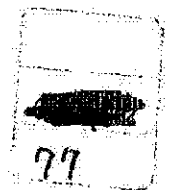


REPUBLIC OF PARAGUARY  
LA COLMENA HIGHWAY FOLLOW-UP SURVEY REPORT

January 1977

JAPAN INTERNATIONAL COOPERATION AGENCY



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## PREFACE

In response to the request of the Government of Paraguay, the Government of Japan decided to make a survey of the Paraguayan plan to build a highway between Acahay and La Colmena in southern Paraguay, and the Japan International Cooperation Agency conducted the survey.

This survey was carried out as a follow-up of the survey on the highway between Carapeguá and La Colmena which was conducted during fiscal 1974, and the follow-up survey was designed to draw a plan to construct a highway between Acahay and La Colmena except the Carapeguá-Acahay section which was built by the Paraguayan Government after the first survey.

The Agency dispatched Mr. Shiro Ishiyama, deputy head of Toll Road Division, Road Bureau of the Ministry of Construction, and Mr. Hiroshi Goto, an adviser of Central Consultant Company, to Paraguay on 21-day mission from September 29 to October 19, in 1976.

The mission held consultations with the Paraguayan Government, gathered data and, after having returned home, computed the cost of the project and examined economic effectiveness.

This report is a summary of the above-mentioned work. We strongly hope that the Acahay-La Colmena highway construction project will be put into force quickly and contribute to strengthening friendship between Paraguay and Japan.

In conclusion, we are very grateful to the Paraguayan Government, as well as the people of Paraguay for the great cooperation they have extended to us in carrying out the latest survey.

January 1977

Masao Oono  
Director  
Social Development Cooperation Department  
Japan International Cooperation Agency

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## I. OUTLINE OF SURVEY

### I-1 Background and Purpose

The Government of Japan received a request for a loan in the yen currency from the Government of the Republic of Paraguay in 1973. To meet the request, the Japanese Government in 1974 dispatched a survey mission, which was organized by the International Cooperation Agency and headed by Mr. Hideo Tokuhiro, Overseas Cooperation Officer of the Construction Promotion Division of the Planning Bureau of the Ministry of Construction, and examined the feasibility of extending the requested loan for the project to the Paraguayan Government.

That survey mission conducted a field survey from April to May 1974 and in August 1974 submitted a report "Republic of Paraguay Carapeguá-La Colmena Highway Survey", which contained the following contents:

- (1) Examination of a report on a feasibility study conducted in 1970 by Louis Berger, an American consulting company.
- (2) Examination of economic effect from new angles.
- (3) Conclusion
  - a. The highway section surveyed was an extension of 42.5km between Carapeguá and La Colmena.
  - b. Louis Berger's plan was generally appropriate.
  - c. The construction period would be two years.
  - d. The total estimated cost of the project was US\$11,539,000 (29.5% in domestic currency and 70.5% in foreign currency).
  - e. The benefit-cost ratio (B/C) was 1.17 and the internal rate of return (I.R.R.) was 10.3%.
  - f. Japanese immigrants were earnestly hoping for the promotion of the project.

The survey of this time was carried out not only to grasp changes in road conditions after the first survey, but also to comprehend the present condition of the section (28.5km between Acahay and La Colmena), through the survey, including calculation of the project cost and examination of the economic effect.

I-2 Mission Members and Survey Program

(1) Mission Members

- a. Shiro Ishiyama (General Supervision)  
Deputy Head of the Toll Road Division, Road Bureau,  
Ministry of Construction of Japan.
- b. Hiroshi Goto (Scheme of Execution)  
Consulting Engineer, Central Consultant Co., Ltd.

(2) Survey Program

Order	Date	Day	Travel	Content of Survey
1.	1976 Sept. 29	Wed.	Departure from Tokyo	Departure from Japan on tour
2.	30	Thurs.	Arrival at Asuncion	Courtesy call at Jap. Embassy and consultations
3.	Oct. 1	Fri.		Consultations with Pettengill Road Bureau Director and Cabaniero Section Chief
4.	2	Sat.		Gathering of data
5.	3	Sun.		"
6.	4	Mon.		Consultations on construction costs
7.	5	Tues.		Consultations on data on the economy
8.	6	Wed.		On-site survey of La Colmena Highway

Order	Date	Day	Travel	Content of Survey
9.	7	Thurs.		On-site survey of Nat. Highways No. 2 & No. 7
10.	8	Fri.		Consultations at Road Bureau on survey results
11.	9	Sat.		(Ishiyama) Re-survey of La Colmena Highway (Goto) On-site survey of Encarnacion-Pirapó Highway
12.	10	Sun.		Data Arrangement
13.	11	Mon.		Meeting at Road Bureau
14.	12	Tues.		Data Arrangement Holiday (Nat. Festival Day)
15.	13	Wed.		Final Consultations with Road Bureau Director
16.	14	Thurs.	Dep. fr. Asuncion Arr. Sao Paulo	Meeting at Jap. Embassy & Travel
17.	15	Fri.		Survey of machinery rents in Brazil
18.	16	Sat.		"
19.	17	Sun.	Dep. fr. Sao Paulo	Travel
20.	18	Mon.		"
21.	19	Tues.	Arrival in Tokyo	Travel, return home



### I-3 Outline of Survey

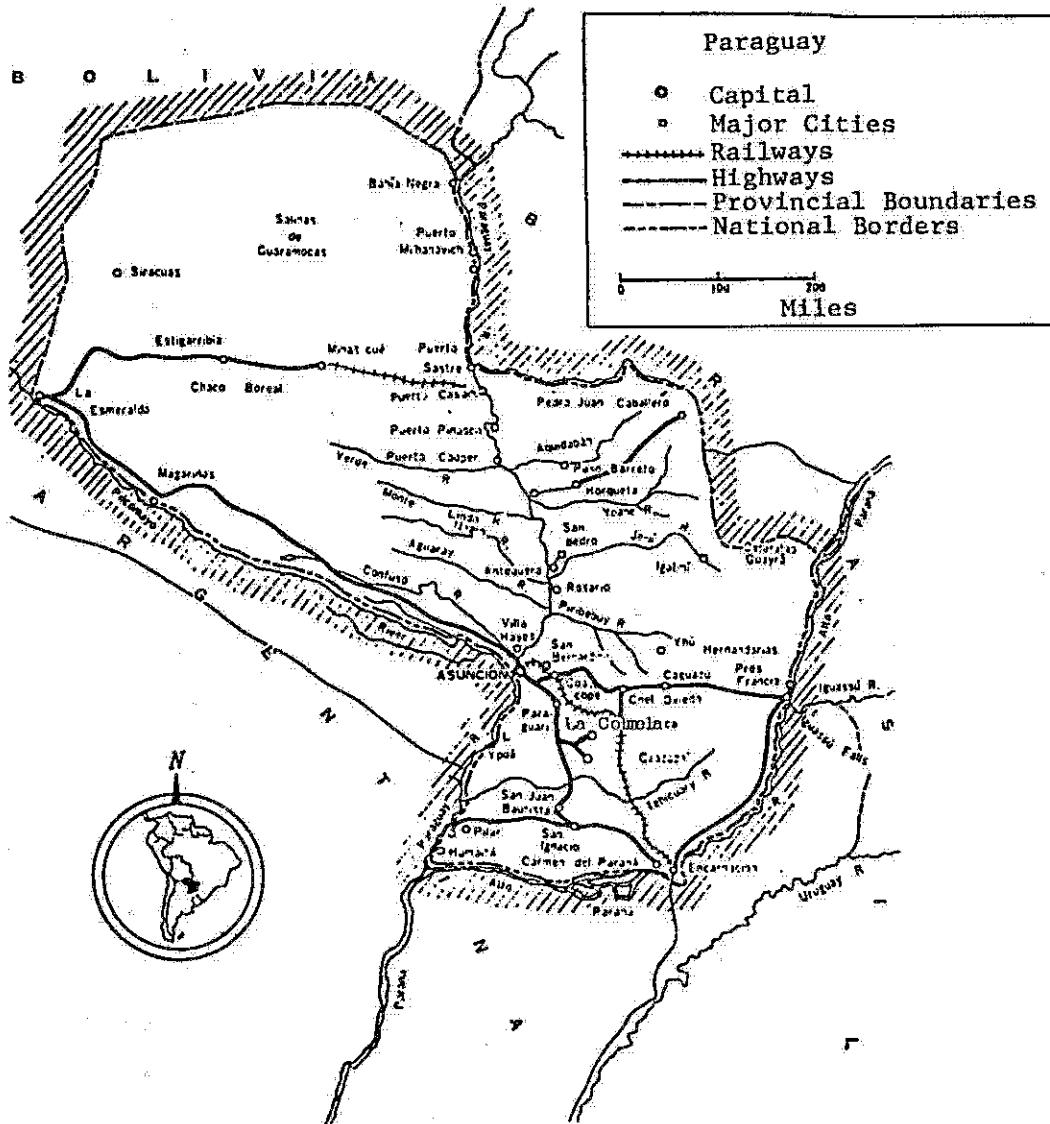
The mission in 1974 led by Mr. Hideo Tokuhiro surveyed the feasibility of an improvement of the Carapeguá-Acahay-La Colmena Highway, a branch line from National Highway No. 1, and reported that an improvement of pavement of the highway has sufficient economic effects and that Japanese immigrants living in the La Colmena area were earnestly looking for the realization of the project.

Meanwhile the major purpose of the survey of this time was to review the previous report in view of changes in the economic situation after the previous survey and to reassess various conditions created as the result of the alteration of the section to be covered by the project following the progress of a highway improvement - the pavement work of the Carapeguá-Acahay-Ybycuí section.

During the stay in Paraguay for about two weeks, the mission not only strived to grasp the road situation of the Republic of Paraguay as a whole mainly through the Road Bureau of the Ministry of Public Works and Communications (Bureau Director: Mr. Juan H. Pettangill), but also surveyed the record conditions of the Acahay-La Colmena section designated as the target for the survey of this time calculated project cost and investigated the economic effects that would be brought about in case the project was put into force.

The survey was smoothly carried out and anticipated objectives were fully achieved thanks to considerations paid by the Government of Paraguay.

Figure I-1 Outline of Paraguay

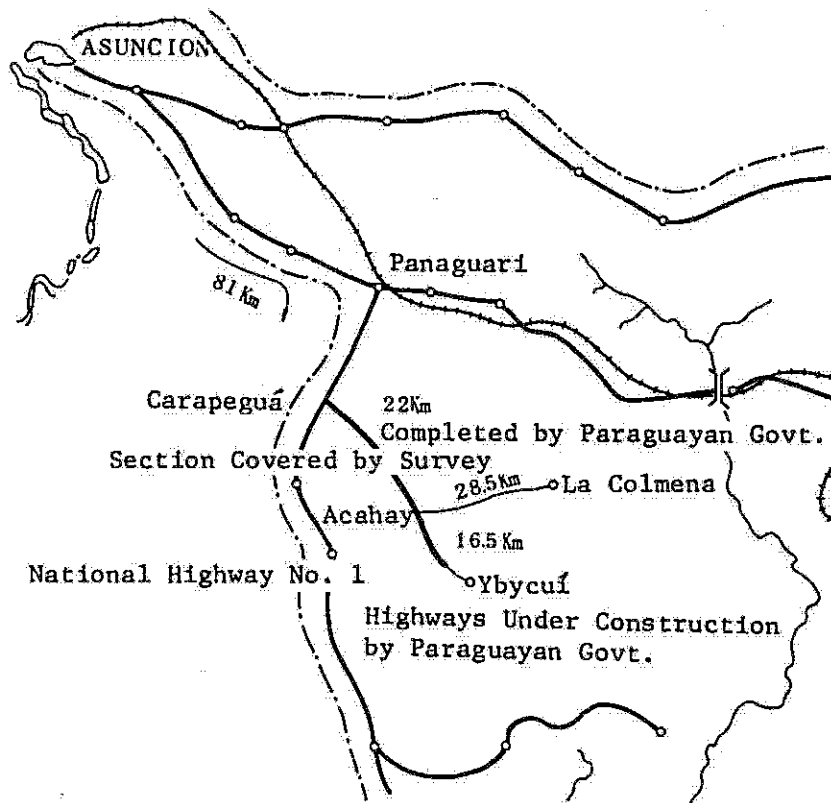


#### I-4 Summary of Survey Results

The mission reached the following conclusions as to the project:

1. The highway section put to the feasibility study of this time was the 28.5km-long Acahay-La Colmena section, a branch highway of the 370km-long National Highway No. 1 between Asuncion and encarnacion. (See Figura I-2)

Figure I-2 Route Map of the Area for Survey



2. The contents of the design prepared by Louis Berger Company are generally appropriate. However it is desirable to review the suitability of the elevation of road and the structure of pavement at launching the project. It is considered to be possible to use the present road in case selecting the route between Station No. 20 and the terminal point. (See Figure I-3)
3. The required construction period is 20 months.

Figure I-3 Route Map for Survey

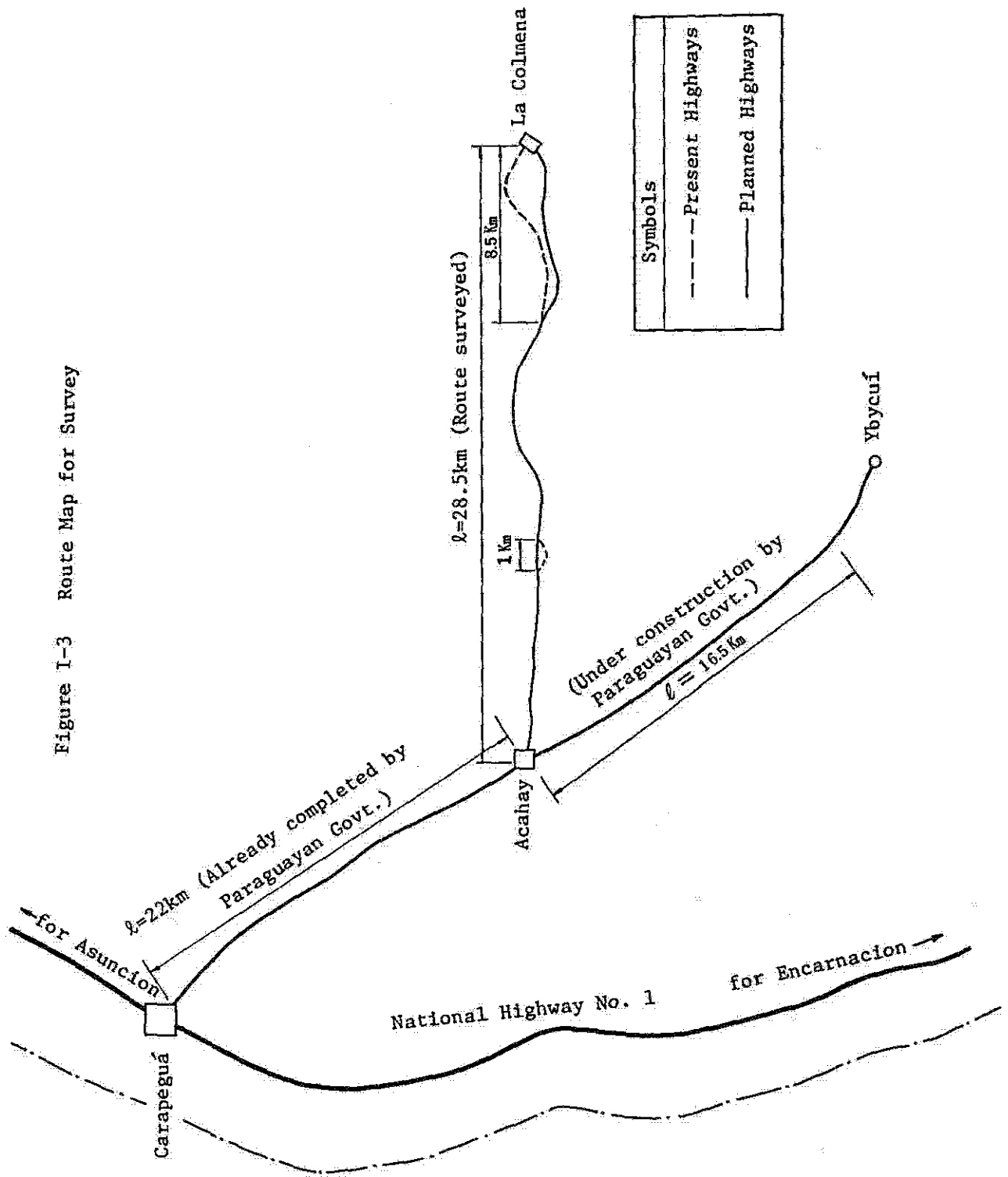
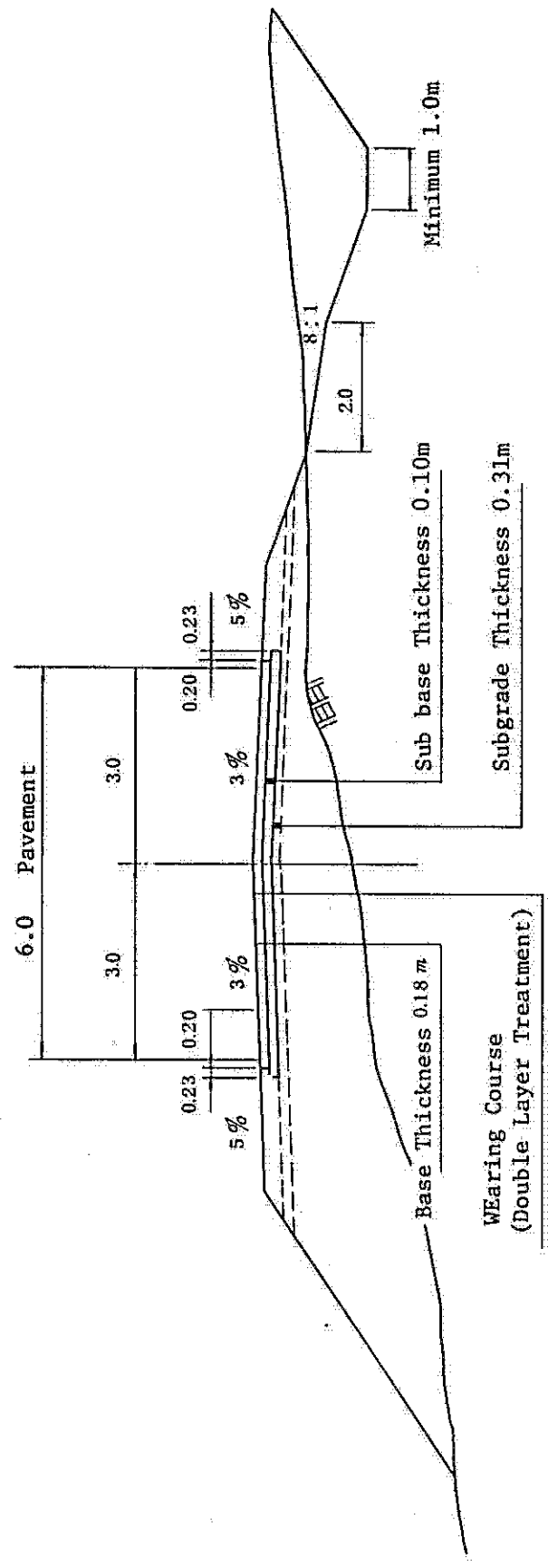


Figure I-4 Earthwork Standard Section



4. The project cost at the price of 1976 is estimated at US\$5,145,000, US\$3,607,000 in foreign currency (70.11%) and US\$1,538,000 in domestic currency (29.89%).  
 Provided that construction work starts in June 1977, including reserve fund (in case, price is assumed to be 12.2%/yr., refer to IV-4) a total estimated cost will be US\$6,257,000, US\$4,387,000 in foreign currency (70.11%) and US\$1,870,000 in domestic currency (29.89%).  
 (see Table I-1)

Table I-1 Project Cost

Item	Foreign currency	Domestic currency	Total
Direct Construction Cost	2,099	747	2,846
Temporary Construction Cost	145	121	266
Common Temp. Construction Cost	204	120	324
Field Expenses	322	138	460
General Administration Cost	341	145	486
Repair & Maintenance Cost	203	87	290
Sub Total	3,314	1,358	4,672
Engineering Fees	293	180	473
Total	3,607	1,538	5,145
Reserve	780	332	1,112
Grand Total	4,387	1,870	6,257
Ratio	70.11%	29.89%	100.00%

5. If the future economic growth rate of the country in real terms is set at 6.0%, the internal rate of return will be about 7.8%. Therefore, in this project whose capital cost is below 7.8% of the financial sources, the benefit-cost ratio (B/C) is over 1.0.
  
6. Japanese immigrants living in the La Colmena district have been diligently engaged in farming business for more than 40 years and have made a great contribution to the enhancement of the social status of the Japanese. These Japanese consider the realization of the project under discussion to be a major factor that could influence greatly the future of their farming business. Considering their social status, they strongly hope that the project will be materialized with the aid from Japan.



## II. HIGHWAY DEVELOPMENT PLAN

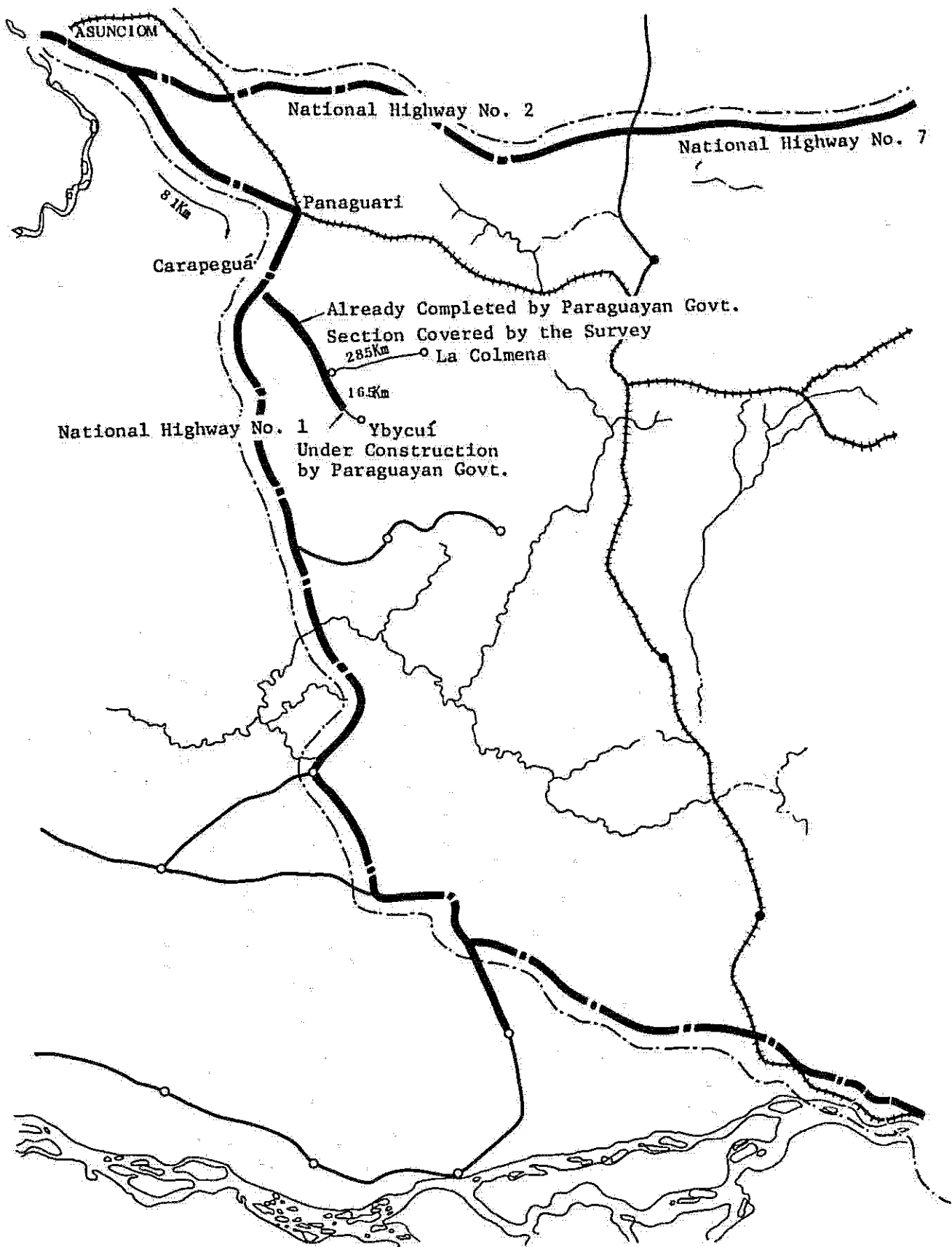
### II-1 Highway Section Surveyed

National Highway No. 1 is a trunk road running about 370 km from the capital of Asuncion to Encarnacion and has several roads branching out on the way. (Figure II-2)

Covered in the previous survey was the 42.5 km of the 50.5 km-long Carapeguá-Acahay-La Colmena section, excluding the sections which either were expected to be built directly by Paraguayan Government or were already completed.

However, construction works under the direct management by the government have smoothly progressed, resulting in covering about 30 km of the Carapeguá-Acahay section. Therefore, covered by the survey of this time is the 28.5 km-long section between Acahay and La Colmena. (see Figure II-1)

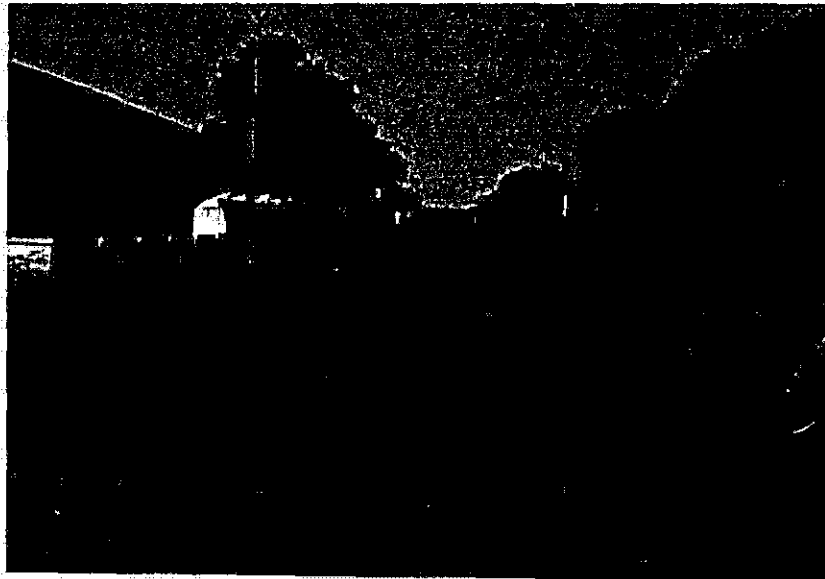
Figure II-1 Route Map of the Area Covered by the Survey



II-2 Present State of the Section Covered by the Survey

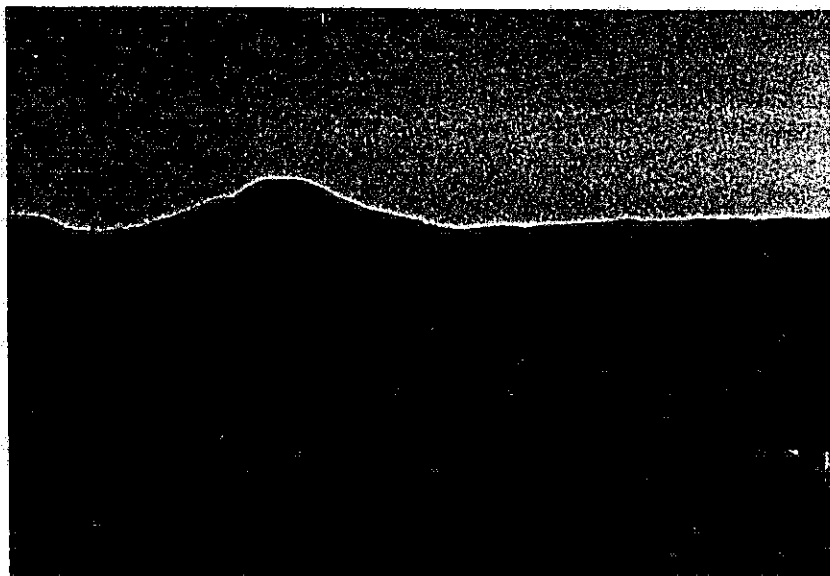
The existing highway was completed in 1965. However, since it was built merely by banking earth from both sides. As a result water always stay in the ditches in the lowland areas and it is flooded whenever it rains.

Since the road body is made of red silt, it turns muddy by soaking up water as it rains, and the road would be closed to traffic until drying. It is said that the closing period lasts for 80 to 100 days a year.



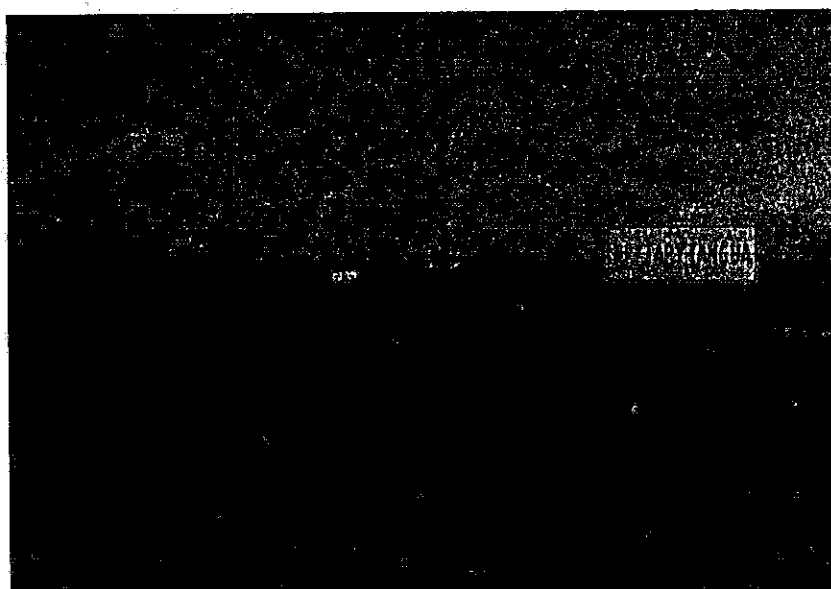
Photograph 1.

Intersection from the town area  
of Acahay City to La Colmena

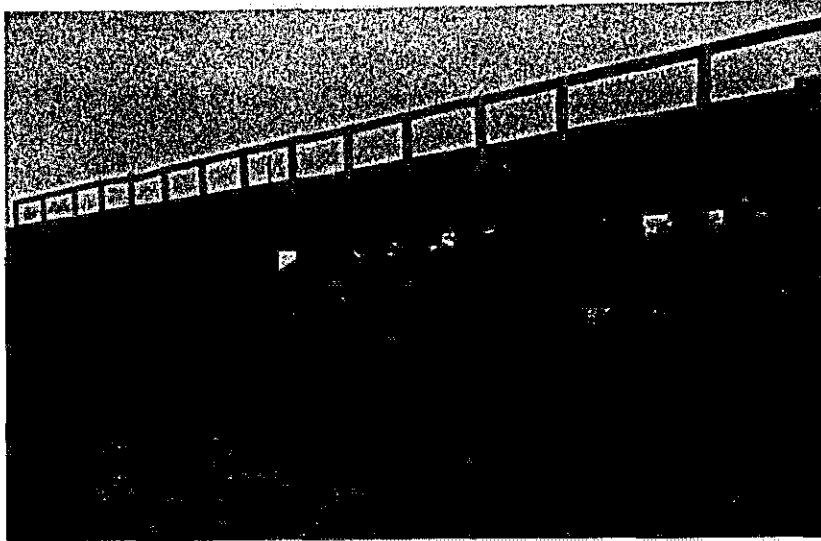


Photograph 2. Present La Colmena Highway  
The mountain in the background is  
called "La Colmena Fuji".

All the bridges on the highway are made of wood, and their structures are very poor. It is difficult for vehicles to pass through the bridges at high speeds, and they are forced to slow down their speeds.



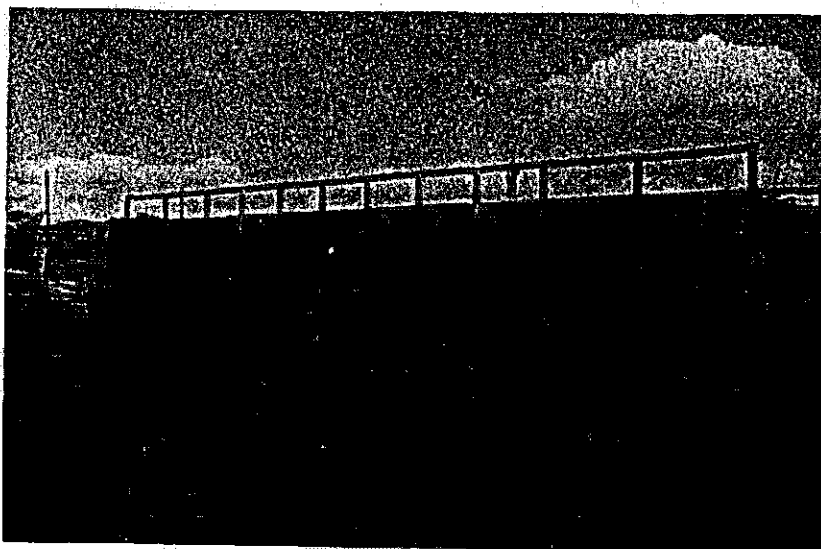
Bridge to be replaced No. 2 + 30M



No. 2 + 30M



No. 8 + 400M

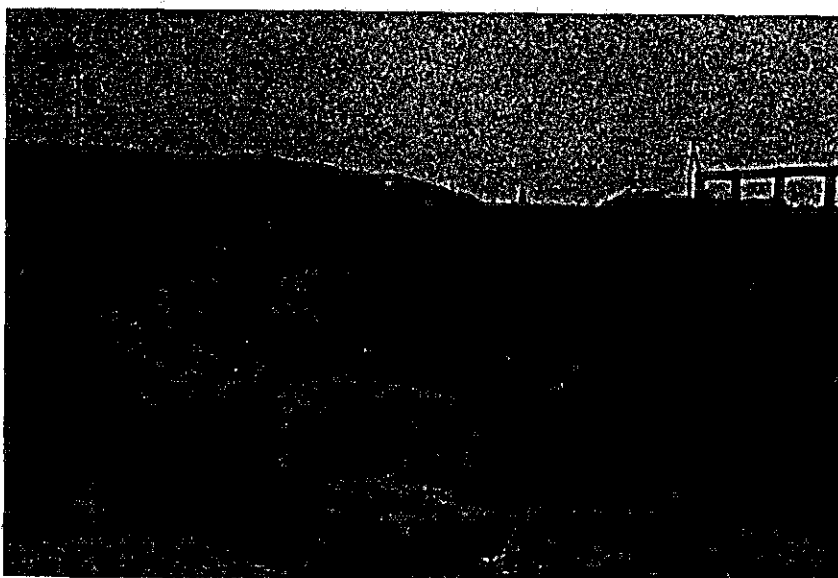


No. 8 + 400M

A trunk road improvement plan proposed to the 1974 mission was to utilize the existing road except the following sections:

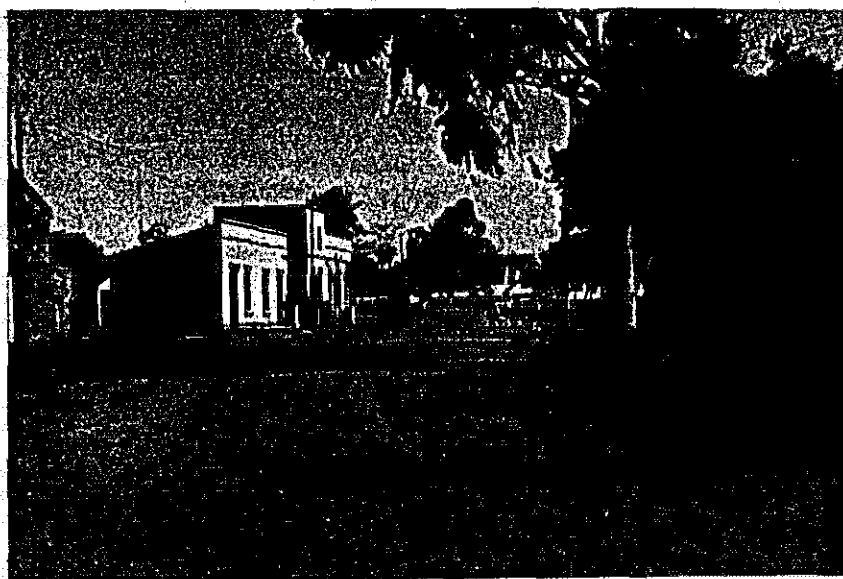
(1) Parts of the lowland areas shall be bypassed. (2) New route shall be built over an extension of about 10km in the La Colmena district where drains on the mountain side are scoured.

There has been no change made to this plan. (see Figure II-2 Map of Planned Route)



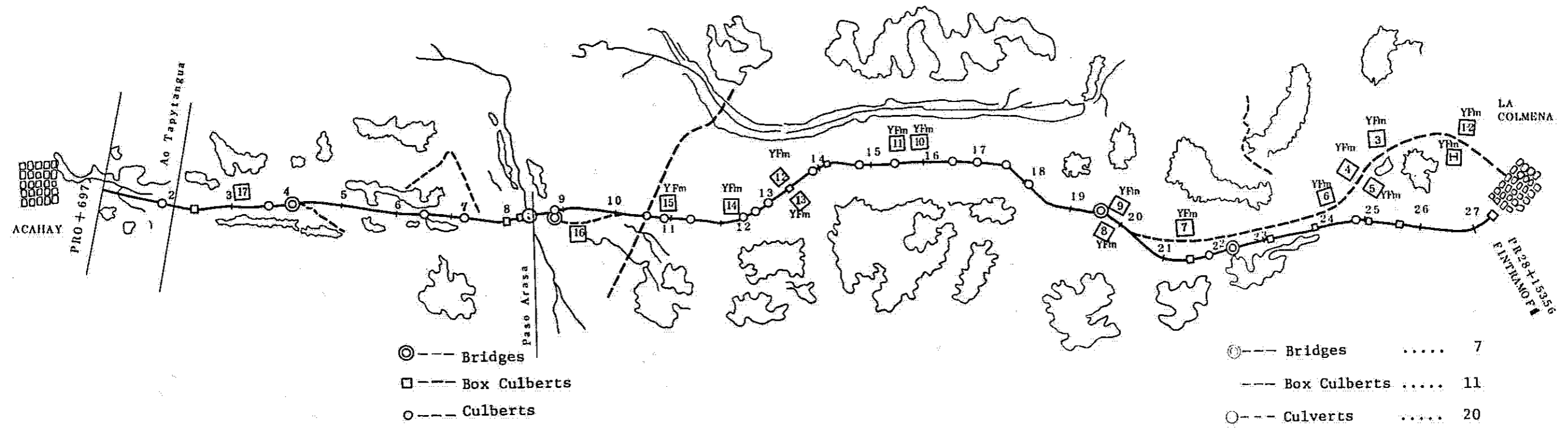
Around No.23  
(Present Road)

State of Scour at La Colmena Highway



Town Area of La Colmena City

Figure II-2 Ground Plan







According to the plan, the width of roadway will be six meters and the whole extension of the road will be banked.

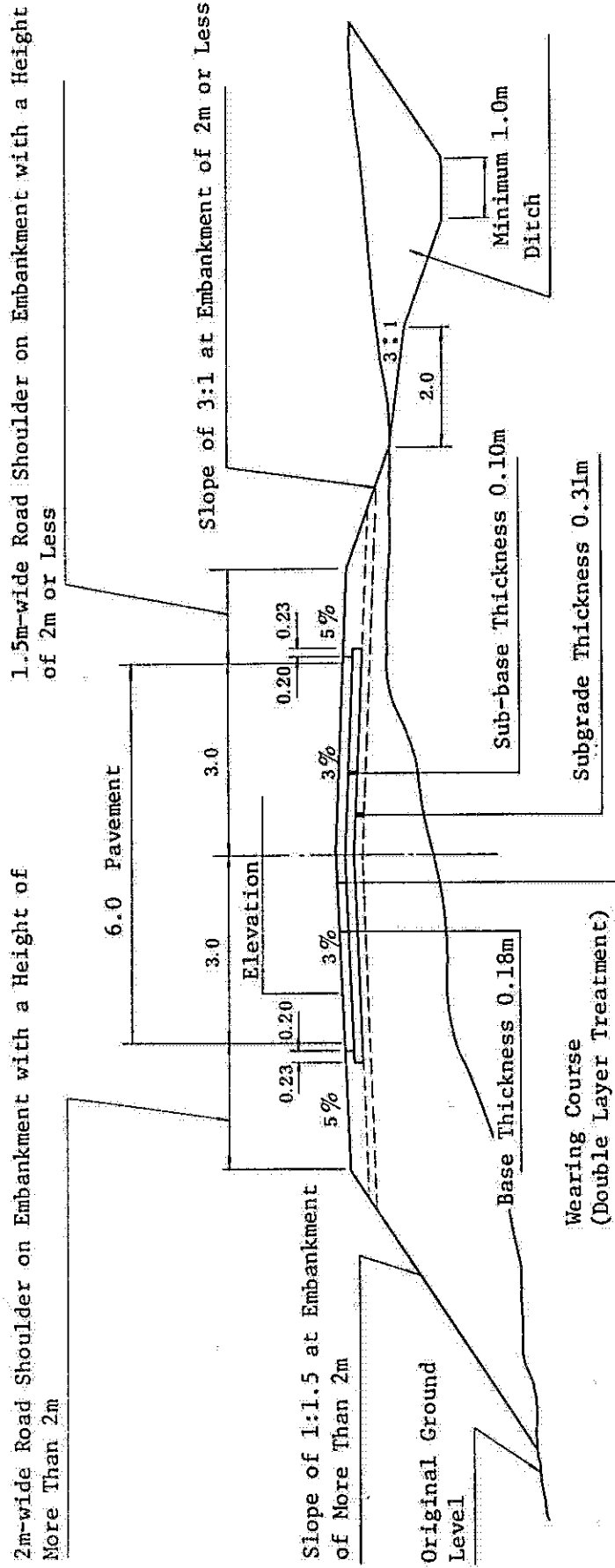
No particular alteration has been made in the formation of the embankment and so on in the survey of this time. The highway is to be built entirely on the embankment in order to raise the road surface and to protect the pavement from inundation when it rains.

Soil of good quality shall be laid as the subgrade with the thickness of 31cm all through the way to maintain a uniformity of the subgrade and thus to protect itself from getting soft and weak by soaking water.

Shown on Figure II-3 (Earthwork Standard Section) is the formation of the typical embankment section.

Subgrade	Soil of A <sub>2</sub> -4 Group
Subbase	Mixture of Crusher-run (60%) and Soil (40%)
Base	Crusher-run or Mixture with Soil
Wearing Course	Double Layer Treatment-Asphalt (3.0 l/m <sup>2</sup> ) and Crushed Stone (30 kg/m <sup>2</sup> )

Figure II-3 Earthwork Standard Section



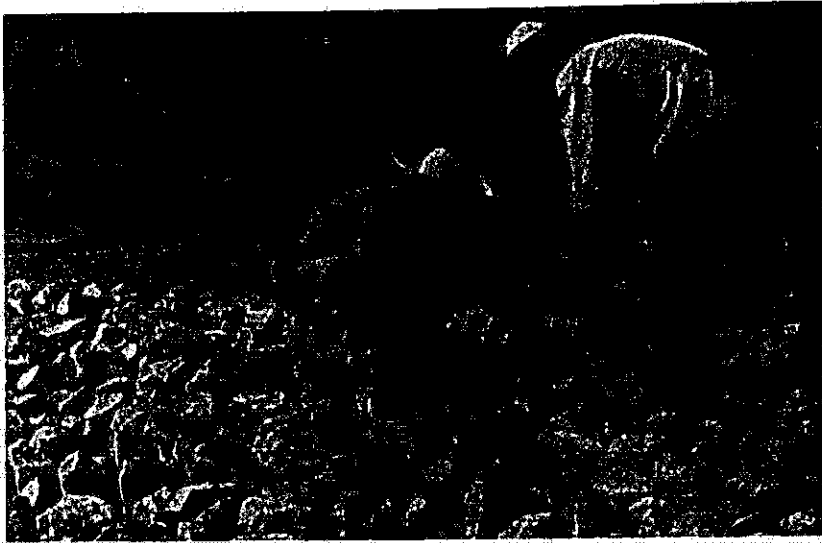
### II-3 Present State of Construction Work in the Vicinity

The construction work which was initiated on the Carapeguá-Acahay-Ybycuí section in 1974 under the direct supervision of the Paraguayan Government, has been going on smoothly, and has reached to an extension of about 30km in a 2 1/2 year period.

Of the section where pavement work is complete, 14km was included in the proposed project at the time of the previous survey, and there was not much difference in basic design between this section and the Acahay-La Colmena section included in this project. However the actual design and specification under the direct supervision quite differs from the design of this project. The adopted method is an asphalt macadam pavement, and the macadam is just laid over the broken stones arranged on the existing embankment.



Macadam Production by Engineering Corps



Photograph

Scene of Leveling  
of Crushed  
Stones



Scene of Leveling  
of Crushed  
Stones



Scene of Leveling  
of Fillers

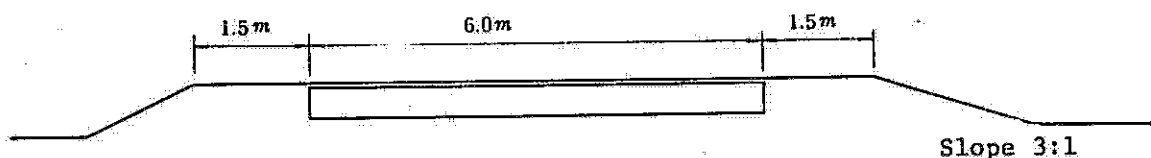
The cross section of the road is shown in Figure II-4.

The speed of this construction work was about one kilometer per month in the early stage, but it has recently risen to two kilometers per month. 30 to 40 workers are always supplied, and laying of crushed stones is being done entirely by manpower. Only one bulldozer, one grader and one paving machine are used for asphalt macadam pavement.

Aggregates are secured from among products manufactured by the army engineering corps in a rock hill located 4km north of Acahay.

Figure II-4 Carapeguá-Acahay Construction Work by Paraguayan Government.

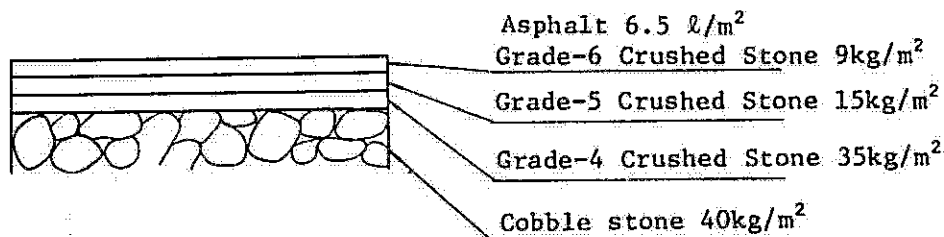
1. Cross Section



1-1 Clearing and grubbing area 40m wide

1-2 The existing road is partly used, while in other areas cut soils are used for embankment.

2. Sectional Construction



## II-4 Examination of Design Contents

### (1) Route Plan

Under the present plan, a new route is to be built on the mountain side in the last 8.5km extension of the 28.5km section included in the project, mainly in order to prevent the danger that the road body could be scoured by inundation and water flow at the time of torrential rains by reason of inadequate drainage facilities.

However, the foundation of the existing road is generally solid, while careful examination is required in water treatment measures even for the alternative route on the mountain side. Therefore, the possibility of using the existing road still remains subject to adequate preventive measures.

### (2) Profile and Cross Section Plan

In the section covered by the project, the level of the planned road is generally higher than the existing road, and 334,000m<sup>3</sup> of soil is needed for the embankment.

The embankment is presumably effective for reducing the damage by inundation and running water at the time of heavy rains. Since the foundation of the existing road is generally compacted and stable, except areas of weak ground and flood areas, the level of the planned road may be changed through a review of the plan.

### (3) Necessity of Upper Subgrade

Under the present design, a 31cm-thick upper subgrade is to be built. According to the principle of pavement structure, the upper subgrade of good quality will raise the bearing capacity of the pavement. The material for the upper subgrade is specified as soil of A<sub>2</sub>-4, and the soil pit is also designated.

However, almost all types of materials required for the purpose are available in the hilly areas of the region. If the material for the embankment is carefully selected it may create the same effect as the upper subgrade, and therefore it will not be necessary to lay the upper subgrade over the embankment. This problem should be fully studied from the economic viewpoint.

(4) Desirability of the Double-Layer Treatment of the Wearing Course

This project adopts a double-layer surface treatment for the wearing course. In this type of surface treatment, the roles of the wearing course are the prevention of wear and the proof against water. The problem of wear is considered to be almost negligible since the traffic volume is very small. More important is presumed to be the problem of waterproof. The subgrade is often destroyed by water permeation. To prevent this phenomenon, it is considered that the wearing course should be finished so as to have as strong water-proof as possible. The most desirable paving would be either a triple-layer surface treatment or heat-mixing bituminous concrete. If the double-layer surface treatment is adopted as present, it would be desirable to re-treat the surface after an appropriate period of time through a careful observation of surface changes.

(5) Comparison with Directly-Operated Work under Way

In the construction work operated directly by the Paraguayan Government, a telford paving using broken stones is employed as the base course and a 3cm-thick asphalt macadam as the wearing course. Although this is a popular road construction method adopted for years in Paraguay, it is hardly adopted for roadway construction in other countries. Major reasons why it has become unpopular are as follows:

- a. Productivity is very low, because work is done by manpower.
- b. There is no way to examine the quality of the base course.
- c. Since the structural balance is kept by the friction of arranged broken stones, structural strains caused by impact load from heavy vehicles could lead to immediate destruction.
- d. When the subgrade is weakened by water permeation from the wearing course, broken stones may move by the pumping action of mud.
- e. Leveling is extremely difficult.

The existing Carapeguá-Acahay-Ybycuí highway seems to have a fairly high load bearing, since the base consisting of broken stones was built on the subgrade filled with crushed stones, and in addition, it is considered to have already turned fairly strong through years of traffic. On the contrary, the subgrade of the Acahay-La Colmena route will be soil because it is almost entirely banked in consideration of inundation of water puddles. Therefore, it is considered difficult to expect the same stability of the subgrade as that of the road constructed under the direct operations of the Paraguayan Government. The stability that may be attained by the telford paving using broken stones is not considered to be completely satisfactory. Therefore, the design adopted in this report is considered more appropriate.



### III. ESTIMATION OF PROJECT COST

#### III-1 Project Cost at the Present Stage

##### (1) Construction Cost Presented by Paraguayan Government

The construction cost of this project presented by the Paraguayan Government through the Japanese Embassy was \$3,750,000 in trial estimation in July 1976 and \$4,400,000 in September 1976. In the latest survey, the quantities of works, unit prices and total costs were shown.

The costs which were used in the trial estimation of the 28.5km Acahay-La Colmena route were based on the unit prices of 1975 and 1976. The former estimate was prepared on the basis of the unit prices used in the Chaco Highway construction. The latter was based on the unit prices for the 76.5km Encarnación-Pirapó Route and Mbocayaty-Independencia Route. However an explanation said that some modifications were made in the figures. (see Table III-1).

Table III-1 Changes in Construction Cost of  
Acahay-La Colmena Highway

Type of Work		Quantity	Unit	Trial Estimation by Paraguay Govt. at the Time of Latest Survey			
				Trial Estimation in 1975		Trial Estimation in 1976	
				Unit Price	Cost	Unit Price	Cost
201	Cutting & Cleaning	114	Ha	691	78,774	826	94,164
203	Rock Excavation	2,274	m <sup>3</sup>	10	22,770	12	27,324
203	Embankment	334,000	"	2.06	688,040	2.4	801,600
206	Structure Removal	3,080	"	16	49,280	18	55,440
303	Sub base	48,300	"	18.6	898,380	22	1,062,600
304	Base	35,340	"	21.2	749,208	25	883,500
305	Upper Sub grade	57,600	"	4.2	241,920	5	288,000
410	Double-Layer Surface Treatment	171,000	m <sup>2</sup>	2.4	410,400	2.8	478,800
601	Concrete	1,370	m <sup>3</sup>	156	213,720	183	250,710
602	Reinforcing Bars	116,852	kg	1.02	119,189	1.22	142,559
603 <sub>B</sub>	Ferro-Concrete Pipes φ80	19.50	m	170	3,315	200	3,900
603 <sub>C</sub>	" φ100	142	"	188	26,696	220	31,240
605	Underground Drainage	2,807	"	43	120,701	50	140,350
610	Concrete for Masonry Structures	622	m <sup>3</sup>	113	70,286	130	80,860

Table III-1 Changes in Construction Cost of  
Acahay-La Colmena Highway (cont'd)

Type of Work		Quantity	Unit	Trial Estimation by Paraguay Govt. at the Time of Latest Survey			
				Trial Estimation in 1975		Trial Estimation in 1976	
				Unit Price	Cost	Unit Price	Cost
612	Railing	399	m	38	12,882	42	14,238
635	Masonry Blocks	1,693	m <sup>3</sup>	9.5	16,083	11	18,623
639	Removal of Wooden Bridges	1	Set		16,656		18,892
640	Removal of Existing Obstructions	1	"		11,700		13,200
Total					3,750,000		4,406,000

(2) Unit Costs of Construction Works Now under Way in Paraguay

The costs of the construction of pavement per kilometer in the road paving works carried out by the Paraguayan Government are as follows:

Construction Project	Base Course	Unit Cost
Chaco Highway	Portland Cement Stabilization Base	US\$125,000/km
Mbocayaty-Independencia	Selected Material Base	US\$151,500/km
Encarnacion-Pirapó	"	US\$144,000/km
Direct Operation Carapeguá-Acahay-Ybycuí	Telford Base	US\$ 65,500/km*

\* Note: The cost of the construction under the direct operation of the Paraguayan Government does not include machinery depreciation, miscellaneous expenses, administrative expenses, interest payments and profits. Attention needs to be paid to the cost of aggregate which is stably supplied by a plant operated by an engineering corps.

The cost (\$4,400,000) of the Acahay-La Colmena Route shown by the Paraguayan Government, the costs of supervision and lodging accomodation and other expenses total US\$4,746,000.

Therefore, the cost per kilometer is as follows:

$$\text{US\$4,746,000} \div 28.5\text{km} = \text{US\$166,500/km}$$

(3) Changes in Prices

The following is the comparison of labor, material and machinery prices between the previous and latest surveys. There are no significant changes in material prices, except those of bituminous materials which have shown sharp rises. (see Table III-2)

Table III-2 Comparison of Material Prices

	Item	Unit Price in 1974 Survey	Unit Price in 1976 Survey
Procurement Abroad	<u>Non-taxed Item for Public Use</u>		
	Reinforcing Bars	54.6 G/kg	55 G/kg
	<u>Taxed Items for Public Use</u>		
	Asphalt	22,000 G/l	37,000 G/l
	Cutback Asphalt	25,000 "	39,000 G/l
	Explosives		200 G/kg
Procurement at Home	<u>Non-taxed Items for Public Use</u>		
	Gasoline	43.4 G/l	41.99 G/l
	Heavy Oil	24 "	24.67 "
	Light Oil	23.8 "	23.8 "
	Oils and Fats	-	25.66 "
	<u>Taxed Items for Public Use</u>		
	Lime	300 G/40 kg Sack	300 G/40 kg Sack
	Cement	410 G/50 kg Sack	410 G/40 kg Sack
	Sand	375 G/m <sup>3</sup>	575 G/m <sup>3</sup>
	Crude Stone	280 G/t	300 G/t
	Crushed Stone No. 3	550 "	600 "
	No. 4	600 "	700 "
	No. 5	800 "	800 "
No. 6	900 "	900 "	

A minimum wage system is adopted in Paraguay. It had continued sharp rise until May 1974. However it has been fixed at 464.51 guaranis per day since May 1974. The following is a list of unit prices for various types of work in a payment report of an Argentine firm, which was obtained during the survey of this time. The unit prices shown on Table III-3 far exceed minimum wages.

Table III-3 Labor Prices

Occupation	Unit Price Shown by an Argentine firm during the Survey
Carpenter	120 guaranis/hour
Reinforcement Worker	120 "
Unskilled Laborer	70 "
Surveyor	80,000 guaranis/month
Machinist	55,000 "
Driver	100 guaranis/hour
Mechanician	90 "
Welder	120 "
Heavy Machine Operator	140 "
Foreman	100,000 guaranis/month
Test Engineer	50,000 "
Test Engineer Assistant	30,000 "
Rammer Operator	140 guaranis/hour
Crushed Stone Layer	100 "
Excavator	120 "
Dynamiter	100 "
Dynamiter Assistant	80 "
Mechanical Engineer Assistant	80 "
Electrical Engineer	30,000 guaranis/month
Paver Assistant	80 guaranis/hour

As to machinery, there is a trial estimation of purchase prices and rents prepared by the Paraguayan Government in 1973, and it was obtained during the previous survey. Made available during the survey of this time are the purchase prices and rents of machines used in the construction of the Encarnacion-Pirapó Route and the rents of machines in the construction of the Mbocayaty-Independencia Route.

Accurate comparison of machine prices is difficult because of differences in specifications and performances.

Table III-4 shows a comparison in the purchase prices of machines of the generally same categories. The trial estimation of 1976 shows some rises compared with that of 1973.

Table III-4 Purchase Prices of Machines  
(in US Dollars)

Machine	Model	Price in 1973	Price in 1976
Bulldozer	D-6	64,603	69,841
"	D-7 with ripper		103,968
"	D-8 with ripper	103,174	104,365
Tire Shovel	1.2m <sup>3</sup>	32,539	42,857
"	1.8m	44,523	63,492
"	2.1m <sup>3</sup>		79,365
Back Hoe	0.6m <sup>3</sup>		79,365
"	1.6m <sup>3</sup>	145,714	103,174
Aggregate Spreader		12,904	11,904
Chip Spreader		Simple Type 2,777	
"			21,428

Table III-4 Purchase Prices of Machines (Cont'd)  
(in US Dollars)

Machine	Model	Price in 1973	Price in 1976
Tire Roller	12t	11,984	12,698
"	18t	25,238	
"	26t	37,460	39,682
Random Roller		18,412	27,142
Macadam Roller	8 ~ 12t	16,269	
Sheep-foot Roller		Trailer Type 2,619	
			49,206
Vibration Roller		14,920	59,529
Asphalt Heater		4,682	
Asphalt Tank	20t	14,603	17,936
Asphalt Distributor		25,714	31,746
Drump Truck	10t	15,396	18,253
Small Truck	3t	11,984	12,222
Trailer	300HP	92,539	149,206
Motor Grader	125HP	35,158	47,619
Crusher Plant	70t/H		238,095
"	100t/H	208,253	265,873
"	150t/H		325,396
Compressor	9m <sup>3</sup>	14,920	15,079
Watering Cart	5,000L	14,047	22,222
Generator	80kW		24,603



It is difficult to compare the rents because of differences in factors forming the basis of calculation, such as durable years, annual operating hours and repair costs.

A general comparison for major machines is shown on Table III-5.

Table III-5 Comparison of Machine Rents

Machine	Model	Total of Machine Depreciation, Parts Repair Cost, Interest, Insurance, etc.	
		Machine Rent in 1973 (US \$/H)	Machine Rent in 1976 (US \$/H)
Bulldozer	D-6	15.7	14.4
"	D-8 with ripper	24.5	30.7
Tire Shovel	1.8m <sup>3</sup>	10.8	13.5
Back Hoe	1.6m <sup>3</sup>	27.3	27.5
Tire Roller	26t	6.1	5.7
Tandem Roller		3.4	3.7
Asphalt Distributor		6.3	6.7
Road Sweeper		2.7	2.7
Dump Truck	10t	3.7	5.8
Small Truck		2.7	3.7
Trailer	300HP	22.4	31.4
Motor Grader		8.5	8.8
Crusher Plant	100t	54.7	46.1
Watering Truck	500ℓ	3.4	5.5

(4) Outlook for Price Rises

a. Price Rises in Foreign Currency (Imports)

According to the Cuentas Nacionales 1962/1975, the average rises in the prices of construction-related items during the last five-year period range from 10.1% for machinery to the highest 38.6% for benzine-related products.

The rise in the weighted average of the unit prices of major types of works is nearly 14% (13.8%).

Just for reference, the average rise of construction costs of Japan was 12.4%, slightly less than that of Paraguay.

b. Price Rises in Domestic Currency

i) Rises in Labor Cost

According to the Cuentas Nacionales, the annual average rise is 8%.

1970	1971	1972	1974	1975
100	105	108.7	139.1	146.7

The rise from 1974 to 1975 was 5.5%, slightly less than the consumer price rise (6.0%) for the same period as shown in Reseña Economica.

ii) Price Rises in Domestic Products

The average rise based on real rises in the 1974-75 period is estimated at 8.7% per year.

iii) Estimated Rise Rate in Construction Work  
(Domestic Currency)

The annual average rise calculated from the component ratios of kinds of works on the basis of the figures in i) and ii) comes to about 8.3%.

c. Estimated Rise in Construction Cost and of This Project

As a result of the examination of a. and b., the composite rise rate which reflects rises in both foreign and domestic currency items is as follows:

$$(F/\text{Currency}) \quad (D/\text{Currency})$$

$$13.9\% \times 0.701 + 8.3\% \times 0.299 = 12.2\%/\text{year} \quad (0.96\%/\text{month})$$

(5) Current Rates of Engineering Services

a. Rates of Engineering Services in Paraguay

Shown in Table III-7 are construction costs and engineering in major road paving works (contracts) now under way for the Paraguayan Government.

Table III-7 Construction Costs and Engineering Expenses of Road Paving Works

Highway Name	Consultant	Construction Period	Construction Cost (A) in US \$	Engineering fee (B) in US\$	(B)/(A) %
Chaco Highway	Consultec (Paraguay) Edward Kelcey Engineering (USA)	34	Approx. 37,500,000	1,515,973	4
Encarnacion-Pirapó Highway	Para Consultant Cadia (Argentina)	27	10,950,000	780,598	7.1
Mbocayaty-Independencia Highway	Organtec-Ingpartec (Argentina)	20	4,154,688	376,978	9.1

The shorter the construction period and the lower the construction cost, the more the ratio of engineering fee to construction cost rise.

The contract terms concluded with the Argentine consultant firms for the construction of the Encarnacion-Pirapó Highway are as follows:

Engineering fee	\$658,330
Travel Expenses. Transportation Costs	\$ 36,330
Rentals for Passenger Cars, Machinery, etc. Car Driving Services	\$ 64,938
Total	US\$780,598

b. State of Consultants' Work

The consultant for the construction of the Encarnacion-Pirapó Highway is the joint venture of Para Consultant (Paraguay) and Cadia.

The main duty of the consultant is to manage the execution of the project. Four Argentines (two engineers, one surveyor and one senior tester) are stationed on a permanent assignment and share duties with Paraguayan engineers.

The engineering consultant is responsible for checking surveys and the quantities of works completed and examine the qualities of works according to specifications. His rigid inspections range over soil property, density, CBR, quality of crushed stones (Los Angeles test, water absorption, CBR), compressive strength of concrete, strength of reinforcing bars and qualities of secondary products in accordance with specifications.

### III-2 Preconditions of Project Cost Calculation

#### (1) Daily Amount of Work and Construction Period

The types and quantities of works as presented by the Paraguayan Government were considered to be generally appropriate, and it was decided that they would be adopted without modifications.

The daily turnouts of respective jobs are shown in Table III-8, and the daily local outputs of materials and the numbers of days required are shown in Table III-9.

Table III-8 Daily Turnouts of Respective Jobs

Type of Job	Quantity	Unit	Daily Turnout	Working Days	Total Days
Cutting & Cleaning	1,140,000	m <sup>2</sup>	11,520 m <sup>2</sup> /day	99 days	149 days
Rock Excavation	2,277	m <sup>3</sup>	128 m <sup>3</sup> /day	18 "	27 "
Embankment	334,000	"	1,376 "	243 "	365 "
Structure Removal	3,080	"	162 "	20 "	30 "
Sub base	48,300	"	328 "	148 "	222 "
Base	35,340	"	312 "	114 "	171 "
Upper Sub grade	57,600	"	384 "	150 "	225 "
Wearing Course	171,000	m <sup>2</sup>	2,560 m <sup>2</sup> /day	67 "	101 "
Concrete	1,370	m <sup>3</sup>	28 m <sup>3</sup> /day	49 "	74 "
Reinforcing Bars	116,852	kg	2,300 kg/day	51 "	77 "
Cross Pipes 80	19.5	m	12 m/day	2 "	3 "
" 100	142	"	12 "	12 "	18 "
Underground Drainage	2,807	"	80 "	36 "	54 "
Masonry Structure	622	m <sup>3</sup>	36 m <sup>3</sup> /day	17 "	26 "
Railing	399	m	15 m/day	27 "	41 "
Masonry Side Gutter	1,693	m <sup>2</sup>	80 m <sup>2</sup> /day	22 "	33 "
Removal of Wooden Bridges	1	set		6 "	9 "
Removal of Existing Objects	1	set		10 "	15 "

Table III-9 Daily Local Outputs of Materials and the Numbers of Days Required

Material Produced	Quantity	Unit	Daily Output	Working Days	Total Days (20 days per month)
Soil	43,785	t	688t	64 days	96 days
Broken Stone (Crude Stone)	169,523	"	720	236 "	354 "
Crusher-run	159,596	"	640	250 "	375 "
Crushed Stones (by gradations)	8,297	"	168	50 "	75 "

Table III-10 is a working table prepared on the basis of the listed construction periods and daily turnouts of respective jobs.

Table III-10 Working Table

Type of Job	Unit	Quantity	Total Days Sationed	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Temporary Earthwork	Cutting & Cleaning	Ha	114	149	$\frac{1,440\text{m}^3/\text{H} \times 8\text{H} = 11,520 \text{ m}^3/\text{day}}{99 \text{ days}}$																			
	Rock Excavation	m <sup>3</sup>	2,276	27	$\frac{10\text{m}^3/\text{H} \times 8\text{H} = 128\text{m}^3/\text{day}}{18 \text{ days}}$																			
	Earthwork	m <sup>3</sup>	334,000	365	$\frac{172\text{m}^3/\text{H} \times 8\text{H} = 1,376\text{m}^3/\text{day}}{243 \text{ days}}$																			
	Removal of Structures	m <sup>3</sup>	3,080	30	$\frac{21\text{m}^3/\text{H} \times 8\text{H} = 162\text{m}^3/\text{day}}{20 \text{ days}}$																			
Pavement	Sub base	m <sup>3</sup>	48,300	222	$\frac{41\text{m}^3/\text{H} \times 8\text{H} = 328\text{m}^3/\text{day}}{148 \text{ days}}$																			
	Base	m <sup>3</sup>	35,340	171	$\frac{39\text{m}^3/\text{H} \times 8\text{H} = 312\text{m}^3/\text{day}}{114 \text{ days}}$																			
	Upper sub grade	m <sup>3</sup>	57,600	225	$\frac{48\text{m}^3/\text{H} \times 8\text{H} = 384\text{m}^3/\text{H}}{150 \text{ days}}$																			
	Surface Treatment	m <sup>2</sup>	171,000	101	$\frac{320\text{m}^2/\text{H} \times 8\text{H} = 2,560\text{m}^2/\text{day}}{67 \text{ days}}$																			



Table III-10 Working Table (cont'd)

Type of Job	Unit	Quantity	Total Days Stationed	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Structure	Ferro-concrete	1,370	150	$\frac{28\text{m}^3/\text{H} \times 5\text{H}}{= 14\text{m}^3/\text{day}} \quad 100 \text{ days}$																			
	Cross Pipes	161.5	21	$\frac{24\text{m}/\text{H} \times 5\text{H}}{= 12\text{m}/\text{day}} \quad 14 \text{ days}$																			
	Under-ground Drainage	2,807	54	$\frac{16\text{m}/\text{H} \times 5\text{H}}{= 80\text{m}/\text{day}} \quad 36 \text{ days}$																			
	Masonry Structure	622	26	$\frac{6\text{m}^3/\text{H} \times 6\text{H}}{= 36\text{m}^3/\text{day}} \quad 17 \text{ days}$																			
	Railing	399	41	$\frac{3\text{m}/\text{H} \times 5\text{H}}{= 15\text{m}/\text{day}} \quad 2 \text{ days}$																			
	Stone Side Gutter	m <sup>2</sup>	1,693	33	$\frac{16\text{m}^2/\text{H} \times 5\text{H}}{= 80\text{m}^2/\text{day}} \quad 22 \text{ days}$																		
Provisional Crushing Plant																							

Table III-10 Working Table (cont'd)

Type of Job		Unit	Quantity	Total Days Saturated	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Local Materials	Soil Excavation	t	43,185	96	$\frac{86t/H \times 8H}{= 688t/days} \quad 64 \text{ days}$																			
	Stone Excavation	t	169,323	354	$\frac{90t/H \times 8H}{720t/days} \quad 296 \text{ days}$																			
	Crusher-run of Broken Stone	t	159,396	375	$\frac{80t/H \times 8H}{640t/days} \quad 250 \text{ days}$																			
	Stone Crushing	t	8,297	75	$\frac{21t/H \times 8H}{168t/days} \quad 50 \text{ days}$																			

(2) Prices of Materials and Labors

As to materials, the figures shown in Table III-2 are adopted. The comparison of figures between 1973 and 1976 shows sharp rises in asphalt-related items.

The unit prices of labors were decided on the basis of the figures presented to the Paraguayan Government by the Argentine firms as shown in Table III-3 and also considering the state of Japanese firms.

Ordinary workers work ten hours a day in Paraguay.

The basic price includes payment for two hours of overtime work in addition to a 16.5% social insurance premium and a 8.333% Oguinaldo to be paid at the time of retirement.

The number of working days is set at 20 days a month, and therefore the daily wages is 5% of the monthly basic pay. It was deemed necessary to employ operators of construction machines and machinists from other countries at the stage of the previous survey, since it was difficult to hire such craftsmen in the country.

Table III-11

Type of Job	Unit Price Used in Regular Calculation				
	Hourly Labor Price	Daily Labor Price per 10-H Working Day	Social Insurance Premium & Oguinaldo (0.165+ 0.0833)	Daily Labor Price Used in Calculation	Daily Labor Price Used in Calculation
Truck Driver	G/H 100	G/day 1,100	G/day 273	G/day 1,373	nsG/day 10.90
Mechanician	90	990	246	1,236	9.81
Reinforcement Worker	120	1,320	327	1,647	13.07
Foreman	500	5,500	1,364	6,864	54.48
Carpenter	120	1,320	327	1,647	13.07
Rock Drilling Worker	120	1,320	327	1,647	13.07
Earthworker	100	1,100	273	1,373	10.90
Unskilled Laborer	70	770	191	961	7.63

(NOTE) 1. The equation to compute the 10-hour-per-day labor price is as follows:

$$\begin{array}{l} \text{(hourly labor price)} \times 8 + \text{(hourly labor price)} \times 1.5 \times 2 = \text{(hourly labor price)} \times 11 \end{array}$$

2. The social insurance premium and Oguinaldo is:

$$16.5\% \times 10 \text{ hour labor price} + 8.33\% \times 10 \text{ hour labor price} = \text{the daily wages} \times 0.248$$

### (3) Rents of Machinery

The list of rents for machinery presented by the Paraguayan Government as shown in Table III-5 was used for the calculation of the cost. Rents in Japan were referred to for machines which are not included in the list.

The materials presented by the Paraguayan Government presupposed 2,000 hours for an annual operating time of machinery, which meant eight hour operation per day.

However, whether machines could actually be operated through the set hours is questionable.

For those machines whose annual operating time may be below 2,000 hours, it is necessary to study how to determine rents for the time when the machines stay in place. The rents of this category should be re-examined because the specifications these machines from being used for other purposes.

For this reason, modifications were made on the basis of rentals adopted in Japan. (see Calculation Material I)

Fuels and operators for machines as well as machinists were included in material and labor costs respectively. Machines used in each type of job are shown in Calculation Material II.

### (4) Engineering Fees

The latest survey found that Engineering fees paid to consultants were mainly for the management of construction work, that is, i) the construction and quality controls, and ii) the inspections of completed works and materials.

The construction control include minor changes in design during construction and approvals of materials and construction methods.

Engineering fees include direct personnel expenses, miscellaneous expenses, technical fees and direct expenses.

For the wages of foreign engineers, the Japanese standards are applied, and for those of domestic engineers, the consultant contracts for the projects now under way are used as reference. (see Table III-12)

Table III-12 Wages of Paraguayan Engineers

Item	Base for Calculation (Latest Survey)
Senior Engineer	1,450 US\$/month
Senior Surveyor	650 "
Field Supervisor	400 "
Tester	300 "
Surveyor	500 "
Tester Assistant	220 "
Surveyor Assistant	180 "
Driver	180 "

### III-3 Calculation of Project Cost

#### (1) Project Cost

A trial calculation of the project cost for this project is shown in Table III-13. Despite a strong request from the Paraguayan Government for starting work in January 1977, the starting date is set for June 1977 in consideration of time required for preparations in various sectors. As a result, reserves are provided to cover possible price rise.

Table III-13

(in US\$1,000)

Item	Foreign Currency	Domestic Currency	Total
Direct Construction Cost	2,099	747	2,846
Temporary Construction Cost	145	121	266
Common Temp. Construction Cost	204	120	324
Field Expenses	322	138	460
General Administration Cost	341	145	486
Repair & Maintenance Cost	203	87	290
Sub Total	3,314	1,358	4,672
Engineering Fees	293	180	473
Total	3,607	1,538	5,145
Reserve	780	332	1,112
Grand Total	4,387	1,870	6,257
Ratio	70.11%	29.89%	100.00%

(2) Construction Costs

a. Direct Construction Cost

Table III-14

(in US\$1,000)

	Foreign Currency	Domestic Currency	Total
Direct Con- struction Cost	2,099	747	2,846
Ratio	73.76%	26.24%	100.00%

Details of direct construction cost with unit prices are shown in Claculation Material III and IV.

b. Temporary Construction Cost

Table III-15

(in US\$1,000)

	Foreign Currency	Domestic Currency	Total
Temporary Con- struction Cost	145	121	266
Ratio	54.61%	45.39%	100.00%

Details of temporary construction cost are shown in Claculation Material V.



c. Common Temporary Construction Cost

Table III-16

(in US\$1,000)

	Foreign Currency	Domestic Currency	Total
Common Temp. Construction Cost	204	120	324
Ratio	63.06%	36.94%	100.00%

Details of common temporary construction cost are shown in Calculation Material VI.

d. Field Expenses

Table III-17

(in US\$1,000)

	Foreign Currency	Domestic Currency	Total
Field Expenses	322	138	460
Ratio	70.11%	29.89%	100.00%

e. General Administration Cost

Table III-18

(in US\$1,000)

	Foreign Currency	Domestic Currency	Total
General Administ. Cost	341	145	486
Ratio	70.11%	29.89%	100.00%

f. Repair & Maintenance Cost

Table III-19

(in US\$1,000)

	Foreign Currency	Domestic Currency	Total
Repair & Maint. Cost	203	87	290
Ratio	70.11%	29.89%	100.00%

(3) Engineering Fees

The following preconditions are provided in calculating Engineering fees.

- a. The project designs are already completed.
- b. Consultants are solely engaged in the management of the execution of pavement works ordered by the Paraguayan Government.
- c. The contractor of the project pays for the costs, of the offices, lodging facilities and laboratories used by the consultants including maintenance expenses.
- d. The same contractor also provides surveying instruments and testing equipments.

Table III-20 Engineering Fees

(in US\$)

Item	Foreign Currency	Domestic Currency	Total
Direct Personnel Expenses	78,050	65,230	143,280
Miscellaneous Expenses	85,855	71,753	157,608
Technical Fees	65,562	-	65,562
Sub Total	229,467	136,983	366,450
Direct Expenses	63,780	43,251	107,031
Total	293,247	180,234	473,481

Details of direct personnel expenses and direct expenses are shown in Table III-21 and Table III-22 respectively.

Table III-21 Direct Personnel Expenses (In US\$)

Item	Unit	Foreign Currency			Domestic Currency			Total	
		Number of Personnel	Unit Rate	Total	Number of Personnel	Unit Rate	Total	Number of Personnel	Total
Supervisor	month	3	1,950	5,850					
Project Manager & Senior Road Engineer	"	20	1,660	33,200	20	1,450	29,000		
Senior Structure Engineer	"	10	1,300	13,000					
Senior Soil & Material Tester (and Senior Pavement Engineer) <sup>o</sup>	"	20	1,300	26,000					
Pavement Engineer	"				15	650	9,750		
Surveyor	"				22	300	6,600		
Surveyor Assistant	"				44	220	9,680		
Tester	"				15	500	9,680		
Tester Assistant	"				15	180	2,700		
Total	"	53		78,050			65,230		

Table III-22 Direct Expenses

(in US\$)

Item	Foreign Currency	Domestic Currency	Total
Travel Expenses	35,780	3,600	39,380
Boarding Expenses	22,500	0	22,500
Car Expenses	0	27,051	27,051
Print & Communication Expenses	5,500	5,500	11,000
Office Supply Expenses	0	3,500	3,500
Field Personnel Expenses	0	3,600	3,600
Total	63,780	43,251	107,031

Details of direct expenses are shown in Calculation Material VII.

(4) Project Cost Including Reserves

a. Introduction of Price Sliding Scale (I)

Providing that construction work will be launched in June 1977, a trial sliding rate was calculated on the basis of the outlook for price rises - III-(4).

Work progress was assumed as follows:

Six months after start	10%
Next six months	40%
Next six months	40%
Final two months	10%

The centroid of Investment is expected to be in June 1978, and the sliding rate up to this point is calculated as 21.1%.

Year Month	(Work Start)		(Invest centroid)		(Work Com- pletion)	
	Oct. 1976	June 1977	Oct. 1977	June 1978	Dec. 1978	Feb. 1979
Indexes	100	107.9	114.3	121.1	128.2	130.7

As a result, the sliding rate is set at 21.1%.

b. Review of Current Plan

Under the current plan, the extension of about nine kilometers in the 28.5km route is to be newly built on the mountain side. As already mentioned in the discussion of the design contents, the existing road is generally stable, and if a new route is to be built, water treatment need to be fully studied. Therefore, it is reasonably possible to modify the plan so as to use the existing road by taking sufficient precautionary measures against water. Accordingly, the reserve should include funds that could be required in the case of design change.

The breakdown is as follows:

Direct Personnel Expenses	\$7,270
Miscellaneous Expenses	7,997
Technical Fees	4,927
Direct Expenses	5,152
Total	US\$35,346 = \$25,000

Details of the breakdown are shown in Calculation Material VIII. This adjustment work must be done before the construction work is launched. If the sliding rate of 6.9% for the time, the total will rise as follows:

$$\text{US\$25,000} \times 1.069 = \text{US\$27,000}$$

c. Others

It is common that the cost is prone to increase during the construction period because of changes in design or construction method. However, any material that would push up the cost sharply during the execution of work was not found through the survey of this time. Meanwhile the estimated figures presented by the Paraguayan Government were considered to include fair margins. As a result, it was concluded that no additional expenses would be required by design changes.

d. Total Reserve

The total reserve fund is calculated as listed below on the basis of the contents of a. - c.

i) Margin for Price Rise

$$\text{US\$5,145,000} \times 21.1\% = \text{US\$1,085,000}$$

ii) Adjustment of Current Plan      US\$27,000

$$\text{TOTAL: } \text{US\$1,085,000} + \text{US\$27,000} = \text{US\$1,112,000}$$

e. Introduction of Price Sliding Scale (II)

A) Rate of Price Rise in Foreign Currency

Adopted as the price rise rate in the current project was 9.0%, which was decided on the basis of the annual average price rises observed in the construction costs of ordinary highways in Japan during the past ten years.

Deflators of construction work as provided by the Planning Bureau of the Ministry of Construction of Japan are as follows:

	65	66	67	68	69	70	71	72	73	74	1975	Average
Deflators	73.7	79.5	87.2	89.5	94.1	100.0	103.4	109.3	137.1	176.1	179.1	9.3%

B) Rate of Price Rise in Domestic Currency

i) Rise of Labor Costs

According to "Cuentas Nacionales" (Statistics of the Paraguayan Central Bank), the average rise during the 1970-75 period is 8.0%.

	1970	1971	1972	1973	1974	1975	Average
Deflators	100	105.0	108.7		139.1	146.7	8.0

ii) Price Rise of Domestic Products

According to "Resenã Economica Financiere Y Monetaria del Año" (Paraguayan Statistics), the price of domestic products have risen about 1.1 times that of labor. Based on this, the rate is set at 8.8%.

iii) The proportion between labor cost and domestic product cost is about 4:6. Accordingly the average rise comes to 8.5%.



C) Total Project Cost

(in US\$1,000)

	1977. 4 Start		1977. 10 Start		1978. 4 Start		Total
	Foreign Currency	Domestic Currency	Foreign Currency	Domestic Currency	Foreign Currency	Domestic Currency	
Construction Costs	3,314	1,358	3,314	1,358	3,314	1,358	4,672
Engineering Fees	293	180	293	180	293	180	473
Reserve	608	234	735	285	934	363	1,297
Total	4,215	1,772	4,342	1,823	4,541	1,901	6,442
Ratio (%)	70.4	29.6	70.4	29.6	70.5	29.5	100

D) Foreign Currency Reserve

1977 June Start  $\{(1.0075)^{20}-1\} \times 3607 = 0.1611 = 581$   
1977 Oct. Start  $\{(1.5075)^{24}-1\} \times 3607 = 0.1964 = 708$   
1978 Apr. Start  $\{(1.0075)^{30}-1\} \times 3607 = 0.2513 \times 3607 = 906$

E) Domestic Currency Reserve

1977 June Start  $\{(1.0071)^{20}-1\} \times 1538 = 0.152 = 234$   
1977 Oct. Start  $\{( \quad )^{24}-1\} \times 1538 = 0.185 = 285$   
1978 Apr. Start  $\{( \quad )^{30}-1\} \times 1538 = 0.236 = 363$

F) Design Review Cost (Foreign Currency)

1977 June Start  $\{(1.0075)^7 \times 25.3 = 27$   
1977 Oct. Start  $(1.0075)^{11} \times 25.3 = 27$   
1978 Apr. Start  $(1.0075)^{17} \times 25.3 = 28$

### III-4 Presumption of Price Rise

#### (1) In Case Work Starts in October 1977

If it is assumed that the construction period is 20 months and that work starts in October 1977, the project will be completed at the end of May 1979. The work progress is assumed to be the same as when work starts in June 1977.

Year Month	(Start)		(Invest. Centroid)		(Work com- pletion)	
	Oct. 1976	Oct. 1977	Apr. 1978	Oct. 1978	Apr. 1979	June 1979
Indexes	100.0	112.2	116.5	125.8	133.2	135.8

In this case the sliding rate is 25.8%.

#### Review of Current Plan

The review of the Current Plan is handled in the same way as when work starts in June 1977.

The breakdown of reserves is as follows:

##### i) Margin for Price Rise

$$\text{US\$5,145,000} \times 0.258 = \text{US\$1,327,000}$$

##### ii) Adjustment of Current Plan

The sliding rate of 11.1% is considered.

$$\text{US\$25,000} \times (1 + 0.11) = \text{US\$28,000}$$

#### Total Reserve:

$$\text{US\$1,327,000} + \text{US\$28,000} = \text{US\$1,355,000}$$

(2) In Case Work Starts in April 1978

If it is assumed that the construction period is 20 months and that work starts in April 1978, the project will be completed at the end of November 1979. The work progress is assumed to be the same as when work starts in June 1977.

Year Month	(Start)		(Invest. centd)		(Work Complt)	
	Oct. 1976	Apr. 1978	Oct. 1978	Apr. 1979	Oct. 1979	Dec. 1979
Indexes	100.0	118.8	125.8	133.2	141.1	143.8

In this case the sliding rate is 33.2%.

Review of Current Plan.

The review of the current plan is handled in the same way as when work starts in June 1977.

The breakdown of reserves is as follows:

i) Margin for Price Rise (Sliding Rate: 33.2%)

$$\text{US\$5,145,000} \times 0.332 = \text{US\$1,708,000}$$

ii) Adjustment of Current Plan

The sliding rate of 17.6% is considered.

$$\text{US\$25,000} \times (1 + 0.176) = \text{US\$30,000}$$

Total Reserve:

$$\text{US\$1,708,000} + \text{US\$30,000} = \text{US\$1,738,000}$$

(NOTE) Change in Project Cost by Difference in Starting Time is shown in Table III-24.

Table III-24

(in US\$1,000)

Time of Work Start Item	June 1977	October 1977	April 1978
Operating Costs	5,145	5,145	5,145
Reserve	1,112	1,355	1,738
Total	6,257	6,500	6,883

(5) Annual Expenditure for Each Fiscal Year

Starting June 1977

Table III-25 Annual Expenditure for Each Fiscal Year

(in US\$1,000)

	Fiscal 1977			Fiscal 1978			Total		
	Foreign Currency	Domestic Currency	Total	Foreign Currency	Domestic Currency	Total	Foreign Currency	Domestic Currency	Total
	Construction Cost	1,212	517	1,729	2,063	880	2,943	3,314	1,358
Engineering Fee	123	52	175	209	89	298	293	180	473
Sub Total	1,335	569	1,904	2,272	969	3,241	3,607	1,538	5,145
Reserve	288	123	411	492	209	701	780	332	1,112
Total	1,623	692	2,315	2,764	1,178	3,942	4,385	1,870	6,257

(NOTE) In case based on the case II, introduction of price sliding scale.

(NOTE) Change in Annual Expenditure by Difference in Starting Time is shown in Table III-26.

Table III-26 Annual Expenditures

(in US\$1,000)

Fiscal Year Starting Month, Year	FY 1977	FY 1978	FY 1979	Total
June 1977	2,315	3,942	—	6,257
October 1977	650	5,200	650	6,550
April 1978		3,442	3,441	6,883

## IV. ECONOMIC EVALUATION

### IV-1 Preconditions of Economic Evaluation

The economic evaluation dealt with here presupposes the following.

1) Road section covered

28.5 km between Acahay and La. Colmena

2) Item of costs and benefits

**Costs:** Costs for construction (salvage values to be deducted in the last year of computation), and maintenance.

**Benefits:** Saving for vehicle operating cost, maintenance cost and time cost.

3) Period to be covered

Two years of construction, and successive twenty years of use

4) Prices

As of 1976

### IV-2 Economic and Industrial Indices for The Influence Area

What is expected to be influenced more or less by the construction of the proposed road will include La. Colmena, Cordillerita, Isla-Alta, Martinez-Que, etc. According to the data presented by the Paraguayan Government concerning "Plan Triangulo", the major economic and industrial indices for these areas are as follows.



1) La Colmena

A town developed in 1936 by Japanese immigrants, having a plantation area of 11,000 ha.

Some seventy families of Japanese and some 450 families of Paraguayans live together.

In 1948, the La Colmena Agricultural Cooperative was established. Ever since then, they have been bending their energies to improve their farming efficiency by, say, switching the crops from unprofitable to lucrative ones.

Table IV-1 Indices for La Colmena

Item	Unit	Co-op's membership		Non-members		Total	
		1968	1979	1968	1979	1968	1979
Output	tons	4,095	7,525	1,715	2,665	5,810	10,190
Number of families		60	80	450	600	510	680
Farming fields	ha.	681	1,183	705	960	1,386	2,143
Total area	ha.					11,000	

2) Cordillerita

A terrace 25 km apart from La Colmena.

It is connected with La Colmena by an earth road.

Here, large plantations of wheat and soybeans are operated.

There are no communities to mention, however.

Table V-2 Indices for Cordillerita

Item	Unit	1968	1979
Output	tons	5,280	6,570
Farming fields	ha.	4,400	—

3) Isla-Alta

In the environments closely resembling Cordillerita, Isla-Alta is chiefly engaged in the production of wheat and soybeans. The only communication available is an approach road leading to La Colmena.

Table V-3 Indices for Isla-Alta

Item	Unit	1968	1979
Output	tons	900	2,160
Farming fields	ha.	750	1,800

4) Martinez-Que

About 6 km from La Colmena. Most of people living here are subsistence farmers.

Table V-4 Indices for Martinez-Que

Item	Unit	1968	1979
Output	tons	900	1,413
Farming fields	ha.	500	700

5) Total

The indices for these areas are summarized in Table V-5 below.

Table V-5 Summary of indices for the influence area

Item	Unit	1968	1979	Growth rate
Output	tons	12,890	20,333	4.2% per annum
Farming fields	ha.	7,036	9,043	
Population	persons	10,000	(18,000)*	3.0% per annum

\* Value estimated for the year 1989

IV-3 Estimation of traffic volume

1) Trend in Traffic Volume

A recent tendency in traffic volume at key spots in Paraguay is shown in Table V-6.

Table V-6 Traffic volume at key spots

Checking point	1973 vehicles/d.	1975 vehicles/d.	1975/1973	Annual average growth rate %
<u>Route 2:</u>				
Cnel. Oviedo	1,144	1,356	1.19	9.1
<u>Routes 3, 5:</u>				
Cnel. Oviedo	385	457	1.19	9.1
Mbutuy Ibranch to Curuguaty)	291	544	2.71	64.6
Tecucara	219	329	1.57	25.3
Santa Rosa (branch to San Pedro)	31	45	1.45	20.4
Yby-Yau	97	115	1.19	9.1
Concepcion	155	186	1.20	9.5
Junction leading to Bella Vista	23	39	1.70	30.4
P. Juan Caballero	428	646	1.53	23.7
<u>Route 7:</u>				
Cnel. Oviedo	681	919	1.35	16.2
Junction leading to Yhu	54	76	1.39	17.9
Caaguazu	562	805	1.43	19.6
Campo 9	596	765	1.35	16.2
Km. 34	395	824	2.09	44.6
Junction leading to Hermandarias	298	1,224	4.11	102.7

According to a 1969 OD survey, the traffic volume between Acahay and La Colmena was 68 vehicles/day. In 1976, it was increased up to 118 vehicles/day, that is to say an annual average growth rate was 8.2%.

2) Forecast of traffic volume growth rate

a) Macroscopic estimation

For the purpose of macroscopic forecast of future traffic growth, cross-section analysis of GNP and car holdings in 49 countries in the world from the data available as of 1971 is made, and the following regression formula is obtained.

$$Y = 0.2995X + 2.523 \quad (R = 0.9233)$$

Y : per capita GNP (thousand yen/person)

X : vehicles per thousand persons

The past GNP growth rate in Paraguay was about 6.5% on the average of five years from 1971 to 1975 (5% for the period from 1974 to 1975) as shown in Table V-7.

Table IV-7 GNP growth rate

(Unit: million guaranies) (Prices in 1972 taken as a basis)		
Year	GNP	Change from a year earlier
1971	92,200	
1972	96,899	1,051
1973	104,499	1,078
1974	113,150	1,083
1975	118,840*	1,050

(\*approx. ¥103 thousand/person)

Source: Paraguayan Ministry of Commerce and Industry's Statistics

The Paraguayan Government sees on its long-term forecast that the future annual average GNP growth rate will be 6%. From the aforesaid regression formula, Paraguayan car holdings or traffic volume is anticipated to rise at an annual average growth rate of about 6%.

b) Estimation from traffic records

Taking stock of the traffic in recent years, the traffic volume on the arteries shows an annual average growth rate of no less than 9%. Although it is hard to make precise judgement on the traffic volume on the secondary roads in defect of traffic counting records, the annual average growth rate of traffic on the secondary roads is estimated to be more than 6.3% if it is assumed to be 70% of that of the arteries.

c) Estimation from regional indices

The estimation of traffic growth from indices such as population and income can be made according to the following formula proposed in Louis Berger's Report.\* (\* Espudio de Factibilidad Tecnico y Economico de Mejoramiento de Carreteras: Plan Triangulo - Area Republica del Paraguay Volumen 1)

$$1 + R = \left( \left( 1 + C \cdot \left( \frac{1 + r_i}{1 + r_p} - 1 \right) \right) \right) \cdot (1 + r_p)$$

R : average growth rate of traffic volume

$r_i$  : growth rate of income

$r_p$  : growth rate of population

C : coefficient (passenger car: 1.5' truck: 1.0)

The growth of income is projected either from its correlation with GNP or from the growth of output.

The GNP vs. national income correlation in the past is as shown in Table V-8. From this,  $r_i$  is estimated to be 6.9%.

Table V-8 Growth of GNP and national income

	1972	1973	1974	1975	Annual average growth rate	Long-term forecast
GNP	100.0	107.8	116.7	122.5	7.0%	6.0%
National income	100.0	108.9	120.7	125.9	7.9%	(6.9%)

The growth of industrial output, on the other hand, is estimated at about 4.2% a year on the average.

(see Table V-5)

A rough judgement of the real growth of the prices of agricultural products from the difference in growth rate between wholesale commodity prices and consumer prices indicates that earnings from agricultural production is about 5%.

From the above two methods, the growth rate of income,  $r_i$ , is estimated to come in the range of 5.0% to 6.9%. Here, the median, 6%, is taken for the sake of convenience.

The population growth rate,  $r_p$ , is 3% so far as Table V-5 shows. But as the plantation settlements have been recently toward the boundary with Brazil, the population growth rate is set at 1.5%. With all these conditions taken into account, the average growth rate of traffic volume,  $R$ , is calculated to be 6.5%.

d) Determination of traffic growth rate

Judging from the results of a) through c) above, the growth rate is found to be in the range of 6.0% to 6.5%. In view of the accuracy of the indices, the lowest value, 6%, is taken as the growth rate of traffic volume.

3) Estimation of traffic volume for the first year

When the road is paved, 80 to 100 days hitherto traffic-closed will be recouped, and the traffic volume will increase as much. The maximum contribution of this increment is expressed by  $D/(365 - D)$  (D: number of days closed during a year). At least half of the maximum value may be counted in. Then, with the traffic growth rate at 6% per annum, the traffic volume,  $T_1$ , at the completion of the road pavement will be as calculated below.

$$T_1 = 118 \text{ vehicles/day} \times (1 + 0.06)^3 \times \left(1 + \frac{100}{365 - 100} \times 1/2\right)$$

$$= 167 \text{ vehicles/day} \quad (D = 100 \text{ days})$$

In the m-th year, the traffic volume,  $T_m$ , is given by the following formula.

$$T_m = 167 \times (1 + 0.06)^{m-1} \text{ vehicles/day}$$

Assuming that the component ratios of traffic volume by type of vehicle remains the same as in 1976, the traffic volume by type of vehicle in the year when the improved road will be available for the first time will be as shown in Table V-9.

Table V-9 Traffic volume by type of vehicle  
(Unit: vehicles/day)

Type of vehicle	1976	First year of use
Passenger cars	10	14
Regular buses	18	25
Trucks	60	85
Small trucks	30	43
Total	118	167

IV-4 Estimation of Benefits

1) Saving for vehicle operating cost

According to the data prepared by the Paraguayan Road Bureau, the vehicle operating costs per kilometer are as follows.

Table V-10 Vehicle operating costs

(as of 1976)

Unit: guarani/km

Type of road	Paved (1)	Gravel (2)	Saving (1) - (2)
Passenger cars	18.18	23.27	5.09
Buses	33.65	54.39	20.74
Trucks	28.04	46.26	18.22

The running benefit, Br<sub>1</sub>, in the first year of use of the 28.5 km paved road between Acahay and La Colmena can be calculated from the above table of economies by type of vehicle and also from Table V-9 showing the daily average traffic volume by type of vehicle as follows.

$$\begin{aligned} \text{Br}_1 = & (5.09 \text{ G} \times 14 \text{ vehicles} + 20.74 \text{ G} \times 25 \text{ vehicles} + \\ & 18.22 \text{ G} \times 85 \text{ vehicles} + 18.22 \text{ G} \times 43 \text{ vehicles} \times \\ & 0.7) \times 28.5 \text{ km} \times 365 \text{ days} = 27,950 \text{ thousand guarani} \end{aligned}$$

The benefit the small truck will take is estimated to be 70% of the ordinary truck.

The vehicle operating cost saving over 20 years of project life (construction for 2 years commencement of service on the third year) is calculated below in terms of the sum of the present worth with the annual average traffic growth rate at 6% and  $\Sigma \text{Br}$  with the discount rate at  $r$ .

$$\text{Sigma Br} = 27,950 \times \frac{(1+r)^{20} - 1.06^{20}}{(r - 0.06) \times (1+r)^{21}} \quad (\text{thousand guaranies})$$



2) Saving for maintenance cost

According to the data prepared by the Paraguayan Road Bureau, the annual costs for maintenance and operation of paved road, gravel road and earth road per km can be expressed in relation to average daily traffic volume (A.D.T.) as follows.

(The costs for maintenance and operation costs for all the road the length of which is 6,674 km, in the year 1976, totaled 426,670 thousand guarani the Paraguayan Road Bureau says.

$$\text{Paved road, } M_1 = 56,000 + 70 \times \text{A.D.T.} \quad \text{guarani/km.yr}$$

$$\text{Gravel road, } M_2 = 16,000 + 380 \times \text{A.D.T.} \quad \text{guarani/km.yr}$$

$$\text{Earth road, } M_3 = 31,000 + 600 \times \text{A.D.T.} \quad \text{guarani/km.yr}$$

The saving ( $M_B$ ) in the costs of maintenance and operation which is expected from the proposed pavement of earth road is written as follows.

$$M_B = M_3 - M_1 = -25,000 + 530 \times \text{A.D.T.} \quad \text{guarani/km.yr}$$

Then, the maintenance and operation benefit,  $B_{m1}$ , for the first year of service of the 28.5 km Acabay - La Colmena section can be calculated from the above equation and Table \_\_\_\_\_ showing the daily traffic volume, as follows.

$$\begin{aligned} B_{m1} &= (-25,000 + 530 \times 167 \text{ vehicles}) \times 28.5 \text{ km} \\ &= -712,500 + 2,522,535 = 1,810 \text{ thousand guarani} \end{aligned}$$

Accordingly, the sum of the present worth of benefits over the 20 years of use can be expressed by the following formula with the discount rate at  $r$ .

$$\begin{aligned} \text{Sigma } B_m &= -712.5 \times \frac{(1+r)^{20} - 1}{r(1+r)^{21}} + 2,522.5 \times \\ &\quad \frac{(1+r)^{20} - 1.06^{20}}{(r - 0.06) \times (1+r)^{21}} \quad (\text{thousand guarani}) \end{aligned}$$

### 3) Saving for Time Cost

#### ° Cargo transportation

In Paraguay, the freight is as follows.

Railway : approx. 4 guarani/ton.km

Truck : appr-x. 8 guarani/ton-km

Shipping by truck costs 4 guarani/ton-km more than by rail. According to a general survey of traffic, the running speed of truck is 57.6 km/hr. on a paved road, while the railway serves at a speed of about 25 km/hr.

(For example, the freight liner takes some 15 hrs to travel 370 km between Asuncion and Encarnación.)

If the truck loading capacity is set at 7 tons/truck in the light of the 1969 OD survey, the time benefit per truck can be calculated as follows.

$$\begin{aligned} \text{Time benefit per truck, } B_{tf} &= \frac{4 \times 7 \times 0.7}{60 \times \left( \frac{1}{25} - \frac{1}{57.6} \right)} \\ &= 14.5 \text{ guarani/truck. min.} \end{aligned}$$

Rounded, it is estimated at about 15 guarani/truck. min.

#### ° Passenger traffic

In Paraguay, the users of passenger cars are considered to have an average income of 50,000 guarani/month.

Then, their return per minute of effort is calculated as follows.

$$50,000 + (25 \text{ days} \times 7 \text{ hrs.} \times 60 \text{ min.}) = 5 \text{ guarani/person.min.}$$

If the number of passengers sharing a drive with each other is set at 1.5 person/car, the time benefit per passenger car is calculated as follows.

$$\text{Time benefit per passenger car, } B_{tp} = 5 \times 1.5 = 7.5 \text{ guarani/car. min.}$$

The benefits of bus services are omitted from computation.

° Reduction of transit time

According to a dynamic survey of traffic, the vehicular running speeds are as follows.

	Unit: km/hr	
	<u>Paved road</u>	<u>Earth road</u>
Passenger cars	75.9	42.5
Trucks	57.6	38.7

Thus, the pavement of the 28.5 km Acahay-La Colmena section will bring about the reduction in travel time as calculated below.

	Earth road		Paved road		Reduction in travel time (1) - (2), min.
	Speed km/hr.	Time min. (1)	Speed km/hr.	Time min. (2)	
Passenger cars	42.5	40	75.9	22	18
Trucks	38.7	44	57.6	30	14

° Time benefit

The time benefit,  $B_t$ , in the first year of service is calculated as follows.

$$B_{t1} = (7.5 G \times 18 \text{ min.} \times 14 \text{ vehicles} + 15 G \times 14 \text{ min.} \times 85 \text{ vehicles} + 15 G \times 14 \text{ min.} \times 43 \text{ vehicles} \times 0.7) \times 365 \text{ days} = 9,512 \text{ thousand Guaranes}$$

Thus, the sum of the present worth of the time benefit over 20 years of use is expressed by the following formula in which the discount rate is set at  $r$  and the traffic growth rate at 6%.

$$\Sigma B_t = 9,512 \times \frac{(1+r)^{20} - 1.06^{20}}{(r - 0.06) \times (1+r)^{21}} \text{ thousand Guaranes}$$

#### IV-5 Estimation of Costs

##### 1) Construction costs

As discussed in IV-3, the construction costs are estimated to amount to US\$5,145 thousand (648,352 thousand Guaranies) exclusive of reserve funds. (Exchange rate: 1 US\$ = 126 Guaranies). As the project is in the nature of public works, some materials and supplies, such as fuel, are considered as exempt in the estimation. In this study of economic effective, however, the market price is employed, and the exempted amount (estimated at US\$9,406) is added to the construction costs to make a total US\$5,155 thousand (649,537 thousand Guaranies).

With the construction period of 2 years and with the construction costs allocated equally in the 2-year period for the sake of simplicity of calculation, the total costs of present worth for the 2 years is expressed as follows at a discount rate of  $r$ .

$$\Sigma C_c = 649,537 \times 1/2 \times \left(1 + \frac{1}{1+r}\right) \text{ thousand Guaranies}$$

##### 2) Costs for maintenance and operation

As discussed in item 2) of V-3, the maintenance and operation costs of the paved road are expressed by the following formula.

$$M_1 = 56,000 + 70 \times \text{A.D.T.} \text{ Guaranies/km-yr}$$

Accordingly, the maintenance and operation costs for the first year of service can be calculated as follows.

$$C_{m1} = (56 + 0.07 \times 167) \times 28.5 = 1,929 \text{ thousand Guaranies}$$

Then, the present worth of the maintenance and operation costs over the 20 years of use will amount to the value given by the following formula in which the traffic growth rate is set at 6% and the discount rate at  $r$ .

$$\Sigma C_m = 1,596 \times \frac{(1+r)^{20} - 1}{r \times (1+r)^{21}} + 333 \times \frac{(1+r)^{20} - 1.06^{20}}{(r - 0.06) \times (1+r)^{21}}$$

thousand Guaranies

### 3) Salvage value

In order to deduct the project costs, the salvage value of the road at the end of the period (after 20 years of service) is evaluated.

The service life of the road is roughly estimated by the type of structures as in Table V-11 in which the construction costs totaling 649,537 thousand Guaranies are prorated among the structures.

Table V-11

Structure	Service life	Salvage value 20 years later	Ratio of construction cost
Pavement	20 years	0	11.5%
Earthwork	40 years	0.5	76.3%
Masonry	40 years	0.5	3.6%
Concrete work	60 years	0.67	8.6%

Accordingly, the salvage value after 20 years of use, Ps, is given by the following calculation.

$$P_s = 649,537 \times ((0.115 \times 0 + (0.763 + 0.036) \times 0.5 + 0.086 \times 0.67)) = 649,537 \times 0.45712 = 296,916$$

thousand Guaranies

The cost above can be discounted at a rate of r to obtain the present worth after 20 years of use to make the present worth Cp.

$$C_p = 296,916 \times (1+r)^{-21} \text{ thousand Guaranies}$$

#### IV-6 Cost-benefit analysis

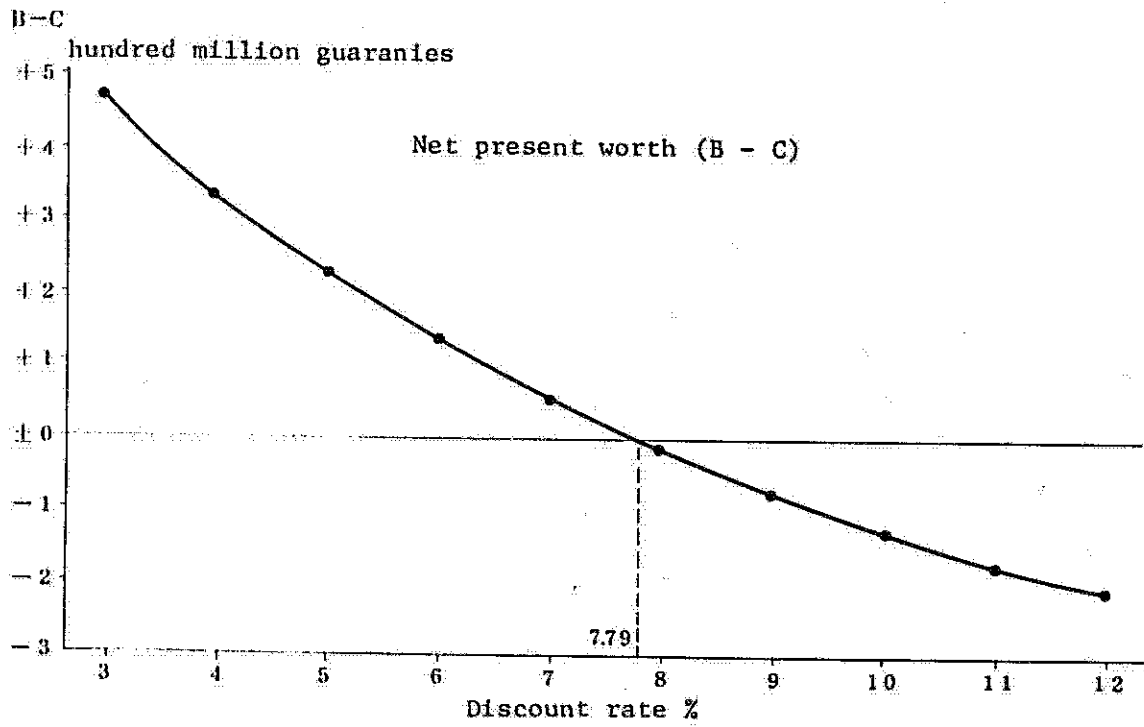
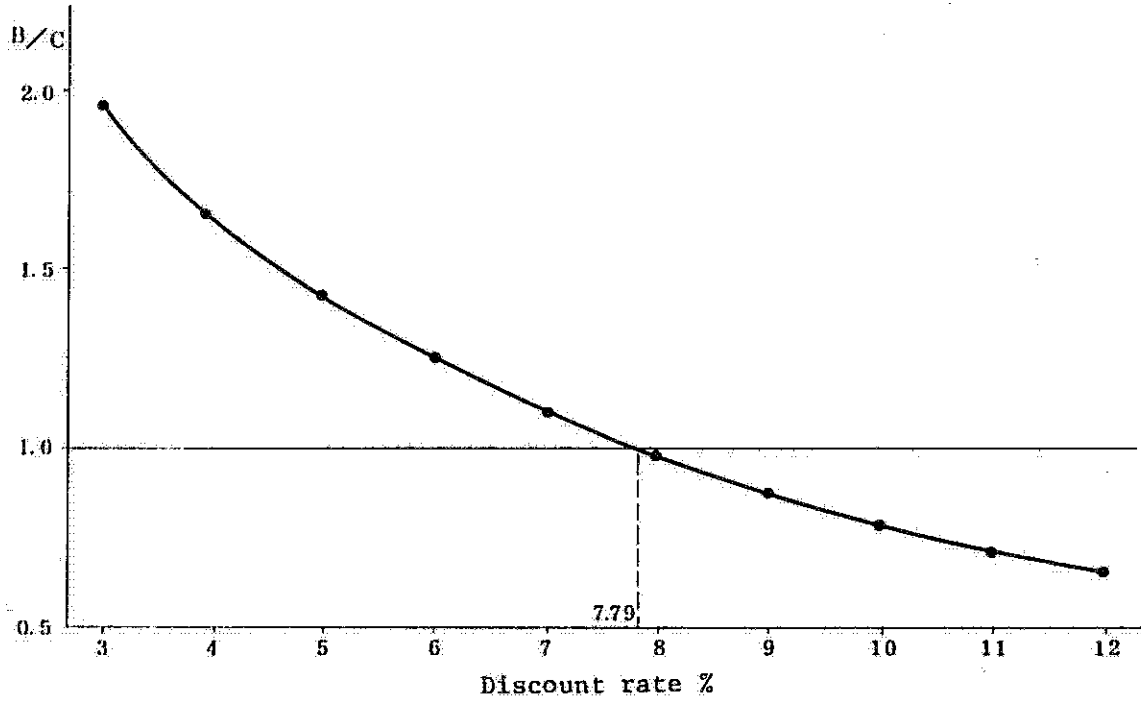
From the costs and benefits estimated in V-4 and V-5, the present worth of the road after 20 years of use is calculated in Table V-12. It is also graphically represented in Figs. V-1 and V-2. Accordingly, the internal rate of return (IRR) of the project is estimated at 7.79%.

Table IV-12 SUMMARY OF COSTS AND BENEFITS

Unit: million guatani

Discount rate Item	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%
<u>Costs (C):-</u>										
Construction	639.8	637.2	633.9	631.3	628.1	625.5	622.9	620.3	617.7	614.5
Salvage value	-159.7	-130.3	-106.6	-87.3	-71.9	-59.1	-48.7	-40.1	-33.3	-27.6
Maintenance	31.5	28.3	25.5	23.2	21.1	19.3	17.8	16.4	15.0	13.9
Total	511.6	535.2	552.8	567.2	577.3	585.7	592.0	596.6	599.4	600.8
<u>Benefits (B):-</u>										
operating cost saving	701.6	623.1	555.6	497.5	447.3	403.6	365.6	332.4	303.3	277.7
Maintenance cost saving	53.0	46.9	41.6	37.2	33.3	29.9	27.0	24.5	22.3	20.3
Time saving	238.8	212.1	189.1	169.3	152.2	137.4	122.4	113.2	103.2	94.5
Total	993.4	882.1	786.3	704.0	632.8	570.9	517.0	470.1	428.8	392.5
B/C	1.942	1.648	1.422	1.241	1.096	0.974	0.873	0.788	0.715	0.653
Net present worth (B - C)	481.8	346.8	230.7	136.8	55.5	-14.8	-75.0	-126.5	-170.6	-208.3

Fig. V-1 B/C ratio





#### IV-7 Other Types of Economic Effects

The Paraguayan Government has now been pushing forward a water resources development project at Rio Alt Parana in cooperation with the Brazilian Government. Stroesner, bordering on Brazil, is reported to have been making a rapid progress as it is favoured with Routes 2 and 7, the most important arteries tying Paraguay and Brazil together. A large tract along Rio Alt Parana extending from Stroesner to Encarnación falls on an alluvial terrain of good fertility, and plantation has been pushed forward vigorously. On the other hand, the La. Colmena area has already celebrated the fortieth anniversary of its plantation, and may be said, as many observe it, to have culminated so far as the land use is concerned. It is therefore believed that the La. Colmena area will gradually take on the nature of a satellite of Asuncion as wholesale agricultural operations move on in the Stroernes-Encarnación area. Following this change, the production of melons, grapes, other fruits, vegetables, eggs, etc. will gradually put on weight, sending up the importance of the conveyances to ensure the transportation of these products. Then, if the road is left intact, that is, if a closure of over 100 days a year is uncared for, it might possibly impede the reformation of La Colmena into suburban agriculture, depriving it of viability with the large-scale plantations. The implementation of the project will assure the La Colmena area of its continued share of worth and contribution to Paraguay and of smooth restructuring into suburban agriculture.

**DATA FOR ESTIMATE OF CONSTRUCTION COSTS**

Data 1. Rents for Machinery (depreciation cost + repair charges)

Equipment		Rent applied for estimate, US\$/hr.
Bulldozer	D-6	16.5
Bulldozer	D-8 w/ripper	33.8
Tractor shovel	1.3 m <sup>3</sup>	10.6
Tractor shovel	1.8 m <sup>3</sup>	13.4
Power shovel	0.6 m <sup>3</sup>	14.7
Power shovel	1.6 m <sup>3</sup>	32.8
Dump truck	10 tons	6.2
Truck	5 tons	4.2
Small truck	3 tons	3.4
Tire roller	18 tons	9.1
Tandem roller	8 - 10 tons	6.8
Sheepsfoot roller	Self- propel- ling	11.0
Vibration roller	do.	4.9
Grader	12 tons	11.6
Base plant	100 tons/hr	15.9
Base spreader	do.	7.0
Road sprinkler	5,000 l	7.7
Road sweeper		2.5
Asphalt tank	20 tons	1.1
Asphalt heater		0.8
Distributor	5,000 l	14.5
Compressor	9 m <sup>3</sup>	5.4
Drill	1-3/4 m <sup>3</sup>	2.9
Mixer	0.3 m <sup>3</sup>	9.0
Crusher plant	Jaw, 100 tons/hr.	90.6
Crusher plant	Impeller, 30 tons/hr.	46.2
Fuel tank truck (Lorry)		7.8
Trailer		31.4
Generator	80 kW	5.9
Wrecker	5 tons	15.0

Data 2. Combination of Equipments by Type of Work

Work	Daily work volume	Equipment used			Heavy machine operator	Machinist
		Name	Spec.	Q'ty		
Clearing & grubbing	1.152 ha.	Bulldozer	D-8 w/ripper	1	1	
		do.	D-6	1	1	
		Grader		1	1	
		Subtotal		3	3	
Rock Digging	128 m <sup>3</sup>	Compressor	9 m <sup>3</sup>	1		0.5
		Drill		2		
		Power shovel	0.6 m <sup>3</sup>	1	1	
		Dump truck		2		
		Subtotal			1	0.5
Embankment	1,376 m <sup>3</sup>	Power shovel	1.2 m <sup>3</sup>	2	2	
		Bulldozer	D-6	2	2	
		Dump truck		6		
		Grader		2	2	
		Sheepsfoot roller	Self-propelling	2	2	
		Compacter	Box type	2		
		Road sprinkler	6,000 m <sup>3</sup>	2		
		Disc harrow	Self-propelling	2	2	
		Subtotal			10	
Excavation for structure	162 m <sup>3</sup>	Power shovel	0.6 m <sup>3</sup>	1	1	
		Dump truck		2		
		Rammer	Small type	2		
		Subtotal			1	

Work	Daily work volume	Equipment used			Heavy machine operator	Machinist
		Name	Spec.	Q'ty		
Subbase course	384 m <sup>3</sup>	Base plant	100 t/H	1		
		Bulldozer	D-6	2	2	
		Dump truck		4		
		Base spreader	100 t/H	1	1	
		Grader		1	1	
		Tyre roller	16 t	2	2	
		Vibration roller	Small type	1		
		Road sprinkler	6,000 ℓ			
		Subtotal				6
Base course	312 m <sup>3</sup>	Base plant		1		0.5
		Bulldozer	D-6	2	2	
		Dump truck		4		
		Base spreader	100 t/H	1	1	
		Grader		1	1	
		Tyre roller	16 t	2	2	
		Vibration roller	Small type	2		
		Road sprinkler	6,000 ℓ	1		
		Sweeper		1		
		Subtotal				6

Work	Daily work volume	Equipment used			Heavy machine operator	Machinist
		Name	Spec.	Q'ty		
Upper subbase	384 m <sup>3</sup>	Power shovel	1.3 m <sup>3</sup>	1	1	
		Bulldozer	D-6	1	1	
		Dump truck		4		
		Grader		2	2	
		Tyre roller		1	1	
		Sheepsfoot roller	Self-propelling	1	1	
		Compactor	Homac	2		
		Road sprinkler	6,000 ℓ	1		
		Subtotal			6	
Surface course	2,560 m <sup>2</sup>	Sweeper	Simple type	1	1	
		Tractor shovel	1.6 m <sup>3</sup>	1		
		Dump truck		2		
		Chip spreader		1	1	
		MC tank	20 t	1		0.5
		Asphalt tank	20 t	1		0.5
		Asphalt heater	10 t	1		0.5
		Distributor	5,000 ℓ	2	2	
		Tandem roller		2	2	
		Subtotal			6	1.5
Concrete work	14 m <sup>3</sup>	Mixer	0.3 m <sup>3</sup>	1		1
		Vibrator	Bar type	2		
		Pump	3"	2		
		Small truck		1		
		Subtotal				1

Work	Daily work volume	Equipment used			Heavy machine operator	Machinist
		Name	Spec.	Q'ty		
Reinforced bar	2,300 kg	Bar bending cutter		1		
		Small truck		1		
		Subtotal				
Cross pipe ø 0.80	12 m	Mixer	0.3 m <sup>3</sup>	1		1
		Vibrator	Bar type	1		
		Form vibrator		1		
		Pump	3"	1		
		Bar bending cutter	For hand work	1		
		Wrecker	5 t	1	1	
		Small truck		1		
		Truck	6 t	1		
		Rammer		2		
		Subtotal				1
Cross pipe ø 1.00	12 m	Mixer	0.3 m <sup>3</sup>	1		1
		Vibrator	Bar type	1		
		Form vibrator		1		
		Pump	3"	1		
		Bar bending cutter	For hand work	1		
		Wrecker	5 t	1	1	
		Small truck		1		
		Truck	6 t	1		
		Rammer		2		
		Subtotal				1

Work	Daily work volume	Equipment used			Heavy machine operator	Machinist
		Name	Spec.	Q'ty		
Sub drainage	80 m	Mixer	0.3 m <sup>3</sup>	1		0.5
		Vibrator	Bar type	1		
		Pump	3"	1		
		Form vibrator		1		
		Power shovel	0.6 m <sup>3</sup>	1	1	
		Dump truck		1		
		Rammer		2		
		Truck	6 t	1		
		Small truck		1		
		Subtotal				1
Masonry concrete	36 m <sup>3</sup>	Mixer	0.3 m <sup>3</sup>	1		1
		Vibrator	Bar type	2		
		Pump	3"	2		
		Small truck		1		
		Subtotal				
Railing work	15 m	Mixer	0.3 m <sup>3</sup>	1		0.5
		Vibrator	Bar type	1		
		Wrecker	5 t	1	1	
		Bar bending cutter	For hand work	1		
		Small truck		1		
		Subtotal				1
Stone pitching	80 m <sup>2</sup>	Small truck		1		
		Subtotal				



Work	Daily work volume	Equipment used			Heavy machine operator	Machinist
		Name	Spec.	Q'ty		
Removal of wooden bridge	1 place	Wrecker	5 t	1	1	
		Truck		1		
		Subtotal			1	
Removal of existing obstructions	1 set	Wrecker	5 t	1	1	
		Truck	6 t	1		
		Subtotal			1	
<u>Products</u>						
Soil excavation	688 t	Power shovel	1.2 m <sup>3</sup>	1	1.5	
		Bulldozer	D-6	1	1.5	
		Dump truck		4		
		Subtotal			3	
Quarrying	720 t	Compressor	9 m <sup>3</sup>	2		1
		Drill		2		
		Bulldozer	D-8	1	1	
		Power shovel	1.2 m <sup>3</sup>	1	1	
		Dump truck		3		
		Subtotal			2	1
Crusher-run	640 t	Crusher	100 t/H	1		1
		Tractor shovel	1.6 m <sup>3</sup>	2	2	
		Dump truck		4		
		Subtotal			2	1
Crushing	168 t	Impeller crusher	30 t/H	1		1
		Tractor shovel	1.0 m <sup>3</sup>	1	1	
		Dump truck		2		
		Subtotal			1	1

Data 3. Schedule of direct work costs

Type or work	Work volume	Unit	Unit cost	Amount US\$	Foreign currency, US\$	Domestic currency, US\$	Unit cost list No.
Clearing & grubbing	114	ha	646.80	73,735.20	54,992.20	18,743.00	1
Rock digging	2,277	m <sup>3</sup>	5.67	12,910.59	7,281.57	5,629.02	2
Embankment	334,000	"	1.83	611,220.00	484,697.46	126,522.54	3
Structures excavation	3,080	"	3.85	11,858.00	5,088.27	6,769.73	4
Subbase	48,300	"	13.65	659,295.00	497,438.07	161,856.93	5
Base course	35,340	"	16.39	579,222.60	431,926.29	147,296.31	6
Upper subgrade	57,600	"	3.91	225,216.00	173,934.31	51,281.69	7
Surface course	171,000	m <sup>2</sup>	1.99	340,290.00	305,444.30	34,845.70	8
Concrete work	1,370	m <sup>3</sup>	80.86	110,778.20	24,814.32	85,963.88	9
Reinforced bar	116,852	kg	0.59	68,742.68	57,702.61	11,040.07	10
Cross pipe ø 0.80	19.5	m	99.75	1,945.13	928.99	1,016.14	11
Cross pipe ø 1.00	142	"	119.83	17,015.86	8,329.26	8,686.60	12
Sub drainage	2,807	"	22.14	62,146.98	16,699.00	45,447.78	13

Type of work	Work volume	Unit	Unit cost	Amount US\$	Foreign currency, US\$	Domestic currency, US\$	Unit cost list No.
Masonry concrete	622	m <sup>3</sup>	40.15	24,973.30	6,455.60	18,517.70	14
Railing work	339	m	58.16	19,716.00	13,519.27	6,196.73	15
Stone side ditch	1,693	m <sup>2</sup>	4.71	7,974.00	1,642.64	6,331.36	16
Removal of wooden bridge	1	set		7,897	3,128.00	4,769.00	17
Removal of existing obstructions	1	set		11,004	5,213.70	5,790.30	18
Total				2,845,940.54	2,099,235.86	746,704.68	
Ratio				100 %	73.76 %	26.24 %	

Data 4. Unit Cost List by Type of Work

List No.1

Type of work	Clearing & grubbing	Name	Qty	Unit	Unit cost	Material cost		Labour cost		Equipment cost		Total
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency	
	1,152 Hz	<u>Material cost</u>			US\$							
		Gas oil	340	ℓ	0.19		45.6					
		Oils and greases	10.5	"	0.20		2.1					
		<u>Labour cost</u>										
		Heavy machine operator	3	per-son	42.7			128.1				
		Assistant	1	"	10.90				10.90			
		Manager	1	"	54.48				54.48			
		Labourer	10	"	7.63				76.30			
		<u>Equipment cost</u>										
		Bulldozer D-8	6	hour	33.8					202.8		
		" D-6	8	"	16.5					132.0		
		Grader	8	"	11.6					92.8		
		Total					47.7	128.1	141.68	427.6		745.08
		Cost per ha.					41.41	111.20	122.99	371.20		646.80
												Foreign currency (25.42 %)
												Domestic currency (74.58 %)

List No. 2

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Material cost		Labour cost		Equipment cost		Total	
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency		
Rock digging	128 m <sup>3</sup>	<u>Materials cost</u>											
		Dynamite	37.4	kg	1.59	59.47							
		Gas oil	274	ℓ	0.19	52.1							
		Oils and greases	13	"	0.20	2.6							
		<u>Labour cost</u>											
		Heavy machine operator	1	per-son	42.7	42.7							
		Mechanic	0.5	"	59.92	29.96							
		Assistant	1	"	10.90	10.90							
		Operator	2	"	10.90	21.80							
		Manager	1	"	54.48	54.48							
		Drillman	2	"	10.90	21.80							
		Labourer	20	"	7.63	152.60							
		<u>Equipment cost</u>											
		Compressor	8	hours	5.4	43.2							
		Drill	16	"	2.9	46.4							
power shovel	6	"	14.7	88.2							Foreign currency (56.4 %)		
Dump truck	16	"	6.2	99.2							Domestic currency (43.6 %)		
Total					59.47	54.7	72.67	261.58	277.0	725.42			
Cost per m <sup>3</sup>					0.46	0.43	0.57	2.04	2.17	5.67			

List No. 3

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Embankment	1,376 m <sup>3</sup>	<u>Materials cost</u>												
		Gas oil	1,037	ℓ	0.19		197.03							
		Gasoline	26	"	0.33		8.58							
		Oils and greases	53	"	0.20		10.6							
		<u>Labour cost</u>												
		Heavy machine operator	10	Per-son	42.7				427					
		Assistant Operator	2	"	10.90					21.8				
		Operator	8	"	10.90					87.2				
		Manager	1	"	54.48					54.5				
		Navy	6	"	10.90					65.4				
		Labourer	10	"	7.63					76.3				
		<u>Equipment cost</u>												
		Power shovel	16	hours	32.80							524.8		
		Bulldozer D-6	10	"	16.50							165		
		Dump truck	48	"	6.20							297.6		
		Grader	16	"	11.60							185.6		
Sheepsfoot roller	16	"	11.0							176.0				
Disc harrow	16	"	5.1							81.6				
Road sprinkler	16	"	7.7							123.2				
Compactor	16	"	0.8							12.8				
Total						216.21		427	305.2	1,566.6		2,515.01		
Cost per m <sup>3</sup>						0.16		0.31	0.22	1.14		1.83		
												Foreign currency (79.3 %)		
												Domestic currency (20.7 %)		

List No. 4

Type of work	Clearing & Grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Structure excavation	162 m <sup>3</sup>	<u>Materials cost</u>												
		Gas oil	184	ℓ	0.19		34.96							
		Gasoline	15	"	0.33		4.95							
		Oils and greases	9	"	0.20		1.8							
		<u>Labour cost</u>												
		Heavy machine operator	1	per-son	42.7				42.7					
		Assistant	1	"	10.90				10.9					
		Operator	2	"	10.90				21.8					
		Manager	1	"	54.48				54.48					
		Navvy	7	"	10.90				76.3					
		Labourer	20	"	7.63				152.6					
		<u>Equipment cost</u>												
		Power shovel (0.6)	8	hour	14.70							117.6		
		Dump truck	16	"	6.2							99.2		
		Rammer	16	"	0.4							6.4		
Total						41.71	42.7	316.08	223.2		623.69			
Cost per m <sup>3</sup>						0.26	0.26	1.95	1.38		3.85			
						0.2						Foreign currency (42.9 %)		
												Domestic currency (57.1 %)		

List No. 5

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Subbase	328 m <sup>3</sup>	<u>Materials cost</u>												
		Crusher-run	531	t	4.92	1985.5	627							
		Soil	239	"	1.3	248.6	62.1							
		Gas oil	614	ℓ	0.19		116.66							
		Gasoline	19	"	0.33		6.3							
		Oils and greases	32	"	0.20		6.4							
		<u>Labour cost</u>												
		Heavy machine operator	6	per-son		42.7			256.2					
		Mechanic	0.5	"		59.92			29.96					
		Assistant	2	"		10.90				21.8				
		Operator	5	"		10.90				54.5				
		Manager	1	"		54.48				54.48				
		Navvy	4	"		10.90				43.6				
		Labour	14	"		7.63				106.82				



List No. 5 (Cont'd)

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total	
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency		
Subbase	328 m <sup>3</sup>	Equipment cost											
		Base plant	8	hour	15.9					127.2			
		Bulldozer (D-6)	12	"	16.5					198			
		Dump truck	32	"	6.2					198.4			
		Base spreader	8	"	7.0					56			
		Grader	8	"	11.6					92.8			Foreign currency (75.45 %)
		Tyre roller	16	"	5.4					86.4			Domestic currency (24.56 %)
		Vibration roller	8	"	4.9					39.2			
		Road sprinkler	8	"	7.7					61.6			
		Total						2,234.1	818.46	286.16	281.2	859.6	
Cost per m <sup>3</sup>						6.81	2.50	0.87	0.85	2.62		13.65	

List No. 6

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Base course	312 m <sup>3</sup>	<u>Materials cost</u>												
		Crusher-run	678	t	4.92	2,535.18	800.6							
		Soil	78	"	1.3	81.12	20.28							
		Gas oil	693	ℓ	0.19		131.67							
		Gasoline	38	"	0.33		12.54							
		Oils and grease	35	"	0.20		7							
		<u>Labour cost</u>												
		Heavy machine operator	6	per-son		42.7			256.2					
		Mechanic	0.5	"		59.92			29.92					
		Assistant	4	"		10.90					43.6			
		Operator	6	"		10.90					65.4			
		Manager	1	"		54.88					54.48			
		Earth worker	1	"		10.90					65.4			
Labourer	13	"		7.63					99.19					

List No. 6 (Cont'd)

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total	
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency		
base course	312 m <sup>3</sup>	<u>Equipment cost</u>											
		Base plant	8	hour	15.90						127.2		
		Bulldozer, (D-6)	13	"	16.5						214.5		
		Dump truck	32	"	6.2						198.4		
		Base spreader	8	"	7.0						56		
		Grader	8	"	11.6						92.8		
		Tyre roller	16	"	5.4						86.4		
		Vibration roller	16	"	4.9						78.4		Foreign currency (74.57 %)
		Road. sprinkler	8	"	4.7						37.6		Domestic currency (25.43 %)
		Sweeper	8	"	2.50						20.0		
		<b>Total</b>				2,616.3	972.09	286.12	328.07	911.3		5,113.88	
		<b>Cost per m<sup>3</sup></b>				8.39	3.11	0.92	1.05	2.92		16.39	

## List No. 7

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Upper subgrade	384 m <sup>3</sup>	<u>Materials cost</u>												
		Gas oil	621	ℓ	0.19		117.99							
		Gasoline	26	"	0.33		8.58							
		Oils and greases	32	"	0.20		6.4							
		<u>Labour cost</u>												
		Heavy machine operator	6	per-son	42.7				256.2					
		Assistant	1	"	10.90					10.9				
		Operator	5	"	10.90					54.5				
		Manager	1	"	54.48					54.48				
		Earth worker	4	"	10.90					43.6				
		Labourer	6	"	7.63					45.78				
		<u>Equipment cost</u>												
		Power shovel (1.3)	8	hour	32.8							262.4		
		Bulldozer, D-6	6	"	16.5							99		
		Dump truck	32	"	6.2							198.4		
		Grader	12	"	11.6							139.2		
		Tyre roller	8	"	5.4							43.2		
Sheepsfoot roller	8	"	11.0							88				
Compactor	16	"	0.8							12.8				
Road sprinkler	8	"	7.7							61.6				
Total						132.97	209.26	256.2	904.6			1,503.03		
Cost per m <sup>3</sup>						0.35	0.54	0.67	2.35			3.91		
												Foreign currency (77.23 %)		
												Domestic currency (22.77 %)		

List No. 8

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Surface course	2,560 m <sup>2</sup>	<u>Materials cost</u>												
		MC	2.69	t	315.87	849.69								
		Asphalt	7.97	"	300.0	2,391.0								
		Crushed stone	79.70	"	7.67	452.4	158.9							
		Gas oil	314	ℓ	0.19		59.66							
		Heavy oil	115	"	0.20		23.0							
		Oils and greases	23	"	0.20		4.6							
		<u>Labour cost</u>												
		Heavy machine operator	6	per-son	42.7		256.2							
		Mechanic	1.5	"	59.92		89.88						43.6	
		Assistant	4	"	10.90								21.8	
		Operator	2	"	10.90								54.48	
		Manager	1	"	54.48								65.4	
Pavement worker	6	"	10.90								91.56			
Labourer	12	"	7.63											

List No. 8 (Cont'd)

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total	
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency		
Surface course	2,560 m <sup>2</sup>	<u>Equipment cost</u>											
		Sweeper	6	hour	2.5					15.0			
		Tractor shovel (1.6)	7	"	10.6					74.2			
		Dump truck	16	"	6.2					99.2			
		Chip spreader	6	"	12.0					72.0			
		MC tank	8	"	1.1					8.8			
		Asphalt tank	8	"	1.6					12.8			
		Asphalt heater	8	"	0.8					6.4			
		Distributor	12	"	14.5					174.0			
		Tandem roller	12	"	6.8					81.6			
		Total						3,693.09	246.16	346.08	276.84	544.0	
Cost per m <sup>3</sup>						1.44	0.10	0.13	0.11	0.21		1.99	

## List No. 9

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Concrete work	14 m <sup>3</sup>	<u>Materials cost</u>												
		Crushed stone	22.5	t	7.67		127.7	44.9						
		River sand	7.5	m <sup>3</sup>	4.56			34.2						
		Cement	4.5	t	71.48			321.66						
		Form	18.0	m <sup>2</sup>	2.38			42.84						
		Scaffolding	1	set				65.69						
		Gasoline	56	ℓ	0.33			18.48						
		Oils and grease	4	"	0.20			0.8						
		<u>Labour cost</u>								59.92				
		Mechanic	1	per-son	59.92									
		Operator	1	"	10.90						10.96			
		Assistant	2	"	10.90						21.80			
		Manager	1	"	54.48						54.48			
		Carpenter	4	"	13.07						52.28			
		Scaffolding man	4	"	13.07						52.28			
Concrete worker	4	"	10.90						43.60					
Labourer	15	"	7.63						114.45					

List No. 9 (Cont'd)

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total	
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency		
Concrete work	14 m <sup>3</sup>	<u>Equipment cost</u>											
		Mixer	5	hour	9.0					45.0			Foreign currency (22.40 %)
		Vibrator	10	"	0.2					2.0			Domestic currency (77.60 %)
		Pump	10	"	0.2					2.0			
		Small truck	5	"	3.4					17.0			
		Total				127.7	528.57	59.92	349.85	66		1,132.04	
		Cost per m <sup>3</sup>				9.12	37.76	4.28	24.99	4.71		80.86	



List No. 10

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total	
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency		
Reinforced bar	2,300 kg	<u>Material cost</u>											
		Reinforced bar	2,530	kg	0.44	1,113.20							
		Gasoline	25	ℓ	0.33		8.25						
		Oils and greases	1	"	0.20		0.2						
		<u>Labour cost</u>											
		Operator	1	per-son	10.90				10.90				
		Manager	1	"	54.48				54.48				
		Reinforced bar worker	4	"	13.07				52.28				
		Labourer	12	"	7.63				91.56				
		<u>Equipment cost</u>											
Bar bending cutter	5	hour	1.4						7.0				
Small truck	5	"	3.4						17.0				
		<b>Total</b>				1,113.2	8.45	209.22	24.0		1,354.87		
		Cost per 1 kg				0.48	0.01	0.09	0.01		0.59		
											Foreign currency (83.94 %)		
											Domestic currency (16.06 %)		

List No. 11

Type of work	Clearing & grubbing	Name	Qty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Cross Pipe, ø 0.80	12 m	<u>Materials cost</u>												
		Crushed stone	5.0	t	7.67	28.4	10.0							
		River sand	1.6	m <sup>3</sup>	4.56		7.29							
		Cement	0.9	t	71.48		64.33							
		Reinforced bar	396	kg	0.44	174.2								
		Form	22	m <sup>2</sup>	2.38		52.36							
		Crusher-run	15.1	t	4.92	56.5	17.8							
		Gas oil	56	ℓ	0.19		10.64							
		Gasoline	65	"	0.33		21.45							
		Oils and greases	6	"	0.20		1.2							
		<u>Labour cost</u>												
		Heavy machine operator	1	per-son	42.7				42.7					
		Mechanic	1	"	59.92					59.92				
		Assistant	4	"	10.90						43.60			
		Operator	2	"	10.90						21.80			
		Manager	2	"	54.48						108.96			
		Carpenter	2	"	13.07						26.14			
Pipe worker	2	"	10.90						21.80					
Reinforced bar worker	1	"	13.07						13.07					
Concrete worker	2	"	10.90						21.80					
Labourer	24	"	7.63						183.1					

List No. 11 (Cont'd)

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total	
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency		
Cross pipe - ø 0.80	12 m	<u>Equipment cost</u>											
		Mixer	5	hour	9.0						45.0		
		Vibrator	5	"	0.2						1.0		
		Form vibrator	5	"	7.8						39.0		
		Pump	5	"	0.2						1.0		Foreign currency (47.76 %)
		Bar bending cutter	5	"	1.4						7.0		Domestic currency (52.24 %)
		Wrecker	5	"	15.0						75.0		
		Small truck	5	"	3.4						17.0		
		Flatbed	5	"	4.2						21.0		
		Rammer	10	"	0.4						4.0		
<b>Total</b>						259.1	185.07	102.62	440.27	210.9		1,197.06	
<b>Cost per m</b>						21.59	15.42	8.55	36.69	17.50		99.75	

List No. 12

Type or work	Clearing & grubbing	Name	Qty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Cross pipe, ø 1.00	12 m	<u>Materials cost</u>												
		Crushed stone	7.1	t	7.67	40.3	14.2							
		River sand	2.3	m <sup>3</sup>	4.56		10.48							
		Cement	1.32	t	71.43		94.29							
		Reinforced bar	674	kg	0.44	296.56								
		Form	27	m <sup>2</sup>	2.38		64.26							
		Crusher-run	15.1	t	4.92	56.5	17.8							
		Gas oil	65	ℓ	0.19		12.35							
		Gasoline	65	"	0.33		21.45							
		Oils and greases	6	"	0.20		1.2							
		<u>Labour cost</u>												
		Heavy machine operator	1	per-son	42.7				42.7					
		Mechanic	1	"	59.92				59.92					
		Assistant	5	"	10.90						54.50			
		Operator	2	"	10.90						21.80			
		Manager	2	"	54.48						108.96			
		Carpenter	3	"	13.07						39.21			
Pipe worker	3	"	10.90						32.70					
Reinforced bar worker	1	"	13.07						13.07					
Concrete worker	2	"	10.90						21.80					
Labourer	27	"	7.63						206.01					

List No. 12 (Cont'd)

Type of work	Clearing & grubbing	Name	Qty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total	
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency		
Cross pipe ø 1.00	12 m	<u>Equipment cost</u>											
		Mixer	5	hour	9.0						45.0		
		Vibrator	5	"	0.2						1.0		
		Form vibrator	5	"	7.8						39.0		
		Pump	5	"	0.2						1.0		
		Bar bending cutter	5	"	1.4						7.0		
		Wrecker	5	"	15.0						75.0		
		Small truck	5	"	3.4						17.0		
		Flatbed	5	"	4.2						21.0		
		Rammer	5	"	0.4						2.0		
		Total				393.36	236.03	102.62	498.05	208		1,438.06	
		Cost per m				32.78	19.67	8.55	41.50	17.33		119.83	

List No. 13

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total	
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency		
Sub drainage	80 m	<u>Materials cost</u>											
		Crushed stone	4.0	t	7.67	7.97	22.7						
		River sand	1.3	m <sup>3</sup>	4.56		5.93						
		Cement	0.6	t	71.43		42.86						
		Form	45.2	m <sup>2</sup>	2.38		107.58						
		Crusher-run	127	t	4.92	149.96	474.9						
		Soil	51	t	1.3	13.26	53.0						
		Gas oil	111	ℓ	0.19		21.09						
		Gasoline	75	"	0.33		24.75						
		Oils and greases	10	"	0.20		2.0						
		<u>Labour cost</u>											
		Heavy machine operator	1	per-son	42.7		42.7						
		Mechanic	0.5	"	59.92		29.96						
		Assistant	2	"	10.90					21.80			
		Operator	3	"	10.90					32.70			
Manager	2	"	54.48					108.96					
Carpenter	4	"	13.07					52.28					
Pipe worker	4	"	13.07					52.28					
Concrete worker	4	"	10.90					43.60					
Labourer	30	"	7.63					228.9					

List No. 13 (Cont'd)

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total	
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency		
Sub drainage	80 m	<u>Equipment cost</u>											
		Mixer	5	hour	9.0					45.0			
		Vibrator	5	"	0.2					1.0			
		Pump	5	"	0.2					1.0			
		Form vibrator	5	"	7.8					39.0			Foreign currency (26.87 %)
		Power shovel	5	"	14.7					73.5			Domestic currency (73.13 %)
		Dump truck	5	"	6.2					31.0			
		Rammer	10	"	0.4					4.0			
		Flatbed	5	"	4.2					21.0			
		Small truck	5	"	3.4					17.0			
		Total				171.19	754.81	72.66	540.52	232.5		1,771.68	
		Cost per 1 m				2.14	9.43	0.91	6.76	2.90		22.14	

List No. 14

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Masonry concrete	36 m <sup>3</sup>	<u>Materials cost</u>												
		Rubble	60.5	t	2.48		109.5	40.5						
		Crushed stone	21.2	"	7.67		120.1	42.4						
		River sand	6.9	m <sup>3</sup>	4.56			31.46						
		Cement	4.0	t	71.43			285.72						
		Form	60	m <sup>2</sup>	2.38			142.80						
		Gasoline	50	ℓ	0.33			16.5						
		Oils and greases	2	"	0.20			0.4						
		<u>Labour cost</u>												
		Mechanic	1	per-son	59.92					59.92				
		Assistant	1	"	10.90						10.90			
		Operator	1	"	10.90						10.90			
		Manager	2	"	54.48						108.96			
Carpenter	6	"	13.07						78.42					
Concrete worker	4	"	10.90						43.60					
Labourer	34	"	7.63						259.42					



List No. 14 (Cont'd)

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Material cost		Labour cost		Equipment cost		Total
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency	
Masonry concrete	36 m <sup>3</sup>	<u>Equipment cost</u>										
		Mixer	6	hour	9.0					54.0		Foreign currency (25.85 %)
		Vibrator	12	"	0.2					2.4		Domestic currency (74.15 %)
		Pump	12	"	0.2					2.4		
		Small truck	6	"	4.2					25.2		
		Total				229.7	559.78	59.92	512.20	84.0		1,445.6
		Cost per m <sup>3</sup>				6.38	15.55	1.66	14.23	2.33		40.15

List No. 15

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total	
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency		
Railing work	15 m	<u>Materials cost</u>											
		Crushed stone	1.8	t	7.67	10.2	3.4						
		River sand	0.6	m <sup>3</sup>	4.56		2.74						
		Cement	0.4	t	71.43		28.57						
		Reinforcing bar	842	kg	0.44	370.48							
		Form	5.4	m <sup>2</sup>	2.38		12.85						
		Gas oil	27	ℓ	0.19		5.13						
		Gasoline	32	"	0.33		10.56						
		Oils and greases	3	"	0.20		0.6						
		<u>Labour cost</u>											
		Heavy machine operator	1	per-son	42.7				42.7				
		Mechanic	0.5	"	59.92				29.96				
		Assistant	1	"	10.90					10.90			
		Manager	1	"	54.48					54.48			
Carpenter	2	"	13.07					26.14					
Reinforced bar worker	1	"	13.07					13.07					
Concrete worker	2	"	10.90					21.80					
Labourer	11	"	7.63					83.93					

List No. 15 (Cont'd)

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency	
Railings work		<u>Equipment cost</u>										
		Mixer	5	hour	9.0					45.0		Foreign currency (68.57 %)
		Vibrator	5	"	0.2					1.0		Domestic currency (31.43 %)
		Wrecker	5	"	15.0					75.0		
		Bar bending cutter	5	"	1.4					7.0		
		Small truck	5	"	3.4					17.0		
		Total				380.68	63.85	72.66	210.32	145		872.51
		Cost per 1 m				25.38	4.26	4.84	14.02	9.66		58.16

List No. 16

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Stone pitching	80 m <sup>2</sup>	<u>Materials cost</u>												
		Rubble	33.5	t	2.48	60.64	22.43							
		River sand	8.8	m <sup>3</sup>	4.56		40.13							
		Gasoline	16	ℓ	0.33		5.28							
		Oils and greases	1	"	0.20		0.20							
		<u>Labour cost</u>												
		Operator	1	per-son	10.90				10.90					Foreign currency (20.60 %)
		Manager	1	"	54.48				54.48					Domestic currency (79.40 %)
		Mason	4	"	10.90				43.60					
		Labourer	16	"	7.63				122.08					
<u>Equipment cost</u>														
		Small truck	5	hour	3.4					17.0				
		<u>Total</u>				60.64	68.04		231.06	17.0		376.74		
		Cost per 1 m <sup>2</sup>				0.76	0.85		2.89	0.21		4.71		

List No. 17

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Removal of wooden bridge	1 place	<u>Materials cost</u>												
		Gas oil	104	ℓ	0.19		19.8							
		Oils and greases	10.5	"	0.20		2.1							
		<u>Labour cost</u>												
		Heavy machine operator	1	per-son	42.7				42.7					
		Assistant	1	"	10.90					10.90				
		Operator	1	"	10.90					10.90				
		Manager	1	"	54.48					54.48				
		Scaffolding man	4	"	13.07					52.28				
		Labourer	15	"	7.63					114.45				
		<u>Equipment cost</u>												
		Wrecker	6.5	hour	15.0							97.5		
		Truck	8	"	4.2							33.6		
		1 place						21.9		42.7	243.01	131.1		438.71
18 places												7,896.78		

List No. 18

Type of work	Clearing & grubbing	Name	Qty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total	
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency		
Removal of existing obstructions	Daily cost	<u>Materials cost</u>											
		Gas oil	106	ℓ	0.19		20.1						
		Oils and greases	9	"	0.20		1.8						
		<u>Labour cost</u>											
		Heavy machine operator	1	per-son	42.7				42.7				
		Assistant	1	"	10.90					10.90			
		Operator	1	"	10.90					10.90			
		Manager	1	"	54.48					54.5			
		Scaffolding man	2	"	13.07					26.1			
		Labourer	9	"	7.63					68.7			
		<u>Equipment cost</u>											
		Wrecker	6.5	hour	15.0							97.5	
		Flatbed	8	"	4.2							33.6	
Total						21.9		42.7	171.1	131.1		366.8	
		Approx. 30 days										11,004	
												Foreign currency (47.38 %)	
												Domestic currency (52.62 %)	

List No. 19

Type of work	Clearing & grubbing	Name	Qty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Soil excavation	688 t	<u>Materials cost</u>												
		Gas oil	320	ℓ	0.19		60.8							
		Oils and greases	18	"	0.20		3.6							
		<u>Labour cost</u>												
		Heavy machine operator	3	per-son	42.7	128.1								
		Assistant	0.5	"	10.90				5.45					
		Operator	4	"	10.90				43.60					
		Manager	0.5	"	54.48				27.24					
		Labourer	5	"	7.63				38.15					
		<u>Equipment cost</u>												
		Power shovel 1.3 m <sup>3</sup>	8	hour	32.8							262.4		
		Bulldozer D-6	7.5	"	16.5							123.75		
		Dump truck	32	"	6.2							201.5		
Total						64.4	128.1	114.44	587.65			894.59		
Cost per 1 t						0.09	0.19	0.17	0.85			1.30		





List No. 21

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total	
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency		
Crusher-run	640 t	<u>Materials cost</u>											
		Quarrying	640	t	2.48	1,158.66	428.54						
		Gas oil	624	ℓ	0.19		118.56						
		Oils and greases	31	"	0.20		6.2						
		<u>Labour cost</u>											
		Heavy machine operator	2	per-son	42.7			85.4					
		Mechanic	1	"	59.92			59.92					
		Assistant	2	"	10.90				21.80				
		Operator	4	"	10.90				43.60				
		Manager	1	"	54.48				54.48				
		Earth worker	4	"	10.90				43.60				
		Labourer	6	"	7.63				45.78				
		<u>Equipment cost</u>											
		Crusher	8	hour	90.6					724.8			
	Tractor shovel	12	"	13.4					160.8				
	Dump truck	32	"	6.2					198.4				
	Total					1,158.66	553.3	145.32	209.26	1,084.0		3,150.54	
	Cost per 1 t					1.81	0.86	0.23	0.33	1.69		4.92	
													Foreign currency (76.00 %)
													Domestic currency (34.00 %)

List No. 22

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Crushing	168 t	<u>Materials cost</u>												
		Quarrying	167	t	2.48	302.34	111.82							
		Gas oil	342	ℓ	0.19		64.98							
		Oils and greases	17	"	0.20		3.4							
		<u>Labour cost</u>												
		Heavy machine operator	1	per-son	42.7				42.7					
		Mechanic	1	"	59.92				59.92					
		Assistant	1	"	10.90					10.90				
		Operator	2	"	10.90					21.80				
		Manager	1	"	54.48					54.48				
		Earth worker	2	"	10.90					21.80				
		Labourer	6	"	7.63					45.78				
		<u>Equipment cost</u>												
		Crusher-run	8	hour	46.2							369.6		
		Tractor shovel	6	"	13.4							80.4		
Dump truck	16	"	6.2							99.2				
		Total				302.34	180.2	102.62	154.76	549.2		1,289.12		
		Cost per 1 t				1.80	1.07	0.61	0.92	3.27		7.67		
												Foreign currency (74.00 %)		
												Domestic currency (36.00 %)		

Data 5. Schedule of Costs for Temporary Works

Type of Work	Work Volume	Unit	Unit Cost	Amount US\$	Foreign Currency US\$	Domestic Currency US\$	List No.
Clearing & leveling	180,000	m <sup>2</sup>	0.14	25,200.0	17,413.2	7,786.8	23
Stockyard	12,000	"	0.81	9,720.0	7,026.6	2,693.4	24
Construction road	2,500	m	9.54	23,850.0	15,908.0	7,942.0	25
Detour	35	Place	821.60	28,756.0	21,797.0	6,959.0	26
Temporary bridge	18	"	852.70	15,348.0	6,584.5	8,763.5	27
Batcher plant	1	Set	22,092.00	22,092.0	8,983.0	13,109.0	28
Soil excavation	1	"	16,409.00	16,409.0	10,995.0	5,414.0	29
Quarrying	1	"	89,235.63	89,236.0	39,442.0	49,794.0	30
Crushing plant	1	"	35,656.00	35,656.0	17,262.0	18,394.0	31
Total :				266,267.0	145,411.3	120,855.7	
Ratio :				100.00 %	54.61 %	45.39 %	

List No. 23

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Clearing & leveling	5,000 m <sup>2</sup> per day	<u>Materials cost</u>												
		Gas oil	305	l	0.19		57.95							
		Oils and greases	16	"	0.20		3.2							
		<u>Labour cost</u>												
		Heavy machine operator	4	Person	42.7				170.8					
		Assistant	1	"	10.90					10.90				
		Manager	1	"	54.48					54.48				
		Labourer	12	"	7.63					91.56				
		<u>Equipment cost</u>												
		Bulldozer	8	Hour	16.5							132		
		Grader	12	"	11.8							141.6		
		Tyre roller	8	"	5.4							43.2		
		<b>Total :</b>							61.15	170.8	156.94	316.8		705.69
<b>Cost per m<sup>2</sup></b>							0.01	0.03	0.03	0.06		0.14		
												Foreign currency 487.6(69.1%)		
												Domestic currency 281.09(30.9%)		

List No. 24

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Stockyard	0.3 ha. per day	Clearing & grubbing	0.3	Ha	646.8	144.8	49.3							
		<u>Materials cost</u>												
		Crusher-run	296	m <sup>3</sup>	4.92	1,106.8	349.5							
		Gas oil	359	l	0.19		68.21							
		Oils and greases	15	"	0.20		3.0							
		<u>Labour cost</u>												
		Heavy machine operator	5	Person	42.7				213.5					
		Manager	1	"	54.48					54.48				
		Earth worker	6	"	10.90					65.4				
		Labourer	11	"	7.63					83.93				
		<u>Equipment cost</u>												
Grader	16	Hour	11.8							188.80				
Tyre roller	12	"	5.4							64.8				
Vibration roller	8	"	4.9							39.2				
Total :						1,251.6	470.01	213.5	203.81	292.8		2,431.72		
Cost per m <sup>2</sup>						0.42	0.16	0.07	0.07	0.09		0.81		
												Foreign currency 1757.9 (72.29 %) Domestic currency 673.82 (27.71 %)		

List No. 25

Type of work	Clearing & grubbing	Name	Qty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total	
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency		
Construction road	300 m per day	Clearing & grubbing	0.3	Ha	646.8	144.8	49.3						
		Pipe, $\phi$ 0.80	8	m	99.75	381.4	416.6						
		<u>Materials cost</u>											
		Crusher-run	270	m <sup>3</sup>	4.92	1,009.6	318.8						
		Gas oil	210	ℓ	0.19		39.9						
		Oils and greases	10	"	0.20		2.0						
		<u>Labour cost</u>											
		Heavy machine operator	3	Person	42.7			128.1					
		Assistant	1	"	10.90				10.90				
		Manager	1	"	54.48				54.48				
		Earth worker	2	"	10.90				21.8				
		Labourer	5	"	7.63				38.2				
		<u>Equipment cost</u>											
		Bulldozer	8	Hour	16.5					132.0			
		Grader	6	"	11.8					70.8			
	Tyre roller	8	"	5.4					43.2				
	Total :					4,535.8	826.6	128.1	125.4	246.0		2,861.9	
	Cost per m					5.12	2.75	0.43	0.42	0.82		9.54	
													Foreign currency 1909.9(66.7%) Domestic currency 952(33.3%)

List No. 26

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Detour	Approx. 150 m per place	<u>Materials cost</u>												
		Crusher-run	90	m <sup>3</sup>	4.92	336.5	106.3							
		Gas oil	123	l	0.19		23.4							
		Oils and greases	8	"	0.20		1.6							
		<u>Labour cost</u>												
		Heavy machine operator	2	Person	42.7				85.4					
		Earth worker	2	"	10.90					21.80				
		Labourer	6	"	7.63						45.78			
		Mechanic										132		
		Bulldozer	8	Hour	16.50							47.2		
		Grader	4	"	11.80							21.6		
Tyre roller	4	"	5.40											
Total :						336.5	131.3	85.4	67.6	200.8		821.6		
												Foreign currency 622.7(75.8%) Domestic currency 198.9(24.2%)		

List No. 27

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Temporary bridge	Cost per place	<u>Materials cost</u>												
		Pipe log	21	Piece	5x1/3			35						
		Girder	7	"	10x1/3			23.3						
		Sheathing plate	32.4	m <sup>2</sup>	5x1/3			54						
		Lining plate	36	"	6x1/3			72						
		Gas oil	166	l	0.19			31.5						
		Oils and greases	9	"	0.20			1.8						
		<u>Labour cost</u>												
		Heavy machine operator	2	Person	42.7					85.4				
		Operator	2	"	10.90						21.8			
		Manager	1	"	54.48						54.48			
		Carpenter	6	"	13.07						78.42			
		Labourer	15	"	7.63						114.5			
		<u>Equipment cost</u>												
		Power shovel		Hour	14.7								102.9	
Wrecker	8	"	15.0								120			
Small truck	16	"	3.4								54.4			
Pump	16	"	0.2								3.2			
<b>Total :</b>							217.6	85.4	269.2	280.5		852.70		
												Foreign currency 365.9(42.9%) Domestic currency 486.8(57.1%)		



List No. 28

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total		
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency			
Batcher plant	100 T/H	Clearing & leveling	5,000	m <sup>2</sup>	0.14	487.6	218.4							
		Stockyard	5,000	"	0.84	1,772.3	775.1							
		Work road	600	m	9.07	3,819.8	1,904							
		Foundation concrete (wet masonry)	30	m <sup>3</sup>		311.4	893.1							
		<u>Materials cost</u>												
				Pile, 3.6m	22	Piece	5		110					
				Timbering	55	"	4		220					
				Fencing	108	m <sup>2</sup>	4		432					
				Gas oil	288	l	0.19		54.72					
				Gasoline	1,572	"	0.33		518.76					
				Oils and greases	96	"	0.20		19.2					
		<u>Labour cost</u>												
				Heavy machine operator	6	Person	42.7			256.2				
		Assistant	6	"	10.90				65.40					
		Manager	10	"	54.48				544.80					
		Carpenter	8	"	13.07				104.56					
		Scaffolding man	12	"	10.90				130.80					
		Labourer	40	"	7.63				305.20					

List No. 28 (Cont'd)

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total			
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency				
Batcher plant		<u>Equipment cost</u>													
		Wrecker	16	Hour	15.0					240					
		Generator	2,096	"	0.8					1,676.8					
		Pump	2,096	"	0.2					419.2					
		<u>Subcontracting cost</u>													
		Electrical work	1	Set									Foreign currency 8,983.3		
		Water work	1	"									Domestic currency 13,109.04		
		Total :						6,391.1	5,145.28	256.2	1,150.76	2,336	6,813	22,092.34	
		Soil excavation		Cleaning & leveling	15,000	m <sup>2</sup>	0.14								
				Work road	1,500	m	9.54		9,544	4,765					
Total :							10,995	5414					16,409		
List No. 29															

## List No. 30

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total	
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency		
Quarrying	Grubbing & leveling	13,500	m <sup>2</sup>	0.14	1,305	85.5							
													Construction road
	Removal of top soil (17,000m <sup>2</sup> )	Materials cost	11,424	l	0.19	2,170.56	114.2						
		Labour cost	Heavy machine operator	30	Person	42.7			1,281.0				
			Operator	42	"	10.90				457.8			
			Manager	28	"	54.48				1,525.44			
			Earth worker	84	"	10.90				915.6			
			Labourer	280	"	7.63				2,136.4			
			Equipment cost										
			Bulldozer, D-8	172	Hour	33.80					5,813.6		
			Bulldozer, D-6	172	"	16.50					2,838		
			Power shovel	86	"	32.80					2,820.8		
		Dump truck	257	"	6.20					1,593.4			

List No. 30 (Cont'd)

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total	
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency		
Quarrying	Tempo-rary building	Subcontracting cost											
		Office	50	m <sup>2</sup>	48					2,400			
		Explosive Magazine	100	m <sup>2</sup>	125							12,500	
	Others		<u>Materials cost</u>										
			Gasoline	8,496	l	0.33		2,803.68					
			Oils and greases	425	"	0.20		85					
			<u>Labour cost</u>										
			Mechanic	77	Day	59.92			4,613.8				
		Operator	236	"	10.90			2,572.40					
		Earth worker	472	"	10.90			5,144.80					
		<u>Equipment cost</u>											
		Generator	1,500	Hour	0.80					1,200.0			
		Pump	1,500	"	0.20					300.0			
		Small truck	750	"	3.40					2,550.0			
	<u>Subcontracting cost</u>												
	Electrical work	1	Set								6,000		
	Water work	1	"								5,854		
	<b>Total :</b>					14,032	12,382.44	5,894.8	13,057.64	19,515.8	24,354	89,235.68	
												Foreign currency 39,441.6 Domestic currency 49,794.08	

List No. 31

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency	
Crushing plant	Jaw crusher, 100 tons	Clearing & levelling	12,000	m <sup>2</sup>	0.14	1,160.8	519.2					
	Impeller crusher, 30 tons	Stockyard	5,000	"	0.81	2,927.6	1,122.4					
		Construction	600	m	9.54	3,817.8	1,906.2					
		Foundation concrete	50	m <sup>3</sup>	40.14	518.8	1,488.2					
			<u>Materials cost</u>									
			Pine log, 3.6 m	28	Piece	5		140				
			Timbering, 3.6 m	70	"	4		280				
			Fencing	180	m <sup>2</sup>	4		720				
			Gas oil	768	l	0.19		145.9				
			Gasoline	9,000	"	0.33		2,970				
			Oils and greases	458	"	0.20		876				
			<u>Labour cost</u>									
			Heavy machine operator	10	Person	42.7			427			
		Mechanic	100	"	59.92			5,992				
		Assistant	12	"	10.90				130.80			
		Manager	15	"	54.48				817.20			
		Carpenter	12	"	13.07				156.8			
		Scaffolding	18	"	10.90				196.2			
		Labourer	60	"	7.53				457.8			

List No. 31 (Cont'd)

Type of work	Clearing & grubbing	Name	Q'ty	Unit	Unit cost	Materials cost		Labour cost		Equipment cost		Total
						Foreign currency	Domestic currency	Foreign currency	Domestic currency	Foreign currency	Domestic currency	
Crushing plant		<u>Equipment cost</u>										
		Wrecker	70	Hour	15.0					1,050		
		Generator	1,368	"	0.8					1,094.4		
		Pump	1,368	"	0.2					273.6		
		<u>Subcontracting cost</u>										
		Electrical work		1	Set						4,000	
	Water work		1	"						2,467		Domestic currency 18,393.7
		<b>Total :</b>				8,425	10,167.9	6419	1,758.8	2,418	6,467	35,655.7

Data 6. Schedule of Costs for Common Temporary Works

Item	Amount US\$	Foreign Currency US\$	Domestic Currency US\$
Transportation of heavy machinery	16,724.6	7,680	9,044.6
Reparation of yard	7,008.4	4,904.1	2,104.3
Temporary building	82,304	41,152	41,152
Costs for facilities	38,160	22,040	16,120
Motor pool	143,740.2	112,006.2	31,734
Safety facilities and security services	8,447.2	1,080	7,367.2
Surveying & testing	27,542	15,410	12,132
Total	323,926.4	204,272.3	119,654.1
Ratio	100 %	63.06 %	36.94 %

Breakdown of Costs for Common Temporary Works

	Foreign Currency	US\$ Domestic Currency
i) Transportation of heavy machinery (Asuncion - site)		
Trailer (30t), 16 units x 2 round trips x 240 US\$	7,680	
Large truck (10t), 24 units x 2 round trips x 80 US\$		3,680
Self-traveling equipment:-		
Driver, 44 units x 2 round trips x 54.50 US\$		4,796
Fuel, oil, grease, 2,843 lit. x 0.20 US\$		568.6
Total :	7,680	9,044.6
ii) Preparation of yard (temporary house, motor pool)		
o Clearing & leveling		
Bulldozer (D-6), 64 hrs. x 16.50 US\$/hr.	1,056	
Fuel, oil, grease, 576 lit. x 0.70 US\$		115.2
Heavy machine operator, 6 man-days x 42.7 US\$	256.2	
Hand, 50 man-days x 7.63 US\$		381.5
o Drainage		
Power shovel (0.6), 32 hrs. x 14.70 US\$	470.4	
Fuel, oil, grease, 512 lit. x 0.20 US\$		102.4
Heavy machine operator, 45 man-days x 42.7 US\$	1,921.5	
Hand, 40 man-days x 7.63 US\$		305.2
o Fencing		
Subcontracted, 600 m x 4 US\$	1,200	1,200
Total :	4,904.1	2,104.3



	Foreign Currency	US\$ Domestic Currency
iii) Temporary building (accommodations for employes and labourers, and motor pool)		
Office, 120 m <sup>2</sup> x 100 US\$/m <sup>2</sup> x 0.8	4,800	4,800
Lodging house, 240 m <sup>2</sup> x 90 US\$/m <sup>2</sup> x 0.8	8,640	8,640
Machine shop, 160 m <sup>2</sup> x 60 US\$/m <sup>2</sup> x 0.8	3,840	3,840
Warehouse, 120 m <sup>2</sup> x 70 US\$/m <sup>2</sup> x 0.8	3,360	3,360
Field station, 108 m <sup>2</sup> x 60 US\$/m <sup>2</sup> x 0.8	2,592	2,592
Bunkhouse, 560 m <sup>2</sup> x 80 US\$/m <sup>2</sup> x 0.8	17,920	17,920
Total :	41,152	41,152
iv) Costs for facilities (for temporary works only)		
Generator (for electricity), 2 units x 2,400 US\$	4,800	
Pump (for water), 2 units 560 US\$	1,120	
Electrical wiring, 14,200 US\$ x 0.8	5,680	5,680
Water supply work (well, reservoir, hydrant, etc.) , 15,800 x 0.8	6,320	6,320
Sewerage (sewer, septic tank), 10,300 US\$ x 0.8	4,120	4,120
Total :	22,040	16,120
v) Motor pool		
Trailer, 320 vehicle-days x 4 hours x 3.14 US\$	4,019.2	
Water wagon, do. x do. x 7.8 US\$	9,984	
Repair, do. x do. x 4.9 US\$	3,136	3,136
Generator (80 kW) do. x do. x 5.9 US\$	7,552	
Shop tooling (press, welding machine, compressor, etc.)	7,400	

	Foreign Currency	US\$ Domestic Currency
v) Passenger car, 2 vehicles x 320 days x 4 hrs. x 1.9 US\$		4,864
Mail & liaison service car, 1 vehicle x 320 days x 1.9 US\$		2,432
Subtotal :	32,091.2	10,432
Mechanic, 2 men x 11 months x 25 days x 59.9 US\$	32,945	
Heavy machine operator, 4 men x 11 months x 25 days x 42.7 US\$	46,970	
Electrician, 2 men x 11 months x 305 US\$		6,710
Subtotal :	79,915	6,710
Gas oil, 160 lit. x 320 days x 0.19 US\$		9,728
Gasoline, 40 lit. x 320 days x 0.33 US\$		4,224
Oils & greases, 10 lit. x 320 days x 0.20 US\$		640
Subtotal :		14,592
Total :	112,006.2	31,734
vi) Safety facilities and security services		
Small truck, 1 vehicle x 320 days x 4 hrs. x 1.9 US\$		2,432
Driver, 1 man x 16 months x 1/2 x 218 US\$		1,744
Labourer, 1 man x 16 months x 1/2 x 153 US\$		1,224
Subtotal :		5,400

	Foreign Currency	US\$ Domestic Currency
vi) Fuel, 12 lit. x 320 days x 0.33 US\$		1,267.2
Sign, 10 units x 25 US\$		250
Barricade, 30 units x 15 US\$		450
Safety cone, 30 units x 20 US\$	600	
Scotch light, 8 units x 60 US\$	480	
Subtotal :	1,080	1,967.2
Total :	1,080	7,367.2
vii) Surveying and testing		
Small truck, 1 vehicle x 160 days x 4 hrs. x 1.9 US\$		1,216
Driver, 1 man x 8 months x 1/2 x 218 US\$		872
Assistant labourer for testing, 2 men x 8 months x 153 US\$		2,448
Assistant labourer for surveying, 4 men x 8 months x 153 US\$		4,896
Finishing stake materials	1,500	1,500
Testing materials	1,200	1,200
Surveying instruments	5,230	
Testing equipment	7,480	
Total :	15,410	12,132
Sub-grand Total :	204,272.3	119,654.1
Grand Total :	323,926.4	

Data 7. Schedule of Direct Costs (US\$)

1. Travel expenses

1) International air fare

Supervisor (Tokyo - Asunción),	2,170 US\$ x 4 times = 8,680
Supervisor (Trazil - Asunción),	400 US\$ x 1 time = 400
Project manager,	2,170 US\$ x 2 times = 4,340
Chief structural engineer,	2,170 US\$ x 1 time = 2,170
Chief testing engineer,	2,170 US\$ x 2 times = 4,340
Subtotal :	19,930 (F)

2) Daily allowances and accommodation charges for overseas travel

Supervisor,	51 US\$ x 7 days x 4 times = 1,428
Project manager	44 US\$ x 7 days x 2 times = 616
Chief structural engineer,	44 US\$ x 7 days x 1 time = 308
Chief testing engineer,	44 US\$ x 7 days x 2 times = 616
Subtotal :	2,968 (F)

3) Intra-Paraguay daily allowances and accommodation charges

Supervisor,	35 US\$ x 2 days x 3 times = 210
Project manager,	30 US\$ x 2 days x 20 times = 1,200
Chief structural engineer,	30 US\$ x 2 days x 10 times = 600
Chief testing engineer,	30 US\$ x 2 days x 20 times = 1,200
Paraguayan engineer,	30 US\$ x 2 days x 60 times = 3,600
Subtotal :	6,810

(Foreign currency : 3,210 US\$)

(Local currency : 3,600 US\$)

4) International air freight charges for personal belongings

8 US\$ x 150 kg x 3 persons (excl. supervisor)	= 3,600
Subtotal :	3,600 (F)

5) International shipping charges for materials and supplies

	5,000
Subtotal :	5,000 (F)

6) Overhead for overseas travel

268 US\$ x 4 persons	= 1,072
Subtotal :	<u>= 1,072 (F)</u>

Breakdown of travel expenses :-

Foreign currency,	
19,930 + 2,968 + 3,210 + 3,600 + 5,000 + 1,072	=35,780
Local currency,	= 3,600 (L)
Total :	<u>=39,380</u>

2. Resident expenses

Supervisor,	500 US\$ x 3 months = 1,500
Project manager,	450 US\$ x 20 months = 9,000
Chief structural engineer & chief testing engineer,	400 US\$ x 30 months =12,000
Total :	<u>=22,500 (L)</u>

3. Vehicle charges

Number of vehicles required: 4

Office, 1 vehicle:

0.127 US\$/km x 3,000 km x 20 months x 1 vehicle = 7,620

Field station, 3 vehicles:

0.127 US\$/km x 3,000 km x 17 months x 3 vehicles =19,431

Total :	<u>=27,051 (L)</u>
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4. Outlays for printing and communication

1) Printing and binding of report

Monthly report, 100 US\$ x 20 months	= 2,000
Final report,	= 1,000
Subtotal :	<u>= 3,000 (L)</u>

2) Communication charges

400 US\$ x 20 months	= 8,000
Subtotal :	= 8,000 (L)
Total :	=11,000 (L)

5. Stationery

200 US\$ x 20 months	= 8,000
Total :	= 8,000 (L)

6. Site labour cost

Driver, 180 US\$ x 20 months x 1 man	= 3,600
Total :	= 3,600 (L)

Data. 8 Schedule of Contingency

- 1) Amount to be taken into account to recoup commodity price increase

Assuming that the annual increase rate is 12.2 %, the rise over 2 years will be 21.1 %.

$$5,145 \text{ thousand US\$} \times 0.211 = 1,085 \text{ thousand US\$}$$

- 2) Review of detailed design (for route reviewing work, L = 10 km)

Required man-months :-

Route surveying (L)

$$3 \text{ men} \times 1 \text{ month} = 3 \text{ man-months}$$

Designing

$$3 \text{ men} \times 2 \text{ months} = 6 \text{ man-months}$$

( F(2) ; L(1) )

Direct labour cost :-

	Foreign currency	Locay currency
Road engineer (A):	1,660 US\$ x 2 man-months = 3,320	
Road engineer (B):	1,300 US\$ x 2 man-months = 2,600	220 US\$ x 4 man-months = 880
Surveyor		300 US\$ x 1 man-month = 300
Assistant to surveyor		200 US\$ x 2 man-month = 440
Total :	= 5,920	= 1,350
Grand Total :	= 7,270 US\$	

Direct expenses :-

Resident expenses,	450 US\$ x 2 months =	900 US\$
	400 US\$ x 2 months =	800 US\$
Vehicle charges,	2.5 x 0.127 x 3,000 =	952 US\$
Communication charges,	400 x 2.5 =	1,000 US\$
Printing expenses,		1,000 US\$
Stationery,	200 x 2.5 =	500 US\$
Total :		<u>5,152 US\$</u>

Summary :-

	Foreign Currency	Local Currency	Total
Direct salary cost	5,920 US\$	1,350 US\$	7,270 US\$
Overhead	6,512	1,485	7,997
Fees	4,927	-	4,927
Subtotal :	17,359	2,835	20,194
Direct expenses	<u>1,700</u>	<u>3,453</u>	<u>5,152</u>
Total :	19,059 US\$	6,288 US\$	25,346 US\$



(2) Where the work is started in April, 1978 :-

Assuming that the construction starts April, 1978 and completes 20 months later at the end of November, 1979, the indexation is as follows, provided that the progress of work will be just the same as when the work is started June, 1977.

Year	Oct., '76	Apr., '78	Oct., '78	Apr., '79	Oct., '79	Dec., '80
Index	100.0	118.8	125.8	133.2	141.1	143.8

Thus, a sliding scale of 32.2 % is adopted.

Review of detailed design :-

As regards the detailed design, the same as in the case where the construction is assumed to be started June, 1977 is applied.

The breakdown of the contingency is as follows.

- i) Component to recoup the commodity price increase (sliding scale, 33.2 %)

$$5,145 \text{ thousand US\$} \times 0.332 = 1,708 \text{ thousand US\$}$$

- ii) Component resulting from review of detailed design

A sliding scale of 17.6 % is applied.

$$25 \text{ thousand US\$} \times (1 + 0.176) = 30 \text{ thousand US\$}$$

Contingency Total :  $1,708 + 30 = 1,738$  thousand US\$

Data 9. Projection of Commodity Price Increase

(1) Where the work is started in October, 1977 :-

Assuming that the construction starts October, 1977 and completes 20 months later at the end of May, 1979, the indexation is as follows, provided that the progress of work will be just the same as when the work is launched upon in June, 1977.

Year	(start)		(Center of investment)		(end)	
	Oct., '76	Oct., '77	Apr., '78	Oct., '78	Apr., '79	June, '79
Index	100.0	112.2	116.5	125.8	133.2	135.8

Since the investments concentrate in Oct., 1978, 25.8 % is taken as a slide scale.

Review of detailed design :-

The review of the detailed design is also considered just the same way as in case the start of work is in June, 1977.

The breakdown of the contingency is as follows.

i) Component to recoup commodity price increase  
 $5,145 \text{ thousand US\$} \times 0.258 = 1,326 \text{ thousand US\$}$

ii) Component resulting from the review of detailed design

Account is taken of an increase of 11.1 %  
 $25 \text{ thousand US\$} \times (1 + 0.11) = 28 \text{ thousand US\$}$

Contingency Total :  $1,326 + 28 = 1,354 \text{ thousand US\$}$

