5.7% and 3.7% for the production and population, the freight and passengers on railways have been projected to increase by 2005 to 2.03 times and 2.32 times the levels in 1985, respectively.

Roads

Freight traffics on roads have been estimated by subtracting the railway traffics from the total traffics for both 1985 and 2005. The estimated road freight in 2005 is 3.37 times the estimate for 1985.

Future passenger traffics on road have been estimated as the product of projected population and traffics per population. The traffics per population have been estimated by using the elasticity with respect to per capita GRDP calculated to be 0.77 from the past data. The passenger traffics on road in 2005 have been thus estimated to be 2.90 times the level in 1985.

The estimated passenger and freight traffics are converted into the number of cars of standard capacity, respectively. The total road traffics are obtained by further converting the number of standard freight cars into passenger car units (PCU's) and adding to the number of passenger cars. The total road traffics in 2005 will be 3.20 times the traffics in 1985 in terms of passenger car units.

Airways

Airways traffics have been forecasted independently from other modes of transportation, as income levels of passengers and purposes of trips are generally quite different for airways. The annual growth rate of passengers is obtained as a product of annual population growth rates of origin and destination areas. In addition to existing Kisumu-Nairobi line, another line for Eldoret-Nairobi was considered. The average annual growth rates of passengers have been calculated to be 13.3% and 13.8% for Kisumu-Nairobi and Eldoret-Nairobi lines, respectively.

(3) Future traffics on network

Future traffics on network have been estimated first by applying the growth ratios calculated above equally to all the present network traffics and second by adjusting them on the basis of difference in growth of different areas as outlined in the previous sub-section.

The growth ratios estimated above are summarized in Table 8.15. These ratios are adjusted for each segment of the network to reflect the difference in growth of origin/destination areas of the segment. The estimated future traffics on the network are shown in Figure 8.14.

8.3 Strategy for Transport Development

8.3.1 Policies related to transport development

(1) National policy

Of the Nation's long-term objectives, equitable or balanced development is particularly related to transportation infrastructure, as well as the economic growth objective (Section 2.2, Master Plan Report). The balanced development has two spatial aspects: i.e. inter-regional balance and intra-regional balance.

As for the inter-regional balance, linkages between different regions as an essential prerequisite have been well established as far as the trunk road network is concerned. In fact, the road network in Kenya has been very well planned, on the basis of functional divisions among different classes of roads, and the implementation of road projects is now entering the age of minor roads from that of trunk roads. The only remaining question related to transport development for inter-regional balance is the capacity of some section of existing trunk roads and railways. This is why the current National Development Plan has accorded the highest priority in transportation to the maintenance and rehabilitation of the existing infrastructure facilities.

For the intra-regional balance, the improvement of linkages between larger urban centers and secondary towns and among smaller towns is necessary, for which there is much to be done. In particular, the Sessional Paper No.1 of 1986 emphasizes the rural-urban balance as one of the important policies to attain high economic performance by improving linkages between productive agricultural areas and urban centers for providing production inputs and marketing channels. Of the general measures emphasized in the paper, those related to transportation infrastructure are the following.

1) To broaden the central Mombasa-Nairobi-Uganda corridor, the Government will upgrade a few existing highways connecting secondary towns with superior growth potential; and

2) To stimulate economic exchange between productive rural areas and small towns, rural roads will be improved where they are likely to enable such towns to grow into distribution and marketing centers.

(2) Regional policy

The LBDA, as the regional development authority for 47,709 km^2 territory and 8.1 million population, has set its policy for the development of basic infrastructure including transportation. The primary objectives for transport development are:

1) to serve productive rural areas,
2) to improve linkages between rural and urban areas, and
3) to improve access to and from outer regions.

The first objective aims at improving rural access and feeder roads first for stimulating the development of agriculture, as the mainstay of the Region's economy, for increased production of important cash and food crops, and second for serving fishery towns along the Lake. The second objective is for facilitating the distribution of production inputs and the marketing of products by improving primary roads. The third objective aims at maintaining and upgrading the existing trunk road and railway networks, connecting this Region to outer regions and the neighbouring countries.

8.3.2 Strategy for transport development

Based on the analysis of existing transportation infrastructure, and in line with the national and region policies related to transport development, the overall strategy for the transport development in the Region has been devised. This strategy dictates in general terms major directions of development for different modes of transport as follows.

1) To improve the existing road network as the prime mode of transportation in the Region to meet both inter- and intra-regional demand first by maintaining and upgrading the existing trunk roads and second by improving such primary roads that would expand the network from the trunk road;

2) To improve the railway transport network primarily as the means to encourage inter-regional and international communication;

3) To utilize the water transport especially of the Winam Gulf not only to connect districts and areas around the Lake but also to serve as an effective link between different modes of transport such as roads and railways; and

4) To improve the air transport by upgrading selected airports and establishing a network of services for promotion of a wider range of activities in a longer run, including conference/communication activities, international tourism and others.

8.3.3 Strategies for road network development

(1) Trunk roads

All the trunk roads of classes A and B in the Region are bitumen paved except some sections of B3 in Narok. For these roads, the following strategies should be taken to further improve the transport capacity.

1) To overlay degraded road sections, especially on A104 as a matter of urgency;

2) To provide climbing lanes or to double the number of lanes to four in selected sections of heavy traffic; and

3) To provide roads with proper geometric design to reduce traffic accidents.

In addition, the following should be considered to create awareness of the people to the public nature of roads as well as to raise additional funds for road construction.

4) To introduce more tolled roads by carefully selecting the routes and considering socio-economic effects, and

5) To examine a petroleum tax as a specified source of fund for road construction.

Flyovers or traffic lights should be provided at inter sections of trunk roads in a longer run.

(2) Primary roads

Primary roads of class C supplement the trunk roads to serve inter-provincial and inter-district needs for transportation. They should be planned reflecting not only financial capacity of the Government but also characteristics of an area which each road is supposed to serve such as distribution and intensity of economic activities, seasonal variation in traffic demand, specific development plans and projects, amount and intensity of rainfalls, topography and other natural conditions.

The ratio of bitumened road length to the total is 27% (1985) for primary roads in the Region. Thus the strategies for this class of roads are:

1) to complete a system of all weather roads, and
2) to increase the ratio of bitumened roads.

Under these strategies, two-step construction of primary roads is recommended. That is, a non-all weather road should first be gravelled with the standard width and alignment, and also sufficient measure for drainage. This will serve traffic demand with small repair costs as long as demand for heavy traffic is small. Second, the road may be bitumened as the traffic demand reaches a certain level. This method will allow the completion of a system of all-weather roads twice as fast with the same budget, as the total costs of paved roads consist of almost equal cost for both civil works and pavement works.

(3) Minor roads

Roads of classes D and E as well as rural access roads serve primarily for daily needs in rural areas. Most of class D/E roads are inadequate in terms of width and alignment, and difficult to pass during or after heavy rains. Rural access roads supplement the class D/E roads in serving public facilities and production activities in rural areas and in supporting land reclamation.

These roads should be improved with the following strategies:

1) To extend the length of all-weather roads of classes D and E under the gravelling program; and

2) To promote the rural access road program aiming at serving not only existing agricultural areas but also new areas to be expanded for agriculture.

(4) Inter-connections with other modes of transport

The transportation network system of the Region consists mainly of roads, only supplemented by other modes of transport. Important inter-connections are those among the port facilities managed by Kenya Railways, fisheries towns and roads connecting to them such as C19 and C28.

8.3.4 Strategies for other modes of transport

(1) Railways

As mentioned above, the railway network is expected to serve primarily inter-regional and international transport needs, which would develop as the Region's economy grows. Thus the railway network development should be planned with a long-term perspective as well as for short-term needs. With these views, the following should constitute the strategy.

1) To make full use of the existing railway lines as the most economical means of long distance transport for bulk commodities; and

2) To prepare for the time when the extension of the railway network may become necessary to meet inter-regional and international transport demand, including newlines, expansion of wagon ferry and connections with other modes of transport.

(2) Waterways

Waterways usually provide most economical means of transportation, if the scale economy is effectively realized by mass transportation. The waterways in the Region centering around the Winam Gulf have potential for more intensive utilization due to its cardinal location. Further development of the waterways in the Region should be sought with the following strategies.

1) To utilize the waterways to inter-connect different areas surrounding the Lake in order to stimulate economic activities in each area and trade among them; and

2) To serve for inter-linkages between different modes of transportation such as roads, railways and airways in order to perfect the transportation network system in the Region.

For these strategies, the following will be instrumental:

a) introduction of faster passenger boats,
b) utilization of wagon ferries, and
c) upgrading of port facilities.

(3) Airways

The Kisumu aerodrome provides the main gateway to the Region. As the Region's economy develops, its market and catchment area have to expand. Thus the following should be the strategy.

1) To improve facilities of the Kisumu aerodrome aiming at making it eventually an international airport having direct access from and to foreign countries.

In addition, the Region has a number of small airports and airstrips. Most of them are special purpose facilities, serving just one of tourism, military or other purposes. Thus services to these airports are occasional or irregular. The following strategy should be taken to meet a wider range of demand for air transport in the future and to make effective use of the existing facilities.

2) To establish a network of airports by inter-connecting the existing airports with an information network system and a single consolidated organization responsible for co-ordinating the operations of different airports.

8.4 Transportation Development Plan

8.4.1 Project ideas

(1) Criteria for project identification

Project ideas have been obtained by using the following as the criteria.

1) Alleviation of traffic bottlenecks as follows.

- Dualing of lanes if the traffic reaches 7,000 passenger car units (PCU's) per day.
- Provision of climbing lanes if the traffic becomes 2000-7000 PCU's per day, the decision being subject also to the degree of heavy vehicles' involvement.
- Bitumening if the traffic exceeds 300 vehicles per day
- Gravelling if the traffic becomes 150-300 vehicles per day
- Completion of a class C road network.
- Extension of rural access roads aiming at road density of 1 km/km^2
- Provision of a new railway line if the traffic reaches 400,000 tons per year.
- Reinforcement of existing railway line if the traffic exceeds the line capacity in terms of either frequency of train services or carrying capacity of a train.

- Improvement of water transport by introducing faster/larger vessels if the water traffic exceeds a vessel transportation capacity.

2) Services to existing/planned economic activities such as establishment of manufacturing enterprises, increase in agricultural production, and fishery and tourism activities.

3) Substitution of inefficient mode of transportation, for instance by introduction of mass-transportation system.

(2) Project ideas

The project ideas thus enumerated are listed in Table 8.16, and illustrated in Figure 8.15. They consist of 33 road projects, four related to railway lines, four for water transport and one for air transport.

8.4.2 Road network development plan

(1) Project formation with phasing

With all the prospective road projects enumerated above, the road network development plan has been prepared by the procedure described hereunder. Criteria used in according priority are:

1) existing programmes for road construction,
2) urgency determined by the time when the demand would exceed the transport capacity, and
3) budgets available to construct different classes of roads (see para. (4) below).

First, those roads which are already bottlenecks to further development with the transport demand exceeding the capacity are given the highest priority. Second, each of primary roads is treated in either one of two ways: i.e. two-stage development if the need is not pressing or single-stage bitumening for those projects which are already in existing programmes for road construction. The second stage of a road to be constructed by the two-stage method is given priority in the subsequent phase.

Third, minor roads of classes D and E are gravelled as much as the budget allows, and the total length that can be improved is allocated to districts in proportion to the present earth road length in respective districts. Fourth, rural access roads are improved to attain at least the current average road density of 1.0 km/km^2 in all the districts. The planned length in each district reflects both the current density and future expansion of agricultural area.

(2) Road projects

Overlay

Overlay should be done in Phase 1 for the following road sections, which are already suffering from deteriorated surface conditions causing travel time loss, shortened life of vehicles and environmental concerns.

		Project code
-	A104 (Malaba-Turbo, Eldoret-Nabkoi)	R-41
-	C 34 (Kisumu-Fort Terman)	R-42
-	C 23 (Kericho-Sotik)	R-43

Dualing

As seen from Table 8.17, the traffic will exceed the capacity on the following road sections both in Phase 3 so that additional lanes need to be provided.

		Project code
-	A1 (Ahero-Kisumu)	R-01
-	A104 (Leseru -Eldoret)	R-02

Climbing lanes

Even if the traffic is below the capacity, extra lanes would be necessary on mountainous roads where over-passing is difficult. Needs for such lanes depend on involvement of slow and heavy vehicles. In order to assess the degree of such involvement, MOTC has set a passenger car unit (PCU) conversion rates for roads in level and mountainous areas as given below.

	PCU Conversion Rates				
	Passenger Car	Light goods vehicle	Medium goods vehicle	Heavy goods vehicle	Buses
i) Level area	1.0	1.0	2.5	3.5	2.0
ii) Rolling terrain	1.0	1.5	5.0	8.0	4.0
iii)Mountainous area	1.5	3.0	10.0	20.0	6.0

If the traffic calculated with these conversion rates exceeds 7,000 PCU's per year, additional lanes are justified. By this criterion, the following road sections have been selected.

		Project code
-	A1 (Awasi-B1 junction)	R-03
-	A104(Timboroa-B1 junction)	R-04
-	B1 (Kiboswa - Chavakali)	R-05

The first project (R-03) should be implemented in Phase 1, and the remaining two in Phase 2.

Bitumening

Table 8.18 shows all the road sections which need to be bituminized by 2005. The forecast traffics on these road section will exceed 300 vehicles per day by 2005. Under the strategy described in subsection 8.3.3, the two-stage construction method is applied to most of the roads, except those at advanced stage ready for implementation. The latter are the following.

	Project Code
- C19 (Kendu Bay-Homa Bay)	R-19
- C21 (Kisii-Tinga)	R-17
- C26 (Oyugis-Koseru)	R-16

All other roads (project codes R-11 to 15, R-18, R-20 to 28) will be constructed in two stages. Some road projects are expected to be just gravelled by 2005, leaving surfacing works to be done thereafter (project codes R-14, 15,29 and 30).

Minor road gravelling

About 50% of the earth roads can be gravelled by 2005. Table 8.19 shows the road length to be gravelled by district and by phase.

Rural access roads

Rural access roads should be constructed to tie up with the agricultural development in the Region expected by this Master Plan. Planned lengths are shown in Table 8.20 by district and by phase.

(3) Road conditions in 2005

The development of road network as planned by 2005 may be summarized as follows.

Type of development	Number of projects	Total road length covered (km)
Dualing	2	34
Climbing lanes	3	21
Bituminizing (class B)	1	93
Bituminizing (class C)	15	790
Gravelling (class C)	10	700
Overlay	2	182
Minor roads	(15 districts)	1,809
Rural access roads	(15 districts)	7,903

Implementation of all the projects will improve by 2005 the road conditions in the Region as follows. Of the total length 2,450 km of primary roads (class C), 1,445 km or 59% will be bitumen paved and about 1,900 km or 81% will be of upgraded quality including gravelling.

The total length of minor roads including rural access roads will increase from 13,100 km in 1985 to about 20,000km by 2005, making the road density of this class in agricultural areas 1.0 km/km^2. Of the increment, about 5,000 km is associated with the expansion of agricultural area.

(4) Development costs and budget

Development costs

Costs of road projects are estimated by applying unit construction cost per km by kind of road works to the length of each road and unit cost per site for bridge construction to the number of bridges ("Economic Feasibility Report on Homa Bay - Mbita Road (C19)"). The kind of road works involved is determined for each road project, based on present conditions of the road such as cross-section and longitudinal alignments, width of right-of-way and carriageway, surface conditions, drainage and existence of bridges, and the planned standard for the road. The unit construction cost is presented in Table 8.21, and the cost of each project is given in Table 8.22.

The cost of surfacing works in staged construction is taken to be about 10% higher than in the case of continuous construction, reflecting the need for repairing damages to structure and earth works completed earlier.

Development budget

Development capital available for road projects is roughly estimated here. Of the total development expenditure which is expected to be available for the Region in the period 1985-2005 estimated to be K£ 2,700 million (Master Plan Report), the allocation to the transportation sector is estimated to be 20% or K£ 540 million based on the shares in recent years. Allocation between road subsector and other subsectors is assumed at 80 to 20, based on the recent trend (Transportation Master Plan by JICA, 1984). Development capital available is estimated by phase as shown below:

(Unit: K£ 10^6)

Sector	Phase 1 1985-93	Phase 2 1994-2000	Phase 3 2000-2005	Total
Roads	131	150	150	431
Others	33	38	38	100
Total	164	188	188	540

(5) Implementation program

Implementation schedule

The implementation schedule for all the road projects has been prepared by assessing the priority of each project. The priority assessment has been made based on the considerations of existing conditions of each road, the ratio of projected traffic demand to the capacity, relationships with economic development and cost-effectiveness. The results are summarized in Table 8.23, which presents the cost by phase of all the road projects. For some primary roads, the two-step construction method has been assumed so that the total costs of the projects are slightly higher than estimated above.

Balance between development budget and costs

The total costs of the road projects by phase and by category of roads are summarized in Table 8.24. As seen from the table, the cost of road development is within the estimated budget for each phase. However, allocation of budget among different classes of roads is considerably different for the Region than the national allocation at present, reflecting the existing road network in the Region and the need for further development to realize the regional development. That is, comparatively more budget should be allocated to roads of classes D and E as well as to primary roads. Trunk roads may receive smaller allocation.

(6) Institutional measures

Needs for road works in the future

Road construction in Kenya has entered the phase of primary road construction, as the trunk roads have been mostly constructed. The improvement and extension of primary roads, which account for 85% in length of all the classified roads, involve large investment and maintenance costs. Conditions affecting construction and maintenance of primary roads are very region- and area-specific. Typically, drainage conditions differ in different areas and affect the design and maintenance of primary roads. Thus the two principal needs for road works in the future are the procurement of funds for road works and the efficient construction of primary roads under specific regional conditions.

Upbringing of domestic constructors

Road works in Kenya have been dominated by foreign-based contractors. The National Construction Corporation (NCC) is a parastatal body formed among other objectives to give technical and professional advice to up and coming indigenous construction firms. The following functions of NCC should be further clarified for indigenous construction firms.

(1) To assist construction firms in filling in tender documents and bills of quantities;
(2) To provide supervising personnel to advise the firms on construction;
(3) To assist in the financial management of the firms; and
(4) To undertake to fulfil contractural obligations of the firms in case the firms fail to do so.

The Government policy for ordering contracts is now to award tenders for construction projects locally through DDC's. The obvious advantage of this policy is that indigenous local contractors stand to benefit and that road engineers in district offices, having much better knowledge on site-specific characteristics, can acquire technical expertises.

Upbringing of transportation industries

As the traffics increase and transportation networks expand, transportation industries will have to thrive to provide sufficient and efficient services.

The freight demand is projected to grow at 6.3% per annum to 2005. The number of trucks and lorries in use, however, have not increased in recent years as shown in Table 8.25. In order to increase cars, loans may be provided to freight carrying industries or other measures taken to encourage the establishment of truck leasing companies.

Matatu industry has an important role in transporting people, covering 33% of road passenger traffics. It provides cost-effective services and adds flexibility in meeting increasing demand. However, poor maintenance and overloaded passengers often cause serious accidents. To overcome these problems, entry registration for matatu services should be more strictly enforced and a loan system should be established for renewing vehicles. Their operating performance should be used as an important criterion in assessing the loan application for renewing vehicles. In this way, those providing better services will expand their business, leading to further improvement of services.

The Kenya Bus Company has been providing public transport services in both Nairobi and Mombasa and the respective councils have shares in the company. A similar arrangement could be started in major towns in the Region to help ease the pressure on public transportation and reduce accidents through lack of competition. The roles to be played by such a company should be supplemental to the private sector services, if the Matatu industry thrives in the right directions as suggested above.

Application of labour intensive works

Labour intensive works have been quite successful in constructing rural access roads. They should be applied to classified roads too, especially minor roads in rural areas. Better economy, higher employment and more effective acquisition of technical expertises can be expected by this application.

8.4.3 Railway network development plan

(1) Railway projects

The only railway project identified by applying any criteria listed in subsection 8.4.1 is the reinforcement of Kisumu-Nakuru line, whose capacity would be exceeded before 2005. However, in view of the long-term strategy for railway transport presented in subsection 8.3.3, those new lines proposed in the past are also included in the list of prospective projects. Each of them is outlined below.

Reinforcement of Kisumu - Nakuru line

The table below presents the comparison between traffics forecasted for 2005 and existing capacity for each railway line.

Line	Line Capacity 1000 tons/year	Freight in 2005 1000 tons/year
Main Line		
Nakuru-Eldoret	2,210	2,113
Eldoret-Malaba	2,210	892
Kisumu Principal Line	730	864
Butere Branch Line	550	-
Kitale Branch Line	550	333

Only on the Kisumu-Nakuru line the projected traffic of 86.4 thousand tons freight exceeds the line capacity. Reinforcement will be necessary along its 235 km length, including standardization, signalization, provision of coupling device and other measures.

Such reinforcement could increase the transport capacity by 150%, sufficient to dissolve the bottleneck. This should be done in Phase 2 before the traffic demand exceeds the existing capacity, and in parallel with the improvement of facilities along the Nakuru-Nairobi-Mombasa lines.

New lines

The new railway lines proposed in the past are the following.

1) Butere - Bungoma
2) Rongo - Homa Bay, and
3) Rongo-Kisii-Sotik-Kisumu

The possibilities of, and measures to be taken for these lines are described in "Supplementary Note on Railway Transport Network," attached to this chapter.

(2) Implementation schedule and costs

As stated above, the reinforcement of the Kisumu-Nakuru line should be completed by Phase 2. The investment costs by phase are summarized as follows.

	Phase 1	Phase 2	Phase 3	Total
Length (km)	100	135	-	235
Costs (Kshs.x10^6)	265	358	-	623

(3) Other measures

As described in Attachment(A), the following should be conducted in Phase 1, related to the extension of railway network. First, the following studies should be conducted: i.e. 1) a detailed study of traffic demand for freight, 2) detailed OD survey along the proposed railway lines and 3) rural socio-economic survey of areas which may be affected by the implementation. Second, a more detailed economic analysis should be carried out to compare the railway network and other modes of transport.

8.4.4 Water transport development plan

(1) Projects of inland navigation

Needs for improving inland navigation on the Lake consists of increasing the speed of transportation, increasing the transport capacity to exploit scale economy and improving inter-connections with road and railway networks. The following four projects have been formulated to meet them.

Tugboat replacement project

The tugboat presently used on the Lake, S.S. Kavirondo introduced in 1912, runs on black oil and consumes four times as much fuel as new tugboats which use diesel oil. A new tugboat should be introduced as soon as possible.

Wagon ferry project

The volume of cargoes carried by inland waterways has been slightly decreasing in recent years. The decrease is attributable to the diversion of cereals transport to trucks and the lack of transport capacity on the Lake. Along with the improvement of railway network, the wagon ferry should be re-introduced on the Lake. As the road C20 from Rongo to Homa Bay has been bitumened to increase the potential of Homa Bay to become another major distribution center along the Lake shore, the wagon ferry should connect Kisumu and Homa Bay.

Port upgrading project

In association with the new tugboat and the re-introduction of wagon ferry, port facilities should be improved. Homa Bay should be equipped with the facilities equivalent to those of Kisumu by 2005. First, a lighter berth should be installed to handle increased cargoes. Second, as the wagon ferry is introduced, a rail rampway and railcar loading facilities must be installed. Additional warehouse capacity and loading/unloading facilities would also become necessary.

Other ports may also be upgraded as the transport of agricultural products, fish, timber and cement increases. Jetties at Kendu Bay, Mbita, Kowuor and Karungu would be improved.

Lake cruize project

A sight-seeing boat may be introduced in the mid-term future between Kisumu and Muhoro in order to promote tourism in the Region. This project is described in Chapter 7 of this report for the tourism sector.

(2) Related projects and measures

Even if a fast passenger boat of 30 knots/hour speed is introduced, it will take about four hours to cover the distance of some 200km between Kisumu and Muhoro so that a round trip cannot be made in a day. Thus the provision of accommodations will be necessary at Homa Bay, Mfangano island or other places on the route in association with the Lake cruize project, unless a luxury passenger boat with lodging facilities is introduced. To integrate the tourism of the Lake with Masai Mara National Reserve, hotel and other service activities should be established also at Muhoro.

Measures need to be taken to encourage the establishment of these services activities in the private sector. Also the size and type of the sight-seeing boat to be introduced should be carefully examined in the next stage. Preliminary analyses indicate that both the tugboat replacement and wagon ferry projects are feasible, but a full feasibility study needs to be carried out for each of them in the nearest future.

(3) Implementation schedule and costs

Costs of the projects related to inland navigation have been estimated by phase as presented in Table 8.26 according to the implementation schedule indicated by Table 8.27.

8.4.5 Air transport development plan

The air transport development plan has been formulated with the basic strategy presented in Section 8.4. It consists of the Kisumu airport improvement project and other measures to establish a network of airports in the Region.

Kisumu airport improvement project

Kenya Airways plan to improve the facilities at Kisumu aerodrome for operating a medium range jet aircraft of DC9-32 or B737-200 class to meet the forecast traffic demand. This will include the following:

- repair and resealing of runway, taxiway and apron,
- construction of a new passenger terminal building,
- provision of navigational aids, and
- improvement of utility facilities.

In a longer run, the Kisumu airport should be further upgraded to the international class airport. This will allow direct access to and from not only neighbouring countries but also European and Middle-Eastern countries. It will have tremendous impacts on the

development of Region's economy by bringing in many foreign tourists and providing outlets for a range of products including the perishable such as horticultural products.

Measures for airport network

An inventory survey should be conducted in the near future to find out the exact status of all the airfields and air strips in the Region, covering facilities, utilization and management. Institutional and organizational measures should be sought for coordinating the operation of different airports, which would lead to the establishment of a consolidated organization or section in existing organization for this function. An information network system should be established on its initiative to meet a range of demand for air transport in a most cost-effective way.

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Table 8.1 Inter-District Peoples' Movement

(1) Roads and railways

(Unit: persons/day)

District	Mode*	KSI	KSM	SYA	SON	BUN	BSA	KKM	KER	NKR	NRK	TNZ	UGS	EMR	NND	WPK	Others	Total
KISII	RD	113	696	17	415	0	0	11	0	11	1	45	4	0	0	0	139	1,452
	RW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KISUMU	RD	703	4,364	3,211	3,017	523	1,091	2,218	540	312	0	555	1,177	3	511	66	1,579	19,870
	RW	0	0	0	0	0	0	15	0	72	0	0	0	0	0	0	573	660
SLAYA	RD	9	2,804	31	28	0	0	2	2	17	0	0	0	0	0	0	171	3,064
	RW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S.NYANZA	RD	296	2,882	24	76	7	48	243	2	33	3	86	104	0	0	0	398	4,202
	RW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BUNGOMA	RD	5	285	0	2	25	35	683	0	13	1	1	769	0	0	0	138	1,957
	RW	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	17	20
BUSIA	RD	0	896	0	36	5	0	15	7	6	0	0	137	0	0	0	187	1,289
	RW	0	0	0	0	0	0	0	0	11	0	0	12	0	0	0	40	72
KAKAMEGA	RD	15	2,636	0	12	544	18	883	22	4	0	305	184	2	51	0	302	4,978
	RW	0	21	0	0	0	0	0	0	18	0	0	0	0	0	0	77	116
KERICHO	RD	6	449	0	3	2	8	0	29	489	0	0	5	0	7	0	70	1,068
	RW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NAKURU	RD	19	130	4	3	0	0	38	384	24	3	101	345	0	15	0	1,753	2,819
	RW	0	91	0	0	3	14	22	0	0	0	0	6	0	0	0	85	221
NAROK	RD	1	67	0	0	0	0	0	0	0	0	0	0	0	0	0	275	343
	RW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T.NZOLA	RD	0	666	2	313	2	0	25	2	46	0	7	1,050	0	0	0	325	2,438
	RW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U.GISHU	RD	0	914	0	22	763	135	56	0	364	1	925	169	20	16	11	290	3,686
	RW	0	0	0	0	2	12	0	0	9	0	0	0	0	0	0	24	47
E.MARAKWET	RD	0	0	0	3	0	0	0	0	0	0	0	11	0	0	0	0	14
	RW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NANDI	RD	0	928	0	0	0	2	92	0	7	0	2	0	0	0	0	14	1,045
	RW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W.POKOT	RD	0	52	0	0	0	0	0	0	0	0	1	0	0	0	0	181	234
	RW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LBDA OTHERS	RD	37	755	14	420	62	1,715	126	545	552	8	35	88	143	340	370	0	5,210
	RW	0	577	0	0	11	33	61	0	48	0	0	11	0	0	0	0	741
TOTAL	RD	1,204	18,524	3,303	4,350	1933	3,052	4,392	1,533	1,878	17	2,063	4,043	168	940	447	5,822	53,669
	RW	0	689	0	0	25	62	98	0	158	0	0	29	0	0	0	816	1,877

Note: *RD; Roads, RW; Railways

(2) Waterways

(Unit: persons/day)

District	Kisumu	South Nyanza	Others	Total
Kisumu	0	116	0	116
Soth Nyanza	116	0	36	152
Others	0	32	0	32
Total	116	148	36	300

(3) Airways

District	Kisumu	Others	Total
Kisumu	0	18	18
Others	17	0	17
Total	17	18	35

Table 8.2 Modal Share in Passenger Traffics in Kenya

	Passengers (thousands)	Share (%)	Passengers Kilometers (millions)	Share (%)
Railway (including inland water way)	2,279	5.5	625	12.1
Road	39,169	94.5	4,550	87.9
Total	41,448	100.0	5,175	100.0

Source: The National Transport Master Plan, by JICA(1984)

Table 8.3 Road Density by Province

Province	Road Length* (km)	Area (km^2)	Road Density (km/km^2)
Coast	1,568.2	83,603	0.018
North-Eastern	1,302.0	126,902	0.010
Eastern	2,842.2	159,891	0.017
Central	1,135.1	13,176	0.086
Nairobi	85.7	684	0.120
Rift Valley	5,065.9	173,868	0.029
Nyanza	1,224.6	16,162	0.075
Western	746.8	8,360	0.089
Kenya Total	13,967.5	582,646	0.024

Note: * Classified Road A, B, C.
Source: Statistical Abstract (1983), The National Transport Master Plan by JICA (1984)

Table 8.4 Characteristics of Transport on Roads

Vehicle Type	The Number of Vehicle Trips per Day	The Number of Passenger Trips per Day	Average Passenger Trips Length (km)	Average Carrying Passenger per Vehicle
Car	6,635 (55)	17,850 (17)	118	2.69
Matatu	3,946 (33)	45,675 (42)	91	11.58
Bus	1,405 (12)	43,786 (41)	142	31.16
Total	11,986	107,311	116	8.95

Note: ( ) shows share to the total in %.
Source: The National Transport Master Plan by JICA (1984)

Table 8.5 Length of Roads in Each District by Surface Condition

	Class A		B		C		D		E		Classified Road Total		Special Purpose Roads		All Weather	Now All Weather (%)
	Bitumen	Gravel Earth	B	G/E	B	G/E	B	G/E	B	G/E	B	G/E	Rural Access Road	Others		
Kisii	31.0	-	48.2	-	41.9	132.5	-	271.4	2.0	524.9	123.1	928.8	436.1	115.5	1029.1	574.4 (35.8)
Kisumu	62.5	-	48.3	-	137.4	33.2	5.4	141.2	-	348.9	253.6	523.6	190.3	624.7	1365.2	226.7 (14.2)
Siaya	-	-	49.5	-	60.4	132.2	-	246.1	1.0	638.2	110.9	1016.5	195.8	8.0	835.2	496.0 (37.2)
S. Nyanza	110.6	-	-	-	32.1	269.0	6.0	407.9	-	1089.3	148.7	1766.2	449.7	162.	16886.5	841.0 (33.2)
Nyanza	204.1	-	146.0	-	271.8	566.9	11.4	1066.6	3.0	2601.3	636.3	4234.8	1271.9	911.1	4916.0	2138.1 (30.3)
Bungoma	81.4	-	-	-	26.3	121.6	6.5	312.9	-	360.2	114.2	794.7	367.7	92.8	850.8	518.6 (37.8)
Busia	14.1	-	27.0	-	-	160.9	-	142.5	-	222.3	41.1	525.7	217.5	0.8	508.1	277.0 (35.2)
Kakamega	116.0	-	12.3	-	63.6	150.7	2.3	353.3	6.4	602.0	200.6	1106.0	304.9	276.0	1310.3	577.2 (30.5)
Western	211.5	-	39.3	-	89.9	433.2	8.8	808.7	6.4	1184.5	355.9	2426.4	890.1	369.6	2669.2	1372.8 (34.0)
Kericho	-	-	99.7	63.4	56.4	228.6	54.3	382.4	-	727.0	210.4	1401.4	357.9	145.4	1332.4	782.7 (37.0)
Nakuru	146.8	-	67.0	36.4	187.9	11.0	53.4	465.7	1.5	540.6	456.6	1053.7	255.9	45.4	1273.4	538.2 (29.7)
Narok	-	-	98.9	41.8	13.1	410.4	-	435.6	-	655.0	112.0	1542.8	-	332.9	1303.2	684.5 (34.4)
T. Nzoia	56.0	-	15.5	-	18.0	106.5	1.9	134.2	-	335.9	91.4	576.6	410.4	46.4	566.2	558.6 (49.7)
U. Gishu	118.4	-	35.2	-	83.1	106.1	13.5	238.1	2.3	277.5	252.5	621.7	292.2	60.7	967.7	259.4 (21.1)
E. Marakwet	-	-	-	18.3	6.0	266.7	-	136.1	-	171.7	6.0	592.8	269.9	5.9	377.2	497.4 (56.8)
Nandi	-	-	-	-	104.0	52.0	50.9	207.3	0.5	356.9	155.4	616.2	311.9	112.7	785.1	411.1 (34.4)
W. Pokot	102.3	-	-	42.7	-	45.0	3.5	223.9	-	596.8	105.8	908.4	336.0	1.2	782.3	569.1 (42.1)
R. Valley	423.5	-	316.3	202.6	468.5	1226.3	177.5	2223.3	4.3	3661.4	1390.1	7313.6	2234.2	750.6	7387.5	4301.0 (36.8)
Total	839.1	-	501.6	202.6	830.2	2226.4	197.7	4098.6	13.7	7447.2	2382.3	13974.8	4396.2	2031.3	14972.7	7811.9 (34.3)
Kenya	2328.5	1241.5	1217.5	1548.1	1931.7	5851.9	713.9	10261.8	378.1	25848.7	6569.7	44752.0	10467.3		33149.2	28639.8 (46.3)

Table 8.6 Goods OD by Railway in 1984 for All Goods

(Unit: ton/year)

	Nakuru	Eldoret	Bungoma	Malaba	Kisumu	Butere	Kitale	Others	Total
Nakuru	-	3,764	384	758	7,409	9	1,877	73,561	87,762
Eldoret	27,455	-	100	109	902	1	947	38,994	68,508
Bungoma	9,737	280	-	669	-	-	0.0	129,650	140,336
Malaba	1,018	40	20	-	-	-	0.0	99,541	100,619
Kisumu	8,780	1	0.0	0.0	-	507	-	56,802	66,090
Butere	-	-	-	-	0.0	-	-	291	291
Kitale	16,364	5,037	22	-	176	1	-	38,891	60,489
Others	251,004	163,667	18,784	156,763	207,937	1,275	31,832	-	831,262
Total	314,358	172,789	19,310	158,299	216,424	1,793	34,656	437,730	-

Table 8.7 Cargo Movement by the Lake Transport (from Kisumu to Lake ports)

(Unit: tons)

	1975	1976	1977	1978	1979	1980	1981	1983
Cement	1,728	1,160	1,740	1,505	7,358	7,229	6,535	1,541
Parcels & Luggage	220	331	406	612	250	244	360	281
Personal Effects	49	24	14	26	134	286	-	392
Timber	1	32	30	57	102	667	217	581
Railway Material	-	150	-	-	446	-	80	5
G. I. Sheet	-	-	-	-	15	106	265	-
General Goods	877	842	772	647	861	695	1,224	2,52
Total	2,875	2,539	2,962	2,847	9,166	9,227	8,681	6,913

Table 8.8 Cargo Movement by the Lake Transport (From Lake ports to Kisumu)

(Unit: tons)

	1975	1976	1977	1978	1979	1980	1981	1983
Maize	-	35,449	38,435	15,240	15,241	-	-	3,903
Beans	553	3,668	1,163	-	45	-	-	-
Groundnuts	635	321	244	454	1,361	-	-	-
Millet	313	1,710	67	-	113	-	-	-
Sisal Fibre	605	-	-	-	1,585	2,199	1,653	156
Parcels & Luggage	-	70	810	426	458	472	551	1,965
Dried Fish	-	5	222	46	202	313	403	6,041
Cotton Seeds	-	-	-	-	-	1,701	326	280
Furniture	-	-	-	-	396	605	398	-
Hide & Skin	-	-	-	-	-	76	53	103
General Goods	20	293	402	280	507	664	612	2,780
Total	2,126	41,516	41,343	16,446	19,908	6,030	3,996	15,228

Table 8.9 Annual Summary of Cargo Tonnage Shipped from Kisumu Pier to Lake Ports

Commodity	Kendu Bay KEN	Kowuor KWR	Homa Bay HMA	Mbita MBX	MF Angano MFO	Total
General Goods	1,231	-	1,292	-	-	2,523
Nails	46	-	289	-	-	335
Cement	698	-	843	-	-	1,541
Machinery	2	-	-	-	-	2
Spirit & Wines	-	-	23	-	-	23
Parcels & Luggage	118	-	163	-	-	281
Oil Goods	18	-	70	-	-	88
G.I. Sheets	176	-	316	-	-	492
Empty Drums	15	-	30	-	-	45
Furniture	27	-	75	-	-	102
Timber	133	-	448	-	-	581
Rlys. Material	2	-	3	-	-	5
Medicine	8	-	-	-	-	8
Poles	24	-	338	-	-	362
Machinery	30	-	71	-	-	101
Stationery	-	-	23	-	-	23
Dried Fish	6	-	11	-	-	17
P/Effects	181	-	211	-	-	392
Printing Papers	-	-	55	-	-	55
Perishable	16	-	21	-	-	37
Total	2,031	-	4,282	-	-	6,913

Table 8.10 Annual Summary of Cargo Tannage Shipped to Kisumu Pier from Lake Ports

Comodity	KEN	KWR	HMA	MBX	MFO	KRG	ASB	Total
Bales Sisal	-	-	156	-	-	-	-	156
Hides & Skins	-	-	81	22	-	-	-	103
Dry Fish	846	383	2,223	1,385	994	210	-	6,041
G. Goods	505	159	1,577	281	240	18	-	2,780
Maize	1,848	-	2,055	-	-	-	-	3,903
Parcels & Luggage	304	112	1,094	211	55	5	184	1,965
Cotton Seeds	180	-	100	-	-	-	-	280
Total	3,683	654	7,286	1,899	1,289	233	184	115,228

Table 8.11 Weekly Frequency of Scheduled Flights between Kisumu and Nairobi

Year	Period	Frequency
1982	Jan. - June	2
	Apr. - Oct.	3
	Nov. - Dec.	5
1983	Jan. - June	5
	July - Dec.	7
1984	Jan. - Oct.	7
	Oct. - Dec.	9
1985	Jan. - Present	9

Source: Kenya Airways

Table 8.12 Real Airfares between Kisumu and Nairobi

Year*	Actual Fare** (Kshs)	GDP Implict Price Deflators/1	Real Fare (Kshs)
1982	405	100	405
1983	465	116	401
1984	465	129	360
1985	465	136	342

Notes: * November each year
** One way
Source: /1 World Bank, Nairobi. Price Deflator for Transport, Storage and Communication Sector.

Table 8.13 Air Traffic Movements at Kisumu Airport

Year	a) Private Charters Annual Total of Passengers			b) Kenya Airways Annual Total of Passengers		
	Arrival	Departure	Total	Arrivals	Departures	Total
1975	1,345	1,153	2,498			
1976	1,946	1,716	3,662			
1977	2,158	2,253	4,411			
1978	3,250	2,641	5,891	Not Operational		
1979	2,661	2,157	4,818			
1980	2,404	2,274	4,678			
1981	3,138	3,104	6,242			
1982	3,899	3,705	7,604	3,353	3,783	7,136
1983	433	428	861	6,360	6,669	13,029
1984	NA	NA	NA	9,042	9,699	18,741
1985	NA	NA	NA	10,276	10,522	20,798

Sources: a) Central Bureau of Statistics (CBS)
b) Kenya Airways Statistic Department

Table 8.14 Seat Load Factors between Nairobi and Kisumu

Month	Year (in percentages)			
	1982	1983	1984	1985
January	NA	75.0	72.9	68.0
February	NA	68.7	77.3	70.5
March	NA	58.9	80.8	71.0
April	71.4	62.9	84.0	66.6
May	76.5	63.5	86.7	63.3
June	75.3	62.4	86.5	64.0
July	79.5	60.5	89.8	66.5
August	96.2	73.9	92.7	72.9
September	78.4	62.8	87.1	62.5
October	78.7	64.5	83.4	-
November	66.0	67.9	69.5	-
December	80.4	70.0	70.6	-

Annual Totals:		
	April 1982 - March 1983	74.7%
	April 1983 - March 1984	69.1%
	April 1984 - March 1985	79.0%

Source: Statistics Department, Kenya Airways Limited.

Table 8.15 Summary of Traffic Growth by Mode

Mode		Growth Ratio between 1985 and 2005
Road		3.37
Railway	(Passenger)	2.32
	(Freight)	2.03
Airway	(Kisumu-Nairobi)	12.1
	(Eldoret-Nairobi)	13.2

Table 8.16 Project Ideas in Transportation Sector

Project Code	Mode of Development	Specification/Dimension		
R-01	Dualing	24.0	A	1
R-02	"	10.0	A	104
R-03	Climbing	10.0	A	1
R-04	"	3.0	A	104
R-05	"	8.0	B	1
R-11	Bitumening	240.0	C	12,13,17
R-12	"	93.0	B	3
R-13	"	29.0	C	15
R-14	"	26.0	C	16
R-15	"	80.0	C	18
R-16	"	23.0	C	26
R-17	"	70.0	C	21
R-18	"	35.0	C	25
R-19	"	104.0	C	19
R-20	"	36.0	C	35
R-21	"	67.0	C	28
R-22	"	58.0	C	29,30
R-23	"	50.0	C	31
R-24	"	48.0	C	41
R-25	"	19.0	C	33
R-26	"	45.0	C	42
R-27	"	63.0	C	44
R-28	"	40.0	C	48
R-29	"	38.0	C	24
R-30	"	15.0	C	20
R-41	Over lay	142.0	A	104
R-42	"	77.0	C	34
R-51	Standard Gravel	15 km, C20		
R-52	"	35 km, C22		
R-53	"	35 km, C30		
R-54	"	10 km, C32		
R-55	"	55 km, C37		
R-56	"	50 km, C50		
R-70	(1) Gravelling programme	1,809 km, 15 districts		
	(2) Rural access Road programme	7,903 km, 15 districts		
K-01	Reinforcement	235 km coupling device signalling, etc.		
K-11	New Line	32 km		
K-12	New Line	40 km		
K-13	New Line	-		
K-1	Tugboat Replace	400 HP, 120 ton lighter x 6		
W-2	Wagon Ferry Introduction	2,300 HP railwagon, 42 units		
W-3	Port Facility	Rail pumpway		
W-4	Sight-seeing Boat Introduction	80 passengers		
A-1	DC-9 Accomodation	Passenger terminal (82 m x 43 m)		

Table 8.17 Phases at which Traffic Exceeds the Capacities

Projects		Capacity	Traffic Volume			
			At Present	1993*	2000*	2005
4-Lane						
A1	Ahero-Kisumu	7,000-8,000	2,649	4,428	6,725	9,036
A104	Leseru-Eldoret	"	2,207	3,785	5,856	7,997
Climbing Lane						
B1	Awasi-Kericho	2,200	1,787	2,951	4,426	5,912
A1	Kisumu-Chavakali	4,300	2,150	3,477	5,112	6,733
A104	Eldoret-Nabokoi	3,800	1,727	2,860	4,297	5,747
Bituminizing Vehicle						
B3	Ngopngop-Sotik	300	237	393	591	791
C15	Sotik-Gorgor	300	177	293	440	589
C16	Keroka-Nyangusu	300	123	203	305	408
C18	Karunga-Oyugis	300	105	174	261	349
C26	Oyugis-Kendu Bay	300	298	493	741	991
C21	Kisii-Chemosit	300	183	303	455	609
C24	Litein-Bomet	300	106	175	262	350
C25	Sondu-kapsiot	300	244	404	607	812
C19	Katilo-Homa Bay	300	190	314	472	631
C35	Fort Ternan-Londiani	300	163	270	406	543
C28	Luanda K.-Rangala	300	145	240	361	483
C29	Siaya-Busonga	300	220	364	547	731
C30	Bumala-Busonga	300	183	303	455	609
C31	Mayoni-Mbwokas	300	198	327	491	657
C33	Bungoma-Chwele	300	402	665	999	1,336
C41	Kakamega-Bungoma	300	132	219	329	440
C42	Malikisi-Chwele	300	199	330	496	663
C44	Turbo-Endebe	300	144	238	358	479
C48	Kitale-Mpiben	300	110	182	273	369
Railway Reinforcement		000 tons				
Kisumu-Nakuru		730	400	545	682	812
Airline Improvement		%				
Kisumu-Nairobi		70 (Load Factor)	70	186	438	805

Note: * Traffics in intermediate year (1993, 2000) are interplanted by using annual growth rates previously projected. Annual growth rate for 1983-1985 is assumed to be 2% for all projects.

Table 8.18 Roads with More Than 300 vehicles/day in 2005, to be Considered for Bituminization

Road		Vehicles/day (in 2005)	in 1983
B3	(Ewaso Ngiro - Sotik)	791	237
C15	(Sotik - Gorgor)	589	177
C16	(Keroka - Nyangusu)	408	123
C18	(Karanga - Oyugis)	349	105
C19	(Homa-Bay - Katito)	631	190
C21	(Kisii - Chemosit)	609	183
C24	(Litein - Bomet)	350	106
C25	(Sondu - Kapsiot)	812	244
C26	(Oyugis - Kendu-Bay)	991	298
C28	(Luanda Kotieno - Rangala)	483	145
C29	(Siaya - Busonga)	731	220
C30	(Busonga - Bumala)	609	183
C31	(Mbweyeka - Moyoni)	657	198
C33	(Bungoma - Chwele)	1,336	402
C35	(Londiani - Fort Terran)	543	163
C41	(Kakamega - Bungoma)	440	132
C42	(Malikisi - Kimiuli)	663	199
C44	(Turbo - Eudebe)	479	144
C48	(Kitale - Mpiben)	369	-

Table 8.19 Planning Length to be Gravelled by District

District	Length of Minor Road D and E (km)*				Gravelling Extension (km)			
	Total	Bitumen	Gravell	Earth	Total	Phase 1	Phase 2	Phase 3
Nyanza								
Kisii	798.2	2.0	426.7	369.6	185	55	65	65
Kisumu	495.5	5.4	429.0	61.1	31	9	11	11
Siaya	885.3	1.0	478.9	405.4	203	63	70	70
South Nyanza	1,503.2	6.0	835.7	661.5	330	100	115	115
Western								
Bungoma	679.7	6.5	362.2	311.0	156	48	54	54
Busia	364.8	0.0	149.9	214.9	107	33	37	37
Kakamega	964.0	3.7	596.3	359.0	180	54	63	63
Rift Valley								
Kericho	1,163.7	54.3	629.2	480.2	239	73	83	83
Nandi	615.6	51.4	400.2	164.0	82	26	28	28
Narok	703.2	0.0	655.2	48.0	24	8	8	8
Trans Nzoia	472.0	1.9	184.5	285.6	143	43	50	50
Uasin Gishu	531.4	15.8	392.3	123.3	62	18	22	22
Others	268.3	7.0	126.9	134.4	67	21	23	23
Total	9,445.0	160.0	5,667.0	3,618.0	1,809	551	629	629

Source: * Road Maintenance Schedule MOTC,1985

Table 8.20 Planned Extension of Rural Access Roads

District	Length of D,E. Road (km)	Length of Access Road (km)*	Agricultural Area 2005 (km^2)	Length of Extension (km)			
				Total	Phase 1	Phase 2	Phase 3
Nyanza							
Kisii	798.2	436.1	1,590	356	104	126	126
Kisumu	495.5	190.3	1,380	695	201	247	247
Siaya	885.3	195.8	1,450	369	107	131	131
South Nyanza	1,503.2	449.7	2,760	807	233	287	287
Western							
Bungoma	679.7	367.7	1,820	773	223	275	275
Busia	364.8	217.5	990	408	118	145	145
Kakamega	964.0	304.9	2,390	1,121	323	399	399
Rift Valley							
Kericho	1,163.7	357.9	2,330	808	232	288	288
Nandi	615.6	311.9	1,510	583	169	207	207
Narok	703.2	0.0	660	0	0	0	0
Trans Naoia	472.0	410.4	1,380	498	144	177	177
Uasin Gishu	531.4	292.2	1,990	1,166	338	414	414
Others	268.3	102.6	690	319	93	113	113
Total	9,445.0	3,637.0	20,940	7,903	2,285	2,809	2,809

Source: * Road Maintenance Schedule MOTC,1985

Table 8.21 Unit Cost by Work Category

(Unit: 1000 Kshs/km)

Construction Level	A	B	C1	C2	D
Continuous Construction					
1) Main Works	-	-	400	1,330	2,420
2) Surfacing Work	-	1,500	1,500	1,500	1,500
Total	-	1,500	1,900	2,800	3,920
Stage Construction					
1) Main Works	-	-	-	1,330	2,420
2) Surfacing Work	-	-	-	1,630	1,740
Total	-	-	-	2,960	4,160
* Gravelling			500		
Rural Access Road			150		

Notes: A - Roads with surfacing completed.
B - Sandy road with standard sections where surfacing work can be done at any time.
C1 - Roads whose rights-of-way is assured but some drainage and main works are required.
C2 - Roads on hilly areas or plain where acquisition of the right-of-way is required.
D - Roads on mountaineous areas where large quantity of earthworks, bridges and drainage works are required.

* Unit cost for Minor Road construction is taken from the Republic of Kenya Development Estimate for 1980/82 by assuming 10% inflation. Construction cost of bridge is taken from the same source and 2.5 million Kshs per site is applied to each road.

Source: Economic Feasibility Report on Home Bay-Mbita Road (C19)

Table 8.22 Costs of Road Development Projects

Project Code	Section	Type of Development	Specification/Dimension			
			Classification	Distance (km)	Work Level	Costs (mil. Kshs)
R-01	Kisumu-Ahero	Dualing	A1	24.0	C1	79.9
R-02	Eldoret-B2 Junction	Dualing	A104	10.0	C1	28.3
R-03	B1 Junction-Awasi	Climbing	A1	10.0	D	23.5
R-04	B1 Junction-Timboroa	Climbing	A104	3.0	D	11.1
R-05	Kiboswa-Chavakali	Climbing	B1	8.0	D	24.8
R-11	Ewaso Ngiro-Masai Mara	Bitumen	C12,13,17	134.0	C2	409.2
R-12	Sotik-Boundary	Bitumen	B3	93.0	C2	274.4
R-13	Sotik-C14 Junction	Bitumen	C15	29.0	C2	89.2
R-14	Keroka-C17 Junction	Bitumen	C16	26.0	C2	76.8
R-15	Oyugis-Karungu	Bitumen	C18	80.0	C2	224.0
R-16	Oyugis-Kendu-bay	Bitumen	C26	23.0	C2	66.6
R-17	Kisii-C23 Junction	Bitumen	C21	70.0	D	280.4
R-18	Sondu-Kapsoit	Bitumen	C25	35.0	C2	98.0
R-19	A1 Junction-Mbita	Bitumen	C19	113.0	C2	326.4
R-20	Fort Teman-Londiani	Bitumen	C35	36.0	C2	104.8
R-21	Asembo-Siaya	Bitumen	C28	35.0	C2	102.0
R-22	Siaya-Ebusonga	Bitumen	C29,30	57.0	C2	167.6
R-23	Busia-Mumias	Bitumen	C31	50.0	C1	109.0
R-24	Bungoma-Kakamega	Bitumen	C41	48.0	C2	144.4
R-25	A104 Junction-Chwele	Bitumen	C33	52.0	C2	159.6
R-26	Kimilili-Malakisi	Bitumen	C42	45.0	D	192.4
R-27	Endebess-C43 Junction	Bitumen	C44	63.0	C2	186.4
R-28	Kitale-Kapeherop	Bitumen	C48	40.0	C2	122.0
R-29	Litein-Bomet	Bitumen	C24	38.0	D	94.0
R-30	Rongo-Ogembo (17 Junc.)	Bitumen	C20	15.0	C2	42.0
R-41	Timbrowa-Eldoret	Overlay	A104	142.0	C2	269.3
R-42	A1 Junction-Muheron	Overlay	C34	77.0	C2	146.3
R-51	Sotik-Atela (A1 Junc.)	Gravelling	C22	35.0	C2	46.6
R-52	Bumala-Koyonzo	Gravelling	C30	35.0	C2	46.6
R-53	Malakisi-Kimaeti	Gravelling	C32	10.0	C2	14.0
R-54	Kapsabet-Turbo	Gravelling	C37	35.0	C2	73.2
R-55	B2 Junction-C48	Gravelling	C50	50.0	C2	65.1
R-70		(1) Minor Road Gravelling Programme			1,809 km	904.5
		(2) Rural Access Road Programme			7,903 km	790.3

Table 8.23 Implementation Schedule of Road Projects (1/2)

Project Code	Road No.	Section	Mode of Development	Work Level	Distance (km)	Cost in Million Kshs Phase I	Phase II	Phase III	Remarks
R-01	A1	Kisumu-Ahero	Dualing	C1	24.0	-	-	79.9	79.9
R-02	A104	Eldoret-B2 Junction	Dualing	C1	10.0	-	-	28.3	28.3
R-03	A1	B1 Junction-Awasi	Climbing	D	10.0	23.5	-	-	23.5
R-04	A104	B1 Junction-Timboroa	Climbing	D	3.0	-	11.1	-	11.1
R-05	A1	Kiboswa-Chavakali	Climbing	D	8.0	-	24.8	-	24.8
Sub-total						23.5	35.9	108.2	167.6
R-11	C13,C17	Kilgoris-Lolgorien-Mara Bridge	Bitumen	C2	50.0	(G) 66.5	(B) 89.3	-	155.8
	C13	Mara Bridge-Muhoroni	Bitumen	C2	84.0	-	-	(G) 111.7	111.7
	C12	Ewaso Ngiro-Masai Mara	Bitumen	C2	75.0	(G) 99.8	(B) 134.5	-	234.3
R-12	B3	Sotik-Boundary	Bitumen	C2	93.0	(G) 123.7	165.6	-	289.3
R-13	C15	Sotik-C14 Junction	Bitumen	C2	29.0	-	(G) 38.6	(B) 56.2	94.8
R-14	C16	Keroka-C17 Junction	Gravelling	C2	26.0	-	-	(G) 34.6	34.6
R-15	C18	Oyugis-Karungu	Gravelling	C2	80.0	-	-	(G) 106.4	106.4
R-16	C26	Oyugis-Kendu-bay	Bitumen	B/C2	23.0	33.3	22.2	-	55.5
		Oyugis-Koscle	Bitumen	B	10.0	(B) 16.0	-	-	16.0
		Koscle-Kendu-bay	Bitumen	C2	13.0	(G) 17.3	(B) 22.2	-	39.5
R-17	C21	Kisii-C23 Junction	Bitumen	B/D	70.0	152.7	91.3	-	244.0
		Kisii-Tinga	Bitumen	B	20.0	(B) 31.7	-	-	31.7
		Tinga-C23 Junction	Bitumen	D	50.0	(G) 121.0	(B) 91.3	-	212.3
R-18	C25	Sondu-Kapsoit	Bitumen	D/C2	35.0	57.5	58.2	-	115.7
		Sondu-Sigowet	Bitumen	D	10.0	(G) 24.2	(B) 17.4	-	41.6
		Sigowet-Kapsoit	Bitumen	C2	25.0	(G) 33.3	(B) 40.8	-	74.1
R-19	C19	A1 Junction-Mbita	Bitumen	C2/C1	113.0	242.4	56.7	-	299.1
		A1 Junction-Kendu-bay	Bitumen	C2	45.0	(B) 129.9	-	-	129.9
		Kendu-bay-Homa-bay	Bitumen	C1	35.0	(B) 69.6	-	-	69.6
		Homa-bay-Mubita	Bitumen	C2	33.0	(G) 42.9	(B) 56.7	-	99.6
R-20	C35	Fort Ternan-Londiani	Bitumen	C2	36.0	-	(G) 47.9	(B) 62.7	110.6
R-21	C28	Asembo-Siaya	Bitumen		35.0	-	(G) 45.5	(B) 61.1	106.6
R-22	C29	Siaya-Ebusonga			57.0	90.9	59.4	-	150.3
	C30	Bumala Siaya-Ebusonga	Bitumen	C1	24.0	(B) 48.0	-	-	48.0
		Ebusonga-Bumala	Bitumen	C2	33.0	(G) 42.9	(B) 59.4	-	102.3

Table 8.23 Implementation Schedule of Road Projects (2/2)

Project Code	Road No.	Section	Mode of Development	Work Level	Distance (km)	Cost in Million Kshs Phase I	Phase II	Phase III	Remarks
R-23	C31	Busia-Mumias	Bitumen	C2	50.0	(G) 20.0	(B) 89.0	-	109.0
R-24	C41	Bungoma-Kakamega	Bitumen	C2	48.0	-	(G) 63.8	(B) 88.2	152.0
R-25	C33				52.0	68.2	98.8	-	167.0
		A104 Junction-Chwele	Bitumen	C2	20.0	(G) 26.6	(B) 38.0	-	64.6
		C40 Junction-Yala	Bitumen	C2	32.0	(G) 41.6	(B) 60.8	-	102.4
R-26	C42	Kimilili-Malakisi	Bitumen	D	45.0	(G) 48.4	(B) 76.5	-	124.9
R-27	C44	Endebess-C43 Junction-Turbo	Bitumen	C2	63.0	-	(G) 39.9	(B) 112.7	152.6
R-28	C48	Kitale-Kapeherop	Bitumen	C2	40.0	-	(G) 26.6	(B) 75.2	101.8
R-29	C24	Litein-Bomet	Gravelling	D	38.0	-	-	(G) 92.0	92.0
R-30	C20	Rongo-Ogembo (17 Junction)	Gravelling	C2	15.0	-	-	(G) 20.0	20.0
Sub-total						1,003.4	1,203.8	820.8	3,028.0
R-41	A104	Timbrowa-Eldoret	Overlay	C2	142.0	269.8	-	-	269.8
R-42	C34	A1 Junction-Muheron	Overlay	C2	40.0	76.0	-	-	76.0
Sub-total						345.8	-	-	345.8
R-51	C22	Sotik-Atela (A1 Junction)	Gavelling	C2	35.0	-	-	46.6	46.6
R-52	C30	Bumala-Koyonzo	Gravelling	C2	35.0	-	-	46.6	46.6
R-53	C32	Malakisi-Kimaeti (A104 Junction)	Gravelling	C2	10.0	-	-	14.0	14.0
R-54	C37	Kapsabet-Turbo (A104 Junction)	Gravelling	C2	55.0	-	-	73.2	73.2
R-55	C50	B2 Junction-C48 Junction-C51 Junction	Gravelling	C2	50.0	-	-	65.6	65.6
Sub-total						-	-	246.0	246.0
R-70	Gravelling Programme				1,809.0	-	-	-	45.2
	Rural Access Programme1				7,903.0	-	-	-	59.1
Sub-total						-	-	-	104.3

Notes: Gravelling (G) : Roads constructed according to the standard design but are not paved over the open to traffic with the gravel condition.
Bitumen (B) : Standard design bitumen road.

Table 8.24 Phased Costs of Road Projects by Class and the Budget Balance of Project Planning

	Phase I	Phase II	Phase III	Total
Trunk Road A, B:				
Budget	63.0	72.0	72.0	207.0
Planning	20.9	10.1	5.4	36.4
Primary Road C:				
Budget	28.0	32.0	32.0	92.0
Planning	47.8	51.9	53.3	153.0
Class D, E (Gravelling Programme):				
Budget	28.0	32.0	32.0	92.0
Planning	13.8	15.7	15.7	45.2
Rural Access Programme:				
Budget	13.0	16.7	16.0	45.0
Planning	17.1	21.0	21.0	59.1
Total: Budget	131.0	150.0	150.0	431.0
Planning	99.6	98.7	95.4	293.7

Note: Unit in K£ million

Table 8.25 Number of Vehicle in Use, New Registrations, and Licence Issued

	1976	1977	1978	1979	1980	1981	1982
The Number of Vehicle in use	20,732	21,007	22,185	23,115	23,594	23,956	23,539
New Registrations	1,417	1,857	2,848	2,669	2,255	2,091	1,355
Licence Issued	4,338	4,150	4,996	3,897	5,931	5,733	6,199

Source: Central Bureau of Statistics

Table 8.26 Estimated Costs for Inland Navigation Projects

(Unit: 10^6 Kshs)

	Phase 1	Phase 2	Phase 3
Tugboat Replacement	6.0	-	-
Wagon Ferty Introduction	-	-	120.0
Port Upgrading	10.8	-	95.0
Total	16.8	-	215.0

Table 8.27 Implementation Schedule for Inland Navigation Project

Phase 1	Phase 2	Phase 3
- New Tugboat Purchase (400 HP, 120 ton x 6) (Lighter)		- Wagon Ferry Introduction (1,200 G/T, 2,800 HP)
- Construction of Lighter Berth (Homa-Bay)		- Rail Rampway - Railcar Loading Facility (Homa-Bay)

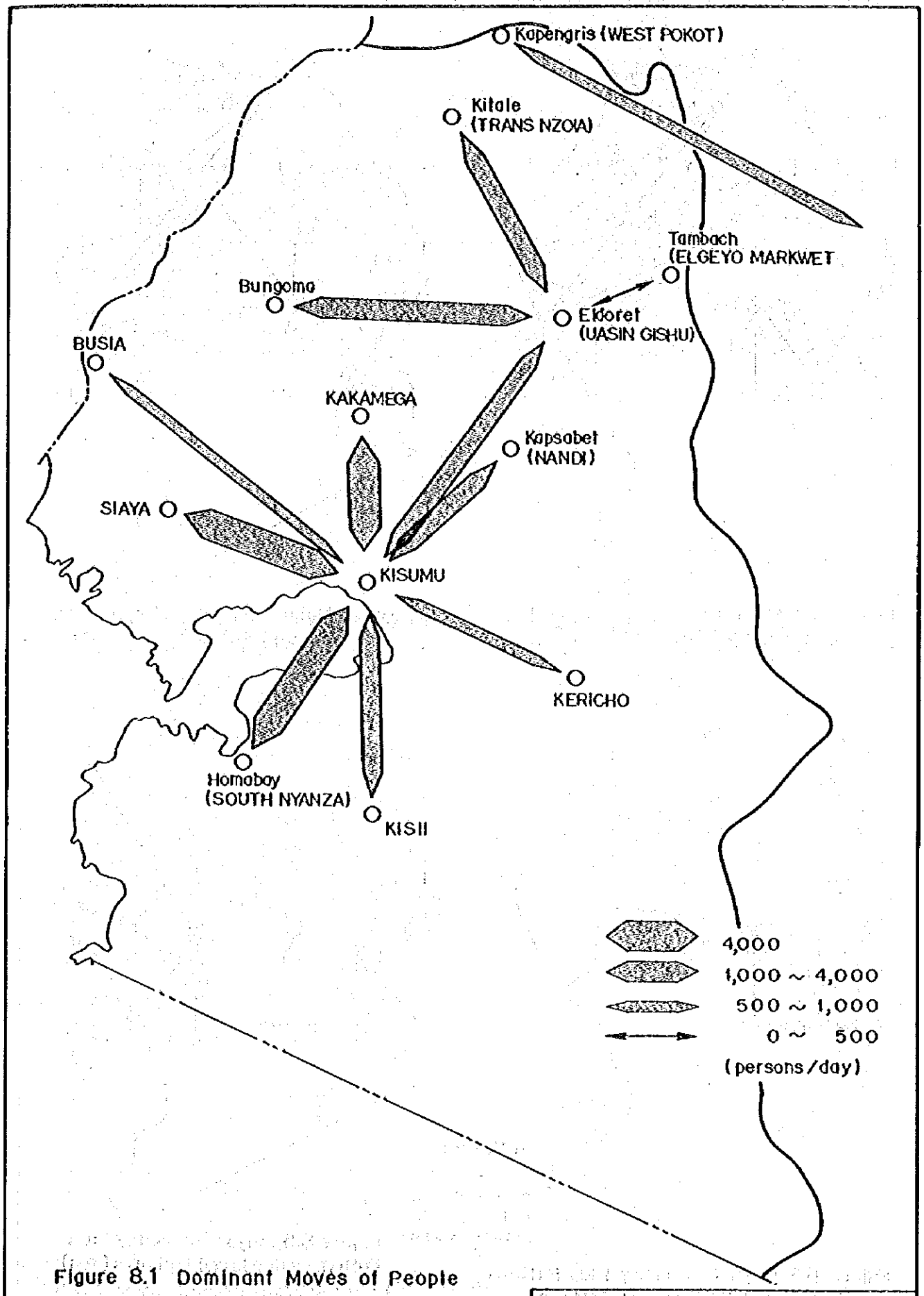

Figure 8.1 Dominant Moves of People between Districts

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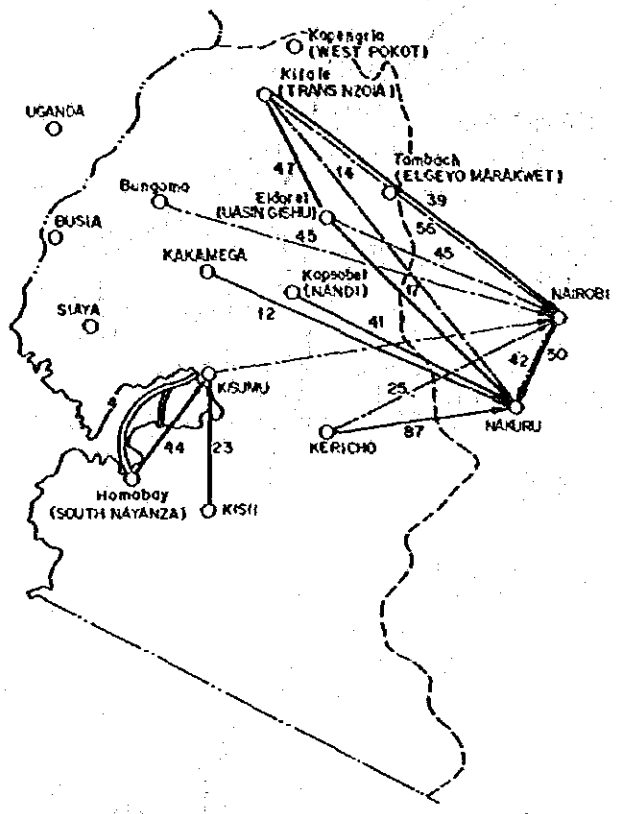


Figure 8.2 Major Commodity Flow Pattern by Roads and Railways (Maize)

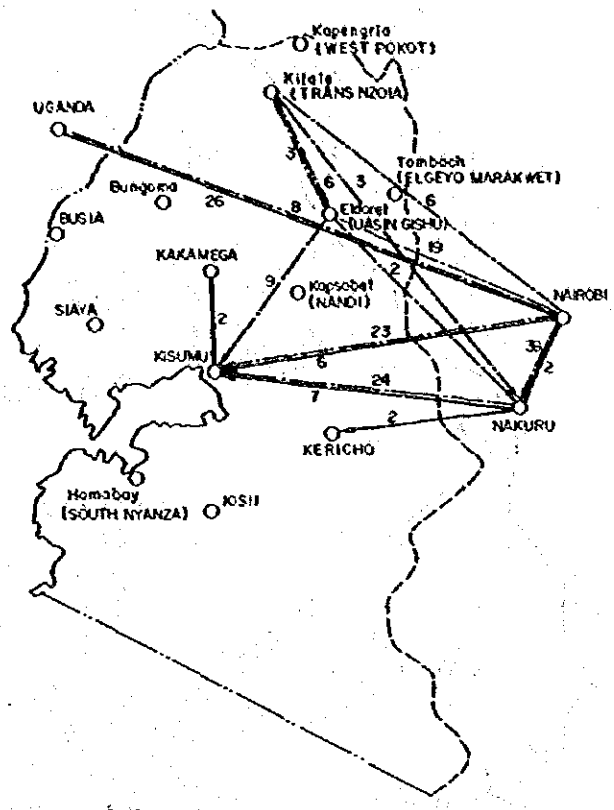


Figure 8.3 Major Commodity Flow Pattern by Roads and Railways (Wheat)

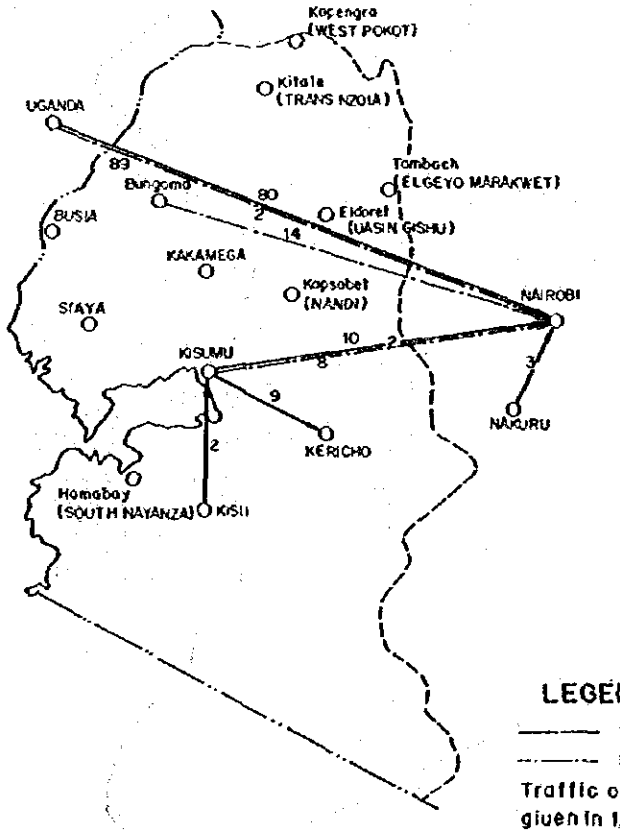
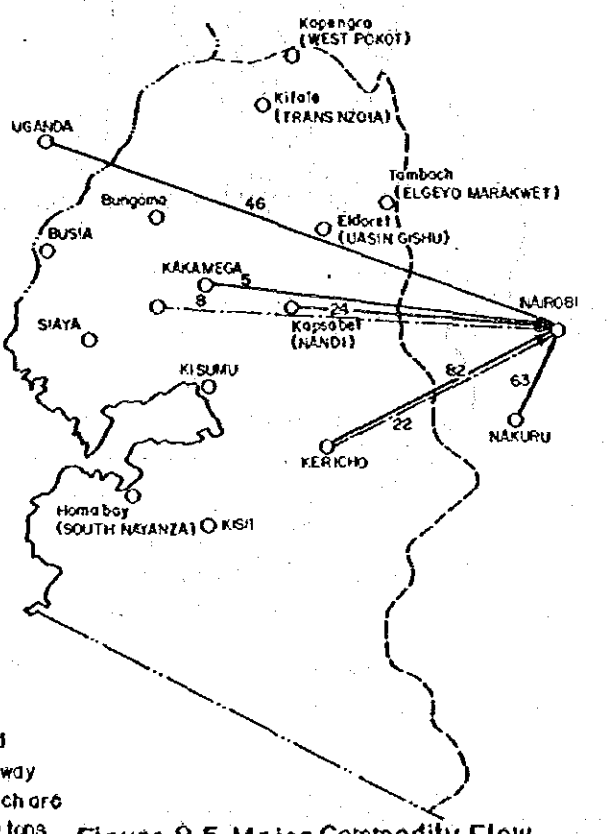


Figure 8.4 Major Commodity Flow Pattern by Roads and Railways (Coffee)



LEGEND

——— Road

———— Railway

Traffic on each are giuen in 1,000 tons

Figure 8.5 Major Commodity Flow Pattern by Roads and Railways (Tea)

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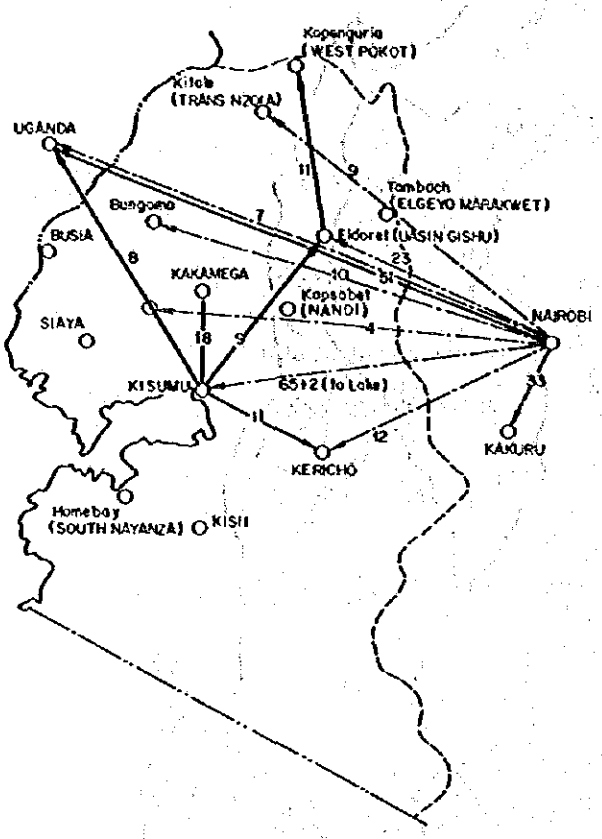


Figure 8.6 Major Commodity Flow Pattern by Roads and Railways (Cement)

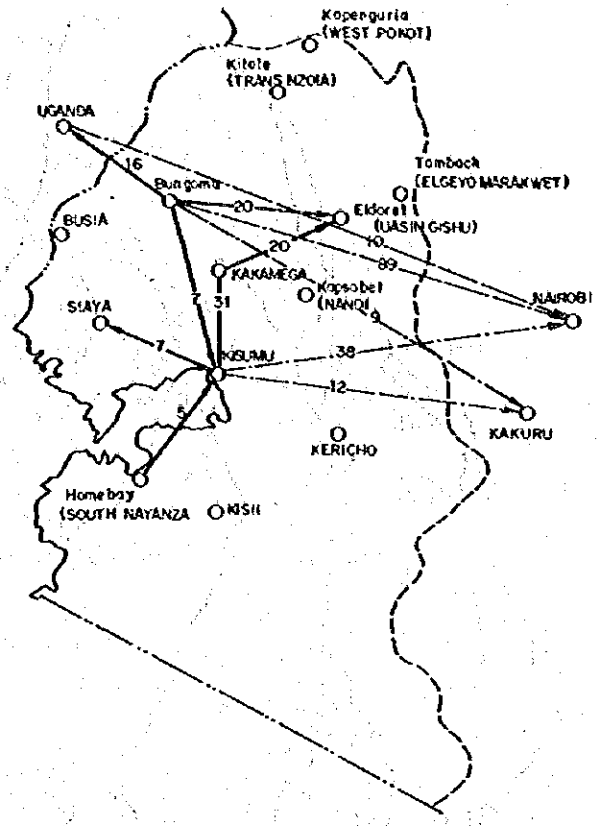
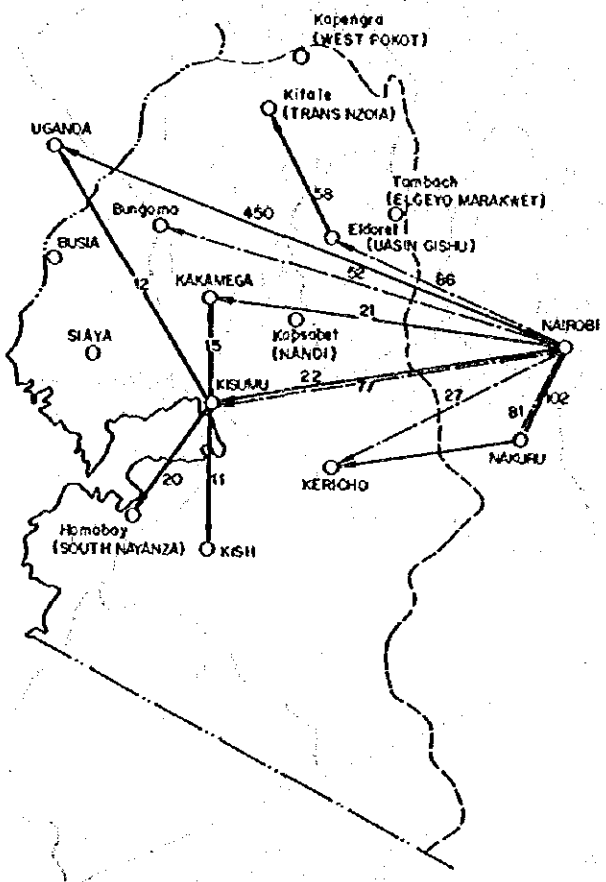


Figure 8.7 Major Commodity Flow Pattern by Roads and Railways (Refined Sugar)



LEGEND

——— Road

—·—·— Railway

Traffic on each arc given in 1,000 tons

Figure 8.8 Major Commodity Flow Pattern by Roads and Railways (Petroleum Fuels and other Petroleum Products)

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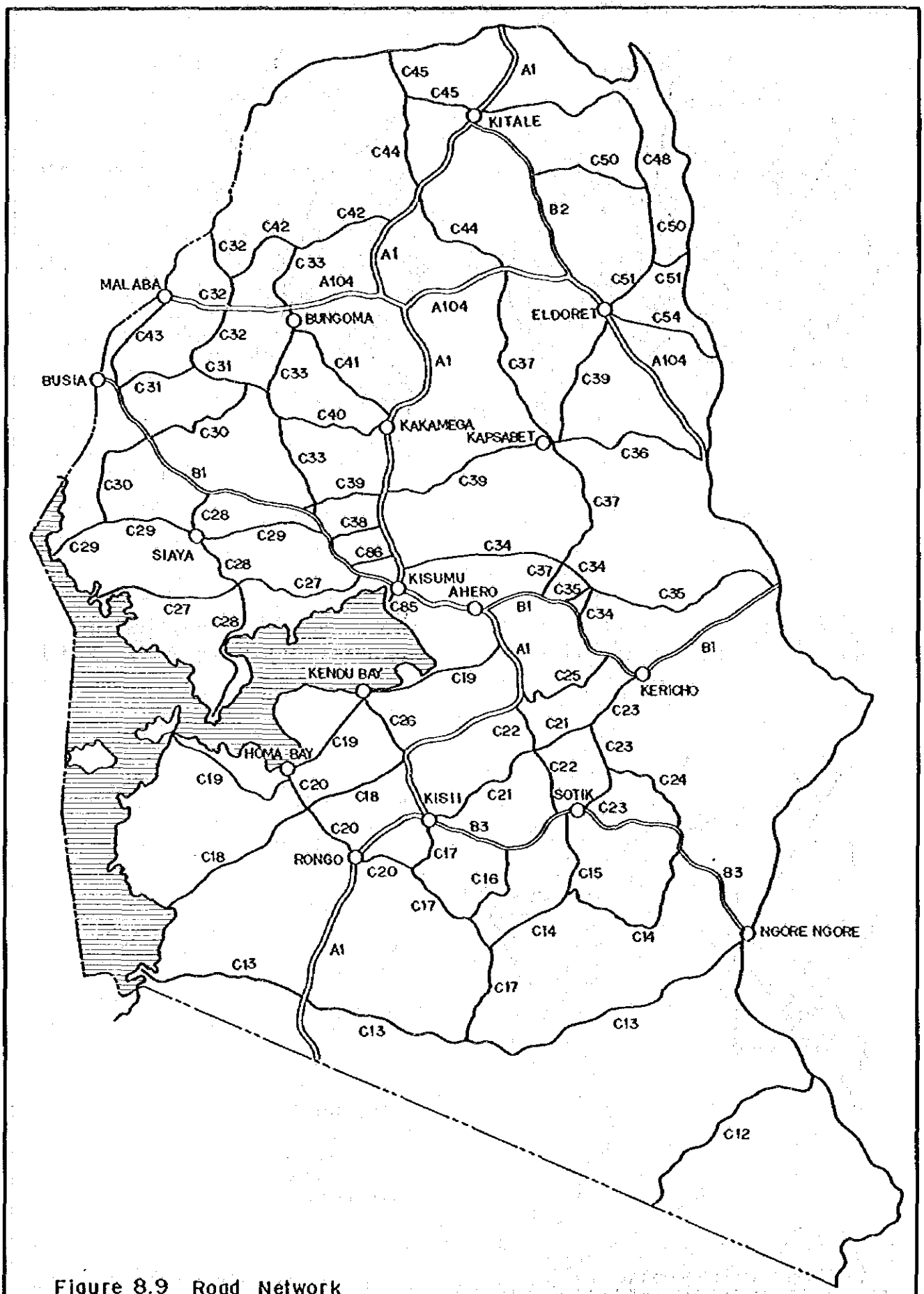

Figure 8.9 Road Network
(Classes A, B and C)

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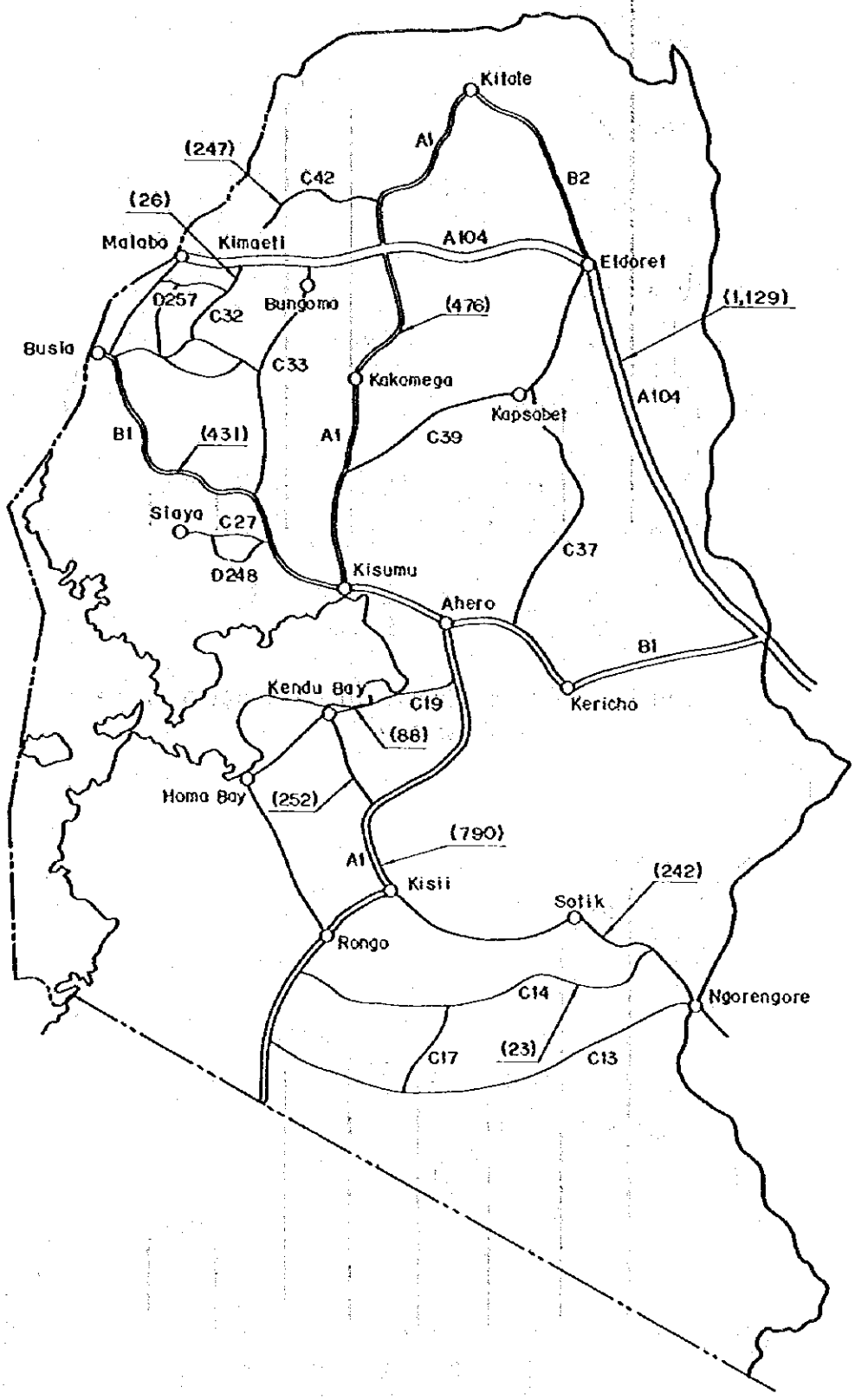

Figure 8.10 Traffic Volume in Vehicles per Day on Selected Roads

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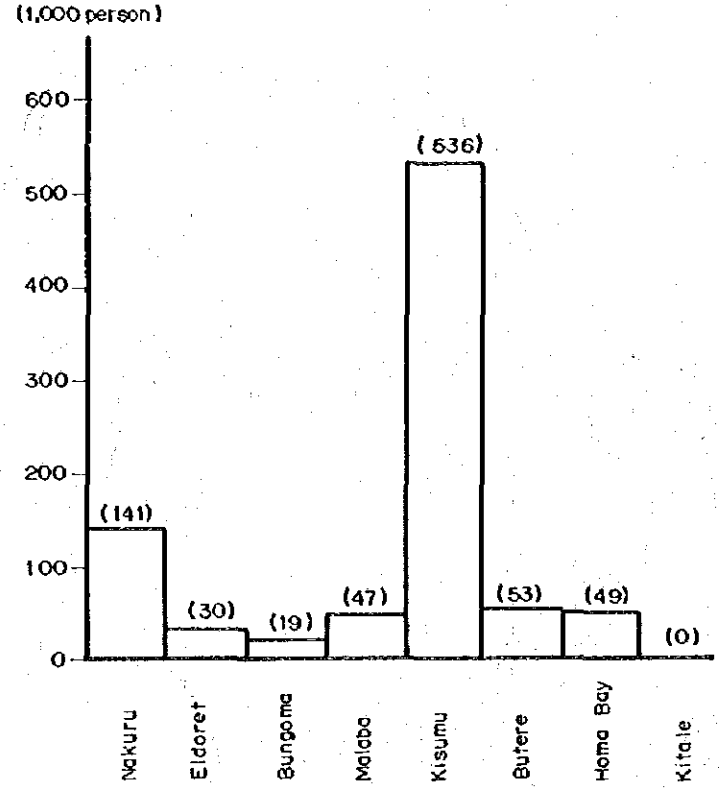

Figure 8.11 Total Number of Passengers Dealt at Each Station

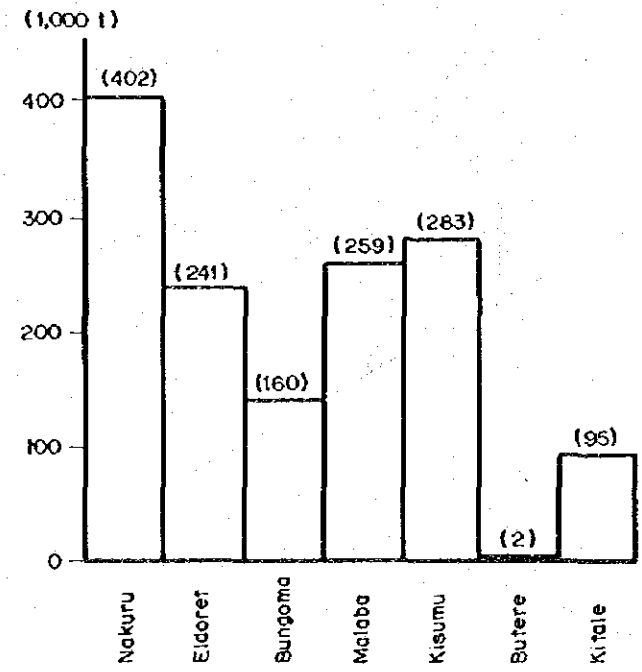

Figure 8.12 Volume of goods Dealt at Each Station

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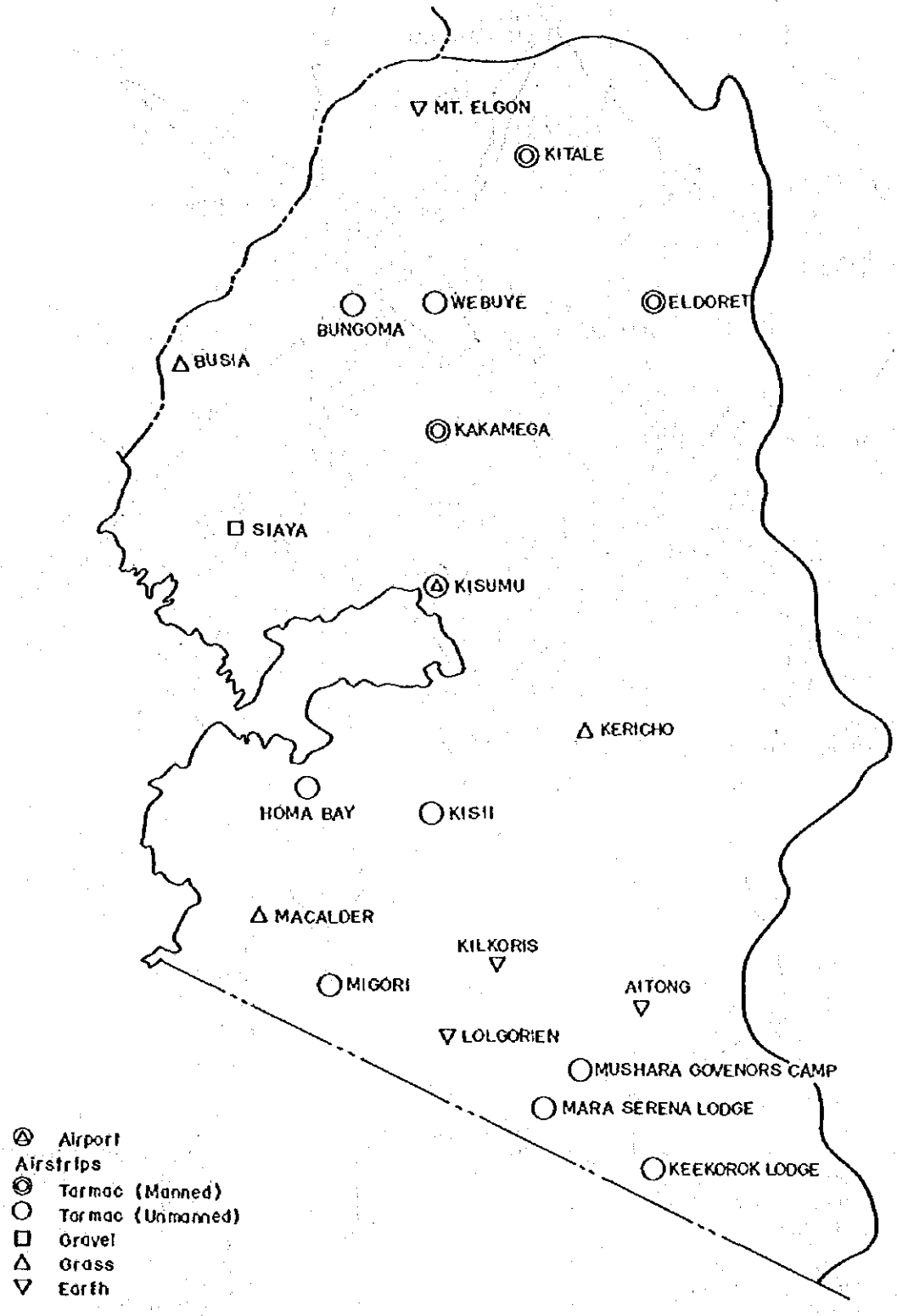

Figure 8.13 Airport and Airstrips

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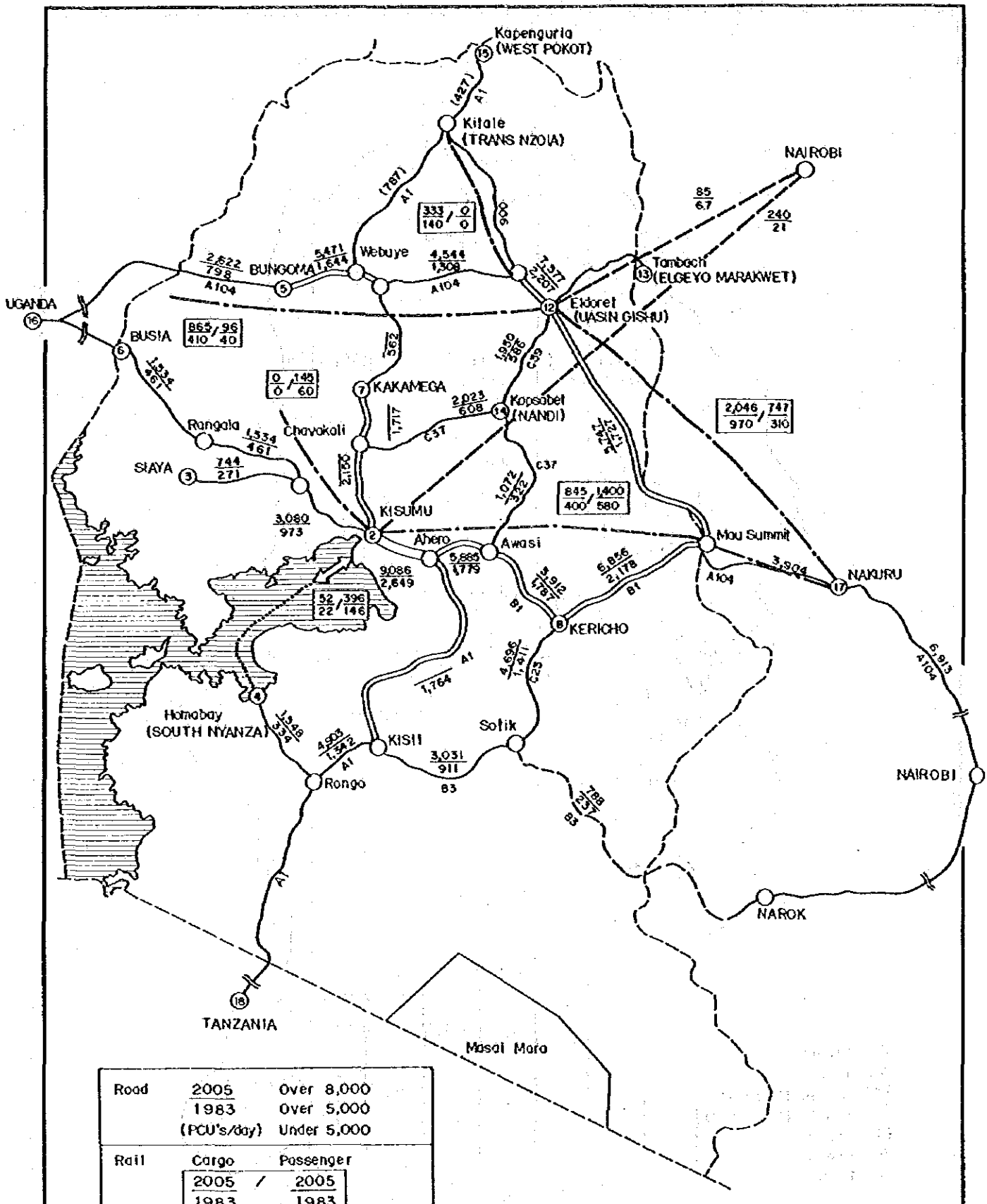

Figure 8.14 Network Traffics Forecast

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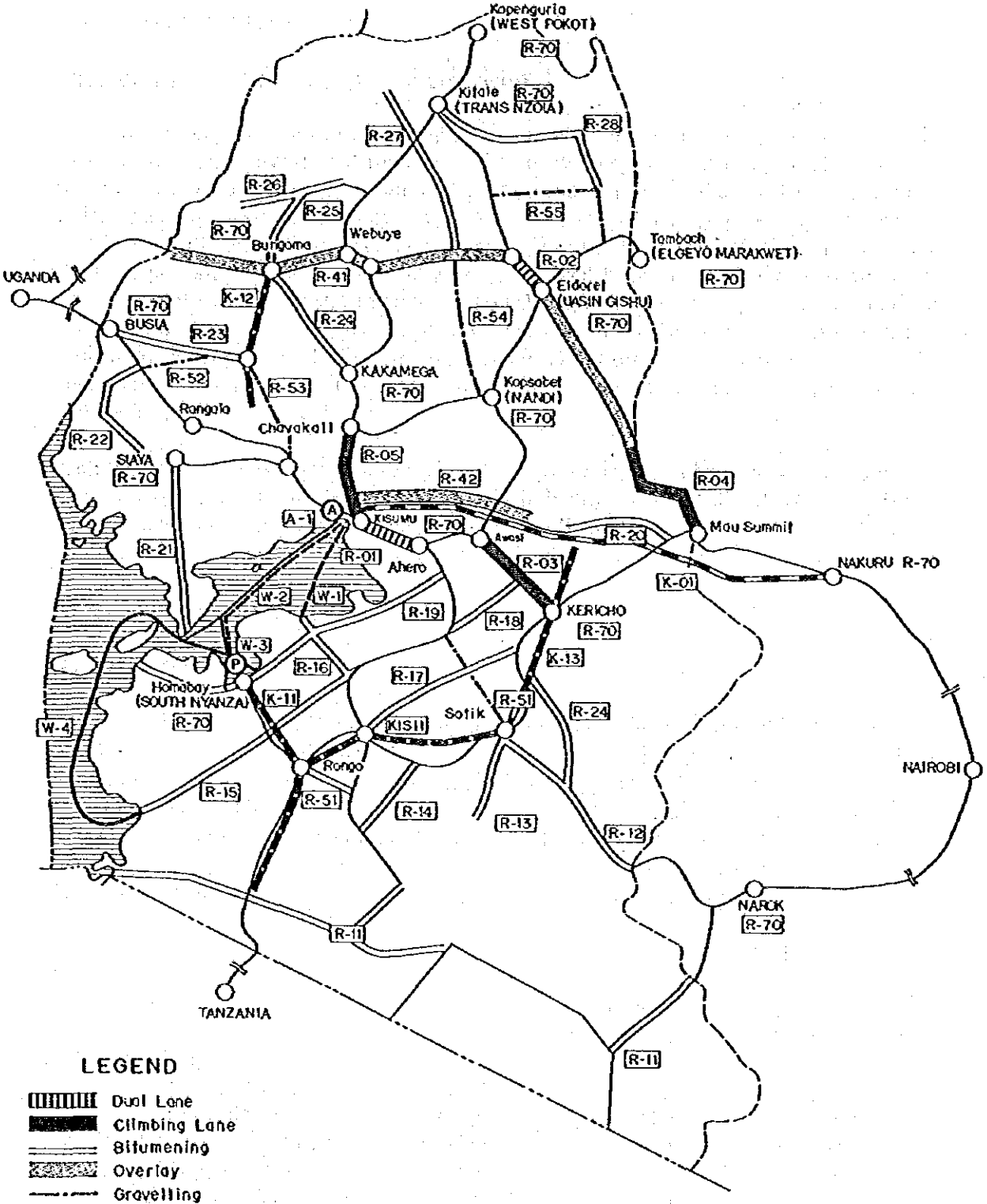

Figure 8.15 Project Ideas in Transportation Sector

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Attachment (A) to Chapter 8:

Supplementary Note on Railway Transport Network

Any railway projects require large initial investment costs so that they cannot be easily justified, when the investment fund and other resources are limited and high economic growth has to be attained in a relatively short period of time --- the two basic conditions under which this Master Plan study has been conducted. However, the railway system once established will continue to serve various purposes over the period much longer than the planning period, and its viability may not be judged based only on the availability of resources in the relatively short period. It could happen that railway projects would draw renewed attention from a broader point of view such as political considerations, and additional resources including investment fund might be made available for the implementation. Therefore it would be useful to prepare basic information, anticipating such an occasion.

With this view, this supplementary note aims at providing such basic information for the railway transport network in the Region and indicating general direction for its future development. For this purpose, both the existing railway lines and proposed new lines are examined.

1. Development of Existing Railway Lines

(1) Present situation

The railway system in the Region is being operated and maintained by the Kenya Railways Corporation as an integral part of the railway network in the country. It consists of the western part of Mombasa-Malaba main line, Kisumu principal line branching off from the main line at Nakuru West, and branch lines of Kisumu-Butere and Eldoret-Kitale. There are over 60 stations in the Region every 10 km or so. The total line length is about 700 km.

The four lines in the Region are operated and carry the following traffics.

(1982)

Line		Freight 1000 tons/year	Passengers 1000 persons/year
Main Line			
Nakuru-Eldoret	(190)	970	2,090
Eldoret-Malaba	(140)	410	880
Kisumu Principal Line	(235)	400	580
Butere Branch Line	(70)	-	60
Kitale Branch Line	(65)	140	-

( ): Length of lines (km)

The Butere branch line does not give a regular service for freights.

(2) Future demand

As reported in the main text of this chapter, the railway freights and passengers in the Region will grow by 2005 to 2.03 and 2.32 times the 1985 levels. The modal shares of railway will decrease in the same period from 27% to 18% for freights and from 5.5% to 4.0% for passengers.

Main commodities carried by railways are grains, oil, cement, sugar and sugarcane. More demand is expected for railway transportation for heavy goods,large goods and bulk commodities.

(3) Supply capacity and development needs

The goods carrying capacities of existing railway lines in the Region were studied by "the National Transport Master Plan" (JICA, 1984), with respect to either frequency of train services or carrying capacity of a train. As the passenger demand for trains is a small portion of the total demand, the line capacity of railway lines is taken to be the goods carrying capacity.

The line capacities and the projected traffics are compared in the following table:

Line	Line capacity 1000 tons/year	Freight in 2005 1000 tons/year
Main Line		
Nakuru-Eldoret	2,210	2,113
Eldoret-Malaba	2,210	892
Kisumu Principal Line	730	864
Butere Branch Line	550	-
Kitale Branch Line	550	333

As seen above, the line capacity of the Kisumu principal line will be exceeded before 2005. Thus the reinforcement will be necessary by standardizing facilities, improving coupling device, introducing a signalling system and taking other associated measures. In this way, the transport capacity can be increased by 150%.

2. New Line Development

(1) Proposed new lines

A few new railway lines have been proposed in the past (Figure 8.A.1). Of them, the branch line to connect the Kisumu principal line and Homa Bay was proposed in late 1950's and its implementation was planned for early 1960's. It did not materialize due to higher priority given to other sectors and projects. These new lines have been receiving renewed attention in recent years.

The current development plan of LBDA (1983-88) has listed three new branch lines. These are proposed on the ground that they would induce the development of agricultural and mineral potentials especially of southern part of the Region. They are described below.

Butere-Bungoma line

The line was originally thought to function as a by-pass to the main line, where congestions existed due to the limited transport capacity of steam locomotives. This issue itself was resolved by the introduction of diesel locomotives.

The line was also expected to give a short-cut for the transportation between the area along the Kisumu principal line and Uganda. This function is still valid at least potentially, as the railway system in the Region is expected to serve primarily for inter-regional and international transport needs, as clarified by the strategy for transport development (Section 8.3 of this chapter). The viability of this line, therefore, depends first on international relationships with neighbouring countries.

This line would also benefit the Mumias Sugar Company for transporting its products currently shipped at Bungoma or carried by trucks. This may induce further increase in production of sugar and other products. Such a regional development is another major factor affecting the viability of the line.

Homa Bay-Awendo line

The line has been proposed aiming at transporting sugar products from the Awendo area through the Lake to consumption areas. The South Nyanza Sugar Company estimated that the factory at Awendo would produce 60,000 to 90,000 tons of refined sugar and 24,000 to 36,000 tons of molasses per annum, when its operation has reached the full scale.

At present, however, sugarcane production is about 320,000 tons per year in South Nyanza district, producing refined sugar of some 32,000 tons per year. Thus the current transportation need cannot justify the line yet.

The viability of this line would depend on how much needs would be generated for bulk transport in future not only for sugar but also for other products.

Rongo-Kisii-Sotik line

This line was proposed as a branch of the Homa Bay-Migori line, extending the line described above. In 1960's, much consideration was given to the possibility of constructing a railway line from Kedowa on the Nakuru-Kisumu line to Kisii via Kericho for the agricultural development in these areas. However, the economic feasibility was not established, and this possibility was left for re-examination in the future. The Rongo-Kisii-Sotik line described in the LBDA plan is a part of this proposed line.

If Sotik is the end of the line, benefits would be confined to the areas along the line and probably the Kisumu area connected by wagon ferry from Homa Bay. To link Sotik and the Kisumu principal line has another meaning that it would serve as a by-pass of the east-

west transport centering around Kisumu, with the Lake as another medium. It would be a short cut for the waterway, too.

(2) Future traffic demand

Framework for forecast

Traffics on the new railway lines would be composed of those traffics to be diverted from other modes of transport and those to be induced as a result of the new opportunities. To estimate the diverted traffics, the following are assumed.

First, such road sections that have both ends within the area served by a new line are taken as the alternatives to the line from which the traffics would be diverted. The service area of the new line is determined by the locations of stations on the line.

Second, the modal share of railway freight to the total freight projected to be 0.18 in 2005, is used as that portion of the traffics to be actually diverted from those alternative roads.

Induced traffics would depend on the progress of regional development. They are roughly estimated in this study based on the production increases as planned.

Future traffics

Within the framework set as above, traffics on the new lines are projected for 2005 as presented below.

1) Diverted traffics

Diverted traffic volume on each of new railway lines is calculated by the following formula.

$$V_D = V_R \times C_f \times G_R \times D_R \times 365$$

where V_D is the diverted traffic volume in tons/year,
V_R is the traffic on alternative roads in PCU's/day,
C_f is the conversion rate from PCU to freight volume in tons set at 0.64,
G_R is the growth ratio of road freight traffics between 1985 and 2005 calculated to be 3.37, and
D_R is the proportion of diversion projected to be 0.18.

The conversion rate, C_f, is determined by assuming that a medium scale truck with 2.5 PCU's travels one way carrying 5 tons of freight and comes back with no freight. When the proportion of trucks in the traffic is 0.64, the conversion rate is calculated to be 0.64

$$0.64 = 0.64 \times \frac{1}{2.5} \times 5 \times \frac{1}{2}$$

The growth ratio, G_R, and the proportion of diversion, D_R, as well as the proportion of trucks are calculated already in the main text of this chapter.

The diverted traffics thus calculated are summarized as follows, based on alternative roads shown in Figure 8.A.2.

New line/Division	Line Length km	Alternative Route	roads PCU's/day (1983)	Diverted traffics tons/year (2005)
Butere-Bungoma	40	C33	571	81,000
Migori-Homa Baya	52			
Migori-Rongo	20	A1	615	87,000
Rongo-Homa Bay	32	C20	334	43,000
Rongo-Kedowa	145			
Rongo-Kisii	20	A1	281	40,000
Kisii-Sotik	50	B3	911	129,000
Sotik-Kedowa	75	C23	1,411	199,000

2) Induced traffics

The kinds of regional development which would be related to the induced traffics are outlined for each new line.

The connection of Butere to the main line would induce the transport of goods to the neighbouring countries from the areas along the Kisumu principal line. Main commodities to be transported would include cement, sugar and machinery. The first two would be much increased by 2005 as a result of implementing this Master Plan.

A sugar company at Awendo once requested Kenya Railways to construct a railway line to Homa Bay for transportation of about 100,000 tons of sugar products and others. These would constitute an induced demand, if the markets for the products are favourable. Another possibility is rice, whose production would be much increased in the Migori area and the traffics be induced by the new Migori-Homa Bay line.

The original proposal of the Rongo-Kedowa line claims that it would serve to transport agricultural products from the southern part of the Region to the outer regions in the east. In addition, a possibility of exporting goods to the neighbouring countries via Lake should be considered.

The following table summarizes the discussion above.

New line	Diverted traffics 1000 tons/year	Induced traffics
Butere-Bungoma	81	- Export goods to the neighbouring countries
Migori-Homa Bay	61	- Sugar products and other (about 100,000 tons/year)
Rongo-Kedowa	145	- Rice from Migori area - Goods to be consumed in the outer regions in the east - Export goods to the neighbouring countries

3. Comparative Analysis of Roads and Railways

In this section, some comparative analysis is made between railways and roads. Qualitative analysis is made first, and an economic analysis is conducted at a preliminary level.

(1) Advantage and disadvantage

Both roads and railways have advantage and disadvantage due to their inherent characteristics, which may be summarized as follows.

Roads	Railways
Speed	Safety
Door-to-door service	Regularity in service
Availability of service at any time	Public operation
Flexibility in transport quantity	Capacity to transport large quantity
	Cost saving for users

Generally, roads are more suitable for time-sensitive and small scale demand for transport, while railways are preferred for mass transport of goods for which the travel time is not a big factor.

Most freights expected to be transported by the new lines are bulk commodities as mentioned in the previous section. Potential advantage of railways, therefore, would not be much challenged with this respect. More important is thus economic comparison between two modes of transport.

(2) Economic costs

Economic costs of roads and railways have been roughly estimated for both construction and operation, as given below.

	Construction costs 10^6 Kshs/km	Operating costs Kshs/km/ton
Railways	6.7 - 12.7	0.38
Roads	2.8 - 3.9	1.12

Sources:
1. "Economic Feasibility Report on Homa Bay - Mbita Road", 1984 for roads.
2. JICA, "National Transport Master Plan, "1984 for operating costs of railways, and
3. "Feasibility Report on Kerio Valley Railway," for construction costs of railways.

As seen from the table above, the construction of railways would be about 3-4 times as expensive as the construction of roads on unit distance basis, while about one shilling would be saved per km per ton transported by railways as compared to roads. Hence the more freight transported, the more need for railways.

(3) An economic analysis

Whether the railways are economically more viable than the roads depends on the amount of freight to be transported. The break-even point between roads and railways may be expressed by the following simplified formula.

$$(C_A - C_R) \times \ell \times \sum_{t=0}^{T} \left(\frac{O_A - O_R}{(1+i)^t} \right) Q_O \times (1+G)^t \times \ell \geq 0$$

where C_A and C_R are construction costs per km for railways and roads, respectively,
O_A and O_R are operation costs per ton-km for railways and roads, respectively,
Q_O is the freight transport demand in tons in the first year of operation,
r is the annual growth rate of freight
T is the project life, and
i is the discount rate.
ℓ is the line length

Assuming that economic life of facilities is 50 years (T=50), and that the annual growth rate of freight, r, is equal to the discount rate, i, and applying the unit cost data presented above, the range of the freight transport demand in the first year of operation is calculated to be between 180 and 340 thousand tons. This implies that the construction of a new railway line should be considered only after the freight transport demand has reached this range, since thereafter the railway line is more economical than the alternative road over the following 50 years.

Kenya Railways Corporation has its own guideline for determining the construction of a new railway line. That is, for a new line to be financially viable, some 400,000 tons/year of freight are required.

A new railway line should be introduced at the time when the demand for freight transport would reach the range between 180 and 340 thousand tons/year according to the calculation above or 400 thousand tons/year following the Kenya Railways guideline. Such a time naturally is different for the new lines examined here. This point is illustrated in Figure 8.A.3.

The figure shows the projected growth of freight demand for each new railway line, and the demand thresholds to determine the timing of introducing new lines. As seen from the figure, all the proposed railway lines should be introduced after 2005, as far as the freight demand grows as assumed in this attachment. The Migori-Homa Bay and the Migori-Kedowa lines may become viable within five years after 2005, while the Butere-Bungoma

line does not seem to be justified for a longer time. These results, however, are subject to the demand growth, and seem to be quite sensitive to induced demand.

4. Policy for Railway Network Development

(1) Development procedure

Based on the foregoing analysis on the present situation and prospect of the railways, the following seem to constitute reasonable steps for developing the railway network in the Region as needs evolve (Figure 8.A.4).

1) The Homa Bay-Rongo-Migori line would be the first to be constructed after the sufficient demand is confirmed due to expansion of sugar production and increases in production of rice and other products. At the same time, it would be necessary that a wagon ferry be introduced between Homa Bay and Kisumu and associated facilities be provided at Homa Bay to link the ferry and the railway.

2) A portion of the Rongo-Kedowa line, i.e. the section between Sotik and Kedowa, could be constructed next, in view of relatively high freight demand at present. However, it should be confirmed if the present demand reflects the freight demand along the entire lengths of the line in order to make sure that the haulage length is long enough to justify the railway.

3) Of the remaining part of the Rongo-Kedowa line, the section between Kisii and Sotik could be constructed, if the new agricultural, livestock and mining activities envisaged in the Kisii area materialize.

4) The Butere-Bungoma line would be constructed as the demand for export goods sufficiently increases, and the communication with Uganda becomes much intensified.

5) Finally, the Rongo-Kisii portion of the Rongo-Kedowa line should be constructed to complete the railway network in the Region.

(2) Measure to promote railway network development

In order to promote the development of the railway network, the following measures should be taken in the order of listing.

1) A detailed study of traffic demand for freight needs to be carried out in order to find out the freight demand along the proposed railway lines. This is necessary because the viability of railways depends not only on the total freight demand but also on the haulage length. This will consist of the following:

   - Detailed OD survey, and
   - Rural socio-economic survey.

2) A more detailed economic analysis should be conducted, including the following:

   - Examination of alternative routes and determination of alignment for each proposed railway line,
   - Estimation of construction costs,
   - Examination of management and operating conditions, and
   - Economic comparison with alternative roads.

3) Ancillary facilities supporting the railways should be improved, as they would involve relatively small costs, and enhance the overall utility of the railway network. They include those facilities already mentioned for reinforcing the existing railway lines, loading and unloading facilities, a wagon ferry and inter-linkage facilities at Homa Bay.

4) A guideline should be prepared to encourage the location of farms and factories in the areas along the proposed lines. Especially, aggregation of large farms and enterprises would support the railway investment, and help also small enterprises to be benefitted by the railway. Such a deliberate and strategic location policy would contribute to inducing large amount of freight demand and lead eventually to successful establishment of a more complete railway transport network for the Region.

Attachment (B) to Chapter 8:

Technical Note on Future Traffic Projection

This attachment presents the technical details of the procedure for future traffic forecast. The forecast is conducted considering shares of different modes of transport for the total network traffics, and difference in growth between areas in the Region.

1. Total Traffics

The total future traffic demand is derived directly from the forecasted economic growth of the Region. Table 8.A.1 shows growth ratios of volume to be transported (i.e. ratios of volume in 2005 to that in 1985, based on the estimated outputs of production sectors. The growth of total freight is the weighted sum of outputs from agriculture and manufacturing sectors, where 0.78 and 0.22 are taken from the current mixture of freight transportation as weights for the respective sectors (Table 8.A.4). As for passengers, traffic volume has been forecasted separately by each mode.

2. Traffic Growth by Mode

Future growths are projected for traffics by mode, i.e railway including waterway, road and airway. Competition between railway and road are considered, while airway traffic is forecasted independently since people preferring airways are quite different from those using railway and roads in the aspects of income level and trip purposes.

(1) Railways

Freight and passenger traffics are assumed to be elastic with respect to total generated goods and population respectively. Due to lack of data for total goods, the growth of GDP has been used instead.

From historical data in Table 8.A.2, the elasticities of railway traffics have been found to be 1.16 for passengers and 0.63 for freight traffics. By applying these elasticities to the growth rate of total freight and population (5.7% and 3.7% respectively), the growth of railway traffics shown in Table 8.A.3 are obtained.

(2) Roads

1) Freight

Since available statistics on road transportation do not cover traffics of all major roads, road traffics are estimated by extracting rail traffic volumes from total traffics. The growth rate, G_R, of road traffics is expressed by the following formula.

$$G_R = \frac{G_A \times A_{85} + G_M \times M_{85} - G_M \times K_{85}}{T_{85} - K_{85}}$$

$$= \frac{(G_A \times W_A + G_M \times W_M)_R - G_K \times S_K}{S_R}$$

where T_{85}, K_{85}, A_{85} and M_{85} are transport volume in 1985 of total freight, railway freight, agricultural freight and manufacturing freights. Other notations, and data to calculate G_R are summarized in Table 8.A.4 and calculated value of G_R is shown in Table 8.A.5

2) Passengers

Future passengers traffic on road is forecasted by the product of projected population and traffics per population. Traffic per population has been forecasted by using its elasticity with respect to per capita GDP. The elasticity has been found to be 0.77 as is shown in Table 8.A.7. All the growth rates used to obtain the elasticities are based on the Report "Study of Road User Charges and Axile Road Limits" by DANIDA, 1981, where relevant data for 1970-1978 are statistically analysed.

Passenger traffics on road grows at the rate expressed by the following formula.

$$\left(1.0 + \left(\begin{matrix}\text{growth rate of} \\ \text{population}\end{matrix}\right)\right) \times \left(1.0 + \left(\begin{matrix}\text{growth rate of} \\ \text{GDP per capita}\end{matrix}\right)\right) - 1.0$$

Then the passenger traffics are forecasted to grow as shown below.

	Growth rate (%)
Population	3.7
GDP per capita	2.2
Traffic per capita	1.7 (=2.2x0.77)
Passenger traffic	5.46(=1.037x1.017-1.0)

Thus the growth ratio of passenger traffics between 1985 and 2005 is calculated to be 2.90.

3) Traffic on road

Road traffic is obtained by adding freight traffic and passenger traffic with weights, 0.639 for freight and 0.361 for passengers, which was obtained by OD Survey in 1983 conducted by MOTC. Growth ratios are summarized in Table 8.A.8.

(3) Airways

Growth rates for airway passengers were estimated by applying a gravity type model. That is, the annual growth rate of passengers between an origin and a destination is calculate as the product of annual population growth rates of the origin and the destination.

Considering future urbanization of Eldoret, scheduled flight service may be necessary. The passengers on the hypothetical Eldoret-Nairobi line are assumed to exist potentially and calculated from those on Kisumu-Nairobi line in proportion to population of Kisumu and Eldoret. The forecast airway traffic is shown in Table 8.A.10.

3. Future Traffic on Network

Future traffic on network is estimated first by multiplying growth ratios obtained above with present network traffics and second by adjusting them considering difference in growth among areas in the Region.

(1) Summary of macro-growth

The growth ratios are summarized in Table 8.A.11. Having considered elasticity of growth of each mode except for airways to the economic growth, these figures in the table reflect a relative competitiveness of each mode.

(2) Consideration of differential growth

An adjustment has been done to future traffic forecast reflecting difference in growth rates of population, agricultural outputs and manufactured outputs. The adjustment has been done by using the coefficient of deviation (COD),which expresses the degree of deviation of growth from the Region's average. The adjustment is formulated in the following way.

Future traffics on the network =(Present traffic) x (Average growth on the network) + (Adjustment term)

Adjustment term for a route between origin i and destination j
= (Future OD traffics between i and j) x(Adjustment ratio for a pair (i,j))

$$\text{Adjustment ratio for } (i, j) = \left(\left(\frac{OGD_i \times PGD_j}{2} \right) + \left(\frac{OGD_j \times PGD_i}{2} \right) \right) - 1$$

$$OGDi = PGDi\ Wp + AGDi\ Wa + MGDi\ Wm$$
$$OGDj = PGDj\ Wp + AGDj\ Wa + MGDj\ Wm$$

where: PGD is population growth deviation,
AGD is agriculture growth deviation,
MGD is manufacturing growth deviation,
i and j denote origin district and destination district, and
Wp, Wa, and Wm, are shares of passengers, agricultural goods and manufactured goods.

Deviation is defined to be the ratio between district's growth ratio and the average growth of the LBDA region. All deviation figures used to obtain the adjustment ratio are shown in Table 8.A.12. Actual adjustments are made as follows by mode.

(1) Roads

Adjustment has been made to road network based on the future OD traffic, obtained by multiplying average road traffic growth ratio with present OD traffic, and the adjustment ratio. As a result, on some road networks adjustment traffic is added to or subtracted from the traffics projected on average. Those routes and adjustment traffic are as follows.

Route		Adjustment Traffic (P.C.U's/day)
C20	(Homa Bay-Rongo)	+437
A1	(Rongo-Kisii)	+437
A1	(Kisii-Ahero)	+306
A1	(Ahero-Kisumu)	+271
A1	(Kisumu-Kakamega)	-422
A1	(Kakamega-Webuye)	- 54
B1	(Mau Summit-Kericho)	-392
B1	(Kericho-Ahero)	- 35
B1	(Kisumu-Luanda)	-158
C29	(Luanda -Siaya)	-158
A104	(Eldoret-Leseru)	+652
A104	(Leseru-Webuye)	+191
B2	(Leseru-Kitale)	+461

Southern part of A1 and C20 will have traffic growth higher than average, reflecting the high growth of population and production generating traffic. In the same way, traffics on A104 and B2 grow, reflecting the high growth of economy in Trans Nzoia and Uasin Gishu. Reductions from average growth of traffics on northern part of A1 and B1 are caused by lower growth rates of economy in Siaya, Kisumu and Kakamega.

2) Railways and waterways

Since adjustment of railway traffic depends upon the aggregate growth of areas along the line, the traffic growth on railway has been assumed to be the same as the macro level. Then no adjustment has been made for rail traffic. On the other hand, waterway traffic has been adjusted considering the traffic reflecting the growth of areas along the Lake shore. Since almost all the traffic on waterway will be between Kisumu and South Nyanza, the adjustment ratio for a pair of Kisumu and South Nyanza are applied for other waterway routes.

3) Airways

Since airway traffic is projected based on the regional growth in Kisumu and Eldoret districts, no adjustment is necessary.

Table 8.A.1 Traffic Growth in 2005

Terms	Ratio (2005/1985)
Population Growth	2.06 (3.7%)
Passenger	3.20 (6.0%)
Agricultural Products	2.64 (5.0%)
Manufactured Products	4.32 (6.5%)
Total Freight	3.01 (5.7%)

( ) Annual growth rate

Table 8.A.2 Current Railway Traffic Data to Obtain Elasticities

Terms		Year		Growth Rate (%)
		1979	1983	
Railway Passengers	($x10^3$)	1,916	2,283	4.48
Railway Freights	($x10^3$ tons)	4,189	4,528	2.63
Population	($x10^6$)	15.33	17.15	3.84
GDP	($x10^6$ K£)	1,462	1,647	4.16
Elasticity				
Passengers	4.48/3.84 = 1.16			
Freights	2.63/4.16 = 0.63			

Table 8.A.3 Growth in Railway Traffic

Terms		Growth Factor
Railway Passenger		
Growth rate	(%)	4.3
Growth ratio	$\left(\frac{2,005}{1,985}\right)$	2.32
Railway Freight		
Growth rate	(%)	3.6
Growth ratio	$\left(\frac{2,005}{1,985}\right)$	2.03

Table 8.A.4 Data to Obtain Road Freight Traffic Growth

Terms		Factors
Growth Ratio		
Agricultural outputs	G_a	2.64
Manufactured output	G_m	4.32
Railway freight transport	G_k	2.03
Modal Share (1985)		
Road	S_r	0.73
Railway	S_k	0.27
Freight Mix (1985)		
Agricultural outputs	W_a	0.78
Manufactured outputs	W_m	0.22

Table 8.A.5 Road Freight Traffics in 2005

Terms	Growth Factor
Road Freight	
Growth rate(%)	6.26
Growth ratio (2005/1985)	3.37

Table 8.A.6 Data to Obtain Road Passenger Traffic Elasticity

Terms	Growth Rate
GDP (£ million)	5.9%
GDP per capita (£)	2.2%
Population	3.6%
No. of passengers (000)	5.4%
No. of passengers per capita	1.7%
Elasticity of per capita passenger traffic to per capita GDP	1.7%/2.2% = 0.77

Table 8.A.7 Summary of Road Traffic Growth

	Growth Ratio (2005/1985)	Growth Rates (%)
Freights	3.37	6.26
Passenger	2.90	5.46
Total	3.20	5.99

Table 8.A.8 Assumption of the Growth Rates

		Kisumu-Nairobi	Eldoret-Nairobi
(1)	Growth Rate of Urban Population in the Origin City 1985-2005*	6.9% (Kisumu)	7.4% (Eldoret)
(2)	Growth Rate of Urban Population in the Destination City 1985-2005**	6.0% (Nairobi)	6.0% (Nairobi)
(3)	Growth Rate of Airway Passenger Traffic (1) x (2)	13.3%	13.8%

Notes: * Assuming the following population growth

	Urban Population* (000) 1985	1995	2005	Growth Rate
Kisumu	211.9	401.4	806.6	6.9%
Eldoret	67.7	135.4	286.7	7.4%

** Projected Growth Rate in Kenya.
(Source: "Population and Development in Kenya" by S. H. Ominde P.62 Table 8.8; Based upon the forecast by Ministry of Finance and Planning.)

*** Application of a Gravity Type model was supposed.

Table 8.A.9 Forecasted Passengers for Regular Flights

(Unit: 1000)

Lines	Year			Growth Rate
	1985	1995	2005	
Kisumu-Nairobi	21	71	240	13.0%
Eldoret-Nairobi	(6.7)*	24	85	13.5%

Note: * Estimated potential demand for regular flight.

Table 8.A.10 Summary of Traffics Growth by Mode

Mode		Growth (2005/1985) Ratio	Growth Rates (%)
Road		3.37	6.3
Rail	(Pax)	2.32	4.3
	(Freight)	2.03	3.6
Waterway	(Pax)	2.71	4.1
	(Freight)	2.38	3.4
Airway	Kisumu-Nairobi	12.1	13.3
	Eldoret-Nairobi	13.2	13.8

Table 8.A.11 Growth Deviation to Obtain Adjustment Ratio

District	*1	*2	*3	*4
Kisii	1.03	0.86	2.98	1.37
Kisumu	1.03	0.86	0.83	0.91
Siaya	0.91	0.96	0.93	0.94
South Nyanza	0.94	1.09	3.04	1.45
Bumgoma	1.02	1.14	0.71	1.00
Busia	1.09	1.05	2.36	1.34
Kakamega	0.92	0.96	0.87	0.93
Kericho	0.97	1.16	0.84	1.05
Nakuru	0.83	1.00	0.34	0.80
Narok	1.10	1.55	1.00	1.27
Trans Nzoia	1.14	1.09	0.86	1.06
Uasin Gishu	1.20	0.99	0.85	1.04
Elkweyo Marakwet	0.83	1.00	0.67	0.92
Nandi	1.06	1.20	0.91	1.09
West Pokot	0.83	1.00	0.58	0.85
West*5	1.00	1.00	1.00	1.00
East	1.00	1.00	1.00	1.00
South	1.00	1.00	1.00	1.00
Average Growth Ratio (L.B. area)	2.06	2.64	3.47	-

Notes:
- *1 Population deviation and used for concentration traffics.
- *2 Agricultural product deviation.
- *3 Manufactured product deviation.
- *4 Correct traffics with weight 0.36 for population, 0.43 agricultural products and 0.21 for manufactured products.
- *5 Growth ratio for outer area are assumed to be the same as the L.B. area average.

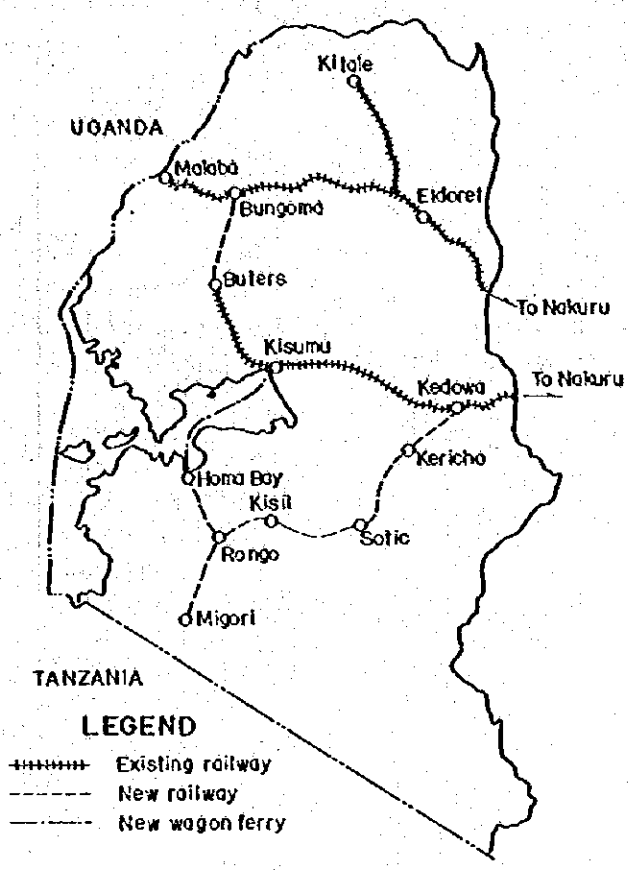

Figure 8.A.1 Railway Transport Network in the Region

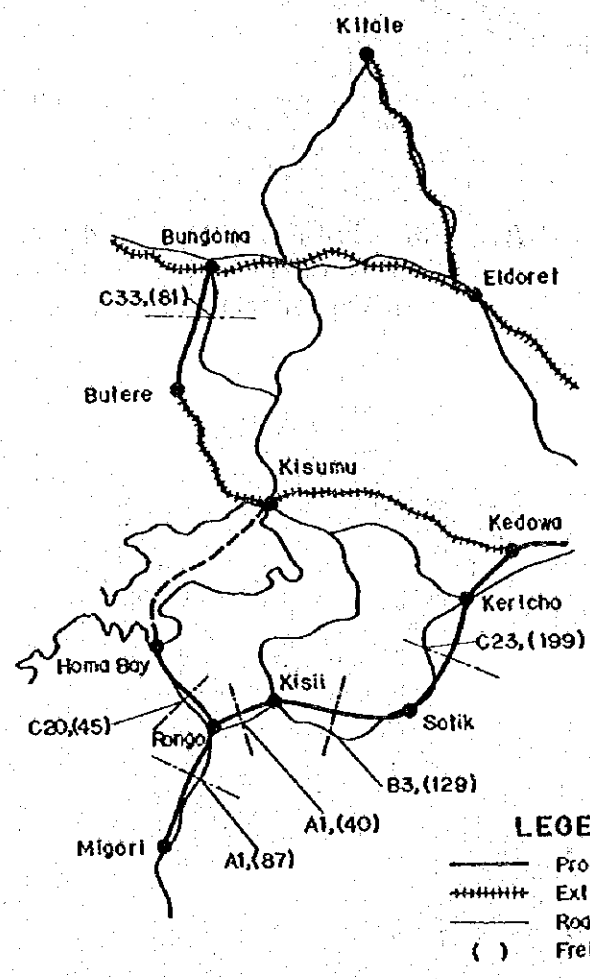

Figure 8.A.2 Freight Traffics on Alternative Roads

REPUBLIC OF KENYA LAKE BASIN DEVELOPMENT AUTHORITY
THE STUDY OF INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE LAKE BASIN DEVELOPMENT AREA
JAPAN INTERNATIONAL COOPERATION AGENCY

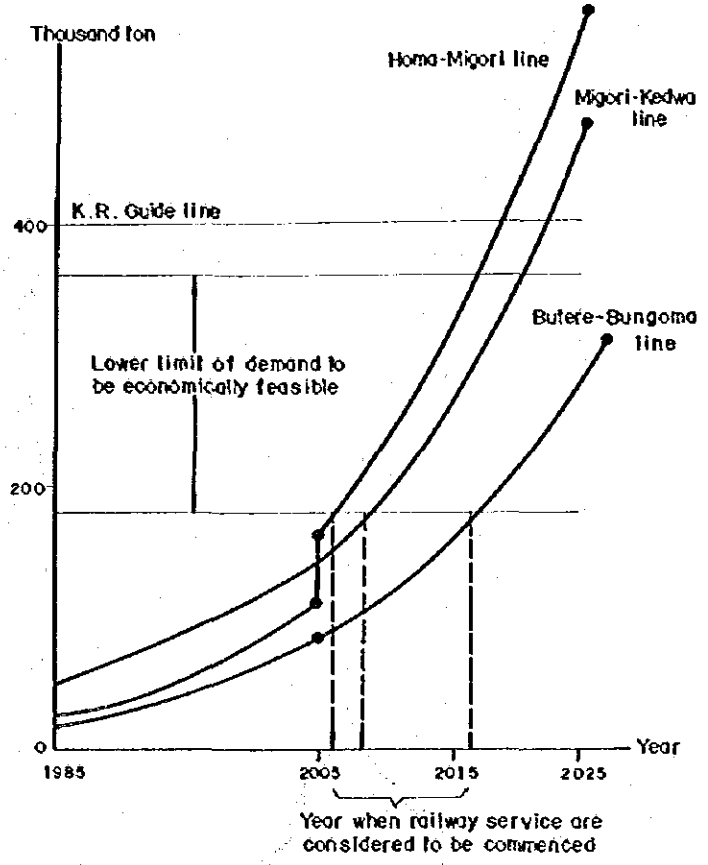

Figure 8.A.3 Expected Freight Demand for New Railway Lines Compared with Threshhold Demand Levels

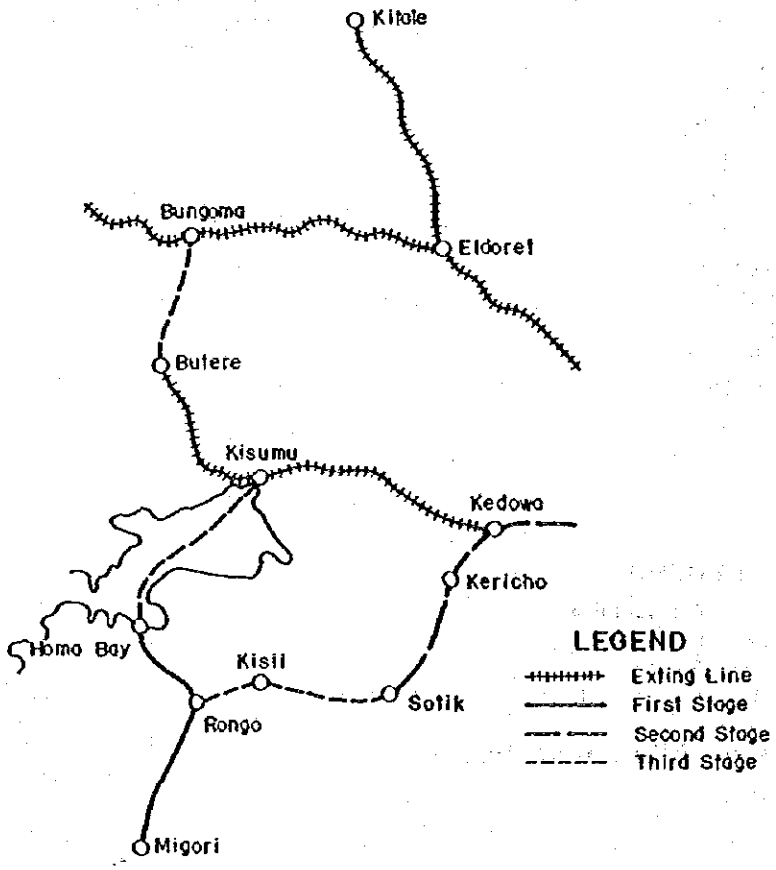

Figure 8.A.4 Staged Development of Railway Network

REPUBLIC OF KENYA LAKE BASIN DEVELOPMENT AUTHORITY
THE STUDY OF INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE LAKE BASIN DEVELOPMENT AREA
JAPAN INTERNATIONAL COOPERATION AGENCY

CHAPTER 9 ENERGY

This chapter presents the results of sector study of the energy sector, carried out as a part of the Integrated Regional Development Master Plan study for the LBDA region. This sector study has been based primarily on existing data and study reports, but some additional data collection was also conducted as well as interviews with officials of the Central Government and districts and others.

In Section 9.1, existing development conditions of the energy sector are described, covering National and regional energy consumption and supply, energy policy and on-going activities for energy development and conservation. Prospects of demand and supply for energy are examined in Section 9.2, covering all the potential sources of energy. Section 9.3 presents the energy development plan, including objective and basic strategy, projects and other related measures.

Chapter 9 ENERGY

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9.1 Present Situation

9.1.1 Current status of demand and supply

(1) Kenya

Consumption

Total consumption of energy at the end-use in Kenya was 5,661 thousand TOE (TOE: tons of oil equivalent; approximately 42 million Joule) in 1980 (Table 9.1). Household sector was the largest energy consumer in Kenya, accounting for 58% of the total consumption. The second largest consumer was industrial sector (15% share), followed by transportation sector (11%), agricultural sector (10%) and commercial sector (5%).

Woodfuel has been playing a major role in energy supply in Kenya. Of the total primary energy supply of 7.83 million TOE in 1985, woodfuel contributed about 5.16 million TOE or about 66% (Table 9.2). After conversion, the woodfuel supply becomes 4.11 million TOE, meeting about 73% of the consumption with 3.49 million TOE of fuelwood and 0.62 million TOE of charcoal.

Petroleum products were the second largest supplier of energy, providing 1.96 million TOE in 1985 or about 31% of the total supply after conversion. Electricity accounted only for 3.4% of the total energy supply after conversion. "Non-Commercial" energies including fuelwood, charcoal and crop residues provided about 72% of the total consumption in 1985, while "Commercial" energies including petroleum products, industrial wood and electricity accounted for a minor part of the total.

Consumption of petroleum products shown in Table 9.3 is the largest in transportation sector, including road transport (38%), aviation (17%), marine (11%) and rail transport (3%). The decrease in petroleum consumption for power generation is attributed to the efforts to expand supply by hydro and geothermal generation as shown in Table 9.4. The stagnated consumption of petroleum products by the industrial and commercial sector is partly due to generally stagnant economy in early 1980's but chiefly attributable to more intensive use of electric energy by this sector.

Consumption of electricity grew from 1,663 GWh in 1981 to 2,014 GWh in 1985, representing an increase of 20% over the five year-period. Large commercial and industrial sector continued to be the major consumer, using 65% of the total. Domestic and small commercial sector, the second largest, accounted for 27% of the total consumption in 1985. The other two groups of users are off-peak and street lighting (Table 9.5).

Supply

The Ministry of Energy and Regional Development estimated that 23.4 million tons of wood were supplied for fuelwood and charcoal in 1985. The annual forest yield, however, is estimated to amount only to around 13 million tons (estimates vary among different sources). Thus, there is already a very large degree of forest "mining" in progress. Kenya's wood resources are being depleted at a rate which varies between four times

regeneration in high population density areas and about two times in other areas. The Ministry explains that this is due to combined effects of unprecedented growth in population and low conversion and end-use efficiency, coupled with the absence of policy intervention to sustain a balance between demand and supply.

Kenya has no oil production, and imports crude oil and petroleum products from Middle East countries. In 1984 around 70% of petroleum products refined in Kenya Oil Refinery's facilities at Mombasa are distributed domestically and the balance is exported to neighbouring countries. Major part of white products including motor spirit, illuminating kerosine, jet fuel and automotive gas oil is transported from Mombasa to Nairobi through a pipeline completed in 1978, and from there, excluding deliveries to Central area, transported to Western part of Kenya by railways and to neighbouring countries by tank trucks. The refinery system in Kenya does not have the capability of transforming the heaviest components of the crude oil into the lighter fractions so that the output mix does not match the domestic demand for different types of petroleum products. Those portions of products not used domestically are therefore exported, although the amount of exports is decreasing in recent years,

The availability of electricity in Kenya is generally limited to the more densely populated narrow area across the southern part of the country from Mombasa through Nairobi to Kisumu, and along the coast. Other areas are not served with electricity due to scattered population except a few population centres served by independent plants. The total installed capacity of all the power plants in Kenya was 572 MW at the end of 1985. The composition was 64% of hydro, 28% of fossil fuel and 8% geothermal (Table 9.6). All hydropower plants except some small ones are concentrated on the Tana River. Oil fired power plants are located at Mombasa. Geothermal power plant at Olkaria started its operation in 1981 and has expanded to 45 MW. Additionally, electricity has been imported from Uganda at 30MW.

(2) LBDA region

Although no specific figures have been found for the LBDA region except for electricity, both the ratio of household consumption and that of woodfuel consumption in the total energy consumption are supposed to be higher than those of the whole country, considering locations of energy resources as well as income level in the Region.

Domestic sector

Fuelwood is the major form of energy used for cooking in rural households. The most common device used for cooking with fuelwood is the traditional three-stone hearth or the clay furnace. Such fuelwood as splitwood, thick branches, twigs, bark, etc. in addition to crop residues and charcoal are used by rural households.

Looking at smallholders' fuelwood supplies in particular, it should be emphasized that to an ever-increasing extent, farmland in Kenya is privately owned. A family's supply of domestic energy comes from its own farm and those in the immediate neighbourhood. Not much land is left for commercial fuellots . In Kisii district for instance, fuelwood from neighbouring farms is either bought or collected free, whereas split wood has to be bought

and twigs are collected free. The sale of tree for fuelwood, however, has appeared to be a more or less specialized activity at least to date.

Table 9.7 shows that the high population density provinces including Nyanza and Western have already entered the process of cutting woodstocks. In each of provinces, over half of the wood is supplied from existing stocks instead of sustainable yield.

According to a survey made by the Beijer Institute of Sweden for KWDP (Kenya Woodfuel Development Programme), 16% of Kakamega district experiences a shortfall of more than 60% of needs (assuming a requirement of 1 m^3 per capita), and only 42% of the district has a surplus. In the densely populated areas of the southern part, shortages of 60% of needs or more are experienced in over 50% of the areas. There are a number of indications that the shortage of fuelwood is becoming more serious in Kisii district, according to another survey made by the Institute. One of such indications is that fuelwood is no longer a free good which can be just collected, as mentioned above. The survey concludes that the most important factors which have led to this situation are as follows:

(a) the availability of natural woody vegetation is rapidly decreasing as a result of the subdivision of farms and intensification of land use, and

(b) most trees are planted for purposes other than for use as fuelwood, i.e. mainly building and timber.

Charcoal is the main type of woodfuel used in metal stove ("Jiko") by urban households. It is mainly because charcoal can bear transportation whereas wood cannot, and it can be handled more easily. Consumption of charcoal in Kakamega district, for instance, is estimated to be 166,000 tons in 1985, based on the consumption of 128.2 kg per annum (see Table 9.8) and 1.3 million population .

The bulk of charcoal is produced in the traditional earth kiln with average conversion efficiency of 12% by weight. It is not produced from sustained yield plantations, but typically from isolated trees and shrubs on range and bushland collected and processed by rural households wanting to earn an off-farm income. Charcoal production usually takes place within a few kilometre radius of the national road network to facilitate its transportation to consumers.

In addition to supplying consumers in respective province with charcoal, some of provinces are exporting it outside. Western and Rift Valley are charcoal exporters to Kisumu, and Rift Valley is also supplying Nairobi with charcoal.

In urban households, two of petroleum products, e.g. kerosine and LPG, are also used for cooking, and electricity is used for cooking as well as refrigeration and water and space heating by high income users. Table 9.9 shows the percentage use by province, of major household fuels in the major end uses, although they might be a little out-of-date figures. The percentages of kerosine used for cooking are not so high in Nyanza, Western and Rift Valley as in Coast and Central.

As can be seen in the table, kerosine is used mainly for lighting in Kenya except in Nairobi. Almost all rural households in Kisii district, for instance, use kerosine instead of fuelwood, the traditional fuel for lighting. Inexpensive and locally made kerosine lamps are usually used, while some families own more expensive kerosine lanterns. Kerosine is available in rural market shops.

In urban areas, electricity is used for lighting. Household electrification ratio, however, is estimated only at 1.5% in Western Supply Region compared with 11.3% of Coast and 6.8% of Nairobi in 1983 (Table 9.10). Consumption of electricity in the Region accounts for only one-eighth of the whole country, where the share of domestic and small commercial sector is 19.2% in 1983, much less than that of the whole country (28.6%) (Table 9.11).

Other sectors

Only very limited data and information are available for energy situations in other sectors than household in the LBDA region.

Fuelwood is used in brick making, pottery and jaggery manufacturing at the rural informal industrial level. It is also used in tea drying, tobacco curing and sugar refining at the level of large industry. Some of industrial plants were using charcoal which were provided by East African Tanning Extract Co. Ltd. (EATEC). EATEC was producing mainly for industrial use at brick-made kiln near Eldoret, but stopped its operation in May, 1986. It is explained by EATEC that the government-regulated price of charcoal (Kshs.24 per sack) had been too low to cover its production cost, and because EATEC found a new outlet for wood which otherwise is to be used for material for charcoal.

9.1.2 Energy policy

(1) National energy policy

Primary strategies

The basic directions of energy policy in Kenya can be summarized as follows:

1) to increase the production of woodfuel and the efficiency of its utilization, and

2) to promote the conservation of energy, especially petroleum.

In order to ensure that adequate supplies of energy are made in line with national development needs, efficiently and at reasonable costs, the energy policy will have to be extended along these two directions.

As mentioned above, woodfuel has been, and will be, a major supplier of energy in Kenya. Therefore, securing its stable supply should be one of the most important aims in energy policy. NEP emphasizes the importance as follows:

> The traditional sector is dominated by a single source of energy, woodfuel, which accounts for 95% of the total. Woodfuel, unlike oil, does not affect directly on the balance of payments and growth strategy, but indirectly through, for example, soil erosion leading to falling agricultural output, adversely affecting national development objectives, such as the alleviation of poverty, the provision of basic needs, preservation of the environment, etc.

On the other hand, petroleum is playing a major role in "the modern sector" and is imported by spending a large portion of foreign currencies. NEP also states as follows:

> The modern sector is dominated by petroleum, which caters for about 83% of its energy needs, 12% from electricity, 4% from coal and 0.27% from ethanol. Stringent efforts are being made to reduce the modern sector's dependence on imported oil through increased electricity from indigenous hydro and geothermal, coal imports, and conservation. The importance of all these measures cannot be over-stated particularly when one realises that in 1983, 42% of the country's foreign exchange earnings net of oil exports was spent in procuring petroleum as against an average of 1% in 1973.

Considering how to secure the stable supply of fuel, NEP proposes to "increase wood production under both on-farm and plantations systems and also increase efficiency of woodfuel utilization at the level of conversion and end use". And electricity is regarded as the "most promising partial substitute for oil." Additionally, substitutes for both wood and petroleum are proposed to be sought in energy sources such as wind, solar, biogas, producer gas and power alcohol, although it is added that a long-term approach should be adopted toward their introduction.

In the understanding of NEP, the growth of national income in Kenya is not at an adequate level to finance entirely by itself a transition from wood energy to petroleum and electricity and satisfy other development goals as well. Cooperation with foreign countries which have sufficient experiences for tiding over the transition must be very critical.

Measures for woodfuel

With regard to the expansion of woodfuel supply, three kinds of forestry programmes are proposed by SP1. The first one is agroforestry, the system of intercropping traditional crops with trees, which farmers will be encouraged to practice. The species of trees selected are typically those which fix nitrogen and thus reduce fertilizer requirements, are fast growing, allow sunlight to pass freely through foliage, and help to retain soil moisture. Agroforestry will not conflict with food and export crop expansion because intercropping with appropriate trees does not reduce crop yields.

The second one is reafforestation in all regions of the country, which will add to wood supply while simultaneously protecting the environment. In medium to high-potential areas, new and replanted forests will protect watersheds and prevent soil erosion. In arid and semi-arid areas, new forests and species will also increase the water carrying capacity of land and help prevent deterioration of the environment.

The third one is woodfuel plantations in reasonably close proximity to urban centres. Charcoal demand can be met on a sustainable basis only with the establishment of efficient woodfuel plantations. These plantations will have to utilize low and medium-potential land to avoid conflict with agricultural growth targets.

On the other hand, a critical review of present wood production methods, an intensification of efforts to select suitable tree species, commercial plantation systems, and other related measures are proposed by NEP for enhancing wood supply.

A demand management policy should be coupled with the wood supply expansion policy. Policy intervention at the demand level proposed by NEP is to positively effect end-use, conversion, pricing and marketing of woodfuel.

Fuelwood is traditionally burnt in three-stone hearth with an average efficiency of 8% at rural household level. The bulk of charcoal is produced in traditional earth kilns with an average efficiency of 12% (1 to 8.5) by weight, which means 24% on calorific basis. The urban charcoal stove, "Jiko", is mainly used for cooking having an average efficiency of 20%. Introducing more efficient types of stove for fuelwood charcoal producing kiln and charcoal stove will contribute to conserving woodfuel to a great extent.

In addition, alternatives to woodfuel such as biogas and agricultural/industrial residues (coffee husk, rice husk, sawdust, etc.) are proposed by NEP to be used directly or in the form of briquettes. The Sessional Paper No. 1 of 1986 also states alternative means to meet the demand for charcoal, including the use of charcoal based on waste from coffee, maize and sugar, as well as the substitution of other forms of energy, which will be evaluated and proposed by the Ministry of Energy and Regional Development.

According to NEP, the main opportunities for marketing and pricing intervention exist for charcoal, used by urban households because rural households are encouraged to practice agroforestry for self-sufficiency under the government's policy. Following measures are proposed for marketing and pricing.

1) To ensure that prices reflect the true cost of production (measured by commercial plantation production cost) as well as grade and quality;
2) To encourage the formation of charcoal cooperatives;
3) To encourage producers to pack charcoal in a more appropriate manner to better protect it from pulverization during transportation and handling; and
4) To encourage wholesalers to prepack charcoal in different size of packs according to weight requirements of different kinds of consumers.

As these measures are proposed, the Government's intention is expressed to avoid a shift from charcoal to kerosine.

Activities for tree planting and woodfuel conservation

Tree planting activities outside the gazetted forest reserves in Kenya began in 1971 when the Forest Department of the Ministry of Environment and Natural Resources launched the Rural Afforestation Extension Scheme (RAES). The major objectives of this scheme were

first to create awareness of the need to plant trees on private lands, and secondly to provide technical services, including establishment of tree nurseries at the district level. As of 1982, the scheme has a total of 145 tree nurseries with a production capacity of over 60 million seedlings a year.

A second milestone was the establishment of the Ministry of Energy in 1979 to oversee the development and conservation of energy in the country. As a part of its activities, the Ministry initiated agroforestry and woodfuel development programmes. These include the Kenya Renewable Energy Development Project (KREDP) and the Kenya Woodfuel Development Project (KWDP). Another important factor was the 1980 Presidential decree requiring every chief to establish a tree nursery in his location. As a result of this decree, 300 chief's nurseries had been established by 1984. The decree also prompted many District Development Committees to initiate tree nurseries in various locations.

Two other recent developments of interest are the formation in 1981 of the Permanent Presidential Commission on Soil Conservation and Afforestation and the setting up of the Presidential Tree Fund in 1985. The former has been successful in creating awareness of the need for tree planting for environmental conservation purposes, while the latter is expected to provide facilities for tree planting at the grassroots level.

Most of tree planting activities are under the Ministries of Environment and Natural Resources, Energy and Regional Development, Agriculture and Livestock Development. As a part of the Government's strategy to enhance tree planting, various international agencies have been invited to assist specific programmes, either through direct funding or through technical assistance. Those who have responded positively include: the World Bank, EEC, United Kingdom, West Germany, Norway, United States, Netherlands and UNESCO. Japan started its technical cooperation in 1986. According to a KREDP's brochure, projects operating independently of the Government machinery are relatively free of logistic constraints and do not depend on the limited skilled staff of the government ministries.

The earliest tree planting activities were through NGO's (Non-Governmental Organizations), long before the Government started taking an active part. Since 1980, many more NGO's have become actively involved in tree planting for energy and soil and water conservation. The NGO's activities in these areas include schools, colleges, self-help community groups, the scout movement, church organizations and other special interest groups. NGO's are in a particularly strategic position to make a significant impact in tree planting in Kenya. Nearly 80% of active nurseries in the country in 1984 is said actually to be maintained by NGO's. In 1982, KENGO (the Kenya Energy Non-Governmental Organizations Association) was formed as an umbrella organization.

Woodfuel conservation technologies are relatively new in Kenya, having gained attention since around 1980. The major performers in this field are KREDP, KENGO, UNICEF and the Special Energy Programme (SEP) of West Germany. Activities have centred around the design, fabrication and testing of improved devices for burning wood and charcoal. One of the success stories in woodfuel conservation is the Kenya Ceramic Jiko, a traditional metal stove lined with fired pottery. This device is 30-50% more efficient than traditional stoves. Another model at an advanced stage of development is the Kuni-Mbili firewood cookstove.

Main foreign-related projects or programmes involved in tree planting and conservation of woodfuel are as follows. One is called KREDP, which was originally funded partly by the United States Agency for International Development (USAID). Since its initiation in 1981 it has been responsible for setting up six agroforestry/energy centres in various ecological zones of the country (coast, arid and semi-arid, upland savanna, central highlands, western highlands and Lake basin). The centres for the Lake basin are in Kisii and at Bukura, Kakamega.

KWDP is another project for promoting tree-planting for multiple purposes. On the basis of a grant from the Dutch Government, KWDP began operations in late 1983 by establishing a district level project in Kakamega, which has a high population density and small average farms, resulting in very heavy pressure on the land for food and woodfuel. In 1985, KWDP extended its activities to Kisii (with support of the Netherlands) as well as to Muranga (with support of the Swedish International Development Authority).

The Special Energy Programme (SEP) in Kenya was initiated by GTZ (the German Agency for Technical Cooperation) with the objective of improving the energy situation in rural areas by promoting the utilization of renewable energy resources. In the LBDA region, biogas projects have been implemented in Kakamega and Kisii, and projects on improved stove and tree planting in Kisii.

The Japan International Cooperation Agency (JICA) has started a project at Kitui and Muguga. The objective of the project is to train personnel from both Governmental and non-governmental organizations on tree nursery technology, with a view to enhancing tree planting efforts in the country.

(2) Regional energy policy and measures

LBDA has set the following objective for energy sector (Development Plan 1983-88).

1) To develop hydropower as a top priority to enhance the overall objectives of the Authority;
2) To promote rural electrification; and
3) To redirect energy demand from costly oil to renewable sources of energy.

With these objectives, several measures have been emphasized. First the following hydropower projects have been enumerated for early implementation: viz. Sondu/Miriu, Webuye Falls, Teremi and Mau Forest. Second, rural electrification has been promoted in every district, although it suffers from the lack of finance in most districts. Third, every effort is to be made to identify and develop alternative sources of energy, including wind, solar, biogas and woodfuel. Fourth, alcohol production from biomass and afforestation for woodfuel are underway for increasing renewable energy supply in the Region. The distillery owned by Agro-Chemical and Food Company (ACFC) is producing ethanol from molasses, a by-product of sugar mills. The distillery is located at Muhoroni, and the product is transported to Nairobi to be blended with gasoline at the ratio of 1 to 9.

9.2 Future Prospects

9.2.1 Alternative forms of energy

(1) Petroleum

Demand

The National demand for petroleum products to the year 2000 has been projected by NEP as shown in Table 9.12. The overall growth rate is 1.8% per annum on average, but differential growth rates are expected, reflecting government policies for substitution and conservation. The growth in gasoline demand has been projected at 1.0% per annum, and the demand for fuel oil at 2.1%.

The regional demand for petroleum products would grow more or less in line with the national demand, but there are some factors unique to the Region which may affect the demand. One is the possible internationalization of Kisumu airport in a long run, which would very much increase the demand for jet kerosene. Another is the expansion of power alcohol production as a result of increased sugar production envisaged by this Master Plan. However, up to 2000 or so, the total demand for petroleum products in the Region will grow more or less at 2.0% per annum.

Supply

Of the petroleum products produced at the refinery in Mombasa, white petroleum products are transported by pipeline to Nairobi, while other products by rail and road. Further transport from Nairobi to inland regions as well as to neighbouring countries is primarily by road and partly by rail.

The transport of petroleum products to the Region by road contributes to the number of road accidents as well as traffic jams in some sections as the roads to the Region pass through mountainous areas. It also causes rapid deterioration of roads. The transportation by rail suffers from inadequacy of locomotives and tankers. In order to meet the increase in demand for petroleum products, these transportation problems have to be overcome or alleviated. Options include the improvement of roads with dualing and provision of climbing lanes, the reinforcement of railway transport system, the extension of oil pipeline, and any combination thereof.

Oil pipeline

The idea of extending the oil pipeline to the western Kenya and further to Uganda has been recurring and recently drawn renewed attention. However, about 60% of the petroleum products transported to the western Kenya is further transported to the neighbouring countries so that the extension cannot be easily justified without considering the export demand. This point may be illustrated below.

Figure 9.1 shows the expected demand for petroleum products which may be transported to the western part of Kenya by the extension of pipeline. The growth rate of 2.0% per annum

has been assumed for both domestic and export demand. For the purpose of analysis, the breakeven point where the pipeline extension becomes viable is taken to be 4,000 tons/km/year, based on the performance of the existing pipeline between Mombasa and Nairobi.

Applying the breakeven point to different sections of proposed extension, the following may be concluded. Up to Londiani, the extension is justified with the present level of demand without the export demand. The extension from Londiani to Eldoret cannot be justified until 2000 without the export demand. The extension from Londiani to Kisumu cannot be justified even in 2000 without the export demand, but may become viable by 1995 if the export demand is taken into account. The further extension to Malaba would have to wait until 2000 or later.

Overall prospect

As examined above by a simple analysis, the extension of oil pipeline as a whole may not be justified until 2000 or a few years later. The justification depends more on the export demand.

The improvement of roads with dualing and provision of climbing lanes would alleviate the transportation problems associated with oil transport, but the capacity of roads would still be limited so that other modes of transport will continue to be required. For the railway transport system to serve for this supplementary function, the current constraints of locomotives and tankers have to be overcome.

According to the sector study of transportation, the reinforcement of Kisumu - Nakuru line would become necessary before 2000 (Chapter 8, Sector Report). The reinforcement then should take account of possible increase in transport capacity for petroleum products.

The internationalization of Kisumu airport is another major factor which would introduce a structural change in the demand for petroleum products. Although this is expected to occur only around 2000, the justification of alternative modes of oil transport would be affected by this change. The expansion of power alcohol production, on the other hand, would not much affect such justification, as the demand for gasoline, with which the power alcohol is mixed, is a small portion of the total demand for petroleum products and expected to grow at much lower rate than the overall growth of petroleum products.

A final decision on means of supply expansion to meet increase in demand should be made after a comprehensive study is conducted to compare the alternative modes of transport for petroleum products, including alternative routes and orders of oil pipeline extension, combinations of pipeline extension and waterway transport, the reinforcement of railway transport system and combination of these with the improvement of roads. This study should be conducted soon after the study of petroleum demand in Uganda in concluded.

(2) Coal

Coal in general is an alternative to oil, being price competitive. Coal in the country has limited use including the recent conversion from oil at cement factories, and will continue to

be that way for short to medium term. This is because widespread use of coal would require the establishment of extensive infrastructure such as handling and storage facilities at ports, conversion of end-use devices and marketing facilities. It would also involve negative environmental problems.

Prospect for coal in the Region is even more meager. The transport of coal from the importing port would not only be constrained by the capacity of railways as mentioned above but also make the costs prohibitively high. Only positive prospect may be presented by a discovery of good quality coal in neighbouring countries, which then may be transported in bulk by using the Lake transport system which should be established in a long run. However, no definite plan can be drawn on such a conjecture.

(3) Electricity

Demand

A recent study to forecast electric power demand was carried out by JICA through the Sondu River Multipurpose Development Project for the entire nation and western region of Kenya. Another study with the title of National Power Development Plan of Kenya to review future demand growth has just been completed by Acres International, Canada.

These forecasts for the entire nation are compared as shown in Table 9.13 and Figure 9.2, giving the higher growth of power demand to Acres estimate. In the JICA estimate, power demand by the year 1990 grows at a rate of 4.7 percent per annum on an average, ranging from 4.3 to 5.5 percent per annum reflecting recent slow-moving economy, while the growth rate of 6 percent per annum will be attained in 1991 onward.

On the other hand, Acres estimates that a growth rate of 5.9 percent per annum on an average will be attained by 1990, while the estimate after 1991 onward is adjusted to 5.3 percent per annum from 6.0 percent per annum generally accepted in the past forecasts as the annual growth rate of medium term . Load factors applied herein is a constant of 0.69 for JICA estimate, but is varied from 0.67 to 0.65 for Acres estimate.

Power and energy demands in the western region of Kenya are also projected by JICA and Acres and summarized as follows.

	JICA		Acres 1/	
Year	Load (MW)	Generation (GWh/yr)	Load (MW)	Generation (GWh/yr)
1983	41	253		
1993	78	479	103	471
2000	129	790	170	781

Note: 1. Acres' forecast for net converted to the sent-out basis

A quite close consistency is observed in the energy projections by JICA and Acres, while a higher power demand is projected by Acres, mainly due to the difference in value taken on the load factor.

There is a tendency that the load factor in any power system moves from a small value to a larger one, as the system becomes large or the day-time power peak becomes greater than the night-time peak. Since the night-time power demand is dominant and still appears as the peak in the western region of Kenya, it is prudent to assume a smaller value for a load factor. Therefore, it is expected that power demand will reach the level of 170MW by the end of year 2000, following the Acres projection.

Supply

Power demand in the nation was projected to increase from 355MW in 1985 to the level of 800 MW in the year 2000 as discussed above, while the energy demand grows from 2,100 GWh/yr in 1985 to 4,900 GWh/yr in 2000. To meet the growing power and energy demands, a power supply plan has to be drawn considering the mobilization of indigenous resources, hydro and geothermal energy, and savings of imported fossil fuels.

A few water resources projects such as the Sondu/Miriu, Magwagwa and Nandi Forest projects, which are identified by this Master Plan to be promising for the development as hydropower projects, are conceived as candidates for sharing parts of growing future power demand. In fact, the Sondu/Miriu and Magwagwa are recommended in the recent feasibility study of the Sondu River Multipurpose Development Project as the hydropower projects to come in the power supply system by 1992 and 1996, respectively. The installation timing of Sondu/Miriu and Magwagwa is re-examined here as well as the Nandi Forest, taking into account the conditions changed after the completion of the Sondu study such as decreases in oil price, new commission of a gas turbine (30MW) and others.

An optimal power supply plan is defined above all as the least cost sequence out of numerous combinations of plants to be added to the power supply system in coming 20 years, in order to meet increasing power and energy requirements. Since the power supply system in Kenya is already linked as one system, the analysis is based on the total power and energy demand in the nation. JICA estimates are basically applied as the power and energy requirements, but the study will extend to the case applying the Acres estimates. The load duration curve assumed for the study is shown in Figure 9.3.

Besides the Sondu/Miriu, Magwagwa and Nandi Forest as mentioned above, several types of plants are considered as the candidates to be newly added to the power supply system. Table 9.14 shows the list of thermal candidates except for geothermal, and Table 9.15 gives hydro candidates, where each plant scale is estimated based on site identification. Projects under construction or committed are added to the power supply system on the appointed commission date with priority: Kipevu gas turbine (30MW) in 1987, Kiambere.(44MW) in 1988 and Turkwell (106MW) in early 1991. Tables 9.16 and 9.17 list all the under-construction and committed plants as well as existing ones. Other assumptions made and data used for the study are summarized in Table 9.18.

Applying a discount rate of 10 percent and dynamic programming as an analytical technique, a least cost sequence of power plants newly added to the power supply system has been searched and the results are given in Table 9.19. The table shows the installation timing of the Sondu/Miriu, Magwagwa and Nandi Forest as in 1992, 1996 and 1998, respectively. The power and energy balances in the least cost sequence are illustrated in Figure 9.4.

As a sensitivity test, the case applying the Acres power demand forecast has also been performed with no significant difference in the results as shown in Table 9.20.

(4) Woodfuel

National demand

Woodfuel is estimated to supply about 77% of total energy used in Kenya. For this, the total of about 23.4 million tons of wood was consumed in 1985, giving a per capita consumption of about 1.2 tons per year. The national wood demand consists of over 60% of fuelwood, about 30% wood for charcoal production and the rest for other purposes such as timber.

Table 9.21 gives further breakdown of demand for woodfuel for 1985. As seen from the table, the urban household demand for woodfuel is mostly for charcoal, while over 80% of rural household demand is for fuelwood. Also the household demand for woodfuel constitutes close to 80% of the total demand.

According to NEP, the demand for woodfuel is projected as the base case to grow from 23.4 million tons in 1985 to 57.3 million tons in 2005, at the rate of 4.6% per annum. A recent study conducted by UNDP/World Bank presents another projection of woodfuel demand growing at 3.7% per annum to reach 42.4 million tons by 2000 or 50.8 million tons in 2005 if extrapolated (Energy Sector Management Assistance Programme; ESMAP, February 1987). It also argues that the demand can be suppressed by as much as 20% by the year 2000, if concerted efforts are made on the Government initiative to conserve energy. Principal measures considered are charcoal stove improvement, improved fuelwood use efficiency and improved kiln efficiency. In this conservation case, the woodfuel demand will increase to 33.6 million tons by 2000 and 38.6 million tons by 2005.

Regional demand

In Kenya as a whole, over 90% of energy is derived from woodfuel in rural areas and about 9% in urban areas, making the overall share of woodfuel in total energy demand about 77%, as some 16% of population live in urban areas. In the Region, only 8% of people live in urban areas so that the share of woodfuel in the total regional energy demand is roughly calculated to be 84%.

This woodfuel demand was met with about 9.5 million tons of wood in 1985. Assuming the same policy measures are taken that would suppress the national woodfuel demand as mentioned above, the demand for woodfuel in the Region will increase to 16.5 million tons