5-5 Scoping for EIA

5-5-1 Methodology

The following scoping process methodology was applied:

i) To limit the scoping framework to a specific time period and target area to assess target impact.

ii) To evaluate magnitude of each impact with utilizing the matrix method which assesses the relations between impacts and environmental factors.

iii) To summarize the results using 4 grades and giving the reasons of evaluation.

The followings were set for the scoping framework:

1) Evaluation period

The objective period of the evaluation for the scoping process includes the entire period from land acquisition to the completion of construction work, and the operation period up to the target year of traffic planning, when the planned traffic volume is expected.

- Preparation and construction period : 3 years (subject to the final implementation plan)
- Target year of traffic planning : 2015

2) Target area for evaluation

The objective area for the evaluation is the right of way (R.O.W) of the proposed road and the vicinity of the road expected to be influenced by the road construction work and its use. As a practical definition, the area of influence was set to be same as the Study Area ; 10 districts through which the planned road passes.

3) Scoping target impacts

As the target of the scoping process, negative impacts must be carefully considered. Then optimum counter plans should be developed to avoid their serious effect on the human and animal environments. Meanwhile, the magnitude of positive impacts shall be evaluated their magnitude during the scoping process land shall be used as reference, when major impacts are expected.

5-5-2 Evaluation of Magnitude of Impacts

(1) Target Items for Scoping Evaluation

The magnitudes of impact of following items were evaluated. These items have been checked in the Screening process as "Yes" or "Unknown". Other items not evaluated here were considered as items which could be excluded from the EIA target because they

represent no significant effect on environments.

1) Natural Environmental Items

① 1) Land (Topography and geology)

② Soil (Erosion)

④ Water (Hydrology of rivers and lakes)

⑥ Fauna and flora

⑧ Landscape

2) Social Environmental Items

① Resettlement

② Economic activities

③ Traffic and community facilities

④ Split of communities

⑤ Cultural properties

⑧ Waste disposal

⑨ Risk of hazards

3) Living Environmental Items

① Air quality

④ Noise and vibration

(2) Matrix Method

To evaluate the magnitude of each item, a matrix method was applied. This method individually checks and estimates the contents and scales of environmental factors affecting the target environmental items, then evaluates the grade of magnitude of the impacts according to the estimated scale of environmental factors.

The matrix is shown on Table 5.5.1.

(3) Evaluation Grade

The results of the scoping evaluation were indicated by the following four (4) grades:

- Grade-A : Anticipating a major and serious impact
- Grade-B : Anticipating a small impact
- Grade-C : Unknown but requires more investigation
- Grade-D : Anticipating no significant effects and can be excluded from EIA targets

Table 5.5.1 Matrix Evaluation of Environmental Factors and Items

Environmental Factors	Construction Stage												Operation Stage				
	Preparation				Construction								Exist	Use			
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o		
Environmental Items	Land Acquisition	Cleaning	Camp Yard	Detour Route	Earth Work	Quarry	Heavy machines	Waste	Water Control	Bridge	Pavemet	Plant (conc. asph.)	Road Facilities	Traffic Flow	Transportation	Evaluation	Selection
(1) Natural Environment																	
1 Land (topography and geology)		B			B	B										B	O
2 Soil Erosion		C	C		C	C										C	O
3 Underground Water																D	
4 Water (hydrological situation)					C				B	B	*		C			B	O
5 Coastal Zone																D	
6 Fauna and Flora		C			*		*					*	*	*	C	C	O
7 Climate																D	
8 Landscape		C	C		C	C				C		C	C			C	O
(2) Social Environment																	
1 Resettlement	B			C												B	O
2 Economic Activities	C		C	B		C							*	C	B	B	O
3 Traffic and Community Facilities				B			B						C	B		B	O
4 Split of Communities													C	C		C	O
5 Cultural Property		C			C	C								*	*	C	O
6 Water Rights/Rights of Common															*	D	
7 Sanitation								C							*	D	
8 Waste Disposal			C					C							*	C	O
9 Risk of Hazards					*	*			C				C		C	C	O
10 Indigenous Communities	*														*	D	
(3) Living Environment																	
1 Air Pollution		C	*		C	C	C	*				C		C		C	O
2 Water Pollution		*	C	*	*	*		*	*	*	*	*		*		D	
3 Soil Contamination			*								C	*		*		D	
4 Noise and Vibration						C	C					C		C		C	O
5 Land subsidence					*											D	
6 Offensive Odors								C			*					D	

Grade of Impact
A=Significant major impact
B=Significant but minor impact
C=Unknown impact
D=Insignificant impact

Environmental Factors
a=Land acquisition
b=Cleaning of ROW (plant cutting, removal of buldings, etc.)
c=Building construction yard and workers' camp
d=Construction of detours
e=Earth work (cut and fill)
f=Excavation of quarries
g=Usage of heavy machines and dump tracks
h=Waste from construction works
i=Water control for construction of drainage facilities
j=Bridge construction
k=Pavement works
l=Operation of construction plants
m=Existence of road and road facilities
n=Increase of traffic volume
o=Inflow of people and goods

5-5-3 Conclusion of the Scoping Process

(1) Natural Environmental Items

1) Land (Topography and geology) = **Grade-B**

The screening results of the negative impact were as follows:

- ■ Changes in land formations(cut or fill)---------- Yes
- ■ Possibility of landslides, slumps, and other mass movements---------- Unknown
- ■ Embankments in unstable areas---------- Yes
- ■ Excavation of scenic areas for quarry sites---------- Yes

Basically, the project road plans to use existing road area mostly, and earth works in the newly cut land will be very limited. The topography of the road area is relatively flat, and the embankment of the new road will be less than 1 m. The volume of excavation at quarry sites is not defined at this interim stage of the preliminary design of the road, but because of the side borrow method of road construction will be used, it is considered that excavation from one quarry site will be limited except for the limited number of quarries of gravel and rocks. It is also important to pay attentions to the impact of embankments on the low lands, because it can cause several environmental problems such as land subsidence, and interruption of surface water drainage in accordance with the construction methods applied.

2) Soil (Erosion) = **Grade-C**

The screening results of negative impacts were as follows:

- ■ Cutting trees and moving top soil for construction ---------- Yes

For the same reason as the item 1) "Land" mentioned above, impact on the soil erosion is considered very limited. However, a further investigation is necessary in a cutting land area especially in Sapucaí, though which the planned road route passes the mountainous area. Attentions must also be paid to eroded areas along the existing road to determine weather they would be treated well during the construction process.

3) Water (Hydrology of rivers and lakes) = **Grade-B**

The screening results of the negative impacts were as follows:

- ■ Changes in waterflow by the construction of bridges---------- Yes
- ■ Interruption of subsoil and overland drainage patterns ---------- Yes
- ■ Increased quantity of suspended sediments in streams---------- Yes

This is the major impact of the planned road on the natural environment because more than half of the area traversed by the road are lowlands which means that flood can be expected every in every 5 to 10 years. A large-scale bridge on the Tebicuary Mf River is also planned, and it is possible that the waterflow of the river will be affected by the piers of the bridge. The effects of suspended sediments shall be limited because they should be treated by adequate means according to the Environmental Technical Specifications of MOPC. The drainage of streams passing over the road as well as road surface water drainage are other important items to be investigated.

4) Fauna and flora = **Grade-C**

The screening results of the negative impact were as follows:

■ Clearing roadside plantings---------- Yes
■ Damage to the territorial ecosystem by the increase of traffic flow--------- Unknown
■ Interruption of migratory routes, disturbance of wildlife habitats ---------- Unknown

There are no unique flora and fauna recorded in the influenced area, nor are there national parks or natural reserves. The impact on this item is considered very limited except for the following. Road side plantings close to the road are observed in the Gallery Forests along rivers and streams. The cutting area will be limited to only 5 to 10 m of either side of the road subject to the planed R.O.W., and it is possible to minimize cutting areas and/or to add a replanting area. Those actions should be part of the Environmental Management Plans.

5) Landscape = **Grade-C**

The screening results of the negative impact were as follows:

■ Excavation of quarry sites ---------- Yes
■ Large-scale or elevated road facilities---------- Yes

Since, the project road will utilize existing road areas, from the viewpoint of impact affecting the natural scenery and landscape by the project road, only the following small effects are anticipated; One is the new embankment and new bridge across the Tebicuary Mf River, and another is the excavation of quarry sites. At this moment, in the interim stage of the road design, their scale, volume and shape have not yet been defined, thus this item shall be further investigated in accordance with the progress of the road design.

(2) Social Environmental Items

1) Resettlement = **Grade-B**

The screening results of the negative impact were as follows:

■ Land acquisition of agricultural lands caused resettlement ---------- Yes
■ Land acquisition of housing area caused resettlement ---------- Yes
■ Land acquisition of commercial area caused resettlement ---------- Yes

The project plans detour routes around the towns to avoid the pollution caused by traffic flow. However, this plan will cause the loss of agricultural lands or the resettlement of households. It is not a large numbers of resettlements in comparison with a new road development in a central area of a city, but will be necessary to determine the numbers of houses to be relocated and the compensation to be given.

2) Economic activities = **Grade-B**

The screening results of the negative impact were as follows:

■ Loss of agricultural production ---------- Yes
■ Changes of economic structure affecting poor peoples ---------- Unknown
☐ Creation of job opportunities for construction and related works ---------- Yes
☐ Promotion of agricultural production by improving transportation --------- Yes
☐ Promotion of rural development and improvement of living conditions --- Yes

Both direct and indirect positive impacts on economic activities can be expected. Many towns along the project road have, at present, a limited potential of agricultural development because of transportation problems. The project will solve these problems, and thereby contribute to regional economies. It is necessary to balance the loss of products and other negative impacts with the positive impacts.

3) Traffic and community facilities = **Grade-B**

The screening results of the negative impact were as follows:

■ Increase in traffic congestion, accidents, pollution ---------- Yes
■ Deterioration of existing traffic facilities by the new route ---------- Yes
☐ Promotion of opportunities for higher education ---------- Yes
☐ Promotion of improved land use allocation (factories, warehouses, etc.)-- Yes

The magnitude of the impacts on traffic and community facilities will depend on the selection of alternative routes. There are currently two viewpoints. To minimize pollution caused by traffic flow, it is recommendable to make a detour route; however to promote existing traffic facilities, it is better to use existing routes in towns. The decision shall be depend on orders of future traffic flow based on road planning. As a result of the initial evaluation, this item shall be assessed carefully after surveying the public opinion in each town. It is necessary to consider that in Paraguarí there is a military base, which means that

training activities may interfere with the road development project.

4) Split of communities = **Grade-C**

The screening results of the negative impact were as follows:

- Interruption of major pedestrian routes by the new road ---------- Unknown
- Split of community boundaries ---------- Unknown

From the same reason as mentioned above, whether communities are broken up will depend on the selection of alternative routes. Thus further investigation will be necessary as the study progresses. From the initial site observation results, it can be said that this impact will generally not be great except in the following areas: Paraguarí, Sapucai, Caballero, and Villarrica.

5) Cultural properties = **Grade-C**

The screening results of the negative impact were as follows:

- Existence of valuable ruins and cultural assets ---------- Yes
- Damage to cultural assets by construction work ---------- Unknown

According to the research report, an archeological site was recorded around Caballero. It is possible that there are other sites around then. Therefore, further investigation will be necessary.

6) Waste disposal = **Grade-C**

The screening results of the negative impact were as follows:

- Unused construction materials such as soil, cut timber, etc. ---------- Unknown
- Untreated waste disposal from construction workers camps ---------- Unknown
- Dump sites ---------- Unknown

The evaluation of this item will depend on the expected volume of waste from the construction works and the treatment capacity of the contractors and surrounding towns. Basically, treatment system for waste disposal will depend on the dump sites, not on burning plants. The locations of dump sites and their capacities are important items to be examined later according to the final implementation plan.

7) Risk of hazards = **Grade-C**

The screening results of the negative impacts were as follows:

- Possibility of unexpected hazards during heavy flooding caused by road embankments and drainage facilities ---------- Unknown

The impact of the new road embankments during unexpected large-scale flooding is unknown. The road will be planned based on the results of simulations at the maximum flood level within a limited period, end a cost/benefit analysis. However, from the viewpoint of the EIA, it will be necessary to assess the possibility of a serious impact caused by the new road in such a case.

(3) Living Environment Items

1) Air quality = **Grade-C**

The screening results of the negative impact were as follows:

■ Connection with heavily traveled roads in towns ---------- Yes

2) Noise and vibration = **Grade-C**

The screening results of the negative impact were as follows:

■ Heavy machine operation close to housing areas ---------- Unknown

■ Connection with heavily traveled roads in towns ---------- Yes

Regarding two items above in relation to living environment items, it is basically anticipated that the impact in the project area will be slight given the planned traffic volume of 3,000 vehicles a day in 2005. However, at some places in the area such as Paraguarí and Villarrica, the impact of air contamination and noise caused by traffic flow should be assessed, because these towns are connection points with higher level roads in a residential areas around the edges of towns. Vibration impacts need not be assessed, because there are no weak housing structures near the planned road. Therefore, vibration problems are not expected.

All the scoping evaluation results are summarized in Table 5.5.2.

Table 5.5.2 Scoping Results

Environmental Items		Evaluation				Reasons for Evaluation
(1) Natural Environment						
①	Land (topography and geology)	A	**B**	C	D	*-Excavation of quarry sites in landmark mountains and embankment in unstable low areas*
②	Soil Erosion	A	B	**C**	D	*-Further investigation of impact of removing top soil and ground cover during construction*
③	Underground Water	A	B	C	**D**	*-No underground facilities and no excavation works affecting underground water*
④	Water (hydrological situation)	A	**B**	C	D	*-Effect of piers for bridges and interference with natural drainage patterns*
⑤	Coastal Zone	A	B	C	**D**	*-No coastal zone in the project area*
⑥	Fauna and Flora	A	B	**C**	D	*-No valuable species exist in the project area, and very small impact on the ecosystem by cutting the road side trees*
⑦	Climate	A	B	C	**D**	*-No activities affecting climatic conditions*
⑧	Landscape	A	B	**C**	D	*-Necessary to investigate impacts of bridges and road embankments*
(2) Social Environment						
①	Resettlement	A	**B**	C	D	*-Necessary to expand ROW to agricultural lands and bypass routes requiereing the resettlement of several housing*
②	Economic Activities	A	**B**	C	D	*-Loss of agricultural lands but promotion of agricultural products, changes in local economy*
③	Traffic and Community Facilities	A	**B**	C	D	*-Effect on surrounding facilitie, and deterioration of traffic facilities by detour route*
④	Split of Communities	A	B	**C**	D	*-Possibilities in some towns according to the selection of detoure routes*
⑤	Cultural Property	A	B	**C**	D	*-Necessary to investigate the research site near Caballero*
⑥	Water Rights Rights of Common	A	B	C	**D**	*-No or very small impact expected*
⑦	Sanitation	A	B	C	**D**	*-No serious related activities*
⑧	Waste Disposal	A	B	**C**	D	*-Necessary to investigate disposal capacities for each town and the total volume of waste from construction work*
⑨	Risk of Hazards	A	B	**C**	D	*-Necessary to investigate impacts of embankments on uprstream duringf floods*
⑩	Indigenous Communities	A	B	C	**D**	*-No communities around the project area*
(3) Living Environment						
①	Air Pollution	A	B	**C**	D	*-Necessary to forecast the impact of toxic materials in towns like Paraguari and Villarrica*
②	Water Pollution	A	B	C	**D**	*-No related environmental factors*
③	Soil Contamination	A	B	C	**D**	*-No related environmental factors*
④	Noise and Vibration	A	B	**C**	D	*-Necessary to forecast the impact of heavy machines near residential areas*
⑤	Land subsidence	A	B	C	**D**	*-No related environmental factors*
⑥	Offensive Odors	A	B	C	**D**	*-No related environmental factors*

Legend: A : Significant Major Impact
B : Significant Minor Impact
C : Magnitude of Impact Is Unknown (further investigation is necessary)
D : No Significant Impact (can be excluded from the IEE or EIA)

5-6 Comprehensive Evaluation of IEE

(1) Environmental Items to be Investigated

As a result of scoping, the following environmental items have been selected for detailed investigation in the next stage.

a. Topography and geology
b. Soil erosion
c. Hydrology
d. Fauna and Flora (Vegetation only)
e. Landscape
f. Resettlement
g. Economic activities
h. Traffic and community facilities
i. Split of communities
j. Cultural properties
k. Waste
l. Risk of hazard
m. Air quality
n. Noise and vibration

(2) Environmental Items Not to Be Investigated

Below is a summary of the reasons for not selecting certain environmental items for further investigation.

a. Underground water

No wells will be dug and underground waters will not be affected..

b. Coastal zone

The project site is not near the sea.

c. Climate

There are no activities that will affect meteorological conditions.

d. Fauna

There is no valuable fauna living in the project area.

e. Water rights and rights of common

There is no water right authorized in the objective area and also there is very few opportunities that some of the land with right of common is in the proposed road area.

f. Sanitation

The project is not expected to cause sanitation conditions in the area to deteriorate.

g. Indigenous communities

There are no indigenous communities in the project area.

h. Water quality

There are some activities that will affect the quality of the surrounding waters for example, earth works near water streams, but counter measures will be required by ETAGs and the possibility of water contamination is very small.

i. Soil contamination

None of the work will cause soil contamination in the construction stage, except in the machine yard. The yard shall be protected against contamination by the ETAG regulations.

j. Land subsidence

There are no activities that will affect land subsidence.

k. Odors

Construction work and use of the road will cause no offensive odors.

Table 5.6.1 Comprehensive Evaluation Results

Environmental Items		Evaluation	Policies for Further Investigation	Remarks
(1) Natural Environment				
①	Land (topography and geology)	B	-To estimate the stability of cuttings and embankment slopes	
②	Soil Erosion	C	-To study adequate measures to protect against soil erosion from embankment slopes	
④	Water (hydrological situation)	B	-To investigate the effects of piers of the new bridges on river flow	
⑥	Fauna and Flora	C	-To estimate the area of roadside trees to be cut	
⑧	Landscape	C	-To simulate landscape changes caused by road embankments and bridges from the viewpoint of the surroundings	
(2) Social Environment				
①	Resettlement	B	-To estimate the houses and agricultural lands to be resettled	
②	Economic Activities	B	-To estimate the decrease of agricultural lands to be taken over by the road site	
③	Traffic and Community Facilities	B	-To identify communuity facilities close to the planned road	
④	Split of Communities	C	-To investigate the major problems of split of community and to plan measures to mitigate the negative effects	
⑤	Cultural Properties	C	-To confirm a value of existing research site, and the possibility other site in the surroundings	
⑧	Waste Disposal	C	-To estimate the volume of waste disposals in the construction period and the disposal capacities of municipality	
⑨	Risk of Hazards	C	-To investigate the maximum water level during floods	
(3) Living Environment				
①	Air Pollution	C	-To estimate the level of air contamination during construction and operation stages	
④	Noise and Vibration	C	-To estimate level of noise generation during the construction and operation stages	

CHAPTER 6

ENVIRONMENTAL INVESTIGATION

CHAPTER 6 ENVIRONMENTAL INVESTIGATION

6-1 Objective and Methodology

6-1-1 Objective

The objective of the Environmental Investigation is to acquire basic data for further forecast and the evaluation of environmental impact, as well as to develop adequate environmental management plans.

6-1-2 Investigation Items

The environmental investigation focused on the following environmental items which were selected in the IEE (Initial Environmental Evaluation), discussed in the previous chapter.

1) Natural Environmental Items
   a. Topography
   b. Geology and Soil
   c. Water (hydrology of river and the lowlands)
   d. Vegetation (roadside forest)
   e. Landscape (general observations)

2) Social Environment Items
   f. Resettlement
   g. Economic activities
   h. Community and traffic facilities
   i. Split of communities
   j. Cultural properties
   k. Waste
   l. Risk of hazards (Flood)

3) Living Environment Items
   m. Air quality
   n. Noise

6-1-3 Investigation Area

The investigation area varies according to the investigation item being considered, but in general, an area with a width of 5 km on either side of the planned road was set for the natural environmental items, and the administrative boundaries of 10 districts in the Departments of Paraguarí and Guairá were set for the social environment items.

6-1-4 Investigation Method

Generally, the following investigation methods were applied:

i) Data collection form bibliographies and maps

ii) Field reconnaissance

iii) Interviews (Survey of 120 inhabitants in 10 districts)

iv) Hearings (Mayors of the 10 districts and the authorities concerned)

6-1-5 Local Consultants

The Study Team conducted its investigation of existing conditions from April to June 1996 through Paraguayan consulting firms; EIT S.R.L. for natural environmental items, and Geosurvey S.R.L. for social environment items. Both firms are located in Asunción, Paraguay.

6-2 Topography

6-2-1 Objective of the Investigation

Topographic conditions were investigated to evaluate the impact of the earth work such as cutting and filling in the area surrounding the project road. As a basis of the evaluation, the general features of the topography and the gradients of the road sections were examined.

6-2-2 Methodology

The methodology used for the work consisted, in a first stage, of a the review of the particular precedents of the region. Subsequently, field recognition was performed using cartographic base, the National Charts of the Military Geographical Institute, (Cartas Nacionales del Instituto Geográfico Militar) Pages: 5469 (Paraguarí), 5569 (San José), and 5669 (Villarrica) on a 1:100.000 scale, and Topographic Charts on a 1:50.000 scale.

The field work covered the existing roadway, considering also the topography for a band of 5 km on either side of the Paraguarí -Villarrica roadway and the branches to La Colmena. The following planimnetric sections were described:

- **Segment I** : Paraguarí - Escobar (4 Sections)
- **Segment II** : Escobar - Sapucai (3 Sections)
- **Segment III** : Sapucai - Gral.B. Caballero (1 Section)
- **Segment IV** : Gral.B. Caballero -Ybytimí (2 Sections)
- **Segment V** : Ybytimí - Parallel to F.C.C.A.L. (railway) - Tebicuary (2 Sections)
- **Segment VI** : Tebicuary - Cnel. Martínez - F. Pérez Cardozo (4 Sections)
- **SegmentVII** : F. Pérez Cardozo - Villarrica (through Cocueré Guaz). (2 Sections).

The alternative routes (traces) to La Colmena (Branches) that were analyzed are:

- **Alternative A** : Ybytymí -Cñía Cañada -Cñía. Potrero Garay - Cñía. Martínez Cué - La Colmena. (6 Sections)
- **Alternative B** : La Colmena - Cñía. Solano Escobar - Cñía. Mbocayaty - Tebicuary Mí-Tebicuary. (14 Sections)
- **Alternative C** : Cñía. Solano Escobar - Cñía. Héctor Vega - Intersection F.C.C.A.L. (5 Sections)
- **Alternative D** : Cñía Cañada - Cñía. Héctor Vega. (1 Section)

6-2-3 Regional Topography

(1) Water Basin

The area of the project is located in two large hydrographic basins that represent physiographic units. They are:

- The Basin of the Caañabé Brook-Creek (Arroyo Caañabé)
- The Basin of the Tebicuary River (Río Tebicuary)

The region constitutes a vast plain-prairie with low and high fields following a West-East orientation. This plain is segmented by the hill chain of Ybytymí (serranía de Ybytimí), which also divides the waters and limits the basins of the Caañabé and Tebicuary (cuencas del Caañabé y Tebicuary).

(2) Caañabé Water Basin

The north side of the basin of the Caañabé is limited by the Altos hill chain (Cordillera de los Altos). The main route of the project road is located in this area, and this segmentation affects the localities (town-villages) of Paraguarí, Escobar and Sapucai.

The topography of this basin is characterized by abrupt springs in the Altos hill chain (cordillera de Altos) (North sector), with maximum levels greater than 400 mts.o.s.l. On the south the basin is limited by a elevated band with maximum levels superior to 200 meters, that following a regional NE - SE orientation. The prairie that constitutes the plain or bed of the valley presents a variable width of approximately 20 to 35 km, and it consists of low and floodable fields, high fields, marshes, and island- and gallery- shaped woodlands. Conical hills are dispersed throughout.

(3) Tebicuary Water Basin

The basin of the Tebicuary, in the project area, has its most abrupt springs in the hill chains of Ybytymí (serranía de Ybytimí) and Tebicuary Mí. The bed of the broad valley consist of low and floodable fields, high fields, island- and gallery- shaped woodlands. The creeks generally flow along ditches.

It is important to indicate that the downtown area of the city of Sapucai constitutes the limit between the two previously mentioned basins. From Sapucai, the area of the project is located in the basin of the Tebicuary.

6-2-4 Gradient of Existing Roads

Table 6.2.1 and Figure 6.2.2 show the analysis result of existing road gradients. The maximum gradients, generally, are not greater than 3% on the current trace of the road, which is characteristically flat. Because of this the superficial glide of the drainage is generally slow, and a dike effect has been observed on this roadway. Figure 6.2.3 shows some typical cross sections of several points on the existing roads.

Table 6.2.1 Gradients of Existing Roads

Segment	Section	Location	Level	Length	Level	Location	Gradient
I	1	Paraguarí	120m	3,100m	130m		0.30%
	2		130	3,500	120		0.29
	3		120	2,000	105		0.75
11,500m	4		105	2,900	135	Escobar	1.03
II	1	Escobar	135	3,000	148		0.40
	2		148	2,000	140		0.40
7,800m	3		140	2,800	200	Sapucai	2.14
III	1	Sapucai	200	9,850	145	Caballero	0.56
9,850							
IV	1	Caballero	145	5,000	130		0.30
10,300m	2		130	5,300	145	Ybytymí	0.28
V	1	Ybytymí	145	9,900	120		0.25
16,400m	2		120	6,500	110	Tebicuary	0.15
VI	1	Tebicuary	110	4,500	120	Martínez	0.22
	2	Martínez	120	2,200	105		0.68
	3		105	3,800	148		1.13
13,000m	4		148	2,300	128	Cardozo	0.87
VII	1	Cardozo	128	4,500	208		1.80
7,000m	2		208	3,000	158	Villarrica	1.70
Alt.A	1	Ybytimí	145	6,500	115	Cañada	0.46
	2		115	4,000	125	Tebicuary Mí	0.25
	3	Tebicuary Mí	125	2,900	132	Potorero Garay	0.24
	4	Potorero Garay	132	3,000	207		2.50
	5		207	2,200	137	A. Mendoza	3.18
20,800m	6		137	2,200	162	La Colmena	1.14
Alt.B	1	La Colmena	160	900	145		1.67
	2		145	1,100	162		1.55
	3		162	2,500	135	A. Roy	1.08
	4	A. Roy	135	3,500	175	Mbocayaty	1.14
	5	Mbocayaty	175	2,000	150		1.25
	6		150	1,000	175		2.50
	7		175	2,900	150		0.86
	8		150	1,100	127	Tebicuary Mí	2.09
	9	Tebicuary Mí	127	2,700	102		0.93
	10		102	1,400	119		1.21
	11		119	2,300	101	A. Tebicuary Mí	0.78
	12		101	1,000	109		0.80
	13		109	2,000	101		0.40
29,400m	14		101	5,000	105	Tebicuary	0.08
Alt.C	1	Solano Escobar	165	7,700	105	A. Tebicuary Mí	0.78
	2	A. Tebicuary Mí	105	2,900	125	H.Vera	0.69
	3	H.Vera	125	3,000	115		0.50
	4		115	2,000	130		0.75
17,000m	5		130	1,400	123	F.C.C.A.L.	0.71
Alt.D	1	H.Vara	125	3,100	120	Cañada	0.16
3,100m							

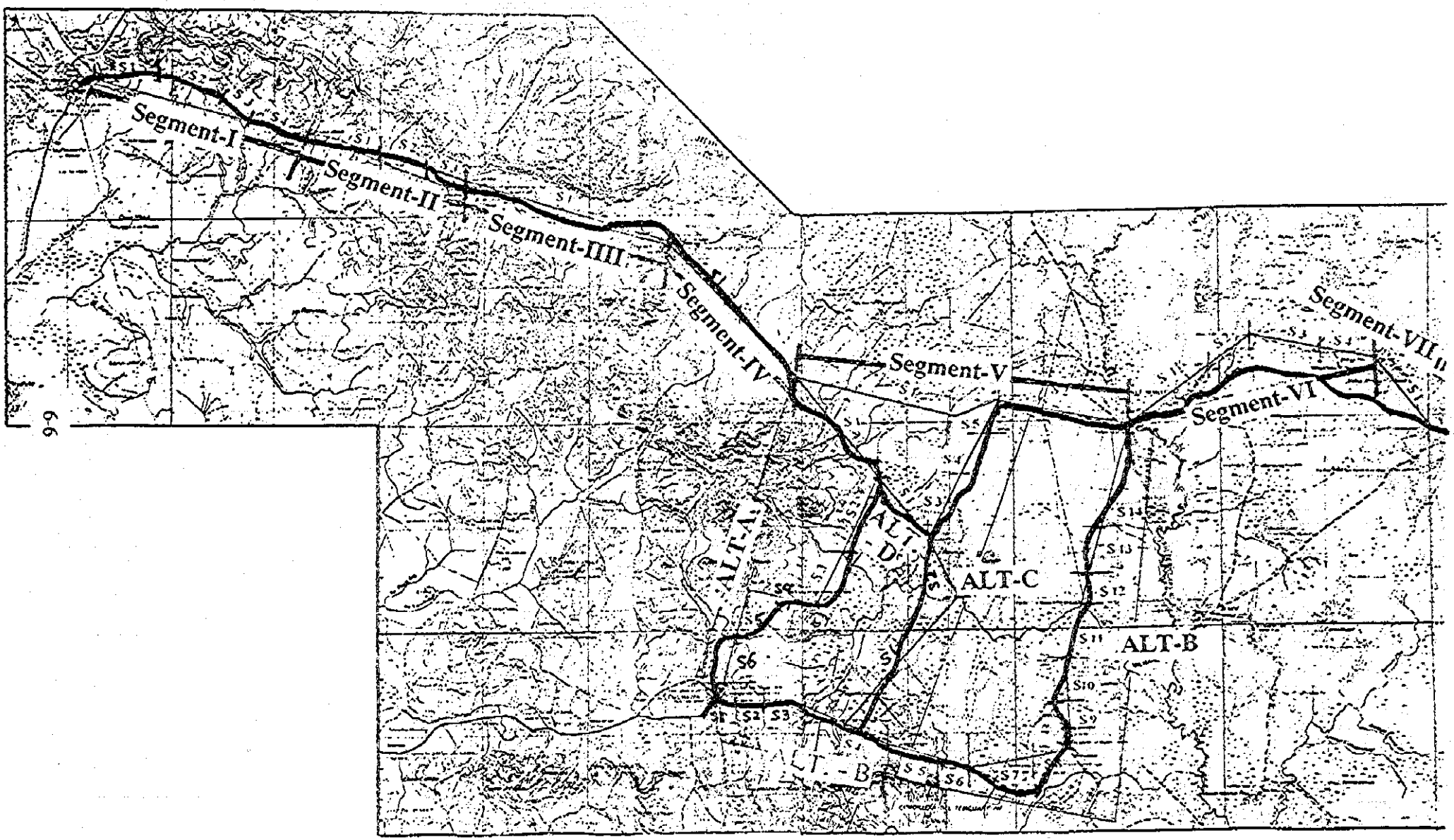


Figure 6.2.1 Location of Road Segments and Sections

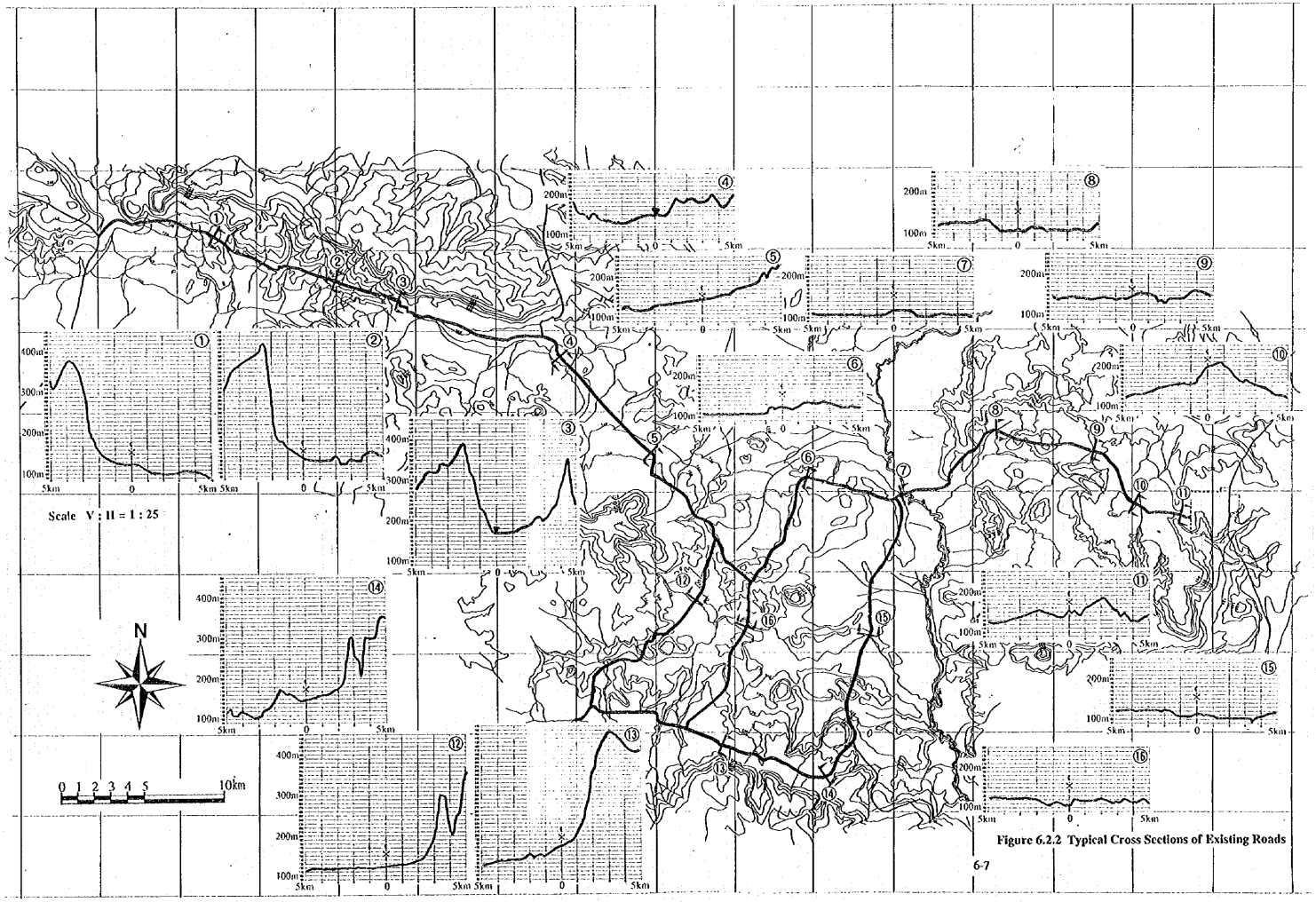


Figure 6.2.2 Typical Cross Sections of Existing Roads

6-3 Geology and Soil

6-3-1 Objective of the Investigation

Geological conditions were investigated to evaluate the impact of erosion by the cutting and filling earth work in the area surrounding the project road as well as in the quarries. As a basis for this evaluation, the general features of geological conditions and the quarry sites were investigated.

6-3-2 Methodology

The methodology of the work consisted in a first stage involving review of the precedents of the geological aspects in the region. Subsequently, known fields were used as a cartographic base, the National Charts of the Military Geographical Institute (Instituto Geográfico Militar), Pages: 5469 (Paraguarí), 5569(San José), and 5669 (Villarrica), on a 1:100.000 scale.o

During the field work, the petrous and unconsolidated materials extraction sites were inspected, as these constitute a potential source of material for the construction of the roadway. At these sites, samples were collected, classified, and described. This was followed up with consultations with the area's residents.

6-3-3 Regional Geological Features

(1) General

The project area is geologically located to the north of the Tebicuary River Subcraton, limited to the Northeast - East by the phanerozoic sequence of the Basin of the Paraná, and to the West by the modern sediments of the Caañabé valley (valle del Caañabé).

The relevant parts of this zone are located within the Rift of Asunción; a distensional mesozoic structural zone with a regional NW-SE orientation. Cenozoic activation and reactivation created alkalines/basic magmatites in the Cretacic period and nephelinics magmatites in the Tertiary period.

(2) Geological History

The phaleozoic units in the Inferior Ordovícic are related directly to the origin and evolution of the Basin of the Paraná. The beginning of deposition of such units is due to marine transgressions with land influence creating the conglomerates and the sandstones

of the Caacupé Group.

At the peak of the Phaleozoic period with the carboniferous eo-hercian epirogenesis, tectonic plaque originated in the areas adjacent to the Tebicuary (RfoTebicuary) Subcraton. In this way, the original Rift of the Acahay Valley (Valle de Acahay) was caused by ancient structures formed during the Brasiliano thermotectonic cycle of the eocambric age.

A distensional tectonic of the inferior Jurassic-Superior Cretacic age caused a fracture in the formation of the project, forming the Rift of Asunción. The structures permit the formation of alkaline/basic magmatites, which create intrusive bodies, and dike systems and basaltic spreading.

In the Cenozoic age, a tectonic reactivation of preexisting fractures in the Asunción block and the Acahay Valley (Andean Cycle) was manifested. The reactivated deep fractures contain magmatites nephelinic and phonolitic intrusion, that form small cones (Miraglia, 1965; Bojanovich, 1977).

Tertiary/quaternary sediments formed by conglomerates, sands, and clays cover the floodable plain areas, crating drainage nets or forming residual soils.

6-3-4 Local Geology

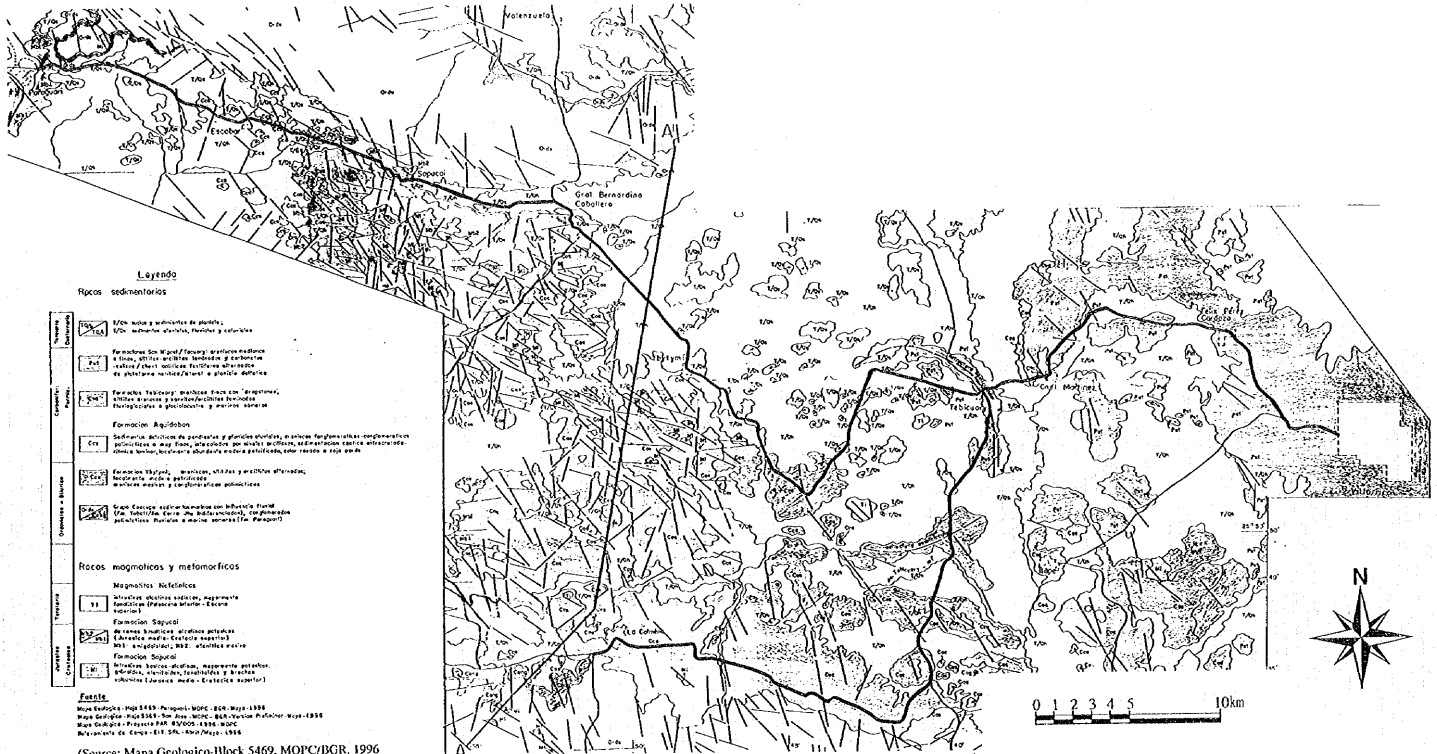
(1) Lithology

1) Paraguarí Lutes :

Eocambric metasediments are in discord with the ordovicic sediments that cover it. Good outcropping expositions exist at the base of the Cristo Redentor Hill (Cerro Cristo Redentor (property of the industrial sugar cane plant). These lutes were formed in a sea-lake environment, and they are finely laminated, appearing greenish yellow as a result of the rusty pigment content they contain.

2) Paraguarí Conglomerate:

This is a brown conglomerate made up predominantly of quartz and quarzite veins. These cloisters appear well rounded to ellipsoidal, are of variable size (diameter of 1 to 30 cm), and are heterogeneous both in the way they are disposed and in the size of the sides. The matrix of the conglomerate is arcosic, consisting of gross granulometry and crossed stratification. In relationship to the depositional ambient this was marine transgressive with a strong river influence.



(Source: Mapa Geologico-Block 5469, MOPC/BGR, 1996
Mapa Geologico-Block 5569, MOPC/BGR, 1996
Mapa Geologico-Project PAR 83/005, MOPC, 1986
Field Survey Map, EIT SRL, 1996)

Figure 6.3.1 Geological Map of the Objective Area

3) Caacupé Group Sandstones of :

These cover the conglomerate bases and correspond to a gradual sedimentation sequence that began with conglomerated sandstones, then changed to arcosics. In the area of the project , they are present in the Altos hills chain (Cordillera de Altos). The inferior level is scantily cemented, with a medium to gross granulometry, and is formed by quartz grains and feldspar. It presents a yellowish to grayish coloration, with crossed stratification and subrounded grains.

The sandstones superior to the arcosic show a better selection, with saccharoidal aspects, little Kaolinic cementation, and appear in a white - yellowish white to reddish color. The sandstones that belong to the Caacupé Group vary in terms of granulometry and color. Generally they are friable and very susceptible to erosion. The hills and preserved headlands are the result of a silicification phenomena caused by intemperism (weather-worn) or intrusions or by both factors. The depositional environment is superficially marine with some fluviatic influence.

4) Aquidabán Sandstones (Cnel. Oviedo Group):

These are present in the Acahay valley (Valle de Acahay), especially in the hilly lands of Ybytymí and Escobar. These sandstones are of the superior carboniferous type deposited in tectonic places formed by Eo-hercinian epirogenesis.

In the Acahay valley there is a basal clayey sandstone sequence , with a reddish color, and thin to very thin granulometry. Higher up, the sequence turns more bulky going from massive sandstones to conglomerated sandstones of poor selection. No fossils are contained, as the sandstones are poorly compactated from a lack of a cement counterfoil. Moreover, they exhibit internal fluvial type chlamynation (zone of Escobar). These sandstones are highly discordance on units of the Caacupé Group as tectonic plaque fill.

The depositional environment at the base is fluvial to lacustrian, of relative low energy causing pronounced lamination. The superior sediments greater energy, typical of fan-shaped alluvials and anastomosant rivers.

5) Limose Sandstones (Fm. Palacios):

These were believed to have been formed after the Jurassic-Paleocenic age.

The Peró Hill (Cerro Peró) of Paraguarí is of this geological type, and it is formed by dark red conglomeratic sandstone, with very heterogeneous cloisters, both in terms of size and mineralogic composition. This is evidenced by the fact that it contains ordovisic-siluric

sediments and crystalline rocks. This heterogeneity reflects a rapid sedimentation in a tectonic plaque environment, caused by chaotic epiclastic to fanglomeratic sedimentation and related to the Rift of Asunción.

6) Basic/Alkanline Magmatites (Mid-Jurassic-Superior-Cretasic):

Intrusive and efusive bodies are related to the distensional tectonism that formed the Rift of Asunción. Some of those bodies can be found encased in ordovic rocks of the Caacupé Group (Hills: Acahay, Santo Tomás, etc) forming silicification aureols. They can also be in Escobar and Sapucai.

Petrographically, the intrusive rocks, are represented by gabros, eruptive rocks (gabro), sienna eruptive rocks (sienogabros), sienna diorites sienodioritas, essexitic eruptive rocks (gabros essexiticos), and essexites. Most of these rocks are rich in K_2O (1.68 to 10.96%) and MgO (0.60 to 10.35%), which gives them potassic to ultrapotassic characteristics.

7) Effusive / Sub - effusive basics:

They are represented by the trachybasalts, trachyandesites, and trachytes that are found in the Acahay valley. These precede the intrusives and are found cut by the intrusives/dikes basics and alkalines.

8) Dikes:

These are arranged in swarms and are located throughout the fractures mostly in a NW-NNW orientation. The sites of these dikes in the ordovic sediments cause local silicification that makes them resistant to erossive processes. They are morfologically expressed by elongated and aligned heights.

9) Nephelinic - Phonolitic Magmatites (Paleocene-Eocene)

They are presently formed as cones, dikes, and nefelinic pyroclastites isolated in the block of Asunción and Acahay valleys (Cerrito). They are associated with the Andean cycle.

10) Tertiary sediments/undifferented quaternary (Miocene-Holocene):

They appear as residual soils, soils redeposited in floodable plains, and current drainage nets. They are of variable texture and composition: fine to medium grain sands in ordovic-siluric and mesozoic areas; conglomerates covering granites and eocambric porfides; clays and organic materials in plains.

(2) Geomorphology:

The area of the project is a great valley (Acahay Valley) interrupted by the Ybytymí mountain chain, giving way to the valleys of Ybytymí and Tebicuary Mí. This hill chain constitutes the watershed of the basins of the Caañabé and Tebicuary Mí streams. The morphology is related to the geological evolution of the Rift of Asunción, causing tectonic plaque formation (actual valleys), and high blocks or horts (parts of the hill chains).

(3) Mineral Resources:

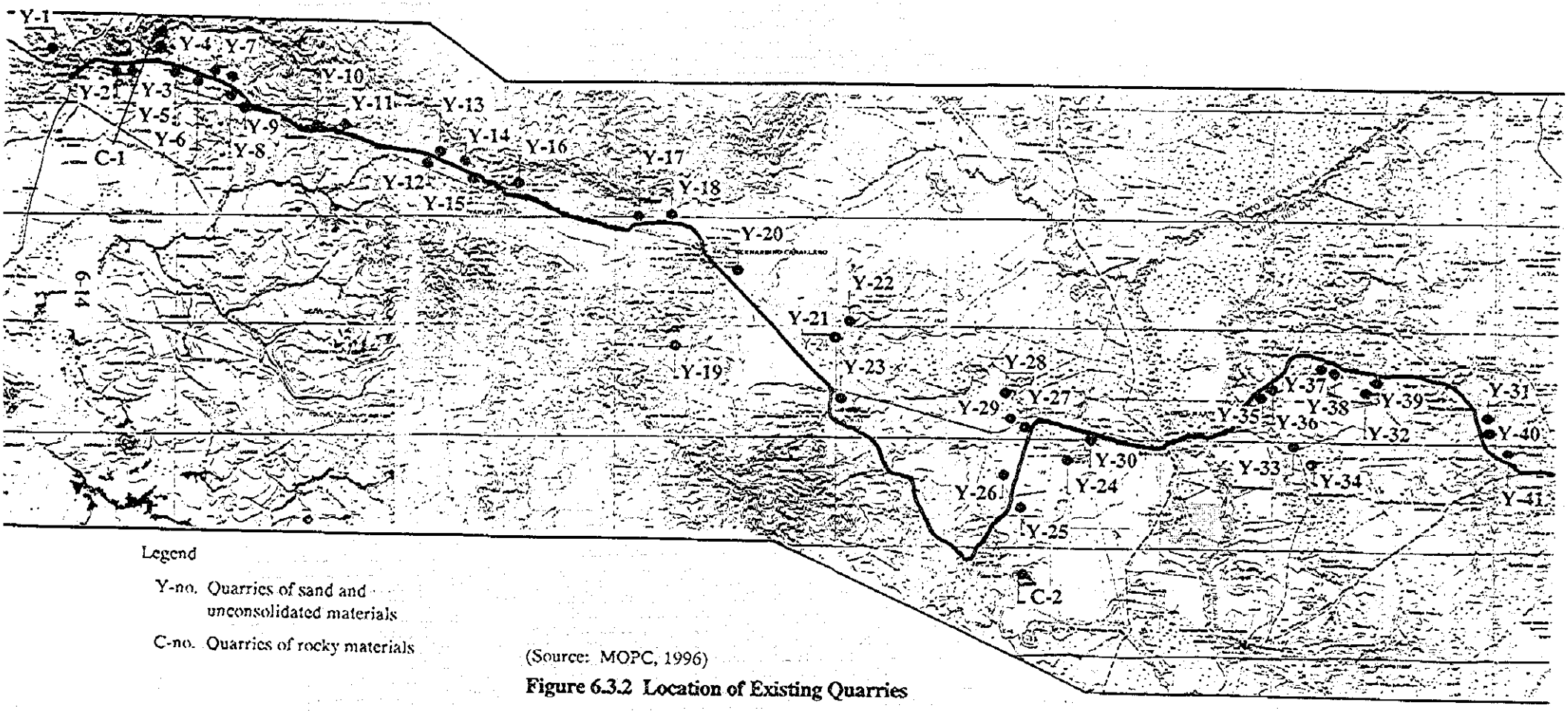
- Stony and unconsolidated material mentioned as important resources consisting in.
- Intrussive and efussive igneous rocks: Santo Tomás Hill, Sapucai, Escobar, Cerrito, Itapé, etc.
- Rubble: in areas with ordovic rocks and floodable valleys.
- Clays, flagstones, sands (throughout the entire project)
- Puzzolana (Acahay valley -Ybytymí)
- Rabble (floodable plains)

(4) Neotectonic

According to data obtained the Seismic Center of the National University of Asunción (Exact and Natural Sciences Faculty - San Lorenzo) *(Centro Sismico de la Universidad Nacional de Asunción, Facultad de Ciencias Exactas y Naturales)* in the years 1957, 1973, 1984, and 1994 telluric movements, which are believed to have been originated as an effect of the readjustment of the Rift of Asunción, have been registered. They have a low intensity, under 5 on the Richter scale.

6-3-5 Quarry Sites

Figure 6.3.2 shows the locations of quarries around the Project road. In the figure, C indicates quarries of rocky materials and Y indicates quarries of sand and uncosolidated materials.



Legend

Y-no. Quarries of sand and unconsolidated materials

C-no. Quarries of rocky materials

(Source: MOPC, 1996)

Figure 6.3.2 Location of Existing Quarries

6-3-6 Erosion

Existing roads are located over several lithologic units, according to the Geological Map. A large part of the route occupies the valley plains, and only short sections present undulated relief, as for example in the entrances to the cities of Escobar and Sapucai, where the gradients are greater.

In the valleys, mainly in the Caballero-Ybytymf-Tebicuary section, soil is clayey and the environment is formed by lowlands with some small hills that have gravel (rubble). These are the areas in which the construction of a terrace will be required to avoid erosional effect by rain waters. At the exit of Ybytymf with orientation toward Villarrica, on the bridge over the creek, a high degree of erosion of the sandy-clayey sediments with gravel layers (see Figure 6.3.3-Photo-1) can be observed. Continuing along the road and linked to the same bridge, land has been very eroded due to the action of the pluvial waters (Photo-2).

At the entrance of Sapucai, the route presents a steep gradient. Project alternative routes (to the north of the urban hull) would go through linches of conglomeratic sandstones, gravel, etc. Depending on the type of material and gradients of slopes, banks should be relatively stable.

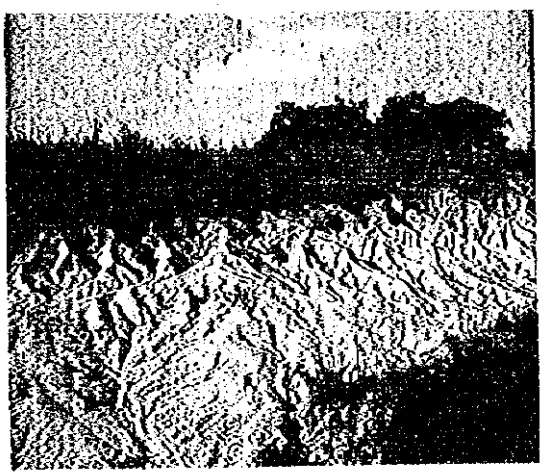


Photo-1

Photo-2

Figure 6.3.3 Soil Erosion

6-4 Hydrology

6-4-1 Objective of the Investigation

Hydrological conditions were investigated to evaluate the impact of road embankment on the water flow of rivers and streams in the areas around the project road. To proved for basis for the evaluation, general hydrological conditions and existing road drainage facilities were investigated.

6-4-2 Methodology

The work methodology consisted, in the first stage, of reviewing the particulars of the region. Subsequently, the basin and sub-basin areas were determined by using as a cartographic base, the National Charts of the Military Geographical Institute (Instituto Geográfico Militar), Pages: 5469 (Paraguarí), 5569 (San José), and 5669 (Villarrica), on a 1:100,000 scale and Topographic Charts on a 1:50.000 scale.

Taking this work as the basis, the main water courses, the object of the field work investigation, covering the existing road of the roadway (Paraguarí - Villarrica and branches to La Colmena) were identified, were different alternative crossings through the urban centers.

6-4-3 Hydrological Conditions by Road Sections

(1) Paraguarí - Sapucai

There are 4 rivers in the section. They are the Ao Yacare, Ao Piraty, Ao Tulio, and Ao Para . All rivers originate in the Cordillera de los Altos. The existing road is located upstream of the rivers, while the railway is located in the downstream. The ground level of the road is between 113-147 m, and the existing drainage system uses mainly box culverts. Because some of the sections of this area are subject to inundation, adequate drainage facilities are required.

(2) Sapucai - Bernardino Caballero

Ao Tororo and Ao Paso Pypucu originate in Cordillera de los Altos and flow into the Tebicuary Mí River, opposite the Paraguarí - Sapucai section because the water basins are separated.

(3) Gral. Bernardino Caballero - Ybytimí

Ao Pirayuvy and Ao Jhu originate in Serranía de Ybytymí. The existing road is located along the railway lines in the downstream. The existing road is almost flat with an elevation between 140-148 m. The existing drainage facilities are mainly bridges. The existing road drainage system is poor.

(4) Ybytimí - Tebicuary

Ao Pachongo and Ao tacuarenboy originate in Serranía de Ybytymí. The existing road shifts to the hilly area. The alternative route runs along the existing railway line, where there are inundable lowlands. However, according to the railway company, flood waters have never reached the railway level. The ground level is between 117-148 m. from Ybytymí to the cross point with the railway, and from that point to Tebicuary the ground level is between 114-126 m. The existing drainage facilities are mainly bridges.

(5) Tebicuary - Martínez

The Río Tebicuary Mí is the largest river in the objective area, with a catchment area of 3,280 km². The gradient slope is 0.5% from north to south, the average width is 80-100 m. The ground level of the existing road is around 104 m. On the both sides of the river, there are inundable areas, which are especially wider on the north side of the existing bridge across the river. There are three bridges for flood relief located on the Martínez side.

(6) Martínez - Felix Pérez Cardozo

The road in this section is covered in the watershed of Ao. Jhu. Cross drainage facilities can be found in Teniente Bogardo village, but they are of poor quality. The existing depressed road running 2 km from Bogardo and 1 km from Lomo is located in low area of Ao.Jhu.

(7) Felix Pérez Cardozo - Villarica

There are two rivers the Ao. Caraguatay and the Ao. Caundy, but they have a small watershed area. The existing road runs parallel to the railway line, and is highly elevated at 140-150 m. There would be no inundation problem, if the new road were built higher than the railway level.

(8) La Colmena - Empalme

In this section there are three rivers, the Ao. Tranquera, the Ao. Cordiller, and Tebicuary Mf. The existing road runs through hilly areas levels between 146-155 m. Serious inundation is not observed in this section.

(9) Empalme - H. Vera - The cross point with the railway

The existing road is located at levels of 140 to 160 m. The inundation problem is not observed in this section. The recent flood water level of the Ao. Tebicuary Mf was recorded 0.5 m below the existing bridge surface.

(10) Empalme - Tebicuary Mf

There are several small streams originating in Crdillera del Tebicuary Mf. The mountain is covered with thick forests, and the existing road is at a ground level of 160-180 m.

(11) Tebicuary Mf - Tebicuary

The existing road, which runs at about 115 m levels, crosses the inundable areas but the existing road is higher than this and not inundated. The area near the Baily type bridge across the Tebicuary Mf River is sometimes inundated, because the road surface near the low area is 107 m and the latest inundation level was 107.2 m

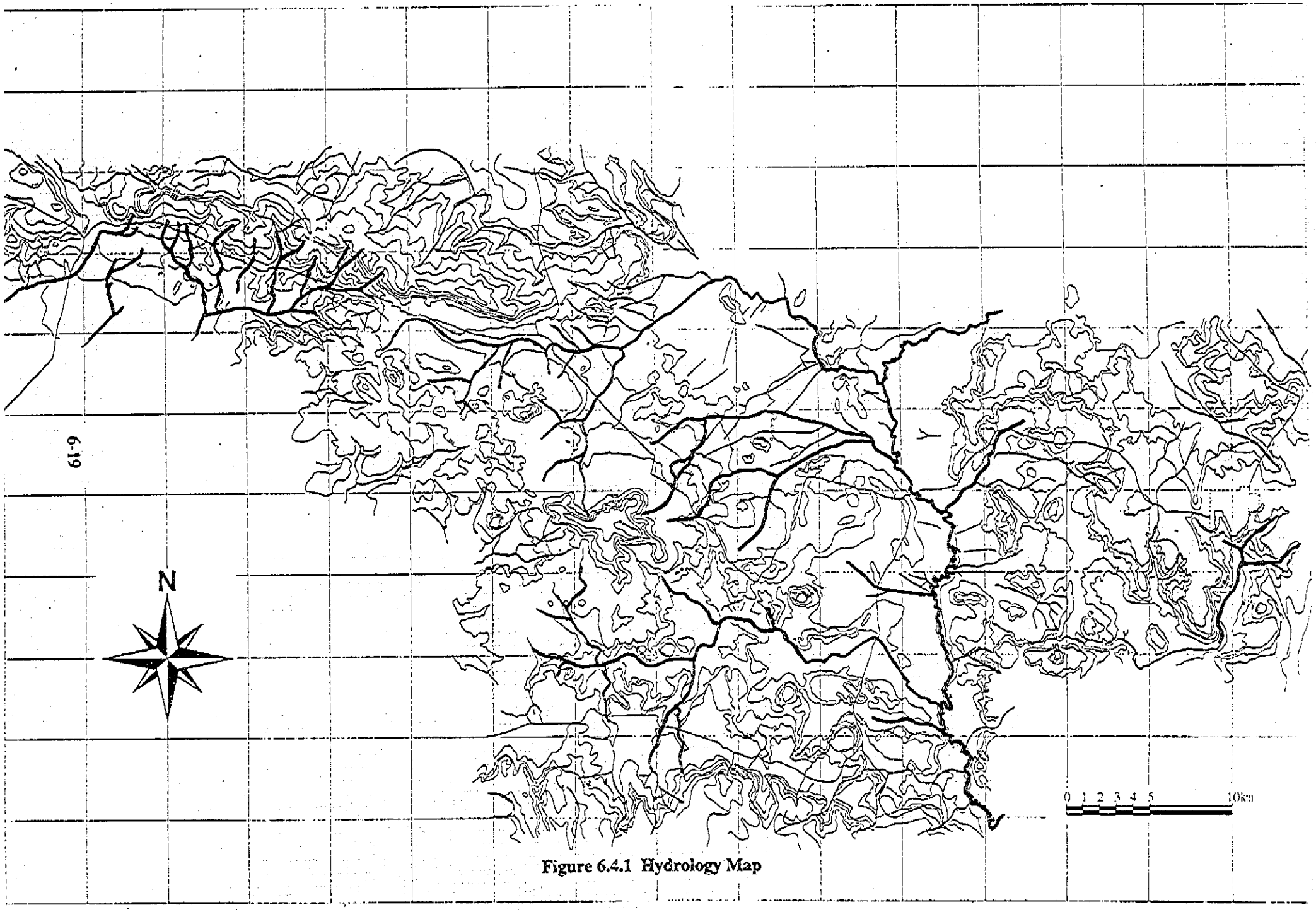


Figure 6.4.1 Hydrology Map

6-5 Fauna and Flora (Roadside Forest)

6-5-1 Objective of the Investigation

The conditions of the roadside forests were investigated in order to evaluate the impact of land clearance works for road construction affecting erosion, causing damage to the ecosystem, and changing the landscape in the surrounding areas of the project road. As a basis of the evaluation, the location of roadside forests and their typical landscapes were investigated.

6-5-2 Methodology

The methodology of the work consisted, in a first stage, of reviewing the cartographic base, the National Charts of the Military Geographical Institute (Instituto Geográfico Militar), Pages: 5469 (Paraguarí), 5569 (San José), and 5669 (Villarrica), on a 1:100,000 scale and Topographic Charts on a 1:50,000 scale, and also aerophotos on a scale of 1 to 50,000 and 20,000 covering the objective area.

Subsequently, a field survey that covered the existing road of the roadway: Paraguarí - Villarrica and branches to La Colmena, as well as the alternative routes, was conducted.

6-5-3 Location of Roadside Forests

Riverside forests can be seen usually at the cross points of roads and rivers, where liner-shaped forests grow rivers. They are known as "Bosques Galleria" which means corridor-type forests. These locations are shown in Figure 6.5.1. Major crossing points of the road are observed in the following areas;

i) From Caballero to Ybytymí

Two larger Bosques Galleria cross the existing road

ii) Near Ybytymí

Two smaller Bosques Galleria cross the existing road

iii) Near Tebicuary

The existing road crosses the largest Bosque Galleria along the River Tebicuary Mí.

iv) From La Colmena to Tebicuary through Tebicuary Mí

The existing road crosses Several Bosque Galleria along small streams and branch rivers. The smaller forest are from 10-30 m wide, and 80-100 m wide in Tebicuary.

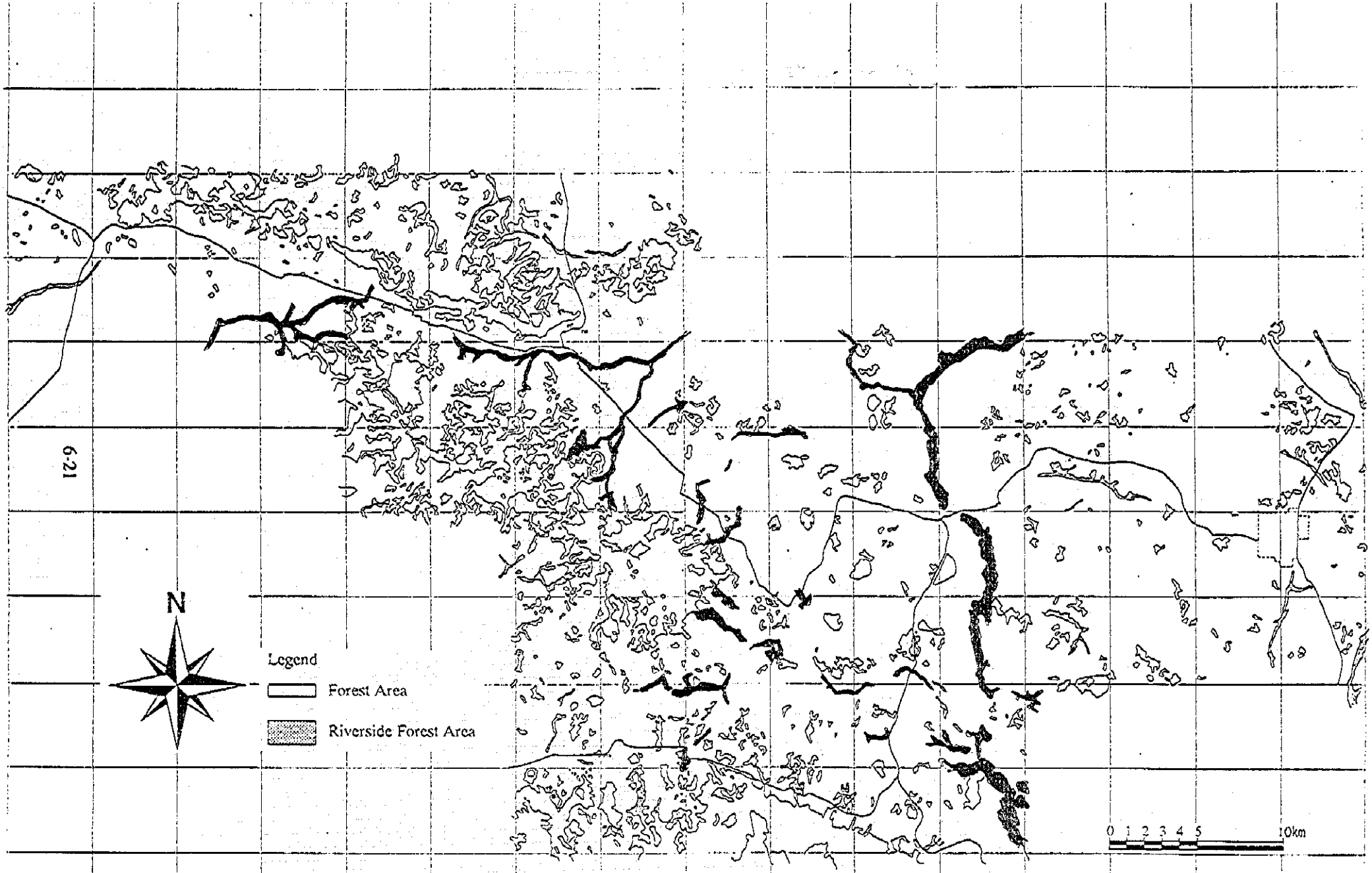


Figure 6.5.1 Location of Bosques Galleria (Riverside Forests)

6-6 Landscape

6-6-1 Objective of the Investigation

The impact of the construction of new roads on the roadside landscape is not expected so serious because the planned road will mainly use the existing road area, which means that there will be no great in land formation. The landscape investigation, accordingly, focused on those areas where a new large-scale road facilities (bridges) and embankment were planned. To evaluate impact, existing landscape conditions were investigated.

6-6-2 Methodology

The investigation area was set in the area surrounding the Tebicuary Mf River where the largest bridge is planned to be constructed. The following methodology was used:

i) To seek observation points around the new bridge by checking maps.

ii) To conduct reconnaissance to select a good point from which the bridge could be observed.

iii) To take photographs in different seasons to discover seasonal changes of landscape. These photographs shall be used for scenery simulation analysis in later forecasting.

6-6-3 Observation Point in Martínez

Figure 6.6.1 shows the photographs of the selected observation point in Martínez, where the new bridge construction site for the Alternative-1 route can be seen, as well as providing a good view of Bosque Galleria.

Figure 6.6.1 Landscape Observation Point

6-7 Resettlement

6-7-1 Objective of the Investigation

The objective of the investigation concerning resettlement is to identify the probable locations and volume to be resettled in clearing of the road development areas. It is also an important objective of this investigation to clarify the legal matters relating to the resettlement in Paraguay.

6-7-2 Methodology

Given the objectives mentioned above, the following surveys were conducted:

i) Map survey : Identifying the locations of human settlements along the planned road using available maps on a scale of 1 to 50,000.

ii) Field survey : Identifying the exact locations of lands and buildings to be relocated according to the final alignment of the proposed road.

iii) Data collection and hearings : The legal procedure of resettlement was investigated through analysis of similar project cases, and hearings were conducted with authorities concerned

6-7-3 Location of Human Settlements

In the administrative system of Paraguay, the basic community is known as a Campana. According to the data from MAG, the location of Campanas is shown in Figure 6.7.1, however, the boundaries are not legally defined.

6-7-4 Areas Subject to Relocation

Since the project road alignment plans to maximum use of the existing road area, only a small number of existing buildings need to be relocated. The major areas to be relocated are as follows, and the total number of buildings are tentatively estimated as 50.

i) Sapucai : Since the planned road runs through the existing town area. Therefore several houses must be relocated. According to the mayor of Sapucai, the municipality land in the center of the urbanized area is available for relocation.

ii) Paraguarí : The alternative route plans would run through the west end of the existing town. This area is not urbanized along half the planned route, therefore it is not necessary to relocate any existing buildings if the right of way of the project road is kept to less than 20 m in the town area.

iii) Villarrica : Here the situation is the same in Paraguarí. The alternative route would run along the north end of the existing town, but the northern side is not yet urbanized. However, several houses along the line of the planned road would have to be relocated. In this case, the land for the relocation is available in the town center.

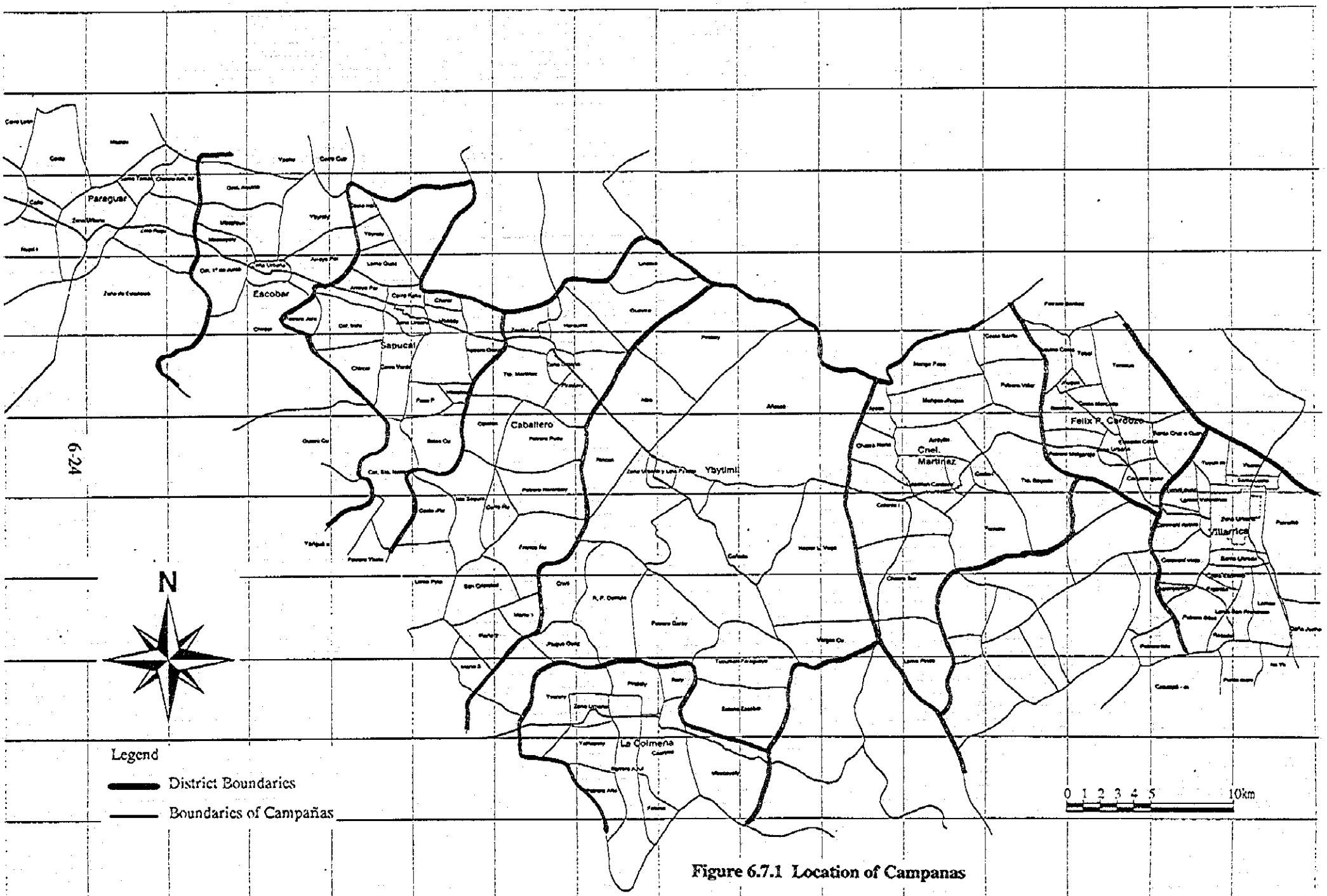


Figure 6.7.1 Location of Campanas

6-7-5 Legal Procedure of Resettlement

In Paraguay, there are no general laws concerning land acquisition for public works, however, laws are usually established for each public projects. According to the laws established for the project of Asunción north-south road construction, the following legal procedures can be expected:

Legislative Power - Law N. 378

Of expropriation for the construction of circumvalation roads with access to the South and North of AsunciÓn.

Article 3: The Ministry of Public Works and Communications will prepare an expedient for each property affected by the expropriation that will contain the following background:
i) The marking of boundaries and measurements.
ii) Existing improvements.
iii) Identification of the area affected by the expropriation.
iv) Antecedents of owner, possessor or person living on the property.

Article 4: the Official Valuation Department from the Ministry of Public Works and Communications will give value to each real estate affected by the expropriation, including improvements, giving compulsory intervention to the owner who will be notified according to the procedure established in the Civil Processal Code for the claim notification. In case the concerned part does not take intervention at the Official Valuation Department within 30 (thirty) running days of the notification, said office will determine the valuation of the property.

Article 5: After the above-mentioned procedure, the Ministry of Public Works and Communications will determine the valuation of each property to be expropriated that will include the value of anything built and planted. The Ministerial Resolution must contain the valuation made, expenses, due payment date, and the designs and boundaries on the official plan.

Article 6: The ministerial resolution referred to in the last article will be notified to the owner at his address or will be sent by telegram. He can either agree or disagree within fifteen days after being notified.

Article 7: After an agreement there will be subscription of the written contract according to what has been determined with respect to the fifth article.

Article 8: If the affected person does not go to the Ministry of Public Works and Communications after the established period, the administrative procedure will end and judicial step will be taken.

6-8 Economic Activities

6-8-1 Objective of the Investigation

The objective of the investigation concerning Economic Activities is to identify existing economic activities in order to evaluate the impact of the project road on changes in the local economy.

6-8-2 Methodology

Basically, statistical data on the local economy was collected mainly focusing on the agricultural sectors. However, because such data was not available in local level, interviews with residents were conducted to obtain details and get an idea of what the inhabitants desired. The targets of this interview process were selected as follows:

- Intendants (mayor of the town)
- Technicians from the Dirección de Extensión Agrícola y Ganadera (Agricultural Extension Office)
- Directors of schools and health centers
- Inhabitants of urban and rural communities

6-8-3 Economic Activities by District

The following is a summary of the local economy identified by available data and hearing results by District:

(1) Paraguarí

- The principal economic activity of the district of Paraguarí centers around primary sector activities. Accordingly, it has been verified through census data, that sugar cane, cotton, and horti-fruiticulture cultivation-tillage are the most important agricultural items.
- Within the companies (town-villages) located in the road's area of influence the production of intensive horti-fruiticulture crops represent 29% of the total production of the district, followed by sugar cane 21% and cotton 2%.
- The horti-fruiticulture items are tomato, pepper, melon, watermelon, onion, kidney-bean, peanut, green bean, and strawberry.
- Furthermore, broom-type sorghum and alfalfa for animal consumption, flower cultivation (chrysanthemums, gladioluses, roses) were also identified.
- The items used for consumption are manioc and beans.
- Cattle-animal production is based on milk production, meat production, fowl breeding, apiculture, pisciculture.

- The activities developed in the secondary sector correspond to micro-companies and industries especially of crafts, footwear, caña blanca (sugar cane alcohol), leather, ceramics, broom manufacturing, candy, brick-tile manufacturing and plastic factories.
- Within the tertiary sector several activities have been identified in commerce and masonry, both in the public and private sector.
- Technical assistance services received by the producers of this district are supervised by the Dirección de Extensión Agraria (Agriculture Extension Office). These services are provided in the form of technical assistance for agricultural production, cattle production, assistance for the improvement of rural housings, assistance, and education in area related to health, nutrition, and food preparation.
- There are also activities that are being conducted jointly by the Ministerio de Agricultura y Ganadería (Ministry of Agriculture) and the G.T.Z., aimed at recovery and conservation of soils for agricultural use, which due to intensive use have become degraded. This recovery is being accomplished with the incorporation of green fertilizer-manure in production plots.
- The organization of producers is other important aspect of economic activities. There are 40 producers' committees and 21 homemakers clubs in this district.
- Income items are marketed through several process:
  - Open Markets: where producers show and market their products through different committees or individually at a local level.
  - Local Municipal Market: where products are offered at permanent sales posts.
  - Marketing Center for producers associated to the Mercado de Abasto (Asunción's Municipal Supply Market): where sales are performed at the wholesaler and retailer levels.

(2) Escobar

- Agriculture is the main economic activity of the district. Census data indicates that sugar cane production in the road's influence areas represents 12% of the district total, intensive horti-fruitculture 6%, and cotton 4%.
- Other agricultural items that generate income for producers have also been identified. These include alfalfa, broom sorghum, and green bean cultivation. Traditional crops like corn, kidney-bean, and manioc are used as consumption items.
- In relation to activities in the cattle sector, smaller animal breeding on a small scale is another activity that generates income for producers. Within these activities we have bovine cattle breeding, so well as smaller animals such as fowl and bees.
- The secondary sector is represented by rural micro-industries such as brick-tile manufacturers, sugar cane hone and starch factories.

- Agricultural products are marketed through two processes:
  - Producing - Consumer: When the producer marketed his produce individually without intermediation.
  - Producing - Committees - Consumer: When producers market their produce through the different committees formed by the Dirección de Extensión Agraria.

(3) Sapucai

- The main economic activities of the district are based on the primary sector ; census data indicates that sugar cane production within the influence areas of the road represents 6% of the district's production, cotton 6%, and intensive horti-fruitculture 3.5%.
- There is a current productive trend based on the diversification of consumption and income items with the adoption of improved practices through technology transfer in a dynamic and participative form, with the objective of obtaining a greater source of income.
- This trend is aimed at replacing the traditional income items that because of different factors, such as price, demand, and a decrease in quality, have caused these crops to be no longer profitable for the small producer, forcing him to seek other forms of income.
- The principal agricultural income-generating items currently introduced correspond to the production of green beans, the production of kidney-beans for seeds and consumption, and the production of alfalfa for animal consumption.
- Cattle-raising has been developed on a smaller scale by small producers with herd of no more than 10 animals.
- Production is marketed through two processes:
  - Producer - Consumer
  - Producer - Intermediary - Consumer: where the agents of the Dirección de Extensión Agraria act as intermediaries in the placement of the products obtained at the property level.

(4) Caballero

- This corresponds to an agricultural zone where the principal agricultural income crops are cotton, sugar cane, and horti-fruitculture items.
- The data obtained through Censo Agropecuario Nacional (National Agricultural Census) indicates that in the road's direct influence area 4% of all the cotton in the district is produced 6% of all the sugar cane, and 4.4% of the cultivation of horti-fruitculture.

- Other crops such as green-beans, are currently being introduced as alternative forms of income generation, in addition to the traditional consumption item cultivation such as manioc, corn, kidney-beans.
- Breeding of smaller animals has been developed on a smaller scale at a small producer's level.
- In the secondary sector, brick-tile manufacturing represents an important item within this district.
- Agricultural products is marketed in the same manner as in the district of Sapucai.

(5) Ybytymí

- Census data indicates that 85% of the area's sugar cane, the principal cultivation item, is cultivated within the road's influence area.
- Other equally important crops are cotton, onion, tomato, and pepper. Among the crops cultivated for consumption are manioc, corn, kidney-beans, and bananas.
- Cattle activity has been developed on a small scale, at the small producer level , with a few producers raising only cows.
- In the lowlands located close to the locality (town-village) of Hector L. Vera, extensive cattle-raising is particularly important, being one of the principal items of the zone. Moreover, the breeding-raising of smaller animals such as pigs, fowl, and cattle for milk is also an important activity in this area.
- Production is marketed by two processes:
  – By individuals: Direct dialing between producer and the consumer.
  – Through committees formed by agents of la Dirección de Extensión Agraria.

(6) La Colmena

- The district of La Colmena is mainly an agricultural zone. Census data reveals that sugar cane production within the road's influence area represents 75% of the total agricultural production of the district.
- Currently, the diversification of other agricultural items, especially of the intensive type, represent one of the principal activities developed at the district level, with advanced cultural practices and good cultivation techniques.
- The following fruits are cultivated: grape, prune, nectarine, mango, orange, tangerine, watermelon, melon, strawberry, blueberry.
- The following vegetables are cultivated: tomato, squash, green pepper, cucumber, turnip, pumpkin, lettuce, carrot, eggplant, cauliflower, onion, etc.

- Extensive items are also cultivated: manioc, corn, kidney-bean, peanut, sweet potato, sugar cane, and cotton.
- In the cattle sector there is cattle-raising for milk and meat; and pisciculture, mainly raising of tilapia and apiculture for real jelly and honey production.
- The largest part of the horticultural and fruitculture production of the zone is marketed in the "Mercado Central de Abasto" (Central Market) through the Japanese Cooperative and the different farmer committees that have been formed, the rest of the production is marketed in Paraguarí, Villarrica, Ciudad del Este, Encarnación, and the local market.
- The neighboring companies of the districts of the Ybucuí, Acahay, Ybytimí and Tebicuary Mí sell their products through the above mentioned organizations and buyers at La Colmena.
- The largest production zone is located between La Colmena and Tebicuary Mí.

(7) District of Tebicuary Mí

- The principal economic activity of the district is sugar cane production, and on a smaller scale, cotton and horti-fruitculture.
- According to data from the Censo Agropecuario Nacional, sugar cane production within the road's influence area accounts for 93% of the production in the district.
- However, there are other agricultural items-products such as green pepper, sweet potato, a wide variety of citrus fruits that were introduced in the zone, and present good expansion possibilities.
- In the lowlands the main activity is cattle-raising.
- Sugar cane production is marketed through Azucarera Paraguay, located near Tebicuary, district of Coronel Martínez.

(8) Martínez

- Agriculture and cattle-raising are the principal economic activities in the zone.
- Sugar cane is the main agricultural production item in the zone, and census data indicates that 94% of the total production of the district is within the road's influence area..
- Currently, this crop has experienced decreased productivity, causing a drop in income that does not cover production costs in many cases. Furthermore, the state of the roads is a limiting factor in the marketing process, as the time required by transport often adversely affects the quality of materials.
- The technology currently used is small, generating small yields.
- Other horti-fruitculture items produced on a smaller scale supply the local market.

(9) Cardozo

- Sugar cane is the main crop in the zone, and 83% of this cultivation is produced in the road's influence area.
- Besides this crop, other items are mainly cultivated for consumption, such as manioc, beans, and corn-maize.
- Sugar cane is marketed through Azucarera Paraguaya located in the locality of Tebicuary, district of Coronel Martínez, and through Azucarera Friedman located in the district of Villarrica.

(10) Villarrica

- The main source of income for producers in this district is sugar cane, and 80% of all agricultural production in the district is within the road's direct influence area. This crop has recently experimented a high productivity decrease, mainly due to the obsolete techniques used for the cultivation.
- Other activities such as home industries or dairy farms have been developed on a small scale by the rural companies.
- Horticultural production has been developed on a small scale at the companies Carovení and Nuevo y Viejo, where the Centro de Investigación Agrícola de Guairá is located.
- Citrus fruit and flower production is conducted with good results by companies (boroughs) close to the urban zone.
- The secondary sector includes family-level micro-industries, located between Carovení, Nuevo y Viejo (seven), and between the companies of Espinillo, Potrero Isla, and Costa Espinillo (four).
- Agricultural production is marketed through Azucarera Friedman and Tebicuary (AZPA), and horti-fruitculture production is marketed in Villarrica.

6-9 Traffic and Community facilities

6-9-1 Objective of the Investigation

The objective of the investigation concerning Traffic and Community Facilities is to identify the locations of these facilities to evaluate the impact of the project road on them resulting from changes in traffic flow and/or increase in traffic volume around schools and hospitals, which required a quiet and safe environment.

6-9-2 Methodology

Basically, statistical data on local facilities was collected, and major works focused on filed investigations aimed at these facilities. A map showing the exact locations of public facilities is provided in the appendix of this report. This may cover the 12 towns located along the project road.

6-9-3 Summary of Public Facilities

The total number of facilities in each town is summarized below:

Table 6.9.1 Traffic and Community Facilities by District

Facilities	Paraguarí	Escobar	Sapucal	Caballero	Ybytimí	Tebicuary
Religious	4	1	2	3	2	1
Educational Centers	8	2	3	3	3	3
Health Centers	2	1	2	1	1	1
Transportation	3	1	1	1	-	-
Trade & Industry	2	-	-	-	1	-
Recreation	3	1	2	-	1	4
Public Services	11	5	6	8	8	2
Others	2	-	1	3	1	-

Facilities	Martínez	Cardozo	Villarrica	Tebicuary Mí	Colmena
Religious	3	3	12	1	3
Educational Centers	2	3	9	2	4
Health Centers	1	1	3	1	1
Transportation	2	1	5	-	2
Trade & Industry	-	-	5	1	1
Recreation	-	1	16	-	2
Public Services	2	4	13	4	9
Others	-	1	6	-	2

6-10 Split of Communities

6-10-1 Objective of the Investigation

The objective of the investigation concerning the Split of Communities is to identify the existing conditions of communities and their territorial distribution in order to evaluate the impact of the project road, and determine whether it would break up local communities.

6-10-2 Methodology

Interviews were conducted to obtain information. The target individuals of these interviews were as same as those in the socio-economic investigation survey:

- Intendants(mayor of the town)
- Technichians from the Dirección de Extensión Agricola y Ganadera (Agricultural Extension Office)
- Directors of schools and health centers
- Inhabitants of urban and rural communities

6-10-3 Results of Rural Population Survey

72.2% of all rural households reside on their farm. Only 27.8% of all rural households live off their farms. In the latter case, the average spatial separation is 2,000 meters. These distances however vary from 200 meters to 10,000 meters. In these cases, the means of transportation from the households to the farm is bus (5.6%), pickup truck (4.2%), and car (4.2%). These families would be using the road representing a total of 14.0%. On the other hand, others would continue using horses, bicycles, horses and wagons. The share of the automobile traffic is estimated as 14.0% of the total.

6-10-4 Results of the Interviews with the Mayors

Below are presented the results of interviews with the mayors of each of the district towns concerning the impact of the project road, and considering the possibility of breakup of communities.

(1) Paraguarí

- Intendants believe that the community will be happy with the pavement of the road as it is expected to bring great advantages in the future, that is, better prices for agricultural products due to a decrease of the freight costs, greater movement of students to secondary schools and universities in nearby communities, and greater commercial

movement due to the future installation of the Regional Market of Paraguarí - Project of the Governance.

- Intendants indicated that the best alternative is Alternative-B because it corresponds to the route currently used by heavy vehicles. This route begins at route 1 near the curve, crosses the railway line, and ends at a crossing leading to Escobar.
- Alternative-A consists of 3 sections. The first section corresponds to the 2nd street to the left at the entrance to Paraguarí, off the route Paraguarí - Piribebuy. The second section passes in front of the army barracks and bends to the right as near a school. The third section ends at a crossing leading to Escobar.
- According to opinion of the Intendents Alternative-B is the best choice because the army would close the third section during field exercises.

(2) Escobsar

- Intendants said that the community would be very happy with the pavement of the route. Many benefits would be expected, especially the following: increase in the horticultural production due to transportation year round and a decrease in freight costs, greater cultural development because young people will be able to go study in Paraguarí, a decrease in the migration of young people due to the creation of chances study and work in Paraguarí or Asunción without living in Escobar.
- Regarding access alternatives to the current road, crossing the city will have a negative impact according to all the institutions: health center, police department, municipality, and school.
- The alternative route passing to the left of the city would not present any social problem.

(3) Sapucai

- The population is very happy about having a permanent route, as this would likely increase dairy cattle and agricultural production. This would also help the growth of small industries.
- Regarding the various alternatives, the Intendants said that there would be no problem, even if people living on municipal lands in the neighborhood Tierra Negra would have to be relocated.

(4) Caballero

- Intendents indicated that the population has high hopes, for the new road, as it would against agricultural production by allowing producers to get to the city sooner and offer

consumers lower prices. Moreover, the town's social life would be improved by greater contact with more developed centers.

- The alternative passing through the high part of the front village to the Health Center involves no access problems for the population to the Center.
- There is no problem with the alternative that passes near to the lands of Mr. Frutos.
- There is a general preference on the part of the population for the third alternative that uses the current route that arrives at Ybytimí and continues along the railway line until the junction of the route Bernadino Caballero - Sapucai.

(5) Ybytymí, H.Vera

- Intendants and the inhabitants believe that the permanent route will be the principal instrument of development in the zone.
- All the interviewees - the Intendants, technicians and inhabitants rejected alternative because it would follow the railway line and not benefit anyone. Also, they indicated that the alternative calling for paving the current road would be in the best interest of the community. In this case, the branch to La Colmena would pass through Tebicuary Mí.

(6) Tebicuary Mí

- Intendants indicated that the population has great expectations that improvement of the section would promote development in the zone.
- Vegetable and fruit production would be increased by the elimination of transport problems.
- There is no problem regarding the alternative proposed.

(7) Martínez, Tebicuary

- The alternatives proposed for Tebicuary and Coronel Martínez present no problems.
- Regarding the Coronel Martínez -Tebicuary section, there is a preference for the alternative that passes along the southern part of the village.

(8) Cardozo

- The alternative South does not have the approval of Intendants or the inhabitants interviewed.
- The alternative North, that runs parallel to the railway line, is preferred by most of the small cattle and agricultural producers.

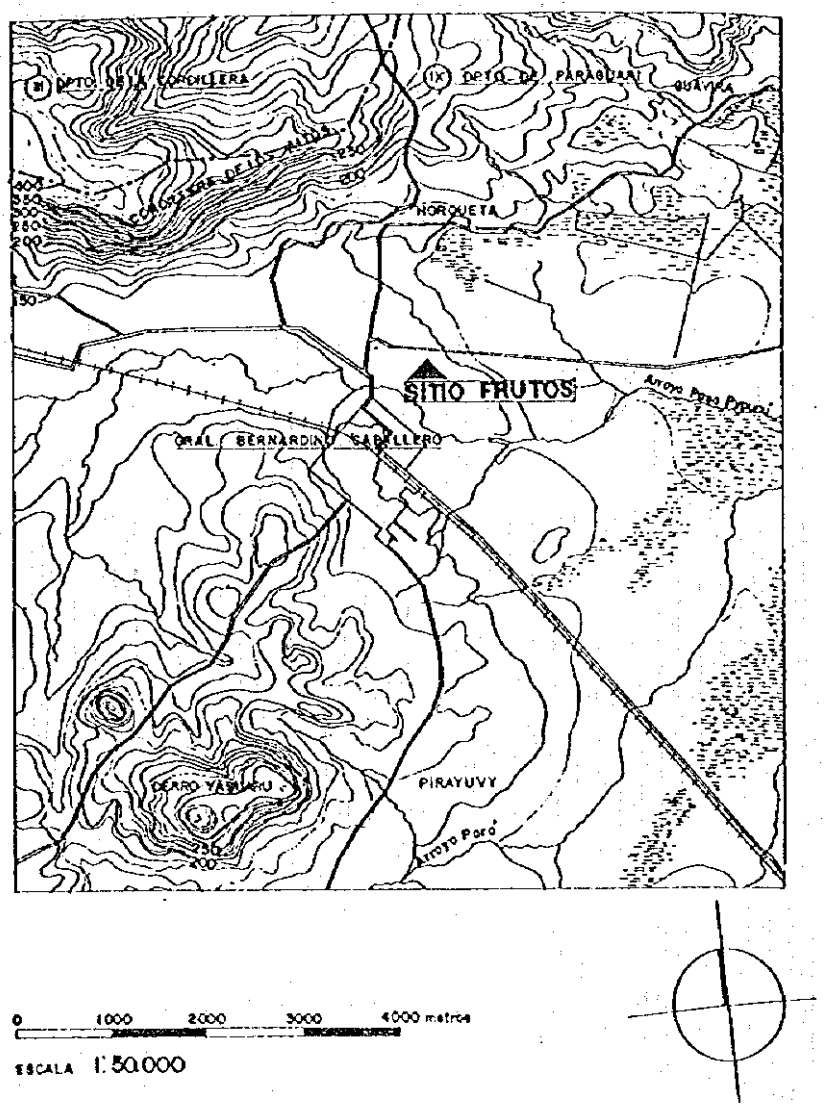
- It has been suggested that this alternative - North - follows the railway line until the junction with the alternative that runs along the southern part of the city.

(9) La Colmena

- Intendants and the inhabitants interviewed all agree that the pavement of the route will increase production in the city, and positively influence services as well.
- Regarding the alternatives linking with the route Paraguarí - Villarrica, the majority opinion was: La Colmena - Potrero Garay - H.L.VERA. This alternative would benefit the service in the city. However, the alternative: La Colmena - Tebicuary Mí - Tebicuary was also considered a good option.

6-11 Cultural Properties

According to a research report entitled "El Hombre Prehistorico del Py-Pucu, 1989" there is an archeological site called "Sito Futuros" near Caballero close to the Project road. Archeological digs have found human bones that are 3,600 years old, representing the prehistoric age of Paraguay. This is the valuable archeological site in Paraguay. No similar sites have been reported in the surrounding area.



Source : El Hombre Prehistorico del Py-Pucu, 1989

Figure 6.11.1 Archeological Sites in Caballero

6-12 Waste Disposal

In order to clarify the waste disposal capacity of municipalities along the project road, interviews were conducted. The results of this survey were as follows:

Only, Paraguarí, La Colmena, Cardozo and Villarrica have garbage collection systems. However, these systems handle only the urban areas. Collected waste is dumped in the lowland and burned.

6-13 Risk of Hazards (Flood)

The main hazard affecting the Project is flooding. Therefore, the possible effects river overflow on the road or changes in waterflow caused by the construction of road embankments are items to be evaluated.

Water level data of the River Tebicuary Mf at ANNP station was recorded monthly from 1972 to 1994. The highest water level of each year is shown in Table 6.13.1. Serious flooding was recorded in 1983 and 1994. The maximum water level was 106.4 m for both years. It is likely that this level will be reached once every 50 years, according to the statistical formulation.

To verify the following item for forecasting the risk of hazard in the future, it is necessary to estimate the expected waterflow in the case of severe flooding over the maximum water level recorded to date after road embankment are constructed.

Table 6.13.1 Yearly Maximum Water Level in the River Tebicuary Mf

Year	Level	Month	Year	Level	Month	Year	Level	Month
1974	103.9m	Nov.	1980	104.0m	May	1986	103.5m	Apr.
1975	103.5	Dec.	1981	103.0	Jan.	1987	103.7	Feb.
1976	103.2	Nov	1982	104.5	Nov.	1991	104.0	Dec.
1977	103.4	Jan.	1983	106.4	May	1992	104.0	June
1978	103.4	Oct.	1984	103.3	Nov.	1993	103.5	May
1979	104.2	May	1985	103.9	Dec.	1994	106.4	Nov.

Source : Survey Data of ANNP Station at Tebicuary Mf River.

6-14 Air Quality and Noise

Time series data concerning these items is not available in Paraguay. Environmental items related to the Living Environment are managed by SENASA under the Ministry of Health. This organization is given administrative powers to establish environmental standards for air quality and noise. However, no standards have yet been established. Only a water quality standard has been set.

According to SENASA officials national standards for air quality and noise will soon be established.

In Asunción, air pollution and noise problems have arisen due to the increased traffic volume. Therefore, the municipality of Asunción has passed a law limiting traffic noise to 45 dB at night in residential areas.

Given this background, it is recommended that international standards be the basis for evaluating the environmental impact of the project.

CHAPTER 7

FORECASTS OF ENVIRONMENTAL IMPACTS

CHAPTER 7 FORECASTS OF ENVIRONMENTAL IMPACTS

7-1 Objectives and Methodology

7-1-1 Objectives

The objective of the Forecasts of Environmental Impacts is to identify the magnitude of environmental impacts caused by each environmental factor of road construction and operation, based on information obtained through the environmental investigation described in the former chapter. The forecasts here will provide the basis of all the evaluations in the following chapter.

7-1-2 Forecast Items

Forecasts were carried out for the following environmental items, which were selected in the IEE (Initial Environmental Evaluation) as the items on which the project will have some environmental impact.

1) Natural Environmental Items
   a. Topography
   b. Geology and Soil
   c. Water (hydrology in rivers and lowlands)
   d. Vegetation (roadside forests and national park)
   e. Landscape

2) Social Environmental Items
   f. Resettlement
   g. Economic activities
   h. Community and traffic facilities
   i. Spliting of communities
   j. Cultural properties
   k. Waste
   l. Risk of hazards (floods and fires)

3) Living Environment Items
   m. Air quality
   n. Noise

7-1-3 Period of Forecasts

The target period of the forecasts was set as follows:

- Construction Period Three years (1999 -2000)
- Operation Period
  - Intermediate target year 2005
  - Final target year 2015

7-1-4 Forecast Method

Generally, the following forecast method was applied:

i) Matrix check between the environmental factors and items one by one

ii) Quantitative forecasts based on the project plan

iii) Qualitative forecasts based on typical experiences with other similar road projects

iv) Quantitative forecasts based on simulations using scientific formulas for items such as air quality and noise level

7-2 Topography and Geology

7-2-1 Impact Caused by the Cleaving of Woods

There are several forest zones along the project road, mainly gallery forests along the rivers. According to the project plan, woods within the right-of-way area (30-40m wide) will generally be cleaved and stripped in the course of the road development work for various reasons, including side-borrow pitting.

Since almost all of the forests are located on flat land, the local topography or geology will not be changed very much by the cleaving of woods, if cleaving is limited to the right-of-way area .

7-2-2 Impact Caused by Earth Works

(1) Displacement of Embankments

Soft ground stretches along both sides of the Rfo Tebicuary-mf. Since the embankment height there will be as much as three to five meters, the ground level may be displaced by the load of embankments. The calculation of the displacement height was simulated as follows:

- Sub-soil conditions

  Boring logs of BST 6 and BST 7

  - Soil : sandy soil
  - Thickness of soft soil layer : 7 m (N<10)
  - Water content of soft ground : 30.3% (on average)

- Relation between "Water Content (Wn)" and "Coefficient of Volume Compression(Mv)"

  - when Wn=30.3% , Mv=0.025cm²/kgf

- Calculation Formula

  - Increment of stress $\Delta p = h \times \gamma$

    where,

    h = average height of embankment (3.1-5.3 meters)

    γ = unit weight of embankment materials (1.9t/m³)

  - Displacement $S = Mv \times p \times H$

    where H = thickness of soft soil layer (7.0 meters)

- Calculation

  - $\Delta p = h \times \gamma = 3.1 \times 1.9 = 0.6 kgf/cm^3$

    $5.3 \times 1.9 = 1.0 kgf/cm^3$

  - $S = Mv \times p \times H = 0.025 \times 0.6 \times 700 = 10.5$ cm

    $= 0.025 \times 1.0 \times 700 = 17.5$ cm

As a result of the calculation, the displacement to be caused by embankments was estimated to be 10.5 cm to 17.5 cm. The earth works have already taken this matter into account, and extra embankments have been planned. As a result, embankments will not be displaced after they are completed.

(2) Stability of Cutting Slope

According to the road plan, the total volume of earth cutting is 122,000m³, one twelfth of the embankment volume. Earth cutting will therefore be applied only to very limited areas. The maximum height of earth cutting will be less than 5m, which will be stable in one slope with a gradient of 1:1 (45°) for rock and 1:2 (26°) for soil. Therefore, no remarkable topographical changes will occur.

(3) Side-Borrow Cutting

According to the plan, the materials for road embankments in the project area will consist of earth obtained from both sides of the road using the side-borrow method. The total volume of side borrowing will be 682,000 m³, and the average volume per meter will be 5.6 m³/m. Therefore, this is estimated as representing a 30 - 60 cm depth on either side of the road within the right-of-way area (30-40m wide.), and changes in local topography or geology will be very limited.

7-2-3 Impact Caused by Quarry Sites

(1) Quarry Sites for Rocky Materials

According to the project plan, the earth to be used for the pavement bed will be transported from the two quarry sites. The total volume of excavation will be 523,000 m³, in which 397,800 m³ will be from Cerro Santo Tomas for road sections 1 and 3 and 125,200 m³ will be from Cerro Itapé for road section 2.

The average depth of the excavation each quarry site is forecast as 0.7 meter in Cerro Santo Tomás and 0.5 meter in Cerro Itapé, as shown in Table 7.2.1. Therefore, only small changes will occur in the existing topography.

Table 7.2.1 Topographical Changes at Quarry Sites

Site	Volume (m³)	Area (ha)	Depth (m)
Cerro Santo Tomás	397,800	54	0.74
Cerro Itapé	125,200	27	0.46

(2) Quarry Sites for Soil Materials (Outside Borrow Cutting)

According to the project plan, materials for road embankments will be obtained not only by the side-borrow method but also by the outside-borrow method as well. The total volume from outside the right-of-way area of the road will be reached at 830,000m³. The average volume to be obtained from one quarry site is estimated to be about 20,000m³, and the maximum depth of the excavation shall be less than two meters. Most of those quarry sites for outside borrow are on hilly land with heights of 2-3 meters. Therefore, topographic changes will be marginal.

7-3 Soil

7-3-1 Impact Caused by the Cleaving of Woods

If the cleaving of woods is restricted to road-side areas, large-scale soil erosion will not result because most of the forests are located in areas with a flat topography.

7-3-2 Impact Caused by Construction Camps

According to the project plan, construction camps for laborers and equipment are planned for three locations. The land planned to be used for camp sites is all not agricultural land as it does not have good top soil. Therefore, the soil erosion effect caused by the construction camps will be negligible.

7-3-3 Impact Caused by Earth Works - Erosion of the Embankment

The embankments of road will be eroded if small gullies develop in the slopes due to the run off produced by rainfalls. These are usually seen along the existing road.

The materials to be utilized for the road body and the roadbed specified in the road project are the same as those used in the construction of the present road embankment. Accordingly, the newly raised embankments can also be expected to erode as a result of rainfall during the construction period.

However, the embankment slopes shall be protected by weeds using surface soil that has been piled up during the surface clearing and cleaning stages. This will present soil erosion , which will represent another positive impact of the new road construction.

7-3-4 Impact Caused by Quarry Sites

At the gravel quarry sites of, there is no top soil, therefore erosion will not occur. In the outside borrow pits of the road embankment bodies, the possibility of erosion is liminished because the land is generally flat and the excavation height is less than two meters. Moreover, the slopes shall be revegetated after excavation according to the general specifications for environmental protection in the construction works regulated by MOPC.

7-4 Hydrology

7-4-1 Impact Caused by Drainage Facilities

According to the project design, numerous box culverts, corrugated pipes and bridges will be installed in order to drain stagnant water on the upstream side of the project road. The drainage capacity of such facilities was calculated by using the proper formulas given the catchment area of each river and branch water stream. The capacity of the opening was designed based on the storm frequency return period as shown in Table below.

Table 7.4.1 Design Storm Frequency Period

Facilities	Frequency
Bridges	1/50 years
Box culverts	1/25
Pipe Culverts	1/10
Embankments	1/25

Therefore, the drainage facilities will not cause any hydrological changes in the project area. Moreover, the project will have a positive impact on the hydrological situation in the project area, since there are many inundated areas along the existing road because of the poor drainage facilities or a total lack of them. The project will greatly improve this situation.

At the same time, it will be necessary to consider the vertical drainage conditions in relation with the depth of the side borrow pits in detailed design stage, as some stagnant water could accumulate in the side borrow pits unless a vertical drainage system is installed.

7-4-2 Impact Caused by Bridge Construction

The planned bridge structure according to the project plan, is shown in Figure 7.4.1. Regarding to the Tebicuary-mf Bridge, there are no piers in the river. Therefore, no influence on water flow is forecast. On the other hand, regarding the Bailey Bridge, a center pier is planned in the river, and this pier structure will certainly affect the water stream. Therefore, some measures to present an adverse hydrological influence are necessary.

7-4-3 Impact Caused by Road Facilities (Existence of Embankments)

The periodic inundation of the eastern part of the project area is a natural phenomenon. However, the planned road embankments will have a relatively large influence on the flood area. Such influence includes the raising of water levels on the upstream side of the

embankments due to the low capacity of the drainage system, even though numerous corrugated pipes will be constructed to provide adequate drainage.

The embankments of the planned road will raise the road surface level in the flood area to 50 cm above the flood level. The opening capacity of drainage facilities crossing the planned road was calculated using the proper formula; therefore, no substantial hydrological changes in the river flow shall occur due to the project earth works.

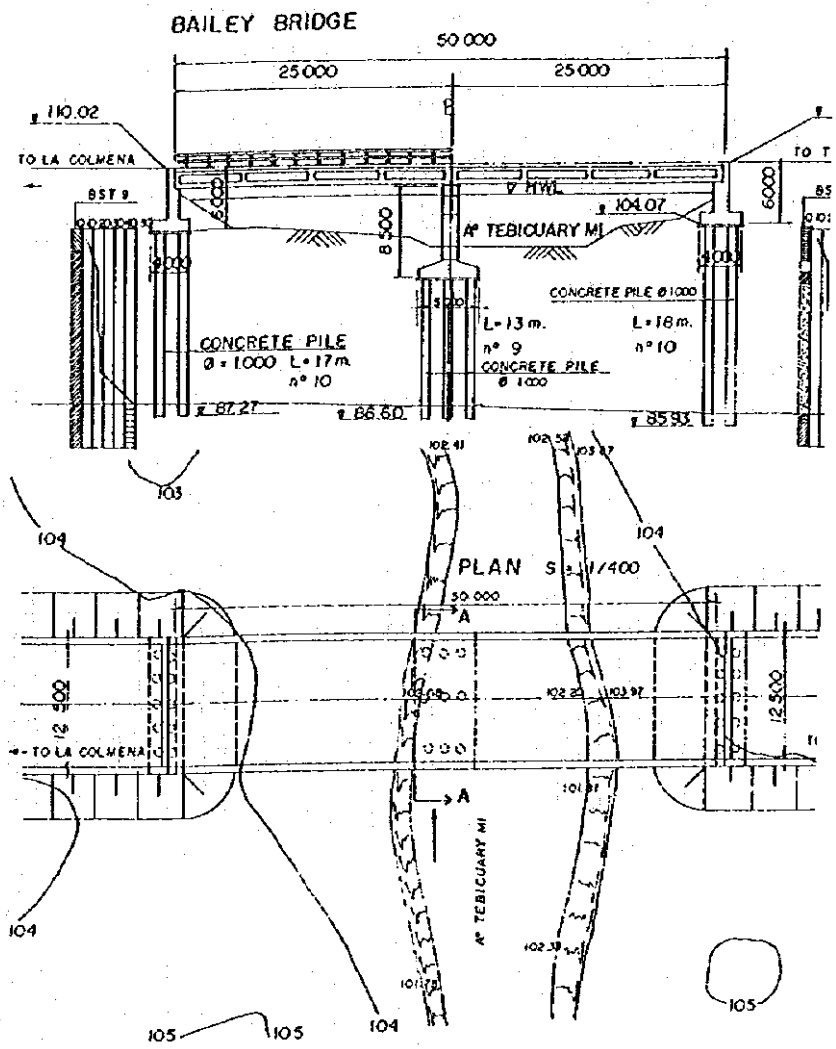


Figure 7.4.1 Planned Bridge Structures

7-5 Flora and Fauna

7-5-1 Impact Caused by the Cleaving of Woods

The existing forest zones along the planned road consist of gallery forests along rivers, which will generally be cleaved within the right-of-way area (30-40 m wide) in the course of the road development work. The cleaving area of forests is estimated at around 25 ha. The total area of destroyed forest will be limited in comparison with the total length of the planned road, 121 km, since a great deal of the project area has already been deforested. However, the influence of such cleaving will extend a certain distance into the remaining forests. The end result will be a decrease in plant life and vegetation formation in the cleaved area.

The most influenced forest in the project area will be the one around the Tebicuary-mf Bridge. A dense gallery forest with a width of around 600m is located there. The cleaving width in this area is planned to be more than 70m, lather than the usual width of 40m, because of the higher embankment depth in this area. Therefore, it will be necessary to take some mitigatory measures to preserve vegetation in the area.

7-5-2 Impact by Increase of Traffic Flow

The increase of traffic flow after the completion of the road construction will have indirect impacts on the Ybycui National Park located in a southern area of La Colmena. These impacts include an increase in the numbber of park visitors, an increase in the opportunity for illegal deforestation, and an increase of fire risk. Some countermeasures to mitigate these impacts.

7-6 Landscape

7-6-1 Impact Caused by the Cleaving of Woods

If the forests along the road project are cleaved with a width of 30-40 m, as called for by the design, the landscape will not change remarkably.

7-6-2 Impact Caused by Earth Works

(1) Cutting and Embankments

Since most of the planned road is located on the existing road area, no remarkable changes in the existing landscape will occur. Even in the newly developed road area, the maximum height of the cutting earth will be less than three meters, and the height of the embankments will generally be less than two meters. Therefore, the landscape will change very little.

(2) Side-borrow Pits

Because of side-borrow pitting, artificial ponds will be formed in several places along the project road. However, those ponds once formed, will be harmonized with the surrounding landscape.

(3) Quarry Sites

The two quarry sites for gravel materials will be located far from the existing roadside, and will not be visible. Therefore, landscape changes will not be visible from various observation points in the living area where most of the people live.

7-6-3 Impact Caused by Construction Camps and Plants

Construction plant facilities for asphalt and concrete, and workers' camps may impact on the surrounding landscape depending on their size and color. This project plans to locate such facilities far from town areas, and the waste expected to be generated by road improvement is quite limited. Therefore, no serious changes in the landscape are expected.

7-6-4 Impact Caused by Road Facilities

(1) Bridges

The landscape will be changed by the construction of large bridges, and the magnitude of this change will depend on the color of the bridge piers and girders. However, the planned bridge will be covered by gallery forests along the rivers which means that most of the bridge structures will not be visible from the surrounding area.

(2) Road Embankments

Although the road embankments in low-lying areas will change the flat plain landscape, the average height of the embankments shall be 2-3 meters and the embankment slopes shall be covered with greenery. The landscape will therefore not be greatly changed. Moreover, the landscape along the existing road shall be improved much by the road embankments, which shall be uniformly covered with green vegetation.

(3) Culverts

The culverts will cause no serious changes in the landscape, since they will be under the road, and will usually not be visible.

7-7 Resettlement

7-7-1 Impact Caused by Land Acquisition

(1) Land to Be Acquired

According to the project plan, the total area of the planned road is estimated as 427.3 ha, of which 225.9 ha or 53% of the total shall be acquired for the project. The land use conditions of this land is as shown in Table 7.7.1 below.

Table 7.7.1 Land Use of the Land to Be Acquired

Item	Unit	Total	Share
Planned Road Area	ha	427.30	100.0%
(Planned Distance)	km	121.10	
(Average R.O.W.)	m	35.28	
Existing Road Area	ha	200.80	47.0%
Public Land	ha	0.60	0.1%
Land to be Acquired	ha	225.90	52.9%
(Land Use)			(100.0%)
- Town Area	ha	7.39	(3.3%)
- Agricultural Land	ha	54.29	(24.0%)
- Pasturage	ha	140.43	(62.2%)
- Forest	ha	23.79	(10.5%)

(2) Agricultural Land

The total area of Agricultural land to be acquired for the planned road is estimated as 54.3 ha or 24% of the total. Most cases of land acquisition of agricultural land will be cuts of 5-10 m strips along the road, and will not include any fruit gardens. Therefore, owners of agricultural land will not be seriously affected economically.

(3) Buildings to Be Relocated

According to the project plan, the right of way of the planned road will be 40m in general in the road from Paraguarf to Villarrica, and 30m in the branch road to La Colmena. Regarding the road sections passing through town areas, where it is difficult to secure a sufficient right of way because the built-up area continues along the road, the right of way will be only 20m in order to minimize the social impacts caused by building relocation. Therefore, the number of buildings to be relocated or removed from their existing sites is limited, that is, about 50.

Since the number of households to be relocated is very small compared with the total length of the planned road, the owners of these houses will easily be able to find new housing lots within the same communities after receiving the compensation for their land and houses. Therefore, the negative impacts on the social environment will be minimized.

(4) Compensation for Land and Buildings

According to the regulations in Paraguay for land acquisition and compensation for public works, compensation shall be determined by MOPC and will likely be based on actual market prices in the surrounding area. Therefore, owners of the land and buildings will be reasonably compensated for their properties.

Table 7.7.2 Location of buildings to be Relocated

Road Section from/to		Number of buildings to be relocated
Paraguarí	Escobar	11
Escobar	Sapucaí	2
Sapucaí	Caballero	3
Caballero	Ybytimí	1
Ybytimí	Tebicuary	0
Tebicuary	Cnel Martínez	1
Cnel Martínez	F.P.Cardozo	8
F.P.Cardozo	Villarriaca	14
Tebicuary	Tebicuari-mí	6
Tebicuari-mí	La Colmena	1
Total		47

7-8 Economic Activities

7-8-1 Impact Caused by Land Acquisition

(1) Loss of Agricultural Land

The agricultural land to be used for the planned road is 54.3 ha, and its share is only 2.5% of the total agricultural land in the project area (10 districts). Therefore, it is considered that the impact on local economic activities will be very limited.

(2) Cash Inflow

Because of cash inflow caused by land acquisition and building compensation, inflation in the local economy is a possibility. However, such cash will be used to purchase new lands and houses for the relocation, and this will have a positive effect on the local economy through the promotion of construction and the service sectors. Therefore, the impact of the land acquisition on economic activities will be a positive one.

7-8-2 Impact Caused by Construction Works

The investment of construction works will have a positive effect on local economies in general. The major effects will be 1) an increase in commercial sales to construction workers, 2) an increase in employment opportunities in the construction works, and 3) an increase in cash income. In the project, the construction labor force will be hired from local communities. Therefore, the impacts of commercial sales to workers will not be great, although employment opportunities will be maximized.

7-8-3 Impact Caused by the Increase in Traffic Flow

From the viewpoint of the development of the local economy, the traffic flow volume will be one of the main factors. According to the traffic demand forecast for the project, future traffic flow is estimated as shown in Table 7.8.1.

According to the above table, it is forecast that the traffic volume will increase from 61 to 112 times (10 - 18 times in the main sections) on average. Therefore, various commercial activities related to traffic and passenger services will increase along the road.

Table 7.8.1 Increase in Future Traffic Volume

Route/Section		Traffic Volume (vehicles/day)			Increase Ratio (times)	
from/to	from/to	1996	2005	2015	1996-2005	1996-2015
Paraguarí	Escobar	412	2,372	3,562	5.76	8.65
Escobar	Sapucaí	248	2,156	3,436	8.69	13.85
Sapucaí	Caballero	94	1,904	3,230	20.26	34.36
Caballero	Ybytimí	4	1,685	3,010	421.25	752.50
Ybytimí	Tebicuary	9	1,482	2,849	164.67	316.56
Tebicuary	Cnel Martínez	80	1,716	2,726	21.45	34.08
Cnel Martínez	F.P.Cardozo	144	1,367	2,614	9.49	18.15
F.P.Cardozo	Caroveni	291	1,389	2,612	4.77	8.98
Caroveni	Villarriaca	753	1,699	2,785	2.26	3.70
Tebicuary	Tebicuari-mí	60	262	941	4.37	15.68
Tebicuari-mí	La Colmena	23	244	527	10.61	22.91
Average Increase Ratio for all sections					61.23	111.77
Average Increase Ratio except the Caballero-Tebicuary sections					9.74	17.82

7-8-4 Impact Caused by the Improvement in Transportation

(1) Shortening of Travel Time

It is very difficult for vehicles to travel easily along the existing road due to poor road conditions and inundation of whole road sections during the rainy season. Therefore, those using this road have always suffered serious inconvenience. Certainly, if these roads were improved and turned into all-weather roads, such inconvenience would disappear completely.

Road development would lead to significant reductions in travel time and distances. In Table 7.8.2, the impact of time saving is calculated for travel from San Lorenzo to the major towns (Caballero, Tebicuary, and Villarrica).

Table 7.8.2 Time and Distance Saving Effects

Town	Route (via)	Without Project		With Project		Savings	
		Time (min.)	Distances (km)	Time (min.)	Distances (km)	Time (min.)	Distances (km)
Caballero	Paraguarí	120	84	60	84	60	0
Tebicuary	San José	150	118	70	109	80	-9
Villarrica	Coronel Oviedo	120	161	80	134	40	-27

From	To	Without Project		With Project		Savings	
		Time (min.)	Distances (km)	Time (min.)	Distances (km)	Time (min.)	Distances (km)
Caballero	Tebicuary	100	34	30	25	70	-9
Tebicuary	Villarrica	75	25	21	25	54	0

(2) Transportation Cost Saving

The significant reductions in travel time and travel distances will also reduce transportation costs for agricultural products, etc. This will result in a tremendous positive impact on communities.

(3) Diversification of Agricultural Production

The major cash crop in the project area is sugar cane, which is harvested and transported to sugar factories in the dry season. However, in other seasons, no major cash crops other than Cassava (Manjoca) can be produced, as shown in Table 7.8.3, and one of the reasons for this is the a lack of road services. An all-weather road will change this situation, making it possible to transport agricultural products to Asunción, the major market, year-round.

Therefore, transportation improvement resulting from the planned road will have a direct positive impact on agricultural production in local communities by increasing the possibility of diversifying the area's cash crops.

Table 7.8.3 Typical Share of Agricultural Products in the Project Area

(Unit : ton)

Products	La Colmena	%	Sapucai	%	Caballero	%	Cardozo	%
Sugar Cane	17,021	75	2,668	22	2,290	14	25,469	83
Cassava	3,435	15	5,927	49	9,266	58	4,598	15
(Sub total)		90		71		73		98
Cotton	660	3	760	6	1,068	7	82	0
Corn	428	2	681	6	212	1	200	0
Peanuts	35	0	42	0	44	0	5	0
Watermelon	676	3	878	7	735	5	112	0
Tomato	172	0	29	0	23	0	-	0
Green Pepper	14	0	12	0	17	0	-	0
Carrot	2	0	12	0	-	0	-	0
Others	304	1	1,044	9	2,201	14	315	1
Total	22,747	100	12,053	100	15,856	100	30,781	100

Source : Agricultural Census 1995

7-9 Traffic and Community Facilities

7-9-1 Impact Caused by Heavy Machinery and Dump Trucks

During the construction period of the planned road, dump trucks from quarry sites will have a negative impact on traffic safety in the communities along the road. In particular, community facilities such as schools, hospitals, and churches shall be influenced. The traffic volume of such trucks was estimated tentatively according to the project plan as shown in the Table below.

Table 7.9.1 Traffic Volume of Dump Trucks during the Construction Period

Road Section	1	2	3	Total
Total Volume of Materials (m^3)	236,233	125,196	161,545	522,974
Working Period (month)	14	12	13	-
Net Work Period in day (day)	294	252	273	-
Truck Capacity (m^3/truck)	6	6	6	-
No. Trucks per day (trucks/day)	134	82	99	315
Traffic Volume (vehicles/day/road)	268	164	198	630

If was estimated that around 466 (268 + 198) trucks/day would pass sections 1 and 3, from Cerro Santo Tomás near Paraguarí to Caballero and La Colmena. This is more than two times the existing traffic volume of related roads. Therefore, this impact will be relatively serious, and some countermeasures for securing traffic safety near community facilities will have to taken.

7-9-2 Impact Caused by the Increase in Traffic Flow

During the operation period of the planned road, the increase in traffic volume in 2005 and 2015 was estimated, as shown in Table 7.8.1. The future traffic volume shows that the increase is around 10 times the existing amount on all the routes, with tremendous increases in some sections, that is, in Sapucaí - Caballero, for example, from 94 vehicles in 1994 to 3,230 vehicles in 2015.

This kind of rapid increase in traffic will cause a serious increase in traffic accidents, especially involving school children on the way to and from schools unless traffic safety countermeasures are taken.

7-9-3 Impact Caused by the Improvement in Transportation

The improvement of transportation due to the development of the planned road will have many positive impacts not only in terms of economics but also in terms of the social environment of the communities along the road. These are:

i) Increase in attendance at higher educational facilities due to punctual and year-round bus services.

ii) Improvement in the standard of public health services through year-round 24-hour ambulance services.

iii) Improvement in the standard of administrative works through convenient access from center towns to local communities, and efficient allocation of public administrative personnel based on daily commuting.

As a result of these effects, major community facilities in the regional center will be upgraded. At the same time, smaller administrative facilities located in local towns will be integrated into central facilities. Therefore, the road development will have a positive impact on the establish went of an efficient administrative system.

7-10 Splitting of Communities

7-10-1 Impact Caused by Earth Works (Detour Routes)

Since the planned road will use mostly the existing road alignment, some of the connections of existing towns with neighboring towns will be affected in a construction period. However, detour routes shall be prepared in the right of way of the planned road, and after the completion of the embankments, it will be possible to use them as temporary roads until the pavement works start. Therefore, the period without detour routes in the construction stage will be very limited, and the negative impact on the affected communities will be negligible.

7-10-2 Impact Caused by the Increase in Traffic Flow

Roads will generally tend to integrate community activities. However, if the traffic volume on the road increases too much, these roads may cause the splitting of community activities. According to the project plan, most of the routes through the existing towns will be bypassed except for Caballero. Therefore, communities will not generally be divided.

In the town of Caballero, because of the number of inhabitants, the planned road route will pass through the center of the town with a 20-meter right of way along the railway. In Caballero, the railway line already divides the town into two parts, which means that the new road, which will follow the railway line, will not have a negative impact on the community of Caballero.

7-10-3 Impact Caused by Road Facilities

Most of the planned road section will be embanked to avoid inundation during the rainy season. Therefore, access roads to communities will be lower than the planned road design level, which will be very inconvenient for passing through junctions. It is estimated that there are around 75 such junctions, and the gap of levels is less than three meters in general. Therefore, some measures to close these gaps shall be taken to mitigate the negative impact.

7-11 Cultural Properties

Since the planned road is located mostly along the existing road area, it is very unlikely that new archaeological sites will be found. However, during the construction of the project road, some archaeological sites might be destroyed due to a lack of information about their location. In the area surrounding the project road, only the site near Caballero has been identified through private research. There is still a small possibility of finding other archaeological sites near there. In fact, road construction work will create a good opportunity to discover unknown cultural properties, since there was a lack of a sufficient budget to excavate the entire area in prior since there was a public works. Therefore, careful monitoring during the construction period will be essential to avoid damaging cultural properties during this project.

7-12 Waste

7-12-1 Impact Caused by Construction Camps

The labor force for the project will be hired from local communities, which means that the populations of construction camps will not be large. The volume of waste to be disposed of will be, accordingly, very small, and capable of being treated within the capacity of local community facilities.

7-12-2 Impact Caused by Construction Works

The waste expected to be dumped from construction works as a whole will be very limited because of the following factors:

i) The top soil cleared prior to the earth works shall be stocked and re-used for planting on the slopes of the embankments.

ii) The cutting and filling works will involve more filling than cutting. Therefore these will be no excess soil or dirt from the construction sites.

iii) The cleaved wood from the 25ha of forest to be cleared will be transferred to the owner of the forest according to environmental regulations (ETAG) of MOPC.

Thus, the impact of waste from the construction works will be negligible.

7-12-3 Impact Caused by the Increase in Traffic Flow

In line with the future increase in traffic flow, waste generated by car passengers is forecast to increase. However there are no major tourist spots where many passengers may stop along the planned road. therefore the volume of waste from those cars will be negligible and the affected area will be limited to the sides of the planned road. This impact will also be very small.

7-13 Risk of Hazards

7-13-1 Flood Risk Caused by Road Facilities

In the inundation area along the planned road, the existence of road embankments will affect the outflow of flood water in the case of heavy flooding outside the design capabilities of drainage facilities. However, in the surrounding area, there are no communities and the land is at last five meters above sea level higher than the top level of the planned road near communities. Therefore, the risk of flood hazard caused by road embankments is negligible.

7-13-2 Fire Risk Caused by the Increase in Traffic Flow

It is likely that the increase in traffic flow will increase the possibility of fires in the forests along the road. However, in the project area, the forest zone near the road is limited to only short distances of gallery forests. Therefore, it is unlikely that passengers in vehicles could cause fires. However, there is still an indirect impact in that forest fires in National Parks in the surrounding areas may result from an increase in illegal activities there.

7-14 Air Quality

Air quality around the road will be affected mainly by dust rising from the ground and exhaust fumes generated by heavy construction machinery and vehicles traveling along the road. The heavy machines, which use diesel engines with large exhaust volumes, generally exhaust SO_2 and small quantities of NO_2 and CO. However, their effect on the project area will be limited to the construction period, and the volume of exhaust will also be limited if the contractor follows ETAG regulations.

On the other hand, gasoline engines generally exhaust NO_2 and CO, as well as small quantities of SO_2, etc. Therefore, NO_2 and CO from vehicles will have a serious impact on air quality, depending on their volume.

7-14-1 Impact Caused by Earth Works

Earth works conducted on embankments and side-borrow pits will generate dust especially during the dry season.

7-14-2 Impact Caused by Heavy Machinery and Dump Trucks

The generation of pollutants by heavy machinery during the road construction work can be controlled by carefully selecting the machinery used. The total volume exhausted from these machine's are will usually be very low if the contractors follow environmental regulations. Moreover, the project area is flat and the dominant wind flow will rapidly disperse pollutants in the air. Therefore, the concentration of pollutants generated by construction machinery will not be so serious.

7-14-3 Impact Caused by the Increase in Traffic Flow

Gasoline engines generally exhaust small quantities of SO_2. Therefore, only NO_2 and CO values are essential for this forecast.

(1) Forecast Conditions

1) Forecast point

Paraguarí was selected for this forecast because the largest volume of future traffic flow was forecast there, and the right of way for the planned road in this area is narrowest.

2) Wind conditions

The predominant wind directions in Paraguarí are stable, "North" and "South", throughout the year. The average wind speed is 3.5m/sec.

3) Other forecasting conditions

- Speed of vehicles : 80 km/h on average
- Traffic volume :

Table 7.14.1 Future Traffic Volume in the Section Paraguari-Escobar Used to Forecast Air Quality

(Unit : vehicles)

Year	Daily Volume			Hourly Volume (day time)		
	Total	Passenger Cars	Buses and Truck	Total	Passenger Cars	Buses and Truck
1996	412	248	164	24	14	10
2005	2,372	1,206	1,166	139	70	69
2015	3,562	1,692	1,870	208	100	108

Source : JICA Study

Note : "Hourly Volume" was calculated based on the following assumptions

H = T×1/R×1/12

where, H= Hourly Volume (day time), T= Total Volume, R= 24-hour/12-hour Ratio

- Topography : Flat
- Coefficient of emission (g/km per vehicle)

NOx	Light vehicle (passenger cars)	: 0.6
	Heavy vehicle (buses and trucks)	: 1.1
CO	Light vehicle	: 2.1
	Heavy vehicle	: 6.3

- Width of road : 20 m in general
- Forecast point : 0m from the border of the road

(2) Forecasting Method

Generally, the Plume model was used where the average wind speed was more than 1.0 m/sec. This formula is as follows:

- Formula (Plume model for wind duration)

$$C(x,y,z) = \frac{Q_p}{2\pi \cdot \sigma_y \cdot \sigma_z \cdot U} \exp\left(-\frac{y^2}{2\sigma_y}\right) \cdot \left\{ \exp\left[-\frac{(z-He)^2}{2\sigma_z^2}\right] + \exp\left[-\frac{(z+He)^2}{2\sigma_z^2}\right] \right\}$$

where

C = Concentration (ppm)
x = Leeward distance along the wind direction (m)
y = Horizontal distance perpendicular to the X axis (m)
z = Vertical distance perpendicular to the X axis (m)
Q_p = Volume of exhausted gas (Nm^3/s)
σ_y = Parameter for the width of diffusion in the vertical [y] direction (m)
σ_z = Parameter for the width of diffusion in the horizontal [z] direction (m)
U = Wind speed (m/s)
He = Height of stack (m)

(Width of diffusion)

$$\sigma_z = 1.5 + 0.31 \cdot L^{0.83}$$

$$\sigma_y = \frac{W}{2} + 0.46 \cdot L^{0.81}$$

L = Distance from the border of the road to the forecast point (m)

- Conversion formula from annual average to daily average

The Plume model formula gives a concentration level of one hour in annual average. The environmental standard will be shown by the one-hour level in daily average. Therefore, conversion was done using the following formula according to the Japanese statistics.

CO : CD = (Cy - 0.18) / 0.56
NO2 : CD = (Cy - 0.0077) / 0.42

where,
CD = Concentration level in daily average,
Cy = Concentration level in annual average

(3) Forecast Results

Air quality simulation results were predicted as concerning the values of CO and NOx at the three stages of at present (1996), intermediate term of road use (2005), and the target year (2015). The results are shown in Table 7.14.2. The maximum forecast concentration was 2015, 0.005784 ppm for CO and 0.002208 ppm for NOx, respectively.

Table 7.14.2 Forecast Concentration in Paraguari

Item	Point	Yearly average(ppb)		Daily Average(ppb)		Daily Average(ppm)	
		North	South	North	South	North	South
CO	1996	0.338000	0.348000	0.407143	0.425000	0.000407	0.000425
	2005	2.130000	2.188000	3.607143	3.710714	0.003607	0.003711
	2015	3.260000	3.349000	5.625000	5.783929	0.005625	0.005784
NOx	1996	0.099000	0.101000	0.217381	0.222143	0.000217	0.000222
	2005	0.600000	0.617000	1.410238	1.450714	0.001410	0.001451
	2015	0.911000	0.935000	2.150714	2.207857	0.002151	0.002208

Note : 1ppb =1 ppm/1000

7-15 Noise

7-15-1 Impact Caused by the Increase in Traffic Flow

In line with the increase in traffic flow, the noise level will also increase. The noise level in Paraguarí was forecast for the years 2005 and 2015 as follow:

(1) Forecast Conditions

- Height of stack : 0.3 m
- Speed of vehicles : 80 km/h
- Topography : Flat land
- Average power level (Lw) in {dB(A)}:

$$L_w = 86 + 0.2V + 10\log(a^1 + 5a^2)$$

where

V = Average speed (km/h)
a^1, a^2 = Vehicle composition (%)
1: Light vehicles
2: Heavy vehicles

- Width of road : 20 m in general
- Forecasting points : 0m from the border of the road
- Traffic volume :

Table 7.15.1 Future Traffic Volume in Paraguarí Used to Forecast Noise

(Unit : vehicles)

Year	Total	Passenger Cars	Buses and Truck
1996	412	248	164
2005	2,372	1,206	1,166
2015	3,562	1,692	1,870

Source : JICA Study

(2) Forecasting Method

The formula used to forecast noise levels is as follows:

$$L_{50} = L_w - 8 - 20\log \ell + 10\log\left(\pi \cdot \frac{\ell}{d} \cdot \tanh\frac{2\pi\ell}{d}\right) + a_i$$

where

L_{50} = Central value of noise {dB(A)}
L_w = Average power level per vehicle {dB(A)}
ℓ = Distance between the noise source and the measured point (m)
a_i = Revised factor
d = Average interval of vehicle (=1000V/N)
V = Average speed of vehicle (80km/h)
N = Hourly traffic volume

(3) Composite Noise with Background Noise

The composite noise, which is equivalent to the noise at the forecasting point and in the forecast year, was calculated using the following formula:

$$Lf_{50} = 10 \times \log(10^{L_B/10} + 10^{L_{50}/10})$$

where;

Lf_{50} = Noise level (dB(A))at the forecasting point

L_B = Present noise level (dB(A))at the forecasting point

*There is no information about the present noise level, therefore the environmental standard levels of 55dB (day time) and 45dB (Night time) were used for the forecast

L_{50} = forecasting noise level (dB(A))caused only by vehicles

(4) Forecast Results

The noise levels forecast for the years 2005 and 2015 are shown in Table 7.15.2. The maximum forecast noise level is for 2015, 61.3 dB in the daytime and 50.1 dB at night-time, respectively.

Table 7.15.2 Simulation of Noise Levels Caused by Traffic Flow

1) Average power level per vehicle

Year	Velocity (km/h)	a^1 (%)	a^2 (%)	L_w (dB)
1996	80	60.2	39.8	106.1
2005	80	50.8	49.2	106.7
2015	80	47.5	52.5	106.9

2) Forecast levels

• Conditions

Year	L_w (dB)	l (m)	d (day) (m)	d (night) (m)	N (24 h) (vehicles)	N (12 h) day (vehicles)	N (12 h) night (vehicles)
1996	106.1	10	3,320.4	7,812.7	412	24.1	10.2
2005	106.7	10	576.7	1,357.0	2,372	138.7	59.0
2015	106.9	10	384.1	903.7	3,562	208.3	88.5

• Results

Year	L_{50} (day) (dB)	L_{50} (night) (dB)
1996	40.7	28.9
2005	56.4	44.7
2015	60.1	48.4

• Hourly traffic volume coefficient

Traffic Volume 24 h/12 h Ratio	Day time	Night Time
	Total Share	
	0.70	0.30
	Hourly Share	
1.425	0.06	0.02

3) Composite noise levels forecast

• Daytime

Year	L_B(db)	L_{50}(db)	Lf_{50}(dB)
1996	55	40.7	55.2
2005	55	56.4	58.8
2015	55	60.1	61.3

• Night-time

Year	L_B(db)	L_{50}(db)	Lf_{50}(dB)
1996	45	28.9	45.1
2005	45	44.7	47.9
2015	45	48.4	50.1

CHAPTER 8

AIMS OF ENVIRONMENTAL CONSERVATION AND EVALUATION

CHAPTER 8 AIMS OF ENVIRONMENTAL CONSERVATION AND EVALUATION

8-1 Objective and Methodology

The objective of this chapter is to set the environmental aims for each environmental item, and to evaluate whether the forecast results mentioned in the previous chapter satisfy these environmental aims. Thus, the magnitude of environmental impacts are first precisely defined. If any environmental item is found not to satisfy the environmental aims, countermeasures shall be implemented to mitigate the negative impact under the Environmental Management Plan, which is explained in the following chapter.

The environmental conservation aims were set on the basis of the followings :

i) National Constitution of Paraguay

ii) Law No. 294 established in 1993 regarding Environmental Impact Assessment

iii) Standards of the international organizations concerned

iv) Japanese Standards where Paraguayan standards have not yet been established

8-2 Environmental Conservation Aims

(1) Topography and Geology

To avoid substantially changing the present topography and geology, and to prevent natural disasters related to both topography and geology such as large-scale landslide and slope collapse.

(2) Soil

To prevent soil erosion and soil outflow, and to preserve present soil conditions.

(3) Hydrology

To avoid causing any substantial hydrological changes in rivers, underground water, or flood areas.

(4) Fauna and Flora

To avoid substantially affecting fauna habitats, and to avoid substantially affecting existing flora.

(5) Landscape

To conserve the beauty of the landscape by avoiding incongruities in the area.

(6) Resettlement

To avoid serious influences on the living basis of inhabitants due to the resettlement caused by land and building acquisition

(7) Economic Activities

To promote the solid development of economic activities in local communities, without adversely affecting sustainable development.

(8) Traffic and Community Facilities

To avoid a substantial adverse effect on traffic safety and the tranquil environment of community facilities such as hospitals, schools, and religious facilities.

(9) Split of Communities

To assist in the formation of harmonious and peaceful communities, without adversely

affecting the living environment of said communities.

(10) Cultural Properties

To avoid damaging ruins and cultural properties in the area.

(11) Waste

To avoid affecting the natural and living environment through the generation of waste, and to promote the recycling of resources.

(12) Risk of Hazards

To prevent increasing the risk of hazards that could damage the natural and living environment.

(13) Air Quality

To avoid exceeding the National Ambient Air Quality Standards of the USA for the purpose of protecting the health of inhabitants (see Table 8.2.1). The U.S. standard is used because no standard has yet been established in Paraguay.

Table 8.2.1 Environmental Air Quality Standards

Items	Standard Value
CO	10mg/m³/8hours (9ppm) 40mg/m³/1hour (35ppm)
SO_2	80ug/m³/day (0.03ppm) 365ug/m³/24hours (0.14ppm)
NOx	100ug/m³/year (0.05ppm) variable in 24hours with NO_2
HC	160mg/m³/3hours (0.24ppm)
O_3	235mg/m³/hours (0.12ppm)
Pb-Ps	1.5mg/m³/3months

Source : National Ambient Air Quality Standards of USA

(14) Noise

To avoid exceeding the standard levels set by ETAG of the MOPC in 1995.

Table 8.2.2 Environmental Noise Level Standards in Paraguay

Area	Standard Value	
	Daytime	Night time
Outdoor	55 dB	45 dB
Indoor	45 dB	-
Working Area	75 dB	-

Source : ETAGs (General Specifications of Environmental Protection) MOPC, 1995

Table 8.2.3 Environmental Noise Level Standards in Other Countries

Area		Standard Value	
		Daytime	Night-time
Japan	Mixed Area with 2-lane road	65 dB	55 dB
USA	Housing, Schools, and Hospitals	67 dB	67 dB

Source : Environmental Standard of Japan in 1971
Ordinance of Federal Road Department of USA in 1976

8-3 Environmental Evaluation

8-3-1 Topography

The project will not cause any substantially changes to the present topography and geology, and will prevent natural disasters related to topography such as large-scale landslides and slope collapse. However, it will be necessary to monitor topographical changes during the construction period.

8-3-2 Geology and Soil

The project will not cause any large-scale soil erosion or soil outflow, if the earth works are carried out according to ETAG regulations. Therefore, it will be necessary to monitor erosion control during the construction period.

Moreover, the project will have a direct positive impact by preventing the erosion of existing gullies in the road area.

8-3-3 Hydrology

The project will not cause any substantial hydrological changes in rivers and underground water, provided that road drainage facilities are sufficiently maintained .

8-3-4 Flora and Fauna

The project will have a small direct negative impact on the forest area, and have a small indirect negative impact due to the increase in the possibility of illegal deforestation in Ybycui National Park, which is near the project area.

Therefore, counternieasures such as mitigatory forestation and inspection of the park area will have to be taken.

8-3-5 Landscape

The project will not greatly change the beauty of the landscape along the roadside area, nor will create any incongruities in the area. However, the color of the bridge on the Tebicuary -mf River will have to be selected so that it harmonizes with the surrounding environment.

8-3-6 Resettlement

The project will have a small direct negative impact of causing about 50 households to resettle in their community. Therefore, adequate compensation shall have to be provided,

and it will be necessary to assist resettled households to re-establish themselves in the community.

8-3-7 Economic Activities

The project will have a large direct positive impact on the local economy through a) cash inflow by sales to construction workers, b) increase in cash-earning job opportunities due to the construction works, and c) decrease in traveling time and transportation costs. Based on these impacts, the project will have indirect positive impacts on the regional economy such as a) diversification of agro-products, and b) promotion of industrial development opportunities. Therefore, it is recommendable that agricultural technical assistance be provided to divert agro-production to daily foods, and to improve transportation facilities.

On the other hand, the project will have a small direct negative impact because some agricultural lands will have to be taken over, and traffic will be temporarily blocked during the construction period. However, these impacts are negligible compared with the positive impacts.

8-3-8 Traffic and Community Facilities

The project will have a large direct positive impact on the improvement of quality of life through the year-round punctual commuting possibilities to neighboring center towns provided by buses and other public transportation services. The major improvements will be in a) school attendance to higher educational facilities, and b) primary health care services due to 24-hour ambulance services, etc. Therefore, it will be necessary to create the facilities that will make it possible to realize this improvement by promoting social development such as improvement of bus services and improvement of energency health care services.

On the other hand, the project will have direct negative impacts on traffic safety. During the construction stage, the traffic volume of dump trucks will be relatively high, and during the operation stage, traffic flow and vehicle speed will greatly increase, thereby increasing the possibility of traffic accidents especially in nearby school zones and town centers. Therefore, it will be necessary to provide traffic safety facilities and traffic safety education.

8-3-9 Split of Communities

The project will not cause any serious splitting of existing communities thanks to the careful selection of bypass routes. However, the project will have a direct negative impact

by elevating the connection level of community access roads with the new road. Therefore, countermeasures to make connection slopes with communities will have to be taken.

8-3-10 Cultural Properties

The project is very unlikely to damage ruins or cultural properties in the area. However, it will be necessary to monitor the existence of cultural properties during the construction period.

8-3-11 Waste

Waste generated by the project will be a very small volume, and will not affect the natural and living environments of the surrounding area.

8-3-12 Risk of Hazards

The project will not increase the risk of flooding, which could damage the natural and living environments. However, the project will have a indirect negative impact to increase the risk of fire in the forest area of the Ybycui National Park. Therefore, it will be necessary to periodically patrol the national park area.

8-3-13 Air Quality

The level of air pollutants in Paraguarí, where maximum traffic volume is expected on the planned road, will remain under the environmental standard level. In the case of CO, the forecast level of 1 hour in 24 hours average is 0.0058 ppm against the standard level is 9.0 ppm in 8 hours on average. For NOx, the level of 1 hour in an annual average is 0.0009 ppm against the standard level of 0.05 ppm. But, this forecast result is based on model cases because there is no information on existing air quality or on auto emissions.

Therefore, it is needed to monitor air quality levels before, during, and after the construction period to collect more data.

8-3-14 Noise

The forecasted noise level in Paraguarí is slightly above the environmental standard level. In the daytime, the forecast noise level is 61 dB against the standard of 55dB, while at night-time the forecast level is 50 dB against 45dB. Nevertheless, this is under usual international standard levels. The evaluation has shown that the project will have a small direct negative impact over a limited area. Therefore, it will be necessary to monitor noise levels before, during, and after the construction period to collect more data. Moreover, it is

also recommended to plant roadside trees in selected urban areas to decrease the noise level. This would also have a positive impact on decreasing air pollutants and beautifying urban centers.

CHAPTER 9

ENVIRONMENTAL MANAGEMENT PLAN

CHAPTER 9 ENVIRONMENTAL MANAGEMENT PLAN

9-1 Objectives

The project will have some negative impacts on the surrounding environment, as well as great positive impacts. It is therefore necessary to mitigate such negative impacts, while promoting the positive impacts. This will be possible only through the adoption of integrated environmental management strategies based on a continuous monitoring of environmental impacts.

The Environmental Management Plan proposed in this part is aimed at serving the above purposes. so that integrated management of the environment shall be possible in the project's surrounding areas. The Plan consists of the following programs.

i) Environmental Auditory Program
ii) Environmental Mitigation Program
iii) Environmental Monitoring Program
iv) Ybycui National Park Conservation Program
v) Social Development Promotion Program

9-2 Environmental Auditory Program

9-2-1 Objectives

The objectives of this program are as follows :

i) To assess all activities under the Environmental Management Plan, and evaluate their progress periodically.

ii) To give adequate instructions and/or directions to solve any problems that may arise with implementation of the plan.

iii) To evaluate the results and their effects of the Plan as a whole at the end of target year.

9-2-2 Activities

In order to achieve the above objectives, the following activities will be required:

i) Elaboration of basic information regarding the area to be influenced by the project in the first year of the program.

ii) Annual evaluation of the progress and effects of each Environmental Plan program.

iii) Comprehensive evaluation of the entire Environmental Management Plan at the end of the target year.

iv) Elaboration of basic information regarding environmental conditions in the target year, and identification of environmental differences between before and after the project

9-2-3 Methodology

The auditory activities shall be carried out by a firm with contract basis organizing professional personnel from interdisciplinary fields related to the important environmental items identified in the Environmental Assessment. The firm will audit once a year to discuss about the progress of sub-programs of the Environmental management Plan. Field surveys shall be carried out according to their necessity.

9-2-4 Outputs

The following reports shall be prepared as the Program output.

i) Report on existing environmental conditions

ii) Reports on the annual evaluation of each program under the Environmental Management Plan

iii) Final report on environmental conditions in the target year

iv) Final report on the comprehensive evaluation of each program under the Environmental Management Plan

v) Final report on the Environmental Auditory Program

9-2-5 Work Schedule

The Environmental Auditory Program will continue for 6 years, starting 1 year before construction works begin and continuing 2 years after the completion of the construction work, including 3 years of the construction period. The time schedule for each sub-program is as follows:

Table 9.2.1 Work Schedule for the Environmental Auditory Program

	year	1	2	3	4	5	6
	Sub-Program	D/D	Construction			Operation	
1	Report on existing environmental conditions	XX					
2	Annual evaluation of each program		X	X	X	X	
3	Report on environmental conditions in target year						X
4	Comprehensive evaluation of each program						X
5	Final report						XX

9-2-6 Personnel Required

To implement the program, the professional from the following disciplines shall participate. All the personnel will be required to have at least 5 years experiences in their fields of experience.

- Biologist, specialized in forestation 4.5 months
- Geologist, specialized in natural geology 4.5 months
- Economist, specialized in agricultural economy 4.5 months
- Agricultural Engineer, specialized in agricultural production 4.5 months
- Sociologist, specialized in community development 4.5 months

9-2-7 Cost Estimate

The costs for the program are estimated as follows:

Table 9.2.2 Cost Estimate for the Environmental Auditory Program

(Unit : US$)

Sub-Program	Unit	Quant.	Unit Cost	Total Amount
Technical Personnel	mm	22.5	6,000	135,000
Assistant Personnel	mm	20.0	1,800	36,000
Equipment and materials	year	6	7,000	42,000
Reports	time	9	1,000	9,000
Travel	trip	30	500	15,000
Sub Total				237,000
Contingency(10%)				23,700
Total Amount				260,700

9-3 Environmental Mitigation Program

9-3-1 Objectives

The objectives of the Environmental Mitigation Program are to mitigate the direct negative impacts of project construction and operation, as well as to minimize the indirect negative influence of the project on areas affected by the project.

9-3-2 Activities

In order to achieve the objectives above, the following activities are proposed:

i) Supervision of the ETAGs
ii) Mitigatory forestation
iii) Development of traffic safety facilities
iv) Traffic safety education programs
v) Roadside planting in urban centers
vi) Construction of connection slopes with communities

9-3-3 Supervision the ETAGs

MOPC already includes general specifications for the environmental mitigation (ETAG) into its contracts with contractors engaged in public works. It is necessary in this project also to monthly supervise mitigation and the monitoring works mentioned in ETAG as follows.

Major ETAG Items

- Careful allocation of construction camp sites
- Permission of land owners to enter their lands and properties
- Obligation to report whenever they find ruins or cultural properties
- Careful activities in forest areas
- Conservation of valuable woods and top soil
- Planting embankment slopes to protect against erosion
- Protection against contamination of surface water and ground water
- Prohibition against emission of chemical pollutants from construction camps
- Prohibition against air contamination by heavy machinery and dump trucks
- Mitigation of quarry sites after the completion of excavation
- Preparation of detour routes and guiding equipment
- Operation of heavy machinery under the environmental noise standards
- Monthly reporting of all environmental mitigatory works

9-3-4 Mitigatory Forestation

According to the project plan, about 25 ha of gallery forest shall be cleaved out to clear the right of way. Deforestation is a serious environmental problem in Paraguay. Therefore, mitigatory forestation is proposed for at least 2 times of the same area of deforested by the project.

During the detailed design period, a forestation specialist shall study adequate locations and species for the purpose. The adequate lands, such as outside borrow pit, riverside and town entrances, shall be acquired and forestation works shall be started by the contractor in line with the construction of the road.

9-3-5 Development of Traffic Safety Facilities

The traffic volume forecast for the planned road shows a rapid increase from 412 vehicles a day in 1996 to 2,372 vehicles in 2005 and 3,562 vehicles in 2015. It marks a six-fold in 9 years and a nine-fold in 19 years. One of the negative impacts of this situation can be forecast, that is, the number of traffic accidents is likely to increase. In order to mitigate this negative impact, countermeasures in terms of hardware (facilities) and software (education) are definitely necessary, especially to protect school children.

The following traffic safety facilities shall be provided at locations near schools and urban centers where the possibility of traffic accidents is high.

- Traffic signals and pedestrian path markings
- Traffic signs indicating caution
- Protected pedestrian walkways near school zones

Locational requirements were identified as follows:

i) Traffic signals shall be installed at 2 crossing points in Paraguarí and Tebicuary where the planned road connects with the major road in the center of town.

ii) Traffic signs and protected pedestrian walkways shall be facilitated at the 10 locations shown in Figure 9.3.1, where the planned road will pass close to the existing primary schools.

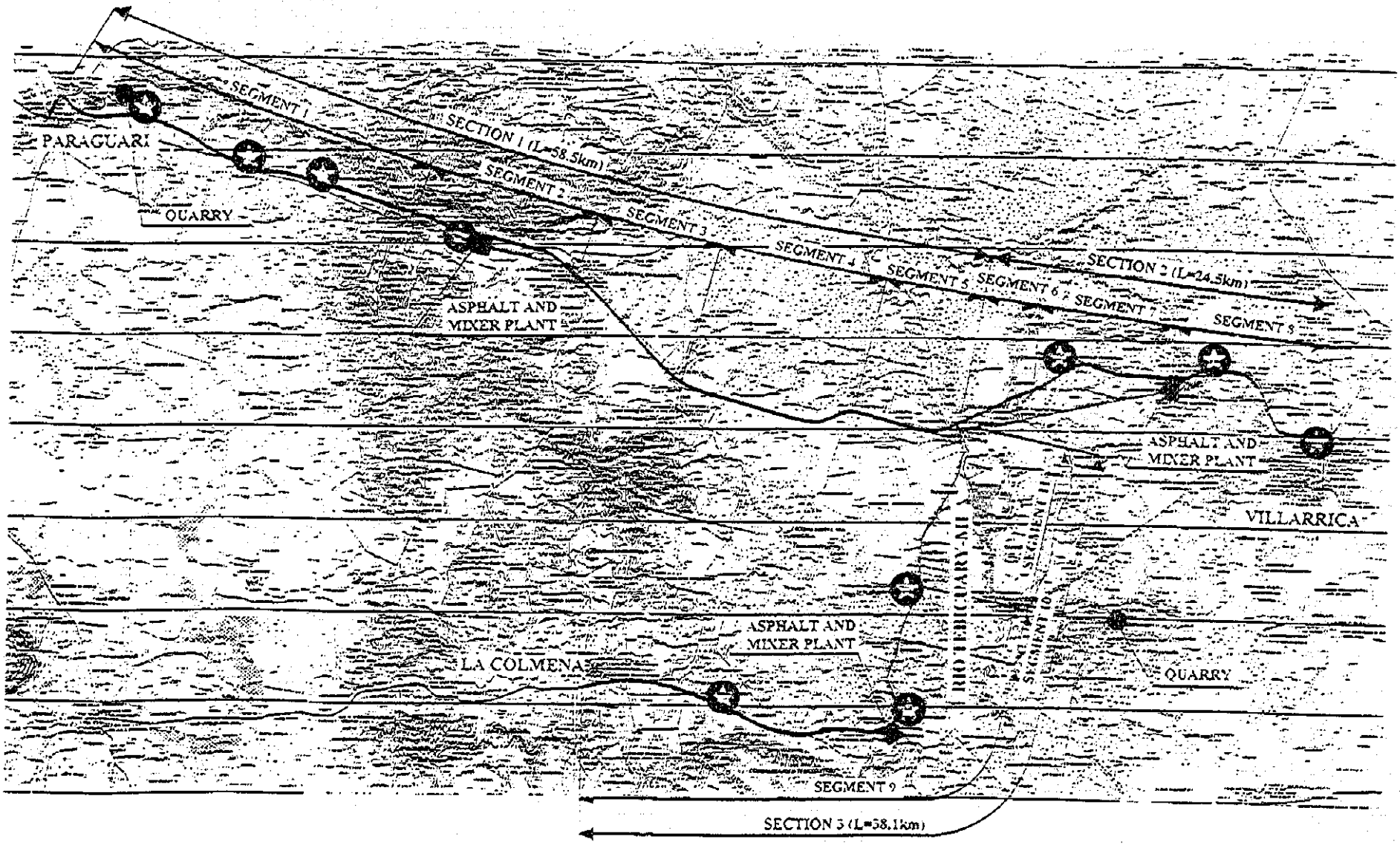


Figure 9-3-1 Location of School Zones