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FINAL REPORT - Feasibility Study

KAFUE RIVER BRIDGE Toll-Weighbridge Project, Zambia

Project Number 690-0280

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MORRISON KNUDSEN CORPORATION
In association with:
Wilbur Smith Associates

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Table of Contents

Tables

Figures

EXECUTIVE SUMMARY

This study analyzes the proposed tolling of a bridge on Road T2, which crosses the Kafue River about 53 kilometers south of Lusaka. The Kafue Weighbridge is sited south of the bridge and a police check point is located between the bridge and the weighbridge. The bridge is the only feasible highway crossing over the Kafue in the area south of Lusaka. Trunk roads feeding into T2 in the bridge area include four from the south and three from north of Lusaka. The road thus fulfills a vital connector role.

Based on traffic studies conducted as part of this study, the average daily traffic (ADT) at the Kafue Road Bridge is 1,595 vehicles per day and 200 pedestrians per day. The average overall traffic growth which has occurred on Road T2 near the weighbridge between 1983 and 1994 has averaged 2.9 percent per year. Average annual percentage change by vehicle type include 3.3 percent for light vehicles, 3.6 percent for buses, a negative 3.5 percent for single bed trucks, and 12.3 percent for heavy vehicles.

From the vehicle classification counts, it was determined that the mix in vehicle traffic traveling on the Kafue River Bridge was 72.1 percent light vehicles, 2.5 percent buses, 12.5 percent single bed trucks, and 12.9 percent heavy trucks.

Data obtained from the origin-destination (OD) surveys revealed that company business was given as the predominant trip purpose for all vehicle classes. Vehicle ownership was primarily private and for the most part, the majority of trips over the Kafue Bridge was made once a week. It was determined that the major northbound vehicle movement was between Mazabuka and Lusaka with southbound movement between Lusaka and Mansa. Pedestrian traffic was made up for the most part of people from the Kafue Area.

As part of the OD survey, motorists and pedestrians were asked what they would be willing to pay if the bridge were tolled. For both directions, the responses ranged averaged from a low of 30 Kwacha for pedestrians to a high of 3,210 Kwacha for single bed truck drivers. Heavy truck drivers indicated on an average they would be willing to pay 2,175 Kwacha.

A range of economic and demographic indicators was examined, in developing the basis for projecting traffic growth rates. The results of which did not present a very bright picture. For example, population increased to 31 percent between 1984 and 1993 with a consequent decline in per capita income. Formal sector employment declined from 551,100 in 1991 to 522,000 in 1993, production in the leading export commodities (zinc, copper, lead, cobalt and tobacco) has been declining over the five years and there was an 180-fold increase in the "all last items" category of the low income CPI between 1985 and 1993.

However, there was compelling evidence to the effect that improvement can be expected. Examples include, the world economy in improving, economic reforms introduced by the Chiluba administration have already reduced the rate of inflation (but will require time to become fully effective), the damping down of wars in Mozambique and Angola should increase regional trade, worldwide copper prices are up, and the ongoing privatization of Zambia parastatal companies will provide funds to help reduce GRZ debt and cut subsidy outlays, while increasing the tax base. Finally, land reform and the privatization of agriculture should increase output in the economic sector in which most Zambians work.

Based on the unique connector role played by Road T2 in the Kafue Road Bridge area, other worldwide regional and Zambian developments which should result in traffic increases, plus recent increases observed in traffic counts in the area, an annual traffic growth rate of 3.0 percent was projected for T2 in the Bridge areas through 1999, increasing to 3.5 percent and remaining at that level through 2014. After a review of toll rates in the U.S. and South Africa, a simplied toll rate structure was developed, as follows:

Table 1
TOLL RATES

Type Vehicle	Toll Levels (Kwacha)		
	A	B	C
Light Vehicle	1000	500	499
Bus	2000	1000	800
Single Bed Truck	3500	1750	1400
Heavy Truck	5000	2500	2000

Based upon the projected traffic and the above toll rates, various annual toll revenue projections were made as a basis for subsequent analysis, including a 20-year projection for all toll rates.

A review of regulations on file in the Library of Legal Affairs turned up only three statutes on road tolls the Tolls Act of 1983 and two amendments. The entry fee provision of this act is still in effect; tolls on incoming non-Zambian vehicles are collected at border custom stations and deposited in the Central Bank of Zambia Account No. 577, earmarked for road maintenance.

With regard to current privatization of toll operations, FEDHAUL (the Federation of Zambia Road Hauliers) is involved in a scheme to print and sell coupons by which truckers would pay border tolls. This would effectively privatize toll collection and handling of border tolls. Based on a review of Toll Act of 1983, recommendations were made for

changes which would be required before any large scale privatization of the road toll operation could be achieved.

The Legal Affairs Library has no regulations on file regarding weighbridge establishment although there are eight stationary weighbridges, two of which reportedly date back to colonial days.

In considering the toll plaza proposed for the Kafue Weighbridge area, it was determined that tolling vehicles by type would minimize toll transaction times and that toll collection equipment is a must, including a vehicle preclassifier which would trigger a patron and collector fare indicator. Requirements for the toll plaza building were also outlined.

The toll operation at the Kafue Toll Plaza was foreseen as a function of the Roads Department. A Toll Collection Manager (TCM) would report to the Deputy Director of the Roads Branch of the Ministry of Works and Supply. Duties and responsibilities of the TCM and his subordinates were reviewed, including the handling of money. Toll lane requirements and transaction times were reviewed and the advantages of one-way tolling were pointed out. Integration of the Kafue Weighbridge operations with those of the toll plaza was indicated as feasible. As weighbridge revenues decline due to reductions in the number of trucks (incident to the drastically higher fines for overloading), this option might become more attractive. Due to the amount of money which the toll plaza would usually have on hand, police protection would be essential. After reviewing examples of typical toll facility construction, the cost of building the Toll Plaza was estimated at K540 million.

Estimates were made of K180 million for the annual operations and maintenance of the toll plaza, K4.2 million for the operation of the Weighbridge, and K0.5 million for the maintenance of the Kafue Road Bridge. Annual maintenance costs for the 134.7 kilometers of Road T2 between Lusaka and Chirundu varied widely, depending upon the scheduling of periodic maintenance.

A review of various examples where toll operations were privatized indicated that a Toll Authority has generally been established. While this would be inappropriate for the toll plaza because of the small scale of the operations, it might be considered for the weighbridge operation. It was recommended that a private sector firm be contracted with to establish a toll collection/weighbridge operation in the Kafue Weighbridge area and a list of private firms active in this area was given.

An analysis of the projected cash flow for the toll plaza indicated that for a 1995 opening year high-level toll, the break-even year would be 1996; for a medium-level toll, it would be 1999; and for a low-level toll it would be 2007.

There are currently three sources of funds earmarked for road maintenance; the fuel levy fund which results from a K10 per liter placed on motor fuel, road user tolls which are collected at customs stations at the border, and fines which are levied on drivers of overweight vehicles by weighbridge operators. These monies are deposed in Account No. 577 at the Central Bank of Zambia.

The K10 per liter fuel levy was instituted in May 1993 as part of the recommendations of a Road Maintenance Policy Reform Seminar held in Lusaka in February of that year. Other recommendations (accepted in principle) included institution of a road tariff consisting of international transit fees and vehicle license fees and a provision that within five years, the road tariff would cover all annual road maintenance requirements. Account No. 577 was established as the result of another recommendation by the fund and a National Roads Board has been established. The tolling of roads in general was not included in the recommendations.

As a result of a heavy increase in fines for overweight vehicles in August 1994 (to K500 per kilogram of overweight per truck) the percentage of overweight trucks detected at the eight weighbridges appears to have declined drastically. However, the weighbridge sites are well known and in most cases, can be bypassed. Further, overweight vehicles should be detected as soon as they cross Zambian border, as possible. It was therefore recommended that nine teams be established, with portable weighbridge equipment, to work out of provincial headquarters on schedules set by the Roads Department. Efforts should be concentrated in areas where the percent of overweight trucks were found to be high.

A review of possible impacts on stakeholders in toll/weighbridge operations indicated that the list includes at least commercial and private vehicle operators, professional transport associations, regional associations, government employees of the system, the national government, consumers, producers, and donors. The impact on trucks would be most pervasive, since they haul both raw materials and finished goods. Weighbridge operations would have no effect on legal weight truck operations. The impact of a medium level toll at the Kafue Toll Plaza would affect only those trucks using the Kafue Road Bridge. Of these, a medium level toll would be such a small percentage of the value of the average truck loading that it would not raise truck transport costs appreciably. Low income bus passengers would be hardest hit, even by a low-level toll. However, road user tolls collected at the borders are Preferential Trade Area (PTA) sanctioned and reciprocal. An addition to these tolls, in the form of a bridge toll, might spark retaliation from neighboring countries.

The economic feasibility of establishing a bridge toll operation near the Kafue Weighbridge was examined by benefit/cost analysis, using three different levels of tolls (A-high, B-medium and C-low), over periods of

5, 10 and 20 years and at three discount rates (10, 12, and 15 percent). Nine variations were therefore necessary for each toll rate.

The analysis showed that the proposed toll plaza was economically feasible for all nine cases for each of the toll rates. However, when the present values of the annual operations of the Kafue Weighbridge plus the annual maintenance costs of the Kafue Road Bridge and Road T2 from Lusaka to Chirundu were totaled and subtracted from the NPV for each of the 27 cases, only the high toll rate (A) could carry the load. In each case, it had a positive NPV. For Toll Rate B, there was a deficit in every case except one, which had a surplus of K9.7 million. Otherwise, deficits ranged from K72.6 million to K258.5 million. For toll Rate C, every case showed a deficit, ranging from K172.9 million to K302.3 million.

The difference between the results of this B/C analysis and the B/C analysis was marked. However, the B/C approach uses economic (not financial) costs and is based on the concept of the present value of future money. The impact of this concept on future values is shown by the fact that while at a 23 percent discount rate, the present value of a dollar is 89 cents for the first year of the discount period; however, for the twentieth year it would be worth only a little more than a dime.

It is proposed that USAID recommend to the Government of Zambia (GRZ) that:

- Necessary changes be made to GRZ laws involving privatization of transportation facilities. As a minimum, this would require:

    1. Change to the part of Section 17.(1), Part IV, Toll Charges of the Toll Act, 1983, which reads, "17.(1) The Board may on any road, bridge, pontoon or other place, operate toll points," to read, "17.(1) The Board may in any road, bridge, pontoon or other place, operate toll points, or it may contact with private companies for such operation".

    2. Change to the part of Section 17.(2) which reads, "Any vehicle passing through a toll point should pay the appropriate toll charge as set out in Part I of the Schedule," to read "Any vehicle passing through a toll point shall pay the appropriate toll charges as set out in Part I of the Schedule. Tolls for facilities operated by contractors will be set by negotiation and separate tariffs published."

- A privatized toll plaza and system be established at the Kafue River Road Bridge as a test case.

- Toll Rate A be implemented as part of the test.

- Subsequent changes to toll rates will depend upon the results of the test.

The real question here is principally political, not economic. A previous toll effort failed because proper ground work was not laid. A test case should be more politically acceptable. If it is successful, then the concept should be expanded.

1.0 INTRODUCTION

This study was prepared for USAID by Morrison Knudsen Corporation (MK) in association with Wilbur Smith Associates (WSA), under the provision of USAID Contract IQC No. PCE-0001-I-00-3013, Delivery Order No. 7. The study examines the proposed tolling of a bridge on Road T2, which crosses the Kafue River some 53 kilometers south of Lusaka. A weighbridge is located just south of this bridge and a police check point is sited between the weighbridge and the bridge. The bridge is the only practical highway crossing of the Kafue River south of Lusaka. Road T2 in the area of the bridge performs a vital connector role; joining four trunk roads from South of Lusaka with three trunk roads north of the city. The objectives of the study are to:

- Explore the feasibility of introducing a road toll collection point at the Kafue River Road Bridge;
- Propose options regarding possible toll rates;
- Examine benefits which might result from incorporating weighbridge management with that of the toll collection operations; and
- Propose alternatives for the management of toll/weighbridge operations and related enforcement, including possible involvement of the private sector.

The analysis involved forecasting of traffic and revenue generated, benefits which might accrue to the transport network from a toll scheme, implications for regional coordination, potential environmental impacts of a toll system, the social and economic impacts of a toll system, institutional issues relating to toll/weighbridge operations and enforcement and the significance of Kafue Bridge Toll point to a national trunk road toll system.

In addition to the above, USAID requested that the study also examine the capability of toll operations at the Kafue River Bridge to support annual maintenance requirements for Road T2 between Lusaka and Chirundu.

The order of presentation of the study is:

(a) Traffic characteristics;
(b) Economic and geographic considerations;
(c) Traffic and revenue forecast;
(d) Toll implementation; and
(e) Economic alternatives, impact and analyses.

2.0 TRAFFIC TRENDS AND CHARACTERISTICS

To evaluate the magnitude and patterns of present and future traffic potential to the proposed toll plaza, traffic studies were undertaken in the second week of October 1994. Motorists were interviewed at a road side station so as to intercept all traffic potential to and from the proposed facility. Manual classified counts were also conducted concurrently with the origin-destination surveys. In addition, historical traffic trends at the weighbridge were reviewed in detail. This chapter presents a summary of traffic trends from historical to current data and traffic characteristics from the motorist travel pattern surveys conducted over a three day period in October 1994.

2.1 Annual Traffic Trends

Annual traffic trends at count station 66A (at the weighbridge) were assembled and reviewed as part of this study. Table 2.1 details annual traffic trends over the past eleven years. This information has been compiled from counts obtained from the Roads Department, other traffic studies, and current counts as footnoted, and is intended to provide an overall indication of annual traffic at the proposed toll plaza.

Traffic has grown by 5 percent per year between 1983 and 1994 at the weighbridge. Average annual percent change by vehicle type includes 6.9 percent for light vehicles, 3.6 percent for buses, a negative 3.5 percent for single bed trucks, and 12.3 percent for heavy trucks.

2.2 Traffic Survey Program

To evaluate the level and pattern of present traffic potential to the proposed toll bridge, comprehensive traffic studies were undertaken in October 1994. This section contains a description of the various surveys used in obtaining this information.

2.2.1 Origin - Destination Survey

Roadside interviews were conducted at the check point on Road T2, approximately 0.8 kilometers south of the Kafue River Bridge. The motorist and pedestrian interview surveys were conducted for a 12 hour period northbound and southbound between 0600 and 1800 for three days during the second week of October 1994. A direct survey approach was used under which motorist and pedestrians were stopped and questioned by interviewers.

Table 2.1
ANNUAL TRAFFIC TRENDS AT KAFUE WEIGHBRIDGE (66-A)
Kafue River Bridge Toll/Weighbridge Feasibility Study

Year	Light Vehicles	Buses	Single Bed Trucks	Heavy Trucks	Total	Percent	
						All Heavy Trucks	Very Heavy Trucks
1983	554	27	295	57	933	38	6
Percent Change	36.5	3.7	(5.4)	3.5	20.1	(21.1)	(16.7)
1984	756	28	279	59	1122	30	5
Percent Change	(21.3)	(17.9)	(1.1)	11.9	(14.4)	20.0	40.0
1985	595	23	276	66	960	36	7
Percent Change	6.7	65.2	2.2	(9.1)	5.7	0.0	(14.3)
1986	635	38	282	60	1015	36	6
Percent Change	(20.2)	(23.7)	(43.6)	66.7	(21.7)	(8.3)	116.7
1987	507	29	159	100	795	33	13
Percent Change	55.0	(55.2)	52.8	61.0	51.3	6.1	0.0
1988	786	13	243	161	1203	35	13
Percent Change	(24.9)	55.2	(28.8)	(19.9)	(24.3)	0.0	0.0
1989	590	19	173	129	911	35	13
Percent Change	25.8	42.1	33.5	55.8	31.7	(37.1)	30.8
1990	742	27	231	201	1200	22	17
Percent Change	(1.9)	11.1	(6.1)	0.5	(1.9)	(4.5)	0.0
1991	728	30	217	202	1177	21	17
Percent Change	12.1	33.3	21.2	(5.4)	11.3	81.0	(11.8)
1992 (1)	816	40	263	191	1310	38	15
Percent Change	(14.8)	(17.5)	(3.0)	(23.6)	(13.8)	(5.3)	(13.3)
1993 (2)	695	33	255	146	1129	36	13
Percent Change	14.2	6.1	(20.0)	(0.1)	4.3	(16.7)	(7.7)
1994 (3)	794	35	204	145	1178	30	12
Percent Change	44.8	14.3	(2.0)	41.4	35.4	(16.7)	8.3
1994 (4)	1150	40	200	205	1595	25	13
Average Annual Percent Change							
19 83 - May 1994	3.3	2.4	(3.3)	8.9	2.1	---	---
1983 - October 1994	6.9	3.6	(3.5)	12.3	5.0	---	---

Source: Roads Department Annual Report, Supplemented

(1) March and July counts conducted by Howard Humphreys-John Burrow Joint Venture - Zambia First Road Project, August 1993
(2) May 1993 by Roads Department
(3) May 1994 by Roads Department
(4) Field surveys conducted by Morrison Knudsen Corporation in association with Wilbur Smith Associates, October 1994

A total of 2,420 interviews were obtained from drivers and 70 interviews from pedestrians from 3,599 vehicles and 463 pedestrians passing the survey station during the hour of interview. Drivers of 67.2 percent of all vehicles and 15.4 percent of all pedestrians were interviewed as shown in Table 2.2 and 2.3. Sample sizes for pedestrians are low due to the fact that a group of two are more pedestrians travelling together was recorded as one interview. This resulted in a smaller sample size but in reality represents a larger number of the pedestrians passing the survey station in both directions.

As indicated on the survey form shown in Figure 2.1, motorists and pedestrians were questioned on the following items:

1. Owner;
2. Vehicle classification;
3. Registration;
4. Truck weight;
5. Origin;
6. Destination;
7. Trip purpose;
8. Trip frequency (trips per week);
9. Vehicle occupancy; and
10. Type of cargo.

As completed forms were returned, they were checked for completeness and coded into a geographic zone system. Information on travel patterns and characteristics for each response were then entered into computer files and tabulated. The following codes were used:

Hour

Code:

06	0600 - 0700	07	0700 - 0800
08	0800 - 0900	09	0900 - 1000
10	1000 - 1100	11	1100 - 1200
12	1200 - 1300	13	1300 - 1400
14	1400 - 1500	15	1500 - 1600
16	1600 - 1700	17	1700 - 1800

Owner

Code:

01 Government
02 Private

Table 2.2
MOTORIST SURVEY DISTRIBUTION
Kafue River Bridge Toll/Weighbridge Feasibility Study

	Northbound			Southbound		
Time Period	Passing Traffic	Usable Sample	Sample Size	Passing Traffic	Usable Sample	Sample Size
0600 - 0700	57	52	91.2	100	92	92.0
0700 - 0800	159	139	87.4	128	121	94.5
0800 - 0900	162	148	91.4	138	117	84.8
0900 - 1000	131	79	60.3	184	124	67.4
1000 - 1100	165	135	81.8	144	125	86.8
1100 - 1200	139	79	56.8	158	110	69.6
1200 - 1300	140	77	55.0	158	101	63.9
1300 - 1400	168	97	57.7	168	141	83.9
1400 - 1500	139	86	61.9	163	112	68.7
1500 - 1600	144	67	46.5	173	103	59.5
1600 - 1700	205	67	32.7	162	99	61.1
1700 - 1800	122	60	49.2	192	89	46.4
Total	1731	1086	62.7	1868	1334	71.4
Total Both Directions			3599		2420	67.2

Source: Field surveys conducted October 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates.

Table 2.3
PEDESTRIAN SURVEY DISTRIBUTION
Kafue River Bridge Toll/Weighbridge Feasibility Study

Time Period	Northbound			Southbound		
	Passing Pedestrians	Usable Sample	Sample Size	Passing Pedestrians	Usable Sample	Sample Size
0600 - 0700	10	7	70.0	12	7	58.3
0700 - 0800	37	1	2.7	24	4	16.7
0800 - 0900	49	8	16.3	9	4	44.4
0900 - 1000	18	1	5.6	22	2	9.1
1000 - 1100	21	4	19.0	45	12	26.7
1100 - 1200	22	5	22.7	45	2	6.9
1200 - 1300	5	1	20.0	29	0	0.0
1300 - 1400	0	0	0.0	12	3	25.0
1400 - 1500	3	1	33.3	19	0	0.0
1500 - 1600	7	2	28.6	16	0	0.0
1600 - 1700	22	0	0.0	24	4	16.7
1700 - 1800	10	1	10.0	26	1	3.8
Total	204	31	15.2	249	39	15.7
Total Both Directions			453		70	15.4

Source: Field surveys conducted October 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates.

KAFUE RIVER BRIDGE TOLL / WEIGHBRIDGE FEASIBILITY STUDY
ORIGIN - DESTINATION SURVEY

STATION NO. ________ STATION LOCATION: ________

HOUR BEGIN: ________ INTERVIEWER: ________

DAY OF WEEK: ________ DATE: ________

HOUR	OWNER		VEHICLE CLASSIFICATION	REGISTRATION	TRUCK WEIGHT	ORIGIN	DESTINATION	TRIP PURPOSE	TRIP FREQ. PER WK.	NO. OF PEOPLE IN VEHICLE	CARGO
	Government	Private	1 Motor Cycles; 2 Cars Including Station Wagons and Taxis; 3 Light Commercial Vehicle; 4 Buses; 5 Heavy 2 & 3 Axle Trucks; 6 Rigid Trucks with Draw Bar Trailers; 7 Semi Trailers; 8 Semi Trailers 6,7,8, 9,10,11 & 12 Axles; 9 Pedestrians					1 To/From Work; 2 Business; 3 Recreation; 4 Other			
			1 2 3 4 5 6 7 8 9					1 2 3 4			
			1 2 3 4 5 6 7 8 9					1 2 3 4			
			1 2 3 4 5 6 7 8 9					1 2 3 4			
			1 2 3 4 5 6 7 8 9					1 2 3 4			
			1 2 3 4 5 6 7 8 9					1 2 3 4			
			1 2 3 4 5 6 7 8 9					1 2 3 4			
			1 2 3 4 5 6 7 8 9					1 2 3 4			
			1 2 3 4 5 6 7 8 9					1 2 3 4			
			1 2 3 4 5 6 7 8 9					1 2 3 4			
			1 2 3 4 5 6 7 8 9					1 2 3 4			

Figure 2.1

Vehicle Class

Code:

1 Motor cycles
2 Cars including station wagons and taxis
3 Light commercial vehicles
4 Buses
5 Heavy 2 and 3 axle trucks
6 Rigid trucks with draw bar trailers
7 Semi trailers
8 Semi trailers 6, 7, 8, 9, 10, 11 & 12 axles
9 Pedestrians
12 Tractors and graders

Registration

Code:

1	Botswana	2	Lesotho
3	Malawi	4	Namibia
5	South Africa	6	Swaziland
7	Tanzania	8	Zaire
9	Zambia	10	Zimbabwe
99	Pedestrian		

Origin - Destination

Code:

1	Botswana	2	Lesotho
3	Malawi	4	Namibia
5	South Africa	6	Swaziland
7	Tanzania	8	Zaire

9 Zambia:

91	Chanida	92	Chingola	93	Chipata
94	Chirundu	95	Choma	96	Kabwe
97	Kafue	98	Kapiri Mposhi	99	Kasama
910	Katete	911	Kawambwa	912	Kitwe
913	Landless Corner	914	Livingstone	913	Luanshya
916	Lundazi	917	Lusaka	918	Luwingu
919	Mansa	920	Mazabuka	921	Mbala
922	Mpika Main	923	Mporokoso	924	Mongu
925	Mufulira	926	Mumbwa	927	Minilunga
928	Nakonde	929	Ndola	930	Nyimba
931	Rufunsa	932	Sesheke	933	Solwezi
934	Zambezi	935	Chilanga	936	Kalomo
937	M. Mainda	938	Siavonga	939	Monze
940	Chikankata	941	Kafue-Gorge	942	Nega-Nega
943	Turn-Park	944	Lusitu	945	Chivuna
946	Mkushi	947	Kaoma	948	Mpulungu
949	Pemba	950	Maamba	951	Namwala
952	Chisekesi	953	Gwembe	954	Luangwa
955	Zimba				

10 Zimbabwe
11 Mozambique

Add to Destination Code

Vehicles were classified from the origin-destination (O-D) as being one of the following:

L = Local (O-D both in Zambia)
I = International (O-D, but not both in Zambia)
T = Transit (neither origin nor destination in Zambia)

Trip Purpose

Code:

1 To/from work
2 Business
3 Recreation
4 Other

Trip Frequency

Code:

1 - 200

Number of People in Vehicle

1 - 200

Cargo

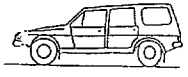
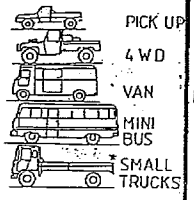
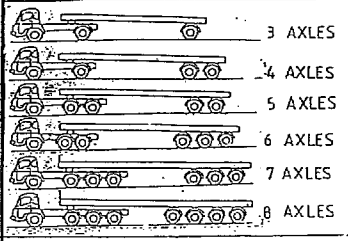
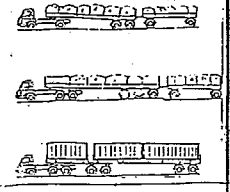
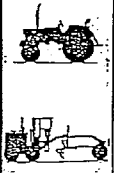
Code:

1 Empty
2 Agriculture products
3 Food products
4 Petro-chemical products
5 Manufactured products
6 Livestock
7 Poultry products
8 Copper
9 Electronics
10 Crush stone
11 Maize
12 Salt

2.2.2 Vehicle Classification Counts

Manual classified counts were made to obtain accurate measurements of the "mix" of vehicle types travelling over the Kafue Road Bridge. Figure 2.2 shows a tally sheet of the type used in this study. Classification counts were done in conjunction with the origin-destination survey from 0600 to 1800 hours. Unlike the origin-destination surveys, classification counts were conducted over a seven day period from October 11 to October 17, 1994. In addition, 24-hour counts were conducted on Wednesday and Saturday in order to develop 24-hour expansion factors. The results of these surveys are discussed in the following section.

TRAFFIC COUNT— LUSAKA KAFUE

LIGHT VEHICLES			HEAVY VEHICLES						
MOTER CYCLES	CARS INCLUDING STATION WAGONS AND TAXIS	LIGHT COMMERCIAL VEHICLES	BUSES	HEAVY 2&3A TRUCKS	RIGID TRUCKS WITH BRAW BAR TRAILERS	SEMI TRAILERS	SEMI TRAILER AND TRAILER	TRACTORS & GRADERS	PEDESTRIANS
	 	 PICK UP 4 WD VAN MINI BUS SMALL TRUCKS				 3 AXLES 4 AXLES 5 AXLES 6 AXLES 7 AXLES 8 AXLES	6 7 & 8 AXLES 9 10 11 & 12 AXLES 		
HOURS			/B	/B	/B	/B		/B	
TOTAL									

DATE : __/__/19__ EXACT POSITION (Description) : ..... KM .....

NAME OF COUNTER .....

* 2 AXLES < 3T

Figure 2.2

2.3 Average Daily Traffic

The manual classified volume counts obtained at the survey station were used to estimate annual daily traffic levels at the Kafue Bridge. Expansion factors obtained from the 24-hour weekday and weekend counts were used in adjusting the 12-hour counts at the survey station to an annual daily volume. The following expansion factors were used:

Table 2.4
24-HOUR EXPANSION FACTORS
Kafue River Bridge Toll/Weighbridge Feasibility Study

	Weekday	Weekend
Pedestrians	1.03	1.03
Vehicle	1.37	1.17

Source: Field surveys conducted October 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates.

Applying the expansion factors developed in Table 2.4 to the 12 hour weekly counts presented in Appendix A resulted in an estimated 1994 annual average daily traffic as shown in Table 2.5:

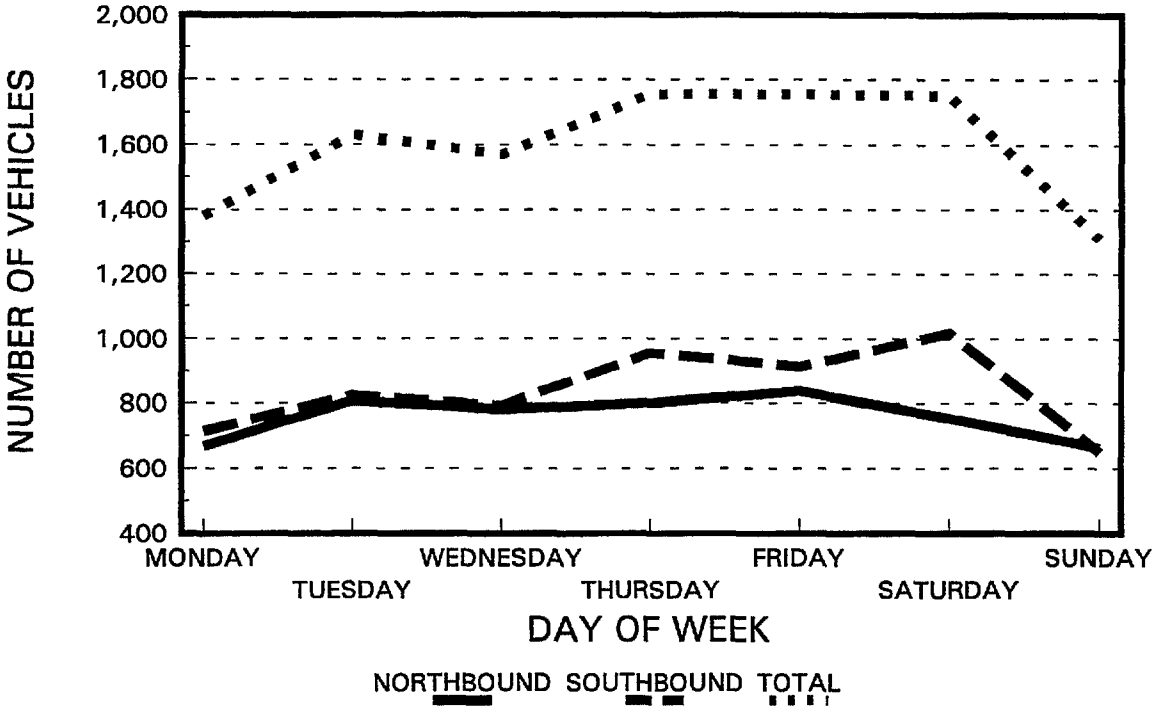
Table 2.5
ESTIMATED 1994 ANNUAL AVERAGE DAILY TRAFFIC AT KAFUE BRIDGE
Kafue River Bridge Toll/Weightbridge Feasibility Study

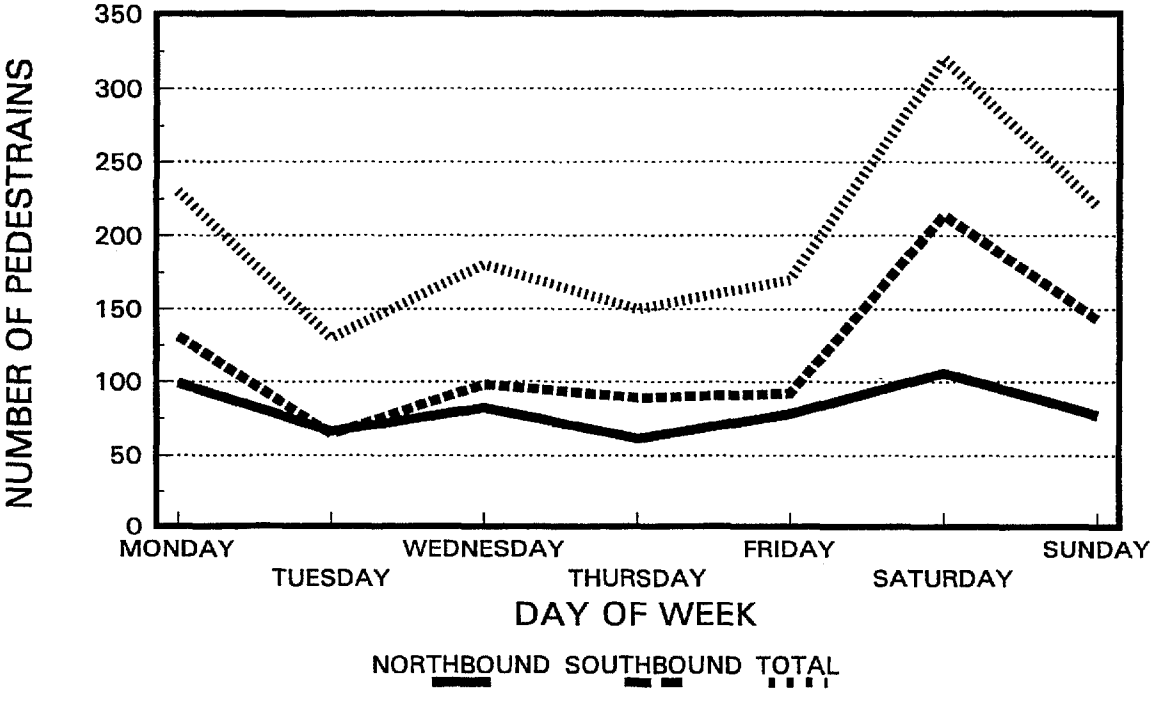
Vehicle Type	Estimated 1994 Average Daily Traffic
Pedestrian	200
Light Vehicle	1,150
Buses	40
Single Bed Trucks	200
Heavy Trucks	205
Total Vehicle Traffic	1,595

Source: Field surveys conducted October 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates.

2.3.1 Daily Traffic and Pedestrian Variation

Daily traffic variations near Kafue Weighbridge Bridge are shown in Table 2.6. For the week covering the period October 11 through October 17, 1994, the peak day occurred on Saturday with Thursday being a close second. The lowest volume day occurred on a Sunday. Southbound traffic remains the predominant movement for both vehicles and pedestrians throughout the week as shown in Figure 2.3. A more balanced condition might have been found if the surveys extended over a two or three week period.





DAILY TRAFFIC AND PEDESTRAIN VARIATIONS NEAR WEIGHBRIDGE

Figure 2.3

The peak day for pedestrian movement occurred on Saturday, with Monday being second. The lowest pedestrian movement occurred on Thursday.

Table 2.6
DAILY TRAFFIC AND VARIATIONS
OCTOBER 11 - 17, 1994
Kafue River Bridge Toll/Weighbridge Feasibility

Day of Week	Traffic Volume	Percent Average Weekday	Pedestrian Volume	Percent Average Weekday
Monday	1380	87	230	115
Tuesday	1630	102	130	65
Wednesday	1570	98	180	90
Thursday	1755	110	150	75
Friday	1750	110	170	85
Saturday	1770	111	320	160
Sunday	1310	82	220	110
Weekly ADT	1595	100	200	100

Source: Field surveys conducted October 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates.

2.3.2 Hourly Variation

Hourly traffic variation near Kafue Weighbridge are shown in Table 2.7. The hourly variations are intended to represent a typical weekday and weekend. As shown, the morning peak occurred between 1100 to 1200 hours, with 8.6 percent of the daily weekend traffic. The afternoon peak hour occurred between the hours of 1800 to 1900 during the weekday, and between 1300 to 1400 hours on the weekend. This represents 7.2 and 8.9 percent of weekend traffic respectively.

Unlike vehicle traffic which tends to travel 24 hours, pedestrian movement is mainly confined to daylight hours as shown in Table 2.7 for weekday and weekend. Peak morning pedestrian movement occurred between 0800 to 0900 hours, with 16.5 percent of the weekday flow. Weekday afternoon peak occurred between the hours 1800 to 1900 hours, with 11.5 percent of the daily flow. Weekend morning peak occurred between the hours of 0800 to 1000 hours, with 22.2 percent of the daily pedestrian flow. Afternoon weekend peak occurred between the hours of 1600 to 1700 hours, with 12.2 percent of the daily pedestrian flow.

Table 2.7
HOURLY TRAFFIC AND PEDESTRIAN VARIATION
Kafue River Bridge Toll/Weighbridge Feasibility Study

	Weekday				Weekend			
Hour Beginning	Traffic Volume	Percent of Daily ADT	Pedestrian Volume	Percent of Daily Total	Traffic Volume	Percent of Daily ADT	Pedestrian Volume	Percent of Daily Total
0100	18	0.9	0	0.0	9	0.5	0	0.0
0200	23	1.5	0	0.0	7	0.4	0	0.0
0300	10	0.6	0	0.0	6	0.3	0	0.0
0400	25	1.6	0	0.0	7	0.4	0	0.0
0500	39	2.5	0	0.0	7	0.4	0	0.0
0600	42	2.7	4	2.2	17	1.0	4	1.3
0700	38	2.4	9	5.0	75	4.2	20	6.2
0800	105	6.9	30	16.5	91	5.2	36	11.2
0900	90	5.7	26	14.3	117	6.6	36	11.2
1000	107	6.8	7	3.9	132	7.5	31	9.7
1100	121	7.7	27	14.8	152	8.6	23	7.2
1200	96	6.1	18	9.9	113	6.4	15	4.7
1300	94	6.0	7	3.9	157	8.9	23	7.2
1400	100	6.4	6	3.3	141	8.0	14	4.4
1500	78	5.0	3	1.6	140	7.9	25	7.8
1600	100	6.4	11	6.0	137	7.7	39	12.2
1700	102	6.5	12	6.6	124	7.0	30	9.4
1800	113	7.2	21	11.5	128	7.2	19	5.9
1900	107	6.8	1	0.5	81	4.6	5	1.6
2000	73	4.7	0	0.0	62	3.5	0	0.0
2100	46	2.9	0	0.0	36	2.0	0	0.0
2200	11	0.7	0	0.0	17	1.0	0	0.0
2300	18	1.1	0	0.0	9	0.5	0	0.0
2400	14	0.9	0	0.0	4	0.2	0	0.0
Total	1570	100.0	182	100.0	1770	100.0	320	100.0

Source: Field survey conducted October 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates.

2.4 Travel Patterns and Characteristics

After completion of the data reduction effort, a comprehensive profile of present travel patterns and characteristics of motorists and pedestrians using the Kafue Road Bridge was developed. A series of tabulations and cross tabulations was prepared in order to determine unique characteristics. The primary objective of the field surveys was to obtain a "real-world" measure of travel patterns and characteristics, as well as current traffic conditions. This information provided valuable insights for the estimation of traffic and revenue potential for the proposed toll plaza operation.

2.4.1 Trip Purpose

Table 2.8 shows that company business accounted for more than 67.0 percent northbound and 74.4 percent of the trips southbound which occurred during the time of the survey. The breakdown of trips by direction also reflects a relatively low percentage of recreational trips northbound and a low percentage of work trips in the southbound direction.

Table 2.8
TRIP PURPOSE BY VEHICLE TYPE
Kafue River Bridge Toll/Weightbridge Feasibility Study

Northbound					
	Trip Purpose				
Type Vehicle	To/From Work	Company Business	Recreation	Other	Total
Pedestrian	0.0	16.1	6.5	77.4	100.0
Light Vehicle	18.6	63.5	7.6	10.3	100.0
Buses	0.0	100.0	0.0	0.0	100.0
Single Bed Truck	27.1	65.4	5.3	2.1	100.0
Heavy Trucks	16.0	83.5	0.5	0.0	100.0
Total	18.1	67.0	5.8	9.1	100.0
Southbound					
	Trip Purpose				
Type of Vehicle	To/From Work	Company Business	Recreation	Other	Total
Pedestrian	20.5	17.9	33.3	28.2	100.0
Light Vehicle	6.7	68.9	13.7	10.7	100.0
Buses	0.0	100.0	0.0	0.0	100.0
Single Bed Truck	2.5	88.8	3.7	5.0	100.0
Heavy Trucks	2.0	91.9	2.0	4.7	100.0
Total	5.6	74.4	10.9	9.1	100.0

Source: Field surveys conducted October 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates.

2.4.2 Vehicle Occupancy

The average vehicle occupancy by type of vehicle and direction of travel is shown in Table 2.9 below.

Table 2.9
AVERAGE VEHICLE OCCUPANCY BY TYPE VEHICLE
Kafue River Bridge Toll/Weighbridge Feasibility

Vehicle Type	Average Vehicle Occupancy	
	Northbound	Southbound
Light Vehicle	5.36	4.13
Buses	46.67	29.93
Single Bed Truck	5.74	5.11
Heavy	3.36	3.43

Source: Field surveys conducted October 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates.

2.4.3 Vehicle Ownership

Vehicle ownership for the survey period is listed by vehicle type and direction of travel in Table 2.10. Most of the vehicles passing the survey station were privately owned. Northbound travel indicates a higher percentage of government-owned vehicles than does southbound. The highest percentage of government vehicles occurred in the single bed truck type in the northbound direction.

Table 2.10
VEHICLE OWNERSHIP BY VEHICLE TYPE
Kafue River Bridge Toll/Weighbridge Feasibility Study

Northbound			
Vehicle Type	Private	Government	Total
Light Vehicle	92.1	7.9	100.0
Buses	100.0	0.0	100.0
Single Bed Trucks	86.5	13.5	100.0
Heavy Trucks	97.4	2.6	100.0
Total	92.6	7.4	100.0
Southbound			
Vehicle Type	Private	Government	Total
Light Vehicle	97.5	2.5	100.0
Buses	95.8	4.2	100.0
Single Bed Trucks	97.5	2.5	100.0
Heavy Trucks	100.0	0.0	100.0
Total	97.7	2.3	100.0

Source: Field surveys conducted October 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates

2.4.4 Trip Frequency

Table 2.11 indicates that approximately 56 percent of the trips surveyed in the northbound direction were made once a week. An additional nine percent or more of the motorists interviewed travelled the route seven or more times per week. Nearly 35 percent of the motorists interviewed report making the trip more than twice a week and no more than six times per week.

In the southbound direction the number of trips which occurred once a week accounted for approximately 51 percent. Trips made twice a week account for just over 34 percent of the total trips. Of the total, nearly nine percent reported trips made three to five times per week and nine percent reported trips made seven or more times per week.

Table 2.11
TRIP FREQUENCY BY VEHICLE TYPE
Kafue River Bridge Toll/Weighbridge Feasibility Study

Northbound								
	Trips Per Week							
Vehicle Type	One	Two	Three	Four	Five	Six	More Than Seven	Total
Pedestrian	29.4	26.5	8.8	11.8	8.8	8.8	5.9	100.0
Light Vehicle	60.8	14.8	8.4	4.0	3.7	0.6	7.7	100.0
Buses	14.7	20.6	20.6	2.9	2.9	8.8	29.4	100.0
Single Bed Truck	40.2	17.4	12.9	2.3	4.5	3.0	18.9	100.0
Heavy truck	60.8	20.6	6.2	3.6	2.1	1.0	6.2	100.0
Total	55.9	16.6	8.9	3.9	3.7	1.5	9.4	100.0

Southbound								
	Trips Per Week							
Vehicle Type	One	Two	Three	Four	Five	Six	More Than Seven	Total
Pedestrian	21.1	36.8	23.7	5.3	5.3	2.6	53.	100.0
Light Vehicle	52.1	27.3	5.8	4.6	1.7	0.8	7.7	100.0
Buses	37.5	31.3	12.5	3.1	1.0	1.0	13.5	100.0
Single Bed Truck	50.9	29.8	5.0	3.1	0.6	1.2	9.3	100.0
Heavy truck	62.1	24.2	3.9	4.6	0.7	4.6	0.0	100.0
Total	51.2	34.1	8.0	5.4	1.9	1.6	9.0	100.0

Source: Field survey conducted October 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates.

Table 2.12
VEHICLE REGISTRATION BY VEHICLE TYPE
Kafue River Bridge Toll/Weighbridge Feasibility Study

	Northbound					Southbound				
	Vehicle Type					Vehicle Type				
Country of Registration	Light Vehicle	Buses	Single Bed Trucks	Heavy Trucks	Total	Light Vehicle	Buses	Single Bed Truck	Heavy Trucks	Total
Botswana	0.7	0.0	0.0	2.6	0.9	0.9	0.0	1.2	1.3	0.9
Lesotho	0.1	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.1
Malawi	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.6	0.0	0.2
Namibia	0.4	0.0	0.0	0.0	0.3	0.0	0.0	0.6	0.7	0.1
South Africa	2.6	0.0	3.0	5.2	3.0	23.0	2.1	1.2	3.3	2.4
Tanzania	1.2	5.9	2.3	3.6	1.9	1.0	0.0	1.2	0.7	0.9
Zaire	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.6	2.7	0.5
Zambia	92.4	76.5	93.2	69.1	87.8	92.2	85.4	85.1	72.0	88.6
Zimbabwe	2.5	17.6	1.5	19.6	5.9	2.8	12.5	9.3	19.3	6.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Field surveys conducted October 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates.

2.4.5 Vehicle Registration

The country of vehicle registration is listed in Table 2.12 by vehicle type and direction of travel. As expected, Zambia registration dominates the distribution with 87.8 percent northbound and 88.6 percent southbound. Zimbabwe accounted for 19.6 percent northbound and 6.1 percent southbound. The remaining 6.3 percent of northbound and 5.3 percent of southbound vehicles had registrations from other countries.

2.4.6 Average Trip Length

Average trip length by pedestrian and vehicle type were computed for travel within Zambia from the origin-destination surveys. Table 2.13 shows the results by vehicle type, pedestrian, and direction of travel in kilometers.

Table 2.13
AVERAGE TRIP LENGTH BY PEDESTRIAN & VEHICLE TYPE
Kafue River Toll/Weighbridge Feasibility Study

Type	Northbound (Kilometers)	Southbound (Kilometers)
Pedestrians	31.5	47.7
Light Vehicle	191.0	260.5
Buses	300.1	280.7
Single Bed Truck	185.0	303.9
Heavy Trucks	351.7	374.8

Source: Field surveys conducted October 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates

The fairly long trip lengths recorded in both directions for pedestrians is primarily due to a high level of hitch-hiking activity and from origins and destinations within the Kafue area.

2.4.7 Cargo by Vehicle Type

Distribution for the survey period for type of cargo is listed by vehicle type in Table 2.14. Most of the light vehicle drivers responding to the survey indicated their vehicles were empty, both in the southbound and northbound direction. Mostly empty loads were also recorded for buses, single bed trucks, and heavy trucks in the southbound direction.

For all vehicle types in the northbound direction, food products accounted for 9.5 percent with manufactured goods accounting for 7.3 percent of the total. Copper was not recorded in the northbound direction which is reasonable considering all copper is mined in northern Zambia.

The type of cargo recorded in the southbound direction for all vehicle types revealed that for other than empty vehicles, manufactured products accounted for 6.4 percent followed by other, with 5.8 percent of the total drivers interviewed. The cargo of livestock was not recorded, due to the fact that ranching (raising of cattle) is mainly in the southern part of Zambia. Most cattle is brought north for sale.

Table 2.14
CARGO BY VEHICLE TYPE
Kafue River Bridge Toll/Weighbridge Feasibility Study

Northbound					
Type Cargo	Type Vehicle				
	Light Vehicles	Buses	Single Bed Truck	Heavy Trucks	Total
Empty	72.7	29.4	39.8	16.0	57.2
Agricultural Products	1.7	0.0	3.0	8.2	2.9
Food Products	7.0	2.9	8.3	20.6	9.5
Petro-Chemical Products	0.8	0.0	2.3	7.7	2.2
Manufactured Products	4.4	0.0	7.5	19.1	7.3
Livestocks	1.1	0.0	3.8	3.6	1.8
Poultry Products	1.2	2.9	3.0	1.0	1.5
Copper	0.0	0.0	0.0	0.0	0.0
Electronics	0.6	0.0	0.0	1.0	0.6
Crush Stone	1.1	0.0	15.8	4.6	3.5
Maize	0.6	0.0	4.5	8.2	2.4
Salt	0.3	0.0	0.0	2.1	0.6
Other	8.6	64.7	12.0	7.7	10.6
Total	100.0	100.0	100.0	100.0	100.0

Source: Field surveys conducted October 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates.

Table 2.14 (cont'd.)
CARGO BY VEHICLE TYPE
Kafue River Bridge Toll/Weighbridge Feasibility Study

Southbound					
Type Cargo	Type Vehicle				
	Light Vehicles	Buses	Single Bed Truck	Heavy Trucks	Total
Empty	85.2	61.5	64.0	63.3	78.5
Agricultural Products	1.1	1.0	5.6	4.7	2.0
Food Products	1.6	2.1	3.7	2.7	2.0
Petro-Chemical Products	1.4	3.1	4.3	8.0	2.6
Manufactured Products	4.7	6.3	11.8	11.3	6.4
Livestocks	0.0	0.0	0.0	0.0	0.0
Poultry Products	0.1	3.1	0.6	0.7	0.4
Copper	0.3	0.0	0.6	3.3	0.7
Electronics	0.1	0.0	1.9	1.3	0.4
Crush Stone	0.2	0.0	1.9	0.0	0.4
Maize	0.4	3.1	0.0	1.3	0.7
Salt	0.0	0.0	0.0	0.0	0.0
Other	4.7	19.8	5.6	3.3	5.8
Total	100.0	100.0	100.0	100.0	100.0

Source: Field surveys conducted October 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates.

2.4.8 Origin-Destination Patterns

Table 2.15 and 2.16 summarize the ranking of the top 20 movements relating to travel over the Kafue River Road Bridge. As shown in Table 2.15, over 23 percent of the northbound movements related to through-trips over the bridge, with origins and destinations between Mazabuka and Lusaka. Overall, the top 20 movements represent 82 percent of all northbound motorists surveyed. In the southbound direction, 15.7 percent of the motorists had origins and destinations between Lusaka and Mansa. Overall, the top 20 southbound movements represent 82 percent of all surveyed. Appendix B contains paired movements for all interviews obtained. Pedestrians surveyed indicated the major movement in both directions were between Kafue and Kafue as shown in Table 2.17.

2.4.9 Type Trip by Vehicle Type

Table 2.18 presents a summary of the type of trip by vehicle class obtained as part of the origin-destination survey. Local trips account

Table 2.15
NORTHBOUND LEADING PAIRED MOVEMENTS
Kafue River Bridge Toll/Weighbridge Feasibility Study

Origin	Destination	Type Trip (1)	Distance Travelled in Zambia	Type Vehicle					Percent of Total Trips
				Light Vehicles	Buses	Single Bed Trucks	Heavy Trucks	Total	
Mazabuka	Lusaka	L	125	184	2	34	35	255	23.5
Siavonga	Lusaka	L	183	79	2	5	3	89	8.2
Choma	Lusaka	L	284	57	6	11	12	86	7.9
Monze	Lusaka	L	185	52	5	2	2	61	5.6
Livingstone	Lusaka	L	472	40	9	9	0	58	5.3
Zimbabwe	Lusaka	I	136	24	6	1	19	50	4.6
Chirundu	Lusaka	L	136	37	0	1	4	42	3.9
South Africa	Lusaka	I	136	10	0	2	16	28	2.6
Mazabuka	Kabwe	L	81	12	0	7	5	24	2.2
Kafue	Kafue	L	12	18	0	4	1	23	2.1
Kafue-Gorge	Kafue	L	70	19	0	2	1	22	2.0
M. Mainda	Lusaka	L	76	7	0	9	6	22	2.0
Kafue-Gorge	Lusaka	L	114	19	0	2	0	21	1.9
M. Mainda	Kafue	L	52	11	0	8	0	19	1.8
Chikankata	Lusaka	L	127	11	0	3	4	18	1.7
Zimbabwe	Zaire	T	581	0	0	0	17	17	1.6
Chirundu	Kafue	L	92	8	0	9	0	17	1.6
Kafue	Lusaka	L	56	8	0	5	2	15	1.4
Turn-Park	Kafue	L	12	12	0	0	0	12	1.1
Kalomo	Lusaka	L	364	9	0	2	0	11	1.0
Subtotal				617	30	116	127	890	82.0
Total Trips: All Northbound Movements				725	34	133	194	1,086	100.0

Source: Field surveys conducted by October 1994 by Morrison Knudsen in association with Wilbur Smith Associates.

(1) L = Local (O-D) both in Zambia
I = International (O-D, but not both in Zambia)
T = Transit (neither origin nor destination in Zambia)

Table 2.16
SOUTHBOUND LEADING PAIRED MOVEMENTS
Kafue River Bridge Toll/Weighbridge Feasibility Study

Origin	Destination	Type Trip (1)	Distance Travelled in Zambia	Type Vehicle					Percent of Total Trips
				Light Vehicles	Buses	Single Bed Trucks	Heavy Trucks	Total	
Lusaka	Mansa	L	561	146	12	24	28	210	15.7
Lusaka	Zimbabwe	I	136	49	19	13	27	108	8.1
Lusaka	Choma	L	284	73	10	11	11	105	7.9
Lusaka	Siavonga	L	183	70	6	3	2	81	6.1
Lusaka	M. Mainda	L	76	48	1	21	4	74	5.5
Lusaka	Livingstone	L	472	45	13	8	6	72	5.4
Lusaka	Monze	L	185	53	10	2	2	67	5.0
Lusaka	Chirundu	L	136	54	3	2	2	61	4.6
Kafue	M. Mainda	L	32	28	1	8	1	38	2.8
Lusaka	Maamba	L	346	18	2	11	5	36	2.7
Kafue	Turn-Park	L	12	29	1	3	1	34	2.5
Lusaka	Kafue	L	44	26	1	4	2	33	2.5
Lusaka	Chikankata	L	127	25	2	1	2	30	2.2
Kafue	Mazabuka	L	81	21	1	3	2	27	2.0
Kafue	Kafue-Gorge	L	20	22	2	1	0	25	1.9
Lusaka	South Africa	I	136	9	1	7	5	22	1.6
Kafue	Kafue	L	12	18	0	1	0	19	1.4
Kafue	Choma	L	240	12	1	5	1	19	1.4
Kafue	Siavonga	L	139	16	1	0	0	17	1.3
Kitwe	South Africa	I	494	3	0	4	9	16	1.2
Subtotal				765	87	132	110	1,094	82.0
Total Trips: All Southbound Movements				927	96	161	150	1,334	100.0

Source: Field surveys conducted by October 1994 by Morrison Knudsen in association with Wilbur Smith Associates.

(1) L = Local (O-D) both in Zambia
I = International (O-D, but not both in Zambia)
T = Transit (neither origin nor destination in Zambia)

Table 2.17
PEDESTRIAN PAIRED MOVEMENTS
Kafue River Bridge Toll/Weighbridge Feasibility Study

Northbound

Origin	Destination	Distance Travelled in Zambia (Km)	Total
Kafue	Kafue	12	13
Mazabuka	Kafue	81	5
Mwanamainda	Kafue	32	5
Kafue-Gorge	Kafue	70	2
Turn-Park	Kafue	12	5
Turn-Park	Lusaka	56	1

Southbound

Origin	Destination	Distance Travelled in Zambia (Km)	Total
Kafue	Kafue	12	18
Kafue	Mazabuka	81	2
Kafue	Mwanamainda	32	4
Kafue	Kafue-Gorge	70	1
Kafue	Turn-Park	12	12
Kafue	Pemba	176	1
Kasama	Kafue-Gorge	964	1

Source: Field surveys conducted October 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates.

Table 2.18
TYPE TRIP BY VEHICLE TYPE
Kafue River Bridge Toll/Weighbridge Feasibility Study

Northbound

Vehicle Type	Type Trip			
	Local	International	Transit	Total
Light Vehicles	92.3	7.3	0.4	100.0
Buses	82.4	17.6	0.0	100.0
Single Bed Truck	97.0	3.0	0.0	100.0
Heavy Truck	54.6	29.9	15.5	100.0
Total	85.8	11.1	3.0	100.0

Southbound

Vehicle Type	Type Trip			
	Local	International	Transit	Total
Light Vehicles	89.2	10.4	0.4	100.0
Buses	79.2	20.8	0.0	100.0
Single Bed Truck	75.2	22.2	2.5	100.0
Heavy Truck	58.0	37.3	4.7	100.0
Total	83.3	15.6	1.1	100.0

Source: Field surveys conducted October 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates.

for 85.8 percent of all trips recorded in the northbound direction. In the southbound direction, local trips account for 83.3 percent of the total. Heavy trucks had the highest percentage of international and transit trips recorded with 29.9 and 15.5 percent respectively, in the northbound direction. In the southbound direction, 37.3 percent of heavy trucks were international trips and 4.7 percent were transit trips.

2.4.10 Sensitivity of the Public to Proposed Toll

As part of the origin-destination survey, motorist and pedestrians were asked what they would be willing to pay if the bridge were tolled. In order not to bias the results by frequent users of the bridge, this attitude survey was only conducted on the last day of the origin-destination survey. This afforded the motorist and pedestrian an opportunity to give an answer without prior thought. Table 2.19 summarizes the findings of this attitude survey, by pedestrian, vehicle type, and direction.

Table 2.19
SENSITIVITY SURVEY RESULTS
Kafue River Bridge Toll/Weighbridge Feasibility Study

Sources	Direction of Travel		
	Northbound (Kwacha)	Southbound (Kwacha)	Average Both Directions
Pedestrians	25	35	30
Light Vehicle Drivers	2340	910	1625
Bus Drivers	2430	755	1595
Single Bed Truck Drivers	2935	3485	3210
Heavy Truck Drivers	1820	2530	2175

Source: Field surveys conducted October 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates.

Note: Values rounded to nearest whole denomination.

As one might expect, pedestrians were willing to pay the least while single bed truck drivers were willing to pay the most. Frequent users such as bus drivers were willing to pay less than drivers of light vehicles. Heavy truck drivers indicated they would prefer to pay a lower toll than single bed truck drivers, perhaps because tolls are already levied on them at the borders.

The most frequently occurring values for pedestrians and vehicle drivers responding to the survey are shown in Table 2.20:

Table 2.20
MODE OF SENSITIVITY SURVEY
Kafue River Bridge Toll/Weighbridge Feasibility Study

Source	Direction of Travel	
	Northbound (Kwacha)	Southbound (Kwacha)
Pedestrians	20	20
Light Vehicle Drivers	500	100
Bus Drivers	1000	400
Single Bed Truck Drivers	500	800
Heavy Truck Drivers	500	500

Source: Field surveys conducted October 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates.

The values presented in Table 2.20 are considerably less than the average toll rates presented in Table 2.19. This is due to the wide range in the responses about a proposed toll. The mode for pedestrians is not to far out of line with the average. This could be attributed to a smaller sample size in that category.

3.0 ECONOMIC AND DEMOGRAPHIC CONSIDERATIONS

This chapter examines a range of Zambian economic and demographic data in order to develop bases for the projection of traffic growth rates for the study road in Section 4.0. Consideration of indicators at the national level is necessary because of the unique role played by Road T2 in the Kafue River area; i.e., the road actually serves as a national road, connecting four trunk roads south of Lusaka with three trunk roads north of the city.

3.1 General

When Zambia achieved its independence in 1964, it had several very definite advantages:

- It had great mineral wealth;
- It had achieved nationhood without fighting a war;
- There was plenty of arable land for the size of its population;
- The virulent hatred between tribes which had rocked other African nations appeared to be muted; and
- The standard of living was about equal to that of South Korea.

After 27 years of economic instability, Zambia still had all of the advantages except the last. Zambia's per capita income now ranks among that of the poorer nations in Africa. Meanwhile, South Korea heartily embraced the free market and became one of Asia's Young Tigers, with an economic growth rate envied by the world.

On October 13, 1991 the pendulum swung back towards the right, with the installment of a new government. Many initiatives have since been taken by the new government which indicate that they have recognized the signposts on the road to economic recovery and have mapped out a course to reach that destination. Economic recovery invariably involves growth.

This section examines certain economic and demographic data which summarize the present situation in Zambia and point up possibilities for achieving growth in the economy. This coverage will provide background for the next section, which will estimate growth rates for future traffic across the study bridge. Since the requirement for transport is a derived demand, i.e., it develops from a need to transport people or goods from place to place, it usually increases as recovery progresses.

3.2 Population and GDP

Population and Gross Domestic Product (GDP) are potent economic indicators. Table 3.1 compares the two, with GDP at constant 1977 prices and rounds off all data to millions. Considering the rounding and the fact that all population figures shown are projections (except for 1990) the results of comparisons of such data can only be approximate. In any event, the average per capita GDP (at constant 1977 prices) declined from K329 in 1994 to K281 in 1993, a reduction of 17 percent.

Table 3.1
Zambian Population vs GDP

Year	Population (1)	GDP @ Constant 1977 Prices (K million)
1984	6.12	2011.5
1985	6.72	2044.5
1986	6.75	2059.3
1987	7.27	2114.3
1988	7.31	2247.1
1989	7.34	2224.2
1990	7.38	2213.6
1991	7.57	2221.2
1992	7.78	2136.5
1993	8.01	2248.0

(1) Population data for 1984-89, incl., were projected from the 1990 census and 1991-93 data were projected from the 1990 census. Mid-year estimates shown.

Source: Central Statistics Office

During the same period, population increased from 6.12 million (1984) to 8.01 million (1993), or by 31 percent. Necessary family planning programs have been initiated but immediate results cannot be expected.

The effects of inflation on GDP are shown by Table 3.2. For example, the 1993 GDP at current prices was K1,423,187 million compared to K2,248 million at constant 1977 prices. The former figure shows a 633 fold increase.

Table 3.2
GDP at Present and Constant 1977 Prices

Year	GDP at Current Prices	GDP at Constant 1977 Prices
	Millions of Kwacha	
1984	4,931.0	2,011.5
1985	7,072.0	2,044.5
1986	12,963.1	2,059.3
1987	19,778.0	2,114.3
1988	30,020.8	2,247.1
1989	60,024.5	2,224.2
1990	127,649.7	2,213.6
1991	247,623.2	2,221.2 (1)
1992	560,207.6	2,136.5 (2)
1993	1,423,186.9	2,248.0 (3)

(1) Update
(2) Preliminary
(3) Provisional, revision likely.

Source: USAID records and Central Statistics Office

3.3 Employment

Employment levels are another key economic indicator. Table 3.3, which shows formal sector employment for 1984-93, excludes the informal sector, defined as consisting of subsistence farmers, self-employed workers, and private enterprises and cooperatives with five or fewer employees. It is estimated that this sector provides over 75 percent of total Zambian employment. The point here is that on Table 3.3, we are looking at only part of the employment picture. It indicates that although there was an increase in total formal employment of 10.1 percent between 1984 and 1985, after that the increases between subsequent years up to 1992, were very small. Employment for that year was 9.3 percent less than 1991 and 1993's total continued the decline, losing 4.8 percent against 1992.

The recent flat performance of employment is due in good part to the fact that the economy is dominated by parastatal firms. These include utilities such as electrical and rail transport and other large services, industrial and commercial firms, many of which are inefficient and losing money. As these are privatized, formal sector employment should increase. However, this is not going to be accomplished overnight.

Table 3.3
FORMAL SECTOR EMPLOYMENT 1984-1993
(Annual Mid-year Data)

No.	Area (1)	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1.	Agriculture, Forestry & Fishing	78.6	79.1	77.2	78.5	80.6	81.9	79.8	77.7	82.0	82.8
2.	Mining & Quarrying	61.3	64.6	64.5	64.6	64.6	64.6	64.7	64.8	62.1	58.2
3.	Manufacturing	72.9	76.7	75.6	74.6	74.5	75.2	77.1	75.4	73.4	67.6
4.	Electricity, Gas & Water	5.9	6.2	6.5	6.6	6.6	7.1	7.1	8.4	8.4	5.7
5.	Construction	41.3	38.5	40.9	39.6	37.3	35.2	33.1	27.8	27.8	22.1
6.	Wholesale & Retail Trade, Restaurants, Hotels	43.8	44.2	47.8	49.7	51.0	54.3	55.1	55.2	57.3	49.3
7.	Transportation, Storage & Communications	35.1	33.0	32.4	32.3	32.8	33.3	33.8	34.4	31.0	29.0
8.	Financing, Insurance, Real Estates & Business Services	28.8	30.7	32.5	32.5	31.5	32.2	32.9	35.8	39.0	39.0
9.	Community, Social & Personal Services	143.5	148.0	149.5	152.1	154.5	156.7	159.4	162.2	170.7	168.3
10.	**TOTAL (2)**	**515.4**	**521.9**	**531.3**	**535.6**	**539.3**	**546.5**	**549.5**	**551.1**	**546.0**	**522.0**

(1) Estimates based on 1985 and 1993 Quarterly Employment Inquiries

(2) Total may not add exactly due to rounding.

Source: Central Statistics Office

There is a significant difference in the number of formal sector employees by employment area. For example, in 1993, community, social and personnel services was first in number of employees (32 percent) followed in descending order by agriculture, forestry and fishing (16 percent), manufacturing (13 percent), mining and quarrying (11 percent), and wholesale and retail trade, restaurants and hotels (9 percent).

With formal sector employment levels dependent in good part upon the pace of privatization, it appears that (at least in the short term) significant increases are unlikely. Informal sector employment will probably continue to increase, but from an uncertain base. The result as far as overall employment is concerned is not clear.

3.4 Agriculture - a Special Case

Zambian agriculture deserves additional attention, since it ranges across both formal and informal employment sectors. With the bulk of the Zambian population employment in this sector, its productivity is of critical concern to the nation. For example, the World Bank recently estimated that agricultural production could be raised 300 percent by 2000 if certain changes were made.[1] Delays in implementing these changes or failure to implement were cited as reducing the possibility of meeting this goal. Changes stated as required included:

- Investment in human capital to increase productivity of farm labor and removal of artificial constraints on such labor;
- Better management of livestock and crop production;
- Reduction of government controls on agriculture, including subsidies and price controls;
- Shifting to crops where the farmer has a comparative advantage;
- Provision of research and extension services to cope with the fact that over half of the Zambian land under cultivation is acidic; and
- Institutional changes, better marketing, input distribution, processing of product, financial support, transportation, storage and conservation of the environment.

[1] Zambia Agriculture Strategy and Options, Vol. I, Main Report No. 9517-ZA, World Bank, Jan 29 1992.

Market liberalization, elimination of price controls, and shift to crops where the farmer has a comparative advantage were cited as short run measures, with the remainder as medium or long run. The changes recommended were cited as changing the structure of Zambian agriculture from 55 percent crop production in 1980-91 to 35 percent in 2000, with the difference to be made up of livestock production and natural resource utilization.

What are the prospects of this goal being met? In a speech given October 22, in Chikankata on October 23 and reported in the *Times of Zambia* on October 23, President Chiluba stated that agriculture was recognized as the principal foundation of the economy, with others like mining necessarily shortlived. Citing problems affecting agriculture such as inflation and high interest rates to farmers, he stated that the government is going to spend K100 billion a year through 2000 in implementing its agricultural policy. Areas mentioned included cropping, cattle and irrigation and 14 other related programs.

The program announced by President Chiluba is a step in the right direction. However, it remains to be seen if needed changes can be made quickly enough to meet the timetable proposed by the World Bank.

3.5 GDP by Sector of Origin

Table 3.4 shows Zambia GDP by sector of origin for 1988 through 1993. Leading sectors in declining order (by percent) of the 1993 table were:

▪ Agriculture, Fishing and Forestry	27
▪ Manufacturing	24
▪ Mining and Quarrying	10
▪ Wholesale and Retail Trade	8
▪ All Others	31
Total	100

Since the agricultural component of the leading sector does not include the product of subsistence farmers which make up the bulk of Zambian farms, it is considerably understated. It is noted that the total GDP for 1993 was 2.5 times that of 1992. This includes increases in leading sectors of: mining and quarrying (x 4.5), transport storage and communication (x 3.8) and agriculture, forestry and fisheries (x 3.2).

Under transport, storage and communication, road transport was up by 5.4 times and rail transport by 4.3 times. There are two points to keep in mind when evaluating the changes shown for 1993. First, the 1993 figure is provisional and subject to change and second, a good part of the increase is due to inflation.

Table 3.4
GDP BY KIND OF ECONOMIC ACTIVITY AT CURRENT PRICES
1988-1993

No.	Sector	1988	1989	1990	1991	1992 (1)	1993 (2)
1	Agriculture, Forestry & Fisheries	5,055.5	10,562.1	20,630.8	41,148.3	121,132.3	393,929.9
2	Mining & Quarrying	3,155.2	7,719.8	10,216.7	17,525.9	31,819.8	142,957.1
3	Manufacturing	9,495.6	17,089.7	36,106.6	73,979.3	189,047.6	350,502.6
4	Electricity, Gas & Water	306.2	398.1	594.2	1,542.0	7,255.1	18,972.0
5	Construction	618.4	884.0	4,418.8	8,357.8	20,975.2	58,216.2
6	Wholesale & Retail Trade	3,449.4	5,109.0	10,827.4	24,893.1	40,189.9	118,276.6
7	Restaurants & Hotels	735.5	1,363.3	2,899.5	4,818.6	21,328.2	22,751.6
8	Transport Storage & Communication	1,206.8	2,880.6	5,501.2	12,092.7	24,896.2	94,919.6
9	Financial Institution & Insurance	1,083.8	1,781.1	3,204.9	4,676.8	17,773.6	17,773.6
10	Real Estate & Business Services	1,483.0	2,072.0	4,878.6	8,327.4	29,716.7	59,929.6
11	Community Social & Personal Services	2,170.5	2,704.6	7,051.0	10,920.2	42,105.3	79,831.8
12	Import Data	1,558.1	3,105.3	7,889.1	12,358.4	33,841.4	79,000.0
13	Less: Imported Banking Service Charges	(297)	(488.4)	(878.8)	(1,282.5)	(4,873.7)	(4,873.7)
Total GDP at Market Prices		30,020.8	55,181.2	113,340.0	219,353.0	560,207.6	1,423,186.9

(1) Preliminary
(2) Provisional, revison likely.
Source: Economic Report 1993 ncdp, Jan. 1994, years 1988-1993.
Central Statistics Office, 1992-1993

3.6 Imports and Exports

Over the past decade, Zambia has generally had a favorable trade balance as far as the import and export of commodities are concerned. Table 3.5 shows the commodities comprising the bulk of the country's export value: copper, zinc, lead, cobalt and tobacco. Again the impact of inflation is obvious. For example, 398,000 tons of copper exported in 1988 were valued at K8,340 million. In 1993, 400,000 tons were exported, at K323,668 million. For nearly the same quantity of metal, the 1993 export value was 39 times greater.

Overall, the annual tonnage of metal produced is not increasing. For example, the 10 year average for copper production was around 434,000 tons, with production for 1991-93, inclusive, below that. The 10 year annual average for zinc was 15 million tons and that level has not even been approached in the past five years. The average annual production of lead calculation was thrown off by a large atypical production in 1986. Annual cobalt production during the past five years has been somewhat above the 10-year average (4.1 million tons). Tobacco has been below its average (1.6 million) for three years out of the last five and over it for two.

So, production in the leading export commodities has been essentially flat (or declining) over the past five years. This has reduced the availability of the foreign exchange needed for development.

3.7 Inflation

Inflation is probably the most serious economic problem facing Zambia. Although its effects has already been mentioned several times, it is examined here principally from the viewpoint of the consumer.

- **The Kwacha** - the worth of the Kwacha in U.S. Dollars declined from 0.5573 in 1984 to 0.0022 in 1993 as shown in Table 3.6. Inflation of this magnitude has a very depressing effect on economic activity. However, the government has attacked this problem head-on and has made progress.

Table 3.5
EXPORT OF PRINCIPAL COMMODITIES
1984-1993

Year	Copper		Zinc		Lead		Cobalt		Tobacco	
	Tonne (000)	K(Mil)	Tonne (000)	K(Mil)	Tonne (000)	K(Mil)	Tonne (000)	K(Mil)	Tonne (000)	K(Mil)
1984	531	1,031	32,113	51,569	8,573	6,547	2,336	19,587	1,519	5,033
1985	475	1,259	20,084	53,189	5,122	7,400	1,924	23,867	1,218	2,233
1986	436	4,429	21,804	99,115	48,113	5,537	4,730	385,151	698	4,254
1997	476	6,845	19,731	130,944	4,447	19,765	4,285	466,211	2,529	16,612
1988	398	8,340	19,230	161,916	3,746	19,028	5,171	598,197	2,112	29,266
1989	432	16,353	12,956	301,948	1,180	8,501	4,210	1,101,188	1,036	24,316
1990	441	33,734	9,489	438,140	40	818	4,931	2,543,888	2,027	125,255
1991	349	33,786	6,196	464,392	1,308	53,453	4,507	1,174,142	1,348	256,433
1992	399	83,783	4,118	781,532	164	10,541	4,277	2,483,051	2,297	786,869
1993	400	323,668	4,498	2,269,700	400	67,677	4,785	10,433,980	1,228	299,100

Source: External Trade Bulletin, Central Statistical Office, July 1994

Table 3.6
KWACHA VS US$

Year	US$ Per Kwacha (1)	Kwacha Per US$ (2)
1984	0.5573	2
1985	0.3685	3
1986	0.1262	8
1987	0.1151	9
1988	0.1210	9
1989	0.0723	14
1990	0.0318	31
1991	0.0155	65
1992	0.0058	172
1993	0.0022	455

(1) Central Statistics Office
(2) Computed

- **Consumer Price Indexes** - Inflation erodes purchasing power and discourages economic growth, particularly when consumer goods are involved. Table 3.7 shows consumer price indexes in eight different consumer item areas for the high income group, with 1985 = 100. The average (all items) index for 1986 (160.1) increased to 23,127.1 in 1993, an 144 fold increase. The areas where the consumer was hit hardest included medical care (+218 times), food and beverages (+166 times), furniture and household goods (+164 times), and transport and communications (+137 times). Inflation at this level wipes out savings and reduces the possibilities of economic growth. Inflation in the price of consumer goods items hits the low income group much harder than it does the high income group because the former is living much closer to the margin. When one is barely scraping by, it does not take much to put him to the wall.

  Table 3.8 shows consumer price indexes for five consumer areas for the low income group, again with 1985 = 100. The "all items" category showed a 180-fold increase between 1985 and 1993. The areas hardest hit were food and beverages (+198-fold), furniture and household goods (+172-fold), and all other goods and services (+161-fold). The heavy rise in food prices was especially damaging to the low income group, because such a high proportion of their income is spent on food.

Table 3.7
CONSUMER PRICE INDEXES, HIGH INCOME GROUP
(1975 WEIGHTS, 1985 = 100)

Year	Food, Beverages & Tobacco	Clothing & Footwear	Rent, Fuel & Lighting	Furniture & Household Goods	Medical Care	Transport & Communications	Recreation & Entertainment	Other Goods & Services	All Items
1984									(1)
1985	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1986	154.5	150.9	145.2	181.3	179.4	173.4	161.4	160.7	160.1
1987	250.5	234.4	211.8	332.8	309.0	234.5	227.6	243.0	250.3
1988	406.9	392.6	227.4	438.2	424.4	318.3	317.2	413.6	375.8
1989	961.8	778.5	246.8	1,033.9	783.6	834.2	752.6	853.2	847.1
1990	1,912.2	1,636.6	389.6	1,929.1	1,612.0	1,728.3	1,484.2	1,972.2	1,696.0
1991	3,620.4	3,236.7	1,031.3	3,809.5	2,946.2	3,972.8	2,913.4	3,596.3	3,366.1
1992	9,276.4	6,968.0	2,683.3	10,839.2	9,813.8	9,436.3	6,749.2	9,129.4	8,480.2
1993	25,604.1	18,791.2	12,382.4	29,778.0	39,038.5	23,782.4	16,949.1	18,876.7	23,127.1

(1) Omitted; available data array these items @ 1975=100

Source: Consumer Price Index, Central Statistics Office, September 23, 1994

Table 3.8
CONSUMER PRICE INDEXES, LOW INCOME GROUP
(1975 Weights, 1985 = 100)

Year	Food, Beverages & Tobacco	Clothing & Footwear	Rent, Fuel & Lighting	Furniture & Household Goods	All Other Goods & Services	All Items
1984						(1)
1985	100.0	100.0	100.0	100.0	100.0	100.0
1986	149.8	153.4	130.1	204.2	162.2	154.0
1987	216.7	244.3	147.6	320.5	226.9	224.3
1988	342.9	417.0	209.4	397.2	333.7	346.9
1989	792.6	846.7	384.4	979.1	836.1	793.5
1990	1,666.3	1,839.0	841.2	1,911.2	1,915.4	1,674.4
1991	3,182.3	3,078.8	2,789.5	3,739.7	3,696.9	3,225.0
1992	10,133.1	6,446.6	5,662.7	12,703.6	7,932.9	9,560.6
1993	29,672.7	15,302.5	15,962.5	35,138.3	26,139.5	27,718.0

(1) Omitted, matching 1984 data was on a 1975=100 basis

Source: Consumer Price Index, Central Statistics Office, Sept 23, 1994

3.8 Motor Fuel Usage

The level of motor fuel use is generally a good indicator of economic activity, Table 3.9 shows motor fuel use by year for 1984 through 1992, with a partial figure for 1993. Data from 1989 through 1990 are reasonably firm, since they were taken from the *Energy Statistics Bulletin*. However, data for 1991 and 1992 are from a special computer run made for the Director of Energy and are suspect, because of the large increases in usage shown during these years (+39.5 percent, 1990 to 1991 and + 42.2 percent, 1991 to 1992). Further, the data for 1993 are incomplete because Mobil failed to report and only BP tonnage was included. Omitting data for year 1991 and 1992 as atypical, the seven-year average is 225,000 tons.

3.9 Annual Vehicle Registration

Between 1984 and 1993 a total of 58,192 new vehicles were registered in Zambia, plus 11,488 used vehicles imported from neighboring countries, total 69,640, an average of 6,964 vehicles per year. However, since vehicle registering and licensing are two completely separate functions in Zambia, only new registrations are shown here and there is no indication of how many older vehicles have been taken out of service.

In order to get the number of vehicles actually operating in the country, a record of vehicles licensed annually would be required. It appears that this is not available at any central location in Zambia. However, it is understood that every car is required to be covered with third party insurance and this information could possibly be obtained from the insurance companies involved. In any event, the total number of vehicles in use in Zambia is an important economic indicator and these data should be collected annually and published by some government agency.

3.10 Roads as an Economic Factor

The principal commercial means of transport in Zambia is railroad and road. Since access to the railroad is available only in the immediate area of the rail line and rail services are limited, the bulk of the inter-Zambia transport border burden falls upon highway.

There are 37,000 miles of Zambian roads of all classes, as indicated by the Minister of Communication and Transport, the Honorable W. Harrington, in an address delivered recently in Lusaka.[2] He stated that

[2] Address by Hon. W. Harrington to 9th RMI/RTTP Annual Coordinating Committee Meeting, Oct.18, 1994, Pamodzi Hotel, Lusaka.

Table 3.9
TRANSPORT USE OF FUEL
1984-93

Year	Gasoline		Diesel	Total	
	Premium	Regular		Overall	Motor Fuel Only (1)
	Tonnes				
1984	85,242	19,204	121,841	226,287	214,973 + 2.6% (2)
1985	79,514	19,966	132,736	232,216	220,605 - 1.8%
1986	76,454	17,155	134,349	227,958	216,560 + 7.0%
1987	87,622	18,050	134,259	243,941	231,744 - 3.9%
1988	93,040	10,277	131,125	234,442	222,720 + 3.6%
1989	80,414	14,948	147,503	242,865	230,722 + 3.1%
1990	81,801	18,016	150,526	250,343	237,826
1991	117,411 (3)	3,091	222,505	343,007	331,882
1992	231,915	5,634	246,584	484,133	471,804
1993	79,198	-	170,053	249,251	-

(1) Zambia Railroad use averages 5% of total.
(2) Percentage change from previous year.
(3) Por 1991-1992, the split between tonnages of premium and regular are inconsistent with previous years, but should not affect the motor fuel total.
(4) For 1993, Mobil did not report at all; only BP figures are shown.

Source: 1984-1990 from Energy Statistics Bulletin 1974-1990, Department of Energy, January, 1992, pp. 10-12. For 1991-1993 inclusive, computer run made by Director of Energy.

in 1990, the proportion of good roads had declined to 20 percent, down from 40 percent in 1987 and that more than US$400 million (or 17 percent) of the worth of the original road network of US$2.3 billion had been lost due to lack of maintenance. He also indicated that more than US$38 million annually would be required in maintenance funds, to prevent further roadway losses.

With all the other fiscal demands placed upon the government, the provision of such annual sums for road maintenance presents a major problem to the Zambian government. However, if the roads are not maintained, transport costs, and vehicle operating costs and travel time will inevitably rise and this will be reflected in commodity prices, with reduced economic growth resulting.

3.11 Corridor Development

The improved T2 corridor running south from Lusaka will serve as a magnet to attract future development, particularly the 15 kilometers of multilane which extends as far as Chilanga. Development has already reached Makeni, some four kilometers south of the city . It appears that development can now be expected as far as Chilanga, in the midterm. In the long-term, industrial and residential development should reach all the way to Kafue, which already has significant development, including a large fertilizer plant.

In short, the improved T2 running south out of Lusaka to Kafue should prove to be a potent attractor of new investment to the area. Development has already occurred in the corridor, more is underway and even more can be expected in the future.

3.12 Environmental Considerations

Since the proposed toll plaza would be placed along the right-of-way of T2, utilizing isolated land that is now lying idle, no ongoing activities would be disrupted. The only change between present operations along T2 and those which would be involved when the toll plaza opened is that there would be some increase in exhaust gas pollution in the plaza area as vehicles stopped to pay tolls. Since the proposed site is in a completely open area, this point pollution would be temporary as it would be dissipated by the wind. Toilet facilities required in the toll plaza would use septic tanks, the same as the weighbridge station presently does. In sum, the proposed toll plaza would cause little (if any) damage to the environment.

3.13 Government Development Plans

The intentions of the government with regard to development are of crucial importance to the nation's economic welfare. The best guide to those intentions is contained in the *Public Investment Program* (or PIP) for 1994-96.[3] For example, in 1993 the government set up a Social Sector Task Force to arrest deterioration, to improve infrastructure and to insure the delivery of social services. Particular attention was to be given to a monitoring implementation of public investment projects. The PIP states that the work of the task force resulted in improvements in the allocation and disbursement of funds to designated sectors. In turn, infrastructure rehabilitation and the delivery of social services also improved.

With regard to governmental cash flow, during the first half of 1993, the PIP reports that domestic revenue was above target by K6.1 billion and expenditure was over target by K4.0 billion. During the second half of the year, inflation and interest rates started down and the Kwacha appreciated.

In 1994, the government's main thrust will be towards achieving a reasonable economic growth, along with social sector rehabilitation. On the productive side, emphasis will be placed on the rehabilitation of trunk and feeder roads, security of food stocks, sustaining the resource base and generation of income and employment through encouraging the establishment of small scale industries. The mining sector will also be restructured, to enhance production and increase employment. The PIP is described as flexible, with changes in it to be contingent upon developments through 1996.

The PIP proposed K861,014.90 million in public investments during the period 1994-1996, of which K179,805.05 million (or 20.9 percent) was for transportation and communication.[4] Of this, K62,730.24 million (or 34.9 percent) was for work on eight roads.[5] The exchange rate used in the calculations was ZMK/US$=575.

[3] Republic of Zambia, Public Investment Program, 1994-1996, Office of the President National Committee for Development Planning, March 1994, p.1

[4] Ibid., Table I.1

[5] Ibid., Table III - 5

It might appear from the foregoing coverage of the current Zambian economic situation that future prospects are not bright. However, the government has already taken action to speed economic recovery and is well into their remedial program. Further there are other reasons why future improvement can be expected:

- Overall, the world economy is improving;
- The bulk of Zambia's current economic problems result from the actions (or inaction) of the government over several decades;
- Economic reforms initiated by the new administration to deal with those problems have already reduced the inflation rate but will require time to become fully effective;
- The damping down of wars in Mozambique and Angola should increase Zambian trade with those countries;
- Increases in worldwide copper consumption, particularly in the manufacture of automobiles in developed countries, will result in the availability of the additional foreign exchange which is needed for development;
- The privatization of parastatal companies will increase their effectiveness and increase the tax base;
- Subsidies paid to parastatals will be eliminated as they are privatized, leaving more tax monies available for other uses; and
- Land reform and the privatization of agriculture should increase output in the economic sector in which most Zambians work.

As a result of the above, it is expected that the performance of the Zambian economy will improve significantly over the next few years and that the economic indicators which have been reviewed earlier will reflect that improvement.

4.0 TRAFFIC AND TOLL REVENUE FORECASTS

This section deals with traffic growth at the Kafue Road Bridge area, traffic projections, toll development and projection of toll revenues.

4.1 Traffic Growth by Vehicle Class

Table 4.1 (shown previously as Table 2.1) lists the results of traffic counts made at Traffic Point 66A (which is located near the Kafue Weighbridge) for the year 1983 through 1993, plus two counts made in 1994, the latest in October. This table indicates that the percentage increases in the number of vehicle by class between the year 1993 and October 1994 were:

Light vehicles	6.9
Buses	3.6
Single bed trucks	(3.5)
Heavy trucks	12.3

The increase in the percentage of heavy (articulated) trucks is particularly important because of the heightened cargo capacity which results. For example, an average loading for a rigid truck might be 10 tons, increased to 15 tons if it is pulling a trailer. In contrast, the average loading of an articulated truck might be 35 tons, or 3.5 times the average loading of a rigid truck without trailer. This capacity increase is significant. Fewer vehicles are doing more work and this might not be reflected by a normal traffic count.

4.2 Future Traffic Estimates (1999, 2004, 2014)

The Kafue-Lusaka Road is unique among South African trunk roads because of its connector role, i.e. it connects four major trunk roads south of Lusaka with three trunk roads running north out of the city. Roads from the south include: Cape Town/Port Elizabeth-Livingstone-Lusaka; Walvis Bay-Livingstone-Lusaka; Durban-Bulawayo-Livingstone-Lusaka; and Beira-Harare-Lusaka. Trunk roads connecting Lusaka to the north include: Lusaka-Llongwe-Dar Es Salaam; Lusaka-Kapiri Mposhi-Lubumbashi, and Lusaka-Maputo. The roads involved are depicted on Figure 4.1.

This unique connector role of the Kafue-Lusaka Road ensures that a good portion of the traffic on it is regional in character and its volume is affected by changing conditions in the countries of southern Africa, Botswana, Namibia, Zimbabwe, Angola, Malawi, Mozambique, Tanzania, Zaire, Uganda and Kenya. An example of one of these changes is a predicted shift from rail to truck if high rated goods, as

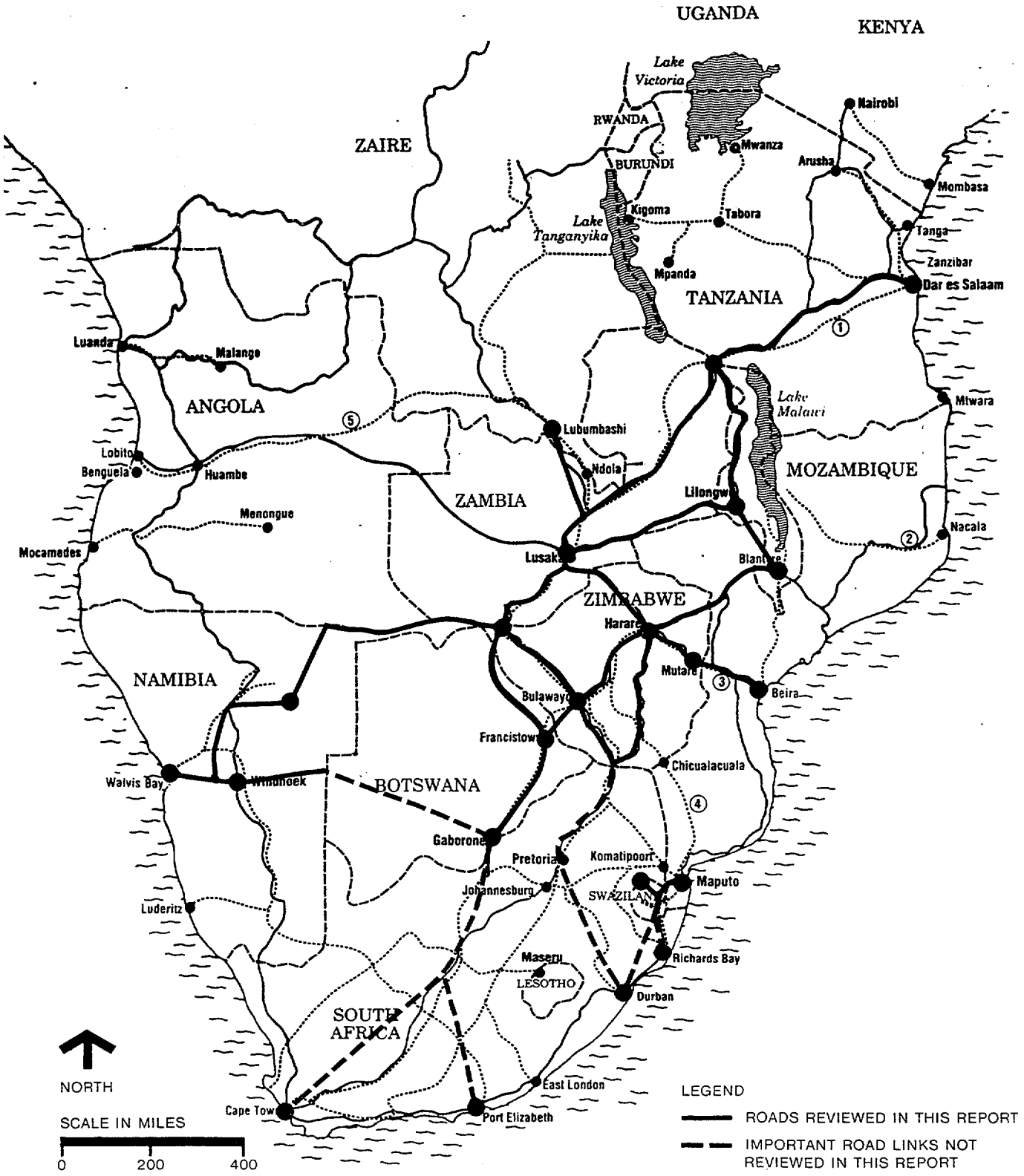
Table 4.1
ANNUAL TRAFFIC TRENDS AT KAFUE WEIGHBRIDGE (66-A)
Kafue River Bridge Toll/Weighbridge Feasibility Study

Year	Light Vehicles	Buses	Single Bed Trucks	Heavy Trucks	Total	Percent	
						All Heavy Trucks	Very Heavy Trucks
1983	554	27	295	57	933	38	6
Percent Change	36.5	3.7	(5.4)	3.5	20.1	(21.1)	(16.7)
1984	756	28	279	59	1122	30	5
Percent Change	(21.3)	(17.9)	(1.1)	11.9	(14.4)	20.0	40.0
1985	595	23	276	66	960	36	7
Percent Change	6.7	65.2	2.2	(9.1)	5.7	0.0	(14.3)
1986	635	38	282	60	1015	36	6
Percent Change	(20.2)	(23.7)	(43.6)	66.7	(21.7)	(8.3)	116.7
1987	507	29	159	100	795	33	13
Percent Change	55.0	(55.2)	52.8	61.0	51.3	6.1	0.0
1988	786	13	243	161	1203	35	13
Percent Change	(24.9)	55.2	(28.8)	(19.9)	(24.3)	0.0	0.0
1989	590	19	173	129	911	35	13
Percent Change	25.8	42.1	33.5	55.8	31.7	(37.1)	30.8
1990	742	27	231	201	1200	22	17
Percent Change	(1.9)	11.1	(6.1)	0.5	(1.9)	(4.5)	0.0
1991	728	30	217	202	1177	21	17
Percent Change	12.1	33.3	21.2	(5.4)	11.3	81.0	(11.8)
1992 (1)	816	40	263	191	1310	38	15
Percent Change	(14.8)	(17.5)	(3.0)	(23.6)	(13.8)	(5.3)	(13.3)
1993 (2)	695	33	255	146	1129	36	13
Percent Change	14.2	6.1	(20.0)	(0.1)	4.3	(16.7)	(7.7)
1994 (3)	794	35	204	145	1178	30	12
Percent Change	44.8	14.3	(2.0)	41.4	35.4	(16.7)	8.3
1994 (4)	1150	40	200	205	1595	25	13
Average Annual Percent Change							
19 83 - May 1994	3.3	2.4	(3.3)	8.9	2.1	---	---
1983 - October 1994	6.9	3.6	(3.5)	12.3	5.0	---	---

Source: Roads Department Annual Report, Supplemented

(1) March and July counts conducted by Howard Humphreys-John Burrow Joint Venture - Zambia First Road Project, August 1993
(2) May 1993 by Roads Department
(3) May 1994 by Roads Department
(4) Field surveys conducted by Morrison Knudsen Corporation in association with Wilbur Smith Associates, October 1994

Figure 4.1
SADCC AREA - PRIMARY ROAD SYSTEMS



Source: SADCC

53

area roads are improved[1]. If this trend develops as predicted, it will leave the railroad with low value, low rated cargo. However, continuing investment in infrastructure, rolling stock and training may improve rail transit times and tend to frustrate this trend.

In addition to regional traffic, the Kafue-Lusaka Road also carries a significant portion of the local traffic. Examples include industrial and residential traffic from the suburb of Makeni South of Lusaka and residential and industrial traffic from farm settlements located west of the Blue Boar turnoff. In fact, Lusaka is expanding south and will probably reach at least to Chilanga. There is also residential and industrial traffic from Kafue City.

However, this study focuses on the Kafue River Bridge, which is located at the southern end of the Kafue-Lusaka Road, and much of the local traffic indicated above does not presently appear in traffic crossing the bridge.

In evaluating a stream of traffic, it is usual to consider its normal, diverted, and generated components. Normal traffic changes result from changes in population, income, production, etc. Kafue Bridge traffic would include this type of traffic. Diverted traffic is that which switches from one road to an improved road, due to the advantages offered by the latter. Since there is no alternative to using the Kafue Bridge, there is no diverted traffic.

Generated traffic develops when a road improvement results in increased economic activity as it reduces travel time, costs and increases accessibility. Since the road crossing the bridge has been paved for a number of years and a bridge has similarly been in place at the site, it would be improper to include generated traffic in any forecast of traffic on the Kafue River Bridge. Considering that the Kafue-Lusaka Road is a funnel which connects seven trunk roads in southern Africa, it is apparent that the traffic from these roads would include traffic representatives of the area, plus others. For example, a much quoted study[2] estimated that 74 percent of the traffic on the Kafue-Lusaka Road was international (with an origin or destination outside of Zambia) and that nine percent was in transit (passing through), with neither origin nor destination in Zambian.

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[1] SADCC Transportation Investment Priority Assessment, Vol. I, Main Report and Appendix A, prepared by Deleuw Cather International, et al, August 1991, p.44.

[2] Investigations and Documentation Study for Initiating Rehabilitation of Major Roads in Zambia, Final Economic Report, prepared by Kampsax/Carl Bro., November 1985.

The same Kampsax/Carl Bro. study projected a traffic growth rate of 2.5 percent per year for the overall Zambian trunk road network, after considering traffic data from historical references and from surveys made during the course of the study on four major truck roads. One of these included the Kafue-Lusaka Road. This 2.5 percent overall growth rate has been adopted by several subsequent studies.

However, Section 3 outlines a series of events in Zambia and elsewhere which have already occurred, are presently in progress, or are planned, which should lead to increased Zambian economic activity. As this occurs, it will be reflected in traffic increases on T2 in the Kafue Road Bridge area, because of the unique role the road plays as a connector between four trunk roads south of Lusaka and three north of Lusaka. Further, as stated earlier, the overall increase in traffic at Traffic Point 66A in the vicinity of the Kafue Weighbridge was 5.0 percent between 1983 and October 1994. Accordingly, an overall 3.0 percent annual growth rate was projected for T2 in the Kafue Road Bridge area, for 1995-1999 inclusive and 3.5 percent through 2014.

Existing and projected future traffic volumes by the general vehicle categories are shown in Table 4.2. Projections are shown at 5, 10, and 20 years levels. These estimates are based on the items discussed in Section 4.2 and are seen as conservative.

As shown, an average annual growth of 3 percent is projected during the period 1994-1999, translating to an increase in total traffic to 1,850 vehicles per day. Projected average traffic volumes are projected to increase to 2,205 vehicles per day by year 2004 and to 3,160 vehicles per day by year 2014.

4.3 Toll Rates on Other Facilities

Toll rate structures on various toll facilities including those in South Africa and in the United States were reviewed. Toll rate structures for a selected number of facilities are shown in Table 4.3, 4.4 and 4.5. As shown in Table 4.3, the average per kilometer toll rate on the Kroonvaal, North Coast, and Highveld/Midland Toll Roads in South Africa include : 0.121 Rands for light vehicles; 0.223 Rands for heavy-medium vehicles; 0.269 Rands for heavy-large vehicles; and 0.345 Rands for heavy extra-large vehicles.

For extra-large heavy vehicles, the equivalent of semitrailer and articulated trucks, the 168.2 kilometer trip on the Kroonvaal Toll Road would be charged a toll of 41 Rand, or approximately $11.18, and 65 Rand or approximately $17.73, for the 150 kilometer trip on the Highveld Toll Road.

Table 4.2
FUTURE AVERAGE DAILY TRAFFIC VOLUMES
Kafue River Bridge, Zambia

Type Vehicle	1994	Average Annual Percent Change	1999	Average Annual Percent Change	2004	Average Annual Percent Change	2014	Average Annual Percent Change 1994 - 2014
Light Vehicle (1)	1,150	3.5	1,365	4.0	1,660	4.0	2,460	3.9
Bus	40	1.0	40	1.0	45	1.0	50	1.1
Single Bed Truck (2)	200	0.0	200	0.5	205	0.5	215	0.4
Heavy Truck (3)	205	3.5	245	4.0	295	4.0	435	3.8
TOTAL	1,595	3.0	1,850	3.6	2,205	3.7	3,160	3.5

(1) Light vehicles include passenger cars, vans, pickup trucks, minibuses
(2) Single bed trucks include two and three axle single bed trucks.
(3) Heavy trucks include semi trailer and articulated trucks

Note: Traffic volumes are rounded to nearest five vehicles per day.

Table 4.3
TOLL STRUCTURE FOR SELECTED
South African Toll Facilities

Toll Road	Kroonval		North Coast			Highveld/Midland		
Toll Plaza	Kroonval	Grasmere	Tongaat	Mvoti	Mtunzini	Mooi River	Tugela	Wilge
Toll Road Length (kilometers)	124.4	43.8	19.5	27	34	94.3	52.8	97.2
	Toll Tariff (SA Rands)							
Class 1	15.00	4.30	2.50	3.20	1.70	7.00	12.00	14.00
Class 2	20.00	8.00	3.70	7.50	2.30	23.50	22.00	23.00
Class 3	23.00	9.50	5.50	10.00	3.50	29.00	27.00	25.00
Class 4	27.00	14.00	9.00	15.00	6.00	34.00	33.00	32.00
	Toll Rate (SA Rands per kilometer)							
Class 1	0.121	0.098	0.128	0.119	0.050	0.074	0.246	0.144
Class 2	0.161	0.183	0.190	0.278	0.068	0.249	0.417	0.237
Class 3	0.185	0.217	0.282	0.370	0.103	0.307	0.511	0.257
Class 4	0.217	0.320	0.461	0.555	0.176	0.361	0.625	0.329

Note: **Class 1 - 2 and more axled light vehicles**
Class 2 - 2 axled heavy (medium) vehicles
Class 3 - 3 and 4 axled heavy (large) vehicles
Class 4 - 5 and more axled heavy (extra large) vehicles

Table 4.4
COMPARATIVE TOLL RATE STRUCTURE
Selected U.S. Toll Roads

Toll Facility	Passenger Car Toll Rate		Five-axle Truck Toll Rate	
	Full Length Trip	Per Kilometer	Full Length Trip	Per Kilometer
	$	$	$	$
New Jersey Turnpike	4.60	0.063	18.20	0.249
Pennsylvania Turnpike	14.70	0.066	55.50	0.257
Florida Turnpike	9.95	0.060	25.90	0.158
Massachusetts Turnpike	4.70	0.061	15.15	0.198
Tri-State Tollway Illinois	2.40	0.050	7.50	0.157

Table 4.5
COMPARATIVE TOLL RATE STRUCTURES
Selected U.S. Toll Bridges

Toll Facility	Passenger Car	Truck		Bus
		Minimum	Maximum	
	$	$	$	$
George Washington Bridge (1)	4.00	8.00	24.00	3.00
Golden Gate Bridge	3.00	3.00 (per axle)	3.00 (per axle)	3.00
Triborough Bridge	3.00	6.00	20.00	6.00
Verrazano-Narrows (1)	6.00	10.00	36.00	10.00

(1) One-way, round trip toll.

4.4 Toll Rate Structure

A simplified toll structure was developed on the basis of economic considerations, relative vehicle axle loadings, and the distribution of traffic by vehicle type. Consideration was also given to toll rate structures on other toll facilities throughout the world, particularly South Africa. A simplified toll rate structure, vehicle classification system and discreet toll rate levels corresponding to readily available currency denominations, along with the toll collection procedures outlined in Section 5, will facilitate the safe and efficient movement of traffic through the minimization of toll transaction times.

Toll rates on a per kilometer were developed with a relative index of 1.0 for light vehicles, 2.0 for buses, 3.5 for single bed trucks, and 5.0 for heavy trucks in an attempt to reflect the relative damage to pavement attributable to each vehicle category. The per kilometer toll rates by vehicle class were in turn, factored to the average trip length within Zambia for each vehicle class of traffic crossing the Kafue River Bridge. From data derived from the motorists survey, average trip lengths included 230 kilometers for light vehicles, 286 kilometers for buses, 250 kilometers for single bed trucks,and 362 kilometers for heavy trucks. Consideration was also given to border crossing tolls and origin destination pattern derived from the motorist surveys. Based on these considerations the toll rate structure which is seen as reasonable for Zambian conditions is shown in Table 4.6.

Table 4.6
TOLLRATE SCHEDULE
Kafue River Bridge, Zambia

Vehicle Type	Two-Way Collection Toll Rate (K)	One-Way Roundtrip Toll Rate (K)
Light Vehicle	500	1,000
Bus	1,000	2,000
Single Bed Truck	1,750	3,500
Heavy Truck	2,500	5,000

4.5 Base Year Transactions and Toll Revenues

Base year 1994 toll transactions and revenues for three alternative toll rate structures are shown in Table 4.7. The alternative rate structures are footnoted within data base year 1994 annual transactions at 582,175 vehicles, translating to toll revenue of K539.9 million for rate A, K269.7 million for rate B, and K215.8 million for rate C.

Table 4.7
BASE YEAR 1994 TRANSACTIONS AND TOLL REVENUE AT ALTERNATIVE TOLL RATE STRUCTURE
Kafue River Bridge, Zambia

Type of Vehicle	Base Year Annual Transactions(5)	Annual Revenue At Alternative Toll Rates (6)		
		A	B	C
		(Million Kwacha)		
Light Vehicle (1)	419,750	209.9	105.0	84.0
Bus	14,600	14.6	7.3	5.8
Single Bed Truck (2)	73,000	127.8	63.9	51.1
Heavy Truck (3)	74,825	187.1	93.5	74.9
TOTAL	582,175	539.4	269.7	215.8

(1) Light vehicles include passenger cars, vans, pick-up trucks, and minibuses
(2) Includes 2 and 3 axle single bed trucks
(3) Heavy trucks include semitrailer and articulated trucks
(4) Based on 1994 vehicle classification counts
(5) Two-way transaction
(6) Alternative toll rate structures include the following:

Rate A - 500K, light vehicles; 1000K, buses; 1750K, single bed trucks; 2500K, heavy trucks.

Rate B - 250K, light vehicles; 500K, buses; 875K, single bed trucks; 1250K, heavy trucks.

Rate C - 200K, Light Vehicles; 400K, Buses; 700K, Single Bed Trucks; 1000K, Heavy Trucks.

4.6 Projected Toll Revenues

Projected annual toll revenues at toll rate structure A are shown in Table 4.8. In the assumed first year of operation (1995), toll transactions are estimated at 599,702 vehicles, yielding a toll revenue of K553.6 million. By 1999, toll revenues are projected at K614.5 million. In year 2014, revenues are projected at K1,002.3 million, reflecting an average annual increase of approximately 3.2 percent.

Table 4.8
PROJECTED TOLL TRANSACTIONS AND REVENUE
Kafue River Bridge, Zambia

Year	Annual Transactions (1)	Annual Revenue (2) (Million Kwacha)
1995	599,702	553.6
1996	617,756	568.2
1997	636,356	583.3
1998	655,515	597.7
1999	675,250	614.5
2000	699,378	634.3
2001	724,368	654.7
2002	750,251	675.8
2003	777,059	697.5
2004	804,825	719.9
2005	834,314	744.1
2006	864,882	768.2
2007	896,572	795.1
2008	929,422	821.8
2009	963,476	849.5
2010	998,777	878.1
2011	1,035,372	907.6
2012	1,073,308	930.1
2013	1,112,633	969.7
2014	1,153,400	1002.3

(1) Two-way transaction

(2) Toll rate schedule A: light vehicles @500K; buses @ 1,000K; single bed trucks @ 1,750K; heavy trucks @ 2,500K.

5.0 TOLL IMPLEMENTATION

This chapter examines Zambian statutes regarding the establishment of toll facilities, reviews past efforts in establishing toll/weighbridge operations, and lists the requirements for establishing a toll plaza, including costs. It also touches upon the possible privatization of the toll plaza and develops a break-even analysis of the toll plaza project.

5.1 Toll Statutes and Past Zambian Toll/Weighbridge Operations

5.1.1 Road Toll Operations

There are three regulations on file in the Library of the Ministry of Legal Affairs, having to do with toll systems and collecting. The first, the Tolls Act of 1983, was enacted is April 15, 1983 and authorized the following:

- Establishment of a Tolls Board;
- Definition of the Board's functions and powers;
- Provision for the charging and collection of toll charges;
- Provision for the charging and collection of entry fees in respect to certain vehicles entering Zambia;
- Provision for a procedure for the purchase of fuel and lubricants with respect to heavy goods vehicles not registered in Zambia; and
- Provision for handling matters connected to or incidental to the foregoing.

The Toll Board was to consist of the Minister responsible for finance (who would be the Chairman of the Board), the Ministers responsible for transport, works and home affairs, the Controller of Customs and Excise, the Road Traffic Commissioner, and two other members appointed by the minister. Members of the Board were to elect a Vice Chairman and the Board was to appoint a Director, a Chief Executive Officer, and Deputy Director as his assistant. A secretary and other staff were also to be appointed.

Section 17, Part IV of the act authorized the Board to operate toll points on any road, bridges, pontoon or other place. A tolls tariff was also set out in Part I of the schedule, as follows in Table 5.1.

Table 5.1
TOLLS TARIFF

Type of Vehicle	K
Passenger Car	0.60
Taxis	0.50
Mini-Buses (Private)	1.20
Mini-Buses (Public	1.00
Heavy Buses (Private)	1.50
Heavy Lorries with two axles	1.50
Heavy Lorries with three axles	2.00
Heavy Lorries with trailers	3.00

Part II of the schedule stated that the entry fee (into Zambia) would be the equivalent (in a currency prescribed by the Minister) of K100, calculated at the prevailing rate of exchange.

Information regarding attempts to initiate the tolls portion of the act is sketchy. Inquiries at Roads Department, Road Traffic Commissioner, and Ministry of Legal Affairs indicated that a toll collection scheme was initiated in 1983. Toll buildings were constructed on both sides of the road at numerous sites, with steel-pipe gates which could swing together to block the road. When the intention to collect tolls was announced, the hue and cry raised was such that the Board backed down. Whether any tolls were ever collected or not is moot. The scheme was abandoned and the toll houses and gates were torn down and the materials removed except for the two which are still in use at the Police Check Point just north of the Kafue Weighbridge.

The entry fee aspect of the Tolls Act of 1983 was implemented and is still in effect. Entry fees are collected by customs on non-Zambian vehicles at Zambian borders and are deposited in Bank of Zambia Account No. 577, which is earmarked for road maintenance, the same as fines assessed by the weighbridge operators on overweight vehicles. The latest circular on these charges (which are collected in US$) is Customs and Excise Circular No. 20, 26 July 1994, "P.T.A Toll fees". The heading of the circular is "Zambia Revenue Authority".

The Tolls Act of 1983 was amended by Statutory Instrument No. 129 of 1983, dated September 16, 1983, which required that the purchase of fuel and lubricants for non-Zambian vehicles be made only from an appointed dealer, in currencies designated by the Board of Market Prices. Subsidies or rebates in effect for a particular type of user (such as for farming) would not be applicable to such buyers.

The Tolls Act of 1983 was again amended by Act No. 2 of April 22, 1988 which required that all non-Zambian vehicles entering the country pay an entry fee, including Zambian vehicles with dual registration numbers. Act No. 2 also repealed Part II of the schedule to the Tolls Act of 1983 (which provided for an entry fee of K100 in a currency prescribed by the Minister and calculated at the prevailing rate of exchange. The new entry fee was set at US$60 or as prescribed by the Minister. In the case of heavy goods vehicles in transit through Zambia to another country, the entry fee would be prescribed by the Minister. In any case, the fee charged was not to be less than the country involved charged Zambia for entry of a like vehicle.

With reciprocal current entry fees at US$120 for goods vehicles for five neighboring countries (and per kilometer in Zambia rates for the rest) it is obvious that there probably have been additional changes to the Tolls Act of 1983. However, none is on file in the official repository, the Library of the Ministry of Legal Affairs. In any event, the Tolls Act of 1983 is the basic statute involved.

The heading of Customs and Excise Circular No. 20 of 26 July 1994 is "Zambia Revenue Authority," and this organization is obviously involved in the handling of road user tolls. It was established by Section 9, Part III of the Zambian Revenue Authority Act of 1993. The functions of the Governing Board of the Authority, as cited by Section II are:

- To assess, charge and collect all revenue due the Government under such laws as the Minister may, by statutory instrument, specify;
- To ensure that all revenue collected is, as soon as reasonably practicable, credited to the Treasury and in this regard sections 24 and 25 shall apply, with necessary modification; and
- Subject only to the laws specified under paragraph (a) to perform such other functions as the Minister may determine.

Section 24 provides for an annual audit by independent auditors, with fees paid by the Authority. Section 25 concerns reports to be submitted by the Governing Board. The Governing Board of the Authority consists of:

- The Permanent Secretary in the Ministry responsible for finance;
- The Permanent Secretary in the Ministry responsible for legal affairs;
- The Governor of the Banks of Zambia; and
- Three persons, each representing the Zambian Confederation of Chambers of Commerce and Industry, the Zambia Institute of

Certified Accountants and the Bankers Association of Zambia, plus two other members appointed by the Minister.

So, it appears that the entry fee provisions of the Tolls Act of 1983 (Part V) are still being implemented.

5.1.2 Privatization of Toll Operations

The procedures to be followed in privatizing a state owned enterprises are listed in Part IV of *The Privatization Act of 1992* of July 4, 1992 and are quite detailed. However, it is possible to achieve some of the benefits of privatization without major legislative changes. For example, as reported in Section 6.8 of this study, FEDHAUL (Federation of Zambian Road Hauliers) along with other associations and truck operators was instrumental in getting an ordinance passed in August 1994 which raised the fine on overweight trucks to K500 per kg of overload. They are presently involved in a scheme to substitute specially printed coupons for paying border road user tolls, to avoid leakage of toll monies and to make it more difficult for drivers who initially failed to pay a Zambian border toll to escape paying on their way out. This proposal has been accepted in principle by the Zambian government and would put FEDHAUL in the business of selling coupons in advance to haulers, with which they would later pay Zambian border tolls. This would effectively privatize the handling of toll monies at Customs Stations on the border and may later be reflected in a change to the Tolls Act, 1983.

It would appear that any broad scale privatization of the toll system (such as establishment of an internal road toll system) would at a minimum require a change in Section 17 (1), Part IV Toll Charges of the Tolls Act, 1983, which reads, "17.(1) The Board may on any road, bridge, pontoon or other place, operate toll points."

This should be changed to read as follows: "17.1 The board may in any road, bridge, pontoon or other place, operate toll points, or it may contract with private companies for such operation."

Section 17 (2) reads: "Any vehicle passing through a toll point shall pay the appropriate toll charge as set out in Part I of the Schedule." This should be changed to read as follows: "Any vehicle passing through a toll point shall pay the appropriate toll charge as set out in Part I of the Schedule. Tolls for facilities operated by contractors will be set by negotiation and separate tariffs published."

5.1.3 Weighbridge Operations

Roads Department personnel recalled that at least two weighbridges were in operation when Zambia was still a colony, but a regulation

which authorized the present eight-weighbridge system could not be located. A search made of the Index of Statutes at the library of the Ministry of Legal Affairs also failed to turn up such a necessary regulation. The Librarian checked with other libraries, to no avail.

Weighbridges are currently in operation at Nakonde, Mpika, Mwami, Kapiri Mposhi, Kafulufuta, Solwezi, Kafue and Livingstone. Only two (those at Kafue and Livingstone) stay open for 24 hours daily. The weighbridge operators report to the Roads Department.

5.2 Toll Plaza Requirements and Components

The identification of toll plaza requirements and components includes personnel and equipment needs and their functional relationship. Policies and procedures need to be established both administratively and operationally to assure the safe and efficient movement of traffic, the collection and deposit of cash toll revenues in a secure manner, and the accounting of toll revenue.

The assuring of safe and efficient movement of traffic derives from the proper design of the toll plaza from both a geometric and functional perspective. The actual toll plaza design and system specification is beyond the scope of this study. But an assumption inherent throughout this study is that should the tolling of the Kafue River Bridge come to fruitation, the toll facility will be properly designed and constructed. From a functional perspective, important elements include interrelated issues relative to toll collection procedures and toll lane capacity, one versus two-way toll collection, incorporation into weighbridge operations, and security.

5.2.1 Toll Collection Procedures

Minimizing toll transaction times and thereby optimizing toll lane capacity not only promotes the safe and efficient movement of traffic, but also minimizes toll plaza maintenance and operating costs, as well as construction costs. Because Zambia's currency is predominantly paper money and the few coins in circulation are of low monetary value, toll lanes will have to be manually attended. Other automating mechanisms such as AVI/ETTM are not presently appropriate; as additional toll roads and toll bridges are introduced, and as traffic increases throughout the country, AVI/ETTM may be appropriate in the future.

The facilitation of manual toll collection can be accomplished by means of a simplified toll rate structure and vehicle classification system, as well as a simplified recording system. The toll rate structure and

vehicle classification system identified in Section 4 of this report are designed with the intent to minimize toll transaction time.

In general, the fewer the number of vehicle classes, the easier it is to train toll collectors. Also, in tolling by vehicle type rather by weight of truck or number of passengers, toll transaction times, for the most part, are minimized. For example, tolling trucks by weight can subject toll collection to possible scale malfunctions and downtime. Scale downtime would negate the ability to collect tolls in the worst case, and at best still cause traffic delay with a back-up system. With regards to tolling buses on a passenger versus a vehicle basis, the latter is preferable. This preference is primarily based on the potential for collector fraud. Toll collection equipment can independently record and account for a vehicle type through pre- and post-classification systems. However, an independent and automated mechanism for recording the number of bus passengers, such as a video recording system would not be practical, even with sampling, and is not totally reliable at the accounting level. With this lack of accountability, a collector could collect for a full bus, record something less, and pocket the difference. In addition, tolling on a passenger basis would increase toll transaction time.

Another aspect of speeding transactions relates to the actual toll rate. With a flat toll rate per vehicle class set at discreet, readily available currency levels, the need for a toll collector to make change would be reduced. This, in turn would reduce overall transaction times.

A simplified toll collecting, transaction recording and accounting system is most appropriate for the Kafue River Bridge. However, even a simplified system still requires relatively sophisticated electronic toll collection equipment. In brief, the process would involve the detection and classification of a vehicle by a preclassifier which in turn would trigger a patron and collector fare indicator, requiring the toll collector only to collect the toll and make change, if necessary. As a backup to the preclassifier, the toll collector could still classify vehicles with a manual lane controller. This equipment would be located in the toll lane and toll booth. In addition a canopy would protect the toll collection area from the elements. Transaction data would then be transmitted to a Toll Plaza Computer located in a Toll Plaza Utility building. The utility building should be located near the toll plaza allowing visual monitoring of activities in the toll lane(s). The Toll Plaza Utility Building would house a supervisory office, a money counting room, a vault room for temporary storage of money and forms, locker areas, rest rooms, and a locked area for the plaza computer.

The supervisory office should be large enough for two desks, side chairs, file cabinets, and a video monitor on which supervisors can monitor transactions as they occur in all lanes. Windows should be

provided so that the supervisors can readily see exiting traffic at all lanes.

The money counting room should provide areas for the toll attendants to count money, complete forms including deposit slips, and provide for the secure storage of empty bank bags. The room also should contain two vaults; one for money and one for records. Vaults should be the type that require both a combination and a key to open. Doors should be provided in the wall above the vaults through which attendants will drop money bags and records into the vault. This room also should contain small safe-like boxes mounted on the wall for use by toll attendants to store their change funds when they are not working. These may be of a key lock type. The forms storage area should be large enough to provide storage for at least a three week supply. These items would be delivered to the toll plaza by courier. Locker areas should provide adequate facilities for toll attendants to change into and out of uniforms when going on and off duty. A separate area should house rest room facilities large enough to accommodate the personnel assigned to the plaza. It is extremely important that the area housing the plaza computer be secure. Toll collection personnel must not have keys to this area. Access to the area should be from outside the building and only toll maintenance personnel should have keys.

The toll plaza should be equipped with a standby generator. The purpose of this generator would be to provide power to toll booths and canopy lighting in case of failure of normal power. All toll collection equipment, plaza computer, and security lights in the utility building should function in emergencies from power supplied by this generator. The toll plaza should be equipped with an uninterruptible power supply (UPS). The UPS is a battery back-up to normal power and provides sufficient capacity for attached equipment to function for 30 minutes. The power supplied to both normal and emergency power should be routed through the UPS for line conditioning, to prevent power surges or deficiencies caused by "brownouts".

It should be noted that the toll plaza procedures and components defined herein are conceptual and preliminary in nature and are a basis for developing preliminary cost estimates. Should the project be implemented, a detailed system design should be accomplished, potentially subjecting the preliminary concept to change. However, the underlying premise of a toll collection system design for Zambia is that the system should be relatively simple and straightforward while being secure against theft at all levels. Also, for the purpose of preliminary cost estimates, assumptions were made relative to personnel requirements. At the relatively small scale of one toll/weighbridge, bureaucracy and administrative personnel should be kept at a minimum, but, at the sametime, there is a need to have in place proper checks and balances to assure the security of money collected. As additional toll/weighbridge and toll roads are added to the nation's

highway network, economies of scale would allow the required addition of upper-level administrative personnel.

As envisioned, the toll collection function would be a section at the Zambia Road Department and headed by a Toll Collection Manager (TCM). The TCM would report directly to the Deputy Director of the Roads Branch of the Ministry of Works and Supply and would be responsible for the development of all policies and procedures relating to the Toll Collection Section. These policies and procedures should include items such as: scheduling of workhours; method of handling transactions by toll attendants; handling of unusual occurrences; required forms and how to complete them; disciplinary actions for various offenders; what to do if equipment malfunctions; how to handle irate travellers; handling of emergency situations; and what to do in case of robbery. This list is not intended to be all inclusive, but only indicative of the type of TCM responsibilities. The TCM would also be responsible for the smooth operation of the Toll Collection Section, coordination between the depositing bank and the armed car service used for delivery of cash from the toll plazas to the depositing bank. He or she would ensure that training of new attendants is sufficient prior to placing them in toll lanes. The TCM would also set procedures for the delivery of supplies, forms, uniforms, etc. to the toll plaza.

A Toll Plaza Operations Supervisor (TPOS) would report directly to the TCM. The TPOS would train and supervise the Toll Collection Section's Courier and Toll Attendant. He would assure that the toll plaza operates according to established procedures. Of primary importance, the TPOS would supervise and monitor toll attendants.

The Toll Attendants (TA) would report directly to the TPOS. Typical procedures for a TA is: secure required supplies and forms; enter toll booth and log-on the system with an identification card; turn on the Lane Open signal; process traffic; upon ending shift of work, turn on the Lane Closed signal; log-off the system; take money and forms to utility building; count money; fill out deposit slip and place in money bag; deposit money bag in cash vault; deposit duplicate deposit slip in record vault; and complete shift.

The rest of the cash handling process would be as follows. The cash vault and record vault each would require a key and a combination to open. When the armed car service arrives, the TPOS unlocks the key lock and the armored car personnel unlock the combination. The money bags are then checked against the money bag receipt, with a copy retained at the toll plaza. The armored car then drives to the bank and delivers the bag to bank personnel. The armored car and bank personnel together check the bag numbers to the money bag report and the bank receipts for all bags delivered. The bank keeps a copy of the money bag report and the armored car personnel takes two copies, one to be retained for their record and one to be sent to Toll

Audit. The Toll Audit copy would be used to determine that all bags delivered to the bank were processed and that none were lost.

Bank personnel would then unlock bags and count money verifying and making any correction, by denomination. The teller counting the money, stamps both copies of the deposit slips with his or her identification. One copy is sent to the Toll Auditor and one copy is retained by the bank.

The Toll Auditor would be independent of the Toll Collection Manager and would report directly to the Deputy Director of the Roads Branch. The Toll Auditor would assure that audits would be completed in a timely manner and would notify the toll maintenance contractor of suspected malfunction of terminals, treadles, loops, or other items of toll collection equipment.

Under all circumstances, the toll maintenance personnel should be independent of toll plaza personnel, in order to avoid collusion relative to equipment malfunctions and toll theft. Typically toll maintenance personnel are outside contractors, and often are also equipment vendors.

5.2.2 Toll Lane Requirements

The estimation of toll lane requirements, were developed on the basis of existing 1994 and projected future traffic volumes for each vehicle class along with estimated toll transaction times for each vehicle class.

Examination of peak hour volumes, trip frequency, and overall trip length indicated that there is not a consistent pattern of peak periods affecting all vehicle classes. In order to be conservative, design hour volumes were developed separately for each vehicle class. For the base condition, design hour volumes as a percentage of ADT per vehicle class were calculated at 13 percent for light vehicles, 27 percent for buses, 16 percent for single bed trucks, and 14 percent for heavy trucks.

Transaction times for each vehicle class were estimated on the basis of results, from a previous recent study conducted by Wilbur Smith Associates of the South Massachusetts Turnpike Authority. For the purpose of this analysis, the higher end of the transaction rates recorded were used. Transaction rates used in this study included 13 seconds for light vehicles, 17 seconds for buses and single bed trucks and 46 seconds for heavy trucks. Even with this very conservative approach, only one toll lane per direction would be necessary. Future toll lane requirements based on traffic growth rates discussed in Section 4 indicate that one toll lane per direction would still suffice. However, in practice, an additional lane, i.e., two lanes per direction,

would be appropriate to allow for toll collector shift change, equipment malfunction or maintenance downtime, and surges in vehicle arrivals.

5.2.3 One-Way Versus Two-Way Toll Collection

One-way toll collection has been implemented on numerous river crossings in the United States. Example of facilities with one-way toll collection include the following:

- Hudson River crossings between New York and New Jersey, operated by the Port Authority of New York and New Jersey, including the George Washington Bridge and the Lincoln and Holland Tunnels;

- The Verrazano-Narrows Bridge connecting Brooklyn and Staten Island in New York City, operated by the Metropolitan Transportation Authority Bridges and Tunnels; and

- Nine bridges spanning the southern stretch of the Delaware and Southern New Jersey, operated by the Delaware River and Bay Authority; the Commodore Barry, Walt Whitman, Ben Franklin, and Betsy Ross Bridges, connecting Philadelphia, Pennsylvania with Southern New Jersey, operated by the Delaware River Port Authority; the Tacony-Palmyre, and the Burlington-Bristol Bridges, connecting Pennsylvania and New Jersey, operated by the Turnpike Authority and the Pennsylvania Turnpike Commission; and the Trenton Route 1 Bridge, operated by the Delaware River Joint Toll Bridge Commission.

This is not an all-inclusive list, but is intended to show the widespread use of one-way toll collection for river crossings.

The obvious benefits of one-way toll collection include improvement in overall traffic flow, reduction in toll collection maintenance and operating costs, and construction costs. The potential disadvantages include possible diversion of traffic and toll revenue in the tolled direction to nearby competitive river crossings with lower or no tolls while retaining or gaining traffic in the toll-free direction.

Typically, with the implementation of one-way toll collection the toll rate is twice that for two-way toll collection, thus retaining a so-called roundtrip toll. If a nearby competitive crossing does not implement a commensurate change relative to the cost of crossing the competitive facility, the doubling of tolls for one-way toll collection may be significant enough to tip the balance in overall trip cost and thus encouraging a motorist to divert even though the trip length and travel time is greater. If the competitive facility is operated by the same agency, traffic diversion, at least from a toll revenue perspective may

not be of concern, whereas traffic and bridge loading capacities may be the important issue.

The traffic and toll revenue diversion issue is exemplified by the conversion to one-way tolls on the nine previously cited Delaware River Bridges. With the nine bridges being operated by six different agencies with six different toll rate structures, there was a definite concern over potential toll revenue transfer from one toll agency to another. With the implementation of one-way tolls, toll rate structures were modified, after thorough analysis and evaluation, to ensure revenue transfers would not occur to any significant degree.

In the case of the Kafue River Bridge, there is no nearby competitive facility suitable to traffic; the Kafue River Bridge is the only bridge crossing the river between the Zimbabwe border to the east and a point approximately 300 kilometers upstream to the northwest on a road extending west out of Lusaka. All traffic relative to Lusaka and points north and west to and from southern Zambia, South Africa, Zimbabwe, Botswana, and Namibia must pass over the bridge. The alternatives for travel to countries to the north of Zambia are through Angola or Zimbabwe and Mozambique. With the lack of nearby competitive river crossings the potential disadvantage of traffic and toll revenue diversion with one-way tolls is not an issue.

The reduction in costs associated with one-way versus two-way toll collection primarily relates to the reduced need of toll lanes and corresponding toll collection equipment, toll booths, toll attendants, etc. Costs associated with toll collection administrative personnel, facilities, and equipment would only be marginally less.

5.2.4 Weighbridge Operations

The Kafue Weighbridge is located just south of the Kafue River Bridge and was implemented during 1989. The weighbridge operates 24 hours per day, with the exception of a 12-hour period from 0600 p.m. Sunday to 0600 a.m. Monday. The weighbridge is staffed by one Transport Machinery Overseer and one Assistant (handyman) per 12-hour shift.

Trucks carrying a load proceed to the scale. Empty trucks proceed through without stopping and being weighed. The drivers of vehicles overweight are issued a certificate and fined. In addition, the truck is detained until a fine is paid at the nearest police station. Until recently, overweight trucks were fined K500. On August 19, 1994 a significant increase in overweight vehicle fines was placed into effect under Statutory Instrument No. 103. This amendment to Regulation 13 calls for a fine of K500 per kilogram above weight limits.

Fines levied under this new regulation can be heavy. A three-day sampling of overweight vehicle reports during December 1993, before the regulation change, indicates the average overweight vehicle at the Kafue Weighbridge exceeded allowable limits by approximately 4,500 kilograms. Under the new regulation, these overweight vehicles, on average, would have had to pay a fine of approximately K2,225,000. This significant increase in overweight fines is reported to have had a dramatic effect on the percentage of overweight vehicles. An overseer at the Kafue Weighbridge stated in an interview on October 16, 1994 that prior to the change in regulation, approximately 80 percent of loaded trucks were overweight; after the regulation change the percentage of overweight trucks decreased to an estimated range of 2 to 5 percent. On October 18, an Overseer at Kapiri Mposhi stated that similar figures for his weighbridge were 80 percent before the regulation change and 12 percent after.

Drivers of legal weight trucks are issued a different type Certificate of Weight. The overseer at the weighbridge also keeps a record of certificates issued to legal weight trucks in a Weighbridge Record Sheet. These sheets are kept during the current year, but then are destroyed.

5.2.5 Integration of Toll and Weighbridge Operations

Toll collection and weighbridge operations should be integrated from an administrative and financial perspective but not from a primary function perspective.

With the significant increase of fines for overweight vehicles, the percentage of overweight trucks has declined. As this trend continues, revenues generated by overweight fines may decline to a level below the cost of weighbridge operations. Yet the need for weighbridge operations will continue as a very important requirement. Thus, it is important to tie weighbridge operations to the revenue generating toll operations at the bridge to assure weighbridge continuance.

The two operations should also be tied administratively to assure weighbridge operation continuity. Weighbridge operation should continue to be part of the Road Department with the weighbridge's Transport Machinery Overseers and assistants reporting to the Toll Collection Operations Supervisor. The weighbridge operations personnel would also have access to the toll plaza utility building facilities.

Functionally, the toll and weighbridge operations should be physically separated, allowing the separation of loaded trucks from the overall traffic stream and assuring the safe and efficient movement of traffic. Weighbridge forms, recording procedures, and accounting should continue in a similar manner. However, weighbridge records which

are currently maintained for a current year then destroyed should be entered into computer files and archives. These records contain important traffic information which could be used for future planning purposes.

5.2.6 Security

Police security is extremely important to the integrity of the toll/weighbridge operation. The police personnel assigned to the toll/weighbridge operation would provide traffic control, toll plaza security, theft investigation, and enforcement. To assure that police security is continuous and to ensure against budgetary cutbacks in police operations, the cost of police security operations should be covered by toll revenues. At least two armed police officers per 12-hour shift should be provided. In addition, the police should be equipped with some form of transport — a motorcycle at the minimum — in order to chase down non-paying motorists or thieves.

5.3 Implementation Costs

Preliminary planning-level detail and construction costs for the toll plaza and utility buildings were developed on the basis of costs for South African toll facilities. Construction of a small toll plaza (two lanes for one-way, four lanes for two-way) would fall in a range of 900,000 to 1,200,000 Rand per toll lane. At K180 per Rand, this translates to K162 - K216 million per toll lane.

Toll equipment costs on southern African toll roads are estimated at 200,000 to 300,000 Rand per toll lane, translating to K36 - K54 million per toll lane.

As discussed earlier, the deciding criteria for one-way versus two-way toll collection for the Kafue River Bridge should be based on cost. It is recommended that one-way northbound toll collection be implemented with the collection of a round-trip toll (doubling of one directional tolls). Based on one-way toll collection and the construction of two toll lanes and a utility building, implementation costs are estimated at K540 million.

5.4 Maintenance and Operating Costs

Maintenance and operating (M&O) costs to be covered by toll revenues include M&O costs for the toll plaza and utility building, toll collection equipment, the weighbridge, the Kafue River Bridge and the roadway sections of 134.5 kilometers for the Kafue-Chirundu and Kafue-Lusaka roads.

M&O costs for the toll plaza/utility building and toll collection equipment were also based on costs for Southern African toll facilities. Planning level costs are estimated at 200,000 to 300,000 Rand per toll lane. For one-way toll collection, this translates to K72 - K108 million. For this analysis, K108 million per year was used.

Maintenance and operating costs for the weighbridge are shown on Table 5.2. As indicated, these costs are approximately 4.2 million Kwacha per year based on costs incurred during 1993. Major costs include approximately K1.8 million for salaries, K0.9 million for stationery (forms), K0.8 million for radio operation, and K0.3 million for weighbridge calibration.

Annual maintenance and operating costs for the Kafue Road Bridge is estimated at approximately K0.5 million. These costs include guardrail repair, guardrail painting, illumination, bridgedeck cleaning and restriping, and landscaping. These costs are seen as applicable over the 20 year forecast period and are uninflated for purposes of this analysis. This is due to the newness of the bridge, the type of construction (including the weathering steel), and the climatic conditions (no freeze-thaw or salt water).

Annual maintenance and operating costs for the Kafue-Chirundu roadway, a length of approximately 134.5 kilometers, are shown in Table 5.3. These costs are comprised of routine maintenance and periodic resealing and shoulder work.

5.5 Privatization

Privatization is a relatively recent innovation in the financing, construction and operation of toll facilities in the United States. In Europe and in South Africa, this concept has been implemented for numerous years. Recent examples of privatization projects that are under construction include the S.R. 91 Express Lanes in southern California and the Dulles Greenway in northern Virginia. Other privatization projects in the states of Washington and South Carolina are currently in the planning and proposal stages respectively. In general privatization projects have emerged in areas lacking a traditional toll road authority and where limited state financial resources have been unable to implement important transportation improvements.

For the most part, toll facilities have been implemented through the establishment of a toll road authority or commission. Examples include the Illinois State Toll Highway Authority, the New Jersey Turnpike Authority, the Oklahoma Turnpike Authority, the Texas Turnpike Authority, and numerous others. In each case these entities are self-sustaining, quasi-public agencies receiving no federal subsidies. Their initial financing derived from the sale of revenue bonds which,

Table 5.2
ANNUAL OPERATING COST
Kafue Weighbridge

Type Cost	Kwacha
Salaries	1,791,816 (1)
Housing	56,706 (2)
Electricity	234,864 (3)
Calibration of Weighbridge	300,000
Water	— (4)
Stationery	911,900 (5)
Uniforms	55,000 (6)
Radio	800,360 (7)
Miscalleneous	12,000 (8)
TOTAL	**4,162,146**

(1) Two TS-7 Transport Machinery Operators @ K472548/Yr each 945,096
Two Assistants @ K423,360 each 846,720
Total Salaries K1,791,816

(2) Two three-room houses, rent free with charges at
6% of salaries (K945,096 x .06) K56,706

(3) Two houses @ K8,400 each x 12 201,600
Office, 1/3 of cost of bill for one house 33,264
Total Electricity K234,864

(4) Water, borehole and handpump no charge

(5) Stationery: Certificates of Weight for vehicles over limits
two pads per month @ K5,000 per
pad of 50 certificates 120,000
Certificates of Weight for vehicles within limit
1,055 sheets per month @ K50 each x 12 633,000
Weighbridge Record Sheets
1,055 per month x 4 (4 per page)
= 264 @ K50 each x 12 158,900
Total Stationary K911,900

(6) Shoes - K15,000; coveralls - K20,000; raincoats - K20,000
two sets for each Overseer; wears two years K55,000

(7) Radio K1.5m, 5 year life 300,000
Spares, incl. mikes, antennaes, etc. 500,000
Operating license 360
Batteries - none; uses office electricity 0
Total Radio K800,360

(8) Miscellaneous - pens, ballpoint pens, stamps, ink - K1000/mo K12,000

Table 5.3
ESTIMATED ROADWAY MAINTENANCE AND OPERATION COSTS
Lusaka to Chirundu - 1994 Costs
(Million Kwacha)

Year	Annual Total	Chilanga-Kafue(1)		Kafue Bridge-Chilanga (2)		Chilanga-Makeni(3)		Makeni-Lusaka (4)	
		Routine	Periodic	Routine	Period	Routine	Periodic	Routine	Periodic
1995	24.14	14.5		6.84		2.0		0.8	
1996	211.04	14.5	186.9	6.84		2.0		0.8	
1997	24.14	14.5		6.84		2.0		0.8	
1998	24.14	14.5		6.84		2.0		0.8	
1999	24.14	14.5		6.84		2.0		0.8	
2000	211.04	14.5	186.9	6.84		2.0		0.8	
2001	260.94	14.5		6.84	236.8	2.0		0.8	
2002	24.14	14.5		6.84		2.0		0.8	
2003	24.14	14.5		6.84		2.0		0.8	
2004	235.74	14.5		6.84		2.0	136.9	0.8	74.7
2005	24.14	14.5		6.84		2.0		0.8	
2006	211.4	14.5	186.9	6.84		2.0		0.8	
2007	24.14	14.5		6.84		2.0		0.8	
2008	24.14	14.5		6.84		2.0		0.8	
2009	24.14	14.5		6.84		2.0		0.8	
2010	24.14	14.5		6.84		2.0		0.8	
2011	260.94	14.5		6.84	236.8	2.0		0.8	
2012	211.04	14.5	186.9	6.84		2.0		0.8	
2013	24.14	14.5		6.84		2.0		0.8	
2014	235.74	14.5		6.84		2.0	136.9	0.8	74.7
2015	24.14	14.5		6.84		2.0		0.8	

(1) Length (Km) 81.5
(2) Length (Km) 38.0
(3) Length (Km) 11.0
(4) Length (Km) 4.0
134.5

Source: W. Nyrop, Sheladia Associates, Inc., November 6, 1994

in turn, were supported by projected future toll revenues. In some cases, excess revenues have gone on to support other transportation projects. For example, excess revenues generated by the New Jersey Turnpike Authority are allocated to the New Jersey Department of Transportation. Excess revenues generated by the Metropolitan Transportation Authority (MTA) Bridges and Tunnels in New York City (formerly the Triborough Bridge and Tunnel Authority) are allocated as a subsidy to the various mass transit agencies under the MTA.

In general, these toll road authorities attempt to minimize their staff levels through the use of private sector contractors (or in the case of security, the state police), with the bulk of authority employees being involved in toll collection and routine roadway maintenance. A recently formed toll road authority, the Transportation Corridor Agencies in southern California, has further streamlined its operation by contracting toll collection to the private sector and routine roadway maintenance to Caltrans. However, regardless of the extent of in-house versus private sector involvement in toll facility operations, it is still extremely important to have at least some minimum level of personnel that are employed by a toll road authority or governmental entity, in order to have the proper checks and balances amongst themselves and with private sector contractors. At the minimum the toll road authority should have a Board of Directors, an Executive Director, and directors of various divisions including finance and accounting, toll collection, engineering, security, and management services.

Such an authority is not appropriate for the Kafue River toll/weighbridge as a stand alone facility but more appropriate to a nationwide system of toll weighbridges. It is understood that the Ministry of Communication and Transport is initiating a process to revamp the country's highway management, operations, and maintenance program. The implementation of a Road Authority may result from that process. However, if tolls are implemented at the Kafue River Bridge prior to reorganization, the facility should come under the purview of the Road Department Director as the individual accountable for operations and moneys collected. The simple toll organization structure previously discussed could potentially be privatized below the Toll Collection Manager and Toll Auditor slots. However, with little or no local experience in the toll collection business, privatization, at least initially would have to come from the outside. The scale of operations of the Kafue River Bridge and the typical desire for a long-term franchise may inhibit the interest of privatization firms. At they very least, a private sector firm should be contracted by the Road Department to establish a toll collection weighbridge operation at the Kafue River Bridge and be retained long enough to train personnel and oversee the toll collection operation. A

selected list of private sector firms involved in toll privatization is as follows:

Mr. Peter J. Erasmus
Toll Road Concessionaires (Pty) Ltd
P. O. Box 1336
Bedfordview, Transvaal 2008
South Africa

Mr. Gerald S. Pfeffer
California Private Transportation Company, L.P.
180 North Riverview Drive
Suite 290
Anaheim, CA 92808

Mr. Ian S. Madden
Managing Director
Toll Highway Development Co. (Pty) Ltd
P. O. Box 751149
Gardenview, 2047
South Africa

Mr. Richard Patterson
Alliance Development Company
2421 Westport Parkway
Suite 200
Fort Worth, TX 76177

Mr. Alain Estiot
Cotiroute Corporation
11060 Sunset Boulevard
Los Angeles, CA 90049

Mr. Robert Garin
c/o CTV, 1230 Columbia Street
San Diego, CA 92101

Mr. Marc Zuppi
Autostrade International SpA
Via Bergamini, 50
00159 Rome, Italy

Mr. Thomas R. Lammers
Bechtel Corporation
P. O. Box 193983
San Francisco, CA 94119

5.6 Break Even Analysis

A break-even analysis was conducted at three toll structure rates. These rate structures reflect one-way, roundtrip tolls and are shown in Table 5.4.

Table 5.4
Alternative Toll Rate Structures[1]
One-Way, Roundtrip
Kafue River Bridge, Zambia

Vehicle Type	Rate A (K)	Rate B (K)	Rate C (K)
Light Vehicle	1,000	500	400
Bus	2,000	1,000	800
Single Bed Truck	3,500	1,750	1,400
Heavy Truck	5,000	2,500	2,000

[1] Rate for one-way toll collection reflect doubling of single direction tolls for round trip.

Under each case, annual maintenance and operating costs associated with the toll plaza/utility building, the weighbridge, and bridge, as well as costs associated with the Kafue-Chirundu and Kafue-Lusaka roadway sections are considered.

The break-even year is measured against the construction cost of the toll plaza/utility building along with the toll collection equipment costs. The estimated implementation cost is K540 million. As shown, in Table 5.5, the break-even year for Toll Rate A is 1996. The break-even years for Toll Rates B and C are shown in Tables 5.6 and 5.7, are 2002 and 2007, respectively.

Table 5.5
BREAK EVEN ANALYSIS TOLL RATE A
Kafue River Bridge Toll/Weighbridge Feasibility Study
(1994 Kwaches)

Year	Annual Revenue	Annual Costs			Toll Plaza Net Revenue	Roadway Maintenance	Total Net Revenue	Accumulative Net Revenue	Toll Plaza Construction Cost
		M&O	Opns.	Maint.					
		Toll Plaza	Weigh Station	Bridge		Lusaka - Chirundu (1)			
	(Million Kwacha)								
1995	539.3	108.0	4.2	0.5	426.6	24.1	402.5	402.5	540.0
1996	553.6	108.0	4.2	0.5	440.8	211.0	229.8	632.3	
1997	568.2	108.0	4.2	0.5	455.5	24.1	431.4	1,063.8	
1998	583.3	108.0	4.2	0.5	470.6	24.1	446.5	1,510.2	
1999	598.7	108.0	4.2	0.5	486.0	24.1	461.8	1,972.1	
2000	614.5	108.0	4.2	0.5	501.8	211.0	290.8	2,262.9	
2001	634.3	108.0	4.2	0.5	521.6	260.9	260.7	2,523.5	
2002	654.7	108.0	4.2	0.5	541.9	24.1	517.8	3,041.4	
2003	675.8	108.0	4.2	0.5	563.1	24.1	538.9	3,580.3	
2004	697.5	108.0	4.2	0.5	584.8	235.7	349.1	3,929.4	
2005	719.9	108.0	4.2	0.5	607.2	24.1	583.1	4,512.5	
2006	744.1	108.0	4.2	0.5	631.4	211.0	420.4	4,932.8	
2007	768.2	108.0	4.2	0.5	655.4	24.1	631.3	5,564.2	
2008	795.1	108.0	4.2	0.5	682.3	24.1	658.2	6,222.5	
2009	821.8	108.0	4.2	0.5	709.1	24.1	685.0	6,907.5	
2010	849.5	108.0	4.2	0.5	736.8	24.1	712.7	7,620.1	
2011	878.1	108.0	4.2	0.5	765.3	260.9	504.4	8,124.5	
2012	907.6	108.0	4.2	0.5	794.8	211.0	583.8	8,708.4	
2013	938.1	108.0	4.2	0.5	825.4	24.1	801.3	9,509.7	
2014	969.7	108.0	4.2	0.5	856.9	235.7	621.3	10,130.9	

(1) Sheladia Associates, Inc., November 5, 1994.

Table 5.6
BREAK EVEN ANALYSIS TOLL RATE B
Kafue River Bridge Toll/Weighbridge Feasibility Study
(1994 Kwaches)

Year	Annual Revenue	Annual Costs			Toll Plaza Net Revenue	Roadway Maintenance	Total Net Revenue	Accumulative Net Revenue	Toll Plaza Construction Cost
		M&O	Opns.	Maint.					
		Toll Plaza	Weigh Station	Bridge		Lusaka - Chirundu (1)			
	(Million Kwacha)								
1995	269.7	108.0	4.2	0.5	157.0	24.1	132.9	132.9	540.0
1996	276.8	108.0	4.2	0.5	164.1	211.0	(46.9)	85.9	
1997	284.1	108.0	4.2	0.5	171.4	24.1	147.3	233.2	
1998	291.6	108.0	4.2	0.5	178.9	24.1	154.8	388.1	
1999	299.3	108.0	4.2	0.5	186.6	24.1	162.5	550.6	
2000	307.3	108.0	4.2	0.5	194.6	211.0	(16.4)	534.1	
2001	317.1	108.0	4.2	0.5	204.4	260.9	(56.5)	477.7	
2002	327.3	108.0	4.2	0.5	214.6	24.1	190.5	668.2	
2003	337.9	108.0	4.2	0.5	225.2	24.1	201.1	869.3	
2004	348.7	108.0	4.2	0.5	236.0	235.7	0.3	869.6	
2005	360.0	108.0	4.2	0.5	247.3	24.1	223.2	1,092.7	
2006	372.1	108.0	4.2	0.5	259.4	211.0	48.4	1,141.1	
2007	384.1	108.0	4.2	0.5	271.4	24.1	247.3	1,388.4	
2008	397.5	108.0	4.2	0.5	284.8	24.1	260.7	1,649.1	
2009	410.9	108.0	4.2	0.5	298.2	24.1	274.1	1,923.2	
2010	424.7	108.0	4.2	0.5	312.0	24.1	287.9	2,211.1	
2011	439.0	108.0	4.2	0.5	326.3	260.9	65.4	2,276.5	
2012	453.8	108.0	4.2	0.5	341.1	211.0	130.1	2,406.6	
2013	469.1	108.0	4.2	0.5	356.4	24.1	332.3	2,738.9	
2014	484.8	108.0	4.2	0.5	372.1	235.7	136.4	2,875.3	

(1) Sheladia Associates, Inc., November 5, 1994.

Table 5.7
BREAK EVEN ANALYSIS TOLL RATE C
Kafue River Bridge Toll/Weighbridge Feasibility Study
(1994 Kwaches)

Year	Annual Revenue	Annual Costs			Toll Plaza Net Revenue	Roadway Maintenance	Total Net Revenue	Accumulative Net Revenue	Toll Plaza Construction Cost
		M&O	Opns.	Maint.					
		Toll Plaza	Weigh Station	Bridge		Lusaka - Chirundu (1)			
	(Million Kwacha)								
1995	215.7	108.0	4.2	0.5	103.0	24.1	78.9	78.9	540.0
1996	221.4	108.0	4.2	0.5	108.7	211.0	(102.3)	(23.4)	
1997	227.3	108.0	4.2	0.5	114.6	24.1	90.5	67.1	
1998	233.3	108.0	4.2	0.5	120.6	24.1	96.5	163.6	
1999	239.5	108.0	4.2	0.5	126.8	24.1	102.7	266.3	
2000	245.8	108.0	4.2	0.5	133.1	211.0	(77.9)	188.4	
2001	253.7	108.0	4.2	0.5	141.0	260.9	(119.9)	68.5	
2002	261.9	108.0	4.2	0.5	149.2	24.1	125.1	193.5	
2003	270.3	108.0	4.2	0.5	157.6	24.1	133.5	327.0	
2004	279.0	108.0	4.2	0.5	166.3	235.7	(69.4)	257.6	
2005	288.0	108.0	4.2	0.5	175.3	24.1	151.2	408.8	
2006	297.6	108.0	4.2	0.5	184.9	211.0	(26.1)	382.7	
2007	307.3	108.0	4.2	0.5	194.6	24.1	170.5	553.2	
2008	318.0	108.0	4.2	0.5	205.3	24.1	181.2	734.4	
2009	328.7	108.0	4.2	0.5	216.0	24.1	191.9	926.3	
2010	339.8	108.0	4.2	0.5	227.1	24.1	203.0	1,129.3	
2011	351.2	108.0	4.2	0.5	238.5	260.9	(22.4)	1,106.9	
2012	363.0	108.0	4.2	0.5	250.3	211.0	39.3	1,146.2	
2013	375.2	108.0	4.2	0.5	262.5	24.1	238.4	1,384.7	
2014	387.9	108.0	4.2	0.5	275.2	235.7	39.5	1,424.1	

(1) Sheladia Associates, Inc., November 5, 1994.

6.0 ECONOMIC ALTERNATIVES, IMPACTS AND ANALYSES

In addition to a section on economic analysis of the toll plaza project, this final chapter includes special studies in a variety of areas, all having to do in one way or another with economic alternatives or impacts.

6.1 Current and Planned Road Maintenance Financing

There are currently three sources of funds which are earmarked for road maintenance. The most important of these is a special K10 tax on every liter of road fuel purchased in Zambia. This tax is levied at the source and so is easily collected. The resulting monies are variously referred to as the Fuel Levy Fund or the Road Fund and are presently deposited in Account No. 577 at the Bank of Zambia.

The second most important source of earmarked maintenance funds is the road tolls which are charged trucks from surrounding countries when they enter Zambia. These funds are deposited in Account No. 577 at the Bank of Zambia and are substantial, since the toll charged is US$120 per single vehicle entry from five of the nations. Trucks of the other three nations are assessed on a per 100 km basis, to Zambian destination and return. If the turnaround distance is short, this three would yield less than the flat US$120 fee. For example, at US$8 per truck per 100 km (as charged to Malawi and South Africa) the round trip would have to be 1500 km long in order to equal the US$120 flat fee. At US$21 per 100 km (as charged to Tanzania), it would take a Zambian round-trip distance of only 570 km. All rates indicated are P.T.A tolls, so they are reciprocal.

The third source of earmarked road maintenance funds is the fines levied at weighbridges on trucks which exceed allowable weight limits. Until August 19, 1994, such fines were set at K500 per incident, regardless of the amount of the overload. As a result, scanty funds were collected. However, Statutory Instrument No. 103 of Cap. 766 was published, which increased the fine to K500 per kilogram over the permitted weight. Such fines are paid to the police and are also routed to Account No. 577. Initially, the increase in fines due to this change in regulation was spectacular, since up to 80 percent of the trucks weighed were reported as over limits. However, recent indications from two weighbridge sites indicate that the number of trucks found overweight (and fined) is now running at 2 to 12 percent of the total. If the other six weighbridges are experiencing a similar reduction in weigh limit violation, it shows that the regulation has achieved its purpose. However, as a result, significant revenues for Account No. 577 cannot be expected.

Even if the toll and weighbridge fine funds deposited in Account No. 577 were used for the purpose intended, they would only partially cover the annual Zambian road maintenance requirement. And, if the proceeds from the K10 per liter fuel tax were used as intended, they would still only meet a portion of that same requirement.

Addition action must obviously be taken to increase funds for road financing. In an address which the Honorable W. Harrington, Minister of Communication and Transport delivered to the Ninth Road Maintenance Initiative/Road Transportation Travel Program Coordinating Committee Meeting in Lusaka on October 18, 1994, the K10 per liter fuel tax was mentioned as having been levied on May 1, 1993.

In another presentation made at the same conference, Ms. I. M. Tembo, RMI National Coordinator for Zambia reviewed a recommendation having to do with financing road maintenance which had been made by the Road Maintenance Policy Reform Seminar held in Zambia 16-19 February and which had been accepted in principle by the government. The recommendation stated that by April 1, 1993 or as shortly thereafter as possible, the government of Zambia should introduce a road tariff consisting of international transit fees, vehicle license fees and a specific surcharge added to the price of fuel. Ms. Tembo pointed out (as had the Honorable W. Harrington) that a K10 surcharge had been added to the price of fuel, effective May 1, 1993. The government had also agreed in principle to revise the international transit fee from US$8 per 100 km driven in Zambia to US$10, with the change due on February 1, 1995.

The government had also accepted in principle the recommendation that within five years, proceeds from the road tariff should cover all annual road maintenance requirements. An expert funded by RMI is now studying the level at which the road tariff should be set to meet that objective. The resulting recommendations will be considered by the National Roads Board, which will initiate action, as necessary.

The seminar also recommended that the government of Zambia should set up a road fund at the Central Bank of Zambia, into which revenue from the road tariff should be deposited and this has been done. As indicated earlier, this is Account No. 577.

The establishment of a Board of Management for the fund was also recommended, to include representatives from the Ministries of Finance; Communications and Transport; Works and Supply; Local Government and Housing; Agriculture; and Food and Fisheries; and Chambers of Commerce and private road sector organizations. Members of the board were to be appointed by the President, based on the advice of the Ministry and organizations represented in the board.

An interim Task Force Coordinating Committee was appointed by the President and has been in operation since May 1993. Disbursements reported from the Road Fund for road maintenance were reported as over K3 billion (nearly U.S.$5 million). However, an October 19 article in the *Zambia Daily Mail* stated that Reverend Dan Pule, Deputy Finance Minister, advised that his ministry had not remitted fuel levy funds into the account established for it and attributed this to pressing needs of the government. The article further stated that the amount in which the fund was in arrears was about K3 million.

The National Roads Board was gazetted via Gazette No. 4217, Vol. XXX, No. 20. The board has been constituted and contains twelve members. Four ministries are represented (Communications and Transport; Finance; Works and Supply; and Local Government and Housing plus the National Commission for Development Planning). Seven other members represent the interests of road users. The seminar further recommended that the road fund be audited by independent auditors and a contract was to be made to cover this.

According to the definition of the road tariff outlined by Ms. I. M. Tembo, the RMI National Coordinator, it includes international transit fees, vehicle licenses fees and specific surcharges added to the price of fuel. It therefore appears that tolling of Zambian roads is not presently being considered as a possible source of road maintenance fees.

The motor fuel tax will provide a much greater return than any of the other measures noted. Monies for the Fuel Levy Fund (or Road Fund) are collected by Zimoil at the source. According to information from the Ministry of Finance, these monies are routed through the ministry, like any other revenue and deposited in the Road Rehabilitation Fund (Account No 577). The Road Board controls the disbursement of these funds.

It was also indicated that an increase in the per liter levy on fuel is being contemplated, but neither the amount nor the timing has been decided.

6.2 Alternative Weight Limit Enforcement System

Since an excellent 1991 study[1] went through the Zambian weighbridge situation with a fine-toothed comb, reference will be made to it here, as necessary.

[1] Weighbridge Study, Draft Final Report, prepared for the Ministry of Works and Supply by E. G. Petit and Partners, Nov. 1991.

6.2.1 Enforcing Weight Limits

Ideally, overweight Zambian vehicles should be caught as soon as possible after they enter the road net to keep surface damages to a minimum. In fact, weighbridges should be sited close enough to the customs stations that they cannot be bypassed. Likewise, non-Zambian vehicles should be intercepted as near the border customs stations as possible. However, the number of additional stationery weighbridges required to achieve these two aims would require a heavy capital investment. For example, the referenced weighbridge study recommended that nine new stationary weighbridges be established:

- Lusaka (north and south T2, east on T4 and west on M9;
- Fisenge Junction on T3 (two bridges);
- Mufulira on M4;
- Kitwe on T3; and
- Kasama on M1.

Tentative sites were also selected for additional stationary weighbridges at border stations:

- Chirundu on T2;
- Mwinilunga on T5;
- Chipata on T4;
- Mongu on M9;
- Mkasio on T2; and
- Mbata on M1.

These locations should be confirmed by analysis of the traffic passing through them. With money as short as it is in the Zambian government today, the chances of funding fifteen new weighbridges do not appear good. However, there are other solutions. Use of the present weighbridge system could be increased by operating all bridges on a 24 hour basis. This has been recommended before. This would catch those vehicles now slipping by at night. However, where a road closes at night at a border the weighbridge should not stay open. Second, another look should be taken at the overweight vehicle situation. The drastic increase in fines for overweight vehicles which was levied on August 19, 1994 may have already resulted in a significant overall reduction in the number of overweight vehicles on the roads. For example, recent indications from two different weighbridges are that the incidence of overweight vehicles had dropped from 80 percent before the increase in fines to 5-12 percent after.

If a similar decrease has been experienced at the other weighbridges, then aim should be taken at those vehicles which are escaping the present weighbridge net. Instead of building additional stationary weighbridges, roving teams with portable weighbridges should be tried. Nine are recommended, working out of Livingstone, Mongu,

Lusaka, Kabwe, Ndola, Solwezi, Chipata, Kasama and Mansa. The teams (four men each) would work our of the Provincial Engineer's Office. He would be advised each day from Lusaka of the sites where the team would be set up the next day. The team would not know where the site would be until the morning of that workday. If they were out on the road, they would be advised by phone. All steps necessary to avoid compromising operating site locations would be taken. Similar action would be required with the police support which would be needed. Teams would operate at night as well as in the daytime and they should have radios for communication. These teams could also be used to check on whether or not operators at the stationary weighbridges are citing overweight vehicles.

A master schedule of portable weighbridge site locations would be prepared by the Roads Department. This would be one of the responsibilities of the Senior Engineer who should be assigned to overseer all weighbridge operations. At present, this position does not exist.

The same records should be kept by the portable weighbridge teams as are maintained by the permanent weighbridges. This requires that a certificate be issued to the drivers of both overweight and legal weight vehicles. Overweight vehicles would be detained. The driver would then proceed to the nearest police station, pay his fine, return and pick up his vehicle. If he could not pay his fine, he would be escorted to the nearest police station at the end of the day and his vehicle kept in an area designated by the police until he did pay. Advance coordination would be necessary with the police and should be carried out at the national level.

After the new weighbridge teams had been operating for six months, a review should be made of the results. If there were an overall decline in the percent of overweight vehicles detected, then the program would have been successful. If not, other measures should be considered. Efforts could be concentrated in areas were the percent of overweight trucks was still high. Additional portable weighbridges might be required. And, it might be necessary to add permanent weighbridges from the list proposed by the weighbridge study. However, a recheck of ADT should be made at all locations considered. In any event, the most cost-effective mix should be selected.

6.2.2 Collection of Fines

As indicated earlier, procedures currently in effect at weighbridge require that a fine certificate be issued to the driver of every overweight vehicle, that he leave the vehicle (usually a trailer) at the weighbridge area, proceed to the nearest police station, pay his fine, return to the weighbridge, show his receipt, and pick up his vehicle. This is very awkward and costly in time and money. However, under present circumstances, there appears to be no alternative to the

truckers paying his fine at the nearest police station. If the weighbridge operator collected the fine, he would be a prime target for hijackers. Plus there is the problem of leakage.

The difficulty is with handling cash. FEDHAUL and others have proposed a coupon system for paying border tolls. But trucking companies know they will have to pay such tolls and can buy coupons and issue them to the driver before he starts the trip. With weighbridge fines, the driver could possibly pay by check, but this approach cannot be used because companies will not give drivers the authority to sign them. So, it appears fines will have to be paid in cash and the police will have to remain in the chain. If an intra-Zamabia toll road system is established, some of the toll plazas could be co-located with weighbridges. Since the toll plaza would have police support, it could accept the fines and issue receipts.

6.2.3 Revenues

The money accepted by the police for fines levied on operators of overweight vehicles is deposited to a local bank and then transferred to Account No. 577 at the Central Bank of Zambia, and is earmarked for road maintenance. Border tolls are also deposited in this same account.

The overweight certificate issued by the weighbridge operator to the driver who is being fined has a serial number. If the deposit slip used by the police at the nearest station to put the money in the bank cited this number and the amount of the fine, an audit could tell if all fines levied by a particular weighbridge operator had been deposited.

The police should also deposit today's fines tomorrow (other things being equal) and the deposit slip should cite the day on which the fines were collected. The local bank could include this date on the transfer of these funds to the Central Bank of Zambia. An auditor could then follow this paper trial to Account No. 577.

Procedures are already in effect to ensure that funds deposited in Account No. 577 are used for road maintenance and withdrawals are to be countersigned. If these procedures are evaded, the auditor could certainly catch it.

Another opportunity also exists for collecting additional weighbridge traffic data. The driver of every truck weighed at a weighbridge gets a certificate, including those whose trucks are legal weight. The weighbridge operator makes a record of each of these weighings (four to a sheet) on a form entitled "Weighbridge Record Sheet". It appears that these records are thrown out at the end of each year. Instead they should be collected by Roads Department on a quarterly basis and the data computerized. Although Roads Department now receives reports

on overweight vehicles whose drivers have been fined, valuable traffic on legal weight vehicles is being lost.

In summary, there are more cost-effective methods of improving Zambian weighbridge operations than adding expensive stationary equipment, and they should be tried, before installation of such equipment is considered.

6.3 Border Charges and Overweight Vehicle Fines

6.3.1 Border Charges

Road users charges levied on non-Zambian vehicles entering the country are indicated by Figure 6.1, Customs and Excise Circular No. 20, 26 July, 1994. The charges listed are to be paid in U.S. Dollars and are P.T.A toll fees, i.e., reciprocal charges are levied on Zambian vehicles entering the countries listed. All fees shown are on a per truck, single entry basis, except those for Malawi, Tanzania and South Africa. Trucks from those nations are assessed fees on a round trip basis at so much per 100 km. The fees for Zimbabwe, which are not shown, are US$8 per 100 km.

Since foreign truckers are already paying user fees on Zambian roads, they can be expected to protest the tolling of a bridge. This was evident in comments made by truck drivers during the O-D survey which was carried out near the Kafue Weighbridge during the period 11-17 October. Drivers pointed out that since they were already paying for the use of the roads, why should they also pay to use a bridge on one of those roads? However, five of the nine nations involved are charged on the basis of US$120 per single vehicle entry. This is a substantial charge. As indicated, a Kafue road medium bridge toll of K2,000 would add only 3.2 percent to their border fee. This should not discourage truckers from using the Kafue Bridge, especially considering that there appears to be no practical alternative.

The situation is somewhat different with regard to those nations which pay on a per 100 km basis. Four of the nations (Malawi, Namibia, South Africa and Zimbabwe) presently pay US$8 per 100 km, round trip. In order for their fees to equal that paid by the nations paying on a single entry basis per truck basis, the intra-Zambia round trip would have to be 1500 km long. For Tanzania, vehicles which pay US$21 per truck per 100 km, the roundtrip would have to be only 570 km long and this would be easily possible. However, it is doubtful that a 1500 km round trip would be the norm for trucks from Malawi and South Africa. Obviously a lesser kilometerage would result in a smaller charges and a higher proportion of Kafue Bridge toll to the border fee.

ZAMBIA REVENUE AUTHORITY

103/7/1

CUSTOMS AND EXCISE CIRCULAR NO. 20
26th JULY, 1994

P.T.A. TOLL FEES

Problems arising from collection and banking of P.T.A. Toll fees have been experienced by some ports of entry.

The following is a clarified schedule and procedure of how the toll fees should be collected and banked.

Schedule of Road Transport Charges

Botswana

U.S.$120 per truck per single entry

Malawi

U.S.$8 per truck per 100km

Tanzania

U.S.$21 per truck per 100km

Namibia

U.S.$120 per truck per single entry

South Africa

U.S. $8 per truck per 100km

Mozambique

U.S.$120 per truck per single entry

Angola

U.S.$120 per truck per single entry

Zaire

U.S.$120 per truck per single entry

The revised rates are with immediate effect.

...../

Figure 6.1

Banking

The P.T.A. toll fees should be deposited in the P.T.A. Fund Account No. 577, on a prescribed bank slip Accounts Form 25 at your local bank. The money will subsequently be transferred to Bank of Zambia.

Order of bank slip distribution is as follows:-

Original	-	Trucker
Duplicate	-	Bank
Triplicate	-	Headquarters
Quadriplicate	-	Fast copy

Monthly returns for amounts collected should be forwarded to Headquarters, Audit Section.

F.B. Hara
Senior Collector
for:ACTING COMMISSIONER OF CUSTOMS AND EXCISE

Figure 6.1 (cont.)

Overall, it appears that the addition of the Kafue bridge toll to border fees already levied on the trucks of surrounding nations should not present any great problem. Since the border tolls charged by Zambia are sanctioned by the PTA, they are reciprocal and it is highly probable that any added charges levied on the trucks of neighboring nation would be reflected (sooner or later) in increases in fees charged Zambia.

Informal information indicates that the US$8 charge per 100 km is soon to be increased to US$10 and that Namibia will change from the fee per truck per single entry to the fee per truck per 100 km. The only drastic change which appears to be in the offing is a proposal which FEDHAUL has made (in cooperation with other southern Africa haulers) to use a coupon system for paying international transit fees with the objective of reducing the evasion and leakage of border transit fees by substituting coupons for cash.

According to Mr Ian Heggie, a World Bank expert, Zambian border collection fees dropped sharply when the responsibility for collecting international transit fees was transferred from British Petroleum (which collected them under contract) to the Customs Department.[2]

The coupon scheme was recommended by the P.T.A and involves Regional Road Freight Associations from Lesotho, Mozambique, South Africa, Namibia, Swaziland, Tanzania, and Zimbabwe, as well as Zambia.

Bank-note-quality coupons would be printed by FEDHAUL and collection agencies would be equipped with counterfeit detectors. Transporters would buy these coupons from FEDHAUL and issue them to their drivers to pay border tolls. Toll collection agencies in Zambia would transfer the coupons back to FEDHAUL, which would remit them to the road maintenance account, currently Account No. 577 at the Central Bank of Zambia. As indicated earlier, the objective of the new system is to reduce toll leakage and ensure that drivers who had evaded paying of tolls do not pass through the border on exit.

The Zambian government has reportedly agreed on the coupon scheme,[3] but there will be a delay while financing the printing of coupons and other matters are worked out. Although the implementation date is not set, the proposal appears to be firmly on track.

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[2] Ian Heggie, Management and Financing of Roads; In Agenda for Reform, SSATP Working Paper No. 8, World Bank, Mar. 1994. p. 80.

[3] Interview, Ms. Heather Chalcraft, FEDHAUL, Oct. 26, 1994.

6.3.2 Overweight Vehicle Fines

As outlined elsewhere, Zambia made a drastic increase in August in the level of fines charged for overweight vehicles, from K500 per incident to K500 per kilogram overweight. According to reports, this has resulted in heavy reduction in the number of vehicles fined. This heavy increase in fines was sponsored by FEDHAUL and others. Its success should encourage imitation in neighboring countries. The result should be a dramatic reduction in overweight truck damage to southern African roads.

From all indications, the road toll coupon proposal and the heavy increase in fines for overweight trucks should be supported.

6.4 Stakeholders in Toll/Weighbridge Operations

Among the prospective parties in toll/weighbridges operations are:

- Commercial vehicle operators;
- Private vehicle operators;
- Professional transport associations;
- Regional associations;
- Government employees who operate the toll/weighbridge systems;
- National government;
- Consumers;
- Producers; and
- Donors.

6.4.1 Commercial Vehicle Operators

Commercial vehicle operators are principally truckers and bus operators and they encompass as wide a range of personality types as might be found in any cross-section of the populace.

6.4.2 Overweight Vehicles

As far as overloaded vehicles are concerned, there is a wide spectrum of different types of operators involved. At one end of the trucking spectrum is the greedy operator who loads his truck with as much as it will carry, ignores the damage the overload causes to the road, and usually neglects his vehicle maintenance. At the opposite end is the operator with judgment enough to realize that sooner or later he will pay in cash for abusing his truck, so he follows the weight laws and keeps his vehicle maintenance current. A similar situation is found among bus operators. However, road damage due to a bus overload is usually much less than that for an overloaded truck because less weight is involved.

According to some of the weighbridge operators, the proportion of overloaded trucks was high before the fine was raised in August to K500 per kilogram overweight.

6.4.3 Border Charges

The problem with border charges is evasion of tolls and possible diversion of toll receipts. With the truckers, it sometimes becomes a game; the offender tries to beat the system and if he is successful, he profits.

According to Ian Heggie, a World Bank transport expert who is quoted elsewhere in this study, Zambian income from tolls collected at borders went down when the government took over from BP.

It is recognized that there are also parastatal hauling concerns, but it is assumed that they will be phased out. In any event they would presumably be more prone to comply with government regulations.

6.4.4 Private Vehicle Operators

These are primarily car owners who are driving their own vehicles. As a general rule, they do not overload enough to damage the roadway, which has been designed to take trucks. The driver typically objects to the time lost while paying the toll as well as to the cost and will avoid paying if he can. Complaints registered by such drivers when Zambia attempted to establish a wide nation road toll system in 1983 were sufficient to cause the scheme to be abandoned.

6.4.5 Professional Transport Associations

These associations have been very involved in road transport matters in southern Africa and have therefore been influential. They also belong to regional associations and cooperate across national borders. On balance, their efforts appear to have been very beneficial. FEDHAUL (Federation of Zambian Road Hauliers), which is based in Lusaka, is a good example. They were instrumental (along with certain other associations and truck operators), in getting the regulation passed in August of this year which raised the fine for overweight vehicles to an effective level. They are also presently involved in a scheme to use specially printed coupons to pay border tolls, thereby hoping to avoid leakage of toll money and to make it harder for drivers who did not initially pay a toll at the Zambian border to escape paying on their way out.

6.4.6 Regional Quasi-Government Associations

These organizations differ from the professional transport associations. They involve governments and concentrate on matters such as setting

tolls. The Preferential Trade Area (PTA) is a good example. For example, the PTA coordinated the establishment of reciprocal road user tolls between nine southern African nations. Their objective is to improve regional cooperation by sponsoring regional agreements. In another example, the PTA is currently trying to transform itself into the Common Market of Eastern and Southern Africa (COMESA). Zambia, along with nine other nations, has ratified the agreement and it is expected that COMESA will become effective by the end of the year.

6.4.7 Government Employees Operating the Systems

This group has a vested interest in seeing that the systems with which they are operating continue to provide them jobs. In many cases, they are underpaid and overworked and therefore subject to temptation in the area of money. When changes require that new procedures and practices be learned, they usually opt for maintenance of a complete status quo. Nevertheless, they remain the backbone of the toll and weighbridge systems and should be consulted when drastic changes (such as privatization) are envisaged.

6.4.8 National Government

The objective of a nation operating a road toll system is to maximize revenue without sparking retaliation from neighboring countries. At the same time, the safety of the monies collected must be ensured until they reach the designated bank account or other similar destination. It can be expected that any time a nation decides to establish a domestic toll system, it will face opposition from its citizenry. Zambia had experience along this line, in 1983. Any such system must also be manned and maintained, a difficult feat when funds are short.

Weighbridge fines are different. Here, a country is typically attempting to reduce the damage to its roads caused by overweight vehicles and the resulting revenue is only auxiliary. Even if fines were raised high enough to reduce overloading, revenues would probably drop because truck operators would eventually lighten loads to avoid fines. However, much of the road network is not covered by stationary weighbridges and use must therefore be made of roving teams with portable equipment. If a successful system of overweight vehicle fines or enforcement is developed by one nation, its neighbors are sure to follow.

It is also incumbent upon the country to insure that funds collected from tolls and weighbridge fines are used for road maintenance, as intended. When this does not happen, it puts off donors who have provided money for road construction.

6.4.9 Consumers

If the imposition of a road toll results means an increase in the price of consumer goods, the consumer is affected directly. However, it is doubtful that a small percentage increase in present road tolls would impact heavily on consumer prices. Similarly, increased fines at weighbridge operations might also affect consumer prices. Overloading can reduce the average cost of transporting a ton of cargo, if the effect of the overload on the vehicle is ignored, which it frequently is. An increase in fines for overloads at weighbridges could conceivably raise consumer prices by increasing per ton transport costs, but this is doubtful. In any event, from an overall viewpoint, the country would benefit because road damages would be reduced.

6.4.10 Producers

If a road toll were heavy enough to be result in an increase in price of producer inputs, this would be reflected in goods provided for the consumer. As indicated above for consumers, it is doubtful that this would occur.

6.4.11 Donors

Since donors have supplied the funds for the construction of hundreds of kilometers of Zambian roads, they are interested in seeing that the investment is protected, i.e., that these roads are maintained. In Zambia, they expect that border road tolls and weighbridge fines will be collected and transferred safely to a special account dedicated to road maintenance and that the funds will then be used for the purposes intended. If this is not done, it becomes known sooner or later and all concerned are embarrassed. Further, future grants from the donors may be endangered, particularly if the gap between funds available for maintenance and required is a large one.

Section 5.1 contains a discussion of Zambian statutes regarding toll/revenue collecting facilities, including a review of past efforts in these areas.

6.5 Economic Impact on User Groups

This section considers possible economic impacts on users of tolls placed upon the Kafue Road Bridge. Users are considered by type of vehicles: buses, passenger cars and trucks. Table 6.1 shows three levels of tolls which have been proposed, by the type vehicle.

Table 6.1
ALTERNATIVE TOLL RATE STRUCTURES

Vehicle Type	Rate A	Rate B	Rate C
	Kwacha		
Light Vehicles	1000	500	400
Bus	2000	1000	800
Single Bed Truck	3500	1750	1400
Heavy truck	5000	2500	2000

Source: Wilbur Smith Associates.

6.5.1 Buses

The typical bus passenger is from the low income group. He buys a ticket because he has no practical alternative. Sometimes rail is also available. However, access to rail service is available only in the vicinity of a station and the rail net is limited.

In attempting to assess user impact of a Kafue Road Bridge toll, a sample was taken at the Lusaka Bus Station of data on bus lines which have routings involving the Kafue Bridge. Companies involved includes Fiataxis, R.P.S. Transport, B.B. Motors, Chiwone Motors and J. Shawa and others. Table 6.2 shows that bus fares charged by the companies were identical to the seven destinations shown. This probably assures that any toll levied on buses crossing the bridge would be passed on to the passengers. In another section of this study, the question of whether to toll by bus or by the number of passengers was considered and the former was found preferable. The amount of the toll is therefore set in vehicle weight, not on passenger numbers. Table 6.1, shows fares for one trip over the bridge. If roundtrip fares were collected, it is assumed that bus companies would apportion the toll (half to each bus crossing, so that the results would be the same as for a one way toll.

It was also observed that bus passengers were predominantly adults or children paying adult fares, estimated here at 90 percent. Children below six do pay a fare; between six and ten they are charged half price and above ten years of age, they pay full fare. The number of children between six and ten years of age was estimated at 10 percent, and a 90-10 split was used in developing the weighted fare.

In allocating bus tolls to passengers, an average loading of a regular bus was found to be 47 passengers, compared to 13 per bus for minibuses. Table 6.2 applies to regular buses. On this table, the average passenger fare per kilometer was calculated and found to be higher to closer destinations, e.g., K11.4/km for the nearest destination

Table 6.2
IMPACT OF PROPOSED KAFUE ROAD BRIDGE TOLL ON PASSENGERS
(Regular Buses)

Lusaka to:	Adult Fare	Weighted Fare (K)	Distance (Km)	Av.Fare per Km (1)	Av. Toll per Pasenger (2)	Av. Pass. Toll per Km (3)	Per Km Av. Fare Plus Av. Toll (4)	Percent Increase Av. Cost/Km (5)	Percent Increase in Weighted Fare (6)
	a	b	c	d	e	f	g	h	i
Mazabuka	1500	1425	125	11.4	21	0.17	11.6	1.8	1.5
Monze	1800	1710	186	9.2	21	0.11	9.3	1.1	1.2
Pemba	2500	2375	221	10.7	21	0.09	10.8	0.9	0.9
Choma	2800	2660	284	9.4	21	0.07	9.5	1.1	0.8
Kalomo	3200	3040	346	8.8	21	0.06	8.9	1.1	0.7
Zimba	3500	3325	396	8.4	21	0.05	8.5	1.2	0.6
Livingstone	4450	4228	472	8.9	21	0.04	8.9	-	0.4

(1) Col. b / Col. c
(2) K1000/47
(3) Col. e / Col. c
(4) Col. d + Col. f
(5) Col. g / Col. d
(6) Col. e / Col. b

Note: All fare and toll data are in Kwacha.

Source: Lusaka Bus Station, Toll Calculated Separately.

(Mazabuka) compared to K8.9/km for the fartherest, Livingstone. The average toll per passenger was next calculated and added to the average passenger fare, to get the total average per kilometer cost per passenger. The toll used was medium level, K1,000 per bus. For 47 passengers, this averages to K21 per passenger. A low-level toll of K800 would average K17 per passenger. The table is otherwise self-explanatory and shows that the addition of the toll increased the average passenger cost per kilometer for 1.1 to 1.2 percent, depending upon the distance. Likewise, increase in weighted fares ranged from 0.4 to 1.5 percent depending upon the distance.

Table 6.3 carries out the same procedures for minibuses. With fewer passengers, (13 vs 47) the average toll per passenger would be higher (K38). Still, the average increase in passenger cost per kilometer ranged only from 0.9 to 1.1 percent. Increases in weighted fares increased from 0.4 to 1.5 percent.

The Zambian Railroad also serves the same destinations shown in Table 6.3 with third class adult fares as shown on Table 6.4. Again a child's fare would be about half the adult fare. The rail adult fares shown are roughly comparable to bus fares, with the bus fare cheaper to four destinations shown. However, northbound trains on this routing arrive in Lusaka at 0800 hours and depart southbound at 1430 hours daily, on Mondays, Wednesdays and Fridays only. In contrast, there are seven southbound regular bus and 17 southbound minibus departures per day from the Lusaka bus station, plus the arrival of a similar number of northbound buses. The possible impact of the tolls upon low income consumers was studied. Based upon information from the Central Statistics Office for 1991[4] and converted to 1993 levels via the CPI, it appears that in 1993 the low income consumer averaged K11,860 per month or K142,320 per year.

[4] Social Dimension Adjustment, Priority Survey No. 1, 1991, CSO.

Table 6.3
IMPACT OF PROPOSED KAFUE ROAD BRIDGE TOLL ON PASSENGERS
(Minibuses)

Lusaka to:	Adult Fare (1)	Weighted Fare (K)	Distance (Km)	Av. Fare per Km (2)	Av. Toll per Pasenger (3)	Av. Pass. Toll per Km (4)	Per Km Av. Fare Plus Av. Toll (5)	Percent Increase Av. Cost/Km (6)	Percent Increase in Weighted Fare (7)
	a	b	c	d	e	f	g	h	i
Mazabuka	1500	1425	125	11.4	38	0.30	11.7	2.6	2.7
Monze	1800	1710	186	9.2	38	0.20	9.4	2.2	2.1
Pemba	2500	2375	221	10.7	38	0.17	10.8	1.9	1.5
Choma	2800	2660	284	9.4	38	0.13	9.5	1.1	1.4
Kalomo	3200	3040	346	8.8	38	0.11	8.9	1.1	1.3
Zimba	3500	3325	396	8.4	38	0.09	8.5	1.2	1.1
Livingstone	4450	4228	472	8.9	38	0.08	8.9	-	0.9

(1) These fares are for two-way collection; a single passenger over the bridge. A roundtrip fare would be double these rates.
(2) Col. b / Col. c
(3) K500 / 13
(4) Col. e / Col. c
(5) Col. d / Col. f
(6) Col. g / Col. d
(7) Col. e / Col. b

Note: All fare and toll data are in Kwacha.

Source: Lusaka bus station toll calculated separately.

Table 6.4
ZAMBIAN RAILROAD FARES TO SELECTED DESTINATIONS

Lusaka To:	Adult Fare (Third Class) K
Mazabuka	1380
Monze	1960
Pemba	2160
Choma	2930
Kalomo	4090
Livingstone	4870

Source: **Tariffs posted in Lusaka Rail Station.**

Assuming a 5.5 day workweek, there are 286 workdays. The 10 holidays were not deducted, assuming that the worker would be paid for them. At 286 workdays the average wage per day would be K497. The average increase in fares due to a middle level toll of K1000 per vehicle levied on regular bus would amount to K21 per passenger, spread over 47 passengers. This amounts to 4.2 percent of the average daily wage of the low income bus passenger, of K497. A low-level toll of K800 would average K17 per passenger, or 3.4 percent of the same daily wage.

For a minibus, a medium-level toll of K500 spread over an average of 13 passengers would equate to K38.5 each or 7.7 percent of the low income daily wage. At a low level of K400, each passenger's share would be K31 or 6.2 percent of the wage.

6.5.2 Passenger Cars

Allocating tolls for a passenger car is easier than for a bus because only the driver is involved, unless he is carrying paying passengers. Considering the expense involved, chances are that anyone owning and operating a car in Zambia would not be in the low income category. An annual medium income level was calculated for 1993 of K1,099,647, halfway between a low income level (K142,320) and that of an employer (K2,056,961). At 286 workdays a year, this would be K3844 a day. A medium level toll of K500 would equal 13 percent of that, which is substantial. However, it was observed during the traffic survey that few passenger cars had only one occupant. With three paying customers, the cost to the vehicle operator of the toll might be zero.

6.5.3 Trucks

A large proportion of the trucks using the Kafue Road Bridge are non-Zambians and road user tolls have already been levied when they enter the country. The economic impact of the bridge toll on trucks is therefore evaluated on two counts: (a) by what percent would the toll increase the toll already paid; and (b) what percent would the toll be of the value of the trucker's lading? Other ancillary matters are also considered.

Table 6.5 restates the road user tolls currently being collected from non-Zambian trucks at the Zambian borders. Five are flat fees (US$120 per single entry) and the other four are on a per 100 km except Tanzania, which is US$21 per 100km. The US$8 per 100 km are scheduled to increase to US$10 on 1 February, 1995.

Table 6.5
ZAMBIA BORDER ROAD USER TOLLS

Trucks From:	Charge (US$)
Malawi	8 per truck per 100 km
South Africa	8 per truck per 100 km
Zimbabwe	8 per truck per 100 km
Tanzania	21 per truck per 100 km
Angola	120 per truck, single entry
Botswana	120 per truck, single entry
Mozambique	120 per truck, single entry
Namibia	120 per truck, single entry
Zaire	120 per truck, single entry

Source: Customs and Excise Circular No. 20, P.T.A Toll Fees, Zambia Revenue Authority, 26 July, 1994.

Table 6.6 summarizes information from an O-D survey made of 103 trucks using the Kafue Road Bridge. The average distance driven in Zambia per truck was 471 km and the average toll paid was US$46.71 (K31,020). This low average was because 87 percent of the trucks was from South Africa or Zimbabwe which pay only US$8 per 100 km driven within Zambia. Looking at these two nations specifically, they paid an average of only US$34.38 (K22,691) per truck. Medium-level bridge tolls are proposed for single bed trucks (K1,750), and for articulated trucks (K2,500). With single bed trucks making up 49.3 percent of the total (October 1994 survey) and articulated trucks at 50.7 percent, this equates to an weighted average toll per truck of K2,130. This is 6.9 percent of the average border toll paid per truck of US$47 (K30,828).

Table 6.6
AVERAGE BORDER TOLL PAID BY NON-ZAMBIAN TRUCKS

Country	No. Trucks	Route KM in Zambia	Truck KM Inside Zambia (a x b)	Border Tolls US$	Toll Paid
	a	b	c	d	e
Namibia	1	983	983	120	120
South Africa	34	334	11,356	8/100 Km	908
Swaziland	1	494	494	8/100 Km	39
Zimbabwe	56	488	27,328	8/100 Km	2,186
Malawi	2	705	1,410	8/100 Km	113
Tanzania	3	1,150	3,450	21/100 Km	725
Zaire	6	581	3,480	120	720
TOTAL	103		48,507 (1)		4,811 (2)

(1) 48,507/103 = Average of 471 km per truck
(2) K4811/105 - Average toll of US$46.71 (K30,828) per truck

Overall, the average distance driven per truck within Zambia by all trucks was 471 km. With an average border toll of US$46.71 (K30,828), this comes to K65.5 per kilometer. A medium average truck toll of K2,130 on the Kafue Bridge would add K4.5 to that average per kilometer cost.

A check was next made of the average value of truck loadings as a basis for estimating economic impact. An O-D survey indicated that the 10 commodities shown on Table 6.7 made up the bulk of the tonnage. The weighted average value of a metric ton of these commodities was calculated at K736,780 (US$1,166), as shown. As stated above, the distribution of straight bed and articulated trucks was found to be 49.3 and 50.7 percent respectively during the October traffic survey. The average lading of a single bed truck is 10 tons, plus a trailer. Assuming 30 percent of these trucks had 5 ton trailers, the average lading could be 11.5 tons. With the average lading of an articulated truck at 28 tons, the average weighted lading could be 19.8 tons. At K736,780 per ton, the average value of this lading would be K14,588,244 (US$22,103).

Table 6.7
WEIGHTED AVERAGE VALUE PER TON OF TRUCK CARGO

Commodity	Percent of Truck Load	Price per Ton	Weighted Cargo Cost per Ton
		Kwacha	
Maize	11.3	65,031	7,349
Other Agriculture Products	18.9	56,444	10,668
Food Products	13.5	25,449	33,946
Petroleum Products	20.3	385,411	78,238
Manufactured Goods	4.7	1,760,000	82,720
Copper	10.4	965,472	100,409
Electronics	4.7	8,880,000	417,360
Crushed Stone	4.7	3,409	160
Sand	4.7	1,052	49
Other	7.1	82,835	5,881
TOTAL			736,780

Source: Various publications and agencies

A medium-level weighted average toll of K2130 would amount to only 0.015 percent of that total.

6.5.4 Summary

The foregoing discussion has considered the economic impact of tolling the Kafue Road Bridge from a number of angles. However, the principal concern is with increases in total cost to the road user:

- Because of their low average annual incomes, bus passengers would be most affected, with minibus passengers faring worse. A medium toll of K1,000 per bus spread over 47 passengers could be K21 per passenger, or 4.2 percent of the low income worker average daily wage of K497. A low-level toll of K800 would average K17 per passenger or 3.4 percent of the daily wage. A medium-level toll of K500 on a minibus would equate to K38.5 per each of 13 passengers or 7.7 percent of the daily wage. A low-level toll of K400 would equate to K31 per passenger or 6.2 percent of that wage.

- A medium-level toll of K500 per car would equate to 13 percent of the average middle income daily wage of K3,844 per day. A low-level toll of K400 would equate to 10.4 percent of the daily wage. However, the driver could easily spread the toll over several

passengers. Very few cars observed during the October 11-17 traffic survey had only one person in them.

- Trucks would be least affected. Although a medium-level weighed average toll of K2,130 would amount to 6.9 percent of the average border toll paid (US$47 or K30,828), the toll would be only 0.015 percent of the weighted average value of a single truck load.

6.6 Economic Impact on Population and Consumption

The question at issue here is, if the Kafue River Bridge were tolled, what impact would it have on overall Zambian production and consumption? At first it might seem incongruous that tolling just one bridge could affect a national economy. However, in Section 4.0, the unique role of T2 in the bridge area was pointed out, i.e. it connects four trunk roads in the south with three trunks in the north. Further, the bridge concerned is the only crossing of the Kafue in the immediate area.

While there might be auxiliary effects, the principal impact from tolling the bridge would be upon those who are serviced by the vehicles using it. Low income passengers would be hardest hit. However, the impact on those using the cargo which trucks haul across the bridge would probably be more pervasive. For example, in Section 6.5 it was pointed out that out of 103 trucks stopped during an O-D survey made during the period October 11-17 at the traffic point (in the Kafue weighbridge area, just south of the bridge), some 56 (54 percent) were from Zimbabwe and 34 (33 percent) were from South Africa. Trucks from other countries included Zaire-6, Tanzania-3, Malawi-2, Swaziland-1, and Namibia-1. So the bulk of the cargo vehicles involved (87 percent) were from just two nations to the south, Zimbabwe and South Africa. Obviously Zambian areas not serviced by trucks using the bridge would not be affected.

Section 6.5 also pointed out that even a medium-level toll would only add about 6.9 percent (K30,808) to the road user tolls which Zambia already collects at the border from truckers. Further, it would add only K4.5 to the truckers average per kilometer cost to the road user. More significantly, a medium-level toll would amount to only 0.015 percent of the average value of the lading. It seems that there should be no major impact upon road freight rates and consequently upon producer costs. Under such conditions, prices to consumers should not be greatly affected. The greatest impact would be psychological. Non-Zambian truckers are already paying border tolls for use of Zambian roads and would resent any addition to those tolls, no matter how small. More importantly, the border tolls are PTA tolls and are reciprocal. Any toll increases will therefore be met by similar increases from neighboring nations. A similar result can be expected if the truck

were carrying finished goods except that the toll increase would be even a smaller proportion of the value of the loading.

Section 6.5 also pointed out that bus passengers could most likely be low income personnel and therefore most affected by a toll on the bridge. A middle-level toll would amount to 4.2 percent of the average daily wage of a low income regular bus passenger compared to 3.4 percent for a lower-level toll. For a minibus bus passenger, it would equate to 7.7 percent for a medium-level toll road or 6.2 percent for a lower-level toll. This additional cost to them would be the equivalent of a pay cut.

A medium-level toll would amount to 13 percent of the daily wage of a medium income passenger car driver, or 10.4 percent if a low-level toll was charged. This is a significant impact, but could easily be reduced if the driver were carrying passengers. In fact, during the October 11-17 traffic survey, few passenger cars were observed with only one driver.

From the foregoing it appears that only producers whose goods are carried in trucks using the Kafue Road Bridge would be affected by tolling it, and the impact of the toll would not be significant. Other producers would probably not be affected. Consumers would not be affected unless producers raised the costs of items they buy, and this is unlikely. Finally, of people using the bridge, bus passengers would be most affected by a bridge toll because they are most likely to be low income. It is from these users that most of the political opposition would probably develop. A previous attempt at large scale road tolling in Zambia foundered a such opposition.

6.7 Benefit Cost Analysis

The analysis carried out in this sector differs from that found in Section 5.0, which was essentially a cash flow, break-even type of operation. Annual costs considered in that analysis included the maintenance and operation of the toll plaza, the operations of Kafue Weighbridge, and the maintenance of the Kafue Road Bridge and the Kafue-Chirundu segment of Road T2. The objective was to determine in what year accumulated net benefits would equal the cost of the toll plaza installation.

In contrast, the present analysis determines the net present value of the toll plaza operation and compares it to the sum of the present values of the costs for the operation of the weighbridge and the maintenance of the Kafue Road Bridge and the Kafue-Chirundu segment of T2. The following analysis conditions were applied:

- The last full year before the analysis started (1993) was the base year.

- Constant economic 1994 costs were used (instead of 1993) for several reasons. First, constant financial costs used in the break-even analysis were for 1994 and the results of the two analysis should be as comparable as possible. Second, the kwacha depreciated significantly against the US$ from 1993 to 1994, with the exchange rate increasing from US$1.00 = K455 to US$1.00 = K660, a loss of 45 percent. The results of an analysis made today using 1993 costs would therefore have been overstated in dollar/kwacha terms. Third, action by the Chiluba government appears to have stopped the slide of the kwacha and the exchange rate seems to have stabilized. In any event, final results of the analysis were converted to 1993 dollar/kwacha terms to illustrate the differences involved.

- Economic costs were estimated at 80 percent of financial costs.

- Foreign exchange costs were estimated at 80 percent; all toll collection and recording equipment will be imported.

- Since the study was completed in November 1994, it was assumed that construction would not start until 1995, with 1996 as the first full year of operation.

- Three toll rates (A-High, B-Medium and C-Low), discount periods (5, 10 and 20 years) and discount rates (10, 20 and 15 percent) were tested. The 27 resulting tables are included as Appendix C. The net present value (NPV), benefit/cost rates (B/C rates) and internal rate of return (IRR) are shown for each alternative. Appendix C also includes tables in which the present values of the annual costs of other facilities were calculated.

6.7.1 Toll Rate A

The results of the analysis are shown in three tables which follow. The first, Table 6.8 is for toll rate A, the high level rate. The B/C ratio and NPV are calculated for each of the six options listed above. The number of the table in Appendix C which backs up each analysis case appears on each line. All those for toll rate A start with an A. The NPV is substantial in all cases. The present values of the three streams of annual costs for the facilities against which the NPV was to be compared were next calculated and subtracted from each NPV, to get an adjusted NPV. In each case, the adjusted NPV was again substantial. The last two columns of Table 6.8 illustrate the point which was made earlier; the use of 1993 costs would have overstated the dollar value of the results, i.e., the dollar value of the adjusted NPV at the 1993 US$/kwacha exchange rate was 45 percent higher than that using the 1994 rate.

6.7.2 Toll Rate B

The result of the analysis of the medium-level toll (toll rate B) is shown by Table 6.9. Again, the number of the applicable back-up tables in Appendix C is shown. Although the toll plaza project is shown as feasible under all conditions, when the PVs of the annual costs of the other facilities were calculated and subtracted from the NPV, the adjusted NPV was negative in almost every case. And again, the adjusted NPV at the 1993 US$1.00/kwacha relationships are shown as overstated.

6.7.3 Toll Rate C

The analysis of the low-level toll, toll rate C, is shown in Table 6.10. The numbers of applicable back-up tables in Appendix C, (all of which start with C) are shown for each case. The NPV's for every case are positive. However, when the PV's of the annual cost of the other facilities are subtracted, the result is a minus in every case. As would be expected, the deficits are larger than toll rate B. And again, 1993-based data were overstated.

6.7.4 Summary

In summary, a B/C analysis of the results of three proposed toll rates (A-High, B-Medium and C-Low) found that a toll plaza operation based on rate A would result in a positive NPV in every case, even after the present values of the annual costs of the other facilities were subtracted. However, although the NPV's of the other toll rate cases (Toll B and C) were positive in every case, they turned negative in all but one case, (B-8, 12 percent, 20 years) when the PV's of the annual costs of the other facilities were deducted. Therefore, only with the high level toll (A) could these annual costs be met.

At the beginning of this section, mention was made of the differences between the cash flow, break-even type of analysis such as that used in Section 5.0 and the B/C technique used here. In view of the differences in results shown between the two systems, additional comment might be in order.

First, the basic difference between the two systems is that the B/C process is based on the concept of the present value of future money; it considers the effects of interest. The impact of this on future annual revenues becomes apparent when it is considered that at a 12 percent discount rate, a dollar value in the first year of the discount period would be reduced to a little over 89 cents and in the twentieth year, it would be worth a little more than a dime. The break-even analysis does not use this principle. Second, the break-even system used financial costs, i.e., market prices. The B/C analysis uses economic costs; financial costs less transfer payments such as taxes and duties.

Table 6.8
ECONOMIC ANALYSIS - TOLL RATE A

Appendix Table	Years of Operation	Discount Rate (%)	B/C Ratio	NPV	Less Supported PV's (1)	Adjusted NPV (2)	In US$, of Year (3)	
				K Millions			US$ Millions	
							1994	1993
B-1	5	10	1.16	100.0	358.5	-258.5	-0.39	-0.57
B-4	10	10	1.56	442.3	611.5	-169.2	-0.26	-0.37
B-7	20	10	1.97	934.0	842.1	-91.9	-0.14	-0.20
B-2	5	12	1.13	74.2	329.5	-255.3	-0.39	-0.56
B-5	10	12	1.49	361.1	542.9	-181.8	-0.28	-0.39
B-8	20	12	1.84	723.0	713.3	9.7	-0.01	-0.02
B-3	5	15	1.08	41.8	291.6	-249.8	-0.38	-0.59
B-6	10	15	1.40	263.4	458.1	-194.7	0.29	-0.43
B-9	20	15	1.67	495.4	568.0	-72.6	0.11	-0.16

(1) **Include PV's of weighbridge operations and maintenance of Kafue Road Bridge and Road T2 from Lusaka to Chirundu.**
(2) **NPV less PV's indicated in Note 1**
(3) **For 1994, US$1.00 = K660; for 1993, US$1.00 = K455.**

Table 6.9
ECONOMIC ANALYSIS - TOLL RATE B

Appendix Table	Years of Operation	Discount Rate (%)	B/C Ratio	NPV	Less Supported PV's (1)	Adjusted NPV (2)	In US$, of Year (3)	
				K Millions			US$ Millions	
							1994	1993
B-1	5	10	1.16	100.0	358.5	-258.5	-0.39	-0.57
B-4	10	10	1.56	442.3	611.5	-169.2	-0.26	-0.37
B-7	20	10	1.97	934.0	842.1	-91.9	-0.14	-0.20
B-2	5	12	1.13	74.2	329.5	-255.3	-0.39	-0.56
B-5	10	12	1.49	361.1	542.9	-181.8	-0.28	-0.39
B-8	20	12	1.84	723.0	713.3	9.7	-0.01	-0.02
B-3	5	15	1.08	41.8	291.6	-249.8	-0.38	-0.59
B-6	10	15	1.40	263.4	458.1	-194.7	-0.29	-0.43
B-9	20	15	1.67	495.4	568.0	-72.6	-0.11	-0.16

(1) Include PV's of weighbridge operations and maintenance of Kafue Road Bridge and Road T2 from Lusaka to Chirundu.
(2) NPV less PV's indicated in Note 1
(3) For 1994, US$1.00 = K660; for 1993, US$1.00 = K455.

Table 6.10
ECONOMIC ANALYSIS - TOLL RATE C

Appendix Table	Years of Operation	Discount Rate (%)	B/C Ratio	NPV	Less Supported PV's (1)	Adjusted NPV (2)	In US$, of Year (3)	
				K Millions			US$ Millions	
							1994	1993
C-1	5	10	1.15	97.1	358.5	-261.4	-0.39	-0.57
C-4	10	10	1.39	309.2	611.5	-302.3	-0.46	-0.66
C-7	20	10	1.69	669.2	842.1	-172.9	-0.26	-0.38
C-2	5	12	1.13	78.4	329.5	-251.1	-0.38	-0.55
C-5	10	12	1.35	255.7	542.9	-287.2	-0.44	-0.63
C-7	20	12	1.61	520.8	713.3	-192.5	-0.19	-0.42
C-3	5	15	1.10	25.9	291.6	-265.7	-0.40	-0.58
C-6	10	15	1.29	191.3	458.1	-266.8	-0.40	-0.59
C-9	20	15	1.49	361.0	568.0	-207.0	-0.31	-0.46

(1) **Include PV's of weighbridge operations and maintenance of Kafue Road Bridge and Road T2 from Lusaka to Chirundu.**
(2) **NPV less PV's indicated in Note 1**
(3) **For 1994, US$1.00 = K660; for 1993, US$1.00 = K455.**

Third, the B/C system discounts back to the base year, the last full year before the year of the feasibility study. The break-even system starts counting when the project goes on-line. Again, the time value of money is involved. The B/C process is much the more rigorous of the two types of analyses.

It is proposed that USAID recommend to GRZ that:

- Necessary changes be made to GRZ laws involving privatization of transportation facilities. As a minimum, this would require:

  (1) Change that part of Section 17,(1), Part IV, Toll Charges of the Toll Act, 1983, which reads, "17.(1) The Board may on any road, bridge, pontoon or other place, operate toll Points," to read, "17.(1) The Board may in any road, bridge, pontoon or other place, operate toll points, or it may contract with private companies for such operation."

  (2) Change that part of Section 17.(2) which reads, "Any vehicle passing through a toll point should pay the appropriate toll charge as set out in Part I of the Schedule," to read, "Any vehicle passing through a toll point shall pay the appropriate toll charge as set out in Part I of the Schedule. Tolls for facilities operated by contractors will be set by negotiation and separate tariffs published."

- A privatized toll plaza and system be established at the Kafue River Road Bridge as a test case.

- Toll Rate A be implemented as part of the test.

- Subsequent changes to toll rates to depend upon the results of the test.

The real question here is principally political, not economic. A previous toll effort failed because proper ground work was not laid. A test case should be more politically acceptable. If it is successful, then the concept could be expanded.

Appendix A: Traffic Counts

Table A.1

KAFUE RIVER BRIDGE TOLL / WEIGHBRIDGE FEASIBILITY STUDY
12 – HOUR VEHICLE CLASSIFICATION COUNT
Monday 17 October 1994

NORTHBOUND

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
06:00 – 07:00	12	0	1	0	13	18
07:00 – 08:00	29	1	10	2	42	7
08:00 – 09:00	34	0	12	4	50	12
09:00 – 10:00	35	0	6	5	46	5
10:00 – 11:00	24	0	13	3	40	4
11:00 – 12:00	28	0	13	3	44	6
12:00 – 13:00	26	1	7	1	35	17
13:00 – 14:00	26	7	5	4	42	5
14:00 – 15:00	25	2	21	4	52	10
15:00 – 16:00	27	0	9	7	43	5
16:00 – 17:00	27	2	5	3	37	5
17:00 – 18:00	26	1	2	10	39	4
12–Hour Total	319	14	104	46	483	98

SOUTHBOUND

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
06:00 – 07:00	15	2	2	4	23	6
07:00 – 08:00	19	2	6	7	34	14
08:00 – 09:00	18	1	9	7	35	11
09:00 – 10:00	22	0	8	1	31	9
10:00 – 11:00	28	2	11	8	49	26
11:00 – 12:00	31	0	7	5	43	9
12:00 – 13:00	32	3	13	5	53	7
13:00 – 14:00	15	0	9	5	29	10
14:00 – 15:00	25	3	9	10	47	7
15:00 – 16:00	42	0	11	6	59	10
16:00 – 17:00	43	1	9	5	58	4
17:00 – 18:00	44	0	5	7	56	17
12–Hour Total	334	14	99	70	517	130

TOTAL TWO–WAY

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
06:00 – 07:00	27	2	3	4	36	24
07:00 – 08:00	48	3	16	9	76	21
08:00 – 09:00	52	1	21	11	85	23
09:00 – 10:00	57	0	14	6	77	14
10:00 – 11:00	52	2	24	11	89	30
11:00 – 12:00	59	0	20	8	87	15
12:00 – 13:00	58	4	20	6	88	24
13:00 – 14:00	41	7	14	9	71	15
14:00 – 15:00	50	5	30	14	99	17
15:00 – 16:00	69	0	20	13	102	15
16:00 – 17:00	70	3	14	8	95	9
17:00 – 18:00	70	1	7	17	95	21
12–Hour Total	653	28	203	116	1000	228

Table A.2

KAFUE RIVER BRIDGE TOLL / WEIGHBRIDGE FEASIBILITY STUDY
12 – HOUR VEHICLE CLASSIFICATION COUNT
Tuesday 11 October 1994

NORTHBOUND

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
06:00 – 07:00	16	0	3	3	22	3
07:00 – 08:00	53	1	4	3	61	11
08:00 – 09:00	39	0	5	1	45	9
09:00 – 10:00	25	1	14	7	47	13
10:00 – 11:00	28	2	14	6	50	3
11:00 – 12:00	20	1	15	6	42	6
12:00 – 13:00	29	0	6	6	41	0
13:00 – 14:00	45	2	4	4	55	0
14:00 – 15:00	41	3	7	8	59	0
15:00 – 16:00	36	0	2	8	46	2
16:00 – 17:00	72	2	11	12	97	19
17:00 – 18:00	17	1	2	1	21	0
12–Hour Total	421	13	87	65	586	66

SOUTHBOUND

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
06:00 – 07:00	40	2	0	8	50	2
07:00 – 08:00	15	2	0	9	26	1
08:00 – 09:00	33	3	0	8	44	5
09:00 – 10:00	55	1	0	8	64	4
10:00 – 11:00	31	0	2	7	40	14
11:00 – 12:00	45	4	0	6	55	5
12:00 – 13:00	39	0	0	11	50	4
13:00 – 14:00	38	1	3	4	46	2
14:00 – 15:00	32	1	1	8	42	2
15:00 – 16:00	45	0	2	10	57	1
16:00 – 17:00	47	0	2	10	59	11
17:00 – 18:00	54	1	2	7	64	13
12–Hour Total	474	15	12	96	597	64

TOTAL TWO–WAY

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
06:00 – 07:00	56	2	3	11	72	5
07:00 – 08:00	68	3	4	12	87	12
08:00 – 09:00	72	3	5	9	89	14
09:00 – 10:00	80	2	14	15	111	17
10:00 – 11:00	59	2	16	13	90	17
11:00 – 12:00	65	5	15	12	97	11
12:00 – 13:00	68	0	6	17	91	4
13:00 – 14:00	83	3	7	8	101	2
14:00 – 15:00	73	4	8	16	101	2
15:00 – 16:00	81	0	4	18	103	3
16:00 – 17:00	119	2	13	22	156	30
17:00 – 18:00	71	2	4	8	85	13
12–Hour Total	895	28	99	161	1183	130

Table A.3

KAFUE RIVER BRIDGE TOLL / WEIGHBRIDGE FEASIBILITY STUDY
24 – HOUR VEHICLE CLASSIFICATION COUNT
Wednesday ,Thursday 12, 13 October 1994

NORTHBOUND

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
00:00 – 01:00	2	0	0	2	4	0
01:00 – 02:00	0	0	0	3	3	0
02:00 – 03:00	0	0	0	3	3	0
03:00 – 04:00	0	0	0	2	2	0
04:00 – 05:00	1	0	1	5	7	0
05:00 – 06:00	3	0	0	2	5	3
06:00 – 07:00	10	0	2	2	14	3
07:00 – 08:00	43	1	7	2	53	17
08:00 – 09:00	36	0	9	3	48	24
09:00 – 10:00	34	1	11	1	47	1
10:00 – 11:00	38	1	23	5	67	11
11:00 – 12:00	18	1	17	9	45	9
12:00 – 13:00	25	0	12	9	46	3
13:00 – 14:00	41	2	7	11	61	0
14:00 – 15:00	20	3	9	7	39	0
15:00 – 16:00	25	0	13	9	47	1
16:00 – 17:00	32	2	6	11	51	0
17:00 – 18:00	36	2	7	5	50	10
18:00 – 19:00	29	0	5	12	46	1
19:00 – 20:00	18	3	0	9	30	0
20:00 – 21:00	14	1	0	2	17	0
21:00 – 22:00	6	0	0	0	6	0
22:00 – 23:00	3	0	0	3	6	0
23:00 – 24:00	1	0	0	3	4	0
TOTAL	435	17	129	120	701	83
	358	13	123	74	568	

SOUTHBOUND

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
00:00 – 01:00	1	0	1	12	14	0
01:00 – 02:00	3	1	1	15	20	0
02:00 – 03:00	0	0	0	7	7	0
03:00 – 04:00	12	4	2	5	23	0
04:00 – 05:00	11	8	2	11	32	0
05:00 – 06:00	14	7	1	15	37	1
06:00 – 07:00	16	2	0	6	24	6
07:00 – 08:00	40	1	2	9	52	13
08:00 – 09:00	39	1	0	2	42	2
09:00 – 10:00	52	2	1	5	60	6
10:00 – 11:00	42	0	2	10	54	16
11:00 – 12:00	40	0	4	7	51	9
12:00 – 13:00	34	3	0	11	48	4
13:00 – 14:00	33	0	0	6	39	6
14:00 – 15:00	20	0	3	16	39	3
15:00 – 16:00	43	0	0	10	53	10
16:00 – 17:00	48	0	1	2	51	12
17:00 – 18:00	54	0	1	8	63	11
18:00 – 19:00	36	2	4	19	61	0
19:00 – 20:00	22	0	4	17	43	0
20:00 – 21:00	8	1	2	18	29	0
21:00 – 22:00	3	0	0	2	5	0
22:00 – 23:00	3	0	3	6	12	0
23:00 – 24:00	3	0	0	7	10	0
TOTAL	577	32	34	226	869	99
	461	9	14	92	576	

TWO – WAY TOTAL

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PERCENT OF TOTAL	PED.
00:00 – 01:00	3	0	1	14	18	1.15	0
01:00 – 02:00	3	1	1	18	23	1.46	0
02:00 – 03:00	0	0	0	10	10	0.64	0
03:00 – 04:00	12	4	2	7	25	1.59	0
04:00 – 05:00	12	8	3	16	39	2.48	0
05:00 – 06:00	17	7	1	17	42	2.68	4
06:00 – 07:00	26	2	2	8	38	2.42	9
07:00 – 08:00	83	2	9	11	105	6.69	30
08:00 – 09:00	75	1	9	5	90	5.73	26
09:00 – 10:00	86	3	12	6	107	6.82	7
10:00 – 11:00	80	1	25	15	121	7.71	27
11:00 – 12:00	58	1	21	16	96	6.11	18
12:00 – 13:00	59	3	12	20	94	5.99	7
13:00 – 14:00	74	2	7	17	100	6.37	6
14:00 – 15:00	40	3	12	23	78	4.97	3
15:00 – 16:00	68	0	13	19	100	6.37	11
16:00 – 17:00	80	2	7	13	102	6.50	12
17:00 – 18:00	90	2	8	13	113	7.20	21
18:00 – 19:00	65	2	9	31	107	6.82	1
19:00 – 20:00	40	3	4	26	73	4.65	0
20:00 – 21:00	22	2	2	20	46	2.93	0
21:00 – 22:00	9	0	0	2	11	0.70	0
22:00 – 23:00	6	0	3	9	18	1.15	0
23:00 – 24:00	4	0	0	10	14	0.89	0
TOTAL	1012	49	163	346	1570	100.00	182

Table A.4

KAFUE RIVER BRIDGE TOLL / WEIGHBRIDGE FEASIBILITY STUDY
12 – HOUR VEHICLE CLASSIFICATION COUNT
Thursday 13 October 1994

NORTHBOUND

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
06:00 – 07:00	13	0	5	3	21	4
07:00 – 08:00	31	1	11	2	45	9
08:00 – 09:00	43	1	15	10	69	16
09:00 – 10:00	22	0	10	5	37	4
10:00 – 11:00	33	1	14	0	48	7
11:00 – 12:00	35	0	7	10	52	7
12:00 – 13:00	33	1	13	6	53	2
13:00 – 14:00	28	5	15	4	52	0
14:00 – 15:00	15	1	14	11	41	3
15:00 – 16:00	30	1	12	8	51	4
16:00 – 17:00	43	2	4	8	57	3
17:00 – 18:00	35	2	10	8	55	0
12–Hour Total	361	15	130	75	581	59

SOUTHBOUND

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
06:00 – 07:00	18	2	1	5	26	4
07:00 – 08:00	37	1	3	9	50	10
08:00 – 09:00	46	3	1	2	52	2
09:00 – 10:00	48	1	5	6	60	12
10:00 – 11:00	30	0	10	10	50	15
11:00 – 12:00	32	3	9	8	52	15
12:00 – 13:00	44	2	3	11	60	3
13:00 – 14:00	54	6	12	11	83	4
14:00 – 15:00	54	4	10	14	82	14
15:00 – 16:00	54	0	0	9	63	5
16:00 – 17:00	41	0	3	8	52	1
17:00 – 18:00	55	0	2	8	65	2
12–Hour Total	513	22	59	101	695	87

TOTAL TWO–WAY

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
06:00 – 07:00	31	2	6	8	47	8
07:00 – 08:00	68	2	14	11	95	19
08:00 – 09:00	89	4	16	12	121	18
09:00 – 10:00	70	1	15	11	97	16
10:00 – 11:00	63	1	24	10	98	22
11:00 – 12:00	67	3	16	18	104	22
12:00 – 13:00	77	3	16	17	113	5
13:00 – 14:00	82	11	27	15	135	4
14:00 – 15:00	69	5	24	25	123	17
15:00 – 16:00	84	1	12	17	114	9
16:00 – 17:00	84	2	7	16	109	4
17:00 – 18:00	90	2	12	16	120	2
12–Hour Total	874	37	189	176	1276	146

Table A.5

KAFUE RIVER BRIDGE TOLL / WEIGHBRIDGE FEASIBILITY STUDY
12 – HOUR VEHICLE CLASSIFICATION COUNT
Friday 14 October 1994

NORTHBOUND

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
06:00 – 07:00	13	0	4	2	19	4
07:00 – 08:00	24	1	11	4	40	3
08:00 – 09:00	33	0	7	9	49	14
09:00 – 10:00	37	0	8	10	55	7
10:00 – 11:00	29	0	15	7	51	4
11:00 – 12:00	31	0	12	7	50	4
12:00 – 13:00	28	1	13	12	54	3
13:00 – 14:00	38	3	9	10	60	6
14:00 – 15:00	30	0	4	10	44	3
15:00 – 16:00	38	2	7	9	56	13
16:00 – 17:00	55	2	8	3	68	4
17:00 – 18:00	43	2	10	7	62	11
12–Hour Total	399	11	108	90	608	76

SOUTHBOUND

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
06:00 – 07:00	23	2	0	8	33	4
07:00 – 08:00	29	2	1	7	39	7
08:00 – 09:00	27	5	0	10	42	6
09:00 – 10:00	45	0	1	6	52	13
10:00 – 11:00	45	1	2	6	54	4
11:00 – 12:00	55	0	0	6	61	9
12:00 – 13:00	48	4	3	9	64	4
13:00 – 14:00	46	2	3	6	57	6
14:00 – 15:00	44	2	7	10	63	10
15:00 – 16:00	64	0	0	5	69	5
16:00 – 17:00	53	0	2	12	67	7
17:00 – 18:00	50	1	7	5	63	14
12–Hour Total	529	19	26	90	664	89

TOTAL TWO–WAY

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
06:00 – 07:00	36	2	4	10	52	8
07:00 – 08:00	53	3	12	11	79	10
08:00 – 09:00	60	5	7	19	91	20
09:00 – 10:00	82	0	9	16	107	20
10:00 – 11:00	74	1	17	13	105	8
11:00 – 12:00	86	0	12	13	111	13
12:00 – 13:00	76	5	16	21	118	7
13:00 – 14:00	84	5	12	16	117	12
14:00 – 15:00	74	2	11	20	107	13
15:00 – 16:00	102	2	7	14	125	18
16:00 – 17:00	108	2	10	15	135	11
17:00 – 18:00	93	3	17	12	125	25
12–Hour Total	928	30	134	180	1272	165

Table A.6

KAFUE RIVER BRIDGE TOLL / WEIGHBRIDGE FEASIBILITY STUDY
24 – HOUR VEHICLE CLASSIFICATION COUNT
Saturday, Sunday 15, 16 October 1994

NORTHBOUND

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
00:00 – 01:00	3	0	1	2	6	0
01:00 – 02:00	3	1	0	1	5	0
02:00 – 03:00	1	0	0	0	1	0
03:00 – 04:00	1	0	0	6	7	0
04:00 – 05:00	2	0	2	2	6	0
05:00 – 06:00	5	1	0	4	10	1
06:00 – 07:00	14	0	4	9	27	14
07:00 – 08:00	16	1	6	2	25	16
08:00 – 09:00	27	1	6	5	39	5
09:00 – 10:00	26	0	14	7	47	6
10:00 – 11:00	31	4	11	10	56	3
11:00 – 12:00	35	0	8	6	49	3
12:00 – 13:00	34	0	9	5	48	6
13:00 – 14:00	48	2	10	4	64	3
14:00 – 15:00	33	3	8	2	46	5
15:00 – 16:00	60	0	12	3	75	22
16:00 – 17:00	63	4	8	5	80	10
17:00 – 18:00	59	2	13	10	84	8
18:00 – 19:00	50	1	3	7	61	4
19:00 – 20:00	37	3	2	2	44	0
20:00 – 21:00	16	0	2	4	22	0
21:00 – 22:00	4	0	1	4	9	0
22:00 – 23:00	5	0	0	1	6	0
23:00 – 24:00	2	1	0	1	4	0
TOTAL	575	24	120	102	821	106

SOUTHBOUND

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
00:00 – 01:00	2	0	0	1	3	0
01:00 – 02:00	2	0	0	0	2	0
02:00 – 03:00	4	0	0	1	5	0
03:00 – 04:00	0	0	0	0	0	0
04:00 – 05:00	1	0	0	0	1	0
05:00 – 06:00	2	1	2	1	6	3
06:00 – 07:00	39	2	0	6	47	6
07:00 – 08:00	51	2	5	8	66	20
08:00 – 09:00	51	5	10	12	78	31
09:00 – 10:00	71	0	3	11	85	25
10:00 – 11:00	83	1	3	9	96	20
11:00 – 12:00	52	0	4	8	64	12
12:00 – 13:00	88	0	7	14	109	17
13:00 – 14:00	67	0	2	8	77	11
14:00 – 15:00	79	1	4	10	94	20
15:00 – 16:00	47	2	7	6	62	17
16:00 – 17:00	33	0	4	7	44	20
17:00 – 18:00	32	0	5	6	43	11
18:00 – 19:00	13	1	2	4	20	1
19:00 – 20:00	13	0	0	5	18	0
20:00 – 21:00	9	0	0	5	14	0
21:00 – 22:00	5	0	0	3	8	0
22:00 – 23:00	2	0	1	0	3	0
23:00 – 24:00	0	0	0	0	0	0
TOTAL	746	15	59	125	945	214

TWO – WAY TOTAL

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
00:00 – 01:00	5	0	1	3	9	0
01:00 – 02:00	5	1	0	1	7	0
02:00 – 03:00	5	0	0	1	6	0
03:00 – 04:00	1	0	0	6	7	0
04:00 – 05:00	3	0	2	2	7	0
05:00 – 06:00	7	2	2	5	16	4
06:00 – 07:00	53	2	4	15	74	20
07:00 – 08:00	67	3	11	10	91	36
08:00 – 09:00	78	6	16	17	117	36
09:00 – 10:00	97	0	17	18	132	31
10:00 – 11:00	114	5	14	19	152	23
11:00 – 12:00	87	0	12	14	113	15
12:00 – 13:00	122	0	16	19	157	23
13:00 – 14:00	115	2	12	12	141	14
14:00 – 15:00	112	4	12	12	140	25
15:00 – 16:00	107	2	19	9	137	39
16:00 – 17:00	96	4	12	12	124	30
17:00 – 18:00	91	2	18	16	127	19
18:00 – 19:00	63	2	5	11	81	5
19:00 – 20:00	50	3	2	7	62	0
20:00 – 21:00	25	0	2	9	36	0
21:00 – 22:00	9	0	1	7	17	0
22:00 – 23:00	7	0	1	1	9	0
23:00 – 24:00	2	1	0	1	4	0
TOTAL	1321	39	179	227	1766	320

Table A.7

KAFUE RIVER BRIDGE TOLL / WEIGHBRIDGE FEASIBILITY STUDY
12 – HOUR VEHICLE CLASSIFICATION COUNT
Sunday 16 October 1994

NORTHBOUND

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
06:00 – 07:00	5	0	1	2	8	1
07:00 – 08:00	10	1	1	0	12	7
08:00 – 09:00	6	0	6	0	12	5
09:00 – 10:00	11	0	6	2	19	1
10:00 – 11:00	29	3	5	0	37	3
11:00 – 12:00	37	0	6	4	47	10
12:00 – 13:00	40	1	14	2	57	1
13:00 – 14:00	32	4	10	12	58	7
14:00 – 15:00	36	0	4	6	46	3
15:00 – 16:00	70	0	9	10	89	7
16:00 – 17:00	65	1	10	4	80	26
17:00 – 18:00	84	4	5	6	99	4
12–Hour Total	425	14	77	48	564	75

SOUTHBOUND

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
06:00 – 07:00	6	1	1	8	16	1
07:00 – 08:00	23	1	2	4	30	7
08:00 – 09:00	34	2	3	6	45	11
09:00 – 10:00	44	1	5	7	57	21
10:00 – 11:00	57	1	9	7	74	12
11:00 – 12:00	39	3	8	6	56	23
12:00 – 13:00	52	1	8	5	66	11
13:00 – 14:00	34	0	2	6	42	6
14:00 – 15:00	30	0	4	3	37	11
15:00 – 16:00	40	0	8	1	49	16
16:00 – 17:00	32	0	5	3	40	10
17:00 – 18:00	32	2	3	3	40	9
12–Hour Total	423	12	58	59	552	138

TOTAL TWO–WAY

TIME	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL	PED.
06:00 – 07:00	11	1	2	10	24	2
07:00 – 08:00	33	2	3	4	42	14
08:00 – 09:00	40	2	9	6	57	16
09:00 – 10:00	55	1	11	9	76	22
10:00 – 11:00	86	4	14	7	111	15
11:00 – 12:00	76	3	14	10	103	33
12:00 – 13:00	92	2	22	7	123	12
13:00 – 14:00	66	4	12	18	100	13
14:00 – 15:00	66	0	8	9	83	14
15:00 – 16:00	110	0	17	11	138	23
16:00 – 17:00	97	1	15	7	120	36
17:00 – 18:00	116	6	8	9	139	13
12–Hour Total	848	26	135	107	1116	213

Table A.8

KAFUE RIVER BRIDGE TOLL / WEIGHBRIDGE FEASIBILITY STUDY
12 – HOUR VEHICLE CLASSIFICATION COUNT

NORTHBOUND

	DAY OF WEEK						
TIME	17/10/94 MONDAY	11/10/94 TUESDAY	12/10/94 WEDNESDAY	13/10/94 THURSDAY	14/10/94 FRIDAY	15/10/94 SATURDAY	16/10/94 SUNDAY
06:00 – 07:00	13	22	14	21	19	27	8
07:00 – 08:00	42	61	53	45	40	25	12
08:00 – 09:00	50	45	48	69	49	39	12
09:00 – 10:00	46	47	47	37	55	47	19
10:00 – 11:00	40	50	67	48	51	56	37
11:00 – 12:00	44	42	45	52	50	49	47
12:00 – 13:00	35	41	46	53	54	48	57
13:00 – 14:00	42	55	61	52	60	64	58
14:00 – 15:00	52	59	39	41	44	46	46
15:00 – 16:00	43	46	47	51	56	75	89
16:00 – 17:00	37	97	51	57	68	80	80
17:00 – 18:00	39	21	50	55	62	84	99
12–Hour Total	483	586	568	581	608	640	564

SOUTHBOUND

	DAY OF WEEK						
TIME	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
06:00 – 07:00	23	50	24	26	33	47	16
07:00 – 08:00	34	26	52	50	39	66	30
08:00 – 09:00	35	44	42	52	42	78	45
09:00 – 10:00	31	64	60	60	52	85	57
10:00 – 11:00	49	40	54	50	54	96	74
11:00 – 12:00	43	55	51	52	61	64	56
12:00 – 13:00	53	50	48	60	64	109	66
13:00 – 14:00	29	46	39	83	57	77	42
14:00 – 15:00	47	42	39	82	63	94	37
15:00 – 16:00	59	57	53	63	69	62	49
16:00 – 17:00	58	59	51	52	67	44	40
17:00 – 18:00	56	64	63	65	63	43	40
12–Hour Total	517	597	576	695	664	865	552

TWO – WAY TOTAL

	DAY OF WEEK						
TIME	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
06:00 – 07:00	36	72	38	47	52	74	24
07:00 – 08:00	76	87	105	95	79	91	42
08:00 – 09:00	85	89	90	121	91	117	57
09:00 – 10:00	77	111	107	97	107	132	76
10:00 – 11:00	89	90	121	98	105	152	111
11:00 – 12:00	87	97	96	104	111	113	103
12:00 – 13:00	88	91	94	113	118	157	123
13:00 – 14:00	71	101	100	135	117	141	100
14:00 – 15:00	99	101	78	123	107	140	83
15:00 – 16:00	102	103	100	114	125	137	138
16:00 – 17:00	95	156	102	109	135	124	120
17:00 – 18:00	95	85	113	120	125	127	139
12–Hour Total	1,000	1,183	1,144	1,276	1,272	1,505	1,116

Appendix B: Origin Destination Paired Movements

Table B.1
NORTHBOUND PAIRED MOVEMENTS
Kafue River Bridge Toll/Weighbridge Feasibility Study

ORIGIN	DESTINATION	TYPE TRIP (1)	DISTANCE TRAVELLED IN ZAMBIA	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL
Botswana	Chingola	I	1072	1	0	0	0	1
Botswana	Lusaka	I	662	1	0	0	0	1
Lesotho	Ndola	I	457	1	0	0	0	1
Namibia	Malawi	T	1231	1	0	0	0	1
Namibia	Ndola	I	983	0	0	0	1	1
South Africa	Zaire	T	581	0	0	0	10	10
South Africa	Kabwe	I	613	1	0	0	2	3
South Africa	Kafue	I	92	1	0	0	0	1
South Africa	Kitwe	I	494	2	0	0	1	3
South Africa	Lusaka	I	136	10	0	2	16	28
South Africa	Mufulira	I	521	0	0	0	1	1
South Africa	Ndola	I	457	0	0	0	1	1
South Africa	Chilanga	I	106	1	0	0	0	1
South Africa	Chikankata	I	150	1	0	0	0	1
South Africa	Mkushi	I	428	0	0	0	1	1
Swaziland	Kitwe	I	494	0	0	0	1	1
Swaziland	Lusaka	I	136	1	0	0	0	1
Zimbabwe	Malawi	T	705	2	0	0	1	3
Zimbabwe	Tanzania	T	1583	0	0	0	2	2
Zimbabwe	Zaire	T	581	0	0	0	17	17
Zimbabwe	Chingola	I	546	0	0	0	1	1
Zimbabwe	Kabwe	I	274	2	0	0	0	2
Zimbabwe	Kitwe	I	494	3	0	1	3	7
Zimbabwe	Luanshya	I	467	1	0	0	0	1
Zimbabwe	Lusaka	I	136	24	6	1	19	50
Zimbabwe	Mumbwa	I	287	1	0	0	0	1
Zimbabwe	Nakonde	I	1150	0	0	0	1	1
Zimbabwe	Ndola	I	457	2	0	0	2	4
Zimbabwe	Chilanga	I	106	0	0	0	2	2
Zimbabwe	Nega-Nega	I	110	0	0	0	1	1
Zimbabwe	Mpulungu	I	1191	0	0	0	5	5
Chipata	Lusaka	L	569	1	0	0	0	1
Chirundu	Choma	L	308	0	0	1	0	1

Table B.1
NORTHBOUND PAIRED MOVEMENTS
Kafue River Bridge Toll/Weighbridge Feasibility Study

ORIGIN	DESTINATION	TYPE TRIP (1)	DISTANCE TRAVELLED IN ZAMBIA	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL
Chirundu	Kafue	L	92	8	0	9	0	17
Chirundu	Kitwe	L	494	1	0	0	0	1
Chirundu	Lusaka	L	136	37	0	1	4	42
Choma	Kabwe	L	274	2	0	2	1	5
Choma	Kafue	L	240	1	1	1	1	4
Choma	Lusaka	L	284	57	6	11	12	86
Choma	Ndola	L	605	3	0	0	7	10
Kafue	Kabwe	L	182	1	0	0	0	1
Kafue	Kafue	L	12	18	0	4	1	23
Kafue	Lusaka	L	56	8	0	5	2	15
M. Mainda	Lusaka	L	81	0	0	0	1	1
Siavonga	Kitwe	L	497	1	0	0	0	1
Livingstone	Chipata	L	1041	0	0	1	0	1
Livingstone	Kabwe	L	610	2	0	1	0	3
Livingstone	Kafue	L	428	4	1	1	0	6
Livingstone	Kapiri Mposhi	L	678	0	0	0	1	1
Livingstone	Kitwe	L	830	0	1	0	0	1
Livingstone	Lusaka	L	472	40	9	9	0	58
Livingstone	Mufulira	L	857	0	0	1	0	1
Livingstone	Ndola	L	793	2	0	0	1	3
Mazabuka	Kafue	L	263	1	0	0	0	1
Mazabuka	Kabwe	L	81	12	0	7	5	24
Mazabuka	Kitwe	L	483	1	0	0	2	3
Mazabuka	Lusaka	L	125	184	2	34	35	255
Mazabuka	Mufulira	L	706	1	0	0	0	1
Mazabuka	Ndola	L	446	1	0	0	2	3
Mazabuka	Chilanga	L	105	4	0	0	2	4
Mazabuka	Kaoma	L	521	1	0	0	0	1
Mazabuka	Mpulungu	L	1180	0	0	0	5	5
Zambezi	Lusaka	L	769	0	0	1	0	1
Kalomo	Lusaka	L	364	9	0	2	0	11
Kalomo	Ndola	L	685	0	0	0	1	1

Table B.1
NORTHBOUND PAIRED MOVEMENTS
Kafue River Bridge Toll/Weighbridge Feasibility Study

ORIGIN	DESTINATION	TYPE TRIP (1)	DISTANCE TRAVELLED IN ZAMBIA	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL
Kalomo	Chilanga	L	344	1	0	0	0	1
M. Mainda	Kabwe	L	211	1	0	0	0	1
M. Mainda	Kafue	L	52	11	0	8	0	19
M. Mainda	Lusaka	L	76	7	0	9	6	22
Siavonga	Kabwe	L	321	1	0	0	0	1
Siavonga	Kafue	L	139	7	0	0	0	7
Siavonga	Kitwe	L	541	3	0	0	0	3
Siavonga	Lusaka	L	183	79	2	5	3	89
Siavonga	Mufulira	L	568	1	0	0	0	1
Monze	Kabwe	L	323	1	0	0	0	1
Monze	Kafue	L	141	3	0	0	0	3
Monze	Lusaka	L	185	52	5	2	2	61
Monze	Mongu	L	766	0	0	0	1	1
Monze	Ndola	L	506	2	0	0	2	4
Monze	Chilanga	L	165	1	0	0	1	2
Chikankata	Kafue	L	83	3	0	1	0	4
Chikankata	Lusaka	L	127	11	0	3	4	18
Chikankata	Chilanga	L	107	1	0	0	0	1
Kafue-Gorge	Kafue	L	70	19	0	2	1	22
Kafue-Gorge	Lusaka	L	114	19	0	2	0	21
Kafue-Gorge	Mazabuka	L	151	0	0	1	0	1
Nega-Nega	Kafue	L	52	6	0	0	0	6
Nega-Nega	Lusaka	L	96	9	0	0	1	10
Turn-Park	Kafue	L	12	12	0	0	0	12
Turn-Park	Lusaka	L	56	1	0	1	0	2
Turn-Park	Chilanga	L	36	1	0	0	0	1
Lusitu	Kabwe	L	264	1	0	0	0	1
Lusitu	Lusaka	L	126	1	0	1	0	2
Chivuna	Kafue	L	86	1	0	0	0	1
Chivuna	Lusaka	L	130	1	0	0	0	1
Pemba	Lusaka	L	220	4	0	0	0	4
Maamba	Kitwe	L	704	1	0	0		1

186

Table B.1
NORTHBOUND PAIRED MOVEMENTS
Kafue River Bridge Toll/Weighbridge Feasibility Study

ORIGIN	DESTINATION	TYPE TRIP (1)	DISTANCE TRAVELLED IN ZAMBIA	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL
Maamba	Lusaka	L	346	3	0	1	2	6
Maamba	Chilanga	L	326	0	0	0	2	2
Namwala	Kabwe	L	590	0	0	1	0	1
Namwala	Lusaka	L	452	3	0	0	0	3
Chisekesi	Lusaka	L	205	0	0	1	0	1
Gwembe	Lusaka	L	221	2	0	0	0	2
Zimba	Lusaka	L	395	0	1	0	0	1
TOTAL				725	34	133	194	1086

Source: Field surveys conducted October, 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates

(1) **L = Local (O-D) both in Zambia)**
I = International (O-D, but not both in Zambia)
T = Transit (Neither Origin nor Destination in Zambia)

Table B.2
SOUTHBOUND PAIRED MOVEMENTS
Kafue River Bridge Toll/Weighbridge Feasibility Study

ORIGIN	DESTINATION	TYPE TRIP (1)	DISTANCE TRAVELLED IN ZAMBIA	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL
Malawi	South Africa	T	705	2	0	1	1	4
Malawi	Siavonga	I	752	1	0	0	0	1
Tanzania	Zimbabwe	T	1150	0	0	2	1	3
Zaire	South Africa	T	581	0	0	0	2	2
Zaire	Zimbabwe	T	581	2	0	1	3	6
Zaire	Choma	I	714	1	0	0	0	1
Chingola	South Africa	I	546	1	0	1	0	2
Chingola	Zimbabwe	I	546	0	0	1	0	1
Chingola	Mazabuka	L	535	1	0	0	0	1
Chingola	Kalomo	L	755	1	0	0	0	1
Chipata	South Africa	I	705	1	0	0	0	1
Chipata	Zimbabwe	I	705	2	0	0	0	2
Chipata	Mazabuka	L	694	0	0	0	1	1
Choma	Zimbabwe	I	308	1	0	0	0	1
Kabwe	Zimbabwe	I	274	1	0	0	0	1
Kabwe	Choma	L	422	0	0	0	1	1
Kabwe	Mazabuka	L	263	0	0	2	2	4
Kabwe	Monze	L	323	0	0	0	1	1
Kabwe	Chikankata	L	263	0	0	1	0	1
Kabwe	Pemba	L	355	1	0	0	0	1
Kabwe	Namwala	L	590	0	1	0	0	1
Kafue	Botswana	I	800	2	0	0	0	2
Kafue	South Africa	I	92	1	0	0	0	1
Kafue	Zimbabwe	I	92	2	0	1	0	3
Kafue	Chirundu	L	92	12	0	0	0	12
Kafue	Choma	L	240	12	1	5	1	19
Kafue	Kafue	L	12	18	0	1	0	19
Kafue	Mazabuka	L	81	21	1	3	2	27
Kafue	Kalomo	L	320	1	0	0	0	1

Table B.2
SOUTHBOUND PAIRED MOVEMENTS
Kafue River Bridge Toll/Weighbridge Feasibility Study

ORIGIN	DESTINATION	TYPE TRIP (1)	DISTANCE TRAVELLED IN ZAMBIA	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL
Kafue	M. Mainda	L	32	28	1	8	1	38
Kafue	Siavonga	L	139	16	1	0	0	17
Kafue	Monze	L	141	5	1	0	0	6
Kafue	Chikankata	L	83	2	0	0	0	2
Kafue	Kafue-Gorge	L	70	22	2	1	0	25
Kafue	Nega-Nega	L	52	5	1	0	0	6
Kafue	Turn-Park	L	12	29	1	3	1	34
Kafue	Pemba	L	176	1	0	0	0	1
Kafue	Maamba	L	302	3	1	0	0	4
Kapiri Mposhi	Zimbabwe	I	342	0	0	0	2	2
Kasama	Swaziland	I	986	1	0	0	0	1
Kasama	Zimbabwe	I	986	1	0	0	0	1
Kitwe	South Africa	I	494	3	0	4	9	16
Kitwe	Zimbabwe	I	494	3	0	2	4	9
Kitwe	Chirundu	L	494	2	1	1	0	4
Kitwe	Livingstone	L	830	2	1	0	0	3
Kitwe	Mazabuka	L	483	3	0	0	0	3
Kitwe	Siavonga	L	541	1	0	0	0	1
Kitwe	Monze	L	543	2	0	0	1	3
Kitwe	Turn-Park	L	414	1	0	0	0	1
Luanshya	South Africa	I	467	0	0	0	1	1
Luanshya	Chirundu	L	467	1	0	0	0	1
Lusaka	Botswana	I	686	9	0	0	1	10
Lusaka	South Africa	I	136	9	1	7	5	22
Lusaka	Swaziland	I	136	1	0	0	0	1
Lusaka	Zimbabwe	I	136	49	19	13	27	108
Lusaka	Mozambique	I	136	0	0	1	2	3
Lusaka	Chirundu	L	136	54	3	2	2	61

Table B.2
SOUTHBOUND PAIRED MOVEMENTS
Kafue River Bridge Toll/Weighbridge Feasibility Study

ORIGIN	DESTINATION	TYPE TRIP (1)	DISTANCE TRAVELLED IN ZAMBIA	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL
Lusaka	Choma	L	284	73	10	11	11	105
Lusaka	Kafue	L	44	26	1	4	2	33
Lusaka	Livingstone	L	472	45	13	8	6	72
Lusaka	Mansa	L	561	146	12	24	28	210
Lusaka	Zambezi	L	769	1	0	0	0	1
Lusaka	Chilanga	L	20	1	0	0	0	1
Lusaka	Kalomo	L	364	7	0	1	0	8
Lusaka	M. Mainda	L	76	48	1	21	4	74
Lusaka	Siavonga	L	183	70	6	3	2	81
Lusaka	Monze	L	185	53	10	2	2	67
Lusaka	Chikankata	L	127	25	2	1	2	30
Lusaka	Kafue-Gorge	L	114	14	0	0	0	14
Lusaka	Nega-Nega	L	96	2	0	0	1	3
Lusaka	Turn-Park	L	56	11	0	1	0	12
Lusaka	Pemba	L	220	2	1	0	0	3
Lusaka	Maamba	L	346	18	2	11	5	36
Lusaka	Namwala	L	452	5	0	0	0	5
Lusaka	Chisekesi	L	205	0	0	0	1	1
Lusaka	Gwembe	L	221	1	0	0	0	1
Mpika	Livingstone	L	1111	1	0	0	0	1
Mongu	Livingstone	L	1053	1	0	0	0	1
Mufulira	South Africa	I	495	1	0	0	2	3
Mufulira	Zimbabwe	I	495	1	0	0	0	1
Mufulira	Siavonga	L	568	2	0	0	0	2
Mumbwa	Kafue	L	207	1	0	0	0	1
Ndola	South Africa	I	457	2	0	1	0	3
Ndola	Zimbabwe	I	457	1	0	3	0	4
Ndola	Chirundu	L	457	1	0	0	0	1
Ndola	Choma	L	605	1	0	4	4	9

130

Table B.2
SOUTHBOUND PAIRED MOVEMENTS
Kafue River Bridge Toll/Weighbridge Feasibility Study

ORIGIN	DESTINATION	TYPE TRIP (1)	DISTANCE TRAVELLED IN ZAMBIA	LIGHT VEHICLES	BUSES	SINGLE BED TRUCKS	HEAVY TRUCKS	TOTAL
Ndola	Livingstone	L	793	3	1	0	1	5
Ndola	Mazabuka	L	446	4	0	2	4	10
Ndola	Siavonga	L	504	1	0	0	0	1
Ndola	Zimba	L	716	0	0	0	1	1
Chilanga	Chirundu	L	106	1	0	0	0	1
Chilanga	Kafue	L	30	2	1	1	0	4
Chilanga	Livingstone	L	452	1	0	0	0	1
Chilanga	Mazabuka	L	105	5	0	0	0	5
Chilanga	Kalomo	L	344	1	0	0	0	1
Chilanga	M. Mainda	L	56	2	0	0	0	2
Chilanga	Monze	L	165	3	0	0	0	3
Chilanga	Chikankata	L	107	2	0	0	0	2
Chilanga	Kafue-Gorge	L	94	1	0	0	0	1
Chilanga	Turn-Park	L	36	2	0	0	0	2
Mkushi	Zimbabwe	I	428	1	0	0	0	1
Mpulungu	Zimbabwe	I	1191	0	0	2	3	5
Luangwa	Zimbabwe	I	332	1	0	0	1	1
TOTAL				927	96	161	150	1334

Source: **Field surveys conducted October, 1994 by Morrison Knudsen Corporation in association with Wilbur Smith Associates.**

(1) **L = Local (O-D) both in Zambia)**
I = International (O-D, but not both in Zambia)
T = Transit (Neither Origin nor Destination in Zambia)

Appendix C: B/C, NPV and PV Analysis Tables

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE A-1
CALCULATION OF NPV, B/C RATIO, IRR
5 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS= 8 DISCOUNT RATE=10.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	357.0	.0	.0	.0
1996	.0	86.4	86.4	64.9	442.9	442.9	332.8
1997	.0	86.4	86.4	59.0	454.6	454.6	310.5
1998	.0	86.4	86.4	53.6	466.6	466.6	289.7
1999	.0	86.4	86.4	48.8	479.0	479.0	270.4
2000	.0	86.4	86.4	44.3	491.6	491.6	252.3
TOT	432.0	432.0	864.0	627.7	2334.7	2334.7	1455.6

BENEFIT/COST RATIO= 2.32
NET PRESENT VALUE= 827.9

KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE A-2
CALCULATION OF NPV, B/C RATIO, IRR
5 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS= 8 DISCOUNT RATE=12.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	344.4	.0	.0	.0
1996	.0	86.4	86.4	61.5	442.9	442.9	315.2
1997	.0	86.4	86.4	54.9	454.6	454.6	288.9
1998	.0	86.4	86.4	49.0	466.6	466.6	264.8
1999	.0	86.4	86.4	43.8	479.0	479.0	242.7
2000	.0	86.4	86.4	39.1	491.6	491.6	222.4
TOT	432.0	432.0	864.0	592.7	2334.7	2334.7	1334.0

BENEFIT/COST RATIO= 2.25
NET PRESENT VALUE= 741.3

KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE A-3
CALCULATION OF NPV, B/C RATIO, IRR
5 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS= 8 DISCOUNT RATE=15.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	326.7	.0	.0	.0
1996	.0	86.4	86.4	56.8	442.9	442.9	291.2
1997	.0	86.4	86.4	49.4	454.6	454.6	259.9
1998	.0	86.4	86.4	43.0	466.6	466.6	232.0
1999	.0	86.4	86.4	37.4	479.0	479.0	207.1
2000	.0	86.4	86.4	32.5	491.6	491.6	184.8
TOT	432.0	432.0	864.0	545.7	2334.7	2334.7	1175.0

BENEFIT/COST RATIO= 2.15
NET PRESENT VALUE= 629.4

KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE A-4
CALCULATION OF NPV, B/C RATIO, IRR
10 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=13 DISCOUNT RATE=10.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	357.0	.0	.0	.0
1996	.0	86.4	86.4	64.9	442.9	442.9	332.8
1997	.0	86.4	86.4	59.0	454.6	454.6	310.5
1998	.0	86.4	86.4	53.6	466.6	466.6	289.7
1999	.0	86.4	86.4	48.8	479.0	479.0	270.4
2000	.0	86.4	86.4	44.3	491.6	491.6	252.3
2001	.0	86.4	86.4	40.3	507.4	507.4	236.7
2002	.0	86.4	86.4	36.6	523.4	523.4	222.0
2003	.0	86.4	86.4	33.3	540.6	540.6	208.4
2004	.0	86.4	86.4	30.3	558.0	558.0	195.6
2005	.0	86.4	86.4	27.5	575.9	575.9	183.5
TOT	432.0	864.0	1296.0	795.8	5040.0	5040.0	2501.8

BENEFIT/COST RATIO= 3.14
NET PRESENT VALUE= 1706.0

KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE A-5
CALCULATION OF NPV, B/C RATIO, IRR
10 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=13 DISCOUNT RATE=12.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	344.4	.0	.0	.0
1996	.0	86.4	86.4	61.5	442.9	442.9	315.2
1997	.0	86.4	86.4	54.9	454.6	454.6	288.9
1998	.0	86.4	86.4	49.0	466.6	466.6	264.8
1999	.0	86.4	86.4	43.8	479.0	479.0	242.7
2000	.0	86.4	86.4	39.1	491.6	491.6	222.4
2001	.0	86.4	86.4	34.9	507.4	507.4	204.9
2002	.0	86.4	86.4	31.2	523.4	523.4	188.7
2003	.0	86.4	86.4	27.8	540.6	540.6	174.1
2004	.0	86.4	86.4	24.8	558.0	558.0	160.4
2005	.0	86.4	86.4	22.2	575.9	575.9	147.8
TOT	432.0	864.0	1296.0	733.6	5040.0	5040.0	2209.9

BENEFIT/COST RATIO= 3.01
NET PRESENT VALUE= 1476.4

KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE A-6
CALCULATION OF NPV, B/C RATIO, IRR
10 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=13 DISCOUNT RATE=15.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	326.7	.0	.0	.0
1996	.0	86.4	86.4	56.8	442.9	442.9	291.2
1997	.0	86.4	86.4	49.4	454.6	454.6	259.9
1998	.0	86.4	86.4	43.0	466.6	466.6	232.0
1999	.0	86.4	86.4	37.4	479.0	479.0	207.1
2000	.0	86.4	86.4	32.5	491.6	491.6	184.8
2001	.0	86.4	86.4	28.2	507.4	507.4	165.9
2002	.0	86.4	86.4	24.6	523.4	523.4	148.8
2003	.0	86.4	86.4	21.4	540.6	540.6	133.6
2004	.0	86.4	86.4	18.6	558.0	558.0	119.9
2005	.0	86.4	86.4	16.1	575.9	575.9	107.6
TOT	432.0	864.0	1296.0	654.5	5040.0	5040.0	1850.9

BENEFIT/COST RATIO= 2.83
NET PRESENT VALUE= 1196.3

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE A-7
CALCULATION OF NPV, B/C RATIO, IRR
10 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=23 DISCOUNT RATE=10.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	357.0	.0	.0	.0
1996	.0	86.4	86.4	64.9	442.9	442.9	332.8
1997	.0	86.4	86.4	59.0	454.6	454.6	310.5
1998	.0	86.4	86.4	53.6	466.6	466.6	289.7
1999	.0	86.4	86.4	48.8	479.0	479.0	270.4
2000	.0	86.4	86.4	44.3	491.6	491.6	252.3
2001	.0	86.4	86.4	40.3	507.4	507.4	236.7
2002	.0	86.4	86.4	36.6	523.4	523.4	222.0
2003	.0	86.4	86.4	33.3	540.6	540.6	208.4
2004	.0	86.4	86.4	30.3	558.0	558.0	195.6
2005	.0	86.4	86.4	27.5	575.9	575.9	183.5
2006	.0	86.4	86.4	25.0	595.3	595.3	172.4
2007	.0	86.4	86.4	22.8	614.6	614.6	161.8
2008	.0	86.4	86.4	20.7	636.1	636.1	152.3
2009	.0	86.4	86.4	18.8	657.4	657.4	143.1
2010	.0	86.4	86.4	17.1	679.6	679.6	134.5
2011	.0	86.4	86.4	15.5	702.5	702.5	126.4
2012	.0	86.4	86.4	14.1	726.1	726.1	118.7
2013	.0	86.4	86.4	12.8	750.5	750.5	111.6
2014	.0	86.4	86.4	11.7	775.8	775.8	104.8
2015	.0	86.4	86.4	10.6	801.9	801.9	98.5
TOT	432.0	1728.0	2160.0	964.9	11979.8	11979.8	3825.9

BENEFIT/COST RATIO= 3.96
NET PRESENT VALUE= 2860.9

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE A-8
CALCULATION OF NPV, B/C RATIO, IRR
10 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=23 DISCOUNT RATE=12.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	344.4	.0	.0	.0
1996	.0	86.4	86.4	61.5	442.9	442.9	315.2
1997	.0	86.4	86.4	54.9	454.6	454.6	288.9
1998	.0	86.4	86.4	49.0	466.6	466.6	264.8
1999	.0	86.4	86.4	43.8	479.0	479.0	242.7
2000	.0	86.4	86.4	39.1	491.6	491.6	222.4
2001	.0	86.4	86.4	34.9	507.4	507.4	204.9
2002	.0	86.4	86.4	31.2	523.4	523.4	188.7
2003	.0	86.4	86.4	27.8	540.6	540.6	174.1
2004	.0	86.4	86.4	24.8	558.0	558.0	160.4
2005	.0	86.4	86.4	22.2	575.9	575.9	147.8
2006	.0	86.4	86.4	19.8	595.3	595.3	136.4
2007	.0	86.4	86.4	17.7	614.6	614.6	125.8
2008	.0	86.4	86.4	15.8	636.1	636.1	116.2
2009	.0	86.4	86.4	14.1	657.4	657.4	107.2
2010	.0	86.4	86.4	12.6	679.6	679.6	99.0
2011	.0	86.4	86.4	11.2	702.5	702.5	91.4
2012	.0	86.4	86.4	10.0	726.1	726.1	84.3
2013	.0	86.4	86.4	9.0	750.5	750.5	77.8
2014	.0	86.4	86.4	8.0	775.8	775.8	71.8
2015	.0	86.4	86.4	7.1	801.9	801.9	66.3
TOT	432.0	1728.0	2160.0	858.9	11979.8	11979.8	3186.1

BENEFIT/COST RATIO= 3.71
NET PRESENT VALUE= 2327.2

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE A-9
CALCULATION OF NPV, B/C RATIO, IRR
10 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=23 DISCOUNT RATE=15.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	326.7	.0	.0	.0
1996	.0	86.4	86.4	56.8	442.9	442.9	291.2
1997	.0	86.4	86.4	49.4	454.6	454.6	259.9
1998	.0	86.4	86.4	43.0	466.6	466.6	232.0
1999	.0	86.4	86.4	37.4	479.0	479.0	207.1
2000	.0	86.4	86.4	32.5	491.6	491.6	184.8
2001	.0	86.4	86.4	28.2	507.4	507.4	165.9
2002	.0	86.4	86.4	24.6	523.4	523.4	148.8
2003	.0	86.4	86.4	21.4	540.6	540.6	133.6
2004	.0	86.4	86.4	18.6	558.0	558.0	119.9
2005	.0	86.4	86.4	16.1	575.9	575.9	107.6
2006	.0	86.4	86.4	14.0	595.3	595.3	96.8
2007	.0	86.4	86.4	12.2	614.6	614.6	86.9
2008	.0	86.4	86.4	10.6	636.1	636.1	78.2
2009	.0	86.4	86.4	9.2	657.4	657.4	70.3
2010	.0	86.4	86.4	8.0	679.6	679.6	63.2
2011	.0	86.4	86.4	7.0	702.5	702.5	56.8
2012	.0	86.4	86.4	6.1	726.1	726.1	51.0
2013	.0	86.4	86.4	5.3	750.5	750.5	45.9
2014	.0	86.4	86.4	4.6	775.8	775.8	41.2
2015	.0	86.4	86.4	4.0	801.9	801.9	37.0
TOT	432.0	1728.0	2160.0	735.6	11979.8	11979.8	2478.0

BENEFIT/COST RATIO= 3.37
NET PRESENT VALUE= 1742.4

KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE B-1
CALCULATION OF NPV, B/C RATIO, IRR
5 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS= 8 DISCOUNT RATE=10.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	357.0	.0	.0	.0
1996	.0	86.4	86.4	64.9	221.4	221.4	166.3
1997	.0	86.4	86.4	59.0	227.3	227.3	155.2
1998	.0	86.4	86.4	53.6	233.3	233.3	144.9
1999	.0	86.4	86.4	48.8	239.4	239.4	135.1
2000	.0	86.4	86.4	44.3	245.8	245.8	126.1
TOT	432.0	432.0	864.0	627.7	1167.2	1167.2	727.7

BENEFIT/COST RATIO= 1.16
NET PRESENT VALUE= 100.0

KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE B-2
CALCULATION OF NPV, B/C RATIO, IRR
5 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS= 8 DISCOUNT RATE=12.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	344.4	.0	.0	.0
1996	.0	86.4	86.4	61.5	221.4	221.4	157.6
1997	.0	86.4	86.4	54.9	227.3	227.3	144.5
1998	.0	86.4	86.4	49.0	233.3	233.3	132.4
1999	.0	86.4	86.4	43.8	239.4	239.4	121.3
2000	.0	86.4	86.4	39.1	245.8	245.8	111.2
TOT	432.0	432.0	864.0	592.7	1167.2	1167.2	666.9

BENEFIT/COST RATIO= 1.13
NET PRESENT VALUE= 74.2

KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE B-3
CALCULATION OF NPV, B/C RATIO, IRR
5 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS= 8 DISCOUNT RATE=15.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	326.7	.0	.0	.0
1996	.0	86.4	86.4	56.8	221.4	221.4	145.6
1997	.0	86.4	86.4	49.4	227.3	227.3	130.0
1998	.0	86.4	86.4	43.0	233.3	233.3	116.0
1999	.0	86.4	86.4	37.4	239.4	239.4	103.5
2000	.0	86.4	86.4	32.5	245.8	245.8	92.4
TOT	432.0	432.0	864.0	545.7	1167.2	1167.2	587.4

BENEFIT/COST RATIO= 1.08
NET PRESENT VALUE= 41.8

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE B-4
CALCULATION OF NPV, B/C RATIO, IRR
10 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=13 DISCOUNT RATE=10.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	357.0	.0	.0	.0
1996	.0	86.4	86.4	64.9	221.4	221.4	166.3
1997	.0	86.4	86.4	59.0	227.3	227.3	155.2
1998	.0	86.4	86.4	53.6	233.3	233.3	144.9
1999	.0	86.4	86.4	48.8	239.4	239.4	135.1
2000	.0	86.4	86.4	44.3	245.8	245.8	126.1
2001	.0	86.4	86.4	40.3	253.7	253.7	118.4
2002	.0	86.4	86.4	36.6	261.8	261.8	111.0
2003	.0	86.4	86.4	33.3	270.3	270.3	104.2
2004	.0	86.4	86.4	30.3	279.0	279.0	97.8
2005	.0	86.4	86.4	27.5	248.0	248.0	79.0
TOT	432.0	864.0	1296.0	795.8	2480.0	2480.0	1238.1

BENEFIT/COST RATIO= 1.56
NET PRESENT VALUE= 442.3

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE B-5
CALCULATION OF NPV, B/C RATIO, IRR
10 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=13 DISCOUNT RATE=12.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	344.4	.0	.0	.0
1996	.0	86.4	86.4	61.5	221.4	221.4	157.6
1997	.0	86.4	86.4	54.9	227.3	227.3	144.5
1998	.0	86.4	86.4	49.0	233.3	233.3	132.4
1999	.0	86.4	86.4	43.8	239.4	239.4	121.3
2000	.0	86.4	86.4	39.1	245.8	245.8	111.2
2001	.0	86.4	86.4	34.9	253.7	253.7	102.5
2002	.0	86.4	86.4	31.2	261.8	261.8	94.4
2003	.0	86.4	86.4	27.8	270.3	270.3	87.0
2004	.0	86.4	86.4	24.8	279.0	279.0	80.2
2005	.0	86.4	86.4	22.2	248.0	248.0	63.7
TOT	432.0	864.0	1296.0	733.6	2480.0	2480.0	1094.7

BENEFIT/COST RATIO= 1.49
NET PRESENT VALUE= 361.1

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE B-6
CALCULATION OF NPV, B/C RATIO, IRR
10 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=13 DISCOUNT RATE=15.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	326.7	.0	.0	.0
1996	.0	86.4	86.4	56.8	221.4	221.4	145.6
1997	.0	86.4	86.4	49.4	227.3	227.3	130.0
1998	.0	86.4	86.4	43.0	233.3	233.3	116.0
1999	.0	86.4	86.4	37.4	239.4	239.4	103.5
2000	.0	86.4	86.4	32.5	245.8	245.8	92.4
2001	.0	86.4	86.4	28.2	253.7	253.7	82.9
2002	.0	86.4	86.4	24.6	261.8	261.8	74.4
2003	.0	86.4	86.4	21.4	270.3	270.3	66.8
2004	.0	86.4	86.4	18.6	279.0	279.0	60.0
2005	.0	86.4	86.4	16.1	248.0	248.0	46.4
TOT	432.0	864.0	1296.0	654.5	2480.0	2480.0	917.9

BENEFIT/COST RATIO= 1.40
NET PRESENT VALUE= 263.4

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE B-7
CALCULATION OF NPV, B/C RATIO, IRR
20 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=23 DISCOUNT RATE=10.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	357.0	.0	.0	.0
1996	.0	86.4	86.4	64.9	221.4	221.4	166.3
1997	.0	86.4	86.4	59.0	227.3	227.3	155.2
1998	.0	86.4	86.4	53.6	233.3	233.3	144.9
1999	.0	86.4	86.4	48.8	239.4	239.4	135.1
2000	.0	86.4	86.4	44.3	245.8	245.8	126.1
2001	.0	86.4	86.4	40.3	253.7	253.7	118.4
2002	.0	86.4	86.4	36.6	261.8	261.8	111.0
2003	.0	86.4	86.4	33.3	270.3	270.3	104.2
2004	.0	86.4	86.4	30.3	279.0	279.0	97.8
2005	.0	86.4	86.4	27.5	248.0	248.0	79.0
2006	.0	86.4	86.4	25.0	297.6	297.6	86.2
2007	.0	86.4	86.4	22.8	307.3	307.3	80.9
2008	.0	86.4	86.4	20.7	318.0	318.0	76.1
2009	.0	86.4	86.4	18.8	328.7	328.7	71.5
2010	.0	86.4	86.4	17.1	339.8	339.8	67.2
2011	.0	86.4	86.4	15.5	345.0	345.0	62.1
2012	.0	86.4	86.4	14.1	363.0	363.0	59.4
2013	.0	86.4	86.4	12.8	375.3	375.3	55.8
2014	.0	86.4	86.4	11.7	387.8	387.8	52.4
2015	.0	86.4	86.4	10.6	400.8	400.8	49.2
TOT	432.0	1728.0	2160.0	964.9	5943.3	5943.3	1899.0

BENEFIT/COST RATIO= 1.97
NET PRESENT VALUE= 934.0

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE B-8
CALCULATION OF NPV, B/C RATIO, IRR
20 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=23 DISCOUNT RATE=12.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	344.4	.0	.0	.0
1996	.0	86.4	86.4	61.5	221.4	221.4	157.6
1997	.0	86.4	86.4	54.9	227.3	227.3	144.5
1998	.0	86.4	86.4	49.0	233.3	233.3	132.4
1999	.0	86.4	86.4	43.8	239.4	239.4	121.3
2000	.0	86.4	86.4	39.1	245.8	245.8	111.2
2001	.0	86.4	86.4	34.9	253.7	253.7	102.5
2002	.0	86.4	86.4	31.2	261.8	261.8	94.4
2003	.0	86.4	86.4	27.8	270.3	270.3	87.0
2004	.0	86.4	86.4	24.8	279.0	279.0	80.2
2005	.0	86.4	86.4	22.2	248.0	248.0	63.7
2006	.0	86.4	86.4	19.8	297.6	297.6	68.2
2007	.0	86.4	86.4	17.7	307.3	307.3	62.9
2008	.0	86.4	86.4	15.8	318.0	318.0	58.1
2009	.0	86.4	86.4	14.1	328.7	328.7	53.6
2010	.0	86.4	86.4	12.6	339.8	339.8	49.5
2011	.0	86.4	86.4	11.2	345.0	345.0	44.9
2012	.0	86.4	86.4	10.0	363.0	363.0	42.1
2013	.0	86.4	86.4	9.0	375.3	375.3	38.9
2014	.0	86.4	86.4	8.0	387.8	387.8	35.9
2015	.0	86.4	86.4	7.1	400.8	400.8	33.1
TOT	432.0	1728.0	2160.0	858.9	5943.3	5943.3	1581.9

BENEFIT/COST RATIO= 1.84
NET PRESENT VALUE= 723.0

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE B-9
CALCULATION OF NPV, B/C RATIO, IRR
20 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=23 DISCOUNT RATE=15.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	326.7	.0	.0	.0
1996	.0	86.4	86.4	56.8	221.4	221.4	145.6
1997	.0	86.4	86.4	49.4	227.3	227.3	130.0
1998	.0	86.4	86.4	43.0	233.3	233.3	116.0
1999	.0	86.4	86.4	37.4	239.4	239.4	103.5
2000	.0	86.4	86.4	32.5	245.8	245.8	92.4
2001	.0	86.4	86.4	28.2	253.7	253.7	82.9
2002	.0	86.4	86.4	24.6	261.8	261.8	74.4
2003	.0	86.4	86.4	21.4	270.3	270.3	66.8
2004	.0	86.4	86.4	18.6	279.0	279.0	60.0
2005	.0	86.4	86.4	16.1	248.0	248.0	46.4
2006	.0	86.4	86.4	14.0	297.6	297.6	48.4
2007	.0	86.4	86.4	12.2	307.3	307.3	43.4
2008	.0	86.4	86.4	10.6	318.0	318.0	39.1
2009	.0	86.4	86.4	9.2	328.7	328.7	35.1
2010	.0	86.4	86.4	8.0	339.8	339.8	31.6
2011	.0	86.4	86.4	7.0	345.0	345.0	27.9
2012	.0	86.4	86.4	6.1	363.0	363.0	25.5
2013	.0	86.4	86.4	5.3	375.3	375.3	22.9
2014	.0	86.4	86.4	4.6	387.8	387.8	20.6
2015	.0	86.4	86.4	4.0	400.8	400.8	18.5
TOT	432.0	1728.0	2160.0	735.6	5943.3	5943.3	1230.9

BENEFIT/COST RATIO= 1.67
NET PRESENT VALUE= 495.4

KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE C-1
CALCULATION OF NPV, B/C RATIO, IRR
20 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS= 8 DISCOUNT RATE=10.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	357.0	172.6	172.6	142.6
1996	.0	86.4	86.4	64.9	177.1	177.1	133.1
1997	.0	86.4	86.4	59.0	181.8	181.8	124.2
1998	.0	86.4	86.4	53.6	186.6	186.6	115.9
1999	.0	86.4	86.4	48.8	191.6	191.6	108.2
2000	.0	86.4	86.4	44.3	196.6	196.6	100.9
TOT	432.0	432.0	864.0	627.7	1106.3	1106.3	724.8

BENEFIT/COST RATIO= 1.15
NET PRESENT VALUE= 97.1

KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE C-2
CALCULATION OF NPV, B/C RATIO, IRR
20 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS= 8 DISCOUNT RATE=12.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	344.4	172.6	172.6	137.6
1996	.0	86.4	86.4	61.5	177.1	177.1	126.1
1997	.0	86.4	86.4	54.9	181.8	181.8	115.5
1998	.0	86.4	86.4	49.0	186.6	186.6	105.9
1999	.0	86.4	86.4	43.8	191.6	191.6	97.1
2000	.0	86.4	86.4	39.1	196.6	196.6	88.9
TOT	432.0	432.0	864.0	592.7	1106.3	1106.3	671.1

BENEFIT/COST RATIO= 1.13
NET PRESENT VALUE= 78.4

KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE C-3
CALCULATION OF NPV, B/C RATIO, IRR
20 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS= 8 DISCOUNT RATE=15.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	326.7	172.6	172.6	130.5
1996	.0	86.4	86.4	56.8	177.1	177.1	116.4
1997	.0	86.4	86.4	49.4	181.8	181.8	103.9
1998	.0	86.4	86.4	43.0	186.6	186.6	92.8
1999	.0	86.4	86.4	37.4	191.6	191.6	82.8
2000	.0	86.4	86.4	32.5	196.6	196.6	73.9
TOT	432.0	432.0	864.0	545.7	1106.3	1106.3	600.4

BENEFIT/COST RATIO= 1.10
NET PRESENT VALUE= 54.8

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE C-4
CALCULATION OF NPV, B/C RATIO, IRR
20 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=13 DISCOUNT RATE=10.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	357.0	172.6	172.6	142.6
1996	.0	86.4	86.4	64.9	177.1	177.1	133.1
1997	.0	86.4	86.4	59.0	181.8	181.8	124.2
1998	.0	86.4	86.4	53.6	186.6	186.6	115.9
1999	.0	86.4	86.4	48.8	191.6	191.6	108.2
2000	.0	86.4	86.4	44.3	196.6	196.6	100.9
2001	.0	86.4	86.4	40.3	187.0	187.0	87.2
2002	.0	86.4	86.4	36.6	209.5	209.5	88.8
2003	.0	86.4	86.4	33.3	136.2	136.2	52.5
2004	.0	86.4	86.4	30.3	223.2	223.2	78.2
2005	.0	86.4	86.4	27.5	230.4	230.4	73.4
TOT	432.0	864.0	1296.0	795.8	2092.6	2092.6	1105.0

BENEFIT/COST RATIO= 1.39
NET PRESENT VALUE= 309.2

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE C-5
CALCULATION OF NPV, B/C RATIO, IRR
10 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=13 DISCOUNT RATE=12.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	344.4	172.6	172.6	137.6
1996	.0	86.4	86.4	61.5	177.1	177.1	126.1
1997	.0	86.4	86.4	54.9	181.8	181.8	115.5
1998	.0	86.4	86.4	49.0	186.6	186.6	105.9
1999	.0	86.4	86.4	43.8	191.6	191.6	97.1
2000	.0	86.4	86.4	39.1	196.6	196.6	88.9
2001	.0	86.4	86.4	34.9	187.0	187.0	75.5
2002	.0	86.4	86.4	31.2	209.5	209.5	75.5
2003	.0	86.4	86.4	27.8	136.2	136.2	43.9
2004	.0	86.4	86.4	24.8	223.2	223.2	64.2
2005	.0	86.4	86.4	22.2	230.4	230.4	59.1
TOT	432.0	864.0	1296.0	733.6	2092.6	2092.6	989.3

BENEFIT/COST RATIO= 1.35
NET PRESENT VALUE= 255.7

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE C-6
CALCULATION OF NPV, B/C RATIO, IRR
10 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=13 DISCOUNT RATE=15.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	326.7	172.6	172.6	130.5
1996	.0	86.4	86.4	56.8	177.1	177.1	116.4
1997	.0	86.4	86.4	49.4	181.8	181.8	103.9
1998	.0	86.4	86.4	43.0	186.6	186.6	92.8
1999	.0	86.4	86.4	37.4	191.6	191.6	82.8
2000	.0	86.4	86.4	32.5	196.6	196.6	73.9
2001	.0	86.4	86.4	28.2	187.0	187.0	61.1
2002	.0	86.4	86.4	24.6	209.5	209.5	59.6
2003	.0	86.4	86.4	21.4	136.2	136.2	33.7
2004	.0	86.4	86.4	18.6	223.2	223.2	48.0
2005	.0	86.4	86.4	16.1	230.4	230.4	43.1
TOT	432.0	864.0	1296.0	654.5	2092.6	2092.6	845.8

BENEFIT/COST RATIO= 1.29
NET PRESENT VALUE= 191.3

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE C-7
CALCULATION OF NPV, B/C RATIO, IRR
20 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=23 DISCOUNT RATE=10.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	357.0	172.6	172.6	142.6
1996	.0	86.4	86.4	64.9	177.1	177.1	133.1
1997	.0	86.4	86.4	59.0	181.8	181.8	124.2
1998	.0	86.4	86.4	53.6	186.6	186.6	115.9
1999	.0	86.4	86.4	48.8	191.6	191.6	108.2
2000	.0	86.4	86.4	44.3	196.6	196.6	100.9
2001	.0	86.4	86.4	40.3	187.0	187.0	87.2
2002	.0	86.4	86.4	36.6	209.5	209.5	88.8
2003	.0	86.4	86.4	33.3	136.2	136.2	52.5
2004	.0	86.4	86.4	30.3	223.2	223.2	78.2
2005	.0	86.4	86.4	27.5	230.4	230.4	73.4
2006	.0	86.4	86.4	25.0	238.1	238.1	69.0
2007	.0	86.4	86.4	22.8	245.8	245.8	64.7
2008	.0	86.4	86.4	20.7	254.4	254.4	60.9
2009	.0	86.4	86.4	18.8	263.0	263.0	57.2
2010	.0	86.4	86.4	17.1	271.8	271.8	53.8
2011	.0	86.4	86.4	15.5	281.0	281.0	50.5
2012	.0	86.4	86.4	14.1	290.4	290.4	47.5
2013	.0	86.4	86.4	12.8	300.2	300.2	44.6
2014	.0	86.4	86.4	11.7	310.0	310.0	41.9
2015	.0	86.4	86.4	10.6	320.2	320.2	39.3
TOT	432.0	1728.0	2160.0	964.9	4867.5	4867.5	1634.5

BENEFIT/COST RATIO= 1.69
NET PRESENT VALUE= 669.6

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE C-8
CALCULATION OF NPV, B/C RATIO, IRR
20 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=23 DISCOUNT RATE=12.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	344.4	172.6	172.6	137.6
1996	.0	86.4	86.4	61.5	177.1	177.1	126.1
1997	.0	86.4	86.4	54.9	181.8	181.8	115.5
1998	.0	86.4	86.4	49.0	186.6	186.6	105.9
1999	.0	86.4	86.4	43.8	191.6	191.6	97.1
2000	.0	86.4	86.4	39.1	196.6	196.6	88.9
2001	.0	86.4	86.4	34.9	187.0	187.0	75.5
2002	.0	86.4	86.4	31.2	209.5	209.5	75.5
2003	.0	86.4	86.4	27.8	136.2	136.2	43.9
2004	.0	86.4	86.4	24.8	223.2	223.2	64.2
2005	.0	86.4	86.4	22.2	230.4	230.4	59.1
2006	.0	86.4	86.4	19.8	238.1	238.1	54.6
2007	.0	86.4	86.4	17.7	245.8	245.8	50.3
2008	.0	86.4	86.4	15.8	254.4	254.4	46.5
2009	.0	86.4	86.4	14.1	263.0	263.0	42.9
2010	.0	86.4	86.4	12.6	271.8	271.8	39.6
2011	.0	86.4	86.4	11.2	281.0	281.0	36.5
2012	.0	86.4	86.4	10.0	290.4	290.4	33.7
2013	.0	86.4	86.4	9.0	300.2	300.2	31.1
2014	.0	86.4	86.4	8.0	310.0	310.0	28.7
2015	.0	86.4	86.4	7.1	320.2	320.2	26.5
TOT	432.0	1728.0	2160.0	858.9	4867.5	4867.5	1379.7

BENEFIT/COST RATIO= 1.61
NET PRESENT VALUE= 520.8

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE C-9
CALCULATION OF NPV, B/C RATIO, IRR
20 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=23 DISCOUNT RATE=15.0 PERCENT

YEAR	CONST. COSTS	M&O COSTS	TOTAL COSTS	PRESENT VALUE	BENEFIT BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	432.0	.0	432.0	326.7	172.6	172.6	130.5
1996	.0	86.4	86.4	56.8	177.1	177.1	116.4
1997	.0	86.4	86.4	49.4	181.8	181.8	103.9
1998	.0	86.4	86.4	43.0	186.6	186.6	92.8
1999	.0	86.4	86.4	37.4	191.6	191.6	82.8
2000	.0	86.4	86.4	32.5	196.6	196.6	73.9
2001	.0	86.4	86.4	28.2	187.0	187.0	61.1
2002	.0	86.4	86.4	24.6	209.5	209.5	59.6
2003	.0	86.4	86.4	21.4	136.2	136.2	33.7
2004	.0	86.4	86.4	18.6	223.2	223.2	48.0
2005	.0	86.4	86.4	16.1	230.4	230.4	43.1
2006	.0	86.4	86.4	14.0	238.1	238.1	38.7
2007	.0	86.4	86.4	12.2	245.8	245.8	34.7
2008	.0	86.4	86.4	10.6	254.4	254.4	31.3
2009	.0	86.4	86.4	9.2	263.0	263.0	28.1
2010	.0	86.4	86.4	8.0	271.8	271.8	25.3
2011	.0	86.4	86.4	7.0	281.0	281.0	22.7
2012	.0	86.4	86.4	6.1	290.4	290.4	20.4
2013	.0	86.4	86.4	5.3	300.2	300.2	18.3
2014	.0	86.4	86.4	4.6	310.0	310.0	16.5
2015	.0	86.4	86.4	4.0	320.2	320.2	14.8
TOT	432.0	1728.0	2160.0	735.6	4867.5	4867.5	1096.6

BENEFIT/COST RATIO= 1.49
NET PRESENT VALUE= 361.0

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE D-1
CALCULATION OF NPV, B/C RATIO, IRR
5 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS= 8 DISCOUNT RATE=10.0 PERCENT

YEAR	WEIGH COSTS	BRIDGE COSTS	ROAD COSTS	TOTAL COSTS	PRESENT VALUE	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	.0	.0	.0	.0	.0	.0	.0
1996	34.4	.4	168.8	203.6	153.0	.0	.0
1997	34.4	.4	19.3	54.1	37.0	.0	.0
1998	34.4	.4	19.3	54.1	33.6	.0	.0
1999	34.4	.4	19.3	54.1	30.5	.0	.0
2000	34.4	.4	168.8	203.6	104.5	.0	.0
TOT	172.0	2.0	395.5	569.5	358.5	.0	.0

BENEFIT/COST RATIO= .00
NET PRESENT VALUE= -358.5
1NO SOLUTION TO THE IRR PROBLEM EXISTS BECAUSE
BENEFITS ARE ALWAYS GREATER THAN OR EQUAL TO COSTS OR VICE VERSA

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE D-2
CALCULATION OF NPV, B/C RATIO, IRR
5 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS= 8 DISCOUNT RATE=12.0 PERCENT

YEAR	WEIGH COSTS	BRIDGE COSTS	ROAD COSTS	TOTAL COSTS	PRESENT VALUE	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	.0	.0	.0	.0	.0	.0	.0
1996	34.4	.4	168.8	203.6	144.9	.0	.0
1997	34.4	.4	19.3	54.1	34.4	.0	.0
1998	34.4	.4	19.3	54.1	30.7	.0	.0
1999	34.4	.4	19.3	54.1	27.4	.0	.0
2000	34.4	.4	168.8	203.6	92.1	.0	.0
TOT	172.0	2.0	395.5	569.5	329.5	.0	.0

BENEFIT/COST RATIO= .00
NET PRESENT VALUE= -329.5
1NO SOLUTION TO THE IRR PROBLEM EXISTS BECAUSE
BENEFITS ARE ALWAYS GREATER THAN OR EQUAL TO COSTS OR VICE VERSA

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE D-3
CALCULATION OF NPV, B/C RATIO, IRR
5 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS= 8 DISCOUNT RATE=15.0 PERCENT

YEAR	WEIGH COSTS	BRIDGE COSTS	ROAD COSTS	TOTAL COSTS	PRESENT VALUE	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	.0	.0	.0	.0	.0	.0	.0
1996	34.4	.4	168.8	203.6	133.9	.0	.0
1997	34.4	.4	19.3	54.1	30.9	.0	.0
1998	34.4	.4	19.3	54.1	26.9	.0	.0
1999	34.4	.4	19.3	54.1	23.4	.0	.0
2000	34.4	.4	168.8	203.6	76.5	.0	.0
TOT	172.0	2.0	395.5	569.5	291.6	.0	.0

BENEFIT/COST RATIO= .00
NET PRESENT VALUE= -291.6
1NO SOLUTION TO THE IRR PROBLEM EXISTS BECAUSE
BENEFITS ARE ALWAYS GREATER THAN OR EQUAL TO COSTS OR VICE VERSA

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE D-4
CALCULATION OF NPV, B/C RATIO, IRR
10 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=13 DISCOUNT RATE=10.0 PERCENT

YEAR	WEIGH COSTS	BRIDGE COSTS	ROAD COSTS	TOTAL COSTS	PRESENT VALUE	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	.0	.0	.0	.0	.0	.0	.0
1996	34.4	.4	168.8	203.6	153.0	.0	.0
1997	34.4	.4	19.3	54.1	37.0	.0	.0
1998	34.4	.4	19.3	54.1	33.6	.0	.0
1999	34.4	.4	19.3	54.1	30.5	.0	.0
2000	34.4	.4	168.8	203.6	104.5	.0	.0
2001	34.4	.4	208.7	243.5	113.6	.0	.0
2002	34.4	.4	19.3	54.1	22.9	.0	.0
2003	34.4	.4	19.3	54.1	20.9	.0	.0
2004	34.4	.4	188.6	223.4	78.3	.0	.0
2005	34.4	.4	19.3	54.1	17.2	.0	.0
TOT	344.0	4.0	850.7	1198.7	611.5	.0	.0

BENEFIT/COST RATIO= .00
NET PRESENT VALUE= -611.5
1NO SOLUTION TO THE IRR PROBLEM EXISTS BECAUSE
BENEFITS ARE ALWAYS GREATER THAN OR EQUAL TO COSTS OR VICE VERSA

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE D-5
CALCULATION OF NPV, B/C RATIO, IRR
10 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=13 DISCOUNT RATE=12.0 PERCENT

YEAR	WEIGH COSTS	BRIDGE COSTS	ROAD COSTS	TOTAL COSTS	PRESENT VALUE	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	.0	.0	.0	.0	.0	.0	.0
1996	34.4	.4	168.8	203.6	144.9	.0	.0
1997	34.4	.4	19.3	54.1	34.4	.0	.0
1998	34.4	.4	19.3	54.1	30.7	.0	.0
1999	34.4	.4	19.3	54.1	27.4	.0	.0
2000	34.4	.4	168.8	203.6	92.1	.0	.0
2001	34.4	.4	208.7	243.5	98.3	.0	.0
2002	34.4	.4	19.3	54.1	19.5	.0	.0
2003	34.4	.4	19.3	54.1	17.4	.0	.0
2004	34.4	.4	188.6	223.4	64.2	.0	.0
2005	34.4	.4	19.3	54.1	13.9	.0	.0
TOT	344.0	4.0	850.7	1198.7	542.9	.0	.0

BENEFIT/COST RATIO= .00
NET PRESENT VALUE= -542.9
1NO SOLUTION TO THE IRR PROBLEM EXISTS BECAUSE
BENEFITS ARE ALWAYS GREATER THAN OR EQUAL TO COSTS OR VICE VERSA

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE D-6
CALCULATION OF NPV, B/C RATIO, IRR
10 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=13 DISCOUNT RATE=15.0 PERCENT

YEAR	WEIGH COSTS	BRIDGE COSTS	ROAD COSTS	TOTAL COSTS	PRESENT VALUE	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	.0	.0	.0	.0	.0	.0	.0
1996	34.4	.4	168.8	203.6	133.9	.0	.0
1997	34.4	.4	19.3	54.1	30.9	.0	.0
1998	34.4	.4	19.3	54.1	26.9	.0	.0
1999	34.4	.4	19.3	54.1	23.4	.0	.0
2000	34.4	.4	168.8	203.6	76.5	.0	.0
2001	34.4	.4	208.7	243.5	79.6	.0	.0
2002	34.4	.4	19.3	54.1	15.4	.0	.0
2003	34.4	.4	19.3	54.1	13.4	.0	.0
2004	34.4	.4	188.6	223.4	48.0	.0	.0
2005	34.4	.4	19.3	54.1	10.1	.0	.0
TOT	344.0	4.0	850.7	1198.7	458.1	.0	.0

BENEFIT/COST RATIO= .00
NET PRESENT VALUE= -458.1
1NO SOLUTION TO THE IRR PROBLEM EXISTS BECAUSE
BENEFITS ARE ALWAYS GREATER THAN OR EQUAL TO COSTS OR VICE VERSA

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE D-7
CALCULATION OF NPV, B/C RATIO, IRR
20 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=23 DISCOUNT RATE=10.0 PERCENT

YEAR	WEIGH COSTS	BRIDGE COSTS	ROAD COSTS	TOTAL COSTS	PRESENT VALUE	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	.0	.0	.0	.0	.0	.0	.0
1996	34.4	.4	168.8	203.6	153.0	.0	.0
1997	34.4	.4	19.3	54.1	37.0	.0	.0
1998	34.4	.4	19.3	54.1	33.6	.0	.0
1999	34.4	.4	19.3	54.1	30.5	.0	.0
2000	34.4	.4	168.8	203.6	104.5	.0	.0
2001	34.4	.4	208.7	243.5	113.6	.0	.0
2002	34.4	.4	19.3	54.1	22.9	.0	.0
2003	34.4	.4	19.3	54.1	20.9	.0	.0
2004	34.4	.4	188.6	223.4	78.3	.0	.0
2005	34.4	.4	19.3	54.1	17.2	.0	.0
2006	34.4	.4	168.8	203.6	59.0	.0	.0
2007	34.4	.4	19.3	54.1	14.2	.0	.0
2008	34.4	.4	19.3	54.1	13.0	.0	.0
2009	34.4	.4	19.3	54.1	11.8	.0	.0
2010	34.4	.4	19.3	54.1	10.7	.0	.0
2011	34.4	.4	208.7	243.5	43.8	.0	.0
2012	34.4	.4	168.8	203.6	33.3	.0	.0
2013	34.4	.4	19.3	54.1	8.0	.0	.0
2014	34.4	.4	188.6	223.4	30.2	.0	.0
2015	34.4	.4	19.3	54.1	6.6	.0	.0
TOT	688.0	8.0	1701.4	2397.4	842.1	.0	.0

BENEFIT/COST RATIO= .00
NET PRESENT VALUE= -842.1
1NO SOLUTION TO THE IRR PROBLEM EXISTS BECAUSE
BENEFITS ARE ALWAYS GREATER THAN OR EQUAL TO COSTS OR VICE VERSA

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE D-8
CALCULATION OF NPV, B/C RATIO, IRR
20 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=23 DISCOUNT RATE=12.0 PERCENT

YEAR	WEIGH COSTS	BRIDGE COSTS	ROAD COSTS	TOTAL COSTS	PRESENT VALUE	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	.0	.0	.0	.0	.0	.0	.0
1996	34.4	.4	168.8	203.6	144.9	.0	.0
1997	34.4	.4	19.3	54.1	34.4	.0	.0
1998	34.4	.4	19.3	54.1	30.7	.0	.0
1999	34.4	.4	19.3	54.1	27.4	.0	.0
2000	34.4	.4	168.8	203.6	92.1	.0	.0
2001	34.4	.4	208.7	243.5	98.3	.0	.0
2002	34.4	.4	19.3	54.1	19.5	.0	.0
2003	34.4	.4	19.3	54.1	17.4	.0	.0
2004	34.4	.4	188.6	223.4	64.2	.0	.0
2005	34.4	.4	19.3	54.1	13.9	.0	.0
2006	34.4	.4	168.8	203.6	46.7	.0	.0
2007	34.4	.4	19.3	54.1	11.1	.0	.0
2008	34.4	.4	19.3	54.1	9.9	.0	.0
2009	34.4	.4	19.3	54.1	8.8	.0	.0
2010	34.4	.4	19.3	54.1	7.9	.0	.0
2011	34.4	.4	208.7	243.5	31.7	.0	.0
2012	34.4	.4	168.8	203.6	23.6	.0	.0
2013	34.4	.4	19.3	54.1	5.6	.0	.0
2014	34.4	.4	188.6	223.4	20.7	.0	.0
2015	34.4	.4	19.3	54.1	4.5	.0	.0
TOT	688.0	8.0	1701.4	2397.4	713.3	.0	.0

BENEFIT/COST RATIO= .00
NET PRESENT VALUE= -713.3
1NO SOLUTION TO THE IRR PROBLEM EXISTS BECAUSE
BENEFITS ARE ALWAYS GREATER THAN OR EQUAL TO COSTS OR VICE VERSA

1KAFUE RIVER BRIDGE TOLL/WEIGHBRIDGE FEASIBILITY STUDY
ALTERNATIVE D-9
CALCULATION OF NPV, B/C RATIO, IRR
20 YEARS OF OPERATION

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=23 DISCOUNT RATE=15.0 PERCENT

YEAR	WEIGH COSTS	BRIDGE COSTS	ROAD COSTS	TOTAL COSTS	PRESENT VALUE	TOTAL BENEFITS	PRESENT VALUE
1993	.0	.0	.0	.0	.0	.0	.0
1994	.0	.0	.0	.0	.0	.0	.0
1995	.0	.0	.0	.0	.0	.0	.0
1996	34.4	.4	168.8	203.6	133.9	.0	.0
1997	34.4	.4	19.3	54.1	30.9	.0	.0
1998	34.4	.4	19.3	54.1	26.9	.0	.0
1999	34.4	.4	19.3	54.1	23.4	.0	.0
2000	34.4	.4	168.8	203.6	76.5	.0	.0
2001	34.4	.4	208.7	243.5	79.6	.0	.0
2002	34.4	.4	19.3	54.1	15.4	.0	.0
2003	34.4	.4	19.3	54.1	13.4	.0	.0
2004	34.4	.4	188.6	223.4	48.0	.0	.0
2005	34.4	.4	19.3	54.1	10.1	.0	.0
2006	34.4	.4	168.8	203.6	33.1	.0	.0
2007	34.4	.4	19.3	54.1	7.6	.0	.0
2008	34.4	.4	19.3	54.1	6.6	.0	.0
2009	34.4	.4	19.3	54.1	5.8	.0	.0
2010	34.4	.4	19.3	54.1	5.0	.0	.0
2011	34.4	.4	208.7	243.5	19.7	.0	.0
2012	34.4	.4	168.8	203.6	14.3	.0	.0
2013	34.4	.4	19.3	54.1	3.3	.0	.0
2014	34.4	.4	188.6	223.4	11.9	.0	.0
2015	34.4	.4	19.3	54.1	2.5	.0	.0
TOT	688.0	8.0	1701.4	2397.4	568.0	.0	.0

BENEFIT/COST RATIO= .00
NET PRESENT VALUE= -568.0
1NO SOLUTION TO THE IRR PROBLEM EXISTS BECAUSE
BENEFITS ARE ALWAYS GREATER THAN OR EQUAL TO COSTS OR VICE VERSA

Appendix D: Terms of Reference

APPENDIX D

Terms of Reference for the Kafue River Bridge Toll/Weighbridge Feasibility Study

1.0 Introduction

About 53 Kms south of Lusaka the Lusaka-Kafue-Chirundu Road crosses the Kafue River. A two-lane bridge spanning the river has recently been completed. This is the only bridge crossing of the river between the Zimbabwean border to the east and a point approximately 300 Kms upstream to the northwest on a road extending west out of Lusaka. All traffic relative to Lusaka and points north and west to and from southern Zambia, South Africa, Zimbabwe, Botswana, Namibia and other countries to the south must pass over this bridge. The alternatives for travel to countries to the north of Zambia are through Angola and Zimbabwe/Mozambique.

The bridge bisects the T2 road link from the Chirundu border post with Zimbabwe to Lusaka which has been rehabilitated through grants from USAID. Immediately to the south of the bridge a new weigh station is being constructed in connection with the USAID grants. The Government of Zambia (GRZ) has embarked on a program of reformation of the mechanisms for the financing of road maintenance, rehabilitation and construction and is also exploring arrangements for regional standardization of road transport systems under the aegis of SADC. Of particular concern to USAID is the ability of the GRZ to continue to maintain the T2 route, including the newly built (with Japanese aid) bridge over the Kafue River. In this connection the GRZ has requested USAID to assist with a study of the feasibility of installing a toll facility at the bridge and various options for the operation of the weighbridge, including the involvement of the private sector.

2.0 Terms of Reference

The objectives of the study are to (1) explore the feasibility of establishing a road toll collection point at the Kafue River Bridge, (2) set out options regarding toll rates, (3) determine benefits from incorporating the management of the weighbridge with the management of the toll collection and (4) set out alternatives for the management of toll/weighbridge operations and related enforcement, including the involvement of the private sector. These analyses will consider forecasts of traffic and revenue which might be generated, the likely benefits arising to the transport network from a toll scheme, current GRZ initiatives for financing the road transport system,

implications for regional (SADC) coordination of transport, potential environmental impacts of a toll system, the social and economic impact of tolls to classes of road users and institutional issues relating to toll/weighbridge operations and enforcement. The study should also speak to the implications of a Kafue Bridge Toll Point for any national trunk road toll system.

To meet these objectives, the Consultants will undertake a variety of investigations and analyses to the degree necessary to lend authority to the study. These might include, but not necessarily be limited to:

- An analysis of available historical information regarding usage of the bridge crossing.
- A detailed program of vehicular traffic counts at the bridge, extending over a one week period. Commercial vehicles should be inventoried by general size, type and estimated weight.
- A travel pattern and characteristics survey conducted for at least 12 hours during three days of the weekly traffic count. This survey should include the origin and destination of trips, and the frequency and purpose of the trips. In the case of commercial vehicles, the general nature of cargo should be inventoried together with information on cargo weights.
- In conjunction with the vehicle count survey, a survey of pedestrians using the bridge and information gathered such as their travel purpose, trip frequency, etc.
- A sensitivity toll rate analysis. This analysis should estimate the proportion of trips now using the bridge that would discontinue trip making in response to progressively higher rates of hypothetical tolls. The toll sensitivity analysis would be performed separately for trucks (by type), passenger cars, buses and other vehicles.
- The alternative of tolling passengers versus buses.
- The potential economic impact from implementing tolls on bridge users, considering for example, low income groups, commercial vehicles, bus passengers, laborers, etc.
- An investigation of road user charges made by Zambia on vehicles entering the country, plus charges made by the surrounding countries on vehicles leaving Zambia, and the overall effect these charges would have when combined with any proposed tolls at the bridge. This would include an analysis of regional plans, programs and recommendations relative to toll and weighbridge operations.
- Consideration of the feasibility of tolling vehicles travelling in only one direction.

- Base year traffic and revenue estimates derived from several levels of tolls as determined by a sensitivity analysis.
- Toll plaza requirements, determined for two-way and one-way toll collection systems, based upon estimated traffic levels.
- A study of the feasibility of operating the toll collection and weighbridge as a combined facility.
- A study of the feasibility of private sector operation of the toll collection/weigh station.
- An investigation of the Government statutes and laws concerning the establishment of toll/revenue collecting facilities and any changes that might be required and, in particular, any related to operation by the private sector.
- An analysis of current and planned road maintenance financing schemes under consideration by the GRZ.
- An analysis of the economic impacts of toll collection with reference to the productive sectors and consumption.
- An institutional analysis of the stakeholders in toll/weighbridge operations and enforcement, including an historical review of Zambian efforts in these areas.
- Develop alternative enforcement systems, procedures and mechanisms to ensure that weight limits are observed, tolls are collected and revenues are used for intended purposes.
- Conduct a break even analysis for volume and mix of traffic required at various toll levels.
- Carry out a cost/benefit analysis to determine the economic viability of the project to include incremental costs, the cost of investment, and savings in road/bridge maintenance expenses in addition to estimated revenues.

In preparing the feasibility, the Consultant will make reference to world-wide experience, especially in LDCs. Net estimated revenue shall be calculated from toll revenue forecasts less estimated operating costs. Net present values of revenue streams of 5, 10 and 20 year durations, discounted at three different interest rates, to be agreed upon during the course of the analysis.

Prior to initiating the study, the Consultant will submit for review by the USAID Mission and the GRZ Roads Department a workplan for the execution of the study which sets out the methodology to be employed.

3.0 Reports

Draft final reports will be submitted to USAID and the Roads Department for review. A final report, incorporating comments from the Roads Department and USAID, will be submitted in twenty-five copies.