

In the process of estimating the future production of such products the following concept is followed: As for food products, it is assumed that they are self-supplied in Haut-Zaire Region and their production in the influence area will be proportional to the future population of the influence area and the City of Kisangani. As for cash products, their future production is estimated by taking into consideration the production level before the independence and the trends in both domestic and international markets. In case of forestry products their future production is estimated by being based on the potentiality of the project area.

In the following, the population forecast, the forecasts of food products, cash products and forestry products, all of which are to be used in the process of the estimation as the basis, are described.

(2) Forecast of Future Population in
Influence Area for Food Products.

It is difficult to estimate quantitatively the influence by the improvement of the project road on the growth of population; however, according to the hearings conducted by the survey team, with inhabitants along the project road and the people concerned, there were many immigrations of local inhabitants to better and more convenient places as the deterioration of the road progressed; and the distribution of villages in the administrative zones along the project road are in a narrow belt area along the road; thereby, it is certain that the road conditions have much influence on the population growth and the population distribution. Accordingly, the future population in the influence area is estimated as follows, distinguishing the cases with and without the

improvement of the project road.

(i) Estimate of Population of Influence Area in 1973
for Production Estimate of Food Products

Table 2.4.11 is the result of the area and the population of the influence area of 40 km wide along the road to be used as the basis in estimating the production of food products. The process of estimation is as follows;

The administrative zones involving the project road and its influence area are Banalia, Buta, Aketi and Bondo which are furthermore divided into the following number of Collectivities (group of villages): 5 for Banalia, 7 for Buta, 9 for Aketi, and 10 for Bondo. And the number of Collectivities which involve the project road and its influence area within are 4 for Banalia, 4 for Buta, 3 for Aketi and 5 for Bondo, 16 Collectivities altogether.

The number of villages in each Collectivite and in the influence area in 1970 are counted using an administrative map compiled around in 1960; also shown in the proportion of the number of villages in the influence area to the total number of villages involved in the affiliated Collectivities.

The population of the influence area is calculated by multiplying the

Table 2.4.11 Population and Area in Project Area (in 1973 Year)

	Administrative Zone		Influence Area			
	Area (1) (Km ²)	Population(2) (Person)	Area (3) (Km ²)	PROtEion POPtEion (3) / (1) (%)	POPtEion Population (2) (Person)	PROtEion POPtEion (4) / (3) (%)
Banalia	24,430	84,222	8,660	35	48,849	58
Buta	18,098	62,612	4,670	26	32,558	52
Aketi	25,417	78,560	5,860	23	21,211	27
Bondo	38,075	99,027	8,950	24	34,659	35
Total	106,020	324,421	28,140	27	137,277	42

proportion of the number of villages in the influence area in 1970 to the population of the affiliated Collectivities in 1973. The thus calculated population of the influence area is examined by calculating the proportion of the length of the project road in each Collectivite, due to the reason that most of the inhabitants in the area along the project road live alongside the project road. The results thus calculated show that the relative proportion of the influence area to the affiliated administrative zones is 27% in area and 42% in population. (See Table 2.4.11).

(ii) Future Population of Kisangani

Kisangani, from which several trunk roads radiate, is the largest city in the north-east territory of Zaire, and the project road is merely one of these five main radiating roads. At the same time there are many factors other than the road conditions which bring the concentration of population to Kisangani, so the influence by the improvement of the project road is considered comparatively small.

Consequently, the future population of Kisangani was estimated, taking into consideration the growth rate which is considered to follow the trend of the period of 1957-1973 and not to be influenced by the improvement of the project road in its urbanization progress. Therefore, the population was estimated to grow for the period from 1974 till 1983, when the road is supposed to be opened, at 6.4% per annum, for 5 years till 1988 at 6.0%, for 5 years till 1993 at 5.8%, and for 10 years till 2003 at 5.5%. The estimated growth rates of population of the influence area by zone are shown in Table 2.4.12.

(a) Population of Influence Area in
Case Without Improvement of Project Road

The future population growth rate of the administrative zones (excluding Kisangani) along the road in the case without the improvement of the road is different depending upon whether the zones involve any urban area or not. In Banalia and Bondo zones which involve no urban area, their past trends are used for their future projections while for Buta and Aketi zones, which involve urban area, higher rates of growth should be used for their future projections.

The estimated growth rates of population are shown in Table 2.4.12.

Table 2.4.12. Estimated Growth Rates of Population of
Administrative Zones Including Influence
Area (Without Road Improvement)

(Unit: %)

<u>Administrative Zones</u>	<u>1973-83</u>	<u>1983-88</u>	<u>1988-93</u>	<u>1993-2003</u>
(Kisangani)	(6.4)	(6.0)	(5.8)	(5.5)
Banalia	1.9	1.7	1.6	1.4
Buta	1.4	1.3	1.2	1.0
Aketi	-0.3	-0.3	-0.3	-0.3
Bondo	-0.5	-0.5	-0.5	-0.5

Influence Area in Banalia and Bondo Zones

If the project road is not improved, the future population growth rates of the influence area in Banalia and Bondo zones are considered to reflect the past trend of the zones; the growth rates are estimated as same as indicated in Table 2.4.12.

Influence Area in Aketi Zone

Because no urban area is included in the influence area in Aketi zone, the population growth rate of the influence area in Aketi zone is considered to be almost as same as that of Bondo zone. Accordingly, in the case without the improvement of the project road, the rate is estimated to remain at -0.5% in the future which means the trend of decrease is expected to continue.

Influence Area in Buta Zone

The whole urban population of Buta Zone is included in the influence area. The past population growth trend of Buta Zone is the integrated total of the high increasing rate of urban population and decreasing rural population. The population growth rates of Buta Zone shown in Table 2.4.12 are the outcome of such urban and rural population as shown in Table 2.4.13.

Table 2.4.13 Estimated Population of Buta Zone
(Without road improvement)

<u>Year</u>	<u>Urban Population</u>		<u>Rural Population</u>		<u>Total</u>	
	<u>Population</u>	<u>Growth Rate (%/year)</u>	<u>Population</u>	<u>Growth Rate (%/year)</u>	<u>Population</u>	<u>Growth Rate (%/year)</u>
1973	22,162	4.2	40,450	-0.5	62,612	1.4
1983	33,479	3.2	38,472	-0.5	71,951	1.3
1988	39,231	2.7	37,520	-0.5	76,751	1.2
1993	44,876	2.1	36,592	-0.5	81,468	1.0
2003	55,189		34,803		89,992	

Viewing the past trends of the population growth in the above Table of urban and rural areas, these trends are considered to be appropriate, and the population of the influence area was estimated by adopting such rates.

The estimated results are shown in Table 2.4.14, the population growth rates of which are shown in Table 2.4.15.

Table 2.4.14 Estimated Population of Influence Area
(Without Road Improvement)

<u>Route Section</u>	<u>1973</u>	<u>1983</u>	<u>1988</u>	<u>1993</u>	<u>2003</u>
Banalia	48,849	58,965	64,151	69,450	79,809
Buta ^{1/}	32,558 (22,162)	43,332 (33,444)	49,026 (39,383)	54,662 (45,258)	63,437 (54,492)
Aketi	21,211	20,174	19,675	19,188	18,250
Bondo	34,659	32,965	32,149	31,353	29,820
<u>Total</u>	<u>137,277</u>	<u>155,436</u>	<u>165,001</u>	<u>174,653</u>	<u>191,316</u>

Note: ^{1/} The population within the parenthesis of Buta Section indicates the urban population.

Table 2.4.15 Estimated Population Growth Rates of
Influence Area (Without Road Improvement) (Unit: %)

<u>Route Section</u>	<u>1973-1983</u>	<u>1983-1988</u>	<u>1988-1993</u>	<u>1993-2003</u>
Banalia	1.9	1.7	1.6	1.4
Buta	2.9 (^{4.2} -0.5)	2.5 (^{3.2} -0.5)	2.2 (^{2.7} -0.5)	1.5 (^{2.1} -0.5)
Aketi	-0.5	-0.5	-0.5	-0.5
Bondo	-0.5	-0.5	-0.5	-0.5
<u>Total</u>	<u>1.2</u>	<u>1.2</u>	<u>1.1</u>	<u>0.9</u>

Note: The growth rates of Buta Section shown in the parenthesis: the upper is that of urban population and the lower is that of rural population.

(b) Population of Influence Area in Case
with Improvement of Project Road

Considering the past experiences that the functions of the local economy and society were paralyzed because of the deterioration of the road, and the local inhabitants immigrated to better and more convenient places along the road, a noticeable effect may be expected in the case of the improvement of the project road in the influence area. The population is estimated as follows for the influence area in each administrative zone by adopting several assumptions.

Banalia Zone

In the influence area in Banalia zone which does not involve any urban area (but it does border with Kisangani which is largely urban), the population keeps a comparatively high growth rate. Furthermore, since this zone has an indication of urbanization already, Banalia is expected to maintain a population growth rate similar to the average population growth rate of Haut-Zaire Region excluding Kisangani area. The growth rate without the road improvement was adopted until 1983 when the project road is expected to be opened. Consequently, as indicated in Table 2.4.17, the growth rate is estimated at 1.9% for five years until 1983, 2.1% for five years until 1988, 2.0% for five years until 1993 and 1.9% for ten years until 2003.

Bondo and Aketi Zones

As for the influence area in Bondo and Aketi zones, the population is estimated to stop its decreasing trend with the improvement of the project road but maintain the average growth rate of Haut-Zaire Region excluding urban areas.^{1/} Accordingly, the population decreases at the rate of 0.5% per annum until 1983 when the project road is supposed to be opened, and then it is estimated to increase at 1.6% per annum for five years until 1988, at 1.5% for five years until 1993 and at 1.3% for ten years until 2003.

Note: ^{1/} According to the statistics of the population of Haut-Zaire Region in 1973 the population of zones involving no urban area was 138,000 in 1957, and 178,000 in 1973. Their average annual growth rate was 1.6% for the period between 1957 and 1973.

Buta Zone

In the influence area in Buta Zone, urban and rural populations are estimated to maintain the same growth rate until 1983 as in the case without the road improvement. The growth rate of the urban population of Buta after the road improvement is estimated to accelerate up to that of Kisangani, while the rural population is estimated to stop its decreasing trend as shown here: The urban population will increase at the annual rate of 4.2% until 1983 and then at 6.0% for five years until 1988 and at 5.8% for five years until 1993 and at 5.5% for ten years until 2003;

while the rural population will decrease at 0.5% per annum until 1983 and at 0% for twenty years between 1983 and 2003.

The above description on population growth is summarized as shown in Table 2.4.16 and the average annual population growth rates are shown in Table 2.4.17.

Table 2.4.16 Estimated Population of Influence Area
(With Project Road Improvement)

<u>Route Section</u>	<u>1973</u>	<u>1983</u>	<u>1988</u>	<u>1993</u>	<u>2003</u>
(Kisangani)	(276,599)	(514,360)	(680,329)	(912,482)	(1,588,651)
Banalia	48,849	58,965	65,422	72,232	87,190
Buta ^{1/}	32,558 (22,162)	43,322 (33,444)	54,644 (44,756)	69,219 (59,331)	111,234 (101,346)
Aketi	21,211	20,174	21,840	23,528	26,772
Bondo	34,659	32,765	35,687	38,446	43,746
Total route section	137,277	155,226	177,593	203,425	268,942

Note: ^{1/} The figures in the parenthesis of Buta Section are only the urban population.

Table 2.4.17 Estimated Population Growth Rates of Influence Area
(With Project Road Improvement) (Unit: %)

<u>Route Section</u>	<u>1973-1983</u>	<u>1983-1988</u>	<u>1988-1993</u>	<u>1993-2003</u>
Banalia	1.9	2.1	2.0	1.9
Buta	2.9	4.7	4.8	4.8
Aketi	-0.5)	1.6	1.5
Bondo	-0.5			
<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
Total route section	1.2	2.7	2.7	2.8

(3) Estimated Production of Food Products

In this paragraph the future production of food products in the influence area is estimated for the cases with and without the project road improvement. As mentioned before, the agricultural products are classified into two categories, namely products for self-consumption and commercialized products, and only the latter affects the volume of traffic on the project road. Then, estimating commercialized products should be conducted taking into consideration their relation with the total production and the quantity of self-consumption.

(i) Current Production of Food Products in Influence Area

The influence area for food products does not coincide with administrative zones, and so the current production of food products in the influence area is calculated as follows:

The production of food products consists of the portion of self-consumption and the commercialized portion. The former is calculated by multiplying the population proportion of the influence area to that of the zone with the total quantity of self-consumption of that zone. The self-consumption is calculated by subtracting the commercialized portion (See Table 2.4.19) from the total production of food products (See Table 2.4.18). The proportion of population of the influence area to that of the administrative zone is calculated in 2.4.2 (2) and is summarized in Table 2.4.11.

The rate of delivery of the commercialized portion is based on the assumption that more products are delivered from a road of high design standard than a road of low design standard. Therefore, the delivery rate is assumed at 0.5 for other accessible main roads in each zone, for the stretch of 20 km of branch roads from the branching points on the project road and on the road Buta - Aketi, and at zero for other roads, while at 1.0 for the project road and the road Buta - Aketi. After calculating the weighted averaged road length in whole zone and in influence area the quantity of commercialized products in the influence area was calculated using the proportion of the weighted average road length afore-mentioned. As the results of such calculation the proportion of the commercialized portion of the influence area to that of the administrative zone is estimated at 70% for Banalia, 60% for Buta, 50% for Aketi and 70% for Bondo. (See Table 2.4.20).

Table 2.4.18 Production of Food Products by Zone (in 1972/73 Year)
(Total Production)

	Cassava	Banana	Paddy	Corn	Groundnuts	Total
Kisangani	5,000	347	70	111	2	5,530
Banalia	105,000	11,740	4,370	1,053	994	123,157
Buta	16,000	17,975	1,345	1,330	1,133	37,783
Aketi	29,000	27,654	3,829	3,028	2,250	65,761
Bondo	35,000	30,440	1,543	5,979	4,098	77,060
Total	190,000	88,156	11,157	11,501	8,477	309,291
Total (except Kisangani)	185,000	87,809	11,087	11,390	8,475	303,761

Source: Division Regional de l'Agriculture "Rapport Annuel" 1972/1983

Table 2.4.19 Production of Food Products by Zone (1972/73 Year)
(Commercialized Portion)

	(Unit; ton)					
	Cassava	Banana	Paddy	Corn	Groundnuts	Total
Kisangani	0	0	0	0	0	0
Banalia	1,200	344	344	0	332	2,220
Buta	300	132	17	37	88	574
Aketi	0	0	1,395	0	76	1,471
Bondo	100	50	50	0	10	210
Total	1,600	526	1,806	37	506	4,475
Total (except Kisangani)	1,600	526	1,806	37	506	4,475

Source: Division Regional de l'Agriculture "Rapport Annuel" 1972/1983

Table 2.4.20 Production of Food Products by Zone and by Influence Area (1972/73)

(unit: ton)

	Production in Administrative Zone			Production in Influence Area		
	Self Consumption	Commercialized Portion	Total	Self Consumption	Commercialized Portion	Total
Banalia	120,937	2,220	123,157	70,143	1,554	71,697
Buta	37,209	574	37,783	19,349	344	19,693
Aketi	64,290	1,471	65,761	17,358	736	18,094
Bondo	76,850	210	77,060	26,898	147	27,045
Total	299,286	4,475	303,761	133,748	2,781	136,529

(ii) Estimate of Production of Food Products in Influence Area In Case Without Road Improvement

As to food products for local inhabitants, the total consumption will not necessarily decrease but, on the contrary, will increase as it has been in the project area in the past, even if the Project Road is not improved. The improvement of distributing functions such as transportation from surplus zones to shortage zones and cashing surplus products cannot be expected unless the road is improved. Therefore, as to self-consuming products, it is considered that they will continue the trend of increase following the trend of population in the future and that the consumption per capita will slightly increase, so the production of food products is estimated to grow at a slightly higher rate than the population growth, and the present proportion of the commercialized portion will continue in the future. The Growth rate of self-consumption in the influence area in every zone was estimated as shown in Table 2.4.21 using the growth rates of their population shown in Table 2.4.15 as the basis. The percentage of commercialized products in Banalia, Buta, Aketi, and Bondo were set at 2.2%, 1.7%, 4.1% and 0.5% respectively using Tables 2.4.18 and 2.4.19 as the basis. Accordingly, the future production of food products in the influence area were calculated as shown in Table 2.4.22.

Table 2.4.21. Estimated Growth Rates of Production of Food Products in Influence Area

(Self Consumption Without Road Improvement) (Unit: %)

<u>Influence Area</u>	<u>1973-83</u>	<u>1983-88</u>	<u>1988-93</u>	<u>1993-2003</u>
Banalia	2.0	1.8	1.7	1.5
Buta	3.0	2.6	2.3	1.6
Aketi	0	0	0	0
Bondo	0	0	0	0
Average of Area	1.5	1.4	1.4	1.2

Table 2.4.22 Estimated Production of Food Products in Influence Area
(Without Road Improvement)

(Unit: ton)

Influence Area	1983		1988		1993		2003	
	Self Consumption	Commercialized Portion	Self Consumption	Commercialized Portion	Self Consumption	Commercialized Portion	Self Consumption	Commercialized Portion
Banalia	85,501	1,897	93,479	2,073	101,699	2,256	118,026	2,618
Buta	26,003	463	29,563	527	33,123	590	38,821	691
Aketi	17,358	736	17,358	736	17,358	736	17,358	736
Bondo	26,898	147	26,898	147	26,898	147	26,898	147
Total	155,760	3,243	167,298	3,483	179,078	3,279	201,103	4,192

(iii) Estimated Production of Food Products in Influence Area
With Road Improvement

The agricultural production in the influence area is considered to be affected by the economic impact of the improvement of the project road in the following three points: firstly, the increase of current production in accordance with the trend of the population growth; secondly, the delivery of products to markets is promoted by the improvement of road conditions, and, consequently, commercialized portion will increase; thirdly, according to the progress of urbanization in Kisangani and Buta, the demand of food products in those urban areas will increase, and that will stimulate the production to satisfy such demand.

(a) The current production will increase at the growth rates indicated in Table 2.4.23 with the improvement of the Road. Such growth rates are estimated on the basis of the respective population growth rates of the influence area in case with the road improvement shown in Table 2.4.17.

Table 2.4.23 Estimated Production Growth Rates of Food Products
in Influence Area (With Road Improvement) (unit: %)

<u>Influence Area</u>	<u>1973-83</u>	<u>1983-88</u>	<u>1988-93</u>	<u>1993-2003</u>
Banalia	2.0	2.2	2.1	2.0
Buta	3.0	5.1	5.0	4.8
Aketi	0	1.7	1.6	1.4
Bondo	0	1.7	1.6	1.4

Note: Such growth rates mean those of the current production, and the increase affected by the stimulation with the road improvement in the influence area is not taken into account

(b) The production estimated in (a), which does not include the production increase affected by the stimulation due to the road improvement consists of the self-consuming portion and commercialized portion. And the growth rate of the commercialized portion is estimated to recover its production level of pre-independence in 5 years with the improvement of the project road. Such a quick recovery is anticipated because the commodity distributing function had normally functioned in the area along the project road in the 1956's. The proportion of the commercialized portion adopted for the influence area in each zone is shown in Table 2.4.24.

Table 2.4.24 Estimated Proportion of Commercialized Portion to the Total Production of Food Products in Influence Area
(With Road Improvement) (unit: %)

<u>Influence Area</u>	<u>1956</u>	<u>1973,1983</u>	<u>1988</u>	<u>1993~2003</u>
Banalia	39.7	2.17	39.7	50.0
Buta	50.0	1.75	50.0	55.0
Aketi	30.2	4.07	30.2	35.0
Bondo	8.4	0.54	8.4	20.0

Note: The production proportion in the above Table is not of the total future production of the influence area, but that of the production described in the aforementioned paragraph (a).

(c) The production of food products per capita in the influence area is shown in Table 2.4.25. The urban population is expected to grow considerably by the time of opening of the project road. According to the forecast as shown in Table 2.4.14 and Table 2.4.16, the population of Kisangani is expected to be about 500,000 in 1983, and about 700,000 in 1988; and the urban population of Buta is expected to be about 33,000 in 1983, and about 45,000 in 1988. Taking into consideration the future improvement of agricultural technique, the promotion of the agricultural extension and guidance service, and the improvement of the local agricultural productivity, it may not be difficult to estimate that the agricultural productivity per capita of rural population will grow 20 to 30% in a period of 5 years after the opening the project road. Therefore, in the case with the improvement of the project road, it is estimated to expect additional 0.3 ton of food products per capita of rural population in the influence area of each zone in a period 5 years after its opening in 1988, and the total quantity of such increase is considered to become a commercialized portion.

Table 2.4.25 Estimated Productivity of Food Products per Capita in Influence Area

(with Road Improvement) (unit: ton/capita)

<u>Influence Area</u>	<u>1973</u>	<u>1983</u>	<u>1988</u>	<u>1993</u>	<u>2003</u>
Banalia	1.46	1.48	1.79 (1.49)	1.80 (1.50)	1.81 (1.51)
Buta	0.92	0.99	1.33 (1.03)	1.37 (1.07)	1.44 (1.14)
Aketi	0.84	0.90	1.20 (0.90)	1.21 (0.91)	1.21 (0.91)
Bondo	0.78	0.82	1.12 (0.82)	1.13 (0.83)	1.14 (0.84)

Note: 1/ The production per capita in parentheses do not include the net increase of 0.3 ton/capita due to the stimulation to production.

2/ 50% of the urban population of Buta was estimated to be agricultural population.

As a result of the case with improvement of the project road, the production of food products in the influence area is estimated as shown in Table 2.4.26. According to the estimation, the growth rate of food production in the influence area as a whole is 1.5% per annum from 1973 to 1983, 4.8% in the ten-year-period from the opening of the road and 1993, and 2.5% for ten years until 2003. There is no anticipated problem for such production increase in the basic agricultural conditions, such as climate, soils, cultivated land, etc., as to the production of food products in the project area.

The proportion of food products by type was determined, taking into consideration the proportion in 1956, 1970/71, and 1972/73. As such a tendency has appeared already in the statistics, the conversion to high-caloried foods is taken into consideration. The proportion in 1983 and 1993 is estimated in Table 2.4.27(a), and that of 1988 is estimated to be the middle value between 1983 and 1993. This proportion is considered the same in the cases with or without the improvement of the project road.

Table 2.4.26 Estimated Production of Food Products in Influence Area
(With Road Improvement)

(unit: ton)

<u>Influence Area</u>	<u>1983</u>		<u>1988</u>	
	<u>Self Consumption</u>	<u>Commercialized Portion</u>	<u>Self Consumption</u>	<u>Commercialized Portion</u>
Banalia	85,501	1,897	58,759	58,312
Buta	26,003	463	16,970	24,579
Aketi	17,358	736	13,740	12,497
Bondo	26,898	147	26,951	13,178
<u>Total</u>	<u>155,760</u>	<u>3,243</u>	<u>116,420</u>	<u>108,566</u>

(unit: ton)

<u>Influence Area</u>	<u>1993</u>		<u>2003</u>	
	<u>Self Consumption</u>	<u>Commercialized Portion</u>	<u>Self Consumption</u>	<u>Commercialized Portion</u>
Banalia	54,057	75,727	65,895	92,052
Buta	19,492	32,928	31,151	51,273
Aketi	13,852	14,517	15,918	16,604
Bondo	27,076	16,312	31,114	18,615
<u>Total</u>	<u>114,477</u>	<u>137,484</u>	<u>144,078</u>	<u>178,544</u>

Note: Self-consumption is consumption by producer themselves.
Commercialized portion satisfies partly local consumption but the majority is transported to other zones.

Table 2.4.27(a) Estimated Proportion of Food Products by Type in Influence Area

(unit: %)

<u>Influence Area</u>	<u>Paddy</u>		<u>Banana</u>		<u>Manioc</u>		<u>Mais</u>		<u>Arachides</u>		<u>Total</u>
	1983	1993	1983	1993	1983	1993	1983	1993	1983	1993	
Banalia	10	15	20	18	66	60	3	5	1	2	100
Buta	7	10	39	37	45	40	5	7	4	6	100
Aketi	8	12	35	32	45	40	8	10	4	6	100
Bondo	4	6	36	35	45	40	10	12	5	7	100

(iv) Cross-Check of Estimated Production of Food Products by Local Consumption

The estimated production of food products is cross-checked here from the viewpoint of the local consumption whether the estimation is appropriate or not.

First, the average annual consumption of food products per capita in Region of Haut Zaire is calculated in the following. In this region the local consumption has been basically selfsupported by the local production, although a small portion of them are exported to other regions. In other words, the annual production of such type is considered to be approximately equal to the local consumption. The actual situation in this field has been as shown in the following table.

Average annual consumption of food products
per capita in Region of Haut Zaire

	1956	1973
Annual production (ton)	1,862,007 ^{2/}	2,911,782 ^{3/}
Population	2,393,369 ^{1/}	3,461,858
Average annual consumption per capita (ton)	0.78	0.84

Notes : 1) Data of 1957.

2) Data is the average of 1955/56.

3) Data is the average of 1972/73.

The average annual consumption of food products per capita is considered to vary by location in the region, but it was impossible to determine the appropriate consumption level because the data necessary for the calculation were not available. The average consumption has shown some increase as shown in the above table, but such a trend is not considered to continue hereafter, on the contrary it will decrease at certain time in the future because of the facts that self-sufficiency has been already attained and that the inhabitants will show the trend to transfer to other high-caloried foods. Consequently the appropriate average annual consumption of food products is estimated to be approximately 0.8 to 0.9 ton per capita.

Tables 2.4.27 (b), 2.4.27 (c) show the average annual consumption of food products per capita in the influence area for the case without the improvement of the project road, which is comparatively high or low because of lack of the appropriate distributing agency of foods and also the local deficiency or surplus of products.

Tables 2.4.27 (c) show the average annual consumption of food products per capita in the influence area for the case with the improvement of

the project road which keep the appropriate consumption level and the its discrepancy between the areas is estimated to be smaller. The reason why it is smaller in Buta and Banalia and larger in Aketi and Bondo after the road is improved is due to the fact that the former situates, nearer to urban area or involve urban area within own area, while the latter situates in rural area. Consequently, the estimated production of food products is considered to be appropriate even if it is cross-checked form the viewpoint of the local consumption.

Table 2.4.27 (b) Current Average Annual Consumption of Food Products per Capita in Influence Area (1973)

(Without Project Road Improvement)

Influence Area	Production	Delivery (ton) ^{1/}		Local ^{2/} Consumption (ton)	Population	Average ^{3/} Consumption per capita (ton)
		Outbound	Inbound			
Banalia	71,697	1,434	-	70,263	48,849	1.44
Buta	19,693	197	262	19,758	32,558	0.61
Aketi	18,094	362	-	17,732	21,211	0.84
Bondo	27,045	162	-	26,883	34,659	0.78
Total	136,529	2,156	262	134,636	137,277	0.98

Note : ^{1/} Outbound means the delivery from the area to other areas and Inbound means the delivery from other areas into the area. The Tonnage of delivery is based on Table 2.4.2 or Table 2.4.3.

^{2/} Local consumption = (Production) - (Outbound delivery) + (Inbound delivery)

^{3/} Average consumption per capita
= local consumption / Population

Table 2.4.27 (c) Estimated Average Annual Consumption of Food Products per Capita in Influence Area

(Without Project Road Improvement)

Influence Area	Production (ton)	Delivery (ton) ^{1/}		Local ^{2/} Consumption (ton)	Population	Average ^{3/} Consumption per capita (ton)
		Outbound	Inbound			
(1983)						
Banalia	87,398	1,748	-	85,650	58,965	1.45
Buta	26,466	265	262	26,463	43,332	0.61
Aketi	18,094	362	-	17,732	20,174	0.88
Bondo	27,045	189	-	26,856	32,965	0.81
Total	159,003	2,564	262	156,701	155,436	1.01

(With Project Road Improvement)

(1988)						
Banalia	177,071	58,536	-	58,536	65,422	0.89
Buta	41,549	1,662	6,076	45,963	54,644	0.84
Aketi	26,237	787	-	25,450	21,840	1.17
Bondo	40,129	3,612	-	36,517	35,687	1.02
Total	224,986	64,597	6,076	166,465	177,593	0.94
(1993)						
Banalia	129,784	75,275	-	54,509	72,232	0.75
Buta	52,420	2,621	7,068	56,867	69,219	0.82
Aketi	28,369	851	-	27,518	23,528	1.17
Bondo	43,388	4,399	-	39,049	38,446	1.02
Total	253,961	83,086	7,068	177,943	203,425	0.87
(2003)						
Banalia	156,947	91,609	-	66,338	87,190	0.76
Buta	82,424	4,121	8,285	86,588	111,234	0.78
Aketi	32,522	976	-	31,546	26,722	1.18
Bondo	49,729	4,973	-	44,756	43,746	1.02
Total	322,622	101,679	8,285	229,228	268,942	0.85

- Notes : 1/ Outbound means the delivery from the area to other areas and Inbound means the delivery from other areas into the area. The tonnage of delivery is based on Table 2.4.2 or Table 2.4.3.
- 2/ Local consumption = (Production) - (Outbound delivery)
+ (Inbound delivery)
- 3/ Average consumption per capita
= local consumption / Population

(4) Estimate of Production of Non-Food Products

In this paragraph, the production of non-food products in the influence area is estimated in cases with and without the improvement of the project road. The fundamental concept on the estimation is as follows:

As mentioned before, Haut-Zaire Region is ranked as one of the important regions according to the national economic policy in which agriculture is given the priority. In this policy it is the target for the time being to recover the production level of plantation agriculture before independence. The finalized and detailed development program has not been made clear, but this development program may be estimated to a certain extent from the report of the agricultural development plan between 1970-80 by the Department of Agriculture. According to this report, it is proposed to expand the cultivated area up to more than 8,000 ha. for oil palm,

more than 3,000 ha. for coffee, and more than 5,000 ha. for rubber until 1980. Unless the problems with which the present plantations are confronted are solved, the Haut-Zaire Region will be confronted with another new problem. Although the plantation agricultural development in the project area was planned out by the aforementioned North-East Territory Development Committee (L'ASSINEZ), the utmost problem in implementing the project is to rehabilitate the deteriorated traffic facilities in the proposed agricultural development zone in the Region. Their rehabilitation needs such a tremendous amount of investment simultaneously with the agricultural project that it hinders a large investment in local agriculture. Consequently, if the improvement of the higher project road is implemented, there is a large possibility for agricultural investment with priority in Haut-Zaire. According to the facts described above, in the case without the improvement of the project road, the future production of non-food products is not considered to increase under the present production level; but their growth rates should be considered extremely low. However, if the project road is improved, the plantations in the influence area will receive direct benefits, and accordingly, it will become possible to be invested in preferentially by the government. The influence of improvement of the project road will appear in the two aspects of new development and also of improvement of existing plantations. In this study, viewing from the fact that it is more effective to give priority to the improvement of the existing plantations than to explore new plantations, it is considered that the production of non-food products is estimated to recover the pre-independence production level within 5 to 10 years after the project road is improved, and that in zones that have already recovered such levels or zones after recovered them, the adequate growth rate by type of products is estimated according to the demand tendency in international markets and the forecast by the government. The future production is estimated by type of product in the cases with and without the improvement of the project road as follows:

(i) Oil Palm Products

Although the national production of oil palm and its products stagnates, its production in the influence area is expected to grow somewhat even if the road is not improved, because the project area as well as Region of Equateur fits for its production. Therefore, the annual growth rate of its product was estimated at 1.5% until 1993 and 1.0% until 2003 without the road project.

In the case with the improvement of the project road, each zone was estimated to recover its 1956's production level in the period of 5-10 years after opening the road. As shown in Table 2.4.28, Banalia and Ango were estimated to recover their 1956's production level in 1988 and other zones in 1993. In this case, the net increase of products between 1983 when the road is anticipated to be opened and 1993 in the influence area is about 15,000 tons, and the average annual growth rate during the period will be about 24%; and according to the development concept by Department de Agriculture, the production increase of this category in Haut-Zaire is expected to reach about 25,000 tons until 1985. This development plan has not been realized yet because of the aggravation of the fundamental conditions in the Region; however, there is a sufficient possibility of gaining the first priority of such an agricultural investment to the influence area by the improvement of the road. And if the productive incentive to the existing plantations is taken into consideration, it may be possible to recover the 1956's production level in 1993.

As to the annual growth rate of products after the recovery, if it is taken into consideration that Haut-Zaire and Equateur Regions are expected to be the national main supplying areas of oil palm products in the future, the average annual growth rate of oil palm products was estimated at 4% that is at least bigger than the average

annual population growth rate.

(ii) Cotton

The future production of cotton in the influence area will be affected much by the industrialization of Kisangani and the improvement of traffic facilities. The main cotton-producing area is situated in the northern part of the influence area, and even if the industrialization of Kisangani progresses, the cotton production will not be stimulated unless the project road is improved. Consequently, the annual growth rate of cotton production was estimated at 1% until 1993 and at 0.5% until 2003 without the project road.

In the case with the improvement of the road, in addition to the industrialization of Kisangani and the demand growth in the project area, the extensive stimulation on the agricultural products is expected; and also in the category of cotton, it is estimated that the cotton-producing area will recover the 1956's production level in a period of 5 to 10 years after the opening of the road. As shown in Table 2.4.29, it is estimated that Banalia and Ango zones will recover the 1956 production level in 1988 and the other zones in 1993. On the basis of this estimation, the annual growth rate of cotton products of the administrative zones along the road is expected at 10 to 15% between 1983 (when the improvement of the road is completed) and the year of recovery; and that of the whole influence area between 1983 and 1993, at 9.6%. Such estimation is reasonable from the viewpoint that the influence area is suitable to raise cotton and that IBRD is presently conducting a survey for an extensive cotton development program in the North-East Territory. Since the relation between the

industrialization of Kisangani and the influence area will become closer after the recovery to the former production level and the noticeable growth of production may be expected in the influence area as an important cotton producing zone, its annual growth rate was estimated at 5%.

(iii) Coffee

Coffee is an exceptional crop which has shown the annual growth rate of products at 2.5% a year since 1956; however recently the growth has slowed down. Accordingly, as with other cash crops, the annual growth rate of the coffee production was estimated at 1.5% until 1993, and at 1.0% until 2003 unless the project road is improved.

Only Banalia and Buta zones are not expected to recover the 1956's production level in 1983 (and the products in 1956 was not so large). Usually coffee plants need about 5 years till their first harvest after they are planted, so Banalia and Buta zones will recover the 1956's production level by 1988. The annual growth rate of coffee in zones that recover the 1956's level or zones which have already recovered (both of which export most of their production) will be directly affected by the demand tendency in the international markets. Seeing that the annual growth rate of coffee in international markets has been 2.5% and the project area plays a relatively important role in the coffee production of Zaire, the annual growth rate was estimated at 3%. The estimated coffee production is shown in Table 2.4.30.

Table 2.4.28 Future Production of Non-Food Products (Oil Palm & its Products)

(Unit: ton)

Zone	Year	1956	1972/73	1983	1988		1993		2003	
					Without	With	Without	With	Without	With
Banalia		574	318	369	398	574*	428	698	473	1,033
Buta		1,097	282	327	353	600	380	1,097*	420	1,624
Aketi		2,520	12	14	15	188	16	2,520*	18	3,730
Bondo		3,973	16	19	20	275	22	3,973*	24	5,880
Sub-Total		8,164	628	729	786	1,637	846	8,288	935	12,267
Ango		180	0	0	0	180*	0	219	0	324
Bambesa		2,353	957	1,111	1,196	1,617	1,289	2,353*	1,424	3,483
Poko		6,295	69	80	86	709	93	6,295*	103	9,318
Sub-Total		8,828	1,026	1,191	1,282	2,506	1,382	8,867	1,527	13,125
Grand Total		16,992	1,654	1,920	2,086	4,143	2,228	17,155	2,462	25,392

Note : * The year when the production is expected to recover the 1956's level.

Without : Case of without project

With : Case of with project

Table 2.4.29 Future Production of Non-Food Products (Cotton)

Year Zone	1956	1972/73	1983	1988		1993		2003	
				Without	With	Without	With	Without	With
Banalia	1,879	995	1,099	1,155	1,879*	1,214	2,398	1,276	3,906
Buta	2,737	611	675	709	1,358	746	2,737*	784	4,458
Aketi	3,342	1,108	1,224	1,286	2,025	1,352	3,342*	1,421	5,444
Bondo	4,957	1,676	1,851	1,946	3,035	2,045	4,957*	2,150	8,074
Sub-Total	12,915	4,390	4,849	5,096	8,297	5,357	13,434	5,631	21,882
Ango	3,434	2,735	3,021	3,175	3,434*	3,337	4,383	3,508	7,139
Bambesa	6,440	2,122	2,344	2,464	3,878	2,589	6,440*	2,722	10,490
Poko	5,323	1,462	1,615	1,697	2,936	1,784	5,323*	1,875	8,671
Sub-Total	15,197	6,319	6,980	7,336	10,248	7,710	16,146	8,105	26,300
Grand Total	28,112	10,709	11,829	12,432	18,545	13,067	29,580	13,736	48,182

Note: * The year when the production is expected to recover the 1956's level
 Without: Case of without project
 With : Case of with project

Table 2.4.30 Future Production of Non-Food Products (Coffee)

(Unit: ton)

Zone	Year	1956		1972/73		1983		1988		1993		2003	
		Without	With	Without	With	Without	With	Without	With	Without	With	Without	With
Banalia		1,618	167	194	1,618*	209	1,876	225	1,876	248	2,521		
Buta		1,164	43	50	1,164*	55	1,349	60	1,349	66	1,813		
Aketi		666	1,394	1,618	1,876	1,743	2,174	1,878	2,174	2,074	2,922		
Bondo		2	95	110	128	119	148	128	148	141	199		
Sub-Total		3,450	1,699	1,972	4,786	2,126	5,547	2,291	5,547	2,529	7,455		
Ango		4	74	86	100	93	116	100	116	110	155		
Bambesa		1,818	1,593	1,849	2,143	1,992	2,485	2,146	2,485	2,370	3,339		
Poko		1,972	7,586	8,804	10,206	9,484	11,832	10,217	11,832	11,286	15,901		
Sub-Total		3,794	9,253	10,739	12,449	11,569	14,433	12,463	14,433	13,766	19,395		
Grand Total		7,244	10,952	12,711	17,235	13,695	19,980	14,754	19,980	16,295	26,850		

Note: * The year when the production is expected to recover the 1956's level.
 Without: Case of without project
 With : Case of with project

Table 2.4.31 Future Production of Non-Food Products (Rubber)

(Unit: ton)

Year Zone	1956	1972/73	1983	1988		1993		2003	
				Without	With	Without	With	Without	With
Banalia	1,090	212	234	246	1,090*	259	1,264	272	1,698
Buta	0	0	0	0	0	0	0	0	0
Aketi	447	0	0	0	447*	0	518	0	696
Bondo	0	0	0	0	0	0	0	0	0
Sub-Total	1,537	212	234	246	1,537	259	1,782	272	2,394
Ango	0	0	0	0	0	0	0	0	0
Bambesa	0	0	0	0	0	0	0	0	0
Poko	0	0	0	0	0	0	0	0	0
Sub-Total	0	0	0	0	0	0	0	0	0
Grand total	1,537	212	234	246	1,537	259	1,782	272	2,394

Note: * The year when the production is expected to recover the 1956's level
 Without: Case of without project
 With : Case of with project

(iv) Rubber

The rubber production in the project area in 1956 was not large, and there exist statistics of rubber production only in Banalia and Aketi zones. There is a problem of such incomplete statistics, the production itself is not larger than that of other crops, and its influence to the volume of traffic is also small. Because only Banalia and Aketi zones had rubber production in 1956, the future rubber production was estimated as the same way as other crops.

In the case without the improvement of the project road, the annual growth rate of rubber was estimated at 1.0% until 1993, and at 0.5% until 2003. In the case with the improvement of the road, the production was estimated to recover its 1956's level of production in 5 years after the opening of the road, and the annual growth rate of 3% thereafter. The production thus estimated is shown in Table 2.4.31.

(5) Estimation of Future Production of Lumber

As to the future possibility of national lumber production, many organizations have already pointed out the abundant lumber resources of Equateur and Haut-Zaire Regions; and the basic survey of forestry resources is presently being carried out in both Regions with the aid of the Canadian government. The definite developing program for the forestry resources will depend solely on the results of the survey which is underway. Consequently, in estimating the future lumber production the data contained in the report prepared by BCEOM in November of 1972, ^{1/} was used in order to study the possibility of forestry resources development in the project area.

Note: 1/ Source: BCEOM, Etude de Transport de la Voie Nationale
Novembre 1972 Vol. 2 Chapitre 2:11, Bois et Industries du
Bois

(i) In Case Without the Improvement of Project Road

In view of the distribution of existing producing areas of lumber, the development of forest resources is closely affiliated with the condition of transport facilities. It is difficult to develop forests in Buta zone where a river is not available for their transports; the situation is the same in Banalia zone except for the short sections of Aruwimi and Lindi rivers. Therefore, without the improvement of the project road, a noticeable increase of lumber in these zones is not expected. However, because lumber production is supported by a demand which is comparatively larger than other categories of agricultural products, it is expected that the lumber production will increase in higher pace when compared with the production of other plantation products, thus 3% till 1993 and 2% after that in Banalia zone as shown in Table 2.4.32.

(ii) In Case With the Improvement of Project Road

According to the aforementioned BCEOM Report, the total lumber production in Haut-Zaire and Equateur Regions in 1988 is estimated at about 3,300,000 tons. In the light of the proportion of forest areas and the proportion of current production, the production in Haut-Zaire is considered to be about 990,000 tons which accounts for 30% of the total of the two regions. If these facts are taken into consideration: (a) that the lumber pro-

duction of Banalia accounts for about 8% of that of Haut Zaire Region, and (b) that the opening of the project road will bring about a new possibility of development of lumber resources in Buta zone, it will be the conservative speculation that Banalia and Buta zones will be responsible for 10% of the lumber production of Haut-Zaire Region in 1988, which is 5 years after the opening of the project road. Accordingly, the production of lumber is estimated at 84,000 tons in Banalia and 15,000 tons in Buta.

Various reports already pointed out the growth of domestic demand and the bigger growth of world demand of lumber. In this chapter, in the light of the forecast and the growth rate that appeared in BCEOM Report, the annual growth rate of lumber production is estimated at 10% for the period 1988-1993 and at 8% until 2003. Table 2.4.32 shows the comparison of the estimated lumber production from the influence area with and without improvement of the project road.

Table 2.4.32 Estimated Production of Lumber in Influence Area
(unit: ton)

<u>Influence Area</u>	<u>1983</u>	<u>1988</u>		<u>1993</u>		<u>2003</u>	
		<u>Without Project</u>	<u>With Project</u>	<u>Without Project</u>	<u>With Project</u>	<u>Without Project</u>	<u>With Project</u>
Banalia	7,070	8,196	84,000	9,501	135,282	11,582	292,060
Buta	0	0	15,000	0	24,158	0	52,155
Total	7,070	8,196	99,000	9,501	159,440	11,582	344,215

2.4.3 Results of Traffic Estimation

The estimated volume of traffic with the project road improvement is shown in Table 2.4.33, while that without the project road improvement in Table 2.4.34. and the developed traffic in Table 2.4.35 which is obtained by subtracting the traffic in Table 2.4.34 from the traffic in Table 2.4.33. The share of the traffic by type of vehicle, for example, those of 1989 which is the 6th year after the opening of the project road, are shown in Table 2.4.36.

In Table 2.4.33 the traffic volume is regarded as being at a constant level after the 20th year. As viewed from the traffic volume, all the sections can be divided into three representative portions; Kisangani to Banalia, Banalia to Buta and north of Buta. The relative importance of the portion Kisangani - Banalia is over-whelmingly significant. This means that the market range of Kisangani involves Banalia.

It is understood from Table 2.4.35, 2.4.36 that most of the traffic with the project road improvement is foreseen the developed traffic. The reason the negative traffic is present at the beginning after the opening of the project road is because the traffic decreases with the increased loading efficiency due to the improvement of the road conditions and the developed traffic is expected not caused yet.

The sharing rate of traffic by type of vehicle will change year by year. For example, those for the year of 1989 are shown already. As described later, the relative shares of light vehicles and buses will increase year by year.

The transition of the traffic volume by type of vehicles in the section Kisangani - Banalia, where the estimated traffic is most heavy, is as shown in Table 2.4.37.

The estimated tonnage of freight to be carried by route section is shown in Tables 2.4.38 and 2.4.39, while the estimated number of passengers by route section is shown in Table 2.4.40 and 2.4.41 respectively.

The estimated tonnage of freight to be carried by route section shows the tonnage of agricultural and forestry products to be delivered. Therefore, miscellaneous consumer commodities which will be carried by trucks on their return trips are not included in this tonnage.

The yearly volume of zone-pair traffic, for example, that of 1989 is shown in Table 2.4.42.

Table 2.4.33 Estimated Traffic Volume by Section (With Project Road Improvement)

(Total vehicular traffic) (Unit: Vehicle /day)

T	Year	Monga ~ Ndu	Bondo ~ Monga	Likati ~ Bondo	Dulia ~ Likati	Buta ~ Dulia	Tele ~ Buta	Kole ~ Tele	Banalia ~ Kole	Bengamisa ~ Banalia	Kisangani ~ Bengamisa
		1	1980								
2	81										
3	82										
4	83	2	2	6	6	7	37	37	37	82	82
5	84	2	2	9	9	11	56	56	56	202	202
6	85	3	3	12	12	17	77	77	77	337	337
7	86	3	3	16	16	24	99	99	99	482	482
8	87	3	3	21	21	32	123	123	123	639	639
9	88	4	4	26	26	40	148	148	148	808	808
10	89	5	5	30	30	44	170	170	170	910	910
11	90	5	5	34	34	48	192	192	192	1,017	1,017
12	91	6	6	38	38	53	215	215	215	1,128	1,128
13	92	7	7	42	42	57	240	240	240	1,243	1,243
14	93	8	8	46	46	61	259	259	259	1,333	1,333
15	94	8	8	47	47	62	277	277	277	1,440	1,440

(Table 2.4.33 continued) (Unit: Vehicles/day)

T	Year	Monga ~ Ndu	Bondo ~ Monga	Likati ~ Bondo	Dulia ~ Likati	Buta ~ Dulia	Tele ~ Buta	Kole ~ Tele	Banalia ~ Kole	Bengamisa ~ Banalia	Kisangani ~ Bengamisa
16	1995	8	8	48	48	64	295	295	295	1,547	1,547
17	96	8	8	49	49	66	314	314	314	1,653	1,653
18	97	8	8	50	50	67	332	332	332	1,760	1,760
19	98	8	8	52	52	67	350	350	350	1,867	1,867
20	99	8	8	53	53	70	368	368	368	1,973	1,973
21	2000	8	8	54	54	72	386	386	386	2,080	2,080
22	01	8	8	54	54	74	404	404	404	2,187	2,187
23	02	8	8	56	56	75	423	423	423	2,294	2,294
24	03	8	8	58	58	77	441	441	441	2,400	2,400
25	04	8	8	58	58	77	441	441	441	2,400	2,400
26	05	8	8	58	58	77	441	441	441	2,400	2,400
27	06	8	8	58	58	77	441	441	441	2,400	2,400
28	07	8	8	58	58	77	441	441	441	2,400	2,400
29	08	8	8	58	58	77	441	441	441	2,400	2,400
30	09	8	8	58	58	77	441	441	441	2,400	2,400

Note : See Table 2.4.36 & 2.4.37.

(Table 2.4.34 continued) (Unit: Vehicles/day)

T	Year	Monga ~ Ndu	Bondo- ~ Monga	Likati ~ Bondo	Dulia ~ Likati	Buta ~ Dulia	Tele ~ Buta	Kole ~ Tele	Banalia ~ Kole	Bengamisa ~ Banalia	Kisangani ~ Bengamisa
16	1995			8	8	9	47	47	47	109	109
17	96			8	8	9	47	47	47	111	111
18	97			8	8	9	48	48	48	112	112
19	98			8	8	9	48	48	48	114	114
20	99			8	8	10	49	49	49	115	115
21	2000			8	8	10	49	49	49	117	117
22	01			8	8	10	49	49	49	118	118
23	02			8	8	10	50	50	50	120	120
24	03			8	8	10	50	50	50	121	121
25	04			8	8	10	50	50	50	121	121
26	05			8	8	10	50	50	50	121	121
27	06			8	8	10	50	50	50	121	121
28	07			8	8	10	50	50	50	121	121
29	08			8	8	10	50	50	50	121	121
30	09			8	8	10	50	50	50	121	121

Note : See table 2.4.37

Table 2.4.35 Estimated Developed Traffic Volume by Section

T	Year	(Total Vehicular traffic)										(Unit: Vehicle/Day)					
		Monga ~ Ndu	Bondo ~ Monga	Likati ~ Bondo	Dulia ~ Likati	Buta ~ Dulia	Tele ~ Buta	Kole ~ Tele	Banalia ~ Kole	Bengamisa ~ Banalia	Kisangani ~ Bengamisa						
1	1980																
2	81																
3	82																
4	83	2	2	-2	-2	-2	-4	-4	-4	-9							
5	84	2	2	1	1	2	14	14	14	110							
6	85	3	3	5	5	8	35	35	35	244							
7	86	3	3	9	9	15	57	57	57	387							
8	87	3	3	14	14	22	80	80	80	544							
9	88	4	4	19	19	31	105	105	105	712							
10	89	5	5	23	23	35	126	126	126	812							
11	90	5	5	26	26	39	148	148	148	917							
12	91	6	6	30	30	43	170	170	170	1,026							
13	92	7	7	35	35	50	194	194	194	1,139							
14	93	8	8	38	38	51	213	213	213	1,227							
15	94	8	8	39	39	53	231	231	231	1,332							

(Table 2.4.35 continued) (Unit: Vehicle/Day)

T	Year	Monga ~ Ndu	Bondo ~ Monga	Likati ~ Bondo	Dulia ~ Likati	Buta ~ Dulia	Tele ~ Buta	Kole ~ Tele	Banalia ~ Kole	Bengamisa ~ Banalia	Kisangani ~ Bengamisa
16	1995	8	8	40	40	55	248	248	248	1,437	1,437
17	96	8	8	41	41	56	266	266	266	1,543	1,543
18	97	8	8	43	43	58	284	284	284	1,648	1,648
19	98	8	8	44	44	57	302	302	302	1,753	1,753
20	99	8	8	45	45	61	320	320	320	1,858	1,858
21	2000	8	8	46	46	63	337	337	337	1,963	1,963
22	01	8	8	47	47	64	355	355	355	2,068	2,068
23	02	8	8	48	48	66	373	373	373	2,174	2,174
24	03	8	8	50	50	67	391	391	391	2,279	2,279
25	04	8	8	50	50	67	391	391	391	2,279	2,279
26	05	8	8	50	50	67	391	391	391	2,279	2,279
27	06	8	8	50	50	67	391	391	391	2,279	2,279
28	07	8	8	50	50	67	391	391	391	2,279	2,279
29	08	8	8	50	50	67	391	391	391	2,279	2,279
30	09	8	8	50	50	67	391	391	391	2,279	2,279

Table 2.4.36 Estimated Traffic Volume by Section and Type of Vehicle

(With Project Road) (1989 Year) (Vehicle / day)

Section Type of Vehicle	Monga	Bondo	Likati	Dulia	Buta	Tele	Kole	Banalia	Bengamisa	Kisangani
	~Ndu	~Monga	~Bongo	~Likati	~Dulia	~Buta	~Tele	~Kole	~Banalia	~Kisangani
Heavy Trucks	1	1	8	8	11	43	43	43	233	233
Light Vehicles	4	4	21	21	31	119	197	197	636	636
Buses			1	1	2	8	8	8	41	41
Total	5	5	30	30	44	170	170	170	910	910

(Without Project Road) (1989 year)

(Vehicle / day)

Section Type of Vehicle	Monga	Bondo	Likati	Dulia	Buta	Tele	Kole	Banalia	Bengamisa	Kisangani
	~Ndu	~Monga	~Bongo	~Likati	~Dulia	~Buta	~Tele	~Kole	~Banalia	~Kisangani
Heavy Trucks			3	3	4	17	17	17	38	38
Light Vehicles			5	5	6	27	27	27	61	61
Buses										
Total	0	0	8	8	10	44	44	44	99	99

Note: This kind of table is existent for each year, but only the example of 1989 is included in the report.

There is no particular reason why the year of 1989 was selected as an example, but because it will be just ten years after the year when the construction is to be commenced.

(See Table 2.4.37)

Table 2.4.37 Estimated Traffic Volume between Kisangani and Banalia
and Type of Vehicle

Seq.	Year	With Project Road Improvement			Without Project Road Improvement			(Vehicle/Day)	
		Heavy Trucks	Light Vehicles	Buses	Total	Heavy Trucks	Light Vehicles		Buses
1	1980								
2	81								
3	82								
4	83	25	56	1	82	35	56		91
5	84	60	138	4	202	35	57		92
6	85	96	232	9	337	36	57		93
7	86	133	333	16	482	36	58		94
8	87	192	443	24	637	37	58		95
9	88	212	563	33	808	37	60		97
10	89	233	636	41	910	38	61		99
11	90	254	713	50	1,017	38	62		100
12	91	275	794	59	1,128	39	63		102
13	92	297	878	68	1,243	40	64		104
14	93	318	942	73	1,333	41	66		107
15	94	344	1,017	79	1,440	41	67		108

(Table 2.4.37 continued) (Vehicle/Day)

Seq.	Year	With Project Road Improvement				Without Project Road Improvement			
		Heavy Trucks	Light Vehicles	Bus	Total	Heavy Trucks	Light Vehicles	Bus	Total
16	1995	369	1,093	85	1,547	42	67		109
17	96	394	1,168	91	1,653	42	68		111
18	97	420	1,243	97	1,760	43	69		112
19	98	445	1,319	103	1,867	44	70		114
20	99	471	1,374	109	1,973	44	71		115
21	2000	496	1,469	115	2,080	45	72		117
22	01	522	1,545	120	2,187	45	73		118
23	02	547	1,620	126	2,294	46	74		120
24	03	573	1,696	132	2,400	47	75		121
25	04	573	1,696	132	2,400	47	75		121
26	05	573	1,696	132	2,400	47	75		121
27	06	573	1,696	132	2,400	47	75		121
28	07	573	1,696	132	2,400	47	75		121
29	08	753	1,696	132	2,400	47	75		121
30	09	573	1,676	132	2,400	47	75		121

Table 2.4.38 Estimated Commodity Flow by Section
(With Project Road Improvement) (Units: ton/day)

T Year	Monga ~ Ndu	Bondo ~ Monga	Likati ~ Bondo	Dulia ~ Likati	Buta ~ Dulia	Tele ~ Buta	Kole ~ Tele	Banalia ~ Kole	Bengamisa ~ Banalia	Kisangani ~ Bengamisa
	1	1980								
2	81									
3	82									
4	83	1	5	5	6	26	26	26	57	57
5	84	2	6	6	8	37	37	37	135	135
6	85	2	8	8	11	50	50	50	217	217
7	86	2	10	10	15	62	62	62	301	301
8	87	2	13	13	19	75	75	75	389	389
9	88	2	16	16	24	88	88	88	480	480
10	89	3	17	17	26	98	98	98	527	527
11	90	3	19	19	27	109	109	109	575	575
12	91	4	21	21	29	119	119	119	623	623
13	92	4	23	23	31	129	129	129	671	671
14	93	4	25	25	33	140	140	140	720	720
15	94	4	25	25	34	150	150	150	777	777

(Units: ton/day)

(Table 2.4.38 continued)

T	Year	Monga ~ Ndu	Bondo ~ Monga	Likati ~ Bondo	Dulia ~ Likati	Buta ~ Dulia	Tele ~ Buta	Kole ~ Tele	Banalia ~ Kole	Bengamisa ~ Banalia	Kisangani ~ Bengamisa
16	1995	4	4	26	26	35	159	159	159	835	835
17	96	4	4	27	27	35	169	169	169	892	892
18	97	4	4	27	27	36	179	179	179	950	950
19	98	4	4	28	28	37	189	189	189	1,007	1,007
20	99	4	4	28	28	38	199	199	199	1,065	1,065
21	2000	4	4	29	29	39	208	208	208	1,123	1,123
22	01	4	4	30	30	40	218	218	218	1,180	1,180
23	02	4	4	30	30	41	228	228	228	1,238	1,238
24	03	4	4	31	31	42	238	238	238	1,295	1,295
25	04	4	4	31	31	42	238	238	238	1,295	1,295
26	05	4	4	31	31	42	238	238	238	1,295	1,295
27	06	4	4	31	31	42	238	238	238	1,295	1,295
28	07	4	4	31	31	42	238	238	238	1,295	1,295
29	08	4	4	31	31	42	238	238	238	1,295	1,295
30	09	4	4	31	31	42	238	238	238	1,295	1,295

Table 2.4.39 Estimated Commodity Flow by Section
(Without Project Road Improvement) (Unit: ton/day)

T	Year	Monga	Bondo	Likati	Dulia	Buta	Tele	Kole	Banalia	Bengamisa	Kisangani
		~ Ndu	~ Monga	~ Bondo	~ Likati	~ Dulia	~ Buta	~ Tele	~ Kole	~ Banalia	~ Bengamisa
1	1980										
2	81										
3	82										
4	83			5	5	6	26	26	26	57	57
5	84			5	5	6	26	26	26	58	58
6	85			5	5	6	26	26	26	58	58
7	86			5	5	6	27	27	27	59	59
8	87			5	5	6	27	27	27	60	60
9	88			5	5	6	27	27	27	60	60
10	89			5	5	6	28	28	28	62	62
11	90			5	5	6	28	28	28	63	63
12	91			5	5	6	28	28	28	64	64
13	92			5	5	6	29	29	29	65	65
14	93			5	5	6	29	29	29	67	67
15	94			5	5	6	29	29	29	68	68

(Unit: ton/day)

(Table 2.4.39 continued)

T	Year	Monga	Bondo	Likati	Dulia	Buta	Tele	Kole	Banalia	Bengamisa	Kisangani
		~ Ndu	~ Monga	~ Bondo	~ Likati	~ Dulia	~ Buta	~ Tele	~ Kole	~ Banalia	~ Bengamisa
16	1995			5	5	6	29	29	29	68	68
17	96			5	5	6	30	30	30	69	69
18	97			5	5	6	30	30	30	70	70
19	98			5	5	6	30	30	30	71	71
20	99			5	5	6	30	30	30	72	72
21	2000			5	5	6	31	31	31	73	73
22	01			5	5	6	31	31	31	74	74
23	02			5	5	6	31	31	31	75	75
24	03			5	5	6	31	31	31	76	76
25	04			5	5	6	31	31	31	76	76
26	05			5	5	6	31	31	31	76	76
27	06			5	5	6	31	31	31	76	76
28	07			5	5	6	31	31	31	76	76
29	08			5	5	6	31	31	31	76	76
30	09			5	5	6	31	31	31	76	76

Table 2.4.40 Estimated Passenger Traffic by Section in Representative Years
(with Project Road Improvement) (Unit: person/day)

Section Year	Monga Ndu	Bondo Monga	Likati Bondo	Dulia Likati	Buta Dulia	Tele Buta	Kole Tele	Banalia Kole	Bengamisa Banalia	Kisangani Bengamisa
1983	6	6	39	39	48	216	216	216	483	483
1993	35	35	193	193	258	1,100	1,100	1,100	5,663	5,663
2003	35	35	244	244	327	1,872	1,872	1,872	10,195	10,195

Table 2.4.41 Estimated Passenger Traffic and by Section in Representative Years
(without Project Road Improvement) (Unit: person/day)

Section Year	Monga Ndu	Bondo Monga	Likati Bondo	Dulia Likati	Buta Dulia	Tele Buta	Kole Tele	Banalia Kole	Bengamisa Banalia	Kisangani Bengamisa
1983	-	-	39	39	48	216	216	216	483	483
1993	-	-	41	41	50	245	245	245	563	563
2003	-	-	42	42	51	266	266	266	643	643

Table 2.4.42 Estimated Tonnage of Rice to be Delivered in 1989

(unit: ton)

<u>From</u>	<u>To Buta</u>	<u>To Kisangani</u>
Bondó	134	16
	32	3

Buta	1,701	129
	0	22

Banalia	239	5,933
	0	194

Aketi	43	21
	14	14

- Note: (a) In every row, the upper and the lower figures show the case with the project road improvement and the case without the project road improvement respectively.
- (b) The table is an example of the rice production in 1989. of course, such a table exists for every type of product every year.

Table 2.4.43 Estimated Zone-pair Traffic in 1989
(Unit: Vehicle by year)

Case Types of Vehicle Zonal Pair	With Project Road Improvement			Without Project Road Improvement		
	Heavy Trucks	Light Vehicles	Buses	Heavy Trucks	Light Vehicles	Buses
Bondo ~ Bangassou	51	138	9	0	0	0
Bondo ~ Buta	1,478	4,036	261	497	800	0
Bondo ~ Kisangani	962	2,627	170	465	911	0
Buta ~ Bangassou	84	229	15	0	0	0
Buta ~ Kisangani	8,834	24,124	1,559	465	750	0
Banalia ~ Buta	1,057	2,887	187	0	0	0
Banalia ~ Kisangani	70,261	191,866	12,399	7,609	12,260	0
Aketi ~ Bangassou	114	313	20	0	0	0
Aketi ~ Buta	236	644	42	111	178	0
Aketi ~ Kisangani	118	322	21	111	178	0
Banalia ~ Bangassou	176	480	31	0	0	0
Bambesa ~ Kisangani	1,391	3,799	245	1,402	2,259	0
Ango ~ Kisangani	692	1,890	122	808	1,302	0
Poko ~ Kisangani	2,788	7,614	492	2,799	4,509	0

Note : Such a kind of table is existent for all years and all zone-pairs, but only the table for 1989 is shown here as an example.

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3. TECHNICAL ANALYSIS

3.1 General Description of Technical Survey of Project Road

The types of the field survey conducted on the project road are as follows:

(a) Hydrology

- Cross sectional survey of rivers at the proposed sites of bridge;
- Measurement of current velocity;
- Past flood water levels investigated through interviewing local inhabitants.

(See A.3.1.1 - A3.1.6.)

(b) Bridges and Culverts (See 3.2.2)

- On-the-spot measurement of main dimension of structures;
- Assessment of the degree of deterioration of structures;
- Assessment of the strength of structures.

(c) Geometric Characteristics of alignment

- Measurement of the horizontal alignment of the road;
(As for curvature, approximate survey was made of radius of less than 300 m.) (See Table 3.2.2)
- Measurement of the longitudinal profile;
(Elevation of sags and crests were measured with a precision altimeter and the cross sections were measured with hand level.) (See Table 3.2.3)

In these surveys only aerial photographs without contour line of 1:50,000 in scale photographed some 20 years ago were available.

(d) Geology

- Observation of rock outcrops on the ground and river beds and the study on their utilization as aggregate materials to be used in the construction;

- Survey on an existing quarry and gravel borrow pits.

(See A.3.2.1 - A.3.2.2.)

(e) Soils

- Surface observation of the road and the surrounding terrain;
- Soil samplings by using auger boring at every 15 km of the road;

Samples were sent to the National Laboratory of Public Works in Kinshasa for conducting physical tests, the data of which were obtained later.

(See A.3.3.1 - A.3.3.3.)

(f) Construction Practice

- Unit prices of road and bridge construction works executed in Zaire in recent years;
- The trend of price escalation in the field of construction in recent years;
- Current official labor wages;
- Current price of main construction materials domestically produced and equipment to be imported;
- Rates of duty and tax on materials and equipment to be imported;
- Local conditions affecting construction costs;
- Conventional maintenance and construction practices;
- Bidding practice in public works.

(g) Local Contractors

The Survey team investigated the leading local contractors which have been actively engaged in road projects in Zaire in recent years. (See 3.4.5.- (3)).

3.2 Current Situation of Project Road

3.2.1 General Description of Existing Road

The existing road between Kisangani and Ndu is an earth road which had been built in the period of 1920 - 1940 and is 4 to 5.5 m wide in the stretch between Kisangani and Buta and 3.5 to 4 m wide in the stretch between Buta and Ndu; the former is under rehabilitation work by the aid of IBRD through which the road is being improved into the width of 5 to 6 m, but the latter has presently no such rehabilitation program except the conventional maintenance program.

According to the field surveys conducted twice in 1974 the existing road was found to be in unfavorable condition as a whole, particularly in the road surface, side ditches and wooden bridges, which result in being unable to operate vehicles smoothly throughout the year. And there are many cases of traffic suspension due to numerous muddy pools caused on the road during the wet season where even 4-wheel driving vehicles or big trucks can hardly pass through, being forced to slow down the speed.

In this study, the road is divided into 10 sections which are grouped into 4 divisions for the purpose of cost estimation of the improvement and the economic evaluation of the project. The length of the existing road by section and division are shown in Table 3.2.1.

Table 3.2.1 Length of Existing Road by Section and Division

(Unit: Km)

Route No.	Division	Section	From	To	Length
#421	IV	10	Kisangani (PK 3.6)	- Bengamisa (PK 50)	46.4
		9	Bengamisa (PK 50)	- Banalia (PK 129)	79.0
				Sum	125.4
	III	8	Banalia (PK 129)	- Kole (PK 206)	77.0
		7	Kole (PK 206)	- Tele (PK 235.8)	29.8
6		Tele (PK 235.8)	- Buta (PK 324.3)	88.5	
			Sum	195.3	
#445	II	5	Buta (PK 0)	- Dulia (PK 75.5)	75.5
4		Dulia (PK 0)	- Likati (PK 65.5)	65.5	
3		Likati (PK 65.5)	- Bondo (PK 125)	59.5	
			Sum	200.5	
#471	I	2	Bondo (PK 125)	- Monga (PK 250)	125.0
#473 & #483		1	Monga (PK 250)	- Ndu (PK 322.4)	72.4
			Sum	197.4	
Grand Total					718.6

The present alignment conditions are shown in Table 3.2.2 and also in plates B.1.1 to B.1.19 in Appendices which are in 1:50,000 scale and include the alignment diagram. The alignment diagram shows the location and the direction of each curve and the radii of curvature which are smaller than 300 m. As it is understandable from Table 3.2.2, 1,022 curves, the accumulated length of which reaches about 198 km including their affiliated curves, out of 1,450 curves of the whole stretch are of such severe curves of radii less than 230 m. The types of curve are generally simple or compound circular curves. The existing alignment passes generally through the highland in the terrain detouring low or marshy areas. The longitudinal profile is also generally flat or slight rolling except in the approaches of bridges and culverts where such steep grades of 5 to 14 per cent are existing; the accumulated length of such steep section of more than 5 per cent including their approaches reaches about 16.4 km and the number of such locations amounts to 86 as shown in Table 3.2.3. The following are the brief descriptions of the present alignment conditions of the existing road by section.

(1) The 10th Section: Kisangani (PK 3.6) - Bengamisa (PK 50)

Route #421 starts with a severe curve of some 60 m radius at its origin of the project road on the north bank of Tshopo River Bridge (PK 3.6). Severe curves of approximately 100 m radius are often seen on the route, but the rest of the route is mostly straight portions of several kilometers long. The road is paved from the origin of the project road to PK 6.2 with a layer of 3 cm thickness surface dressing which is damaged at numerous places; both shoulders are mostly eroded away and the pavement edges are severely damaged where vehicles are forced to slow down. The profile of the route is mostly flat except steep grades more than 6% at PK 33.5, PK 36.8 and the approaches of Lindi River Bridge. There is no large river except Lindi River and Tshopo River. The elevation at Lindi River bed is as low as about 370 m. After crossing Lindi River the route proceeds on the right bank parallel to the river where the elevation is about 430 m and there exist many severe curves. Immediately before entering Bengamisa there is a long down grade of 5% (See Plates B-1-1 - B-1-2.).

Table 3.2.2 Distribution of Horizontal Curves on Existing Project Road

Tableau 3.2.2

Repartition de courbes horizontales sur la route de projet

No. N°	Road Section Tronçon de route		Length of Section Longueur du tronçon km	Length of Curve (m)										Sum Somme	
	From de	To à		R < 60	60 ≤ R < 100	100 ≤ R < 150	150 ≤ R < 230	230 ≤ R < 380	380 ≤ R	380 ≤ R	380 ≤ R	380 ≤ R			
10	Kisangani	- Bengamisa	46.4		24- 5,800	17- 3,150	12- 1,800	5- 1,050	9- 1,650						67- 13,450
9	Bengamisa	- Banalia	79.0		33- 8,400	39- 9,500	36- 8,150	16- 3,050	69-12,950						193- 42,050
8	Banalia	- Kole	77.0		26- 7,250	31- 7,200	42-11,000	17- 3,700	53- 9,650						169- 38,800
7	Kole	- Tele	29.8		24- 5,800	30- 6,000	20- 4,300	3- 800	12- 2,200						89- 19,100
6	Tele	- Buta	88.5		57-11,200	48- 8,150	50- 8,050	7- 900	30- 5,050						192- 33,350
5	Buta	- Dulia	75.5	1- 50	22- 3,550	27- 4,100	27- 4,900	2- 450	36- 5,950						115- 19,000
4	Dulia	- Likati	65.5		17- 2,950	15- 2,750	17- 3,150	7- 1,500	19- 3,650						75- 14,000
3	Likati	- Bondo	59.5		34- 5,700	28- 5,000	36- 6,300	9- 1,050	40- 7,050						147- 25,100
2	Bondo	- Monga	125.0	3-500	51- 9,500	48- 7,550	74-10,800	11- 1,900	43- 6,900						230- 37,150
1	Monga	- Bangassou (Ndu)	72.4		47- 8,650	37- 6,900	49-10,000	7- 1,100	33- 6,800						173- 33,450
Total			718.6		4-550	320-60,300	363-68,450	84-15,500	344-61,850						1,450-275,450
					1,022-198,100		428-77,350								

Note: In the above Table, the former figures show the number of locations, while the latter show the accumulated length of curves.

Dans le Tableau, le chiffre précédent démontre du nombre d'emplacement, tandis que celui-ci accumulé longueur de pentes.

Table 3.2.3 Distribution of Steep Grades in Profile of Existing Project Road
 Tableau 3.2.3 Distribution des pentes raides dans le tracé de la route de projet

Section Tronçon	3% < i ≤ 4%	4% < i ≤ 5%	5% < i ≤ 6%	6% < i ≤ 7%	7% < i ≤ 10%	10% < i ≤ 14%	Total
	m	m	m	m	m	m	
	1-350	5- 850	1- 150	2- 200	1- 100	0	10- 1,650
10	*	3- 800	1- 300	2- 250	1- 50	0	7- 1,400
9	*	14- 2,400	8-1,800	7-1,150	8-1,350	1- 100	38- 6,800
8	*	1- 550	2- 250	0	0	0	3- 800
7	*	0	0	0	0	0	0
6	*	2- 400	2- 300	0	0	0	4- 700
5	*	1- 550	5- 900	2- 400	2- 350	0	10- 2,200
4	*	3- 750	3- 800	2- 250	1- 200	0	9- 2,000
3	*	3- 950	0	0	0	0	3- 950
2	*	10- 3,500	5-1,800	1- 200	2- 450	0	18- 5,950
1	*	3- 1,050	6-1,300	2- 300	5-1,250	6-1,150	22- 5,050
Total	2-700	53-13,450	35-8,050	22-3,200	22-3,900	7-1,250	141-30,550
				86-16,400			

Note: * 3% < i ≤ 4% was ignored in the rolling terrain sections because i is within the design standard.

3% < i ≤ 4% ne tenait aucun compte de tronçon du terrain vallonné parce que i est avec au modèle normal.

In the above Table, the former figures show the number of locations, while the latter show the accumulated length of grades.

Dans le Tableau, le chiffre précédent démontre du nombre d'emplacement, tandis que celui-ci accumulé longueur de raides.

(2) The 9th Section: Bengamisa(PK 50) - Banalia(PK 129)

The route reaches the south bank of Aruwimi River at PK 126. On the way it passes many severe curves and variations of profile where the elevation is 475 m at the highest and gradually descends down to 420 m as the route approaches the river. In this section, the route crosses many small streams with pipe culverts where the profile varies abruptly in their approaches. Particularly at PK 61.5, PK 63.2 and PK 101.5 large sags are formed with steep grades of 5 to 7 per cent in the approaches. The stretch beyond PK 120 is almost flat. The route turns upstream from PK 126 along the left bank of Aruwimi River and reaches the Banalia ferry site at PK 129 (See Plates B-1-2 to B-1-4.).

(3) The 8th Section: Banalia(PK 129) - Kole(PK 206)

After crossing Aruwimi River (640 m in width) Route #421 proceeds northward on a terrain of about 420 m in elevation parallel to the Aruwimi River as far as PK 154 where the profile is almost flat and curves are slow winding. The road goes further north parting from the Aruwimi River, taking a comparatively gentle alignment except for many severe curves seen between PK 170 and Kole at PK 206 with elevation gradually increasing from 450 to 475 m. There are no large rivers in this section except Zambeke River of 28 m wide at PK 159 and Kole River of 19 m wide at PK 196.5, and the rest of the streams are crossed either with pipe culverts or wooden bridges. (See Plates B-1-4 to B-1-6.)

(4) The 7th and the 6th Sections: Kole(PK 206) - Buta(PK 324.3)

Route #421 turns its direction to north-west at Kole and then north at PK 209 to reach Buta. The route in these sections is full of severe curves, and particularly a succession of small winding curves is seen between PK 245 and PK 275. The profile is either flat or a succession of gentle rolling grades with the elevation ranging from 355 m to 480 m. Major rivers in these sections are the 39 m wide Tele River at PK 235.8, the 16 m wide Yeme River at PK 309.1 and the 90 m wide Rubi River at the entrance of the town of Buta. Other small streams are crossed either with pipe culverts or wooden bridges. (See Plates B-1-6 to B-1-9.)

(5) The 5th Section: Buta(PK 0) - Dulia(PK 75.5)

The project road shifts from Route #421 to Route #445 at Buta, taking westerly direction to proceed in parallel with Vici-Zaire Railroad on its south side until the grade crossing at PK 24.3, from where the route runs on the north side of and parallel to the railroad to reach Dulia. Except for a steel bridge on the 24 m wide Longa River at PK 8, the route crosses other small streams with wooden bridges. The profile is somewhat steep at the approaches to these bridges but the rest of the section has a flat profile with the elevation of 390 m to 405 m and a gentle alignment. (See Plates B-1-9 to B-1-11.)

(6) The 4th Section: Dulia(PK 0) - Likati(PK 65.5)

A large square is located at the junction of Dulia, from where the project road diverts its course from Route #445 to Route #471 and proceeds northward along the east side of Likati River. The alignment of the route is monotonous and the profile becomes somewhat steeper at the approaches of wooden bridges crossing small streams. The elevation varies from 380 m to 410 m and the route joins with the road from Angu at PK 60 where the route takes a westerly direction. After crossing 84 m wide Likati River at PK 64.5 the route climbs up the grade of about 7 per cent and again takes northerly direction when it crosses on grade the Bondo branch line of Vici-Zaire Railroad. (See Plates B-1-11 & B-1-12.)

(7) The 3rd Section: Likati(PK 65.5) - Bondo(PK 125)

The route proceeds north-west along the railroad and crosses Likati River again on a railroad bridge commonly used as a road bridge where the alignment passes an S-shaped curve at the approaches of the bridge. As the volume of traffic on both the railroad and the road is so slack at this bridge, there is no hindrance to one another. On both sides of the bridge, gates of simple structures are provided on the road which are opened only when vehicles pass. After crossing this bridge, the route passes by Libogo Railway Station from where the road proceeds north in parallel with the railroad, and again passes a railroad crossing at PK 117 to reach the south bank of Uélé River.

Many curves are seen in this section and the elevation varies widely between 390 m and 510 m but grades on the way are not steep.

Bondo is located on the north bank of Uélé River which is about 200 m wide at the ferry site. (See Plates B-1-12 to B-1-14.)

(8) The 2nd Section: Bondo (PK 125) - Monga (PK 250)

A rotary is located on the Bondo side of Uélé River where the route turns to the left and passes in front of the zonal government office of Bondo and then turns to the right to pass through the town. The route proceeds northwest about 4 km from the town and takes a westerly direction at the junction of Airo, extending for about 20 km in parallel with the Uélé River.

The alignment up to PK 150 is monotonous. At a sag at PK 151, a pipe culvert is provided with the road passing on a fill about 4 to 5 m high, which is not usually seen at similar culvert sites. The elevation of the road gradually increases and the road takes a winding course along the river on the hilly terrain of 500 to 550 m in elevation. A hill pass is located at PK 157.4 where the road passes a cut of a maximum depth of 4.5 m over a distance of about 150 m. That is the only cut section existing between Kisangani and Ndu.

Many small wooden bridges exist at sags between PK 183 and PK 200 and also there are many rises and falls on the way. A small road branches off to Dongobe at Gaya (PK 217). The route proceeds westward from Gaya gradually losing its elevation and reaches Faka on the south bank of Bili River which is about 150 m wide and is served by a rowing-type ferry without guide-cable.

After crossing Bili River, the route turns further west-ward and reaches Monga at PK 250.

The profile in this section is flat or gently rolling between rivers except at river approaches where it becomes steep. The elevation of the route gradually loses its altitude, particularly from PK 238 and is reduced to 430 m at the wooden bridge at PK 248.5 and the route finally reaches a square at the center of the town of Monga at PK 249. (See Plates B-1-14 to B-1-17.)

(9) The 1st Section: Monga (PK 250) - Ndu (PK 322.4)

The project road diverts from Route #471 at Monga to Route #473 and proceeds northward to Ndu. The elevation of the route gradually increases and after the route passes the highest location (Elevation = 590 m) of the project road, it proceeds on a table land with the elevation of 480 m. The profile of this section also varies widely at the approaches to small streams while the alignment has a succession of severe curves between PK 270 to PK 271, PK 275 - PK 277, PK 280, PK 285 - PK 289, PK 292 - PK 295, PK 298 - PK 302 and PK 326 - PK 317. (See Plates B-1-17 to B-1-19.)

(10) Classification of Existing Road Surface Conditions

Through the field survey on the surface conditions of the existing earth road conducted in January - March and October - December in 1974 the following classification of the road surface conditions was formulated as follow:

Conditions of Classification of Road Surface

Class	Road Surface	Average Operating Speed (km/h)			
		Small Vehicles		Large Vehicles	
		Dry Season	Wet Season	Dry Season	Wet Season
A	Good	45	30	43	28
B	Fair	40	20	36	18
C	Not Fair	30	10	27	8
D	Poor	15	5	10	3

Note: The operating speeds in the table are solely due to the surface conditions of the road and those due to the alignment are excluded.

Table 3.2.4 shows the results of the existing earth road classified according to the classification of the road surface defined above.

The sections of silty soils are classified mainly in Classes of D, C and partly in B in Table 3.2.4. The surface conditions of the 4th Section (Dulia - Likati) and the 3rd Section (Likati - Bondo) have long continuations

of deep muddy pools in wet season where vehicles stall in mud or wheels skid and motors overheat and slippery ascending portions are difficult to pass; and they have wide holes, deep gullies and dried mud-pits in dry season where vehicles slow down the operating speed and their chassis are badly twisted and shaken. Such types of long difficult portions exist partly in the 9th and the 8th sections. (See Photos 1 & 2)

Length of Road by Classification of Surface

Table 3.2.4 Conditions of Existing Road (1974)

(Unit: km)

Section	Length of Road by Class				Total
	Class A	Class B	Class C	Class D	
10	19.4 (42%)	23.0 (49%)	4.0 (9%)	-	46.4 (100%)
9	46.0 (58%)	28.0 (35%)	3.0 (4%)	2.0 (3%)	79.0 (100%)
8	45.0 (59%)	28.0 (36%)	3.0 (4%)	1.0 (1%)	77.0 (100%)
7	15.8 (53%)	12.0 (40%)	2.0 (7%)	-	29.8 (100%)
6	51.5 (58%)	31.0 (35%)	6.0 (7%)	-	88.5 (100%)
5	38.5 (51%)	35.0 (46%)	2.0 (3%)	-	75.5 (100%)
4	4.5 (7%)	32.0 (49%)	21.0 (32%)	8.0 (12%)	65.5 (100%)
3	10.5 (18%)	30.0 (50%)	16.0 (27%)	3.0 (5%)	59.5 (100%)
2	40.4 (32%)	73.6 (59%)	11.0 (9%)	-	125.0 (100%)
1	42.4 (59%)	25.0 (34%)	5.0 (7%)	-	72.4 (100%)
Total	314.0 (44%)	317.6 (44%)	73.0 (10%)	14.0 (2%)	718.6 (100%)

(11) Drainage and Erosion

Seen from drainage point of view, the existing earth road is characterized by the following:

- (a) The existing earth road has been usually built by shoving top-soils to both sides of the road and by cutting a shallow V-shaped-ditch on both sides of the road at the time of the original construction. Therefore, since no substantial embankment has ever been built, the road surface is generally lower than the surrounding natural ground.

- (b) Moreover, as the road has not been maintained for long time the crossfall is not sufficient and the side ditches are buried with dirt. And as the surrounding natural ground is higher than the road, rain water is led to the road during the wet season; and because drainage of such water to the surrounding bushes are impossible, the road turns easily into muddy pools.
- (c) Even at such location where the side ditches are existent, the side ditches are usually shallow and the crossfall of the road surface is insufficient. In the section where the rehabilitation is underway, turnout ditches to drain the water into the roadside forests are seen in the flat terrain, but a deep hole is dug at each end of turnout ditches where such ditches are not effective because of lack of an adequate drainage slope. (See Photo 5)
- (d) Erosion is noticeably observed at such locations where the longitudinal profile is steeper than 4 per cent. At such locations erosion has developed deep V-shaped gullies not only in side ditches but also on the carriage way, and sand which is eroded away from the road surface sedimented at sags where wheel tires of vehicles often slip and the stability of vehicles is endangered.
- (e) As there is no crossing culvert where it should be at many locations the road is often overflowed with water from marshes during the wet season.
- (f) At the locations on the road that are under the shade of bamboo bushes the road surface does not get dry even in the dry season and such locations develop into muddy pools even in the dry season.
- (g) There was not seen any location where the counter measure to protect the side slopes from erosion is provided except for sodding.

3.2.2 Culverts and Bridges

Presently, the following number of culverts and bridges exist on the project road:

<u>Type</u>	<u>Number of Locations</u>	<u>Accumulated Length</u>
Culverts	163	
Wooden Bridges	119	611.4 m
Reinforced Concrete Bridges	3	37.2 m
Steel Bridges	12	648.4 m
Total of Bridges	134	1,297.0 m

The details of those culverts and bridges by section are shown in Table 3.2.5 and Table 3.2.6 respectively.

(1) Culverts

The breakdown of the culverts existing on the project road is as follows:

<u>Type</u>	<u>Number of Locations</u>	<u>Sectional Dimension</u>
Box Culverts	4	0.5 m x 0.5 m to 1.5 m x 1.5 m
Concrete Pipes	59	0.4 m to 0.8 m in dia.
Steel Corrugated Pipes	100	1.0 m to 5.0 m in dia.
Total	163	

As the sectional dimensions of concrete pipes are small, they are often clogged with deposits of dirt and debris because they are difficult to clean. Most of the corrugated steel pipes are of large sections and are in satisfactory condition, and those with diameter exceeding 3.5 m are of semi-circular type. (See Photos 3 & 4)

At those culverts which are clogged with dirt the water overflows the road surface across the road. Although the existing road as a whole is located on flat or gently rolling terrains, the number of culverts is in such a small rate as one culvert for an average of a 5 km stretch. There are sections in the north of Dulia where no crossing culvert exists for a stretch of 60 to 70 km.

(2) Wooden Bridges

Among existing wooden bridges, those of 2 m to 5 m long occupy about 60 per cent of the total number of locations, and those longer than 10 m are only at 10 locations. But the longest wooden bridge is 18.8 m long. 93 per cent of the total wooden bridges are situated in the sections north of Buta, and the rest of them are situated in the sections south of Buta where most of the small bridges are permanent structures. (See Photos 6 and 7)

Generally, wooden bridges are an inadequate type which is only lumber and logs laid parallel and wheels of vehicles are often caught in the gaps between logs. Such wooden bridges are all weak in strength and inadequate from the viewpoint of safety for traffic to serve not only as a national road but also an international road. Presently traffic signs are seen at every wooden bridge, prohibiting passage of vehicles more than 8 tons in weight.

(3) Reinforced Concrete Bridges

In the sections south of Banalia the following reinforced concrete bridges exist on the project road:

<u>Type of Bridges</u>	<u>Number of Locations</u>	<u>Width</u>	<u>Length</u>
Slab-type Bridge	1	6.5 m	5.0 m
T-shape Girder Type	1	6.5 m	10.2 m
Arch-type	1	4.0 m	22.0 m
	<u>3</u>		<u>37.2 m</u>

Those reinforced concrete bridges are mostly older than 20 years; and since their construction and their design plans are not available, it is difficult to check their strength.

(4) Steel Bridges

The following steel bridges exist on the project road:

<u>Types of Bridges</u>	<u>Number of Locations</u>	<u>Width</u>	<u>Length</u>
Plate girder bridges	3	5.9m to 6.8m	8.2m to 12.0m
Pratt Trussed bridge (Commonly used with railroad)	1	2.75 m	72 m
Warren trussed bridge	1	3.85 m	28.8 m
Bailey trussed bridges	7	3.25 m	15.4m to 245.5m

Those steel bridges were erected in the period of social disorder after 1960 as military bridges for emergency rehabilitation and their design loads are not standardized. In case of Bailey trussed bridges the types of SS, DS, DD, and TD are used at random without taking into consideration their strength in the relation to their span length. Presently, the weight of passing vehicles is restricted to 2 vehicles of 8 to 10 tons on a span simultaneously and the speed is limited to 10 km/h on bridges. (For details of bridges, see Table 3.2.6.) They are all 16-to 22-years-old and their widths and strength are inadequate and are impossible to improve or strengthen. (See Photos 8 ,9 and 10.)

Table 3.2.5 Existing Bridges & Culverts
Tableau 3.2.5 Ponts & enterrés existants

No.	Sections Tronçons	From de	To à	No. of Pipe Culverts	Wooden Bridges		R.C. Bridges		Steel Bridges	
					No.	Total Length Ponts en bois No. Longueur totale	No.	Total Length Ponts en béton armé No. Longueur totale	No.	Total Length Ponts d'acier No. Longueur totale
10	Kisangani - Bengamisa (3.6 km - 50.0 km)			22			1	10.2 m	2	253.0 m
9	Bengamisa - Banalia (50.0 km - 129.0 km)			62			2	27.0	2	21.3
8	Banalia - Kole (129.0 km - 206.5 km)			30	2	12.9 m			2	47.8
7	Kole - Tele (206.5 km - 235.8 km)			8					1	39.9
6	Tele - Buta (235.8 km - 324.3 km)			30	4	11.8			2	109.2
5	Buta - Dulia (0.0 km - 75.5 km)			6	12	112.0			1	24.8
4	Dulia - Likati (0.0 km - 65.5 km)			-	22	94.4			1	80.4
3	Likati - Bondo (65.5 km - 125.1 km)			2	17	59.9			1	72.0
2	Bondo - Monga (125.1 km - 250.0 km)			3	62	221.4				
1	Monga - Ndu (250.0 km - 322.4 km)			-	10	49.0				
Total				163	129	611.4 m	3	37.2 m	12	648.4 m

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Table 3.2.6 Existing Steel Bridges
 Tableau Ponts d'acier existant

<u>No. of Section</u> <u>No. de tronçon</u>	<u>Name of Rivers</u> <u>Nom de Rivières</u>	<u>Type of Bridges</u> <u>Type de ponts</u>	<u>No. of Spans x Span Length</u> <u>No. de travées x Longueur de travée</u>	<u>Total Length</u> <u>Longueur totale</u>
10	Angokpa	Plate girder Poutre en tôles	1 x 6.80 m	7.5 m
	Lindi	Bailey - DD,DT	2 x 24.4m + 3 x 47.5m + 1 x 54.9m	245.5 m
9	Longala	Plate girder Poutre en tôles	1 x 12.0 m	12.7 m
	Bokokua	Plate girder Poutre en tôles	1 x 8.15 m	8.6 m
8	Kole	Bailey - DS	1 x 18.3 m	19.0 m
	Zambeke	Warren truss Treillis système warren	1 x 28.0 m	28.8 m
7	Tele	Bailey - DD	1 x 39.65 m	39.9 m
6	Yeme	Bailey - SS	1 x 15.25 m	15.4 m
	Rubi	Bailey - TD	2 x 46.88 m	93.8 m
5	Longa	Bailey - DS	1 x 24.4 m	24.8 m
4	Likati	Bailey - DD	2 x 39.65 m	80.4 m
3	Libogo	Pratt truss Treillis système pratt	2 x 24.0m + 1 x 18.0m	72.0 m
Total				648.4 m

3.2.3 Ferries

There exist four ferry-operating rivers in the section between Kisangani and Bangassou of this project road. Those ferries, listed below, are all owned by Office of Roads, Ministry of Public Works and, consequently crossing rivers aboard ferry is free of charge.

(1) Ferry Across Aruwimi River at Banalia (the 8th Section)

Aruwimi River is 640 m wide and 7 m deep in the wet season and 1.5 m to 3.0 m deep in the dry season. There is a shallow place about 500 m downstream from the existing ferry site, where one can wade the river in the dry season.

The existing ferry is a 35 ton-type using 5 steel pontoons and equipped with two 150-horse-powered diesel engines. The present ferry began its operation in 1973. The loading capacity is 4 large trucks or 6 TOYOTA Land Cruisers or 8 compact passenger cars. There is a landing facility using pontoons and a rampway that adjusts to the fluctuation of the river water level. The operation of the ferry has been entrusted to Dumez Zaire since 1974, a local contractor which is responsible for the rehabilitation work of the road between Kisangani and Buta by the aid of IBRD.

Usually crossing the river takes about 20 minutes including loading and unloading vehicles and if the average waiting time is added it takes about 30 minutes.

The ferry operation starts at 7:30 and ends at 21:00 every day, being operated by a crew of 5 men in 2 shifts. They crossed the river 12 times carrying 24 vehicles and 280 passengers a day on an average according to the operation record in 1973. After Dumez Zaire started the ferry operation and the repair of the ferry has been facilitated, there has been no suspension of operation due to the lack of fuel, oil and spare parts. (See Photo 11.)

(2) Ferry Across Uélé River at Bondo (the 3rd Section)

Uélé River is about 200 m wide, and 25 m and 19 m deep in the wet season and the dry season respectively. The current velocity is 1.8 m/sec. in midstream in the wet season and 0.5 m/sec in the dry season.