM peak period, the corresponding figures are 1,299,067 veh-min, 3,840 veh-min and 67 minutes.

The trial concept tested is the removal of left-turn flows from Jinja Road (East) to Access Road and from Kitante Road to Jinja Road (East) from the roundabout by means of the provision of left-turn slip roads. In the AM peak period, aggregate queuing delay would be 688,795 veh-min and aggregate geometric delay would be 2,946 veh-min. In the PM peak period, the corresponding figures are 534,145 veh-min, 2,939 veh-min and 36 min/veh. The time savings attributable to the concept design in 2005 are forecast at 3,399,995 veh-min.

Table 11.6 Junction Delays

	Peak Hour (each 2 hours)	Queuing Delay (vehicle-minutes)	Geometric Delay (vehicle-minutes)
Natete	AM	4,346 (9,871)	248 (691)
	PM	4,008 (5,200)	265 (668)
Makerere	AM	28,015 (171,550)	1,208 (1,508)
	PM	13,756 (60,735)	1,248 (1,513)
Kibuye	AM	75,314 (521,983)	2,034 (2,362)
	PM	133,217 (658,637)	2,302 (2,658)
Port Bell/Jinja Road	AM	27,983 (231,360)	631 (631)
	PM	17,036 (196,320)	599 (599)
Wandegeya	AM	306,244 (800,925)	1,115 (2,196)
	PM	296,344 (495,120)	1,196 (2,116)
Jinja Road	AM	688,795 (1,268,656)	3,849 (2,946)
	PM	534,145 (1,299,067)	3,840 (2,939)

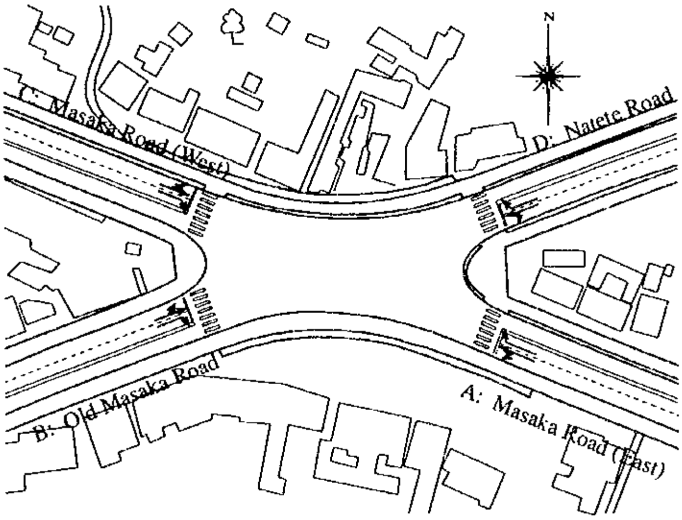
( ) - without improvement case.

11.3.5 Prospect of Future Junction Traffic Management

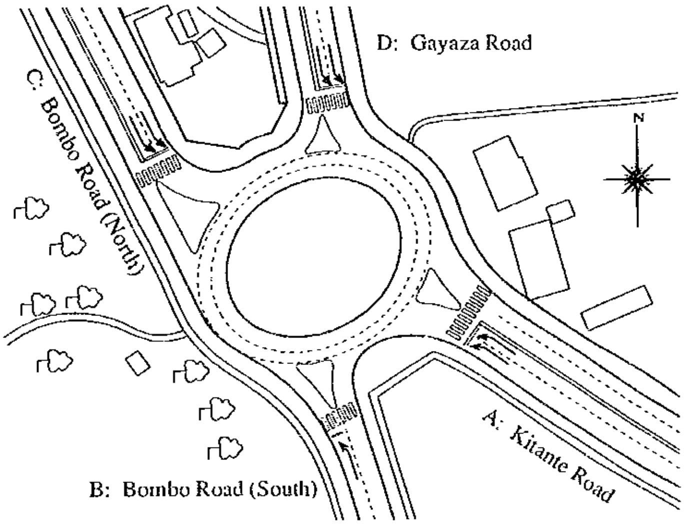
New designs have been developed and tested against the forecast turning flows for the year 2005 in order to have a consistent basis for an initial assessment. The designs for Natete and Port Bell Road are adequate for the forecast demand. Analysis indicates that there will be a short queue on the Gayaza Road approach to the new Makerere roundabout during the AM peak period, but that the design is otherwise satisfactory. At the new Kibuye roundabout, there will be long queues on the Makindye Road approach during the AM peak period on the Queensway approach during the PM peak period; together, these will have the AM peak period and on the Queensway approach during the PM peak period, together, these will have the effect of suppressing some commuter grade demand. Kibuye junction and Wandegeya junction will be fully saturated in near future if there is no drastic road network to divert through traffic in the city.

Intersection designs based on the above concept are shown in Fig. 11.2 (1), (2) and Drawings.

Natete Junction



Makerere Junction



Kibuye Junction

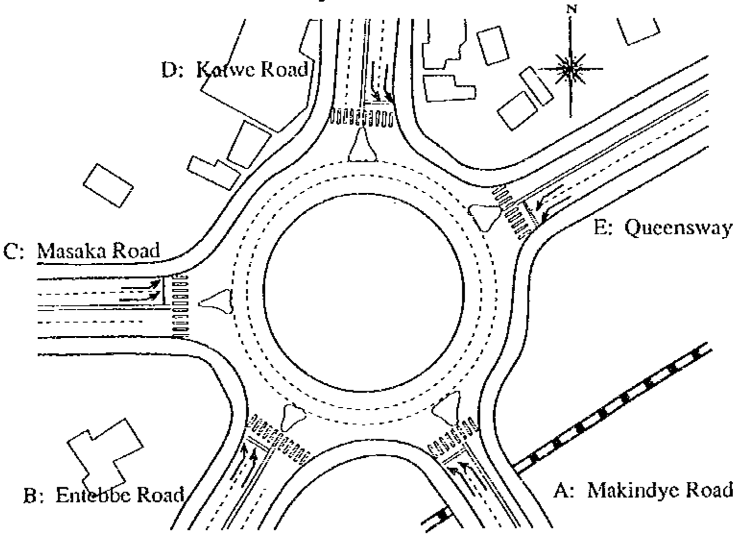
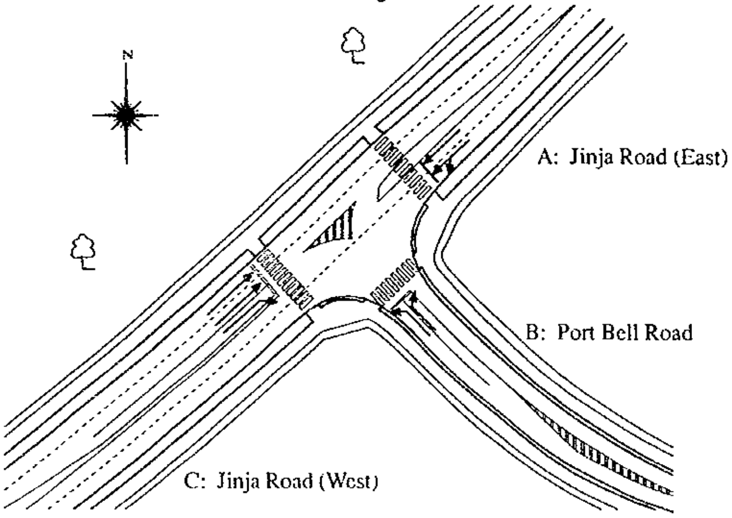
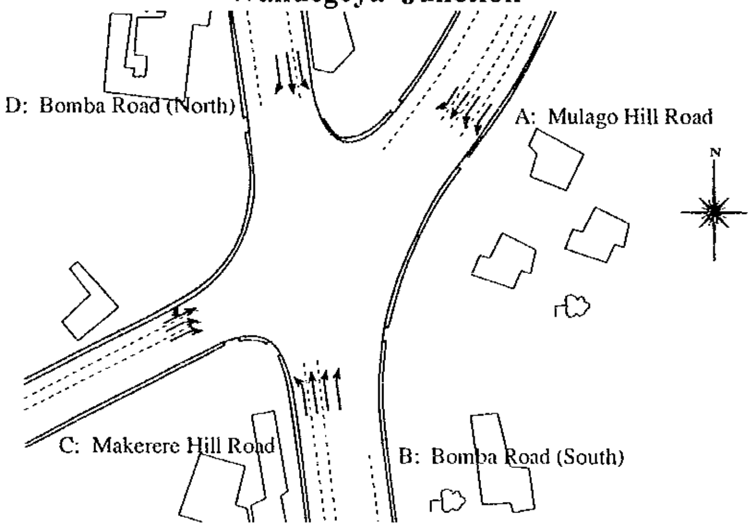


Figure 11.2 (1) Intersection Design

Port Bell Road/Jinja Road Junction



Wandegeya Junction



Jinja Road Junction

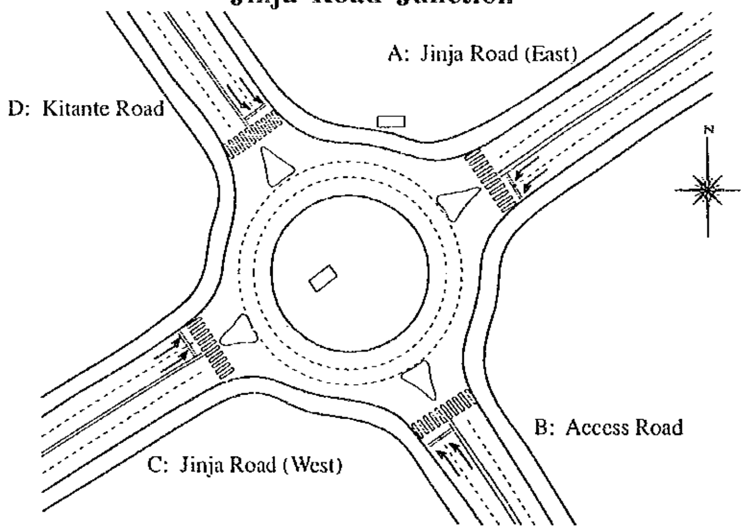


Figure 11.2 (2) Intersection Design

11.4 Drainage Design

Drainage provision is one of the most important factors to keep the roads in a safe condition for traffic and to extend the life of road structures, especially that of the pavement.

Crossfall of carriage ways, foot ways and so on shall be designed to ensure the rapid drainage of surface water without causing any discomfort and danger to road users.

Culverts:

- The minimum dimension for pipe culverts shall be 600 mm for ease of maintenance.
- Pipe culverts shall be designed using concrete head walls, wing walls, protective aprons and toes.

Ditches:

- Roadside ditches should be covered with grouted rip-rap to prevent erosion of road structures and cut slopes.
- The minimum dimension of roadside ditches should be 2.5 m x 1.0 m (upper width x height).

11.5 Pavement Design

11.5.1 Selection of Pavement Type

The pavement structure is divided, by and large, into two types namely, flexible pavement (asphalt pavement) and rigid pavement (concrete pavement). The type of pavement is determined on the basis of its characteristics of flexibility or rigidness taking into account the following factors:

(i) Construction practices in terms of design life (10 years for flexible pavement and 40 years for rigid pavement)

(ii) Construction economy (initial cost of rigid pavement is higher than that of flexible pavement).

(iii) Easy maintenance (flexible pavement is easier than rigid pavement).

(iv) Local conditions (experience, availability of materials, government policy, and so on.)

Considering the construction economy and local conditions, flexible pavement was adopted for the project roads.

11.5.2 Alternatives of Pavement

Two possibilities of flexible pavement were considered for the study: Double Bitumen Surface Treatment (DBST) and Asphalt Mixed Concrete (AMC).

(1) Double Bitumen Surface Treatment (DBST)

This method is very common in Uganda because of its easy maintenance and low construction cost if compared with asphalt mixed concrete. However, this type of pavement is not recommendable for arterial urban roads with heavy traffic because of its short duration and unreliable quality.

Durability, water proofing and stability of DBST will not be reliable unless the work is done by skilled laborers because of the difficulty of quality control during the construction.

DBST, therefore, will not perform satisfactorily unless regular maintenance in the form of resealing of patching work would be properly and periodically provided.

DBST is recommendable to be adopted for sidewalks and shoulder pavements, but not for high standard roads such as the project roads.

(2) Asphalt Mixed Concrete (AMC)

AMC pavement is currently used for urban roads, particularly on those roads with heavy traffic. The initial cost of AMC is higher than that of DBST since it requires an asphalt mix plant with well trained operators and quality control at construction sites.

However, AMC has a longer duration than DBST and the quality of the pavement such as waterproofing and stability is superior to DBST pavement. This is because it is mixed and measured properly in a mechanical plant. AMC is particularly suitable for busy urban roads since it can be opened to traffic immediately after lay out. As such, traffic congestion could be reduced during the construction.

Although AMC pavement requires a higher initial investment, it is recommended to be used for the project roads as it reduces the maintenance cost afterwards.

11.5.3 Thickness Design

The preliminary thickness design of flexible pavement was carried out in accordance with the "Manual for Asphalt Pavement, 1996" published by the Japan Road Association. The Japanese method of asphalt pavement has been developed via domestic technology, incorporated with the principles of AASHTO Road Test and the CBR Design Curve method.

Traffic load estimates were carried out applying the results of axle and survey. Design inputs including effective modules of subgrade reaction were estimated by referring to available data and information obtained from the engineering survey.

The thickness and the structure of individual layers of pavement were designed by adopting a comprehensive judgment of various factors including the subgrade, traffic and climatic conditions.

(1) Classification of Roads in terms of Traffic

The one way daily traffic volume of heavy vehicles in the 10th year after opening the road to public was forecast to classify the road characteristics in accordance with Asphalt Pavement Manual by Japan Road Association as shown in Table 11.7.

Table 11.7 Traffic Classification for Pavement Design

Road Classification	Traffic Volume of Heavy Vehicles (One way)
L	Less than 100
A	100 to 250
B	250 to 1,000
C	1,000 to 3,000
D	more than 3,000

Source: Asphalt Pavement Manual, Japan Road Association

One way daily traffic volume of heavy vehicles for 2010 was forecast for each road section in conformity with future traffic analysis conducted in Chapter 5. The summary of estimated traffic volume by road section and corresponding traffic classification are presented in Table 11.8.

Table 11.8 Forecast Traffic Volume and Traffic Classification

Road Section	Traffic Volume of Heavy Vehicles in 2010 (One way)	Corresponding Road Classification
Natete Road	380	B
Gaba Road	480	B

Port Bell Road	240	A
Gayaza	510	B
Hoima Road	220	A

Heavy vehicles refers to buses, trucks and special vehicles.

(2) Design CBR Value

For estimating the design CBR values, subgrade soils were sampled at 1.0 km intervals along the project roads. The design CBR of each project road is shown in Table 11.9.

Table 11.9 Design CBR of Project Roads

Proposed Roads	Station	CBR of Subgrade
Natete Road	No. 0+000 ~ No. 3+700	12.0%
	No. 3+700 ~ No. 4+000	4.0%
Gaba Road	No. 0+000 ~ No. 1+700	12.0%
	No. 1+700 ~ No. 2+700	6.0%
	No. 2+700 ~ No. 11+000	20.0%
Port Bell Road	No. 0+000 ~ No. 1+750	12.0%
	No. 1+750 ~ No. 2+700	6.0%
	No. 2+700 ~ No. 3+500	20.0%
	No. 3+500 ~ No. 4+000	6.0%
	No. 4+000 ~ No. 5+000	20.0%
	No. 5+000 ~ No. 6+500	4.0%
Gayaza/Bombo Road	No. 0+000 ~ No. 1+800	2.0%
	No. 1+800 ~ No. 4+300	6.0%
	No. 4+300 ~ No. 5+300	20.0%
	No. 5+300 ~ No. 5+900	8.0%
Hoima Road	No. 0+000 ~ No. 0+700	6.0%
	No. 0+700 ~ No. 5+300	12.0%
	No. 5+300 ~ No. 8+500	20.0%
Natete junction		4.0%
Makerere Junction		2.0%
Kibuye Junction		4.0%
Port Bell/Jinja Road Junction		12.0%
Wandegeya Junction		2.0%
Jinja Road Junction		4.0%

(3) Pavement Thickness Design

The target values of thickness design were determined according to a formula developed by the Japan Road Development Association in June 1996 as shown in Table 11.10.

Table 11.10 Target Values of T_A

	T_A Values by traffic Classification				
Design CBR	Class L	Class A	Class B	Class C	Class D
2%	17	21	29	39	51
3%	15	19	26	35	45
4%	14	18	24	32	41
6%	12	16	21	28	37
8%	11	14	19	26	34
12%	11	13	17	23	30
20% or more	11	13	17	20	26

Note: T_A represents the pavement thickness which would be required if the entire depth of the pavement were to be constructed of hot-mixed asphalt concrete for binder and surface courses.

The thickness of the pavement structure for project roads was determined as shown in Table 11.12.

(4) Thickness Design of Pavement Structure

Prototypes of pavement structures for the project roads were designed as shown in Fig. 11.3 so that the thickness of individual layers of pavement by prototype of pavement could satisfy the following condition:

$$T_A^* = a_1T_1 + a_2T_2 + \ldots\ldots a_nT_n$$

Where,

T_A^* : Selected T_A value in the formula shown in Table 11.10

$a_1, a_2 \ldots a_n$: Coefficient of relative strength

$T_1, T_2 \ldots T_n$: Thickness of individual layers of pavement (cm)

The coefficients of relative strength in Table 11.11 indicate the thickness of hot-mixed asphalt in cm used for the binder and surface courses, with a strength equivalent to a 1.0 cm layer of pavement of other materials. For instance, the coefficient of 0.35 for mechanically stabilized materials indicates that the strength of a 1 cm layer of material is equivalent to that of 0.35 cm layer of hot mixed asphalt used for the binder and surface courses.

(5) Selection of Pavement Type

Selection of pavement type for reconstruction cases was done based on the calculated value of TA, in which eight (8) types of pavement were prepared.

Table 11.11 Conversion Coefficient for the Calculation of TA

Pavement Course	Method and Material for Construction	Conditions for Construction	Coefficient a_n
Surface & binder course	Hot asphalt mix for surface and binder course		1.00
Base	Bituminous stabilization	Hot-mixed stability: 350 kgf or more	0.80
		Cold mixed stability: 250 kgf or more	0.55
	Cement stabilization	Unconfined compression strength (7 days): 30 kgf/cm^2	0.55
	Lime stabilization	Unconfined compression strength (10 days): 10 kgf/cm^2	0.45
	Crushed stone for mechanical stabilization	Modified CBR value: 80 or more	0.35
	Slag for mechanical stabilization	Modified CBR value: 80 or more	0.55
	Hydraulic slag	unconfined compression strength (14 days) 12 kgf/cm^2 or more	0.55
Subbase	Crusher-run, slag, sand, etc.	Modified CBR value:	
		30 or more	0.25
		20 to 30	0.20
	Cement stabilization	Unconfined compression strength (7 days): 10 kgf/cm^2	0.25
	Lime stabilization	Unconfined compression strength (10 days): 7 kgf/cm^2	

Table 11.12 Pavement Design for Project Roads

Proposed Roads	Road Classification	Station	CBR of Subgrade	TA	Pavement Type
Natete Road	B	No. 0+000 ~ No. 3+700	12.0%	17 cm	Re-8
	B	No. 3+700 ~ No. 4+000	4.0%	24 cm	Re-5
Gaba Road	B	No. 0+000 ~ No. 1+700	12.0%	17 cm	Re-8
	B	No. 1+700 ~ No. 2+700	6.0%	21 cm	Re-6
	B	No. 2+700 ~ No. 11+000	20.0%	17 cm	Re-8
Port Bell Road	A	No. 0+000 ~ No. 1+750	12.0%	13 cm	Re-3
	A	No. 1+750 ~ No. 2+700	6.0%	16 cm	Re-2
	A	No. 2+700 ~ No. 3+500	20.0%	13 cm	Re-3
	A	No. 3+500 ~ No. 4+000	6.0%	16 cm	Re-2
	A	No. 4+000 ~ No. 5+000	20.0%	13 cm	Re-3
	A	No. 5+000 ~ No. 6+500	4.0%	18 cm	Re-1
Gayaza/Bombo Road	B	No. 0+000 ~ No. 1+800	2.0%	29 cm	Re-4
	B	No. 1+800 ~ No. 4+300	6.0%	21 cm	Re-6
	B	No. 4+300 ~ No. 5+300	20.0%	17 cm	Re-8
	B	No. 5+300 ~ No. 5+900	8.0%	19 cm	Re-7
Hoima Road	A	No. 0+000 ~ No. 0+700	6.0%	16 cm	Re-2
	A	No. 0+700 ~ No. 5+300	12.0%	13 cm	Re-3
	A	No. 5+300 ~ No. 8+500	20.0%	13 cm	Re-3
Natete junction			4.0%	24 cm	Re-5
Makerere Junction			2.0%	29 cm	Re-4
Kibuye Junction			4.0%	24 cm	Re-5
Port Bell/Jinja Road Junction			12.0%	13 cm	Re-3
Wandegeya Junction			2.0%	29 cm	Re-4
Jinja Road Junction			4.0%	24 cm	Re-5

11.5.4 Overlay Pavement

The overlay design for the project roads was carried out assuming a pavement design life of 10 years. The types of overlay adopted by road section of the project road are shown in Table 11.13.

Table 11.13 Overlay Design of Each Proposed Roads

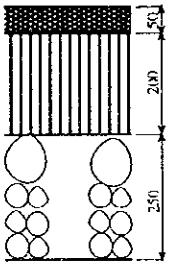
Proposed Roads	Station	T_A	T_{AO}			Overlay Thickness	Overlay Type
			Surfacing	Base	Subbase		
Natete Road	No. 0+000 ~ No. 3+700	17 cm	2.7	5.3	4.9	4.1 cm	Ov-5
	No. 3+700 ~ No. 4+000	24 cm	1.8	5.3	3.8	13.1 cm	Ov-2
Gaba Road	No. 0+000 ~ No. 1+700	17 cm	3.4	6.2	4.1	3.3 cm	Ov-5
	No. 1+700 ~ No. 2+700	21 cm	2.7	5.3	3.8	9.2 cm	Ov-4
	No. 2+700 ~ No. 11+000	17 cm	2.5	4.7	3.6	6.2 cm	Ov-4
Port Bell Road	No. 0+000 ~ No. 1+750	13 cm	4.5	1.6	2.2	4.7 cm	Ov-5
	No. 1+750 ~ No. 2+700	16 cm	1.8	3.5	2.5	8.2 cm	Ov-3
	No. 2+700 ~ No. 3+500	13 cm	1.8	3.0	3.9	4.3 cm	Ov-5
	No. 3+500 ~ No. 4+000	16 cm	2.7	3.5	2.5	7.3 cm	Ov-3
	No. 4+000 ~ No. 5+000	13 cm	0.9	5.3	2.5	4.3 cm	Ov-5
	No. 5+000 ~ No. 6+500	18 cm	2.7	7.0	3.8	4.5 cm	Ov-5
Gayaza/Bombo Road	No. 0+000 ~ No. 1+800	29 cm	4.3	5.3	4.4	15.0 cm	Ov-1
	No. 1+800 ~ No. 4+300	21 cm	1.4	7.1	3.8	8.7 cm	Ov-4
	No. 4+300 ~ No. 5+300	17 cm	1.8	2.1	3.8	9.3 cm	Ov-4
	No. 5+300 ~ No. 5+900	19 cm	2.7	2.6	2.5	11.2 cm	Ov-2
Hoima Road	No. 0+000 ~ No. 0+700	16 cm	6.0	3.2	2.5	4.3 cm	Ov-5
	No. 0+700 ~ No. 5+300	13 cm	2.6	3.6	3.1	3.7 cm	Ov-5
	No. 5+300 ~ No. 8+500	13 cm	1.2	4.7	4.5	2.6 cm	Ov-5
Natete junction		24 cm	1.8	5.3	3.8	13.1 cm	Ov-2
Makerere Round About		29 cm	4.3	5.3	4.4	15.0 cm	Ov-1
Kibuye Round About		24 cm	1.8	5.3	3.8	13.1 cm	Ov-2
Port Bell/Jinja Road Junction		13 cm	4.5	1.6	2.2	4.7 cm	Ov-5
Wandegeya Junction		29 cm	4.3	5.3	4.4	15.0 cm	Ov-1
Jinja Road Junction		24 cm	1.8	5.3	3.8	13.1 cm	Ov-2

The type of pavement are shown in Fig. 11.3.

Reconstruction Type

A-Traffic

Re-1 Design C.B.R. 4%

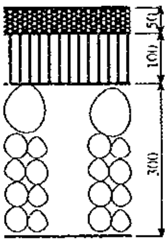


Surface (dense grade asphalt concrete)

Base (Mechanical stabilization)

Sub base (Crusherrun)

Re-2 Design C.B.R. 6%

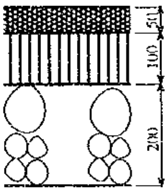


Surface (dense grade asphalt concrete)

Base (Mechanical stabilization)

Sub base (Crusherrun)

Re-3 Design C.B.R. 12% and 20%



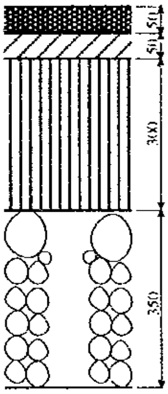
Surface (dense grade asphalt concrete)

Base (Mechanical stabilization)

Sub base (Crusherrun)

B-Traffic

Re-4 Design C.B.R. 2%



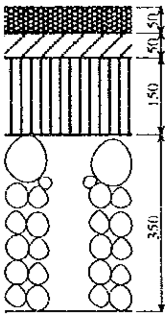
Surface (dense grade asphalt concrete)

Binder (coarse grade asphalt concrete)

Base (Mechanical stabilization)

Sub base (Crusherrun)

Re-5 Design C.B.R. 4%



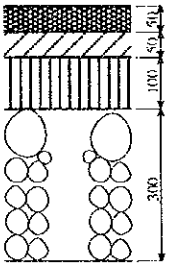
Surface (dense grade asphalt concrete)

Binder (coarse grade asphalt concrete)

Base (Mechanical stabilization)

Sub base (Crusherrun)

Re-6 Design C.B.R. 6%



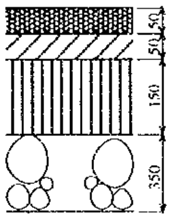
Surface (dense grade asphalt concrete)

Binder (coarse grade asphalt concrete)

Base (Mechanical stabilization)

Sub base (Crusherrun)

Re-7 Design C.B.R. 8%



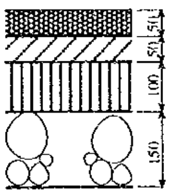
Surface (dense grade asphalt concrete)

Binder (coarse grade asphalt concrete)

Base (Mechanical stabilization)

Sub base (Crusherrun)

Re-8 Design C.B.R. 12% and 20%



Surface (dense grade asphalt concrete)

Binder (coarse grade asphalt concrete)

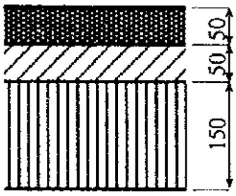
Base (Mechanical stabilization)

Sub base (Crusherrun)

Figure 11.3 Type of Pavement (1)

Overlay Type

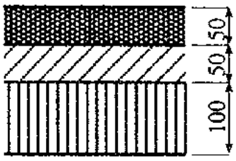
OV-1



Surface (dense grade asphalt concrete)
Binder (coarse grade asphalt concrete)

Base (Mechanical stabilization)

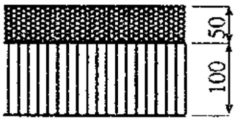
OV-2



Surface (dense grade asphalt concrete)
Binder (coarse grade asphalt concrete)

Base (Mechanical stabilization)

OV-3



Surface (dense grade asphalt concrete)

Base (Mechanical stabilization)

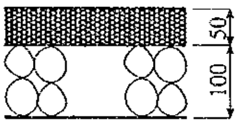
OV-4

Surface (dense grade asphalt concrete)
Binder (coarse grade asphalt concrete)

OV-5

Surface (dense grade asphalt concrete)

Side Walk



Surface (dense grade asphalt concrete)

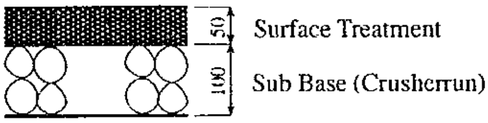
Sub Base (Crusherrun)

Figure 11.3 Type of Pavement (2)

11.5.5 Pavement Structure of Side walks

The pavement structure for the side walks was determined as shown in Fig. 11.4.

Figure 11.4 Pavement Structure of Side walks



11.5.6 Selection of Pavement Type

Selection of pavement type for overlay cases was done on the basis of calculated values of T_{AO}, in which five (5) type of pavement were selected.

11.6 Road Facility Design

11.6.1 Utilities Space for Public Services

Public service utilities, either underground or overhead are proposed to be set aside under the side walks. The 3.0 m wide shoulder and sidewalk would accommodate the following public utilities:

(i) Water mains and distribution pipes

(ii) Electric power ducts

(iii) Telecommunication lines

11.6.2 Bus Bays

For the orderly operation of bus services and reduction of the on-off loading of passengers on carriageway, bus bays were proposed to be installed at proper locations at appropriate intervals.

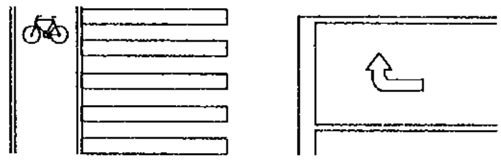
Bus bays consist of a stopping bay tapered at both ends. A stopping bay 15.0 m long and 3.0 m wide was proposed so as to accommodate a large bus. A 20 m long taper would reduce the mixture of traffic on the through lanes.

Proposed location of bus bays are shown in Drawings. It is recommended that shelters are provided at each bus bay.

11.6.3 Pedestrian Crossing

Pedestrian crossings are recommended to be provided at appropriate intervals so as to reduce traffic accidents during the crossing of roads by pedestrians and to streamline the traffic flow.

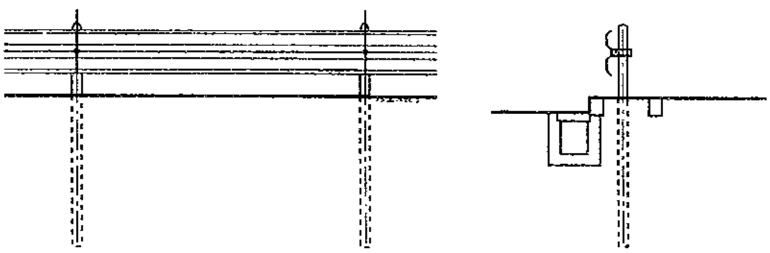
Location of pedestrian crossings along the project roads and at intersections is shown in Drawings along with the prototypes of pedestrian crossing to be adopted.



11.6.4 Guard Rails

Guard rails are most helpful for the safety of pedestrians and vehicles at busy intersections and are also effective for preventing intrusion of pedestrians onto the carriageway. The type of guard rail to be adopted and location of installation are shown in Drawings.

Guard rail (Gr-4E)



11.6.5 Street Lighting

The numbers of lighting columns, the mounting position and the height of luminaries have been determined by the degree of road surface luminance.

11.6.6 Traffic Signs and Carriageway Markings

(1) Traffic Signs

On heavily trafficked urban roads, traffic signs are essential to prevent congestion and accidents. Warning signs, restriction signs and information signs should be installed at proper locations.

(2) Carriage way markings

Carriageway markings were proposed to be placed along the project roads so as to define traffic lanes and to guide vehicles at junctions properly and to indicate the position of bus stops and waiting lanes.

Yellow markings were proposed to be placed on the busy roads to reduce the number of traffic signs. Reflecting studs were also proposed for the road where the right of way situation is tight.

11.6.7 Traffic Signal

Traffic signals were proposed to be installed at some of the intersections.

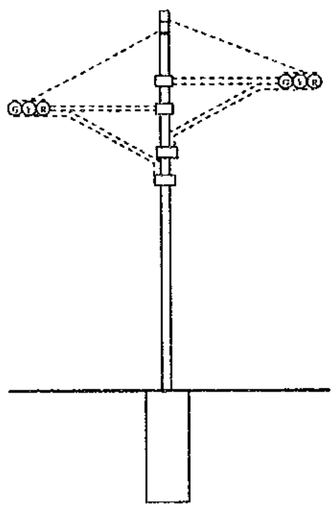
Detailed elements considered in the study of traffic signals are as follows:

- Signal type,
- Signal equipment, and
- Signal control system.

A traffic signal having standard lenses with red, amber and green colour is recommended. It should be installed on overhanging, tapered poles with an arm at a height of 6 m so as to be clearly seen from far away.

The pedestrian signal, which is a signal head with a symbol of a pedestrian or standard red and green colour, is also recommended to be installed at the height of 3.5 m.

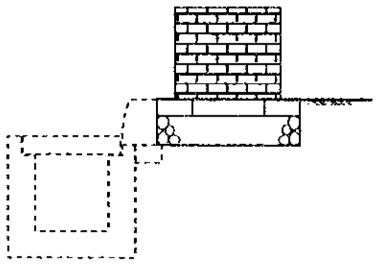
Traffic Signal



11.6.8 Flower Bed

It is recommended to introduce flower beds at the boundary of the carriage way and the pedestrian way . These flower beds would not only reduce project costs due to their easy procurement in Uganda, but would enhance the aesthetic value of the road environment.

Flower Bed



CHAPTER 12

CONSTRUCTION PLAN AND COST ESTIMATE

12. CONSTRUCTION PLAN AND COST ESTIMATE

12.1 Construction Plan

12.1.1 Project Description

As discussed in the previous Chapter, the project consists of following projects:

(Bottleneck Junction Improvement)

- Natete Junction Improvement
- Makerere Junction Improvement
- Kibuye Junction Improvement
- Port Bell/Jinja Road Junction Improvement
- Wandegeya Junction Improvement
- Jinja Road Junction Improvement

(Road Section Improvement)

- Natete Road Improvement (L = 3.8 km)
- Gaba Road Improvement (L = 9.1 km)
- Port Bell Road Improvement (L = 4.8 km)
- Gayaza Road Improvement (L = 4.6 km)
- Hoima Road Improvement (L = 8.5 km)

12.1.2 Construction Principles

As the basis for the project cost estimation, the following principles and stances for the project implementation were introduced:

- Maximization of local participants in the implementation of the project
- Maximum utilization of local resources
- Project implementation by package

(1) Maximization of Local Participants in the Implementation of the Project

The technical and managerial capability in the field of road development work in Uganda is at a high level as most of the contractors possess skilled engineers and the necessary construction machinery. Project implementation by local contractors and enterprises under the initiative of MOWTC with the assistance from foreign expatriates and contractor is recommended. This would result in the smooth, efficient and low cost achievement of the project.

(2) Utilization of Local Resources

In terms of construction materials and equipment, Uganda has sufficient resources of high quality. It is recommended that these local materials and equipment should be mobilized as much as possible to stimulate the local industry and to enhance the quality of the products and technical standard as a result. This would contribute to the reduction of the project cost.

(3) Project Implementation by Package

In terms of efficiency of project implementation, classification of individual project components into construction packages is deemed effective and inevitable. The definition of the construction package was done taking the following aspects into consideration:

- Similarity of project components in terms of content of works and expected effect after the completion,
- expected volume of work entailed within a certain construction period and capability of mobilization of machinery and equipment at one time,
- degree of urgency in terms of improvement of urban traffic situation, and
- location of the project sites.

With this recognition, construction packages, with regard to high-priority projects to be done by the year 2005, were introduced as below:

Package 1 : Mainly consist of bottleneck junction improvement projects. Junctions included in this package are Natete, Makerere, Kibuye, Port Bell/Jinja Road, and Wandegeya. A one (1) year construction period for this package is considered appropriate.

Package 2 : Simultaneous improvement of two road sections, i.e. Natete Road and Gaba Road. Combination of two contrasted road sections; Natete Road, urban short-cut route with short length of 3.8 km, and Gaba Road, radiating truck road with length of 9.1 km. Both need urgent improvement works. A two (2) year construction period for this package is considered appropriate.

Package 3 : Improvement of Port Bell Road, typical infra-regional trunk road, with length of 4.8 km, in the area within an industrial zone. A one (1) year construction period is considered appropriate for this package.

Package 4 : Improvement of Gayaza Road. Section of the national trunk road, with length of 4.6 km, connecting to the northern part of the nation. A one (1) year construction period is considered appropriate for this package.

Package 5 : Improvement of Hoima Road and Jinja Junction. Combination of a national trunk road, with length 8.5 km, located in the urban periphery with a great work volume and junction in the city center. A two (2) year construction period is considered appropriate for this package.

12.2 Site Condition

As the basis for the cost estimation, site condition in terms of availability of local materials and equipment, possibility of relocation of facilities and so on were studied as described below:

(1) Availability of Natural Materials Sources

As a result of the field survey, the following material sources were identified available for producing concrete and pavement aggregate:

Materials	Material Sources (Borrow Pits and Quarry Sites)
Soil	Mutundwe, Lubuya (Natete Road)
	Mbuya (Port Bell Road)
	Lubuya (Hoima Road)
	Kikaya, Kawempe, Jinja (Gayaza Road)
Crushed Stone	Kiwatu
Sand	Butto, Kitubulu (Kampala City) Kisambi (Entebbe City)

(2) Availability of Local Plant and Equipment

Most of the construction equipment is available on a rental basis in Kampala. Major equipment available in Kampala is as follows:

- Dump Truck (2 - 11 ton)
- Bulldozer (15 - 32 ton)
- Macadam Roller (10 ton)
- Tyre Roller (8 ton)
- Motor Grader (3.1 m)
- Asphalt Plant (30 t/hr, 110 kW)
- Concrete Plant (0.5 m^3/h, 7.5 kW)

These items of equipment, however are generally not maintained in good condition and the capacity and number of equipment are relatively limited. As such, some of the equipment to be used for critical work of the project, should be brought into Kampala by an international contractor.

(3) Possibility of Public Utility Relocation

All the public utilities affected by the proposed road improvement works must be relocated and replaced. Normally the authorities or agencies concerned are responsible for the relocation and replacement of electric facilities, telephones cables, water mains at their own cost.

As all the underground utilities (water mains, sewage, and power and telephone cables) are mostly laid beneath the existing sidewalks, the road improvement work has to be carried out without affecting these underground utilities. However, relocation of such facilities as electric poles are expected along very limited sections of the project sites, especially at junction sites.

(4) Possibility of Land Acquisition and Demolition/Relocation of Buildings

There is no problem of additional land acquisition and demolition of buildings/housings for the following two (2) reasons: For one thing, the right-of-ways in the project site are fully provided, and secondly, the designing of the project facilities was carried out taking into account the site condition constraints as discussed in Chapter 11.

12.3 Prerequisite of Project Cost Estimate

The project cost were estimated by project package on the basis of the basic design and construction principle. The unit prices were estimated on the basis of the following assumptions:

(1) The project cost were estimated assuming all the construction works would be carried out under the initiative of an international contractor.

(2) The unit prices of labour, materials and equipment were determined based on the economic condition and market prices of Uganda as of July 1997.

(3) The exchange rate for the United States Dollar (US$), Japanese Yen and Ugandan Shilling were determined as follows:

US$1 = ¥120.88 = UShs. 1,042.52

(UShs. 1.0 = ¥0.1159)

(Adopted average exchange rates during February 1997 and July 1997)

(4) The unit prices were divided into a foreign currency portions and a local currency portions. The foreign and local components contain the following items of expenses respectively:

(a) Foreign Currency Components:

- Imported equipment, materials and supplies,
- Imported materials in the local market,
- Wages of expatriate personnel, and
- Overhead and profit of the foreign contractor and consultant.

(b) Local Currency Components:

- Domestic materials and supplies,
- Wages of local personnel,
- Indirect local costs including temporary facilities, and
- Duties and tax.

(5) Components of the Project Cost

The project cost consists of the following items:

- Construction cost,
- Engineering cost including detailed design and construction supervision,
- Physical contingency,
- Land/house acquisition cost including the cost for relocation of existing utilities, and
- Government administration expenses.

(6) Component of the Construction Cost

Construction cost consists of the following work items:

- Direct construction cost,
- Direct cost for temporary works,
- General cost for temporary works,
- Transportation cost and packaging cost,
- Site operation and administration cost, and
- Contractor's general expenses.

(7) Imported equipment and materials except for fuel were assumed to be exempt from tax and duties by the Ugandan Government. Fuel, including tax and duties, was estimated in the local currency.

(8) 20% overhead including profit was included in the unit costs.

(9) The fee for engineering services was assumed to be 10% of the total construction cost.

12.4 Unit Rates

12.4.1 Unit Prices of Materials, Labour and Equipment

1) Materials

Construction materials to be imported are as follows:

- Materials to be imported from Japan, include traffic signals, street lights, paints for road marking, bead, admixture, barbed wire, and epoxy resin.
- The unit price is estimated in terms of CIF at Mombasa Port, Kenya and includes the cost for inland transport from Mombasa to project sites.

The unit prices of the materials estimated are shown in Table 12.1 (a).

2) Labour

The unit prices of labour were estimated on the basis of average daily wages of construction workers, employed by international contractors, at the current road construction projects in Kampala. The daily wages include an allowance for overtime. The average daily wages by labour classification are shown in Table 12.1 (b).

3) Equipment

Some contractors in Uganda have an enough capability for execution of the works and hold minimum level equipment and have experience of similar road improvement projects including those financed by EU. The unit prices of equipment were investigated by item at major contractors and the lowest unit prices among them was used. The unit prices of equipment by specification were estimated as shown in Table 12.1. (c).

12.4.2 Unit Cost of Major Work Items

The unit costs of equipment, materials and labour were estimated by work item on the basis of the construction schedule and method, availability of local reports, combination and workability of equipment, and quantities of equipment, materials and labour to be adopted. The contractor's overhead and profit was also included in the unit costs. Unit costs of the major work items are shown in Table 12.2.

Table 12.1 (a) Unit Cost of Construction Materials

No.	Material	Unit	¥	US$	Ushs
1	Aggregate up to 20 mm	ton			19,658
2	Aggregate up to 30 mm	ton			17,094
3	Crusher-run for road sub-base	ton			10,256
4	Crusher-run for coarse aggregate	ton			17,094
5	Selected stones up to 250 mm	ton			12,821
6	Murram or crusher feed	ton			10,000
7	Sand for Base course	ton			15,000
8	Sand for fine aggregate	ton			11,966
9	Deformed bars D = 12mm	kg			532
10	Deformed bars D = 16mm	kg			606
11	Deformed bars D = 20mm	kg			606
12	Round bars D = 10mm	kg			680
13	Cement ordinary	ton			240,000
14	Fuel	Liter			1,050
15	Diesel	Liter			910
16	Asphalt emulsion, MC30 for Prime Coat	Liter			731
17	Straight asphalt, MC80/100	kg			450
18	Timber (Hardwood)	m3			300,000
19	Plywood, t = 12 mm	m2			8,850
20	Pipe Culvert, D = 1000 mm	m			119,658
21	Pipe Culvert, D = 600 mm	m			65,000
22	Pipe Culvert, D = 1200 mm	m			153,846
23	Nail	kg			889
24	Admixture	kg	295		
25	Barbed Wire	kg	142		
26	Form Oil	kg	243		
27	Grating	set	8,230		
28	Beads	kg	283		
29	H-Beam	ton	35,100		
30	Highway Lighting	set	797,250		
31	Signal Installation	set	13,548,193		
32	Epoxy Resin	Liter	1,107		
33	Coating Plywood	m2	858		60,000
34	Traffic sign plate	set			192,600
35	Traffic Informatory signs	set			253,100
36	Grass	m2			333
37	Chatter-bar (Jiggle bars)	nos.	8,470		
38	Heavy oil, grude petroleum	Liter			2,612
39	Brick (Selected Bricks)	nos.			85
40	Fence	nos.			178,752
41	Shrub, Scrub (up to 400 mm)	each			1,000
42	Tree (Up to 3000 mm)	each			5,000
43	Guardrail	set	6,600		
44	Cut-back asphalt for Prime coat	m3			427,350
45	Cut-back asphalt for Tack coat	m3			427,350
46	Paint for Road marking	kg	162		

Table 12.1 (b) Unit Cost of Labour (Wage Rate)

Unit: Ushs.

No.	Material	Unit	Wage Rate
1	Foreman	Man-Day	13,287
2	Mechanic	Man-Day	7,853
3	Electrician	Man-Day	7,461
4	Operator	Man-Day	11,391
5	Assistant operator	Man-Day	7,724
6	Assistant operator	Man-Day	5,876
7	Driver	Man-Day	5,969
8	Mason	Man-Day	5,766
9	Rigger	Man-Day	8,500
10	Welder	Man-Day	7,539
11	Pipe Fitter	Man-Day	8,500
12	Pavement worker	Man-Day	7,500
13	Steel worker	Man-Day	6,099
14	concrete worker	Man-Day	7,500
15	Carpenter	Man-Day	6,099
16	Semi-skilled labour	Man-Day	3,935
17	Common labour	Man-Day	4,167

Table12.1(c) Unit Cost of Majour Equipment

Unit : Ushs.

No.	Particular	Specification	Unit	¥	Ushs.	***
1	Bulldozer	15t	hr		112,465	
2	Back hoe	0.6m3	hr		58,287	
3	Back hoe	0.35m3	hr		31,561	
4	Tractor shovel	1.0m3	hr		65,008	
5	Dunp Truck	11t	hr		38,521	
6	Dunp Truck	2t	hr		14,373	
7	Track with Crane	4.0t、2.9t	hr		19,622	
8	Track	4t	hr		19,433	
9	Track	2t	hr		14,959	
10	Trailer	20t	hr		52,330	
11	Track crane	4.8-4.9t	hr		27,087	
12	Track crane	15-16t	hr		58,854	
13	Track crane	25t	hr		66,565	
14	Motor grader	3.1m	hr		93,076	
15	Road roller	10-12t	hr		48,122	
16	Tire roller	8-20t	hr		65,595	
17	Vibrating rubber tired roller	3-4t	hr		28,052	
18	Asphalt finisher	2.4-5.0m	hr		98,629	
19	Road sprinkler	5.5-6.5kltr	hr		39,011	
20	Mobile hydraulic platform	12-13m	hr		74,901	
21	Concrete mixer	1.6-1.7m3	hr		23,144	
22	Breaker	1,300kg	hr		58,287	
23	Concrete cutter	30cm	day		16,560	
24	Tampa/Ranma	60-100kg	day		20,027	
25	Asphalt sprayer	200ltr	day		84,999	
26	Line marker	80-120kg	hr		34,091	
27	Concrete plant	0.5m3	hr		24,892	
28	Asphalt plant	50t/hr	hr		132,819	
29	Micro-bas	26 persons	hr		73,875	
30	Four-wheel drive	5 persons	hr		33,646	
31	Air Compressor	3.5-3.7m3/min	day		74,713	
32	Air Compressor	17m3/min	day		225,561	
33	Concrete breaker	20kg	day		8,000	
34	Bulldozer	32t	hr		140,442	
35	Back hoe	1.0m3	hr		83,557	
36	Tractor shovel	3.2m3	hr		105,963	
37	Tractor shovel	2.1m3	hr		75,611	
38	Track	11t	hr		31,476	
39	Track crane	20t	hr		63,561	
40	Tire roller	8t	hr		46,151	
41	Vibrating rubber tired roller	0.5t	hr		14,216	

Table12.2 Unit Cost for Major Work Items

Unit:Ushs.

No.	Description	Unit	Unit Price		Total
			Foreign Currency	Local Current	
1	Removable of existing pavement material	m2		510	510
2	Excavation(common)-A	m3		7,359	7,359
3	Excavation(common)-B	m3		5,599	5,599
4	Embankment	m3		18,383	18,383
5	Sodding	m2		1,664	1,664
6	Planting-A	Each		8,956	8,956
7	Planting-B	Each		2,904	2,904
8	Box culvert(2.25x1.5x4)	Each	2,728,163	72,764,870	75,493,033
9	Box culvert(1.8x1.5x3)	Each	1,979,356	48,861,543	50,840,899
10	Box culvert(2.2x1.2)	Each	915,129	22,371,775	23,286,904
11	Pipe culvert D600 (Type-A)	m	793	181,887	182,680
12	Pipe culvert D600 (Type-B)	m	3,096	252,545	255,641
13	L-side ditch	m	1,527	39,873	41,400
14	U-shaped drain ditch	m	4,683	96,230	100,913
15	Catch pit Type-A (400x700x1000)	Each	11,677	443,347	455,024
16	Catch pit Type-B (1000x1000x1000)	Each	155,645	277,499	433,144
17	Open Drain Type-A(2.5x1.0x0.5m)	m	9,970	160,690	170,660
18	Open Drain Type-B(3.5x1.0x0.5m)	m	12,894	203,912	216,806
19	Cleaning for existing Open Drain	m		7,729	7,729
20	Cleaning for existing Pipe Culvert	m		3,910	3,910
21	Cleaning for existing Box Culvert	m		19,948	19,948
22	Cleaning for existing Catch pit	Each		598	598
23	In-Outlet	Each	2,846	68,925	71,771
24	Head Wall(3300x500x1500)	Each	18,241	319,153	337,394
25	Median Kerb	m	1,587	30,419	32,006
26	Kerb stone	m	1,018	16,690	17,708
27	Flush Kerb	m	535	8,895	9,430
28	Flower Bed	m	931	29,210	30,141
29	Reinforced Concrete Slab	Each	11,117	414,445	425,562
30	Preparation of Subbase Course	m2		575	575
31	Subbase Course(t=15cm,1layer)	m2		4,787	4,787
32	Subbase Course(t=20cm,1layer)	m2		6,117	6,117
33	Subbase Course(t=25cm,2layers)	m2		8,244	8,244
34	Subbase Course(t=30cm,2layers)	m2		9,574	9,574
35	Subbase Course(t=35cm,2layers)	m2		10,904	10,904
36	Base Course(t=10cm,1layer)	m2		5,956	5,956
37	Base Course(t=15cm,1layer)	m2		8,485	8,485
38	Base Course(t=20cm,2layers)	m2		11,912	11,912
39	Base Course(t=30cm,2layers)	m2		16,970	16,970
40	Preparation for Overlay	m2	526	2,120	2,646
41	Asphalt Surface Course t=5cm	m2		9,963	9,963
42	Asphalt Binder Course t=5cm	m2		9,742	9,742
43	Tack Coat	m2		326	326
44	Prime Coat	m2		947	947
45	Side Walk	m2		5,964	5,964
46	Road Marking	m2	5,908	1,971	7,879
47	Traffic Signal	Set	116,845,319		116,845,319
48	Street Light	Each	6,398,889		6,398,889
49	Guardrail	m	173,518	1,050	174,568
50	Fence	m	664	63,842	64,506
51	Chatter-bar	Each	193,057	2,231	195,288
52	Guard Block	Each	2,104	55,246	57,350
53	Staircase of Embankment	Each	16,628	887,946	904,574
54	Excavating for Side Walk	m3	345	3,175	3,520
55	Access Road	Each		1,413,480	1,413,480
56	Road Sign	Each		194,831	194,831

12.5 Work Quantities

Work quantities were estimated on the basis of the basic design. A list of major work quantities is shown in Table 12.3.

12.6 Estimated Project Costs

Project costs were estimated as the product of unit cost for work items shown in Table 12.2 and work quantities shown in Table 12.3 as shown in Table 12.4, 5. These include a construction cost, physical contingency and price contingency as well as the engineering costs for the detailed design and construction supervision. A summary of the project cost by currency component is shown in Table 12.6.

12.7 Maintenance Cost

Road maintenance costs which are required after completion of the project are divided into two categories as follows.

- Routine maintenance
- Periodic maintenance

The content of each of the maintenance works and costs required were estimated as below.

(1) Routine Maintenance Cost

Routine maintenance consists of the following work items:

- Operation cost : Costs for electricity for street lighting, signal operation, etc.
- Cleaning cost : Costs for cleaning the road surface, drainage facilities, traffic sign boards, traffic divides, etc.
- Repairing cost : Costs for pavement repair, overlays, repainting of road markings, safety devices, and repair of traffic control facilities, etc.

According to the data for road maintenance by Kampala City Council, the average annual maintenance cost spent by the MOWTC Kampala district station in the past years is estimated at Ushs. 4 million per km. Taking these figures into consideration, the total routine maintenance cost for the above is estimated at around Ush. 6 million considering inflation until the start year of the project.

Table12.3 Summary of Work Quantities

No.	Description	Unit	Package 1					Package 2		Package 3	Package 4	Package 5	
			Natete Jct	Wandegeya Jct	Kibuye Jct	Port Bell Jct	Makerere Jct	Natete Road	Gaba Road	Port Bell Road	Gayaza Road	Hoima Road	Jinja Jct
1	Removable of existing pavement material	m2	200	700				900	1,200	2,300	1,100	2,000	
2	Excavation(common)-A	m3						7,000	9,000	6,000	8,000	8,000	
3	Excavation(common)-B	m3						3,000	4,000	5,000	3,000	4,000	
4	Embankment	m3						20,000	30,000	25,000	15,000	30,000	
5	Sodding	m2	1,000	1,300	2,000	720	1,300						2,000
6	Planting-A	Each			130	100	130						130
7	Planting-B	Each			4,900		5,200	37,000	59,400	28,000	19,000	65,000	4,900
8	Box culvert(2.25x1.5x4)	Each										1	
9	Box culvert(1.8x1.5x3)	Each							1				
10	Box culvert(2.2x1.2)	Each						2					
11	Pipe culvert D600 (Type-A)	m						1,070	2,120	780	830	1,830	
12	Pipe culvert D601 (Type-B)	m				50		22			14	14	
13	L-side ditch	m						1,790	3,560	1,320	1,370	3,050	
14	U-shaped drain ditch	m	1,500	1,400	1,000	750	1,000	7,540	11,000	1,970	1,850	12,600	1,200
15	Catch pit Type-A (400x700x1000)	Each	16	16	20	8	16						16
16	Catch pit Type-B (1000x1000x1000)	Each				4		142	282	104	112	246	
17	Open Drain Type-A(2.5x1.0x0.5m)	m				700	550	3,750	5,900			6,750	
18	Open Drain Type-B(3.5x1.0x0.5m)	m							4,420	8,550	7,360	6,900	
19	Cleaning for existing Open Drain	m	50	50	50	50	100	100	100	100	100	100	50
20	Cleaning for existing Pipe Culvert	m	30	30	30	30	30	30	50	110	180	70	30
21	Cleaning for existing Box Culvert	m						10	60	20	30	40	
22	Cleaning for existing Catch pit	Each	20	20	20	20	20	6	10	22	36	14	20
23	In-Outlet	Each						6	10	22	36	14	
24	Head Wall(3300x500x1500)	Each				1		10	38	14	26	46	
25	Median Kerb	m	250	250	400	100	300						980
26	Kerb stone	m					150	7,540	11,000	1,970	1,850	12,600	150
27	Flush Kerb	m	1,500	1,300	1,200	750	1,000	7,540	11,000	1,970	1,850	12,600	1,300
28	Flower Bed	m	1,000	1,300	900	250	950	6,910	11,000	1,970	1,850	12,600	900
29	Reinforced Concrete Slab	Each						30	46	35	14	45	
30	Preparation of Subbase Course	m2	6,800	5,100	1,200	3,100	1,600	7,960	29,000	19,840	22,750	23,600	1,200
31	Subbase Course(t=15cm,1layer)	m2						7,820	27,000		8,000		
32	Subbase Course(t=20cm,1layer)	m2				3,100				9,000		22,200	
33	Subbase Course(t=25cm,2layers)	m2								5,240			
34	Subbase Course(t=30cm,2layers)	m2							2,000	5,600	13,700	1,400	
35	Subbase Course(t=35cm,2layers)	m2	6,800	5,100	1,200		1,600	140			1,050		1,200
36	Base Course(t=10cm,1layer)	m2	2,200		7,000	3,100		8,230	29,000	23,300	22,300	23,600	8,800
37	Base Course(t=15cm,1layer)	m2	6,800	7,900			4,700	140			6,150		1,200
38	Base Course(t=20cm,2layers)	m2								5,240			
39	Base Course(t=30cm,2layers)	m2		5,100	1,200		1,600				1,050		
40	Preparation for Overlay	m2	2,200	7,900	7,000	2,700	4,700	22,800	54,600	28,920	27,600	51,000	8,800
41	Asphalt Surface Course t=5cm	m2	9,000	13,000	8,200	5,800	6,300	30,570	72,800	38,560	39,400	68,000	10,000
42	Asphalt Binder Course t=5cm	m2	9,000	13,000	8,200		6,300	8,370	73,400		50,500		10,000
43	Tack Coat	m2	9,000	13,000	8,200		6,300	30,570	117,200	20,220	60,400	51,000	10,000
44	Prime Coat	m2	9,000	13,000	1,200	5,800	6,300	8,370	29,000	18,340	29,500	17,000	10,000
45	Side Walk	m2	4,370	4,200	3,000	2,140	3,000	22,610	54,600	28,920	27,750	51,000	3,600
46	Road Marking	m2	460	560	160	320	120	470	1,050	710	740	910	280
47	Traffic Signal	Set	1	1		1							
48	Street Light	Each	22	39	30	17	23						34
49	Guardrail	m											
50	Fence	m		100					800	740		3,650	
51	Chatter-bar	Each	20	20	20	20	20						20
52	Guard Block	Each	22	39	30	17	23						34
53	Staircase of Embankment	Each		3				6	10	4	6	10	
54	Excavating for Side Walk	m3	500	1,000	1,300	500	2,300						1,300
55	Access Road	Each						71	141	62	61	121	
56	Road Sign	Each	12	12	15	9	12	20	45	30	30	35	12

Table12.4 Summary of Construction Cost

Unit:Ushs.

No.	Description	Unit	Package 1					Package 2		Package 3	Package 4	Package 5		Total
			Natete Jct	Makerere Jct	Kibuye Jct	Port Bell Jct	Wandegeya Jct	Natete Road	Gaba Road	Port Bell Road	Gayaza Road	Hoima Road	Jinja Jct	
1	Removable of existing pavement material	m2	102,000				357,000	459,000	612,000	1,173,000	561,000	1,020,000		4,284,000
2	Excavation(common)-A	m3						51,513,000	66,231,000	44,154,000	58,872,000	58,872,000		279,642,000
3	Excavation(common)-B	m3						16,797,000	22,396,000	27,995,000	16,797,000	22,396,000		106,381,000
4	Embankment	m3						367,660,000	551,490,000	459,575,000	275,745,000	551,490,000		2,205,960,000
5	Sodding	m2	1,664,000	2,163,200	3,328,000	1,198,080	2,163,200						3,328,000	13,844,480
6	Planting-A	Each		1,164,280	1,164,280	895,600							1,164,280	4,388,440
7	Planting-B	Each		15,100,800	14,229,600			107,448,000	172,497,600	81,312,000	55,176,000	188,760,000	14,229,600	648,753,600
8	Box culvert(2.25x1.5x4)	Each										75,493,033		75,493,033
9	Box culvert(1.8x1.5x3)	Each							50,840,899					50,840,899
10	Box culvert(2.2x1.2)	Each						46,573,807						46,573,807
11	Pipe culvert D600 (Type-A)	m						195,468,078	387,282,547	142,490,748	151,624,771	334,305,218		1,211,171,362
12	Pipe culvert D601 (Type-B)	m				12,782,058		5,624,106			3,578,976	3,578,976		25,564,117
13	L-side ditch	m						74,105,145	147,382,300	54,647,370	56,717,346	126,268,544		459,120,705
14	U-shaped drain ditch	m	151,369,591	100,913,061	100,913,061	75,684,795	141,278,285	760,884,477	1,110,043,666	198,798,729	186,689,162	1,271,504,563	121,095,673	4,219,175,062
15	Catch pit Type-A (400x700x1000)	Each	7,280,391	7,280,391	9,100,489	3,640,196	7,280,391						7,280,391	41,862,251
16	Catch pit Type-B (1000x1000x1000)	Each				1,732,576		61,506,437	122,146,587	45,046,968	48,512,120	106,553,405		385,498,093
17	Open Drain Type-A(2.5x1.0x0.5m)	m		93,862,907		119,461,881		639,974,365	1,006,893,000			1,151,953,856		3,012,146,010
18	Open Drain Type-B(3.5x1.0x0.5m)	m							958,280,351	1,853,687,104	1,595,688,548	1,495,958,014		5,903,614,017
19	Cleaning for existing Open Drain	m	386,450	772,900	386,450	386,450	386,450	772,900	772,900	772,900	772,900	772,900	386,450	6,569,650
20	Cleaning for existing Pipe Culvert	m	117,300	117,300	117,300	117,300	117,300	117,300	195,500	430,100	703,800	273,700	117,300	2,424,200
21	Cleaning for existing Box Culvert	m						199,480	1,196,880	398,960	598,440	797,920		3,191,680
22	Cleaning for existing Catch pit	Each	11,960	11,960	11,960	11,960	11,960	3,588	5,980	13,156	21,528	8,372	11,960	124,384
23	In-Outlet	Each						430,626	717,711	1,578,963	2,583,758	1,004,795		6,315,853
24	Head Wall(3300x500x1500)	Each				337,394		3,373,937	12,820,959	4,723,511	8,772,235	15,520,108		45,548,143
25	Median Kerb	m	8,001,473	9,601,768	12,802,357	3,200,589	8,001,473						31,365,776	72,973,437
26	Kerb stone	m		2,656,152				133,515,920	194,784,498	34,884,133	32,759,211	223,116,789	2,656,152	624,372,856
27	Flush Kerb	m	14,144,571	9,429,714	11,315,657	7,072,286	12,258,628	71,100,044	103,726,855	18,576,537	17,444,971	118,814,398	12,258,628	396,142,289
28	Flower Bed	m	30,141,437	28,634,366	27,127,294	7,535,359	39,183,869	208,277,333	331,555,812	59,378,632	55,761,659	379,782,112	27,127,294	1,194,505,166
29	Reinforced Concrete Slab	Each						12,766,856	19,575,846	14,894,666	5,957,866	19,150,285		72,345,519
30	Preparation of Subbase Course	m2	3,910,000	920,000	690,000	1,782,500	2,932,500	4,577,000	16,675,000	11,408,000	13,081,250	13,570,000	690,000	70,236,250
31	Subbase Course(t=15cm,1layer)	m2						37,434,340	129,249,000		38,296,000			204,979,340
32	Subbase Course(t=20cm,1layer)	m2				18,962,700				55,053,000		135,797,400		209,813,100
33	Subbase Course(t=25cm,2layers)	m2								43,198,560				43,198,560
34	Subbase Course(t=30cm,2layers)	m2							19,148,000	53,614,400	131,163,800	13,403,600		217,329,800
35	Subbase Course(t=35cm,2layers)	m2	74,147,200	17,446,400	13,084,800		55,610,400	1,526,560			11,449,200		13,084,800	186,349,360
36	Base Course(t=10cm,1layer)	m2	13,103,200		41,692,000	18,463,600		49,017,880	172,724,000	138,774,800	132,818,800	140,561,600	52,412,800	759,568,680
37	Base Course(t=15cm,1layer)	m2	57,698,000	39,879,500			67,031,500	1,187,900			52,182,750		10,182,000	228,161,650
38	Base Course(t=20cm,2layers)	m2								62,418,880				62,418,880
39	Base Course(t=30cm,2layers)	m2		27,152,000	20,364,000		86,547,000				17,818,500			151,881,500
40	Preparation for Overlay	m2	5,821,397	12,436,621	18,522,628	7,144,442	20,904,108	60,330,845	144,476,496	76,524,913	73,032,075	134,950,573	23,285,589	577,429,689
41	Asphalt Surface Course t=5cm	m2	89,667,000	62,766,900	81,696,600	57,785,400	129,519,000	304,568,910	725,306,400	384,173,280	392,542,200	677,484,000	99,630,000	3,005,139,690
42	Asphalt Binder Course t=5cm	m2	87,678,000	61,374,600	79,884,400		126,646,000	81,540,540	715,062,800		491,971,000		97,420,000	1,741,577,340
43	Tack Coat	m2	2,934,000	2,053,800	2,673,200		4,238,000	9,965,820	38,207,200	6,591,720	19,690,400	16,626,000	3,260,000	106,240,140
44	Prime Coat	m2	8,523,000	5,966,100	1,136,400	5,492,600	12,311,000	7,926,390	27,463,000	17,367,980	27,936,500	16,099,000	9,470,000	139,691,970
45	Side Walk	m2	26,062,680	17,892,000	17,892,000	12,762,960	25,048,800	134,846,040	325,634,400	172,478,880	165,501,000	304,164,000	21,470,400	1,223,753,160
46	Road Marking	m2	3,624,215	945,447	1,260,597	2,521,193	4,412,088	3,703,002	8,272,665	5,593,897	5,830,259	7,169,643	2,206,044	45,539,050
47	Traffic Signal	Set	116,845,319			116,845,319	116,845,319							350,535,957
48	Street Light	Each	140,775,560	147,174,449	191,966,673	108,781,115	249,556,675						217,562,229	1,055,816,701
49	Guardrail	m												
50	Fence	m					6,450,608		51,604,864	47,734,500		235,447,193		341,237,165
51	Chatter-bar	Each	3,905,766	3,905,766	3,905,766	3,905,766	3,905,766						3,905,766	23,434,598
52	Guard Block	Each	1,261,708	1,319,058	1,720,511	974,956	2,236,664						1,949,912	9,462,809
53	Staircase of Embankment	Each					2,713,722	5,427,443	9,045,739	3,618,296	5,427,443	9,045,739		35,278,381
54	Excavating for Side Walk	m3	1,759,988	8,095,947	4,575,970	1,759,988	3,519,977						4,575,970	24,287,840
55	Access Road	Each						100,357,080	199,300,680	87,635,760	86,222,280	171,031,080		644,546,880
56	Road Sign	Each	2,337,972	2,337,972	2,922,465	1,753,479	2,337,972	3,896,620	8,767,395	5,844,930	5,844,930	6,819,085	2,337,972	45,200,792

Table12.5 Summary of Project Cost by Construction Package

No.	Description	Unit	Unit Rate (Ushs.)	Package1 Quantity	Package1 Amount(Ushs.)	Package2 Quantity	Package2 Amount(Ushs.)	Package3 Quantity	Package3 Amount(Ushs.)	Package4 Quantity	Package4 Amount(Ushs.)	Package5 Quantity	Package5 Amount(Ushs.)	Total Quantity	Total Amount(Ushs.)
A. Construction Cost															
1	Removable of existing pavement material	m2	510	900	459,000	2,100	1,071,000	2,300	1,173,000	1,100	561,000	2,000	1,020,000	8,400	4,284,000
2	Excavation(common)-A	m3	7,359			16,000	117,744,000	6,000	44,154,000	8,000	58,872,000	8,000	58,872,000	38,000	279,642,000
3	Excavation(common)-B	m3	5,599			7,000	39,193,000	5,000	27,995,000	3,000	16,797,000	4,000	22,396,000	19,000	106,381,000
4	Embankment	m3	18,383			50,000	919,150,000	25,000	459,575,000	15,000	275,745,000	30,000	551,490,000	120,000	2,205,960,000
5	Sodding	m2	1,664	6,320	10,516,480							2,000	3,328,000	8,320	13,844,480
6	Planting-A	Each	8,956	360	3,224,160							130	1,164,280	490	4,388,440
7	Planting-B	Each	2,904	10,100	29,330,400	96,400	279,945,600	28,000	81,312,000	19,000	55,176,000	69,900	202,989,600	223,400	648,753,600
8	Box culvert(2.25x1.5x4)	Each	75,493,033									1	75,493,033	1	75,493,033
9	Box culvert(1.8x1.5x3)	Each	50,840,899			1	50,840,899							1	50,840,899
10	Box culvert(2.2x1.2)	Each	23,286,904			2	46,573,807							2	46,573,807
11	Pipe culvert D600 (Type-A)	m	182,680			3,190	582,750,625	780	142,490,748	830	151,624,771	1,830	334,305,218	6,630	1,211,171,362
12	Pipe culvert D601 (Type-B)	m	255,641	50	12,782,058	22	5,624,106			14	3,578,976	14	3,578,976	100	25,564,117
13	L-side ditch	m	41,400			5,350	221,487,445	1,320	54,647,370	1,370	56,717,346	3,050	126,268,544	11,090	459,120,705
14	U-shaped drain ditch	m	100,913	5,650	570,158,792	18,540	1,870,928,143	1,970	198,798,729	1,850	186,689,162	13,800	1,392,600,236	41,810	4,219,175,062
15	Catch pit Type-A (400x700x1000)	Each	455,024	76	34,581,859							16	7,280,391	92	41,862,251
16	Catch pit Type-B (1000x1000x1000)	Each	433,144	4	1,732,576	424	183,653,024	104	45,046,968	112	48,512,120	246	106,553,405	890	385,498,093
17	Open Drain Type-A(2.5x1.0x0.5m)	m	170,660	1,250	213,324,788	9,650	1,646,867,365					6,750	1,151,953,856	17,650	3,012,146,010
18	Open Drain Type-B(3.5x1.0x0.5m)	m	216,806			4,420	958,280,351	8,550	1,853,687,104	7,360	1,595,688,548	6,900	1,495,958,014	27,230	5,903,614,017
19	Cleaning for existing Open Drain	m	7,729	300	2,318,700	200	1,545,800	100	772,900	100	772,900	150	1,159,350	850	6,569,650
20	Cleaning for existing Pipe Culvert	m	3,910	150	586,500	80	312,800	110	430,100	180	703,800	100	391,000	620	2,424,200
21	Cleaning for existing Box Culvert	m	19,948			70	1,396,360	20	398,960	30	598,440	40	797,920	160	3,191,680
22	Cleaning for existing Catch pit	Each	598	100	59,800	16	9,568	22	13,156	36	21,528	34	20,332	208	124,384
23	In-Outlet	Each	71,771			16	1,148,337	22	1,578,963	36	2,583,758	14	1,004,795	88	6,315,853
24	Head Wall(3300x500x1500)	Each	337,394	1	337,394	48	16,194,895	14	4,723,511	26	8,772,235	46	15,520,108	135	45,548,143
25	Median Kerb	m	32,006	1,300	41,607,661							980	31,365,776	2,280	72,973,437
26	Kerb stone	m	17,708	150	2,656,152	18,540	328,300,418	1,970	34,884,133	1,850	32,759,211	12,750	225,772,941	35,260	624,372,856
27	Flush Kerb	m	9,430	5,750	54,220,856	18,540	174,826,899	1,970	18,576,537	1,850	17,444,971	13,900	131,073,026	42,010	396,142,289
28	Flower Bed	m	30,141	4,400	132,622,325	17,910	539,833,145	1,970	59,378,632	1,850	55,761,659	13,500	406,909,406	39,630	1,194,505,166
29	Reinforced Concrete Slab	Each	425,562			76	32,342,703	35	14,894,666	14	5,957,866	45	19,150,285	170	72,345,519
30	Preparation of Subbase Course	m2	575	17,800	10,235,000	36,960	21,252,000	19,840	11,408,000	22,750	13,081,250	24,800	14,260,000	122,150	70,236,250
31	Subbase Course(t=15cm,1layer)	m2	4,787			34,820	166,683,340			8,000	38,296,000			42,820	204,979,340
32	Subbase Course(t=20cm,1layer)	m2	6,117	3,100	18,962,700			9,000	55,053,000			22,200	135,797,400	34,300	209,813,100
33	Subbase Course(t=25cm,2layers)	m2	8,244					5,240	43,198,560					5,240	43,198,560
34	Subbase Course(t=30cm,2layers)	m2	9,574			2,000	19,148,000	5,600	53,614,400	13,700	131,163,800	1,400	13,403,600	22,700	217,329,800
35	Subbase Course(t=35cm,2layers)	m2	10,904	14,700	160,288,800	140	1,526,560			1,050	11,449,200	1,200	13,084,800	17,090	186,349,360
36	Base Course(t=10cm,1layer)	m2	5,956	12,300	73,258,800	37,230	221,741,880	23,300	138,774,800	22,300	132,818,800	32,400	192,974,400	127,530	759,568,680
37	Base Course(t=15cm,1layer)	m2	8,485	19,400	164,609,000	140	1,187,900			6,150	52,182,750	1,200	10,182,000	26,890	228,161,650
38	Base Course(t=20cm,2layers)	m2	11,912					5,240	62,418,880					5,240	62,418,880
39	Base Course(t=30cm,2layers)	m2	16,970	7,900	134,063,000					1,050	17,818,500			8,950	151,881,500
40	Preparation for Overlay	m2	2,646	24,500	64,829,197	77,400	204,807,341	28,920	76,524,913	27,600	73,032,075	59,800	158,236,163	218,220	577,429,689
41	Asphalt Surface Course t=5cm	m2	9,963	42,300	421,434,900	103,370	1,029,875,310	38,560	384,173,280	39,400	392,542,200	78,000	777,114,000	301,630	3,005,139,690
42	Asphalt Binder Course t=5cm	m2	9,742	36,500	355,583,000	81,770	796,603,340			50,500	491,971,000	10,000	97,420,000	178,770	1,741,577,340
43	Tack Coat	m2	326	36,500	11,899,000	147,770	48,173,020	20,220	6,591,720	60,400	19,690,400	61,000	19,886,000	325,890	106,240,140
44	Prime Coat	m2	947	35,300	33,429,100	37,370	35,389,390	18,340	17,367,980	29,500	27,936,500	27,000	25,569,000	147,510	139,691,970
45	Side Walk	m2	5,964	16,710	99,658,440	77,210	460,480,440	28,920	172,478,880	27,750	165,501,000	54,600	325,634,400	205,190	1,223,753,160
46	Road Marking	m2	7,879	1,620	12,763,540	1,520	11,975,667	710	5,593,897	740	5,830,259	1,190	9,375,687	5,780	45,539,050
47	Traffic Signal	Set	116,845,319	3	350,535,957									3	350,535,957
48	Street Light	Each	6,398,889	131	838,254,472							34	217,562,229	165	1,055,816,701
49	Guardrail	m	174,568												
50	Fence	m	64,506	100	6,450,608	800	51,604,864	740	47,734,500			3,650	235,447,193	5,290	341,237,165
51	Chatter-bar	Each	195,288	100	19,528,832							20	3,905,766	120	23,434,598
52	Guard Block	Each	57,350	131	7,512,897							34	1,949,912	165	9,462,809
53	Staircase of Embankment	Each	904,574	3	2,713,722	16	14,473,182	4	3,618,296	6	5,427,443	10	9,045,739	39	35,278,381
54	Excavating for Side Walk	m3	3,520	5,600	19,711,870							1,300	4,575,970	6,900	24,287,840
55	Access Road	Each	1,413,480			212	299,657,760	62	87,635,760	61	86,222,280	121	171,031,080	456	644,546,880
56	Road Sign	Each	194,831	60	11,689,860	65	12,664,015	30	5,844,930	30	5,844,930	47	9,157,057	232	45,200,792
		Total(A)			3,927,932,197		11,417,264,300		4,216,563,273		4,246,146,679		8,814,028,887		32,621,935,336
B. Contractor Overhead															
	(20% of the construction cost)				785,586,439		2,283,452,860		843,312,655		849,229,336		1,762,805,777		6,524,387,067
C. Consultancy Service															
	Detail Design (4% of the construction cost)				157,117,288		456,690,572		168,662,531		169,845,867		352,561,155		1,304,877,413
	Supervison (6% of the construction cost)				235,675,932		685,035,858		252,993,796		254,768,801		528,841,733		1,957,316,120
		Total(C)			392,793,220		1,141,726,430		421,656,327		424,614,668		881,402,889		3,262,193,534
	Total of the Project Cost (A+B+C)				5,106,311,855		14,842,443,590		5,481,532,255		5,519,990,682		11,458,237,554		42,408,515,937
D. Administration Cost of Uganda Government															
	Operation Cost of Government Project Office (1% of the construction cost)				26,450,592		109,989,472		40,527,100		40,980,423		82,468,456		300,416,043
		Total(D)			26,450,592		109,989,472		40,527,100		40,980,423		82,468,456		300,416,043
	Grand Total (A+B+C+D)				5,132,762,448		14,952,433,062		5,522,059,355		5,560,971,106		11,540,706,009		42,708,931,980

US$=1.0=¥120.88=Ushs.1042.52

Table12.6 Summary of Project Costs by Currency Portion

Unit : Ushs.

No. Description	Amount		
	Foreign Portion	Local Portion	Total
A. Construction Cost			
(Package-1)			
Natete Jct	274,917,424	578,356,756	853,274,180
Makerere rdbt	167,460,598	515,914,762	683,375,360
Kibya rdbt	207,998,602	456,485,855	664,484,457
Port Bell Jct	245,179,567	347,812,976	592,992,543
Wandegeya Jct	387,316,760	746,488,896	1,133,805,656
Total (1)	1,282,872,952	2,645,059,245	3,927,932,197
(Package-2)			
Natete Road	133,824,087	3,431,053,682	3,564,877,769
Gaba Road	284,493,031	7,567,893,500	7,852,386,531
Total (2)	418,317,118	10,998,947,182	11,417,264,300
(Package-3)			
Port Bell Road	163,853,260	4,052,710,013	4,216,563,273
Total (3)	163,853,260	4,052,710,013	4,216,563,273
(Package-4)			
Gayaza Road	148,104,369	4,098,042,310	4,246,146,679
Total (4)	148,104,369	4,098,042,310	4,246,146,679
(Package-5)			
Hoima Road	329,908,447	7,699,655,454	8,029,563,901
Jinja rdbt	237,274,889	547,190,098	784,464,987
Total (5)	567,183,335	8,246,845,552	8,814,028,887
Total (1)+(2)+(3)+(4)+(5)	2,580,331,034	30,041,604,302	32,621,935,336
B. Contractor Overhead (20% of Const. cost)	516,066,207	6,008,320,860	6,524,387,067
C. Engineering Cost Detailed Design & Supervision (10% of Const. cost)	258,033,103	3,004,160,430	3,262,193,534
D. Government Administration Cost (1% of Const. cost)		300,416,043	300,416,043
Grand Total (A)+(B)+(C)+(D)	3,354,430,344	39,354,501,636	42,708,931,980

US$=1.0=¥120.88=Ushs.1042.52

(2) Periodic Maintenance Cost

Periodic maintenance work was assumed to be executed throughout the project life with a large scale overlay at a 10 year interval. In the overlay work 5 cm thick resurfacing work was proposed. The cost of periodic maintenance work was estimated at around Ushs. 80 million per km. It was assumed that the periodic maintenance work would be carried out on the two thirds of the total length of the road sections.

12.8 Proposal for Strengthening of Road Maintenance Capability

12.8.1 Technical Issues on Maintenance Work and Improvement Measures

(1) Special Care for Roadside Drainage Structure

The main cause of pavement deterioration is generally due to an increase in traffic volume of large-sized vehicles. However, in Kampala inadequate maintenance, especially on drainage facilities, is the main causes of permanent deterioration.

The roadside drainage system in urban and sub- urban areas are mostly served by lined channels and underground piped systems, however, these systems are not working well due to the small capacity of the structures as well as inadequate drainage maintenance.

Kampala City is dusty throughout the seasons due to the nature of the soil and the geology. Blocking of gratings by soils, in addition to the sedimentation in drainage structure, have frequently brought about flooding along the roadsides which have caused serious difficulties for vehicles and pedestrians during the rainy season. Such flooding had also greatly shortened the pavement life. The problems can be solved if routine maintenance including the following works is undertaken properly and timely:

a) Cleaning the blocked of gratings and sedimentation in the roadside drainage structures,

b) Removing the sand/mud heaped on the road and sidewalk,

c) Dredging the mud in the channels, and

d) Widening of the channels.

The above works are labour intensive routine maintenance which may not require a large budget, so it is advised for the agencies concerned to give priority to the above routine maintenance and allocate a sufficient budget for these works.

(2) Improvement of Storm Drainage System

With the current rapid increase of people in Kampala, the urban area is expanding outside the city and spreading in a rather uncontrolled and disorderly manner. In the newly developed urban areas, improvement and maintenance of storm drainage is a serious problem which needs to be solved. These improvement measures, however, should be implemented incorporating the development plan of other sectors, especially the road sector to minimize the investment as well the environmental investment program.

(3) Rehabilitation of Pavement by Private Works

Some of the pavements of roads in the city are already damaged in several places by the installation of water supply and sewerage pipes incidental to the construction of building alongside the road. This destruction should be repaired soon after completion of the building work, however it is usually left for a long time without any emergency repair, which results in the expansion of pavement deterioration as well as serious traffic accidents.

Improvement of the repairing system for such type of destruction should be established as soon as possible with a penalty system being applied to the person responsible for repairs.

(4) Introduction of Systematic Maintenance Program

The Ministry are currently not using systems for the planning and programming of local maintenance operations. The Uganda Highway Evaluation Model, UHEM, which was used to define the original Four Year Programme is no longer being used. Consultants are currently developing a new system in parallel with this Study which has been based on the principles embodied in the old UHEM but which is being structured so that it can be used as a management tool for the planning and monitoring of both periodic and routine maintenance. The new system will use condition data from the district engineers, collected in the same format as for the current Study, to define the state of the network and prioritize required maintenance treatments within defined budget constraints.

In 1994, the Ministry commissioned a local software consultancy to develop a Management Information System, MIS, for use by the Maintenance and Planning Sections. The development work was not completed and it is understood that there were problems incorporating engineering related aspects into the system design. The system was being set up to store and procure data from the district engineers' monthly reports. A cost accounting module was also to form part of the final MIS.

(5) Strengthening of Training Facilities for Road Maintenance

The Public Works Training center at Kyambogo, which has been rehabilitated and reequipped in 1995, constitutes the main training facility available to MOWTC. Facilities include offices, residential accommodation classrooms and a conference hall. However, these facilities are not fully operated for the training of road maintenance engineers. Fully utilization of the facilities is strongly recommended.

12.8.2 Institutional Issues on Maintenance Work and Improvement Measures

(1) Integration of Road Administration

The MOWTC is responsible for the management of the main roads while Local Authorities are responsible for the feeder and urban roads management. The Engineering Department of the Ministry of Local Government (MOLG) offers technical support to the Local Authorities. Feeder roads, urban roads and main roads are all part and parcel of an integrated road network.

It is hence essential to develop linkages between the various road administrations in order to adopt an integrated and complimentary approach to the management of the road network. An appropriate road agency with the responsibility of managing the entire road network needs to be established. Such an agency should be adequately facilitated and should have an autonomous status to enable it execute its affairs outside conventional government bureaucracy.

(2) Adequate and Timely Financing for Road Maintenance

The establishment of a road fund as a financing mechanism that would ensure adequate and timely financing of road and traffic management operations is a necessity. The funds to be directly channeled to the road fund may either be the budgeted resources of the identified road user charges. The road fund would have the advantage of attracting additional extra-budgetary resources to further ensure financing adequacy. Early establishment of road funding system is being requested.

(3) Institutional Strengthening of MOWTC

There is a need to strengthen the capacity of the MOWTC to undertake the maintenance work as well as the functions of planning and monitoring, project and contract management, procurement and construction supervision of road works.

It is the intention of the government that under the 10-Year Road Sector Development Proposal technical assistance or consultants' support will be provided to the planning and implementation of road maintenance works. The programme should provide for the training of engineers with the courses in planning, procurement, monitoring, control, evaluation and management in terms of financial, economical, technical and legal aspects of projects.

(4) Updating/development of MOWTC's management, operating and maintenance policies, standards and procedures ensuring a commercial approach

MOWTC has done much work in these areas in the recent past. A comprehensive review, harmonization and improvement of the current policies/strategies/practices is, however, still necessary in the following areas:

(a) Road network management and operational policies and strategies;

Functional classification of road network, introduction of road hierarchy, traffic management by area, and so on.

(b) Road design and maintenance standards and specifications;

Preparation of road design standard and specifications for urban roads.

(c) Maintenance work execution procedures;

Strengthening of planning function, streamlining of financial procedure and arrangement, pulse taking and monitoring of on-going plans, and provision of adjustment function.

(d) Systematic road maintenance procedures;

Introduction of central management system, mobilization plan of maintenance equipment, machinery and personnels. Simplification of contract method and coordination with private sector.

(e) Road safety and traffic management;

Strengthening of traffic management during the execution of maintenance work, with the provision of information system, personnel and necessary equipment. Coordination with traffic police, education of drivers and pedestrians.

(f) Environment protection works in road construction and maintenance;

Introduction of environmental guideline and strengthening of penalty system in the case of violation and monitoring system. Specification of construction measure to protect environment.

(5) The development of the local construction industry

It is general government policy to divest itself of most public enterprises and pass them on to the private sector. In this context, MOWTC seeks to involve the private sector to the greatest extent possible in all areas of road design, construction and maintenance. This calls for a private consulting and contracting industry that is capable of taking on the challenge. The ministry has pursued this policy for some time but stepped it up in the last 4 years so that to date, all manual routine maintenance is done by lengthman contractors, 30% mechanized routine maintenance by local contractors and all periodic maintenance by contract. The target is that by 1998, 80% of all road maintenance should be executed by contract. Likewise all upgrading, improvement and rehabilitation works are done by contract. On average, road maintenance works which are generally small in scope are done by local or domestic contractors while the large upgrading, improvement ad rehabilitation projects study and design assignments are undertaken by multi-national firms of contractors and consultants owing to their big sizes and multi-disciplinary character. From a sustainability point of view, government intends to institute and pursue a deliberate policy to strengthen and facilitate domestic contractors and consultants up to a point when they can take over from multi-national firms the bulk or all of the road maintenance and construction works.

(6) Strengthening of the functions of the central materials laboratory

The Central Materials Laboratory (CML) is a section of the Development Department of MOWTC.

CML is a national testing centre for construction materials. The Laboratory also perform is the following functions for the entire construction industry:

(a) Quality control;
(b) Geotechnical investigations;
(c) Pavement evaluations;
(d) Structural evaluation of buildings;
(e) Research, and
(f) Training.

Presently, CML can no longer meet the demands of the construction industry. There is urgent need for improvement of the functions and management of CML in order to improve the overall quality of services rendered by the construction industry. It is proposed to strengthen the laboratory by:

- Provision of needed equipment, technical assistance and training,
- Assistance with research in the use of non-traditional road building materials and satellite technology in the survey and location of road construction materials,
- Establishment of appropriate regional materials laboratories, and
- Provision of new physical facilities.

12.9 Traffic Signal Management System

(1) Outline

After examining the Kampala city intersection's existing traffic signal system, the following adjustments (pertaining to discussed improvements) are necessary to promote a more efficient system.

Presently four of the five inter city traffic signals are in working order. However, these traffic signals are not well maintained in the following sense:.

(a) Inappropriate traffic signal cycle timing,

(b) Lack of vehicle road markings for lane indication function,

(c) Inadequate power supply system,

(d) Lack of pedestrian safety system, and

(e) Lack of routine maintenance on existing systems.

(2) Traffic Signal Management

In order for vehicles to follow the proper rules at intersections, road markings including right-turn lane, pedestrian crossing, stop lines, lane division line, etc. will be necessary. To maintain pedestrian safety, a guardrail or flower bed will be used to distinguish the road from pedestrian ways. Likewise, a pedestrian crossing signal or sidewalk will be established.

Our proposal to stabilize the power supply to traffic signals is as follows:

a) From the power source (high voltage line) directly supply junctions via a step down facility (low voltage electricity). In the event of an area power outage, junction power supply will be uninterrupted.

b) In the event of power outage, install battery back-up system at junction.

(3) Traffic Signal Maintenance System

The following will be required for signal maintenance system:

Vehicle

- Lift car (1 Nos) for signal cleaning and/or lamp exchange etc.
- Cargo truck (1 Nos) for crew and materials transportation.

Staff

- Mechanical engineer (1)
- Electrical engineer (1)
- Common worker (2)
- Vehicle driver (2)

One maintenance crew consists of two vehicles and six crew members.

12.10 Traffic Management During the Execution of Project

The widening of the existing road may sometimes seriously interfere with the traffic flow during construction. Since the project roads and junctions carry large numbers of vehicles, special care has to be taken for traffic management. Detours during the construction shall be properly provided with the introduction of appropriate traffic signs and guides. Also, night work is recommended to be minimized.

Road improvement works require relocation of existing bus bays and bus stops which may hinder the operation of public transport services. A temporary facility shall be provided nearby the existing bus bays for the convenience of bus users during the execution of the project.