## 17.2 Restructuring Plan of Bus Lines

The new trunk bus on Av. E. Ayala will operate on the same section as 37 existing bus lines. Thus, it is necessary to restructure these existing lines in order to reduce congestion on Av. E. Ayala and in Centro and improve passenger services. The following restructuring plans are considered (Fig.17-2-1).

Pattern 1: Bus lines that pass more the greater part of Av. E. Ayala

1-1: Lines that start outside San Lorenzo and enter Centro will be stopped at the terminal in San Lorenzo for transfer.
1-2: Lines that serve almost the entire leugth of Av. E. Ayala and a shorter distance on other roads will be regarded as local buses and remain unchanged.

Pattern 2: Bus lines that pass only a portion of Av. E. Ayala

2-1: If a line that enters Av. E. Ayala halfway and continues into Centro serves other sections longer than Av. E. Ayala, it will be converted into a feeder line that connects with the bus stop on Av. E. Ayala.
2-2: If a line that enters Av. E. Ayala halfway and continues into Centro serves other sections shorter than Av. E. Ayala, it will be left unchanged as a local bus line.

Pattern 3: Lines that cross Av. E. Ayala

They will be left as they are now but connected to the bus stop on the trunk line.

Pattern 4: Other lines (not passing Av. E. Ayala)

They will remain unchanged.

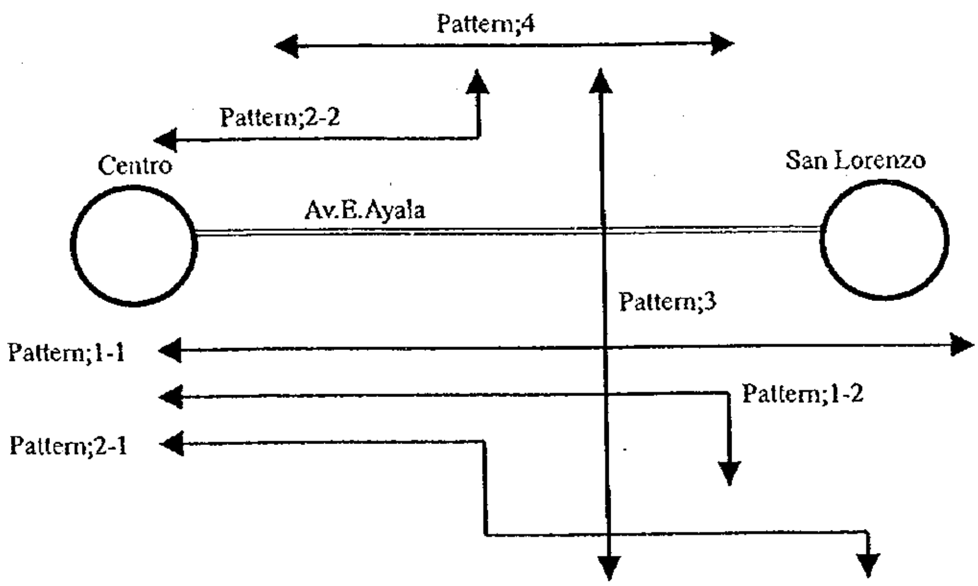



**Fig. 17-2-1 Restructuring Pattern of Bus Lines**

According to the above classification, the existing lines can be summarized in Table 17-2-1.

**Table 17-2-1 Bus Line Classification by Restructuring Patterns**

| Pattern | Number of Lines |
|---|---|
| 1-1 | 9 |
| 1-2 | 10 |
| 2-1 | 8 |
| 2-2 | 10 |
| 3 | 12 |
| 4 | 65 |
| Total | 114 |

Among them, lines that need to be restructured and converted into feeder services are 17, Patterns 1-1 and 2-1.

The other lines will continue their services on the same routes and share lanes with other private vehicles. Table 17-2-2 shows bus lines that will need restructuring.

**Table 17-2-2 Bus Lines to be Restructured after the Introduction of Trunk Bus**

| Restructuring Patterns | | Number of Lines | Line Number |
|---|---|---|---|
| 1-1 | Feeder lines from San Lorenzo outward to the San Lorenzo terminal | 9 | 11-2, 19-1, 20-1, 20-2, 27-0, 29-2, 43-0, 45-0, 59-0 |
| 2-1 | Feeder lines from other roads to Av. E. Ayala | 8 | 02-2, 10-1, 10-2, 11-1, 15-2, 17-0, 18-1, 47-0 |

At least nine lines on Av. E. Ayala will stop their operation, which results in a reduction of about 2,200 bus vehicles per day in 2005. Likewise, the halt of 17 lines into Centro will reduce about 3,300 bus vehicles per day and contribute to an alleviation of traffic congestion.
Fig. 17-2-2 shows feeder bus routes.

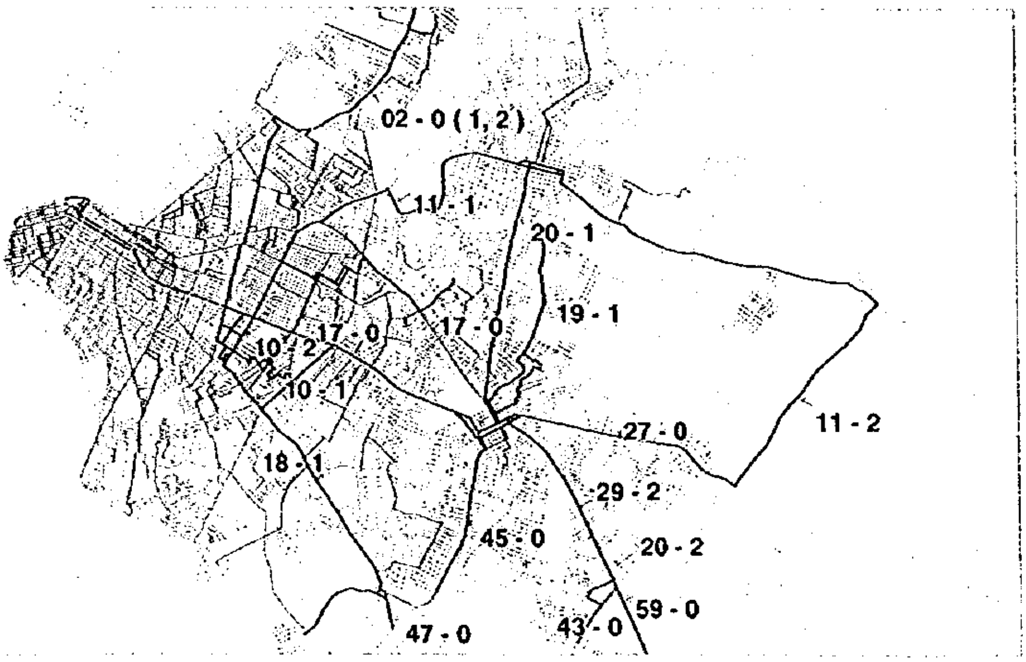



**Fig. 17-2-2 Feeder Bus Lines after the Introduction of the Trunk Bus System**

There are two types of operation scheme of the bus companies subject to restructuring: (1) a joint operation of the trunk and feeder bus lines and (2) independent operations of feeder lines. In addition, companies operating feeder lines can be integrated and form a new organization that oversees its services and examines new lines.

For the bus lines of Pattern 1-1, which arrive at the San Lorenzo terminal from suburbs and continue into Centro, a joint operation with the trunk line is considered appropriate. The lines of Pattern 2-2 are not planned for restructuring, but depending on future conditions of the trunk bus system, they may need to be integrated with the trunk bus. For instance, Line 33 may need to consolidate its three sub-lines into one feeder line. If the lines in Pattern 2-2 are restructured, about 1,300 vehicles per day can cut the number of buses into Centro.

## 17.3 Cost Estimation of the Trunk Bus Facility (Bus Terminals)

### 17.3.1 Condition of calculation

They are structures with an average of 200 m2 that will be built in order to support the new San Lorenzo Bus Terminal on dry land with normal strength that does not involve land settlement.

The analysis includes the value of the land (in the case of San Lorenzo), but it does not include the professional fees for the project and for the direction of the works, nor the general expenses or the constructor's benefits, such as wastages and breakages. It does not include construction taxes, rates, and permissions (Municipality, ANDE, CORPOSANA).

The prices for materials and labor are the prices published by MANDU'A Magazines. All the construction costs are included in its guide. The cost for labor is based on interviews with contractors and construction professionals. They do not include social fees, insurance, etc.

### 17.3.2 Cost Estimation of The Trunk Bus Terminals

Development of the Project:
Foundation: made of stone, common bricks (0.30m). Box insulation with two waterproof layers, horizontal and vertical. Elevation (0.15m) with hollow brick (12 x 20 x 25), reinforced with continuous railing made of two 8 mm rods, and concrete pier in the form of perimeter in some cases. In some buildings it is common to see pre-stressed concrete for the pillars of the maintenance room and the laundry room.

Roof:
Structural work made with concrete girders and wooden tie beams in the part to be used for offices and ticket booths. A metal structure is used as roof in most of the support buildings of the San Lorenzo Terminal with the profiles made of aluminum plates.

Floor Base, Floor, Socle, and Lining:
The base floor is made of rubble stone concrete (15 cm) for vehicle access, and (10 cm) for the rest of the building. The sidewalk floor is made of 20 x 20 tiles, and inside the building is made of tiles of different colors and shapes. The use of asphalt for the lining of the internal streets of the terminal is essential for the execution of the works, because it requires layers of different materials as base. Calcareous socles (10 x 25 cm) are used on waterproof mortar. In

the bathroom, enameled tiles (20 x 20) are used on a waterproof layer.
There is a protection path surrounding the works, made of insulated concrete.

Waterproof Plastering:
A base with a waterproof layer of sand and concrete (0.5 cm) and plastering with a waterproof ingredient is used in the interior part as 1 layer, and in the exterior part as a perimeter strip (0.5 m) and on the rowlock in the ceiling. It includes the rubblework in the corners and the border of the openings.

Painting:
Interior and exterior latex with fixer and color. Mock brick work with silicon-based waterproof protection, previous cleaning with muriatic acid. Wooden structural work with varnish, and metal structure work with enamel, both of them with two layers, minimum.
Installations:
Three-phase electric installation with metal box, plastic tubes for electric installations, and underground rigid electroduct. It does not include lighting devices, sanitary installations, or sewers. Pluvial and hydraulic installations use PVC. Tinwork with gutters and down pipes made of galvanized plates. Concerning the terminal itself, the installations are specially prepared against fire, they are prepared for computer work, and lighting with an independent transformer, etc.

### 17.3.3 Cost Estimation of The Trunk Bus Terminals

(1) San Lorenzo Terminal

Area: 19,720 m2
Total Cost: Gs. US$ 4,421,234
Land Cost: US$ 1,265,367

(2) Centro Terminal

Area: 6,128 m2
Total Cost: US$ 1,665,601
Land Cost: Municipal( US$723,333)

(3) Parking Area for the Trunk Bus

Area: 6,937 m2
Total Cost: (Gs. 2,299,009,887); US$ 766,377
Land Cost: Municipal (1,331,904,000Gs,US$443,968)

Table 17-3-1, 17-3-2,17-3-3 shows cost estimation of the trunk bus terminals and parking area.

Table 17-3-1 Cost Estimation of the Trunk Bus Terminal in San Lorenzo

| Terminal of San Lorenzo | | | |
|---|---|---|---|
| | | Financial(Gs) | Foreign(US$) |
| 1 | Preliminary Works | 886,275,960 | - |
| 2 | Asphalt Layer | 1,987,200,000 | - |
| | 2.1-Layer Asphaltttic s/ Surface Course | 993,600,000 | - |
| | 2.2-Base Course | 993,600,000 | - |
| 3 | Sidewalk | 1,515,162,610 | - |
| | 3.1-Replanning and Marking | 10,737,000 | - |
| | 3.2-Coloc. Floor of Brick | 1,004,231,610 | - |
| | 3.3-Plastering | 76,100,000 | - |
| | 3.4-Pedestrian Deck | 379,610,000 | - |
| | 3.5-Fence | 44,484,000 | - |
| 4 | Buildings | 1,447,780,314 | - |
| | 4.1-Ticket office 1 | 59,731,451 | - |
| | 4.2-Ticket office 2 | 135,246,534 | - |
| | 4.3-Washing Space | 149,925,164 | - |
| | 4.4-Factor of Maintenance | 161,016,900 | - |
| | 4.5-Office | 186,290,085 | - |
| | 4.6-Gas station | 360,000,000 | - |
| | 4.7-Waiting Room | 151,113,362 | - |
| | 4.8 Restaurant | 244,456,818 | - |
| 5 | Special Facility(Miscellaneous Work) | - | 300,000 |
| 6 | Mobilization & Other Works(30% of Total Cost) | 1,750,925,665 | 90,000 |
| 7 | Sub Total | 7,587,344,549 | 390,000 |
| 8 | Engineering Cost(10% of 7) | 758,734,455 | 39,000 |
| 9 | Contingency(10% of 7+8) | 834,607,900 | 42,900 |
| 10 | Ground Total Cost(7+8+9) | 9,180,686,904 | 471,900 |
| 11 | Construction Cost(US$) | | 3,532,129 |
| 12 | Cost of the Land(US$) | | 1,265,367 |
| 13 | **Total** | | 4,797,496 |

### Table 17-3-2 Cost Estimation of the Trunk Bus Terminal in Centro

| Terminal of Centro | | | |
|---|---|---|---|
| | | Financial(Gs) | Foreign(US$) |
| 1 | Preliminary Works | 364,937,160 | - |
| 2 | Asphalt Layer | 627,440,000 | - |
| | 2.1-Layer Asphalttic s/ Surface Course | 491,040,000 | - |
| | 2.2-Base Course | 136,400,000 | - |
| 3 | Sidewalk | 58,703,130 | - |
| | 3.1-Replanning and Marking | 621,000 | - |
| | 3.2-Coloc. Floor of Brick | 58,082,130 | - |
| 4 | Contention Wall | 62,941,000 | - |
| 5 | Filler | 284,757,000 | - |
| 6 | Buildings | 54,300,000 | - |
| | 6.1-Ticket office | 54,300,000 | - |
| 7 | Plastering | 44,000,000 | - |
| 8 | Spccial Facility(Miscellaneous Work) | - | 100,000 |
| 9 | Mobilization & Other Works(30% of Total Cost) | 449,123,487 | 30,000 |
| 10 | Sub Total | 1,946,201,777 | 130,000 |
| 11 | Engineering Cost(10% of 10) | 194,620,178 | 13,000 |
| 12 | Contingency(10% of 10+11) | 214,082,196 | 14,300 |
| 13 | Ground Total Cost (10+11+12) | 2,354,904,151 | 157,300 |
| 14 | Construction Cost(US$) | | 942,268 |
| 15 | Cost of the Land(US$) | | 723,333 |
| 16 | **Total** | | **1,665,601** |

### Table 17-3-3 Cost Estimation of the Trunk Bus Terminal Parking Area

| General View Articulated Buses | | | | | |
|---|---|---|---|---|---|
| | Description | Unit | Quality | Price/Unit | Total |
| 1 | Capa de Asfalto | | | | |
| | 1.1-Capa Asfáltica s/ Curso de Superficie | m2 | 6,937.00 | 30,000 | 208,110,000 |
| | 1.2-Curso de Base | m2 | 6,937.00 | 20,000 | 138,740,000 |
| 2 | Muro | | | | |
| | 2.1-Trabajos Ejecutados | gl | | | 149,853,074 |
| | 2.2-Cimientos | m3 | 6.75 | 82,500 | 556,875 |
| 3 | Muro de Nivelación | m2 | 22.50 | 42,500 | 956,250 |
| 4 | Muro de Elevación | m2 | 113.00 | 41,500 | 4,689,500 |
| 5 | Aislamiento | ml | 75.00 | 10,000 | 750,000 |
| 6 | Revoque del Muro | m2 | 226.00 | 10,000 | 2,260,000 |
| 7 | Poste | | | | |
| | 7.1- 15 (0,30 x 0,30 x 1,50) | m3 | 0.10 | 443,795 | 665,693 |
| 8 | Puerta de Entrada | | | | |
| | 8.1- 2 Poste | | | | |
| | 8.2- 2 (0,30 x 0,30 x 1,50) | m3 | 0.20 | 443,795 | 177,518 |
| | 8.3-Puerta Matálica | gl | | | 545,000 |
| 9 | Costos de la Tierra | m2 | 6,937.00 | 192,000 | 1,331,904,000 |
| 10 | Costos Varios | | | | |
| | Variación del 25% del Costo Total | gl | | | 459,801,977 |
| 11 | **Total** | **Gs.** | | | **2,299,009,887** |
| | | **US$** | | | **766,337** |

## 17.4 Project Management Plan

### 17.4.1 Operation of the Trunk Bus Project

The operation plan is as follows:

Total annual travel distance: 6.9 million km by the trunk bus and 29.3 million km by feeder buses.
Passengers of the trunk bus: 220,000 passengers/day (in 2005)
Number of employees: about 1,000 persons

- Operation of trunk and feeder buses
- Project period is 20 years from 2000 to 2020. The first 5 years are the period for preparation, such as construction. The system starts its operation in 2005.
- Total investment cost: US$ 120,340,000 (including the purchase of bus fleet).
- Ratio of owner's equity: 10% of the total capital cost minus the purchase of bus fleet. US$ 8,522,000.
- Long-term loan: repayment period, 10 years. Grace period, 3 years. Interest rate, 8%.
- Required number of buses: 49 trunk buses and 311 feeder buses in 2005.
- Number of operation days per year: 365 days. 240 weekdays and 125 weekend days and holidays. Operation frequencies on weekends and holidays are half of that on weekdays.
- Fares: Gs1, 000 for trunk bus (free transfer from and to a feeder bus). Gs850 for feeder bus.
- Operation costs of Bus Company include fixed costs and costs of operating bus.

**Table 17-4-1 Costs of Trunk Bus Projects**

(US$ thousands)

| Projects | Project Cost | Land Acquisition |
|---|---|---|
| Widening of Av. E. Ayala | 66,816 | 8,180 |
| Grade-separated intersections | 10,348 | 2,018 |
| Bus stops | 1,208 | - |
| San Lorenzo Bus Terminal | 4,421 | 1,265 |
| Centro Bus Terminal | 1,666 | 723 |
| Bus Storage Facilities | 766 | 555 |
| Total for Infrastructure | 85,224 | 12,741 |
| Purchase of Trunk Bus Fleet | 14,460 | - |
| Purchase of Feeder Bus Fleet | 20,656 | - |
| Total for Bus Fleet Purchase | 35,116 | - |
| Grand Total | 120,340 | 12,741 |

### 17.4.2 Financial Analysis

Cash flow of the project is calculated based on the assumption that the capital is 10% of the total construction cost, or US$8,522,000, an interest of long-term borrowings of 8%, the trunk bus fare Gs1, 000, and the feeder bus fare Gs850.

If it operates only the trunk bus, the cash flow turns positive after five years of operation, or 2009. On the other hand, if it operates only feeder buses, it will incur deficits every year during the project period. Joint operation of the trunk and feeder buses will make it profitable in the 14th year of the project, or in 2013, and its financial internal rate of return is 7.9%.

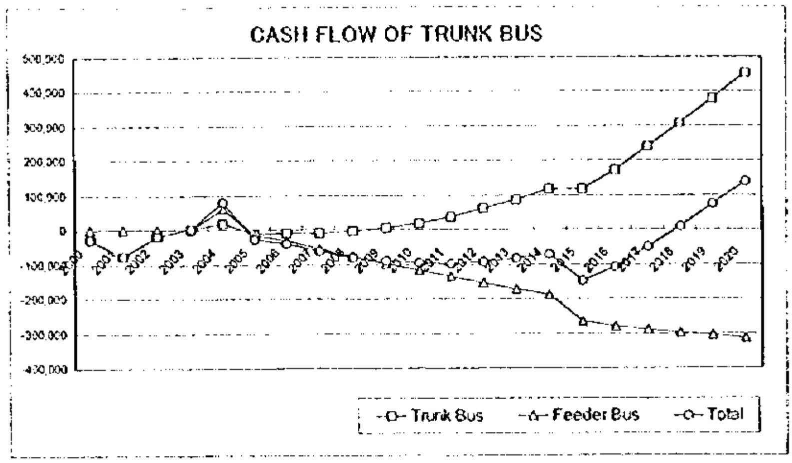



**Fig. 17-4-1 Cash Flow of Trunk Bus Project (Whole Project)**

The FIRR increases to 27.1 to 44.2% when the public funding can be secured for the widening and a grade-separation of the intersection of Av. E. Ayala. In particular, when the public sector is in charge of the widening of Av. E. Ayala, including grade-separation of intersections, the FIRR will improve dramatically from 7.9 to 27.1%.

**Table 17-4-2 Financial Sensibility Analysis of Trunk Bus Project**

| | Widening Av. E. Ayala (including grade-separated intersection) | Bus Terminal | Bus Bays | Bus Procurement | FIRR |
|---|---|---|---|---|---|
| Base Case | B | B | B | B | 7.9% |
| Case 1 | P | B | B | B | 27.1% |
| Case 2 | P | P | B | B | 37.2% |
| Case 3 | P | P | P | B | 41.2% |

Note: B = paid by the bus operator. P = paid by the public sector

### 17.4.3 Alternatives for Operating Body

The following schemes can be considered for construction and maintenance of trunk bus infrastructure and operating body of the trunk bus.

(1) Alternative A: Public Corporation

A public corporation will be established and funded by municipalities in the metropolitan area. It takes part in all the necessary functions, including building infrastructure and operating buses. This type of company is very common in European and United States' cities. Since it is a public institution, it is relatively easy to receive loans from international aid organizations.

(2) Alternative B: Public-Private Mixed Entity

A public-private mixed entity will be formed by a group of municipalities with their own funds and the existing bus companies with their own financial resources as well. As in Alternative A, it builds infrastructure and operates buses. Bus companies related to the Trunk bus will be integrated and share a part of the capital of the entity, and operational efficiency of the private sector can be gained as well. Because of the semipublic status, international assistance may be easily available. However, there is little past experience of this kind of company in Paraguay.

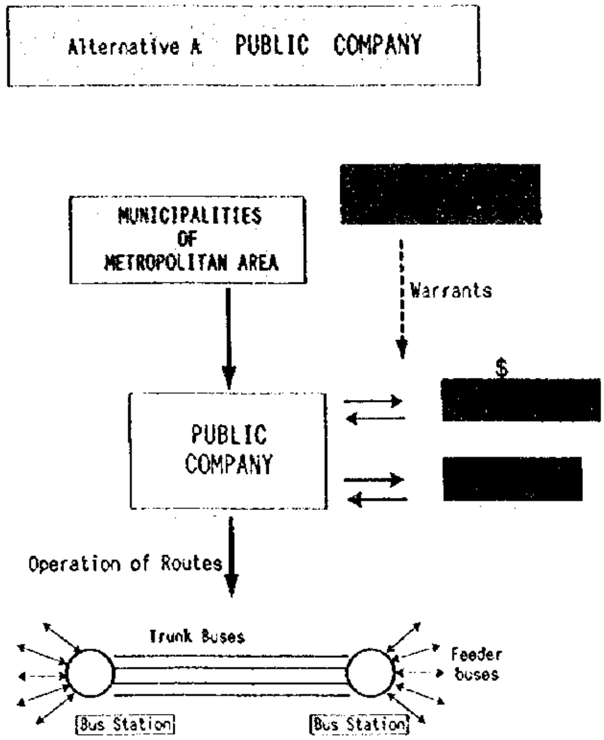



Fig. 17-4-2 Alternative A: Public Company

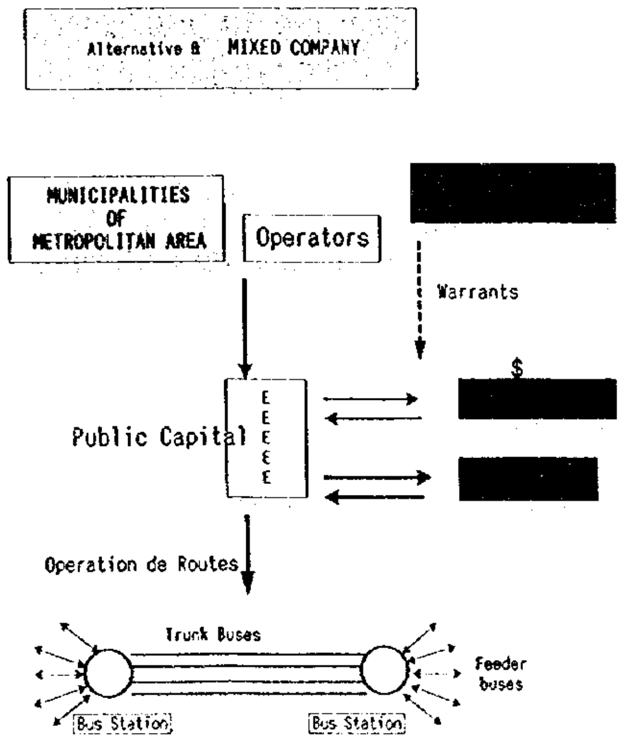



Fig. 17-4-3 Alternative B: Public-Private Mixed Company

(3) Alternative C: Integrated Company of Existing Bus Companies (or Cooperation)

Bus companies affected by the project will form an association or consolidate themselves into a new company and then operate trunk and feeder buses. Municipalities of Metropolitan Area will construct exclusive bus lanes and terminals, receive commissions from the association or new company, and supervise it.

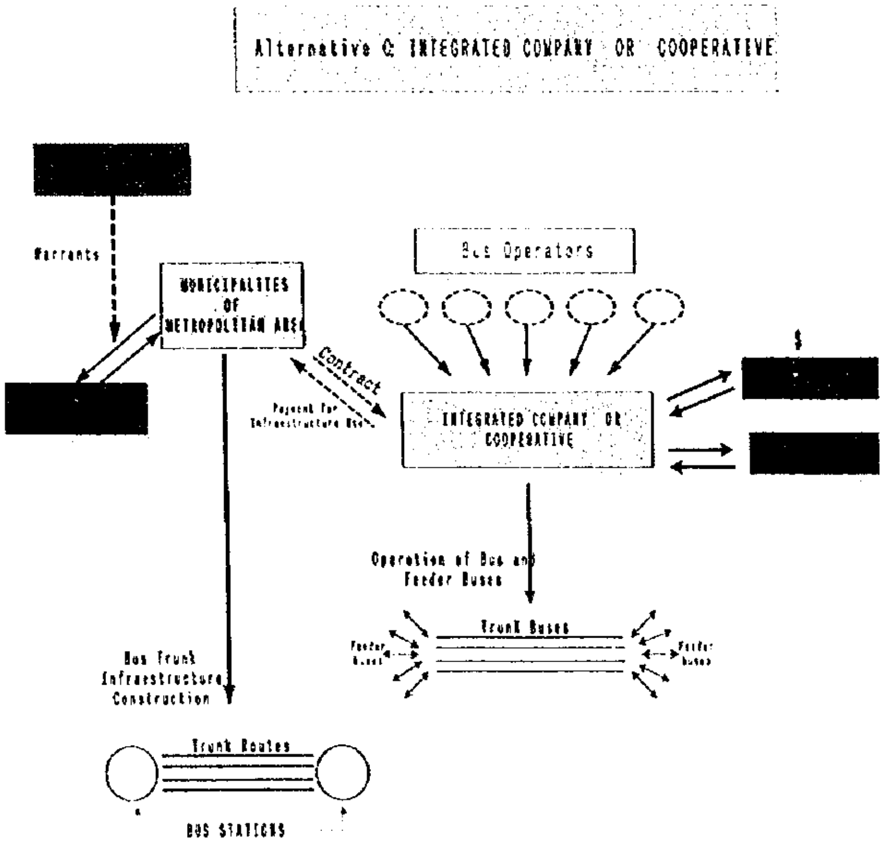



Fig. 17-4-4 Alternative C: Integrated Company (or Cooperative)

(4) Alternative D: Concession

Municipalities of the metropolitan area will construct exclusive bus lanes and terminals and procure bus fleet with low-interest public funds. They will open a tender for those facilities and the right of bus use and then give a concession to a private entity to operate the bus.

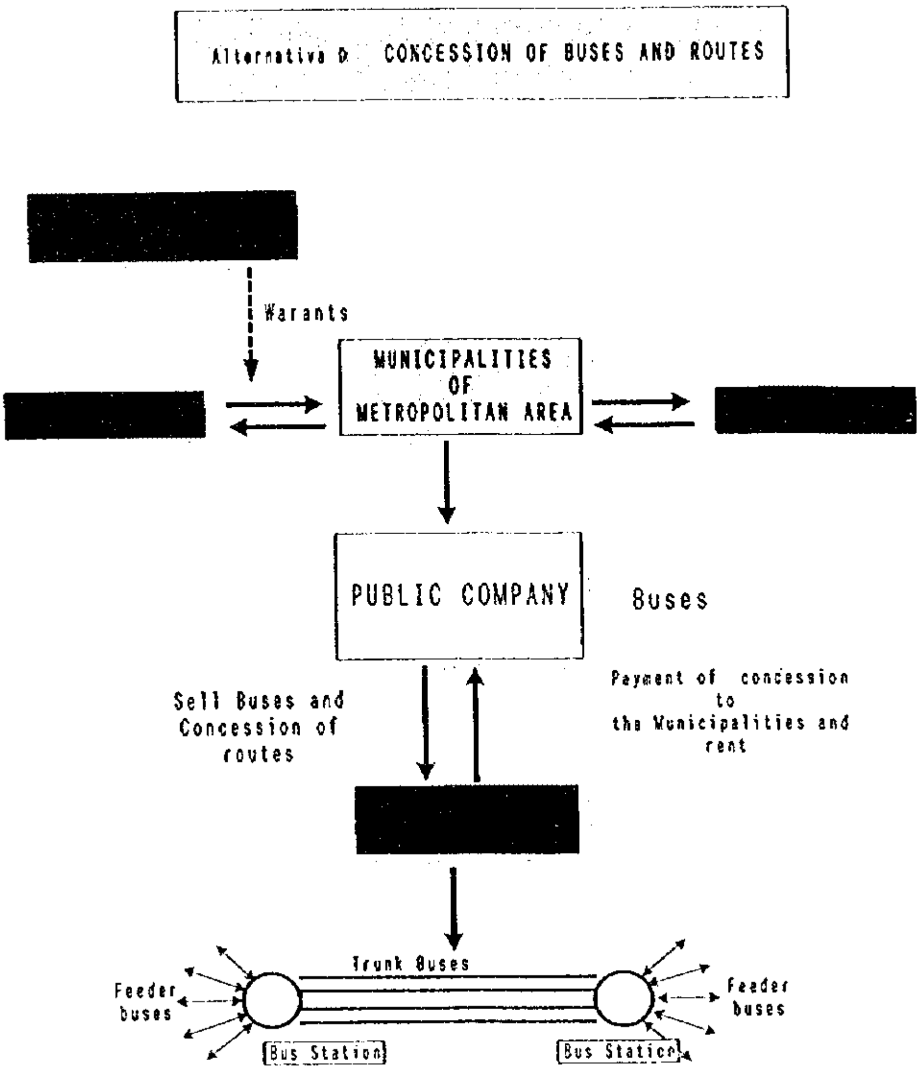



**Fig. 17-4-5 Alternative D: Concession**

In Paraguay, there has been rare experience in establishing a public corporation, and thus there is no accumulation of this know-how. The tertiary sector scheme (a public-private mixed company) has been implemented in some cases, which did not turn out to be very successful. In addition, there are problems of coordinating with the existing bus companies in adopting the concession scheme. However, the cash flow discussed below shows that this project is feasible for a private company if loans with low interest rate are available. By inviting them, it is possible to avoid unnecessary conflicts and make the most of their knowledge and experience accumulated to date. Therefore, among these alternatives, Alternative C has proved to be the most appropriate under the socioeconomic conditions of Paraguay. Nevertheless, it is imperative for the public sector like municipalities to take an initiative in securing funding sources and resolving any conflicts or interests among private bus companies.

The comparison of the operation body alternatives is summarized as Table 17-4-3.

**Table 17-4-3 Comparison of Operating Body**

| Item | Alter. A Public C. | Alter. B Mixed E. | Alter. C Integrated C. | Alter. D Concession | Remarks |
|---|---|---|---|---|---|
| Public fund requirement | B | F | G | G | Fund for establishment |
| Easiness of foreign fund procurement | G | G | F | F | Fund from World Bank etc. |
| Conflict with existing operators | B | F | G | B | Consensus |
| Efficient operation | B | F | G | G | Efficiency by private sector |
| Institutional conformity | B | F | G | G | Privatization is a recent policy of Government |

Note, G: Good F: Fair B: Bad

### 17.4.4 Bus Fare System

The number of bus users varies with a bus fare, so do the FIRR of the trunk bus and EIRR of the metropolitan area as a whole. The results of the analysis show that if a fare remains between Gs1,000 and 1,200, the FIRR or EIRR does not change very much, but a fare of over Gs1,300 would reduce both of the indicators. Thus, it has been determined reasonable to set the fare around Gs1,000 to 1,200.

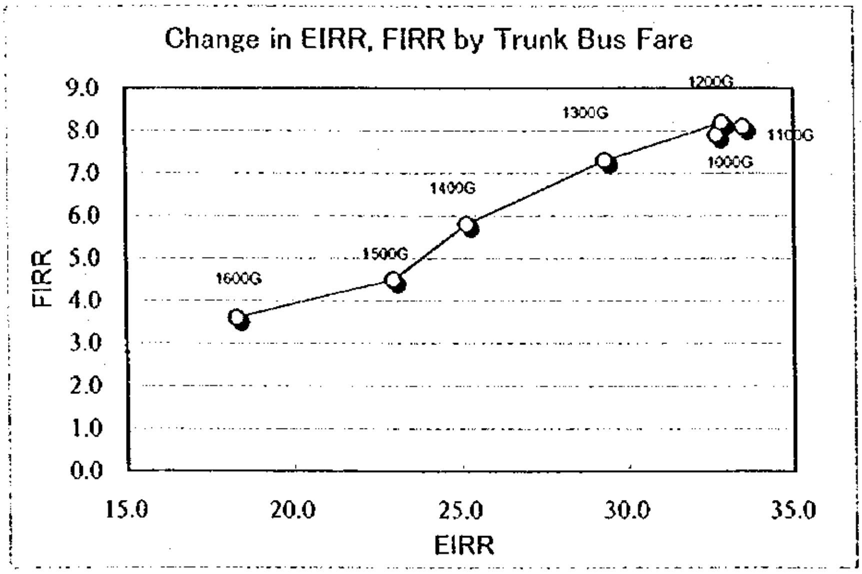



**Fig. 17-4-6 Change in EIRR and FIRR by Trunk Bus Fare**

1) In order to stop the motorization trend and increase the attractiveness of public transport, it is necessary to simplify the bus fare structure and make it user friendly.
2) Efficient operation of the bus requires restructuring and integration of bus lines. However, the existing fare system obstructs this restructuring effort, and thus radical reform is

necessary.

3) The introduction of a hierarchical route system and the separation of trunk lines from feeders will not be a problem for bus users if they are allowed to transfer with low costs.
4) Common tickets that allow for transfer within two hours of first ride will be introduced.
5) A flat fare system in the Metropolitan Area or a system with large fare zones must be adopted.
6) Sales of discounted tickets, such as one-day, one-month, and three-month pass, for promotion. For social welfare purposes, students of elementary schools and the retired are discounted.
7) Tickets should be purchased before boarding at bus terminals, bus stations, or kiosks near bus stops.
8) On boarding, tickets are inserted in a machine near the driver's seat that records the boarding time. Transfers are done in a similar way.

## 17.5 Institutional Improvement

### 17.5.1 Funding Sources

Feasibility of this project is fairly good if a loan with low interest rate is available. However, capital demand and interest burden during the first few years of the project will be significant, and the largest amount of accumulated debt will reach about US$25 million. There is no single bus company that can sustain itself in these financial conditions, and even an integration of some companies will be confronted with some difficulties.

There exist other kinds of development scheme, namely BOT (Build, Operate and Transfer) or PFI (Private Finance Initiative). BOT and PFI are defined as social capital development schemes by means of direct capital participation of private entities. Recently in both developed countries and developing countries in order to make amends for shortage of public finance resources this type of scheme is being adopted. While BOT has various merits such as the promotion of social infrastructure development under the situation of shortage of governmental finance resources, BOT has many kinds of demerits as follows; 1) Only profitable sections are developed and the rest are left to be undeveloped. 2) Pursuit of profit may cause the contempt of quality of works, safety and environmental aspects. 3) Troubles between the public and the private may occur, when the scope of responsibility and right is not clear.

In this case of the project implementation including infrastructure development such as the exclusive bus lane construction, the large amount of accumulated deficit will not attract the participation of a private entity as a concessionaire of BOT.

PFI scheme has experiences mainly in developed countries especially in United Kingdom. PFI scheme has wider scope than one of BOT, but it is necessary to arrange related matters such as laws, regulations, organizations and also supporting systems of banking for large fund. It is difficult to adapt PFI Scheme to this project in Paraguay at present.

Therefore, it would be desirable for the public sector to take responsibility for infrastructure works such as the construction of the exclusive bus lane and the bus terminals. In this way, the private operator only pays fees for using them, and the public sector repays its debt each year and makes interest payments. Implementation of the project requires administrative initiatives by the public sector including municipalities.

### 17.5.2 Institutional Reform

The introduction of the trunk bus system requires revisions of the existing institutions, such as relevant laws and organizations. First, it is necessary to establish an organization that plans, promotes, regulates, and oversees the project, and for this, the surface transportation act currently under discussion in the parliament is waited for passing soon. It is also recommendable to establish an organization like a public corporation or public-private entity, if necessary, for construction and operation of the project. Moreover, securing funding sources requires some revisions of the laws and regulations. Finally, an organization is sought that can plan, implement, and monitor urban transportation in the metropolitan area from a comprehensive standpoint.

### 17.5.3 Cooperation of Citizens

Restructuring of the bus lines and a new ticket system introduced along the new trunk bus system will cause some confusion and questions among citizens. It is necessary, if such things occur, to make them understand that the project will benefit them and ask for their cooperation. Deeper understanding among citizens requires periodic disclosure of information and public hearings where they can express their opinions.

### 17.5.4 Further Study

Restructuring of bus lines needs numerous calculations, presentation of extensive data, and negotiations that take a long time before consensus can be formed among the public institutions, bus companies, and users. Inviting foreign technical experts can be very helpful in this process.

# Chapter 18 Road Improvement Plan

## 18.1 Road Design Standards

Road design standards, which are established by Asunción Municipal Government, are applied. The standards are shown in Table 18-1-1.

**Table 18-1-1 Road Design Standards in the Project**

| Design Speed | Unit | 40 km/h | 60 km/h |
|---|---|---|---|
| 1. Horizontal alignment | | | |
| Minimum radius | m | 60 | 130 |
| 2. Sight distance | | | |
| Stopping sight distance | m | 46 | 76 |
| Passing sight distance | m | 145 | 290 |
| 3. Vertical alignment | | | |
| Maximum gradient and length | %,m | 4% (450m) | |
| | | 5% (360m) | |
| | | 6% (300m) | |
| | | 7% (260m) | |
| | | 8%(230m) | |
| | | 9%(200m) | |
| | | 10%(180m) | |
| Vertical radius | | | |
| Crest | m | 610 | 1829-2438 |
| Sag | m | 915 | 1829-2134 |
| 4. Construction gauge | m | 5.0 | |

Intersections are designed based on the following standards.

- The minimum turning radius of vehicles: R=15.0m
- The length of waiting lane has been determined based on the following formula:

  $$L= N*(3600/C)*6.5$$

  *L: waiting lane (m)*
  *N: the number of left turn vehicles per hour (vehicle)*
  *C: cycle length (sec)*
  *6.5: average length per vehicle (m)*

- The length of speed and transition lanes has been determined based on the following formula:

  $$L1=(V/\triangle W)/6$$
  $$L2=(V/\triangle W)/3$$

  *L1 : speed change lane (the minimum length is 30.0m) (m)*
  *L2 : transition lane (the minimum length is 40.0m) (m)*
  *V : design speed (km/h)*
  *$\triangle$W: shift length of vehicle (m)*

## 18.2 Widening of Eusebio Ayala Avenue

In this section, a road improvement plan with the introduction of exclusive trunk bus lanes, which facilitates smooth operation of trunk bus between San Lorenzo City and Centro, is stated

In order to introduce exclusive trunk bus route, either new road construction or widening of existing road is required. However, since the study area is highly urbanized, new road construction will have significant negative impacts on the affected area and also its project cost can be very high due to the magnitude of expropriation of existing buildings and land. Accordingly, in this project, it has been decided that existing Eusebio Ayala Avenue will be widened to have exclusive trunk bus lanes.

Eusebio Ayala Avenue can be divided, into the following three sections. The details of road improvement plan in each section are described below.
-Centro
-Avenida Eusebio Ayala – Ruta Mariscal Estigarribia
-San Lorenzo City area

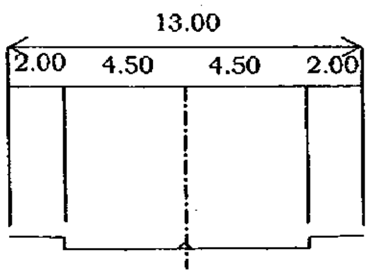
### 18.2.1 Roads

(1) Cross Section

The cross section of each section of Avenue is as described below.

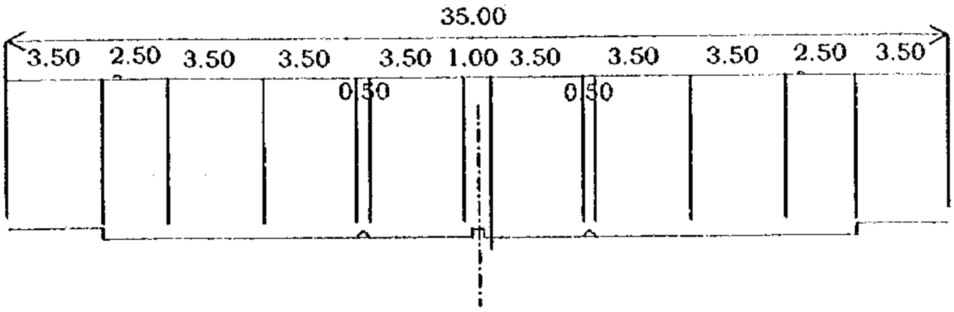
1) Centro

It is extremely difficult to widen the existing road, since this area is highly urbanized. Consequently, in this section, exclusive trunk bus lanes will be introduced maintaining the existing road. The following is the proposed width of the road.



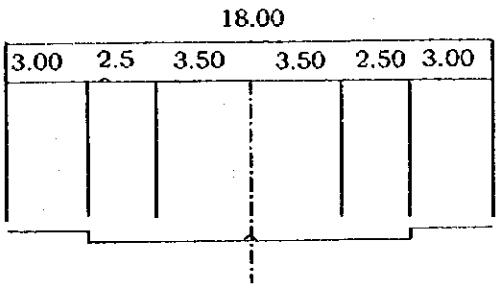

2) Avenida Eusebio Ayala – Ruta Mariscal Estigarribia

This is a main route, which connects Asunción, Fernando de la Mora and San Lorenzo cities. The existing road has four lanes for the both directions. In case exclusive trunk lanes will be introduced on the existing road, there only remain two lanes for both directions for other vehicles. However, as a result of the traffic demand forecast, it has been revealed that these two lanes are not sufficient to meet the future traffic demand. Accordingly, this road will be widened to six lanes for the both directions. The following is the proposed width of the route.




3) San Lorenzo City

As in the case of Centro, this is a highly urbanized area and it is extremely difficult to widen the road. Consequently, in this section, exclusive trunk bus lanes will be introduced on the existing road without widening. The following is the proposed width of the road.




(2) Horizontal Alignment

The horizontal alignment of each section is described below.

1) Centro

The trunk bus route starts at the proposed Centro Bus Terminal, which will be constructed in a lot, which belongs to Asunción Municipality. The bus terminal will be constructed in front of a naval facility, which is situated along Jaen River as shown in Figure 17-1-9. Then the route continues to General Diaz-Don Bosco-Humaita-Fulgencio R. Moreno-Pettirossi and to Eusebio Ayala. As stated in an earlier section, it will not be basically widened. However, at curves, taking turning radius of trunk bus, which is 12m, into account, slight widening is required. In total, there are four curves, which will be widened.

With regard to the connection from Fulgencio R. Moreno to Pettirossi, though the actual route makes a left turn on Brasil and enters Pettirossi, in order to secure smooth operation of trunk bus and avoid possible traffic congestion, Fulgencio R. Moreno will be extended and pass through actual residential area to Pettirossi.

The road alignment at this point is slightly cranked, therefore it should be essentially changed to be straight. However, in case it will be straightened, a historically preserved house would have to be removed. In consequence, this road will not be widened.

With regard to the route from Eusebio Ayala to Centro, it passes Eusebio Ayala-General Aquino-Azara-Centro Bus Terminal. General Aquino is actually used as an access route from Eusebio Ayala to Centro. In this project, in order to avoid traffic congestion and secure smooth operation of trunk bus, only trunk bus and other feeder buses will be allowed to pass on this road. Other vehicles will pass on General Bruguez and enter Azara.

2) Avenida Eusebio Ayala and Ruta Mariscal Estigarribia

The existing road alignment has been basically maintained in this section. Though there are some slight curves, it is considered that they are insignificant in terms of vehicle operation. The minimum radius is 500m and in general the total alignment is smooth.

In this section, intersections are designed as follows:

- Trunk bus stops are basically set up at principal intersections. Accordingly, these intersections are to be designed as four-way intersection, which provides full access.

- Apart from the above-mentioned intersections, at other existing intersections, in order to secure smooth operation of trunk bus, vehicles can only make right turn and cannot pass through Eusebio Ayala.

The entire section will be widened to 35m of width in order to secure six lanes, of which the central two lanes will be used as exclusive trunk bus lanes. The average actual width of Eusebio Ayala is 33m, therefore about 1.0m of widening on both sides of the road will be required. On the other hand, the average actual width of Mariscal Estigarribia is 32m and about 1.5m of widening on both sides will be required.

Since a viaduct at the intersection of Eusebio Ayala and Avenida Madame Lynch is under construction, this project will be consistent with this work.

3) San Lorenzo city

The trunk bus route in this section is Mariscal Estigarribia-San Lorenzo Bus Terminal-Julia Miranda Cueto de Estigarribia-Mariscal Esticarribia, as shown in Figure 17-1-10. Since this section is also highly urbanized, it is basically not widened. Hover, in order to secure minimum radius of trunk bus of 12m, slight widening will be required at the curves. There are three curves, which require widening.

(2) Vertical Alignment

The vertical alignment of each section will be described below.

1) Centro

Since this section is highly urbanized, it is extremely difficult to change gradient. Accordingly, existing vertical alignment is maintained. In the existing vertical alignment there is a sharp gradient and rolling terrain for a short section. Since it is required to make it consistent with the existing vertical alignment, the maximum gradient in the plan is 10.0%, which is very steep.

This section has no problem in terms of relationship between drainage and vertical alignment, in so far as the existing vertical alignment will not be significantly altered. This is due to the fact that drainage facilities in this section are relatively well developed.

2) Avenida Eusebio Ayala and Ruta mariscal Estigarribia

This section is also urbanized area, though not as much as in Centro and San Lorenzo. Accordingly it is impossible to alter the existing gradient. In consequence, vertical alignment in this project will be consistent with the existing one. The maximum and minimum gradients are 4.14% and 0.30% respectively. Drainage has been taken into consideration in determining the minimum gradient. In addition, since a drainage system is considered in determining vertical alignment, the cathment basin should be located at the sag point of the gradient.

3) San Lorenzo City

This section is also highly urbanized area as in the case of Centro and it is extremely difficult to change existing gradients. Accordingly, vertical alignment of this section will be consistent with the existing one. However, unlike Centro, since there is no rolling terrain in this section, the maximum gradient, 3.90%, is relatively gentle.

### 18.2.2 Rainwater Drainage

Rainwater drainage improvement is planned on Eusebio Ayala and Mariscal Estigarribia. Since the drainage system on these roads has not been fully developed, when it rains they always have flood problems, which sometimes cause serious problems in terms of vehicles operation.

For this section, the report titled "Storm Drainage System Improvement Project in Asunción City," which was conducted in 1986 by JICA, has been examined. Drainage system on these roads was described in the report.

(1) Rainwater Drainage Facility Design Standards

1) Rainfall Intensity

The rainfall intensity duration for various return period (Table18-2-1), which was prepared in the Storm Water Drainage Improvement Project, has been applied in this study. With a return period of 1 year, and a concentration time of 10minutes for the road surface storm water drainage design, the rainfall intensity will be 74.3 mm/hour.

**Table 18-2-1 Rainfall Intensity for Various Return Periods**

Unit: mm/hr

| Time | Return Period (Year) | | | | |
|---|---|---|---|---|---|
| (min) | 1 | 2 | 3 | 5 | 10 |
| 5 | 88.5 | 131.6 | 152.2 | 174.9 | 204.1 |
| 10 | 74.3 | 116.9 | 135.8 | 156.8 | 183.4 |
| 15 | 65.1 | 105.1 | 122.6 | 142 | 166.5 |
| 20 | 57.8 | 95.4 | 111.7 | 129.8 | 152.5 |
| 30 | 47.5 | 80.6 | 94.9 | 110.7 | 130.5 |
| 45 | 37.4 | 65.4 | 77.4 | 90.7 | 107.3 |
| 60 | 30.8 | 55.0 | 65.4 | 76.9 | 91.1 |
| 120 | 18.1 | 33.7 | 40.3 | 47.7 | 56.8 |
| 180 | 12.8 | 24.2 | 29.1 | 34.6 | 41.3 |
| 360 | 6.8 | 13.2 | 15.9 | 18.9 | 22.7 |
| 720 | 3.5 | 6.9 | 8.3 | 9.9 | 11.9 |

2) Runoff Coefficient (c)

Runoff coefficient shows the degree of drain to flow through the surface of the earth side without how much rainwater permeating underground. The amount of drain becomes big as much as runoff coefficient becomes big. It was decided that runoff coefficient applied the value of Basin, which copes with our plan zone in each Basin shown in the Table 18-2-2.

CENTRO – ARGENTINA Street (B-1 Mburicao) : c=0.57
ARGENTINA Street– ANGEL TORRES Street (B-18 Itay) : c=0.50
ANGEL TORRES Street – SAN LORENZO (B-23 San Lorenzo) : c=0.35

3) Runoff Volume Estimation

It is necessary for the calculation of the amount of rainwater drain to decide the scale of the drainage establishment. The following formula is applied for the estimation of the runoff:

$$Q = 1/(3.6 \times 10^{6}) \times C \times I \times A$$

Where: Q = Volume of flow (Runoff) (m3/sec)
C = Runoff coefficient
I = Average storm intensity during concentration time (mm/hour)
A = Storm water drainage area ($m^2$)

Furthermore, to determine the section of drainage, the planned volume of flow of Q/0.8 was adopted so that the runoff volume was equal to 80% of a planned section.

## Table 18-2-2 Increment of Runoff Coefficient

| River Basin | Name of Basin | Runoff Coefficient | | |
|---|---|---|---|---|
| | | 1965 | 1984 | 2005 |
| B-1 | Varadero | 0.54 | 0.62 | 0.66 |
| B-2 | Jardin | 0.65 | 0.68 | 0.68 |
| B-3 | Centro | 0.59 | 0.62 | 0.67 |
| B-4 | Jaen | 0.57 | 0.65 | 0.67 |
| B-5 | Tacumbu | 0.48 | 0.53 | 0.53 |
| B-6 | Salamanca | 0.52 | 0.57 | 0.58 |
| B-7 | Zanja Moroti | 0.63 | 0.64 | 0.65 |
| B-8 | Ferreira | 0.50 | 0.63 | 0.66 |
| B-9 | Villa Universitaria | 0.32 | 0.44 | 0.60 |
| B-10 | Las Mercedes | 0.48 | 0.59 | 0.62 |
| B-11 | Mariscal Lopez | 0.56 | 0.62 | 0.63 |
| B-12 | Bella Vista | 0.50 | 0.63 | 0.65 |
| B-13 | Tablada | 0.45 | 0.62 | 0.63 |
| B-14 | Mburicao | 0.42 | 0.50 | 0.57 |
| B-15 | Ycua Carrillo | 0.37 | 0.44 | 0.63 |
| B-16 | Santa Rosa | 0.33 | 0.41 | 0.56 |
| B-17 | Tres Puentes Cue | 0.30 | 0.35 | 0.41 |
| B-18 | Itay | 0.33 | 0.41 | 0.50 |
| B-19 | Lancare | 0.36 | 0.51 | 0.67 |
| B-20 | Valle Apua | 0.30 | 0.38 | 0.40 |
| B-21 | Villa Elesa | 0.31 | 0.40 | 0.51 |
| B-22 | Nemby | 0.30 | 0.36 | 0.44 |
| B-23 | San Lorenzo | 0.30 | 0.32 | 0.35 |
| B-24 | Tayazuape | 0.30 | 0.32 | 0.35 |
| B-26 | Zeballos Cue | 0.32 | 0.35 | 0.41 |
| B-27 | Paso Cai | 0.32 | 0.34 | 0.52 |

4) Runoff Capacity Estimation

The estimation of discharge capacity, which determines the section of the storm water drainage channel, is based on the "Manning uniform flow" formula:

$Q = A \times V$

$V = 1/n \times (I^{1/2} \times R^{2/3})$

$R = A/P$

Where: Q = discharge (m3/sec)
V = flow speed (m/sec)
N = roughness coefficient
I = slope (%)
R = Hydraulic depth
A = Area of cross section ($m^2$)
P = Wet perimeter

Since the storm water drainage structure will be concrete, the roughness coefficient will be n = 0.013.

(2) Drainage

1) Underground Streams

The location of Underground streams and down stream rivers of proposed drainage facilities are shown in Fig. 18-2-1

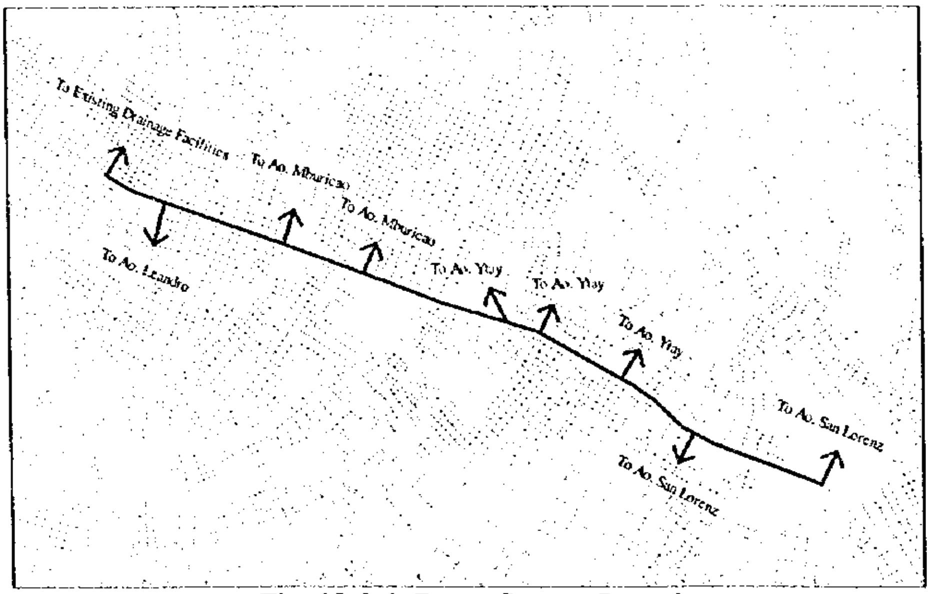



**Fig. 18-2-1 Down Stream Location**

2) Catchment Basin

The catchment basin of proposed project area is shown in Fig. 18-2-2.

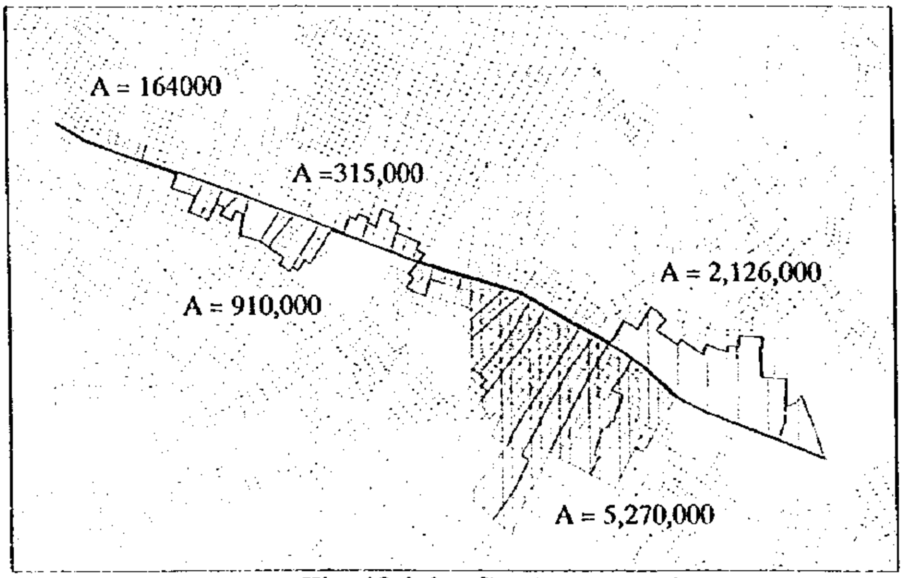



**Fig. 18-2-2 Catchment Basin**

3) Drainage Facilities

The size of required drainage facilities is determined for each catchment basin, which is shown in Fig. 18-2-3. The determined drainage facilities are shown in Table 18-2-3.

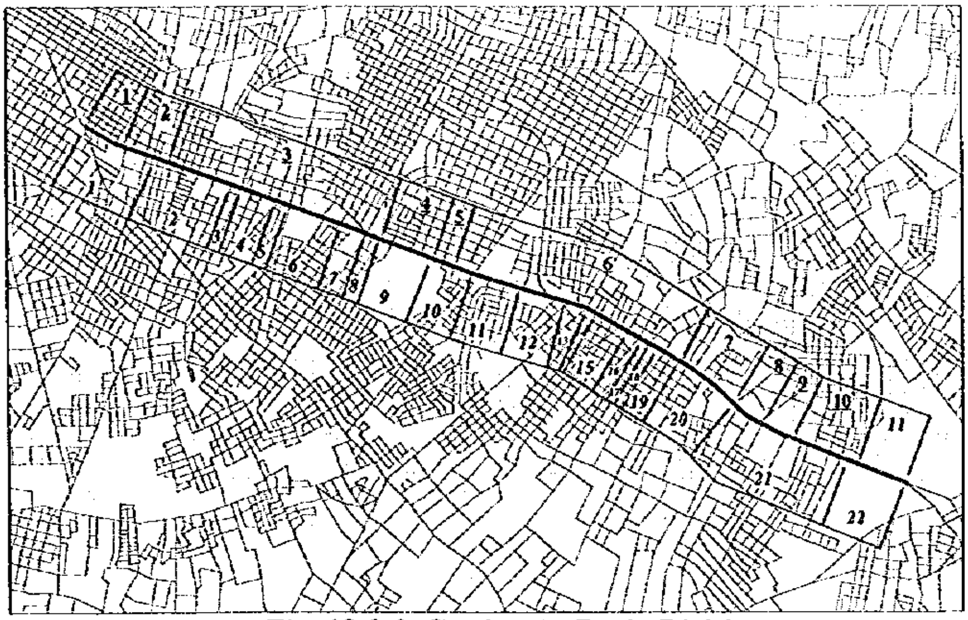


**Fig. 18-2-3 Catchment Basin Division**

**Table 18-2-3 Drainage Facilities**

| Left Side | | | | | Right Side | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Catchment Basin NO | Drainage Facilities | | | Length | Catchment Basin NO | Drainage Facilities | | | Length |
| 1 | PIPE CULVERT | φ | 0.5 | 520 | 1 | PIPE CULVERT | φ | 0.5 | 900 |
| 2 | PIPE CULVERT | φ | 1.0 | 590 | 2 | PIPE CULVERT | φ | 1.0 | 1,030 |
| 3 | PIPE CULVERT | φ | 0.5 | 2,720 | 3 | PIPE CULVERT | φ | 0.5 | 120 |
| 4 | PIPE CULVERT | φ | 1.5 | 690 | 4 | PIPE CULVERT | φ | 1.0 | 450 |
| 5 | PIPE CULVERT | φ | 1.0 | 300 | 5 | PIPE CULVERT | φ | 1.5 | 160 |
| 6 | PIPE CULVERT | φ | 0.5 | 2,930 | 6 | PIPE CULVERT | φ | 1.0 | 670 |
| 7 | PIPE CULVERT | φ | 2.0 | 950 | 7 | PIPE CULVERT | φ | 1.5 | 340 |
| 8 | PIPE CULVERT | φ | 1.5 | 440 | 8 | PIPE CULVERT | φ | 2.0 | 160 |
| 9 | PIPE CULVERT | φ | 1.0 | 410 | 9 | PIPE CULVERT | φ | 1.0 | 690 |
| 10 | PIPE CULVERT | φ | 1.5 | 850 | 10 | PIPE CULVERT | φ | 0.5 | 620 |
| 11 | PIPE CULVERT | φ | 2.0 | 550 | 11 | PIPE CULVERT | φ | 1.0 | 520 |
| | | | | | 12 | PIPE CULVERT | φ | 1.5 | 610 |
| | | | | | 13 | PIPE CULVERT | φ | 1.0 | 260 |
| | | | | | 14 | BOX CULVERT | 2.5*2.0 | | 90 |
| | | | | | 15 | PIPE CULVERT | φ | 2.0 | 490 |
| | | | | | 16 | PIPE CULVERT | φ | 1.5 | 200 |
| | | | | | 17 | PIPE CULVERT | φ | 1.0 | 90 |
| | | | | | 18 | PIPE CULVERT | φ | 1.5 | 110 |
| | | | | | 19 | BOX CULVERT | 2.0*2.0 | | 240 |
| | | | | | 20 | PIPE CULVERT | φ | 2.0 | 1,010 |
| | | | | | 21 | PIPE CULVERT | φ | 0.5 | 1,500 |
| | | | | | 22 | PIPE CULVERT | φ | 1.0 | 690 |

### 18.2.3 Design of Pavement Structure

Pavement structure was designed according to the "AASHTO-Guide for the Design of a Pavement Structure (1986)".

(1) Analysis Period

The analysis period in the design of pavement structure was considered to be eleven years from the commencement of the use of developed roads.

(2) Design Traffic

The design traffic is the cumulative traffic volume during the analysis period. It is described by type of vehicle. In this case, the design traffic was calculated for the period from 2004 to 2015. The calculated design traffic is shown in Table 18-2-4.

**Table 18-2-4 Design Traffic**

| Road section | Year | Passenger cars | Buses | Truck Buses |
|---|---|---|---|---|
| EUSEBIO AYALA | 2004 | 38,151 | 2,753 | 1,572 |
| | 2015 | 49,446 | 3,541 | 1,748 |
| Design Traffic | | 175,850,978 | 12,635,205 | 6,664,900 |
| MARISCAL ESTIGARRIBIA | 2004 | 37,533 | 4,557 | 1,572 |
| | 2015 | 48,644 | 5,860 | 1,748 |
| Design Traffic | | 173,000,328 | 20,912,128 | 6,664,900 |

(3) Axle Load of Each Type of vehicle

According to this design method, it is necessary to know the axle load of each type of vehicle first, then to convert it to an 18-kip equivalent single axle load (E.S.A.L.).

**Table 18-2-5 Axle Load Distribution by Type of Vehicle**

| Vehicle type | Total weight | Load distribution | | |
|---|---|---|---|---|
| | | Front wheel | Middle wheel | Rear wheel |
| Passenger car | 1.30 | 0.6813 | - | 0.6174 |
| Bus | 13.80 | 4.7248 | - | 9.0752 |
| Truck Bus | 24.10 | 6.8000 | 9.9500 | 7.3500 |

Note: W = total weight

(4) Cumulative 18-kip Equivalent Single Axle Load (E.S.A.L.)

First, applying the values in Table 18-2-5, the E.S.A.L.Factor for each type of vehicle was calculated as shown in Table 18-2-6.

**Table 18-2-6 Calculation of Total Esal Factor**

| Vehicle type | Axle | Axle load | | ESAL Factor | |
|---|---|---|---|---|---|
| | | Tons | Kips | Axle | Total |
| Passenger Car | Front | 0.6813 | 1.5 | 0.0002 | |
| | Rear | 0.6174 | 1.4 | 0.0002 | 0.0004 |
| Bus | Front | 4.7248 | 10.4 | 0.0880 | |
| | Rear | 9.0752 | 20.0 | 1.5100 | 1.5980 |
| Truck Bus | Front | 6.8000 | 15.0 | 0.4915 | |
| | Middle | 9.9500 | 21.9 | 2.1465 | |
| | Rear | 7.3500 | 16.2 | 0.6607 | 3.2987 |

Note: 1) kips=kilo-pounds

2) ESAL factors of axle in the fifth column come from the table d.4 and d.5 in the "AASHTO Guide for design of pavement structure (1986)", assuming that the serviceability and structural numbers are 2.5 and 5.0, respectively. The guide said "in most cases, such an assumption provides information sufficiently accurate for design for design purposes.

Using the total EASL Factor calculated above, the design ESAL and cumulative 18-kip ESAL for each road section were obtained as follows.

In this table, Cumulative 18-kip Esais calculated for both trunk and other vehicles for each section. In this project, taking safety into consideration, the largest value was adopted in each section.

**Table 18-2-7 Design ESAL and Cumulative 18-kip ESAL by Road Section**

| Road section | Vehicle type | Design traffic (A) | ESAL Factor (B) | Design Esal (AxB) | Cumulative 18-kip esal |
|---|---|---|---|---|---|
| EUSEBIO AYALA | Passenger car | 175,850,978 | 0.0004 | 70,340 | 31,653 |
| | Bus | 12,635,205 | 1.5980 | 20,191,058 | 9,085,976 |
| | Total | | | | 9,117,629 |
| | Truck bus | 6,664,900 | 3.2987 | 21,985,506 | 10,992,753 |
| MARISCAL ESTIGARRIBIA | Passenger car | 173,000,328 | 0.0004 | 69,200 | 31,140 |
| | Bus | 20,912,128 | 1.5980 | 33,417,580 | 15,037,911 |
| | Total | | | | 15,069,051 |
| | Truck bus | 6,664,900 | 3.2987 | 21,985,506 | 10,992,753 |

Note: 1) (Cumulative 18-kip ESAL)=(Design ESAL)*DD*DL
Where ,DD= Directional distribution factor =0.5, DL= lane distribution factor = 0.9

(5) CBR of Sub-grade

Since CBR 6 is adopted in Asunción Municipality, in this project CBR 6 will also be applied.

(6) Roadbed MR

The AASHTO Guide recommends calculating the Elastic Resilient Modulus of the roadbed (MR) according to the following formula and tables:

MR =1,500*CBR (psi)
Where CBR = CBR value of roadbed soil (%)

Accordingly, in this project, it is calculated as follows:

MR =1,500*6 = 9,000 (psi)

(7) Reliability (R)

The AASHTO Guide recommends that the value of Reliability for a principal arterial road in an urban area such as the study road should be from 80% to 99%. In this case, a value of 90% was applied.

**Table 18-2-8 Suggested Levels of Reliability for Various Functional Classifications**

| Functional Classification | Recommended Level of Reliability | |
|---|---|---|
| | Urban | Rural |
| Interstate and other freeways | 85-99.9 | 80-99.9 |
| Principal Arterials | 80-99 | 75-95 |
| Collectors | 80-95 | 75-95 |
| Local | 50-80 | 50-80 |

(8) Standard Deviation (So)

In flexible pavement design, the standard deviation can be considered to be 0.45.

(9) Design Serviceability Loss (PSI)

Design Serviceability Loss can be obtained from the following formula:

PSI = Po-Pt

*Where Po = Initial Serviceability (AASHTO Guide recommends 4.2 for a flexible pavement.)*
*Pt = Terminal Serviceability (AASHTO Guide recommends 2.5 for a principal arterial road.)*

So, PSI = 4.2-2.5 = 1.7

(10) Structural Number (SNi)

Based on the values of Cumulative 18-kip ESAL, Elastic Resilient Modulus, Reliability, Standard Deviation, and Design Serviceability Loss, the Structural Number can be obtained using a nomogram prepared in the Guide. The obtained Structural Numbers by road section are summarized in Table 18-2-9.

**Table 18-2-9 Structual Number (SNi)**

| Segument | EUSEBIO AYALA | MARISCAL ESTIGARRIBIA |
|---|---|---|
| Sni | 4.7 | 4.9 |

(11) Layer Coefficient (ai)

The Layer Coefficient of a layer is determined by the characteristics of the layer material.

According to the description of the Guide, the following values have been assumed for this case:

**Table 18-2-10 Layer Coefficients**

| Pavement component | Method, Material | Description | SN |
|---|---|---|---|
| Surface course | Hot-mixed asphalt mixture | | 0.39 |
| Base course | Crushed stone for mechanical stabilization | Modified CBR (more 80) | 0.14 |
| | Bituminous treated cement treated | Hot-mixing, stability (more 350kg/cm2) | 0.31 |
| | Cement treated | Compressive strength at 7days (30kg/cm2) | 0.22 |
| | Lime treated | Compressive strength at 10 days (10kg/cm2) | 0.18 |
| Sub-base course | Crushed Stone | Modified CBR(more 30) | 0.10 |
| | | Modified CBR(more 20) | 0.08 |
| | Cement Treated | Compressive Strength at 7days(10kg/cm2) | 0.10 |

(12) Thickness of each layer

Based on the values of the Structural Number (SNi) and Layer Coefficient (ai) obtained up to this point, the thickness of each layer can be obtained from the following formula:

$SN = a1D1 + a2D2 + a3D3 + \cdots$

*Where, a1,a2,a3 ⋯ = layer coefficients representative of surface, base, and sub- base courses, respectively*

*D1,D2,D3, ⋯ =actual thickness (in inches) of surface, base, and sub-base courses, respectively*

Accordingly, pavement component of each section is as shown in Table 18-2-11.

**Table 18-2-11 Pavement Components**

| SECTION | Pavemmt component | Method, Material | Thickness(cm) |
|---|---|---|---|
| EUSEBIO AYALA | Surface Course | Hot-mixed asphalt mixture | 10 |
| | Base Course | Bituminous treated cement treated | 15 |
| | SubBase Course | Crushed Stone | 35 |
| | Total | | 60 |
| MARISCAL ESTIGARRIBIA | Surface Course | Hot-mixed asphalt mixture | 10 |
| | Base Course | Bituminous treated cement treated | 15 |
| | SubBase Course | Crushed Stone | 40 |
| | Total | | 65 |

### 18.2.4 Viaduct

Four viaducts will be constructed at four intersections on Eusebio Ayala (Fig. 18-2-4). Viaducts will be constructed on roads, which cross Eusebio Ayala.

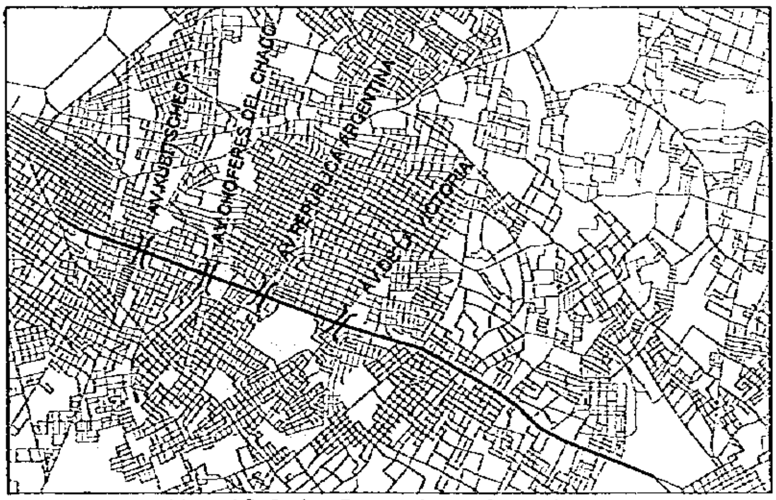



**Fig. 18-2-4 Location of Viaducts**

(1) Design Standards

1) Live Load

AASHTO prescribes hour kinds of live loads. In view of the fact that the designing of the bridges and its Metropolitan Area is at hand, the heaviest, HS20-44 loading shall be used.

2) Earthquake Effects

Although earthquakes are not so frequent in Paraguay, they occasionally happen without damage to structures. The Study shall consider seismic load with the lowest coefficient value prescribed in AASHTO; C=0.06.

3) Clearance

According to AASHTO standard, horizontal clearance is roadway width (including the curbs), and vertical clearance is 16 feet. The Study shall use the rounded figure of 5.0m for vertical clearance.

4) Material Strength

The strengths of cement concrete were decided taking into account the actual conditions in Asunción, and the strength of steel is based on the ASTM standard. The strengths of principal materials are shown in Table 18-2-12.

**Table 18-2-12 Materials Strength**

| Material | Strength |
|---|---|
| Concrete for Superstructure | Fc= 350kg/m2 |
| Pier | Fc= 270kg/m2 |
| Foundation | Fc= 210kg/m2 |
| Prestressed Concrete | Fc= 350kg/m2 |
| Reinforcing Bar (Grade 40) | Fy= 2,800kg/m2 |
| Prestressing Steel (Grade 270) | Fy= 161kg/m2 |
| Structural Steel (M-183) | Fu= 4,000kg/m2 |

Note: fc: specified compressive strength of concrete at 28 days
Fy: specified yield strength of reinforcement
Fu: minimum tension strength

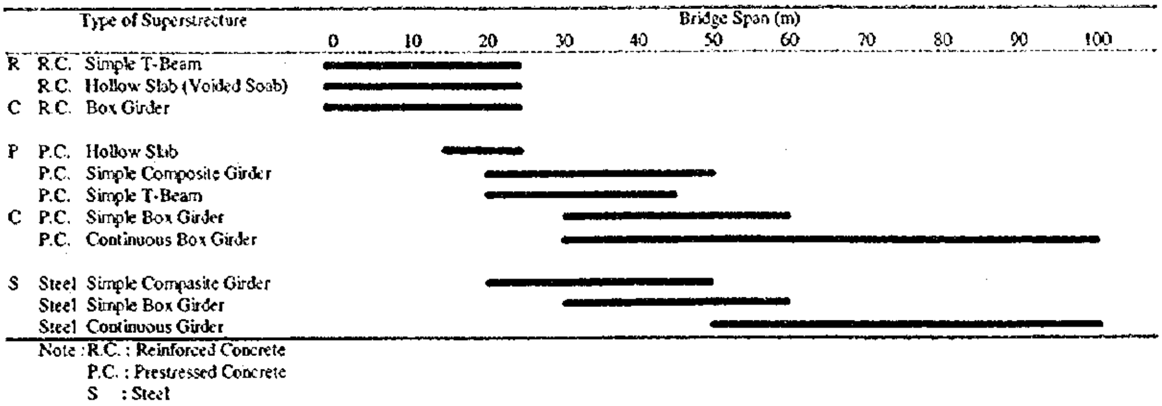
(2) Superstructure of Bridges

1) Types of Bridges

The superstructures of the bridges can generally be classified into tree types: reinforced concrete bridges (hereinafter called "RC bridge"), pre-stressed concrete bridges (hereinafter called "PC bridge") and steel bridges. The general applicable spans of each bridge are given in Table 18-2-13. The RC shall be applied only to small spans, while both the PC and steel bridges shall be applied to small, medium and long spans.

Taking into consideration the size of bridges, maintenance cost, social condition of Asunción City and etc., the PC simple composite girder is adopted for the superstructure of the viaduct.

**Table 18-2-13 Bridge Type Standard Span Application**




2) Span Length

The superstructure span length was determined taking into account the following aspects:

a. Dimension of the intersection
b. Reduction of girder height
c. Location of abutments
d. Lowering the total cost of the bridges

Concerning the abutments, the minimum vertical clearance under the girder was planned at minimum 2.0m. With this provision, the height of the approach retaining wall gets reduced and the existing community separation is avoided to the maximum.

The span length of the viaducts, which are indicated next, are distances taken from the center of the pier to the center of the next pier.

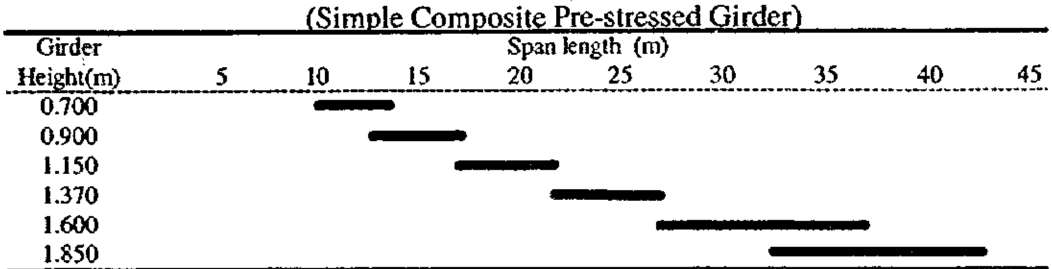
- Kubitscheck : L = 4*38.0 = 152.0m
- Chofe. Chaco : L = 4*38.0 = 152.0m
- Rca.Argentina : L = 5*38.0 = 190.0m
- De la Victoria : L = 3*38.0 = 114.0m

3) Girder Height

Table 18-2-14 shows the relation between the standard girder height and the span length established by AASHTO.

Since span length of the bridge is 38.0m, girder height will be 1.85m.

**Table 18-2-14 Relation Between Span Length and Girder Height**
(Simple Composite Pre-stressed Girder)



(3) Substructure

1) Subsoil Characteristics

The subsoil at the planned bridge site consists of silty to clayey type sand layer called "Patino Formation." The foundations of the structure are planned based on the soil layer at a depth of 3.0 to 10.0m from the surface with an N value of over 50, judging from construction experience in Asunción City.

2) Foundation Type

At present, the soil stratum with "N" value of over 50 is taken as bearing stratum, and considering the economic aspects, ease of construction, water table level, width of work, etc., a direct foundation will be employed when the solid stratum is at a depth of around 5.0m, and in case it gets deeper, a piled foundation will be employed. Considering the small seismic intensity and previous experience, a $\phi$ 400 reinforced concrete prefabricated pile will be adopted.

3) Footing Depth

The depth of the upper surface of the footing will be taken as 1.0m as a minimum, considering the future underground installation, pavement depth, vegetation, etc.

4) Pier Form

Concerning the form of the pier, it could sometimes be restrained by external factors, such as the alignment of the street under the viaduct, etc. Also, from the esthetic point of view, it is necessary to take note of the standardization factor according to conditions such as location, sector, etc. As typical shape of pier, there are three types: rigid frame, T type and wall type. In this project, the most common T type is selected.

5) Foundation Summary

Table 18-2-15 shows the summary of the foundation of each viaduct.

**Table 18-2-15 Summary Table of Foundation**

| Viaduct Location | Pier Type | Foundation | | | | |
|---|---|---|---|---|---|---|
| | | Depth of Solid | Foundation Type | No. of Piles | Dimensioon of the Foundation (m) | Note |
| Kubitscheck Avenue | T type (t=1.5m) | GL-10.0 | With piles (3 units) | L=8.8m<br>75 units | 8.0*5.0*1.3 | |
| Cho. del Chaco Avenue | T type (t=1.5m) | GL-4.0 | Direct (3 units) | | 8.0*6.0*1.2 | |
| Rca. Argentina Avenue | T type (t=1.5m) | GL-4.0 to GL-4.8 | Direct (4 units) | | 8.0*6.0*1.2 | |
| De la Victoria Avenue | T type (t=1.5m) | GL-4.1 to GL-4.2 | Direct (2 units) | | 8.0*6.0*1.2 | |

## 18.3 Other Projects

Apart from above-mentioned projects, there are three projects. These projects are described below.

- Road widening project
- Rainwater drainage project
- Pavement improvement project

### 18.3.1 Road Widening Project

In the road-widening project, the following four roads are covered.

- Avenida Choferes del Chaco
- Avenida Maximo Santos
- Avenida Rafael Franco
- Avenida Julio Correa

(1) Road Design Standards

As for the road-widening project as well, the road design is applied by using each standard shown in Chapter18.1.

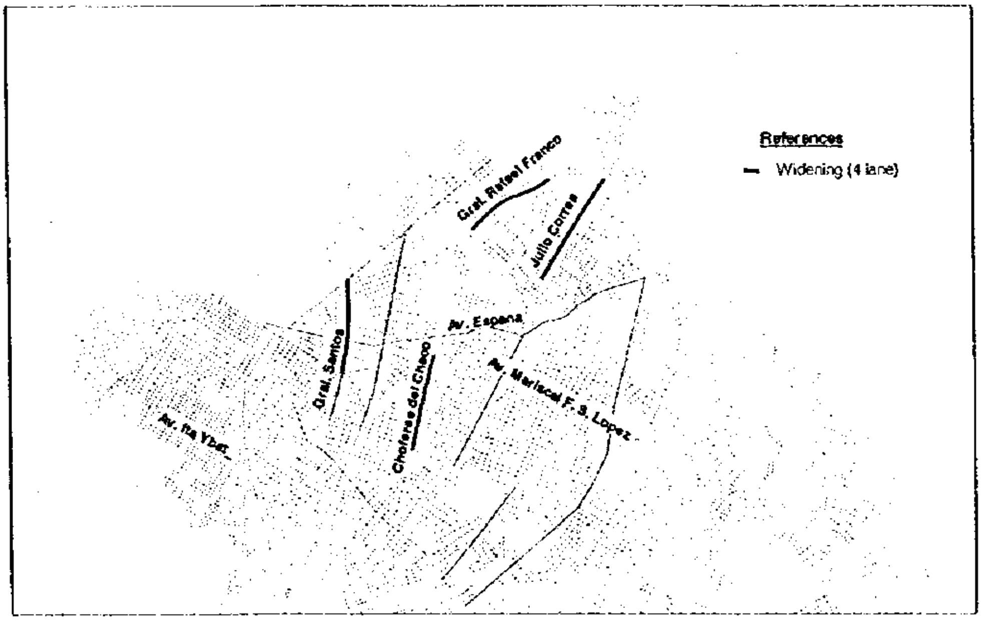



**Fig. 18-3-1 Location of the Road Widening Projects**

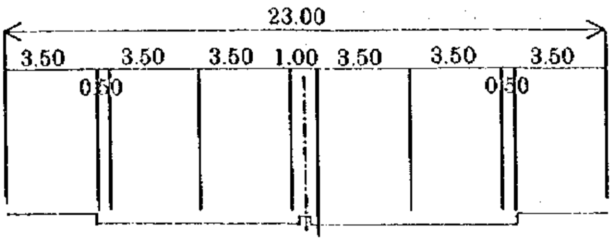
(2) Component of Cross Section

With regard to actual lane component of each road, though their width differs, basically they have two lanes. The total width varies from 15.0m to 22.0m (Table 18-3-1).

Table 18-3-1 Present Cross Section Component of Each Road

| Roads | Sidewalk | | Roadway | Total width |
|---|---|---|---|---|
| | Left (m) | Right (m) | (m) | (m) |
| Avenida Choferes del Chaco | 6.3 | 6.8 | 8.9 | 22.0 |
| Avenida Maximo Santos | 3.0 | 3.0 | 9.0 | 15.0 |
| Avenida Rafael Franco | 3.2 | 2.9 | 9.1 | 15.2 |
| Avenida Julio Correa | 3.5 | 3.3 | 9.0 | 15.8 |

Proposed cross section component is four lanes with sidewalks on both sides. The cross section component is shown below.




(3) Horizontal Alignment

Horizontal alignment of each road is described below.

1) Avenida Choferes del Chaco

This road is going to be the widened from present two lanes to four lanes by widening both sides. Accordingly, actual horizontal alignment will be maintained. Elements of alignment all consist of straight lines and it is very smooth. Right of way is relatively secured and the required width for widening is about 1.0m.

2) Avenida Maximo Santos

The basic concept of widening of this road is the same as Choferes del Chaco. In the future, when the road network will have been improved, this road will be connected to the intersection between access road from Franja Costera, which is planned along Paraguay River, and Avenida Artigas.

As for elements of alignment, the minimum radius is 300m and the alignment is relatively smooth. This road will be widened by about 8.0m.

Since, as for the section from Avenida Ayala to Avenida Mariscal López on Avenida Maximo Santos, 4 lane widening with the median strip and improvement works were mostly completed between the whole division within Avenida Maximo Santos, it considered as the object section of widening of Avenida Mariscal López to Avenida Artigas in this Project.

3) Avenida Rafael Franco

The concept of widening of this road is the same as the above two roads. Like Avenida Maximo Santos, in the future, at the intersection with Ruta Trans Chaco, it will become a four-way intersection with the improvement of Itapua, which runs along the railway.

As for elements of alignment, the minimum radius is 300m and the alignment is relatively smooth. This road will be widened by about 8.0m.

Since some historical buildings called "Patrimony of the Republic house" are identified in three places on the scheduled widening route, the route alignment shall be taken into consideration for being avoided them .

4) Avenida Julio Correa

Between Avenida DR Molas López and Avenida Primer Presidente, the existing road will be widened, as in the case of other roads. However, from the intersection between Julio Correa and Avenida Primer Presidente to Avenida Gregorio Villalba, a new road will be constructed. The purpose of the alignment of the new road is, to connect to Avenida Gragorio Villalba, using -S-shaped alignment. Elements of alignment are a reverse curve, whose radius is 500m to 400m, however, since the radius is relatively large it is considered that there will be no problem in terms of vehicle operation.

In addition, even Avenida Tte.2 do M.Pino Gonzales are included and it is defined as widening plan of Avenida Julio Correa.

(4) Vertical Alignment

The vertical alignment of each road is determined based on the present gradient. The topography of all these road areas is in general flat terrain and alignment is relatively smooth. However, there are some steep points on Julio Correa. The maximum gradient of each road is described below.

| | |
|---|---|
| Avenida Choferes del Chaco: | I=2.88% |
| Avenida Maximo Santos: | I=4.11% |
| Avenida Rafael Franco: | I=1.68% |
| Avenida Julio Correa: | I=8.85% |

### 18.3.2 Intersections

Intersections at start and end point of roads, and Itá Ybaté will be improved. The basic shape of improved intersections is shown in Fig. 18-3-2.

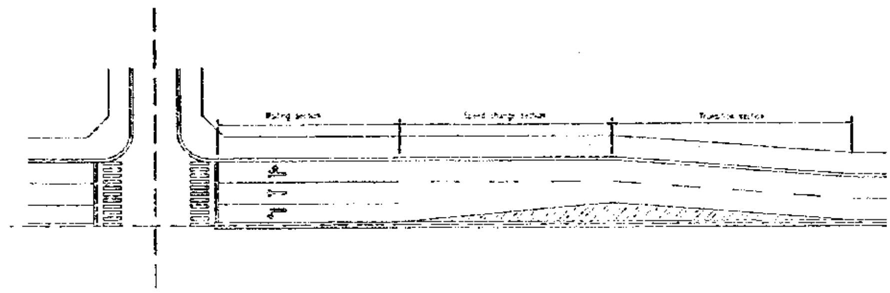


**Fig. 18-3-2 Standard Design of the Intersection**

The waiting lane length was determined for each intersection as shown in Table 18-3-2, according to estimates for future traffic turning demands.
The transition lane extension was planned to ensure the required length for each design speed.

The dimensions for the speed change lane and the exclusive lane are indicated in Table 18-3-3.

**Table 18-3-2 Waiting Lane Length by Avenue**

| Intersection | Artery | Waiting lane length (m) |
|---|---|---|
| Choferes del Chaco - Mriscal Lopez | Mariscal Lopez (W) | 145.0 |
| | Mariscal Lopez (E) | 30.0 |
| | Choferes del Chaco | 30.0 |
| | Santisimo Sacramento | 30.0 |
| Maximo Santos - Mariscal Lopez | Mariscal Lopez (W) | 30.0 |
| | Mariscal Lopez (E) | 30.0 |
| | Maximo Santos (N) | 30.0 |
| | Maximo Santos (S) | 30.0 |
| Maximo Santos - Artigas | Artigas (W) | 30.0 |
| | Artigas (E) | 30.0 |
| | Maximo Santos (N) | 35.0 |
| | Maximo Santos (S) | - |
| | New Road | 30.0 |
| Rafael Franco - Santisimo Sacramento | Santisimo Sacramento (N) | 30.0 |
| | Santisimo Sacramento (S) | - |
| | Rafael Franco | - |
| Rafael Franco - Ruta Transchaco | Ruta Transchaco (W) | 30.0 |
| | Ruta Transchaco (E) | 75.0 |
| | Rafael Franco | 30.0 |
| | Itapua | 50.0 |
| Julio Crrea - Molas Lopez | Molas Lopez (N) | 30.0 |
| | Molas Lopez (S) | 30.0 |
| | Julio Crrea | 50.0 |
| | Bogarin | 30.0 |
| Julio Crrea - Gregorio Vilalba | Gregorio Vilalba | 30.0 |
| | Julio Crrea | - |
| | Itapua (N) | - |
| | Itapua (S) | - |
| Ita Ybate - J.F.Bogado | J.F.Bogado (N) | - |
| | J.F.Bogado (S) | 30.0 |
| | Ita Ybate | - |

**Table 18-3-3 Design Standard of Exclusive Lane for Left Turn**

| Design speed (km/h) | Speed change lane (m) | Transition lane (m) |
|---|---|---|
| 60 | 35 | 40 |
| 40 | 30 | 40 |

### 18.3.3 Rain Water Drainage Improvement

Rainwater drainage system at the following critical points will be improved.

-Avenida Mariscal López and Avenida Choferes del Chaco
-Avenida Mariscal López and Avenida General Garay
-Avenida Mariscal López and Avenida San Martin
-Avenida Mariscal López and Bernardino Caballero

Their locations, catchment basin and catchment basin areas are shown in Fig. 18-3-3.

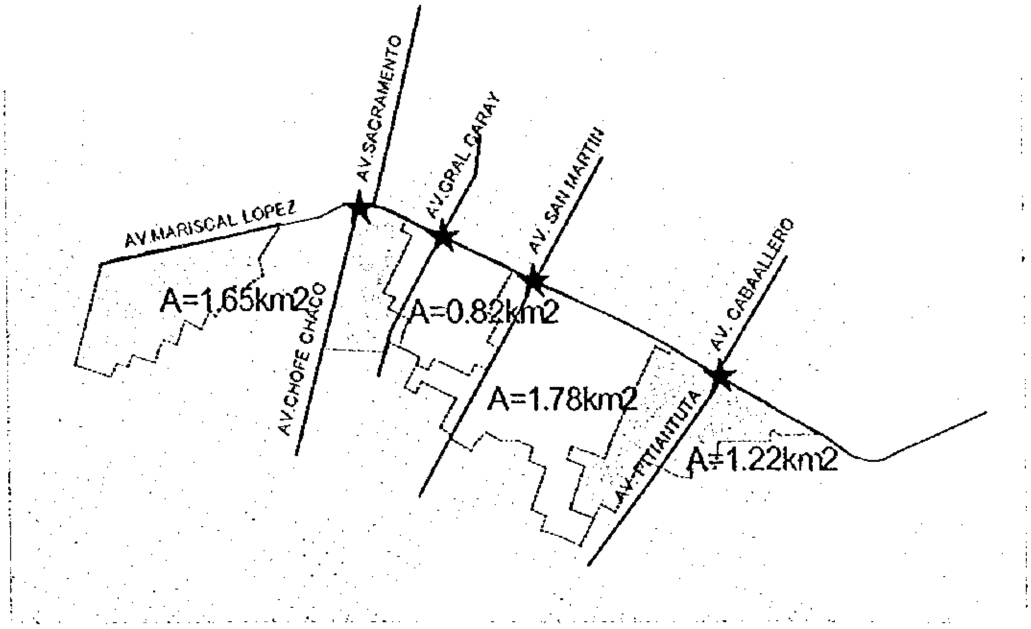



Fig. 18-3-3 Location of Roadway Drainage to be Improved

(1) Rainwater Drainage Facility Design Standards

The same standards, which are used for drainage facility design in 18-2-2, are applied.

(2) Drainage in Each Section

1) Avenida Mariscal Lopez and Avenida General Santos

The catchment basin at this intersection is Mburicao River. The area of this basin is shown in Fig. 18-3-2. The down stream of this drainage system is planned to be on a Centro side of the intersection on Mariscal Lopez. The discharge at down stream is 15.81m3/s. A pipe culvert, whose diameter is 2.0m, is used for the largest drainage facility.

2) Avenida Mariscal Lopez and Avenida General Garay

The down stream of this drainage system is Mburicao River. The exact location of down stream is 200m to the north of the intersection on Avenida General Garay. The discharge at down stream is 8.45m3/s. A pipe culvert, whose diameter is 1.5m, is used for the largest drainage facility.

3) Avenida Mariscal Lopez and Avenida San Martin

The down stream of this drainage is also Mburicao River. The location of down stream is 300m to the north of the intersection on Avenida San Martin. The discharge at down stream is 20.91m3/s. A box culvert of 2.0mx2.0m is used for the largest drainage facility.

4) Avenida Mariscal Lopez and Bernardino Caballero

The catchment basin of this intersection is Ytai River. The location of down stream is situated at the intersection between Avenida Mariscal Lopez and Avenida Madame Lynch. The distance from the intersection to down stream is 700m and relatively long. The discharge at down stream is 12.59m3. A pipe culvert, whose diameter is 2.0m, is used for the largest drainage facility.

(3) Drainage Facilities

The Location of drainage facilities is shown in Fig. 18-3-4. Drainage structures at each location are shown in Table 18-3-4.

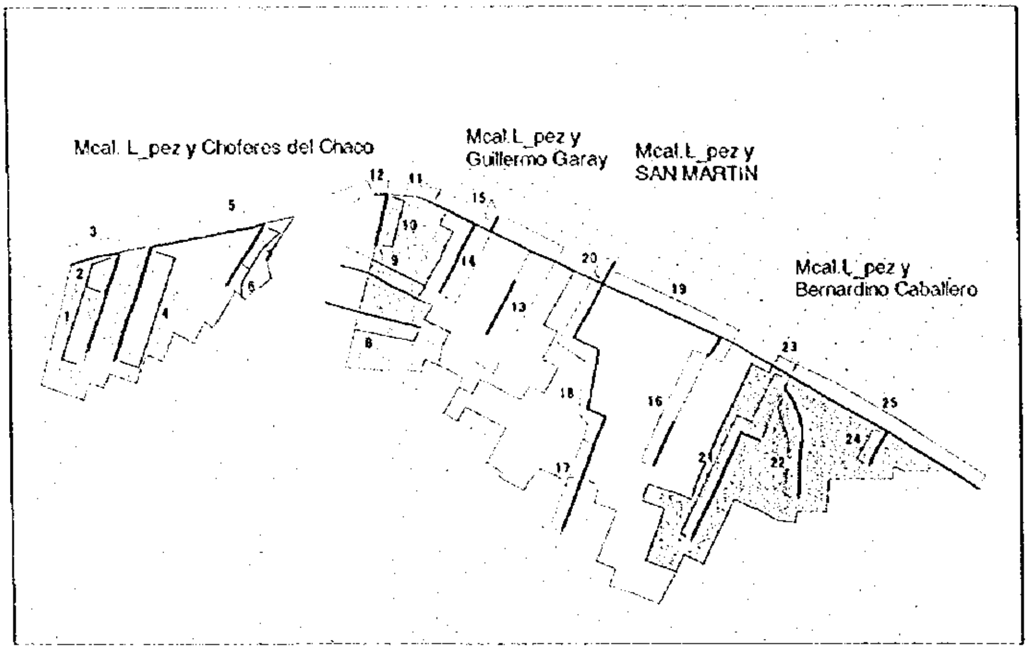



**Fig. 18-3-4 Location of Drainage Facilities**

**Table 18-3-4 Drainage Structures at Each Location**

| Catchment Basin NO | Drainage Facilities | | | Length | Catchment Basin NO | Drainage Facilities | | | Length |
|---|---|---|---|---|---|---|---|---|---|
| CHOFERES DEL CHACO | | | | | SAN MARTIN | | | | |
| 1 | PIPE | . | 1.0 | 500 | 16 | PIPE | . | 1.5 | 1,220 |
| 2 | PIPE | . | 1.5 | 250 | 17 | PIPE | . | 1.5 | 590 |
| 3 | PIPE | . | 0.5 | 310 | 18 | PIPE | . | 2.0 | 1,280 |
| 4 | PIPE | . | 1.0 | 780 | 19 | PIPE | . | 1.5 | 580 |
| 5 | PIPE | . | 2.0 | 1,680 | 20 | BOX | 2.5*2.0 | | 110 |
| 6 | PIPE | . | 1.0 | 160 | CABALLERO | | | | |
| 7 | PIPE | . | 1.5 | 300 | 21 | PIPE | . | 1.5 | 1,350 |
| 8 | PIPE | . | 1.5 | 610 | 22 | PIPE | . | 1.5 | 1,000 |
| 9 | PIPE | . | 1.0 | 550 | 23 | PIPE | . | 1.0 | 150 |
| 10 | PIPE | . | 1.0 | 300 | 24 | PIPE | . | 1.0 | 250 |
| 11 | PIPE | . | 1.0 | 310 | 25 | PIPE | . | 2.0 | 1,400 |
| 12 | PIPE | . | 1.5 | 250 | | | | | |
| GNAL GARAY | | | | | | | | | |
| 13 | PIPE | . | 1.5 | 1,100 | | | | | |
| 14 | PIPE | . | 1.0 | 600 | | | | | |
| 15 | PIPE | . | 1.5 | 100 | | | | | |
| | | | | | | | | | |

### 18.3.4 Pavement Planning

Asphalt pavement of Itá Ybaté has been planned. Actual pavement is boulder pavement. The same design standards and calculation as in the section 18.2.3 are used.

In this section, only principal conditions and results are described.

(1) Design Traffic

Traffic volume in the year 2005 and 2015 will be as shown in Table 18-3-5.

**Table 18-3-5 Design Traffic**

| Road section | Year | Passenger cars | Buses |
|---|---|---|---|
| ITA YBATE | 2005 | 14,445 | 146 |
| | 2015 | 18,379 | 160 |
| Design Traffic | | 59,903,800 | 558,450 |

(2) Structural Number (SNi)

Structural number has been calculated based on the above design traffic. The same formula, which is used in 18.2.3, has been utilized. The result is shown in Table 18-3-6

**Table 18-3-6 Structural Number (SNi)**

| Segment | Ita Ybate |
|---|---|
| Sni | 2.7 |

(3) Pavement Component

Pavement component is shown in the table below.

**Table 18-3-7 Pavement Component**

| Section | Pavement component | Method and Material | Thickness (cm) |
|---|---|---|---|
| Ita Ybate | Surface Course | Hot-mixed asphalt mixture | 8 |
| | Base Course | Bituminous treated cement treated | 14 |
| | SubBase Course | Crushed Stone | 18 |
| | Total | | 40 |

## 18.4 Project Cost Estimation

### 18.4.1 Costs of Priority Projects Examined for Feasibility Study

(1) Widening Project of Av. E. Ayala

1) Project Summary

Components of the project can be summarized as follows, and Fig. 18-4-1 illustrates them.

- Widening
- Construction of exclusive lanes for trunk buses
- Construction of four flyovers, including improvements of the connecting roads
- Improvements of major intersections
- Improvements of drainage facilities

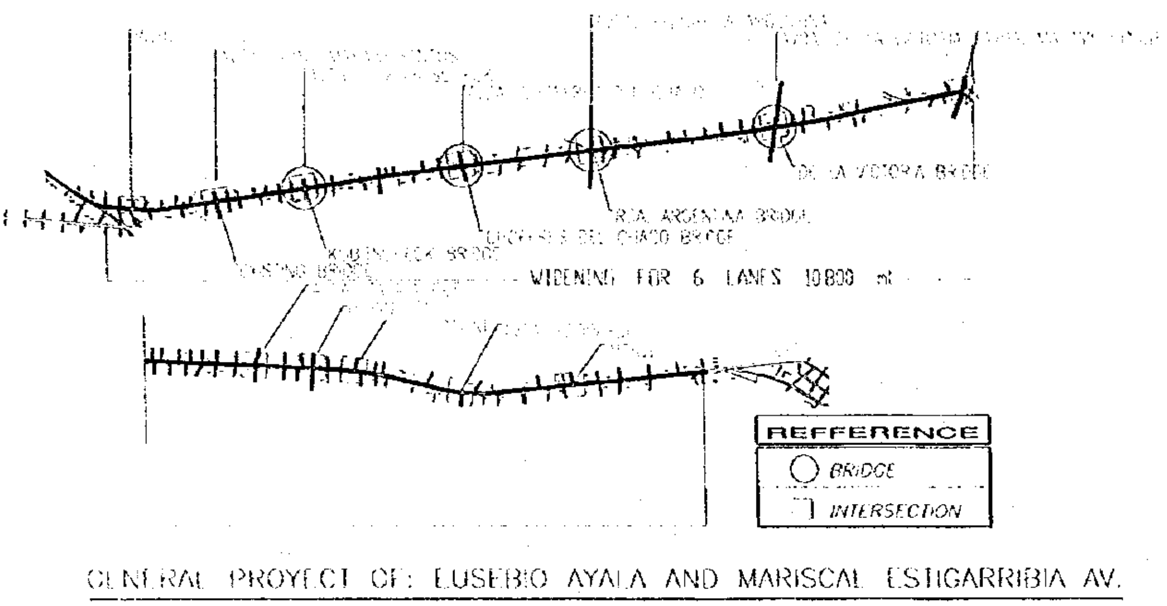



**Fig. 18-4-1 Summary of Widening Project on Av. E. Ayala**

2) Project Costs

Costs have been estimated for different types of construction works, based on data obtained from interviews with the Municipality of Asunción, MOPC, and AGA.

Main types of construction works include preparation works, pavement, earth works, drainage, retaining walls, flyovers, and other works. Based on representative unit costs for each work type, cost estimation has been conducted, taking into account expected changes in pavement structure in Asunción and between Mme Lynch and San Lorenzo. Table 18-4-1 shows its results.

## Table 18-4-1 Summary Cost Estimation of Av. E. Ayala

Rate:1US$=3000Gs=120Yen

| Item | Unit | Quantity | Unit Praice | | Total Prace (Mill Gs) | | Total F (1000US$) |
|---|---|---|---|---|---|---|---|
| | | | Foreign (US$) | Financial (Gs) | Foreign (US$) | Financial (Gs) | |
| 1. Preparation Works | | | | | | | |
| Clearing and Grubbing | m2 | 37,985 | 0.49 | 1,374 | 18,712.21 | 52,202,202 | 36 |
| Demolesh works | m3 | 234,767 | 12.81 | 39,018 | 3,006,633.27 | 9,160,235,832 | 6,060 |
| Sub-1 | | | | | 3,025,345.47 | 9,212,438,034 | 6,096 |
| 2. Pavement | | | | | | | |
| Road Asphalt Type I (10+15+35) | m2 | 275,756 | 23.12 | 56,104 | 6,374,513.57 | 15,471,000,836 | 11,532 |
| Road Asphalt Type II (10+15+40) | m2 | 175,507 | 24.24 | 58,833 | 4,254,816.20 | 10,325,550,679 | 7,697 |
| Footway Pavement | m2 | 151,817 | 5.76 | 34,780 | 875,156.69 | 5,280,240,046 | 2,635 |
| Sub-2 | | | | | 11,504,486.46 | 31,076,791,561 | 21,863 |
| 3. Earth Work | | | | | | | |
| Excavation(Common) | m3 | 64,556 | 2.26 | 5,784 | 145,751.75 | 373,387,318 | 270 |
| Embaankment | m3 | 18,424 | 3.16 | 7,999 | 58,137.15 | 147,379,969 | 107 |
| Disposal soil (L=5km) | m3 | 46,132 | 1.51 | 4,505 | 69,710.07 | 207,835,386 | 139 |
| Sub-3 | | | | | 273,598.96 | 728,602,672 | 516 |
| 4. Drainage | | | | | | | |
| Pipe Culvert (D=50cm) | m | 10,295 | 56.64 | 156,956 | 583,071.31 | 1,615,859,854 | 1,122 |
| Pipe Culvert (D=100cm) | m | 5,700 | 158.87 | 388,752 | 905,549.99 | 2,215,886,644 | 1,644 |
| Pipe Culvert (D=150cm) | m | 3,400 | 240.04 | 580,222 | 816,146.21 | 1,972,754,456 | 1,474 |
| Pipe Culvert (D=200cm) | m | 3,160 | 398.65 | 908,172 | 1,259,732.96 | 2,869,823,890 | 2,216 |
| Box Culvert (B=2.0m,H=2.0m) | m | 240 | 547.41 | 1,634,517 | 131,378.19 | 392,284,060 | 262 |
| Box Culvert (B=2.5m,H=2.0m) | m | 90 | 657.58 | 2,000,600 | 59,182.07 | 180,053,973 | 119 |
| Catch basin (1.2m x 1.2m) | No | 1,184 | 184.43 | 723,668 | 218,360.38 | 856,822,912 | 504 |
| Sub-4 | | | | | 3,973,421.11 | 10,103,485,789 | 7,341 |
| 5. Retainning Wall | | | | | | | |
| RC Ritainning Wall (h=2.0m) | m | 1238 | 70.02 | 295,682 | 86,689.87 | 366,054,427 | 209 |
| RC Ritainning Wall (h=5.5m with pill) | m | 90 | 896.04 | 2,464,104 | 80,643.60 | 221,769,355 | 155 |
| RC Ritainning Wall (h=6.0m with pill) | m | 100 | 921.43 | 2,569,558 | 92,142.54 | 256,955,764 | 178 |
| RC Ritainning Wall (h=7.0m) | m | 70 | 524.66 | 1,854,509 | 36,726.10 | 129,815,603 | 80 |
| RC Ritainning Wall (h=8.0m) | m | 150 | 669.64 | 2,329,634 | 100,445.32 | 349,445,062 | 217 |
| RC Ritainning Wall (h=8.5m) | m | 160 | 744.39 | 2,573,324 | 119,102.12 | 411,731,806 | 256 |
| Sub-5 | | | | | 515,749.55 | 1,735,772,018 | 1,094 |
| 6. Flyover | | | | | | | |
| JUSCEKINO KUBITSCHECK | unit | | | | 566,116.74 | 1,541,012,676 | 1,080 |
| CHOFERES DEL CHACO | unit | | | | 530,459.37 | 1,523,096,429 | 1,038 |
| REPUBLIVA ARGENTINA | unit | | | | 655,954.90 | 1,881,676,389 | 1,283 |
| DE LA VICTORIA | unit | | | | 400,327.11 | 1,152,888,465 | 785 |
| Sub-6 | | | | | 2,152,858.13 | 6,098,673,959 | 4,186 |
| 7. Trunk Bus Stops | unit | 20 | | 115,224,150 | 0.00 | 2,304,483,000 | 768 |
| 8. Miscellaneous Works | | | | | | | |
| Lighting | No | 756 | 1,085.10 | 957,649 | 820,335.60 | 723,982,644 | 1,062 |
| Line Marking | m | 34,730 | 0.66 | 1,567 | 23,088.40 | 54,431,313 | 41 |
| Concrete Curb (for Side) | m | 20,073 | 0.00 | 23,249 | 0.00 | 466,670,959 | 156 |
| Concrete Curb (for Median) | m | 12,637 | 1.29 | 47,372 | 16,257.50 | 598,635,478 | 216 |
| Sub-7 | | | | | 859,681.50 | 1,843,720,394 | 1,474 |
| 9. Mobilization & Other Works (30% of Total Cost) | | | | | 6,691,542.36 | 18,931,190,243 | 13,002 |
| 10. Sub-Total | | | | | 28,996,683.54 | 82,035,157,720 | 56,342 |
| 11. Engineering Cost (10% of 9) | | | | | 2,899,668.35 | 8,203,515,772 | 5,634 |
| 12. Contingency (10% of 9+10) | | | | | 3,189,635.19 | 9,023,867,349 | 6,198 |
| Ground Total Cost (9+10+11) | | | | | 35,085,987.08 | 99,262,540,841 | 68,174 |

According to the roadside field survey, there are 157 houses and buildings with an area of 65,515m$^2$, 96 parcels of land, or an area of 27,509m$^2$, and in total 253 cases of 93,024m$^2$ will be affected by the project. The acquisition of them will require US$8.18 million.

Likewise, costs for land acquisition required to build flyovers are estimated at US$2.02 million, and land related to widening of Av. E. Ayala will costUS$10.2 million.

The total number of bus stops installed on major intersections in the widened section is 20 (10 intersections), they will be equipped with roofs. One bus stop costs US$38,400, and US$768,000 for the 20 in total.

(2) Other Improvement Projects

Other projects related to road infrastructure include road widening (4 lanes), improvements of surface drainage (1 lane), and pavement improvements (1 lane). Roads for each project are described below, and Fig. 18-4-2 shows the summary.

- Widening: Gral Santos, Chof. del Chaco, Rafael Franco, and Julio Correa. Correa includes a section on Tte. 2do M. Pino Gonzalez.
- Drainage: Mcal López
- Pavement: Itá Ybaté


**Fig. 18-4-2 Summary of Other Road Projects**

Components of the widening project are earth works, drainage, retaining walls, flyovers, and others. It is assumed that unit costs of the Ayala project can be applied, and costs are estimated based on construction costs of 1km.

The number of buildings affected on the above four roads and their land values are described below.

- Gral. Santos: 46 units, US$2.17 million
- Chof. del Chaco: 13 units, US$0.24 million
- Rafael Franco: 28 units, US$0.98 million
- Julio Correa (including Tte. 2do M.Pino Gonzalez): 24 units, US$1.68 million

The four-lane section contains 111 units in total, and land acquisition costs US$5.02 million. Table 18-4-2 shows the total construction costs for each road.

**Table 18-4-2 Cost Estimation of Other Road Projects**

Unit:Cost(1000US$)

| Widening Project for 4 lane | Construction | Land | Total |
|---|---|---|---|
| Avenida Maximo Santos | 2,855 | 2,147 | 5,002 |
| Avenida Choferes del Chaco | 3,412 | 244 | 3,656 |
| Avenida Rafael Franco | 2,986 | 984 | 3,970 |
| Avenida Julio Correa | 3,804 | 1,648 | 5,452 |
| Total(4 ruoute) | 13,057 | 5,023 | 18,080 |

| Drainage Project | Cost(1000US$) |
|---|---|
| Avenida Mariscal Lopez | 8849 |

| Pavement Project | Cost(1000US$) |
|---|---|
| Ita Ybate | 2,613 |

## 18.5 Construction Method of the Widening of Eusebio Ayala Avenue

For the widening of Eusebio Ayala Avenue, the same construction method as AGA project will be adopted.

### 18.5.1 Regulation of Traffic during the Construction Work

In order to secure smooth traffic flow during the construction work, simultaneous traffic regulation on both sides of Eusebio Ayala will not be adopted.
The widening will be executed only on one side, which consists of three lanes and sidewalk, and the other side will be operated.
During the period in which one side is under construction, among passable three lanes on the other side, two lanes are operated for the same direction as before the construction and one lane is used for the opposite direction.
In order to secure traffic flow, during the traffic regulation, drivers will be warned by traffic signs. The first traffic sign on traffic regulation is placed 450m ahead of the construction site and the other signs are placed every 150m to the site.

### 18.5.2 Procedure of Road Widening

1) Widening of roadway in order to secure 35m of width
2) Removal of existing asphalt pavement of roadway and median strips
   -General Aquino-Madame Lynch: 60cm of thickness
   -Madame Lynch-San Lorenzo: 65cm of thickness
3) Paving of widened roadway with asphalt
4) Construction of sidewalk

After the completion of above-mentioned work on one side, the completed side will be operated and the widening of the other side will be executed in the same way.

### 18.5.3 Maintenance System of Widened Eusebio Ayala

Due to the lack of finances of Asuncion City at this moment, there is no efficient maintenance system for roads. Accordingly, in this project, which consists of the introduction of trunk bus system and the widening of Eusebio Ayala to six lanes, the following road maintenance system will be recommended since heavy two-car buses will pass on the trunk bus lane, which is painted yellow.

Road Maintenance System:

Ordinary Maintenance: to identify pavement damages, road mark fading and the conditions of traffic signs. Damages on roads, which are caused by traffic accidents, etc., will also be checked.

1) Periodical Maintenance (once in every two to three years): to principally check the conditions of bridges, in terms of existence of cracks and the necessity of repainting.
2) Overlay: to execute overlay on asphalt pavement, which covers all the trace of six lanes, basically every 10 years. In addition to that, trunk bus lane will be repainted yellow.

# Chapter 19 Traffic Management Plan

## 19.1 Traffic Signal Control Plan

### 19.1.1 Current Conditions

There are 178 signalized intersections in Asunción (Fig.19-1-1). Policía Municipal de Tránsito, or PMT, under the Urban Area General Direction of the Municipality of Asunción, controls signals.

As shown in Fig.19-1-2, traffic signals are centrally controlled in Centro, but other radial roads employ a multi-pattern fixed-time control system, not a coordinated control system.

The structure of a central control system consists, as shown in Fig. 19-1-3, of two controllers, a keyboard, a data printer, and a projector for the panel. The control center manages signals at 44 different locations.

Terminal equipment includes 85 vehicle detectors, other than signals and control boxes.

According to the logic pre-programmed in the control center, traffic signals are automatically controlled, based on the real-time data obtained from the vehicle detectors.

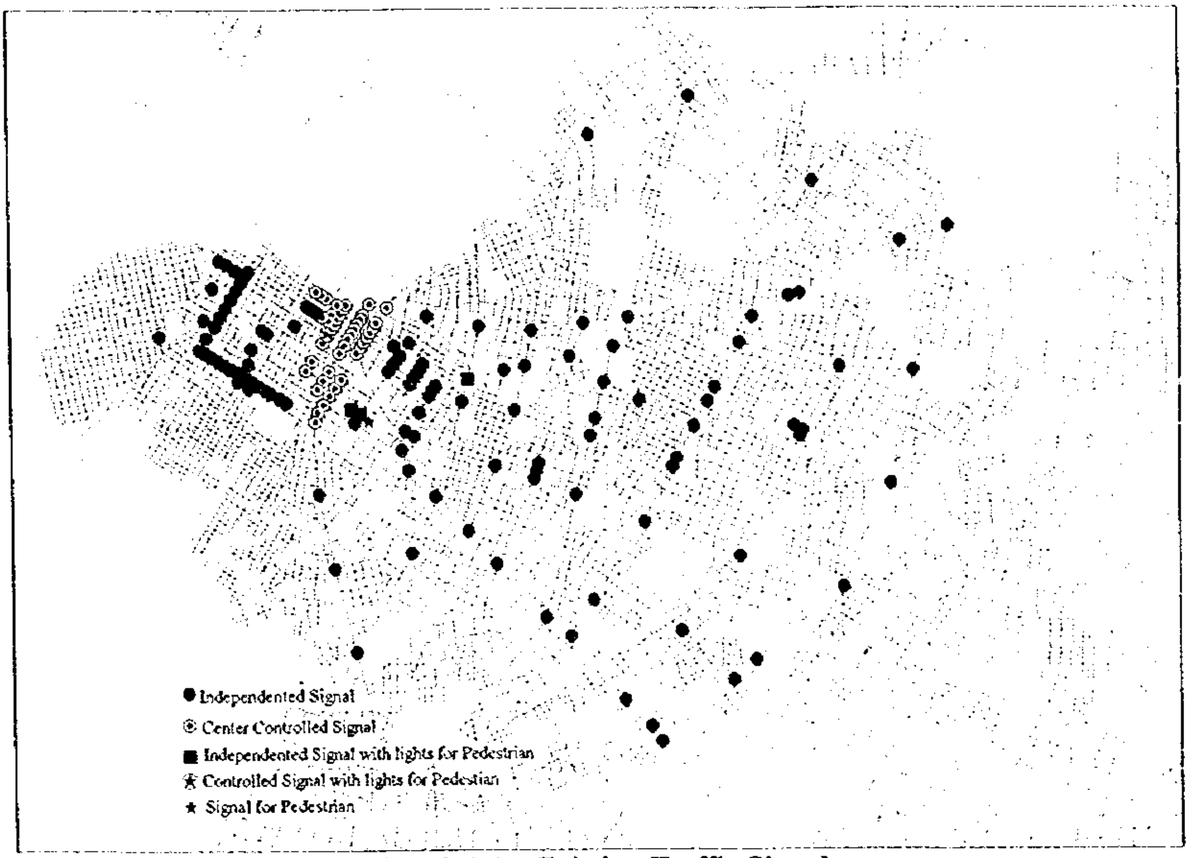



**Fig. 19-1-1 Existing Traffic Signals**

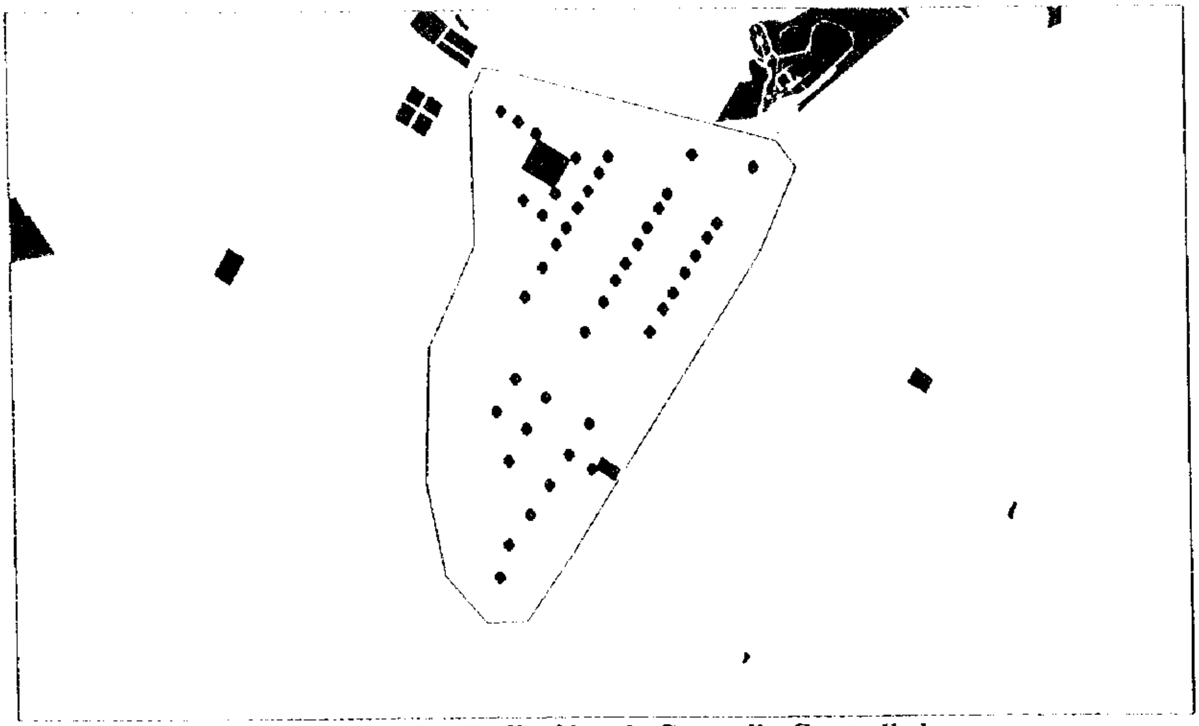


Fig. 19-1-2 Traffic Signals Centrally Controlled

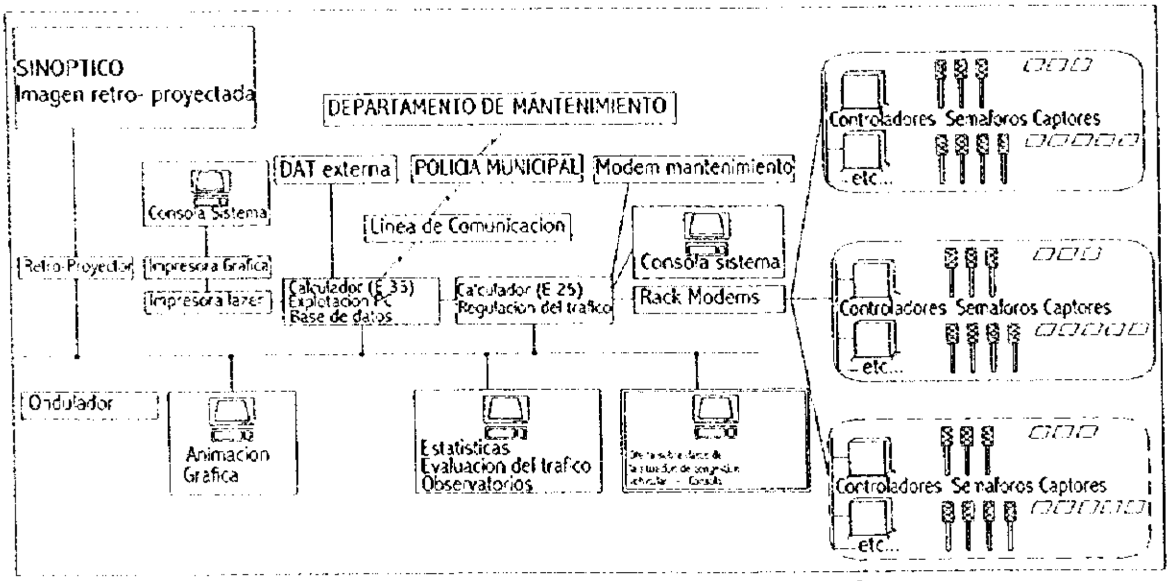



Fig. 19-1-3 Central Center of Traffic Control System

### 19.1.2 Problems with the Current Conditions

There are five problems regarding the current practice of the traffic signal control system.

- It is not possible to identify the real-time traffic flow.
- Control is not based on traffic data.
- Distances between signals are short in Centro.
- It is difficult to recognize signals because they are small and set too close to the vehicles stopping for red lights (Fig. 19-1-4).
- There is little coordination among signal control, marking, and traffic control.

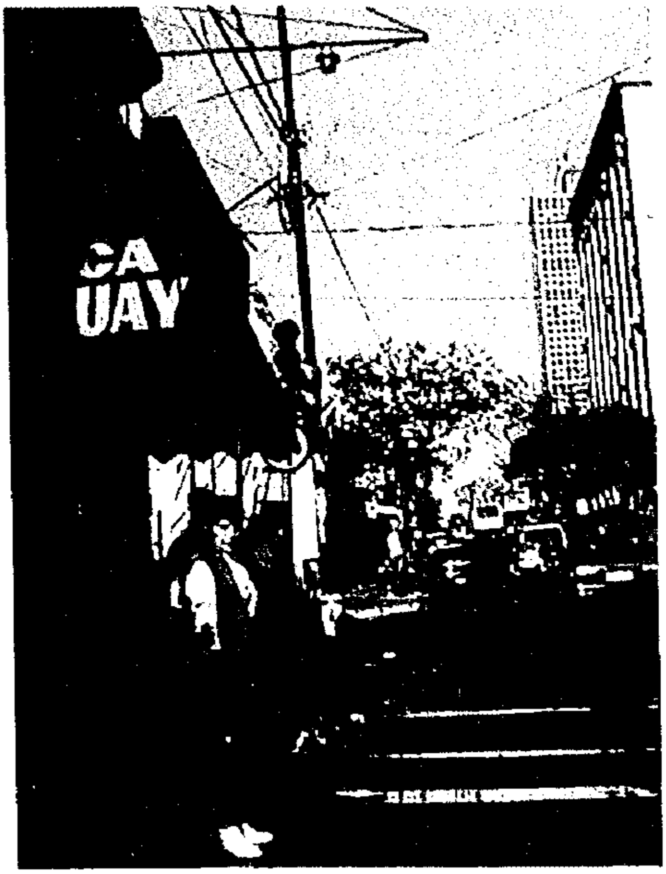


Fig. 19-1-4 Existing Signal Lights

### 19.1.3 Planning Concept

The traffic signal control system will be improved by utilizing the existing signal system.

In order to accommodate commuter traffic at rush hours in the morning and evening, the bus network and traffic control will be coordinated in Centro, and a coordinated control will be introduced in arterial roads such as Av. Ayala, Av. España, Av. Mcal. Lopéz, Av. Fdo. de la Mora, Av. Cnel. Bogado.
The control center will automatically control all the signals. In so doing, each intersection will be equipped with vehicle detectors and process traffic data.

Av. Ayala, with a new trunk bus system introduced, will use signals that give priority to buses. Therefore, it is necessary to install bus detectors at major points in the section between San Lorenzo and Centro and control the signals by coordinating them with the central control system.

### 19.1.4 Plan Content

1) Target Area

The target area is divided into two parts. One is an area in Centro surrounded by Av. Cnel. Bogado and Av. Figueroa as north-south axes, and Av. EEUU and Av. Colon as east-west axes. The other includes the sections of the major arterial roads, namely Av. España, Av. Mcal. López, Av. E. Ayala, Av. Fdo. de la Mora, and Av. Cnel. Bogado, starting in Centro and ending at the intersections with Av. Mme. Lynch. Fig.19-1-5 shows this target area.

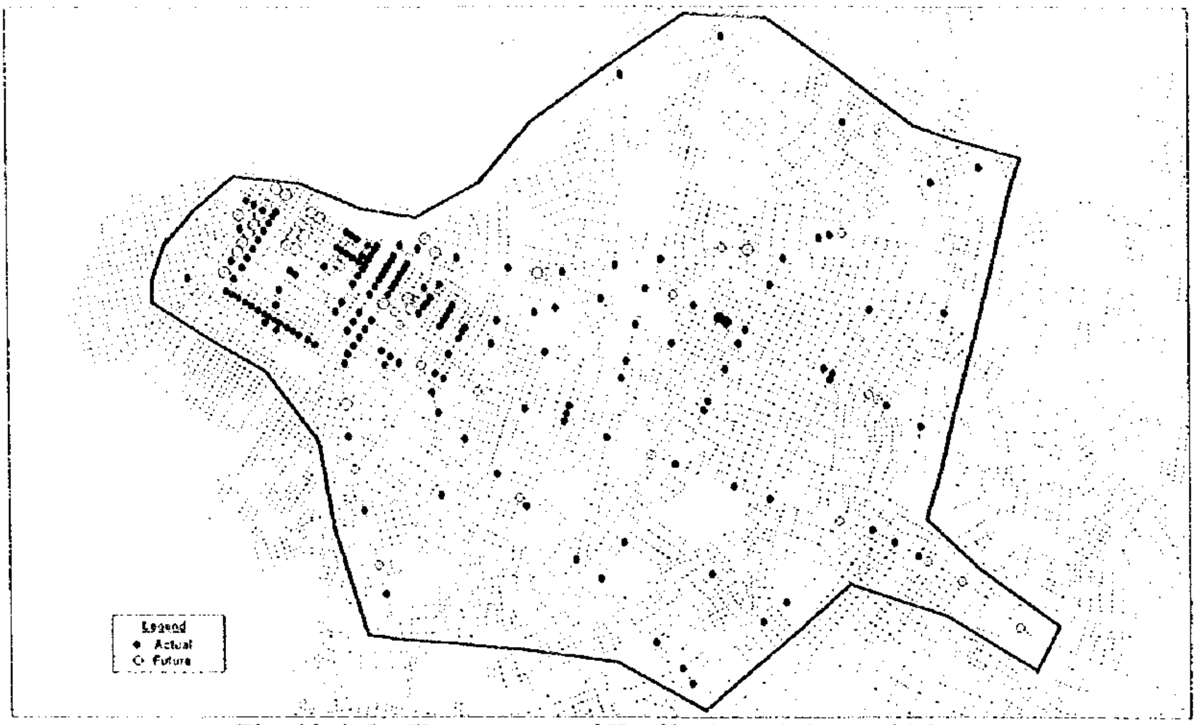



**Fig. 19-1-5 Target Area of Traffic Signal Control Plan**

2) Necessary Functions

The current system is capable of controlling 300 intersections. However, there is little communication between the system administrator and equipment, and it is not ready to respond to traffic flow that changes every hour.

In future, there will be demands for new functions in response to an increase in traffic volume and newly constructed roads. In particular, it is necessary to introduce a new control system including traffic demand management that takes into account the inflow of traffic from surrounding cities such as Lambaré, Fernando de la Mora, Luque, Mariano R. Alonso, and San Lorenzo.

Basic functions for traffic signal control in Asunción should be:

- To monitor traffic conditions real-time
- To raise the capacity to monitor the control.
- To collect traffic data automatically and use them to update the control system.
- To introduce a man-machine system and respond to sudden accidents like change in traffic flow and equipment breakdowns.
- To be expandable to accommodate future traffic demand and transport plan.
- To provide information to road users.
- To standardize the control system.

3) System Components

(1) Traffic Signal Control

The control scheme in Centro should be area-wide in order to respond to an increase in the system scale. Thus, it is necessary to modify and improve the logic of the existing system.

The arterial roads should have a new central control system and introduce a traffic-actuated control scheme by installing detectors at major intersections.

The linear control system sets an offset that prioritizes traffic flow toward Centro during the morning peak hours and that toward the suburbs during the evening peak hours.

In order to control them, it is necessary to coordinate traffic signals and set control segment as shown in Fig. 19-1-6.

In order to determine parameters for traffic signals, it is necessary to collect real-time traffic data from vehicle detectors and calculate saturation flows with the control center equipment. The parameters obtained above are put into the pre-programmed logic and used to determine signal cycles, phases, splits, and offsets.

Data of the results are stored as statistically processed data with the preset frequencies.

The system components are as follows. The current system contains most of the following components but there is a need to expand them and update the software.

- Collection of data
- Processing and arrangement of data
- Display of processed data
- Communication by the man-machine system
- Equipment management
- Storing of statistical data
- Monitoring of control
- Provision of information to users

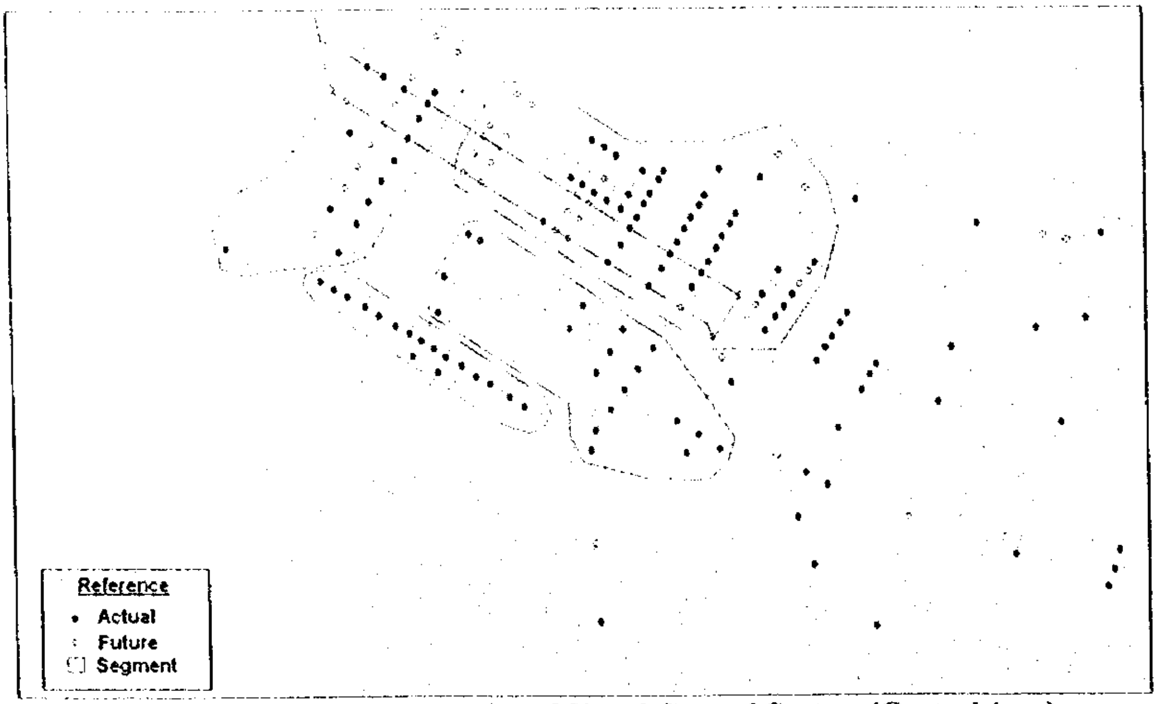



**Fig. 19-1-6 (1) Coverage Area of Signal Control System (Central Area)**

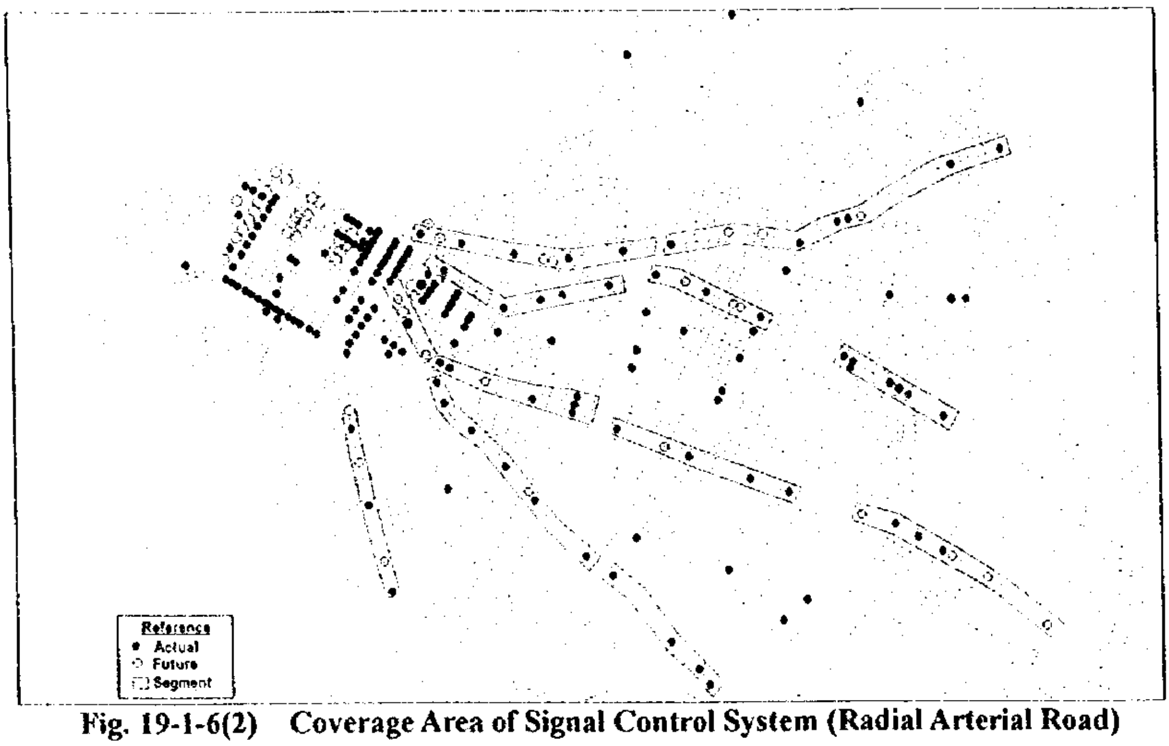



**Fig. 19-1-6(2) Coverage Area of Signal Control System (Radial Arterial Road)**

(2) System Equipment

Based on the existing equipment, requirements of the hardware for a local controller at signalized intersections is to increase signals, control boxes, and vehicle detectors.

In the control center, the existing equipment is mostly sufficient, but it is necessary to increase the memory of the central processing equipment. Table 19-1-1 shows system equipment requirements at the center and terminals.

By building up the data collection equipment via vehicle detectors, it is possible to identify congestion conditions of a large area. For the sake of traffic control, congestion information will be distributed through the media such as radio and television, to road users.

**Table 19-1-1 Components of Signal Control System**

| Location | Equipment | Unit | Existed | Planned | Remarks |
|---|---|---|---|---|---|
| Terminals | Traffic Signal | Piece | 178(44) | +54 | One per intersection<br>Existing 44 are centrally controlled<br>Planned ones are all centrally controlled |
| | Control Box | Set | 178 | +54 | |
| | Vehicle Detector | Piece | 85 | 60 | All approaches of key intersection |
| Central Equipment | Central Control Equipment (Database) | Set | 1 | - | |
| | Central Control Equipment (Control) | Set | 1 | 1 | Memory Built-Up |
| | Console (System) | Set | 1 | 1 | |
| | Console (Statistics) | Set | 1 | - | |
| | Console (Graphics) | Set | 1 | - | |
| | Display Equipment (Console) | Set | 1 | - | |
| | Display Equipment (Projector) | LS | 1 | - | |
| | Printer | Set | 2 | - | |
| | Modem | Set | 1 | - | |
| | Electricity Supply Equipment | Set | 1 | - | |
| | Air Conditioner | Set | 1 | - | |
| | Information Provision Facility | LS | - | 1 | Radio, and TV broadcasting equipment |

A. Traffic Signals

Currently, many traffic accidents occur even at signalized intersections. It is difficult to recognize signals because they are small and set too close to the vehicles that stop at red lights. As an improvement measure, it is suggested that as shown in Fig. 19-1-7, the current signal lights of 25 cm in diameter be changed into 30 cm. Moreover, overhead signals will be installed, and they will be also installed for the traffic of the opposite direction at intersections with a large volume of heavy vehicles.

B. Vehicle Detectors

Currently, vehicle detectors are installed mostly in Centro, and their purpose is to control signals on-line. In response to an increase in traffic volume and inflow traffic to Centro resulting from the use of the radial arterial roads, vehicle detectors will be installed at key intersections shown in Fig. 19-1-8 to grasp traffic conditions and collect data for control.

These vehicle detectors will be newly installed, as shown in Fig. 19-1-9, at 50 to 300 meters before the mouth of the intersection to detect traffic congestion in radial roads, in addition to those set at the mouth as required by the current standard.

Devices employ inner loop like the existing ones and collect data on traffic volume and occupancy.

C. Improvement of the Network

Currently, the network between the central control equipment and terminal signal control equipment is done through an exclusive line. This makes sense when the numbers of network and control are few. However, as the controlled section is long, and the number of equipment is large, it is necessary to convert to a telephone line in order to keep the costs low.

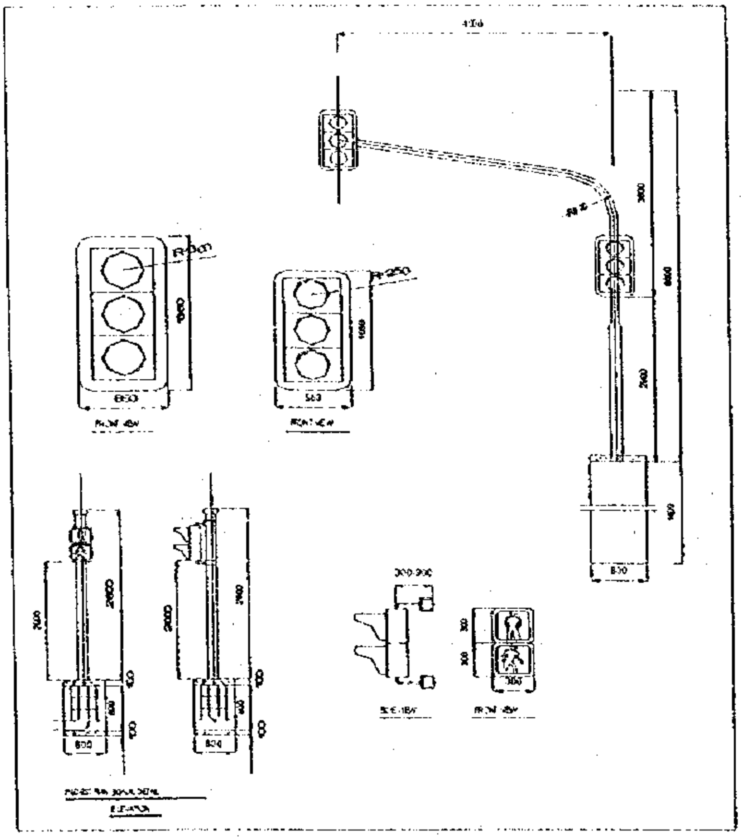


Fig. 19-1-7 Traffic Signals

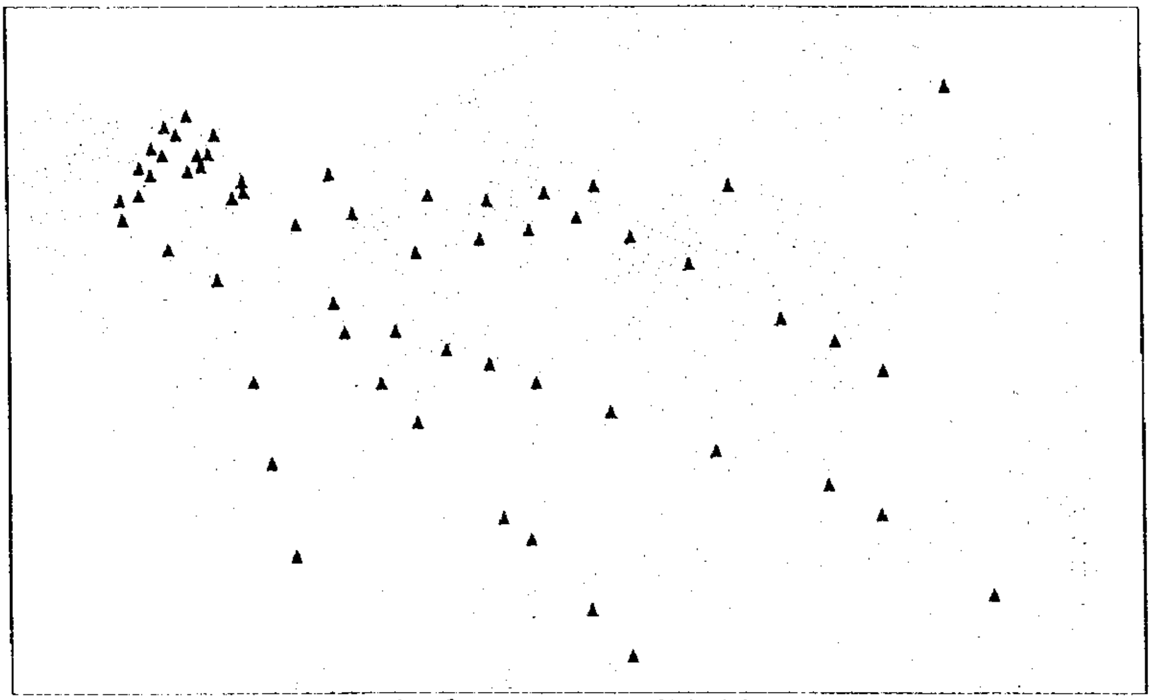


Fig. 19-1-8 Coverage Area of Vehicle Detectors

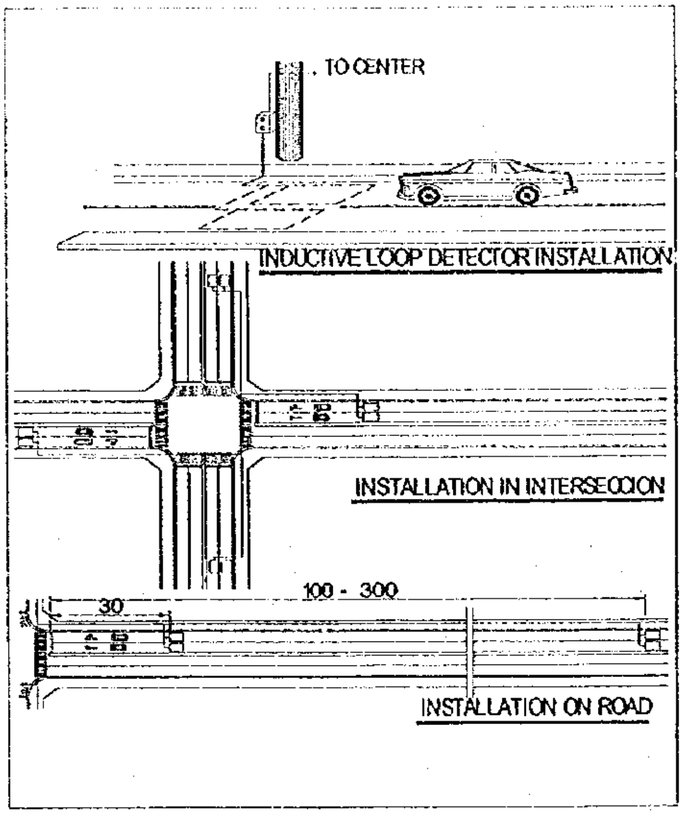



**Fig. 19-1-9 Vehicle Detector Installation**

(3) Man-Machine System

Urban traffic conditions constantly change by day and time of the day and vary with weather and road conditions. A pre-programmed logic cannot deal with sudden incidents such as rain and traffic accidents. The man-machine system allows computers and operators to communicate with each other, identify traffic conditions resulting from sudden incidents, change the control logic, and manage the equipment.

The current system functions well to some extent but will be further improved with the increase in traffic signals and vehicle detectors and the introduction of more complex control equipment.

### 19.1.5 Implementation Plan

1) Phasing

This improvement is designated as an urgent project to deal with traffic concentration in Centro and reduce congestion in arterial roads. In addition, since this improvement plan also serves as a complementary system for the project to introduce the trunk bus system, it will be completed by 2005.

Implementation is phased into three for the period until 2005. In the first phase, equipment in the control center will be expanded, and software will be built up. In the meantime, managers and operators will be trained. The second phase makes improvements to and expansions of terminal equipment in Centro. The third phase will introduce terminal equipment into arterial roads and install vehicle detectors.

2) Implementation Schedule

Fig. 19-1-10 shows a schedule that takes into account the three phases. The first phase will be completed by 2002, the second and third phases by 2005. However, the training in the first phase will be executed as necessity arises when new equipment is installed. Moreover, in introducing new equipment, it is necessary to supervise the works as part of the engineering service.

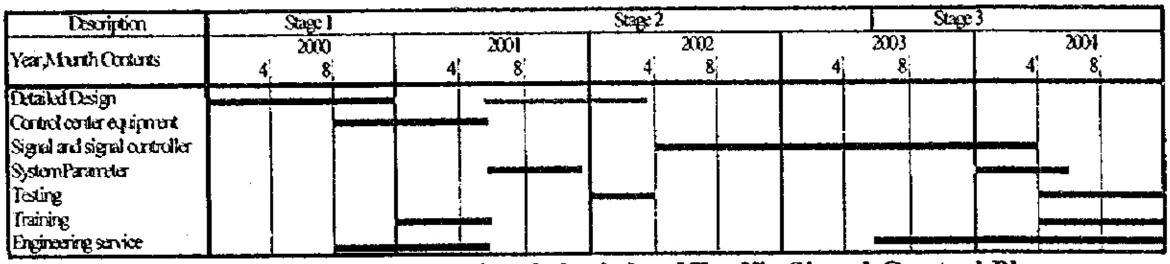



**Fig. 19-1-10 Implementation Schedule of Traffic Signal Control Plan**

### 19.1.6 Project Cost

Construction costs in the traffic signal control plan are shown in Table 19-1-2. Assumptions for the estimate are as follows:

- To make the maximum use of the existing traffic signals and minimize the expansion.
- To include construction costs for props and pavement in calculating the costs of signals and vehicle detectors.
- To use telephone lines for communication between the control center and the terminals, but exclude costs for using the lines.
- To use the existing control center without any expansion or renovation.
- To increase the memory and improve the software for the central control equipment but use the existing equipment.
- To regard labor costs as the costs for detailed design, training, and engineering services.

**Table 19-1-2 Cost Estimates of Traffic Signal Control Plan**

| | Unit | Quantity | Unit Cost | | Amount | | |
|---|---|---|---|---|---|---|---|
| | | | Foreign(1000US$) | Local(MillionGs) | Foreign(1000US$) | Local(MillionGs) | Total(1000US$) |
| 1.Intersection | | | | | | | |
| Signal Equipment | int. | 51 | 11.81 | 0.53 | 602.31 | 27.03 | 611.32 |
| Vehicle Detector | int. | 60 | 10.60 | 1.68 | 636.00 | 100.80 | 669.60 |
| Sub-Total | | | | | 1,238.31 | 127.83 | 1,280.92 |
| 2.Control Center | | | | | | | |
| Hardware | LS | 1 | | | 20.00 | | 20.00 |
| Software | LS | 1 | | | 55.50 | | 55.50 |
| System Console | LS | 1 | | | 5.00 | | 5.00 |
| Timing Parameter | LS | 1 | | | 65.00 | | 65.00 |
| Sub-Total | | | | | 145.50 | | 70.00 |
| 3.Documentation | LS | 1 | | | 76.00 | | 76.00 |
| 4.Training | LS | 1 | | | 54.00 | | 54.00 |
| 5.Spare Parts | LS | 1 | | | 43.20 | 2.00 | 43.87 |
| 6.Engineering Service | | | | | | | |
| Detailed Design | LS | 1 | | | 240.00 | 340.00 | 353.33 |
| Construction Supervision | LS | 1 | | | 338.00 | 390.00 | 468.00 |
| Sub-Total | | | | | 578.00 | 730.00 | 821.33 |
| Total | | | | | 2,091.81 | 857.83 | 2,302.25 |
| Contingency(5%) | | | | | 104.59 | 42.89 | |
| All Total | | | | | 2,196.40 | 900.72 | 2,496.64 |

## 19.2 Road and Traffic Sign Plan

### 19.2.1 Sign Improvement Plan

Road signs include destinations, regulations, directions, and warnings. Signs for street names are generally well provided in arterial roads and narrow streets. There are many warning signs for *ramada* in narrow streets, but some places lack them. Since it is difficult to see some signs at night, it is necessary to make some improvements by putting lights inside the sign and doing periodic checks for maintenance.

The most important road signs in the city are directional signs and markings at intersections. Many directional signs in the city include no-parking and one-way signs, stop sign at unsignalized intersections, and no left-turning signs on arterial roads. No-left-turning signs are set at the end of sidewalk, about 30 meters before the intersections, and it is difficult to see them. Vehicles that fail to follow the sign often cause traffic accident.

At major intersections that prohibit left-turn, traffic signals will be coordinated with signs, and signs will be attached to the poles of the overhead traffic signals as shown in Fig. 19-2-1. In other cases, signs will be installed at the center, in addition to the end of sidewalk.

The target points for installation are Av. España, Av. Mcal. López, Av. E. Ayala, Av. Fdo. de la Mora, and Cnel. Bogado.

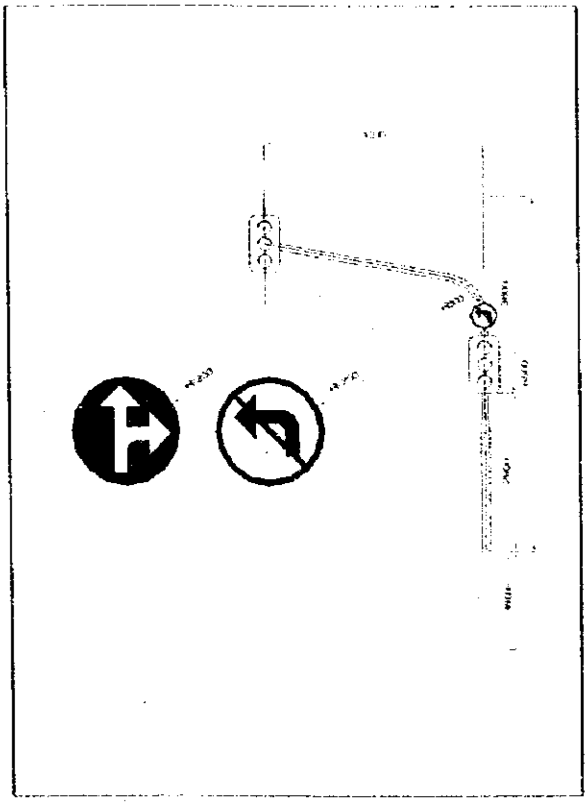


**Fig. 19-2-1 The Overhead Traffic Signals**

Among road markings, center lane markings are relatively clear, but markings at intersections such as stop lines and crosswalk lines are not sufficient. Many of the existing markings are erased and unclear because of insufficient maintenance. Furthermore, there are no standards for road markings, and there are two types of sidewalk, mainly stripe lines with and without vertical lines.

This Plan proposes that together with intersection improvements, road markings are provided at major intersections. Fig. 19-2-2 illustrates a model for road markings at an intersection. Fig. 19-2-3 shows the target intersections.

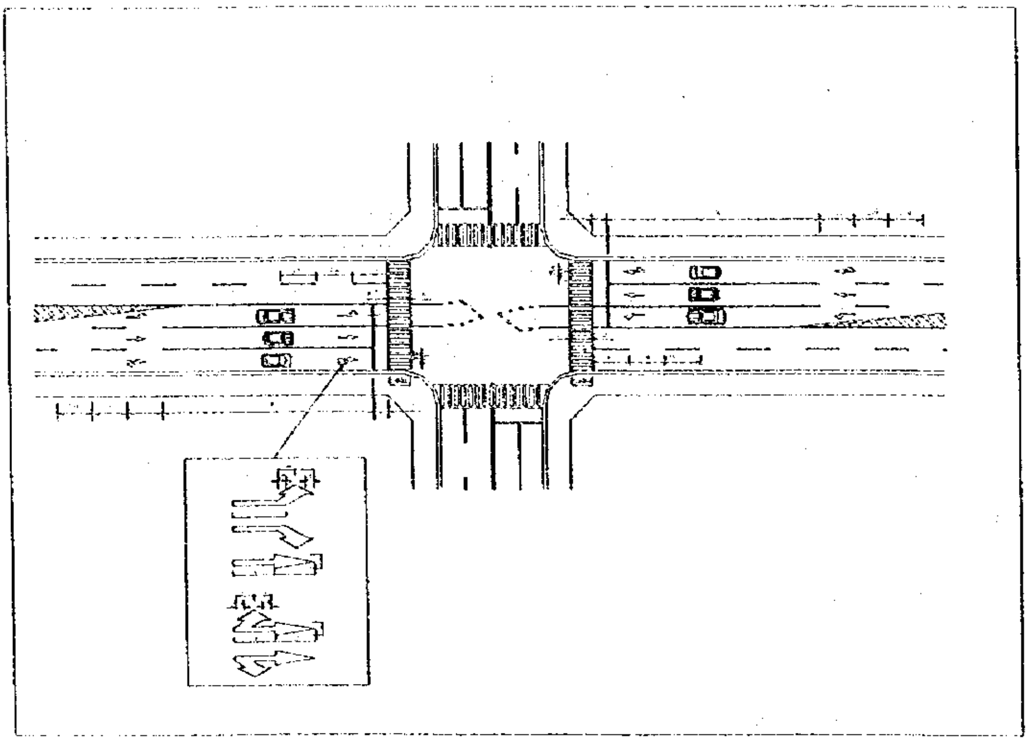


Fig. 19-2-2 Typical Plans for Intersection Marking

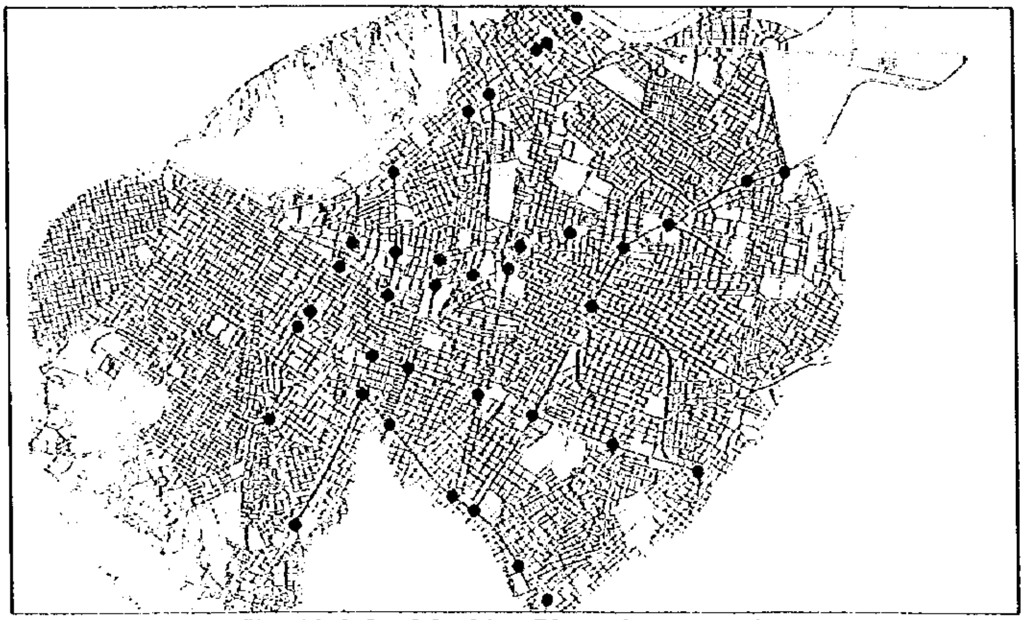


Fig. 19-2-3 Marking Plan of Intersection

### 19.2.2 Project Cost

The costs for this Plan are shown in Table 19-2-1. Assumptions for the cost estimate are as follows:

- The total project cost is the sum of direct and indirect costs of the works necessary for construction.
- Directional signs will be installed, by standard, at two points of each approach, and their costs include poles.
- An intersection with four lanes in the main direction is considered to calculate the costs for road markings.

**Table 19-2-1 Cost Estimates of Road and Traffic Signs Plan**

| | | | Unit Cost | | Amount | | |
|---|---|---|---|---|---|---|---|
| | Unit | Quantity | Foreign(1000US$) | Local(MillionGs) | Foreign(1000US$) | Local(MillionGs) | Total(1000US$) |
| Marking | int. | 35 | 5.649 | | 197.715 | | 197.715 |
| Regulatory Sign | int. | 35 | 0.207 | 0.110 | 7.245 | 3.850 | 8.528 |
| | | | | | | | |
| Total | | | | | 204.960 | 3.850 | 206.243 |

# Chapter 20 Environmental Impact Assessment of the Trunk Bus Project

## 20.1 Introduction

Based on the Master Plan Study, it has been clarified that there is a necessity of improving public transport system in Greater Asunción Area since existing public transport system cannot obviously meet increasing demand for public transport.

The Master Plan Study has revealed that several improvements are indispensable in order to meet the increasing demand for the public transportation system, which is described below.

1) Reorganization of operation system

Asunción Metropolitan Area has been expanding towards outside and public transport operation system must be improved to match with this new reality.

2) Introduction of trunk bus system

Private enterprises, which provide public transportation services, must be reorganized and modified, as well as the system itself, so that they will be more profitable and efficient with less operational cost and more productive, and at the same time with the least possible negative environmental impact.

3) Development and improvement of buses

Actual buses should be renovated by replacing them with newly fabricated ones, which have appropriate technology.

4) Planned transport network

In order to meet the demand on the diverse roads and their future development, it is indispensable in the near future to consider the introduction of advanced technology between San Lorenzo-Micro Center and Luque-Micro Center.

Consequently the Study Team has selected a Trunk Bus Project (the Project) for feasibility study aiming at alleviating future traffic congestion on Avenida Eusebio Ayala, which is estimated to be the most congested road in the area based upon the traffic demand forecast.

This Environmental Impact Assessment (EIA) has evaluated the Project from various environmental viewpoints. The EIA has been conducted, in accordance with the Low No. 294/93 on Environmental Impact Assessment aiming at identifying both negative and positive environmental impacts of the Project.

## 20.2 Purpose of the EIA

The objectives of the EIA are to study existing environmental conditions in the Project area, assess the potential environmental impacts of the project and recommend measures for mitigation of the adverse impacts and formulate a monitoring plan.

## 20.3 Methodology

The methodology adopted in the EIA is as follows:

- Review of existing/data by literature surveys, visits to relevant agencies and study of similar project reports.
- Conducting limited field surveys to assess existing environmental conditions in the area affected by the proposed Trunk Bus Project.
- Complement and verify the available secondary information/data with the primary data collected by the field surveys.
- Assess the potential Environmental Impacts of the proposed Trunk Bus Project.
- Recommend action for mitigation of the identified adverse impacts of the project.
- Propose a monitoring plan to check the adherence to the mitigation action and residual impacts.

As an integral part of the approach to social survey, interviews with affected stakeholders were held, by using semi-structured interview sheets.

Land use surveys were conducted along the proposed road to identify the magnitude of involuntary resettlement

Assessment of impacts was made with relation to existing information and similar projects undertaken earlier.

Team meetings and consultations formulated action for mitigation of the adverse impacts and a monitoring plan.

## 20.4 Land Acquisition and Resettlement Policy, Regulations and Guidelines

### 20.4.1 Laws and Regulations

In Paraguay, there is no particular law which regulates land acquisition. However, different laws and regulations partly deal with land acquisition issues. These laws and regulations can be divided into three groups: Normas Generales or General Norms, Normas Especiales or Special Norms and Normas de Aplicacion or Norms of Application. In case of the land acquisition for road projects, the Norms of Application are referred.

**Table 20-4-1 Norms Related to Land Acquisition**

| Classification of Norms | Title of Laws and Regulations |
|---|---|
| General Norms | National Constitution |
| | Administrative Organization Law |
| | Paraguayan Civil Code |
| | Rural Code and its modification |
| Special Norms | Municipal Organic Law |
| | Law No. 75 which modifies the organization of the Directorate General of Road |
| | Forest Law |
| | CORPOSANA Law |
| | ANDE Law |
| | Railway Law |
| | I.B.R Law |
| | Agrarian Law |
| Norms of Application | Decree No. 10.025 Land acquisition for Route No. 5 |
| | Decree No. 14.171 Prohibition of exploitation of forest |
| | Decree No. 18.000 Land acquisition for Pinasco Port Road |
| | Transchaco Route |
| | Decree No. 19.983 Land acquisition between Coronel Oviedo and Puerto Presidente Franco |
| | Resolution No. 253 Prohibition of cutting trees in the fringe of dominion |

Source: Estudio de Impacto Ambiental del Tramo: Paraguari-Yaguaron-Ita-Guarambare-Ypane-Ñemby-Cuatro Mojones-Empalme Ruta 9-Limpio Emboscada, Final Report, 1993, Ministry of Public Works and Communications

### 20.4.2 Land Acquisition Process

However, in reality, all the above-mentioned laws and regulations are not necessarily valid at this moment. Consequently there are implicit measures, which are consistent with the Constitution. Table 20-4-1 shows the process of land acquisition in the case of the construction and widening of national roads.

### 20.4.3 Compensation

The purpose of compensation is to pay the owner of the expropriated property for its value. Because of its nature, no taxes affect compensation. The valuation of the property is based on a previous urban or rural awarded case.
Urban properties will be valued in square meters, and rural properties will be valued in hectares. The valuation must take into account the location of the property, the neighborhood it belongs to, the advantages it will receive from the execution of the public works, the damage it will suffer as a consequence for the loss of part of it, when it is partial; whether or not the owner can continue developing the activity the property was used for, and the value of a similar property nearby.

The valuation must also consider the type of construction already existing on the property, its age and current conditions, and its value per square meter. According to the current Constitution, the compensation must be totally paid in cash, since there is no possibility of establishing deferred payment, unless the owner of the expropriated property expresses his/her will to do it so. The owner is entitled to appeal against the payment resolution for unconstitutionality if it is against the constitution.

The Ministry of Public Works and Communications (MOPC) shall identify the owner of every property using the land ledger. The MOPC shall contact the owner, make the valuation offer, and if there is an agreement, proceed with the preparation of the property papers. If there is no agreement, it shall issue a resolution including the valuation of the property, the criteria used for the valuation, and an expropriation demand, to be presented before the corresponding court. The owner shall be personally notified of such demand. If his address is unknown, he shall be notified through three ads published in a newspaper of national circulation, with a 15-day deadline from the last notifications to claim for his rights. If no appeals are filed, the notified valuation shall be considered final. After the compensation amount has been judicially deposited through the Treasury, the expropriating party shall be entitled to take possession of the property.

### 20.4.4 Involuntary Resettlement

There are no laws and regulations in Paraguay on involuntary resettlement of people affected by public works.

## 20.5 Existing Environment

### 20.5.1 Existing Transport Infrastructure

Table 20-5-1 shows existing transport infrastructure in the study area or along the trunk bus route. The route consists of ten sections: Centro, Pettirossi-Santos, Santos-Kubistcheck, Kubistcheck-Chofer, Chofer-Argentina, Argentina-La Victoria, La Victoria-Defensores, Defensores-Leopardi, Leopardi-San Lorenzo and San Lorenzo.

There are a large number of poles such as telegraph poles and road signs, which are followed by manholes and signals.

**Table 20-5-1 Existing Transport Infrastructure**

| Section | Telegraph and other poles | Road signs | Signals | Parking meters | Bus stop (with roof) | Bus stop (without roof) | Manholes | Drainages | Hydrants |
|---|---|---|---|---|---|---|---|---|---|
| Centro | 506 | 109 | 41 | 36 | 2 | 17 | 73 | 46 | 4 |
| Pettirossi-Santos | 104 | 16 | 2 | 0 | 0 | 2 | 3 | 1 | 0 |
| Santos-Kubistcheck | 74 | 14 | 4 | 0 | 2 | 0 | 13 | 1 | 1 |
| Kubistcheck-Chofer | 133 | 11 | 9 | 0 | 0 | 4 | 23 | 1 | 0 |
| Chofer-Argentina | 111 | 9 | 3 | 0 | 1 | 0 | 14 | 0 | 0 |
| Argentina-La Victoria | 184 | 22 | 9 | 0 | 0 | 3 | 10 | 0 | 0 |
| La Victoria-Defensores | 113 | 16 | 3 | 0 | 1 | 0 | 8 | 0 | 0 |
| Defensores-Leopardi | 263 | 52 | 13 | 0 | 3 | 6 | 15 | 3 | 0 |
| Leopardi-San Lorenzo | 205 | 12 | 3 | 0 | 2 | 1 | 9 | 1 | 0 |
| San Lorenzo | 322 | 25 | 9 | 0 | 2 | 5 | 2 | 2 | 0 |
| Total | 2015 | 286 | 96 | 36 | 13 | 38 | 170 | 55 | 5 |

### 20.5.2 Existing Traffic Conditions

The traffic flow on Avenida Eusebio Ayala in 1998 is 27,138 veh/14h, which is one of the highest among all the radial trunk roads, which flow into Asunción. Traffic flow on Eusebio

Ayala in 1984 was 23,220 veh/14h and actual traffic volume has increased by 17%.

Fig. 20-5-1 shows traffic composition on Eusebio Ayala in 1984 and 1998. It has revealed that the proportion of automobiles significantly increased while buses decreased, which implies that at present more people use private cars for transportation rather than the public transport system.

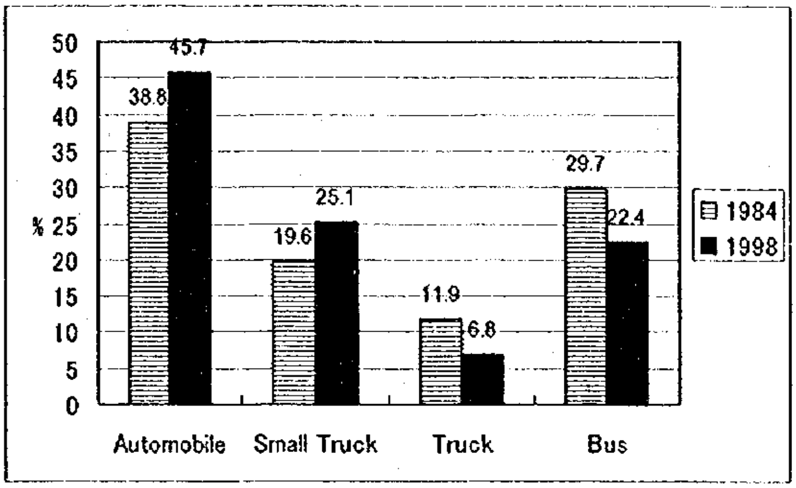



**Fig. 20-5-1 Traffic Composition on Eusebio Ayala in 1984 and 1998**

### 20.5.3 Air Quality and Noise Level

1) Air Quality

Background information on the ambient air quality in the study area is scarce. As stated in Chapter 7, the Municipal Government has carried out a monitoring of air pollution on Eusebio Ayala in 1995. The monitoring has been carried out at the point between Eusebio Ayala and Tacuary, and the value of NOx was 0.02 ppm.

The Study Team also conducted in 1998 its own air quality monitoring (see Chapter 7) and the value of NOx at the point between Choferes del Chaco and Eusebio Ayala was 0.03ppm.

2) Noise Level

For noise levels too, available background information is very little. The Study Team conducted its own noise level monitoring on Eusebio Ayala in 1998 and the result was as presented below.

**Table 20-5-2 Noise Level on Eusebio Ayala in 1998 Monitoring**

| Period | Value of LEQ (dB) |
|---|---|
| Morning | 76.4 |
| Midday | 76.1 |
| Afternoon | 75.5 |
| Average | 76.0 |

| No. | Zone | Value of LEQ (dB) |
|---|---|---|
| 1 | M. Aviacion and Mme. Lynch | 78.2 |
| 2 | 33 Orientales and G Caballero | 77.6 |
| 3 | Pariri and Gaudioso Nunez | 77.4 |
| 4 | Tte. Alvarenga and P Lezcano | 77.2 |
| 5 | Chof. del Chaco and S. C. Sierra | 77.2 |

### 20.5.4 Land Use

The project site, Eusebio Ayala and Mariscal Estigarribia, which is targeted for widening, is classified, according to Asunción Regulatory Plan, as Mixed Fringe. Mixed Fringes are those used to absorb the growth of economic activities, especially commercial ones and services of longer scale than the ones located in residential areas. They allow a diversification of activities and scales, including residential use with housing density of different levels, depending on the category of the Mixed Fringe.

In this area, all commercial or service programs shall have priority over any other type of settlement. The following land use regimen has been established:

Allowed use:

- Housing for one single family
- Multi-family housing: Duplex housing, Residential Blocks
- Housing Estate
- Small Scale Commerce and Services
- Medium Scale Commerce and Services
- Small Scale Community and Institutional Equipment

Conditioned Uses and Use Conditions:

- Medium and Large scale commerce and services
- Medium and Large Scale Community and Institutional Equipment
- Small Scale Warehouse
- Medium Scale Warehouse
- Small Scale non-polluting Industries

Forbidden Uses:

- All others

The Fig. 20-5-2 shows actual land use pattern that was observed in the field survey of the proposed project site, which covers the entire Trunk Bus Route. The survey has revealed that 79% of land is used for commercial purposes.

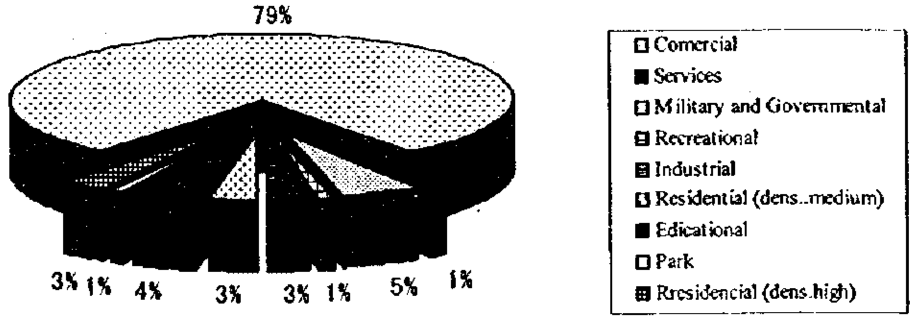



**Fig. 20-5-2 Present Land Use Condition of Av. Eusebio Ayala**

Table 20-5-3 Roadside Population of Section to be Widened

| | Zone | Roadside population 1998 | Roadside population 2015 |
|---|---|---|---|
| 1 | Mburicao | 293 | 300 |
| 2 | Tembetary | 269 | 266 |
| 3 | Los Laureles | 344 | 353 |
| 4 | Ciudad Nueva | 401 | 397 |
| 5 | Pinoza | 628 | 652 |
| 6 | Vista Alegre | 468 | 475 |
| 7 | Nazareth | 313 | 318 |
| 8 | Bernardino Caballero | 293 | 290 |
| 9 | Hipodromo | 354 | 392 |
| 10 | Villa Aurelia | 365 | 377 |
| 11 | San Pablo | 634 | 703 |
| 12 | Fdo. de la Mora Sur | 614 | 855 |
| 13 | Fdo. de la Mora Norte | 995 | 1032 |
| 14 | San Lorenzo Sur | 325 | 839 |
| | Total | 6295 | 7247 |

Note: Roadside means 50m on each side of the road.

### 20.5.5 Social Environment

(1) Affected Properties

Table 20-5-4 shows all the properties that have been identified along the Trunk Bus Route.

Table 20-5-4 Properties by Classification Along the Trunk Bus Route

| Section | Residential | Commercial | Deposit | Community & Institutional | Industries |
|---|---|---|---|---|---|
| Centro | 332 | 355 | 3 | 38 | 12 |
| Pettirossi-Santos | 10 | 52 | 0 | 0 | 0 |
| Santos-Kubist. | 17 | 17 | 56 | 1 | 1 |
| Kubist.-Chofer | 17 | 17 | 61 | 0 | 13 |
| Chofer-Argentina | 12 | 12 | 42 | 0 | 6 |
| Argentina-Victoria | 21 | 21 | 86 | 0 | 5 |
| Victoria-Defensor | 8 | 8 | 33 | 0 | 4 |
| Defensor-Leopardi | 28 | 28 | 110 | 1 | 18 |
| Leopardi-Lorenzo | 23 | 23 | 31 | 1 | 13 |
| San Lorenzo | 74 | 208 | 18 | 26 | 2 |
| Total | 542 | 741 | 440 | 67 | 74 |

(2) Social Situation of Affected People

1) Social Survey on Eusebio Ayala s

A social survey was carried out, in order to understand the social situation of affected people by road widening, on Eusebio Ayala between General Aquino Street and San Lorenzo. 150 sample families in total were selected at random, out of which 100 were selected between General Aquino and Madame Lynch in Asunción City, 30 in Fernando de la Mora City and 20 in San Lorenzo City.

The main objective of this survey was to evaluate the awareness and acceptability of the Project by the people, who live along the mentioned avenue. Their opinions on the road widening and the public transportation system were asked.

2) Methodology

For the sample selection, first the total distance to be covered was divided by the number of surveys on each side and that value connected into meters was used to mark on a map the location of the samples. When a selected sample could not be taken, the surveyors went to the property located immediately next to the chosen one, and so on until the desired data could be obtained.

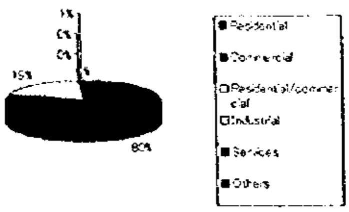
The data gathered were loaded into a general database. From this database, different charts were elaborated with data from the questions or groups of related questions. Some questions were divided or re-structured in order to get a better understanding of the results and a better graphic representation. Finally, the percentages were calculated and the graphs were elaborated.

For some of the questions in the questionnaire, it was necessary to calculate rate values, which were obtained based on the total divided by the quantity of the data gathered.

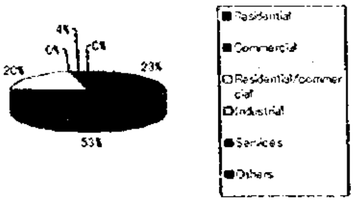
3) Findings

A. Present Land Use

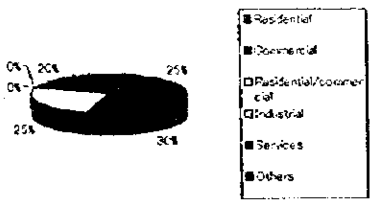
General Aquino-
Madame Lynch




Fernando de la Mora




San Lorenzo



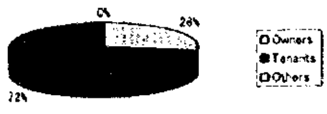

B. Basic data of people (age and education level)

**Table 20-5-5 Education level and age**

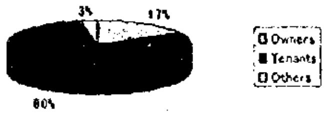
| | Gral. Aquino Mme. Lynch | Fernando de la Mora | San Lorenzo |
|---|---|---|---|
| Male | 69 % | 57 | 50 |
| Female | 31% | 43 | 50 |
| | | | |
| Elementary Education | 5% | 3 | 21 |
| Secondary Education | 49% | 60 | 37 |
| Tertiary level | 44% | 37 | 42 |
| Did not answer | 2% | 0 | 0 |
| Average age | 45 | 35 | 24 |

C. House or Shop Ownership

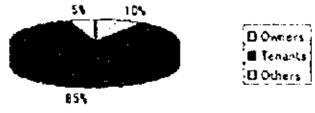
General Aquino-
Madame Lynch




Fernando de la Mora

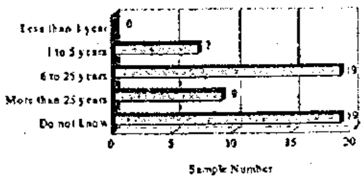



San Lorenzo

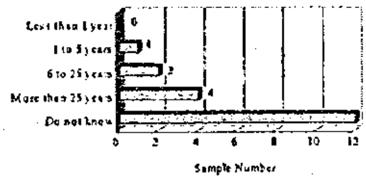



D. Age of construction: One-story constructions

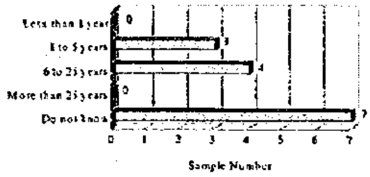
General Aquino -
Madame Lynch




Fdo. de la Mora

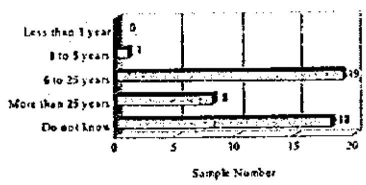



San Lorenzo

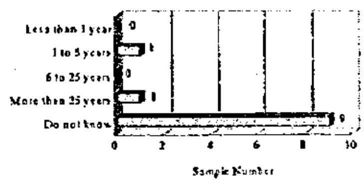



E. Age of construction: More than two-story constructions

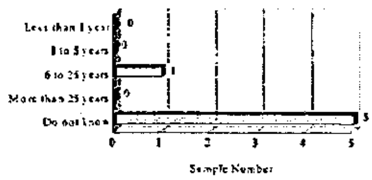
General Aquino -
Madame Lynch




Fdo. de la Mora




San Lorenzo




Since most of the respondents are tenants, they did not know exactly the age of properties. Accordingly, it is difficult to judge whether or not these properties have a long history.

F. Present Condition of the Avenue

The opinion of the people who were interviewed is the following:

**Table 20-5-6 Present Condition of the Avenue**

| | Gral. Aquino – Mme. Lynch | Fernando de la Mora | San Lorenzo |
|---|---|---|---|
| Good | 5% | 33% | 25% |
| Fair | 24% | 33% | 35% |
| Bad | 24% | 24% | 10% |
| Very Bad | 47% | 10% | 10% |

Note: "Present condition" means traffic conditions and roadside environment.

According to the finding, 71% of respondents, who live along between Aquino and Madame Lynch, consider the traffic conditions and roadside environment of Avenue unfavorable, while 34% in Fernando and 20% in San Lorenzo feel the same way.

When they were asked whether they want the avenue to be improved or not, they responded as follows:

**Table 20-5-7 Answer to Improvement of the Avenue**

| | -General Aquino Madame Lynch | Fernando de la Mora | San Lorenzo |
|---|---|---|---|
| Yes: | 98% | 97% | 80% |
| No: | 2% | 3% | 5% |
| Do not know: | 0% | 0% | 0% |
| No answer: | 0% | 0% | 10% |
| Depends | 0% | 0% | 5% |

The survey has revealed that the majority of sample people request to improve the conditions of the Avenue.

### 20.5.6 Cultural Aspects in the Study Area

In general culturally sensitive areas are not located in the Study Area. Even when such places are found, they are scattered in a larger geographical area. The Study Team identified such culturally significant places scattered along the target route. They include the following:
-Evangelic Church
-Medalla Milagrosa Church